Auranga B2

STORMWATER MANAGEMENT PLAN

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PREPARED FOR:

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1.0 INTRODUCTION

1.1 Background

The Auranga B2 development is located just to the west of Drury and is in addition to the existing Drury 1 Precinct (Auranga A and Auranga B1). The B2 area is approximately 38 km south of Auckland's central business district, 13 km south of the Manukau Centre, and 4 km southeast of the Papakura Centre. The Auranga B2 Private Plan Change (PPC) area is identified in Figure 1.

The Auranga B2 area is approximately 33.65 ha. The development will include both commercial and residential development. These are connected by a road network integrated with the adjoining Drury 1 Precinct. Access to the site is from Burberry Road and Karaka Road (SH22) from the south, and consented roading development to the north from Bremner Road, through land within Drury Precinct 1.

The PPC applicant, Karaka and Drury Ltd, plans to rezone the land to allow commercial and housing development to continue from the existing (and extended by PC6) Drury 1 Precinct. The PPC provides additional critical mass to support infrastructure development and to provide a sustained supply of housing and local amenities to serve Auckland's growth. The development of the Auranga B2 area is in line with the Auckland Unitary Plan (AUP) which has zoned the area as 'Future Urban' (FUZ). The Auranga B2 area is also identified in the Auckland Council (Council) Future Urban Land Supply Strategy (FULSS). According to the Auckland Council Future Urban Land Supply Strategy, Auranga B2 is covered within the wider Drury West area that is nominated to be development ready' by 2022.

The PPC area is proposed as a new Precinct. The applicant has identified as part of the PPC overlay that the provisions of *Chapter E10: Stormwater Management Area Flow 1* of the AUP should be utilised (and apply to the PPC area) to suitably manage ongoing stormwater mitigation and water sensitive design requirements.

The Auranga B2 area is characterised by flat to gently rolling pastoral landform dropping off to the estuarine riparian edge of Drury Creek to the east and an unnamed tributary of Ngakaroa Stream, immediately adjacent to SH22, to the south east. A large constructed pond is the main freshwater feature within the area. It is also subject to several permanent, intermittent and ephemeral streams.

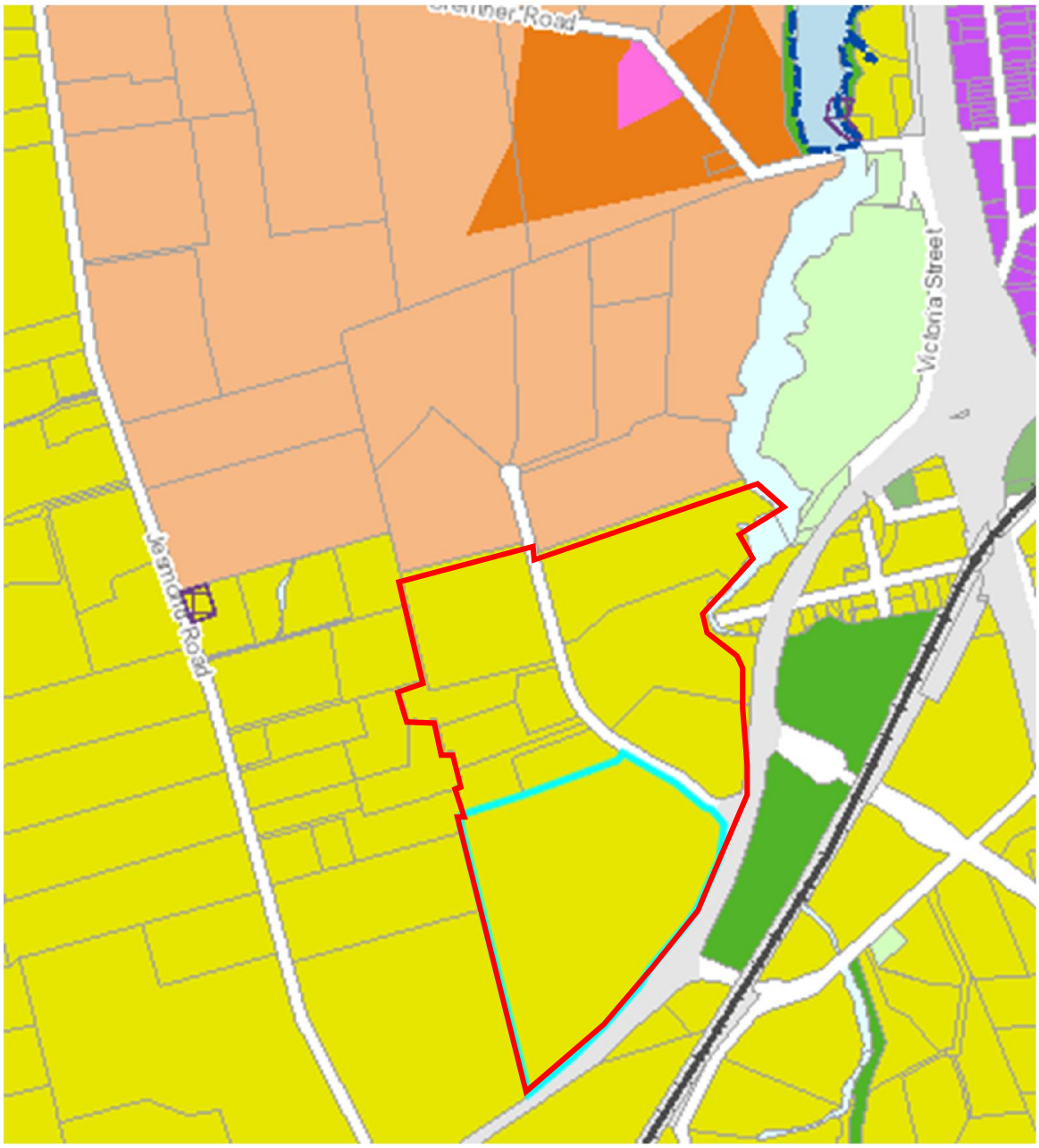

Figure 1: Auranga B2 Private Plan Change Area

1.2 Purpose

This SMP has been prepared to support an application for a Private Plan Change ("PPC") by Karaka and Drury Ltd.

The overall purpose of the SMP is to provide guidance to the applicant and Auckland Council on how stormwater will be managed based on a developed future land use scenario, and to support the PPC application.

The SMP is consistent with Councils policies and plans. Non-statutory policy and planning documents are also considered.

1.3 Scope of the SMP

The scope of the SMP is to:

- Detail proposed stormwater management for development of the PPC area;
- Demonstrate how stormwater management related expectations under the AUP and Auckland Council's Stormwater Network Discharge Consent have been met; and
- Demonstrate design principles and consistency with the Stormwater Code of Practice (SWCOP) for initial approval of concept for stormwater assets to be vested to Council.

1.4 Outcomes of the SMP

The outcomes sought by the SMP are:

- An integrated stormwater management approach;
- A water sensitive treatment framework that manages and mitigates the impact of land use change from agricultural use to urban;
- Provide for retention of stream habitat, and protection and enhancement of riparian and estuary margins;
- Identify flood risk areas and ensure any development is located outside the floodplain;
- A set of Best Practicable Options (BPO) for stormwater that can be applied to the development;
- Utilisation of the *Chapter E10: Stormwater Management Area Flow 1* requirements as a template for the hydrological mitigation aspects of stormwater management;
- Promote water conservation where possible and practicable; and
- Recognise opportunities to manage stormwater areas for multiple values and functions.

1.5 Infrastructure planning and funding

The costs of implementing the stormwater management devices, including private infrastructure, will be the responsibility of each landowner or developer, as part of each subdivision stage.

Maintenance for devices on private lots will be the sole responsibility of the future lot owners. Devices in public areas (roads and reserves) will be vested in Council, who will assume the ongoing maintenance costs (devices in roads expected to become the responsibility of Auckland Transport after vesting). Land to be vested with stormwater management devices, or which contain the stream network (up to the 100-year flow) will be vested at no cost.

Private on lot devices such as onsite tanks will be the sole responsibility of future purchasers. Communal devices (if located on private land such as rear lanes) will require ongoing maintenance by the future purchasers through a resident's society or body corporate (or similar). Details of how these will be managed and maintained in perpetuity can form part of the resource consent approval process (and is governed by the Council's recent stormwater bylaw).

No infrastructure funding agreement is considered necessary as there is no expectation that Council will be developing or funding stormwater infrastructure within the Auranga B2 at its cost. All infrastructure will be the responsibility of the developers/landowners to fund.

1.6 Network Discharge Consent (NDC)

Auckland Council obtained a Region-wide Network Discharge Consent to authorise the diversion and discharge of stormwater. The area covered by the NDC includes all future urban zoned land.

The preparation of a SMP is a direct requirement of the NDC for any activity seeking to utilise or fall with in parameters of the NDC by having the SMP "adopted" into the NDC framework.

In relation to a notified Plan Change the NDC requires that a SMP can only be adopted if a SMP has been prepared to support the notified Plan Change and the Plan Change must be consistent with that SMP (condition 13b).

As identified above, this SMP has been prepared to support the PPC for the rezoning of land known as Auranga B2. It Is expected that the recommendations of this SMP are implemented via the PPC and that the documents will be "consistent".

2.0 SITE DESCRIPTION

2.1 Summary of data sources and dates

Existing site appraisal item	Source and date of data used
Topography	• Auckland Council GIS records, April 2020
Geotechnical / soil conditions	• Preliminary Geotechnical Appraisal Report for Auranga B2 Re-zoning Concept, Drury, dated March 2019, Lander Geotechnical • Landcare S-Maps, April 2020
Existing stormwater network	• Watercourse Assessment Report ("WAR"), Morphum Environmental Consultants
Existing hydrological features	• Watercourse Assessment Report ("WAR"), Morphum Environmental Consultants
Stream, river, coastal erosion	• Preliminary Geotechnical Appraisal Report for Auranga B2 Re-zoning Concept, Drury, dated March 2019, Lander Geotechnical
Flooding and flowpaths	• Auckland Council GIS Rapid Flood Hazard Mapping • Auranga B SMP – T&T, May 2017
Coastal Inundation	• Auranga B SMP – T&T, May 2017
Ecological / environmental areas	• Ecology Report, Dr Graham Ussher of RMA Ecology Ltd

Existing site appraisal item	Source and date of data used
Cultural and heritage sites	•
Contaminated land	•

2.2 Heritage

Archaeological sites, built heritage, history and cultural values are identified by Auckland Council's Heritage Report for the Drury Ophake Structure Plan (DOSP) area.

There is no evidence of pre-1900 archaeology or heritage, or significant 20th century heritage found within the PPC area.

2.3 Natural and physical characteristics

2.3.1 Catchment and Typography

The land is characterised by flat to gently rolling pastoral landform dropping off to the estuarine riparian edge of Drury Creek to the east and an unnamed tributary stream of Ngakoroa Stream, immediately adjacent to SH22, to the south east. The topography rises from, approximately, RL 5m, on the eastern boundary, to, approximately, RL 22m, along the western boundary. The area slopes up-wards, generally, in a north-westerly direction. The central and northern parts of the PPC area are predominantly flat, at approximately RL 15m. The land then falls in a southerly direction towards SH22 at approximately RL 10m. There is a more significant rise adjacent to SH22 where the gradient is, generally, 5% with some steeper gradients, of 10%. The Land Parcels consist of lifestyle-blocks and pastoral activities. A 1.3ha (approx.) ornamental pond is the main freshwater feature within the area. It is also subject to several permanent, intermittent and ephemeral streams.

2.3.2 Floodplains and overland flow paths

The Auranga B2 land is at the downstream end of the Ngakoroa Stream catchments. Land within Auranga B2 has a land form dominated by rolling country and generally drains to the north or north east. Within the site two streams receive the flows, being the Ngakaroa Stream (Stream K), and Stream H (and its tributaries), which conveys stormwater in a general north or north easterly direction.

The Council GIS website shows the floodplain and overland flow paths that comprise the north and south streams. The 1% AEP floodplain extent is derived from Rapid Flood Hazard Mapping of the Auckland Region undertaken in 2009. It simulates the 1% AEP rainfall event (without climate change) with 10 mm initial storage and 2.5 mm/h continuous rainfall loss with the terrain modelled with 10 m by 10 m grid. Refer Figure 2

An updated flood hazard assessment based on improved modelling has been undertaken specifically for the Auranga A & B catchment of which Stream H was part of the model. This is presented and discussed in Section 5.2 of this report. The finding of that updated flood hazard assessment is that there are no buildings/dwellings at risk from flooding

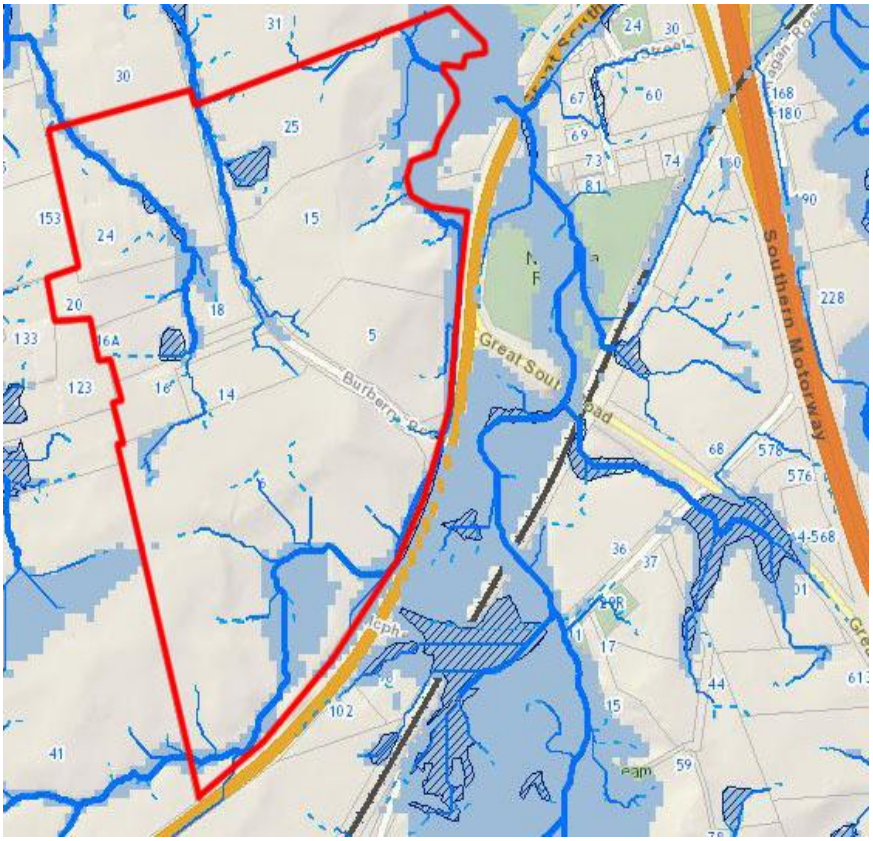

Figure 2: Auranga B2 Flood Plain and Overland Flow Paths (Source AC GeoMaps)

2.4 Current land use

The PPC area comprise a number of lifestyle landholdings with approximately ten dwellings with associated swimming pools, garages, barns, tennis courts and accessory sheds and buildings. The majority of the land is characterised by the lifestyle properties with small scale grazed pastoral land use, expansive mowed lawn areas and amenity plantings around the dwellings. Gravel and paved drives traverse the site providing vehicular access to the individual properties.

Burberry Road provides access to the site from SH22 and the Drury State Highway 1 ("SH1") motorway intersection and the Ngakoroa Stream bridge (Jesmond Bridge). Burberry Road is currently rural in character being relatively narrow and devoid of kerb and channel, street lighting or footpaths.

2.5 Geotechnical

2.5.1 Soils

Landcare S-Map indicates that soil in the area is predominantly well drained, with the exception of the southern margin along SH 22 and the Ngakaroa Stream being poorly drained. Refer Figure 3.

A geotechnical assessment was completed by Lander Geotechnical, in a report titled "Preliminary Geotechnical Appraisal Report for Auranga B2 Re-zoning Concept, Drury", dated March 2019. The geotechnical investigations from 26 boreholes around the site have indicated that the majority

show the top 2 m consisting of either clayey silts, silty clays, silts and clays, with occasional sand and limonite inclusions. Typical topsoil depths ranged between 100mm and 400mm in thickness, averaging approximately 200mm.

Percolation rate tests have been undertaken across the wider Auranga area, but none were located within the Auranga B2 area. The closest (P4) was not tested due to a high standing water level following pre-soaking, indicating very slow percolation at this location.

