Hydrological Assessment

Buller Plateaux Continuation Project

7 August 2026

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MINE WASTE MANAGEMENT
GREENROAD GROUP

BATHURST
RESOURCES LIMITED

Hydrological Assessment

Buller Plateaux Continuation Project

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EXECUTIVE SUMMARY

This report presents a review of current hydrological data and previous hydrological studies relating to the Buller Plateaux Continuation Project (BPCP or Project). The Project seeks to continue and extend mining operations across two main areas known as the Stockton Plateau and Denniston Plateau (together, the Buller Plateaux). The site is described with respect to four main operational areas: Stockton, Mount Frederick South, Escarpment Extended, and the Upper Waimangaroa Haul Road. Mining will also take place at the already approved Cypress Mine which is considered when describing the hydrology at the BPCP site.

The four operational areas are described with reference to five surface-water catchments: the Ngākawau River, Granity Stream, the Waimangaroa River, the Whareatea River, and Cascade Creek (Rapid Stream is included as part of the Whareatea catchment). In addition to defining the area of these catchments and their drainage networks, soil and landcover distributions within the catchments are mapped as they will influence the hydrological response and surface water runoff.

The spatial and temporal rainfall pattern across the BPCP site is characterised using observed rainfall records for Stockton Office, Lake Brazil and Cypress meteorological stations. In addition, regional data and long-term records at Downertown, Westport, Birchfield and Ngakawau are referenced. The data are used to indicate the spatial and temporal variability of rainfall at the site and derive design rainfall magnitudes and frequency statistics. Consistent with Ministry of Environment (MFE) guidelines, the influence of climate change on current rainfall is assessed using the High Intensity Rainfall Design System (HIRDS). Regional climate change projections for the site are also reviewed.

Hydrological data for the BPCP site are collated and presented as timeseries, flow duration curves and summary statistics (5th and 95th percentile flow (Q5 and Q95); 7-day mean annual low flow; and long-term mean and median). Specific discharges for gauged rivers are calculated to re-scale observed timeseries to ungauged rivers. Statistical summaries of monitored river timeseries are presented. Characterisation of flood statistics are presented for several sites and are used for flood modelling where the potential impact of expected flood magnitude is greatest. A high-level review of current downstream water-users is made relative to the predicted impacts of the BPCP project on water availability.

To assess the impacts of mining activities on surface water hydrology, a review of technical reports relating to water management in each mining area was made. This included identification of proposed water management activities including diversions, water treatment, water abstraction and water discharges. In combination with results from water balance modelling and associated analytical calculations, the downstream influence of site water management are assessed.

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INTRODUCTION

Mine Waste Management Limited (MWM) was commissioned by Bathurst Resources Limited (BRL) to provide a review and analysis of hydrological data held for the Buller Plateaux Continuation Project (BPCP or Project) for its assessment of environmental effects (AEE) for the Fast-track Approvals Act 2024 (FTAA) application.

1.1 Purpose and Scope

The aim of this review was to describe surface-water flows, waterbodies and drainage paths across the Buller Plateaux, and the extent to which they may be impacted by proposed mining activities at the BPCP. Rainfall, runoff characteristics, risk of flooding erosion and water availability, are described for catchments within and downstream of the proposed BPCP consent area. Hydrological data and subsequent analysis are also described with respect to the Ngākawau, Granity, Waimangaroa, Whareatea (including Rapid), and Cascade catchments; and with respect to the Stockton, Mount Frederick South (MFS), and Escarpment Extended (ESE) mining areas. Mining will also take place at the already approved Cypress Mine, which is considered when describing the hydrology at the BPCP site.

1.1.1 Objectives

This report is intended to provide an assessment of present and future hydrological regimes across the Buller Plateaux, and of the potential impacts of water management practices proposed in the BPCP.

1.1.2 Scope of Work

The scope of work covered within this report can be divided into two main components.

1. Review of existing related literature and reports including:
    - The BPCP Project Description as provided in the BPCP FTAA Application AEE.
    - Water load balance model reports by MWM (2026a; 2026b; 2026c).
2. Compilation and analysis of hydrological data and information including:
    - Creation of hydrologically adjusted, 1 m digital elevation model (DEM) from (Land Information New Zealand (LINZ) repository) LiDAR data for the Buller Plateaux and associated downstream areas.
    - Creation of a digital streamflow network with associated surface water bodies.
    - Definition of surface water catchment boundaries and areas for relevant monitoring and compliance locations.
    - Description of observed flow timeseries: daily, seasonal and annual variability; and flood probability.
    - Scaling of observed river flow data to ungauged catchments within and downstream of the proposed mining areas.

- Assessment of potential increased risk of flooding or low flows downstream of proposed mining activities.

1.2 Approach

The approach taken in this study is to first describe existing catchments within and downstream of the BPCP boundary and then assess the likely impacts of mining activities as represented in documentation available at the time of writing. It should be borne in mind that the area of any catchment impacted by earth works or other mining activities (including water management) may change over time. This will be noted in the text wherever it influences resulting flow estimation and characterisation.

1.3 The Buller Plateaux Continuation Project

The BPCP will expand mining activities across the Buller Plateaux to allow for coking coal to be mined over a 25-year timeframe. It will utilise existing infrastructure facilities at Stockton Mine to support and extend the mine life of the current Stockton Operations on the West Coast. The Project will comprise site preparation and transportation infrastructure and ancillary buildings; water diversion, control and treatment facilities; mining operations; vegetation clearance, overburden disposal, and rehabilitation activities; and historic acid mine drainage rehabilitation. For the purpose, of this report the study area is described with respect to five main sub-areas associated with the BPCP and as shown in Table 1 and Figure 1.

Table 1: BPCP sub-area and scope.

PROJECT SUB-AREA	SCOPE
Stockton Mine	Completion of mining of existing pits and remaining coal resources. Ongoing utilisation of existing infrastructure. Includes Stockton and Millerton mining areas. Activities lie within the Ngākawau and Granity catchments.
Mount Frederick South (MFS)	Development of an access road from the Waimangaroa Valley into the Mount Frederick South mine area, initial mining through old underground workings, and extension into unmined areas to the northwest.
Escarpment Extended (ESE)	Mining of an existing pit (Escarpment), underground workings (Whareatea), and an extension into unworked areas (West Whareatea).
Upper Waimangaroa Haul Road (UWHR)	Road connecting Stockton with Mount Frederick South and Escarpment Extended. Combination of upgrades to existing roads and development of new section through the Waimangaroa Valley.
Cypress	Ongoing mining development (North and South pits) under existing consents.

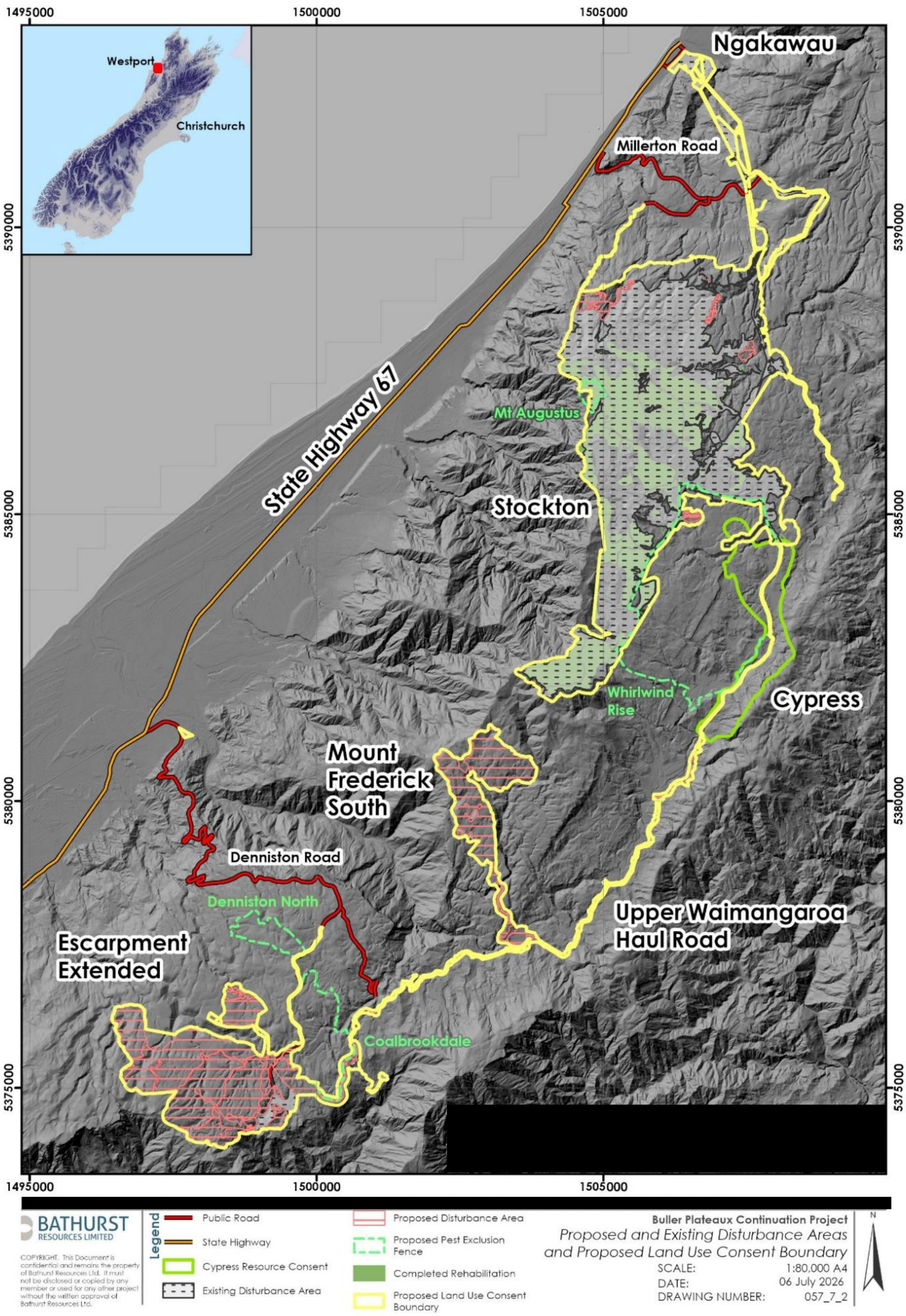


Figure 1: Location of Stockton Mine, Mt. Frederick South, Cypress Mine, Escarpment Extended, and Upper Waimangaroa Haul Road.

2 SITE CHARACTERISTICS

The Buller Plateaux has a mean elevation of approximately 690 m (ranging from approximately 400 m in the Granity catchment, to 1,105 m at Mount Frederick. It can be roughly divided into two separate sections, the Stockton Plateau to the north and the Denniston Plateau to the south. The Buller Plateaux is bound to the east by the Mount William fault and to the west by the Mount Frederick and Kongahu faults (Bishop 1992). The geology of the area consists of the Brunner Coal Measures, and sedimentary rock sequences of sandstones, mudstones (including the Kaiata Mudstone), and coal beds (Flores and Sykes, 1996). More detailed descriptions of the site geology and geomorphology can be found in Flores and Sykes (1995), and Barry (1998).

Many of the larger streams and rivers draining the Buller Plateaux originate from headwaters that are incised into the Brunner Coal Measures. Downstream channels are then largely confined by adjacent hillslopes until they converge to form larger streams and subsequent rivers. The lower reaches of the Ngākawau, Granity, Waimangaroa, and Whareatea flow northwest to the coast whilst Cascade Creek flows southwest into the Buller River (Figure 2).

Proposed mining activities at the Stockton and Millerton mines fall largely within Granity Stream and Ngākawau River catchments. The Mount Frederick South sub-area drains predominantly into the Waimangaroa River catchment. The Escarpment Extended sub-area straddles the Whareatea River and Cascade Creek catchments (Figure 2). The Ngākawau catchment is the largest (199 km^2), followed by the Waimangaroa (51.6 km^2), Cascade (43.1 km^2) and Whareatea (36.7 km^2 including Rapid Stream (10.4 km^2)). Granity Stream has the smallest catchment (4.69 km^2).

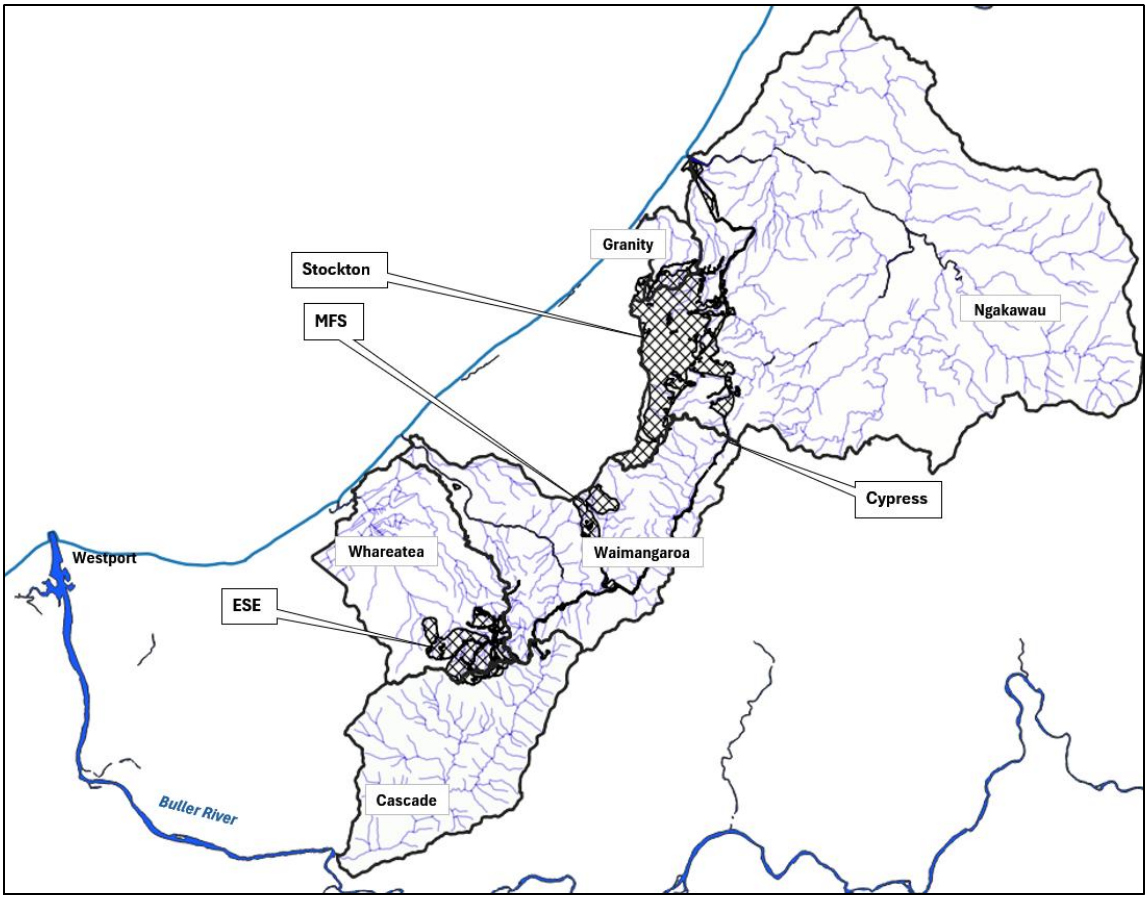


Figure 2: Surface-water catchments with location of proposed mining sub-areas (hatched).
Source: LINZ, NZ Mine Polygons, 2025.

The boundary between the Ngākawau and Waimangaroa catchments falls roughly across the Cypress mining area. The Waimangaroa River runs south from its upper reaches, some of which drain from clean water diverted around the Cypress mine and then turns northwest around Mount Frederick (to its north) before flowing to the coast. As the river turns from southerly to north-westerly it also forms the boundary between the Stockton (Stockton Mine, Mount Frederick South and Cypress Mine) and the Denniston (Escarpment Extended sub-area) Plateau. This means that the northern section of the Denniston Plateaux drains into the Waimangaroa, and the southern and westerly section drains to the Whareatea catchment. The proposed Upper Waimangaroa Haul Road will run across three catchments, from the south Ngākawau, through the eastern (upper) Waimangaroa and into the upper Whareatea.

2.1 Catchment Delineation and Area

The 1m resolution digital terrain model (DTM) obtained via the LINZ portal. New Zealand LiDAR 1m DTM, West Coast Regional Council (2025), Survey Date: 05/16/2020 - 07/11/2024) was prepared for hydrological analysis using QGIS software. This involved filling depressions within the DTM raw data to create a hydrologically continuous elevation model. The adjusted elevation model was then used to define surface water drainage lines, calculate cumulative drainage areas, and define catchment boundaries. Using a 1m resolution DTM produces a high level of detail (for example drainage from engineered landforms at the existing Stockton mine can be seen in Figure 3), but resulting catchment boundaries will not reflect diverted, piped or other mechanical transfers of water from one catchment to another. As a result, some manual adjustment of the derived catchment boundaries and areas was required to reflect different phases of surface water management during the life of mine. Catchment characterisation at a larger scale will be more accurate as changes in calculated catchment area will usually be small relative to total catchment size.

[redacted]

Catchment area has been calculated for over fifty flow and water quality monitoring locations. A ‘flow accumulation’ GIS coverage has also been created that allows calculation of additional monitoring site areas if required. The accuracy of these estimates is dependent on the accuracy of the co-ordinates used for each monitoring point, and of the DTM from which the hydrological network has been derived. Some locations needed manual adjusted to ensure coherence with the derived network (this involves moving the actual location by ±5m). The derived catchment areas of each monitoring point are shown (in km^2 and Ha) in Table 2. Of this group, locations at which flow is monitored or derived are illustrated in Figure 4.

The estimated catchment areas are used in hydrological analysis to calculate specific discharge ($m^3/s/km^2$) and related hydrological metrics such as unit median flow, and quartiles. The availability of flow timeseries from each of the catchments is also indicated in Table 2. Flow time series are described in more detail in Section 3 and their availability illustrated in more detail in Appendix B Table 28. The length of gauged site timeseries will influence the validity of derived hydrological statistics which is of note where such statistics are then used to derive hydrological characteristics in nearby ungauged catchments. This is discussed in more detail in Section 3.2.

It should also be noted that catchment areas may change throughout the course of construction and development activities due to water diversion or catchment boundary management. There may also be some differences depending on the scale of basemaps used for definition of catchment areas: compare for example the catchment outlines in Figure 2 with earlier maps illustrated in Appendix A (Figure 60 and Figure 61). Unless otherwise stated, all catchment areas used in this report are based on the 1m x 1m resolution DTM described above.

[redacted]

CATCHMENT	SUB-CATCHMENT	SITE NAME	FLOW	AREA (km^2)	AREA (Ha)	NOTES
Ngākawau	Miller	DCA	✓	N/A	N/A	Flow from portal (Mine Creek West branch).
Granity	Miller	S24A	✓	2.82	282	Miller Stream above Granity confluence.
Granity	-	S25	✓	1.18	118	Granity Stream above Miller Confluence
Granity	-	GT1		0.24	24	
Granity	-	Granity B		4.69	469	Lower Granity
Rudolf	-	S28U		0.078	7.8	Draining outside Ngākawau catchment.
Waimangaroa	Cypress	7W	✓	2.17	217	Cypress Stream above Whirlwind Str.
Waimangaroa	-	WRBBC	✓	5.55	555	Below Byrne Creek,
Waimangaroa	-	2W** (Smokestack)	✓	18.67	1,867	
Waimangaroa	Billo	BS01	✓	1.02	102	Deep Stream
Waimangaroa	Deep Stream	SW01	✓	3.61	361	Deep Stream below Billo Creek.
Waimangaroa	Deep Stream	SW03	✓	5.68	568	Billo and Adjacent to Deep
Waimangaroa	Deep Stream	SW04		2.02	202	Upstream of SW01
Waimangaroa	Deep Stream	SW05		0.46	46	
Waimangaroa	-	SW02		0.15	14.5	Below Billow Creek, adjacent to Deep Stream.
Waimangaroa	Cypress	7W_A		2.16	216	
Waimangaroa	Cypress	7W_B		2.16	216	
Waimangaroa	Herbert	UC2		0.094	9.4	
Waimangaroa	Whirlwind	S4		0.06	6	Branch to Whirlwind
Waimangaroa	-	6W		4.8	480	After Herbert and Whirlwind
Waimangaroa	-	-		46.64	4,664	Waimangaroa at SH67
Whareatea	V70 Stream	V70	✓	1.82	182	
Whareatea	Conglomerate	CM1	✓	1.18	118	
Whareatea	V62	V62	✓	0.82	82	
Whareatea	-	WM1	✓	0.67	67	
Whareatea	-	WM2	✓	3.85	385	
Whareatea	-	WM3	✓	11.35	1,135	
Whareatea	V40	F1	✓	0.236	23.6	
Whareatea	S creek	F2	✓	0.65	65	
Whareatea	-	KEL		5.09	509	V72 at KEL intake
Whareatea	Rapid	W07	✓	1.29	129	Rapid
Whareatea	Rapid	-		7.9	790	Rapid at SH67
Whareatea	-	-		2.26	226	Whareatea West at SH67
Whareatea	-	-		11.35	1,135	Whareatea at SH67
Cascade	V8 Creek	V8	✓	3.73	373	
Cascade	V8 Creek	MM1		0.66	66	
Cascade	V37 Creek	V37-F		0.3	30	
Cascade	V37 Creek	V37-G		0.077	7.7	

Table notes:

✓ indicates flow or depth monitored at that site.

**S14 and S14B may occasionally be increased by operational water from Mine Creek and Miller Creek.*

***Recently, water from Smokestack upper catchment has been diverted to Plover Stream (St Patrick's catchment). Water is channelled from Cypress Mine back for treatment and then discharged into St Patrick's thus reducing Smokestack catchment to 16.9 km^2. It should also be noted that the original area defined by NIWA in 1974 was 19.6 km^2. Catchment areas for 8W (Waimangaroa)), and S16 and PLAOFM (St. Patricks), also account from this diversion change to catchment areas.*

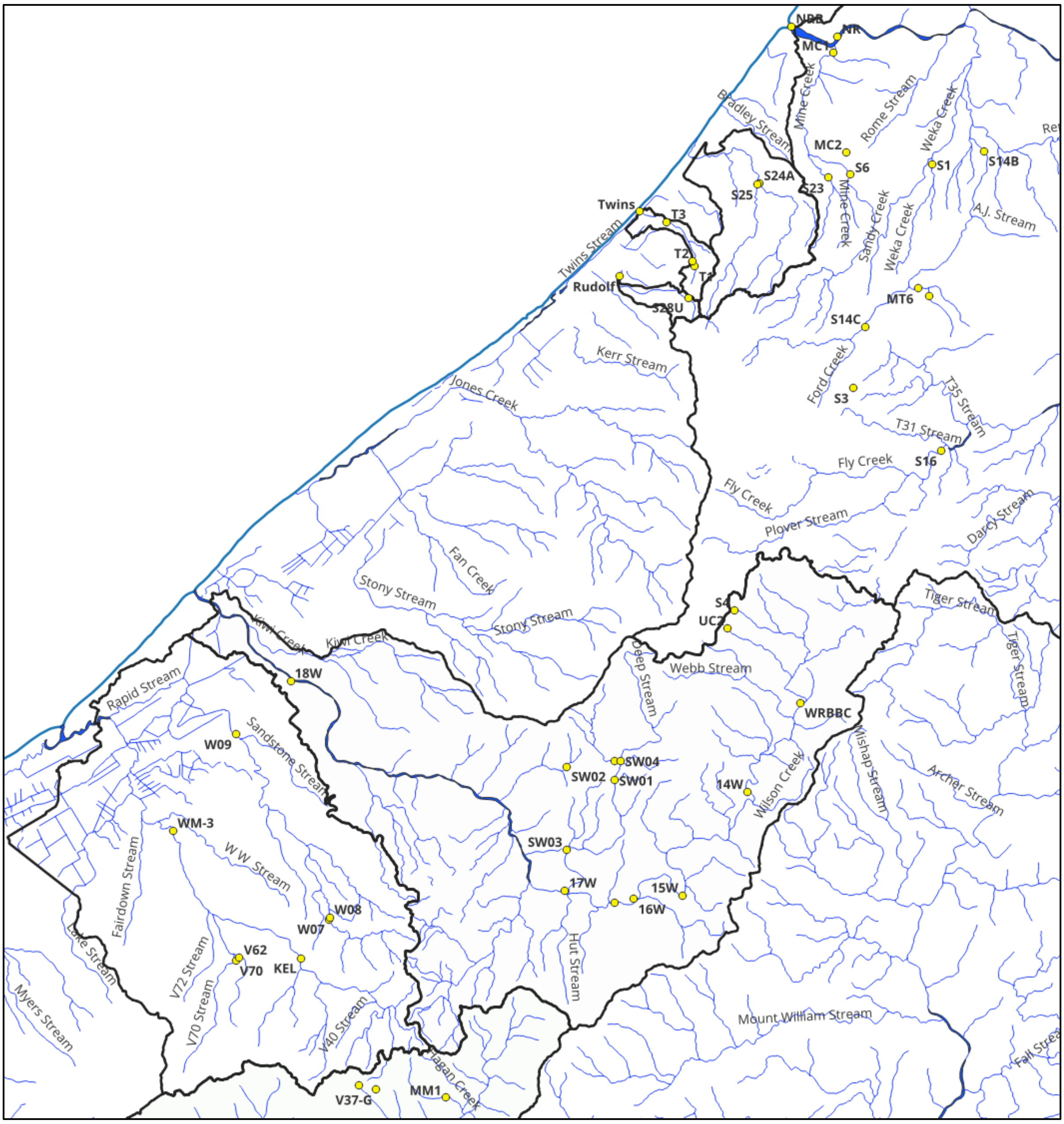


Figure 4: Location of flow reference sites within Ngākawau, Granity, Waimangaroa, Whareatea, and Cascade catchments (minor catchments west of Granity (Twins and Rudolf) also shown).

2.2 Meteorology

The climate of the Buller Plateaux is characterised as temperate - alpine and experiences mild to cool temperatures, high humidity, and high rainfall, all of which vary both spatially and temporally across the site in relation to elevation and topography. The rainfall distribution in the region has been described by

Macara (2016), and whilst long-term mean annual rainfall at Westport and Reefton are 2,064 mm and 1,943 mm respectfully, the mean rainfall at the BPCP site is closer to that of Franz Josef (5751 mm) (see Figure 5). It is noted that the nearest long-term met station (Westport Aero) receives less than half the rainfall on the Stockton Plateau.

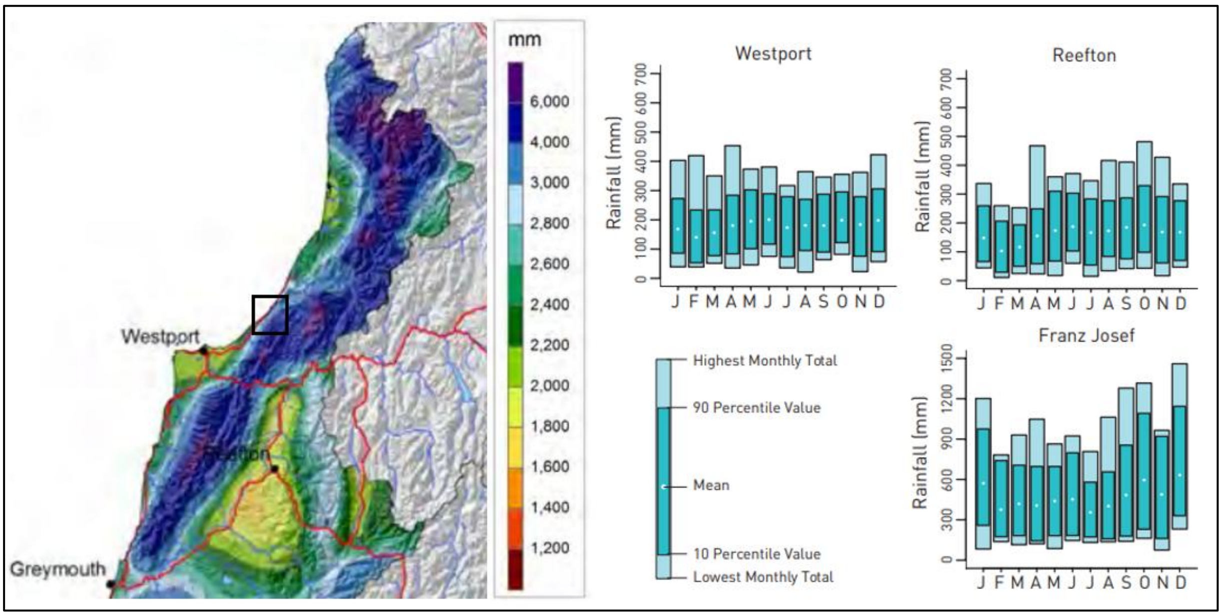


Figure 5: West Coast median annual rainfall (1981–2010). Inset square on map in left image indicates location of BPCP.

Source: Macara, 2016.

Given the fact that elevation across the site ranges from 400 m to 1500m, and that the site extends for almost 20 km from north to south there can be significant spatial and temporal variability in short and long-term climate and rainfall. Meteorological and rainfall stations across the Plateaux are presented in Figure 6. Detailed comparison of precipitation timeseries between Stockton Office, Lake Brazil (13 km to the south-west), Cypress (2.3 km to the southeast) and Downertown (2 km to the north) have proved unsuccessful as the coverage of timeseries are too different between sites to allow derivation of statistically significant metrics (Mandy Chater, *pers. comm*. 4-11-2025).

2.2.1 Stockton Office Meteorological Station

The Stockton Office meteorological station is at an altitude of 790 m and recorded a mean annual rainfall of 5,684 mm (2009-2024). Whilst monthly variation is similar to the historical (1982-2010) monthly data at Franz Josef the more recent data are dominated by exceptionally high rainfall that occurred in February 2022 (1,612 mm) (see Figure 7, Figure 8, and Figure 9). The rainfall record starts in 2008 and has only one period of missing record (mid 2013). This was infilled with data from the Cypress rainfall gauge for subsequent analysis.

A closer look at rainfall records from the Stockton Office meteorological station (2008-2025) can help indicate the likely volume of water that will need to be managed across the BPCP area over different durations. 24-hour rainfall estimates at Stockton Office were found to be well aligned with other local long-term daily records (Mandy Chater, pers. comm. 07-06-2026). The 24-hour rainfall for the mean annual flood (MAF) at the site was 260 mm (Figure 10 and Table 3). For higher rainfall, February 2022 saw consecutive daily rainfall of 272, 409, and 263 mm (944 mm in total) from 2nd to 4th February, which represented a 72-hour event with a return period greater than 100 years. Maximum rainfall intensity associated with the February event, however, was just 29 mm/hour (compared to shorter duration events that have intensities up to 40 mm/hour). These magnitudes confirm the findings of Alexander et al. (2024) who identified an hourly maximum rainfall of 41.1 mm and a maximum 24-hour rainfall of 498 mm in the period 2011-2023.

Figure 6: Location of climate stations across the BPCP site.

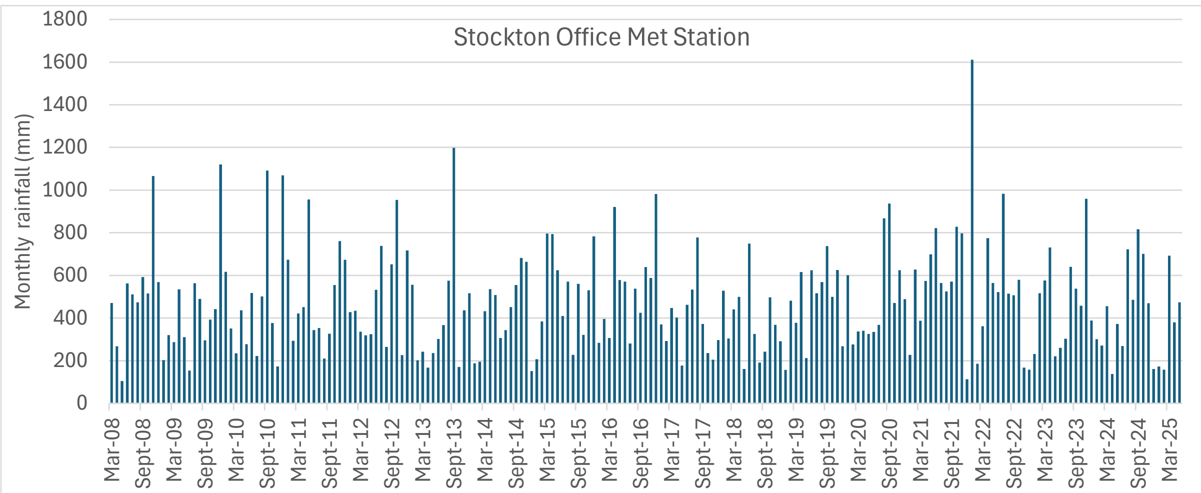


Figure 7: Monthly rainfall (mm) at Stockton Office Met Station (March 2008 to June 2025).

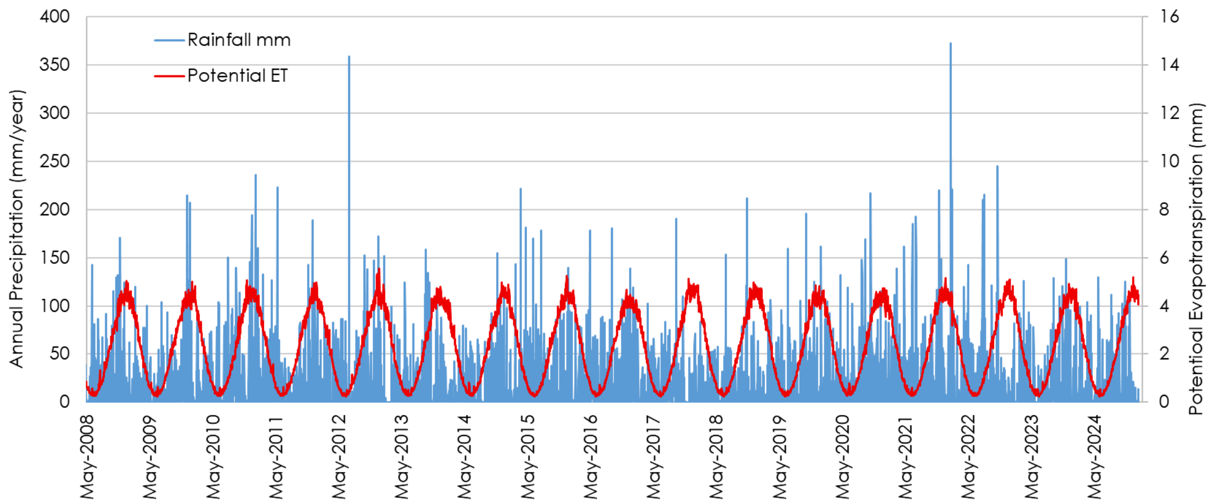


Figure 8: Daily rainfall (mm) and potential ET at Stockton Office Met Station (March 2008 to June 2025).

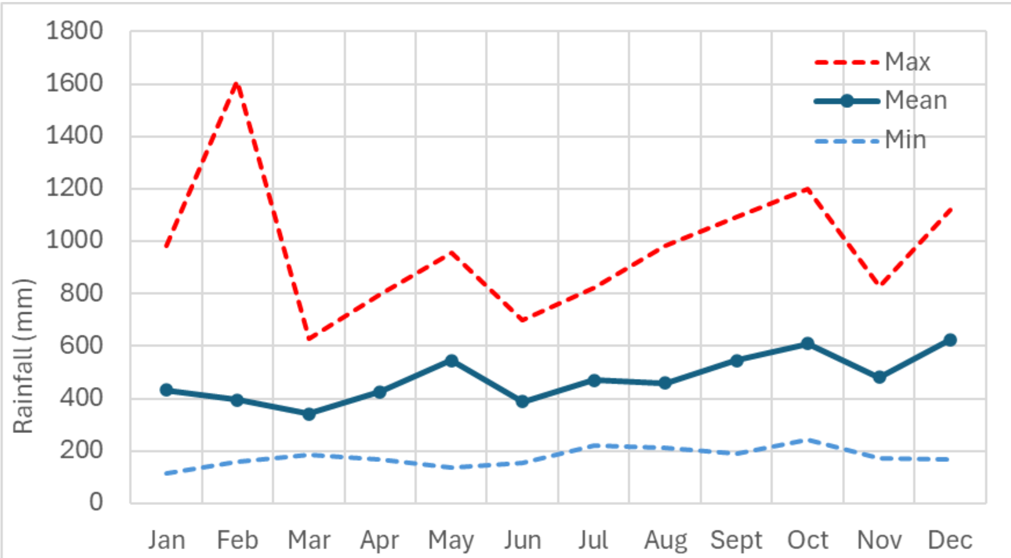


Figure 9: Mean, minimum, and maximum monthly rainfall (2009-2024) Stockton Office Met Station.

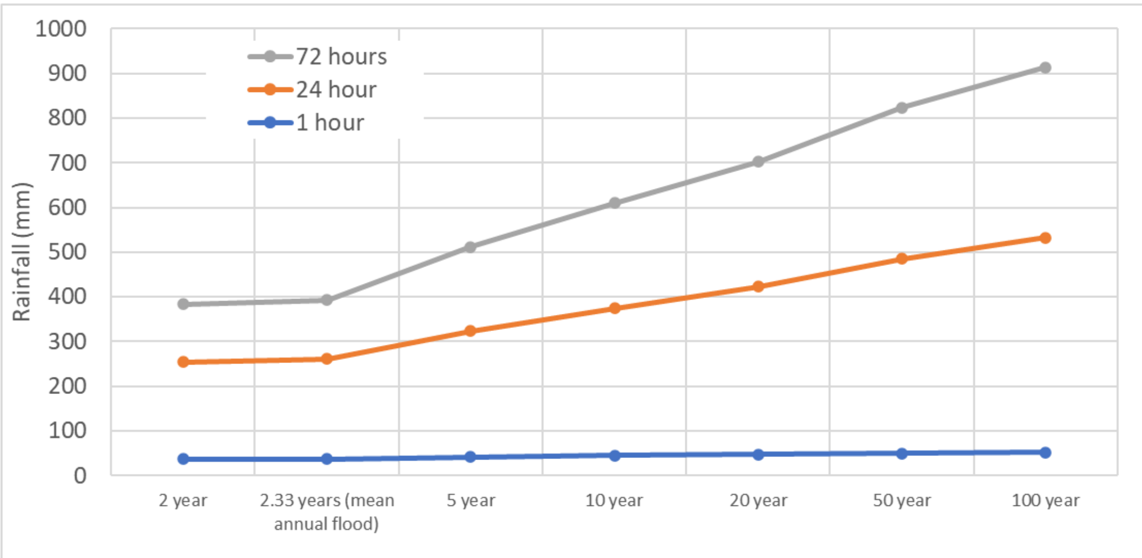


Figure 10: 72, 24, and 1-hour event rainfall for different return intervals at Stockton Office Met Station.

Rainfall intensity across New Zealand has been modelled by the High Rainfall Intensity Design System (HIRDS) (Carey-Smith et al., 2018). Rainfall intensity data for the nearest HIRDS rainfall gauge at Downertown (Appendix B Table 34) compares well with data collected at the Stockton Office meteorological station for low duration events (Table 3). For example, the 1-hour rainfall for a 50-year event predicted from Stockton data is 50 mm, whereas the equivalent rainfall predicted by HIRDS for Downertown is 52 mm (without using any areal reduction factor). For longer duration events however, the difference increases, with 485.6 mm indicated for a 50-year 24-hour event in the Stockton data compared to just 350.4 in the HIRDS data.

Table 3: 72-, 24-, and 1-hour event rainfall (mm) for differing return intervals for Stockton Office.

RETURN PERIOD	1 HOUR	24 HOUR	72 HOURS
2 years	36.7	254	384
2.33 years (MAF)	37.3	260.6	392.6
5 years	42	323	512.2
10 years	45	373.8	609.4
20 years	47.4	422.5	702.7
50 years	50	485.6	823.4
100 years	51.6	532.9	913.9

Evapotranspiration across the site can be calculated from monitoring of net solar radiation, temperature, wind speed, and air pressure. These variables are available for the site at a regional scale from the Earth Sciences New Zealand Virtual Climate Station Network (VCSN). Apart from solar radiation, these variables are also available from monitoring equipment at Stockton and Lake Brazil, which will be used to validate the regional-scale estimates of evapotranspiration.

2.2.2 Cypress Meteorological Station

Rainfall timeseries can be compiled for the Cypress Mine by using data from the Stockton Office (01/03/2008 to 28/06/2025) to fill gaps in the Cypress timeseries (28/05/2010 to 16/09/2024) (Figure 11). GHD (2021) concur that the two sites exhibit similar rainfall patterns with Stockton Office the higher of the two by a small margin. The strength of the relationship is illustrated in Figure 12.

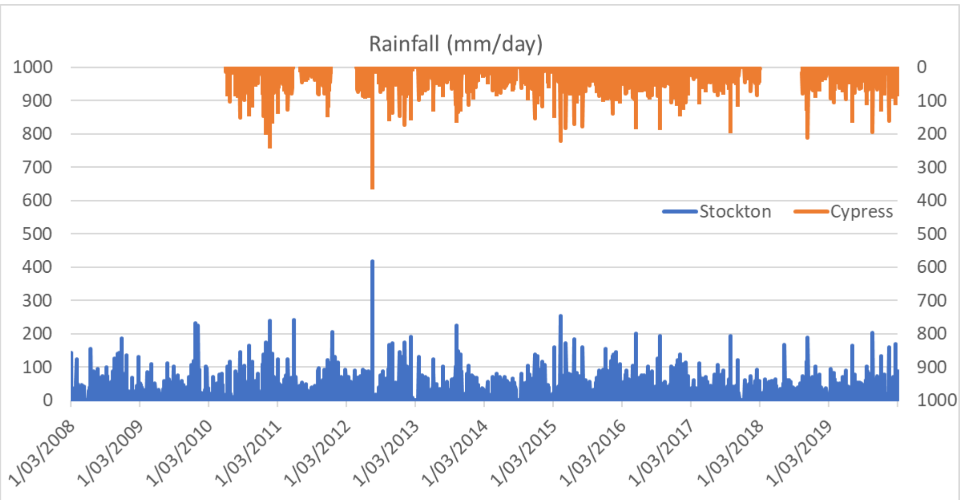


Figure 11: Comparison of rainfall timeseries observed at Stockton Office and Cypress meteorological stations.

