BEACHLANDS SOUTH

Stormwater Management Plan

Beachlands South Limited Partnership

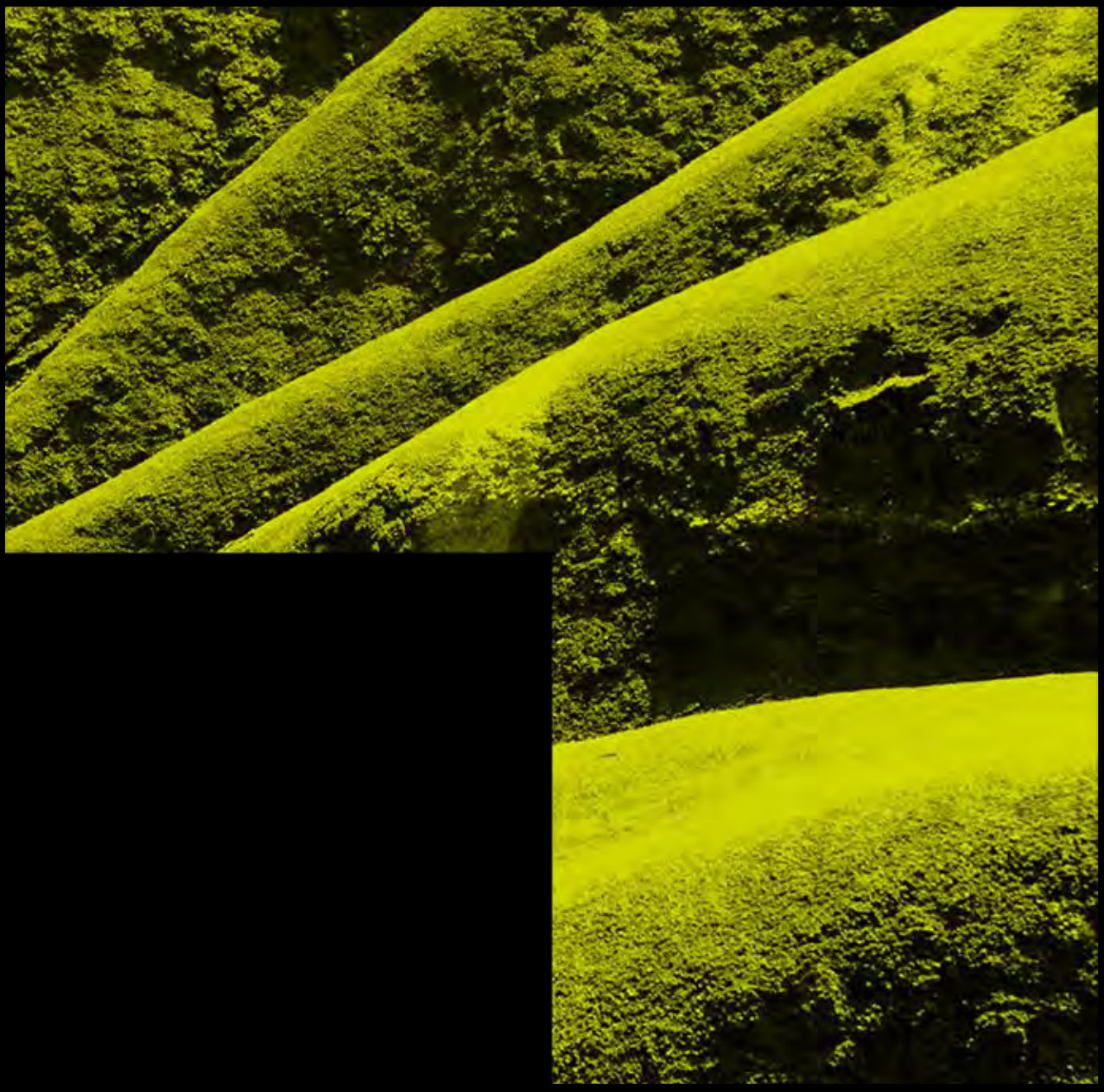

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Table of contents

Executive summary

This document sets out the framework and strategy for stormwater management required to facilitate the urban development as envisaged in the Beachlands South Structure Plan and Private Plan Change Application comprising 110 Jack Lachlan Drive, and adjacent sites 620 and 680 – 770 Whitford-Maraetai Road, proposed to be Future Urban Zoned (FUZ).

The development is classified as a large greenfield site under Schedule 4 of the Regional Network Discharge Consent (NDC). The relevant NDC requirements have been identified and detailed within this document. This Stormwater Management Plan (SMP) is intended to address the proposed developments on the site in support of the Plan Change.

The stormwater management of the site is simplified by the ridgeline running adjacent to Whitford-Maraetai Road, forming a catchment boundary, and restricting the contributing catchment to the site itself. The site drains five significant sub-catchments, two of which discharge to an existing & heavily modified watercourse via culverts beneath Jack Lachlan Drive. The remaining three sub-catchments discharge directly to the estuarine environment of the Waikopua Creek.

The proposed development layout has been established using a Water Sensitive Design (WSD) approach that closely mimics existing sub-catchment boundaries and preserves all valuable existing surface water features. A toolbox of stormwater management devices including small-scale bioretention devices and communal scale detention features is proposed to provide a treatment train including hydrological mitigation, treatment, and peak flow attenuation for runoff generated within developed areas of the site.

The proposed stormwater management systems will manage overland flow paths within the road reserves, engineered flow paths, and streams to mitigate the flood hazard presented to people and property both on-site and downstream. This approach carefully manages discharges to the existing watercourse north of the site to avoid creating new flood hazards or increasing existing flood hazards.

The current proposal supports the use of treatment and attenuation devices including living roofs, rainwater tanks, treatment swales, wetlands, wet ponds, dry ponds, and infiltration trenches. The use of on-site, small-scale devices throughout the catchment area are a part of the WSD approach that protects and incorporates natural site features into the plan. These devices better reflect the sustainability goals outlined for this project.

Recognising the sensitive nature of the Waikopua Creek and surrounding receiving environment, the proposed stormwater management approach will be further developed as parallel geotechnical and ecological assessments provide insights into the likely effects on streambed and bank erosion and sediment deposition in the estuary. These findings could

influence peak flow attenuation standards imposed on the development or the type and extent of in-stream interventions.

The outlined stormwater management plan for the proposed Plan Change and Structure Plan was developed in accordance with the Auckland Unitary Plan (AUP), WSD approach and Schedule 4 of the NDC. This approach provides a suitable framework and strategy for the sustainability goals and best practice approaches to be met or enhanced.

1 Existing site appraisal

1.1 Summary of data sources and dates

Table 1: Data summary.

Existing site appraisal item	Source and date of data used
TOPOGRAPHY	• Site topographical survey, SurveyWorx (June 2021) • Auckland Council GeoMaps Viewer (June 2021)
GEOTECHNICAL / SOIL CONDITIONS	• Auckland Council GeoMaps Viewer (June 2021) • Geotechnical Desktop Study, Tonkin & Taylor (September 2021) • Erosion & Sediment Control Plan (ESCP), Harrison Grierson (December 2021)
EXISTING STORMWATER NETWORK	• Site topographical survey, SurveyWorx (June 2021) • Auckland Council GeoMaps Viewer (June 2021)
EXISTING HYDROLOGICAL FEATURES	• Site topographical survey, SurveyWorx (June 2021) • Auckland Council GeoMaps Viewer (June 2021)
STREAM, RIVER, COASTAL EROSION	• Beachlands Hydraulic Modelling – Stream Assessment, Harrison Grierson (August 2021) • Site topographical survey, SurveyWorx (June 2021) • Auckland Council GeoMaps Viewer (June 2021)
FLOODING AND FLOWPATHS	• Beachlands Hydraulic Modelling – Floodplain Assessment, Harrison Grierson (August 2021) • Site topographical survey, SurveyWorx (June 2021) • Auckland Council GeoMaps Viewer (June 2021)
COASTAL INUNDATION	• Coastal Hazards Report, Tonkin & Taylor (January 2022) • Auckland Council GeoMaps Viewer (June 2021)
ECOLOGICAL / ENVIRONMENTAL AREAS	• Ecological Effects Assessment: Executive Overview, Tonkin & Taylor (March 2022) • Terrestrial Ecology Effects Assessment, Tonkin & Taylor (March 2022)

Existing site appraisal item	Source and date of data used
	• Freshwater Wetland Ecological Effects Assessment, Tonkin & Taylor (March 2022) • Stream Ecological Effects Assessment, Tonkin & Taylor (March 2022) • Marine Ecological Effects Assessment, Tonkin & Taylor (March 2022) • Water Quality and Sedimentation Modelling Report, Tonkin & Taylor (November 2021)
CULTURAL AND HERITAGE SITES	• Tapuwae Ohiti i Kahawairahi Cultural Values Assessment, Ngāi Tai Ki Tāmaki (March 2022) • Archaeological Assessment, Clough & Associates Ltd. (March 2022)
CONTAMINATED LAND	• Contamination Report, Tonkin & Taylor (August 2021)

1.2 Location and general information

The proposed Structure Plan and Plan Change consists of approximately 307 ha of land at the current Formosa Golf Course, located at 110 Jack Lachlan Drive and 620 to 770 Whitford-Maraetai Road, Beachlands. The site location is shown with respect to the wider Auckland Region in Figure 1.

Figure 1: Site location within the wider Auckland area.

The site location and Plan Change areas are outlined in Table 2.

Table 2: Existing site elements.

Existing site element	
SITE ADDRESS	**Live Zone:** • 110 Jack Lachlan Drive Beachlands Auckland 2571 (Formosa Golf Resort) (170.4750 ha) **Future Urban Zone:** • 620 Whitford-Maraetai Road Whitford Auckland 2571 (79.9444 ha) • 770 Whitford-Maraetai Road Whitford Auckland 2571 (6.8665 ha) • 758 Whitford-Maraetai Road Whitford Auckland 2571 (6.1403ha) • 746 Whitford-Maraetai Road Whitford Auckland 2571 (5.7997 ha) • 740 Whitford-Maraetai Road Whitford Auckland 2571 (5.1448 ha) • 732 Whitford-Maraetai Road Whitford Auckland 2571 (5.0940 ha) • 722 Whitford-Maraetai Road Whitford Auckland 2571 (4.9227 ha) • 712 Whitford-Maraetai Road Whitford Auckland 2571 (4.7518 ha) • 702 Whitford-Maraetai Road Whitford Auckland 2571 (2.1341 ha) • 692 Whitford-Maraetai Road Whitford Auckland 2571 (1.7747 ha) • 682 Whitford-Maraetai Road Whitford Auckland 2571 (1.2583 ha) • 680 Whitford-Maraetai Road Whitford Auckland 2571 (12.8125 ha)
LEGAL DESCRIPTION	**Live Zone:** • Lot 2 DP 501271 **Future Urban Zone:** • Lot 100 DP 504488 • Lot 10 DP 54105 • Lot 9 DP 54105 • Lot 8 DP 54105 • Lot 7 DP 54105 • Lot 6 DP 54105 • Lot 5 DP 54105 • Lot 4 DP 54105 • Lot 1 DP 208997 • Lot 1 DP 197719 • Lot 1 DP 187934 • Lot 26 DP 504488
CURRENT LAND USE	• Golf course & resort • Rural – Countryside Living Zone
CURRENT BUILDING COVERAGE	• Minimal
HISTORICAL LAND USE	• Rural

1.3 Topography

The Private Plan Change (PPC) area is characterised by a ridgeline running adjacent to Whitford-Maraetai Road along the eastern boundary, forming a sub-catchment boundary. This ridgeline falls from around 75 m RL in the south to 60 m RL at the northern intersection with Jack Lachlan Drive. The northern site boundary follows Jack Lachlan Drive, falling gradually to around 10 m RL near the Pine Harbour Marina. The western boundary of the site fronts onto the estuarine environment of the Waikopua Creek.

The Formosa Golf Resort makes up the northern region of the site. This circa 170-hectare area is characterised by flat to rolling topography, minimal vegetation, extensive artificial surface water features, and well-vegetated & moderate to steep stream embankments.

The southern region of the site is characterised by rolling to steep topography, very well-defined stream extents, steep to extremely steep stream embankments, and densely vegetated riparian margins.

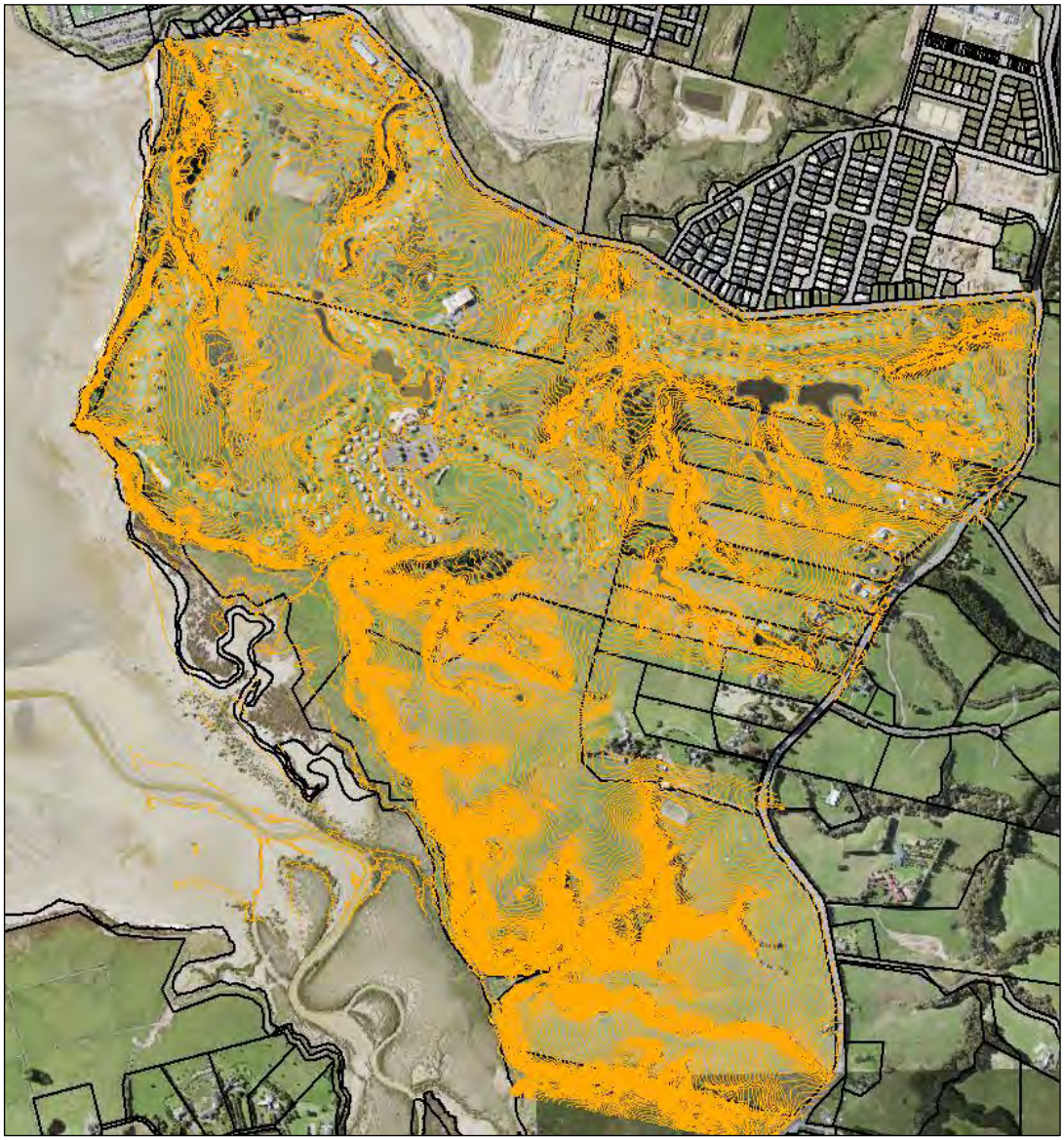


Figure 2: Existing topography surrounding the site. (Auckland Council, 2021)

1.4 Geotechnical

A geotechnical desktop study report has been prepared by Tonkin & Taylor (T&T) (2021) which indicates that the ground conditions are generally suitable for the proposed Structure Plan and Private Plan Change. Assessments undertaken as part of the investigation included:

- Desktop review of site geology and topography; and
- site walkovers on 11 July 2019 and 3 July 2020.

Supplementary site investigations are required to confirm this conclusion for informing future subdivision design. We provide a summary of T&T's findings below.

1.4.1 Underlying geology and soil characteristics

The desktop review into the underlying geology identified that the ground conditions are expected to be typical of Auckland conditions, generally comprising a thin veneer of topsoil overlying very stiff to hard East Coast Bays Formation soils. The general formation was as follows:

- Topsoil (100 – 300 mm thickness)
- Fill
- Tauranga Group
- East Coast Bays Formation (Waitemata Group)

Localised areas of fill associated with golf course landscaping are expected and have been preliminarily mapped and investigated. The fill encountered to date has been competent, however normal geotechnical investigation and design measures will still be required at subdivision and building design stages.

Previous reporting indicates that uncontrolled fill associated with marina dredging could be present in the north of site. Future site investigations will be required to assess the extent of this material and its suitability for development under future consents.

1.4.2 Building Foundations

Traditional shallow foundations are likely to be suitable for the vast majority of the building typologies proposed under the Structure Plan and Private Plan Change. Stiffer/stronger foundations may be required for buildings greater than 3 storeys high or heavier buildings (e.g., masonry cladding, tiled roofs, concrete structures). Foundation piles are generally unlikely to be required except for concentrated loads. The very stiff soils and low groundwater are likely to provide relatively favourable conditions for trench or basement excavations. Boreholes encountered perched groundwater at varying depths, between 0.7-18 m below ground level. Therefore, perched groundwater may be encountered within the earthworks fill on the site.

1.4.3 Slope Stability and Earthworks

Localised historical and recent landslip movement has been found within the Private Plan Change area, however most of the areas of instability are located in areas designated for

ecological protection areas rather than housing or other development. Normal geotechnical investigations and analysis should be carried out during design of the subdivision, to establish Building Restriction Lines and/or inform design of earthworks.

Site visits during 2019 and 2020 identified a destabilised local cut slope adjacent to Jack Lachlan drive. No other clear areas of slippage were observed, however the potential for future of instability cannot be ruled out. Only small areas of instability on coastal slopes were found. Contour maps suggest these areas may be drainage pathways. The steepness of the coastal slopes also suggest that the terraces are a result of sea level change. Gully slopes were also observed however the Structure Plan and Private Plan Change generally designates these areas for ecological purposes.

The very stiff to hard ECBF soils beneath most of the site are usually suitable for earthworks fill, subject to normal engineering measures. Normal geotechnical investigations and analysis should be carried out during design of the subdivision, to establish Building Restriction Lines and/or inform design of earthworks.

1.4.4 Excavations

The very stiff soils and low groundwater are likely to provide relatively favourable conditions for trench or basement excavations. Perched groundwater may be encountered.

1.4.5 Liquefaction

Liquefaction is unlikely to be a significant design issue for latter stages of subdivision. Common design solutions such as embedment of strip footings or use of stiffened (waffle/rib raft) slabs are likely to be suitable for buildings in these ground conditions.

1.5 Existing drainage features and stormwater infrastructure

The site is located within two stormwater catchments: the Beachlands/Maraetai Catchment and Waikopua Creek Catchment. The catchment extents are shown along with OLFPs extracted from a region-wide Auckland Council dataset on Figure 4.

The portion of the Beachlands/Maraetai catchment discharging through the site is bound to the north by Jack Lachlan Drive and to the east by Whitford-Maraetai Road. Runoff discharging through the site is predominantly generated within the Formosa Golf Resort and neighbouring properties to the west of Whitford-Maraetai Road. The southern corner of the site is within the Waikopua Creek Catchment, and discharges via a Significant Ecological Area – SEA Marine 1.

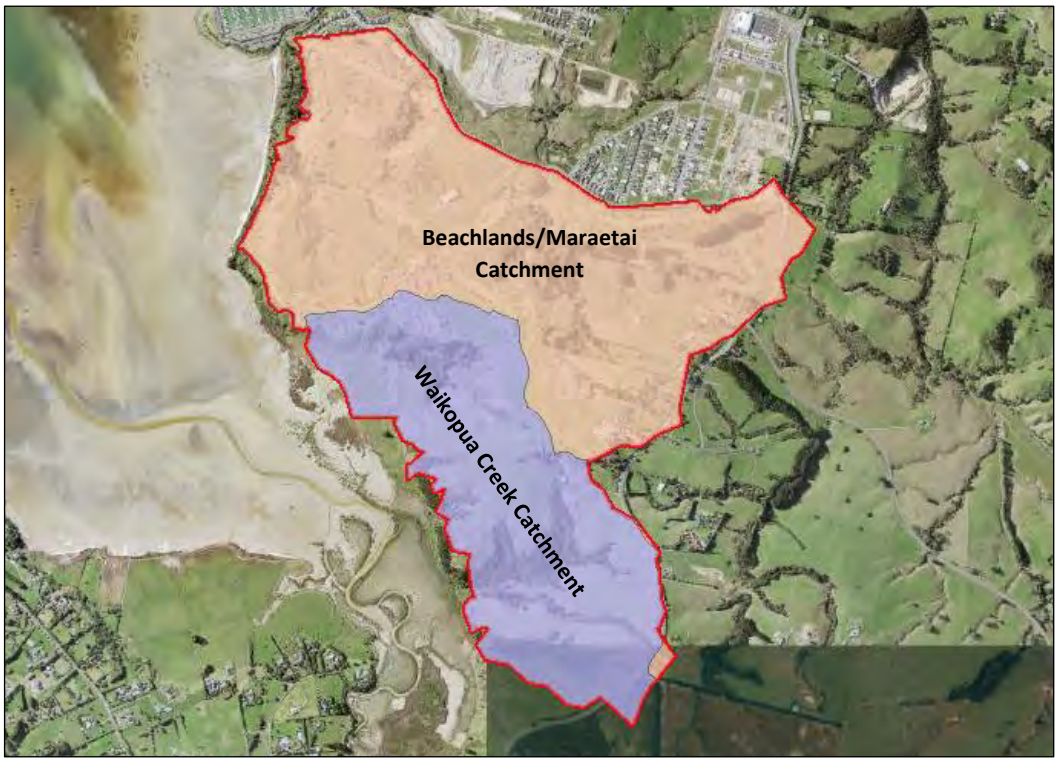


Figure 3: Beachlands/Maraetai catchment and Waikopua Creek catchments.

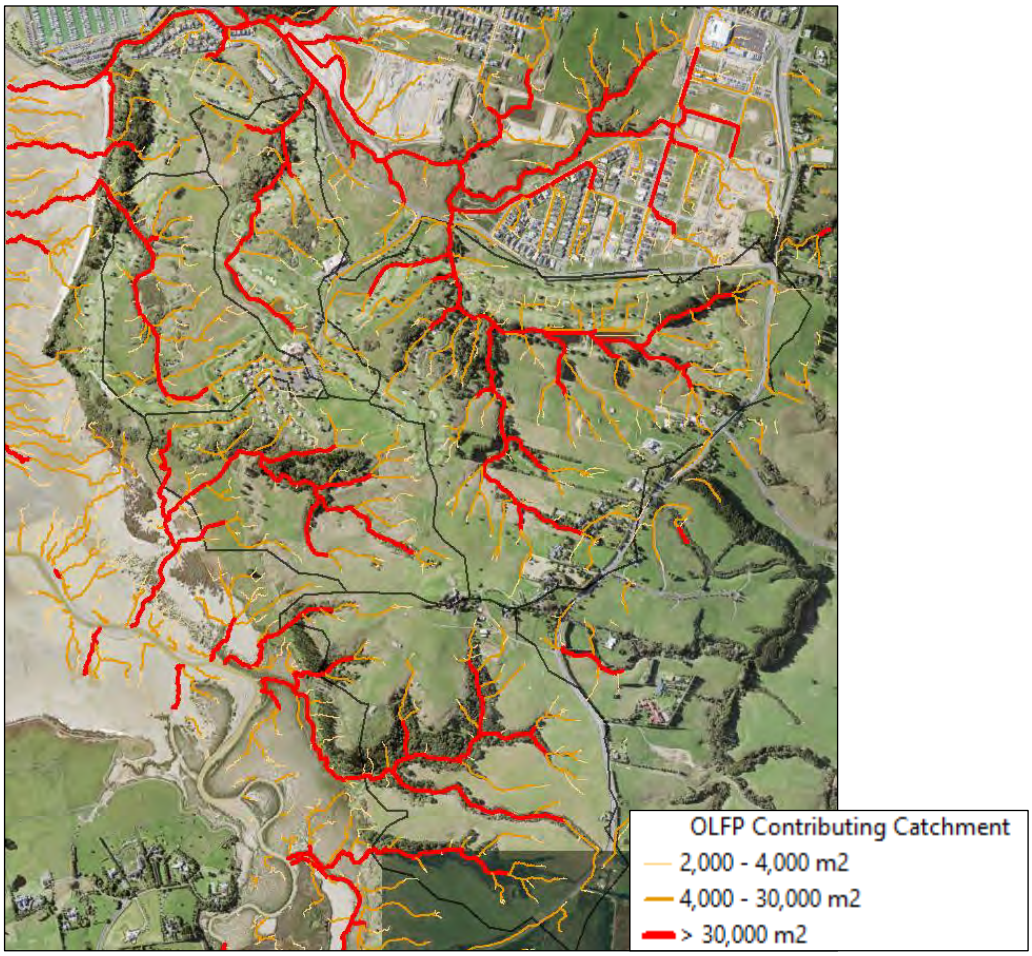


Figure 4: Overland flowpaths existing within the development site.

1.6 Receiving environment

A series of ecological assessments and reporting was completed by (Tonkin & Taylor, 2022) in support of the Structure Plan and Private Plan Change. Key findings from the assessment, relevant to stormwater management, are summarised below. Reference can be made to the AEcE for further detail.

The site discharges to the estuarine environment at the mouth of the Waikopua Creek. The receiving environment to the west is coastal SEA Marine 1 and 2.

The immediate receiving environment to the north is a heavily modified, naturalised stream receiving runoff from recent residential developments to the north of Jack Lachlan Drive. The stream has an approximately 200 m long concrete lined section further downstream, at the rear of 167-189 Jack Lachlan Drive, followed by an approximately 420 m long rock armoured section between 189 Jack Lachlan Drive and the coastal outlet. The rock armouring and check-dams in the lower stream reaches, along with the concrete-lined section of the stream, may restrict fish passage to the site. Informal discussions with Auckland Council Healthy Waters suggests the concrete-lined and rock-armoured stream reaches have insufficient capacity to convey extreme event runoff resulting in repeat nuisance flooding events. These stream reaches are indicated in Figure 5.

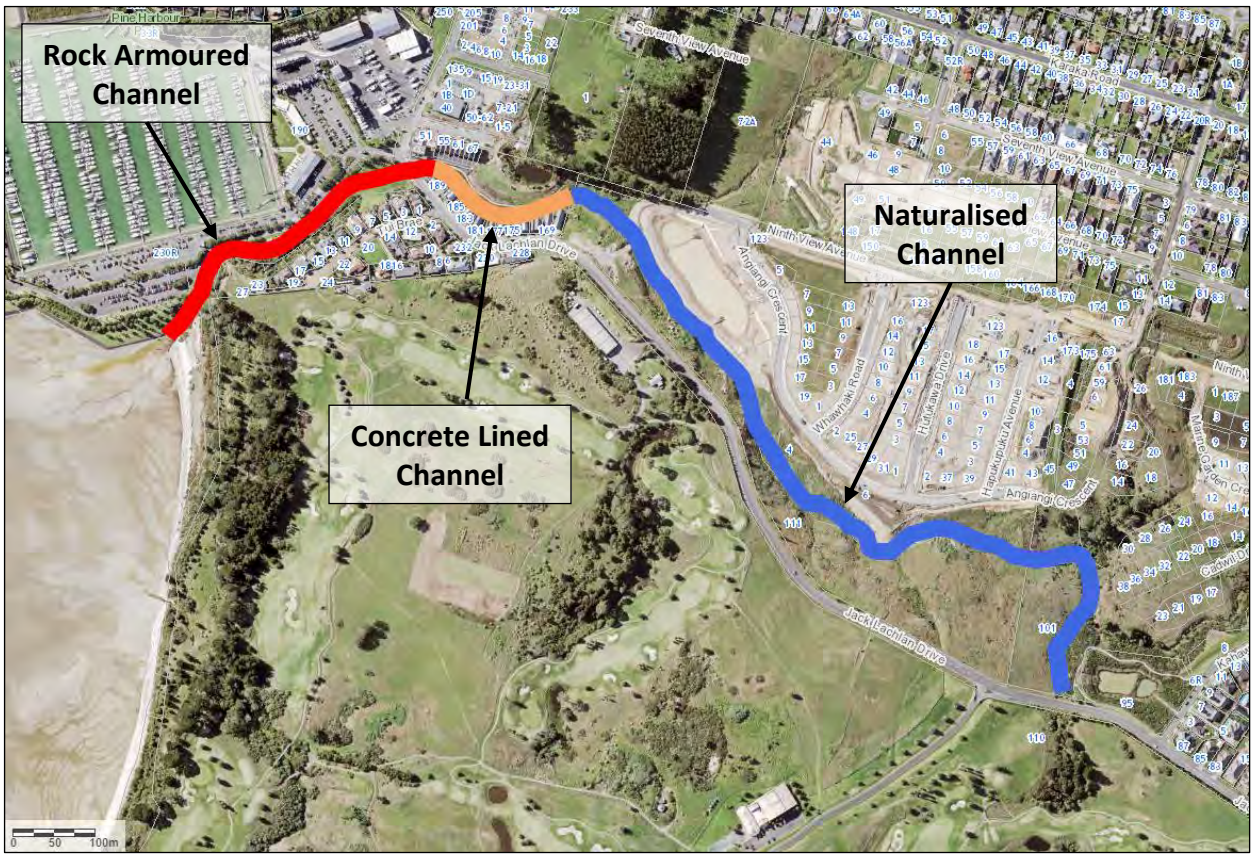


Figure 5: Receiving watercourse & approximate extent of lined channel reaches

The marine receiving environment is located adjacent to the Waikopua Creek and along the coastal margin to the west of the Formosa Golf Course at 110 Jack Lachlan Drive and the neighbouring property at 620 Whitford-Maraetai Road.

Waikopua Creek is a nationally and regionally significant estuarine habitat (including mangrove shrubland ecosystems), in the Hunua Ecological District and provides a complex of intertidal mud, sand and shell flats. The intertidal banks are a very rich feeding ground and important mid-tide roost for a variety of international migratory and New Zealand endemic wading birds including a number of threatened species. A large shell bank at the Waikopua Creek mouth is used as a high tide roost by birds.

Waikopua Creek provides important habitat for fish species, including shelter and nursery grounds. The creek also provides a pathway for migrating freshwater fish that are migrating upstream or to freshwater catchments, or downstream for spawning purposes. A 2001 study of shellfish in the Whitford embayment by NIWA identified that the dominant suspension feeder in the embayment was the cockle (*Austrovenus stutchburyi*).

Waikopua estuary monitoring sites have displayed trends consistent with increased sedimentation since monitoring began in 2004. This included increased percentages of very fine sands/mud and decreasing number of taxa identified in fauna samples. Seagrass beds are present within the zone of influence within the Waikopua estuary. A NIWA study (2009) concluded that the seagrass habitat is absent from the Whitford Embayment. Recent aerials captured in 2017 and 2021 indicate an increase in the cover of seagrass habitat in the embayment, indicating that this habitat type is currently in a period of recovery. Historical imagery also indicated mangrove growth seaward from the Waikopua Creek since the 1960s.

1.7 Existing hydrological features

Field investigations were undertaken by T&T from December 2020 to April 2021 to characterise and map freshwater wetland values within the development footprint. (Tonkin & Taylor, 2022) identified a total of 61 freshwater wetlands present within the proposed Private Plan Change area and immediately adjacent (Appendix A – Plans of existing and proposed site features). These wetlands make up 4.9 ha of the Private Plan Change area in total. Wetlands currently present at the site are described as ‘natural’ or ‘constructed’ under the National Policy Statement for Freshwater Management (NPS-FM). The wetlands within the Private Plan Change area were assessed as being of moderate value due to the threat status of wetlands per se and habitat suitability for threatened species. These wetlands were classified into the following five distinct categories of habitat types and include a range of native species including wetland bird species that are listed as nationally ‘Threatened’ or ‘At Risk’.

1. Constructed native wetlands
2. Constructed exotic wetlands
3. Constructed open wetlands (including constructed golf ponds or gully ponds)
4. Natural oioi, restiad rushland/reedland wetland (WL10)

5. Natural exotic wetlands

The loss of ‘natural’ wetlands is not permitted as a result of land use changes associated with the proposed Private Plan Change. The proposed land use changes are expected to result in the loss of 2.09 ha of moderate value constructed wetlands and to also include a range of indirect effects on constructed and natural wetlands through stormwater discharge and general disturbance (Tonkin & Taylor, 2022). Measures to avoid, remedy or mitigate adverse effects are summarised in Section 6.3.6 of this report. After mitigative measures are put into action, the proposed land use changes are expected to result in residual adverse effects of ‘moderate’ on constructed native and exotic wetlands and potentially ‘high’ levels on pūweto, pāteke and weweia (Tonkin & Taylor, 2022). Any effects on freshwater wetland values will be addressed through compensation as described in Section 6.3.6 (Tonkin & Taylor, 2022).

Five main sub-catchments are identified within the site, three of which discharge directly into the Waikopua Creek via streams generated primarily within the site boundary. The other two sub-catchments discharge indirectly into the Waikopua Creek via a watercourse running along the northern side of Jack Lachlan Drive (Figure 3 & Figure 4). Details of each sub-catchment are provided in Figure 6 below.

A total of 15 drainage culverts and 15 open wetlands (golf ponds or gully ponds) were identified within the site during site visits. Asset data was recorded by SurveyWorx including inlet and outlet levels and configurations, pipe sizes, materials, and condition. Where individual data points were unavailable these were inferred based on site observations.

