Oceana Gold NZ Limited

FY2023 Hydrogeology Support for WUG

December 12, 2024

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Hydrogeologic Conceptual Site Model

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Project:	Oceana Gold NZ Limited
Subject:	FY2023 Hydrogeology Support for WUG
Date:	December 12, 2024
Document Ref. FS:	1022310402-R-01

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Revision Status

Review	Date	Description	Prepared by:	Reviewed by:	Approved by:
A	April 30, 2023	Internal review	V.Revelo / A.Santos	F. Lemos	
A	May 2, 2023	Internal review	V.Revelo / A.Santos	J. Fortuna	
B	July 7, 2023	Issued to client	J. Fortuna		J. Fortuna
C	September 6, 2023	Internal review	A. Santos / S. Ruiz	J. Fortuna	
0	September 13, 2023	Issued to client	J. Fortuna		J. Fortuna
1	December 12, 2024	Revised		J. Fortuna	J. Fortuna

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1. INTRODUCTION

Oceana Gold New Zealand Limited (OGNZL) is the owner and operator of the Waihi underground mine, located in the town of Waihi on the North Island of New Zealand. FloSolutions Ecuador S.A.S. (FloSolutions) was contracted by OGNZL in early 2021 for hydrogeology support services for the OGC Waihi North project, including the proposed Wharekirauponga Underground (WUG) project development.

Substantial hydrogeological project work has been undertaken since late 2021 by OGNZL, GWS Limited (GWS), FloSolutions, and others – including field work (drilling, hydraulic testing, water level measurements, water quality sampling, etc.), data analysis and evaluation, conceptualization, and analytical and 3D numerical groundwater flow modeling. This work was undertaken to support groundwater effects assessment and to assess the potential for underground mine development at Wharekirauponga to impact surface water streams in the overlying catchments. These studies have greatly improved site conceptualization and understanding of the groundwater system and potential surface water - groundwater dynamics.

This report presents an updated, comprehensive hydrogeologic conceptual site model for the Wharekirauponga area and the proposed WUG project development.

1.1 Project overview

The proposed WUG project is located north of Waihi, New Zealand, in the Coromandel Ranges. The orebody and proposed mine is situated beneath land administered by the Department of Conservation (DOC). Site access is limited, and minimizing disturbance to the surface environment is a critical consideration in obtaining landowner and regulatory approvals. As a result, only a small number of drilling pads have been permitted to date, which restricts the amount of hydrogeologic (and other) data that can be collected.

The Wharekirauponga orebody is a high-grade gold deposit hosted in steeply dipping quartz veins that were emplaced along a northeast-trending regional-scale fault structure. OGNZL proposes to develop an underground mine (WUG) to access the orebody, with an AVOCA bottom-up mining method. Due to difficulties associated with obtaining an Access Arrangement (AA) to develop mine infrastructure on DOC lands, an underground tunnel will be developed to access the mineralized vein system. The portal would be established on farmland to the south of Wharekirauponga near Waihi (where OGNZL currently has its operations), and advanced northwards approximately 6 km to access the orebody from underground. If the project is developed, mined ore would be transported via the tunnel back to existing Waihi facilities for processing.

Further details of the proposed project development are described in Section 3.

1.2 Study objectives

Project consenting and approvals are overseen by the Waikato Regional Council. A key part of the project understanding in support of approval relates to the potential effects of mining development on groundwater resources. The groundwater effects assessment must consider mine inflows, groundwater drawdown, deep recharge, potential effects on shallow groundwater, potential impacts to streams (baseflow reduction), and related effects. To properly assess and model these effects, a comprehensive understanding of the site groundwater system(s) is required.

The objective of this report is to summarize previous and recent work into a comprehensive hydrogeologic conceptual site model that can be used as a framework to support the groundwater effects assessment and future studies and modeling.

1.3 Report contents

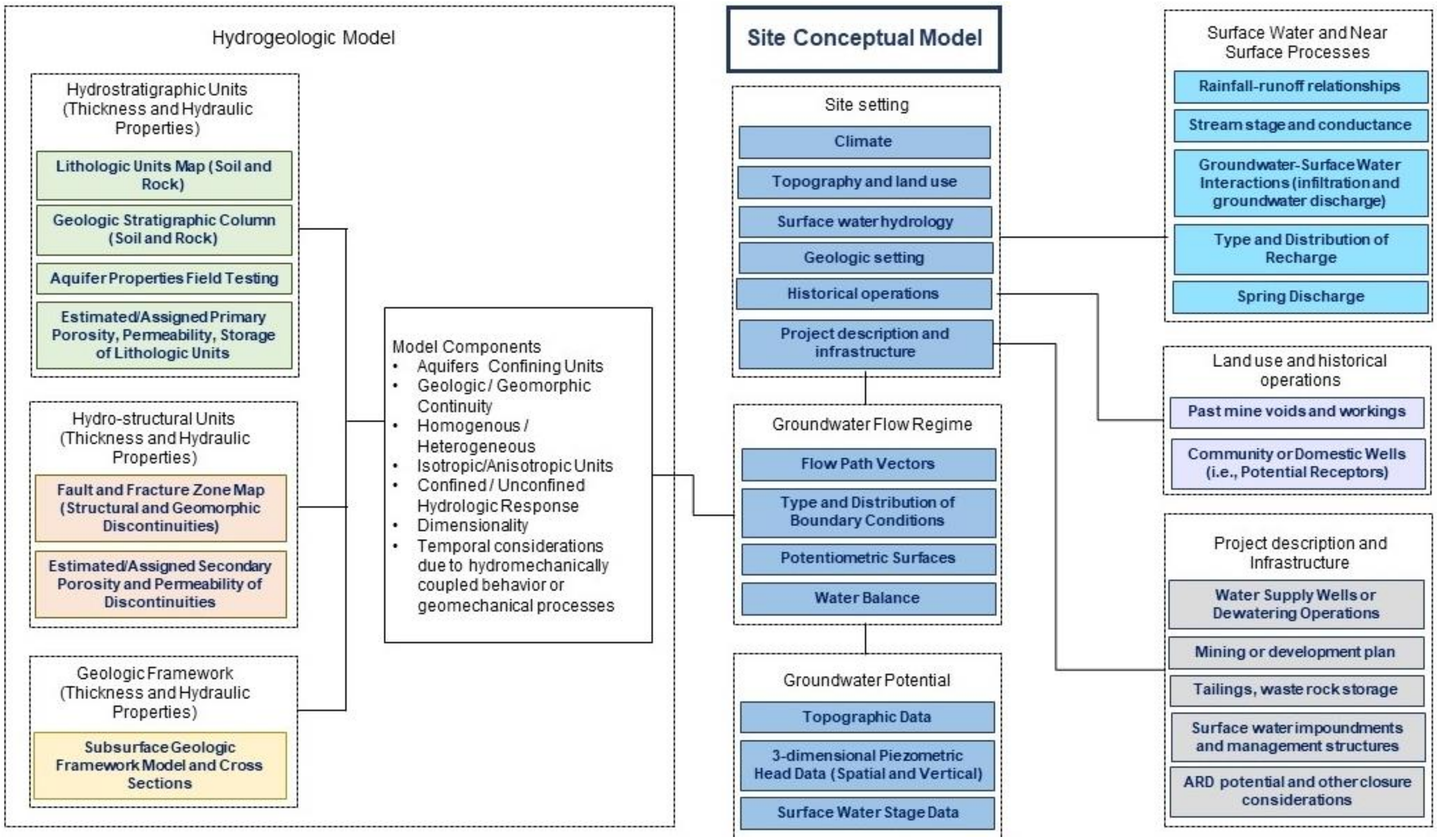
A hydrogeologic conceptual site model (CSM) is a simplified representation of a complex natural hydrogeological system. It consists of a series of hypotheses, supported by data, describing the current understanding of the groundwater flow system(s) underlying a site. It starts with a description of the geographic, geologic, and hydrologic framework governing the occurrence and flow of groundwater within and through a basin. It includes information on hydrostratigraphic units, aquifer properties and boundaries, recharge and discharge, groundwater levels, gradients and flow directions, and other salient features of the groundwater system.

Although a CSM must be supported by available data, there is always uncertainty in conceptual understanding of groundwater systems, and CSMs should be updated as additional data and information become available.

Ideally, a complete CSM for a mine development project contains all the elements shown in Figure 1-1, although for many sites some of this information is unavailable or unknown. Water chemistry and hydrochemistry may also be important components of the CSM, especially where there is potential for generation of acid mine drainage / acid rock drainage (AMD / ARD) or other water quality impacts.

The current document will cover the key elements of a CSM as shown in Figure 1-1. To date, FloSolutions has primarily been working on the conceptual and numerical hydrogeologic model (left side of this figure). Additional site information of other CSM elements – such as historical land use, planned site operations, surface water balance, etc. – have been made available by OGNZL and their consultants including GHD, Valenza and GWS.

Figure 1-1: Elements of a conceptual site model (FloSolutions).



1.4 Data sources

The complete list of data and information used to develop the CSM are contained in Appendix A - Data and Information Sources.

The main studies and reports used to develop the overall understanding of project conditions, characteristics, and the CSM are summarized below.

- (OceanaGold, 2020) - *Waihi District Study* - Preliminary Economic Assessment - NI 43-101 Technical Report.
- (Miskell, 2022)- Terrestrial Ecology Values and Effects of the WUG
- (Daysh, 2022) - *Wharekirauponga underground mine groundwater conditions.*
- (GWS, 2021)- Assessment of Groundwater Effects - Tunnel Elements.
- (GWS, 2022)- *Assessment of Effects on Groundwater*
- (GWS, 2022) - *Dewatering Effects* (Technical Presentation)
- (FloSolutions, 2022) - *EG-Vein* - Updated Conceptual Model
- (FloSolutions, 2022) - Analytical Modeling - *Assessment for potential stream capture* - Technical Memo
- (FloSolutions, 2022) - *Data Gaps and Field Program Recommendations* - WUG Conceptual Model - Technical Memo
- (FloSolutions, 2022) - *Pumping Test Planning* - Technical Memo
- (FloSolutions, 2022) - *Shallow Piezometer Replacement* - Technical Memo
- (FloSolutions, 2022) - *Clay Alteration Review and Rhyolite Volcaniclastics differentiation*
- (Valenza, 2022) - *Wharekirauponga Conceptual Mitigation* Phase 1 Report
- (Valenza, Wharekirauponga Underground Project - Baseline Data Acquisition and Mitigation Measure Strategy, 2022-B)- OGNZL - Wharekirauponga Underground Project (WUG)- *Baseline Data Acquisition and Mitigation Measure Strategy.*
- (WSP, 2022) - *Geotechnical Assessment Underground Mine and Tunnels*

2. SITE SETTING

2.1 Site location

The WUG project is located in the Coromandel peninsula in northeastern New Zealand, approximately 10 km north of the township of Waihi and 6 km west of Whiritoa. The Wharekirauponga orebody lies beneath the Coromandel Forest Park in the land managed by the Department of Conservation (DOC). It is near to the closed, historic mine of Golden Cross (4.5 Km SW to the Wharekirauponga deposit). Figure 2-1shows the Wharekirauponga deposit location and nearby towns.

2.2 Topography and land use

The proposed WUG project is in the Wharekirauponga Valley, characterized by higher elevations in the southwest – around 600 meters above mean sea level (mamsl) – that gradually decrease towards the northeast. The topography forms a catchment aligned in the SW-NE direction, following the course of the Wharekirauponga River.

The project's main area of interest, where mineralized veins are found, is situated in the central part of the catchment. This region spans approximately 1 km^2 and has elevations ranging from 260 to 110 mamsl. The slope gradients vary, with steep slopes in the SW and NW portions and flatter regions in the NE, averaging around 22 degrees with some slopes reaching up to 60 degrees (Figure 2-2).

