Part B

Appendix B12.4.15

West Haul Road Culvert Design and Flood Risk Assessment

PATTLE DELAMORE PARTNERS LTD
Level 2, 134 Oxford Terrace
Christchurch Central, Christchurch 8011
PO Box 389, Christchurch 8140, New Zealand

Office +64 3 345 7100
Web www.pdp.co.nz

solutions *for your environment*

memorandum

TO	Cam Russell	FROM	Verity Kirstein
	Winstone Aggregates	DATE	30 March 2026
RE	West Haul Road Culvert – Design and Flood Risk Assessment		

1.0 Introduction

Winstone Aggregates, a division of Fletcher Concrete and Infrastructure Limited, is seeking to develop the Symonds Hill Pit at its Hunua Quarry site, as part of the pit design a new haulage road is required to enable the pit development.

PDP has been engaged by Winstone Aggregate to complete a desktop assessment of two culvert crossings underneath the proposed west haulage road and assess the effects in relation to natural hazards under Auckland Council's Plan Change 120. This memo outlines the design flows, culvert size, and fish passage requirements for the culverts and the effects assessment.

The affected catchment of the two culverts is located in an area which will become part of the quarry pit (stage 7- 8 of the development), as seen in Figure 1. Therefore, the culverts have a limited installation period and are not considered to have a long-term effect on the environment should the proposed quarry expansion be accepted.

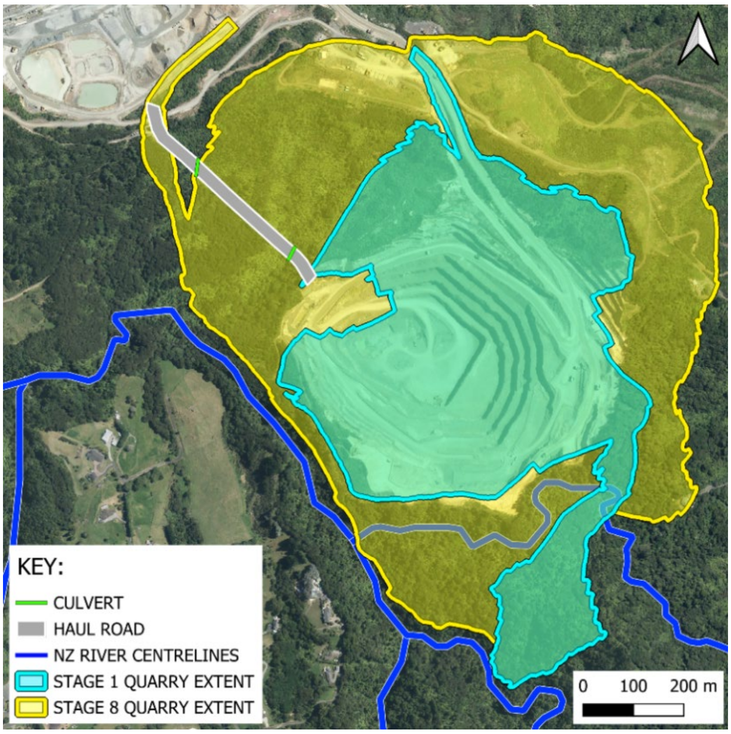

Figure 1: Stage 1 and Stage 8 Quarry extents and location of the west haul road.

2.0 Hydrology

The proposed haul road crosses two steep catchments that currently discharge to the Mangapū Stream. To maintain the existing drainage conditions and to safeguard the haul road, two new culverts (East Culvert and West Culvert) are required at the crossing locations shown in Figure 2.

In the current landscape, there are flow paths for minor intermittent streams that cross the future haul road between the two proposed culverts. It is assumed that given the size and nature of the catchment for these streams, they don't possess formal channels and that this flow will be routed to the quarry's stormwater water treatment system or directed to the culverted streams via clean water cut off drains.

