STORMWATER MANAGEMENT PLAN FOR PPC REQUEST

Warkworth South Plan Change, Warkworth Auckland

CIVIL ENGINEERING ▾ SURVEYING ▾ LAND DEVELOPMENT

PROJECT INFORMATION

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TABLE OF CONTENTS

1 INTRODUCTION

The purpose of this Stormwater Management Plan ('SMP') is to outline the proposed management of Stormwater for the Warkworth South Plan Change Area ('PCA'), located south of Warkworth. This SMP is prepared to support the Warkworth South PCA application with Auckland Council to rezone from Future Urban to a mixture of Terrace Housing and Apartment Buildings (THAB), Mixed Housing Urban (MHU), Single House Zone (SHZ), Conservation Zone (CZ), Large Lot (LL), Local Centre (LC) and Mixed Rural Zone. The proposed zoning for this PCA can be find in Figure 1 below.

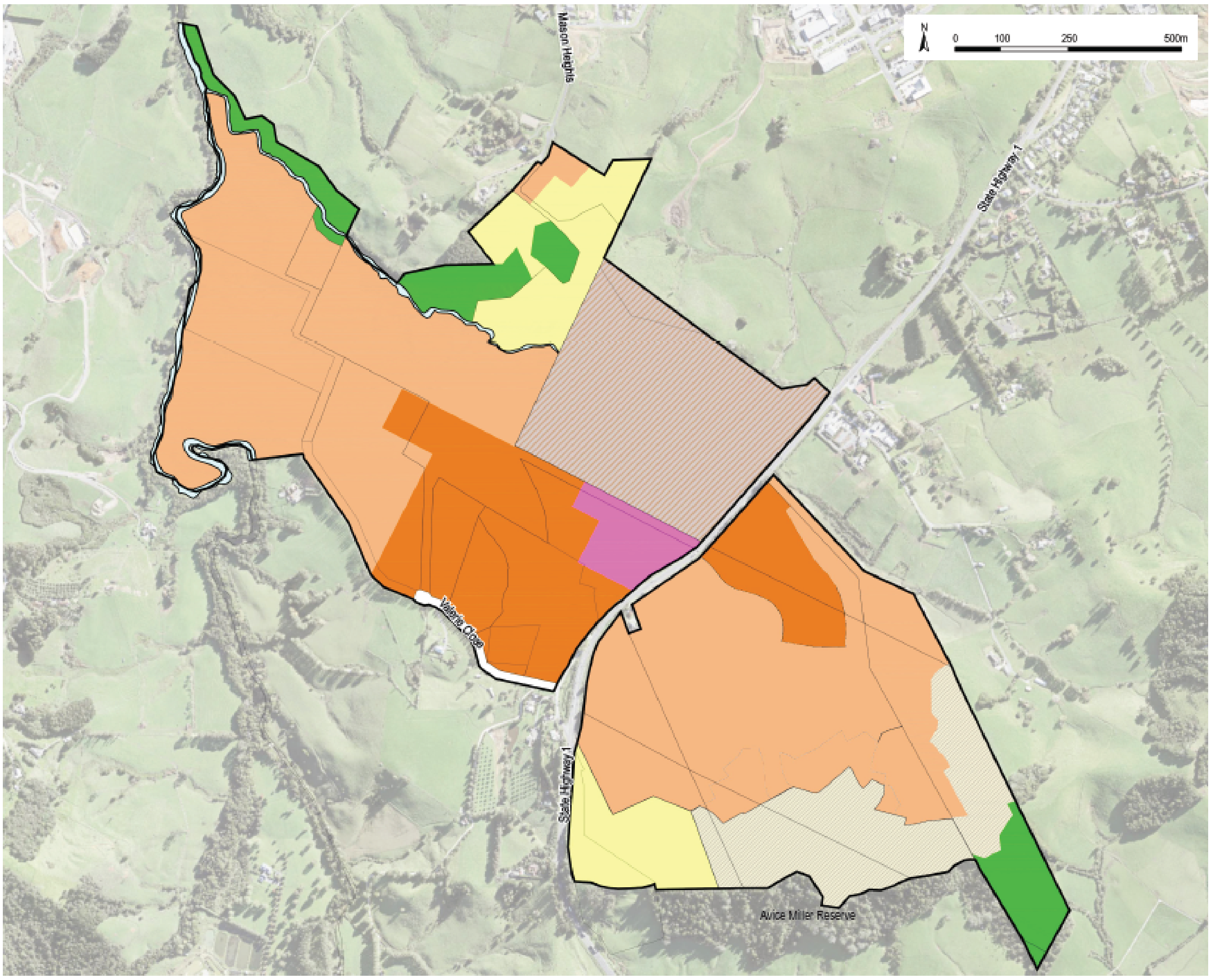

Figure 1: Preliminary Zoning Plan for Warkworth South Plan Change

Auckland Council has published a Structure Plan for Warkworth which provided a long-term guidance for urbanization of the Warkworth area. A preliminary SMP for the whole Warkworth Structure Plan area has been prepared by Tonkin Taylor in 2019. This SMP provides direction for future stormwater management outcomes and approaches which accord with Healthy Water's Auckland Wide Networks Discharge (NDC).

This SMP prepared for Warkworth South PCA has adopted the framework from the Tonkin and Taylor's Structural SMP to ensure that the receiving environment is protected and enhanced as it undergoes change from the current rural environment to an urban form. The stormwater management approach is considered to generally align with the outcomes of the NDC. Final stormwater management solutions will be worked through in detail as part of any future resource consent(s), based on locked down layouts, design and site-specific constraints. Future resource consent applications will, however, ensure compliance with the outcomes of this overarching SMP.

2 EXISTING SITE APPRAISAL

This section of the report summaries the existing site characteristics and conditions within the plan change area (PCA), as the relate to stormwater management.

2.1 SUMMARY OF DATA SOURCES AND DATES

This section provides a summary on key datasets used in the writing of this SMP, including those that have been used to generate supporting figures provided in Appendixes.

Table 1: Regulatory and design requirements

PCA Characteristics	Source and date of data used
Topography	• Maven Topographical Survey, March 2020
Geotechnical / soil conditions	• Private Plan Change- Geotechnical Assessment Valerie Close, Warkworth by Land Development & Engineering Ltd
Existing stormwater network	• Maven Topographical Survey, March 2020 • Auckland Council GeoMap, Stormwater Assets, 2021
Existing hydrological features	• Auckland Council GEOMAPS, Catchments And Hydrology Layer, 2021 • Maven Topographical Survey, March 2020 • Auckland Council GEOMAPS, Catchments And Hydrology Layer, 2021
Stream, river, coastal erosion	• Warkworth South Plan Change: baseline Ecology July 2021 by Bioresearches • Auckland Council GEOMAPS, Catchments And Hydrology Layer, 2021
Flooding and flowpaths	• Flood modelling report by Maven Associates Ltd • Auckland Council GEOMAPS, Overland Flow Paths Layer, 2021
Coastal Inundation	• N/A
Ecological / environmental areas	• Auckland Council Unitary Plan Viewer, significant vegetation layer, 2021 • Auckland Council Unitary Plan Viewer, significant ecological area layer, 2021
Cultural and heritage sites	• Warkworth South Plan Change, 1738 State Highway 1: Archaeological Assessment by Clough & Associates Ltd • Auckland Council GEOMAPS, cultural heritage site, 2021

PCA Characteristics	Source and date of data used
Contaminated land	• Soil Contamination preliminary Site Investigation for Proposed Resident Subdivision December 2020 by Land Development & Exploration Ltd • Auckland Council GEOMAPS, contaminated land site, 2021

2.2 LOCATION AND GENERAL INFORMATION

The PCA is approximately 2km south (via State Highway 1) of the Warkworth township and about 55km from downtown Auckland City. The development site is currently accessible directly off SH1, Valerie Close and will be accessible from a proposed road, referred to as the Wider Western Link Road that will be constructed in part during the development of the western side of the Plan Change area. The location in relation to the greater Auckland Region is illustrated in Figure 1, below

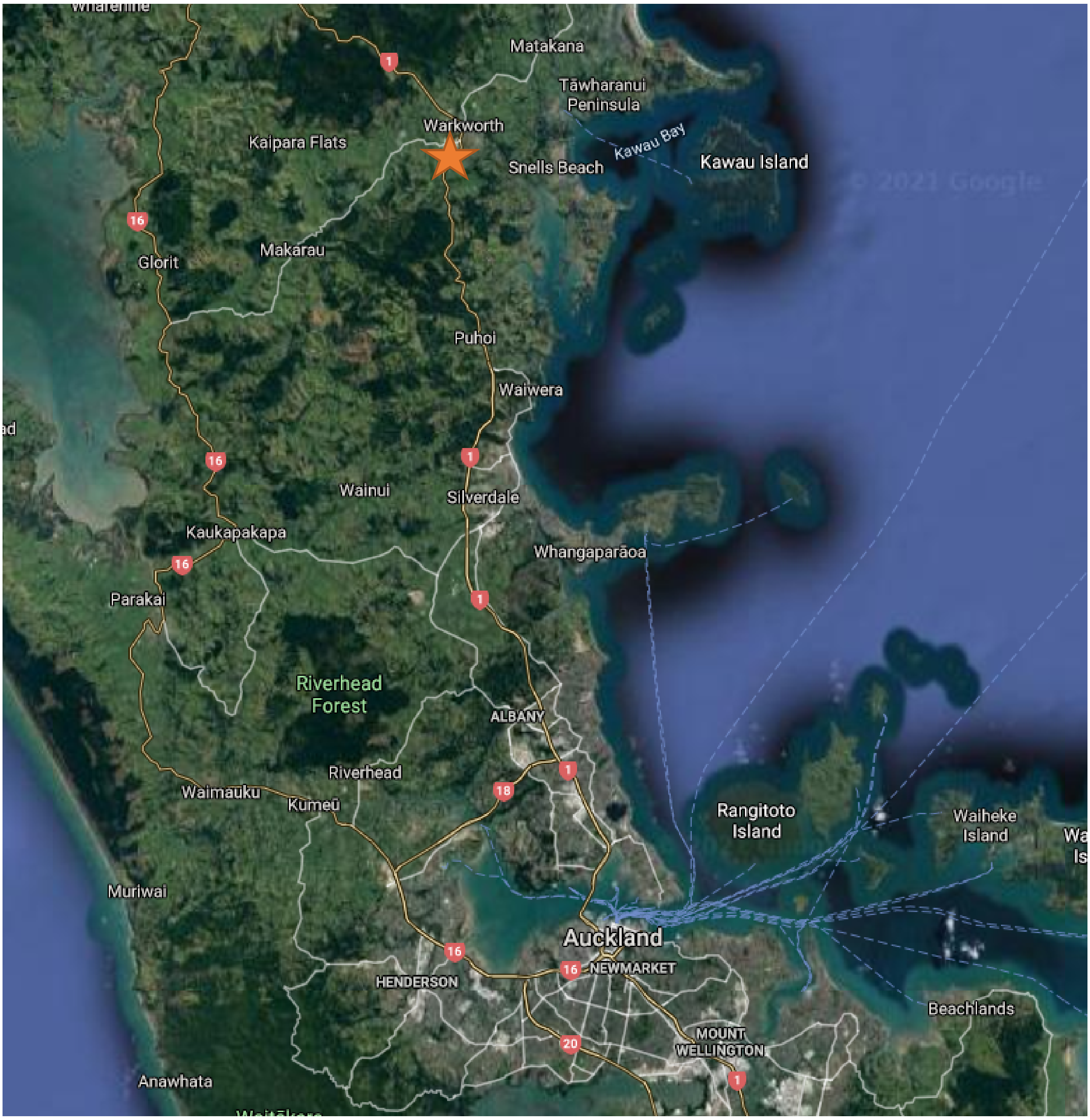

Figure 2: Warkworth South Precinct Location (Star)

The PCA is located within a predominantly rural area within the Warkworth Future Urban Zone (FUZ) in the Auckland Unitary Plan (AUP). It comprises two areas divided by State Highway 1 (SH1) through the combined PCA. The PCA is approximately 164ha in total size and is greenfield in nature. The western portion is bounded by Valerie Close to the south, SH1 to the east, a permanent stream to the west and surrounded by private properties to the north and south. The eastern portion is bounded SH1 to the west, Avice Miller Scenic Reserve to the south and surrounded by private properties to the east and north.

Table 2 provides key property details of the PCA and Figure 2 show the location and extent of the PCA with addresses shown.

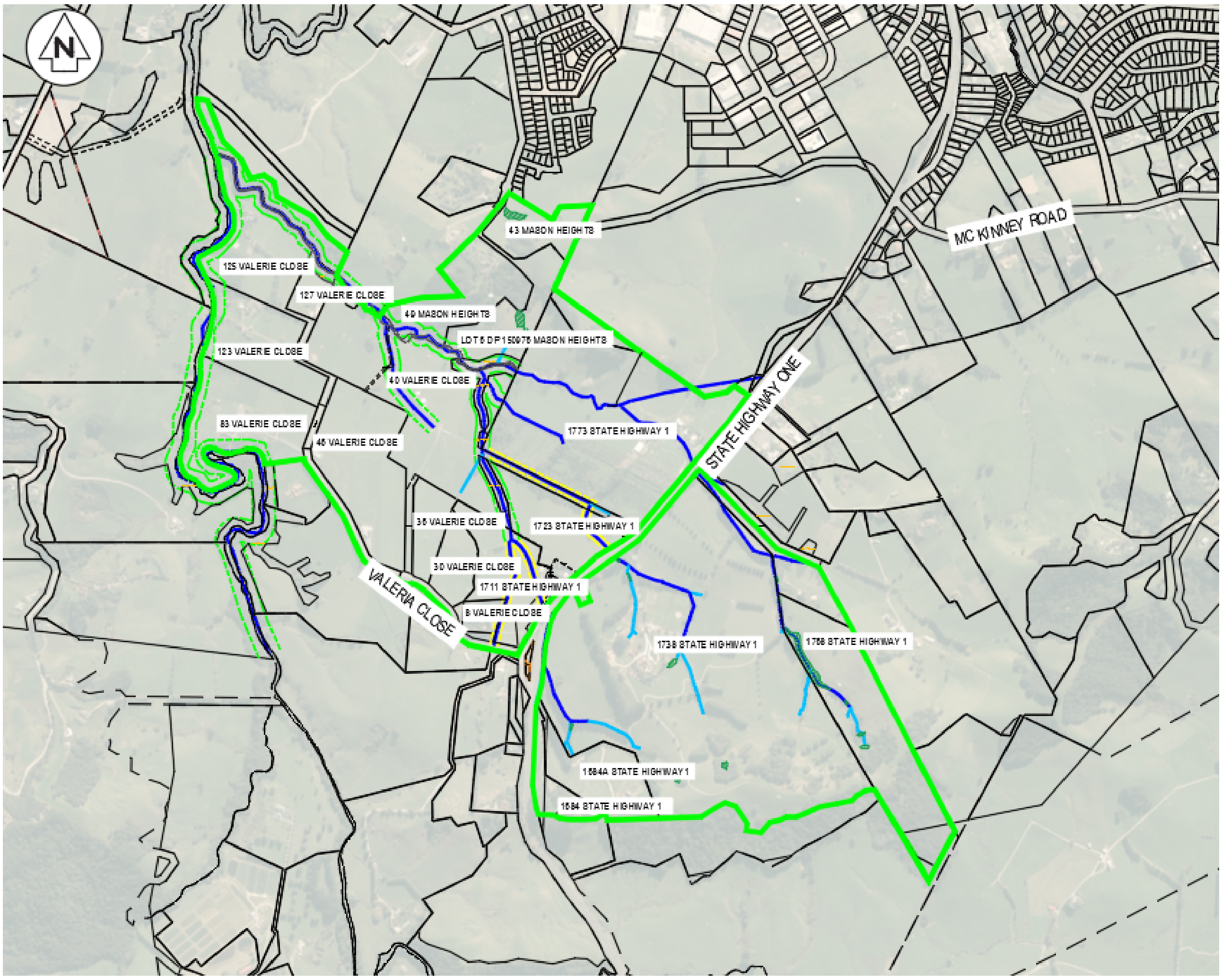

Figure 3: Map Showing Warkworth South Plan Change Area outlined in green

Table 2: Property information

Existing site element	Details
Site address	• 1684, 1684a, 1711, 1723,1738, 1768 & 1773 State Highway 1; • 8, 30, 36, 40, 46, 83, 123, 125 & 127 Valerie Close; • 43,49 & Lot 6 DP 150976 Mason Heights
Legal description	• Pt Allot 72 Psh of Mahurangi SO 891, Pt Allot 73 Psh of SO 891E, PT Allot 64 Psh of Mahurangi SO 891E, Pt Allot 72 Psh of Mahurangi SO 891, Pt Allot 73 Psh of Mahurangi SO 891E • Pt Allot 64 Psh of Mahurangi SO 891E, Pt Allot 72 Psh of SO 891E, Pt Allot 73 Psh of SO 891E

Existing site element	Details
	• Lot 1-4 DP539629 • PT ALLT 64 Paro Mahurangi • Lot 4-6 DP 353748 • Lot 2 DP 451512 • Lot 3, 5 & 6 DP 155544 • Lot 1 & 2 DP 344489 • Lot 5-7 DP 150976 • Lot 1-2 DP 119449
Current Land Use	• The PCA comprises open greenspace for farming, horticulture, and rural lifestyle
Current building coverage	• Approximately 4.4Ha of the PCA comprise buildings or other impervious surfaces
Historical Land Use	• Rural- residential and farmland

2.3 TOPOGRAPHY AND CATCHMENTS

2.3.1 Topography

The western portion of the PCA is moderately flat with a valley centrally located, that runs in an east-west direction. The landform is characterised by two ridge lines which run along the north-eastern and south-eastern boundaries. The existing ground elevations fall approximately 30m & 60m respectively from the top of the ridge lines on the south & north to the central gully.

The eastern portion of PCA has rolling terrain with the high point at the south boundary and moderately sloping land towards the north. The elevation falls approximately 85m from the highest point toward the lowest point across site.

2.3.2 Catchments

The greater Warkworth Structure Plan area is located within the lower Mahurangi River Catchment in the north of the Auckland Region. The Mahurangi River Catchment is approximately 5,892ha in area and drains to the Mahurangi Harbour within the Hauraki Gulf. In total, 164ha of land is located within the PCA.

The western site catchment is constrained by the two ridgelines running east-west along the northern and southern boundaries. The flat central plain of the western portion is dissected by permanent streams and a series of farm drains. The permanent streams are tributaries of the southern Mahurangi River branch.

The eastern site catchment is undulating, with the predominant fall and gullies provided with a westerly aspect. These catchments are upstream of the western portion of the plan change area.

The whole catchment is predominantly used for agricultural purposes and are undeveloped, farmlands. The extent of the catchment is illustrated in Figure 4 below:

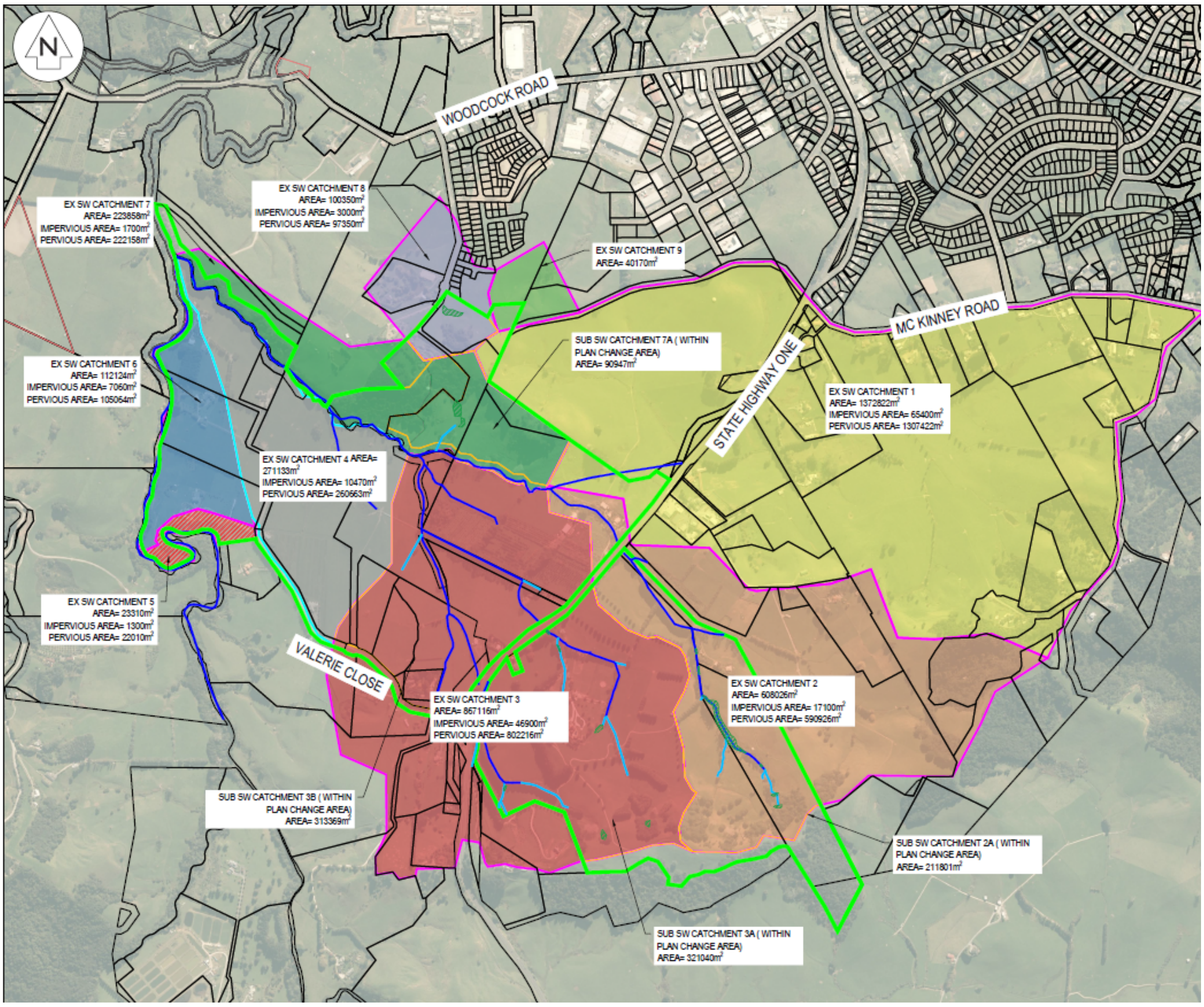

Figure 4: Existing stormwater catchment plan

The natural topography of the PCA forms twelve catchments. Some of these catchments extend outside of the PCA area as shown in Figure 3, above. A summary of these catchments can be found in Table 3 below and discussed further in Section 2.6 of this Report

Table 3: catchment coverage summary

Catchment	Pasture/crop/ forest area	Roading/ driveway	Residential & farm building	Total area (m^2)	Total Impervious Area (m^2)[1]	Total Pervious Area (m^2)
1	1,307,422	18,500	46,900	1,372,822	65,400	1,307,422
2	590,926	3,300	13,800	608,026	17,100	590,926
3	820,216	19,400	23,000	867,116	46,900	820,216
4	260,663	4,070	6,400	271,133	10,470	260,663
5	22,010	300	1,000	23,310	1,300	22,010
6	105,064	660	6,400	112,124	7,060	105,064
7	222,158	-	1,700	223,858	1,700	222,158
8	97,350	1,200	1,800	100,350	3,000	97350
9	40,179	-	-	40,179	-	40179
				3,618,918	152,930	3,465,988

Notes: The impervious area is based on desktop study.

2.4 GEOTECHNICAL

Geotechnical investigation has been undertaken throughout the PCA. The western portion has been investigated by Land Development & Engineering Ltd and CMW Geotechnical for the eastern portion.

Published geological maps and geotechnical fieldwork indicate the proposed development is predominantly underlain by Pakiri Formation of the Waitemata Group and the hillslope deposits of the Tauranga Group. The Tauranga Group soil is generally located at the base of hill slopes and adjacent to the stream margins. The remaining area is mostly residual soils of the weathered Pakiri Formation.

The Pariki formation is Neogene Sedimentary rock comprising of alternating, thick-bed, volcanic rich graded sandstone and siltstone with volcaniclastic grit beds. The residual soils generally comprise of a silty clays and silts with varying degrees of sand and gravels. They tend to be bright orange, red, pinks and purple in colour. These deposits typically comprise weak to very weak sandstones and siltstones. This type of soil is generally classified as Soil Class C in accordance with TP108 soil classification.

The reporting identifies some land stability matters of interest within the southern extent of the PCA. The balance of the PCA is considered generally suitable for intensified residential development. The low-lying areas of the region will be required to undercut and backfill with competent engineering fill that complies with NZS4404. The steep southern area of the PCA will be suitable for a lower-density residential development.

Please find attached geotechnical investigation reports for detail information and recommendations regarding the PCA.

2.5 EXISTING DRAINAGE FEATURES AND STORMWATER INFRASTRUCTURE

2.5.1 PUBLIC STORMWATER INFRASTRUCTURE

Figure 5: GEOMAPS Extract

Figure 6: GEOMAPS Extract

Auckland Council's GEOMAPS (Figure 5&6) identifies that there are no extensive public stormwater networks present in the vicinity of the plan change area, other than a few existing stormwater culverts have been identified by GEOMAPS within State Highway 1, along Valerie Close and at the intersection of Valerie Close & State Highway 1. There are also existing public stormwater networks located at Mason Height Road. This public network terminates at the northern boundary of the PCA and discharges to the existing watercourse within the PCA. All sites within the plan change area currently discharge stormwater run-off via various private stormwater systems to watercourse and overland flow path directly.

2.5.2 EXISTING DRAINAGE FEATURES

Streams within the PCA are all part of the Mahurangi River system. These streams vary from natural permanent streams with good quality indigenous riparian vegetation to farm drains. The southern branches of the main Mahurangi River tributary traverse the western boundary of the PCA. Various tributaries of this southern branch originate and/or bisect the PCA area. Many of the existing watercourse have been modified to some degree in the past through historical farming practices and to manage stormwater drainage within the sites. The existing drainage features are summarised below:

- Catchment 1: this is the largest catchment that contributes to the main permanent stream that crosses through the western portion of the PCA. Only a small portion of the PCA flows into this catchment. The overland flowpath / stream within this catchment has been heavily modified due to historic farming activities. More than half of this catchment is restricted by a culvert under SH1. This culvert has been identified by Healthy Waters to be upgraded in the future.

- Catchment 2: this catchment is located immediately north of the eastern portion of the PCA. The overland flowpath / stream in this area is comparable to Catchment 1 which has been modified to suit. There is a good quality constructed wetland located near SH1. The overland flow path/ stream is then piped under SH1. This culvert also been identified to be upgraded as part of the Structure Plan.
- Catchment 3: This is the second largest catchment within the PCA. Two tributaries originate from the eastern portion of the PCA. These tributaries are conveyed under SH1 via existing stormwater culverts.
- Catchment 4: this catchment is relatively flat with a series of farm drains within the grassed paddocks and vineyards. A constructed wetland with established vegetation is located at the downstream of this catchment. Established riparian planting is present along the northern extent of this catchment along the permanent river.
- Catchment 5: this catchment comprises of various smaller sub-catchments that drain directly into the southern branches of the Mahurangi River. A part of this area has been identified as significant ecological areas – Terrestrial under the AUP.
- Catchment 6: this catchment is flat with two noticeable farm drains that discharge directly towards the southern branches of the Mahurangi River with good riparian planting along the western boundaries of this catchment.
- Catchment 7: this catchment is hilly with re-established forest planting. The overland flow paths within this catchment are largely unmodified.
- Catchments 8 & 9: these two catchments are at the top of their catchment. there is a natural wetland located on the downstream of catchment 8. Both catchment 8 and 9 is adjacent to a developed area south of Warkworth township extent.

Ultimately all catchments within this SMP drain to the southern branches of the Mahurangi River. Refer to the catchment plan in Figure 7, below:

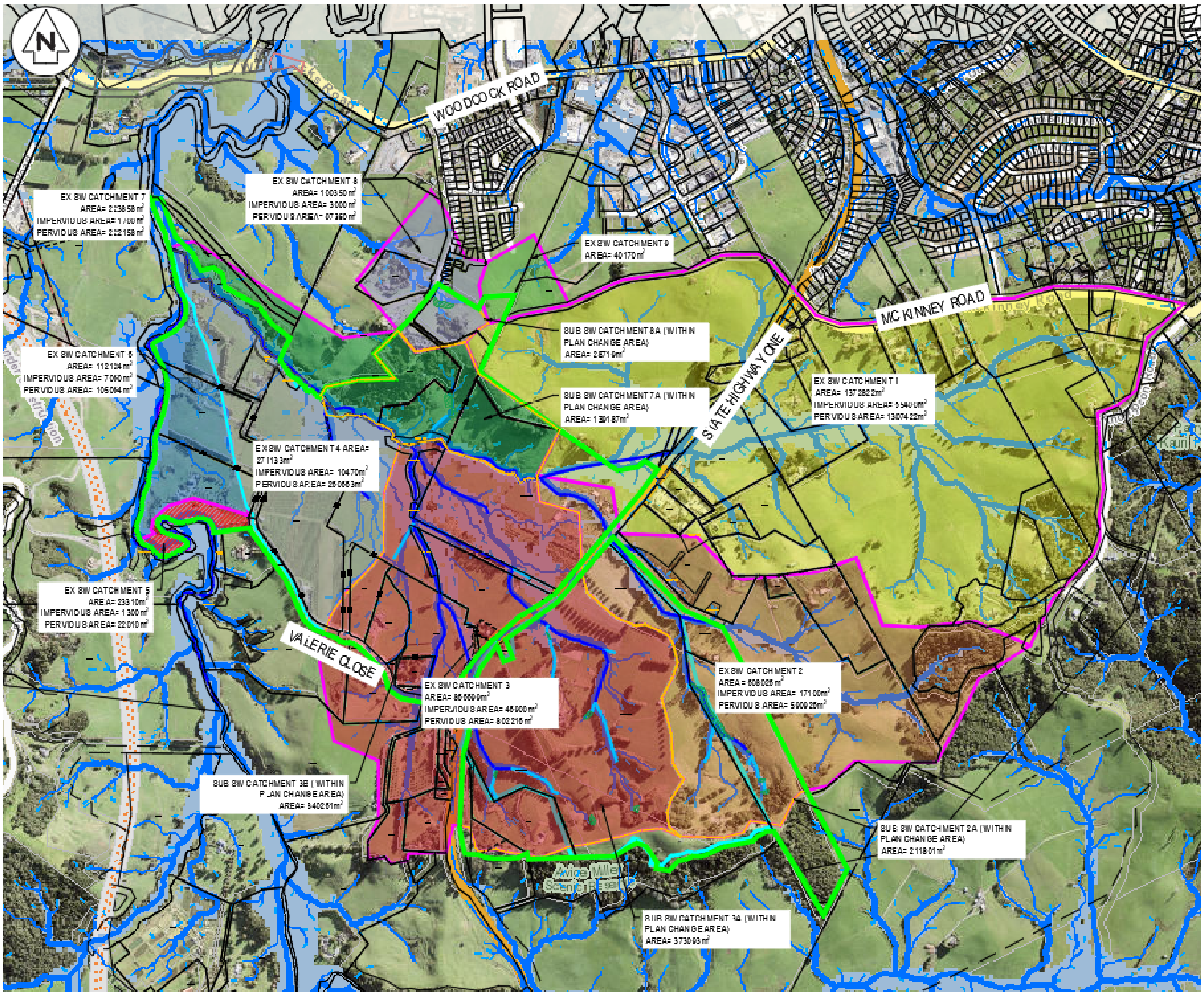

Figure 7: Existing catchments and hydrological features

2.6 RECEIVING ENVIRONMENT

2.6.1 MAHURANGI RIVER

All catchments within the PCA discharge to the main southern tributary flowing to the Mahurangi River. The river section immediately downstream of the PCA has been identified as a Natural Stream Management Area, the riparian margin of the western boundary to the PCA is also identified as being within the Significant Ecological Areas overlay of the AUP. Refer to Figure 8, below for reference:

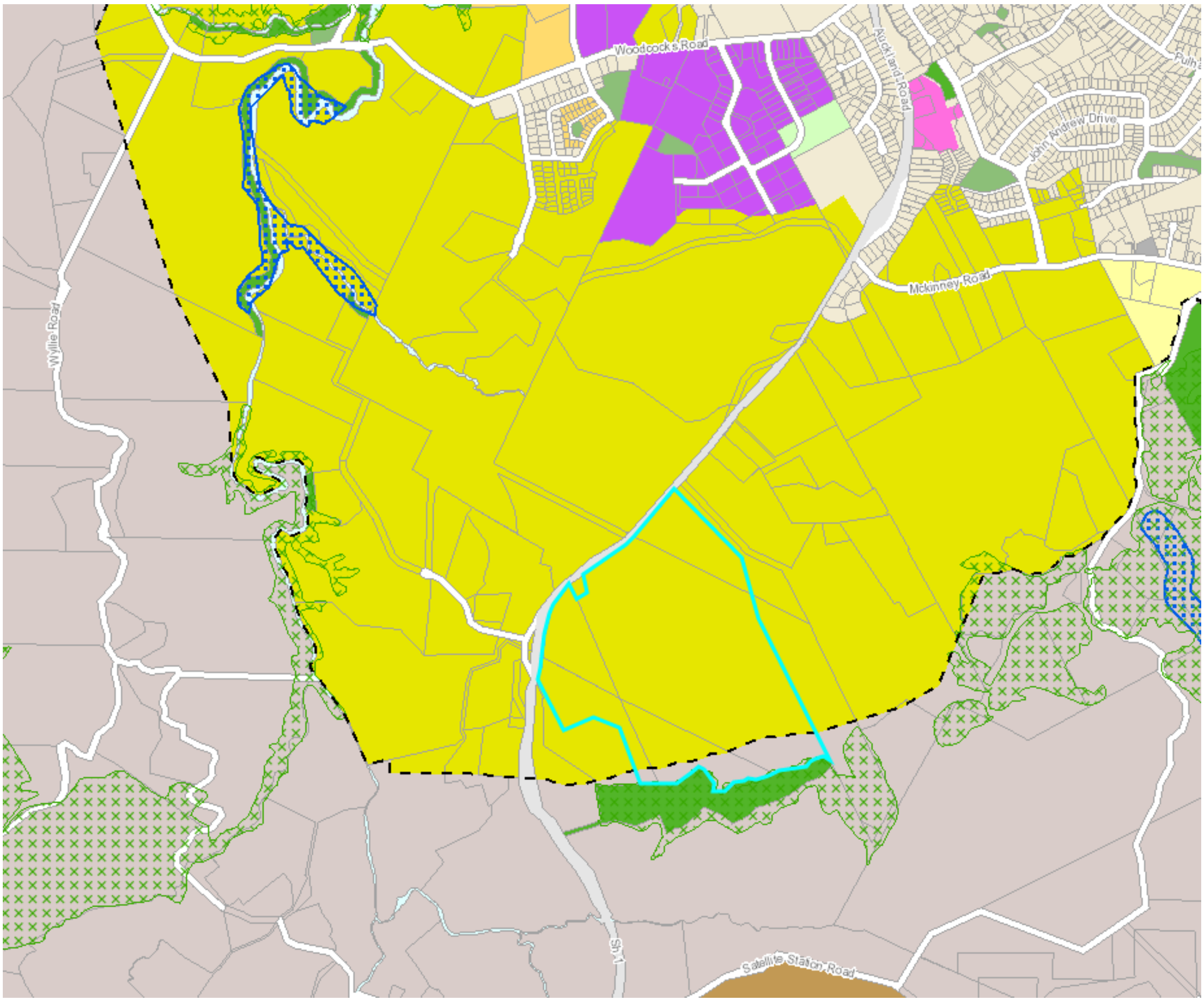

Figure 8: Significant Ecological Areas overlay

The overall health of the Mahurangi River has been scored as average to good from the Auckland Council Fresh Water Report Card with a good riparian margins planting. Most of the catchment of the Mahurangi River still pastoral land with large forest area remained. However, the water quality within the river only achieved a lower-than-average score due to the farming activities over the wider catchments.

The urbanisation of the Mahurangi river will increase the downstream flood risk and potential loses to the upstream habitat. With a careful planning and the use of stormwater management devices, these effects can be mitigated or offset. There is potential of enhancing the existing upstream tributaries with riparian planting and improvement of water quality with the implementation water sensitive design practices.

2.6.2 HAURAKI GULF

The ultimate receiving environment is the Coastal Marine Area (CMA), the Mahurangi Harbour within the Hauraki Gulf. The overall health of the Hauraki Gulf is declining over a century due to anthropogenic activity. The New Zealand Government has put in place a series of measurement and control in place such as the New Zealand Coastal Policy Statement 2010, the Hauraki Gulf Marine Park Act 2000 and the latest Revitalising the Gulf: Government action on sea change Plan. These legislation and plan aim to restore and regenerate the Gulf's environment.

The policies and objective of those documents mentioned above will have direct influence on the objective and outcomes of this SMP. The key outcome for this SMP would involve the control and/or elimination of contamination at source, improving the stormwater run-off quality and enhancing the riparian yard to improve the overall health and biodiversity of the existing stream and watercourse on site to improve the overall health of the downstream received environment.

2.7 FLOODING AND FLOWPATHS

The greater Warkworth Structure Plan's SMP identified that upstream development may increase the flood risk to existing buildings in Warkworth. If this is found to be the case, then catchment scale attenuation devices may be required to avoid increasing flooding to existing developed areas.

A comprehensive flood modelling report has been prepared by Maven Associates Ltd has been developed to accompany this plan change proposal. The flood modelling has been calibrated against the previous flooding information provided by Heathy Waters who has developed a flooding extent for the Mahurangi Catchment. The flood modelling report provides a detailed assessment of the potential effects of increased impervious area due to the development associated with this plan change. The report compares design run-off with baseline flows in various scenario to demonstrate that no adverse effects to the downstream environment can be expected. Maven's Flood Modelling Report can be found in Appendix D of this report.

While this SMP was being prepared, a similar report was being prepared and was subsequently published by Healthy Waters, which is available online, within Auckland Council GeoMaps. The results of that modelling exercise are based on an assumed climate change increase of 3.8 Celsius, which prompts a significant increase of the rain fall depth across all design rain fall events. It is notable that this increase is much more conservative than the current Auckland Council's Stormwater Code of Practice (SWCOP) revision 3.0. The flood modelling that Maven has provided in Appendix D of this report only considers 2.1 Celsius degree increased by 2090, as recommended in the currently operative SWCOP.

Within the PCA area, there is a networks of streams/ overland flow paths that convey stormwater run-off generated from the highland areas towards the southern branch of the Mahurangi River which is located on the western extent of the PCA. A snapshot of these stream/overland flow path and 100 years flood plan can be found in Figure 9, below:

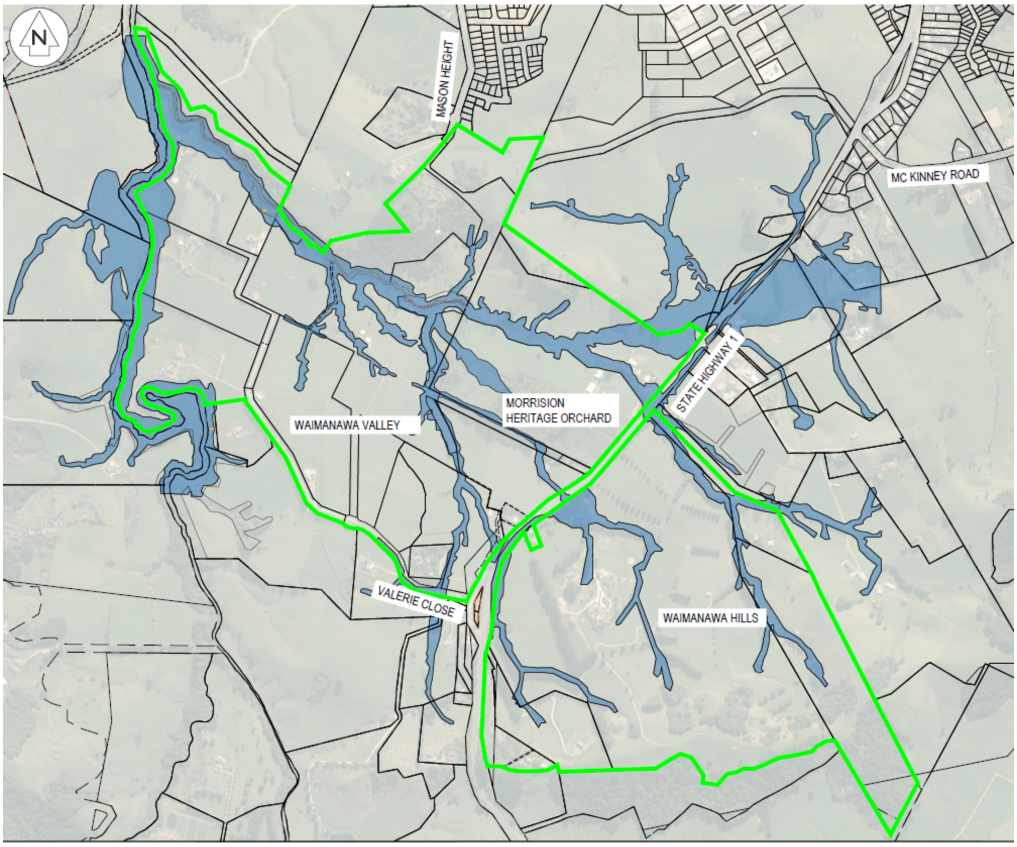

Figure 9: Existing Overland Flow Path and Flood Plain area

The comprehensive flood report identified that the wider catchments peak water run-off from the upstream environment is approximately one hour behind the peak water run-off generated from within the PCA. Based on modelling outcome and in summary, the flood modelling report recommendation is to pass forward flows for both 10 and 100 year events to mitigate coinciding peak flow from upstream and newly generated or detained flows.

2.8 COASTAL INUNDATION

The plan change area is located above the influence of the coastal inundation area, as such no further investigation has been completed.

2.9 BIODIVERSITY

Bioresearches has prepared an ecological report in support of the Plan Change application. In accordance with their Report, there are various permanent and intermittent watercourses and natural wetlands found within the PCA.

In accordance with the findings of the ecology report mentioned above, the biodiversity of the PCA can be broken down into two main areas, of which are summarised below:

2.9.1 FOREST COVERAGE

The western portion of the PCA contains two significant stands of indigenous vegetation cover which included the Kanuka Forest in the north-west and the Puriri forest in the southwest. The Puriri forest has been scored as high value within the ecology report while the Kanuka forest area has been scored at moderate value.

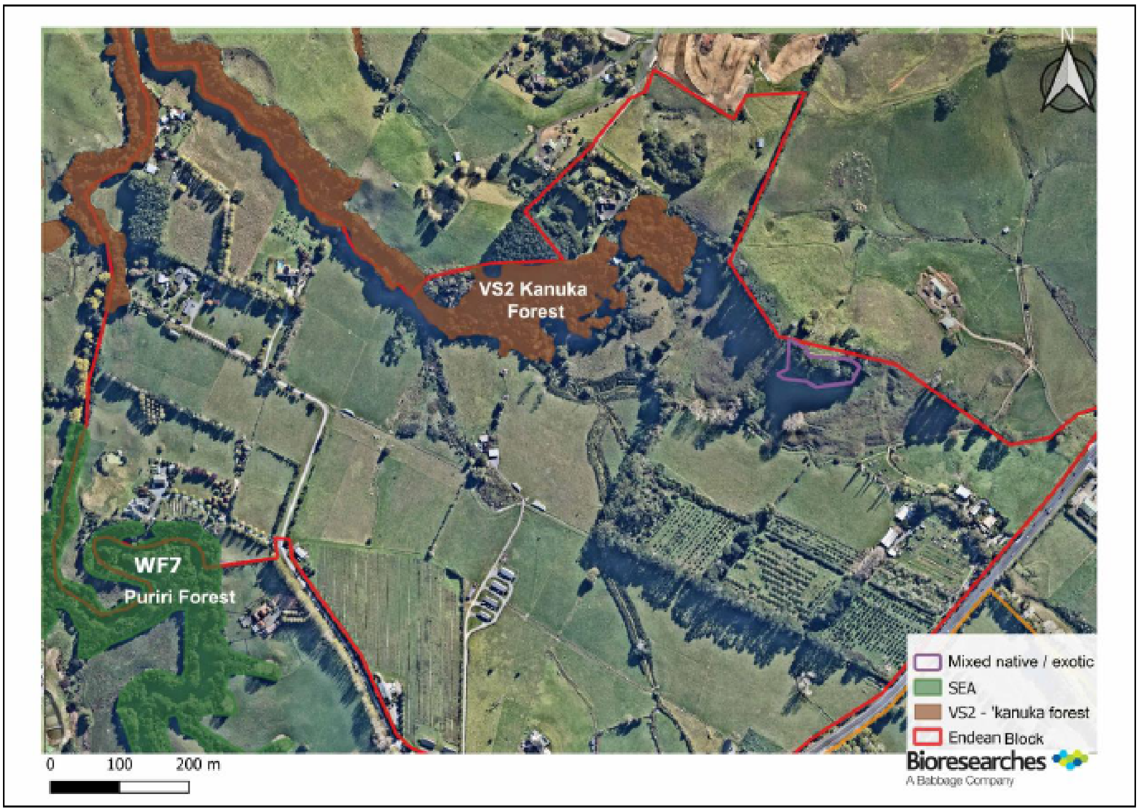

Figure 10: Extent of existing forests on the western portion.

The Puriri forest to the south of the area has been classified as Significant Ecological Area (SEA) under the Auckland GEOMAPS. While the Kanuka forest area has a Natural Stream Management Area overlayed. Please refer figure below:

Figure 11: Extent of Significant Ecology Area and Natural Stream Management Area overlay

This eastern portion of the PCA contain a few fractions of indigenous vegetation cover with the largest area located to the south. This area is abutting the Avice Miller Scenic Reserve which has been classified as a SEA under the AUP and has scored a high value in the ecology report. Please refer to the figure below for the extent of the indigenous vegetation cover within this portion of the PCA.

Figure 12: Extent of Significant Ecology and indigenous vegetation area on the eastern portion.

2.9.2 STREAM AND WETLAND ECOLOGY VALUE

The western side of the PCA contains the following stream and wetland features:

- Permanent River
  - Watercourse 19: This is a permanent river which is one of the main tributaries to the southern branch of the Mahurangi River. The catchment relates to watercourses 1- 17.
- Permanent Stream
  - Watercourse 1: upper catchment of this stream is located outside of the PCA area. The watercourse is piped under Valerie Close. The wetted width of the upper reach was 0.5-1.5m wide and the deepest section was 0.38m.
  - Watercourse 2: this stream originates from the eastern portion of the PCA. The stream is piped under SH1 with a large pool downstream of the pipe (up to 1m in depth). This flows west in a defined channel prior joining watercourse 1
  - Watercourse 4: this water course originates from the eastern portion of the PCA. The stream is piped under SH1. The channel size and depth varies along the length. The catchment is large with continuous flowing water. This stream is piped under the existing farm driveway of #40 Valerie Close before discharging towards Stream 5.
  - Watercourse 5: the upper reach of this watercourse is a constructed drain along the farm driveway on #40 Valerie Close. This upper reach has a few still pools and is classified as an intermittent

stream. After the confluence with Watercourse 4, the stream bank is wider and deeper. This section is classified as permanent stream.

- Watercourse 12: this watercourse receives water from watercourses 1,5 and 7. It has a deep channel with regenerating native planting within the 10m of riparian yard.
- Watercourse 13: this watercourse originates from the existing Morrison Orchard with a well-defined channel and native vegetation along the channel. This stream discharges toward Watercourse 12.

➢ Modified Permanent Stream

- Watercourse 15: this watercourse receives the water from watercourses 9,10 & 11 on the eastern, upper reach and 14 & 16 on the western, lower reach. The watercourse has a narrow well-defined channel. Predominantly terrestrial vegetation is located downstream within the riparian yard. A man-made wetland is located around this watercourse which is covered with more detail within the ecological report.

➢ Intermittent Stream

- Watercourse 7: a shallow channel is present along this watercourse with deep pools along the length if the watercourse.
- Watercourse 11: this contains a well-defined channel with boggy ground and aquatic vegetation within the base of the channel.
- Watercourse 18: this watercourse is quite short with a well-defined channel with large amount of water celery and macrophyte throughout the channel. The channel has no flowing water at the time of site visit. The upper reach of this stream has been piped or reclaimed. The current channel is the remnant of and old watercourse. A manmade pond is located north of this stream.

➢ Ephemeral overland flow path

- Watercourse 3: in accordance with Auckland Council GEOMAPS, an overland flow path is located in this location. There is a small depression found during the site visit with no sign of any aquatic vegetation.

➢ Artificial watercourse

- Watercourse 6,8,9,10,14,16 and 17: these watercourses are classified as artificial watercourses which was constructed as part of the farming activities on site.

➢ Wetlands

- Natural wetlands 23 and 24 are identified in the ecological report. However, it has a low water depth or insignificant water ponding which does not support any aquatic habitat.

The watercourse maps for this area from Bioresearch can be find in figure below.

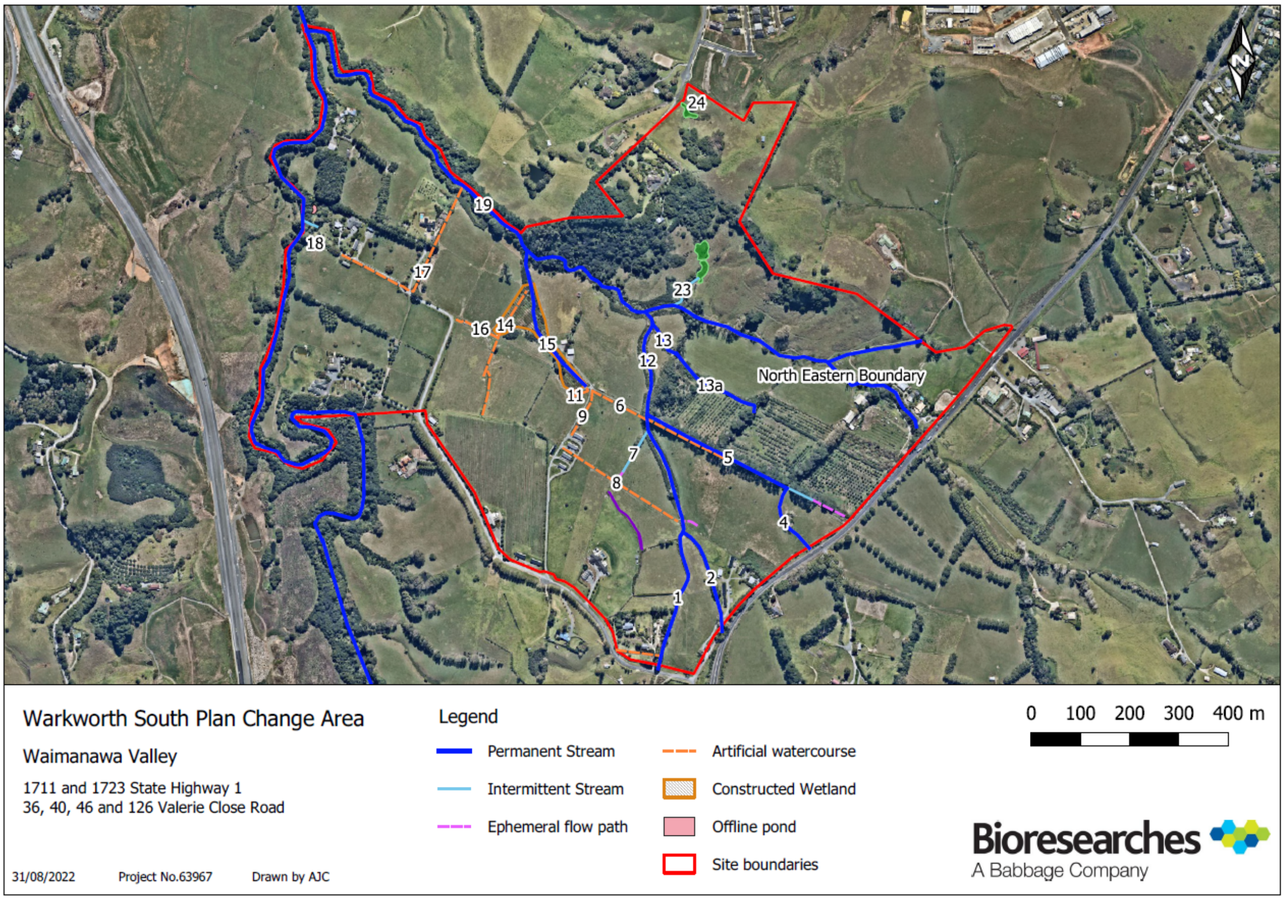

Figure 13: Existing watercourse classification and location maps by Bioresearch on the western portion.

The eastern portion of the PCA contains three main catchments; identified as eastern, central and western systems in the ecology report. A summary of the stream and wetland features is provided below:

➢ Permanent Stream

- Watercourse 35: the main collector of the stormwater run-off from the eastern system with an average depth of 0.15m and an average width of 1.5m. This drains west via a culvert under SH1 and connects to watercourse 19 to the west.
- Watercourse 38: This watercourse located upstream of watercourse 35. It has ab average width of 0.3m and an average depth of 0.16m with a general slow flow of water. The upstream of this watercourse contain a high drop which acts as barrier for fish passage.
- Watercourse 25: the main collector of the stormwater run-off from the central area. This watercourse is restricted by the undersized culvert with a vertical drop which prevents fish passage. This

watercourse has a water depth between 0.1-0.25m deep and is approximately 1m wide. This watercourse drains west though a culvert under SH1 which connect to Watercourse 4 on the western side.

- Watercourse 30: the main watercourse of the western system has an approximate stream width of 0.5 to 1m and average depth of 0.1-0.2m. The watercourse is piped under SH1 and connects to Watercourse 2 on the western side.

➢ Intermittent Stream

- Watercourse 36 & 37: these watercourses are upstream of permanent stream 35 and 38 within the eastern system. The stream receives water from within the PCA and lacks aquatic habitat and low riparian vegetation.
- Watercourse 26, 27, 28, 29: these watercourses are upstream of permanent stream 25 of the central system. These watercourses have defined stream banks, and some have running water. However, most of the riparian planting consist of low value grazed pasture grass.
- Watercourses 31, 32, 33, 34: these watercourses are upstream of the permanent stream 30 of the western system. Some of these watercourses originated from within the PCA some are outside of the PCA area. These watercourses have defined banks with some having shallow, running water.

➢ Wetlands

- Wetland 4, 5 & 10-16: Wetland 4 is approximately 133m², while wetland 5 is approximately 170m². Wetland 6 which is later described as a combination of 4 wetland (wetland 13,14,15,16) is the largest wetland located within the PCA. These wetlands receive runoff from watercourse 36, 37 & 38. Wetland 10-12 is relatively small, boggy and pugged. All the wetlands within this eastern system are low quality with dominance of exotic pest vegetation and poor-quality aquatic habitat.
- Wetland 1, 2, 3 & 7: Wetland 1 is approximately 93m², Wetland 2 is approximately 36m², Wetland 3 is approximately 290m². The size of Wetland 7 is not defined. All these wetlands are within the central system with limited riparian planting with mostly grassed or exotic pest vegetation.
- Wetland 8 & 9: belong the western system with Wetland 9 being approximately 125m², receiving runoff water from watercourse 32 whilst Wetland 8 is located at the upstream of an ephemeral stream. Both of these wetlands feature low biodiversity and low-quality aquatic habitat.

The watercourse maps for this area from Bioresearch can be find in figure below.

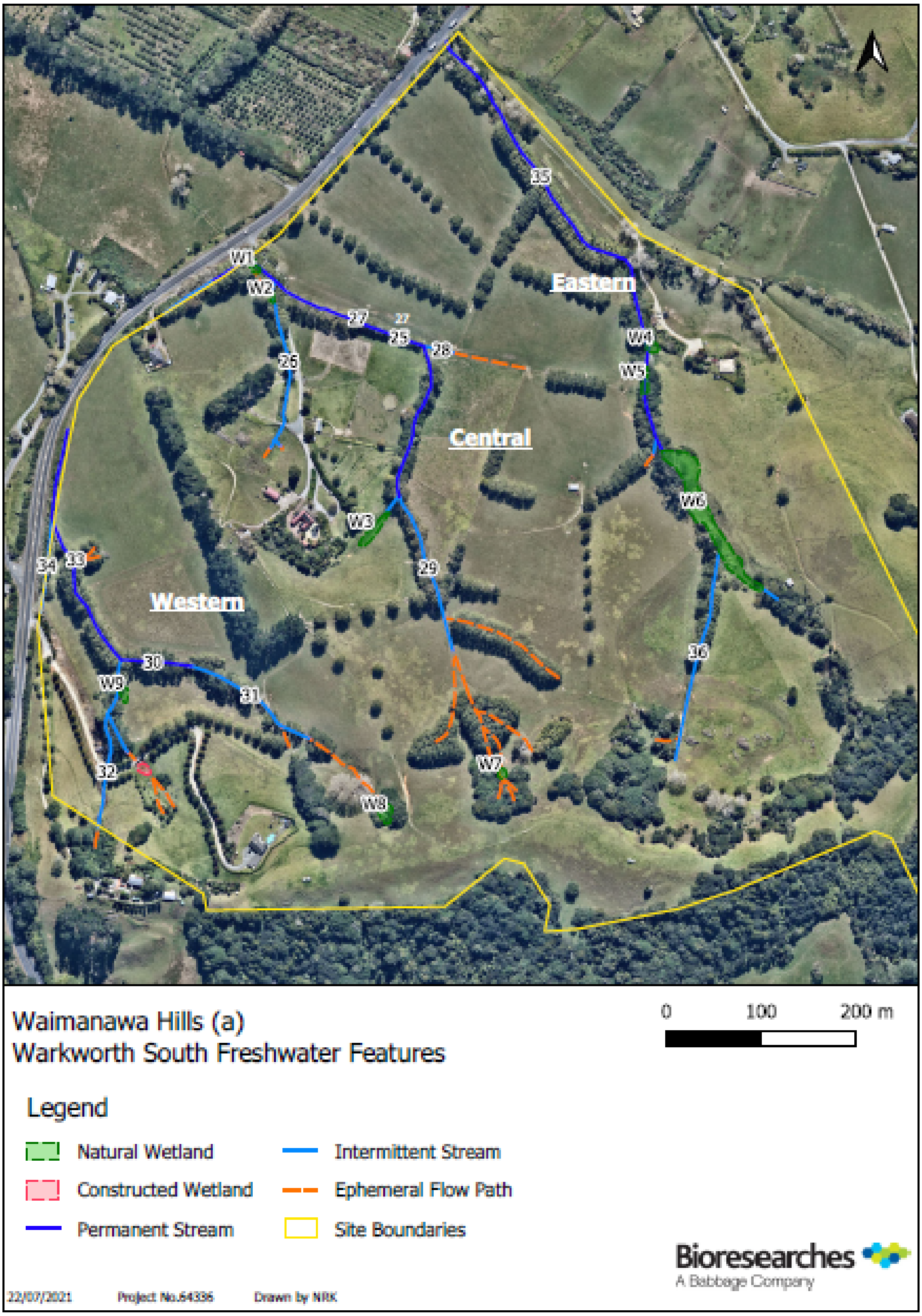

Figure 14: Existing watercourse classification and location maps by Bioresearch on the eastern portion.

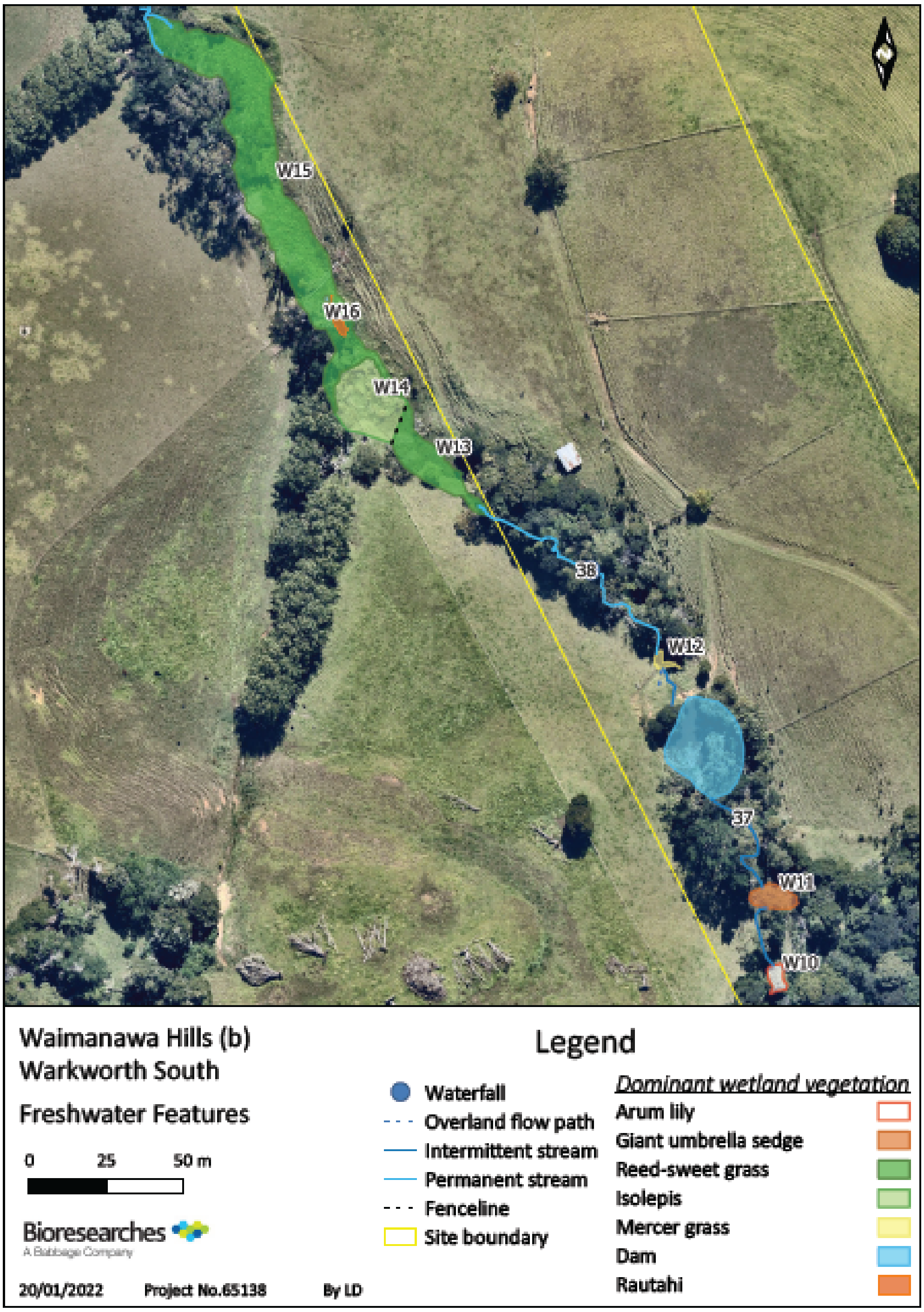

Figure 15: Further investigation on existing watercourse classification by Bioresearch on the eastern portion.

Overall, streams within the PCA have low ecological value, with the exception of watercourses 15 and 19. A fish survey was carried out within the PCA which only recorded one shortfin eel. This has further indicated that most of the watercourses on site are degraded and do not support aquatic habitat. Most of existing streams have some form of fish barrier such as farm crossing which prevents the natural movement of fish species.

2.10 CULTURAL AND HERITAGE SITES

An archaeological assessment was prepared for the plan change area by Clough & Associates Ltd in July 2021. The conclusion of the Archaeological assessment can be found below:

"There is no archaeological or other historic heritage sites have been previously recorded within the proposed Plan Change Area, and none were identified during the archaeological survey. For more information, please refer the archaeological assessment report attached.

Future development as a result of the proposed Plan Change is therefore unlikely to have any adverse effects on archaeological/historic heritage sites. However, if unidentified archaeological remains were to be exposed by future development, this is provided for in the AUP OP under the Accidental Discovery Rule and by the archaeological provisions of the HNZPTA."

Furthermore, a desktop study based on the information provided on the AUP management layers in Auckland Council GEOMAPS has concluded that there are no identified natural heritage sites, historic heritage sites or places of significant to Mana Whenua within this PCA. However, the Warkworth Structural Plan has identified the significant value of the existing Orchard located on the Northern boundary along SH1. This orchard is going to be preserved as Morrison's Heritage Orchard within this PCA application and there will be no development proposed within this area.

2.11 CONTAMINATED LAND

Land Development & Exploration Limited have completed a Soil Contamination Preliminary Site Investigation (PSI) Report for the Western PCA area. The report concluded the following:

"Historical imagery, site observations and anecdotal information show that the site has been used primarily for dairy farming, viticulture and grazing, and more recently, lifestyle purposes. As a result, the handling and application of sprays and other hazardous materials has more than likely taken place. There has also been waste disposal to land in the form of pruning waste incineration and landfilling, as well as the bulk storage of treated timbers on bare ground, motor vehicle workshops and possible boat maintenance activities therefore we consider that **HAIL A10:** 'Persistent pesticide bulk storage or use including sport turfs, market gardens, orchards, glass houses or spray sheds', **HAIL G5:** 'Waste disposal to land (excluding where biosolids have been used as soil conditioners)', **HAL G3:** 'Landfill sites', **HAIL A18:** 'Wood treatment or preservation including the commercial use of anti-sapstain chemicals during milling, or bulk storage of treated timber outside', **HAIL F4:** 'Motor vehicle workshops', **HAIL F5:** 'Port activities including dry docks or marine vessel maintenance facilities', **HAIL 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', and **HAIL 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', are more likely than not to have occurred at the site.

LDE considers that the NES applies under Regulation 5(5) and 5(6) due to the proposed change in landuse and proposed subdivision of the site. As HAIL A10, G5, G3, A18, F4, F5, and I have been identified to have possibly occurred, or is occurring on the site, a Detailed Site Investigation (including specific site sampling) was therefore required to establish any actual human health risks associated with future land use at the site."

For the eastern portion of the PCA, a Detailed Site Investigation (DSI) done by Focus Environmental Services Ltd. The DSI report has concluded that the soil on site is suitable for retention onsite for future development. However, there are localised spot where soil contain low levels of contamination which are not suitable to classified as clean fill and need to be disposed of at suitable licensed disposal facility during the construction phrase. For more information, please refer the PSI and DSI report provided in support of the PPC application.

3 DEVELOPMENT SUMMARY AND PLANNING CONTEXT

Following the initial site appraisal through the section two of this report, the regulatory and planning requirement of the AUP will be discussed in details below

3.1 REGULATORY AND DESIGN REQUIREMENTS

In accordance with the AUP, the Auckland Council's Regulatory and design requirements are listed in Table 4, below:

Requirement	Relevant regulatory / design to follow
National Policy Statement for Freshwater Management 2020	• Ministry for the Environment
New Zealand Coastal Policy Statement 2010	• Department of Conservation
Natural resources of the Regional Policy Statement	• AUP Chapter B7
High-use stream management areas	• AUP Chapter D3
Natural Stream Management Area	• AUP Chapter D4
Significant Ecological Areas	• AUP Chapter D9
Water Quality and integrated management	• AUP Chapter E1
Discharge and Diversion	• AUP Chapter E8
High Contaminant Generating Areas	• AUP Chapter E9
Hydrological mitigation	• AUP Chapter E10
Natural Hazards and Flooding	• AUP Chapter E36
Auckland Council Regionwide Network Discharge Consent	• NDC Schedule 4
Structural Plan	• Warkworth Structural Plan (Auckland Council, 2019)
Catchment Management Plan	• Warkworth FUZ SMP (T&T, Draft 2019)
Stormwater Management Devices in the Auckland Region	• GD01 (Auckland Council, 2017)
Application of principals of water sensitive design	• GD04 (Auckland Council, 2015)

3.1.2 NETWORK DISCHARGE CONSENT

The Auckland region-wide network discharge consent (NDC) came into effect in October 2019. The NDC allows for the stormwater diversion and discharges from developments to be incorporated under Auckland Council's consent, and for stormwater infrastructure assets to be vested to Auckland Council, provided they comply with the NDC conditions. The NDC requirements for greenfield developments, relevant to the PCA, and as stipulated in the NDC Schedule 4, are:

Receiving Environment:

- Minimise the stormwater related effects of the development.
- Retain/ restore natural hydrology as far as practicable.
- Minimise the generation and discharge of contaminants (including gross stormwater pollutants and stormwater flows at source).
- Minimise temperature related effects.
- Enhance freshwater systems including streams and riparian margins.
- Minimised the location of engineered structures in streams.
- Protect the values of Significant Ecological Areas as identified in the AUP.

Water Quality:

- Treatments of impervious areas by a water quality device designed in accordance with GD01 for the relevant contaminants

Stream hydrology:

- Achieve equivalent hydrology (runoff volume, peak flow) to pre-development (grassed state) level via SMAF 1 stormwater controls.

Flooding:

- Ensure that there is sufficient capacity within the pipe networks downstream of the connection point to cater for the stormwater runoff associated with development in the 10% AEP even including incorporating flows from contributing catchments as maximum probable development by:
    - Demonstrating sufficient capacity is available including flows from the catchment at (maximum probable development) draining to the relevant pipe network in the 10% AEP event;
    - Attenuating and reducing stormwater flows and volume on-site such that there is no increase in peak flow in a 10% AEP event from the site compared to that prior to the new development. Note that any devices associated with this option will also require an operation and maintenance plan to ensure the long-term efficacy of such a system;
    - Upgrading the relevant pipe network to a size that can cater for the additional flows from the development in the 10% AEP even (taking into account existing flows from the contributing catchment); or
    - Upgrading the relevant pipe network to a size that is larger than would otherwise be required to cater for the 10% AEP event for the development, due to the need to cater for flows from the contributing catchment at maximum probable development, subject to a fair and proportionate funding agreement with Healthy Waters.
    - Building in 1% AEP event shall be in accordance with Stormwater Code of Practice.

Assets:

- All new assets that are intended to become part of the public stormwater network are to be designed and constructed to be durable and perform to the required level of service for the life of the asset, subject to reasonable asset maintenance.

3.1.3 STRUCTURE PLAN

The Warkworth Structure Plan sets out key stormwater opportunities and constraints relating to development of the structure plan area, and include:

Flooding

Constraints:

- Upstream development may increase the flood risk to existing buildings in Warkworth. If this is found to be the case, then catchment scale attenuation devices may be required to avoid increased flooding to habitable areas.
- Any new development should occur outside of the 100-year floodplain.
- Allow for conveyance of overland flow.

Opportunities:

- Protection of 100-year floodplain also provides an opportunity to enhance riparian corridors. This provides enhanced stormwater management functions, contributes to the ecological values of stream corridors and provides public amenity. Green corridors should be considered to manage the flood hazard, protect ecological values, provide amenity and for walking and cycling tracks.

Hydrological change

Constraints:

- The presence of low permeability ultic clays in the structure plan area may preclude the use of infiltration devices in some areas.
- Slope instability risk may preclude the use of infiltration devices in some areas.
- The viability of water reuse as a stormwater management tool is contingent on land use activity and will need to be assessed on a site-by-site basis.
- Opportunities:
- The structure plan area is a greenfield area which provides an opportunity to incorporate integrated stormwater management to maintain pre-development hydrology.
- Providing opportunity for on-site infiltration to improve aquifer recharge and stream baseflows.
- Providing opportunities for water reuse especially for housing and for industrial/commercial activities (depending on water demand).

Enhancing freshwater systems

Constraints:

- Permanent and intermittent streams will need to be protected.
- Riparian buffer areas around streams needs to be included. In some areas existing riparian vegetation has been classified as a terrestrial SEA and must be protected.

Opportunities:

- Water quality in the water bodies within the structure plan area is currently relatively good for an urban catchment. Use of integrated stormwater management is an opportunity to maintain or enhance water quality.
- Design stormwater management for future urban areas that provides for a high level of water quality to protect the high ecological values and good water quality present in the area.
- Use riparian margins as part of the water conveyance system and to provide connections to other freshwater systems and other habitat types.
- The change in land use from rural land to urban is an opportunity to revert to natural sedimentation loading in freshwater systems and in the harbour.
- Naturalisation of existing modified watercourses to re-develop hydraulic and habitat diversity.
- Removal/modification of artificial fish passage barriers to improve the ability of migrant fish species to access upstream habitat.
- Restoration of wetlands to help regulate stream flows and enhance ecological functions.
- Erosion and sedimentation management during development applying best practice that responses to the sensitive receiving environments and aspirations for freshwater management set out in the SMP and AUP.

3.1.4 CATCHMENT MANAGEMENT PLAN

The Warkworth Structure Plan has provided a high-level guidance on the stormwater management framework for the Warkworth area which will be relevant to the PCA. The high-level stormwater management recommendations are summaries below:

General

- Use an integrated stormwater management approach involving water sensitive design. This will involve the following components:
  - Minimise the generation of stormwater runoff and contaminants with measures such as clustering development, reducing impervious surfaces and using inert building materials.
  - Manage runoff and contaminants as close to source as possible with measures such as capture and reuse, green roofs, permeable pavements and terrestrial revegetation.
  - Use swales for stormwater conveyance where possible as an alternative to pipes and filter strips where practicable as pre-treatment to downstream treatment devices.
  - Utilising downstream treatment devices which mimic natural physical, biological and physical treatment processes.
  - Enhance the receiving environment by preserving and restoring riparian vegetation along banks, natural floodplains and wetland margins, including linking areas of riparian vegetation to create continuous green corridors.
  - Utilise existing natural systems for stormwater management function including the restoration/enhancement of wetlands
- Remove or modify artificial fish passage barriers where possible to improve the ability of migrant fish species to access upstream habitat. Water quality

- Provide near or at-source water quality treatment of runoff for high use roads and High Contaminant Generated Carparks (>30 carparks). Water quality treatment to target sediment, metals and gross pollutants.
- Use "inert" building materials, or otherwise site-specific treatment is required.
- Minimising or mitigating the effects on freshwater systems arising from changes in water temperature caused by stormwater discharges.
- Erosion protection in the stormwater systems including discharges to streams. Consider green outfalls for discharges to streams.

Minimising and mitigating hydrological change

- Further assessment that considers the site-specific constraints of the Warkworth Structure Plan Area is required to determine how to minimise or mitigate any changes in hydrology and whether it can practicably be achieved. If there are residual impacts on streams after implementing hydrological mitigation (as per AUP section E10) then other solutions such as instream works should be considered to mitigate the effects of changes in hydrology.
- After exploring location specific options in accordance with greenfield policies and where those options are demonstrably not practical to implement, the minimum standard shall be to provide 'hydrological mitigation' in accordance with Table E10.6.3.1.1 of the AUP where the specific effect to be managed is in-stream erosion.
- Utilise stormwater infiltration for retention where it is possible to do so in a safe, and effective manner.
- Utilise rainfall harvesting for retention for residential buildings and industrial/commercial where there is re-use demand.

Flood management

- Use streams and their associated riparian margins to provide storage and conveyance to manage flood waters.
- Avoid locating buildings or infrastructure within the 100-year ARI modified floodplain unless it can be designed to be resilient to flood related damage.
- Ensure all development and changes within the 100-year floodplain do not increase adverse effects or increased flood depths or velocities to other properties upstream or downstream of the site.
- Identify overland flowpaths and ensure that they remain unobstructed and able to safely convey runoff.

3.1.5 STORMWATER MANAGEMENT DEVICES IN AUCKLAND REGION

The stormwater management devices in Auckland Region Guideline Document 001 (GD01) is developed in 2017 to replace Technical publication 10 (TP10) . GD01 provide wide range of stormwater management devices to address the stormwater detention, retention, and water quality requirement for the whole Auckland region. Those devices listed in this document is considered a best practice options for mitigating the adverse effects from the land-use and subdivision activities.

4 MANA WHENUA MATTERS

5 STAKEHOLDER ENGAGEMENT AND CONSULTATION

5.1 HEALTHY WATERS

Private plan change documentation has been provided to Healthy Waters for their feedback. Healthy water has provided initial feedback regarding this SMP. These feedbacks have been adopted to reflect on this updated revision of this SMP. The changes is listed below:

Water quality:

The water quality chapter has been revised to include a wide range contamination present in impervious area within the urban setting as per GD01.

Hydrology mitigation:

The requirement for hydrology mitigation has been revised to SMAF 1 as per Schedule 4 of the NDC.

Flooding management:

The flooding report has been revised to expand the effect to further downstream with consideration to other reach located further downstream. Overall, the flood modelling report has been revised as per the comments from the initial feedback.

Stormwater management approach:

The SMP has been updated with the preference of using Wetland as the main stormwater management devices where practically possible.

Overall, the applicant is committed to working with Healthy Water to achieve the best possible outcome and one that it is consistent with HW's expectations. On-going consultation will be carried out with Healthy Water to ensure that the SMP meet HW's expectation.

5.2 IWI CONSULTATION

Various iwi groups have been contacted for providing feedback toward this SMP. The consultation process is on-going. And this chapter will be updated accordingly.

6 PROPOSED DEVELOPMENT

KA Waimanawa Limited Partnership and Stepping Towards Far Ltd are applying to rezone the proposed Warkworth South PCA from the current FUZ to a mixture of residential, commercial and open space zones. The total dwellings forecasted for this plan change is approximately 1400 HUE to 2000 HUE. For the purpose of the Plan Change and infrastructural assessments, a yield of 2000 HUEs has been used as the baseline equivalent for modelling purposes.

The land zoning is generally in accordance with the Warkworth Structure Plan which was approved by Auckland Council in 2019. The final residential yield for this PCA is subject to market drivers and resource consents to Auckland Council. The proposed development comprises the PCA shown in Figure 2 and discussed in detail within Section 2. This section of the report summarises the planned future development in the PCA, particularly as it relates to stormwater management.

6.1 PROPOSED REZONING INFORMATION

The proposed plan change is considered a greenfield development as the proposal entails changing the existing zoning from FUZ to a combination of residential, commercial, and open space zonings. The conceptual design is shown in Figure 16 and summarised below:

- A local centre at the heart of the PCA abutting SH1 with multiple transports modes and options.
- A major park with multiple recreational sporting options and various smaller parks throughout the PCA
- Various drainage reserves created to cater for the stormwater mitigation and management.
- The creation of Morrison's Heritage Orchard which was identified by the Warkworth Structure Plan.
- Medium density THAB zoning to allow for apartments or terrace houses adjacent to the proposed Town Centre and amenities.
- MHU zone within the walking distance to the Town Centre.
- MHS zone at the outskirts of the PCA; and
- Large lot/ lifestyle blocks/ single house zone in the highlands (stepper areas) of the PCA.

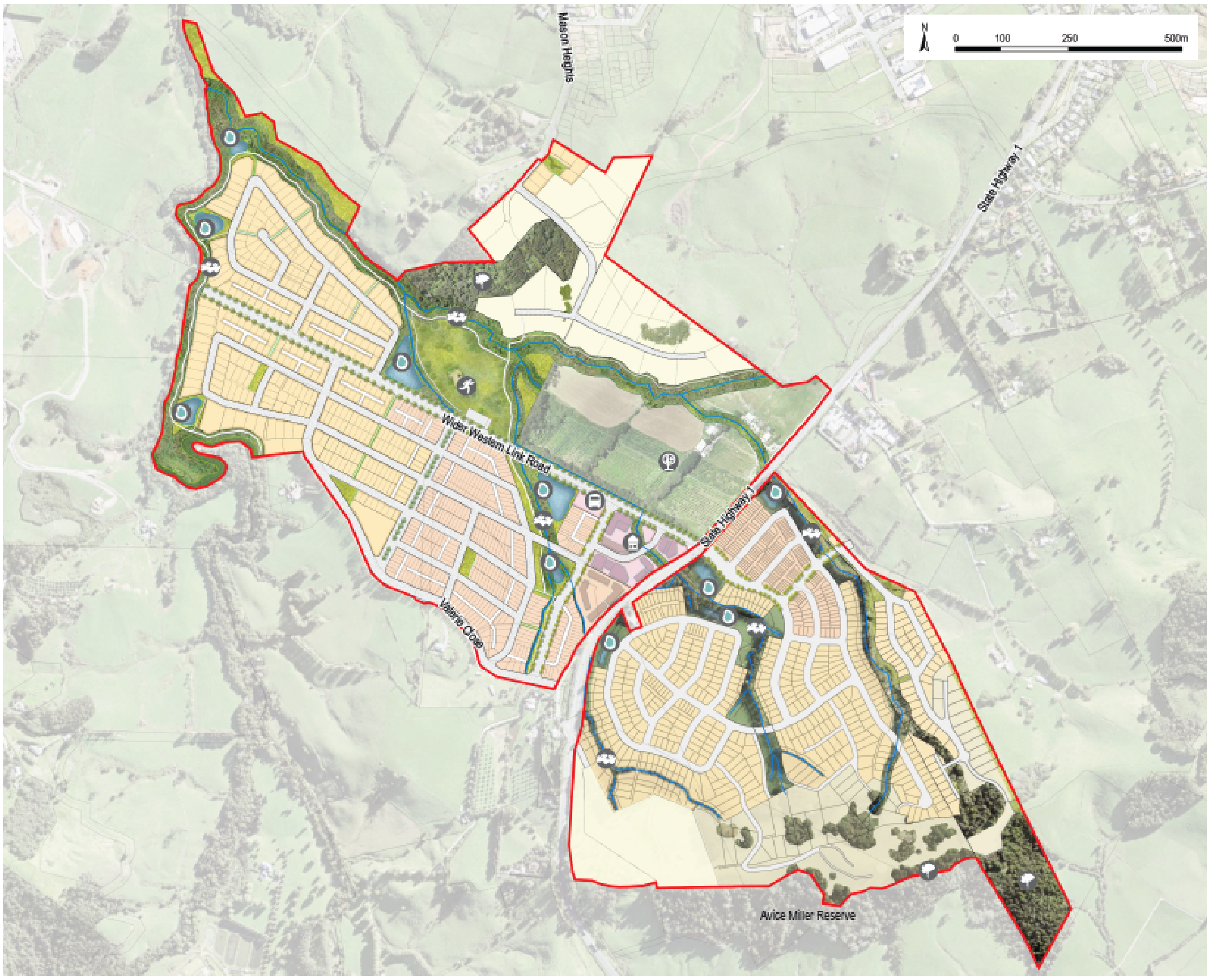

Figure 16: Proposed Development Overview

6.2 SITE LAYOUT AND URBAN FORM

The proposed layout of Waimanawa Valley and Waimanawa Hill are shown in Figure 17 & 18, below:

Figure 17: Proposed Waimanawa Valley Development Overview

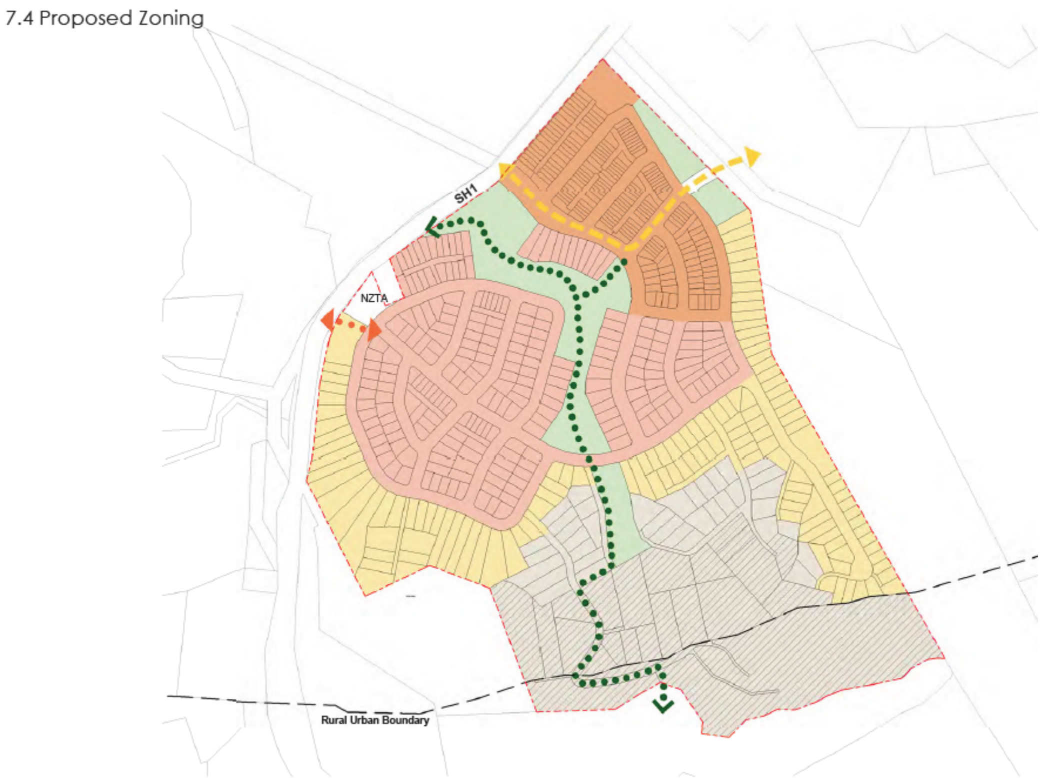

Figure 18: Proposed Waimanawa Hill Development Overview

The urban form of the PCA has been developed around Water Sensitive Urban Design (WSUD) principles. Substantial areas have been reserved for stormwater drainage reserves and stream riparian yards which is consistent with the Warkworth Structure Plan layout (refer to Figure 19 below for comparison). The wetlands are strategically located within the low points of the catchments to provided treatment to the stormwater run-off prior to discharge into the receiving environment.

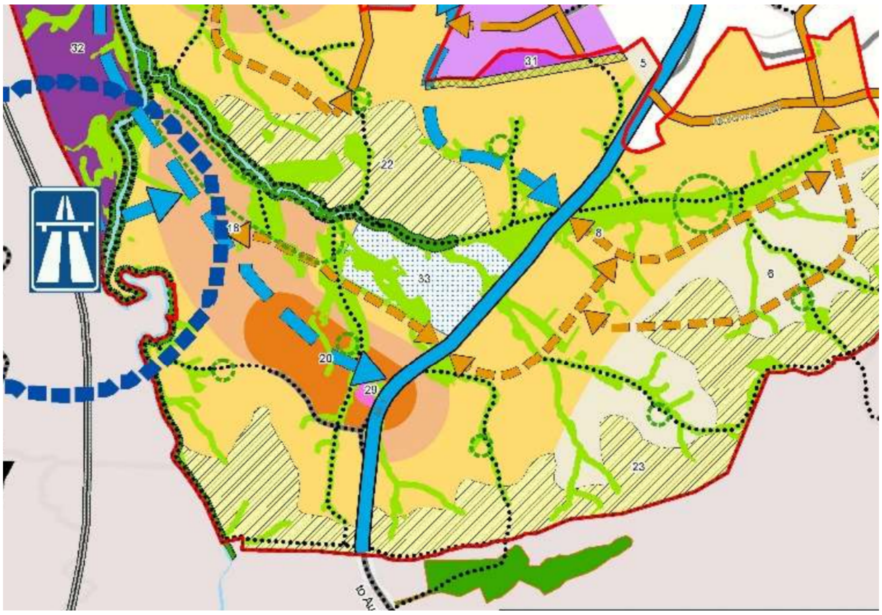

Figure 19: Warkworth Structure Plan blue & green corridors

6.3 EARTHWORKS

An infrastructure report has been prepared to support this plan change application. A preliminary earthworks modal is developed for the plan change area to indicate the volume of enable earthworks required to provide a suitable building platform and the roading networks servicing the plan change area.

The preliminary earthworks design has taken the following into consideration:

- Ex permanent and intermittent streams and associated riparian yards.
- The northern side of watercourses 19 & 23.
- The Morrison's Heritage Orchard.
- The southern ridgeline abutting Avice Miller Scenic Reserve.

See appended Earthworks Plans for further details. Proposed earthworks volumes are tabled below:

Site Area	164.0 Ha
Earthworks Area	81.3 Ha
Cut Volume	355,000 m^3
Fill	444,000 m^3

All major overland flow paths / Watercourse within the greater PCA site are to be maintained. A number of lesser overland flow path will be modified / redirected to enable the proposed plan change layout and enable key features outlined in the Structure plan such as the collector road. The detail design of these engineered overland flow paths will be provided at the resource consent stage.

Future resource consents will require erosion and sediment control measures to be implemented and maintained in accordance with the approved Engineering Drawings.

Silt control measures will need to be installed onsite prior to or during (as specified) earthworks commencement. All silt control measures will be checked and confirmed acceptable by the Engineer and relevant council compliance and monitoring specialists before relevant earthworks commence.

The site will be progressively stabilised as areas of earthworks are completed. Erosion and sediment control measures will be maintained in accordance with the Engineering Drawings.

6.4 POST DEVELOPMENT CATCHMENT PLAN

A comprehensive post-development catchment plan has been formulated for the plan change area, considering the existing topography of the site and identifying the essential infrastructure needed for feasible development. It is important to note that this post-development catchment plan is based on a desktop analysis of the proposed masterplan, which is subject to alteration during resources consent design and processing.

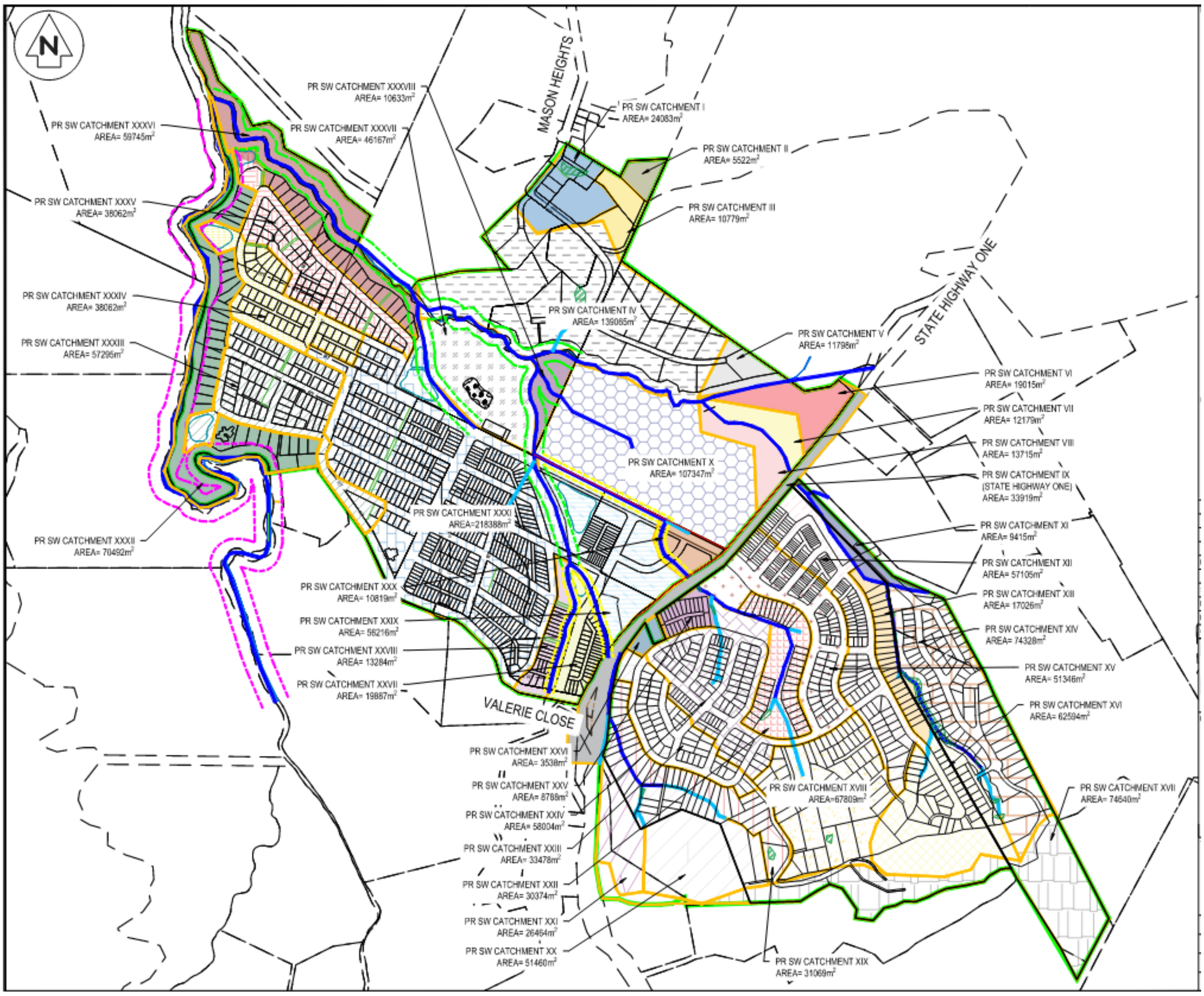

Figure 20: Preliminary Post development Catchment Plan

The plan change area consists of a total of approximately 38 post-development catchment areas, which can be further categorized into four main zones: Stormwater Management Zone A, B, C, and D. These zones have distinct characteristics and considerations.

Stormwater Management Zone A is characterised by post-development catchment areas with predominantly flat to gentle slopes, making them highly suitable for wetland construction. Within this zone, the specific post development catchment areas included are XII, XV, XXIV, XXVII, XXIX, XXXI, XXXIII, XXXIV, and XXXV. Additionally, Stormwater Management Zone A is further divided into two sub-zones: Sub-zone A-1, which pertains to the Waimanawa Valley Precinct, and Sub-zone A-2, designated for the Waimanawa Hills Precincts.

Stormwater Management Zone B encompasses catchment areas that are typically situated in highland areas with steeper slopes or fragmented catchments near existing streams. These areas are not suitable for large communal stormwater devices. Instead, it is recommended to manage stormwater at the source through a Best Practice Option (BPO) approach to quality treatment. The post-development catchment areas falling within Zone B include I-V, XI, XIII-XIV, XVI-XXIII, XXV-XXVI, XXVIII, XXX, XXXII, and XXXVI. Due to the scattered distribution of post-development catchments within this zone, Stormwater Management Zone B is further divided into five sub-zones.

Stormwater Management Zone C encompasses the catchments of Morrison Orchard and the open space area. The Morrison Orchard is designated as a proposed heritage site, and its land use and activities are expected to remain largely unchanged. The open space area will primarily consist of green spaces, with minimal increases in impervious areas. While these catchments are still subject to water quality and hydraulic mitigation requirements outlined in this SMP, the relatively small and minor increase in impervious areas suggests that smaller at source devices provide for their management in a Best Practice Option (BPO) approach. The catchments within Stormwater Management Zone C include VI-VIII, X, XXXVIII, and XXXVII.

Stormwater Management Zone D is specifically designated for the section of State Highway one that traverses through the plan change area. Currently, this highway section cuts across multiple existing stormwater catchment areas and has its own established stormwater network that discharges into various existing streams. As this section of State Highway one is expected to undergo urbanisation and upgrade to an arterial road, it is important to note that the discharge locations remain fixed, and significant changes to the road's vertical alignment are not anticipated. Consequently, there is no opportunity to introduce wetlands or bulk management devices within this area. To meet the objectives outlined in this SMP, it is recommended to utilise smaller at source devices providing treatment and stormwater mitigation at source as preferable treatment measures as a BPO. Stormwater Management Zone D only encompasses the post-development catchment IX.

Please refer to the Figure below for a visual representation of the stormwater management zone area.

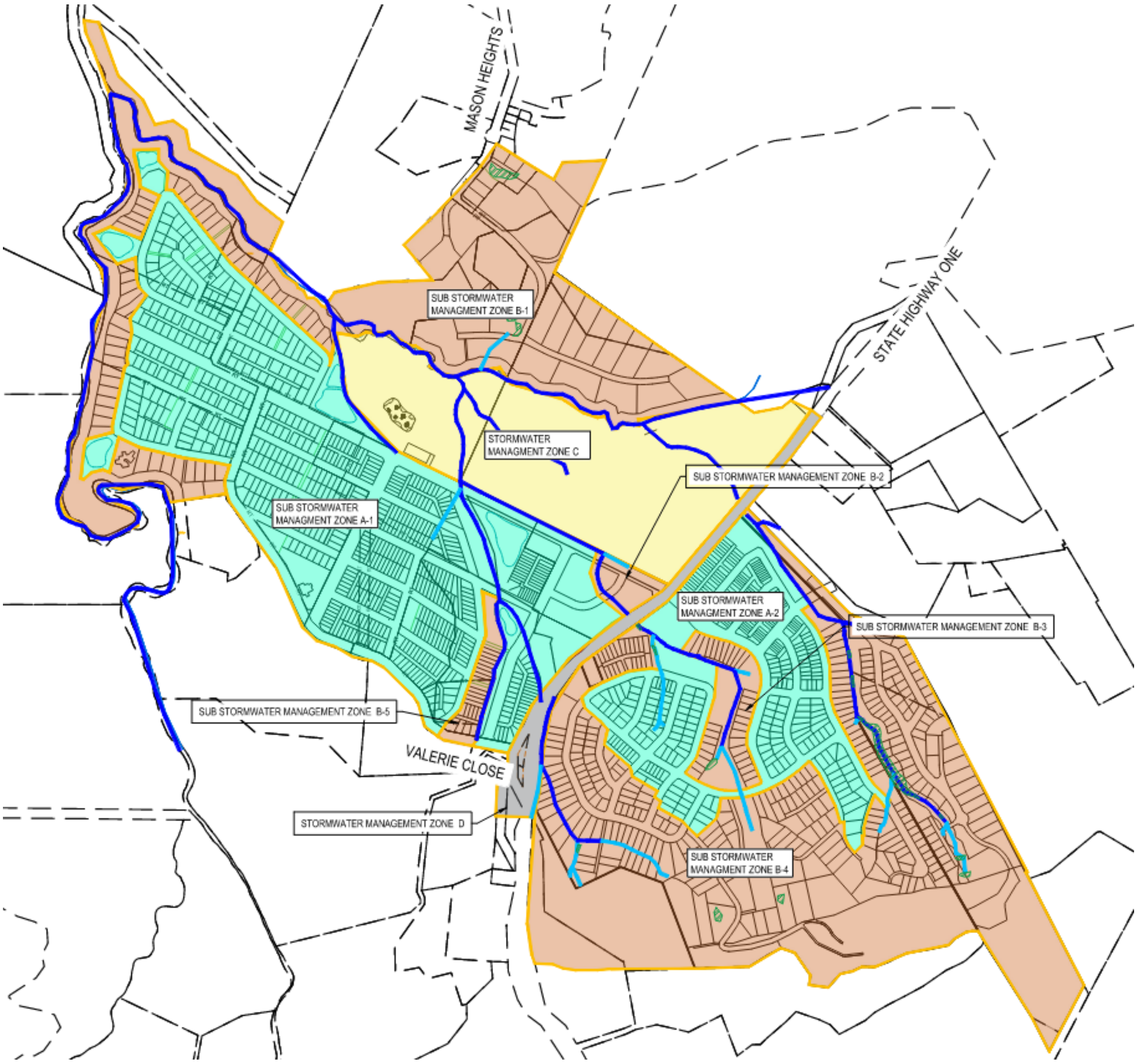

Figure 21: Post Development Catchment Management Zone Plan

A thorough desktop analysis of each post-development catchment plan has been conducted to determine the appropriate classification of each catchment area into its respective stormwater management zone. This analysis provides detailed information and justification for the placement of each catchment within the designated zones A through D. Please refer to Appenedix E for more information.

7 STORMWATER MANAGEMENT

The post development stormwater management plan is presented and discussed within this section of the report. This SMP has been developed in accordance with relevant policies and regulatory requirements. The stormwater management techniques are considered to provide the best practice options (BPO) whilst providing a flexible framework for interdisciplinary planning for an integrated stormwater management approach.

7.1 PRINCIPLES OF STORMWATER MANAGEMENT

7.1.1 ORIGINAL PRINCIPLES

The stormwater management principles present below are consistent with the site-specific constraints & opportunities, AUP policies and the networks discharge consent.

The stormwater management frameworks for this plan change pursues:

- Water Quality –
    - Treatment of all impervious areas by a water quality device designed in accordance with GD01/TP 10 for the relevant contaminants.

Or

-
    - An alternative level of mitigation determined through a SMP that:
        - applies an Integrated Stormwater Management Approach (as per above);
        - meets the NDC Objectives and Outcomes in Schedule 2; and
        - is considered the BPO.

- Frequent Rain Event Management – Hydrology mitigation in accordance with the Stormwater Management for Flow Area 1 provisions as defined in Chapter E10 of the AUP(OP).
- Conveyance – Provide a stormwater network to convey runoff generated from the 10% AEP event from the development and convey this to the receiving environment. Where this network is proposed to be vested with the Auckland Council, the network should be designed in accordance with the requirements set out in the SWCoP.
- Overland Flow Management – Natural overland flowpaths are to be retained and improved where practical in the developed scenario. Flowpaths through development sites will be required to be incorporated into the final landform with the improvement of flood storage and conveyance. So that flooding does not to pose a risk to property or people. Flowpaths will also be protected and kept free from obstruction. Similar to flow attenuation, where alterations are made to the overland flowpath as a result of earthworks, it will be necessary for the developer to demonstrate no negative impacts are caused by the proposed changes.
- Floodplain Management – The management of the floodplain will be provided through the provisions contained within the AUP(OP). No vulnerable activities will be allowed within the floodplain (unless suitably mitigated) and general levels of development will be kept to a minimum in such areas. It is noted that the existing landform may subject to change, to suite the development layout. Although development must demonstrate that any change will not have any adverse effect.

- Flood mitigation: - adopting pass forward flow approach with no hydrology mitigation proposed beyond SMAF 1 requirement listed above.
- Receiving Environment – To provide protection to and promotion of the receiving environment.
- Residential Zones:

– Consideration of catchment wide approach, which could include, but is not limited to the following solutions:

  - Wetlands at end of catchment

or

– Consideration of lot-based application of WSUD where catchment wide approach is not possible, which could include, but is not limited to the following solutions:

  - Reuse tanks for roof water.
  - Bioretention devices for trafficable and impervious area

- Roads – No additional requirements or considerations above the minimum set out (above).

The SMP ensures compliance with the NDC Schedule 4 requirements for Greenfield developments, these requirements are listed in Table 2 in section 6.2.1 and form the outcomes sought by the stormwater management strategy. The stormwater strategy developed for the site demonstrates the overarching principles of how stormwater is to be managed within the development, as required by the regional NDC. The stormwater management proposed for the site generally aligns with the concept of a Water Sensitive Design.
The strategy for the stormwater management is outcome focused. The stormwater management plan provides a solution-based approach for the receiving environment. The plan sets up a clear process to mitigate the effects on the receiving environment, which is the Mahurangi River - located immediate downstream of the development.

Maven Associates believes the proposed stormwater strategy ensures the proposed outcomes are consistent with Schedule 4 of the regional NDC and relevant mana whenua values.

7.1.2 UPDATED PRINCIPLES

*****Not applicable within this SMP version***'**

7.2 PROPOSED STORMWATER MANAGEMENT

7.2.1 GENERAL

The water quality, conveyance, hydrological and flood mitigation outcomes are consistent throughout the PCA. The key outcomes are listed below:

Water quality:

Mitigating the contamination generated from land-use activity via the use of water quality treatment devices designed in accordance with council guidelines, best practice, or the relevant device specification.

The preferred treatment devices will be an end of catchment bulk treatment device such as a wetland to provide full water quality treatment for the catchment wide with exception of any areas not able to be served/captured by strategically located wetland.

A high-level review of the potential post development catchment areas has been developed to sort catchments where wetland is the preferred stormwater management device from catchment where a BPO approach to managing stormwater outcomes is recommended. Refer to Appendix E for more information.

Stream hydrology mitigation:

- Provide SMAF-1 hydrological control to mitigate ongoing hydrological effects to Watercourse

Flooding:

- Overland flow paths (secondary systems) shall be designed with sufficient capacity to accommodate the 1% AEP event for the MPD/adjusted climate change scenario.
- Utilising the existing intermittent and permanent stream riparian yards for the storage and conveyance of the 100-year flows.
- Proposed buildings shall be clear of the flooding hazards and designed in accordance with stormwater code of practice.

Assets:

- All new public stormwater networks (primary systems) shall be designed to accommodate the 10% AEP event (incl. MPD and climate change) in accordance with stormwater code of practice.

Receiving Environment:

- Enhancing the riparian margin planting and overall health of the existing streams.
- Removing redundant culverts and in stream obstructions to restore fish passage through the PCA.
- Minimise were possible hard engineering structures within existing streams and provide integrated fish ladder designs into any structures that remain where of ecological benefit.
- Safeguarding the Significant Ecological Areas immediately downstream of the PCA

7.2.2 WATER SENSITIVE DESIGN

The key principals of water sensitive design approach can be implemented to the stormwater management framework for this PCA as shown below:

Promoting inter-disciplinary planning and design, through:

- Water sensitive urban design workshops were undertaken early with other consultants to develop a master plan based around core WSUD outcomes.
- Developing the BPO toolbox and circulate the BPO toolbox with other consultants for feedback to refine the BPO toolbox for resource consent applications.
- Undertake consultation with Iwi and Healthy Waters and integrate this feedback into the SMP.

Protect and enhance the values and functions of natural ecosystems, by:

- Promoting and adopting the blue-green networks throughout the PCA.
- Protecting and enhancing the riparian planting of the existing streams within the PCA.
- Removal of barrier to fish passage.
- Incorporate fish ladder designs within instream structures that need to be retained/provided.

Address stormwater effects as close to source as possible, through the inclusion of:

- Prevention of contamination via the use of inert building materials, and private proprietary stormwater treatment devices for privately own high contaminant carparks and COALs.
- For high use roads, the stormwater treatment devices will be located at source, where possible.
- Design wetlands to be located at the downstream of catchments (where practical/possible) to mitigate the effect of the stormwater prior to discharge into the receiving environment.
- Where catchment wide treatment is not feasible, adopting at source or smaller stormwater treatment devices to mitigate the effect of the stormwater prior to discharge into the receiving environment.

Mimic natural systems and processes for stormwater management by:

- Restoring and enhancing the riparian planting to improve the natural hydrological function of the existing streams.
- Design stormwater devices and green infrastructure that provides infiltration where practical/possible.

7.2.3 WATER QUALITY

The change of land-use from rural to residential has the potential to increase the adverse effects on the receiving environment through contamination, if left unmitigated. The common contaminations that can generated from residential areas are listed below:

- Heavy metals
- Oil & grease
- Temperature
- Sediment and suspend solid
- Indicative bacteria
- Nutrients

The proposed strategy will incorporate a WSUD approach focusing on reducing or eliminating stormwater contaminates through source control, using stormwater treatment devices consistent with Auckland Council guidelines such as GD01, GD04 and GD05. The water quality principals of this SMP targets the mitigation of all contamination generated from land-use activities. This can be achieved with stormwater quality treatment devices developed through guidance of GD01 & GD05. Please refer to Tables below for each respect Stormwater management Zone.

