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W-REF: P24-128
4 August 2025

STREAM EROSION RISK ASSESSMENT

Milldale Fast Track Application – Stages 10-13

1. Introduction

Section 53(2) of the Fast-track Approvals Act 2024 enables the Expert Consenting Panel to invite written comments on the application from specified persons and groups.

This memorandum has been prepared in response to the technical specialist memorandums issued by Auckland Council as part of their assessment of the Milldale Fast-track Application. It specifically addresses the matters raised by Council and provides clarification, additional assessment, and updates where required.

Specifically, this memo provides response to the following:

- Memorandum of Planning Matters for Auckland Council (29 July 2025)
- Annexure A2 (Appendix B #8 – Geomorphic Risk Assessment)

Since the initial lodgement of the Substantive Application with the Environmental Protection Authority (EPA), there has been ongoing engagement between the Applicant's expert team and Auckland Council specialists through meetings, design workshops, and site discussions.

1.1. Background

Woods have undertaken a Stream Erosion Risk assessment to support the Fast Track application of Milldale development Stages 10 – 13. The applicant (Fulton Hogan Land Development) received feedback from Healthy Waters (part of Auckland Council) where a 'Geomorphic and Erosion Risk Assessment' was requested. A meeting to clarify the request was held between the applicant's consultants (Woods and B&A) and Auckland Council where the following points were recommended to be addressed to satisfy the original request:

Conduct a Geomorphic Risk Assessment parallel to the Geotechnical and Ecological assessments, including:

- *Evaluating the Current Network State - Assess the present condition and sensitivity of the stream network, including its response to flow modifications and increased impervious surfaces.*
- *Identify Development Impacts and Mitigation Strategies - Determine whether the proposed development will affect the health and stability of the stream network and provide a detailed mitigation plan to address any adverse impacts.*

- *Assess Natural Hazards and Public Safety Risks – Evaluate whether the stream network's sensitivity poses risks to the development or public safety. Develop strategies to mitigate these risks, with a preference towards nature-based solutions and green infrastructure.*

There is an adopted Stormwater Management Plan (Wainui East Future Urban Zone SMP, Version 4, dated 07/09/2016) for the entire Milldale development area which also includes the proposed Stages 10 – 13 within its extent. The current Milldale area, including the proposed development stages are live zoned, and the adopted SMP provides various measures to address any adverse erosion effects that may arise from the increase in impervious coverage because of the development. In line with the provisions of the SMP, the proposed development includes SMAF 1 hydrology mitigation measures which are expected to minimise any adverse erosional effects and preserve the health of existing stream network.

1.2. Scope

The scope of this assessment includes an evaluation of the current state of the streams, assesses development impacts (if any), and evaluates the need for any further mitigation measures in addition to the provisions included in the SMP. Additionally, the assessment informs on the suitability of the riparian margins provided for the streams being enhanced as part of the development, and whether the potential erosion risk in streams will pose any risk to the development or public safety.

It should be noted that this assessment does not allow for SMAF mitigation provisions as included in the SMP and is therefore considered to be a very conservative assessment especially for frequent events. A 1D-2D hydrodynamic flood model has been developed to undertake the assessment. As part of this, two model scenarios were developed.

- **Pre-development model** scenario representing existing conditions.
- **Post-development model** scenario representing development conditions.

This memorandum contains details regarding the model updates, assumptions for each model scenario, methodology adopted for the assessment, analysis of results, and conclusion/recommendations for erosion protection measures required for the streams (if any).

The assessment has been carried out for 2-, 10- and 100-year ARI storm events with allowance for future 3.8°C temperature increase by 2110 under Maximum Probable Development (MPD) impervious coverage assumption.

A geomorphic change detection analysis was also undertaken to quantify vertical changes in elevation over time and identify patterns of erosion and deposition within the stream corridor from two periods 2016 and 2024, using LiDAR.

2. Stream network

An ecological study was carried out for the development area, and streams of ecological importance were proposed to be retained. This covers a network of intermittent and permanent streams including six smaller reaches (named Stream 2, Stream 20, Stream 26, Stream 35, Stream 42, and Stream 43) which discharge to a main tributary (Stream 21) which in turn discharges to Waterloo Creek.

The wider stream network comprises of other streams within and downstream of the Milldale development including Orewa Stream and Weiti Stream, however, the proposed Stages 10-13 form part of a separate tributary and therefore have been excluded from the scope of the assessment. Furthermore, as shall be discussed in this report, the Wainui SMP (which is the overarching management document for all of Milldale) recommended measures (including provision of SMAF implementation) which will be implemented within the development stages to address any potential effects downstream, hence this report focuses on the development extent.

It is noted that the six reaches will be realigned as part of the Stages 10 – 13 proposal to enable improved integration into the urban structure of the development. These realigned reaches will be formed into engineered fills. It is also noted that Stream 21 generally is retained on its predevelopment alignment, with some sections being naturalised as part of previously consented works in Milldale.

Figure 1 shows the streams included as part of proposed development extent and the downstream network.

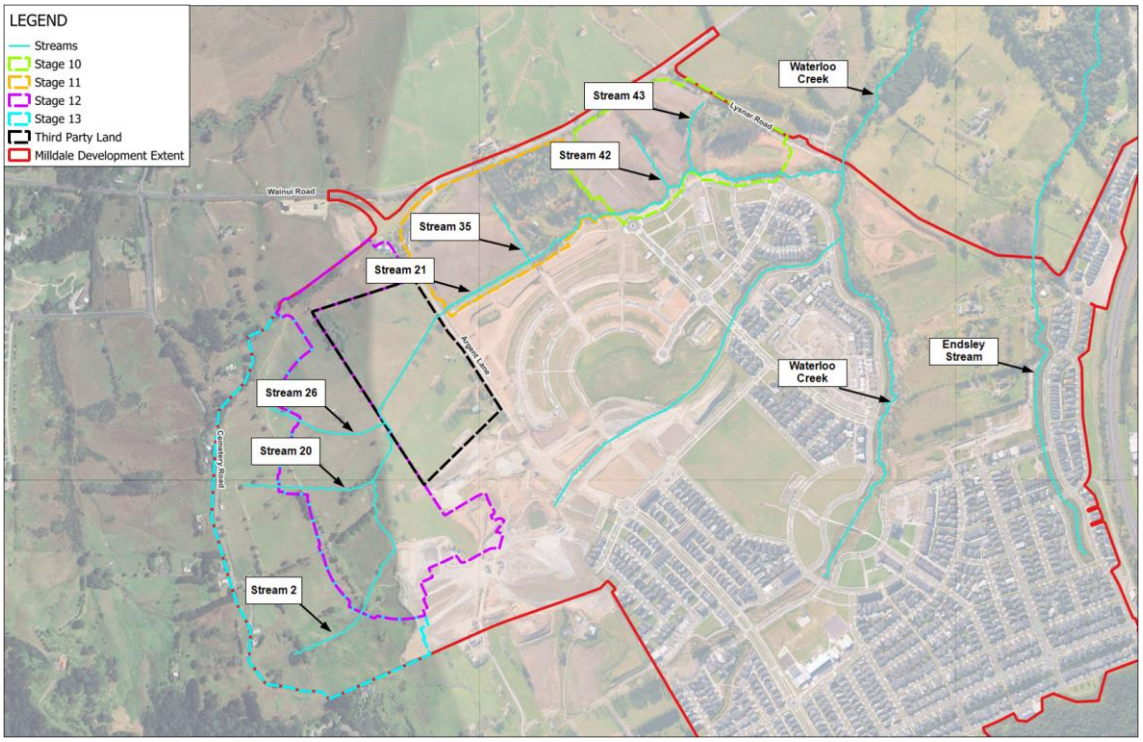


Figure 1: Stream network within proposed development, Milldale and downstream

3. Flood model

3.1. Model updates

The assessment utilised a cutdown 1D-2D hydrodynamic flood model from the wider flood model for Milldale. The cutdown approach was adopted for accuracy in relation to Bed Shear Stress calculations and to reduce computation time. The report, "*Flood Assessment", dated 05/08/2025, Version 1,* prepared by Woods contains details regarding the wider flood model while the cutdown model updates have been included in the sections below. The *Flood Assessment* report also contains information regarding parameters used to represent hydrological and hydraulic components of the flood model.

3.1.1. Cutdown model extent

The cutdown model includes the proposed development extent, Stream 21 and any other upstream catchment area. The cutdown model extent is bound by the Cemetery Road towards the West, Lysnar Road to the East, and Wainui Road to the North.

Figure 2 shows the cutdown model extent.

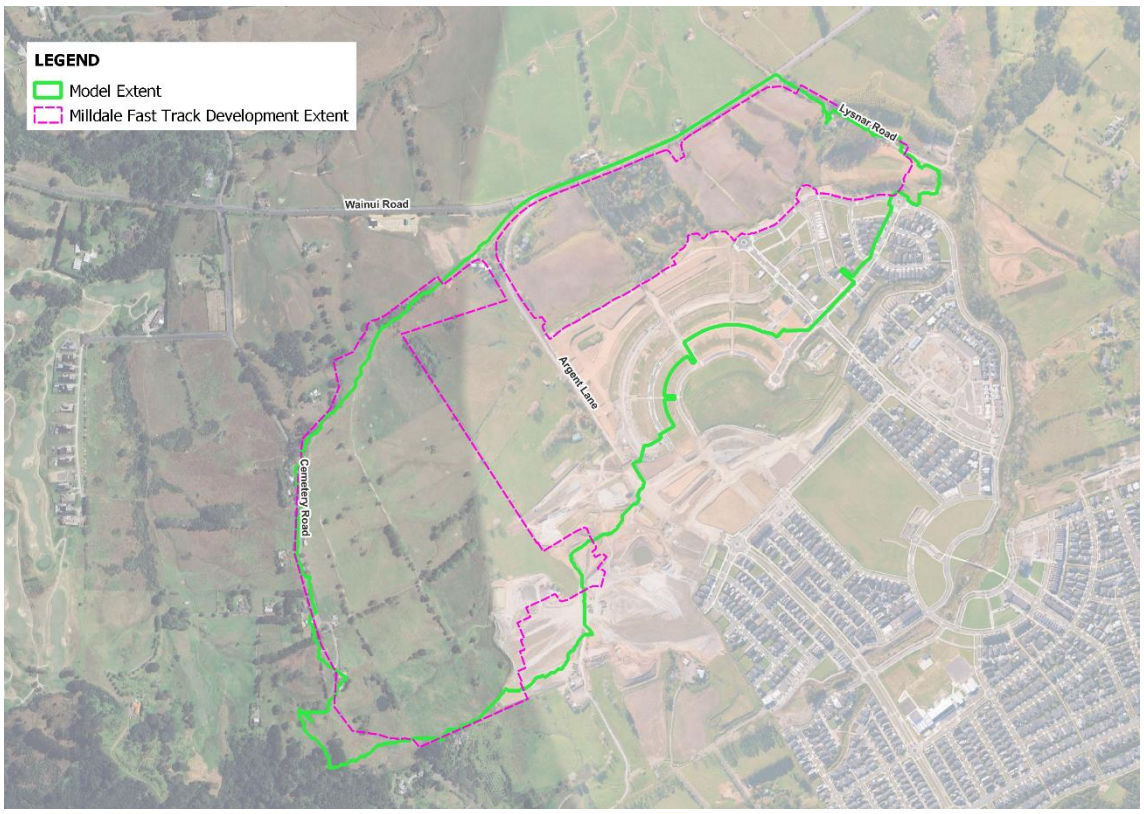


Figure 2: Cutdown model extent

3.1.2. Model approach

The wider flood model represents streams within the development extent in 2D, with the Stream 21 modelled using 1D cross sections. In the cutdown model, Stream 21 has been updated to a 2D representation to analyse finer elements of the stream (thalweg levels, varying geometry) and enable a more accurate identification of potential erosional hotspots (if any).

A short section of Stream 21 tributary has been modelled using 1D cross-sections to maintain model stability. This section has been excluded from the assessment and lies outside the proposed development extent (Stages 10–13).

3.1.3. Subcatchments delineation

The subcatchments delineation in the cutdown model has been updated with respect to the simulated rainfall events and is consistent with the civil design.

In the post-development model scenario, the design streams within the proposed development extent receive limited flows for storm events up to the 10-year ARI via a diversion manhole in the stormwater network. For events exceeding the 10-year ARI, the streams receive additional overland flows. As a result, subcatchments delineation is consistent for the 2- and 10-year ARI storm events but different for the 100-year ARI event.

For the pre-development model scenario, subcatchments delineation is the same for all simulated storm events.

Figure 3, Figure 4, Figure 5 show subcatchment delineation for the pre- and post-development model scenario.

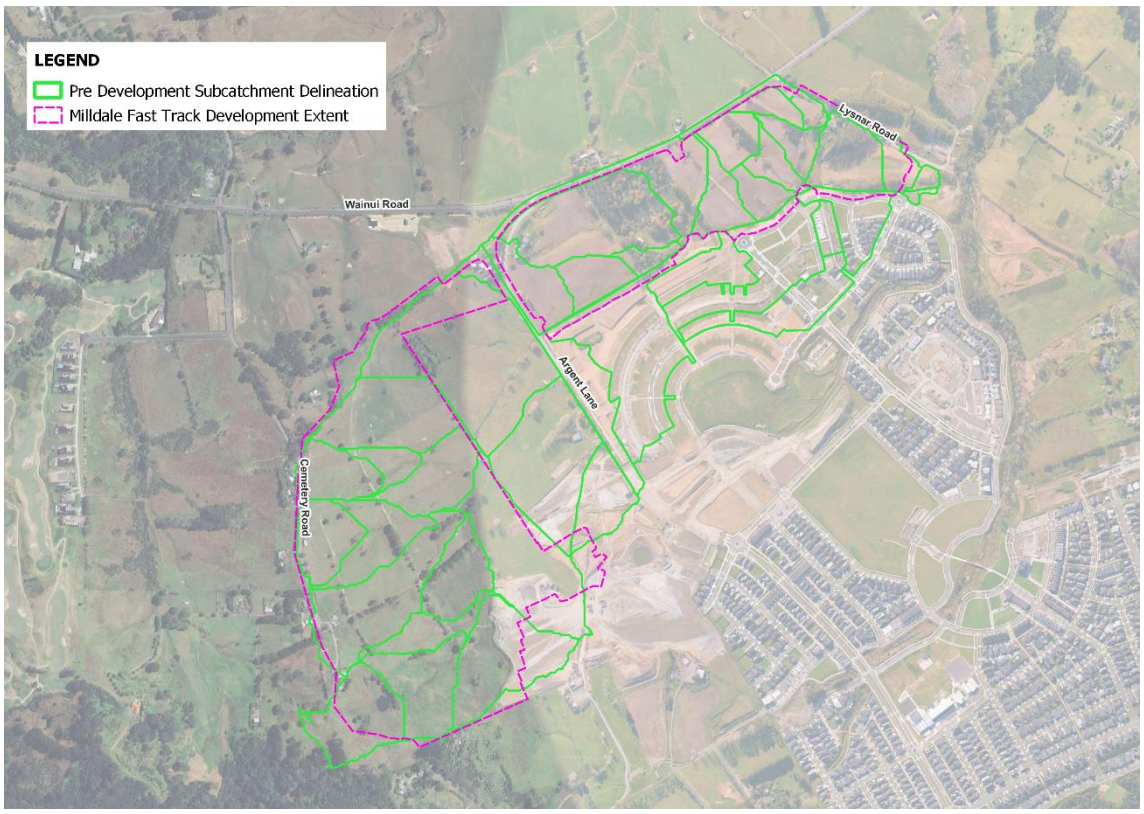


Figure 3: Pre-development model scenario subcatchments delineation

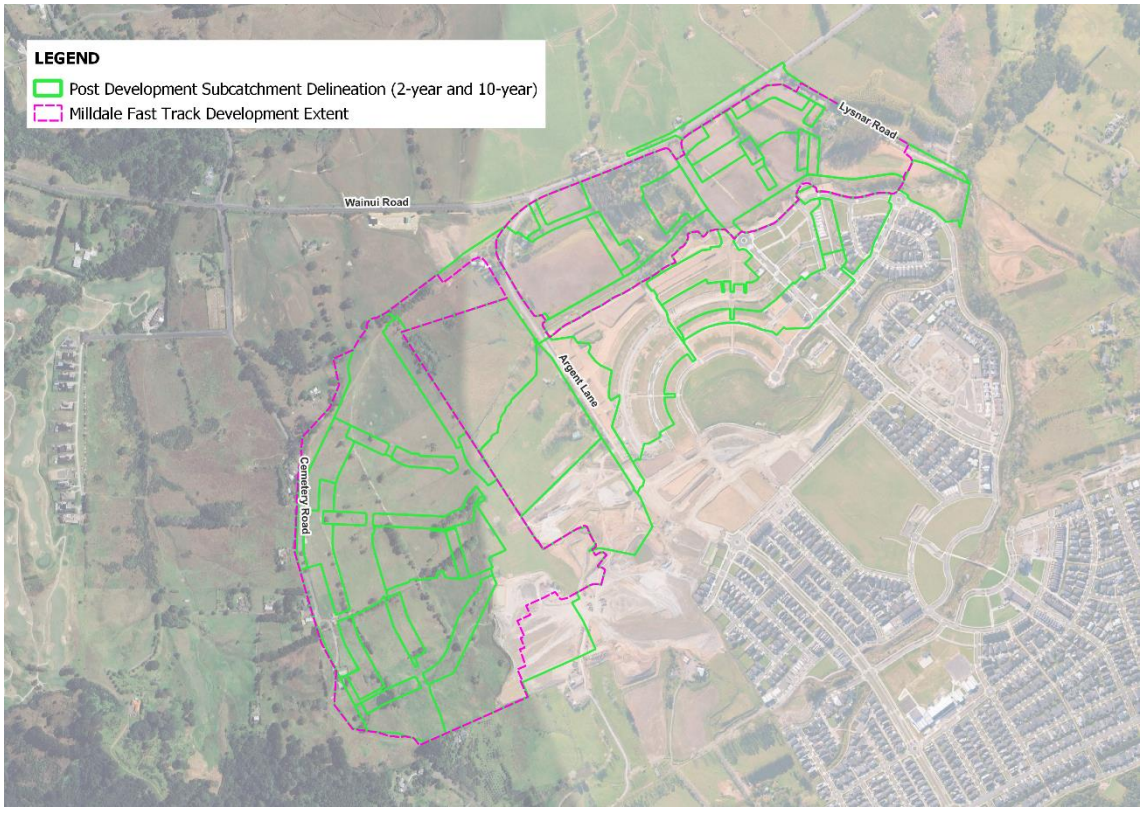


Figure 4: Post Development subcatchment delineation (2-year and 10-year ARI storm event)