Historically, indigenous forest covered most of the New Zealand islands, including the project location, before the arrival of the Maori populations from eastern Polynesia around 1300 CE. Forested areas were reduced and cleared by fire to support the growing Maori village sites, farms, and along routes of travel (Newsome, 1987). In 1840, Europeans arrived and began clearing forest and harvesting kauri (in the north), totara, rimu and matai, timber that was used in both domestic and foreign markets (Newsome, 1987). Since the mid-1920s, the Forest Service planted exotic pine forests in large scales, but the lowland forest and scrubs were cleared for an agricultural purpose during the 1950s (Newsome, 1987). Figure 2-3 shows the land use modification over the years.

Currently, the project area is covered by indigenous forest of matai, rimu and matai trees (Environment Waikato , 2010). Although, there are small surfaces of exotic forest and bigger areas of exotic scrubs (LAWA, 2023).

Figure 2-1 Location of the WUG project

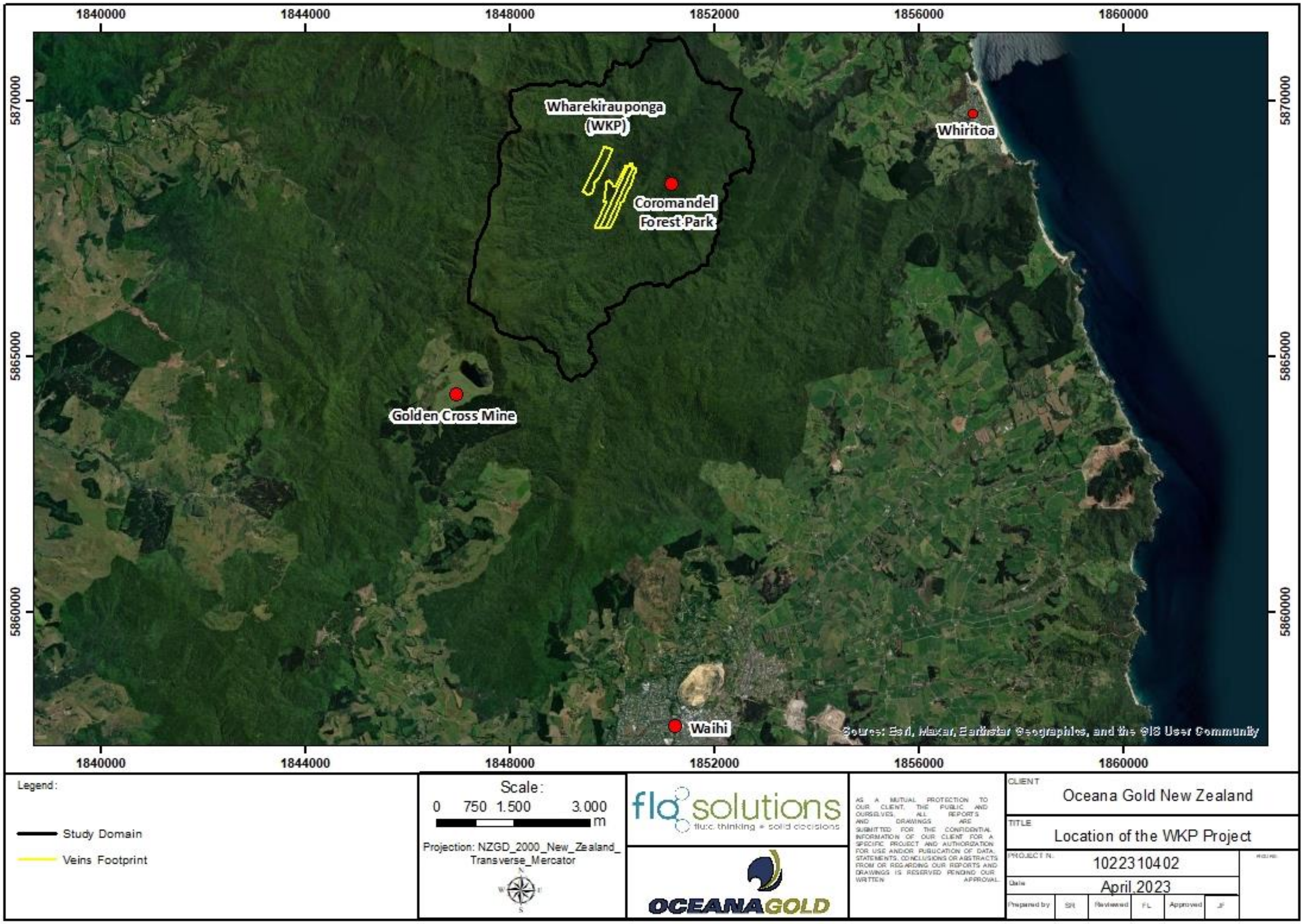


Figure 2-2: Topographical and slope gradients maps

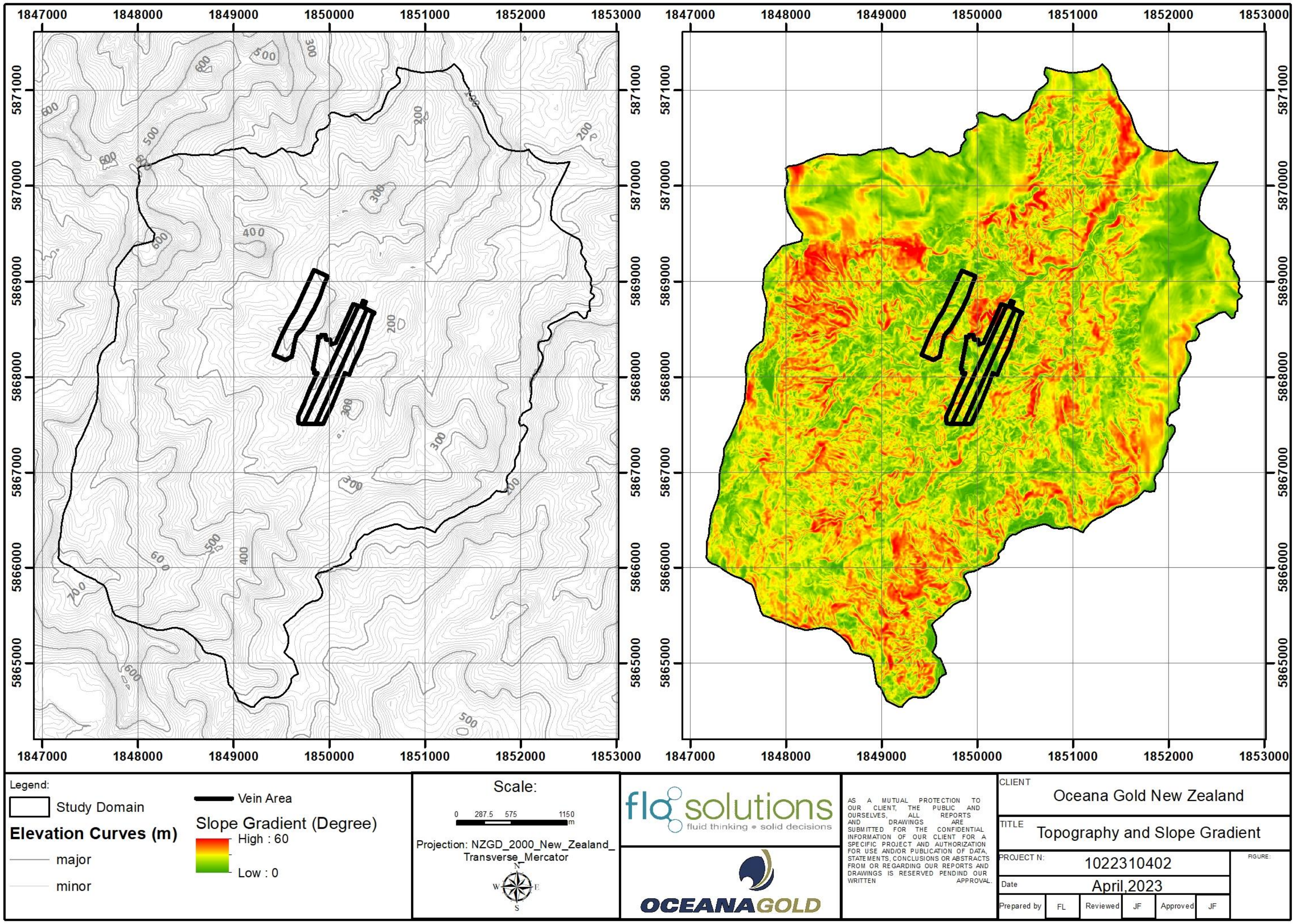


Figure 2-3: Land cover change in New Zealand over the time. (Week, Overton, & Walker, 2012)