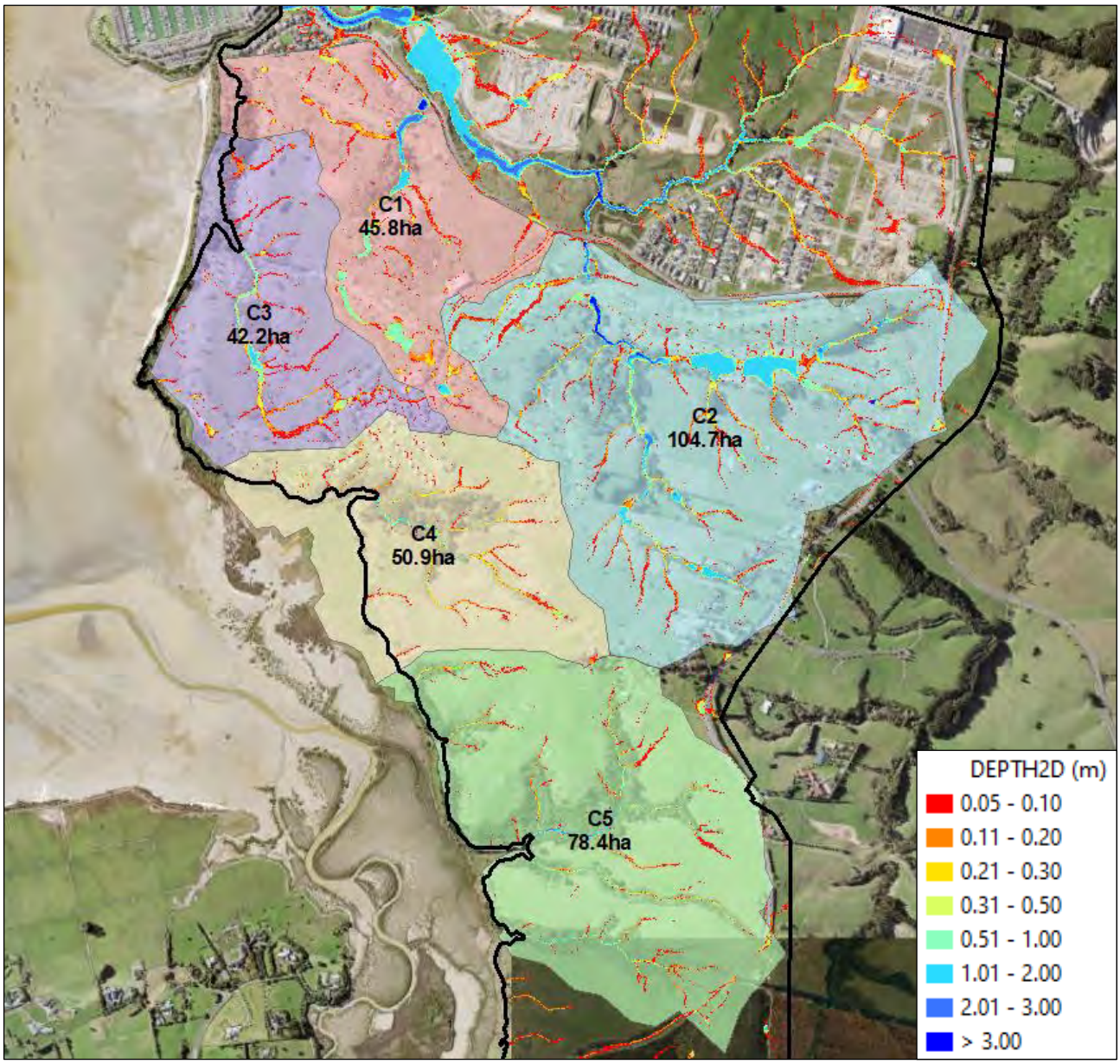


Figure 6: Approximate boundaries of major stream sub-catchments overlaid by flood extents resulting from a 1% AEP design storm event in the existing land use scenario. Large areas along the western site boundary indicating flood depths greater than 3 metres are within the modelled costal boundary and are not part of the on-site floodplain.

1.7.1 Sub-catchment 1 (Northern)

Sub-catchment 1 is part of the Beachlands/Maraetai Catchment.

The main watercourse traversing sub-catchment 1 is heavily modified. The main water features in the upper reaches of the sub-catchment are a series of artificial water features and remnant stream reaches (Figure 7).

Basin 5 is the largest water feature within sub-catchment 3. The basin is constrained by the pedestrian walkway at the northernmost end, and discharges to basin 6 via a concrete culvert of approximately 675 mm diameter.

These basins were constructed to shape the Golf Resort but also provide a low level of depression storage attenuating peak flow runoff. These water features discharge to the main watercourse traversing the sub-catchment.

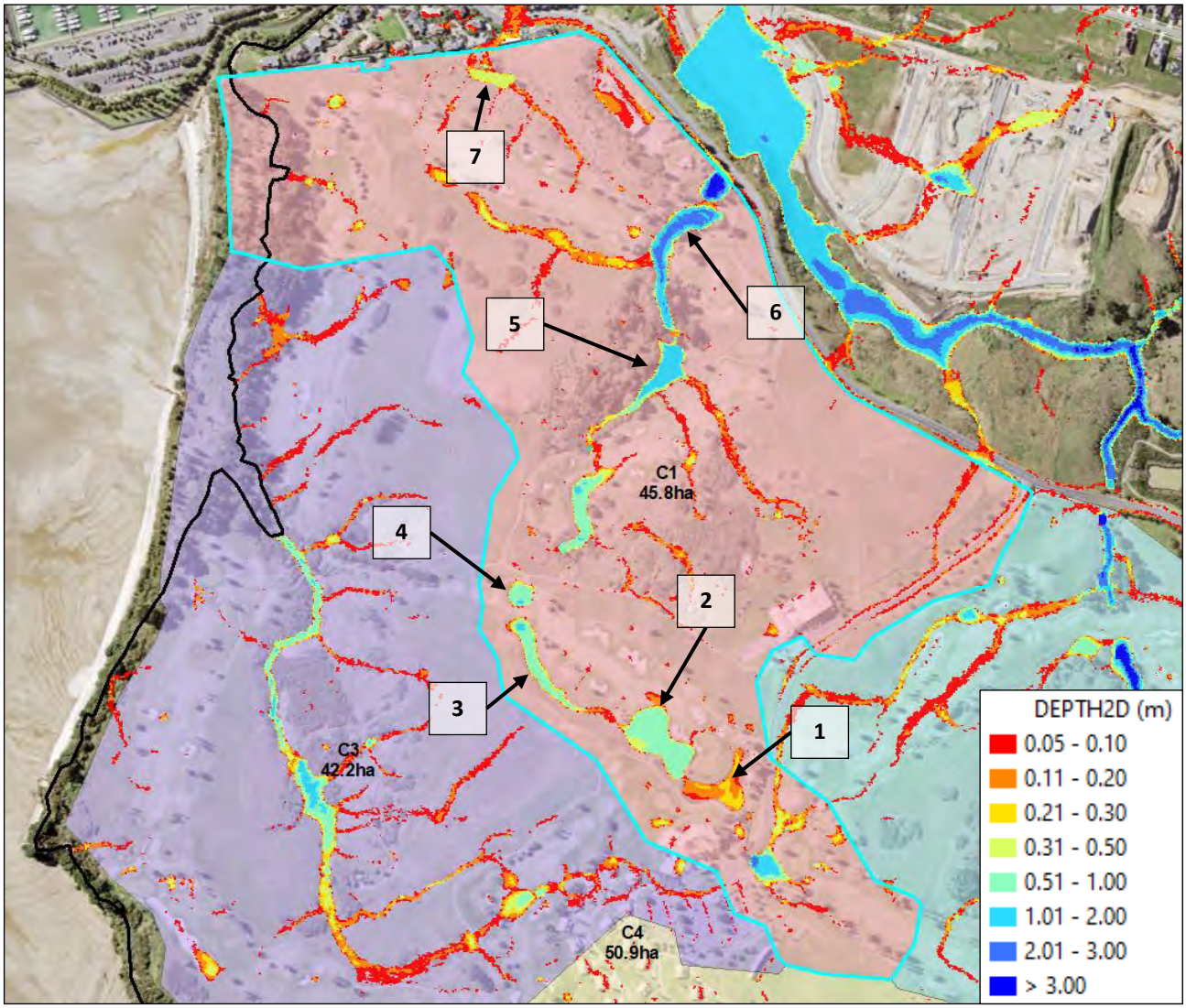


Figure 7: Sub-catchment 1 flood data and features overlaid by flood extents resulting from a 1% AEP design storm event in the existing land use scenario.

The lower reaches of the watercourse are heavily incised, with densely vegetated embankments. The modelled floodplain associated with the watercourse is largely contained within the streambanks. The watercourse is discharged into the receiving naturalised stream reach via an 1800 mm diameter culvert beneath Jack Lachlan Drive (Figure 8).

Table 3 provides some information on the outlet structures of these basins.

Table 3: Sub-catchment 1 basin outlets.

Basin	Primary service outlet	Secondary outlet
1	Unknown	Overland spill to basin 2
2	Unknown	Overland spill to basin 3
3	700 mm dia culvert discharging to basin 4	Overland spill to basin 4
4	500 mm dia culvert to stream	Overland spill to basin 5
5	675 mm dia. culvert discharging to basin 6	Overland spill to watercourse
6	900 mm dia culvert discharging to Jack Lachlan Drive culvert headwater	Overland spill to Jack Lachlan Drive
7	Minor culvert	Overland spill to Jack Lachlan Drive

Figure 8: Jack Lachlan Drive culvert.

1.1.1 Sub-catchment 2 (Eastern)

Sub-catchment 2 is part of the Beachlands/Maraetai Catchment.

The main watercourse traversing sub-catchment 2 is heavily modified. The main water features within the site boundary are a series of on-line golf ponds (Figure 9). These ponds were constructed as golf ponds for the Golf Resort but also provide a low level of depression storage to attenuate peak flow runoff. The ponds discharge to the main watercourse traversing the sub-catchment.

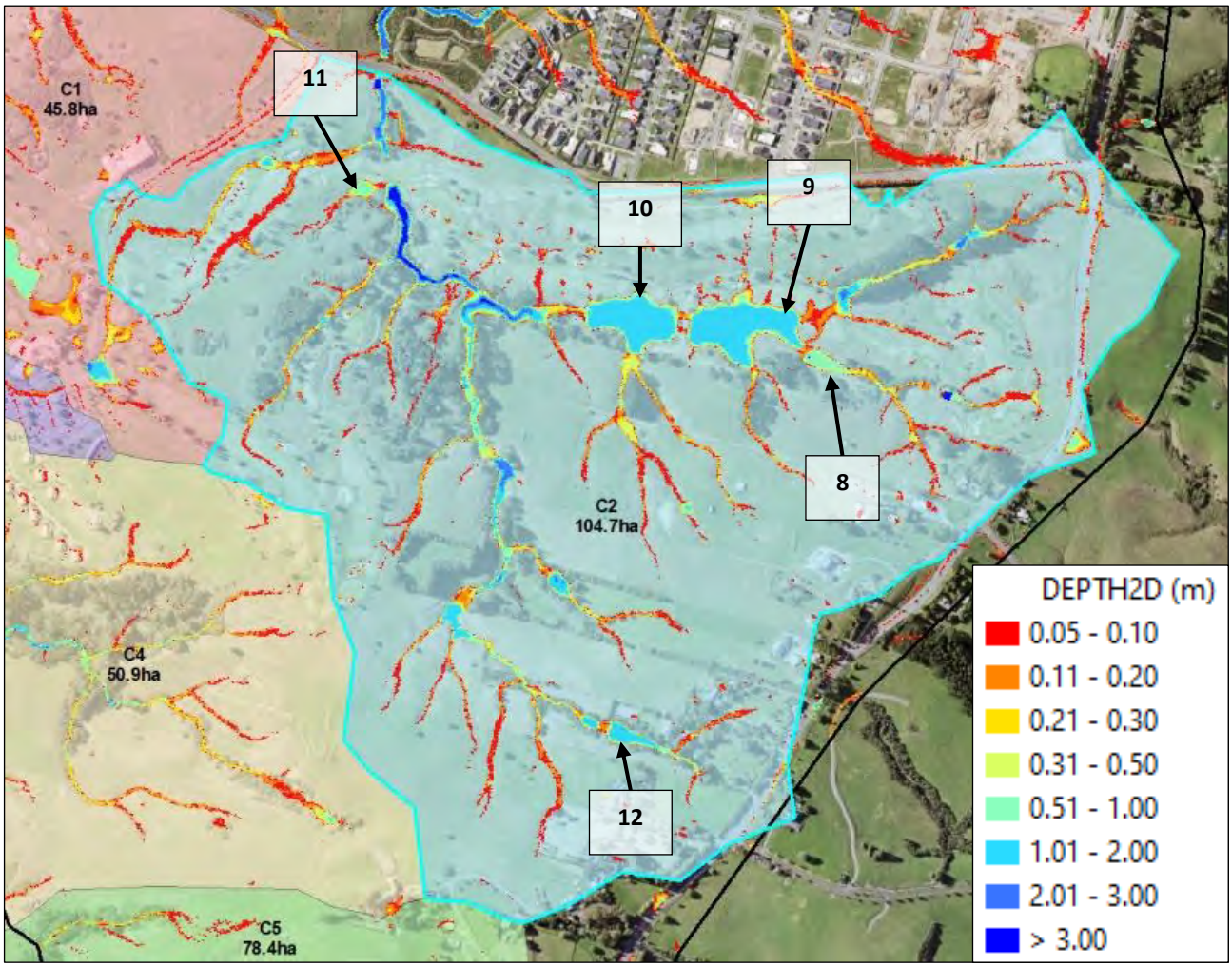


Figure 9: Sub-catchment 2 flood data and features overlaid by flood extents resulting from a 1% AEP design storm event in the existing land use scenario.

The middle and lower reaches of the watercourse are relatively incised & sinuous and have densely vegetated streambanks. The modelled floodplain associated with the watercourse is largely contained within the streambanks. The watercourse is conveyed beneath the walkway via an 1800 mm dia culvert and discharged into the receiving naturalised stream reach via a 2750 mm dia culvert beneath Jack Lachlan Drive.

Table 4 provides some information on the outlet structures of these basins.

Table 4: Eastern sub-catchment basin outlets.

Basin	Primary service outlet	Secondary outlet
8	Unknown	Overland spill to basin 9
10	Grated riser and culvert discharging to basin 11	Overland spill to basin 11
11	Grated riser and culvert discharging to stream	Overland spill to stream
12	Minor culvert	Overland spill to stream
13	Culvert discharging to stream	Overland spill to stream

Figure 10: Pond 9 & 10 outlet structures.

1.1.2 Sub-catchment 3 (Western)

Sub-catchment 3 is part of the Beachlands/Maraetai Catchment.

The main watercourse traversing sub-catchment 3 is less incised, less densely vegetated, and flatter than the watercourses in sub-catchments 1, 4 & 5. A number of pool and riffle sequences were observed along the low flow channel. A single headwater basin (Figure 11) exists in the upper reaches of the sub-catchment. The extent of flooding associated with the watercourse is also minimal. The lower reaches of the stream channel (downstream of the pedestrian bridges) are considerably steeper than the upper reaches.

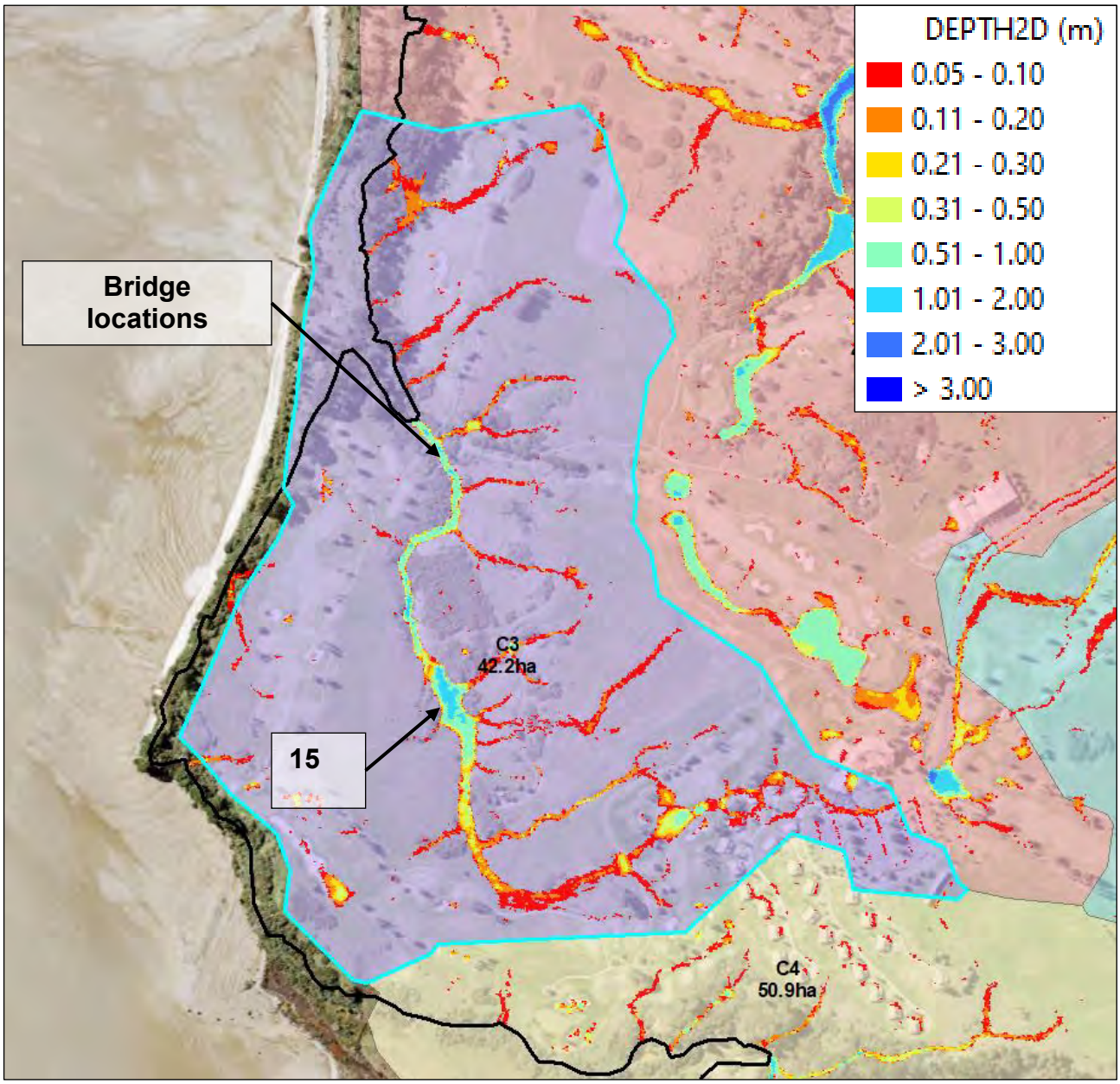


Figure 11: Sub-catchment 3 flood data and features overlaid by flood extents resulting from a 1% AEP design storm event in the existing land use scenario.

Figure 12: Rolling terrain surrounding the online pond 15.

The watercourse is not culverted under any pathways but is bridged in two locations (Figure 13). The concrete bridge, located further upstream, appears to be a newer structure than the timber bridge to the north. The deck level of the concrete bridge is considerably lower than the deck level of the timber bridge. Both bridge decks are significantly higher than the anticipated floodplain level in the 1% AEP, MPD scenario.

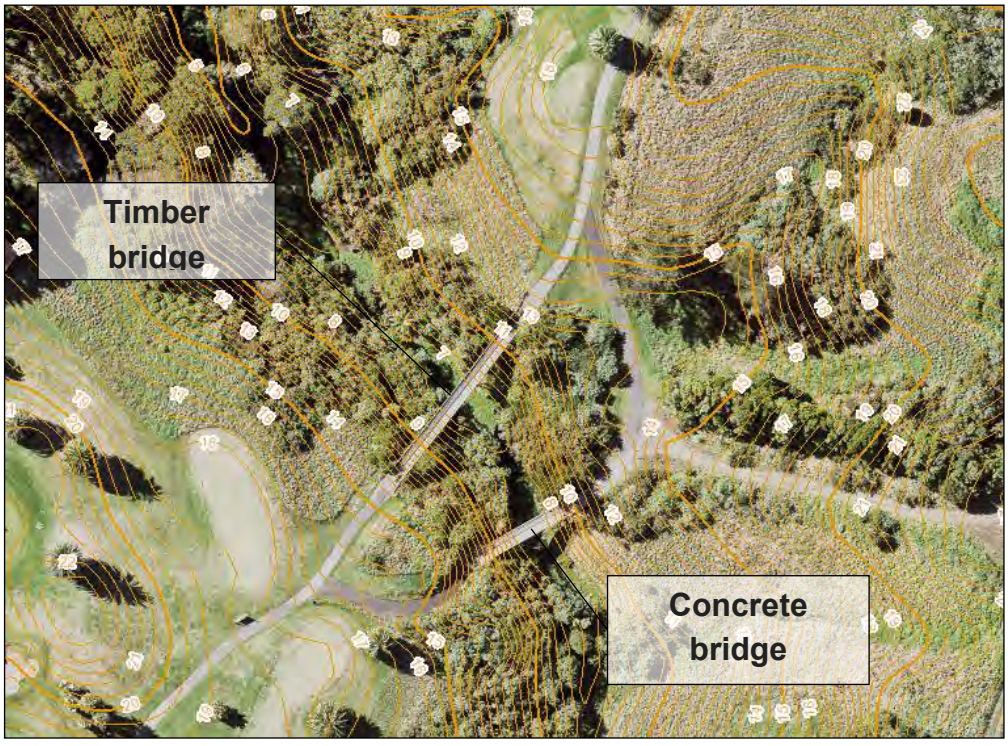


Figure 13: Lower catchment bridge structures.

1.1.3 Sub-catchment 4 (Southern Formosa Golf Resort)

Sub-catchment 4 (Figure 14) is a portion of the Waikopua Creek stormwater catchment. Runoff discharged from this sub-catchment is predominantly generated within the site itself. The landform in this area is generally more highly elevated than other areas within the site and falls away quickly down a steep gully towards the creek. The extent of flooding outside of the gully is minimal and generally of a low depth. Due to the steep terrain, high ecological value, and sensitive receiving environment, the potential development yield within this sub-catchment is relatively low.

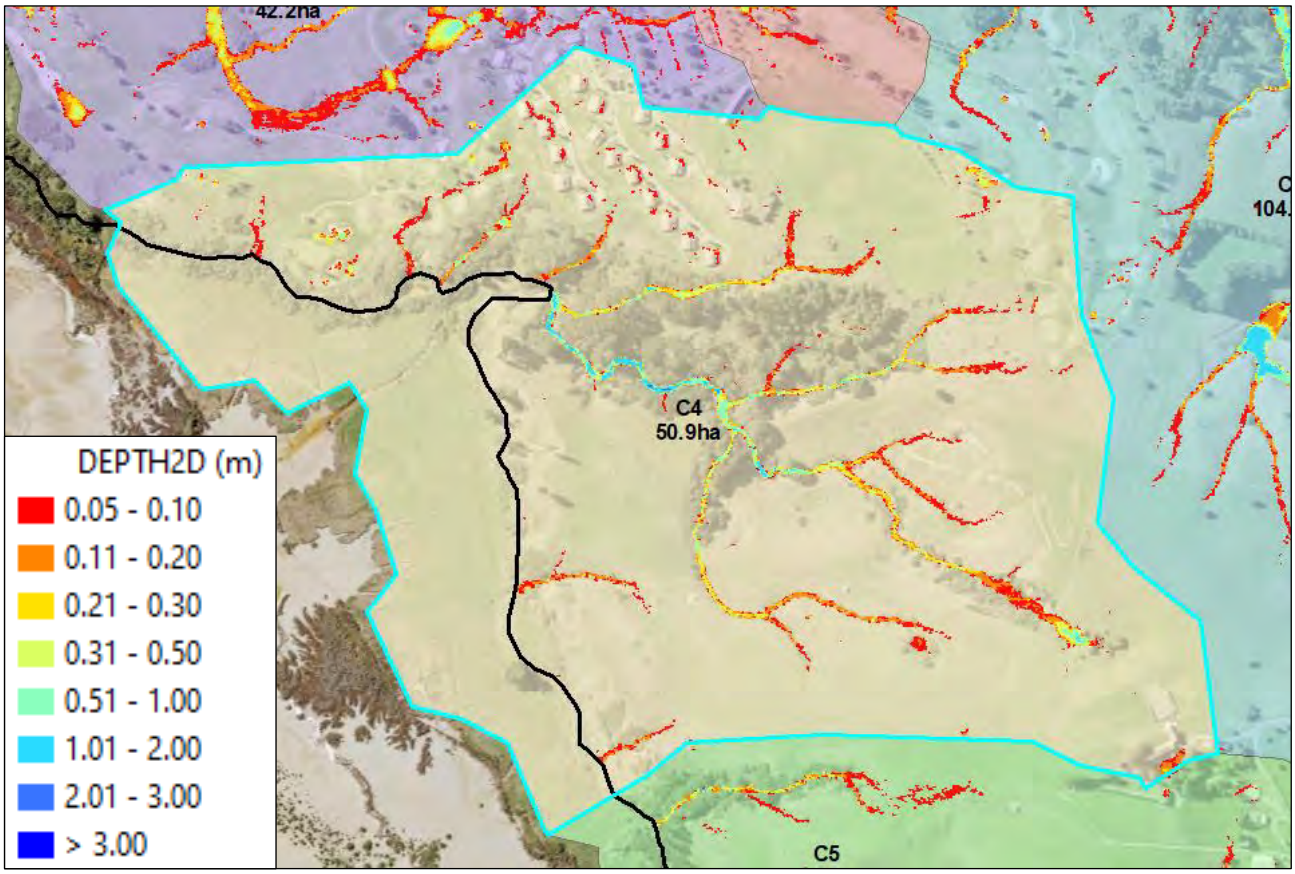


Figure 14: Sub-catchment 4 flood data and features overlaid by flood extents resulting from a 1% AEP design storm event in the existing land use scenario.

Figure 15: Pooling areas within the lower stream reach.

1.1.4 Sub-catchment 5 (Southern)

Sub-catchment 5 (Figure 16) is a portion of the Waikopua Creek stormwater catchment. Runoff discharged from this sub-catchment is predominantly generated on-site. The landform in this area is generally more highly elevated than other areas within the site and falls away quickly down a steep gully towards the creek. The extent of flooding outside of the gully is minimal and generally of a low depth. Due to the steep terrain, high ecological value, and sensitive receiving environment, the anticipated development yield within this sub-catchment is relatively low. Stream reaches within this sub-catchment are characterised by extremely high and steep embankments.

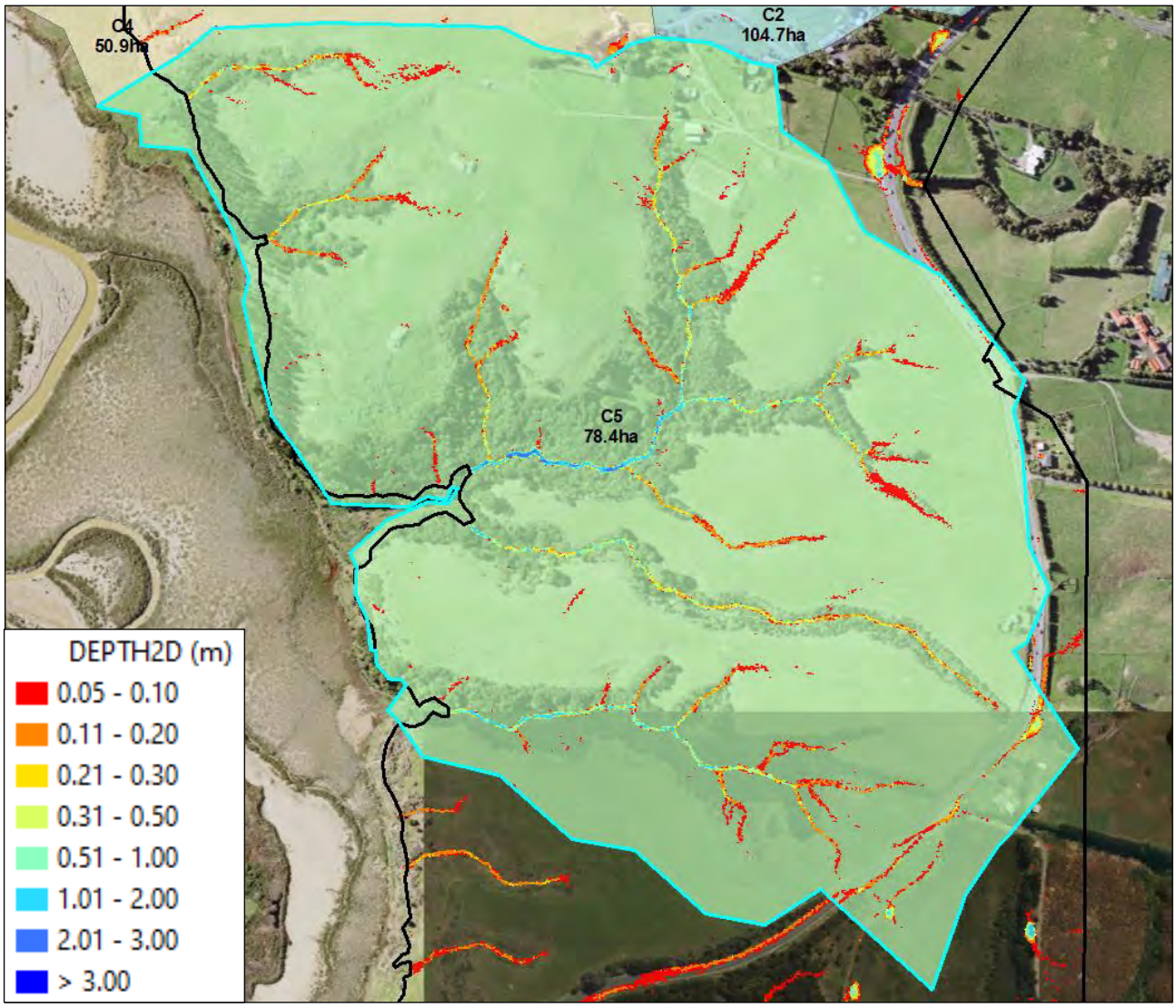


Figure 16: Sub-catchment 5 flood data and features overlaid by flood extents resulting from a 1% AEP design storm event in the existing land use scenario.

1.8 Flooding and flowpaths

The major overland flowpaths existing within the site are shown on Figure 4. This data was retrieved from Auckland Council's Healthy Waters team. Modelled OLFPs and floodplain extents produced as part of this application are presented throughout this report.

1.9 Coastal inundation

Coastal boundaries and inundation hazards are identified on GeoMaps in terms of the 1% AEP as set out in the policy framework of E36 Natural Hazards and Flooding. Figure 17 shows the indicative coastline and the extent of coastal inundation anticipated in a 1% AEP event, allowing for 1 metre of sea-level rise. This shows only small areas of the site are directly influenced by sea-level rise.

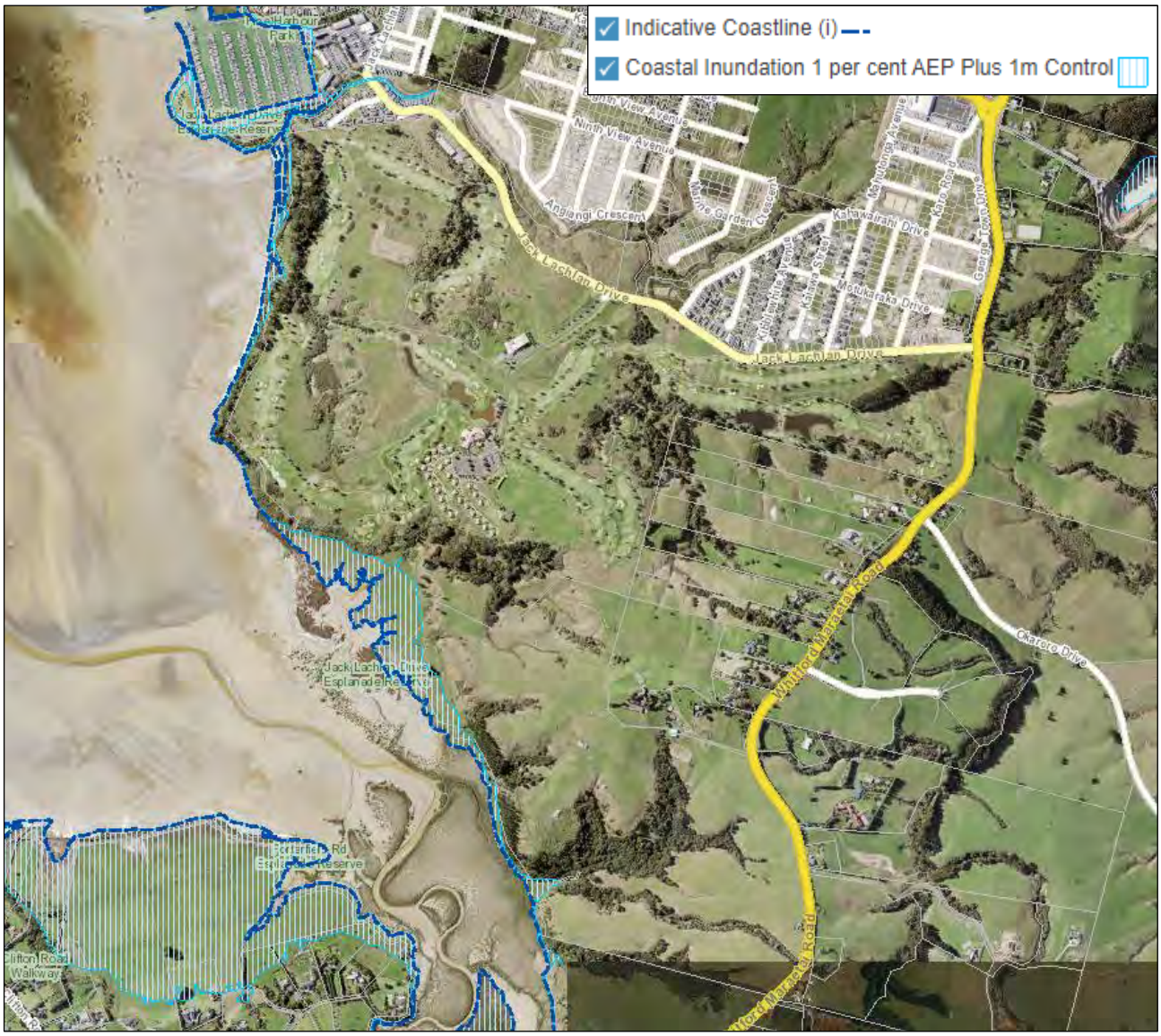


Figure 17: Costal inundation extents sourced from GeoMaps viewer.

