# Appendix E

**Healthy Waters Review of Adequacy of Information for a Private Plan Change (PPC) Request**

**Drury East – Fulton Hogan and Kiwi Property**

**02 February 2020**

The table below includes the requests for additional and further information from Healthy Waters in relation to the three Drury East Plan changes. Reference to the full responses to these requests as developed by T+T and Woods is indicated in the "Response" column of the table.

| Assessment category | | Comments /requests | Reason for comments/requests | Responses |
|---|---|---|---|---|
| **No** | **Category** | | | |
| 01 | Stormwater Planning | Please provide an assessment of how the proposed plan changes meet the outcomes of the NPS-FM and the related matters in the AUP Regional Policy Statement.<br><br>How does the s32 report acknowledge and address methods to meet regional policy statement objectives that are relevant to the plan change areas, including B7.3<br><br>E1.3.8 and E1.310? Please update if necessary. | The policy framework acknowledged in the s32 reports primarily addresses matters relating to urban development and the provision of land for urban growth. While there is some acknowledgement of the NPS-FM, this appears to be limited to how streams and other natural hydrological features are recognized in the proposed plan changes. NPS-FM Objectives and Policies relating to water quality, and Regional Policy Statement objectives and policies for water quality and integrated stormwater management, do not appear to be addressed.<br><br>The process and outcome of urbanising land has significant environmental effects both immediately and into the future. There appears to be little acknowledgement of these effects on the receiving environment (which the NPS and RPS objectives and policies refer to) or adequate demonstration of how these effects will be mitigated through the proposed precinct plan provisions and proposed stormwater management plan. | Refer to Planning Response and the Response to Auckland Council Further Information Request for Drury East – Drury East Plan Changes - Ecology Response in Appendix E. |
| 02 | Stormwater quality | Please clarify how objectives in the AUP for water quality will be met. The Planning report (pg46) emphasises that high contaminant generating roads and carparks will be treated (treatment of these roads is covered by region wide rules in Chapter E9 AUP). However, it is unclear how many roads are anticipated to meet the thresholds to trigger E9 rules and if | AUP E1.3.8 directs to avoid as far as practicable the adverse effects of development on water quality.<br><br>AUP Objective E1.2.3 and Policies 1.3.2 and 1.3.3 directly implements the NPS-FM 2017. Avoiding adverse effects on water quality should be demonstrated in the planning report | Refer to Table 13 and Section 8.2.3 of the SMP or Section 1: Stormwater Managment in the Response to Auckland Council Further Information Request on Stormwater Matters for Drury East memo in Appendix E. |

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| | | additional roads should be treated to meet the proposed objective.<br><br>There is also reference in the Drury East – Fulton Hogan request (page 46) to a treatment train approach and secondary treatment but it is unclear if this is part of the approach to treat high contaminant generating roads or is an additional response applied to all roads to meet objectives E1.3.8 and E1.3.8 and meet Schedule 4 NDC requirements greenfield developments.<br><br>A matrix showing what tools will be used in what proposed land use zone to avoid any adverse effects on water quality should be included in the SMPs as part of identifying how adverse effects will be mitigated and how these achieve AUP policies for water quality. | and SMP. The creation of adverse effects on water quality due to contaminants in runoff from impervious surfaces is an effect of urban land use. Therefore, this should be part of the S32 report and AEE.<br><br>Reliance on region wide rules in the AUP may not be sufficient to meet AUP policies for this plan change area and for the associated receiving environment which is a Significant Ecological Area; some of which (such as Drury Creek Islands) have further restoration and enhancement underway.<br><br>Additional detail on the methods for treating stormwater to avoid adverse effects may also be sought prior to notification of this plan change as part of the SMP in support of stormwater discharge authorisation. | |
| 03 | Water quality | Please more fully describe how the water quality policies in E1 will be achieved, and what options have been considered to meet the policies. | The current descriptions in the SMPs are confusing and appear to rely solely on the region-wide rules. Given the AUP policy directives for greenfield development and the sensitivity of the receiving environment, additional treatment (such as a treatment train approach) may be justified. | Refer to Planning Response and the Response to Auckland Council Further Information Request for Drury East – Drury East Plan Changes - Ecology Response in Appendix E. |
| 04 | Hydrology Mitigation | Please provide an assessment of the degree to which SMAF1 avoids or remedies changes in hydrology which will result from the urban land uses proposed in the plan changes.<br><br>A Regional Erosion Threshold Metric risk assessment identifies areas at risk of erosion and provides some quantification of the amount of erosion caused, however it does not address how effects will be avoided, remedied or mitigated.<br><br>Identification of measures to avoid effects and mitigate should also be made and the BSTEM model is appropriate for this | The AUP states that for greenfield areas adverse effects of development shall be avoided as far as practicable or otherwise remedied or mitigated and this includes changes in hydrology (Policy E1.3.8). No SMAF controls were applied to greenfield areas in the AUP as it was expected that an assessment on what hydrological mitigation is required would be undertaken as part of plan change process. The Drury-Opaheke Structure Plan SMP also identified that hydrological mitigation and erosion assessments should be completed at the scale of the plan changes so that the particular effects of proposed land uses would be identified, and mitigation measures would be determined, at scale proportionate to the proposed activities and effects. | Refer to Section 8.2.5 of the SMP or : the Response to Auckland Council Further Information Request on Stormwater Matters for Drury East - Stream Erosion Risk Assessment memo in Appendix E. |

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| | | task. More detail on this tool is being supplied to the applicants. | | |
| 05 | Flooding | Please address the matters identified and discussed in the memo to Healthy Waters from Tonkin + Taylor dated 19 February 2020.<br><br>We note that all applicants need to explain what the effect cumulatively across developments will be on the Drury township flooding and parts of the catchment that interact with the Slippery Creek floodplain. | Flooding in the Hingaia catchment is complex and needs to be considered in conjunction with other plan changes proposed for the area; acknowledge any interactions with other catchments and the cumulative impact of potential development in the surrounding areas and the point of discharge downstream. Understanding the impact of development on the flood plain within the plan change sites and impacts downstream is necessary to evaluate the plan change proposal and ensure any potential flood effects are avoided or mitigated.<br><br>Several discussions between Healthy Waters and the applicant's planners have occurred on the best way to approach flood modelling and the memo from T+T dated 19 February 2020 reflects our agreement with regard to flooding matters. | Refer to Section 7 of the SMP or Section 3 - Flood Management in the Response to Auckland Council Further Information Request on Stormwater Matters for Drury East memo in Appendix E. |
| 06 | Riparian Margins | Please explain why a 10m wide riparian margin is proposed when the Drury-Opaheke Structure Plan Stormwater Management Plan identified a 20m riparian margin as being appropriate. No evaluation of these two options is provided including their consistency with the objectives and policies of the AUP. | A 20m wide riparian margin was consulted on as part of the Drury-Opaheke Structure Plan 'Blue Green Network' and associated the Stormwater Management Plan. The purpose of the wide margin is to provide an ecological corridor and provide a buffer for the stream noting that stream meander may occur due to erosion. These benefits support achievement of AUP objectives and policies. A rationale for a lesser width margin is not provided in the s32 report. | Refer to Planning Response and the Response to Auckland Council Further Information Request for Drury East – Drury East Plan Changes - Ecology Response in Appendix E. |
| 07 | Ecological corridors and Blue Green network. | Please clarify what the ecological corridors are and how they contribute to meeting objectives and policies of the AUP.<br><br>They are mentioned briefly but there is no description on how these align to the Blue Green network identified in the Drury-Opaheke Structure Plan, nor are the streams or corridors noted specifically in the precinct plan or stormwater management plan. | A blue green network utilising the natural hydrological features of existing streams was identified as part of Auckland Council's Drury-Opaheke Structure Plan. If and how streams are used in this way has implications in relation to:<br><br>• Identifying the impact of urban development on streams (if they are intended to be retained or not).<br>• Keeping flood conveyance channels available as part of the 'pass-it-forward' approach outlined in the Drury-Opaheke Structure Plan.<br>• Mitigation of effects anticipated by urban development, including hydrology mitigation. | Refer to Planning Response and the Response to Auckland Council Further Information Request for Drury East – Drury East Plan Changes - Ecology Response in Appendix E. |

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| | | Planning provisions to enable the ecological corridor are not provided in the precinct plan nor is an assessment given in s32 assessment reports. | The precinct plan and stormwater management plan lack information on the ecological corridors making their purpose for achieving AUP objectives and policies or as part of effects mitigation unclear.<br><br>We note public access such as walkways/cycle network need to be located outside riparian setbacks and the minimum width required to accommodate water sensitive devices. | |
| 08 | Development staging | Please explain if and how the precinct plan is to manage flood risks (such as staging of development in conjunction with flood mitigation measures).<br><br>Flood attenuation is proposed in the SMP but there are no precinct plan provisions to ensure that flood attenuation is provided or when it would be appropriate to not have flood attenuation. | The plan change areas are areas of significant flood hazard and developing the plan change areas could increase the flooding downstream in the existing Drury township.<br><br>Fulton Hogan, in their SMP page 6 propose as part of their flood management approach for Zone A to provide:<br><br>*Temporary flood attenuation to pre-develop flow – to enable development in advance of culvert upgrades*<br><br>There is no indication in their SMP or precinct plan of when this would be provided or when it will not be provided. The attenuation relates to current culvert capacity at Great South Rd and Flannagan Rd. These culverts will likely need upgrading in the future when road upgrades are done but this requirement is not linked to transport infrastructure upgrades or backed up by analysis of culvert capacity. | With respect to Fulton Hogan and their proposed attenuation, this will be provided once more clarity around development and staging is available.<br><br>The SMP was alluding to the potential for development to occur prior to upgrade of culverts.<br><br>A staging plan will be provided upon finalization of approach which won't be available until resource consent stage. |

# Memo

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| **To:** | **Rachel Morgan** | **Job No:** | **1003297.6000** |
| **From:** | **Justine Quinn** | **Date:** | **24 March 2020** |
| **cc:** | **Nick Carter, Gary Bramley** | | |
| **Subject:** | **Drury East Plan Changes - Ecology Response** | | |

This memo has been prepared to address selected ecological responses as required by the Request for Further Information (RFI) from Auckland Council for Drury East Plan Change requests by Fulton Hogan, Oyster Capital and Kiwi Property. It has been prepared by three ecologists, being Gary Bramley (for Fulton Hogan), Justine Quinn (for Kiwi Property) and Nick Carter (for Oyster Capital) and summarises the results of an ecology workshop, literature review and collaborative drafting of this response. This memo should be read in conjunction with the stormwater memo and only applies to those specific matters outlined below.

## 1 Erosion and sedimentation effects

The following response has been prepared in relation to RFI E10 (Kiwi), E11 + E12 (Fulton Hogan), E10 + E11 (Oyster) which collectively request that more information is provided to assess the effects of sediment and erosion on the life supporting capacity of the marine significant ecological area.

**Existing environment – plan change area**

The collective area that the three plan changes apply to (the plan change area) is currently in predominantly agricultural and horticultural land use, including cropping, dairy farming and grazing. Many of the streams within the plan change area are intermittently flowing headwater systems that have unrestricted stock access to enable grazing when the streams are dry in summer. The Hingaia Stream which flows along the western boundary of the wider plan change area is the largest stream affected by the plan change. Photograph 1.1 below provides a representative image of the smaller streams within the plan change area.

Riparian vegetation is effectively absent over much of the plan change area and most of the stream length is unfenced. Stream banks and channels have been impacted by stock access, with slumping and bank instability prevalent throughout the plan change area. Auckland Council's survey of streams in the Hingaia area[1] revealed that bank stability was generally poor to fair. While erosion scars were typically less than 20%, erosion at inlet/outlets was often moderate or severe. Banks were identified as being highly erodible due to the general lack of vegetation and the soft erosive soils within the catchment. Sediment deposition was overserved to be ~17% on average across the entire Hingaia catchment, and notably, areas of active sediment deposition of >30% were linked to areas where stream banks of >20% erosion scarring was present.

[1] Spyksma, A., Bennett, K., Kane-Sanderson, P., Lindgreen, M., Pertziger, F., Allen, J., Gasson, S and Canal, L. (2018) Hingaia Stream Catchment Watercourse Assessment Report. 4Sight Consulting and Urban Solutions for Auckland Council. Auckland Council [technical report, TR20xx/xxx]

Auckland Council also surveyed streams within the Slippery Creek area[2], however most of the stream length present within the plan change area was not mapped. Therefore, we rely on the observations made during field assessments and reported in Freshwater Solutions (2019) where intermittent watercourses were found to be unfenced with severely damaged streambanks and channels. The section of the Waihoihoi Stream flowing adjacent to the plan change area was fenced but lined with low stature weed species and occasional mature trees so the streambanks were susceptible to streambank undercutting, slumping (i.e., due to poor root stability) and sedimentation (Photograph 1.2).

*Photograph 1.1: Evidence of unrestricted stock access, lack of riparian margins, upper bank instability.*

*Photograph 1.2: Lack of riparian margins and bank instability along Waihoihoi Stream.*

[2] Ingley, R., Rieger, A., Magee, J., Reeves, E., Macintosh, K., Lowe, M., Young, D. (2016) Watercourse Assessment Report: Slippery Creek Catchment. Morphum Environmental for Auckland Council. Auckland Council [technical report, TR20xx/xxx]

**Existing environment – marine receiving environment**

The marine receiving environment is the Drury Creek and wider Pahurehure Inlet. The immediate marine environment is recognised as a Significant Ecological Area (SEA), which includes SEA-M1_29a, SEA-M2_29b and SEA-M2_29w1-2, shown on Figure 1.1.

Immediately adjacent to State Highway One, the intertidal area is classified as an 'SEA-M1' indicating that its physical form, scale or inherent values are considered to be the most vulnerable to any adverse effects of inappropriate subdivision, use and development. The AUP OP identifies that within these upper tidal reaches of Drury Creek there are a variety of marshes, grading from mangroves through to extensive areas of jointed rush-dominated saltmarsh, to freshwater vegetation in response to salinity changes. This same area is a migration pathway between the marine and freshwater environments for a number of native diadromous freshwater fish species.

Beyond this, the wider intertidal area is classified as an 'SEA-M2' being an area of regional, national or international significance which does not warrant a SEA-M1 identification as they are generally more robust. This has similar ecological values, but also provides roost areas of importance to wading birds including pied stilt.

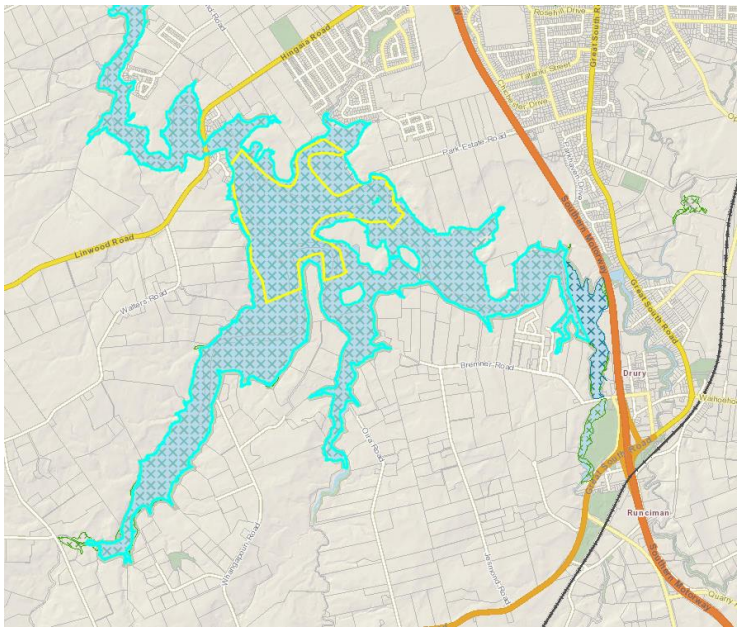



*Figure 1.1: Marine SEA in the Pahurehure Inlet and wider Drury Creek estuarine area*

**Sediment in the marine environment**

NIWA were engaged by the Ministry for the Environment to develop and apply a new empirical model that estimates mean annual river suspended sediment load and sediment deposition in coastal hydrosystems[3]. The model includes suspended sediment load and inherently includes sediment supply from eroding streambanks as well as upstream hill-slope erosion processes.

Shallow drowned valleys such as the Pahurehure Inlet have intermediate level deposition rates (median of 0.7 mm/year), where near-bed velocities are low, little resuspension by currents occurs, and a main channel morphology tends to be absent. The trapping efficiency of a shallow drowned valley is typically quite high, and the Pahurehure Inlet has a predicted trapping efficiency of 0.963. Trapping efficiency is the proportion of incoming sediment load that is retained and settles within the water body measured on a scale of 0 to 1, where 1 means that 'all river-sourced sediment is

[3] Hicks, M., Semadeni-Davies, A., Haddadchi, A., Shankar, U and Plew, D. (2019). Updated Sediment Load Estimator for New Zealand. Prepared by NIWA for the Ministry for the Environment. March 2019. NIWA client report 2018341CH.

retained in the coastal hydrosystem'. What this tells us, is that the marine receiving environment is a natural deposition zone and sediment deposition is expected and required for the environment to continue to function.

*Zostera*, the sea grass grows in soft-sediment environments and is present in the wider Pahurehure Inlet. One of the key functions of seagrass is to trap and stabilise bottom sediments, to protect against sediment erosion in the coastal environment[4]. Seagrasses also depend on sediments for nutrients and anchorage.

**Potential sedimentation effects of the plan change**

The plan change area is currently predominantly in rural land use which typically has a higher overall sediment load than urban land use[5]. The change in hydrological regime may result in streambank sediment entering the receiving environment at times (e.g. after heavy rain). This will be balanced in part by the effective removal of contributing sediment loads from agricultural land use and the future potential benefits associated with planting along the blue-green network throughout the plan change area (e.g., root establishment, increased streambank stability and filtering capacity).

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 plan change area comprises only a very small portion of the 37,637 ha[5] Pahurehure Inlet catchment. Even at the more local scale of the upper Drury Creek, the plan change area comprises a small proportion of the overall contributing catchment. On that basis, any changes within the plan change area on sediment levels in Hingaia Stream would be very difficult to distinguish from changes elsewhere within the catchment.

**Auckland Council Stream Erosion Risk Tool**

As is explained in the stomwater memo (ref W-REF: P16-335), the Auckland Council Stream Erosion Risk Tool was investigated to provide further quantifiable information regarding the potential risks of erosion from within the plan change. Some issues with this tool were identified and next steps are proposed within the stormwater memo. The tool when working will quantify the change in exceedance of critical shear stress will only indicate a change in erosion potential i.e. how much the erosion risk changes. It will not quantify how much extra erosion will occur, nor the change in sediment load will be to the receiving environment, so it cannot be used to directly assess effects. The tool will identify areas with increased erosion risk and where extra mitigation measures should be applied.

Until further assessment is undertaken, a robust ecological assessment of the potential effects of sedimentation in the marine SEA cannot be completed. Further assessment of the change in sediment contribution to the wider environment will be undertaken prior to a plan change hearing, although this may be risk based. This will provide more assessment of the anticipated changes in sediment risk and will incorporate mitigation measures which will reduce the potential stream bank erosion and therefore sediment generation.

Until further assessment or quantification is undertaken, a robust ecological assessment of the potential effects of sedimentation in the marine SEA cannot be completed. Further assessment to quantify the change in sediment contribution to the wider environment will be undertaken prior to a plan change hearing. This will provide a more quantitative assessment of the anticipated changes in sediment generation and will incorporate mitigation measures which will reduce the potential

[4] Turner, S. and Schwarz, A. (2006). Management and conservation of seagrass in New Zealand: an introduction. Science for Conservation 264. Prepared by the Department of Conservation.

[5] Parshotam, A. (2008). Southeastern Manukau Harbour / Pahurehure Inlet Contaminant Study. Sediment Load Model Results. Prepared by NIWA for Auckland Regional Council. Auckland Regional Council Technical Report 2008/052.

stream bank erosion and therefore sediment generation. We have identified a range of potential mitigation measures which may aid in the management of erosion and sedimentation in the plan change area:

- 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.
- Modification of hydrograph mitigated through stormwater retention/detention (MSAF 1 hydrological mitigation) measures which will slow flows.
- 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.
- Potential targeted in-stream erosion protection measures within the Hingaia Stream and other larger streams.

While the effectiveness of these measures cannot be quantified at this stage, these are still considered to provide some benefit to erosion and sediment generation from stream channels affected by the change in hydrology within the plan change area.

## 2 Water quality

The following response has been prepared in relation to RFI Stormwater 01 and 03 to address questions pertaining to water quality and effects on ecology. This response should be read in conjunction with the planning response and stormwater memo.

Chapter E1 of the AUP OP identifies that where freshwater quality is degraded, that it be improved over time and that the macroinvertebrate community index (MCI) be used as a 'guideline' or indicator of freshwater ecosystem health. Aquatic macroinvertebrate community structure, abundance and diversity are standard indicators of the long-term health of streams. Different aquatic invertebrate taxa have varying tolerances of pollutants so their presence or absence can provide an indication of stream condition and overall health (i.e., water quality and habitat quality).

Policy E1.3.(2) identifies some 'national bottom lines' for stream health using the 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 Report[1] (WAR), a sample taken from the Fitzgerald Stream was indicative of poor water and habitat quality (MCIsb = 68). Just downstream of the plan change area near Wykita Lane, a similar MCI of 67 was recorded. A similar assessment was undertaken for the 2016 Slippery Creek WAR however the streams within the plan change were not assessed. Downstream and in the mainstem of the Waihoihoi Stream a sample was taken which indicates 'fair' water and habitat quality (MCIsb=99). Freshwater Solutions sampled a section of the Waihoihoi Stream within the plan change area and reported an MCI-sb indicative of poor stream health (MCIsb = 78). The current state of freshwater ecosystems within the plan change area is typically below the bottom line for rural landuse (i.e., MCI = <94). Under a future landuse of urban the national bottom line of 68 is met. The proposed stormwater management approach needs to at least maintain, but preferably improve, on the existing condition.

Many of the stream systems are expected to be nutrient enriched at present based on the observed prevalence of macrophytes, unrestricted access by livestock and the adjacent agricultural and horticultural land use. Further, with a near complete lack of shade along a high proportion of watercourses within the plan change area, it is expected that elevated water temperatures may be limiting the presence of some invertebrate taxa. It is considered that the main driver of poor macroinvertebrate communities is the lack of riparian vegetation which provides shade, adult aquatic insect habitat, bank stability and source of woody debris and leaf litter. 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. Further, the connectivity of the riparian margins with existing vegetation east of Drury Hills Road, will provide a corridor from source populations of macroinvertebrates in the headwaters throughout the catchment. Restoration of streams including restoring sinuosity, removal of inline ponds, adding retreats and armouring where appropriate is also expected to improve stream habitat quality.

An integrated stormwater management approach has been proposed as a 'Stormwater Management Toolbox' which incorporates a range of measures to manage potential effects associated with the proposed change in land use and outlines the devices proposed within each of the proposed zones. The proposed stormwater management approach includes a range of different devices that will be consistent with GD01[6]. The devices proposed and the overall approach is consistent with the recommendations of TR2013/035. Specifically, these devices (if designed and constructed properly) will meet the historically proposed 'design effluent quality requirements' (DEQR). In relation to zinc and copper (as surrogates for other urban contaminants) these were defined as 30 ug/l for zinc and 10 ug/L for copper. These concentrations were at the point of discharge and do not take into consideration the assimilative capacity of the environment, reasonable mixing or the benefits of a treatment train approach. Further, these values were considered to be conservative, in that most devices perform substantially better than these DEQRs and were chosen for that reason after consultation with Mana Whenua.

It is considered that the implementation of the stormwater management toolbox in conjunction with the enhancement of riparian margins will be sufficient to manage the potential effects associated with changes in water quality and as measured by the macroinvertebrate community indices.

## 3 Blue-green network

The following response has been prepared in relation to Stormwater 07 in relation to the blue-green network. Refer to Appendix A which shows the Blue-Green Network envisaged under the Structure Plan, overlain with the riparian corridors as proposed in the Plan Change. 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.

## 4 Riparian margins

Please refer to the Planning response in relation to RFI E11 + E12 + E13 + E14 (Kiwi), E14 + E16 (Fulton Hogan), E12 + E13 + E14 (Oyster) and Stormwater 06 to address questions in regards to riparian margins around streams and wetlands.

[6] Stormwater Management Devices in the Auckland Region, December 2017, Guideline Document 2017/001 Version1.

# Appendix A: Blue Green Network Map


KEY

Council indicated new suburb park (Size 3-5ha) (Structure Plan)

Council indicated new neighbourhood park (Size 0.3-0.5ha) (Structure Plan)

Flood Plains

Stream Connections

Permanent and Intermitent Streams and 20m Riparian Margins (width may change) - from Structure Plan

Rail line

Rail station (indicative)

State Highway 1

Arterial roads (existing & upgrades)

New arterial roads (indicative)

Collector Road (existing & upgrades) with pedestrian and cycle connections

New collector roads (indicative) with pedestrian and cycle connections

Stream with pedestrian & cycle connections and a 10m riparian margin (Plan Change)

Parks (indicative) (Plan Change)

Scale 1:11,000

**To**

*Auckland Council*
*Carmel O'Sullivan; Mark Iszard*

**From**

*Woods*
*Pranil Wadan - Principal Engineer*

*Tonkin + Taylor*
*Tim Fisher - Engineering Executive Leader*

*W-REF: P16-335*
*25 March 2020*

# Response to Auckland Council Further Information Request on Stormwater Matters for Drury East

This memo has been written to summarise the additional stormwater assessments undertaken in response to the Further Information Request (FIR) from Auckland Council for the Drury East Plan Change requests.

