TECHNICAL MEMO

Subject:	**Stream Erosion Risk Assessment**	Date:	**18/10/2024**
		Memo No:	**44712-ME-C-EG04-D**
Site Address:	**Whenuapai Business Park, Whenuapai, Auckland**	Status:	**For Notification**
Author:	**Paul Kleynhans (CPEng, BE)**	No of Pages:	**35**

Memo

1.0 Introduction

This memo is prepared to support the proposed plan change for the Whenuapai Business Park, applied for by Neil Construction Limited, and seeks to address the further information requested under Clause 23 of the First Schedule of the Resource Management Act (1991) regarding stream erosion that may result from the change in land-use in the Plan Change Area (PCA).

This memo outlines the stream erosion assessment undertaken by using the Erosion Screening Tool (EST) Version 2024.0 provided by Healthy Waters and Auckland Council. The memo also cites the existing stream condition assessment from the "Whenuapai Business Park-Stream Condition Assessment" prepared by Viridis Environmental Consultants Ltd in April 2024 (attached).

2.0 Stream Erosion Risk Assessment

Assessment locations:

The stream erosion risk assessment was undertaken at 4 locations. Locations 1 to 3 are at the upstream, middle and the downstream sections of the unnamed stream within the eastern part of the plan change area (PCA 1). Location 4 is positioned just to the west of PCA2 upstream of Sinton stream. The locations are shown in Figure 1.

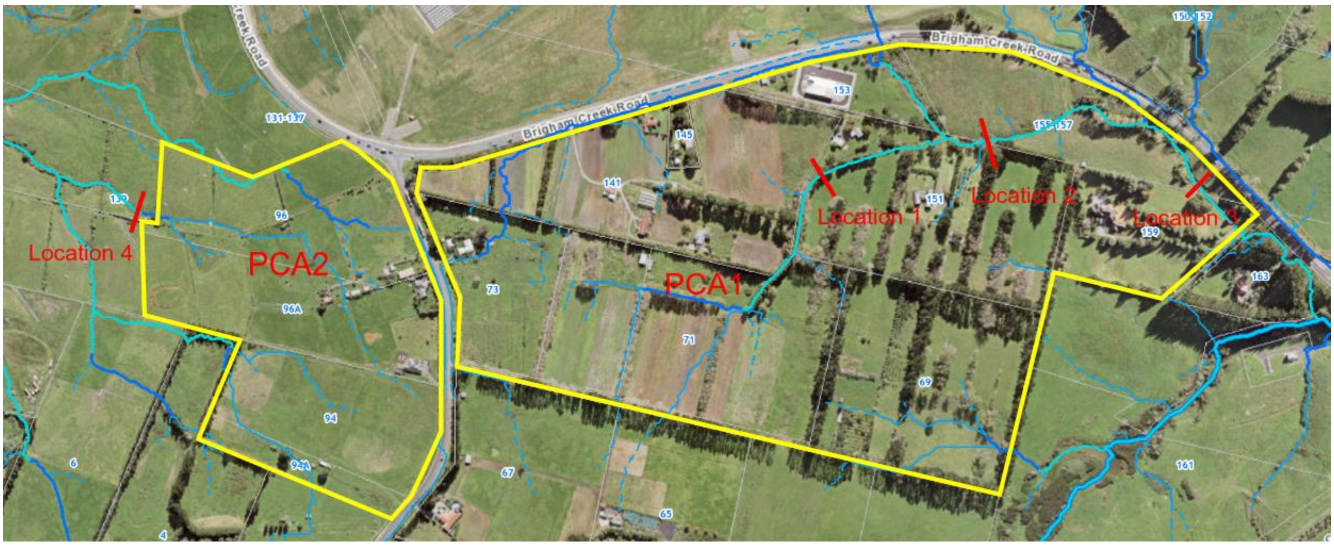


Figure 1 Assessment Locations

Site geology:

Geological map for the area indicates the regional geology as Puketoka Formation. Site specific investigations have been carried out by CMW Geosciences across the proposed plan change area.

The geotechnical assessment report prepared by CMW Geosciences in October 2023 for the private plan change application described the PCA as predominantly comprising "firm to very stiff clayey silts and silty clays. There are dense sand deposits recorded at depth in several cone penetrometer tests (CPTs) towards the north and north-east part of the subject area, and East Coast Bays Formation rock has been identified during investigations for a future bridge within 157 Brigham Creek Road". A detailed investigation report for a future bridge across the watercourse at 157 Brigham Creek Road dated 23 March 2023 identified East Cost Bays Formation rock and high strength soils averaging 100-130kPa in most locations except one borehole positioned some distance from the stream, where unengineered fill was encountered.

Stream condition assessment:

The existing watercourse in PCA1 was surveyed by Neil Construction in 2020 with photos being taken. The author of the "Whenuapai Business Park-Stream Condition Assessment" from Viridis Environmental Consultants revisited the survey photo locations in April 2024 and provided their stream condition assessment memo which is included in Appendix B. The memo describes that the condition of the waterways within the PCA was good and that there was largely no evidence of erosion, scour or other bank damage. Even the significant storm events experienced in Auckland early in 2023 did not appear to have caused any noticeable erosion or scour of the stream banks. The memo describes the stream bed and banks as showing a high degree of resilience to changes in hydrological regime.

The following table summarizes the geological layer and the site observation by Vidiris during stream condition assessment at the proposed erosion assessment locations.

Table 1 Geological Layer and Site Observation for Each Assessment Location

Erosion assessment locations	Geological Layer	Stream assessment observation (By Vidiris)
Location 1	Puketoka Formation	Moderately incised. Vegetation growth along the channel banks. (Photo point E1)
Location 2	Puketoka Formation	Downstream of the existing artificial pond. No scour, erosion or bank cutting were observed, suggesting the bank is stable. Well vegetated. (Photo point M).
Location 3	Puketoka Formation	Channel is well defined, wetted area slightly incised; water was present. Bank is steep, slumping has occurred due to the steep bank and the sheet flow from Brigham Creek Road. (Photo Point W)
Location 4	Puketoka Formation	Not Applicable

Erosion Screening Tool:

A few issues and limitations were identified when applying the Erosion Screening Tool (EST) provided by Auckland Council and Healthy Waters:

- The EST does not allow for the integration of stormwater mitigation such as Stormwater Management Area (SMAF) mitigation. The tool requires SMAF-generated hydrographs to be entered into the tool. As discussed in the result section, the effect on the erosion risk is shown to be small, therefore mitigation was excluded from the calculations. This causes the result to be conservative.

- The critical shear stress was not available from the geotechnical testing done for the site to date. Published critical shear stresses were used as described below.

- The EST only quantifies the erosion risk caused by flow rates and does not quantify the impacts of other factors in relation to erosion (such as the very high level of vegetation which exists, and will be enhanced during development, on the stream banks). Therefore, it cannot be used to assess the effects of incorporating such measures.

- The hydraulic shear stress is very sensitive to the bed levels in small flows, which may result in inconsistent results.

This assessment using the EST focuses on comparing the erosion potential between pre-development and post-development scenarios.

Parameters:

The 24hr rainfall depths for the subject site for the 2-year Annual Recurrence Interval (ARI) and above were obtained from TP108 and the rainfall depths for the smaller storm events are generated by the EST. Curve numbers of 74 and 98 were used for the pervious areas and impervious areas respectively. 0.03 was used as the Manning's roughness value, "n".

Adopted Critical shear stress:

TR2009-038 Erosion Parameters for Cohesive Sediment in Auckland Streams published by Auckland Regional Council provides the critical shear stress measured by jet tests in eleven streams in the wider Auckland region, which are presented in Figure 2.

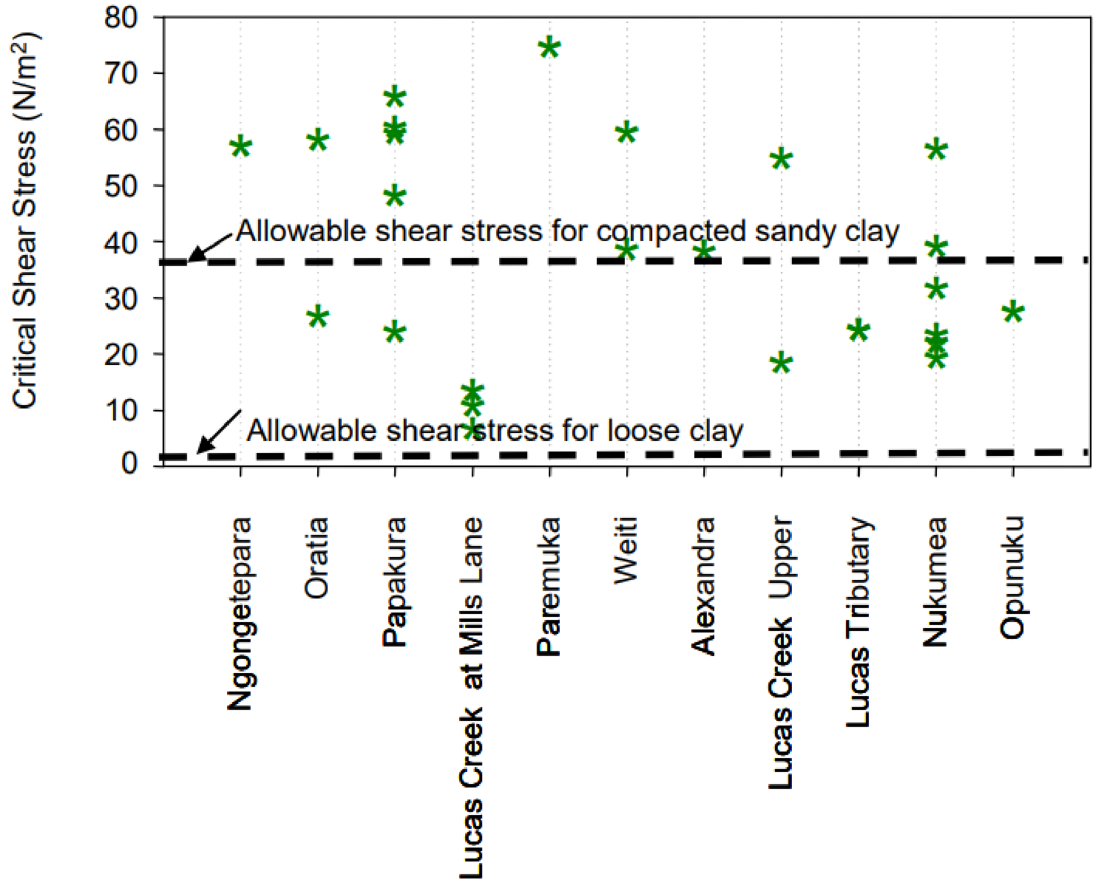


Figure 2: Critical shear stress measured by jet tests in Auckland streams/locations, (Taken from AC TR2009-038)

Auckland Council has undertaken testing around the Auckland region to determine shear stresses as summarised in Table 2.

Table 2: Critical Shear Stress Testing by Auckland Council

(table taken from Auckland Council erosion risk screening tool)

All Cardno Data		Hoteo	Awaruku	Omaru	Oakley	Misc. Urban	Elliott et al. (2005)		
Percentile	τ_c	τ_c	τ_c	τ_c	τ_c	τ_c	τ_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

The geotechnical report provided by CMW Ltd indicates that the soils in the subject site are firm and very stiff clayey silts and silty clays, likely to be stronger than the average critical shear stress found for Puketoka soils, which aligns with the site observations done by Viridis Ltd.

TR 2009-038 suggests adopting the median critical shear stress of 33Pa for Auckland soils in the absence of site-specific parameters.

Therefore, based on the presence of the soils in the site, it is appropriate to adopt the 50-percentile median critical shear stress of 32.6Pa from Table 2.

Erosion Threshold:

Auckland Council proposes to assess the risk as shown in below Table 3. Each threshold represents the excess shear which is a ratio representing how much the shear stress exerted by the stream flow differs from the critical shear stress.

Table 3 Erosion Threshold

(table taken from Auckland Council erosion risk screening tool)

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

3.0 Results

The excess shear at each location has been calculated by using the EST for 0.25-year, 0.5-year, 1-year, 2-year, 5-year, 10-year and 100-year storm events for both pre-development and post-development, in both existing climate and allowing for climate change (3.8^{0}C change) scenarios. The detailed results are included in Appendix A. In order to compare the results from the EST against the visual observations on site, the assessment concentrated on the existing climate scenario.

The stream erosion risk was assessed by analysing the duration of the excess shear in each erosion threshold. The percentage of time exceeding this threshold at each location in the existing climate scenario for both pre-development (ED+C) and post-development (PD+C) is shown below.