Table 7: Water quality treatment toolbox within the PCA for Stormwater Management Zone A

Stormwater Devices Toolbox for Water Quality		
Activity	Water quality treatment target	Recommended devices
Residential communal car park or COAL	• Heavy metal, grease and oil • Suspended solid removal • Water Temperature	• Catchment wide stormwater management device ➢ Wetland

Residential and commercial roof area	• Metal from roofing material • Organic debris from natural sources	• Catchment wide stormwater management device ➢ Wetland
High contaminant generating car park	• Heavy metal, grease, and oil • Suspended solid removal • Water Temperature	• Catchment wide stormwater management device ➢ Wetland
Public local Road	• Heavy metal, grease and oil • Suspended solid removal • Water Temperature	• Catchment wide stormwater management device ➢ Wetland
High use road	• Heavy metal, grease and oil • Suspended solid removal • Water Temperature	• Catchment wide stormwater management device ➢ Wetland
Stormwater run-off from any communal waste storage areas in apartment and multi-unit development	• Indicative bacteria • Nutrients	• Catchment wide stormwater management device ➢ Wetland
Earthworks	Mitigate the sediment generated from earthworks	Provide sediment and erosion control in accordance with GD05: • Decant earth bund • Sediment retention pond • Silt fence • Water diversion bund • Filter socks • Stabilised vehicle entrance • Wheel wash station • Chemical Treatment

Table 8: Water quality treatment toolbox within the PCA for Stormwater Management Zone B,C,D

Stormwater Devices Toolbox for Water Quality		
Activity	Water quality treatment target	Recommended devices
Residential communal car park and COAL	• Heavy metal, grease and oil • Suspended solid removal • Water Temperature	• Bioretention devices for private lot ➢ Rain gardens ➢ Grass or vegetated swales ➢ Stormwater tree pit ➢ Planter box

		Proprietary treatment devices
Residential and commercial roof area	• Metal from roofing material • Organic debris from natural sources	• Living roof • Planter box • Tree pit • Rain garden
High contaminant generating car park	• Heavy metal, grease, and oil • Suspended solid removal • Water Temperature	• Bioretention devices: ➢ Rain gardens ➢ Grass or vegetated swales ➢ Stormwater tree pit • Proprietary treatment devices if located in private land
Public local Road	• Heavy metal, grease and oil • Suspended solid removal • Water Temperature	• Bioretention devices at source ➢ Rain gardens ➢ Grass or vegetated swales ➢ Stormwater tree pit
High use road	• Heavy metal, grease and oil • Suspended solid removal • Water Temperature	• Provide at sources treatment Bioretention devices: ➢ Rain gardens ➢ Grass or vegetated swales ➢ Stormwater tree pit
Stormwater run-off from any communal waste storage areas in apartment and multi-unit development	• Indicative bacteria • Nutrients	• Provide at sources treatment Bioretention devices: ➢ Rain gardens ➢ Grass or vegetated swales ➢ Stormwater tree pit ➢ Planter box • Proprietary treatment devices if located in private land
Earthworks	Mitigate the sediment generated from earthworks	Provide sediment and erosion control in accordance with GD05: • Decant earth bund • Sediment retention pond • Silt fence • Water diversion bund • Filter socks • Stabilised vehicle entrance • Wheel wash station • Chemical Treatment

7.2.4 WATER QUANTITY

The intended urbanisation of the PCA will increase the impervious area which will increase stormwater runoff (both flow rates and volume). The existing impervious area of catchments within the PCA ranges from 0-5%. The post development impervious area will be increased to a range between 30 to 70%.

The water quantity principals of this SMP have proposed to pass forward flow for the 10 year and 100 year events. The SMP area will only provide hydrological mitigation for stream protection. Any rainfall event larger than the SMAF 1 event will not be detained. This approach is discussed further in the flood management chapter (7.2.5).

High level TP108 calculations have identified the hydrological mitigation volume required in post development scenarios for the PCA. Detailed values will be provided at resource consent stage(s) when the final layout has been confirmed. Table 8 outlines the high-level mitigation volume required for each catchment:

Catchment	SMAF1 Detention (m^3)
2	1516
3	7706
4	3143
6	1319
7	363
8	293

Table 9: Post development hydrological mitigation volume required for the PCA

Notes:

- The preliminary geotechnical investigation report has identified that there is limited infiltration on site. Hence the retention volume as per SMAF1 requirement has been added to the detention volume.
- The post development impervious area of catchments 1,5 & 9 are only increased a small fraction with the increase in volume and peak flow rate being negligible. The actual calculations will be provided at resource consent stage(s), as required. All new impervious areas within these catchments will required to meet the SMP objectives in terms of water quality and hydrological mitigation.

7.2.4.1 Hydrological mitigation

As mentioned in the early chapter of this Report, the Warkworth Township is subject to the SMAF 1 control. Given the PCA is located upstream of Warkworth and discharges directly to the southern branches of the

Mahurangi River. It is considered important to provide hydrology mitigation (as per SMAF 1) to mitigate the effect of lesser and more frequent storm events on the downstream stream erosion.

Consistent with the requirement of E10: Stormwater Management Area of AUP, the stormwater hydrological control on site will be as below:

Retention:

- Due to geotechnical/geological constraints, it has been recommended that no ground disposal/infiltration devices are included in the stormwater management plan. As such, the only likely cases where retention (greywater reuse) will be practical will be in any area not served by catchment-wide management devices (Wetlands) and at source management devices required, in accordance with AUP E10 requirements.

Detention:

- Provide detention (temporary storage) and a drain down period of 24 hours for the difference between the predevelopment and post-development runoff volumes from the 95th percentile, 24-hour rainfall event minus any retention volume that is achieved, over the impervious area for which hydrology mitigation is required.

A toolbox of hydraulic mitigation devices has been developed for the PCA to meet the stormwater hydraulic mitigation for each stormwater management zone as listed below:

Table 10: Hydrological mitigation device toolbox within the PCA for stormwater management zone A

Activity	Recommended Devices for Hydrological Mitigation
Residential communal car park and COAL	• Catchment-wide management devices ➢ Wetland
Residential and commercial roof area	• Catchment-wide management devices ➢ Wetland
Public Road	• Catchment-wide management devices ➢ Wetland

Table 11: Hydrological mitigation device toolbox within the PCA for stormwater management zone B,C,D

Activity	Recommended Devices for Hydrological Mitigation
Residential communal car park and COAL	• At source management devices ➢ Bioretention devices ➢ Detention tank
Residential and commercial roof area	• At source management devices ➢ Bioretention devices ➢ Retention/ reuse tank
Public Road	• At source management devices ➢ Bioretention devices

The SMP for the Warkworth Structure Plan has indicated that infiltration may be challenging for some areas of Warkworth. Preliminary geotechnical investigation and soakage tests has been carried out on the PCA. Please refer to the geotechnical report for more information. Based on the finding today, the soakage ability of the site is low. There are opportunity for ground infiltration. However, it is limited to a few pocket on the PCA. This will ultimately need to be confirmed by via geotechnical investigation and recommendation at resource consent stage. E10 of AUP has provided an alternative solution for location where soakage is not an option to meet the retention requirement under the SMAF control:

- *A suitably qualified person has confirmed that soil infiltration rates are less than 2mm/hr or there is no area on the site of sufficient size to accommodate all required infiltration that is free of geotechnical limitations (including slope, setback from infrastructure, building structures or boundaries and water table depth); and*
- *Rainwater reuse is not available because:*
  (i) The quality of the stormwater runoff is not suitable for on-site reuse (i.e. for non-potable water supply, garden/crop irrigation or toilet flushing); or
  (ii) There are no activities occurring on the site that can re-use the full 5mm retention volume of water.
- *The retention volume can be taken up by detention as follows:*
  (i) Provide detention (temporary storage) and a drain down period of 24 hours for the difference between the pre-development and post development runoff volumes from the 95th percentile (SMAF 1) / 90th percentile (SMAF 2), 24 hour rainfall event minus any retention volume that is achieved, over the impervious area for which hydrology mitigation is required.

7.2.4.2 Riparian Planting

Planting of riparian margins assists in evapotranspiration and infiltration improving ground water retention and stream health within the PCA. Riparian planting is a key player of the water cycle progress, planting initiates the natural water intake and infiltration through tree roots, promotes the water evaporation through tree leaves, protects the stream banks via tree roots and slows down the water velocity via the obstruction of flow, enhancing the water quality by absorbing the nutrients and heavy metals within the stormwater run-off while enhancing the eco system via the planting of native trees. As such these key measurements are proposed for the PCA:

- Minimum of 10m riparian planting required along the permanent streams and wetlands.
- Provide for and enhance riparian planting along intermediate streams & overland flow paths where possible.
- Stormwater outfall structures to be design in accordance with Auckland Council Technical Report 2013/018 - Hydraulic Energy Management.
- Promote the use of indigenous species for the riparian yard planting

Within the extent of this PCA there are various permanent streams, intermediate streams, and natural wetlands. Through a multiple discipline design approach, these natural assets will be preserved and enhanced to achieve improved freshwater and amenities outcome.

7.2.5 FLOODING MANAGEMENT

7.2.5.1 Downstream flooding management

There is risk of flooding downstream properties located in low-lying areas in the Mahurangi Catchment. The PCA is located in the middle of the Mahurangi Catchment. As a result, the peak run-off generated during large storm events has a lag from the upstream catchment compared to peak run-off generated from the PCA. This lag of peak run-off flow is presented in the Flood Modelling report in Appendix D.

Further flood modelling has been carried out to assess the impact to the down stream flood risk which is included in the Flood modelling report. In accordance with the flood modelling report passing forward the stormwater run-off from the PCA will not generate any adverse effect the downstream flooding. Please refer to an overlay of the pre to post hydrograph below for more information, in summary, increased time of concentration pushes PCA flows (yellow on graph) ahead of upstream flows (green, magenta) visible through the slight deviation ahead of an equivalent peak flow (in blue) within Figure 20.

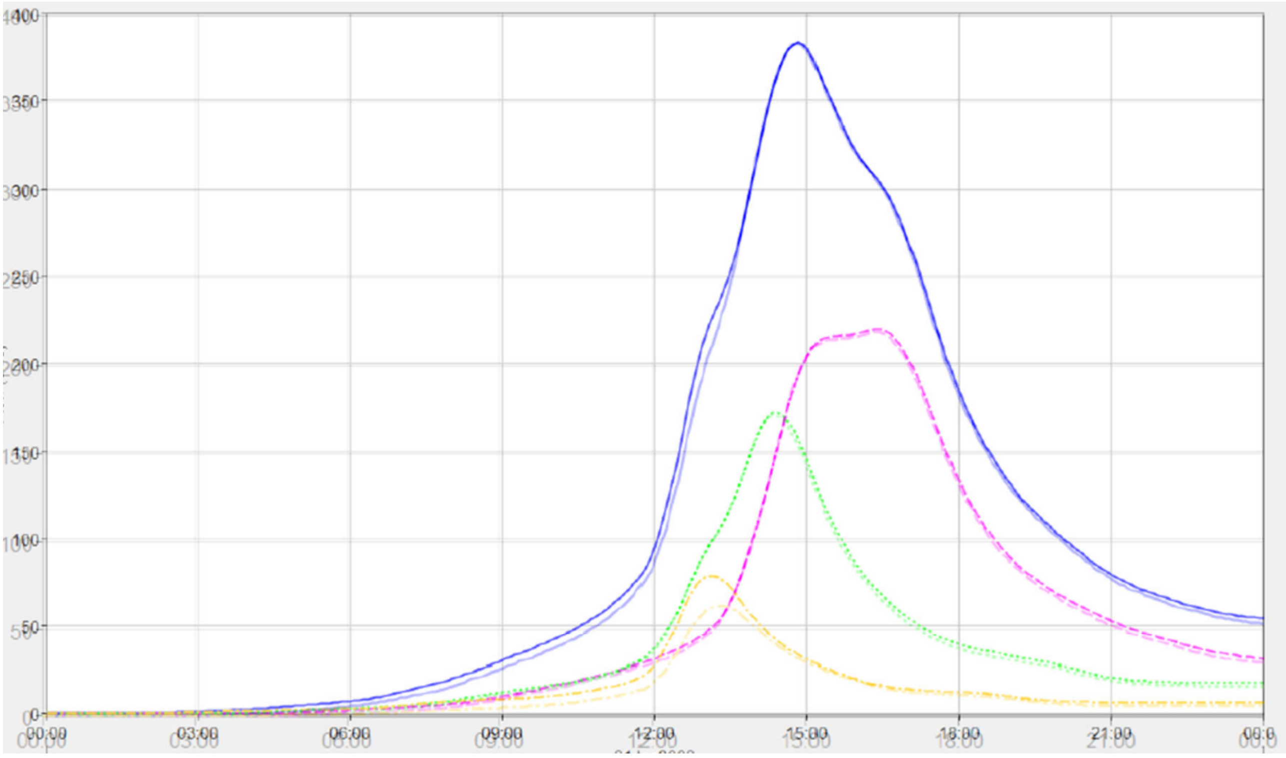

Figure 22: The Pre & Post Development Hydrograph overlay (faint line is pre-dev hydrograph)

It is therefore crucial to pass forward the stormwater generated from this site to mitigate the known risk of flooding downstream. Any attenuation of PCA flows will otherwise coincide with the large stormwater run-off generated from the upstream of the PCA and would amplify any existing downstream flooding issues.

The passing forward of the post-development 100-year flows is the primary tool for managing downstream flood risk in the wider catchment.

Another key recommendation from the flood modelling report is the recommendation to not provide any mitigation for the 10-year rainfall event. Attenuation of the 10-year storm event potentially delays the peak flow coinciding with upstream flows, similarly to the 1% AEP events, potentially causing adverse effect to the downstream environment.

7.2.5.2 Onsite flood management

The PCA has a network of major overland flow paths and extensive flood plain areas. This on-site constraint has been considered within the precinct and zoning plans developed for the PCA. Flood risks will be avoided within the PCA through the following recommendations:

- All building platforms to be located outside of the flood plain extent in the 100-year ARI MPD with climate change scenario.

- A minimum floor level will be set for each dwelling in accordance with Building Code and Auckland's Stormwater Code of Practice.
- Infrastructure to be located outside of the 100-year flood plain area, unless designed to be flood resilient.
- A networks of secondary flow paths will be designed to convey future 100-year flows.
- Utilising stream margins as areas of flood storage in the 100-year storm event.

7.2.6 CONVEYANCE

The stormwater run-off generated from within the PCA will be conveyed via primary and secondary stormwater systems. These systems will be designed in accordance with the current Stormwater Code of Practice.

The primary stormwater system:

This system consists of mainly manmade assets such as road kerbs, catchpits, manholes and pipes. This system will be designed to convey the stormwater runoff generated for and up to a 10-year storm event. The water runoff will be collected from each sub-catchment from the road catchpits and lot connections and conveyed to the water quality devices at the end of each catchment prior to discharge towards the existing stream networks/ secondary flow paths.

The secondary stormwater system:

The secondary stormwater system will consist of man-made assets such as roading networks, engineering swales and overland flow path discharging to naturally occurring conveyance means; the existing stream networks located throughout the PCA.

This system will be designed with the capacity to convey the run-off generated from the PCA in storm event up to the 100 year ARI. The existing stream networks on site will be investigated and improve (removing in stream structures/obstructions) to ensure there is adequate capacity in the 100 year ARI, for the MPD include climate change scenario.

The secondary flow path will be in large consistent with the existing over land flow path route located on the PCA extent.

7.2.7 DEVELOPMENT STAGING

*****To be addressed at Resource Consent stage*****

7.3 HYDRAULIC CONNECTIVITY

*****To be addressed at Resource Consent stage***'**

7.4 ASSET OWNERSHIP

All proposed public stormwater networks & management devices within land, road or park reserves will be vested to, owned and maintained by Auckland Council or the relevant CCO (Healthy Waters, Auckland Transport).

All stormwater management devices in the public road reserve shall be vested to, owned and maintained by Auckland Transport.

Stormwater devices treating JOALs are to be owned and maintained by Body Corporates/Resident Associations or Lot owners.

All public roadways and related assets within public reserves will be owned by Auckland Transport.

7.5 ONGOING MAINTENANCE REQUIREMENTS

All public stormwater extensions at the site, pipes and manholes forming the extent there of, are to be maintained by Auckland Council. All private devices are to be maintained by related Body Corporates/Resident Associations or lot owners.

It is proposed that all stormwater devices proposed are proprietary systems that have documented operation and maintenance schedules and plans for such activities.

Operation and maintenance plans will be provided for all stormwater management devices that will be vested with Council. This will be required as a condition of any approved consent.

7.6 IMPLEMENTATION OF STORMWATER NETWORK

It is expected that the new stormwater network will be constructed progressively as the PCA is developed, catchment wide stormwater devices will be required to be built at the cost of the developer, ensuring the device is able to cater or be developed to serve the full MPD catchment. Provisions on protecting the downstream network shall be met through implementing temporary sediment and erosion controls to ensure stormwater discharge is properly treated and discharged during construction.

The methodology for implementation of the proposed networks are as follows:

- Bulk Earthworks completed.
- Construction/relocation of public stormwater/wastewater infrastructure.
- Construction of private drainage under accessways.
- Stabilisation of the site and construction of accessways.
- Vesting of newly constructed public drainage assets.
- Construction of residential dwellings and associated private drainage.

The specific design and implementation of the stormwater network and associated devices will be subject to detailed design at future resource consent stages. The details of which will be included in future SMPs that will be required in support of the resource consent(s). This SMP sets out the high-level framework for the PCA, of which any future SMP will adhere too.

7.7 DEPENDENCIES

*****Not applicable within this SMP*****

7.8 RISKS

Table 10: Risk Matrix for the PCA

What is the risk to the proposed stormwater management?	How can this be mitigated / managed?	What other management / mitigation could be used?	When does this risk need to be addressed?	What is the resultant level of risk?
Passing forward the 100- & 10-years flood flow which may inundate downstream property	Working closely with Healthy Water flood modelling team to verify the finding and recommendation of pass forward flow	Detention ponds for up to 100 years, however, if this may have a negative impact to the flooding downstream if the time of concentration is as per the flood modelling report finding.	Plan change stage	moderate
The effectiveness of downstream stream erosion protection	Detail stream bank investigation to ensure that existing stream has adequate capacity and there is no known risk of erosion	SMAF 1 hydrological mitigation will provide stream erosion protection on the frequent rainfall event which has been detailed in the chapter 7.2.4.1.	Through the implementation of this SMP	moderate
The possibility of ground infiltration on the PCA	Detail ground soakage testing through the PCA	n/a	Plan change stage and detail investigation at resources consent stage	low
The ground stabilities due to the use of ground soakage devices	Detail site geotechnical investigation	n/a	Plan change stage and detail investigation at resources consent stage	low
The water quality discharge from the plan change area does not meet NDC requirement	Implementing the water quality treatment guidelines as set out in chapter 7.2.3 of this SMP. This will ensure that the water quality discharge from the plan	Promoting the water quality treatment train and water sensitive design throughout all phrases of the development	Through the implementation of this SMP	Low

	change area meet the design criteria from NDC.			
Riparian planting fails to thrive and damaged during large storm event	Promote the use of indigenous plant species to be used for the riparian planting to ensure survival rate of the riparian planting. Ensure a maintenance plan is put in place for annual survey and maintenance the riparian yard planting or after a large storm event	n/a	Plan change stage where the principal has been set and resources consent stage when the development layout has been confirmed.	Low
Existing natural stream will be polluted with rubbish and illegal dumping	Provide workshop with the local residents to promote a sense of guardianship toward natural resources	n/a	Through out all phrases of development	Low
An increase in provision for climate change due to revision of the Stormwater Code of Practice (SWCoP)	Working closely with Healthy Waters flood modelling team to analyse the findings of revised modelling and adopt a new management strategy if required.	n/a	If the SWCoP is revised	Low

8 DEPARTURES FROM REGULATORY OR DESIGN CODES

There are no known departures from Auckland regulatory and design standards.

9 CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK

9.1 CONCLUSIONS

This SMP for the Warkworth South PCA has been developed based on AUP regulatory policies, Auckland Council stormwater-specific guidelines and the overarching NDC requirements.

The overarching principle of the SMP is to implement an integrated stormwater management approach, which includes:

- Recognising the key constraints and opportunities on site and wider Mahurangi catchment.
- Devising an integrated stormwater management approach to facilitate urban development and optimise available land.
- Emphasising a water-sensitive design approach that:
  - manages the impact of land use change from rural to urban
  - protects and enhances stream systems
  - mitigates for hydrological changes and manages flooding effects
- Mitigate the generation and discharge of contaminants/sediments into the sensitive receiving environments downstream of the PCA.
- Facilitating urban development and protecting key infrastructure, people and the environment from significant flooding events.
- To achieve these outcomes, the proposed stormwater management approach will:
  - Provide catchment wide treatment devices such as Wetland at the end of each catchment or at source stormwater devices where wetland is not feasible.
  - Provide a minimum of SMAF 1 hydrological mitigation for all impervious surfaces within the PCA
  - Adopt the 'pass forward flow' flood management approach which is recommended in the flood modelling report to mitigate the effects on downstream flooding
  - Protect, restore, enhance and incorporate streams and overland flow paths as elements of future primary and secondary stormwater conveyance systems.

The detailed design of the proposed stormwater management approach, including device selection, sizing and location will be addressed at the resource consent stages of plan change area.

Based on the investigations that have been completed at this stage, it is expected that stormwater effects from the PCA can be appropriately and adequately managed consistently with the requirements of the AUP and NDC. The plan change can, therefore, proceed with all stormwater management matters mitigated through the recommendations of this SMP.

9.2 RECOMMENDATIONS

This SMP sets out a high-level stormwater management framework for the PCA. Detailed SMPs will be required at the resource consent design stage to provide a detailed design response for the respective catchments. These future SMPs will adhere to the overarching principals of this Plan Change SMP. These future SMPs will be adopted under the Healthy Waters Region wide NDC and will authorise the future stormwater discharge from the PCA.

Further recommendation to support the next phases of development within the Waimanawa development are listed below:

- The design recommended within this SMP will guide site specific SMPs which will support the future development within the PCA.
- Specific design and implementation of the stormwater network and associated devices will adhere to the design outcomes set out in this Plan Change SMP.
- Site specific SMPs will detail compliance with Schedule 4 of the Region wide NDC, and once adopted will authorise stormwater discharge.
- Targeted percolation testing in support of resource consent(s) is recommended to confirm if there are localised areas, outside of the catchment wide stormwater management devices, with infiltration capacity.

APPENDIX A – PLANS OF EXISTING SITE FEATURES

Auckland Council

Map

DISCLAIMER:
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Height datum: Auckland 1946.

Warkworth South

0 80 160 240
Meters

Scale @ A3
= 1:8,000

Date Printed:
22/07/2022

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Rivers and Permanent Streams
- Open Watercourse
- Piped Watercourse
- Culvert
- Pond

Overland Flow Paths
Overland Flow Paths - 100ha and above (25,000)
- Overland Flow Paths - 100ha and above (25,000)

Overland Flow Paths - 3ha to 100ha (25,000)
- Overland Flow Paths - 3ha to 100ha (25,000)

Overland Flow Paths - 1ha to 3ha (15,000)
- Overland Flow Paths - 1ha to 3ha (15,000)

Overland Flow Paths - 4000m2 to 1ha (8,000)
- Overland Flow Paths - 4000m2 to 1ha (8,000)

Stormwater Management Plans
- Adopted
- Provisional

Flood Prone Areas
- Flood Prone Areas

Flood Sensitive Area
- Flood Sensitive Area

Flood Plains
- Flood Plains

Wastewater
Local Network
Wastewater Pipe GIS ID Label (Local)
- Wastewater Pipe GIS ID Label (Local)

Wastewater Pipe (Local)
- Operational
- Operational Not Vested
- Abandoned / Not Operational

Wastewater Structure (Local)
Wastewater Other Structure (Local)
- Wastewater Other Structure (Local)

Wastewater Pump Station (Local)
- Wastewater Pump Station (Local)

Transmission Network
Wastewater Pipe (Transmission)
- Operational
- Not Operational
- Proposed

Wastewater Structure (Transmission)
Stormwater
Stormwater Treatment Device
- Public
- Private

Stormwater Pond or Wetland Components
Stormwater Forebay
- Public
- Private

Stormwater Treatment Facility
- Public
- Private

Stormwater Watercourse
- Public
- Private

Stormwater Pipe SAP ID label
- Stormwater Pipe SAP ID label

Stormwater Pipe
- Public - Gravity Mains
- Private - Gravity Mains
- KiwiRail, Gravity Mains
- Public - Culvert/Tunnel
- Private - Culvert/Tunnel
- KiwiRail, Culvert/Tunnel; KiwiRail, In Service, Culvert
- Public - Rising Main
- Private - Rising Main
- Public - Subsoil Drain
- Private - Subsoil Drain

Stormwater Connection
- Public
- Private

Stormwater Channel
- Public lined
- Public Watercourse
- Private Watercourse

Stormwater Pump Station
- Public
- Private

Stormwater Planting
- Public
- Private

Stormwater Erosion And Flood Control
- Public - Wall Structure
- Private - Wall Structure
- Public - Other Structure
- Private - Other Structure

Stormwater Abandoned Assets
Stormwater Abandoned Pipe
- Public - Gravity Mains
- Public - Culvert/Tunnel
- Public - Rising Main
- Public - Subsoil Drain

Stormwater Abandoned Connection
- Public

Septic Tank
- Public - Hi-Tech
- Private - Hi-Tech
- Public - Other
- Private - Other

Water
Local Network
Water Fitting (Local)
Water Pipe (Local)
- Operational (Non-Potable)
- Operational (Potable)
- Operational Not Vested
- Abandoned / Not Operational

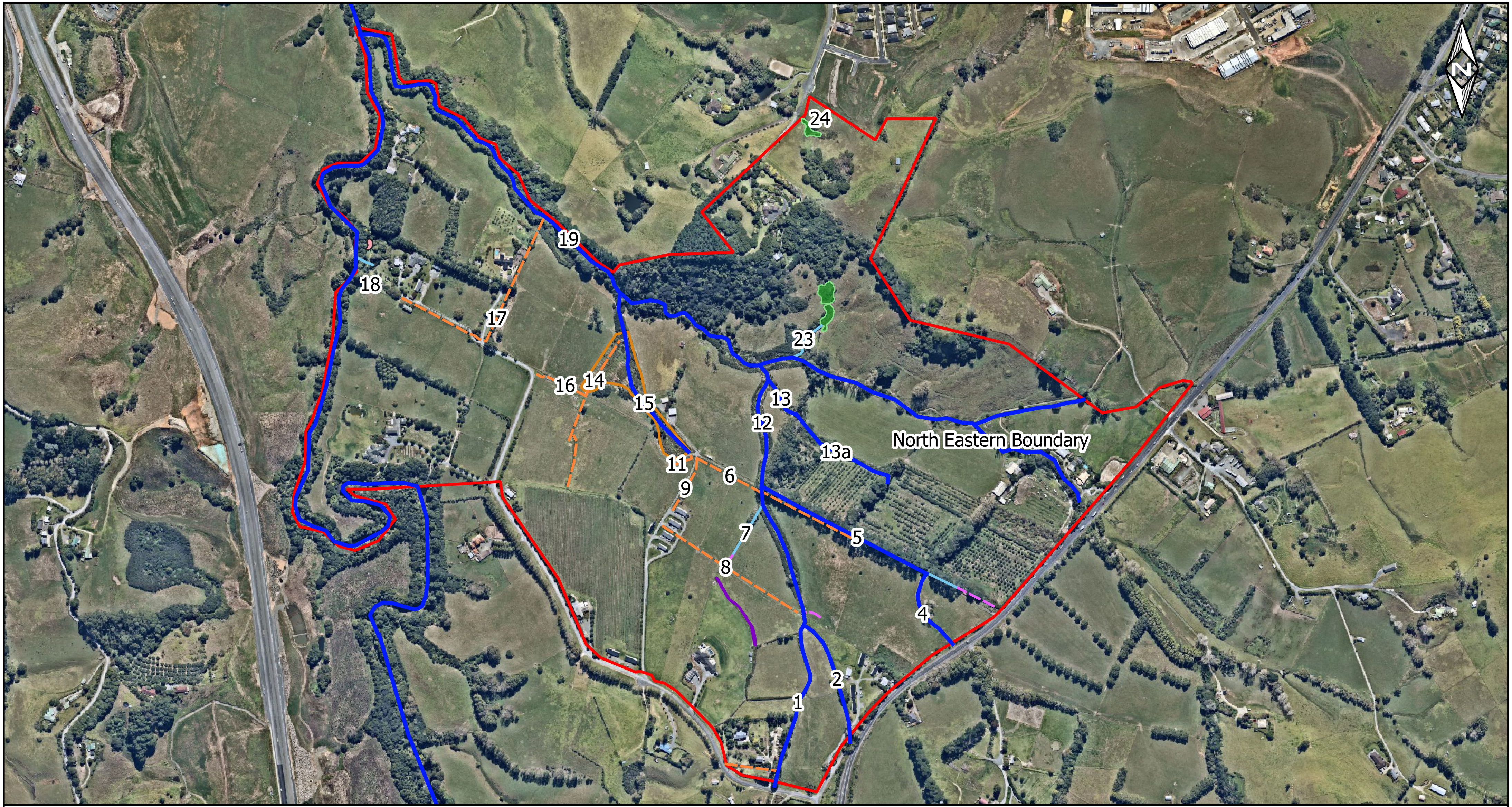
Water Structure (Local)
Water Other Structure (Local)
- Water Other Structure (Local)

Water Pump Station (Local)
- Water Pump Station (Local)

Legend

Date Printed: 22/07/2022

Auckland Council
Te Kaunihera o Tāmaki Makaurau



Warkworth South Plan Change Area

Waimanawa Valley

1711 and 1723 State Highway 1
36, 40, 46 and 126 Valerie Close Road

Legend

- Permanent Stream
- Intermittent Stream
- Ephemeral flow path
- Artificial watercourse
- Constructed Wetland
- Offline pond
- Site boundaries

0 100 200 300 400 m

Bioresearches
A Babbage Company

31/08/2022 Project No.63967 Drawn by AJC

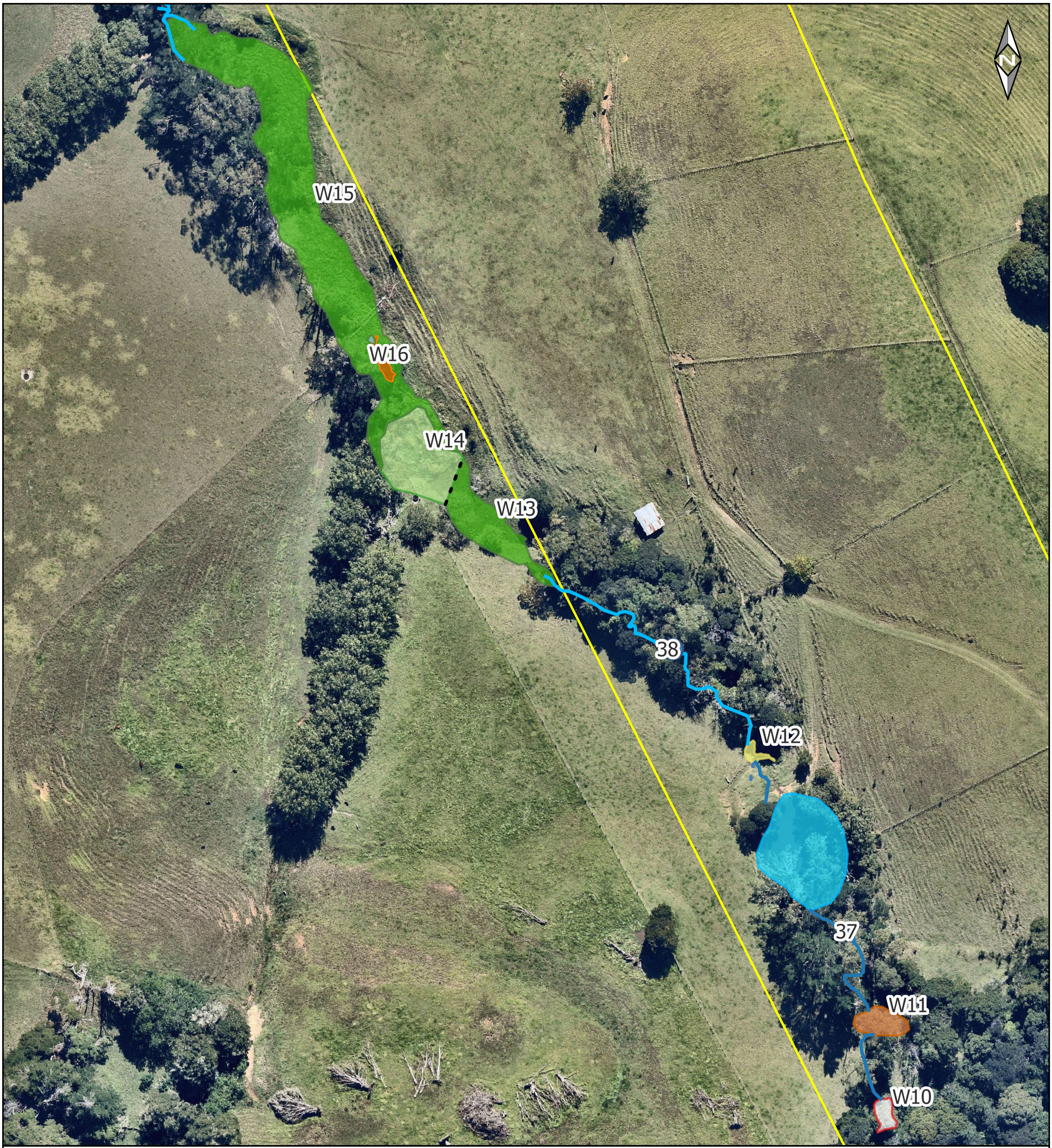
Waimanawa Hills (a)
Warkworth South Freshwater Features

Legend

- Natural Wetland
- Constructed Wetland
- Permanent Stream
- Intermittent Stream
- Ephemeral Flow Path
- Site Boundaries

Bioresearches
A Babbage Company

22/07/2021 Project No.64336 Drawn by NRK



Waimanawa Hills (b)
Warkworth South
Freshwater Features

0 25 50 m

Legend

- Waterfall
- Overland flow path
- Intermittent stream
- Permanent stream
- Fenceline
- Site boundary

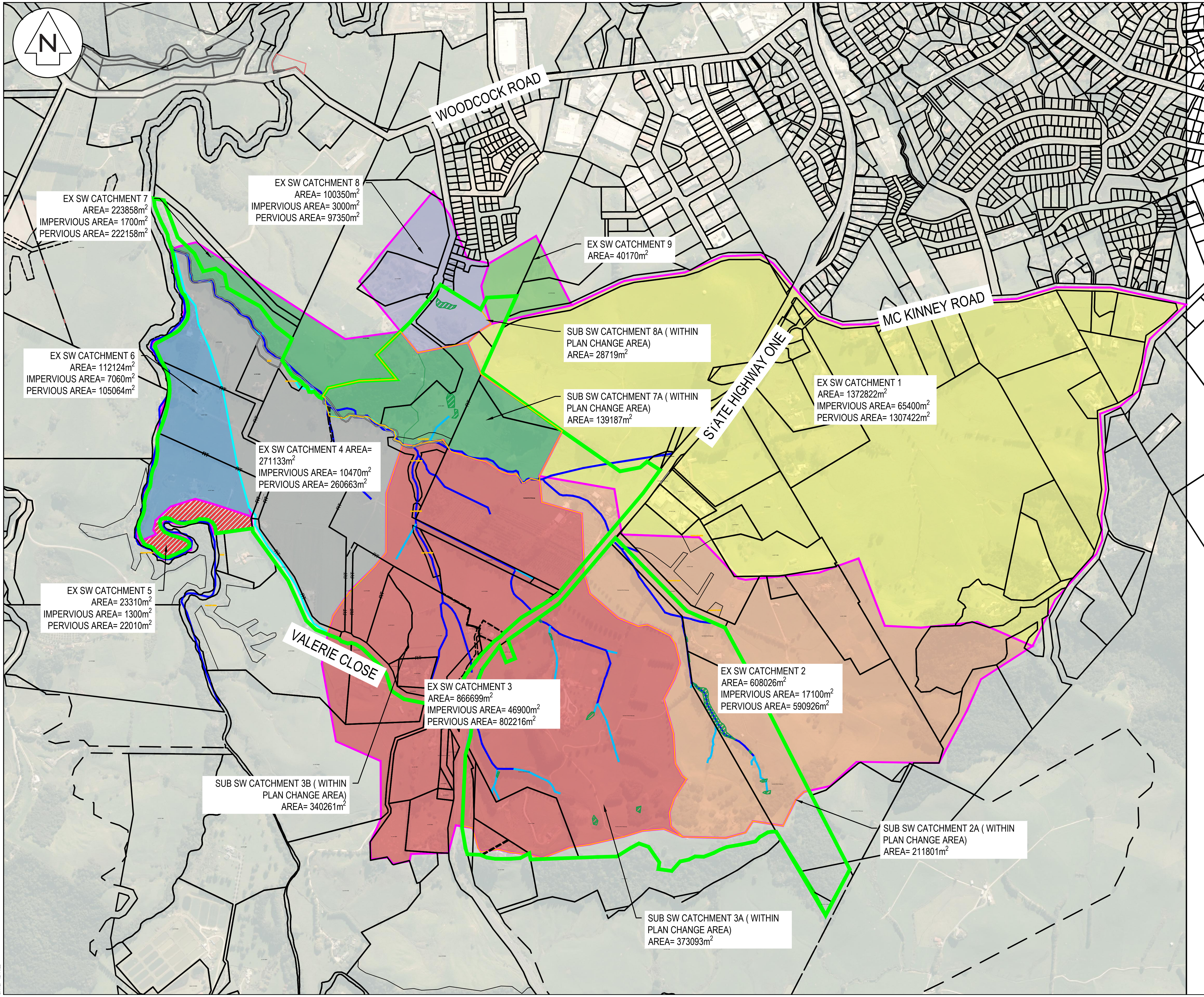
Dominant wetland vegetation

- Arum lily
- Giant umbrella sedge
- Reed-sweet grass
- Isolepis
- Mercer grass
- Dam
- Rautahi

Bioresearches
A Babbage Company

20/01/2022 Project No.65138 By LD

APPENDIX B – ENGINEERING PLANS



Notes
1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Legend

(black line)	EX BDY
(green line)	PLAN CHANGE BDY
(magenta line)	SW CATCHMENT
(orange line)	SUB SW CATCHMENT
(blue line)	EX PERM. STREAM
(cyan line)	EX INTER. STREAM
(hatched)	EX WETLAND

Rev	Description	By	Date
B	PPC EXTENT UPDATE	KH	12/22
A	PPC	KH	08/22

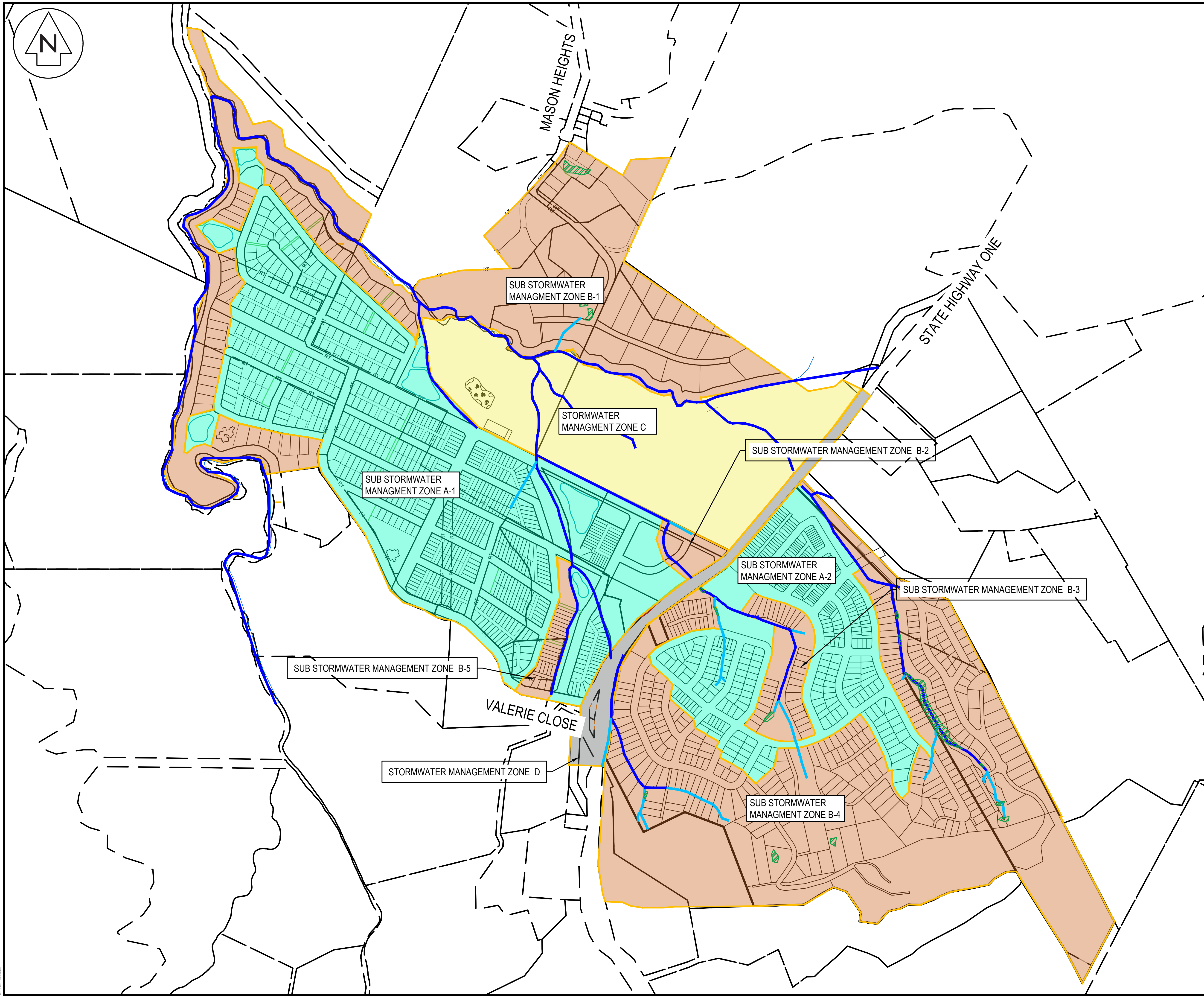
	By	Date
Survey	PARALAX & MAVEN	03/21
Design		
Drawn	KH	08/22
Checked	GB	08/22

MAVEN
Maven Associates
09 571 0050
info@maven.co.nz
www.maven.co.nz
5 Owens Road, Epsom
Auckland 1023

Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
EXISTING STORMWATER CATCHMENT PLAN

Project no.	211001
Scale	1:10000 @ A3
Cad file	SMP PLAN.DWG
Drawing no.	C450
Rev	B



Notes
1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Legend
- EX BDY
- PLAN CHANGE BDY
- SW CATCHMENT
- SUB SW CATCHMENT
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND
- SW MANAGEMENT ZONE A
- SW MANAGEMENT ZONE B
- SW MANAGEMENT ZONE C
- SW MANAGEMENT ZONE D

Rev	Description	By	Date
A	PPC RFI	KH	06/23

	By	Date
Survey	PARALAX & MAVEN	03/21
Design	KH	06/23
Drawn	KH	06/23
Checked	LC	06/23

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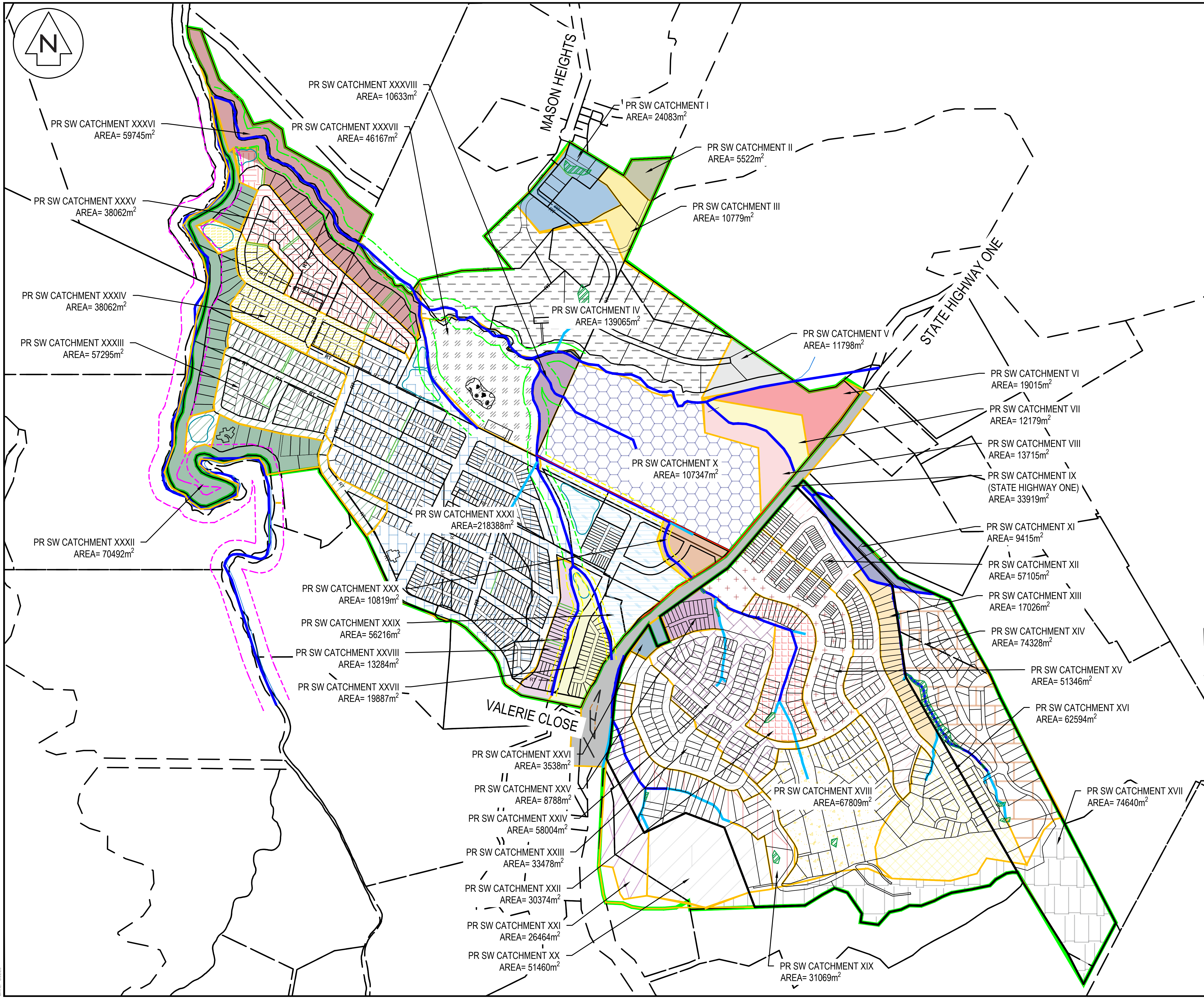
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT STORMWATER MANGEMENT ZONE PLAN

Project no.	211001
Scale	1:10000 @ A3
Cad file	211001- C452 SMZ.DWG
Drawing no.	C452
Rev	A



Notes
1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Legend

EX BDY	
PLAN CHANGE BDY	
SW CATCHMENT	
SUB SW CATCHMENT	
EX PERM. STREAM	
EX INTER. STREAM	
EX WETLAND	

Rev	Description	By	Date
A	PPC	KH	08/22

	By	Date
Survey	PARALAX & MAVEN	03/21
Design		
Drawn	KH	08/22
Checked	GB	08/22

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Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT STORMWATER CATCHMENT PLAN

Project no.	211001
Scale	1:10000 @ A3
Cad file	211001- C451 PRO DEV CATCHMENT.DWG
Drawing no.	C451
Rev	A

DATE: 6/22/23

APPENDIX C – ENGINEERING CALCULATIONS

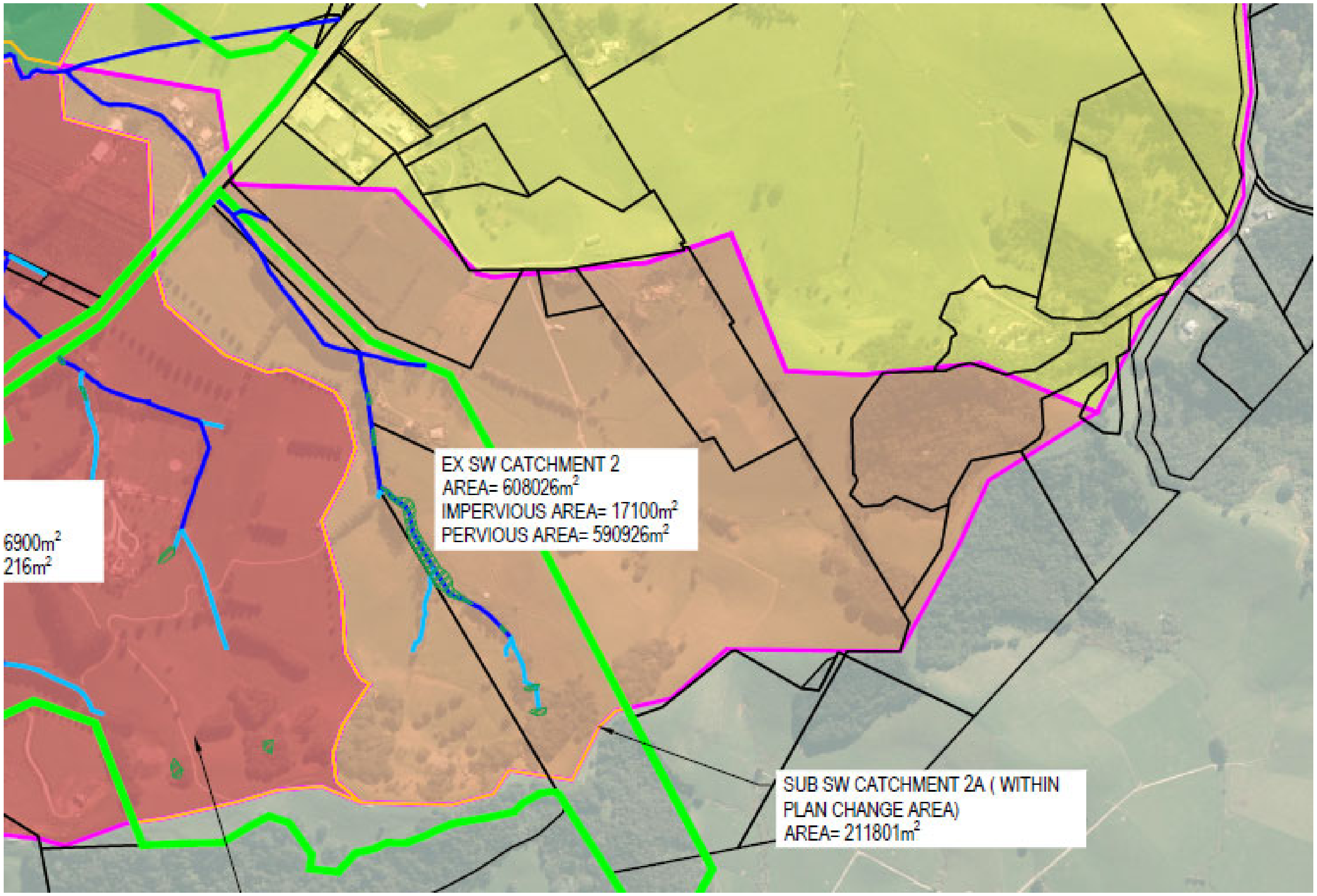
MAVEN ASSOCIATES		**Job Number** 211001	**Sheet** 1	**Rev** C
Job Title	**WARKWORTH SOUTH PCA**	**Author** KH	**Date** 13/12/2022	**Checked** LC
Calc Title	**PRE TO POST SW RUN-OFF CATCHMENT 2**			

Catchment	Area*	SMAF1 Detention volume (m3)**
2	608020	1516
Total	608020	1516

* the plan change area within this catchment is 211801m2

** the geotechnical report has indicate that there is limited infiltration on site. Hence the retention volume is added on top of the detention volume

post development MPD within the plan change area of catchment 2 is assumped to be 50% where the upper reach of the catchment is large lot and single zone lot with maximum impervious area is 35% of the site as per AUP and there is one major watercourse running at the center of catchment within plan change area .
While the outside of the plan change area the total impervious area is assumped to be 5% of the total catchment


EX SW CATCHMENT 2
AREA= 608026m2
IMPERVIOUS AREA= 17100m2
PERVIOUS AREA= 590926m2
6900m2
216m2
SUB SW CATCHMENT 2A (WITHIN
PLAN CHANGE AREA)
AREA= 211801m2

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 2	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	3.0401	297.93
C	Open space (Pervious)	74	57.7619	4274.38
* from Appendix B		Totals =	60.8020	4572.31

CN (weighted) = total product / total area = 4572.31 / 60.802 = 75.2

Ia (average) = 5 x pervious area / total area = 5 x 57.7619 / 60.802 = 4.8 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 2.338 km (along drainage path)

Catchment Slope Sc= 0.0195 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 75.2 / (200- 75.2) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14   1   1.75   1.32   3.26   = 1.06 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.71 hrs

42.44 mins

OK
use
1.06 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 3	Rev C
Job Title WARKWORTH SOUTH PCA Calc Title PRE TO POST SW RUN-OFF CATCHMENT 2	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.60802	km2(100ha =1km2)
Runoff curve number	CN=	75.2	(from worksheet 1)
Initial abstraction	Ia=	4.8	mm (from worksheet 1)
Time of concentration	tc=	1.06	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 83.8 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
Climate change %					
24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.16				
6. Specific peak flow rate q*	0.023				
7. Peak flow rate, q_p=q*A*P_{24}	**0.587**				m3/s
8. Runoff depth, $Q_{24} = (P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	11.5				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	6971.52				(m3)

Worksheet 2: Graphical Peak Flow Rate

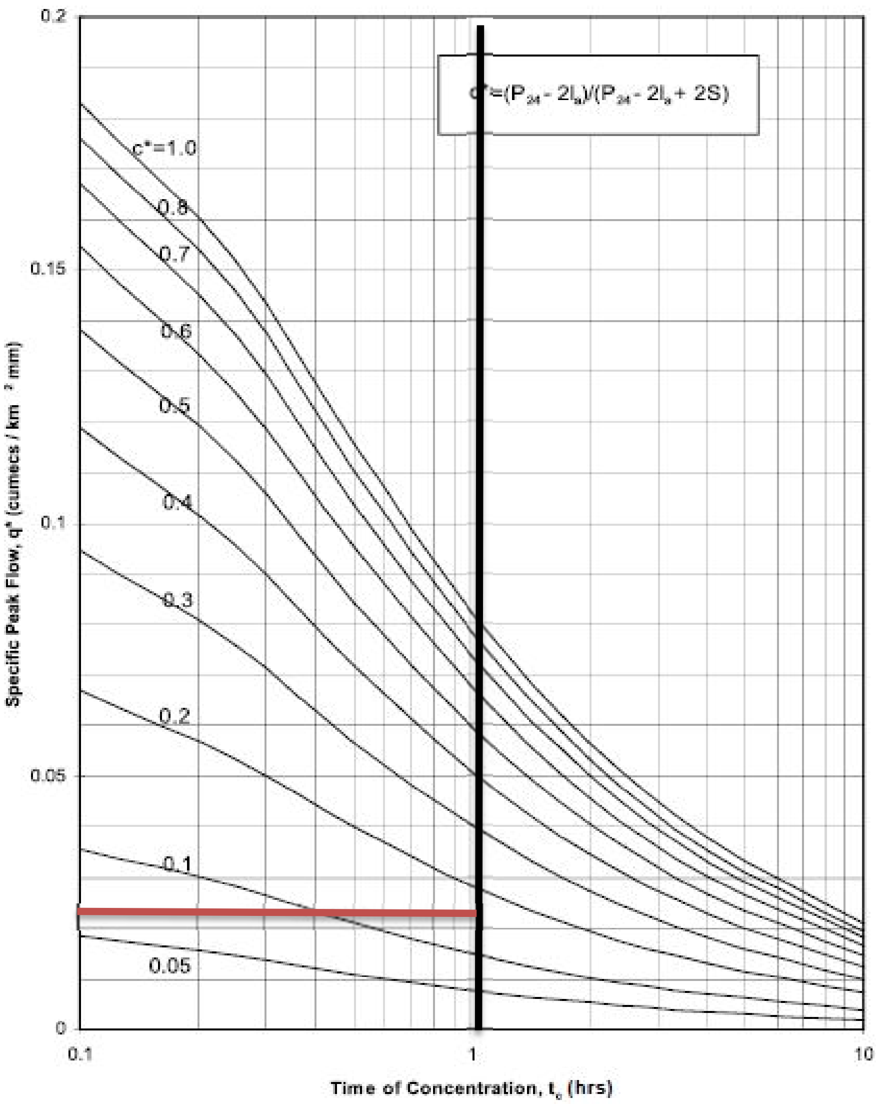


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 4	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 2	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	13.6302	1335.75
C	Grass (landscape and gardens)	74	47.1719	3490.72
* from Appendix B		Totals =	60.8020	4826.47

CN (weighted) = total product / total area = 4826.47 / 60.802 = 79.4

Ia (average) = 5 x pervious area / total area = 5 x 47.1719 / 60.802 = 3.9 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 2.338 km (along drainage path)

Catchment Slope Sc= 0.0195 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 79.4 / (200- 79.4) = 0.66

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.75 1.26 3.26 = 0.60 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.40 hrs

4.26 mins

OK

use

0.6034553 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 5	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 2	Author KH	Date 13/12/2022	Checked LC

1. Data
   Catchment Area A= 0.60802 km2(100ha =1km2)

   Runoff curve number CN= 79.4 (from worksheet 1)

   Initial abstraction Ia= 3.9 mm (from worksheet 1)

   Time of concentration tc= 0.60 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 66.0 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
P24					(%)
4. 24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.21				
6. Specific peak flow rate q*	0.036				
7. Peak flow rate, q_p=q*A*P_{24}	0.919				m3/s
PEAK FLOW RATE PRE DEV=	0.587				
PRE TO POST FLOW RATE=	**0.332**				
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	14.0				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	8487.74				(m3)
RUNOFF VOLUME PRE DEV=	6971.52				
PRE TO POST VOLUME=	**1516.22**				

Worksheet 2: Graphical Peak Flow Rate

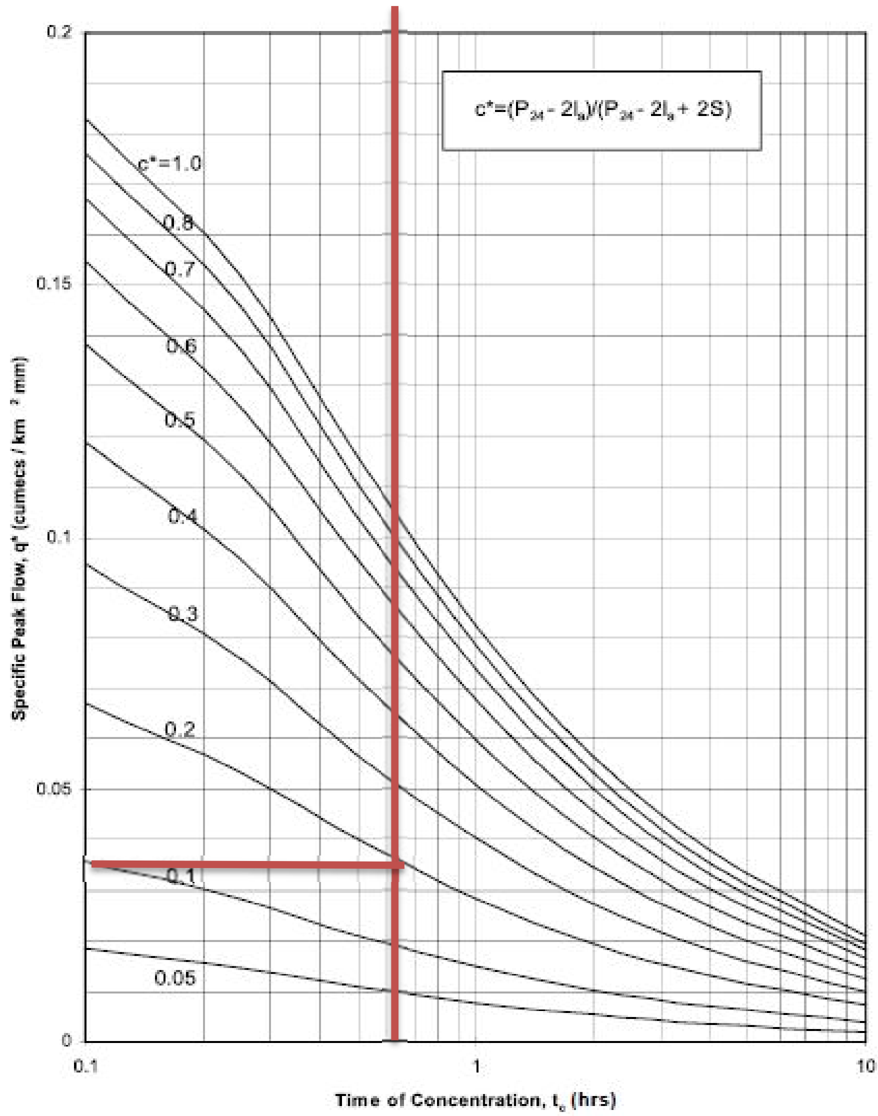


Figure 5.1 – Specific Peak Flow Rate

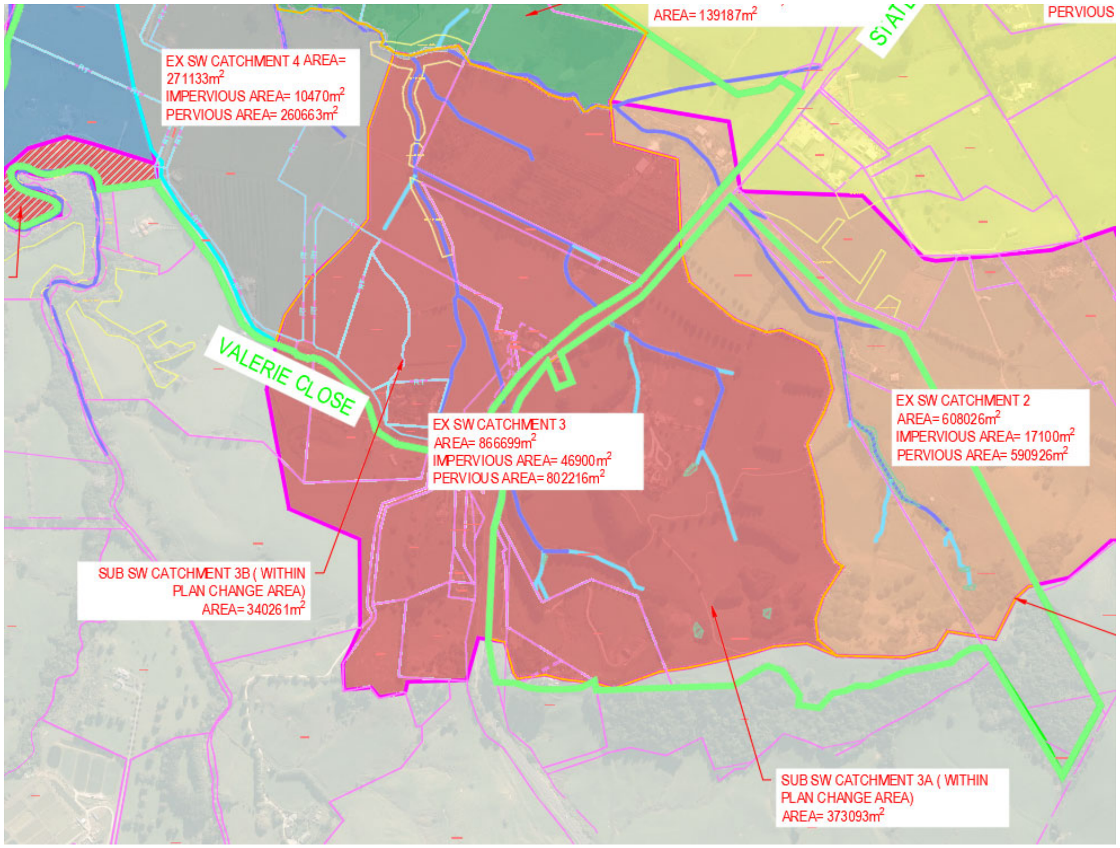
MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 3	Author KH	Date 13/12/2022	Checked LC

Catchment	Area*	SMAF1 Detention volume (m3)**
3	866699	7706
Total	866699	7706

* the plan change area within this catchment is 713354m2

** the geotechnical report has indicate that there is limited infiltration on site. Hence the retention volume is added on top of the detention volume

post development MPD within the plan change area of catchment 3 is assumped to be 60% where the upper reach of the catchment is large lot and single zone lot with maximum impervious area is 35% of the site as per AUP and there is central park area plus various watercourses . While the outside of the plan change area the total impervious area is assumped to be 5% of the total catchment



F:\MAVEN\Projects\211001\Excel\tp108 for volume mitigation\221213 Detention SW CALC TP108 Catchment 3

MAVEN ASSOCIATES		Job Number 211001	Sheet 2	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 3	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	4.3335	424.68
C	Open space (Pervious)	74	82.3364	6092.89
* from Appendix B		Totals =	86.6699	6517.58

CN (weighted) = total product = 6517.58 = 75.2
total area 86.670

Ia (average) = 5 x pervious area = 5 x 82.3364 4.8 mm
total area 86.670

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 2.11 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN = 75.2 = 0.60
200 - CN 200- 75.2

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.64 1.32 3.06 = 0.93 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.62 hrs
37.27 mins

OK
use
0.93 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 3	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 3	Author KH	Date 13/12/2022	Checked LC

1. Data
   Catchment Area A= 0.866699 km2(100ha =1km2)

   Runoff curve number CN= 75.2 (from worksheet 1)

   Initial abstraction Ia= 4.8 mm (from worksheet 1)

   Time of concentration tc= 0.93 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 83.8 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
Climate change %					
24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.16				
6. Specific peak flow rate q*	0.023				
7. Peak flow rate, q_p=q*A*P_{24}	**0.837**				m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	11.5				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	9937.52				(m3)

Worksheet 2: Graphical Peak Flow Rate

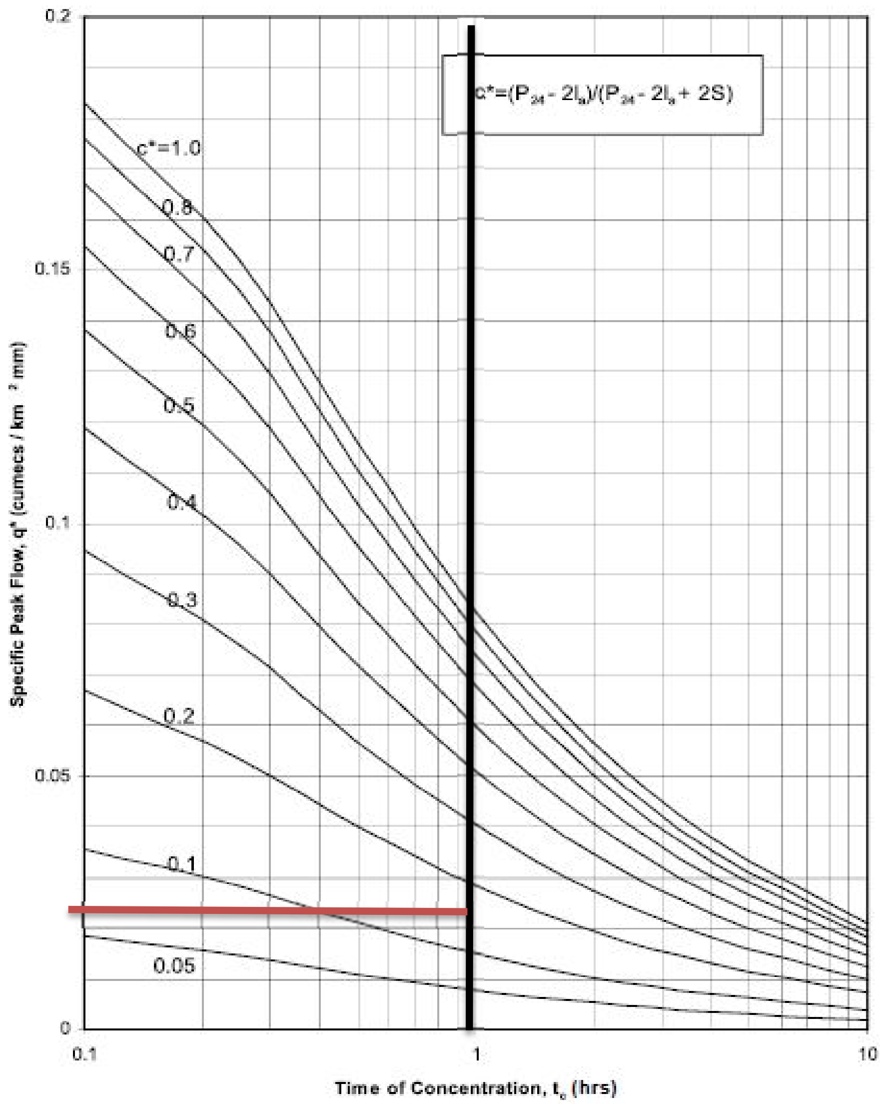


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES		Job Number 211001	Sheet 4	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 3	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	47.1347	4619.20
C	Grass (landscape and gardens)	74	39.5352	2925.60
* from Appendix B		Totals =	86.6699	7544.81

CN (weighted) = total product / total area = 7544.81 / 86.670 = 87.1

Ia (average) = 5 x pervious area / total area = 5 x 39.5352 / 86.670 = 2.3 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 2.11 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 87.1 / (200- 87.1) = 0.77

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.64 1.15 3.06 = 0.49 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.33 hrs

4.26 mins

OK

use

0.4857874 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 5	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 3	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.866699	km2(100ha =1km2)
Runoff curve number	CN=	87.1	(from worksheet 1)
Initial abstraction	Ia=	2.3	mm (from worksheet 1)
Time of concentration	tc=	0.49	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 37.8 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
P24					(%)
4. 24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.33				
6. Specific peak flow rate q*	0.057				
7. Peak flow rate, q_p=q*A*P_{24}	2.075				m3/s
PEAK FLOW RATE PRE DEV=	0.837				
PRE TO POST FLOW RATE=	**1.238**				
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	20.4				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	17643.24				(m3)
RUNOFF VOLUME PRE DEV=	9937.52				
PRE TO POST VOLUME=	**7705.71**				

Worksheet 2: Graphical Peak Flow Rate

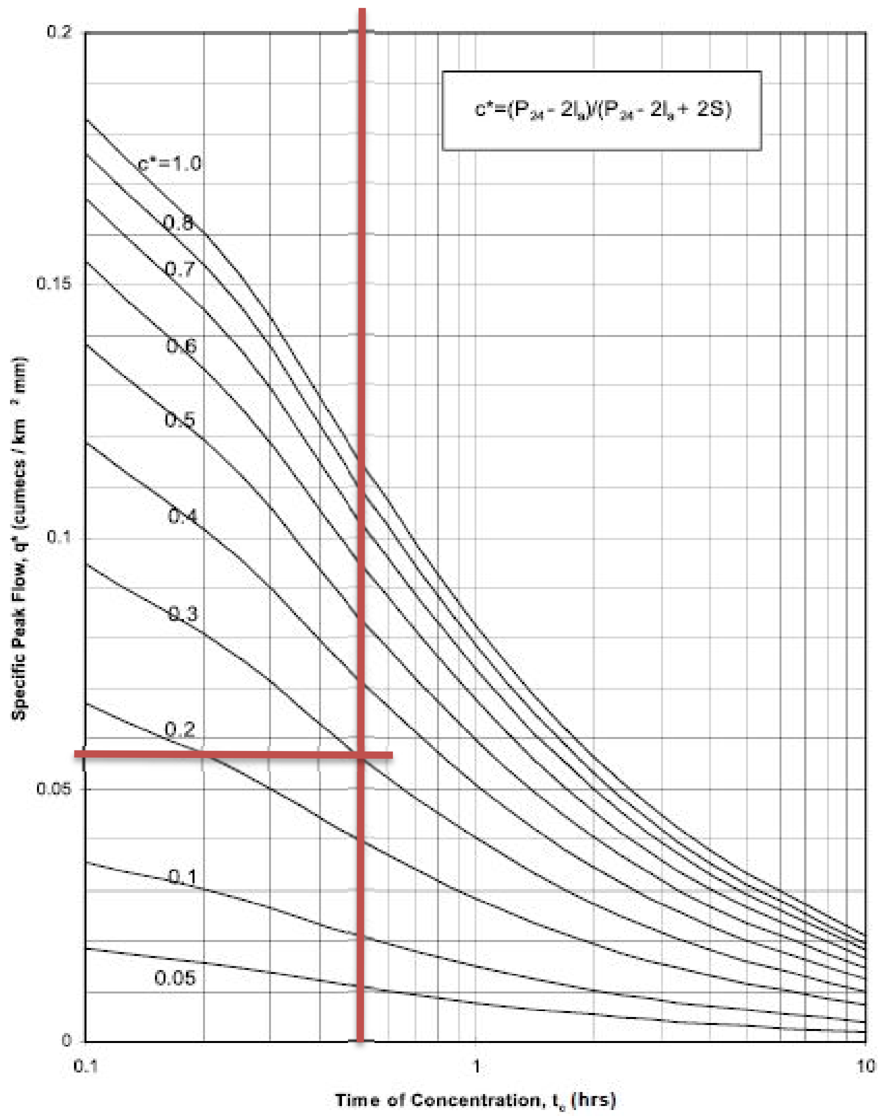


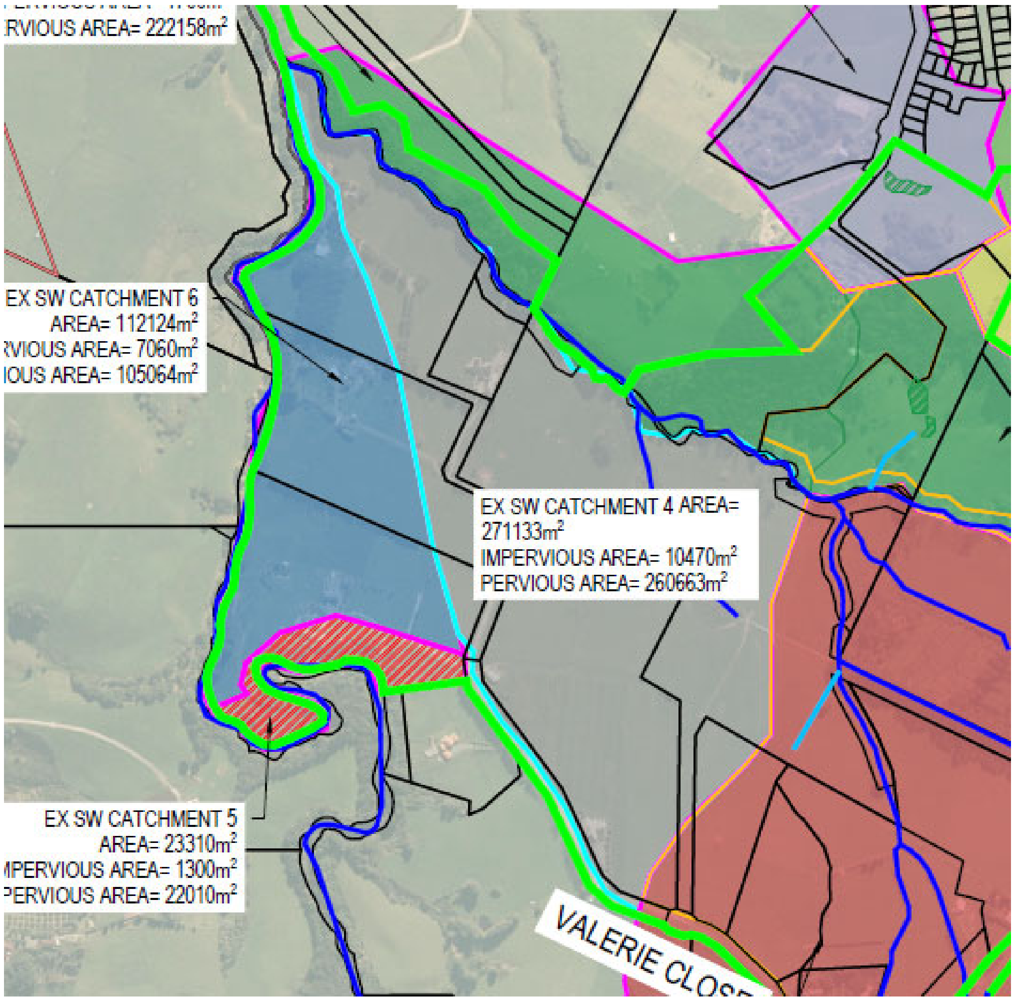
Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 4	Author KH	Date 13/12/2022	Checked LC

Catchment	Area	SMAF1 Detention volume (m3)*
4	267102	3143
Total	267102	3143

* the geotechnical report has indicate that there is limited infiltration on site. Hence the retention volume is added on top of the detention volume

post development MPD within the plan change area of catchment 4 is assumped to be 65% where a major watercourses running paralel to its catchment


RVIOUS AREA= 222158m²
EX SW CATCHMENT 6
AREA= 112124m²
RVIOUS AREA= 7060m²
IOUS AREA= 105064m²
EX SW CATCHMENT 4 AREA=
271133m²
IMPERVIOUS AREA= 10470m²
PERVIOUS AREA= 260663m²
EX SW CATCHMENT 5
AREA= 23310m²
IPERVIOUS AREA= 1300m²
PERVIOUS AREA= 22010m²
VALERIE CLOSE

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev C
Job Title / Calc Title: WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 4	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	1.3355	130.88
C	Open space (Pervious)	74	25.3747	1877.73
* from Appendix B		Totals =	26.7102	2008.61

CN (weighted) = total product / total area = 2008.61 / 26.710 = 75.2

Ia (average) = 5 x pervious area / total area = 5 x 25.3747 / 26.710 = 4.8 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.981 km (along drainage path)

Catchment Slope Sc= 0.0187 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 75.2 / (200- 75.2) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.57 1.32 3.30 = 0.96 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.64 hrs

38.53 mins

OK

use

0.96 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 3	Rev C
Job Title / Calc Title — WARKWORTH SOUTH PCA / PRE TO POST SW RUN-OFF / CATCHMENT 4	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.267102	km2(100ha =1km2)
Runoff curve number	CN=	75.2	(from worksheet 1)
Initial abstraction	Ia=	4.8	mm (from worksheet 1)
Time of concentration	tc=	0.96	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 83.8 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
Climate change %					
24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.16				
6. Specific peak flow rate q*	0.023				
7. Peak flow rate, q_p=q*A*P_{24}	**0.258**				m3/s
8. Runoff depth, $Q_{24} = (P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	11.5				mm
9. Runoff volume, $V_{24} = 1000 x Q_{24} A$	3062.58				(m3)

Worksheet 2: Graphical Peak Flow Rate

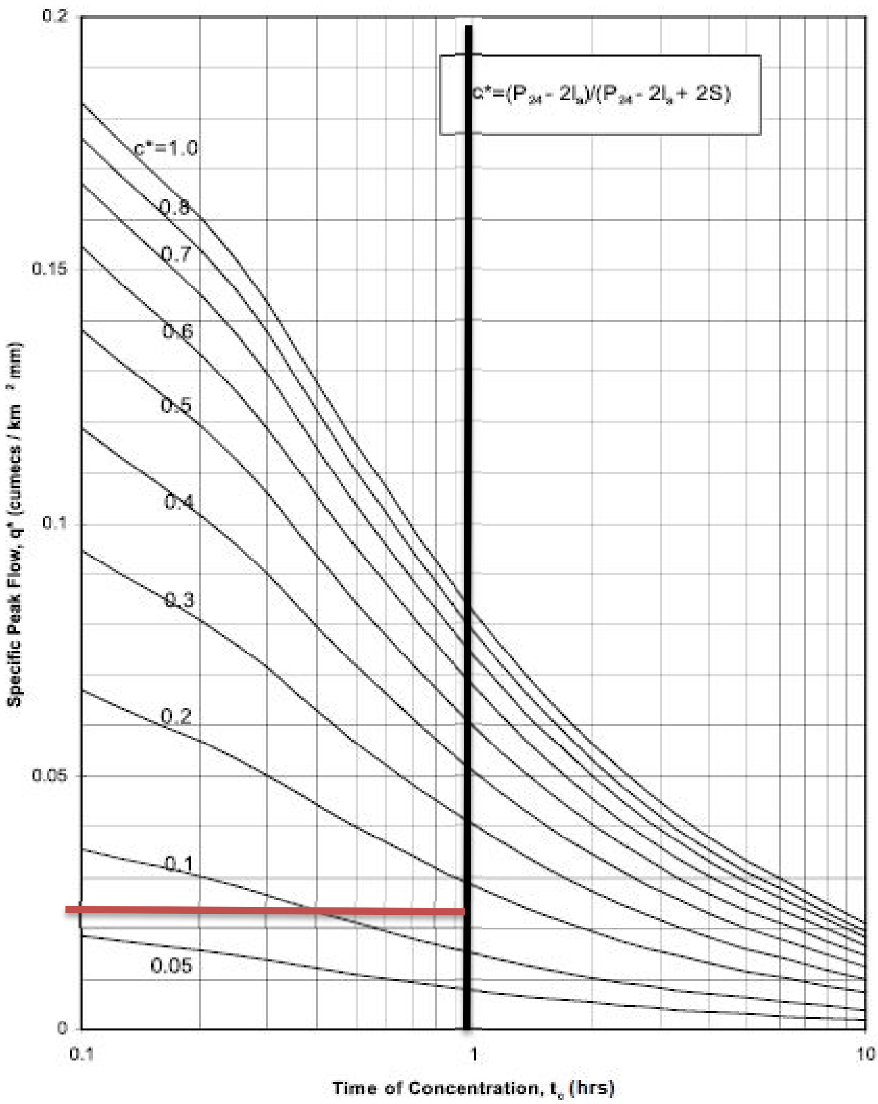


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES		Job Number 211001	Sheet 4	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 4	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	17.3616	1701.44
C	Grass (landscape and gardens)	74	9.3486	691.79
* from Appendix B		Totals =	26.7102	2393.23

CN (weighted) = total product / total area = 2393.23 / 26.710 = 89.6

Ia (average) = 5 x pervious area / total area = 5 x 9.3486 / 26.710 = 1.8 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 1.981 km (along drainage path)

Catchment Slope Sc= 0.0187 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 89.6 / (200- 89.6) = 0.81

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.57 1.12 3.30 = 0.49 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.33 hrs

4.26 mins

OK

use

0.4881285 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 5	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 4	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.267102	km2(100ha =1km2)
Runoff curve number	CN=	89.6	(from worksheet 1)
Initial abstraction	Ia=	1.8	mm (from worksheet 1)
Time of concentration	tc=	0.49	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 29.5 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
P24					(%)
4. 24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.40				
6. Specific peak flow rate q*	0.071				
7. Peak flow rate, q_p=q*A*P_{24}	0.796				m3/s
PEAK FLOW RATE PRE DEV=	0.258				
PRE TO POST FLOW RATE=	**0.538**				
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	23.2				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	6205.49				(m3)
RUNOFF VOLUME PRE DEV=	3062.58				
PRE TO POST VOLUME=	**3142.91**				

Worksheet 2: Graphical Peak Flow Rate

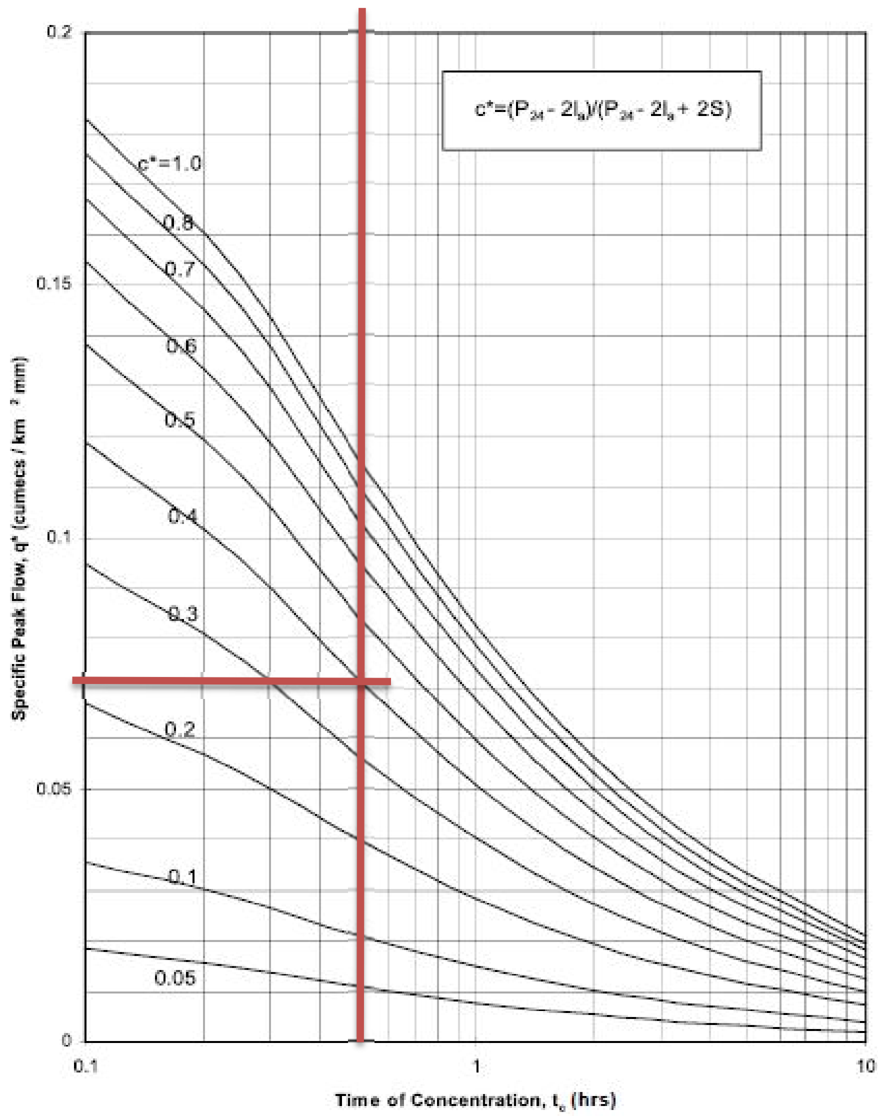


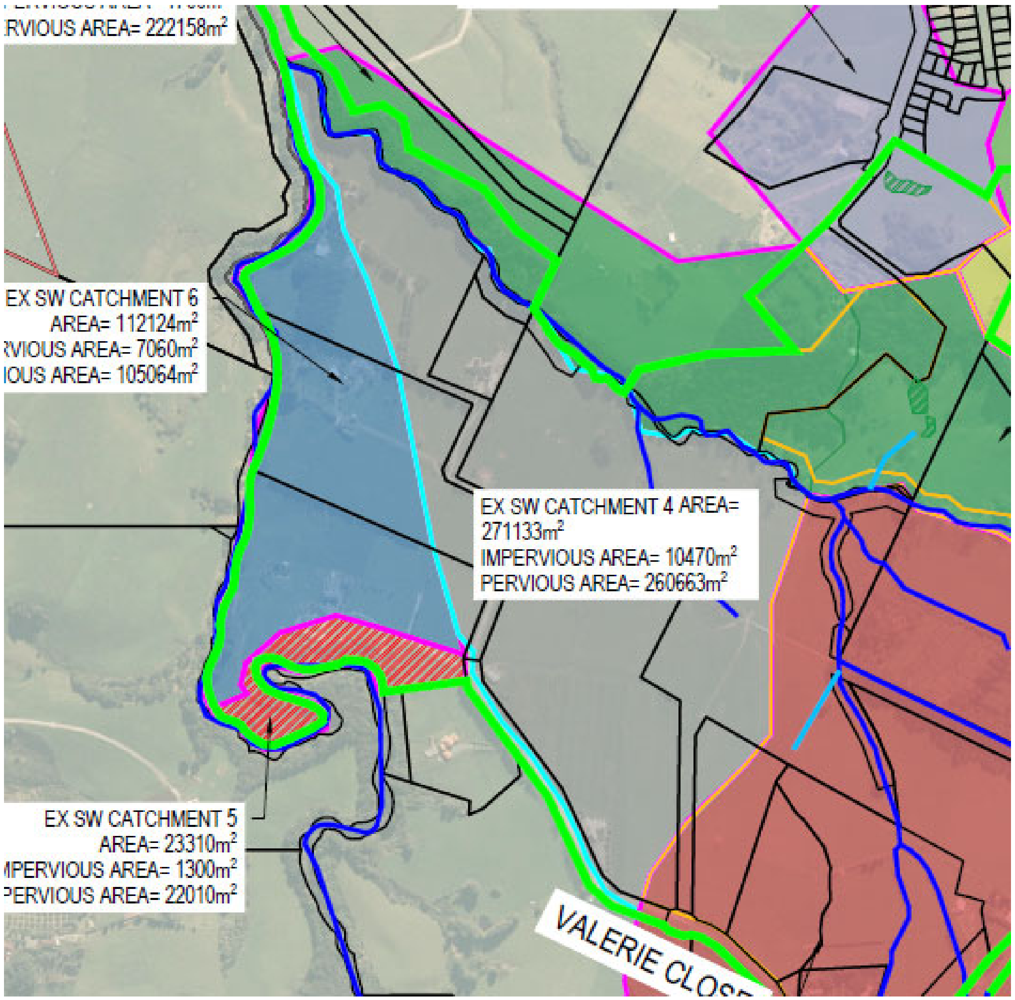
Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 6	Author KH	Date 13/12/2022	Checked LC

Catchment	Area	SMAF1 Detention volume (m3)*
6	112124	1319
Total	112124	1319

* the geotechnical report has indicate that there is limited infiltration on site. Hence the retention volume is added on top of the detention volume

post development MPD within the plan change area of catchment 6 is assumped to be 65% where a major watercourses running paralel to its catchment



:RVIOUS AREA= 222158m²
EX SW CATCHMENT 6
AREA= 112124m²
:RVIOUS AREA= 7060m²
IOUS AREA= 105064m²
EX SW CATCHMENT 4 AREA=
271133m²
IMPERVIOUS AREA= 10470m²
PERVIOUS AREA= 260663m²
EX SW CATCHMENT 5
AREA= 23310m²
IPERVIOUS AREA= 1300m²
PERVIOUS AREA= 22010m²
VALERIE CLOSE

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 6	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	0.5606	54.94
C	Open space (Pervious)	74	10.6518	788.23
* from Appendix B		Totals =	11.2124	843.17

CN (weighted) = total product / total area = 843.17 / 11.212 = 75.2

Ia (average) = 5 x pervious area / total area = 5 x 10.6518 / 11.212 = 4.8 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.363 km (along drainage path)

Catchment Slope Sc= 0.011 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 75.2 / (200- 75.2) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.23 1.32 3.87 = 0.88 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.59 hrs

35.29 mins

OK
use
0.88 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 3	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 6	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.112124	km2(100ha =1km2)
Runoff curve number	CN=	75.2	(from worksheet 1)
Initial abstraction	Ia=	4.8	mm (from worksheet 1)
Time of concentration	tc=	0.88	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 83.8 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
Climate change %					
24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.16				
6. Specific peak flow rate q*	0.026				
7. Peak flow rate, q_p=q*A*P_{24}	**0.122**				m3/s
8. Runoff depth, Q_{24} = $(P_{24}-Ia)^2/(P_{24}-Ia)+S$	11.5				mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	1285.61				(m3)

Worksheet 2: Graphical Peak Flow Rate

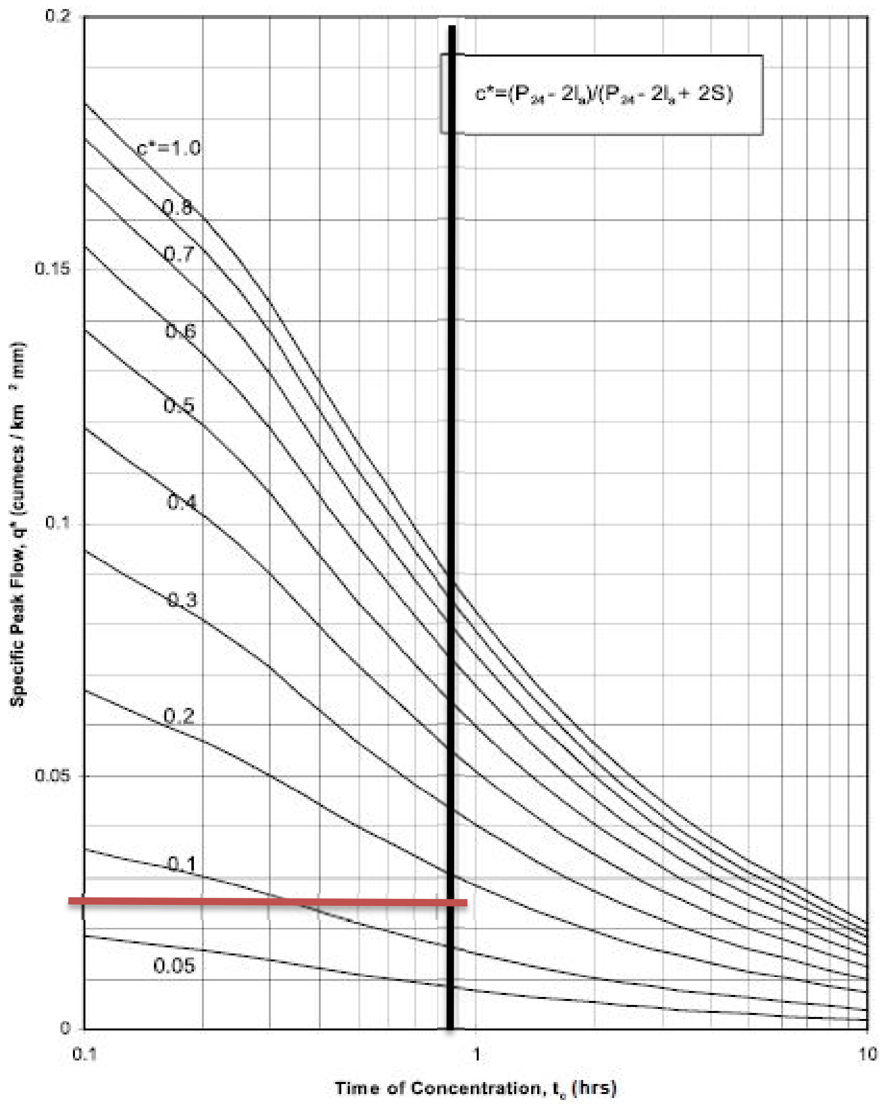


Figure 5.1 – Specific Peak Flow Rate

	MAVEN ASSOCIATES	Job Number 211001	Sheet 4	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 6	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	7.2881	714.23
C	Grass (landscape and gardens)	74	3.9243	290.40
* from Appendix B		Totals =	11.2124	1004.63

CN (weighted) = total product / total area = 1004.63 / 11.212 = 89.6

Ia (average) = 5 x pervious area / total area = 5 x 3.9243 / 11.212 = 1.8 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 1.363 km (along drainage path)

Catchment Slope Sc= 0.011 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 89.6 / 200- 89.6 = 0.81

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.23 1.12 3.87 = 0.45 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.30 hrs

4.26 mins

OK

use

0.4471903 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 5	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 6	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.112124	km2(100ha =1km2)
Runoff curve number	CN=	89.6	(from worksheet 1)
Initial abstraction	Ia=	1.8	mm (from worksheet 1)
Time of concentration	tc=	0.45	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 29.5 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth P24	42				(mm)
					(%)
4. 24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.40				
6. Specific peak flow rate q*	0.076				
7. Peak flow rate, q_p=q*A*P_{24}	0.358				m3/s
PEAK FLOW RATE PRE DEV=	0.122				
PRE TO POST FLOW RATE=	**0.235**				
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	23.2				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	2604.94				(m3)
RUNOFF VOLUME PRE DEV=	1285.61				
PRE TO POST VOLUME=	**1319.33**				

Worksheet 2: Graphical Peak Flow Rate

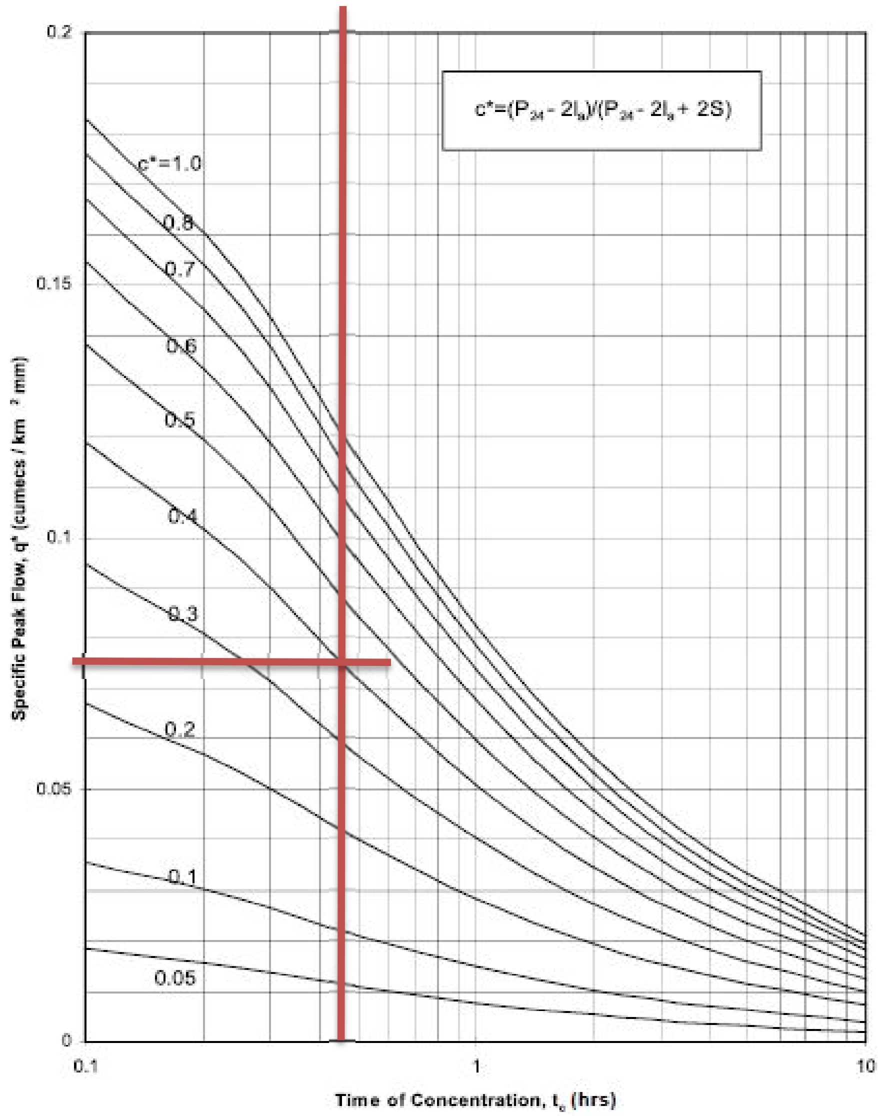


Figure 5.1 – Specific Peak Flow Rate

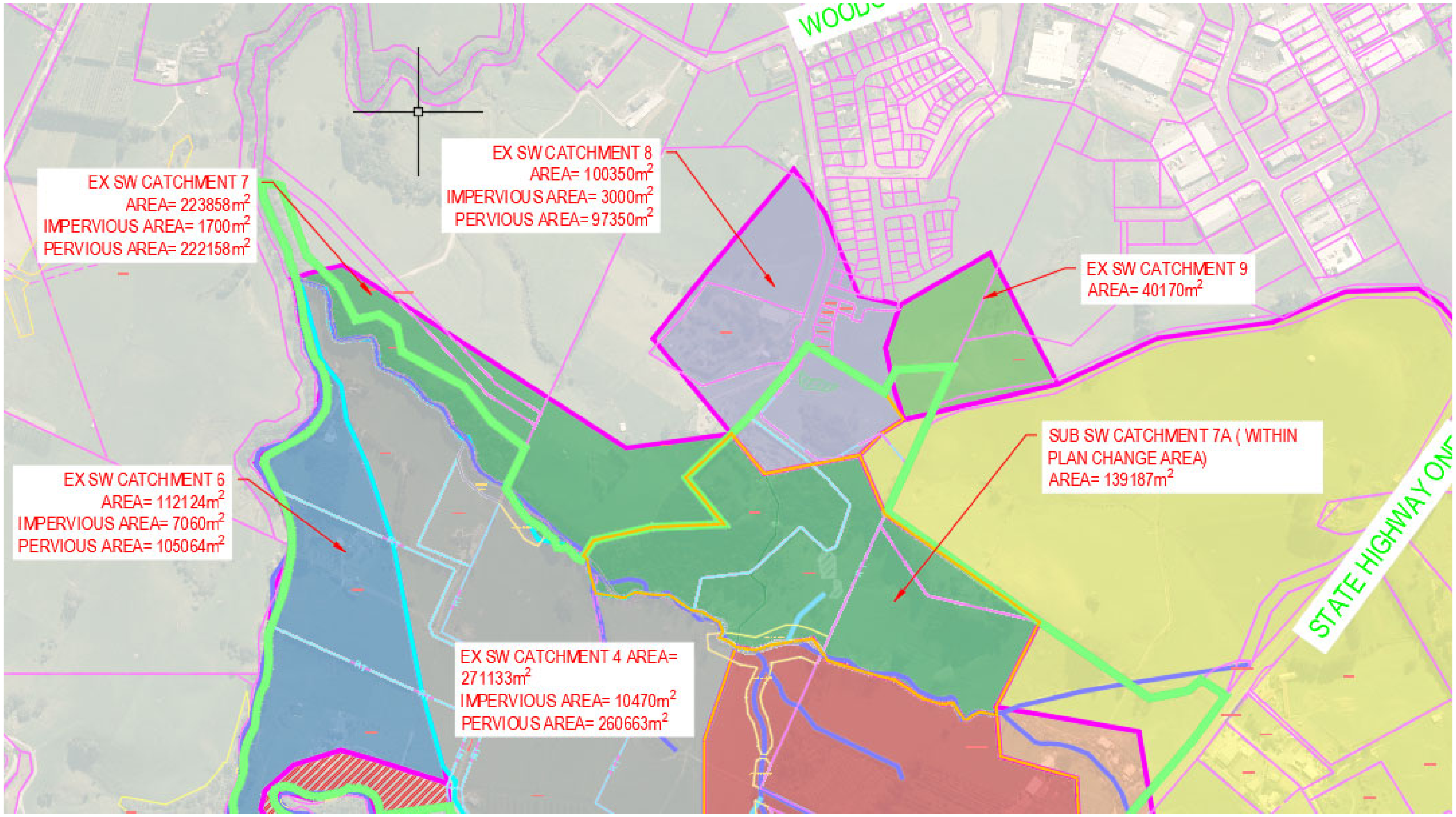
MAVEN ASSOCIATES

	MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 7	Author KH	Date 13/12/2022	Checked LC

Catchment	Area*	SMAF1 Detention volume (m3)**
7	223858	363
Total	223858	363

* the plan change area within this catchment is 139187m2
** the geotechnical report has indicate that there is limited infiltration on site. Hence the retention volume is added on top of the detention volume

post development MPD within the plan change area of catchment 7 is assumped to be 20% where a major watercourses running paralel to its catchment, most of the lot will be large lot or rural zone, protective bush area



WOODC
EX SW CATCHMENT 7
AREA= 223858m2
IMPERVIOUS AREA= 1700m2
PERVIOUS AREA= 222158m2
EX SW CATCHMENT 8
AREA= 100350m2
IMPERVIOUS AREA= 3000m2
PERVIOUS AREA= 97350m2
EX SW CATCHMENT 9
AREA= 40170m2
SUB SW CATCHMENT 7A (WITHIN
PLAN CHANGE AREA)
AREA= 139187m2
EX SW CATCHMENT 6
AREA= 112124m2
IMPERVIOUS AREA= 7060m2
PERVIOUS AREA= 105064m2
EX SW CATCHMENT 4 AREA=
271133m2
IMPERVIOUS AREA= 10470m2
PERVIOUS AREA= 260663m2
STATE HIGHWAY ONE

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 7	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	22.3941	1657.16
* from Appendix B		Totals =	22.3941	1657.16

CN (weighted) = total product / total area = 1657.16 / 22.394 = 74.0

Ia (average) = 5 x pervious area / total area = 5 x 22.3941 / 22.394 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.342 km (along drainage path)

Catchment Slope Sc= 0.041 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 1.21 1.34 2.61 = 0.59 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.40 hrs

23.88 mins

OK

use

0.59 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 3	Rev C
Job Title / Calc Title: WARKWORTH SOUTH PCA / PRE TO POST SW RUN-OFF / CATCHMENT 7	Author KH	Date 13/12/2022	Checked LC

1. Data
   Catchment Area A= 0.223941 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= 0.59 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
Climate change %					
24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15				
6. Specific peak flow rate q*	0.028				
7. Peak flow rate, q_p=q*A*P_{24}	**0.263**				m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	10.8				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	2428.45				(m3)

Worksheet 2: Graphical Peak Flow Rate

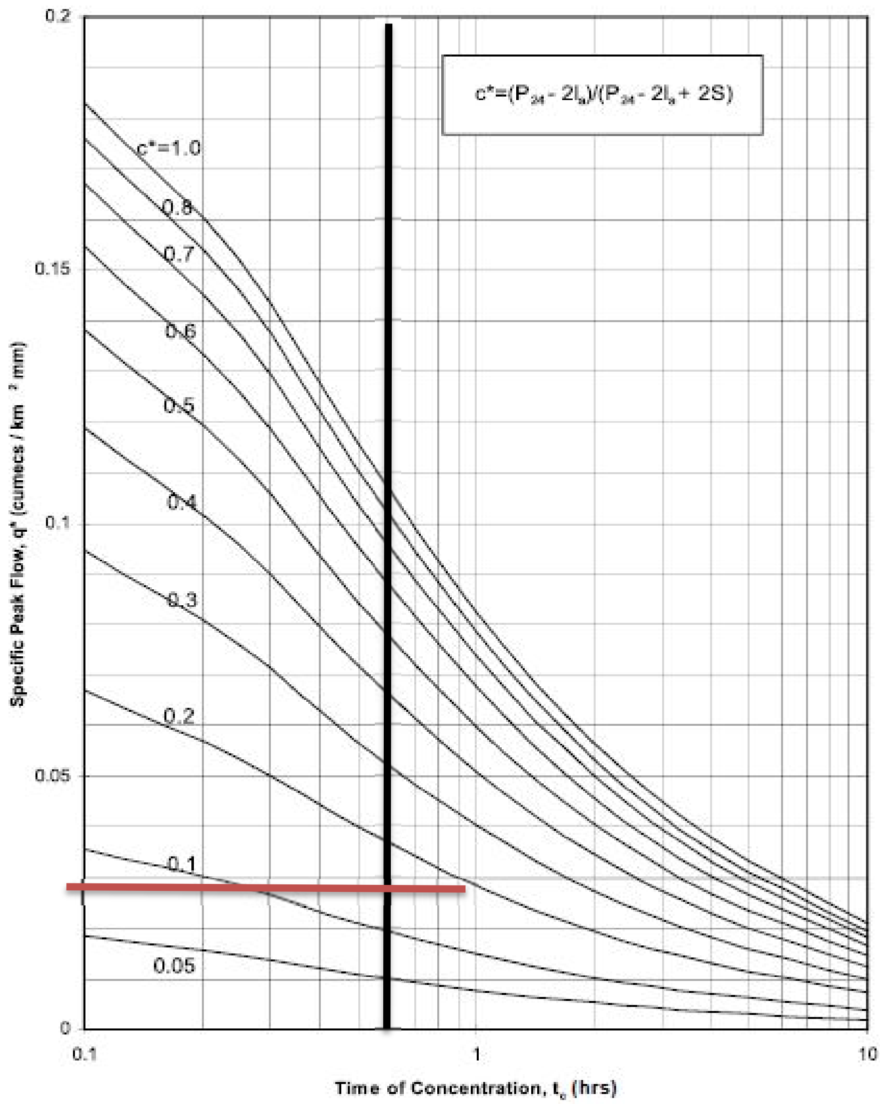


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 4	Rev C
Job Title / Calc Title: WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 7	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	2.7837	272.81
C	Grass (landscape and gardens)	74	19.6104	1451.17
* from Appendix B		Totals =	22.3941	1723.97

CN (weighted) = total product / total area = 1723.97 / 22.394 = 77.0

Ia (average) = 5 x pervious area / total area = 5 x 19.6104 / 22.394 = 4.4 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 1.342 km (along drainage path)

Catchment Slope Sc= 0.041 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 77.0 / (200- 77.0) = 0.63

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.21 1.29 2.61 = 0.34 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.23 hrs

4.26 mins

OK

use

0.3441301 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 5	Rev C
Job Title WARKWORTH SOUTH PCA Calc Title PRE TO POST SW RUN-OFF CATCHMENT 7	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area A= 0.223941 km2(100ha =1km2)

Runoff curve number CN= 77.0 (from worksheet 1)

Initial abstraction Ia= 4.4 mm (from worksheet 1)

Time of concentration tc= 0.34 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 75.9 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
P24					(%)
4. 24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.18				
6. Specific peak flow rate q*	0.044				
7. Peak flow rate, q_p=q*A*P_{24}	0.414				m3/s
PEAK FLOW RATE PRE DEV=	0.263				
PRE TO POST FLOW RATE=	**0.150**				
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	12.5				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	2791.07				(m3)
<u>RUNOFF VOLUME PRE DEV=</u>	2428.45				
PRE TO POST VOLUME=	**362.62**				

Worksheet 2: Graphical Peak Flow Rate

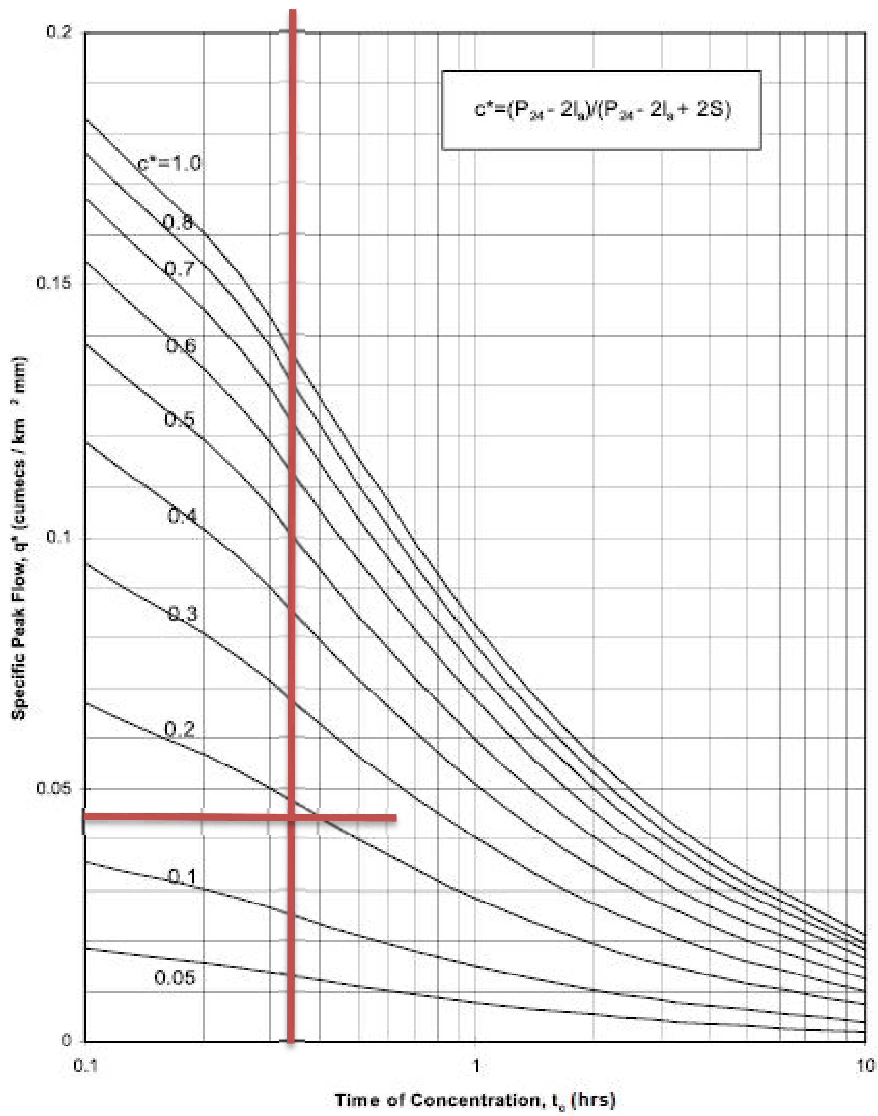


Figure 5.1 – Specific Peak Flow Rate

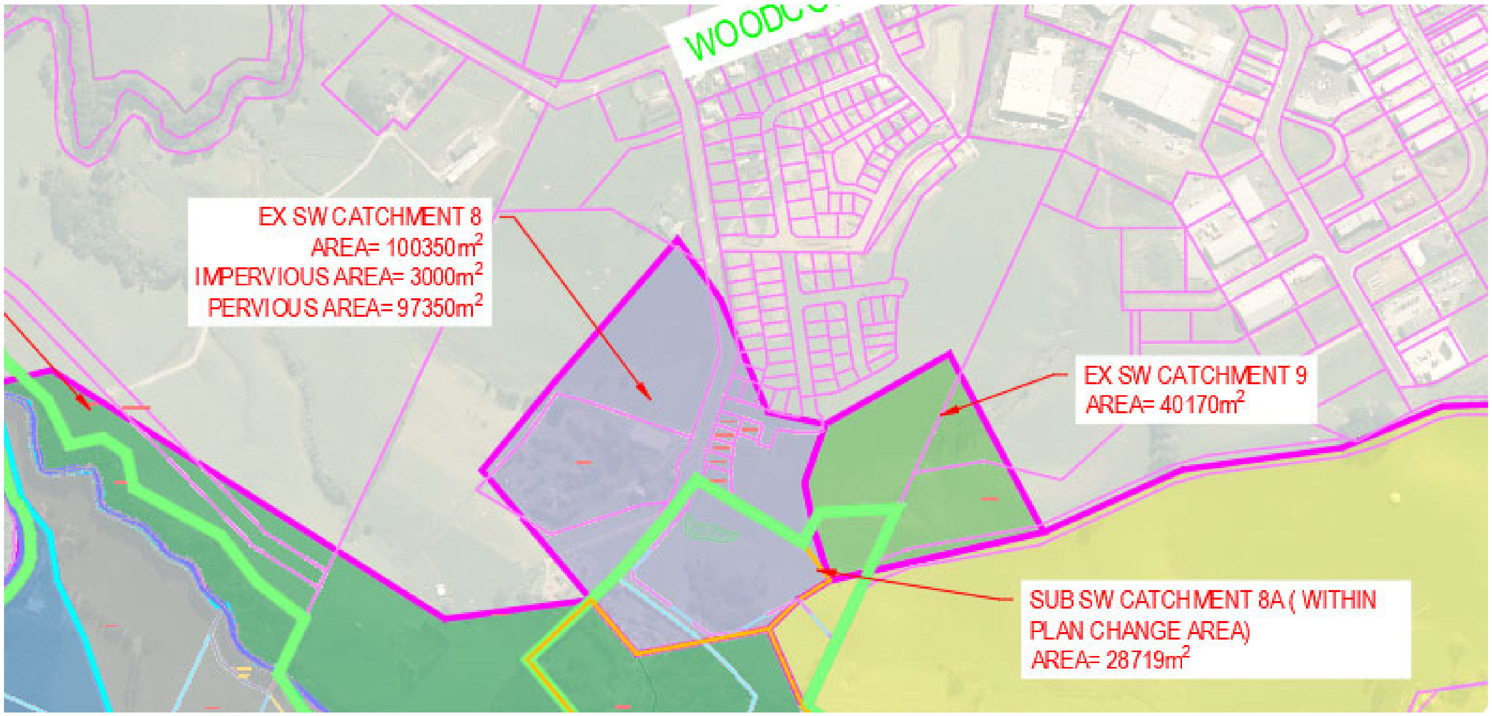
MAVEN	**MAVEN ASSOCIATES**	**Job Number** **211001**	**Sheet** **1**	**Rev** **C**
Job Title **Calc Title**	**WARKWORTH SOUTH PCA** **PRE TO POST SW RUN-OFF** **CATCHMENT 8**	**Author** **KH**	**Date** **13/12/2022**	**Checked** **LC**

Catchment	Area*	SMAF1 Detention volume (m3)**
8	100350	293
Total	100350	293

* the plan change area within this catchment is 28719m2

** the geotechnical report has indicate that there is limited infiltration on site. Hence the retention volume is added on top of the detention volume

post development MPD within the plan change area of catchment 8 is assumped to be 70% and area outside of plan change is assumped to be 5% where a large portion of this area still undevelop



F:\MAVEN\Projects\211001\Excel\tp108 for volume mitigation\221213 Detention SW CALC TP108 Catchment 8

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 8	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	0.5018	49.17
C	Open space (Pervious)	74	9.5333	705.46
* from Appendix B		Totals =	10.0350	754.63

CN (weighted) = total product / total area = 754.63 / 10.035 = 75.2

Ia (average) = 5 x pervious area / total area = 5 x 9.5333 / 10.035 = 4.8 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 0.351 km (along drainage path)

Catchment Slope Sc= 0.057 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 75.2 / (200- 75.2) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 0.50 1.32 2.36 = 0.22 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.15 hrs

8.80 mins

OK
use
0.22 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 3	Rev C
Job Title / Calc Title: WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 8	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.10035	km2(100ha =1km2)
Runoff curve number	CN=	75.2	(from worksheet 1)
Initial abstraction	Ia=	4.8	mm (from worksheet 1)
Time of concentration	tc=	0.22	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 83.8 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
Climate change %					
24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.16				
6. Specific peak flow rate q*	0.044				
7. Peak flow rate, q_p=q*A*P_{24}	**0.185**				m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	11.5				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	1150.61				(m3)

Worksheet 2: Graphical Peak Flow Rate

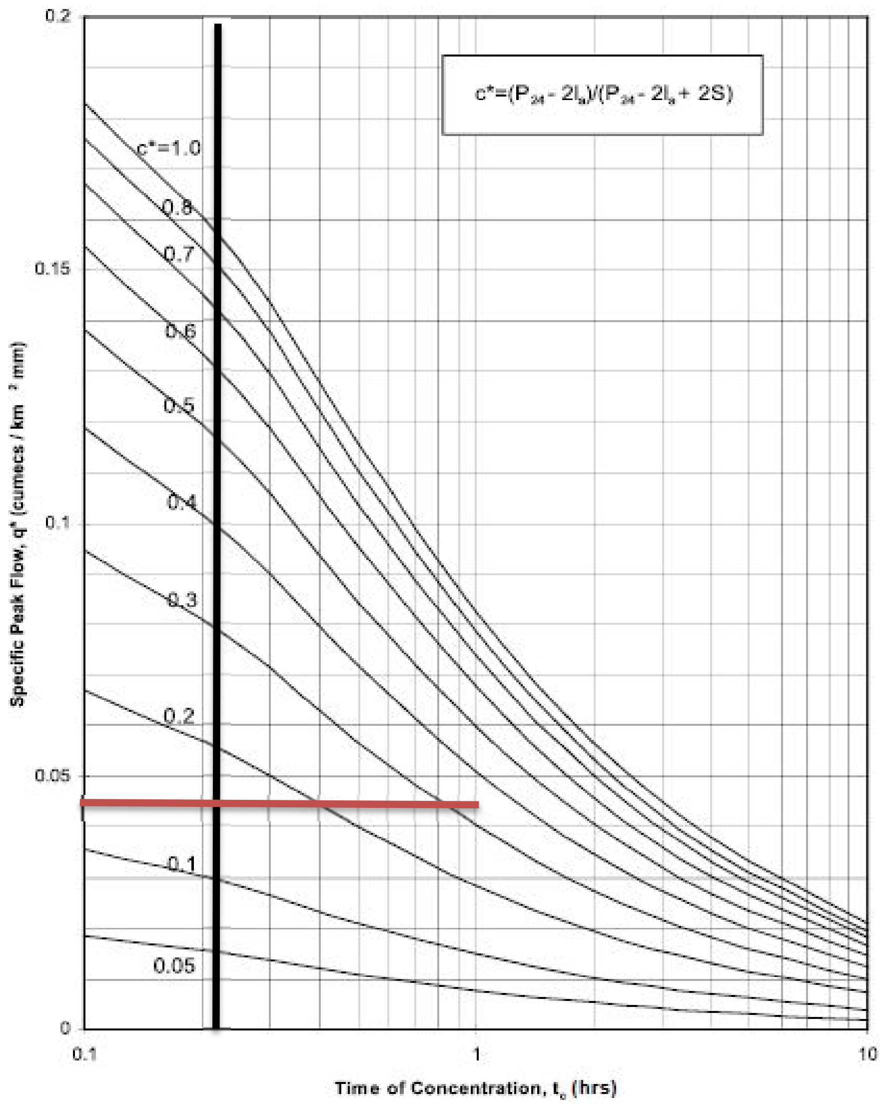


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	**Job Number** 211001	**Sheet** 4	**Rev** C
Job Title / **Calc Title** — **WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 8**	**Author** KH	**Date** 13/12/2022	**Checked** LC

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	Paved (concrete, gravel, metal, etc)	98	2.5121	246.18
C	Grass (landscape and gardens)	74	7.5229	556.70
* from Appendix B		Totals =	10.0350	802.88

CN (weighted) = total product / total area = 802.88 / 10.035 = 80.0

Ia (average) = 5 x pervious area / total area = 5 x 7.5229 / 10.035 = 3.7 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.351 km (along drainage path)

Catchment Slope Sc= 0.057 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 80.0 / 200- 80.0 = 0.67

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.50 1.25 2.36 = 0.12 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.08 hrs

4.26 mins

NO GOOD

use

0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 5	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 8	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.10035	km2(100ha =1km2)
Runoff curve number	CN=	80.0	(from worksheet 1)
Initial abstraction	Ia=	3.7	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 63.5 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
P24					(%)
4. 24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.21				
6. Specific peak flow rate q*	0.063				
7. Peak flow rate, q_p=q*A*P_{24}	0.266				m3/s
PEAK FLOW RATE PRE DEV=	0.185				
PRE TO POST FLOW RATE=	**0.081**				
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	14.4				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	1443.48				(m3)
RUNOFF VOLUME PRE DEV=	1150.61				
PRE TO POST VOLUME=	**292.87**				

Worksheet 2: Graphical Peak Flow Rate

APPENDIX D – FLOOD MODELLING REPORT

STORMWATER MODELLING REPORT

FOR

PROPOSED WARKWORTH SOUTH

PLAN CHANGE AREA

Maven Associates	**Job Number** 211001		**Rev** G
Job Title 1711 & 1723 State Highway 1, Warkworth Plan Change Area **Title** Stormwater Modelling Report	**Author** YW	**Date** 18.01.23	**Checked** LC

CONTENTS

1 INTRODUCTION

1.1 PROJECT

Maven Associates have been engaged to assist in the development of a plan change application including determining setting baseline scenarios for predevelopment scenarios in various storm events and assessing the effects of development specific to the proposed plan change area (PCA) at 1711 & 1723 State Highway 1, Warkworth. Figure 1.1 shows the study area.