A coastal hazards and inundation assessment was completed by (Tonkin & Taylor, 2022) which produced the coastal hazards map shown on Figure 18. The assessment concludes that with the consideration of inundation impacts of up to 2 m sea level rise, the AUP framework for addressing hazards and climate change will be sufficient for addressing coastal inundation hazards and no specific mitigation is required. This 2 m SLR standard is consistent with the hydraulic modelling undertaken for this SMP. The proposed development being situated to avoid coastal hazards and having all property parcels, key assets, and infrastructure located landward of the 2130 area susceptible to coastal instability and erosion and tsunami hazard the proposed development will not exacerbate or accelerate any of the existing hazards present (Tonkin & Taylor, 2022).

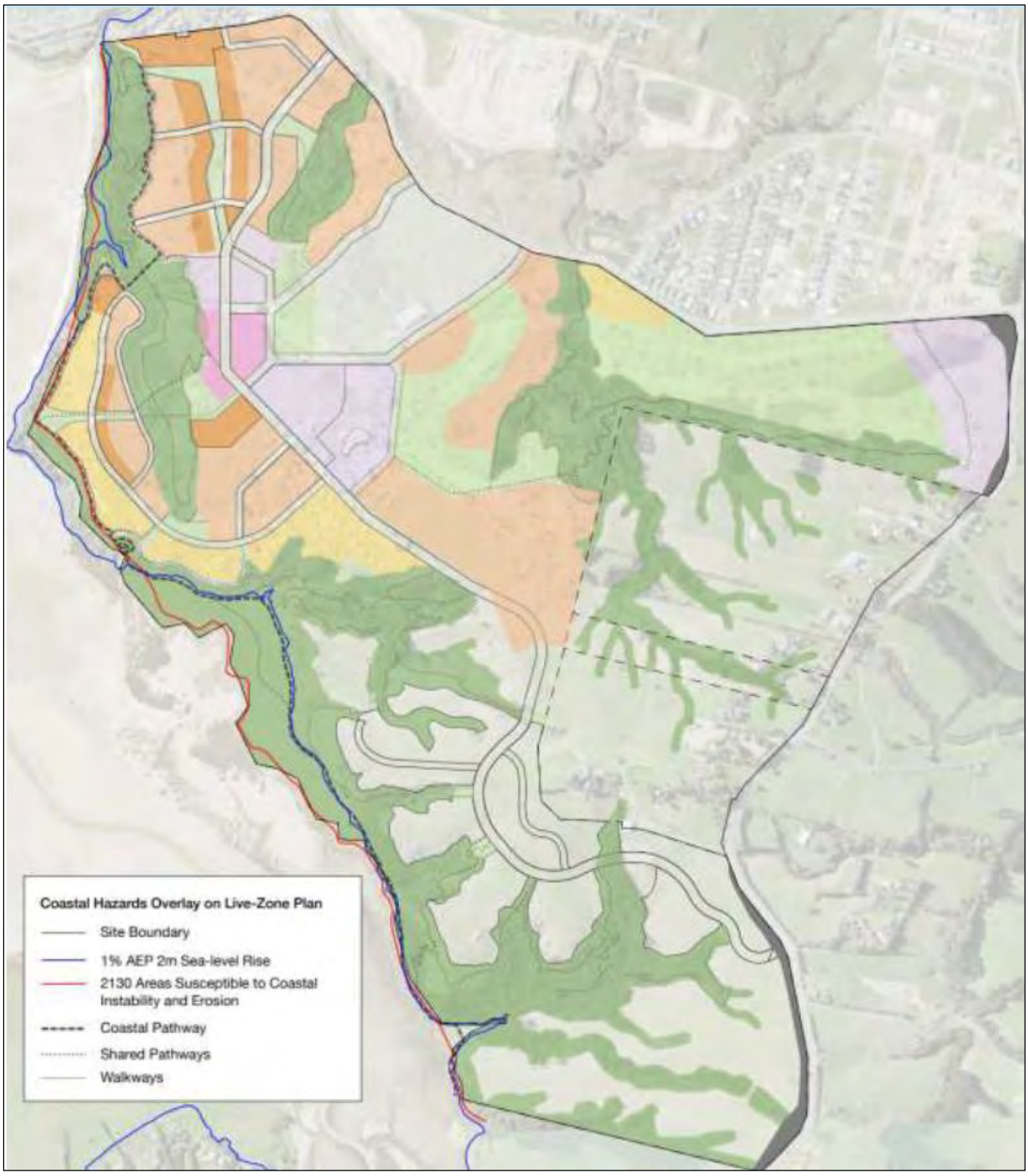


Figure 18: Coastal Hazards Map (Tonkin & Taylor, 2022).

1.10 Biodiversity

(Tonkin & Taylor, 2022) has undertaken four ecological assessments covering terrestrial, wetland, stream, and coastal aspects for the Private Plan Change and Structure Plan area. A biodiversity compensation model was also used to Biodiversity modelling was used to assist in determining the type and magnitude of habitat restoration and enhancement measures that would likely be required to address residual adverse effects associated with the proposed land-use change that could not be avoided, remedied, or mitigated.

All wetland types currently within the Private Plan Change area were assessed as being of 'moderate' value due to the threat status of wetlands and habitat suitability for threatened species. This includes 19 native freshwater wetland bird species and native vegetation. The proposed land use change has the potential to result in a range of adverse effects on freshwater wetland ecological values. This includes:

- loss of habitats through vegetation clearance and drainage,
- wetland degradation through sedimentation or discharges that effect water quality, and general noise.

Mitigative efforts have been undertaken through the optioneering and concept design phases of the project. T&T concluded that provided the proposed measures outlined in the Wetland Ecological Effects Assessment (202) (reproduced in Section 6.3.6 of this report) are undertaken, then potential effects on wetland biodiversity can be adequately addressed.

The ecological effects associated with the proposed Private Plan Change on the marine environment were assessed as 'moderate' for effects on firm muddy sand flat/cockle shell covered flats, shell bank habitats, mangroves, and coastal birds. Further management to reduce the overall effects on habitats, coastal avifauna and mangrove vegetation will be required as per the EIANZ framework. It was concluded that residual effects on marine and coastal values due to the PPC and subsequent development can be adequately addressed through the effects management measures outlined in the Marine Ecological Effects Assessment report and as guided by the Auckland-wide and proposed precinct provisions.

1.11 Cultural and heritage sites

Beachlands South GP Limited and Ngāi Tai ki Tāmaki have developed an ongoing relationship throughout the development throughout the development of this Structure Plan and Private Plan Change Application. Ngāi Tai ki Tāmaki are a development partner for Beachlands South and will continue to play an integral role in the development of the plan change area into the future.

An Archaeological Assessment prepared by (Clough & Associates Ltd., 2022) identified around 30 archaeological sites within the plan change area. Clough found that bush including stands of kauri forest would have dominated the hillsides prior to settlement. Shell middens with some earthwork sites of Māori origin along the coastal margin were identified in the locations shown in Figure 19 (Clough & Associates Ltd., 2022). The midden deposits consisted mainly of marine shell, terrace, and pit sites. The location at R11/1619 was identified as a pā site (Figure 20) (Clough & Associates Ltd., 2022). The pā site is a significant primary cultural and historic importance and should be protected through the proposed precinct provisions in Precinct Plan 4: Cultural Landscape Plan, standard I.7.10 Mana Whenua, in combination with the archaeological provisions of the HNZPTA. Figure 19 summaries the archaeological site extents. This is to be reviewed after a field survey.

Ngāi Tai stated in the CVA (2022) that it is essential that the pa and where possible, the defensive sites, are protected from development as they cannot be replaced once destroyed. If the Ngāi Tai Take Mauri Take Hono Cultural Health Indicators were applied, the pa, defensive ditch, native trees, awa, Significant Natural Area, Waikopua Estuary, Ngā Tai e Rua, Motokaraka and air quality would equate to zero impact (Ngāi Tai ki Tāmaki Trust, 2022). Figure 21 outlines the approximate extent of these culturally significant areas.

(Clough & Associates Ltd., 2022) proposes the following management and mitigation approaches for the archaeological sites:

1. *The pā site R11/1619 and associated sites in close proximity possible (R11/1440, R11/1441, R11/2522, R11/1442, and R11/2521) should be protected through the proposed precinct provisions in Precinct Plan 4: Cultural Landscape Plan, standard I.7.10 Mana Whenua, in combination with the archaeological provisions of the HNZPTA.*
2. *A Biodiversity Management Plan should be prepared for the EPAN overlay along the coastal edge which take the locations of the recorded archaeological sites into account and ensure that impacts on known sites from vegetation clearance and planting are avoided or minimised. Only appropriate shallow rooting species should be planted on or in the near vicinity of the known archaeological sites.*
3. *Construction of the coastal walkway should avoid impacting on adjacent archaeological sites as far as possible. Any accessways from the walkway to the beachfront should be located away from the identified archaeological sites.*
4. *Consideration should be given to providing signage or other appropriate interpretation along the walkway (in consultation with Mana Whenua) to highlight the extant archaeological features and the history of the place.*
5. *Future development plans should take account of the locations of the recorded archaeological sites and ensure that they are avoided to the extent possible.*
6. *If any of the recorded sites cannot be avoided, an Authority must be applied for under Section 44(a) of the HNZPTA and granted by Heritage NZ prior to the start of any works that will affect them. (Note that this is a legal requirement).*
7. *Archaeological Authorities must also be obtained for planting, amenity, and other works in the EPAN overlay along the coastal edge that have the potential to affect the recorded archaeological sites.*
8. *Due to the increased potential for additional unrecorded archaeological sites within the EPAN and coastal protection yard, authorities should be applied for to cover all amenity and planting works in these areas.*
9. *Archaeological investigation of sites that cannot be avoided, or sites exposed during future works, should be carried out under Authority from Heritage NZ to recover information relating to the history of the area and the results presented to Mana Whenua and the community.*
10. *Archaeological Management Plans must be prepared as part of Authority applications (this is a Heritage NZ requirement) and should be included within the CEMP.*
11. *The Archaeological Management Plans should include standard procedures required by Heritage NZ (see appended example), including for:*
    - *The temporary marking out or fencing off of known archaeological sites prior to the start of any works (including planting) in their vicinity to protect them from accidental damage from heavy machinery, amenity development works and inappropriate planting.*

- *Pre-start meetings with contractors to brief them on the archaeological and cultural requirements.*
- *Protocols for managing the discovery of previously unidentified subsurface archaeological remains, kōiwi tangata and taonga tūturu in consultation with Mana Whenua.*
- *Identification of areas where archaeological monitoring of works is required.*
- *Procedures for the investigation and recording of any archaeological remains that cannot be avoided.*
- *Reporting on the results of archaeological monitoring and investigation.*

12. *If kōiwi tangata are found, work must cease immediately within 20m of the remains and Mana Whenua, Heritage NZ, the NZ Police and Council must be contacted so that appropriate arrangements can be made from cultural and statutory perspectives.*
13. *Potential effects on unrecorded sites away from the coastal edge (where the potential for sites to be present is lower) can be managed under the AUP Accidental Discovery Rule E12.6.1.* (Clough & Associates Ltd., 2022) *concludes that adverse effects on archaeological sites resulting from development for the Private Plan Change are likely to be minor if the proposed mitigative measures are followed.*

Ngāi Tai Kaitaki will perform cultural monitoring duties, which will commence with mihi and karakia (Ngāi Tai ki Tāmaki Trust, 2022). The relevant sections of the RMA include section 6e, 7a and 8. These sections enable Ngāi Tai to maintain the relationship with their rohe under development and ensure a collaboration with the developer, project professionals and contractors during monitoring.

The proposed precinct provisions also provide for the recognition, protection, and enhancement of mana whenua cultural, spiritual, and historical values within the plan change area.

Figure 19: Current extents of archaeological sites based on Felgate (1995), Baquié et al. 2012 and the 2021 surveys. The location of R11/1622 is not known exactly. R11/1620 is part of R11/344.

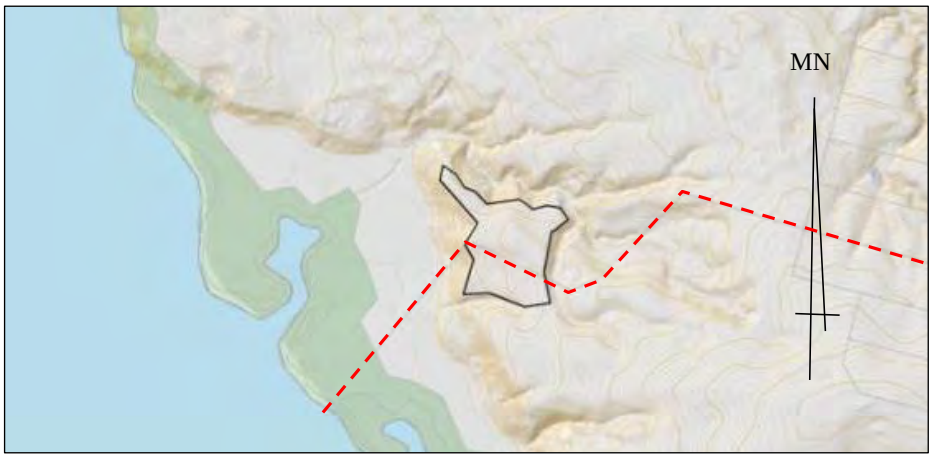


Figure 20: Location and probable extent of the pā, R11/1619, with property boundary shown in red.

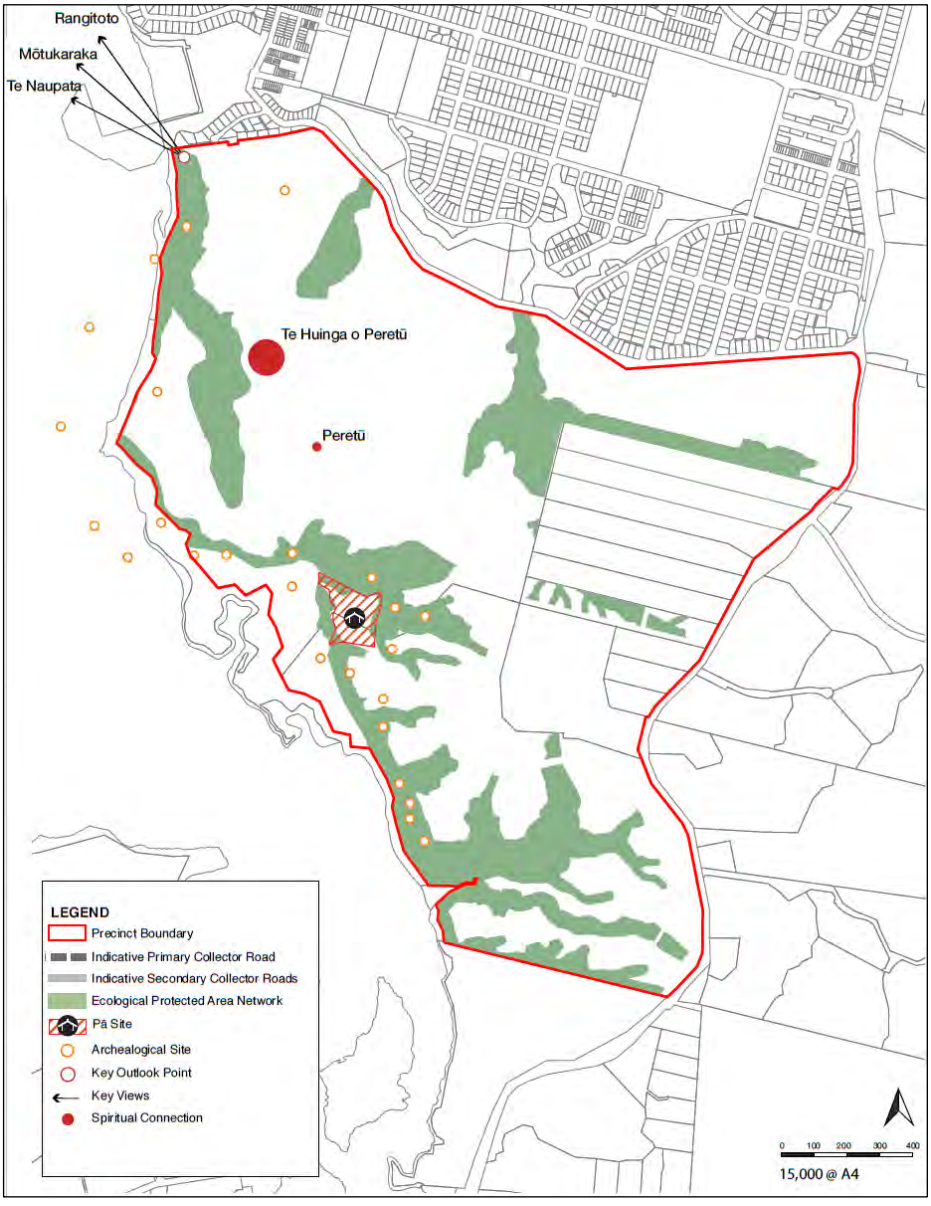


Figure 21: Beachlands South Precinct Plan 4 – Cultural Landscape Plan (Ngāi Tai ki Tāmaki Trust, 2022).

1.12 Contaminated land

Tonkin & Taylor prepared a detailed ground contamination assessment (2021) for the Private Plan Change and Structure Plan area. The investigation concluded that potential contamination sources were found at the site that will require further investigation to support the Private plan change application. The following recommendations have been made:

- In an effort to minimise disposal cost, additional soil testing in the building footprint of the existing 'hazardous storage' area may be warranted once demolished – depending on investigations costs.
- Current structures at the site were constructed in the late 1990's and therefore unlikely to contain asbestos. However, due to time constraints access was not given to the Driving Range and Tee off Kiosk. It is to be confirmed whether these locations have been inspected for asbestos as required as per Asbestos Regulations.

Further recommendations will be supplied after additional soil sampling has been carried out.

2 Development summary and planning context

2.1 Regulatory and design requirements

Table 5: Regulatory and design requirements.

Requirement	Relevant regulatory / design to follow
UNITARY PLAN – SMAF 1 HYDROLOGY MITIGATION	• Provide retention (volume reduction) of at least 5mm runoff depth for the impervious area for which hydrology mitigation is required; and • 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 the 5 mm retention volume or any greater retention volume that is achieved, over the impervious area for which hydrology mitigation is required.
HIGH CONTAMINANT GENERATING AREAS	• Treatment of runoff from HCGAs/HURs using bioretention devices sized in accordance with GD/01.
NATURAL HAZARDS	• Development floodplains estimated through floodplain modelling in accordance with Auckland Council technical specifications.

Requirement	Relevant regulatory / design to follow
	• Increases in downstream flood hazards mitigated using peak flow attenuation devices throughout the site sub-catchments. • Peak flow attenuation provided to 100% of the peak pre-development rate in the 1% AEP event for catchments discharging to the existing watercourse north of the site • Peak flow attenuation provided to 100% of the peak pre-development rate in the 50% AEP event for catchments discharging to the Waikopua Creek via tributary watercourses within the site
AUCKLAND UNITARY PLAN PRECINCT	• As part of the Private Plan Change the site will be removed from Whitford sub-precinct B and a new Beachlands South precinct will be introduced with specific precinct provisions for stormwater management accordance with this SMP and the Council's region-wide network discharge consent.
EXISTING CATCHMENT MANAGEMENT PLAN	• N/A
AUCKLAND COUNCIL REGIONWIDE NETWORK DISCHARGE CONSENT	• Greenfield Development under Schedule 4 of the Auckland Council Network Discharge Consent

3 Mana whenua: Te ao Māori and mātauranga Māori

Beachlands South GP Limited and Ngāi Tai ki Tāmaki have developed an ongoing relationship throughout the development throughout the development of this Structure Plan and Private Plan Change Application. Ngāi Tai ki Tāmaki prepared a Cultural Values Assessment (CVA) (2022) - Tapuwae Ohiti to express the explicit values and concerns of Ngāi Tai ki Tāmaki.

3.1 Identification and incorporation of mana whenua values

Ngāi Tai prepared a Cultural Values Assessment to address te mauri o te whenua, te mauri o tew ai, the mana of their tupuna and to the people of Ngāi Tai ki Tāmaki today (Ngāi Tai ki Tāmaki Trust, 2022). This enables Ngāi Tai to express its identity, history, and concerns regarding the project to assist in the planning processes including cultural strategies for crisis management (Ngāi Tai ki Tāmaki Trust, 2022).

The values of the Ngāi Tai ki Tāmaki trust have been identified and assessed in accordance with the proposed Structure Plan and FUZ. Ngāi Tai's core values of:

- Kaitiakitanga
- Rangatiratanga
- Whanaungatanga
- Manaakitanga
- Mana Whenua
- Kotahitanga

The assessment concluded that the overall trend is that the iwi values have been positively recognised and impacted from the work the Beachlands South LP (BSLP) owners have undertaken so far (Ngāi Tai ki Tāmaki Trust, 2022). Ngāi Tai supports the plan change on the basis of the detailed technical reports prepared by BSLP and the mitigation measures offered by BSLP through these reports (Ngāi Tai ki Tāmaki Trust, 2022).

Ngāi Tai's connections with Te Taiao (The Environment) features strongly throughout the cultural assessment summary. Protection, restoration, and education with respect to Ngāi Tai taonga is fundamental to their commitment and responsibilities as Kaitiaki (Ngāi Tai ki Tāmaki Trust, 2022). The key objective for Kaitiaki, is to ensure that the mauri of the environment is preserved or enhanced for future generations (Ngāi Tai ki Tāmaki Trust, 2022). This is critical in maintaining mana whenua, mana tangata and kaitiaki status for Ngāi Tai as part of exercising rangatiratanga across their rohe.

The natural and physical resources in this region were, and still are, of vital importance to ensure the survival of future generations of Ngāi Tai (Ngāi Tai ki Tāmaki Trust, 2022). As tangata whenua, Ngāi Tai have been inherently charged with upholding guardianship

obligations. The land carries a deep sense of belonging and identity for their iwi (Ngāi Tai ki Tāmaki Trust, 2022).

The cultural values and corresponding cultural assessment for the purpose of the proposed Structure Plan are summarised in Table 6.

Table 6: Ngāi Tai ki Tāmaki Trust values and cultural values assessment for the proposed Structure Plan (Ngāi Tai ki Tāmaki Trust, 2022).

Value	Assessment
MANA WHENUA	Over the past decade, the BSLP owners have genuinely involved Ngāi Tai as the mana whenua and mana moana for the area. Ngāi Tai recognises that BSLP has helped reinforce mana whenua with its transparent and partnership-based approach to the overarching development and related matters. A key outcome announced by the Structure Plan is expected to be recognition and adoption of mana whenua values. This is evident from Ngāi Tai involvement in consultation and activation across design and related aspects of the proposed Structure Plan.
KAITIAKITANGA	The Beachlands South vision incorporates a place defined by a symbiotic relationship with the natural environment and seeks an innovative, regenerative, sustainable, and resilient development. The vision is highly consistent with the tribe's kaitiakitanga value. The BSLP owners have demonstrated significant appreciation of this value and adopted it as one of the key outcomes for the Structure Plan (along with Mauri Tū and Te Taiao). Kaitiakitanga responsiveness is happening through extensive work around sustainability, transport, and modal shift, three waters, ecology and biodiversity, carbon footprint, coastal matters, hazards, and landscape and visual work – and Ngāi Tai looks forward to further engagement for and demonstration of kaitiakitanga as the development progresses. There is excellent consideration and planning to mitigate various environmental effects.
RANGATIRATANGA	The proposed Structure Plan has a number of rangatiratanga touchpoints including kōiwi/tūpuna protocols (e.g., archaeological), transparency around ownership for the development and related matters (e.g., infrastructure), constant external communications with stakeholders and the communities of interest around the Ngāi Tai rangatiratanga for the area. The BSLP owners have provided for greater Ngāi Tai expression of rangatiratanga through social, environmental, cultural, and economic objectives over time. This includes specific engagement around the pā site.
WHANAUNGATANGA	Whanaungatanga is a key outcome for the Structure Plan. BSLP owners have facilitated an enduring partnership ethic with Ngāi Tai by involving our governance and management in key design and infrastructure discussions. It is expected that these

Value	Assessment
	relationships will continue at organisational levels as Ngāi Tai seeks to ensure a cultural footprint across the entire development – from design through to delivery.
MANAAKITANGA	It is expected that the Structure Plan will focus on sustainable, safe, and accessible transport options. These pathways will be complemented by safe open spaces and recreation areas as well as an accessible coastline. The proposed infrastructure development includes social infrastructure e.g., schools, that will make the area more liveable and sustainable compared to the status quo. The quality and quantity of housing choices proposed across various typologies and renting/ownership arrangements, demonstrate the awareness of BSLP owners to deliver Beachlands South for many diverse demographics with wellbeing and belonging at the core.
KOTAHITANGA	The kotahitanga concept has been promoted by BSLP owners from the outset of the proposed Structure Plan. This has included a number of hui with Ngāi Tai and also the local community. The owners have sought whole of central government, Council, community, and tangata whenua and mana whenua support for this large project.

The proposed stormwater management devices are discussed in detail in Section 6.3. Stormwater management devices and measures have been proposed to manage the runoff from roads and public areas including bioretention swales and rain gardens site to provide pre-treatment and hydrological mitigation for runoff generated on new road surfaces. Suitable devices identified to manage the runoff from private lots include rain water tanks, permeable and porous paving slabs, small-scale bioretention systems, and living roofs. This approach offers multiple benefits including reducing mains water consumption, protecting valuable streams within the site, and improving the resilience of the public stormwater network. Communal devices are required to attenuate peak flows generated by the loss of depression storage and urban intensification prior to discharging stormwater runoff into the stream network. Treatment and peak flow attenuation wetlands are proposed to provide multiple outcomes for all on-site sub catchments. Careful landscape design can create significant ecological value within these wetlands as well as amenity value for the ultimate development. Native species will be prioritised for the landscaping of vegetated swales and wetlands to protect the area and enhance the cultural value.

Many estuaries are still at threat from stormwater pollution and damage. Implementation of strong stormwater management controls will assist in restoring and protecting estuaries and coastal areas from physical and economic damage from flood events (Ngāi Tai ki Tāmaki Trust, 2022). The proposed management and silt run-off protection measures will improve the current sedimentation run-off from land.

An increase in flood levels, weather bombs and heavy rainfall events have been experienced in the past year, resulting in waters carrying pollutants. The proposed measures by BSLP will help mitigate and improve the impact of stormwater run-off which affect the quality of Te Waitemata and Tikapa Moana, surrounding foreshores and tidal streams (Ngāi Tai ki Tāmaki Trust, 2022).

Coastal erosion has caused substantial damage to the coastal edges, walkways, large trees, and beach fronts surrounding the site. Ngāi Tai (2022) noted that the mitigative measures proposed by BSLP adequately address potential effects of coastal erosion and sediment discharge that might result from the urbanisation of the site.

The main project issues measured in the CVA (2022) are summarised in Table 7.

Table 7: Project issues to measure in the Cultural Values Assessment (Ngāi Tai ki Tāmaki Trust, 2022).

Value	Assessment
THE DEGRADATION TO THE MAURI OF THE WATERWAYS.	Stormwater control, management, and filtration through on site landscaping, stormwater filter devices, stormwater ponds and wetlands. Also, during construction silt control devices are proposed including decanting earth bunds, silt fences, reduced open earthwork areas. The Plan Change includes provisions that will result in better than best practice stormwater management and sediment control measures.
CONTINUED LOSS OF MANA, OUR SPIRITUAL AND PHYSICAL CONNECTION WITH THE AREA.	The inclusion of a Cultural Framework Plan with associated assessment criteria and planning rules relating to any works in the identified pā area.
THE POTENTIAL OF UNEARTHING/EXPOSING CULTURAL REMAINS INCLUDING KŌIWI (HUMAN REMAINS).	Archaeological discovery protocols.
SIGNIFICANT GROUND DISTURBANCE RESULTING IN PERMANENT DAMAGE TO NATURAL LAND CHARACTERS.	Resource consent requirements and conditions for earthworks as well as existing AUP provisions relating to coastal cliffs.
DESTRUCTION OF CULTURAL HERITAGE.	Cultural Framework Plan, proposed Mana Whenua planning rule in Plan Change, Archaeological Discovery Protocol.

Value	Assessment
THE POTENTIAL DESTRUCTION OF CULTURAL REMAINS IN SITU.	Cultural Framework Plan, proposed Mana Whenua planning rule in Plan Change, Archaeological Discovery Protocol.
CROSS CULTURAL IMPLICATIONS TO NGĀI TAI WAIRUA, TINANA, WHĀNAU, AND HINENGARO.	Management of engagement with Iwi by BSLP.
WĀHI TAPU SITE CHECK INCLUDES NATURAL, NATIVE FLORA AND FAUNA SITES.	Cultural Framework Plan, proposed Mana Whenua planning rule, Archaeological Discovery Protocols.
EFFECTS ON TERRESTRIAL ECOLOGY/SIGNIFICANT NATURAL AREAS.	Ecological mitigation measures as set out in the ecological reports and supported by specific objectives, polices, rules and assessment criteria in the plan change. These are also supported by the existing AUP SEA Overlay and rules. The overall result is the protection and restoration of the Ecological Protection Area Network which is an 80-hectare area of land.
DAMAGE TO THE VARYING ECOTONES AND THEIR ENVIRONMENTS.	Ecological mitigation measures as set out in the ecological reports and supported by specific objectives, polices, rules and assessment criteria in the plan change. These are also supported by the existing AUP SEA Overlay and rules.
EFFECTS ON MARINE AND SHOREBIRD ECOLOGY.	Ecological mitigation measures as set out in the ecological reports and supported by specific objectives, polices, rules and assessment criteria in the plan change. These are also supported by the existing AUP SEA Overlay and rules.
EARTHWORKS AND SEDIMENT CONTROLS.	Managed by existing AUP rules and addressed in Earthworks and Sedimentation reports prepared for plan change. Will also be addressed as part of any future resource consent applications.
WORKS IN AND AROUND CULTURALLY SIGNIFICANT WATERCOURSES/WATERBODIES.	Addressed in Earthworks, Sedimentation, Stormwater and Ecological Reports and will also be addressed by Archaeological Discovery Protocols.
LOSS OF POTENTIAL NOTABLE NATIVE TREES AND VEGETATION.	Replaced by significant ecological restoration proposed. An Ecological Protection Area Network has been established which covers and protects approximately 80ha of

Value	Assessment
	the site of which approximately 30 ha will be revegetated and restored with native plants.
WATER QUALITY MANAGEMENT, CONCERN FOR POOR TREATMENT FOR NEW AND EXISTING IMPERVIOUS AREAS.	Managed by Stormwater Management Plan and proposed Plan Change rule preventing the use of high contaminant yield materials. Stormwater filters, treatment ponds and wetland proposed to improve water quality of discharges.
DIVERSION OF GROUNDWATER.	If proposed the existing AUP standards manage the effects of groundwater diversion, and the process requires consultation with Mana Whenua.
AIR QUALITY POLLUTION.	The proposed development will be a low carbon impact with forest sequestration required as well as the protection, restoration, and enhancement of 80ha of ecologically important land.
MATERIAL MANAGEMENT/DISPOSAL OF WASTE TO LANDFILL.	Contamination assessment require site management plans and disposal of any contaminated land to an approved landfill.
IDENTIFICATION AND IMPLEMENTATION OF SUSTAINABILITY MEASURES, PROCUREMENT, AND MATERIALS.	The proposed development will be a low carbon impact with forest sequestration required as well as the protection, restoration, and enhancement of 80ha of ecologically important land.
STORMWATER AND WASTEWATER EFFECTS.	Managed by the Stormwater Management Plan and proposed Wastewater treatment approach.
EARTHWORKS AND MITIGATION EFFECTS TO OUR WATERWAYS.	Managed by existing AUP rules and addressed in Earthworks and Sedimentation reports prepared for plan change. Will also be addressed as part of any future resource consent applications.
CROSS CONTAMINATION I.E., INTRODUCING KAURI DIE BACK DISEASE OR MYRTLE RUST WITHIN THE NGĀI TAI ROHE/DEVELOPMENT AREA FROM CONTAMINATED WHENUA ON EARTHWORKS MACHINERY.	The Formosa Golf site has been previously heavily earthworked and recontoured. BSLP have advised that they will work with Ngai Tai on an ongoing basis to mitigate this risk.

Value	Assessment
EFFECTS OF THE PROJECT ON OUR NATURAL RESOURCES E.G., WATER TAKE FROM AQUIFER TO BE METRED.	Water permits will be monitored to ensure sustainability of the aquifer. Existing permit conditions require this.
APPROPRIATE CULTURAL MITIGATION MEASURES, INCLUDING BUT NOT RESTRICTED TO, CULTURAL MONITORING REQUIRED FOR EARTH WORKS, FISH RELOCATION.	Cultural Framework Plan included in Plan Change and Mana Whenua input will be required for any watercourse works and earthworks with potential Mana Whenua impacts. Archaeological Discovery Protocols will also be in place.

Ngāi Tai are committed to working alongside Beachlands South, for a development that upholds with their cultural values, is above best practice and puts the natural environment at the heart of the development.

4 Stakeholder engagement and consultation

Ongoing stakeholder engagement and consultation has been a key feature of this process.

Table 8: Stakeholder engagement and consultation record.

Stakeholders	What is the reason for interest?	What engagement has been completed?	Feedback and response
Local residents		Ongoing consultation including attendance at a community open day held on 3rd and 4th December 2021.	Generally positive response. The open day featured on the front page of the Pohutukawa Coast Times issue on 10 December 2021.
Ngāi Tai ki Tāmaki	Mana whenua Ngāi Tai ki Tāmaki have a strong historical connection to the area, often referred to as Kahawairahi and/or Kauriwhakiwhaki.	Ongoing partnership with Ngāi Tai ki Tāmaki over several years.	A Cultural Value Assessment (CVA) (2022) has been produced. This report concluded that the iwi values have been positively recognised and impacted from the work the Beachlands South LP (BSLP) owners have undertaken so far.
Mana whenua with registered interest in the development area as per council records.	Mana Whenua that have registered interest in the site and surrounding area as per the Council records.	This consultation involved preparation of a letter providing an overview of the plan change application by BSLP, the key outcomes sought and confirming that Ngāi Tai Ki Tāmaki have been engaged by BSLP as a development partner for Beachlands South.	Comments were invited from other iwi groups, but no responses were received.
Local Board	Local Boards provide governance at the local level within Auckland Council. Local Boards are tasked with decision-making on local issues, activities, and services, and provide input into regional strategies, policies, plans and decisions.	A high-level presentation was given to Councillor Bill Cashmore on 20 October 2020. A presentation to the Local Board was also made on 29 October 2021.	Generally positive response - see attached meeting minutes in Consultation Summary Report capturing key items capturing those discussions.

