Drury East Stormwater Management Plan

Drury Centre and Drury East Plan Change Areas

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Document control

Title: Drury Centre and Drury East Plan Change Areas					
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List of Acronyms

Acronym	Description
AEP	Annual Exceedance Probability
ARI	Annual Recurrence Interval
AUP	Auckland Unitary Plan: Operative in Part
BPO	Best Practicable Option
CMA	Coastal Marine Area
DEM	Digital Elevation Model
FHLD	Fulton Hogan Land Development
FIR	For Information Request
FUZ	Future Urban Zone
GPT	Gross Pollutant Traps
HCGA	High Contaminant Generating Activity
ITA	Integrated Transport Assessment
MCI	Macroinvertebrate Community Index
MHS	Mixed Housing Suburban
MHU	Mixed Housing Urban
MPD	Maximum Probable Development
NDC	Network Discharge Consent
PAUP	Proposed Auckland Unitary Plan
PCA	Plan Change Area
PPC	Private Plan Change
SEA	Significant Ecological Area
SEV	Stream Ecological Valuation
SMAF	Stormwater Management Area: Flow
SMP	Stormwater Management Plan
SWCOP	The Stormwater Code of Practice
THAB	Terrace Housing and Apartment Building
WP	Waihoehoe Precinct
WQ	Water Quality
WSD	Water Sensitive Design

Executive summary

There have been three separate Plan Change applications made to rezone Future Urban land at Drury East:

- Kiwi Property no. 2 is applying to rezone the Drury Centre Precinct comprising approximately 95 hectares of land from Future Urban Zone (FUZ) to Metropolitan Centre, Mixed-Use and Open space zones.
- Fulton Hogan Land Development (FHLD) is applying to rezone the Drury East Precinct comprising approximately 187 hectares from FUZ to a mixture of Terrace Housing and Apartment Building (THAB), Mixed Housing Urban (MHU), Mixed Housing Suburban (MHS) and Mixed-Use zones.
- Oyster Capital is applying to rezone the proposed Waihoehoe Precinct (WP) from FUZ to THAB Residential zoning.

The Drury Centre and Drury East Plan Change Areas (PCA) are located within the Hingaia Stream catchment, whereas the Waihoehoe PCA is located within the Slippery Creek catchment as shown in Figure 1. The SMP for the Waihoehoe Plan Change is being prepared separately because of the different catchment characteristics, opportunities and issues.

Tonkin & Taylor Ltd (T+T) and Woods have previously prepared three separate SMPs in support of the Drury East Plan Change applications, which were lodged in December 2020. Since then, Healthy Waters have reviewed the application for the Drury East Plan Change applications and have provided feedback and requested further information. Consultants for Oyster, Kiwi Property and FHLD replied to the Further Information Request with 6 memos covering stormwater management, stream erosion, flooding and ecology. This revision of the SMP includes information presented in these memos and integrates the stormwater management approaches for the three Drury East PCAs.

The purpose of this SMP is to provide guidance to the applicants and Auckland Council on how stormwater will be managed within the Drury Centre and Drury East PCAs. It demonstrates that the proposed stormwater management is the best practicable option, taking into consideration the existing site features and the future land use. This guidance is consistent with regulatory and stormwater-specific guidelines and based on conventional stormwater management techniques to meet Auckland Unitary Plan, Operative in Part (AUP), provisions. The Draft Drury-Opāheke Future Urban Zone Stormwater Management Plan (FUZ SMP) has been referred to ensure to the stormwater management approach integrates with existing and future stormwater systems in the Hingaia Stream catchment.

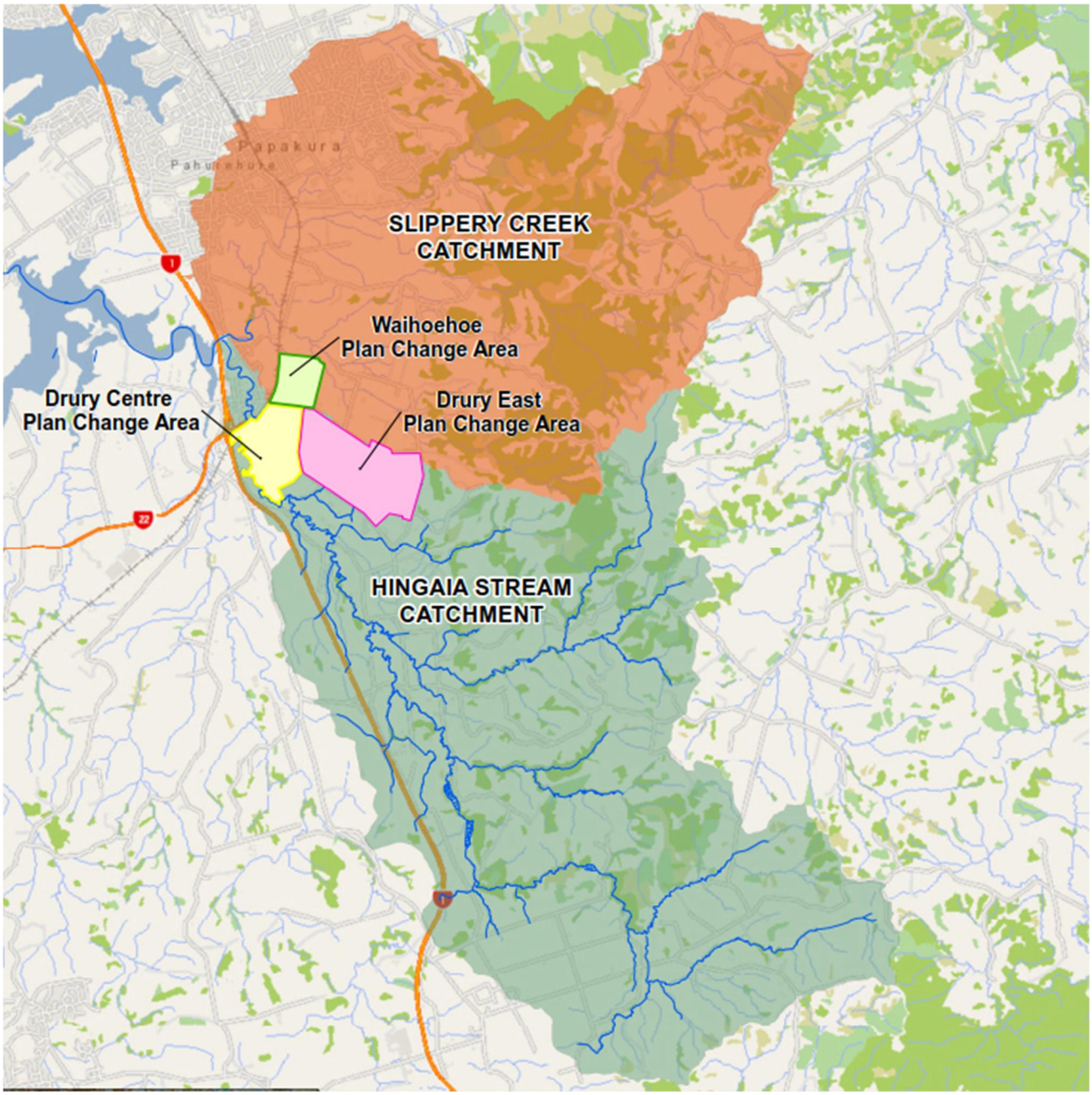

Figure E1: Hingaia and Slippery Creek catchment extents and PCAs

The SMP, as it stands, is intended to support the Drury Centre and Drury East Plan Change applications. The SMP may need to be developed in further detail at future stages for it to be adopted within Auckland Council's Network Discharge Consent (NDC). It will support future Resource Consents and Engineering Plan Approvals for the proposed developments.

The overarching principle of the SMP is to implement an integrated stormwater management approach for all three Drury East PCAs, which includes:

- Facilitate urban development and optimise available land
- Recognise the key constraints and opportunities on site and in the Hingaia and Slippery Creek catchments
- Develop a set of Best Practicable Options (BPOs) for stormwater that can be incorporated into the development

- Emphasise a water sensitive design approach that:
  - manages the impact of land use change from rural to urban
  - minimises or mitigates the adverse effects on water quality, freshwater systems, stream health and ecological values of the receiving environment through the implementation of stormwater management devices; this includes tributaries of the Hingaia Stream and Slippery Creek
  - protects and enhances stream systems and riparian margins
- Minimise the generation and discharge of contaminants/sediments into the sensitive receiving environment of the Drury Creek and Manukau Harbour, including changes in water temperature caused by stormwater discharges
- Recognise a Blue-Green network approach with the stormwater management system to integrate "blue" aspects of the PCA (the streams and flood plains) and the "green" aspects of the environment (indigenous biodiversity and ecological significance, and the parks and reserves)
- Protect key infrastructure, people and the environment from significant flooding events. Not worsen downstream flooding

To achieve these outcomes, the proposed stormwater management approach is to:

- Preserve, protect and enhance streams and floodplains in the Blue-Green network, which can also provide amenity and connectivity with communities
- Eliminate and minimise the generation of contaminants. Provide near-source water quality treatment of runoff for all contaminant generating impervious surfaces. Water quality treatment to target sediment, metals and gross pollutants should be provided. Green infrastructure is preferred
- Provide a minimum of SMAF 1 hydrological mitigation for all impervious surfaces within the Drury Centre and Drury East PCAs. Intervene with stream erosion mitigation methods
- Generally adopt the "Pass forward flows" flood management approach, but for Fitzgerald Stream provide temporary on-site flood attenuation to mitigate changes within the 100 year flood plain attributed to the development of the PCA before the downstream network is upgraded

To meet the stormwater management approach set out above, a Stormwater Management Toolbox (refer to Table E1) has been developed to assist in selecting BPO stormwater management devices (or a combination of devices) that will achieve the stormwater management outcomes for the various land use zones at all three Drury East PCAs.

Table E1: Stormwater Management Toolbox

Zone	Land Use	Performance Outcomes				Toolbox	Notes
		Water Quality	Hydrological Mitigation	Flood Attenuation	Water Sensitivity Design [1]		[1] The proposed stormwater management options adopt a Blue-Green network approach that includes other devices or measures which are not listed in this table i.e. filter strips, green outfalls (where practicable), streams protected and enhanced with riparian buffer and re-vegetation planting. The need for bank stabilisation/instream works to be determined by stream erosion assessments. [2] Stormwater Management Devices in the Auckland Region –Guideline Document 20017/001 (GD01). (December 2017). Auckland Council Eliminate or minimise the generation and discharge of contaminants. Treat all contaminant generating impervious areas at or near source by a water quality device designed in accordance with GD01 to target sediment, metals and gross pollutants. Elimination of contamination generation is considered the BPO option so if inert roofing materials are used, these impervious surfaces will not generate contaminants and therefore will not require water quality treatment. [3] AUP Auckland Council The PCA does not fall within a Stormwater Management Area - Flow 1 (SMAF 1) overlay but this will be adopted as the minimum requirement across all three sites. This stormwater management approach is consistent with Policy E1.3.10. The minimum hydrological mitigation requirements proposed are as follows: · Retention (volume reduction) of at least 5mm of runoff depth from impervious surfaces · Detention of the 95th percentile event for the difference between the pre-development and post-development runoff volumes from a 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 ground and rainwater reuse is not possible. It is noted that if retention cannot be met, devices are to be lined with the retention volume being treated as a detention through bioretention devices. An erosion assessment is to be carried out to determine if additional measures (such as additional detention requirements) are required to mitigate the hydrological impacts of development. [4] No increase in peak flood level effects to properties upstream and downstream of the PCAs. [5] Devices will be provided and sized for WQ treatment for carparks (greater than 30 vehicles) only for the Residential Zones. [6] Includes the option for large communal devices to provide treatment and hydrology mitigation to public roads and impervious areas. Gross Pollutant Traps (GPT) or alternative proprietary devices will be installed upstream of communal devices. The communal devices may be dual-purpose as they could also provide flood attenuation, if required. [7] Hydrology mitigation will be provided for impervious areas; Water quality treatment will be provided where contaminants are generated e.g. Water quality treatment won't be provided for roofs with inert building material or footpaths. Bio-retention devices generally have the added benefit of providing WQ treatment too.
Performance standard		GD01[2]	AUP: SMAF 1 minimum[3]	100 Year ARI: Not worsen downstream flooding [4]			
Mixed use Metropolitan Centre	Roads	✓	✓	X	✓	Bio-retention devices including: · Raingardens · Tree pits · Vegetated swales	
	Carparks	✓	✓	✓	✓		
	Other	✓[2]	✓	✓	✓	Inert Building materials Rainwater tanks for re-use of roof runoff Permeable pavements for public realm areas Communal detention devices	
Mixed Housing – Urban Mixed Housing – Suburban Terraced Housing Apartment Buildings	Roads	✓	✓	✓[6]	✓	Communal devices[5] Bio-retention devices including: · Raingardens · Tree pits · Vegetated swales	
	Carparks > 30 Vehicles	✓[5]	✓	✓[6]	✓		
	Roofs, jointly-own access lot driveways, driveways, gardens/landscaping	X✓[2,7]	✓	✓	✓	Inert Building materials Rainwater tanks for re-use of roof runoff Permeable pavements for driveways or laneways Communal devices[5] Bio-retention devices including: · Living Roofs · Raingardens · Tree pits · Vegetated swales	

The stormwater management approach has been discussed with Mana Whenua over a number of hui and workshops. Mana Whenua have expressed support towards integration of green infrastructure and promotion of water reuse via rainwater harvesting tanks. Mana Whenua stressed their concern over Auckland Council's ability to maintain the growing number of green infrastructure assets over the long term to ensure efficiency of devices are maintained. Through these discussions, an alternative option of using proprietary devices such as Gross Pollutant Traps (GPTs) was tabled combined with communal green infrastructure devices.

The SMP is supported by a flood hazard assessment, which was carried out using the Auckland Council flood model for the Hingaia Stream catchment. The assessment confirmed the proposed flood management approaches for the PCA and did not indicate any flood effects that would be considered more than minor:

- No additional flood risk to downstream habitable floor or properties attributed to development of the PCAs i.e. the total number of properties flooded are unchanged
- A slight increase in flood extent within Drury Township only for the post-development 100 year scenario when comparing the pre- development scenario but no change in flood risk to the buildings
- No increases in flood extents or flood risk within Drury Township for the 2 year and 10 year scenarios
- No risk to development within the PCAs as a result of to future upstream development

Based on the investigations that have been completed at this stage, it is expected that stormwater effects from the Drury Centre and the Drury East PCA can be managed safely and without damage to the receiving environment. The Plan Changes can, therefore, proceed without any major concerns relating to stormwater management.

1 Introduction

The Drury East development comprises three Plan Changes: the Drury Centre Plan Change request by Kiwi Property, The Drury East Plan Change request by Fulton Hogan Land Development FHLD and the Waihoehoe Plan Change request by Oyster Capital. The Drury Centre and the Drury East Plan Change Areas (PCAs) are located within the Hingaia Stream catchment while the Waihoehoe PCA is located within the Slippery Creek catchment as shown in Figure 1.

An integrated stormwater management approach will be adopted across all three Drury East PCAs, however different flood assessment approaches are required for the two Plan Changes within the Hingaia Stream catchment and the Waihoehoe Plan Change within the Slippery Creek catchment to address the unique catchment characteristics, opportunities and issues, the scale of development and availability of modelling tools.

Tonkin & Taylor Ltd (T+T) and Woods have previously prepared three separate SMPs in support of the Drury East Plan Change applications, which were lodged in December 2020:

- *Stormwater Management Plan – Drury Metropolitan Centre (Kiwi Property Trust Ltd)* report prepared by T+T and issued in August 2019 (Job Number: 1003297.v4)
- *Stormwater Management Plan – Drury East (Fulton Hogan Land Development)* report prepared by Woods and issued 08 November 2019 (Project Number: P16-335)

  Pre-purchase review of stormwater and flooding – 116 Waihoehoe Road and surrounds (Oyster Capital) report prepared by T+T and issued in October 2018 (Job Number: 1008200.v1)

Since the Plan Change lodgement, Healthy Waters have reviewed the application for the Drury East PCAs and have provided feedback and queries in the *Further Information Request – Drury East Plan Changes* table included within the *Healthy Waters Review of Adequacy of Information for a Private Plan Change Request – Drury East -Fulton Hogan and Kiwi Property.* The Healthy Waters Review of Adequacy of Information for a Private Plan Change (PPC) Request is included in Appendix E. The *For Information Request* (FIR) items generally relate to stormwater management, hydrological mitigation and flood management.

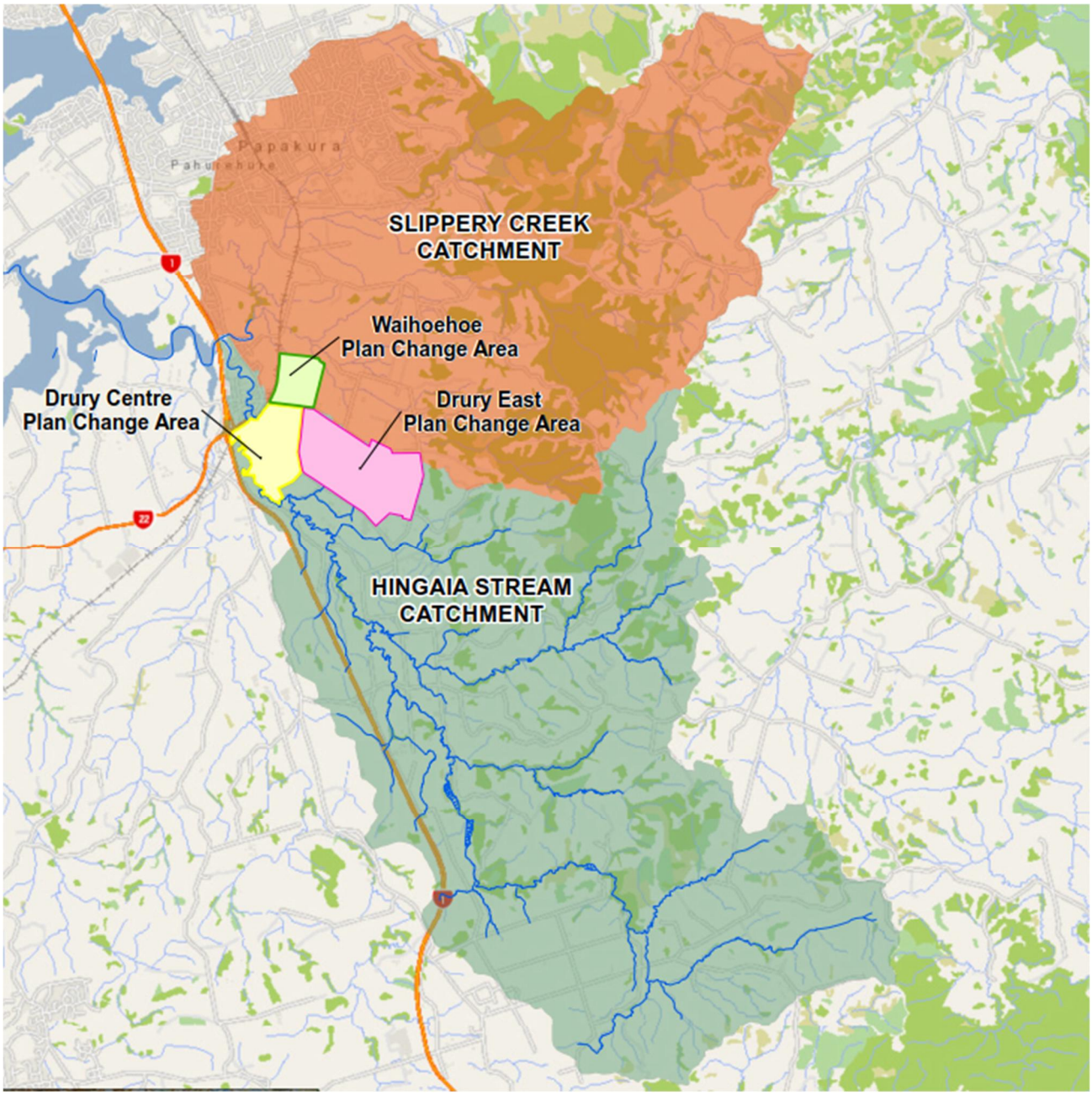

Figure 1: Hingaia and Slippery Creek catchment extents and PCAs

This integrated Stormwater Management Plan (SMP) has been prepared by T+T and Woods to support the Plan Change applications by Kiwi Property to rezone 95 hectares of Future Urban land to Business (Mixed Use and Metropolitan Centre Zoning) and Open space – Informal Recreation zone and apply the Drury Centre Precinct, and the Plan Change application by FHLD to rezone 187 hectares of Future Urban land to a mixture of Terrace Housing and Apartment Building (THAB), Mixed Housing Urban (MHU), Mixed Housing Suburban (MHS) and Mixed Use Zone. It combines information presented in the Drury Centre and Drury East SMPs listed above, as well as six memos prepared for Healthy Waters in response to the Further Information Request, listed below. All supporting memos are included in full in Appendix E.

- *Drury East (Kiwi and Fulton Hogan) flood modelling – response to Auckland Council modelling requests* memo prepared by T+T and issued 10 February 2020
- *Drury East (Kiwi and Fulton Hogan) flood modelling – response to Auckland Council modelling requests V2* memo prepared by T+T and issued 19 February 2020

- *Response to Auckland Council Further Information Request on Stormwater Matters for Drury East* memo prepared by T+T and Woods and issued 25 March 2020, which provided an integrated summary of stormwater management and flooding for the Hingaia
- *Response to Auckland Council Further Information Request on Stormwater Matters for Drury East - Stream Erosion Risk Assessment for Hingaia Catchment* memo prepared by T+T and Woods and issued 6 April 2020, which provided an integrated assessment of stream erosion in the Hingaia.
- *Response to Auckland Council Further Information Request on Ecological Matters for Drury East – Drury East Plan Changes – Ecology Response* memo prepared by T+T, The Ecology Company and Freshwater Solutions and issued 24 March 2020
- *Drury East (Oyster Capital) flood modelling – Response to Auckland Council Further Information Request on Stormwater Matters (Version 2)* memo prepared by T+T and issued 6 April 2020

The SMP for the Waihoehoe Plan Change is being prepared separately.

The purpose of the SMP is to provide guidance to the applicant and Auckland Council on how stormwater will be managed within the Drury Centre and Drury East PCAs. It demonstrates that the proposed stormwater management is the Best Practicable Option (BPO), taking into consideration the existing site features and the future land use master plan. This guidance is consistent with Auckland Councils policies and plans and based on conventional stormwater management techniques to meet Auckland Unitary Plan, Operative in Part (AUP) provisions, and to integrate with existing approved and future stormwater systems in the Hingaia Stream catchment.

The SMP, as it stands, is intended to support the Plan Change application. The SMP may need to be developed in further detail at future stages for it to be adopted within Auckland Council's Network Discharge Consent (NDC). It will support future Resource Consents and Engineering Plan Approvals for the proposed developments.

The text '***Not applicable within this SMP***' indicates sections that are not relevant to this Plan Change application and '***To be addressed at Resource Consent***' indicates sections that will need to be addressed as the design is progressed.

2 Existing site appraisal

This section of the report summarises the existing site characteristics and conditions within the Drury Centre and Drury East PCA, as they relate to stormwater management.

2.1 Summary of data sources and dates

This section provides a summary on key datasets used in the writing of this SMP, including those that have been used to generate supporting figures provided in Appendices A1 and C1.