The objective of this report is to provide a preliminary analysis of the overland flowpaths in terms of peak flows and water level constraints. This will enable the assessment of mitigation measures required to ensure the proposal does not result in any adverse effect on the downstream properties. The analysis will be for a range of annual return period storms and include rainfall increases due to climate change.

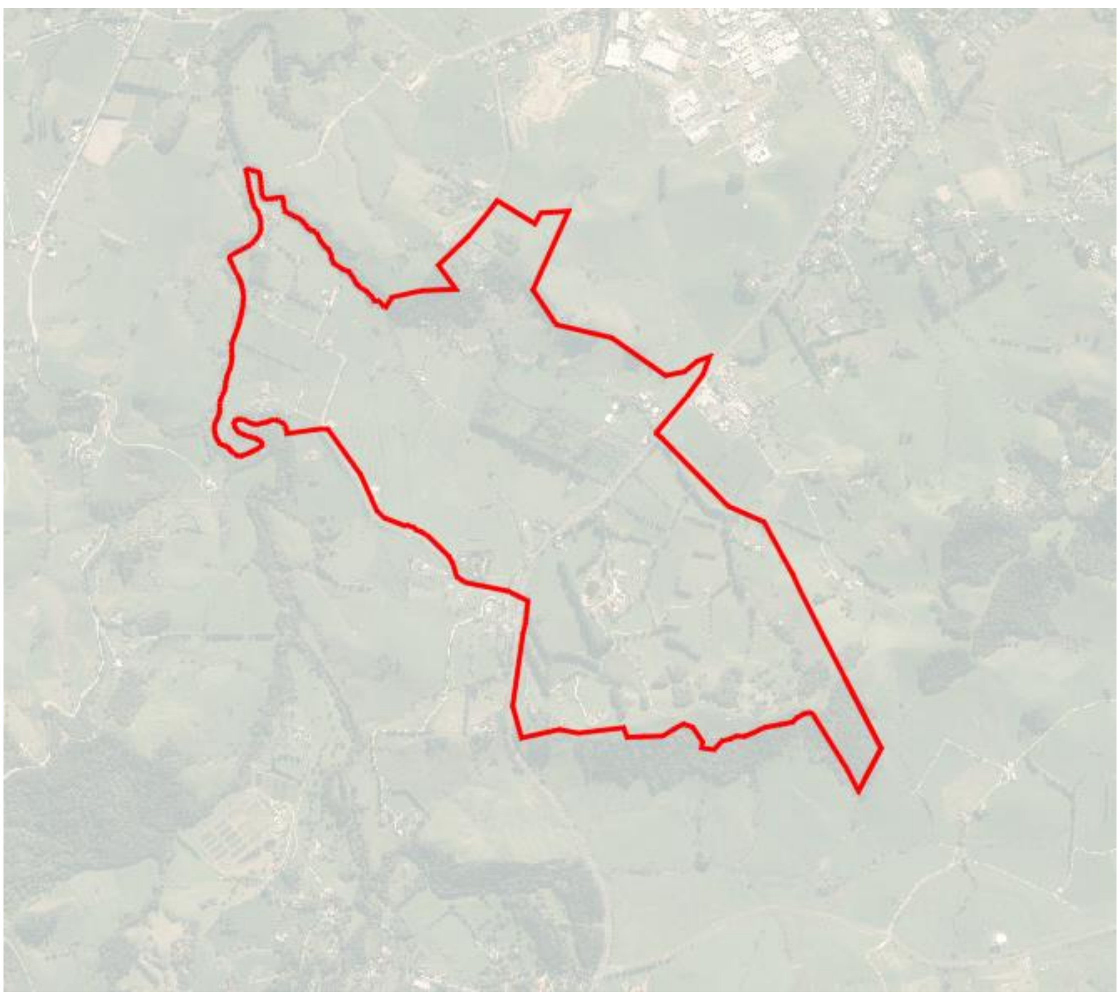


Figure 1.1 – Catchment Delineation

1.2 PREVIOUS STUDY

A Rapid Flood Hazard Assessment was undertaken by DHI in 2009. This was done on a 10m grid. This assessment did not include either climate change or land development changes.

1.3 PROPOSED STRATEGY

A 2D model will be used in the area around the Scheme Plan boundary. This will enable the identification of all overland flowpaths. The upper catchment area will be modelled as individual catchments to provide boundary inflows. All analyses will be done using TP108, HEC-HMS and HEC-RAS in accordance with guidelines of the Auckland Council Stormwater Code of Practice.

1.4 SCENARIOS MODELLED

Table 1.1 shows the scenarios modelled. Scenarios will indicate the difference between today's existing flow environment and the future.

Scenario	**Return period**	**Land-use**	**Rainfall**
1	100-year	Existing	Existing - historical
2	100-year	Existing	Climate change
3	100-year	Developed	Climate change
4	50-year	Developed	Climate change
5	20-year	Developed	Climate change
7	10-year	Developed	Climate change
8	100-year	Developed	Existing - historical
9	10-year	Developed	Existing - historical
10	10-year	Existing	Existing - historical

Table 1.1 – Scenarios modelled

1.5 SOURCES OF DATA

Attribute	**Organisation**
Catchment Plans	Auckland Council Geomaps
Contours	LINZ DEM 1m. The Terrain datum is New Zealand Vertical Datum. LiDAR/Site Survey by Parrallax Ltd. LiDAR/Site Survey by Maven Associates.
Flow & WL data	Healthywaters
Flood level evidence	None

Table 1.2 – Source of Data

1.6 REFERENCE TECHNICAL DOCUMENTS

- AUCKLAND COUNCIL CODE OF PRACTICE FOR LAND DEVELOPMENT AND SUBDIVISION. CHAPTER4 – STORMWATER, VERSION 3.00
- ACCEPTABLE SOLUTIONS AND VERIFIABLE METHODS, DOCUMENT E1 SURFACE WATER, MINISTRYOF BUSINESS, INNOVATION AND EMPLOYMENT,
- AUCKLAND COUNCIL TP108

2 HYDROLOGICAL MODELLING WITH HEC-HMS

2.1 METHODOLOGY

The analysis was done using the following steps:

1. Delineate the catchments,
2. Use Tp108 to calculate parameters,
3. Use HEC-HMS to create a rainfall hyetograph and flow hydrographs,

2.2 RAINFALL DATA

TP108 gives the following rainfall depths which are then adjusted for climate change as shown in Table 2.2. Climate change factor have been applied in accordance with Auckland Council code of practice (Version 3) assuming a 2.1°C increase in temperature as shown below;

Annual Exceedance probability exceedance	**Percentage Increase in 24-hour design rainfall depth due to future climate change***
50%	9.0%
10%	13.2%
5%	15.1%
2%	16.8%
1%	16.8%

* Assuming 2.1°C increase in temperature

Table 2.1 - Climate change factors

In accordance with TP108 section 2.3 an areal reduction factor (ARF) has been applies as the catchment has an area above 10 km2. ARF adjusted rainfalls are also shown in table 2.2. An ARF factor of 0.92 was used per TP108 table 2.2.

	TP108	**Climate change**	**ARF adjusted**
2-year	112	122	112
10-year	170	192	176
20-year	208	239	220
50-year	238	278	256
100-year	270	315	290

Table 2.2 – Rain depths

2.3 CATCHMENT SIZE

Figure 2.1 shows the catchment area modelled. Naming conventions of the subcatchments have been split between upstream and downstream of the PCA. The upper catchments are named upstream A to F and downstream catchments, downstream A to H. The yellow area (including the red boundary) is the 2D grid with the excess *Rain*. The catchment outflow of the Mahurangi River is at the northern edge. The Scheme Plan boundary is blue. The total area is 49km^2.

2.4 LAND-USE AND SOILS

The soil is assumed to be Group C with a curve number of 74. The land cover for the existing scenario has been obtained via delineation of impervious areas shown on the Auckland Council GIS aerial. The land-use is predominantly Rural-production and Rural-coastal with a small area of conservation, according to the AUP, see Figure 2.2. For the proposed scenario, the MPD (maximum probable development) of the proposed zoning has been used as well as MPD for the yellow designated FutureUrban. The FutureUrban zoning included in the developed scenarios assumes an average impervious area of 60%. The combined curve numbers and initial abstractions have been calculated according to TP108 and may be found in appendix D based on existing and developed land-use. Only catchments *Rain* and upstream catchment *F* will have a change in impervious area.

The full TP108 details to calculate the peak flows and times of concentration may be found in Appendix D. The total catchment area and the time of concentration suggests an area reduction factor of 0.92. This has been applied to the rainfall as per Table 2.2. This data can now be inserted into a HEC-HMS model.

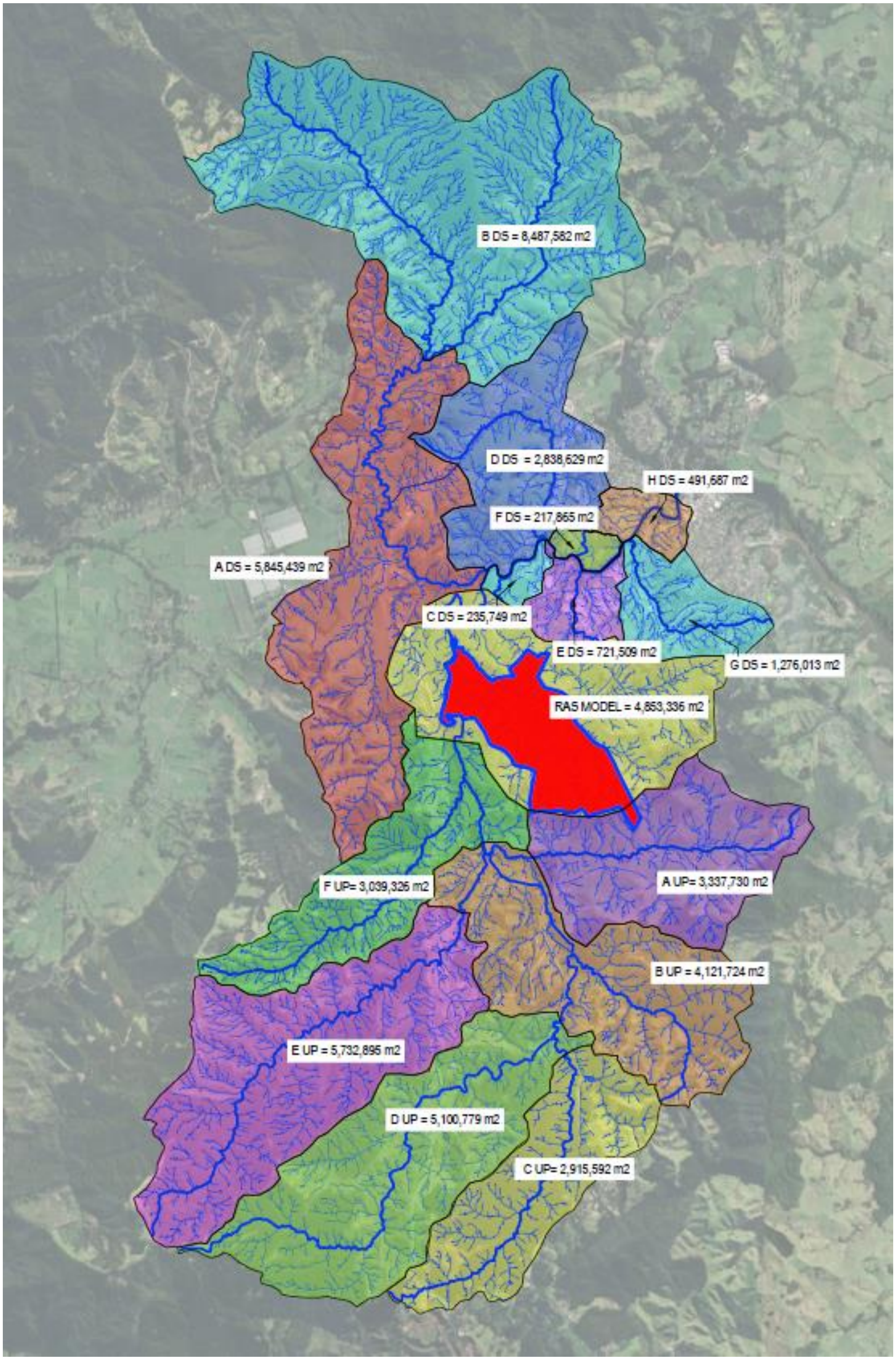


Figure 2.1 – Catchment Boundary

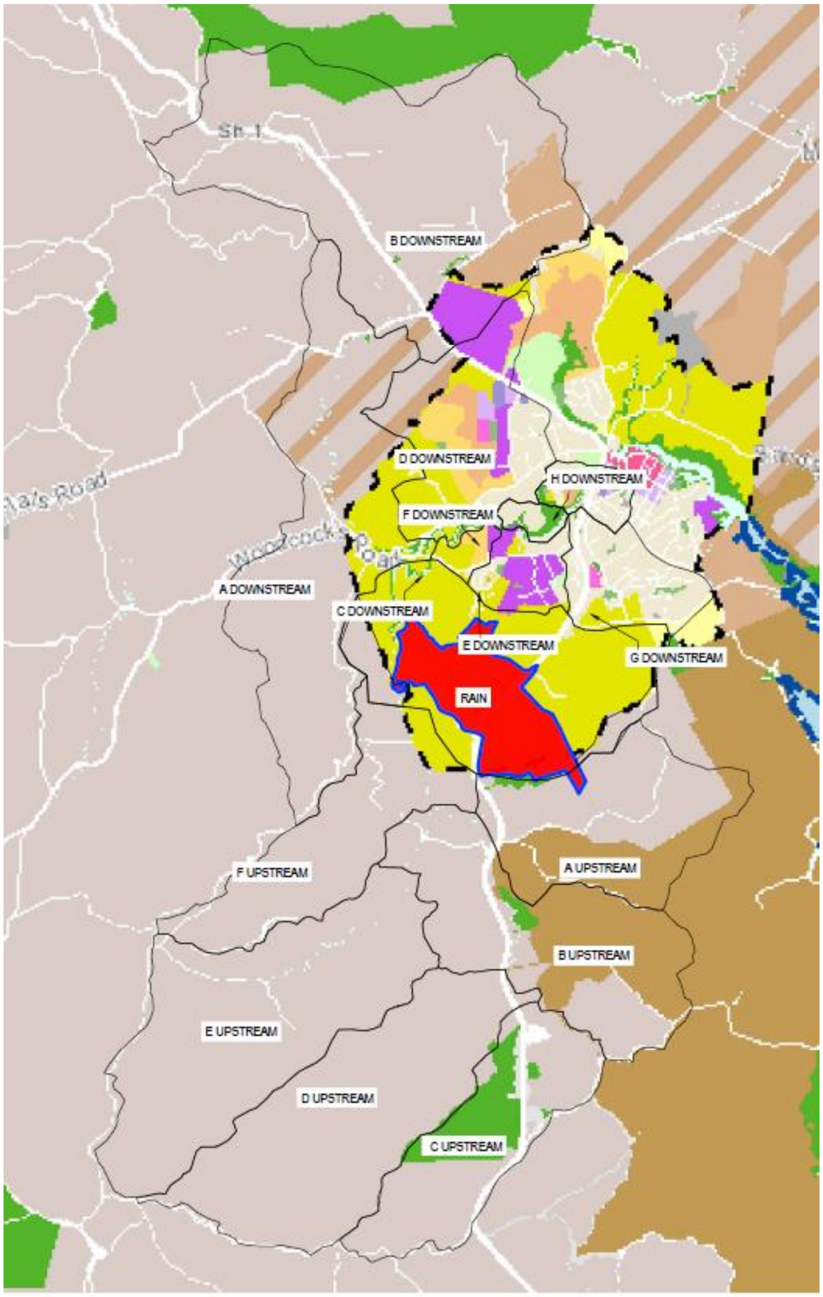


Figure 2.2 – Land-use zones

		Upstream of PCA							Downstream of PCA							
	Impervious %	Rain	A	B	C	D	E	F	A	B	C	D	E	F	G	H
Total		485	334	412	292	510	573	304	585	849	24	284	72	22	128	49
Rural / Vegetated area	1%	471	331	405	291	481	572	302	581	845	12	276	27	22	15	10
Urban MPD	60%	0	0	0	0	0	0	0	0	0	12	5	0	0	113	39
Open Space - Conservation	1%	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transort Corridor	90%	13	3	7	1	0	0	2	4	4	0	3	0	0	0	0
Residential - Large Lot	35%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential - Single House	60%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential - Mixed Housing Urban	60%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential - Terrace & Apartment	70%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Business - Local Centre Zone	100%	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0
Impervious		16.42	6.01	10.35	3.81	4.81	5.72	4.82	9.41	12.05	7.32	8.46	45.27	0.22	67.71	23.60
Pervious		468.91	327.76	401.82	287.75	505.27	567.57	299.11	575.13	836.71	16.25	275.40	26.88	21.57	59.89	25.57

Figure 2.3 – Existing land use calculations

	Upstream of PCA								Downstream of PCA							
	Impervious %	Rain	A	B	C	D	E	F	A	B	C	D	E	F	G	H
Total		485	334	412	292	510	573	304	585	849	24	284	72	22	128	49
Rural / Vegetated area	1%	51	331	405	291	481	572	285	581	845	12	276	27	22	15	10
Urban MPD to	60%	276	0	0	0	0	0	17	0	0	12	5	0	0	113	39
Open Space - Conservation	1%	5.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transort Corridor	90%	13.0	3	7	1	0	0	2	4	4	0	3	0	0	0	0
Residential - Large Lot	35%	13.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential - Single House	60%	22.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential - Mixed Housing Urban	60%	74.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential - Terrace & Apartment	70%	25.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Business - Local Centre Zone	100%	3.4	0	0	0	0	0	0	0	0	0	0	45	0	0	0
Impervious		261.76	6.01	10.35	3.81	4.81	5.72	15.10	9.41	12.05	7.32	8.46	45.27	0.22	67.71	23.60
Pervious		223.57	327.76	401.82	287.75	505.27	567.57	288.83	575.13	836.71	16.25	275.40	26.88	21.57	59.89	25.57

Figure 2.4 – Developed land use calculations

2.5 HEC-HMS MODEL

The data was then transferred to HEC-HMS. Figure 2.5 shows the model set-up. Calculations for the time of concentration of the reaches may be found in Appendix D. The reaches between junctions have been incorporated respectively to reflect the time it would take to arrive at the downstream connection.

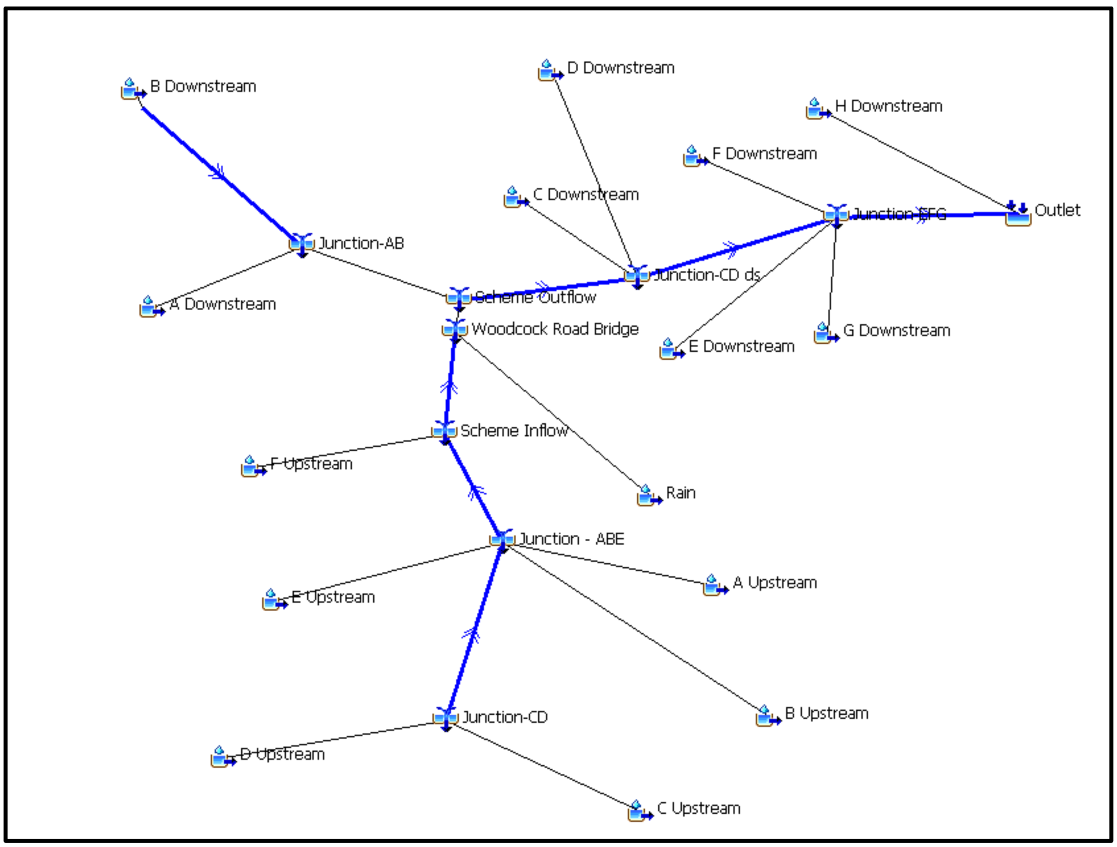


Figure 2.5 – HEC-HMS model set-up

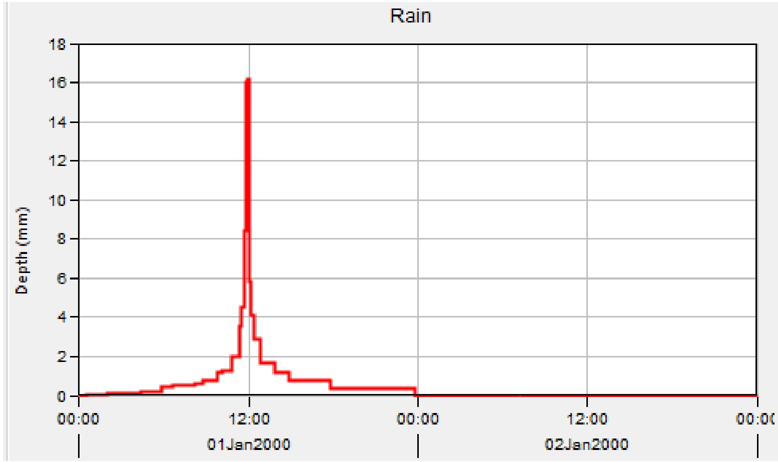


Figure 2.6 shows the 100-year developed land-use rainfall hyetograph for the grid.

Figure 2.6 – Rainfall excess, 100-year, climate change, developed

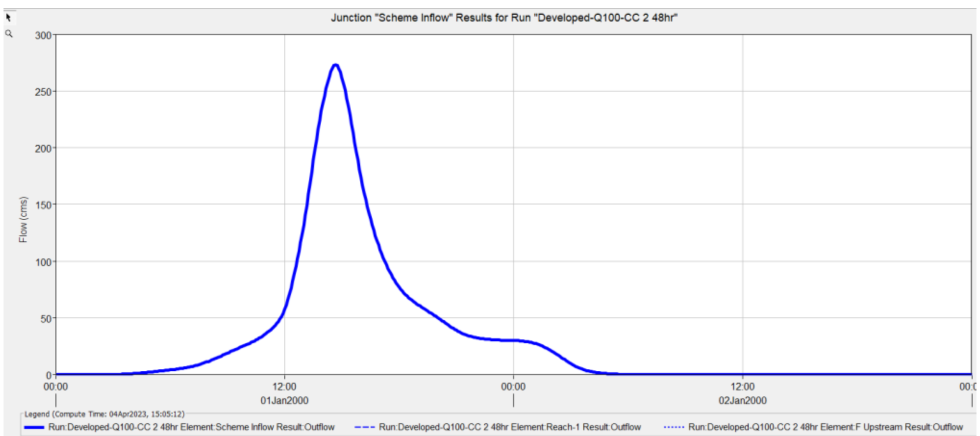


Figure 2.7 shows the hydrograph for scheme inflow for the 100-year storm with climate change rain and developed.

Figure 2.7 – Flow hydrograph, 100-year, climate change, developed

2.5.1 Effects of climate change

Figure 2.8 shows the global summary of the existing catchment flows against those that are expected to occur due to climate change and development. The scheme inflow has increased from 224m^3/s to 273m^3/s. Most of the 49m^3/s increase is due to climate change.The volume increase is almost 0.91 million m^3.

At the scheme outflow the changes are 347m^3/s to 421m^3/s. Thus, the catchment is expected to yield 74m^3/s, (this entire increase is due to climate change as explained in section 2.5.2). This increase is 17%. The volume increase is 1.6 million m^3.

Figure 2.8 – Global summary of flows and volumes for the 100-year storm (historical rain, existing land-use vs climate change rain and existing land-use vs. historical rain, proposed land-use vs climate changed rain and developed)

Global Summary Results for Run "Existing-Q100-existing"

Project: Warkworth South Simulation Run: Existing-Q100-existing

Start of Run: 01Jan2000, 00:00
End of Run: 03Jan2000, 00:00
Compute Time: 19Jul2023, 13:37:48

Basin Model: Existing Land-Use
Meteorologic Model: 100yr-existing-existing-land
Control Specifications: 24hr

Show Elements: All Elements Volume Units: MM (•) 1000 M3 Sorting: Alphabetic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
A Downstream	5.845	55.714	1 January 2000, 13:50	1045.239
A Upstream	3.338	36.862	1 January 2000, 13:20	596.881
B Downstream	8.488	91.342	1 January 2000, 13:25	1515.594
B Upstream	4.122	46.674	1 January 2000, 13:20	739.118
C Downstream	0.236	5.013	1 January 2000, 12:25	46.655
C Upstream	2.916	35.384	1 January 2000, 13:10	520.626
D Downstream	2.839	36.462	1 January 2000, 13:00	509.696
D Upstream	5.101	56.151	1 January 2000, 13:20	909.088
E Downstream	0.722	16.171	1 January 2000, 12:25	157.655
E Upstream	5.733	58.755	1 January 2000, 13:35	1021.743
F Downstream	0.218	4.582	1 January 2000, 12:20	38.855
F Upstream	3.039	38.647	1 January 2000, 13:00	543.469
G Downstream	1.276	25.093	1 January 2000, 12:30	270.600
H Downstream	0.492	11.328	1 January 2000, 12:20	102.645
Junction - ABE	21.209	209.162	1 January 2000, 13:55	3787.456
Junction-AB	14.333	132.158	1 January 2000, 14:50	2560.833
Junction-CD	8.016	90.794	1 January 2000, 13:15	1429.714
Junction-CD ds	46.509	356.995	1 January 2000, 16:05	8321.218
Junction-EFG	48.725	361.625	1 January 2000, 16:55	8788.329
Outlet	49.216	362.659	1 January 2000, 17:35	8890.974
Rain	4.853	54.418	1 January 2000, 13:20	873.110
Reach-1	21.209	208.985	1 January 2000, 14:40	3787.456
Reach-2	8.016	90.655	1 January 2000, 14:20	1429.714
Reach-3	8.488	91.306	1 January 2000, 15:00	1515.594
Reach-4	24.249	225.278	1 January 2000, 15:55	4330.925
Reach-5	43.435	348.691	1 January 2000, 16:10	7764.868
Reach-6	46.509	356.945	1 January 2000, 16:55	8321.218
Reach-7	48.725	361.625	1 January 2000, 17:35	8788.329
Scheme Inflow	24.249	225.278	1 January 2000, 14:40	4330.925
Scheme Outflow	43.435	348.781	1 January 2000, 15:30	7764.868
Woodcock Road Bridge	29.102	243.581	1 January 2000, 15:50	5204.035

Global Summary Results for Run "Developed-Q100-existing"

Project: Warkworth South Simulation Run: Developed-Q100-existing

Start of Run: 01Jan2000, 00:00 Basin Model: Developed Land-Use
End of Run: 03Jan2000, 00:00 Meteorologic Model: 100yr-existing-existing-land
Compute Time: 19Jul2023, 13:37:45 Control Specifications: 24hr

Show Elements: All Elements Volume Units: MM 1000 M3 Sorting: Alphabetic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
A Downstream	5.845	55.714	1 January 2000, 13:50	1045.239
A Upstream	3.338	36.862	1 January 2000, 13:20	596.881
B Downstream	8.488	91.342	1 January 2000, 13:25	1515.594
B Upstream	4.122	46.674	1 January 2000, 13:20	739.118
C Downstream	0.236	5.013	1 January 2000, 12:25	46.655
C Upstream	2.916	35.384	1 January 2000, 13:10	520.626
D Downstream	2.839	36.462	1 January 2000, 13:00	509.696
D Upstream	5.101	56.151	1 January 2000, 13:20	909.088
E Downstream	0.722	16.171	1 January 2000, 12:25	157.655
E Upstream	5.733	58.755	1 January 2000, 13:35	1021.743
F Downstream	0.218	4.582	1 January 2000, 12:20	38.855
F Upstream	3.039	39.328	1 January 2000, 13:00	549.792
G Downstream	1.276	25.093	1 January 2000, 12:30	270.600
H Downstream	0.492	11.328	1 January 2000, 12:20	102.645
Junction - ABE	21.209	209.162	1 January 2000, 13:55	3787.456
Junction-AB	14.333	132.158	1 January 2000, 14:50	2560.833
Junction-CD	8.016	90.794	1 January 2000, 13:15	1429.714
Junction-CD ds	46.509	356.525	1 January 2000, 16:05	8486.109
Junction-EFG ds	48.725	361.134	1 January 2000, 16:55	8953.220
Outlet	49.216	362.168	1 January 2000, 17:35	9055.865
Rain	4.853	68.200	1 January 2000, 13:10	1031.679
Reach-1	21.209	208.985	1 January 2000, 14:40	3787.456
Reach-2	8.016	90.655	1 January 2000, 14:20	1429.714
Reach-3	8.488	91.306	1 January 2000, 15:00	1515.594
Reach-4	24.249	225.289	1 January 2000, 15:55	4337.247
Reach-5	43.435	348.169	1 January 2000, 16:10	7929.758
Reach-6	46.509	356.454	1 January 2000, 16:55	8486.109
Reach-7	48.725	361.134	1 January 2000, 17:35	8953.220
Scheme Inflow	24.249	225.289	1 January 2000, 14:40	4337.247
Scheme Outflow	43.435	348.268	1 January 2000, 15:30	7929.758
Woodcock Road Bridge	29.102	242.998	1 January 2000, 15:50	5368.926

Global Summary Results for Run "Developed-Q100-CC"

Project: Warkworth South   Simulation Run: Developed-Q100-CC

Start of Run: 01Jan2000, 00:00   Basin Model: Developed Land-Use
End of Run: 03Jan2000, 00:00   Meteorologic Model: 100yr-CC-developed-land-use
Compute Time: 19Jul2023, 13:37:44   Control Specifications: 24hr

Show Elements: All Elements   Volume Units: MM 1000 M3   Sorting: Alphabetic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
A Downstream	5.845	67.891	1 January 2000, 13:50	1275.513
A Upstream	3.338	44.937	1 January 2000, 13:20	728.378
B Downstream	8.488	111.357	1 January 2000, 13:25	1849.780
B Upstream	4.122	56.845	1 January 2000, 13:20	901.669
C Downstream	0.236	6.011	1 January 2000, 12:25	56.238
C Upstream	2.916	43.112	1 January 2000, 13:10	635.423
D Downstream	2.839	44.413	1 January 2000, 13:00	621.694
D Upstream	5.101	68.484	1 January 2000, 13:20	1109.811
E Downstream	0.722	19.120	1 January 2000, 12:25	187.628
E Upstream	5.733	71.633	1 January 2000, 13:35	1247.341
F Downstream	0.218	5.578	1 January 2000, 12:20	47.430
F Upstream	3.039	47.852	1 January 2000, 13:00	670.018
G Downstream	1.276	29.809	1 January 2000, 12:30	323.317
H Downstream	0.492	13.482	1 January 2000, 12:20	122.895
Junction - ABE	21.209	254.787	1 January 2000, 13:55	4622.622
Junction-AB	14.333	160.933	1 January 2000, 14:45	3125.293
Junction-CD	8.016	110.711	1 January 2000, 13:15	1745.234
Junction-CD ds	46.509	433.327	1 January 2000, 16:05	10328.154
Junction-EFG ds	48.725	438.681	1 January 2000, 16:55	10886.529
Outlet	49.216	439.897	1 January 2000, 17:35	11009.424
Rain	4.853	80.989	1 January 2000, 13:10	1232.289
Reach-1	21.209	254.638	1 January 2000, 14:40	4622.622
Reach-2	8.016	110.516	1 January 2000, 14:15	1745.234
Reach-3	8.488	111.298	1 January 2000, 15:00	1849.780
Reach-4	24.249	274.228	1 January 2000, 15:55	5292.640
Reach-5	43.435	423.234	1 January 2000, 16:05	9650.223
Reach-6	46.509	433.171	1 January 2000, 16:55	10328.154
Reach-7	48.725	438.681	1 January 2000, 17:35	10886.529
Scheme Inflow	24.249	274.228	1 January 2000, 14:40	5292.640
Scheme Outflow	43.435	423.321	1 January 2000, 15:30	9650.223
Woodcock Road Bridge	29.102	295.252	1 January 2000, 15:50	6524.929

2.5.3 Effects of the proposed development

A graph of the flows at the scheme outflow of the existing catchment flow with climate change against flow of the developed catchment with climate change can be found in the appendix A, the table below summaries the findings.

Rain event	Land-use	Climate change	Catchments A-F (m3/s)	Rain (m3/s)	Woodcock bridge (m3/s) outflow	Scheme Outflow (m3/s)
100yr	Existing	No	225.3	54.4	243.6	348.8
100yr	Developed	No	225.3	68.2	243.0	348.3
100yr	Existing	Yes	274.2	66.3	296.4	424.4
100yr	Developed	Yes	274.2	81.0	295.3	420.6
10yr	Existing	No	121.1	38.6	128.1	184.3
10yr	Developed	No	121.1	48.8	129.2	185.7

Table 2.3 – Peak flow comparison, 10-year & 100-year, climate change, existing vs developed.

Table 2.3 shows that the peak flow for 100year storm events exiting the scheme area (Scheme outflow) decreases by 0.9m^3/s for the climate change scenario and decrease of 0.6m3/s for the scenario without climate change , even though there is an increase in impervious area of the development. This is explained by the decrease in time of concentration of the developed Rain catchment, which results in the runoff from the catchment reaching the Scheme outflow before the runoff from the upstream catchments (A-F). As shown in figure 2.8, for the developed catchment, the 100year time of peak flow of the *Rain* catchment is 13:10 and for the upstream catchments, *A to F* (Reach 4) is 15:55. This demonstrates the peak flow from the *Rain* catchment exits the catchment boundary 2 hour 45 min prior to the arrival of upper catchment peak flow.

For the 10-year storm event (without climate change), the increase in impervious area from the development shows an increase in peak flow of 10.2 m3/s (from 38.6 m3/s to 48.8 m3/s) exiting the PCC. However, at the confluence to the stream (at Woodcock Road bridge) an increase in peak flow of 1.1 m3/s is shown. Similar to the 100year storm event effect described above the peak flow from the catchment upstream (A to F) of the PCC arrives at 15:55 later than the peak flow from the Rain catchment at 12:45.

Hydrographs for the described rain events may be found in Appendix A.

Downstream effects

Table 2.4 below shows the peak 100year stormwater events at the catchment junctions downstream of the site. Similarly to the effects described above the it is noted that the peak flows decrease as a result of the development. This is explained by the decrease in time of concentration of the developed Rain catchment, which results in the runoff from the catchment reaching the Scheme outflow before the runoff from the upstream catchments (A-F).

Rain event	Land-use	Climate change	Downstream Junction CD (m3/s)	Downstream Junction EFG (m3/s)
10yr	Existing	No	188.0	190.8
10yr	Developed	No	189.4	192.2
100yr	Existing	No	354.7	359.4
100yr	Developed	No	352.3	358.9
100yr	Existing	Yes	431.7	437.1
100yr	Developed	Yes	430.6	436.0

Table 2.4 Peak 10yr & 100yr flows at junctions downstream of the proposed development

2.5.3 Localised event scenario

A localised event scenario has been modelled which includes an Upstream PCA 2yr event and a 100yr event within the PCA (rain catchment) and downstream catchments of the PCA 100yr ARI for before and post development, no climate change. These runs are considered necessary to understand the effects of the development on the existing scenarios.

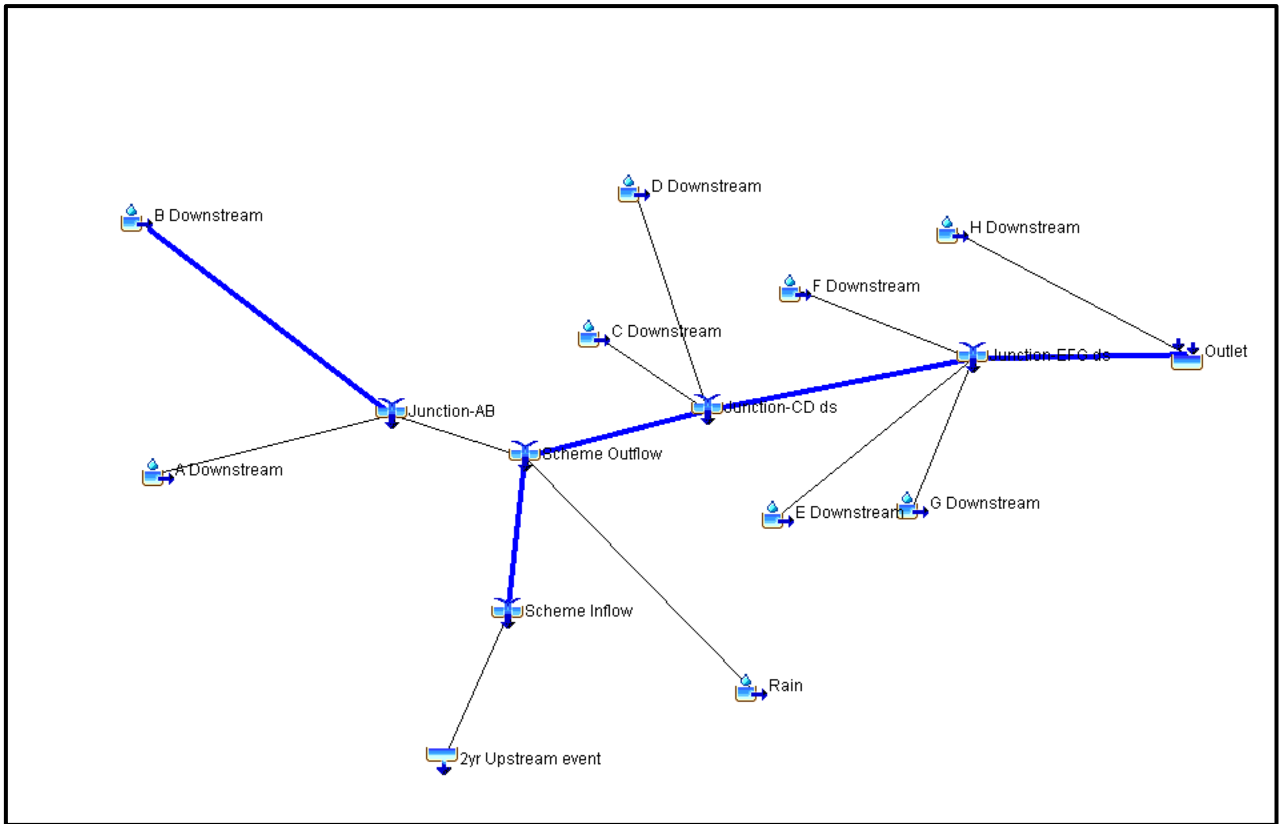


Figure 2.-9 Localised Event Scenario

Rain event	Land-use	Climate change	Scheme Outflow (m3 /s)	Downstream Junction CD (m3/s)	Downstream Junction EFG (m3/s)
100yr	Existing	No	212.6	222.8	227.6
100yr	Developed	No	212.4	222.6	227.4

Table 2.5 Peak 100yr flows at junctions downstream of the proposed development for a localised 100yr event scenario without climate change

Table 2.5 above shows the 100yr peak stormwater event for a localised 100yr event for the PCA area and downstream PCA area. Similarly to the effects described above the it is noted that the peak flows slightly decrease as a result of the development. This is explained by the decrease in time of concentration of the developed Rain catchment, which results in the runoff from the catchment reaching the Scheme outflow before the runoff from the upstream catchments (A-F).

3 HYDRAULIC MODELLING WITH HEC-RAS

3.1 METHODOLOGY

The analysis was done using the following steps:

1. Delineate the perimeter for the grid,
2. Create a grid and sub-grid areas,
3. Input flow hydrographs and other boundaries
4. Input structures,
5. Run scenarios.

3.2 HEC-RAS MODEL LAYOUT

HEC-RAS software was used to generate water levels throughout the catchment. A 2D model was developed using a combination of LINZ Terrain data and site-specific LiDAR and topographical survey. A Manning's n of 0.1 was used in the grid.A 5m x 5m grid was used. Figure 3.1 shows the grid and its boundary conditions. Appendix B shows culvert details used in the model.

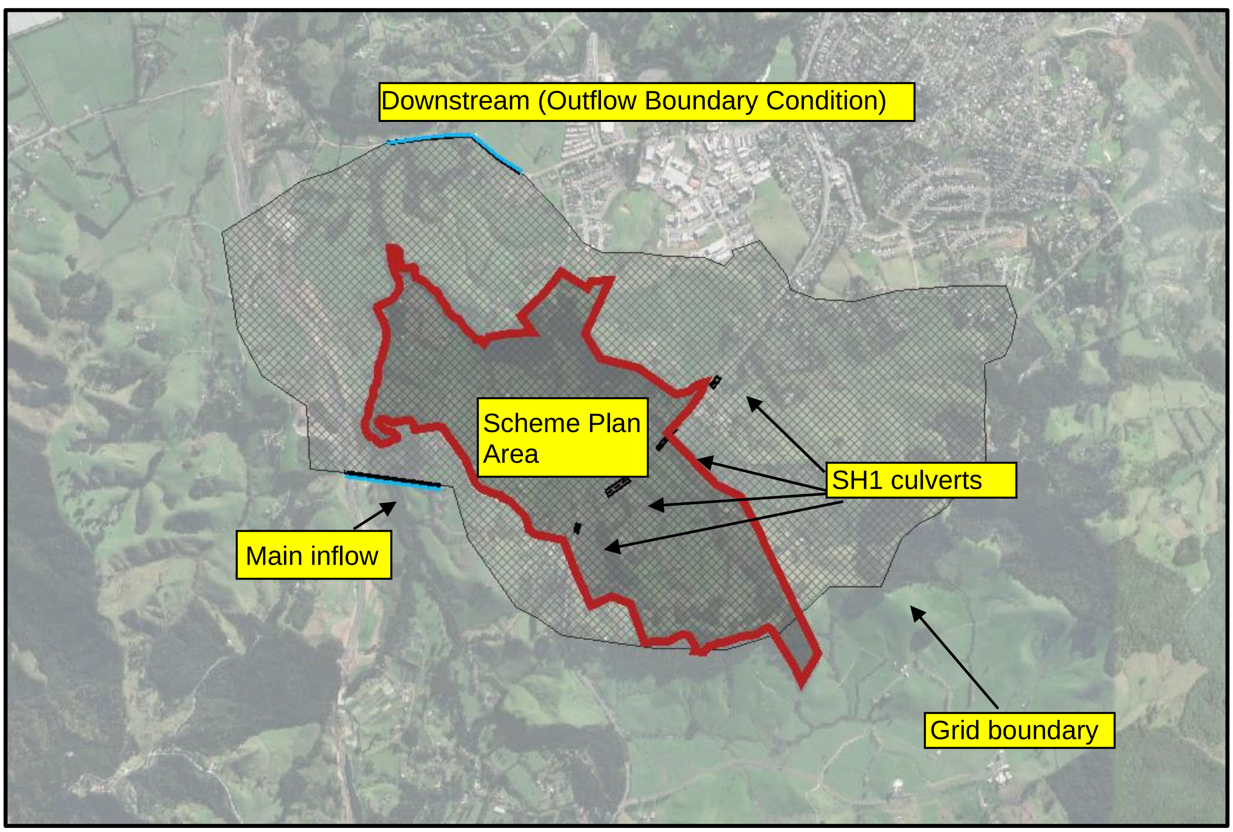


Figure 3.1 – HEC-RAS model set-up

3.3 BOUNDARIES

There are three boundaries. These are:

- Rain on grid – as per figure 3.1.
- Main inflow for Mahurangi river gradient of 0.004
- Downstream boundary using a normal depth method with a gradient of 0.004 (refer to figure 3.1 above for location).

  The outflow boundary condition is located at Woodcock bridge. Flow at the bridge has been assessed in section 3.8 confirming flow is unobstructed and freeflowing for all assessed scenarios.

3.4 FLOODPLAIN COMPARISON

Figure 3.2 compares the Geomaps floodplain against the 100-year storm for developed land and climate change rainfall. The patterns are similar. The flow at critical pinch points in the north-east at the confluence have similar widths.

The only difference of note is in the central scheme area, area A. Geomaps shows more flooding while the new model is more defined in the channels due to a specific site survey of the stream being modelled. In general, the new model appears to replicate the Geomaps floodplain.

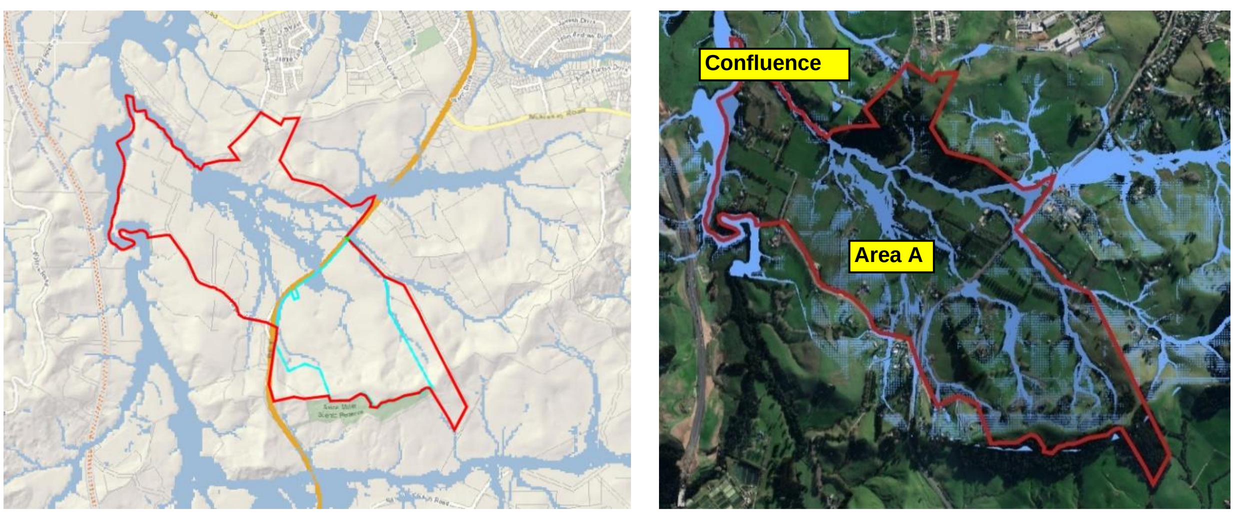


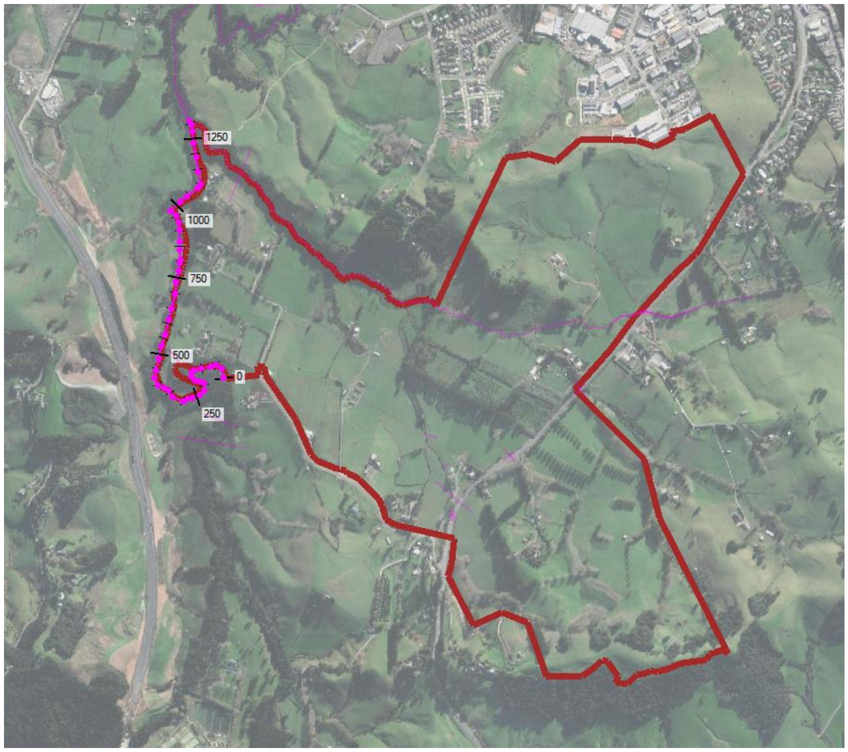
Figure 3.2 – Floodplain comparison – 100yr-storm

3.5 FLOW CHECK

All watercourse arrive at the point of confluence from the east making up about 332ha. The estimate TP108 graphical method 100-year peak flow is estimated at $47m^3/s$. This is the existing rainfall and land-use. The modelled peak flow at this point is $53m^3/s$. The model is higher than what TP108 estimates catchment run-off should be. However, the 2D terrain model uses a Manning's n of 0.1 which might be smoother than reality, but it also encourages higher flows. Importantly the model gives reasonable peak flows even though the finite volume method in HEC-RAS has pockets of water "stuck in hollows" inside the 5m grid. However, this does not affect the peak flow.

3.6 HYDRAULIC GRADE LINE

Figures 3.3 shows the HGL along the Mahurangi River on the west boundary of the scheme plan. The 100-year developed scenario ranges from RL32.4m to RL26.6m NZVD at a grade of 1 in 240. The range of water levels from 10-year to 100-year is about 1.3m.



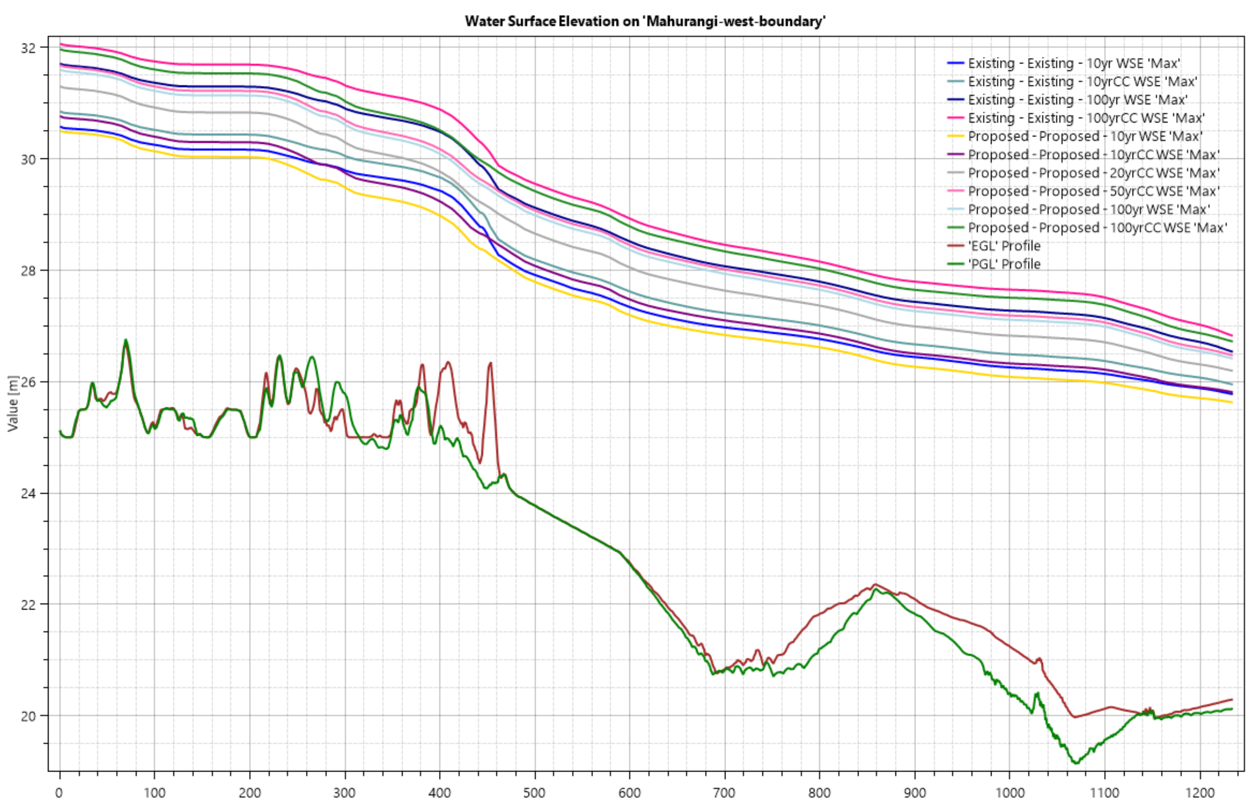


Figure 3.3 – HGL– Mahurangi River boundary (NZVD)

Figure 3.4 shows the HGL along the main scheme stream from east of the SH1 culverts across to the confluence with the Mahurangi River. The SH1 Culverts will cause a pond that is 200m long and 135m wide.

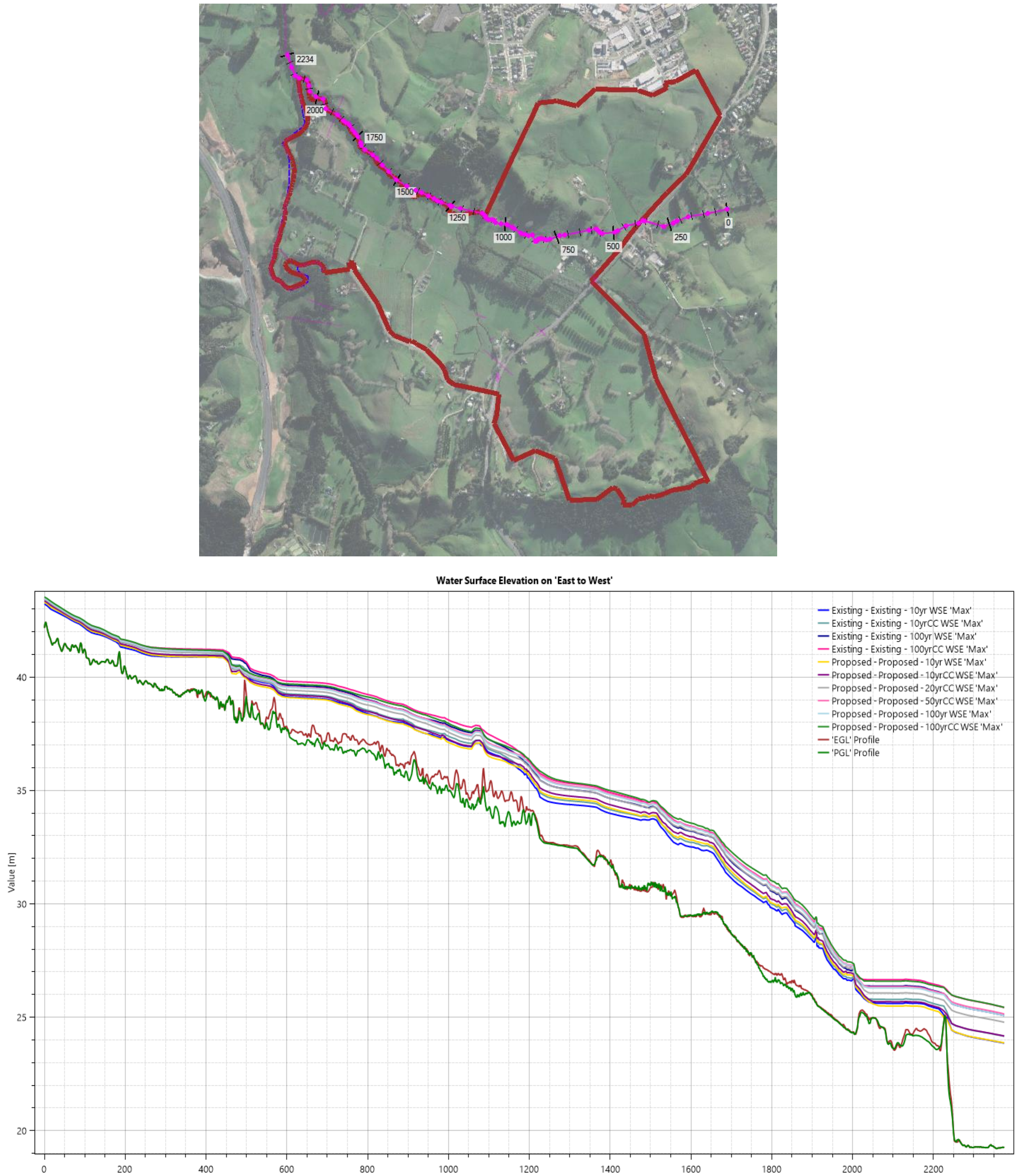


Figure 3.4 – HGL– Main east to west stream (NZVD)

3.7 FLOW HYDROGRAPHS

Figure 3.5 shows the flow hydrographs in the east-west stream just before the connection to the Mahurangi River. Table 3.1 below shows peak flows and time to peak at connection to Mahurangi River. The table shows increase in peak flows and a minor decrease in time of concentration as a results of the plan change.

As noted earlier in the report (refer to section 2.5), due to the large time of concentration difference between the plan change site and the overall catchment, the increase in peak flows produced from the proposed plan change has no effect on the peak flows downstream of the site.

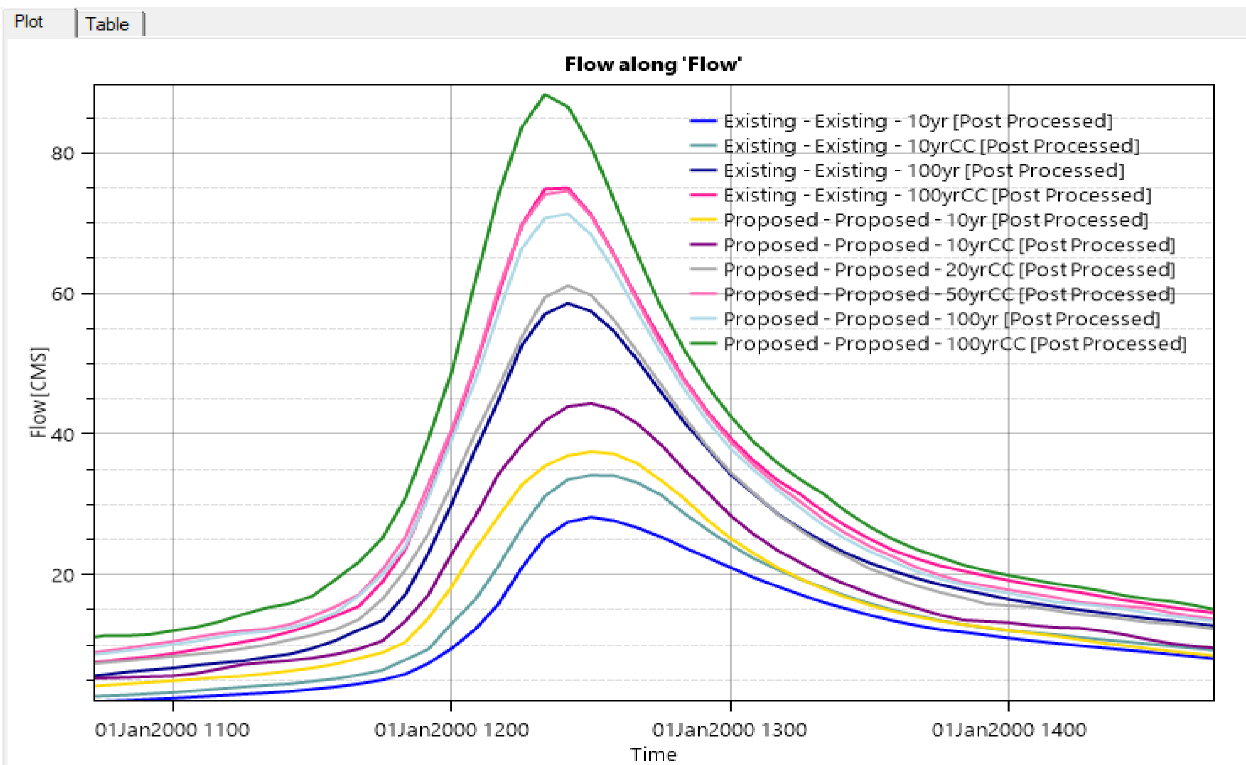


Figure 3.5 – Flow hydrograph for east-west stream outlet

Rain event	Land use	Climate change	Peak flow (m3/s)	Peak flow time (hr)
100yr	Developed	Yes	88.32	12:20
100yr	Developed	No	71.34	12:25
100yr	Existing	Yes	75.00	12:25
100yr	Existing	No	58.62	12:25
50yr	Developed	Yes	74.61	12:25
20yr	Developed	Yes	61.12	12:25
10yr	Developed	Yes	44.36	12:30
10yr	Developed	No	36.51	12:30
10yr	Existing	Yes	34.18	12:30
10yr	Existing	No	28.20	12:30

Table 3.1 HEC HMS Peak flows and times to peak

3.8 CHECK ON DOWNSTREAM LEVEL

The model grid stops at Woodcocks Road bridge. Plan C050 shows site topographical survey of the bridge and may be found in Appendix E. The road deck of the bridge has been surveyed to be RL23.52. The peak 1% AEP event with climate change flow level at this location has been calculated to a level of 19.31m for the existing and proposed scenario, this shows a freeboard of approximately 3.5m (between water surface and underside of bridge). We conclude there is sufficient freeboard to prevent any backwater effects.

3.9 CULVERTS CAPACITY ASSESSMENT

Cross sections showing water surface elevations across the four culverts through SH 1 maybe found in appendix B.

Cross sections indicate the two northern culverts (names Culvert north and Culvert mid) are under capacity and are overtopped for all modelled storm events (10yr through to 100yr). The next adjacent culvert to the south (culvert south) is show to only overtop during a 100yr event for the developed scenario. The southern most culvert is shown to have sufficient capacity for the developed scenario.

It is noted that the entire section of SH1 which is shown to be have under capacity culvert is proposed to be upgraded in the future by Auckland Transport once the road is eventually repurposed as an arterial road and the opening of Ara Tūhono – Pūhoi to Warkworth state highway.

3.10 OUTFLOW VOLUME VALIDATION

HEC-RAS uses an Implicit Finite Volume Algorithm. The consequence of this is to have small volumes of water in the base of a cell that does not escape. A method to remove the potential holding back of water is to run the models with low flows in the initial stages to fill the hollows. The main storm run-off can then flow over the top. This is not a problem as long as there is volume continuity.

Figure 3.6 shows the volume generated in HEC-HMS for the existing land-use and 100-year historical rainfall. The volume is 5,204,000m^3. Figure 3.7 shows the volume accumulated at the HEC-RAS downstream boundary after 36 hours of simulation. The volume is 5,153,000m^3. This is an error of 0.01% which is extremely small. The volume integrity is excellent.

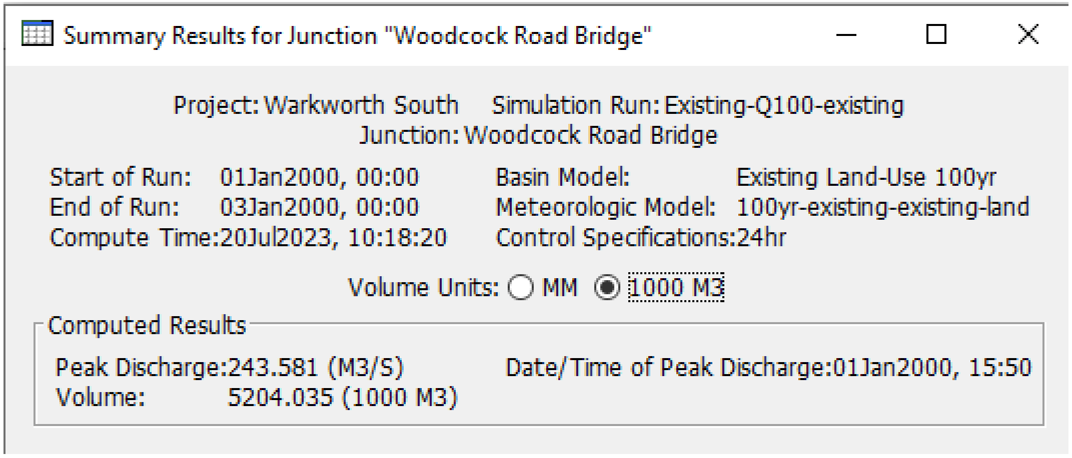


Figure 3.6 – HEC-HMS volume of run-off

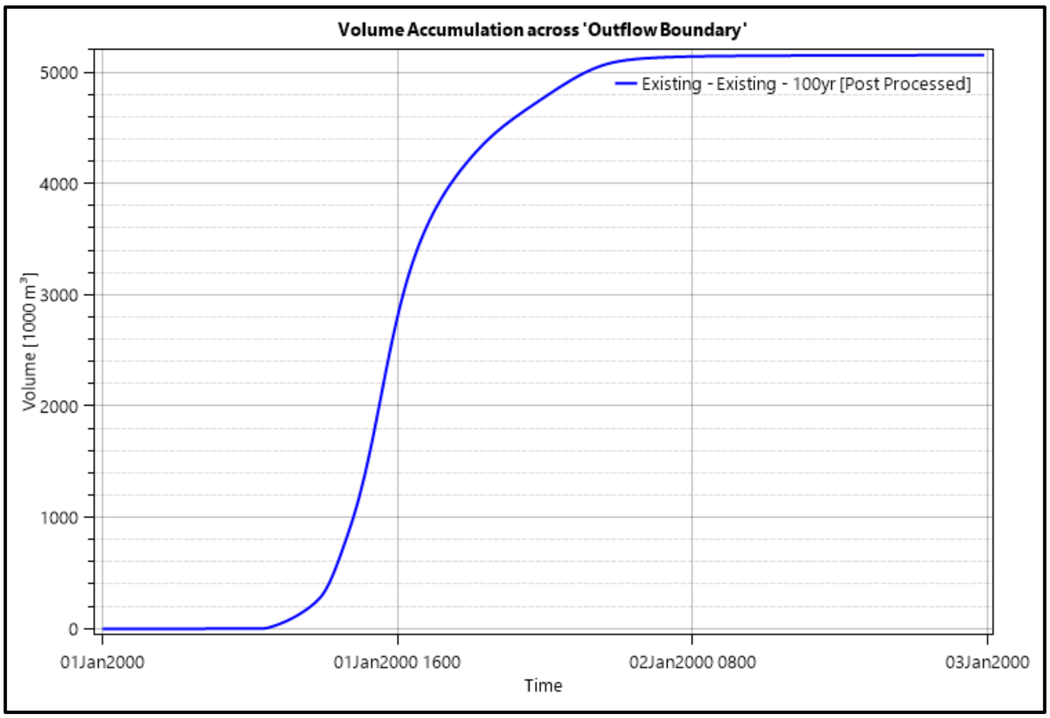


Figure 3.7 – HEC-RAS outflow boundary cumulative volume

3.11 HEALTHY WATERS MODELLING

Auckland Council HealthyWaters have supplied flow data of their modelling of the Warkworth catchment, for Mahurangi River. A comparison of this reports results and Healthywaters are summarised in the table below;

	XS 95 - SCHEME INFLOW (m3/s)					
	10yr Developed CC			100yr Developed CC		
Scenario	Peak Time	Peak Flow	Water level	Peak Time	Peak Flow	Water level
Healthy waters	13:40	199	31.34	13:40	340	32.88
Maven	14:40	143	31.92	14:40	273	33.19

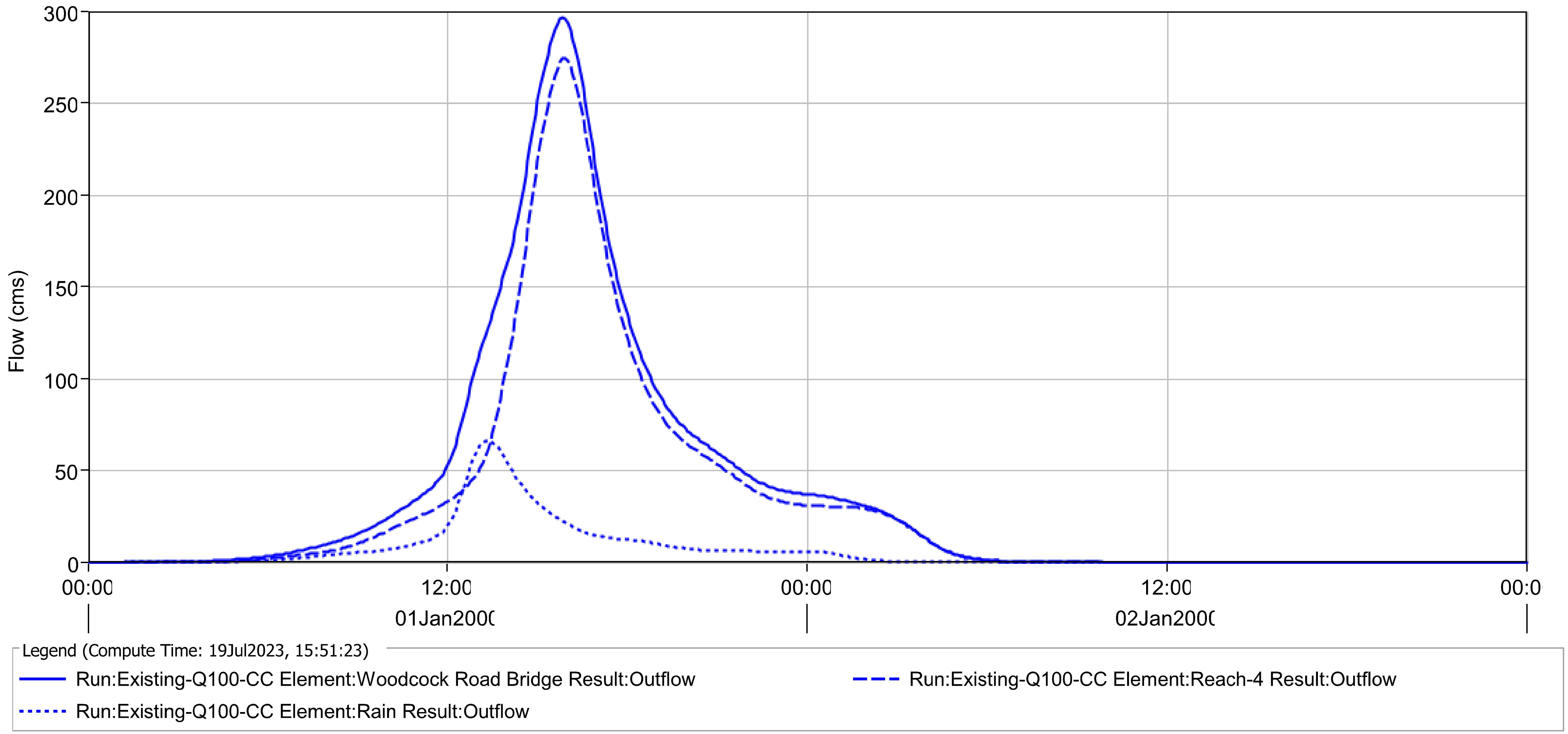
	XS87 - SCHEME OUTFLOW (m3/s)					
	10yr Developed CC			100yr Developed CC		
Scenario	Peak Time	Peak Flow	Water level	Peak Time	Peak Flow	Water Level
Healthy waters	14:10	223	22.16	14:15	326	23.74
Maven	15:10	152	22.12	15:15	289	23.15

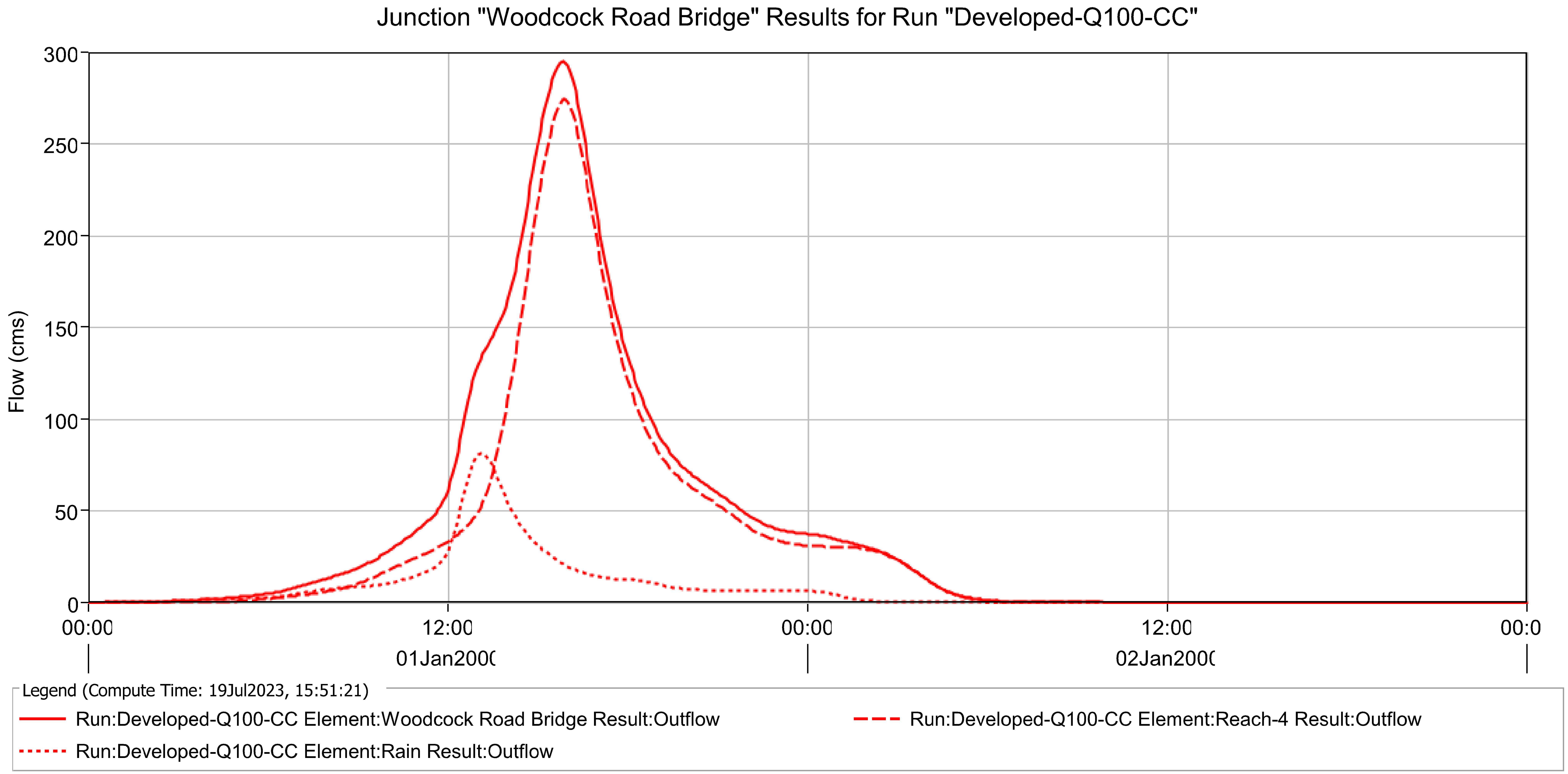
Figure 3.8 MPD Modelling results comparison to Healthy waters model

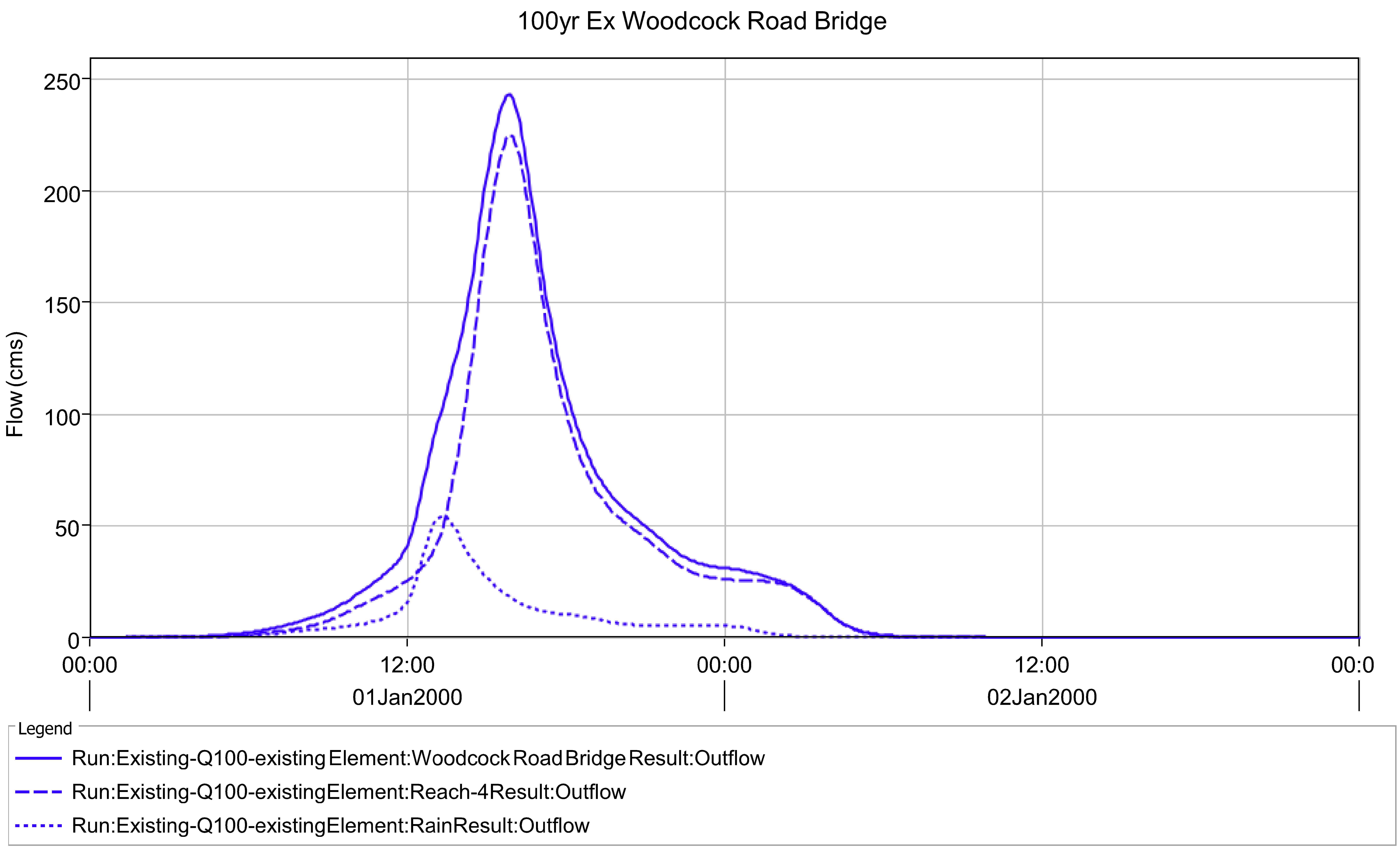
Two notable points of comparison of modelling results are the times of peak flows and the water levels. The peak flow times produced in the model are generally 1 hour later than that from the Healthywaters model. A comparison of the water levels show similar peak flood levels with a difference of upto to 0.59m. This discrepancy is likely a result of the difference in terrain model used. As the terrain used in this reports model uses a combination of site survey and drone data, it has a higher degree of accuracy in comparison to the Lidar survey used in the Healthwaters model.