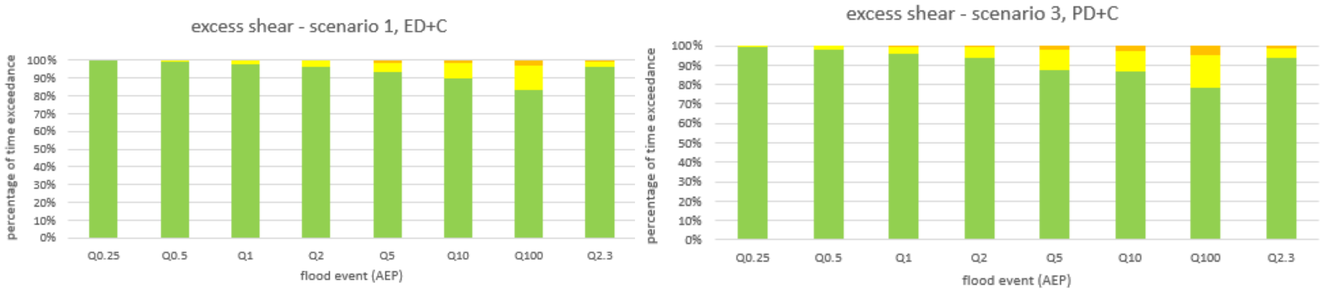


Figure 3 Location 1 Percentage of Time Exceedance

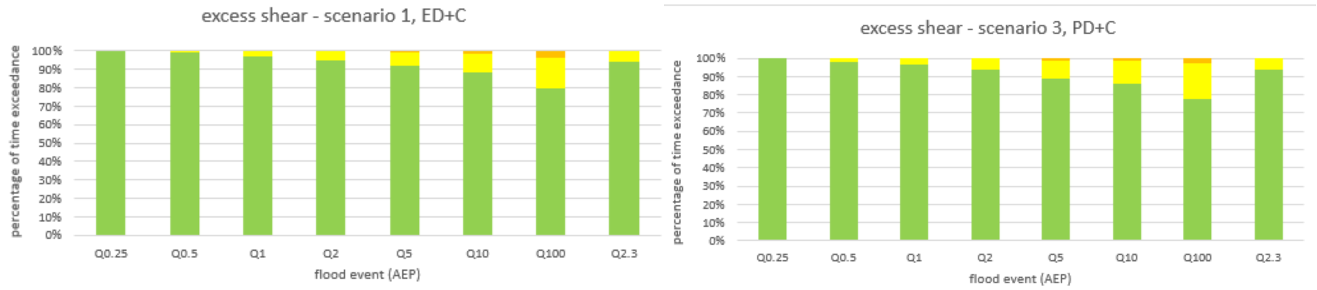


Figure 4 Location 2 Percentage of Time Exceedance

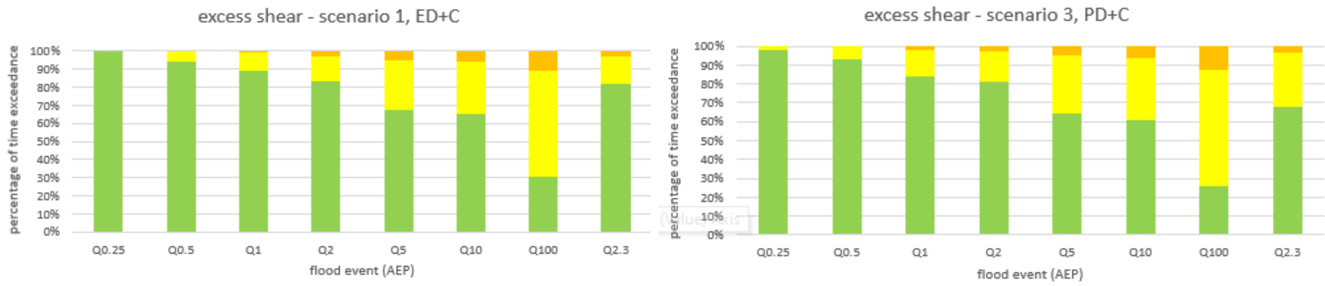


Figure 5 Location 3 Percentage of Time Exceedance

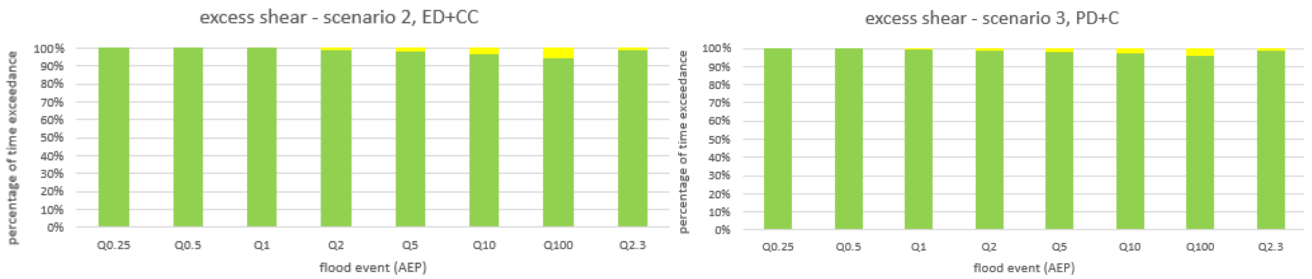


Figure 6 Location 4 Percentage of Time Exceedance

The results show that there is some potential for erosion in both pre- and post-development scenarios from 1 year ARI and above storm events at Locations 1 and 2, potential for some erosion from 0.5 year ARI and above storm events at location 3, and minor potential for some erosion from 2 year ARI and above storm events at Location 4. However, the excess shear remains low at the assessed locations with small percentage changes in erodibility potential between the pre-development and post-development scenarios.

To determine the severity in change of erosion risk caused by the proposed land use change, the changes in the percentage of duration that erosion potential is triggered (excess shear bigger than 1) were compared between the pre- and post-development scenarios. The analysis is focused on the smaller events because the sources of increased erosion potential are often associated with flows from more frequent smaller storm events.

Below is a summary of changes in the percentage of duration that erosion potential is triggered (excess shear bigger than 1) during the 0.5-year, 1-year, and 2-year storm events.

Table 4 Changes in percentage of duration that erosion potential is triggered

Locations	0.5-year			1 year			2 Year		
	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change
Location 1	0.7%	2.1%	1.4%	2.1%	4.2%	2.1%	3.5%	6.3%	3.1%
Location 2	0.7%	2.0%	1.3%	2.8%	3.5%	0.7%	4.9%	6.3%	1.4%
Location 3	5.6%	6.9%	1.3%	11.1%	15.9%	4.8%	16.7%	18.8%	2.1%
Location 4	0	0	0	0	0.7%	0.7%	0	1.4%	1.4%

The results show that the changes are generally small at all locations, which indicates the changes of erosion potential are small from pre-development to post-development. Therefore, based on the analysis above, the effect of the development of the PCA on the erosion risk in the streams is less than minor.

It is noted that the above results exclude the benefits that are likely to be seen from the provision of SMAF mitigation and other measures noted in Section 7.0.

4.0 Site Verification

Table 4 shows the changes in erosion potential are small between pre- and post-development. However, the Figures 3 to 5 show that there is potential for some erosion in the storm events of 0.5-year ARI and above at Locations 1, 2 and 3, which are not consistent with the site observation described in the "Stream Condition Assessment" Memo provided by Viridis Ltd.

The critical shear stress of the stream is very site specific and dependent on factors such as soil geology, channel conditions and stream banks conditions. Given there is no observed erosion along the stream even after the significant storm events that occurred in 2023, and the stream bank is well vegetated, the critical stress is likely to be higher than the average.

As shown in Table 2, the 75th percentile critical shear stress in Auckland streams is 71.6N/m2. Figures 7 to 10 show the percentage of time exceedance when critical shear stress of 71.6N/m2 is applied at all assessed locations. The EST results are more aligned with the existing situation and show that the changes between pre- and post-development are insignificant.

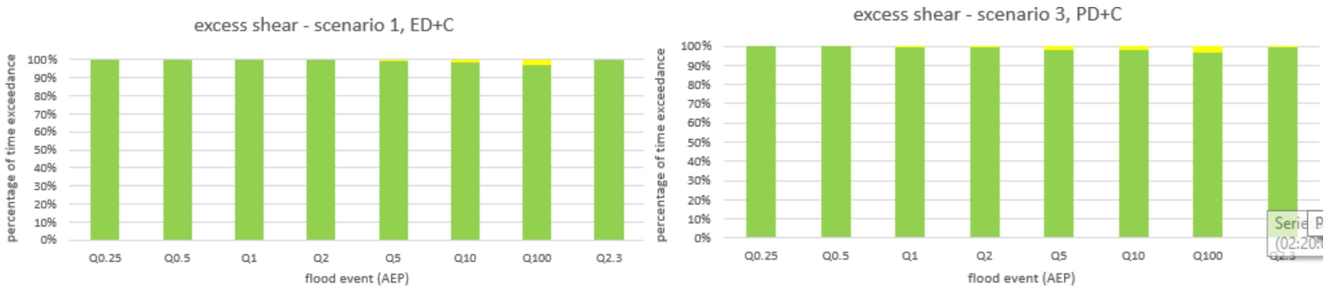


Figure 7 Location 1 Percentage of Time Exceedance (Critical shear stress 71.6N/m2)

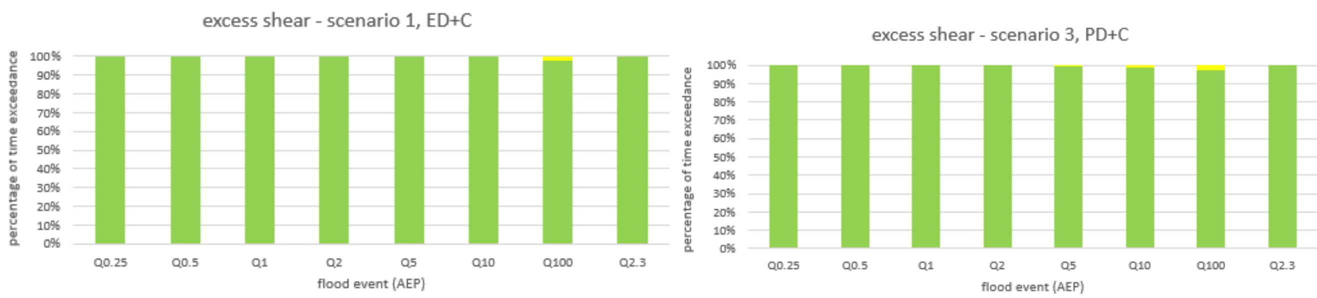


Figure 8 Location 2 Percentage of Time Exceedance (Critical shear stress 71.6N/m2)

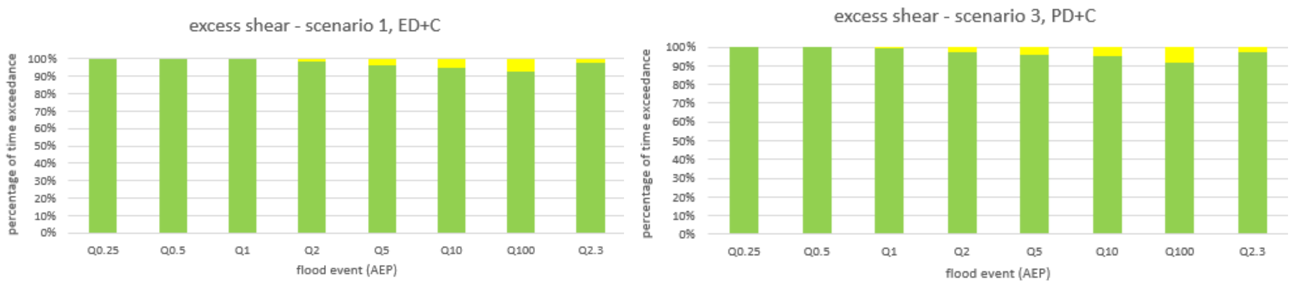


Figure 9 Location 3 Percentage of Time Exceedance (Critical shear stress 71.6N/m2)

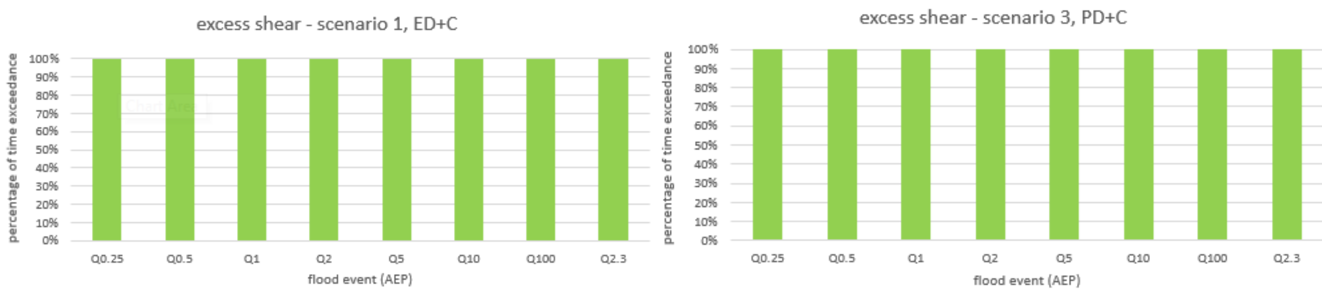


Figure 10 Location 4 Percentage of Time Exceedance (Critical shear stress 71.6N/m2)

5.0 SMAF Mitigation

The EST is focused on the erosion caused by flow. SMAF mitigation aims to manage hydrology on-site before runoff is concentrated at the discharge points by preserving of the channel forming hydrograph volume for the 95th percentile rainfall event and below. SMAF mitigation is not integrated into the EST at present; however, the results above indicate the changes in erosion potential are very small even without mitigation measures.

6.0 Riparian Margin Width

Healthy Waters questioned the use of 10-metre-wide riparian margins in the further information requested under Clause 23 of the First Schedule of the Resource Management Act (1991) and asked whether 20 metres would be more appropriate.

Based on the results discussed above, the stream condition assessment (see attached), and site investigations, there is no evidence to suggest that the stream is sufficiently mobile to require a wider riparian margin to manage if a shift in alignment of the stream occurs in the existing situation, or as an effect of the change in land use in the PCA.

The riparian margins will remain in private ownership (i.e. will not be vested), and it will remain the responsibility of the landowner/s to manage any observed erosion or observed shifts/meanderings of the watercourse. Possible mitigation measures are discussed in Section 7.0.

The response previously submitted to the request for information included the following with regards to the proposed riparian margins:

> *In regard to the 10m riparian yard setback proposed for the plan change area, it is considered sufficient. The proposed riparian yard setback is in accordance with the proposed zoning for the land and Auckland Council's guidance, as stated in TP148 a 10m wide buffer: "allow[s] for indigenous vegetation succession and should result in a relatively low maintenance riparian zone. Edge effects mean that the outer 1-2 metres of the buffer is likely to suffer weed infestations, and these weeds would spread to the interior of the riparian zone wherever canopy gaps occurred."*
>
> *The existing riparian yards are of limited ecological value and are comprised of narrow strips of exotic vegetation and pasture. Future development enabled by the PPC adjacent to the waterways on the site will require the planting of the 10m riparian yard setback which will significantly improve the current status of the land.*
>
> *The proposed 10m riparian yard setback is consistent with the proposed zoning and Unitary Plan requirements and is considered to be appropriate.*

7.0 Possible Mitigation Measures

Despite the changes in the potential of erosion being less than minor between pre- and post-development, the following measures are recommended in order to protect the receiving environment and reduce erosion potential (in addition to providing on-site SMAF mitigation as required under the proposed Stormwater Management Plan and the regionwide Network Discharge Consent requirements):

- Remove existing culverts and artificial ponds and reinstate the stream bed,
- Water quality treatment to provide for impervious areas to reduce sediment discharging to the stream,
- 10m wide riparian planting either side of the stream,
- Outlet structures are set back from the stream with riprap protection, and the use of green outfall structures where practicable.