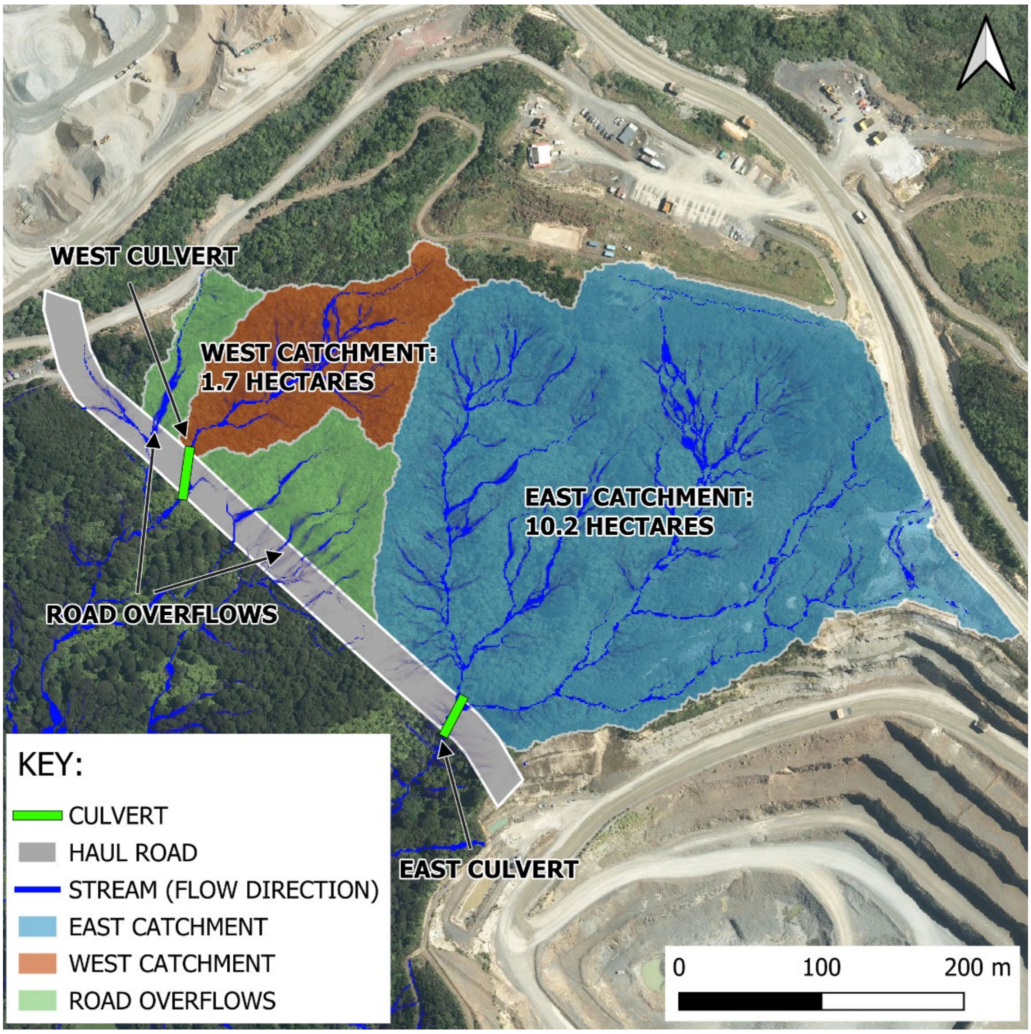

Figure 2: Culvert catchment plan

2.1 Design Flows

The design flows for the East and West catchments were estimated following the Auckland Regional Council TP108 rainfall-runoff methodology and in line with Auckland Council Infrastructure Code of Practice[1] accounting for 3.8 degrees of climate change. The design hydrological inputs for both catchments are shown in Table 1. Design flows for both the East and West catchments are shown in Table 2.

[1] The Auckland Code of Practice for Land Development and Subdivision Chapter 4 Stormwater, March 2026.

Table 1: Hydrological Data Inputs

Input	West Culvert	East Culvert
Catchment Area (ha)	1.7	10.2
Flow path length (m)	249	473
Slope (m/m)	0.29	0.24
Channelisation Factor[1]	0.8	0.8
Time of Concentration (min)	7	11
Curve Number[2]	52	52

Note:

1. *Used to reduce catchment response time to allow for higher velocities in engineered channels*
2. *Defines the shape of the rainfall-runoff relationship and varies from 0 (no runoff) to 100 (complete runoff)*

Table 2: Design Flows

Return Period (ARI)	West Culvert (m^3/s)	East Culvert (m^3/s)
2-year	0.013	0.075
10-year	0.10	0.53
20-year	0.15	0.80
50-year	0.23	1.23
100-year	0.31	1.61

2.2 Low flows

To inform the fish passage requirements for the two culverts the low flow volumes have been estimated for both catchments. Estimated low flow conditions are shown in Table 3.