Table 2: Regulatory and design requirements

Existing site appraisal item	Source and date of data used
Topography	· Auckland Lidar 1m DEM (2013). Lidar was captured for Auckland Council by NZ Aerial Mapping & Aerial Surveying Limited.
Geotechnical / soil conditions	· GNS Science Auckland geological map (2020) · Percolation Testing to Support Stormwater Assessment for Drury Development Project, Drury, Auckland report prepared by ENGEO Limited and issued 19th February 2019 (Reference 13451.000.000_18) · Drury Plan Change – Geotechnical Assessment Report prepared by CMW Geosciences for FHLD and issued 9 August 2019 (Reference AKL2018-0233AB Rev 3)
Existing stormwater network	· Auckland Council GeoMaps – Underground Services: Stormwater (2018)
Stream, river, coastal erosion	· Auckland Council GeoMaps – Catchments and Hydrology: River names (2018)
Flooding and flow paths	· Auckland Council GeoMaps – Catchment and Hydrology: Overland Flow Paths, Flood Prone Areas, Flood Sensitive Areas and Flood Plains (2018)
Aquifers	· Auckland Council GeoMaps - AUP management layers: Overlays – Natural Resources – High-Use Aquifer Management Areas Overlay (2016)
Coastal Inundation	· Auckland Council GeoMaps - Emergency Management: Coastal inundation (2018)
Ecological / environmental areas	· Auckland Council GeoMaps– Natural Resources: Significant Ecological Areas (2016) · Drury East Master Plan – Ecological Considerations for Kiwi Property Limited report prepared by T+T and issued in March 2018 (Job Number: 1003886) · Drury Metropolitan Centre – Assessment of Ecological Effects report prepared by T+T and issued in September 2019 (Job Number: 1003297.1000) · Ecological values within the area affected by the proposed Drury East Plan Change report prepared by The Ecology Company and issued August 2019
Cultural and heritage sites	· Auckland Council GeoMaps - Cultural Heritage Inventory (2018)
Contaminated land	· N/A

2.2 Location and general information

The Drury Centre and Drury East PCAs are zoned Future Urban Zone (FUZ) in the AUP and included within the Drury-Opāheke Structure Plan(refer to Figure 2). The area covered by the Plan Changes is located to the east of State Highway 1/ Great South Road interchange, approximately 36km away from Auckland CBD. The Drury Foothills are located to the east of the PCA and are zoned Rural Countryside Living Zone.

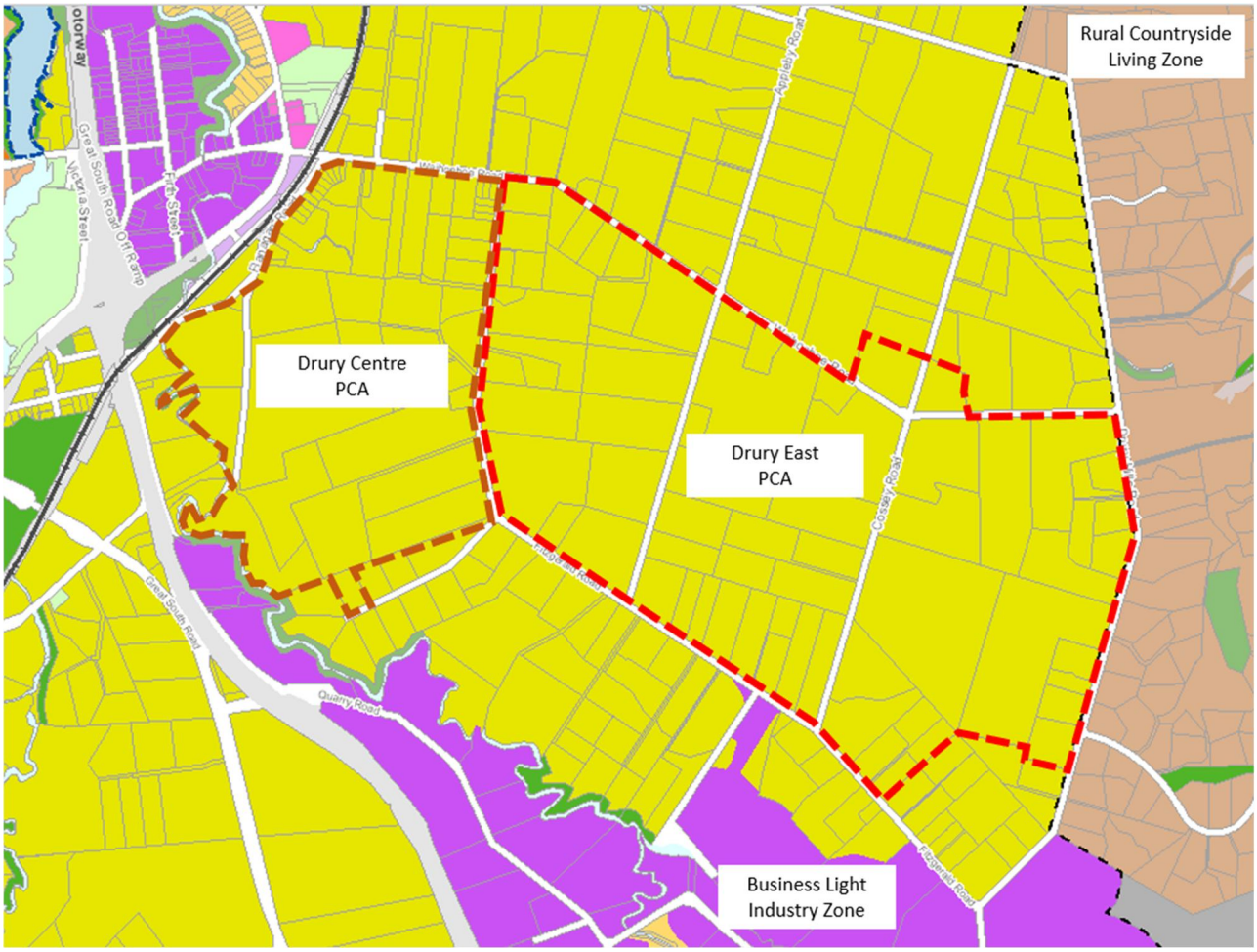

Figure 2: Auckland Unitary Plan Zoning with Drury Centre and Drury East

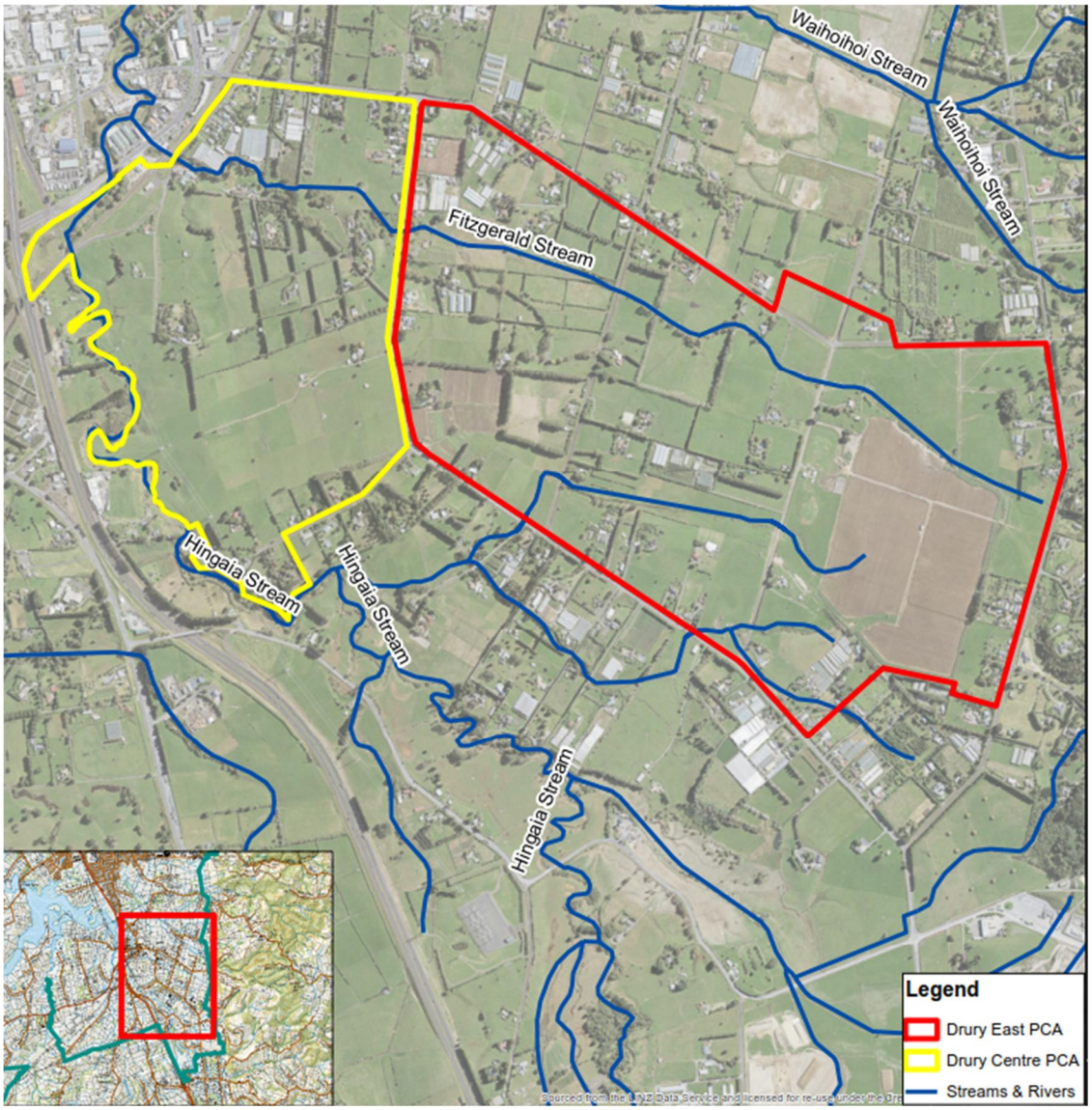

Figure 3: Location plan for the Drury Centre and Drury East PCAs

2.2.1 Drury Centre

The Drury Centre PCA is approximately 995,000 m^2 and is located to the south of the existing Drury Township that comprises of Light Industry Zone and Mixed Use Zones. The Drury Centre PCA has frontage to Fitzgerald Road to the east, Brookfield Road to the south, Flanagan Road to the west and Waihoehoe Road to the north. The proposed Drury Centre will only occupy approximately 530,000 m^2 of the wider area that is the subject of the Plan Change. Table 3 provides key property details of the Drury Centre PCA and Error! Reference source not found. shows the location and extent of the two site boundaries.

Table 3: Property information for the Drury Centre

Existing site element	Details
Site address	· 8 to 120 Flanagan Road, Drury Auckland 2113 · 35 to 115 Waihoehoe Road, Drury Auckland 2113 · 1 to 133 Fitzgerald Road, Drury Auckland 2113 · 61 to 110 Brookfield Road, Drury Auckland 2577

Existing site element	Details
Legal description	· Lot 4 DP 14711 to Lot 1 DP 165262, 1/6 SH Lot 10 DP 165262 · Lot 3 DP 334434 to Lot 2 DP 41154 · Lot 3 DP 41154 to Lot 2 DP 57466, Lot 3 DP 57466, Lot 4 DP 57466, Lot 5 DP 57466, Pt Lot 2 DP 24845, Lot 1 DP 87159, Pt Lot 1 DP 57466 · Lot 1 DP 101367 to Lot 17 DP 104552
Total land area	· 995,453 m^2
Current land use	· The PCA comprises predominantly high producing exotic grassland for farming. The northern corner of the PCA compromises residential area and greenhouses.
Current building coverage	· Less than 10% of the Drury Centre PCA comprise buildings or other impervious surfaces
Historical land use	· Rural-residential

2.2.2 Drury East

The Drury East PCA comprises approximately 1,870,000 m2, bound by Drury Hills Road and remnant forest to the east, Fitzgerald Road to the south and west and Waihoehoe Road to the north. It shares a boundary with the Drury Centre PCA along Fitzgerald road. Table 4 provides key property details of the Drury East PCA and Figure 3 shows the location and extent.

Table 4: Property Information for Drury East Precinct

Existing site element	Details
Site address	· 6 to 468 Fitzgerald Road, Drury Auckland 2113 · 171 to 319 Waihoehoe Road, Drury Auckland 2113 · 276 to 80 Drury Hills Road, Drury Auckland 2577 · 26 to 148 Fielding Road, Drury Auckland 2577 · 45 to 9 Cossey Road, Drury Auckland 2577
Legal description	· Lot 1 DP 91744 to Lot 1 DP 78904 · Lot 1 DP 103511 to Lot 1 DP 154964 · Lot 2 DP 157361 to Lot 3 DP 157934 · Lot 1 DP 68163 to Lot 2 DP 92454, Lot 1 DP 128680 · Lot 1 DP 487007 to Lot 2 DP 104277
Total land area	· 1,872,229m^2
Current land use	· Predominantly rural in nature
Current building coverage	· Less than 10% of the Drury East PCA comprise buildings or other impervious surfaces
Historical land use	· Rural-residential

2.3 Topography and catchments

The Drury East PCA is located within the lower Hingaia Stream and Slippery Creek catchments (refer to Figure 1) which are part of the greater Drury-Opāheke catchment. The draft Drury-Opāheke Future Urban Zone Stormwater Management Plan (FUZ SMP) notes that the topography across the majority of the Drury-Opāheke catchment is "*characterised by low elevation gently undulating land*".

The Hingaia Stream catchment is approximately 57.5 km2 and includes the Drury Centre and the majority of the Drury East PCAs, the urban area of Drury Township and Drury South industrial and residential areas currently under construction. The rest of the catchment remains predominantly rural with scattered residential and agricultural properties. The Waihoehoe PCA and a small portion of the Drury East PCA (located on the northern side of Waihoehoe Road) are within the Slippery Creek catchment, which comprises approximately 46.3 km^2 of predominantly rural land with 50% in pasture and 25% in indigenous forest.

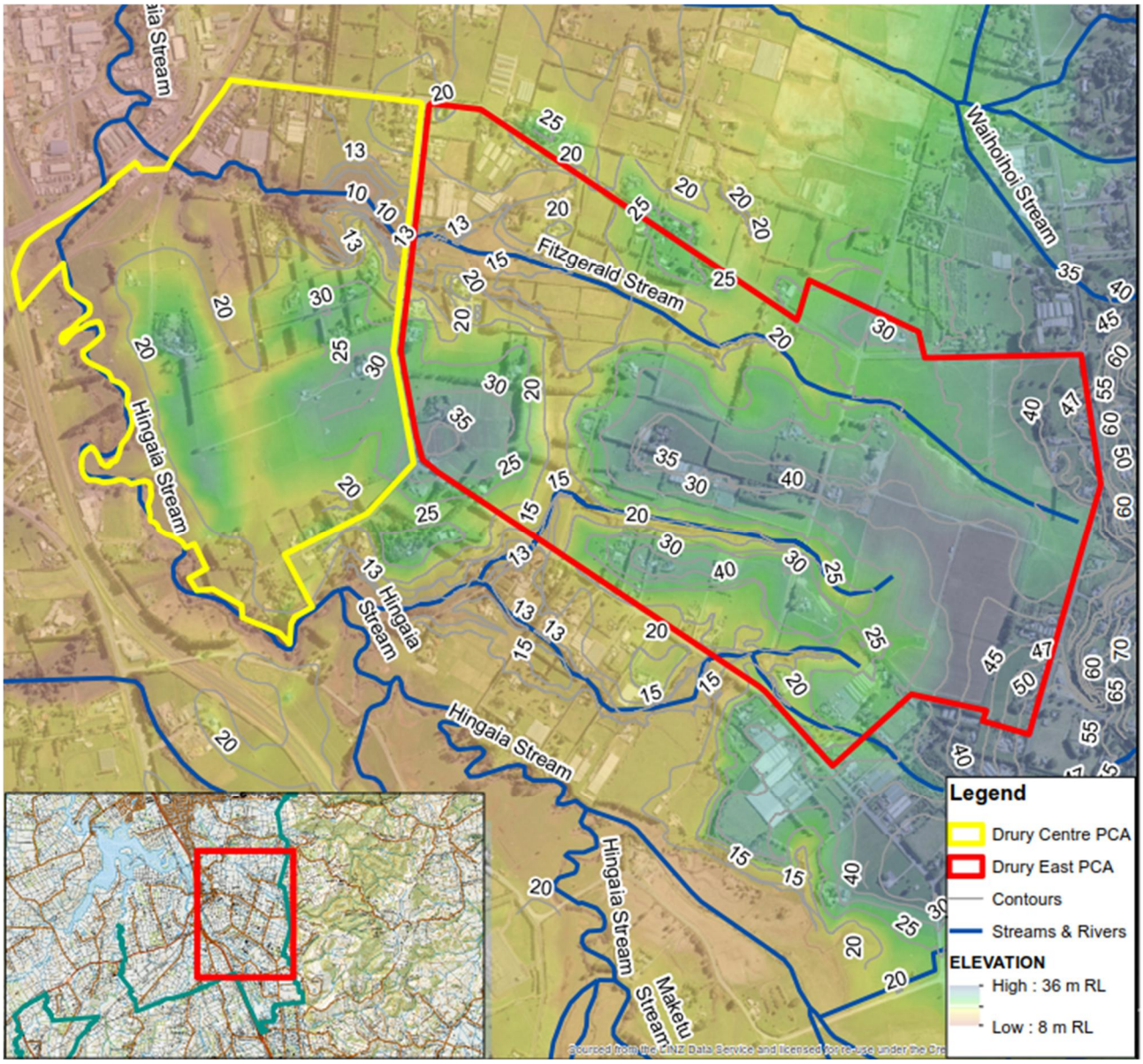

Figure 4: Existing topography for Drury Centre and Drury East PCAs

2.3.1 Drury Centre

The natural topography of the Drury Centre PCA is gently undulating, with elevations ranging between 8 m RL to 36 m RL and a ridgeline through the southern corner of the site (refer to Figure 4). Fitzgerald Stream (a tributary of the Hingaia Stream referred to as river #438401 on GeoMaps) conveys flow from west to east approximately through the middle of the PCA. Approximately 430,000 m^2 of the site drains north and south towards Fitzgerald Stream, and the remaining 565,000 m^2 drains south towards Hingaia Stream. The Drury Centre PCA receives no runoff from properties outside the PCA boundary.

2.3.2 Drury East

The existing topography of the Drury East PCA is mostly undulating with several ridgelines which range between 13 m RL and 25 m RL from Fitzgerald to Fielding Road (refer to Figure 4). The PCA rises up to approximately 47 m RL closer to the hills at Drury Hills Road. There are three first order tributaries of Hingaia Stream, which convey flow from west to east through the site: Fitzgerald stream is located in the northern half of the PCA and two tributaries of the Hingaia Stream located in the southern portion of the PCA. The streams are relatively incised with steep adjacent banks.

2.4 Geotechnical

GNS Science Auckland geological map classifies the underlying geology of the wider Drury East developments as part of the Puketoka formation, OIS1 Holocene River deposits (both of the Tauranga Group) and the Kerikeri Volcanic groups (refer to Figure 5). These groups comprise predominantly alluvial and volcanic deposits from the South Auckland Volcanic Field. Therefore, the materials can be highly variable spatially, but are likely to generally comprise:

- Formation Pup, comprising alluvial deposits of pumiceous mud, sand and gravel with muddy black peat and lignite; rhyolite pumice, including non-welded ignimbrite, tephra and alluvial pumice deposits
- Formation Qvs, consisting of basalt and scoria with areas of ash, lapilli and lithic tuff
- Isolated areas of more recent Holocene aged Tauranga Group materials (Q1a), comprising alluvial/colluvial deposits
- Rhyolite pumice, including non-welded ignimbrite, tephra and alluvial pumice deposits
- Massive micaceous sand

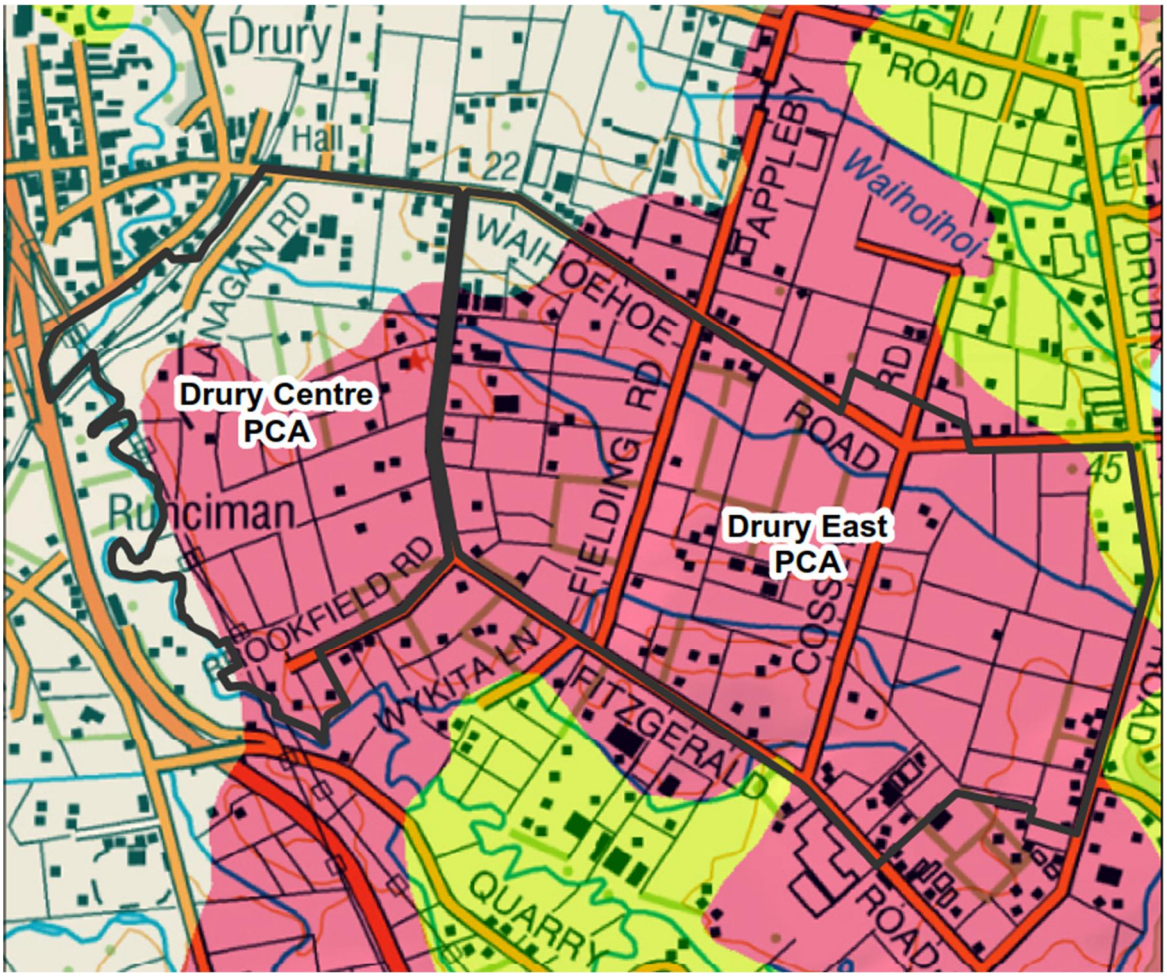

Figure 5: Underlying geology of the Drury East developments

2.4.1 Drury Centre

Percolation testing was carried out in the Drury Centre PCA to assess suitability of site soils for stormwater soakage design. The testing was completed by ENGEO and in accordance with Auckland Council's Technical Report 2013/040. The ENGEO Percolation testing memo[1] indicates that the topsoil is comprised of clayey silt, with the sub-soil geology largely made up of high plasticity silty clay in the northern half of the Drury Centre PCA. Areas to the south and to the west of the Drury Centre PCA are comprised of clayey silts with low plasticity, between depths of 0.5 and 0.8 metres. Percolation testing was done at 10 borehole locations. The testing was conducted in the boreholes that were hand augured to a depth of 3 m below existing ground. The percolation rates were an average of 0.017 L/m2/min with minimum and maximum percolation rates of 0.0054 L/m2/min and 0.0617 L/m2/min, respectively. The minimum required infiltration rate for when infiltration can be relied on for devices such as raingardens is stipulated within Auckland Council's Guidance Document 2017/001 - Stormwater Management Devices in the Auckland Region (GD01) to be greater than 2 mm/hr, or 0.03 L/m^2/min. It was therefore deemed that infiltration systems would likely not be feasible for use within the Drury Centre PCA unless areas of high infiltration rates are identified by additional, more targeted testing. The boreholes also recorded groundwater levels

[1] ENGEO Limited, 19th February 2019, Percolation Testing to Support Stormwater Assessment for Drury Development Project, Drury, Auckland (Reference 13451.000.000_18)

between 2.2 m and 2.8 m below ground level. Full geotechnical investigation results can be found in Appendix A2.