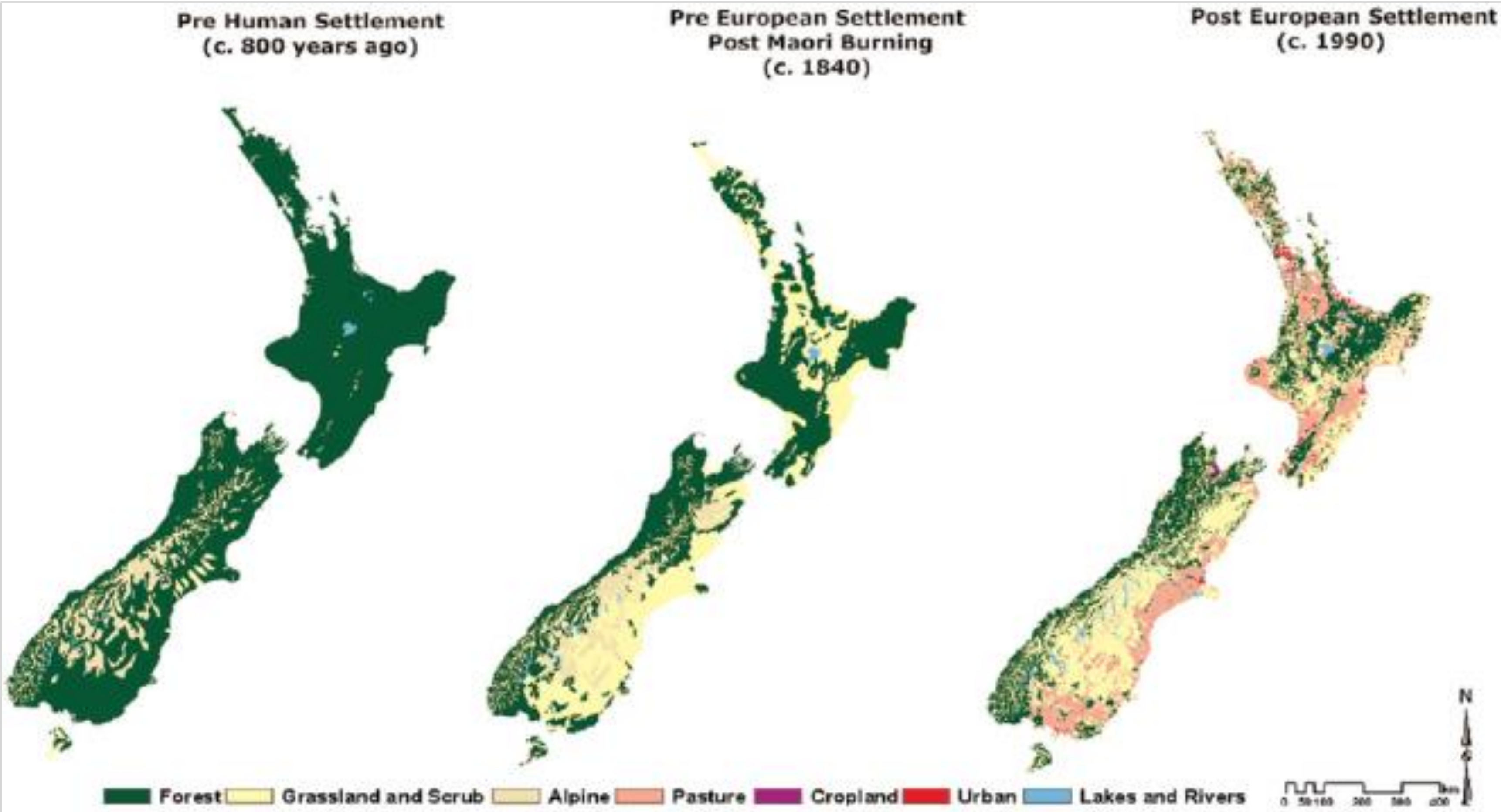
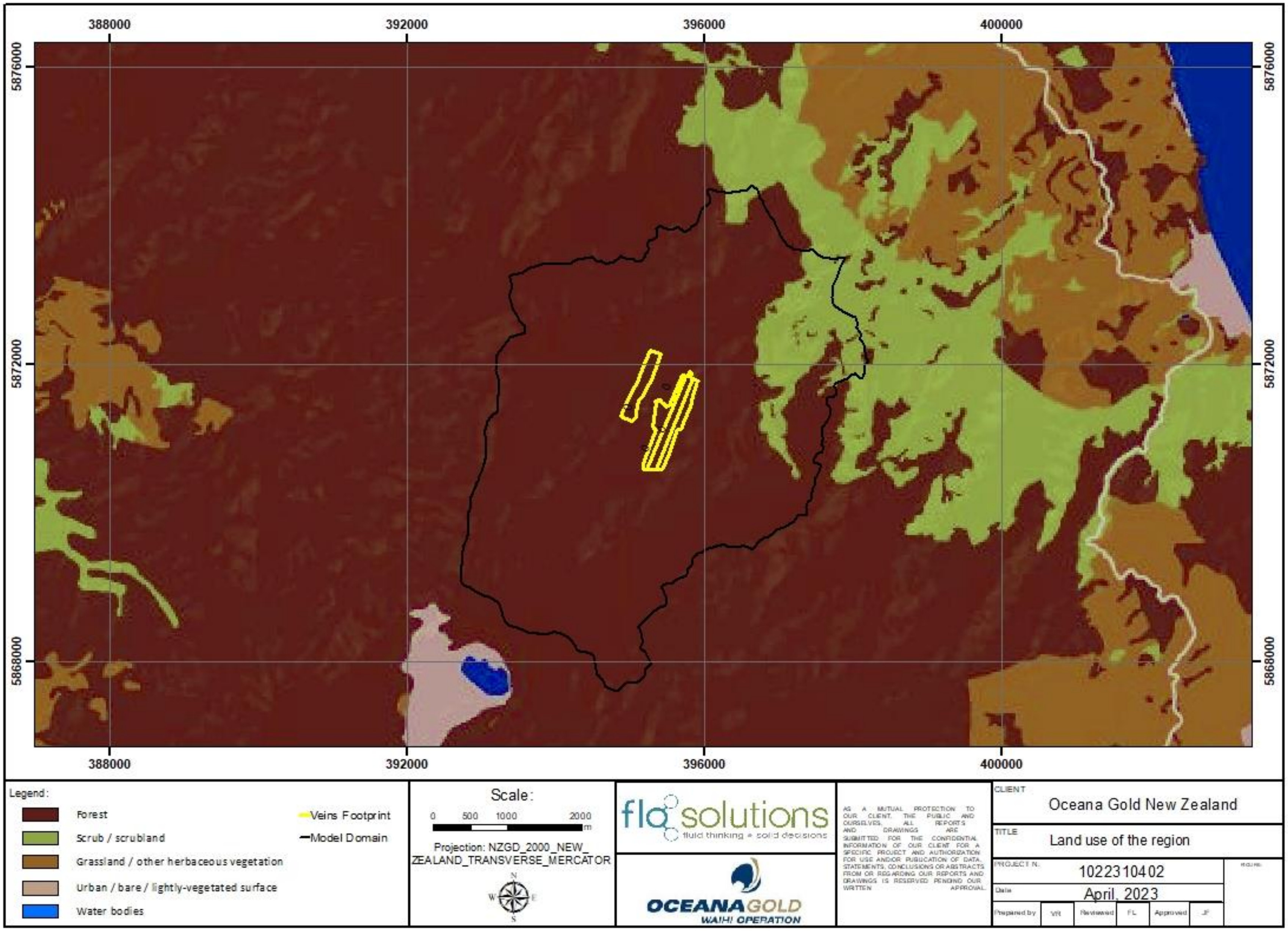


Figure 2-4: Land use of the region (LAWA,2023) – Image captured from https://www.lawa.org.nz.



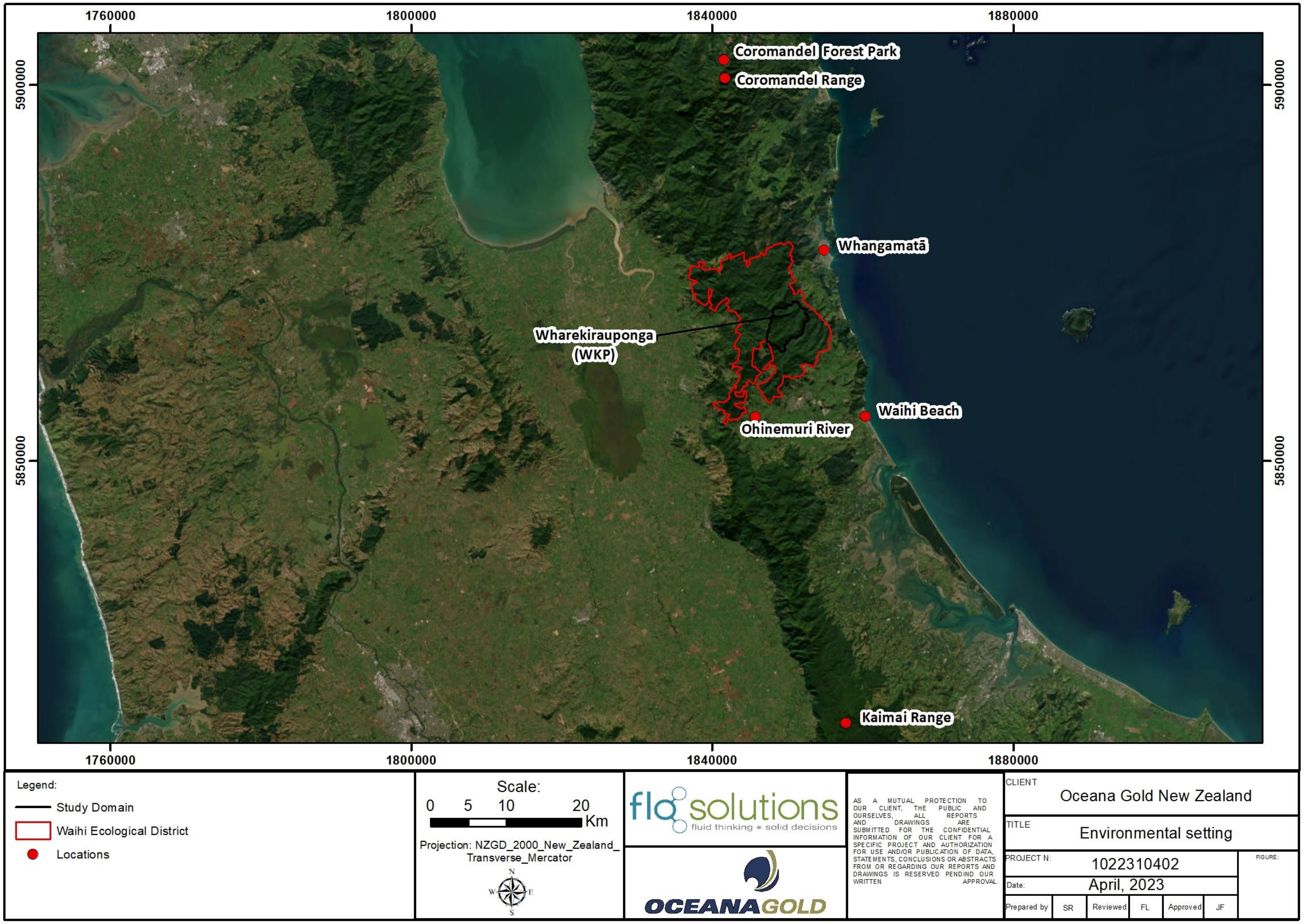
2.3 Environmental setting

The WUG project is part of the Coromandel Forest Park and includes the Waihi Ecological District, an area of approximately 43,700 ha located at the southern end of the Coromandel Range and northern end of the Kaimai Range (Figure 2-5), with the Ohinemuri River catchment between and includes the east coast between Whangamatā and Waihi Beach (Environment Waikato , 2010).

In the WUG project area, most of the lowland alluvial podocarp forest is gone, but the Waitekauri Valley still contains small but relatively intact examples of kahikatea and rimu/matai/miro/totara forests (Environment Waikato , 2010).

Among the species that live in the area, it is important to mention the Hochstetter's frog occurs at the southern end of the Coromandel Range, east of Paeroa, also, Archey's frog is found at higher altitudes within the Coromandel Range and less commonly at mid altitudes. Further details are contained in (OceanaGold, 2022)

Figure 2-5 Waihi Ecological District Location



2.4 Climate and rainfall

The north region of New Zealand is characterized by a sub-tropical climate with rainy and warm summers and gentle winters with higher precipitation. The maximum air temperatures vary from 22°C to 26°C but can reach up to 30°C during summer. Minimum air temperatures can fall to 6°C or less during winter (NIWA, 2023).

Annual average precipitation (AAP) in the project area usually exceeds 2000 mm. In a very rainy year, the annual precipitation may be as much above 3000mm (at Waitekauri River Station), significantly higher than the AAP. Winter is the rainiest season, with peak rainfall in June and July. During the rainy season maximum precipitation rates can reach up to 480mm per month. The driest season is usually distributed between the months of January and February with rainfall rates ranging around 50mm/month.

The Table 2-1 below summarizes the averages rainfall calculated by the Waitekauri River Station (WRS) (https://waikatoregion.govt.nz/), Waihi rainfall data compiled by GHD (GHD, 2023) and the derived Wharekirauponga rainfall from the GHD hydrological model report (GHD, 2023), from 2019 to 2022.