Percolation rate tests for adjacent land in Auranga A, and Auranga B (to the north of the Auranga B2) show a range of infiltration rates with 0.0028 m/min to 0.0007 m/min and percolation rate of 0.24 L/m²/min to 0.05 L/m²/min, refer to Lander Geotechnical percolation tests November 2015 (submitted with PV15). Infiltration for the purpose of hydrological mitigation is possible for these soils based on these rates. Site specific infiltration testing can be undertaken for devices that require infiltration at subdivision/land use stage.

Figure 3 – Soil Drainage S-Map, from Landcare Research

2.5.2 Groundwater

A groundwater assessment was completed by Lander Geotechnical, in a report titled "Preliminary Geotechnical Appraisal Report for Auranga B2 Re-zoning Concept, Drury", dated March 2019. Groundwater during site investigations was encountered within ten of the test locations between depths of 1.5m and 4.9m. Groundwater was not encountered in the other borehole locations and

could be reasoned for by the dry summer period at the time of the investigations. A summary of the groundwater levels measured is also shown on Figure 4.

Site specific testing for groundwater levels including seasonal variation will be required for design of infrastructure, especially for stormwater devices that will rely on infiltration.

Borehole No.	Land Use Area**	Depth Encountered (m)	Standing GWL (m)
HA 2015 – 14	Outside B2 Area	2.0	1.2
HA2015 - 15	Outside B2 Area	1.5	1.0
HA2015 - 67	Outside B2 Area	4.0	4.2
HA2015 - 68	Outside B2 Area	2.7	2.7
HA2015 - 70	Outside B2 Area	3.0	3.0
HA2015 - 71	Outside B2 Area	4.9	4.9
HA2017 - 14	B2 Town Centre Zone	1.8	2.0
HA2017 - 15	B2 Town Centre Zone	2.2	2.2
HA2017- 18	Outside B2 Area	1.8	1.8
TP2017 - 03	Outside B2 Area	3.4	*NE

Note: groundwater levels have only been displayed for boreholes where groundwater was encountered. The remaining tests did not encounter groundwater over the depths drilled on the date of testing.
**NE = Groundwater not observed at the end of testing.*
*** Refer McKenzie and Co drawing 003, Rev A, Project No. 1823-PC2B for land use area references.*

Figure 4: Auranga B2 - Groundwater depth relative to ground level. Note table is from the Preliminary Geotechnical Appraisal Report, Lander Geotechnical, March 2019

2.5.3 Contamination

The land within the PPC area, are largely used for agricultural and pastoral grazing purposes, in addition to lifestyle residential activities. No Preliminary Contamination Report has been undertaken upon the site, however, based on previous experience in Greenfields development and upon review of historic aerial imagery of the area which identified the sites historic use for pastoral farming purposes, it is considered highly likely that the site comprises some areas of potential contamination and HAIL activities. Specific assessment of these areas would be undertaken initially in the form of Preliminary Site Investigation (PSI) during the subdivision/land use stage and related consenting.

2.6 Ecology/Streams

An Ecology Report prepared by Dr Graham Ussher of RMA Ecology Ltd addresses the ecological values of the Auranga B2 site (Refer to AEE for details).

Figure 5 below illustrates and classifies the stream and pond features situated within the PPC area:

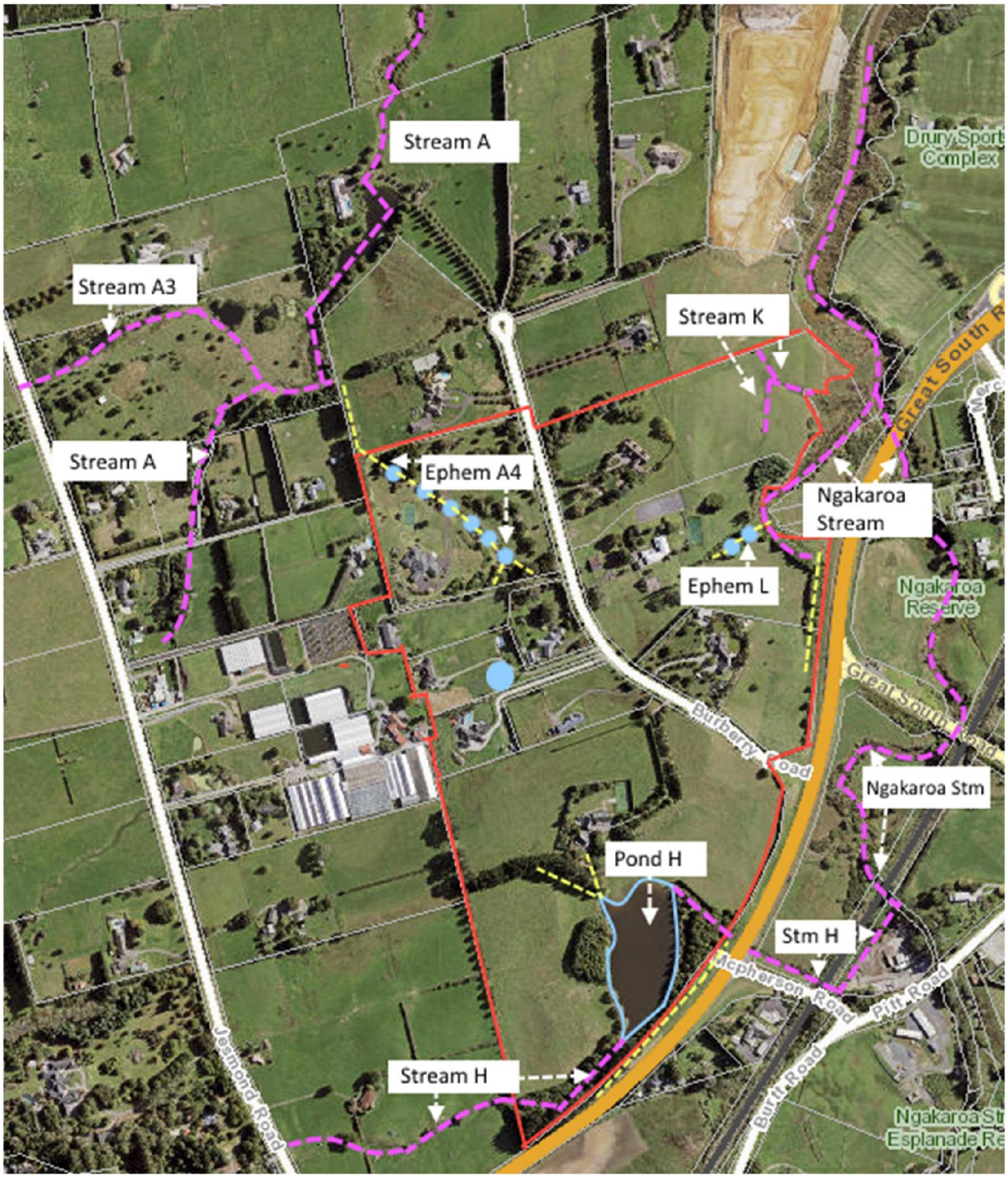

Figure 5: Stream types, and water features within the PPC area

The plan above demonstrates a combination of permanent, intermittent and ephemeral streams located in this portion of the PPC site.

Stream H

Stream H for the first part within the PPC area (before it enters the Pond H) deemed to follow the natural alignment. Thereafter, the flowpaths have been identified as significantly modified such that overflow from the pond via an intermittently flowing spillway channel, is fed into a culvert under SH22, under the adjacent rail line and through a constructed channel to the true right arm of Ngakoroa Creek.

The presumed natural flowpath of Stream H is along the true left of SH22 to join with the true left arm of Ngakaroa Creek. Instead, this portion of the natural stream has been infilled (around Burberry Road) and channelised to form a drain through which the remaining ephemeral flow is conveyed to the wetland area at the head of the true left arm of Ngakaroa Creek.

Stream H is identified as a permanent stream reach until it reaches the Stream H pond, after which it becomes an intermittent spillway (and thereafter exists the PPC area site).

Stream H is a permeant stream, which flows from the west to the east. This stream has a number of tributary inflows which either directly adjoin Stream H or flow through the adjacent pond and eventually join the stream. The stream has an average width of 0.92m and is shallow with an average depth of 6cm. The permanent section of the stream is soft bottomed and has a slow velocity. The stream is fenced from stock. A SEV was undertaken at this site which indicated moderate ecological value. This stream extends further to the east, then shown in the above plan, within land which is included in the Auranga B2 PPC site.

Pond H

The pond is fed by Stream H and a number of intermittent and ephemeral streams.

Ephemeral Streams L and A4

Ephemeral Stream L is located on the eastern side of PPC area and discharges to the true left arm of Ngakaroa Creek. The catchment size is small, and the watercourse is heavily modified.

Ephemeral watercourse A4 has been modified considerably, with a series of excavated ponds within 24 Burberry Road to capture water and excavated channels between ponds to enable overflow. The ponds flow into 30 Burberry Road (outside of the PPC boundary).

Ngakaora Stream

The Ngakoroa Stream extends along the north-eastern corner of the site.

Auckland Council's Watercourse Assessment for the Ngakoroa Stream prepared for the DOSP area (by Morphum) describes the Ngakoroa Stream catchment as being 40.15km2. The catchment is primarily drained by the Ngakoroa Stream, which discharges to Drury Creek and then to the Pahurehure Inlet of the Manukau Harbour.

The Ngakoroa Stream also includes a large tributary, designated as Ngakoroa West, which splits from the main branch in the Runciman area and extends south west. A small sub-catchment draining directly to the Pahurehure Inlet is also present to the west of Drury.

Due to the gentle topography of the area, Morphum have identified that freshwater systems tend to be low order, low energy watercourses connected to large wetland areas and that these waterways serve vital drainage and flood protection functions throughout this landscape.

The Watercourse Assessment identified that the catchment was highly modified, with historical vegetation clearance resulting in only small, fragmented pockets of native vegetation remaining. Modified stream channels were evident throughout the catchment, with the most common form of modification being straightening to increase conveyance.

RMA Ecology have identified the true left arm of Ngakaroa Stream forms part of the eastern boundary of PPC area with a broad floodplain and escarpment from SH22 north to the confluence with Stream K.

2.6.1 *Terrestrial and freshwater ecology values*

Riparian margins around the pond have been planted in predominantly exotic species including redwoods, alder and cypress, willow, pin and English oak and sweet gum. Exotic rushes were also noted along with indigenous flax. Over 50% of the buffer zone around the pond was wider than 10m.

Stream H was well shaded for most of its length by a mature stand of pine, macrocarpa and willow trees, which have been planted on both sides of the stream bank. Ferns were also present in places. A SEV was undertaken at this site which indicated moderate ecological value.

The RMA Ecology reporting identified that fish habitat was scarce within the PCP area, and that while the ponds are likely to support shortfin eel, the ephemeral watercourses and Stream K lack any habitat of note, and lack flow to support fish.

Stream H may support fish in the short section of plantation pine upstream of the Stream H pond, however the spillway to the pond was identified by RMA Ecology to likely present a barrier to fish as it was a wide, rock-lined channel that rarely supports flow.

Council's Ecology Reporting for the DOSP identifies that the area was likely to contain habitant for native skinks (mostly along margins of pasture and watercourses), however surveying was nto considered necessary given the low likelihood of detection at present densities.

Stream H had a large amount of organic matter within the stream, which was likely to provide a food source and habitat for resident macroinvertebrates. Fish cover was present in the form of undercut banks and wood immediately upstream of the pond, and gambusia were noted in the stream.

The Council's Ecology Reporting for the DOSP identified that due to the degraded nature of the watercourses, species present were likely to consist predominantly of pollution tolerant and common (non-threatened) species such as shortfin eel, common smelt, common bully and Cran's bully. However, two threatened fish species (Inagna and Torrentfish) have been identified as being present with the DOSP area.

It is also acknowledged that the Ngakoroa stream is identified in the AUP as being a SEA Terrestrial (T_530b) and as meeting factor 2 (Threat Status and Rarity) of the Schedule 3 criteria.

The Council's Ecology Reporting for the DOSP identified that vegetation in the SEA included some nationally or regionally threatened plant species (Native oxtongue and Mingimingi), and that nationally or regionally threatened bird species have been recorded in the SEA (Caspian tern and South Island pied oystercatcher).

The Watercourse Assessment has identified that the Ngakoroa Stream mouth (adjacent to the PPC area) is an inanga spawning area and identified this area as a potential enhancement opportunity.

2.6.2 Water Course Assessment

A Watercourse Assessment Report ("WAR") was undertaken by Morphum Environmental Consultants as part of the SMP for the DOSP area for the Ngakaroa Catchment. Map Series 1 (Refer Figure 6) identifies the following tributaries in the PPC area:

- Nga_Trib2_i
- Nga_Trib2_1,
- Nga_Trib2_3,
- Nga_Trib2_4
- Nga_Trib2_5
- Nga_Main_1

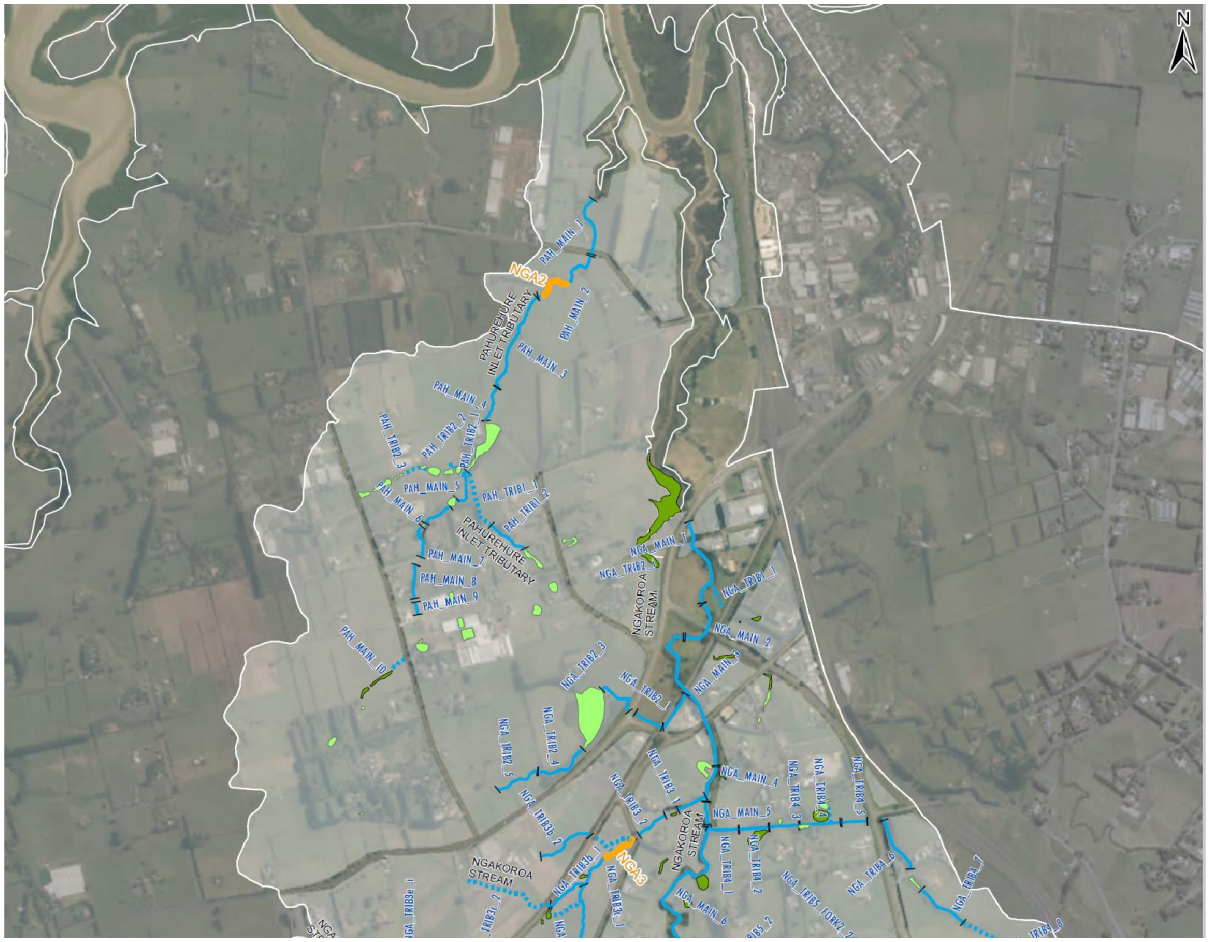

Figure 6: WAR Map 1A Overview Map (Source Morphum Environmental)

The WAR also identified the streams within the site as being in Management Zones. As per Figure 7 below.