If erosion is witnessed to be occurring in sections of the watercourse within the PCA, the following measures may be utilised to stabilise these sections of watercourse (no erosion has been identified to date):

- Reshape the stream banks if they are steep,
- Rock armouring of banks where there may be potential for future erosion,
- Installing geotextile cloth to stabilise any observed eroding banks,
- Other measures that may be recommended by the geotechnical engineer, such as the use of check-dams, etc.

8.0 Summary

Auckland Council's Erosion Screening Tool was applied to assess the stream erosion potential for the streams within the proposed plan change area within the Whenuapai Business Park. A critical shear stress of 32.6N/m^2 was adopted from Auckland Council database as recommended. An analysis of the results shows that there was a small erosion potential for both pre- and post-development scenarios, and that the changes between the pre- and post-development even without SMAF mitigation are no more than minor.

A stream condition assessment prepared by Viridis Environmental Consultants Ltd (attached for reference) was undertaken by comparing the condition of the stream in 2020 and 2024. The Memo indicates that no erosion occurred, with the stream bed and banks showing a high degree of resilience to changes in hydrological regime, even after the significant storm events experienced in Auckland early in 2023.

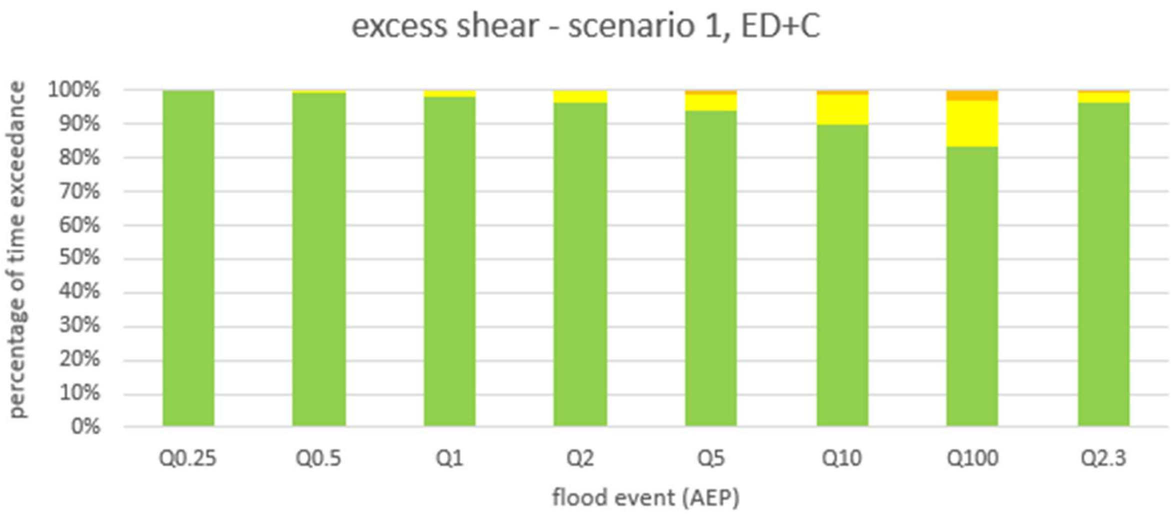
A critical shear stress of 71.6N/m2 was trialled to match the visual inspections on site (i.e. no visual signs of erosion were identified on site). The results show the changes of stream erosion risk between pre- and post-development scenarios are less than minor.

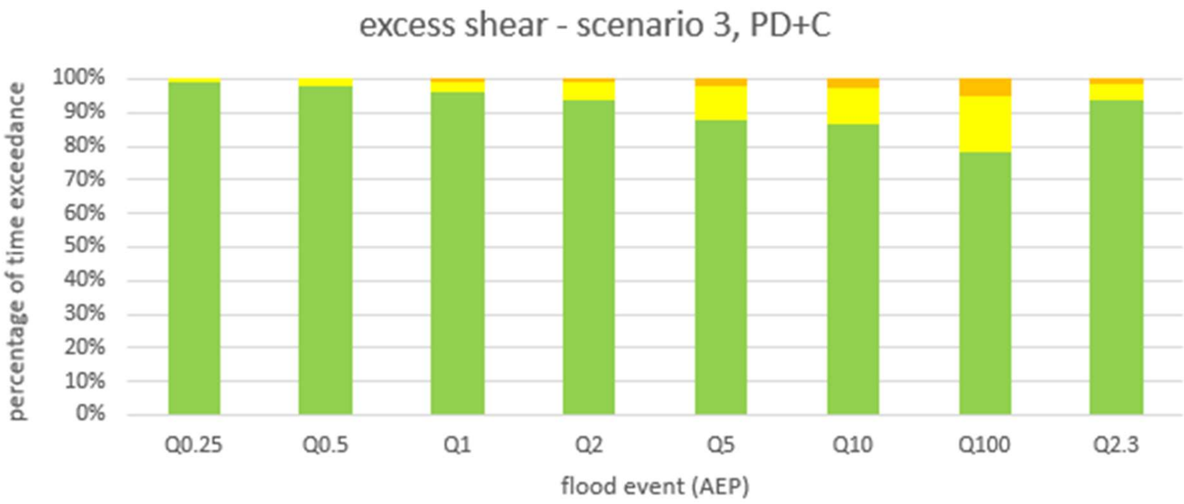
In conclusion, the stream erosion risk is highly unlikely to be exacerbated by the development of the PCA based on the EST results and the Stream Conditions Assessment. The proposed stormwater management for the PCA includes SMAF mitigation which would further reduce the impact of the plan change on the stream erosion risk.

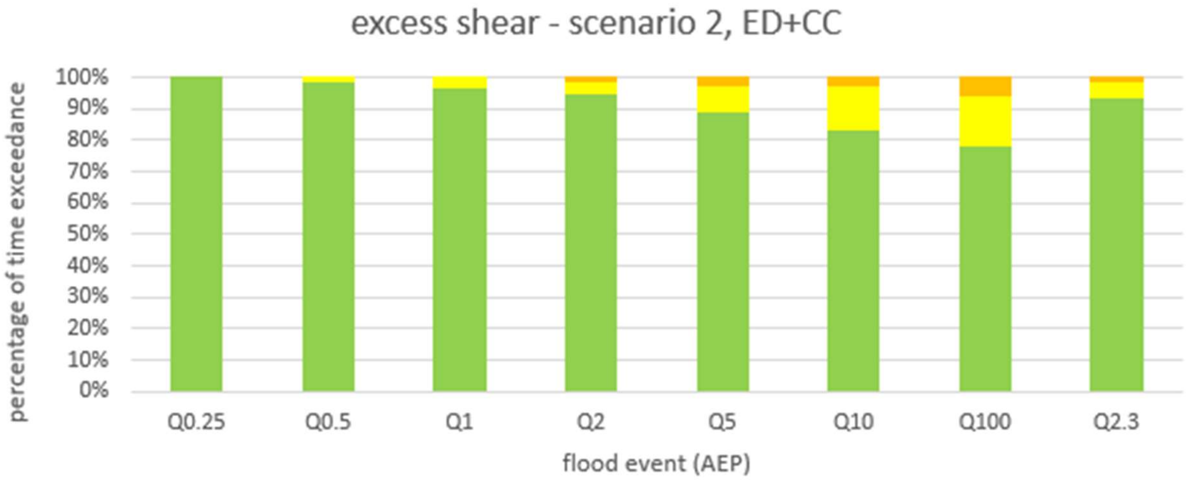
Distribution: **Neil Construction Limited, Auckland Council**

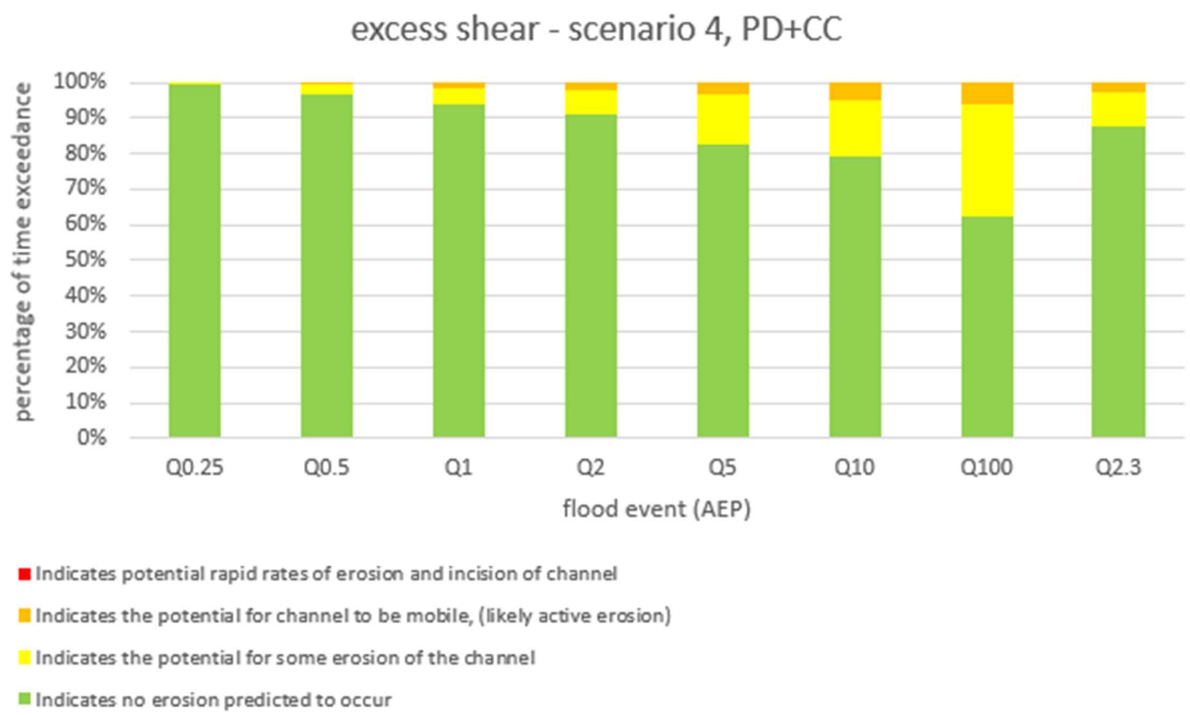
Our Office: **Henderson**

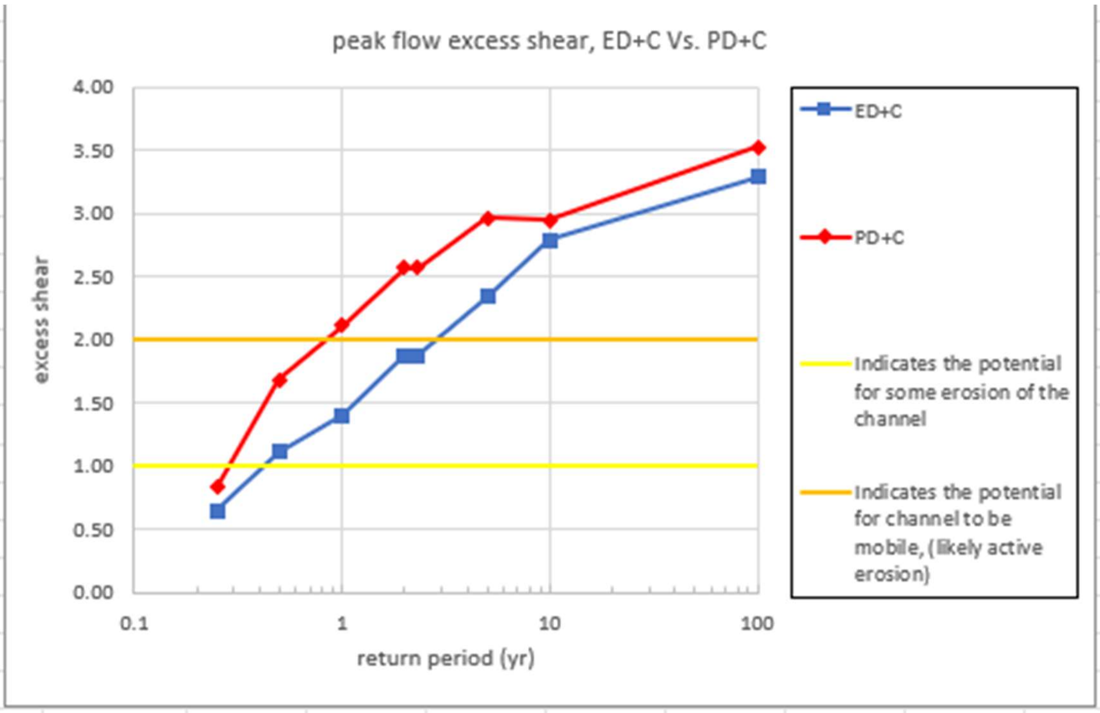
Location 1								
return period (yr)	0.25	0.5	1	2	2.30	5	10	100
Scenario 1 ED+C								
boundary shear stress at peak (N/m2)	21.21	36.43	45.75	61.22	61.22	76.29	90.88	107.21
excess shear at peak	0.65	1.12	1.40	1.88	1.88	2.34	2.79	3.29
excess shear excedence (min)								
<1 (min)	1440	1430	1410	1390	1390	1350	1290	1200
>1 & <2 (min)	0	10	30	50	40	70	130	200
>2 & <10 (min)	0	0	0	0	10	20	20	40
>10 (min)	0	0	0	0	0	0	0	0
Scenario 2 ED+CC								
boundary shear stress at peak (N/m2)	21.21	45.75	61.22	83.66	83.66	90.53	107.21	134.03
excess shear at peak	0.65	1.40	1.88	2.57	2.57	2.78	3.29	4.11
excess shear excedence (min)								
<1 (min)	1440	1420	1390	1360	1340	1280	1200	1120
>1 & <2 (min)	0	20	50	60	80	120	200	230
>2 & <10 (min)	0	0	0	20	20	40	40	90
>10 (min)	0	0	0	0	0	0	0	0
Scenario 3 PD+C								
boundary shear stress at peak (N/m2)	27.01	54.94	68.81	83.66	83.66	96.52	96.17	115.03
excess shear at peak	0.83	1.69	2.11	2.57	2.57	2.96	2.95	3.53
excess shear excedence (min)								
<1 (min)	1430	1410	1380	1350	1350	1260	1250	1130
>1 & <2 (min)	10	30	50	80	70	150	150	240
>2 & <10 (min)	0	0	10	10	20	30	40	70
>10 (min)	0	0	0	0	0	0	0	0
Scenario 4 PD+CC								
boundary shear stress at peak (N/m2)	36.43	61.22	83.66	90.53	96.17	112.60	115.03	137.10
excess shear at peak	1.12	1.88	2.57	2.78	2.95	3.45	3.53	4.21
excess shear excedence (min)								
<1 (min)	1430	1390	1350	1310	1260	1190	1140	900
>1 & <2 (min)	10	40	70	100	140	200	230	450
>2 & <10 (min)	0	10	20	30	40	50	70	90
>10 (min)	0	0	0	0	0	0	0	0