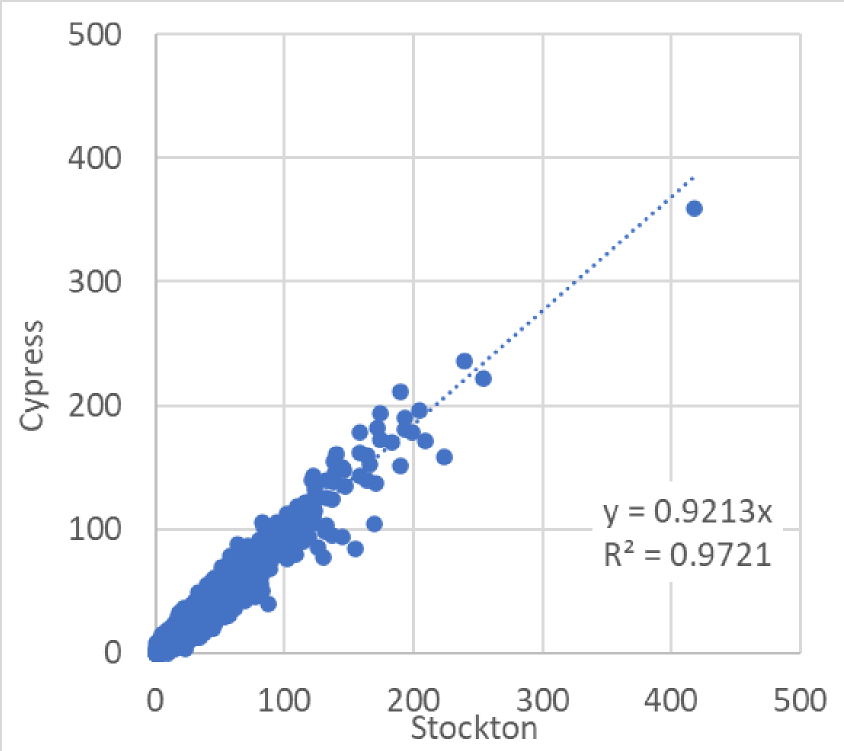


Figure 12: Relationship between daily rainfall at Cypress and Stockton Office meteorological stations.

2.2.3 Lake Brazil Rainfall

Figure 13 illustrates the daily rainfall record observed at Lake Brazil from 2010 to 2023 compared to observations at Stockton Office over the same period. It can be seen that whilst there is generally a good correlation between the two sites, individual events can differ significantly (Figure 14).

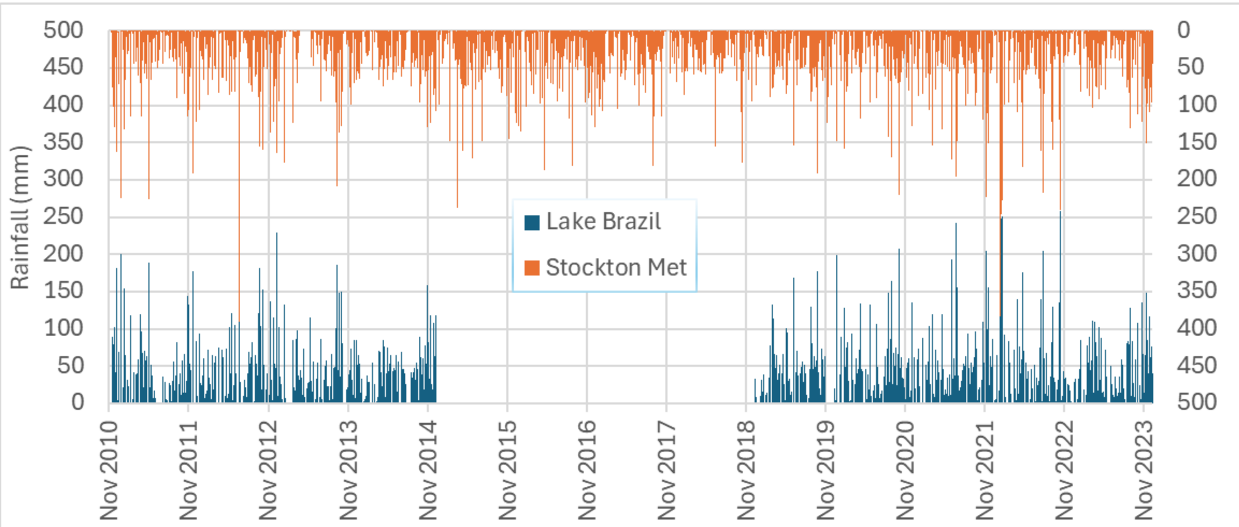


Figure 13: Comparison of daily rainfall record for Lake Brazil and Stockton Office from 27 November 2010 to 31 December 2023.

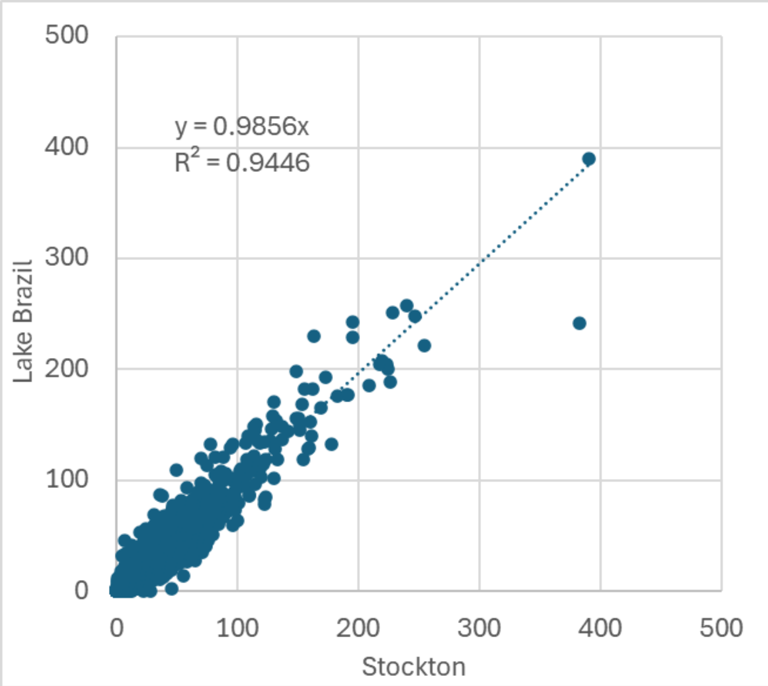


Figure 14: Relationship between daily rainfall at Lake Brazil and Stockton Office meteorological stations (2010 to 2023).

2.2.4 Rainfall Spatial Variability

Whilst observations from Stockton Office station provide representative data for the Stockton and Millerton areas, data from the Lake Brazil station is considered more representative for Escarpment Extended and Mount Frederick South areas (Mandy Chater *pers comm*, 4-11-2025). Interestingly, Lake Brazil (639 m asl) receives similar annual rainfall to Cypress (707 m asl) despite being at lower elevation (see Figure 6 and Figure 15). Data from a number of gauges have been used to produce a curve of rainfall against altitude across the whole site (Chater, 2024a&b). Rainfall at Denniston, appears to be influenced by topography and it is suspected that a topographic rainfall anomaly may also occur around Mount Frederick South. Additional rain gauge instrumentation is planned for that area (Mandy Chater *pers comm*, 4-11-2025), to better inform future decision-making related to flow management in response to spatially heterogeneous prolonged or high intensity rainfall events.

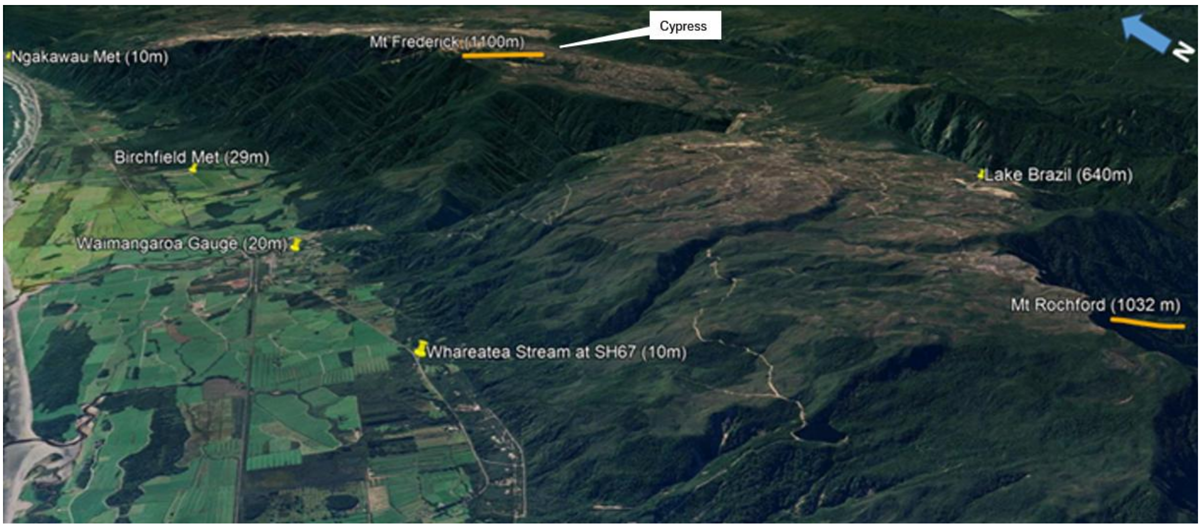


Figure 15: Illustration of topographic variation relative to location of rainfall monitoring.

Analysis of rainfall data from sources illustrated in Figure 15 (and detailed in Table 4) identified the trend of increasing rainfall with elevation (Figure 16). This relationship is used to define rainfall at locations across the Buller Plateaux.

Table 4: Rainfall data used to assess relationship between rainfall and elevation (from Chater, 2024b).

SITE	ALTITUDE (ABOVE SEA LEVEL)	RECORD	NOTES
Lake Brazil	640 m	2010 – present	Ten-minute rainfall record containing gaps. Daily record developed by infilling gaps with daily estimates from adjacent gauges.
Waimangaroa	20 m	1970 -1973	Daily record. Sourced from NIWA Climate Database.
Birchfield Met	29 m	2007 – 2012	Hourly rainfall record, 8 days missing record.
Ngākawau Met	10 m	2012 – present	Ten-minute rainfall, no gaps.
Westport Aero	2 m	1944 - present	Daily rainfall, some missing record – but minimal given the length of record.

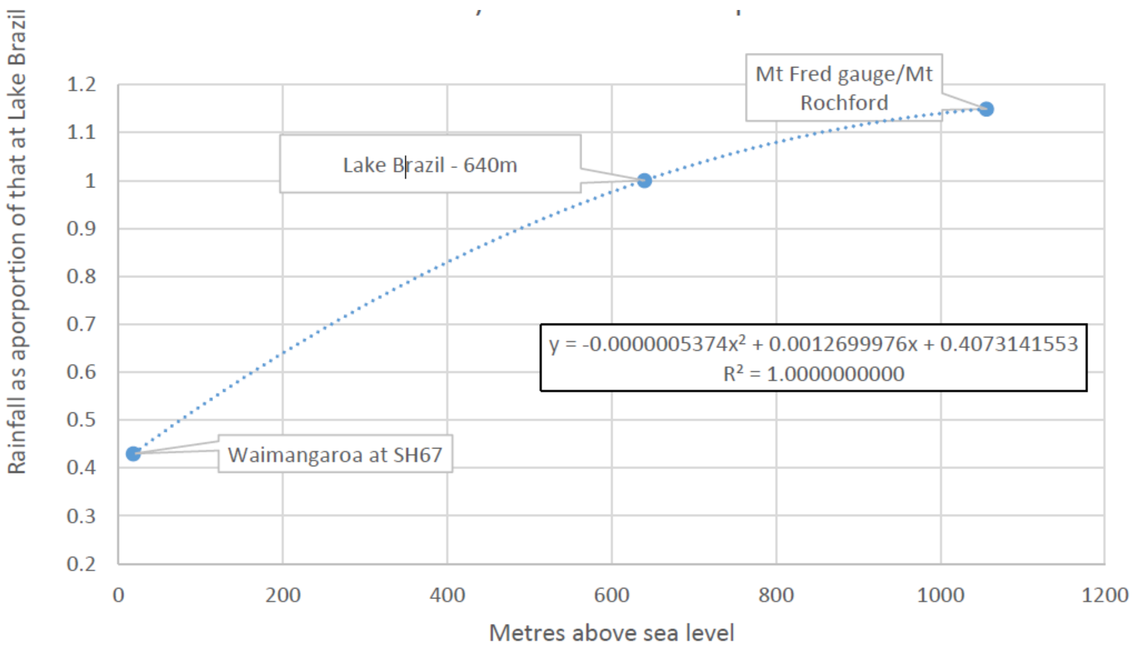


Figure 16: Relationship of rainfall (as proportions of Lake Brazil rainfall) varying with elevation

Source: Chater, 2024b.

2.3 Climate Change

The Ministry for the Environment (MFE) provides national climate change projections and climate change data for New Zealand. Estimation of climate change at the local scale can be made using the method described within the *Climate Change Projections for New Zealand* report (Ministry for the Environment, 2018). Whilst updated scenarios and data from the latest (6^{th}) Intergovernmental Panel on Climate Change (IPCC) assessment report are available for New Zealand, these are currently being downscaled to regional scale by Earth Sciences New Zealand (ESNZ). In the interim MFE suggests using the approach recommended in their 2018 report using climate model simulations from the 5^{th} IPCC report. The analysis along with the HIRDS guidelines indicate that very extreme rainfall is likely to increase in all areas across New Zealand, with increases more pronounced for shorter duration events.

Whilst the Shared Socioeconomic Pathway (SSPs) scenarios of the 6th IPCC report are not directly comparable with the Representative Concentration Pathway (RCPs) of the 5th IPCC report, Figure 17 indicates a similar order of magnitude of change is expected for temperature and rainfall.

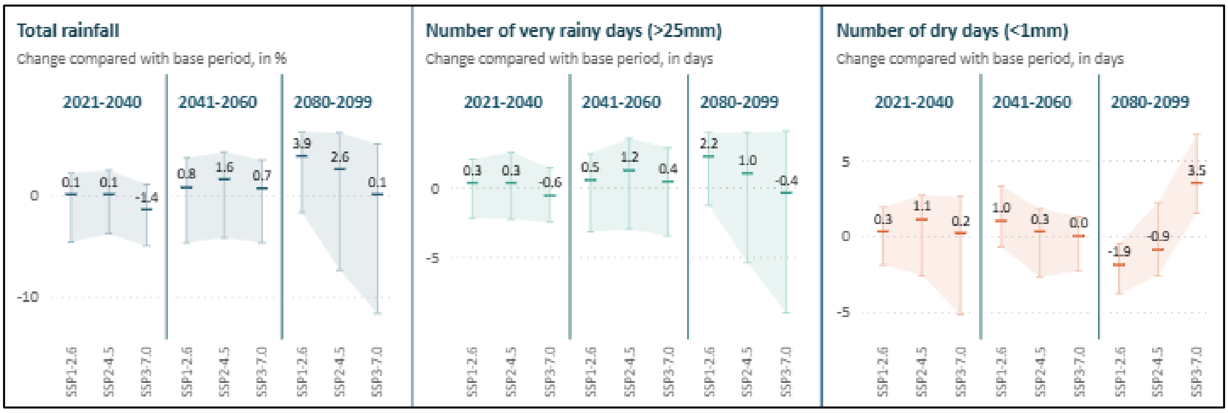


Figure 17: Screenshot from the Ministry of the Environment climate projections dashboard.

Chater (2025) provided estimates of projected changes to the rainfall record at Stockton using the MFE, (2018) guidance and data. Design rainfall for 2, 5, 10, 20, 50 and 100-year events were produced for three future 20-year periods (2031-2050; 2081-2100; and 2101-2120) for three duration events (1, 24 and 72-hour). Table 5 can be used to look-up expected design events for any of the modelled future climate change scenarios (RCP 2.6, 6.0, 8.5). For example, rainfall for a 100-year event can be expected to increase from the current estimate of 914 mm to 967 mm, 1076 mm, and 1111 mm in the periods 2031-2050; 2081-2100; and 2101-2120 respectively (under RCP 8.5). Figure 18 illustrates a similar trend for 24-hour events for 2, 5, 10, 20, 50 and 100-year events.

Table 5: Design rainfall projected for three future climate periods (from Chater, 2025)).

2031 TO 2050	1 HOUR				24 HOURS				72 HOURS			
Return Period	Actual	RCP 2.6	RCP 6.0	RCP 8.5	Actual	RCP 2.6	RCP 6.0	RCP 8.5	Actual	RCP 2.6	RCP 6.0	RCP 8.5
2 years	36.7	39.3	39.7	40.5	254	264.8	266.4	269.5	384	396.5	398.4	402.0
5 years	42	45.2	45.7	46.6	323	337.9	340.1	344.4	512.2	530.9	533.8	539.2
10 years	45	48.5	49.0	50.0	373.8	391.7	394.4	399.5	609.4	632.8	636.3	643.1
20 years	47.4	51.1	51.7	52.8	422.5	442.9	446.1	451.9	702.7	730.1	734.2	742.1
50 years	50	54.0	54.6	55.7	485.6	509.7	513.3	520.3	823.4	856.4	861.5	871.0
100 years	51.6	55.7	56.4	57.6	532.9	559.9	564.1	571.9	913.9	951.1	956.8	967.5
2081 TO 2100	1 HOUR				24 HOURS				72 HOURS			
Return Period	Actual	RCP 2.6	RCP 6.0	RCP 8.5	Actual	RCP 2.6	RCP 6.0	RCP 8.5	Actual	RCP 2.6	RCP 6.0	RCP 8.5
2 years	36.7	39.3	44.0	48.3	254	264.8	283.8	301.2	384	396.5	418.4	438.5
5 years	42	45.2	50.8	55.9	323	337.9	364.1	388.0	512.2	530.9	564.0	594.1
10 years	45	48.5	54.6	60.2	373.8	391.7	423.2	451.9	609.4	632.8	674.0	711.6
20 years	47.4	51.1	57.7	63.7	422.5	442.9	479.0	511.9	702.7	730.1	778.3	822.4
50 years	50	54.0	61.0	67.4	485.6	509.7	552.1	590.8	823.4	856.4	914.7	967.9
100 years	51.6	55.7	63.0	69.7	532.9	559.9	607.6	651.1	913.9	951.1	1016.7	1076.6

2101 TO 2120	1 HOUR				24 HOURS				72 HOURS			
Return Period	Actual	RCP 2.6	RCP 6.0	RCP 8.5	Actual	RCP 2.6	RCP 6.0	RCP 8.5	Actual	RCP 2.6	RCP 6.0	RCP 8.5
2 years	36.7	39.3	47.0	50.7	254	264.8	296.2	311.2	384	396.5	432.8	450.1
5 years	42	45.2	54.4	58.8	323	337.9	381.2	401.9	512.2	530.9	585.6	611.6
10 years	45	48.5	58.6	63.5	373.8	391.7	443.7	468.6	609.4	632.8	700.9	733.4
20 years	47.4	51.1	62.0	67.1	422.5	442.9	502.5	530.9	702.7	730.1	809.8	847.9
50 years	50	54.0	65.6	71.1	485.6	509.7	579.8	613.3	823.4	856.4	952.7	998.7
100 years	51.6	55.7	67.8	73.6	532.9	559.9	638.8	676.3	913.9	951.1	1059.6	1111.3

For comparison, HIRDS data for Downertown for the period 2031-2050 for RCP 8.5 is shown in Appendix B Table 34. The full dataset can be accessed from the High Intensity Rainfall System.

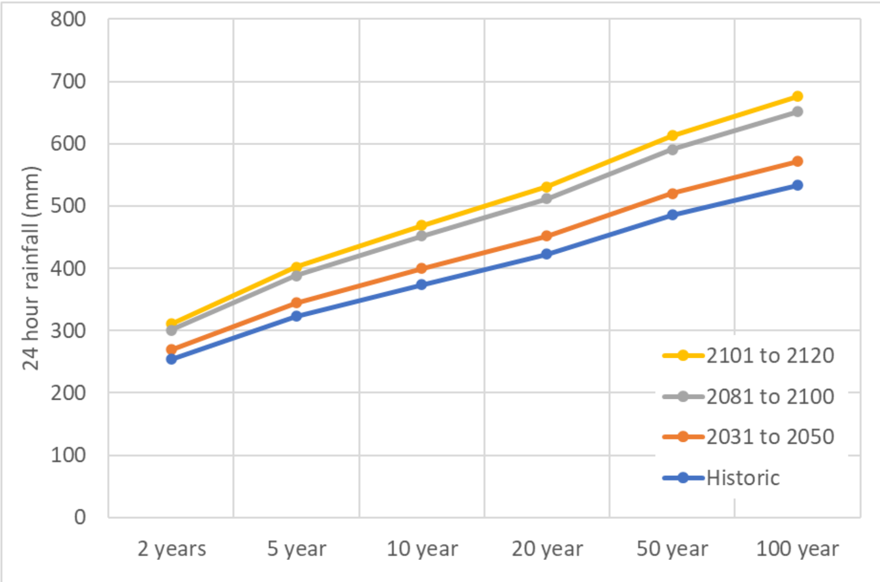


Figure 18: Increasing 24-hour rainfall for design events under future climate change scenarios.

For rainfall periods of less than 24-hour duration, prediction of future trends becomes more difficult due to the scale of global circulation models. However, Table 6 illustrates observed (Stockton and Lake Brazil) and projected magnitude of 10-minute storm events of differing return periods.

Table 6: Magnitude of 10-min design rainfall: observed (Stockton and Lake Brazil) and projected.

		10 MIN			
RETURN PERIOD	STOCKTON	LAKE BRAZIL	RCP 2.6	RCP 6.0	RCP 8.5
2 years	11.9	12.2	12.8	12.9	13.1
5 years	14.5	14.25	15.6	15.8	16.1
10 years	16	15.8	17.2	17.4	17.8
20 years	16.8	17.2	18.1	18.3	18.7
50 years	18.7	18.95	20.2	20.4	20.8
100 years	19.7	20.25	21.3	21.5	22.0

Climate change was represented within water balance models at ESE, Stockton and Mount Frederick South mining areas using a linear interpolation between 2025 to 2100. A precipitation multiplication factor (shown in Figure 19) was used to represent a uniform 9% increase in precipitation from the present time to 2100. This was based off climate change projections for New Zealand Ministry for the Environment (2018), utilising the RCP 6.0 scenario. The function represents a uniform increase relative to existing rainfall.

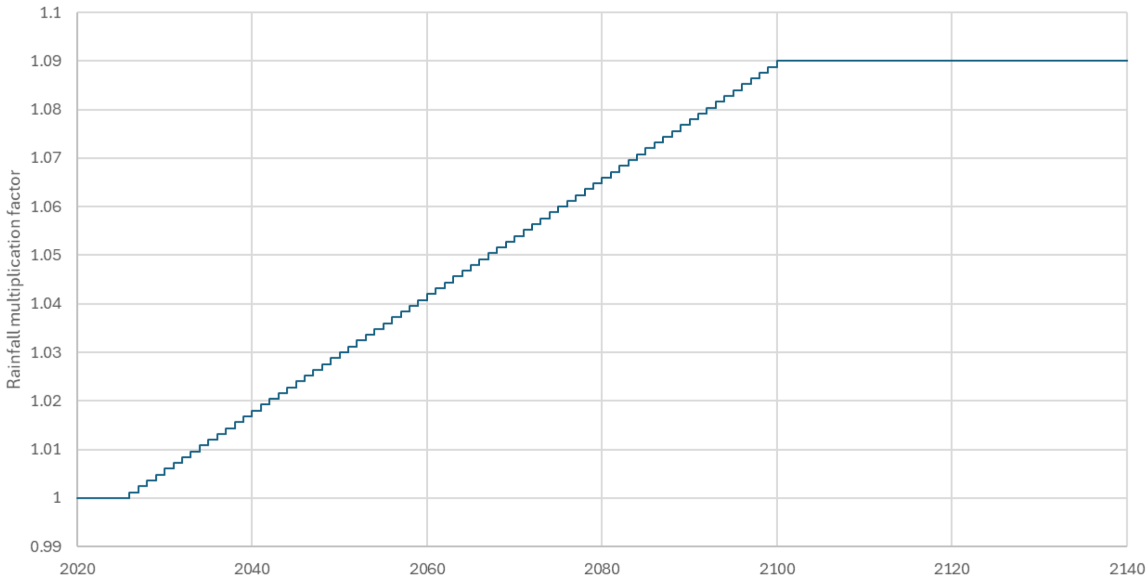


Figure 19: Multiplication factors used to represent influence of climate change on future precipitation (relative to historic data).

Source: Ministry for the Environment, 2018, Table 11, West Coast Hokitika, rcp 6.0

Increase of annual precipitation applied directly to rainfall dataset with the assumption this is more conservative than the 1986–2005 time series referenced by Ministry for the Environment (2018)

2.4 Soil and Landcover

The current soil and landcover surrounding and within the BPCP area is a mixture of steep vegetated and forested slopes and valleys, tussock and scrub, and the gently sloping pavement rock. Ecological Solutions Limited (2025) provided a coverage of wetland distribution at the BPCP site (Figure 20). This can be used in conjunction with NZ land-cover maps (Newsome et al., 2008) and soil maps (Hewitt, 2010) to provide guidance on runoff characteristics for individual catchments.

For example, much of the BPCP area exhibits podzol-type soils that are generally associated with areas of high rainfall and periodically or predominantly saturated conditions. Placic perch-gley (ZPP) soils, have a peaty top layer with a slowly permeable under-layer for which vertical saturated hydraulic conductivity is less than 4 mm/h (1.0×10^{-6} m/s).

Similarly, forested areas are known to generally produce slower runoff response to rainfall whilst rock pavements will produce quicker and higher peak flows in nearby streams and rivers. Both these effects may be attenuated however, as water courses in forested valleys may be deeply incised into the bedrock producing quicker runoff transport. Similarly, the pavement rock areas can become covered by tussock, shrubs and moss which will reduce the runoff response rate.

For hydrological detailed modelling of runoff from the BPCP sub-areas (rather than relatively course-scale water resource estimation conducted for the site water balance models), the data in Figure 20 can be used to formulate a more sophisticated representation of surface response to rainfall, including canopy interception, evapotranspiration, infiltration, groundwater recharge and rainfall runoff.

Alternatively, as gauged streamflow data are available at several locations, catchment specific discharge ($m^3/s/km^2$) can be used to estimate the flow characteristics of neighbouring catchments with similar landcover characteristics.

A mitigating factor against the use of specific discharge to estimate streamflow in ungauged catchments is if there are differences in landcover distribution. For example, the landcover distributions in the four largest catchments at the BPCP are markedly different (see Figure 21), leading to quite different specific discharge values.

Clearly, the Cascade catchment is predominantly forest landcover (96%). This is closely followed by the Ngākawau catchment (forest 69%). The Whareatea catchment has almost equal proportions of forest, grass and scrub vegetation cover (approximately 20%), and Granity catchment has the largest bare land percentage (13.5%).

Estimation of percentage landcover and soil type can be repeated for all the sub-catchment of interest to the study to allow greater confidence in transferability of observed catchment yield to similar catchments.

[redacted]

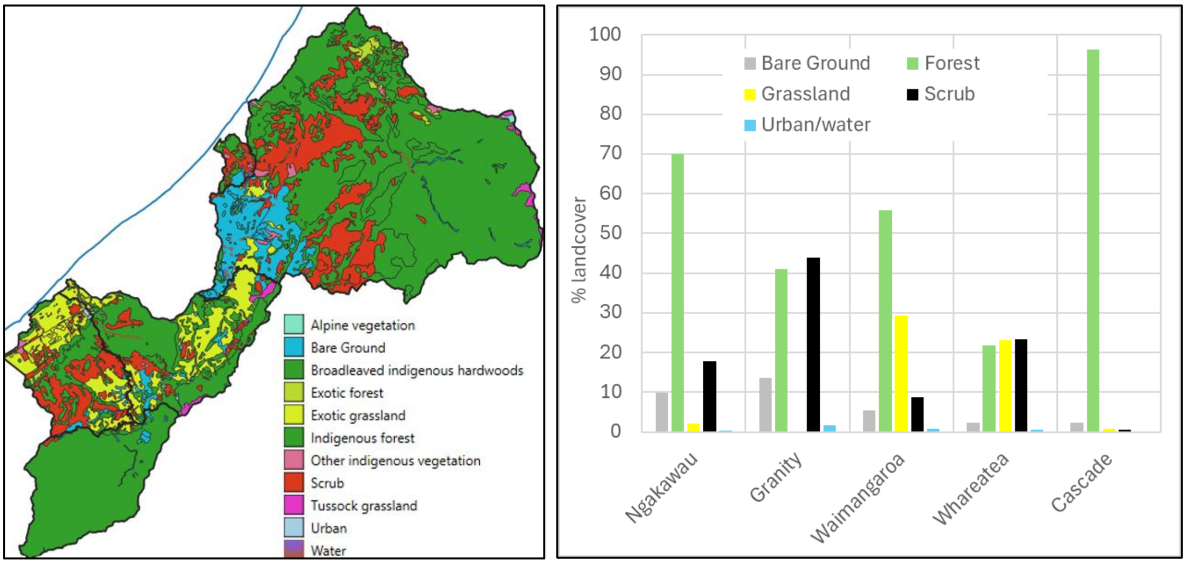


Figure 21: Landcover[1] distribution across Ngākawau, Granity, Waimangaroa, Whareatea and Cascade catchments.

1 NZ Landcover map (LCDB v5.0 - Land Cover Database version 5.0, Mainland, New Zealand).

3 SURFACE WATER HYDROLOGY

Surface water flow data from the BPCP area consists of thirty-five flow timeseries (see summary table at Appendix B, Table 28). The longest record is held for the NR monitoring site in the Ngākawau catchment which runs from 1974 to 2022. Second longest record is for the Smokestack site in the Waimangaroa catchment (1974-2015). There are at least 15 flow gauges currently deployed across the BPCP area. A summary of each flow timeseries record, referenced by mining area and sub-catchment is also shown in Appendix B). For each record, the following statistics have been provided by BRL ([redacted] mean, median, minimum, maximum, standard deviation, and upper and lower quartile values.

3.1 Timeseries Analysis

For the monitoring gauges at the Stockton mine, the statistics have been provided in Appendix B for the complete record and for a 10-year common overlapping period (2015 to 2024) (Table 30). For the Escarpment Extended and Mount Frederick South sub-areas, statistics have been provided in Appendix B for the complete record (Table 31) and for a 2.5-year common overlapping period (2012 to 2014) (Table 32), or 2-year common overlapping period (2018 to 2020) (Table 33). At most monitoring sites there has been limited or no gauging validation of the high end of the site rating curves. Stockton curves have been extended using measured areas with estimated velocity curve, and log-log technique, as is accepted practice ([redacted] As a result, there is increased uncertainty associated with maximum values within the timeseries. As the maximum values represent a very small fraction of the total number of flow observations, their impact on other flow statistics will be low. Nevertheless, ongoing monitoring at the BPCP site will continue to target the capture of high flows to improve the robustness of current high flow estimates (Appendix B Figure 83 to Figure 87).

Estimated catchment area for the monitoring locations can be used to calculate specific discharge equivalents for each of the produced statistics (Table 7). These values can be used to compare catchment yield between different sub-catchments or to convert flow timeseries from monitoring sites to nearby catchments of similar landcover type as surrogate data. Statistics are based on longest available flow record at each monitoring site (as indicated in Appendix B Table 28).

Table 7: Specific discharge ($m^3/s/km^2$) equivalent flow statistics.

CATCHMENT	AREA (km^2)	CODE	MIN	MAX	MEAN	STD DEV	L.Q.	MEDIAN	U.Q.
Granity Stream	1.18	S25	0.003	-	0.121	0.371	0.018	0.033	0.086
	2.82	S24A	0.003	-	0.093	0.113	0.041	0.063	0.102
Mine Creek (Ngākawau)	0.01	DCA	N/A flow from portal 2						
	8.08	S23	0.002	-	0.028	0.029	0.011	0.019	0.033
	7.11	S6*	0.000	-	0.033	0.083	0.005	0.011	0.024
	10.96	MASC	0.004	-	0.061	0.127	0.015	0.027	0.057
Mangatini Stream (Ngākawau)	2.04	MGD	0.000	-	0.143	0.170	0.003	0.082	0.206
	0.21	FC2	0.024	-	0.871	1.938	0.119	0.333	0.748
	6.39	S14	0.002	-	0.343	0.911	0.072	0.139	0.276
	11.4[1]	S14B	0.000	-	0.242	0.673	0.037	0.069	0.160
Ngākawau	189	Lineslip (NR)	0.005	4.548	0.122	0.254	0.024	0.041	0.095
St Patricks Str. (Ngākawau)	1.3	8W	0	-	0.241	0.744	0.021	0.038	0.132
	3.96	PLAOFM	0.000	-	0.342	0.846	0.029	0.091	0.248

CATCHMENT	AREA (km^2)	CODE	MIN	MAX	MEAN	STD DEV	L.Q.	MEDIAN	U.Q.
	3.19	Fly 5	0.002	-	0.177	0.475	0.022	0.041	0.111
	11.6	S16*	0.014	9.657	0.203	0.404	0.042	0.075	0.165
Waimangaroa River	18.67	2W (Smokestack)	0.005	10.080	0.185	0.520	0.020	0.038	0.111
	2.17	7W	0.000	-	0.037	0.098	0.006	0.010	0.023
	5.55	WRBBC	0.011	-	0.113	0.317	0.021	0.030	0.060
Whareatea River	0.67	WM1	0.000	-	0.201	0.721	0.007	0.019	0.073
	3.85	WM2	0	-	0.149	0.475	0.004	0.014	0.065
	1.18[1]	CM1	0	-	0.097	0.161	0.008	0.025	0.112
	10.9[1]	WM-3	0.007	-	0.153	0.572	0.015	0.026	0.075
	0.24	F2	0.000	-	0.352	1.309	0.004	0.021	0.114
	0.65	F1	0.000	-	0.057	0.255	0.002	0.003	0.017
	0.82	V62	0.004	-	0.327	1.062	0.024	0.043	0.111
	1.82	V70	0.00	-	0.11	0.50	0.00	0.01	0.03
Cascade	3.73	V8	0.03	8.48	0.17	0.27	0.05	0.09	0.17
Rapid Stream (Whareatea)	10.9	SHB	0.01	-	0.14	0.53	0.02	0.02	0.06
Deep Stream (Waimangaroa)	3.61	SW01	0.006	-	0.103	0.478	0.010	0.014	0.032
	1.02	BS01	0.004	-	0.135	0.541	0.010	0.020	0.051
	5.68	SW03	0.000	-	0.007	0.024	0.000	0.001	0.004

Notes:

** The flow record at St Patrick's Stream (S16) is influenced by losses to groundwater (which subsequently re-emerges downstream); [1] station has limited high flow estimates; - missing data in maximum flow column is the result of uncertainty in high flow measurement (i.e. unvalidated rating curve at high flows).*

3.1.1 Previous Studies

For comparison, Alexander et al. (2024) completed a baseline fluvial geomorphological assessment of streams on both the Denniston and Stockton Plateaux. Their assessment focussed on tributaries of Deep Stream (in the upper Waimangaroa), and the Whareatea River. They quantified the dimensions, characteristics and physical processes of streams within each catchment. Mean observed flow (mean of all daily observations); mean monthly flows (mean of all daily observations for a month of interest); annual maxima (maximum estimated or observed annual flow); and flood frequency statistics from observations spanning at least 12 months were also collated. Table 8 presents the specific discharge equivalents of summary statistics. Similar values are noted for Cascade Stream V8 as have been found in this study (Table 7).

Alexander et al. (2024) identified a consistent trend between peak discharge and catchment area in the sites they analysed. Porteus (2013) previously generated flood frequency statistics for the Waimangaroa at Smokestack. These data and other peak flow data from the site were used to plot the regression between mean annual flood (return period 2.33 years) and catchment area (Figure 22). The derived relationship indicates that mean annual flow approximated to 11 times the catchment area to the power of 0.8 (i.e. Mean annual flow = 11 x Drainage area$^{0.8}$). This pattern was repeated for other locations at the site.

From the same datasets it was also noted that mean monthly streamflow correlated with mean monthly precipitation, with peaks occurring in both datasets in early winter (May-June) and early spring

(October), and minimums occurring during the winter (July-September). Across the BPCP site there was significant variability in mean monthly flows of up to an order of magnitude, from one year to another.

For the Smokestack catchment (area estimated at 19.6 km^2), Dickson (1988) reported a mean annual flow that ranged from 1.4 to 7.4 m^3/s from 1975 to 1987, with a maximum flood of 158 m^3/s, and an average annual maximum of 105 m^3/s. Minimum annual flows were found to range from 0.1 to 7.6 m^3/s, with an average annual 7-day minimum flow of 0.91 m^3/s. These figures are consistent with the data presented in Appendix B Table 31. At WM2 (with a catchment of 4.4 km^2), which lies in the Whareatea rather than Waimangaroa catchment, mean flows ranged from 0.3 to 0.9 m^3/s but exhibited a similar seasonal pattern to the Smokestack data. Maximum measured streamflow at WM2 was about 4.0 m^3/s and maximum estimated streamflow was estimated to be 39 m^3/s (with a mean stream of 0.57 m^3/s). Unsurprisingly, at SHB (with a catchment of 11.95 km^2), also in the Whareatea, the pattern of mean monthly variation was similar to WM2 with monthly flows ranging from 0.8 to 2.7 m^3/s, a maximum mean monthly streamflow of 20 m^3/s. An absolute estimated maximum during the period of observation was 165 m^3/s and mean streamflow of 1.7 m^3/s.

What the above comparison indicates is that flow monitoring sites that are reasonably close together will exhibit analogous flow regimes, and that timeseries from gauged catchments can be scaled to ungauged catchments using estimates of specific discharge (as indicated in Table 7 and Table 8). Comparison of flow yields from S25, Smokestack and WM2 (expressed as exceedance) indicates that caution should be used when scaling catchments of differing soil or vegetation types. For example, whilst the WM2 catchment exhibits high runoff (low infiltration), the Smokestack catchment exhibits higher base flow than WM2 due to more vegetation cover. The S25 sees both higher infiltration and base flow due to greater vegetation in its upper catchment.

Table 8: Specific discharge ($m^3/s/km^2$) estimates from Alexander et al. (2024).

SITE NAME	AREA (km^2)	PERIOD (YEARS)	MINIMUM ($m^3/s/km^2$)	MAXIMUM ($m^3/s/km^2$)	MEAN ($m^3/s/km^2$)	7-DAY LF ($m^3/s/km^2$)
Cascade Stream above V8 Stream[1]	3.73	2012–2013 (1)	0.03	9.5	0.17	0.03
Whareatea at WM2	4.39	2011–2015 (3.75)	0.0002	10.0	0.13	N/A
Whareatea at SHB[2]	11.95	2011–2012 (1.5)	0.007	13.8	0.15	N/A
Waimangaroa River at 2W (Smokestack) (93602)[3]	19.6	1975–1987 (13)	0.005	8.1	0.21	0.05
Waimangaroa River at 2w (Smokestack) (93602)[1]	19.6	Up to 2013 (10.3) *	0.005	8.1	0.18	0.006
Waimangaroa River at Conn's Flat (93601)[4]	45.5	1974–1977 (2.75)	0.01	4.2	0.48	N/A
Ngākawau River at Lineslip (93901)[4]	186	1974–1991 (11.3)	0.007	4.9	0.37	N/A
Mōkihinui River at Welcome Bay (94303)[1]	673	Up to 2013 (20.4) *	0.44	4.27	0.13	0.01

Table Notes:

1 - Porteous (2013); 2 - Bathurst Resources Limited; 3 - Dickson (1988); 4 -National Institute of Water and Atmospheric Sciences (NIWA) records. Data with a '' superscript indicate the period of record is not specified in detail beyond what is shown here; for example, for a period of record 'up to 2013' indicates the actual years of record prior to 2013 used for the calculation of statistics were not reported by the authors. The data are normalized to their respective drainage areas for the purposes of comparison.*

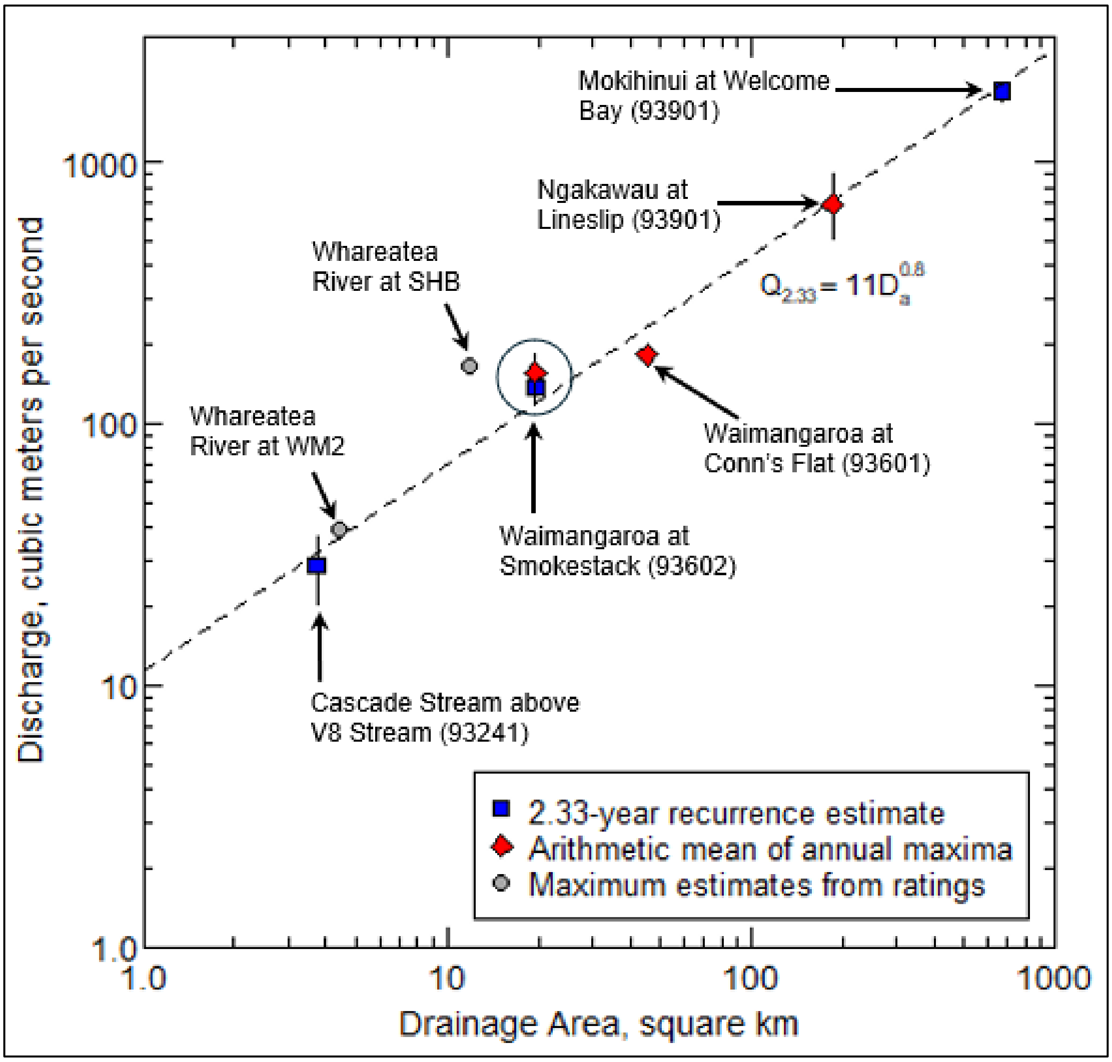


Figure 22: Relationship between mean annual flood and catchment area.