2.4.2 Drury East

Site specific percolation testing has not been carried out in the Drury East PCA. The Geotechnical assessment report[2] prepared by CMW Geosciences suggests that site soils are likely to provide moderate infiltration capability (based on their experience in similar soils). This should be confirmed with specific testing as part of detailed stormwater design.

Based on the known history of the Drury East PCA and surrounding land uses, some existing superficial depths of fill would also be anticipated as a result of landscaping and/or minor earthworks during prior development and infilling of ponds.

2.5 Existing stormwater infrastructure and hydrological features

2.5.1 Existing public stormwater infrastructure

Auckland Council GeoMaps indicates public stormwater infrastructure in the road corridors adjacent to the western and northern boundary of the Drury Centre PCA, as follows:

- Public gravity mains are present, running across the railway line from Flanagan Road to Great South Road. These mains vary in size from 450 mm to 2200 mm in diameter and are under Auckland Transport ownership.
- An 1800 mm diameter culvert at the Fitzgerald Road crossing of the Fitzgerald Stream.
- An isolated branch of 150 mm to 225 mm diameter concrete pipes along the southern side of Waihoehoe Road.

Auckland Council GeoMaps does not map any stormwater infrastructure within either PCAs.

2.5.2 Existing private stormwater infrastructure and hydrological features

Fitzgerald Stream and the Hingaia tributaries play a critical role in conveyance of runoff for both the Drury Centre and Drury East PCAs (refer to Figure 6 and Figure 7, respectively). It is noted that the existing culverts are generally undersized resulting in flows being restricted leading to upstream flooding.

Within the Drury Centre PCA

- Fitzgerald Stream conveys flow from east to west approximately through the middle of the PCA. The Fitzgerald stream is fed by contributions from small and unnamed intermittent streams within the Drury Centre PCA and the Drury East PCA further upstream. It discharges to the Hingaia Stream via a 2100 mm diameter culvert under the railway. It is noted that the existing culverts are generally undersized resulting in flows being embanked leading to upstream flooding
- The Hingaia Stream runs along the western boundary of the site, in a northerly direction
- Stream A comprises intermittent an d permanent stream reaches of approximately 400 m length. It emerges in a paddock, via a series of small intermittent tributaries, before becoming a permanent channel which flows south to north to the Fitzgerald Stream
- Stream B is approximately 120 m in length and comprises intermittent and permanent stream reaches. Encroachment of weeds into the channel has resulted in a wetland typology in the upper

[2] CMW Geosciences, 9 August 2019, Drury Plan Change - Geotechnical Assessment report, prepared for Fulton Hogan Land development Limited (Reference AKL2018-0233AB Rev 3)

reaches, which is likely exacerbated by the absence of a riparian margin. The entire area is fenced and there is no stock access to stream channel. A culvert is present in the lower 20 m of the reach. It discharges to the Hingaia Stream

- Stream C is an intermittent stream approximately 40 m long, which has been straightened along a fence line. The stream appears to be spring fed. While the stream lacks a riparian margin, it is fenced and some shading is provided in the upper reach. It discharges to the Hingaia Stream
- Stream D is a remnant channel of the Hingaia Stream that is no longer connected to the main channel
- A private stormwater drain is located in the middle section of Stream D. Although the usage and function of this stormwater drain are unconfirmed
- There were two streams observed that lie outside of Kiwi Property landholdings but within the Drury Centre PCA. These streams were not walked, however they were observed from a distance and their presence assessed from aerial imagery. These two streams are likely to be intermittent. They are unfenced and unshaded streams, with excessive macrophyte growth. Unrestricted stock access is likely to have caused damage to the stream banks and exacerbated nutrients entering the stream. Both streams are expected to have similar ecological values as Stream A
- Two seepage wetlands were identified in depressions on the true right margin of the Hingaia Stream. Wetland 1 encompasses an area of approximately 150 m2 and is currently unfenced allowing unrestricted stock access to the entire wetland area. Wetland 2 is approximately 1,000 m2. The upper section is unfenced with riparian vegetation consisting of grazed pasture grasses and sporadic gorse. The lower section of Wetland 2 is located alongside the Hingaia Stream edge and is fenced with Willow present.

Figure 6: Stream classification (source: Drury Metropolitan Centre– Assessment of Ecological effects by Tonkin + Taylor, June 2019)

Within the Drury East PCA

- As already mentioned, there are three first order tributaries of Hingaia Stream which convey flow from west to east through the site:
  - Fitzgerald stream is located in the northern half of the site. This permanent stream is fed by contributions from small and unnamed intermittent streams within the Drury East PCA. It drains north-west via the perched culvert under Fitzgerald Road and then into the Hingaia Stream downstream of the Drury Centre PCA
  - Two tributaries of the Hingaia Stream are located in the southern portion of the site. These permanent streams are also fed by contributions from small and unnamed intermittent streams within the Drury East PCA and join the main Hingaia Stream further downstream
- Several smaller watercourses run through the PCA, generally falling to the east and eventually discharge into the Fitzgerald Stream and the Hingaia Stream tributary. The watercourses and tributaries within the PCA have been substantially altered by previous land uses. Stream modifications generally include channeliation and straightening, removal of riparian vegetation, construction of ponds and pollution. According to the Ecological assessment, "*these changes have resulted in low aquatic habitat diversity, low aquatic biodiversity and poor water quality.*"
- There are a number of culverts passing under Cossey Road, Fielding Road and Fitzgerald Road (refer to Figure 8 for indicative locations). These culverts are not shown on Auckland Council GeoMaps and hence are assumed to be private
- There are no natural wetlands remaining within the PCA, but at least six artificial ponds have been created to provide water for livestock
- Private artificial farm drains, culverts and irrigation dams exist within the Drury East PCA and affect fish passage and water quality

Figure 7: Stream classification (Sourced from The Ecology Company Limited)

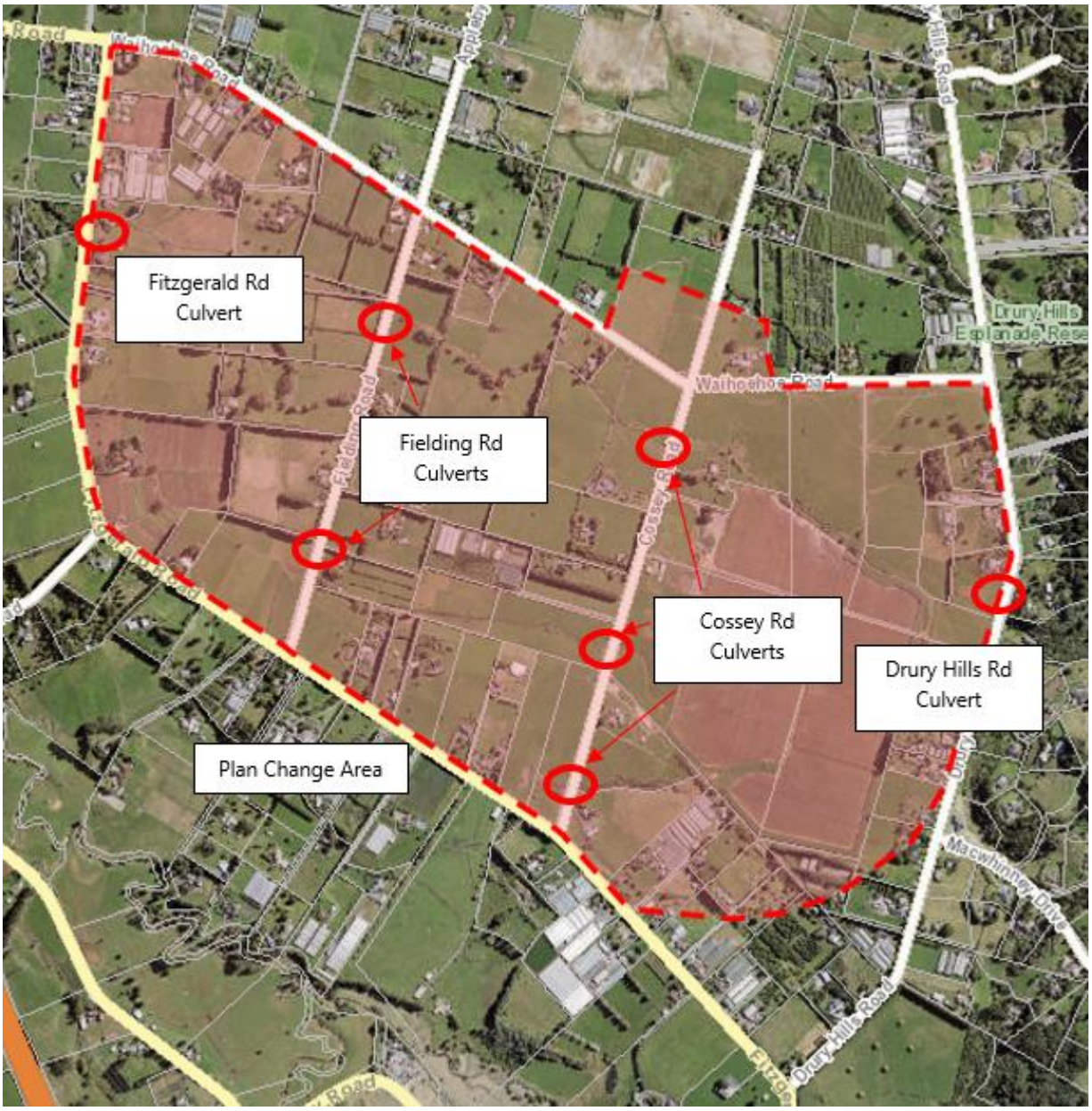

Figure 8: Existing culverts at Drury East

2.6 Receiving environment

2.6.1 Fitzgerald Stream

As noted above, the northern sub-catchments of the Drury Centre and Drury East PCAs flow into Fitzgerald Stream. The Hingaia Stream Watercourse Assessment[3] found the condition of the Fitzgerald Stream west of Fitzgerald Road to generally have than less than 20% erosion scarring with some pockets where erosion scarring was between 20% and 40%. No erosion hotspots were noted. The Pfankuch bank stability score for this section of stream was generally 'fair'.

[3] 4Sight Consulting and Urban Solutions, July 2018, Hingaia Stream Catchment Watercourse Assessment Report, prepared for Auckland Council

The Fitzgerald Stream connects with the Hingaia Stream through a set of culverts under Flanagan Road, railway and Great South Road. Management Zones relevant to both the Fitzgerald Stream and Hingaia Stream are discussed in the following section.

There are no Significant Ecological Areas identified within the PCAs.

2.6.2 Hingaia Stream

The southern sub-catchments of the Drury East PCA contain tributaries of Hingaia Stream. The southern and western extent of the Drury Centre PCA is also traversed by and discharges into the Hingaia Stream.

The Hingaia Stream Watercourse Assessment[3] reported some form of erosion scarring on almost 97% of the total permanent/intermittent stream length assessed within the Hingaia catchment. This is likely the result of a combination of generally steep bank angles which (57° on average) and the general lack of riparian vegetation within the catchment. 58% of the total stream length has erosion scarring less than 20%, 37% had between 20% and 40% erosion scarring and 5% had more than 40% erosion scarring. More than 96% of the total stream length was assessed as having either a 'fair' (74.9%) or 'poor' (21.5%) Pfankuch bank stability score, which would indicate the potential for ongoing erosion and slumping issues. In general, watercourses scored between 'fair' and 'good' in mass wasting and debris jams categories but poorly on land slope and bank vegetation.

The degree of erosion scarring and bank stability scores for the stream reaches in the vicinity of the Drury Centre and Drury East PCAs are shown in Figure 9. For the Hingaia Stream north of Brookfield Road there was generally less than 20% erosion scarring on both banks, with the exception of the reach between Flanagan Road and Great South Road which has between 20% and 60% erosion scarring. On this section of the Hingaia Stream there were five erosion hotspots observed; two of these were to the west of the PCA and three were downstream of the PCA on the reach between Flanagan Road and Great South Road. The Pfankuch bank stability score for this section of the Hingaia Stream was generally 'poor' or 'fair'.

There are no Significant Ecological Areas identified within the PCAs.

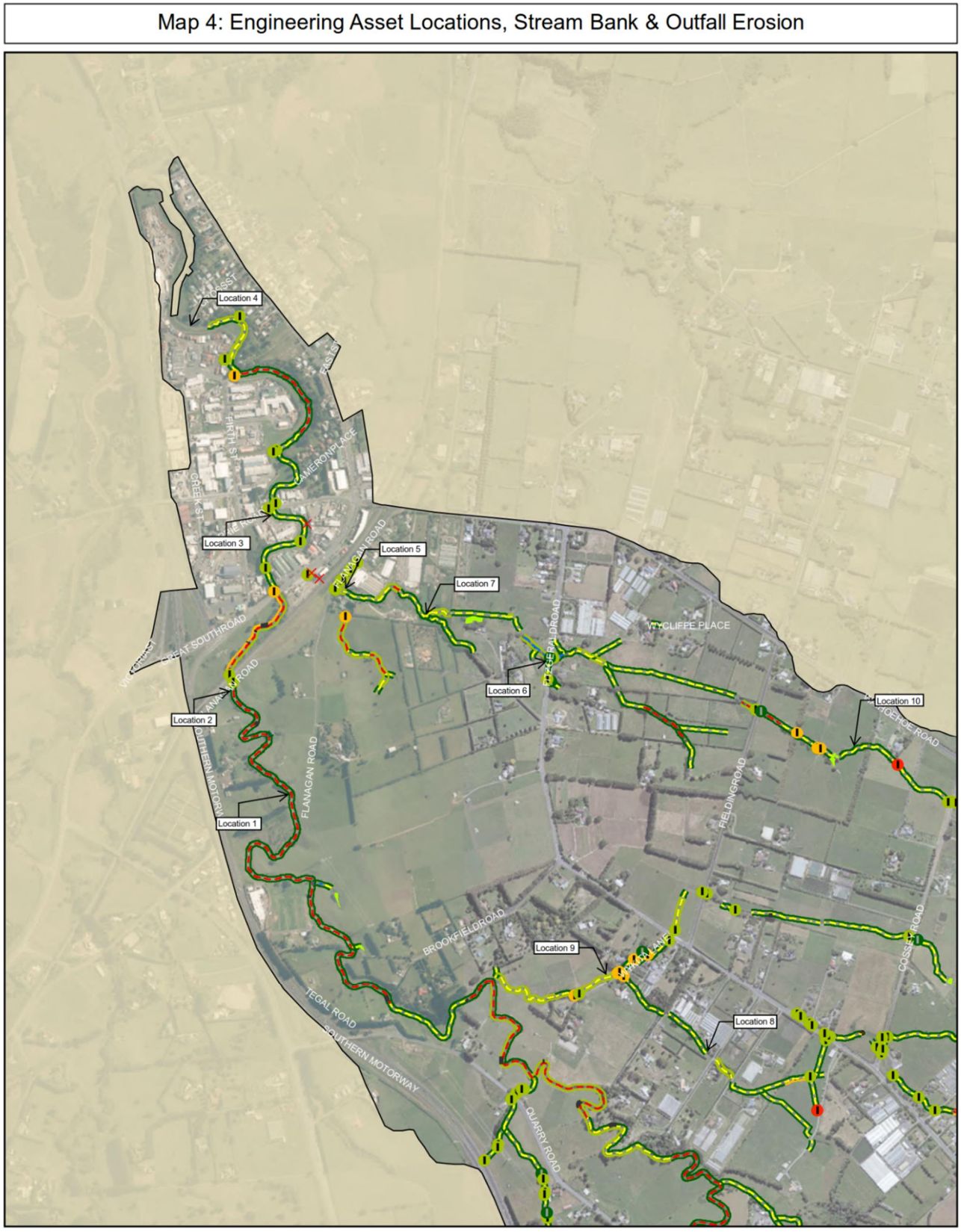

Figure 9: Engineering Asset Locations, Stream Bank and Outfall Erosion Map sourced from the Auckland Council Hingaia Stream Watercourse Assessment

Table 5: Erosion Scar and Bank stability condition from the Auckland Council Hingaia Stream Watercourse Assessment

ID	Erosion Scars	Bank Stability
Location 1	0 – 20%	Poor
Location 2	0 – 20%	Poor
Location 3	0 – 20%	Fair
Location 4	0 – 20%, 21 – 40%	Fair
Location 5	0 – 20% - 21 - 40%	Fair
Location 6	21 – 40%	Good
Location 7	0 – 20%, 21 – 40%	Fair
Location 8	0 – 20%	Fair
Location 9	21 – 40%	Fair
Location 10	0 – 20% *	Fair

2.6.3 Hingaia and Fitzgerald Management Zones Stream

According to the Hingaia Stream Watercourse Assessment[3], the section of Hingaia Stream and Fitzgerald Stream which pass through the Drury Centre and Drury East PCAs are located within Management Zone 1 (MZ1): Lower Catchment Urban/Future Urban Zones which extends as far south as Ararimu Road. Due to the ongoing and potential development within MZ1 this management zone was identified as having the greatest potential for large scale stream protection and enhancement. Consequently, the four highest priority Enhancement Opportunities identified in the Watercourse Assessment report are located within this management zone.

Some of the relevant goals and objectives identified in the Watercourse Assessment Report for MZ1 (in regard to development and stormwater management within the Drury Centre and Drury East PCAs) are as follows:

- Investigate and remedy all assets with flooding issues on public and private land
- Address erosions issues, both erosion hotspots and culvert erosion before and/or as urban development occurs
- Futureproof stormwater conveyance capacity in areas that may be put under pressure by further development. Remove unnecessary culverts and replace undersized culverts before land development occurs
- Encourage landowners and/or developers to restore, enhance and/or protect riparian zones
- Improve aquatic habitat in the northern tributaries by naturalising modified streams and removing potential fish barriers
- Ensure ecological, amenity and stormwater management linkages are established between existing, developing and future urban zones
- Look to create a continuous riparian corridor (with a walkway/cycleway) from the Hingaia Stream mouth to Ararimu Road, integrating with proposed riparian improvements within the Drury South developments
- Create better public access to the existing esplanade reserves within the Drury Township

- Improve the amenity value of the stream network by incorporating walkways/cycleways into the design of new public open spaces, particularly within Esplanade Reserves
- Take advantage of greenfield development to leverage stream enhancement outcomes (improving ecological, amenity and stormwater functions)

2.6.4 Drury Creek

Hingaia Stream drains into the upper reaches of Drury Creek. The area near the Hingaia Stream mouth and within the upper tidal reaches of Drury Creek are classified as a Significant Ecological Area (SEA) – Marine 1 (M1) in the AUP due to the presence of a variety of marshes. The M1 subtype covers highly significant areas that, due to their physical form, are considered to be the most vulnerable to any adverse effects of inappropriate subdivision, use and development. These areas are also a migration path between the marine and freshwater habitats for a number of native freshwater fish species.

Beyond this, the lower reaches of Drury Creek are classified as SEA – Marine 2 (M2) in the AUP, and comprise various intertidal habitats, ranging from sandy mud intertidal flats, currently exposed rocky reef habitats, and a variety of saline vegetation. The M2 subtype covers similarly significant areas which do not warrant an SEA-M1 identification as they are generally considered to be more robust. Figure 10 shows the extent of the areas classified as SEAs.

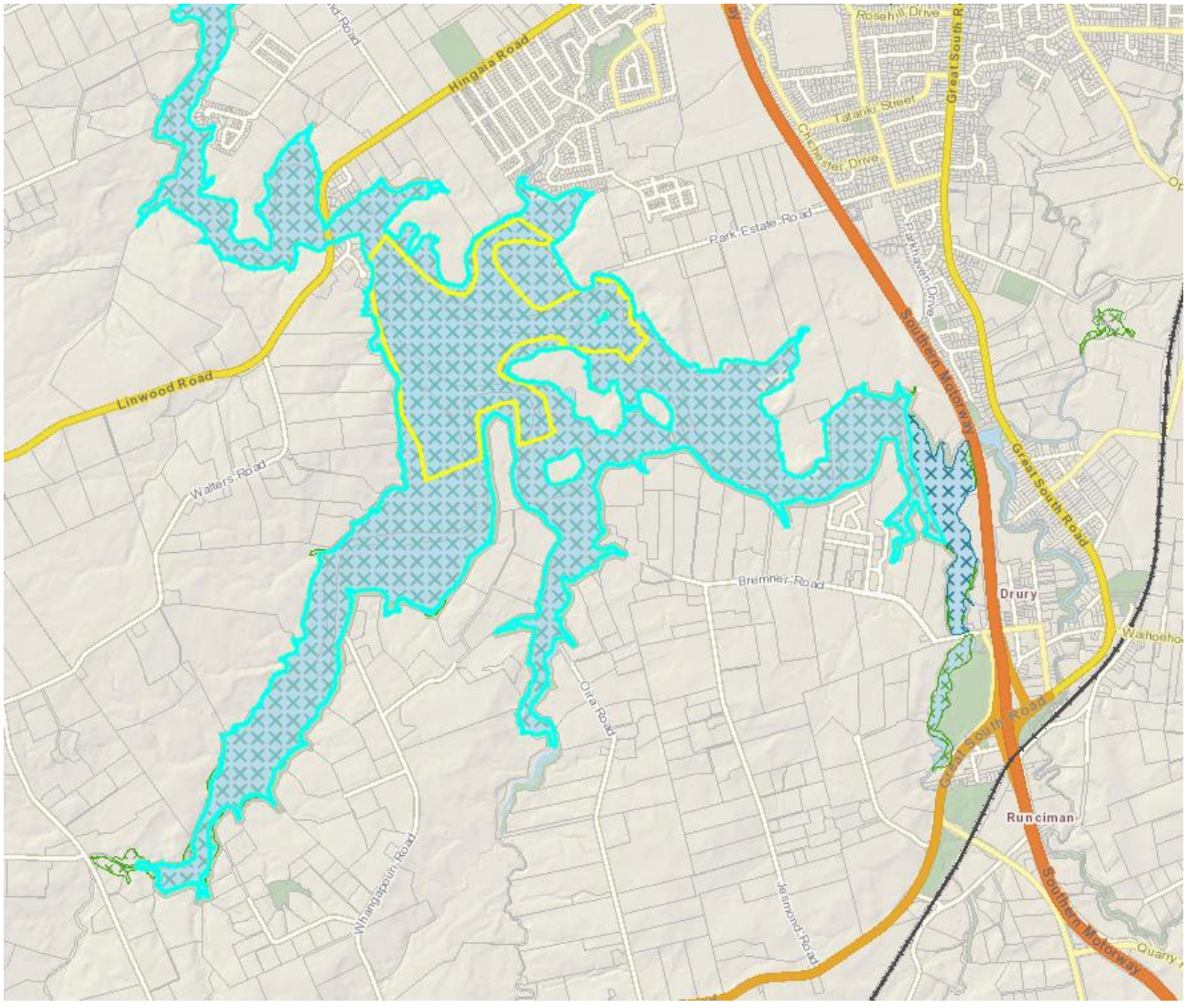

Figure 10: Significant Ecological Areas - Marine in the Pāhurehure Inlet and wider Drury Creek estuarine area

2.6.5 Pāhurehure Inlet

Drury Creek discharges into the Pāhurehure Inlet within the upper reaches of the ultimate receiving environment – the Manukau Harbour. Pāhurehure Inlet is classified as a 'Degraded 1' coastal water area under section B7 – Natural Resources of the Regional Policy Statement in the AUP. Degraded coastal water areas are progressively improved over time. Adverse effects of stormwater runoff and wastewater discharges on coastal waters are minimised and existing effects are progressively removed.

2.6.6 Manukau Harbour

The Pāhurehure Inlet and Channel flows into the Manukau Harbour. Manukau Harbour is the second largest harbour in New Zealand. It is home to many sharks and an important nursery area for fish. The latest Marine Report card by Auckland Council is from 2016 and rates the Manukau Harbour with an overall grade of D on a scale from A to F, which is based on water quality, contaminants in sediment and ecology. Water quality has been ranked as 'poor' due to elevated nutrients and more turbid water. Concentrations of contaminants are generally low in Manukau Harbour. Ecological health in the Manukau Harbour varies greatly from sites with the Pāhurehure Inlet ranked as 'unhealthy'.