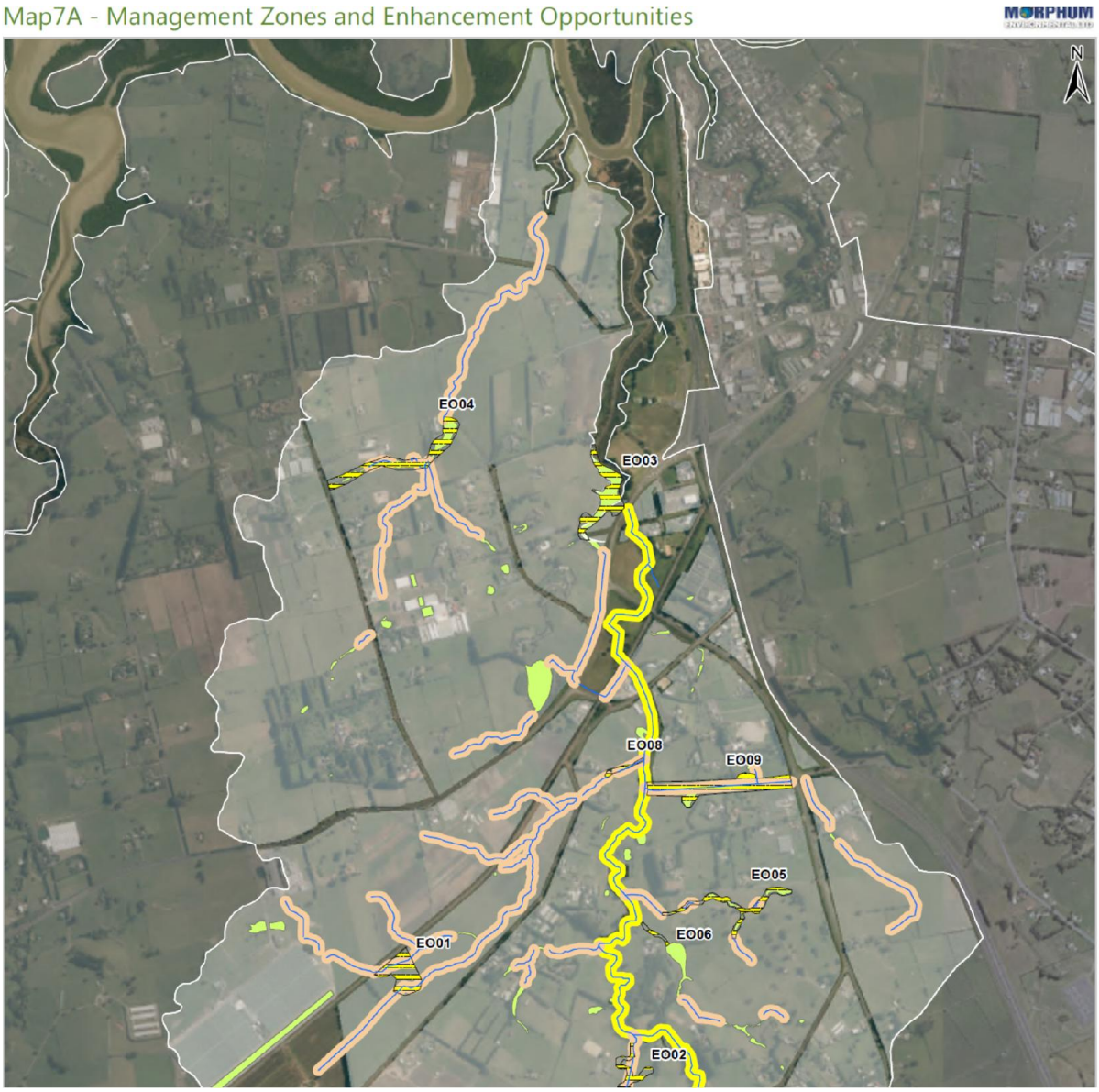

Figure 7: WAR Management Zones Map (Source Morphum Environmental)

2.7 Receiving environments

2.7.1 Streams, lakes and wetlands

The Auranga B2 discharges to Streams to the North and South. The receiving environments are summarised in Section 2.6.

2.7.2 Aquifers and soakage

The aquifers that are identified in the AUP are shown on Figure 1Figure 8 below.

The AUP overlays note the area as being within a High Use Stream Management Area. This is not addressed further as the development will not be taking water from the streams.

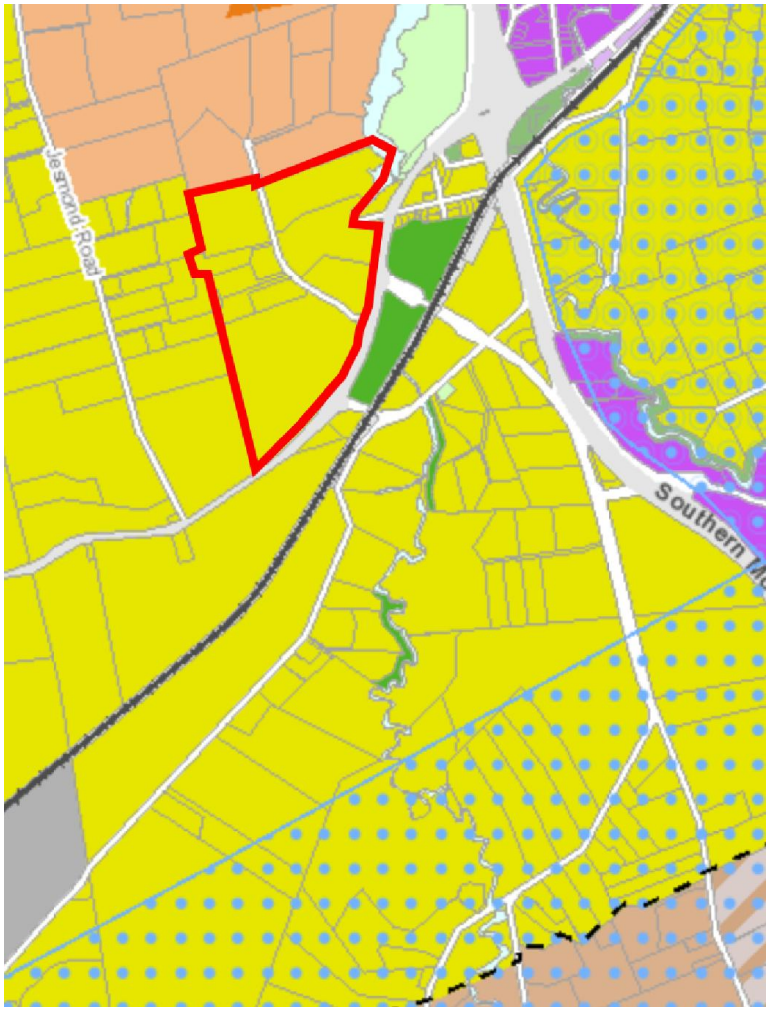

Figure 8 – Auranga B2 – Aquifers as per the AUP

2.7.1 Coastal Environment

The PPC does not directly adjoin the coastal environment, however the Ngakoroa Stream drains into the area known as the Duruy Creek approximately 500m north of the PPC area.

The wider coastal environment of the Drury Creek (north of the PPC area) is also identified as SEA Marine 1 and 2 areas for intertidal habitat and wading bird areas, and saltmarsh areas.

The Council's Ecology Reporting for the DOSP identifies while virtually all native vegetation has been removed from the terrestrial coastal edge, the coastal marine area itself remains largely intact and of good ecological health.

2.8 Existing stormwater network and other infrastructure

2.8.1 Existing stormwater network

Council GIS data does not show any existing stormwater culverts crossing Karaka Road at the southern boundary of the area. Most of this section of the network is in a traditional road embankment setup with cross fall (super-elevation) to side water channels within Agency designation. While not recorded on Council GIS, there are two culverts that pass under Karaka

Road (SH22) between Burberry and McPherson Roads, refer Figure 9 below. The culvert south of Burberry is a 375mm diameter RC pipe with 2.8-3.6m cover. This culvert is in average condition and is almost certainly not to current P46 specification standard for performance. The culvert north of McPherson is a 750mm diameter RC culvert with ~2.2-4.0m cover.

Drainage of this whole area is largely informal and follows natural flow paths.

Figure 9 Stormwater Infrastructure in SH22

2.8.2 Other infrastructure

Council GIS data does not show any existing wastewater or water infrastructure in the area.

The First Gas gas transmission line runs through 6,16,16A,20 and 24 Burberry Road, refer to Figure 10.

Transpower Transmission Lines are located outside of the site, approximately 700m to the east.

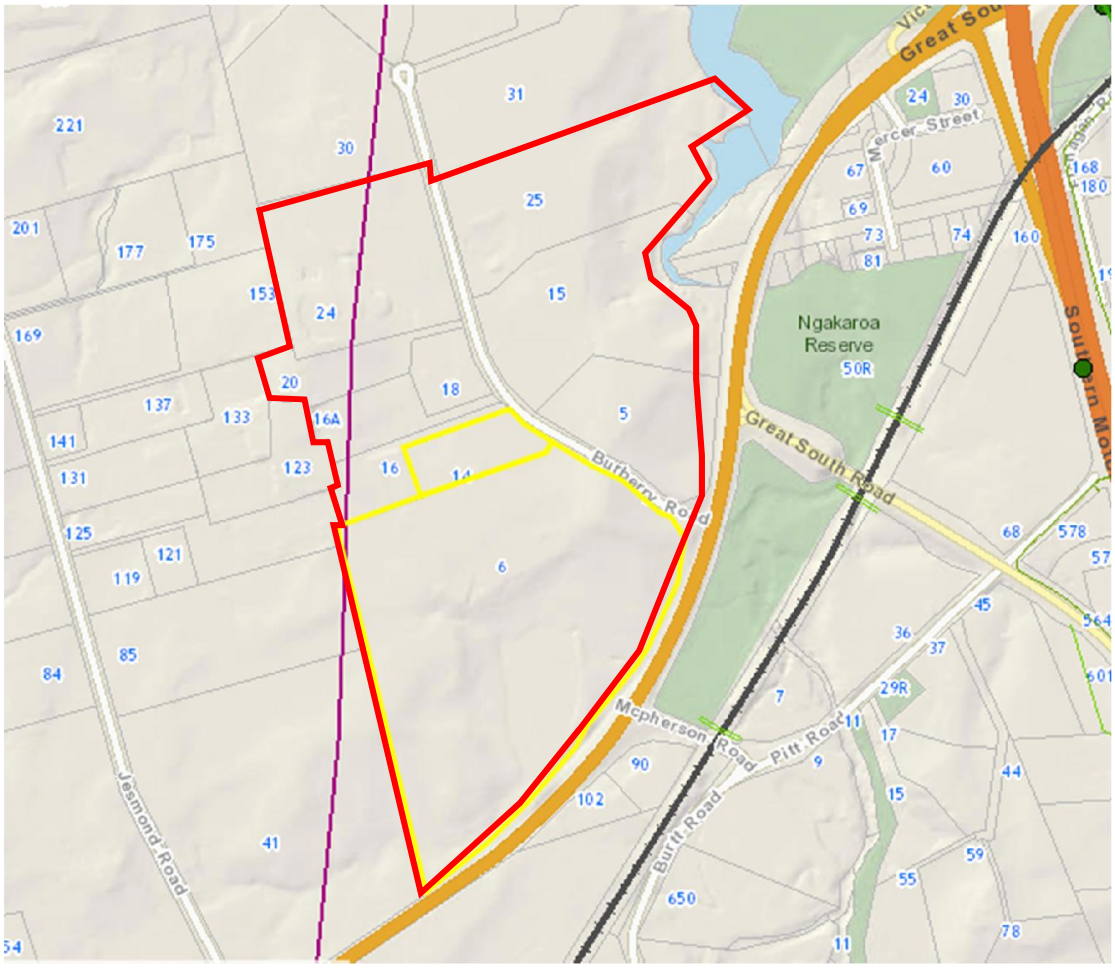

Figure 10: Gas Transmission line

3.0 Development Summary and Planning Context

3.1 Summary of Regulatory Requirements

A summary of the existing Regulatory Requirements is provided in the table below.

Table 1 – Regulatory Requirements

Requirement	Relevant regulatory / design to follow
Unitary Plan – SMAF hydrology mitigation	• Chapter E10 of the AUP is not applicable without a PPC. However, hydrology mitigation is intertwined in AUP objectives.
High Contaminant Generating Areas	• Chapter E9 of the AUP is not directly applicable at PPC stage (as no new uses are specifically proposed) but should be noted and utilised in BPO for stormwater management and identification of high use roads.
Natural Hazards	• Chapter E36 of the AUP is not directly applicable at PPC stage (as no new uses are specifically proposed) but should

	be noted and utilised in BPO for stormwater management and identification of hazard areas. Those hazards applicable to the PPC area include flooding and coastal inundation.
Auckland Unitary Plan Precinct	• There is no Precinct applicable to the land. However, the site adjoins the Drury 1 Precinct and therefore the provisions of that Precinct in respect to stormwater management should be taken into consideration in any BPO assessment.
Existing Catchment Management Plan	• There is no existing Catchment Management Plan applicable. However Auckland Council has prepared a Stormwater Management Plan for the entire Drury-Opaheke Structure Plan area.
Auckland Council Regionwide Network Discharge Consent	• The Auckland Council Stormwater Network Diversion and Discharge Consent DIS60063613 is applicable.

3.2 Regulatory Design Requirements:

The AUP is the planning document for Auckland that replace the former Regional Policy Statement and the 13 regional and district plans. The AUP became 'operative in part' on 15 November 2016. The AUP sets out objectives, policies and rules for development on both a city-wide scale and in some cases on a site-specific scale for areas that have been designated as 'precincts'. The general AUP policies for management of stormwater and flooding are covered in Section E – Auckland Wide rules, namely:

- Section E1 – Water quality and integrated management
- Section E3 – Lakes, rivers, streams and wetlands
- Section E8 – Stormwater – Discharge and diversion
- Section E9 – Stormwater quality – High Contaminant generating car parks and high use roads
- Section E10 – Stormwater management area – Flow 1 and Flow 2
- Section E36 - Natural hazards and flooding.

The objectives are generally broad and the underlying policies that relate to stormwater management are considered to ensure correct interpretation of the objectives. The policies are wide ranging about what should be considered and do not specifically direct towards any water management solutions. The general outtakes from the assessment of these policies is that stormwater management for greenfield sites should avoid and/or minimise effects on the environment (especially for sensitive receiving environments) as far as is practicable and apply an integrated stormwater water management approach (AUP E.1.3(8)).

The following subsections summarise the most relevant policies in the AUP that development in Auranga B2 needs to give effect to. A more detailed review of all the relevant AUP objectives and policies has been undertaken in the Plan Change Assessment of Effects, prepared by Tollemache Consultants.

3.2.1 General

Policy 8 in Section E1 (Policy E1.3.8) sets out the following policies for management of stormwater runoff from greenfield development:

> *Avoid as far as practicable, or otherwise minimise or mitigate, adverse effects of stormwater runoff from greenfield development on freshwater systems, freshwater and coastal water by:*
>
> - *taking an integrated stormwater management approach (refer to Policy E1.3.10);*
> - *minimising the generation and discharge of contaminants, particularly from high contaminant generating car parks and high use roads and into sensitive receiving environments;*
> - *minimising or mitigating changes in hydrology, including loss of infiltration, to:*
>
> i. *minimise erosion and associated effects on stream health and values;*
>
> ii. *maintain stream baseflows; and*
>
> iii. *support groundwater recharge;*
>
> - *where practicable, minimising or mitigating the effects on freshwater systems arising from changes in water temperature caused by stormwater discharges; and*
> - *providing for the management of gross stormwater pollutants, such as litter, in areas where the generation of these may be an issue.*

The other relevant policies from Section E1 are summarised briefly below:

- Maintain or enhance water quality, flows, stream channels and their margins where MCI scores for the existing streams are above the guidelines in Table E1.3.1 or Enhance water quality, flows, stream channels and their margins where MCI scores for the existing streams are below the guidelines in Table E1.3.1 (Policy E1.3.2a, Policy E1.3.2b and Policy E1.3.3).
- Discharges must avoid contamination that will have an adverse effect on the life supporting capacity of freshwater (Policy E1.3.4).
- Discharges must avoid contamination that will have an adverse effect on health of people and communities (Policy E1.3.5).
- An integrated stormwater management approach (Policy E1.3.10) must have regard to all of the following:
  - i. The nature and scale of the development and practical and cost considerations.
  - ii. The location and design of site and infrastructure to protect significant site features and minimise effects on receiving environments.
  - iii. The nature and sensitivity of receiving environments.
  - iv. Reducing stormwater flows and contaminants at source.
  - v. The use and enhancement of natural hydrological features and green infrastructure where practicable.