5 Proposed development

BSLP is seeking a Private Plan Change across multiple contiguous properties in Beachlands, Auckland. The proposed Structure Plan and Private Plan Change consists of approximately 307 hectares of land at the current Formosa Golf Course, located at 110 Jack Lachlan Drive along with adjacent sites proposed to become FUZ.

The Private *Plan Change area is currently zoned Rural-Countryside Living under the Auckland Unitary Plan. BSLP is seeking to rezone the land to a combination of Business (Mixed Use, Local Centre, and Neighbourhood Centre), Open Spaces, Residential (THAB, MHU, and Large Lot) and Future Urban Zone (FUZ).*

5.1 General development information

The proposed site layout and zoning is shown on Figure 22, and additional controls and overlays, on Figure 23. The Private Plan Change proposes a live zone area in the north of the site and Future Urban Zone (FUZ) in the southern portion of the site. As demonstrated, the proposal includes a diverse range of zoning including Business – Light Industry, Mixed Use, Local Centre, Terraced Housing & Apartment Building, and Sport and Active Recreation zones. This layout has been replicated in the hydraulic models used to develop stream and floodplain extents across the site.

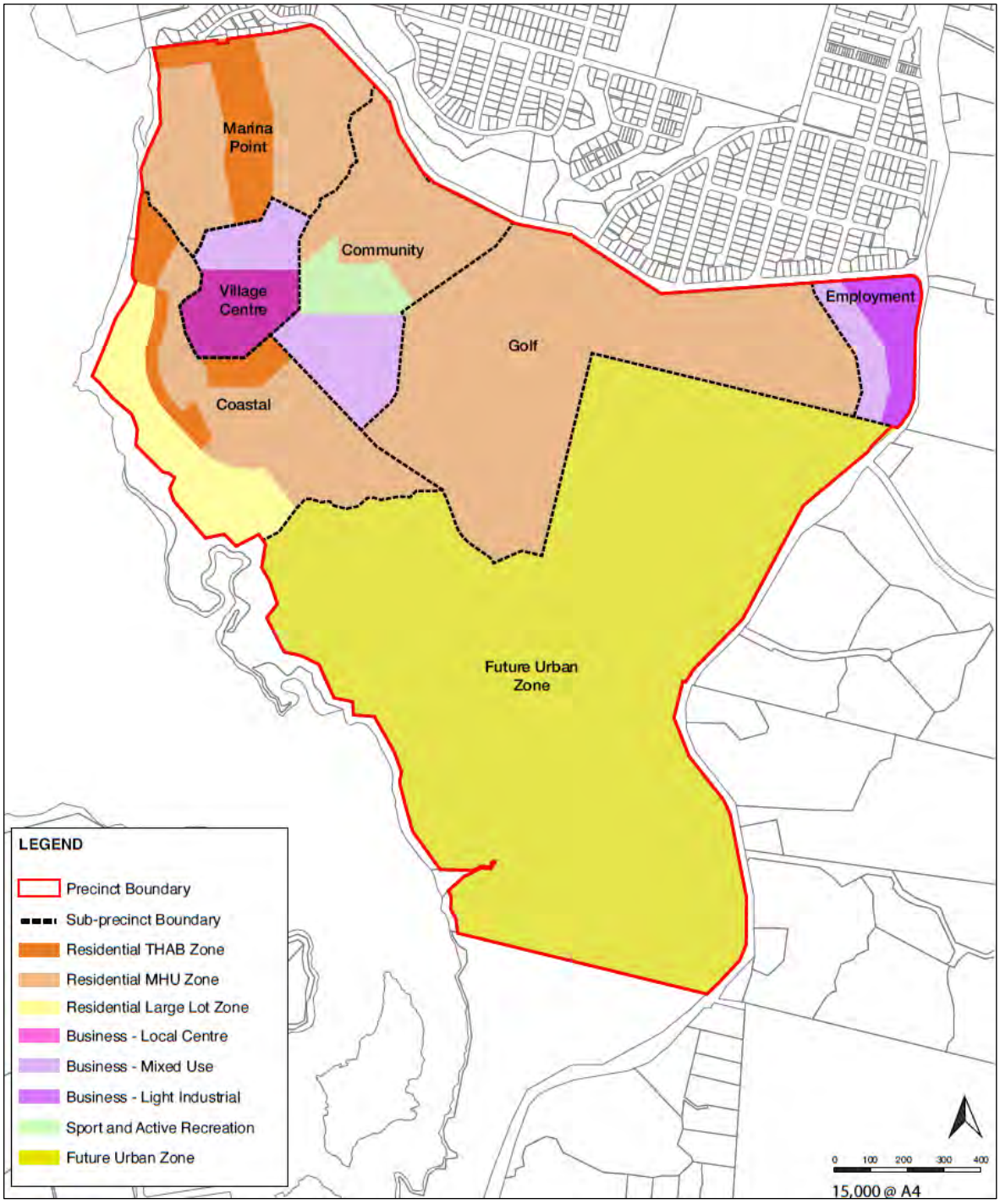


Figure 22: Beachlands South Precinct Plan – Zoning Plan

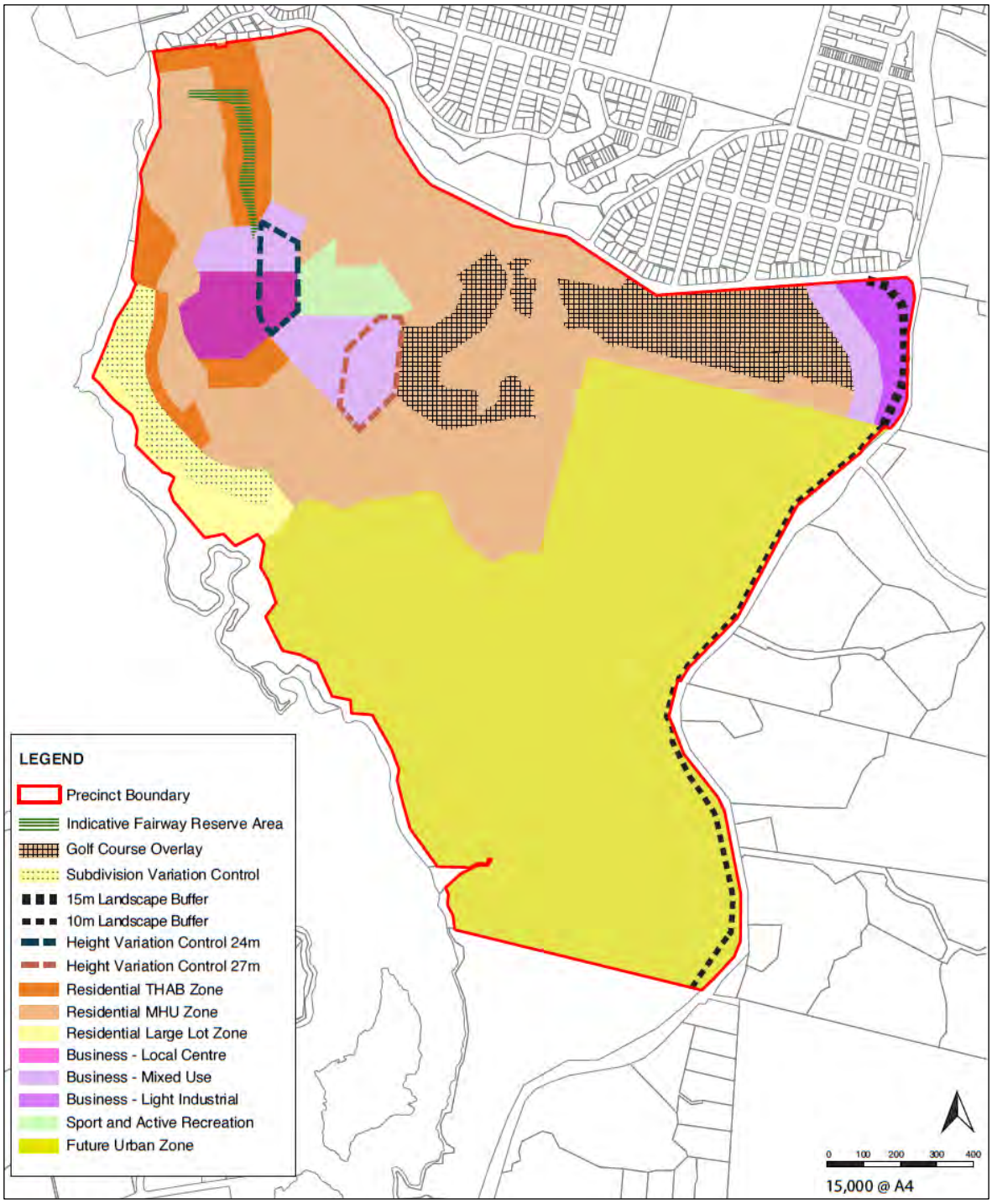


Figure 23: Beachlands South Precinct Plan – Additional Controls and Overlays Plan

The proposed development layout will influence some changes in sub-catchment boundaries. This is caused by spine road layouts and the need for relatively flat sections of land to build upon. Care was taken throughout the process to align spine roads with the sub-catchment boundaries as far as practicable to avoid significant diversions occurring. The extents of the five major sub-catchments are shown on Figure 24 and Table 9. These indicate small changes in the extents of sub-catchments 1, 2, 4 and 5, and a larger change in the extent of sub-catchment 3. Attention should be given to further minimise the impacts

of sub-catchment diversion on the stream reach draining sub-catchment 3 throughout the design process.

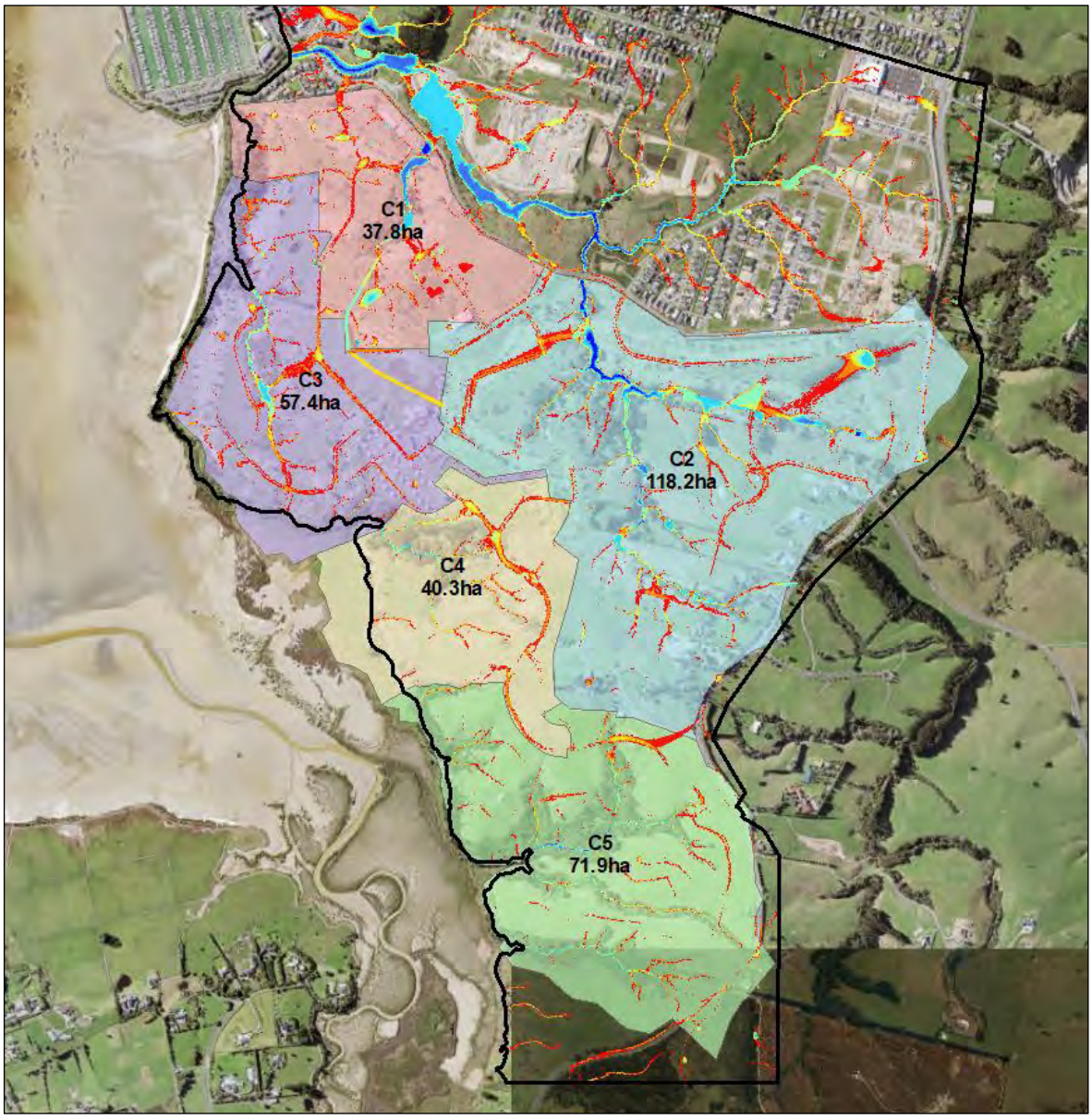


Figure 24: Developed site sub-catchment layout plan.

Table 9: Major sub-catchment extents.

Sub-catchment	Pre-development area	Post-development area	Percentage change
1	45.8 ha	37.8 ha	-17%
2	104.7 ha	118.2 ha	+13%
3	42.2 ha	57.4 ha	+36%
4	50.9 ha	40.3 ha	-21%
5	78.4 ha	71.9 ha	-8%

5.2 Location and area

The site location and Private Plan Change area is as follows:

- Live Zone:
    - 110 Jack Lachlan Drive Beachlands Auckland 2571 (170.4750 ha)
- Future Urban Zone:
    - 620 Whitford-Maraetai Road Whitford Auckland 2571 (79.9444 ha)
    - 770 Whitford-Maraetai Road Whitford Auckland 2571 (6.8665 ha)
    - 758 Whitford-Maraetai Road Whitford Auckland 2571 (6.1403ha)
    - 746 Whitford-Maraetai Road Whitford Auckland 2571 (5.7997 ha)
    - 740 Whitford-Maraetai Road Whitford Auckland 2571 (5.1448 ha)
    - 732 Whitford-Maraetai Road Whitford Auckland 2571 (5.0940 ha)
    - 722 Whitford-Maraetai Road Whitford Auckland 2571 (4.9227 ha)
    - 712 Whitford-Maraetai Road Whitford Auckland 2571 (4.7518 ha)
    - 702 Whitford-Maraetai Road Whitford Auckland 2571 (2.1341 ha)
    - 692 Whitford-Maraetai Road Whitford Auckland 2571 (1.7747 ha)
    - 682 Whitford-Maraetai Road Whitford Auckland 2571 (1.2583 ha)
    - 680 Whitford-Maraetai Road Whitford Auckland 2571 (12.8125 ha)

5.3 Purpose of the development

The plan change for Beachlands South is committed to delivering a sustainable and resilient community. The proposal will provide opportunities for the development of housing for the local community to grow, a local school from primary to secondary level, job opportunities and traffic improvements. These provisions aim to improve the living standards of the local community economically, socially, and environmentally.

The Beachlands South Masterplan Sustainability Strategy (2021) for the development encompasses the following aspects:

- Water management and water sensitive design
- Biodiversity and ecological regeneration
- Community health and well-being
- Renewable energy and energy efficiency
- Low carbon development
- Mode shift and healthy streets.

An innovative and resilient three waters management strategy will aim to ensure long term benefit to the community and surrounding environment. The built environment will embody principles enabling and upholding the mental, social, cultural, and physical wellbeing of residents and visitors of the area. The natural environment is placed at the heart of the development in the concept, design, and construction phases of the project. The emissions associated with housing will be addressed through on-site carbon sequestration. Energy and water efficiency, renewable energy generation and individual

lifestyle considerations will aim to reduce the impact on the environment. A transportation network the prioritises active modes of transport will make streets safer, quieter, and healthier.

5.4 Site layout and urban form

The proposal includes a diverse range of zoning from Business and Light Industry through to Terraced Housing & Apartment Building and Sport and Active Recreation zones. The areas to be zoned as Future Urban Zone will require a future Plan Change (and Stormwater Management Plan) in order to be developed.

5.5 Earthworks

Earthworks are required to form stormwater management devices, as well as to allow for the installation of drainage and utilities.

A Beachlands South ESCP Report was prepared by Harrison Grierson (2021). The following describes the key points of the report. Earthworks will be undertaken in a manner to minimise sediment runoff and discharge into the receiving environments. Earthworks will be undertaken in stages to prevent a large area being left open at any one time, which can increase the chances of sediment runoff. The best practice Auckland Council GD05 (Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Regions) mitigation and control strategies will be followed as a minimum standard.

The ESCP illustrates the scale of the catchment and suggests how earthworks might be conducted. While some catchments are indicated as larger than 4 ha, only 4 ha will be disturbed at any given point in time. This is discussed in detail in Section 4 and Appendix 1 of the ESCP Report (2021).

6 Stormwater management

The proposed stormwater management is aligned with the objectives of the Beachlands South Structure Plan and Private Plan Change sustainability strategy. The proposed stormwater management are rooted in the principles of water sensitive urban design.

The Structure Plan development process has been an interdisciplinary exercise from start to finish, with frequent touchpoints between civil engineers, planners, urban designers, surveyors, hydraulic modellers, and coastal specialists. The proposed site layout, riparian margins, and esplanade reserves were set out by a collaborative process between hydraulic modellers and surveyors to determine the mean annual flood based on a comprehensive site and stream survey. All proposed live and zones are included in all aspects of this assessment. Although FUZ areas will need to be assessed in a future plan change and under a separate SMP, they have been represented with a moderate level of development as part of this assessment.

Collaboration between hydraulic modellers and coastal specialists has produced a comprehensive assessment of potential sediment transport in the stream channels discharging runoff from the site. This assessment considers the existing and developed scenarios as well as several critical points during the earthworks and civil construction phases to identify and mitigate significant sediment discharges into the sensitive receiving environment. Further measures to protect and enhance the values and functions of the natural ecosystems include ecological assessments of existing water features to identify ecological value, preservation of valuable water features, and the proposed in-filling of low value, artificial water features and the successive creation of new, naturalised stream channels in their place.

Stormwater effects are addressed as close to the source as possible. The multi-criteria analysis and life-cycle cost assessment appended to this report consider the efficacy of different stormwater quality and quantity management interventions to meet quality, quantity, and hydrological mitigation targets. The proposed approach includes the use of bioretention rain gardens and swales providing first-flush treatment within the public road reserves, with hydrological mitigation and peak flow attenuation provided within multi-purpose attenuation basins as a second line of defence. The use of on-site hydrological mitigation in accordance with the SMAF 1 controls of the AUP, particularly through the capture and non-potable reuse of roof runoff, is also supported to provide broader outcomes and improve the resilience of the stormwater management system.

Natural systems and processes are mimicked as far as possible. All stormwater management devices proposed through this Plan Change are vegetated "green" devices performing a bioretention function. Existing catchment boundaries are preserved as far as possible to avoid localised adverse effects associated with an individual discharge. Existing artificial water features created by drainage culverts will in many cases be removed and restored to a more natural state through progressive stages of remediation. Finally, the proposed development is characterised by short stormwater pipelines discharging into the stream networks in multiple locations, avoiding the excessive use of grey networks and diluting & distributing point source discharges throughout the streams.

6.1 Principles of stormwater management

Water Management and Water-Sensitive Urban Design

An innovative and resilient three waters strategy to ensure long-term benefit to the development, the wider community and surrounding natural environment. A water sensitive design approach that avoids environmental degradation, maintains, and enhances the quality of the existing stream network, contributes to healthy soils & enhances the quality of the receiving environment by reducing the amount of nitrogen and contaminants flowing into the sea.

Biodiversity and Ecological Regeneration

Protect and enhance existing ecological values and improve ecological connectivity through the site and with the wider landscape to address the biodiversity crisis. This includes extensive restorative and regenerative planting, especially around waterways, creating new habitat areas for fauna and flora and a healthy environment for residents and visitors to enjoy.

Well protected, connected, and regenerative natural areas provide a wide range of benefits, including local fauna and flora habitat, positively impacting on the wider ecological network and in turn the local community. Supplementing the existing significant ecological areas (SEA) with extensive native vegetation through the extensive Ecological Protection Area Network (EPAN) spanning the site will further attract birdsong and reinforce a sense of place and the custodianship of these spaces.

Low-Carbon Development

A low carbon development, in both embodied and operational energy, which balances the emissions associated with the houses through on-site carbon sequestration.

An extensive planting strategy will aim to sequester carbon emissions over the lifetime of the development. A masterplan that will encourage travel by walking, cycling or public transport rather than private vehicle use, reducing individual carbon emissions and reliance on non-renewable forms of energy.

Health, Wellbeing and Culture

A built environment that embodies principles that foster the physical, mental, social, cultural, and economic wellbeing of residents and visitors of Beachlands South. This includes design principles that align with Te Ao Māori by providing neighbourhoods with strong visual and physical connections to nature and including employment areas and public amenities that promote sustainable communities.

Access to green spaces and natural areas are associated with a wide range of health benefits such as lower levels of anxiety and depression and improved physical and mental recovery from stress and fatigue. Beachlands South aims to bring people closer to nature through visual and physical connections between the built and natural environment, enhancing the well-being of residents and visitors.

6.2 Hydraulic Modelling

Hydraulic models were developed using InfoWorks ICM v11 software to support the Structure Plan and Private Plan Change application. These models are primarily 2D models using topographical survey data presented in this report to identify stream extents and flood hazards within the existing site and through the future development process. 1D structures based on asset survey data presented in this report are included in the models where necessary to facilitate drainage through culverts.

A total of five hydraulic model simulations were completed. These are set out in Table 10. The results of these model simulations provide stream extents for stream and future lot boundary definition, existing floodplain extents to approximate current infrastructure constraints and downstream hazards, and how these might change as a result of the future development of the Private Plan Change area. Detailed flood maps are attached to this report in Appendix C – Flood modelling results maps.

Table 10: Hydraulic model simulations

Development scenario	Rainfall AEP %	Rainfall ARI	Scenario purpose	Climate change factors included	Design rainfall depth	Storm profile
ED	43%	1-in-2.33-years	Mean annual flood for stream definition	No	79 mm	TP108 SCS
ED	10%	1-in-10-years	Flood hazards, pipe networks & peak flow attenuation	Yes	154 mm	TP108 SCS
ED	1%	1-in-100-years	Flood hazards, overland flowpaths & peak flow attenuation	Yes	243 mm	TP108 SCS
MPD	10%	1-in-10-years	Flood hazards, pipe networks & peak flow attenuation	Yes	154 mm	TP108 SCS
MPD	1%	1-in-100-years	Flood hazards, overland flowpaths & peak flow attenuation	Yes	243 mm	TP108 SCS

The results of the 1% AEP ED scenario flood model are presented below.

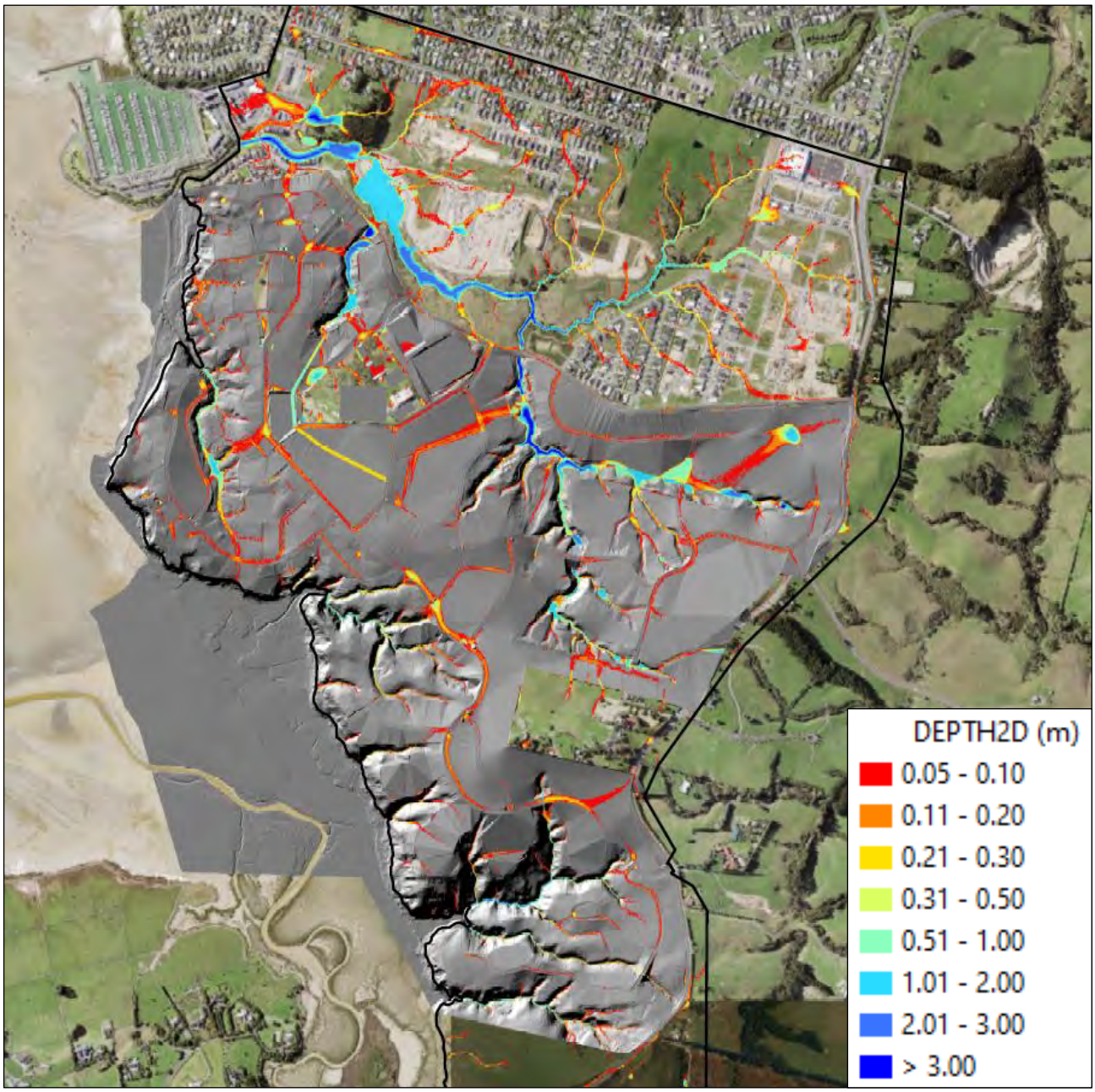


Figure 25: Existing Scenario, 1% AEP hydraulic model results. Modelled extent outlined in black.

The equivalent results of the 1% AEP scenario flood model for the developed site scenario are provided below. This is a simplified model that does not include primary stormwater networks or peak flow attenuation features that will be required to mitigate the potential impacts of development.

6.2.1 Model Assumptions & Exclusions

- All drainage culverts identified within the site with diameter of 375mm or more, were included in the InfoWorks ICM hydraulic models. Modelled pipe sizes ranged from 450 mm to 2750 mm diameter, the largest culverts being located beneath Jack Lachlan Drive.

- New pipe networks associated with future development were not included in the model. This exclusion caused ponding in several depression areas, most notably throughout sub-catchment 2.
- The extent of future development within sub-catchment 2 extends across the existing Golf Resort water features, restricting the extent of the stream. This conforms with the proposed Structure Plan layout and assumes a 10-metre-wide stream extent with 20-metre-wide esplanade reserves provided either side.
- The model ground surface was modified to facilitate drainage only in extreme cases where proposed road crossings would create significant ponding spilling into adjacent lots without a culvert or bridge structure being modelled.
- Primary network and secondary network sub-catchments are assumed to have equal extents. This is a typical assumption for rain-on-grid modelling. As the Structure Plan layout and proposed stormwater management uses small sub-catchments discharging to peak flow attenuation devices prior to discharge into local watercourses, this is not a significant departure from reality.
- All hydraulic models assume that all sites proposed to be FUZ are developed to 71% imperviousness. This accounts for future roads to be included in the FUZ areas as well as urban areas with around 60% imperviousness.
- Maximum imperviousness limits associated with the proposed zoning under the Structure Plan and Plan Change are not exceeded in any of the proposed development areas.
- The coastal boundary is a static water level set at 4.5 m RL, corresponding with the indicative coastline extent indicated on Auckland Council GeoMaps, including 2 metres of sea-level rise.
- In small, localised areas where topographical survey could not be undertaken due to safety concerns, Council LiDAR data was used to fill the gaps.
- Peak flow attenuation devices proposed under this Structure Plan are excluded from the model.
- The proposed ground model was slightly modified in Catchment 1 by adding an overland flow path in the hydraulic model to divert some of the surface runoff from discharging to Catchment 3. This helped the post development catchment extent to better match with the existing condition.

6.2.2 Design Rainfall

All hydraulic model simulations use TP108 SCS method rainfall with climate change factors applied in accordance with the Auckland Council Stormwater Code of Practice v2.

Runoff zones were delineated across the site based on soil types and proposed density. Runoff hydrographs were applied directly to rainfall zones within the model using the ‘net rainfall’ approach, whereby initial & constant losses are subtracted from the rainfall hyetograph prior to modelling. Design rainfall depths are shown on Table 10.

6.2.3 Catchment Imperviousness

The pre-development scenario was modelled using weighted curve numbers derived from different land use zones based on percentage impervious coverage.

The post-development scenario was modelled using weighted curve numbers derived from the allowable impervious coverage anticipated under the structure plan. The impervious coverage zones anticipated in the modelling are shown on Figure 26.

A weighted curve number of CN = 88 was used for the predominantly rural areas to the north of Jack Lachlan Drive, assuming 60% impervious coverage.

Weighted curve numbers of CN = 75, 86-93, and 96 were used for green spaces, residential areas, and Business Zones within the Structure Plan area respectively.

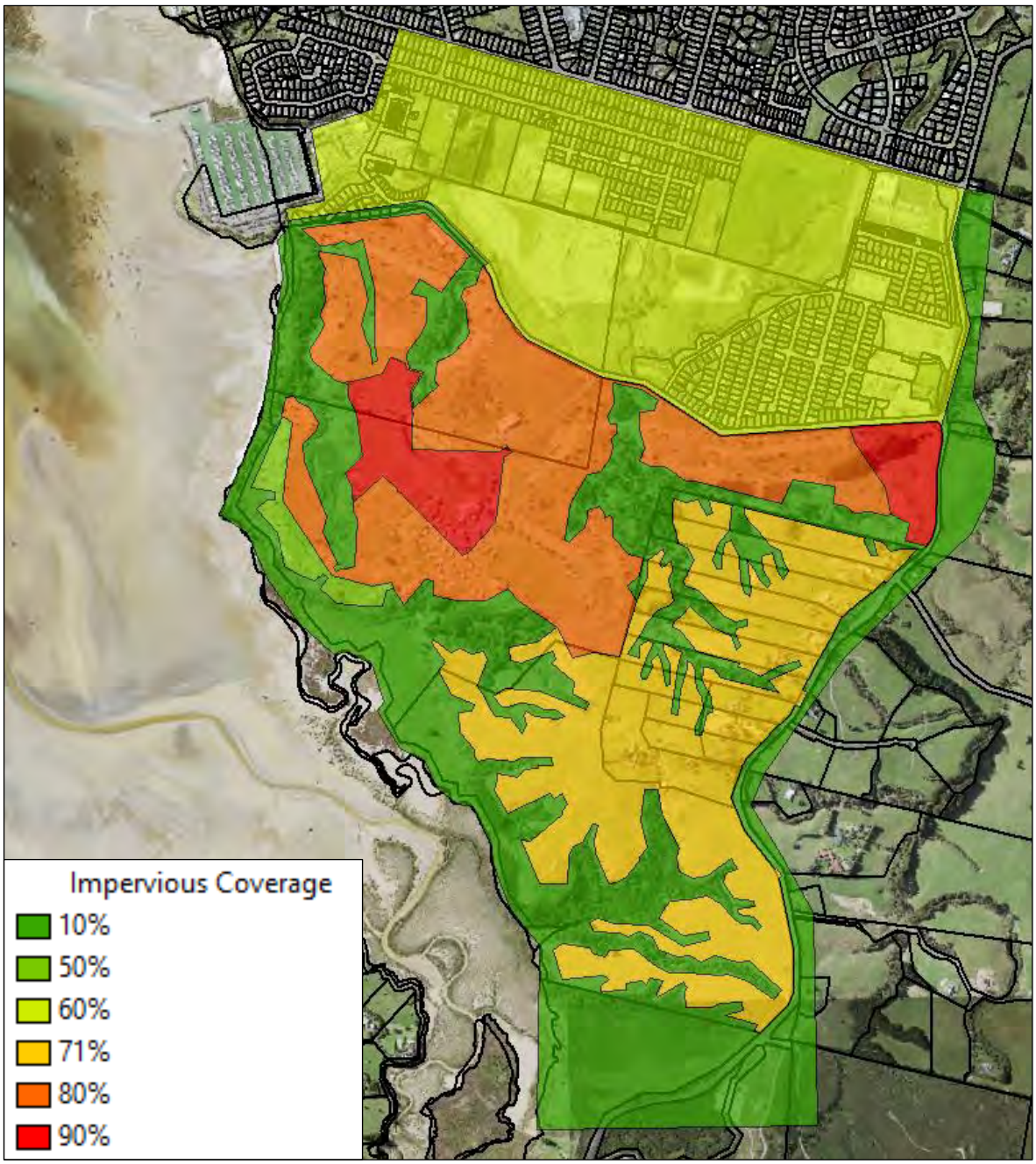


Figure 26: Impervious coverage anticipated under the structure plan.

6.2.4 Surface Roughness

Surface roughness values for the existing scenario were derived by validating observations from successive site visits against Manning's roughness values put forward in Chow (1959). Roughness zones were imported into the ED scenario hydraulic model (Figure 27) and replicated in the MPD scenario model. This applies relatively low roughness values for middle and upper catchment areas within the live zoned area reflecting the landscaped features of the golf resort. This is also a valid general assumption for the MPD scenario due to the level of intensity anticipated under the structure plan. The surface roughness used in the hydraulic models is shown on Figure 27.