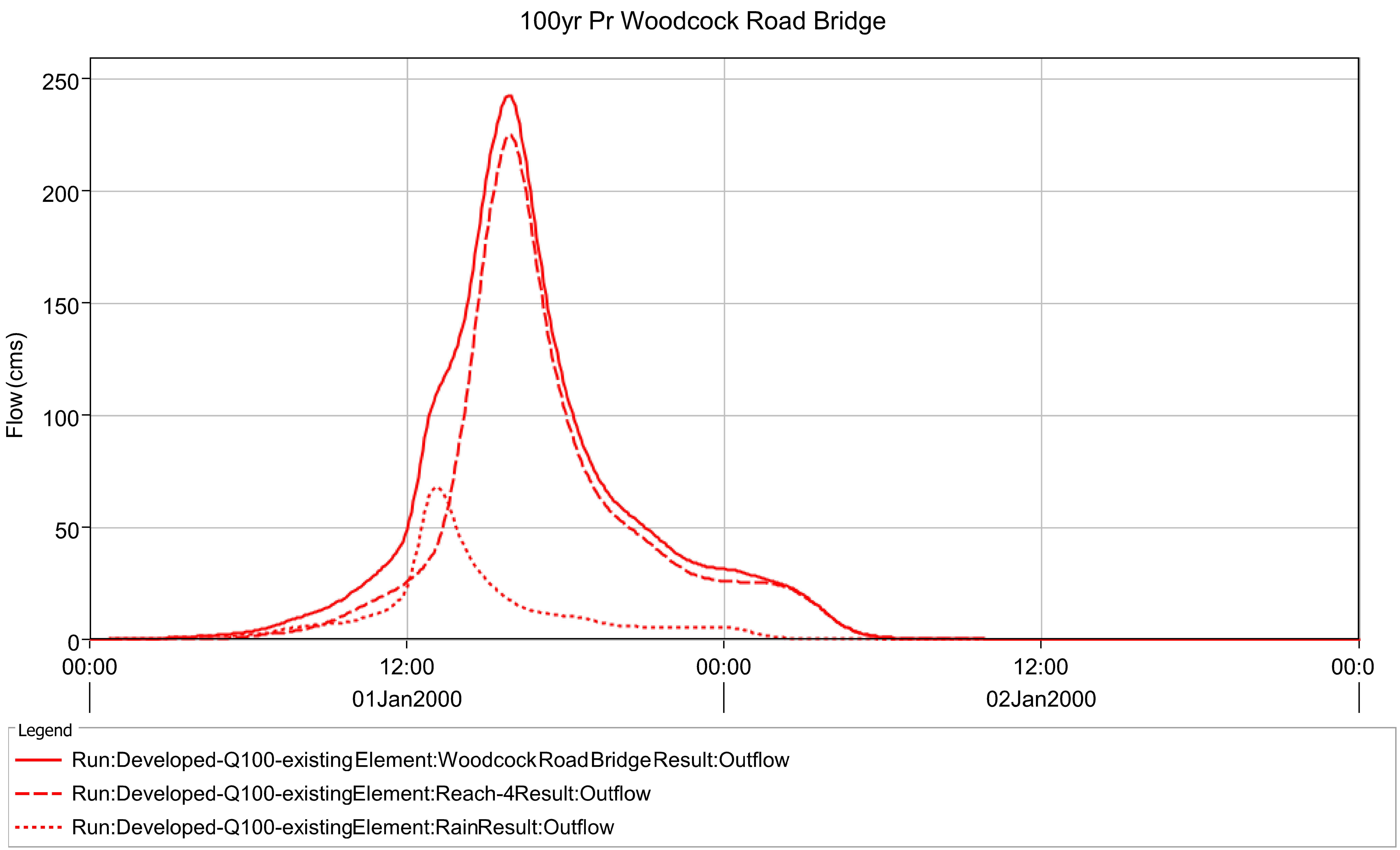
APPENDIX A – 100YR YEAR FLOW HYDROGRAPH

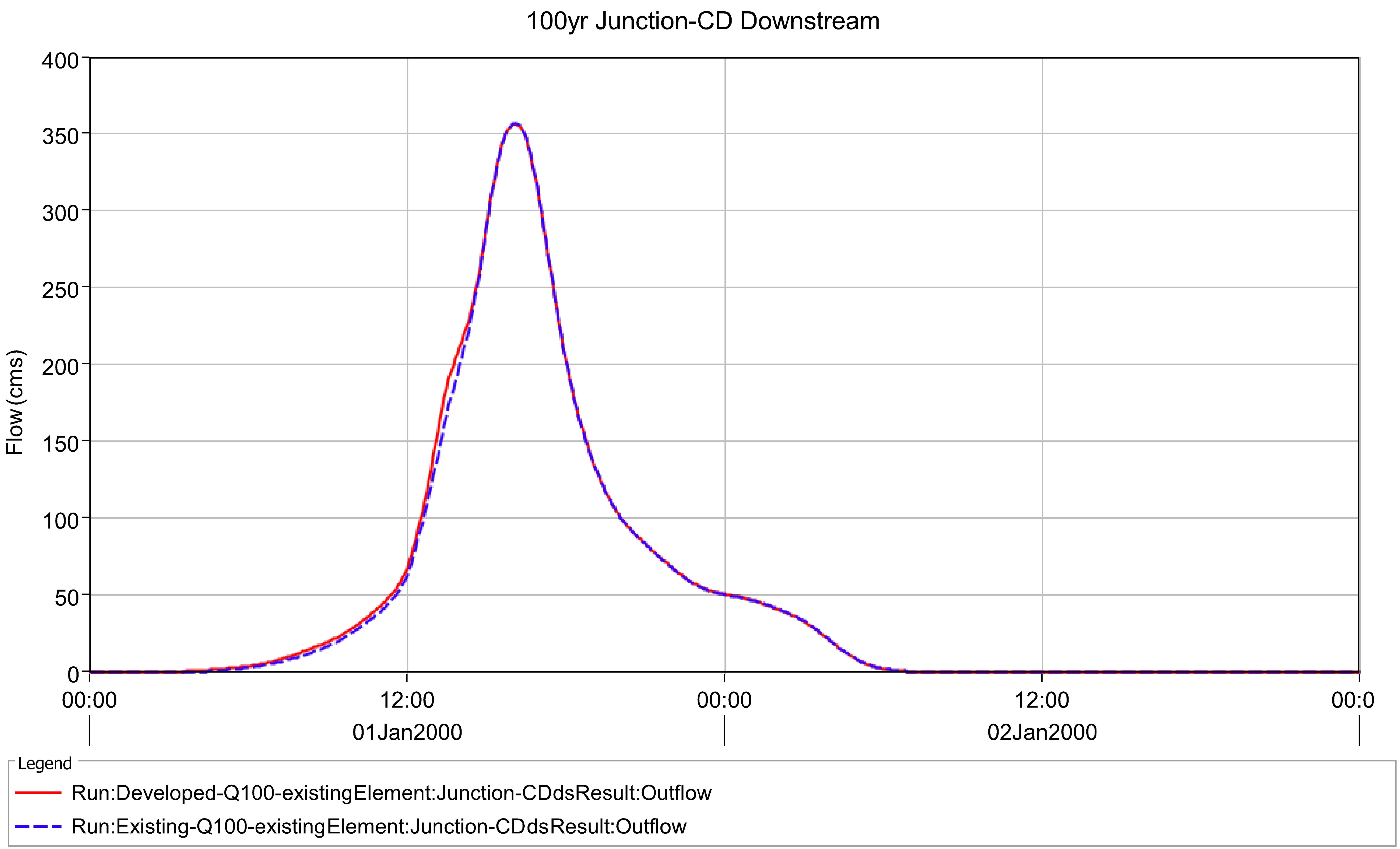
Junction "Woodcock Road Bridge" Results for Run "Existing-Q100-CC"



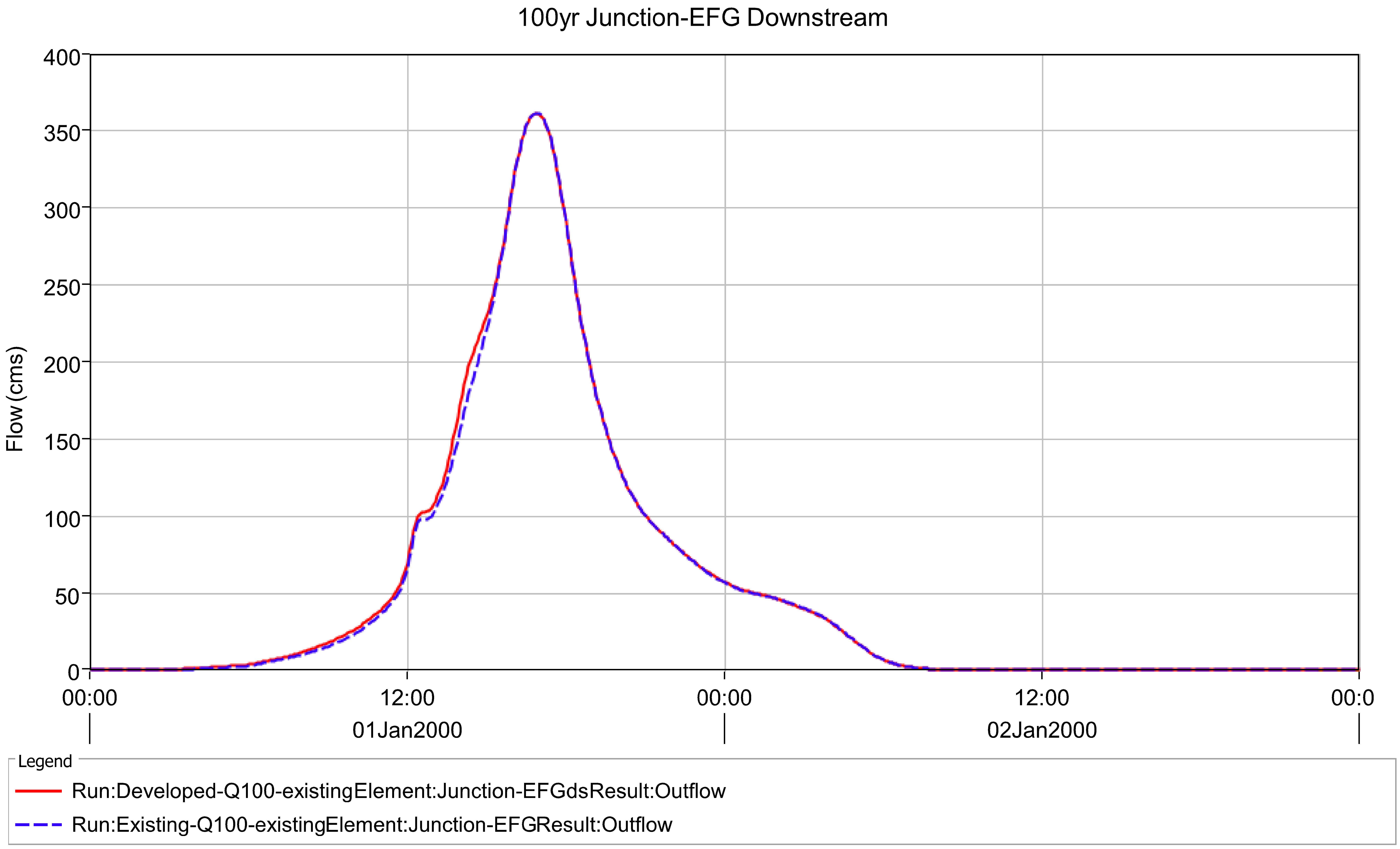

Junction "Woodcock Road Bridge" Results for Run "Developed-Q100-CC"
300
250
200
150
100
50
0
Flow (cms)
00:00
12:00
00:00
12:00
00:0
01Jan200(
02Jan200(
Legend (Compute Time: 19Jul2023, 15:51:21)
Run:Developed-Q100-CC Element:Woodcock Road Bridge Result:Outflow
Run:Developed-Q100-CC Element:Reach-4 Result:Outflow
Run:Developed-Q100-CC Element:Rain Result:Outflow

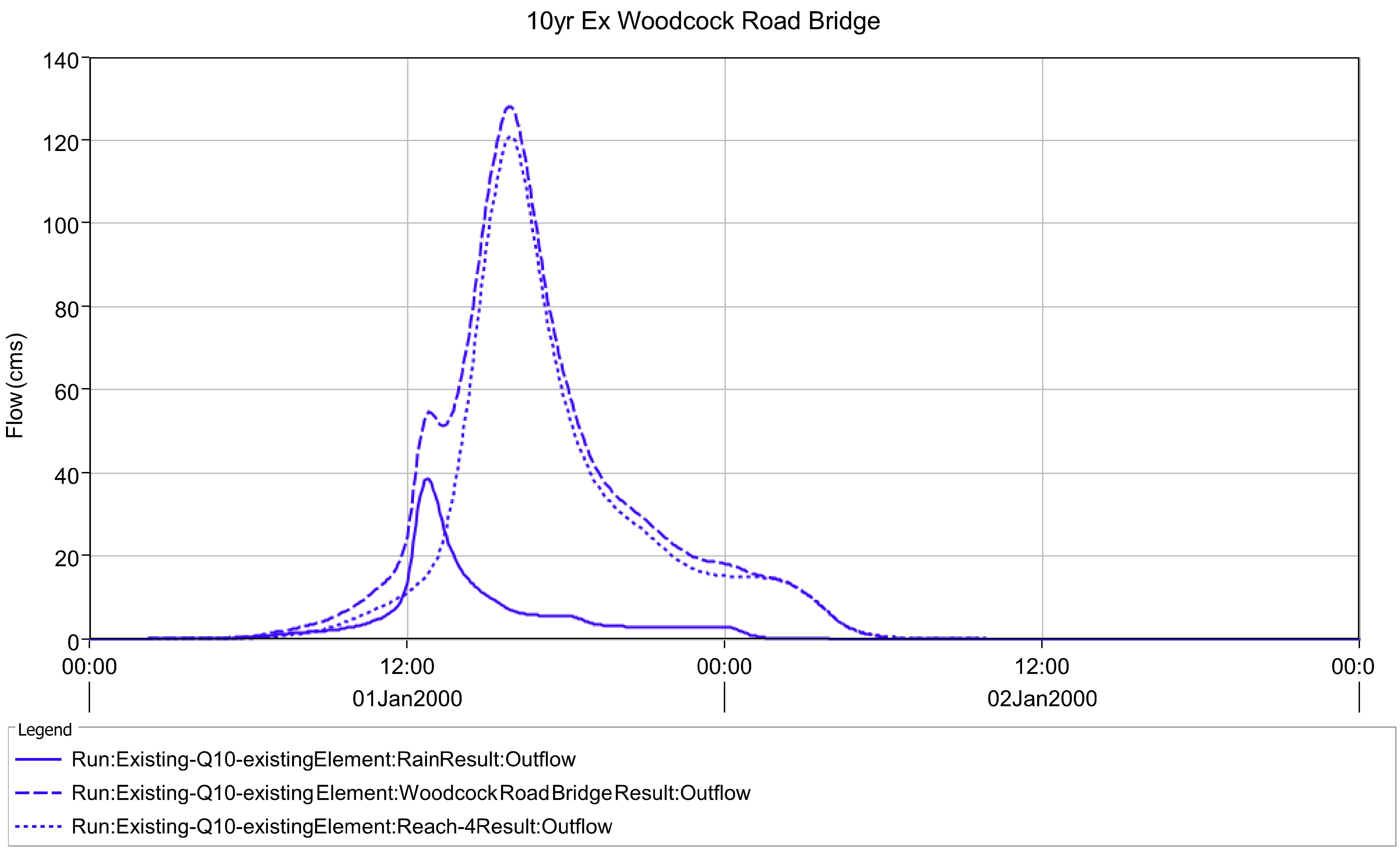

100yr Ex Woodcock Road Bridge
Flow (cms)
250
200
150
100
50
0
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
Legend
Run:Existing-Q100-existing Element:Woodcock Road Bridge Result:Outflow
Run:Existing-Q100-existingElement:Reach-4Result:Outflow
Run:Existing-Q100-existingElement:RainResult:Outflow

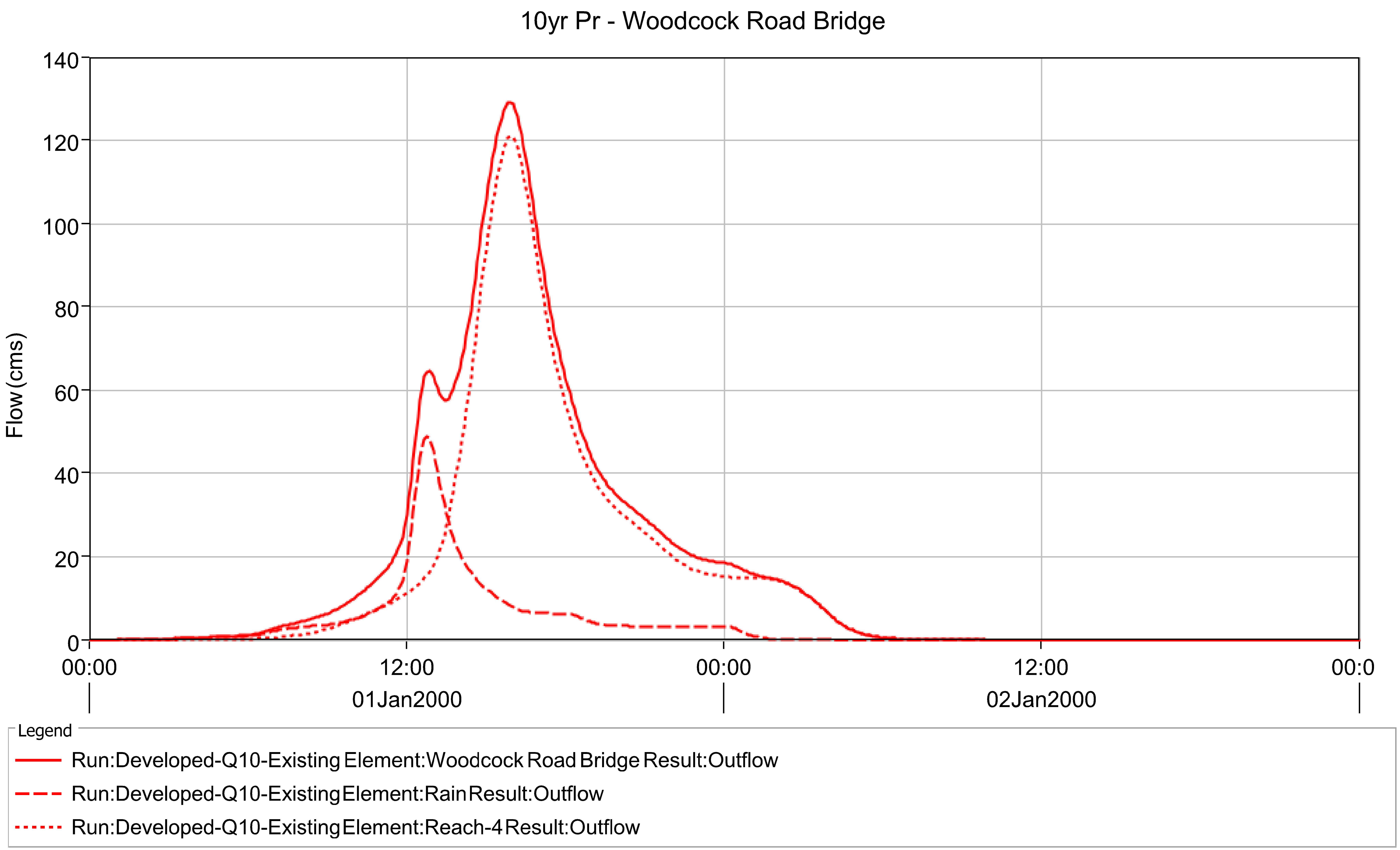

100yr Pr Woodcock Road Bridge
Flow (cms)
250
200
150
100
50
0
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
Legend
Run:Developed-Q100-existing Element:Woodcock Road Bridge Result:Outflow
Run:Developed-Q100-existingElement:Reach-4Result:Outflow
Run:Developed-Q100-existingElement:RainResult:Outflow

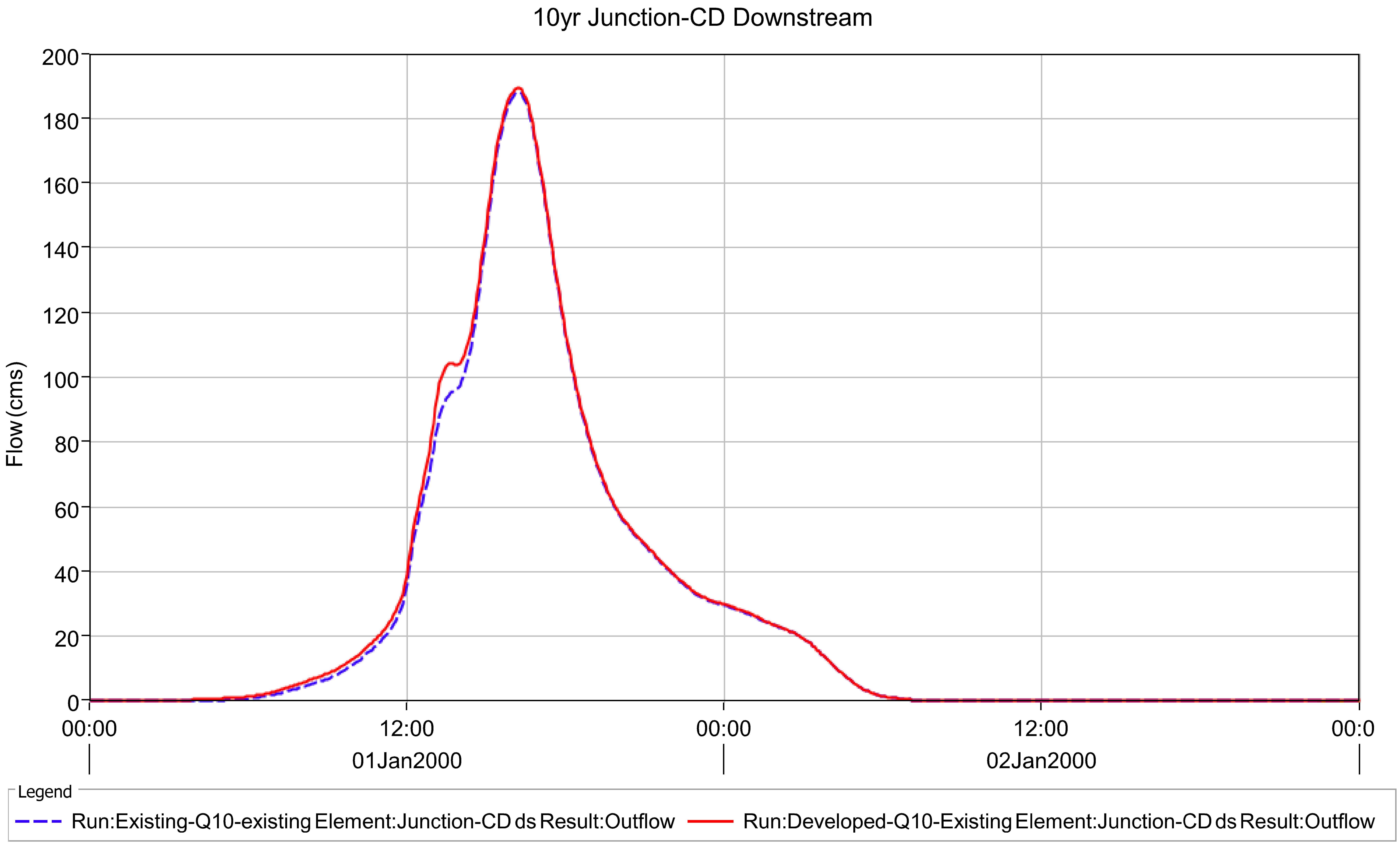


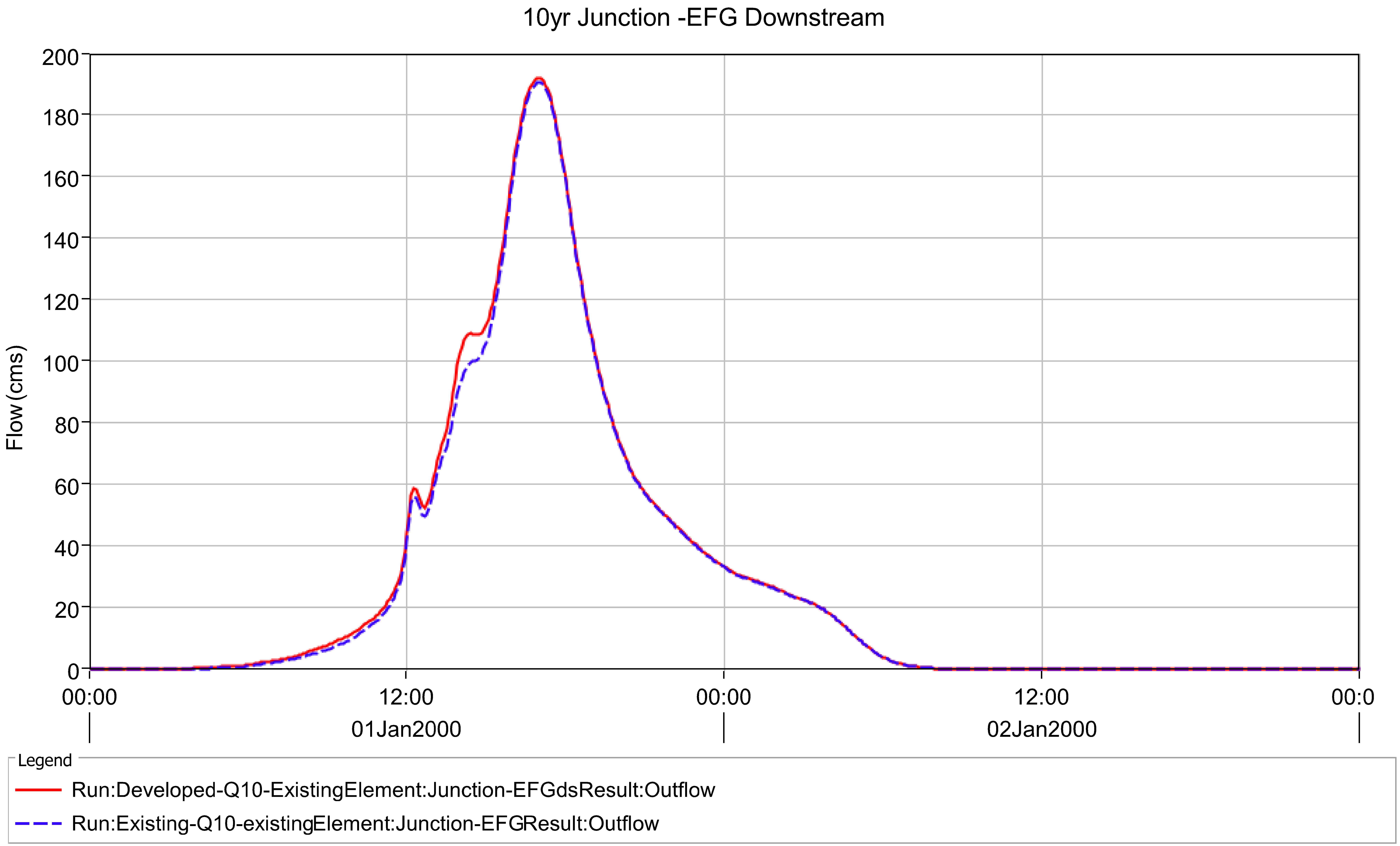
100yr Junction-CD Downstream
Flow (cms)
400
350
300
250
200
150
100
50
0
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
Legend
Run:Developed-Q100-existingElement:Junction-CDdsResult:Outflow
Run:Existing-Q100-existingElement:Junction-CDdsResult:Outflow


100yr Junction-EFG Downstream
Flow (cms)
400
350
300
250
200
150
100
50
0
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
Legend
Run:Developed-Q100-existingElement:Junction-EFGdsResult:Outflow
Run:Existing-Q100-existingElement:Junction-EFGResult:Outflow


10yr Ex Woodcock Road Bridge
Flow (cms)
140
120
100
80
60
40
20
0
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
Legend
Run:Existing-Q10-existingElement:RainResult:Outflow
Run:Existing-Q10-existing Element:Woodcock Road Bridge Result:Outflow
Run:Existing-Q10-existingElement:Reach-4Result:Outflow

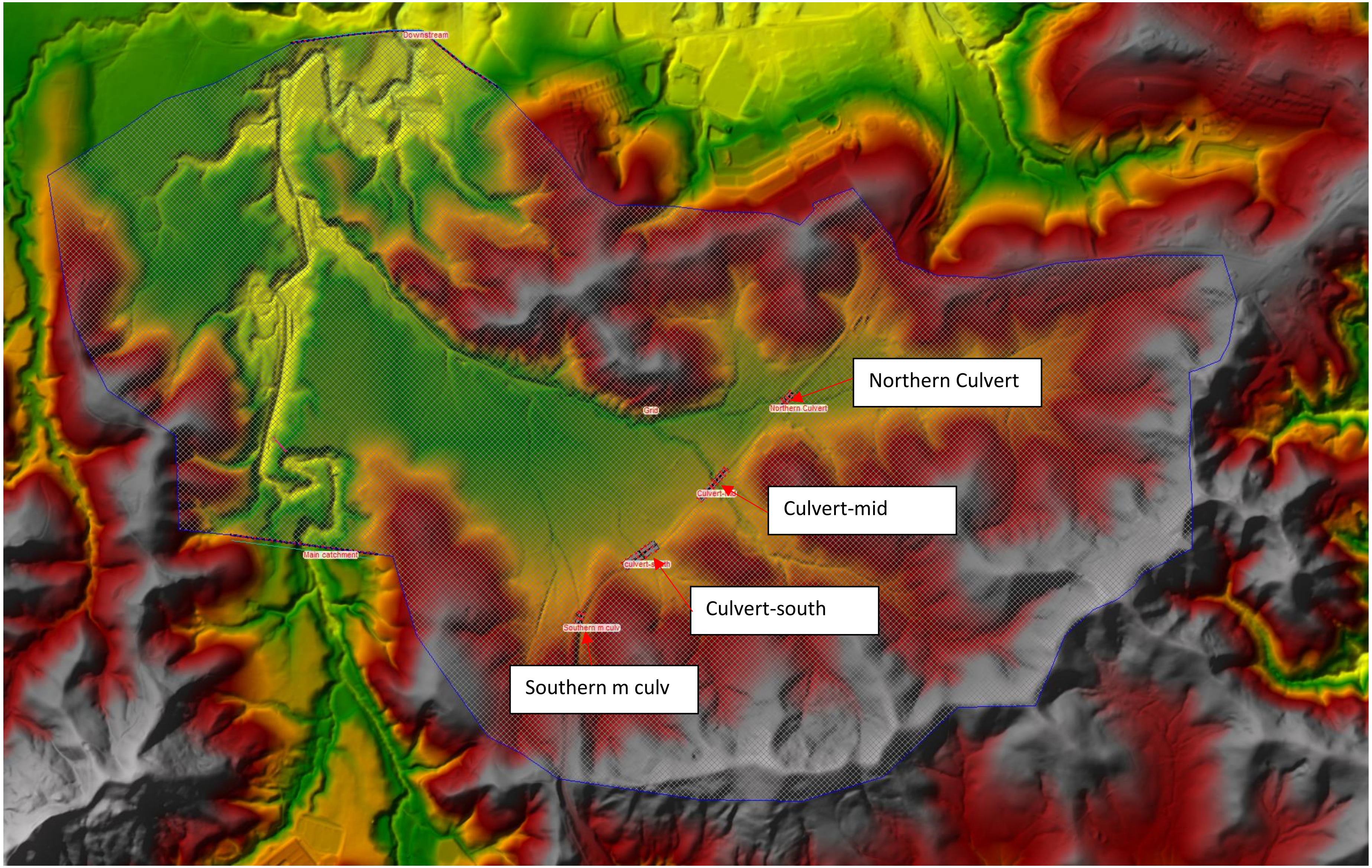

10yr Pr - Woodcock Road Bridge
Flow (cms)
140
120
100
80
60
40
20
0
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
Legend
Run:Developed-Q10-Existing Element:Woodcock Road Bridge Result:Outflow
Run:Developed-Q10-Existing Element:Rain Result:Outflow
Run:Developed-Q10-Existing Element:Reach-4 Result:Outflow


10yr Junction-CD Downstream
Flow (cms)
200
180
160
140
120
100
80
60
40
20
0
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
Legend
Run:Existing-Q10-existing Element:Junction-CD ds Result:Outflow
Run:Developed-Q10-Existing Element:Junction-CD ds Result:Outflow



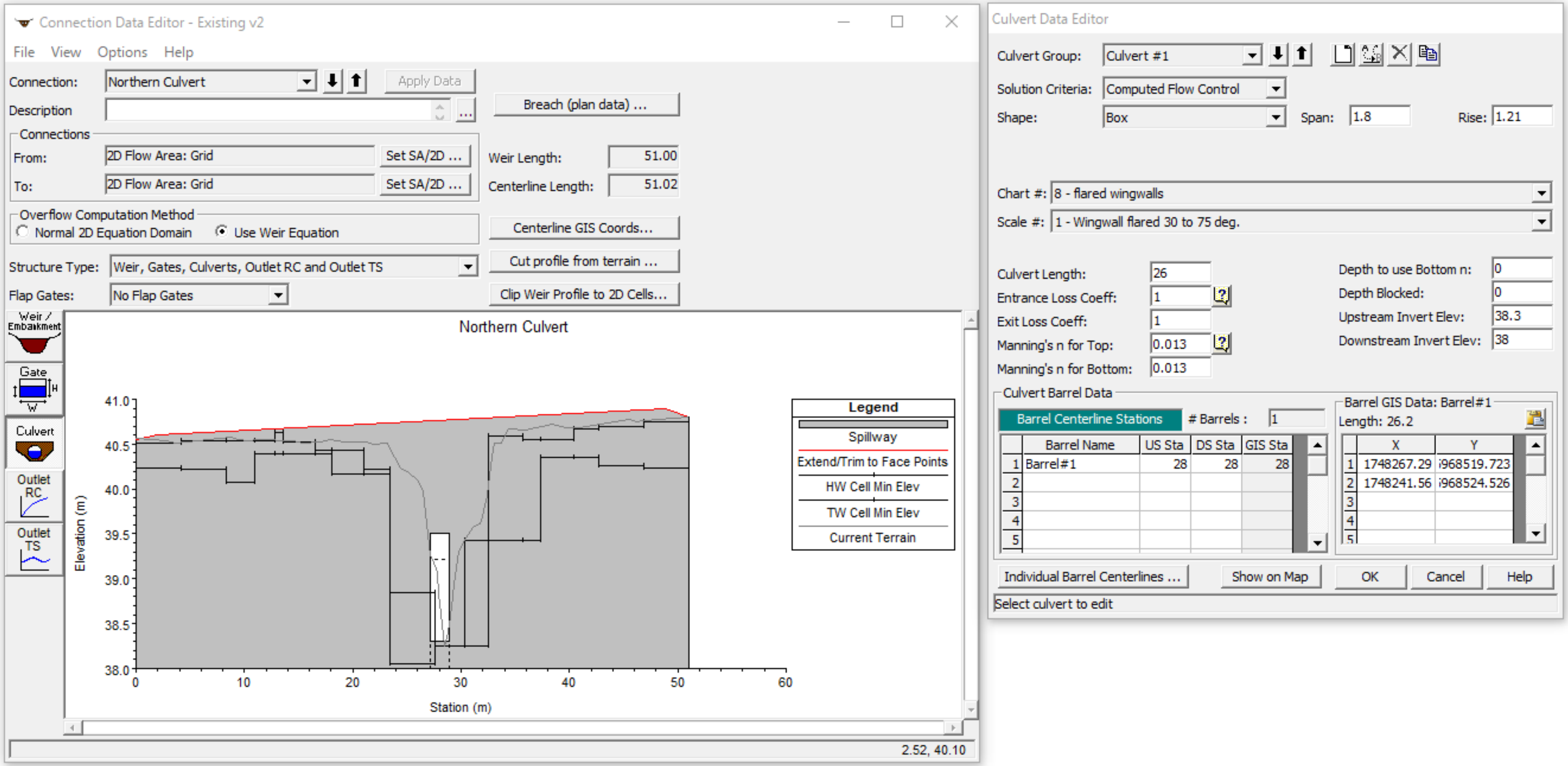
10yr Junction -EFG Downstream
Flow (cms)
200
180
160
140
120
100
80
60
40
20
0
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
Legend
Run:Developed-Q10-ExistingElement:Junction-EFGdsResult:Outflow
Run:Existing-Q10-existingElement:Junction-EFGResult:Outflow

APPENDIX B – HEC RAS CULVERT DETAIL

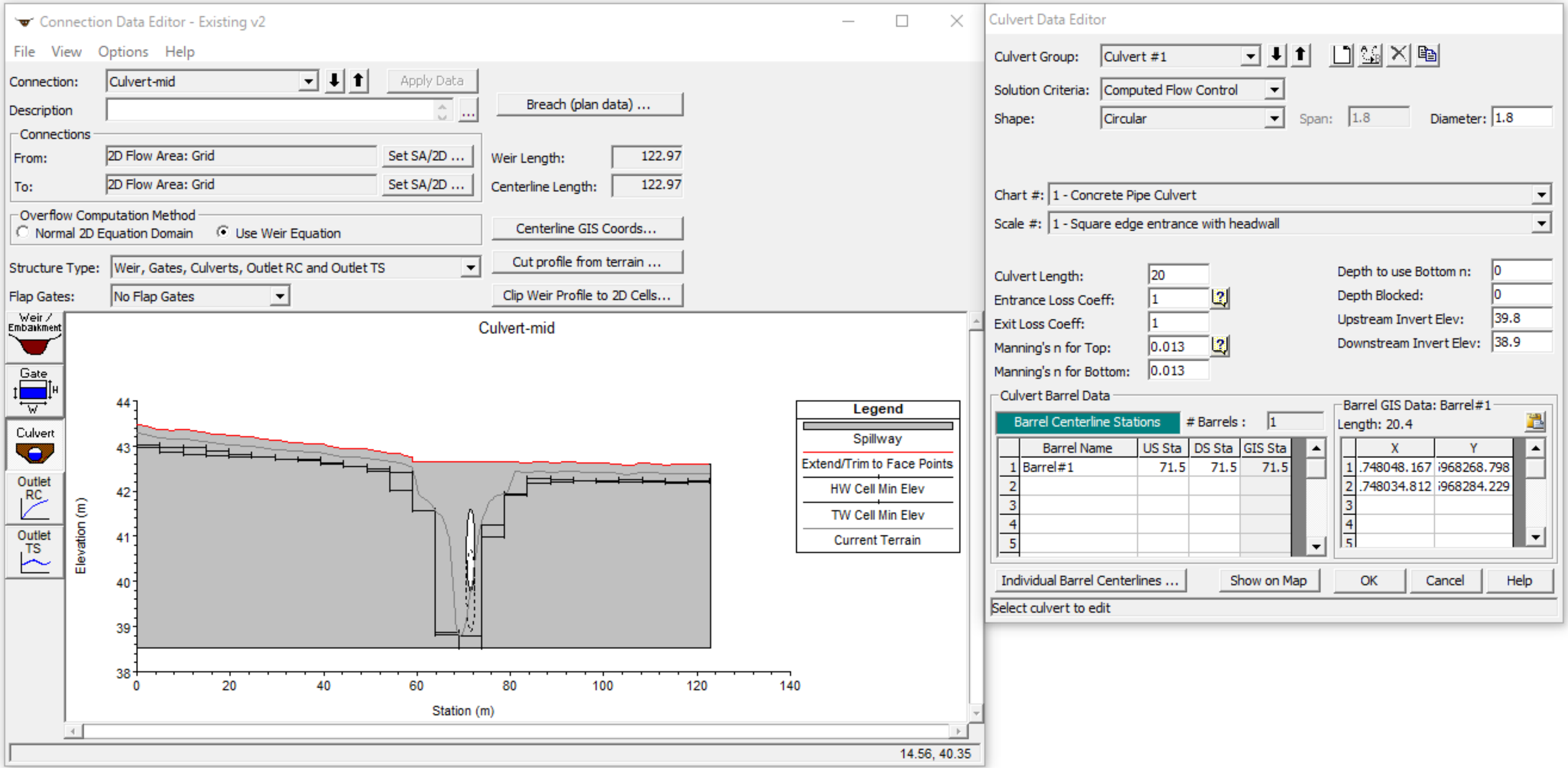


Downstream
Northern Culvert
Grid
Northern Culvert
Culvert-mid
Culvert-mid
Main catchment
Culvert-south
Southern m culv
Southern m culv

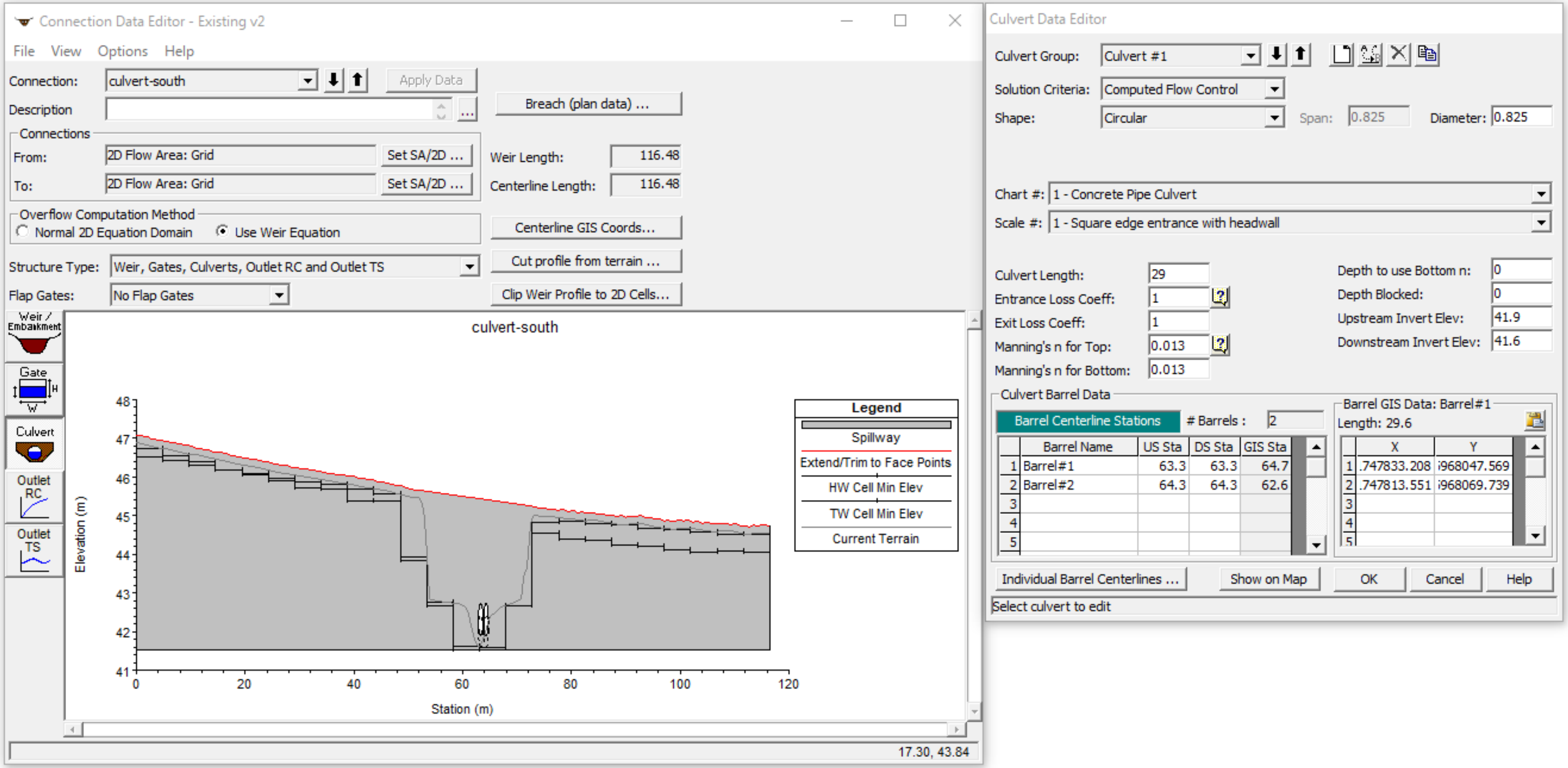
Northern Culvert - Details



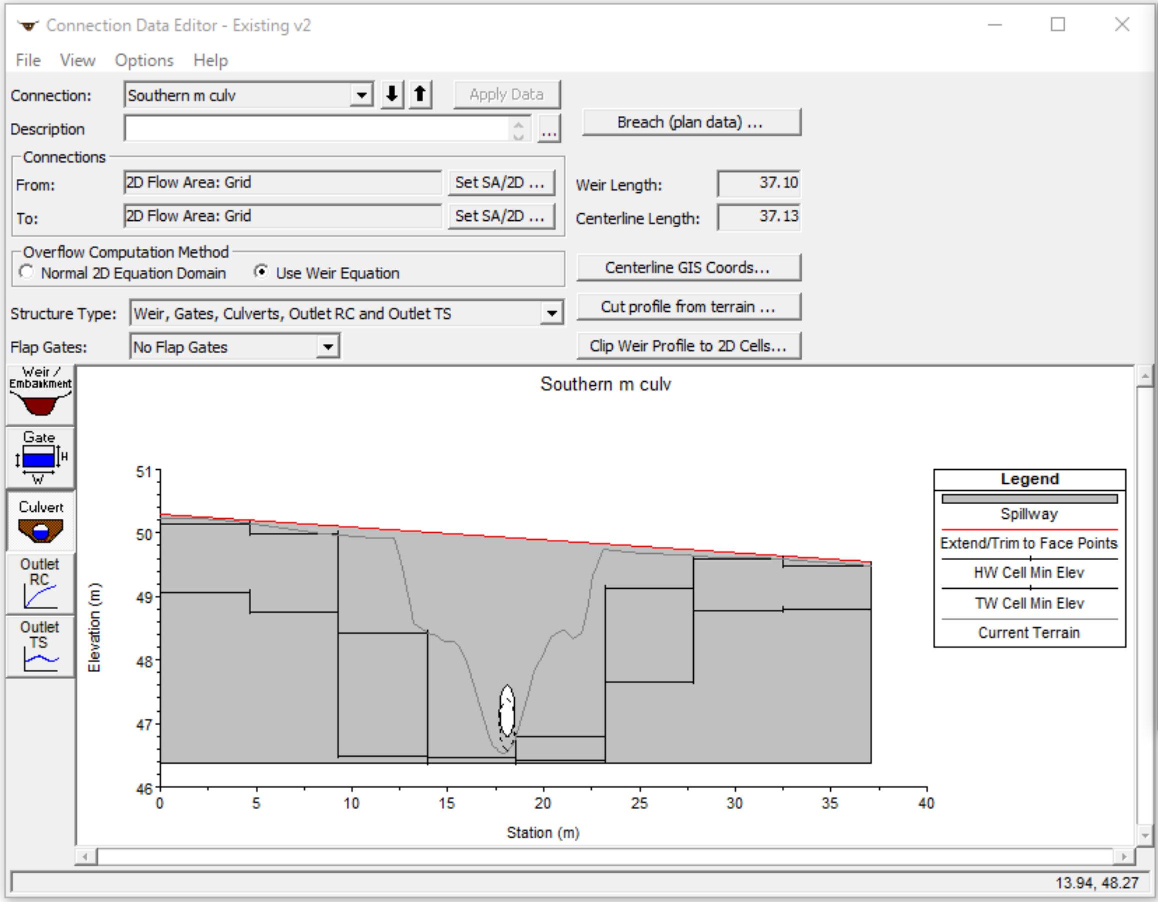
Culvert mid - Details

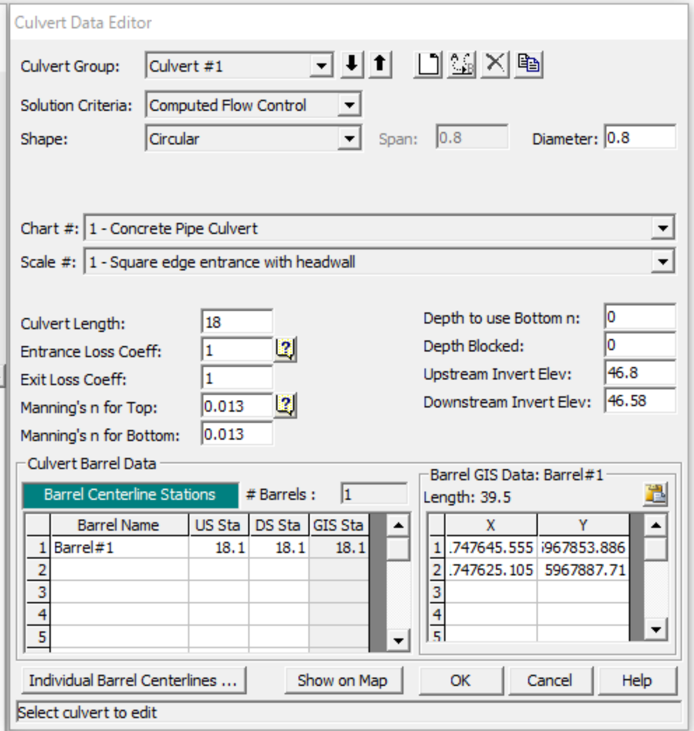


Culvert south - Details

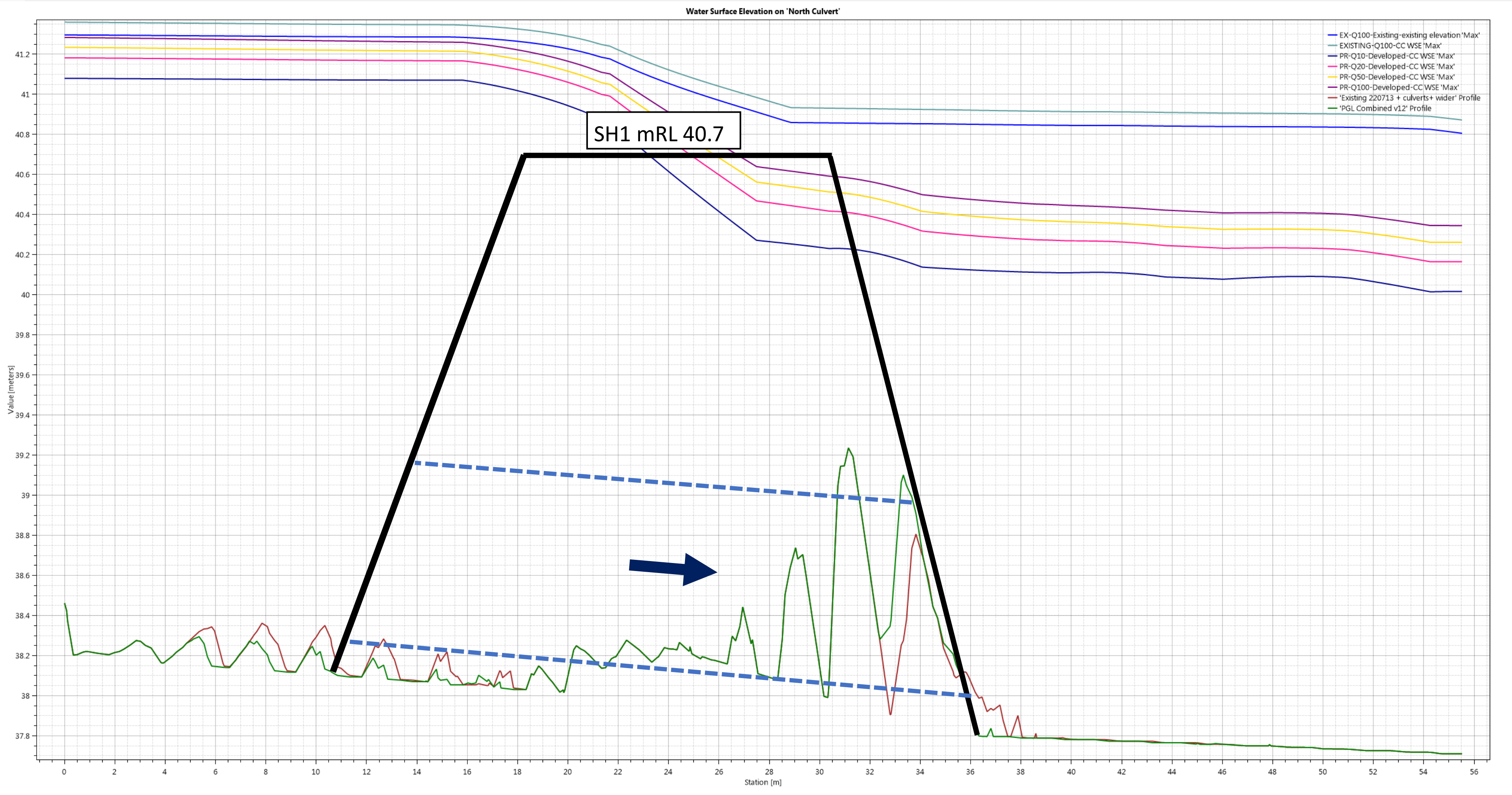


Culvert m south - Details

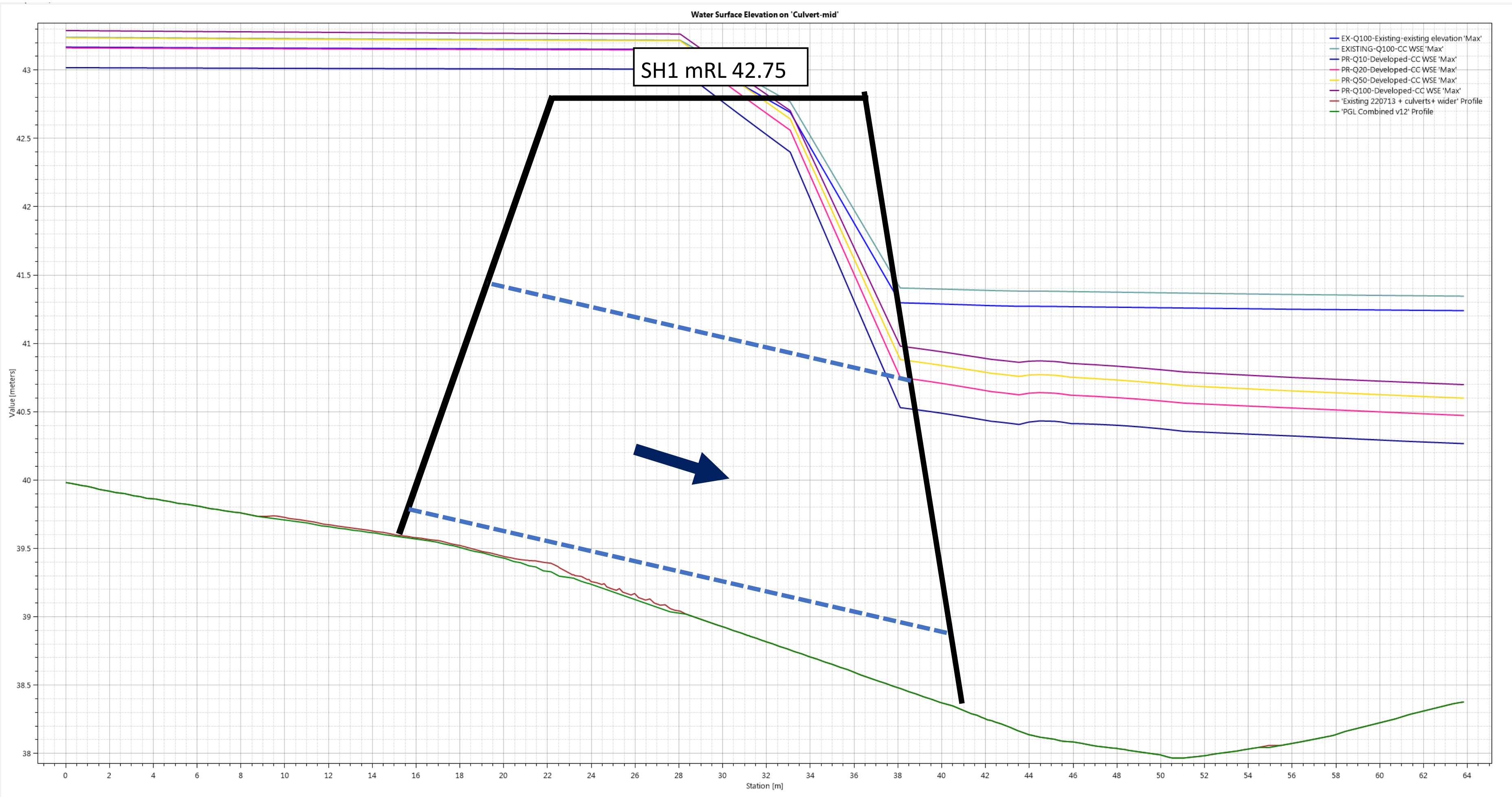




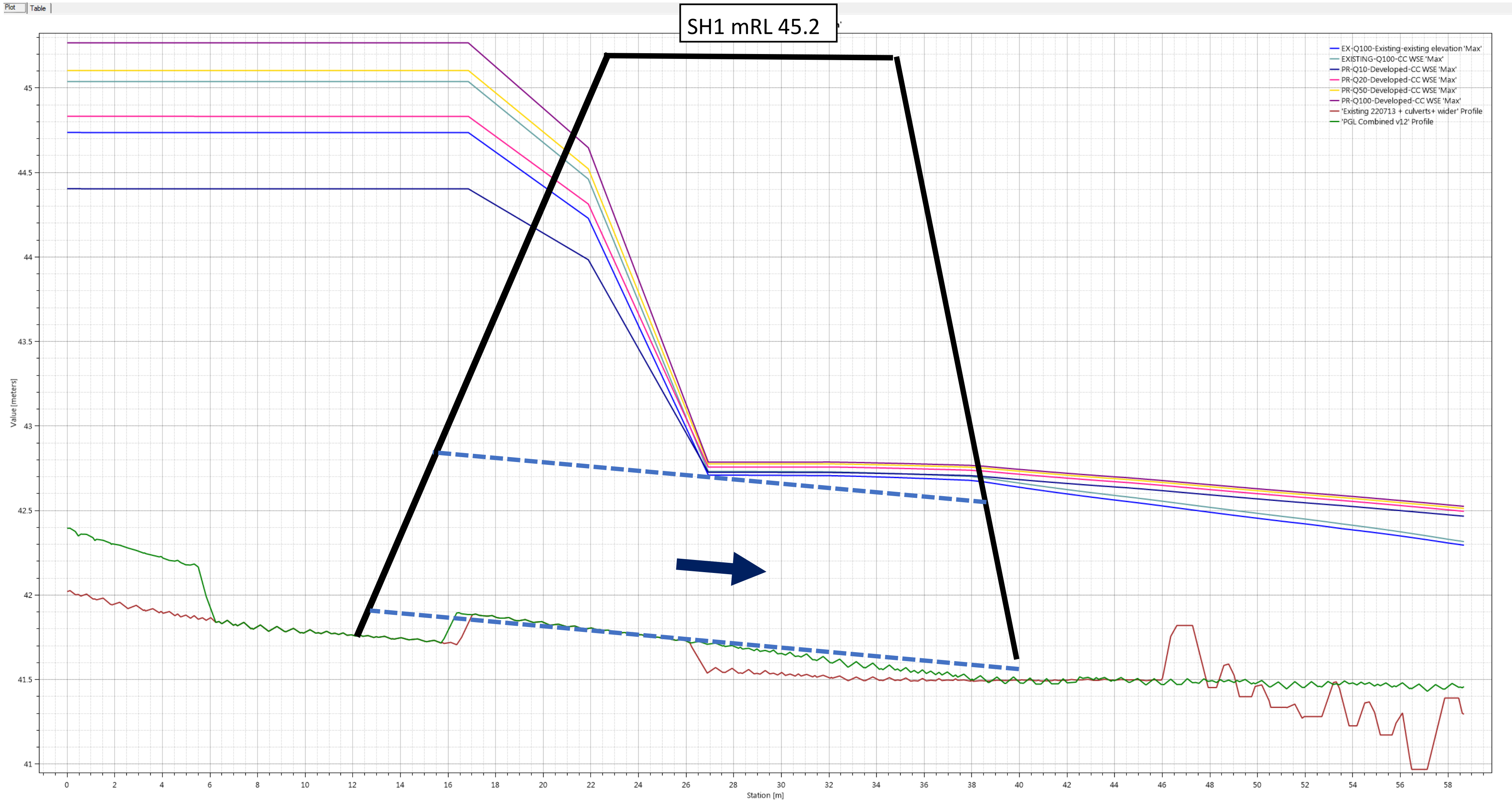
Northern Culvert (1800mm x 1200mm box)



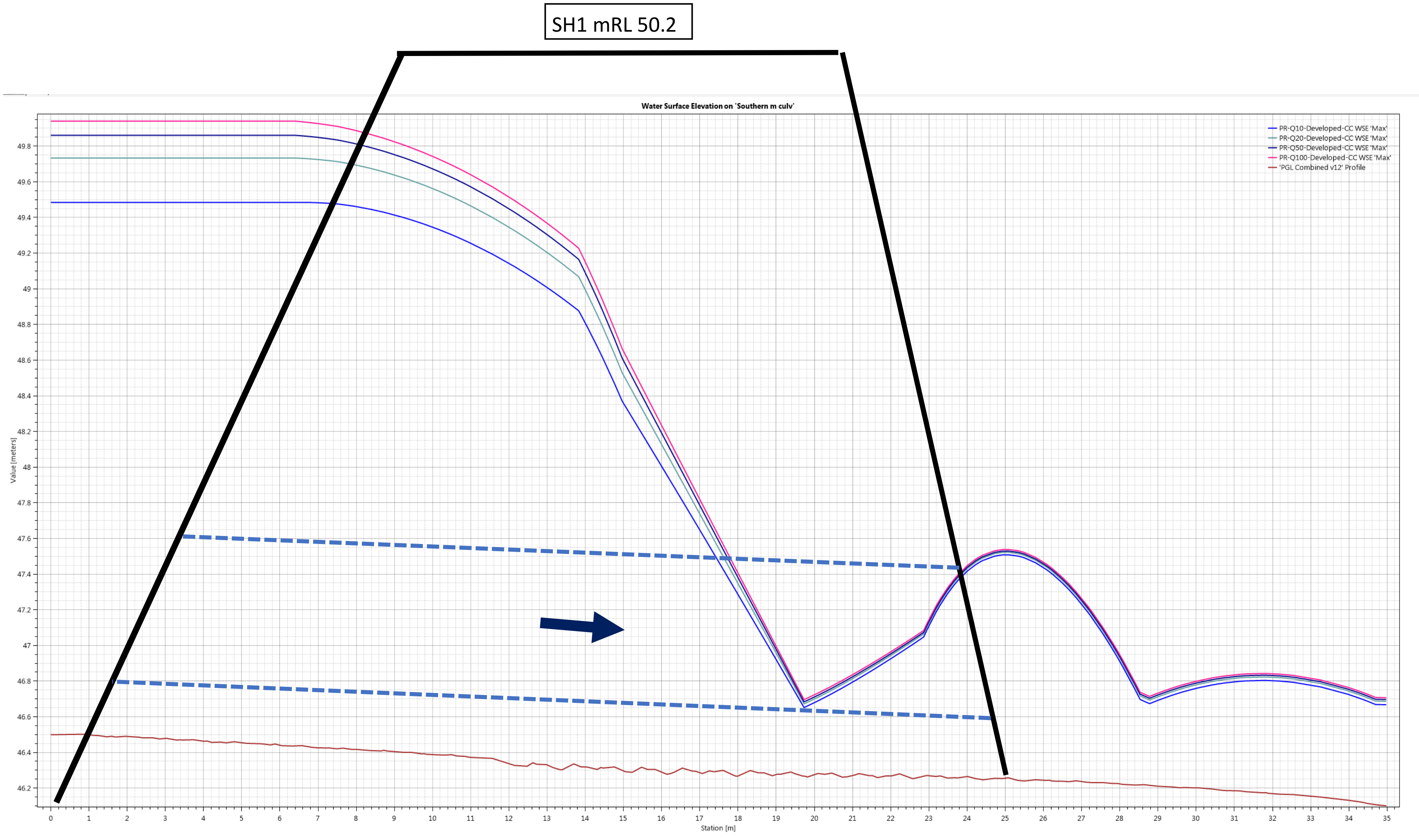
Mid Culvert (1800mm circular)



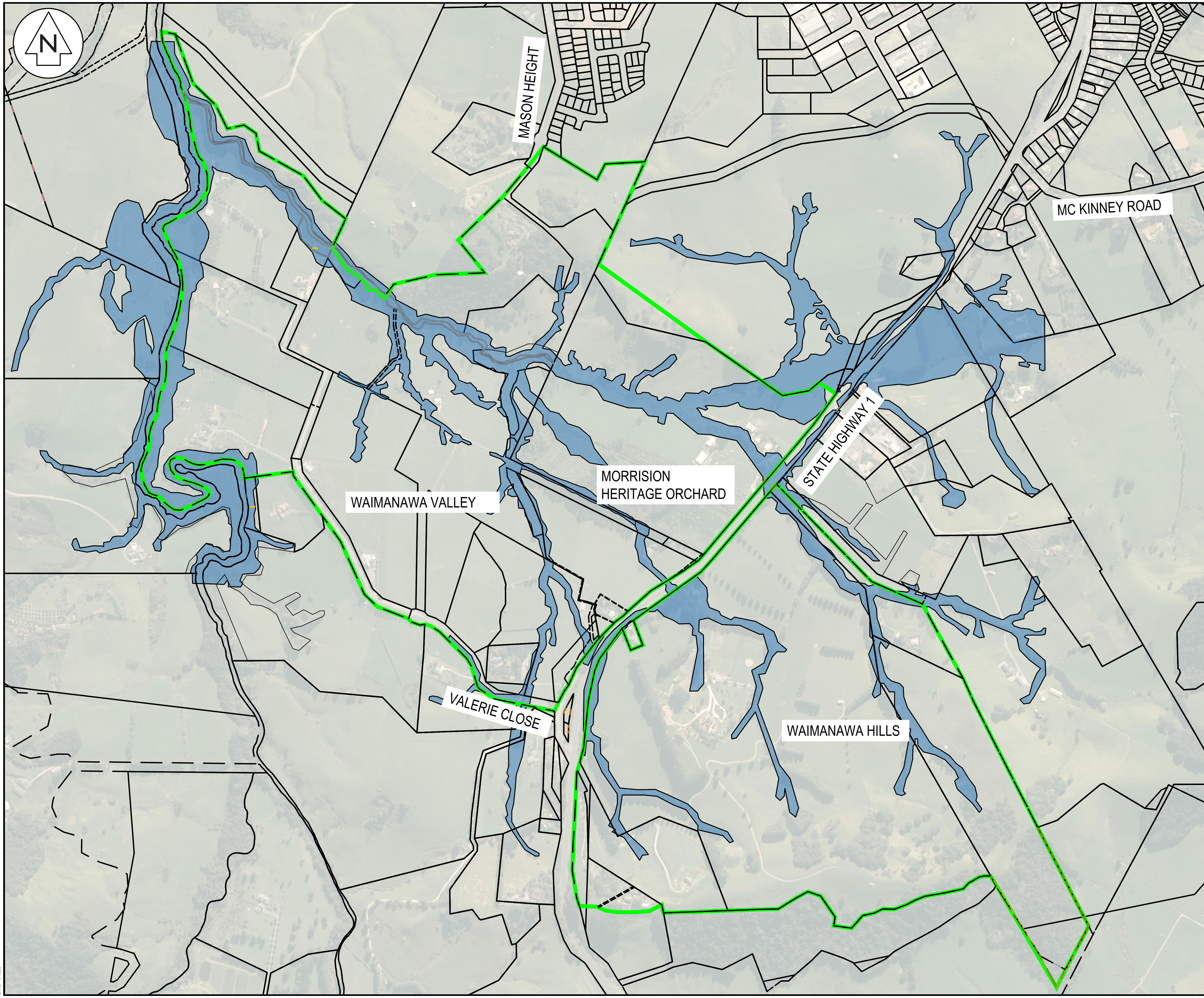
Culvert South (825mm circular x 2)



Culvert m south (800mm circular)



APPENDIX C – Preliminary Pre & Post Development Flood Extent Plan



Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Legend

- EX BDY
- PLAN CHANGE BDY
- FLODD EXTENT

Rev	Description	By	Date
B	PC EXTENT UPDATE	KH	12/22
A	PPC	KH	08/22

	By	Date
Survey	PARALAX & MAVEN	03/21
Design	-	-
Drawn	KH	08/22
Checked	GB	08/22

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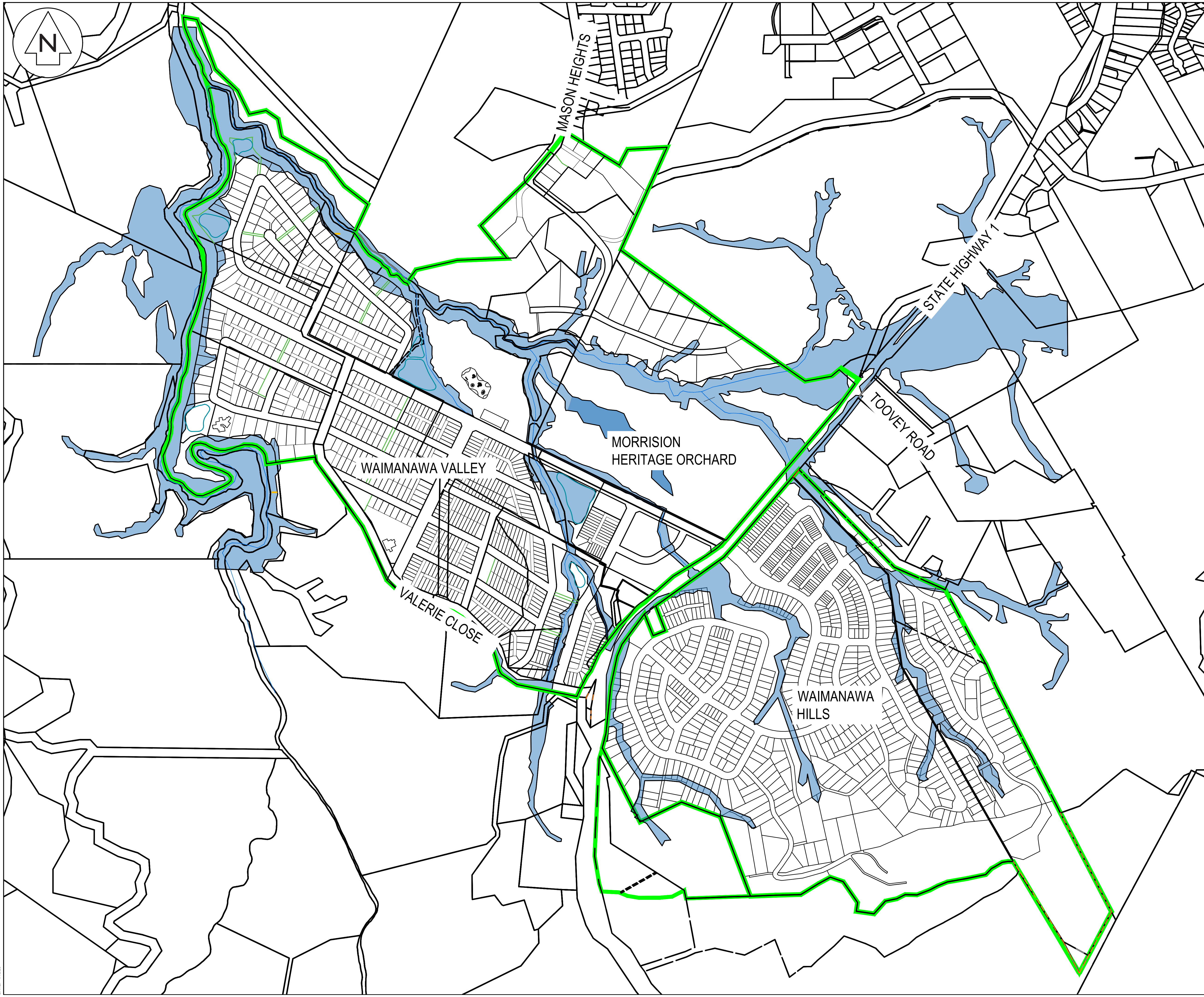
Project

WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title

EXISTING 100 YEARS FLOOD EXTENT PLAN

Project no.	211001		
Scale	1:7500 @ A3		
Cad file	100YR EX FLOODING.DWG		
Drawing no.	C460	Rev	B



Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.
3. It is the contractors responsibility to locate all services that may be affected by his operations.

Legend

- EX BDY
- PLAN CHANGE BDY
- FLODD EXTENT

Rev	Description	By	Date
B	PC EXTENT UPDATE	KH	12/22
A	PPC	KH	08/2022

	By	Date
Survey	PARALAX & MAVEN	03/21
Design	-	-
Drawn	KH	08/22
Checked	GB	08/22

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Project

WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title

PROPOSED 100 YEARS FLOOD EXTENT PLAN

Project no.	211001
Scale	1:7500 @ A3
Cad file	100YR CC EX PROPOSED.DWG
Drawing no.	C465
Rev	B

APPENDIX D – TP108 and Time of concentration calculations

Notes
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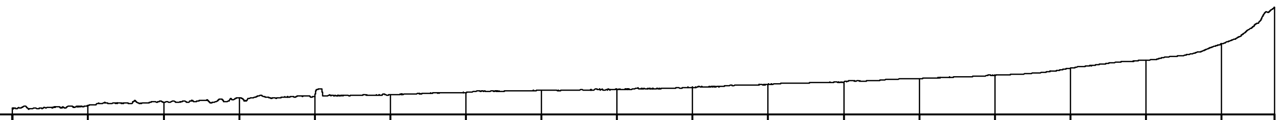
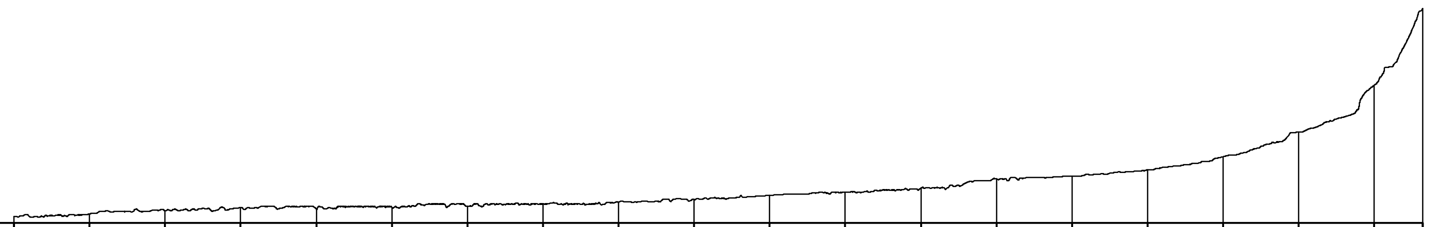


DATUM 28.00m

EXISTING LEVELS	32.28	34.00	36.25	39.17	40.12	41.28	42.75	44.24	44.70	46.13	48.24	49.61	51.99	54.17	58.84	64.00	75.19	99.44
DESIGN LEVELS	32.28	34.00	36.25	39.17	40.12	41.28	42.75	44.24	44.70	46.13	48.24	49.61	51.99	54.17	58.84	64.00	75.19	99.44
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4175.47

Upstream A Longsection

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3



DATUM 28.00m

EXISTING LEVELS	32.28	34.00	36.25	38.23	37.17	38.27	39.08	40.57	41.75	43.25	46.24	48.25	50.92	57.29	58.86	63.00	71.78	88.16	119.12	169.78
DESIGN LEVELS	32.28	34.00	36.25	38.23	37.17	38.27	39.08	40.57	41.75	43.25	46.24	48.25	50.92	57.29	58.86	63.00	71.78	88.16	119.12	169.78
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4659.46

Upstream B Longsection

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DRAFT FOR REVIEW

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
Drawn	BY	MM/YYY
Checked	##	####

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Auckland 1023

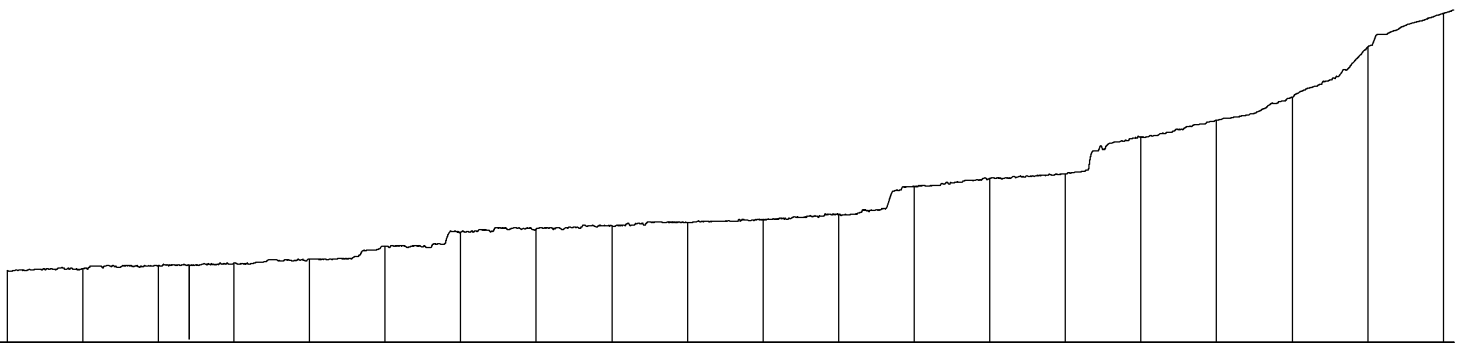
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK001
Rev	A

Notes

1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

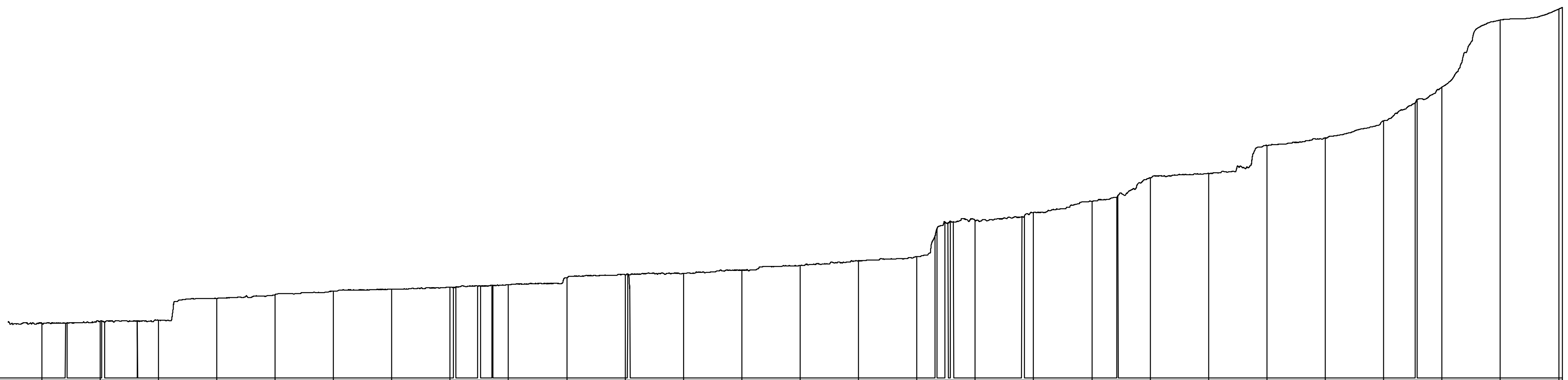


DATUM -2.00m

CHAINAGE	EXISTING LEVELS	DESIGN LEVELS	CUT/FILL
0.00	45.50	45.50	0.00
250.00	46.62	46.62	0.00
500.00	48.65	48.65	0.00
750.00	50.35	50.35	0.00
1000.00	53.20	53.20	0.00
1250.00	61.68	61.68	0.00
1500.00	70.62	70.62	0.00
1750.00	73.09	73.09	0.00
2000.00	74.95	74.95	0.00
2250.00	77.25	77.25	0.00
2500.00	79.02	79.02	0.00
2750.00	82.58	82.58	0.00
3000.00	101.03	101.03	0.00
3250.00	106.38	106.38	0.00
3500.00	109.38	109.38	0.00
3750.00	133.64	133.64	0.00
4000.00	144.97	144.97	0.00
4250.00	160.00	160.00	0.00
4500.00	193.31	193.31	0.00
4750.00 4764.22	215.51	215.51	0.00

Upstream C Longsection

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3



DATUM -2.00m

CHAINAGE	EXISTING LEVELS	DESIGN LEVELS	CUT/FILL
0.00			
250.00	46.95	46.95	0.00
500.00	48.59	48.59	0.00
750.00	49.62	49.62	0.00
1000.00	68.25	68.25	0.00
1250.00	71.28	71.28	0.00
1500.00	74.24	74.24	0.00
1750.00	76.00	76.00	0.00
2000.00	78.00	78.00	0.00
2250.00	80.00	80.00	0.00
2500.00	86.00	86.00	0.00
2750.00	88.56	88.56	0.00
3000.00	89.51	89.51	0.00
3250.00	92.54	92.54	0.00
3500.00	96.42	96.42	0.00
3750.00	100.66	100.66	0.00
4000.00	104.05	104.05	0.00
4250.00	134.95	134.95	0.00
4500.00	141.95	141.95	0.00
4750.00	151.52	151.52	0.00
5000.00	171.50	171.50	0.00
5250.00	175.39	175.39	0.00
5500.00	199.50	199.50	0.00
5750.00	205.84	205.84	0.00
6000.00	220.55	220.55	0.00
6250.00	249.44	249.44	0.00
6500.00	307.01	307.01	0.00
6750.00 6763.96	316.43 317.73	316.43 317.73	0.00 0.00

Upstream D Longsection

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DRAFT FOR REVIEW

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
Drawn	BY	MM/YYY
Checked	##	####

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Project

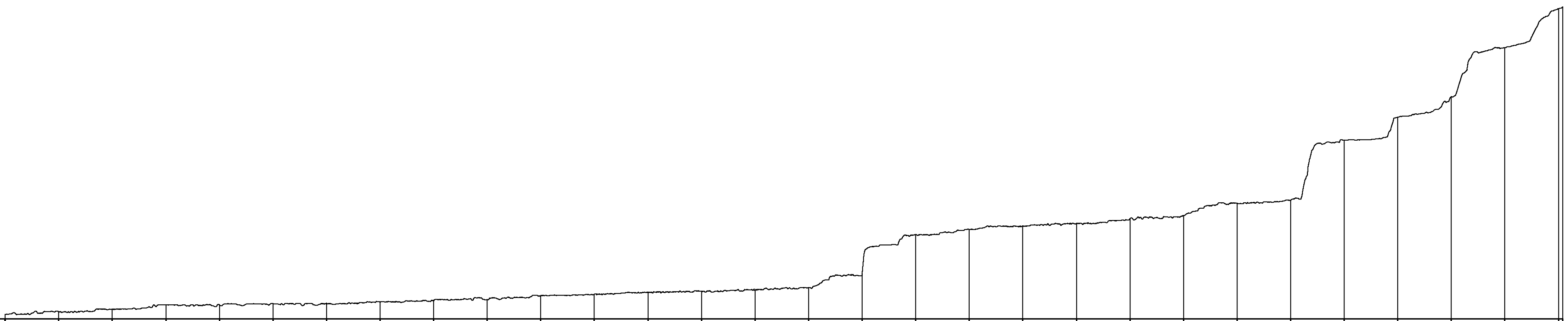
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title

FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK002
Rev	A

DATE: 4/6/23



DATUM 28.00m

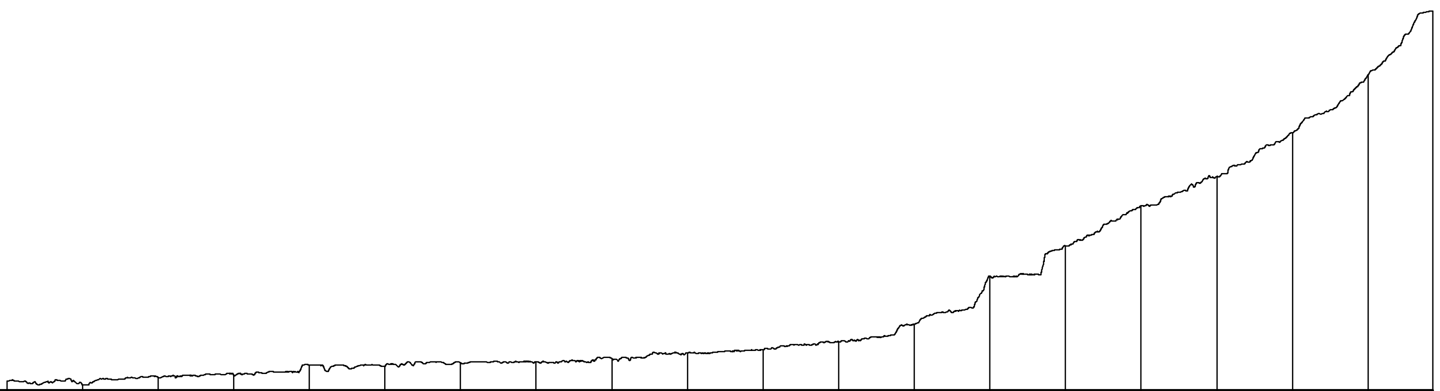
EXISTING LEVELS	32.28	34.30	36.89	40.94	41.10	42.21	42.20	43.56	45.09	45.93
DESIGN LEVELS	32.28	34.30	36.89	40.94	41.10	42.21	42.20	43.56	45.09	45.93
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00

EXISTING LEVELS	49.28	50.91	52.65	53.91	54.75	57.17	70.10	106.58	111.41	114.56
DESIGN LEVELS	49.28	50.91	52.65	53.91	54.75	57.17	70.10	106.58	111.41	114.56
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4750.00

EXISTING LEVELS	117.06	121.38	124.48	135.68	138.56	194.75	216.09	235.23	280.99	317.36 316.91
DESIGN LEVELS	117.06	121.38	124.48	135.68	138.56	194.75	216.09	235.23	280.99	317.36 316.91
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00 0.00
CHAINAGE	5000.00	5250.00	5500.00	5750.00	6000.00	6250.00	6500.00	6750.00	7000.00	7250.00 7269.59

Upstream E Longsection

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3



DATUM 24.00m

EXISTING LEVELS	29.95	27.50	32.26	33.64	40.50	39.50	41.91	42.75	44.86	48.59
DESIGN LEVELS	29.95	27.50	32.26	33.64	40.50	39.50	41.91	42.75	44.86	48.59
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00

EXISTING LEVELS	50.50	55.91	67.32	99.25	119.28	145.68	165.10	194.00	232.28	274.71
DESIGN LEVELS	50.50	55.91	67.32	99.25	119.28	145.68	165.10	194.00	232.28	274.71
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4714.37

Upstream F Longsection

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DRAFT FOR REVIEW

Notes

1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
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Checked	##	####

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Project

WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title

FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK003
Rev	A

DATE: 4/6/23

DATUM 24.00m

EXISTING LEVELS	29.95	27.50	31.89	32.02	32.01	32.28
DESIGN LEVELS	29.95	27.50	31.89	32.02	32.01	32.28
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1186.53

Upstream Reach ABE to Inflow

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM 28.00m

EXISTING LEVELS	32.28	34.00	36.25	38.23	37.17	38.27	39.08	40.57	41.67	42.07			
DESIGN LEVELS	32.28	34.00	36.25	38.23	37.17	38.27	39.08	40.57	41.67	42.07			
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	2864.59

Upstream Reach CD TO ABE

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Notes

1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
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Project

WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title

FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK004
Rev	A

DRAFT FOR REVIEW

DATE: 4/6/23

Notes
1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

DATUM 22.00m

EXISTING LEVELS				27.00	29.21	29.97	29.94	30.28	32.47	32.26	33.04	32.75	33.50	34.33	36.28	37.86	37.42	38.05	39.90	40.55	45.00	52.27	58.22	67.56	97.30	140.02
DESIGN LEVELS				27.00	29.21	29.97	29.94	30.28	32.47	32.26	33.04	32.75	33.50	34.33	36.28	37.86	37.42	38.05	39.90	40.55	45.00	52.27	58.22	67.56	97.30	140.02
CUT/FILL				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4750.00	5000.00	5250.00	5500.00	5750.00	6000.00	6121.08

Downstream A Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM 36.00m

EXISTING LEVELS	40.68	42.00	43.75	45.80	48.87	49.50	53.82	56.49	62.25	94.33	148.64	288.82
DESIGN LEVELS	40.68	42.00	43.75	45.80	48.87	49.50	53.82	56.49	62.25	94.33	148.64	288.82
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	500.00	1000.00	1500.00	2000.00	2500.00	3000.00	3500.00	4000.00	4500.00	5000.00	5305.61

Downstream B Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
Drawn	BY	MM/YYY
Checked	##	####

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Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

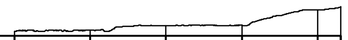
Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK005 — Rev A

DRAFT FOR REVIEW

DATE: 4/5/23

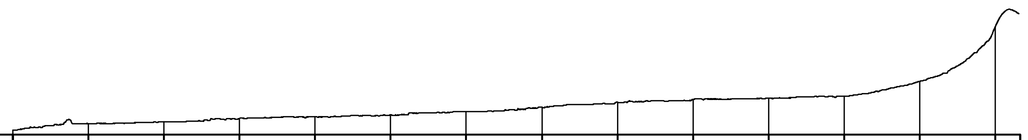
Notes
1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.



DATUM 8.00m

EXISTING LEVELS	11.10	12.01	15.07	15.32	25.65	27.77
DESIGN LEVELS	11.10	12.01	15.07	15.32	25.65	27.77
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1077.43

Downstream C Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3



DATUM 8.00m

EXISTING LEVELS	11.10	15.39	16.50	18.89	20.21	21.24	23.25	26.41	29.58	31.42	32.24	33.74	43.47	79.73	
DESIGN LEVELS	11.10	15.39	16.50	18.89	20.21	21.24	23.25	26.41	29.58	31.42	32.24	33.74	43.47	79.73	
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3331.05

Downstream D Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM 6.00m

EXISTING LEVELS	8.98	11.99	10.36	18.24	26.47	34.17	44.66	57.08
DESIGN LEVELS	8.98	11.99	10.36	18.24	26.47	34.17	44.66	57.08
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1695.06

Downstream E Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DRAFT FOR REVIEW

DATE: 4/6/23

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
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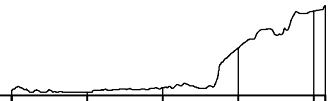
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK006
Rev	A

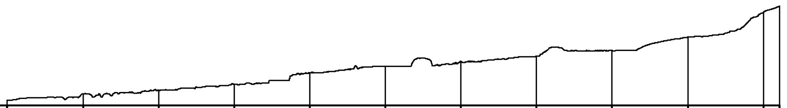
DATUM 6.00m



EXISTING LEVELS	8.98	8.25	10.88	37.35	61.78	65.08
DESIGN LEVELS	8.98	8.25	10.88	37.35	61.78	65.08
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1056.58

Downstream F Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

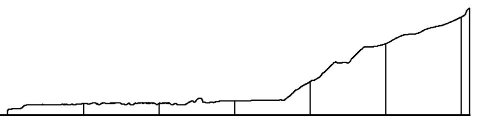
DATUM 6.00m



EXISTING LEVELS	9.39	13.78	16.27	20.00	27.46	31.75	35.09	38.48	42.35	51.20	67.66	71.51
DESIGN LEVELS	9.39	13.78	16.27	20.00	27.46	31.75	35.09	38.48	42.35	51.20	67.66	71.51
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2553.95

Downstream G Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM -4.00m



EXISTING LEVELS	-0.75	3.75	3.58	5.25	18.08	43.07	60.60	66.28
DESIGN LEVELS	-0.75	3.75	3.58	5.25	18.08	43.07	60.60	66.28
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1527.10

Downstream H Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DRAFT FOR REVIEW

DATE: 4/6/23

Notes
1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
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Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK007
Rev	A

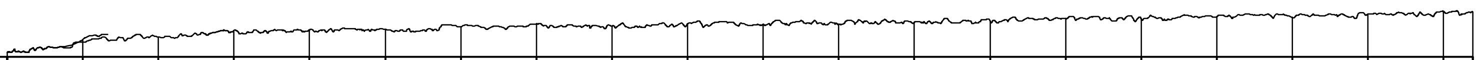
Notes
1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

DATUM 12.00m

EXISTING LEVELS	15.00	16.00	16.25	18.76	19.25	21.21	22.75	21.19	25.66	23.47	25.60	26.79	31.12
DESIGN LEVELS	15.00	16.00	16.25	18.76	19.25	21.21	22.75	21.19	25.66	23.47	25.60	26.79	31.12
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	2873.05

Reach Scheme In to Scheme Out
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM 12.00m



EXISTING LEVELS				29.43	29.86	30.15	31.76	33.75	32.25	33.75	33.58	33.34	34.85	35.73	37.29	37.03	38.50	37.84	40.12	42.08	41.68
DESIGN LEVELS	15.02	23.42																			
CUT/FILL																					
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4750.00	4847.70

Downstream Reach B to A Scheme Out
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
Drawn	BY	MM/YYY
Checked	##	####

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Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK008
Rev	A

DRAFT FOR REVIEW

DATE: 4/6/23

DATUM 8.00m

EXISTING LEVELS	11.10	11.77	15.05	15.33	15.00
DESIGN LEVELS	11.10	11.77	15.05	15.33	15.00
CUT/FILL	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1006.09

Downstream Reach Scheme Out B to CD
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM 6.00m

EXISTING LEVELS	9.38	9.81	9.88	11.71	11.00	11.02	11.11
DESIGN LEVELS	9.38	9.81	9.88	11.71	11.00	11.02	11.11
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1303.55

Downstream Reach CD to EFG
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM 0.00m

EXISTING LEVELS	2.75	3.92	3.45	5.74	8.00	9.41
DESIGN LEVELS	2.75	3.92	3.45	5.74	8.00	9.41
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1078.37

Downstream Reach EFH to Out
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DRAFT FOR REVIEW

Notes
1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
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Drawn	BY	MM/YYY
Checked	##	####

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Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

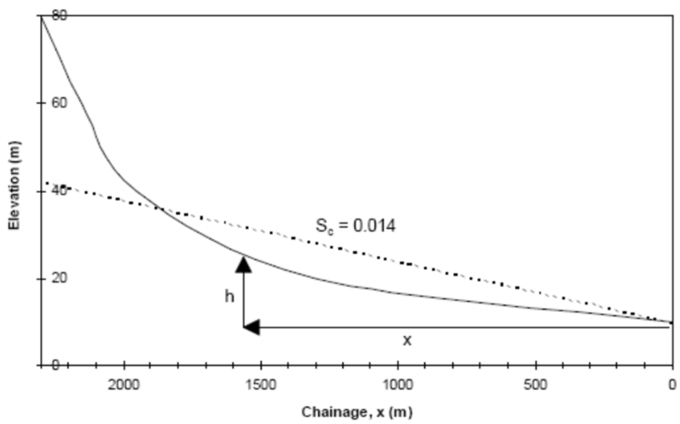
Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK009
Rev	A

DATE: 4/6/23

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Catchment A	**CHKD BY:**	

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



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

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	32.3	0	0			
2	42.75	10.45	1500	1500	5.225	7837.5
3	52	19.7	3000	1500	15.075	22612.5
4	64	31.7	3750	750	25.7	19275
5	99.4	67.1	4175	425	49.4	20995
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 =	4175	TOTAL =	70720

S_c = 0.008

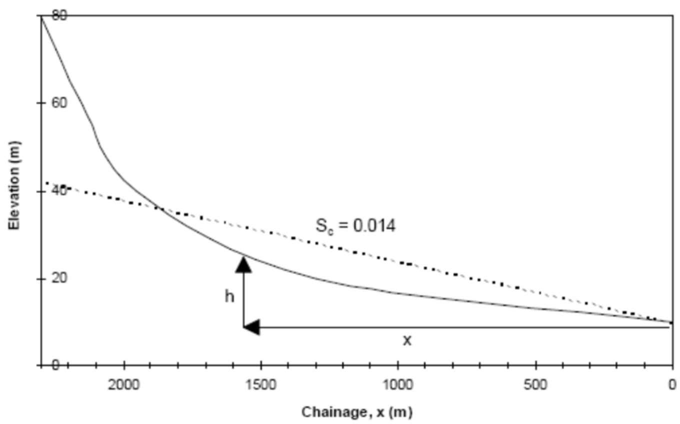
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	DATE:	30/03/2023
JOB NO:	211001	DES BY:	YW
SUBJECT:	Upstream Catchment B	CHKD BY:	

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



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

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	32.3	0	0			
2	40.6	8.3	1750	1750	4.15	7262.5
3	50.9	18.6	3000	1250	13.45	16812.5
4	57.3	25	3250	250	21.8	5450
5	88	55.7	4250	1000	40.35	40350
6	169.8	137.5	4660	410	96.6	39606
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 =	4660	TOTAL =	109481

S_c = 0.010

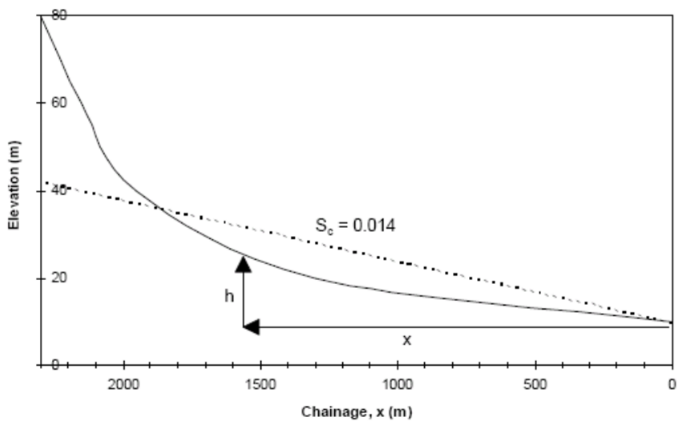
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Catchment C	**CHKD BY:**	

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



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

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1	45.5	0	0			
2	70.6	25.1	1500	1500	12.55	18825
3	82.6	37.1	2750	1250	31.1	38875
4	101	55.5	3500	750	46.3	34725
5	133.6	88.1	3750	250	71.8	17950
6	215.5	170	4750	1000	129.05	129050
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 =	4750	TOTAL =	239425

S_c = 0.021

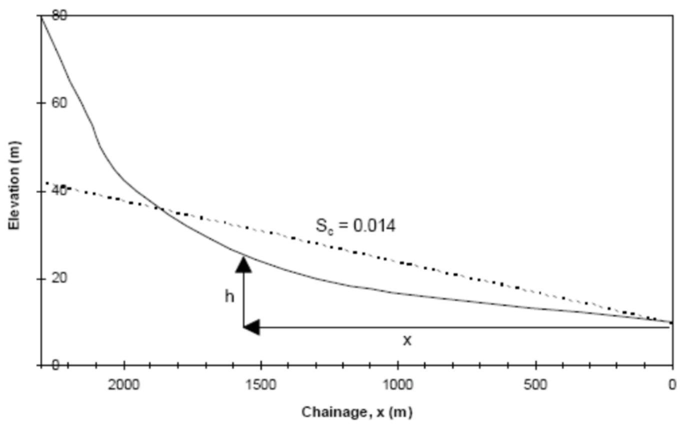
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Catchment D	**CHKD BY:**	

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



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

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	46.95	0	0			
2	76	29.05	1750	1750	14.525	25418.75
3	92.5	45.55	3250	1500	37.3	55950
4	142	95.05	4500	1250	70.3	87875
5	205.84	158.89	5750	1250	126.97	158712.5
6	317	270.05	6750	1000	214.47	214470
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 =	6750	**TOTAL =**	542426.25

S_c = 0.024

Post-development

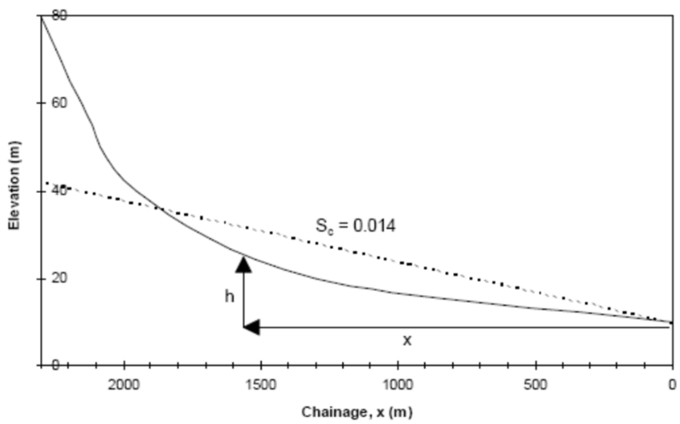
Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

D

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	DATE:	30/03/2023
JOB NO:	211001	DES BY:	YW
SUBJECT:	Upstream Catchment E	CHKD BY:	

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



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

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	32.3	0	0			
2	45.1	12.8	2000	2000	6.4	12800
3	57.2	24.9	3750	1750	18.85	32987.5
4	111.4	79.1	4500	750	52	39000
5	135.7	103.4	5750	1250	91.25	114062.5
6	194.8	162.5	6250	500	132.95	66475
7	317	284.7	7250	1000	223.6	223600
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 =	7250	TOTAL =	488925

S_c = 0.019

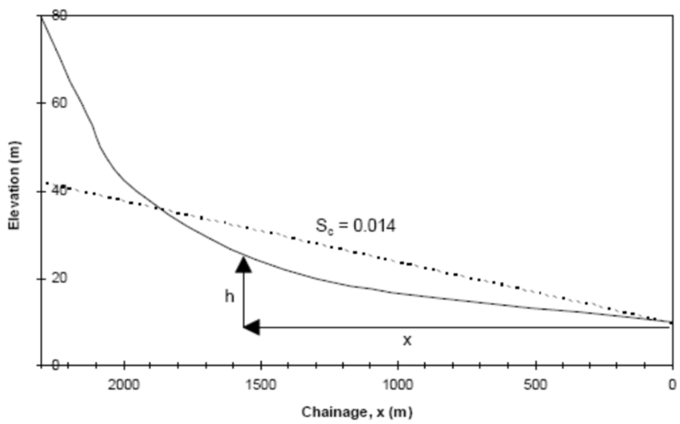
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Catchment F	**CHKD BY:**	

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



(This graph is from the ARC TP 108, April 1999, pg.14)

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

Data Entry Cells
Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	29.95	0	0			
2	44.86	14.91	2000	2000	7.455	14910
3	55.91	25.96	2750	750	20.435	15326.25
4	99.25	69.3	3250	500	47.63	23815
5	165.1	135.15	4000	750	102.225	76668.75
6	274.7	244.75	4714.4	714.4	189.95	135700.28
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 =	4714.4	**TOTAL =**	266420.28

S_c = 0.024

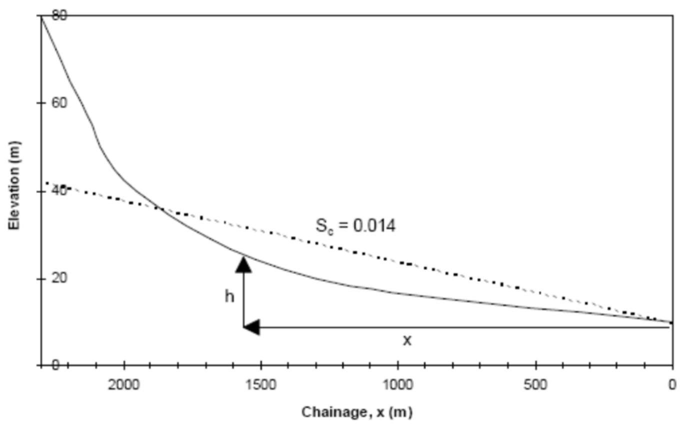
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Reach ABE to Scheme Inflow	**CHKD BY:**	

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



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

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	29.95	0	0			
2	31.9	1.95	500	500	0.975	487.5
3	32.01	2.06	750	250	2.005	501.25
4	32.28	2.33	1186	436	2.195	957.02
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 =	1186	**TOTAL =**	1945.77

S_c = 0.003

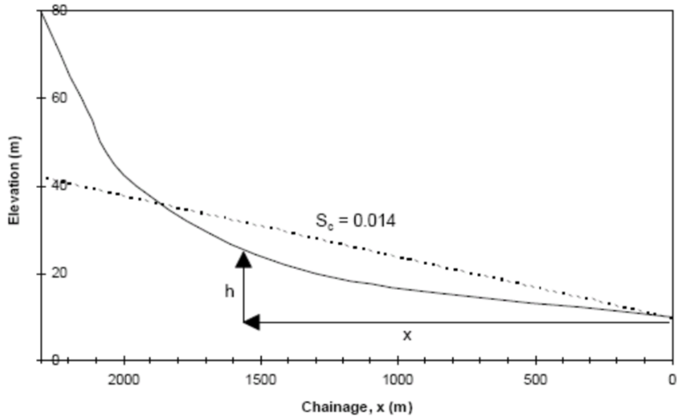
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Reach CD to ABE	**CHKD BY:**	

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



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

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	32.3	0	0			
2	37.2	4.9	1000	1000	2.45	2450
3	39.1	6.8	1500	500	5.85	2925
4	42.1	9.8	2250	750	8.3	6225
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 =	2250	TOTAL =	11600

S_c = 0.005

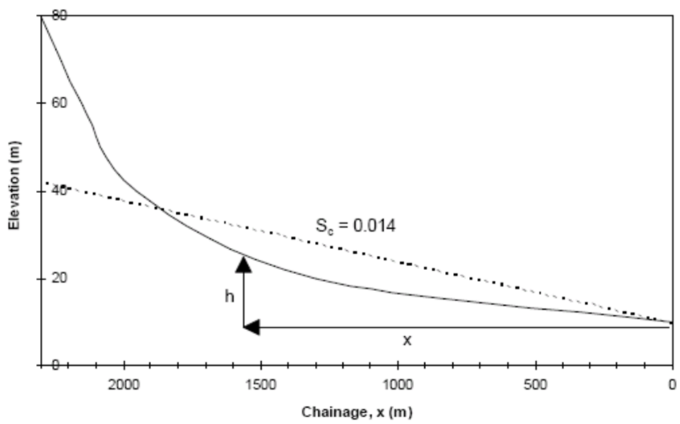
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream A	**CHKD BY:**	

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



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

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h} \Delta x)$
1	27	0	0			
2	33.5	6.5	3000	3000	3.25	9750
3	39.9	12.9	4500	1500	9.7	14550
4	67.56	40.56	5750	1250	26.73	33412.5
5	140	113	6120	370	76.78	28408.6
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 =	6120	**TOTAL =**	86121.1

S_c = 0.005

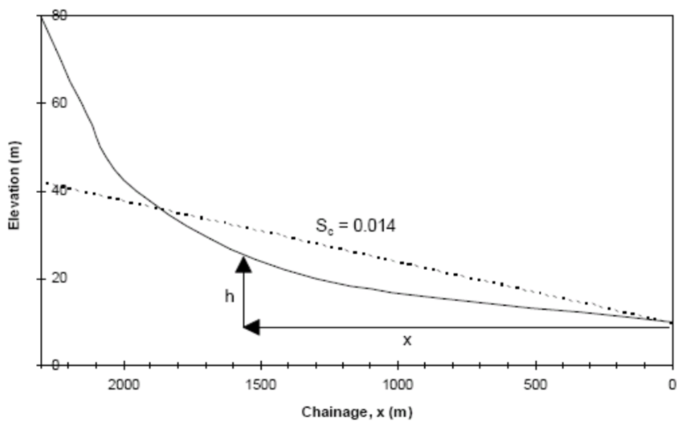
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h} \Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream B	**CHKD BY:**	

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



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

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	40.7	0	0			
2	48.87	8.17	2000	2000	4.085	8170
3	56.5	15.8	3500	1500	11.985	17977.5
4	94.3	53.6	4500	1000	34.7	34700
5	148.64	107.94	5000	500	80.77	40385
6	288.82	248.12	5306	306	178.03	54477.18
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 =	5306	**TOTAL =**	155709.68

S_c = 0.011

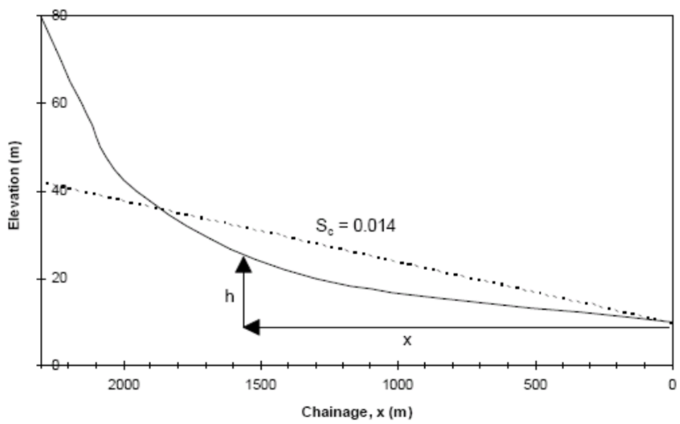
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream C	**CHKD BY:**	

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



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

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	11.1	0	0			
2	15.07	3.97	500	500	1.985	992.5
3	15.3	4.2	750	250	4.085	1021.25
4	25.67	14.57	1000	250	9.385	2346.25
5	27.77	16.67	1077	77	15.62	1202.74
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 =	1077	TOTAL =	5562.74

S_c = 0.010

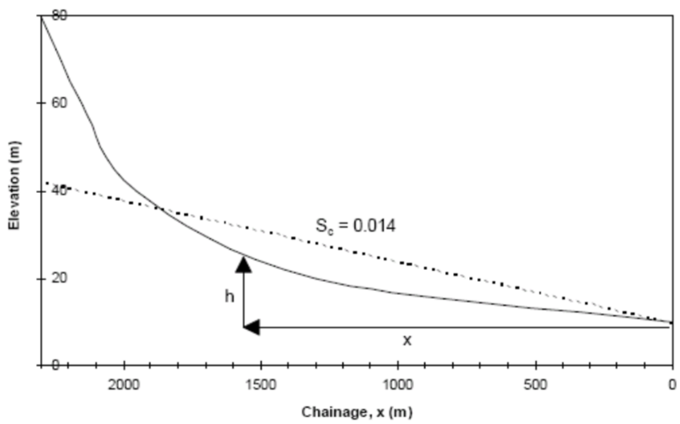
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream D	**CHKD BY:**	

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



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

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1	11.1	0	0			
2	20.2	9.1	1000	1000	4.55	4550
3	29.6	18.5	2000	1000	13.8	13800
4	33.74	22.64	2750	750	20.57	15427.5
5	43.5	32.4	3000	250	27.52	6880
6	79.7	68.6	3250	250	50.5	12625
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 =	3250	TOTAL =	53282.5

S_c = 0.010

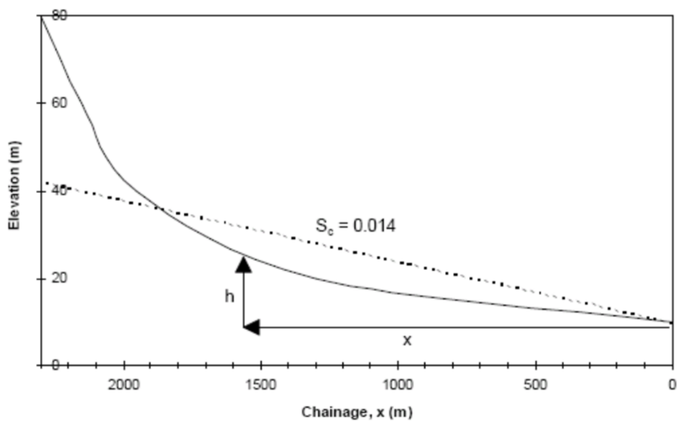
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream E	**CHKD BY:**	

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



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

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	8.9	0	0			
2	10.36	1.46	500	500	0.73	365
3	18.24	9.34	750	250	5.4	1350
4	34.2	25.3	1250	500	17.32	8660
5	57.1	48.2	1695	445	36.75	16353.75
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 =	1695	TOTAL =	26728.75

S_c = 0.019

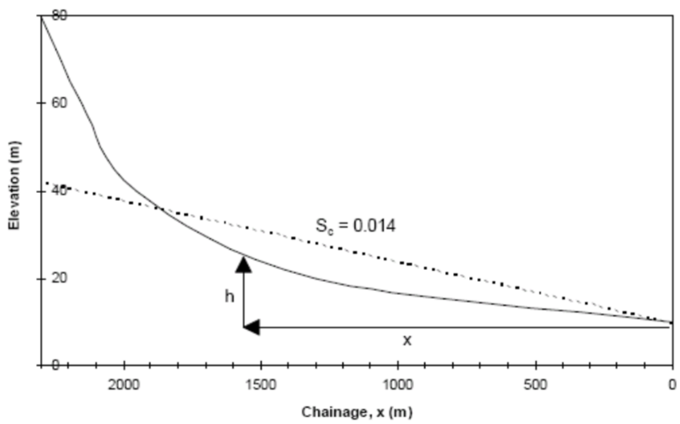
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream F	**CHKD BY:**	

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



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

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1	8.98	0	0			
2	10.88	1.9	500	500	0.95	475
3	37.35	28.37	750	250	15.135	3783.75
4	65	56.02	1036	286	42.195	12067.77
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 =	1036	**TOTAL =**	16326.52

S_c = 0.030

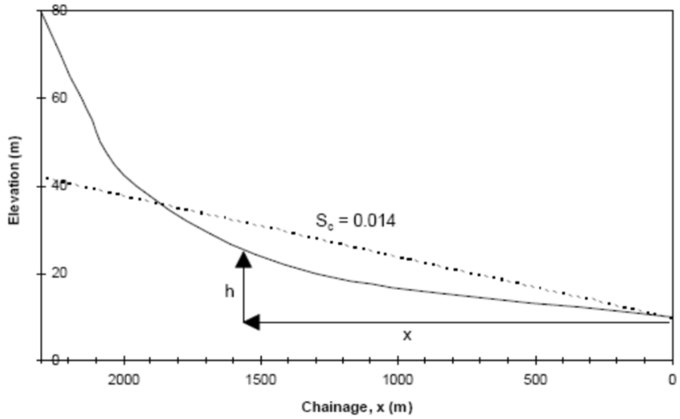
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream G	**CHKD BY:**	

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



(This graph is from the ARC TP 108, April 1999, pg.14)

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

Data Entry Cells
Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	9.4	0	0			
2	27.5	18.1	1000	1000	9.05	9050
3	38.5	29.1	1750	750	23.6	17700
4	71.5	62.1	2553	803	45.6	36616.8
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 =	2553	TOTAL =	63366.8

S_c = 0.019

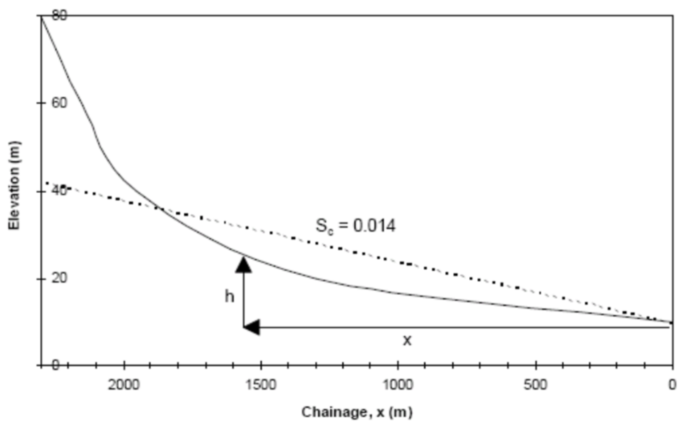
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream H	**CHKD BY:**	

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



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

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	0	0	0			
2	3.75	3.75	250	250	1.875	468.75
3	5.25	5.25	750	500	4.5	2250
4	18.1	18.1	1000	250	11.675	2918.75
5	43.1	43.1	1250	250	30.6	7650
6	60	60	1520	270	51.55	13918.5
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 =	1520	TOTAL =	27206

S_c = 0.024

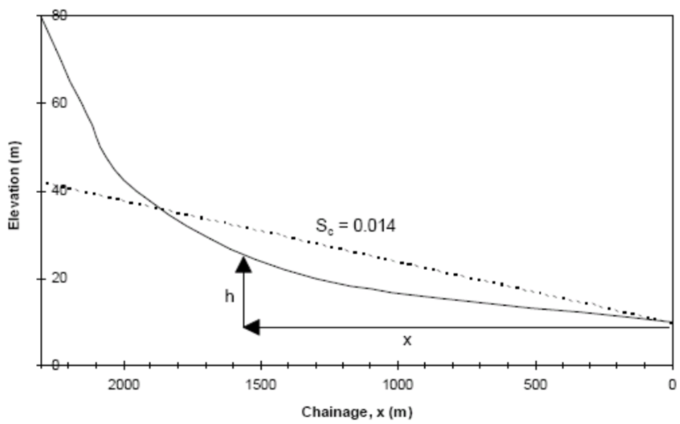
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream Reach Scheme In to Out	**CHKD BY:**	

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



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

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	15	0	0			
2	19.25	4.25	1000	1000	2.125	2125
3	25.66	10.66	2000	1000	7.455	7455
4	31.1	16.1	2973	973	13.38	13018.74
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 =	2973	**TOTAL =**	22598.74

S_c = 0.005

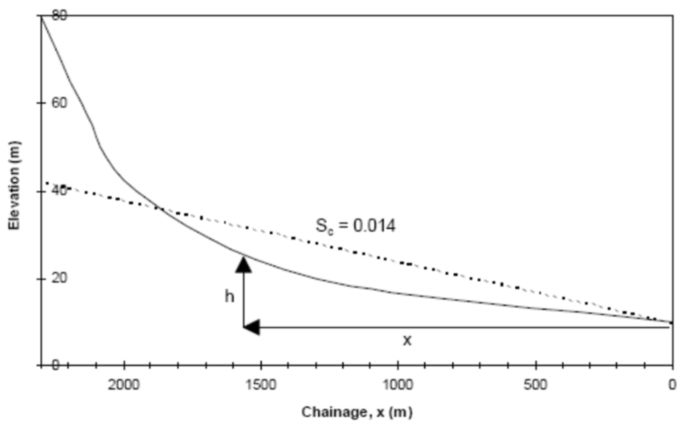
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream Reach Bto Scheme Out	**CHKD BY:**	

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



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

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\overline{h}$	$\Delta A(=\overline{h}\Delta x)$
1	15	0	0			
2	29.43	14.43	750	750	7.215	5411.25
3	32.25	17.25	2000	1250	15.84	19800
4	35.73	20.73	3250	1250	18.99	23737.5
5	41.7	26.7	4850	1600	23.715	37944
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 =	4850	**TOTAL =**	86892.75

S_c = 0.007

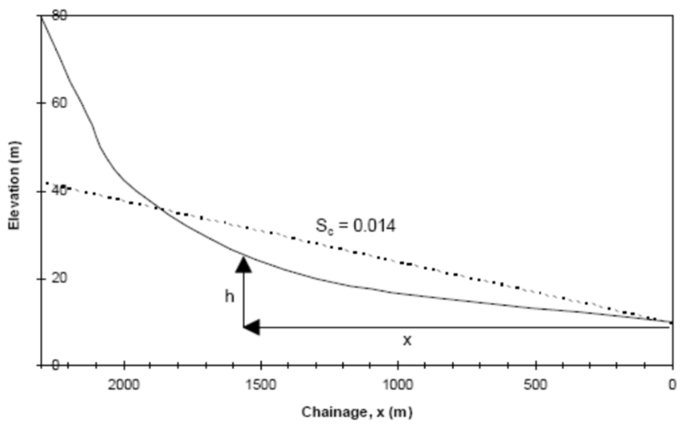
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\overline{h}$	$\Delta A(=\overline{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream Reach Scheme Out B to CD	**CHKD BY:**	

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



(This graph is from the ARC TP 108, April 1999, pg.14)

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

Data Entry Cells
Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	11.1	0	0			
2	11.77	0.67	250	250	0.335	83.75
3	15	3.9	1000	750	2.285	1713.75
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 =	1000	**TOTAL =**	1797.5

S_c = 0.004

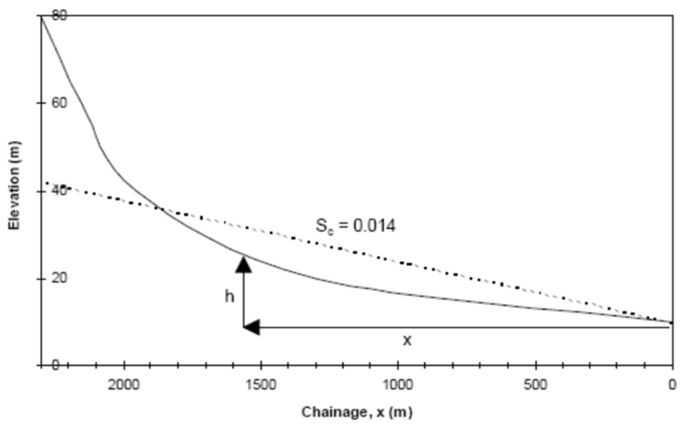
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	DATE:	30/03/2023
JOB NO:	211001	DES BY:	YW
SUBJECT:	Downstream Reach CD to EFG	CHKD BY:	

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



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

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h} \Delta x)$
1	9.38	0	0			
2	9.8	0.42	250	250	0.21	52.5
3	11	1.62	1000	750	1.02	765
4	11.11	1.73	1303	303	1.675	507.525
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 =	1303	TOTAL =	1325.025

S_c = 0.002

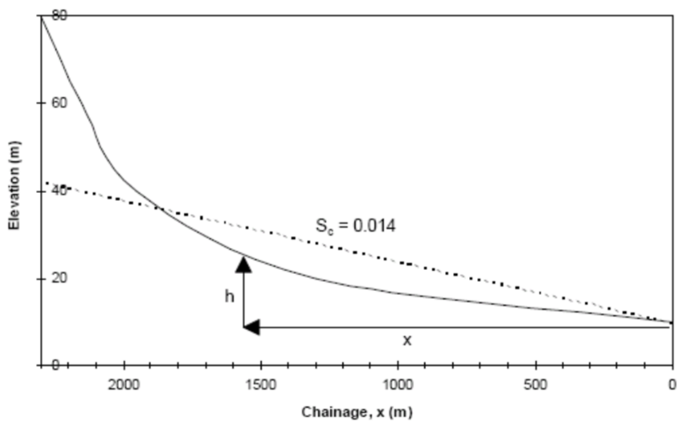
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h} \Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	DATE:	30/03/2023
JOB NO:	211001	DES BY:	YW
SUBJECT:	Downstream Reach EFG TO OUT	CHKD BY:	

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



(This graph is from the ARC TP 108, April 1999, pg.14)

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

Data Entry Cells
Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	2.75	0	0			
2	3.45	0.7	500	500	0.35	175
3	8	5.25	1000	500	2.975	1487.5
4	9.41	6.66	1080	80	5.955	476.4
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 =	1080	TOTAL =	2138.9

S_c = 0.004

Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
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 =	0	TOTAL =	0

S_c = #DIV/0!