Table 3: Estimated Low Flow

Flow Description	Western Culvert (L/s)	Eastern Culvert (L/s)
10% of 2-year ARI	1.3	7.5
50% of 2-year ARI	6.5	37.5
7-day low flow (scaled from the Mangapū Stream)	0.03	0.21

Due to the small size of the 7-day low flow for the West culvert it is considered likely that the stream is intermittent (as confirmed by the ecology technical report produced by Boffa Miskell) and without a permanent flow. It is unlikely that fish will be present in the stream at the proposed culvert location and upstream of it given the hydraulic conditions and limited sustainable habitat.

3.0 Culvert Sizing

Using the Hy-8 Culvert Hydraulic Analysis Program, the two culverts have been sized to pass the 50-year ARI peak flows without surcharging, assuming a Manning's roughness coefficient of 0.013 (for pipe material), a pipe embedment of 25% of its diameter, with the embedded material represented by a Manning's roughness of 0.05 (for embedded gravel/small boulders). A sensitivity check was also undertaken for the 100-year ARI event flow to ensure that surcharge depths are acceptably small in larger events (e.g. do not overtop the road or exceed 1.0 m depth). Rock aprons were sized for both culverts using the 100-year ARI event.

3.1 Western Culvert

The required pipe size for the western culvert is:

- 40m length.
- A circular 600 mm diameter pipe.

Resulting design velocities are summarised in Table 4, including velocities for the embedded condition and a conservative worst-case scenario assuming loss of embedment material due to erosion.

Table 4: Estimated Western Culvert Outlet Velocity

Average Recurrence Interval	With Embedment (m/s)	Without Embedment (m/s)
50-year	2.00	5.22
100-year	2.24	5.69

The high velocities will require placement of rock protection at the culvert outlet to protect the stream bed from scour. The sizing of the rock was calculated using the Auckland Council guideline document GD08 riprap apron equations, generating the sizing requirements shown in Table 5.

Table 5: Estimated Western Culvert Outlet Structure Dimensions

Outlet Structure Dimensions	Western Culvert
D_{50} Rock Size (m)	0.36
Apron Width (m)	3.2
Apron Length (m)	3.0
Apron Depth (m)	0.8

Due to the expected velocities, the rock will likely need to be grouted into the culvert to ensure a stable erosion control measure. Prior to installation of the culvert, the dimensions of the outlet structure should be compared to the physical survey of downstream channel dimensions, and any existing erosion of the channel shall be taken into consideration in the final design.

3.2 Eastern Culvert

The required pipe size for the Eastern Culvert is:

- 75 m length.
- A circular 1200 mm diameter pipe.

Resulting design velocities are summarised in Table 6, including velocities for the embedded condition and a conservative worst-case scenario assuming loss of embedment material due to erosion.

Table 6: Estimated Eastern Culvert Outlet Velocity

Average Recurrence Interval	With Embedment (m/s)	Without Embedment (m/s)
50-year	3.65	8.98
100-year	4.07	9.47

Due to the expected high outlet velocities, a high-level energy dissipation calculation for a potential apron size for the culvert outlet was completed using the Auckland Council guideline document GD08 riprap apron equations, resulting in the size requirements shown in Table 7.

Table 7: Estimated East Culvert Outlet Structure Dimensions

Outlet Structure Dimensions	Eastern Culvert
D_{50} Rock Size (m)	0.90
Apron Width (m)	9.2
Apron Length (m)	8.4
Apron Depth (m)	1.8

Note:

1. *D50 larger than max D50 of 500 mm specified in GD08 - apron length calculated using 7D as per 500 mm dimensions in Table 3-8.*

As with the Western culvert, the rock will need to be grouted into the culvert to ensure a stable erosion control measure to resist the expected high velocities. Prior to installation of the culvert, the dimensions of the outlet structure should be compared to the physical survey of downstream channel dimensions, and any existing erosion of the channel shall be taken into consideration in the final design.