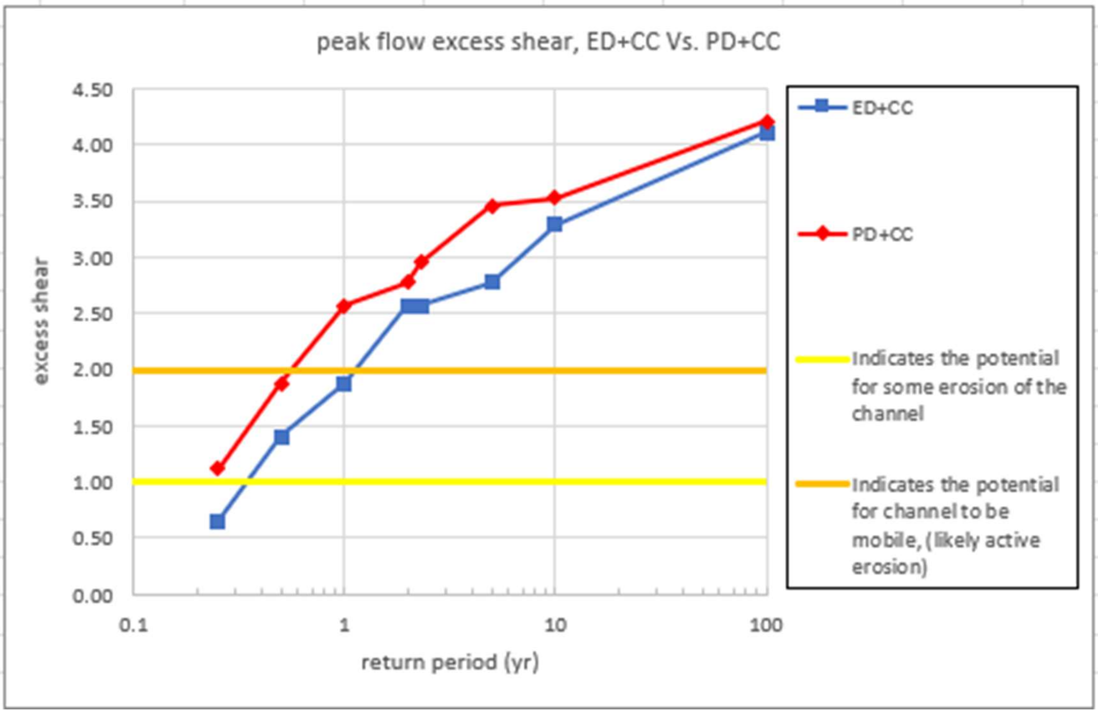



excess shear - scenario 3, PD+C
percentage of time exceedance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Q0.25
Q0.5
Q1
Q2
Q5
Q10
Q100
Q2.3
flood event (AEP)


excess shear - scenario 2, ED+CC
percentage of time exceedance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Q0.25
Q0.5
Q1
Q2
Q5
Q10
Q100
Q2.3
flood event (AEP)

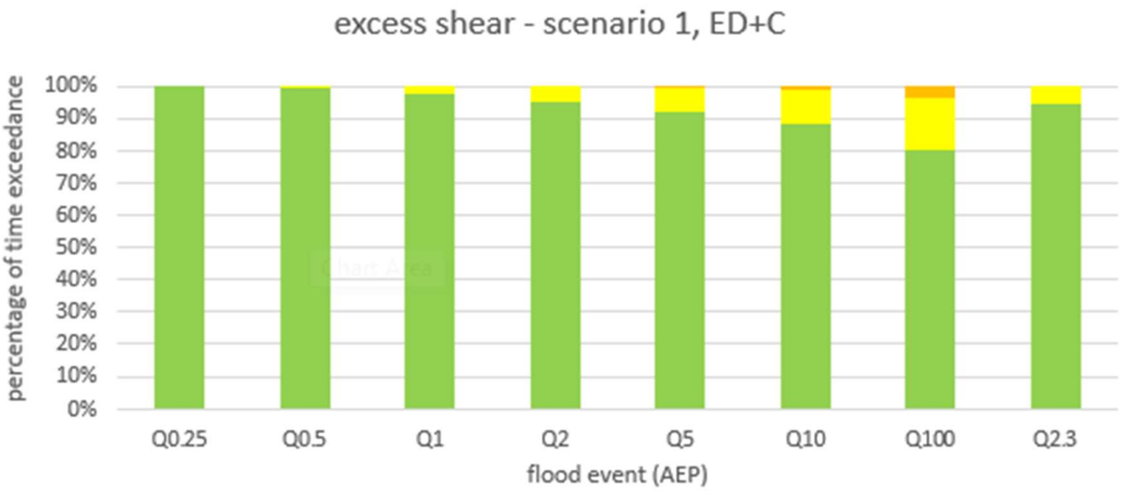

excess shear - scenario 4, PD+CC
percentage of time exceedance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Q0.25
Q0.5
Q1
Q2
Q5
Q10
Q100
Q2.3
flood event (AEP)
Indicates potential rapid rates of erosion and incision of channel
Indicates the potential for channel to be mobile, (likely active erosion)
Indicates the potential for some erosion of the channel
Indicates no erosion predicted to occur

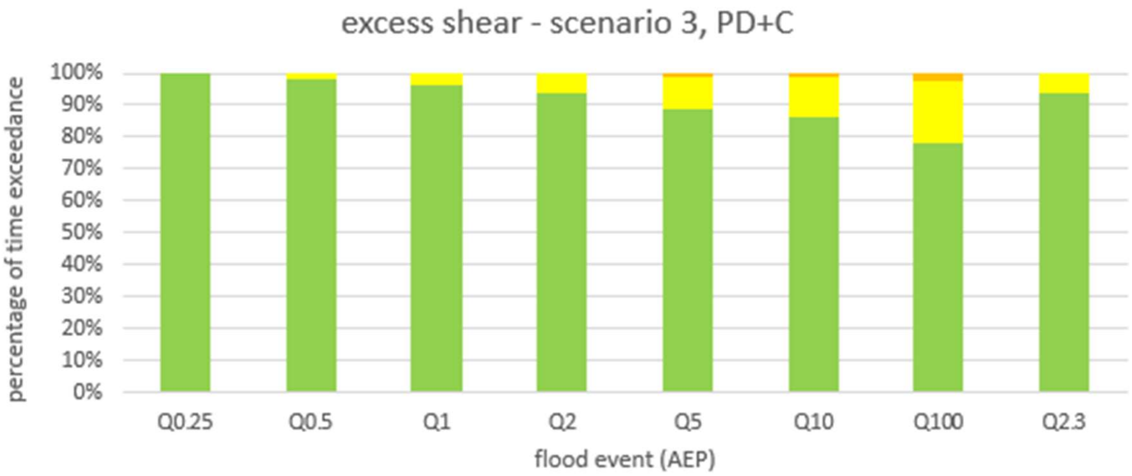

peak flow excess shear, ED+C Vs. PD+C
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
excess shear
0.1
1
10
100
return period (yr)
ED+C
PD+C
Indicates the potential for some erosion of the channel
Indicates the potential for channel to be mobile, (likely active erosion)

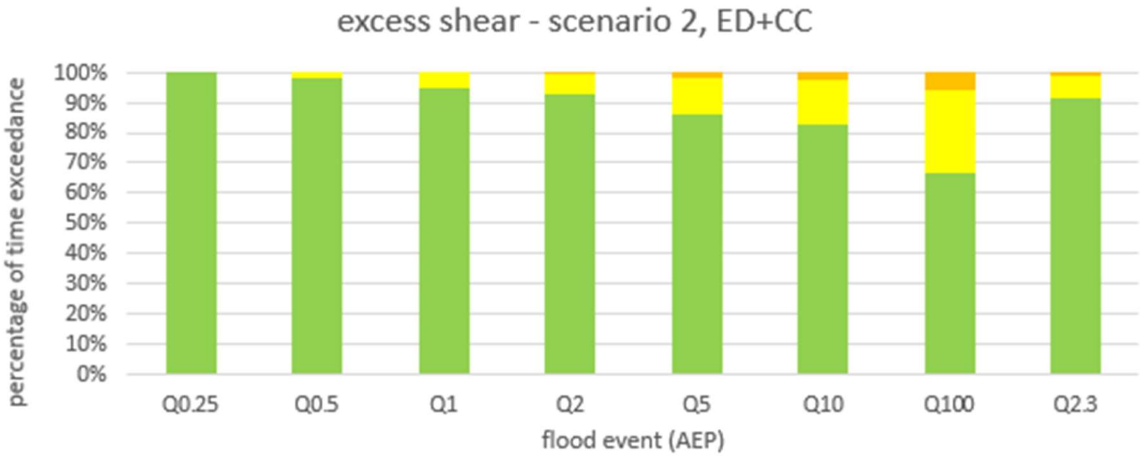

peak flow excess shear, ED+CC Vs. PD+CC
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
excess shear
0.1
1
10
100
return period (yr)
ED+CC
PD+CC
Indicates the potential for some erosion of the channel
Indicates the potential for channel to be mobile, (likely active erosion)

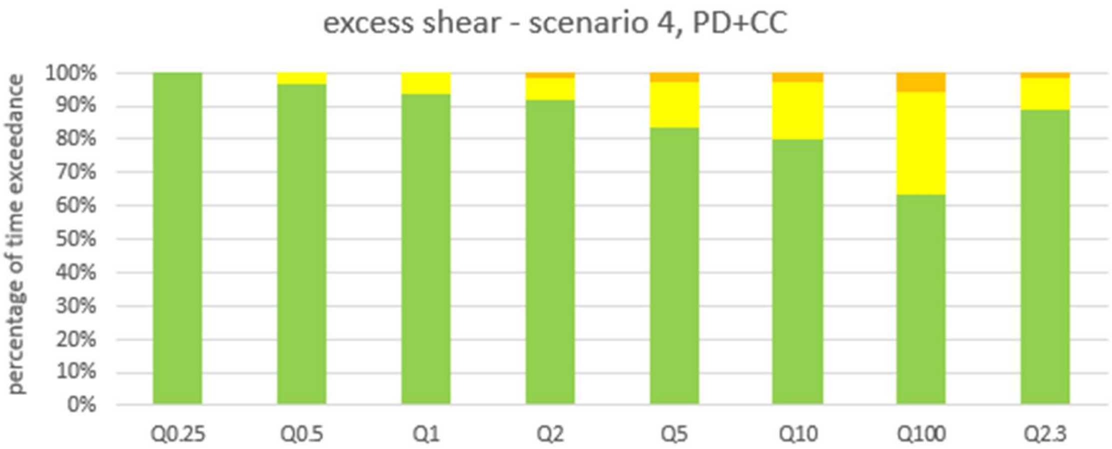
Location 2

return period (yr)	0.25	0.5	1	2	2.30	5	10	100
Scenario 1 ED+C								
boundary shear stress at peak (N/m2)	21.62	33.97	45.33	54.07	58.43	65.71	71.49	88.38
excess shear at peak	0.66	1.04	1.39	1.66	1.79	2.02	2.19	2.71
excess shear excedence (min)								
<1 (min)	1440	1430	1400	1370	1360	1320	1270	1150
>1 & <2 (min)	0	10	40	70	80	110	150	240
>2 & <10 (min)	0	0	0	0	0	10	20	50
>10 (min)	0	0	0	0	0	0	0	0
Scenario 2 ED+CC								
boundary shear stress at peak (N/m2)	23.83	43.51	58.43	67.84	69.66	79.73	86.08	104.63
excess shear at peak	0.73	1.33	1.79	2.08	2.14	2.45	2.64	3.21
excess shear excedence (min)								
<1 (min)	1440	1410	1370	1340	1320	1240	1190	960
>1 & <2 (min)	0	30	70	90	100	170	210	400
>2 & <10 (min)	0	0	0	10	20	30	40	80
>10 (min)	0	0	0	0	0	0	0	0
Scenario 3 PD+C								
boundary shear stress at peak (N/m2)	27.70	41.23	54.56	59.60	64.07	71.49	77.70	92.62
excess shear at peak	0.85	1.26	1.67	1.83	1.97	2.19	2.38	2.84
excess shear excedence (min)								
<1 (min)	1440	1410	1390	1350	1350	1280	1240	1120
>1 & <2 (min)	0	30	50	90	90	140	180	280
>2 & <10 (min)	0	0	0	0	0	20	20	40
>10 (min)	0	0	0	0	0	0	0	0
Scenario 4 PD+CC								
boundary shear stress at peak (N/m2)	29.07	50.23	61.84	73.73	75.64	86.08	92.62	106.95
excess shear at peak	0.89	1.54	1.90	2.26	2.32	2.64	2.84	3.28
excess shear excedence (min)								
<1 (min)	1440	1390	1350	1320	1280	1200	1150	910
>1 & <2 (min)	0	50	90	100	140	200	250	450
>2 & <10 (min)	0	0	0	20	20	40	40	80
>10 (min)	0	0	0	0	0	0	0	0