100YR TIME OF CONCENTRATION CALCS

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title Warkworth South Plan Change **Calc Title** TP108 Calculation - Pre-Development Upstream Catchment A	**Author** YW	**Date** 30/03/2023	**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	Total Impervious	98	6.0077	588.75
C	Total Pervious	74	327.7623	24254.41
* from Appendix B		Totals =	333.770	24843.16

CN (weighted) = total product / total area = ###### / ###### = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 327.7623 / 333.770 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.117 km (along drainage path)

Catchment Slope Sc= 0.008 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.54 1.33 4.26 = 2.02 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.35 hrs

OK
use
2.0218088 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Upstream Catchment B	Author YW	Date 30/03/2023	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	Total Impervious	98	10.3517	1014.47
C	Total Pervious	74	401.8183	29734.55
* from Appendix B		Totals =	412.170	30749.02

CN (weighted) = total product / total area = ###### / ###### = 74.6

Ia (average) = 5 x pervious area / total area = 5 x 401.8183 / 412.170 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.29 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.6 / (200- 74.6) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.61 1.33 3.98 = 1.94 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.30 hrs

OK
use
1.939068 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Upstream Catchment C	Author YW	Date 18/01/2023	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	Total Impervious	98	3.8056	372.95
C	Total Pervious	74	287.7544	21293.83
* from Appendix B		Totals =	291.560	21666.77

CN (weighted) = total product / total area = ###### / ###### = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 287.7544 / 291.560 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.89 km (along drainage path)

Catchment Slope Sc= 0.021 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.85 1.34 3.19 = 1.70 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.14 hrs

OK
use
1.6979653 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Upstream Catchment D	Author YW	Date 18/01/2023	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	Total Impervious	98	4.8100	471.38
C	Total Pervious	74	505.2700	37389.98
* from Appendix B		Totals =	510.080	37861.36

CN (weighted) = total product / total area = 37861.36 / 510.080 = 74.2

Ia (average) = 5 x pervious area / total area = 5 x 505.2700 / 510.080 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 6.687 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.2 / (200- 74.2) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 3.50 1.34 3.06 = 2.01 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.35 hrs

OK
use
2.0076355 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title **Calc Title**	**Warkworth South Plan Change** **TP108 Calculation - Pre-Development** **Upstream Catchment E**	**Author** **YW**	**Date** **30/03/2023**	**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	Total Impervious	98	5.7200	560.56
C	Total Pervious	74	567.5700	42000.18
* from Appendix B		Totals =	573.290	42560.74

CN (weighted) = total product = / total area = 42560.74 / 573.290 = 74.2

Ia (average) = 5 x pervious area = / total area = 5 x 567.5700 / 573.290 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 7.153 km (along drainage path)

Catchment Slope Sc= 0.019 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.2 / (200- 74.2) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 3.66 1.34 3.28 = 2.25 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.51 hrs

OK
use
2.2509428 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Upstream Catchment F	Author YW	Date 18/01/2023	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	Total Impervious	98	4.8193	472.29
C	Total Pervious	74	299.1107	22134.19
* from Appendix B		Totals =	303.930	22606.48

CN (weighted) = total product / total area = 22606.48 / 303.930 = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 299.1107 / 303.930 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.596 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.74 1.33 3.06 = 1.56 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.05 hrs

OK
use
1.5646387 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Post Development Upstream Catchment F	Author YW	Date 18/01/2023	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	Total Impervious	98	15.1030	1480.09
C	Total Pervious	74	288.8270	21373.20
* from Appendix B		Totals =	303.930	22853.29

CN (weighted) = total product / total area = 22853.29 / 303.930 = 75.2

Ia (average) = 5 x pervious area / total area = 5 x 288.8270 / 303.930 = 4.8 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.596 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 75.2 / (200- 75.2) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.74 1.32 3.06 = 1.55 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.04 hrs

OK
use
1.5497843 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development pstream Reach Catchment ABE - Inflow	Author YW	Date 30/03/2023	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	Total Impervious	98	22.0794	2163.78
C	Total Pervious	74	1297.1506	95989.14
* from Appendix B		Totals =	1319.230	98152.93

CN (weighted) = total product / total area = ###### / ###### = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 1297.1506 / 1319.230 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.186 km (along drainage path)

Catchment Slope Sc= 0.003 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14   1   1.12   1.33   5.71 = 1.19 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.80 hrs

OK
use
1.193873089 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Upstream Reach CD to ABE	Author YW	Date 18/01/2023	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	Total Impervious	98	8.6156	844.33
C	Total Pervious	74	793.0244	58683.81
* from Appendix B		Totals =	801.640	59528.13

CN (weighted) = total product / total area = ###### / ###### = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 793.0244 / 801.640 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 2.25 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.71 1.34 4.90 = 1.57 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.05 hrs

OK
use
1.5656087 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Downstream Catchment A	Author YW	Date 30/03/2023	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	Total Impervious	98	9.4054	921.73
C	Total Pervious	74	575.1346	42559.96
* from Appendix B		Totals =	584.540	43481.69

CN (weighted) = total product / total area = 43481.69 / 584.540 = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 575.1346 / 584.540 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.848 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.83 1.33 4.90 = 2.59 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.74 hrs

OK
use
2.5945274 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development Downstream Catchment B	Author YW	Date 30/03/2023	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	Total Impervious	98	12.0476	1180.66
C	Total Pervious	74	836.7124	61916.72
* from Appendix B		Totals =	848.760	63097.38

CN (weighted) = total product / total area = 63097.38 / 848.760 = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 836.7124 / 848.760 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 5.031 km (along drainage path)

Catchment Slope Sc= 0.011 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.90 1.33 3.87 = 2.10 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.41 hrs

OK
use
2.0998325 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development Downstream Catchment C	Author YW	Date 30/03/2023	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	Total Impervious	98	7.3200	717.36
C	Total Pervious	74	16.2500	1202.50
* from Appendix B		Totals =	23.570	1919.86

CN (weighted) = total product / total area = 1919.86 / 23.570 = 81.5

Ia (average) = 5 x pervious area / total area = 5 x 16.2500 / 23.570 = 3.4 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.018 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 81.5 / (200- 81.5) = 0.69

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.01 1.23 3.98 = 0.69 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.46 hrs

OK
use
0.6932339 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development TP108 Downstream Catchment D	Author YW	Date 18/01/2023	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	Total Impervious	98	8.4586	828.94
C	Total Pervious	74	275.4014	20379.70
* from Appendix B		Totals =	283.860	21208.65

CN (weighted) = total product / total area = 21208.65 / 283.860 = 74.7

Ia (average) = 5 x pervious area / total area = 5 x 275.4014 / 283.860 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 3.056 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.7 / (200- 74.7) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.09 1.33 3.98 = 1.55 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.04 hrs

OK
use
1.5480986 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Down Catchment E	Author YW	Date 18/01/2023	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	Total Impervious	98	45.2715	4436.61
C	Total Pervious	74	26.8785	1989.01
* from Appendix B		Totals =	72.150	6425.62

CN (weighted) = total product / total area = 6425.62 / 72.150 = 89.1

Ia (average) = 5 x pervious area / total area = 5 x 26.8785 / 72.150 = 1.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.665 km (along drainage path)

Catchment Slope Sc= 0.019 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 89.1 / (200- 89.1) = 0.80

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.40 1.13 3.28 = 0.73 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.49 hrs

OK
use
0.7262942 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Downstream Catchment F	Author YW	Date 18/01/2023	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	Total Impervious	98	0.2200	21.56
C	Total Pervious	74	21.5700	1596.18
* from Appendix B		Totals =	21.790	1617.74

CN (weighted) = total product / total area = 1617.74 / 21.790 = 74.2

Ia (average) = 5 x pervious area / total area = 5 x 21.5700 / 21.790 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.076 km (along drainage path)

Catchment Slope Sc= 0.03 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.2 / (200- 74.2) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.05 1.34 2.86 = 0.56 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.38 hrs

OK
use
0.5621775 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development Downstream Catchment G	Author YW	Date 18/01/2023	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	Total Impervious	98	67.7100	6635.58
C	Total Pervious	74	59.8900	4431.86
* from Appendix B		Totals =	127.600	11067.44

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{11067.44}{127.600} = 86.7$

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 59.8900}{127.600}$ 2.3 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 2.412 km (along drainage path)

Catchment Slope Sc= 0.019 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{86.7}{200- 86.7} = 0.77$

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.79 1.16 3.28 = 0.95 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.64 hrs

OK
use
0.9519511 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title Warkworth South Plan Change **Calc Title** TP108 Calculation - Pre-Development Downstream Catchment H	**Author** YW	**Date** 18/01/2023	**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	Total Impervious	98	23.6020	2313.00
C	Total Pervious	74	25.5680	1892.03
* from Appendix B		Totals =	49.170	4205.03

CN (weighted) = total product / total area = 4205.03 / 49.170 = 85.5

Ia (average) = 5 x pervious area / total area = 5 x 25.5680 / 49.170 = 2.6 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.471 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 85.5 / (200- 85.5) = 0.75

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.29 1.17 3.06 = 0.65 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.43 hrs

OK
use
0.6491606 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Reach Scheme in to out	Author YW	Date 18/01/2023	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	Total Impervious	98	30.9143	3029.60
C	Total Pervious	74	2111.7450	156269.13
* from Appendix B		Totals =	2142.659	159298.73

CN (weighted) = total product / total area = ####### / 2142.659 = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 2111.7450 / 2142.659 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 2.973 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.05 1.33 4.90 = 1.88 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.26 hrs

OK
use
1.87974775 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development Downstream Reach B to SCHEME OUT	Author YW	Date 30/03/2023	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	Total Impervious	98	12.0476	1180.66
C	Total Pervious	74	836.7124	61916.72
* from Appendix B		Totals =	848.760	63097.38

CN (weighted) = total product / total area = 63097.38 / 848.760 = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 836.7124 / 848.760 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.85 km (along drainage path)

Catchment Slope Sc= 0.007 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.84 1.33 4.43 = 2.35 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.57 hrs

OK
use
2.3473116 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Downstream Reach Scheme out to CD	Author YW	Date 18/01/2023	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	Total Impervious	98	68.7906	6741.48
C	Total Pervious	74	3992.4987	295444.90
* from Appendix B		Totals =	4061.289	302186.38

CN (weighted) = total product / total area = ####### / 4061.289 = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 3992.4987 / 4061.289 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1 km (along drainage path)

Catchment Slope Sc= 0.004 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.00 1.33 5.24 = 0.98 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.66 hrs

OK
use
0.97848894 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development Downstream Reach CD to EFG	Author YW	Date 18/01/2023	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	Total Impervious	98	84.5692	8287.78
C	Total Pervious	74	4284.1501	317027.11
* from Appendix B		Totals =	4368.719	325314.89

CN (weighted) = total product = ####### = 74.5
total area 4368.719

Ia (average) = 5 x pervious area = 5 x 4284.1501 4.9 mm
total area 4368.719

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1 km (along drainage path)

Catchment Slope Sc= 0.002 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.5 / (200- 74.5) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.00 1.33 6.45 = 1.20 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.81 hrs

OK
use
1.2038381 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title Warkworth South Plan Change **Calc Title** TP108 Calculation - Pre-Development Downstream Reach EFG to Outlet	**Author** YW	**Date** 31/03/2023	**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	Total Impervious	98	197.7707	19381.53
C	Total Pervious	74	4392.4886	325044.16
* from Appendix B		Totals =	4590.259	344425.69

CN (weighted) = total product / total area = ####### / 4590.259 = 75.0

Ia (average) = 5 x pervious area / total area = 5 x 4392.4886 / 4590.259 = 4.8 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.08 km (along drainage path)

Catchment Slope Sc= 0.004 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 75.0 / (200- 75.0) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.05 1.32 5.24 = 1.02 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.68 hrs

OK
use
1.02191107 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

10YR TIME OF CONCENTRATION CALCS

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10yr Catchment Rain	Author YW	Date 20/07/2023	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	Total Impervious	98	16.4233	1609.48
C	Total Pervious	74	468.9067	34699.10
* from Appendix B		Totals =	485.330	36308.58

CN (weighted) = total product / total area = 36308.58 / 485.330 = 74.8

Ia (average) = 5 x pervious area / total area = 5 x 468.9067 / 485.330 = 4.8 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 4.054 km (along drainage path)

Catchment Slope Sc= 0.008 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.8 / (200- 74.8) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 2.52 1.33 4.26 = 1.20 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.80 hrs

OK
use
1.1954464 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Post Development 10yr Catchment Rain	Author YW	Date 20/07/2023	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	Total Impervious	98	3.3879	332.02
C	Total Pervious	74	261.7558	19369.93
* from Appendix B		Totals =	265.144	19701.95

CN (weighted) = total product / total area = 19701.95 / 265.144 = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 261.7558 / 265.144 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 4.054 km (along drainage path)

Catchment Slope Sc= 0.008 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 2.52 1.34 4.26 = 1.20 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.81 hrs

OK
use
1.2025746 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development 10YR Downstream Catchment A	Author YW	Date 20/07/2023	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	Total Impervious	98	9.4054	921.73
C	Total Pervious	74	575.1346	42559.96
* from Appendix B		Totals =	584.540	43481.69

CN (weighted) = total product / total area = 43481.69 / 584.540 = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 575.1346 / 584.540 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.848 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.83 1.33 4.90 = 2.59 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.74 hrs

OK
use
2.5945274 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development 10yr Downstream Catchment B	Author YW	Date 20/07/2023	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	Total Impervious	98	12.0476	1180.66
C	Total Pervious	74	836.7124	61916.72
* from Appendix B		Totals =	848.760	63097.38

CN (weighted) = total product / total area = 63097.38 / 848.760 = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 836.7124 / 848.760 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 5.031 km (along drainage path)

Catchment Slope Sc= 0.011 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.90 1.33 3.87 = 2.10 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.41 hrs

OK
use
2.0998325 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10YR Downstream Catchment C	Author YW	Date 20/07/2023	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	Total Impervious	98	7.3200	717.36
C	Total Pervious	74	16.2500	1202.50
* from Appendix B		Totals =	23.570	1919.86

CN (weighted) = total product / total area = 1919.86 / 23.570 = 81.5

Ia (average) = 5 x pervious area / total area = 5 x 16.2500 / 23.570 = 3.4 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 1.018 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 81.5 / (200- 81.5) = 0.69

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.01 1.23 3.98 = 0.42 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.28 hrs

OK
use
0.4159403 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10YR TP108 Downstream Catchment D	Author YW	Date 20/07/2023	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	Total Impervious	98	8.4586	828.94
C	Total Pervious	74	275.4014	20379.70
* from Appendix B		Totals =	283.860	21208.65

CN (weighted) = total product / total area = 21208.65 / 283.860 = 74.7

Ia (average) = 5 x pervious area / total area = 5 x 275.4014 / 283.860 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 3.056 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.7 / (200- 74.7) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 2.09 1.33 3.98 = 0.93 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.62 hrs

OK
use
0.9288591 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10YR Down Catchment E	Author YW	Date 20/07/2023	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	Total Impervious	98	45.2715	4436.61
C	Total Pervious	74	26.8785	1989.01
* from Appendix B		Totals =	72.150	6425.62

CN (weighted) = total product / total area = 6425.62 / 72.150 = 89.1

Ia (average) = 5 x pervious area / total area = 5 x 26.8785 / 72.150 = 1.9 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 1.665 km (along drainage path)

Catchment Slope Sc= 0.019 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 89.1 / (200- 89.1) = 0.80

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.40 1.13 3.28 = 0.44 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.29 hrs

OK
use
0.4357765 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development 10yr Downstream Catchment F	Author YW	Date 20/072023	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	Total Impervious	98	0.2200	21.56
C	Total Pervious	74	21.5700	1596.18
* from Appendix B		Totals =	21.790	1617.74

CN (weighted) = total product = 1617.74 = 74.2
total area 21.790

Ia (average) = 5 x pervious area = 5 x 21.5700 4.9 mm
total area 21.790

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 1.076 km (along drainage path)

Catchment Slope Sc= 0.03 m/m (by equal area method)

Runoff factor, CN = 74.2 = 0.59
200 - CN 200- 74.2

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.05 1.34 2.86 = 0.34 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.23 hrs

OK
use
0.3373065 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10yr Downstream Catchment G	Author YW	Date 20/07/2023	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	Total Impervious	98	67.7100	6635.58
C	Total Pervious	74	59.8900	4431.86
* from Appendix B		Totals =	127.600	11067.44

CN (weighted) = total product / total area = 11067.44 / 127.600 = 86.7

Ia (average) = 5 x pervious area / total area = 5 x 59.8900 / 127.600 = 2.3 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 2.412 km (along drainage path)

Catchment Slope Sc= 0.019 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 86.7 / (200- 86.7) = 0.77

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.79 1.16 3.28 = 0.57 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.38 hrs

OK
use
0.5711707 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10YR Downstream Catchment H	Author YW	Date 20/07/2023	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	Total Impervious	98	23.6020	2313.00
C	Total Pervious	74	25.5680	1892.03
* from Appendix B		Totals =	49.170	4205.03

CN (weighted) = total product / total area = 4205.03 / 49.170 = 85.5

Ia (average) = 5 x pervious area / total area = 5 x 25.5680 / 49.170 = 2.6 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 1.471 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 85.5 / (200- 85.5) = 0.75

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.29 1.17 3.06 = 0.39 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.26 hrs

OK
use
0.3894963 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development 10yr Reach Scheme in to out	Author YW	Date 20/07/2023	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	Total Impervious	98	30.9143	3029.60
C	Total Pervious	74	2111.7450	156269.13
* from Appendix B		Totals =	2142.659	159298.73

CN (weighted) = total product / total area = ####### / ####### = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 2111.7450 / 2142.659 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 2.973 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.05 1.33 4.90 = 1.88 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.26 hrs

OK
use
1.87974775 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development pstream Reach Catchment ABE - Inflow 10yr	Author YW	Date 20/07/2023	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	Total Impervious	98	22.0794	2163.78
C	Total Pervious	74	1297.1506	95989.14
* from Appendix B		Totals =	1319.230	98152.93

CN (weighted) = total product / total area = ###### / ###### = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 1297.1506 / 1319.230 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.186 km (along drainage path)

Catchment Slope Sc= 0.003 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.12 1.33 5.71 = 1.19 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.80 hrs

OK
use
1.193873089 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10yr Upstream Reach CD to ABE	Author YW	Date 20/07/2023	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	Total Impervious	98	8.6156	844.33
C	Total Pervious	74	793.0244	58683.81
* from Appendix B		Totals =	801.640	59528.13

CN (weighted) = total product / total area = ###### / ###### = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 793.0244 / 801.640 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 2.25 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.71 1.34 4.90 = 1.57 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.05 hrs

OK
use
1.5656087 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development Downstream Reach Scheme out to CD	10yr Author YW	Date 20/07/2023	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	Total Impervious	98	68.7906	6741.48
C	Total Pervious	74	3992.4987	295444.90
* from Appendix B		Totals =	4061.289	302186.38

CN (weighted) = total product = / total area = ####### / ####### = 74.4

Ia (average) = 5 x pervious area = / total area = 5 x 3992.4987 / 4061.289 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1 km (along drainage path)

Catchment Slope Sc= 0.004 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 74.4 / 200- 74.4 = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.00 1.33 5.24 = 0.98 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.66 hrs

OK
use
0.97848894 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

F:\MAVEN\Projects\211001\HEC\230328 RFI\TP108\10yr\Channelisation kept at 1\TP108 Downstream Reach Outflow to CD

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development 10yr Downstream Reach CD to EFG	Author YW	Date 20/07/2023	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	Total Impervious	98	84.5692	8287.78
C	Total Pervious	74	4284.1501	317027.11
* from Appendix B		Totals =	4368.719	325314.89

CN (weighted) = total product / total area = ####### / ####### = 74.5

Ia (average) = 5 x pervious area / total area = 5 x 4284.1501 / 4368.719 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1 km (along drainage path)

Catchment Slope Sc= 0.002 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.5 / (200- 74.5) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.00 1.33 6.45 = 1.20 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.81 hrs

OK
use
1.2038381 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10YR Downstream Reach B to HG	Author YW	Date 20/07/2023	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	Total Impervious	98	12.0476	1180.66
C	Total Pervious	74	836.7124	61916.72
* from Appendix B		Totals =	848.760	63097.38

CN (weighted) = total product / total area = 63097.38 / 848.760 = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 836.7124 / 848.760 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.85 km (along drainage path)

Catchment Slope Sc= 0.007 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.84 1.33 4.43 = 2.35 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.57 hrs

OK
use
2.3473116 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10YR Downstream Reach EFG to Outlet	Author YW	Date 20/07/2023	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	Total Impervious	98	197.7707	19381.53
C	Total Pervious	74	4392.4886	325044.16
* from Appendix B		Totals =	4590.259	344425.69

CN (weighted) = total product / total area = ####### / ####### = 75.0

Ia (average) = 5 x pervious area / total area = 5 x 4392.4886 / 4590.259 = 4.8 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.08 km (along drainage path)

Catchment Slope Sc= 0.004 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 75.0 / (200- 75.0) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.05 1.32 5.24 = 1.02 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.68 hrs

OK
use
1.02191107 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10yr Upstream Catchment A	Author YW	Date 20/07/2023	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	Total Impervious	98	6.0077	588.75
C	Total Pervious	74	327.7623	24254.41
* from Appendix B		Totals =	333.770	24843.16

CN (weighted) = total product / total area = ###### / ###### = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 327.7623 / 333.770 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.117 km (along drainage path)

Catchment Slope Sc= 0.008 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.54 1.33 4.26 = 2.02 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.35 hrs

OK
use
2.0218088 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development 10YR Upstream Catchment C	Author YW	Date 20/07/2023	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	Total Impervious	98	3.8056	372.95
C	Total Pervious	74	287.7544	21293.83
* from Appendix B		Totals =	291.560	21666.77

CN (weighted) = total product / total area = ###### / ###### = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 287.7544 / 291.560 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.89 km (along drainage path)

Catchment Slope Sc= 0.021 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.85 1.34 3.19 = 1.70 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.14 hrs

OK
use
1.6979653 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development 10YR Upstream Catchment D	Author YW	Date 20/07/2023	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	Total Impervious	98	4.8100	471.38
C	Total Pervious	74	505.2700	37389.98
* from Appendix B		Totals =	510.080	37861.36

CN (weighted) = total product / total area = 37861.36 / 510.080 = 74.2

Ia (average) = 5 x pervious area / total area = 5 x 505.2700 / 510.080 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 6.687 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.2 / (200- 74.2) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 3.50 1.34 3.06 = 2.01 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.35 hrs

OK
use
2.0076355 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: Warkworth South Plan Change, TP108 Calculation - Pre-Development, 10yr Upstream Catchment E	Author YW	Date 20/07/2023	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	Total Impervious	98	5.7200	560.56
C	Total Pervious	74	567.5700	42000.18
* from Appendix B		Totals =	573.290	42560.74

CN (weighted) = total product / total area = 42560.74 / 573.290 = 74.2

Ia (average) = 5 x pervious area / total area = 5 x 567.5700 / 573.290 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 7.153 km (along drainage path)

Catchment Slope Sc= 0.019 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.2 / (200- 74.2) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 3.66 1.34 3.28 = 2.25 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.51 hrs

OK
use
2.2509428 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	**Job Number** **211001**	**Sheet** **1**	**Rev** **A**
Job Title **Calc Title** — **Warkworth South Plan Change** **TP108 Calculation - Pre-Development** **10yr Upstream Catchment F**	**Author** **YW**	**Date** **20/07/2023**	**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	Total Impervious	98	4.8193	472.29
C	Total Pervious	74	299.1107	22134.19
* from Appendix B		Totals =	303.930	22606.48

CN (weighted) = total product = / total area = 22606.48 / 303.930 = 74.4

Ia (average) = 5 x pervious area = / total area = 5 x 299.1107 / 303.930 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.596 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 74.4 / 200- 74.4 = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.74 1.33 3.06 = 1.56 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.05 hrs

OK
use
1.5646387 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Post Development 10yr Upstream Catchment F	Author YW	Date 20/07/2023	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	Total Impervious	98	0.0000	0.00
C	Total Pervious	74	15.1030	1117.62
* from Appendix B		Totals =	15.103	1117.62

CN (weighted) = total product / total area = 1117.62 / 15.103 = 74.0

Ia (average) = 5 x pervious area / total area = 5 x 15.1030 / 15.103 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.596 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.0 / (200- 74.0) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

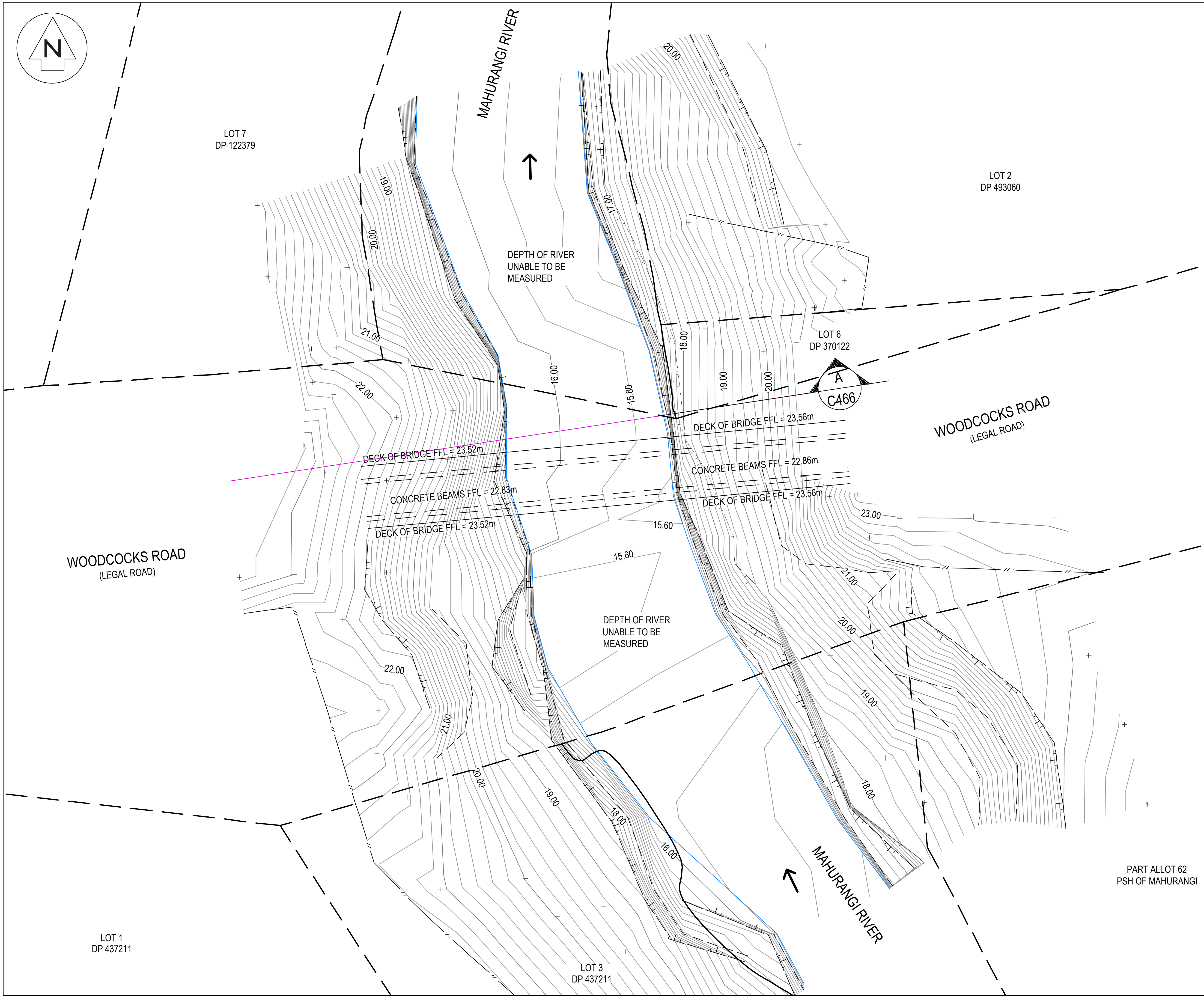
= 0.14 1 2.74 1.34 3.06 = 1.57 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.05 hrs

OK
use
1.5716717 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

APPENDIX E – Woodcocks Road Bridge



Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000
3. Levels in terms of the Auckland Vertical Datum 1946.
4. Origin of Levels = CA 97 (ABLQ)
   Published RL= 43.46, sourced from The LINZ Digital Geodetic Database.
5. Boundaries are subject to final survey.

Legend

- EX BDY ABUTTALS
- EX MAJOR CONTOUR
- EX MINOR CONTOUR
- EX BANK TOP
- EX BANK BOTTOM
- EX FENCE
- EX WATERS EDGE
- EX BRIDGE DECK
- EX CONCRETE BEAM
- SURVEY SPOT HEIGHT

Rev	Description	By	Date
A	FOR ISSUE	MAVEN	04/2023

	By	Date
Survey	CC	04/2023
Design		
Drawn	CC	04/2023
Checked	MH	04/2023

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Project

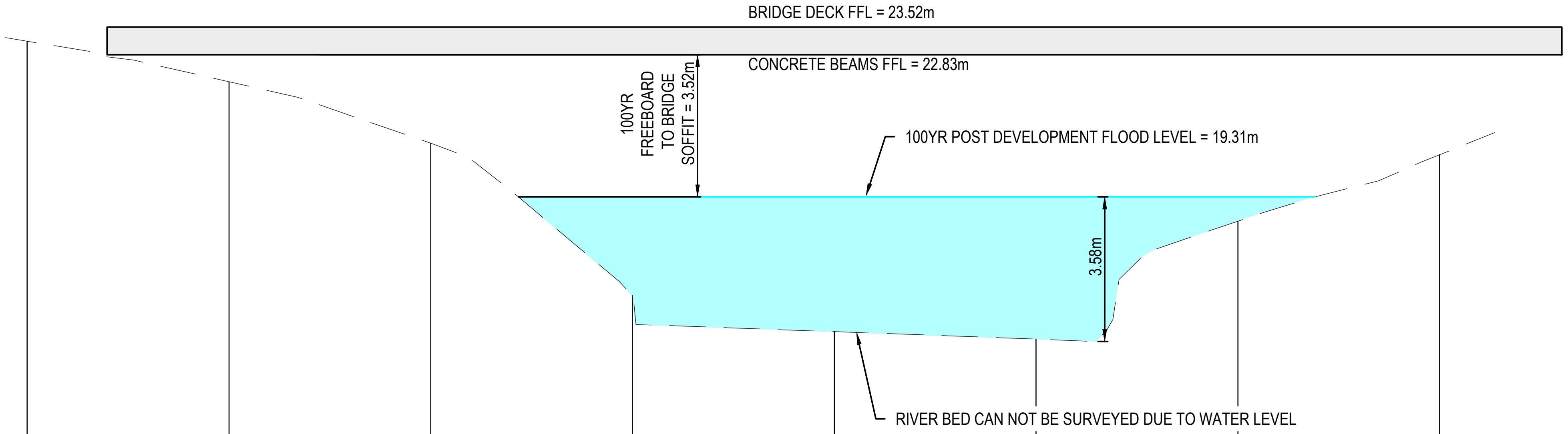
WARKWORTH SOUTH PLAN CHANGE FOR KA WAMANAWA LP & STEPPIG TOWARDS FAR LTD

Title

TOPOGRAPHICAL SURVEY PLAN (WOODCOCK ROAD)

Project no.	211001
Scale	1:250 @ A3
Cad file	211001-C466 BRIDGE.DWG
Drawing no.	C055
Rev	A

Notes
1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000
3. Levels in terms of the Auckland Vertical Datum 1946.
4. Origin of Levels = CA 97 (ABLQ)
   Published RL= 43.46, sourced from The LINZ Digital Geodetic Database.
5. Boundaries are subject to final survey.



DATUM 12.00m

EXISTING LEVELS		23.17	22.16	20.64	16.87	15.96	15.78	18.70	20.35	
DESIGN LEVELS		23.17	22.16	20.64	16.87	15.96	15.78	18.70	20.35	
CUT/FILL		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CHAINAGE	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	42.08

CROSS SECTION A
SCALE: HORI 1:150 VERT 1:150

Rev	Description	By	Date
B	PCC RFI	YW	07/2023
A	PPC RFI	YW	06/2023

	By	Date
Survey	CC	04/2023
Design		
Drawn	YW	06/23
Checked	LC	07/23

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Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAMANAWA LP & STEPPIG TOWARDS FAR LTD

Title
WOODCOCK BRIDGE CROSS SECTION PLAN

Project no.	211001
Scale	1:150 @ A3
Cad file	211001-C466 BRIDGE.DWG
Drawing no.	C466
Rev	B

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev B
Job Title Warkworth South Plan Change Calc Title 100yr Overland Flow at Woodcock bridge Existing Flow Check	Author YW	Date 20-Jul	Checked LC

Design Spreadsheet for Mannings Formula

Calc 1: Capacity of Channel Flow (Q), Mannings formula

	Q=	$(AR^{2/3}S^{1/2})/n$	R=A/P
Where	Q=	Channel Flow	l/s
	S =	Longitudinal Slope	m/m
	A =	Cross sectional area	m2
	P=	Wetted Perimeter	m
	R =	Hydraulic Radius	m
	n =	Mannings n	

Longitudinal slope

S=	**0.004**	m/m

Section Location 1

Depth=	4.2	m
Width=	22.57	m
S=	0.004	m/m
A=	47.79	m^2
P=	6.05	m
R=	7.906	
n=	0.040	Stream, clean, winding , some pools and shoals
Velocity (V) R(2/3) S(1/2)/ n	6.279	m/sec
Channel Flow (Q) VxA	**300,078**	l/sec
100 year peak discharge =	296,360	l/sec OK

* Refer TP108 Modelling for Flow rates

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev B
Job Title: Warkworth South Plan Change Calc Title: 100yr Overland Flow at Woodcock bridge Proposed Flow Check	Author YW	Date 20-Jul	Checked LC

Design Spreadsheet for Mannings Formula

Calc 1: Capacity of Channel Flow (Q), Mannings formula

Q= $(AR^{2/3}S^{1/2})/n$ R=A/P

Where	Q=	Channel Flow	l/s
	S =	Longitudinal Slope	m/m
	A =	Cross sectional area	m2
	P=	Wetted Perimeter	m
	R =	Hydraulic Radius	m
	n =	Mannings n	

Longitudinal slope

S= **0.004** m/m

Section Location 1

Depth=	4.2	m
Width=	22.57	m
S=	0.004	m/m
A=	47.79	m^2
P=	6.05	m
R=	7.906	
n=	0.040	Stream, clean, winding , some pools and shoals
Velocity (V) R(2/3) S(1/2)/ n	6.279	m/sec
Channel Flow (Q) VxA	**300,078**	l/sec
100 year peak discharge =	295,200	l/sec OK

* Refer TP108 Modelling for Flow rates

APPENDIX E – POST DEVELOPMENT CATCHMENT ANALYSIS REPORT

POST DEVELOPMENT CATCHMENT ANALYSIS

PROPOSED WARKWORTH SOUTH PLAN CHANGE AREA FOR KA WAIMANAWA LP & STEPPING TOWARDS FARS LTD

Maven Associates	Job Number 211001		Rev A
Job Title: Warkworth South Plan Change **Title:** Post development Catchment analysis	**Author** KH	**Date** Jun 2023	**Checked** LC

1.0 INTRODUCTION

1.1 PROJECT BACKGROUND

The objective of this report is to provide further detail of stormwater catchments within the PCA in support of the Stormwater Management Plan (SMP) developed for the Warkworth South Plan Change.

While the SMP outlines the recommended stormwater controls and management strategy of the wider PCA, this report contains a comprehensive assessment considering the unique characteristics and constraints of individual catchments expected post development in order to support the wider recommendations. For a visual representation of the plan change area, please refer to Figure 1: Locality Plan below.

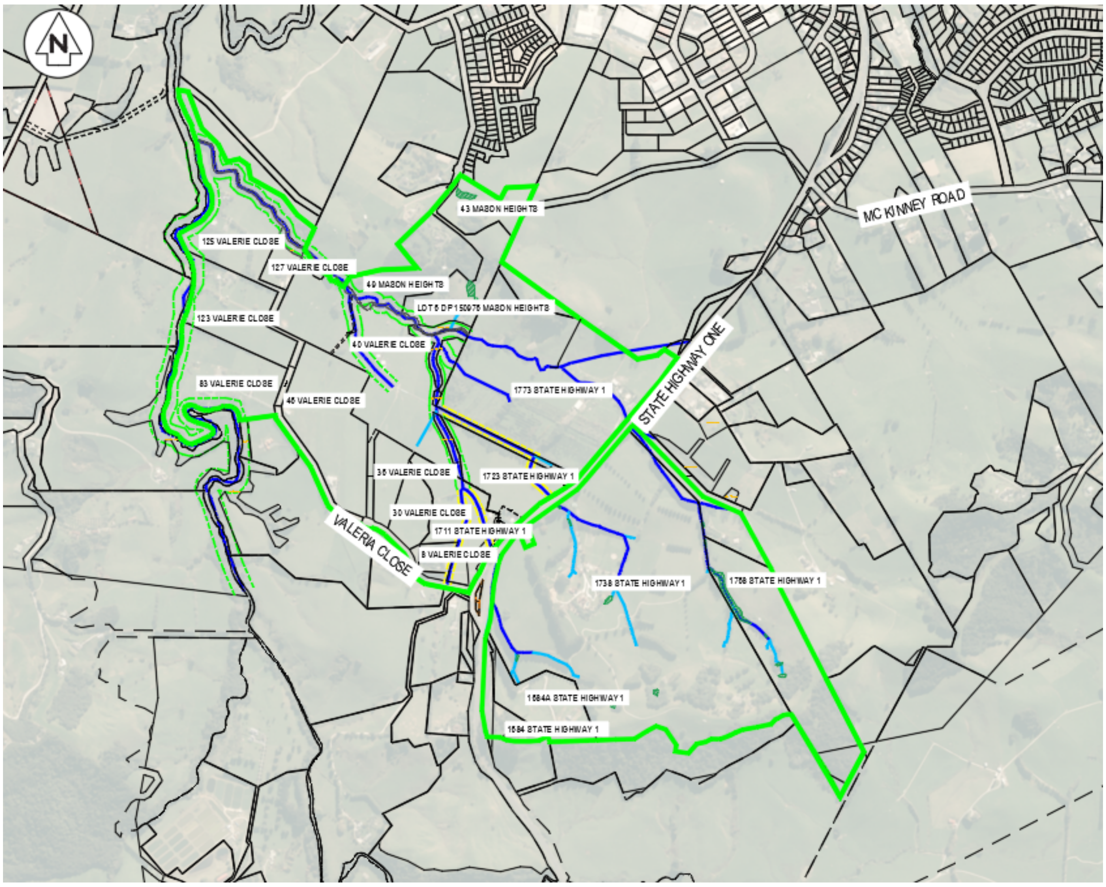


Figure 1: Locality Plan

The SMP has been submitted as part of the support documentation for the Warkworth South Area plan change application. Healthy Waters (HW) has provided initial feedback and requested additional documentation supporting the SMP. In response to this request, a high-level post development catchment plan has been developed, assuming the current master plan is developed without significant alteration. This plan identifies and splits the post development catchment into four distinct stormwater management zones, each with its own recommended stormwater management controls based on the local environment.

To gain a comprehensive understanding of the stormwater strategy, it is recommended that this report is read in conjunction with the SMP, as it provides further clarification and support for the stormwater management strategies of the PCA.

2.0 POST DEVELOPMENT CATCHMENT ANALYSIS

Based on the high-level post development catchment plan, the following four Stormwater Management Zones (SMZ) have been established:

- Stormwater Management Zone A: Catchments are generally a flat to moderate slope where the preferred management method is a Wetland as the preferred stormwater treatment device.
- Stormwater Management Zone B: Catchments are generally steep or too narrow to construct a wetland for stormwater treatment. In this catchment the Best Practical Option (BPO) approach to quality treatment is recommended; likely to be at source type devices.
- Stormwater Management Zone C: These Catchments have an existing specific land use (heritage Orchard and open space area) where no significant increase in impervious area is expected. Although wetland construction is feasible in these catchments, any requirement for treatment will be relatively small (And a bulk catchment device economically burdening for the scale of any small redevelopment)
- Stormwater Management Zone D: This zone is exclusively for the current State Highway One catchment which drains directly to the existing watercourse via an existing swale. The existing road legal width is too narrow, nor is it expected that any adjacent space will be made available for construction given the proximity to existing natural features and given the topography through the PCA. A BPO approach to stormwater quality treatment is recommended.

The four distinct stormwater management zone layouts are shown in Figure below:

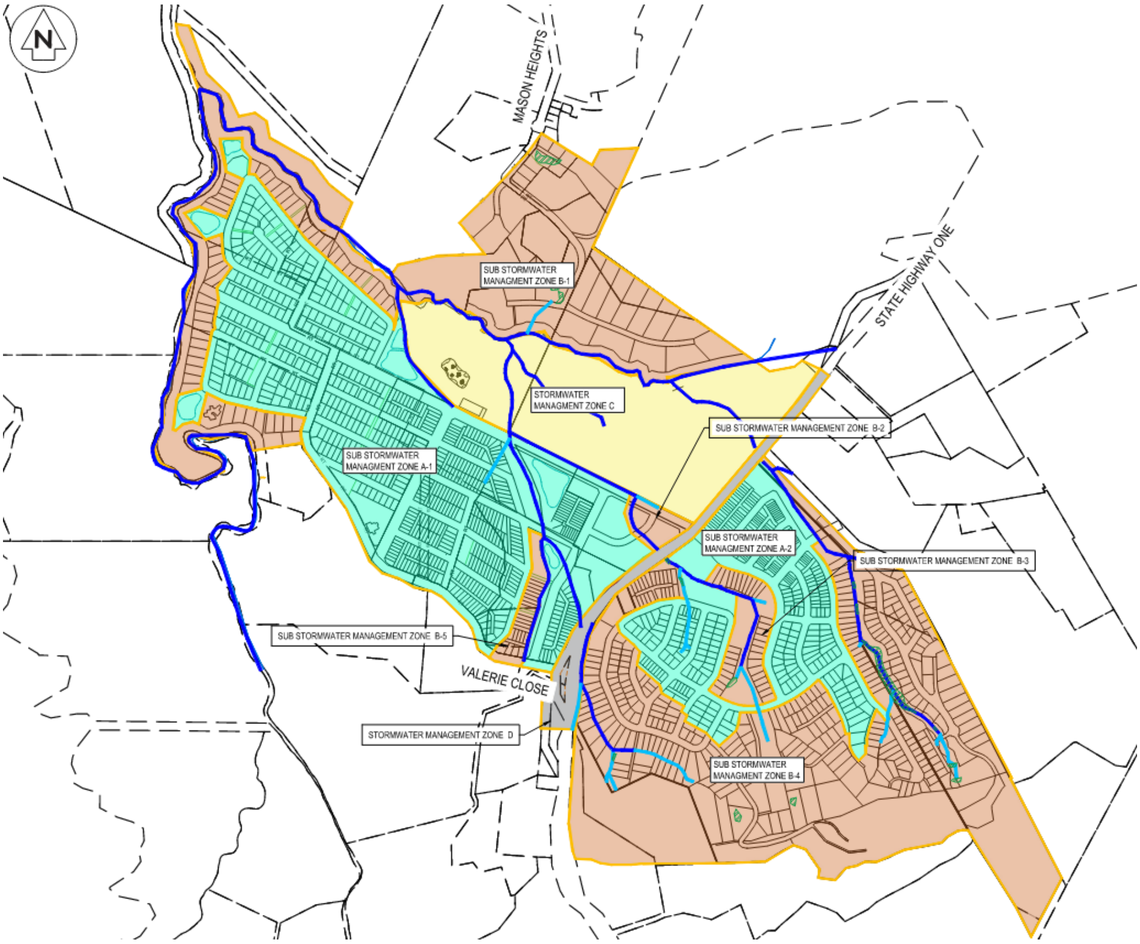


Figure 2: Stormwater Management Zone Plan

2.1 STORMWATER MANAGEMENT ZONE A

The post development catchment contained within this zone are: XII, XV, XXIV, XXVII, XXIX, XXXI, XXXIII, XXXIV, and XXXV.

An initial wetland sizing calculation has been conducted for all stormwater catchments listed above, the results are appended (Appendix A) and indicates the potential size of a typical wetland required to treat this catchment. The initial sizing is based on the maximum MPD and provides a high-level indication of the potential dimensions of the wetland. It should be noted that there are various ways to size the wetland to achieve the required volume required of GD01. This report focuses solely on the catchment and its suitability for specific stormwater devices, while the detailed design and workings of any device within the subdivision will be subject to a more thorough design process and review at a later stage.

CATCHMENT XII:

Catchment XII, located within the Waimanawa Hills Precinct, is adjacent to State Highway one on its northern boundary. Its western boundary aligns with an existing ridgeline, which may be modified however efforts should be made to retain the existing stormwater catchment boundary. The eastern boundary of Catchment XII abuts an existing stream and follows a proposed road alignment, ensuring that the public road is captured and treated by potential Wetland 8 as depicted in the master plan.

As illustrated in the accompanying figure, the downstream portion of Catchment XII is generally flat, making it suitable for wetland construction. Although the sizing and shape factors indicated by the engineering calculations may not be fully met, the overall area does meet the criteria. As the scheme plan is only indicative it can be adjusted as necessary to accommodate the proposed wetland. Please refer to Appendix B for relevant engineering drawings.

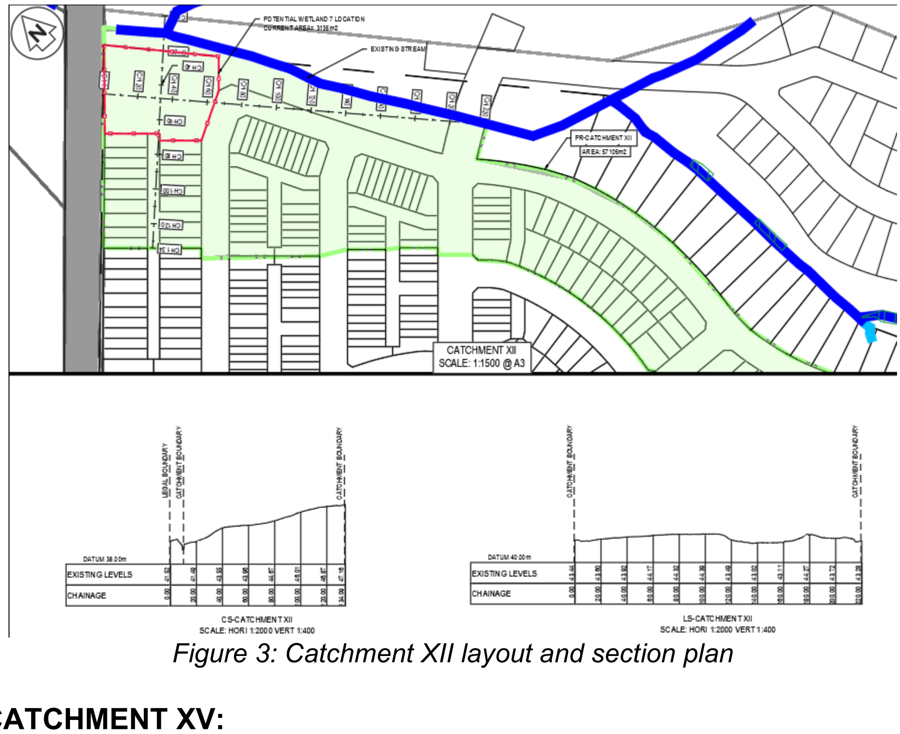


Figure 3: Catchment XII layout and section plan

CATCHMENT XV:

Catchment XV is situated within the Waimanawa Hills Precinct and shares its northern boundary with State Highway One. The eastern boundary aligns with an existing ridgeline, which may undergo modifications through earthworks. However, efforts will be made to preserve the highest point of the ridge to minimize alterations to the existing stormwater catchment boundary. On its western side, Catchment XV adjoins a stream and follows a road alignment, ensuring that the public road is encompassed and treated by potential Wetland 7, as indicated in the master plan.

The downstream section of Catchment XV, as depicted in the accompanying figure, includes a gradual slope that can be worked during the bulk earthwork operations, rendering it suitable for constructing a wetland. The chosen location for this wetland also satisfies the specified size, shape, and area requirements determined through engineering calculations. Therefore we find the location suitable and it is recommended the location indicated is utilised for a stormwater management device, such as a wetland. Please refer to Appendix B for relevant engineering drawings.

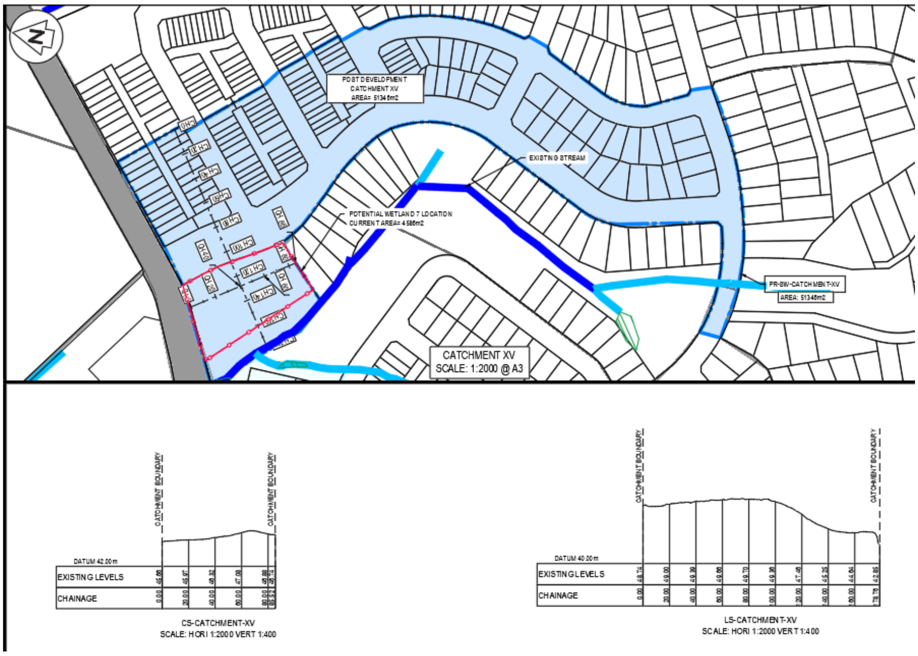


Figure 4: Catchment XV layout and section plan

CATCHMENT XXIV:

Catchment XXIV, situated within the Waimanawa Hills Precinct, has an irregular shape and shares its eastern boundary with a major stream. Its southern boundary aligns with an existing ridgeline, which may undergo modifications. However, efforts should be made to retain the existing stormwater catchment boundary.

The downstream portion of Catchment XXIV, as depicted in the accompanying figure, is generally characterized by a flat to moderate slope. With some minor reshaping of the ground around the designated location according to the master plan, it would be suitable for constructing a bulk treatment device such as a wetland. The chosen location for this wetland also satisfies the specified size, shape, and area requirements determined through engineering calculations. Therefore, we find the location suitable, and it is recommended the location indicated is utilised for a stormwater management device, such as a wetland. Please refer to Appendix B for the relevant engineering drawings.

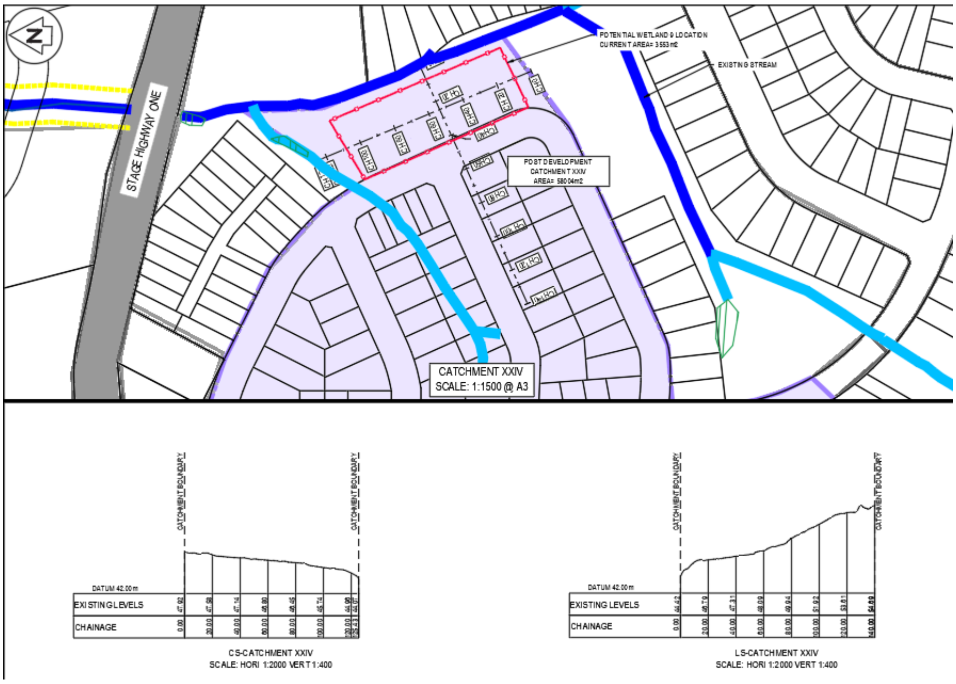


Figure 5: Catchment XXIV layout and section plan

CATCHMENT XXVII:

Catchment XXVII, situated within the Waimanawa Valley Precinct, has an irregular shape and is adjacent to a major stream on both its eastern and western boundaries. Its southern boundary abuts State Highway One.

As shown in the accompanying figure, the downstream portion of Catchment XXVII exhibits a generally flat terrain, making it suitable for the construction of a wetland. The chosen location for this wetland also fulfils the specified length and area requirements based on engineering calculations. Therefore, we find the location suitable and it is recommended the location indicated is utilised for a stormwater management device, such as a wetland. However, considering the proximity of this wetland to existing watercourses, additional consideration for ecological constraints and the riparian margin will be necessary during the resources consent stage. Refer to Appendix B, which contains the relevant engineering drawings.

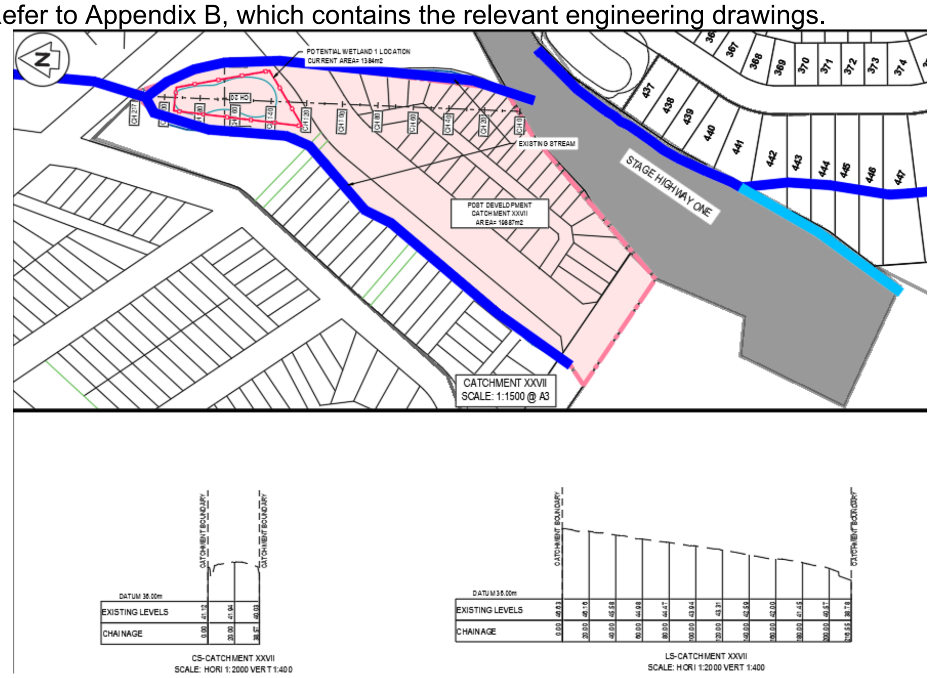


Figure 6: Catchment XXVII layout and section plan

CATCHMENT XXIX:

Catchment XXIX, situated within the Waimanawa Valley Precinct, it is an irregular shape and adjacent to a major stream on its western boundary. On the eastern side, this catchment's boundary abuts the Wider Western Link Road, a future arterial road. Its southern boundary is contiguous with the current State Highway One reserve.

As depicted in the accompanying figure, the downstream portion of Catchment XXIX features predominantly flat terrain, rendering it suitable for the construction of a wetland. The chosen location for this wetland also satisfies the specified size, shape, and area requirements as determined through engineering calculations. Therefore, we find the location suitable and it is recommended the location indicated is utilised for a stormwater management device, such as a wetland. Please refer to Appendix B for relevant engineering drawings.

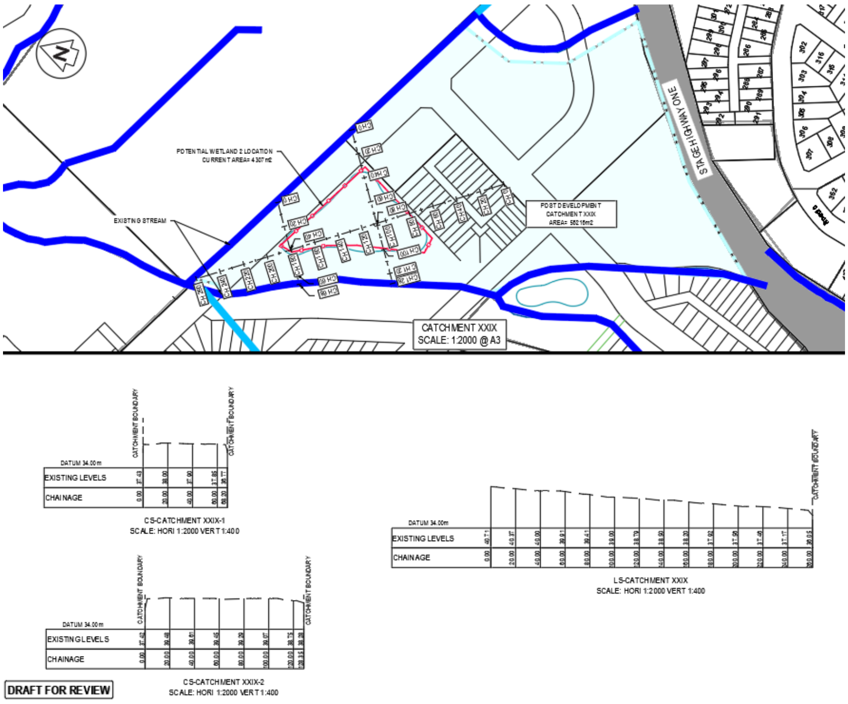


Figure 7: Catchment XXIX layout and section plan

CATCHMENT XXXI:

Catchment XXXI, situated within the Waimanawa Valley Precinct, exhibits an irregular shape and is the largest stormwater catchment, covering an area of 21.8 hectares. It is to be surrounded by a local roading network to the west and the Wider Western Link Road to the south. Its eastern boundary abuts a permanent stream.

As illustrated in the accompanying figure, the downstream portion of Catchment XXXI features generally flat terrain, making it suitable for wetland construction. However, the chosen location for this wetland falls short in terms of the required area as calculated by the engineering assessment. The shape factor is also marginally inadequate. It is important to note that failing to meet these high-level preliminary sizing guidelines does not necessarily mean the wetland is unsuitable for the designated location. Considering the close proximity to an existing stream, a reassessment of the final location for this wetland will be necessary. Nevertheless, the location in principle remains suitable for a bulk treatment device such as a wetland. Therefore, a detailed engineering design of the wetland will be required to ensure a compliant outcome is achieved during the resource consent process. Refer to Appendix B for relevant engineering drawings.

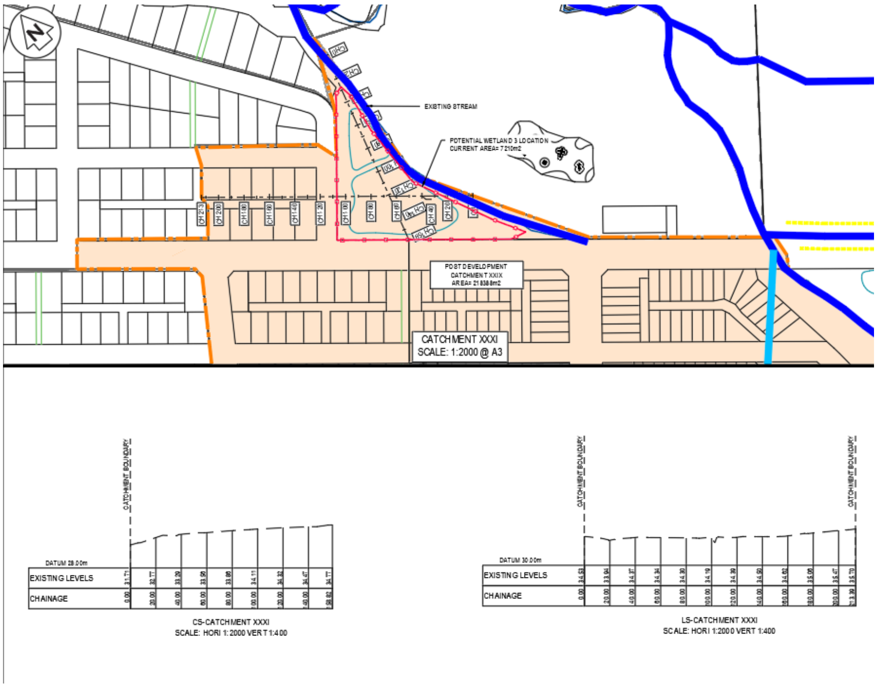


Figure 8: Catchment XXXI layout and section plan

CATCHMENT XXXIII:

Catchment XXXIII, located within the Waimanawa Valley Precinct, exhibits an irregular shape and currently features an inundated landscape, necessitating significant earthworks along its boundaries where housing platforms, infrastructure and other services are to be located.

As depicted in the accompanying figure, the downstream portion of Catchment XXXIII possesses a moderate slope, requiring earthwork to establish a suitable construction area for the wetland. The chosen location for this wetland aligns with the size, shape, and area requirements specified for the wetland within its catchment. Therefore, a wetland is the recommended management device and preferred method of servicing the catchment. However, a detailed engineering design of the wetland will be necessary during the resources consent stage to ensure that the modified landscape can effectively contain the proposed wetland. Refer to Appendix B for relevant engineering drawings.

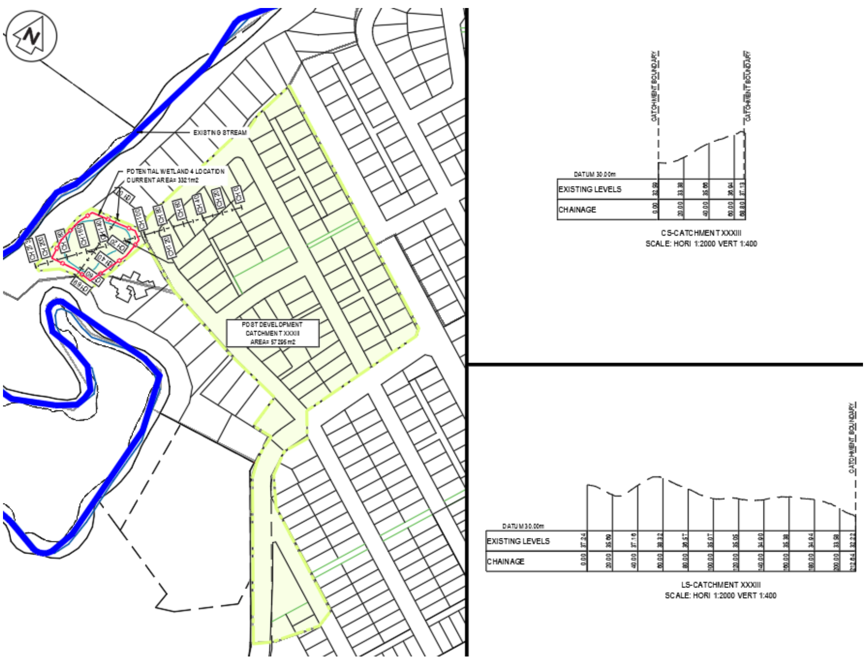


Figure 9: Catchment XXXIII layout and section plan

CATCHMENT XXXIV:

Located within the Waimanawa Valley Precinct, Catchment XXXIV is irregular in shape and is currently characterized by an inundated landscape, necessitating significant earthworks along its boundaries where housing platforms, infrastructure and other services are to be located.

As illustrated in the accompanying figure, the downstream portion of Catchment XXXIV exhibits a moderate slope that will require earthworks to create an appropriate construction area for the proposed wetland. The designated location for this wetland adheres to the specified size, shape, and area requirements of this catchment. Therefore, a wetland is recommended as the preferred stormwater management device. However, during the resources consent stage, a detailed engineering design of the wetland will be necessary to ensure that the modified landscape is capable of effectively containing the proposed wetland. Refer to Appendix B for relevant engineering drawings.

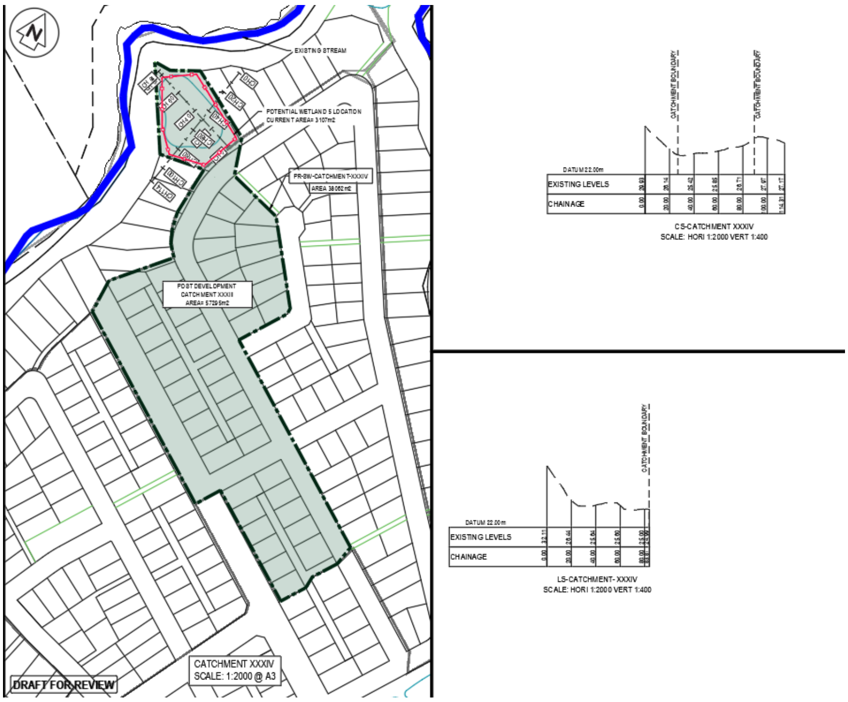


Figure 10: Catchment XXXIII layout and section plan

CATCHMENT XXXV:

Catchment XXXV, located within the Waimanawa Valley Precinct, is irregular in shape and is characterised as moderated sloped.

As illustrated in the accompanying figure, the downstream portion of Catchment XXXV has an undulating and moderate sloped terrain, requiring significant earthworks to create a suitable area for a stormwater management device such as a wetland. The allocated location for this wetland meets the area requirement for the wetland within the catchment, but the shape factor is marginal. It is recommended this catchment is served by a bulk device (wetland) as the preferred treatment device for this catchment, pending further investigation into the earthworks required to establish a wetland. A detailed engineering design of the wetland will be necessary during the resources consent stage to ensure that the modified landscape can effectively contain the proposed wetland. For more information, please refer to Appendix B for relevant engineering drawings.

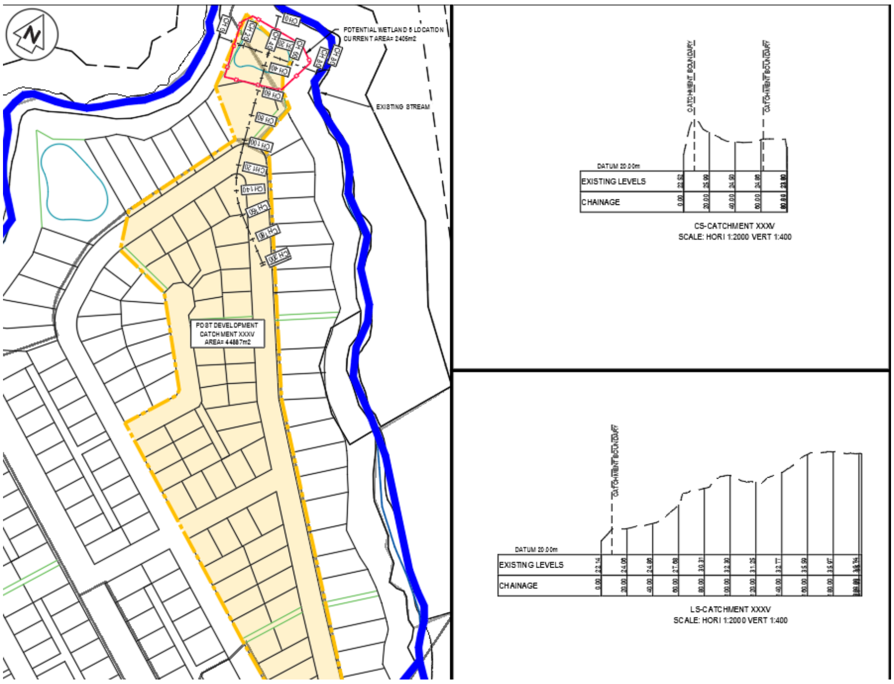


Figure 11: Catchment XXX layout and section plan

2.2 STORMWATER MANAGEMENT ZONE B

The stormwater catchments within this zone that are considered post-development include catchments I-V, XI, XIII-XIV, XVI-XXIII, XXV-XXVI, XXVIII, XXX, XXXII, and XXXVI.

A common characteristic among these post-development catchments is that they either have steeper slopes or are too small and narrow to accommodate large, catchment wide stormwater device effectively. As a result, the Best Practicable Option (BPO) is recommended in terms of providing stormwater management in these catchments. The engineering plans, depicting the locations of the catchments and the general ground profile, can be found within Appendix B.

CATCHMENT I:

Catchment I is situated in the northern portion of the Waimanawa Valley Precinct and can be accessed legally through Mason Heights. This catchment is characterized by hilly terrain, and an interesting feature is the presence of a localized depression that has formed a natural wetland within its northern extent. The natural ground of catchment I can be observed in the Figure provided below.

Figure 12: Catchment I layout and section plan

CATCHMENT II:

Catchment II is situated in the northern portion of the Waimanawa Valley Precinct and shares three of its boundaries with neighbouring lots. It is important to note that any significant changes in the level of Catchment II would have an impact on the neighbouring land. Additionally, Catchment II features a steep slope that descends towards its northern extent, as depicted in the Figure provided below:

Figure 13: Catchment II layout and section plan

CATCHMENT III:

Catchment III is located between Catchment I and Catchment II, and it is characterized by a ridgeline that runs through the catchment. Due to the presence of this ridge line, construction of a wetland in Catchment III is not considered feasible. The natural landform of Catchment III can be observed in the image provided below:

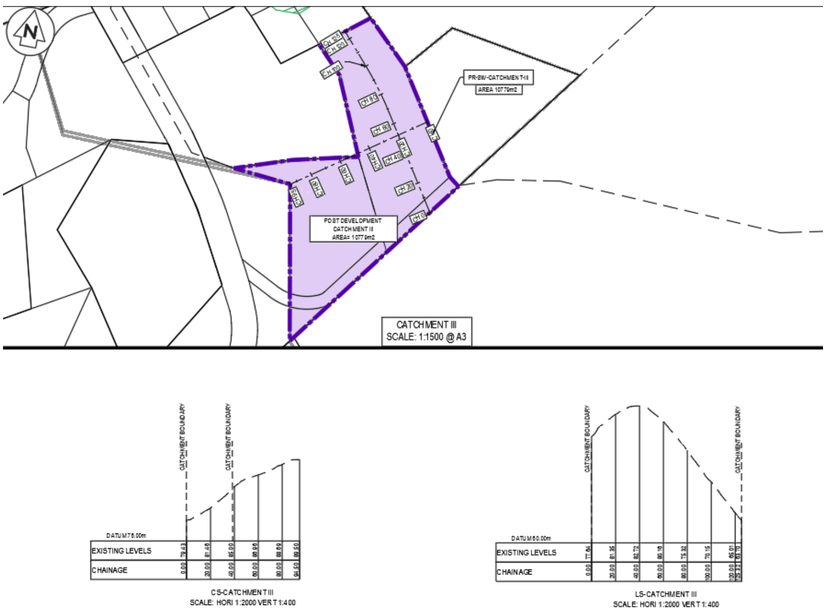


Figure 14: Catchment III layout and section plan

CATCHMENT IV:

Catchment IV, located within the Waimanawa Valley Precinct, is a significant catchment that consists of two hills on its eastern and western extents, with a natural valley situated in the central part of the catchment. The terrain is generally very steep and the catchment is predominantly covered by a protected Kanuka forest located in the western extent of the catchment, imposing limitations on any earthwork or alterations within this protected area. The natural landform of Catchment IV can be observed in the image provided below:

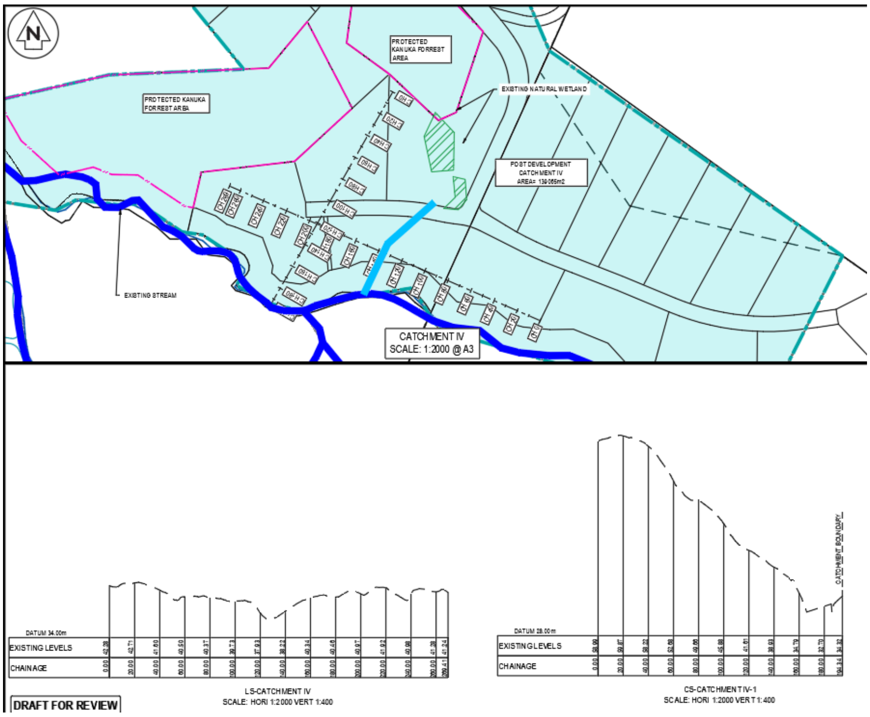


Figure 15: Catchment IV layout and section plan

CATCHMENT V:

Catchment V, positioned within the Waimanawa Valley Precinct, is a small catchment situated to the west of Catchment IV. It has a catchment area of 1.17 hectares, runoff of this catchment would be considered as sheet flow towards the stream traversing its southern boundary. The site exhibits a steep slope, making wetland construction impractical and unfeasible. For a better understanding of the site's characteristics, please refer to the site cross section depicted in the figure below:

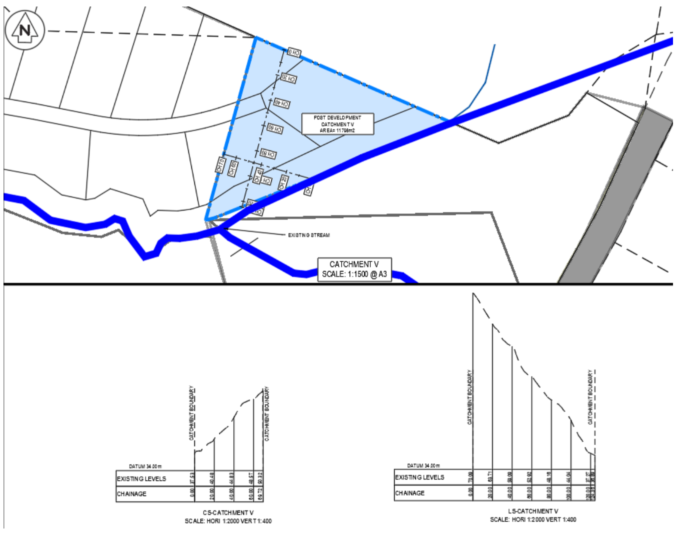


Figure 16: Catchment V layout and section plan

CATCHMENT XI:

Catchment XI, located within the Waimanawa Hills Precinct, is a narrow strip of land that borders a stream along its southwestern boundary. The limited width of this catchment makes it unsuitable for any type of residential development. However, there is a small section designated for a future road connection within this catchment. This road connection is intended to provide access to the northeastern portion of the Waimanawa Hill Precinct and also serve as a future connection to neighbouring lands should they be developed in accordance with the Warkworth Structure Plan.

Considering the shape of the land and its limitations, it is recommended ay development and subsequent stormwater management be the BPO in Catchment XI. The natural landform of Catchment XI can be observed in the image provided below:

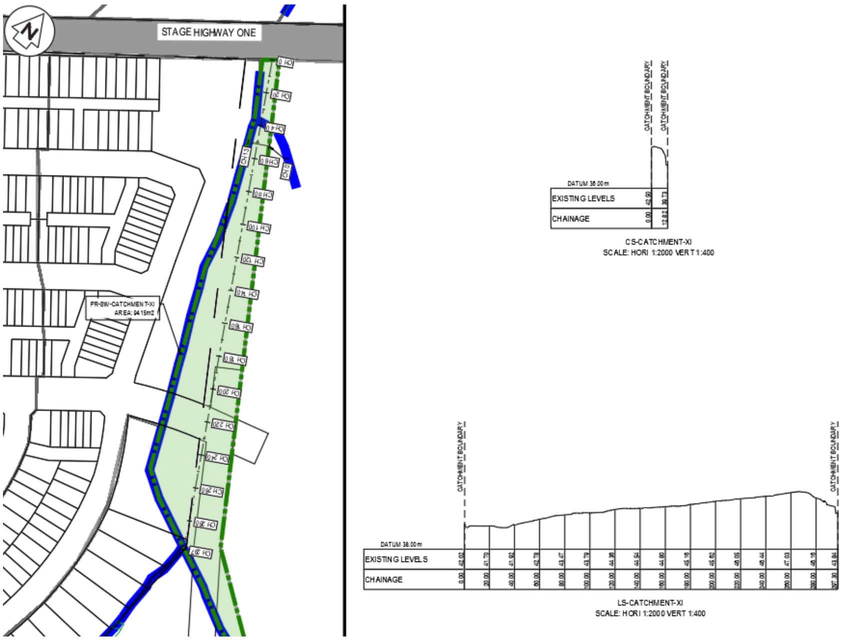


Figure 17: Catchment XI layout and section plan

CATCHMENT XIII:

Catchment XII, situated within the Waimanawa Hills Precinct, shares similarities with Catchment XI, as it is also a narrow strip of land. It is bounded by a permanent stream on its eastern boundary and a local road on its western boundary. The land in Catchment XII features a steep cross fall along the stream alignment, making wetland construction challenging.

Considering that most of the catchment comprises residential lots, a BPO to any required stormwater management in Catchment XII is recommended. The specific details and visual representation of Catchment XII can be found in the Figure provided below.

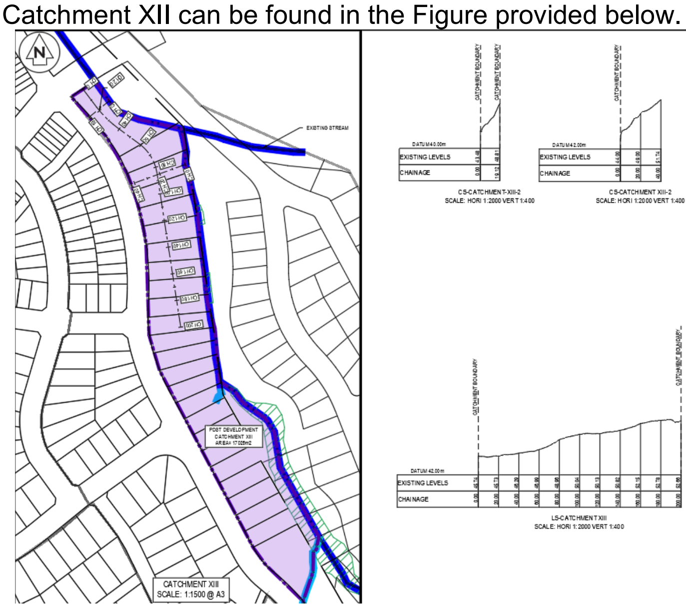


Figure 18: Catchment XIII layout and section plan

CATCHMENT XIV:

Catchment XIV is located as the northeast extent of the Waimanawa Hills precinct. The lower end of this catchment is dissected by two permanent streams, the landform is elevated through its center and low on both fringes as a result. The southern extent of the catchment is the southern ridge line of the Warkworth South PCA. The combination of natural topographical does not support large stormwater devices due to its fragmented falls, non-concentrated flows. Hence a BPO to stormwater management devices is recommended in this catchment. Please refer to Figure below for more information.

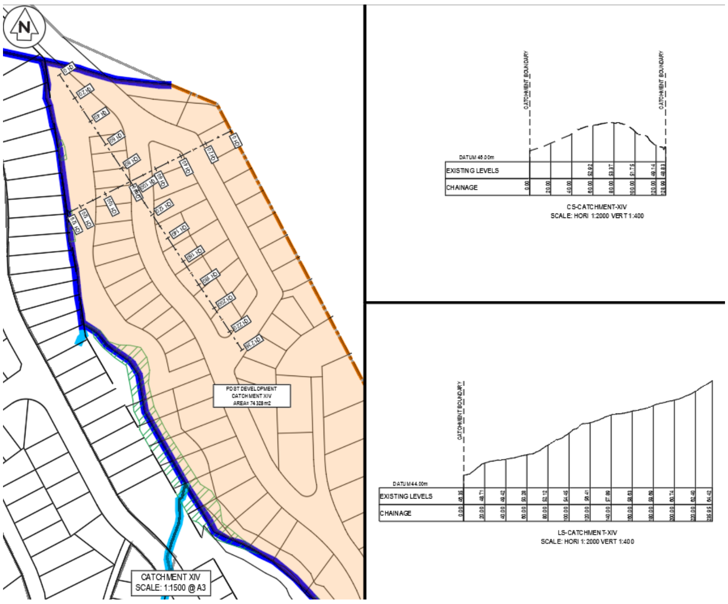


Figure 19: Catchment XIV layout and section plan

CATCHMENT XVI:

Catchment XVI, positioned within the Waimanawa Hills Precinct, is similar to Catchment XIV in terms of its constraints. It is limited by a natural stream in the lower catchment and features a steep landform in the north-south direction. This combination of natural features makes the implementation of large stormwater devices unfeasible. Please refer to Figure below for more information.

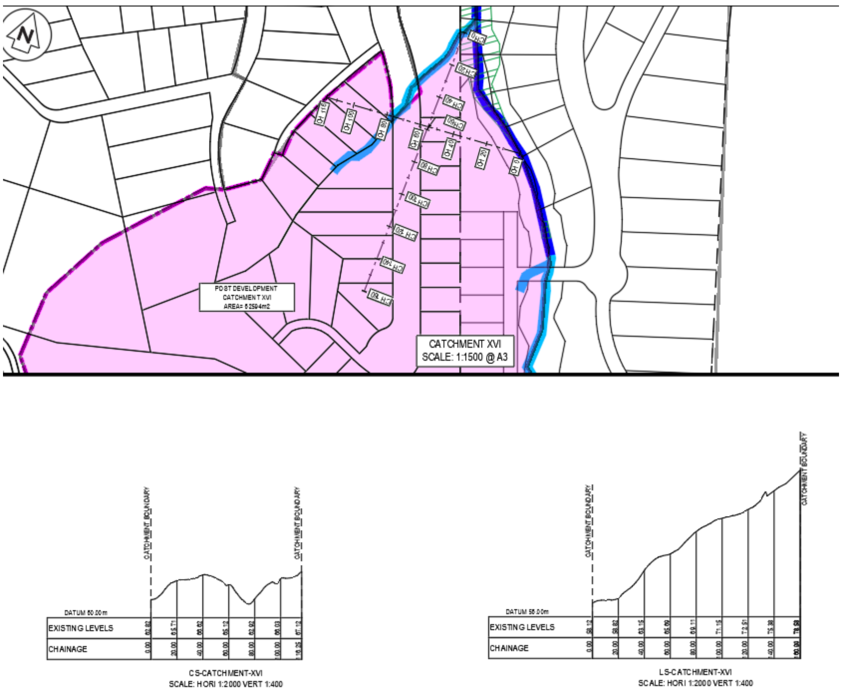


Figure 20: Catchment XVI layout and section plan

CATCHMENT XVII:

Catchment XVII, situated within the Waimanawa Hills Precinct, is a distinctive catchment situated just south of the main ridge line at the boundary of the future urban zone. Unlike the rest of the plan change area, the stormwater runoff from this catchment is drained into a distinct receiving environment. Due to its location on the ridgeline, any significant earthwork is prohibited in this area to preserve the natural landform

Given these considerations, a BPO approach is recommended for stormwater management in Catchment XVII. The BPO approach will ensure appropriate stormwater treatment while respecting the constraints imposed by the ridgeline and the need to maintain the natural landform. Please refer to Figure below for more information.

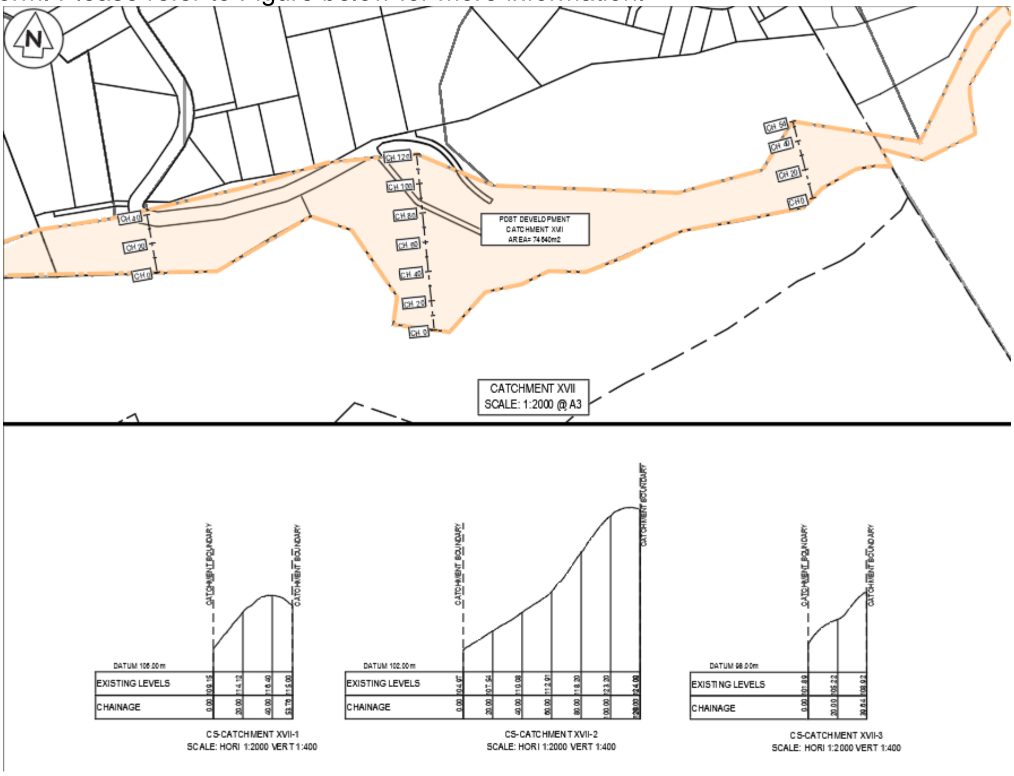


Figure 21: Catchment XVII layout and section plan

CATCHMENT XVIII:

Catchment XVIII, located within the Waimanawa Hills Precinct, is in the high land area of Waimanawa Hill precinct. Its landform is a deep valley with the steep slopes in all direction. Given it landform, a BPO to stormwater management is recommended. Please refer to Figure below for more information.

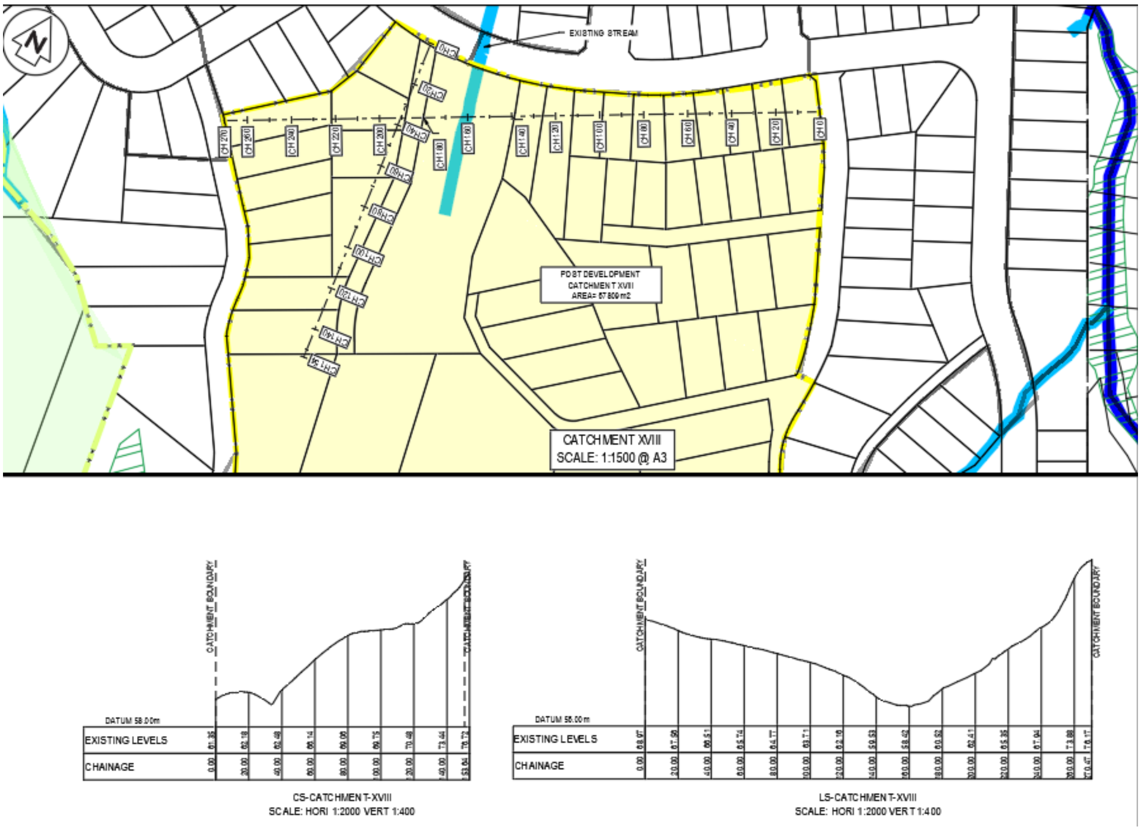


Figure 22: Catchment XVIII layout and section plan

CATCHMENT XIX:

Catchment XIX, positioned within the Waimanawa Hills Precinct, is a narrow strip of land that is bordered by a permanent stream on its western boundary and a local road on its eastern boundary. Additionally, its level is further restricted by State Highway One. The catchment has a moderate cross fall along the stream alignment, making the construction of a catchment wide device or wetland challenging.

Considering that the majority of the catchment is occupied by residential lots, it is recommended a BPO approach is taken for stormwater management in Catchment XIX. The BPO approach will ensure suitable stormwater treatment while taking into account the constraints posed by the catchment's shape, cross fall, and surrounding infrastructure. Please refer to Figure below for more information.

Figure 23: Catchment XIX layout and section plan

CATCHMENT XX:

Similar to Catchment XIV & XVI, catchment XX of the Waimanawa Hill Precinct is constrained by two natural intermediate stream to the lower catchment and the steep landform in the north-south direction, located below a public road and expected stormwater infrastructure. This natural landform making large stormwater devices impractical in terms of construction. Please refer to Figure below for more information

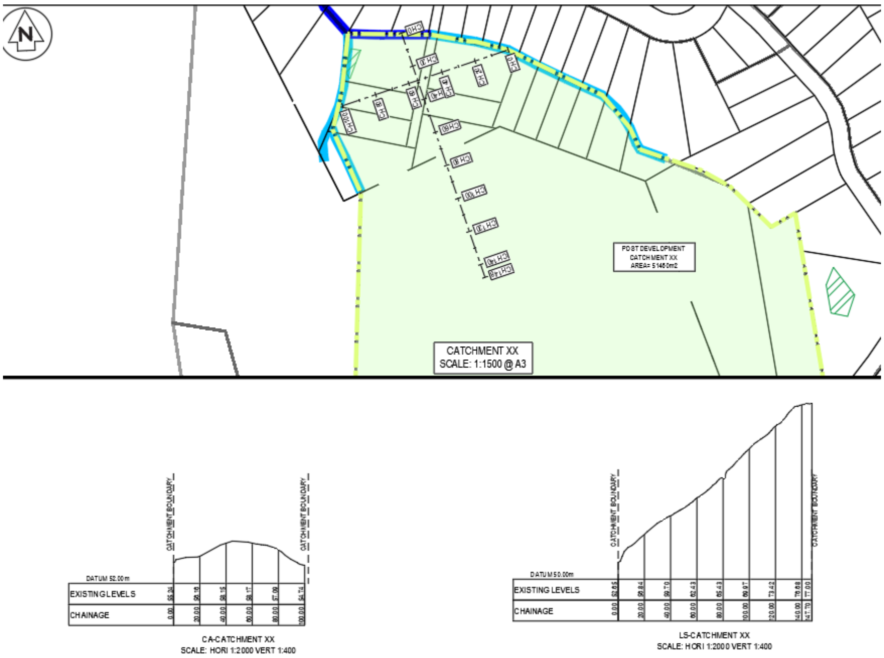


Figure 24: Catchment XX layout and section plan

CATCHMENT XXI:

Catchment XXI, positioned within the Waimanawa Valley Precinct, is constrained by a permanent stream on its eastern boundary and State Highway One to its western boundary. This unique landform restricts any significant earthwork operation in this catchment, a large stormwater device is not considered practical given the surrounding constraints. Please refer to Figure below for more information

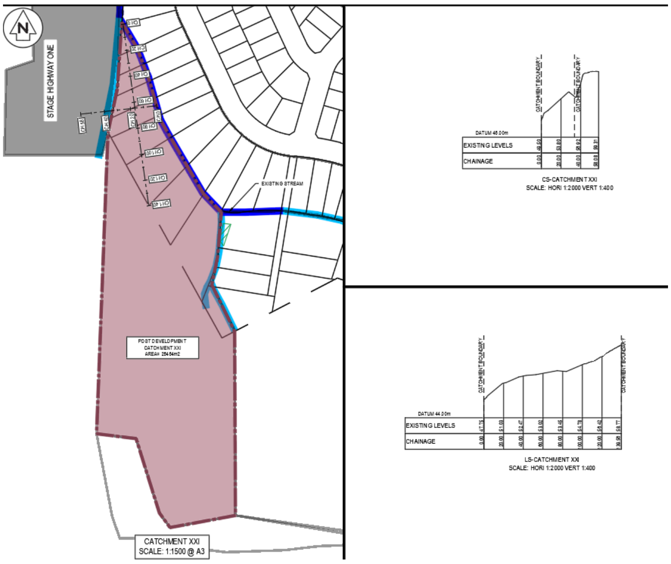


Figure 25: Catchment XXI layout and section plan

CATCHMENT XXII:

Catchment XXII, situated within the Waimanawa Valley Precinct, is a combination of three fragmented catchments that are part of an existing stream bank below the expected position of a public road. More than half of this catchment is designated as a stream corridor and open space, while three isolated blocks of residential areas are indicated in the master plan

The first residential block to the west faces a constraint posed by the deep valley created by the stream. This prevents the capture and conveyance of stormwater from this block back to the proposed wetland in Catchment XXIV.

Similarly, the second residential block to the east encounters a similar situation. The first half of the block is constrained by a steep stream embankment, while the second half is restricted by an intermediate stream stub located downstream within its catchment.

The third residential block experiences a steep cross fall that prevents it from discharging its stormwater back to the proposed wetland within Catchment XV.

Given these constraints and limitations, a BPO approach is recommended for stormwater management in Catchment XXII. The BPO approach will ensure appropriate stormwater treatment considering the unique characteristics and challenges within this catchment. Please refer to Figure below for more information.

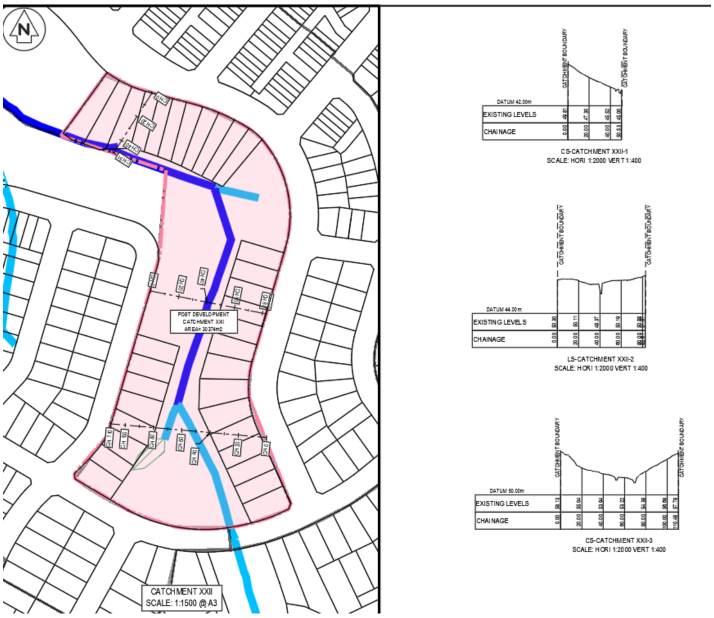


Figure 26: Catchment XXII layout and section plan

CATCHMENT XXIII:

Upon close inspection of the topography near the downstream area of Catchment XXII of Waimnawa Hills Precinct, it has been observed that the site slopes steeply towards the existing watercourse. This topographical feature poses a challenge in creating a level platform for the wetland within the catchment.

To achieve a suitable construction area for a bulk stormwater device, significant earthworks and landscape modifications would be required. These changes may have a significant impact on the natural landscape and may not be practical or feasible within the context of the site.

Please refer to the Figure below for a visual representation and a better understanding of the topographical characteristics and challenges associated with creating a bulk treatment device or wetland in this catchment.

Considering the complexities and constraints involved, it is recommended the stormwater management approach for this catchment is explored further and alternative options that are more compatible with the natural landscape and environmental conditions are considered.

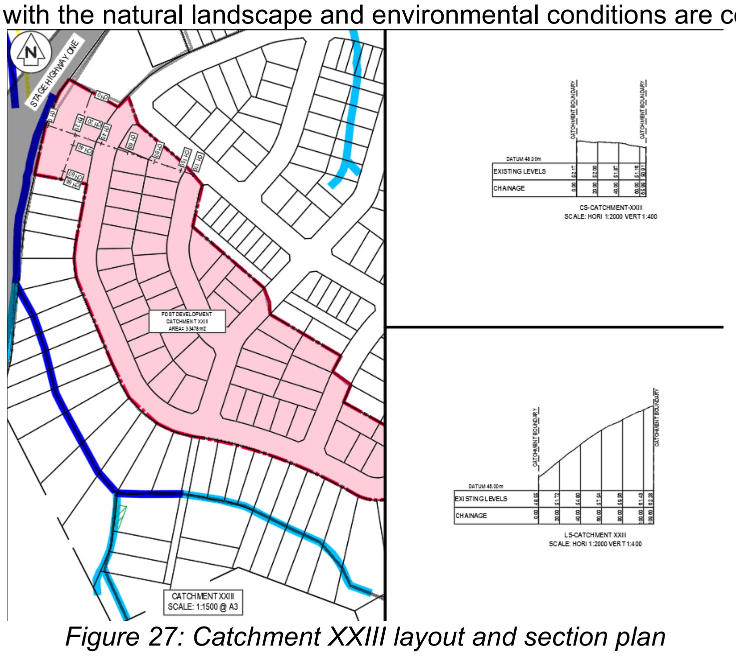


Figure 27: Catchment XXIII layout and section plan

CATCHMENT XXV:

Catchment XXV, positioned within the Waimanawa Hills Precinct, is a fragmented catchment located between State Highway One and the existing stream network. The lower portion of this catchment falls within an existing floodplain. This floodplain has been formed as a result of undersized culverts that were installed during the construction of Stage Highway One. The catchment has a relatively small area of 0.87Ha and consists mainly of residential lots and private property.

Given the size and characteristics of this catchment, implementing a BPO approach to stormwater management would be suitable to mitigate any impact of stormwater runoff from this catchment. Please refer to Figure below for more information.

Figure 28: Catchment XXV layout and section plan

CATCHMENT XXVI:

Catchment XXVI is a unique catchment that includes an area not covered by the Warkworth South Plan Change's Stormwater Management Plan (SMP). This specific area is a property located at 1728 Stage Highway One, currently owned by Waka Kotahi. The remaining area within this post-development catchment is designated as open space with minimal impervious surface area expected to be created.

Given the nature of the catchment, where the majority of the area is designated as open space and there is limited potential for significant impervious surface development. The size and scale of any expected development will be relatively small, stormwater treatment will need to be provided to treat any contaminant generating area, subject to the use, size and scale as the BPO. Please refer to Figure below for more information.

Figure 29: Catchment XXV layout and section plan

CATCHMENT XXVIII:

Catchment XXVIII, situiated within the Waimanawa Valley Precinct, is a small catchment wedge between catchment XXXI and catchment XXVII, abutting an existing stream on its eastern boundary and a public road on the western boundary. The catchment only caters for residential lot area without any public road. Its landform is flat in nature. However, given it in close approximate to the stream. A BPO approach to stormwater management will apply given individual lot runoff/discharge to the stream is likely. Please refer to the site cross section in figure below:

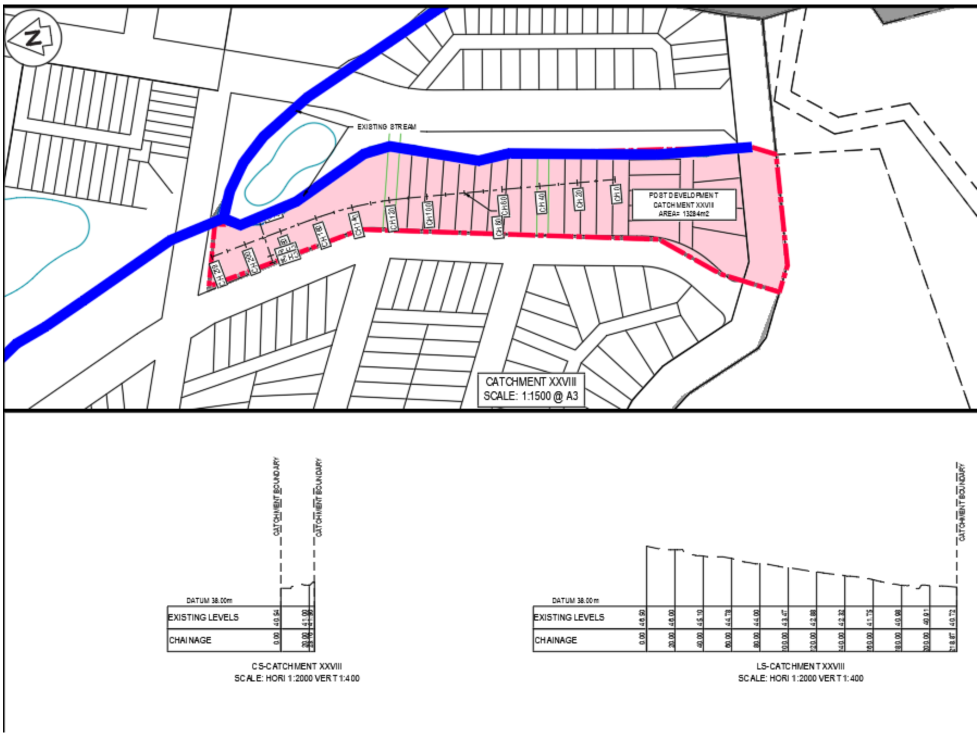


Figure 30: Catchment XXVIII layout and section plan

CATCHMENT XXX:

Catchment XXX, lcoated within the Waimanawa Valley Precinct, is a small catchment wedge between an existing stream to its south and west boundary with the Wider Western Link Road located to it the northern portion of the catchment and State Highway one to the east. The presence of key infrastructure and existing stream have reduced the usable catchment to be less than half of its size. These restrictions reduce the possible area that can be utilised for the Wetland hence BPO is recommended for this catchment is recommended. Please refer to Figure below for more information.

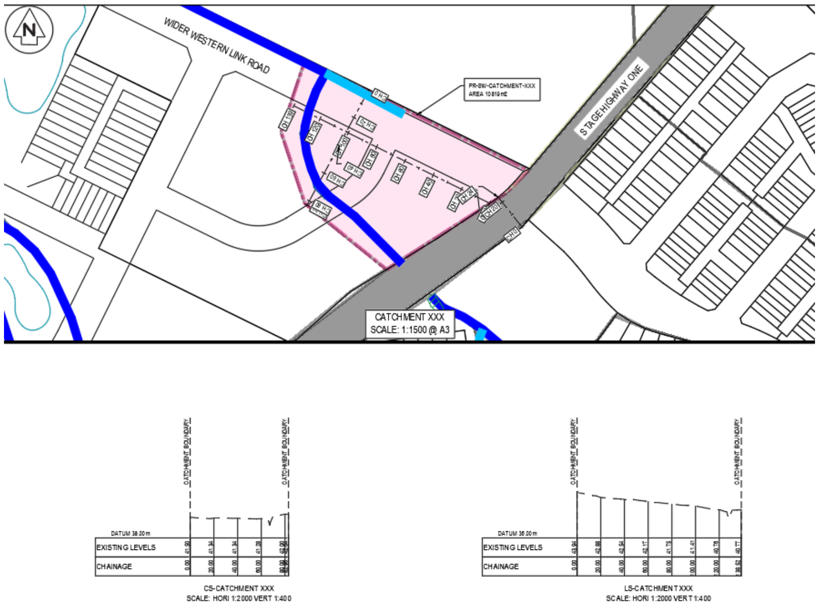


Figure 31: Catchment XXX layout and section plan

CATCHMENT XXXII:

Catchment XXXII, positioned within the Waimanawa Valley Precinct, is a small piece of land between a major stream on the western extent of the plan change area, State Highway 1 and a proposed road. A steep embankment is located along the existing stream alignment which prevents construction of any collecting network or large stormwater management device. Several proposed wetlands are present in the close approximate of this catchment. Those location are where moderated slopes are present which have been utilized to treat the stormwater run-off from various other catchment. A BPO approach to stormwater management will apply given individual lot runoff/discharge to the stream is likely, please refer to figure below for more information.