The structure of the memo is as follows:

- Stormwater management
- Hydrological mitigation
- Flood management

How the response relates to the Auckland Council FIR table is summarised in Appendix A.

## 1. Stormwater management

A matrix of stormwater management outcomes and tools for different land use zones is presented in Table 1 to demonstrate that an integrated stormwater management approach will be implemented across all three Plan Change Areas (Kiwi Property, Fulton Hogan and Oyster Property). The matrix is compiled from the current Stormwater Management Plans (SMP) for each Plan Change and will form part of the updated SMP. It shows alignment of stormwater quality, hydrological mitigation and flood attenuation approaches across the three Plan Change Areas. An ecological assessment will be provided to address potential impacts on the Significant Ecological Area.

In addition, a broad range of Best Practicable Options (BPOs) for mitigating effects and/or achieving these outcomes are listed for the corresponding land-use. This toolbox will be used to develop each development's stormwater management approach, though different devices and/or combinations may be adopted across the three Plan Change Areas to achieve the outcomes.

Feedback from Auckland Council at our update meeting of 19 February 2020 was that the performance standards should be as consistent as possible across the three Plan Change Areas, and the stormwater management toolbox as broad as possible to have flexibility of implementation.

**Table 1: Stormwater Management Toolbox**

| Zone | Land Use | Performance Outcomes | | | | Best Practicable Options | Notes |
|---|---|---|---|---|---|---|---|
| | | **Water Quality** | **Hydrological Mitigation** | **Flood Attenuation** | **Water Sensitivity Design [1]** | | [1] The proposed stormwater management options adopt a Blue Green Corridor 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. |
| Performance standard | | GD01[2] | AUP:OP SMAF 1[3] | 1% AEP: $Q_{pre} = Q_{post}$[4] | | | [2] Stormwater Management Devices in the Auckland Region –Guideline Document 20017/001 (GD01). (December 2017). Auckland Council |
| Mixed use Metropolitan Centre | Roads | ✓ | ✓ | X | ✓ | **Bio-retention devices including:**<br>• Raingardens<br>• Tree pits<br>• Vegetated swales | [3] Auckland Unitary Plan –Operative in Part (AUP:OP). Auckland Council |
| | Non Roads | ✓ | ✓ | X | ✓ | Inert Building materials<br>Rainwater tanks for re-use of roof runoff<br>Permeable pavements for public realm areas<br>Communal detention devices<br>**Bio-retention devices including:**<br>• Raingardens<br>• Tree pits<br>• Vegetated swales | The Plan Change Area 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:<br>• Retention (volume reduction) of at least 5mm of runoff depth from impervious surfaces<br>• 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.<br>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.<br>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. |
| Mixed Housing – Urban<br><br>Mixed Housing – Suburban<br><br>Terraced Housing Apartment Buildings | Roads | ✓ | ✓ | X✓[6,7] | ✓ | Communal devices[5]<br>Offline Wetlands/Dry Basins[5]<br>**Bio-retention devices including:**<br>• Raingardens[4]<br>• Tree pits<br>• Vegetated swales | [4] Post-development peak flows to match pre-development peak flows for the 1 % Annual Exceedance Event (AEP). |
| | Carparks > 30 Vehicles | ✓[5] | ✓ | X✓[6,7] | ✓ | Inert Building materials<br>Rainwater tanks for re-use of roof runoff<br>Permeable pavements for driveways or laneways<br>Communal devices[5] | [5] Devices will be provided and sized for WQ treatment for carparks (greater than 30 vehicles) only for the Residential Zones. |
| | Roofs, JOALS, driveways, gardens/landscaping | X✓[8] | ✓ | ✓ | ✓ | **Bio-retention devices including:**<br>• Communal detention devices<br>• Living Roofs<br>• Raingardens<br>• Vegetated swales | [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.<br>[7] Flood attenuation for Oyster Southern Zone.<br>[8] Hydrology mitigation will be provided for these impervious areas; the use of devices such as bio-retention for mitigation will also provide WQ treatment. |

# 2. Hydrological Mitigation

## 2.1 Stormwater management

Hydrological mitigation controls should be applied within the Plan Change Area as it is located upstream of a Stormwater Management Area control - Flow 1 (SMAF 1) and is a greenfield development where Policy E1.3.8 requires "*…minimising or mitigating changes in hydrology…*" and effects on rivers and streams.

The proposed Drury East (three Plan Change Areas) approach to hydrological mitigation and addressing stream erosion risk is to provide a minimum of SMAF 1 hydrological mitigation (detention and retention) for all impervious surfaces . The minimum hydrological mitigation requirements proposed are as follows:

- Retention (volume reduction) of at least 5mm of runoff depth from impervious surfaces where possible (refer Table E10.6.3.1.1)
- 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.

A stream erosion assessment (refer Section 2.2) is to be carried out to identify high risk areas and determine if additional measures (such as additional detention requirements) are required to mitigate the hydrological impacts of development.

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.

For roads and car-parks within the Plan Change Area, hydrological mitigation can be achieved through vegetated bio-retention devices such as raingardens, tree pits and swales. These devices generally provide multiple functions: retention/detention, visual amenity and water quality treatment close to the source.

For residential lots within the Plan Change Area, hydrological mitigation of roof runoff may be achieved through rainwater tanks. Rainwater tanks promote the recycling and re-use of rainwater, while mitigating stormwater runoff at source. Stormwater runoff from other impervious surfaces within residential lots could be managed within permeable pavements on private or shared driveways. If this is not practicable, communal underground detention tanks could be utilised to minimise the land take required whilst achieving the required detention volume.

Within the Metropolitan Centre, rainwater tanks, communal detention devices and/or permeable pavements could be used to achieve hydrological mitigation. Rainwater tanks will only be utilised where there is sufficient demand for water reuse. Where practicable, raingardens can also be used to achieve hydrological mitigation alongside water quality mitigation e.g. for roads and carparks and surrounding public spaces where practicable.

## 2.2 Stream erosion

The extend and effects of stream erosion on the streams and Drury Creek are described in the Drury East Plan Change – Ecology Response (19 March).

All stream tributaries within the Plan Change Area are highly eroded and degraded. This is attributed to a combination of poor bank stability, unrestricted stock access leading to ongoing agricultural related nutrient inputs, instream channel disturbance, minimal stream channel shading and bare or sparsely vegetated riparian vegetation within the catchment.

Drury East Plan Change – Ecology Response (19 March) has identified the follow mitigation measures as being those which will aid in the management of erosion and sedimentation in the Plan Change aArea:

- 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.
- Modification of hydrograph mitigated through stormwater retention/detention (SMAF 1 hydrological mitigation) measures which will slow flows.
- 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 the Hingaia Stream and other larger streams.

While the effectiveness of these measures cannot be quantified at this stage, these are still considered to provide some benefit to erosion and sediment generation from stream channels affected by the change in hydrology within the Plan Change Area.

This proposed approach to addressing stream erosion risk recognises that there are several mitigating factors including the fact that Plan Change Area is proportionally a very small part of the overall Hingaia Catchment and is towards the bottom of the catchment so instream works are likely to be the best way to address locally derived erosion risk. Also, that the proposed urban land use has typically a lower sediment load than for rural land.

## 2.3 Stream erosion risk assessment

The Auckland Council Stream Erosion Risk Tool was investigated as a mechanism to analyse stream erosion resulting from the development. We have encountered issues with the simplistic tool, that means this assessment cannot be completed within the timeframes of the FIR response.

The issues and our next steps are summarised below:

| # | Issue | Next step |
|---|---|---|
| 1 | TP108 hydrology is too coarse for a large catchment such as the Hingaia where a refined hydraulic model is available | Use hydrographs from the flood model. Rebuild Stream Erosion Risk Tool to allow this. |
| 2 | Hydraulic shear stress is very sensitive to Slope (S) and thalweg/bed levels are too variable and result in non-sensible results | Use bed shear stress calculated by the hydraulic model at all locations and at all time steps. Rebuild the Stream Erosion Risk Tool to allow for these inputs. |
| 3 | Simplification of channel cross-sections to a trapezoid is too coarse | |
| 4 | Critical shear stress cannot be determined from the geotechnical testing already done for the site. | Estimate this from Auckland Council databases in the Stream Erosion Risk Tool. |
| 5 | Quantification of change in exceedance of critical shear stress will only indicate a change in erosion potential. It will not quantify how much extra erosion and what the change in sediment load will be to the receiving environment, so it cannot be used to assess effects. | Auckland Council to advise how they see this working. The tool will identify areas with increased erosion risk and where extra mitigation measures should be applied. |

The technology and understanding in this area are evolving but is not ready yet. We will work with Council to complete this assessment for the hearing stage of the Plan Change.

# 3. Flood Management

Additional flood modelling was undertaken to assess the potential flooding mechanisms and effects caused by a "development only flood' scenario. This scenario assumes extreme rainfall (2, 10, 100 year ARI rainfall) in the lower catchment only (over existing Drury and Plan Change Areas). A proposed flood modelling methodology was outlined in the memo *Drury East (Kiwi and Fulton Hogan) flood modelling – response to Auckland Council Modelling requests* prepared by Tonkin + Taylor to Auckland Council on 10 and 19 February 2020, and accepted as a part of the lodgement of Plan Changes for Drury East by Fulton Hogan and Kiwi Property in the FIR from Auckland Council.

The proposed steps outlined in the memo were:

1 *For 10-year and 100-year ARI model runs (pre-development and post development) map the buildings with floors at risk from flooding. This is the "full catchment flood scenario". Shape file with building extents and floor levels to be supplied by Auckland Council. Use T+T/Woods current models as they are (model version, Drury South included and impervious assumptions).*

2 *Simulate the potential flooding caused by development of the lower catchment. This is the "development only flood scenario". Reconfigure the post development models to:*
   - *apply 10-year and 100-year ARI rainfall to the lower catchment including existing Drury Township and the developed Future Urban areas inclusive of developments (e.g. MPD in the FU areas)*
   - *Allow for nominal "fresh" flow of 50 m3/s from the upper catchment*
   - *Map the buildings that flood*

3 *Compare the flood extents and buildings that flood for full catchment flood scenario (pre and post) to development only flood scenario*

4 *Assess the impacts on existing Drury due to the developments from both the flood for full catchment flood scenario and development only flood scenario*

## 3.1 Model build and updates

These model scenarios were based on the Drury South Precinct Plan Change model that has been reviewed and signed off by Auckland Council as a part of the Drury South Precinct Plan Change application. Previous changes to the model have been documented in the D*rury Town Centre - Kiwi Property - Model Build* Memo prepared by Tonkin +Taylor to Auckland Council on 17 June 2019, and includes changes to the Hingaia Stream catchment model representing the pre- and post-development catchment scenarios supplied by Fulton Hogan and Kiwi Property for the Drury East Plan Change applications.

Any additional changes to the models are captured in Tables 2 and 3 below, which outline the catchment and development only model matrices agreed with Auckland Council as a part of this request. Associated supporting information will be supplied to Auckland Council for review of the flood model build/changes.

### 3.1.1 Post Development Model Structures

A plan showing the structures that have been "opened" or modified is available in Appendix B; a summary of this is as follows:

- Great South Road Culvert, Railway Culvert, Flanagan Road Culvert –Supplemented with 2mx2.5m box culvert
- Off Flanagan Rd (Private Bridge) - Opened
- Fitzgerald Culvert - Opened
- Field Road Culvert - Opened
- Cossey Road Culvert - Opened
- Fitzgerald Road Culvert (off – Fielding Road) - Opened
- Fitzgerald Road Culvert (off – Cossey Road) - Opene

**Table 2: Model matrix – Catchment Models**

| Scenario | Baseline Model (and key assumptions) | 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 | Model ID | Event | Climate Change | Model Changes |
|---|---|---|---|---|---|---|---|---|
| Pre-Development Model | Drury South Precinct Plan Change model *(post development impervious and landforms)* | Existing Culverts | 10% Imperviousness within FUZ; Drury South - Post Development; Upstream rural zonings at 10% imperviousness | 10% Imperviousness within FUZ (including PCA) | 01 | 2yr | Yes | - Hydrology updated to use 2yr Future Rainfall using Model 02<br>- No other changes |
| | | | | | 02 | 10yr | | - Model developed as a part of preparing Stormwater Management Plan for Drury East Plan Change Area for Fulton Hogan and Kiwi Properties |
| | | | | | 03 | 100yr | | - Model developed as a part of preparing Stormwater Management Plan for Drury East Plan Change Area for Fulton Hogan and Kiwi Properties |
| Post-Development Model | Drury South Precinct Plan Change model *(post development impervious and landforms)* | Culverts open with post development landforms within Plan Change areas (these culverts will be designed for 100yr 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%<br>Imperviousness for Kiwi Property land = 70%<br>Imperviousness for Fulton Hogan land = 65%<br>Future Urban Zone outside of Plan Change Area = 60% | 04 | 2yr | yes | - Hydrology updated to use 2yr Future Rainfall using Model 05<br>- No other changes |
| | | | | | 05 | 10yr | | - Model developed as a part of preparing Stormwater Management Plan for Drury East Plan Change Area for Fulton Hogan and Kiwi Properties |
| | | | | | 06 | 100yr | | - Model developed as a part of preparing Stormwater Management Plan for Drury East Plan Change Area for Fulton Hogan and Kiwi Properties |
| | | | | | 07 | 2yr | No | - Hydrology updated to use 2yr Existing Rainfall using Model 01<br>- No other changes |

**Table 3: Model matrix – Development Only Models**

| Scenario | Model ID | Event | Climate Change | Model Changes |
|---|---|---|---|---|
| Pre-Development Model | 08 | 10yr | Yes | - Mike 11 network model updated using Model 02<br>- Hingaia Stream river branch was disconnected at chainage 14723 to a dummy outlet<br>  o Dummy outlet was modelled with dummy river branch and wide cross sections<br>  o Channel bed of dummy branch was set equal to the channel bed on Hingaia Stream branch at chainage 14723<br>  o Q-h relationship was set as a boundary condition to discharge unrestricted flows out of the system<br>- Hingaia Stream river branch was modelled with inflows of $30m^3/s$ and $50m^3/s$ are applied for 10yr and 100yr scenarios respectively along Hingaia Stream at upstream chainage of 14724<br>- No other changes |
| | 09 | 100yr | | |
| Post-Development Model | 10 | 10yr | Yes | - Mike 11 network model updated using Model 05<br>- Hingaia Stream river branch was disconnected at chainage 14723 to a dummy outlet<br>  o Dummy outlet was modelled with dummy river branch and wide cross sections<br>  o Channel bed of dummy branch was set equal to the channel bed on Hingaia Stream branch at chainage 14723<br>  o Q-h relationship was set as a boundary condition to discharge unrestricted flows out of the system<br>- Hingaia Stream river branch was modelled with inflows of $30m^3/s$ and $50m^3/s$ are applied for 10yr and 100yr scenarios respectively along Hingaia Stream at upstream chainage of 14724<br>- No other changes |
| | 11 | 100yr | | |

## 3.2 Results analysis

Model results were analysed for flood extents, peak water levels and flood depths for all building footprints for each scenario to understand the flood risk for the pre and post development scenarios. Analysis was limited to the building footprints within Drury Township (excludes existing building footprints within the Plan Change Areas) and covers the area encompassed by –

- Southern Motorway bridge to the north
- Southern Motorway to the west
- Great South Road to the east
- Flanagan Road to the south.

This is shown as 'Area of interest' on the flood maps provided in Appendix B.

The intention of this assessment was to understand if there is any increase in flood risk to properties downstream of the Plan Change Areas with the increases in flows associated with higher imperviousness within these developments. This area of analysis is shown in figures (provided in Appendix B) and all flood results outside this extent as less reliable with the model setup.

## 3.3 Building Flood Risk

The 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 150mm above the respective ground levels
- Flood maps were generated for all scenarios (provided in Appendix B) to understand the differences.

A total of 81 buildings footprints within the 'Area of interest' were analysed based on the above approach and tabulated in Table 4 below.

The 'Development only' models were run for the 10yr and 100yr scenarios and Catchment models were run for the 2yr scenario with and without climate change.

The 2yr model Catchment model results were analysed in addition to agreed scenarios to understand if there are any adverse flood risks with the proposed development for smaller rainfall events.

The analysis shows 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.

**Table 4: 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 |
| 2yr 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** |
| 2yr 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** |
| 10yr with Climate Change | Above Floor Level | - | - | n/a | n/a |
| | Below Floor Level | 4 | 4 | n/a | n/a |
| | Flood Depth > 0.15m | 1 | 1 | n/a | n/a |
| | Flood Depth < 0.15m | 1 | 1 | n/a | n/a |
| | **Total Flooded properties** | **6** | **6** | **n/a** | **n/a** |
| 100yr with Climate Change | Above Floor Level[1] | 2 | 1 | n/a | n/a |
| | Below Floor Level[1] | 10 | 12 | n/a | n/a |
| | Flood Depth > 0.15m[2] | 5 | 4 | n/a | n/a |
| | Flood Depth < 0.15m[2] | 1 | 1 | n/a | n/a |
| | **Total Flooded properties** | **18** | **18** | **n/a** | **n/a** |

1 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)
2 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 100yr with Climate Change scenario for 'Development only' is denoted in grey to indicate differences in the results as the total number of flooded properties are overall unchanged but there is an improvement with one property which flooded above floor level, floods below floor level for the post development scenario.

## 3.4 Flow and peak time comparisons

Flows were extracted for the 10yr and 100yr scenarios to understand the differences between the pre and post development scenarios for the 'Development only'. The post development flows are peakier when compared to the pre-development scenario but have shorter time to peak with no lag as seen in Figure 1 and 2 below.

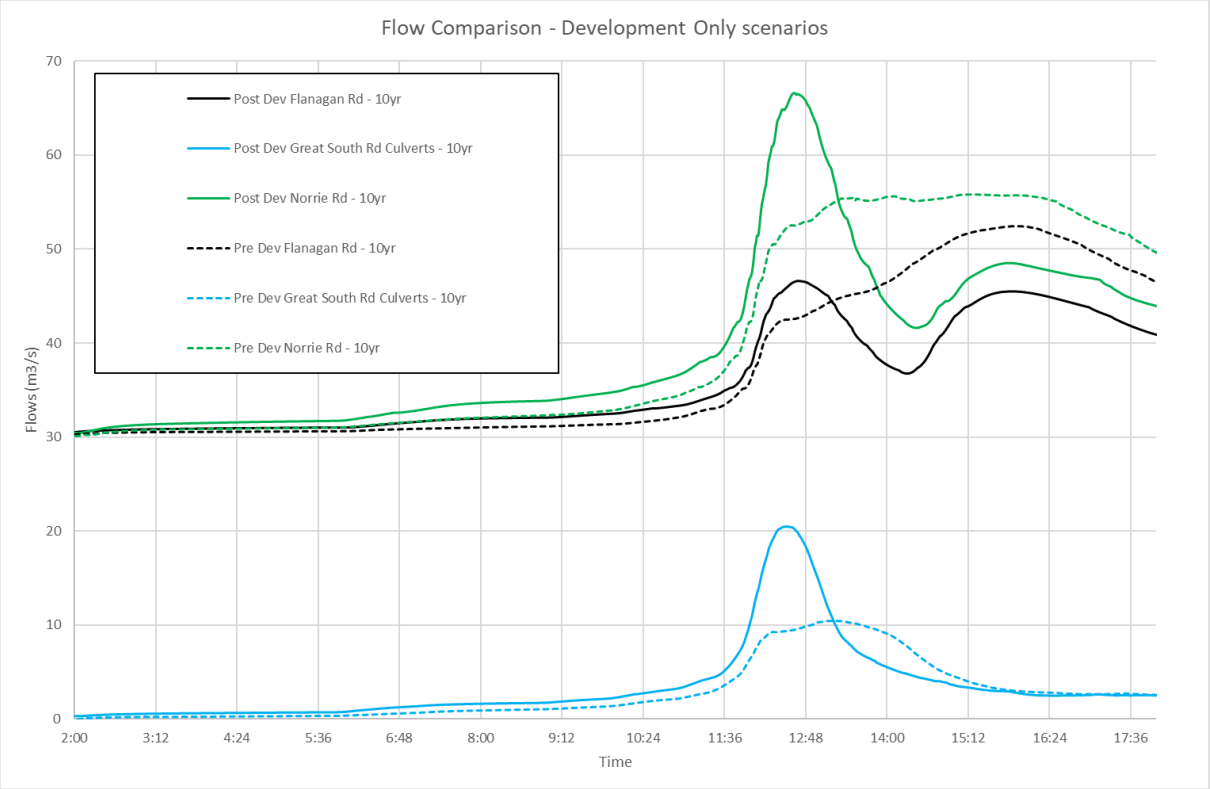



Figure 1: Flow comparison – 10yr

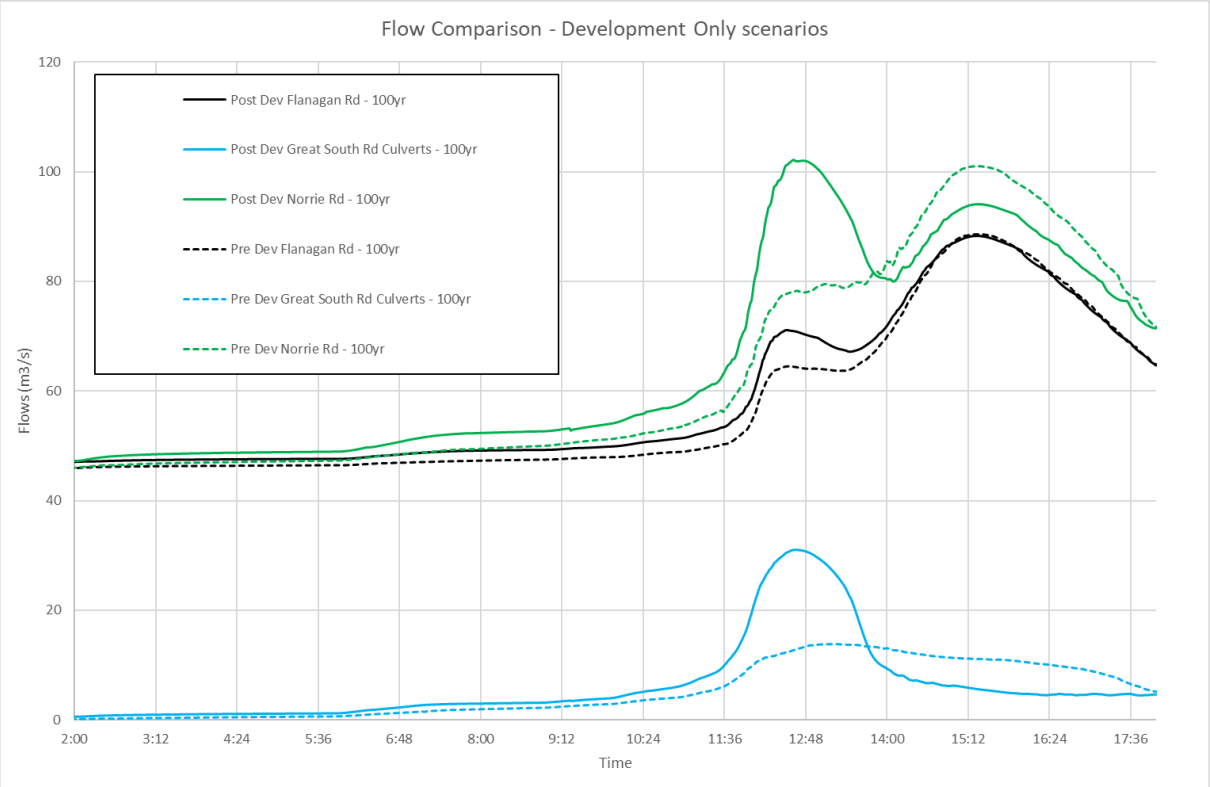



Figure 2: Flow comparison – 100yr

The 10yr flows at Norrie Road bridge were compared for the catchment and 'Development only' models flows which confirm that a 'pass flows' forward approach works better for the proposed development to discharge majority of the flows before the peak of the upstream flows reach Drury township.

This is supported by the building floor risk analysis which shows no increased flood risk to buildings/habitable floors with the 'pass flows forward' approach.