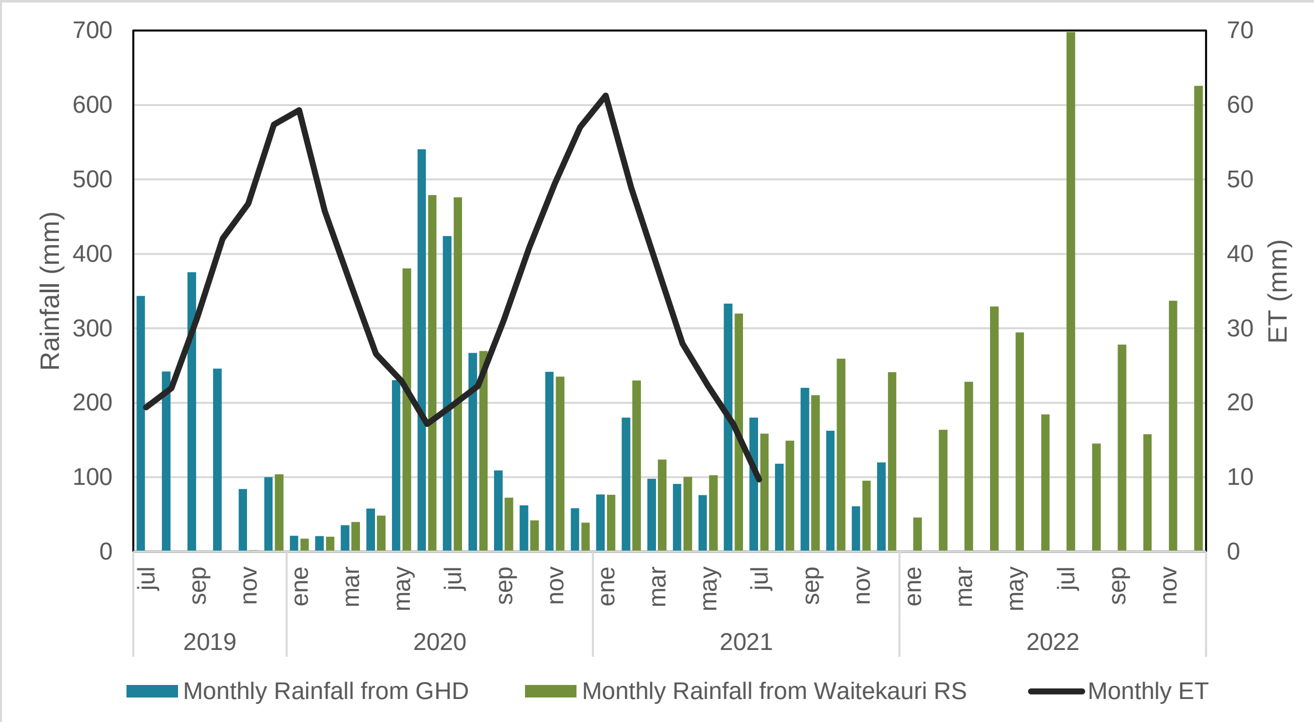
Table 2-1: Average monthly rainfall data from WRS and GHD, between 2019 and 2022.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (mm)
Waitekauri River Station	46.7	137.8	130.5	159.5	259.2	327.8	444.2	187.8	186.8	152.8	222.5	301.8	2557.4
Waihi	151.7	174.2	85.6	96.1	115.5	242.4	326.1	156.2	191.1	169.3	140.9	164.0	2012.9
Wharekirauponga	224.2	294.5	63.8	121.7	166.9	293.8	359.4	217.0	231.7	159.2	162.8	79.3	2374.0

It's important to emphasize that the rainfall records from January and February of 2023 were substantially higher when compared to the average for these same months. These outliers have increased the averages from 46.3 mm to 151.7 mm in January and 97.8 mm to 174.2 mm in February – for the Waihi dataset. For the Wharekirauponga dataset, the increments were: 59.3 mm to 224.2 mm in January and 136.5 mm to 294.5 mm in February.

A comparison of rainfall distribution and evapotranspiration is summarized in Figure 2-6 (note different scales). Evapotranspiration is highest during the summer months (January/February) and lower during winter (June). Values vary from 60mm/month (January) to 17mm/month (June). Annual average evapotranspiration can range around 400 mm/yr. The average evapotranspiration is usually lower than the average rainfall in any month, except during the driest months.

Figure 2-6: Rainfall distribution compared to evapotranspiration.



2.5 Surface water hydrology

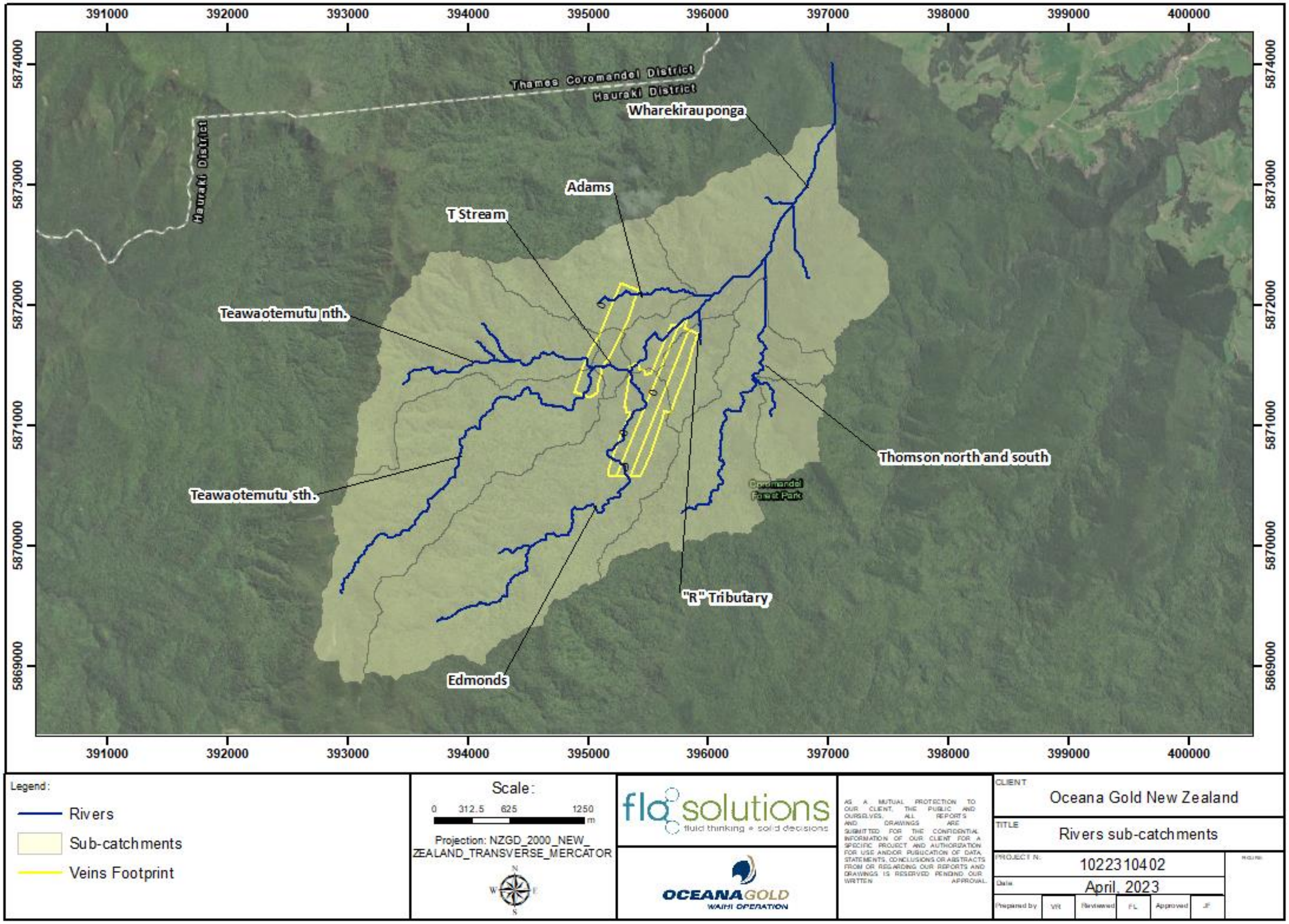
2.5.1 General information

The area of interest is in the catchment of the Wharekirauponga Stream (Wharekirauponga Stream). The catchment covers an area of 14.5 km^2 according to GWS report (GWS, 2022).

The Wharekirauponga Stream is fed by several tributaries distributed throughout the higher portions of the catchment (Figure 2-7). The largest and most important is the Teawaotemutu Stream or “T Stream”, followed by the Edmonds Stream, Thomson Stream, and smaller tributaries like Adams Stream. The Wharekirauponga stream flows downstream in a NE direction and is a significant tributary of the Otahu River (which flows to the sea).

The catchment is currently monitored by a series of regular flow gauges, some of them automated with pressure transducers. GHD (GHD, 2023) has developed a catchment-scale water balance based on continuous flow monitoring to assess baseline flow conditions in support of ecological assessments. Predicted mean annual low flow (MALF) was modeled statistically for 7 subcatchments, ranging from 14 L/S in the Thompson stream to more than 100 L/s in WKP01 (GHD, 2023).

Figure 2-7: Wharekirauponga catchment and main tributaries

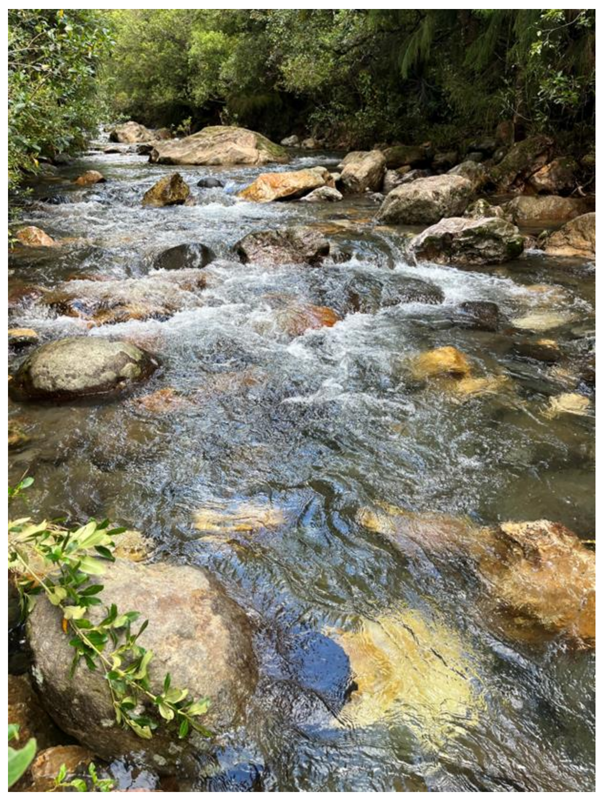


2.5.2 Springs

A warm spring is present at a discrete location on the Wharekirauponga stream bank. Although the spring discharge is evident at a discrete location, a large section of stream appears to be receiving diffuse discharge, suggesting a broader discharge zone (Figure 2-8).

(GWS, 2022) interprets Warm Spring formation as due to fluids upwelling from the greywacke basement rocks through the main Edmonds Fault mixed with shallower groundwaters. The spring is generally in the order of 20°C and as such is not deemed as being geothermal nor is it related to a geothermal source. The spring expected to be hydraulically connected to the EG main vein system during mine dewatering it will cease to discharge into the stream for the duration of mining (GWS, 2022). Ongoing ecological work indicates there are no biota of ecological significance in the warm spring. In terms of the total flow of the catchment, due to small volumes identified in that specific spring, the overall catchment flow should not be affected substantially if this water source ceases (GWS, 2022).

Figure 2-8: The 'Warm Spring'. Left – point discharge on eastern bank of Wharekirauponga Stream. Right – diffuse discharge in Wharekirauponga Stream. (Source: FloSolutions)



2.6 Historical operations

The area around Waihi has been explored for gold and minerals since 1879. The location of historic mining operations is shown in Figure 2-9.