- Avoid, minimise or mitigate adverse effects of stormwater diversions and discharges (Policy E1.3.11).
- Manage contaminants in stormwater runoff from high contaminant generating carparks (> 30 cars) and high use roads (>5000 vehicles per day) to minimise adverse effects on water and sediment quality (Policy E1.3.12).
- Require Stormwater quality or flow management to be achieved on-site unless there is a downstream communal device (Policy E1.3.13).
- Adopt the best practicable option to minimise the adverse effects of stormwater discharges (Policy E1.3.14).
- Utilise stormwater discharge to ground soakage where it is possible to do so in a safe, and effective manner (Policy E1.3.15).

3.2.2 Hydrological Mitigation

Section E10 sets out controls for sites identified in the Stormwater management area control – Flow 1 and Flow 2. These controls are referred to as '*hydrological mitigation*' as they seek to minimise the change in hydrology, namely runoff volumes and flow rate, as a result of development. Hydrological mitigation is aimed at protecting rivers and streams that are particularly susceptible to the effects of development or have relatively high values.

While the SMAF overlay is not directly applicable to the site in its current form, the same/similar provisions have been applied to the existing Drury 1 Precinct area which directly adjoins the PPC area, and which drains to the same coastal receiving environment. Therefore, the outcomes to be achieved via the SMAF 1 principles have been taken into account.

The SMAF 1 hydrological mitigation requirements are outlined in Table E10.6.3.1.1 in the AUP and are as follows:

- Retention (volume reduction) of at least 5mm of runoff depth from impervious surfaces.
- Detention (temporary storage) and a drain down period of 24 hours for the difference between the pre-development and post-development runoff volumes from impervious surfaces in the 95th percentile, 24-hour rainfall event minus the achieved retention volume.

Exceptions for providing retention can be made in cases where soil infiltration rates preclude disposal to groundwater and rainwater reuse is not possible.

3.2.3 Natural hazards and flooding

Section E36 sets out the policies relating to management of natural hazards and flooding. The relevant policies are summarised briefly below:

- Identify land subject to natural hazards, taking into account the likely effects of climate change (Policy E36.3.1).

- Avoid development in greenfield areas which would result in an increased risk of adverse effects from coastal hazards, taking account of a longer-term rise in sea level in areas subject to coastal hazard (Policy E36.3.5).
- Avoid locating buildings in the 100-year ARI floodplain (Policy E36.3.17).
- Earthworks within the 100-year ARI floodplain should not permanently reduce floodplain conveyance or exacerbate flooding experienced by other sites upstream or downstream (Policy E36.3.20).
- Ensure all development in the 100-year floodplain does not increase adverse effects or increased flood depths or velocities to other properties upstream or downstream of the site (Policy E36.3.21).
- Maintain the function and capacity of overland flowpaths to convey stormwater runoff safely and without damage to the receiving environment (Policy E36.3.29) and Policy E36.3.30).

3.3 Drury-Opaheke Structure Plan

The Drury-Opaheke Structure Plan report identifies the following key outcomes regards to stormwater and flood management:

- The location and form of development avoids the impacts of natural hazards
- Management of the natural environment in a way that respects and is guided by Māori tikanga.
- Freshwater quality within the catchment is improved.
- The quality of the marine receiving environment is maintained or improved.
- The freshwater management functions of riparian margins are improved.
- Protect and improve biodiversity.

The guidance for stormwater and flood management is based on the Drury-Opaheke SMP which is outlined in further detail below.

3.4 Drury-Opaheke Draft Stormwater Management Plan

A draft Stormwater Management Plan was prepared by Mott McDonald to support the development of the Council's Drury Opaheke Structure Plan (DOSP).

The SMP recognises the key constraints and opportunities in the catchments and reflects the requirements of the Auckland Unitary Plan and region wide Network Discharge Consent. The SMP therefore seeks to achieve the following outcomes:

- Protecting and enhancing the environment and to connect communities to water.
- Ecological values are maintained or enhanced.
- Stream health is maintained or enhanced through improved baseflow.

- Urban development is facilitated, key infrastructure is protected, and people and the environment protected from significant flooding events.
- Stormwater is integrated with land uses and other values (e.g. landscape) so that the amount of land available for development is optimised.
- Sediment into sensitive receiving environments is minimised.
- Contaminants input into the sensitive receiving environments of the Drury Sands aquifer and Te Mānukanuka o Hoturoa / Manukau Harbour are minimised.

The recommended stormwater management approach takes into account the sensitivity of the receiving environments to further contaminants and makes use of water sensitive design as a tool to achieve integrated stormwater management as directed in policies E1.3(8) and (10) of the Auckland Unitary Plan.

To achieve these outcomes the SMP identifies a number of requirements for management of stormwater some of which are Structure Plan wide and others are specific to each catchment. For this PPC area the requirements for the Ngakaroa Stream catchment are relevant.

Key requirements are:

General:

- Development to be carried out using an integrated stormwater management (in accordance with E1.3.8 and E1.3.10 of the AUP) approach i.e. water sensitive design.

Water Quality:

- Freshwater and sediment quality are maintained where it is excellent or good and progressively improved over time in degraded areas in accordance with Section E1.2(1) of the AUP.
- Treatment of all impervious areas (excluding non-contaminant generating areas such as patios) to be provided at or near source using devices such as swales, rain gardens, tree pits. Runoff to be treated prior to discharge to the council system or directly to receiving environments (such as aquifers).
- Use inert building materials.
- Contaminant specific treatment devices are required for industrial or trade activities in accordance with E33 of the AUP.
- Sediment and erosion control measures, in accordance with GD05, are to be provided during earthworks and construction, including individual lot construction.
- Integrated naturalised (green) outfalls to be used when discharging to streams.

Minimising and mitigating hydrological change

- Changes in hydrology are avoided as far as practicable and any changes in hydrology are minimised or mitigated (in accordance with E1.3.8 of the AUP).
- The minimum requirement when hydrological mitigation is necessary is in accordance with Table E10.6.3.1.1 of the AUP.

- Stream erosion management may require staging of development so that the bottom of the catchment is developed first and stream bank strengthening is carried out in tandem. Council may consider collaborating or contributing to stream works in the event of multiple developers in the same sub-catchment.

Streams

- Protect and enhance all permanent and intermittent streams.
- A minimum 10m planted riparian margin shall be provided either side of intermittent streams and a minimum 20m riparian margin either side of permanent streams.
- Prepare natural stream channels for future storm flows through bioengineered erosion protection works.
- Watercourse margins should be sufficiently sized to allow space for gentle sloping embankments and revegetation of riparian margins.
- Outfalls should be pulled back from the streams where possible to allow for dispersal of flows and to disconnect impervious surfaces from the receiving environment to form part of a treatment train approach.
- Provide distributed stormwater outlets into watercourses rather than single discharge points.
- Barriers to fish passage occur at perched or steeply inclined culverts. Redevelopment presents an opportunity to remediate this issue through the removal and replacement of problem culverts.
- Integrate bioengineering to increase habitat values for fish.
- Improve inanga spawning habitat.
- Incorporate shared cycle/walkways along riparian corridors to improve connectivity to key recreational and transport infrastructure.
- Upgrade and install all required inlets and outlets to appropriate inlet outlet standards
- Retain existing stream meander patterns and reintroduce stream meanders and naturalisation where possible. Avoid any further channel straightening.
- Address erosion issues, both erosion hotspots and culvert erosion before and/or as urban development occurs.
- Carry out maintenance of existing culverts such as structural repairs, vegetation clearance and provision of erosion protection.
- For essential stream crossings, bank-to-bank bridges with minimal riparian and stream bed disturbance are preferred.
- Implement Enhancement Opportunities.
- Development of the FUZ should ensure that fish passage is maintained and where possible enhanced between the coastal marine area and natural stream management areas.

Ngakoroa Stream

- Remove redundant farm culverts during development.
- Investigate potential to implement esplanade reserves on Pahurehure Inlet tributary and Tributaries 3 and 8 as part of development.

Flood Management

- All buildings to be outside the 100-year ARI floodplain in accordance with E36.3.17.
- Avoid locating infrastructure in the 100-year ARI floodplain unless it can be designed to be resilient to flood damage.
- Ensure all development and changes within the 100-year floodplain do not increase adverse effects or increased flood depths or velocities to other properties upstream or downstream of the site.
- Avoid increasing flood risk and flood extent upstream and downstream for all flood events up to the 100-year ARI.
- Identify overland flowpaths and ensure that they remain unobstructed and able to safely convey runoff.
- Use capacity available in riparian margins as part of the water conveyance system and enhance intermittent streams to provide capacity and conveyance as a means to manage flood waters.

3.5 Watercourse Assessment

A Watercourse Assessment Report ("WAR") was undertaken by Morphum Environmental Consultants as part of the SMP for the DOSP area for the Ngakaroa Catchment.

Streams within the PPC area are identified in the WAR are Management Zone 2, and key issues and objectives are listed for this Management Zone in Table 9, which is replicated below in Figure 11.

Table 9: MZ2 Issues and Objectives	
Specific Issues	**Suggested Objectives and Actions**
Watercourses and historic wetlands have been modified to become straight deep channels and extensively fragment the ecological landscape.	Re-meandering of modified watercourses, consider daylighting options, and formation of contiguous green corridors. See EO1, EO2, EO6, EO7, EO8, EO9 (Section 6.0)
High water table and flood prone areas	Expected limitations on development within floodplains provide opportunities for the creation of public open space for passive recreational use combined with stormwater management. This could include detention basins, integrated with naturalised stream corridors to increase sinuosity with consideration of conveyance capacity (see EO7; Section 6.0)
Four culverts under the rail corridor intersecting first order tributaries of NGA_TRIB3 were overgrown with blackberry and gorse and inaccessible to determine condition, particularly from the outlet (647 Burtt Rd). Asset IDs: NGAPR_015, NGAPR_016, NGAPR_017	Refer maintenance recommendations to the appropriate authority (e.g. Kiwirail)
Poor condition of numerous private culverts on farm tracks	Advocate for the removal of redundant farm culverts through development
Stock damage to banks and watercourses	Advocate for the fencing and planting of riparian margins through the development process
Limited existing public open space or riparian reserves	Consider potential to implement esplanade reserves on Pahurehure Inlet tributary, and Tributaries 3 and 8 through future development.
Online ponds	Remove/remediate ponds to address associated impacts on water quality and freshwater ecology (see EO4, EO5; Section 6.0)
Barriers to fish migration within the Ngakoroa catchment	Remediate barriers to fish passage, namely: The perched culvert and its outlet structure (Asset IDs NGAPR_065 and NGA_139 respectively) which are located on NGA_TRIB3_4; A culvert located on PAH_MAIN_5 (Asset ID: NGAP_048), which is perched by 0.3 m; A perched PVC pipe (Asset ID: NGAP_050) located on PAH_TRIB2_2.
Culvert under shared driveway on NGA_TRIB8_6 presents a flood risk to non-habitable floors and access to properties (see Asset ID NGA_056)	Investigate remediation of undersized culvert to prevent flooding issues (see EO7; Section 6.0)

Figure 11: Management Zone Issues

Notably, none of the directly identified Tributaries or Assets fall within the PPC area.

3.6 Technical guidance

The following technical guidance is used to support the Stormwater Management Plan.

Table 2 – Stormwater Management Plan Guidance

Technical guidance	Application

Auckland Council, TR 2013/035, Auckland Unitary Plan stormwater management provisions: Technical basis of contaminant and volume management requirements (2013)	95th percentile 24 hr rainfall depth for hydrological mitigation devices.
GD01: Stormwater management devices in the Auckland Region, December 2017. (Note this supersedes TP10).	Design of approved stormwater quality devices.
Auckland Council, GD 2015/04, Water Sensitive Design for Stormwater.	Consideration of Water Sensitive Design approaches.
Auckland Council, TP 124, Low Impact Design Manual for the Auckland Region.	Design of low impact stormwater treatment devices.
Auckland Council, TP108, Guidelines for stormwater runoff modelling in the Auckland Region (1999)	Hydrological method for flood modelling.
SW CoP: Code of Practice for Land Development and Subdivision, Chapter 4 – Stormwater, **November 2015**	Design of stormwater assets.

4.0 MANA WHENUA MATTERS

4.1 Identification and incorporation of mana whenua values

Stormwater management for previous stages of Auranga was subject to iwi feedback – this is outlined below:

- Treatment of contaminants this includes stormwater discharge treatment solutions with a treatment train approach to provide retention and detention;
- Managing effects (avoid, remedy, minimize, mitigate, balance); and
- Groundwater recharge.

More detailed iwi requirements are listed below:

- Streams and esplanades preserved in their natural state;
- Esplanade reserves should be 20 m in width and riparian margins 10 m;
- All riparian plantings to be eco-sourced natives;
- Sustainable development in all areas;
- Stormwater devices outside of the 100-year flood plain;
- Drains, waterways, wet areas and overland flow paths preserved and enhanced;
- A minimum of a three train, bio/low impact design treatment for all stormwater runoff;
- Reuse of roof water to lessen effects of water take from public supply;
- Groundwater recharge implemented;
- Narrower roads = less impervious=less flow=smaller raingardens;
- Use of pervious paving for footpaths [increases groundwater recharge ability];
- Pervious paving;
- Roading [where possible] to be around esplanade to allow for visual amenity;
- Removal of culverts and replacement with bridges [unless for pedestrian access only];

- Retention of view shafts for visual amenity;
- Use of "non-chemical" methods for weed removal, as far as possible;
- Cultural monitoring, especially around stream and coastal margins; and
- Naming opportunities.
- Naturalised (green) outfalls.

The DOSP also sought feedback from local iwi. Recommendations from that feedback was summarised in the DOSP SMP as:

- limiting development around awa to maintain access, preserve amenity, retain views and protect water quality;
- promoting resilient and water sensitive communities through water sensitive design that encourages water conservation;
- ensuring activity allows for the recharge of aquifers with uncontaminated water (such as the use of pervious paving);
- preserving sensitive and high value areas (such as floodplains, areas of indigenous vegetation and wetlands); and
- ensuring cumulative impacts and effects have been considered and measured at all steps.

5.0 STAKEHOLDER ENGAGEMENT AND CONSULTATION

As this PPC essentially drains to the same receiving environment as the Drury 1 Precinct, and this PPC is a progression of the existing Auranga development, no other engagement and consultation has been undertaken (other than iwi).

6.0 PROPOSED DEVELOPMENT

6.1 Proposed land use changes

The PPC is based on the Precinct Plan shown in Figure 12 below includes the following:

- Rezoning approximately 33.65 ha of land as Town Centre (TC), Terrace Housing and Apartment Building (THAB) and Mixed Housing Urban (MHU);
- A precinct plan illustrating:
  - the distribution of zones and higher order road networks;
  - the lake feature for protection
  - future esplanade reserve (however, this is subject to council accepting vesting etc at subdivision stage)
  - key retail and general retail frontages along key town centre roads
- Utilising the ATCOP hierarchy of road cross sections;
- Utilising the AUP underlying subdivision rules providing for vacant fee simple lots;
- Utilising the AUP underlying subdivision rules to provide a subdivision pattern; and
- Utilising the AUP underlying TC, THAB, and MHU zone rules with regard to building coverage and impervious surfaces on residential sites.

The extent of any public open space will be determined through Council's preferences in respect to acquisition.