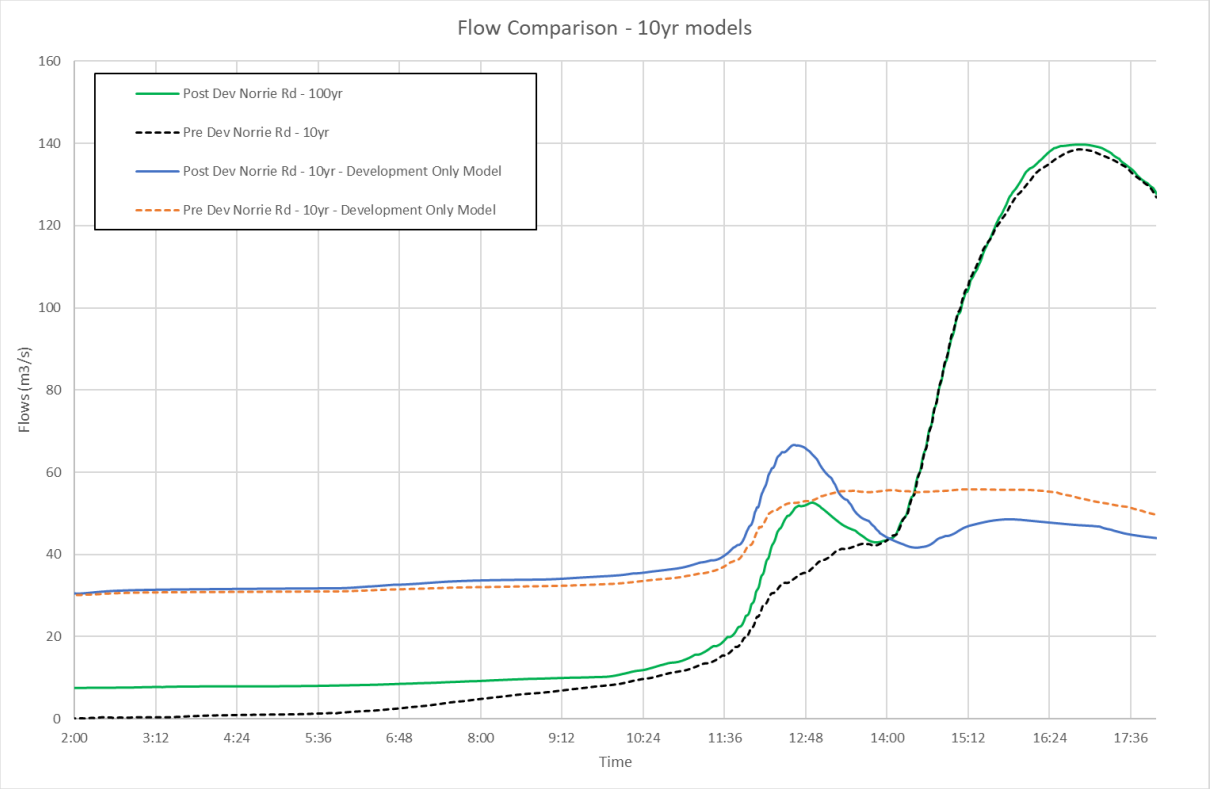



Figure 3: 10yr Flow comparison

APPENDIX A: Technical Memos

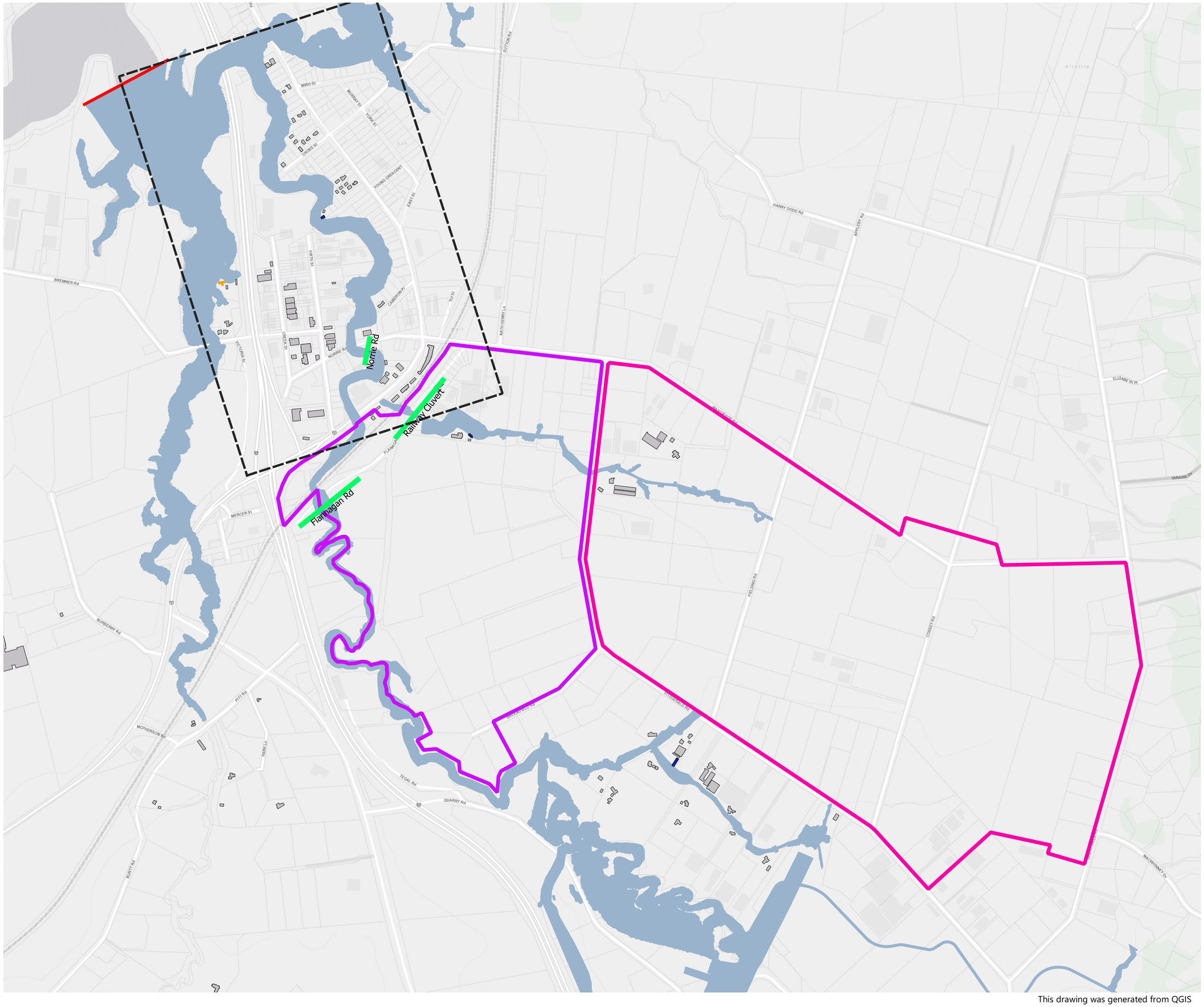
| Assessment category | | Comments /requests | Reason for comments/requests | Responses |
|---|---|---|---|---|
| No | Category | | | |
| 01 | Stormwater Planning | Please provide an assessment of how the proposed plan changes meet the outcomes of the NPS-FM and the related matters in the AUP Regional Policy Statement.<br><br>How does the s32 report acknowledge and address methods to meet regional policy statement objectives that are relevant to the plan change areas, including B7.3<br>E1.3.8 and E1.310? Please update if necessary. | The policy framework acknowledged in the s32 reports primarily addresses matters relating to urban development and the provision of land for urban growth. While there is some acknowledgement of the NPS-FM, this appears to be limited to how streams and other natural hydrological features are recognized in the proposed plan changes. NPS-FM Objectives and Policies relating to water quality; and Regional Policy Statement objectives and policies for water quality and integrated stormwater management do not appear to be addressed.<br><br>The process and outcome of urbanising land has significant environmental effects both immediately and into the future. There appears to be little acknowledgement of these effects on the receiving environment (which the NPS and RPS objectives and policies refer to) or adequate demonstration of how these effects will be mitigated through the proposed precinct plan provisions and proposed stormwater management plan. | Refer to Planning and Ecology Response |
| 02 | Stormwater quality | Please clarify how objectives in the AUP for water quality will be met. The Planning report (pg46) emphasises that high contaminant generating roads and carparks will be treated (treatment of these roads is covered by region wide rules in Chapter E9 AUP). However, it is unclear how many roads are anticipated to meet the thresholds to trigger E9 rules and if additional roads should be treated to meet the proposed objective.<br><br>There is also reference in the Drury East – Fulton Hogan request (page 46) to a treatment train approach and secondary treatment but it is unclear if this is part of the approach to treat high contaminant generating roads or is an additional response applied to all roads to meet objectives E1.3.8 and E1.3.8 and meet Schedule 4 NDC requirements greenfield developments. | AUP E1.3.8 directs to avoid as far as practicable the adverse effects of development on water quality.<br><br>AUP Objective E1.2.3 and Policies 1.3.2 and 1.3.3 directly implements the NPS-FM 2017. Avoiding adverse effects on water quality should be demonstrated in the planning report and SMP. The creation of adverse effects on water quality due to contaminants in runoff from impervious surfaces is an effect of urban land use. Therefore, this should be part of the S32 report and AEE.<br><br>Reliance on region wide rules in the AUP may not sufficient to meet AUP policies for this plan change area and for the associated receiving environment which is a Significant Ecological Area; some of which (such as Drury Creek Islands) have further restoration and enhancement underway.<br><br>Additional detail on the methods for treating stormwater to avoid adverse effects may also be sought prior to notification of this plan change as part of the SMP in support of stormwater discharge authorisation. | Refer to Section 1: Stormwater management of Memo P16-335. |

| | | | | |
|---|---|---|---|---|
| | | A matrix showing what tools will be used in what proposed land use zone to avoid any adverse effects on water quality should be included in the SMPs as part of identifying how adverse effects will be mitigated and how these achieve AUP policies for water quality. | | |
| 03 | Water quality | Please more fully describe how the water quality policies in E1 will be achieved, and what options have been considered to meet the policies. | The current descriptions in the SMPs are confusing and appear to rely solely on the region wide rules. Given the AUP policy directives for greenfield development and the sensitivity of the receiving environment, additional treatment (such as a treatment train approach) may be justified. | Refer to Planning and Ecology Response |
| 04 | Hydrology Mitigation | Please provide an assessment of the degree to which SMAF1 avoids or remedies changes in hydrology which will result from the urban land uses proposed in the plan changes.<br><br>A Regional Erosion Threshold Metric risk assessment identifies areas at risk of erosion and provides some quantification of the amount of erosion caused, however it does not address how effects will be avoided, remedied or mitigated.<br><br>Identification of measures to avoid effects and mitigate should also be made and the BSTEM model is appropriate for this task. More detail on this tool is being supplied to the applicants. | The AUP states that for greenfield areas adverse effects of development shall be avoided as far as practicable or otherwise remedied or mitigated and this includes changes in hydrology (Policy E1.3.8). No SMAF controls were applied to greenfield areas in the AUP as it was expected that an assessment on what hydrological mitigation is required, would be undertaken as part of plan change process. The Drury-Opaheke Structure Plan SMP also identified that hydrological mitigation and erosion assessments should be completed at the scale of the plan changes so that the particular effects of proposed land uses would be identified, and mitigation measures would be determined, at scale proportionate to the proposed activities and effects. | Refer to Section 2: Hydrological Mitigation of Memo P16-335. |
| 05 | Flooding | Please address the matters identified and discussed in the memo to Healthy Waters from Tonkin and Taylor dated 19 Feb 2020.<br><br>We note that all applicants need to explain what the effect cumulatively across developments will be on the Drury township flooding and parts of the catchment that interact with the Slippery Creek floodplain. | Flooding in the Hingaia catchment is complex and needs to be considered in conjunction with other plan changes proposed for the area; acknowledge any interactions with other catchments and the cumulative impact of potential development in the surrounding areas and the point of discharge downstream. Understanding the impact of development on the flood plain within the plan change sites and impacts downstream is necessary to evaluate the plan change proposal and ensure any potential flood effects are avoided or mitigated.<br><br>Several discussions between Healthy Waters and the applicant's planners have occurred on the best way to approach flood | Refer to Section 3: Flooding of Memo P16-335. |

| | | | | |
|---|---|---|---|---|
| | | | modelling and the memo from T&T dated 19 Feb 2020 reflects our agreement with regards to flooding matters. | |
| 06 | Riparian Margins | Please explain why a 10m wide riparian margin is proposed when the Drury-Opaheke Structure Plan Stormwater Management Plan identified a 20m riparian margin as being appropriate. No evaluation of these two options is provided including their consistency with the objectives and policies of the AUP. | A 20m wide riparian margin was consulted on as part of the Drury-Opaheke Structure Plan 'Blue Green Network' and associated the Stormwater Management Plan. The purpose of the wide margin is to provide an ecological corridor and provide a buffer for the stream noting that stream meander may occur due to erosion. These benefits support achievement of AUP objectives and policies. A rationale for a lesser width margin is not provided in the s32 report. | Refer to Planning and Ecology Response |
| 07 | Ecological corridors and blue green network. | Please clarify what the ecological corridors are and how they contribute to meeting objectives and policies of the AUP.<br><br>They are mentioned briefly but there is no description on how these align to the Blue-Green network identified in the Drury-Opaheke Structure Plan, nor are the streams or corridors noted specifically in the precinct plan or stormwater management plan.<br><br>Planning provisions to enable the ecological corridor are not provided in the precinct plan nor is an assessment given in s32 assessment reports. | A blue green network utilising the natural hydrological features of existing streams was identified as part of Auckland Council's Drury-Opaheke Structure Plan. If and how streams are used in this way has implications in relation to:<br><br>• Identifying the impact of urban development on streams (if they are intended to be retained or not);<br>• Keeping flood conveyance channels available as part of the 'pass-it-forward' approach outlined in the Drury-Opaheke Structure Plan<br>• Mitigation of effects anticipated by urban development, including hydrology mitigation.<br><br>The precinct plan and stormwater management plan lack information on the ecological corridors making their purpose for achieving AUP objectives and policies or as part of effects mitigation unclear.<br><br>We note public access such as walkways/cycle network need to be located outside riparian setbacks and the minimum width required to accommodate water sensitive devices. | Refer to Planning and Ecology Response |
| 08 | Development staging | Please explain if and how the precinct plan is to manage flood risks (such as staging of development in conjunction with flood mitigation measures).<br><br>Flood attenuation is proposed in the SMP but there are no precinct plan provisions to ensure that flood attenuation is provided or when it | The plan change areas are areas of significant flood hazard and developing the plan change areas could increase the flooding downstream in the existing Drury township.<br><br>Fulton Hogan, in their SMP page 6 propose as part of their flood management approach for Zone A to provide:<br><br>*Temporary flood attenuation to pre-develop flow – to enable development in advance of culvert upgrades* | With respect to Fulton Hogan and their proposed attenuation, this will be provided once more clarity around development and staging is available.<br><br>The SMP was alluding to the potential for development to occur prior to upgrade of |

| | | | | |
|---|---|---|---|---|
| | | would be appropriate to not have flood attenuation. | There is no indication in their SMP or precinct plan of when this would be provided or when it will not be provided. The attenuation relates to current culvert capacity at Great South Rd and Flannagan Rd. These culverts will likely need upgrading in the future when road upgrades are done but this requirement is not linked to transport infrastructure upgrades or backed up by analysis of culvert capacity. | downstream assets i.e. railway culverts.<br><br>A staging plan will be provided upon finalization of approach which won't be available until resource consent stage. |

APPENDIX B: Flood Maps




Tonkin+Taylor

WOODS Est.1970

## LEGEND

- Flood Extent

### Buildings

- Flood depth <0.15m
- No flooding
- Flood level < Building level
- Flood level > Building level
- Flood level > 0.15m
- Flood Model Boundary
- Fulton Hogan Development
- Kiwi Property Plan Change (Feb 2019)
- Flow Cross Sections
- Area of Interest

| REVISION DETAILS | | BY | DATE |
|---|---|---|---|
| 1.0 | Issued for Information | PW | 17/03/2020 |
| | | | |
| | | | |
| | | | |

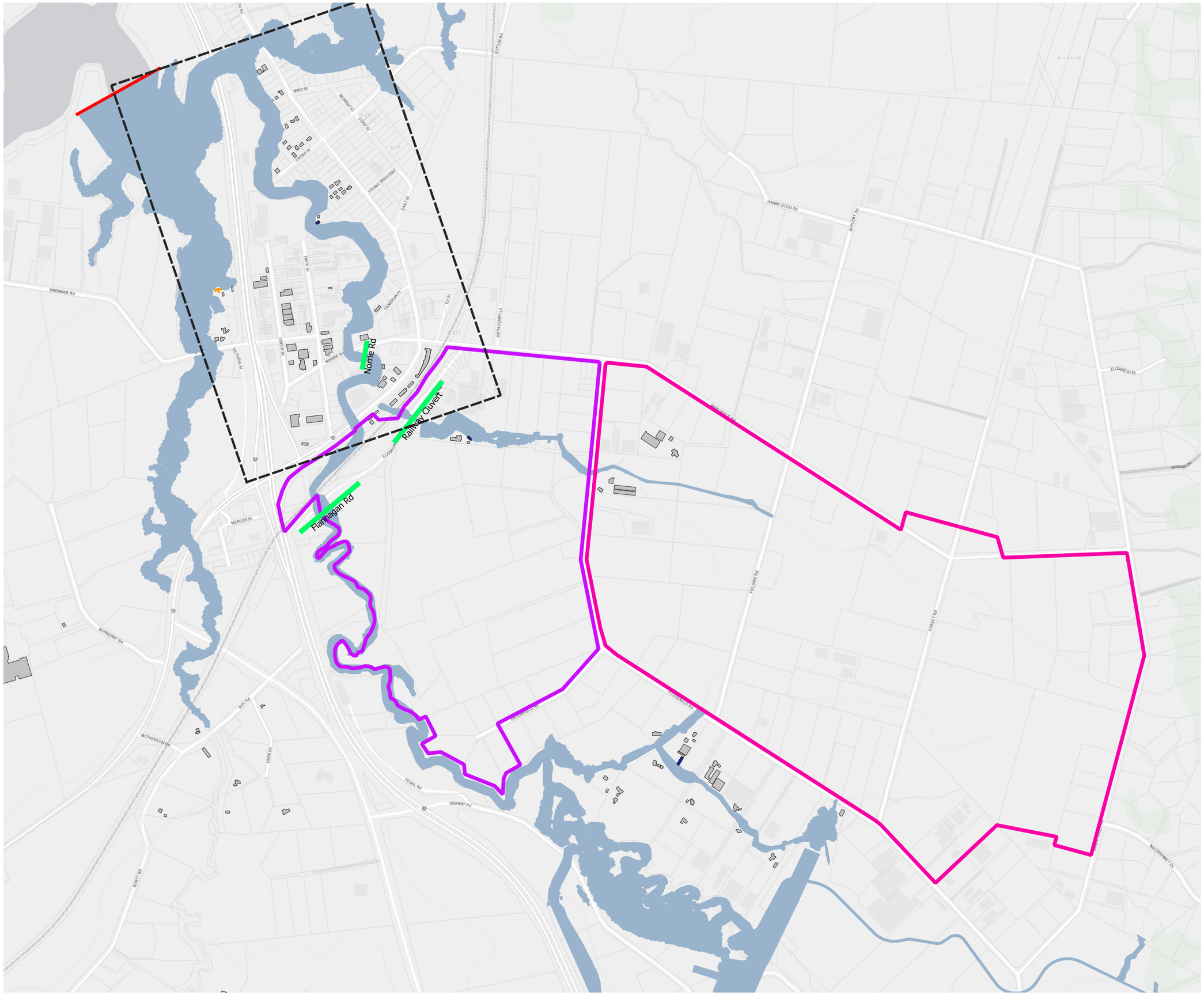
| | | |
|---|---|---|
| SURVEYED | AC | |
| DESIGNED | PW/AD | |
| DRAWN | SH | |
| CHECKED | PW | |
| APPROVED | PW | WOODS.CO.NZ |

N

Pre Development 2 Year MPD Flood Assessment
Catchment Model
Climate Change - YES

| | | |
|---|---|---|
| STATUS | ISSUED FOR INFORMATION | REV |
| SCALE | 1:12000 @ A3 | 1.0 |
| COUNCIL | AUCKLAND COUNCIL | |
| DWG NO | P16-335-SKT-0003 | |

This drawing was generated from QGIS




## LEGEND

- Flood Extent

### Buildings

- Flood depth <0.15m
- No flooding
- Flood level < Building level
- Flood level > Building level
- Flood level > 0.15m
- Flood Model Boundary
- Fulton Hogan Development
- Kiwi Property Plan Change (Feb 2019)
- Flow Cross Sections
- Area of Interest

| REVISION DETAILS | | BY | DATE |
|---|---|---|---|
| 1.0 | Issued for Information | PW | 17/03/2020 |
| | | | |
| | | | |
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| | | |
|---|---|---|
| SURVEYED | AC | |
| DESIGNED | PW/AD | |
| DRAWN | SH | |
| CHECKED | PW | |
| APPROVED | PW | WOODS.CO.NZ |

N

Post Development 2 Year MPD Flood Assessment
Catchment Model
Climate Change - YES

| | | |
|---|---|---|
| STATUS | ISSUED FOR INFORMATION | REV |
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| COUNCIL | AUCKLAND COUNCIL | |
| DWG NO | P16-335-SKT-0004 | |

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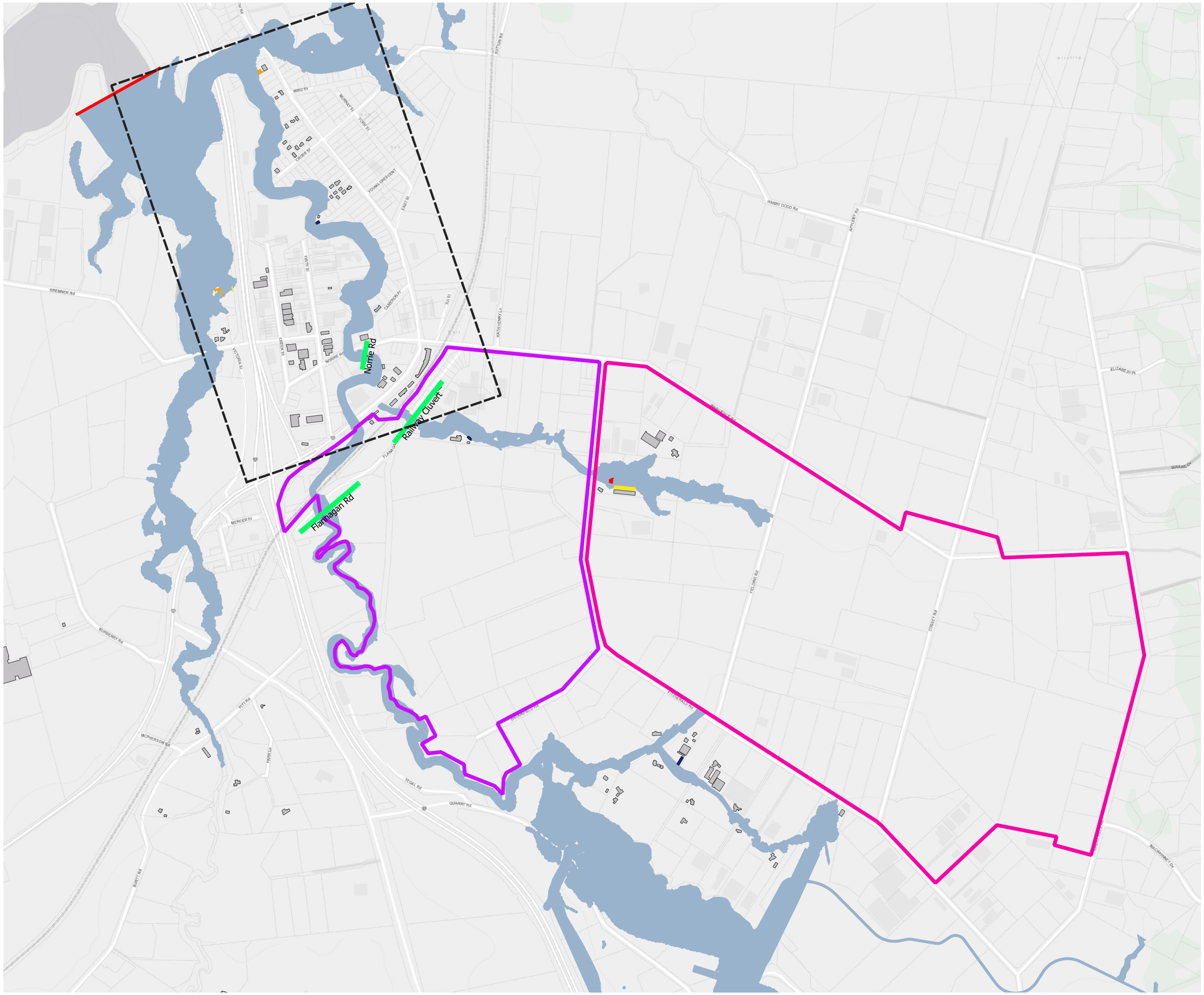