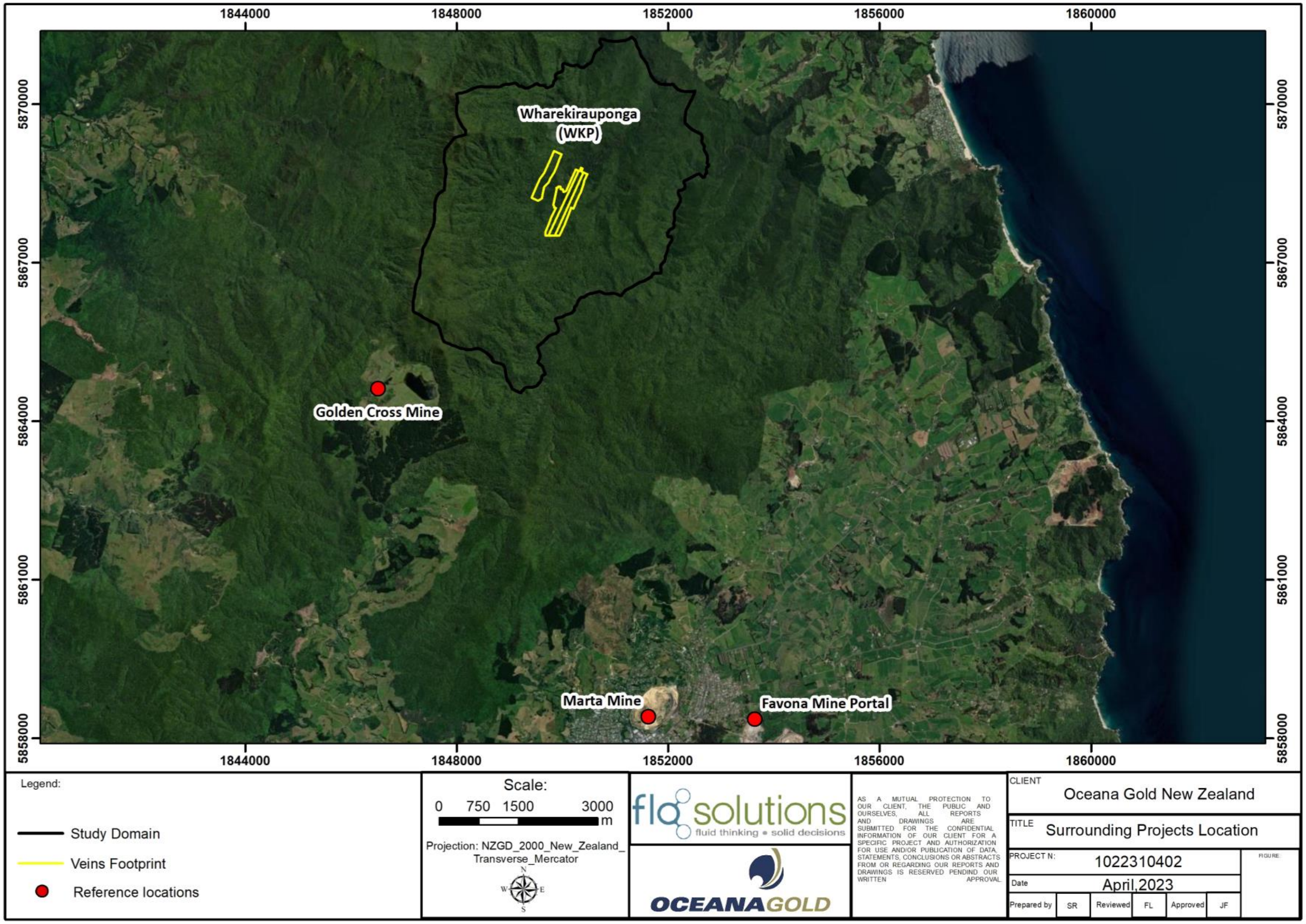
2.6.1 Local mines

The underground Martha Mine included seven vertical shafts; the deepest was 600 meters from the surface. Radiating from the shafts was a network of 175 kilometers of tunnels on 15 horizontal levels. In 1952 the mine was closed. During its operational years, the Martha Mine produced 174,160.00 kg (5.6 million oz) of gold and 1,193,180.00 kg (38.4 million oz) of silver from 11,932,000.00 tons of ore. The gold price rise in the late 1970s led to renewed and interest in the Martha Mine. A mining license was granted to develop the Martha Open Pit Mine in 1987.

The Favona Mining Permit 41808 was granted in March 2004, with a 25-year duration, to mine the Favona ore body located about 2 km east of the Martha ore body. Underground mining resumed in Waihi in 2004 with the development of the Favona decline and subsequent mining of the Favona, Moonlight, Trio, Daybreak, and Correnso ore bodies.

Modern exploration for gold began at Wharekirauponga in 1978, with several mining companies completing geological mapping, surface rock, soil and stream sediment geochemical surveys, aeromagnetic and resistivity surveys and 5,505m of exploration drilling during the 1980s and 1990s. From 2009-2013, Newmont (the former owner of the Waihi Gold Mine) continued exploration in joint venture with Glass Earth. This included additional geological mapping, surface geochemical and resistivity surveys and a further 7,607m of exploration drilling. OceanaGold purchased the Newmont/Glass Earth interest at Wharekirauponga in 2016, incorporating it into its Waihi operations and ongoing exploration program in the Hauraki region.

Figure 2-9: Martha Company / Golden Cross Mine and Favona Mine Portal



2.6.2 Historical mine dewatering and effects

Mining of the Martha ore bodies began in 1878 with a series of open cut operations at the higher location of Martha Hill, where gold could be extracted above the groundwater level. A groundwater withdrawal well was activated once the water table was reached and advanced at a moderately steady rate of about 18 m/year. These depths were problematic because of limitations in pumping technology, and groundwater inflows impeded access to reserves at increasing depth (OceanaGold, 2021).

Histories of pumped water volumes were kept after 1900, and the average daily inflows relative to shaft depth are shown in Figure 2-10. As shaft depths increased, periods of high initial groundwater inflows were experienced exceeding 9000 m^3/d. Records state that the water levels in the mine and shafts from 950 to 730 m RL were pulled down after several months of pumping at a rate of 13,000 m^3/d, which eventually reduced inflows to between 4,900 to 6,500 m^3/d. Peak inflows were noted to occur closely after accessing the veins at the 780 m RL, when peak inflows were first estimated to be 26,000 m^3/d when first cut (OceanaGold, 2021).

In the 1920's and 1930's the mine was expanded along strike from 650 to 557 m RL and groundwater inflows steadied to 4,200 m3/d, a rate considered “normal” for the Martha Mine (OceanaGold, 2021). Water levels were reduced from 730 to 550 m RL.

Historical mining activities resulted in a series of shafts being sunk and drives excavated along the veins at various levels to enable stoping, increasing interconnection. The opening of old workings after extraction is fairly well documented, as shown in Figure 2-11 which shows void volume in 10 m increments; although consolidation and adjustment of rock mass in the stoped areas is likely to have reduced void space (OceanaGold, 2021).

After the closure of the historical mines, the old workings were collapsed locally and allowed to fill with water, forming the depression of what became the Martha Lake. The water level in the lake recovered to an elevation of approximately 1110 m RL which reflected the groundwater level in the interconnected vein system.

The ore bodies of the Martha area are hosted by andesites of relatively low permeability. Groundwater levels in the andesite rocks are influenced by current mine dewatering. Groundwater levels and directions are controlled by the presence and interconnections (where they occur) of the workings, vein systems and post mineralization structures (faults and fracture zones). Mine dewatering is limited by faults that act as hydraulic barriers to the north and west (OceanaGold, 2021).

Figure 2-10: Historical Martha annualized average pumping rates and levels (Source: OceanaGold 2021, after GWS).

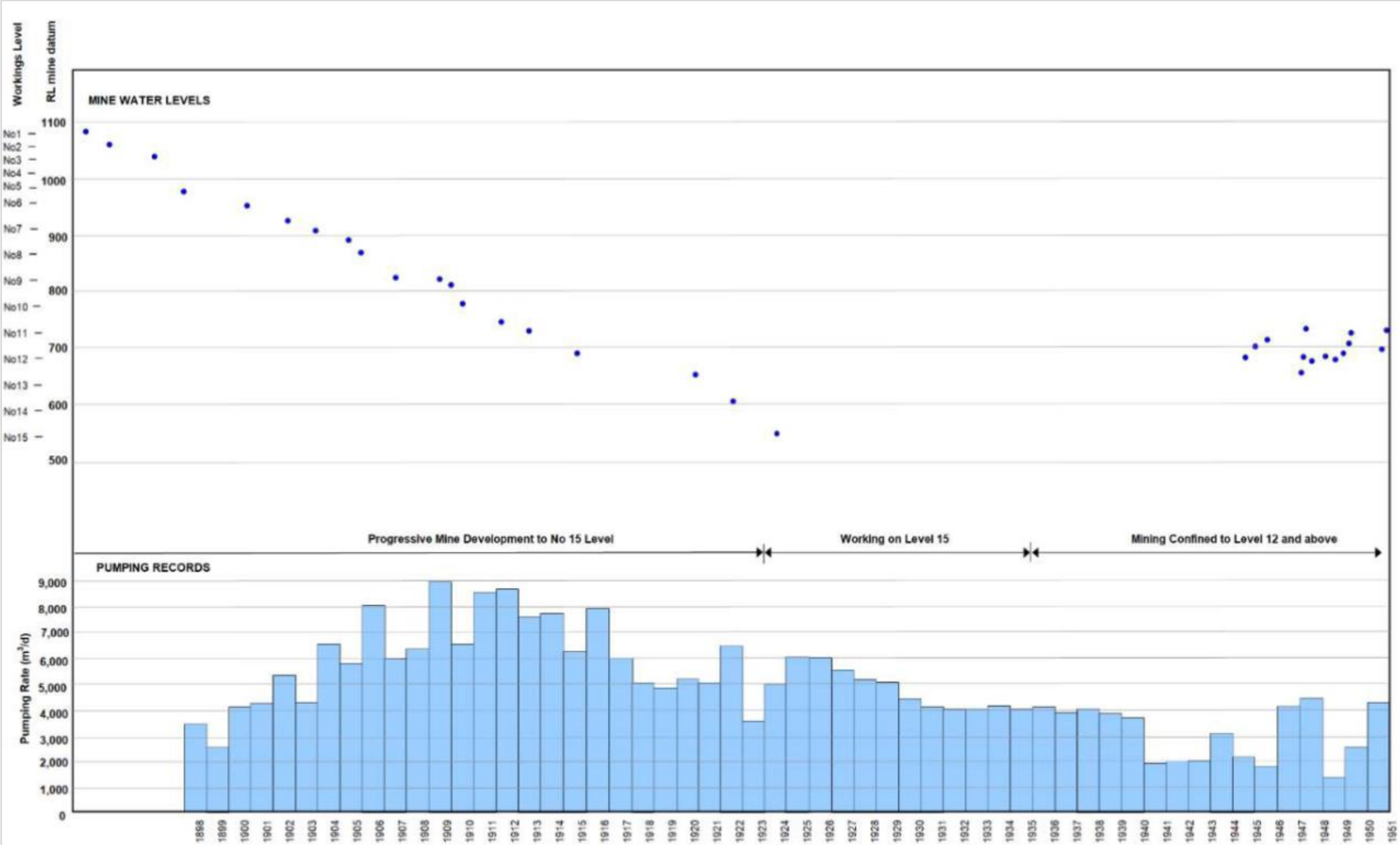
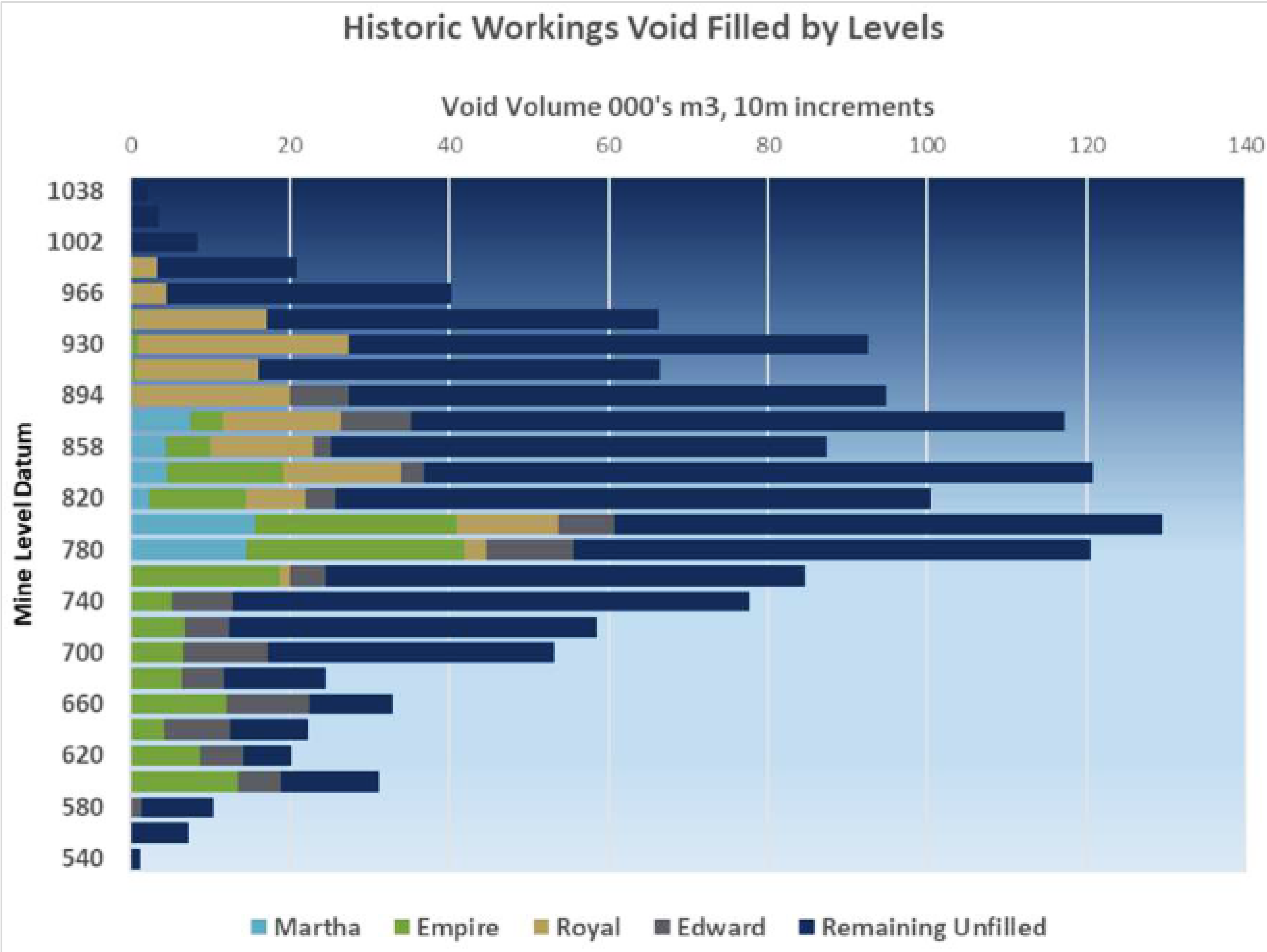