2.6.7 Aquifers

There are two high-use aquifers mapped in the vicinity the Drury Centre and Drury East PCA (refer to Figure 11):

- Bombay-Drury Kaawa
- Drury Sand

These aquifers are within a High-Use Aquifer Management Area as shown in the AUP overlays. In general, high use aquifers are sensitive to increasing imperviousness which can result in a reduction in infiltration and aquifer recharge. Minimising reductions in infiltration as a result of development is an important consideration for the continuing viability of aquifer resources. Additionally, any stormwater discharge into the aquifer through injection should be preceded by water quality treatment to ensure there is no contamination of the aquifer.

As stated in the FUZ SMP "*The Drury Sand Aquifer is also in a 'Quality-Sensitive Aquifer Management' area. It is shallow and unconfined and therefore susceptible to pollution from surface sources such as excess fertiliser application or discharges of contaminants such as stormwater or sewage*".

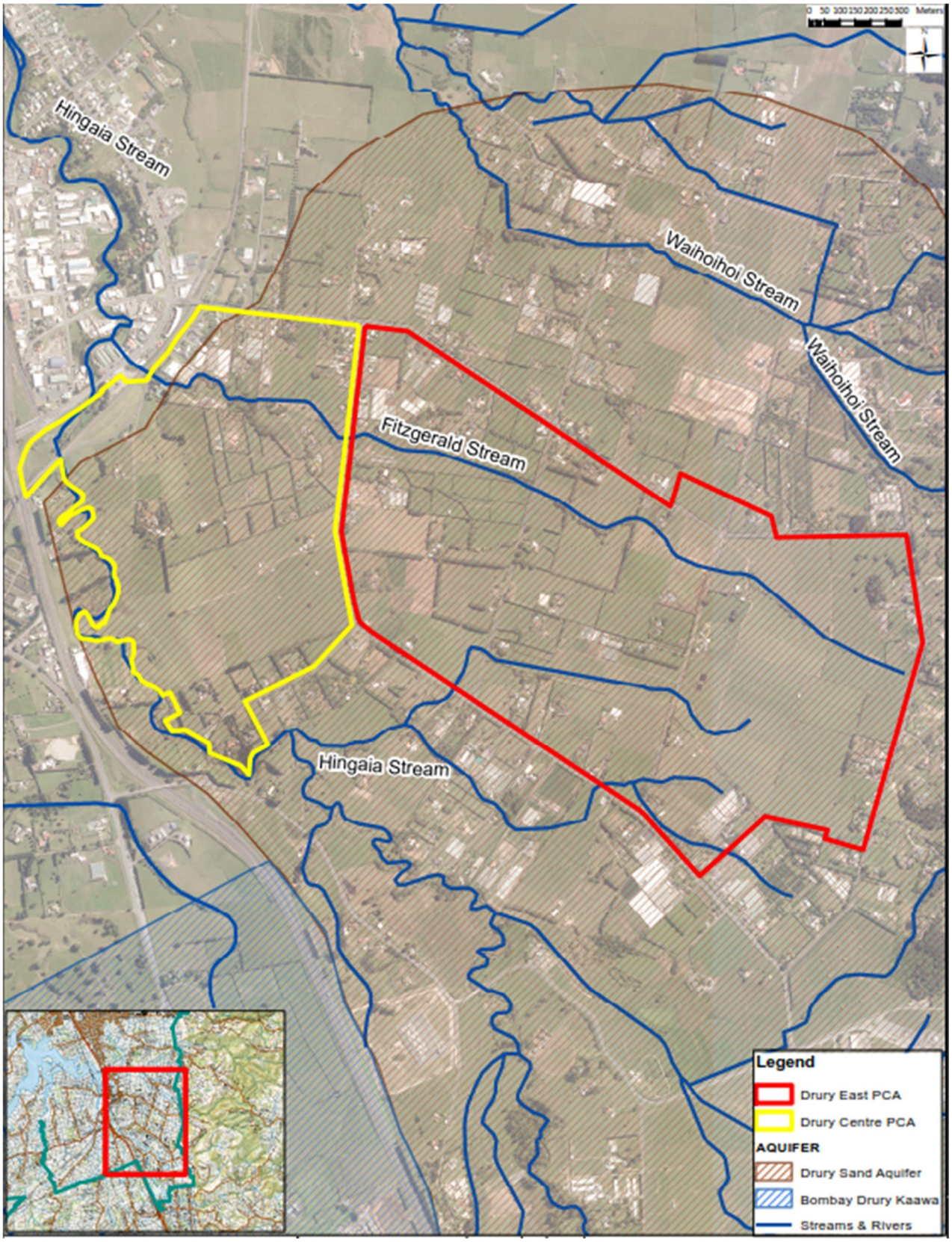

Figure 11: Aquifers in the vicinity of Drury Centre and Drury East

2.7 Flooding and flow paths

According to the FUZ SMP, "*the Slippery Creek and Hingaia Stream catchments (including the FUZ areas) have historically suffered from significant flooding. Due to past development within the floodplain the stream channel is highly constrained through the urbanised Drury Township at the downstream end of the catchment, [and accordingly,] Drury Township suffers from frequent and extensive flooding. The FUZ is also subject to flooding. Bridge and culvert infrastructure capacity is limited in places, resulting in overtopping of roads during large order events. Future development must consider the management of flooding, effects on other property and critical infrastructure, such as the North Island Main Trunk railway, Great South Road and SH 1.*"

The Hingaia and Slippery Creek catchments connect at the downstream end. The catchment response times for the Hingaia Stream and Slippery Creek are similar. This can result in flooding at the connection point for both these creeks near Drury Township.

Three flooding mechanisms have been considered to understand a more complete picture of the flooding issues within the Drury Centre and Drury East PCAs:

- Overland flow paths are topographical low points that become routes for stormwater conveyance. It is essential to identify the presence of overland flow paths within the PCA to ensure that they remain unobstructed and able to safely convey runoff in the post development scenario. Overland flow paths can also be permanent, intermittent, ephemeral and/or artificial watercourses
- Flood plains are areas predicted to be covered by flood water as result of a 100 year Annual Recurrence Interval (ARI) rainstorm event. In Auckland, the floodplain is defined by the 100 year (ARI) event, including an allowance for climate change and maximum probable development (MPD) scenario. The specifications for climate change include a temperature increase of 2.1°C, and a rainfall depth adjustment of 16.8% for a 100 year ARI storm event, in accordance with the Auckland Council Stormwater Flood Modelling Specifications 2011. A Maximum Probable Development (MPD) scenario has also been modelled as part of the specifications, to take into account the maximum impervious surface limits within the modelled catchment, and where land is zoned for future development, the probable level of development arising from zone changes
- Flood prone areas indicate topographical depressions that may fill with runoff rapidly during a storm event due to a lack of capacity or blockage of the outlet. They can be natural low points or constructed areas where water can pool (e.g. due to an embankment such as a road)

The figures included in the sub-sections below show the Auckland Council mapped overland flow paths floodplains and flood prone areas within and in the vicinity of the Drury Centre and Drury East PCAs, based on flood risk information for the Hingaia Stream catchment updated by the Auckland Council Stormwater Hydraulic Modelling team in October 2018.

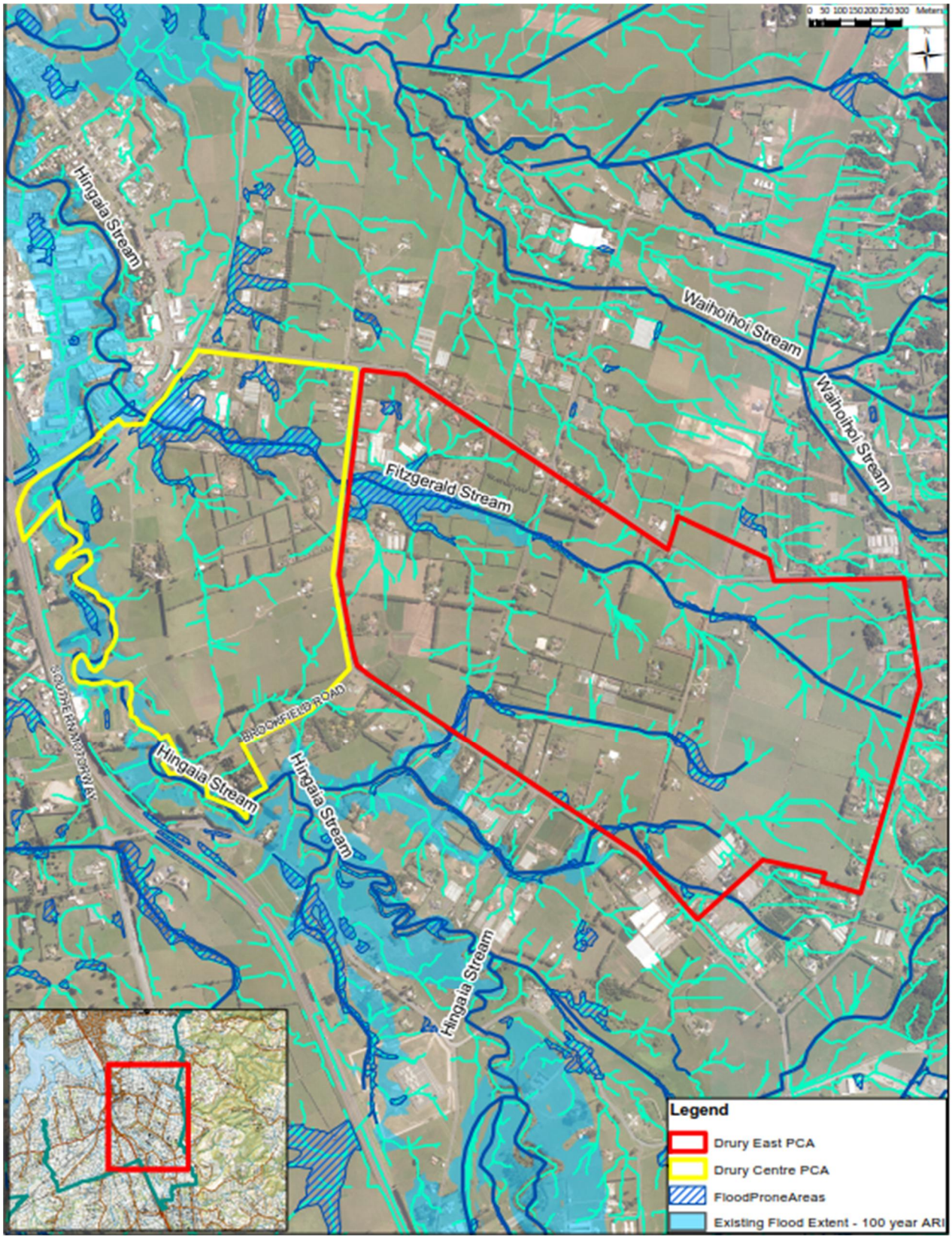

Figure 12: Existing floodplains and overland flow paths – Drury Centre (source: Auckland Council Geomaps)

2.7.1 Drury Centre

Existing overland flow paths have also been mapped by Auckland Council in the vicinity of the Drury Centre PCA, as shown in Figure 12. There are four main overland flows paths which are generally mapped along the same alignment as Fitzgerald stream, Hingaia Stream, Stream A (and extending further south) and a tributary of Hingaia Stream located outside the southern corner of the Drury Centre PCA. These main overland flow paths are fed by contributions from smaller overland flow paths where stormwater runoff has consolidated.

The modelled flood plain extents for the 100 year ARI storm event indicate that the floodplain follows the Hingaia Stream, and as a result, the existing floodplain is along the western boundary of the Drury Centre PCA. The mapped floodplain also follows the Fitzgerald Stream. 'Flood prone areas' within the Drury Centre PCA are located adjacent to the northern boundary along Waihoehoe Road, and along the Fitzgerald Stream traversing the PCA from south to north.

Flood prone areas sit within some of the flood plains within the PCA, particularly around Fitzgerald Stream.

2.7.2 Drury East

Auckland Council GeoMaps indicates three major overland flow paths generally mapped along the same alignment as Fitzgerald stream and tributaries of Hingaia Stream (refer to Figure 12). Existing undersized culverts along the Fitzgerald Stream under Fitzgerald Road and under the railway result in flows being constricted leading to upstream flooding.

There is also a mapped overland flow path shown entering the Drury East PCA at the eastern boundary by Drury Hills Road before continuing north along Drury Hills Road and into Slippery Creek catchment. Site observations and flood analysis found that this overland flow path skirts along the road corridors and does not enter the PCA.

The mapped flood plains and flood prone areas indicate that flooding is typically contained within the stream and gully features, with the exception of a perched culvert under Fitzgerald Road which acts as a flow constriction.

2.8 Coastal inundation

Coastal inundation is not a risk to the PCA based on the AUP management layers on Auckland Council GeoMaps, which is due to its elevation.

2.9 Biodiversity

2.9.1 T+T Ecological Assessment (2019)

Stream classifications from the T+T ecological assessment[4] are shown in Figure 6. All stream tributaries and wetlands within the PCA have unrestricted stock access and riparian margins are either bare or sparsely vegetated by predominately exotic species. The combination of poor bank stability, instream channel disturbance, ongoing agricultural related nutrient inputs, and minimal stream channel shading have resulted in the general degradation of these streams. Stream Ecological Valuation (SEV) assessments undertaken resulted in a score of 0.55, which reflects the 'moderate' current ecological function of these streams and is typical of rural streams in the Auckland region.

Onsite streams are likely important foraging and spawning habitats for native aquatic fauna (i.e. fish and macroinvertebrates) and wetlands provide important ecological function by filtering and improving water

[4] Tonkin + Taylor, June 2019, Drury Metropolitan Centre– Assessment of Ecological effects

quality. Known native fish populations (i.e. eels, bullies and galaxiids) have been recorded in the wider Hingaia Stream catchment and are likely to inhabit stream tributaries onsite, although fish barriers (i.e. perched culverts) are likely to present a partial or complete barrier to fish passage in some tributaries.

2.9.2 The Ecology Company Ecological Assessment (2019)

Stream classifications for the Drury East PCA were determined in The Ecology Company ecological assessment[5] and are shown in Figure 7. It is noted that this ecological assessment was undertaken during unusually dry weather and not all sites could be accessed, thus there are some differences between the assigned stream classifications and Auckland Council's assessment of the streams.

The ecological assessment describes the watercourses within the Drury East PCA as "*substantially altered by previous land uses* [...] *resulting in low aquatic habitat diversity, low aquatic biodiversity and poor water quality".* Furthermore, "*any original wetlands have been drained, filled or otherwise reclaimed, largely for agricultural purposes. These modifications have resulted in a near complete loss of wetland ecosystem types from the area along with the biota dependent on them. The ecosystem services provided by wetland systems including flow attenuation and water quality improvement have also been lost."* An SEV assessment will be completed as part of the future recourse consent process.

The ecological assessment concluded that "*the ecological values of the PCA are currently very limited, however there is considerable potential for the ecological values to be restored and enhanced across the PCA as it is developed and for ecological connections to be restored across the wider area via the use of riparian and other plantings*."

2.10 Cultural and heritage sites

Based on the information provided on the AUP management layers in Auckland Council GeoMaps, there are no known natural heritage, historic heritage or places of significance to Mana Whenua within the Drury Centre and Drury East PCA.

The outcomes of the consultation with mana whenua is summarised in Section 4 of this report.

2.11 Contaminated land

Not applicable within this SMP

[5] The Ecology Company, August 2019, Ecological values within the area affected by the proposed Drury East Plan Change

3 Development summary and planning context

The relevant planning and regulatory requirements for future stormwater management within the PCA have been informed by the initial site appraisal (summarised in Section 2 of this report) along with the requirements of the AUP, and are discussed in detail in the following sub-sections.

3.1 Regulatory and design requirements

A review of Auckland Council's regulatory and stormwater-specific guidelines has determined the stormwater management requirements. The relevant regulatory guidelines are listed in Table 6 and a summary on each of the listed requirements is presented in the sections that follow.

Table 6: Regulatory and design requirements

Requirement	Relevant regulatory / design to follow
Natural resources of the Regional Policy Statement	· AUP Chapter B7
Significant ecological areas	· AUP Chapter D9
Water quality and integrated management	· AUP Chapter E1
Stormwater management devices design	· GD01
Application of principles of water sensitive design	· GD04
Discharge and diversion	· AUP Chapter E8
High contaminant generating areas	· AUP Chapter E9
Hydrological mitigation	· AUP Chapter E10
Natural hazards and flooding	· AUP Chapter E36 · Auckland Council Stormwater Flood Modelling Specifications (2011). Auckland Council.
Auckland Council regionwide network discharge consent	· NDC Schedule 4
Structure Plan	· Drury- Opāheke Structure Plan (Auckland Council, 2019)
Catchment management plan	· Drury-Opāheke FUZ SMP (Mott MacDonald, DRAFT 2019)
Hydrology in Auckland Region	· Guidelines for Stormwater Runoff Modelling in the Auckland Region – Technical Publication 108 (1999). Auckland Regional Council.
Stormwater Management approach in the PAUP	· Auckland Unitary Plan stormwater management provisions: technical basis of contaminant and volume management requirements– Technical Report 2013/035 (2013). Auckland Council.

Requirement	Relevant regulatory / design to follow
Design and Construction of Stormwater systems for Land development and Subdivision	· Auckland Code of Practice: For Land Development and Subdivision (Chapter 4 - Stormwater) - November (2015). Auckland Council.
Detail on Stormwater Management including WSD, Flood Risk Management, Freeboard allowance etc.	· NZS4404 – Land development and Subdivision infrastructure.

3.1.1 Natural resources of the Regional Policy Statement

Chapter B7 of the AUP sets out policies for degraded coastal water, freshwater and geothermal water areas including an integrated management, the minimisation of the generation and discharge of contaminants in stormwater and the adoption of the BPO for every stormwater diversion and discharge. These are:

- Policy 4, 6 and 7 (B7.4.2.4, B7.4.2.6 and B7.4.2.7)

  Identify areas of coastal water and freshwater bodies that have been degraded by human activities and progressively improve water quality in areas identified as having degraded water quality through managing subdivision, use, development and discharges to avoid where practicable, and otherwise minimise, all of the following:
  - *significant bacterial contamination of freshwater and coastal water*
  - *adverse effects on the quality of freshwater and coastal water*
  - *adverse effects from contaminants, including nutrients generated on or applied to land, and the potential for these to enter freshwater and coastal water from both point and non-point sources*
  - *adverse effects on Mana Whenua values associated with coastal water, freshwater and geothermal water, including wāhi tapu, wāhi taonga and mahinga kai*
  - *adverse effects on the water quality of catchments and aquifers that provide water for domestic and municipal supply*
- Policy 8 (B7.4.2.8)

  Minimise the loss of sediment from subdivision, use and development, and

  manage the discharge of sediment into freshwater and coastal water, by:
  - *promoting the use of soil conservation and management measures to retain soil and sediment on land*
  - *requiring land disturbing activities to use industry best practice and standards appropriate to the nature and scale of the land disturbing activity and the sensitivity of the receiving environment*
- Policy 9 (B7.4.2.9)

  Manage stormwater by all of the following:
  - *requiring subdivision, use and development to:*
    - *minimise the generation and discharge of contaminants*
    - *minimise adverse effects on freshwater and coastal water and the capacity of the stormwater network*
  - *adopting the BPO for every stormwater diversion and discharge*
  - *controlling the diversion and discharge of stormwater outside of areas serviced by a public stormwater network*

3.1.2 Significant ecological areas

Chapter D9 of the AUP sets out policies regarding the management of stormwater runoff to receiving environments within a SEA overlay. The relevant stormwater policy is summarised below:

- Policy 2 (D9.3.2)

  Adverse effects on indigenous biodiversity values in significant ecological areas that are required to be avoided, remedied, mitigated or offset may include, but are not limited to, downstream effects on wetlands, rivers, streams, and lakes from hydrological changes further up the catchment

3.1.3 Water quality and integrated management requirements

Chapter E1 of the AUP contains the following relevant stormwater management policies:

- Policy 2a and 2b (E1.3.2a and E1.3.2b)

  Manage discharges, subdivision, use and development that affect freshwater systems to:

  - *maintain or enhance water quality, flows, stream channels and their margins and other freshwater values where the current condition is above the relevant thresholds (refer Table E1.3.1 of the AUP)*

    OR

  - *enhance water quality, flows, stream channels and their margins and other freshwater values where the current condition is below the relevant thresholds (refer Table E1.3.1 of the AUP)*

Policy E1.3.(2) identifies some 'national bottom lines' for stream health using the Macroinvertebrate Community Index (MCI) and directs that where the current condition is lower than the bottom line that these systems be enhanced. If the bottom line is met, then the current condition should be maintained or enhanced. The bottom line MCIs of 94 and 68 for rural and urban environments respectively are relevant to this assessment. An MCI score of 94 is indicative of 'fair' stream health (i.e., MCI range 80-99) whilst anything lower than 80 is deemed 'poor' and representative of a degraded aquatic system.

In the 2018 Hingaia Watercourse Assessment[6], a sample taken from the Fitzgerald Stream was indicative of poor water and habitat quality (MCIsb = 68). Just downstream of the Drury East PCA near Wykita Lane, a similar MCI of 67 was recorded. Under a future landuse of urban the national bottom line of 68 is not met and therefore Policy E1.3.2b takes precedence over Policy E1.3.2a as the MCI scores for the existing streams are below the guidelines in Table E1.3.1.

- Policy 3 (E1.3.3)

  Require freshwater systems to be enhanced unless existing intensive land use and development has irreversibly modified them such that it practicably precludes enhancement

- Policy 4 (E1.3.4)

  Discharges must avoid contamination that will have an adverse effect on the life supporting capacity of freshwater

- Policy 5 (E1.3.5)

  Discharges must avoid contamination that will have an adverse effect on health of people and communities

- Policy 8 (E1.3.8)

  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)*

[6] Hingaia Stream Catchment Watercourse, Assessment Report, July 2018, Auckland Council

- *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:*
    - *minimise erosion and associated effects on stream health and values*
    - *maintain stream baseflows*
    - *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*

· Policy 9 (E1.3.9)

Policy 9 in Section E1 (Policy E1.3.9) sets out the following policies for management of stormwater runoff from redevelopment of existing urban areas:

Minimise or mitigate new adverse effects of stormwater runoff; and where practicable progressively reduce existing adverse effects of stormwater runoff, on freshwater systems, freshwater and coastal waters during intensification and redevelopment of existing urban areas by all of the following:

- *requiring measures to reduce contaminates, particularly from high contaminate-generating car parks and high use roads*
- *requiring measures to reduce the discharge of gross stormwater pollutants*
- *requiring measures to be adopted to reduce the peak flow rate and volume of stormwater flows:*
    - *within sites identified in the Stormwater Management Area – Flow 1 and Flow 2 Control (as shown on the planning maps)*
    - *where development exceeds the maximum impervious area for the relevant zone; or*
    - *from areas of impervious surface where discharges may give rise to flooding or adversely affect rivers and streams*

· Policy 10 (E1.3.10)

An integrated stormwater management approach must have regard to all of the following:

- the nature and scale of the development and practical and cost considerations
- the location and design of site and infrastructure to protect significant site features and minimise effects on receiving environments
- the nature and sensitivity of receiving environments
- reducing stormwater flows and contaminants at source
- the use and enhancement of natural hydrological features and green infrastructure where practicable

· Policy 11 (E1.3.11)

Avoid, minimise or mitigate adverse effects of stormwater diversions and discharges

· Policy 12 (E1.3.12)

Manage contaminants in stormwater runoff from high contaminant generating car parks (> 50 cars*) and high use roads* (>5000 vehicles per day) *to minimise new adverse effects and progressively reduce existing adverse effects on water and sediment quality in freshwater systems and coastal waters*

· Policy 13 (E1.3.13)

Require Stormwater quality or flow management to be achieved on-site unless there is a downstream communal device

· Policy 14 (E1.3.14)

Adopt the best practicable option to minimise the adverse effects of stormwater discharges

- Policy 15 (E1.3.15)

  Utilise stormwater discharge to ground soakage where it is possible to do so in a safe and effective manner

3.1.4 Water sensitive design

Water-sensitive design is a philosophy that is integral to achieving integrated stormwater management, required by Policy 8 (E1.3.8). Water-sensitive design is defined 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."[7]

Water-sensitive design principles are further detailed in Guidance Document 2015/004 – Water Sensitive Design for Stormwater (GD04). The key principles for water sensitive design are summarised as follows:

- Promoting inter-disciplinary planning and design
- Protecting and enhancing the values and functions of natural ecosystems
- Addressing stormwater effects as close to source as possible
- Mimicking natural systems and processes for stormwater management

3.1.5 Discharge and diversion

Chapter E8 of the AUP sets out policies which regulate the diversion and discharge of stormwater runoff from impervious areas into or onto land, or into water, or into the coastal marine area. The objectives are consistent with Chapter E1 and E2 of the AUP. The general standards (E8.6.1) are summarised below:

- The design of the proposed stormwater management device(s) must have consistent with any relevant precinct plan that addresses or addressed stormwater matters
- The diversion and discharge must not cause or increase scouring or erosion at the point if discharge or downstream
- The diversion and discharge must not result in or increase the following:
  - *flooding of other properties in rainfall events up to the 10 Year ARI; or*
  - *inundation of buildings on other properties in events up to the 100 Year ARI*
- The diversion and discharge must not cause or increase nuisance or damage to other properties
- The diversion and discharge of stormwater runoff must not give rise to the following in any surface water:
  - *the production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials*
  - *any conspicuous change in colour or visual clarity*
  - *any emissions of objectionable odour*
  - *the rendering of fresh water unsuitable for consumption by farm animals; or*
  - *any significant adverse effects on aquatic life*

[7] Auckland Council, December 2017, Guidance Document 2017/001 (GD01) – Stormwater Management Devices in the Auckland Region

- Any existing requirements for ground soakage, including devices to manage discharges and soakage, must be complied with

For diversion and discharge of stormwater runoff from lawfully established impervious areas as at 30 September 2013 not directed to a stormwater network or combined sewer network (E8.6.2.2) the following policies also apply:

- As a result of a new land activity, a change in land use or the removal of existing stormwater management measures, stormwater flows and volumes and the concentration and load of contaminants in stormwater flows from the existing impervious areas must not be increased above those that would result from lawfully established impervious areas existing as of 30 September 2013
- Any existing stormwater management devices must not be reduced, and the location of discharge must not change

3.1.6 High contaminant generating areas

Chapter E9 of the AUP outlines the regional land use rules for managing stormwater runoff quality from high contaminant generating areas (HCGAs). Treatment of runoff is required for HCGAs (as defined in the AUP) including:

- High use roads (with greater than 5,000 vehicle movements per day)
- Car park areas with greater than 30 vehicles per day
- High contaminant yielding building and roofing materials
- Industrial/Trade sites listed as high risk in Schedule 3 will require assessment under the ITA rules which may result in treatment being provided
- Treatment of discharges to the CMA will be required due to the receiving environment being identified as a SEA

Stormwater runoff from the HCGAs is to be treated by stormwater management device(s) which is sized and design in accordance with GD01 or where alternative devices are proposed, the device must demonstrate it is designed to achieve an equivalent level of contaminant or sediment removal performance to that in GD01.