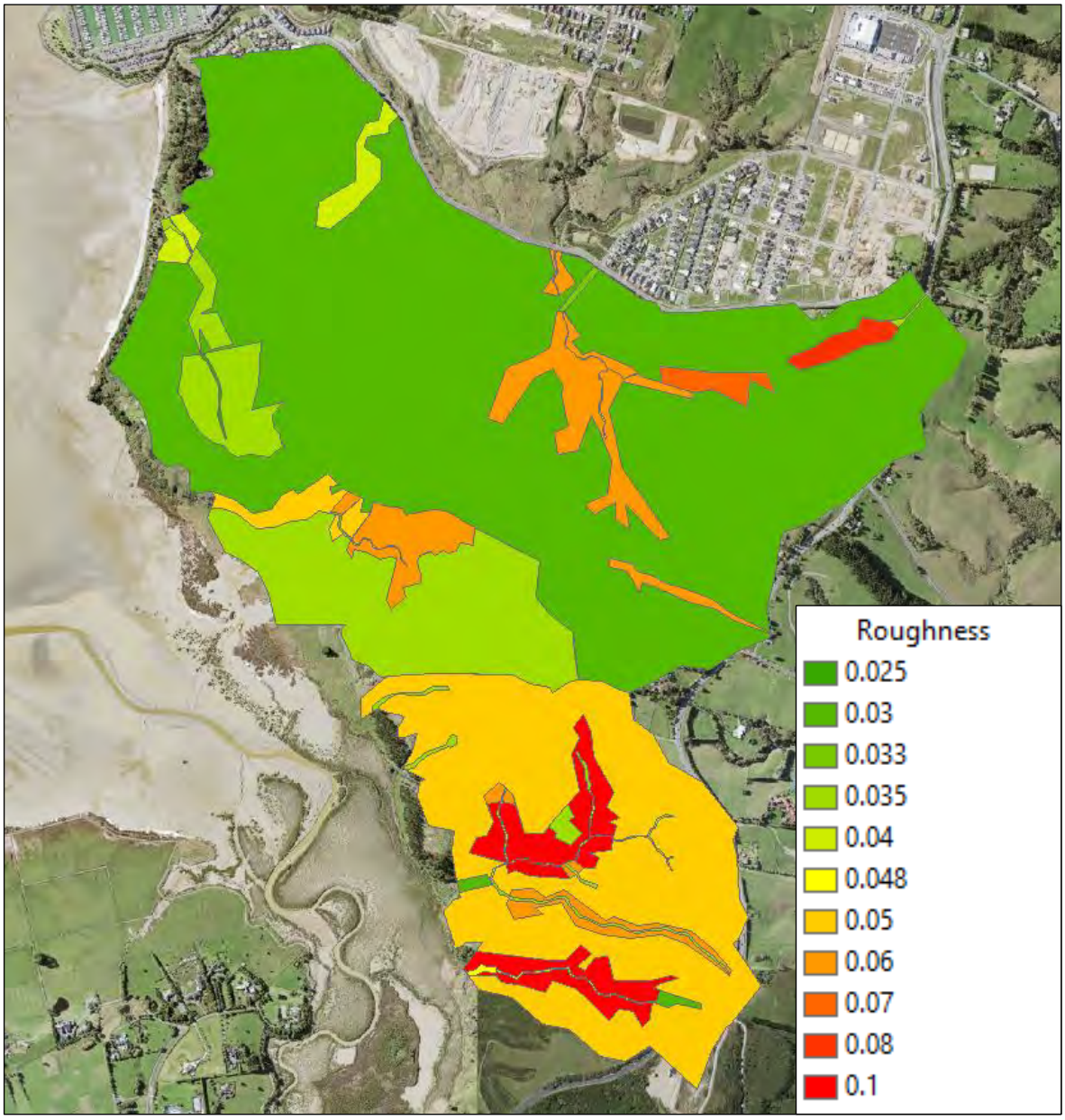


Figure 27: Hydraulic model surface roughness values (Manning's n values).

6.2.5 Downstream Impacts

Flood maps indicating changes in the extents and severity of flooding experienced across the site and receiving environment in the 10% and 1% AEP scenarios are provided in

Appendix A – Plans of existing and proposed site features. Excerpts from flood maps and discharge hydrographs are provided below. These results indicate that without peak flow attenuation there is in some areas an increase in peak water levels in the watercourse receiving runoff from stream catchments 1 & 2 of 20 to 140 mm.

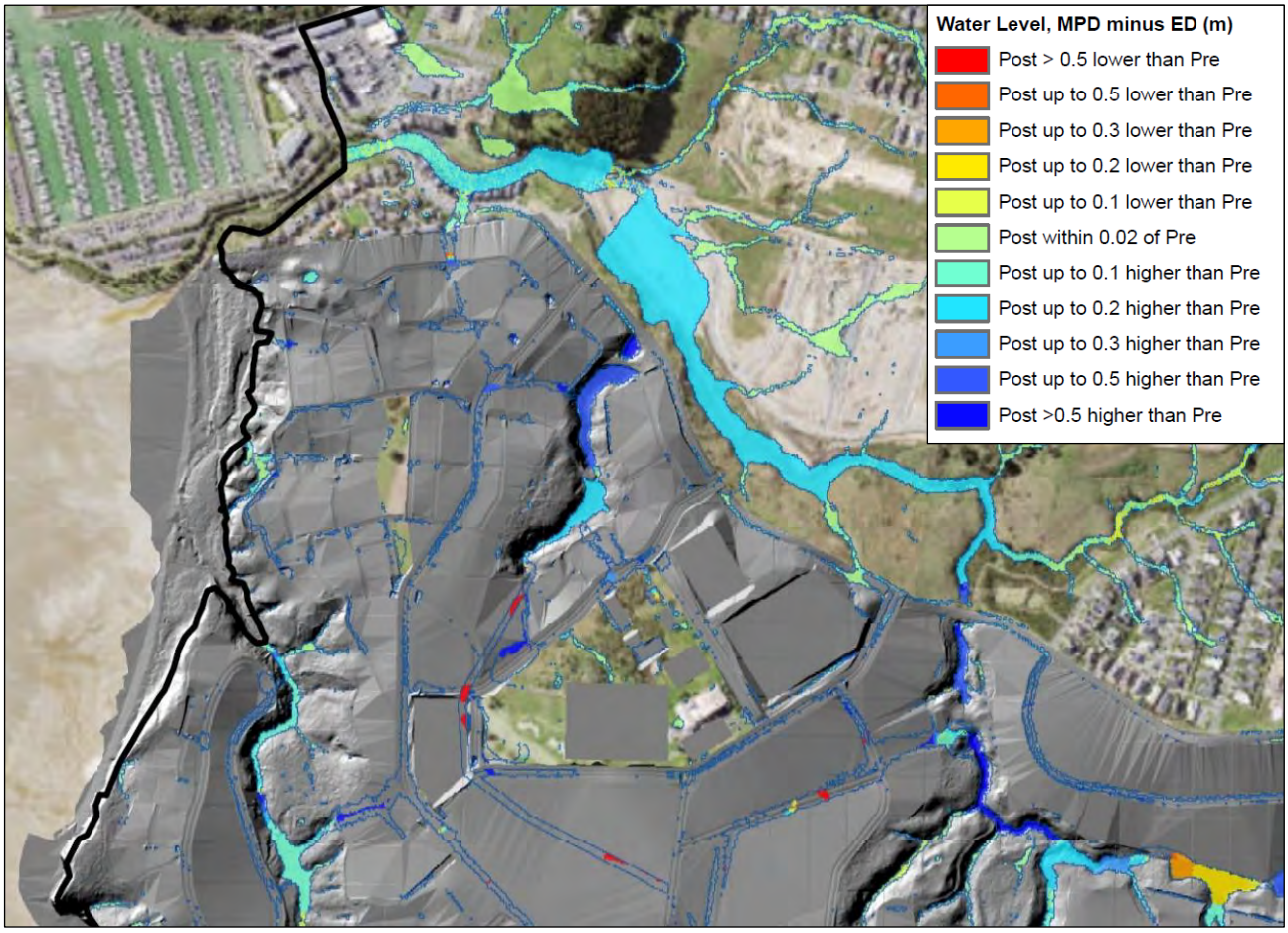


Figure 28: Difference in flood depth and extents between the 1% AEP ED and 1% AEP MPD flood model scenarios.

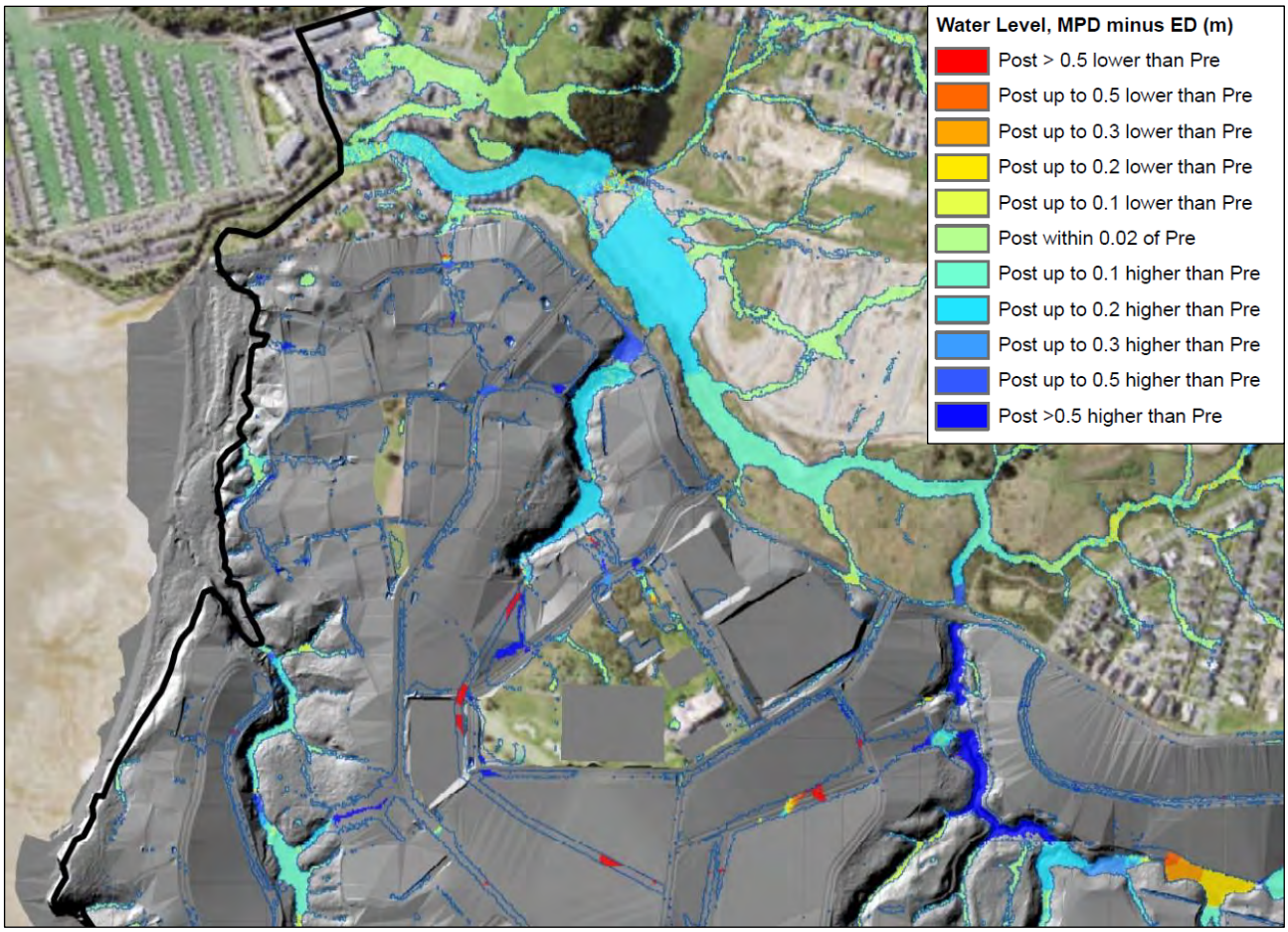
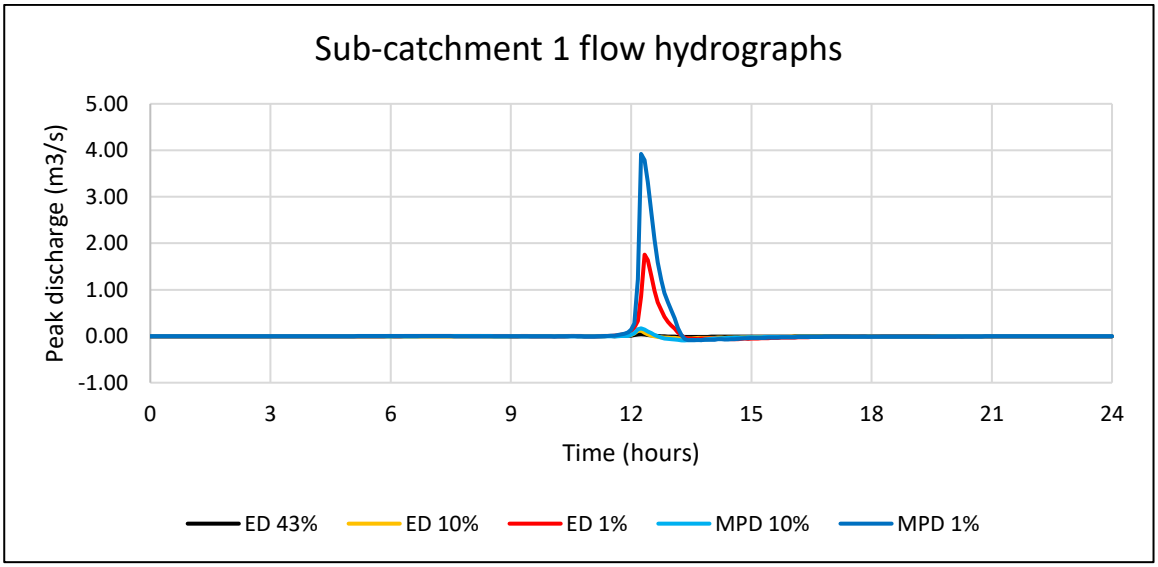


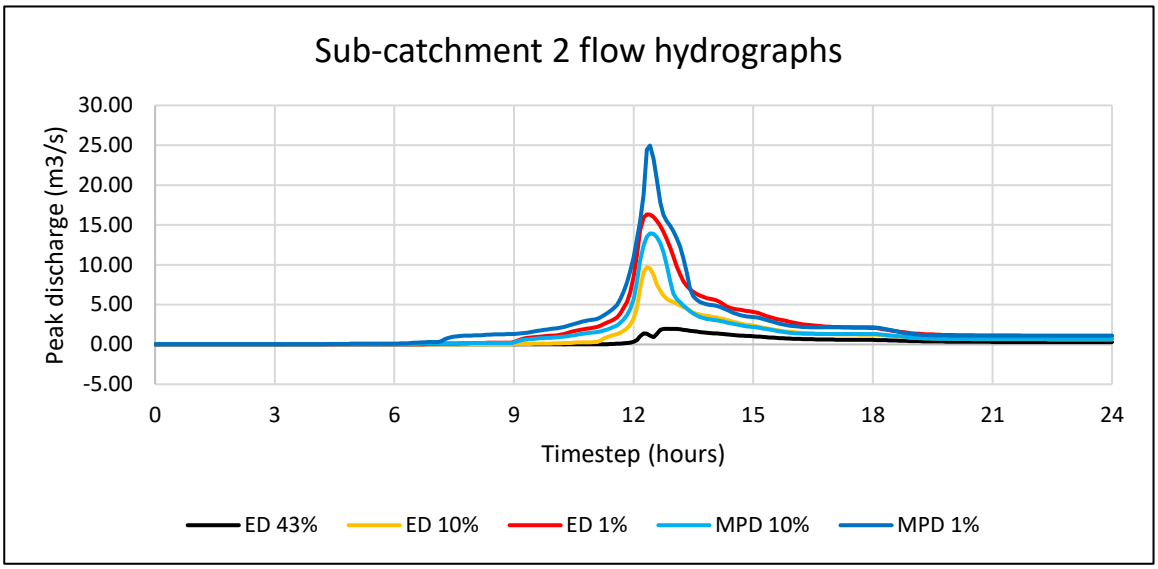
Figure 29: Difference in flood depth and extents between the 10% AEP ED and 10% AEP MPD flood model scenarios.

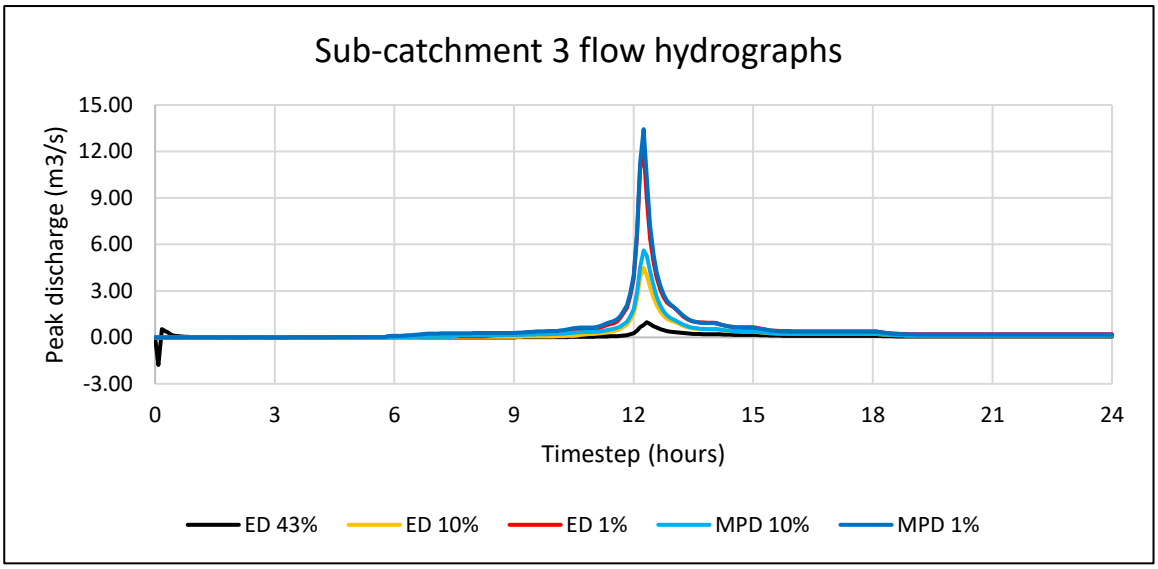
The changes in flows discharged from each major sub-catchment are shown on Figure 30 and Table 11. These graphs indicate that in all five sub-catchments, the peak discharge generated in the 10% and 1% AEP MPD scenarios is greater than the peak discharge generated in the 1% AEP ED scenario. This demonstrates the need for peak flow attenuation controls across the site.

Table 11: Peak Flow Rates Discharged from the Subject Site.

Model scenario & sub-catchment	Peak flow rate discharged from catchment (m3/s)				
	43% AEP ED	10% AEP ED	1% AEP ED	10% AEP MPD	1% AEP MPD
Sub-catchment 1	0.05	0.12	1.76	**0.17**	**3.92**
Sub-catchment 2	1.96	9.69	16.32	**13.94**	**24.96**
Sub-catchment 3	0.98	4.49	12.15	**5.62**	**13.44**
Sub-catchment 4	2.04	5.34	10.85	**6.27**	**11.46**
Sub-catchment 5	2.73	7.13	14.62	**8.82**	**16.45**


Sub-catchment 1 flow hydrographs
Peak discharge (m3/s)
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
0
3
6
9
12
15
18
21
24
Time (hours)
ED 43%
ED 10%
ED 1%
MPD 10%
MPD 1%


Sub-catchment 2 flow hydrographs
Peak discharge (m3/s)
30.00
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
0
3
6
9
12
15
18
21
24
Timestep (hours)
ED 43%
ED 10%
ED 1%
MPD 10%
MPD 1%


Sub-catchment 3 flow hydrographs
Peak discharge (m3/s)
15.00
12.00
9.00
6.00
3.00
0.00
-3.00
0
3
6
9
12
15
18
21
24
Timestep (hours)
ED 43%
ED 10%
ED 1%
MPD 10%
MPD 1%

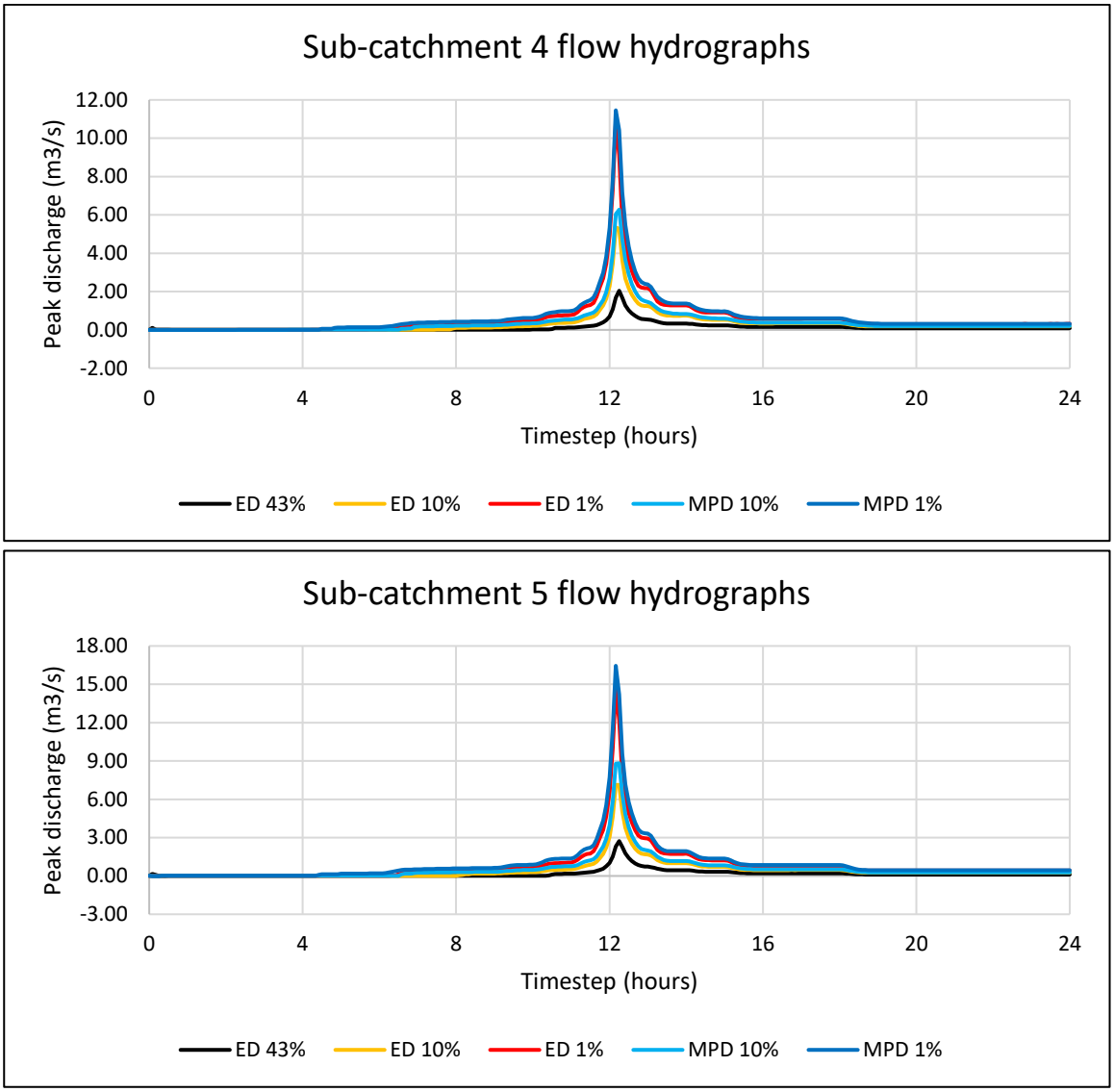


Figure 30: Flow hydrographs extracted from 2D Network Results Lines built into the hydraulic model surface mesh. Hydrographs for Catchment 1 & 2 extracted upstream of each Jack Lachlan Drive culvert.

6.3 Proposed stormwater management

The proposed stormwater management is intended to comply with the requirements of Auckland's regionwide stormwater network discharge consent. The strategy has been developed to demonstrate the overarching principles of how stormwater will be managed for the site proposed to be live zoned, as required by the regional NDC, AUP and Stormwater Code of Practice v2 (SW CoP).

6.3.1 Network Discharge Consent

The regionwide stormwater Network Discharge Consent (NDC) is a tool for managing and integrating land use, stormwater discharge and the region's natural water assets to mitigate the impacts of climate change and flooding (Auckland Council, 2021). It allows multiple community and environmental outcomes to be realised. Schedule 4 of the regionwide NDC outlines development requirements for greenfields developments within

Auckland. The greenfields connection requirements section of Schedule 4 of the regionwide NDC is reproduced below for reference.

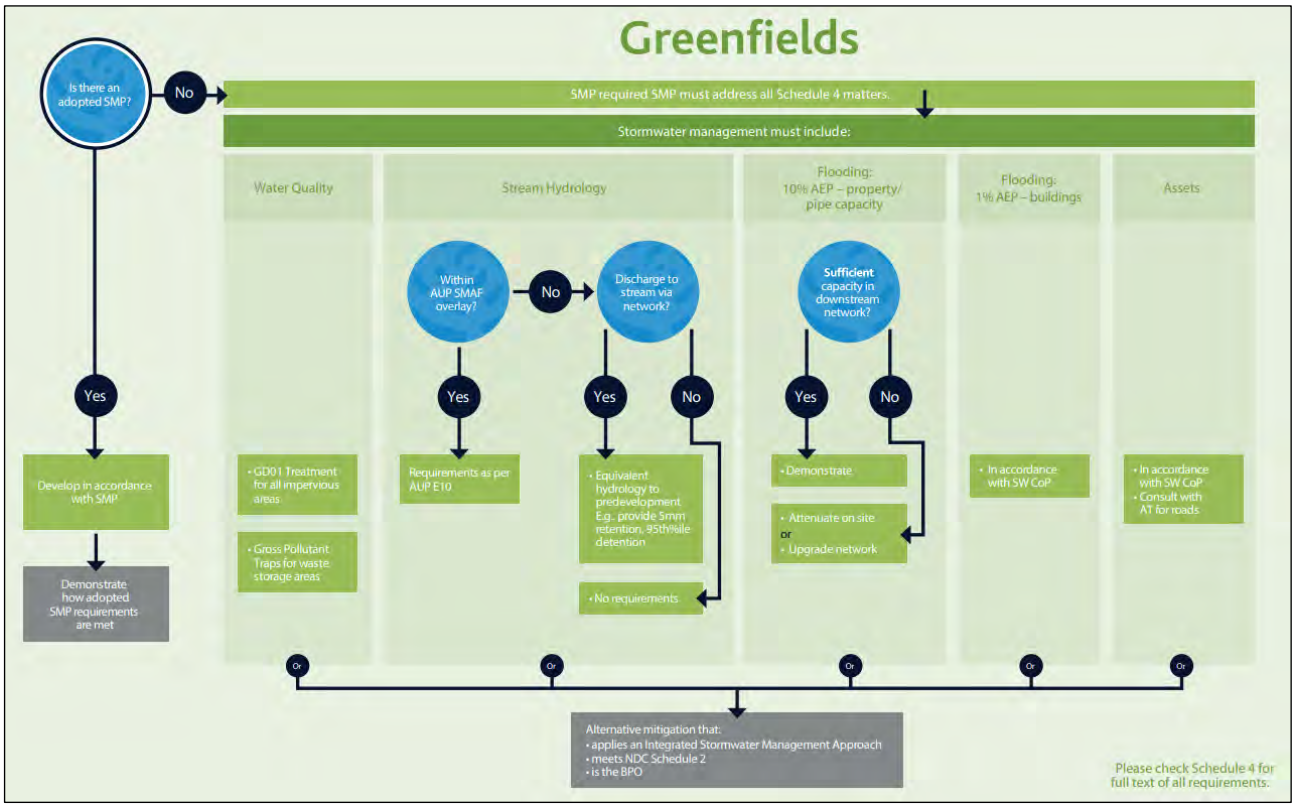


Figure 31 Greenfields connection requirements flowchart. Schedule 4, Auckland Council Regionwide stormwater network discharge consent.

Table 12 below summarises how the future development of the site will meet the requirements of the greenfields section of the regionwide NDC.

Table 12: NDC Requirements for Greenfields Developments.

Stormwater Management Requirements	Design Approach
Water Quality Treatment	• Water Quality Treatment to GD01 standard or equivalent for all new impervious areas, and areas with High Contaminant Generating Activities. • Gross Pollutant Traps for waste storage areas.
Stream Hydrology (discharge to streams via the public stormwater network outside of AUP SMAF 1)	• Hydrological mitigation to SMAF 1 standard for all new impervious areas to GD01 standard or equivalent. This will be managed using a SMAF 1 overlay applying to the total extent of the Plan Change area.
Flooding 50% AEP – Coastal Catchments	• Attenuate stormwater runoff generated within coastal catchments 3, 4, and 5 to 100% of the peak flow rate generated in the existing scenario, 50% AEP rainfall event.
Flooding 10% AEP - Pipe Network Capacity	• Attenuate stormwater runoff generated within northern stream catchments 1 & 2 in the 10% AEP rainfall event as required to avoid adverse effects and comply with AC SW CoP requirements and AT SW CoP requirements for all existing public stormwater infrastructure draining runoff from the site. • Alternatively, upgrade the existing public stormwater infrastructure draining runoff generated within the site to achieve the same level of performance.
Flooding 1% AEP – Buildings	• Attenuate stormwater runoff generated within northern stream catchments 1 & 2 in the 1% AEP rainfall event as required to avoid adverse effects and comply with AC SW CoP requirements and AT SW CoP requirements for all existing public stormwater infrastructure draining runoff from the site. • Manage OLFPs safely within engineered OLFP channels and drainage reserves and establish minimum finished floor levels for new buildings as per AC SWCoP and NZBC.
Assets	• All new public stormwater infrastructure will be designed and constructed in accordance with AC SW CoP and AT SW CoP requirements.

6.3.2 General

The proposed stormwater management approach aims to protect and enhance existing watercourses within the site. It preserves all watercourses and natural wetland features identified as having ecological value. It also creates new valuable ecological areas by removing several artificial water features within the golf resort area and creating new stream reaches in their place. It provides peak flow attenuation for extreme storm runoff to avoid adversely impacting properties downstream of catchments 1 & 2, and to reduce the potential erosive effects of new development on the bed and banks of Waikopua Creek tributary streams within catchments 1, 2, 3, 4, & 5. It provides hydrological mitigation for all new impervious areas within the site, and water quality treatment for all impervious areas within the site. It also enables on-site, non-potable reuse of runoff from new buildings constructed within the site.

The stormwater management of the subject site should follow an integrated approach to ensure protection of sensitive features & the receiving environment. The applicable stormwater requirements under this SMP are summarised in Table 13.

Table 13: Beachlands South Stormwater management summary.

Component	Minimum requirements	Recommended approaches	Guidelines
• Water quality treatment	• Treatment of runoff from all new impervious areas prior to discharge into the receiving environment • Requiring the use of inert building materials to eliminate or minimise the generation and discharge of contaminants. Includes new buildings, and additions to buildings being constructed using inert cladding, roofing and spouting building materials that do not have an exposed surface made from contaminants of concern to water quality (i.e., zinc, copper, and lead).	• 'Treatment train' approach to stormwater management. • Treatment of runoff can be provided through volume-based devices using the WQV calculation method, or through flow-based devices & using the WQF method. • Pre-treatment is provided at the source, and a second stage of treatment is provided prior to discharge. • Multi-purpose devices, e.g., bioretention swales are specified at each stage in the treatment train such that there is redundancy and resilience embedded in the network. • Treatment devices with bioretention components should be specified for treatment of HCGAs/HURs. • Proprietary treatment devices should only be considered for treating specific contaminants discharged from HCGAs/HURs, or as offline devices within small catchments, or where there are significant infrastructural constraints in a particular area that mean other options are infeasible.	• Auckland Council GD01 • Auckland Council GD04 • Auckland Council TR2013/035
• Stream hydrology	• Provide retention (volume reduction) of at least 5mm runoff depth for the impervious area for which hydrology mitigation is required; and • 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 the 5 mm retention volume or any greater retention volume that is achieved, over the impervious area for which hydrology mitigation is required.	• In communal management catchments, SMAF1 detention is provided within the live storage zone of dual-purpose wetlands or ponds. • In at-source management catchments, SMAF1 detention is provided within bioretention devices such as living roofs, swales, or rain gardens, and where this is infeasible, within rain water tanks, wetlands, or ponds where this is infeasible. • Retention volumes should be provided as a non-potable water source or infiltrated into the ground over a 72-hour period to promote baseflow in local streams. • In areas where geotechnical assessments or percolation tests demonstrate instability issues or that subsoils have insufficient drainage capacity to support infiltration, retention volumes may be provided as part of the detention volume.	• Auckland Council GD01 • Beachlands South Stream Ecology Assessment Report
• Erosion protection	• Required at all stormwater outlets into the receiving environment.	• Green outfalls should be specified where possible, particularly where outlet pipes are small and the presence of a large wingwall structure would have adverse effects on the amenity value of public spaces. • All outlets will be located outside of the SEA as far as practicable. • Specific design of all outlet erosion protection features is required. Outlet erosion protection features that can be integrated with surrounding vegetation (e.g., reno mattresses) should be specified where feasible. • Erosion protection requirements should be addressed in the design of any remediated or realigned stream reaches within the site.	• Auckland Council TR2013/018
• Stormwater conveyance	• Conveyance of runoff generated in the 10% AEP rainfall event through the primary stormwater network into the receiving environment. • Conveyance of runoff generated in events greater than the 10% AEP rainfall event and up to the 1% AEP rainfall event through the secondary network.	• In order to reduce the embodied carbon associated with pipe networks, bioretention swales should be provided in small headwater catchments where feasible, to provide treatment, hydrological mitigation, and conveyance of the 10% AEP runoff into the network. • Secondary runoff should be established within road carriageways and engineered overland flowpaths and reviewed against v*d criteria to ensure safe conveyance from the site.	• Auckland Council GD01 • Auckland Council GD04 • Auckland Council Stormwater Code of Practice • Auckland Transport Stormwater Code of Practice
• Development staging	• Erosion and sediment control plans required prior to development and construction and in accordance with GD05 requirements.	• No more than 4 hectares of active (exposed) earthworks should be constructed in any catchment per the Beachlands South ESCP report (Harrison Grierson, 2021).	• Auckland Council GD05

Table 14 lists the proposed stormwater management device options that could be applied across the Beachlands site in accordance with GD/01. Appendix B – Stormwater management selection process and assessment provides a multi-criteria analysis for these stormwater management devices. This is a qualitative analysis that considers the objectives of the Plan Change, and the size and functionality of each device.