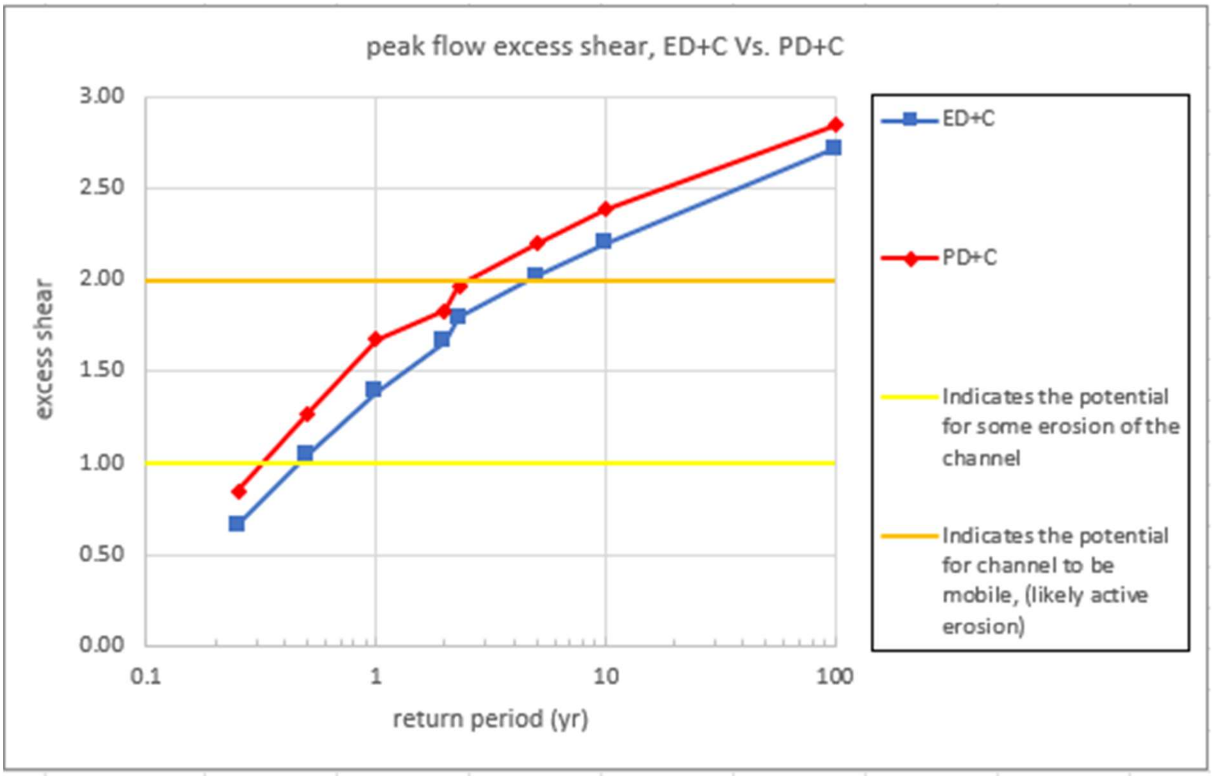


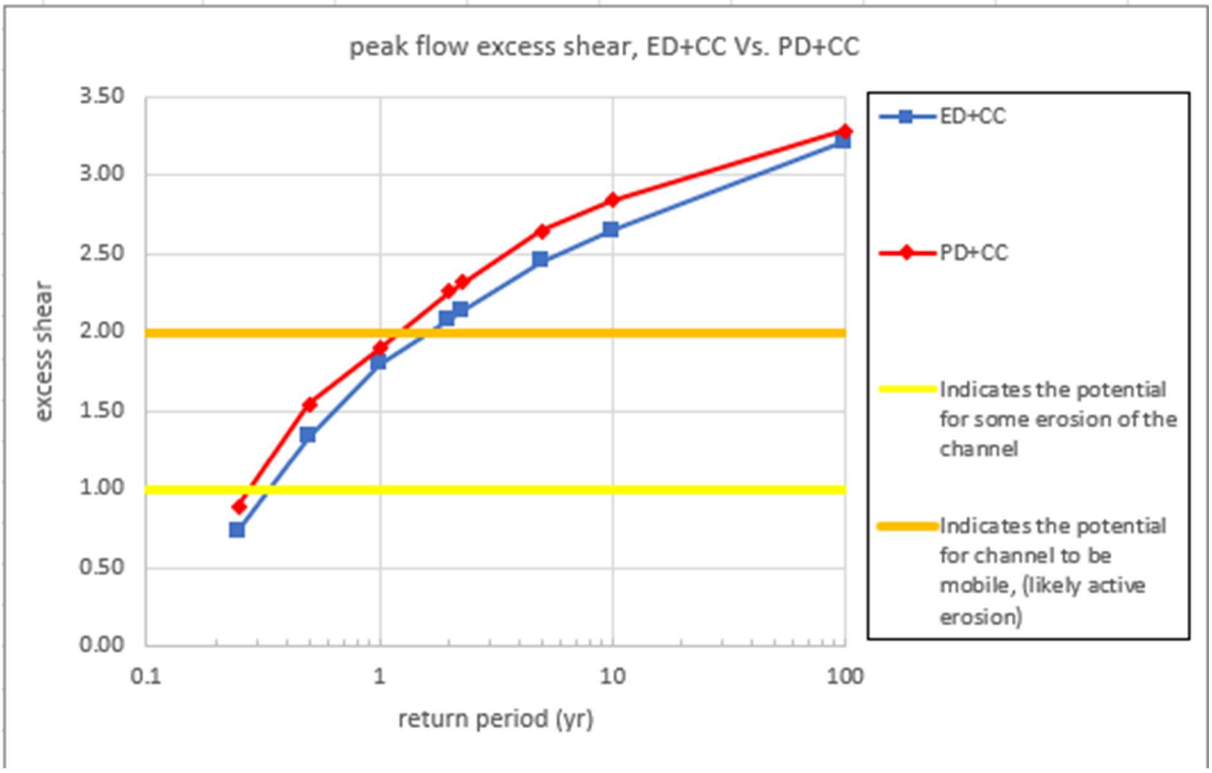






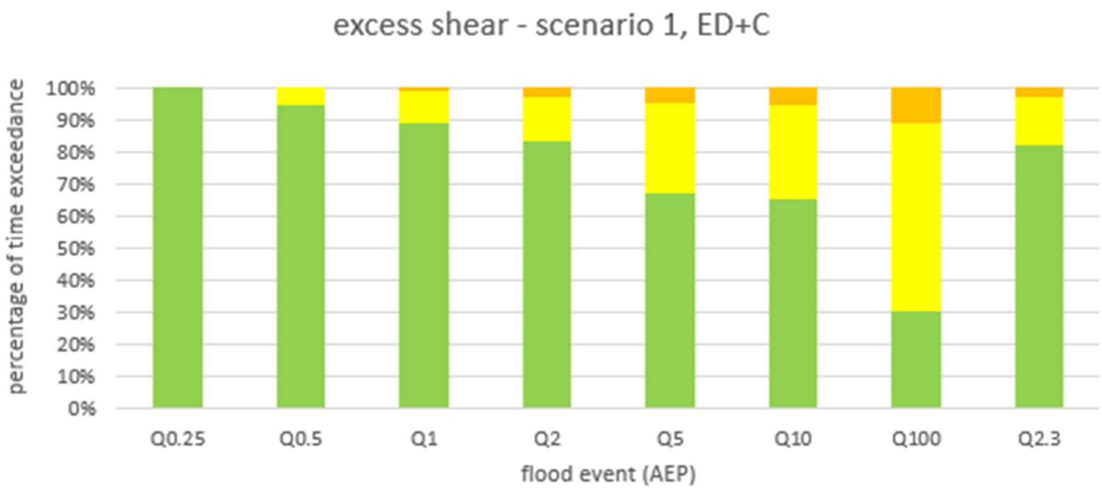
- Indicates potential rapid rates of erosion and incision of channel
- Indicates the potential for channel to be mobile, (likely active erosion)
- Indicates the potential for some erosion of the channel
- Indicates no erosion predicted to occur

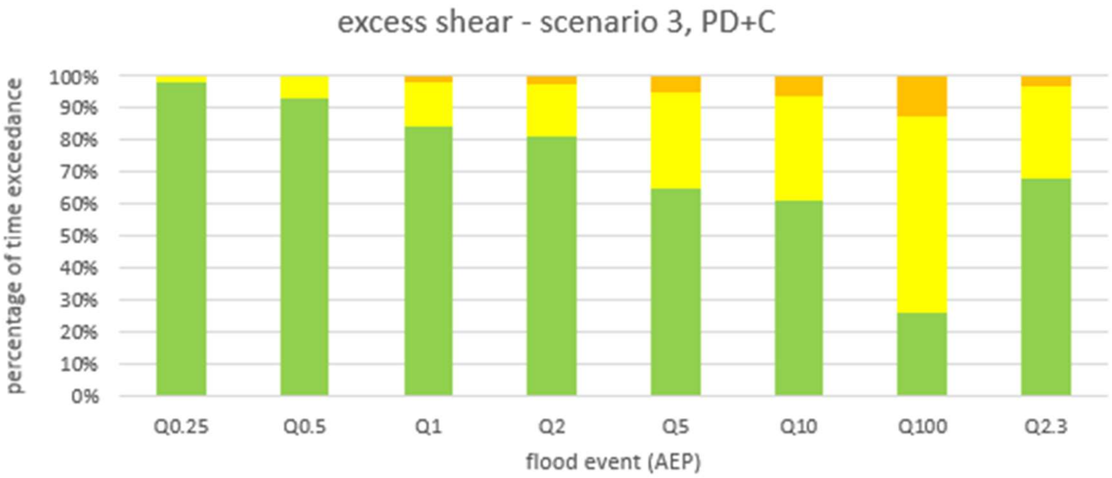

peak flow excess shear, ED+C Vs. PD+C
3.00
2.50
2.00
1.50
1.00
0.50
0.00
excess shear
0.1
1
10
100
return period (yr)
ED+C
PD+C
Indicates the potential for some erosion of the channel
Indicates the potential for channel to be mobile, (likely active erosion)

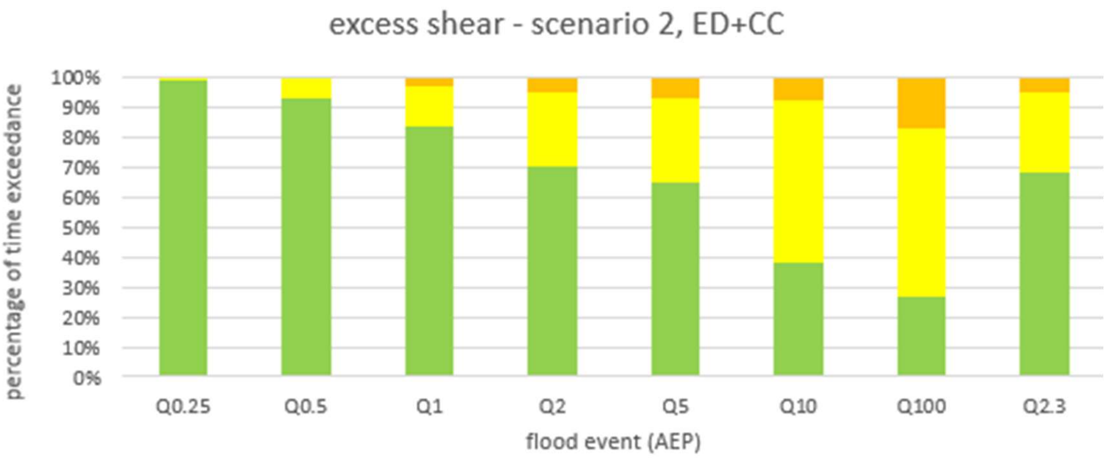

peak flow excess shear, ED+CC Vs. PD+CC
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
excess shear
0.1
1
10
100
return period (yr)
ED+CC
PD+CC
Indicates the potential for some erosion of the channel
Indicates the potential for channel to be mobile, (likely active erosion)