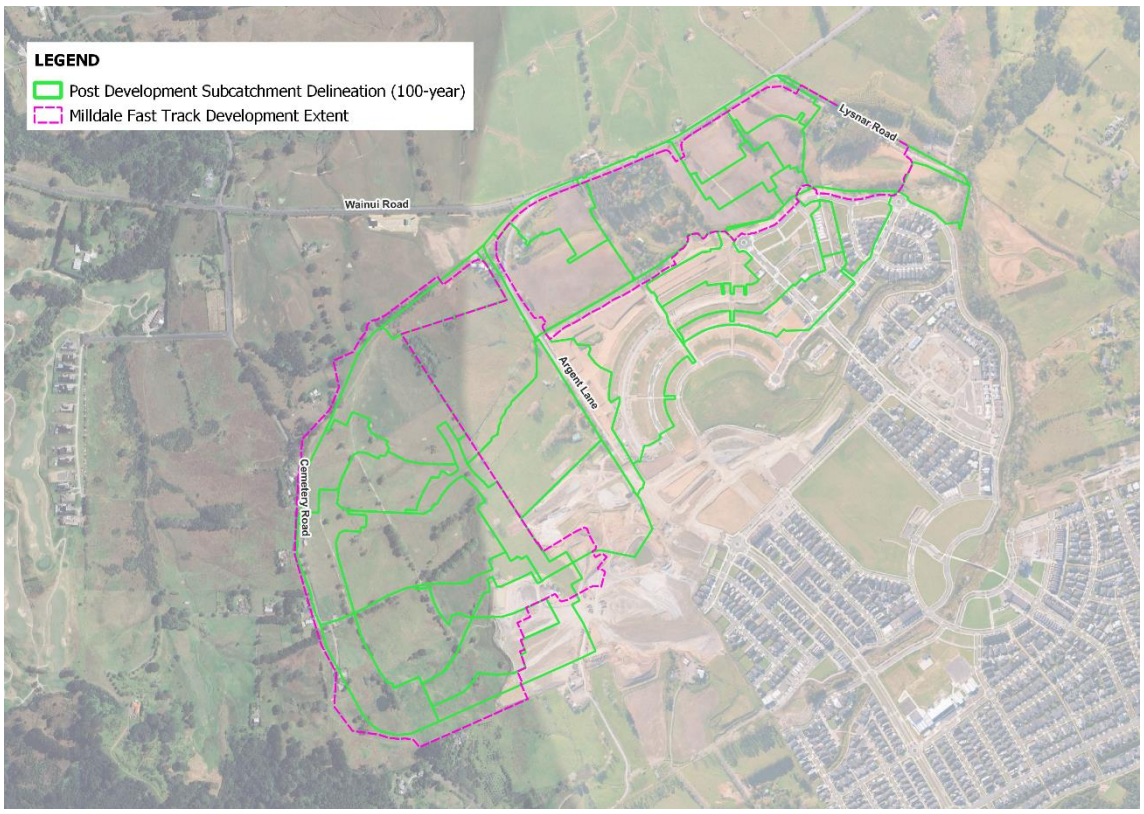


Figure 5: Post Development subcatchment delineation (100-year ARI storm event)

3.1.4. Boundary conditions

3.1.4.1. Rainfall

The model scenarios have been simulated for 2-, 10- and 100-year ARI storm events with allowance for 3.8°C future temperature increase by 2110.

Rainfall depths used in the flood model scenarios are based on the adopted Wainui East Future Urban Zone Stormwater Management Plan (referred to as "Wainui East SMP"), prepared by Woods, dated Sept 2016, Version 4 and have been adjusted using the 3.8°C climate change uplift factor as specified in Table 1 of SWCoP Version 4, July 2025. The input rainfall hyetograph is derived from the TP108 profile, also adjusted for 3.8°C future climate change in accordance with Table 2 of SWCoP Version 4.

Table 1 shows the baseline 24-hour rainfall depth, upliftment factor and the final adjusted rainfall depth used in model simulations.

Table 1: Modelled existing and adjusted 24-hour rainfall depth

Storm event	Existing 24-hour rainfall depth (mm)	Percentage Increase in 24-hour design rainfall depth due to future climate change – 3.8°	Adjusted 24-hour rainfall depth (mm)
2-year	88	27.40%	112.1
10-year	145	30.80%	189.6
100-year	225	32.70%	298.6

3.1.4.2. Downstream boundary condition

The downstream boundary condition has been represented as a free outfall. This is considered appropriate as the location of the boundary conditions lies 140m downstream of the proposed development extent and is not expected to meaningfully influence water levels upstream.

The location of the downstream boundary condition has been shown in Figure 6.

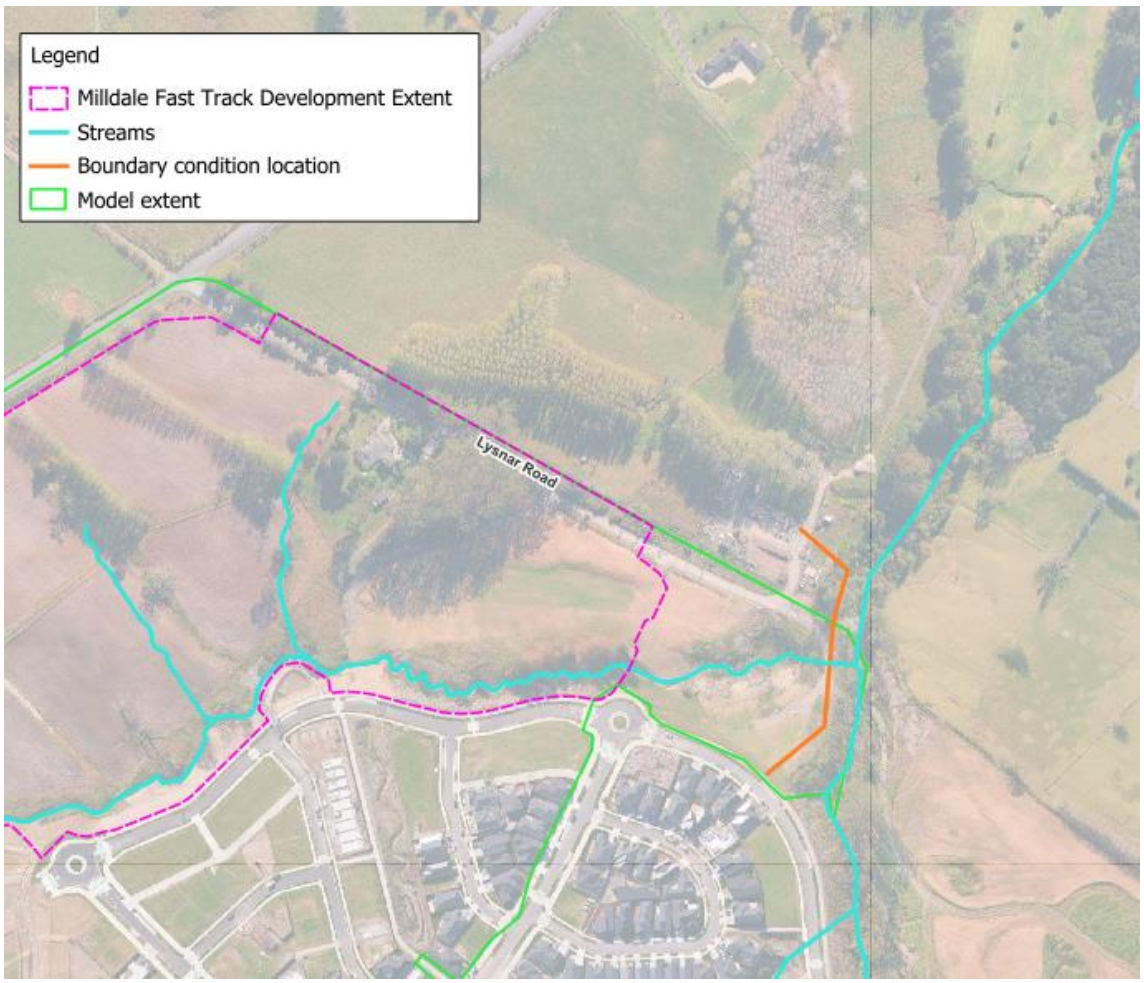


Figure 6: Location of the downstream boundary condition

3.2. Model scenarios

As discussed previously, pre-development and post-development model scenarios have been modelled.

1. Pre-development scenario

The pre-development model scenario has been developed to evaluate the potential of erosion on Stream 21 tributary in the existing state. The model scenario helps establish a baseline to compare if the proposed development will exacerbate erosion along Stream 21.

The model scenario considers 5% impervious coverage for all areas within the proposed development extent (Stage 10-13) which represents existing impervious coverage and is consistent with the assumption stated in Wainui East SMP. It is noted that there is a consented and active construction/occupation development at Milldale, and its contribution to this scenario is considered at MPD impervious coverage, i.e. 65% impervious coverage and consistent with the assumption stated in Wainui East SMP.

Given that the existing stream network is being modified as part of the proposed works, the model uses design surface and stream network information for a comparative assessment. This approach enables evaluation of potential adverse erosion impacts on the newly constructed stream network resulting from the proposed development. The Stream 21 tributary has already been designed and constructed under previous development stages, while the remaining reaches are proposed under this application. The model scenario incorporates the final design and constructed form of the Stream 21 tributary and applies design information for the remaining reaches yet to be constructed.

It should be noted that because the existing stream network is being modified as part of the application, the purpose of pre-development model scenario will be limited to compare the change in potential erosion risk for Stream 21 tributary.

2. Post development scenario

The post development scenario has been developed to assess potential erosion risk for streams within the proposed development (Stage 10-13) and Stream 21. The results of the model scenario have been compared with the pre-development scenario to assess if the potential erosion risk to the stream has been exacerbated as a result of the proposed development.

The model scenario considers MPD impervious coverage for all areas within the model. A constant 65% impervious coverage has been used to represent MPD impervious coverage which is consistent with the *Flood Assessment report* attached with the application.

The model scenario uses design information for landform and streams included as part of the proposed development, whereas the design + constructed form has been used for Stream 21 tributary in the model scenario.

The model results of this scenario further inform any design changes that may be required for the new reaches and the tributary, and if any interventions are required to mitigate increased erosion Table 2 provides a summary of the assumptions used in the development of each model scenario.

Table 2: Summary of assumptions for model scenarios

Scenario	Simulated storm events	Impervious coverage assumption	Landform
Pre-development	2-, 10- and 100-year ARI storm events with allowance for 3.8°C future climate change	5% impervious coverage (existing state) for areas within the proposed development extent (Stage 10-13), and 65% impervious coverage (MPD) for other areas of currently ongoing consented Milldale development discharging runoff to Stream 21.	Design surface, design + constructed form for Stream 21 tributary
Post-development	2-, 10- and 100-year ARI storm events with allowance for 3.8°C future climate change	65% impervious coverage (MPD) for all areas included within the model extent	Design surface, design + constructed form for Stream 21 tributary

4. Assessment

4.1. Methodology

This section outlines the methodology adopted to undertake the assessment.

Healthy Water's Auckland Council has provided Woods with an Erosion Screening Tool (EST) which provides a methodology to estimate potential erosion risk in streams. The profiles for excess shear as provided in EST have been used to carry out the assessment.

The maximum excess shear stress results have been extracted for all simulated scenarios, which have been analysed to find erosional hotspots. At the selected locations, bed shear stress results were extracted for all computed timesteps (n=97) over the 24-hour simulation period. The bed shear stress results were converted into excess shear stress results and categorised based on the risk thresholds as stated in the EST. The resultant output which was used to draw conclusions included percentage exceedances.

Table 3 provides the Auckland Council erosion risk profiles as stated in the EST.

Table 3: EST erosion risk profile

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

4.1.1. Critical shear

In the absence of site-specific geotechnical parameters, the 50th percentile median critical shear stress (32.6 Pa) was adopted from Auckland-specific data compiled by Cardno for Auckland Council. 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.

4.2. Model results

This section presents model results and compares the two scenarios: pre-development and post-development. Maximum excess shear stress outputs were extracted to identify erosional hotspots and assess whether the proposed development introduces new areas of concern. It is recognised that erosion is a time-dependent process, and therefore, a time-series analysis was undertaken. Zones of potential erosion were identified, and 24-hour bed shear stress data were extracted and compared across all simulated storm events for both scenarios.

4.2.1. Maximum excess shear stress maps

This section contains the maximum excess shear stress maps for all model scenarios. Appendix 1 contains excess shear maps for all simulated storm events. For purposes of reporting, only 100-year ARI storm events have been included below (as shown in Figure 7 and Figure 8).

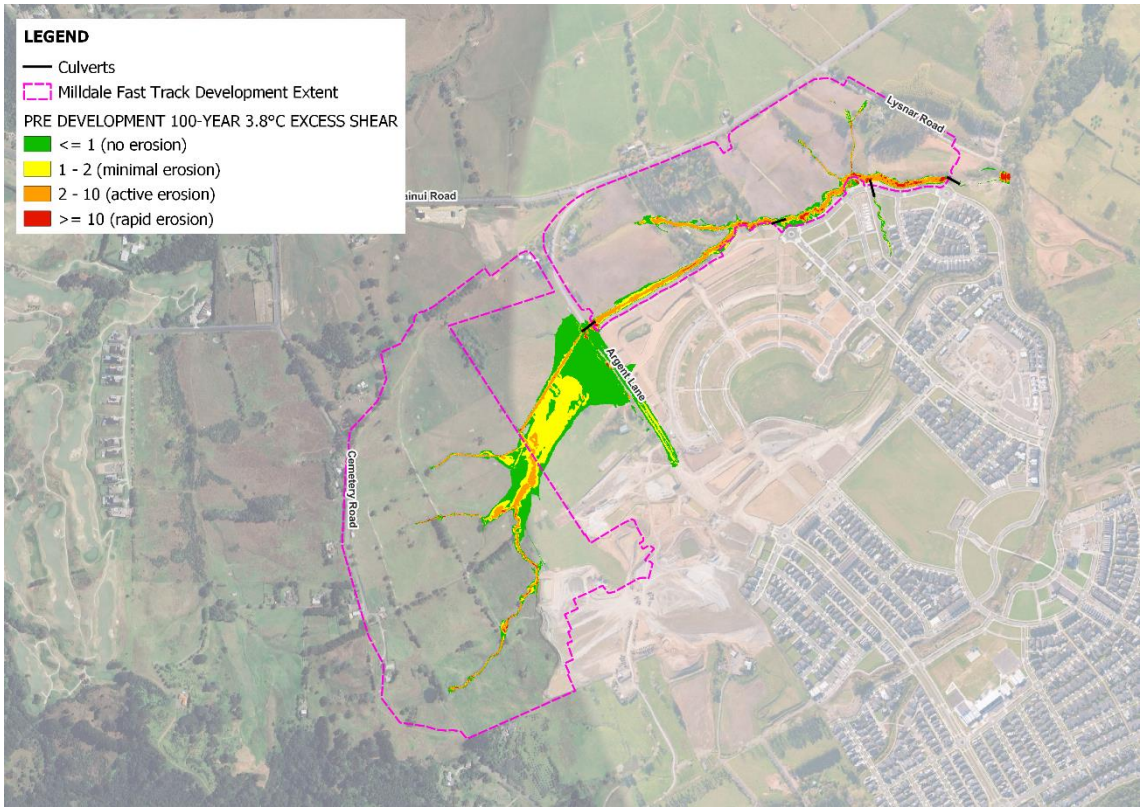


Figure 7: Maximum excess shear stress results for pre-development model scenarios (100-year ARI)

The results for pre-development model scenario indicates that:

- There is active erosion in all reaches and the main tributary (Stream 21). There is also noticeable rapid erosion within the stream which generally occur at bends as well as along some straight sections.