Figure 2-11: Historical workings void filled by levels (Source: OceanaGold, 2021, after GWS)



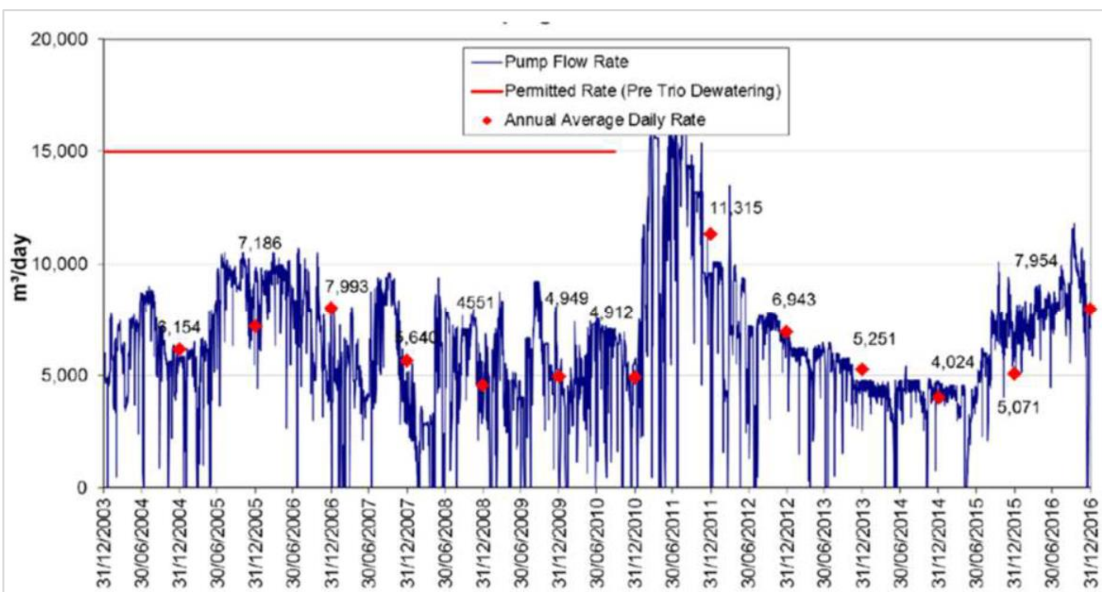
2.6.3 Recent mine dewatering

The original Martha mine was closed in 1952 and since its reactivation as a mine in 1989, dewatering was required initially in the Martha Lake and then increasingly in the mine workings as excavation progressed. to the hydraulics of the area the other vein systems.

More recent mine dewatering records (2003-2016) in Martha and Correnso operations are include in Figure 2-12.

- From 2003 and 2008 high initial pumping capacities were > 7,000 m³/d, demonstrating as the mine deepened and the water table dropped rapidly.
- In 2008 to 2010, a constant drainage capacity of between 4,000 to 5,000 m³/d was achieved, corresponding to the historical groundwater inflows.
- From 2010-2011, underground mining at Trio began and due to the combination with other veins system and the rate of mine development the pumping capacity increased to over 15,000 m³/d while the water table was drastically lowered.
- Between 2011 to 2015 these volumes decreased until the pumping capacity stabilized at 4,000 and 5,000 m³/d.
- 2015-2016, a gradual increase in pumped volumes is observed which is interpreted as due to rapid construction work and development at lower elevations, leading to greater water release and lowering the water level by 795 m RL.

Figure 2-12 Pumping rates for the Martha and Correnso from 2003 to 2016 (GWS, Martha groundwater effects assessment, 2021).



2.6.4 Dewatering summary

Stabilized groundwater inflow rates of 4,000-5,000 m^3/day are considered typical of historical and modern workings, although peak inflow rates can be significantly higher when new veins are encountered, and new mining levels are developed.

The groundwater response to dewatering at the Martha Pit and the underground mines has been observed at a network of piezometers located around the Waihi area. It has been shown, over time, that the vein systems of the Martha ore bodies (Martha, Empire, Royal, Trio and Correnso) are all highly interconnected and are separated from the Waihi East ore bodies (Favona, Moonlight).

To date, groundwater monitoring has shown that the pressure variation in the vein systems due to pumping has had little effect on groundwater levels in the overlying younger volcanic rocks during mine dewatering (OceanaGold, 2021). Drawdown effects propagate preferentially within and along the vein systems due to their higher permeability relative to the low permeability andesite host rocks.

2.7 Geology

A geologic model for the Coromandel Peninsula illustrating major geologic groups is included as Figure 2-13, taken from (Zakharovskyi & Nemeth, 2022).

2.7.1 Regional geology

The Coromandel Volcanic Zone (CVZ) is an extinct volcanic arc within the Coromandel Peninsula of the North Island, New Zealand. The associated volcanic and volcaniclastic sedimentary units record a history of andesitic and rhyolitic eruptions, which persisted throughout the Miocene to Pliocene (18 to 4 Ma; (Skinner, 1986). The distribution of these rocks is shown in Figure 2-14. Subsequent epithermal gold-silver deposits were developed within the region between 16 to 2 Ma forming the Hauraki goldfield (Mauk, Hall, Chesley, & Barra, 2011).

The region is underlain by basement rocks comprising Mesozoic sedimentary units known as the Manaia Hill Group (Skinner, 1986). These units consist of monotonous greywacke-argillite sequences, which are structurally complex and grade into the polyphase Haast Schist, ranging up to amphibolite facies. The basement rocks in this area formed as a result of plate convergence and subduction, resulting in a series of Permian-Early Cretaceous forearc basins, trench-slope basins, and accretionary complexes along the Gondwana margin (Mortimer, 2004). The basement rocks are unconformably overlain by volcanic and intrusive rocks of the Coromandel Group and volcanic flows and pyroclastics of the Whitianga Group. The Whitianga Group Rhyolite flows and related volcaniclastic rocks are commonly associated with calderas (Malengreau, Skinner, Bromley, & Black, 2000).

2.7.2 Structural setting

The CVZ is cut by regional to local scale faults that are partly inferred to be inherited from structures within the Mesozoic metasedimentary basement (Skinner, 1986). Within the CVZ, major faults and lineaments are oriented NNE-SSW to NNW-SSE and ENE-WSW. Three structural corridors, which correspond to regions of low magnetic intensity and intense hydrothermal alteration, extend across the CVZ: Tapu-Whitianga Fault Zone, Tairua-Hikuai-Hihi-Kaueranga lineament, and the Karangahake-Ohui structural trend (KOST) (Zuquim, 2013) (Figure 2-15). The WUG project is located in the KOST structural trend.

The KOST contains several significant historical deposits of the Hauraki Goldfield (Karangahake, Golden Cross, Komata), as well as areas of continued exploration interest (Onemana, Wharekirauponga). The KOST trend comprises two segments, NE KOST and SW KOST, that are defined by host-rock lithology (rhyolite versus andesite, respectively), and by the orientation of veins and controlling faults.

In the SW segment of the KOST, mineralized faults of the Tui mine, Karangahake-Rahu and Lower Waitekauri strike N-to-NNE and show oblique (normal/right lateral) displacement NE-striking extension veins (Figure 2-16). At Golden Cross the main reef strikes NE and formed as an extensional shear within a normal fault system. According to (Zuquim, 2013), all other orientations of faults will likely reactivate as oblique slip structures, and the N-to-NNE striking faults would have an oblique normal/right-lateral displacement.

Figure 2-13: Geologic model of the Coromandel Peninsula. Modified from: (Zakharovskyi & Nemeth, 2022).