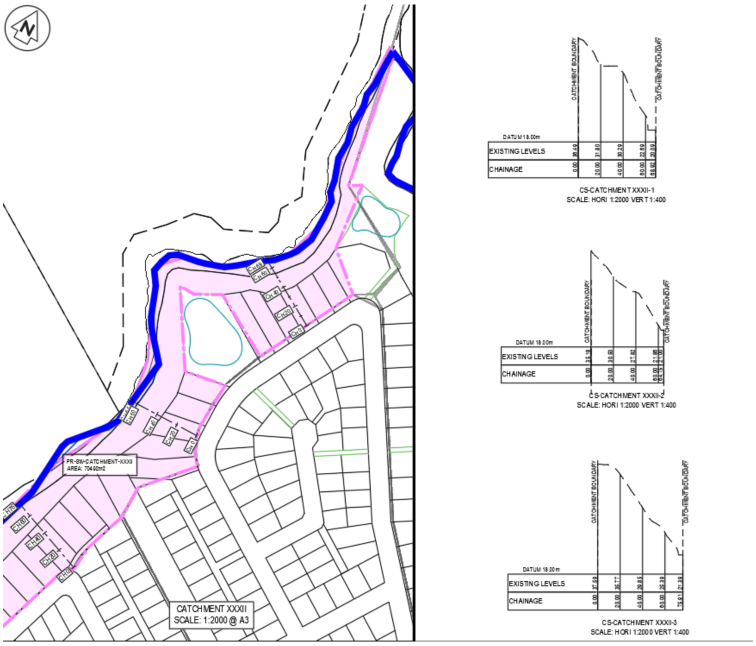


Figure 32: Catchment XXXII layout and section plan

CATCHMENT XXXVI:

Similar to Catchment XXXII, Catchment XXXVI of Waimanawa Valley Precinct, is a thin portion of urban land abutting a major stream and a proposed road, which contains steep cross fall throughout its alignment. This natural topographical is expected to be protected from development for the most part and challenging to capture or manage. Any management requirement will need to be the BPO given the terrain and extent of contaminant generating area and that individual lot runoff/discharge to the stream is likely. Please refer to Figure below for more information.

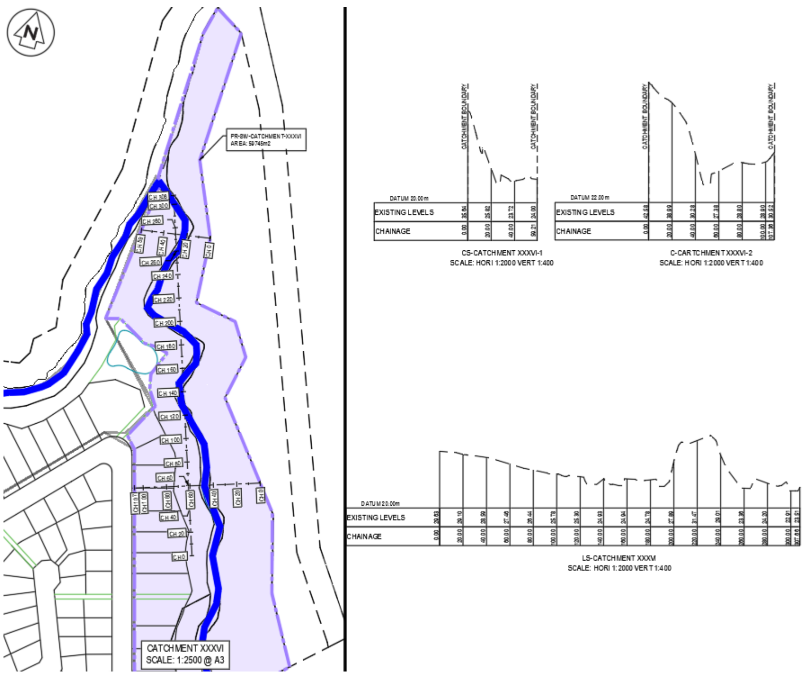


Figure 33: Catchment XXXVI layout and section plan

2.3 STORMWATER MANAGEMENT ZONE C

The stormwater catchments within Zone C cover the existing Morrision Heritage Orchard and the central park area within the Waimanawa Valley Precinct.

Given the proposed land use activities are not overly onerous in terms of creating impervious area, contaminant generating or other trade activities. The stormwater management method is to be the BPO considering the size and scope of any proposed works. The general landform and cross section for these catchments have been prepared and attached in Appendix A. Catchment within this zone are: VI-VIII, X, XXXVII & XXXVIII.

2.4 STORMWATER MANAGEMENT ZONE D

Stormwater Management Zone D contains post development catchment IX. This catchment exclusively exists for what is currently State Highway One. This catchment has established stormwater discharge locations along its narrow corridor which are not suitable for any form of retrofitted bulk stormwater treatment device. Stormwater management shall be considered further at the time of consenting when the regulating authority can comment further. Please refer to image below for more information.

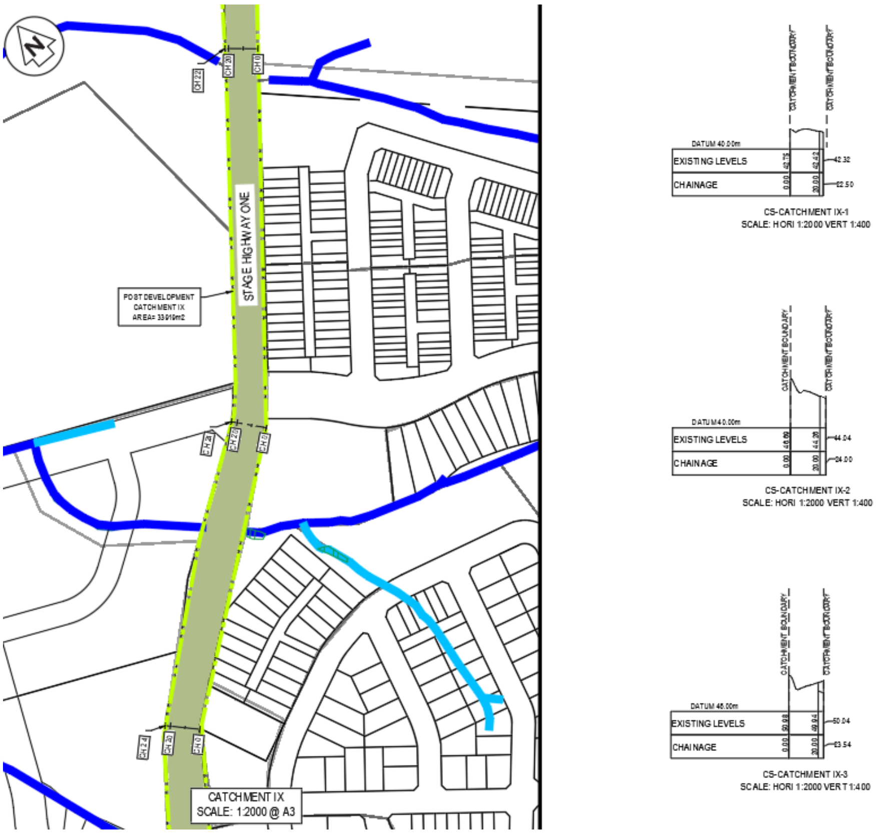
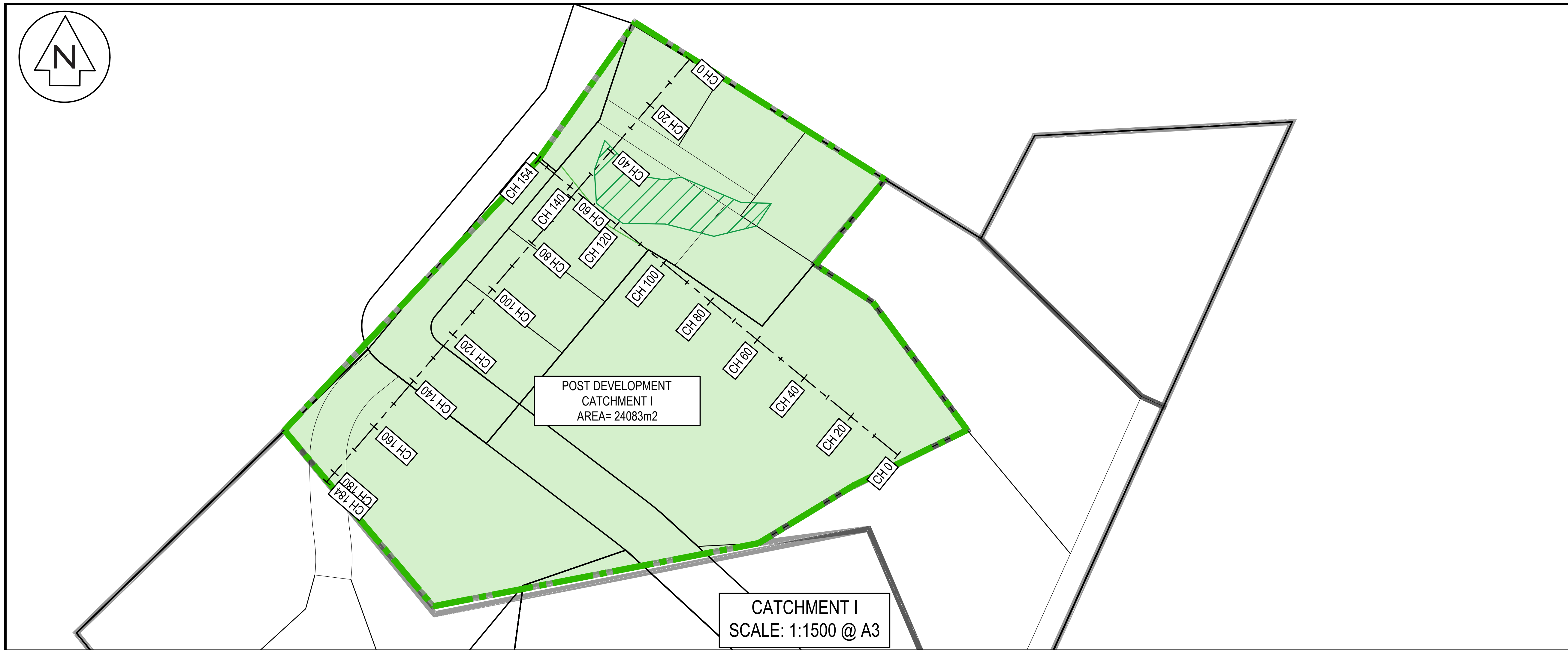


Figure 34: Catchment IX layout and section plan

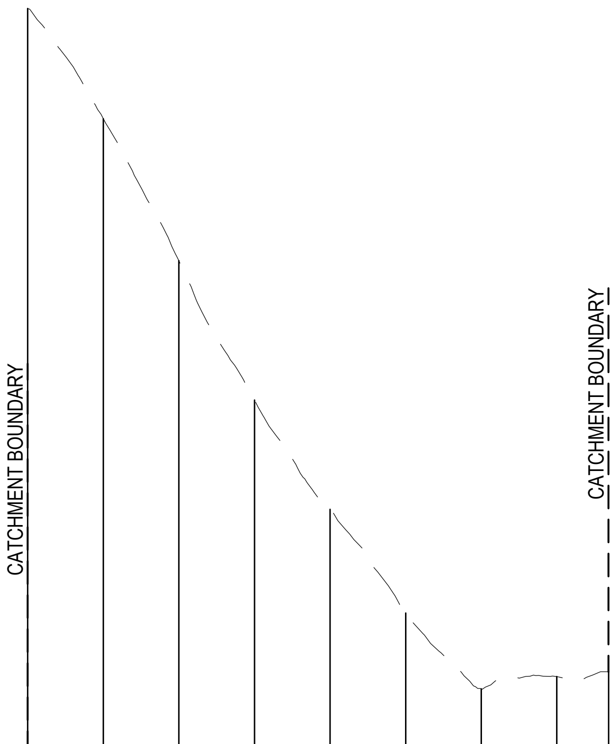
3.0 CONCLUSIONS

Based on the high-level catchment analysis, four stormwater management zones are recommended for the plan change area. These zones help clarify the required stormwater treatment devices for each catchment. It is important to note that these recommendations are based on preliminary conclusions at the master planning level. During the resources consent stage, there may be changes to the zoning of certain catchments to align them with their preferred stormwater treatment devices. Any changes made will need to be reviewed and approved by Healthy Water.

APPENDIX A – ENGINEERING PLAN



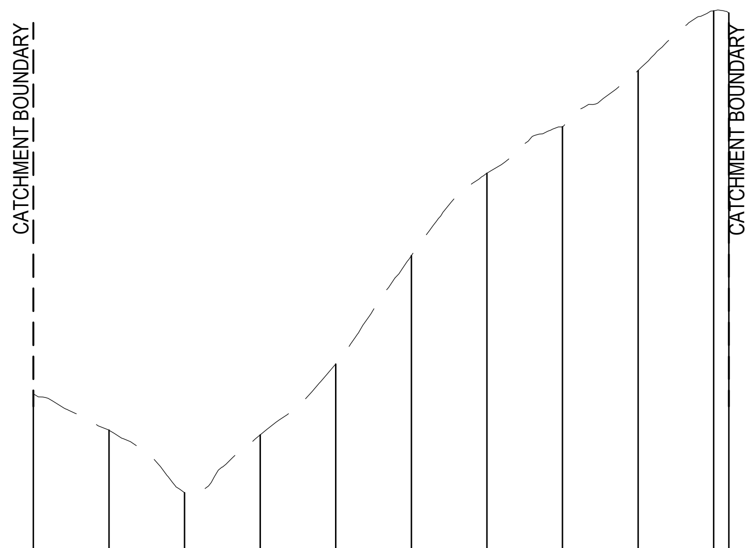
CATCHMENT I
SCALE: 1:1500 @ A3



DATUM 48.00m

EXISTING LEVELS	87.09	81.26	73.74	66.37	60.59	55.11	51.09	51.74	52.00
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	153.68

CS-CATCHMENT I
SCALE: HORI 1:2000 VERT 1:400



DATUM 46.00m

EXISTING LEVELS	54.38	52.45	49.15	52.20	55.95	61.69	66.05	68.50	71.48	74.63	74.52
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	184.02

LS-CATCHMENT I
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

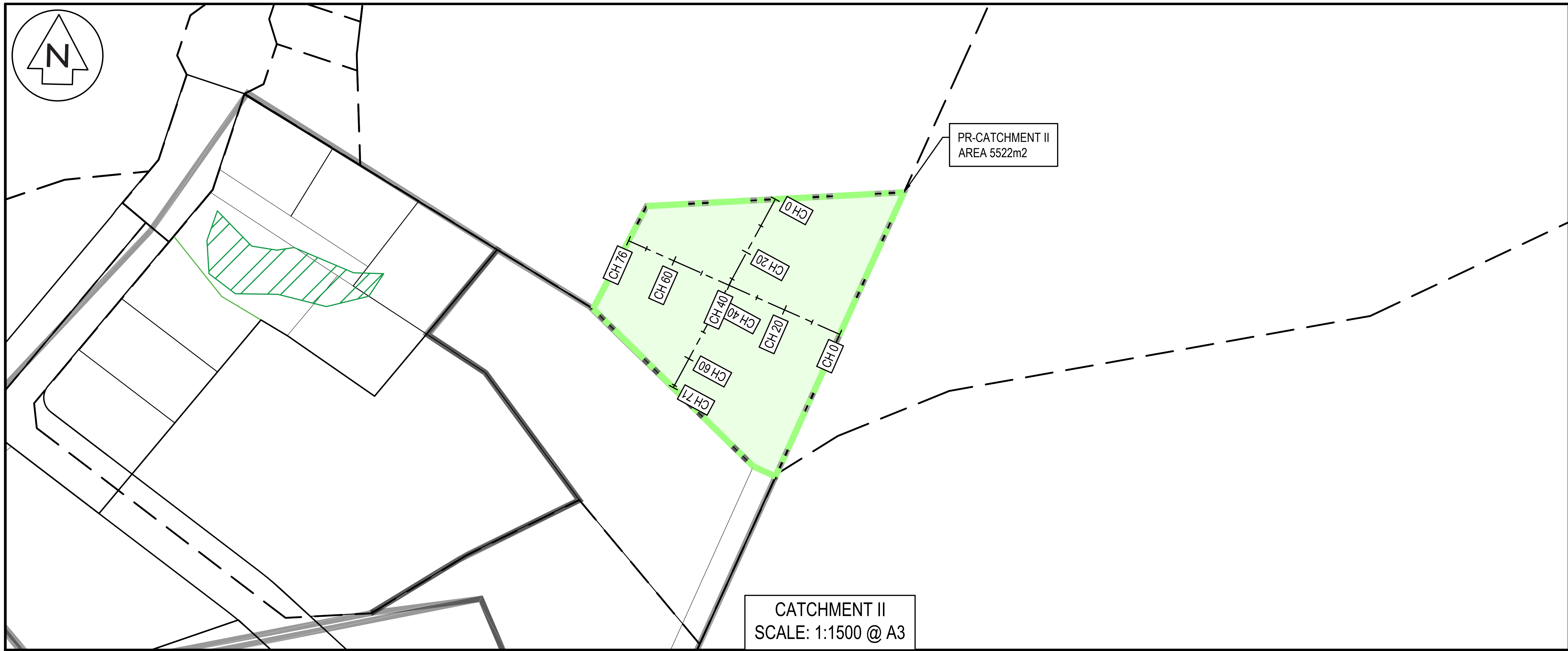
	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

Maven Associates
09 571 0050
info@maven.co.nz
www.maven.co.nz
5 Owens Road, Epsom
Auckland 1023

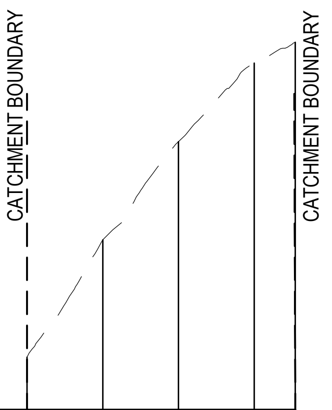
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT I PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-1
Rev	A



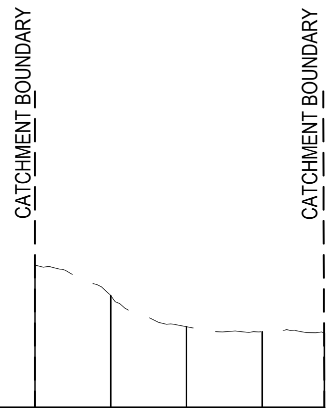
CATCHMENT II
SCALE: 1:1500 @ A3



DATUM 60.00m

EXISTING LEVELS	62.78	68.98	74.18	78.34	79.43
CHAINAGE	0.00	20.00	40.00	60.00	70.86

CS-CATCHMENT II
SCALE: HORI 1:2000 VERT 1:400



DATUM 68.00m

EXISTING LEVELS	75.52	73.91	72.27	72.01	71.92
CHAINAGE	0.00	20.00	40.00	60.00	76.44

LS-CATCHMENT II
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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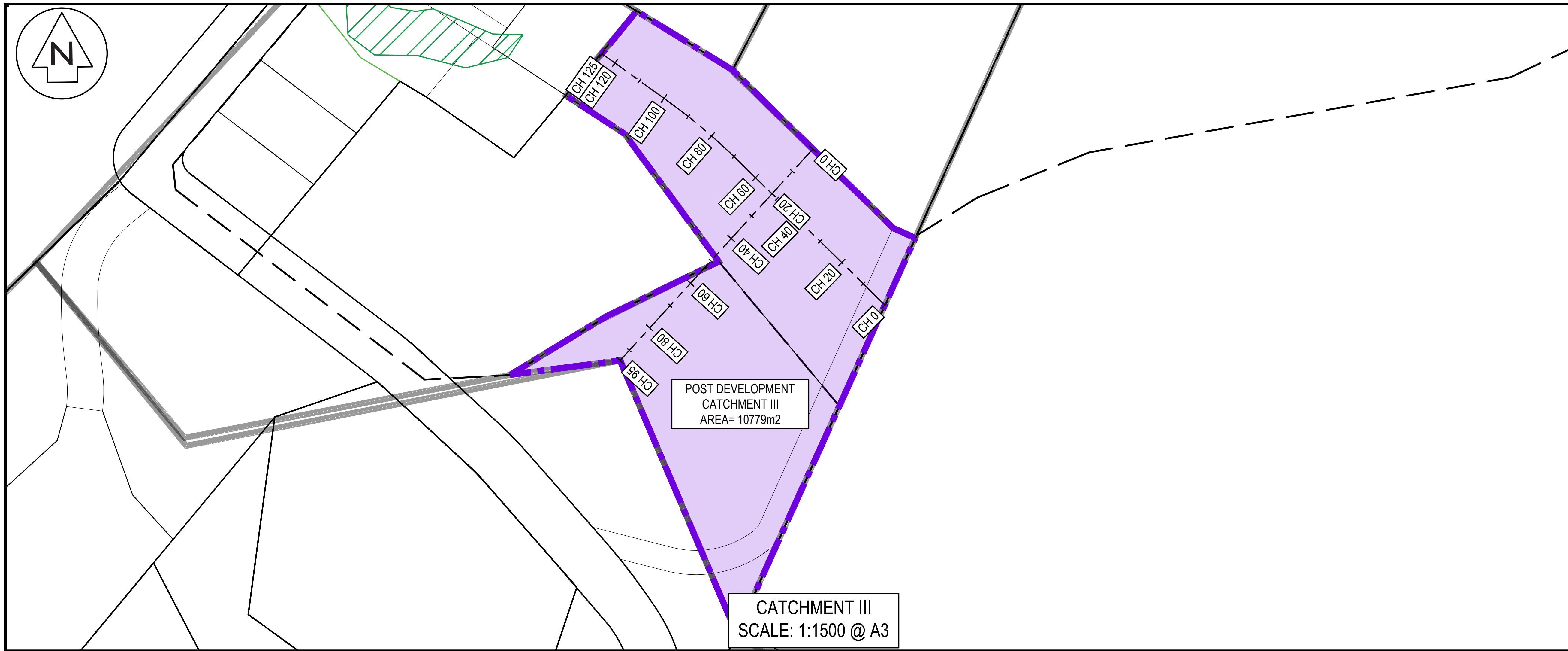
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT II PLAN

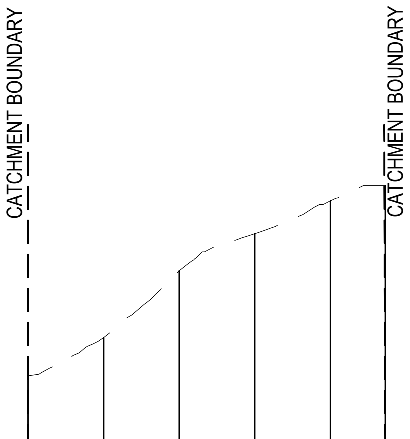
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-2 Rev A



CATCHMENT III
SCALE: 1:1500 @ A3

Notes
1. All works to be in accordance with Auckland council standards.

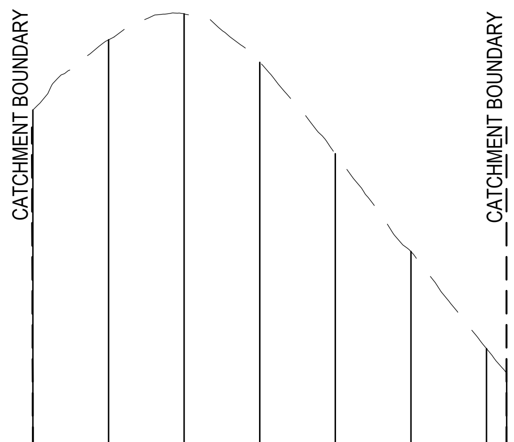
Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND



DATUM 76.00m

EXISTING LEVELS	79.43	81.46	85.00	86.96	88.69	89.50
CHAINAGE	0.00	20.00	40.00	60.00	80.00	94.50

CS-CATCHMENT III
SCALE: HORI 1:2000 VERT 1:400



DATUM 60.00m

EXISTING LEVELS	77.64	81.35	82.72	80.16	75.32	70.15	65.01	63.70
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	125.32

LS-CATCHMENT III
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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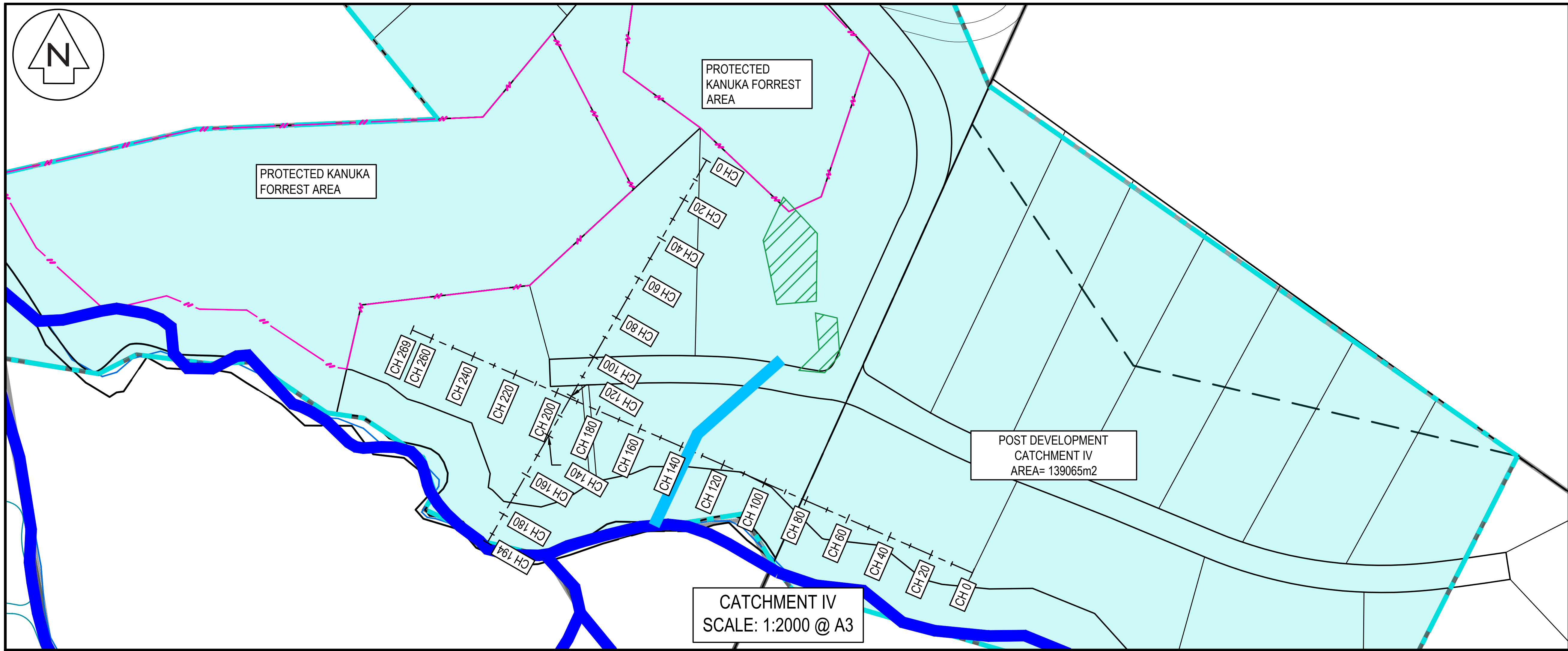
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT III PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-3
Rev	A

DATE: 7/2023

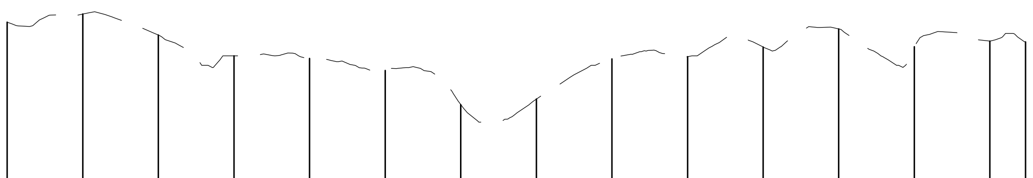
Notes
1. All works to be in accordance with Auckland council standards.



CATCHMENT IV
SCALE: 1:2000 @ A3

Legend

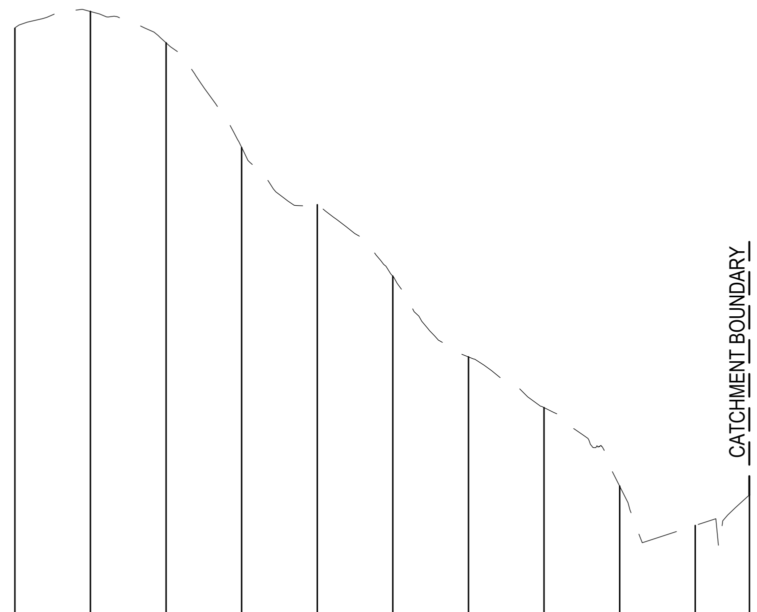
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND



DATUM 34.00m

EXISTING LEVELS	42.28	42.71	41.60	40.50	40.37	39.73	37.93	38.22	40.34	40.46	40.97	41.92	40.98	41.28	41.24
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00	269.41

LS-CATCHMENT IV
SCALE: HORI 1:2000 VERT 1:400



DATUM 28.00m

EXISTING LEVELS	58.99	59.87	58.22	52.68	49.66	45.88	41.61	38.93	34.79	32.70	34.32
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	194.34

CS-CATCHMENT IV-1
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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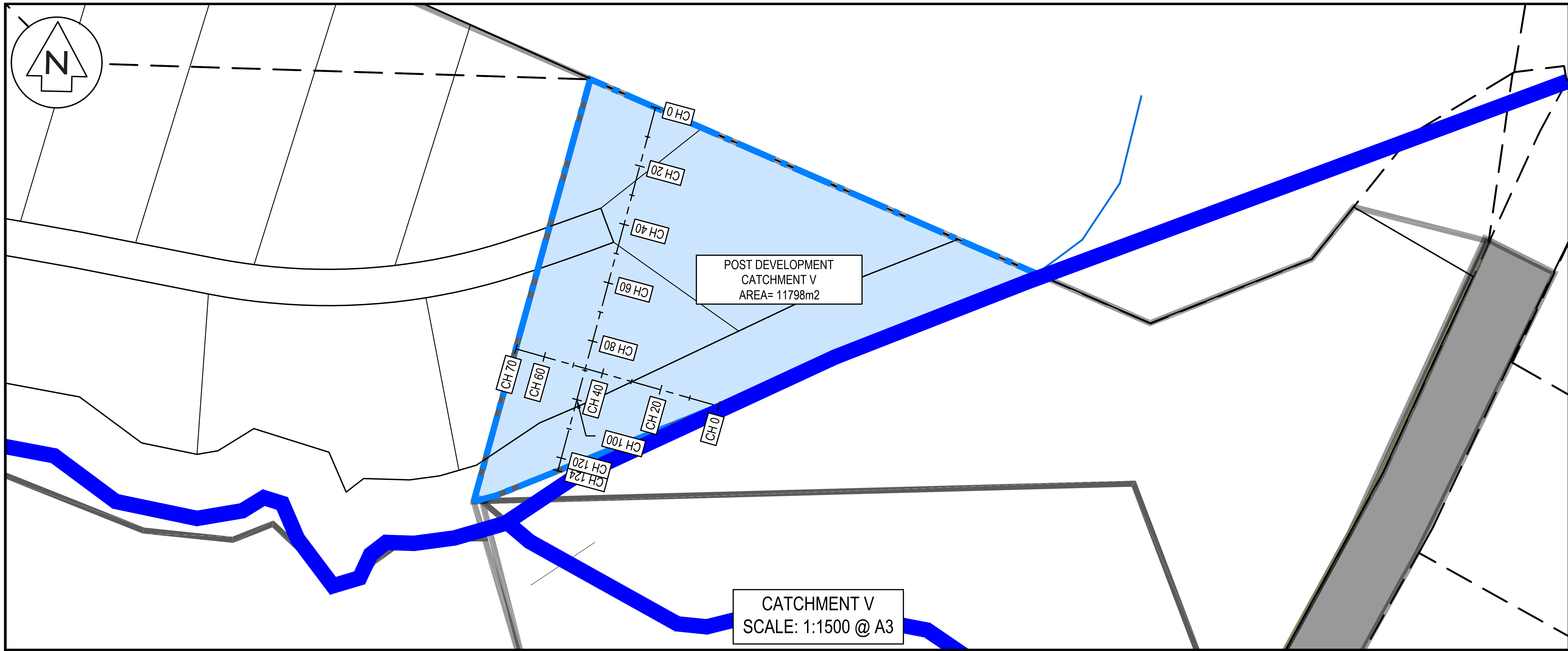
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT IV PLAN

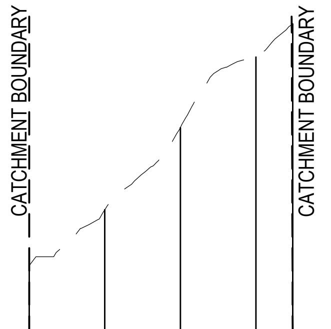
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-4
Rev	A



CATCHMENT V
SCALE: 1:1500 @ A3

Notes
1. All works to be in accordance with Auckland council standards.

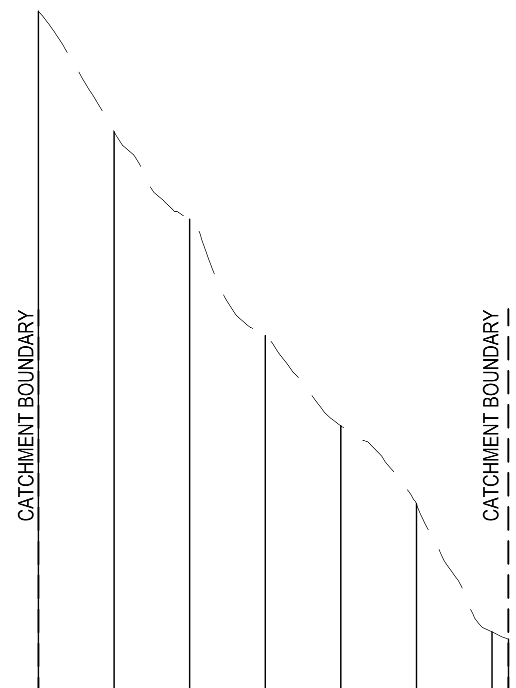
Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND



DATUM 34.00m

EXISTING LEVELS	37.53	40.48	44.83	48.57	50.32
CHAINAGE	0.00	20.00	40.00	60.00	69.72

CS-CATCHMENT V
SCALE: HORI 1:2000 VERT 1:400



DATUM 34.00m

EXISTING LEVELS	70.09	63.71	59.09	52.92	48.16	44.04	37.27	36.89
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	124.36

LS-CATCHMENT V
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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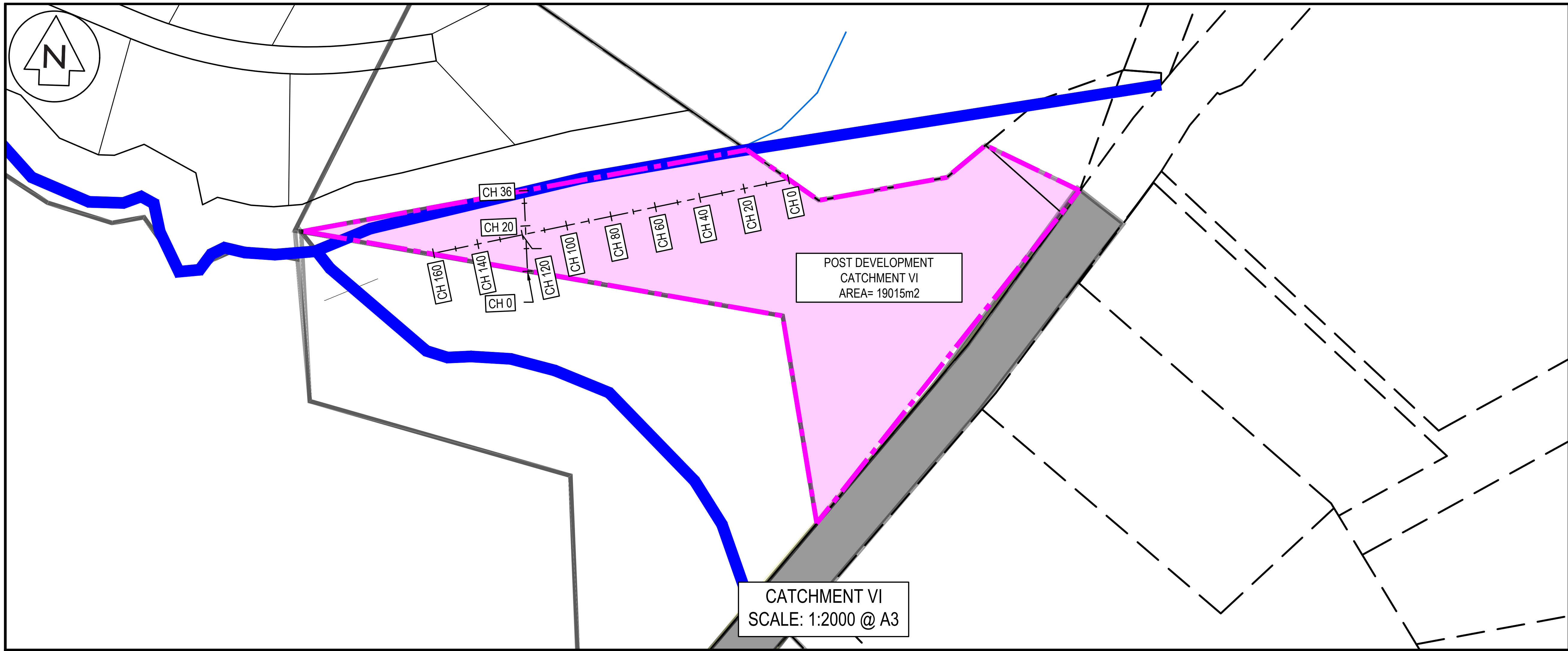
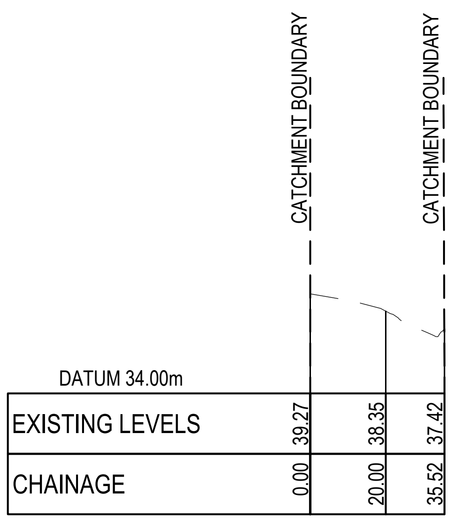
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT V PLAN

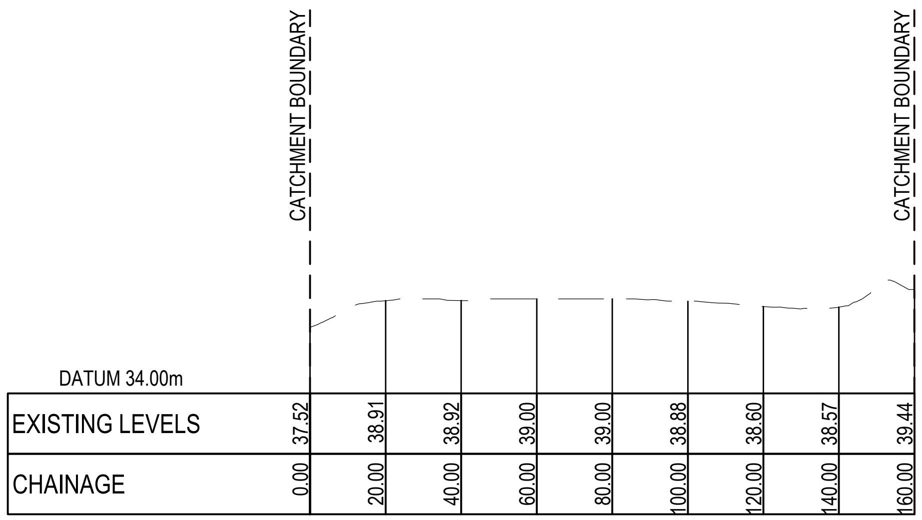
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-5 — Rev A

DATE: 7/3/23





CS-CATCHMENT VI
SCALE: HORI 1:2000 VERT 1:400



LS-CATCHMENT VI
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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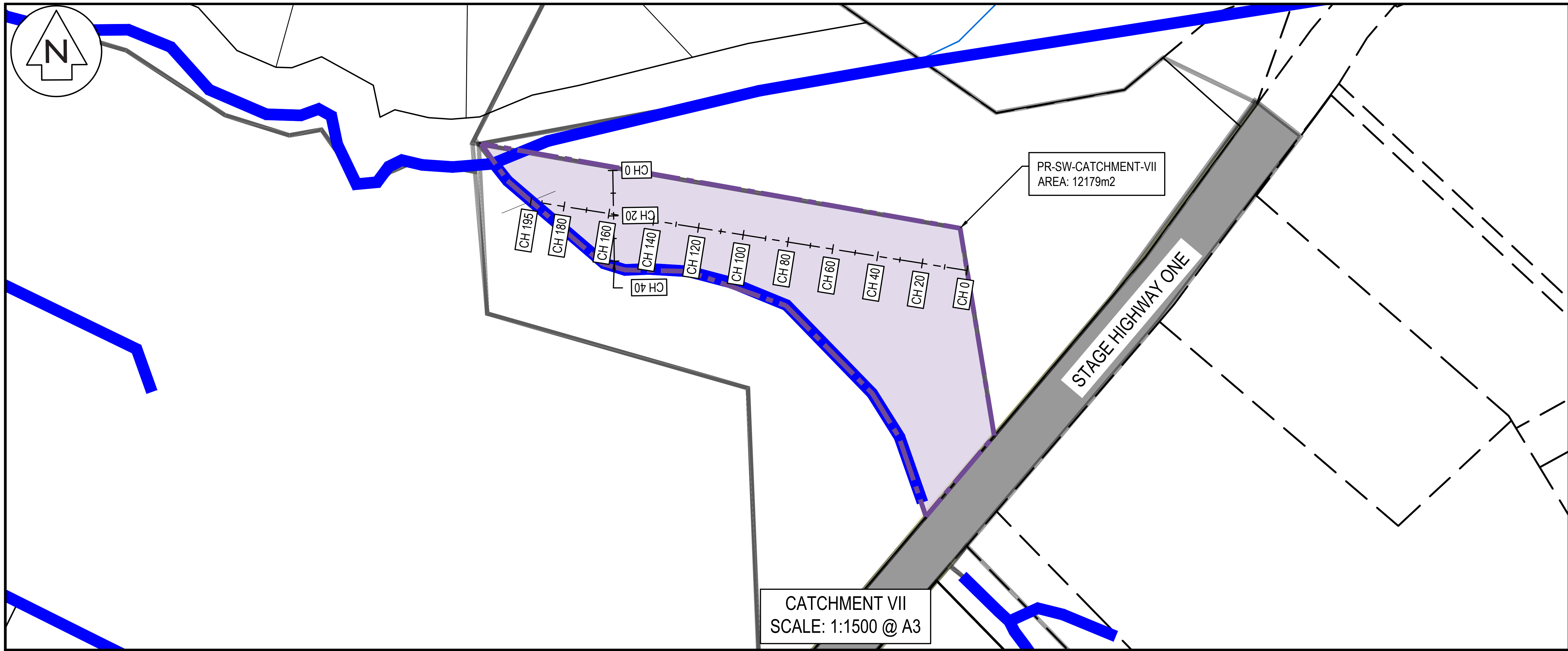
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT VI PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-6
Rev	A



Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

CATCHMENT BOUNDARY | CATCHMENT BOUNDARY

DATUM 34.00m

EXISTING LEVELS	39.03	39.00	37.91
CHAINAGE	0.00	20.00	39.97

CS-CATCHMENT VII
SCALE: HORI 1:2000 VERT 1:400

CATCHMENT BOUNDARY | CATCHMENT BOUNDARY

DATUM 34.00m

EXISTING LEVELS	40.48	40.50	40.37	40.13	39.97	39.94	39.71	39.25	39.00	37.71	36.50
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	194.84

LS-CATCHMENT VII
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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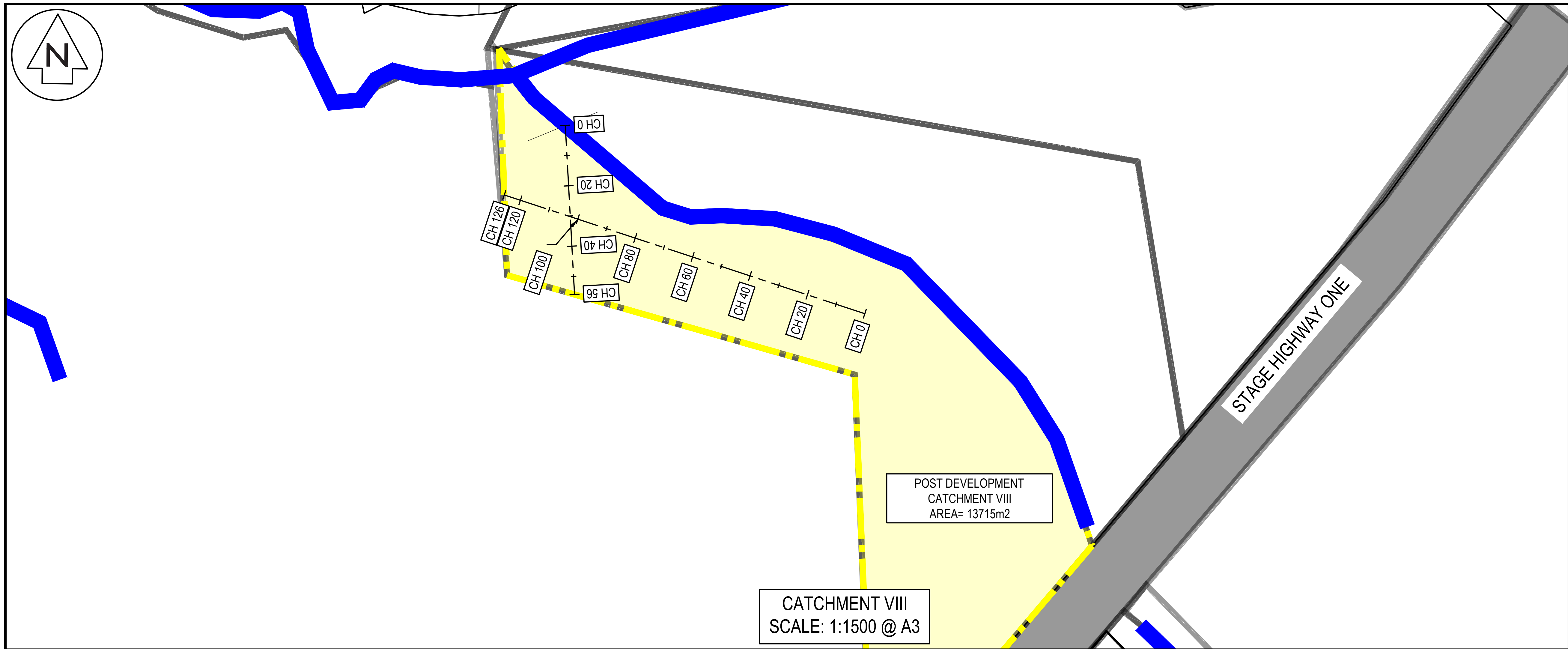
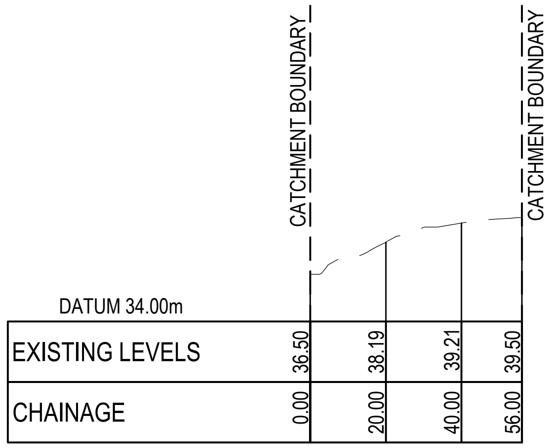
Title
POST DEVELOPMENT CATCHMENT VII PLAN

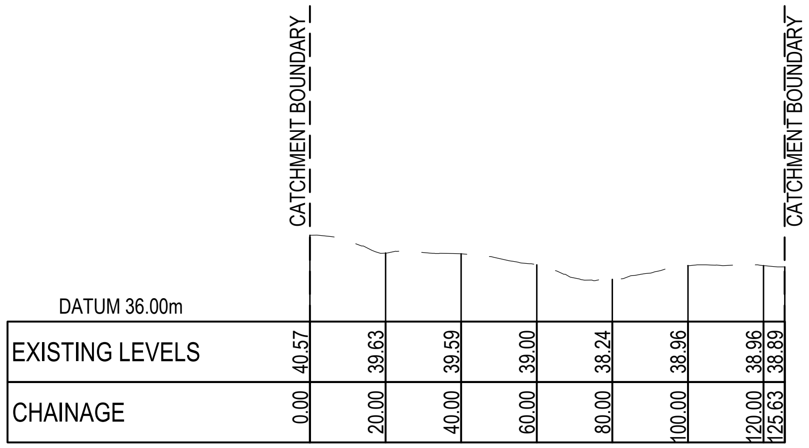
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-7 Rev A



CATCHMENT VIII
SCALE: 1:1500 @ A3



CS-CATCHMENT VIII
SCALE: HORI 1:2000 VERT 1:400



LS-CATCHMENT VIII
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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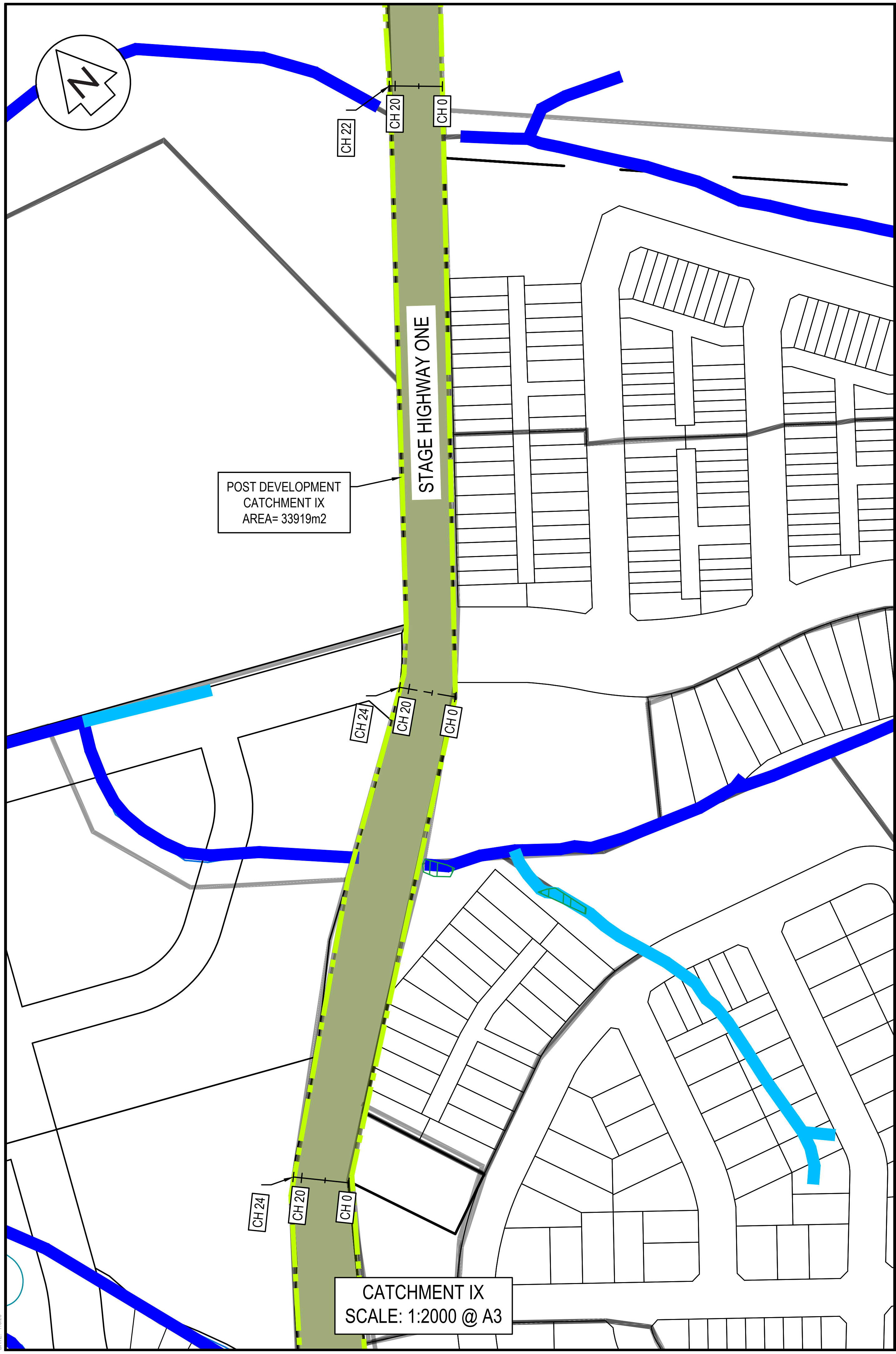
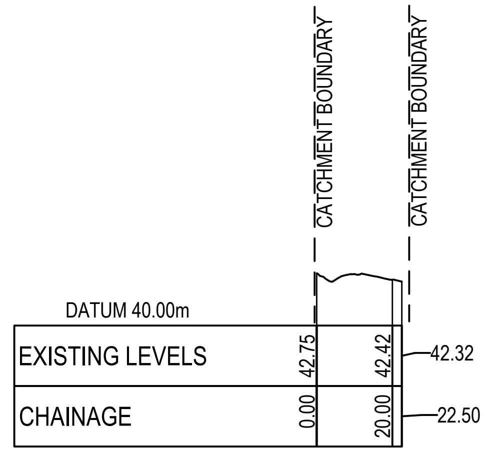
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT VIII PLAN

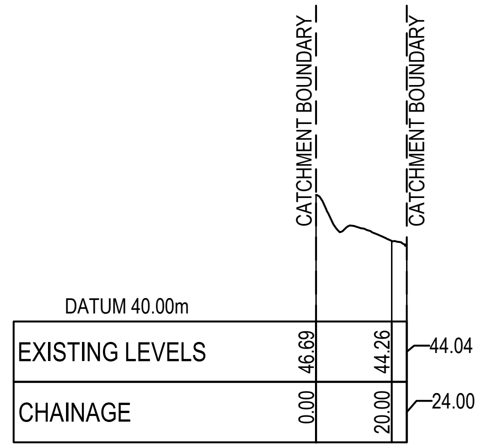
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-8
Rev	A



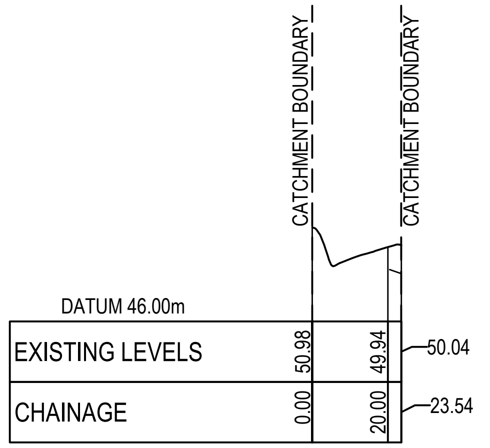
CATCHMENT IX
SCALE: 1:2000 @ A3



CS-CATCHMENT IX-1
SCALE: HORI 1:2000 VERT 1:400



CS-CATCHMENT IX-2
SCALE: HORI 1:2000 VERT 1:400



CS-CATCHMENT IX-3
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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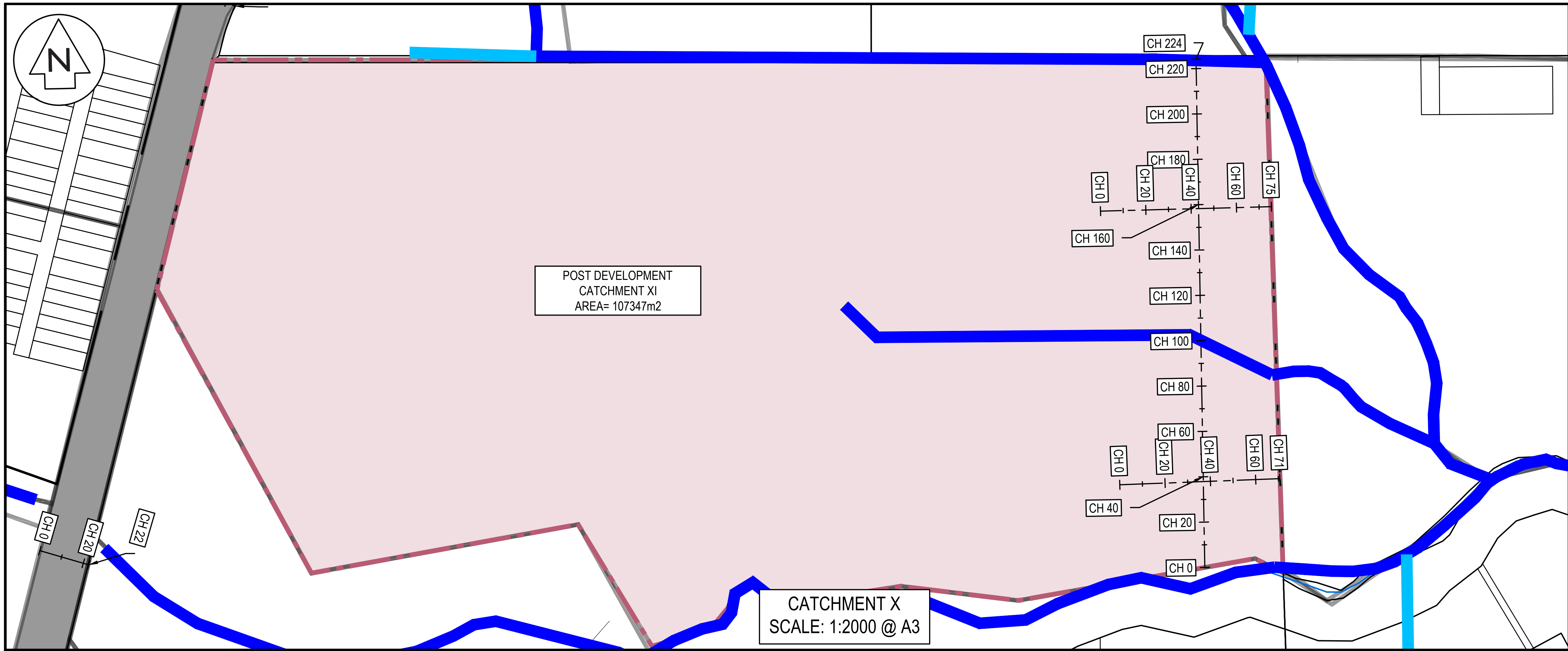
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT IX PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-9
Rev	A

Notes
1. All works to be in accordance with Auckland council standards.



Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

DATUM 34.00m

EXISTING LEVELS	37.50	37.50	37.33	37.00	36.86
CHAINAGE	0.00	20.00	40.00	60.00	70.69

CATCHMENT BOUNDARY

CAS-CATCHMENT X-1
SCALE: HORI 1:2000 VERT 1:400

DATUM 32.00m

EXISTING LEVELS	37.00	36.73	36.50	36.00	35.93
CHAINAGE	0.00	20.00	40.00	60.00	75.43

CATCHMENT BOUNDARY

CS-CATCHMENT X-2
SCALE: HORI 1:2000 VERT 1:400

DATUM 32.00m

CATCHMENT BOUNDARY

EXISTING LEVELS	34.50	37.03	37.41	37.19	36.77	35.74	36.33	36.49	36.50	36.74	37.00	36.96	35.75
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	224.19

CATCHMENT BOUNDARY

LS-CATCHMENT X
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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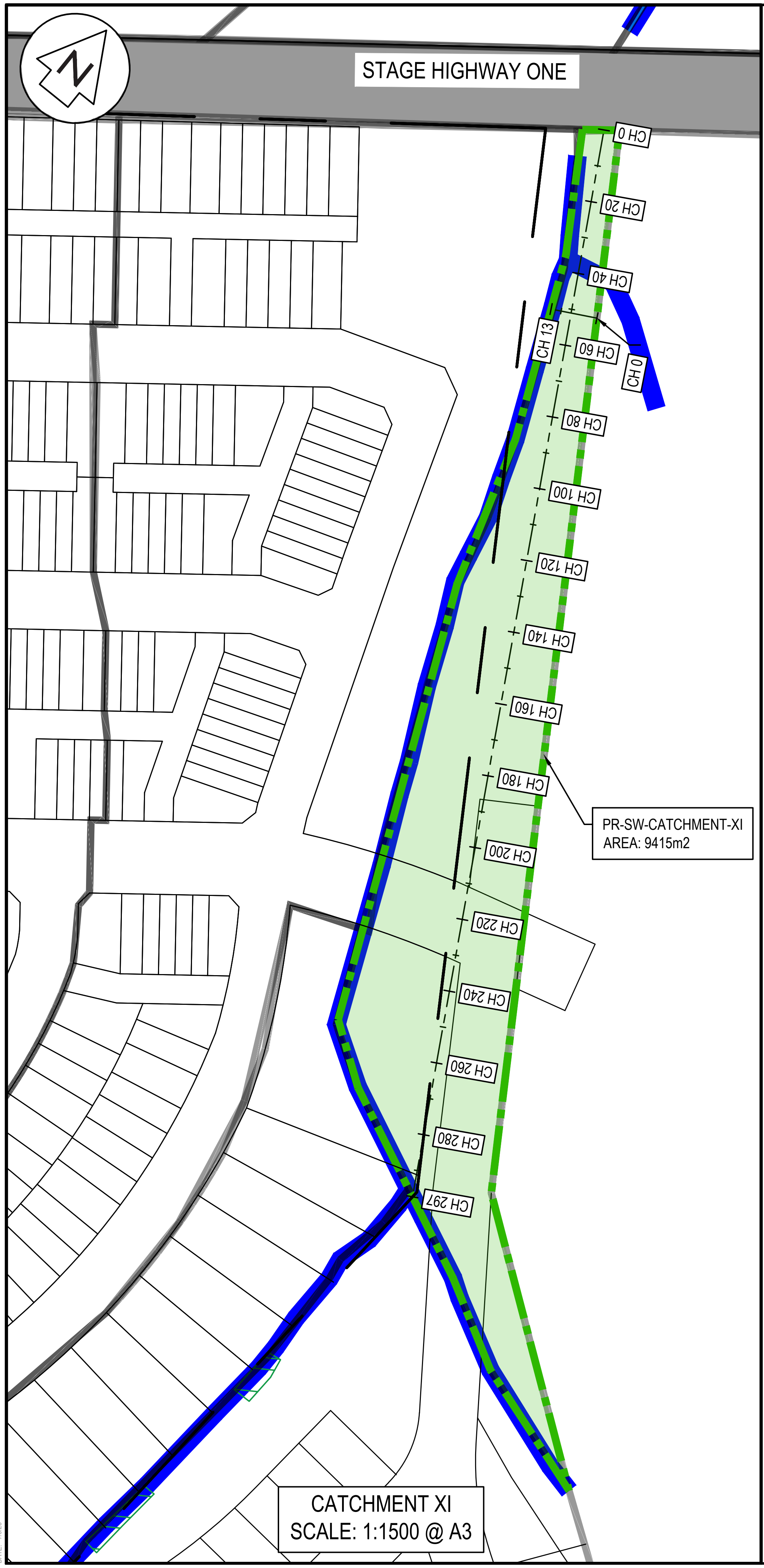
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

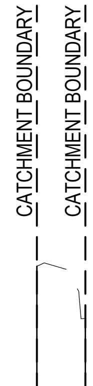
Title
POST DEVELOPMENT CATCHMENT X PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-10
Rev	A

DATE: 7/3/23



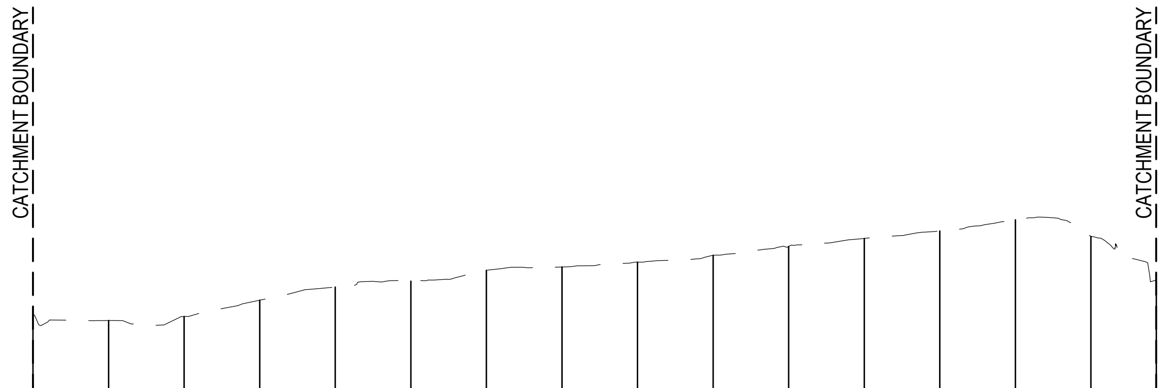
CATCHMENT XI
SCALE: 1:1500 @ A3



DATUM 36.00m

EXISTING LEVELS	42.50	39.73
CHAINAGE	0.00	12.82

CS-CATCHMENT-XI
SCALE: HORI 1:2000 VERT 1:400



DATUM 38.00m

EXISTING LEVELS	42.02	41.70	41.92	42.78	43.47	43.79	44.36	44.54	44.80	45.16	45.62	46.05	46.44	47.03	46.16	43.84
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00	280.00	297.30

LS-CATCHMENT-XI
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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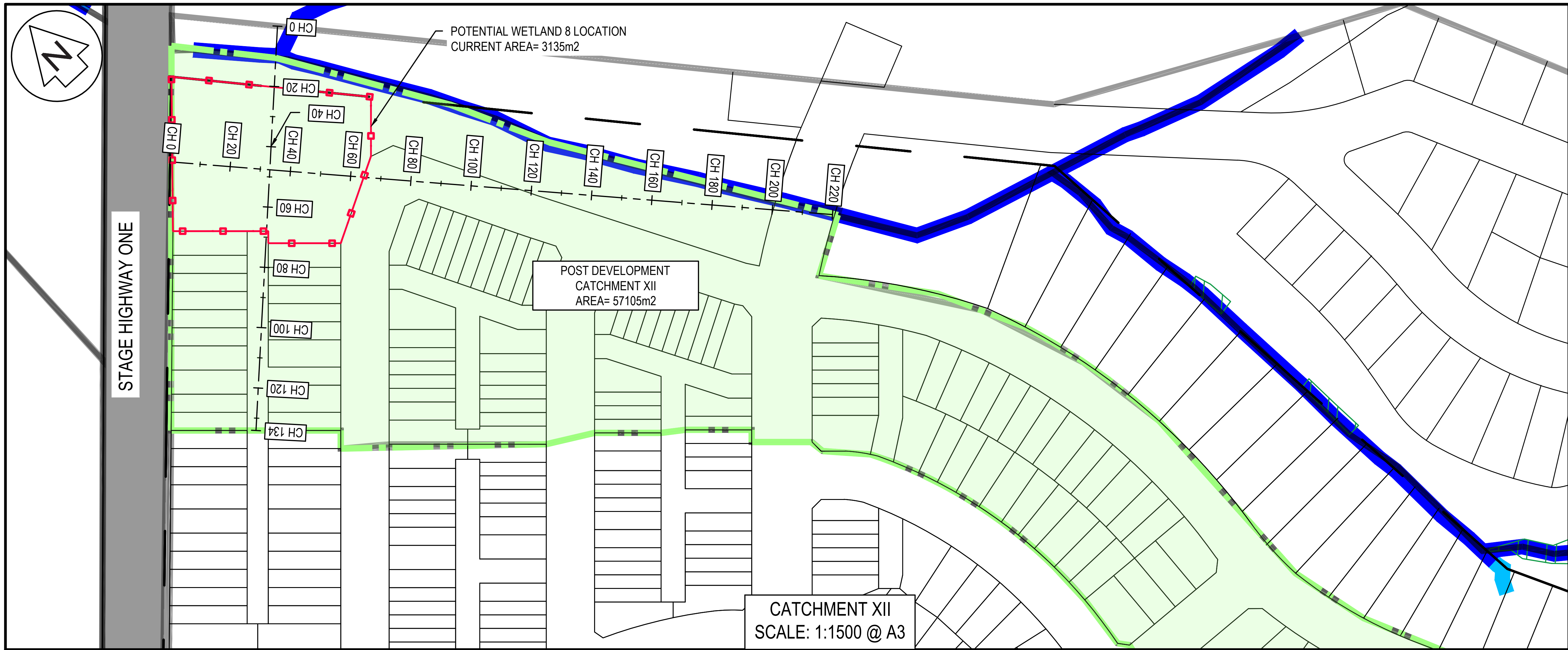
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XI PLAN

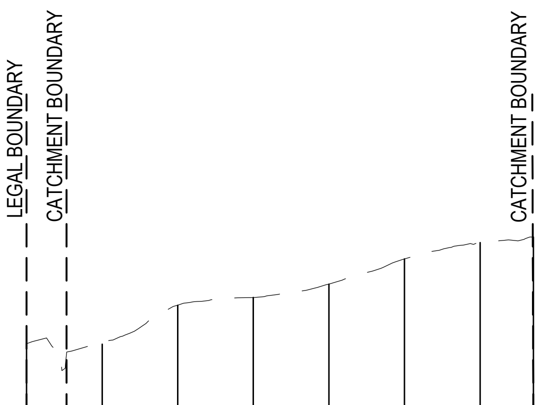
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-11
Rev	A



CATCHMENT XII
SCALE: 1:1500 @ A3

Notes
1. All works to be in accordance with Auckland council standards.

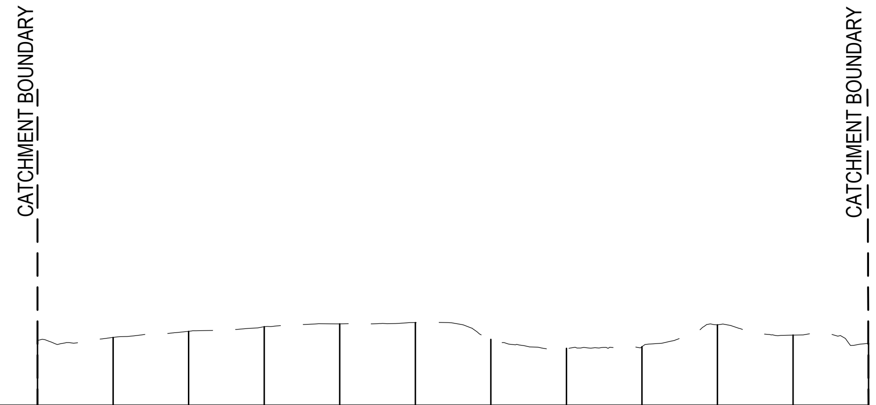
Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND



DATUM 38.00m

EXISTING LEVELS	41.52	41.49	43.55	43.96	44.67	46.01	46.87	47.16
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	134.09

CS-CATCHMENT XII
SCALE: HORI 1:2000 VERT 1:400



DATUM 40.00m

EXISTING LEVELS	43.44	43.60	43.92	44.17	44.32	44.39	43.49	43.02	43.11	44.27	43.72	43.28
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00

LS-CATCHMENT XII
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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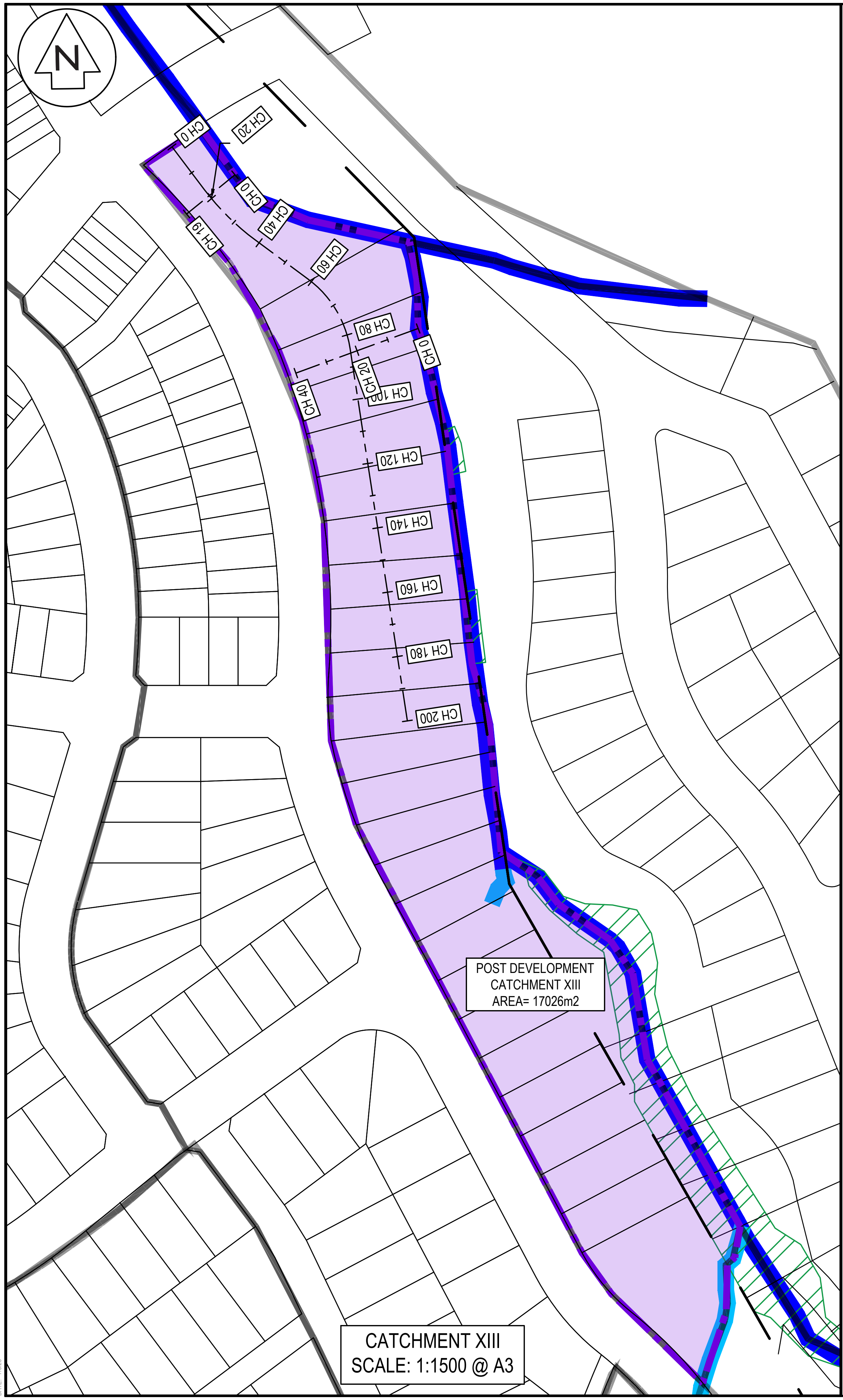
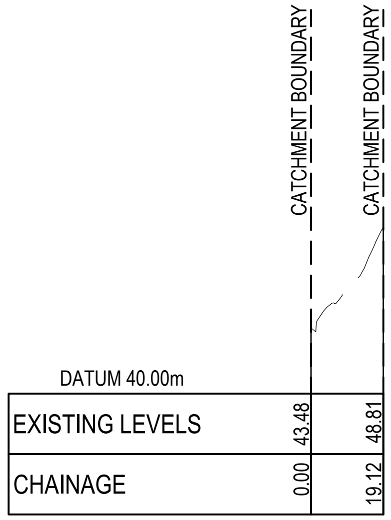
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XII PLAN

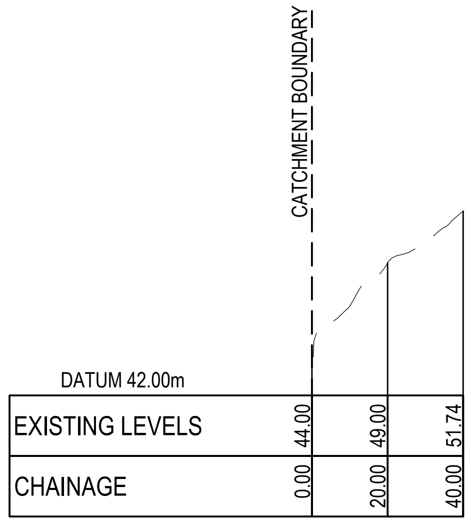
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-12 Rev A



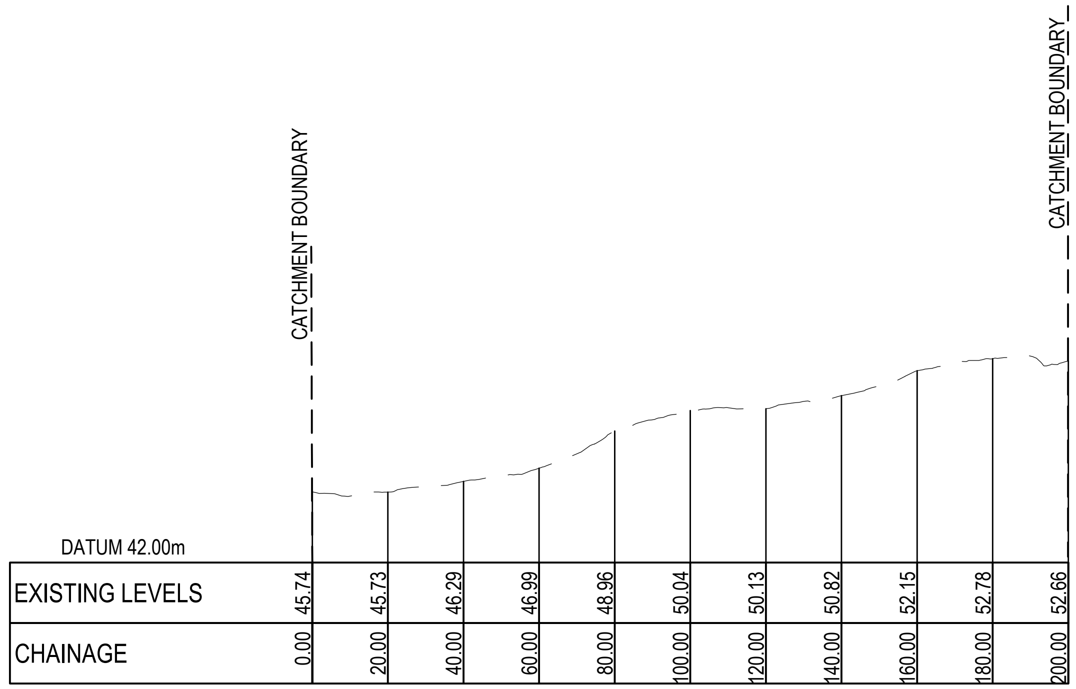
CATCHMENT XIII
SCALE: 1:1500 @ A3



CS-CATCHMENT-XIII-2
SCALE: HORI 1:2000 VERT 1:400



CS-CATCHMENT XIII-2
SCALE: HORI 1:2000 VERT 1:400



LS-CATCHMENT XIII
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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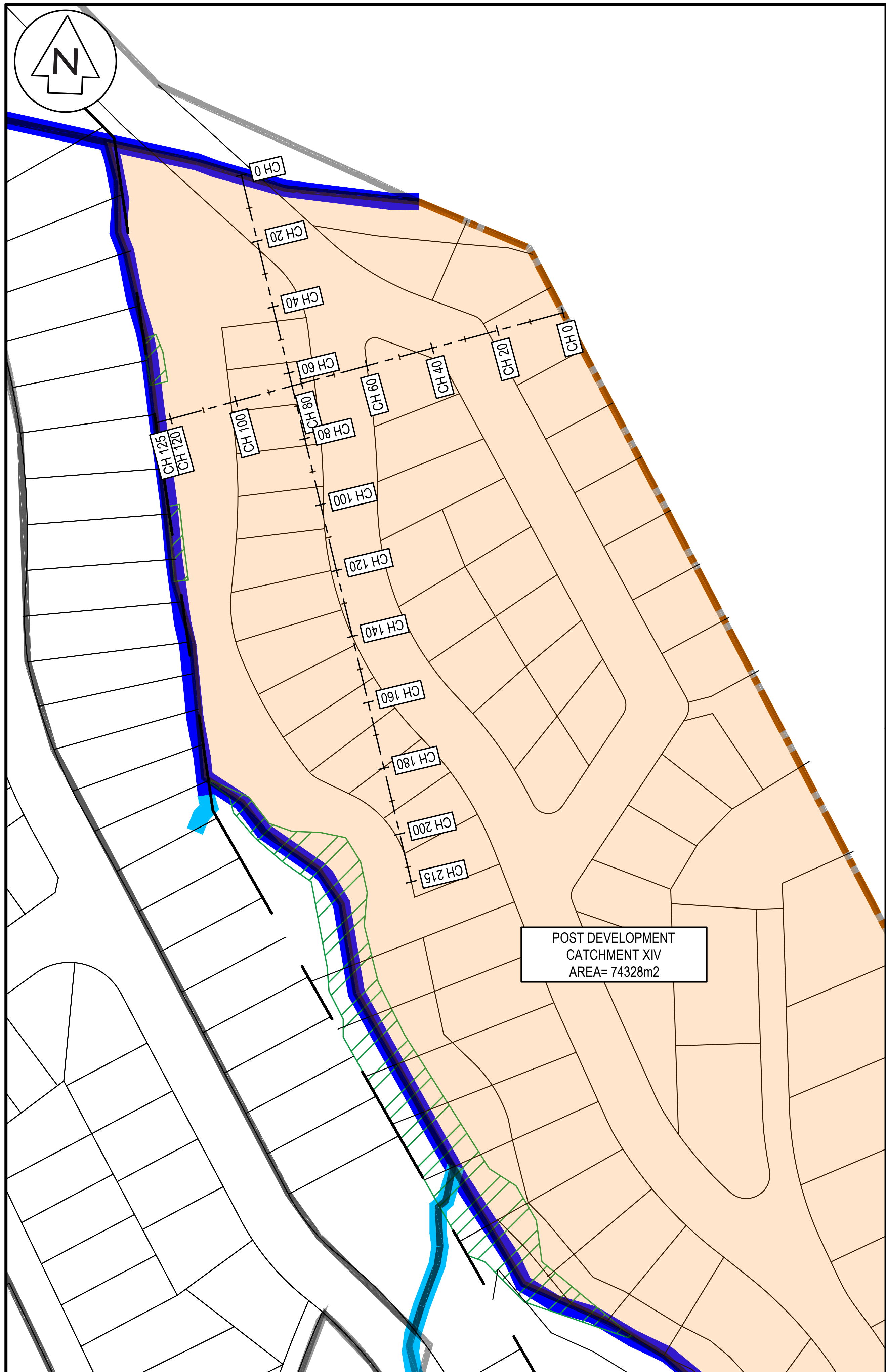
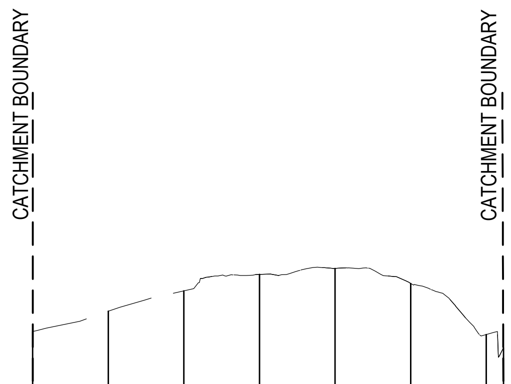
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XIII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-13 Rev A



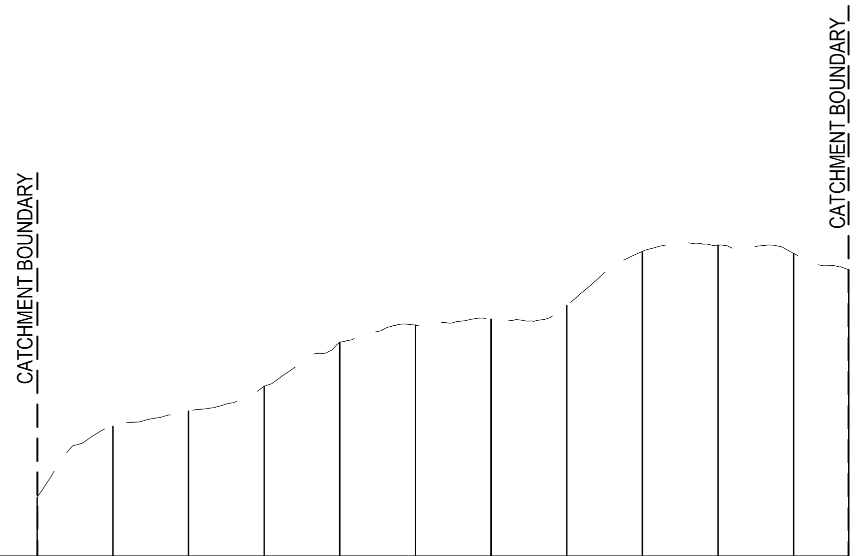
CATCHMENT XIV
SCALE: 1:1500 @ A3



DATUM 44.00m

EXISTING LEVELS	48.08	49.15	50.23	51.10	51.41	50.62	47.92	47.22
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	124.53

CS-CATCHMENT-XIV
SCALE: HORI 1:2000 VERT 1:400



DATUM 42.00m

EXISTING LEVELS	45.12	48.88	49.69	51.01	53.33	54.24	54.56	55.29	58.15	58.48	58.04	57.19
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	214.53

LS-CATCHMENT-XIV
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
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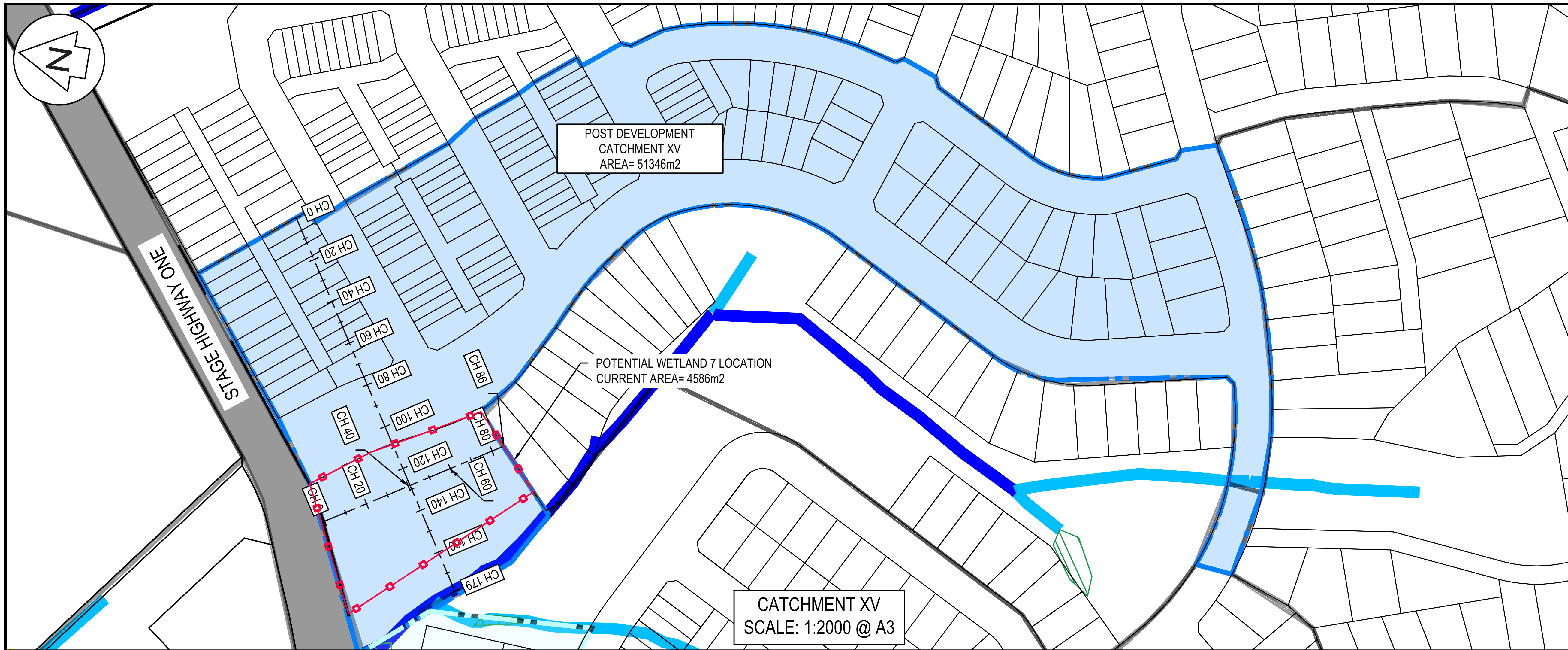
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XIV PLAN

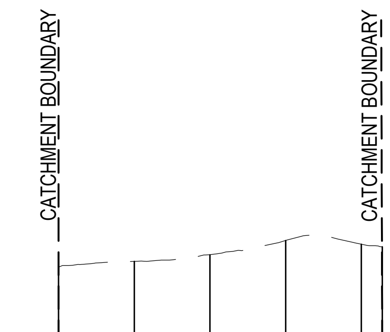
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-14
Rev	A



Notes
1. All works to be in accordance with Auckland council standards.

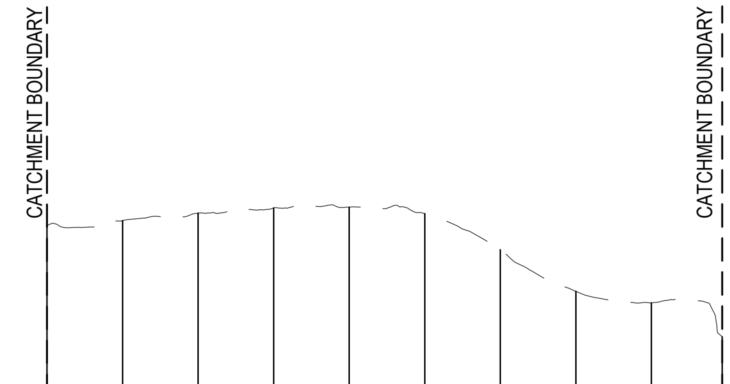
Legend

(black line)	EX BDY
(blue line)	EX PERM. STREAM
(light blue line)	EX INTER. STREAM
(hatched box)	EX WETLAND



EXISTING LEVELS	45.66	45.97	46.32	47.08	46.88	46.74
CHAINAGE	0.00	20.00	40.00	60.00	80.00	85.52

CS-CATCHMENT-XV
SCALE: HORI 1:2000 VERT 1:400



EXISTING LEVELS	48.74	49.00	49.39	49.66	49.70	49.36	47.46	45.25	44.64	42.85
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	178.76

LS-CATCHMENT-XV
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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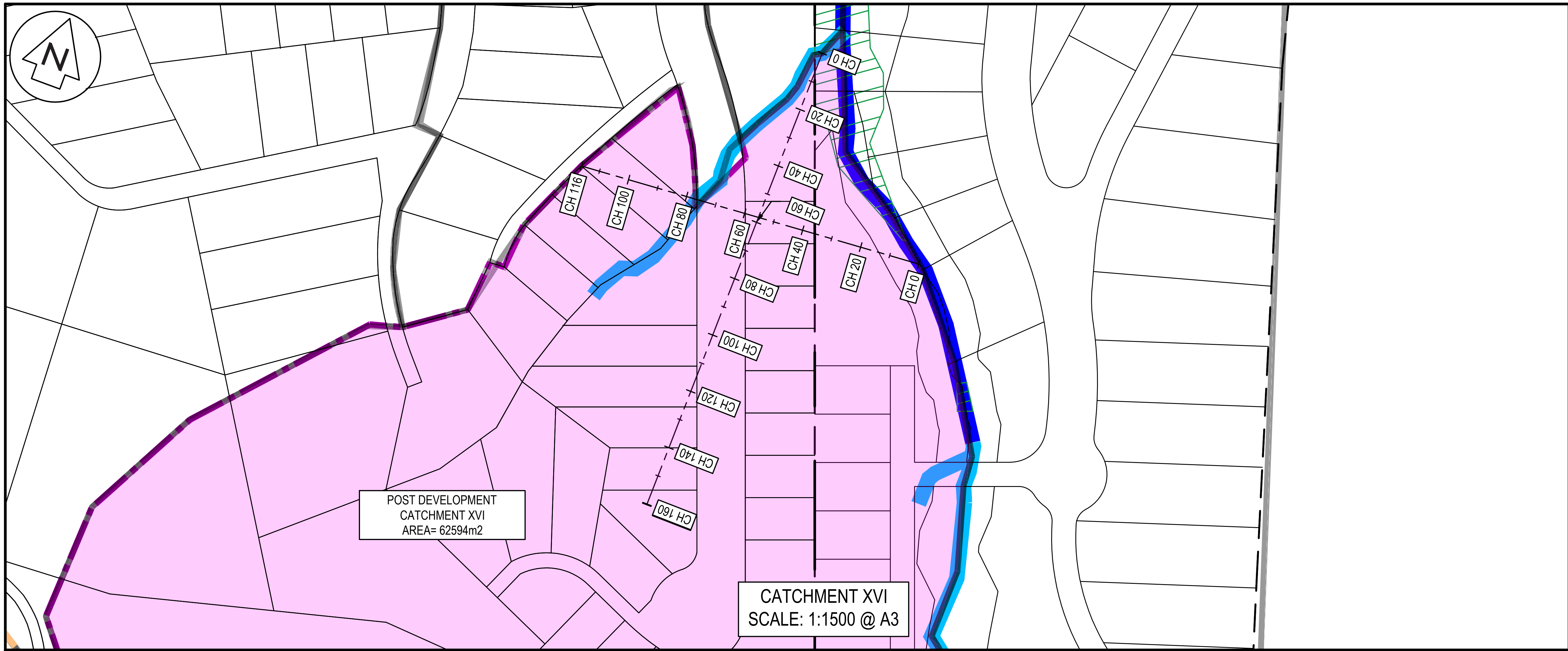
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XV PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-15
Rev	A

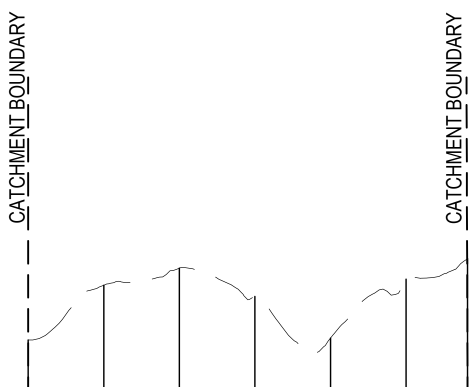
DATE: 7/3/23

Notes
1. All works to be in accordance with Auckland council standards.



CATCHMENT XVI
SCALE: 1:1500 @ A3

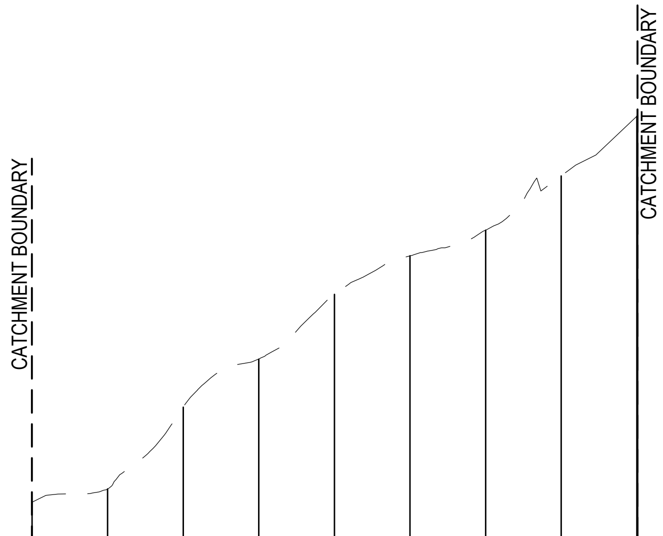
Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND



DATUM 60.00m

EXISTING LEVELS	62.82	65.71	66.62	65.12	62.92	66.03	67.12
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	116.25

CS-CATCHMENT-XVI
SCALE: HORI 1:2000 VERT 1:400



DATUM 56.00m

EXISTING LEVELS	58.12	58.82	63.15	65.69	69.11	71.15	72.51	75.38	78.58
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00

LS-CATCHMENT-XVI
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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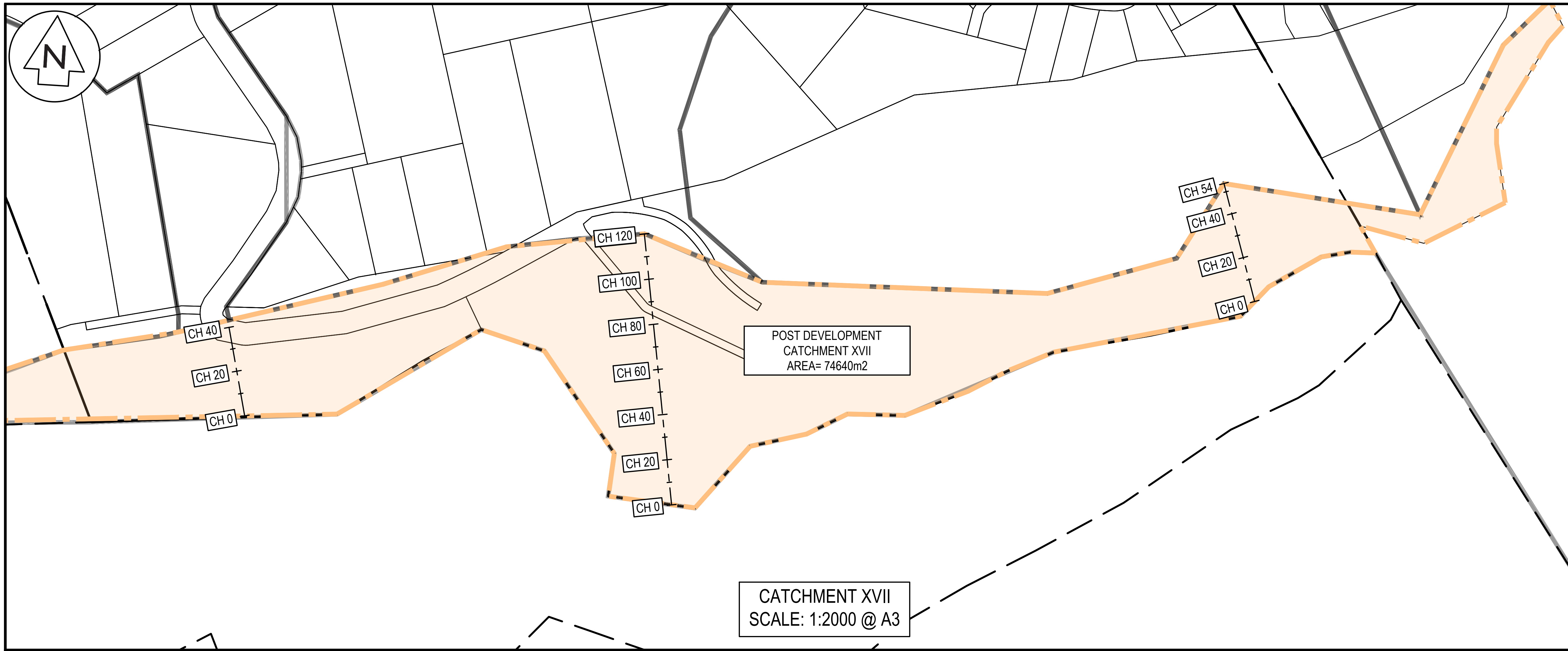
Title
POST DEVELOPMENT CATCHMENT XVI PLAN

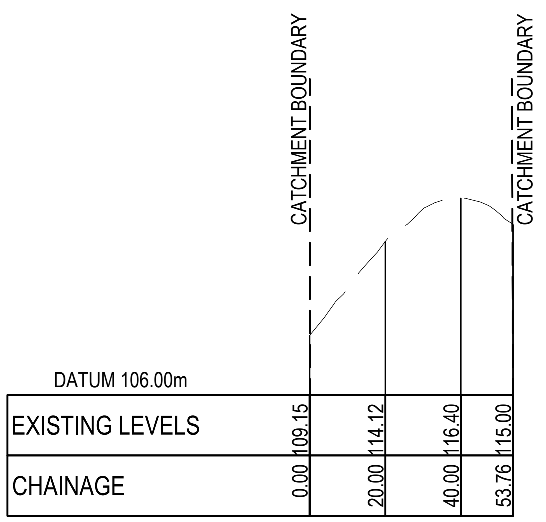
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-16 Rev A

DATE: 7/3/23

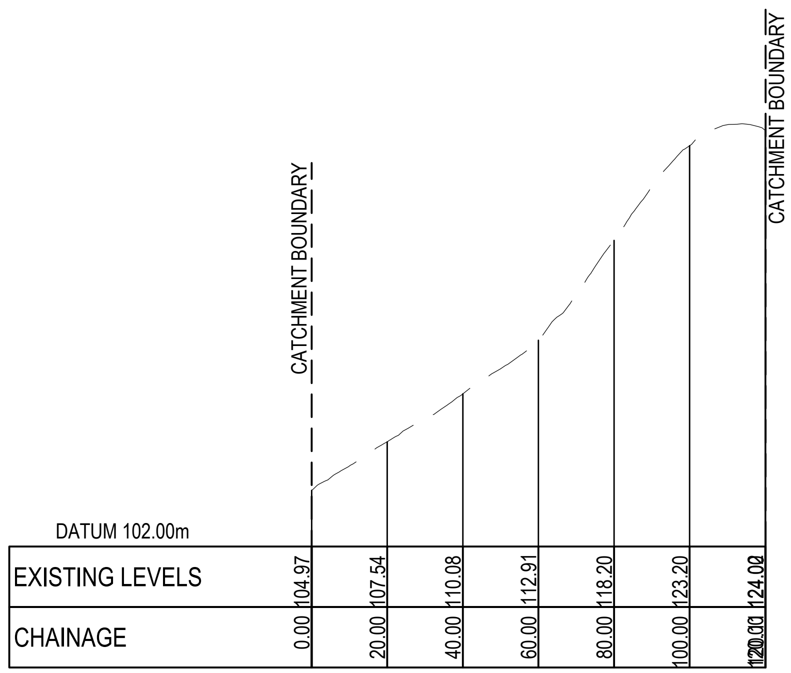


Notes
1. All works to be in accordance with Auckland council standards.

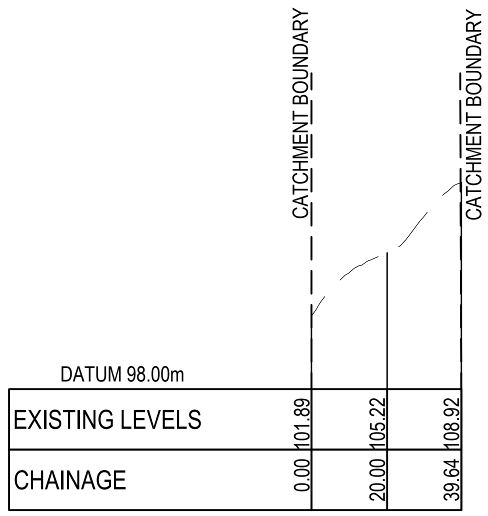
Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND



CS-CATCHMENT XVII-1
SCALE: HORI 1:2000 VERT 1:400



CS-CATCHMENT XVII-2
SCALE: HORI 1:2000 VERT 1:400



CS-CATCHMENT XVII-3
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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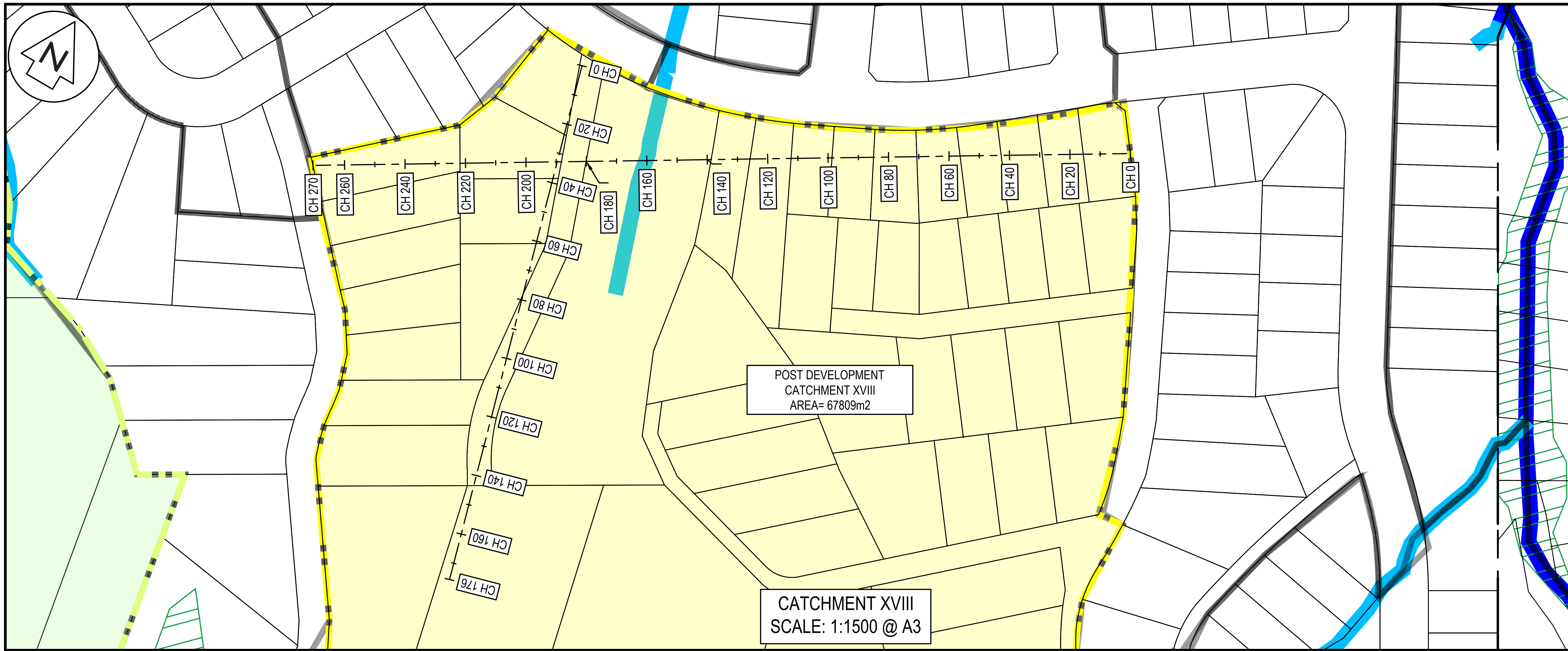
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XVII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-17 Rev A

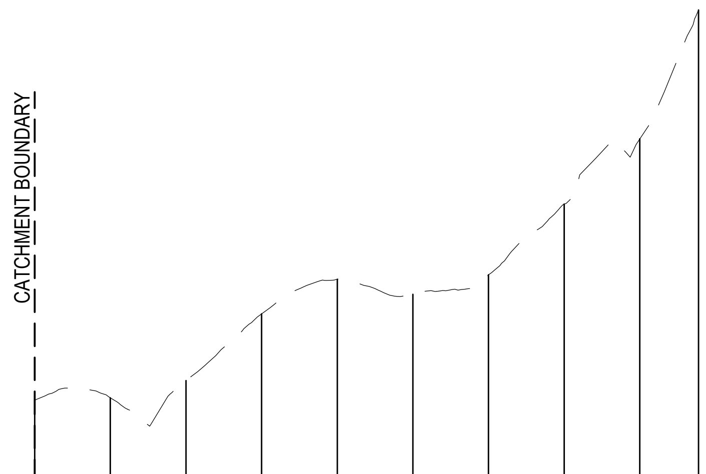


CATCHMENT XVIII
SCALE: 1:1500 @ A3

Notes
1. All works to be in accordance with Auckland council standards.