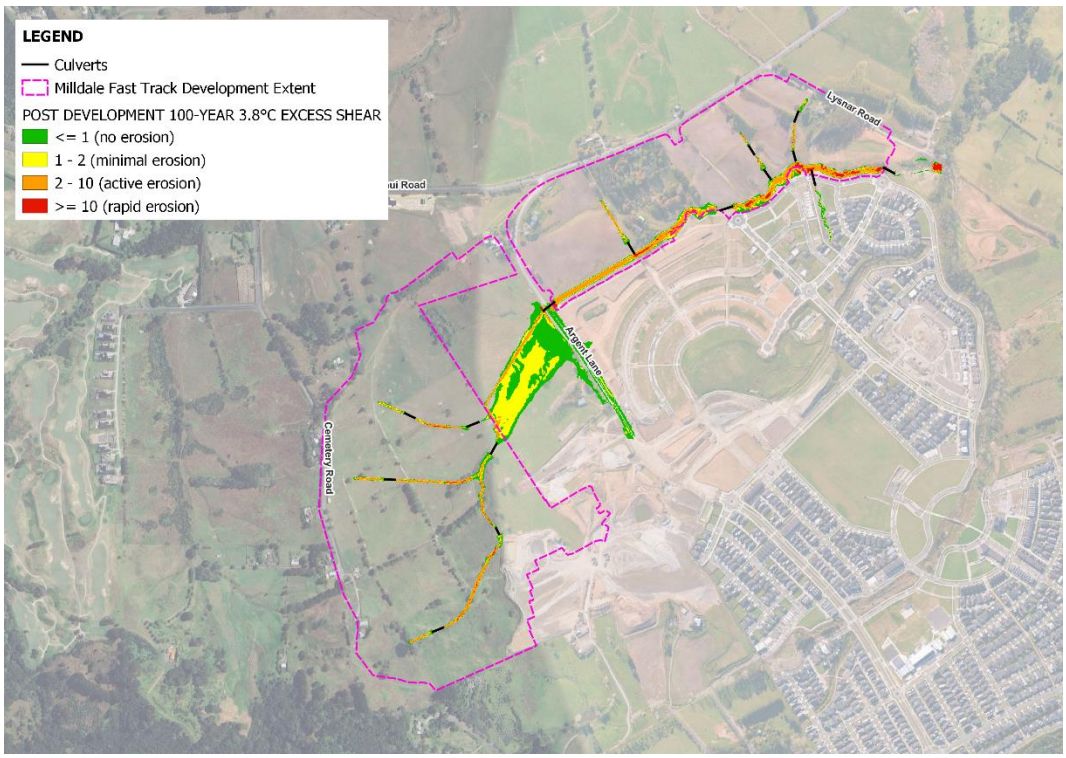


Figure 8: Maximum excess shear stress results for post-development model scenarios (100-year ARI)

The results for post-development model scenario indicates that:

- Generally, the potential erosion risk to upper reaches is similar to pre-development model scenario results. Noting that these are being designed as part of the development, direct comparison with the existing upper reaches which are removed/modified is not warranted, and therefore, excluded from further analysis.
- The results for Stream 21 indicate an increased extent of erosion potential compared to the pre-development scenario. This outcome is consistent with the anticipated effects of increased impervious surface area associated with the proposed development. Specific locations were noted to have been subjected to additional erosion in the post development model scenario (as highlighted in Figure 9), which have been further analysed below;
- Location 1 – There is a major culvert at this location which is currently going through design and will be constructed as part of Stage 6H of Milldale development. It is expected that the culvert design will incorporate riprap and other features which will dissipate energy and mitigate erosional potential at this location.
    - Location 2 and Location 3 – These locations includes culvert inlets/outlets and therefore, suspectible to rapid erosion. This can however be addressed during the detailed design stage where provision of energy dissipation features (including rip-rap etc.) can be incorporated to minimise any excessive erosion.
    - Zone 1 to Zone 4 – These areas have been further analysed between the two model scenario to understand the percentage exceedances for a 24-hour simulated storm events (refer to 4.2.2).

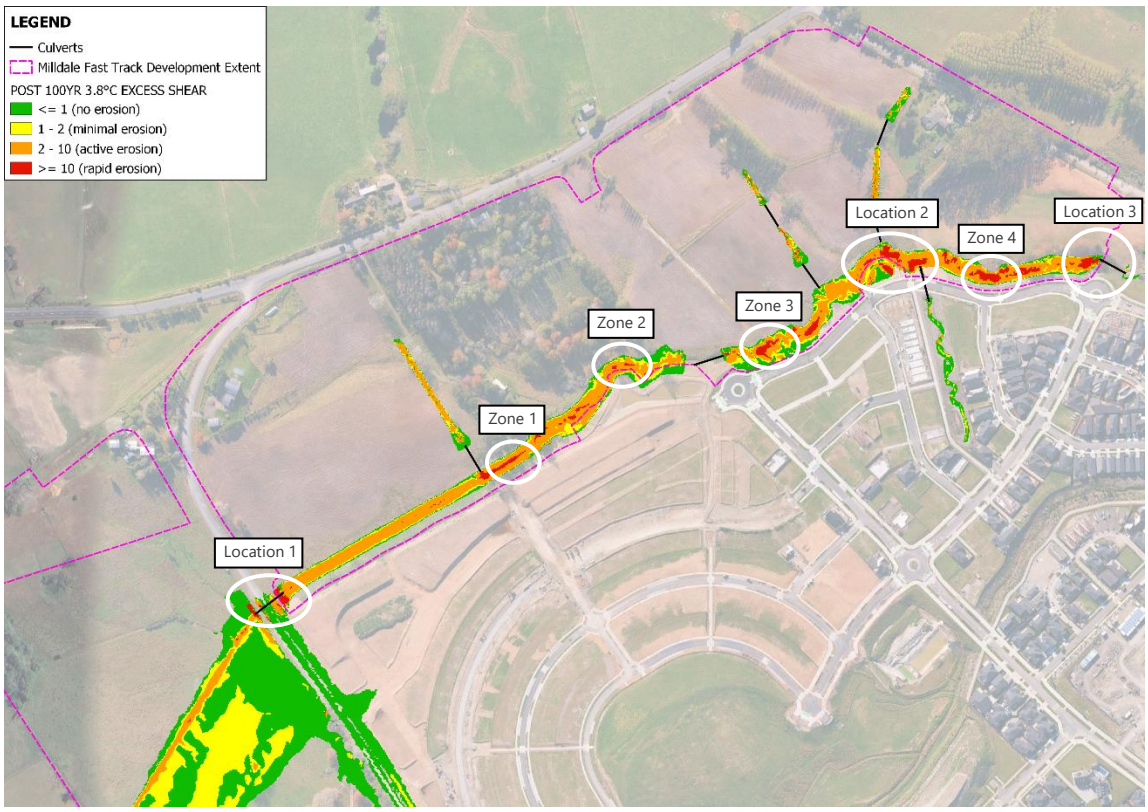


Figure 9: Erosional hotspots and areas of analysis for excess shear exceedances

4.2.2. Excess shear exceedances

The 24-hour excess shear exceedances have been evaluated between the two model for 2-, 10-, and 100-year ARI storm events at Zones 1 to 4. Table 4 to Table 7 show the percentage exceedances for the two model scenarios at Zone 1 to Zone 4.

Appendix 2 contains excess shear stress results for all modelled scenarios.

Table 4: Zone 1 excess shear stress results

Zone 1	Post development			Pre-development			Change		
	2-year	10-year	100-year	2-year	10-year	100-year	2-year	10-year	100-year
<1 (%)	26%	6%	9%	27%	27%	9%	-1%	-21%	0%
>1 & <2 (%)	34%	21%	19%	51%	37%	16%	-16%	-16%	2%
>2 & <10 (%)	38%	69%	70%	23%	36%	71%	15%	33%	-1%
>10 (%)	2%	4%	2%	0%	0%	2%	2%	4%	0%

The results for Zone 1 show that:

- There is an increase in '*active erosion*' profile for 2-year ARI storm event, however, with the provision of SMAF mitigation as required by the existing SMP for the site, this increase will be minimised and insignificant.
- There is an increase in '*active erosion*' profile in post development scenario when compared to pre-development scenario for 10-year ARI storm event.
    - Note that this increase will be mitigated via the energy dissipation features to be incorporated in the future stormwater network outlet design (located upstream of Zone 1).
- The results for 100-year ARI storm event show minimal differences between the two model scenarios.

Table 5: Zone 2 excess shear stress results

Zone 2	Post development			Pre-development			Change		
	2-year	10-year	100-year	2-year	10-year	100-year	2-year	10-year	100-year
<1 (%)	9%	7%	3%	14%	8%	6%	-5%	-1%	-3%
>1 & <2 (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%
>2 & <10 (%)	0%	0%	0%	37%	4%	0%	-37%	-4%	0%
>10 (%)	91%	93%	97%	48%	88%	93%	42%	5%	4%

The results for Zone 2 show that:

- There is an increase in '*rapid erosion*' profile for 2-year ARI storm event, however, with the provision of SMAF mitigation as required by the SMP, any increase will be minimised and insignificant.
- There is no significant increase in erosion for 10- and 100-year ARI storm events between the two model scenarios.
- Based on the above, there are no adverse erosional effects determined to result from the proposed development.

Table 6: Zone 3 excess shear stress results

Zone 3	Post development			Pre-development			Change		
	2-year	10-year	100-year	2-year	10-year	100-year	2-year	10-year	100-year
<1 (%)	27%	28%	8%	49%	26%	10%	-23%	2%	-2%
>1 & <2 (%)	36%	0%	10%	3%	1%	2%	33%	-1%	8%
>2 & <10 (%)	35%	67%	72%	44%	66%	75%	-9%	1%	-3%
>10 (%)	2%	5%	9%	3%	7%	11%	-1%	-2%	-2%

The results for Zone 3 show that:

- There is an increase in '*some erosion*' profile threshold for 2-year ARI storm event, however, this is not considered to be an adverse erosional effect and with the provision of SMAF mitigation, this increase will be minimised.
- There is no significant increase in erosion for 10- and 100-year ARI storm events between the two model scenarios.
- Based on the above, there are no adverse erosional effects determined to result from the proposed development.

Table 7: Zone 4 excess shear stress results

Zone 4	Post development			Pre-development			Change		
	2-year	10-year	100-year	2-year	10-year	100-year	2-year	10-year	100-year
<1 (%)	63%	27%	51%	64%	28%	20%	-1%	-1%	31%
>1 & <2 (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%
>2 & <10 (%)	31%	60%	28%	29%	59%	57%	2%	1%	-29%
>10 (%)	6%	13%	22%	7%	13%	23%	-1%	0%	-1%

The results for Zone 4 show that:

- There is no significant increase in erosion for 2, 10- and 100-year ARI storm events between the two model scenarios

5. Geomorphic change detection (GCD) analysis

A geomorphic change detection analysis has been undertaken to assess the vertical change in elevations and identify patterns of erosion and deposition within the stream corridor.

The geomorphic change detection model uses Auckland LiDAR data from 2016 and 2024 to generate a DEM difference. The area of interest (shown in) focused on the entire site, including the main branch of the stream (Stream 21) and its tributaries.

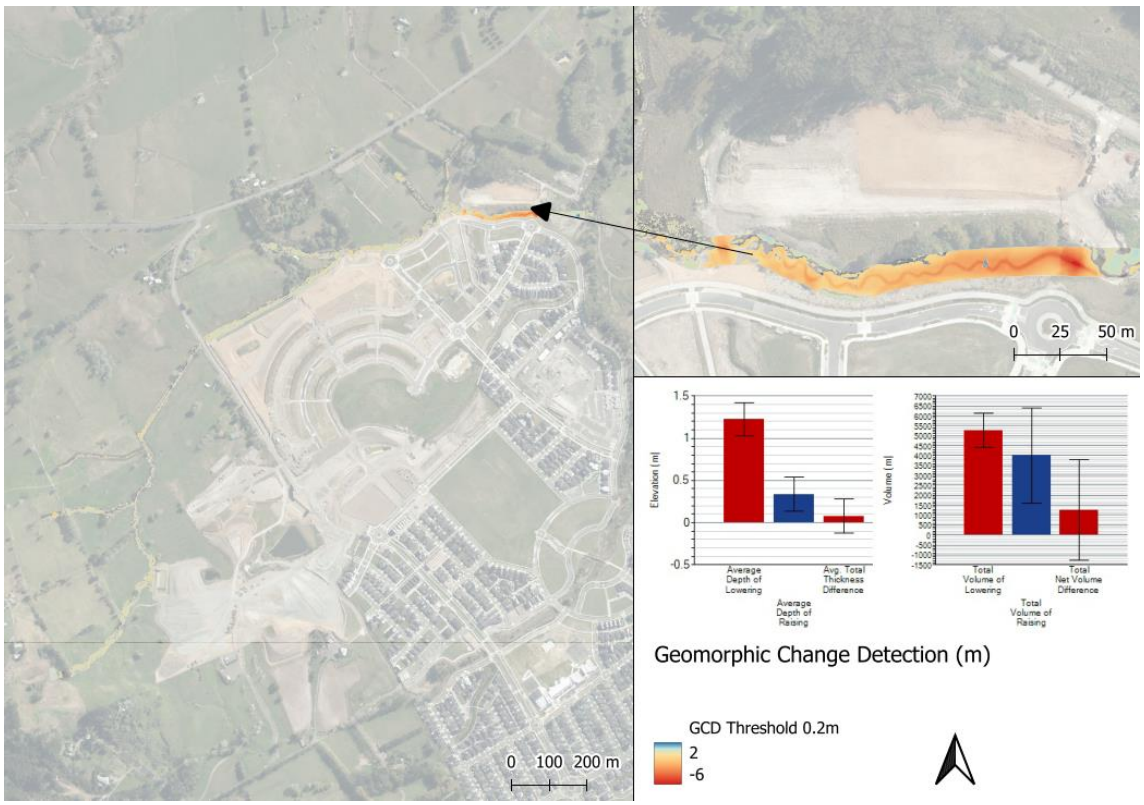


Figure 10: Geomorphic change detection analysis

The stream appears to be in a state of dynamic equilibrium, with no significant erosional hotspots or incision observed. The most substantial change is noted at the lower reach of the main branch, where an existing dam and upstream farm pond, was naturalised back to stream. This included an engineered sinuous meandering channel remediation. There are no significant natural erosion or aggradation areas as indicated in Figure 10.

6. Summary of Findings

The assessment concludes that the proposed development does not result in adverse erosion effects on the existing or proposed stream network.

The main tributary (Stream 21) is relatively flat, while the upper reaches (Streams 2, 20, 26, 35, 42, and 43) have steeper longitudinal gradients. The associated risk to the upper stream reaches is considered low due to the following:

- More than 20m of stream riparian margin has been provided for all streams which is considered suitable width to allow adjacent property and infrastructure to be well set back from the stream and associated flood plains.
- SMAF measures included in the development will further mitigate erosion potential enacted by frequent events.
- The streams are designed to receive low, controlled flows (mitigated stormwater flows in accordance with the SMP) during most storm events (up to the 10-year ARI), reducing erosion potential.
- Erosion risk will be further reduced through planting and in-stream features to be discussed during the detailed design phase.

Based on this assessment, the upper reaches of the stream are considered to have a low erosion risk and pose minimal safety risk to the development and public. However, as Stream 21 receives flows from all upper catchments, a toolbox has been provided of measures beyond those outlined in the SMP to further stream enhancement. While the SMP measures are deemed appropriate for managing erosion, these supplementary measures will enhance risk mitigation.

- It is proposed that a combination of soft *(nature-based solution)* and engineering measures be used to further mitigate erosion potential for Stream 21.
- Based on the guidelines provided in *Technical Guidelines for Waterway Management*, a toolbox has been prepared which lists out relevant measures that can be used at Stream 21. This will be refined and implemented during Engineering Plan approval / detailed design stage.

Appendix 3 contains the toolbox of options and examples of sites/projects where stream enhancement measures have been implemented.

7. Conclusion

Woods has undertaken a Stream Erosion Risk Assessment in support of the Fast Track application for the Milldale Development, Stages 10–13. The assessment evaluates the existing erosional potential in the stream, identifies development impacts (if any), and provides mitigation strategies if required. The scope of the assessment includes stream reaches located within the proposed development area the main tributary (Stream 21).

There is an adopted Stormwater Management Plan for the entire Milldale development area which includes the proposed Stages 10 – 13 within its extent. The current Milldale area, including the proposed development stages are live zoned, and the adopted SMP provides various measures such as implementation of SMAF, revegetation of riparian margins and retention of high ecological areas to address any adverse erosional effects that may arise from the proposed development.

A pre-development and post development model scenario was developed to carry out the assessment. The assessment has been carried out for 2-, 10- and 100-year ARI storm events with allowance for future 3.8°C temperature increase by 2110 under Maximum Probable Development (MPD) impervious coverage assumption.

The assessment concludes that:

- The existing stream network will undergo *active erosion* without any development.
- As per the GCD, the stream network appears to be in dynamic equilibrium with no significant erosional hotspots or incision observed. There are no significant natural erosion or aggradation areas detected.
- There is increased erosion as a result of the development, however, it is not significant, and implementation of measures as required by the SMP (i.e. SMAF mitigation, riprap at inlets and outlets) will further reduce erosion potential.
- The provision of riparian margins as included in the application is considered to be suitable.
- Stream 21 is noted to be the main tributary which receives flows from all upper reaches, and therefore, additional mitigation measures to further reduce the erosion potential have been recommended.
    - It is proposed that a combination of soft (nature-based solution) and engineering be used to further mitigate erosion potential for Stream 21. A toolbox of options has been prepared which lists out relevant measures that can be used at Stream 21 to be finalised during detailed design stage.

The development will not cause erosional effects to surrounding areas or the stream network. The erosion control measures in the adopted Stormwater Management Plan are adequate, and the proposed riparian margins within the site are suitable.