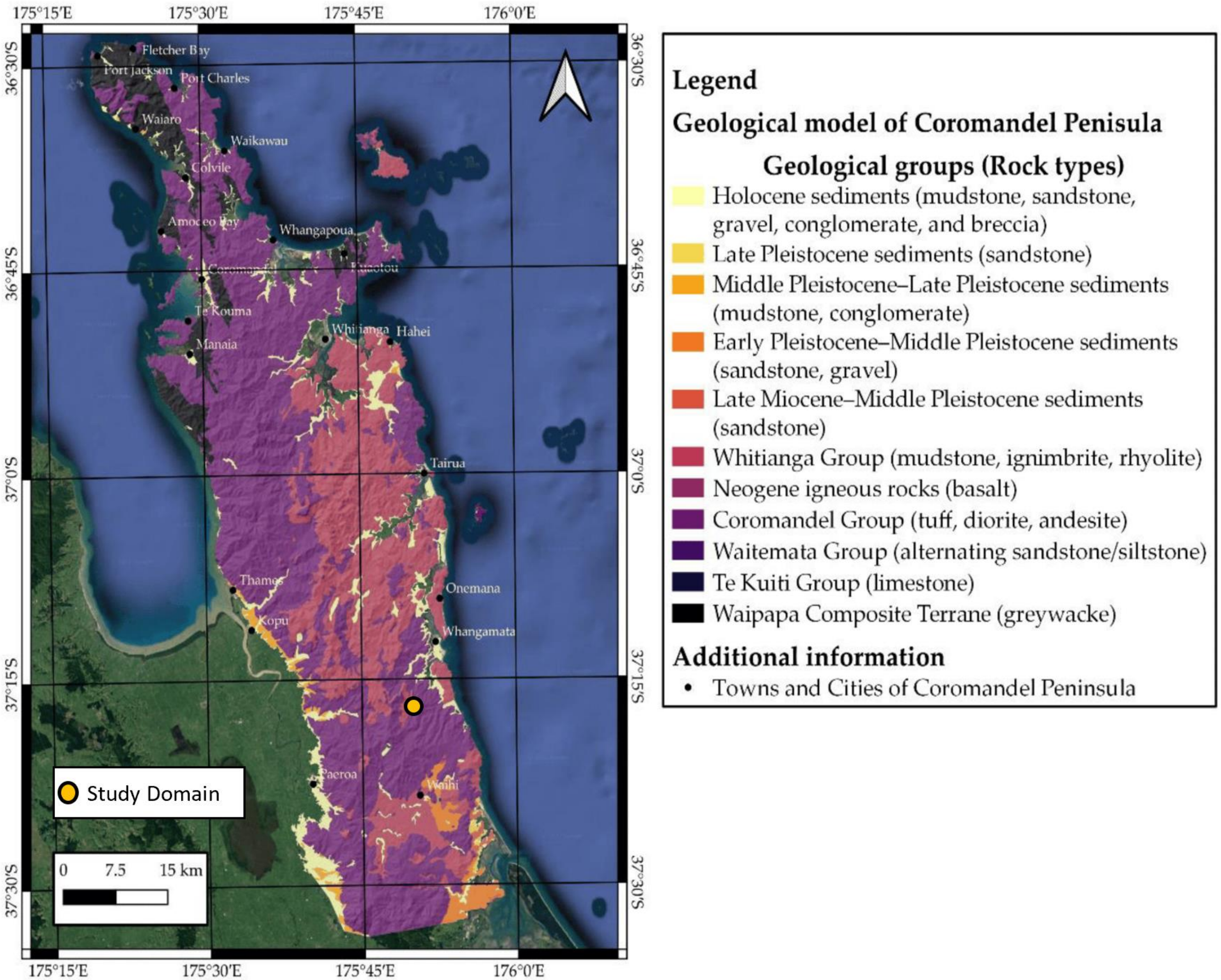


Figure 2-14: Distribution of volcanics in the CVZ. Modified from: (Barker, Hood, Hughes, & Richards, 2019).

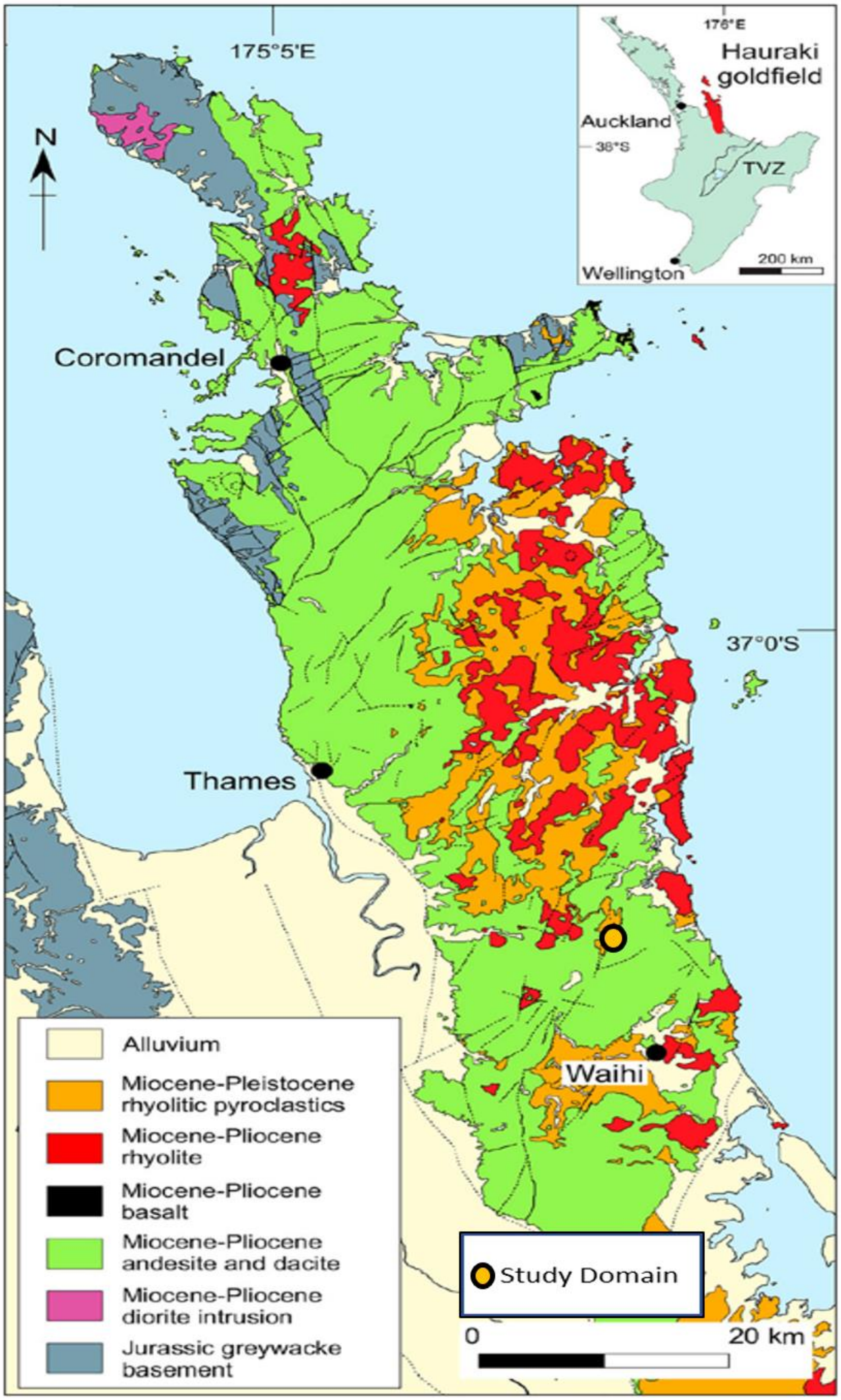
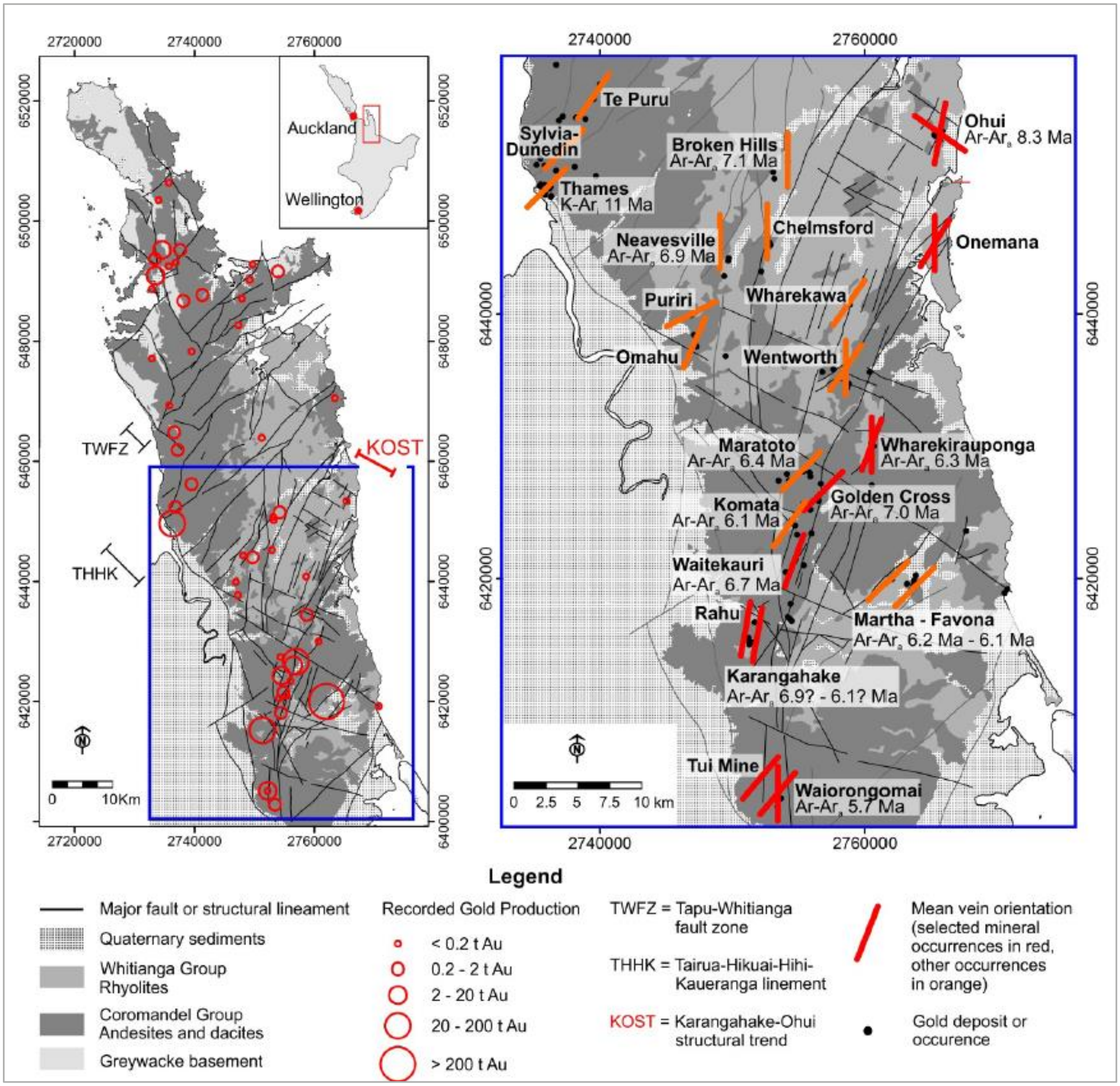
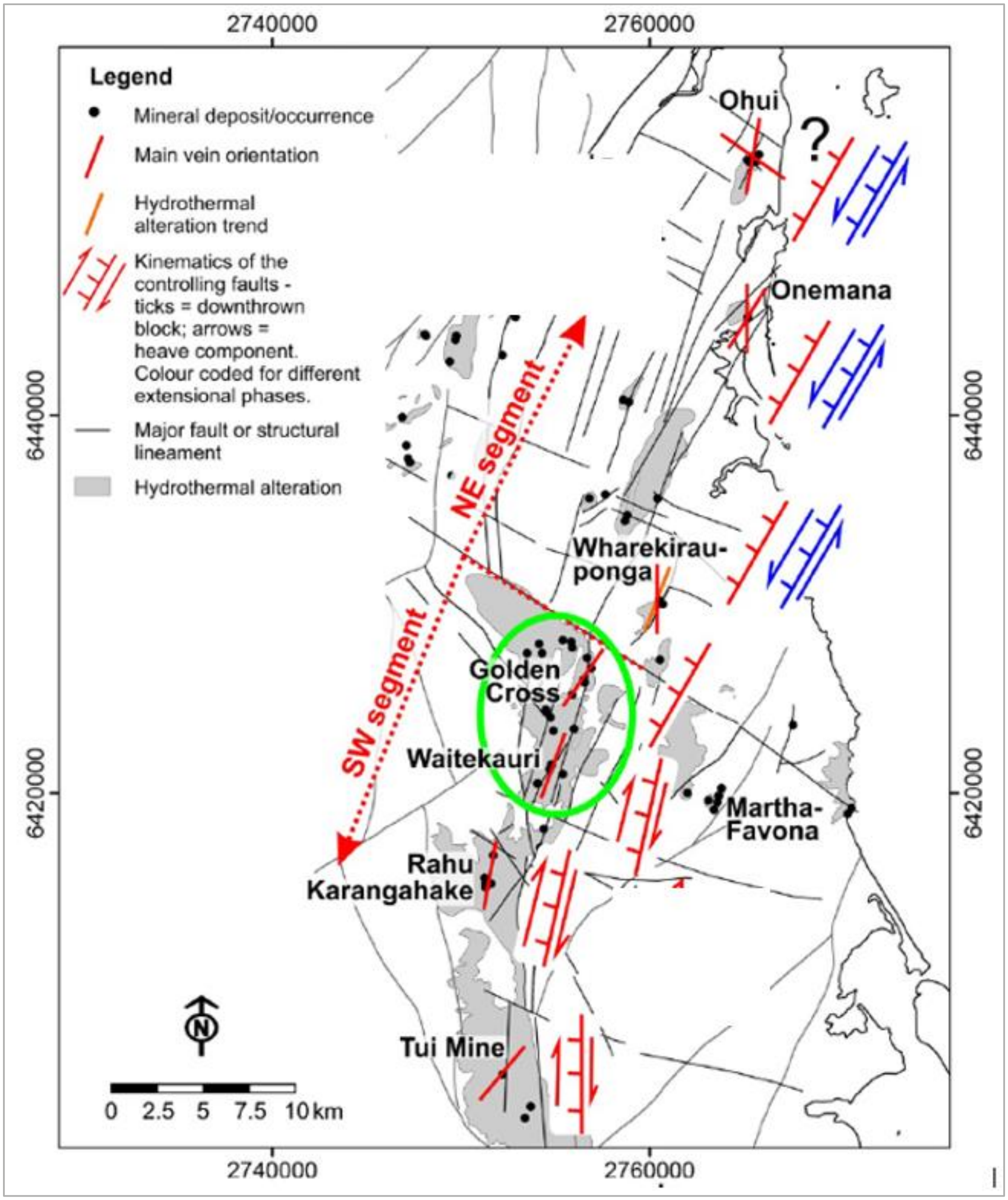


Figure 2-15: Left- Localization of the CVZ structural trend and other regional structural corridors / Right - Mean orientation and age of the veins of the KOST and adjacent mineral occurrences. From (Zuquim, 2013).