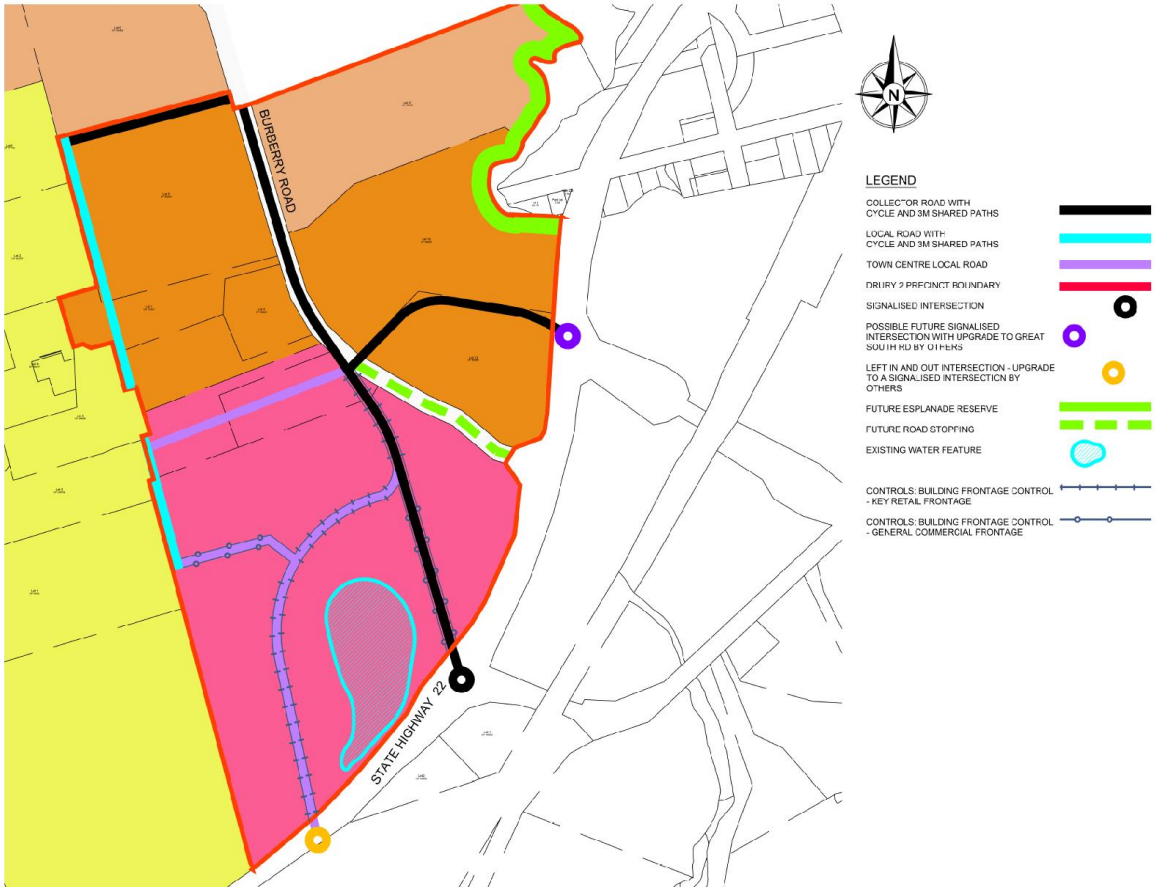

Figure 12 – Proposed Precinct Plan

6.2 Infrastructure upgrades

Specific transport improvements are required to support the Auranga B2 development. In summary, an upgrade of SH22 is required, to four lanes. It is also proposed to realign Burberry Road to exit to SH22, via signalised intersection, in the location opposite McPherson Road. All works will require upgrade in accordance with ATCOP. These roading typologies provide for stormwater devices such as raingardens (which will provide water quality and hydrological mitigation), and will also be subject to the E9 Stormwater Quality provisions, where identified as high use roads.

The floodplains will be managed in accordance with the AUP provisions, with all residential dwellings outside of these locations. It may be necessary to shape the floodplain within the green corridors (reserves).

As recommended by the ecology reporting the permanent and any intermittent streams margins will be enhanced with riparian planting (required by the proposed Drury 1 Precinct rules), undertaken progressively with each subdivision application.

7.0 FLOOD AND COASTAL RISK MANAGEMENT

7.1 Flood hazard assessment

Flood hazard assessment and modelling for the wider catchment was undertaken as part of the Auranga B1 PPC and included land subject to this PPC and SMP.

The assessment was carried out using a 2D model with 2013 LiDAR coupled with a 1D component to represent Hingaia Road Bridge. The flood modelling included major inflows from Slippery Creek, Hingaia Creek, and Ngakaroa Stream.

The method and assumptions used for the flood hazard assessment are detailed in the Tonkin + Taylor Auranga Flood Hazard Model Development memo May 2017, which was reviewed and considered acceptable by Council as part of the Auranga B1 PPC process. There is no need to update this further.

The flood hazard assessment was undertaken for the Scenario 5 that included MPD, climate change, 1% AEP rain event with mean high-water springs (MHWS) and 1 m sea level rise (3.1 mRL).

7.2 Modelled Flood risk

The flood hazard for the Auranga B2 was modelling by Tonkin and Taylor as part of the work for Auranga B1, and included the B2 area. These model results are shown in Figure 13 and Figure 14. The findings of the modelling show that the water level range for the 100-year ARI rainfall with MHWS and climate change was 5.5mRL at the edge of the Ngakaora stream/eastern edge of the PPC area and between 10-20 mRL at some inland locations in the vicinity of streams and flowpaths. Water levels along the SH22 edge drainage system were in the vicinity of 7.5-8.0 mRL.

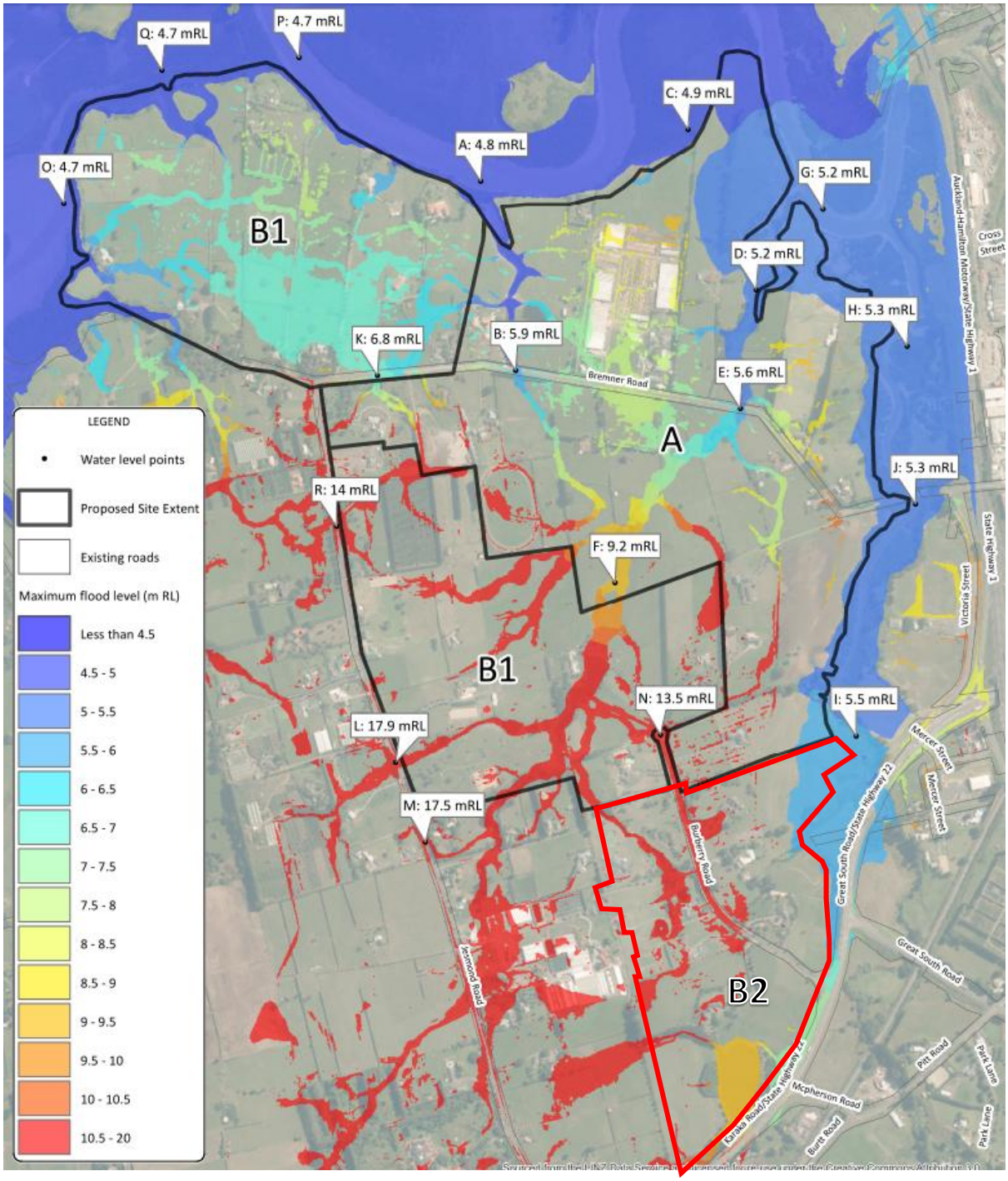

Figure 13: Auranga B2 – Flood hazard map - MPD, climate change, 1% AEP rain event with mean high-water springs (MHWS) and 1 m sea level rise (5.5 mRL)

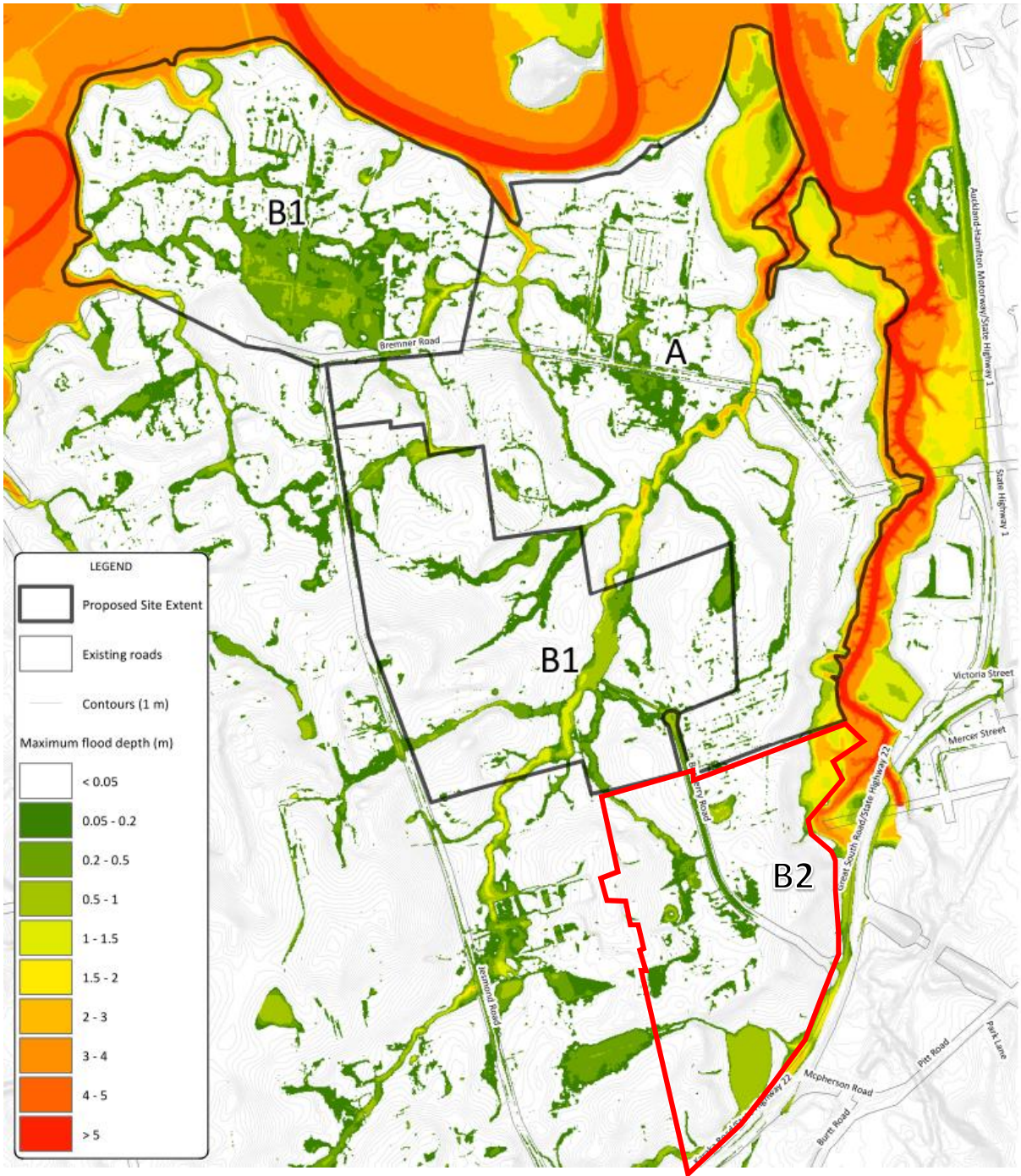

Figure 14 Auranga B2 – Flood hazard map for - MPD, climate change, 1% AEP rain event with 10% AEP extreme sea level and 1 m sea level rise

7.3 Coastal hazards

The coastal inundation hazards are based on the 100-year ARI extreme tide level and an appropriate allowance for sea level rise.

As part of the 2016 T&T work for Auranga B1 (but which also included the B2 site), extreme tide levels were obtained by T&T from NIWA (2013) where the closest modelled site (point 66) has a

100-year ARI tide of 3.5 m RL (AVD-46). Sea level rise was added to the extreme tide for the inundation level, this was taken as 1.0 m to 2115, giving a total inundation level of 4.5 mRL.

7.4 Flooding and coastal hazard management

The proposed development of the Auranga B2 PPC area does not change the flood hazard to buildings/dwellings in the area or downstream of it. Therefore, the focus of flood management is to protect new development from the future flood hazard.

The flood and coastal hazard management proposed to protect new development from future flood and coastal hazards is as described in Table 3 and is the same strategy as approved for Auranga B1.

As the flood levels predicted by the flood assessment are higher than those for the coastal inundation hazard of 4.5 mRL, the higher flood level should be used in preference to the coastal inundation hazard level for coastal areas in avoiding hazards.

Table 3: Flood and coastal management for Auranga B1

Proposed flood and coastal management		
Approach	**Management**	**Existing AUP Provisions**
Avoid the floodplain (including coastal inundation)	• Define the floodplain as Scenario 5 for the MPD, climate change, 1% AEP rainfall event and MHWS with 1 m sea level rise. • Exclude vulnerable development from the floodplain (car parking etc may be acceptable in the floodplain depends on depths and velocities etc – this can be managed at resource consent stage). • The floodplains will be managed within the stream corridors and its associated riparian margins. While it may be necessary to shape the floodplain within the green corridors, but the main channel of the streams will not be modified. • Apply freeboard of 500 mm to above the flood levels in Scenario 5 for building floor levels, which will accommodate hydrological and hydraulic uncertainties.	Existing E36 and E38 Rules applicable
Flood resilience infrastructure	• Design road crossings to be flood free for Scenario 5. • Update the floodplain for any hydraulic changes resulting from infrastructure at the subdivision design stage.	Existing E36 and E38 Rules applicable
Maintaining the proposed subcatchments as close as possible to the existing subcatchments	• Maintain the catchment divides for Stream A and the Ngakaroa Stream and its tributaries, so that more flow does not enter these and increase the floodplains and flood hazard.	
Maintain overland flow paths capacity	• Maintain or redirect overland flow paths, but provide capacity in these for MPD, climate change, 1% AEP flows.	Existing E12, E36 and E38 Rules applicable

Avoid the Coastal Erosion Hazard Zone (CEHZ)	• Define the CEHZ. • Exclude development from the CEHZ.	Existing E36 and E38 Rules applicable

8.0 STORMWATER MANAGEMENT APPROACH

8.1 Summary of stormwater management

The National Policy Statement for Freshwater Management, the New Zealand Coastal Policy Statement and the AUP seek to improve the integrated management of freshwater and the use and development of land. Policy E1.3.8(a) of the AUP requires that greenfield development be carried out using an integrated stormwater management approach. This can be achieved using Water Sensitive Design (WSD) which is defined in GD04 as:

"**An approach to freshwater management, it is applied to land use planning and development at complementary scales including region, catchment, development and site. Water sensitive design seeks to protect and enhance natural freshwater systems, sustainably manage water resources, and mimic natural processes to achieve enhanced outcomes for ecosystems and our communities."**

Integrated approaches such as WSD are important to minimise the adverse effects of growth and development on freshwater systems and coastal waters. In addition, WSD provides more resilience (to flooding, for example) than traditional approaches. It is also Auckland Council's preferred stormwater management approach.