Source: Alexander et al. (2024).

Blue squares indicate mean annual flood values calculated by Porteus (2013) with 95% error bars.

Red diamonds - arithmetic mean annual flood estimated by NIWA; with error bars indicating range of annual maximums.

Grey circles - maximum flows estimated for stream gauges operated by Bathurst Resources Limited. on the Whareatea River.

Dashed line -least-squares regression fit to mean annual flood values of Porteus (2013).

3.2 Estimating Flow in Ungauged Catchments

Specific discharge (flow per unit area) determined from gauged catchments can be used to estimate flow in nearby or similar ungauged catchments. However, the method is heavily dependent on the length of gauged records available, and the degree of hydraulic similarity (determined by soil type, landcover, topography, rainfall, and water management). Alternative methods include hydrological modelling or interpolation from whatever data are available at the ungauged site. In the absence of any such data, consideration of sources of uncertainty that might arise from inferring ungauged data from specific discharge from gauged catchments should be made.

Table 9 illustrates which gauged catchments have been used to infer ungauged catchment flow characteristics. The area and location were first considered, such that both catchments should be of similar size and location. The length of the gauged catchment record is also important, as is average rainfall during observation period compared to the long-term average. It is noted that observed flow records from V8 and BS01 are both less than 1 year in length, and both occur in years in which rainfall was lower than the long-term mean (81% and 84% respectively). This means that the long-term mean flow (or other hydrological statistics) will be conservative for water resource estimates. Increased flow monitoring density in the upper Cascade and upper Billo Stream will provide additional data to improve water resource estimates in the future.

Table 9: Comparison of ungauged site characteristics with gauged sites from which flow statistics have been derived (scaled by area).

UNGAUGED SITE NAME	UNGAUGED AREA (km^2)	GAUGED SITE NAME	GAUGED AREA (km^2)	OBSERVATION PERIOD RAINFALL AS FRACTION OF LONG-TERM MEAN	DOMINANT LANDCOVER: UNGAUGED-GAUGED	LOCATION WITHIN CATCHMENT
S4	0.06	PLAOFM	3.956	0.96	mine - scrub	Whirlwind vs. Mangatini similar area
UC2	0.09	PLAOFM	3.956	0.96	grass - scrub	Herbert vs. Mangatini similar area
SW04	2.02	BS01	1.02	0.84	forest - forest	Billo Stream is neighbour to Deep Stream
KEL[1]	5.09	WM2	3.85	0.95	scrub - forest	Whareatea upstream (and CM1)
W07	1.29	WM2	3.85	0.95	Indig forest - forest	WM2 is neighbour to Rapid Stream
MM1	0.66	V8	3.73	0.81	forest - forest	Cascade downstream from MM1
V37-F	0.3	V8	3.73	0.81	forest - forest	Cascade downstream from headwater
V37-G	0.08	V8	3.73	0.81	forest - forest	Cascade downstream from headwater

Notes: 1- Flow statistics for KEL were also estimated by summing statistics for two upstream sites (WM2 and CM1)

Table 10 illustrates the ungauged catchments for which flow characteristics have been derived using the specific discharge method. Sites SW04, MM1, V37-F and V37-G are based on less than 12 months of monitored data and in drier than average years (approximately 80% of mean annual rainfall). As a result, estimated flow statistics at these sites are conservative (i.e., they may under-estimate flow by approximately 20%). The upper Cascade and upper Billo Streams should therefore be monitored to provide more robust estimates of the hydrological regimes of these catchments to improve confidence in estimates of water availability at these locations.

Table 10: Estimated lower quartile, median and upper quartile at ungauged sites based on closest gauged sites.

				SCALED FLOW	SCALED FLOW	SCALED FLOW
UNGAUGED SITE NAME	GAUGED SITE NAME	GAUGED TIMESERIES (YEARS)	SCALING FACTOR	LOWER QUARTILE	MEDIAN	UPPER QUARTILE
S4	PLAOFM	14	0.015	0.0003	0.0001	0.0004
UC2	PLAOFM	14	0.02	0.0004	0.0001	0.0006
SW04	BS01	0.6	1.98	0.0020	0.040	0.103
KEL	WM2	4	1.32	0.0212	0.073	0.332
W07	WM2	4	0.34	0.0054	0.018	0.084
MM1	V8	1	0.18	0.0317	0.057	0.115
V37-F	V8	1	0.08	0.0144	0.026	0.052
V37-G	V8	1	0.02	0.0038	0.007	0.014

3.3 Extreme Events

Frequency analysis of flow records has been undertaken for several key flow recorder sites at Stockton and Denniston plateaux (Chater, 2025) including Smokestack (Waimangaroa catchment), S14B (Mangatini Stream (Ngākawau catchment)), T35 (Mt Stockton (Ngākawau catchment)), Lineslip (Ngākawau catchment), and Cascade Stream (above V8). These sites were chosen because they were adjudged to have robust high flow rating relationships (i.e., flow gauge data for peak flows had been validated with field observation), there was sufficient length of record to produce valid statistical relationships, and sites were generally considered to be representative of different parts of the BPCP area from the Ngākawau catchment in the north to Cascade Stream in the south.

Estimated design flows (10, 50, and 100-year return periods) and their yield equivalent values ($m^3/s/km^2$) for the seven sites are shown in Table 35 (Appendix B). It should be noted that the Waimangaroa catchment area is different from that given previously in this document as part of the catchment was diverted to Plover Stream for the duration of the record.

Gumbel (EV1), General Extreme Value (EV2 and EV3), Pearson 3, and Log Pearson 3 distributions were fitted to the annual maxima series for each site noted above. The General Extreme Value (GEV) distributions generally achieved best fit on the annual maxima against probability of occurrence graphs. The same distributions were used to generate the flow frequency statistics summarised in Table 35 (Appendix B) for all sites apart from T35 which exhibited a shorter timeseries. For T35 the Gumbel EV3 was more representative (Chater, 2025). Despite its short record, T35 was included in the analysis due to its location and reliable high flow record (slackline gauging facility used for high flows).

3.4 Stream Erodibility

Susceptibility for streambank erosion has been mapped across New Zealand by Manaaki Whenua – Landcare Research (Smith and Betts, 2021). The index is derived from ESNZ's (formerly NIWA's) Regional Flood Estimation Tool v.2 (Henderson and Collins, 2016; Henderson et al., 2018) and other data within the River Environment Classification (v.2) and the fact that increasing bank migration (and thus erosion) is linked with increasing bankfull discharge, mean annual flood, and stream power. Although only a relative measure of stream erodibility, the index can be used to identify which stream sections within the BPCP area may be more prone to erosion under high rainfall conditions (Figure 23).

The erodibility index values found the project site range from 0 to 25.7 but has a highly skewed distribution. However, the index is useful in identifying locations at which stream bank erosivity and hence stability may be more sensitive to either increased variability of flows or increase in flow exceedance.

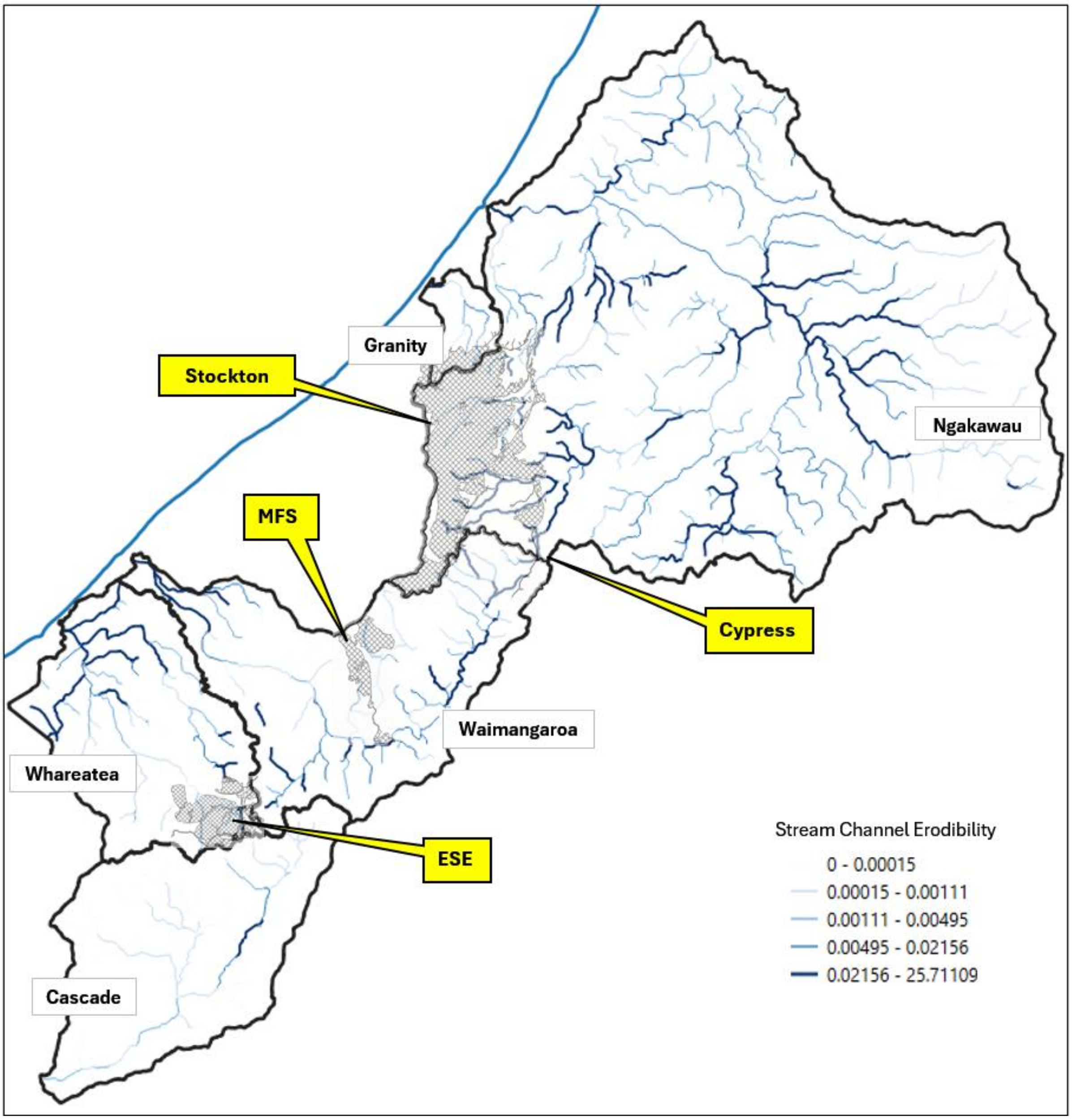


Figure 23: Stream erodibility index mapped onto catchments within and around the BPCP site.

Source: Stream erodibility index from Manaaki Whenua – Landcare Research (Smith and Betts, 2021).

4 SURFACE WATER MANAGEMENT

Before, during, and after mining at each sub-area within the BPCP, a range of water management practices will be employed to utilise, divert, protect, and process freshwater. Whilst more detailed descriptions of these practices are developed in the technical documents relating to each sub-area, this section summarises the nett impacts of mining activities based on water balance calculations. Mine water management activities represented within the water balance models include:

- Catchment boundary changes and changes in surface water discharges to (on and off-site) waterbodies (including ponds, streams and wetlands).
- Alteration or removal of existing surface water channels (including clean and mine influenced water diversions).

Potential for changes to groundwater levels across.

- Discharges from water treatment facilities (during construction, operations (active treatment), active closure (active and passive treatment), and post closure (passive treatment)).

This section draws extensively from water balance and water management studies completed for the BPCP, which are used to summarise the impacts on drainage to the surrounding environment. The following reports provide additional detail of the water balance calculations employed:

- MWM, 2026a. Mount Frederick South Water and Load Balance Model. J-NZ0377-003-R-FINAL.
- MWM 2026b. Escarpment Extended Water and Load Balance Model. J-NZ0433-003-R-FINAL.
- MWM 2026c. Construction Phase Report. J-NZ0453-007-R-FINAL.
- BRL 2026a. Millerton Block Water and AMD Management Report, February 2026, Stockton.
- BRL 2026b. Stockton Mine 80-year water quality forecast, BRL memo, 12 March 2026.

4.1 Stockton

4.1.1 Existing Conditions

The Stockton sub-area covers existing mining operations within the Stockton Coal Mining Licence including the Coal Handling and Processing Plant (CHPP), the Coal Aerial Ropeway, and the Ngākawau Rail Loadout. As Stockton is an existing operational mine, much of the Stockton sub-area has previously been disturbed, and catchments have changed over time as mining activities have modified the natural landform (Figure 24). Bathurst proposes to mine additional areas in the north of the Stockton Mine, continue using the existing infrastructure and facilities, and carry out further excavation activities in the A-Drive Borrow Pit to provide aggregate for the construction of the proposed UWHR.

Water management at Stockton aims to capture and treat mine impacted water (sediment and AMD) from historic and current mining activities. This is achieved through diversion of clean water around disturbed areas; use of sediment control structures for run-off from disturbed areas; and use of in-pit sumps to capture and settle disturbed area runoff prior to pumping. Major water management infrastructure within the Millerton Block (including Granity Stream, Miller Streams, Mine Creek, and Ngakawau River) is proposed and described at a high level in the BPCP FTAA Application AEE. Further details of the proposed work are described in a technical assessment (BRL, 2026a). The Project will include the construction of significant water management infrastructure to capture and treat AMD from historic and current workings in the Millerton area. The hydrological effects of this plan are discussed in Section 6 of this report.

[redacted]

The Stockton mine drains to tributaries of the Ngākawau River: north and west to Mine Creek, Miller Stream, and Granity Stream (Millerton Block); and east to the Mangatini Stream (Stockton), and St Patricks (Stockton). The Millerton Block also drains west to Twins Stream, and Rudolph Stream (Figure 25).

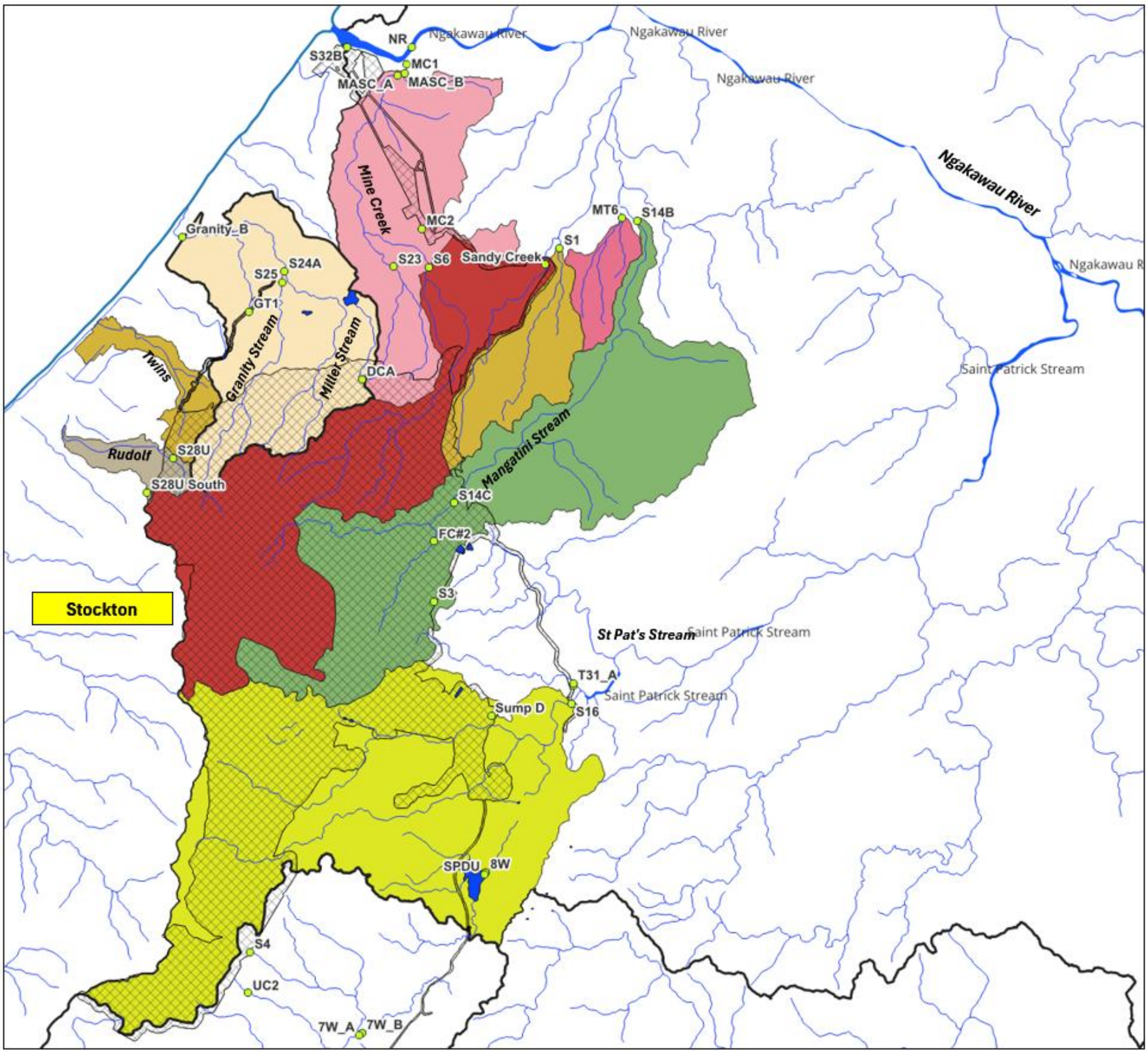


Figure 25: Surface water catchments around the Stockton mining area (hatched area).

St Patrick's Stream (S16); Mangatini Stream (S14B, MT6, S1); Mine Creek (S6, S23); Granity Stream (S25, S24a); Twins; Rudolf.

4.1.1.1 Mangatini Catchment

The Mangatini catchment consists of predominantly rehabilitated mining areas, with run-off from disturbed and rehabilitated areas reporting to the Mangatini Sump for treatment and settlement (see Figure 24). The MG15 and Ford Creek sumps (Figure 24) provide the main water supply for preparing the CaO slurry used for AMD neutralisation. The Mangatini Sump provides primary settling for sediment and AMD precipitates. Water for dust suppression is taken from the treated Mangatini Stream, and from the MG15 sump, where run off from roads does not report directly offsite. The decommissioned A18 coal fines sump is positioned in the Mangatini catchment and discharges to the Mangatini Sump.

4.1.1.2 St Patrick's Catchment

St Patrick's catchment also consists of predominantly rehabilitated mining areas but also has a small (relative to total catchment) area of active mining (see Figure 24). The southern portion of the catchment, which is predominantly rehabilitated, reports directly to Plover Stream with no treatment currently undertaken (though future treatment of Plover Stream is proposed to commence in 2034, coinciding with Cypress acid loads ceasing to report to McCabes Sump). Localised sediment ponds provide primary settling before discharging into No 1 North Dam. McCabes Lower Sump is a treatment sump for sediment and AMD precipitates, receiving historic AMD impacted water from Fly Creek and McCabes catchment including the McCabes CFS and pumped water from Cypress mine areas.

St Patrick's dam discharges to St. Patrick's Stream and provides sediment capture for the Cypress haul road run-off. Water for dust suppression use on haul roads is taken from A-Drive Sump or St Patrick's Dam. The historic Fly Creek underground mine sits in the northern area of the St Patrick's catchment and contributes AMD to St Patrick's Stream. These historic workings are located downstream of St Patrick catchment AMD treatment infrastructure (i.e., McCabes Sump) and discharges from these workings cannot be diverted for treatment.

4.1.1.3 Millerton Catchment

Millerton catchment is predominantly fractured sandstone overlying underground workings. Drainage reports to Granity Stream, Miller Stream, or Mine Creek (which are influenced by discharge from the underground workings and run-off from pyrite-rich Brunner Coal Measures). Disturbed surface water is directed south into Millerton pit area and main pit-sump. Track run-off that cannot report back to the pit is controlled through sediment check dams in tributary gullies. The Hope Lyons pit (west of Millerton pit) currently discharges mostly to Granity Stream with some discharges reporting to Miller Stream, both via a sediment control dam. Filter beds within the Millerton catchment provide dewatering of low-density sludge (LDS) from Mangatini Sump. The upper portion of Rockies area is diverted to Mangatini Sump while the lower Rockies West and Rockies East Pit voids discharge to Twins Stream and / or Granity Stream, via a sump from which overspill is pumped back to the Mangatini Sump.

4.1.2 Downstream Influence

4.1.2.1 Mangatini Catchment

A high proportion of the Upper Mangatini Catchment is disturbed by mining. This includes 441 ha of the total 639 ha catchment above the key monitoring site S14C. Mining in the Mangatini Catchment is largely complete, and any additional mining / backfill activities are assumed to have a negligible effect on the surface water regime. A maximum 50 L/s will be taken from Ford Creek for back-up water supply for the lime dosing plant (LDP1). Another 350 L/s (maximum) will be taken from the Mangatini and MG15 sumps to supply LDP1 and for fire suppression (may also be partly taken from Duncan's Sump). However, it is unlikely that the maximum rate will be taken all of the time.

4.1.2.2 St Patrick's Catchment

Future mining activity in St Patrick's catchment will influence mainly the upper tributaries of Fly Creek and Plover Stream; McCabes area to the west of the McCabes Treatment System; and the northern portion of the Cypress Project in the headwaters of St Patrick Stream.

Mining activities will continue at the Cypress Project to 2031. Operation of capture sumps and pump / pipelines at the Cypress Project has resulted in water reporting to St Patrick Reservoir, as measured at the St Patrick Dam Underdrain (SPDU) monitoring site.

Mining in the wider St Patrick Catchment (including Fly Creek, Plover, and McCabes areas) is largely complete. Any additional mining / backfill activities in these areas is assumed to have a negligible impact.

Table 11 summarises the disturbance area by landform type in the St Patrick Catchment, which includes 159.5 ha of unrehabilitated land which includes active work areas, coal stockpiles, overburden dumps, rehab stage 1, and highwalls. Rehabilitated land (234.2 ha completed to date) includes Stage 2, 3, or vegetation direct transfer (VDT) rehab types. Other landform types in the catchment include infrastructure, topsoil stockpiles, water infrastructure (106.3 ha).

Table 11: St Patricks Catchment – Rehabilitated and unrehabilitated surface area for landforms assumed to contribute AMD, as at May 2025.

LANDFORM TYPE	AREA (HA)
Total unrehabilitated	159.5
Active Work Areas	61.6
Coal Stockpiles	21.5
Overburden Dumps	68.8
Rehab Stage 1	4.8
Highwall	2.8
Total rehabilitated area	234.2
Stage 2	0.09
Stage 3	207.8
VDT	26.4

A maximum 400 L/s water take for the St. Patrick's catchment includes 100 L/s for water cart filling from St Pat's Dam; 100 L/s from CHPP, LDP2, workshops, wash pad and offices in the Plover catchment; 150 L/s from the Fly Stream catchment (water cart filling from A-Drive Sump, and for LDP2; and 50 L/s for the fire hydrant and for drilling water from Bathhouse Dams. Again, it is unlikely that all the takes would be taken simultaneously all of the time.

4.1.2.3 Millerton Catchment

In this section, the nett impacts to the flow regimes at monitoring sites on Granity Stream (S25, S24a), Mine Creek (S23, S6), and Twins catchment (T1, T2 and T3) (Figure 26) are assessed with respect to water-takes during the life of mine. The location of the water-takes and associated sumps are indicated in Figure 27.

Changes in flow regime are described by comparing sump water takes to 'current' flow distribution curves for the opencast phase (from 2010 – 2025 datasets). Flow distributions for water takes were then scaled to mimic the 'current' natural flow distribution. This involved comparing the catchment areas reporting to each pre-disturbance (2010) site, with the envisaged maximum disturbance during operations; scaling the 'current' flow distribution to account for increases or decreases in catchment size; and spilling the proportion of flows exceeding the 90th percentile flow rate.

[redacted]

The change to stream flows due to capture of disturbed footprint runoff in sumps and pumping to the Mangatini Sump have been estimated by comparing sump-water takes to ‘current’ flow distribution curves for the opencast phase (nominally 2010 – 2025 datasets). Flow distributions for the pit sump water takes were scaled to mimic the ‘current’ natural flow distribution. This involved:

- Comparing the catchment area reporting to each site pre disturbance (2010) and during operations (assuming maximum disturbance footprint);
- Scaling the site specific 'current' flow distribution proportional to the increase / decrease in catchment size; and
- Spilling the proportion of flows exceeding the 90th percentile flow rate (for a given catchment).

Changes to the flow distribution at each downstream monitoring site through the remaining Life of Mine and until pit sump pumping ceases in each catchment are illustrated in Figure 28.

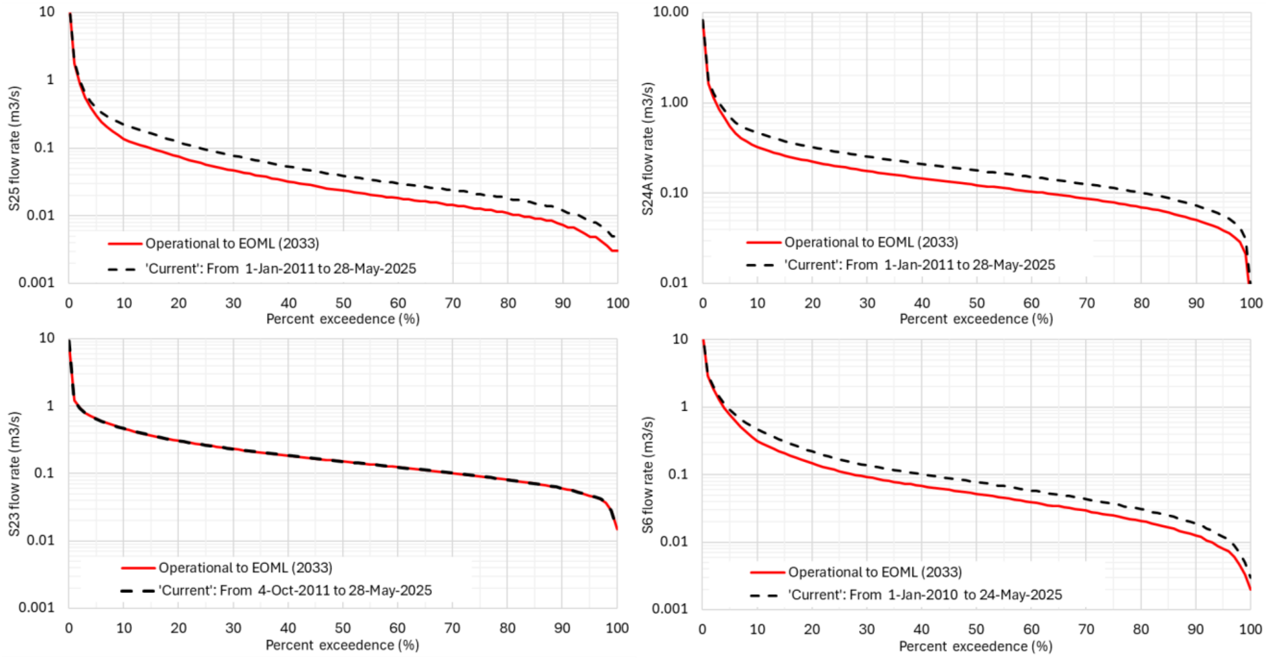


Figure 28: Estimated changes to flow distribution due to operational pit sump pumping.

An indicative summary of changes to the 90th percentile and median flow rates is shown in Table 12 which compares current observed flow rates (derived from flow monitoring data through the opencast period (typically ~2011 to 2025), and forecast flow rates with catchment changes and sump pumping.

Table 12: Operational phase changes to 90th percentile and median flow rates.

	90 %ILE FLOW (L/S)			MEDIAN FLOW (L/S)		
SITE	CURRENT	WITH SUMP PUMPING	% CHANGE	CURRENT	WITH SUMP PUMPING	% CHANGE
Granity S25	225	136	-40	39	24	-40
Granity S24A	466	322	-31	178	123	-31
Mine S23	464	464	0	151	151	0
Mine S6	473	316	-33	78	52	-33

Long term continuous flow monitoring data are not available for Twins Stream flows. As such, it is not possible to estimate the changes to Twins Stream flow rate (on a L/s basis) due to pumping AMD collected in Twins Sump to other catchments. An indicative assessment of percentage changes to flow rates at key sites (T1, T2, and T3) along Twins Stream has been undertaken based on the difference between:

- Current / Pre-opencast surface catchment areas; and
- Catchment surface areas during the operational phase where up to 11.3 ha of the upper Twins Stream catchment (comprising highwall, coal floor, and pit sump areas) is collected in Pit Sumps and pumped to Mangatini, leaving 5.6 ha reporting to T1.

The estimated effect on Twins Stream flow rates is summarised in Table 13. This assessment is conservative as it does not include the base flow rate from the historic underground workings that will continue to be diverted to Twins Stream (above T1) throughout the operational phase to control the current level of AMD impact (discussed in BRL, 2026).

It should be noted that this assessment of effects on T1 stream flows is proportional to the maximum disturbance area. Detailed staging will have some effect on when and for how long the maximum diversion occurs.

Table 13: Estimated effects of mining on Twins Stream flow rates during the Operational Phase and out to 2040.

	CURRENT / PRE-OPENCAST	OPERATIONS AND TO 2040
	Surface catchment areas (m2)	
Twins Pit (pit shell)	0	**113,000***
T1	171,500	56,500
T2 (inc. T1)	232,800	110,400
T3 (incl. T1 and T2)	490,000	367,600
	Flow change (%)	
T1 flow change	-	-67.1%
T2 flow change	-	-52.6%
T3 flow change	-	-25.0%

** Twins Pit catchment area equates to maximum disturbance and assumes all flows collected in the pit sump are pumped out of Twins Stream catchment for treatment / controlled discharge until 2040.*

Estimation of stream flows for end of mine life (2033 - 2046) were separated into two groups according to the ability of catchments to require ongoing treatment or not. Flows for S23, S24A, and S25 stabilize between 2033 and 2037. Post 2047, S6 flow rates will transition to a closure distribution as the M16 sump is allowed to naturally spill treated water to Mine Creek S6 tributary. Flows to S6 were calculated by comparing pre-2010 records and catchment area changes (including disturbed and undisturbed areas). The effect of increased underground flow paths reporting to S6 is also quantified by adding DCA flows (i.e., flows from portal No.2) back into the S6 flow distribution.

The Rockies West and Rockies East Pit final landform AMD surface types include highwall and coal floor. AMD loads from these landform types are expected to decay relatively quickly such that long term water quality in Twins Stream will be constrained by the effect of remnant ~3.3 ha historic underground workings located downstream of the Rockies West Pit void (BRL, 2025b).

The stream flows for the End of Mine Life (EOML) (2033) – 2046 phase are separated into two groups:

- Catchments that reach the Closure phase / can discharge remnant AMD naturally within the betterment reference before 2046:
    - S23 which has no disturbed surface footprint at EOML (2033);
    - S24A which likely meets the betterment reference at EOML (2033); and

  - S25 which requires pumping to Mangatini for treatment until 2037 and likely meets betterment reference from 2038 onwards.
- Catchments requiring ongoing pumping / AMD treatment to show betterment:
  - S6 which requires pumping from MW16 to Mangatini for treatment until 2047.

Stream flow estimates for the catchment that require ongoing pumping / AMD treatment (S6) are the same as the operational period, where the effect of pit sump pumping is compared against ‘current’ flow distributions.

Stream flow estimates for catchments that can discharge AMD naturally within the betterment reference by 2046 (S23, S24A, S25) are presented showing the ‘Closure Phase’ stream flow effect. The ‘Closure Phase’ stream flow effect is calculated by comparing:

- Indicative pre opencast (pre-2010) flow distributions using available data for each flow monitoring site; and
- Linearly scaling up / down the closure flow distribution, proportional to changes in catchment surface area, including disturbed and undisturbed areas.

This provides an indication of the change in flow rate for each sub-catchment due to overall Millerton opencast mining i.e., comparing 2010 to closure flow rates. These flow changes are proportional to surface catchment changes only. The effects of changes to seepages and groundwater flow regimes as landforms transition from operational to a final landform / rehabilitated status are described in GHD (2026).

Changes to the flow distribution at each downstream monitoring site that reaches the Closure Phase in the EOML (2033) – 2046 phase are shown in Figure 29.

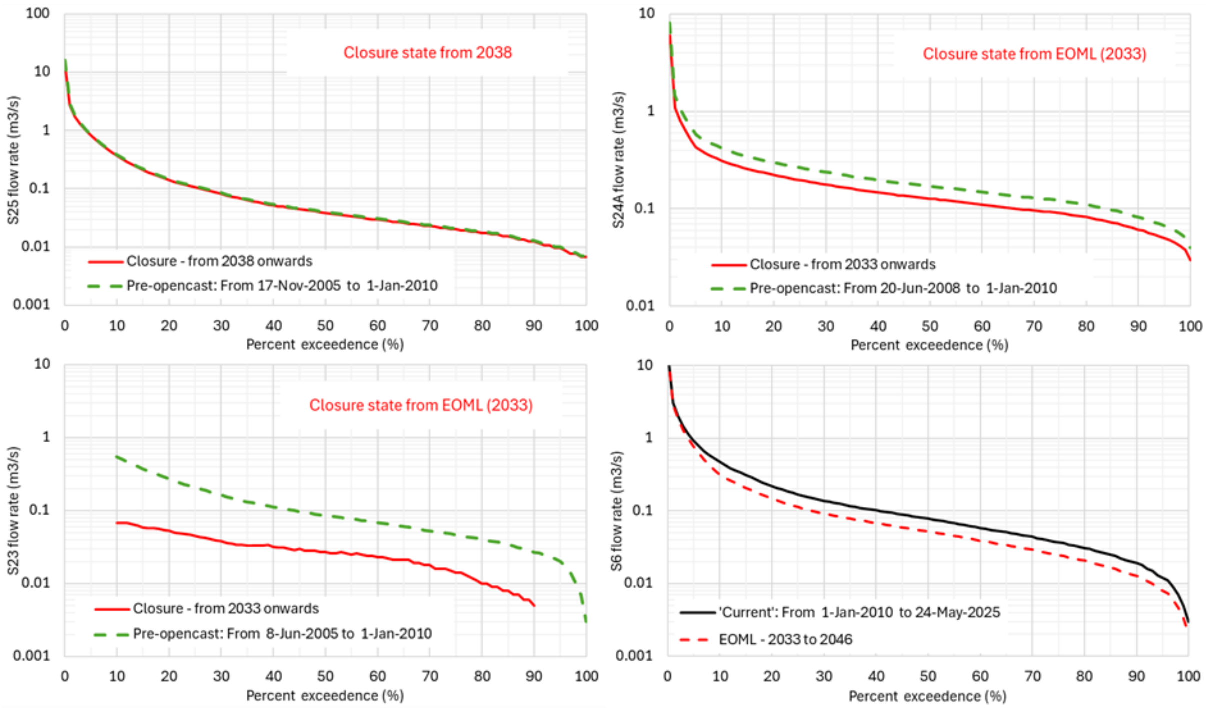


Figure 29: Estimated changes to flow distribution EOML (2033) – 2046 phase.

A summary of changes to the 90th percentile and median flow rates is shown Table 14 which compares pre-opencast flow rates (derived from flow monitoring data available prior to 2010), and closure phase flow rate estimates proportional to catchment area changes between 2010 and EOML.

There is no change to the S23 surface catchment area between 2010 and EOML. However, there is a significant amount of underground workings reporting to S23 that are removed (reduction from 152.4 ha in 2010 to 32.5 ha at EOML). Quantifying the effect of these workings being removed based on current acidity loads is complicated by the effect of fire suppression.

The closure S23 flow rate estimate quantification process included subtracting the operational phase DCA flow distribution (which includes the effect of fire suppression water) from the operational phase S23 flow distribution. The calculation gave anomalous results for high and low flow conditions, which are omitted from the flow duration figures above. The pre-opencast S23 high flow (> 90th percentile) distribution is considered inaccurate (also omitted the flow duration curves above) due to a lack of high flow rating.

Table 14: Operational phase changes to 90th percentile and median flow rates.

	90 %ILE FLOW (L/s)			MEDIAN FLOW (L/s)		
SITE	PRE-OPENCAST (L/s)	CLOSURE	% CHANGE	PRE-OPENCAST (L/s)	CLOSURE	% CHANGE
S25 (Closure)	439	423	-4	40	39	-4
S24A (Closure)	419	312	-26	171	127	-26
S23 (Closure)	545	68*	-88	85	27	-68
S6 (EOML-2046)	MW16 pumping ongoing. Flow effects as per 'Operational' Phase in Table 12					

** 90th percentile closure flow rate estimates for S6 may be unreliable due to DCA flow distribution being unreliable at high flows.*

An indicative assessment of percentage changes to flow rates at key sites along Twins Stream has been undertaken based on the difference between:

- Current / Pre-opencast surface catchment areas; and
- Catchment surface areas during the closure phase (post 2040 when Twins Sump pumping to Granity Stream ceases) where the 11.3 ha disturbed footprint in the upper Twins Stream catchment (comprising highwall, coal floor, and pit sump areas) is collected in Pit Sumps and allowed to naturally spill to Twins Stream (above T1).

The estimated effect on Twins Stream flow rates is summarized in Table 15. Expected Closure Phase flow rate changes are minor due to the small changes in catchment area and an assumption that flows discharging historic underground workings are unchanged.

Table 15: Estimated effects of mining on Twins Stream flow rates during the Operational Phase and out to 2040

	CURRENT / PRE-OPENCAST	EOML (2040 ONWARDS)
	Surface catchment areas (m^2)	
Twins Pit (pit shell)	0	113,000*
T1	171,500	169,500
T2 (inc. T1)	232,800	223,400
T3 (incl. T1 and T2)	490,000	480,600
	Flow change (%)	

T1 flow change	-	-1.2%
T2 flow change	-	-4.0%
T3 flow change	-	-1.9%

** Twins Pit catchment area equates to maximum disturbance and assumes all flows naturally spill to Twins Stream post 2040.*

The closure phase of the Stockton mine will include revegetation using native species and rock field features. Key roads will be retained but reduced in size. The proposed final landform will include 933 hectares of rehabilitation completed by mid-2047. Rehabilitation will be completed progressively, and will use a combination of natural material, VDT, topsoil, and slash material. Closure landforms will include native ecosystem, vegetated highwalls, rock-field rehabilitation, water infrastructure, and general infrastructure (including retained roading network).

As discussed previously, the flows for S23, S24A, and S25 stabilise at Closure Phase levels between 2033 and 2037. Pumping of AMD from MW16 Sump to Mangatini is expected to cease in 2046. Post 2047 (when long term MW16 AMD is treated by alkaline dosing in-sump) the S6 flow rates will transition to the Closure distribution as the sump is allowed to naturally spill treated water to Mine Creek S6 tributary.

The S6 Closure Phase stream flow is calculated by comparing:

- Indicative pre opencast (pre-2010) flow distributions using available data; and
- Linearly scaling up / down the closure flow distribution, proportional to changes in catchment surface area, including disturbed and undisturbed areas.

The effect of increased underground workings flow paths reporting to MW16 Sump / S6 is also quantified by adding DCA flows to the S6 flow distribution.

Changes to the S6 flow distribution from pre opencast to the Closure Phase post 2047 are shown in Figure 30.

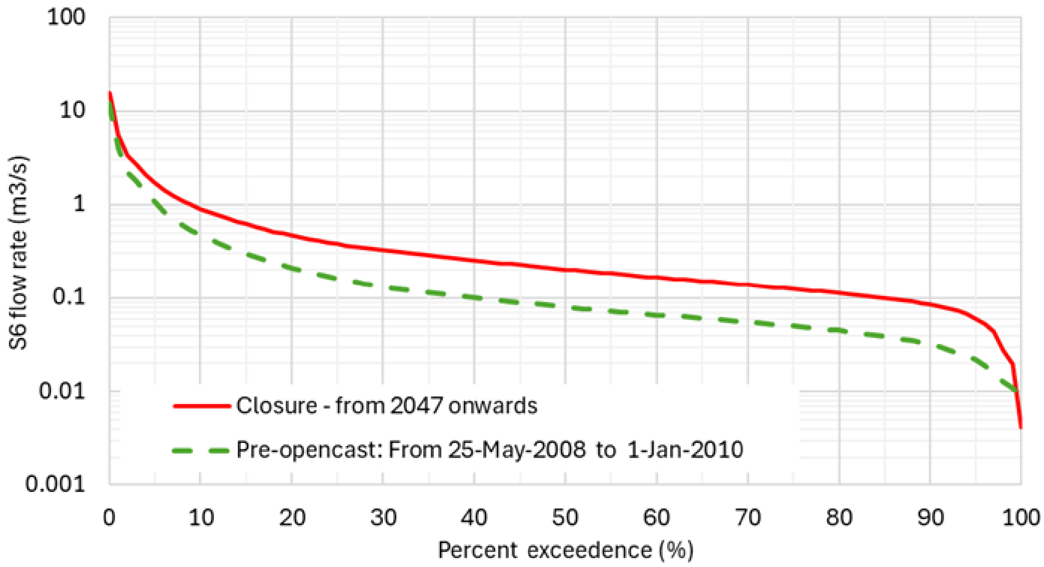


Figure 30: Estimated changes to S6 flow distribution curve at closure.