Appendix 1 – Maximum excess shear stress maps

LEGEND

Maximum Excess Shear:
Pre-development (2-year ARI 3.8°C)

- <= 1 (no erosion)
- 1 - 2 (minimal erosion)
- 2 - 10 (active erosion)
- >= 10 (rapid erosion)
- Existing culverts
- Milldale Fast Track Development Extent
- Milldale Development Extent

Wainui Road
Lysnar Road
Argent Lane
Cemetery Road

REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	FOR INFORMATION	-	01/08/2025	DESIGNED	
-	-	-	-	DRAWN	SS
-	-	-	-	CHECKED	-
				APPROVED	-

8 NUGENT STREET
GRAFTON 1023
AUCKAND

WOODS
EST.1970

WOODS.CO.NZ

P24-128 MILLDALE FAST TRACK S10-S13
MAXIMUM EXCESS SHEAR STRESS MAPS
PRE-DEVELOPMENT 2-YEAR ARI 3.8°C

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	
DWG NO		

LEGEND

Maximum Excess Shear:
Pre-development (10-year ARI 3.8°C)

- <= 1 (no erosion)
- 1 - 2 (minimal erosion)
- 2 - 10 (active erosion)
- >= 10 (rapid erosion)
- Existing culverts
- Milldale Fast Track Development Extent
- Milldale Development Extent

Wainui Road
Lysnar Road
Argent Lane
Cemetery Road

REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	FOR INFORMATION	-	01/08/2025	DESIGNED	
-	-	-	-	DRAWN	SS
-	-	-	-	CHECKED	-
				APPROVED	-

8 NUGENT STREET
GRAFTON 1023
AUCKAND

WOODS
Est.1970

WOODS.CO.NZ

P24-128 MILLDALE FAST TRACK S10-S13
MAXIMUM EXCESS SHEAR STRESS MAPS
PRE-DEVELOPMENT 10-YEAR ARI 3.8°C

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	
DWG NO		

LEGEND

Maximum Excess Shear:
Pre-development (100-year ARI 3.8°C)

- <= 1 (no erosion)
- 1 - 2 (minimal erosion)
- 2 - 10 (active erosion)
- >= 10 (rapid erosion)
- Existing culverts
- Milldale Fast Track Development Extent
- Milldale Development Extent

Wainui Road
Lysnar Road
Argent Lane
Cemetery Road

REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	FOR INFORMATION	-	01/08/2025	DESIGNED	
-	-	-	-	DRAWN	SS
-	-	-	-	CHECKED	-
				APPROVED	-

8 NUGENT STREET
GRAFTON 1023
AUCKAND

WOODS
Est.1970

WOODS.CO.NZ

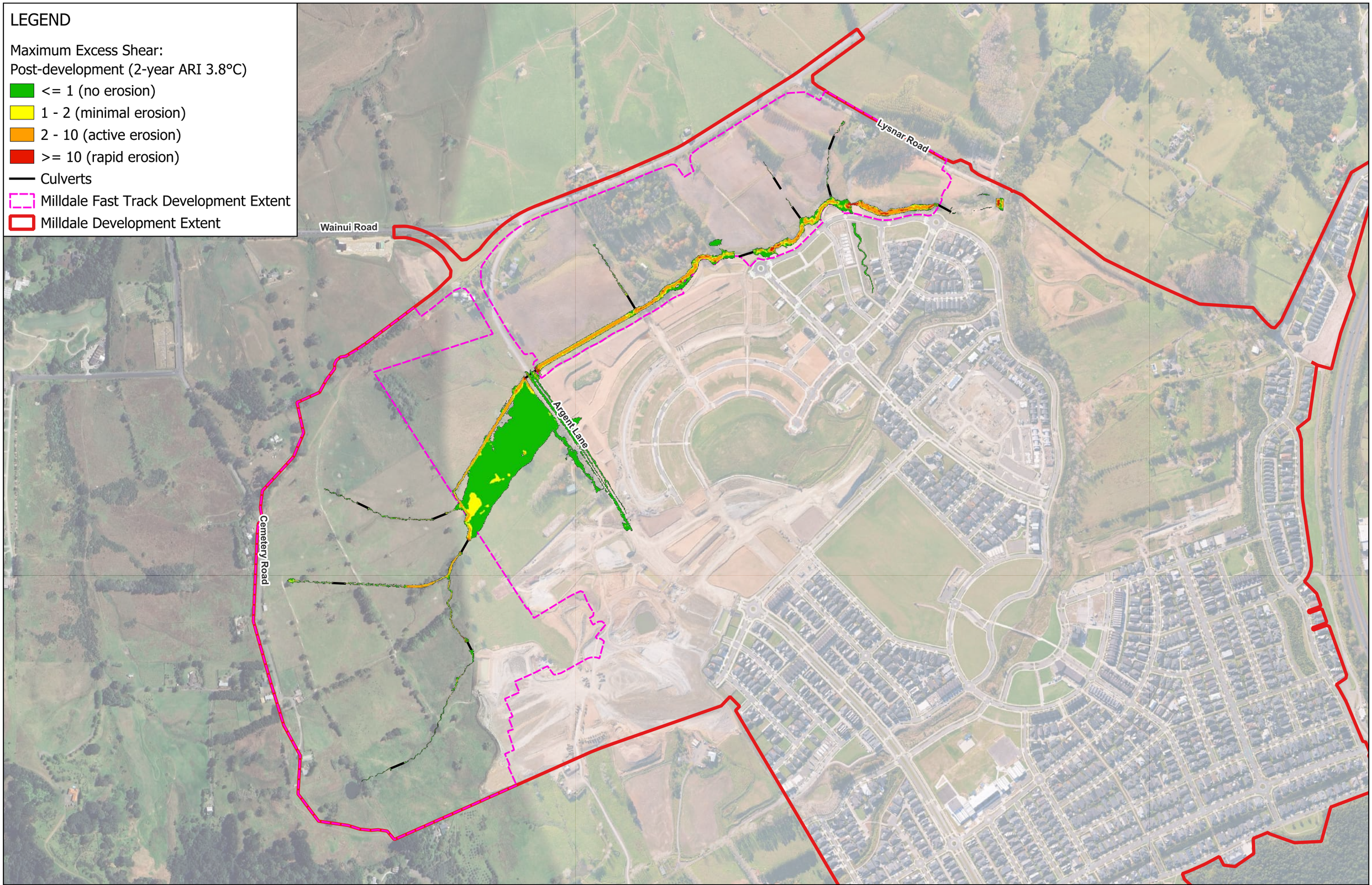
P24-128 MILLDALE FAST TRACK S10-S13
MAXIMUM EXCESS SHEAR STRESS MAPS
PRE-DEVELOPMENT 100-YEAR ARI 3.8°C

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	
DWG NO		

LEGEND

Maximum Excess Shear:
Post-development (2-year ARI 3.8°C)

- <= 1 (no erosion)
- 1 - 2 (minimal erosion)
- 2 - 10 (active erosion)
- >= 10 (rapid erosion)
- Culverts
- Milldale Fast Track Development Extent
- Milldale Development Extent



REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	FOR INFORMATION	-	01/08/2025	DESIGNED	
-	-	-	-	DRAWN	SS
-	-	-	-	CHECKED	-
				APPROVED	-

8 NUGENT STREET
GRAFTON 1023
AUCKAND

WOODS.CO.NZ

WOODS EST.1970

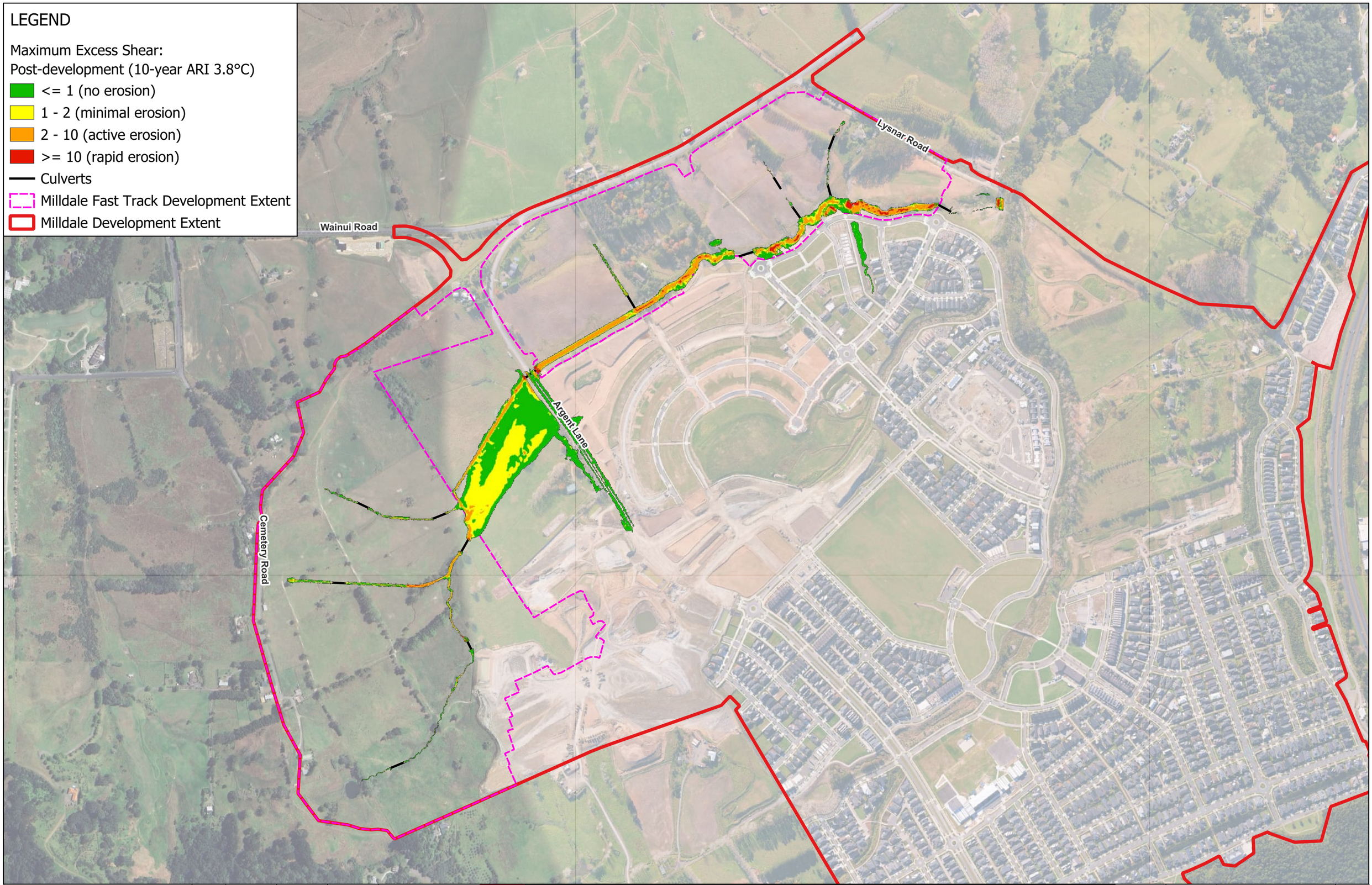
P24-128 MILLDALE FAST TRACK S10-S13
MAXIMUM EXCESS SHEAR STRESS MAPS
POST-DEVELOPMENT 2-YEAR ARI 3.8°C

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	
DWG NO		

LEGEND

Maximum Excess Shear:
Post-development (10-year ARI 3.8°C)

- <= 1 (no erosion)
- 1 - 2 (minimal erosion)
- 2 - 10 (active erosion)
- >= 10 (rapid erosion)
- Culverts
- Milldale Fast Track Development Extent
- Milldale Development Extent



REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	FOR INFORMATION	-	01/08/2025	DESIGNED	
-	-	-	-	DRAWN	SS
-	-	-	-	CHECKED	-
				APPROVED	-

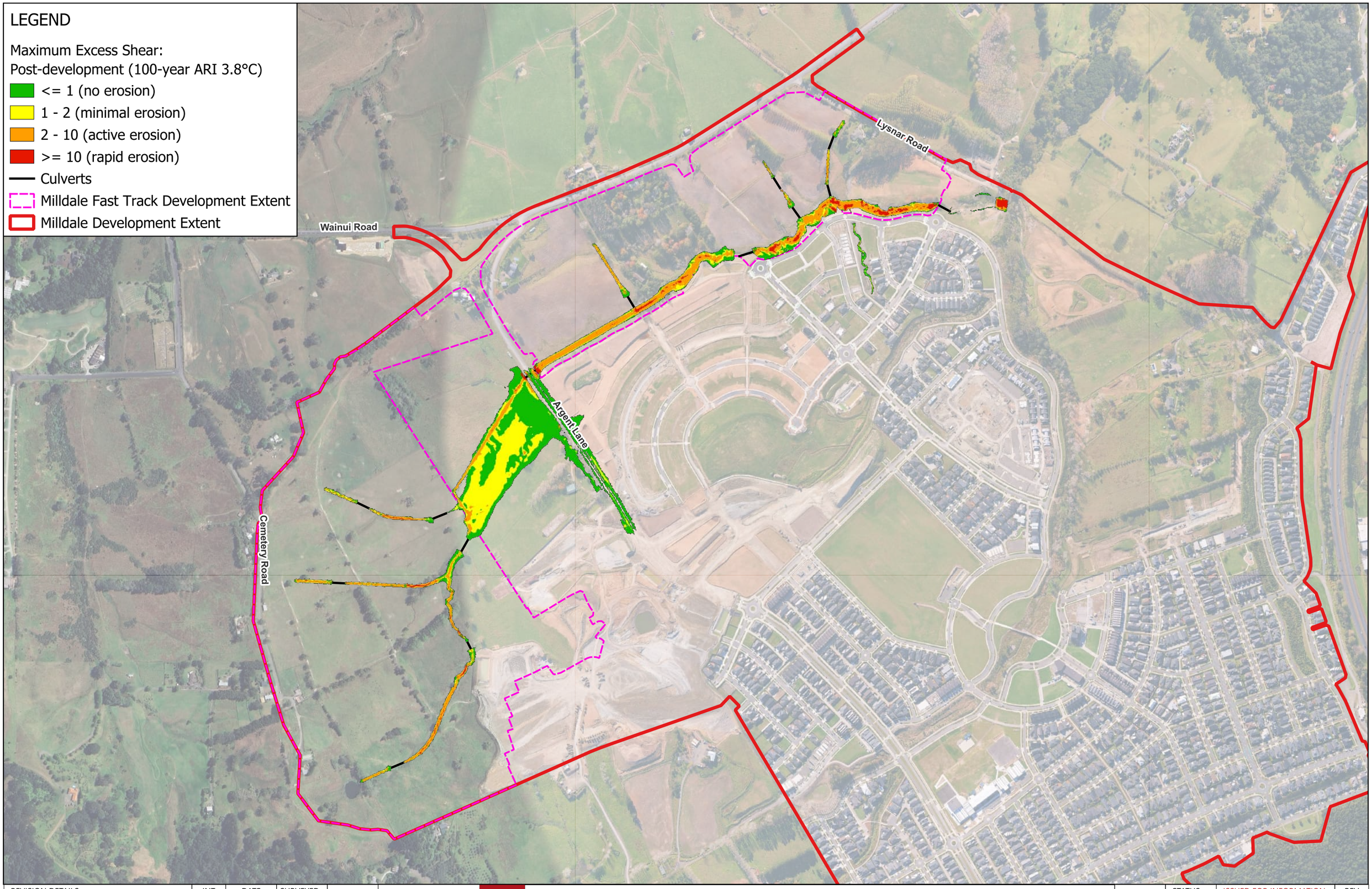
8 NUGENT STREET
GRAFTON 1023
AUCKAND

WOODS.CO.NZ

WOODS Est.1970

P24-128 MILLDALE FAST TRACK S10-S13
MAXIMUM EXCESS SHEAR STRESS MAPS
POST-DEVELOPMENT 10-YEAR ARI 3.8°C

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	
DWG NO		



REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	FOR INFORMATION	-	01/08/2025	DESIGNED	
-	-	-	-	DRAWN	SS
-	-	-	-	CHECKED	-
				APPROVED	-

8 NUGENT STREET
GRAFTON 1023
AUCKAND

WOODS
Est.1970

WOODS.CO.NZ

P24-128 MILLDALE FAST TRACK S10-S13
MAXIMUM EXCESS SHEAR STRESS MAPS
POST-DEVELOPMENT 100-YEAR ARI 3.8°C

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	
DWG NO		

Appendix 2 – Bed shear stress outputs and exceedances

2-YEAR 3.8 POST			10-YEAR 3.8 POST			100-YEAR 3.8 POST		
Time	bed shear	Excess shear	Time	bed shear	Excess shear	Time	bed shear	Excess shear
0.00	-9999.99	-306.75	0.00	-9999.99	-306.75	0.00	-9999.99	-306.75
0.25	-9999.99	-306.75	0.25	-9999.99	-306.75	0.25	-9999.99	-306.75
0.50	-9999.99	-306.75	0.50	-9999.99	-306.75	0.50	-9999.99	-306.75
0.75	-9999.99	-306.75	0.75	-9999.99	-306.75	0.75	-9999.99	-306.75
1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00
1.25	0.40	0.01	1.25	0.00	0.00	1.25	0.00	0.00
1.50	0.00	0.00	1.50	42.26	1.30	1.50	0.00	0.00
1.75	0.95	0.03	1.75	34.80	1.07	1.75	0.00	0.00
2.00	0.00	0.00	2.00	38.58	1.18	2.00	0.00	0.00
2.25	0.00	0.00	2.25	40.59	1.25	2.25	55.43	1.70
2.50	14.99	0.46	2.50	42.02	1.29	2.50	33.57	1.03
2.75	16.67	0.51	2.75	43.19	1.32	2.75	34.83	1.07
3.00	18.99	0.58	3.00	44.52	1.37	3.00	36.00	1.10
3.25	20.01	0.61	3.25	45.53	1.40	3.25	36.93	1.13
3.50	21.00	0.64	3.50	46.51	1.43	3.50	37.73	1.16
3.75	21.81	0.67	3.75	47.51	1.46	3.75	38.41	1.18
4.00	22.58	0.69	4.00	48.31	1.48	4.00	39.13	1.20
4.25	23.27	0.71	4.25	49.32	1.51	4.25	39.36	1.21
4.50	23.85	0.73	4.50	49.87	1.53	4.50	39.88	1.22
4.75	24.46	0.75	4.75	50.30	1.54	4.75	40.35	1.24
5.00	25.13	0.77	5.00	50.76	1.56	5.00	40.82	1.25
5.25	26.03	0.80	5.25	51.04	1.57	5.25	41.22	1.26
5.50	26.27	0.81	5.50	51.34	1.57	5.50	41.60	1.28
5.75	26.78	0.82	5.75	51.67	1.58	5.75	41.96	1.29
6.00	27.24	0.84	6.00	51.99	1.59	6.00	42.30	1.30
6.25	35.70	1.10	6.25	60.86	1.87	6.25	58.47	1.79
6.50	64.12	1.97	6.50	85.16	2.61	6.50	78.08	2.40
6.75	75.81	2.33	6.75	86.41	2.65	6.75	80.49	2.47
7.00	55.34	1.70	7.00	87.46	2.68	7.00	81.16	2.49
7.25	56.46	1.73	7.25	89.47	2.74	7.25	81.61	2.50
7.50	55.32	1.70	7.50	90.46	2.77	7.50	82.42	2.53
7.75	56.25	1.73	7.75	91.09	2.79	7.75	82.98	2.55
8.00	56.97	1.75	8.00	91.60	2.81	8.00	83.21	2.55
8.25	57.71	1.77	8.25	92.00	2.82	8.25	83.98	2.58
8.50	58.33	1.79	8.50	92.48	2.84	8.50	84.33	2.59
8.75	58.90	1.81	8.75	92.66	2.84	8.75	84.66	2.60
9.00	59.45	1.82	9.00	93.16	2.86	9.00	84.96	2.61
9.25	94.57	2.90	9.25	99.17	3.04	9.25	90.43	2.77
9.50	77.27	2.37	9.50	111.32	3.41	9.50	98.65	3.03
9.75	80.16	2.46	9.75	113.32	3.48	9.75	99.39	3.05
10.00	80.93	2.48	10.00	114.59	3.51	10.00	99.78	3.06
10.25	88.03	2.70	10.25	130.40	4.00	10.25	113.58	3.48
10.50	105.00	3.22	10.50	154.86	4.75	10.50	130.66	4.01
10.75	106.18	3.26	10.75	156.89	4.81	10.75	132.25	4.06
11.00	106.81	3.28	11.00	157.82	4.84	11.00	132.99	4.08
11.25	120.71	3.70	11.25	192.58	5.91	11.25	155.79	4.78
11.50	143.01	4.39	11.50	224.10	6.87	11.50	174.06	5.34
11.75	175.79	5.39	11.75	283.26	8.69	11.75	220.00	6.75
12.00	248.82	7.63	12.00	378.03	11.60	12.00	306.68	9.41
12.25	352.68	10.82	12.25	534.53	16.40	12.25	434.44	13.33
12.50	328.38	10.07	12.50	473.89	14.54	12.50	407.48	12.50
12.75	241.10	7.40	12.75	351.36	10.78	12.75	320.27	9.82
13.00	202.53	6.21	13.00	310.30	9.52	13.00	292.06	8.96
13.25	176.67	5.42	13.25	266.27	8.17	13.25	265.13	8.13
13.50	144.16	4.42	13.50	214.68	6.59	13.50	247.98	7.61
13.75	136.94	4.20	13.75	199.59	6.12	13.75	195.74	6.00
14.00	135.88	4.17	14.00	196.56	6.03	14.00	154.69	4.75
14.25	127.99	3.93	14.25	185.21	5.68	14.25	141.45	4.34
14.50	116.47	3.57	14.50	166.80	5.12	14.50	129.82	3.98
14.75	115.56	3.54	14.75	164.57	5.05	14.75	128.61	3.95
15.00	115.59	3.55	15.00	163.32	5.01	15.00	127.97	3.93
15.25	107.77	3.31	15.25	144.32	4.43	15.25	112.95	3.46
15.50	88.97	2.73	15.50	117.03	3.59	15.50	96.39	2.96
15.75	86.27	2.65	15.75	114.93	3.53	15.75	95.52	2.93
16.00	86.28	2.65	16.00	114.83	3.52	16.00	95.46	2.93
16.25	86.29	2.65	16.25	114.79	3.52	16.25	95.45	2.93
16.50	86.31	2.65	16.50	114.80	3.52	16.50	95.44	2.93
16.75	86.30	2.65	16.75	114.82	3.52	16.75	95.45	2.93
17.00	86.36	2.65	17.00	114.85	3.52	17.00	95.46	2.93