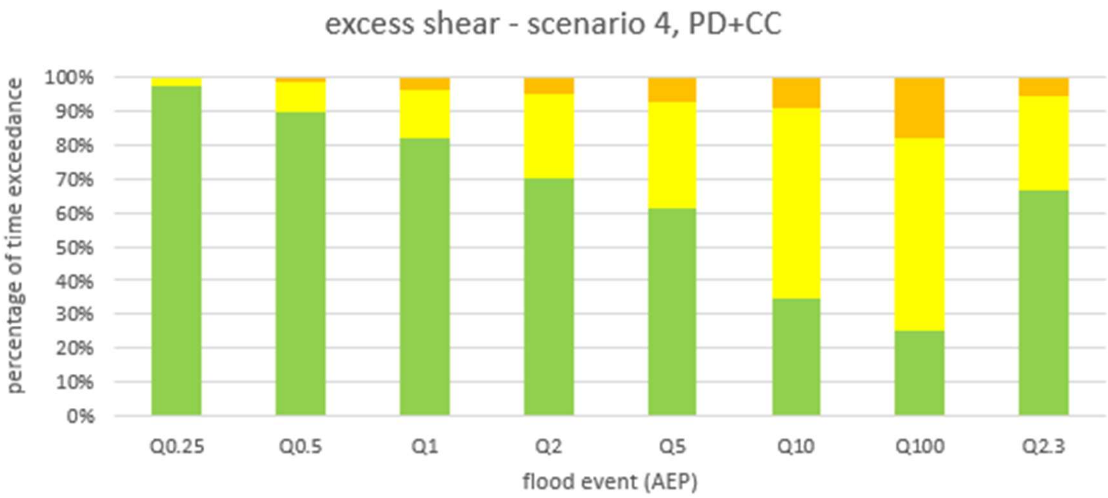
Location 3

return period (yr)	0.25	0.5	1	2	2.30	5	10	100
Scenario 1 ED+C								
boundary shear stress at peak (N/m2	32.10	51.99	67.05	78.10	75.07	87.30	92.10	112.92
excess shear at peak	0.98	1.59	2.06	2.40	2.30	2.68	2.83	3.46
excess shear excedence (min)								
<1 (min)	1440	1360	1280	1200	1180	970	940	440
>1 & <2 (min)	0	80	150	200	220	400	420	840
>2 & <10 (min)	0	0	10	40	40	70	80	160
>10 (min)	0	0	0	0	0	0	0	0
Scenario 2 ED+CC								
boundary shear stress at peak (N/m2	36.58	64.29	75.07	87.30	88.59	102.33	109.56	133.23
excess shear at peak	1.12	1.97	2.30	2.68	2.72	3.14	3.36	4.09
excess shear excedence (min)								
<1 (min)	1430	1340	1210	1010	980	940	550	390
>1 & <2 (min)	10	100	190	360	390	400	780	810
>2 & <10 (min)	0	0	40	70	70	100	110	240
>10 (min)	0	0	0	0	0	0	0	0
Scenario 3 PD+C								
boundary shear stress at peak (N/m2	38.06	61.70	74.99	86.03	86.59	92.10	98.58	116.50
excess shear at peak	1.17	1.89	2.30	2.64	2.66	2.83	3.02	3.57
excess shear excedence (min)								
<1 (min)	1410	1340	1210	1170	980	930	880	370
>1 & <2 (min)	30	100	200	230	410	440	470	890
>2 & <10 (min)	0	0	30	40	50	70	90	180
>10 (min)	0	0	0	0	0	0	0	0
Scenario 4 PD+CC								
boundary shear stress at peak (N/m2	45.45	73.76	84.13	95.58	102.40	109.56	116.50	142.25
excess shear at peak	1.39	2.26	2.58	2.93	3.14	3.36	3.57	4.36
excess shear excedence (min)								
<1 (min)	1400	1290	1180	1010	960	880	500	360
>1 & <2 (min)	40	130	210	360	400	460	810	820
>2 & <10 (min)	0	20	50	70	80	100	130	260
>10 (min)	0	0	0	0	0	0	0	0









- Indicates potential rapid rates of erosion and incision of channel
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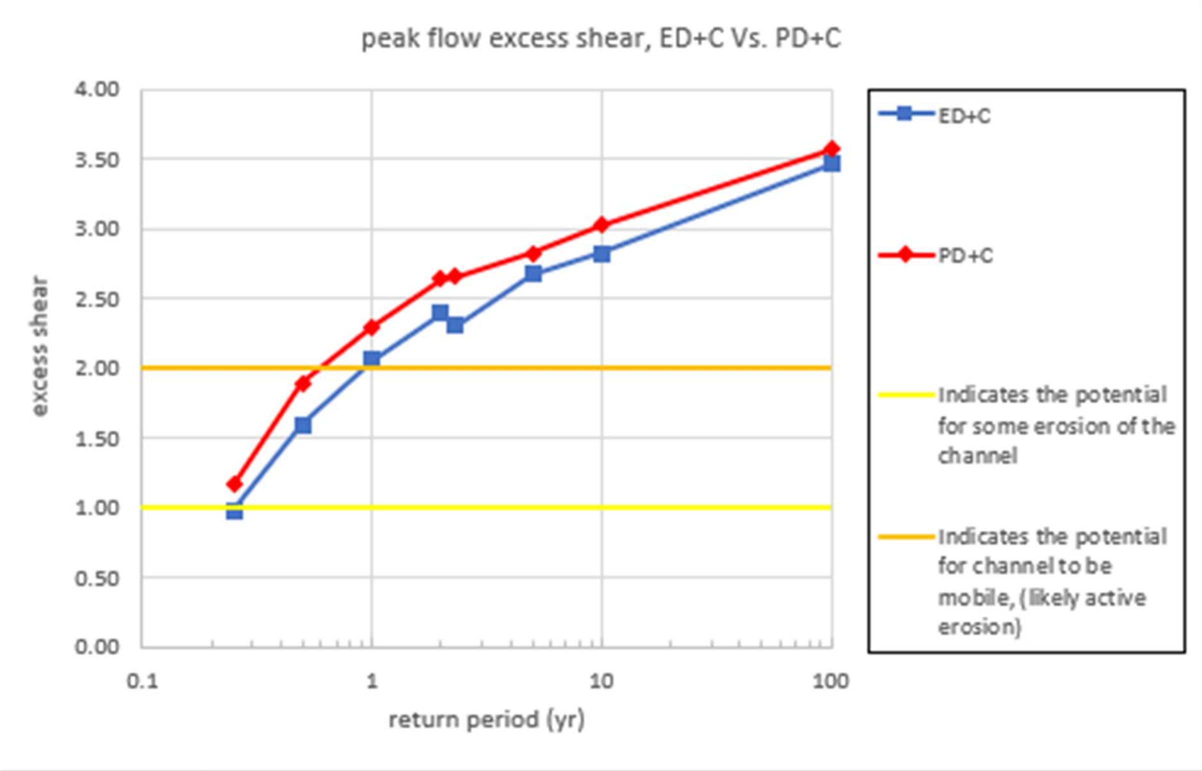
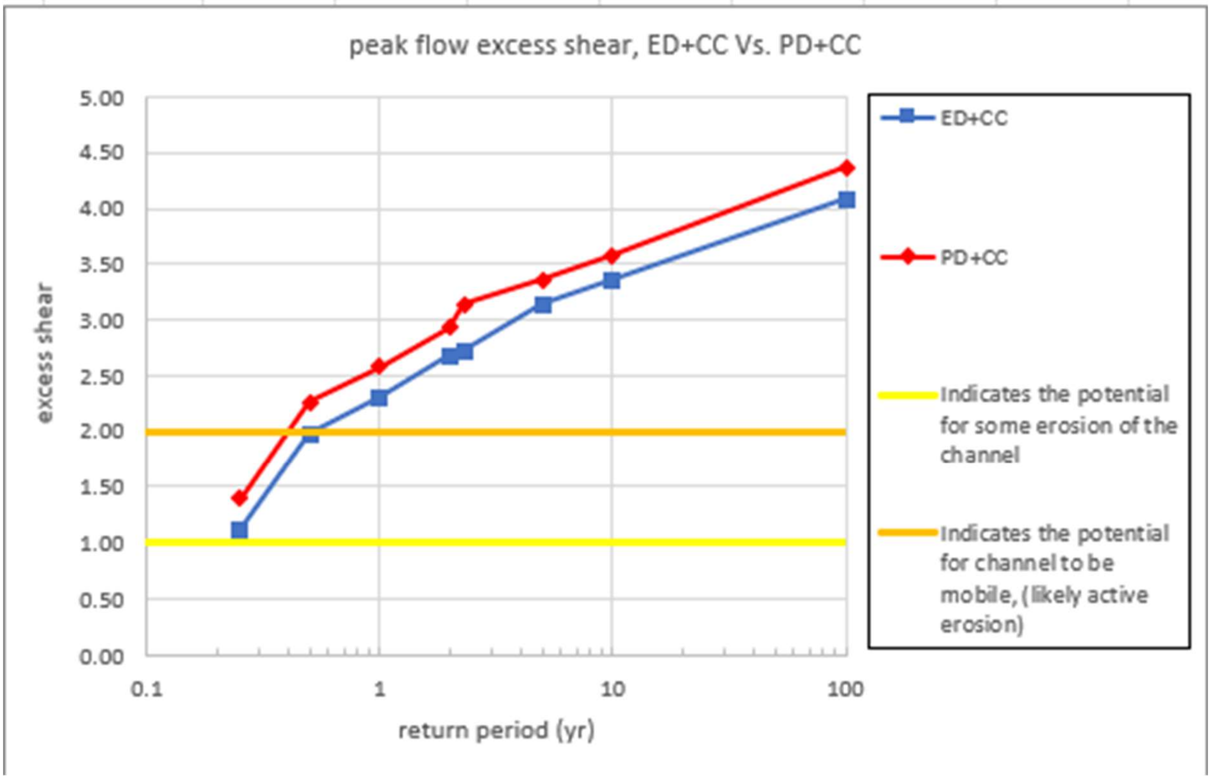
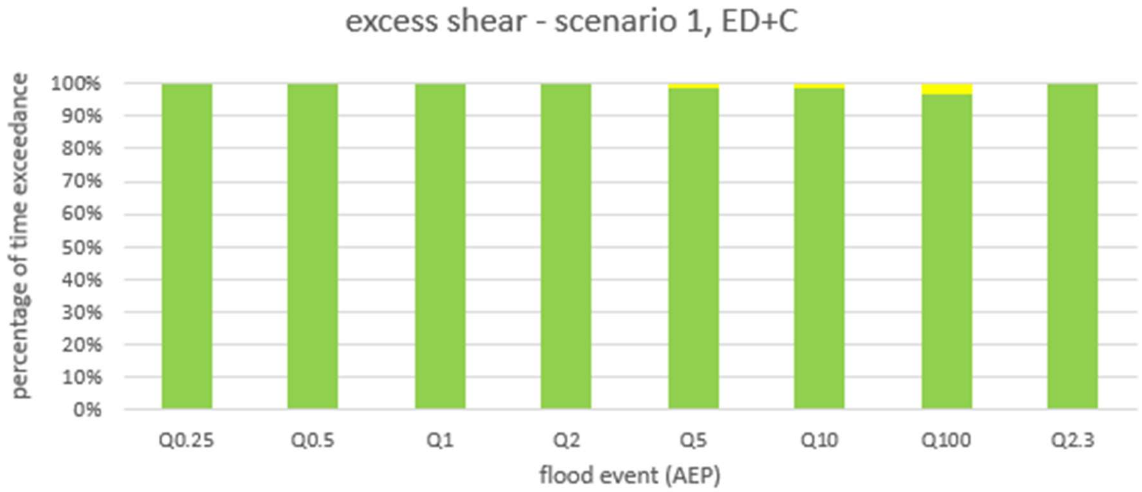
- Indicates the potential for some erosion of the channel
- Indicates no erosion predicted to occur

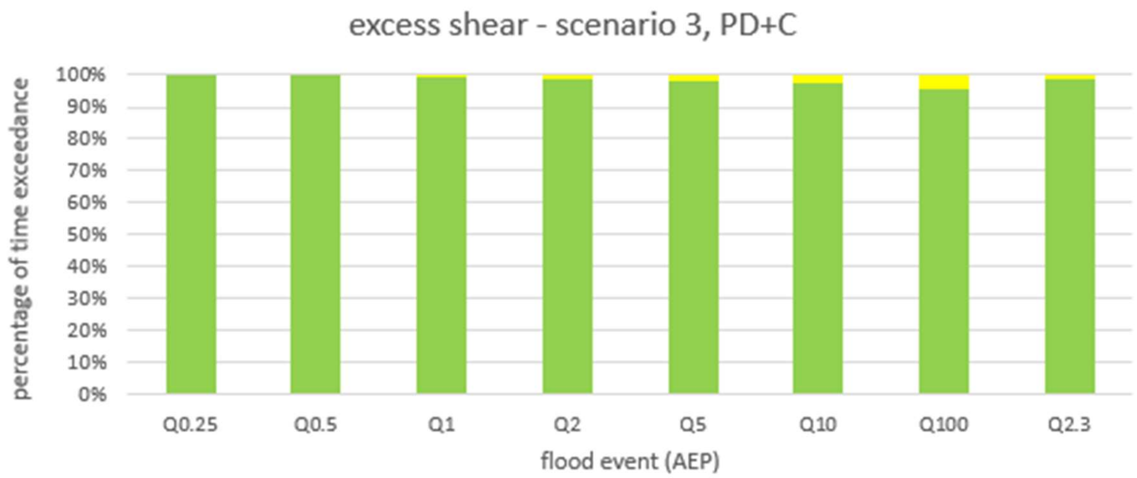

peak flow excess shear, ED+C Vs. PD+C
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
excess shear
0.1
1
10
100
return period (yr)
ED+C
PD+C
Indicates the potential for some erosion of the channel
Indicates the potential for channel to be mobile, (likely active erosion)

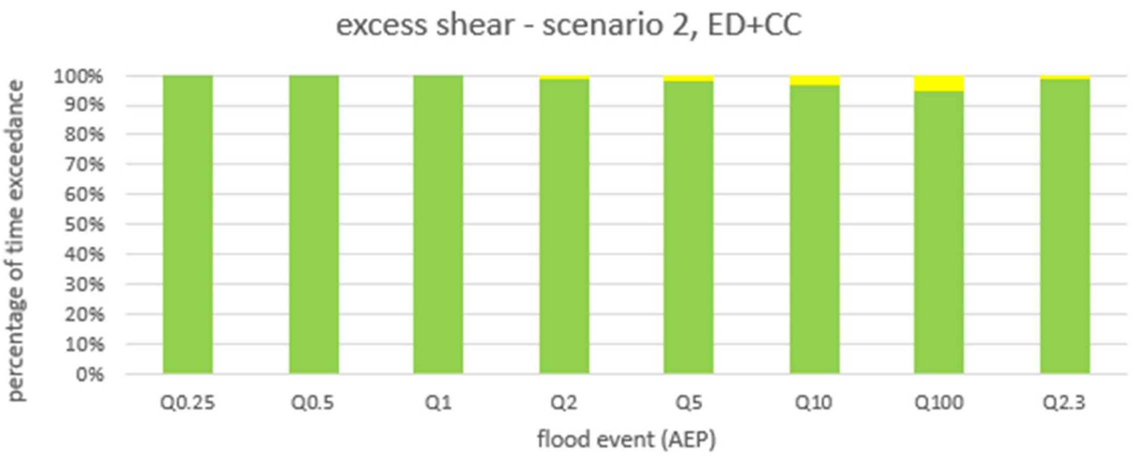

peak flow excess shear, ED+CC Vs. PD+CC
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
excess shear
0.1
1
10
100
return period (yr)
ED+CC
PD+CC
Indicates the potential for some erosion of the channel
Indicates the potential for channel to be mobile, (likely active erosion)