Tonkin+Taylor

WOODS Est.1970

## LEGEND

- Flood Extent

### Buildings

- Flood depth <0.15m
- No flooding
- Flood level < Building level
- Flood level > Building level
- Flood level > 0.15m
- Flood Model Boundary
- Fulton Hogan Development
- Kiwi Property Plan Change (Feb 2019)
- Flow Cross Sections
- Area of Interest

| REVISION DETAILS | | BY | DATE |
|---|---|---|---|
| 1.0 | Issued for Information | PW | 17/03/2020 |
| | | | |
| | | | |
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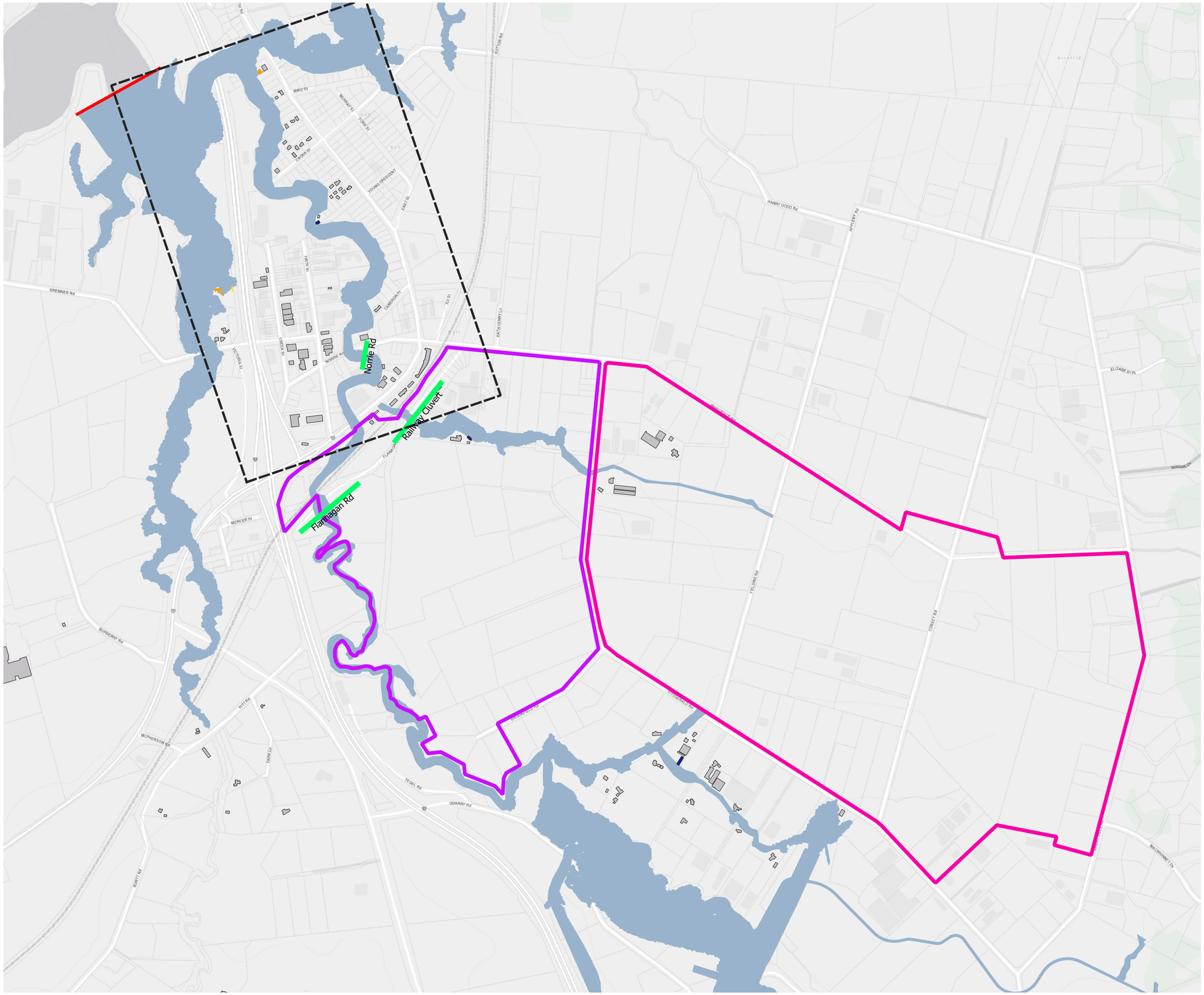
| | | |
|---|---|---|
| SURVEYED | AC | |
| DESIGNED | PW/AD | |
| DRAWN | SH | |
| CHECKED | PW | |
| APPROVED | PW | WOODS.CO.NZ |

N

Pre Development 10 Year MPD Flood Assessment
Development Model
Climate Change - YES

| | | |
|---|---|---|
| STATUS | ISSUED FOR INFORMATION | REV |
| SCALE | 1:12000 @ A3 | 1.0 |
| COUNCIL | AUCKLAND COUNCIL | |
| DWG NO | P16-335-SKT-0007 | |

This drawing was generated from QGIS




Tonkin+Taylor

WOODS EST.1970

## LEGEND

- Flood Extent

### Buildings

- Flood depth <0.15m
- No flooding
- Flood level < Building level
- Flood level > Building level
- Flood level > 0.15m
- Flood Model Boundary
- Fulton Hogan Development
- Kiwi Property Plan Change (Feb 2019)
- Flow Cross Sections
- Area of Interest

| REVISION DETAILS | | BY | DATE |
|---|---|---|---|
| 1.0 | Issued for Information | PW | 17/03/2020 |
| | | | |
| | | | |
| | | | |

| | | |
|---|---|---|
| SURVEYED | AC | |
| DESIGNED | PW/AD | |
| DRAWN | SH | |
| CHECKED | PW | |
| APPROVED | PW | WOODS.CO.NZ |

N

Post Development 10 Year MPD Flood Assessment
Development Model
Climate Change - YES

| | | |
|---|---|---|
| STATUS | ISSUED FOR INFORMATION | REV |
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| COUNCIL | AUCKLAND COUNCIL | |
| DWG NO | P16-335-SKT-0008 | |

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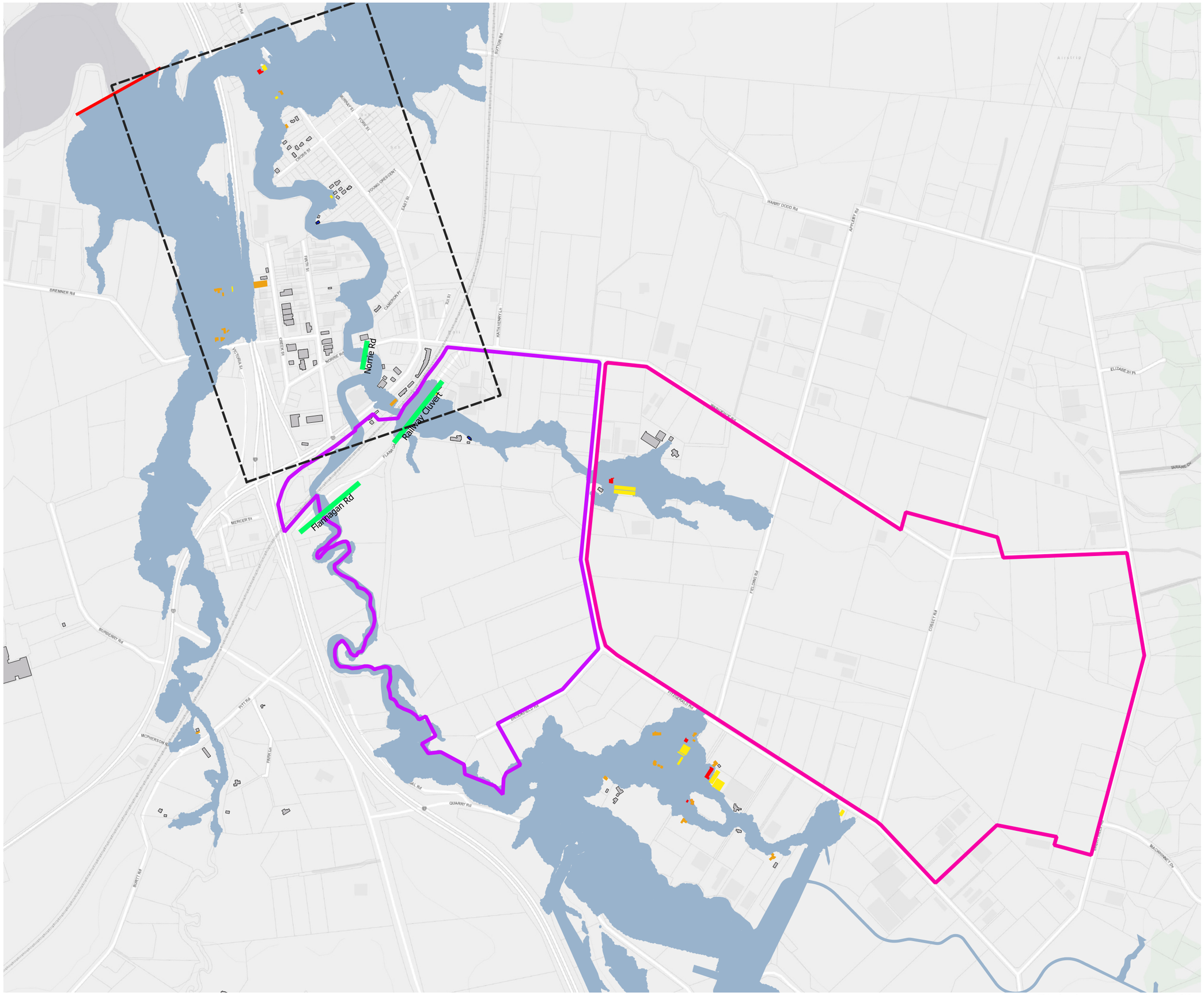



Tonkin+Taylor

WOODS Est.1970

## LEGEND

- Flood Extent

### Buildings

- Flood depth <0.15m
- No flooding
- Flood level < Building level
- Flood level > Building level
- Flood level > 0.15m
- Flood Model Boundary
- Fulton Hogan Development
- Kiwi Property Plan Change (Feb 2019)
- Flow Cross Sections
- Area of Interest

| REVISION DETAILS | | BY | DATE |
|---|---|---|---|
| 1.0 | Issued for Information | PW | 17/03/2020 |
| | | | |
| | | | |
| | | | |

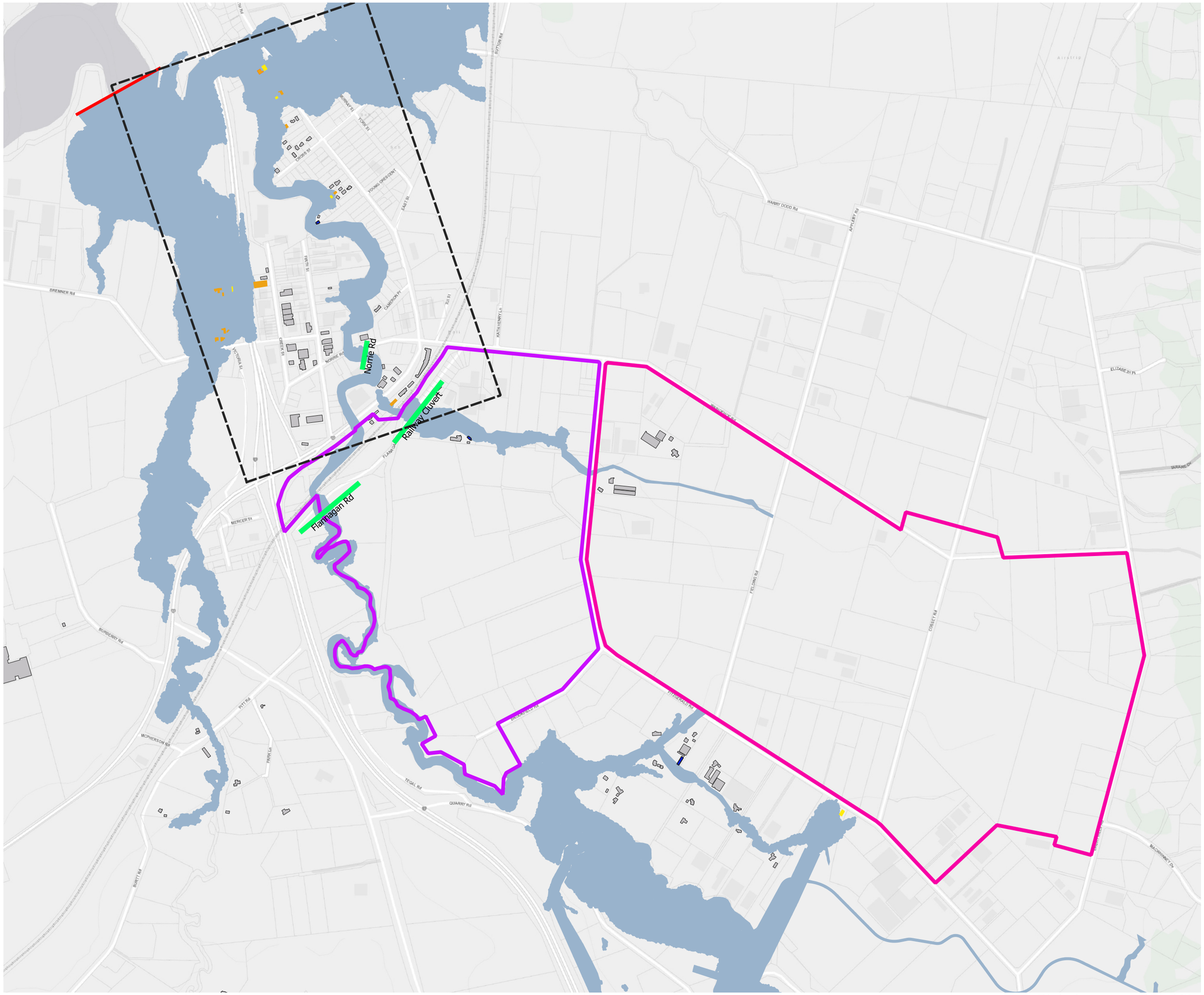
| | | |
|---|---|---|
| SURVEYED | AC | |
| DESIGNED | PW/AD | |
| DRAWN | SH | |
| CHECKED | PW | |
| APPROVED | PW | WOODS.CO.NZ |

N

Pre Development 100 Year MPD Flood Assessment
Development Model
Climate Change - YES

| | | |
|---|---|---|
| STATUS | ISSUED FOR INFORMATION | REV |
| SCALE | 1:12000 @ A3 | 1.0 |
| COUNCIL | AUCKLAND COUNCIL | |
| DWG NO | P16-335-SKT-0011 | |

This drawing was generated from QGIS




Tonkin+Taylor

WOODS EST.1970

## LEGEND

- Flood Extent

### Buildings

- Flood depth <0.15m
- No flooding
- Flood level < Building level
- Flood level > Building level
- Flood level > 0.15m
- Flood Model Boundary
- Fulton Hogan Development
- Kiwi Property Plan Change (Feb 2019)
- Flow Cross Sections
- Area of Interest

| REVISION DETAILS | | BY | DATE |
|---|---|---|---|
| 1.0 | Issued for Information | PW | 17/03/2020 |
| | | | |
| | | | |
| | | | |

| | | |
|---|---|---|
| SURVEYED | AC | |
| DESIGNED | PW/AD | |
| DRAWN | SH | |
| CHECKED | PW | |
| APPROVED | PW | WOODS.CO.NZ |

N

Post Development 100 Year MPD
Flood Assessment
Development Model
Climate Change - YES

| | | |
|---|---|---|
| STATUS | ISSUED FOR INFORMATION | REV |
| SCALE | 1:12000 @ A3 | 1.0 |
| COUNCIL | AUCKLAND COUNCIL | |
| DWG NO | P16-335-SKT-0012 | |

This drawing was generated from QGIS

# Memo

| | | | |
|---|---|---|---|
| **To:** | **Mark Iszard and Carmel O'Sullivan (Auckland Council)** | **Job No:** | **1003297** |
| **From:** | **Charlotte Peyroux and Tim Fisher (T+T) and Pranil Wadan (Woods)** | **Date:** | **6 April 2020** |
| **cc:** | **David Schwartfeger (Kiwi Property), Greg Dewe (Fulton Hogan), Andrew McCarthy (Oyster), Nick Roberts (Barkers),** | | |
| **Subject:** | **Response to Auckland Council Further Information Request on Stormwater Matters for Drury East - Stream Erosion Risk Assessment for Hingaia Catchment** | | |

## 1 Introduction

This memo summarises the findings of a stream erosion assessment undertaken to verify the proposed hydrological mitigation approach, identify high risk areas and determine if additional mitigation measures are required for two developments (Kiwi Property and Fulton Hogan) at Drury East in the Hingaia catchment.

The third Drury East development by Oyster Capital is in the adjacent Slippery Creek catchment, which will be addressed separately. However, the context and the learnings from this assessment are relevant to the Oyster Capital plan change.

This memo builds on the *Response to Auckland Council Further Information Request on Stormwater Matters for Drury East* prepared by Woods and Tonkin + Taylor on 25 March 2020 in response to Item 4 of the *Further Information Request (FIR) - Drury East Plan Changes* included in the *Healthy Waters Review of Adequacy of Information for a Private Plan Change (PPC) Request – Drury East - Fulton Hogan and Kiwi Property* memo from Auckland Council on 2 February 2020.

## 2 Background

### 2.1 Proposed approach to hydrological mitigation

The three Plan Change Areas at Drury East are greenfield developments and the proposed approach for the developments is to provide a minimum of Stormwater Management Area control - Flow 1 (SMAF 1) hydrological mitigation (detention and retention) for all impervious surfaces.

This responds to Auckland Unitary Plan Operative in part (AUP OP) Policy E1.3.8 that requires *minimising or mitigating changes in hydrology including loss of infiltration, to: minimise erosion and*

*associated effects on stream health and values; maintain stream baseflows; and support groundwater recharge.* This approach aligns with the Auckland Councils Region-wide Network Discharge Consent and Guidance Document 01 (GD01).

The minimum hydrological mitigation requirements follow SMAF 1 in AUP OP Table E10.6.3.1.1 as follows:

- Retention (volume reduction) of at least 5mm of runoff depth from impervious surfaces where possible with limitations set out in Table E10.6.3.1.1.
- Detention of the 95$^{th}$ percentile event for the difference between the pre-development and post-development runoff volumes from a 95$^{th}$ percentile, 24-hour rainfall event minus the achieved retention volume.

### 2.2 Proposed approach to stream erosion

Drury East Plan Change – Ecology Response (19 March 2020) and *Response to Auckland Council Further Information Request on Stormwater Matters for Drury East* by Woods and Tonkin + Taylor (25 March 2020) have identified the follow mitigation measures as being those, which will aid in the management of stream erosion and sedimentation in the Plan Change Area:

- 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.
- Modification of hydrograph mitigated through stormwater retention/detention (SMAF 1 hydrological mitigation) measures which will slow flows.
- 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 the Hingaia Stream and other larger streams.

## 3 Stream Erosion Risk Assessment

### 3.1 Auckland Council Stream Erosion Risk Tool

Auckland Council have assisted in this matter by supplying the Auckland Council Stream Erosion Risk Tool and by providing a technical briefing on 14 February 2020.

The Auckland Council Stream Erosion Risk Tool was initially investigated as a mechanism to analyse stream erosion. The tool was considered too simplistic for the Drury East area because better quality inputs were available, as summarised below:

*Table 1 - Identified issues of use for Auckland Council Stream Erosion Tool*

| # | Issue | Next step |
|---|---|---|
| 1 | TP108 hydrology is too coarse for a large catchment such as the Hingaia where a refined hydraulic model is available | Use hydrographs from the flood model. Rebuild Stream Erosion Risk Tool to allow this. Note, input hydrology is not required if hydraulic shear stress is available from hydraulic models, refer issues #2 and #3 |
| 2 | Hydraulic shear stress is very sensitive to Slope (S) and thalweg/bed levels are too variable and result in non-sensible results | Use bed shear stress calculated by the hydraulic model at all locations and at all time steps as this uses the actual channel cross-section and simulated flow, water surface slope, velocity and depth. Rebuild the Stream Erosion Risk Tool to allow for these inputs. |
| 3 | Simplification of channel cross-sections to a trapezoid is too coarse | |
| 4 | Critical shear stress cannot be determined from the geotechnical testing already done for the site. | Estimate this from Auckland Council databases and references. |
| 5 | Quantification of change in exceedance of critical shear stress will only indicate a change in erosion potential. It will not quantify how much extra erosion and what the change in sediment load will be to the receiving environment, so it cannot be used to assess effects. | Auckland Council to advise how they see this working. T+T/Woods consider that the tool will identify areas with increased erosion risk and where extra mitigation measures might be considered. |

## 3.2 Modified Stream Erosion Risk Tool

In response to the issues identified with the Auckland Council Stream Erosion Risk Tool a Modified Stream Erosion Risk Tool was developed. The overarching principal remains the same, which is to compare the hydraulic shear stress[1] exerted by the driving force of water to the critical shear stress of the material lining the stream channel. The modified methodology is as follows:

- Select locations for the Stream Erosion Risk assessment – Refer to Section 2.1.
- Extract the 2, 10, and 100 year Annual Recurrence Internal (ARI) hydraulic shear stress at the analysis locations from the flood model for pre- and post-development scenarios – Refer to Section 2.2.
- Assess for potential erosion and identify high risk areas:
  - Use 2, 10, and 100 year ARI hydraulic shear stress as described above and compare against an expected critical shear stress – Refer to Section 2.3.
  - Use the Auckland Council defined erosion thresholds to determine the stream erosion potential at each location during each design storm - Refer Section 2.4.

The tool will indicate a change in **erosion potential** by quantifying the duration of exceedance of critical shear stress.

It will not quantify how much extra erosion will occur, nor will it quantify the change in sediment load to the receiving environment, so it cannot be used to directly assess effects. Therefore, to support the Plan Change, the tool will be used to identify areas with erosion risk, and where these change as a result of the development, and where extra mitigation measures may be required.

The results of this assessment are included in Section 3 of this memo.

## 3.3 Assessment locations

A stream erosion risk assessment was carried out at 10 locations relevant to the Kiwi Property and Fulton Hogan Plan Change Areas. These locations are along the Hingaia stream and tributaries including Fitzgerald Stream. The locations were selected to assess for potential erosion due to hydrology changes attributed to the land use change associated with the Plan Change.

The details of these locations are included in Table 2 and a locality plan included in Appendix A.

[1] Hydraulic shear stress is the MIKE output date type "bed shear stress" as given by Manning's equation $=pgV^2n^2/ y^{1/3}$

*Table 2 - Assessment locations for Modified Stream Erosion Risk Tool*

| ID | Description | Model Location | Chainage |
|---|---|---|---|
| Location 1 | Hingaia Stream, mid-point of Kiwi Plan Change Area | HINGAIA STREAM | 16585.5 |
| Location 2 | Hingaia Stream, upstream of Flanagan Bridge | HINGAIA STREAM | 17105.5 |
| Location 3 | Hingaia Stream, upstream of Norrie Road | HINGAIA STREAM | 17848.6 |
| Location 4 | Hingaia Stream, lower | HINGAIA STREAM | 18918 |
| Location 5 | Fitzgerald Stream, upstream of Flanagan Road | HINGAIA TRIBUTARY 7 | 2086.75 |
| Location 6 | Fitzgerald Stream, downstream of Fitzgerald Road | HINGAIA TRIBUTARY 7 | 1323 |
| Location 7 | Fitzgerald Stream, mid-point of Kiwi Plan Change Area | HINGAIA TRIBUTARY 7 | 1768 |
| Location 8 | Hingaia Tributary, downstream of Fulton Hogan Plan Change Areas | HINGAIA SUB TRIBUTARY 2 | 851.5 |
| Location 9 | Hingaia Tributary, downstream of Fulton Hogan Plan Change Areas | HINGAIA TRIBUTARY 6 | 1241 |
| Location 10 | Fitzgerald Stream, within Fulton Hogan Plan Change Areas | HINGAIA TRIBUTARY 7 | 325 |

## 3.4 Flood models

The 2, 10 and 100 year ARI storm events (inclusive of climate change) were run in the Hingaia hydraulic model for both the pre- and post-development scenarios and a corresponding time series of the estimated hydraulic shear stresses occurring within the channel extracted at each location.

The 2 year ARI storm event is considered to be the most relevant frequency as the 2 year ARI flood event strongly influences the geomorphology of the stream, especially the size of the main channel.

The flood models included an allowance for climate change and used our baseline model for the pre-development scenarios which includes Drury South. Suitability of this baseline (pre-development) model is discussed in the *Drury East (Kiwi and Fulton Hogan) flood modelling – response to Auckland Council modelling requests* memo prepared by Tonkin + Taylor on 10 February 2020 for Auckland Council. For pre-development scenario the flood model assumed 10% imperviousness for undeveloped catchments within Future Urban Zone (FUZ) (including the Plan Change Area) and upstream rural zonings. The post-development scenario includes the development of the Plan Change Areas flood model in accordance with Table 2 of *Response to Auckland Council Further Information Request on Stormwater Matters for Drury East* prepared by Woods and Tonkin + Taylor on 25 March 2020, but does not include allowances for SMAF-1 hydrological mitigation as these target the smaller more frequent 95th percentile rainfall event.

## 3.5 Critical shear stress of the stream

The critical shear stress of a stream refers to when the hydraulic shear stress exerted by the driving force of water in the stream channel exceeds the critical shear stress of the material lining of the stream channel, at which point erosion is initiated. The critical shear stress is a parameter associated with the bed media. It is smallest (more erodible) for silts and sand but increases (less erodible) with grain size e.g. gravel and cobbles, and also increases (less erodible) for percentage of clays as these soils become cohesive. If the bed and bank materials and riparian planting vary along a stream, then it is challenging to find a representative critical shear stress.