It is important to recognise that this SMP is the third SMP prepared for the Auranga development area and as such incorporating WSD at all levels of planning and development is well known to the team and is in keeping with principles set for previous stages. This includes:

- Interdisciplinary planning and design during all stages of progression of development plans and PPC documentation;
- Identification of natural ecosystems for protection and enhancement;
- At source stormwater management options; and
- Stormwater systems mimicking natural systems and processes.

The detailed design of stormwater management should be based on the proposed stormwater management set out in Table 5Table 3. Unlike previous stages of Auranga this PPC area does not drain directly to the Coastal environment, and instead drains to either Stream A, or the Ngakaora Stream via Stream H.

As such these stormwater management approaches apply across the PPC area for stream receiving environments and are intended to meet the hydrological mitigation requirements set by the direction of the AUP. To meet the primary recommendation of this SMP, the PPC seeks to have the SMAF 1 Overlay applied to the entire Auranga B2 area. This sets up as a starting point the 'base requirement' for stormwater management.

Table 3Table 5 below outlines the approach for stormwater management (based on the Chapter E10 SMAF requirements).

The detailed design (at resource consent stage) will also need to consider local issues and constraints such as physical constraints, ground conditions and local receiving environments.

8.2 Water Quality & Quantity

The general approach for water quality is to adhere to the underlying AUP provisions in E9 which seeks to minimise the generation of contaminants as much as possible at source.

This requires that all high use roads and high use car parking areas (both as defined in the AUP) which occur in the PPC area will be appropriately treated using a range of bio-retention device options including swales, raingardens and tree pits.

Given our recent experiences with Auckland Council on other projects, it is not considered necessary to determine which devices will be used for the roads and car parks separately (as these are subject to change dependent on AT/Healthy Waters requirements for each stage), and it is more appropriate to enable flexibility of choice to suit circumstances and specific design at development stages. All options have the added positive of being able to contribute to the hydrological mitigation requirements (thus performing water quality and quantity functions).

It is acknowledged that previous stages of Auranga also had a requirement for a level of treatment for local roads in coastal catchments. As this catchment only discharges to stream environments this has not been replicated, however it is acknowledged that the hydrological mitigation required for all impervious surfaces (including low use roads) will perform some water quality function.

Development areas with stormwater discharges to streams (from the runoff from impervious areas) require water quantity measures (hydrological mitigation) to adhere to the SMAF 1 requirements of the AUP for retention and dentition. A toolbox range of options is proposed only by this SMP (which is based on the DOSP SMP toolbox, replicated in Appendix B). The specific use of each device and its appropriateness for the development can be managed at individual land use and/or subdivision application stages as solutions are more appropriately tailor made for each development. Further, the application of a SMAF 1 Overlay and its associated E10 provisions ensures that resource consents are required for any impermeable surface exceeding 25m2. Therefore, Council will have ample opportunity to assess the appropriateness of the toolbox options utilised for each development as well as its design.

Roads

For all roads hydrological mitigation of runoff will be achieved through a combination of features. These features include vegetated swales, raingardens and tree pits.

Vegetated swales and rain gardens provide not only provide for retention/detention as previously identified they can also provide for water quality treatment close to the source.

Residential Allotments – THAB zone

For all residential lots (and including for any shared access to service lots), hydrological mitigation of runoff will be achieved through a combination of features. While individual lot rainwater tanks are preferred (as they can promote the recycling and re-use of rainwater), there are space constrains associated with these features and they may not always be able to provide for the types of dwellings/residential allotments anticipated in a Terraced Housing and Apartment Zone.

For this reason, communal devices (underground tanks) and raingardens may be appropriate. Other features such a permeable paving also from part of the options available to achieve hydrological mitigation.

Town Centre Zone (including car parking areas)

In the Town Centre zone, a range of options is proposed to achieve hydrological mitigation. These include, rainwater tanks, communal detention devices (e.g. raingardens) and/or permeable pavements.

Rainwater tanks will only be utilised where there is sufficient demand for water reuse and where they can be accommodated onsite (due to space constraints).

Table 5 provides a summary of Toolbox options for lots.

Green Spaces

Naturalised outfalls into streams are preferred over harder traditional structures, to provide erosion protection at the discharge location and opportunity for treatment through vegetation (including temperature control).

Where impermeable surfaces occur for public use tracks, playgrounds, open space activities etc the hydrological mitigation requirements will apply. This recognises that not all activities will be able to utilise permeable pavements.

The Town Centre Lake has not been identified as being required for additional detention or treatment functions, however at specific design stages the ability for the lake to contribute to the town centre detention requirements could be addressed and considered.

Table 4 Areas with stormwater discharges to streams – Options analysis and proposed stormwater management

Activity	Proposed stormwater management	Design requirements	Reason, treatment, maintenance, costs, aesthetics
High use roads and high contaminant car park	Raingardens Swales Tree Pits Other bio-retention devices	Quality treatment and hydrological mitigation	Raingardens addresses both stormwater quality and hydrological mitigation. They add aesthetic value to the environment and provide treatment close to source.
Other roads	Raingardens Swales	Hydrological mitigation	Raingardens address hydrological issues and dual purpose of water quality treatment where required. They add aesthetic value to the environment and provide treatment close to source.
Residential lots	Combination of: ○ Rain tanks for roof water ○ Permeable paving for driveways and accessways ○ Communal retention/ detention devices (including raingardens, underground tanks)	Hydrological mitigation	BPO based on site specific constraints especially space constraints Rain tanks for roof water due to possible re-use for potable water Permeable paving for driveways. Raingardens, applicable but subject to space/geotechnical constraints within the lots (site specific consideration). Communal retention/ detention device located in rear service lanes (in applicable lots) due to space constrains within lots where hydrological mitigation not achieved by other devices.
Town Centre Zone	Combination of: ○ Rain tanks for roof water (if possible) ○ Permeable paving for driveways and laneways ○ Communal retention/ detention device (including rain gardens, underground tanks)	Hydrological mitigation	BPO based on site specific constraints especially space constraints Rain tanks for roof water due to possible re-use for potable water but could be an issue due to space constraints and demand Permeable paving. Communal retention/ detention devices (raingardens etc)
Stormwater outfalls to streams	Naturalised outfalls preferred, with harder, traditional structures where there are high ground levels relative to the discharge invert level.	Minimise stream erosion	Naturalised outfalls provide erosion protection at the discharge location and opportunity for treatment through vegetation (including temperature control).
Open Spaces	Combination of:	Hydrological mitigation	Where impermeable surfaces occur for public use tracks, playgrounds, open space activities etc the hydrological mitigation

	○ permeable paving ○ Communal retention/ detention device (swales, raingardens etc).		requirements will apply. This recognises that not all activities will be able to utilise permeable pavements.

8.3 Flooding and coastal hazard management

The flood and coastal hazard management proposed to protect new development from future flood and coastal hazards is as described in Table 5.

Table 5: Flood and coastal management for Auranga B2

Proposed flood and coastal management	
Approach	**Management**
Avoid the floodplain (including coastal inundation)	• Define the floodplain as Scenario 5 for the MPD, climate change, 1% AEP rainfall event and MHWS with 1 m sea level rise. • Exclude development (housing, some exceptions necessary for infrastructure) from the floodplain. • The floodplains will be managed within the stream corridors, with the residential areas outside of the floodplains. It may be necessary to shape the floodplain within the corridors, but the main channel of the streams will not be modified. • Apply freeboard of 500 mm to above the flood levels in Scenario 5 for building floor levels, which will accommodate hydrological and hydraulic uncertainties. This will also account for the more extreme event represent by Scenario 6 for the MPD, climate change, 1% AEP flood and the 10% AEP extreme sea level with 1 m sea level rise.
Flood resilience infrastructure	• Design road crossings to be flood free for Scenario 5. • Update the floodplain for any hydraulic changes resulting from infrastructure at the subdivision design stage.
Maintaining the proposed subcatchments as close as possible to the existing subcatchments	• Maintain the catchment divides for Stream A, and Ngakaroa Stream tributaries, so that more flow does not enter these and increase the floodplains and flood hazard.
Maintain overland flow paths capacity	• Maintain or redirect overland flow paths, but provide capacity in these for MPD, climate change, 1% AEP flows.
Avoid the Coastal Erosion Hazard Zone (CEHZ)	• Define the CEHZ • Exclude development from the CEHZ.

8.4 Stormwater Conveyance

Primary flows generated by a 10-year ARI storm event will be conveyed by a piped stormwater network to the downstream receiving environment. For events greater than a 10-year ARI rainfall event, the excess flow or secondary flows will be conveyed by using roads as overland flow routes.

The downstream receiving environment will also be protected from erosion through the use of naturalised outfalls and vegetated channels to dissipate energy prior to discharge to the receiving environment.

8.5 Subcatchments

Sub catchments will be maintained as close to the existing sub-catchments as possible, refer Table 5. A subcatchment plan is shown below in Figure 15 – Indicative Auranga B2 Subcatchments.

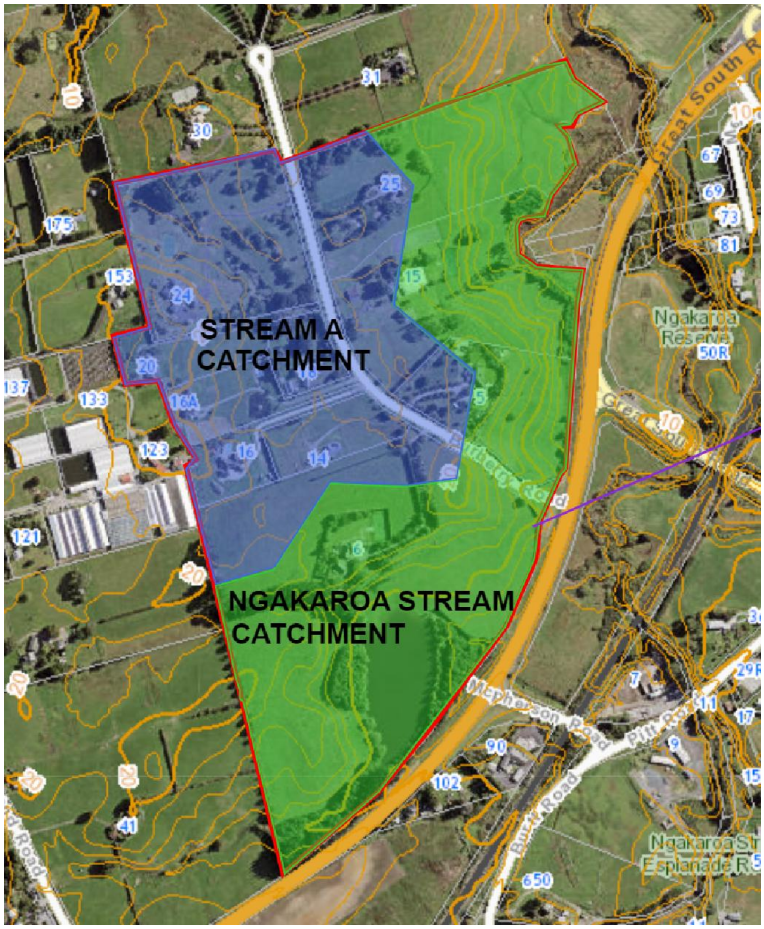

Figure 15 – Indicative Auranga B2 Subcatchments

8.6 Stormwater infrastructure

Stormwater infrastructure is proposed to be located in the road corridor to provide easy access for maintenance. Outfall pipes are generally proposed to be 600mm or less in diameter where practical. Naturalised outfalls are to be implemented on a site by site basis as it may not be appropriate for all sites (due to site topography and erosion potential). The subdivision applications will demonstrate the details of the approach to stormwater infrastructure that will subsequently applied across the PPC area.

8.7 Overland flowpaths

All roads are recommended to be a minimum of 200mm lower than all lot Finished Ground Level. Based on assumed 300mm thick floor slab for buildings, this will meet 500mm freeboard requirement. Therefore, overland flowpaths are proposed to follow the roads. All flow paths are proposed to be located within public areas (roads/parks) and not private properties or where occurring in private properties secured in perpetuity via consent notices at subdivision stage.

8.8 Integrated stormwater management

The AUP establishes some overarching policies, including the requirement for an integrated stormwater management approach. The PPC and SMP incorporates aspects that provide an integrated stormwater management approach, which includes:

- Corridors along streams that provide a buffer to the streams to protect and retain stream habitats, manage stormwater (naturalised/green outfalls) and flooding;
- Enhance the stream habitats (including Terrestrial SEA) with riparian planting;
- Setback from streams to provide flood and erosion protection;
- Stormwater management as detailed above to mitigate the effects of stormwater on the environment, in particular the treatment roads and carparks and the hydrological mitigation for impervious areas discharging to streams

8.9 Approach

The PPC seeks to establish the Auranga B2 site as located within the Stormwater Management Area Control – Ngakaroa Stream, Flow 1 (SMAF). This is considered the most efficient way to manage ongoing stormwater mitigation and water sensitive design requirements. Although previous stage of Auranga including specific provisions for stormwater this was in part due to the ongoing nature of the AUP decision making process. As the AUP is operative in part, its objectives and methods have been tested via planning section 32 assessments and determined to be appropriate outcomes. Therefore, it is considered reasonable to utilise where possible existing methods to achieve outcomes.

8.10 Asset ownership and maintenance requirements

Given our recent experiences with Auckland Council on other projects, it is not considered necessary to determine which devices will be used for the roads and car parks separately (as these are subject to change dependent on AT/Healthy Waters requirements for each stage), and it is more appropriate to enable flexibility of chose to suit circumstances and specific design at development stages.

A toolbox range of options for stormwater management devices is proposed only by this SMP. The specific use of each device and its approrpiateness for the development can be managed at individual land use and/or subdivision application stages as solutions are more appropriately tailor made for each development.

Further, the application of a SMAF 1 Overlay and its associated E10 provisions ensures that resource consents are required for any impermeable surface exceeding 25m2. Therefore, Council will have ample opportunity to assess the appropriateness of the toolbox options utilised for each development as well as its design, and any proposals for assets (devices, riparian margins/streams etc) to be vested or private and the associated ongoing maintenance obligations.

8.11 Stormwater requirements summary

The requirements for stormwater management that will be adopted for the PPC and subsequent development are based primarily on the AUP SMAF 1 stormwater and the operative flooding provisions. These are summarised below.

Details of the following aspects of the stormwater system will be addressed as part of subdivision design and land use consenting:

- Overland flowpath layout;
- Location and specific use and design of proposed stormwater management device(s), including outfall location; and
- Primary stormwater conveyance network for 10% AEP flows.