Table 14: Proposed stormwater management device options.

Mitigation outcomes	Proposed stormwater management device options
SMAF 1 Detention	• Living Roofs • Rainwater Tanks • Wetlands • Wet Ponds • Dry Ponds • Bioretention Swales • Bioretention Rain gardens
SMAF 1 Retention	• Living Roofs • Rainwater Tanks • Infiltration Trenches • Bioretention Swales • Bioretention Rain gardens
Water Quality Treatment	• Bioretention Swales • Bioretention Rain gardens • Wetlands
Peak Flow Attenuation	• Wetlands • Wet Ponds • Dry Ponds

6.3.3 Managing runoff from roads and public spaces

6.3.3.1 Bioretention swales

Bioretention swales are proposed throughout the site to provide pre-treatment and hydrological mitigation for runoff generated on new road surfaces. Vegetated bioretention swales are the preferred stormwater management devices for road runoff, with good performance in removing total suspended solids, oils, and heavy metals as well as preserving stream baseflows by infiltrating runoff into the ground. Refer to the multi-criteria analysis provided in Appendix B – Stormwater management selection process and assessment. These versatile devices can reduce the extents of stormwater networks required to service a site, and also form part of the overland flowpath management system. Vegetated bioretention swales are typically more than 30 metres in length.

6.3.3.2 Bioretention rain gardens

Vegetated bioretention rain gardens are also proposed for use throughout the site. Bioretention rain gardens serve the same purpose as bioretention swales, but are smaller

devices designed for smaller, local catchments. Bioretention rain gardens are effective devices for managing small road catchments, but do not offer the same benefits for pipe network sizing or overland flowpath resilience. Bioretention rain gardens are proposed to be used in service-rich environments or areas where the need for kerb crossings and access roads into superlots means that swales cannot be constructed at the public road construction phase with certainty that clashes can be avoided at the superlot development phase.

6.3.4 Managing runoff from private lots

A toolbox of devices exists for managing runoff from private lots. Devices suitable for meeting treatment and hydrological mitigation requirements include rain water tanks, permeable and porous paving slabs, small-scale bioretention systems, and living roofs. Devices suitable for meeting peak flow attenuation requirements include attenuation basins (wet ponds, dry ponds, and wetlands) and rain water tanks. The preferred solution for managing stormwater effects at the source within private lots is to install dual-purpose rain water tanks designed to provide retention (through non-potable reuse) and detention of runoff prior to discharge into the public stormwater network. These devices can also be expanded to provide peak flow attenuation for runoff generated in the 50% AEP rainfall event to meet the attenuation requirement for catchments 3, 4, and 5. They are preferred as they can be installed above or below ground and are compatible with a range of housing typologies due to their small footprint area. This approach offers multiple benefits including reducing mains water consumption, improving stream baseflows, protecting valuable streams within the site, and improving the resilience of the public stormwater network.

6.3.5 Communal stormwater management

6.3.5.1 Communal treatment & attenuation basins

Communal devices are required to attenuate peak flows generated by the loss of depression storage and urban intensification prior to discharging stormwater runoff into the stream network.

Furthermore, communal devices can provide a second stage of treatment for runoff generated on road surfaces, as well as hydrological mitigation, to mitigate the adverse effects of frequent storm events on receiving stream reaches.

Treatment and peak flow attenuation wetlands are proposed to provide multiple outcomes for all on-site subcatchments. Through specific design of inlet and outlet structures and spillways these devices can detain runoff for a range of events including the SMAF1 event (36 mm rainfall) through to the 1% AEP design storm (243 mm rainfall). Careful landscape design can create significant ecological value within these wetlands as well as amenity value for the ultimate development.

A catchment layout plan for Beachlands South is shown on drawings 470 to 473 Rev 2, attached to this report in Appendix A – Plans of existing and proposed site features. This

catchment layout plan delineates sub-catchments discharging to fifteen proposed attenuation devices prior to discharge to the receiving environment. Sub-catchments that do not have a well-defined outlet point or do not fall towards a suitable location for an attenuation are proposed to be mitigated on-site using smaller or alternative devices.

6.3.6 Wetland Management

The Private Plan Change area contains existing 'natural' and 'constructed' wetlands, as discussed in Section 1.7. The following discussion provides a high-level summary of the mitigation measures proposed by Tonkin & Taylor in the Wetland Ecological Effects Assessment (2022).

To ensure ecological enhancement and protection, loss of any 'natural' wetlands associated with the land use changes in this project is not permitted. Efforts to avoid, remedy or mitigate the loss of moderate value 'constructed' wetlands have been proposed by Tonkin & Taylor (2022). Approximately 2.09 ha of moderate value 'constructed' wetlands is expected to be lost due to the proposed land use changes.

To address the indirect residual effects on 'natural' wetlands and 'constructed' wetlands summarised in Section 1.10, it is proposed to undertake:

- *Habitat restoration and enhancement measures within the 88.7 ha EPAN, including:*
  - *30.8 ha of terrestrial revegetation and habitat enhancement into all available terrestrial planting areas within the network to create additional habitat for terrestrial biodiversity.*
  - *Inclusion of a minimum 10 m native vegetation buffer around all high value terrestrial habitats and wetlands that are within the EPAN. The 10 m vegetation buffer lies within the EPAN boundary and will minimise potential effects associated with the proposed land use change within the Live Zone.*
  - *Approximately 2.14 ha of native wetland enrichment planting, including a 20-year weed control programme within all exotic vegetation dominated PPC area wetlands that are outside the proposed development footprint.*
  - *8.8 ha of stream riparian planting to restore and enhance existing streams to address stream reclamation impacts within the Live Zone (impacts and offset for the FUZ to be determined at a later date); and*
  - *88.7 ha of mammalian and invasive weed pest control for 35 years, which will further protect and enhance terrestrial and wetland biodiversity values.*
- *The creation of approximately 5 ha of stormwater ponds and associated wetland plant revegetation, which is expected to address adverse effects associated with the loss of constructed wetlands and associated wetland bird values.*
- *Habitat restoration and enhancement measures within the 'Very High' value 0.34 ha oioi, restiad rushland/reedland wetland to further enhance these values.*
- *Coastal bird nesting roosting and foraging habitat enhancement measures including:*
  - *The control of mammalian predators along the coastal margin adjacent to the proposed PPC coastal boundary (this pest control will be contiguous with pest control within the EPAN).*
  - *Enhancement of existing roost sites in the adjacent CMA through elevation and expansion of shell banks and invasive weed and mangrove management.*

- *Enhancement and maintenance of high-quality coastal bird foraging habitat in the inter-tidal mud/sand flats in the adjacent CMA through selective mangrove management in recently colonised areas and areas that are expected to be colonised by mangroves in the future.*

(Tonkin & Taylor, 2022) concludes that all residual effects associated with land use changes will be adequately addressed through the proposed mitigation measures that no Net Loss outcomes within 20 years of commencement of the above measures. A wetland biodiversity monitoring programme will also be necessary to verify the that the expected gains are observed and to guide adaptive management actions where required.

6.3.7 Attenuation Device Sizing

A concept design of peak flow attenuation devices mitigating peak runoff within the site is provided, using spreadsheet calculations based on the TP108 SCS method. This design proposes fifteen discrete wetland catchments, shown on drawings 470 to 473 attached to this report in Appendix A – Plans of existing and proposed site features. A calculation summary is provided below. These calculations are based on the following assumptions:

- Attenuation device catchments were derived based on existing & proposed site contours, road alignments, riparian margins, and natural wetland extents.
- Flows from catchments 1 & 2 are attenuated to 100% of the peak flow rate in the 1% AEP design storm event.
- Flows from catchments 3, 4, & 5 are attenuated to 100% of the peak flow rate in the 50% AEP design storm event.
- The peak flow attenuation device volumes also include storage volumes for SMAF 1 detention.
- Impervious coverage is as per the anticipated future site coverage as shown on Figure 26.
- Attenuation devices within catchments 1 & 2 provide an additional 9,100 m^3 attenuation volume to account for the flood storage volume associated with depression storage areas that is projected to be lost through the future development of the site.
- Attenuation devices are assumed to be treatment wetlands providing multiple functions including water quality treatment, hydrological mitigation, and peak flow attenuation.
- The live attenuation volume storage required is 70% of the total calculated attenuation volume required for the same catchment, to account for cumulative simultaneous inflows and outflows.
- Attenuation footprint areas are estimated using an average live storage depth of 1.5 m. Conservative estimates are used including a 30% buffer to provide for internal embankments, and a further 70% buffer to provide for maintenance access tracks, spillways, external batter slopes, and sediment drying areas. These assumptions should be tested through the preliminary and detailed design stages of any future site development to refine the footprint area of any peak flow attenuation devices to be constructed within the site.

Table 15: Peak flow attenuation basins.

Basin catchment ID	Stream sub-catchment	Catchment area (m^2)	Downstream flood hazard?	Attenuation standard	Attenuation volume (m^3)	Attenuation footprint area (m^2) including access and batters
B1	1	50,200	Yes	1% AEP	2,508	3,700
B2	3	51,000	No	50% AEP	1,217	1,800
B3	2	65,700	Yes	1% AEP	3,432	5,100
B4	3	135,600	No	50% AEP	3,639	5,400
B5	1	117,800	Yes	1% AEP	5,886	8,700
B6	2	149,000	Yes	1% AEP	6,055	8,900
B7	2	89,600	Yes	1% AEP	3,641	5,400
B8	2	247,900	Yes	1% AEP	9,060	13,300
B9	2	217,800	Yes	1% AEP	8,851	13,000
B10	2	52,400	Yes	1% AEP	2,368	3,500
B11	3	94,500	No	50% AEP	2,254	3,300
B12	3	82,600	No	50% AEP	1,971	2,900
B13	4	107,300	No	50% AEP	2,272	3,300
B14	5	122,600	No	50% AEP	2,596	3,800
B15	5	35,300	No	50% AEP	747	1,100
Total		**1,619,300**			**56,500**	**83,200**

6.3.8 Water quality device sizing

Water quality treatment will be provided for runoff from all new impervious areas throughout the structure plan area through bioretention swales, rain gardens, and communal wetlands. Where HCGAs or HURs are identified, water quality treatment will be provided in accordance with Chapter E9 of the Auckland Unitary Plan and the proposed Beachlands South precinct conditions.

6.3.9 Stream hydrology

SMAF 1 retention & detention will be provided for all new impervious areas within the site requiring hydrological mitigation.

An estimated 1,500 lineal metres of bioretention rain gardens and 4,300 lineal metres of bioretention swales are required to provide hydrological mitigation for the proposed public roads. These devices would have a total surface area of around 13,000 m^2.

A range of options to achieve hydrological mitigation for private lots are provided in Section 6.3.4.

6.3.10 Flooding 10 percent AEP event (Network Capacity)

The site is presently serviced by a network of natural & modified watercourses with pipe networks provided only as necessary to facilitate drainage through the golf course. New pipe networks will be constructed within the site to convey runoff from roads and other public areas and future developed lots into stormwater management devices and watercourses and in accordance with the Auckland Council Stormwater Code of Practice v2.

6.3.11 Flooding 1 percent AEP event (Habitable floors)

Local flooding within the site will be addressed at the lot development stage. Minimum finished floor levels will be set relative to peak water levels associated with the 1% AEP, MPD scenario floodplain and in accordance with the Auckland Council Stormwater Code of Practice v2. As per Table 15, attenuation features within stream sub-catchments 1 and 2 will provide peak flow attenuation up to 100% of the peak flow rate in the 1% AEP, ED scenario.

6.3.12 Overland flowpath and floodplain management

Overland flowpaths and floodplains are to be managed through the public roads, engineered flow paths, and drainage reserves. Finished floor levels on developable land within the site will be set relative to peak water levels identified through the hydraulic modelling undertaken for the Structure Plan and successive modelling for approvals processes.

6.3.13 Development staging

As stormwater related effects are mitigated close to the source no significant issues associated with development staging and stormwater servicing are anticipated. As development staging plans are developed this assumption should be continually tested and revisited.

6.4 Hydraulic connectivity

Refer to Section 1.7 of this report.

6.5 Asset ownership

All existing drainage assets within the site are understood to be under private ownership.

New public assets including bioretention swales, rain gardens, and piped stormwater networks are to be vested in Auckland Council following completion.

6.6 Ongoing maintenance requirements

All communal stormwater management devices proposed within the plan change area will be designed in accordance with Auckland Council guidelines and standards and vested to the Council following completion. The operation & maintenance activities required to support the ongoing function of the stormwater devices will be set out in an operation & maintenance plan provided to the Council in draft format at the consent stage and progressively updated following commissioning & approval of AsBuilt drawings.

6.7 Implementation of stormwater network

Implementation of the stormwater network would fall under the development staging as set out in the staging plans attached to this report. This approach would limit the active earthworks and civil works extents to a 4-hectare active (exposed) area and one or two catchments at a time and allow for successive extensions of the new stormwater network to support progressive development through multiple stages across several years. The methodology for implementation will be in accordance with the sustainability and environmental protection outcomes outlined for this project.

6.8 Dependencies

Dependencies will be addressed at a development staging level. Stormwater upgrades are ultimately dependent on successive stages of earthworks, civil works, road construction, and building.

6.9 Risks

This SMP was prepared to set out the framework and strategy for stormwater management required to facilitate the urban development as envisaged in the Beachlands South Structure Plan and Private Plan Change Application. More detailed information will be provided at the later subdivision & development stage, and the risks identified and the means of managing them will also evolve.

Table 16: Project risks record.

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?
Development staging does not progress as it is anticipated at this point in time.	Develop a stormwater management concept that works within small sub-catchments and is flexible to change.	-	Subdivision stage.	Medium
Raised groundwater levels inhibit the function of peak flow attenuation basins.	Relocate devices to areas with higher groundwater levels. Design devices with shallow live storage to raise pools above groundwater levels.	Apply a reduced attenuation standard in areas of the site with higher groundwater levels and over-attenuate runoff in other areas of the site.	Subdivision stage.	Low
Increased stormwater runoff overwhelms the capacity of existing public stormwater drainage assets and causes nuisance flooding.	Providing peak flow attenuation devices throughout the site and progressively reviewing the performance of existing assets against development plans.	Upgrading existing public stormwater drainage assets.	Subdivision stage.	Very low

7 Departures from regulatory or design codes

The information in this document complies with the standards and procedures set out in the Auckland Council Stormwater Code of Practice v2.

This assessment assumes 13.2% and 16.8% climate change factors on design 10% and 1% AEP design rainfall events respectively, and 2 metres of sea-level rise, which exceeds the minimum sea-level rise requirements of the Stormwater Code of Practice.

No significant departures from regulatory or design codes are identified as part of this application. This will be progressively reviewed throughout the preliminary and detailed design process as designs and development plans are finalised.

8 Conclusions and recommendations for future work

This SMP demonstrates that stormwater within the Structure Plan and Private Plan Change application area will be managed in accordance with the relevant standards and requirements. No major concerns are anticipated relating to stormwater management across the parts of the site that are to be live zoned, and those that are proposed to be included in the FUZ. Based on the investigations that have been completed, it is expected that stormwater effects from the Private Plan Change area can be appropriately and adequately managed in accordance with the requirements of the AUP and NDC. This SMP will continue to be updated as the project progresses, and as further investigations are carried out.

8.1 Conclusions

The Beachlands South Structure Plan and Private Plan Change proposes an integrated development that will significantly expand the Beachlands urban area. This report provides insights into the existing site features and the interventions that may be required to mitigate the potential adverse effects of urban intensification on the receiving environment. These interventions include riparian planting and stormwater management controls including water quality treatment, SMAF 1 retention & detention, and peak flow attenuation of the 50%, 10%, and 1% AEP rainfall events.

The current AUP provisions are sufficient for stormwater management of the site relating to SMAF 1, water quality treatment, and peak flow attenuation. This SMP further requires peak flow attenuation of the peak runoff from the coastal catchments in rainfall events up to the 2% AEP to provide additional protection for the steep tributary streams discharging into the Waikopua Estuary.

This proposal seeks to preserve the ecological value of existing natural features within the site, including wetlands and stream reaches, and will create new valuable areas by removing golf ponds/water features within the Golf Resort and creating new, higher-value stream corridors in their place. This proposal provides a range of stormwater management controls that could be used to provide several stormwater quality and quantity management outcomes, which are proposed to mitigate impacts on existing watercourses within the site, existing flood-prone properties downstream of the site, and the sensitive estuarine environment of the Waikopua Creek.

A formal partnership has been created with Ngāi Tai Ki Tāmaki, which delivered a detailed Cultural Values Assessment report. This assessment identified iwi values in the PPC area and concluded that the values have been positively recognised and preserved through the work the BSLP has undertaken so far (Ngāi Tai ki Tāmaki Trust, 2022). Ngāi Tai supports the plan change on the basis of the detailed technical reports prepared by BSLP and the

mitigation measures offered by BSLP through these reports (Ngāi Tai ki Tāmaki Trust, 2022).

Hydraulic modelling was used to provide stream extents for stream and future lot boundary definition, existing floodplain extents to approximate current infrastructure constraints and downstream hazards, and how these might change as a result of the future development of the Private Plan Change area. Increases in downstream flood hazards identified through the hydraulic modelling can be mitigated using peak flow attenuation devices as demonstrated in Table 15 (Section 6.3.7).

Stormwater management devices proposed in the SMP have been chosen to align with the sustainability goals and mana whenua values of this project. They are in accordance with WSD guidelines for the Auckland Region and Schedule 4 of the Regional NDC. These devices include living roofs, rainwater tanks, wetlands, bioretention swales and rain gardens, and ponds, to achieve the retention, detention, water quality, and peak flow attenuation requirements set out in this report. The findings of this report support that the implementation of these devices will help protect the area from stormwater quality and quantity hazards and enhance the cultural and ecological value of the area.

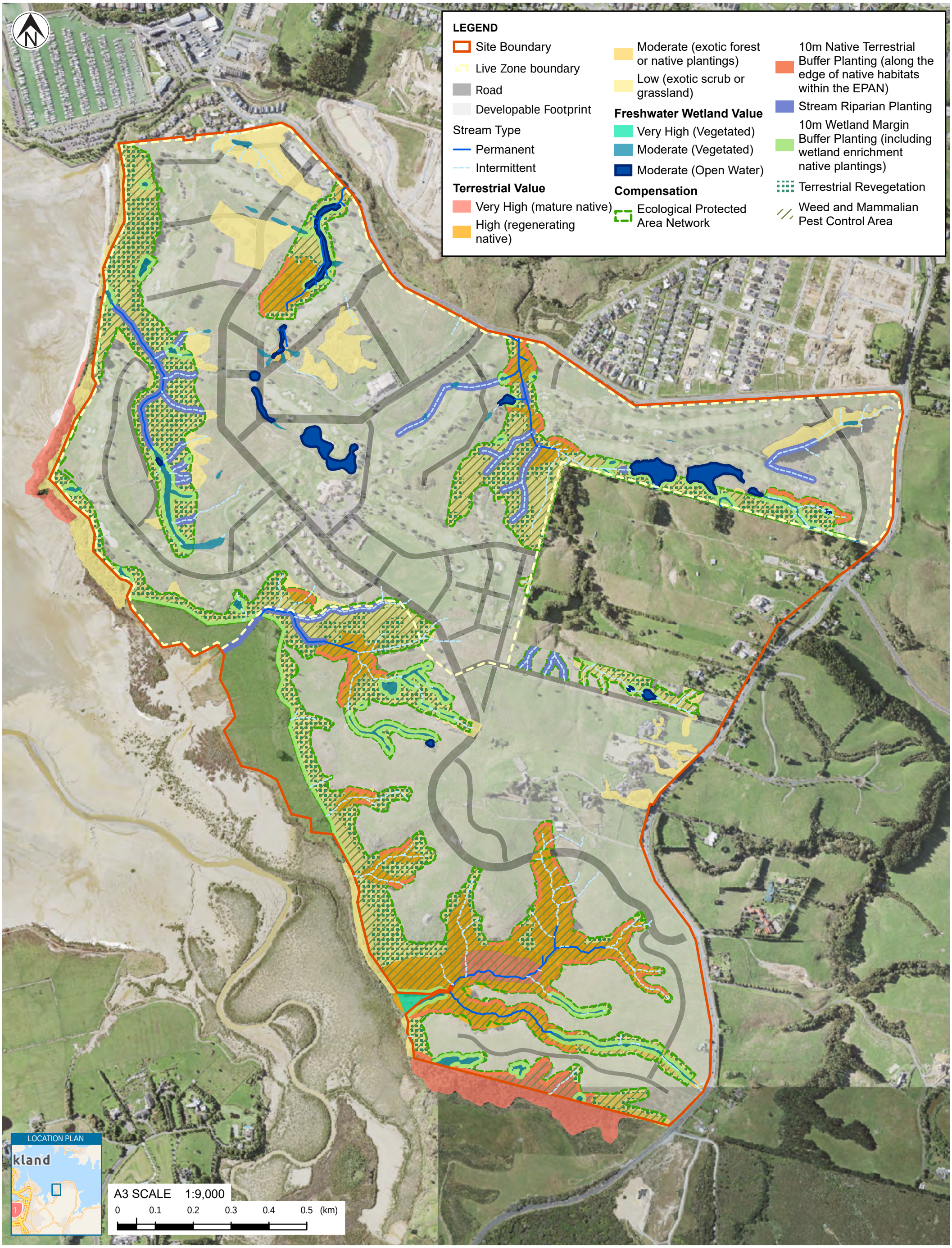
8.2 Recommendations

Ongoing consultation with mana whenua and the local community is required for successful project implementation. The findings of this assessment should be validated against the observations and expectations of iwi/hapū groups and local community members.

Much of the assessment in this report is based on hydraulic modelling undertaken using a concept design surface of a potential future development within the plan change area. There is significant scope for change within the layout. The stormwater modelling and design tasks presented in this report should be progressively refined in line with specific future development proposals and any future changes to engineering codes, particularly any changes to climate change impacts on rainfall or stormwater device design requirements.

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Appendix A – Plans of existing and proposed site features



\\ttgroup.local\files\AKL\Projects\1014358\1014358.4000\Working\Material\GIS\Map_Documents\P1014358_FreshwaterandTerrestrialMaps.aprx Layout: 1014358_Compensation_Fig1_WholeSite 2022-Mar-16 1:10 pm Drawn by: JORB

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NOTES: Stream lines derived from overland flow paths produced by Auckland Council. Licensed for reuse under Creative Commons 4.0.
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REV	DESCRIPTION	GIS	CHK	DATE
0	First version	JORB	ANTH	08/11/21

PROJECT No.	1014358.4000	
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APPROVED	DCM	MAR 22

CLIENT **BEACHLANDS SOUTH LIMITED PARTNERSHIP**
PROJECT **BEACHLANDS PLAN CHANGE**
TITLE PROPOSED TERRESTRIAL, STREAM AND WETLAND COMPENSATION MEASURES
SCALE (A3) 1:9,000 FIG No. FIGURE 1. REV 0

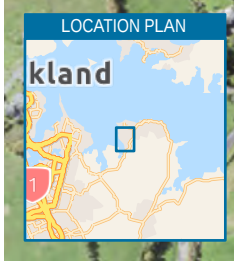
LEGEND

- Bat
- Lizard
- Forest Birds
- ABM
- Site Boundary
- Live Zone boundary
- Road
- Developable Footprint
- Ecological Protected Area Network

Vegetation Classifications

- CL1
- EF
- EG
- ES
- MS
- PL
- PL2
- PL.3
- VS2
- VS3
- VS5
- WF4
- WF9
- WF13

LOCATION PLAN



A3 SCALE 1:8,500

0 100 200 300 400 500 m

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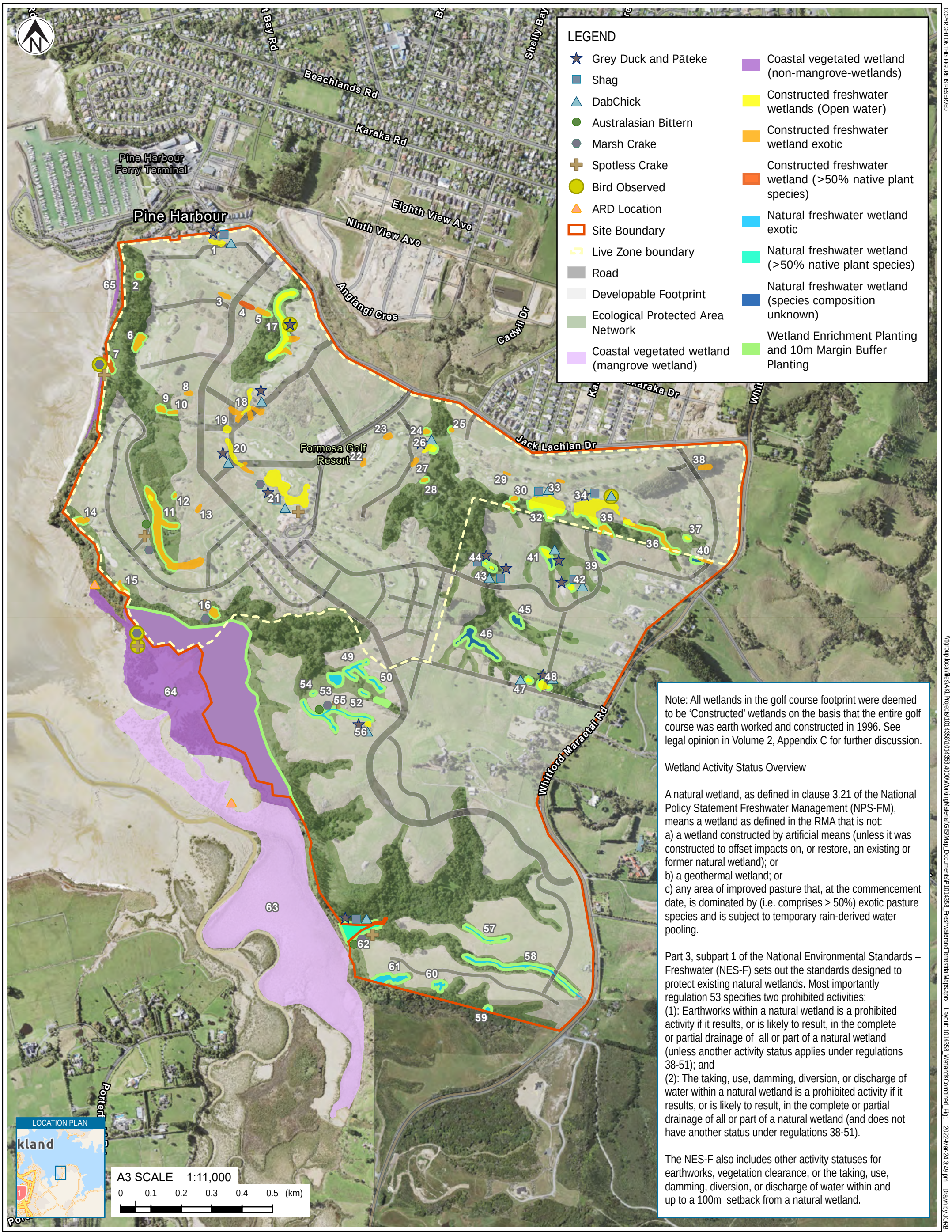
CLIENT **BEACHLANDS SOUTH LIMITED PARTNERSHIP**

PROJECT **BEACHLANDS PLAN CHANGE**

TITLE TERRESTRIAL VEGETATION AND FAUNA

SCALE (A3) 1:8,500 FIG No. FIGURE 1. REV 0



Note: All wetlands in the golf course footprint were deemed to be 'Constructed' wetlands on the basis that the entire golf course was earth worked and constructed in 1996. See legal opinion in Volume 2, Appendix C for further discussion.

Wetland Activity Status Overview

A natural wetland, as defined in clause 3.21 of the National Policy Statement Freshwater Management (NPS-FM), means a wetland as defined in the RMA that is not:
a) a wetland constructed by artificial means (unless it was constructed to offset impacts on, or restore, an existing or former natural wetland); or
b) a geothermal wetland; or
c) any area of improved pasture that, at the commencement date, is dominated by (i.e. comprises > 50%) exotic pasture species and is subject to temporary rain-derived water pooling.

Part 3, subpart 1 of the National Environmental Standards – Freshwater (NES-F) sets out the standards designed to protect existing natural wetlands. Most importantly regulation 53 specifies two prohibited activities:
(1): Earthworks within a natural wetland is a prohibited activity if it results, or is likely to result, in the complete or partial drainage of all or part of a natural wetland (unless another activity status applies under regulations 38-51); and
(2): The taking, use, damming, diversion, or discharge of water within a natural wetland is a prohibited activity if it results, or is likely to result, in the complete or partial drainage of all or part of a natural wetland (and does not have another status under regulations 38-51).

The NES-F also includes other activity statuses for earthworks, vegetation clearance, or the taking, use, damming, diversion, or discharge of water within and up to a 100m setback from a natural wetland.

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CLIENT **BEACHLANDS SOUTH LIMITED PARTNERSHIP**
PROJECT **BEACHLANDS PLAN CHANGE**
TITLE WETLAND DELINEATION AND BIRD HABITATS
SCALE (A3) 1:11,000 FIG No. FIGURE 1. REV 0

LEGEND

- Site Boundary
- Live Zone boundary
- Road
- Developable Footprint
- Ecological Protected Area Network

Stream Type

- Permanent
- Intermittent
- Ephemeral
- Not Assessed

Assessed Wetlands

- Coastal vegetated wetland (mangrove wetland)
- Coastal vegetated wetland (non-mangrove-wetlands)
- Constructed freshwater wetlands (Open water)
- Constructed freshwater wetland exotic
- Constructed freshwater wetland (>50% native plant species)
- Natural freshwater wetland exotic
- Natural freshwater wetland (>50% native plant species)
- Natural freshwater wetland (species composition unknown)

Pine Harbour Ferry Terminal
Pine Harbour
Ninth View
Jack Lachlan Dr
Northern Catchment
Western Catchment
Formosa Golf Resort
Eastern Catchment
Southern Catchment
620 Catchment
Cadw
Lydiard Pl
Kibblewhite Ave
Kaiawa St
Motukaraka Dr
Karo Rd
Whitford Maraetai Rd
Okaroro Dr

LOCATION PLAN

A3 SCALE 1:9,000

0 0.1 0.2 0.3 0.4 0.5 (km)

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CLIENT **BEACHLANDS SOUTH LIMITED PARTNERSHIP**
PROJECT **BEACHLANDS PLAN CHANGE**
TITLE STREAM CLASSIFICATION
SCALE (A3) 1:9,000 FIG No. FIGURE 1. REV 1

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LEGEND

- Site Boundary
- Live Zone boundary
- Road
- Developable Footprint
- Ecological Protected Area Network

Stream Survey Location

- Summer (Permanent Streams)
- Winter (Intermittent and Ephemeral Streams)
- Stream loss

Stream Type

- Permanent
- Intermittent
- Ephemeral
- Not Assessed

Assessed Wetlands

- Coastal vegetated wetland (mangrove wetland)
- Coastal vegetated wetland (non-mangrove-wetlands)
- Constructed freshwater wetlands (Open water)
- Constructed freshwater wetland exotic
- Constructed freshwater wetland (>50% native plant species)
- Natural freshwater wetland exotic
- Natural freshwater wetland (>50% native plant species)
- Natural freshwater wetland (species composition unknown)

Pine Harbour Ferry Terminal
Pine Harbour
Seventh View
Eighth View
Ninth View Ave
Whawhaki Rd
Hutiukawa Dr
Jack Lachlan Dr
Lydiard
Kibblewhite
Kakaraka Dr
Formosa Golf Resort
Northern Catchment
Western Catchment
Eastern Catchment
Southern Catchment
620 Catchment
Whitford Maraetai Rd
Okaroro Dr
N-UT4
N1
N2
N2-2
N-UT2
N4
N-UT1
N-UT3
N5
W1
W2
W3
W-UT1
W-UT2
W-UT3
W-UT4
W-UT5
W-UT6
W-UT7
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W-UT9
W-UT10
E1
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E-UT2
E-UT3
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E-UT7
E-UT8
E-UT9
E-UT10
E-UT11
E-UT12
E-UT13
E-UT14
E-UT15
E-UT16
E-UT17
E-UT18
E-UT19
S1
S2
S-UT1
S-UT2
S-UT3
S-UT4
S-UT5*
S-UT6*
620-1
620-2
620-3
620-UT1
620-UT2
620-UT3
620-UT4

LOCATION PLAN

A3 SCALE 1:9,000

0 0.1 0.2 0.3 0.4 0.5 (km)

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PROJECT No. 1014358.4000

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DRAWN	JORB	MAR.22
CHECKED	ANTH	MAR.22

CLIENT **BEACHLANDS SOUTH LIMITED PARTNERSHIP**
PROJECT **BEACHLANDS PLAN CHANGE**
TITLE STREAM ASSESSMENT SITES AND STREAM LOSS IMPACTS
SCALE (A3) 1:9,000 FIG No. FIGURE 2. REV 1

\\ttgroup.local\files\AKLProjects\1014358\1014358.4000\WorkingMaterial\GIS\Map_Documents\P1014358_FreshwaterandTerrestrialMaps.aprx Layout: 1014358_SEAs_Fig1_Land 2022-Mar-11 6:11 pm Drawn by JORB

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NOTES:

Hybrid Reference Layer: LINZ, Stats NZ, Eagle Technology, Esri, HERE, Garmin, METI/NASA, USGS. World Imagery: Waikato Regional, Maxar. New Zealand Imagery.lyr: Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors. NZ Navigation Map: Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth, ©