According to geological maps, the 10 stream erosion assessment locations are located in three different geological units: Puketoka formation; Holocene river deposits and Kerikeri Volcanic group. The site geotechnical testing is not at these locations, nor does it cover all of these geological units so we do not have soils descriptions for all of these units, nor does the geotechnical testing include critical shear stress which is a very specialised test.

The geological maps aren't spatially accurate or reliable enough to describe the geology at specific locations along the streams. Even if they were, there isn't enough information in the following references and studies to support a specific critical shear stress based on a geological base unit, nor prove this correlation between Auckland streams and Auckland geological layers.

- *Erosion Parameters for Cohesive Sediment in Auckland Streams*, Auckland Council Technical Report 038 (2009)
- *Auckland Urban stream erodibility investigations,* Prepared by Elliot et al. for NIWA Client Report HAM2005-031 (2005)
- *Resistance and Critical Height of Streambanks in Selected Catchments of the Auckland Region*. Prepared by Cardno for Auckland Council (Draft version, March 2020)
- B-STEM (Bank-Stability and Toe Erosion Model) slides provided by Auckland Council

Furthermore, in light of the lockdown to slow the spread of Covid-19, site-specific investigation is not possible at this time.

In the absence of site-specific geotechnical parameters, the 50$^{th}$ percentile median critical shear stress (32.6 Pa) was adopted from Auckland-specific data compiled by Cardno for Auckland Council (refer Table 3) and included in the Stream Erosion Tool. This is supported by recommendations in Auckland Council Technical Report 038 / 2009 *Erosion Parameters for Cohesive Sediment in Auckland Streams* which suggests "using the median critical shear stress (approximately 33 Pa)" if specific parameters are not developed for a stream. A sensitivity assessment is included in Section 4.

*Table 3 – Critical shear stress in the bank materials at various locations around the Auckland region.*

| All Cardno Data | | Hoteo | Awaruku | Omaru | Oakley | Misc. Urban | Elliott et al. (2005) | | |
|---|---|---|---|---|---|---|---|---|---|
| Percentile | $\tau_c$ | $\tau_c$ | $\tau_c$ | $\tau_c$ | $\tau_c$ | $\tau_c$ | $\tau_c$ | Avg | Median |
| 99.99 | 403 | 404 | 164 | 218 | 64.2 | 336 | 72.3 | 237.4 | 218.4 |
| 99.9 | 395 | 398 | 163 | 218 | 63.9 | 334 | 72.1 | 234.9 | 218.4 |
| 99 | 324 | 335 | 158 | 218 | 61.4 | 312 | 70.1 | 211.2 | 217.8 |
| 95 | 208 | 158 | 134 | 215 | 50.5 | 262 | 62.1 | 155.6 | 157.8 |
| 90 | 138 | 121 | 117 | 168 | 39.7 | 237 | 57.6 | 125.7 | 121.2 |
| 85 | 113 | 109 | 109 | 147 | 34.8 | 194 | 57.1 | 109.0 | 109.1 |
| 80 | 85.3 | 72.0 | 95.4 | 128 | 30.9 | 155 | 55.9 | 89.0 | 85.3 |
| **75** | **71.6** | **62.1** | **78.4** | **102** | **27.6** | **78.3** | **54.5** | **67.8** | **71.6** |
| 70 | 61.3 | 54.5 | 76.6 | 97.6 | 22.9 | 76.9 | 53.3 | 63.3 | 61.3 |
| 65 | 52.4 | 45.2 | 72.3 | 90.2 | 19.8 | 65.3 | 47.5 | 56.1 | 52.4 |
| 60 | 41.4 | 29.7 | 63.3 | 64.6 | 19.4 | 51.7 | 36.9 | 43.9 | 41.4 |
| 55 | 32.0 | 24.7 | 54.4 | 57.2 | 19.3 | 40.5 | 36.1 | 37.8 | 36.1 |
| **50** | **25.0** | **15.9** | **42.8** | **49.1** | **19.2** | **35.1** | **32.6** | **31.4** | **32.6** |
| 45 | 19.4 | 13.5 | 33.8 | 36.1 | 16.9 | 30.7 | 26.4 | 25.3 | 26.4 |
| 40 | 13.8 | 10.2 | 30.1 | 25.0 | 15.2 | 21.9 | 24.5 | 20.1 | 21.9 |
| 35 | 10.4 | 8.6 | 21.2 | 21.7 | 14.2 | 8.3 | 22.1 | 15.2 | 14.2 |
| 30 | 7.8 | 6.6 | 15.3 | 19.9 | 10.9 | 4.4 | 22.0 | 12.4 | 10.9 |
| **25** | **6.4** | **5.0** | **11.0** | **14.2** | **6.5** | **3.1** | **21.3** | **9.6** | **6.5** |
| 20 | 4.4 | 3.1 | 8.4 | 10.3 | 6.4 | 3.1 | 19.7 | 7.9 | 6.4 |
| 15 | 2.8 | 1.5 | 6.3 | 7.0 | 5.7 | 2.8 | 16.8 | 6.1 | 5.7 |
| 10 | 1.0 | 0.61 | 4.2 | 4.2 | 3.5 | 1.5 | 13.7 | 4.1 | 3.5 |
| 5 | 0.34 | 0.17 | 2.4 | 2.6 | 2.1 | 0.46 | 9.1 | 2.5 | 2.1 |
| 1 | 0.06 | 0.05 | 0.78 | 0.67 | 1.2 | 0.22 | 5.3 | 1.2 | 0.7 |
| 0.1 | 0.04 | 0.04 | 0.42 | 0.22 | 1.0 | 0.18 | 4.4 | 0.9 | 0.2 |

## 3.6 Erosion Thresholds

Auckland Council use four bands to assess the magnitude of predicted erosion in the Auckland Council Stream Erosion Risk Tool. Each threshold is based on the excess shear - a ratio of the hydraulic shear stress exerted by the driving force of water in the stream channel to critical shear

stress. Potential erosion occurs when the excess shear is greater than 1 and erosion is theoretically initiated in the channel. When excess shear is more than 2 there is potential for active erosion and the channel to be mobile. Anything greater than 10 indicates a very rapid rate of erosion. The basis of the thresholds for excess shear at 2 and 10 is not clear.

*Table 4 - Auckland Council Erosion Risk Thresholds*

| Threshold | Excess Shear | Description |
|---|---|---|
| Green | <1.0 | Indicates no erosion predicted to occur |
| Yellow | >1.0 <2.0 | Indicates the potential for some erosion of the channel |
| Orange | >2.0 <10.0 | Indicates the potential for channel to be mobile, (likely active erosion) |
| Red | >10.0 | Indicates potential rapid rates of erosion and incision of channel |

Many stream tributaries within the Drury East Plan Change Area have some erosion so excess shear greater than 1 is expected at peak flow. We are interested in the change from the pre and post development design storms and do this by comparing the duration that a threshold is exceeded.

# 4 Results

## 4.1 Erosion potential

Note: The 2 year ARI storm event was run for 24 hours while the 10 and 100 year ARI storm events were only run for 18 hours and this impacts the duration data, which invalidates comparison between the 2 year ARI storm and the 10 and 100 year ARI events. Also, there was a spike at the beginning of the design storm which is abnormal and attributed to initial conditions, so data is only presented from 1 hour into the storm event.

The excess shear for the 2 year ARI storm event is presented in normalised bar chart form in Figure 1. The 10 and 100 year ARI storm events are included in Appendix B. Time series of hydraulic shear stress at each location for all three storms are also included in Appendix B.

The results from the 2 year ARI storm suggest there is erosion potential (duration of excess shear >1) at Locations 1, 6, 7 and 10 during the pre- development scenario. For the post-development scenarios the erosion potential increases very slightly at these locations, with the excess shear exceeding 2 for a small amount of time at Location 6 and a small amount of new erosion potential at Location 9.

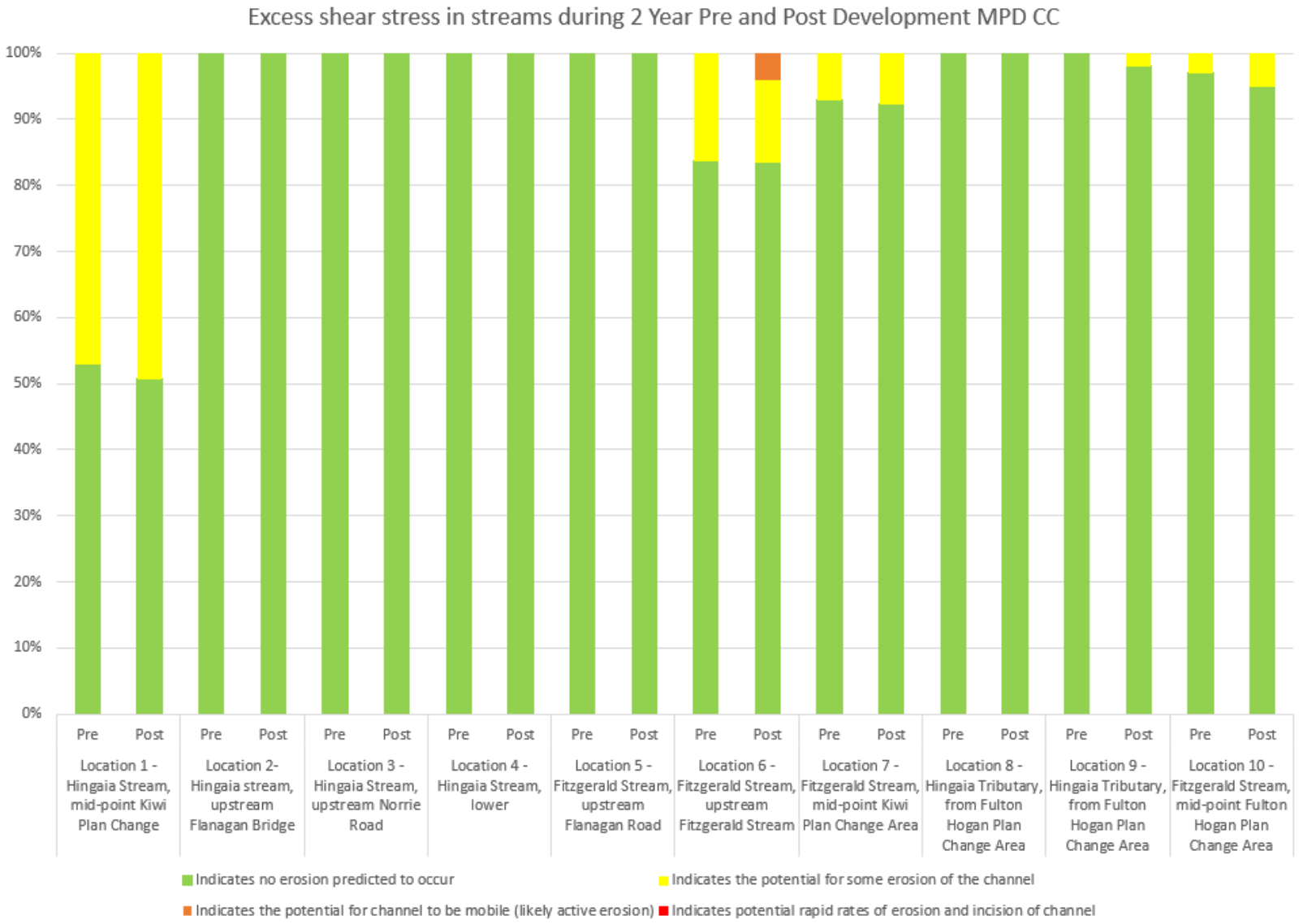
For Locations 1, 6, 7, 9 and 10, Table 5 quantifies the exceedance of critical shear stress by comparing maximum excess shear and durations for which the excess shear was greater than 1 (erosion potential).

*Table 5 – Maximum excess shear between pre- and post-development 2 year storm events at five locations*

| | Location 1 | | Location 6 | | Location 7 | | Location 9 | | Location 10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post |
| **Max Excess shear** | 1.41 | 1.41 | 1.76 | 2.64 | 1.21 | 1.95 | 0.66 | 1.04 | 1.11 | 1.93 |
| **Difference** | | - | | 0.87 | | 0.73 | | 0.38 | | 0.82 |
| **% of Duration >1 1< & >2** | 45% | 47% | 16% | 12% **4%** | 7% | 7% | 0% | 2% | 3% | 5% |

The change in duration over which excess shear exceeds the threshold for the five locations (1, 6, 7, 9 and 10) was 2%, 4%, 1%, 2% and 2%, respectively. These are considered to be very small changes. The changes in maximum excess shear are higher for four locations (6, 7, 9 and 10) that are smaller streams with more land use changes in the catchments.

*Figure 1- Normalised bar chart comparing excess shear stress during 2 year pre- and post-development events*



## 4.2 Verification

These changes in erosion potential were compared against a survey of the erosion scars and bank stability within the Hingaia Stream Catchment Watercourse completed by Auckland Council in 2018. The results of both the watercourse survey and this erosion assessment are summarised in Table 6. The map from the Auckland Council survey showing the engineering asset locations, stream bank and outlet erosion has been marked up with the ten assessment locations and included in Appendix A. There is no clear correlation between the observed erosion and the predicted erosion.

*Table 6 - 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 |

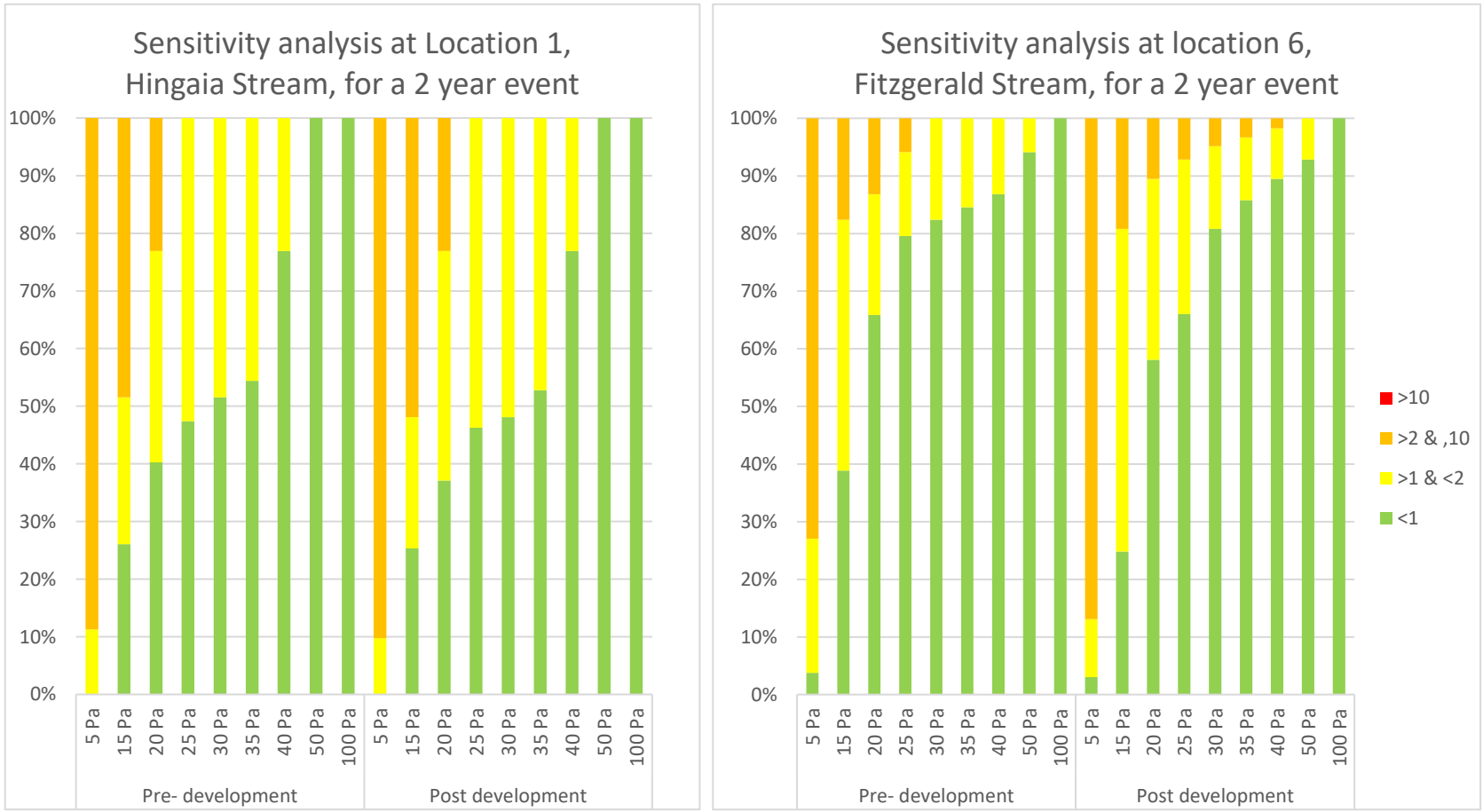
## 4.3 Discussion

The lack of correlation between observed and predicted, puts doubt in the predictive ability of the stream erosion risk erosion assessment to identify erosion risk locations. Although the Stream Erosion Risk Assessment has value in assessing the change in erosion risk due to development.

# 5 Sensitivity

The critical shear stress of the stream is very site specific and dependent on factors including underlying geological features, substrate types, channel conditions such as the degree of weathering and the channel shape, and the conditions along the stream banks, such as vegetation. All of these variables change spatially along and across the stream channel. A sensitivity analysis was done at two locations to assess the suitability of estimating the critical shear stress from region wide testing due to the lack of site-specific testing. Figure 2 analyses the estimated erodibility potential at two locations (Location 1 at the mid-point along the Hingaia Stream of the Kiwi Property Plan Change Area and Location 6 along Fitzgerald Stream) for the 2 year event for a range of critical shear stresses between 5 Pa and 100 Pa. These both show a significant change in erosion potential depending on the critical shear stress.

*Figure 2a and b - Sensitivity analysis for excess shear stress at Location 1, Hingaia stream and Location 6, Fitzgerald Stream for a 2 year event*



However, Table 7 summarises the percentage increase in duration with an excess shear of more than 1 (which indicates that no erosion is expected to occur during that timestep).

*Table 7: Percentage duration change in excess shear exceeding varying critical shear stress*

| | Duration change in excess shear exceeding 1 for varying critical shear stress (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **5 Pa** | **15 Pa** | **20 Pa** | **25 Pa** | **30 Pa** | **35 Pa** | **40 Pa** | **50 Pa** | **100 Pa** |
| **Location 1** | 0% | 0.7% | 3.0% | 1.2% | 3.5% | 1.6% | 0.1% | 0% | 0% |
| **Location 6** | 0.7% | 14.0% | 7.8% | 13.5% | 1.6% | -1.2% | -2.7% | 1.3% | 0% |

This suggests that whilst there is a significant change in the predicted erosion for different critical shear stresses (shown by Figure 2), there are small percentage changes in erodibility potential between the pre-development and post development scenarios for each critical shear stress (Table 7) with Location 1 being more consistently low than Location 6. Therefore, the change in erosion potential (duration of excess shear >1) is reasonably insensitive of the critical shear stress.

# 6 Conclusion

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.

A 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, which puts doubt in the predictive ability of the 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. There was a very minor increase to erosion potential (duration of excess shear >1) at five locations due to hydrological changes as a result of the development. The changes in maximum excess shear are higher for four locations (6, 7, 9 and 10) that are smaller streams (including Fitzgerald Stream) with more land use changes in the catchments. The erosion potential in the main Hingaia Stream was not materially changed.

At this stage we have not run flood models or assessed the erosion potential that accounts for the proposed SMAF 1 hydrological mitigation for all impervious surfaces in the Plan Change Areas. The application of SMAF 1 hydrological mitigation will result in an even smaller increase to the erosion risk than the post-development scenario assessed in this memo. The benefit from SMAF 1 hydrological mitigation will increase for smaller events.

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

# 7 Recommendations

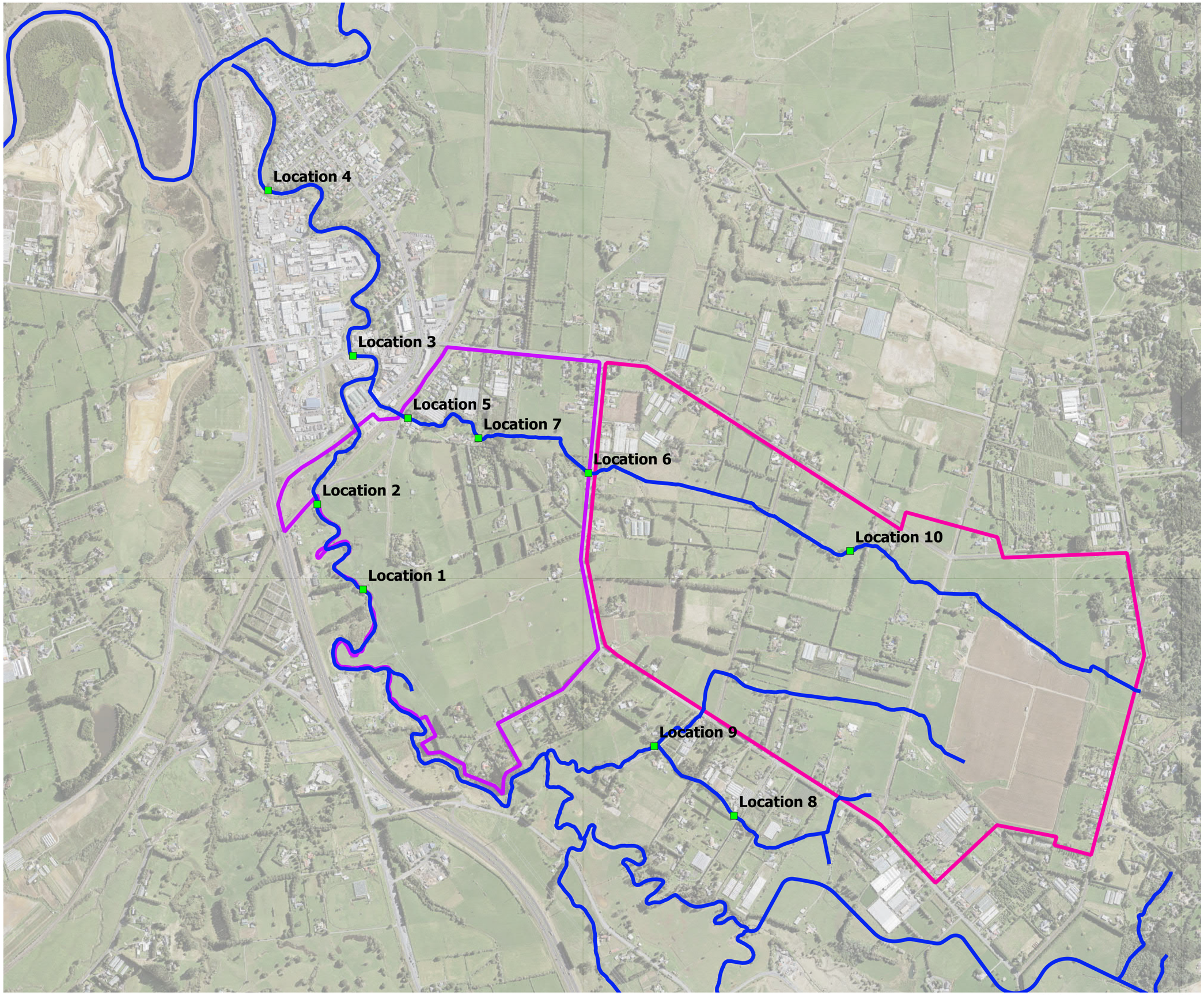
The ecology and stormwater experts for Kiwi Property and Fulton Hogan recommend stream erosion mitigation measures for the Plan Change Areas as follows:

- 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.
- Modification of hydrograph mitigated through stormwater retention/detention (SMAF 1 hydrological mitigation) measures which will slow flows.

- 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 the Hingaia Stream and other larger streams.