Table 0.6: Auranga B2 – Recommended requirements for stormwater management

Activity	Proposed Management	Design Requirements/Standards	Reference	Justification
New residential buildings or habitable areas	Avoid new residential buildings or habitable areas in the floodplain	New residential buildings are required to be outside the 1% AEP floodplain (including the effects of climate change over a 100-year timeframe and a 1 m sea level rise).	AUP Chapter E36.4 Activity Table E36.4.1 Activities in the 1% annual exceedance probability (AEP) floodplain and overland flow paths, permitted activity A24 surface parking areas to comply with E36.6.1.7. Activities A34 to A38 relate to new structures or buildings in the floodplain and A42 to new structures or building in an overland flow path. The 'requirements' are recommended to avoid restricted discretionary (RD) status and associated requirements.	As the AUP is operative in part (and the E36 provisions are not subject to any further appeals), its objectives and methods have been tested via planning section 32 assessments and determined to be appropriate outcomes. Therefore, it is considered reasonable to utilise where possible existing methods to achieve outcomes.
New residential buildings or habitable areas	Avoid new residential buildings or habitable areas in the identified coastal inundation area	Habitable areas of buildings must be above the coastal storm inundation levels from the 1% AEP extreme sea level plus 1 m sea level rise.	AUP Chapter E36.4 Activity Table E36.4.1 permitted activities A12, A13, habitable areas to comply with E36.6.1.1.	As the AUP is operative in part (and the E36 provisions are not subject to any further appeals), its objectives and methods have been tested via planning section 32 assessments and determined to be appropriate outcomes. Therefore, it is considered reasonable to utilise where possible existing methods to achieve outcomes.
High use roads (>5,000 vehicles per day (vpd))	Combination of: • Vegetated swales; • Tree pits; • Raingardens.	Stormwater runoff from high use road are to be treated by an approved stormwater quality device.	AUP Chapter E9 – Stormwater quality – High contaminant generating car parks and high use roads. Standards E9.6.1.4	As the AUP is operative in part (and the E9 & E10 provisions are not subject to any further appeals), its objectives and methods have been tested via planning section 32 assessments and determined to be

		Approved stormwater quality devices sized and designed in accordance with GD01. Hydrological mitigation in accordance	(permitted activities) and E9.6.2.2. (controlled activities). SMAF 1 in Table E10.6.3.1.1	appropriate outcomes. Therefore, it is considered reasonable to utilise where possible existing methods to achieve outcomes. Vegetated swales provide conveyance, natural aesthetics and provide treatment close to the source. Raingardens and tree pits provide at source treatment and hydrological mitigation.
High contaminant car park such as for shopping areas (>30 vehicles, refer to full definition in reference material)	Combination of: • Vegetated swales; • Tree pits; • Raingardens • Detention tanks (underground)	Stormwater runoff from high use road are to be treated by an approved stormwater quality device. Approved stormwater quality devices sized and designed in accordance with GD01. Hydrological mitigation in accordance	AUP Chapter E.9 – Stormwater quality – High contaminant generating car parks and high use roads. Standards E9.6.1.3 (permitted activities) and E9.6.2.1 (controlled activities). Hydrological mitigation in accordance with SMAF 1 in Table E10.6.3.1.1	As the AUP is operative in part (and the E9 & E10 provisions are not subject to any further appeals), its objectives and methods have been tested via planning section 32 assessments and determined to be appropriate outcomes. Therefore, it is considered reasonable to utilise where possible existing methods to achieve outcomes. Vegetated swales provide conveyance, natural aesthetics and provide treatment close to the source. Raingardens and tree pits provide at source treatment and hydrological mitigation. Detention tanks will not provide for hydrological mitigation requirements – detention only

Other roads and carparks areas that are not high contaminant generating activities e.g. **Minor roads** **Residential, commercial**	Combination of: • Vegetated swales; • Tree pits; • Raingardens • Pervious pavements (car parks only) Combination of quantity mechanism will inherently provide some level of treatment.	Hydrological Mitigation	Hydrological mitigation in accordance with SMAF 1 in Table E10.6.3.1.1	As the AUP is operative in part (and the E9 & E10 provisions are not subject to any further appeals), its objectives and methods have been tested via planning section 32 assessments and determined to be appropriate outcomes. Therefore, it is considered reasonable to utilise where possible existing methods to achieve outcomes. The combination of quantity mechanisms will inherently provide some level of treatment.
Residential Lots /THAB Zone	Combination of: • Rainwater tanks for roof runoff; • Permeable pavements for accessways and driveways; and/or • Communal devices (rain gardens, detention tanks etc)	• Hydrological Mitigation	Hydrological mitigation in accordance with SMAF 1 in Table E10.6.3.1.1	As the AUP is operative in part (and the E10 provisions are not subject to any further appeals), its objectives and methods have been tested via planning section 32 assessments and determined to be appropriate outcomes. Therefore, it is considered reasonable to utilise where possible existing methods to achieve outcomes. Rain tanks for roof can also provide for re-use for potable water, however are subject to space restrictions and may not be feasible for apartment style buildings., Permeable paving for driveways and accessways. Raingardens, applicable but subject to space/geotechnical constraints within the lots (site specific consideration).

				Communal retention/ detention device located in rear service lanes (in applicable lots) due to space constrains within lots where hydrological mitigation not achieved by other devices.
Town Centre Zone activities	Combination of: • Rainwater tanks for roof runoff (subject to demand/space); • Permeable pavements • Communal devices (rain gardens, detention tanks etc	Hydrological Mitigation	Hydrological mitigation in accordance with SMAF 1 in Table E10.6.3.1.1	As the AUP is operative in part (and the E10 provisions are not subject to any further appeals), its objectives and methods have been tested via planning section 32 assessments and determined to be appropriate outcomes. Therefore, it is considered reasonable to utilise where possible existing methods to achieve outcomes. Rain tanks for roof can also provide for re-use for potable water, however are subject to space restrictions and may not be feasible for town centre activities. Permeable paving for public areas (footpaths/plazas etc). Communal retention/ detention devices more likely (raingardens, tree pits etc).
Open spaces and riparian margins	• Naturalised outfalls to stream • Riparian buffer planting • Communal devices • Permeable paving for tracks;	Hydrological Mitigation (for impervious surfaces) Protect streams and ecological functions/values Protect Terrestrial SEA	Hydrological mitigation in accordance with SMAF 1 in Table E10.6.3.1.1	Naturalised outfalls provide erosion protection at the discharge location, and provide ecological value through vegetation. Where impermeable surfaces occur for public use tracks, playgrounds, open space activities etc the hydrological mitigation requirements will apply. This recognises that not all

	• Swales, filter strips etc			activities will be able to utilise permeable pavements.

9.0 DEPARTURES FROM REGULARTORY OR DESIGN CODES

There are no departures proposed as part of this SMP.

10.0 CONCLUSION & RECOMMENDATIONS

This Stormwater Management Plan (SMP) has been prepared to support an application for the Private Plan Change (PPC) made by Karaka and Drury Ltd. The SMP will support the PPC and future discharge and network discharge consents (NDC), through demonstrating the proposed stormwater management is the best practicable option, taking into consideration the existing site features The stormwater management meets the requirements, objectives and outcomes of the NDC, together with the Code of Practice, GD01 and GD04.

The requirements for stormwater management are based primarily on the Auckland Unitary Plan (AUP) SMAF 1 provisions.

The SMP is supported by a flood hazard assessment, which was carried out using a 2D model with 2013 LiDAR coupled with a 1D component to represent Hingaia Road Bridge. The outcomes are flood hazard maps and proposed approaches for flood and coastal management for Auranga B2 (which align with previous approaches utilised for Auranga A and B1).

The development follows a water sensitive design approach (as required in the AUP). The proposed stormwater management plan is summarised in Section 8.0. However, the preferred approaches match those of the SMAF 1 provisions.

APPENDIX A – REPORT FIGURES

APPENDIX B – TOOLBOX FOR WSD

Replicated from Table 13 of the P:

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Table 13: Water Sensitive Design Toolbox

Key Principles

Working with the existing landform - minimising cutting and filling that effects infiltration and changes the natural flowpaths, as far as practicable.
Minimise impervious surfaces and land disturbance thereby retaining the natural infiltration capacity of the soil
Apply exemplar erosion and sediment control measures (including small site development) to minimise the impact on the downstream receiving environment
Disconnection of impervious surfaces from the receiving environment to encourage infiltration and attenuation prior to discharge to the stormwater system
Utilise soakage into basaltic soils – directly via pervious surfaces or using soakage devices coupled with stormwater treatment.
Utilise soakage into peat soils
Utilise soakage in high use aquifer managements areas and high use stream management areas.
Avoid soil compaction or undertake cultivation to include organics and restore damage to maximise permeability
Re-vegetation/planting to reduce runoff and erosion and maximise biodiversity
Use inert building materials
Capture and reuse of rainwater for buildings and landscapes – the reuse component diverts stormwater first flush to wastewater (toilet flushing) or to ground for infiltration.

Land Use	Requirements	Options	Auckland Council Guidance Documents (refer Section 4.6 above)
Residential	Hydrological Mitigation – Retention and Detention	Above ground rainwater storage/re-use tanks Rain gardens/planter boxes Underground storage tanks, structural cells Permeable pavement and porous concrete Filter trenches/trench drains Note: Infiltration for retention is preferred.	TR035 GD04 GD01
	Primary Stormwater Conveyance	In order of preference: Soakholes (where practicable, and subject to testing) Retain and enhance permanent and intermittent streams Swales Pipe network	GD04 SW CoP GD01
	Secondary Stormwater Conveyance	In order of preference: Retain and enhance permanent and intermittent streams Swales and open channels Road corridors	GD04 SW CoP

Key Principles

	Flood Risk Attenuation (where required)	'At source' storage, e.g. underground storage Wetlands. 'Dry' basins with multi-purpose functionality	GD04 SW CoP GD01
All roads/ carparking	Hydrological Mitigation - Retention and Detention	Rain gardens Tree pits Filter trenches/trench drains Permeable pavement and porous concrete Note: Infiltration for retention is preferred.	TR035 GD04 GD01
	Stormwater Treatment	Rain gardens Tree pits Filter strips/swales Wetlands	GD01
	Primary Stormwater Conveyance	In order of preference: Soakholes (where practicable, and subject to testing) Retain and enhance permanent and intermittent streams Swales Pipe network	GD04 SW CoP GD01
	Secondary Stormwater Conveyance	In order of preference: Retain and enhance permanent and intermittent streams Swales and open channels Road corridors	GD04 SW CoP
	Flood Risk Attenuation (where required)	'At source' storage, e.g. underground storage Wetlands 'Dry' basins with multi-purpose functionality	GD04 SW CoP GD01
Business	Hydrological Mitigation - Retention and Detention	Above ground rainwater storage tanks Rain gardens/planter boxes Underground storage tanks, structural	TR035 GD04 GD01

		cells Permeable pavement and porous concrete Filter trenches/trench drains Detention basins Note: Infiltration for retention is preferred. Where retention is not achieved then treatment of impervious surfaces is required prior to discharge	
	Stormwater Treatment	Rain gardens Tree pits Filter strips/swales Proprietary treatment devices Wetlands Contaminant specific treatment devices are required for industrial or trade activities	GD01
	Primary Stormwater Conveyance	In order of preference: Soakholes (where practicable, and subject to testing) Retain and enhance permanent and intermittent streams Swales Pipe network	GD04 SW CoP GD01
	Secondary Stormwater Conveyance	In order of preference: Retain and enhance permanent and intermittent streams Swales and open channels Road corridors	GD04 SW CoP
	Flood Risk Attenuation (where required)	'At source' storage, e.g. underground storage Wetlands 'Dry' basins with multi-purpose functionality	GD04 SW CoP GD01
Special Purpose	Hydrological Mitigation - Retention and Detention	To be confirmed	

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APPENDIX C – LANDER PERCOLOATION TEST

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Memorandum

To	**Mark Tollemache**	From	**Shane Lander**
Email	**marktollemache@ihug.co.nz**	Date	**20 April 2017**
Company	**Karaka & Drury Limited**	Reference	**J00557**
cc		Pages	**1 of 1, plus attachments**
Subject	**Auranga B1 – Percolation Test Results**		

Lander Geotechnical have been engaged to undertake 4 percolation boreholes and conduct falling head percolation tests, in accordance with Auckland Council's guidelines. The tests were undertaken within 100mm diameter boreholes drilled in positions indicated on the attached site plan. They were positioned near existing site investigation boreholes from the Auranga B1 Preliminary Geotechnical Appraisal Report (Ref J00557 dated 17 February 2017), and accordingly for ease of reference are numbered the same as those adjacent boreholes.

Pre-soaking was undertaken the day prior to testing. The depth of each borehole drilled was a function of the position of the standing groundwater table at the time of pre-drilling.

Full results and associated plots are appended for your interpretation, use and distribution.

For and on behalf of Lander Geotechnical Consultants Limited

S G Lander

Principal Geotechnical Engineer

Encl.

STORMWATER PERCOLATION TEST

Client:	KARAKA & DRURY LIMITED	Job No:	J00557
Location:	AURANGA B1, DRURY	Date:	11.04.17
		Page	1 of 2
Hole No:	HA2017-02	Diamete	0.1 (m)
Location:	BREMNER ROAD	Depth:	1.96 (m)
Weather conditions preceding test:		Dry	
Details of presoaking:		17 Hrs	

Time of Test (hr.min)	Time Interval (min)	Depth Reading (m)	Water Depth (m)	Cum Time (min)
8:25	-	0.25	1.71	0
8:30	5	0.30	1.66	5
8:35	5	0.35	1.61	10
8:40	5	0.39	1.57	15
8:45	5	0.41	1.55	20
8:50	5	0.42	1.54	25
8:55	5	0.44	1.52	30
9:00	5	0.46	1.50	35
9:15	15	0.49	1.47	50
9:30	15	0.51	1.45	65
9:45	15	0.53	1.43	80
10:00	15	0.54	1.42	95
10:15	15	0.55	1.41	110
10:30	15	0.55	1.41	125
10:45	15	0.55	1.41	140
10:45	0	0.25	1.71	140
11:03	18	0.40	1.56	158
11:15	12	0.45	1.51	170
11:30	15	0.48	1.48	185
11:45	15	0.50	1.46	200
12:00	15	0.52	1.44	215
12:15	15	0.53	1.43	230
12:25	10	0.54	1.42	240

Test	HA2017-02	
Gradient	0.0007	m/min
Percolation	0.01	$L/m^2/min$

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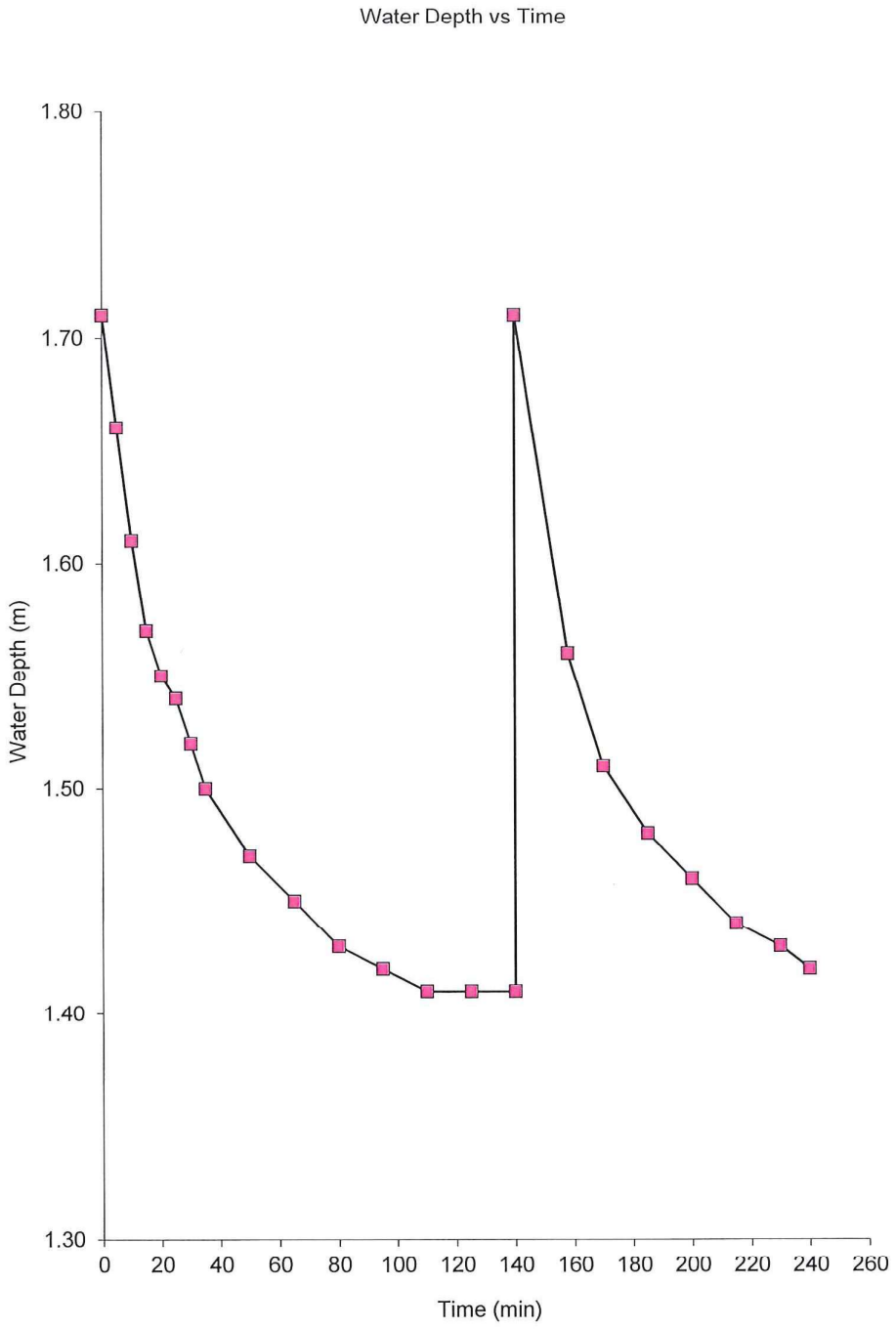
Operator: JL

Checked: JL

STORMWATER PERCOLATION TEST

Client:	KARAKA & DRURY LIMITED	Job No:	J00557
Location:	AURANGA B1, DRURY	Date:	11.04.17
	0	Page	2 of 2
Hole No:	HA2017-02	Diameter:	0.1 (m)
Location:	BREMNER ROAD	Depth:	2.0 (m)