A summary of changes to the 90th percentile and median flow rates is shown in Table 16 which compares pre-opencast flow rates (derived from flow monitoring data available prior to 2010) and closure phase flow rate estimates proportional to catchment area changes between 2010 and EOML.

Table 16: EOML (2033) to 2046 phase changes to 90th percentile and median flow rates.

	90 %ILE FLOW (L/s)			MEDIAN FLOW (L/s)		
SITE	PRE-OPENCAST (L/s)	CLOSURE	% CHANGE	PRE-OPENCAST (L/s)	CLOSURE	% CHANGE
S6 (Closure)	472	898	90	80	203	153

4.2 Mount Frederick South

4.2.1 Existing Conditions

MFS lies within the Waimangaroa River catchment (Figure 31). Historical underground and surficial mining of limited extent is present within the catchment but is unlikely to influence the existing hydrological characteristics given the vast majority of the catchment is undisturbed (approximately 95%).

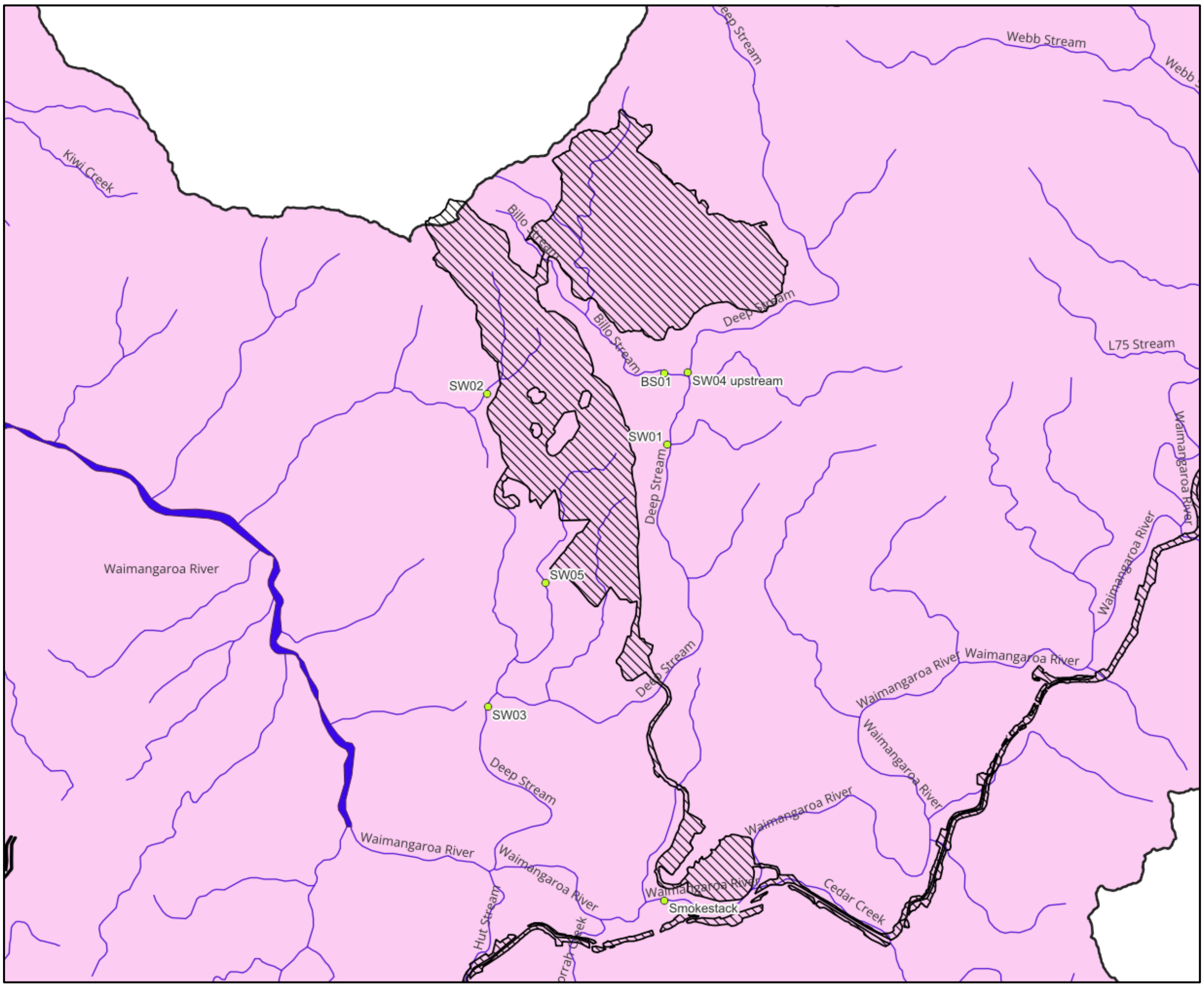


Figure 31: MFS mine area (hatched) draining to the middle Waimangaroa catchment.

Note: alternative notation used for Deep Stream (i.e. 'Deep Creek used in some mapping coverages).

4.2.2 Water Management

The water management strategy for MFS aims to collect and treat the majority of mine impacted water and is outlined in more detail in Mine Waste Management (2026a). Appendix A Figure 67 and Figure 68 illustrate the planned site water management, which will include collection of engineered landform

(ELF) seepage and runoff from non-rehabilitated mine surfaces in purpose-excavated sumps within the Deep Stream catchment. Flows higher than the (non-exceedance) 95th percentile will bypass the collection sumps and be discharged to the receiving environment (i.e., when creek flows are high), upstream of SW01 and SW03 compliance sites.

Conveyance of the collected mine impacted water to the Mount Frederick South active water treatment plant via pipeline, will ultimately discharge to the Waimangaroa River above the Smokestack compliance site following treatment. When flows in the Waimangaroa River are high (above the 90th percentile), 50% of the collected water will be treated through the Water Treatment Plant (WTP) while the remaining amount will be discharged to the receiving environment.

ELFs will be progressively rehabilitated, some as early as the first few years of mine life at Mount Frederick South. When rehabilitated ELF seepage is of sufficient quality, it will be treated passively with mussel shell reactors and polishing ponds before discharge to the receiving environment.

Where practicable, clean water diversions will be constructed to route water around mine disturbance to minimise the amount of water interacting with mine waste and therefore minimise the volume of water requiring treatment.

A water-take up to 140 L/s from the Waimangaroa River, upstream from the WTP location, is proposed to support operational water demand (e.g., dust suppression) and WTP commissioning.

Active treatment for Mount Frederick South is planned to be decommissioned after ~2046, after which point ELF seepage will be passively treated before discharging to the receiving environment (Appendix A Figure 68).

4.2.3 Downstream Influence

Flow diagrams at Appendix A Figure 67 and Figure 68 illustrate that nett downstream impacts will be seen at Deep Stream (Waimangaroa catchment (SW01, SW03)) and in the Upper Waimangaroa (at Smokestack). Simulated flow duration curves for baseline conditions, operational conditions and post closure conditions are shown in Figure 32, Figure 33 and Figure 34. It should be noted that these curves are used to represent relative change from observed conditions and are thus used to estimate the magnitude of change from observed conditions rather than represent absolute values.

For SW01, the ‘active treatment phase’ indicates limited change to the hydrograph, however, there is a reduction in flows and total water volume as water is removed from the catchment for treatment. High flows are also impacted by higher net percolation rates associated with the ELFs. For the ‘Post Closure Phase’, seepages from groundwater storage in the ELFs (via the MSR) combine with higher rainfall under climate change to create higher baseflows.

At SW03, active treatment also has limited impact on stream hydrographs, but the reduction in total flow and volume indicated in Figure 33 is again the result of some water being sent for treatment. High flows are also impacted by higher net percolation rates into to ELFs. Similar to SWO1, Post Closure Phase result in higher base flows, due to seepages from the ELF and small discharges from the MSR (and to a lesser extent climate change).

Finally, active treatment conditions will produce increased baseflow at Smokestack (2W) due to the surge capacity of the east and west pit sumps and extended operation of the WTP into low flow conditions (Figure 34). The Post Closure Phase will see increased baseflow due to MSR discharges from the coal stockpile pad (and to a lesser extent climate change).

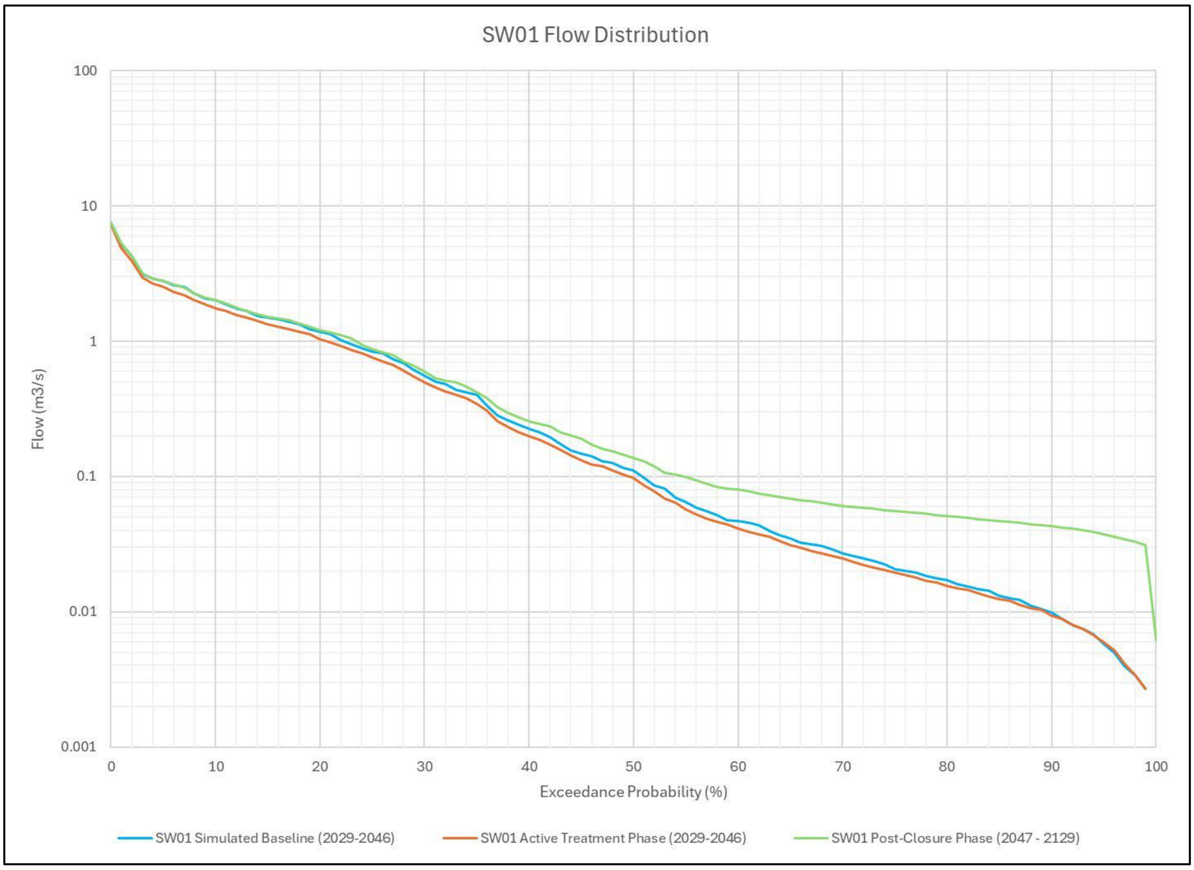


Figure 32: SW01 flow duration curve for baseline, active treatment and Post Closure Phase.

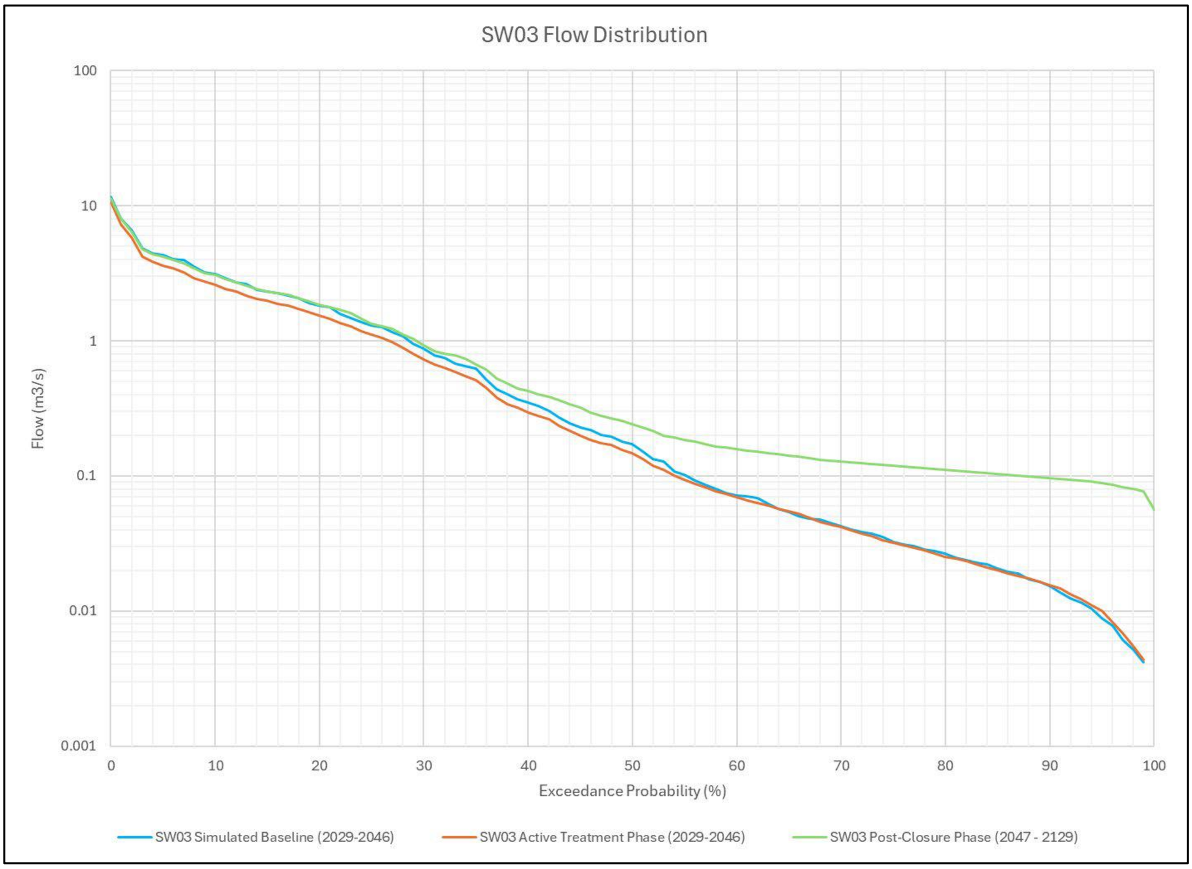


Figure 33: SW03 flow duration curve for baseline, active treatment and Post Closure Phase.

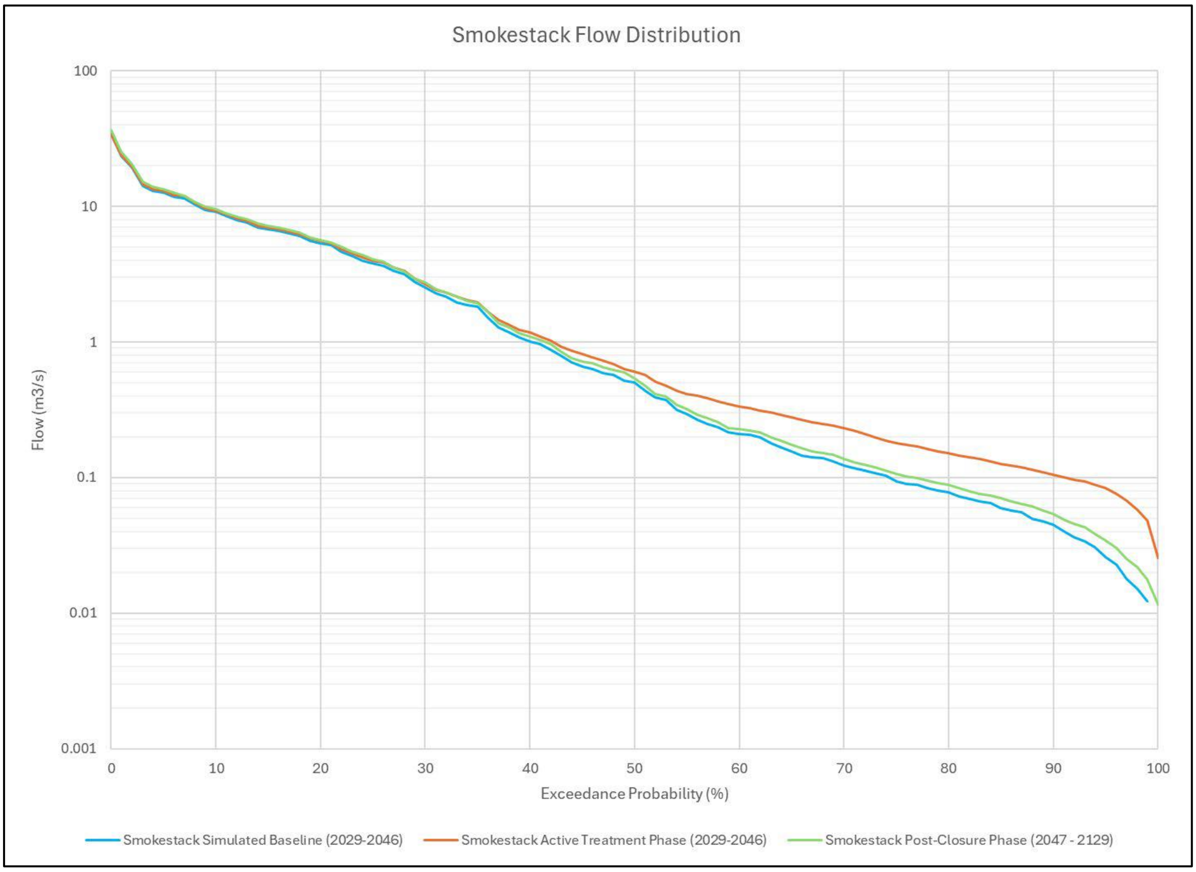


Figure 34: Smokestack flow duration curve for baseline, active treatment and Post Closure Phase.

4.3 Upper Waimangaroa Haul Road

The UWHR alignment runs from the middle of the Stockton Plateaux and mining area (near Fly Creek) to the upper boundary of Cascade Creek catchment on the Denniston Plateaux (Figure 35). At 11.5 km in length, the road will be 8.6 m wide and where possible, the selected alignment will leverage existing access roads and previously cleared areas to minimise the disturbance footprint (particularly in its most northern section above Cypress mine). 4 km of the haul road traverses previously undisturbed ground, comprising 1 km adjacent to the ESE mining area and 3 km connecting the haul road to Cypress mining operations in the north.

The UWHR predominantly impacts the upper Waimangaroa River which runs between the Mt Frederick and Mt William ranges, and receives drainage from multiple water ways including:

- Deep Stream and Billo, which drain the Mount Frederick South mining area;
- Whirlwind and Herbert Streams, draining the historic Mount Frederick South mining area;
- Cypress Stream and Byrne Creek, from the Cypress mining area; and
- Downstream of the Hut Stream tributary and the confluence of Burnett Stream into the Waimangaroa River, (from Coalbrookdale and Burnetts Face mining areas.

The construction for the UWHR along the eastern flank of the Upper Waimangaroa corridor will intersect multiple tributaries that drain northwest from the William Range, the largest being Ernest Stream, Wilson Creek, Cedar Creek, Gomorroh Creek, and Hut Stream. More technical details of the UWHR are given in Mine Waste Management (2026c).

[redacted]

Typical features of the UWHR will include roadside drainage paths and clean water diversion drains around the disturbance footprint. Water management of the UWHR during the construction and operational phases of mining areas will include the following features (BRL, 2026c):

- Cut surfaces (e.g., road cuttings) and road surface run-off will be captured in sediment retention ponds that will be managed during the construction and operational phases, as per (BRL, 2026a).
- Natural surface run-off will be diverted along and under the road via channels and culverts, maintaining the natural water flow and quality feeding into the Upper Waimangaroa River.

- A water quality monitoring program will be undertaken to inform management of environmental effects during the construction and operational phases, ceasing in the closure phase after rehabilitation of the road is complete.

At closure, the UWHR and MFS Access Road will be rehabilitated, allowing minimum access for site maintenance. It is expected that AMD and TSS generation will be suitably controlled for closure to not require ongoing management.

4.3.1 Downstream Influence

Stream and drainage channels intersected by the UWHR will be diverted along or under the road via culverts which will be sized to have minimal impact on downstream flow characteristics. Road surface run-off will be captured in sediment ponds that will be managed during the construction and operational phases of mining activities. The volume of such runoff is small compared to natural catchment runoff and so will only marginally increase the risk of downstream flooding during high rainfall conditions. Assessment of individual catchment runoff response will be conducted during detailed road design work. There is a risk of increase sediment mobilisation and transport to downstream water bodies during road construction that will necessitate increased sediment management (as described in SLR, 2026).

During the Construction Phase of the BPCP, several streams have the potential to be impacted by development of the infrastructure areas and roadways. Monitoring of any effects on water quality during within the vicinity of the UWHR will thus be undertaken (as described in MWM, 2026c).

4.4 Escarpment Extended

4.4.1 Existing Conditions

Figure 36 illustrates catchments potentially impacted by ESE mining activity areas, including the Whareatea and Cascade catchments, and to a lesser extent the Waimangaroa catchment. The existing Escarpment Mine has been in care and maintenance since July 2016 (for fuller description see MWM 2026b). The schematic diagram of current water management at the existing Escarpment Mine is illustrated in Appendix A (Figure 69). Most discharges from the site flow into Cascade Creek, including treated water discharged via V8 Creek and drainage from the Escarpment adit into V37 (Figure 37). The latter does not enter water management infrastructure at the existing Escarpment Mine and thus provides an example of historic water entering directly into the Cascade Creek catchment. Currently no MIW discharge from the Escarpment Mine enters the Whareatea River catchment, only the two clean water diversion drains shown in green in Figure 38. Mine disturbance is also present within Cascade Creek catchment, with both surficial mining and the discharge of mine water from a large network of underground workings that extend beneath the Whareatea and Waimangaroa catchments. Rapid Stream also receives discharge from historic underground workings (Sullivan Underground Mine).

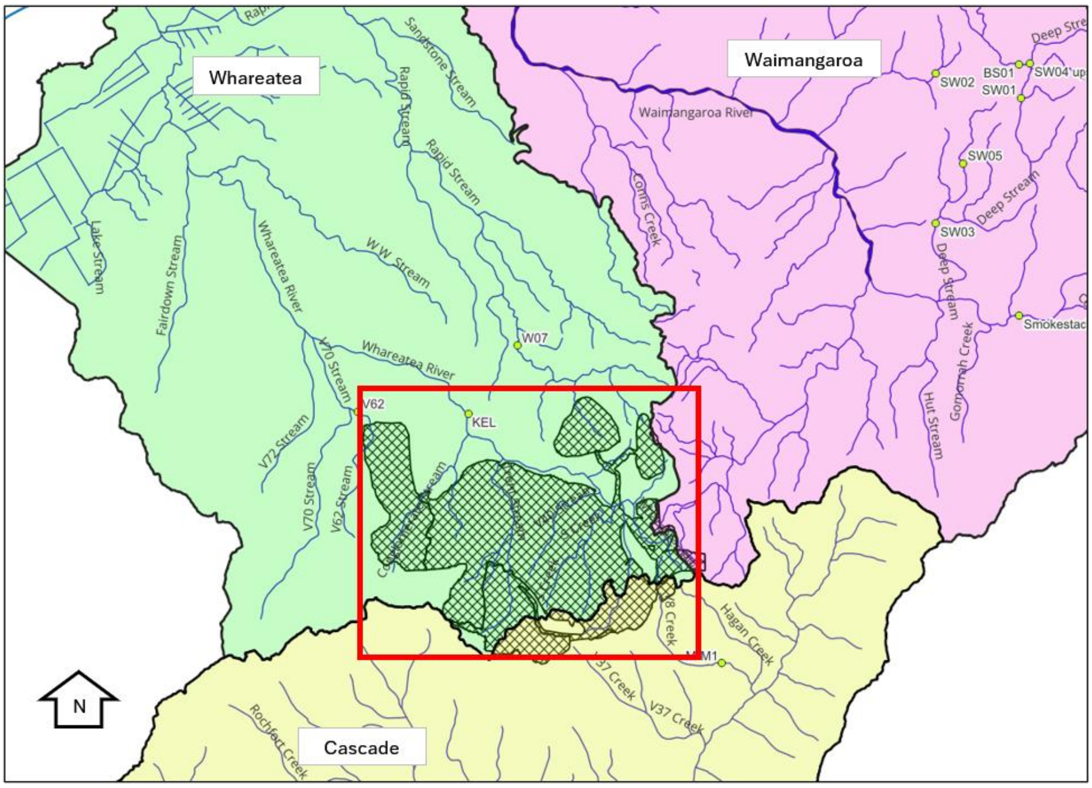


Figure 36: Whareatea, Waimangaroa, and Cascade catchments influenced by drainage from the Escarpment Extended mine area (hatched).

Note: Red insert indicates location of Figure 37.

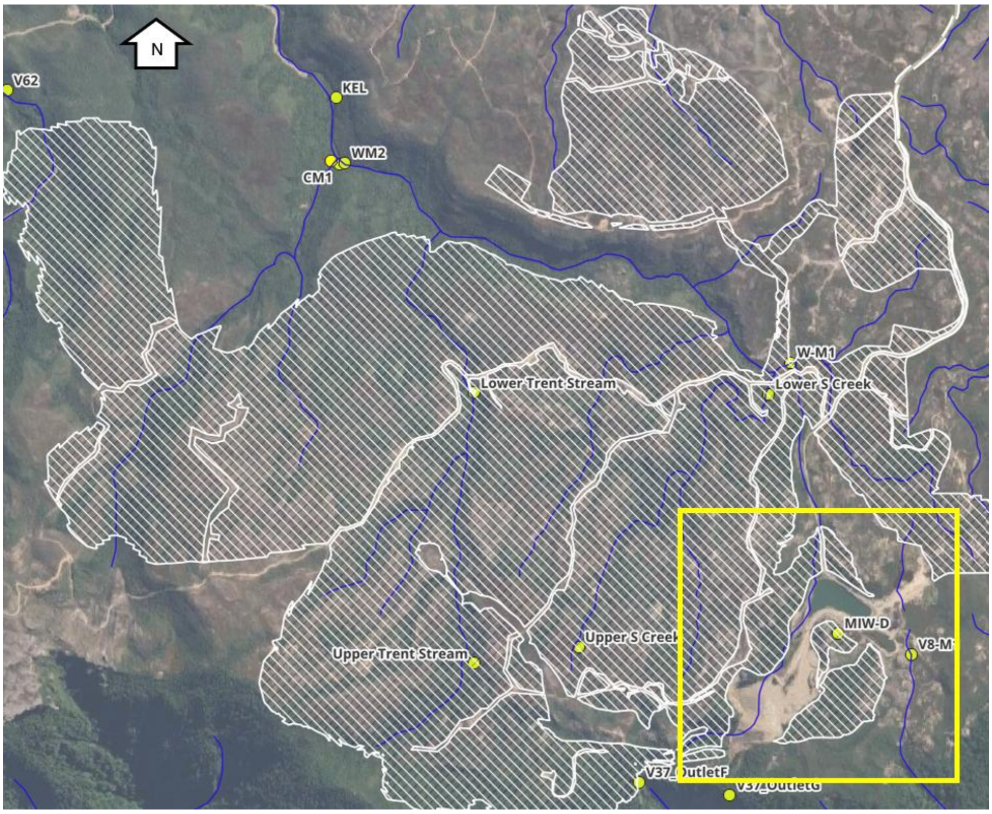


Figure 37: Detail of Escarpment Extended mine area (white hatched) which drains north to the Whareatea River and south to Cascade Creek

Note: Yellow line indicates location in Figure 38.

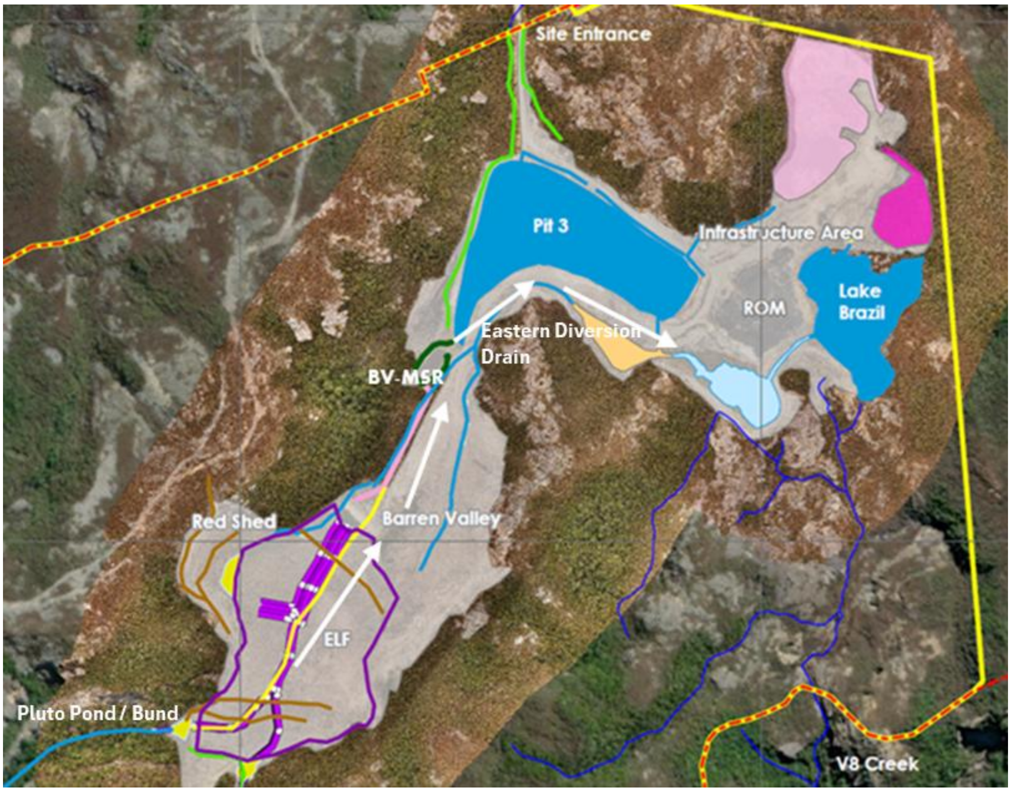


Figure 38: Detail of Figure 37 showing clean water diversion (green) draining to the Whareatea.

4.4.2 Water Management

Whareatea River – the bulk of the Escarpment Extended mining operations will lie within the Whareatea River catchment (Figure 36). The schematic diagram of water management during active treatment at the Escarpment Extended mine area is illustrated in Appendix A (Figure 72). Mine water management will include:

- Collection of ELF seepage and runoff from non-rehabilitated mine surfaces in purpose excavated sumps. Flows higher than the 95% percentile will bypass or spill from the collection sumps and be discharged (i.e., when creek flows are high), to the Whareatea River upstream of monitoring location KEL and V62 Stream. Sump water is pumped to the WTP Surge Pond.
- Conveyance of the collected mine impacted water to the WTP, ultimately discharging to the Whareatea River above the KEL compliance monitoring site. Bypass does not occur from the WTP Surge Pond. During the construction phase water will be sent to Pit 3 and then discharge to V8 Creek.
- ELFs will be progressively rehabilitated, some as early as the first few years of mine life at ESE. When rehabilitated ELF seepage is of sufficient quality, it will be treated passively with mussel shell reactors and polishing ponds before discharge to the receiving environment.

Where practicable, clean water diversions will be constructed to divert water around mine disturbance to minimise the amount requiring treatment.

Cascade Creek – During operations, this catchment will receive runoff from infrastructure areas, clean water diversions, bypass and spilling of mine water collection infrastructure above 95th percentile flows, and discharge of treated water from the WTP up to 40 L/s. The underground workings draining to this catchment will also be reduced by mining out and sealing of workings by ESE. Pumping from the WTP will cease during the operational phase and this catchment will then receive rehabilitated mine runoff and seepage from ELF (via the MSRs and polishing ponds). A water take from this catchment, near Lake Brazil, is proposed to support operational water demand (e.g., dust suppression) and WTP commissioning.

Rapid Stream - The Rapid Stream catchment will consist of roading, infrastructure, a borrow-pit and the NSUL ELF. Mine impacted water will be graded back into the Whareatea Catchment for collection and treatment. Where grade is insufficient water will be pumped to the WTP, in particular seepage and unrehabilitated runoff from the NSUL ELF. At closure, the ELF will be rehabilitated with seepage discharged to the receiving environment following passive treatment via MSRs and polishing ponds.

Active treatment for Escarpment Extended is planned to be decommissioned after 2058, after which point ELF seepage and runoff from pit voids treatment will be passively treated before discharging to the receiving environment (Appendix A, Figure 73).

4.4.3 Downstream Influence

During baseline conditions which include flows from historical workings, downstream drainage from the existing Escarpment Mine flow to the lower Whareatea River (V62, KEL), Rapid Stream (W07) and Cascade Creek (MM1, V37). During operations (active water treatment) and closure (passive water treatment) at Escarpment Extended, surface water flow and discharges to these outflow points will become more complex (as indicated in Appendix A Figure 72 and Figure 73). The expected influence of mining operations on downstream flows has been modelled using GoldSim software (MWM, 2026b). Estimated impact on the flow duration curve at monitoring points KEL, V62, W07 and MM1 are illustrated in Figure 39, Figure 40, Figure 41, and Figure 42. It should be noted that the changes in flow regime represent relative change to modelled rather than observed baseflow. However, the modelled percentage changes to future flow conditions can be applied to observed flow regimes at each of the sites.

Low flows at the KEL monitoring point are expected to increase during operations followed by a slight reduction (but still above baseline) after closure. The increases in low flows are the result of increased release of treated water. Reduction in high flows results from? up to 40 L/s being diverted from the Whareatea catchment to Cascade Creek. Minimal changes were indicated for V62 between baseline and operational conditions. However, there is an increase of flow in the Post Closure Phase due to water diversion and thus effectively the increased catchment size. At W07 there is a small decrease in flow during operational conditions due to runoff and seepage capture by the ELF. During closure, low flows are expected to increase by 20 L/s due to additional seepage from the ELF. At M-M1 there is a decrease in high flows and an increase in low flows during operations due to an additional 40 L/s of treated water being delivered to V8 Creek. The low flows subsequently decrease after closure but are still above baseline conditions. High flows remain attenuated after closure due to reduced catchment size.

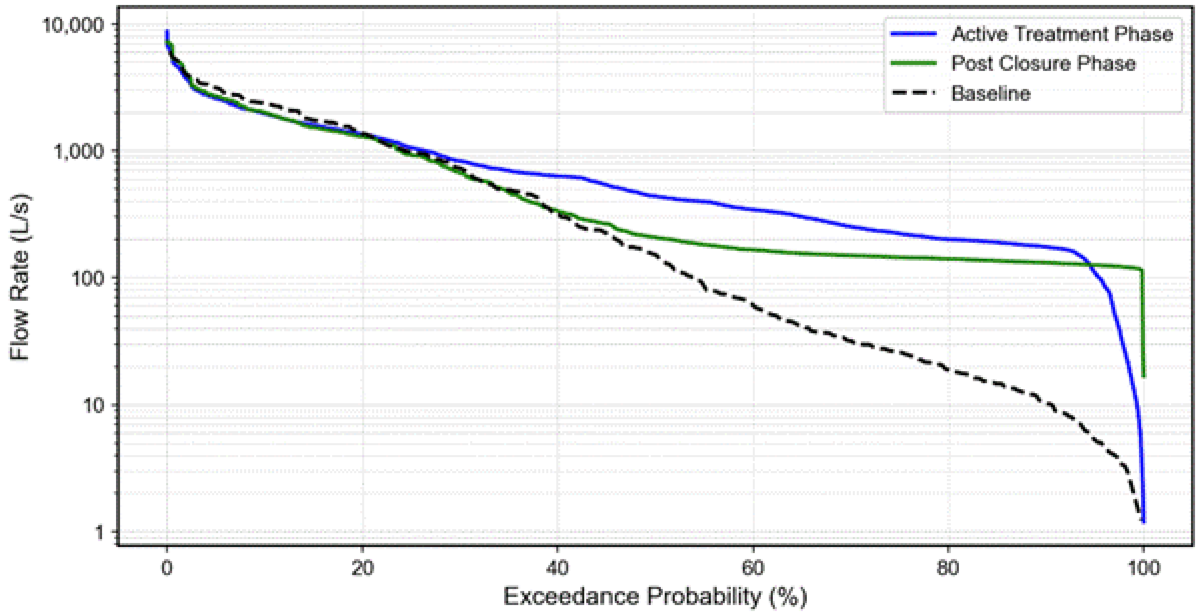


Figure 39: Flow regime of KEL for baseline, operations and Post Closure Phase

Source: MWM (2026).

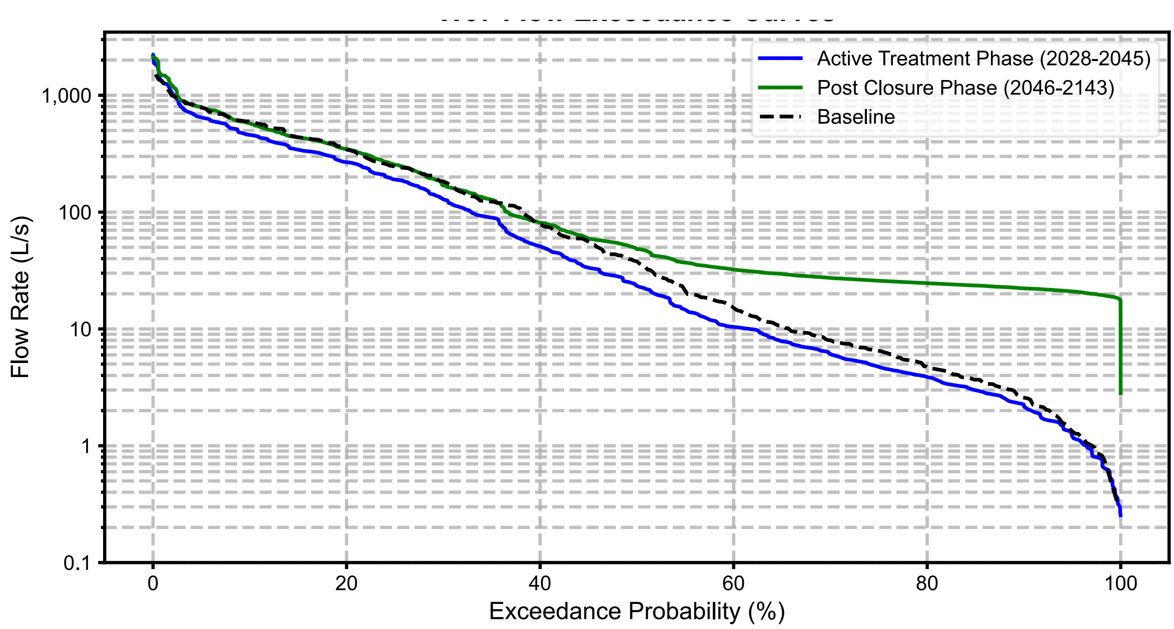


Figure 40: Flow regime of W07 for baseline, operations and Post Closure Phase.

Source: MWM (2026).

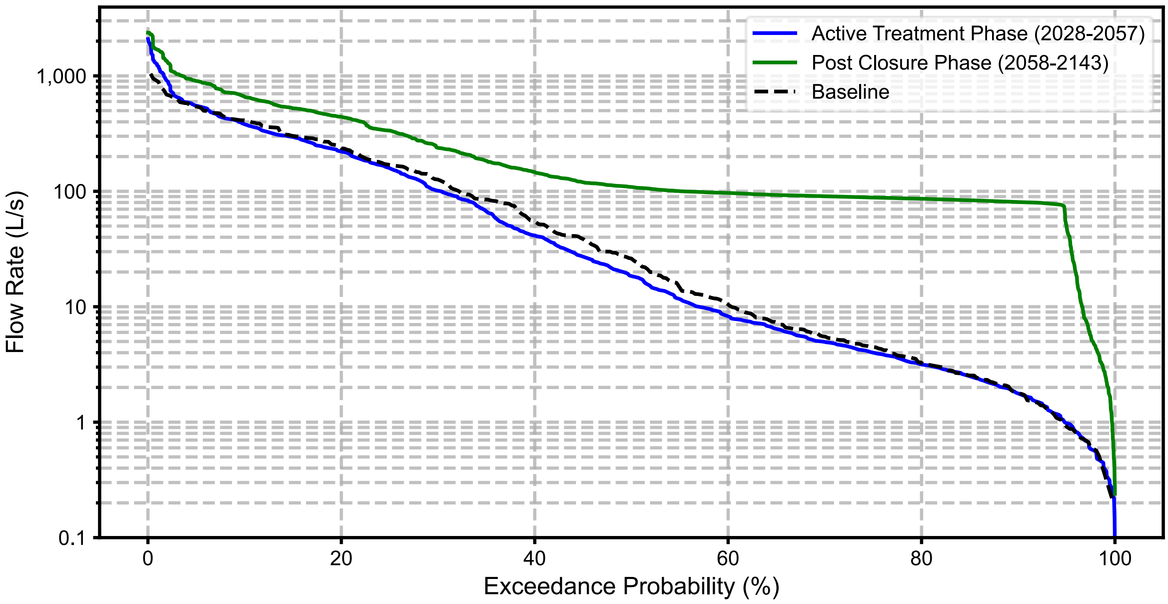


Figure 41: Flow regime of V62 for baseline, operations and Post Closure Phase.
Source: MWM (2026).