6-Apr-20
t:\tauranga\projects\1003297\1003297.6000\issueddocuments\rfi final response to barkers\drury east fir response - stream erosion risk assessment memo.docx

# Appendix A:




This drawing was generated from QGIS

Tonkin+Taylor

WOODS Est.1970

**LEGEND**

- Locations
- Rivers
- Fulton Hogan Plan Change Area
- Kiwi Property Plan Change

| REVISION DETAILS | | BY | DATE |
|---|---|---|---|
| 1.0 | Issued for Information | PW | 31/3/2020 |
| | | | |
| | | | |
| | | | |

| | | |
|---|---|---|
| SURVEYED | AC | |
| DESIGNED | PW/AD | |
| DRAWN | SH | |
| CHECKED | PW | |
| APPROVED | PW | WOODS.CO.NZ |

N

Modified Stream Erosion Risk Tool Assessment Locations

| | | |
|---|---|---|
| STATUS | ISSUED FOR INFORMATION | REV |
| SCALE | 1:12000 @ A3 | 1.0 |
| COUNCIL | AUCKLAND COUNCIL | |
| DWG NO | P16-335-SKT-0014 | |

# Map 4: Engineering Asset Locations, Stream Bank & Outfall Erosion


Document Path: F:\FELIX_DATA\4SIGHT\AA3135_Hingaia_WARIMAPS\MAP_04_Eng_Assets.mxd

Auckland Council

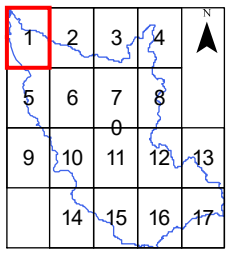
## HINGAIA CATCHMENT STREAM SURVEY

**Erosion Scars**
- 0-20%
- 21-40%
- 41-60%
- >60%
- Erosion Hotspot

**Bank Stability**
- Excellent
- Good
- Fair
- Poor
- Wetland

**Inlet/Outlet Erosion**
- None
- Slight
- Moderate
- Severe
- Could not locate

0 0.25 0.5 1 km



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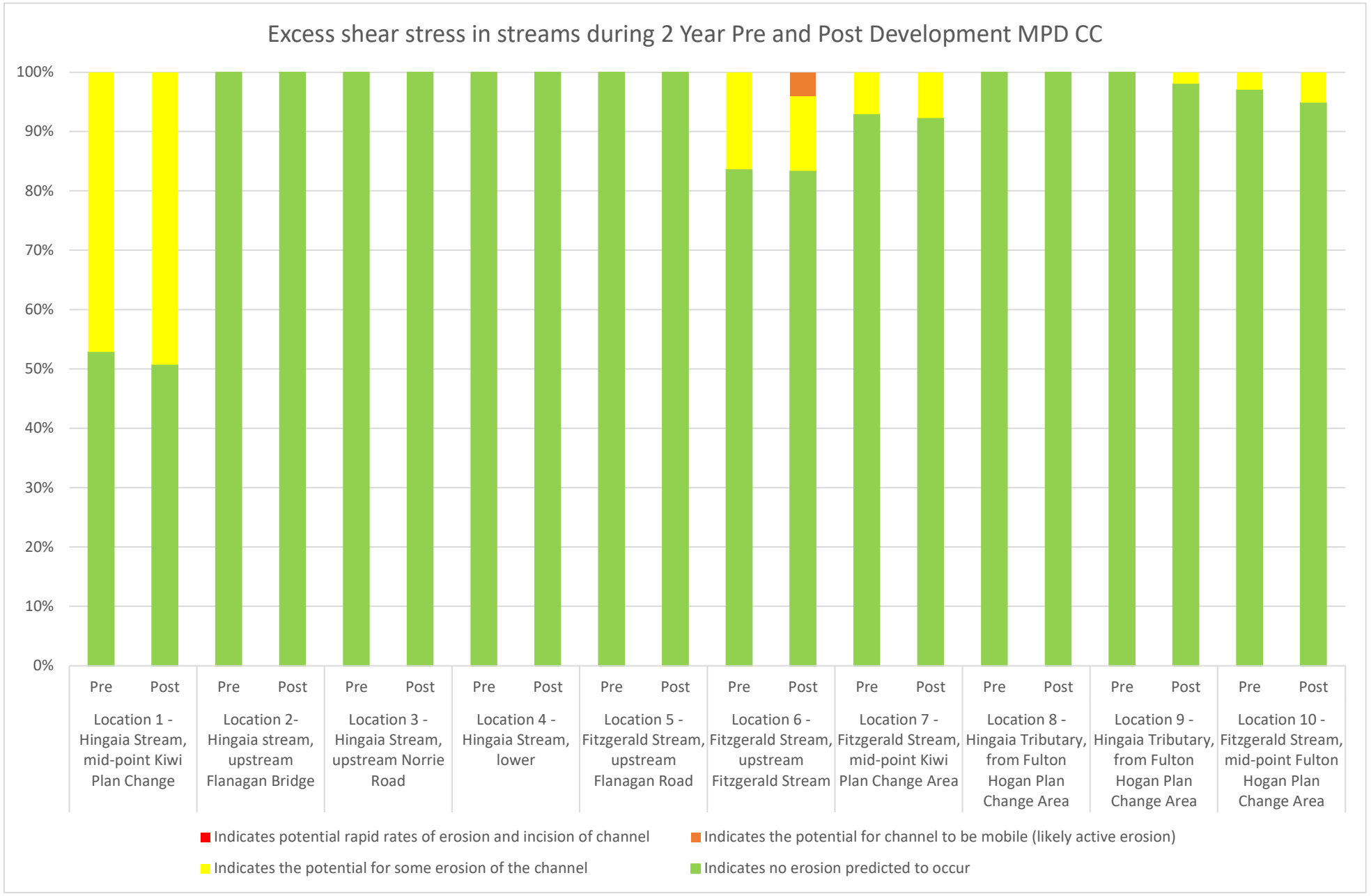
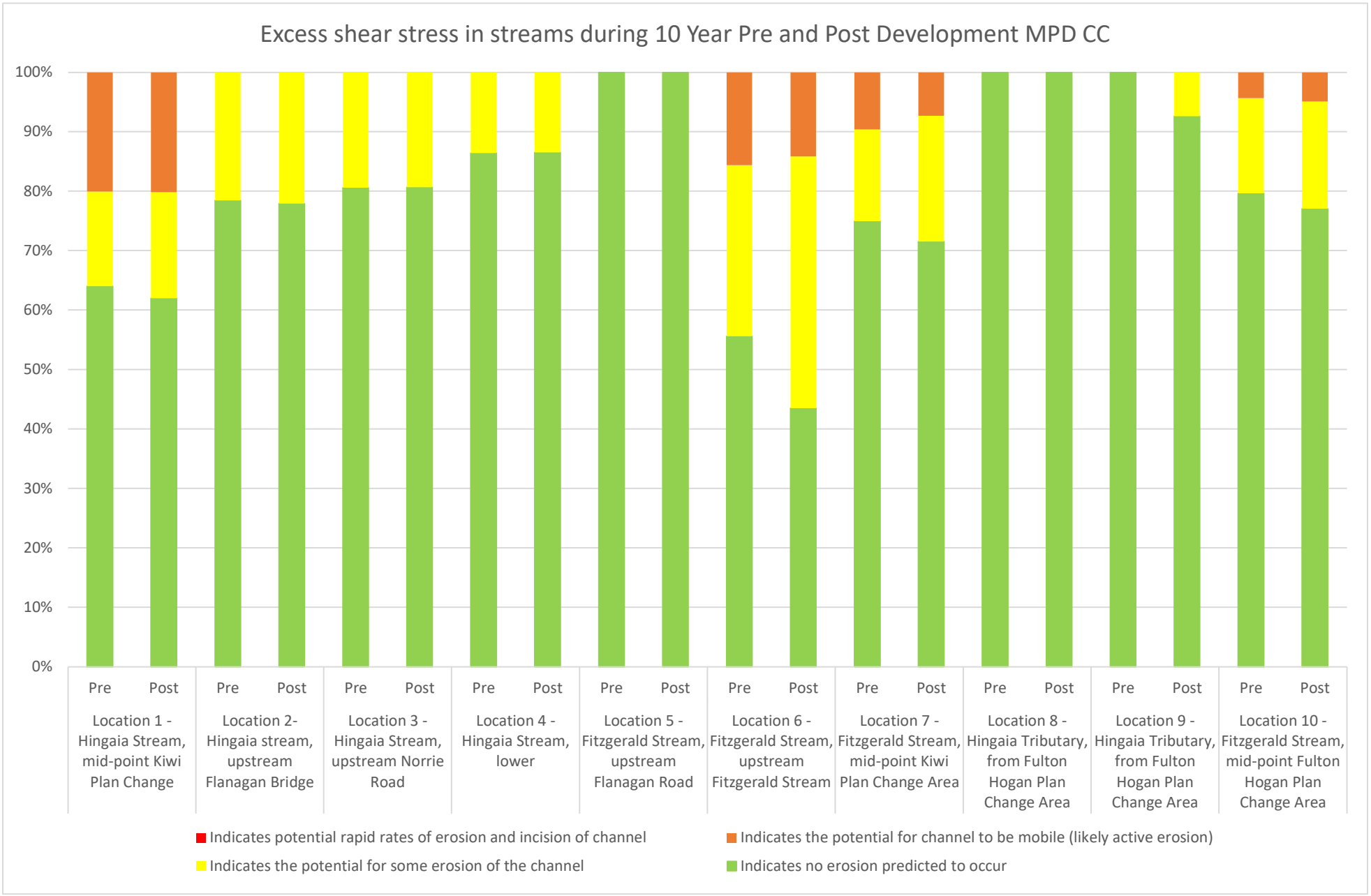
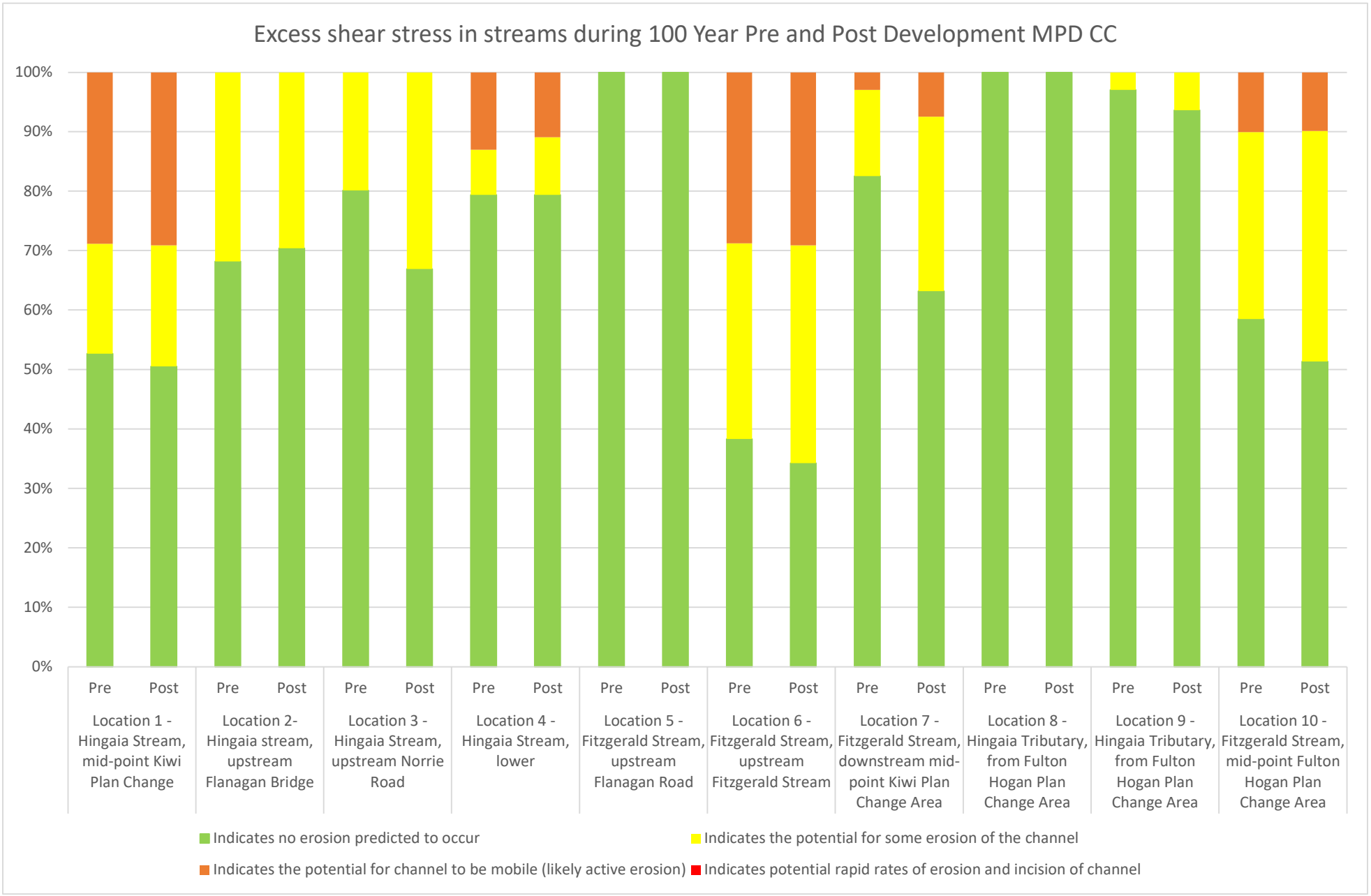
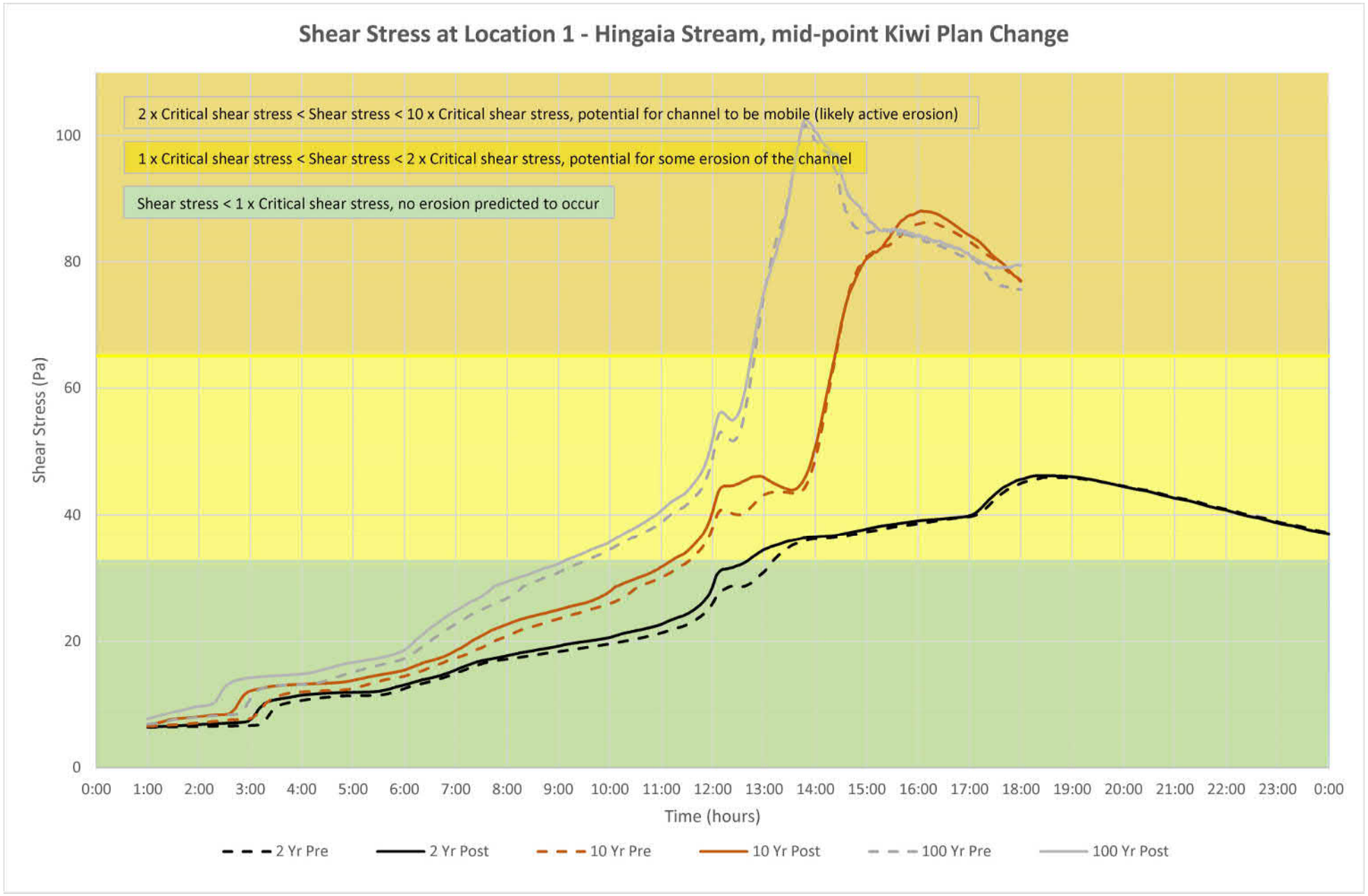
| Scale: | 1:10,000 |
| Page Size: | A3 |
| Status: | Draft |
| Author: | FP |
| Checked: | AS |
| Approved: | KB |

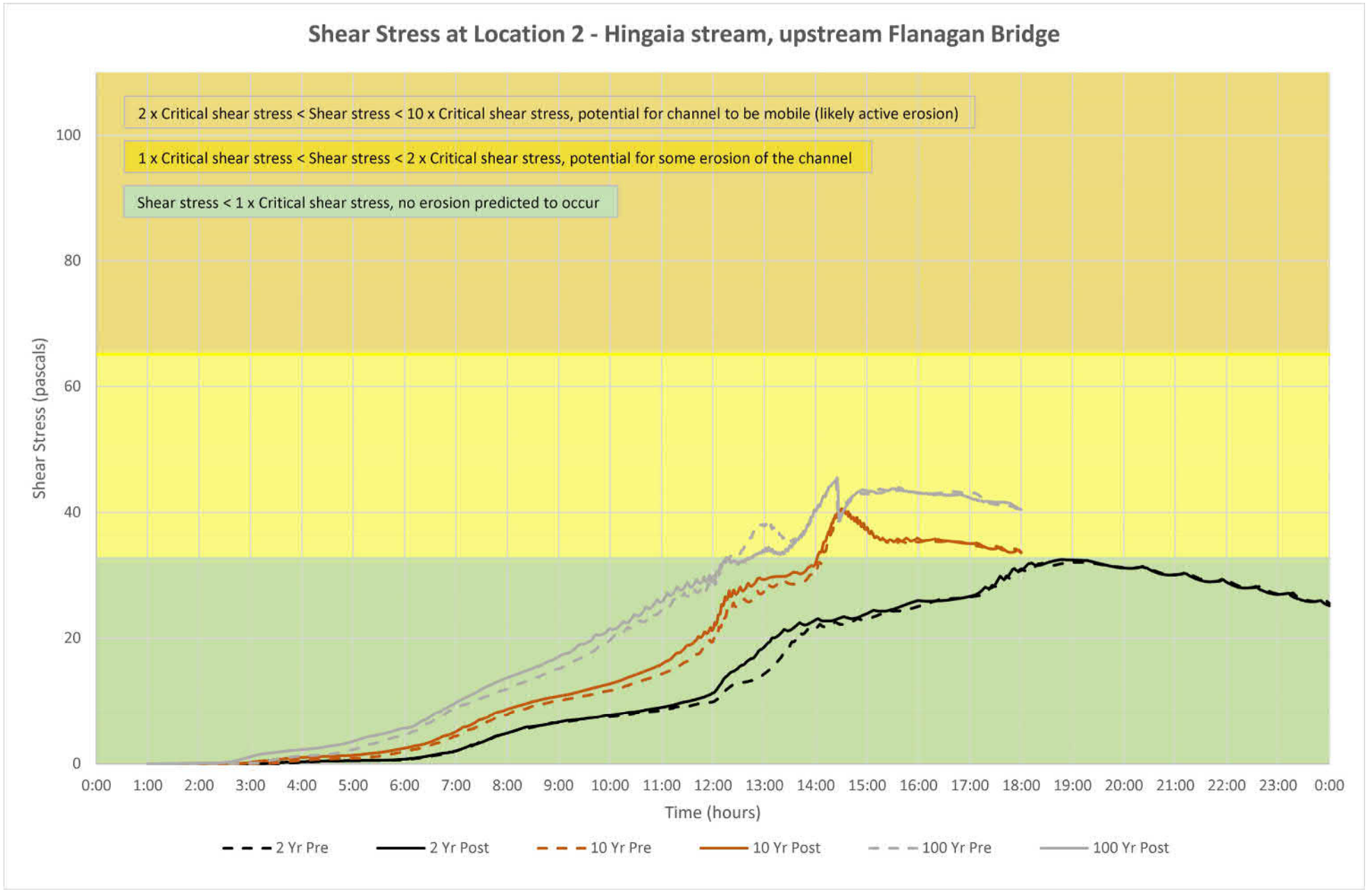
# Appendix B:

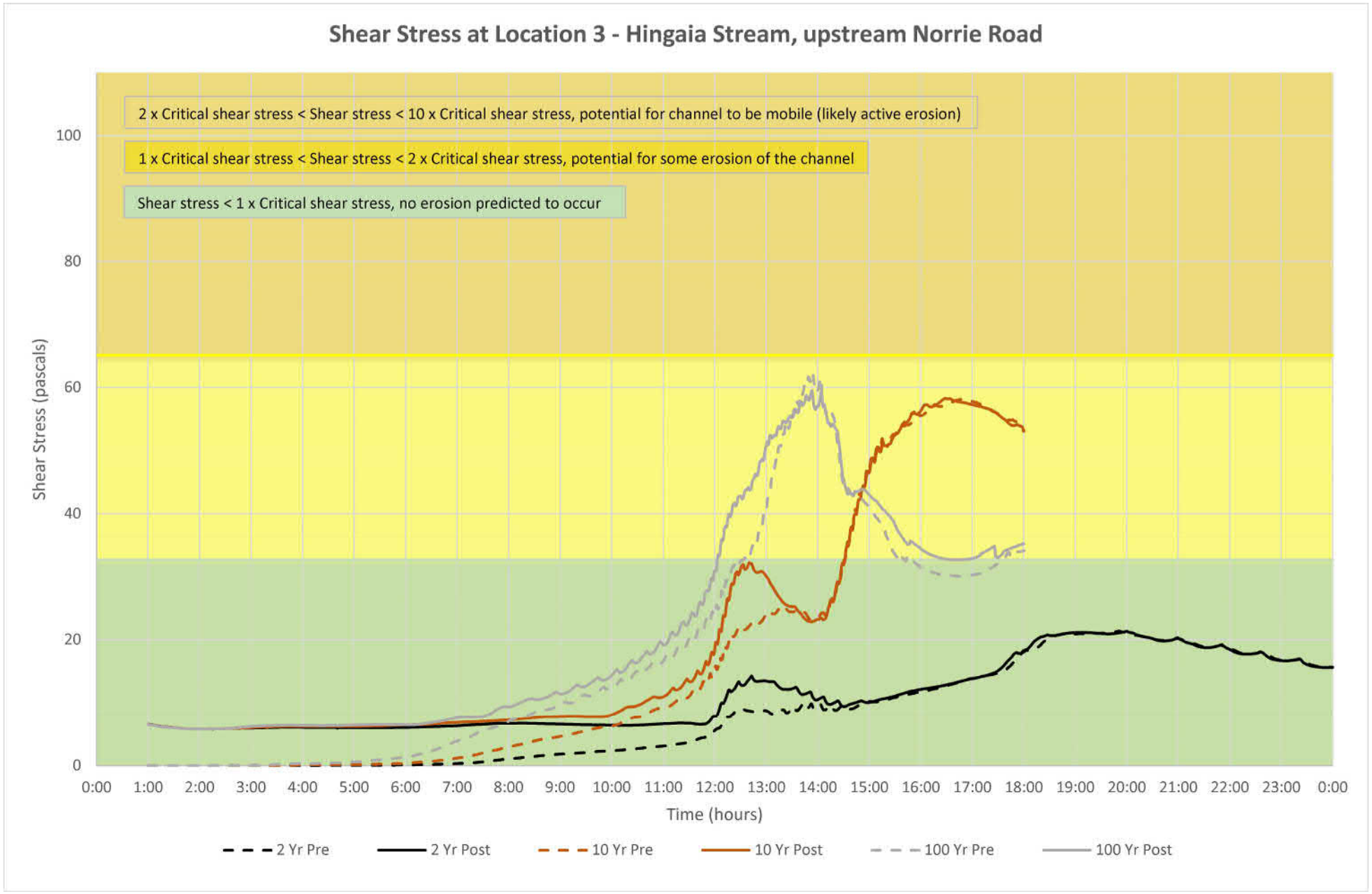

Excess shear stress in streams during 2 Year Pre and Post Development MPD CC
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Pre
Post
Location 1 - Hingaia Stream, mid-point Kiwi Plan Change
Location 2- Hingaia stream, upstream Flanagan Bridge
Location 3 - Hingaia Stream, upstream Norrie Road
Location 4 - Hingaia Stream, lower
Location 5 - Fitzgerald Stream, upstream Flanagan Road
Location 6 - Fitzgerald Stream, upstream Fitzgerald Stream
Location 7 - Fitzgerald Stream, mid-point Kiwi Plan Change Area
Location 8 - Hingaia Tributary, from Fulton Hogan Plan Change Area
Location 9 - Hingaia Tributary, from Fulton Hogan Plan Change Area
Location 10 - Fitzgerald Stream, mid-point Fulton Hogan Plan Change Area
Indicates potential rapid rates of erosion and incision of channel
Indicates the potential for channel to be mobile (likely active erosion)
Indicates the potential for some erosion of the channel
Indicates no erosion predicted to occur