2-YEAR 3.8 PRE			10-YEAR 3.8 PRE			100-YEAR 3.8 PRE		
Time	bed shear	Excess shear	Time	bed shear	Excess shear	Time	bed shear	Excess shear
0.00	-9999.99	-306.75	0.00	-9999.99	-306.75	0.00	-9999.99	-306.75
0.25	-9999.99	-306.75	0.25	-9999.99	-306.75	0.25	-9999.99	-306.75
0.50	-9999.99	-306.75	0.50	-9999.99	-306.75	0.50	-9999.99	-306.75
0.75	-9999.99	-306.75	0.75	-9999.99	-306.75	0.75	0.38	0.01
1.00	-9999.99	-306.75	1.00	-9999.99	-306.75	1.00	0.55	0.02
1.25	0.00	0.00	1.25	-9999.99	-306.75	1.25	0.00	0.00
1.50	0.00	0.00	1.50	-9999.99	-306.75	1.50	22.03	0.68
1.75	0.00	0.00	1.75	5.25	0.16	1.75	26.46	0.81
2.00	0.00	0.00	2.00	1.94	0.06	2.00	32.02	0.98
2.25	0.34	0.01	2.25	9.15	0.28	2.25	34.86	1.07
2.50	1.06	0.03	2.50	10.29	0.32	2.50	39.32	1.21
2.75	12.04	0.37	2.75	12.44	0.38	2.75	41.20	1.26
3.00	13.88	0.43	3.00	13.30	0.41	3.00	42.83	1.31
3.25	14.60	0.45	3.25	14.47	0.44	3.25	44.31	1.36
3.50	15.06	0.46	3.50	17.48	0.54	3.50	45.48	1.40
3.75	15.55	0.48	3.75	18.14	0.56	3.75	46.44	1.42
4.00	0.00	0.00	4.00	18.59	0.57	4.00	47.23	1.45
4.25	0.00	0.00	4.25	19.03	0.58	4.25	48.73	1.49
4.50	0.00	0.00	4.50	19.39	0.59	4.50	49.32	1.51
4.75	3.95	0.12	4.75	19.69	0.60	4.75	49.89	1.53
5.00	19.11	0.59	5.00	19.98	0.61	5.00	50.47	1.55
5.25	5.05	0.16	5.25	20.23	0.62	5.25	51.10	1.57
5.50	19.79	0.61	5.50	20.47	0.63	5.50	51.45	1.58
5.75	19.98	0.61	5.75	20.77	0.64	5.75	51.98	1.59
6.00	20.13	0.62	6.00	21.02	0.64	6.00	52.39	1.61
6.25	24.65	0.76	6.25	46.27	1.42	6.25	72.74	2.23
6.50	33.65	1.03	6.50	0.00	0.00	6.50	89.19	2.74
6.75	38.74	1.19	6.75	53.52	1.64	6.75	93.22	2.86
7.00	40.56	1.24	7.00	54.29	1.67	7.00	94.03	2.88
7.25	41.73	1.28	7.25	54.94	1.69	7.25	94.61	2.90
7.50	42.52	1.30	7.50	55.44	1.70	7.50	95.16	2.92
7.75	43.17	1.32	7.75	55.89	1.71	7.75	95.82	2.94
8.00	43.99	1.35	8.00	56.27	1.73	8.00	96.64	2.96
8.25	44.78	1.37	8.25	56.58	1.74	8.25	97.12	2.98
8.50	45.30	1.39	8.50	56.91	1.75	8.50	97.51	2.99
8.75	45.74	1.40	8.75	57.22	1.76	8.75	97.91	3.00
9.00	46.27	1.42	9.00	57.51	1.76	9.00	98.15	3.01
9.25	51.94	1.59	9.25	63.16	1.94	9.25	103.99	3.19
9.50	60.48	1.86	9.50	70.03	2.15	9.50	112.55	3.45
9.75	63.15	1.94	9.75	71.38	2.19	9.75	113.92	3.49
10.00	63.81	1.96	10.00	71.76	2.20	10.00	114.35	3.51
10.25	73.23	2.25	10.25	81.46	2.50	10.25	127.87	3.92
10.50	82.28	2.52	10.50	92.14	2.83	10.50	145.75	4.47
10.75	84.24	2.58	10.75	94.16	2.89	10.75	148.37	4.55
11.00	84.73	2.60	11.00	94.70	2.90	11.00	149.02	4.57
11.25	94.99	2.91	11.25	109.11	3.35	11.25	167.77	5.15
11.50	107.00	3.28	11.50	129.24	3.96	11.50	185.36	5.69
11.75	127.42	3.91	11.75	154.25	4.73	11.75	214.63	6.58
12.00	174.02	5.34	12.00	199.03	6.11	12.00	263.74	8.09
12.25	230.99	7.09	12.25	260.03	7.98	12.25	337.96	10.37
12.50	228.04	7.00	12.50	247.26	7.58	12.50	337.72	10.36
12.75	210.86	6.47	12.75	234.56	7.20	12.75	315.01	9.66
13.00	148.38	4.55	13.00	225.39	6.91	13.00	284.18	8.72
13.25	124.24	3.81	13.25	208.02	6.38	13.25	264.77	8.12
13.50	101.70	3.12	13.50	180.06	5.52	13.50	256.17	7.86
13.75	99.07	3.04	13.75	114.88	3.52	13.75	246.18	7.55
14.00	98.94	3.03	14.00	112.80	3.46	14.00	233.99	7.18
14.25	94.09	2.89	14.25	104.69	3.21	14.25	212.96	6.53
14.50	87.45	2.68	14.50	94.97	2.91	14.50	152.08	4.67
14.75	86.32	2.65	14.75	93.74	2.88	14.75	146.20	4.48
15.00	86.34	2.65	15.00	93.73	2.88	15.00	144.96	4.45
15.25	79.82	2.45	15.25	84.62	2.60	15.25	130.44	4.00
15.50	68.98	2.12	15.50	72.49	2.22	15.50	112.26	3.44
15.75	64.82	1.99	15.75	70.37	2.16	15.75	109.62	3.36
16.00	64.61	1.98	16.00	70.34	2.16	16.00	109.29	3.35
16.25	64.65	1.98	16.25	70.34	2.16	16.25	109.03	3.34
16.50	64.70	1.98	16.50	70.37	2.16	16.50	108.96	3.34
16.75	64.73	1.99	16.75	70.38	2.16	16.75	108.90	3.34
17.00	64.77	1.99	17.00	70.39	2.16	17.00	108.88	3.34

	Post development			Pre-development			Change		
	2-year	10-year	100-year	2-year	10-year	100-year	2-year	10-year	100-year
<1 (%)	26%	6%	9%	27%	27%	9%	-1%	-21%	0%
>1 & <2 (%)	34%	21%	19%	51%	37%	16%	-16%	-16%	2%
>2 & <10 (%)	38%	69%	70%	23%	36%	71%	15%	33%	-1%
>10 (%)	2%	4%	2%	0%	0%	2%	2%	4%	0%
	100%	100%	100%						

17.25	86.43	2.65	17.25	114.90	3.52	17.25	95.49	2.93	17.25	64.81	1.99	17.25	70.41	2.16	17.25	108.92	3.34
17.50	86.41	2.65	17.50	114.93	3.53	17.50	95.49	2.93	17.50	64.85	1.99	17.50	70.42	2.16	17.50	108.90	3.34
17.75	86.51	2.65	17.75	115.00	3.53	17.75	95.54	2.93	17.75	64.89	1.99	17.75	70.44	2.16	17.75	108.91	3.34
18.00	86.50	2.65	18.00	115.00	3.53	18.00	95.53	2.93	18.00	64.92	1.99	18.00	70.44	2.16	18.00	108.97	3.34
18.25	80.04	2.46	18.25	102.36	3.14	18.25	85.83	2.63	18.25	56.06	1.72	18.25	62.30	1.91	18.25	98.65	3.03
18.50	76.47	2.35	18.50	83.21	2.55	18.50	100.72	3.09	18.50	43.01	1.32	18.50	47.95	1.47	18.50	82.28	2.52
18.75	64.87	1.99	18.75	79.54	2.44	18.75	65.72	2.02	18.75	38.09	1.17	18.75	42.81	1.31	18.75	79.00	2.42
19.00	64.10	1.97	19.00	79.37	2.43	19.00	65.72	2.02	19.00	37.51	1.15	19.00	42.48	1.30	19.00	78.89	2.42
19.25	64.10	1.97	19.25	79.35	2.43	19.25	65.69	2.02	19.25	37.49	1.15	19.25	42.49	1.30	19.25	78.89	2.42
19.50	64.12	1.97	19.50	79.33	2.43	19.50	65.66	2.01	19.50	37.51	1.15	19.50	42.49	1.30	19.50	78.89	2.42
19.75	64.14	1.97	19.75	79.32	2.43	19.75	65.66	2.01	19.75	37.52	1.15	19.75	42.49	1.30	19.75	78.89	2.42
20.00	64.12	1.97	20.00	79.30	2.43	20.00	65.64	2.01	20.00	37.52	1.15	20.00	42.50	1.30	20.00	78.90	2.42
20.25	64.14	1.97	20.25	79.32	2.43	20.25	65.66	2.01	20.25	37.54	1.15	20.25	42.51	1.30	20.25	78.89	2.42
20.50	64.18	1.97	20.50	79.33	2.43	20.50	65.65	2.01	20.50	37.54	1.15	20.50	42.51	1.30	20.50	78.90	2.42
20.75	64.22	1.97	20.75	79.33	2.43	20.75	65.64	2.01	20.75	37.55	1.15	20.75	42.52	1.30	20.75	78.90	2.42
21.00	64.24	1.97	21.00	79.35	2.43	21.00	65.64	2.01	21.00	37.55	1.15	21.00	42.53	1.30	21.00	78.90	2.42
21.25	64.28	1.97	21.25	79.35	2.43	21.25	65.66	2.01	21.25	37.58	1.15	21.25	42.53	1.30	21.25	78.92	2.42
21.50	64.31	1.97	21.50	79.37	2.43	21.50	65.67	2.01	21.50	37.56	1.15	21.50	42.54	1.31	21.50	78.91	2.42
21.75	64.35	1.97	21.75	79.38	2.43	21.75	65.67	2.01	21.75	37.58	1.15	21.75	42.56	1.31	21.75	78.92	2.42
22.00	64.36	1.97	22.00	79.39	2.44	22.00	65.67	2.01	22.00	37.58	1.15	22.00	42.56	1.31	22.00	78.92	2.42
22.25	64.39	1.98	22.25	79.40	2.44	22.25	65.69	2.01	22.25	37.59	1.15	22.25	42.57	1.31	22.25	78.91	2.42
22.50	64.42	1.98	22.50	79.40	2.44	22.50	65.72	2.02	22.50	37.61	1.15	22.50	42.58	1.31	22.50	78.93	2.42
22.75	64.45	1.98	22.75	79.43	2.44	22.75	65.70	2.02	22.75	37.62	1.15	22.75	42.57	1.31	22.75	78.94	2.42
23.00	64.46	1.98	23.00	79.44	2.44	23.00	65.73	2.02	23.00	37.62	1.15	23.00	42.60	1.31	23.00	78.93	2.42
23.25	64.51	1.98	23.25	79.44	2.44	23.25	65.71	2.02	23.25	37.64	1.15	23.25	42.60	1.31	23.25	78.95	2.42
23.50	64.52	1.98	23.50	79.45	2.44	23.50	65.71	2.02	23.50	37.64	1.15	23.50	42.61	1.31	23.50	78.94	2.42
23.75	64.57	1.98	23.75	79.46	2.44	23.75	65.72	2.02	23.75	37.65	1.15	23.75	42.62	1.31	23.75	78.94	2.42
24.00	60.85	1.87	24.00	75.85	2.33	24.00	64.28	1.97	24.00	35.49	1.09	24.00	57.53	1.76	24.00	74.64	2.29

2-YEAR 3.8 POST			10-YEAR 3.8 POST			100-YEAR 3.8 POST		
Time	bed shear	Excess shear	time	bed shear	Excess shear	time	bed shear	Excess shear
0.00	-9999.99	-306.75	0.00	0.00	0.00	0.00	0.00	0.00
0.25	-9999.99	-306.75	0.25	0.00	0.00	0.25	0.00	0.00
0.50	-9999.99	-306.75	0.50	0.00	0.00	0.50	0.00	0.00
0.75	-9999.99	-306.75	0.75	0.00	0.00	0.75	86.03	2.64
1.00	-9999.99	-306.75	1.00	0.00	0.00	1.00	194.82	5.98
1.25	-9999.99	-306.75	1.25	0.00	0.00	1.25	250.54	7.69
1.50	-9999.99	-306.75	1.50	0.00	0.00	1.50	292.17	8.96
1.75	-9999.99	-306.75	1.75	250.50	7.68	1.75	301.57	9.25
2.00	0.00	0.00	2.00	264.34	8.11	2.00	307.88	9.44
2.25	204.43	6.27	2.25	272.74	8.37	2.25	312.91	9.60
2.50	219.88	6.74	2.50	277.19	8.50	2.50	317.36	9.73
2.75	225.24	6.91	2.75	280.94	8.62	2.75	320.55	9.83
3.00	232.21	7.12	3.00	284.31	8.72	3.00	323.24	9.92
3.25	236.14	7.24	3.25	287.28	8.81	3.25	325.57	9.99
3.50	238.67	7.32	3.50	290.17	8.90	3.50	327.56	10.05
3.75	240.91	7.39	3.75	292.59	8.98	3.75	329.24	10.10
4.00	242.82	7.45	4.00	294.66	9.04	4.00	330.80	10.15
4.25	244.49	7.50	4.25	296.45	9.09	4.25	332.20	10.19
4.50	246.12	7.55	4.50	297.98	9.14	4.50	333.49	10.23
4.75	247.64	7.60	4.75	299.43	9.18	4.75	334.59	10.26
5.00	249.32	7.65	5.00	300.92	9.23	5.00	335.64	10.30
5.25	250.86	7.69	5.25	302.12	9.27	5.25	336.59	10.32
5.50	252.18	7.74	5.50	303.26	9.30	5.50	337.39	10.35
5.75	253.45	7.77	5.75	304.28	9.33	5.75	338.20	10.37
6.00	254.58	7.81	6.00	305.21	9.36	6.00	338.95	10.40
6.25	271.33	8.32	6.25	324.87	9.97	6.25	364.72	11.19
6.50	308.30	9.46	6.50	366.16	11.23	6.50	393.26	12.06
6.75	324.69	9.96	6.75	371.65	11.40	6.75	395.99	12.15
7.00	327.46	10.04	7.00	372.99	11.44	7.00	396.70	12.17
7.25	329.28	10.10	7.25	374.58	11.49	7.25	397.44	12.19
7.50	330.80	10.15	7.50	375.76	11.53	7.50	397.87	12.20
7.75	332.23	10.19	7.75	376.61	11.55	7.75	398.32	12.22
8.00	333.53	10.23	8.00	377.48	11.58	8.00	398.70	12.23
8.25	334.72	10.27	8.25	378.27	11.60	8.25	399.05	12.24
8.50	335.73	10.30	8.50	379.01	11.63	8.50	399.15	12.24
8.75	336.68	10.33	8.75	379.65	11.65	8.75	399.41	12.25
9.00	337.52	10.35	9.00	380.28	11.67	9.00	399.76	12.26
9.25	343.78	10.55	9.25	386.60	11.86	9.25	403.91	12.39
9.50	359.19	11.02	9.50	394.96	12.12	9.50	404.98	12.42
9.75	362.40	11.12	9.75	395.80	12.14	9.75	404.94	12.42
10.00	363.30	11.14	10.00	396.16	12.15	10.00	405.34	12.43
10.25	371.91	11.41	10.25	399.25	12.25	10.25	408.94	12.54
10.50	389.95	11.96	10.50	401.88	12.33	10.50	410.69	12.60
10.75	391.75	12.02	10.75	402.02	12.33	10.75	410.94	12.61
11.00	392.31	12.03	11.00	401.58	12.32	11.00	411.10	12.61
11.25	399.18	12.24	11.25	404.10	12.40	11.25	417.47	12.81
11.50	401.28	12.31	11.50	403.54	12.38	11.50	419.03	12.85
11.75	404.60	12.41	11.75	405.82	12.45	11.75	429.50	13.17
12.00	405.94	12.45	12.00	416.79	12.78	12.00	362.95	11.13
12.25	417.22	12.80	12.25	226.94	6.96	12.25	120.65	3.70
12.50	402.39	12.34	12.50	222.90	6.84	12.50	107.91	3.31
12.75	401.11	12.30	12.75	404.27	12.40	12.75	254.35	7.80
13.00	402.17	12.34	13.00	403.68	12.38	13.00	345.71	10.60
13.25	400.23	12.28	13.25	401.71	12.32	13.25	343.56	10.54
13.50	399.40	12.25	13.50	401.50	12.32	13.50	421.64	12.93
13.75	399.26	12.25	13.75	401.81	12.33	13.75	411.93	12.64
14.00	399.12	12.24	14.00	401.90	12.33	14.00	415.16	12.74
14.25	397.26	12.19	14.25	401.03	12.30	14.25	412.06	12.64
14.50	392.95	12.05	14.50	400.80	12.29	14.50	409.93	12.57
14.75	392.47	12.04	14.75	400.78	12.29	14.75	409.86	12.57
15.00	392.48	12.04	15.00	400.83	12.30	15.00	409.80	12.57
15.25	387.49	11.89	15.25	399.30	12.25	15.25	406.00	12.45
15.50	369.44	11.33	15.50	394.74	12.11	15.50	402.47	12.35
15.75	365.19	11.20	15.75	394.04	12.09	15.75	402.57	12.35
16.00	365.05	11.20	16.00	394.03	12.09	16.00	402.57	12.35
16.25	365.08	11.20	16.25	394.01	12.09	16.25	402.56	12.35
16.50	365.11	11.20	16.50	394.00	12.09	16.50	402.56	12.35
16.75	365.15	11.20	16.75	394.01	12.09	16.75	402.56	12.35
17.00	365.20	11.20	17.00	394.03	12.09	17.00	402.56	12.35