3.1.7 Hydrological mitigation

Hydrological mitigation seeks to minimise the change in hydrology, namely runoff volumes and flow rate, as a result of development. Chapter E10 of the AUP sets out a hydrological mitigation framework for brownfield sites which discharge to sensitive or high-value stream environments that have been identified as particularly susceptible to the effects of development. This framework must be applied to developments within the AUP management Stormwater Management Area Control – Flow 1 and Flow 2 (SMAF) overlay.

The PCA is a greenfield development and therefore does not fall within the AUP SMAF overlay. However, the general approach of this SMP is to provide a minimum of the SMAF 1 framework to provide hydrological mitigation for all impervious surfaces within the PCA. The SMAF 1 hydrological mitigation requirements in the AUP are:

- Retention (volume reduction) of at least 5 mm of runoff depth from impervious surfaces where possible with limitations set out in Table E10.6.3.1.1
- Detention (temporary storage) and a drain down period of 24 hours for the difference between the pre-development and post-development runoff volumes from a 95th percentile, 24-hour rainfall event minus the achieved retention volume, over the impervious area for which hydrology mitigation is required

Exceptions for providing retention can be made in cases where soil infiltration rates preclude disposal to ground and rainwater reuse is not possible. It is noted that if retention [8] cannot be met, devices are to be lined with the retention volume being treated as a detention through bioretention devices.

3.1.8 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:

- Policy 1 (E36.3.1)

  Identify land subject to natural hazards, taking into account the likely effects of climate change
- Policy 1 (E36.3.5)

  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)
- Policy 17 (E36.3.17)

  Avoid locating buildings in the 100 year ARI flood plain unless it can be design to be resilient to flood related damage
- Policy 20 (E36.3.20)

  Earthworks within the 100 year ARI flood plain should not permanently reduce floodplain conveyance or exacerbate flooding experienced by other sites upstream or downstream
- Policy 21 (E36.3.21)

  Ensure all development in the 100 year flood plain does not increase adverse effects or increased flood depths or velocities to other properties upstream or downstream of the site
- Policy 29 and 30 (E36.3.29 and E36.3.30)

  Maintain the function and capacity of overland flow paths to convey stormwater runoff safely and without damage to the receiving environment

3.1.9 Network Discharge Consent

The Auckland region-wide network discharge consent (NDC) came into effect in October 2019. The NDC allows for the stormwater diversion and discharges from developments to be incorporated under Auckland Council's consent, and for assets to be vested to Auckland Council, provided they comply with the NDC conditions.

The revised requirements and template for an SMP under the NDC are quite different to previous SMP formats and identify either a compliant approach or a BPO approach. The NDC requirements for greenfield developments, relevant to the PCA, and as stipulated in the NDC Schedule 4, are:

- Treatment of 100% of impervious areas by a water quality device designed in accordance with GD01/TP10 for the relevant contaminants
- Achieve equivalent hydrology (infiltration, runoff volume, peak flow) to pre-development (grassed state) levels. A method of achieving equivalent hydrology to pre-development (grassed state) is to provide retention (volume reduction) and detention (temporary storage) for all impervious areas to meet a minimum of SMAF 1

- Ensure that there is sufficient capacity within the pipe network downstream of the connection point to cater for the stormwater associated with the development in the 10 year ARI event, including incorporating flows from contributing catchment at MPD
- Buildings must not be flooded in the 100 Year ARI event

The requirement to provide water quality and hydrological mitigation to all impervious surfaces is more stringent than the regulations outlined in AUP, which only require treatment for high contaminant generating car parks and high use roads. It is common practice on greenfield developments to have treatment for all impervious areas (at least those generating contaminants, so if inert building materials are adopted it is expected that roofs can be excluded).

The intention is for this SMP to eventually be adopted into Auckland Council's Network Discharge Consent.

3.1.10 Drury-Opāheke development guidance

3.1.10.1 Drury-Opāheke Structure Plan

The Drury-Opāheke Structure Plan[9] provides a "blueprint" for urban development with the Drury-Opāheke FUZ. The key outcomes identified in this report with regards to stormwater and flood management are as follows:

- 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
- Protect and enhance the Blue-Green network that supports the area through water sensitive design, tree planting, parks, greenways and riparian enhancement margins. Auckland Council's Blue-Green network which was included in Drury-Opāheke Structure Plan in shown in Figure 13
- 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

Guidance for stormwater and flood management is also given in this report based on the Drury-Opāheke SMP (refer Section 3.1.10.2).

[9] Mott MacDonald, 12 April 2019, Drury-Opāheke Structure Plan Future Urban Zone – Stormwater Management Plan Version 04C prepared for Auckland Council

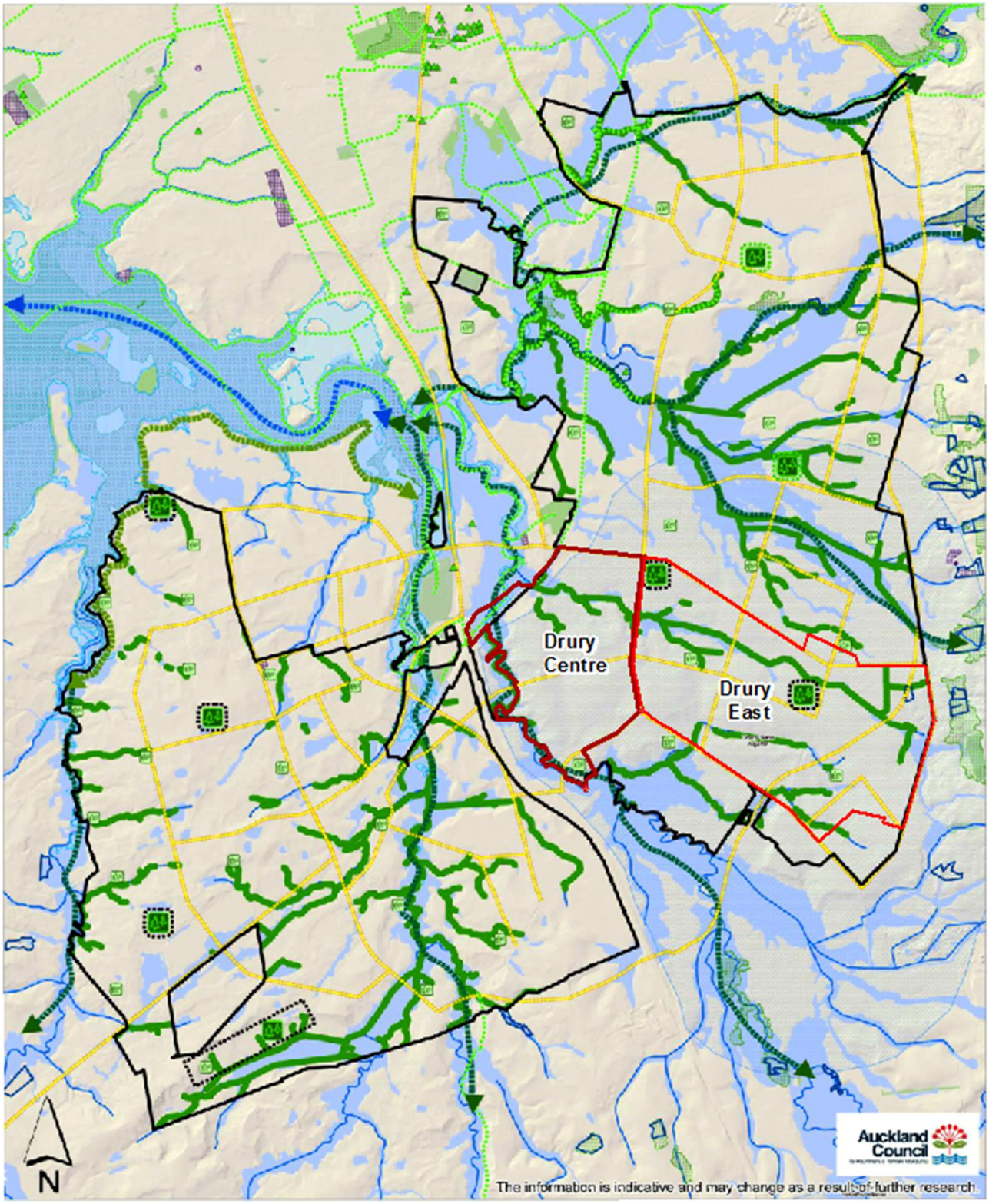

Figure 13: Blue-Green Network Map from Drury-Opāheke Structure Plan 2019

3.1.10.2 Drury-Opāheke Draft Stormwater Management Plan

Mott McDonald have produced a draft SMP for the Drury-Opāheke FUZ to support Auckland Council's Drury-Opāheke Structure Plan. The FUZ SMP recognises the key constraints and opportunities in the catchments and reflects the requirements of the AUP. The SMP 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 Manukau Harbour are minimised

To achieve these outcomes the SMP identifies a number of requirements for management of stormwater within the FUZ. The key requirements for the Hingaia Catchment are summarised below.

General

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

Water quality

- Treatment of all impervious areas (excluding non-contaminant generating areas) to be provided at or near source using devices such as swales, rain gardens and tree pits
- Use inert building materials
- Exemplary sediment and erosion control measures are to be provided during earthworks and construction
- Integrated green outfalls to be used when discharging to streams

Flooding

- The general management approach for the FUZ in the Hingaia Catchment will be to pass forward large storm event flows
- All buildings to be outside the 100 year ARI floodplain in accordance with E36.3.17 of the AUP. Avoid locating infrastructure in the 100 year ARI floodplain unless it can be designed to be resilient to flood damage
- Avoid increasing flood risk and flood extent upstream and downstream for all flood events up to the 100 year ARI
- Identify overland flow paths 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

Hydrological mitigation

- 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. An erosion assessment is to be carried out to determine if additional measures (such as additional detention requirements) are required to mitigate the hydrological impacts of development

Streams

- Protect and enhance all permanent and intermittent streams as directed in the AUP
- 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
- Provide distributed stormwater outlets into watercourses where possible, rather than single discharge points
- For essential stream crossings, bank-to-bank bridges with minimal riparian and stream bed disturbance are preferred
- Address erosion issues, both erosion hotspots and culvert erosion before and/or as urban development occurs. Details for each watercourse is provided in the Watercourse Assessment Report (refer Section 2.6)

4 Mana whenua matters

Consultation with Mana Whenua was undertaken separately for the Drury Centre and Drury East PCAs throughout the SMP development process. The outcomes of these discussions for each of the developments are summarised below and the points raised during the consultation have been reflected in the proposed integrated stormwater management approach within this SMP.

4.1 Identification and incorporation of mana whenua values

4.1.1 Drury Centre

The proposed stormwater management approach for the Drury Centre PCA was discussed during a hui with Mana Whenua on 29 July 2019 attended by representatives of the following Iwi groups:

- Ngāti Tamaoho
- Ngāti Te Ata
- Ngai Tai ki Tamaki

During the engagement process, Iwi expressed support for the adoption of the following stormwater and flood risk management approaches in the Drury Centre PCA:

- Promotion of rainwater harvesting tanks across the development area to achieve water re-use
- Integration of 'green' concepts, and the retention of green outfalls rather than pipe and headwall outfall structures
- Use of permeable pavements be limited to areas accessed by pedestrians and cyclists, to minimise contaminants from traffic leaking through the permeable pavement system and subsequently into groundwater sources
- Use of tree pits be limited, or designed, operated and maintained in such a way that they function without blockages and sediment 'washout'. Previous examples of tree pits functioning ineffectively and causing localised ponding were stated during the discussions
- Where wetlands are present, it was requested that they be used as secondary or tertiary stormwater and flood management devices. It was also requested that stormwater attenuation within wetlands is not included in the management approach

4.1.2 Drury East

The proposed stormwater management approach for the Drury East PCA was discussed during various hui and workshops with Mana Whenua. Details of these hui can be found in Appendix 18 to the Drury East Section 32 Assessment Report. These were attended by representatives of the following Iwi groups:

- Ngaati Whanaunga
- Ngāti Tamaoho
- Ngati Te Ata
- Ngāi Tai ki Tāmaki
- Waikato Tainui
- Te Akitai Waiohua

During the engagement process, Mana Whenua expressed their concerns in respect to the management of stormwater in the Drury East, as summarised below:

Treatment of stormwater runoff

Treatment of stormwater runoff prior to discharging to the receiving environment was identified as a priority during the consultation process. It was discussed at the hui that the quality of stormwater discharge during house construction stage also required consideration

Operation and Maintenance, Long term performance and Resilience

Mana Whenua expressed concern over operation and maintenance of stormwater management devices, particularly around upkeep of devices and performance in the long run. Solely relying on green infrastructure for providing stormwater mitigation requires Auckland Council to continually maintain the asset. Iwi stressed their concern over Auckland Council's ability to maintain the growing number of green infrastructure assets over the long term to ensure efficiency of devices are maintained.

Through these discussions, an alternative option of using proprietary devices such as Gross Pollutant Traps (GPTs) was tabled combined with communal green infrastructure devices. GPTs provide treatment of stormwater runoff prior to discharging to green infrastructure devices. In doing so, the performance and efficiency of green infrastructure devices would be increased, and the stress placed on adequate maintenance of the devices to ensure performance would decrease.

Similarly, GPTs have a periodical operation and maintenance schedule, the maintenance would be undertaken by a third-party contractor organised by the supplier of the devices which would guarantee timely and effective maintenance of the GPTs.

Using communal green infrastructure devices leads to a lesser number of devices when compared with the traditional at source bioretention devices. This would provide a cost saving and make the cost of maintenance more effective as the devices would be easier to maintain when located adjacent to streams versus on a road.

GPTs coupled with large green infrastructure devices would also provide pre-treatment of flows during the construction period of dwellings. This would eliminate the need to use at-source bioretention devices on roads, which would likely get damaged during construction.

Recharging of the ground water table and focus on maximising re-use

Retention via re-use of roof water in dwellings was also deemed a priority in stormwater management. The focus would be to maximise re-use within lots, greater than the required 5 mm as per AUP. Similarly, Mana Whenua were interested in retaining stormwater runoff and recharging the ground water table where possible and practical.

5 Stakeholder engagement and consultation

An overview of stakeholder engagement and consultation is provided in Section 9.3 of the Drury Centre Section 32 Assessment Report and Section 9.3 of the Drury East Section 32 Assessment Report.

6 Proposed development

Auckland is projected to reach a population of more than 2.4 million by the year 2047. Currently, it is anticipated that 400,000 new dwellings will be required to accommodate for this growth. The AUP has identified approximately 15,000 hectares of greenfield land around Auckland for future urban growth.

According to the Auckland Future Urban Land Supply Strategy[10] the Drury-Opāheke Future Urban area spans 1,149 hectares, with 8,200 proposed dwellings and a town centre. The majority of dwellings are sequenced for development between 2028 and 2032.

This section of the report summarises the planned future development in the Drury Centre and Drury East PCA, particularly as it relates to stormwater management.

6.1 Location and area

Refer to Section 2.2 for location and general information for the Drury Centre and Drury East PCAs and Section 2.3 for details on the Hingaia catchment.

6.2 Purpose of the development

The Drury East development comprises three PCAs:

Drury Centre

Kiwi Property is applying to rezone approximately 95 hectares of FUZ land to Mixed-Use, Metropolitan Centre and Open space zoning and apply the Drury Centre Precinct (refer to Figure 14). The extent of the Drury Centre PCA, including the extent of the PCA boundaries, is shown in Figure 3 and discussed in detail in Section 2.

Drury East

FHLD is applying to rezone approximately 187 hectares of FUZ land to a mixture of THAB, MHU, MHS and Mixed-Use zonings and apply the Drury East Precinct. The proposed zoning pattern is largely in accordance with the proposed structure plan zoning shown in Figure 15.

Waihoehoe

The SMP for the Waihoehoe Plan Change is being prepared separately.

[10] Auckland Council, July 2017, Auckland Future Urban Land Supply Strategy

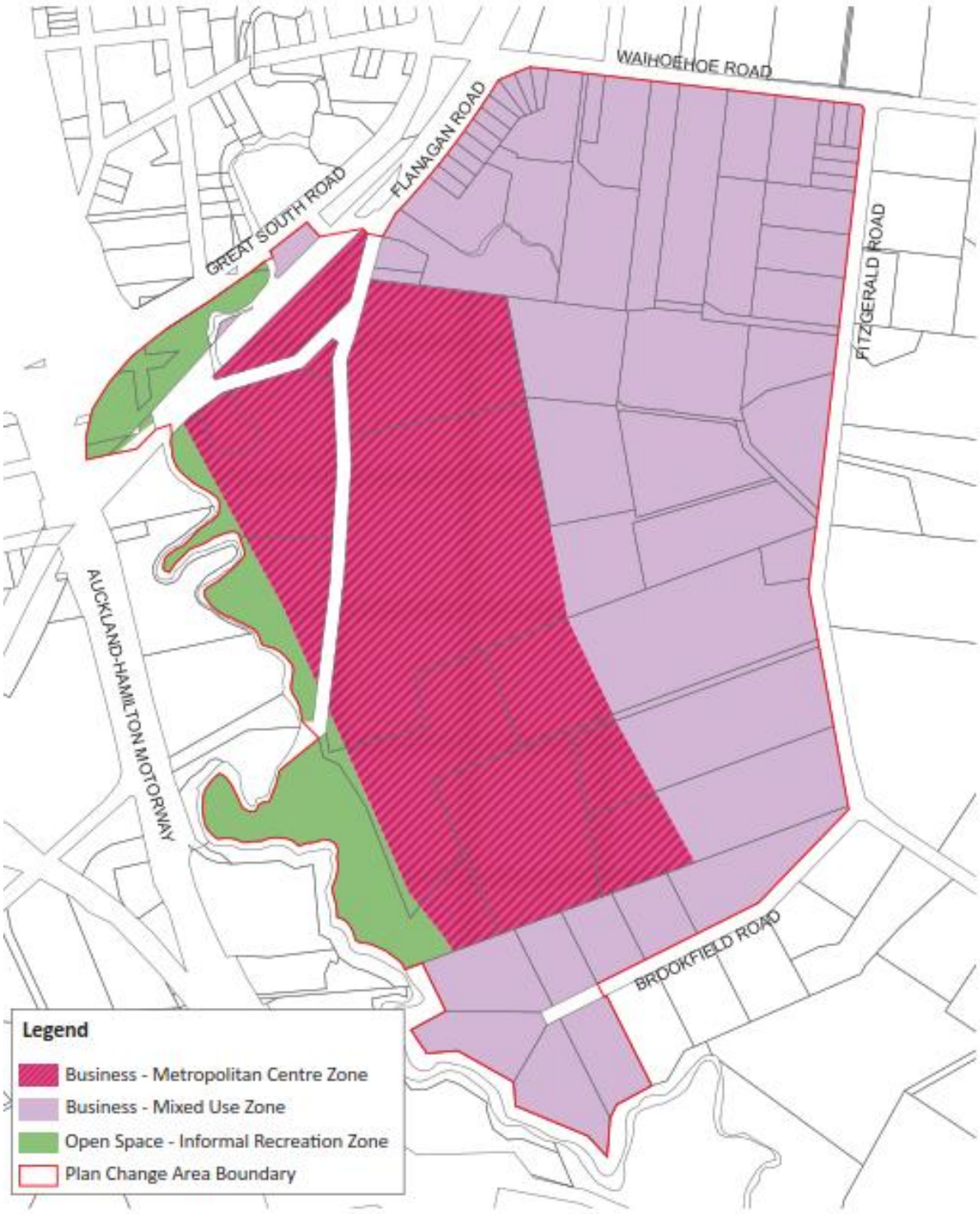

Figure 14: Drury Centre Zoning Plan

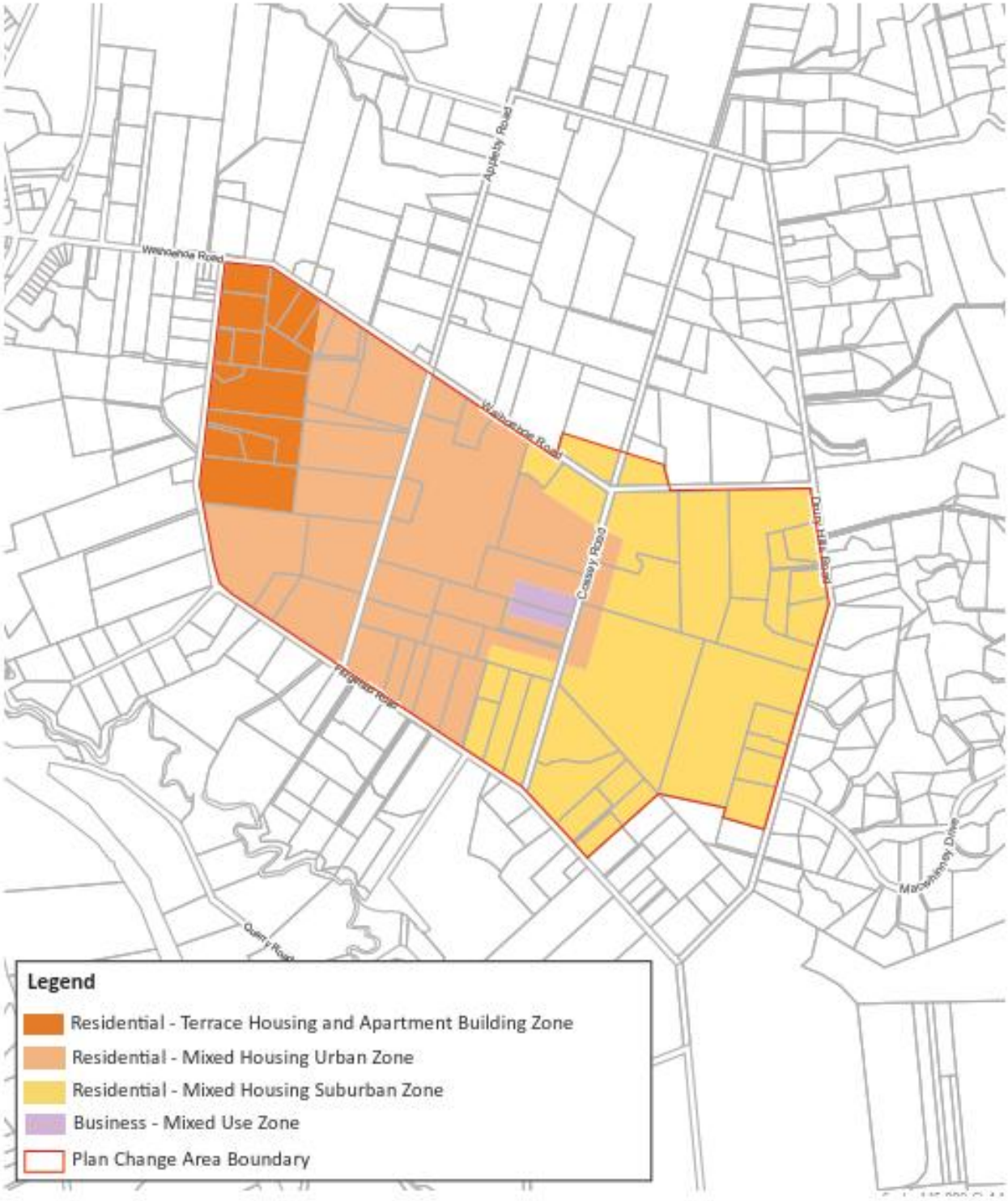

Figure 15: Drury East Zoning Plan

6.3 Site layout and urban form

6.3.1 Drury Centre

The Master plan for the Drury Centre PCA, prepared by Civitas 24 June 2019, is shown in Figure 16 and will include the following features:

- A rail/bus public transport hub adjacent to Flanagan Road and the main railway line at the north end of the Centre
- A Metropolitan Centre, extending south from the transport hub. The centre is likely to feature multi-storey development and a range of retail and commercial activities. Residential development is proposed within the centre
- An open space reserve is proposed along the western boundary of the Centre, encompassing the Hingaia Stream
- Several public parks are proposed to be located in areas of existing vegetation and natural features.
- A mixed-use zone is proposed to occupy the bulk of the remainder of the PCA to the east, south and northeast of the Metropolitan Centre. A range of commercial and residential land uses will occupy this area

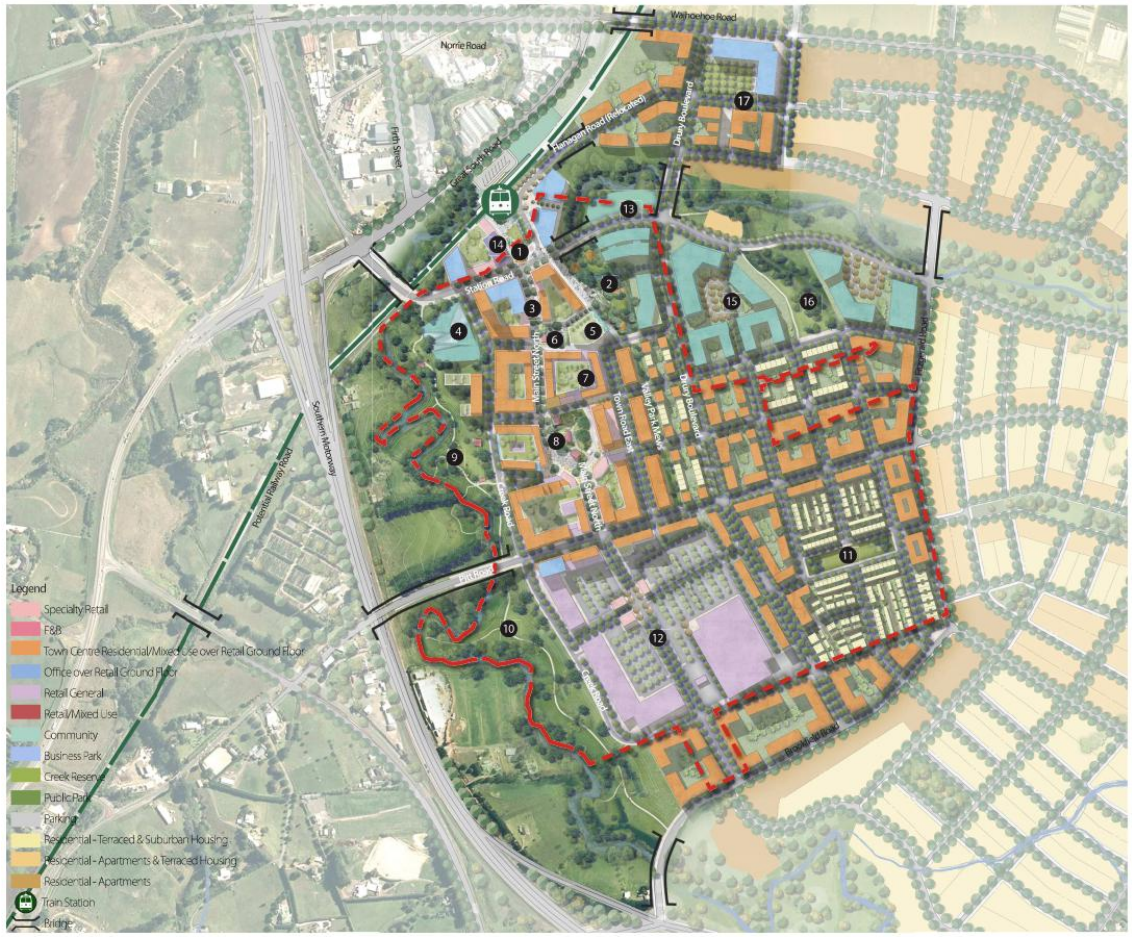

Figure 16: Drury centre masterplan layout (24 June 2019)

6.3.2 Drury East

A Master plan for the Drury East PCA has not been developed at this stage. The structure plan is included in Figure 17. As part of the development of Drury East, approximately 188 m of intermittent stream and 467 m of permanent stream will be removed. Where adverse effects on waterways and/or loss of reaches of intermittent or permanent streams cannot be avoided, then that adverse effect will be mitigated or compensated for.

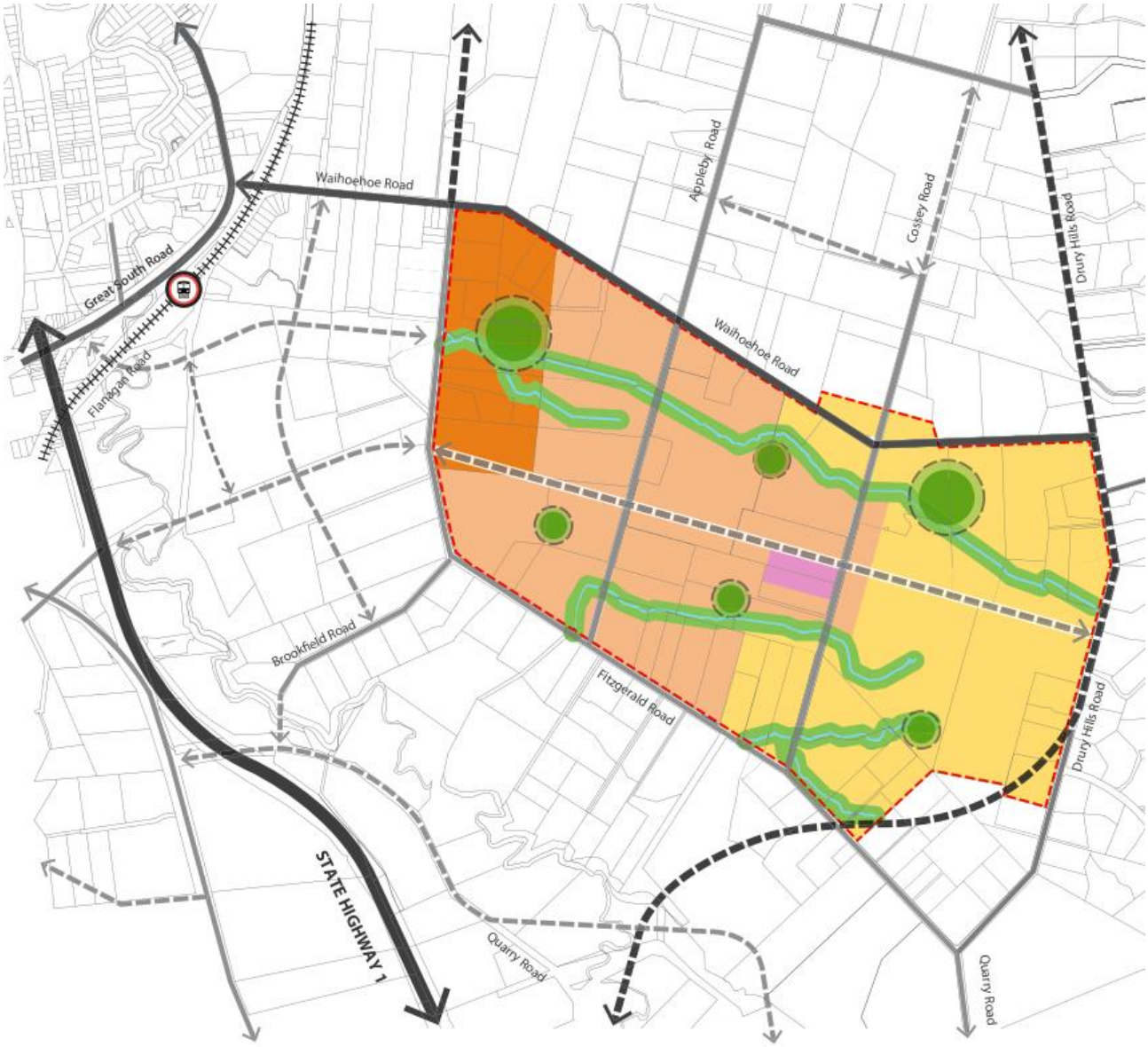

Figure 17: Drury East Draft Structure Plan

6.4 Earthworks and sub-catchments

6.4.1 Drury Centre

Blue Barn Consulting Engineers[11] have prepared an infrastructure report to support the Drury Centre Plan Change, which includes an assessment of earthworks required for the development. It states:

"*As the area proposed for the Metropolitan Centre and Mixed Use zones on the southern two thirds of the site are well elevated above the level of the 100-year floodplain as depicted on the Council flood hazard maps, any future development of the area will not be subject to inundation by flooding. Earthworks over the northern third of the plan change area will need to be designed so as to avoid any impact on the 100 year flood plain and the areas shown as being flood prone. On site overland flowpaths for runoff that cannot be conveyed through piped infrastructure will need to be provided to ensure that flow can be safely conveyed to the receiving environments. This overland flow will be redirected down future road carriageways and green swales to discharge into the existing permanent streams to avoid adverse effects of stream erosion or flooding. All buildings will be designed with appropriate freeboard in accordance with the AUP.*

The future earthworks for the development will be designed to achieve a cut fill balance over the Drury Metropolitan Centre Plan Change Area. The preliminary geotechnical investigations to date have confirmed that the underlying soils are suitable for a bulk cut to fill operation.

There will also likely be soft saturated alluvium soils in the valleys that will require removal as unsuitable material as part of the bulk earthworks exercise. These additional excavations will require replacement with engineered fill and appropriate underfill drainage.

There may also be non-engineered or non-documented fill in the vicinity of the existing railway, roads and industrial buildings that will need to be investigated as part of an extended geotechnical site investigation in due course."

The sub-catchments and existing discharge points that are described in section 2.3.1 will be maintained.

6.4.2 Drury East

The Drury East PCA does not have proposed layouts or earthworks plans at this stage. These will be developed as part of the detail design of the subdivision once the plan change is in place.

The sub-catchments and existing discharge points that are described in section 2.3.1 will be maintained, with the exception of a small portion of land located on the northern side of Waihoehoe Road. This portion currently discharges to Slippery Creek catchment, as discussed in Section 2.3. However, once developed, the landform is proposed to discharge to Hingaia Stream catchment.

[11] Blue Barn Consulting Engineers, 9 September 2019, Infrastructure Report for Drury Metropolitan Centre Plan Change (Document number 1486-RP-1858_Rev4)

7 Flooding

Detailed 1D – 2D Flood modelling has been developed using the Auckland Council flood model for the Hingaia Stream catchment.

Councils flood modelling has been undertaken using the MIKE FLOOD Software suite developed by DHI Water and Environment. This is a dynamically coupled 1D-2D model of the Hingaia Stream which has been updated to the latest MIKE FLOOD version 2017 SP0 software release.

The one-dimensional river model uses a number of surveyed structures and stream cross sections in the vicinity of the development site. The two-dimensional model has been developed using the 2013 LiDAR data converted into a 1 m grid to represent the existing terrain.

Council's Drury South post-development model was used as the base for the Drury East post-development model in discussion and agreement with Healthy Waters. The post-development model has been developed to include the proposed terrain and landform/ land use changes proposed for the PCAs.

7.1 Initial Modelling

Initial modelling was undertaken and shared with Council as part of the plan change application. The associated assessments and documents are listed below (memos included in Appendix C1):

- *Drury Town Centre – Kiwi Property – Model Build* memo prepared by T+T and issued 17 June 2019
- *Drury Flood Modelling – Effects of Proposed development* memo prepared by T+T and issued 9 July 2019
- *Stormwater Management Plan – Drury Metropolitan Centre (Kiwi Property Trust Ltd)* report prepared by T+T and issued in August 2019 (Job Number: 1003297.v4)
- *Stormwater Management Plan – Drury East (Fulton Hogan Land Development)* report prepared by Woods and issued 08 November 2019 (Project Number: P16-335)
- *Drury East flood modelling - response to Auckland Council modelling request* memo prepared by T+T and Woods and issued 31 January 2020

Modelling was undertaken for 10 year and 100 year ARI scenarios as tabulated in Table 7 below. All the post-development models incorporate the proposed Great South Road culvert upgrade which has been discussed further in Section 8.2.6. The model results confirmed that there were no differences in water levels or flood extents, indicating changes in flood levels are less than minor.

7.2 Additional Flood Modelling

Further flood modelling and flood analysis was undertaken in response to Auckland Council Further Information Request and after discussion with Healthy Waters. These discussions were recorded in the following documents included in Appendix C1:

- *Drury East (Kiwi and Fulton Hogan) flood modelling – response to Auckland Council modelling requests* memo prepared by T+T and issued 10 February 2020
- *Drury East (Kiwi and Fulton Hogan) flood modelling – response to Auckland Council modelling requests V2* memo prepared by T+T and issued 19 February 2020

The work undertaken involved the following tasks as detailed in Table 7 and Table 8 below:

- Mapping the buildings with floors at risk from flooding for the 10-year ARI and 100-year ARI model runs for the pre- and post-development scenarios (termed as 'Full Catchment Flood Scenarios')

- Mapping the buildings with floors at risk from flooding for the 10-year ARI and 100-year ARI model runs for the development scenarios assuming there are no upstream inflows (termed as 'Development Only Scenarios')

The outcomes from this analysis were documented in the *Response to Auckland Council Further Information Request on Stormwater Matters for Drury East* memo prepared by T+T and Woods and issued to Healthy Waters on 25 March 2020 (refer to Appendix E).

Table 7: Model matrix – Catchment Models

Scenario	Great South Road tributary culvert status	Land use outside Fulton Hogan and Kiwi Property Plan Change Area	Land use within Fulton Hogan and Kiwi Property Plan Change Area	Event	Climate Change
Pre-development Model	Existing Culverts	10% Imperviousness within FUZ; Drury South – Post-development; Upstream rural zonings at 10% imperviousness	10% Imperviousness within FUZ (including PCA)	2 year	Yes
				10 year	
				100 year	
Post-development Model	Culverts open with post-development landforms within Plan Change areas (these culverts will be designed for 100 year conveyance capacity based on pass flows forward approach)	10% Imperviousness within FUZ; Drury South – Post-development; Upstream rural zonings at 10% imperviousness	Imperviousness for Metropolitan Centre = 100% Imperviousness for Kiwi Property land = 70% Imperviousness for Fulton Hogan land = 65% Future Urban Zone outside of Plan Change Area = 60%	2 year	yes
				10 year	
				100 year	
				2 year	No

Table 8: Model matrix – Development Only Models

Scenario	Model ID	Event	Climate Change	Model Changes
Pre-development Model	08	10 year	Yes	Hingaia Stream river branch was modelled with inflows of $30m^3/s$ and $50m^3/s$ are applied for 10 year and 100 year scenarios respectively along Hingaia Stream (upstream)
	09	100 year		
Post-development Model	10	10 year		
	11	100 year		

The results confirmed that the total number of properties flooded are unchanged, for the 'Development Only' as well as Catchment models for the scenarios analysed. This confirms there is no additional flood risk to habitable floor or properties with the proposed development in place. The buildings at flood risk are tabulated here in Table 9 below.

Table 9: Building footprints at Flood Risk

Scenario	Flood Risk	Development Only Model	Catchment Model

	Building Flooding	Pre - development Model	Post - development Model	Pre - development Model	Post - development Model
2 year without Climate Change	Above Floor Level	n/a	n/a	-	-
	Below Floor Level	n/a	n/a	1	1
	Flood Depth > 0.15m	n/a	n/a	-	-
	Flood Depth < 0.15m	n/a	n/a	1	1
	Total Flooded properties	n/a	n/a	2	2
2 year with Climate Change	Above Floor Level	n/a	n/a	-	-
	Below Floor Level	n/a	n/a	1	1
	Flood Depth > 0.15m	n/a	n/a	-	-
	Flood Depth < 0.15m	n/a	n/a	1	1
	Total Flooded properties	n/a	n/a	2	2
10 year with Climate Change	Above Floor Level	-	-	-	-
	Below Floor Level	4	4	7	7
	Flood Depth > 0.15m	1	1	2	2
	Flood Depth < 0.15m	1	1	1	1
	Total Flooded properties	6	6	10	10
100 year with Climate Change	Above Floor Level	2	1	9	7
	Below Floor Level	10	12	27	29
	Flood Depth > 0.15m	5	4	14	13
	Flood Depth < 0.15m	1	1	-	-
	Total Flooded properties	18	18	50	49

- Above Floor level: Model water level > Building Floor Levels (provided by Auckland Council)
- Below Floor level: Model water level < Building Floor Levels (provided by Auckland Council)
- Flood Depth > 0.15m: Model flood depth > 0.15m at building where floor level is not available
- Flood Depth < 0.15m: Model flood depth < 0.15m at building where floor level is not available

The number of buildings attributed for 100 year with Climate Change scenario for 'Development Only' is highlighted differently in the table as the total number of flooded properties are unchanged but there is an improvement with one property which flooded above floor level, floods below floor level for the post-development scenario.

7.3 Pre-notification Flood Modelling

7.3.1 Model scenarios

Further modelling was undertaken in consultation with Healthy Waters team to incorporate the latest Hingaia Stream catchment model improvements to be used for effects assessment. Table 10 below provides the scenarios modelled.

Table 10: Pre-hearing Model matrix

Scenario	Great South Road tributary culvert status	Event	Land use outside Plan Change Area	Land use within Plan Change Area	Climate Change	Purpose
Pre-development Model	Culverts existing	2 year	Existing (1-3%)	Existing (1-3%)	No	Effects Assessment
		10 year				
		100 year				
Post-development Model	Culverts open, post-development landform for PCA	2 year		Imperviousness for Metropolitan Centre = 100% Imperviousness for Kiwi Property land = 70% Imperviousness for Fulton Hogan land = 65% Future Urban Zone outside of Plan Change Area = 60%		
		10 year				
		100 year				
		10 year	60% Imperviousness within FUZ; Drury South – Post-development; Upstream rural zonings (MPD) - as per Base Hingaia Stream Model		Yes	Hazard Risk Assessment
		100 year				

7.3.2 Modelling Approach

The model hydrology was updated to reflect the land uses for the tabled scenarios with separate overlapping catchments modelled for pervious and impervious areas using Mike 11 Rainfall Runoff (RR) module.

Each catchment was modelled as overlapping catchments representing pervious and impervious component as detailed below:

- Catchment boundaries and names as per Hingaia Stream model
- Slope and Stream lengths as per Hingaia Stream model
- Rainfall profiles unchanged as per Hingaia Stream model
- Pervious Curve Numbers unchanged as per Hingaia Stream model and 98 for impervious catchments
- Initial abstraction is assumed as 0 for impervious catchments and 5 for pervious catchments
- Lag times for pervious and impervious are unchanged as per Hingaia Stream model
- ARF of 0.92 as per Hingaia Stream model
- Catchment loading unchanged as per Hingaia Stream model
- Catchment HING_345 (Quarry) modelled with zero area as per previous model in Mike 11 nwk file as per Hingaia Stream model

For Existing situation, impervious areas were calculated for each catchment using the following datasets:

- Building footprints
- Impervious surfaces

For MPD situation, impervious areas were calculated for each parcel based on Unitary Plan and further determined for each catchment. Imperviousness for parcels within Rural zonings were calculated based on the rule that the maximum permitted impervious areas per lot is 5000 m^2.

Table 11: Unitary Plan imperviousness

Zone	Imperviousness %
Rural - Mixed Rural Zone	calculate
Rural - Rural Coastal Zone	calculate
Open Space - Conservation Zone	calculate
Open Space - Informal Recreation Zone	calculate
Rural - Rural Production Zone	calculate
Business - Light Industry Zone	90%
Strategic Transport Corridor	100%
Road	90%
Business - Neighbourhood Centre Zone	100%
Rural - Countryside Living Zone	25%
Special Purpose - Quarry Zone	80%
Businesss - Heavy Industry Zone	100%
Coastal - General Coastal Marine Zone	100%
Business - Local Centre Zone	100%
Business - Metropolitan Centre Zone	100%
Business - Town Centre Zone	100%
Coastal - Coastal Transition Zone	0%
Business - Mixed Use Zone	100
Residential - Single House Zone	60%
Mixed Housing Suburban	60%
Residential - Mixed Housing Urban Zone	60%
Residential - Terrace Housing and Apartment Buildings Zone	70%
Residential - Rural and Coastal Settlement Zone (Hingaia Stream catchment)	35%
Open Space - Community Zone	70%
Special Purpose - Cemetery Zone	60%
Water	100%
Open Space - Sport and Active Recreation Zone	40%
Special Purpose - School Zone	70%

No other changes were made to the model.

7.3.3 Model Results

Model results were analysed to extract the flood extents, peak water levels and flood depths for all building footprints (within downstream areas and PCAs) for each scenario to understand the flood risk for the pre- and post-development scenarios. The intention of this assessment was to understand if there is any increase in flood risk to properties downstream of the PCAs with the increases in flows associated with higher imperviousness within these developments and also to understand the risk to the PCAs with any future upstream development.