Legend

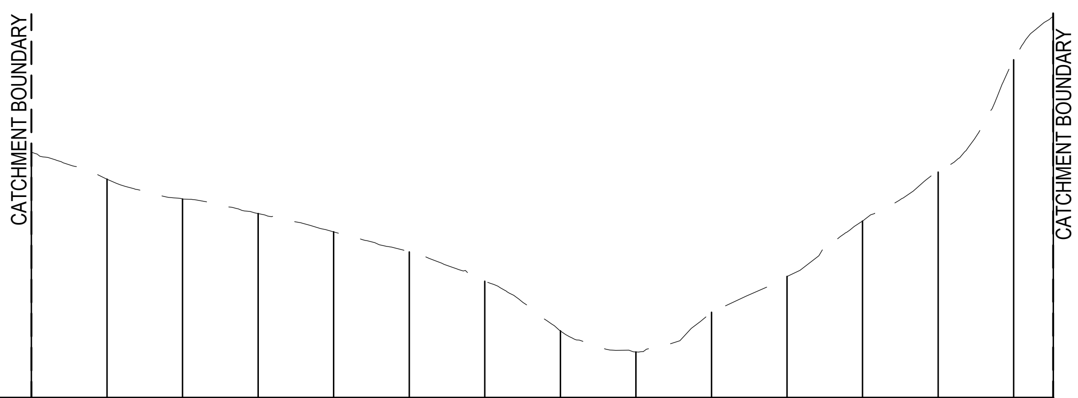
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND



DATUM 58.00m

EXISTING LEVELS	61.98	62.11	63.03	66.55	68.38	67.59	68.62	72.36	75.82	82.64
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	175.54

CS-CATCHMENT-XVIII
SCALE: HORI 1:2000 VERT 1:400



DATUM 56.00m

EXISTING LEVELS	68.97	67.56	66.51	65.74	64.77	63.71	62.16	59.53	58.42	60.52	62.41	65.35	67.94	73.88	76.17
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00	270.47

LS-CATCHMENT-XVIII
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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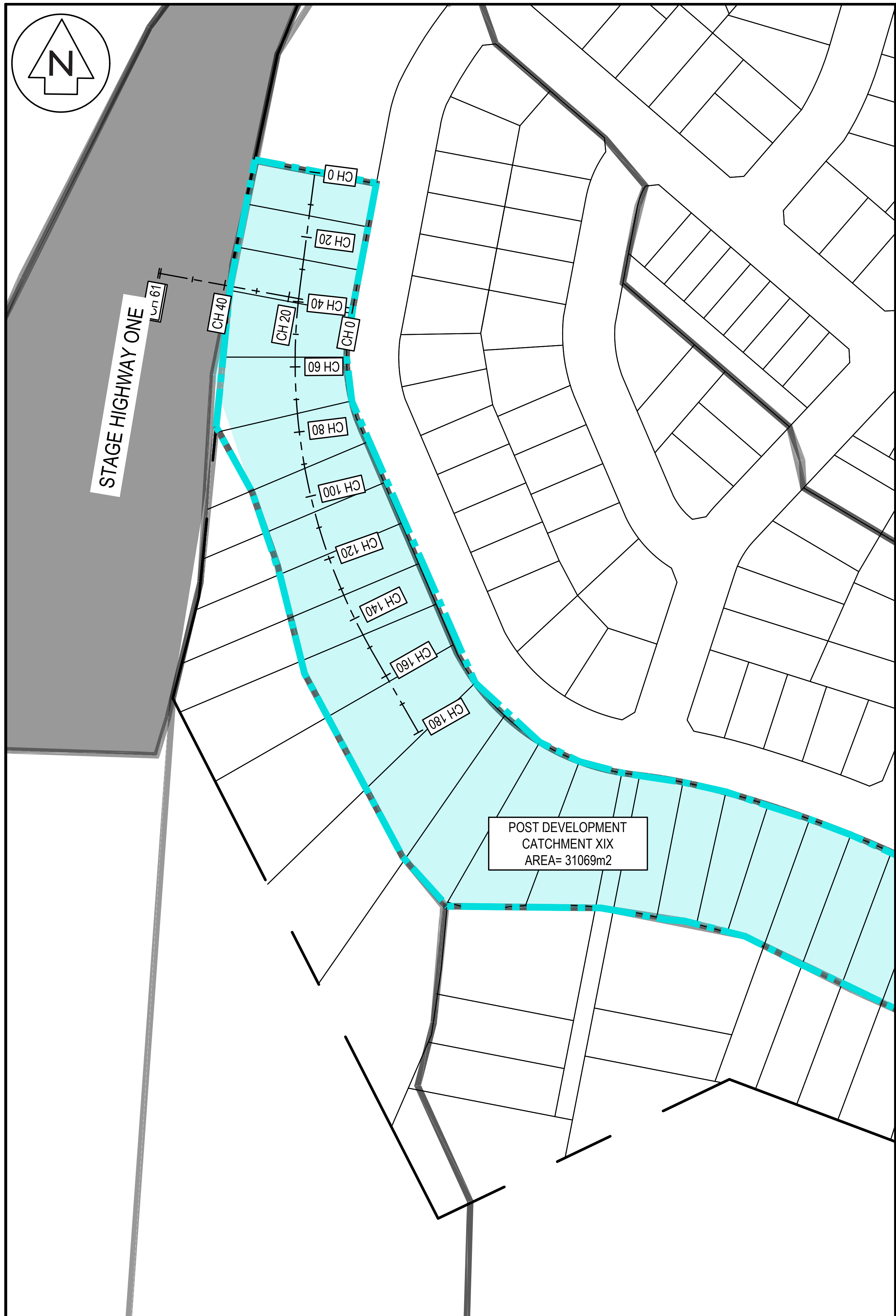
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

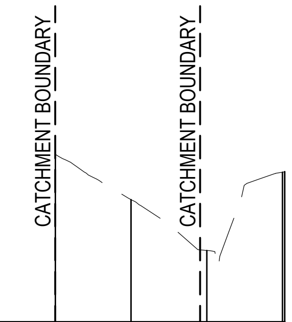
Title
POST DEVELOPMENT CATCHMENT XVIII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-18
Rev	A

DATE: 7/3/23



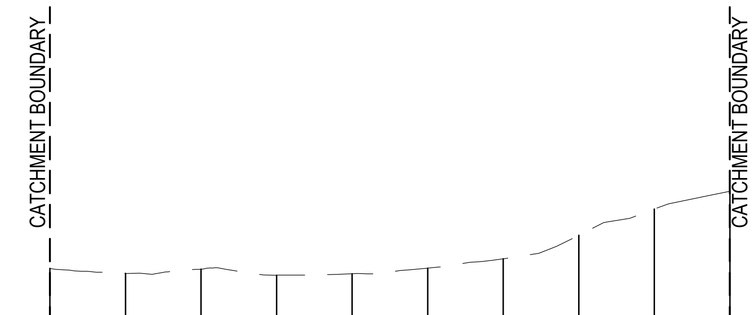
CATCHMENT XIX
SCALE: 1:1500 @ A3



DATUM 44.00m

EXISTING LEVELS	52.87	50.48	47.79	[illegible]
CHAINAGE	0.00	20.00	40.00	[illegible]

CS-CATCHMENT XIX
SCALE: HORI 1:2000 VERT 1:400



DATUM 48.00m

EXISTING LEVELS	50.89	50.62	50.84	50.52	50.60	50.90	51.40	52.64	54.02	54.97
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00

LS-CATCHMENT XIX
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend

- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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Project
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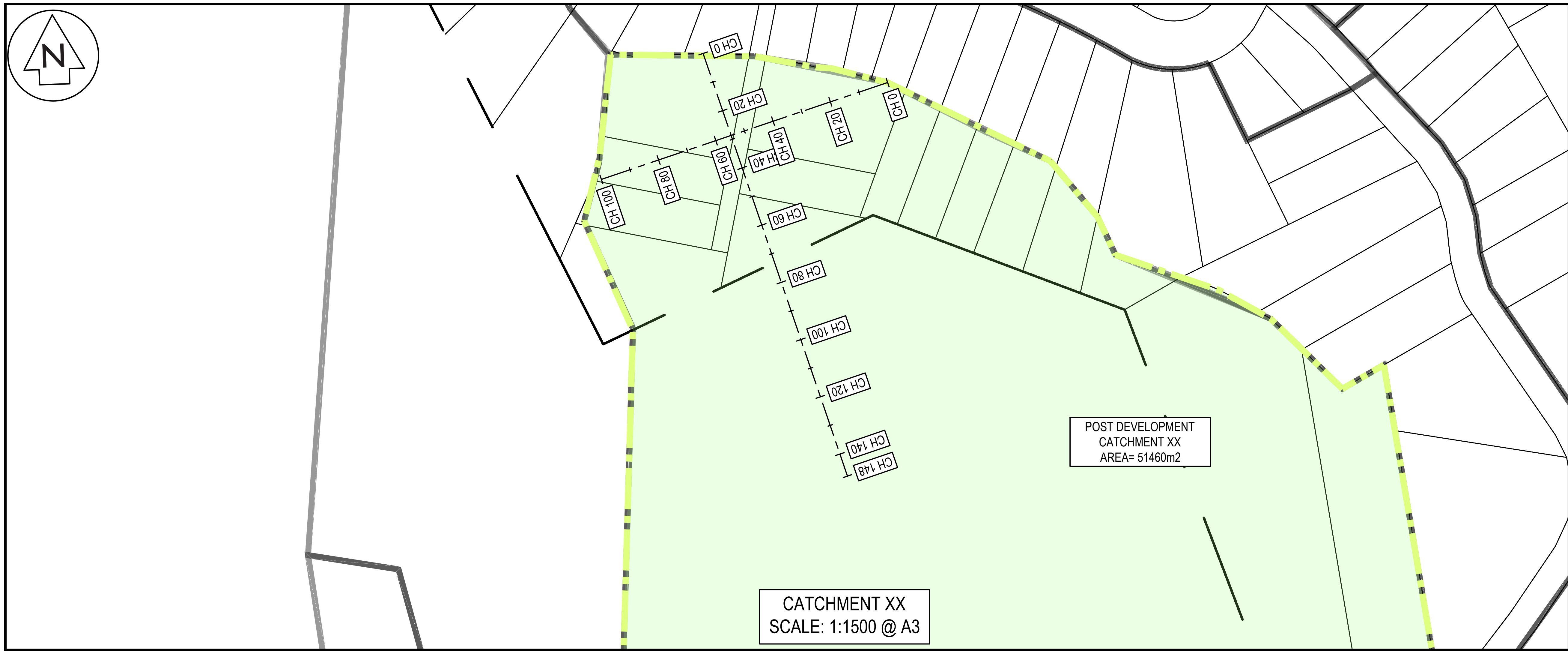
Title
POST DEVELOPMENT CATCHMENT XIX PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-19
Rev	A

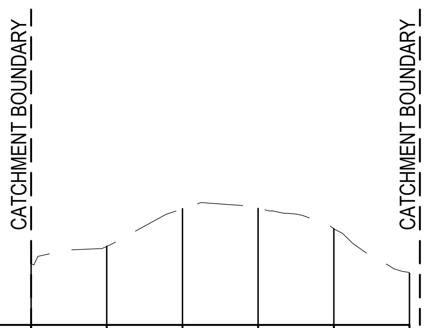
DATE: 7/3/23



CATCHMENT XX
SCALE: 1:1500 @ A3

Notes
1. All works to be in accordance with Auckland council standards.

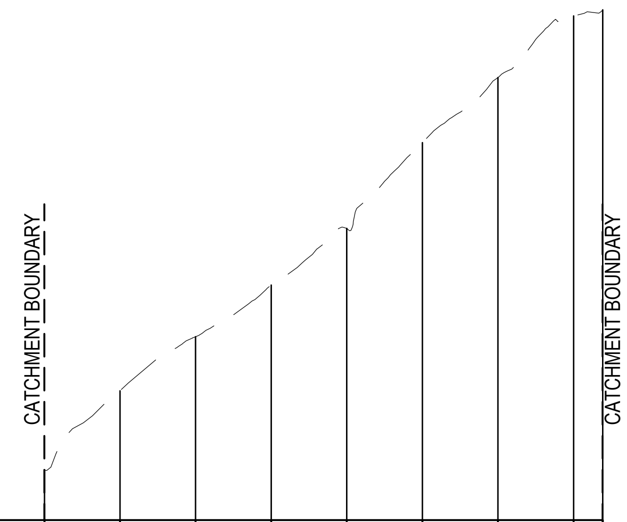
Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND



DATUM 52.00m

EXISTING LEVELS	55.24	56.16	58.15	58.17	57.09	54.74
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00

CA-CATCHMENT XX
SCALE: HORI 1:2000 VERT 1:400



DATUM 50.00m

EXISTING LEVELS	52.65	56.84	59.70	62.43	65.43	69.97	73.42	76.68	77.00
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	147.70

LS-CATCHMENT XX
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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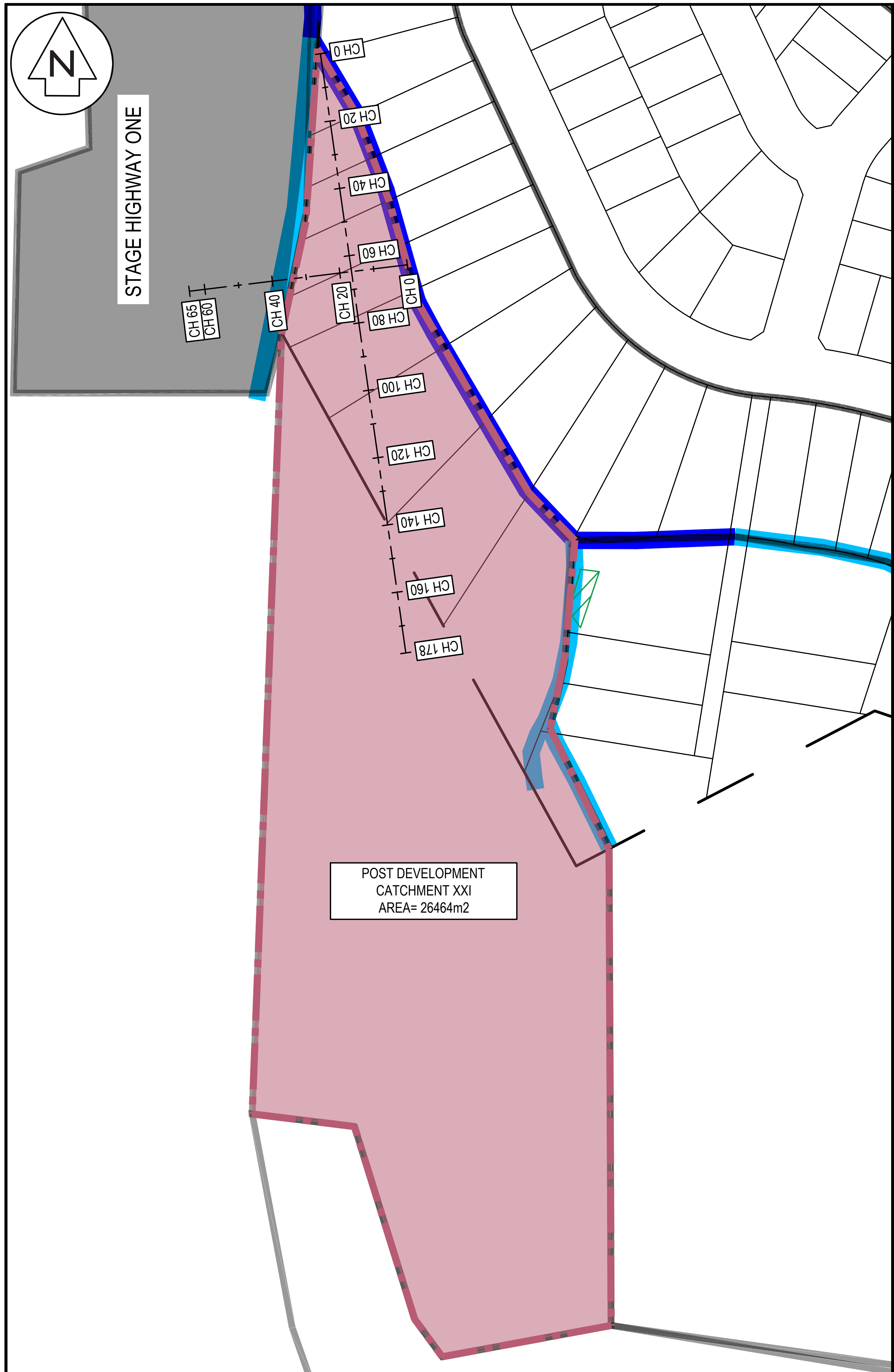
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

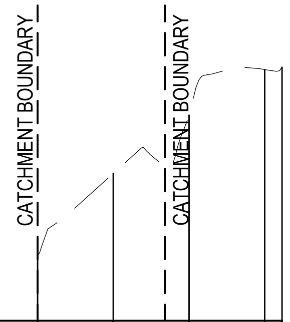
Title
POST DEVELOPMENT CATCHMENT XX PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-20 — Rev A

Notes
1. All works to be in accordance with Auckland council standards.



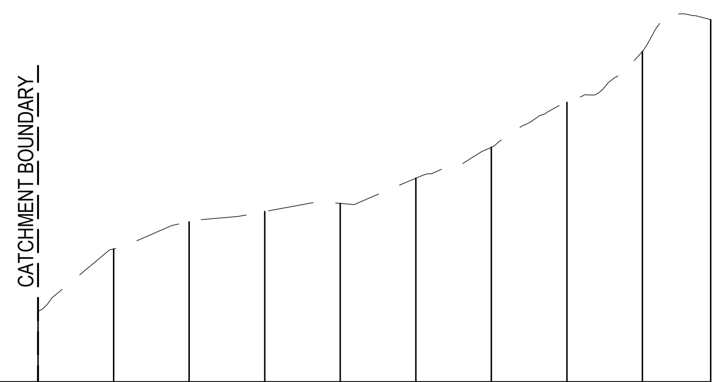
CATCHMENT XXI
SCALE: 1:1500 @ A3



DATUM 46.00m

EXISTING LEVELS	49.50	53.81	56.90	59.31	59.44
CHAINAGE	0.00	20.00	40.00	60.00	64.56

CS-CATCHMENT XXI
SCALE: HORI 1:2000 VERT 1:400



DATUM 44.00m

EXISTING LEVELS	47.75	51.03	52.46	53.01	53.44	54.77	56.41	58.78	61.47	63.14
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	178.03

LS-CATCHMENT XXI
SCALE: HORI 1:2000 VERT 1:400

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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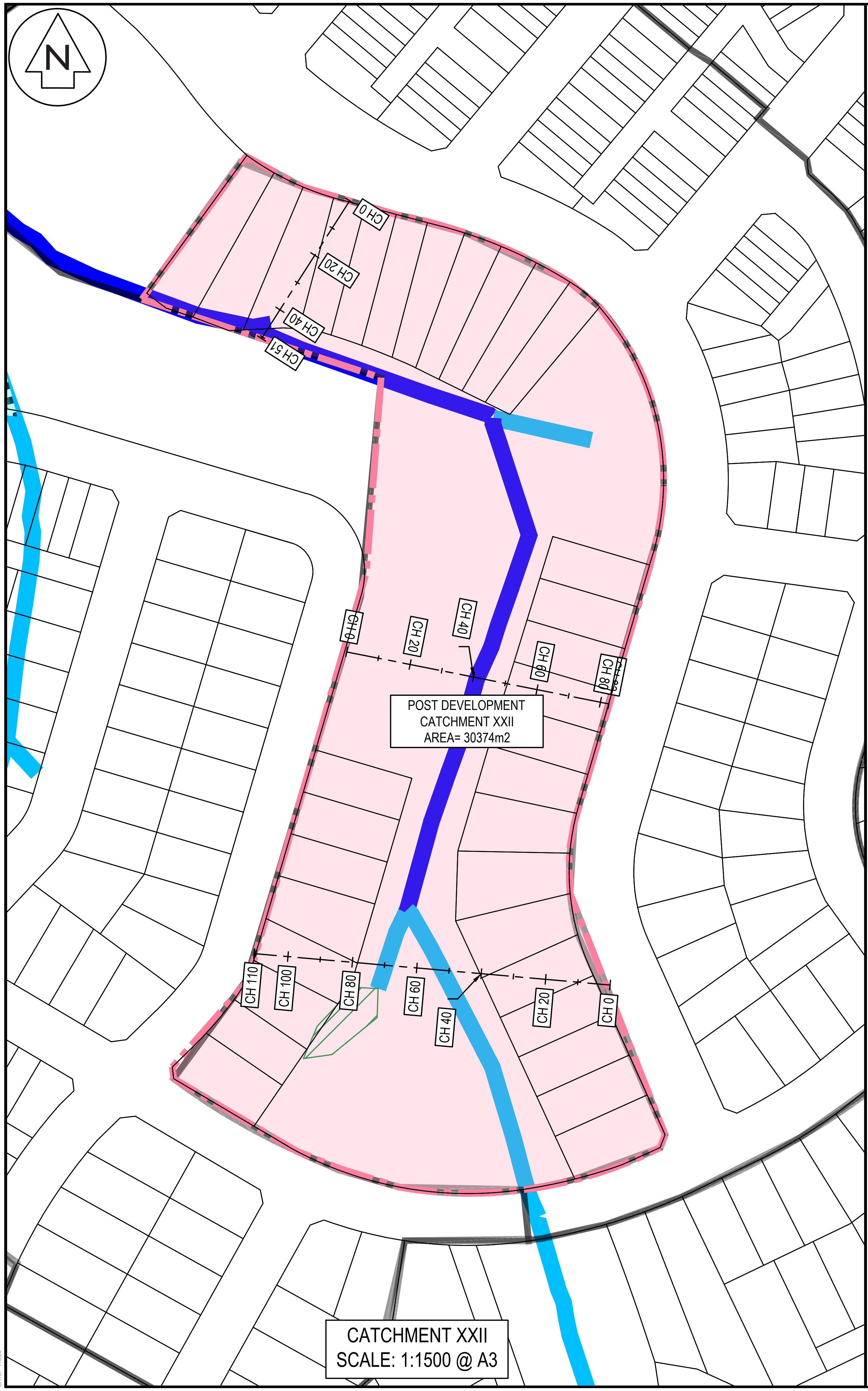
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

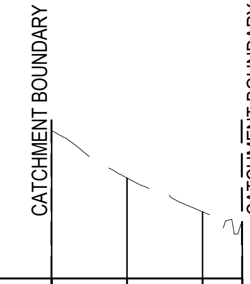
Title
POST DEVELOPMENT CATCHMENT XXI PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-21
Rev	A

DATE: 7/3/23



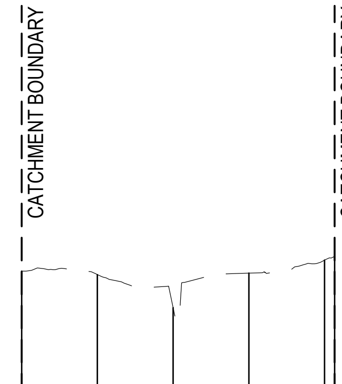
CATCHMENT XXII
SCALE: 1:1500 @ A3



DATUM 42.00m

EXISTING LEVELS	49.81	47.30	45.52	45.00
CHAINAGE	0.00	20.00	40.00	50.53

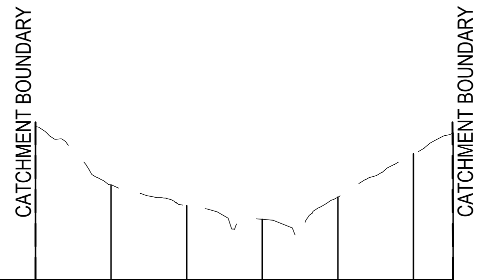
CS-CATCHMENT XXII-1
SCALE: HORI 1:2000 VERT 1:400



DATUM 44.00m

EXISTING LEVELS	50.30	50.11	48.37	50.19	50.88	51.07
CHAINAGE	0.00	20.00	40.00	60.00	80.00	82.67

LS-CATCHMENT XXII-2
SCALE: HORI 1:2000 VERT 1:400



DATUM 50.00m

EXISTING LEVELS	58.13	55.04	53.94	53.22	54.39	56.69	57.79
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	110.48

CS-CATCHMENT XXII-3
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend

(black line)	EX BDY
(blue line)	EX PERM. STREAM
(light blue line)	EX INTER. STREAM
(green hatch)	EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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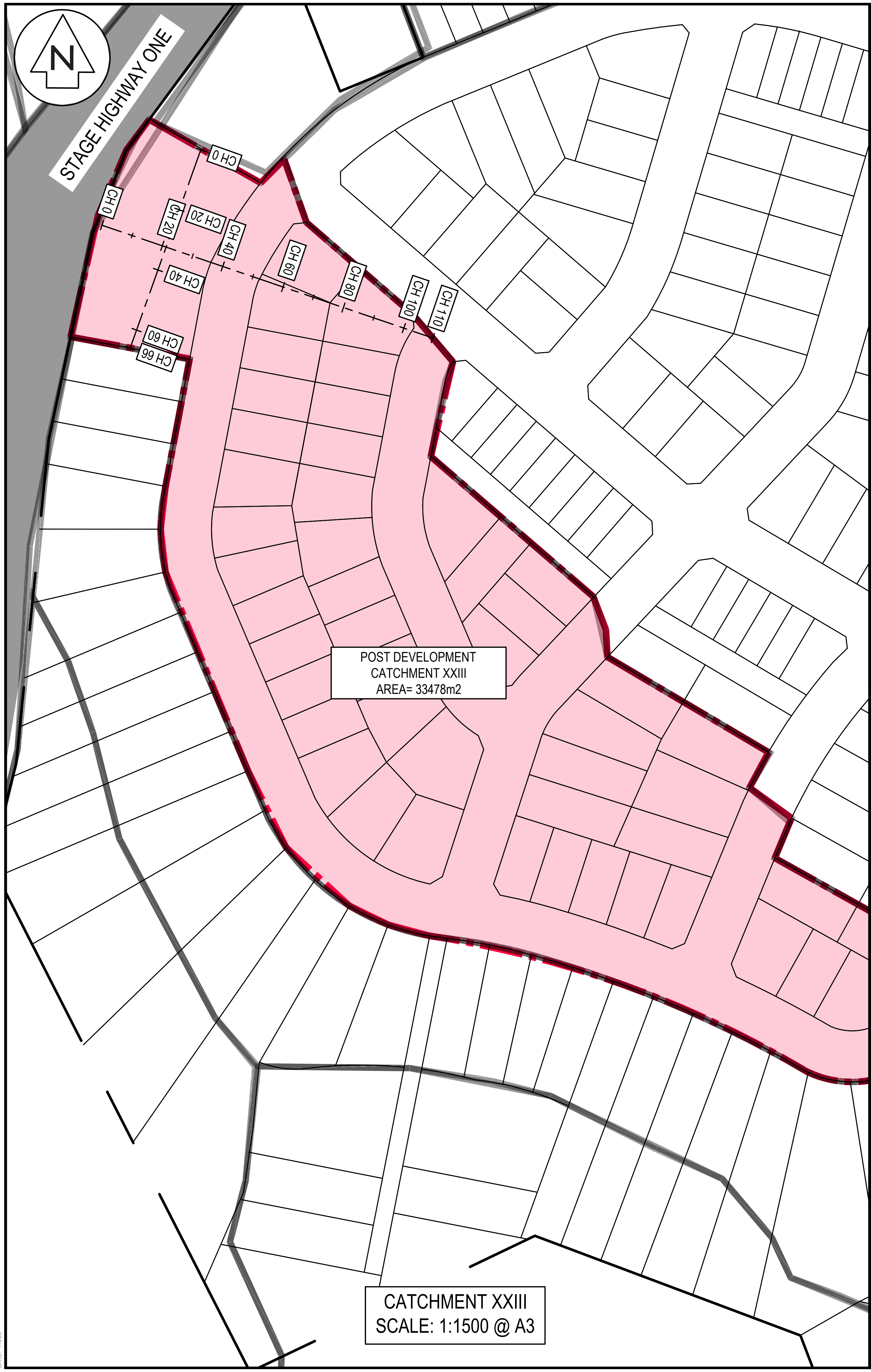
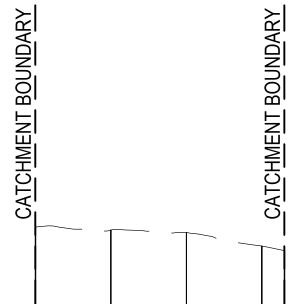
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XXII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-22
Rev	A



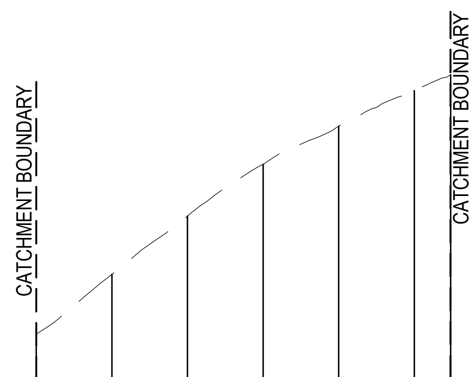
CATCHMENT XXIII
SCALE: 1:1500 @ A3



DATUM 48.00m

EXISTING LEVELS	52.17	52.00	51.87	51.16	50.91
CHAINAGE	0.00	20.00	40.00	60.00	65.99

CS-CATCHMENT-XXIII
SCALE: HORI 1:2000 VERT 1:400



DATUM 46.00m

EXISTING LEVELS	48.55	51.72	54.80	57.54	59.56	61.43	62.28
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	109.60

LS-CATCHMENT XXIII
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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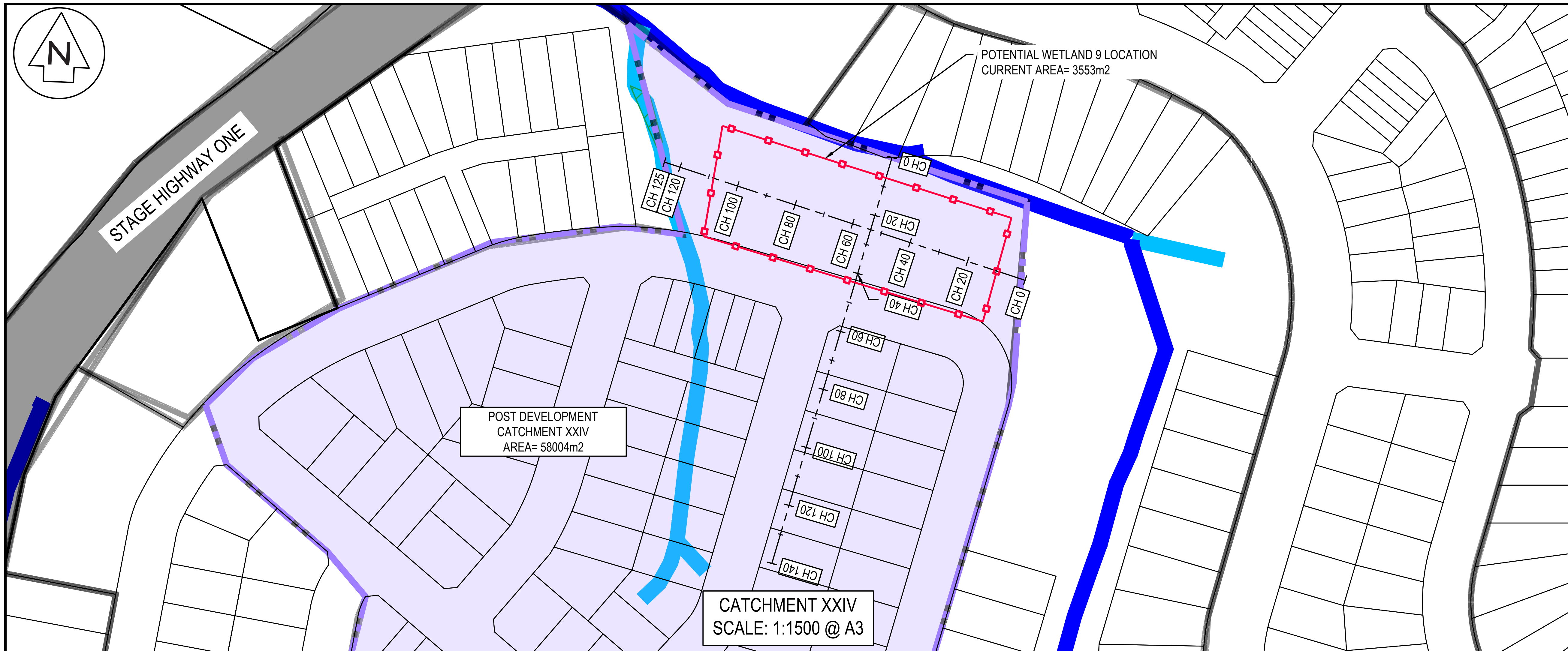
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XXIII PLAN

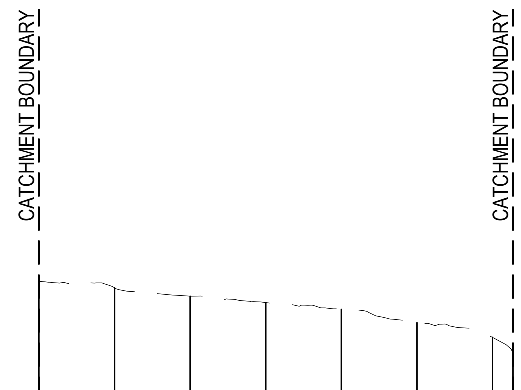
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-23
Rev	A

DATE: 7/2023



Notes
1. All works to be in accordance with Auckland council standards.

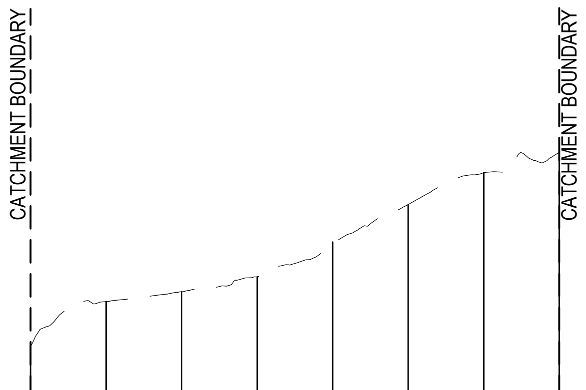
Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND



DATUM 42.00m

EXISTING LEVELS	47.92	47.58	47.14	46.80	46.45	45.74	44.96	44.07
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	125.43

CS-CATCHMENT XXIV
SCALE: HORI 1:2000 VERT 1:400



DATUM 42.00m

EXISTING LEVELS	44.42	46.79	47.31	48.09	49.94	51.92	53.61	54.69
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00

LS-CATCHMENT XXIV
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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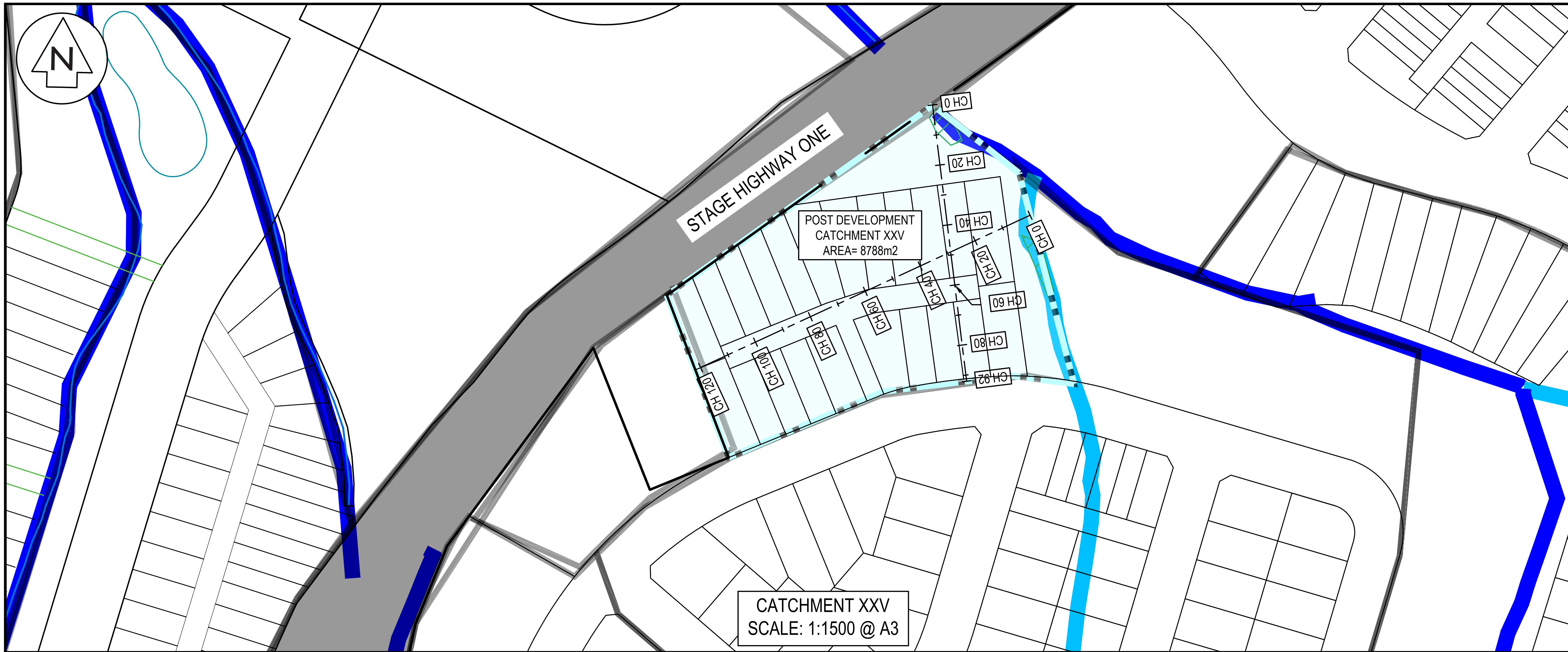
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XXIV PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-24 Rev A

DATE: 7/3/23

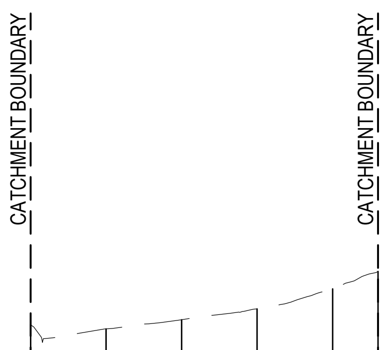


Notes

1. All works to be in accordance with Auckland council standards.

Legend

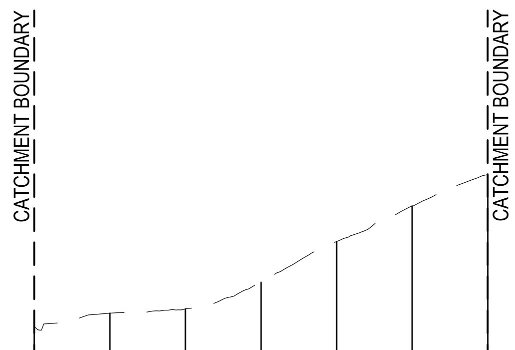
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND



DATUM 40.00m

EXISTING LEVELS	43.86	43.62	44.10	44.68	45.74	46.66
CHAINAGE	0.00	20.00	40.00	60.00	80.00	92.05

CS-CATCHMENT XXV
SCALE: HORI 1:2000 VERT 1:400



DATUM 40.00m

EXISTING LEVELS	43.56	44.30	44.53	45.93	48.09	49.96	51.62
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00

LS-CATCHMENT XXV
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

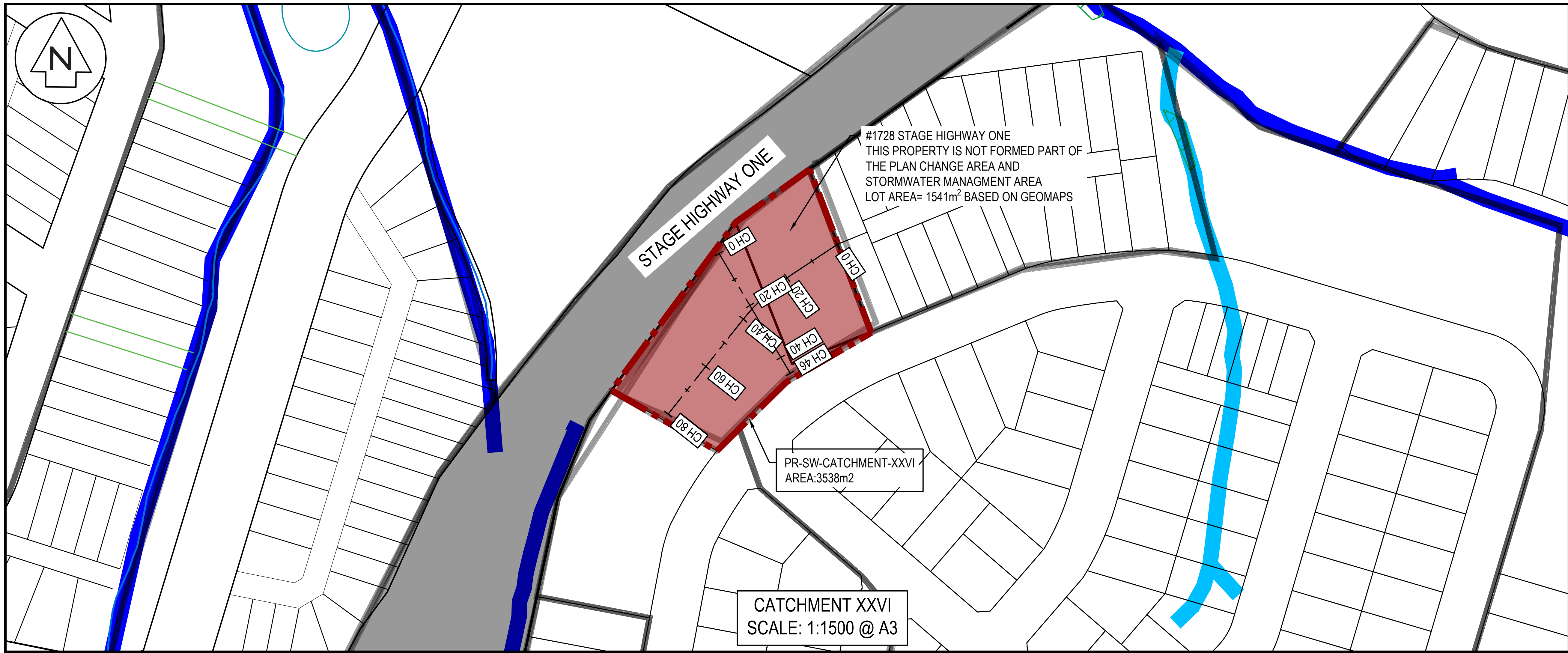
Title

POST DEVELOPMENT CATCHMENT XXV PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-25
Rev	A

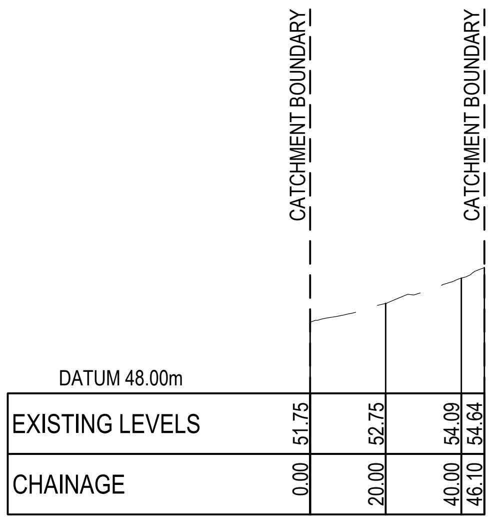
DATE: 7/2/23

Notes
1. All works to be in accordance with Auckland council standards.

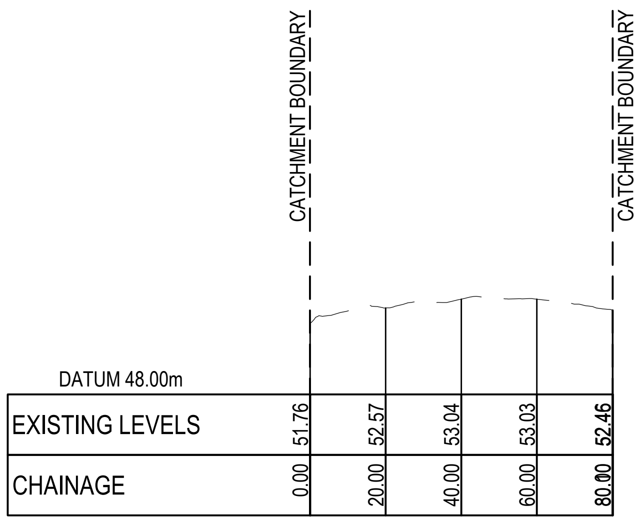


Legend

EX BDY	
EX PERM. STREAM	
EX INTER. STREAM	
EX WETLAND	



CS-CATCHMENT XXVI
SCALE: HORI 1:2000 VERT 1:400



LS-CATCHMENT XXVI
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	DRAFT	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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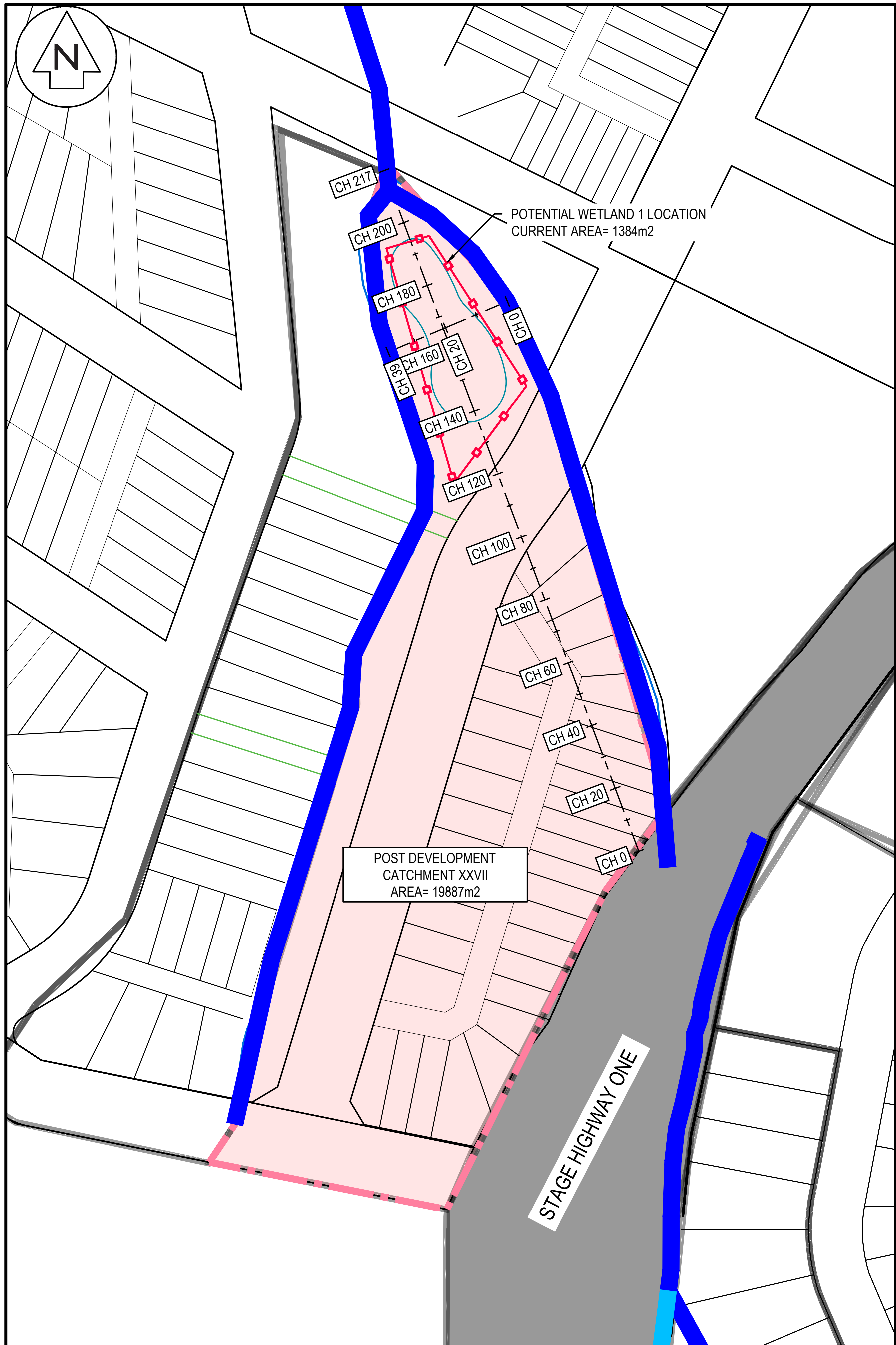
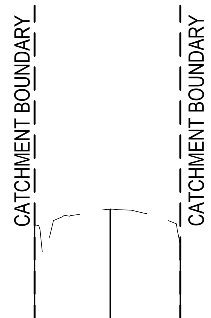
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XXVI PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-26
Rev	A



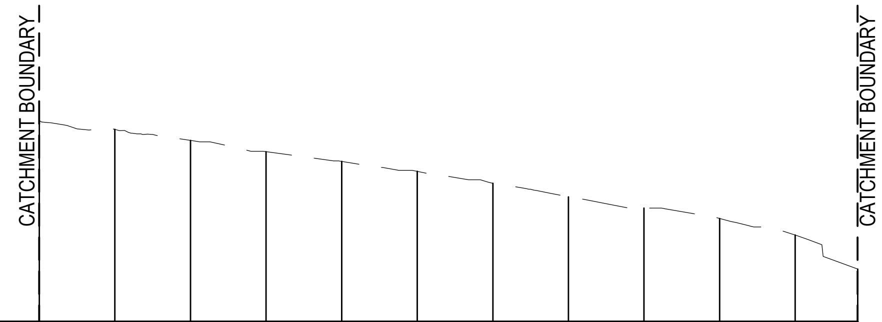
CATCHMENT XXVII
SCALE: 1:1500 @ A3



DATUM 36.00m

EXISTING LEVELS	41.12	41.94	40.03
CHAINAGE	0.00	20.00	38.57

CS-CATCHMENT XXVII
SCALE: HORI 1:2000 VERT 1:400



DATUM 36.00m

EXISTING LEVELS	46.63	46.16	45.58	44.98	44.47	43.94	43.31	42.59	42.00	41.45	40.57	38.78
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	216.55

LS-CATCHMENT XXVII
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend

- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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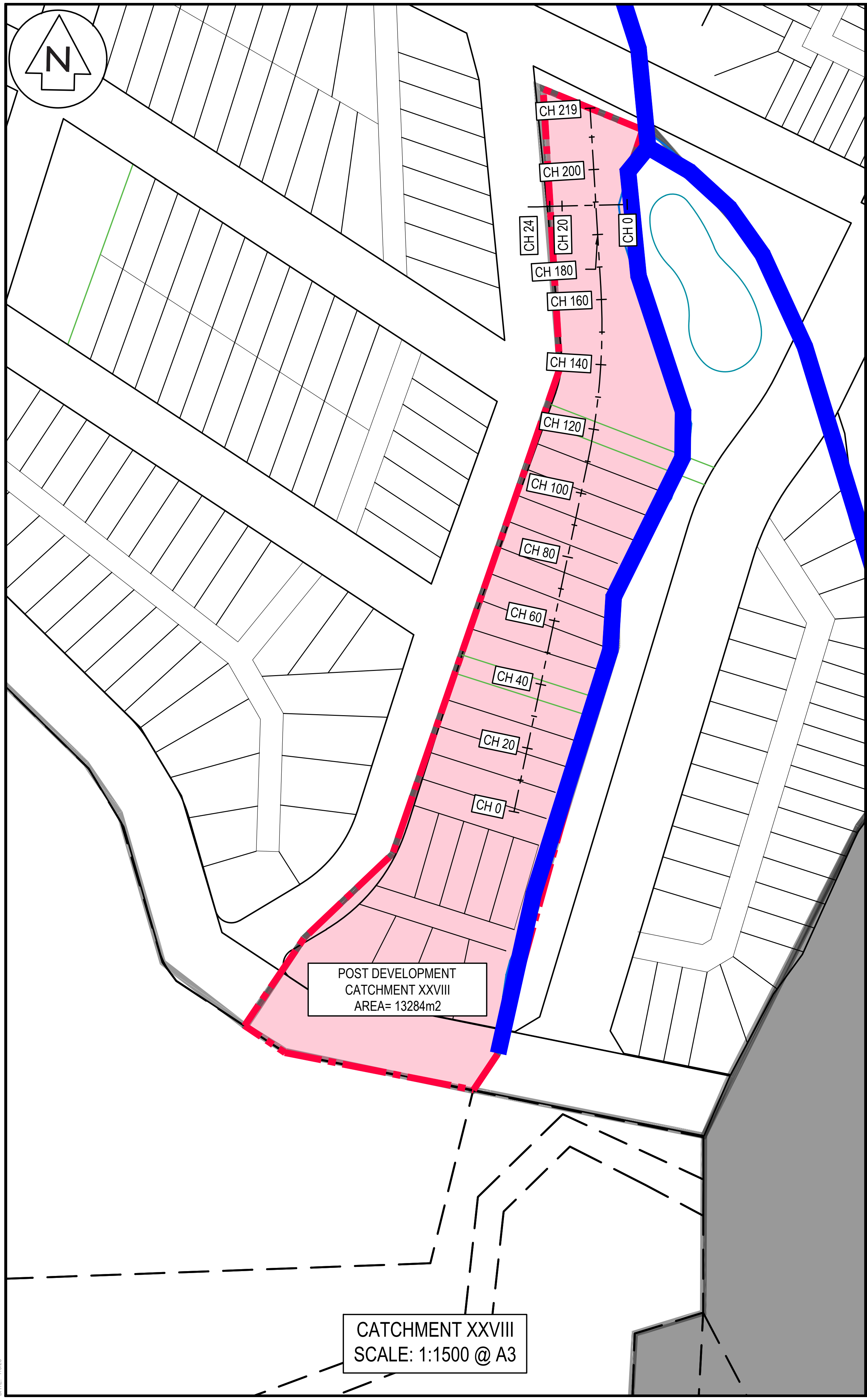
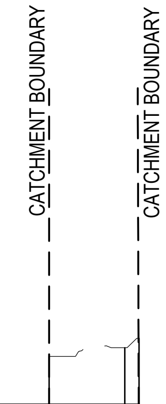
Title
POST DEVELOPMENT CATCHMENT XXVII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-27 Rev A



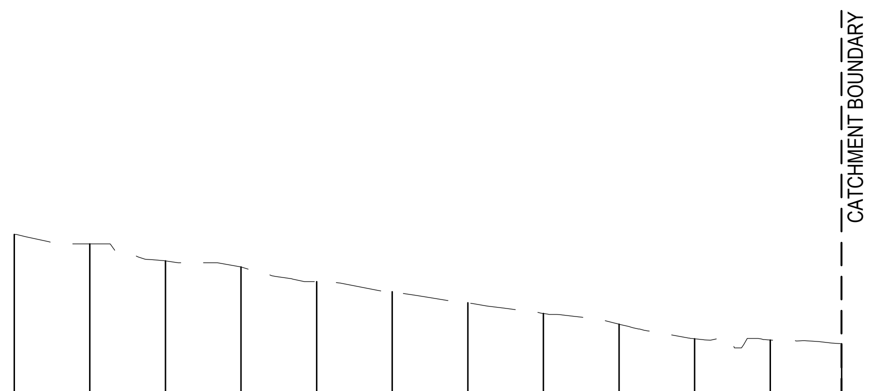
CATCHMENT XXVIII
SCALE: 1:1500 @ A3



DATUM 38.00m

EXISTING LEVELS	40.54	41.00	41.50
CHAINAGE	0.00	20.00	23.76

CS-CATCHMENT XXVIII
SCALE: HORI 1:2000 VERT 1:400



DATUM 38.00m

EXISTING LEVELS	46.50	46.00	45.10	44.78	44.00	43.47	42.88	42.32	41.75	40.98	40.91	40.72
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	218.87

LS-CATCHMENT XXVIII
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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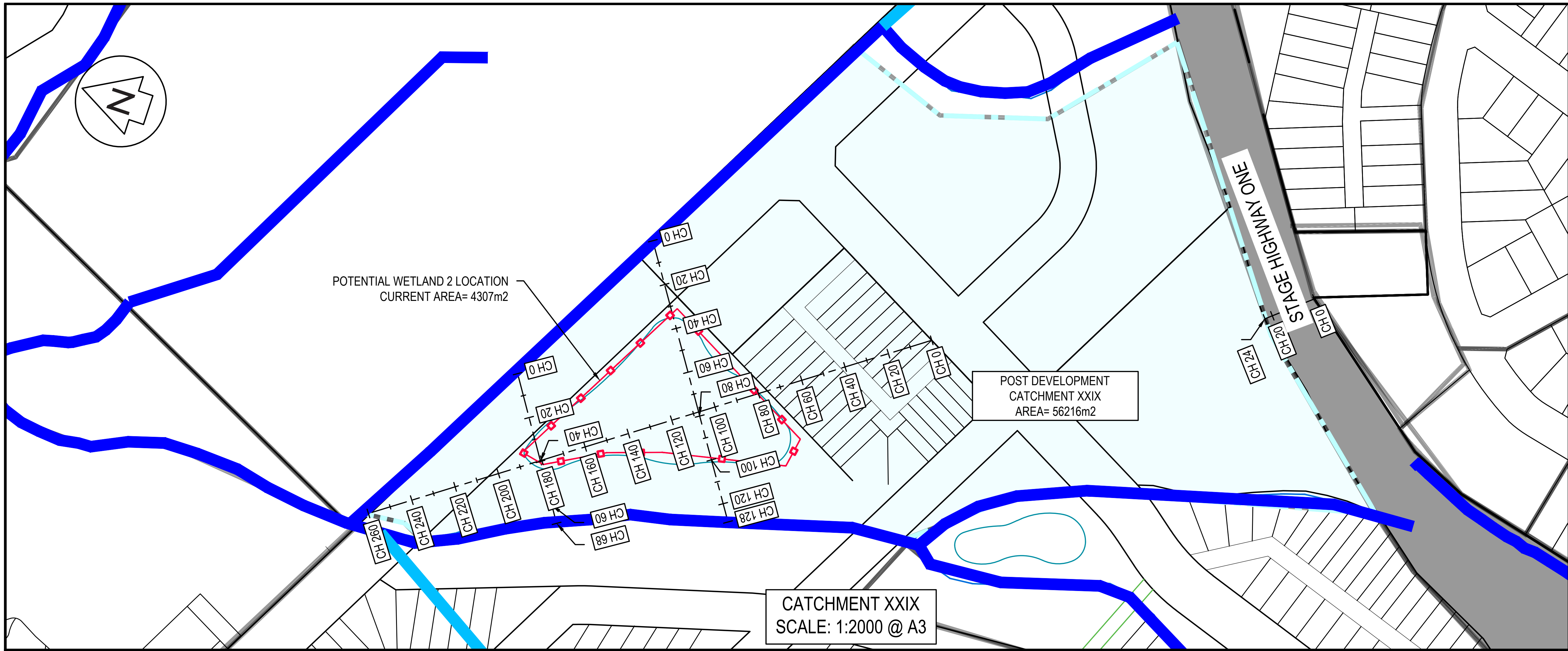
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XXVIII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-28 Rev A



CATCHMENT XXIX
SCALE: 1:2000 @ A3

Notes
1. All works to be in accordance with Auckland council standards.

Legend

- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

CS-CATCHMENT XXIX-1

DATUM 34.00m

EXISTING LEVELS	37.43	38.00	37.90	37.85	36.77
CHAINAGE	0.00	20.00	40.00	60.00	68.20

CATCHMENT BOUNDARY — CATCHMENT BOUNDARY

CS-CATCHMENT XXIX-1
SCALE: HORI 1:2000 VERT 1:400

CS-CATCHMENT XXIX-2

DATUM 34.00m

EXISTING LEVELS	37.42	39.48	39.61	39.45	39.29	39.07	38.75	38.28
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	128.35

CATCHMENT BOUNDARY — CATCHMENT BOUNDARY

CS-CATCHMENT XXIX-2
SCALE: HORI 1:2000 VERT 1:400

LS-CATCHMENT XXIX

DATUM 34.00m

EXISTING LEVELS	40.71	40.37	40.00	39.91	39.41	39.00	38.79	38.50	38.20	37.92	37.56	37.46	37.17	36.05
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00

CATCHMENT BOUNDARY

LS-CATCHMENT XXIX
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
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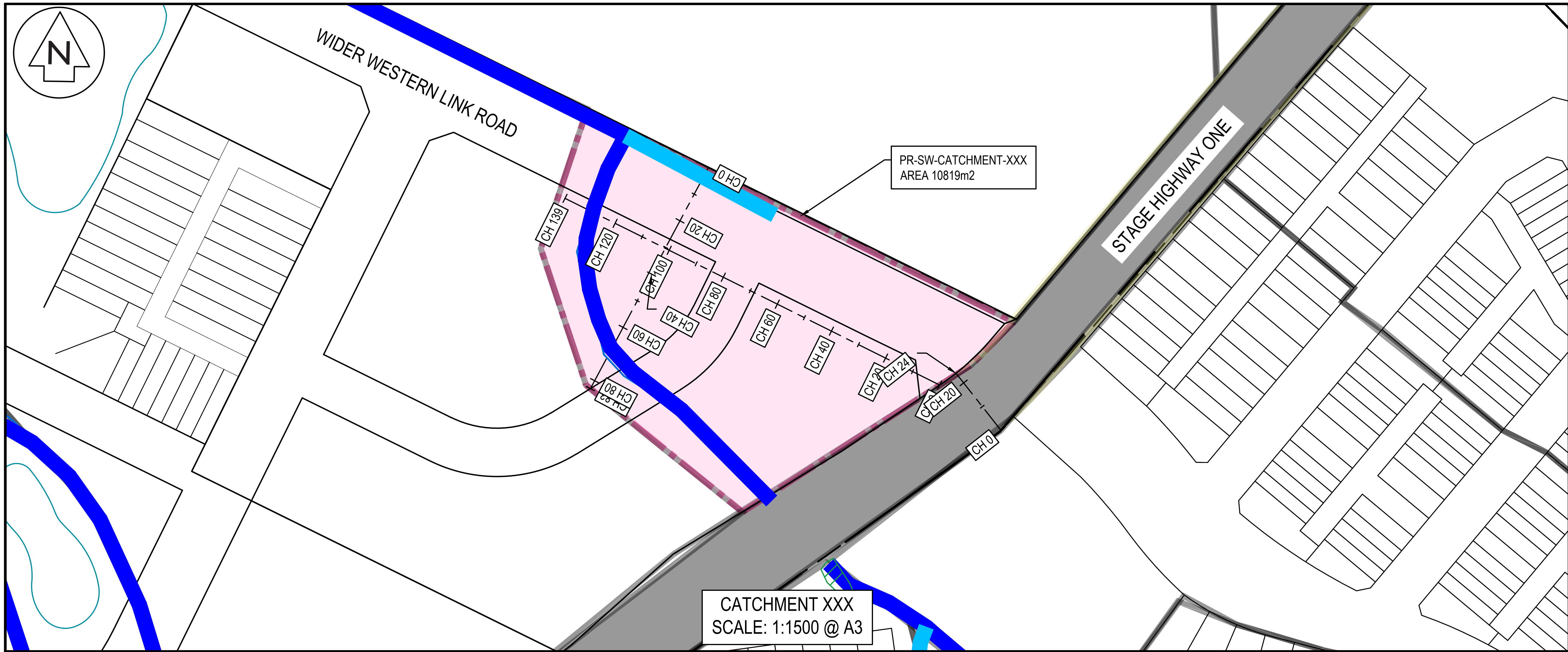
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

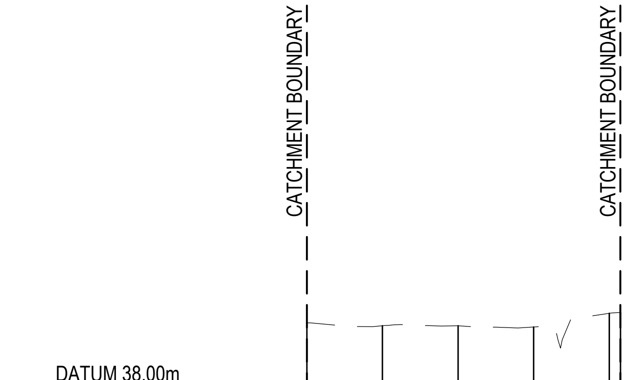
Title
POST DEVELOPMENT CATCHMENT XXIX PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-29 Rev A



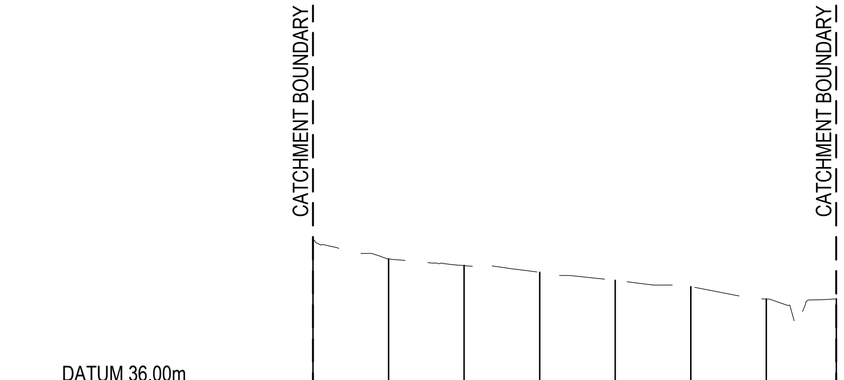
Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND



EXISTING LEVELS	41.50	41.34	41.34	41.28	42.00 42.04
CHAINAGE	0.00	20.00	40.00	60.00	80.00 82.90

CS-CATCHMENT XXX
SCALE: HORI 1:2000 VERT 1:400



EXISTING LEVELS	43.94	42.88	42.54	42.17	41.75	41.41	40.76	40.77
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	138.52

LS-CATCHMENT XXX
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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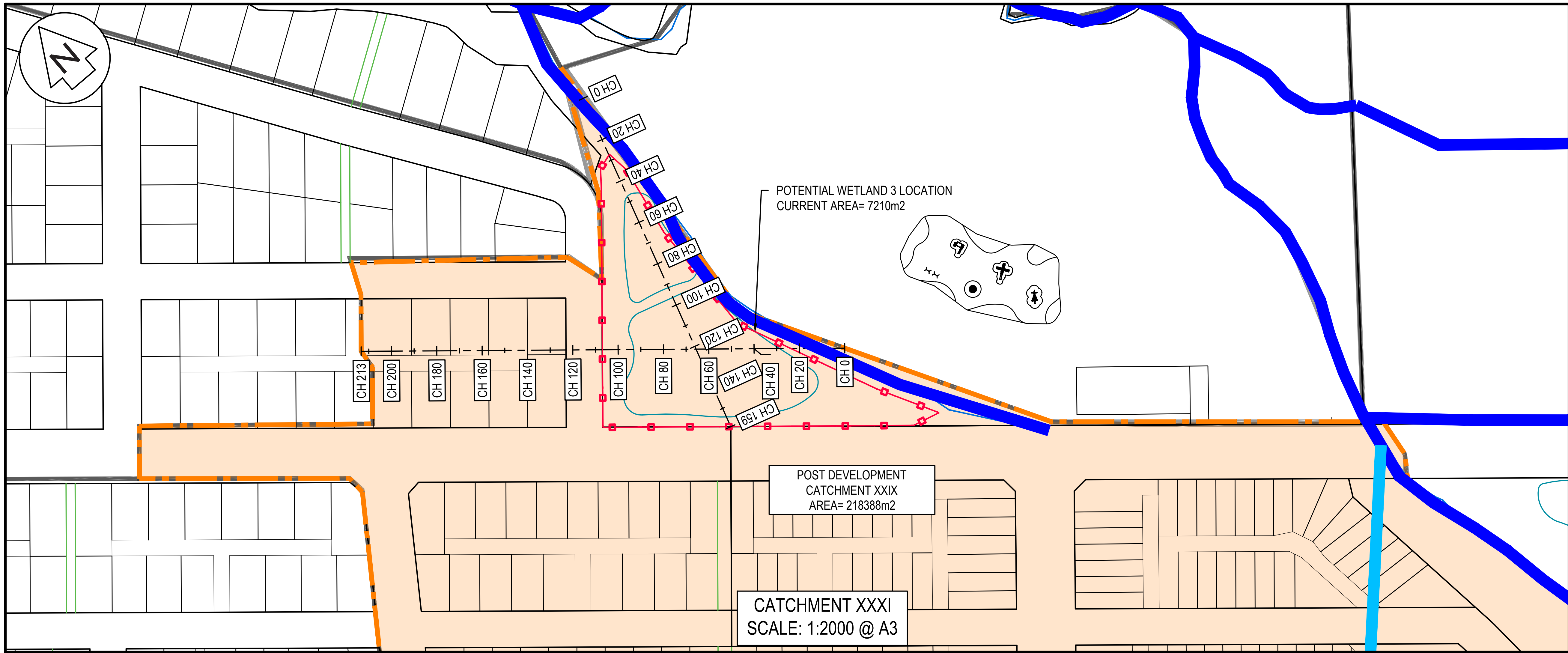
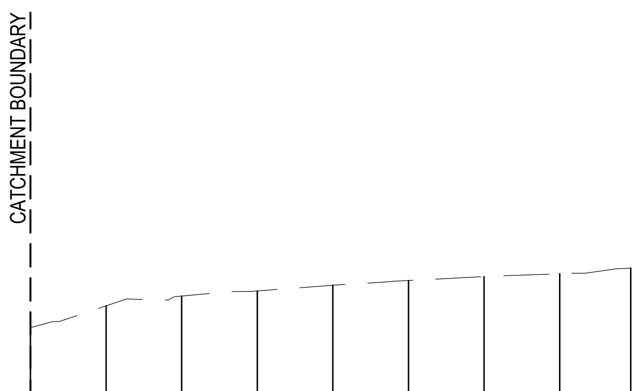
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XXX PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-30
Rev	A

Notes
1. All works to be in accordance with Auckland council standards.

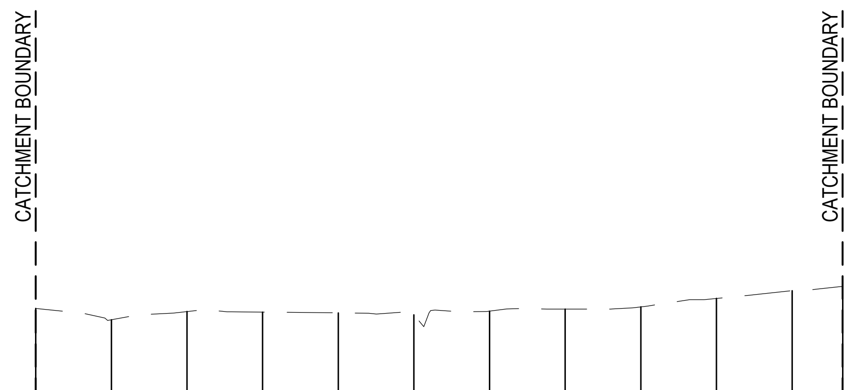




DATUM 28.00m

EXISTING LEVELS	31.71	32.77	33.29	33.56	33.86	34.11	34.32	34.47	34.77
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	158.82

CS-CATCHMENT XXXI
SCALE: HORI 1:2000 VERT 1:400



DATUM 30.00m

EXISTING LEVELS	34.53	33.94	34.37	34.34	34.30	34.19	34.39	34.50	34.62	35.06	35.47	35.70
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	213.39

LS-CATCHMENT XXXI
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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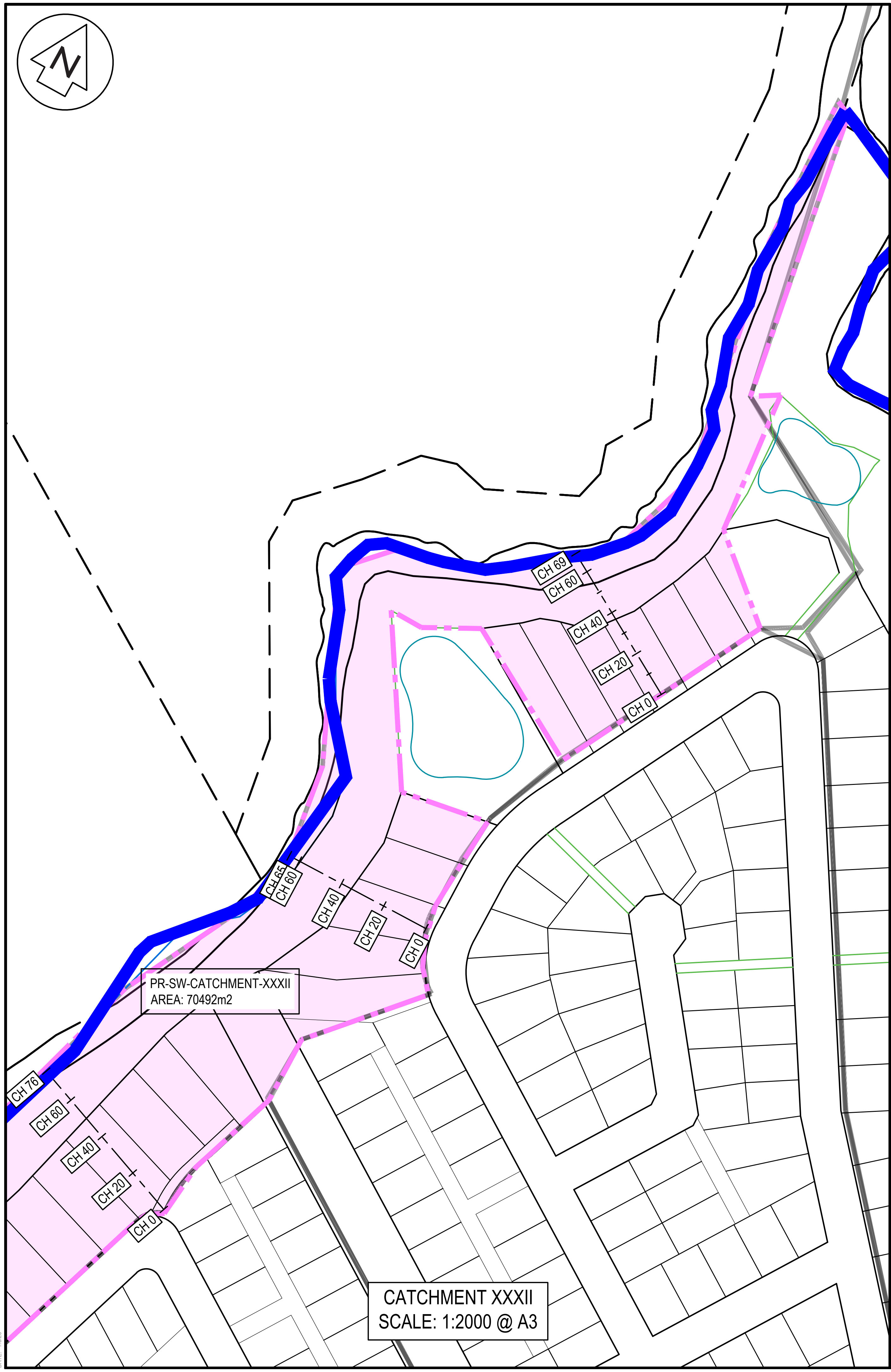
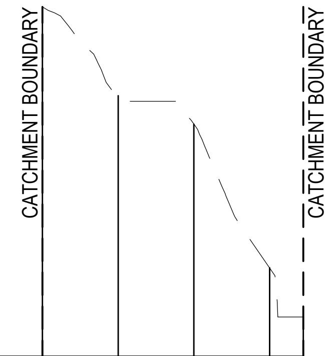
Title
POST DEVELOPMENT CATCHMENT XXXI PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-31 Rev A

DATE : 7/2/23



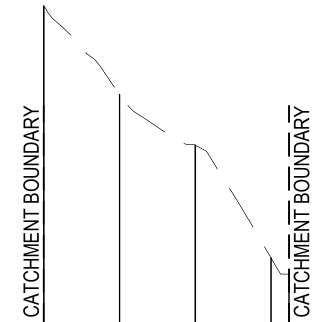
CATCHMENT XXXII
SCALE: 1:2000 @ A3



DATUM 18.00m

EXISTING LEVELS	36.49	31.80	30.29	22.69	20.09
CHAINAGE	0.00	20.00	40.00	60.00	68.92

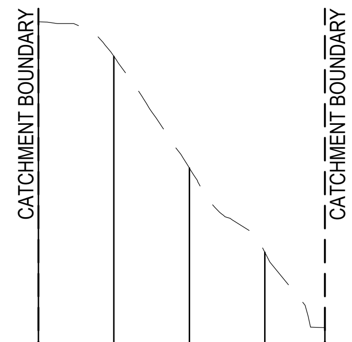
CS-CATCHMENT XXXII-1
SCALE: HORI 1:2000 VERT 1:400



DATUM 18.00m

EXISTING LEVELS	35.18	30.50	27.82	21.86	21.00
CHAINAGE	0.00	20.00	40.00	60.00	64.75

CS-CATCHMENT XXXII-2
SCALE: HORI 1:2000 VERT 1:400



DATUM 18.00m

EXISTING LEVELS	37.59	35.77	29.85	25.39	21.39
CHAINAGE	0.00	20.00	40.00	60.00	75.91

CS-CATCHMENT XXXII-3
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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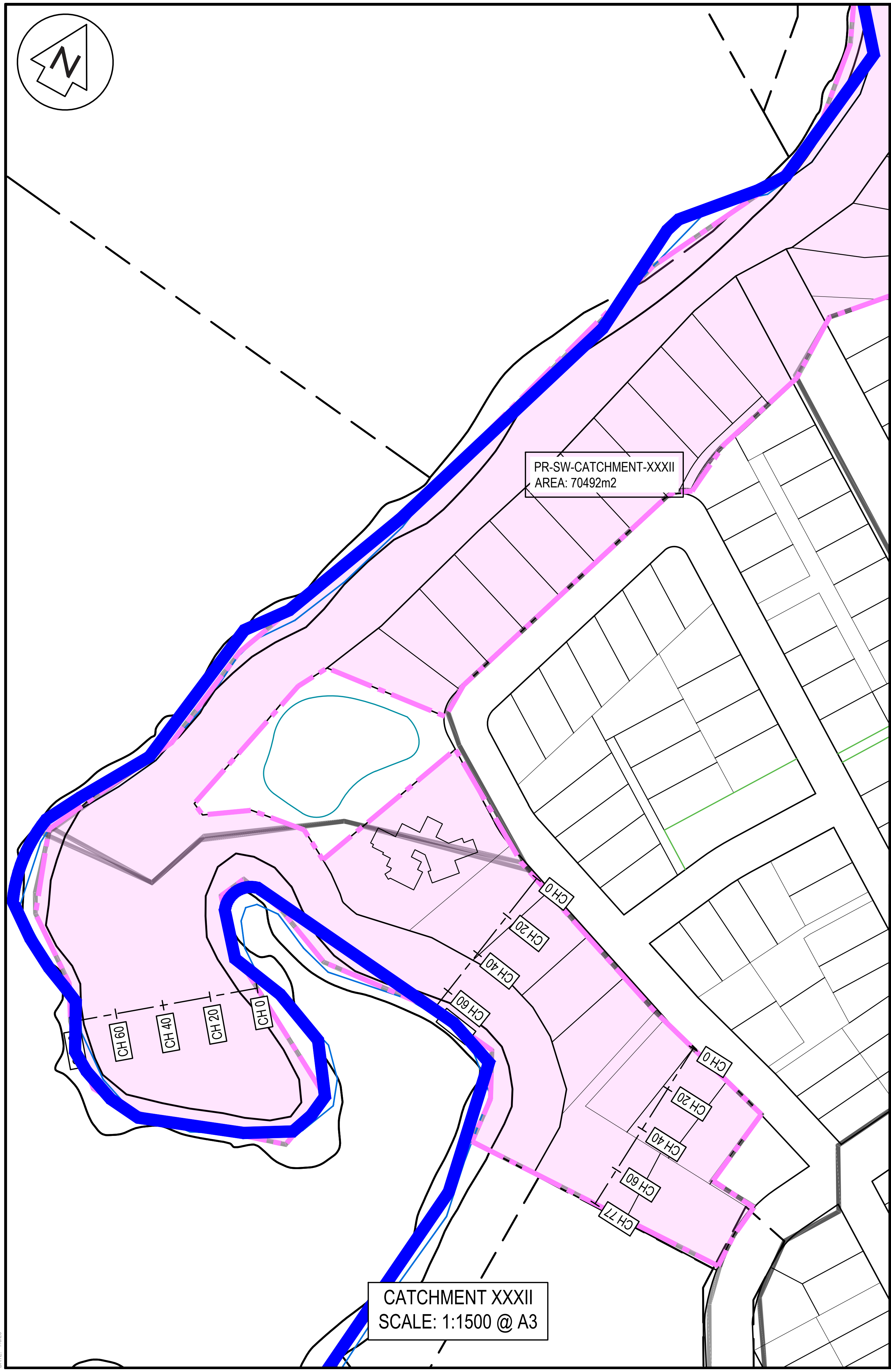
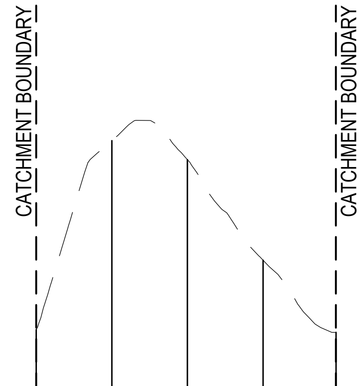
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XXXII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-32-1 Rev A

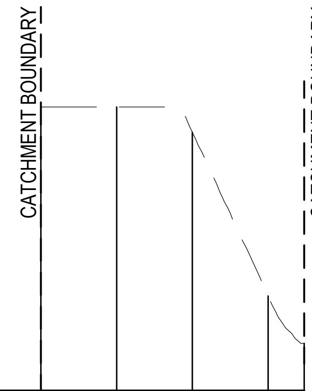




DATUM 22.00m

EXISTING LEVELS	25.14	35.14	34.14	28.82	25.00
CHAINAGE	0.00	20.00	40.00	60.00	79.30

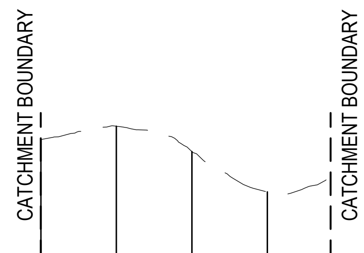
CS-CATCHMENT XXXII-4
SCALE: HORI 1:2000 VERT 1:400



DATUM 24.00m

EXISTING LEVELS	39.00	39.00	37.67	29.00	26.50
CHAINAGE	0.00	20.00	40.00	60.00	69.54

CS-CATCHMENT XXXII-5
SCALE: HORI 1:2000 VERT 1:400



DATUM 34.00m

EXISTING LEVELS	40.07	40.78	39.44	37.30	
CHAINAGE	0.00	20.00	40.00	60.00	76.78

CS-CATCHMENT XXXII-6
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
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Drawn	LCH	06/2023
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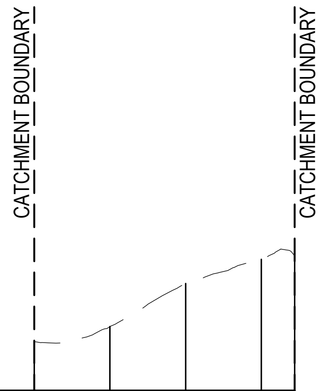
Title
POST DEVELOPMENT CATCHMENT XXXII PLAN

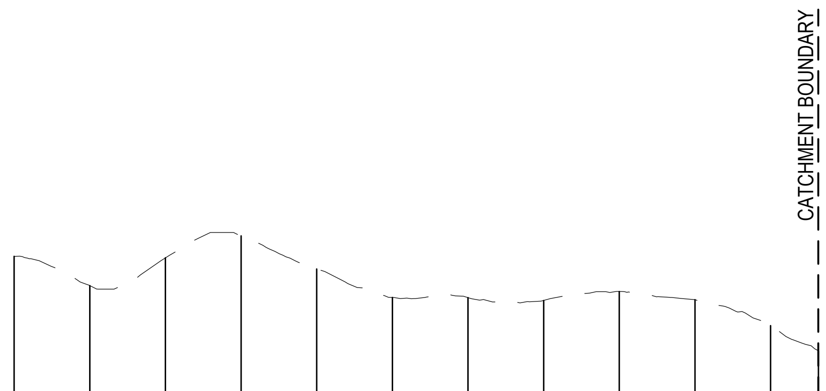
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-32-2
Rev	A



DATUM 30.00m

EXISTING LEVELS	32.59	33.38	35.66	36.94	37.13
CHAINAGE	0.00	20.00	40.00	60.00	68.80

CS-CATCHMENT XXXIII
SCALE: HORI 1:2000 VERT 1:400



DATUM 30.00m

EXISTING LEVELS	37.24	35.69	37.16	38.32	36.57	35.07	35.05	34.90	35.38	34.94	33.58	32.22
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	212.64

LS-CATCHMENT XXXIII
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend

(black line)	EX BDY
(blue line)	EX PERM. STREAM
(cyan line)	EX INTER. STREAM
(green symbol)	EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
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Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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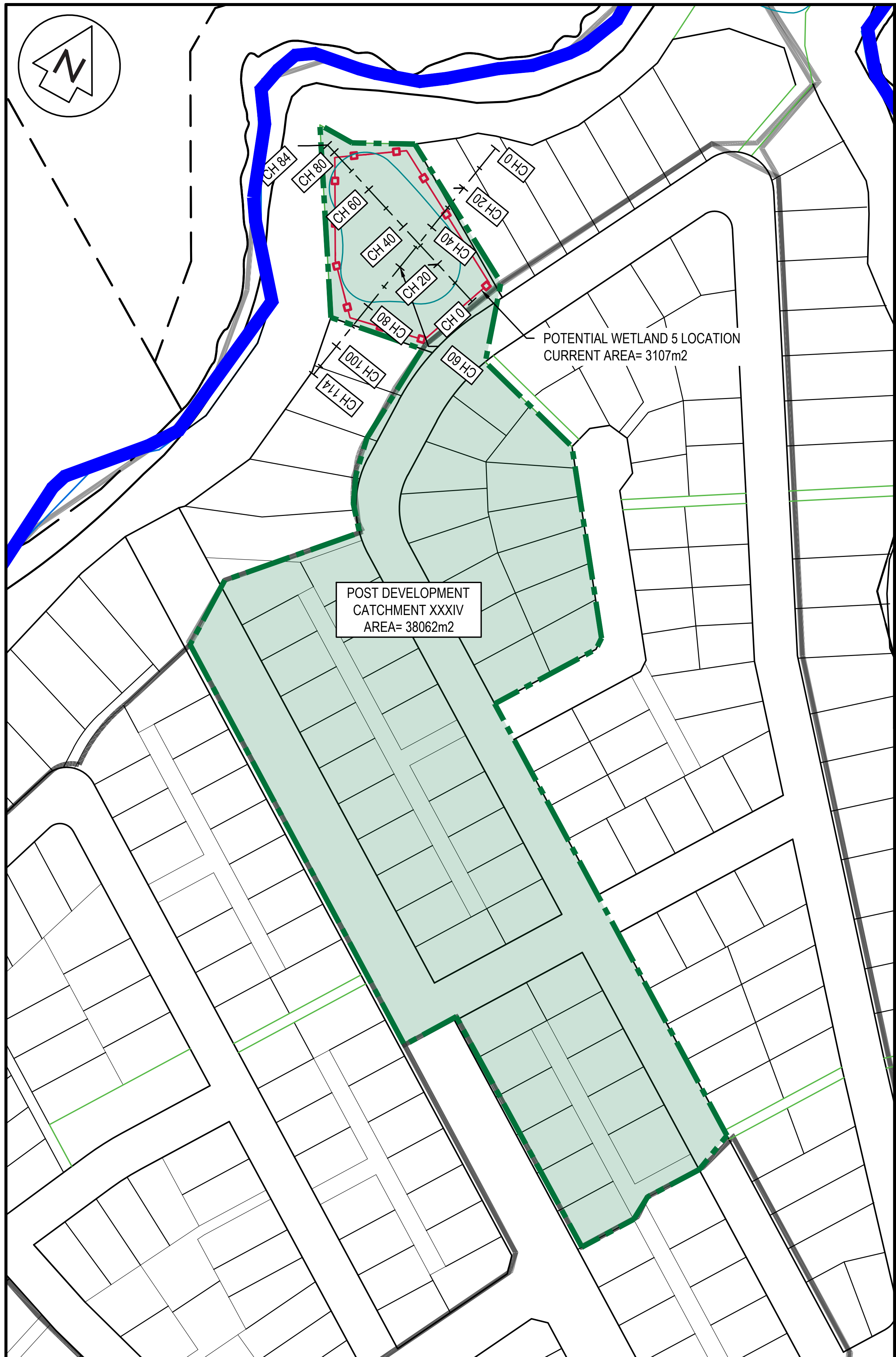
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

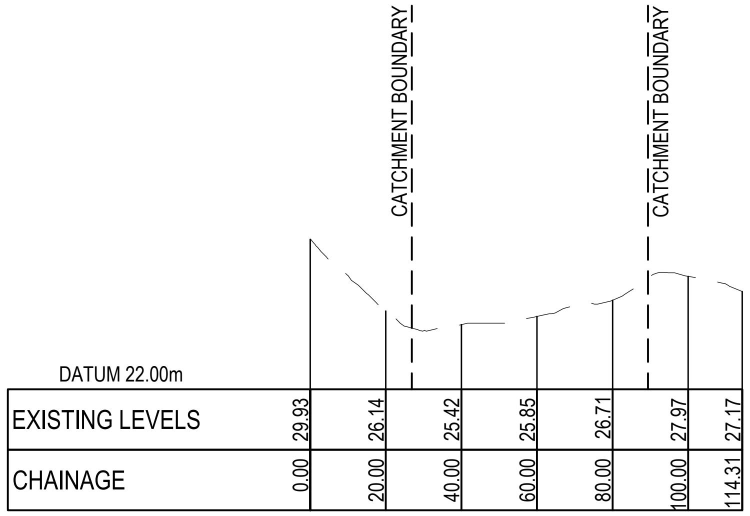
Title
POST DEVELOPMENT CATCHMENT XXXIII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-33
Rev	A

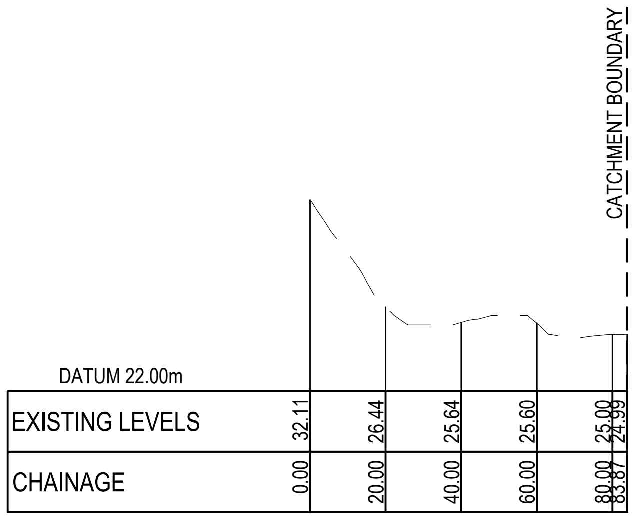
DATE: 7/2023



CATCHMENT XXXIV
SCALE: 1:2000 @ A3



CS-CATCHMENT XXXIV
SCALE: HORI 1:2000 VERT 1:400



LS-CATCHMENT- XXXIV
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
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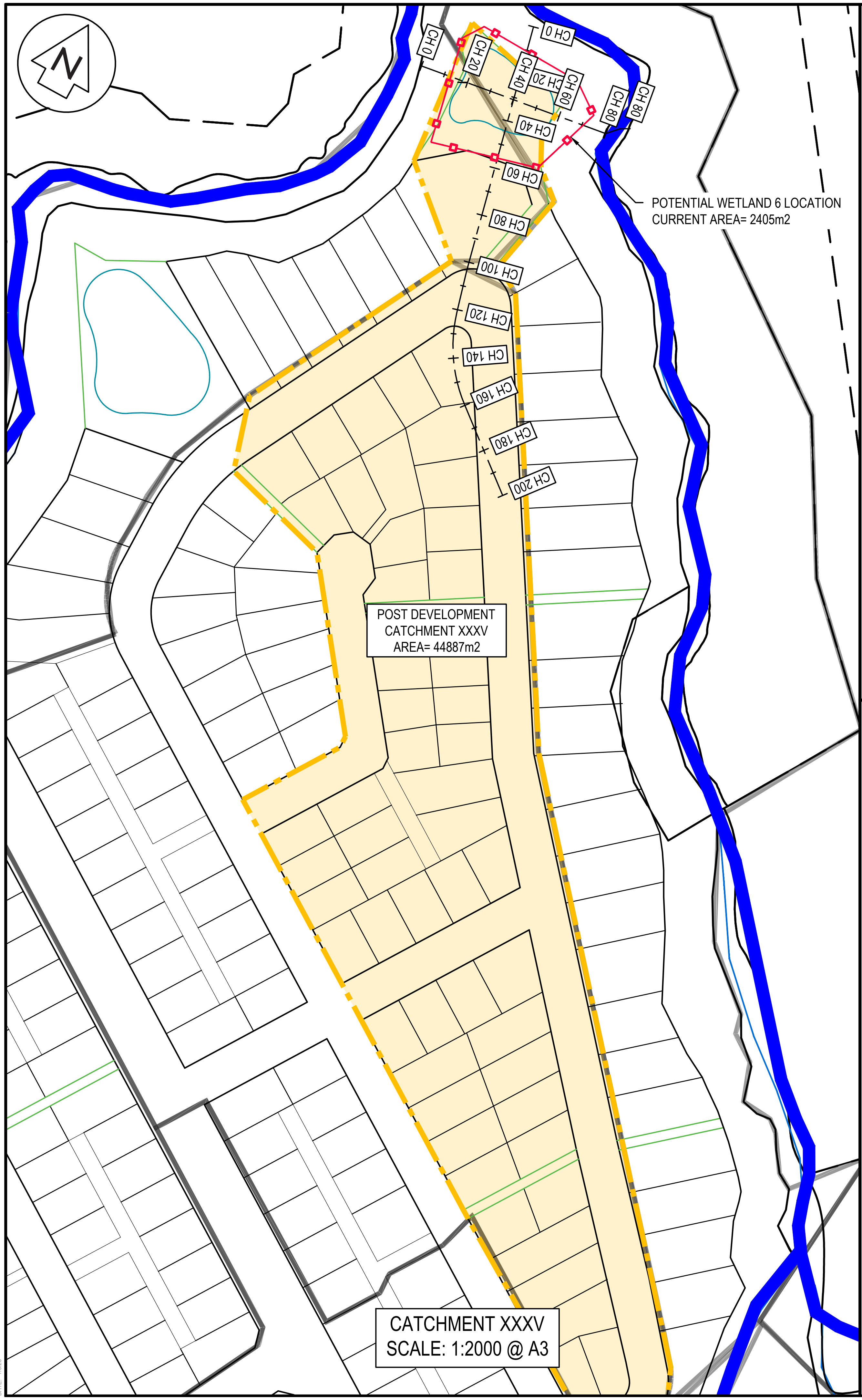
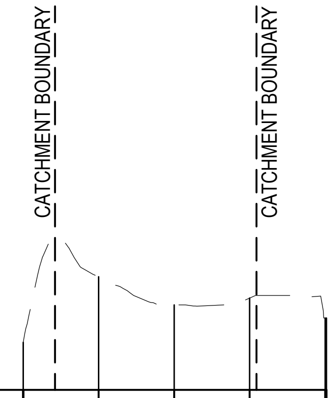
Title
POST DEVELOPMENT CATCHMENT XXXIV PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-34
Rev	A



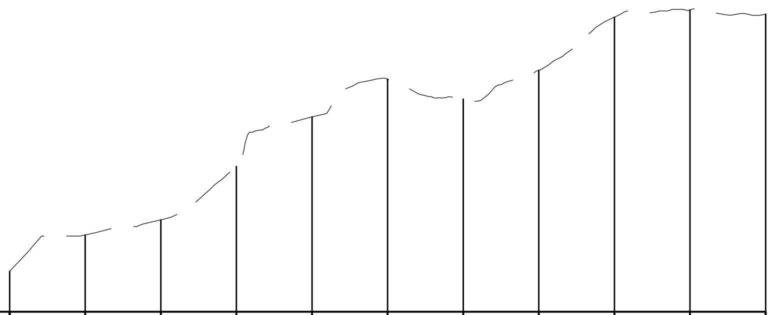
CATCHMENT XXXV
SCALE: 1:2000 @ A3



DATUM 20.00m

EXISTING LEVELS	22.52	25.99	24.50	24.86	23.80
CHAINAGE	0.00	20.00	40.00	60.00	80.00

CS-CATCHMENT XXXV
SCALE: HORI 1:2000 VERT 1:400



DATUM 20.00m

EXISTING LEVELS	22.14	24.06	24.86	27.68	30.31	32.30	31.25	32.77	35.59	35.97	35.74
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00

LS-CATCHMENT XXXV
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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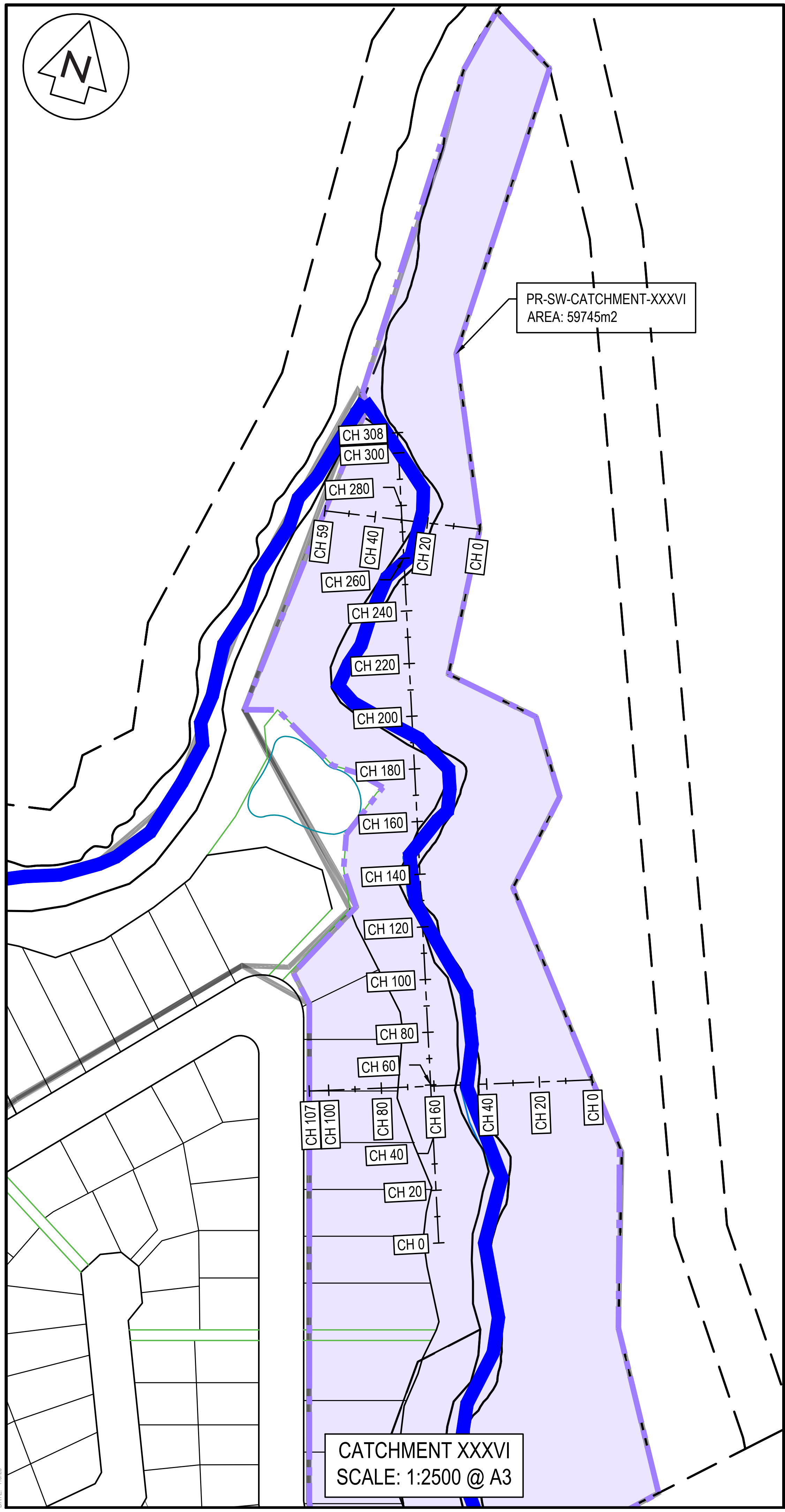
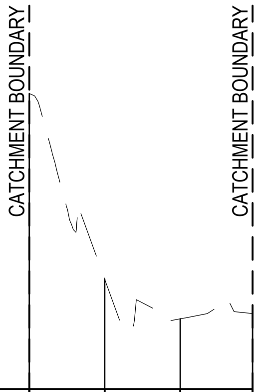
Title
POST DEVELOPMENT CATCHMENT XXXV PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-35
Rev	A

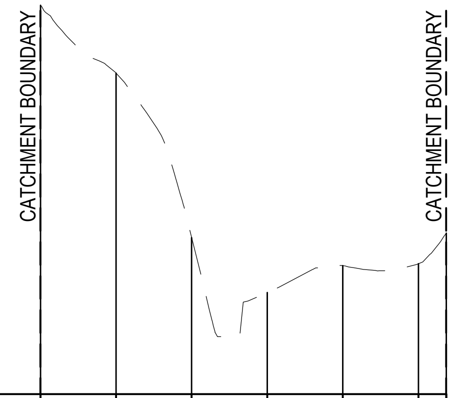




DATUM 20.00m

EXISTING LEVELS	35.64	25.82	23.72	24.00
CHAINAGE	0.00	20.00	40.00	59.21

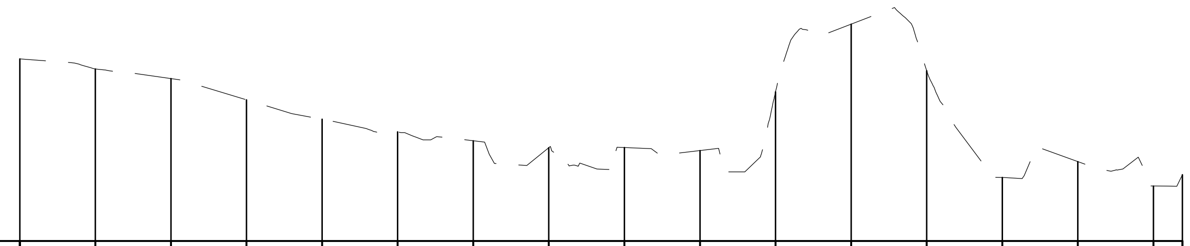
CS-CATCHMENT XXXVI-1
SCALE: HORI 1:2000 VERT 1:400



DATUM 22.00m

EXISTING LEVELS	42.58	38.99	30.28	27.38	28.80	28.90	30.52
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	107.36

C-CARTCHMENT XXXVI-2
SCALE: HORI 1:2000 VERT 1:400



DATUM 20.00m

EXISTING LEVELS	29.63	29.10	28.59	27.46	26.44	25.78	25.30	24.93	24.94	24.78	27.89	31.47	29.01	23.36	24.20	22.91	23.51
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00	280.00	300.00	307.66

LS-CATCHMENT XXXVI
SCALE: HORI 1:2000 VERT 1:400

Notes

1. All works to be in accordance with Auckland council standards.

Legend

- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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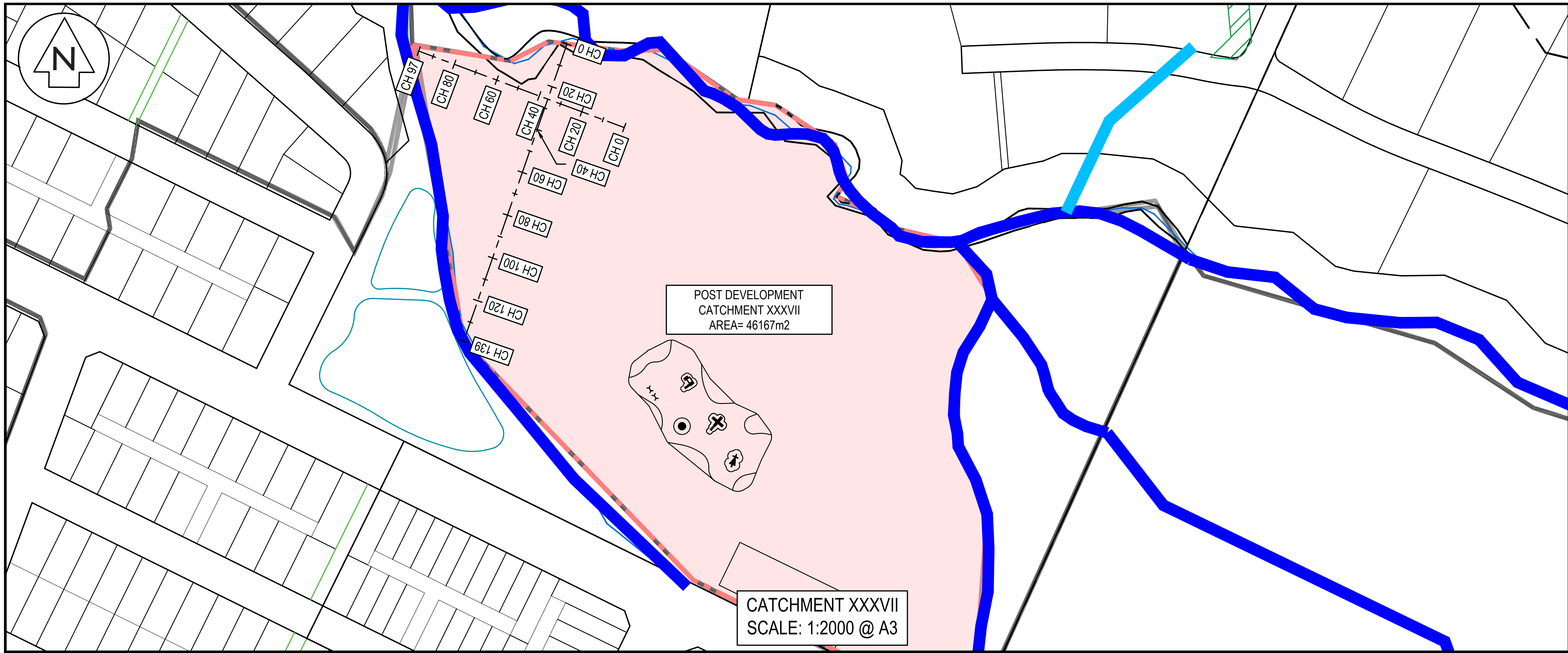
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title

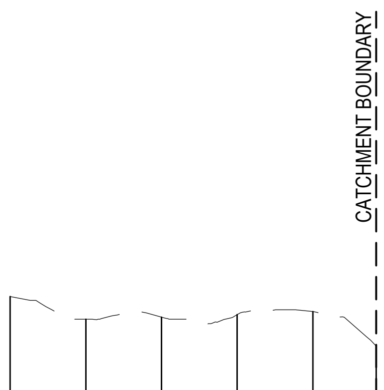
POST DEVELOPMENT CATCHMENT XXXVI PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-36 Rev A



Notes
1. All works to be in accordance with Auckland council standards.