2-YEAR 3.8 PRE			10-YEAR 3.8 PRE			100-YEAR 3.8 PRE		
Time	bed shear	Excess shear	Time	bed shear	Excess shear	Time	bed shear	Excess shear
0.00	-9999.99	-306.75	0.00	-9999.99	-306.75	0.00	0.00	0.00
0.25	-9999.99	-306.75	0.25	-9999.99	-306.75	0.25	0.00	0.00
0.50	-9999.99	-306.75	0.50	-9999.99	-306.75	0.50	0.00	0.00
0.75	-9999.99	-306.75	0.75	-9999.99	-306.75	0.75	0.00	0.00
1.00	-9999.99	-306.75	1.00	-9999.99	-306.75	1.00	0.00	0.00
1.25	-9999.99	-306.75	1.25	-9999.99	-306.75	1.25	0.00	0.00
1.50	-9999.99	-306.75	1.50	-9999.99	-306.75	1.50	307.13	9.42
1.75	-9999.99	-306.75	1.75	263.82	8.09	1.75	333.06	10.22
2.00	-9999.99	-306.75	2.00	0.00	0.00	2.00	356.64	10.94
2.25	-9999.99	-306.75	2.25	298.42	9.15	2.25	365.72	11.22
2.50	0.00	0.00	2.50	304.31	9.33	2.50	376.40	11.55
2.75	0.00	0.00	2.75	318.22	9.76	2.75	380.76	11.68
3.00	0.00	0.00	3.00	329.24	10.10	3.00	383.73	11.77
3.25	0.00	0.00	3.25	333.29	10.22	3.25	386.12	11.84
3.50	211.30	6.48	3.50	341.40	10.47	3.50	388.19	11.91
3.75	213.99	6.56	3.75	344.20	10.56	3.75	389.95	11.96
4.00	225.62	6.92	4.00	346.49	10.63	4.00	391.26	12.00
4.25	228.77	7.02	4.25	348.40	10.69	4.25	392.57	12.04
4.50	235.71	7.23	4.50	350.28	10.74	4.50	393.82	12.08
4.75	237.96	7.30	4.75	352.06	10.80	4.75	394.49	12.10
5.00	240.59	7.38	5.00	353.46	10.84	5.00	395.45	12.13
5.25	246.29	7.55	5.25	354.74	10.88	5.25	396.35	12.16
5.50	248.12	7.61	5.50	355.89	10.92	5.50	397.12	12.18
5.75	249.66	7.66	5.75	356.89	10.95	5.75	398.28	12.22
6.00	250.92	7.70	6.00	357.80	10.98	6.00	398.96	12.24
6.25	267.62	8.21	6.25	380.64	11.68	6.25	420.35	12.89
6.50	303.88	9.32	6.50	411.53	12.62	6.50	446.76	13.70
6.75	321.69	9.87	6.75	419.93	12.88	6.75	450.17	13.81
7.00	326.92	10.03	7.00	421.61	12.93	7.00	451.07	13.84
7.25	329.13	10.10	7.25	422.86	12.97	7.25	451.73	13.86
7.50	330.90	10.15	7.50	423.84	13.00	7.50	452.32	13.87
7.75	332.62	10.20	7.75	424.63	13.03	7.75	452.89	13.89
8.00	333.99	10.25	8.00	425.41	13.05	8.00	453.40	13.91
8.25	335.30	10.29	8.25	426.09	13.07	8.25	453.46	13.91
8.50	336.50	10.32	8.50	426.32	13.08	8.50	453.89	13.92
8.75	337.61	10.36	8.75	426.91	13.10	8.75	454.20	13.93
9.00	338.64	10.39	9.00	427.43	13.11	9.00	454.51	13.94
9.25	347.30	10.65	9.25	433.86	13.31	9.25	459.48	14.09
9.50	361.70	11.10	9.50	444.10	13.62	9.50	463.61	14.22
9.75	366.25	11.23	9.75	445.97	13.68	9.75	464.77	14.26
10.00	367.61	11.28	10.00	446.45	13.69	10.00	465.07	14.27
10.25	380.59	11.67	10.25	454.23	13.93	10.25	475.05	14.57
10.50	398.03	12.21	10.50	461.64	14.16	10.50	486.72	14.93
10.75	403.22	12.37	10.75	462.29	14.18	10.75	488.40	14.98
11.00	404.32	12.40	11.00	462.64	14.19	11.00	489.13	15.00
11.25	417.77	12.82	11.25	473.54	14.53	11.25	504.06	15.46
11.50	432.61	13.27	11.50	485.95	14.91	11.50	520.57	15.97
11.75	451.27	13.84	11.75	505.65	15.51	11.75	559.12	17.15
12.00	490.34	15.04	12.00	561.79	17.23	12.00	662.28	20.32
12.25	578.16	17.74	12.25	714.40	21.91	12.25	493.31	15.13
12.50	553.33	16.97	12.50	650.89	19.97	12.50	478.16	14.67
12.75	528.64	16.22	12.75	616.37	18.91	12.75	746.08	22.89
13.00	470.92	14.45	13.00	598.15	18.35	13.00	684.77	21.01
13.25	449.57	13.79	13.25	564.33	17.31	13.25	637.63	19.56
13.50	426.26	13.08	13.50	530.45	16.27	13.50	619.53	19.00
13.75	422.59	12.96	13.75	476.38	14.61	13.75	602.01	18.47
14.00	422.35	12.96	14.00	474.91	14.57	14.00	581.92	17.85
14.25	417.01	12.79	14.25	469.51	14.40	14.25	550.50	16.89
14.50	406.88	12.48	14.50	462.45	14.19	14.50	493.18	15.13
14.75	404.71	12.41	14.75	461.61	14.16	14.75	486.78	14.93
15.00	404.70	12.41	15.00	461.59	14.16	15.00	485.95	14.91
15.25	394.96	12.12	15.25	455.11	13.96	15.25	476.30	14.61
15.50	375.19	11.51	15.50	445.41	13.66	15.50	463.27	14.21
15.75	367.50	11.27	15.75	442.42	13.57	15.75	461.23	14.15
16.00	367.02	11.26	16.00	442.36	13.57	16.00	461.03	14.14
16.25	367.07	11.26	16.25	442.38	13.57	16.25	460.89	14.14
16.50	367.13	11.26	16.50	442.39	13.57	16.50	460.81	14.14
16.75	367.19	11.26	16.75	442.40	13.57	16.75	460.80	14.13
17.00	367.29	11.27	17.00	442.43	13.57	17.00	460.80	14.13

	Post development			Pre-development			Change		
	2-year	10-year	100-year	2-year	10-year	100-year	2-year	10-year	100-year
<1 (%)	9%	7%	3%	14%	8%	6%	-5%	-1%	-3%
>1 & <2 (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%
>2 & <10 (%)	0%	0%	0%	37%	4%	0%	-37%	-4%	0%
>10 (%)	91%	93%	97%	48%	88%	93%	42%	5%	4%
	100%	100%	100%						

17.25	365.25	11.20	17.25	394.05	12.09	17.25	402.56	12.35	17.25	367.30	11.27	17.25	442.46	13.57	17.25	460.79	14.13
17.50	365.33	11.21	17.50	394.04	12.09	17.50	402.56	12.35	17.50	367.37	11.27	17.50	442.47	13.57	17.50	460.80	14.14
17.75	365.41	11.21	17.75	394.08	12.09	17.75	402.57	12.35	17.75	367.42	11.27	17.75	442.49	13.57	17.75	460.80	14.14
18.00	365.48	11.21	18.00	394.07	12.09	18.00	402.58	12.35	18.00	367.45	11.27	18.00	442.48	13.57	18.00	460.81	14.14
18.25	357.33	10.96	18.25	388.67	11.92	18.25	399.09	12.24	18.25	356.58	10.94	18.25	433.36	13.29	18.25	454.06	13.93
18.50	330.92	10.15	18.50	364.39	11.18	18.50	383.69	11.77	18.50	328.65	10.08	18.50	411.23	12.61	18.50	437.54	13.42
18.75	317.76	9.75	18.75	357.30	10.96	18.75	378.72	11.62	18.75	313.54	9.62	18.75	403.37	12.37	18.75	431.37	13.23
19.00	316.69	9.71	19.00	356.94	10.95	19.00	378.68	11.62	19.00	310.68	9.53	19.00	402.54	12.35	19.00	431.08	13.22
19.25	316.65	9.71	19.25	356.92	10.95	19.25	378.68	11.62	19.25	310.59	9.53	19.25	402.52	12.35	19.25	431.10	13.22
19.50	316.67	9.71	19.50	356.89	10.95	19.50	378.63	11.61	19.50	310.61	9.53	19.50	402.54	12.35	19.50	431.09	13.22
19.75	316.67	9.71	19.75	356.87	10.95	19.75	378.61	11.61	19.75	310.64	9.53	19.75	402.54	12.35	19.75	431.09	13.22
20.00	316.70	9.71	20.00	356.86	10.95	20.00	378.62	11.61	20.00	310.68	9.53	20.00	402.59	12.35	20.00	431.09	13.22
20.25	316.72	9.72	20.25	356.88	10.95	20.25	378.62	11.61	20.25	310.69	9.53	20.25	402.59	12.35	20.25	431.09	13.22
20.50	316.72	9.72	20.50	356.88	10.95	20.50	378.63	11.61	20.50	310.72	9.53	20.50	402.61	12.35	20.50	431.10	13.22
20.75	316.76	9.72	20.75	356.89	10.95	20.75	378.63	11.61	20.75	310.75	9.53	20.75	402.61	12.35	20.75	431.11	13.22
21.00	316.77	9.72	21.00	356.90	10.95	21.00	378.62	11.61	21.00	310.79	9.53	21.00	402.62	12.35	21.00	431.12	13.22
21.25	316.82	9.72	21.25	356.93	10.95	21.25	378.65	11.61	21.25	310.82	9.53	21.25	402.64	12.35	21.25	431.12	13.22
21.50	316.84	9.72	21.50	356.94	10.95	21.50	378.65	11.62	21.50	310.84	9.53	21.50	402.64	12.35	21.50	431.12	13.22
21.75	316.88	9.72	21.75	356.94	10.95	21.75	378.67	11.62	21.75	310.88	9.54	21.75	402.65	12.35	21.75	431.13	13.22
22.00	316.90	9.72	22.00	356.96	10.95	22.00	378.66	11.62	22.00	310.90	9.54	22.00	402.67	12.35	22.00	431.14	13.23
22.25	316.92	9.72	22.25	356.97	10.95	22.25	378.67	11.62	22.25	310.91	9.54	22.25	402.69	12.35	22.25	431.15	13.23
22.50	316.96	9.72	22.50	356.98	10.95	22.50	378.69	11.62	22.50	310.96	9.54	22.50	402.69	12.35	22.50	431.14	13.23
22.75	316.99	9.72	22.75	357.03	10.95	22.75	378.69	11.62	22.75	310.98	9.54	22.75	402.71	12.35	22.75	431.15	13.23
23.00	317.00	9.72	23.00	357.03	10.95	23.00	378.70	11.62	23.00	311.01	9.54	23.00	402.72	12.35	23.00	431.16	13.23
23.25	317.04	9.73	23.25	357.07	10.95	23.25	378.71	11.62	23.25	311.03	9.54	23.25	402.72	12.35	23.25	431.16	13.23
23.50	317.06	9.73	23.50	357.06	10.95	23.50	378.71	11.62	23.50	311.07	9.54	23.50	402.76	12.35	23.50	431.17	13.23
23.75	317.09	9.73	23.75	357.08	10.95	23.75	378.72	11.62	23.75	311.10	9.54	23.75	402.83	12.36	23.75	431.18	13.23
24.00	316.14	9.70	24.00	355.32	10.90	24.00	373.25	11.45	24.00	308.33	9.46	24.00	400.30	12.28	24.00	428.95	13.16
									24.00	308.38							

2-YEAR 3.8 POST			10-YEAR 3.8 POST			100-YEAR 3.8 POST		
Time	bed shear	Excess shear	Time	bed shear	Excess shear	Time	bed shear	Excess shear
0.00	-9999.99	-306.75	0.00	-9999.99	-306.75	0.00	-9999.99	-306.75
0.25	-9999.99	-306.75	0.25	-9999.99	-306.75	0.25	-9999.99	-306.75
0.50	-9999.99	-306.75	0.50	-9999.99	-306.75	0.50	-9999.99	-306.75
0.75	-9999.99	-306.75	0.75	-9999.99	-306.75	0.75	-9999.99	-306.75
1.00	-9999.99	-306.75	1.00	27.70	0.85	1.00	-9999.99	-306.75
1.25	-9999.99	-306.75	1.25	0.00	0.00	1.25	0.00	0.00
1.50	-9999.99	-306.75	1.50	0.00	0.00	1.50	0.00	0.00
1.75	-9999.99	-306.75	1.75	0.00	0.00	1.75	0.00	0.00
2.00	0.00	0.00	2.00	0.00	0.00	2.00	49.58	1.52
2.25	0.00	0.00	2.25	0.00	0.00	2.25	52.25	1.60
2.50	11.20	0.34	2.50	0.00	0.00	2.50	54.59	1.67
2.75	13.35	0.41	2.75	0.00	0.00	2.75	57.14	1.75
3.00	14.52	0.45	3.00	0.00	0.00	3.00	58.78	1.80
3.25	15.50	0.48	3.25	0.00	0.00	3.25	60.24	1.85
3.50	16.05	0.49	3.50	0.00	0.00	3.50	61.48	1.89
3.75	16.52	0.51	3.75	0.00	0.00	3.75	62.65	1.92
4.00	16.96	0.52	4.00	0.00	0.00	4.00	63.73	1.96
4.25	17.33	0.53	4.25	0.00	0.00	4.25	64.67	1.98
4.50	17.69	0.54	4.50	0.00	0.00	4.50	65.55	2.01
4.75	18.06	0.55	4.75	0.00	0.00	4.75	66.31	2.03
5.00	18.44	0.57	5.00	0.00	0.00	5.00	67.04	2.06
5.25	18.78	0.58	5.25	0.00	0.00	5.25	67.73	2.08
5.50	19.12	0.59	5.50	0.00	0.00	5.50	68.34	2.10
5.75	19.42	0.60	5.75	0.00	0.00	5.75	68.96	2.12
6.00	19.70	0.60	6.00	0.00	0.00	6.00	69.50	2.13
6.25	24.30	0.75	6.25	0.00	0.00	6.25	91.73	2.81
6.50	35.10	1.08	6.50	93.36	2.86	6.50	144.35	4.43
6.75	44.39	1.36	6.75	104.83	3.22	6.75	158.88	4.87
7.00	45.70	1.40	7.00	106.76	3.27	7.00	161.15	4.94
7.25	46.69	1.43	7.25	109.31	3.35	7.25	163.34	5.01
7.50	47.55	1.46	7.50	112.28	3.44	7.50	165.45	5.08
7.75	48.34	1.48	7.75	113.91	3.49	7.75	167.11	5.13
8.00	49.06	1.50	8.00	115.37	3.54	8.00	168.58	5.17
8.25	49.78	1.53	8.25	116.60	3.58	8.25	170.04	5.22
8.50	50.40	1.55	8.50	117.84	3.61	8.50	171.33	5.26
8.75	50.99	1.56	8.75	118.93	3.65	8.75	172.55	5.29
9.00	51.53	1.58	9.00	120.07	3.68	9.00	173.74	5.33
9.25	55.74	1.71	9.25	130.65	4.01	9.25	100.67	3.09
9.50	66.38	2.04	9.50	157.56	4.83	9.50	121.60	3.73
9.75	70.81	2.17	9.75	162.84	4.99	9.75	125.68	3.86
10.00	71.83	2.20	10.00	164.84	5.06	10.00	127.24	3.90
10.25	81.12	2.49	10.25	189.14	5.80	10.25	150.25	4.61
10.50	105.91	3.25	10.50	240.48	7.38	10.50	193.00	5.92
10.75	110.76	3.40	10.75	247.92	7.60	10.75	199.89	6.13
11.00	112.23	3.44	11.00	250.94	7.70	11.00	201.58	6.18
11.25	131.72	4.04	11.25	162.22	4.98	11.25	244.93	7.51
11.50	92.23	2.83	11.50	208.86	6.41	11.50	306.28	9.39
11.75	121.50	3.73	11.75	283.59	8.70	11.75	395.26	12.12
12.00	221.04	6.78	12.00	496.34	15.23	12.00	554.08	17.00
12.25	468.96	14.39	12.25	727.85	22.33	12.25	590.43	18.11
12.50	464.69	14.25	12.50	702.62	21.55	12.50	595.50	18.27
12.75	247.90	7.60	12.75	495.57	15.20	12.75	592.80	18.18
13.00	171.31	5.25	13.00	370.04	11.35	13.00	559.00	17.15
13.25	133.04	4.08	13.25	293.07	8.99	13.25	526.54	16.15
13.50	92.44	2.84	13.50	210.95	6.47	13.50	476.40	14.61
13.75	84.01	2.58	13.75	188.25	5.77	13.75	423.30	12.98
14.00	82.62	2.53	14.00	183.58	5.63	14.00	268.22	8.23
14.25	76.91	2.36	14.25	167.99	5.15	14.25	232.68	7.14
14.50	123.86	3.80	14.50	270.27	8.29	14.50	200.83	6.16
14.75	120.83	3.71	14.75	264.18	8.10	14.75	195.51	6.00
15.00	120.85	3.71	15.00	261.57	8.02	15.00	194.09	5.95
15.25	108.69	3.33	15.25	231.50	7.10	15.25	169.84	5.21
15.50	82.60	2.53	15.50	175.14	5.37	15.50	127.92	3.92
15.75	76.53	2.35	15.75	167.25	5.13	15.75	125.49	3.85
16.00	76.28	2.34	16.00	166.94	5.12	16.00	125.41	3.85
16.25	76.32	2.34	16.25	166.88	5.12	16.25	125.40	3.85
16.50	76.36	2.34	16.50	166.86	5.12	16.50	125.40	3.85
16.75	76.40	2.34	16.75	166.91	5.12	16.75	125.41	3.85
17.00	76.45	2.35	17.00	166.98	5.12	17.00	125.42	3.85