Approach identified for understanding Flood Risk for buildings was as below:

- Peak modelled Flood levels were extracted for buildings footprints where floor levels were available
- Peak Flood Depths were extracted for buildings footprints where floor levels were not available and habitable floor level was assumed to be 150 mm above the respective ground levels
- Flood maps were generated for all scenarios (provided in Appendix C1) to understand the differences

Table 12: Pre-notification Modelling - Building footprints at Flood Risk

Scenario	Flood Risk	Development only Model	
	Building Flooding	Pre-development Model	Post-development Model
2 year ED without Climate Change	Above Floor Level	0	0
	Below Floor Level	0	0
	Flood Depth > 0.15m	0	0
	Flood Depth < 0.15m	2	2
	Total Flooded properties	2	2
10 year ED without Climate Change	Above Floor Level	0	0
	Below Floor Level	0	0
	Flood Depth > 0.15m	1	1
	Flood Depth < 0.15m	1	1
	Total Flooded properties	2	2
100 year ED without Climate Change	Above Floor Level	8	8
	Below Floor Level	19	19
	Flood Depth > 0.15m	9	8
	Flood Depth < 0.15m	0	0
	Total Flooded properties	36	35

- Above Floor level: Model water level > Building Floor Levels (provided by Auckland Council)
- Below Floor level: Model water level < Building Floor Levels (provided by Auckland Council)
- Flood Depth > 0.15m: Model flood depth > 0.15m at building where floor level is not available
- Flood Depth < 0.15m: Model flood depth < 0.15m at building where floor level is not available

7.3.4 Conclusions

The analysis concluded that:

- There is no flood risk to the proposed developments within PCAs for all the scenarios listed below
- The PCAs can pass upstream MPD with Climate Change flows through the site with no increased risk to the proposed development
- There is no increased flood risk to buildings within Drury township when comparing pre- and post-development scenarios (see number of buildings at flood risk tabulated above)
- There is a slight increase in flood extent within Drury Township (area between Norrie Road and Great South Road) for 100 year scenario when comparing post-development to pre-development scenario but no change in flood risk to the buildings therein

- There is a slight local increase in flood depth along the stream to the south of Fulton Hogan site discharging towards Drury South with pass flows forward approach but there is no increased risk to any habitable floors

8 Stormwater management

This section presents the integrated approach to post-development stormwater management across all three Drury East PCAs. The approaches are consistent with regulatory, Hingaia catchment management plans and stormwater-specific guidelines. The approaches incorporate feedback from the Mana Whenua. The stormwater management plan provides the framework consents and development.

8.1 Principles of stormwater management

The stormwater management principles for the integrated stormwater management approach described below are consistent with:

- Site-specific constraints and opportunities identified and presented in Section 2
- AUP policies on integrated stormwater management, region-wide NDC, and draft FUZ SMP as outlined in Section 3

8.1.1 Original principles

The stormwater management approach seeks to implement an integrated stormwater management approach for all three Drury East PCAs, which includes:

- Facilitate urban development and optimise available land
- Recognise the key constraints and opportunities on site and in the Hingaia and Slippery Creek catchments
- Develop a set of BPOs for stormwater that can be incorporated into the development
- Emphasise a water sensitive design approach that:
  - manages the impact of land use change from rural to urban
  - minimises or mitigates the adverse effects on water quality, freshwater systems, stream health and ecological values of the receiving environment through the implementation of stormwater management devices; this includes tributaries of the Hingaia Stream and Slippery Creek
  - protects and enhances stream systems and riparian margins
- Minimise the generation and discharge of contaminants/sediments into the sensitive receiving environment of the Drury Creek and Manukau Harbour, including changes in water temperature caused by stormwater discharges
- Recognise a Blue-Green approach with the stormwater management system to integrate “blue” aspects of the PCA (the streams and flood plains) and the “green” aspects of the environment (indigenous biodiversity and ecological significance, and the parks and reserves)
- Protect key infrastructure, people and the environment from significant flooding events. Not worsen downstream flooding

8.1.2 Updated principles

Not applicable within this SMP

8.2 Proposed stormwater management

This section of the SMP presents the detail of the proposed stormwater management approach. The approach is generally consistent with the NDC requirements and FUZ SMP recommendations, and where it is not this section demonstrates why the proposed option is the BPO for the development.

8.2.1 Summary

The proposed approach, based on water sensitive design to deliver water quality, conveyance, hydrological and flood mitigation outcomes, comprises:

- Preserving, protecting and enhancing streams and floodplains in the Blue-Green network, which can also provide amenity and connectivity with communities
- Eliminating and minimising the generation of contaminants. Provide near-source water quality treatment of runoff for all contaminant generating impervious surfaces. Water quality treatment to target sediment, metals and gross pollutants should be provided. Green infrastructure is preferred
- Providing a minimum of SMAF 1 hydrological mitigation for all impervious surfaces within the Drury Centre and Drury East PCAs. Intervene with stream erosion mitigation methods
- Generally adopting the "Pass forward flows" flood management approach, but for Fitzgerald Stream provide temporary on-site flood attenuation to mitigate changes within the 100 year flood plain attributed to the development of the PCA before the downstream network is upgraded

A matrix of stormwater management outcomes (as described above) and corresponding tools for different land use zones are presented in Table 13. This toolbox has been developed to show alignment of stormwater quality, hydrological mitigation and flood attenuation approaches across all three Drury East PCAs. In addition, a broad range of BPOs for mitigating effects and/or achieving these outcomes are listed for the corresponding land-use.

This toolbox will be used to develop an integrated stormwater management approach for the Drury East PCAs, with different devices and/or combinations may be adopted across the three Drury East PCAs to achieve the same performance outcomes. This creates performance standards as consistent as possible across the three Drury East PCAs, and provides a stormwater management toolbox as broad as possible to allow for flexibility of implementation.

Table 13: Stormwater Management Toolbox

Zone	Land Use	Performance Outcomes				Toolbox	Notes
		Water Quality	Hydrological Mitigation	Flood Attenuation	Water Sensitivity Design [1]		[1] The proposed stormwater management options adopt a Blue-Green network approach that includes other devices or measures which are not listed in this table i.e. filter strips, green outfalls (where practicable), streams protected and enhanced with riparian buffer and re-vegetation planting. The need for bank stabilisation/instream works to be determined by stream erosion assessments. [2] Stormwater Management Devices in the Auckland Region –Guideline Document 20017/001 (GD01). (December 2017). Auckland Council Eliminate or minimise the generation and discharge of contaminants. Treat all contaminant generating impervious areas at or near source by a water quality device designed in accordance with GD01 to target sediment, metals and gross pollutants. Elimination of contamination generation is considered the BPO option so if inert roofing materials are used, these impervious surfaces will not generate contaminants and therefore will not require water quality treatment. [3] AUP Auckland Council The PCA does not fall within a Stormwater Management Area - Flow 1 (SMAF 1) overlay but this will be adopted as the minimum requirement across all three sites. This stormwater management approach is consistent with Policy E1.3.10. The minimum hydrological mitigation requirements proposed are as follows: • Retention (volume reduction) of at least 5mm of runoff depth from impervious surfaces • Detention of the 95th percentile event for the difference between the pre-development and post-development runoff volumes from a 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 ground and rainwater reuse is not possible. It is noted that if retention cannot be met, devices are to be lined with the retention volume being treated as a detention through bioretention devices. An erosion assessment is to be carried out to determine if additional measures (such as additional detention requirements) are required to mitigate the hydrological impacts of development. [4] No increase in peak flood level effects to properties upstream and downstream of the PCAs [5] Devices will be provided and sized for WQ treatment for carparks (greater than 30 vehicles) only for the Residential Zones. [6] Includes the option for large communal devices to provide treatment and hydrology mitigation to public roads and impervious areas. Gross Pollutant Traps (GPT) or alternative proprietary devices will be installed upstream of communal devices. The communal devices may be dual-purpose as they could also provide flood attenuation, if required. [7] Hydrology mitigation will be provided for these impervious areas. Bio-retention devices generally have the added benefit of providing WQ treatment too.
Performance standard		GD01[2]	AUP: SMAF 1 minimum[3]	100 Year ARI: Not worsen downstream flooding [4]			
Mixed use Metropolitan Centre	Roads	✓	✓	X	✓	Bio-retention devices including: · Raingardens · Tree pits · Vegetated swales	
	Carparks	✓	✓	✓	✓		
	Other	✓[2]	✓	✓	✓	Inert Building materials Rainwater tanks for re-use of roof runoff Permeable pavements for public realm areas Communal detention devices	
Mixed Housing – Urban Mixed Housing – Suburban Terraced Housing Apartment Buildings	Roads	✓	✓	✓[6]	✓	Communal devices[5] Bio-retention devices including: · Raingardens · Tree pits · Vegetated swales	
	Carparks > 30 Vehicles	✓[5]	✓	✓[6]	✓		
	Roofs, jointly-own access lot driveways, driveways, gardens/landscaping	X✓[7]	✓	✓	✓	Inert Building materials Rainwater tanks for re-use of roof runoff Permeable pavements for driveways or laneways Communal devices[5] Bio-retention devices including: · Living Roofs · Raingardens · Tree pits · Vegetated swales	

8.2.1.1 Example and explanation of communal devices

Two examples of appropriately selected stormwater management strategies for the Drury East PCA are presented in Figure 18 to demonstrate how this toolbox could be applied.

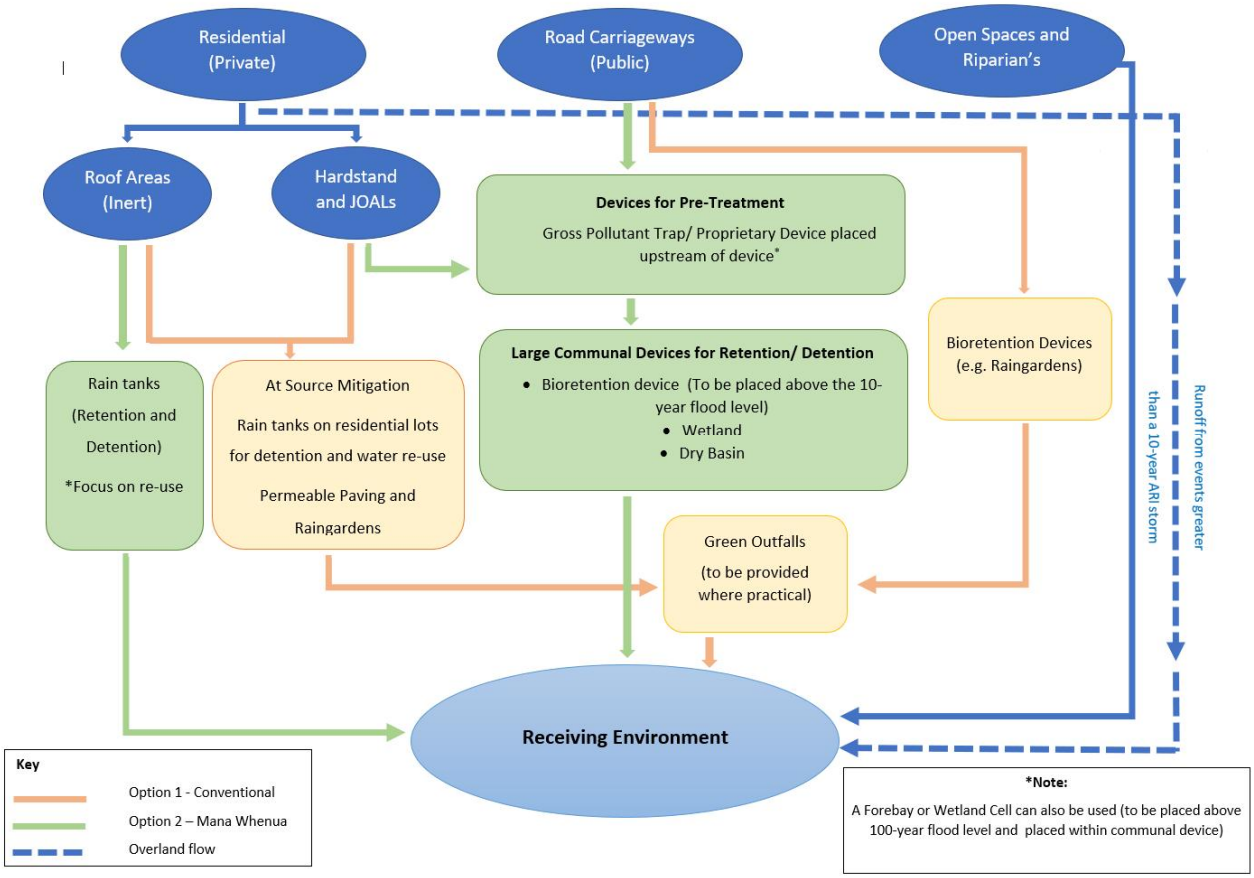

Figure 18: Proposed Stormwater Management Strategy for the Drury East Precinct

Option One adopts a conventional form of hydrology mitigation where runoff is collected from roof areas, hardstand and jointly-own access lot driveways within private residential areas and discharged into onsite rain tanks (for reuse and detention), permeable paving and rain gardens. In both options, inert materials will be used on roof surfaces so that these surfaces do not generate contaminants and runoff can be re-used without water quality treatment.

At-source bio-retention devices are also proposed for public roads. The runoff be discharged to the receiving environment via a green outfall, where practical. This conventional approach is consistent with Auckland Council and the FUZ SMP.

Option 2 has been developed through consultation with the Mana Whenua. It proposes that roof areas are managed via rain tanks. The rain tanks will provide retention and detention, with a focus on reuse. Runoff from public roads, residential hardstand and jointly-own access lot driveways will undergo pre-treatment in GPTs, forebays or similar prior to discharging to large communal devices for secondary treatment. The use of large communal devices instead of conventional at-source bio-retention devices is discussed further in Sections 8.2.3.

8.2.2 Water sensitive design

The key water sensitive design principles outlined in GD04 and how they are incorporated in the stormwater management approach for the PCA are summarised in Table 14.

Table 14: Application of water sensitive design principles within the PCA

Water sensitive design principles	Application within PCA
Promote interdisciplinary planning and design	· Early engagement with urban designers has ensured open space provisions for integrated stormwater management is factored into the PCA Masterplans.
Protect and enhance the values and functions of natural ecosystem	· Riparian buffers and filter strips have been proposed for use within the public open spaces where practicable, to minimise impact of stormwater runoff and overland flow on the receiving downstream environment. · Vegetated bio-retention devices have been proposed for water quality and hydrological mitigation within the PCAs to mitigate effects on receiving environments (streams). · Recognition of Auckland Council Blue-Green network or similar.
Address stormwater effects as close to source as possible	· Generation of contaminants will be prevented as far as possible through the use of inert building materials. · Where contaminants are generated (i.e. road and car parks), green infrastructure will be provided to mimic natural physical, biological and physical treatment processes as close to the source as practicable.
Mimic natural systems and processes for stormwater management	· Green infrastructure such as vegetated bio-retention devices, filter strips and green outfalls have been proposed for use within the PCAs. · Riparian buffer planting has been proposed to protect the stream networks within the PCAs. · Discharge of stormwater to the stream environment will be balanced so as to not change the stream flow regime within the PCAs.

8.2.3 Water quality

Urbanisation of the Drury East development could result in increased contamination of stormwater runoff due to the land-use changes and increased impervious area. The stormwater quality will therefore change and may negatively impact the sensitive receiving environments if unmitigated.

The water quality management approach seeks to minimise the generation of contaminants as much as possible. Where contaminants are generated, the preferred approach is to use green infrastructure to treat contaminants at-source, or as close to the source as practicable. Specifically, this approach seeks to:

- Eliminate or minimise the generation and discharge of contaminants
- Treat all contaminant generating impervious areas at or near source by a water quality device designed in accordance with GD01 to target sediment, metals and gross pollutants

These objectives will generally be met through the following measures and stormwater management devices:

Residential and Drury Centre buildings

- Using inert building materials to prevent generation of contaminant-laden runoff within residential lots and around buildings, i.e. avoiding use of high contaminant yielding building products which have:
  - exposed surface(s) or surface coating of metallic zinc of any alloy containing greater than 10% zinc
  - exposed surface(s) or surface coating of metallic copper or any alloy containing greater than 10% copper
  - exposed treated timber surface(s) or any roof material with a copper-containing or zinc-containing algaecide

  It is noted that the region-wide NDC specifies treatment of all impervious areas for the relevant contaminants. Elimination of contamination generation is considered the BPO option so if inert roofing materials are used, these impervious surfaces will not generate contaminants and therefore will not require water quality treatment. However, if the building materials listed above are used, site-specific water quality treatment measures will be required to treat those surfaces
- Providing roofs for communal waste storage areas in apartments or multi-unit buildings to reduce the volume of contaminated runoff. In cases where this is not practical, pre-treatment devices, (i.e. GPTs) should be installed immediately downstream of the waste storage areas to provide primary treatment prior to discharging to the next device in the treatment train

Roads, carparks, driveways and jointly owned access lots

Treating runoff from all public roads and carparks, hardstand and private or jointly-own access lot driveways:

- Using grated catchpits and inlets to the stormwater network for capturing of gross contaminants, solids, sediment, and gravels
- Installing bio-retention devices designed to provide water quality treatment to target sediment, metals and gross pollutants. Suitable bio-retention devices include swales, filter strips, rain gardens and tree pits which can be integrated within landscaping areas in the road berms and, therefore, close to the runoff source
  - vegetated swales and filter strips located within the road berm provide an alternative conveyance route, close-to-source treatment, and visual amenity, when compared to a piped network. Bio-retention devices can be designed to provide hydrological mitigation too
  - during consultation with Mana Whenua, it was suggested that communal bio-retention devices are more efficient, and provide timely and cost-effective construction, operation and maintenance. Therefore, the preferred approach is to use fewer but larger communal bio-retention devices to capture contaminant-laden runoff from public roads, car parks, and public spaces as well as residential hardstand and jointly-own access lot driveways
  - suitable bio-retention devices include tree pits located within road berms and raingardens located within road berms or, preferably, adjacent to streams and elevated above the 10-year flood event. GPT or alternative proprietary devices will be installed upstream of communal devices to improve the efficiency of the device. The communal devices may be dual-purpose as they could also provide hydrological mitigation and flood attenuation, if required

8.2.4 Water quantity

The Drury East development will increase the impervious area, which will generate more stormwater runoff (peak magnitude and volume). The percentage of impervious cover within the Drury Centre and Drury East

PCA is currently less than 10% and is expected to increase to more than 70%[12] and approximately 65%, respectively, once the Drury Centre and Drury East PCAs have been fully developed.

This section considers the requirements for water quantity management for runoff from smaller frequent storm events to mitigate the effects of development. These smaller storm events strongly influence the geomorphology of receiving streams and therefore the effects on downstream erosion risk are also considered in this section. The hydrological mitigation measures identified here will have the most effect during smaller events but will mitigate (to some extent) runoff in all storm events. Water quantity management for extreme storm events is discussed in Section 8.2.6.

The general approach to water quantity management for small storm events is to provide a minimum of SMAF 1 hydrological mitigation for all impervious surfaces within the PCAs (refer Section 3.1.7). The SMAF 1 hydrological mitigation objectives outlined in the AUP are:

- Retention of at least 5 mm of runoff depth from impervious surfaces where possible
- Detention and a drain-down period of 24 hours for the difference between the pre-development and post-development runoff volumes from a 95th percentile, 24-hour rainfall event less the achieved retention volume, over the impervious area for which hydrological mitigation is required

Retention is the process of storing and using stormwater runoff onsite, reducing the volume of stormwater discharged to the receiving environment. Detention is the temporary storage and slower release of runoff, which effectively reduces peak flows and mitigates their effect on the receiving environment.

The hydrological mitigation outcome is achieved though both retention and detention. The viability of water retention is contingent on land use activity (i.e. water re-use demand) and geological conditions. The stormwater management approach seeks to maximise re-use within lots (i.e. provide retention volumes greater than the minimum requirement of 5 mm as per AUP). If this can be achieved, it will result in less detention volume and achieve a better outcome for the receiving environment.

Exceptions for providing retention are acceptable in cases where soil infiltration rates preclude disposal to ground and the demand for rainwater re-use is limited, in which case the retention volume can be replaced by detention as the BPO. Local ground stability and soil infiltration rates will be confirmed during detailed design stages.

To meet the hydrological mitigation objectives, the following management options are proposed:

For retention

- By infiltration, where feasible (infiltration rates greater than 2 mm/hr) and possible in a safe, and effective manner
  - this may be provided appropriately designed bio-retention devices, such as rain gardens, tree pits and swales
  - pervious pavements or porous concrete could be used for hardstand areas within the PCAs, such as driveways (private) and carpark areas, footpaths, parking bays (public) and jointly-own access lot driveways
- Underground storage tanks infiltration to ground and overflow to piped network could also be adopted, however this would require site specific design
- At-source for all residential and buildings, through the use of rainwater tanks for collection of roof runoff where there is re-use demand for non-potable use e.g. toilet flushing, laundries and gardens. Overflow connection to piped network could also be adopted

[12] Expected increase in impervious area at Drury Centre based on 100% imperviousness for the Metropolitan Centre 100%and 70% imperviousness for the remaining Kiwi Property land.

For detention

- Raingardens, planter boxes, swales, living roofs and tree pits are bio-retention devices which can be designed to also provide detention within private residential property or along road corridors and within public impervious spaces, while adding to the landscape value of the PCA
- Large communal bio-retention devices are proposed on public roads, car parks, and public spaces as well as residential hardstand and jointly-own access lot driveways to meet the hydrology requirements and therefore the detention component can be provided within these. It is proposed that these devices be sized on a minimum 5% of the contributing impervious area as per GD01 for meeting SMAF requirements. It is noted that the 5% exceeds the minimum water quality treatment requirements as GD01 recommends water quality devices be sized for a minimum of 3.5% of the contributing impervious area
- Above-ground rainwater storage tanks or underground detention tanks will be provided within residential lots to provide storage volumes for reuse, and a separate detention volume with a controlled discharge rate, with the latter devices minimising land take

8.2.5 Stream hydrology

The Drury Centre and Drury East PCAs are currently predominantly in greenfield land and, unless carefully managed, urbanisation may have the following effects on the receiving environment (i.e. Fitzgerald Stream, Hingaia Stream and their tributaries):

- Change in stream morphology caused by changes to overland flow paths and increased peak flows within streams
- Deterioration of stream banks at the discharge point and downstream caused by increased stormwater flows and volumes, which may result in ongoing bank instability due to increased stream erosion potential
- Change in stream ecology

As outlined in Section 8.2.4 above, the general approach to offset urbanisation effects is to provide a minimum of SMAF 1 hydrological mitigation for all impervious surfaces within the Drury Centre and Drury East PCAs

A stream erosion assessment identified changes in erosion potential at 10 locations (refer to Figure 9) along the Hingaia Stream, Fitzgerald Stream and their tributaries relevant to the Drury Centre and Drury East PCAs for the 2, 10 and 100 year ARI design storm. The erosion potential was quantified by the duration of exceedance of critical shear stress and comparing this for the pre-development and post-development (not including an allowance for hydrological mitigation) scenarios. The assessment sought to verify the proposed hydrological mitigation approach, identify high risk areas and determine if additional mitigation measures are required within the Drury Centre and Drury East PCAs. The findings of this assessment are summarised below:

- A Modified Stream Erosion Risk Assessment was developed to utilise high quality hydraulic modelling results that were available for the site, which we consider has enhanced the Auckland Council Stream Erosion Risk Assessment
- The tool's application was limited to assessing the change in erosion risk due to development. (i.e. it did not quantify how much extra erosion would occur, nor the change in sediment load that would be to the receiving environment so it cannot be used to directly assess effects)
- The Modified Stream Erosion Risk Assessment has shown that there is existing erosion potential at four out of 10 assessed locations along the Hingaia stream and its tributaries. However, there was poor correlation between predicted erosion locations and observed erosion (refer to Table 15), which puts doubt in the predictive ability of the Modified Stream Erosion Risk Assessment to identify erosion risk areas. Nonetheless, the stream erosion risk erosion assessment has value in assessing the change in erosion risk due to development

- The assessment placed emphasis on the 2 year ARI design storm event as smaller events strongly influence the geomorphology of the stream, especially the size of the main channel. There was a very minor increase to erosion potential (duration of excess shear >1) at three locations during the 2 year ARI storm event due to hydrological changes as a result of the development, with the excess shear exceeding 2 for a small amount of time at Location 6 and a small amount of new erosion potential introduced at Location 9

Table 15: Comparison of results from 2018 Hingaia watercourse survey and Modified Stream Erosion Risk Tool

	Auckland Council Watercourse survey		Modified Stream Erosion Risk Tool	
ID	Erosion Scars	Bank Stability	Maximum Erosion Threshold	
Location 1	0 – 20%	Poor	1.41	1.42
Location 2	0 – 20%	Poor	0.98	0.99
Location 3	0 – 20%	Fair	0.66	0.66
Location 4	0 – 20%, 21 – 40%	Fair	0.33	0.34
Location 5	0 – 20% - 21 - 40%	Fair	0.46	0.68
Location 6	21 – 40%	Good	1.76	2.64
Location 7	0 – 20%, 21 – 40%	Fair	1.21	1.95
Location 8	0 – 20%	Fair	0.48	0.75
Location 9	21 – 40%	Fair	0.66	1.04
Location 10	0 – 20% *	Fair	1.11	1.93

- The Modified Stream Erosion Risk Assessment found very minor increase to erosion potential during the 2, 10 and 100 year ARI storm events and predicted that the application of SMAF 1 hydrological mitigation would result in an even smaller increase to the erosion risk. The benefit from SMAF 1 hydrological mitigation would also increase for smaller events (i.e. the 95th percentile design storm event) because the retention/detention volumes are a large proportion of the events
- It was expected that the application of SMAF 1 hydrological mitigation to those design storm events would result in very little to no change as the runoff stored through retention or detention volumes would be taken at beginning of the design storm and have no effect on the middle of the event, which is when the peak flows and peak shear stressed are typically experienced

For more a detailed summary of the findings please refer to the memo 'Response to Auckland Council Further Information Request on Stormwater Matters for Drury East - Stream Erosion Risk Assessment for Hingaia Catchment' from 6 April 2020 included in Appendix E.