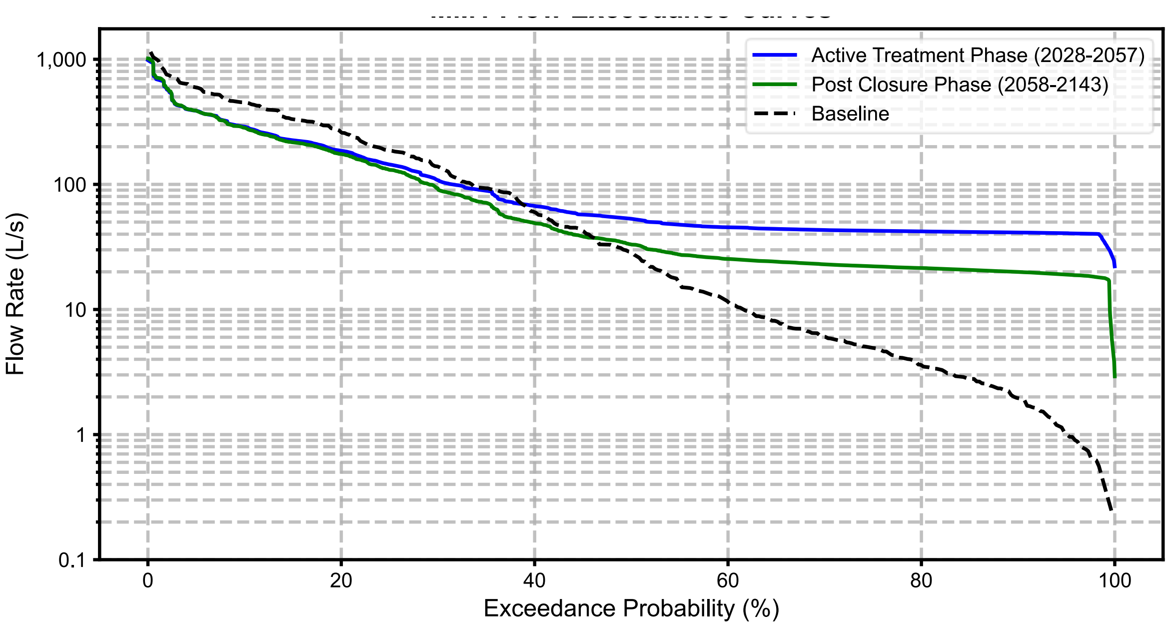


Figure 42: Flow regime of MM1 for baseline, operations and Post Closure Phase.
Source: MWM (2026).

5 DOWNSTREAM WATER CONSENTS

To assess the potential impacts of mine development on water availability to downstream users (e.g. for recreation, water abstraction, etc), the downstream water demand was reviewed relative to available consent data. Data relating to existing water-take consents (maximum annual supply and maximum annual rate of extraction) were obtained from the West Coast Regional Council (WCRC) Rest service[1]. Two datasets ('Consents' and 'Consented water takes') were available. The former contained information relating to the consent applicant but not conditions, whereas the latter contained information relating to consent conditions (maximum annual take (m^3/year) and maximum take rate (L/s)), but not the consent applicant.

Figure 43 illustrates the location and maximum allowed abstraction of consented surface water takes in the region that fall within the Waimangaroa, Cascade or Ngākawau catchments. There were no downstream surface water takes in the Whareatea (or Rapid) catchments. Table 17 lists only downstream surface water takes (for which maximum take conditions are noted), and surface or groundwater takes (for which no maximum take conditions are noted).

[redacted]

The WCRC Regional Land and Water Plan (RLWP) allows for some water take activities to occur as permitted activities:

- Rule 40: take and use of surface water (general)
- Rule 41: take, use and diversion of surface water for small scale hydro electricity generation
- Rule 44: take and use of groundwater (general)

Each of these three Rules contains the requirement that "*The council is informed in writing of the location, expected rate and frequency of the take prior to the take occurring, and contact details of the person taking*".

The WCRC online consents database was also interrogated by BRL (and its technical advisors). BRL also requested information from WCRC relating to any regional authorisations in the vicinity of the BPCP and was supplied with a considerable number of authorisation documents in response. Collectively, these two processes identified only one certificate of compliance (CC2016-0001-01) that has been issued by WCRC for a permitted water take and use (of surface water) in the vicinity of the BPCP, located in Granity. This permitted water take has been included in the assessment. Additional consideration of mine impacts with respect to downstream water quality are addressed in Hickey (2026).

6 ANALYSIS OF HYDROLOGICAL IMPACTS

This section presents a high-level summary of the cumulative downstream impact of mining activities and associated water management at the Stockton, Mount Frederick South and Escarpment Extended mining areas. The information is drawn from the water balance studies summarised in Section 3 (MWM 2026a; 2026b; 2026c; BRL 2026), which describe percentage change from modelled baseline conditions. The changes represent the impact of clean water diversions, treatment of mine-impacted water, potential increases or decreases in groundwater seepage, and outflows from on-site water treatment facilities. Estimated impacts (percentage change in flow) are applied to observed (or scaled) downstream flow timeseries characteristics (lower quartile, median, and upper quartile). The location of the downstream catchments assessed relative to mining areas are illustrated in Figure 44.

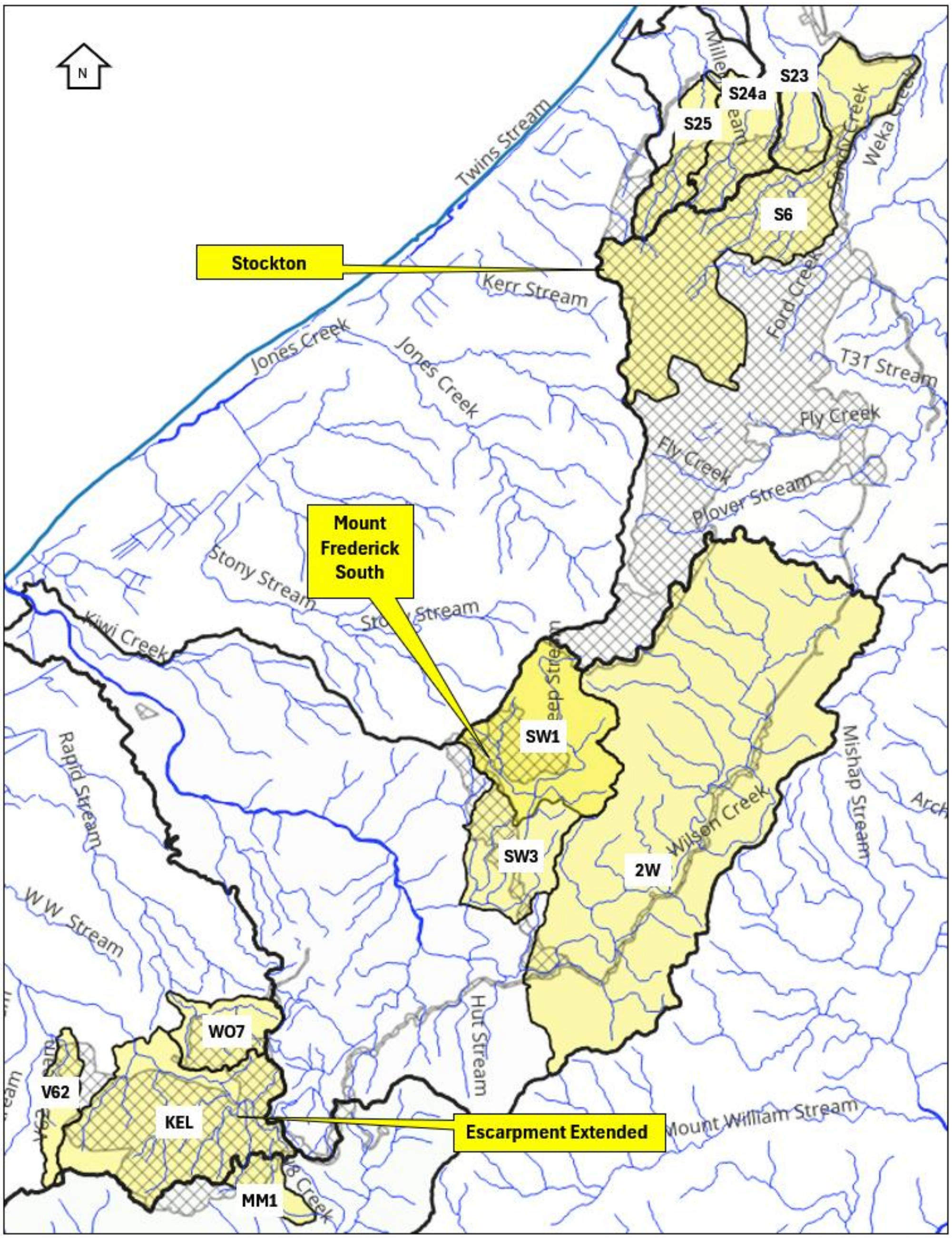


Figure 44: Location of compliance site catchments assessed relative to downstream impacts from each mining areas.

Note: As estimated from WLBMs.

6.1 Impacts on Median Flow

The summary of impacts on the median flow statistic (Table 18) is organised by downstream catchment impacted, mining schedules represented by operational and closure conditions and by each mine area.

Table 18: Observed median flow with estimated operational (active treatment) and post closure median flow (also expressed as % change).

			MEDIAN (m³/s) [%]		
SITE	CATCHMENT	CODE	OBSERVED	OPERATIONAL (ACTIVE TREATMENT)	POST CLOSURE PHASE
Stockton	Granity	S25	0.039	0.024 [-38]	0.039 [-1]
		S24a	0.179	0.123 [-31]	0.127 [-26]
	Ngākawau	S23	0.151	0.151 [0]	0.027 [-82]
		S6	0.078	0.052 [-33]	0.203 [+160]
Mount Frederick South	Waimangaroa	SW01	0.049	0.043 [-12]	0.060 [+23]
		SW03	0.006	0.005 [-15]	0.008 [+41]
		2W (Smokestack)	0.717	0.867 [+20]	0.775 [+8]
Escarpment Extended	Whareatea	V62	0.035	0.025 [-29]	0.142 [+307]
		KEL	0.084	0.246 [+193]	0.116 [+39]
	Rapid	W07	0.018	0.011 [-38]	0.022 [+21]
	Cascade	MM1	0.057	0.105 [+85]	0.066 [+15]

Cumulative downstream impacts of estimated changes to median flow at the compliance sites (Table 18) will occur as the flow from S25 and S24, and S23 and S6, (Stockton) converge to the Granity Stream and Mine Creek respectively. The combined downstream impact (as a percentage change in flow) will be less than the impact at each upstream location, as the ratio of flow to catchment area increases downstream (see Table 19).

The situation is more complex at MFS where changes to flow at SW01 will be added to changes in flow at SW03 (both on Deep Stream), and Smokestack (2W) (Waimangaroa River). The total impact on median flows at 17W (downstream of the Deep Stream and Waimangaroa junction) is estimated to increase by 13% and 6%, for operational and post-closure conditions respectively.

A similar effect occurs at ESE where impacted flows from KEL and V62, accumulate at WM-3, where median flow is increased by 52% and 48% under operational conditions and post-closure conditions respectively).

Table 19: Cumulative modelled downstream change in median flow for operational and closure conditions.

DOWNSTREAM LOCATION	MEDIAN FLOW (m³/s) *	OPERATIONAL FLOW (m³/s)	POST CLOSURE FLOW (m³/s)	OPERATIONAL % CHANGE	POST-CLOSURE % CHANGE
Granity Stream (outlet)	0.22	0.146	0.16	-32	-23
Mine Creek (MC1)	0.29	0.27	0.29	-8.8	0.3
Waimangaroa (17W)	1.08	1.23	1.15	13	6.6
Whareatea (WM3)	0.29	0.44	0.43	52	48
Cascade (V8)	0.32	0.37	0.33	15	2.7

** Estimated from upstream flows for Granity outlet and Waimangaroa (17W)*

6.2 Impacts on Low Flows

Collation of regional council consent information relating to surface or groundwater takes is difficult due to errors in the available datasets (for example, subsumed, duplicate, and missing records) (Booker and Henderson, 2019; Booker et al., 2024). However, Section 5 presented the available consent data and indicates the maximum rate of abstraction for water takes in the Waimangaroa was just 40 L/s in Conns Creek which is not directly impacted by mining activities; and up to 7 L/s in the lower Ngākawau catchment. Remaining takes listed in Table 17 are situated in catchments west from the lower Whareatea and are thus not downstream from mining activities.

For an approximate measure of the impact of mining on downstream low flows, and therefore, available water resources (that are often conditioned by minimum flow criteria), the lower quartile value of baseline and impacted flow regimes at the given compliance points are illustrated in Table 20. Again, these figures are informed by the change in downstream flow predicted by site water load balance models summarised in Section 4 (MWM 2026a; 2026b; 2026c; BRL, 2026). Cumulative downstream impacts are again greatest at ESE, where post-closure percentage changes of up to 243% of the lower quartile flow may occur in the Whareatea catchment (Table 21).

Table 20: Observed lower quartile flow with estimated operational (active treatment) and post closure equivalent (also expressed as % change).

			LOWER QUARTILE (m^3/s)		
SITE	CATCHMENT	CODE	OBSERVED	OPERATIONAL (ACTIVE TREATMENT)	POST CLOSURE PHASE
Stockton	Granity	S25	0.021	0.013 [-38]	0.020 [-5]
		S24a	0.117	0.079 [-32]	0.090 [-23]
	Ngākawau	S23	0.091	0.091 [0]	0.014 [-85]
		S6	0.037	0.025 [-34]	0.126 [+233]
Mount Frederick South	Waimangaroa	SW01	0.036	0.034 [-5]	0.097 [+168]
		SW03	0.002	0.002 [-1]	0.007 [+268]
		2W (Smokestack)	0.372	0.712 [+91]	0.418 [+12]
Escarpment Extended	Whareatea	V62	0.020	0.018 [-11]	0.388 [+1838]
		KEL	0.026	0.215 [+728]	0.145 [+458]
		W07	0.0054	0.004 [-27]	0.018 [+235]
	Cascade	MM1	0.0317	0.274 [+763]	0.142 [+348]

Table 21: Cumulative modelled downstream change in lower quartile flow for operational and closure conditions.

DOWNSTREAM LOCATION	LOWER QUARTILE FLOW (m^3/s) *	OPERATIONAL FLOW (m^3/ s)	POST CLOSURE FLOW (m^3/s)	OPERATIONAL % CHANGE	POST-CLOSURE % CHANGE
Granity Stream (outlet)	0.13	0.09	0.10	-34	-21
Mine Creek (MC1)	0.2	0.2	0.2	-7.1	7.1
Waimangaroa (17W)	0.6	0.9	0.7	60	20
Whareatea (WM3)	0.2	0.39	0.69	94	243
Cascade (V8)	0.2	0.4	0.3	135	62

** Estimated from upstream flows for Granity outlet and Waimangaroa (17W).*

6.3 Impacts on High Flows

The potential impact of mine activities on high flows, as represented by the 75th percentile flow statistics can also be represented. Table 22 indicates the observed upper quartile flow under current conditions. The upper quartile value was chosen as this represents higher-than-average flow conditions and is not impacted by the uncertainty associated with measurement of the highest monitored flows. The expected percentage changes to the upper quartile flow values, as predicted from site water load balance models described in Section 4 (MWM 2026a; 2026b; 2026c; BRL, 2026), have been applied to the observed upper quartiles to produce equivalent measures for operational and post closure conditions.

Table 22: Observed upper quartile flow with estimated operational (active treatment) and Post Closure Phase equivalent (also expressed as % change).

			UPPER QUARTILE (m^3/s)		
SITE	CATCHMENT	CODE	OBSERVED	OPERATIONAL (ACTIVE TREATMENT)	POST CLOSURE PHASE
Stockton	Granity	S25	0.095	0.057 [-44]	0.106 [+5]
		S24a	0.264	0.198 [-31]	0.196 [-32]
	Ngākawau	S23	0.264	0.264 [0]	0.045 [-83]
		S6	0.169	0.113 [-33]	0.381 [+124]
Mount Frederick South	Waimangaroa	SW01	0.117	0.105 [-10]	0.121 [+3]
		SW03	0.024	0.020 [-15]	0.025 [+3]
		2W (Smokestack)	2.077	2.181 [+5]	2.222 [+7]
Escarpment Extended	Whareatea	V62	0.091	0.085 [-6.5]	0.172 [+89]
		KEL	0.383	0.421 [10]	0.367 [-4]
		W07	0.084	0.065 [-23]	0.088 [+5]
	Cascade	MM1	0.115	0.089 [-22]	0.081 [-30]

Table 23 illustrates cumulative downstream impact to upper quartile flows (which are generally less significant than the impacts on median flows.

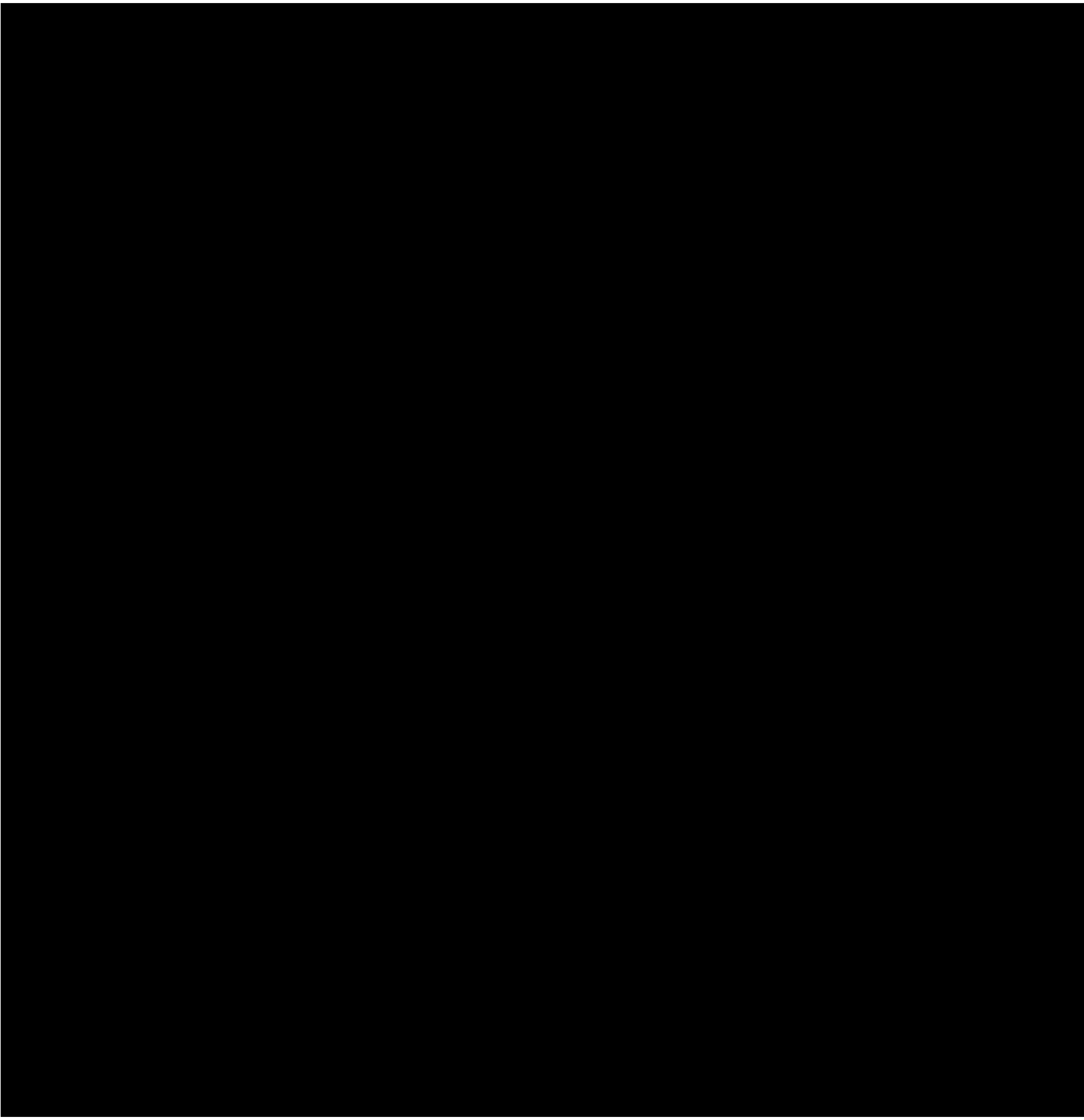
Table 23: Cumulative modelled downstream change in upper quartile flow for operational and closure conditions.

DOWNSTREAM LOCATION	UPPER QUARTILE FLOW (m^3/s) *	OPERATIONAL FLOW (m^3/s)	POST CLOSURE FLOW (m^3/s)	OPERATIONAL % CHANGE	POST-CLOSURE % CHANGE
Granity Stream (outlet)	0.39	0.29	0.33	-26	-14
Mine Creek (MC1)	0.6	0.6	0.6	-9.0	-1.1
Waimangaroa (17W)	3.1	3.2	3.3	2.8	4.8
Whareatea (WM3)	0.9	0.93	0.96	3.6	7.2
Cascade (V8)	0.6	0.6	0.6	-3.9	-5.3

** Estimated from upstream flows for Granity outlet and Waimangaroa (17W)*

6.4 Discharges to Off-Site Receiving Natural Channels

The modelled changes in flow at the downstream compliance sites (Table 18, Table 20, and Table 22), represent the combined impact of individual discharges from the disturbed areas. The location of the discharges are indicated in Figure 45, Figure 46, and Figure 47 for Stockton, ESE and MFS respectively. The managed discharges areas are indicated in yellow, whilst the catchment areas of natural channels that outflow from the disturbed areas are indicated in grey. At Stockton, most channels drain north or east from within site, whereas MFS drains predominantly south and west. By contrast, ESE drains to all compass directions.



[redacted]

At locations where managed discharge area is greater than the receiving catchment area, several water management strategies can be adopted to reduce the risk of downstream managed flow releases exceeding channel capacity. Identified options include:

1. Bypass flow off-takes – To reduce flows from sump bypass discharges (MWM, 2026a; 2026b) to a receiving waterway that cannot take the flow, offtakes from the bypass flow stream will be established upstream of the existing sump. The bypass offtakes will be able to release water from the bypass flow stream to off-site catchments located upstream of the sump, of appropriate size relative to the receiving waterway (potential offtake location for each discharge sites are identified in Figure 46 and Figure 47). Lower magnitude sump bypass flows can continue to report to the main sump. Further bypass methodologies can be investigated to optimise discharge flows.
2. Slow Release – Storage ponds or sumps can be used to provide a buffer storage for discharges that exceed the capacity of the receiving off-site natural channels. Sumps will be temporary (for the mining period only) and designed so that they do not spill, and with decant rates appropriate to the downstream environment.
3. Return flow to original catchment where practical – For closure conditions, landforms may be constructed to mimic pre-development catchment drainage locations where practical. Water

management strategies will be updated to reflect post-development catchment areas and associated flow regimes.

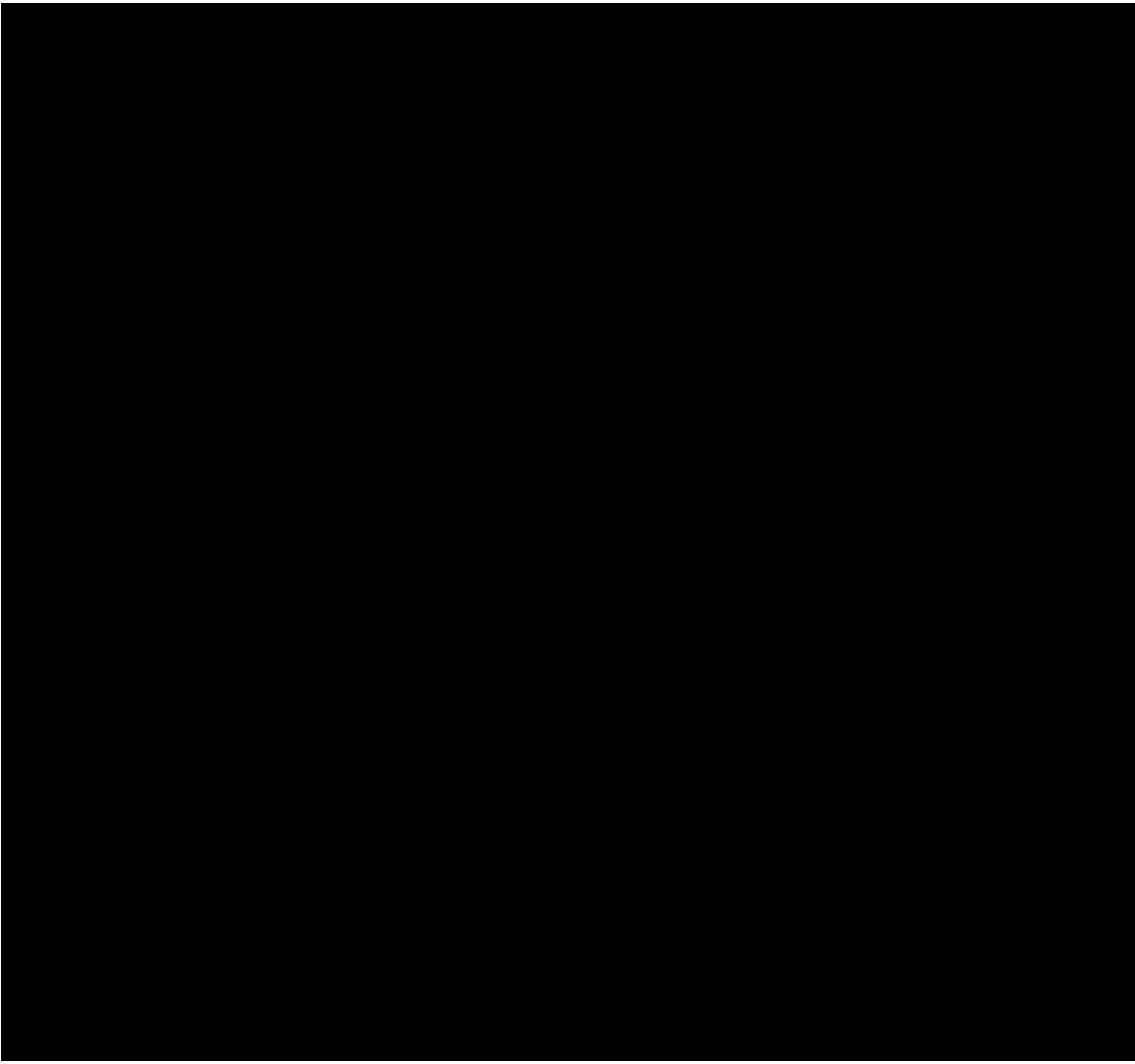


Table 24 and Table 25 illustrate the preferred management option for each discharge location at MFS and ESE respectively which depends on the magnitude of the difference between the pre- and post-development catchment area (and in which phase (operational or closure) the largest difference occurs). These tables are provided for the 'worst-case' scenario (i.e., largest difference between pre- and post-development catchment area). Discharge management will be required in the operational phase regardless. There is no equivalent table for the Stockton area, as much of the site drainage channel sump network is already established (as indicated in Figure 24).

Table 24 Comparison of pre- and post-development catchment area at ESE discharge points.

LOCATION	'WORST CASE' SCENARIO	OPERATIONAL OR CLOSURE DISCHARGE MANAGEMENT	POST-DEVELOPMENT AREA (HA)	PRE-DEVELOPMENT AREA (HA)
V62	Closure	Surplus to original catchments	126.8	73.65
CPD	Closure	Surplus to original catchments.	99.06	55.93
WSDP	Closure	Surplus to original catchments.	197	117.61
V37_F	Closure	Surplus to original catchments.	67.28	30.01
V37_G	Closure	No action needed	0.52	6.97
NSUL	Closure	Surplus rehab waters to natural catchments	31.18	27.5
C12	Closure	Surplus to original catchments.	5.50	3.17
WTPD*	Closure	Surplus to original catchments.	53.48	23.4
Lake Brazil	Closure	No action needed	3.04	26.1

Table 25 Comparison of pre- and post-development catchment area at MFS discharge points.

LOCATION	'WORST CASE' SCENARIO	OPERATIONAL OR CLOSURE DISCHARGE MANAGEMENT	POST-DEVELOPMENT AREA (HA)	PRE-DEVELOPMENT AREA (HA)
CWD1a	Operations	Surplus to original catchments. Slow-release sump	29.38	8.26
CWD4a	Operations	Surplus to original catchments. Slow-release sump	15.8	1.38
East Pit Bypass	Closure	Manage between 3 outlets: E1 E2 E3	34.3 24.6 13.0	68.68 9.51 18.67
East Pit Spillway	Closure	Manage between 3 outlets: E1 E2 E3	70.7 29.9 13.1	68.68 9.51 18.67
West Pit Sump	Closure	Manage to 5 outlets: WC1 WC2 WC3 WC4 Spillway	9.9 15.7 9.7 4.1 23.4	14.3 2.7 9.4 6.7 1.3
Coal Pad Rehab1	Closure	Surplus to original catchments.	2.54	0.29
Coal Pad Rehab2	Closure	Surplus rehab waters to original catchments.	3.04	1.74
WTP Discharge*	Operations	Pipe surplus to Waimangaroa river crossing. Spill to CWDD between coal pad and WTP infrastructure area.	1.74	0.03

The flow regime of the channels receiving discharges from the mining areas can be characterised by scaling hydrological statistics from the nearest compliance monitoring points (indicated in Table 26). For the Stockton site, this allows the flow statistics of managed discharges from each sump to be estimated; whilst for ESE and MFS, the pre-development flow regime of the receiving catchments are indicated (Table 27). Now, the impact of the maximum likely change in catchment area at each discharge point can be estimated by multiplying the percentage change in pre- to post-development area (Table 25), by the pre-development flow regime statistic of interest (Table 27).

Table 26: Hydrological statistics for compliance sites.

SUB-AREA	CATCHMENT	COMPLIANCE SITE	AREA (km^2)	MEAN (m^3/s)	MEDIAN (m^3/s)	5th %ILE (m^3/s)	95th %ILE (m^3/s)
Stockton	Granity	S25	1.18	0.14	0.04	0.498	0.009
	Ngākawau	S6	7.11	0.24	0.08	0.929	0.012
	Mangatini	FC2	0.21	0.183	0.07	0.88	0.01
Mount Frederick South	Waimangaroa	SW01	3.61	0.371	0.049	1.305	0.026
	Deep Stream	SW03	5.68	0.041	0.006	2.05	0.04
	Waimangaroa	2W (Smokestack)	18.67	3.46	0.717	15.694	0.203
Escarpment Extended	Whareatea	V62	0.82	0.268	0.035	1.227	0.003
	Whareatea	KEL	5.09	0.756	0.084	3.806	0.004
	Rapid	W07	1.29	0.214	0.012	1.031	0.001
	Cascade	MM1	0.66	0.109	0.057	0.988	0.002

Table 27: Estimated flow regime for mine discharge locations.

SITE	REFERENCE COMPLIANCE SITE	OUTFLOW POINT	MEAN (L/s)	MEDIAN (L/s)	5TH %ILE (L/s)	95TH %ILE (L/s)
Stockton	S25	Hope Lyons West Sump	22	6	77	1
		Rockies North Sump	5	5	65	1
	S6	Loop Road Check Dam	6	2	22	0
		Millerton East Check Dam	1	0	2	0
		Mine Creek Dam	3	1	13	0
	FC2	Campbells #2	172	66	827	9
		Campbells #3	30	11	144	2
		MG Quarry	3430	1312	16495	187
		A Drive East	426	163	2049	23
		C Drive	56	21	269	3
		Fly Creek Weir	2096	802	10078	115
		Lake Cumming	368	141	1770	20
		McCabes #4	697	267	3354	38
		N_NELF Sump	30	12	146	2
		Whirlwind	19	7	92	1
MFS	SW01	CWD1a	8.5	1.1	30	0.6
		CWD4a	1.4	0.2	5	0.1
		E1	71	9.3	248	4.9
		E2	9.8	1.3	34	0.7
		E3	19.2	2.5	67	1.3
		WC3 to Billow Stream	9.7	1.3	34	0.7
		WC4 to Billow Stream	6.9	0.9	24	0.5
	SW03	WC1 to Deep Creek	1.0	0.2	52	1.0
		WC2 to Deep Creek	0.2	0.0	9.7	0.2
		West Pit Spillway	0.1	0.0	4.7	0.1
		West Pit Bypass	1.4	0.2	72	1.4

	2W	Coal Pad Rehab1	0.5	0.1	2.4	0.0
	Smokestack	Coal Pad Rehab2	3.2	0.7	15	0.2
		WTP Discharge	0.1	0.0	0.3	0.0
ESE	V62	V62	241	31	1,102	3
	W07	NSUL	46	2.6	220	0.2
	KEL	CPD	83	9.2	418	0.4
		WSDP	175	19.4	879	0.9
		C12	4.7	0.5	24	0.0
		WTPD	35	3.9	175	0.2
	MM1	V37_F	50	25.9	449	0.9
		V37_G	12	6.0	104	0.2
		Lake Brazil	43	22.5	391	0.8

** Flow regimes for Stockton are estimated for existing sump outflow location rather than downstream location. The indicated statistics are therefore estimated for the managed catchment area rather than natural catchment for the Stockton sites.*

6.5 Flood Risk

Overlaying the disturbance footprint on the stream network allowed identification of areas where rivers at bank-full condition may potentially impact mine workings or infrastructure. Figure 48, Figure 49, and Figure 50 indicate potential risk to infrastructure identified at Stockton, Mount Frederick South, and Escarpment Extended sub-areas, based on the proximity of stream channels to mine footprint. More detailed mapping of flood extent in these areas will be conducted to inform engineering designs. Areas that require channel management or stream diversion in the upper catchment are not identified as flood risk is greatly reduced in the upper catchments (smaller contributing catchments).

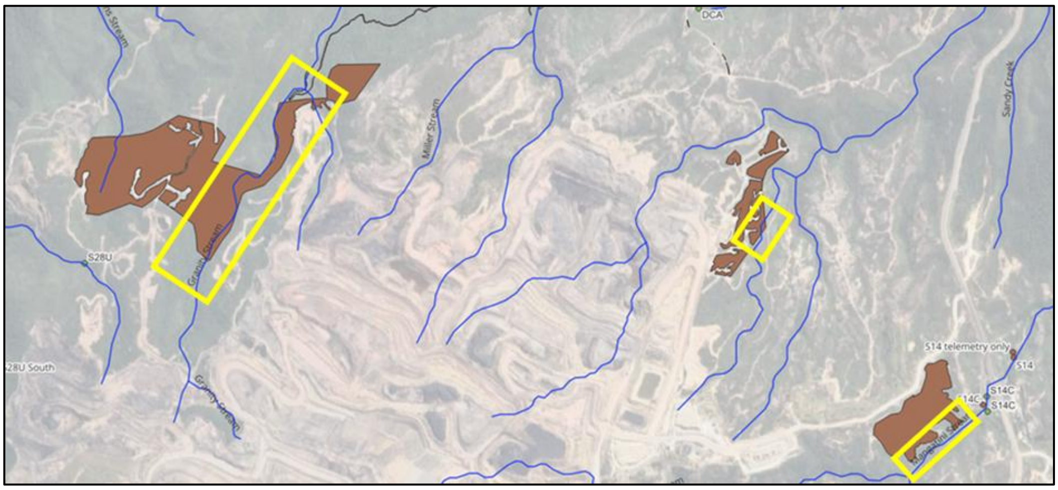


Figure 48: Areas of higher flood risk and impact identified (yellow outline) at the Stockton sub-area on Granity Stream, upper Mine Creek and Mangatini Stream.

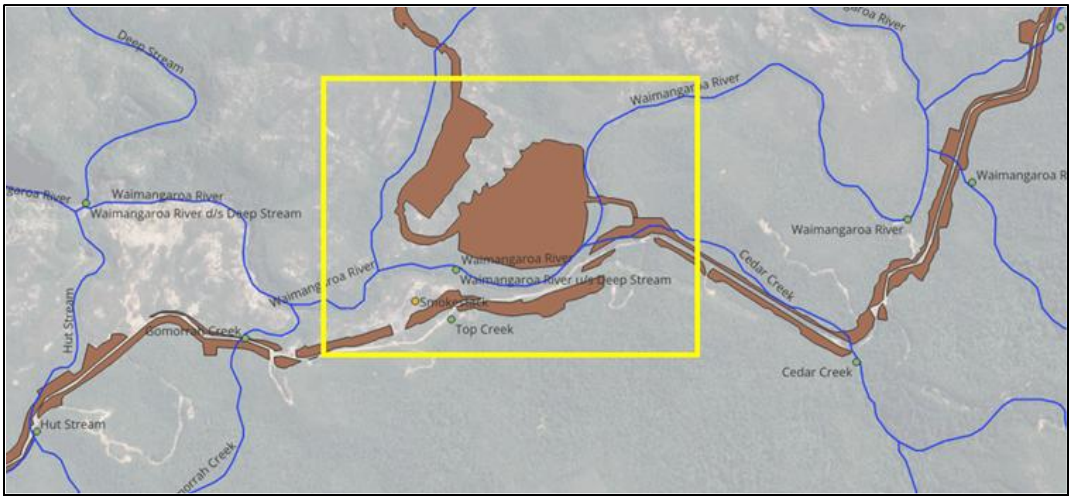


Figure 49: Areas of higher flood risk and impact identified (yellow outline) adjacent to the Mount Frederick South disturbance footprint on the Waimangaroa River and associated tributaries.

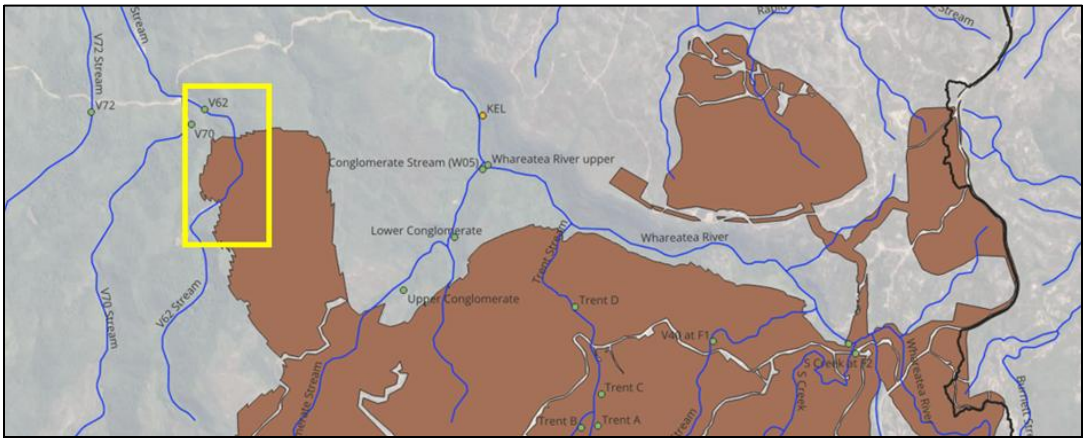


Figure 50: Areas of higher flood risk and impact identified (yellow outline) at ESE sub-area across the V62 Stream.

6.5.1 Flood Extent at Waimangaroa

A more detailed assessment of flood extent that would result from a 100-year return period event was performed for the Waimangaroa River at Smokestack (2W) (Figure 49). However this was to better inform downstream risk that might result from flooding of the coal storage pad which lies adjacent to the river at this location. To produce the map, the HEC-RAS hydraulic modelling software (US Army Corps of Engineers) was used with observed flow timeseries for Smokestack (2W).

The magnitude of a 100-year event (based on 11 years of flow data from Smokestack) was defined by the National Institute of Water and Atmospheric Science (NIWA) to be 187 m^3/s. Subsequent analysis by BRL ([redacted] based on 10-years of data drawn from between 1974 and 2015, indicated a flow of 201 m^3/s (Figure 51). The highest observed flow at the Smokestack gauge location was 188 m^3/s on 16/03/2015. As this event magnitude is close to that of the NIWA estimated 100-year event, the observed hydrograph was used to define flood event depth and extent in the model. It is noted that 190 mm and 160 mm of rainfall were recorded over a 24-hour period at the Lake Brazil and Stockton meteorological stations respectively, for this event.

A HEC-RAS 2D unsteady flow model was developed to estimate the maximum flood extent that would result from the 188 m^3/s peak flow observed at the Smokestack monitoring gauge. A 6-hour warm-up period was used in the model, and upstream inflows were defined for the Waimangaroa River (174 m^3/s) and its tributary Cedar Creek (14 m^3/s). The model was run at 30 second time steps.