REVISIONS	NO.	BY
First version (29/07/21)	0	JORB

PROJECT No. 1014358.4000

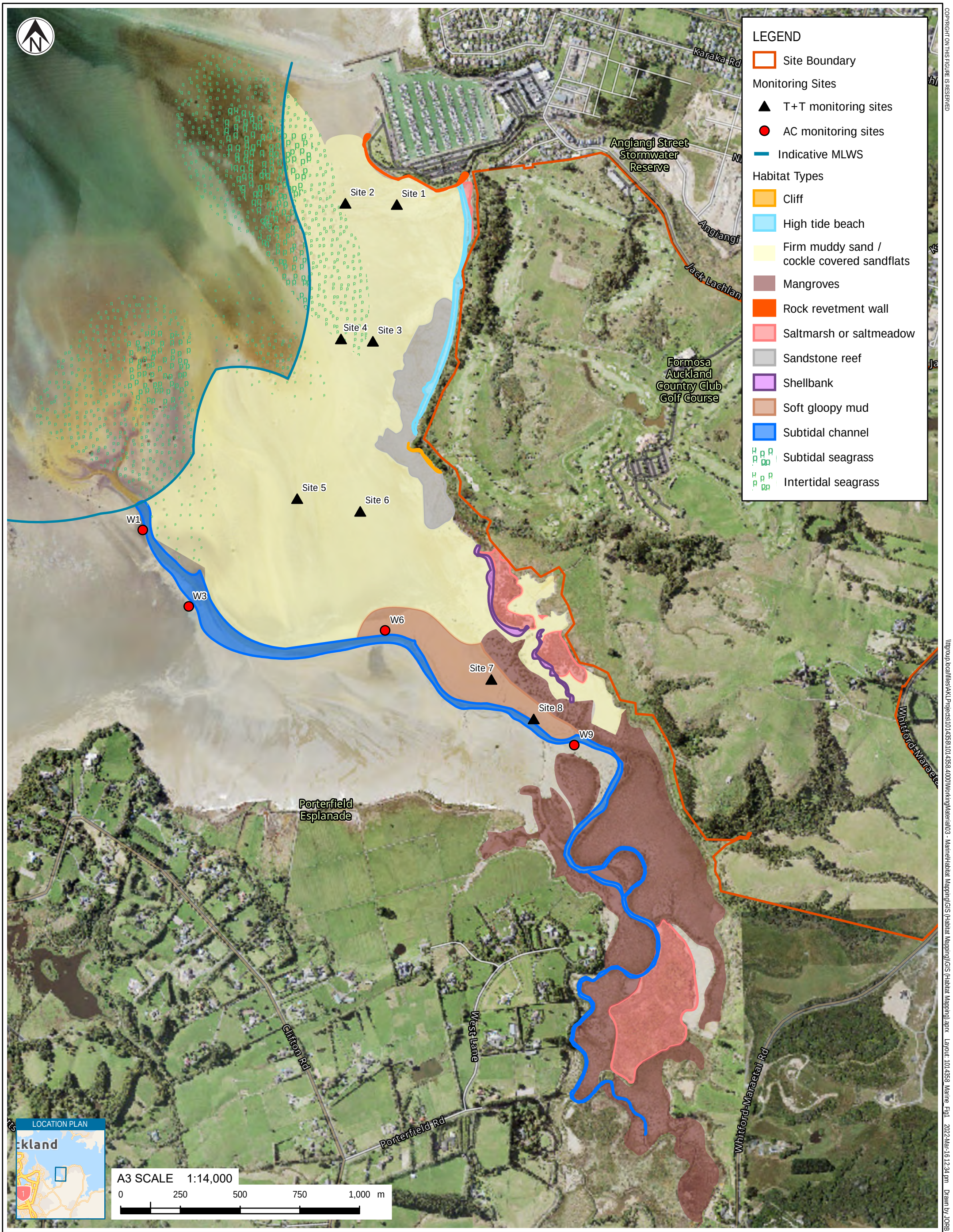
DESIGNED	JORB	MAR.22
DRAWN	JORB	MAR.22
CHECKED	CHSA	MAR.22
DCM		MAR 22
APPROVED		DATE

CLIENT **BEACHLANDS SOUTH LIMITED PARTNERSHIP**

PROJECT **BEACHLANDS PLAN CHANGE**

TITLE AUCKLAND COUNCIL SIGNIFICANT ECOLOGICAL AREAS

SCALE (A4) 1:35,000 FIG No. FIGURE 1. REV 0



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REV	DESCRIPTION	GIS	CHK	DATE
0	First version	KARO	JORB	16/03/22

PROJECT No.	1014358.4000	
DESIGNED	KARO	MAR.22
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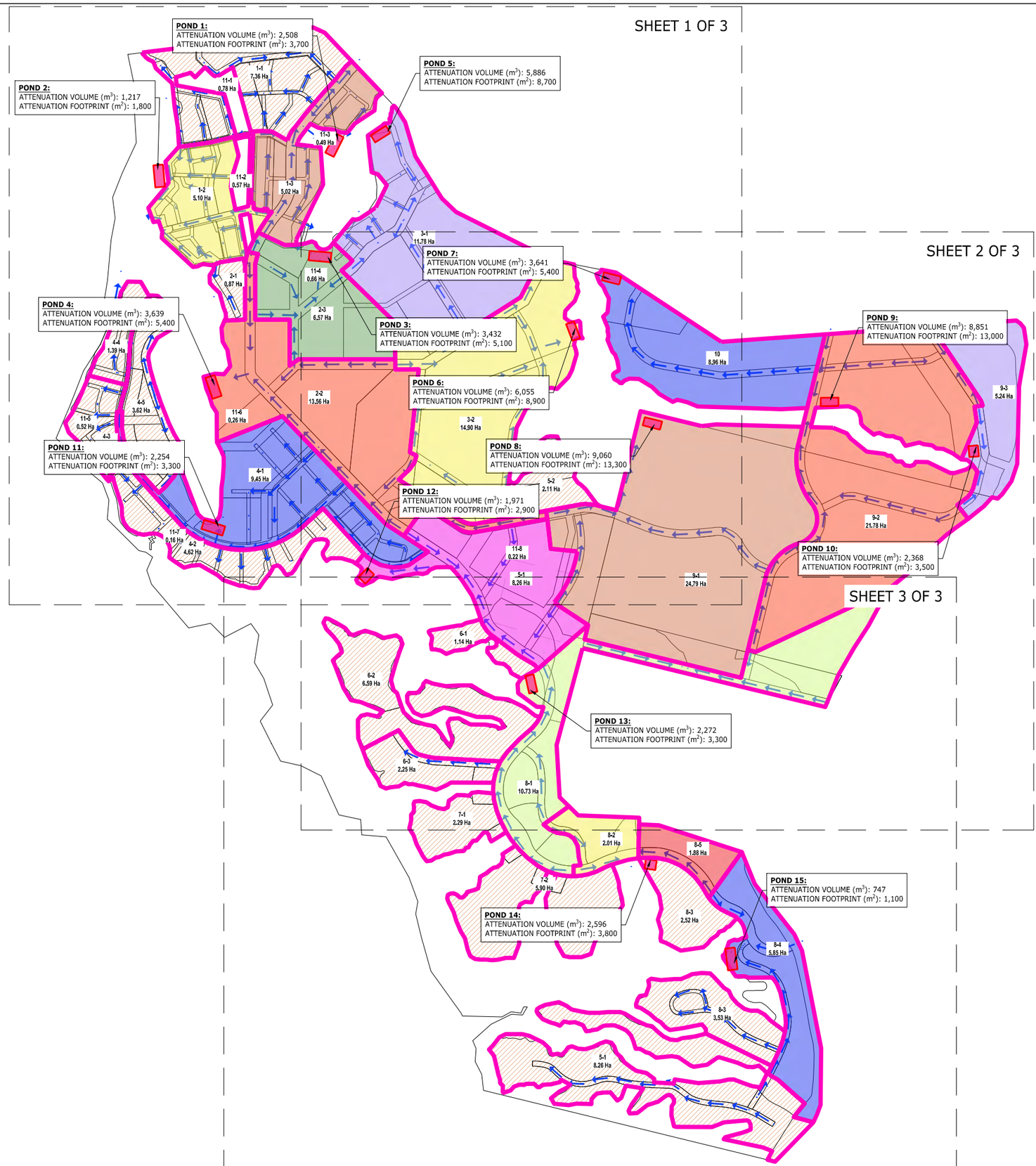
CHECKED	JORB	MAR.22
APPROVED	DCM	MAR 22

CLIENT **BEACHLANDS SOUTH LIMITED PARTNERSHIP**
PROJECT **BEACHLANDS PLAN CHANGE**
TITLE MARINE HABITATS AND MONITORING SITES
SCALE (A3) 1:14,000 FIG No. FIGURE 2. REV 0



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ISO 9001 QUALITY ASSURED

LEGEND:

- 2-3 / 0.13 Ha — CATCHMENT NAME AND AREA
- CATCHMENT BOUNDARY
- PROPOSED OLFP
- PROPOSED STORMWATER MANAGEMENT DEVICE
- PROPOSED ONSITE MITIGATION

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REF	REVISIONS	BY	DATE
2	ISSUED FOR INFORMATION - SMP REPORT	DXK	17.03.22
1	ISSUED FOR INFORMATION	MNH	04.05.21

PROJECT:

BEACHLANDS SOUTH

TITLE:

OVERALL STORMWATER CATCHMENT LAYOUT PLAN

ORIGINATOR: MNH	DATE: 04.05.21	SIGNED:	PLOT BY: DXK
DRAWN: DXK	DATE: 17.03.22	SIGNED:	PLOT DATE: 17.03.22
CHECKED: MNH	DATE: 17.03.22	SIGNED:	SURVEY BY:
APPROVED: DAS	DATE: 17.03.22	SIGNED:	SURVEY DATE:

ISSUE STATUS: FOR INFORMATION

PROJECT No: A2001228.00

SCALES: 1:5000 - A1, 1:10000 - A3

A1

DRAWING No: A2001228-470

REV 2

POND 1:
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ATTENUATION FOOTPRINT (m^2): 3,700

POND 2:
ATTENUATION VOLUME (m^3): 1,217
ATTENUATION FOOTPRINT (m^2): 1,800

POND 3:
ATTENUATION VOLUME (m^3): 3,432
ATTENUATION FOOTPRINT (m^2): 5,100

POND 4:
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ATTENUATION FOOTPRINT (m^2): 5,400

POND 5:
ATTENUATION VOLUME (m^3): 5,886
ATTENUATION FOOTPRINT (m^2): 8,700

POND 6:
ATTENUATION VOLUME (m^3): 6,055
ATTENUATION FOOTPRINT (m^2): 8,900

POND 7:
ATTENUATION VOLUME (m^3): 3,641
ATTENUATION FOOTPRINT (m^2): 5,400

POND 8:
ATTENUATION VOLUME (m^3): 9,060
ATTENUATION FOOTPRINT (m^2): 13,300

POND 11:
ATTENUATION VOLUME (m^3): 2,254
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POND 12:
ATTENUATION VOLUME (m^3): 1,971
ATTENUATION FOOTPRINT (m^2): 2,900

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11-1 0.78 Ha
11-3 0.49 Ha
1-2 5.10 Ha
11-2 0.57 Ha
1-3 5.02 Ha
2-1 0.87 Ha
11-4 0.66 Ha
2-3 6.57 Ha
3-1 11.78 Ha
4-4 1.39 Ha
4-5 3.62 Ha
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4-3
2-2 13.56 Ha
11-6 0.26 Ha
3-2 14.90 Ha
4-1 9.45 Ha
11-7 0.16 Ha
4-2 4.62 Ha
5-2 2.11 Ha
11-8 0.22 Ha
5-1 8.26 Ha
10 8.96 Ha
9-1 24.79 Ha

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LEGEND:

- 2-3 / 0.13 Ha — CATCHMENT NAME AND AREA
- CATCHMENT BOUNDARY
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- PROPOSED STORMWATER MANAGEMENT DEVICE
- PROPOSED ONSITE MITIGATION
- -1:17.2 — PROPOSED SLOPES

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1	ISSUED FOR INFORMATION	MNH	04.05.21
REF	REVISIONS	BY	DATE

PROJECT:

BEACHLANDS SOUTH

TITLE:

STORMWATER CATCHMENT LAYOUT PLAN
SHEET 1 OF 3

ORIGINATOR: MNH	DATE: 04.05.21	SIGNED:	PLOT BY: DXK
DRAWN: DXK	DATE: 17.03.22	SIGNED:	PLOT DATE: 17.03.22
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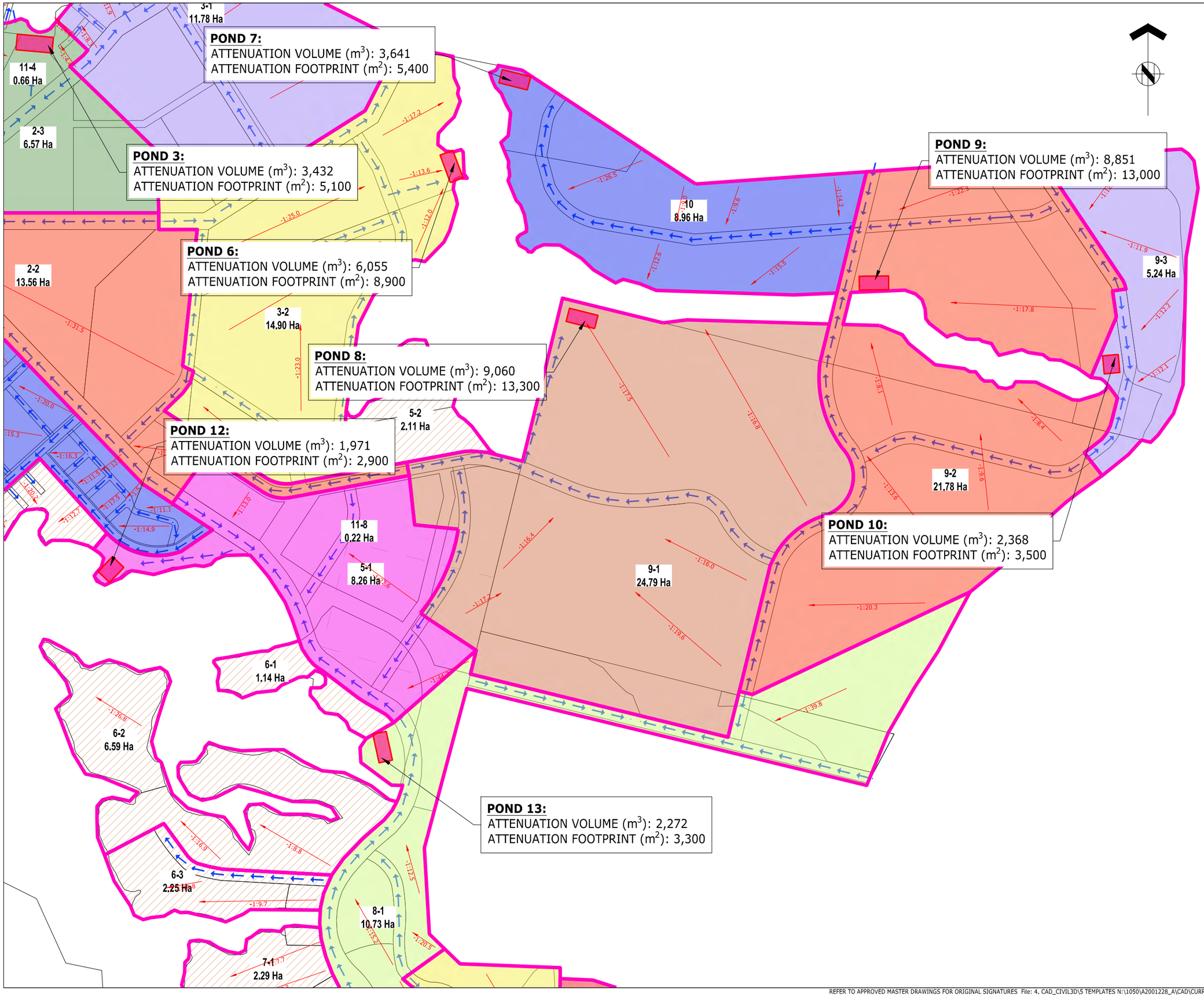
APPROVED: DAS	DATE: 17.03.22	SIGNED:	SURVEY DATE:

ISSUE STATUS: FOR INFORMATION

PROJECT No: A2001228.00
SCALES: 1:2500 - A1, 1:5000 - A3
A1

DRAWING No: A2001228-471
REV 2



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LEGEND:

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- CATCHMENT BOUNDARY
- PROPOSED OLFP
- PROPOSED STORMWATER MANAGEMENT DEVICE
- PROPOSED ONSITE MITIGATION
- -1:17.2 — PROPOSED SLOPES

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REF	REVISIONS	BY	DATE
2	ISSUED FOR INFORMATION - SMP REPORT	DXK	17.03.22
1	ISSUED FOR INFORMATION	MNH	04.05.21

PROJECT:

BEACHLANDS SOUTH

TITLE:

STORMWATER CATCHMENT LAYOUT PLAN SHEET 2 OF 3

ORIGINATOR: MNH	DATE: 04.05.21	SIGNED:	PLOT BY: DXK
DRAWN: DXK	DATE: 17.03.22	SIGNED:	PLOT DATE: 17.03.22
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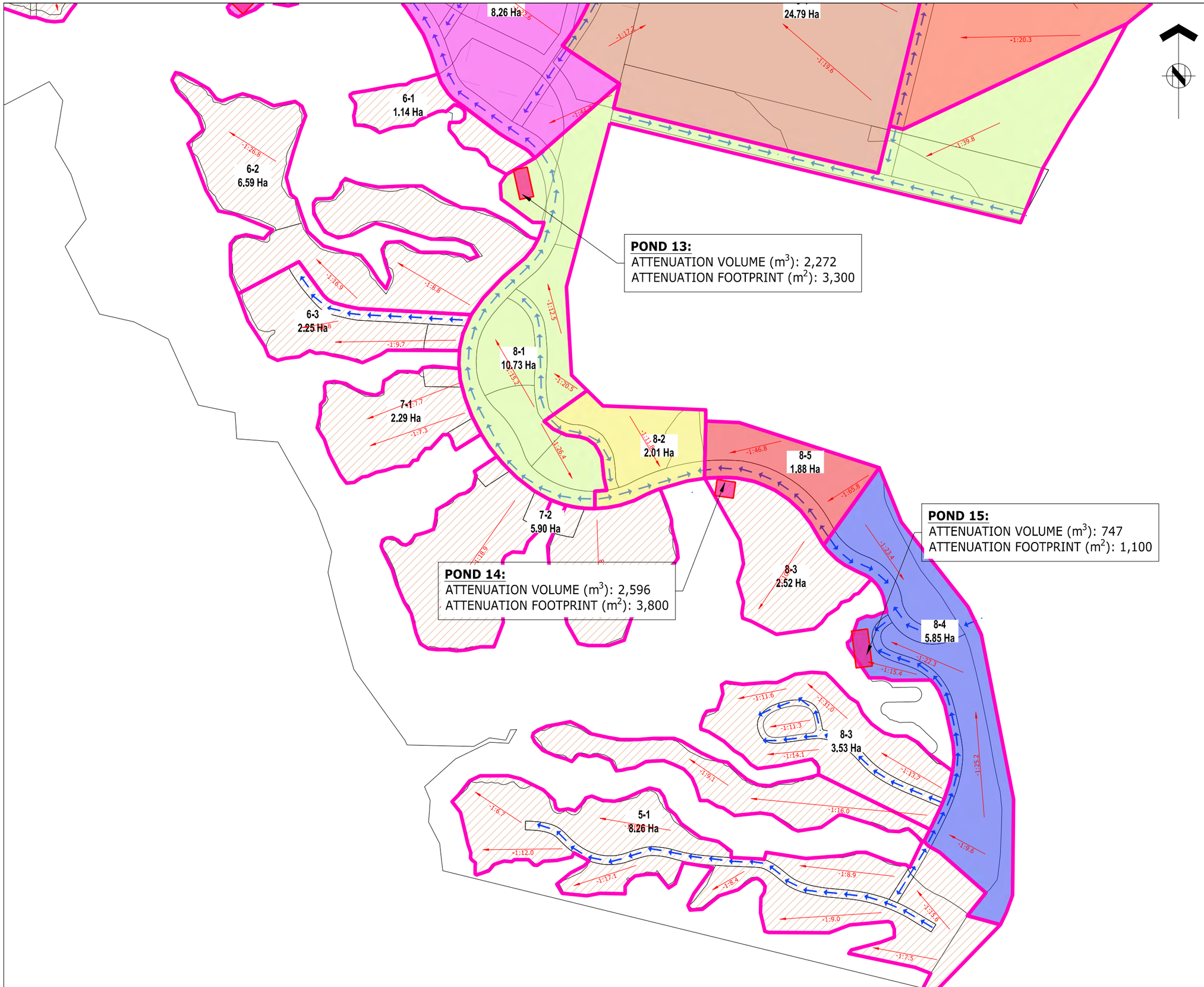
APPROVED: DAS	DATE: 17.03.22	SIGNED:	SURVEY DATE:

ISSUE STATUS: FOR INFORMATION

PROJECT No:	SCALES:	
A2001228.00	1:2500 - A1 1:5000 - A3	A1

DRAWING No: A2001228-472 REV 2



LEGEND:

- 2-3 / 0.13 Ha — CATCHMENT NAME AND AREA
- CATCHMENT BOUNDARY
- PROPOSED OLFP
- PROPOSED STORMWATER MANAGEMENT DEVICE
- PROPOSED ONSITE MITIGATION
- -1:17.2 — PROPOSED SLOPES

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REF	REVISIONS	BY	DATE
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1	ISSUED FOR INFORMATION	MNH	04.05.21

PROJECT:

BEACHLANDS SOUTH

TITLE:

STORMWATER CATCHMENT
LAYOUT PLAN
SHEET 3 OF 3

ORIGINATOR: MNH	DATE: 04.05.21	SIGNED:	PLOT BY: DXK
DRAWN: DXK	DATE: 17.03.22	SIGNED:	PLOT DATE: 17.03.22
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APPROVED: DAS	DATE: 17.03.22	SIGNED:	SURVEY DATE:

ISSUE STATUS: FOR INFORMATION

PROJECT No: A2001228.00	SCALES: 1:2500 - A1, 1:5000 - A3	A1
DRAWING No: A2001228-473		REV 2

Appendix B – Stormwater management selection process and assessment

1.1 Multi-Criteria Analysis

This section provides a multi-criteria analysis for a range of stormwater management devices that could be applied across the Beachlands site. This is a qualitative analysis that considers the objectives of the Structure Plan, and the size and functionality of each device. Table B1.1 and B1.2 assess different stormwater quality & quantity management devices across multiple criteria to inform the structure plan process.

Table B1.1: Device mitigation outcomes under GD/01

Device	Detention	Retention	Water quality	Peak flow attenuation
Pervious pavements	✓	✓		
Bioretention rain gardens	✓	✓	✓	
Bioretention swales	✓	✓	✓	
Living roofs	✓	✓		
Rainwater tanks	✓	✓		
Treatment swales			✓	
Infiltration trenches		✓		
Infiltration chambers		✓		
Wetlands	✓		✓	✓
Wet ponds	✓			✓
Dry ponds	✓			✓

Table B1.2: Beachlands South Structure Plan – stormwater management multi-criteria analysis												
Outcomes	**Values**	**Pervious pavements**	**Bioretention rain gardens**	**Bioretention swales**	**Living roofs**	**Rainwater tanks**	**Treatment swales**	**Infiltration trenches**	**Infiltration chambers**	**Wetlands**	**Wet ponds**	**Dry ponds**
Stream Health	Water Quality	+	++	++	++	/	++	/	/	++	/	/
	Habitat	/	/	+	/	/	/	/	/	+	+	/
	Stream Flow	+	++	++	++	+	/	++	++	++	++	+
	Erosion Protection	+	++	++	++	+	/	+	+	++	+	+
Estuarine Health	Water quality	/	+	+	+	/	++	/	/	++	/	/
	Habitat	/	+	+	+	/	+	/	/	+	+	+
	Erosion Protection	++	++	++	++	+	/	+	+	+	+	+
Wellbeing	Homes and places	+	+	+	+	/	+	+	+	+	+	/
	Transport and access	+	+	+	++	++	+	+	+	+	+	+
	Opportunity and prosperity	+	+	+	+	+	+	+	+	+	+	+
Costs	Land required	++	++	++	++	+	+	-	/	-	-	-
	Construction costs	-	-	-	--	/	+	-	--	/	+	+
	Operational costs	--	-	+	/	+	++	-	-	/	/	/
Health and safety	Constructability	-	/	/	-	/	+	/	-	+	+	+
	Maintenance requirements	--	/	/	-	+	+	-	-	/	/	/
	Operability	-	+	+	+	++	++	/	-	+	+	++
Compliance	AC SW Code of Practice v2	+	+	+	+	+	+	+	+	+	+	+
	AT SW Code of Practice	n/a	+	+	+	n/a	+	+	+	n/a	n/a	n/a
	GD01 SW Devices Guidance	+	+	+	+	+	+	+	+	+	+	+
	GD04 WSD Guidance	+	+	+	+	+	+	+	+	+	+	+
TOTALS		**6**	**18**	**21**	**17**	**14**	**20**	**7**	**5**	**18**	**14**	**12**

1.2 Life Cycle Cost Assessment

This section provides a life cycle cost assessment for a range of stormwater management approaches to provide water quality and water quantity management outcomes for the subject site. The rates used in this assessment are based on a limited amount of information from publicly available sources as well as recent construction contracts and engineers' estimates. The total costs in this section have a *very* high margin of error associated with them and are provided for information only.

The cost and maintenance estimates used in this memo are derived from the July 2019 report, *Understanding Costs and Maintenance of WSUD in New Zealand: Activating WSUD for Healthy Resilient Communities* authored by Sue Ira and Robyn Simcock. The life-cycle cost in this case is defined using a cradle-to-grave model being the sum of

1. Total Acquisition Costs (TAC), being the sum of design and installation,
2. Routine Maintenance Costs (RMC),
3. Corrective Maintenance Costs (CMC),
4. Land Value Costs (LVC), and
5. Decommissioning Costs (DC).

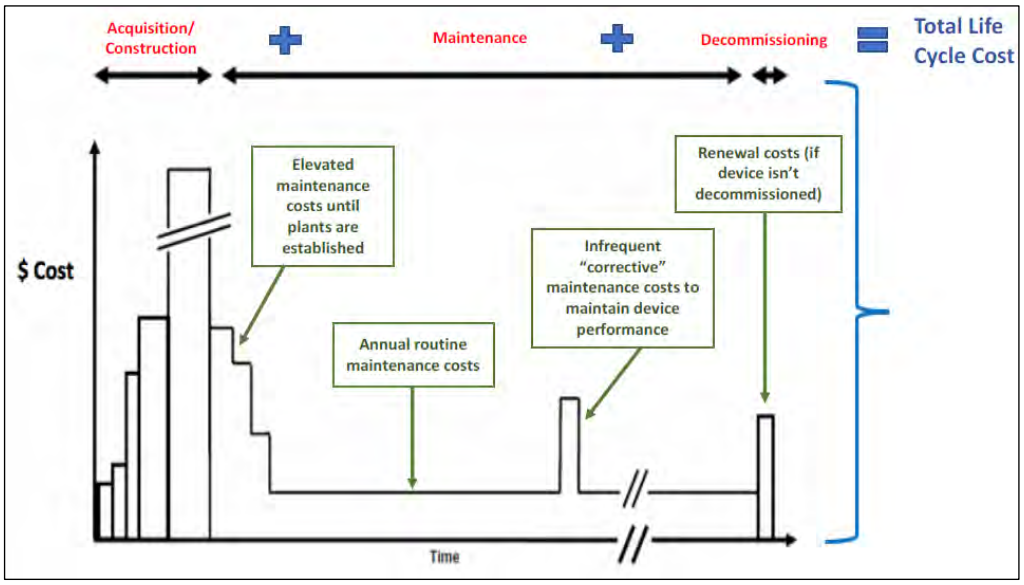

Figure B2.1: Phases in the life cycle of a stormwater practice and potentially associated costs. Fig 2-1, Ira & Simcock, 2019.

1.1.1 Stormwater Device Cost Data

Total Acquisition Costs

Ira & Simcock (2019) presents total acquisition costs for a range of stormwater treatment devices, reproduced on Figure B2.2. Rates are as $/m^2 for all devices except swales which are as $/m length assuming a 2-3 m wide swale.

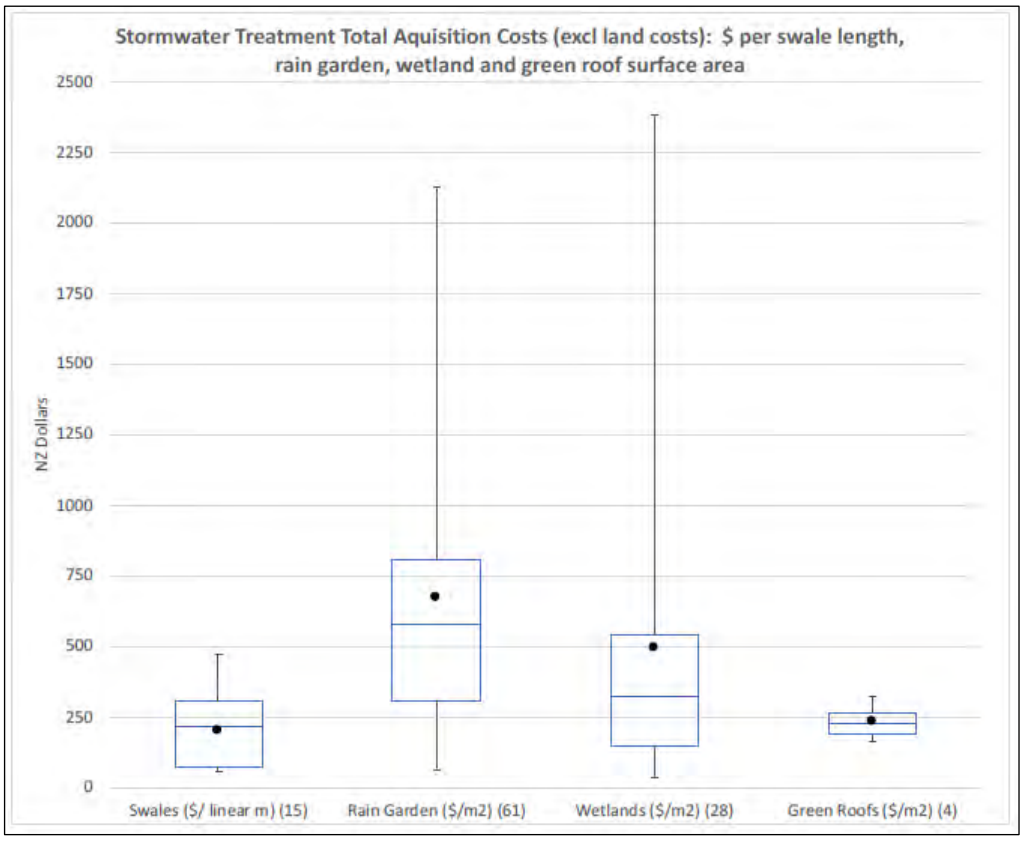

Figure B2.2: Green Infrastructure Total Acquisition Costs. Fig 4-1, Ira & Simcock, 2019.

The author makes several recommendations for interpreting the numbers in Figure B2.2 which we have interpreted as follows:

- For concrete box bioretention rain gardens, use a rate in the upper cost spectrum.
- For bioretention rain gardens without concrete edging and underdrains, use a lower rate.
- For wetlands requiring clay liners due to high groundwater levels or permeable underlying soils, use a higher cost estimate than the median.

Further cost estimates drawn from recent construction contracts administered by Harrison Grierson in Auckland are shown on Table B2.3.

Table B2.3: Total acquisition cost estimates for stormwater devices

Device	Device	Device	Device
Bioretention rain garden (concrete box)	$2,000 - $2,300/m^2	Nov 2020	West Auckland site. Sourced from contractor's price submission. Excludes labour.
	$1,450/m^2	Oct 2019	South Auckland site. Sourced from contractor's price submission. Excludes labour.
	$1,500/m^2	Aug 2020	South Auckland site. Engineer's estimate. Excludes labour.
Filterra rain garden unit	$5,000 - $12,500/m^2	Nov 2020	Large units more cost effective. Bulk purchase discounts applied. Two West Auckland sites. Sourced from contractor's price submissions. Excludes labour.

Table B2.3: Total acquisition cost estimates for stormwater devices			
Device	**Device**	**Device**	**Device**
Treatment wetland	$300-$500/m^2	May 2019	Treatment wetland receiving 10% and 1% AEP flows. South Auckland site. Total cost at completion.
	$250-$400/m^2	Aug 2018	Treatment wetland receiving 10% AEP flows. South Auckland site. Total cost at completion.
Bioretention swale	$45/m	Oct 2019	South Auckland site. Sourced from contractor's price submission. Excludes labour, drainage media, and underdrains.
	$60/m	Aug 2020	South Auckland site. Sourced from engineer's estimate. Excludes labour, drainage media, and underdrains.
	$130/m	July 2020	West Auckland site. Sourced from contractor's price submission. Includes labour, drainage media, and underdrains.

Routine & Corrective Maintenance Costs

RMCs and CMCs are derived from Ira & Simcock (2019) Tables 4-1, 4-2, and 4-3. For this assessment, maintenance is assumed at a *Functional* level, which uses a balance of more frequent but less stringent inspections. Concurrent projections are made using low-cost and high-cost estimates.

The routine maintenance activities included in the assessment are shown on Table B2.4.

Table B2.4: Routine maintenance cost estimates for stormwater devices				
Device	**Activity**	**Tasks per year**	**Low-cost estimate**	**High-cost estimate**
Bioretention rain garden	Routine Landscaping – Functional Standard	9	$0.50/m^2	$1.30/m^2
	Functional Drainage Maintenance	2	$120/RG	$312/RG
	Traffic Control	0	$1.00/m^2	$3.20/m^2
	Minor Repairs	1	$96/RG	$120/RG
	Vandalism – Make Good	2	$120/RG	$132/RG
Planted bioretention swale	General Maintenance	3	$0.23/m^2	$3.00/m^2
	Inspections	2	$36/SW	$48/SW
	Vandalism – Make Good	1	$174/SW	$288/SW
Wetland	General Maintenance	4	$0.24/m^2	$0.60/m^2
	Debris Removal	4	$48/WL	$164/WL
	Inspections	1	$300/WL	$480/WL
	Scheduled Mechanical	1	$384/WL	$660/WL
	Vandalism – Make Good	1	$25.20/m^2	$97.80/m^2
	Weeds	2	$0.30/m^2	$0.35/m^2
	Aquatic Weeds	1	$0.29/m^2	$0.53/m^2

The corrective maintenance activities included in the assessment are shown on Table B2.5.