2-YEAR 3.8 PRE			10-YEAR 3.8 PRE			100-YEAR 3.8 PRE		
Time	bed shear	Excess shear	Time	bed shear	Excess shear	Time	bed shear	Excess shear
0.00	-9999.99	-306.75	0.00	-9999.99	-306.75	0.00	-9999.99	-306.75
0.25	-9999.99	-306.75	0.25	-9999.99	-306.75	0.25	-9999.99	-306.75
0.50	-9999.99	-306.75	0.50	-9999.99	-306.75	0.50	-9999.99	-306.75
0.75	-9999.99	-306.75	0.75	-9999.99	-306.75	0.75	-9999.99	-306.75
1.00	-9999.99	-306.75	1.00	-9999.99	-306.75	1.00	-9999.99	-306.75
1.25	-9999.99	-306.75	1.25	-9999.99	-306.75	1.25	-9999.99	-306.75
1.50	-9999.99	-306.75	1.50	-9999.99	-306.75	1.50	0.00	0.00
1.75	-9999.99	-306.75	1.75	-9999.99	-306.75	1.75	0.00	0.00
2.00	-9999.99	-306.75	2.00	0.00	0.00	2.00	0.00	0.00
2.25	-9999.99	-306.75	2.25	0.00	0.00	2.25	0.00	0.00
2.50	-9999.99	-306.75	2.50	0.00	0.00	2.50	61.29	1.88
2.75	0.00	0.00	2.75	0.00	0.00	2.75	64.60	1.98
3.00	0.00	0.00	3.00	0.00	0.00	3.00	66.84	2.05
3.25	0.00	0.00	3.25	0.00	0.00	3.25	68.78	2.11
3.50	0.00	0.00	3.50	0.00	0.00	3.50	70.67	2.17
3.75	0.00	0.00	3.75	0.00	0.00	3.75	72.48	2.22
4.00	0.00	0.00	4.00	0.00	0.00	4.00	73.74	2.26
4.25	0.00	0.00	4.25	0.00	0.00	4.25	74.92	2.30
4.50	0.00	0.00	4.50	0.00	0.00	4.50	75.96	2.33
4.75	0.00	0.00	4.75	0.00	0.00	4.75	76.92	2.36
5.00	0.00	0.00	5.00	0.00	0.00	5.00	77.79	2.39
5.25	0.00	0.00	5.25	0.00	0.00	5.25	78.59	2.41
5.50	0.00	0.00	5.50	0.00	0.00	5.50	79.35	2.43
5.75	0.00	0.00	5.75	0.00	0.00	5.75	80.06	2.46
6.00	0.00	0.00	6.00	0.00	0.00	6.00	80.73	2.48
6.25	0.00	0.00	6.25	61.21	1.88	6.25	100.65	3.09
6.50	0.00	0.00	6.50	92.74	2.84	6.50	155.67	4.78
6.75	60.31	1.85	6.75	108.29	3.32	6.75	173.59	5.32
7.00	63.93	1.96	7.00	111.68	3.43	7.00	177.06	5.43
7.25	65.43	2.01	7.25	113.37	3.48	7.25	179.28	5.50
7.50	66.65	2.04	7.50	114.91	3.52	7.50	181.10	5.56
7.75	67.74	2.08	7.75	116.27	3.57	7.75	182.97	5.61
8.00	68.69	2.11	8.00	117.52	3.60	8.00	184.67	5.66
8.25	69.58	2.13	8.25	118.66	3.64	8.25	186.27	5.71
8.50	70.64	2.17	8.50	119.79	3.67	8.50	187.91	5.76
8.75	71.75	2.20	8.75	120.80	3.71	8.75	189.31	5.81
9.00	72.46	2.22	9.00	121.77	3.74	9.00	190.59	5.85
9.25	77.26	2.37	9.25	132.13	4.05	9.25	208.34	6.39
9.50	89.26	2.74	9.50	154.24	4.73	9.50	131.83	4.04
9.75	95.34	2.92	9.75	162.00	4.97	9.75	137.00	4.20
10.00	97.05	2.98	10.00	163.65	5.02	10.00	138.20	4.24
10.25	109.05	3.35	10.25	186.23	5.71	10.25	159.14	4.88
10.50	136.23	4.18	10.50	125.80	3.86	10.50	200.00	6.13
10.75	145.98	4.48	10.75	132.82	4.07	10.75	207.71	6.37
11.00	148.06	4.54	11.00	134.26	4.12	11.00	210.31	6.45
11.25	171.30	5.25	11.25	158.02	4.85	11.25	244.30	7.49
11.50	221.33	6.79	11.50	203.90	6.25	11.50	303.88	9.32
11.75	153.95	4.72	11.75	256.13	7.86	11.75	397.83	12.20
12.00	250.75	7.69	12.00	404.66	12.41	12.00	515.97	15.83
12.25	459.51	14.10	12.25	563.01	17.27	12.25	627.03	19.23
12.50	434.11	13.32	12.50	532.52	16.33	12.50	608.15	18.65
12.75	396.62	12.17	12.75	499.33	15.32	12.75	591.05	18.13
13.00	259.26	7.95	13.00	474.23	14.55	13.00	552.09	16.94
13.25	175.36	5.38	13.25	437.23	13.41	13.25	515.38	15.81
13.50	224.01	6.87	13.50	374.02	11.47	13.50	493.11	15.13
13.75	201.78	6.19	13.75	189.14	5.80	13.75	471.74	14.47
14.00	200.35	6.15	14.00	178.85	5.49	14.00	450.91	13.83
14.25	188.20	5.77	14.25	165.75	5.08	14.25	403.41	12.37
14.50	162.59	4.99	14.50	140.99	4.32	14.50	273.44	8.39
14.75	155.66	4.77	14.75	135.78	4.17	14.75	212.75	6.53
15.00	155.44	4.77	15.00	135.65	4.16	15.00	209.60	6.43
15.25	142.41	4.37	15.25	227.89	6.99	15.25	186.88	5.73
15.50	111.99	3.44	15.50	175.21	5.37	15.50	141.49	4.34
15.75	100.90	3.10	15.75	162.04	4.97	15.75	131.92	4.05
16.00	99.89	3.06	16.00	161.50	4.95	16.00	131.06	4.02
16.25	99.93	3.07	16.25	161.52	4.95	16.25	130.67	4.01
16.50	100.01	3.07	16.50	161.57	4.96	16.50	130.37	4.00
16.75	100.07	3.07	16.75	161.61	4.96	16.75	130.30	4.00
17.00	100.13	3.07	17.00	161.68	4.96	17.00	130.29	4.00

	Post development			Pre-development			Change		
	2-year	10-year	100-year	2-year	10-year	100-year	2-year	10-year	100-year
<1 (%)	27%	28%	8%	49%	26%	10%	-23%	2%	-2%
>1 & <2 (%)	36%	0%	10%	3%	1%	2%	33%	-1%	8%
>2 & <10 (%)	35%	67%	72%	44%	66%	75%	-9%	1%	-3%
>10 (%)	2%	5%	9%	3%	7%	11%	-1%	-2%	-2%
	100%	100%	100%						

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17.25	76.50	2.35	17.25	167.06	5.12	17.25	125.43	3.85	17.25	100.22	3.07	17.25	161.72	4.96	17.25	130.30	4.00
17.50	76.57	2.35	17.50	167.14	5.13	17.50	125.46	3.85	17.50	100.27	3.08	17.50	161.81	4.96	17.50	130.31	4.00
17.75	76.62	2.35	17.75	167.22	5.13	17.75	125.47	3.85	17.75	100.32	3.08	17.75	161.86	4.96	17.75	130.32	4.00
18.00	76.69	2.35	18.00	167.31	5.13	18.00	125.48	3.85	18.00	100.41	3.08	18.00	161.93	4.97	18.00	130.34	4.00
18.25	68.72	2.11	18.25	144.57	4.43	18.25	191.52	5.87	18.25	91.28	2.80	18.25	144.58	4.43	18.25	213.37	6.55
18.50	50.81	1.56	18.50	96.79	2.97	18.50	132.19	4.05	18.50	69.49	2.13	18.50	105.11	3.22	18.50	151.31	4.64
18.75	42.52	1.30	18.75	84.61	2.60	18.75	118.54	3.64	18.75	58.95	1.81	18.75	90.47	2.78	18.75	133.93	4.11
19.00	41.69	1.28	19.00	83.99	2.58	19.00	118.36	3.63	19.00	0.00	0.00	19.00	88.97	2.73	19.00	132.92	4.08
19.25	41.66	1.28	19.25	83.97	2.58	19.25	118.35	3.63	19.25	0.00	0.00	19.25	88.96	2.73	19.25	132.91	4.08
19.50	41.66	1.28	19.50	83.93	2.57	19.50	118.29	3.63	19.50	0.00	0.00	19.50	88.95	2.73	19.50	132.91	4.08
19.75	41.67	1.28	19.75	83.92	2.57	19.75	118.25	3.63	19.75	0.00	0.00	19.75	88.96	2.73	19.75	132.92	4.08
20.00	41.69	1.28	20.00	83.91	2.57	20.00	118.27	3.63	20.00	0.00	0.00	20.00	88.99	2.73	20.00	132.92	4.08
20.25	41.69	1.28	20.25	83.93	2.57	20.25	118.27	3.63	20.25	0.00	0.00	20.25	89.00	2.73	20.25	132.92	4.08
20.50	41.70	1.28	20.50	83.93	2.57	20.50	118.25	3.63	20.50	0.00	0.00	20.50	89.01	2.73	20.50	132.96	4.08
20.75	41.71	1.28	20.75	83.94	2.57	20.75	118.26	3.63	20.75	0.00	0.00	20.75	89.02	2.73	20.75	132.97	4.08
21.00	41.73	1.28	21.00	83.97	2.58	21.00	118.26	3.63	21.00	0.00	0.00	21.00	89.04	2.73	21.00	132.96	4.08
21.25	41.75	1.28	21.25	83.97	2.58	21.25	118.27	3.63	21.25	0.00	0.00	21.25	89.04	2.73	21.25	132.96	4.08
21.50	41.75	1.28	21.50	83.99	2.58	21.50	118.30	3.63	21.50	0.00	0.00	21.50	89.06	2.73	21.50	132.99	4.08
21.75	41.77	1.28	21.75	84.01	2.58	21.75	118.34	3.63	21.75	0.00	0.00	21.75	89.06	2.73	21.75	132.99	4.08
22.00	41.78	1.28	22.00	84.03	2.58	22.00	118.32	3.63	22.00	0.00	0.00	22.00	89.08	2.73	22.00	133.01	4.08
22.25	41.78	1.28	22.25	84.05	2.58	22.25	118.33	3.63	22.25	0.00	0.00	22.25	89.10	2.73	22.25	133.02	4.08
22.50	41.82	1.28	22.50	84.06	2.58	22.50	118.36	3.63	22.50	0.00	0.00	22.50	89.11	2.73	22.50	133.01	4.08
22.75	41.83	1.28	22.75	84.08	2.58	22.75	118.36	3.63	22.75	0.00	0.00	22.75	89.11	2.73	22.75	133.04	4.08
23.00	41.83	1.28	23.00	84.10	2.58	23.00	118.39	3.63	23.00	0.00	0.00	23.00	89.13	2.73	23.00	133.04	4.08
23.25	41.85	1.28	23.25	84.12	2.58	23.25	118.40	3.63	23.25	0.00	0.00	23.25	89.14	2.73	23.25	133.05	4.08
23.50	41.87	1.28	23.50	84.14	2.58	23.50	118.42	3.63	23.50	0.00	0.00	23.50	89.16	2.73	23.50	133.08	4.08
23.75	41.88	1.28	23.75	84.15	2.58	23.75	118.41	3.63	23.75	0.00	0.00	23.75	89.17	2.74	23.75	133.10	4.08
24.00	40.19	1.23	24.00	0.00	0.00	24.00	116.64	3.58	24.00	0.00	0.00	24.00	87.67	2.69	24.00	131.00	4.02
									24.00	54.47							

2-YEAR 3.8 POST			10-YEAR 3.8 POST			100-YEAR 3.8 POST		
time	bed shear	Excess shear	time	bed shear	Excess shear	Time	bed shear	Excess shear
0.00	0.00	0.00	0.00	0.00	0.00	0.00	-9999.99	-306.75
0.25	0.00	0.00	0.25	0.00	0.00	0.25	-9999.99	-306.75
0.50	0.00	0.00	0.50	0.00	0.00	0.50	-9999.99	-306.75
0.75	0.00	0.00	0.75	0.00	0.00	0.75	-9999.99	-306.75
1.00	0.00	0.00	1.00	0.00	0.00	1.00	-9999.99	-306.75
1.25	0.00	0.00	1.25	0.00	0.00	1.25	0.00	0.00
1.50	0.00	0.00	1.50	0.00	0.00	1.50	0.00	0.00
1.75	0.00	0.00	1.75	0.00	0.00	1.75	0.00	0.00
2.00	0.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00
2.25	0.00	0.00	2.25	0.00	0.00	2.25	0.00	0.00
2.50	0.00	0.00	2.50	0.00	0.00	2.50	0.00	0.00
2.75	0.00	0.00	2.75	0.00	0.00	2.75	0.00	0.00
3.00	0.00	0.00	3.00	0.00	0.00	3.00	0.00	0.00
3.25	0.00	0.00	3.25	0.00	0.00	3.25	0.00	0.00
3.50	0.00	0.00	3.50	0.00	0.00	3.50	0.00	0.00
3.75	0.00	0.00	3.75	0.00	0.00	3.75	0.00	0.00
4.00	0.00	0.00	4.00	0.00	0.00	4.00	0.00	0.00
4.25	0.00	0.00	4.25	0.00	0.00	4.25	0.00	0.00
4.50	0.00	0.00	4.50	0.00	0.00	4.50	0.00	0.00
4.75	0.00	0.00	4.75	0.00	0.00	4.75	0.00	0.00
5.00	0.00	0.00	5.00	0.00	0.00	5.00	0.00	0.00
5.25	0.00	0.00	5.25	0.00	0.00	5.25	0.00	0.00
5.50	0.00	0.00	5.50	0.00	0.00	5.50	0.00	0.00
5.75	0.00	0.00	5.75	0.00	0.00	5.75	0.00	0.00
6.00	0.00	0.00	6.00	0.00	0.00	6.00	0.00	0.00
6.25	0.00	0.00	6.25	0.00	0.00	6.25	0.00	0.00
6.50	0.00	0.00	6.50	103.93	3.19	6.50	0.00	0.00
6.75	0.00	0.00	6.75	129.25	3.96	6.75	184.75	5.67
7.00	0.00	0.00	7.00	130.84	4.01	7.00	186.83	5.73
7.25	0.00	0.00	7.25	132.01	4.05	7.25	187.62	5.76
7.50	0.00	0.00	7.50	133.95	4.11	7.50	191.81	5.88
7.75	0.00	0.00	7.75	134.43	4.12	7.75	192.47	5.90
8.00	0.00	0.00	8.00	134.82	4.14	8.00	193.55	5.94
8.25	0.00	0.00	8.25	136.50	4.19	8.25	193.60	5.94
8.50	0.00	0.00	8.50	136.51	4.19	8.50	194.01	5.95
8.75	0.00	0.00	8.75	140.69	4.32	8.75	194.44	5.96
9.00	0.00	0.00	9.00	142.08	4.36	9.00	196.41	6.02
9.25	0.00	0.00	9.25	145.06	4.45	9.25	201.77	6.19
9.50	109.39	3.36	9.50	161.13	4.94	9.50	223.15	6.85
9.75	114.05	3.50	9.75	169.67	5.20	9.75	234.67	7.20
10.00	114.60	3.52	10.00	170.74	5.24	10.00	236.04	7.24
10.25	123.55	3.79	10.25	174.54	5.35	10.25	344.68	10.57
10.50	148.35	4.55	10.50	297.19	9.12	10.50	389.41	11.95
10.75	160.31	4.92	10.75	308.29	9.46	10.75	398.78	12.23
11.00	160.92	4.94	11.00	310.17	9.51	11.00	400.06	12.27
11.25	163.01	5.00	11.25	326.10	10.00	11.25	421.33	12.92
11.50	281.19	8.63	11.50	375.48	11.52	11.50	470.57	14.43
11.75	314.96	9.66	11.75	405.98	12.45	11.75	524.37	16.08
12.00	395.71	12.14	12.00	503.20	15.44	12.00	680.04	20.86
12.25	545.02	16.72	12.25	727.70	22.32	12.25	1055.81	32.39
12.50	632.57	19.40	12.50	853.56	26.18	12.50	1064.58	32.66
12.75	478.20	14.67	12.75	624.24	19.15	12.75	847.58	26.00
13.00	391.97	12.02	13.00	503.17	15.43	13.00	699.36	21.45
13.25	361.61	11.09	13.25	451.90	13.86	13.25	655.00	20.09
13.50	304.50	9.34	13.50	388.54	11.92	13.50	591.94	18.16
13.75	201.34	6.18	13.75	362.72	11.13	13.75	575.30	17.65
14.00	197.66	6.06	14.00	356.72	10.94	14.00	452.18	13.87
14.25	195.18	5.99	14.25	349.25	10.71	14.25	425.39	13.05
14.50	181.17	5.56	14.50	322.86	9.90	14.50	400.24	12.28
14.75	174.68	5.36	14.75	316.45	9.71	14.75	394.15	12.09
15.00	174.76	5.36	15.00	315.17	9.67	15.00	392.94	12.05
15.25	172.43	5.29	15.25	308.12	9.45	15.25	378.51	11.61
15.50	145.80	4.47	15.50	188.08	5.77	15.50	244.99	7.52
15.75	132.92	4.08	15.75	178.88	5.49	15.75	225.69	6.92
16.00	131.16	4.02	16.00	178.29	5.47	16.00	226.07	6.93
16.25	131.06	4.02	16.25	178.23	5.47	16.25	226.20	6.94
16.50	131.09	4.02	16.50	178.24	5.47	16.50	225.97	6.93
16.75	131.17	4.02	16.75	178.21	5.47	16.75	225.94	6.93
17.00	131.24	4.03	17.00	178.28	5.47	17.00	225.99	6.93