3.3 Fish Passage

According to the ecological technical report produced by Boffa Miskell, the Eastern catchment has previously been surveyed for fish, with shortfin eels, banded kokopu and koura being found in the stream. Therefore, the culvert will need to be designed to accommodate for the movement of these fish within the stream. As the West culvert is situated in an intermittent stream with limited sustainable habitat upstream of the crossing, fish passage has not been considered.

Following the NZ Fish Passage Guidelines, the fish passage design flow is the equivalent of 50 % of the 2-year ARI flow which represents an approximation of the bank full flow, and the fish passage lower flow threshold is the equivalent of 10 % of the 2-year ARI flow. As the Eastern Culvert stream has permanent flow and had fish species present an assessment of the flow conditions through the culvert have been tested for 10 %, and 50 % of the 2-year ARI which gives an indication on flows that will allow fish movement through the culvert.

- In 10 % of the 2-year flow the average flow depth is 10 mm, and velocity 0.87 m/s,
- In 50 % of the 2-year flow the average flow depth is 30 mm, and velocity 1.14 m/s.

The NZ fish passage guidelines recommend a minimum water depth of 150 mm at the lower flow threshold (10 % of the 2-year flow). The estimated flow depth for this flow is 10 mm which is less than the recommended depth.

The low flow thresholds experienced in the culvert are not conducive to fish passage as the water flow is too fast and the water depth insufficient. The steep gradient of the stream makes achieving adequate water depths and low velocities within the culvert impossible.

From stage 7 of the quarry development, the streams and connected tributaries will disappear as the quarry pit expands into this location. The loss of these streams has been considered by including them in the quarry offset plan. Given the limited sustainable habitat upstream of the culverts, the installation period and that the stream loss has been considered in the offset plan, fish passage has not been developed for either of the proposed culverts.

4.0 Flood Risk Assessment

4.1 Mineral Extraction

The quarry development is on land which is subject to the hazards associated with flooding. The areas mapped as flood plain and flood prone areas by Auckland Council are generally confined to stream channels and in some cases extend beyond the channels into the gullies where the streams are located. These mapped features have been overlaid with the quarry development phases, as shown in Figure 3 below.