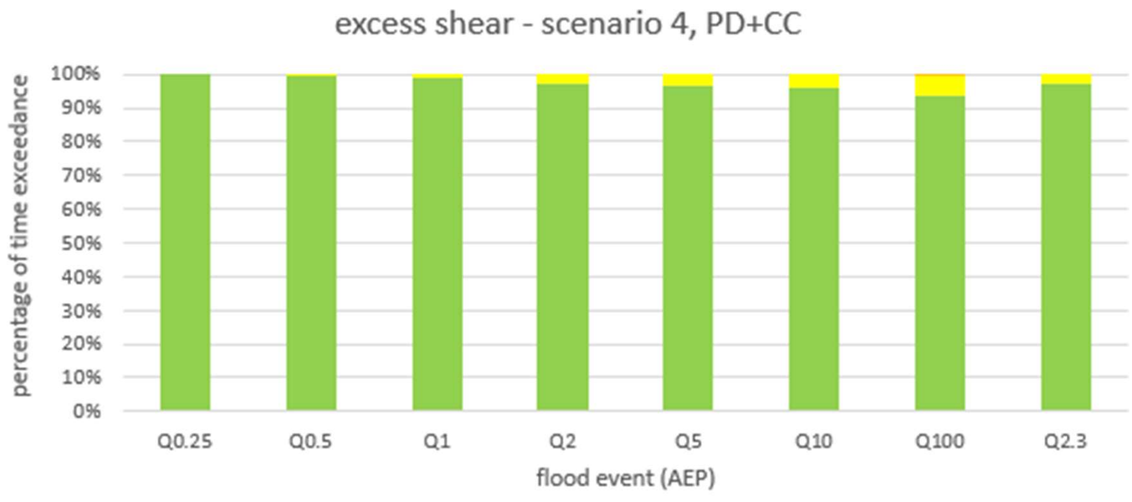
Location 4

return period (yr)	0.25	0.5	1	2	2.30	5	10	100
Scenario 1 ED+C								
boundary shear stress at peak (N/m2	9.90	14.71	23.28	27.71	27.71	33.57	39.22	49.89
excess shear at peak	0.30	0.45	0.71	0.85	0.85	1.03	1.20	1.53
excess shear excedence (min)								
<1 (min)	1440	1440	1440	1440	1440	1420	1420	1390
>1 & <2 (min)	0	0	0	0	0	20	20	50
>2 & <10 (min)	0	0	0	0	0	0	0	0
>10 (min)	0	0	0	0	0	0	0	0
Scenario 2 ED+CC								
boundary shear stress at peak (N/m2	9.90	20.83	27.71	33.57	36.30	44.34	47.06	60.48
excess shear at peak	0.30	0.64	0.85	1.03	1.11	1.36	1.44	1.86
excess shear excedence (min)								
<1 (min)	1440	1440	1440	1420	1420	1410	1390	1360
>1 & <2 (min)	0	0	0	20	20	30	50	80
>2 & <10 (min)	0	0	0	0	0	0	0	0
>10 (min)	0	0	0	0	0	0	0	0
Scenario 3 PD+C								
boundary shear stress at peak (N/m2	19.50	27.71	33.57	36.30	39.22	44.34	47.06	55.57
excess shear at peak	0.60	0.85	1.03	1.11	1.20	1.36	1.44	1.70
excess shear excedence (min)								
<1 (min)	1440	1440	1430	1420	1420	1410	1400	1380
>1 & <2 (min)	0	0	10	20	20	30	40	60
>2 & <10 (min)	0	0	0	0	0	0	0	0
>10 (min)	0	0	0	0	0	0	0	0
Scenario 4 PD+CC								
boundary shear stress at peak (N/m2	20.83	32.50	39.22	44.34	47.06	54.86	55.57	67.96
excess shear at peak	0.64	1.00	1.20	1.36	1.44	1.68	1.70	2.08
excess shear excedence (min)								
<1 (min)	1440	1430	1420	1400	1400	1390	1380	1350
>1 & <2 (min)	0	10	20	40	40	50	60	80
>2 & <10 (min)	0	0	0	0	0	0	0	10
>10 (min)	0	0	0	0	0	0	0	0







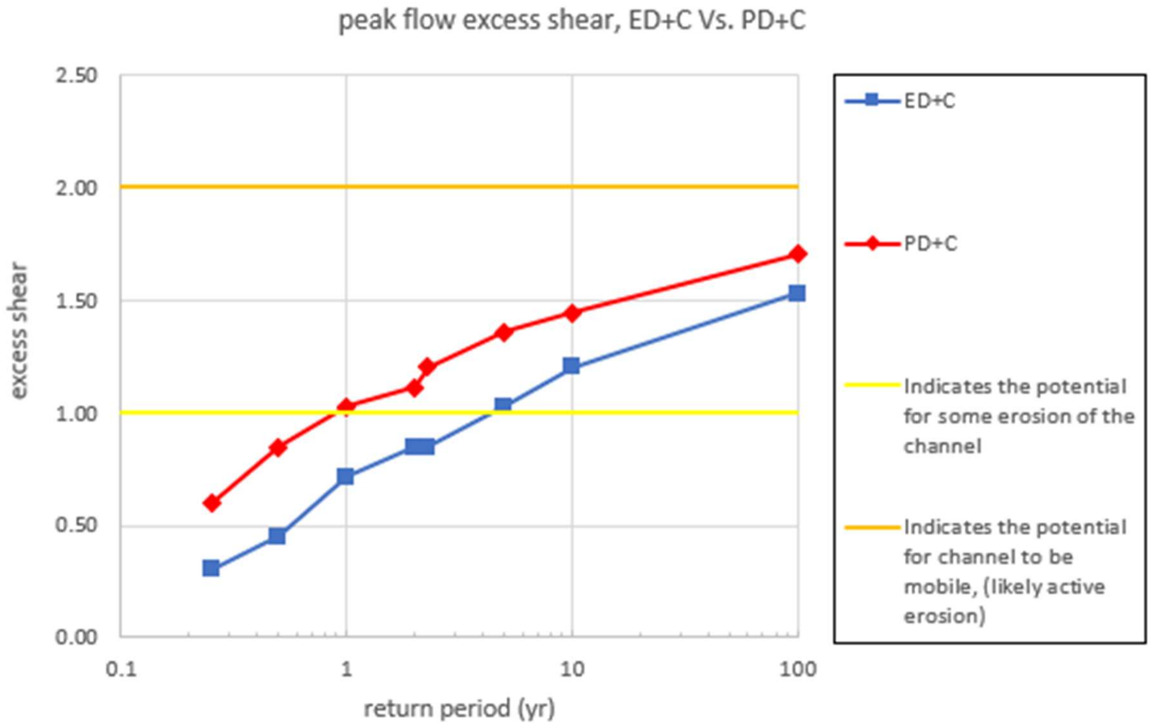


Indicates potential rapid rates of erosion and incision of channel

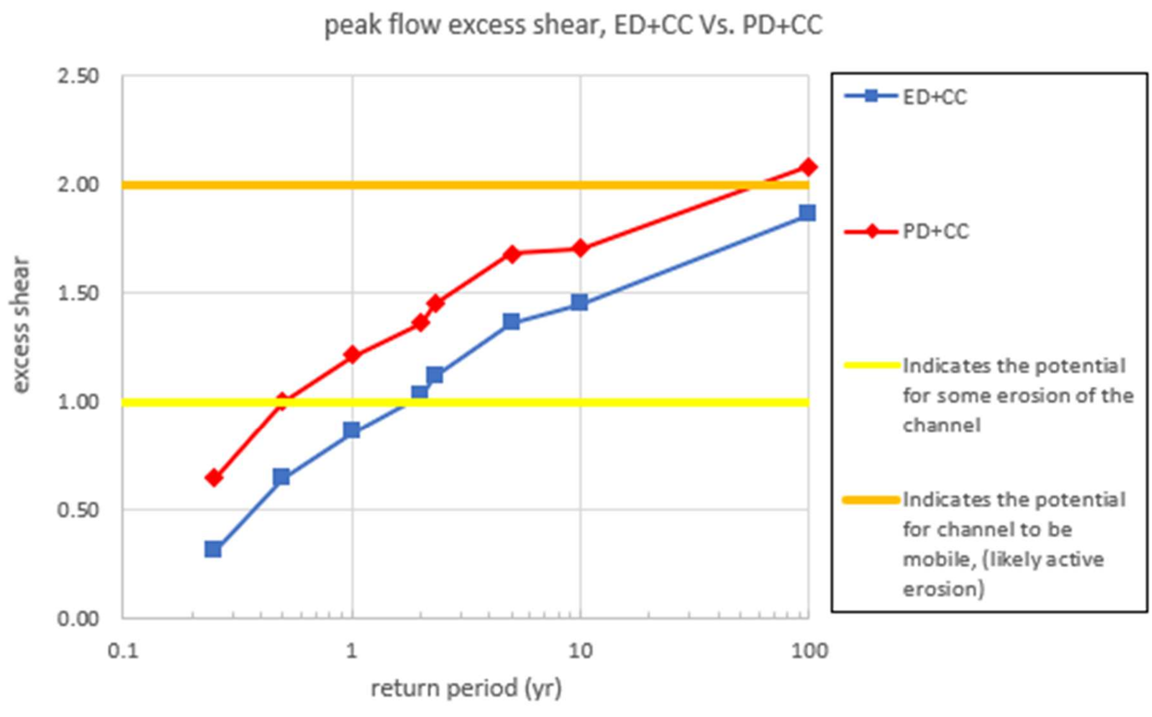
Indicates the potential for channel to be mobile, (likely active erosion)

Indicates the potential for some erosion of the channel

Indicates no erosion predicted to occur



peak flow excess shear, ED+C Vs. PD+C
excess shear
return period (yr)
2.50
2.00
1.50
1.00
0.50
0.00
0.1
1
10
100
ED+C
PD+C
Indicates the potential for some erosion of the channel
Indicates the potential for channel to be mobile, (likely active erosion)



peak flow excess shear, ED+CC Vs. PD+CC
excess shear
return period (yr)
2.50
2.00
1.50
1.00
0.50
0.00
0.1
1
10
100
ED+CC
PD+CC
Indicates the potential for some erosion of the channel
Indicates the potential for channel to be mobile, (likely active erosion)

TO:	Todd Elder	Date:	11 April 2024
	Auckland Council		
COPY TO:	Matt Ashworth, Trevor Canty (Neil Group Ltd)	Document No:	10139-003-1
FROM:	Annabelle Coates		

WHENUAPAI BUSINESS PARK – STREAM CONDITION ASSESSMENT

Introduction

Neil Construction Limited is applying to Auckland Council for a Private Plan Change (PPC) to rezone the land at 141-159 Brigham Creek Road and 69, 71, 73, 94, 96 and 96a Trig Road, Whenuapai ('the site'). The PPC seeks to rezone approximately 47 ha of land from Future Urban Zone to Business - Light Industry Zone in an integrated and comprehensive manner.

Auckland Council requested further information under s92 of the Resource Management Act (1991) regarding stream erosion and the ability of the stream bed and banks to withstand any changes in the hydrological regime that may result from the change in land use.

The contents of this memorandum provide a condition assessment of the permanent and intermittent stream within the site. It is intended to partially fulfil the s92 requirement.

Methodology

The site was visited on 8 April 2024. The site visit partially replicated a watercourse survey that was prepared for Neil Construction Limited in 2020. The 2020 survey provided photo points at various stages along the watercourses and provided a physical survey of the channels, including widths at periodic locations. The author of this memo (who also completed the site work) has previously completed extensive open waterway condition assessments (approx. 100 km), including identifying and quantifying faults, damage, lining materials, and drainage values.

The 2020 physical survey was not repeated. The survey photo points were revisited with new photos taken during April 2024. Each photo point was replicated as closely as possible. Exact replication was not always possible. During the 2020 survey the stream appeared to be largely dry, while water was present within the channel along much of the permanent reach during the 2024 survey.

Any obvious areas of damage, such as scour, erosion, and bank collapse were noted, along with general comments about the condition of the channel, including the state of vegetation.

Condition Assessment

A plan showing photo points is provided in Attachment A. Where possible, the 2020 and 2024 photos are presented side by side, with commentary provided below each.

Photo point C

2020 **2024**

Photo point C was located near the upstream extent of the watercourse. The channel was represented by a formed, but shallow depression. Leaf litter and debris was present on the base suggesting no recent flushing flows. No significant changes in the reach of stream were observed with the exception of continued growth of vegetation. Exotic weeds such as woolly nightshade and privet were abundant and appeared to be more prolific than during the 2020 survey. Channel form was largely unchanged despite the significant flood event in 2023.

Photo point E1

2020 **2024**

Photo point E1 was located directly south of the Spark NZ facility on Brigham Creek Road. The channel was moderately incised during both the 2020 and 2024 surveys. There were no significant changes in channel condition, despite the significant 2023 flood event. Vegetation growth along the channel banks had increased, likely due to the removal of grazing stock.