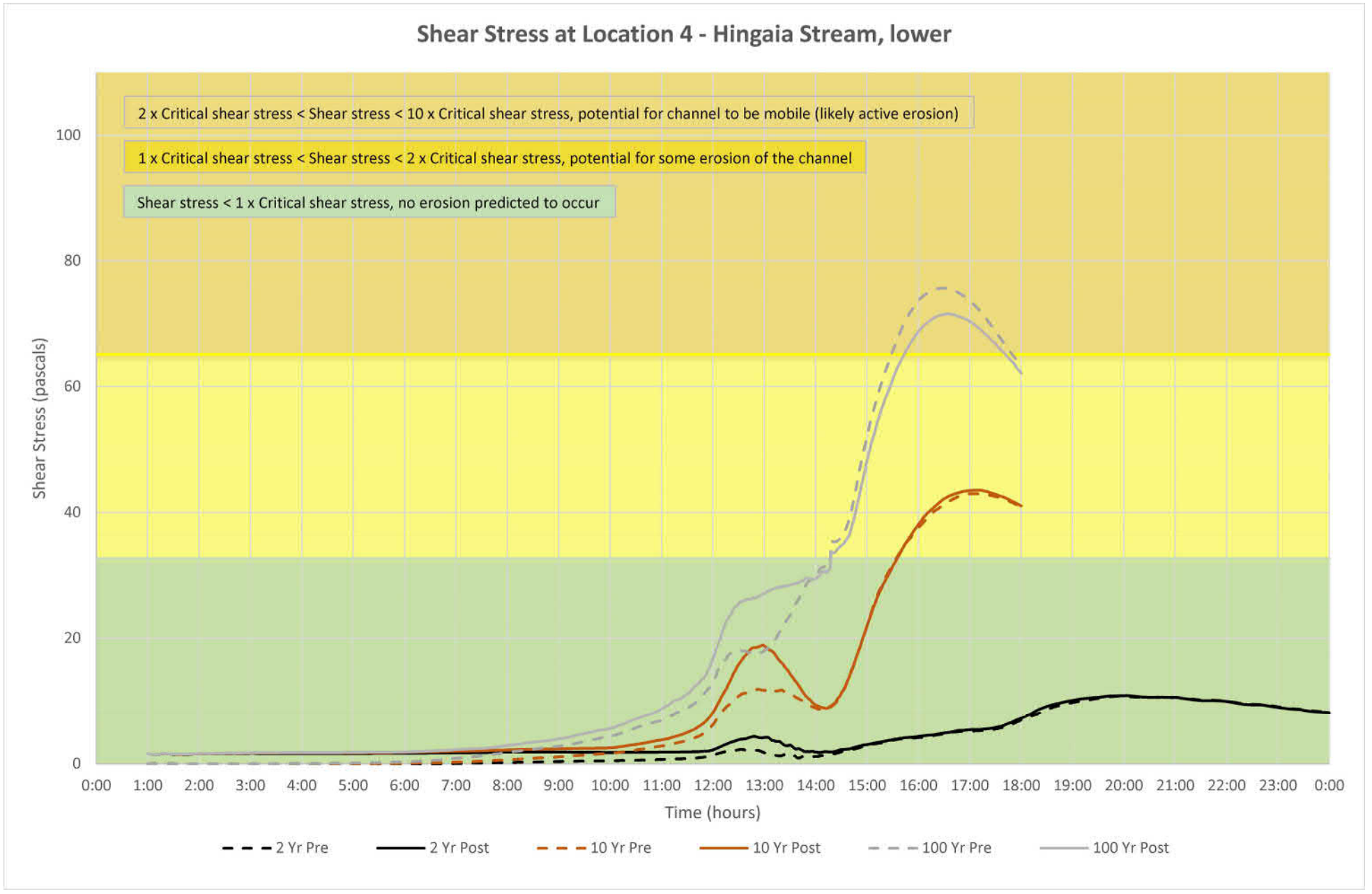

Excess shear stress in streams during 10 Year Pre and Post Development MPD CC
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Pre
Post
Location 1 - Hingaia Stream, mid-point Kiwi Plan Change
Location 2- Hingaia stream, upstream Flanagan Bridge
Location 3 - Hingaia Stream, upstream Norrie Road
Location 4 - Hingaia Stream, lower
Location 5 - Fitzgerald Stream, upstream Flanagan Road
Location 6 - Fitzgerald Stream, upstream Fitzgerald Stream
Location 7 - Fitzgerald Stream, mid-point Kiwi Plan Change Area
Location 8 - Hingaia Tributary, from Fulton Hogan Plan Change Area
Location 9 - Hingaia Tributary, from Fulton Hogan Plan Change Area
Location 10 - Fitzgerald Stream, mid-point Fulton Hogan Plan Change Area
Indicates potential rapid rates of erosion and incision of channel
Indicates the potential for channel to be mobile (likely active erosion)
Indicates the potential for some erosion of the channel
Indicates no erosion predicted to occur

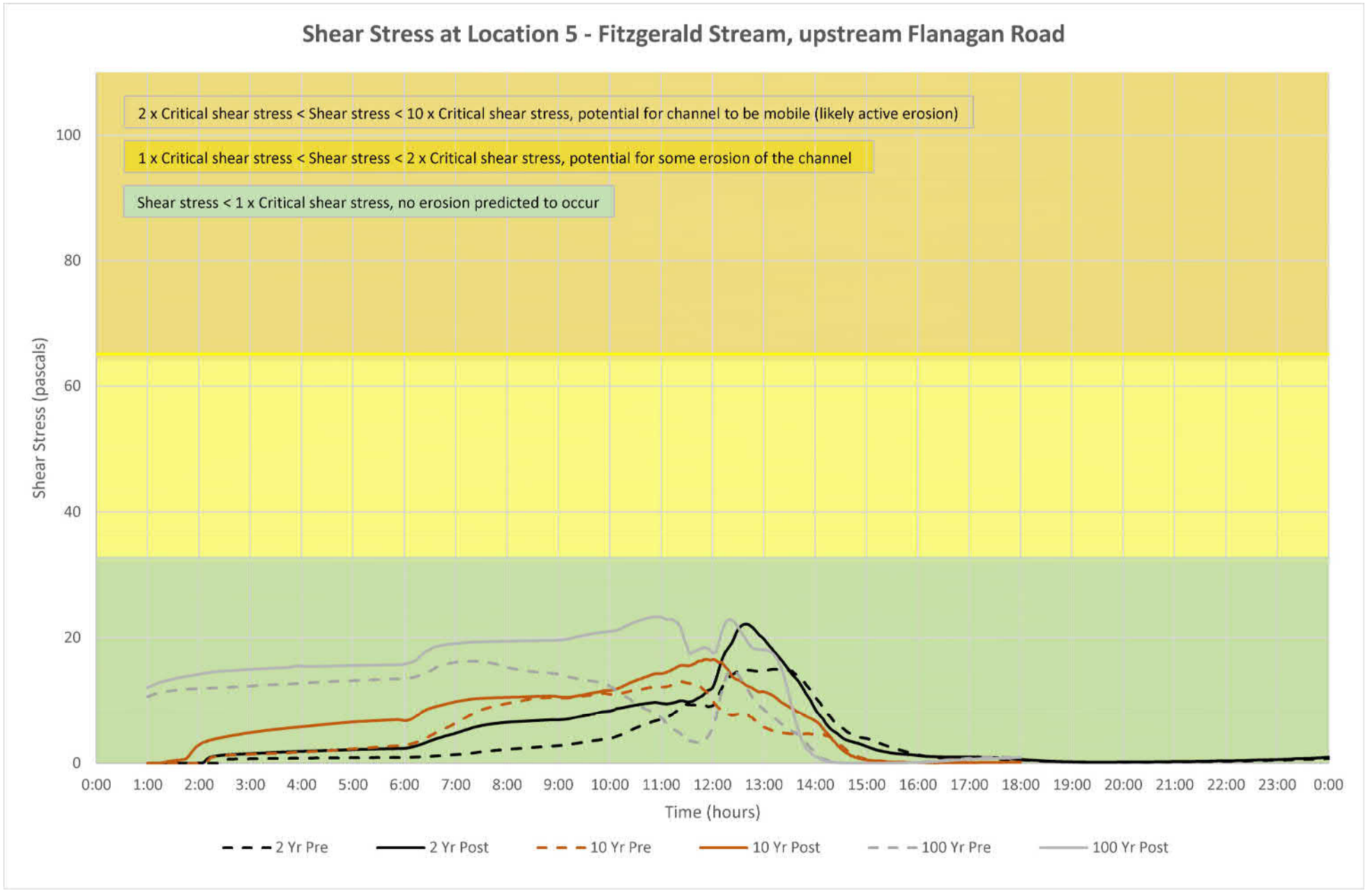

Excess shear stress in streams during 100 Year Pre and Post Development MPD CC
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Pre
Post
Location 1 - Hingaia Stream, mid-point Kiwi Plan Change
Location 2- Hingaia stream, upstream Flanagan Bridge
Location 3 - Hingaia Stream, upstream Norrie Road
Location 4 - Hingaia Stream, lower
Location 5 - Fitzgerald Stream, upstream Flanagan Road
Location 6 - Fitzgerald Stream, upstream Fitzgerald Stream
Location 7 - Fitzgerald Stream, downstream mid-point Kiwi Plan Change Area
Location 8 - Hingaia Tributary, from Fulton Hogan Plan Change Area
Location 9 - Hingaia Tributary, from Fulton Hogan Plan Change Area
Location 10 - Fitzgerald Stream, mid-point Fulton Hogan Plan Change Area
Indicates no erosion predicted to occur
Indicates the potential for some erosion of the channel
Indicates the potential for channel to be mobile (likely active erosion)
Indicates potential rapid rates of erosion and incision of channel


Shear Stress at Location 1 - Hingaia Stream, mid-point Kiwi Plan Change
2 x Critical shear stress < Shear stress < 10 x Critical shear stress, potential for channel to be mobile (likely active erosion)
1 x Critical shear stress < Shear stress < 2 x Critical shear stress, potential for some erosion of the channel
Shear stress < 1 x Critical shear stress, no erosion predicted to occur
Shear Stress (Pa)
0
20
40
60
80
100
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time (hours)
2 Yr Pre
2 Yr Post
10 Yr Pre
10 Yr Post
100 Yr Pre
100 Yr Post


Shear Stress at Location 2 - Hingaia stream, upstream Flanagan Bridge
2 x Critical shear stress < Shear stress < 10 x Critical shear stress, potential for channel to be mobile (likely active erosion)
1 x Critical shear stress < Shear stress < 2 x Critical shear stress, potential for some erosion of the channel
Shear stress < 1 x Critical shear stress, no erosion predicted to occur
Shear Stress (pascals)
0
20
40
60
80
100
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time (hours)
2 Yr Pre
2 Yr Post
10 Yr Pre
10 Yr Post
100 Yr Pre
100 Yr Post


Shear Stress at Location 3 - Hingaia Stream, upstream Norrie Road
2 x Critical shear stress < Shear stress < 10 x Critical shear stress, potential for channel to be mobile (likely active erosion)
1 x Critical shear stress < Shear stress < 2 x Critical shear stress, potential for some erosion of the channel
Shear stress < 1 x Critical shear stress, no erosion predicted to occur
Shear Stress (pascals)
0
20
40
60
80
100
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time (hours)
2 Yr Pre
2 Yr Post
10 Yr Pre
10 Yr Post
100 Yr Pre
100 Yr Post


Shear Stress at Location 4 - Hingaia Stream, lower
2 x Critical shear stress < Shear stress < 10 x Critical shear stress, potential for channel to be mobile (likely active erosion)
1 x Critical shear stress < Shear stress < 2 x Critical shear stress, potential for some erosion of the channel
Shear stress < 1 x Critical shear stress, no erosion predicted to occur
Shear Stress (pascals)
0
20
40
60
80
100
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time (hours)
2 Yr Pre
2 Yr Post
10 Yr Pre
10 Yr Post
100 Yr Pre
100 Yr Post


Shear Stress at Location 5 - Fitzgerald Stream, upstream Flanagan Road
2 x Critical shear stress < Shear stress < 10 x Critical shear stress, potential for channel to be mobile (likely active erosion)
1 x Critical shear stress < Shear stress < 2 x Critical shear stress, potential for some erosion of the channel
Shear stress < 1 x Critical shear stress, no erosion predicted to occur
Shear Stress (pascals)
0
20
40
60
80
100
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
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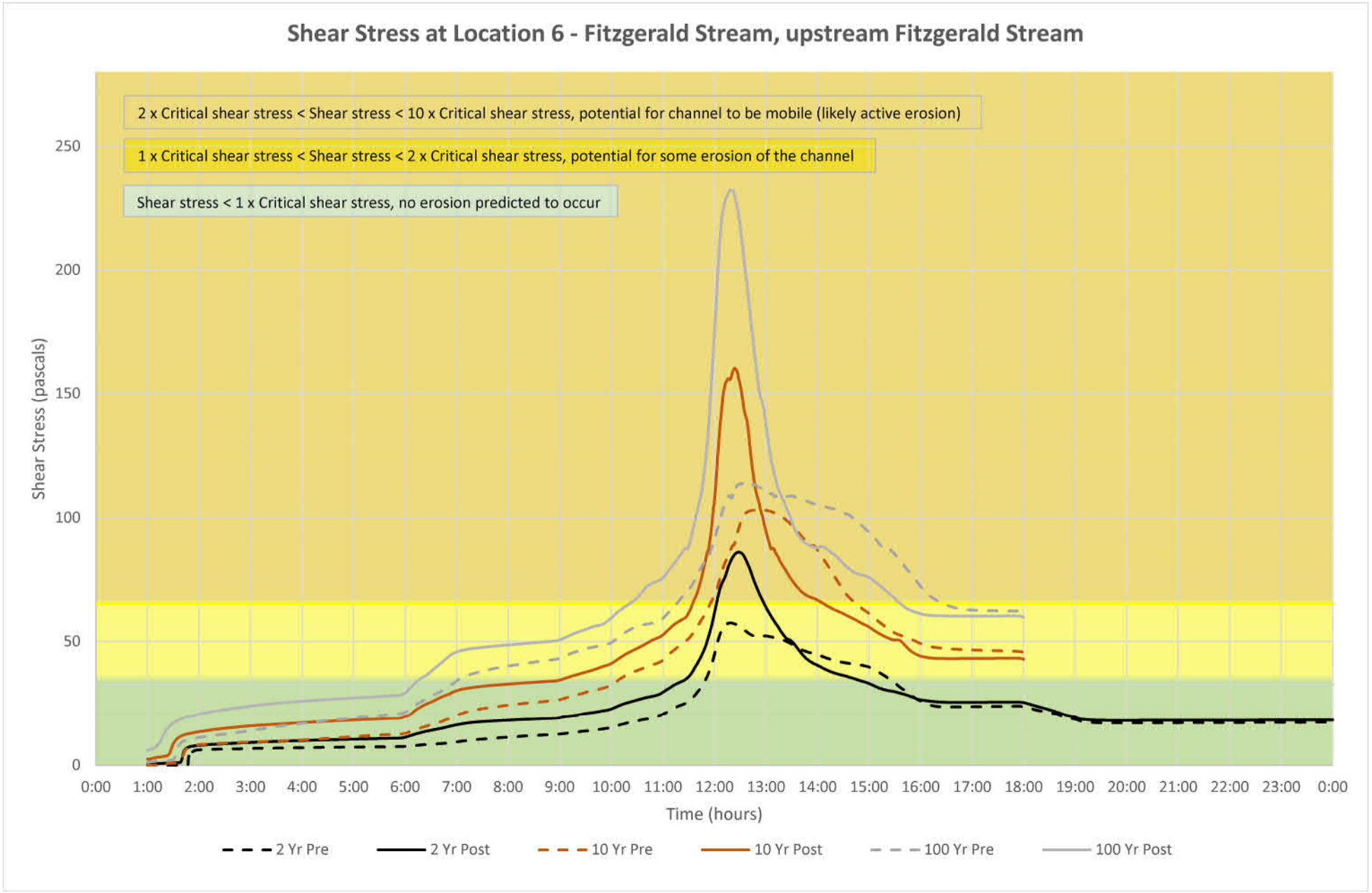
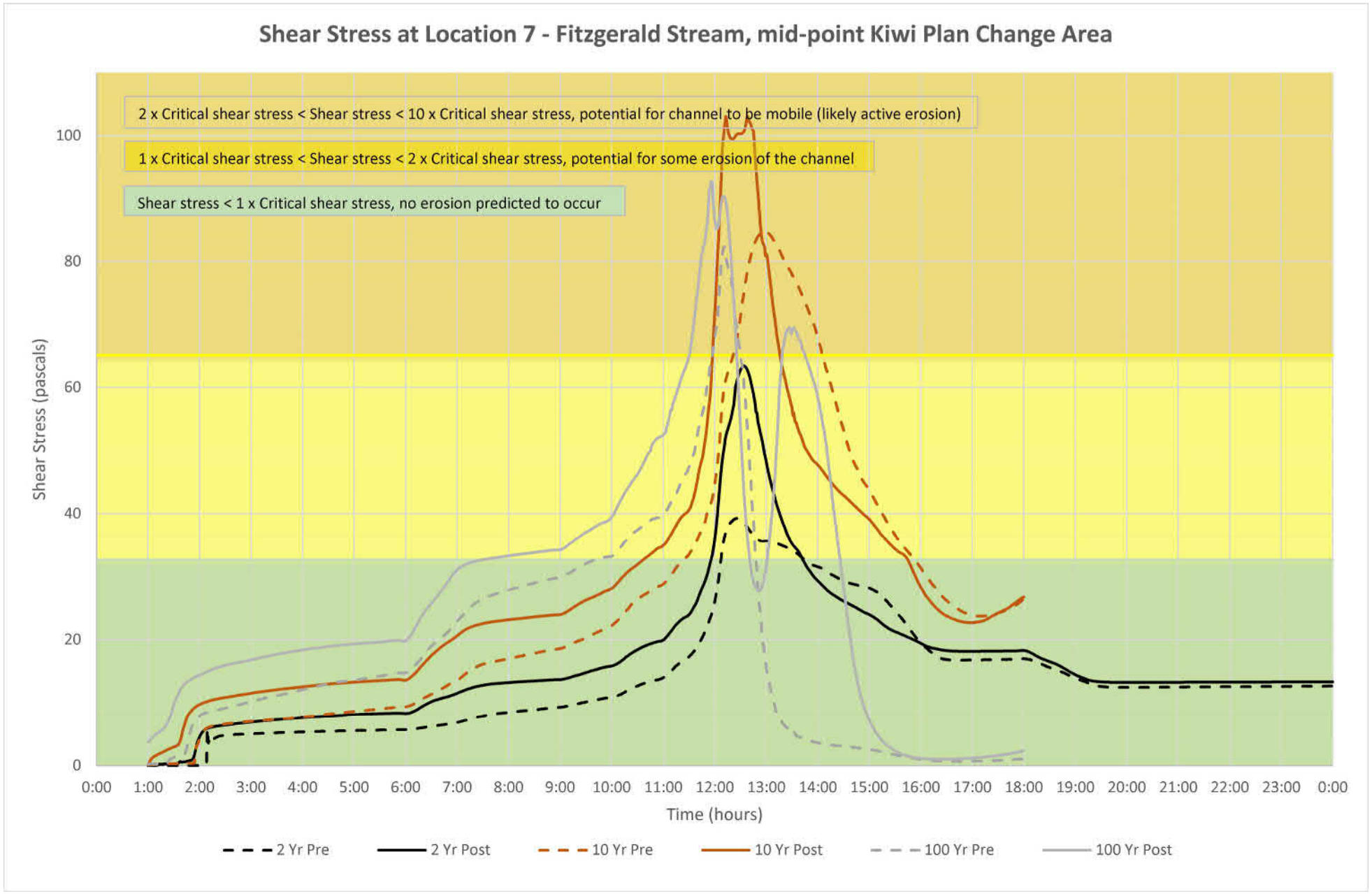
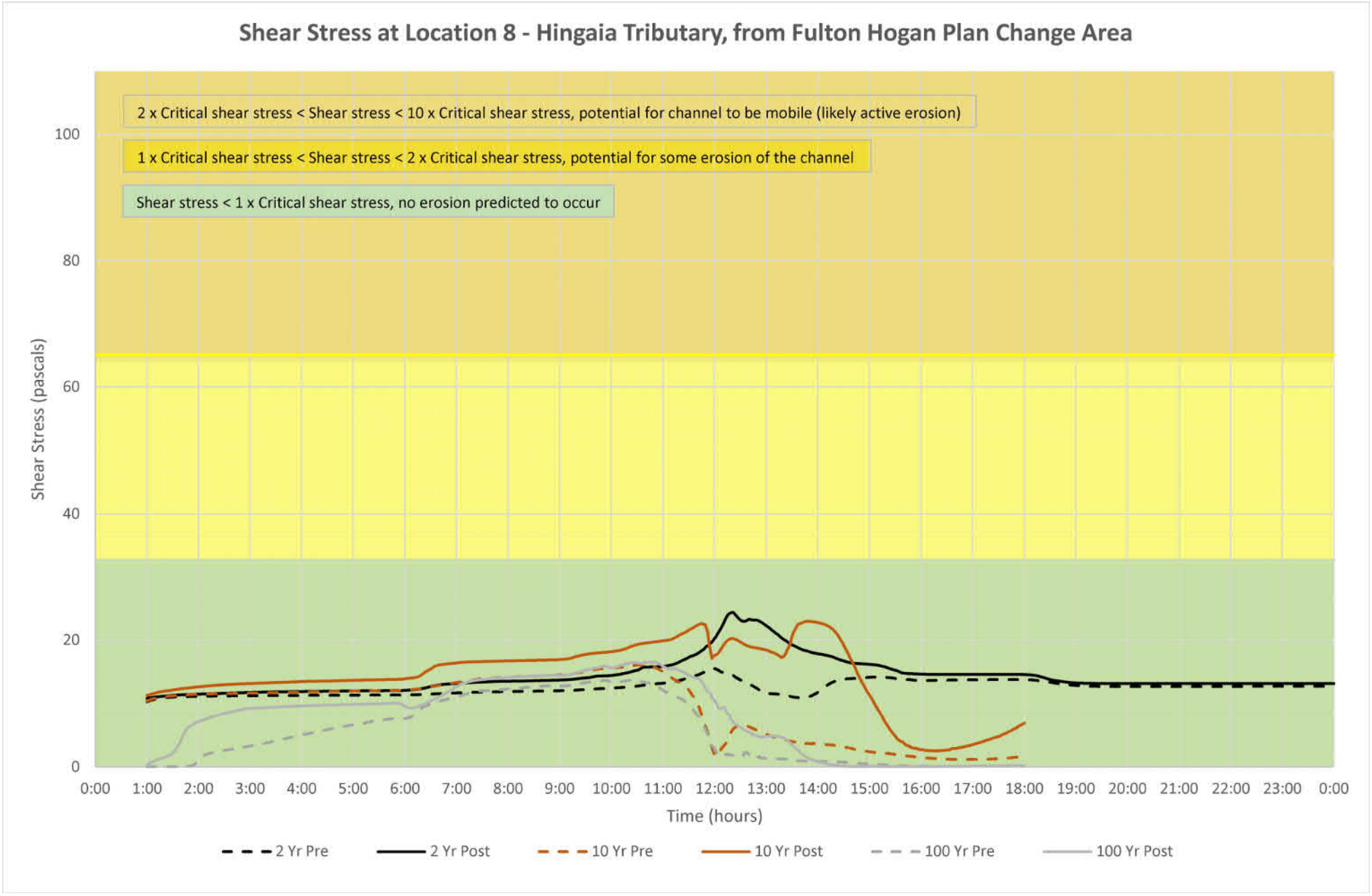
2 Yr Post
10 Yr Pre
10 Yr Post
100 Yr Pre
100 Yr Post


Shear Stress at Location 6 - Fitzgerald Stream, upstream Fitzgerald Stream
2 x Critical shear stress < Shear stress < 10 x Critical shear stress, potential for channel to be mobile (likely active erosion)
1 x Critical shear stress < Shear stress < 2 x Critical shear stress, potential for some erosion of the channel
Shear stress < 1 x Critical shear stress, no erosion predicted to occur
Shear Stress (pascals)
0
50
100
150
200
250
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time (hours)
2 Yr Pre
2 Yr Post
10 Yr Pre
10 Yr Post
100 Yr Pre
100 Yr Post


Shear Stress at Location 7 - Fitzgerald Stream, mid-point Kiwi Plan Change Area
2 x Critical shear stress < Shear stress < 10 x Critical shear stress, potential for channel to be mobile (likely active erosion)
1 x Critical shear stress < Shear stress < 2 x Critical shear stress, potential for some erosion of the channel
Shear stress < 1 x Critical shear stress, no erosion predicted to occur
Shear Stress (pascals)
0
20
40
60
80
100
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time (hours)
2 Yr Pre
2 Yr Post
10 Yr Pre
10 Yr Post
100 Yr Pre
100 Yr Post