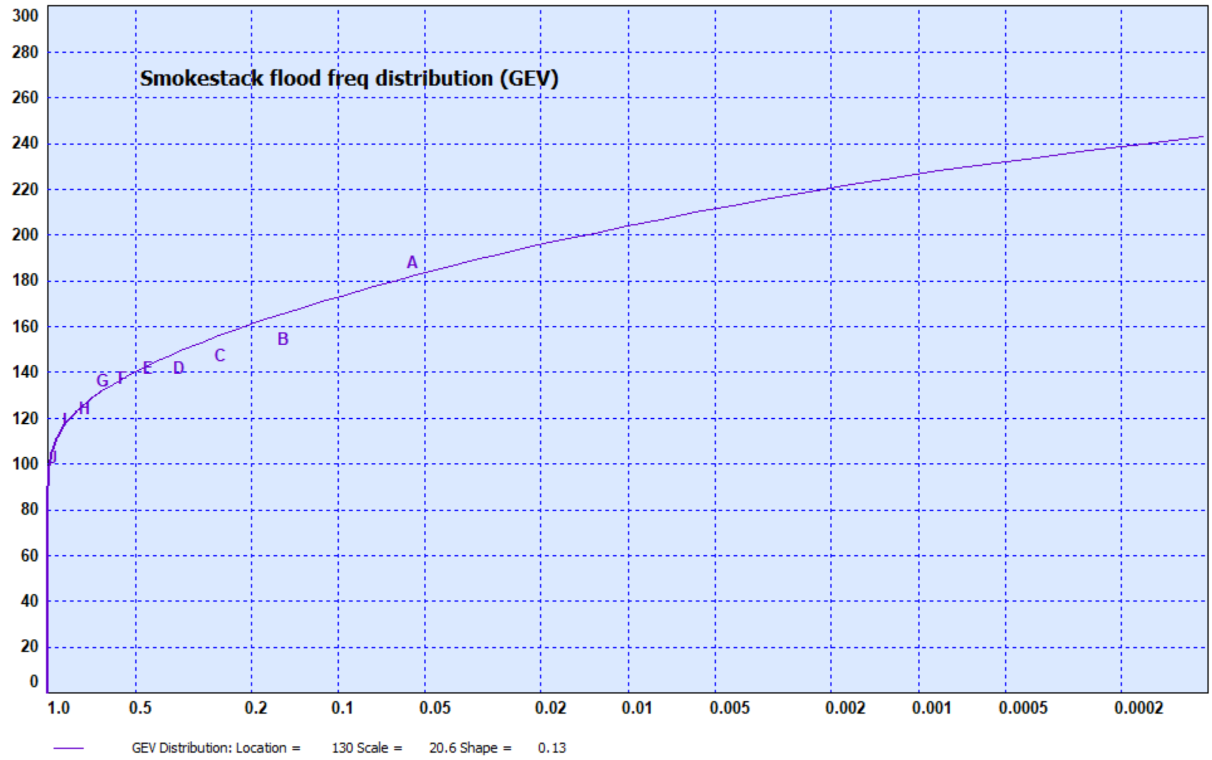


Figure 51: Estimated flood frequency distribution for the Waimangaroa at Smokestack (letters represent observed peak flows).

Operational activities at the site will require a road crossing over the Waimangaroa River, the specifications for which were provided by BRL and included indicative road and culvert dimensions, and location across the river (Figure 52). It is noted that the bridge design was developed for a 10-year return period flow in the river, which, based on analysis by BRL (Mandy Chater, per comm. (03-09-25), is 170 m^3/s, i.e., just 18 m^3/s less than the peak flow used in the model (188 m^3/s).

To represent the bridge and fill-sections shown in Figure 52, the HEC-RAS model was set-up so that five box culvert barrels fill the available (~13 m) width of the existing riverbed as indicated in Figure 53. The length of the embankment (modelled as a weir) section was set to 157 m long with the approximate road alignment indicated within Figure 52. The embankment was placed over the existing profile terrain with a surface elevation ranging from 513 m to 515 m from west to the east across the river. Each box culvert through the embankment was given a 2.5 m span (due to the limited width of the existing riverbed), and the height of each culvert was extended to 4.5 m to increase potential flow capacity.

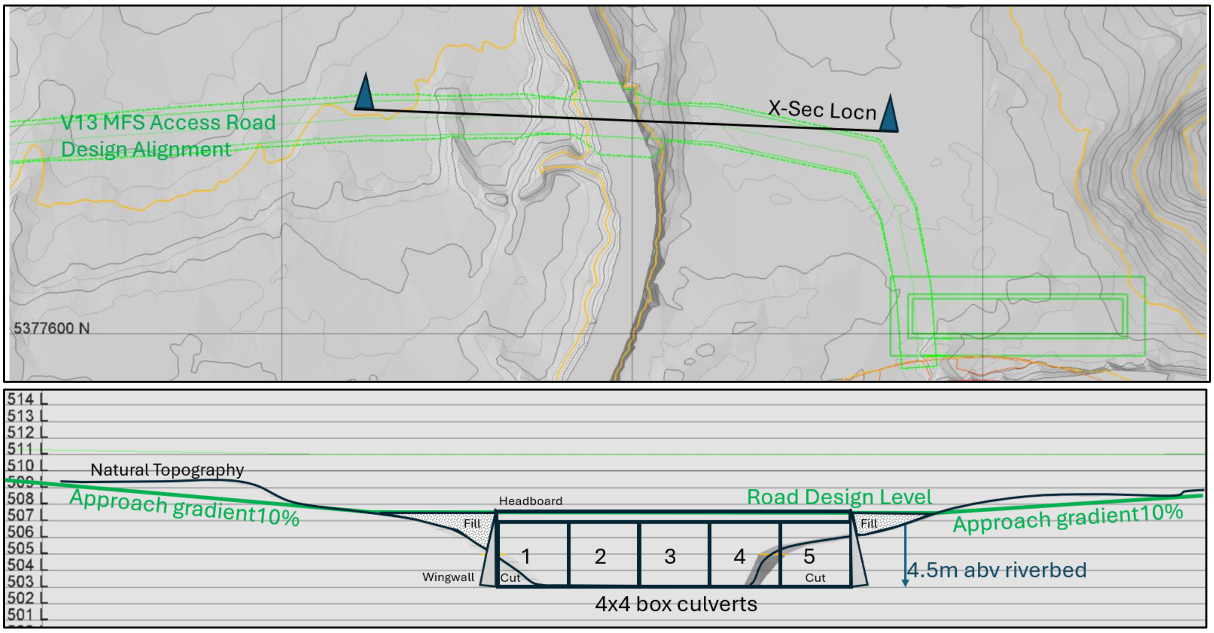


Figure 52: Proposed Waimangaroa River road crossing with culverts within existing river channel (indicative dimensions only).

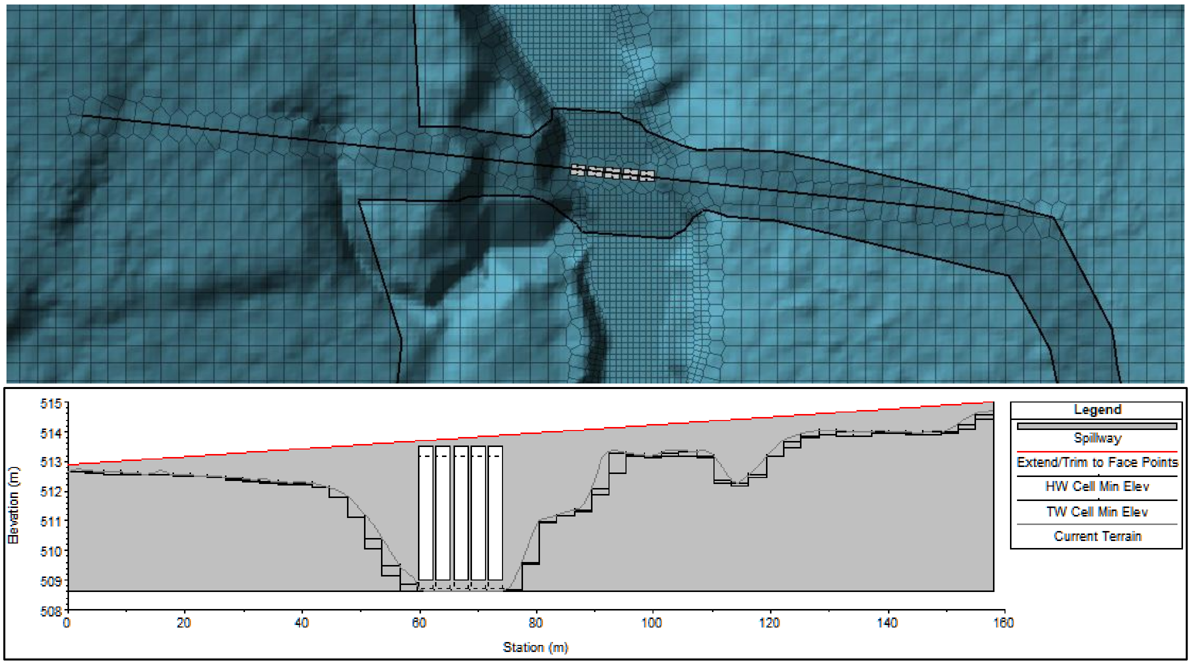


Figure 53: Representation of long (157 m) embankment and culverts in HEC-RAS 2D unsteady flow model.

6.5.1.1 Pre-development Condition

Estimated flood extent and depth, relative to proposed infrastructure area (coal storage shown by shaded area), are shown in Figure 54. Infringement of infrastructure by the flooded area occurs in the southern section of the infrastructure footprint. In this area the predicted depth of water ranges from 0.2 to 1.2 m. The deepest areas occur in relic flood channel landforms rather than surrounding floodplain on which flood depths are of up to just 0.2 m. Modelled flow velocities range from 0.2 m/s to 6 m/s (see

Figure 55). The highest water velocities occur within the main channel, and the lowest velocities occur where water has spilled over to the floodplain.

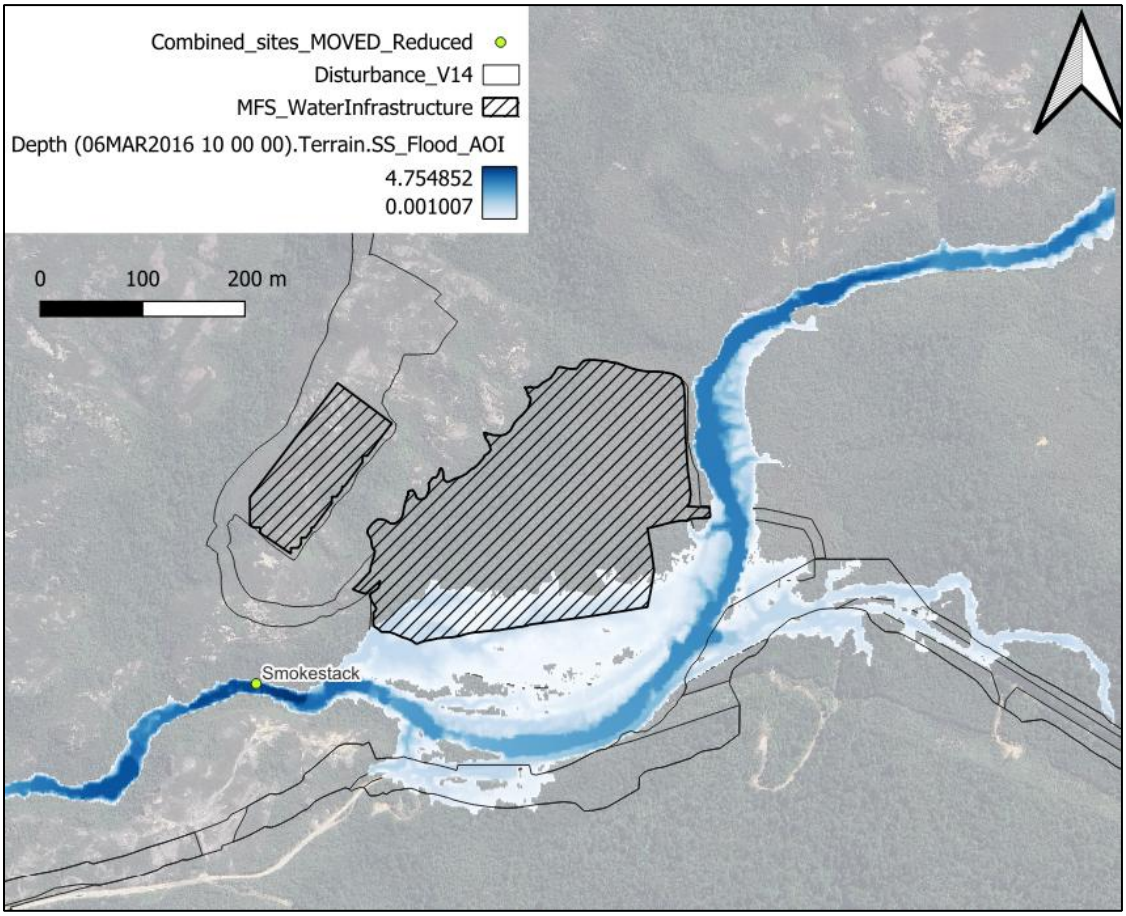


Figure 54: Estimated flood extent and depth for a 174 m^3/s flood (hatched area and road outlines indicate proposed infrastructure footprint but culverts not included in model).

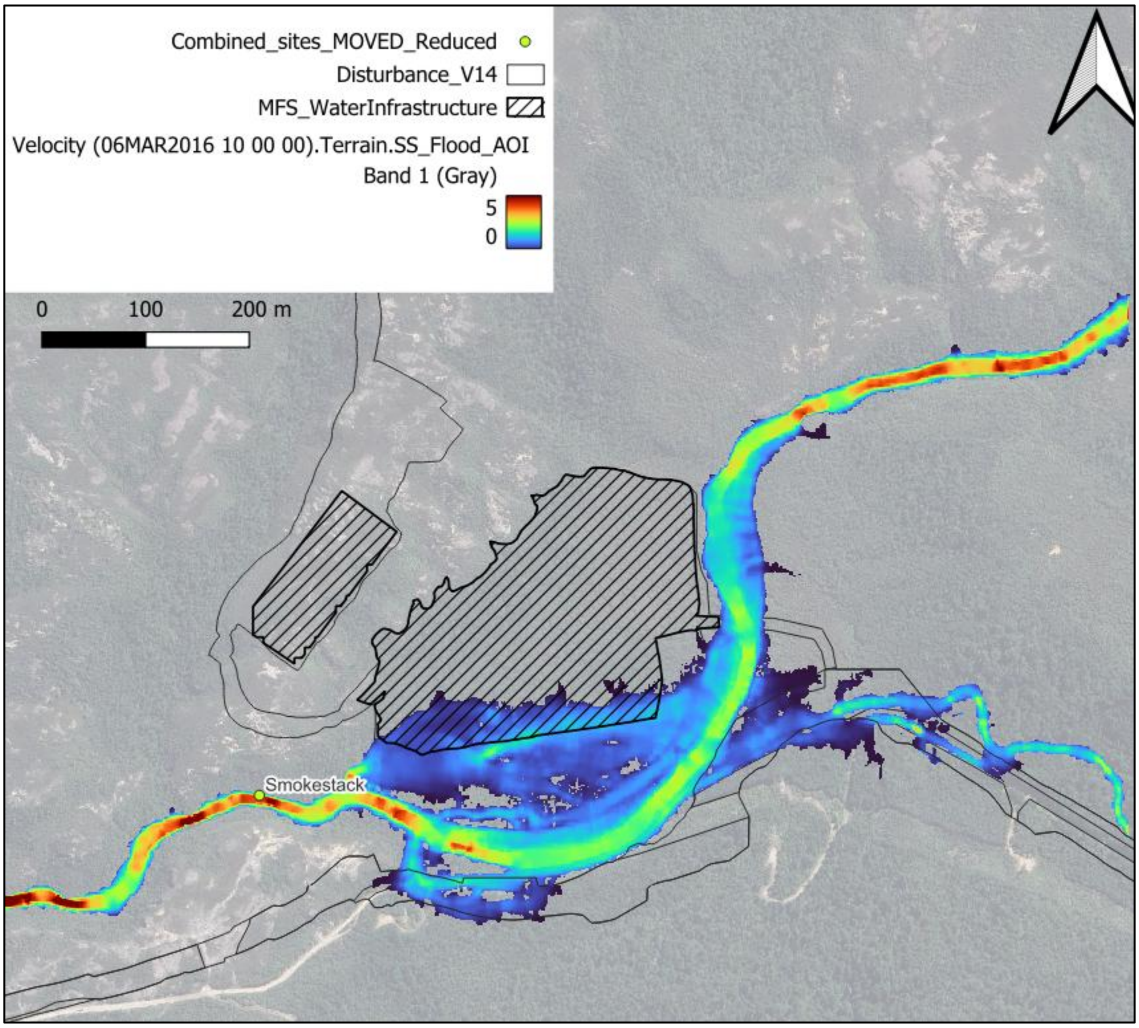


Figure 55: Estimated flow velocity distribution estimated for a 188 m^3/s flood (hatched area and road outline indicate proposed infrastructure footprint but culverts not included in model).

6.5.1.2 Operational Condition

The impact on estimated flood extent and depth after inclusion of the 157 m road embankment and culvert section was an increase in water depth upstream of the culvert section (see Figure 56). Water levels upstream of the culvert were 513.2 m compared to 512.7 m downstream. Water by-passes the embankment structure at its eastern end at peak flow and flows into Cedar Creek before flowing back into the main channel (Figure 56). This bypass possibly prevented excessive weir overtopping of the embankment and culvert structure. Flow velocities increase markedly on the approach to the culvert section because of channel narrowing (Figure 57). This resulted in increased instability of the model and prevented reliable modelling of scenarios with wider culvert barrel widths.

Figure 58 illustrates the flow hydrographs over and through the weir embankment and culverts. Peak flow through the culverts is 153 m^3/s, at which time the weir is overtopped on its eastern side (at 513.5 m (asl)) by a flow of 3.7 m^3/s. Whilst having impact on the upstream side of the roadway, the diversion of flow around the roadway embankment (as shown in Figure 56) has limited impact on downstream flood inundation.

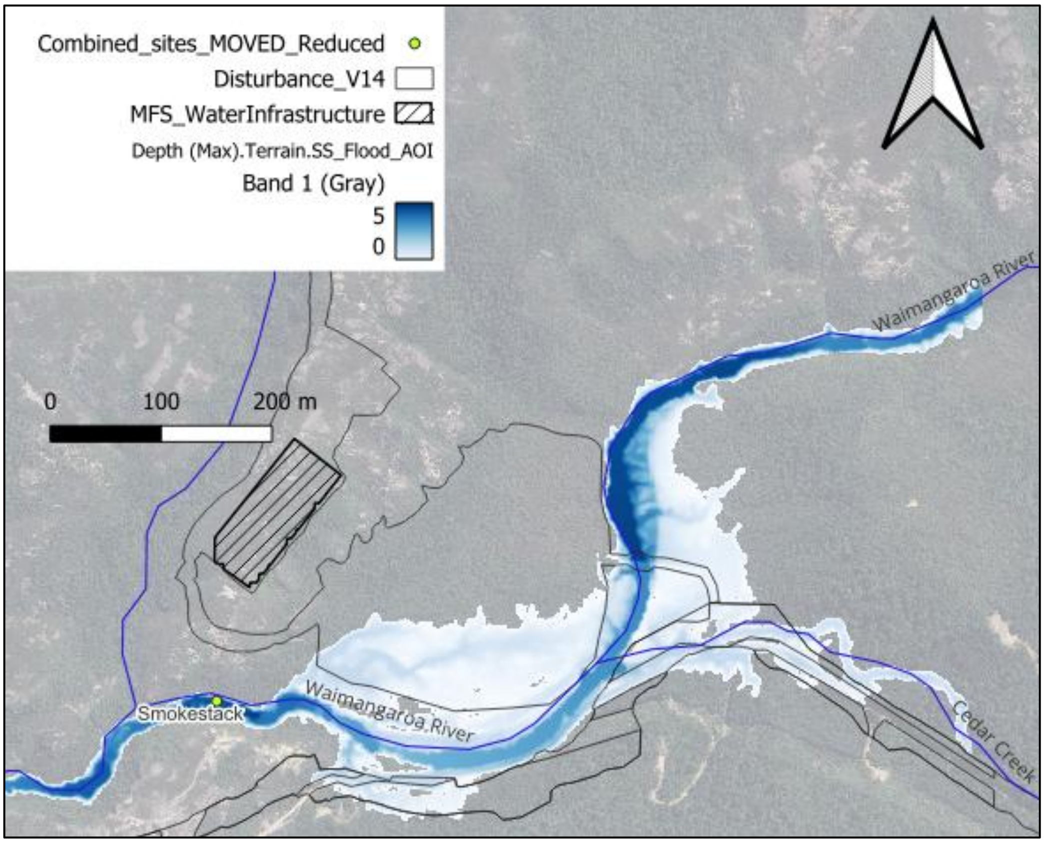


Figure 56: Flood extent and depth estimated for a 188 m^3/s flood at Smokestack (with 157 m embankment and culvert section).

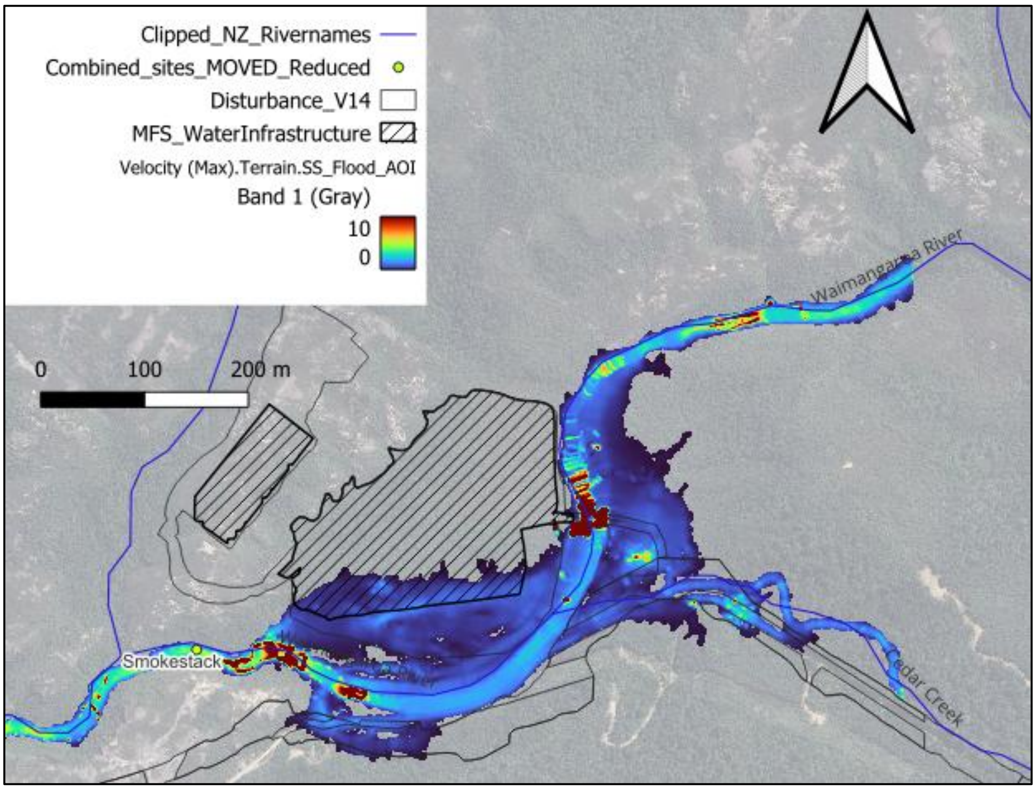


Figure 57: Flow velocity distribution estimated for 188 m^3/s peak flood at Smokestack (with 157 m embankment and culvert section).

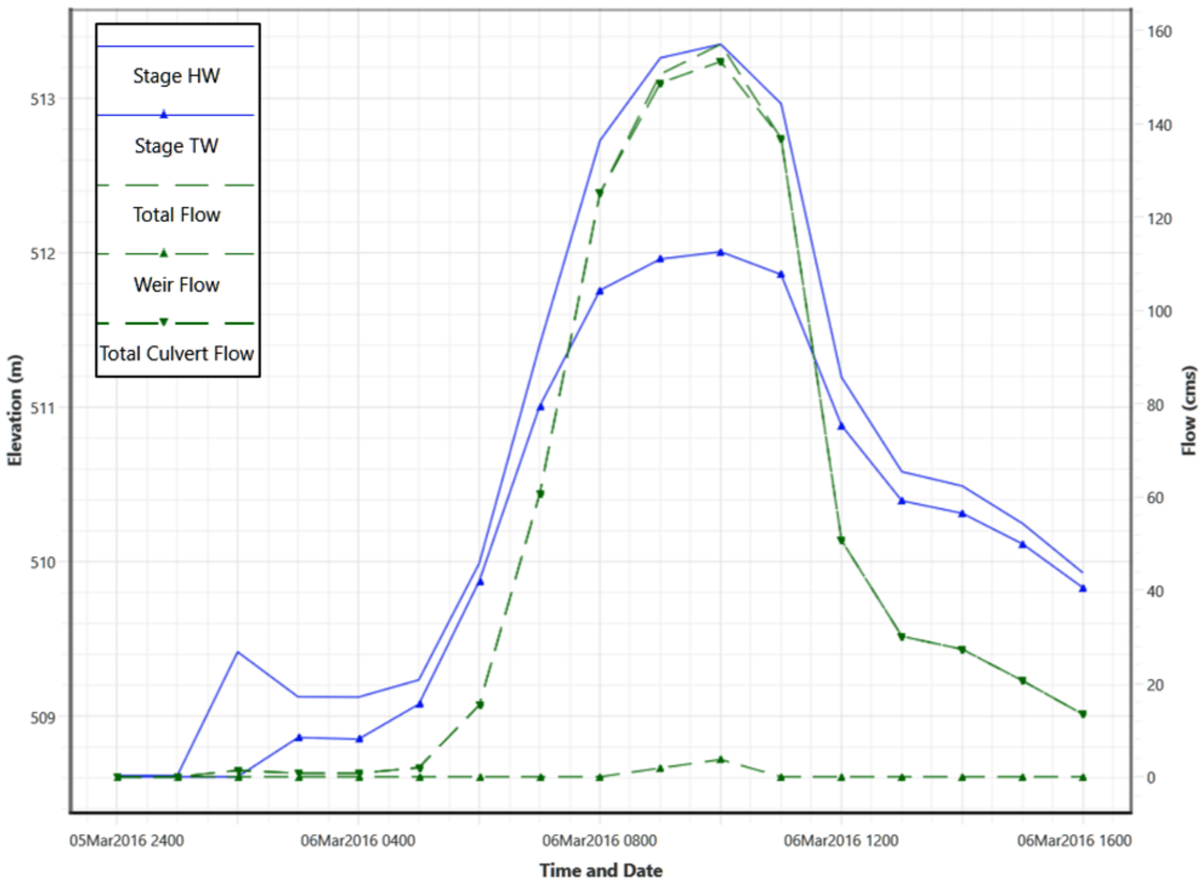


Figure 58: Flow hydrographs for the weir and culverts (m^3/s (labelled as cms)); and headwater and tail water stage height (m).

6.6 Climate Change

The impact of climate change on flow regimes across the BPCP was represented in water load balance models (as described in Section 2.3) and the results summarised in Table 18 and Table 22. At the event scale, expected changes in design rainfall (described in Section 2.3) can be applied to historic hydrological statistics. More detailed estimation of the impacts of climate change can be made for local flow regimes, using hydrological models and ensemble scenarios but was considered outside the scope of this study. However, work by Collins (2020) and Collins et al., (2018) have indicated general trends for the region, and can be broadly interpreted to be indicative of likely changes at the BPCP. Expected changes include:

- Increases in the magnitude of the mean annual flood (MAF).
- Reductions in the value of mean annual low flows (MALF), and possible delayed arrival of the low flows seasons.

The likely magnitude of the above changes across New Zealand (based on over 43,862 river locations around the country) are illustrated in Figure 59.

The sixth IPCC assessment indicates increased risk of both flooding and droughts in the Buller District. Climate change is expected to alter the spatial, temporal and intensity trends of rainfall across the region. By 2090, summer and autumn rainfall is expected to increase by 2-5% but there is still large uncertainty around these figures (Mullan et al., 2018). Winter rainfall however is expected to increase by 8-29% by the same year (relative to 1995 rates) based on Ministry for the Environment. 2018. Increased rainfall intensity will bring increased risk of flooding and landslide.

The average temperature of the West Coast is expected to increase by up to 1.0˚C by 2040 and as much as 3.0˚C of warming by 2090. Most of this warming will be experienced in summer and autumn (Ministry for the Environment. 2018). The West Coast is predicted to experience up to 30 more extreme heat days (temperature > 25°C) per year. Whilst the region is exposed to some climate change-driven drought risk, only a 5% increase in time spent in drought conditions is expected by 2030-2050, but up to 10% by 2070-2090, (Clark et al., 2016). With the more severe SSP scenarios, the frequency, duration and severity of droughts and wildfires will likely be more significant (Urban Intelligence Ltd and Resilient Organisations Ltd., 2022).

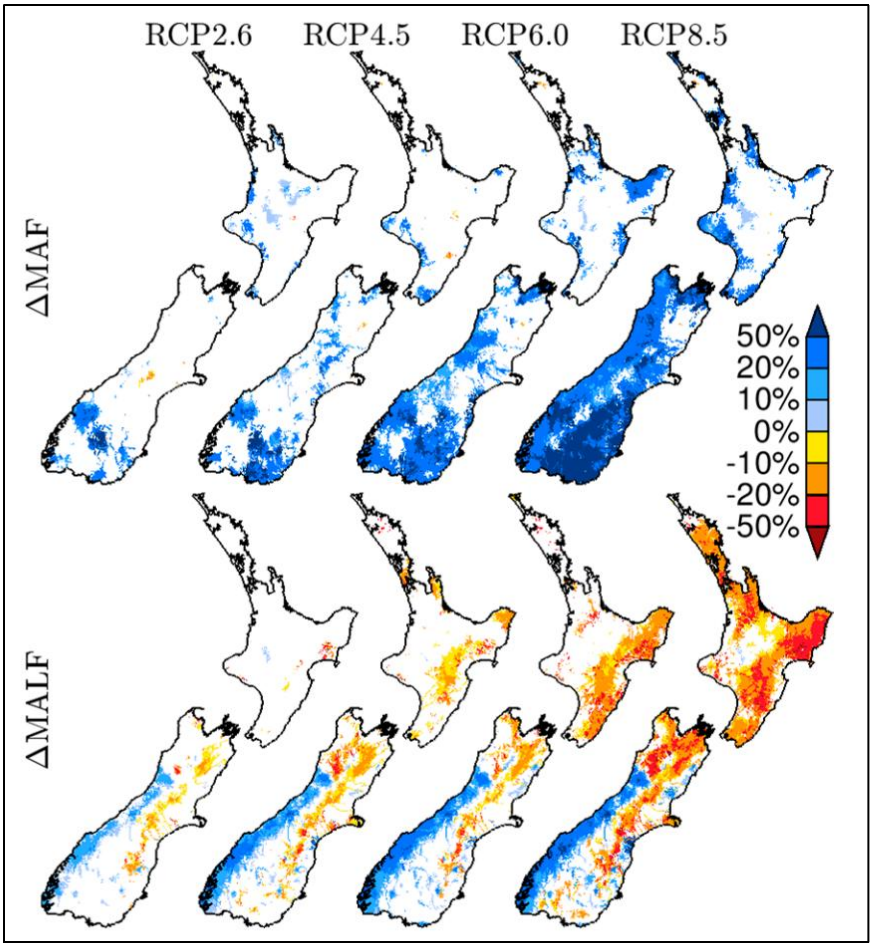


Figure 59: Late century percentage changes in MALF and MAF for four RCP’s relative to reference period.

Source: Collins (2020).

7 SUMMARY AND RECOMMENDATIONS

This report is a high-level summary of the hydrology of the BPCP site and associated catchments. It describes the conceptual understanding of site hydrology from which the impacts to downstream hydrology can be estimated. Existing and proposed engineering and water management practices associated with the BPCP are described in sufficient detail to understand the outputs from water load balance models and related technical reports. Greater detail of assumptions made within mine water load and balance models can be found in MWM (2026 a, b, & c). A summary and overarching recommendations based on analysis conducted in this report are provided below.

7.1 Catchment and Channel Mapping

The hydrological network and associated surface water catchments used in this report have been derived from a 1m resolution DEM for the site. The DEM has been hydrologically conditioned to achieve hydrological continuity within individual catchments and then derive associated hydrological statistics and catchment characteristics. Ground-truthing of digitally derived catchment boundaries and the associated hydrological network will be conducted where necessary at the detailed design stage (for example, in areas that are susceptible to flooding. In addition, it will be important to maintain the accuracy of the underlying DEM data as work within the site progresses and catchment boundaries change.

7.2 Meteorological Monitoring

Evapotranspiration estimates across the site have been modelled or verified using regional-scale solar radiation (obtained from the Earth Sciences New Zealand VCSN). Going forward, model robustness will be improved by strategic additions to the on-site monitoring network, for example, a new rain gauge will be placed at Mount Frederick South to provide local rather than site averaged data. Similarly, net solar radiation loggers will be installed at Cypress to improve estimation of lake evaporation and surface evapotranspiration.

7.3 Hydrological Monitoring

Site water management and modelling will improve as the spatial and temporal granularity of hydrological monitoring increases with time. For example, the deployment of mobile surface water velocity sensors at Stockton, Denniston, and Mount Frederick South, to monitor high flows, will improve monitoring site rating curves and the availability and thus improve confidence in the use of site datasets for model validation.

Going forward, it is recommended that a compendium of hydrological data for the BPCP area, similar to that compiled for the Appendix of this report, is maintained as a live document. Such a document in addition to being a referenceable source of data, would facilitate the identification of data gaps and provide a single source for logging future changes to the monitoring network. Areas of study that typically rely on hydrological data typically include water resource assessments, flood risk analysis, ecological impact assessment and water quality modelling.

7.4 Downstream Users

A review of downstream consents and consented water takes indicated several consented takes in the Waimangaroa, Cascade and Ngākawau catchments but none in the Whareatea or Rapid catchments. There were no surface water users directly downstream of mining activities in the Whareatea or

Waimangaroa catchments. Whilst there are community water supplies in both the Waimangaroa and Granity catchments, they are separated topographically from potentially impacted streams.

7.5 Flood Risk Assessment

A preliminary assessment of flood risk at the site has been conducted to identify locations at which the hydrological network may be interrupted by the planned infrastructure development. Detailed modelling and mapping of the flood extent that would result from a 100-year river-flow event has been conducted for the Waimangaroa at Smokestack (2W). River bathymetry and proposed channel and landform modification will be used to improve the resolution of these maps at the detailed design stage.

The developed model assumed that the digital elevation model is representative of the existing riverbed, and whilst this limited the width of the culverts that could be incorporated in the model, it represents a conservative approach to modelling potential flood inundation extent (as in reality the capacity of the channel to transport water will be larger than is represented within the model). For finer scale model development, higher resolution bathymetry data (for the riverbed) and planned road alignment (for representation of the culverts) can be used to provide more accurate flood model results. It is envisaged that the more detailed culvert design will also include finer detail relating to river widening and embankment dimensions to allow better representation within future flood models.

Based on HEC-RAS modelling of the 16/03/2015 flood event (peak flow 188 m^3/s) for existing topography (i.e., no infrastructure), the predicted flood extent would extend to the southern section of the planned infrastructure area (coal storage pad). Maximum flood depth modelled at this location is 1.2 m, therefore, infrastructure areas greater than 1.2 m above the modelled topography would not be at risk of inundation.

When the road crossing is represented within the model (as a culverted weir embankment), a similar inundation pattern is seen around the southern section of the planned infrastructure (coal storage pad). This is because the area is flooded by water from downstream of the road crossing and is thus unaffected by it. Upstream of the road crossing however, the water level is higher due to the reduction of flow in the river channel caused by emplacement of the culverted weir embankment. At the flood peak, water upstream of the culverts (513.3 m) is approximately 1.3 m higher than downstream (512 m). Peak flow through the culverts is 153 m^3/s

Flood extent maps will be created all sites where potential downstream impact would result on-site flooding (for example through increased flow or sediment transport).

Recommendation #1	Reduction of flood extent around infrastructure footprint.	• Bunding for flood protection relative to the 100-year event should be constructed to protect against inundation in the coal storage pad area if the infrastructure foundation level is less than 1.2 m above the current topography.
Recommendation #2	Reduction of water diverted around modelled roadway.	• Alignment of the culverts across the river channel (with appropriate wing walls) will reduce modelled water levels upstream of the culverts and thus reduce the risk of water diversion around the culverts at peak flow.

7.6 Water Balance Models

Water load balance models developed as part of the BPCP have been used to describe the impact of mining activities on flow regimes describing the magnitude of change relative to modelled baseline conditions (rather than actual observed baseline data).The predicted change from base conditions was then applied to observed data (where available) to estimate the change in flow conditions for operational (active water treatment) and post closure mining phases. This approach will allow future changes in water management (and resulting downstream change) to be incorporated into catchment water balances as they occur.

The water balance model results referred to above represent a mixed picture of flow increase and decreases relative to current conditions and dependent on mining activities (active treatment; post closure). The results are presented with respect to impacts at downstream compliance points as it would be difficult to provide more detailed description for all downstream locations. Additional detail of non-impacted discharges from the site to natural catchments have also been provided (e.g. runoff excess or sump bypass).

Current WLBMs for the site estimate the impact to downstream flow regimes as a 'relative change (%)'. This is because estimates of runoff and streamflow could not be validated sufficiently long timeseries due to changing catchment size impacting flow measurement continuity at many downstream locations. As a result, runoff and streamflow estimates are based on models that are parameterised with soil hydrological and land-cover parameters drawn from the literature and with the use of expert judgment based on any available flow data within the catchment.

Recommendation #3	Model validation	• To validate assumptions used within runoff models, 2 years of flow data collated from ongoing and new monitoring locations will be reviewed.

7.7 Hydrological Impacts

Outputs from WLBMs provide an indication of likely changes to surface water flow regimes around the different mining area during operations and after mine closure. At Stockton, based on modelling results, the median flow draining north may be reduced by up to 38% (Granity Stream) but this falls to 26% after closure. Similarly, drainage to the Ngākawau catchment via Mine Creek may be reduced by up to 33% during operation but then exhibit a marginal nett increase (0.4%) in the median flow after mine closure. This median measure is reflected in both high and low flow indicators (Q25 and Q75) indicating similar patterns. Flow changes east from Stockton into the Mangatini Stream and St Patrick’s Stream are less significant and will be largely masked by the higher flow regime in those catchments.

At MFS, surface water from the site drains to the Waimangaroa River mainly via Deep Stream and its tributaries. Modelled compliance site flows indicate a small (12-25%) reduction in median flows in some streams during operations. After closure, this changes to a nett increase in median surface water flows at all modelled locations. Similar to Stockton, this pattern is reflected in low and, to a certain extent, high flows, and is generally the response of increased rainfall infiltration into the engineered landforms that results in increased baseflow. The impacts of climate change and increased rainfall-runoff are also included in the closure figures.

Surface water drainage at ESE flow north towards the Whareatea River and Rapid Stream, and south into tributaries of Cascade Creek. For much the same reasons as flow regime changes from MFS, median flows north from ESE may marginally decrease during operations and then increase after closure. However, there is more variability between individual streams at ESE because of the shape of the site and changes to the water management regime during operations. Flows south in to Cascade Creek increase in operations as catchment sizes there are marginally increased.

Whilst the impacts to flow regimes described above will accumulate downstream (as impacted streams converge), the effect is offset by increasing catchment area, and greater contribution of non-impacted waters. Downstream impacts, as a percentage of observed flows are greatest for lower quartile flows, with largest impacts seen downstream of the ESE mining area.

7.8 Climate Change

A detailed review of the potential impact of climate change on rainfall and resulting river flows will be made if downscaled regional estimates for IPCC 6.0 become more widely available. Review of future climate impact studies on the west coast could also be utilised if performed in the near future.

Recommendation #4	Climate change impacts	• Annual review of rainfall and flow data to assess potential changes in storm return periods compared to initial estimates. (Changes may also occur if monitoring is increased).

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9 LIMITATIONS

Attention is drawn to the document "Limitations", which is included in Appendix C of this report. The statements presented in this document are intended to provide advice on what the realistic expectations of this report should be, and to present recommendations on how to minimise the risks associated with this project. The document is not intended to reduce the level of responsibility accepted by Mine Waste Management, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in doing so.

APPENDIX A MAPS AND FIGURES

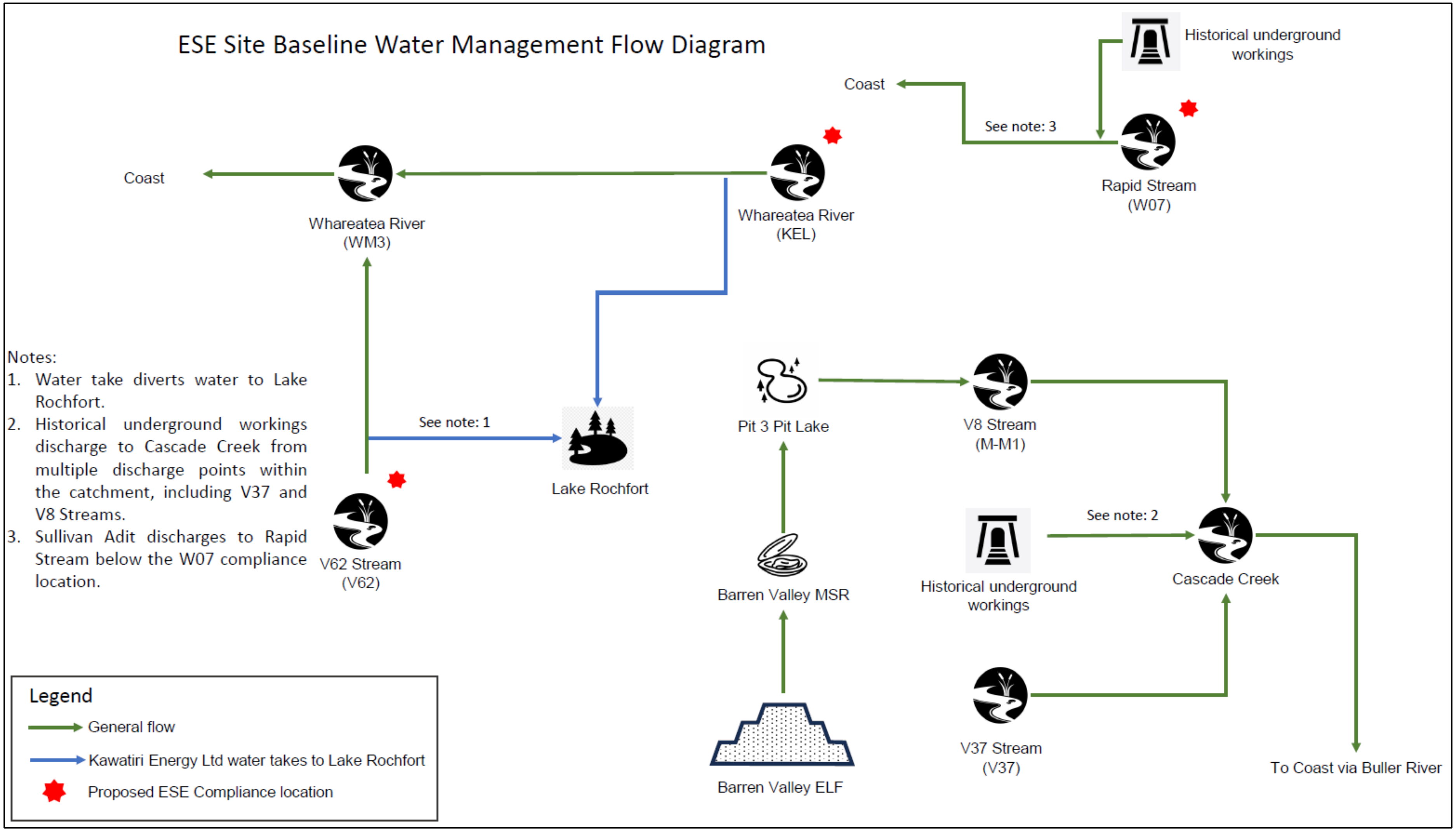

Figure 69: ESE Site Baseline Water Management Flow Diagram.