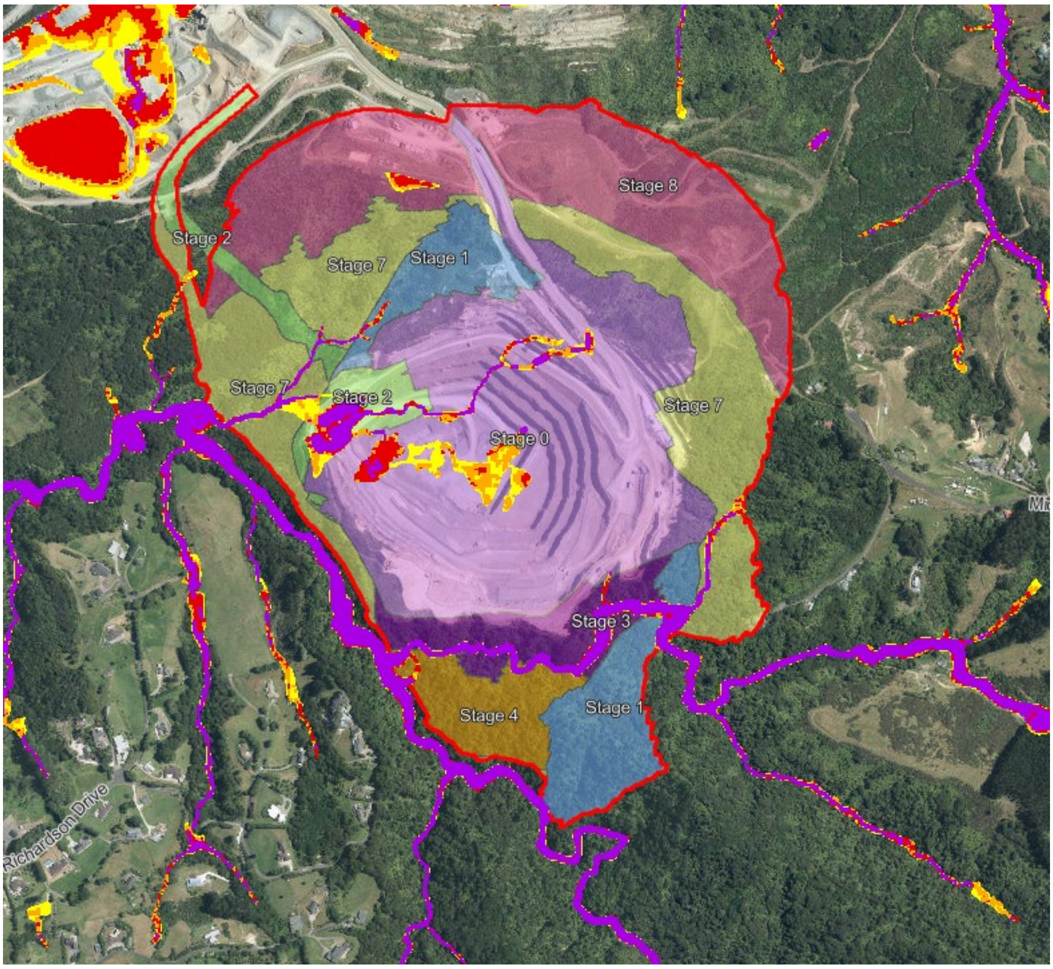

Figure 3: Quarry development phases and flood hazard areas.

It should be noted that the hazard mapping is incorrect for the current pit formation, as it shows hazard areas within the pit. These mapped streams, tributaries and flood plains no longer exist as they have been removed by the quarrying operation. All surface water generated in the pit is now routed through the quarry stormwater treatment facilities.

In progressing the quarry expansion from stage 0 to stage 8, the streams and tributaries subject to the identified flood hazards, as well as the flood prone area to the west of the existing haul road, will be removed from the landscape as the ground they occupy will be excavated and removed to form the expanded quarry pit, thus removing the hazard from the area.

4.2 Culvert Installation

The proposed activity is the construction of a haul road over two streams. The West culvert is over a minor, intermittent stream which is not classified as a flood zone (Auckland Council Geomaps) and as such has not been assessed. The East culvert crosses a permanent stream with continuous flow and has been mapped as being within the 1% AEP (100-year ARI) flood plain.

The flood zone is contained within the stream channel which is situated in a steep sided gully. The proposed haul road will cross the steam channel by culverting part of the stream, enabling crossings over the gully and without interaction with flowing water.

As discussed, the stream channel is within a deep, steep sided gully where flows are well contained and highly unlikely to breach the gully. The installation of a culvert has the potential to affect the flow of flood waters by restricting the flow and causing the flood water to back up the channel. The effects of water backing up will be localised within the gully and within the quarry property, so not affecting people or properties outside of the quarry boundary.

The culvert has been sized to convey a 2% AEP (50-year ARI) flood. For floods larger than the 2% AEP event, the culvert will not pass the total volume of water. The effects associated with this are that that flood waters will back up, elevating the water level by as much as 0.3 m at the culvert and tapering off further upstream. The stream channel is within a steep sided gully and as such the water will be contained and will not overtop the gully or the haul road and create a residual risk in the form an overland flow path.

While this hazard considered a long-term one, it is also transient in that, as the quarry development progresses, the streams will ultimately be lost as the ground that they occupy is removed and becomes part of the quarry pit. This is stage 7 of the quarry development and occurs approximately in year 50 of the development plan.

The design of the culverts has taken into account the flood hazard, by considering the appropriate sizing to convey a defined flood size and to mitigate the localised effects of altering the stream channel by installing a structure. Localised effects include channel erosion at the culvert site which will be mitigated by the installation of rock armouring at the downstream end of the culvert. This mitigation will prevent bed scour and the potential for increased sediment transport, over and above what occurs naturally in a flood event.

The risk posed by the hazard is not made worse by the development of the quarry, specifically the construction of the haul road and installation of culverts. Potential effects include slightly elevated water levels upstream of the structure, which are well contained within the stream gully and do not pose a residual risk to the quarry land or people and property outside of the quarry boundary.

5.0 Limitations

This memorandum has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Winstone Aggregates, a division of Fletcher Concrete and Infrastructure Limited and others (not directly contracted by PDP for the work), including Boffa Miskell. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the memorandum. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

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Prepared by

Tylan Collins

Environmental Engineer – Water Infrastructure

Prepared & reviewed by

Verity Kirstein

Service Leader – River Engineering

Approved by

Eoghan O'Neill

Technical Director – Water Infrastructure