Shear Stress at Location 8 - Hingaia Tributary, from Fulton Hogan Plan Change Area
2 x Critical shear stress < Shear stress < 10 x Critical shear stress, potential for channel to be mobile (likely active erosion)
1 x Critical shear stress < Shear stress < 2 x Critical shear stress, potential for some erosion of the channel
Shear stress < 1 x Critical shear stress, no erosion predicted to occur
Shear Stress (pascals)
0
20
40
60
80
100
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
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0:00
Time (hours)
2 Yr Pre
2 Yr Post
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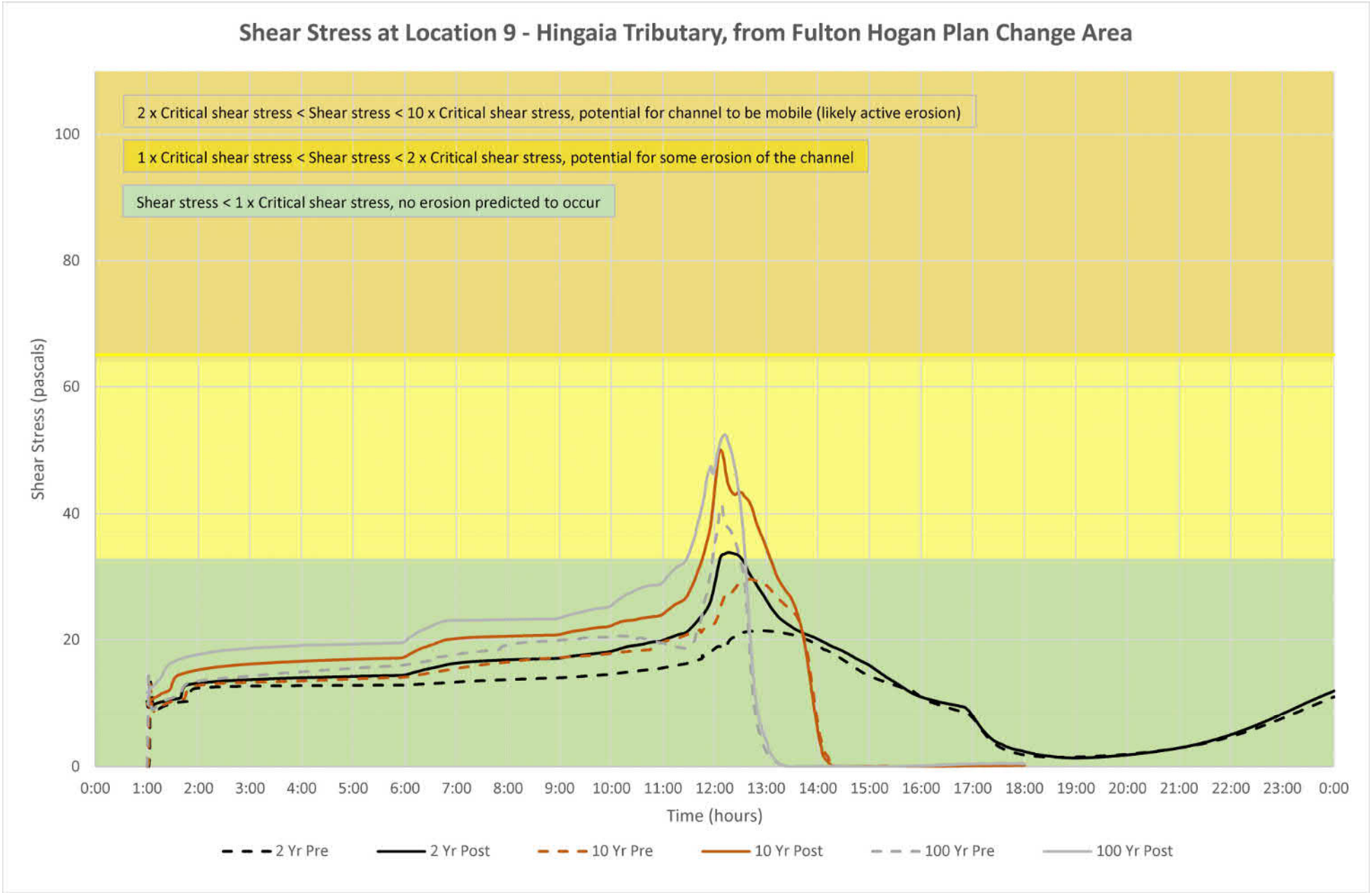
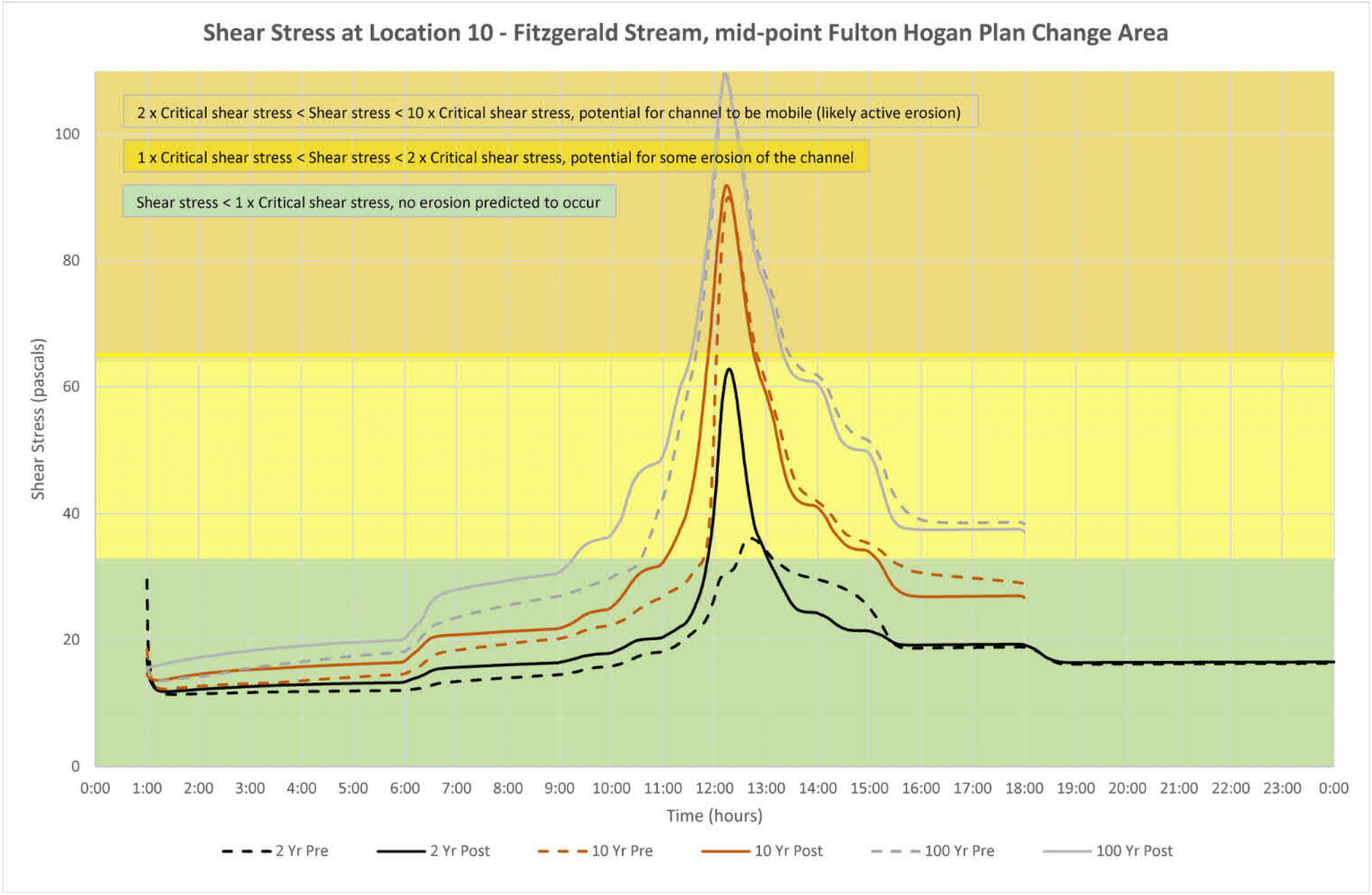
10 Yr Post
100 Yr Pre
100 Yr Post


Shear Stress at Location 9 - Hingaia Tributary, from Fulton Hogan Plan Change Area
2 x Critical shear stress < Shear stress < 10 x Critical shear stress, potential for channel to be mobile (likely active erosion)
1 x Critical shear stress < Shear stress < 2 x Critical shear stress, potential for some erosion of the channel
Shear stress < 1 x Critical shear stress, no erosion predicted to occur
Shear Stress (pascals)
0
20
40
60
80
100
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time (hours)
2 Yr Pre
2 Yr Post
10 Yr Pre
10 Yr Post
100 Yr Pre
100 Yr Post


Shear Stress at Location 10 - Fitzgerald Stream, mid-point Fulton Hogan Plan Change Area
2 x Critical shear stress < Shear stress < 10 x Critical shear stress, potential for channel to be mobile (likely active erosion)
1 x Critical shear stress < Shear stress < 2 x Critical shear stress, potential for some erosion of the channel
Shear stress < 1 x Critical shear stress, no erosion predicted to occur
Shear Stress (pascals)
0
20
40
60
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# MEMORANDUM

B&A
Urban & Environmental

**To:** Auckland Council: Michael Luong

**From:** Barker & Associates

**Date:** April 2020

**Re:** Drury Centre Plan Change: Second RFI Response

**Drury Centre Plan Change Request - Kiwi Property no.2 Limited**

We write in response to your request dated 20 April 2020 for further information under Clause 23(1) to Schedule 1 of the Resource Management Act 1991 relating to the above private plan change request. This letter sets out our responses to the matters raised in your letter, and is supported by the following attachment prepared by the technical specialists supporting the plan change request:

- Attachment 1: Drury Centre Plan Change Application dated 24 March 2020
- Attachment 2: Drury Plan Change dated 24 March 2020
- Attachment 3: Response to Stormwater Request for Further Information
- Attachment 4: Response to Transport Request for Further Information
- Attachment 5: Response to Economic Request for Further Information

The requests and our responses are set out below.

## 1.0 STORMWATER

### 1.1 STREAM BANK EROSION

***Request 1:*** *The RFI assessment provided concludes that it is difficult to determine if there will be significant impact from development on stream erosion. It is unclear from the information provided if the calculations for shear stress included events smaller than 2yr ARI; included an evaluation on what would happen if SMAF 1 applied; and accounted for the fact that future development is also likely to occur upstream in the future (based on current zoning and permitted activity rules) so cumulative shear stress may be greater than presented in RFI information. Please provide detail on the shear stress calculations.*

**Events smaller than the 2 year ARI (T+T)**

The Modified Stream Erosion Assessment included in the T+T/Wood 6 April 2020 memo identifies changes in erosion potential at 10 locations during the 2, 10 and 100 year ARI design storm by quantifying the duration of exceedance of critical shear stress and comparing this for the pre-development and post-development scenarios. The assessment places 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.

Design storm events smaller than the 2 year ARI were not considered for the following reasons:

- The 2, 10, 100 year ARI design storm events that were assessed are consistent with those included in the Auckland Council Stream Erosion Risk tool; and

- The hydraulic model has been based on predicting flood flows (in general accordance with Auckland Council Stormwater Modelling Specification) and these models have more uncertainty (are untested) for smaller events; and
- For the 2, 10 and 100 year ARI design storm events, we determined that there was small amounts of erosion predicted and uncertainty in the predictive ability (compared to observed erosion); and
- The greatest uncertainty in the assessments is the critical shear stress, which is very hard to describe as set out in T+T/Wood 6 April 2020. Further assessment of more storm events or mitigation measures does not overcome this problem; and
- Therefore further modelling of events smaller than the 2 year ARI was not beneficial.

**SMAF evaluation (T+T)**

For the reasons given above, we have not run flood models or assessed the erosion potential that accounts for the proposed SMAF 1 hydrological mitigation for all impervious surfaces in the Plan Change Areas nor for the stream erosion mitigation measures recommended section 7 of the memo.

An assessment including the SMAF 1 hydrological mitigation would involve changing the flood model hydrology files to represent an effective rainfall which accounted for the SMAF 1 storage within hydrological mitigation devices.

The assessments done to date identified only very minor change between the pre-development and post-development scenarios for all three design storms (2, 10, 100 year ARI design storm events). It is expected that the application of SMAF 1 hydrological mitigation to those design storms would also 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.

The benefit from SMAF 1 hydrological mitigation is conceptually clearer for smaller design storm events (i.e the 95$^{th}$ percentile design storm event) because the retention/detention volumes are a large proportion of the events.

**Future development of the upstream catchment (T+T)**

The post-development scenario includes the development of the Plan Change Areas in accordance with Table 2 of *Response to Auckland Council Further Information Request on Stormwater Matters for Drury East* prepared by Woods and Tonkin + Taylor on 25 March 2020 (relevant portion included below). It also allowed for future development of 60% imperviousness for the catchment within the Future Urban Zone and outside of the Plan Change Area.

**Shear Stress calculations for the Modified Stream Erosion Assessment (T+T)**

Please refer to Attachment 3, which is our spreadsheet model for the erosion assessment. Note the shear stress calculations are undertaken in the MIKE Flood hydraulic model.

## 1.2 MANAGEMENT METHODS

***Request 2:*** *The 'T and T' 6 April 2020 assessment concludes that the ecology and stormwater experts for Kiwi Property and Fulton Hogan recommend stream erosion mitigation measures for the Plan*

*Change areas. Can you please advise how the stream erosion mitigation measures can be implemented? Is there a need for Precinct specific policies and measures?*

The Plan Change proposes to manage stream erosion from a result of increased impervious area largely through applying SMAF 1 to reduce and manage stormwater runoff. The SMAF 1 rules require consent for the creation of impervious area greater than 50m$^2$. This rule would be triggered as part of any subdivision consent to redevelop land by virtue of the impervious surface created by roads. At this point, an assessment of the additional stormwater runoff, including future impervious area for any super lots created, would be assessed. The matters of discretion for the development of impervious surface greater than 50m$^2$ are set out in clause E10.7.2(1) of the AUP and specifically refers to policies E1.3(1)-(5), and (8)-(9). These policies provide clear scope and policy direction to manage the effects of stormwater runoff on stream health. We note the relevant extracts below and highlight the relevant sections:

> *Policy 2: Manage discharges, subdivision, use, and development that affect freshwater systems to:*
> *(a)* ***maintain or enhance water quality, flows, stream channels and their margins and other freshwater values, where the current condition is above National Policy Statement for Freshwater Management National Bottom Lines*** *and the relevant Macroinvertebrate Community Index guideline in Table E1.3.1 below; or*
> *(b)* ***enhance water quality, flows, stream channels and their margins and other freshwater values where the current condition is below national bottom lines*** *or the relevant Macroinvertebrate Community Index guideline in Table E1.3.1 below.*
>
> *Policy 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:*
> *(a) taking an* ***integrated stormwater management approach*** *(refer to Policy E1.3.10);*
> *(b)* ***minimising the generation and discharge of contaminants,*** *particularly from high contaminant generating car parks and high use roads and into sensitive receiving environments;*
> *(c) minimising or mitigating changes in hydrology, including loss of infiltration, to:*
> *(i)* ***minimise erosion and associated effects on stream health and values****;*
> *(ii) maintain stream baseflows; and*
> *(iii) support groundwater recharge;*
> *(d) where practicable, minimising or mitigating the effects on freshwater systems arising from changes in water temperature caused by stormwater discharges; and*
> *(e) providing for the management of gross stormwater pollutants, such as litter, in areas where the generation of these may be an issue.*

These policies provide clear direction to future consenting officers as to the matters that must be assessed through future resource consent applications for impervious area. It also provides sufficient scope to assess the effects of increased stormwater runoff on stream health as required by Policy 8(c)(i). It is also worth noting that the discharge of stormwater to an authorised network will require the SMP to be either be adopted by Council into their Network Discharge Consent, or for Kiwi to seek their own private discharge consent. The SMP will set the framework for assessment of development against the policies referenced above. In our view, there is no need to duplicate these policies in the precinct, unless there is an area-specific resource management issue that needs to be managed. This approach is consistent with the approach to precincts throughout the Auckland Unitary Plan as detailed in the updated s32 report.

*To include a clear diagram or similar setting out the Auckland-wide activity triggers and matters of assessment /policies to confirm that all matters are covered – include the additional proposed policies if David S agrees to those.*

A riparian planting rule is also proposed along permanent and intermittent streams which will also contribute to managing stream bank erosion. T&T are continuing to analyse the extent of stream erosion that will result from development of the Plan Change area to determine if there is a need for further bank stabilisation / in stream works in addition to riparian planting and managing stormwater runoff. To ensure that the Plan Change includes a policy directive to manage stream bank erosion resulting from subdivision and development within the Plan Change area an additional policy is now proposed:

> *(18) In addition to the matters in Policy E1.3(8), manage erosion and associated effects on stream health and values arising from development in the precinct, including parts of the Fitzgerald and Hingaia streams, and enable in-stream works to mitigate any effects.*

Applications for subdivision and development within the Plan Change area will need to demonstrate consistency with this policy direction. If any subsequent in stream works are required these remain subject to the regional provisions of Chapter E3 of the AUP which are generally enabling of erosion control structures.

## 1.3 STREAM CORRIDORS

***Request 3:*** *Please provide further clarification of the costs and benefits of mapping streams.*

Chapter E3 of the AUP effectively manages streams, and in our opinion, there is no resource management reasons to spatially identify streams on a precinct plan given that it does not link with any specific method in the Drury Centre precinct. Furthermore, as stream alignments can vary over time, the introduction of a precinct plan which spatially defines streams could create uncertainty and potentially mislead future property owners. Despite these reasons we understand that the Council would still prefer streams to be spatially depicted for consistency with other greenfield precincts.

As discussed in the Section 32 assessment report[1] some stream reclamation is likely to be required with Drury Centre to facilitate efficient urban development. Therefore, to accurately map the future stream network within Drury Centre we need to undertake further work to understand the extent of this proposed reclamation. An additional policy has been included within the precinct to signal this approach:

> *(19) In addition to the matters in Policy E.3.3(13), recognise that there may be no practicable alternative to stream works, including culverting, diversion and/or reclamation, where they are required to construct critical infrastructure.*

We acknowledge that further work with Council is required to develop this policy and the supporting provision, and that further discussions with iwi will be required. We will continue to engage with Council and iwi regarding this.

## 1.4 WATER QUALITY

[1] Drury Centre Plan Change Request Section 32 Assessment Report Section 10.5.1

***Request 4:*** *Can you please confirm how SMAF 1 and water quality requirements will be met by communal devices?*

The Plan Change proposes to manage water quality through appropriately designed SMAF 1 devices and treatment of all roads (rather than just high use roads as required by Chapter E9 of the regional rules).

While some SMAF devices (particularly communal devices) are only effective as hydrological mitigation the devices that will be utilised as part of the Stormwater Management Toolbox offer both hydrological mitigation and water quality treatment. The matrix is compiled from the current Stormwater Management Plans (SMP) for each Plan Change and will form part of the updated SMP which the applicant will be seeking to have adopted into the Council's Network Discharge Consent (NDC). Given the SMP must be adopted by the Council to form part of the NDC additional precinct provisions are not required to specify the SMAF devices that need to be utilised.

We understand that Council is also concerned that the current drafting of Standard IX6.6. Stormwater Quality will exempt existing roads from stormwater treatment. The applicant has no control over stormwater treatment of existing roads as these are controlled by Auckland Transport. In our view, it is more appropriate to achieve this outcome through working with Auckland Transport through the development process rather than including a specific standard within the Drury Centre Precinct.

## 1.5 FLOODING

***Request 5:*** *Please confirm if flood modelling includes the assumption that the Fitzgerald culvert and culverts under Great South Road will be upgraded prior to subdivision or development in the plan change areas and if this has a material impact on the floodplain within and downstream of the plan change areas.*

The post-development scenarios include the assumption that the the Fitzgerald culvert and culverts under Great South Road*/Railway/Flanagan Road* have been upgraded to allow for pass-forward of additional runoff. (T+T/Woods)

***Request 6:*** *If the flood model assumes upsized culverts, then please consider whether and how this requirement would be reflected in appropriate Precinct provisions.*

The flood modelling has indicated that the Fitzgerald culvert and culverts under Great South Road*/Railway/Flanagan Road* will need to be upgraded to facilitate development within Drury Centre. It is anticipated that prior to a hearing the developers funding agreement will have confirmed the timing and funding of these upgrades. To recognise this required upgrade in the precinct amendments are proposed to broaden Policy 15 which is currently focused on coordinating development with transport infrastructure. The proposed amendments will ensure this policy also covers stormwater, water supply and wastewater infrastructure.

> *(15) Ensure that the timing of development in Drury East is coordinated with ~~the~~ transport, stormwater, water supply and wastewater infrastructure upgrades necessary to provide for development within the precinct and mitigate the adverse effects of development on the effectiveness and safety of the immediately surrounding transport network.*

Assessment criteria IX.8.2 (3)(n) and IX.8.2 (4)(d) require an assessment for new buildings to ensure there is adequate capacity in the existing or proposed public reticulated water supply, wastewater and stormwater network to service the proposed development. This criteria is now proposed to be amended to specifically reference the capacity of the Fitzgerald culvert and culverts under Great South Road:

> *Whether there is adequate capacity in the existing or proposed public reticulated water supply, wastewater and stormwater network to service the proposed development having particular regard to the capacity of the Fitzgerald culvert and culverts under Great South Road/Railway/Flanagan Road.*

### 1.6 RIPARIAN MARGINS

***Request 7:*** *Could you please clarify the various provisions relating to margins and planted strips as they apply to the range of circumstances that are likely to be encountered and within this context, review whether the proposed riparian planting standard and a riparian margin policy or standard should be re considered.*

The table below provides an overview of the building setback and the minimum required planted riparian margin.

| *Circumstance* | *Building Setback – Total Width* | *Riparian Planting* |
|---|---|---|
| *Intermittent streams (Note that Intermittent Streams can be greater or less than 3m)* | 20m if the stream is 3 metres or more in width in accordance with Standard IX6.4 Riparian Margins<br><br>10m if the stream is less than 3m in width in accordance with Standard H9.6.6 Yards or H13.6.5 Yards | 10m in accordance with Standard IX6.4 Riparian Margins |
| *Stream of less than 3m in width, within a site that is not to be vested or otherwise subject to public access, or which forms part of a wider ecological corridor* | 10m in accordance with Standard H9.6.6 Yards or H13.6.5 Yards | 10m in accordance with Standard IX6.4 Riparian Margins |
| *Stream less than 3m in width that will likely be vested, and/or form part of a wider ecological corridor* | 10m in accordance with Standard H9.6.6 Yards or H13.6.5 Yards | 10m in accordance with Standard IX6.4 Riparian Margins |
| *Streams over 3m in width which are subject to Esplanade reserve requirements* | 20m in accordance with Standard IX6.4 Riparian Margins | 10m in accordance with Standard IX6.4 Riparian Margins |

We understand that the Council would prefer a 20m building setback along the entire length of the Fitzgerald Stream regardless of the width of the stream to provide enough space for flood conveyance and re-establishment of natural meanders. The reasons for Council requesting this larger building setback are twofold. Firstly, the Council is concerned that from a natural hazards perspective more space is required between streams and buildings to provide space for additional conveyance in extreme rain events. The Council is also seeking a wider building setback for amenity reasons to enable provision for connected paths and cycle paths along streams.

An additional building setback from streams is not required to provide for additional conveyance during extreme rain events as Chapter E38 requires proposed subdivisions to respond to the presence of natural hazards. Floodplains will be modelled in detail as part of future subdivision consent applications to ensure the proposed layout can accommodate the 100 year ARI in a way that ensures development will not be impacted by flooding. This assessment is a more effective response to providing adequate space to manage flooding rather than a building setback.

An additional building setback from streams is also not required from an amenity perspective as the assessment criteria for open space encourage the alignment of roads, cycle paths and footpaths with open space and streams:

> *Location and design of publicly accessible open spaces greater than 1000m$^2$ in Sub-Precinct A*
>
> *(a) Whether Homestead Park and Station Plaza are provided in locations generally consistent with their indicative locations shown on IX.10.2 Drury Centre Precinct Plan 2 and have adequate street frontage to ensure the open spaces are visually prominent and safe;*
>
> *…*
>
> *Location and design of any other open spaces greater than 1000m² including any riparian planting*
>
> *…*
>
> *(b) Whether the subdivision or development provides for the recreation and amenity needs of residents by providing suitably sized open spaces that are prominent and accessible to pedestrians within a neighbourhood;*
>
> *(c) Encourage the location and design of open spaces to integrate with surrounding natural features including the network of permanent and intermittent streams;*
>
> *(d) Whether a network of pedestrian and cycle paths are provided along both sides of permanent streams and one side of intermittent streams within proposed open spaces; and*

To ensure this policy intent is clear and to create a linkage to this assessment criteria amendments are proposed to Policy 6:

> *(6) Ensure that development provides a local road network that achieves a highly connected street layout and integrates with the collector road network within the precinct, and the surrounding transport network, and supports the safety and amenity of the open space and stream network.*

In addition, we note that the subdivision policies (E28.3(25) in particular) include the ability to take an integrated approach to the assessment of esplanade reserve requirements. This policy recognises that

a reduced width may be appropriate in some locations, where it can be offset by an increase in width in other locations that would result in a positive public benefit in terms of access and recreation. This would provide scope for some averaging to occur across the length of the Fitzgerald stream for example. This approach is preferred, over a more inflexible setback requirements that does not respond to the specific characteristics of the site and development.

## 2.0 TRANSPORT

### 2.1 FUNDING AGREEMENT INFRASTRUCTURE UPGRADES

***Request 5:*** *Can you please advise on progress developing a funding agreement.*

A funding agreement is being progressed however this cannot be finalised until we understand the Governments decisions regarding the funding of "shovel ready" projects and until we have an update from the Strategic Growth Alliance on the Drury Transport Implementation Programme. We will continue to update the Council about progress on this funding agreement.

DRAFT