Table B2.5: Corrective maintenance cost estimates for stormwater devices

Device	Activity	Task frequency	Low-cost estimate	High-cost estimate
Bioretention rain garden	Various Minor Tasks	5-yearly	2.60/m^2	6.00/m^2
	Outlet Erosion	5-yearly	0.50/m^2	0.75/m^2
	Sediment Removal & Disposal	50-yearly	5.50/m^2	14.70/m^2
	Complete Replanting	50-yearly	1.50/m^2	7.20/m^2
	Major Maintenance	15-yearly	1,200/RG	3,900/RG
	Traffic Control (Lane Closure)	50-yearly	1.00/m^2	3.20/m^2
Planted bioretention swale	Maintain Flow	25-yearly	$300/SW	$600/SW
	Dispose Sediment	25-yearly	$55/$m^2$	$148/$m^2$
	Re-Plant	25-yearly	$15/$m^2$	$20/$m^2$
	Minor Repairs	10-yearly	$48/SW	$240/SW
	Replace Underdrain	25-yearly	$22/$m^2$	$28/$m^2$
Wetland	Structural	50-yearly	$12,000/WL	$18,804/WL
	Replacement Parts	50-yearly	$1,200/WL	$7,200/WL
	Replanting Wetland Zone	50-yearly	$11/$m^2$	$15/$m^2$
	Desilting Forebay	50-yearly	$105/$m^2$	$310/$m^2$
	Desilting Main Pond	50-yearly	$105/$m^2$	$310/$m^2$

Land Values

Land values are estimated as $1,000 - $1,200/$m^2$ for high yield developable sections within the site.

For each stormwater device the value of the land required was adjusted to consider the potential of alternative development options in that location. Values shown on Table B2.6.

Table B2.6: Land values and modifiers

Device	Land value modifier	Adopted land value	Notes
Bioretention rain garden	-70%	$360/$m^2$	Bioretention rain gardens are located within the road corridor, filling the same space as parallel parking spaces, street trees, and street lighting. As no vertical concrete walls are included, the devices are less space-efficient and thereby reduce the available developable land.
Planted bioretention swale	-50% (land take)	$360/$m^2$	Planted bioretention swales are located within the road corridor. As bioretention swales serve a dual purpose as part of the primary stormwater network there are significant cost savings associated with bioretention

Table B2.6: Land values and modifiers			
Device	**Land value modifier**	**Adopted land value**	**Notes**
	-20% (SW network savings)		swales draining small sub-catchments associated with the opportunity cost of constructing an adjacent pipe network. However, when swales are draining a larger catchment, a wider cross-section is required which has knock-on effects on the extent of the road corridor.
Wetland	-15%	$960/m^2	Wetlands are not located within the road corridor. As wetlands are typically constructed within relatively low value but otherwise developable land, the associated opportunity cost is significantly higher.

Decommissioning Costs

Following Ira & Simcock (2019), decommissioning costs were not included in the models.

1.1.2 Cost Projections

Three scenarios were modelled based on an early draft of this stormwater management plan in accordance with the rules set out above. The areas, volumes, and numbers of devices shown in this part of the report may vary from what is shown in the main body of the report and are provided for information only.

1. Vegetated treatment wetlands providing water quality treatment and peak flow attenuation for runoff from the developed site. This option would require a departure from the standard as wetlands do not typically provide retention.
2. Vegetated bioretention rain gardens providing pre-treatment for road runoff prior to discharge into vegetated wetlands providing hydraulic mitigation and peak flow attenuation for runoff from the developed site.
3. Vegetated bioretention rain gardens and swales providing pre-treatment for road runoff prior to discharge into vegetated wetlands providing hydraulic mitigation and peak flow attenuation for runoff from the developed site. Assumes 80% of the rain gardens from option 2 can be replaced with swales instead.

Table B2.7: Life cycle cost assessment device options				
SW device	**Criteria**	**Option one: wetlands only**	**Option two: rain gardens & wetlands**	**Option three: rain gardens, swales, & wetlands**
Rain gardens	Number		420	84
	Area		16,700 m^2	3,300 m^2
Swales	Number			85
	Area			9,400 m^2
	Length			4,300 m
Wetlands	Number	15	15	15
	Area	75,100 m^2	69,700 m^2	69,700 m^2

1.1.3 Model Assumptions

The following assumptions were used in calculation:

- Costs were projected over a 50-year life cycle.
- Adopted a discount rate of 5% pa from Treasury guidance.
- Adopted a contractor rate inflation of 3.5% pa.
- Rain garden device cost assumed \$300/m^2 plus 30% labour cost.
- Swale device cost assumed \$300/m length plus 20% labour cost.
- Wetland cost assumed \$500/m^2 plus 10% labour cost.
- Land values for each device are as per Table 20.
- Internal rain garden area equals external rain garden area. No concrete box units are allowed for.
- For Option 1, two wetlands with a conservative estimate of 500 m^2 surface area are included. These wetlands represent the additional headwater basins and tanks discussed in Sections 1.6.3 & 1.6.4 of this report.
- For Option 2, the footprint area of rain gardens is assumed as 5% of total impervious area.
- For Option 3, the footprint area and number of swales is extrapolated from the requirements for Option 1.
- For Option 4, the footprint area of wetlands is assumed as 8% of total impervious area.
- Rain gardens are assumed to have 12m^2 footprint areas on average.
- Swales are assumed to be 50 m long on average.
- All options assume the works are carried out over two earth working seasons.
- All options assume all devices, materials, and land are purchased during the first year.

1.1.4 Model Results

Model results are shown on Table B2.8 and on Figures B2.3 to B2.8 as NPV\$-2017. Note that land value costs are excluded from Figures B2.3 to B2.8 to avoid obscuring other costs.

The stormwater management options assessed have a total life cycle cost averaged to \$2M to \$2.4M (\$-2017) per year in the low maintenance-cost model, and from \$2.6M to \$3.2M (\$-2017) in the high maintenance-cost model. Note that in both scenarios the most expensive cost centre is the land value cost (LVC). These results are indicative only and have not been validated in the field beyond the information sources listed above. We welcome feedback and collaboration from Auckland Council and Auckland Transport to develop a more robust knowledge base for life-cycle cost assessments in the future.

Table B2.8: Life cycle cost assessment results

Costs	Option one: wetlands only	Option two: rain gardens & wetlands	Option three: rain gardens, swales, & wetlands
Low Maintenance Cost Estimate			
Total Acquisition Cost	\$8,080,000	\$13,880,000	\$10,270,000
Routine Maintenance Cost	\$5,470,000	\$16,300,000	\$8,300,000

Table B2.8: Life cycle cost assessment results			
Costs	**Option one: wetlands only**	**Option two: rain gardens & wetlands**	**Option three: rain gardens, swales, & wetlands**
Corrective Maintenance Cost	$13,930,000	$14,370,000	$14,170,000
Land Value Cost	$72,100,000	$72,930,000	$71,490,000
Total Cost	**$99,580,000**	**$117,480,000**	**$104,230,000**
High Maintenance Cost Estimate			
Total Acquisition Cost	$8,080,000	$13,880,000	$10,270,000
Routine Maintenance Cost	$10,690,000	$31,990,000	$18,490,000
Corrective Maintenance Cost	$39,760,000	$41,130,000	$39,900,000
Land Value Cost	$72,100,000	$72,930,000	$71,490,000
Total Cost	**$130,630,000**	**$159,930,000**	**$140,150,000**

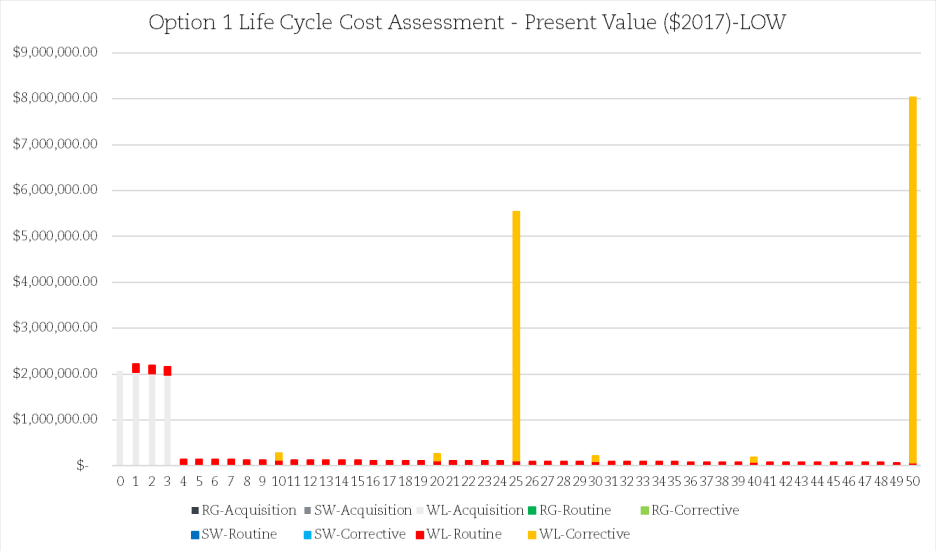

Figure B2.3: Option 1 (wetlands only) low maintenance-cost lifecycle model.

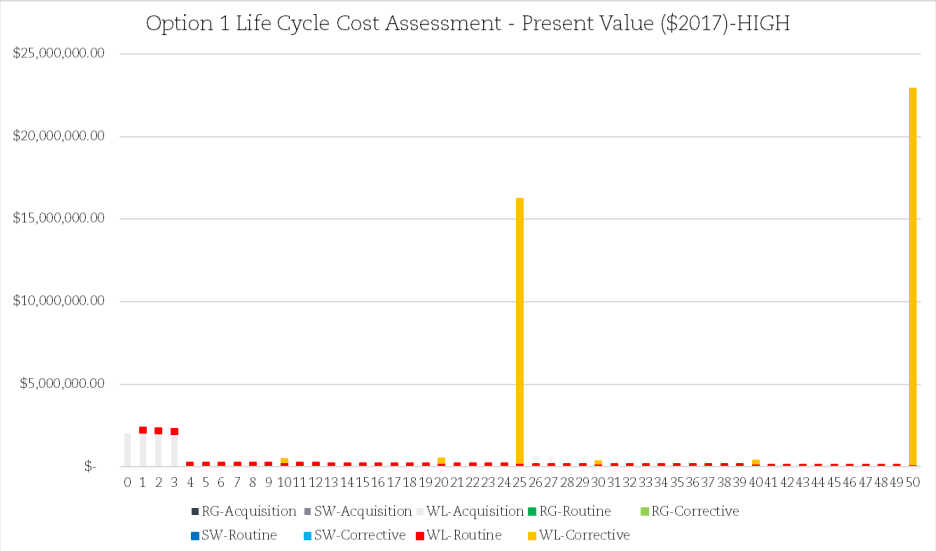

Figure B2.4: Option 1 (wetlands only) high maintenance-cost lifecycle model.

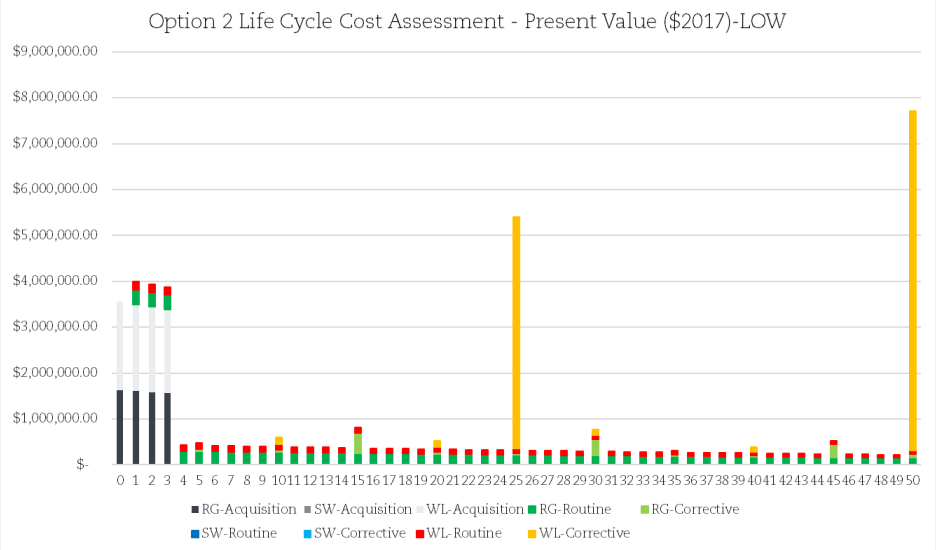

Figure B2.5: Option 2 (rain gardens & wetlands) low maintenance-cost lifecycle model.

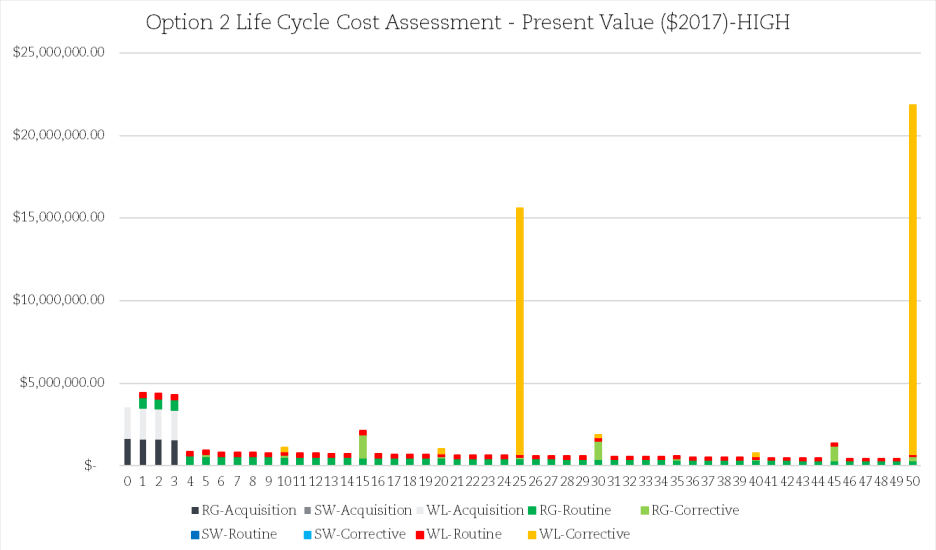

Figure B2.6: Option 2 (rain gardens & wetlands) high maintenance-cost lifecycle.

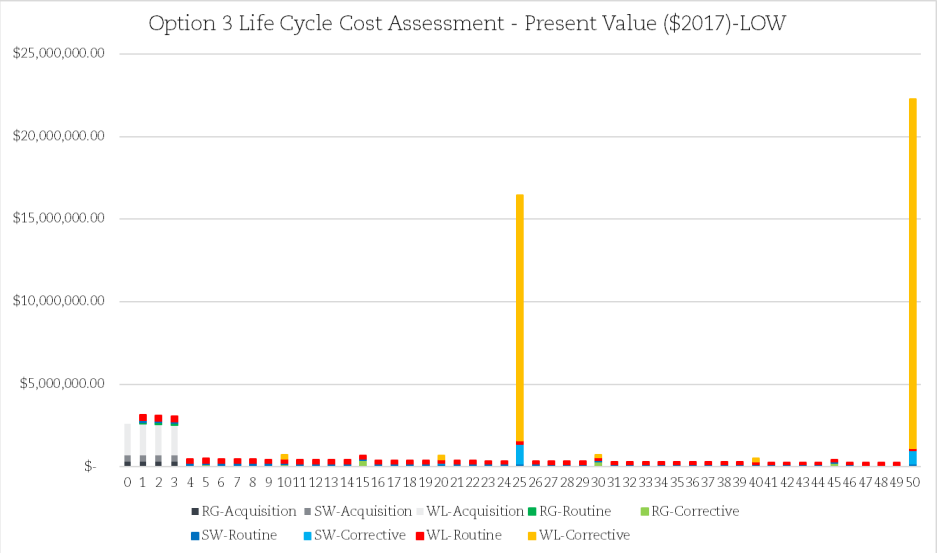

Figure B2.7: Option 3 (rain gardens, swales & wetlands) low maintenance-cost lifecycle.

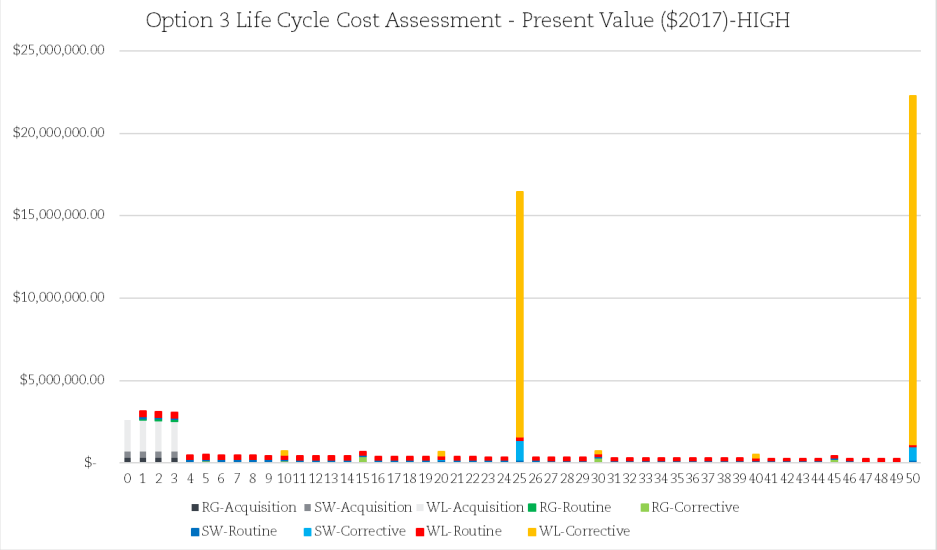

Figure B2.8: Option 3 (rain gardens, swales & wetlands) high maintenance-cost lifecycle.

Appendix C – Flood modelling results maps

HARRISON GRIERSON

Legend

2D Model Boundary

Flood Depth (m)

- 0.05 - 0.10
- 0.11 - 0.20
- 0.21 - 0.30
- 0.31 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 10.00

REV	ISSUE STATUS	DATE
v3	FOR INFORMATION	220316

DESIGNED:	SXG	DATE:	16/03/2022
DRAWN:	SXG	DATE:	16/03/2022
CHECKED:	JMC	DATE:	16/03/2022
APPROVED:	JMC	DATE:	16/03/2022

N

Scale: 1:12,000 (A3 Size)

0 0.1 0.2 0.4 Kilometers

Beachlands South Flood Risk Assessment

Flood Depth Map 10yr ED CC

MAP NO:

A2001228_01_002

HARRISON GRIERSON

Legend

2D Model Boundary

Flood Depth (m)

- 0.05 - 0.10
- 0.11 - 0.20
- 0.21 - 0.30
- 0.31 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 10.00

REV	ISSUE STATUS	DATE
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APPROVED:	JMC	DATE:	16/03/2022

N

Scale: 1:12,000 (A3 Size)

0 0.1 0.2 0.4 Kilometers

Beachlands South Flood Risk Assessment

Flood Depth Map 100yr ED CC

MAP NO:

A2001228_01_003

HARRISON GRIERSON

Legend

2D Model Boundary

Flood Depth (m)

- 0.05 - 0.10
- 0.11 - 0.20
- 0.21 - 0.30
- 0.31 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 10.00

Proposed Earthworks

High : 80.71

Low : -0.78

REV	ISSUE STATUS	DATE
v6.31	FOR INFORMATION	220316

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APPROVED:	JMC	DATE:	16/03/2022

N

Scale: 1:12,000 (A3 Size)

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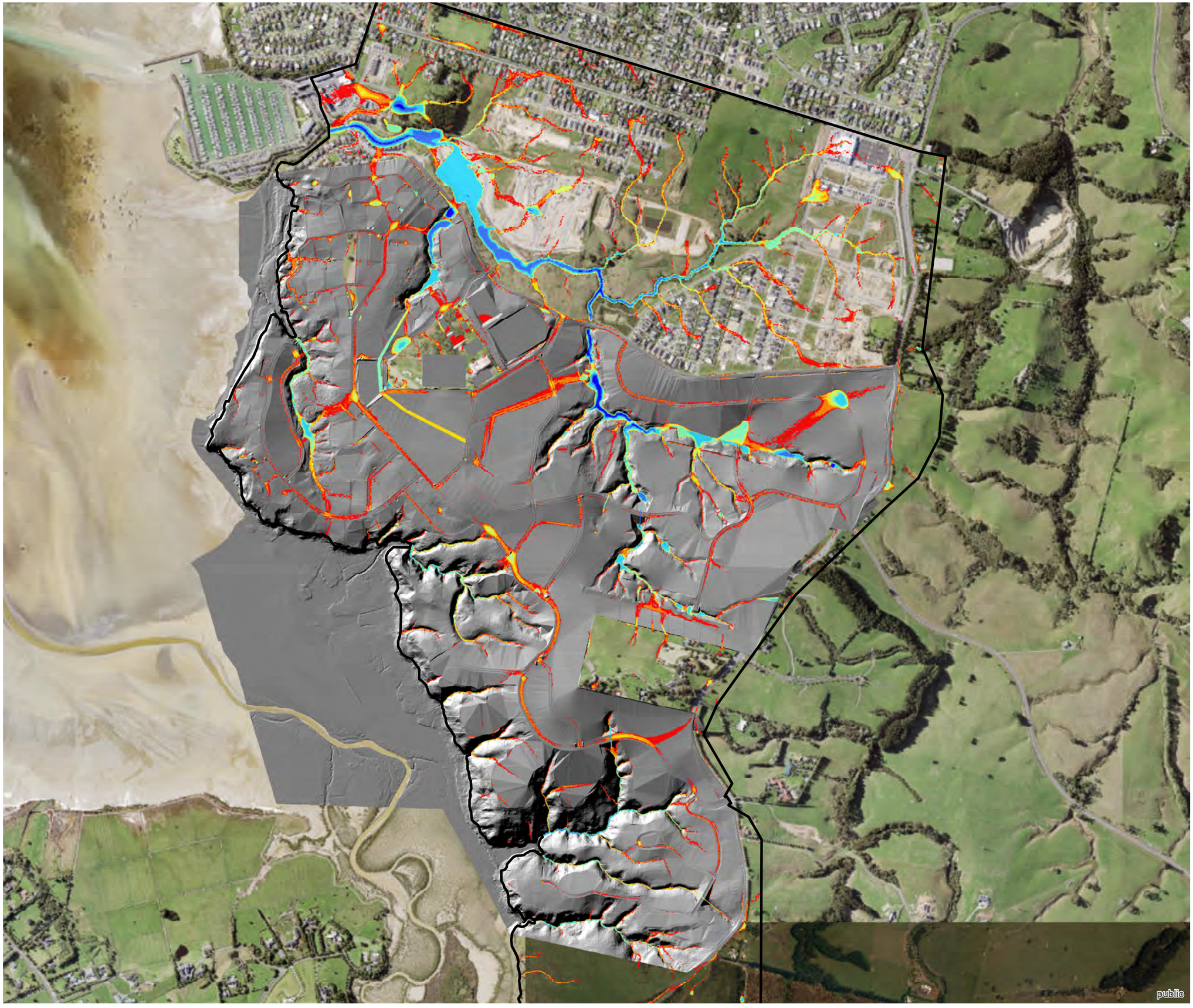
Beachlands South Flood Risk Assessment

Flood Depth Map 10yr MPD CC

MAP NO:

A2001228_01_004



HARRISON GRIERSON

Legend

2D Model Boundary

Flood Depth (m)

- 0.05 - 0.10
- 0.11 - 0.20
- 0.21 - 0.30
- 0.31 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 10.00

Proposed Earthworks

High : 80.71

Low : -0.78

REV	ISSUE STATUS	DATE
v6.31	FOR INFORMATION	220316

DESIGNED:	SXG	DATE:	16/03/2022
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APPROVED:	JMC	DATE:	16/03/2022

N

Scale: 1:12,000 (A3 Size)

0 0.1 0.2 0.4 Kilometers

Beachlands South Flood Risk Assessment

Flood Depth Map 100yr MPD CC

MAP NO:

A2001228_01_005

esri

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HARRISON GRIERSON

Legend

- 2D Model Boundary
- Flood Extent, 10yr MPD

Water Level 10yr, MPD minus ED (m)

- Post > 0.5 lower than Pre
- Post up to 0.5 lower than Pre
- Post up to 0.3 lower than Pre
- Post up to 0.2 lower than Pre
- Post up to 0.1 lower than Pre
- Post within 0.02 of Pre
- Post up to 0.1 higher than Pre
- Post up to 0.2 higher than Pre
- Post up to 0.3 higher than Pre
- Post up to 0.5 higher than Pre
- Post >0.5 higher than Pre

Proposed Earthworks

High : 80.71

Low : -0.78

REV	ISSUE STATUS	DATE
v6.31	FOR INFORMATION	220316

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CHECKED:	JMC	DATE:	16/03/2022
APPROVED:	JMC	DATE:	16/03/2022

N

Scale: 1:12,000 (A3 Size)

0 0.1 0.2 0.4 Kilometers

Beachlands South Flood Risk Assessment

Flood Level Difference Map 10yr MPD CC minus 10yr ED CC

MAP NO:

A2001228_01_006

HARRISON GRIERSON

Legend

- 2D Model Boundary
- Flood Extent, 100yr MPD

Water Level 100yr, MPD minus ED (m)

- Post > 0.5 lower than Pre
- Post up to 0.5 lower than Pre
- Post up to 0.3 lower than Pre
- Post up to 0.2 lower than Pre
- Post up to 0.1 lower than Pre
- Post within 0.02 of Pre
- Post up to 0.1 higher than Pre
- Post up to 0.2 higher than Pre
- Post up to 0.3 higher than Pre
- Post up to 0.5 higher than Pre
- Post >0.5 higher than Pre

Proposed Earthworks

High : 80.71

Low : -0.78

REV	ISSUE STATUS	DATE
v6.31	FOR INFORMATION	220316

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APPROVED:	JMC	DATE:	16/03/2022

N

Scale: 1:12,000 (A3 Size)

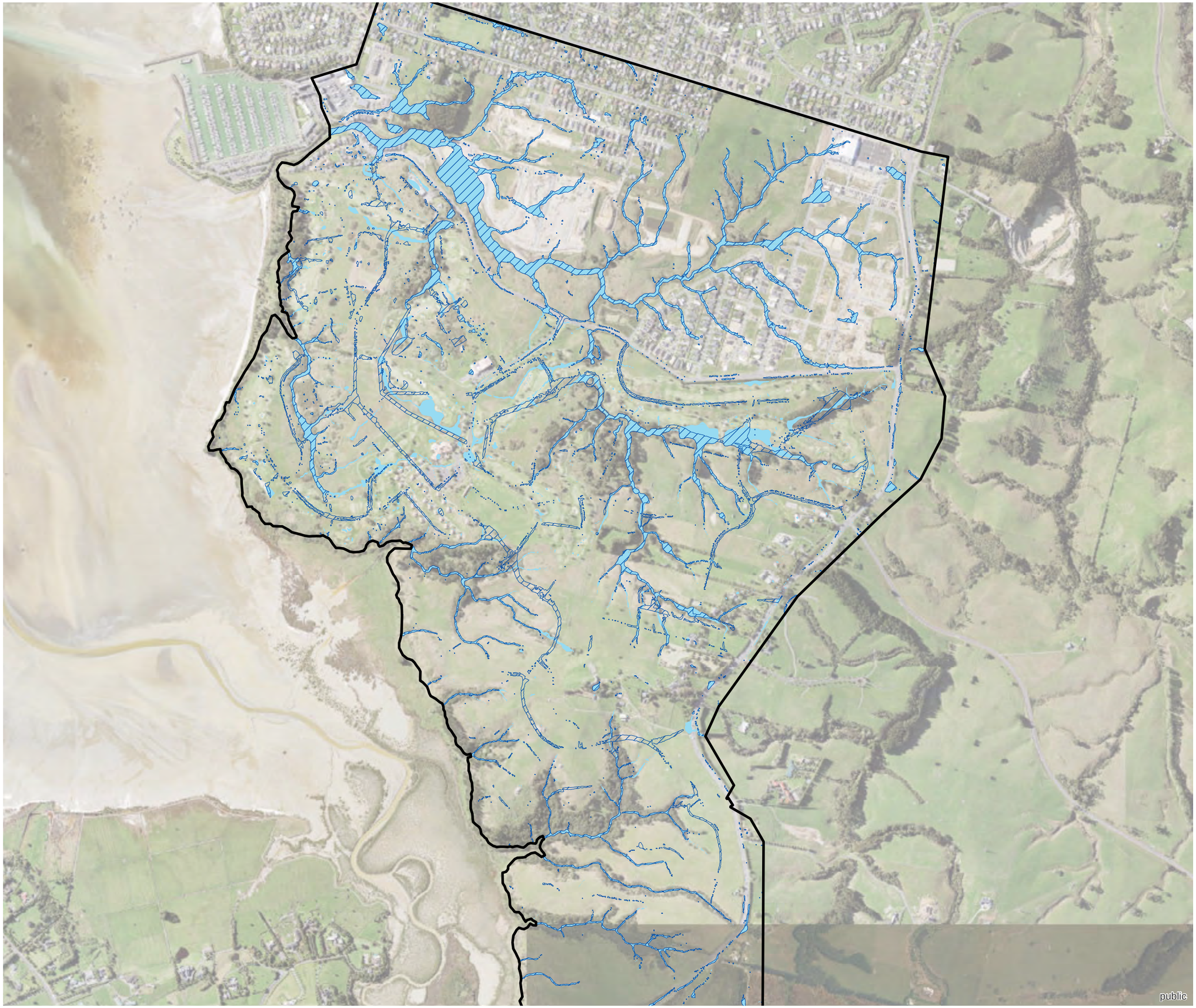
0 0.1 0.2 0.4 Kilometers

Beachlands South Flood Risk Assessment

Flood Level Difference Map 100yr MPD CC minus 100yr ED CC

MAP NO:

A2001228_01_007



HARRISON GRIERSON

Legend

- 2D Model Boundary
- Flood Extent, 10yr MPD
- Flood Extent, 10yr ED

REV	ISSUE STATUS	DATE
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DESIGNED:	SXG	DATE:	16/03/2022
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APPROVED:	JMC	DATE:	16/03/2022

Scale: 1:12,000 (A3 Size)

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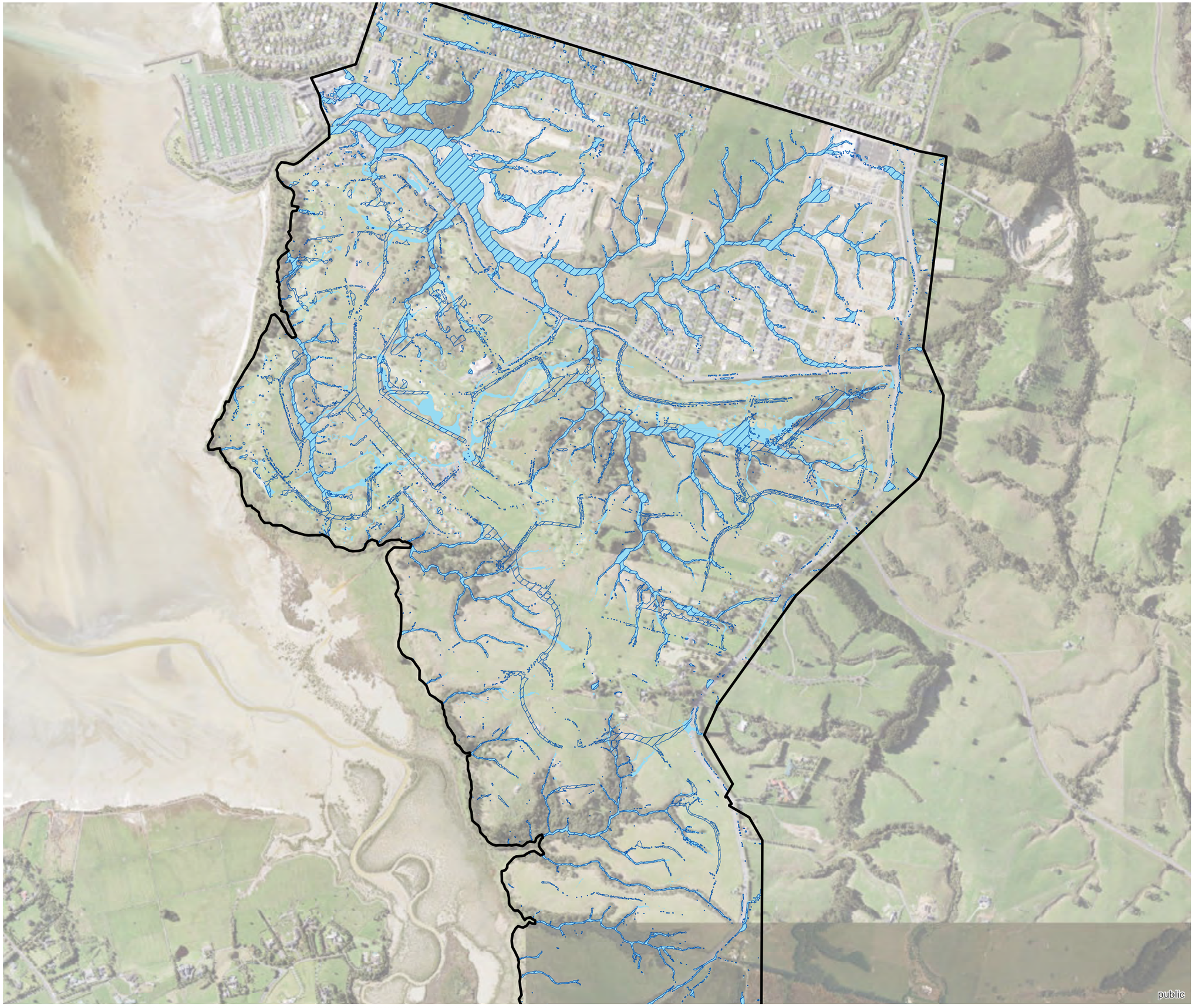
Beachlands South
Flood Risk Assessment

Flood Extent Map
10yr MPD CC vs. 10yr ED CC

MAP NO:

A2001228_01_008



HARRISON GRIERSON

Legend

- 2D Model Boundary
- Flood Extent, 100yr MPD
- Flood Extent, 100yr ED

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ISO 9001 QUALITY ASSURED

REV	ISSUE STATUS	DATE
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APPROVED:	JMC	DATE:	16/03/2022

N

Scale: 1:12,000 (A3 Size)

0 0.1 0.2 0.4 Kilometers

Beachlands South
Flood Risk Assessment

Flood Extent Map
100yr MPD CC vs. 100yr ED CC

MAP NO:

A2001228_01_009

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