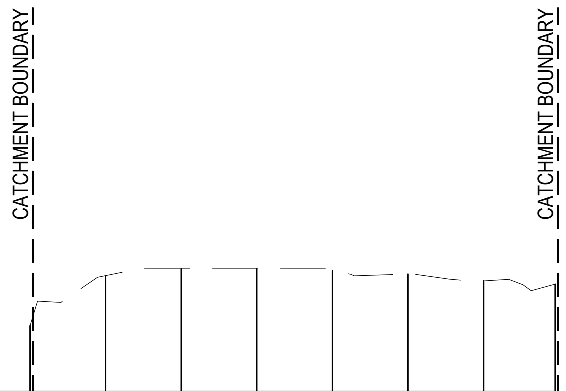
Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND



DATUM 30.00m

EXISTING LEVELS	35.20	34.00	34.11	34.24	34.40	32.57
CHAINAGE	0.00	20.00	40.00	60.00	80.00	96.72

CS-CATCHMENT XXXVII
SCALE: HORI 1:2000 VERT 1:400



DATUM 28.00m

EXISTING LEVELS	31.49	34.14	34.50	34.50	34.41	34.22	33.86	33.69
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	138.94

LS-CATCHMENT XXXVII
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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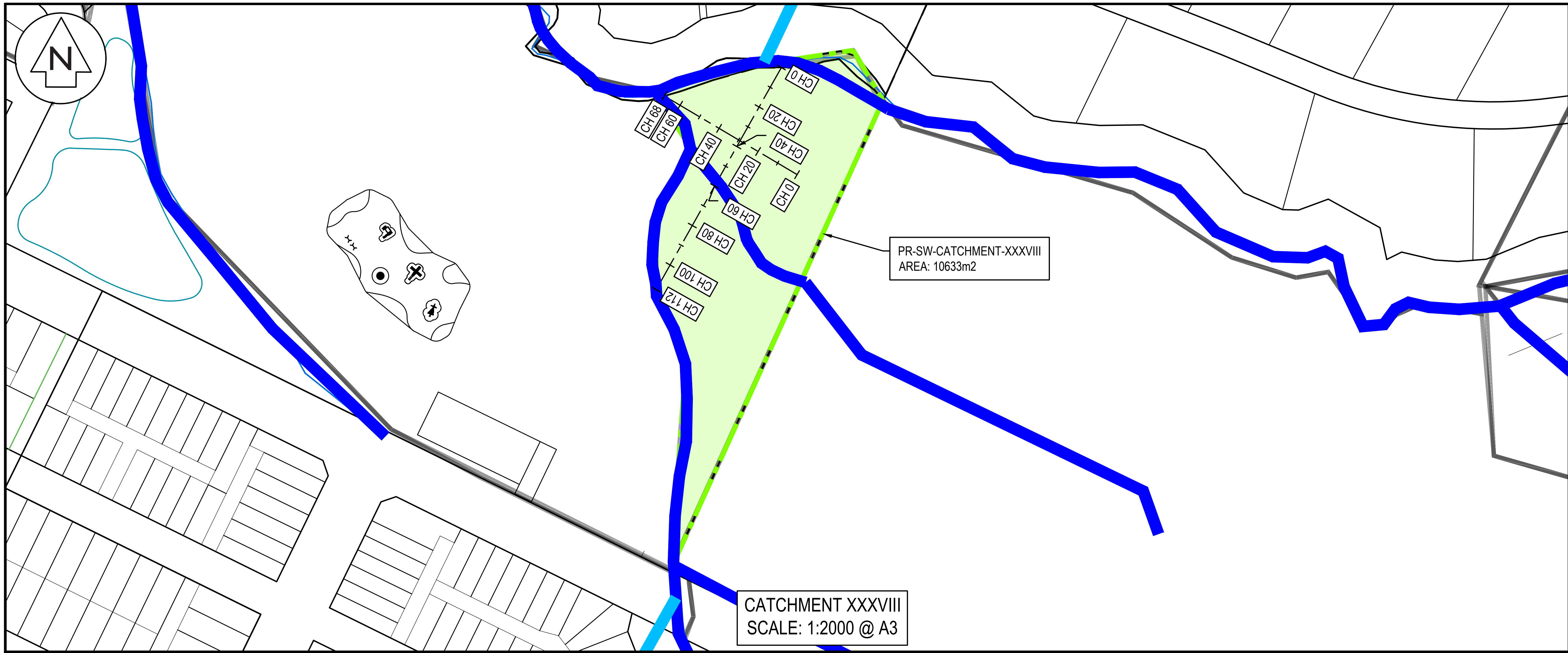
Title
POST DEVELOPMENT CATCHMENT XXXVII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-37
Rev	A

DATE: 7/2/23

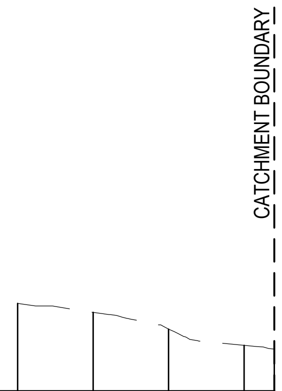


CATCHMENT XXXVIII
SCALE: 1:2000 @ A3

Notes
1. All works to be in accordance with Auckland council standards.

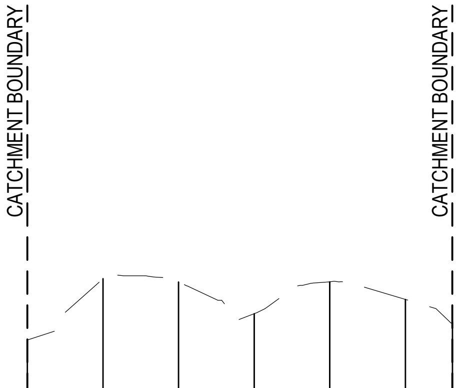
Legend

EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND



EXISTING LEVELS	36.64	36.17	35.28	34.42	34.22
CHAINAGE	0.00	20.00	40.00	60.00	68.03

CS-CATCHMENT XXXVIII
SCALE: HORI 1:2000 VERT 1:400



EXISTING LEVELS	32.61	35.85	35.67	34.00	35.68	34.75	33.55
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	112.45

LS-CATCHMENT XXXVIII
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
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Title
POST DEVELOPMENT CATCHMENT XXXVIII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-38 — Rev A

DATE: 7/2023

APPENDIX B – ENGINEERING CALCULATION

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title WARKWORTH SOUTH PCA Calc Title WETLAND SIZING CALCULATION WETLAND 1 CATCHMENT XXVII	Author KH	Date 7/06/2023	Checked LC

Catchment	Area	SMAF1 Mitigation volume (m3)	SMAF2 Post Dev runoff volume (m3)	Wetland estimate size
XXVII	19887	277	298	24.56m(w)*54.56m(L)
Total	19887	277	298	1340 (m2)

MAVEN ASSOCIATES	**Job Number** 211001	**Sheet** 1	**Rev** A
Job Title WARKWORTH SOUTH PCA **Calc Title** WETLAND SIZING CALCULATION WETLAND 1 CATCHMENT XXVII	**Author** KH	**Date** 13/12/2022	**Checked** LC

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	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	1.9887	147.16
* from Appendix B		Totals =	1.9887	147.16

CN (weighted) = total product / total area = 147.16 / 1.989 = 74.0

Ia (average) = 5 x pervious area / total area = 5 x 1.9887 / 1.989 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 0.6 km (along drainage path)

Catchment Slope Sc= 0.019 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 0.71 1.34 3.28 = 0.44 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.29 hrs

17.68 mins

OK
use
0.44 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 3	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 1 CATCHMENT XXVII	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.019887	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=	0.44	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
Climate change %			13.2		
24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15	0.10	0.51		
6. Specific peak flow rate q*	0.033	0.022	0.091		
7. Peak flow rate, q_p=q*A*P_{24}	**0.028**	**0.013**	**0.348**		m3/s
8. Runoff depth, Q_{24} = $(P_{24}-Ia)^2/(P_{24}-Ia)+S$	10.8	5.5	127.0		mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	215.66	108.80	2525.29		(m3)

Worksheet 2: Graphical Peak Flow Rate

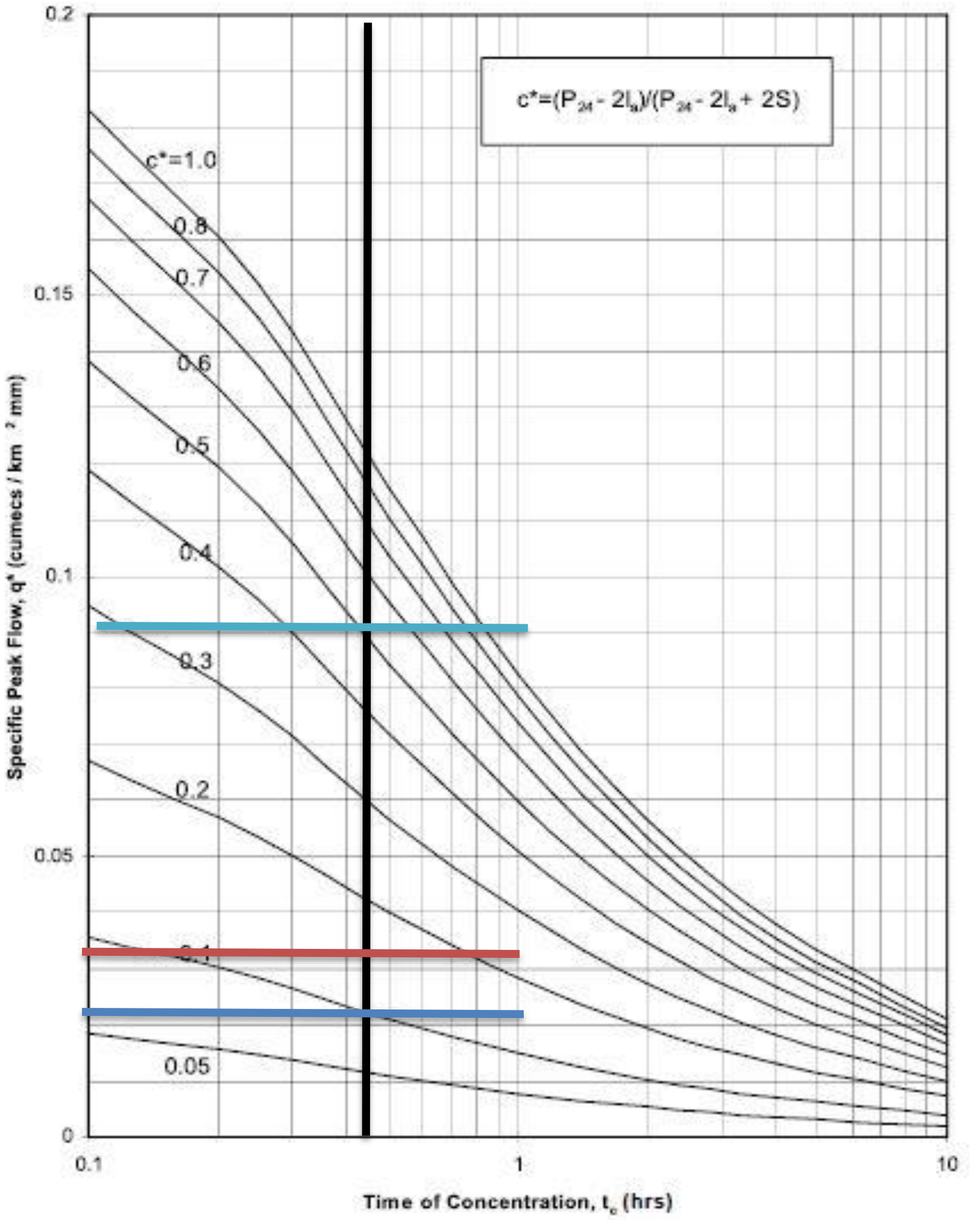


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001 0	Sheet 1	Rev A
Job Title / Calc Title — WARKWORTH SOUTH PCA / WETLAND SIZING CALCULATION / WETLAND 1 CATCHMENT XXVII	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	1.3921	136.42
C	Grass (landscape and gardens)	74	0.5966	44.15
* from Appendix B		Totals =	1.9887	180.57

CN (weighted) = total product / total area = 180.57 / 1.989 = 90.8

Ia (average) = 5 x pervious area / total area = 5 x 0.5966 / 1.989 = 1.5 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.4 km (along drainage path)

Catchment Slope Sc= 0.025 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 90.8 / 200- 90.8 = 0.83

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.55 1.11 3.02 = 0.15 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.10 hrs

4.26 mins

NO GOOD

use

0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA, WETLAND SIZING CALCULATION, WETLAND 1 CATCHMENT XXVII	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.019887	km2(100ha =1km2)
Runoff curve number	CN=	90.8	(from worksheet 1)
Initial abstraction	Ia=	1.5	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 25.7 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
P24			13.2		(%)
4. 24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.43	0.34	0.79		
6. Specific peak flow rate q*	0.110	0.091	0.155		
7. Peak flow rate, q_p=q*A*P_{24}	0.092	0.054	0.593		m3/s
PEAK FLOW RATE PRE DEV=	0.028	0.013	0.348		
PRE TO POST FLOW RATE=	**0.064**	**0.041**	**0.245**		
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	24.8	15.0	168.3		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	492.48	297.83	3346.21		(m3)
RUNOFF VOLUME PRE DEV=	215.66	108.80	2525.29		
PRE TO POST VOLUME=	**276.82**	**189.04**	**820.92**		

SMAF 1 retention volume =	**69.6**	m3	
SMAF 1 Detention volume =	**207.2**	m3	
Total SMAF 1 mitigation volume=	**276.8**	m3	
SMAF 2 post development run-off volume=	**297.8**	m3	= WQV
Wetland Based requirement is=	595.7	m2	= QWV/0.5m of maximum death storage depth
Wetand base measuremetn (1 in 3 shape)	15mx 45m= 675	m2	= width * length
SMAF 1 storage height=	0.41	m	= SMAF 1/ 675m2
Additonal space for SMAF 1 storage=	1.28	m	= side slope at 32% grade
additional space for maintanace track=	3.5	m	
final wetland size =	24.56m*54.56m= 1340m2		= (width+1.28*2+3.5*2)*(length+1.28*2+3.5*2)

Worksheet 2: Graphical Peak Flow Rate

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 2 CATCHMENT XXIX	Author KH	Date 7/06/2023	Checked LC

Catchment	Area*	SMAF1 Mitigation volume (m3)	SMAF2 Post Dev runoff volume (m3)	Wetland estimate size
XXIX	56216	783	842	33.84m(w)*81.84m(L)
Total	56216	783	842	2769.5m2

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 2 CATCHMENT XXIX	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	5.6216	416.00
* from Appendix B		Totals =	5.6216	416.00

CN (weighted) = total product / total area = 416.00 / 5.622 = 74.0

Ia (average) = 5 x pervious area / total area = 5 x 5.6216 / 5.622 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 0.65 km (along drainage path)

Catchment Slope Sc= 0.013 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 0.75 1.34 3.68 = 0.52 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.35 hrs

20.88 mins

OK

use

0.52 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 3	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 2 CATCHMENT XXIX	Author KH	Date 13/12/2022	Checked LC

1. Data
   - Catchment Area A= 0.056216 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= 0.52 hrs (from worksheet 1)
2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
Climate change %			13.2		
24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15	0.10	0.51		
6. Specific peak flow rate q*	0.030	0.020	0.084		
7. Peak flow rate, q_p=q*A*P_{24}	**0.071**	**0.034**	**0.909**		m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	10.8	5.5	127.0		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	609.61	307.55	7138.41		(m3)

Worksheet 2: Graphical Peak Flow Rate

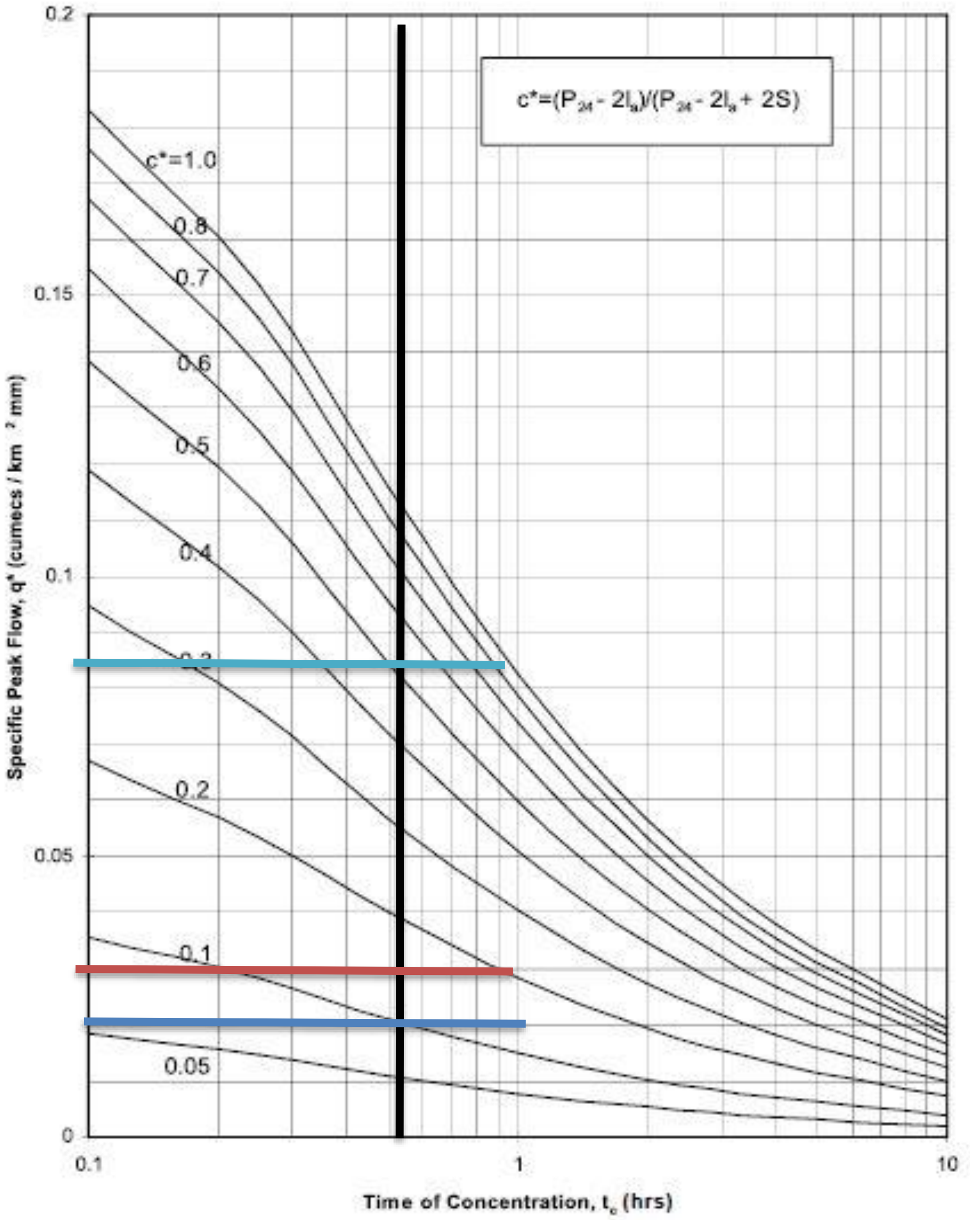


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 2 CATCHMENT XXIX	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	3.9351	385.64
C	Grass (landscape and gardens)	74	1.6865	124.80
* from Appendix B		Totals =	5.6216	510.44

CN (weighted) = total product / total area = 510.44 / 5.622 = 90.8

Ia (average) = 5 x pervious area / total area = 5 x 1.6865 / 5.622 = 1.5 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.45 km (along drainage path)

Catchment Slope Sc= 0.021 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 90.8 / (200- 90.8) = 0.83

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.59 1.11 3.19 = 0.17 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.12 hrs

4.26 mins

OK

use

0.1749077 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 2 CATCHMENT XXIX	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.056216	km2(100ha =1km2)
Runoff curve number	CN=	90.8	(from worksheet 1)
Initial abstraction	Ia=	1.5	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 25.7 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
P24			13.2		(%)
4. 24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.43	0.34	0.79		
6. Specific peak flow rate q*	0.109	0.091	0.155		
7. Peak flow rate, q_p=q*A*P_{24}	0.257	0.153	1.677		m3/s
PEAK FLOW RATE PRE DEV=	0.071	0.034	0.909		
PRE TO POST FLOW RATE=	**0.187**	**0.120**	**0.768**		
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	24.8	15.0	168.3		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	1392.12	841.91	9458.96		(m3)
RUNOFF VOLUME PRE DEV=	609.61	307.55	7138.41		
PRE TO POST VOLUME=	**782.51**	**534.36**	**2320.55**		

SMAF 1 retention volume =	**196.8**	m3	
SMAF 1 Detention volume =	**585.8**	m3	
Total SMAF 1 mitigation volume=	**782.5**	m3	
SMAF 2 post development run-off volume=	**841.9**	m3	= WQV
Wetland Based requirement is=	1683.8	m2	= death storage depth
Wetand base measuremetn (1 in 3 shape)	24mx 72m= 1728	m2	= width * length
SMAF 1 storage height=	0.45	m	= SMAF 1/ 1728m2
Additonal space for SMAF 1 storage=	1.42	m	= side slope at 32% grade
additional space for maintanace track=	3.5	m	
final wetland size =	33.84m*81.84m= 2769.5m2		= (width+1.42*2+3.5*2)*(length+1.42*2+3.5*2)

Worksheet 2: Graphical Peak Flow Rate

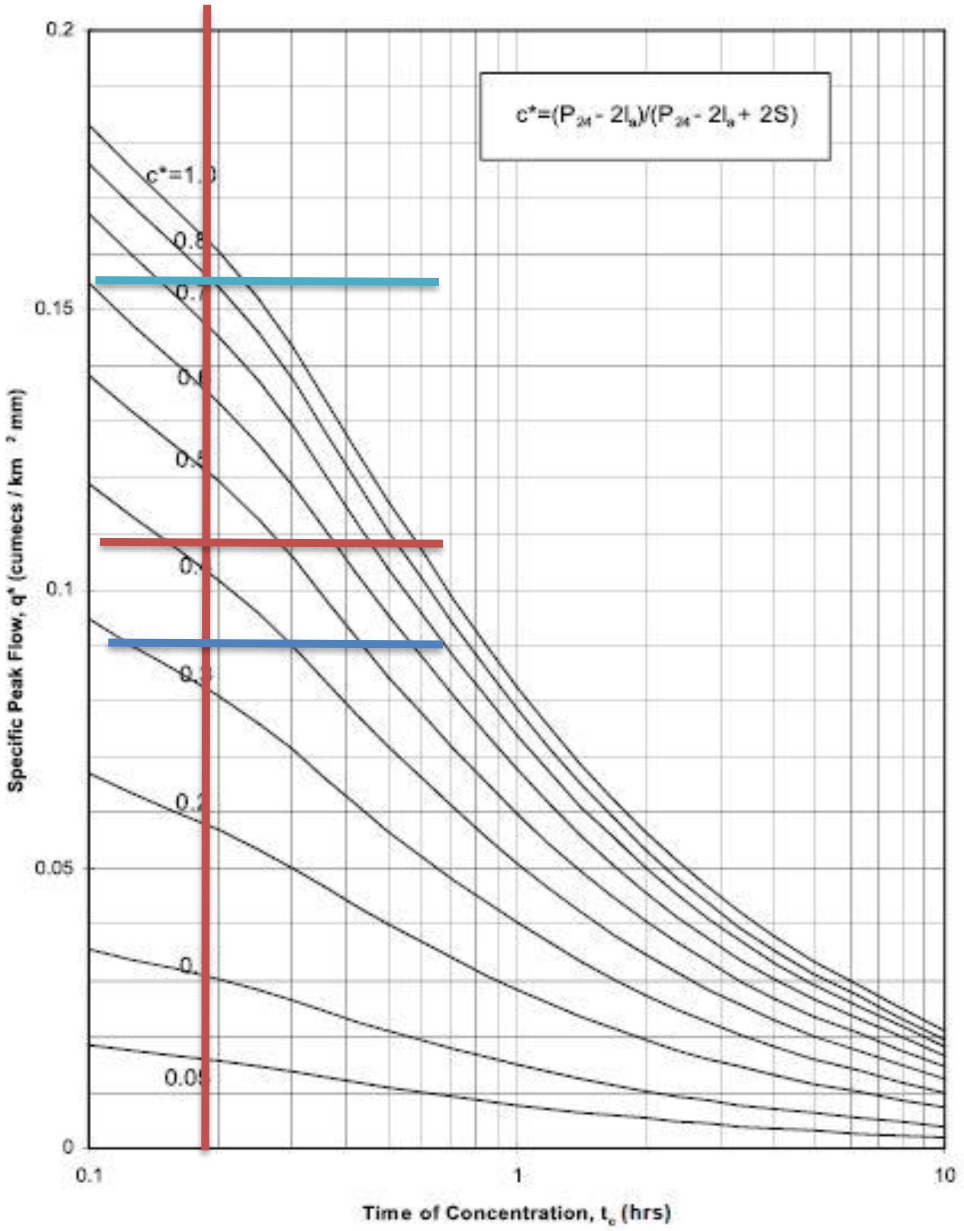


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 3 CATCHMENT XXXI	Author KH	Date 7/06/2023	Checked LC

Catchment	Area*	SMAF1 Mitigation volume (m3)	SMAF2 Post Dev runoff volume (m3)	Wetland estimate size
XXXI	218388	3040	3271	56.86m (W)*150.86m(L)
Total	218388	3040	3271	8577.9m2

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 3 CATCHMENT XXXI	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	21.8388	1616.07
* from Appendix B		Totals =	21.8388	1616.07

CN (weighted) = total product / total area = 1616.07 / 21.839 = 74.0

Ia (average) = 5 x pervious area / total area = 5 x 21.8388 / 21.839 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.5 km (along drainage path)

Catchment Slope Sc= 0.012 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 1.31 1.34 3.77 = 0.92 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.62 hrs

37.15 mins

OK
use
0.92 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 3	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 3 CATCHMENT XXXI	Author KH	Date 13/12/2022	Checked LC

1. Data
   Catchment Area A= 0.218388 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= 0.92 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. <u>24 hour rainfall depth</u>	42	30	170		(mm)
Climate change %			13.2		
24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15	0.10	0.51		
6. Specific peak flow rate q*	0.024	0.015	0.064		
7. Peak flow rate, q_p=q*A*P_{24}	**0.220**	**0.098**	**2.690**		m3/s
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	10.8	5.5	127.0		mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	2368.23	1194.75	27731.32		(m3)

Worksheet 2: Graphical Peak Flow Rate

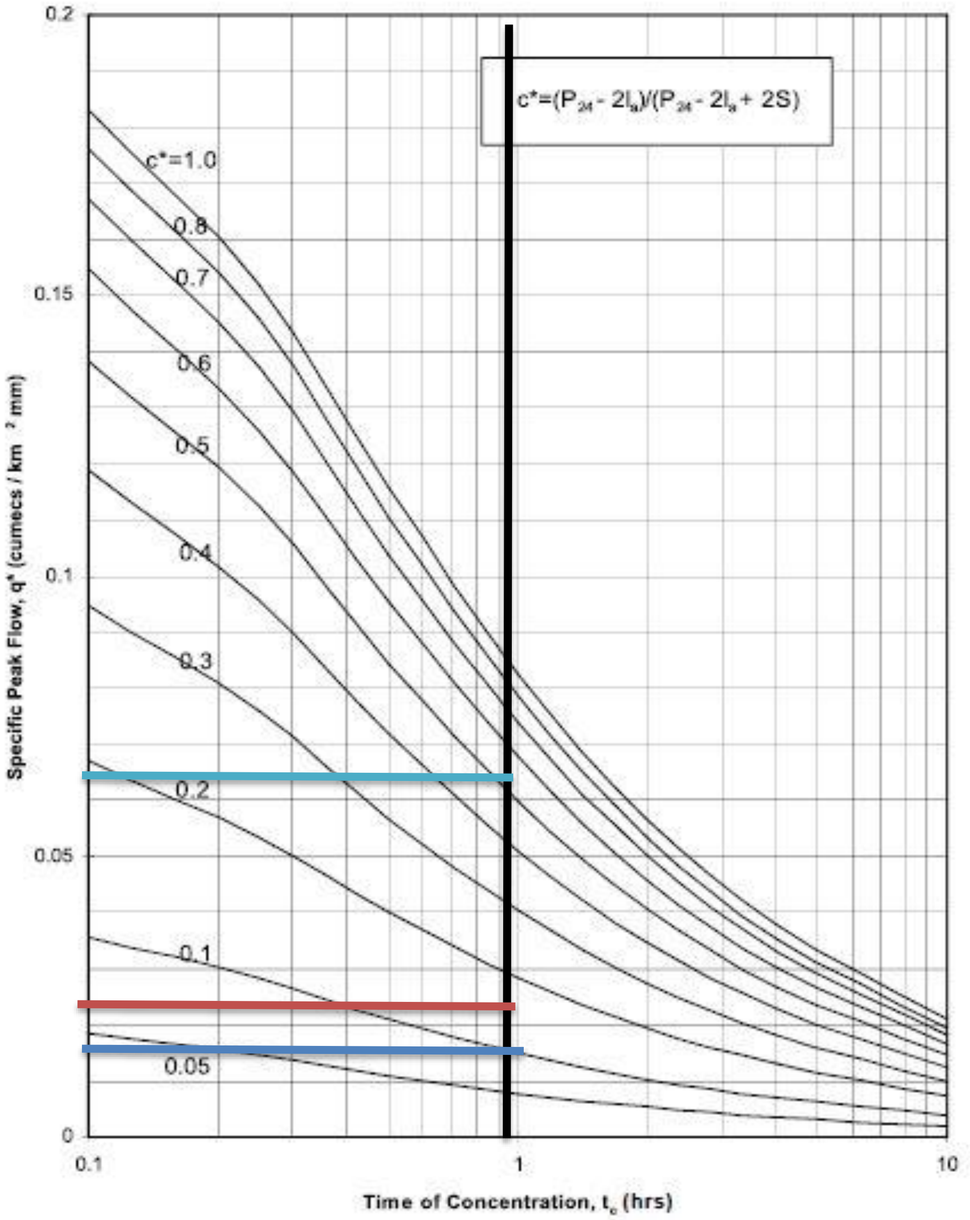


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 3 CATCHMENT XXXI	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	15.2872	1498.14
C	Grass (landscape and gardens)	74	6.5516	484.82
* from Appendix B		Totals =	21.8388	1982.96

CN (weighted) = total product / total area = 1982.96 / 21.839 = 90.8

Ia (average) = 5 x pervious area / total area = 5 x 6.5516 / 21.839 = 1.5 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 1 km (along drainage path)

Catchment Slope Sc= 0.019 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 90.8 / (200- 90.8) = 0.83

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.00 1.11 3.28 = 0.31 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.20 hrs

4.26 mins

OK

use

0.3053012 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 3 CATCHMENT XXXI	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.218388	km2(100ha =1km2)
Runoff curve number	CN=	90.8	(from worksheet 1)
Initial abstraction	Ia=	1.5	mm (from worksheet 1)
Time of concentration	tc=	0.31	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 25.7 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
P24			13.2		(%)
4. 24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.43	0.34	0.79		
6. Specific peak flow rate q*	0.095	0.078	0.135		
7. Peak flow rate, q_p=q*A*P_{24}	0.871	0.511	5.674		m3/s
PEAK FLOW RATE PRE DEV=	0.220	0.098	2.690		
PRE TO POST FLOW RATE=	**0.651**	**0.413**	**2.984**		
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	24.8	15.0	168.3		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	5408.13	3270.64	36746.20		(m3)
RUNOFF VOLUME PRE DEV=	2368.23	1194.75	27731.32		
PRE TO POST VOLUME=	**3039.89**	**2075.89**	**9014.88**		

SMAF 1 retention volume = **764.4** m3
SMAF 1 Detention volume = **2275.5** m3
Total SMAF 1 mitigation volume= **3039.9** m3

SMAF 2 post development run-off volume= **3270.6** m3
Wetland Based requirement is= 6541.3 m2 = death storage depth

Wetand base measuremetn (1 in 3 shape) 47mx 141m= 6627 m2 = width * length
SMAF 1 storage height= 0.46 m = SMAF 1/ 6627m2
Additonal space for SMAF 1 storage= 1.43 m = side slope at 32% grade
additional space for maintanace track= 3.5 m

final wetland size = 56.86m*150.86m= 8577.9r = (width+1.43*2+3.5*2)*(length+1.43*2+3.5*2)

Worksheet 2: Graphical Peak Flow Rate

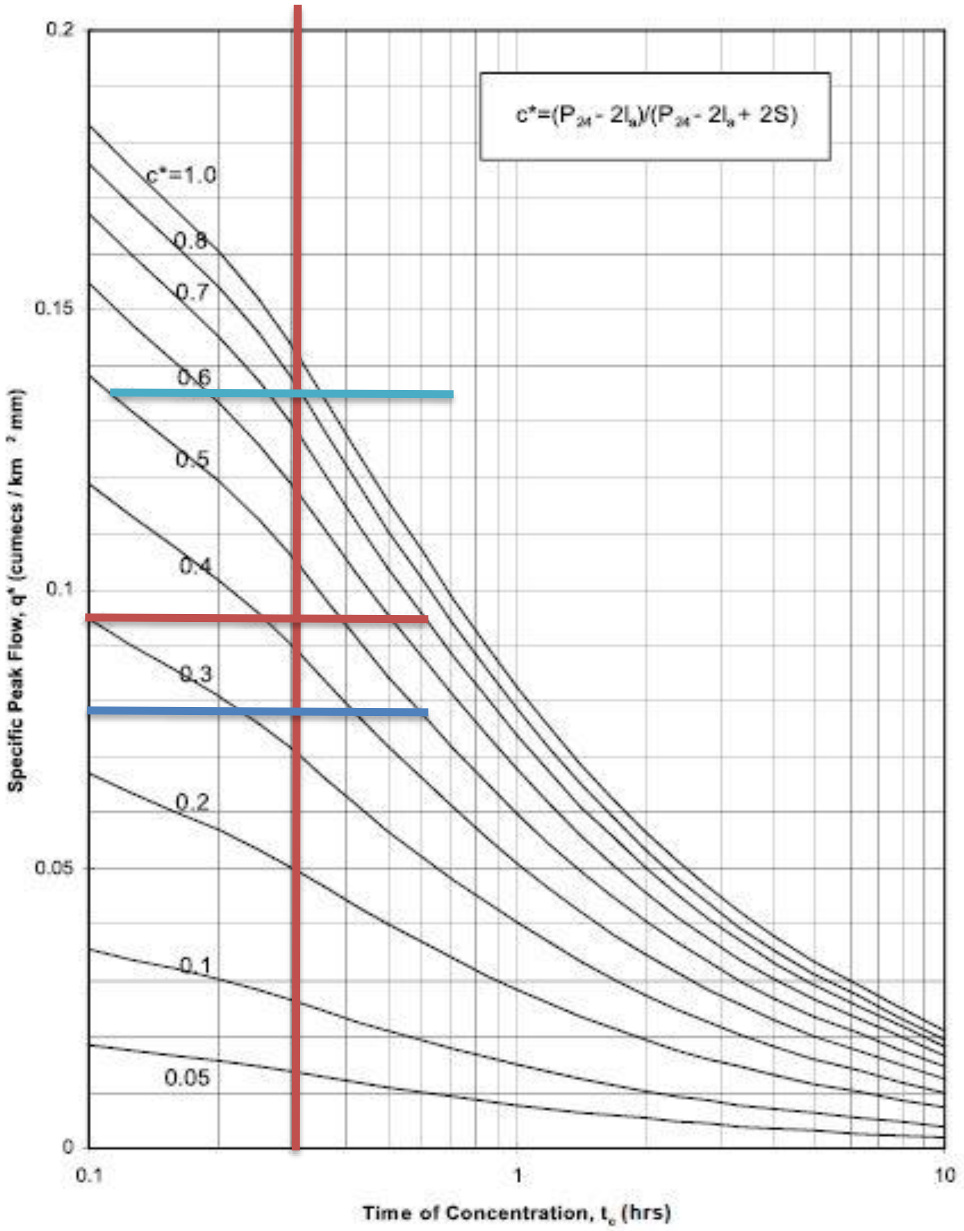


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title WARKWORTH SOUTH PCA Calc Title WETLAND SIZING CALCULATION WETLAND 4 CATCHMENT XXXIV	Author KH	Date 7/06/2023	Checked LC

Catchment	Area*	SMAF1 Mitigation volume (m3)	SMAF2 Post Dev runoff volume (m3)	Wetland estimate size
XXXIV	57295	798	858	33.84m(w)*81.84m(L)
Total	57295	798	858	2769.5m2

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 4 CATCHMENT XXXIV	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	5.7295	423.98
* from Appendix B		Totals =	5.7295	423.98

CN (weighted) = total product / total area = 423.98 / 5.730 = 74.0

Ia (average) = 5 x pervious area / total area = 5 x 5.7295 / 5.730 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 0.7 km (along drainage path)

Catchment Slope Sc= 0.032 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 0.79 1.34 2.81 = 0.42 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.28 hrs

16.74 mins

OK

use

0.42 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 3	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 4 CATCHMENT XXXIV	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.057295	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=	0.42	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
Climate change %			13.2		
24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15	0.10	0.51		
6. Specific peak flow rate q*	0.035	0.022	0.094		
7. Peak flow rate, q_p=q*A*P_{24}	**0.084**	**0.038**	**1.036**		m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	10.8	5.5	127.0		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	621.32	313.45	7275.43		(m3)

Worksheet 2: Graphical Peak Flow Rate

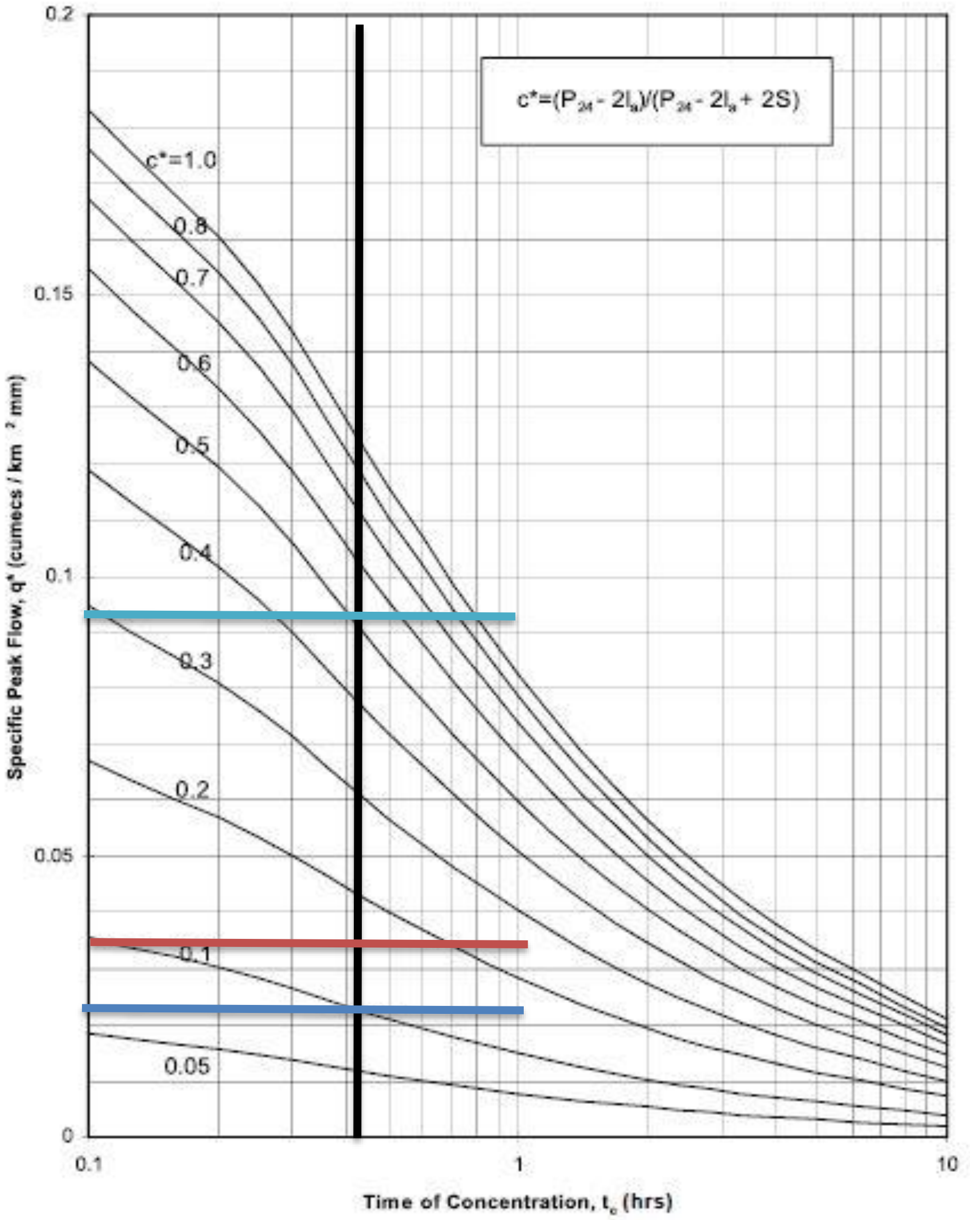


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 4 CATCHMENT XXXIV	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	4.0107	393.04
C	Grass (landscape and gardens)	74	1.7189	127.19
* from Appendix B		Totals =	5.7295	520.24

CN (weighted) = total product / total area = 520.24 / 5.730 = 90.8

Ia (average) = 5 x pervious area / total area = 5 x 1.7189 / 5.730 = 1.5 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.45 km (along drainage path)

Catchment Slope Sc= 0.049 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 90.8 / (200- 90.8) = 0.83

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.59 1.11 2.47 = 0.14 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.09 hrs

4.26 mins

NO GOOD

use

0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 2	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 4 CATCHMENT XXXIV	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.057295	km2(100ha =1km2)
Runoff curve number	CN=	90.8	(from worksheet 1)
Initial abstraction	Ia=	1.5	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 25.7 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
P24			13.2		(%)
4. 24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.43	0.34	0.79		
6. Specific peak flow rate q*	0.110	0.090	0.156		
7. Peak flow rate, q_p=q*A*P_{24}	0.265	0.155	1.720		m3/s
PEAK FLOW RATE PRE DEV=	0.084	0.038	1.036		
PRE TO POST FLOW RATE=	**0.180**	**0.117**	**0.684**		
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	24.8	15.0	168.3		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	1418.84	858.07	9640.52		(m3)
RUNOFF VOLUME PRE DEV=	621.32	313.45	7275.43		
PRE TO POST VOLUME=	**797.53**	**544.62**	**2365.09**		

SMAF 1 retention volume = **200.5** m3
SMAF 1 Detention volume = **597.0** m3
Total SMAF 1 mitigation volume= **797.5** m3

SMAF 2 post development run-off volume= **858.1** m3
Wetland Based requirement is= 1716.1 m2 = death storage depth
24mx72m
Wetand base measuremetn (1 in 3 shape) = 1728 m2 = width * length
SMAF 1 storage height= 0.46 m = SMAF 1/ 1728m2
Additonal space for SMAF 1 storage= 1.44 m = side slope at 32% grade
additional space for maintanace track= 3.5 m
final wetland size = 33.84m*81.84m= 2769.5m = (length+1.42*2+3.5*2)

Worksheet 2: Graphical Peak Flow Rate

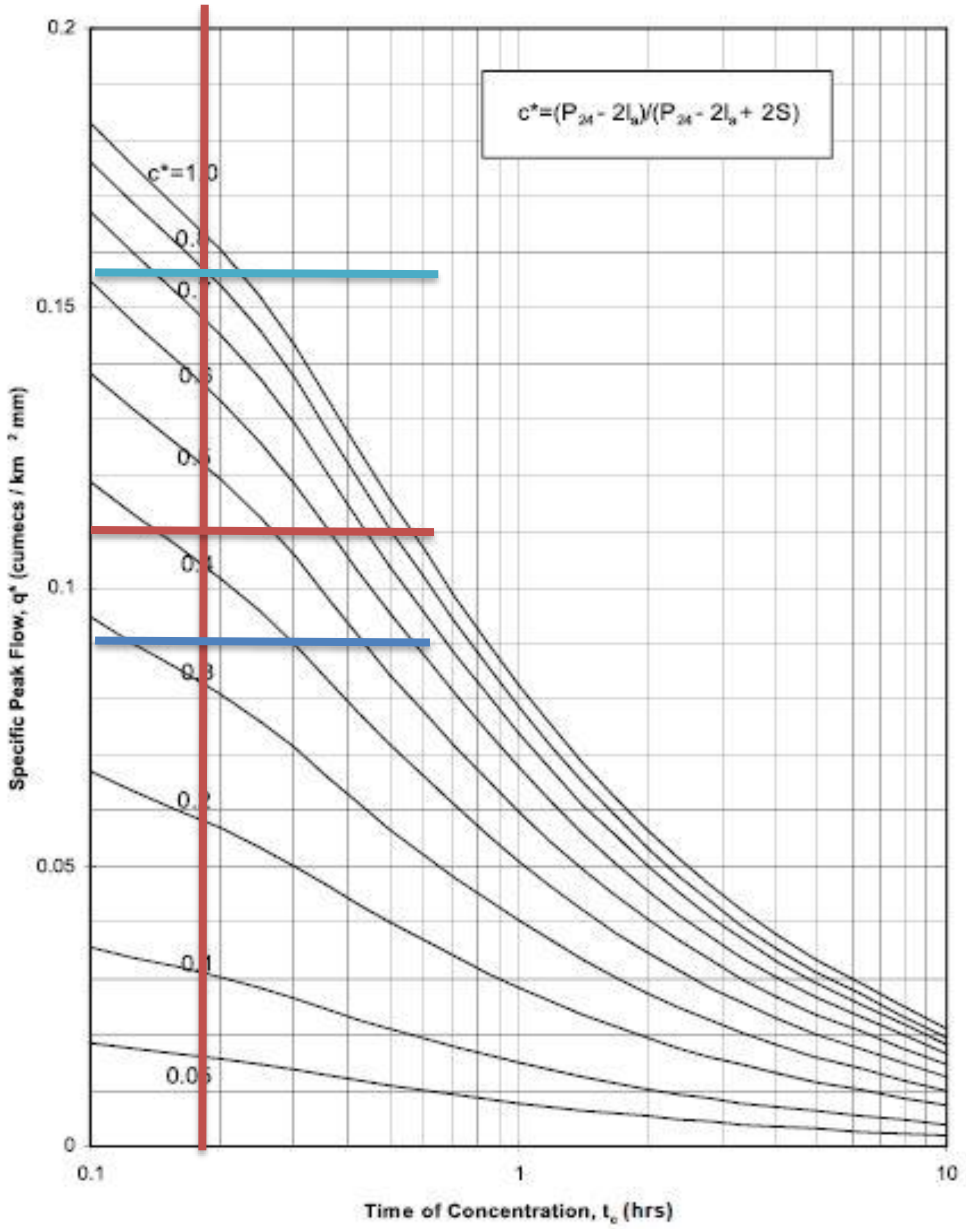


Figure 5.1 – Specific Peak Flow Rate

	MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 5 CATCHMENT XXXIV	Author KH	Date 7/06/2023	Checked LC

Catchment	Area*	SMAF1 Mitigation volume (m3)	SMAF2 Post Dev runoff volume (m3)	Wetland estimate size
XXXIV	38062	530	570	29.76m(w)*69.76m(L)
Total	38062	530	570	2076m2

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 5 CATCHMENT XXXIV	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	3.8062	281.66
* from Appendix B		Totals =	3.8062	281.66

CN (weighted) = total product / total area = 281.66 / 3.806 = 74.0

Ia (average) = 5 x pervious area / total area = 5 x 3.8062 / 3.806 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 0.65 km (along drainage path)

Catchment Slope Sc= 0.0165 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 0.75 1.34 3.43 = 0.48 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.32 hrs

19.44 mins

OK

use

0.48 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 3	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 5 CATCHMENT XXXIV	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.038062	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=	0.48	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. <u>24 hour rainfall depth</u>	42	30	170		(mm)
Climate change %			13.2		
24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15	0.10	0.51		
6. Specific peak flow rate q*	0.032	0.022	0.087		
7. Peak flow rate, q_p=q*A*P_{24}	**0.051**	**0.025**	**0.637**		m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	10.8	5.5	127.0		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	412.75	208.23	4833.18		(m3)

Worksheet 2: Graphical Peak Flow Rate

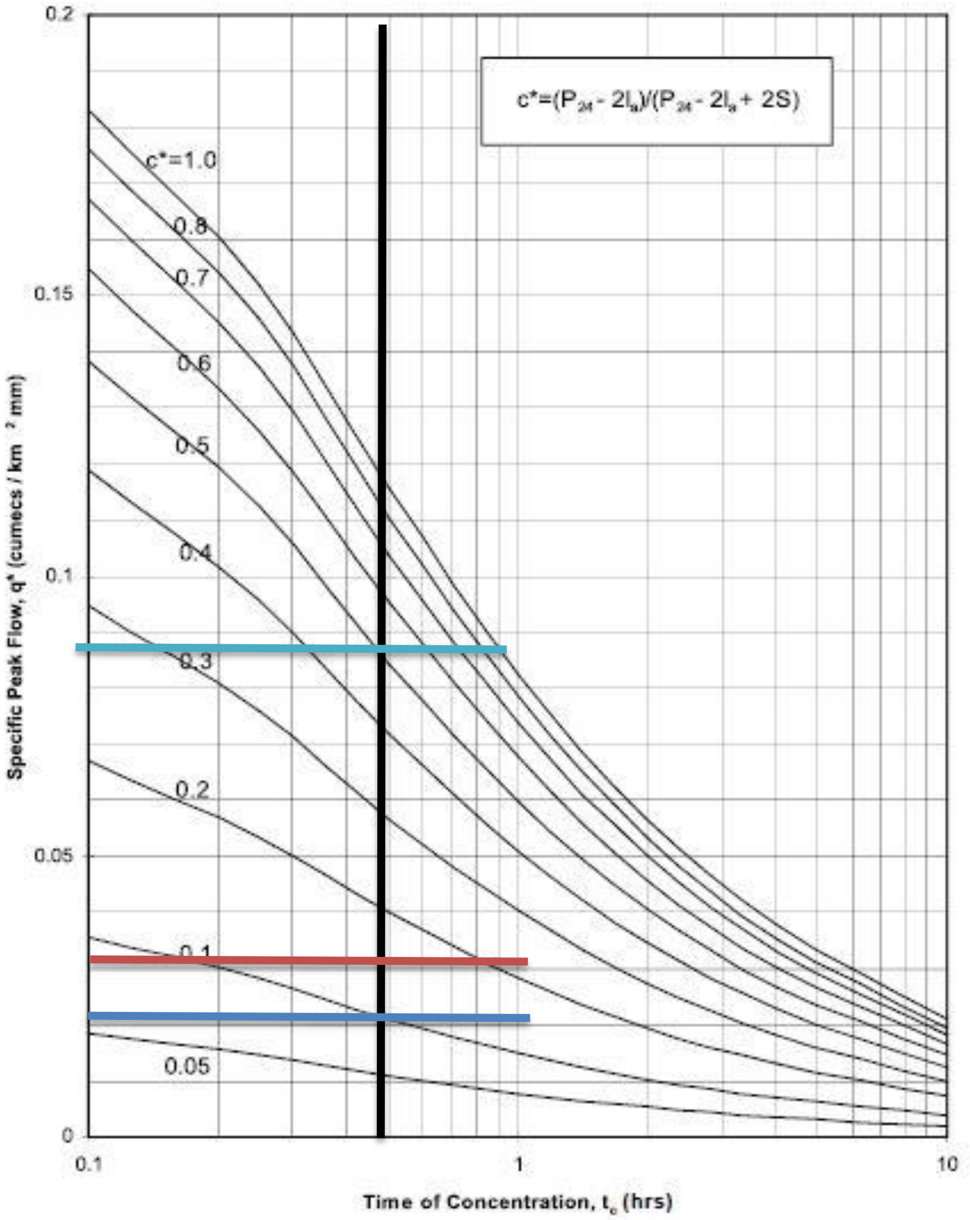


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title — WARKWORTH SOUTH PCA / WETLAND SIZING CALCULATION / WETLAND 5 CATCHMENT XXXIV	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	2.6643	261.11
C	Grass (landscape and gardens)	74	1.1419	84.50
* from Appendix B		Totals =	3.8062	345.60

CN (weighted) = total product / total area = 345.60 / 3.806 = 90.8

Ia (average) = 5 x pervious area / total area = 5 x 1.1419 / 3.806 = 1.5 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.6 km (along drainage path)

Catchment Slope Sc= 0.02 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 90.8 / 200- 90.8 = 0.83

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.71 1.11 3.23 = 0.21 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.14 hrs

4.26 mins

OK

use

0.2145978 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA / WETLAND SIZING CALCULATION / WETLAND 5 CATCHMENT XXXIV	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.038062	km2(100ha =1km2)
Runoff curve number	CN=	90.8	(from worksheet 1)
Initial abstraction	Ia=	1.5	mm (from worksheet 1)
Time of concentration	tc=	0.21	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 25.7 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
P24			13.2		(%)
4. 24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.43	0.34	0.79		
6. Specific peak flow rate q*	0.105	0.088	0.152		
7. Peak flow rate, q_p=q*A*P_{24}	0.168	0.100	1.113		m3/s
PEAK FLOW RATE PRE DEV=	0.051	0.025	0.637		
PRE TO POST FLOW RATE=	**0.117**	**0.075**	**0.476**		
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	24.8	15.0	168.3		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	942.56	570.03	6404.35		(m3)
RUNOFF VOLUME PRE DEV=	412.75	208.23	4833.18		
PRE TO POST VOLUME=	**529.81**	**361.80**	**1571.17**		

SMAF 1 retention volume =	**133.2**	m3	
SMAF 1 Detention volume =	**396.6**	m3	
Total SMAF 1 mitigation volume=	**529.8**	m3	
SMAF 2 post development run-off volume=	**570.0**	m3	
Wetland Based requirement is=	1140.1	m2	= death storage depth
Wetand base measuremetn (1 in 3 shape)	20mx60m = 1200	m2	= width * length
SMAF 1 storage height=	0.44	m	= SMAF 1/ 1200m2
Additonal space for SMAF 1 storage=	1.38	m	= side slope at 32% grade
additional space for maintanace track=	3.5	m	
final wetland size =	29.76m*69.76m= 2076m2		= (length+1.38*2+3.5*2)

Worksheet 2: Graphical Peak Flow Rate

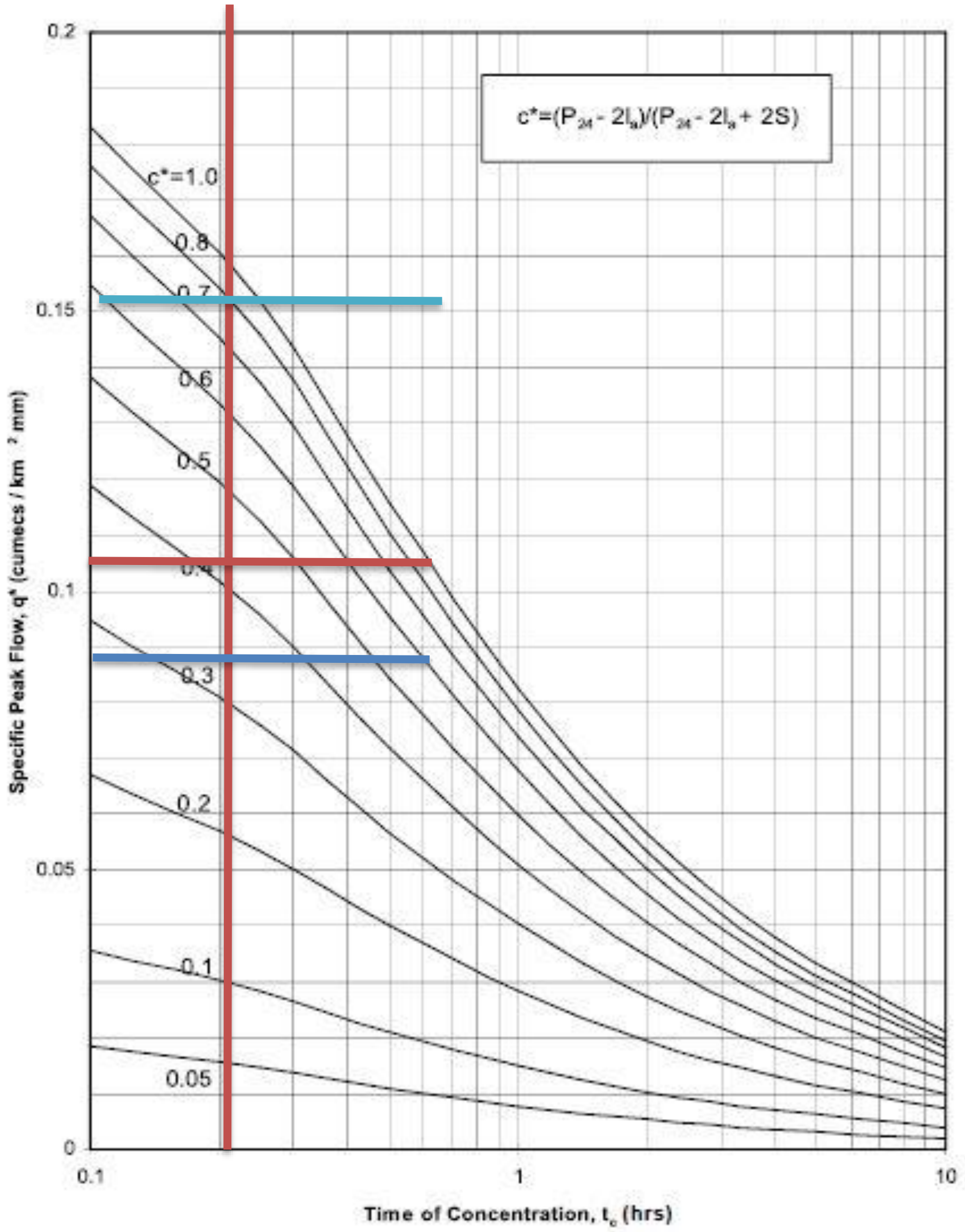


Figure 5.1 – Specific Peak Flow Rate

	MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 6 CATCHMENT XXXV	Author KH	Date 7/06/2023	Checked LC

Catchment	Area*	SMAF1 Mitigation volume (m3)	SMAF2 Post Dev runoff volume (m3)	Wetland estimate size
XXXV	44614	621	668	30.94m(w)*72.94m(L)
Total	44614	621	668	2256.8m2

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 6 CATCHMENT XXXV	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	4.4614	330.14
* from Appendix B		Totals =	4.4614	330.14

CN (weighted) = total product / total area = 330.14 / 4.461 = 74.0

Ia (average) = 5 x pervious area / total area = 5 x 4.4614 / 4.461 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 0.75 km (along drainage path)

Catchment Slope Sc= 0.012 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.0 / (200- 74.0) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 0.83 1.34 3.77 = 0.58 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.39 hrs

23.51 mins

OK
use
0.58 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 3	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 6 CATCHMENT XXXV	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.044614	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=	0.58	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. <u>24 hour rainfall depth</u>	42	30	170		(mm)
Climate change %			13.2		
24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15	0.10	0.51		
6. Specific peak flow rate q*	0.030	0.020	0.081		
7. Peak flow rate, q_p=q*A*P_{24}	**0.056**	**0.027**	**0.695**		m3/s
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	10.8	5.5	127.0		mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	483.80	244.07	5665.17		(m3)

Worksheet 2: Graphical Peak Flow Rate

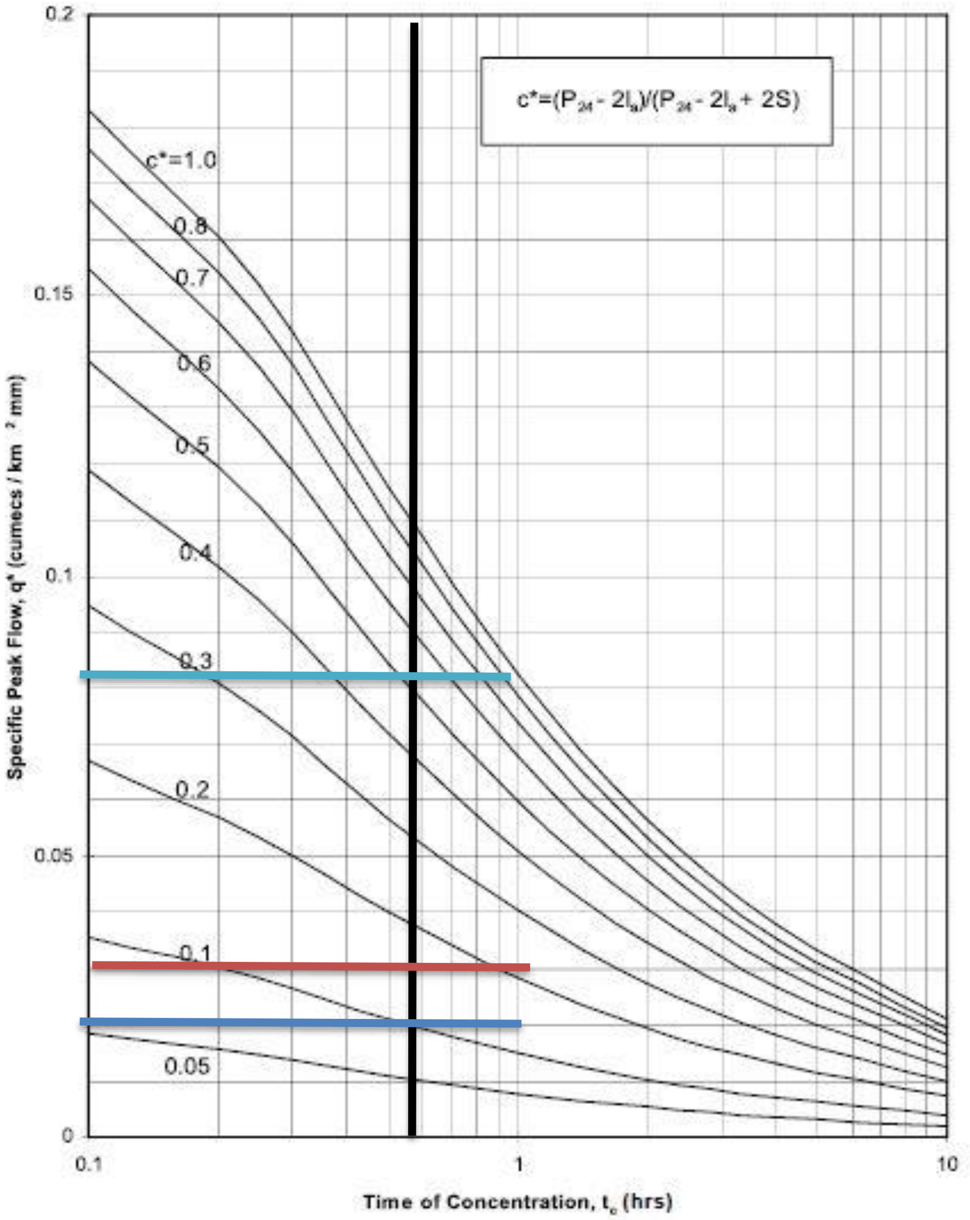


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 6 CATCHMENT XXXV	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	3.1230	306.05
C	Grass (landscape and gardens)	74	1.3384	99.04
* from Appendix B		Totals =	4.4614	405.10

CN (weighted) = total product / total area = 405.10 / 4.461 = 90.8

Ia (average) = 5 x pervious area / total area = 5 x 1.3384 / 4.461 = 1.5 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.55 km (along drainage path)

Catchment Slope Sc= 0.0193 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 90.8 / (200- 90.8) = 0.83

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.67 1.11 3.27 = 0.20 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.14 hrs

4.26 mins

OK

use

0.2047985 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 6 CATCHMENT XXXV	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area A= 0.044614 km2(100ha =1km2)

Runoff curve number CN= 90.8 (from worksheet 1)

Initial abstraction Ia= 1.5 mm (from worksheet 1)

Time of concentration tc= 0.20 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 25.7 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth P24	42	30	170		(mm)
			13.2		(%)
4. 24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.43	0.34	0.79		
6. Specific peak flow rate q*	0.119	0.090	0.153		
7. Peak flow rate, q_p=q*A*P_{24}	0.223	0.120	1.314		m3/s
PEAK FLOW RATE PRE DEV=	0.056	0.027	0.695		
PRE TO POST FLOW RATE=	**0.167**	**0.094**	**0.618**		
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	24.8	15.0	168.3		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	1104.81	668.15	7506.80		(m3)
RUNOFF VOLUME PRE DEV=	483.80	244.07	5665.17		
PRE TO POST VOLUME=	**621.01**	**424.08**	**1841.63**		

SMAF 1 retention volume = **156.1** m3
SMAF 1 Detention volume = **464.9** m3
Total SMAF 1 mitigation volume= **621.0** m3
SMAF 2 post development run-off volume= **668.2** m2
Wetland Based requirement is= 1336.3 m2 = death storage depth
Wetand base measuremetn (1 in 3 shape) 21mx63m = 1323 m2 = width * length
SMAF 1 storage height= 0.47 m = SMAF 1/ 1728m2
Additonal space for SMAF 1 storage= 1.47 m = side slope at 32% grade
additional space for maintanace track= 3.5 m
final wetland size = 30.94m*72.94m= 2256.8m = (length+1.47*2+3.5*2)

Worksheet 2: Graphical Peak Flow Rate

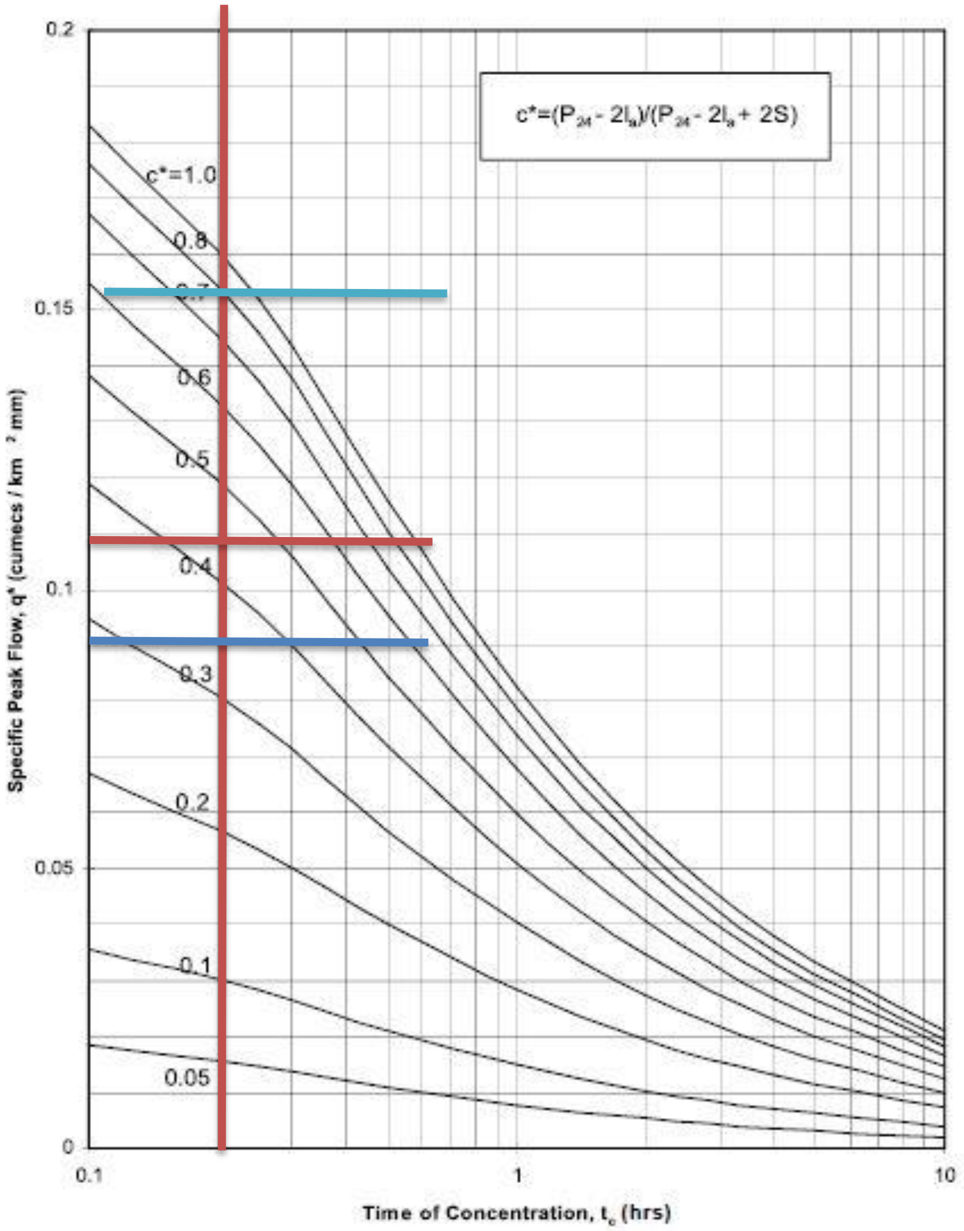


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title WARKWORTH SOUTH PCA Calc Title WETLAND SIZING CALCULATION WETLAND 7 CATCHMENT XV	Author KH	Date 7/06/2023	Checked LC

Catchment	Area*	SMAF1 Mitigation volume (m3)	SMAF2 Post Dev runoff volume (m3)	Wetland estimate size
XV	51346	715	769	32.82m(w)*78.82m(L)
Total	51346	715	769	2586.9m2

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title — WARKWORTH SOUTH PCA / WETLAND SIZING CALCULATION / WETLAND 7 CATCHMENT XV	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	5.1346	379.96
* from Appendix B		Totals =	5.1346	379.96

CN (weighted) = total product / total area = 379.96 / 5.135 = 74.0

Ia (average) = 5 x pervious area / total area = 5 x 5.1346 / 5.135 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 0.75 km (along drainage path)

Catchment Slope Sc= 0.03 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 0.83 1.34 2.86 = 0.44 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.30 hrs

17.86 mins

OK

use

0.44 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 3	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 7 CATCHMENT XV	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.051346	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=	0.44	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
Climate change %			13.2		
24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15	0.10	0.51		
6. Specific peak flow rate q*	0.034	0.022	0.091		
7. Peak flow rate, q_p=q*A*P_{24}	**0.073**	**0.034**	**0.899**		m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	10.8	5.5	127.0		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	556.80	280.90	6520.01		(m3)

Worksheet 2: Graphical Peak Flow Rate

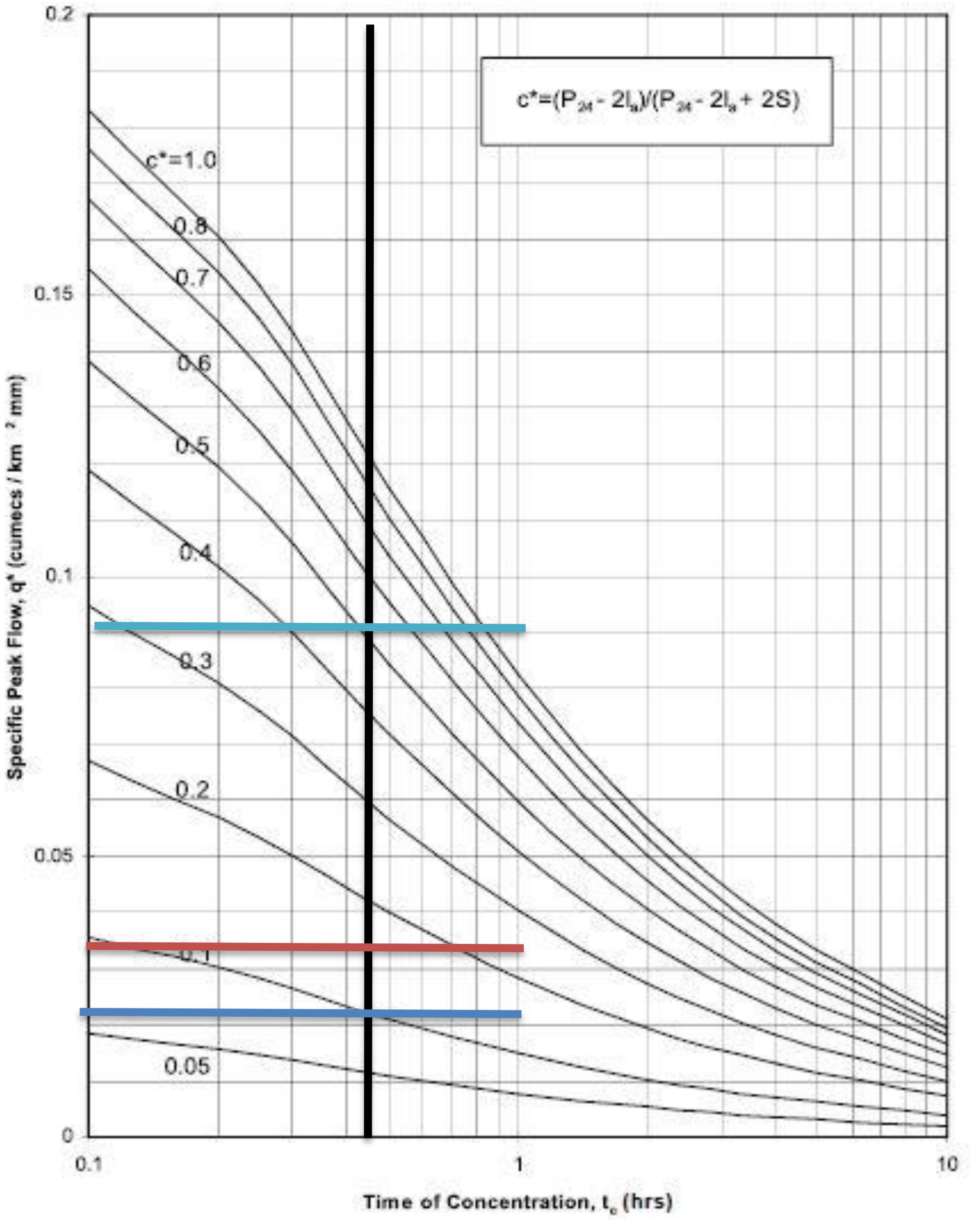


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA / WETLAND SIZING CALCULATION / WETLAND 7 CATCHMENT XV	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	3.5942	352.23
C	Grass (landscape and gardens)	74	1.5404	113.99
* from Appendix B		Totals =	5.1346	466.22

CN (weighted) = total product / total area = 466.22 / 5.135 = 90.8

Ia (average) = 5 x pervious area / total area = 5 x 1.5404 / 5.135 = 1.5 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= 0.043 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 90.8 / (200- 90.8) = 0.83

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.63 1.11 2.57 = 0.15 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.10 hrs

4.26 mins

NO GOOD

use

0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 7 CATCHMENT XV	Author KH	Date 13/12/2022	Checked LC

1. Data
   Catchment Area A= 0.051346 km2(100ha =1km2)

   Runoff curve number CN= 90.8 (from worksheet 1)

   Initial abstraction Ia= 1.5 mm (from worksheet 1)

   Time of concentration tc= 0.17 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 25.7 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
P24			13.2		(%)
4. 24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.43	0.34	0.79		
6. Specific peak flow rate q*	0.109	0.089	0.156		
7. Peak flow rate, q_p=q*A*P_{24}	0.235	0.137	1.541		m3/s
PEAK FLOW RATE PRE DEV=	0.073	0.034	0.899		
PRE TO POST FLOW RATE=	**0.162**	**0.103**	**0.642**		
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	24.8	15.0	168.3		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	1271.52	768.97	8639.53		(m3)
RUNOFF VOLUME PRE DEV=	556.80	280.90	6520.01		
PRE TO POST VOLUME=	**714.72**	**488.07**	**2119.52**		

SMAF 1 retention volume =	**179.7**	m3		
SMAF 1 Detention volume =	**535.0**	m3		
Total SMAF 1 mitigation volume=	**714.7**	m3		
SMAF 2 post development run-off volume=	**769.0**	m3		
Wetland Based requirement is=	1537.9	m2	=	death storage depth
Wetand base measuremetn (1 in 3 shape)	23mx69m = 1587	m2	=	width * length
SMAF 1 storage height=	0.45	m	=	SMAF 1/ 1587m2
Additonal space for SMAF 1 storage=	1.41	m	=	side slope at 32% grade
additional space for maintanace track=	3.5	m		
final wetland size =	32.82m*78.82m= 2586.9m		=	(length+1.41*2+3.5*2)

Worksheet 2: Graphical Peak Flow Rate

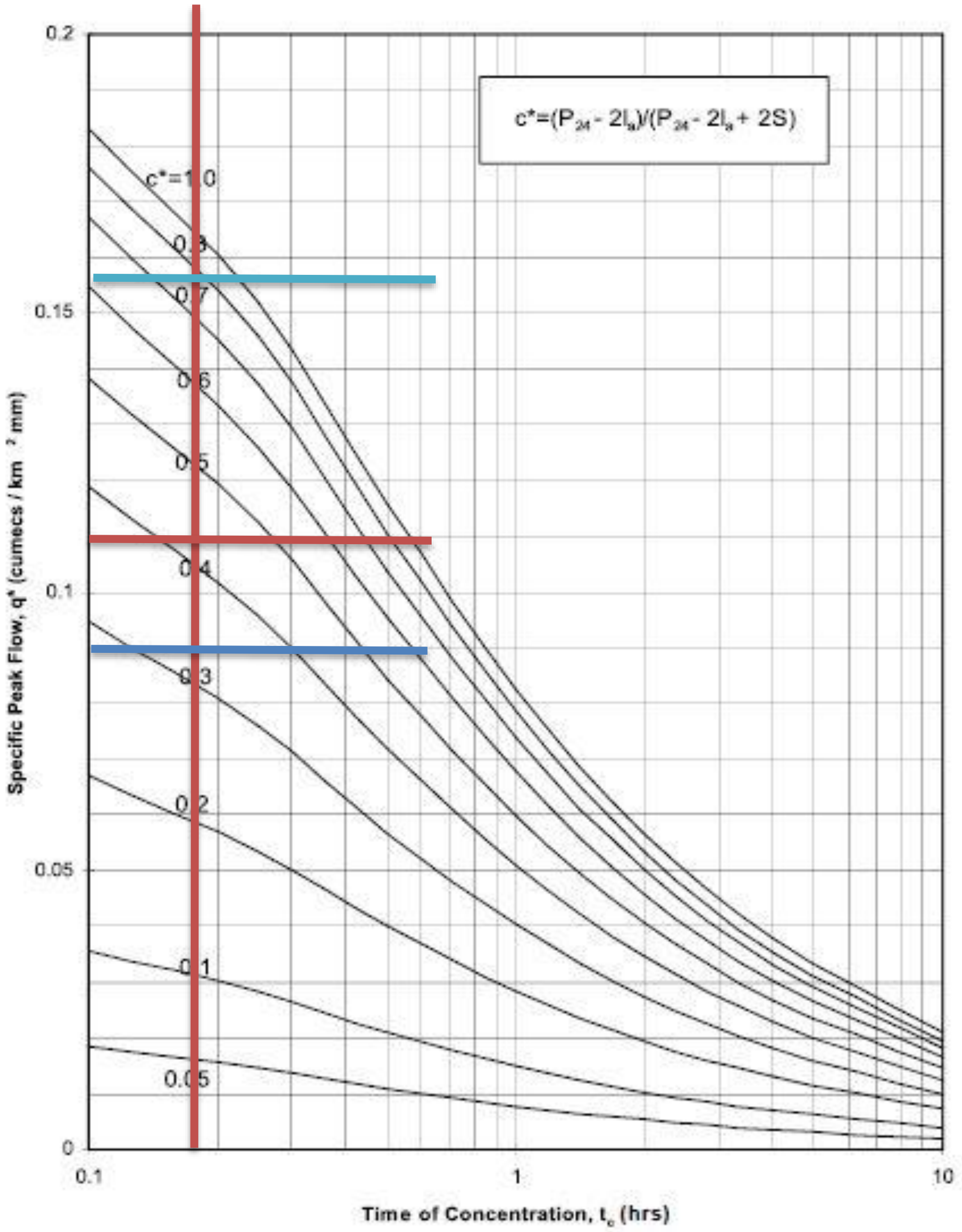


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 8 CATCHMENT XII	Author KH	Date 7/06/2023	Checked LC

Catchment	Area*	SMAF1 Mitigation volume (m3)	SMAF2 Post Dev runoff volume (m3)	Wetland estimate size
XII	57015	794	854	33.88m(w)*81.88m(L)
Total	57015	794	854	2774.1m2

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 8 CATCHMENT XII	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	5.7015	421.91
* from Appendix B		Totals =	5.7015	421.91

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{421.91}{5.702}$ = 74.0

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}}$ = $\frac{5 \times 5.7015}{5.702}$ = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1 km (along drainage path)

Catchment Slope Sc= 0.035 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 1.00 1.34 2.73 = 0.51 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.34 hrs

20.62 mins

OK
use
0.51 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 3	Rev A
Job Title WARKWORTH SOUTH PCA Calc Title WETLAND SIZING CALCULATION WETLAND 8 CATCHMENT XII	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.057015	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=	0.51	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
Climate change %			13.2		
24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15	0.10	0.51		
6. Specific peak flow rate q*	0.030	0.021	0.083		
7. Peak flow rate, q_p=q*A*P_{24}	**0.072**	**0.036**	**0.911**		m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	10.8	5.5	127.0		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	618.28	311.92	7239.87		(m3)

Worksheet 2: Graphical Peak Flow Rate

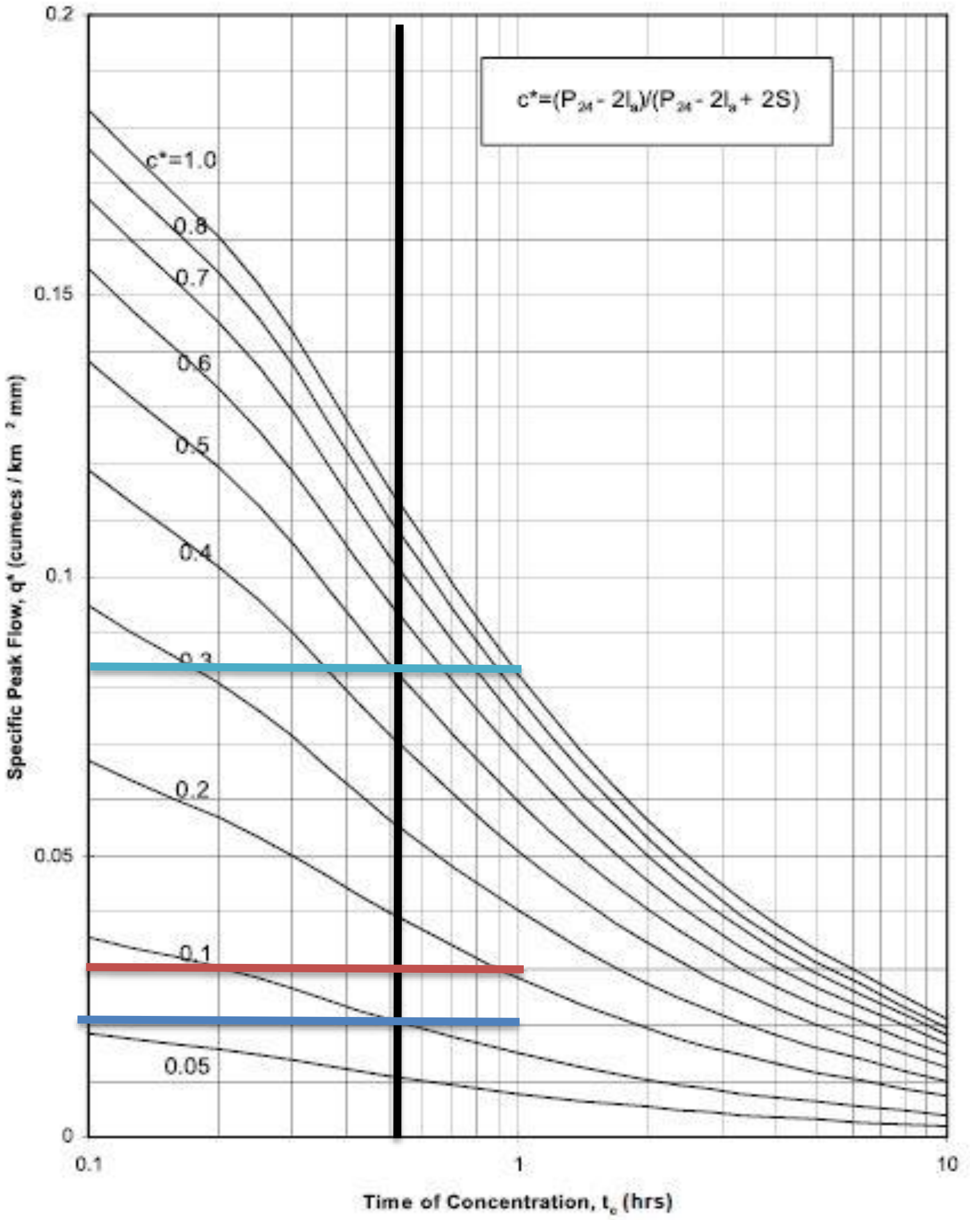


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	**Job Number** 211001	**Sheet** 1	**Rev** A
Job Title **Calc Title** — **WARKWORTH SOUTH PCA** **WETLAND SIZING CALCULATION** **WETLAND 8 CATCHMENT XII**	**Author** KH	**Date** 13/12/2022	**Checked** LC

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	Paved (concrete, gravel, metal, etc)	98	3.9911	391.12
C	Grass (landscape and gardens)	74	1.7105	126.57
* from Appendix B		Totals =	5.7015	517.70

CN (weighted) = total product / total area = 517.70 / 5.702 = 90.8

Ia (average) = 5 x pervious area / total area = 5 x 1.7105 / 5.702 = 1.5 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.7 km (along drainage path)

Catchment Slope Sc= 0.029 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 90.8 / (200- 90.8) = 0.83

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.79 1.11 2.89 = 0.21 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.14 hrs

4.26 mins

OK

use

0.21252 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 8 CATCHMENT XII	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.057015	km2(100ha =1km2)
Runoff curve number	CN=	90.8	(from worksheet 1)
Initial abstraction	Ia=	1.5	mm (from worksheet 1)
Time of concentration	tc=	0.21	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 25.7 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
P24			13.2		(%)
4. 24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.43	0.34	0.79		
6. Specific peak flow rate q*	0.108	0.089	0.153		
7. Peak flow rate, q_p=q*A*P_{24}	0.259	0.152	1.679		m3/s
PEAK FLOW RATE PRE DEV=	0.072	0.036	0.911		
PRE TO POST FLOW RATE=	**0.187**	**0.116**	**0.768**		
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	24.8	15.0	168.3		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	1411.91	853.87	9593.41		(m3)
RUNOFF VOLUME PRE DEV=	618.28	311.92	7239.87		
PRE TO POST VOLUME=	**793.63**	**541.96**	**2353.53**		

SMAF 1 retention volume =	**199.6**	m3		
SMAF 1 Detention volume =	**594.1**	m3		
Total SMAF 1 mitigation volume=	**793.6**	m3		
SMAF 2 post development run-off volume=	**853.9**	m3		
Wetland Based requirement is=	1707.7	m2	=	death storage depth
Wetand base measuremetn (1 in 3 shape)	24mx72m = 1728	m2	=	width * length
SMAF 1 storage height=	0.46	m	=	SMAF 1/ 1728m2
Additonal space for SMAF 1 storage=	1.44	m	=	side slope at 32% grade
additional space for maintanace track=	3.5	m		
final wetland size =	33.88m*81.88m=2774.1m2		=	(length+1.44*2+3.5*2)

Worksheet 2: Graphical Peak Flow Rate

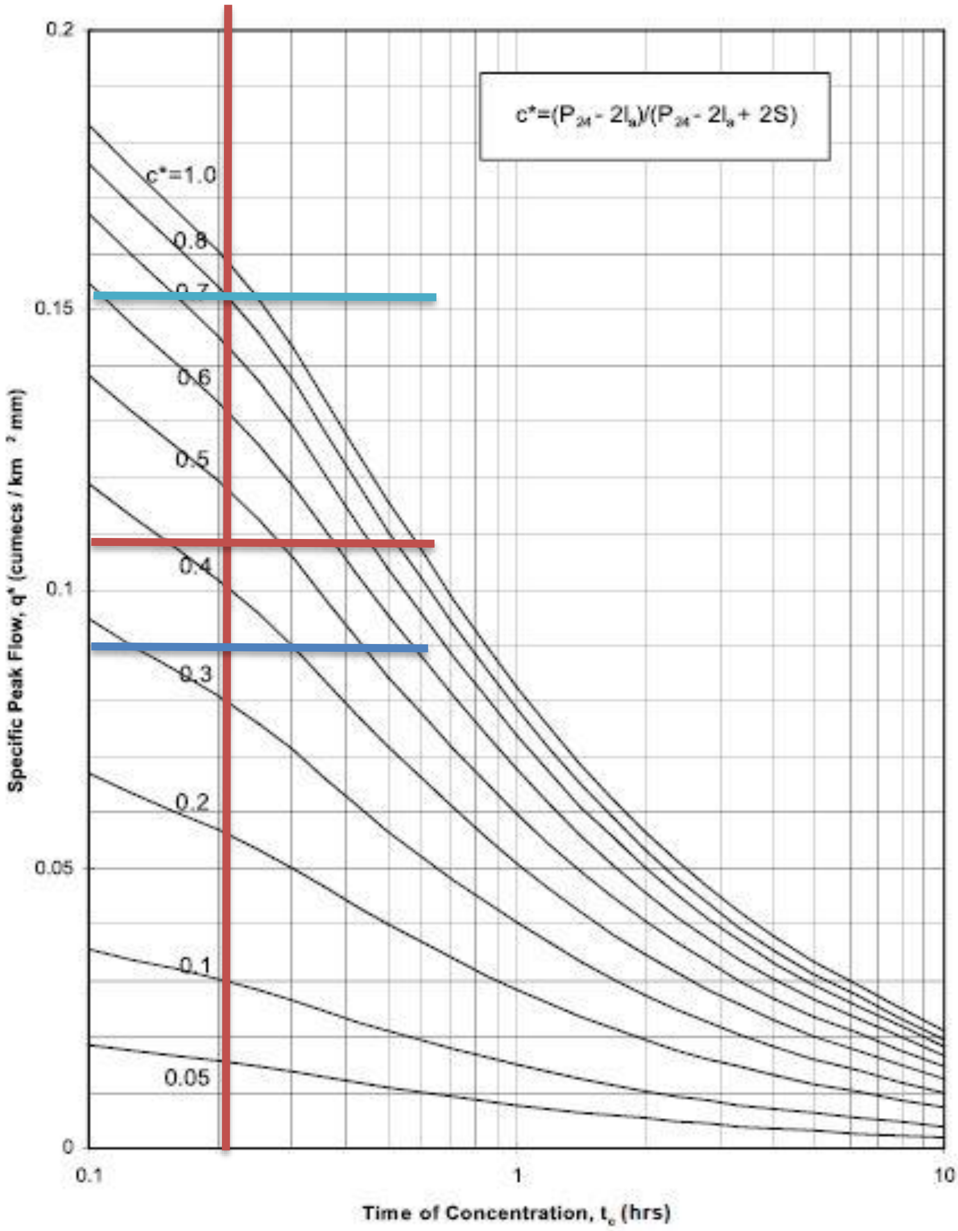


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 9 CATCHMENT XXIV	Author KH	Date 7/06/2023	Checked LC

Catchment	Area*	SMAF1 Mitigation volume (m3)	SMAF2 Post Dev runoff volume (m3)	Wetland estimate size
XXIV	58004	807	869	33.88m(w)*81.88m(L)
Total	58004	807	869	2774.1m2

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 9 CATCHMENT XXIV	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	5.8004	429.23
* from Appendix B		Totals =	5.8004	429.23

CN (weighted) = total product / total area = 429.23 / 5.800 = 74.0

Ia (average) = 5 x pervious area / total area = 5 x 5.8004 / 5.800 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 0.6 km (along drainage path)

Catchment Slope Sc= 0.049 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.0 / (200- 74.0) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 0.71 1.34 2.47 = 0.33 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.22 hrs

13.30 mins

OK
use
0.33 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	**Job Number** **211001**	**Sheet** **3**	**Rev** **A**
Job Title **WARKWORTH SOUTH PCA** **Calc Title** **WETLAND SIZING CALCULATION** **WETLAND 9 CATCHMENT XXIV**	**Author** **KH**	**Date** **13/12/2022**	**Checked** **LC**

1. Data

Catchment Area	A=	0.058004	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=	0.33	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. <u>24 hour rainfall depth</u>	42	30	170		(mm)
Climate change %			13.2		
24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15	0.10	0.51		
6. Specific peak flow rate q*	0.036	0.026	0.103		
7. Peak flow rate, q_p=q*A*P_{24}	**0.088**	**0.045**	**1.150**		m3/s
8. Runoff depth, Q_{24} = $(P_{24}-Ia)^2/(P_{24}-Ia)+S$	10.8	5.5	127.0		mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	629.00	317.33	7365.46		(m3)

Worksheet 2: Graphical Peak Flow Rate

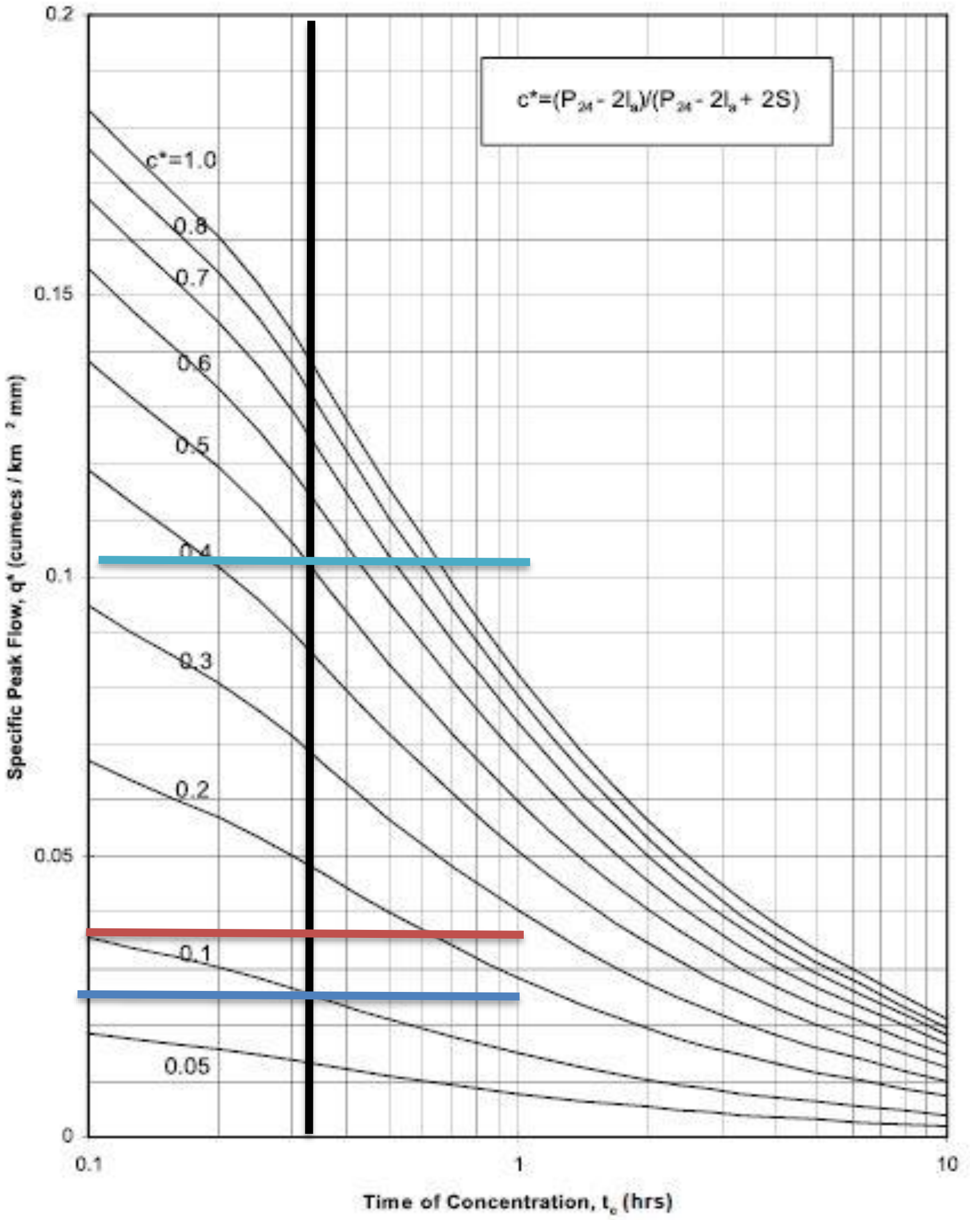


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA / WETLAND SIZING CALCULATION / WETLAND 9 CATCHMENT XXIV	Author KH	Date 13/12/2022	Checked LC

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	Paved (concrete, gravel, metal, etc)	98	4.0603	397.91
C	Grass (landscape and gardens)	74	1.7401	128.77
* from Appendix B		Totals =	5.8004	526.68

CN (weighted) = total product / total area = 526.68 / 5.800 = 90.8

Ia (average) = 5 x pervious area / total area = 5 x 1.7401 / 5.800 = 1.5 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.4 km (along drainage path)

Catchment Slope Sc= 0.065 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 90.8 / (200- 90.8) = 0.83

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.55 1.11 2.27 = 0.12 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.08 hrs

4.26 mins

NO GOOD

use

0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 9 CATCHMENT XXIV	Author KH	Date 13/12/2022	Checked LC

1. Data
   - Catchment Area A= 0.058004 km2(100ha =1km2)
   - Runoff curve number CN= 90.8 (from worksheet 1)
   - Initial abstraction Ia= 1.5 mm (from worksheet 1)
   - Time of concentration tc= 0.17 hrs (from worksheet 1)
2. Calculate storage, S =(1000/CN - 10)25.4 = 25.7 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
P24			13.2		(%)
4. 24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.43	0.34	0.79		
6. Specific peak flow rate q*	0.112	0.092	0.157		
7. Peak flow rate, q_p=q*A*P_{24}	0.273	0.160	1.752		m3/s
PEAK FLOW RATE PRE DEV=	0.088	0.045	1.150		
PRE TO POST FLOW RATE=	**0.185**	**0.115**	**0.603**		
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	24.8	15.0	168.3		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	1436.40	868.69	9759.82		(m3)
RUNOFF VOLUME PRE DEV=	629.00	317.33	7365.46		
PRE TO POST VOLUME=	**807.40**	**551.36**	**2394.36**		

SMAF 1 retention volume =	**203.0** m3		
SMAF 1 Detention volume =	**604.4** m3		
Total SMAF 1 mitigation volume=	**807.4** m3		
SMAF 2 post development run-off volume=	**868.7** m3		
Wetland Based requirement is=	1737.4 m2	=	death storage depth
	24mx72m		
Wetand base measuremetn (1 in 3 shape)	= 1728 m2	=	width * length
SMAF 1 storage height=	0.47 m	=	SMAF 1/ 1728m2
Additonal space for SMAF 1 storage=	1.46 m	=	side slope at 32% grade
additional space for maintanace track=	3.5 m		
final wetland size =	33.88m*81.88m=2774.1m2	=	(length+1.46*2+3.5*2)

Worksheet 2: Graphical Peak Flow Rate

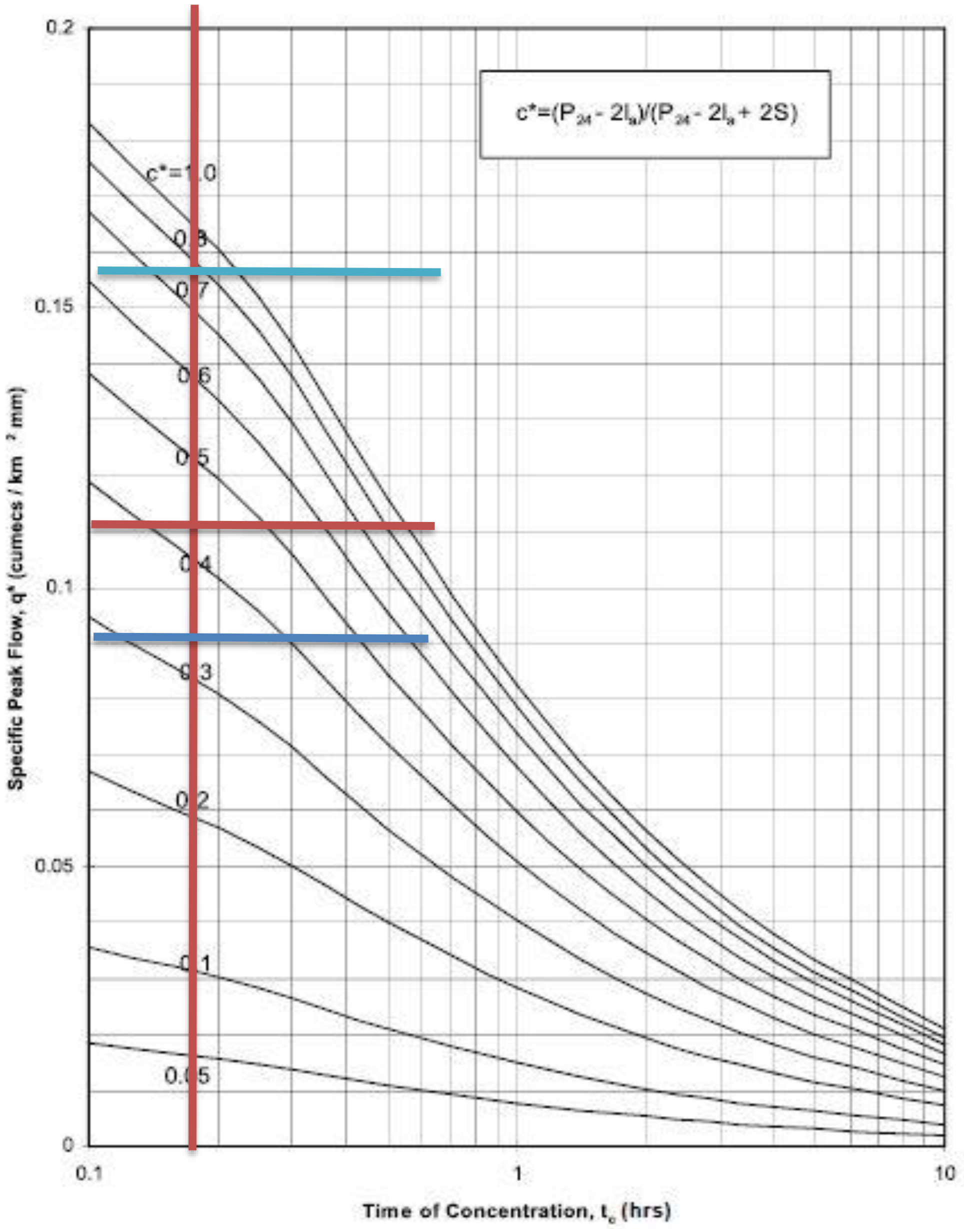
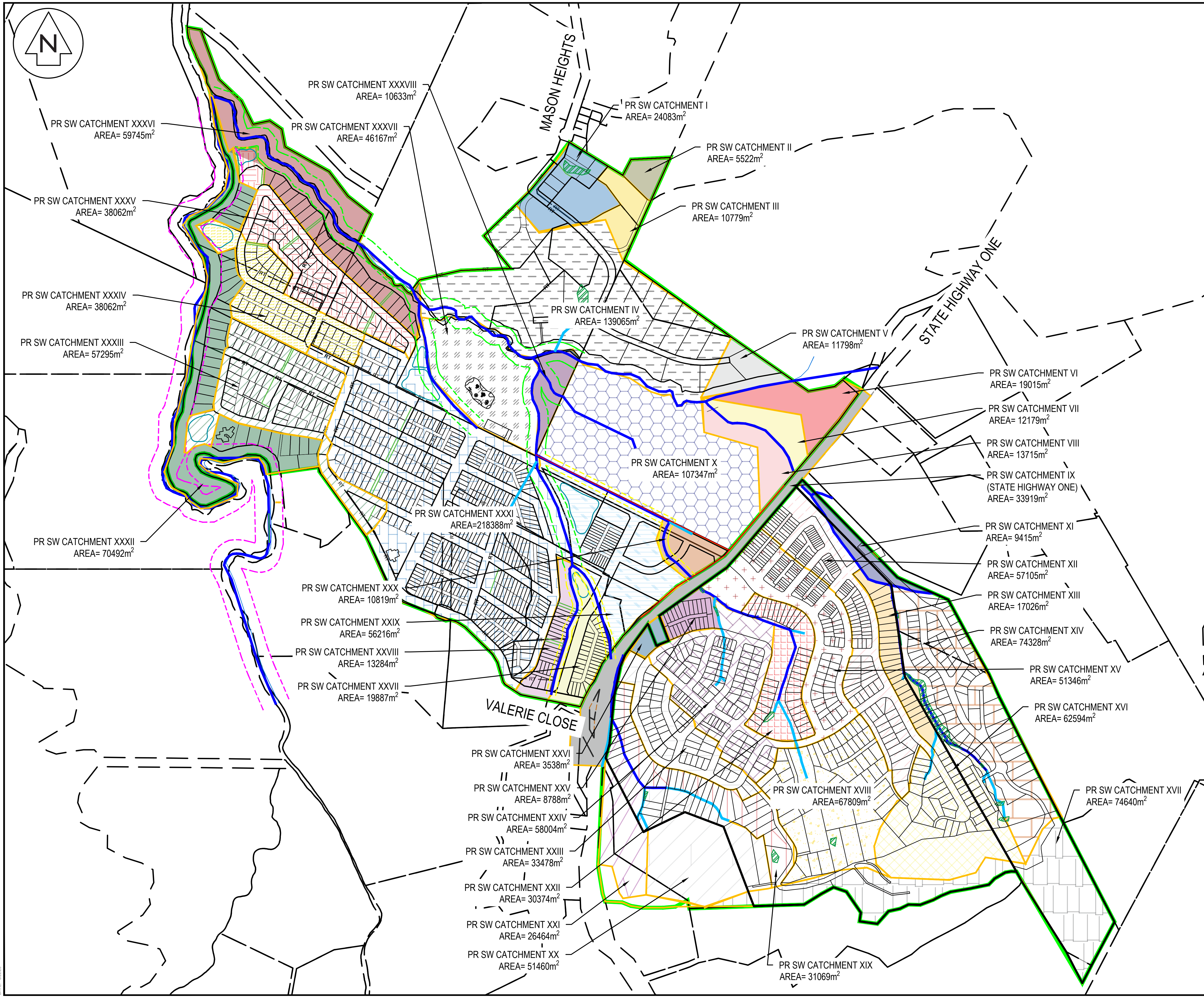


Figure 5.1 – Specific Peak Flow Rate



Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Legend

- EX BDY
- PLAN CHANGE BDY
- SW CATCHMENT
- SUB SW CATCHMENT
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC	KH	08/22

	By	Date
Survey	PARALAX & MAVEN	03/21
Design		
Drawn	KH	08/22
Checked	GB	08/22

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5 Owens Road, Epsom
Auckland 1023

Project

WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title

POST DEVELOPMENT STORMWATER CATCHMENT PLAN

Project no.	211001
Scale	1:10000 @ A3
Cad file	211001- C451 PRO DEV CATCHMENT.DWG
Drawing no.	C451
Rev	A