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STORMWATER PERCOLATION TEST

Client:	KARAKA & DRURY LIMITED	Job No:	J00557
Location:	AURANGA B1, DRURY	Date:	11.04.17
		Page	1 of 2
Hole No:	HA2017-05	Diamete 0.1	(m)
Location:	BREMNER ROAD	Depth: 0.97	(m)
Weather conditions preceding test:	Dry		
Details of presoaking:	17 Hrs		

Time of Test (hr.min)	Time Interval (min)	Depth Reading (m)	Water Depth (m)	Cum Time (min)
13:00	-	0.250	0.72	0
13:05	5	0.260	0.71	5
13:10	5	0.270	0.70	10
13:15	5	0.280	0.69	15
13:20	5	0.290	0.68	20
13:25	5	0.295	0.68	25
13:30	5	0.300	0.67	30
13:45	15	0.320	0.65	45
14:00	15	0.335	0.64	60
14:15	15	0.355	0.62	75
14:30	15	0.375	0.60	90
14:45	15	0.395	0.58	105
15:00	15	0.400	0.57	120
15:17	17	0.410	0.56	137
15:30	13	0.420	0.55	150
15:47	17	0.430	0.54	167
16:00	13	0.435	0.54	180
16:15	15	0.445	0.53	195
16:30	15	0.450	0.52	210
16:45	15	0.455	0.52	225
17:00	15	0.460	0.51	240

Test	HA2017-05	
Gradient	0.0003	m/min
Percolation	0.02	$L/m^2/min$

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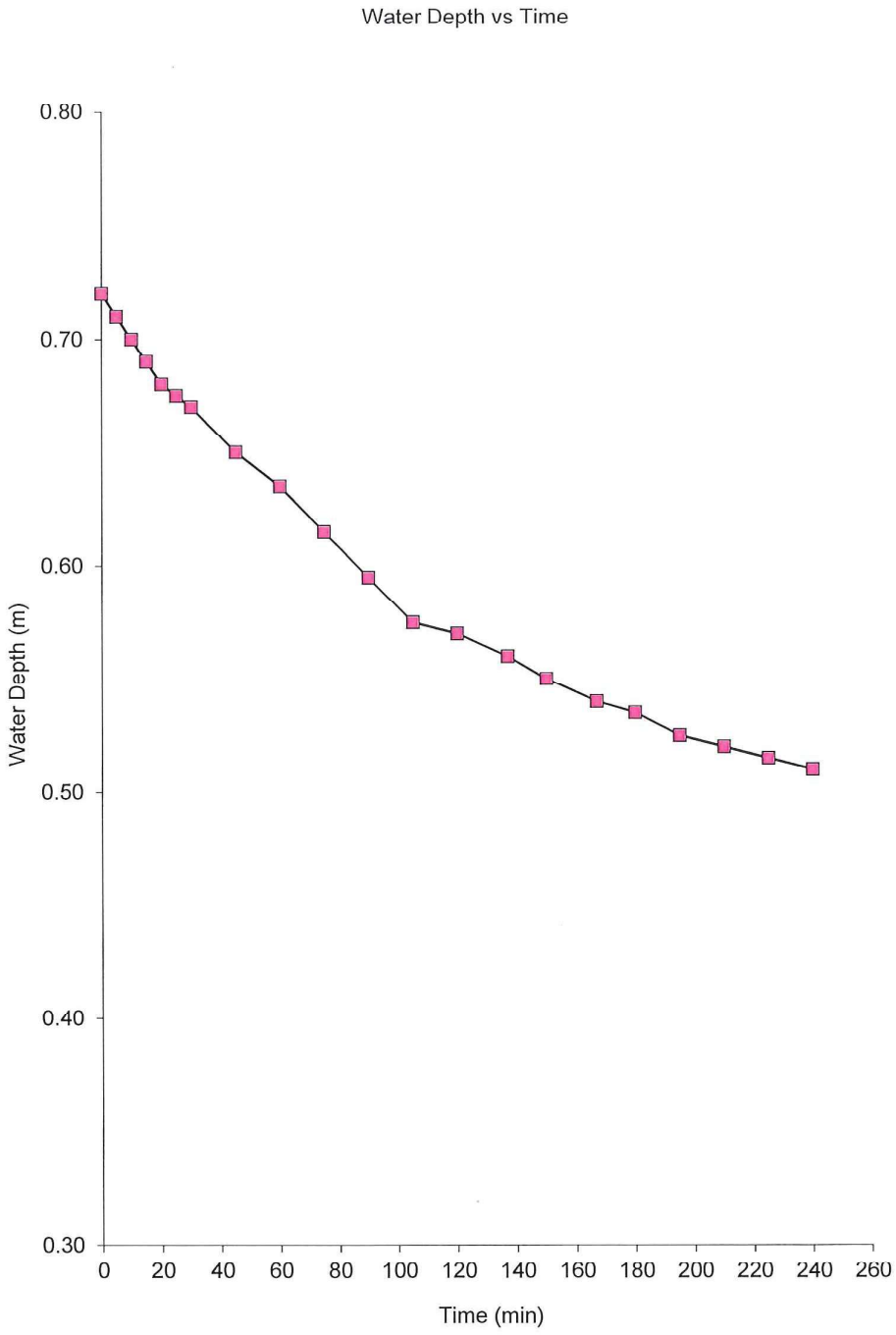
STORMWATER PERCOLATION TEST

Client:	KARAKA & DRURY LIMITED	Job No:	J00557
Location:	AURANGA B1, DRURY	Date:	11.04.17
	0	Page	2 of 2
Hole No:	HA2017-05	Diameter:	0.1 (m)
Location:	BREMNER ROAD	Depth:	1.0 (m)



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STORMWATER PERCOLATION TEST

Client:	KARAKA & DRURY LIMITED	Job No:	J00557
Location:	AURANGA B1, DRURY	Date:	11.04.17
		Page	1 of 2
Hole No:	HA2017-08	Diamete	0.1 (m)
Location:	JESMOND ROAD	Depth:	2.3 (m)
Weather conditions preceding test:		Dry	
Details of presoaking:		17 Hrs	

Time of Test (hr.min)	Time Interval (min)	Depth Reading (m)	Water Depth (m)	Cum Time (min)
8:45	-	0.10	2.20	0
8:46	1	0.15	2.15	1
8:48	2	0.20	2.10	3
8:53	5	0.30	2.00	8
9:00	7	0.40	1.90	15
9:15	15	0.57	1.73	30
9:45	30	0.79	1.51	60
10:15	30	1.00	1.30	90
10:45	30	1.20	1.10	120
11:15	30	1.40	0.90	150
11:45	30	1.50	0.80	180
12:15	30	1.60	0.70	210
12:45	30	1.70	0.60	240

Test	HA2017-08	
Gradient	0.0033	m/min
Percolation	0.13	$L/m^2/min$

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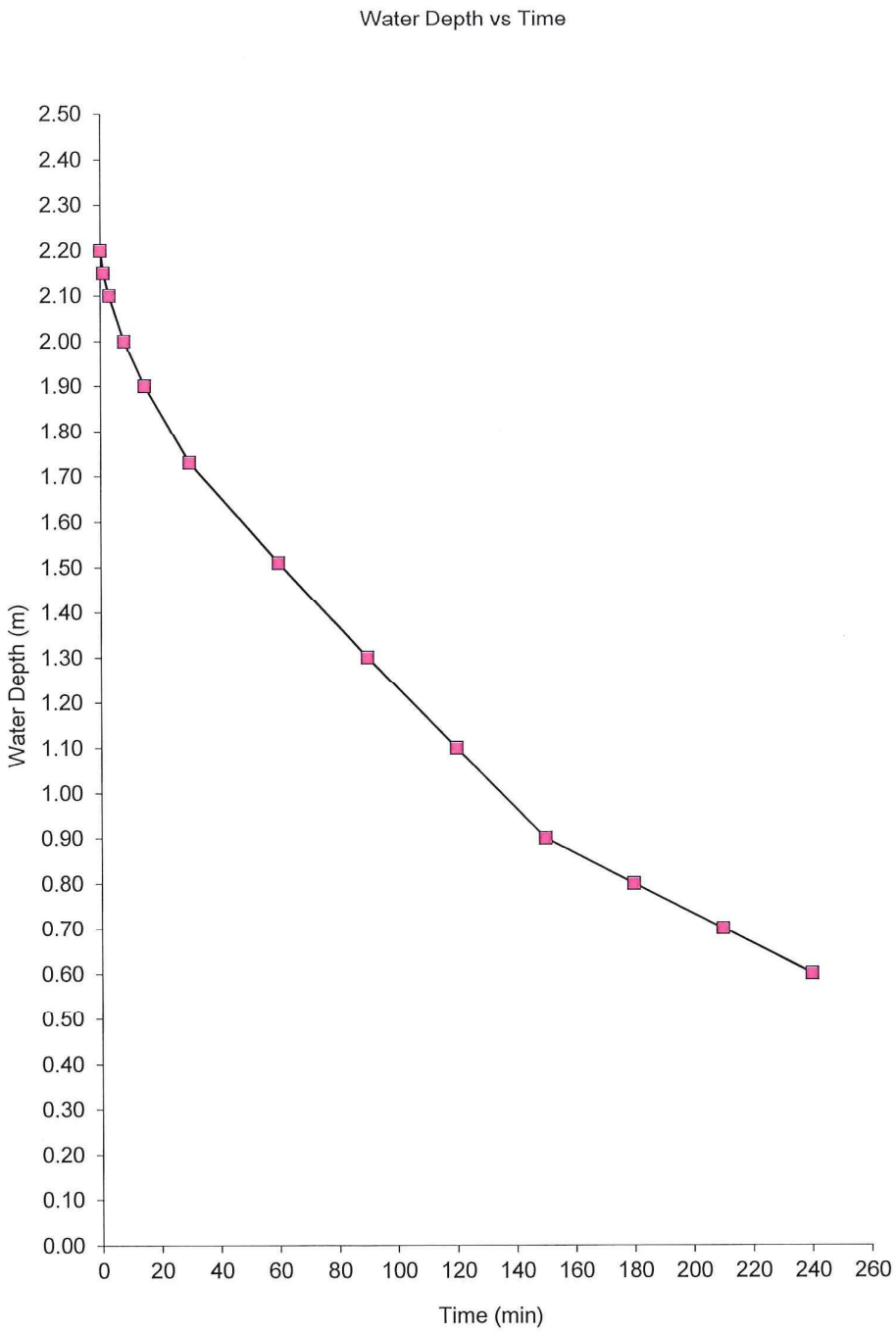
Email: shane@landergeotechnical.co.nz

Operator: AB

Checked: JL

STORMWATER PERCOLATION TEST

Client:	KARAKA & DRURY LIMITED	Job No:	J00557
Location:	AURANGA B1, DRURY	Date:	11.04.17
	0	Page	2 of 2
Hole No:	HA2017-08	Diameter:	0.1 (m)
Location:	JESMOND ROAD	Depth:	2.3 (m)



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STORMWATER PERCOLATION TEST

Client:	KARAKA & DRURY LIMITED	Job No:	J00557
Location:	AURANGA B1, DRURY	Date:	11.04.17
		Page	1 of 2
Hole No:	HA2017-11	Diamete	0.1 (m)
Location:	BURBERRY ROAD	Depth:	2.1 (m)
Weather conditions preceding test:	Dry		
Details of presoaking:	17 Hrs		

Time of Test (hr.min)	Time Interval (min)	Depth Reading (m)	Water Depth (m)	Cum Time (min)
12:58	-	0.10	2.00	0
12:59	1	0.27	1.83	1
13:01	2	0.44	1.66	3
13:06	5	0.70	1.40	8
13:13	7	0.95	1.15	15
13:28	15	1.22	0.88	30
13:58	30	1.50	0.60	60
14:28	30	1.60	0.50	90
14:58	30	1.65	0.45	120
15:28	30	1.70	0.40	150
15:58	30	1.76	0.34	180
15:58	0	0.10	2.00	180
15:59	1	0.27	1.83	181
16:01	2	0.42	1.68	183
16:06	5	0.69	1.41	188
16:13	7	0.95	1.15	195
16:28	15	1.20	0.90	210
16:56	28	1.49	0.61	238

Test	HA2017-11	
Gradient	0.0017	m/min
Percolation	0.09	$L/m^2/min$

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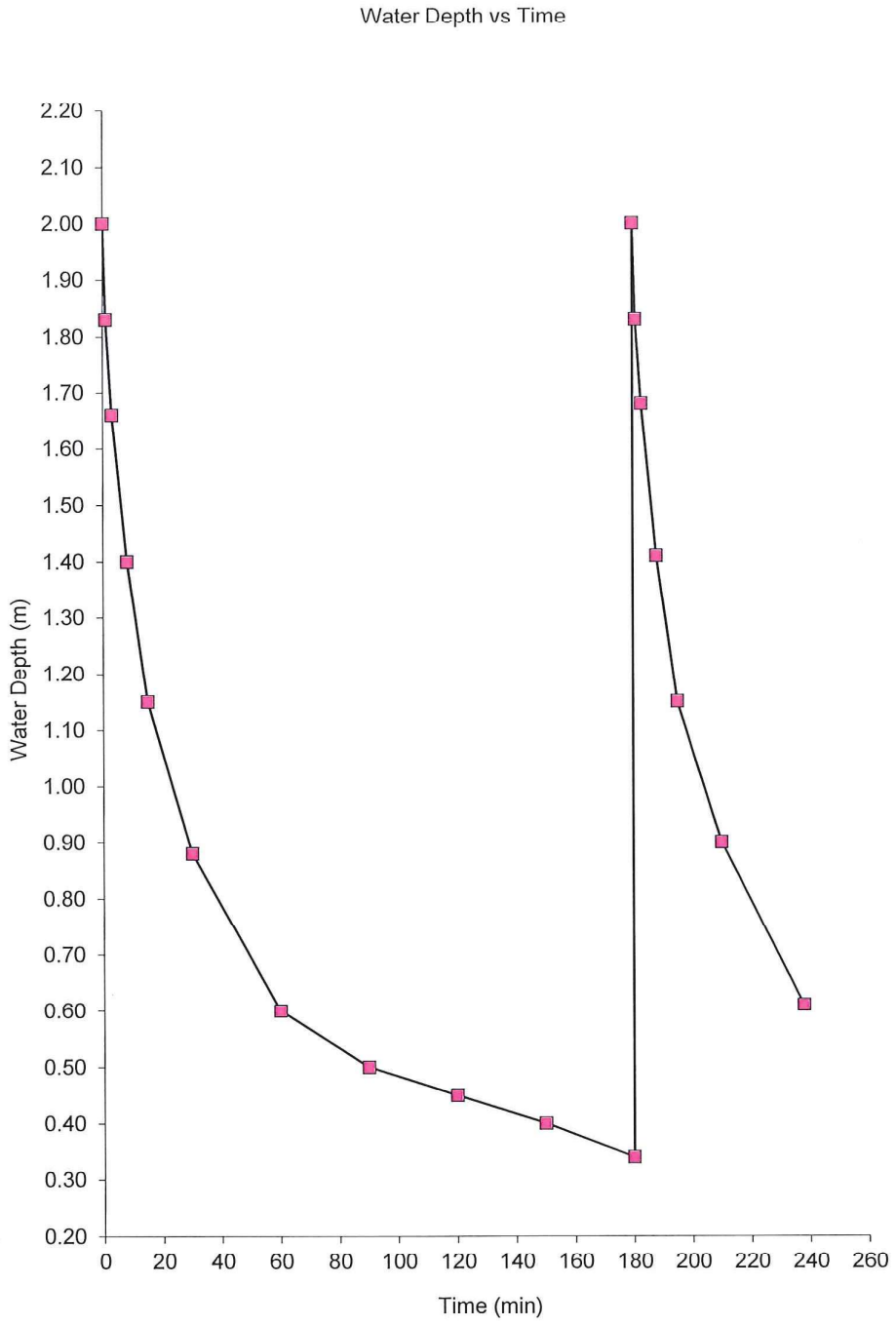
STORMWATER PERCOLATION TEST

Client:	KARAKA & DRURY LIMITED		Job No:	J00557	
Location:	AURANGA B1, DRURY		Date:	11.04.17	
	0		Page	2 of 2	
Hole No:	HA2017-11	Diameter:	0.1	(m)	
Location:	BURBERRY ROAD	Depth:	2.1	(m)	



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