In conclusion, the Modified Stream Erosion Risk Assessment adds a more detailed assessment, but uncertainty remains as to the existing and future erosion risk.

In addition to SMAF 1 hydrological mitigation, the following measures are recommended by ecology and stormwater experts as stream erosion mitigation methods:

- Removal of stock from the site and therefore avoiding active bank de-stabilisation through stock access and pugging
- Incorporation of green spaces adjacent to stream networks to provide for planting of riparian margins to improve bank stability and reduce erosion potential
- Remediation or removal of existing in-stream structures (culverts, inlets/outlets) which are currently identified as having erosion issues

- Realignment of streams which have been channelised to a more natural alignment
- Incorporation of erosion and scour protection measures at all outfalls to minimise erosion at new structures
- Targeted in-stream erosion protection measures may be required within larger streams
- Restoration of streams including restoring sinuosity, removal of inline ponds, adding retreats and armouring where appropriate is also expected to improve stream habitat quality
- Proposed riparian planting along stream corridors to develop the Blue-Green network will result in a demonstrable improvement in instream habitat (i.e., increased stability, woody debris) and water temperature control that will enhance conditions for aquatic fauna

We also note that there may be other drivers for potential bank stabilisation works including visual amenity and to protect developable land in areas where there are long term erosion trends. Any additional mitigation for stream erosion can be developed as the SMP progresses based on site observations of erosion and/or improved erosion modelling when the data is available, and the methodology is improved.

It was also worth mentioning that there are some benefits to the receiving environment through urbanisation. Many of the stream systems are expected to be nutrient enriched at present based on the observed prevalence of macrophytes attributed to unrestricted access by livestock and the adjacent agricultural and horticultural land use. The increase in streambank sediment entering the receiving environment will be balanced in part by the effective removal of contributing sediment loads from agricultural land use and the future potential benefits associated with stream enhancement and restoration measures.

Furthermore, The Hingaia Stream, which is known to have erosion issues, is most affected by the flows entering the stream from the wider catchment, which is currently undergoing significant development, thus the impact of the proposal on Hingaia Stream needs to be considered in the wider context of the whole catchment. The Drury Centre and Drury East PCAs comprises only a very small portion of the 37,637 hectares Pāhurehure Inlet catchment. Even at the more local scale of the upper Drury Creek, the PCA comprises a small proportion of the overall contributing catchment. On that basis, any changes within the PCA on sediment levels in Hingaia Stream would be very difficult to distinguish from changes elsewhere within the catchment.

This proposed approach to addressing stream erosion risk recognises that there are several mitigating factors, including the fact that PCAs are proportionally a very small part of the overall Hingaia Catchment and are located towards the bottom of the catchment so instream works are likely to be the best way to address erosion risk, if measures beyond SMAF1 hydrological mitigation are required. Combined with the condition of the streams discussed in Sections 2.6.1 and 2.6.2 (i.e. generally fair bank stability and low evidence of erosion scarring), the proposed hydrological and stream erosion mitigation measures will ultimately minimise and mitigate the erosion risks in the receiving environment attributed to development of the Drury Centre and Drury East PCAs.

8.2.6 Flood management

8.2.6.1 General

Flood risk management within the Drury Centre and Drury East PCAs will be achieved through a proactive approach. To ensure that there are no adverse flooding effects within the PCAs itself, the following are proposed to manage flood risk:

- Adopt a “pass flows forward” approach for the Drury Centre PCA and Drury East PCA, subject to infrastructure upgrades and staging for the Fitzgerald Stream (see below). After water quality and hydrological mitigation treatment, flows from the site will be discharged without further attenuation in order to pass them to the receiving environment before the peak flows from the upper catchment reach the area

- The Drury Centre and Drury East sub-catchments which discharge to the Fitzgerald Stream require a unique flood management approach as a number of culverts downstream and along Fitzgerald stream have been identified as flow constraints to the 100 year ARI storm with MPD. The flood management approach seeks to provide temporary flood attenuation so that peak flows generated by development within these sub-catchments are attenuated within the site. Attenuation basins will detain the difference between the pre-development and post-development flows for up to the 100 year ARI storms. These temporary attenuation devices can be removed once the Great South Road and Flannagan/railway culverts are upgraded and the "pass flows forward' approach is viable
- All roads, car parks and building platforms to be located outside of and set above the 100 year ARI MPD climate change flood plain, with a suitable allowance for freeboard. It is also recommended that infrastructure is located outside this extent, unless it can be designed to be resilient to flood damage. 'Green reserves' will be provided within floodplain extents
- For rainfall events greater than a 10 year ARI storm event and up to a 100 year ARI storm event, secondary flows will be conveyed along road corridors into existing overland flow paths. All overland flow paths will be retained or redirected with allowance for adequate conveyance capacity and will be located within public areas (roads and parks) and not private properties
- Any changes to the landform in the 100 year ARI floodplain will be designed with appropriate mitigation to ensure there is no worsening of flooding to dwellings and/or adverse impacts to the amenity of property at the upstream and downstream ends of the PCA
- Not worsen flooding on land inside the PCA without property owner agreement
- Protection of 100 year flood plain within the Blue-Green network also enables enhancement of riparian corridors around intermittent streams. As well as providing enhanced stormwater management functions and public amenity, and contributing to the ecological value of stream corridors, riparian margins assist management of flood waters as they provide capacity for the secondary conveyance system

8.2.6.2 Fitzgerald Stream special requirements

As mentioned in Section 2.7, the general flood management approach outlined in the FUZ SMP for the Hingaia catchment is to pass forward large storm event flows.

Flows from the northern sub-catchment of Drury East discharge into Fitzgerald Stream and traverse north-west via a culvert under Fitzgerald Road. These flows combine with runoff from northern sub-catchment of the Drury Centre PCA and then discharge into Hingaia Stream via the Flanagan/Railway and Great South Road culverts (as shown in Figure 19). Modelling of the pre-development scenarios indicate that the existing Flanagan/Railway and Great South Road culverts are undersized and throttle the upstream flows, exacerbating upstream flood risk. If these culverts were upgraded so they no longer presented a flow restriction/constraint, then the flows from full development of the catchment can be passed forward without impacting on predicted flood levels in Drury Township. It is noted that flows resulting from partial development of these sub-catchments could possibly be passed forward without culvert upgrades but this approach would need to be tested and modelled to confirm.

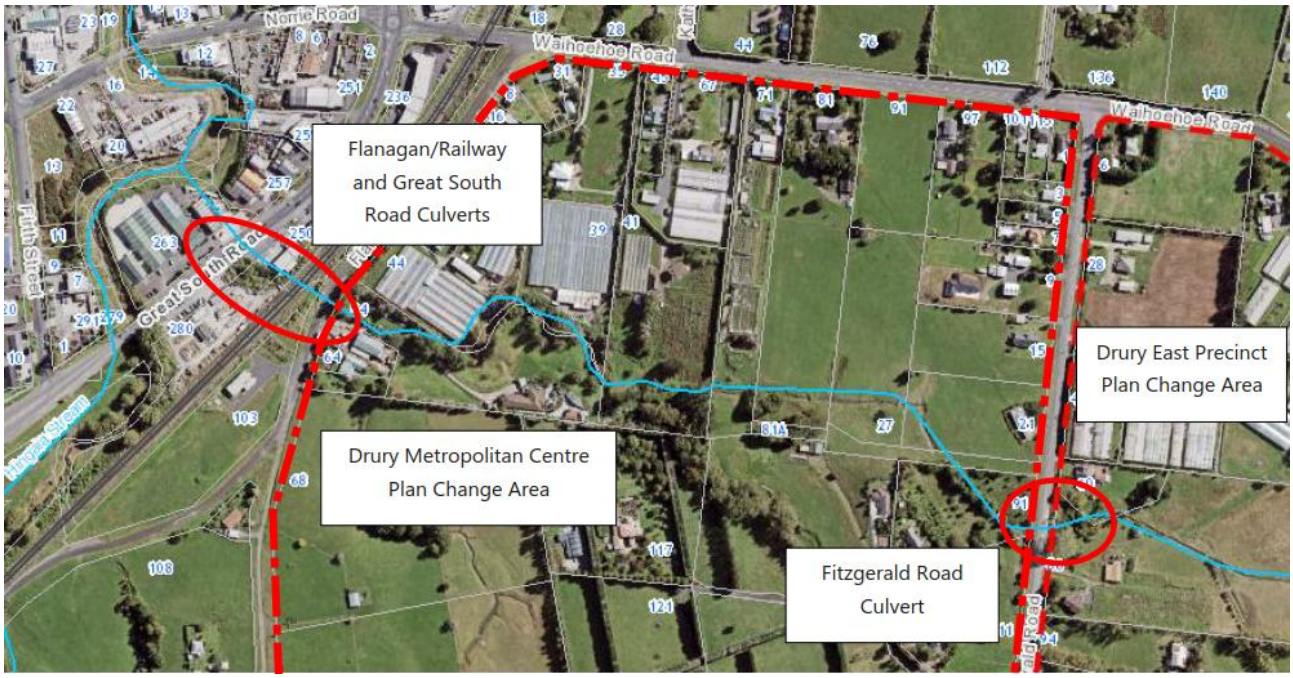

Figure 19: Flanagan/ Railway/ Great South Rd Culverts and Fitzgerald Culvert

An interim solution to develop these sub-catchments prior to upgrading the Flanagan/Railway and Great South Road culverts is to provide temporary on-site flood attenuation, which would ensure no increase in pre-development peak flows up to the 100 year ARI before the culverts are upgraded The additional volume will be temporarily stored onsite, in devices such as detention basins, wetland and ponds, and released at a rate which does not exceed pre-development peak flows. Accordingly, there will be no net effect on the extent of flooding on downstream properties or receiving environments.

It is important to note that these devices are temporary and therefore can be removed once the works proposed on the Great South Road and Flanagan/Railway culverts have been completed. For more information refer to Development staging in Section 8.2.8

8.2.7 Conveyance

8.2.7.1 Stormwater network

Primary flows generated by flows up to the 10 year ARI storm event will be conveyed by swales and piped network to the downstream receiving environment. Stormwater infrastructure will be designed to accommodate the 10 year ARI storm event for the MPD, including climate change, and in accordance with requirements of Chapter 4 of the Auckland Council Code of Practice for Land Development and Subdivision (Auckland Council SWCOP) [13].

8.2.7.2 Overland flow paths

For events greater than a 10 year ARI storm event and up to a 100 year ARI storm, secondary flows (i.e. the flows which exceed the primary network) will be conveyed by along road and drainage reserves and green spaces as overland flow paths. Overland flow path alignments will be dependent on the overall built environment. It is envisaged that the overland flow paths will adhere to the following design criteria:

[13] Auckland Council, 1 November 2015, *Code of Practice for Land Development and Subdivision. Chapter 4 – Stormwater version 2.0*

- Overland flow paths will be designed with sufficient capacity to accommodate the 100 year ARI storm event for the MPD, including climate change, in accordance with the Auckland Council SWCOP
- They will be unobstructed, with capacity to safely convey runoff through the development
- Overland flows to follow either road reserves or dedicated green areas. All flow paths are proposed to be located within public areas (roads/parks) and not private properties
- Overland flows to be within the depth and flow velocity parameters as outlined in Auckland Council SWCOP

8.2.7.3 Blue-Green network

The Blue-Green Network envisaged under the Structure Plan, overlain with the riparian corridors as proposed in the Plan Change is shown in Figure 20. There are some parts of the site where stream alignment does not correspond between the two datasets. We consider that for the most part this relates to a lack of spatial resolution. The plan is conceptual and provides sufficient information at this time to identify that the Blue-Green network, including the important connectivity with SEA to the west of Drury Hills Road, is integral to the Plan Change.

Figure 20: Blue-Green network within the Drury Centre

8.2.8 Development staging

As discussed in Section 8.2.6, the flood modelling has indicated that the capacity of the existing Fitzgerald/Railway and Great South Road culverts is inadequate to support future development within the Drury Centre and Drury East PCAs. The culverts will need to be upgraded to provide additional capacity before flows from the full development are able to be passed forward without onsite flood attenuation. The upgrades of these culverts needs coordination between Auckland Council, Auckland Transport, KiwiRail and other stakeholders.

Flows resulting from partial development could possibly be passed forward without culvert upgrades but this approach would need to be tested and modelled to confirm.

The interim solution is to provide on-site flood attenuation for the difference between the pre-development and post-development flows for up to the 100 year ARI storms for development within Zone A of the Drury East PCA or Drury Centre PCA eastern areas. This could enable full development of the PCAs before the future culvert upgrade. The attenuation devices could then be removed once the Great South Road and Flannagan/Railway culverts are upgraded and the "pass flows forward' is made viable.

A number of other strategies and alignment options have been explored to utilise the culverts' existing capacity and are contained in Appendix C1.

8.2.9 Asset ownership

All public stormwater infrastructure within the Drury Centre and Drury East PCAs, including the reticulated stormwater network and any communal bioretention devices, are intended to be vested to Auckland Council upon completion of construction.

8.2.10 Hydraulic connectivity

To be addressed at Resource Consent

8.2.11 Ongoing maintenance requirements

To be addressed at Resource Consent

8.2.12 Implementation of stormwater network

To be addressed at Resource Consent

8.2.13 Dependencies

Auckland Transport and Kiwi Rail for the Flanagan/Railway and Great South Road culvert upgrades.

8.3 Risks

Table 16 presents the identified risks to the proposed stormwater management within the Drury Centre and Drury East PCAs and addresses how these risks might be mitigated or managed. As the application for adoption of this SMP under the NDC progresses, it is expected that this list will be further populated as more risks are identified.

Table 16: Risk Register

What is the risk to the proposed stormwater management?	How can this be mitigated / managed?	What other management / mitigation could be used?	When does this risk need to be addressed?	What is the resultant level of risk?
Unknown In-situ soil infiltration rates	Percolation testing required	Retention through re-use or made up as detention	During the Resource Consent phase	Low
No verification of SMAF 1 hydrological mitigation approach to mitigate stream erosion risk	Erosion stream risk assessment, but methodologies unproven	Approaches to develop design stream restoration	During the Resource Consent phase	Moderate
Auckland Council Overland flow mapping doesn't align with natural drainage features on the properties	Verified through survey	N/A	During the Resource Consent phase	Low
Flanagan/Railway and Great South Road culverts - Multiparty interests and uncertainty over other infrastructure dependencies e.g. rail station delay decision making	Discussions and agreements	Determine threshold of development that can occur before culverts need upgrades. Onsite attenuation by developers to be independent of culverts	When infrastructure funding decision are made	Moderate

9 Departures from regulatory or design codes

The stormwater management approach for development with the PCA meets the minimum regulatory or design codes standards and is considered the BPO approach.

10 Conclusions and recommendations for future work

Guidance on how stormwater will be managed across the Drury Centre and Drury East PCA is summarised in this section, along with specific recommendations for further investigation to support of the next phases of development within the Drury Centre and Drury East PCAs.

10.1 Conclusions

This SMP has been developed

An integrated stormwater management approach will be adopted across all three Drury East PCAs. It has been developed based on AUP regulatory policies, Auckland Council stormwater-specific guidelines and NDC requirements, feedback from Mana Whenua and the FUZ SMP.

The overarching principle of the SMP is to implement an integrated stormwater management approach for all three Drury East PCAs, which includes:

- Facilitate urban development and optimise available land
- Recognise the key constraints and opportunities on site and in the Hingaia and Slippery Creek catchments
- Develop a set of Best Practicable Options (BPOs) for stormwater that can be incorporated into the development
- Emphasise a water sensitive design approach that:
  - manages the impact of land use change from rural to urban
  - minimises or mitigates the adverse effects on water quality, freshwater systems, stream health and ecological values of the receiving environment through the implementation of stormwater management devices; this includes tributaries of the Hingaia Stream and Slippery Creek
  - protects and enhances stream systems and riparian margins
- Minimise the generation and discharge of contaminants/sediments into the sensitive receiving environment of the Drury Creek and Manukau Harbour, including changes in water temperature caused by stormwater discharges
- Recognise a Blue-Green network approach with the stormwater management system to integrate “blue” aspects of the PCA (the streams and flood plains) and the “green” aspects of the environment (indigenous biodiversity and ecological significance, and the parks and reserves)
- Protect key infrastructure, people and the environment from significant flooding events. Not worsen downstream flooding.

The proposed approach, based on water sensitive design to deliver water quality, conveyance, hydrological and flood mitigation outcomes, comprises:

- Preserving, protecting and enhancing streams and floodplains in the Blue-Green network, which can also provide amenity and connectivity with communities
- Eliminating and minimising the generation of contaminants. Provide near-source water quality treatment of runoff for all contaminant generating impervious surfaces. Water quality treatment to target sediment, metals and gross pollutants should be provided. Green infrastructure is preferred
- Providing a minimum of SMAF 1 hydrological mitigation for all impervious surfaces within the Drury Centre and Drury East PCAs. Intervene with stream erosion mitigation methods
- Generally adopting the “Pass forward flows” flood management approach, but for Fitzgerald Stream provide temporary on-site flood attenuation to mitigate changes within the 100 year flood plain attributed to the development of the PCA before the downstream network is upgraded

The SMP is supported by a flood hazard assessment, which was carried out using the Auckland Council flood model for the Hingaia Stream catchment. The assessment confirmed the proposed flood

management approaches for the PCA and did not indicate any effects that would be considered more than minor:

- No additional flood risk to downstream habitable floor or properties attributed to development of the PCAs i.e. the total number of properties flooded are unchanged
- A slight increase in flood extent within Drury Township when comparing the pre- and post-development 100 year scenario but no change in flood risk to the buildings
- No risk to development within the PCAs as a result of to future upstream development

The Stormwater Management Toolbox has been developed to facilitate selection of BPO devices (or a combination of devices) that will achieve the stormwater management outcomes for the various land use zones at all three Drury East PCAs.

Table 17 (repeated): Stormwater Management Toolbox

Zone	Land Use	Performance Outcomes				Toolbox	Notes
		Water Quality	Hydrological Mitigation	Flood Attenuation	Water Sensitivity Design [1]		[1] The proposed stormwater management options adopt a Blue-Green network approach that includes other devices or measures which are not listed in this table i.e. filter strips, green outfalls (where practicable), streams protected and enhanced with riparian buffer and re-vegetation planting. The need for bank stabilisation/instream works to be determined by stream erosion assessments. [2] Stormwater Management Devices in the Auckland Region –Guideline Document 20017/001 (GD01). (December 2017). Auckland Council Eliminate or minimise the generation and discharge of contaminants. Treat all contaminant generating impervious areas at or near source by a water quality device designed in accordance with GD01 to target sediment, metals and gross pollutants. Elimination of contamination generation is considered the BPO option so if inert roofing materials are used, these impervious surfaces will not generate contaminants and therefore will not require water quality treatment. [3] AUP Auckland Council The PCA does not fall within a Stormwater Management Area - Flow 1 (SMAF 1) overlay but this will be adopted as the minimum requirement across all three sites. This stormwater management approach is consistent with Policy E1.3.10. The minimum hydrological mitigation requirements proposed are as follows: • Retention (volume reduction) of at least 5mm of runoff depth from impervious surfaces • Detention of the 95th percentile event for the difference between the pre-development and post-development runoff volumes from a 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 ground and rainwater reuse is not possible. It is noted that if retention cannot be met, devices are to be lined with the retention volume being treated as a detention through bioretention devices. An erosion assessment is to be carried out to determine if additional measures (such as additional detention requirements) are required to mitigate the hydrological impacts of development. [4] No increase in peak flood level effects to properties upstream and downstream of the PCAs. [5] Devices will be provided and sized for WQ treatment for carparks (greater than 30 vehicles) only for the Residential Zones. [6] Includes the option for large communal devices to provide treatment and hydrology mitigation to public roads and impervious areas. Gross Pollutant Traps (GPT) or alternative proprietary devices will be installed upstream of communal devices. The communal devices may be dual-purpose as they could also provide flood attenuation, if required. [7] Hydrology mitigation will be provided for these impervious areas. Bio-retention devices generally have the added benefit of providing WQ treatment too.
Performance standard		GD01[2]	AUP: SMAF 1 minimum[3]	100 Year ARI: Not worsen downstream flooding [4]			
Mixed use Metropolitan Centre	Roads	✓	✓	✗	✓	Bio-retention devices including: · Raingardens · Tree pits · Vegetated swales	
	Carparks	✓	✓	✓	✓		
	Other	✓[2]	✓	✓	✓	Inert Building materials Rainwater tanks for re-use of roof runoff Permeable pavements for public realm areas Communal detention devices	
Mixed Housing – Urban Mixed Housing – Suburban Terraced Housing Apartment Buildings	Roads	✓	✓	✓[6]	✓	Communal devices[5] Bio-retention devices including: · Raingardens · Tree pits · Vegetated swales	
	Carparks > 30 Vehicles	✓[5]	✓	✓[6]	✓		
	Roofs, jointly-own access lot driveways, driveways, gardens/landscaping	✗✓[7]	✓	✓	✓	Inert Building materials Rainwater tanks for re-use of roof runoff Permeable pavements for driveways or laneways Communal devices[5] Bio-retention devices including: · Living Roofs · Raingardens · Tree pits · Vegetated swales	

Detailed design of the proposed stormwater management approach, including device selection, sizing and location will be addressed at later stages of development.

Based on the investigations that have been completed at this stage, it is expected that stormwater effects from the Drury Centre and Drury East PCA can be managed safely and without damage to the receiving environment. The plan changes can, therefore, proceed without any major concerns relating to stormwater management.

10.2 Recommendations

Recommendations for further investigation to support of the next phases of development within the Drury Centre and Drury East PCAs are listed below:

- Percolation testing has been carried out at 10 locations within the Drury Centre PCA and suggested that infiltration would likely not be feasible for use within the Drury Centre PCA. Additional, targeted percolation testing is recommended to confirm if there are hotspots of high infiltration capacity
- Percolation test has not been carried out at the Drury East PCA. Site-specific percolation testing should be carried to determine if infiltration is viable and to inform conceptual or detailed design of infiltration devices
- Detailed design of the proposed stormwater management approach, including device selection, sizing and location and overland flow path layout
- Flows resulting from partial development of the sub-catchments which discharge into Fitzgerald Stream could possibly be passed forward without culvert upgrades. This approach would need to be tested and modelled to confirm and will form part of the detailed design process
- The SMP be updated as development progresses and be adopted into Auckland Council's Network Discharge Consent.

11 Applicability

This report has been prepared for the exclusive use of our client Fulton Hogan Land Development and Kiwi Property, with respect to the particular brief given to us we understand and agree that they will submit this report as part of an application for Plan Change and that Auckland Council, as the consenting authority, will use the report for the purpose of assessing that application.

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Appendix A1 – Plans of existing site features

Appendix A2 – Existing site appraisal referenced reports

Appendix B1 – Proposed development plans

Appendix C1 – Flooding

Appendix D1 – Stormwater management selection process and assessment

To be addressed at Resource Consent

Appendix D2 – Draft operation and maintenance

To be addressed at Resource Consent

Appendix E – Referenced SMPs and Memos

Auckland Council
Te Kaunihera o Tāmaki Makaurau