Source: MWM (2026b).

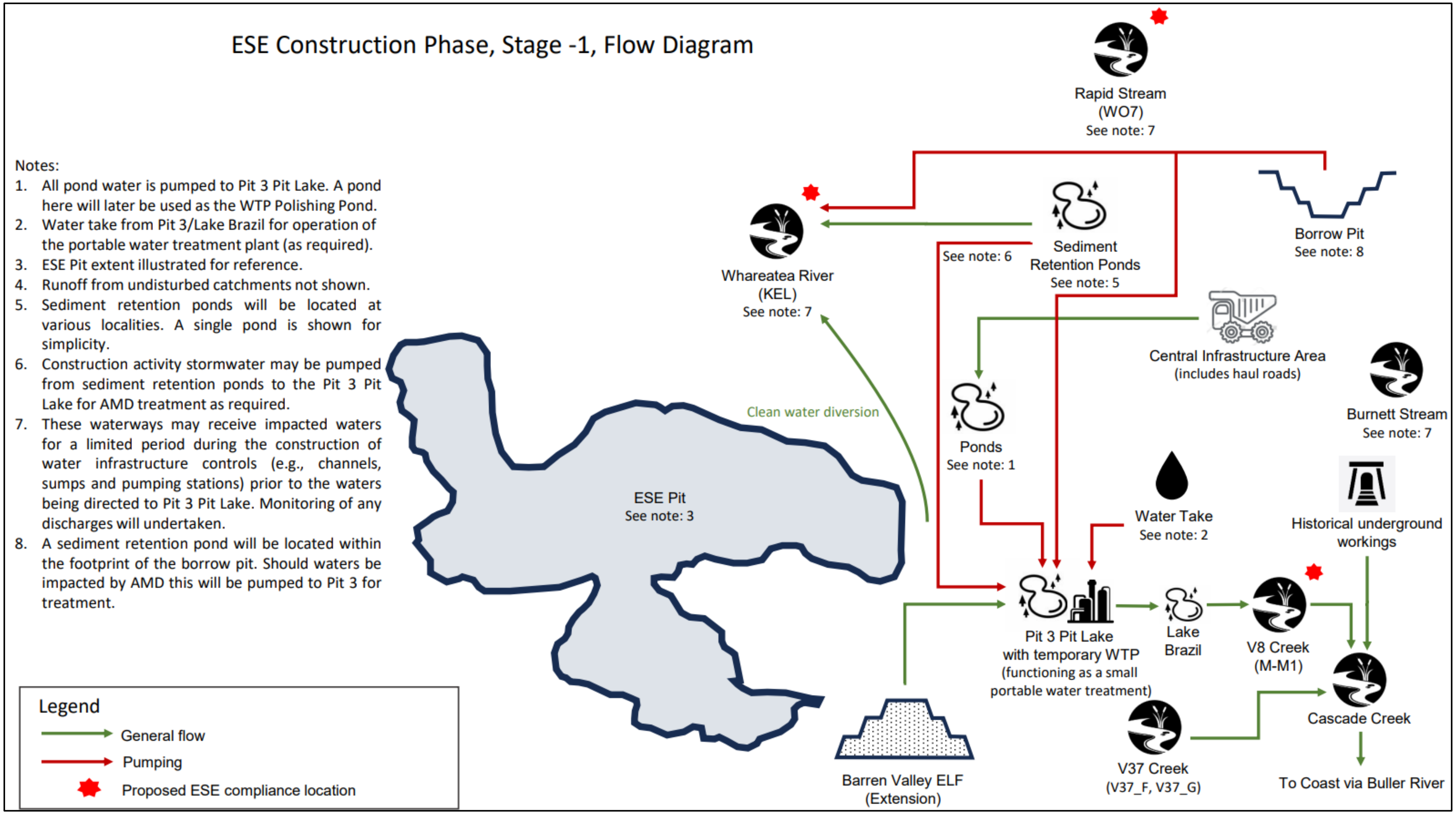

Figure 70: ESE Construction Phase, Stage -1, Flow Diagram.

Source: MWM (2026b).

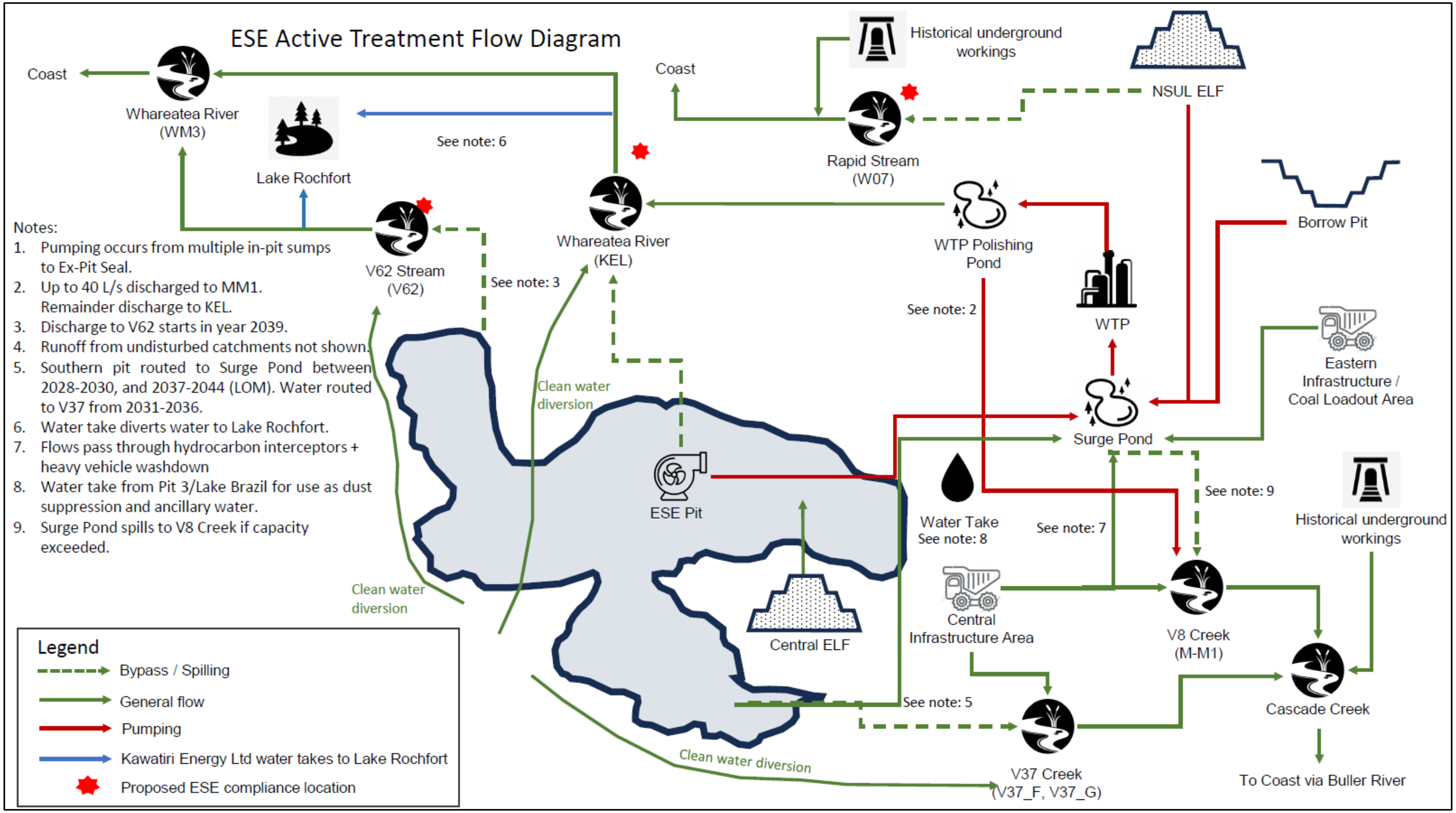

Figure 72: ESE Active Treatment Flow Diagram.

Source: MWM (2026b).

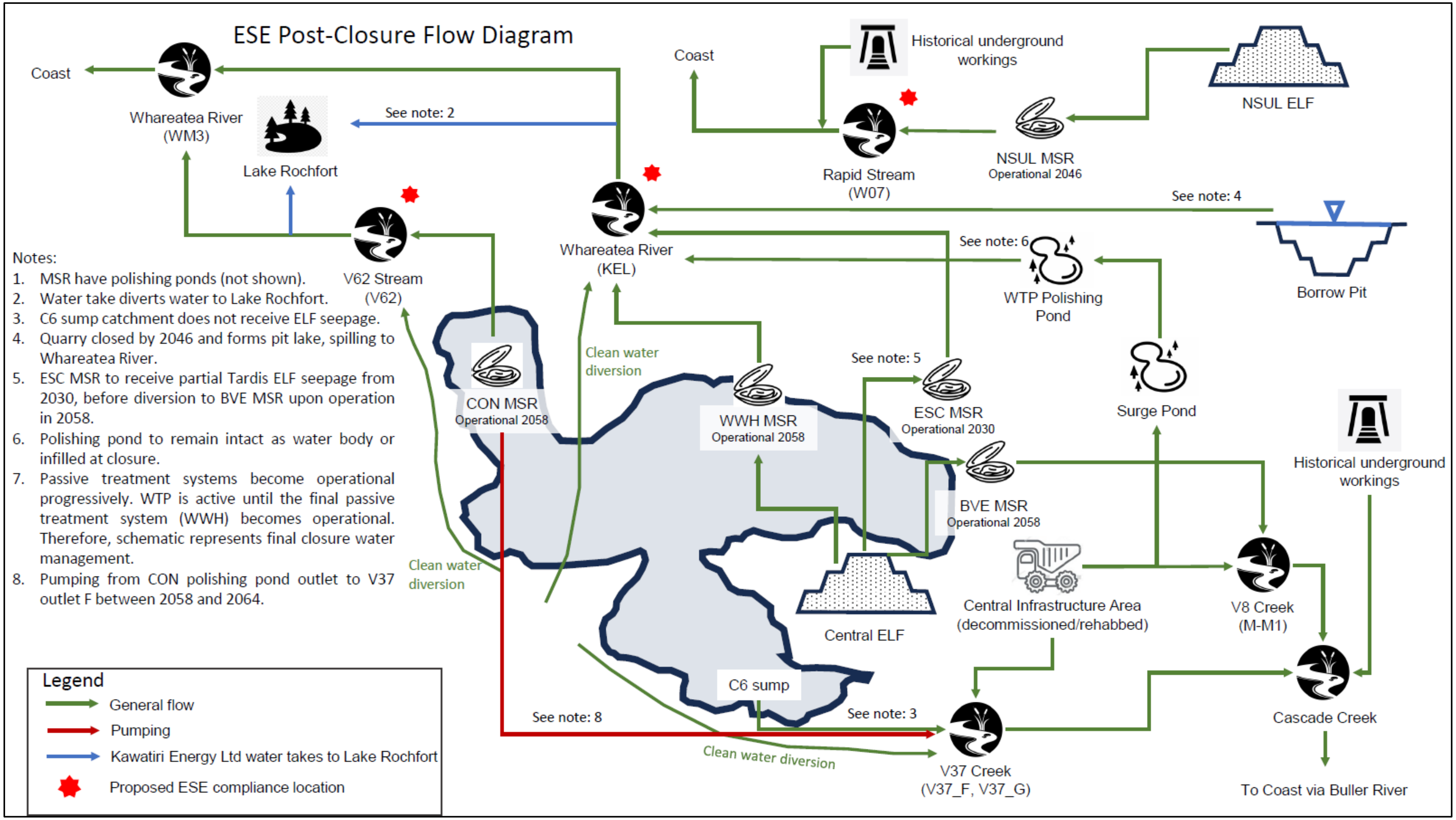

Figure 73: ESE Post-Closure Flow Diagram.

Source: MWM (2026b).

APPENDIX B DATA TABLES AND CHARTS

Table 28: Illustration of surface-water flow records available for the BPCP site.

Catchment	Code	Start	Stop	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Ngakawau	NR	7-Jun-74	10-Feb-22																																																	◆			
Ngakawau	8W	1-Apr-09	24-Mar-25																																																				◆
St Patricks Str.	PLAOFM	21-Mar-11	9-Dec-24																																																			◆	
St Patricks Str.	Fly 5	11-Jul-09	3-Jan-24																																																			◆	
St Patricks Str.	S16	16-Nov-00	25-Mar-25																																																				◆
Granity	S25	17-Nov-05	28-May-25																																																				◆
Granity	S24A	20-Jun-08	28-May-25																																																				◆
Mine	DCA@ portal 2	18-Apr-10	28-May-25																																																				◆
Mine	S23	4-Oct-11	28-May-25																																																				◆
Mine	S6	25-May-08	24-May-25																																																				◆
Mine	MC1																																																						
Mine	MASC	12-Oct-12	22-Mar-25																																																				◆
Mangatini	MGD																																																						
Mangatini	FC2	27-Oct-04	1-Jan-17																																										◆								
Mangatini	S14	31-Mar-03	19-Mar-25																																																				◆
Mangatini	S14B	2-Apr-06	19-Mar-25																																																				◆
Waimangaroa	7W	3-Oct-19	24-Mar-25																																																				◆
Waimangaroa	Byrne Creek																																																						
Waimangaroa	WRBBC	6-Dec-22	24-Mar-25																																																				◆
Waimangaroa	Smokestack	18-Jun-74	11-Apr-15																																								◆										
Deep Creek	SW01	12-Nov-24	23-Jul-25																																																				◆
Deep Creek	BS01	12-Nov-24	23-Jul-25																																																				◆
Deep Creek	SW03	13-Nov-24	23-Jul-25																																																				◆
Whareatea River	WM1	4-Nov-10	20-Mar-14																																							◆											
Whareatea River	WM2	9-Mar-11	1-Jan-15																																								◆										
Whareatea River	CM1	3-May-12	25-Nov-15																																								◆										
Whareatea River	SHB (W-M3)	9-Mar-11	17-Sept-12																																					◆													
Whareatea River	F2	12-Nov-10	9-May-12																																					◆													
Whareatea River	F1	12-Nov-10	20-Mar-14																																							◆											
Whareatea River	V62	1-May-18	3-May-20																																												◆					
Whareatea River	V70	1-May-18	3-May-20																																												◆					
Rapid Stream	Above adits	28-May-18	12-Aug-20																																												◆					
Rapid Stream	Below adits	28-May-18	12-Aug-20																																												◆					
Rapid Stream	SHB	28-May-18	12-Aug-20																																												◆					
Cascade	V8	27-Sept-12	11-Sept-13																																						◆												

'◆' indicates year to which archived statistics have been prepared for. Current monitoring stations run beyond end of 2025.

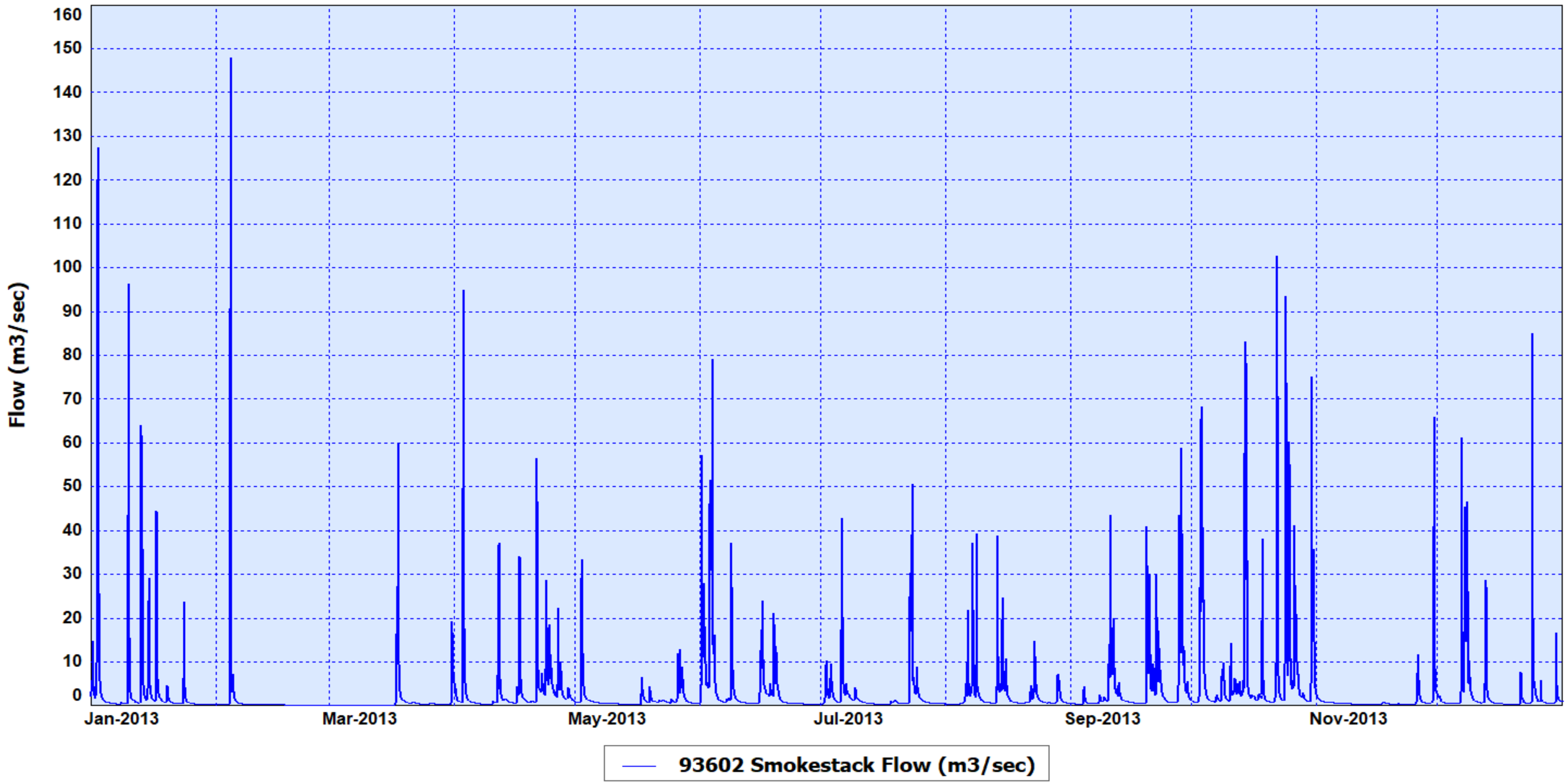

Figure 74: Sample flow timeseries from Waimangaroa at Smokestack (2013).

Peak flows values are indicative only due to rating curve uncertainty.

[redacted].

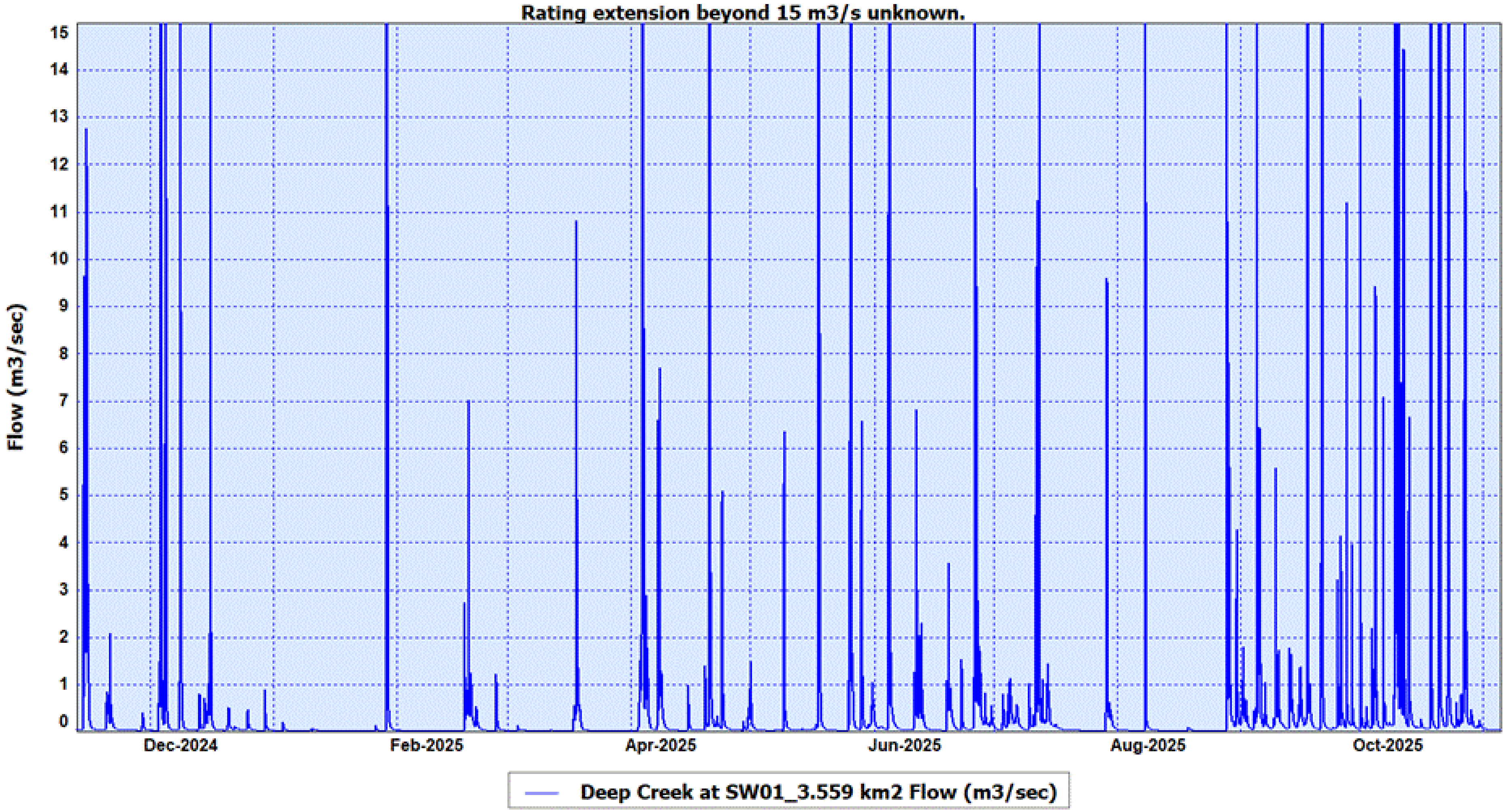

Figure 75: Sample flow timeseries from Deep Stream at SW01 (December 2024 to November 2025).

[redacted]

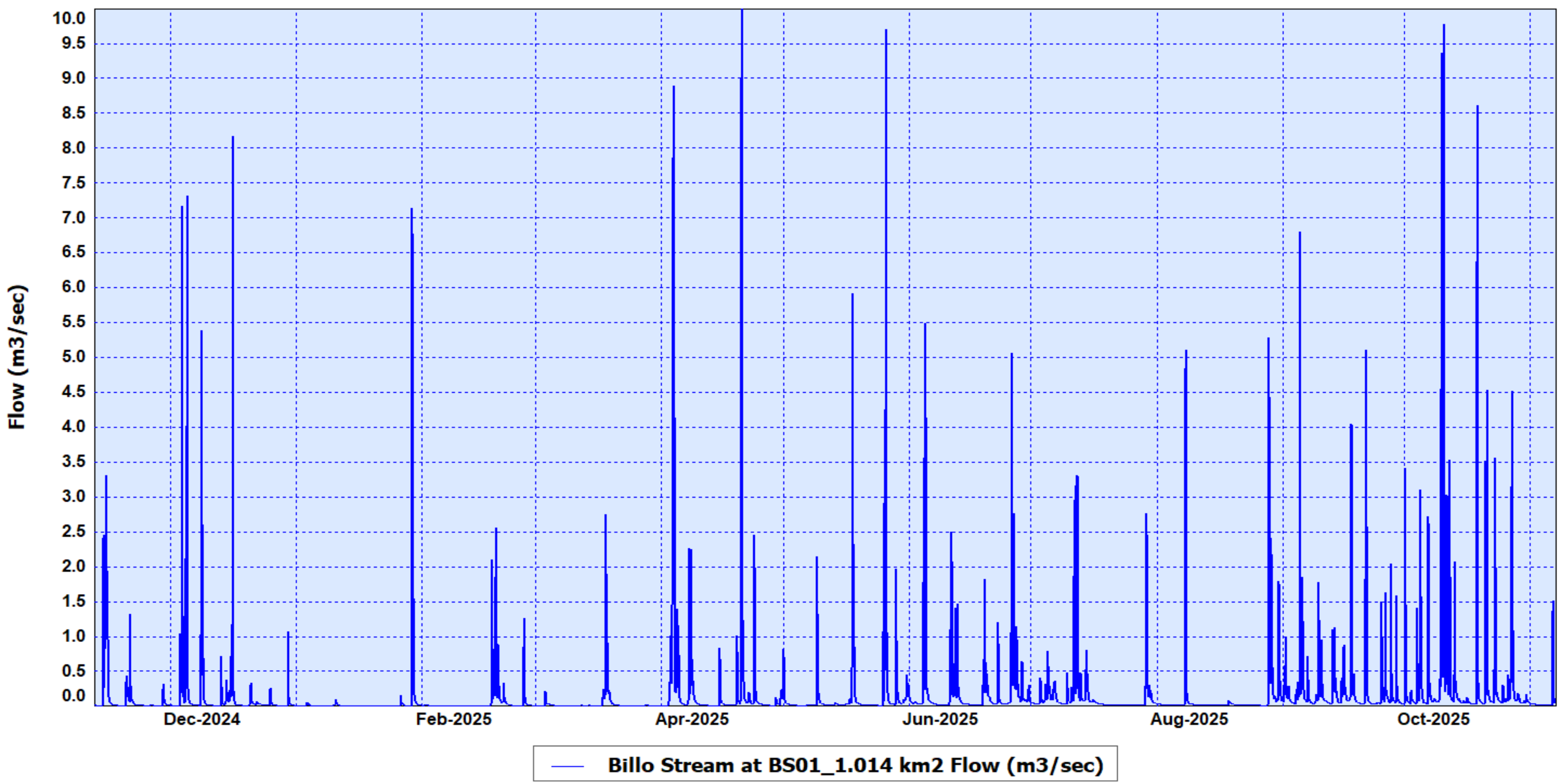

Figure 76: Sample flow timeseries from Billo Stream at BS01 (December 2024 to November 2025).

Peak flows values are indicative only due to rating curve uncertainty.

[redacted]

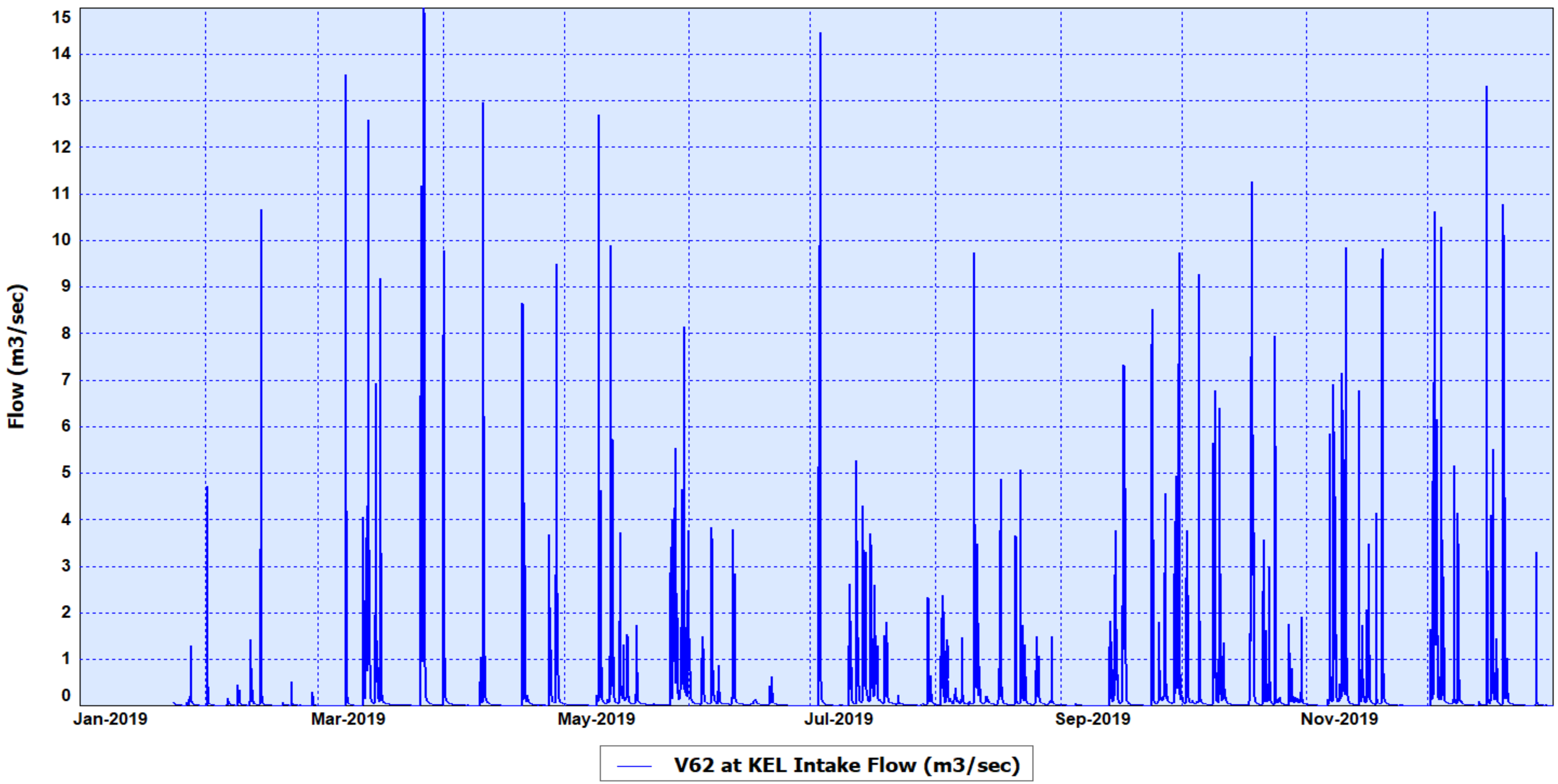

Figure 77: Sample flow timeseries from V62 Stream at KEL Intake (2019).

Peak flows values are indicative only due to rating curve uncertainty.

[redacted]

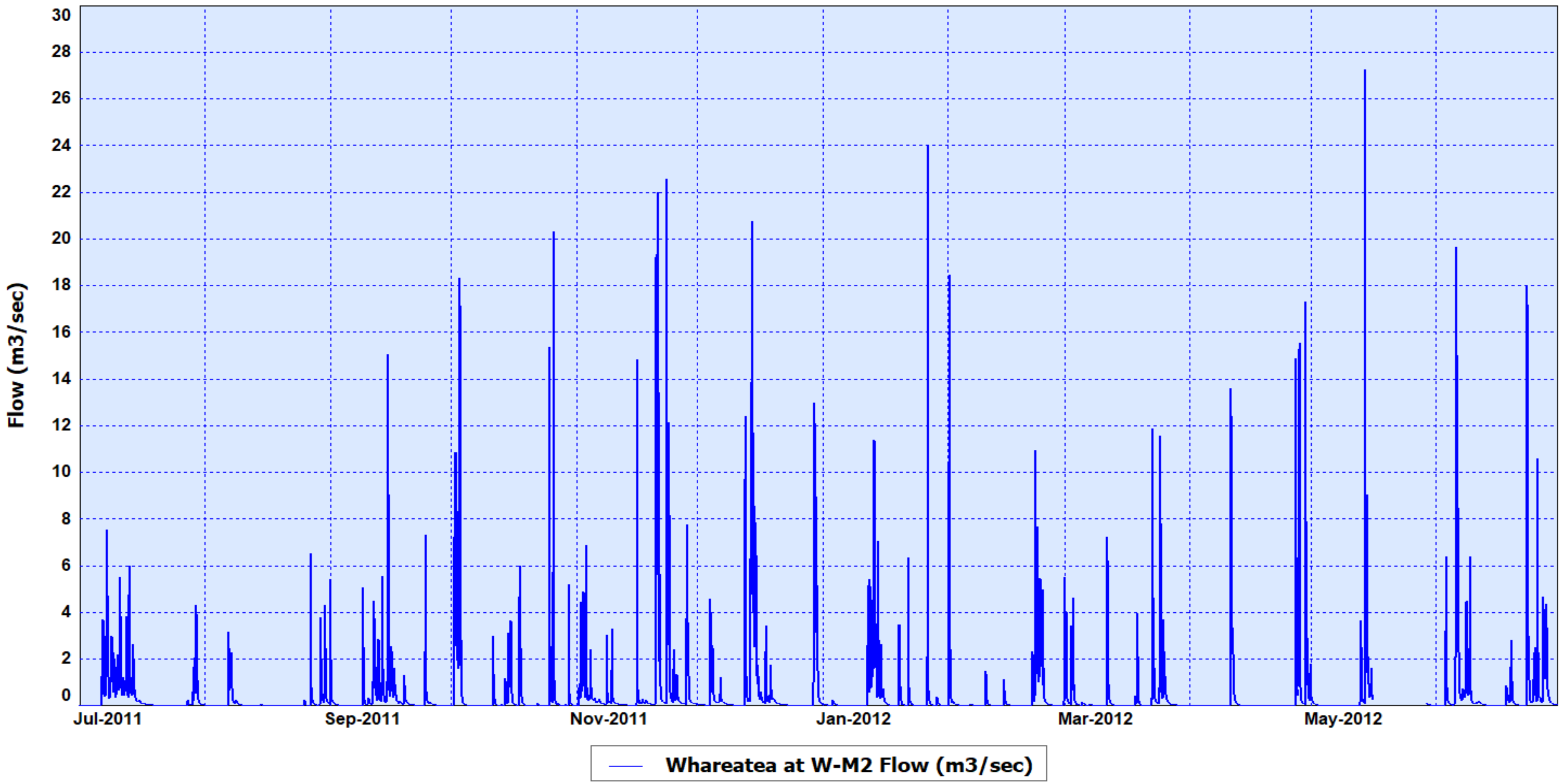

Figure 78: Sample flow timeseries from Whareatea River at WM2 Intake (July 2011 to June 2012).

Peak flows values are indicative only due to rating curve uncertainty.

[redacted]

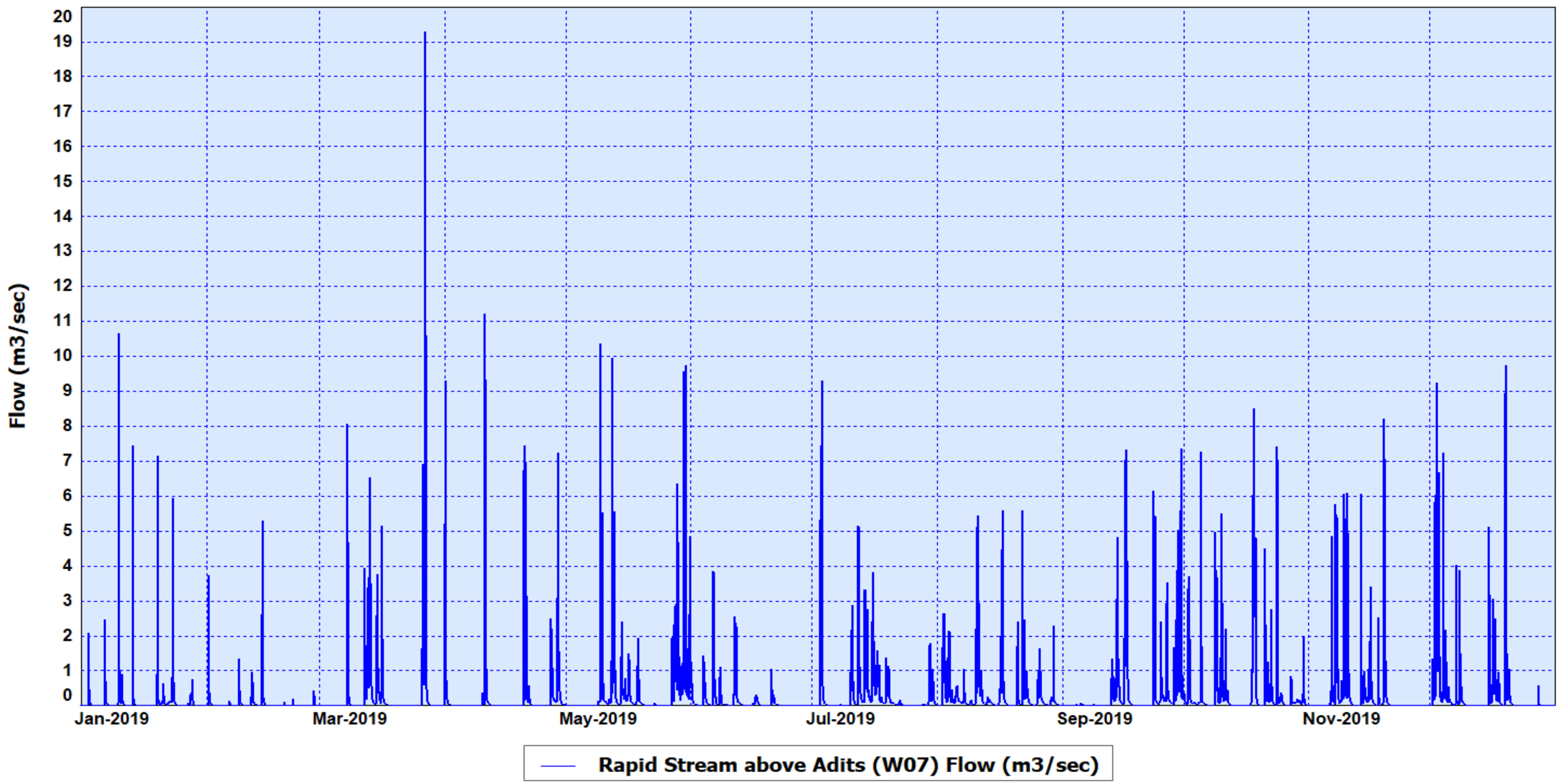

Figure 79: Sample flow timeseries from Rapid Stream at W07 (2019).

Peak flows values are indicative only due to rating curve uncertainty.

[redacted]

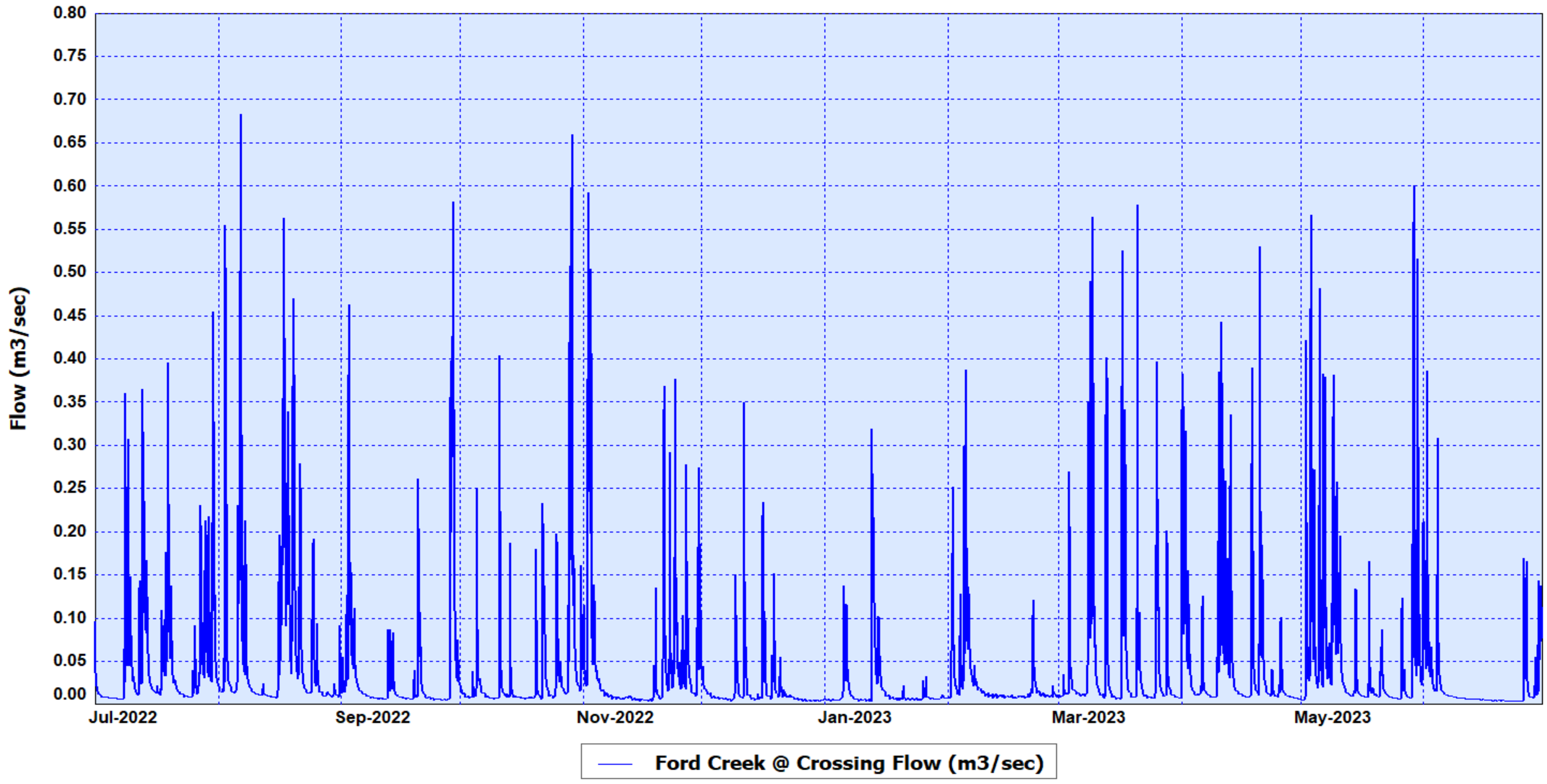

Figure 80: Sample flow timeseries from Ford Creek (FC2) at ‘Crossing’ (July 2022 to June 2023).