2-YEAR 3.8 PRE			10-YEAR 3.8 PRE			100-YEAR 3.8 PRE		
time	bed shear	Excess shear	Time	bed shear	Excess shear	Time	bed shear	Excess shear
Time		0.00	0.00	-9999.99	-306.75	0.00	-9999.99	-306.75
0.00	0.00	0.00	0.25	-9999.99	-306.75	0.25	-9999.99	-306.75
0.25	0.00	0.00	0.50	-9999.99	-306.75	0.50	-9999.99	-306.75
0.50	0.00	0.00	0.75	-9999.99	-306.75	0.75	-9999.99	-306.75
0.75	0.00	0.00	1.00	-9999.99	-306.75	1.00	0.00	0.00
1.00	0.00	0.00	1.25	0.00	0.00	1.25	0.00	0.00
1.25	0.00	0.00	1.50	0.00	0.00	1.50	0.00	0.00
1.50	0.00	0.00	1.75	0.00	0.00	1.75	0.00	0.00
1.75	0.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00
2.00	0.00	0.00	2.25	0.00	0.00	2.25	0.00	0.00
2.25	0.00	0.00	2.50	0.00	0.00	2.50	0.00	0.00
2.50	0.00	0.00	2.75	0.00	0.00	2.75	0.00	0.00
2.75	0.00	0.00	3.00	0.00	0.00	3.00	0.00	0.00
3.00	0.00	0.00	3.25	0.00	0.00	3.25	0.00	0.00
3.25	0.00	0.00	3.50	0.00	0.00	3.50	0.00	0.00
3.50	0.00	0.00	3.75	0.00	0.00	3.75	0.00	0.00
3.75	0.00	0.00	4.00	0.00	0.00	4.00	0.00	0.00
4.00	0.00	0.00	4.25	0.00	0.00	4.25	0.00	0.00
4.25	0.00	0.00	4.50	0.00	0.00	4.50	0.00	0.00
4.50	0.00	0.00	4.75	0.00	0.00	4.75	119.09	3.65
4.75	0.00	0.00	5.00	0.00	0.00	5.00	119.90	3.68
5.00	0.00	0.00	5.25	0.00	0.00	5.25	120.87	3.71
5.25	0.00	0.00	5.50	0.00	0.00	5.50	121.52	3.73
5.50	0.00	0.00	5.75	0.00	0.00	5.75	122.14	3.75
5.75	0.00	0.00	6.00	0.00	0.00	6.00	122.77	3.77
6.00	0.00	0.00	6.25	0.00	0.00	6.25	132.33	4.06
6.25	0.00	0.00	6.50	0.00	0.00	6.50	154.02	4.72
6.50	0.00	0.00	6.75	141.83	4.35	6.75	186.30	5.71
6.75	0.00	0.00	7.00	145.89	4.48	7.00	194.04	5.95
7.00	0.00	0.00	7.25	146.85	4.50	7.25	199.24	6.11
7.25	0.00	0.00	7.50	147.77	4.53	7.50	201.86	6.19
7.50	0.00	0.00	7.75	148.70	4.56	7.75	205.80	6.31
7.75	0.00	0.00	8.00	149.48	4.59	8.00	207.40	6.36
8.00	0.00	0.00	8.25	150.40	4.61	8.25	209.38	6.42
8.25	0.00	0.00	8.50	151.17	4.64	8.50	211.09	6.48
8.50	0.00	0.00	8.75	151.76	4.66	8.75	212.02	6.50
8.75	0.00	0.00	9.00	133.69	4.10	9.00	213.21	6.54
9.00	0.00	0.00	9.25	136.83	4.20	9.25	222.14	6.81
9.25	0.00	0.00	9.50	160.11	4.91	9.50	266.51	8.18
9.50	0.00	0.00	9.75	172.58	5.29	9.75	285.68	8.76
9.75	126.60	3.88	10.00	175.67	5.39	10.00	289.66	8.89
10.00	0.00	0.00	10.25	199.58	6.12	10.25	351.67	10.79
10.25	140.36	4.31	10.50	248.85	7.63	10.50	406.93	12.48
10.50	137.99	4.23	10.75	275.48	8.45	10.75	422.55	12.96
10.75	154.17	4.73	11.00	279.78	8.58	11.00	425.80	13.06
11.00	156.05	4.79	11.25	347.71	10.67	11.25	451.95	13.86
11.25	175.35	5.38	11.50	410.03	12.58	11.50	503.20	15.44
11.50	233.50	7.16	11.75	458.64	14.07	11.75	561.96	17.24
11.75	337.71	10.36	12.00	565.28	17.34	12.00	671.99	20.61
12.00	449.80	13.80	12.25	744.55	22.84	12.25	887.33	27.22
12.25	609.06	18.68	12.50	693.91	21.29	12.50	801.16	24.58
12.50	593.09	18.19	12.75	645.33	19.80	12.75	770.44	23.63
12.75	560.87	17.20	13.00	620.28	19.03	13.00	712.18	21.85
13.00	490.85	15.06	13.25	587.28	18.01	13.25	660.72	20.27
13.25	378.14	11.60	13.50	543.90	16.68	13.50	631.20	19.36
13.50	256.39	7.86	13.75	417.89	12.82	13.75	616.33	18.91
13.75	217.85	6.68	14.00	372.42	11.42	14.00	597.82	18.34
14.00	215.24	6.60	14.25	358.18	10.99	14.25	567.25	17.40
14.25	209.70	6.43	14.50	325.13	9.97	14.50	500.87	15.36
14.50	179.13	5.49	14.75	275.12	8.44	14.75	417.43	12.80
14.75	164.86	5.06	15.00	273.91	8.40	15.00	413.23	12.68
15.00	163.87	5.03	15.25	252.69	7.75	15.25	391.28	12.00
15.25	153.98	4.72	15.50	201.03	6.17	15.50	328.52	10.08
15.50	126.31	3.87	15.75	173.70	5.33	15.75	265.70	8.15
15.75	103.43	3.17	16.00	171.25	5.25	16.00	263.06	8.07
16.00	100.76	3.09	16.25	171.27	5.25	16.25	262.18	8.04
16.25	100.35	3.08	16.50	171.39	5.26	16.50	261.50	8.02
16.50	100.80	3.09	16.75	171.37	5.26	16.75	261.34	8.02
16.75	100.87	3.09	17.00	171.43	5.26	17.00	261.28	8.01

	Post development			Pre-development			Change		
	2-year	10-year	100-year	2-year	10-year	100-year	2-year	10-year	100-year
<1 (%)	63%	27%	51%	64%	28%	20%	-1%	-1%	31%
>1 & <2 (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%
>2 & <10 (%)	31%	60%	28%	29%	59%	57%	2%	1%	-29%
>10 (%)	6%	13%	22%	7%	13%	23%	-1%	0%	-1%
	100%	100%	100%						

17.25	131.32		4.03	17.25	178.35		5.47	17.25	225.99		6.93	17.00	100.96		3.10	17.25	171.56		5.26	17.25	261.27		8.01
17.50	131.34		4.03	17.50	178.40		5.47	17.50	226.00		6.93	17.25	101.03		3.10	17.50	171.62		5.26	17.50	261.34		8.02
17.75	131.47		4.03	17.75	178.34		5.47	17.75	226.02		6.93	17.50	101.10		3.10	17.75	171.69		5.27	17.75	261.38		8.02
18.00	131.60		4.04	18.00	178.49		5.48	18.00	225.75		6.92	17.75	101.15		3.10	18.00	171.77		5.27	18.00	261.40		8.02
18.25	129.41		3.97	18.25	177.05		5.43	18.25	219.61		6.74	18.00	101.23		3.11	18.25	158.71		4.87	18.25	237.69		7.29
18.50	0.00		0.00	18.50	145.41		4.46	18.50	185.96		5.70	18.25	91.95		2.82	18.50	121.24		3.72	18.50	173.33		5.32
18.75	0.00		0.00	18.75	122.27		3.75	18.75	0.00		0.00	18.50	78.44		2.41	18.75	91.17		2.80	18.75	143.83		4.41
19.00	0.00		0.00	19.00	122.41		3.75	19.00	0.00		0.00	18.75	0.00		0.00	19.00	85.52		2.62	19.00	141.21		4.33
19.25	0.00		0.00	19.25	122.36		3.75	19.25	0.00		0.00	19.00	0.00		0.00	19.25	85.28		2.62	19.25	141.18		4.33
19.50	0.00		0.00	19.50	121.94		3.74	19.50	0.00		0.00	19.25	0.00		0.00	19.50	85.30		2.62	19.50	141.19		4.33
19.75	0.00		0.00	19.75	121.92		3.74	19.75	0.00		0.00	19.50	0.00		0.00	19.75	85.31		2.62	19.75	141.23		4.33
20.00	0.00		0.00	20.00	121.91		3.74	20.00	0.00		0.00	19.75	0.00		0.00	20.00	85.35		2.62	20.00	141.24		4.33
20.25	0.00		0.00	20.25	122.34		3.75	20.25	0.00		0.00	20.00	0.00		0.00	20.25	85.37		2.62	20.25	141.20		4.33
20.50	0.00		0.00	20.50	121.93		3.74	20.50	0.00		0.00	20.25	0.00		0.00	20.50	85.39		2.62	20.50	141.20		4.33
20.75	0.00		0.00	20.75	122.33		3.75	20.75	0.00		0.00	20.50	0.00		0.00	20.75	85.41		2.62	20.75	141.22		4.33
21.00	0.00		0.00	21.00	121.95		3.74	21.00	0.00		0.00	20.75	0.00		0.00	21.00	85.51		2.62	21.00	141.22		4.33
21.25	0.00		0.00	21.25	121.98		3.74	21.25	0.00		0.00	21.00	0.00		0.00	21.25	85.46		2.62	21.25	141.21		4.33
21.50	0.00		0.00	21.50	122.38		3.75	21.50	0.00		0.00	21.25	0.00		0.00	21.50	85.49		2.62	21.50	141.25		4.33
21.75	0.00		0.00	21.75	122.40		3.75	21.75	0.00		0.00	21.50	0.00		0.00	21.75	85.52		2.62	21.75	141.28		4.33
22.00	0.00		0.00	22.00	122.40		3.75	22.00	0.00		0.00	21.75	0.00		0.00	22.00	85.52		2.62	22.00	141.27		4.33
22.25	0.00		0.00	22.25	122.43		3.76	22.25	0.00		0.00	22.00	0.00		0.00	22.25	85.56		2.62	22.25	141.27		4.33
22.50	0.00		0.00	22.50	122.43		3.76	22.50	0.00		0.00	22.25	0.00		0.00	22.50	85.57		2.62	22.50	141.28		4.33
22.75	0.00		0.00	22.75	122.48		3.76	22.75	0.00		0.00	22.50	0.00		0.00	22.75	85.61		2.63	22.75	141.29		4.33
23.00	0.00		0.00	23.00	120.23		3.69	23.00	0.00		0.00	22.75	0.00		0.00	23.00	85.62		2.63	23.00	141.33		4.34
23.25	0.00		0.00	23.25	122.49		3.76	23.25	0.00		0.00	23.00	0.00		0.00	23.25	85.67		2.63	23.25	141.34		4.34
23.50	0.00		0.00	23.50	120.26		3.69	23.50	0.00		0.00	23.25	0.00		0.00	23.50	85.67		2.63	23.50	141.31		4.33
23.75	0.00		0.00	23.75	122.14		3.75	23.75	0.00		0.00	23.50	0.00		0.00	23.75	85.72		2.63	23.75	141.36		4.34
24.00	0.00		0.00	24.00	134.58		4.13	24.00	0.00		0.00	23.75	0.00		0.00	24.00	84.63		2.60	24.00	141.10		4.33
												24.00	0.00										

Appendix 3 – Stream enhancement toolbox and example sites

Table 8: Stream enhancement toolbox

Mitigation measure	Description	Why implement?	Potential advantages	Potential disadvantages
Riparian margin	Native vegetation establishment and management includes the management of both remnant vegetation and the establishment of new plant species growing on or in a site, reach or waterway	Vegetating riparian land through targeted species selection and placement can improve channel stability and reduce sediment transport	Streambank stability, improved water quality, enhanced riparian vegetation and improve terrestrial and aquatic ecosystem health	-
Bank battering	Modification of the riverbank to a design bank angle to reduce erosion and enable vegetation establishment	Provide a stable surface for vegetation; accelerate recovery from past channel incision	Increase recovery rate, reduce erosion and downstream sedimentation, increase success rate for vegetation	Removes bank diversity, habitat features, can destabilize banks post-flood
Bed load sediment retention	Use of bed seeding or sediment trapping structures to stabilize and rehabilitate streams	Capture sediment load downstream using structures that increase roughness	Promotes sediment deposition and seed accumulation, incision control	May cause local instabilities, flood risks, structural displacement
Engineered log jams	Large timber amalgams to create hydraulic and habitat influence	Provide habitat and influence sediment erosion/deposition	Maintains bed diversity, increases channel complexity, reduces stream power	Can cause instabilities, structural displacement, flood risks
Large wood installation	Placement of wood in streams to create habitat, reduce sediment transport, and support vegetation	Increase roughness, reduce velocity, encourage sedimentation and vegetation	Stabilizes mobile beds, supports instream vegetation	Instabilities, flood risks, structural displacement
Log sills	Large logs placed across the stream to create habitat and control bed erosion	Create pool habitat, support fish migration, and sediment trapping	Stabilizes incising beds, creates hydraulic diversity	Risk of undermining and erosion if not well-anchored
Wood revetment	Protective structures of logs to stabilize riverbanks	Armour riverbanks using bioengineered techniques	Reduces erosion, promotes sediment deposition and vegetation	May shift erosion elsewhere, disrupt meander evolution
Pile fields	Lines of timber piles placed in streams to reduce velocity and promote sedimentation	Reduce near-bank velocity and enhance riparian vegetation through sediment accumulation	Erosion control, promotes sediment deposition and vegetation	Instream disturbance, unsuitable for cobble bed streams
Rock beaching	Placement of rock on banks to protect from erosion	Protect economic assets, used with other structures for erosion control	Immediate protection, erosion control, reduced sediment loads	May cause downstream erosion, disrupts meander, habitat loss
Rock chutes	Excavation and placement of rock to form weirs and dissipate energy	Control channel gradient, support fish passage, reduce erosion	Stable beds, fish passage, pool-riffle sequences, sediment storage	Sediment starvation, poorly designed structures affect fish passage

Table 9: Stream erosion mitigation implementation examples

Mitigation Measure	Example
Root wads	
	

Root wads and riprap	
Rock mattresses	

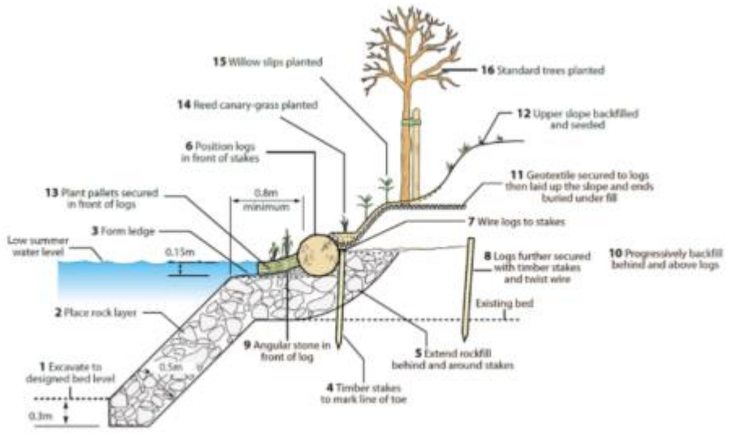

Figure 12. Profile for log toe revetment. Source: River Restoration Manual 4.3

Matting/netting

Combination riprap on lower banks and erosion mats on upper banks