Photo point H2

2020

2024

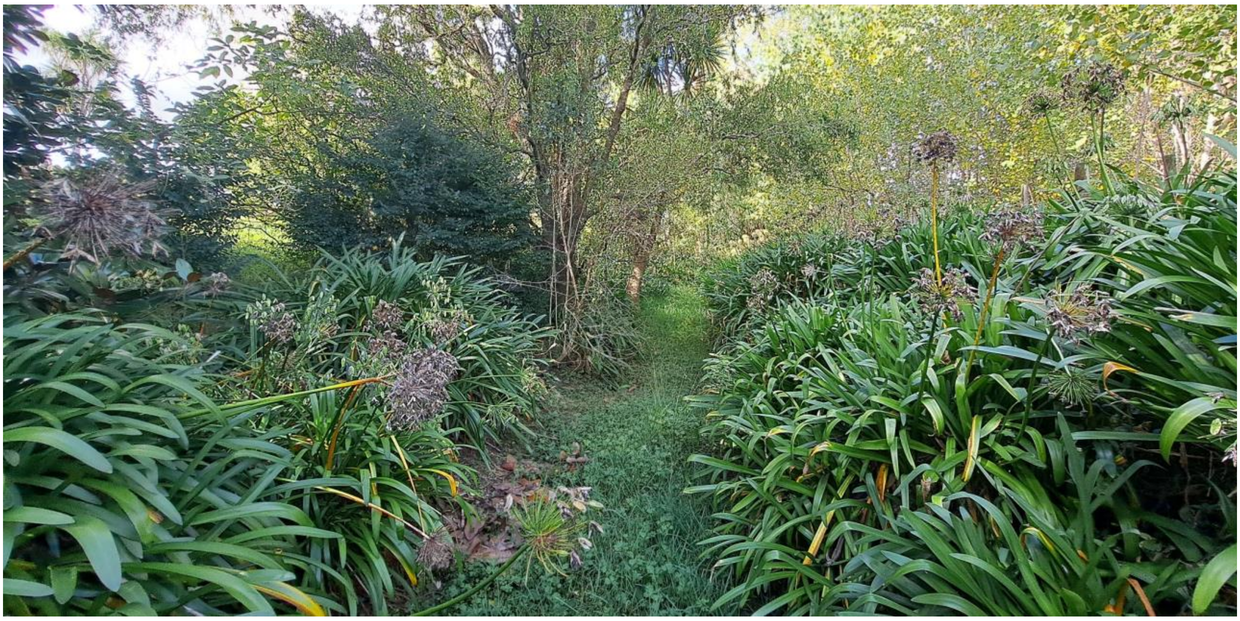


Photo point H2 was located in what would have been the front garden of the main house at 151 Brigham Creek Road, which has been demolished. There were no significant changes in the channel or banks, despite the 2023 flood event. The channel was defined and not incised. During both surveys, the channel contained terrestrial vegetation, indicating it is not regularly inundated. The banks were characterised by abundant agapanthus, along with other garden and ornamental plants and trees.

Photo point K

2020

2024

Photo point K was located looking upstream, towards the culvert (indicated by the red arrows) that would have provided access to the main house at 151 Brigham Creek Road (now demolished). The channel was ill defined, and occupied a shallow vegetated depression. During both surveys the channel was entirely filled with leaf litter, suggesting no flushing flows. There was no evidence of scour or erosion, including around the culvert. Pest plants such as agapanthus and arum lily were abundant during both surveys.

Photo point L

2020

2024

Photo point L could not be perfectly replicated due to the presence of water. It was located looking upstream, towards the upstream end of the artificial pond located at the confluence of the two main intermittent channels. The banks were well defined, as expected of a constructed pond. There was no undercutting, scour or areas of obvious erosion, despite water being present during 2024, but not during 2020. The perimeter of the pond was stable, likely the result of the significant vegetation in the immediate surrounds.

Photo point L3

2020 **2024**

Photo point L3 was located on the intermittent tributary that flows from the stormwater pond within the airbase on the opposite side of Brigham Creek Road. The watercourse was ill defined. The main difference between the two surveys was the proliferation of vegetation, including mixed pasture grasses, blackberry and pampas, attributable to the removal of stock from the paddock. The 2020 survey yielded significant pugging on this reach, however no pugging was observed during 2024, due to the lack of stock. The watercourse was considered to be more stable in 2024, despite the significant floods experienced in 2023, likely due to the removal of stock from the paddocks.

Photo point M

2020 **2024**

Photo point M was located at the downstream end of the artificial pond. The photo point could not be replicated due to the presence of water within the pond. The 2020 image was taken from within the pond when it was dry. Despite not being able to replicate the photo, the banks of the pond were observed. No evidence of scour, erosion or bank undercutting were observed, suggesting the outlet of the pond was stable, despite the significant floods that occurred in 2023. The vegetation growth around the pond has likely contributed to bank stability.

Photo point O

2020 **2024**

Photo point O was located downstream of the constructed pond, looking downstream. The channel during both surveys was ill defined, and contained no obvious flow or non-vegetated channel. Cattle were present during 2020, which have likely caused the shallowness of the channel through pugging and trampling. During 2024 there was some water present, though the channel can be more accurately described as damp ground rather than a flowing channel, however the channel was no more defined than 2020, despite the high flows experience during 2023, and the removal of cattle from the paddocks.

Photo point Q

2020 **2024**

Photo point Q was located on a culvert crossing, looking upstream towards the constructed pond (which is located in the vegetated area in the distance). The watercourse was contained within a defined, but shallow channel, which widened towards the upstream end of this photo where it became less defined. The channel was well vegetated during both surveys, with blackberry encroaching along the entire length during the 2024. There was no evidence of any scour or erosion, including around the culvert. Some water was present during 2024, however it can be more accurately described as a damp channel, rather than flowing or standing water.

Photo point R

2020

2024

Photo point R was located downstream of the culvert crossing within an area of native dominated vegetation. The wetted channel was present, but not easily defined. It was present in a generally low area. There were no obvious changes between the two surveys. During 2024 water was present, however it was not flowing and it formed a series of isolated, stagnant pools. Abundant leaf litter was present within the channel suggesting no recent flushing flows. No evidence of scour, erosion or channel damage was identified.

Photo point U

2020 **2024**

Photo point U was located close to Brigham Creek Road. The channel was shallow, and moderately incised, and located within an area of mixed vegetation, with a high incidence of weeds. Water was present during the 2024 survey, but did not appear to be present during 2020. Water was not flowing during 2024, rather it was present as a shallow, stagnant pool. Extensive leaf litter was present during both surveys suggesting no recent flushing flows. No evidence of scour or erosion were observed.

Photo point V

2020 **2024**

Photo point V was taken looking downstream towards a culvert crossing. The channel was well defined, and contained within relatively steep, but not incised banks. During both surveys vegetation was abundant on the channel banks and around the culvert. There were no obvious differences between the two surveys, and no evidence of scour, erosion of bank damage.

Photo point W

2020

2024

Photo point W was the only location where there was evidence of erosion observed. The photo point was located downstream of a culvert crossing, looking downstream. The channel was well defined, with the wetted area slightly incised. Water was present, during 2024 though flow was not obvious. The channel was dry during 2020. On the true left bank an area of slumping was present during 2024 (indicated by the red arrow). As a result, a gap of approximately 0.5 m was present between the ground level and the fence. Where the slumping has occurred, the bank is steep. The slumping does not appear to have been caused by the flow of the stream. Rather, it is likely overland sheet flow, potentially from Brigham Creek Road, has made its way towards the stream via an ephemeral flow path, resulting in the bank slumping. The slumping itself is above the normal level of the stream, on the upper bank. It is expected this area will continue to erode during periods of high flow, though it is noted that high flows appear to be uncommon.

Photo points V1 and V2

V1 2020

V1 2024

V2 2020

V2 2024

Photo points V1 and V2 were located on the opposite side of Brigham Creek Road on a channel that drains a constructed pond, and flows through a culvert under Brigham Creek Road and into the watercourse within the site. The channel was ill defined, and was represented by a shallow depression rather than a formed channel. The area was entirely vegetated. Vegetation was significantly more dense during 2024 than 2020. No evidence of scour, erosion of channel damage was observed.

Photo point Z

2020

2024

Photo point Z was located along the Brigham Road embankment, near its intersection with Kauri Road. The channel not easily observable during 2024 due to vegetation growth, while it was readily visible during 2020. The extensive vegetation growth suggests the channel and banks are stable enough to allow vegetation to proliferate. No evidence of scour or erosion were observed, including around the culverted entry between 159 and 163 Brigham Creek Road, which was where the photo was taken from.

Photo points Z2 and Z3

Z2 2020

Z2 2024

Z3 2020

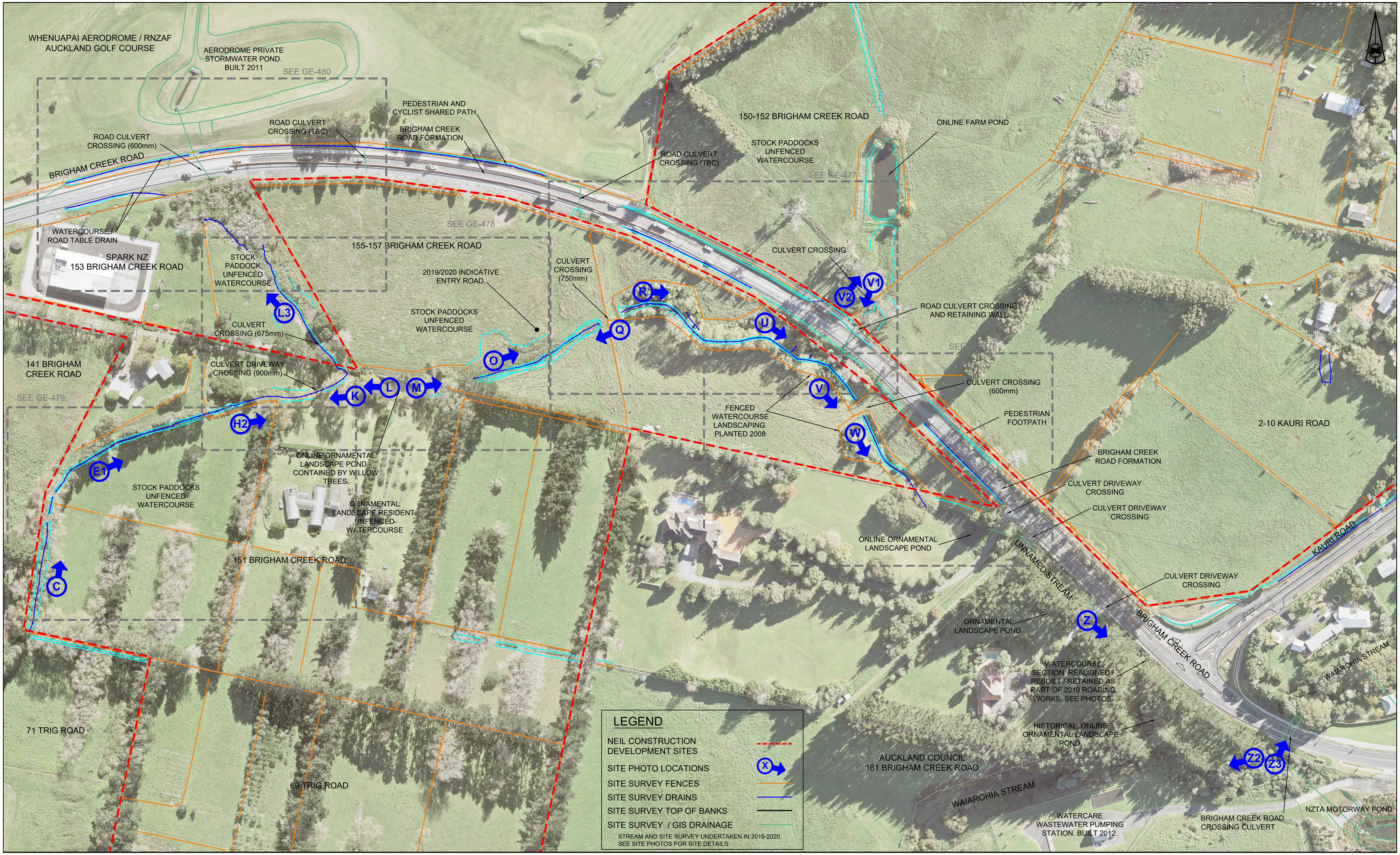
Z3 2024

Photo points Z2 and Z3 were located at the downstream end of the watercourse, where it flows under Brigham Creek Road. Neither photo point could be fully replicated due to the depth of the water within the stream. However, extensive vegetation was present during both surveys and there was no evidence of any scour, erosion of channel damage observed, despite the high flows experienced during 2023.

Summary

Generally, the condition of the intermittent and permanent waterways within the site was good. There was largely no evidence of erosion or scour, or other bank damage such as undercutting, slumping, cracking or undermining of vegetation. The only exception was an area of bank slumping around photo point W. The removal of stock from the site has resulted in vegetation growth increasing, though there were no obvious improvement in channel condition, such as narrowing of the channel and resumption of a more natural cross section. It is likely the lack of regular flows has prevented normal stream processes, such as a normal level of erosion, occurring. The extensive vegetation along large portions of the riparian margin are also likely playing a stabilising role for the watercourses. Removal of vegetation may increase the risk of the erosion, however this can be easily mitigated through planting of the riparian yard, appropriately engineering culverts and crossings, and addition of rock rip rap in any erosion prone areas such as bends in the channel.

Overall, there were no significant differences found between the 2020 and 2024 surveys with regard to stream channel condition. The flood events the Auckland region experienced during 2023, which represented an unprecedented, significant stormwater event, did not appear to have cause any erosion, scour or damage to the banks of the stream. Therefore, the stream bed and banks show a high degree of resilience to changes in hydrological regime. The proposed stormwater controls and stormwater management plan provisions should be sufficient to address any effects on the stream caused by the change in land use.



Rev	Description	By	Date
A	FOR INFORMATION	CK	08/20

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Job Title
BRIGHAM CREEK AREA DEVELOPMENTS

Drawing Title
AREA WATERCOURSES
SITE SURVEY & PHOTO RECORD

	By	Date	Scale	Job No.
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Designed:	–			Rev A
Drawn:	CK	08/20		
Approved:	–			

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