Peak flows values are indicative only due to rating curve uncertainty.

[redacted]

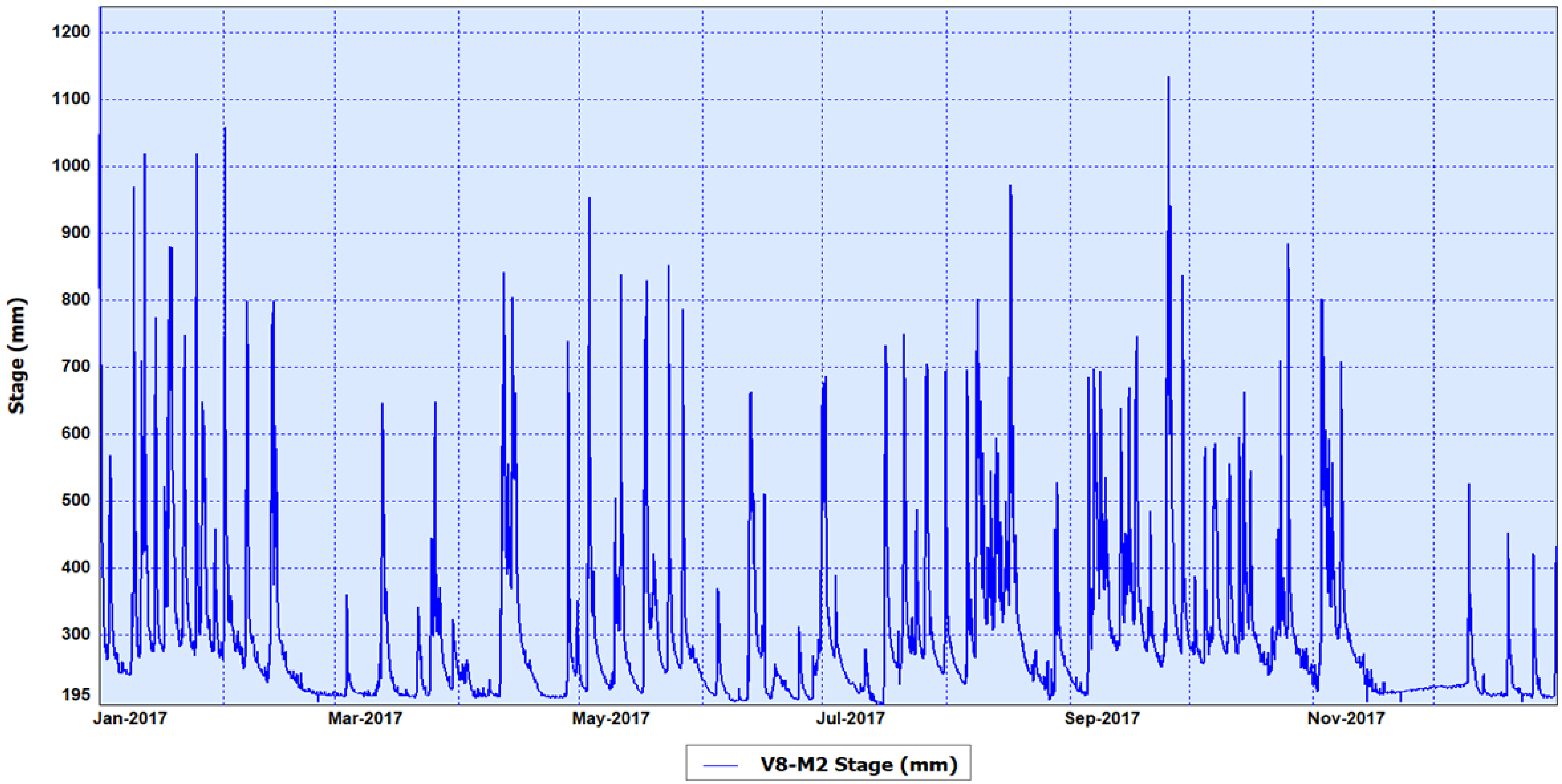

Figure 81: Sample stage height (m) timeseries from V8 Stream at V8-M2 (2017).

Peak flows values are indicative only due to rating curve uncertainty.

[redacted]

Table 29: Surface water flow characteristics from Stockton mine - complete record period (m^3/s).

CATCHMENT	CODE	MIN	MAX	MEAN	STD DEV	L.Q.	MEDIAN	U.Q.	5^{TH} %ile	95^{TH} %ile	START	STOP
Granity	S25	0.004		0.143	0.438	0.021	0.039	0.101	0.498	0.009	17-Nov-2005	28-May-2025
	S24A	0.008		0.261	0.319	0.117	0.179	0.287	0.681	0.058	20-Jun-2008	28-May-2025
Mine	DCA@ port 2	0.0		0.178	0.201	0.071	0.113	0.205			18-Apr-201	28-May-2025
	S23	0.015		0.224	0.234	0.091	0.151	0.264	0.646	0.047	4-Oct-2011	28-May-2025
	S6 *	0.003		0.235	0.593	0.038	0.078	0.168	0.929	0.012	25-May-2008	24-May-2025
	MC1	As for site MASC										
	MASC	0.046		0.669	1.387	0.169	0.294	0.622			12-Oct-2012	22-Mar-2025
Mangatini	MGD	n/a										
	FC2**	0.005		0.183	0.407	0.025	0.07	0.157	0.880	0.01	27-Oct-2004	1-Jan-2017
	S14	0.008		1.154	3.061	0.241	0.467	0.927			31-Mar-2003	19-Mar-2025
	S14B	0.003	*	2.004	5.577	0.308	0.575	1.323			2-Apr-2006	19-Mar-2025
Ngākawau	Lineslip (NR)	1.047	907.5	24.321	50.666	4.723	8.121	18.872			7-Jun-1974	10-Feb-2022
	8W	-0.006		0.313	0.967	0.027	0.049	0.172			1-Apr-2009	24-Mar-2025
St Patricks Str.	PLAOFM	-0.008		0.621	1.538	0.053	0.166	0.451			21-Mar-2011	9-Dec-2024
	Fly 5	0.005		0.565	1.514	0.071	0.131	0.354			11-Jul-2009	3-Jan-2024
	S16	0.161	112.02	2.35	4.692	0.486	0.872	1.913			16-Nov-2000	25-Mar-2025
Waimangaroa	7W	0.001		0.081	0.213	0.013	0.021	0.049			3-Oct-2019	24-Mar-2025
	Byrne Creek *	No rating available										
	WRBBC	0.063		0.627	1.757	0.116	0.165	0.335			6-Dec-2022	24-Mar-2025

Notes:

** Site not rated for high flows.*

***5 and 95^{th} %iles based on period Oct 2004 to May 2013.*

Table 30: Surface water flow characteristics (m^3/s) from Stockton mine for 10-year overlapping period from 2015 to 2024 (unless otherwise stated).

CATCHMENT	CODE	MIN	MAX	MEAN	STD DEV	L.Q.	MEDIAN	U.Q.	5^{TH} %ile	95^{TH} %ile	START	STOP
Granity	S25	0.005		0.131	0.39	0.022	0.04	0.098				
	S24A	0.008		0.258	0.366	0.100	0.162	0.263				
Mine	DCA@ portal 2	0		0.173	0.198	0.072	0.11	0.193				
	S23*	0.017		0.232	0.237	0.099	0.158	0.271				
	S6	0.004		0.248	0.601	0.04	0.085	0.185				
	MC1				N/A							
	MASC	0.047		0.682	1.383	0.177	0.298	0.638				
Mangatini	MGD	0		0.292	0.347	0.007	0.168	0.421				
	FC2				N/A							
	S14	0.008		1.307	3.713	0.201	0.406	0.896				
	S14B	0.003	*	2.163	5.963	0.326	0.583	1.353				
Ngākawau	Lineslip (NR)	1.184	868.104	24.13	50.644	4.722	8.255	18.54				10-Feb-2022
	8W	0.004		0.274	0.983	0.023	0.038	0.104				
St Patricks Stream	PLAOFM	0.001		0.664	1.596	0.065	0.189	0.476				9-Dec-2024
	Fly 5	0.011		0.569	1.548	0.066	0.125	0.343				3-Jan-2024
	S16	0.18	112.02	2.461	4.94	0.622	0.983	1.939				
Waimangaroa	7W				gauged from 2019							
	Byrne Creek				gauged from March 2024							
	WRBBC				gauged from December 2022							

Notes:

** Site not rated for high flows.*

1-Jan-2015 00:00:00 to 1-Jan-2025 00:00:00 unless otherwise stated.

Table 31: Surface water flow characteristics (m^3/s) from Escarpment and Mount Frederick South for complete record period (m^3/s).

CATCHMENT	CODE	MIN	MAX	MEAN	STD DEV	L.Q.	MEDIAN	U.Q.	5^{TH} %ile	95^{TH} %ile *	START	STOP
Whareatea River	WM1	0		0.135	0.483	0.005	0.013	0.049			4-Nov-2010	20-Mar-2014
	WM2	0		0.572	1.83	0.016	0.055	0.251	2.879	0.003	9-Mar-2011	1-Jan-2015
	CM1	0		0.114	0.19	0.01	0.029	0.132			3-May-2012	25-Nov-2015
	SHB (WM3)	0.082		1.733	6.487	0.166	0.291	0.855		0.097	9-Mar-2011	17-Sep-2012
	F2	0		0.083	0.309	0.001	0.005	0.027			12-Nov-2010	9-May-2012
	F1	0		0.037	0.166	0.001	0.002	0.011			12-Nov-2010	20-Mar-2014
	V62	0.003		0.268	0.871	0.02	0.035	0.091	1.227	0.003	1-May-2018	3-May-202
	V70	0		0.194	0.903	0.007	0.014	0.056			1-May-2018	3-May-2020
Waimangaroa	2W (Smokestack)	0.101	188.2	3.46	9.712	0.372	0.717	2.077	15.694	0.203	18-Jun-1974	11-Apr-2015
Cascade	V8	0.113	31.63	0.616	1.01	0.179	0.32	0.648			27-Sep-2012	11-Sep-2013
Rapid Stream	Above adits (WO7)	0		0.214	0.744	0.005	0.012	0.081	1.031	0.001	28-May-2018	12-Aug-2020
	Below adits	0.007		0.339	1.388	0.032	0.049	0.128			28-May-2018	12-Aug-2020
	SHB	0.069		1.087	4.223	0.121	0.192	0.452		0.081	28-May-2018	12-Aug-2020
Deep Stream	SW01	0.023		0.371	1.727	0.036	0.049	0.117	1.305	0.026	12-Nov-2024	23-Jul-2025
	BS01	0.004		0.138	0.552	0.01	0.02	0.052	0.721	0.006	12-Nov-2024	23-Jul-2025
	SW03*	0		0.041	0.134	0.002	0.006	0.024	2.05	0.04	13-Nov-2024	23-Jul-2025

Notes:

** WM2 95^{th} %ile for period 9-Mar-2011 16:10:00 to 1-Jan-2015 00:00:00;*

WM3 95^{th} %ile for period 3-May-2012 14:30:02 to 25-Nov-2015 16:15:00;

SHB (Rapid) 95^{th} %ile for the period 28-May-2018 15:51:00 to 12-Aug-2020 14:30:00;

2W (Smokestack) 95^{th} %ile for the period 18-Jun-1974 15:30:00 to 11-Apr-2015 14:15:00;

SW03 95^{th} and 5^{th} %iles scaled by area from SW01.

Table 32: Surface water flow characteristics (m^3/s) from Escarpment and Mount Frederick South for 2.5-year overlapping period*.

CATCHMENT	CODE	MIN	MAX	MEAN	STD DEV	L.Q.	MEDIAN	U.Q.	5^{TH} %ile	95^{TH} %ile	START	STOP
Whareatea River	WM1	0		0.153	0.522	0.005	0.013	0.058				20-Mar-2014
	WM2	0		0.607	1.924	0.016	0.058	0.287	0.2879	0.003		
	CM1	0		0.113	0.178	0.011	0.032	0.133				
	SHB (W-M3)			Insufficient data								
	F2			Insufficient data								
	F1	0		0.033	0.156	0.001	0.002	0.009				20-Mar-2014
Waimangaroa	2W (Smokestack)	0.149	147.912	3.136	8.268	0.435	0.797	2.108			5-Sept-2012	
Cascade	V8			Insufficient data								

Notes:

** 3-May-2012 00:00:00 to 1-Jan-2025 00:00:00 unless otherwise stated.*

Table 33: Surface water flow characteristics (m^3/s) from Escarpment and Mount Frederick South for 2-year overlapping period*.

CATCHMENT	CODE	MIN	MAX	MEAN	STD DEV	L.Q.	MEDIAN	U.Q.	5^{TH} %ile	95^{TH} %ile	START	STOP
Whareatea River	V62	0.003		0.268	0.88	0.02	0.035	0.089				
	V70	0		0.196	0.916	0.007	0.014	0.055				
Rapid Stream	Above adits	0		0.223	0.76	0.005	0.013	0.086				
	Below adits	0.019		0.352	1.416	0.032	0.051	0.132				
	SHB	0.069		1.087	4.223	0.121	0.192	0.452				12-Aug-2020
Deep Stream	SW01			No data in that period								
	BS01			No data in that period								
	SW03			No data in that period								

Notes:

1-Jun-2018 00:00:00 to 3-May-2020 00:00:00 unless otherwise stated.

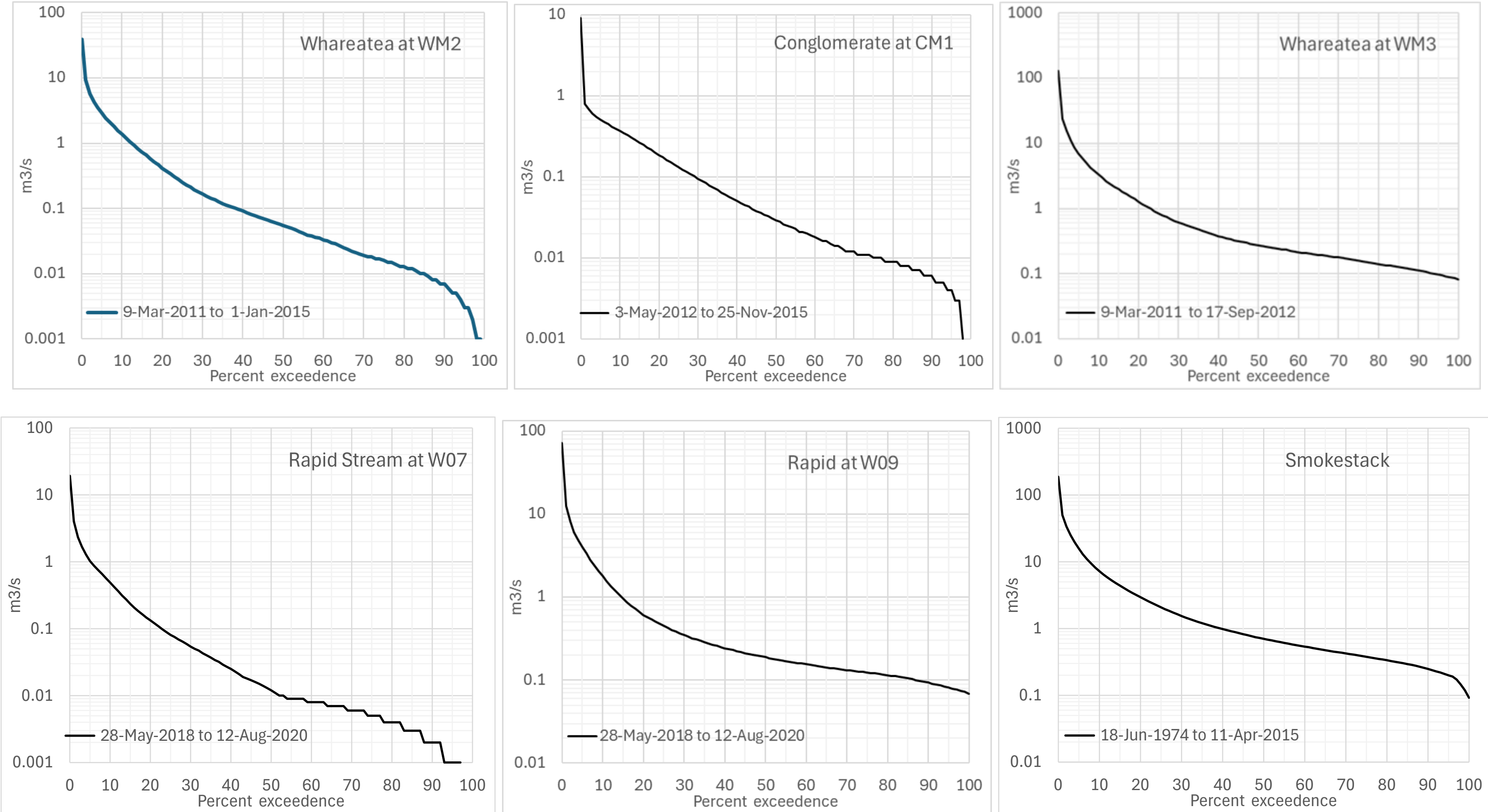

Figure 82: Selected flow duration curves.

Table 34: Rainfall intensity-duration-frequency curves for Downertown, West Coast ().

RAINFALL INTENSITIES (MM/HR): HISTORICAL DATA

ARI	AEP	10M	20M	30M	1H	2H	6H	12H	24H	48H	72H	96H	120H
1.58	0.633	46.1	34.5	29.6	23.2	18.5	12.7	9.84	7.35	5.23	4.18	3.51	3.04
2	0.5	50.7	37.8	32.4	25.4	20.1	13.8	10.7	7.94	5.64	4.49	3.77	3.27
5	0.2	66.7	49.5	42.2	32.8	25.8	17.5	13.4	9.9	6.98	5.54	4.64	4.01
10	0.1	79	58.3	49.6	38.3	30	20.2	15.4	11.3	7.94	6.28	5.25	4.52
20	0.05	92.1	67.6	57.3	44.1	34.3	23	17.4	12.7	8.89	7.02	5.85	5.03
30	0.033	100	73.3	62	47.6	37	24.6	18.6	13.6	9.45	7.44	6.2	5.33
40	0.025	106	77.4	65.5	50.1	38.8	25.8	19.4	14.2	9.84	7.75	6.44	5.54
50	0.02	111	80.7	68.2	52.1	40.3	26.7	20.1	14.6	10.1	7.98	6.63	5.7
60	0.017	114	83.4	70.4	53.7	41.5	27.5	20.6	15	10.4	8.17	6.79	5.83
80	0.013	121	87.7	74	56.4	43.5	28.7	21.5	15.6	10.8	8.46	7.03	6.03
100	0.01	125	91.1	76.8	58.4	45	29.6	22.2	16	11.1	8.69	7.21	6.19
250	0.004	146	105	88.6	67	51.3	33.4	24.9	17.9	12.3	9.6	7.94	6.8

RAINFALL INTENSITIES (MM/HR):: RCP8.5 FOR THE PERIOD 2031-2050

ARI	AEP	10M	20M	30M	1H	2H	6H	12H	24H	48H	72H	96H	120H
1.58	0.633	50.7	38	32.6	25.6	20.2	13.8	10.5	7.78	5.49	4.36	3.65	3.16
2	0.5	55.9	41.8	35.8	28	22.1	15	11.4	8.42	5.93	4.7	3.94	3.4
5	0.2	74	54.9	46.8	36.4	28.5	19.1	14.4	10.6	7.38	5.83	4.86	4.19
10	0.1	87.8	64.8	55.1	42.6	33.2	22.1	16.6	12.1	8.41	6.63	5.51	4.74
20	0.05	102	75.2	63.8	49.1	38.1	25.1	18.8	13.6	9.44	7.41	6.16	5.28
30	0.033	111	81.6	69.1	53	41	26.9	20.1	14.5	10	7.87	6.53	5.6
40	0.025	118	86.2	72.9	55.8	43.1	28.3	21.1	15.2	10.5	8.19	6.79	5.82
50	0.02	123	89.9	76	58.1	44.8	29.3	21.8	15.7	10.8	8.44	6.99	5.99
60	0.017	128	92.9	78.5	59.9	46.1	30.1	22.4	16.1	11.1	8.65	7.16	6.13
80	0.013	135	97.8	82.5	62.9	48.3	31.4	23.3	16.7	11.5	8.96	7.41	6.35
100	0.01	140	102	85.7	65.2	50	32.5	24.1	17.2	11.8	9.2	7.61	6.51
250	0.004	163	118	98.8	74.7	57	36.6	27	19.2	13.1	10.2	8.38	7.15

[redacted].

Table 35: Estimated surface water design flows and equivalent catchment yield.

SITE (COMMON NAME)	CATCHMENT AREA	FULL YEARS	MEAN ANNUAL FLOOD		10 YEAR RETURN PERIOD		50 YEAR RETURN PERIOD		100 YEAR RETURN PERIOD
			Flow m^3/s	Yield $m^3/s/km^2$	Flow m^3/s	Yield $m^3/s/km^2$	Flow m^3/s	Yield $m^3/s/km^2$	(m^3/s) and Q100/MAF
Waimangaroa at 2W (Smokestack)	16.9* #	11	138	8.17	158	9.35	178	10.53	187, 1.36
Waimangaroa at 2W (Smokestack)	16.9*	10	139.5	8.25	170	10.06	193	11.42	201, 1.44
Mangatini at S14B	10.31	17	101.5	9.84	143.3	13.9	178	17.26	191.6, 1.89
Mangatini at S14B	11.3	17	101.1	9.85	143.3	12.63	178	15.69	191.6, 1.89
T35	2.31	6	21.5	9.31	29.8	12.9	38.1	16.49	41.2, 1.93
Cascade Above V8	3.73	N/A	28.7	7.69	38.2	10.24	47.6	12.76	1.8 adopted
Ngakawau at Lineslip (NR)	188.8	21	700.87	3.71	859	4.55	961	5.09	955, 1.42

Notes:

** Excludes area diverted to the Plover stream catchment.*

 # Excludes 2015 flood event (peak flow 189 m3/s).

[redacted]

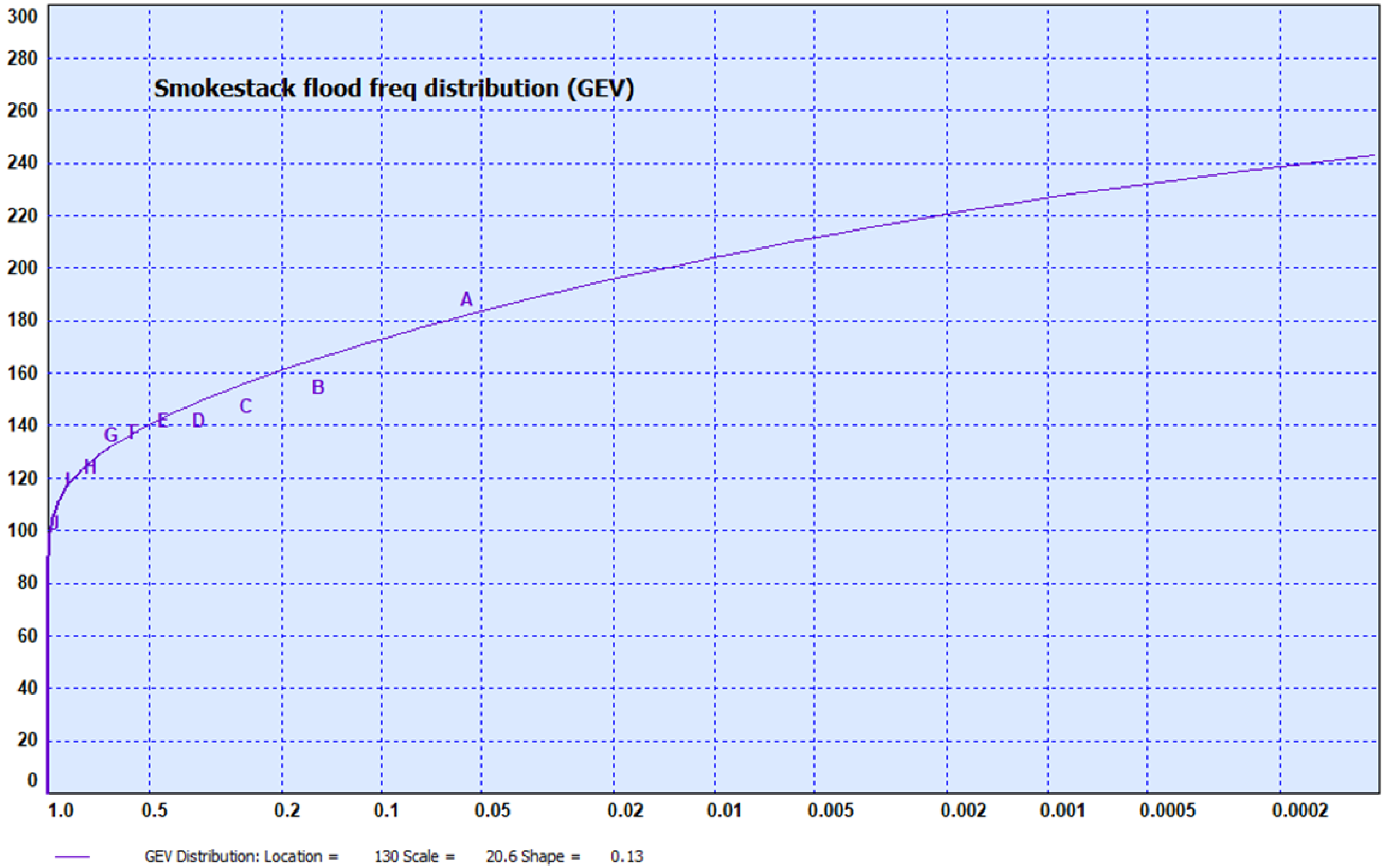

Figure 83: Waimangaroa (at 2W (Smokestack)) flood frequency distribution (cumecs).

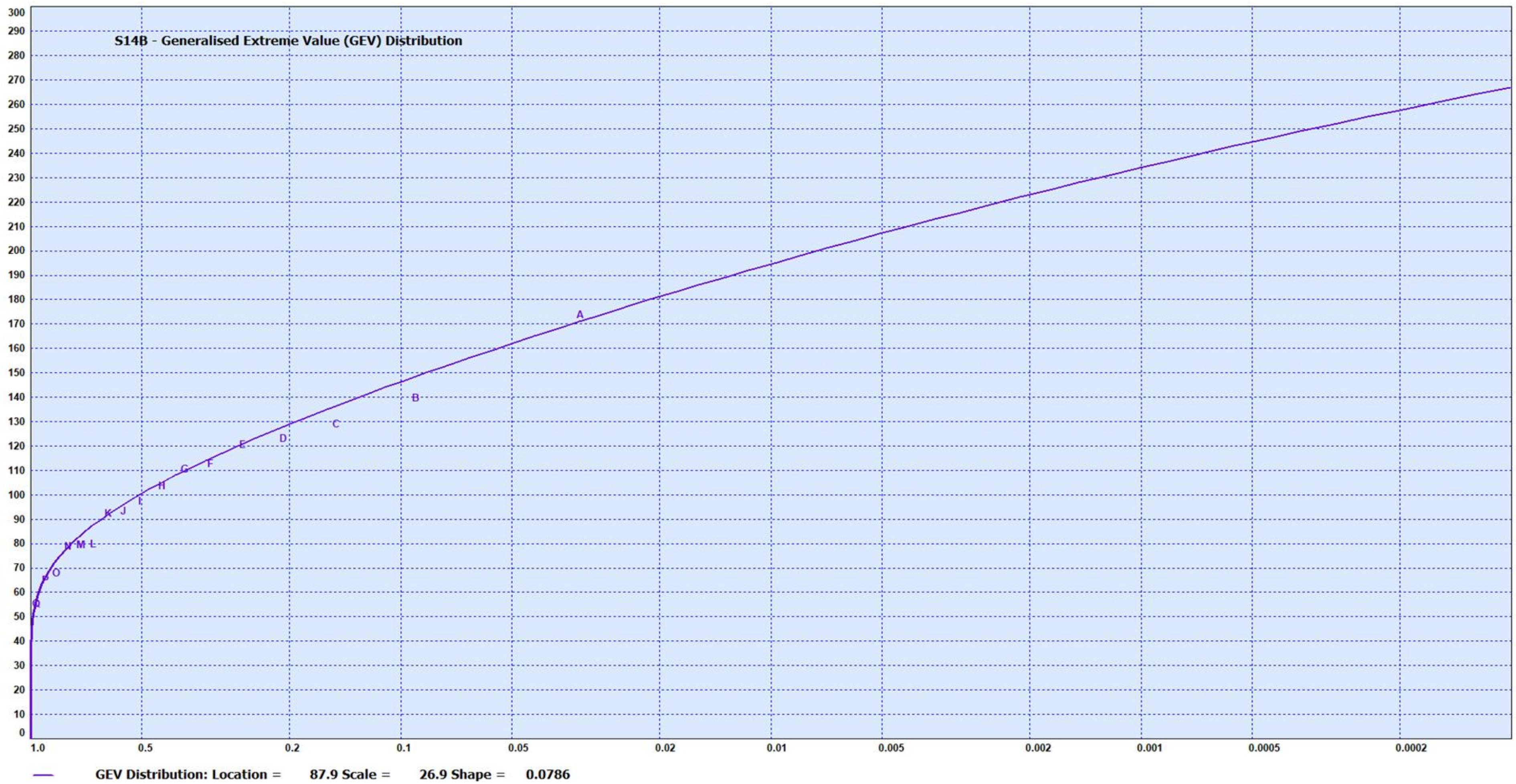

Figure 84: Mangatini at Above Fall (S14B) flood frequency distribution (cumecs).

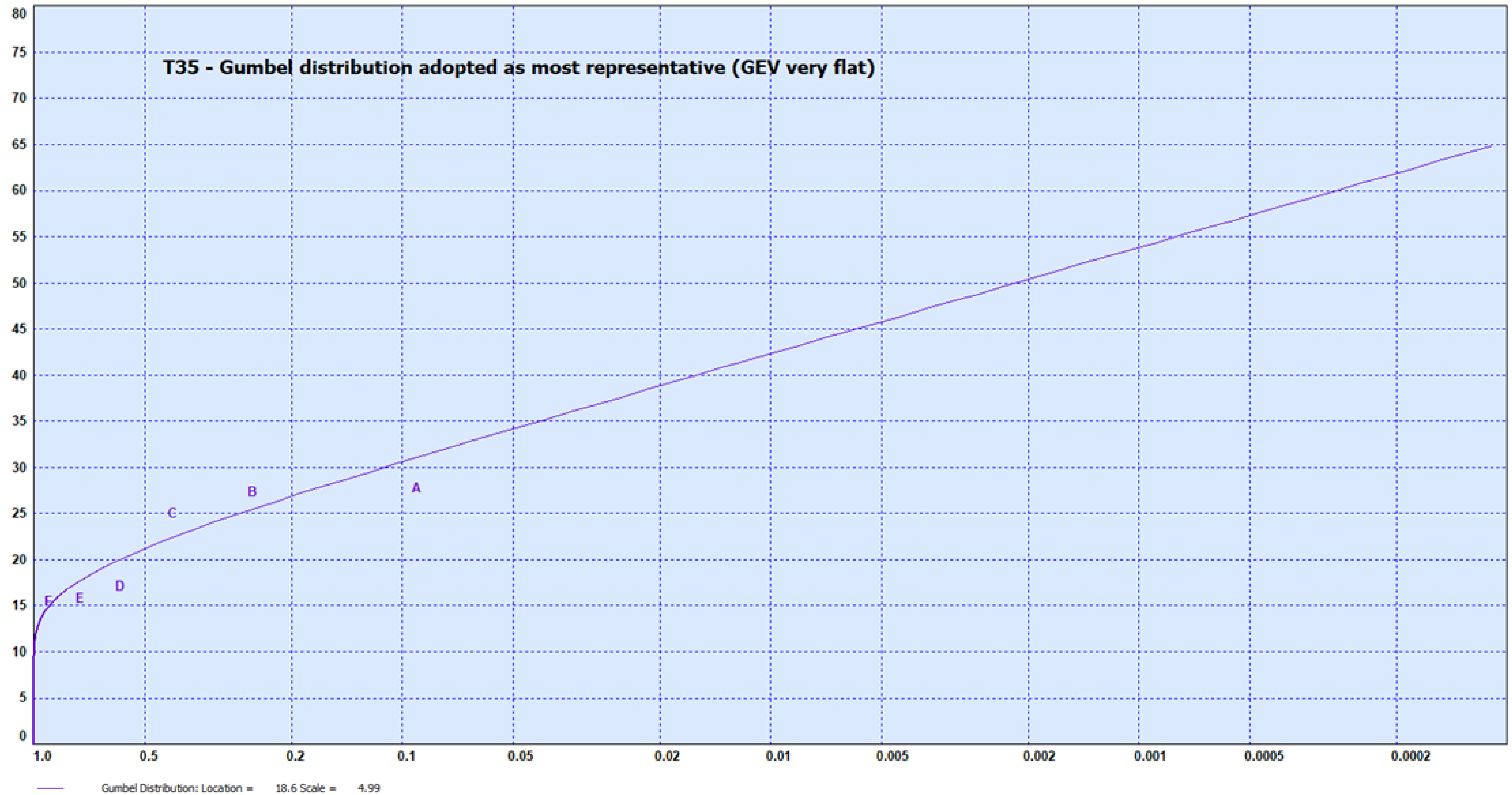

Figure 85: Mt Stockton (T35) flood frequency distribution (cumecs).

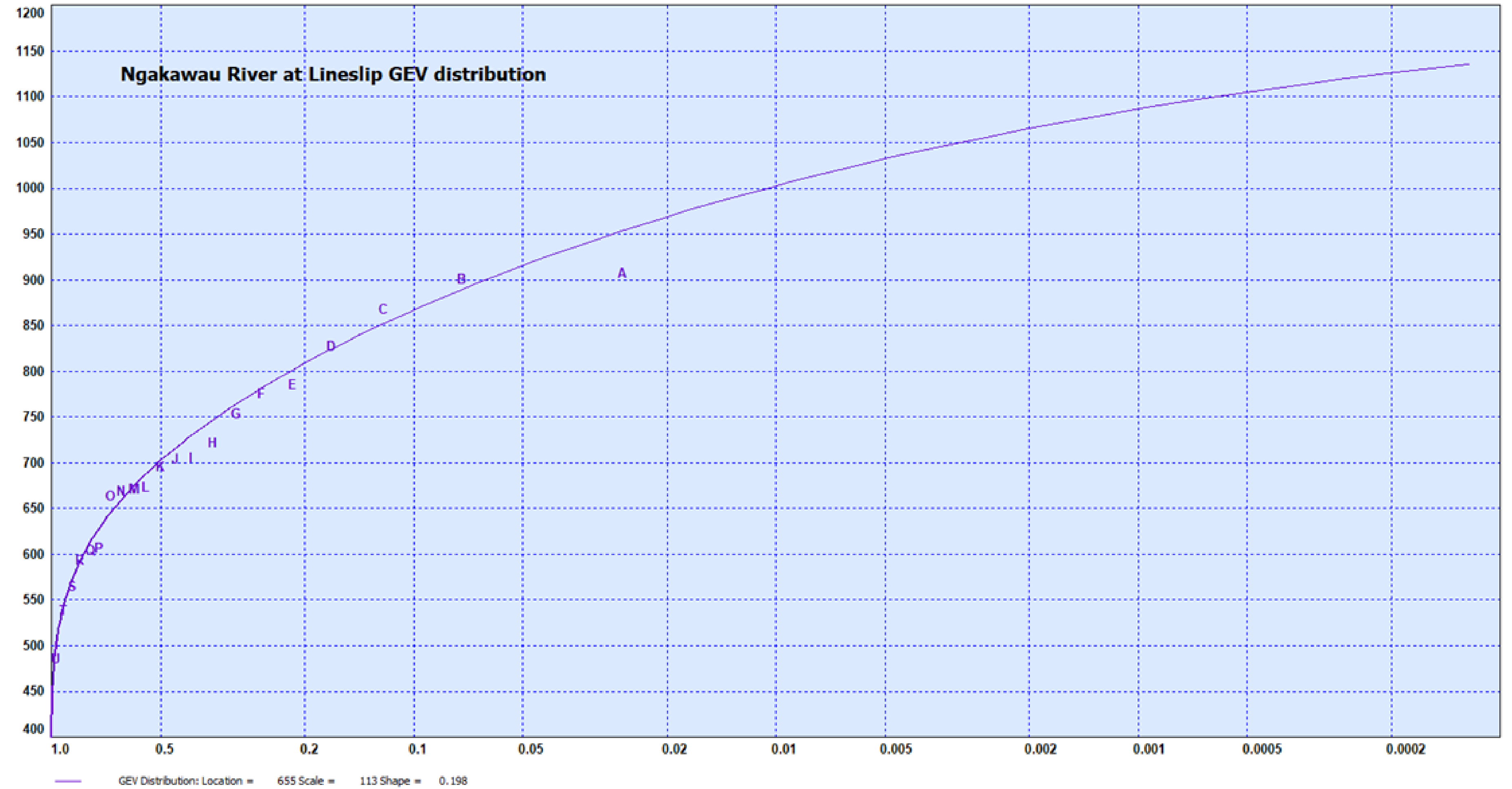

Figure 86: Ngakawau River (at Lineslip) flood frequency distribution (cumecs).

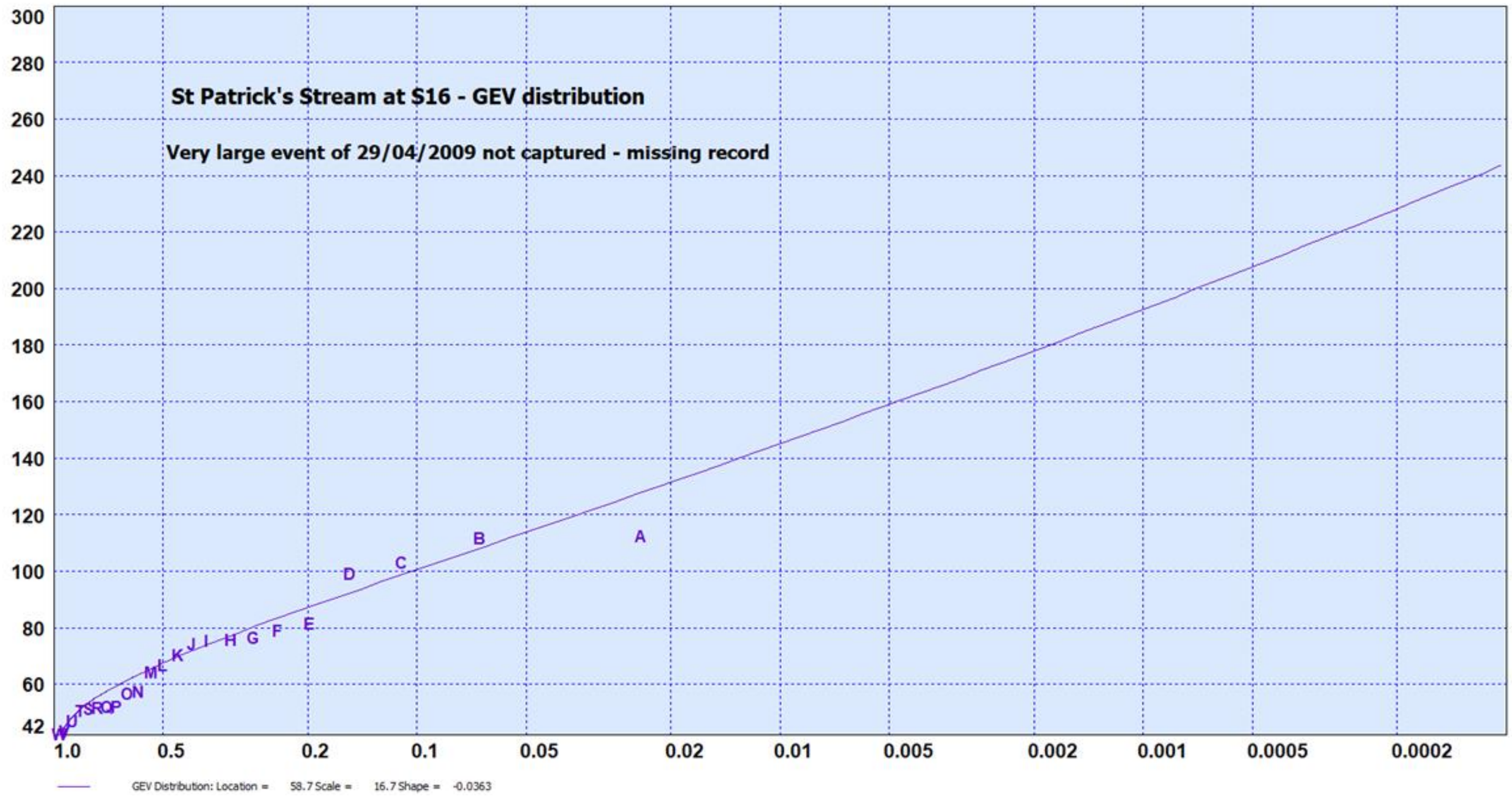

Figure 87: St Patrick's Steam (S16) flood frequency distribution (cumecs).

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