In the NE KOST, extensional veins at Wharekirauponga strike NNE and are subvertical (pre-tilting) and have the same orientation as some of the hydrothermal breccia zones at Onemana (Figure 2-16). Controlling faults of both areas strike NNE to NE and are predominantly normal dip-slip with a minor strike-slip component. At Wharekirauponga, limited kinematic indicators indicate left-lateral displacement on the more easterly striking structures, and tectonic comminution of mineralized vein breccias (Zuquim, 2013), which suggests that the controlling faults were initially dilatational but reactivated in shear during the activity of the epithermal system.

Figure 2-16: KOST Kinematics model. Green ellipse = cluster of mineral occurrences where the controlling faults deflect from N-S to NE trend and splits into several branches. Modified from (Zuquim, 2013).



2.7.3 Mineralization at Waihi

The Waihi Mine and WUG project are in an area known for hosting over fifty gold and silver deposits within the Hauraki Goldfield. The Coromandel Volcanic Zone (CVZ) extends across the peninsula and contains various types of deposits, including low- to medium-sulphidation epithermal gold-silver (Au-Ag) and copper porphyry (Cu) deposits (OceanaGold, 2021).

The Waihi District and Wharekirauponga are classical low-sulphidation adularia-sericite epithermal quartz vein systems, closely associated with north to northeast trending faults. The primary ore minerals in these systems are electrum (a gold-silver alloy) and silver sulphides, typically found within quartz veins (OceanaGold, 2021). Pyrite is commonly present in these veins, along with localized minerals such as adularia, calcite, illite, smectite, sphalerite, galena, chalcopyrite, and rhodochrosite. Although base metal sulphide content is generally low, it tends to increase with depth.

Although both areas have the same geological and structural configuration, there are certain differences in the distribution of the deposits. Most of deposits in the southern part of the Hauraki district, including the Waihi district, are hosted by andesite flows of the Waipupu Formation which are interlayered with volcaniclastic and tuffaceous intervals. Wharekirauponga, however, is different in that it is hosted by an extensive area of flow banded rhyolite and felsic lithic tuff, as discussed in more detail in section 2.7.5 .

In the Waihi District all known Au and Ag mineralization in is confined to veining or vein fragment within hydrothermal eruption breccia. The major mineralized veins are typically coincident with dip slip, normal faults (Figure 2-17) believed to have formed in an extensional setting related to early, back-arc rifting of the TVZ dated at ca 6.1 Ma (Mauk, 2011)

Some of the main mineralized veins within the Waihi area include the Martha Vein System, which is characterized by its complexity, with the prominent Martha vein dipping to the southeast and several subsidiary northwest-dipping hanging wall veins, including Empire, Welcome, Royal, and Rex veins (Figure 2-17). The Martha vein is the largest, with some areas reaching up to 30 meters in thickness, but typically averaging between 6 to 15 meters in width. Wider sections of the vein are associated with steeper dips, increasing from an average of 65-70 degrees to approximately 85 degrees southeastward. These steeper sections tend to have higher concentrations of gold (Au) and silver (Ag). The vein primarily consists of intact brecciated quartz material, indicating its formation during late-stage dip-slip faulting. The quartz within the Martha vein exhibits multiphase brecciation and various textures, ranging from fine, microcrystalline, and chalcedonic to coarser crystalline structures, particularly at greater depths (OceanaGold, 2021).

Smaller-scale splay veins are also present, connecting the larger vein structures and contributing to mineralization, especially in the Martha Open Pit. These splays typically consist of smaller veins, ranging from 5 to 50 centimeters in width, filling extensional structures without fault displacement and moderately dipping to the northwest. Additionally, the network includes two steeply dipping north-northeast-trending veins called Edward and Albert.

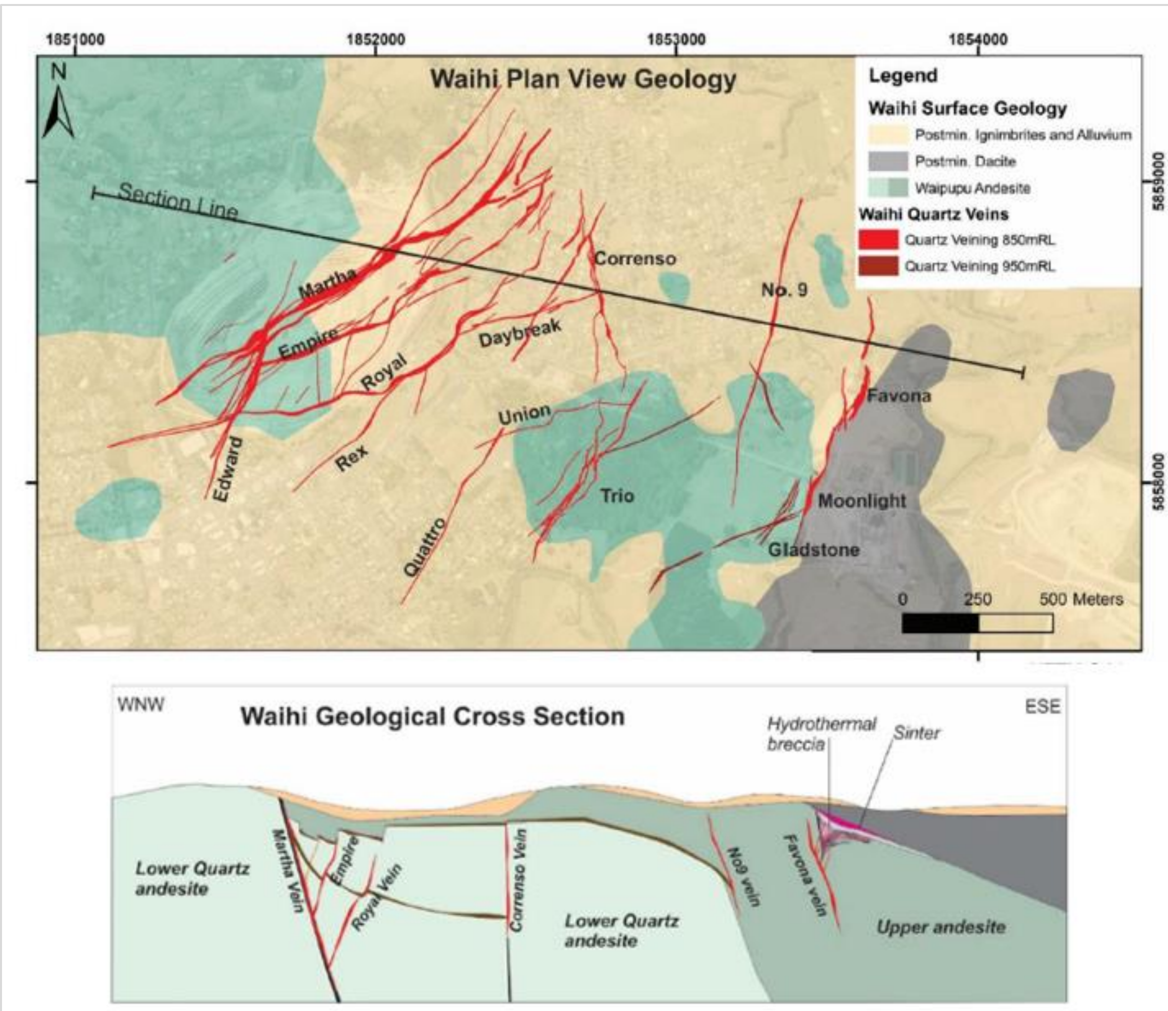
The andesitic host rocks near the veins have undergone significant hydrothermal alteration, often leading to complete replacement of the original mineral composition. The primary alteration types include:

- **Argillic Alteration:** This alteration type is closest to the veins and is characterized by the presence of quartz, adularia, pyrite, and illite.
- **Propylitic Alteration:** This alteration type extends laterally for tens of meters from major veins. It includes weak quartz, weak pyrite, carbonate minerals, chlorite, and interlayered illite-smectite and chlorite-smectite clays.

The extent and intensity of alteration in the Waihi District vary, depending on the specific type of host rock and the proximity to vein structures (OceanaGold, 2021).

Gold is primarily found as small inclusions of electrum, with an average silver content of 38%. It occurs both as free grains in quartz and as inclusions in sulfide minerals such as pyrite, galena, sphalerite, and occasionally chalcopyrite. Free gold is rarely observed, and Acanthine is the main silver mineral and is associated with pyrite and galena (OceanaGold, 2021).

Figure 2-17 Geological Map and Section Across the Waihi Area



2.7.4 Mineralization at Wharekirauponga

At Wharekirauponga gold mineralization occurs in association with quartz veining developed along three main groups of veins in the deposit: the so-called "Eastern Graben" or EG veins, the T-Stream veins, and the Western vein (F).

The principal veins, namely the EG-, T-Stream and Western Veins occupy laterally continuous, NE trending (025-47 degrees), moderately dipping (60-65 degrees) fault structures reaching up to 10 m in width. More subsidiary, extensional veins (1-100 cm wide) are developed between or adjacent to the principal fault hosted veins. These veins often form significant arrays that are moderate to steeply dipping with a more northerly to NNE strike and appear to lack lateral and vertical continuity compared to the principal veins.

The EG-Vein, dipping to the west, is the largest vein at Wharekirauponga, spanning over 1000 meters with most of the economic gold deposits. Toward its upper reaches, the vein becomes thinner or disappears, transitioning into clay alteration, which can contain gold in some areas. Veining observed in drill core is characterized by multiphase white quartz/chalcedony with textures including colloform banding, brecciation, vein sediments and quartz replacing platey calcite (OceanaGold, 2021).

There are a series of sheeted hanging wall veins along the EG structure containing significant Au grade in places. These veins appear to have a more northerly strike with sub-vertical dips.

The T-Stream Vein is a breccia zone within rhyolite flows containing mineralized quartz veins located approximately 500 m to the west of the main EG Vein. The brecciated vein zone is exposed at the surface and appears oxidized and often broken at depth. Low-grade Au occurs over the entire width of the structure with narrow internal pockets of high Au grade veins (OceanaGold, 2021).

The Western Vein zone is located approximately one km to the west of the EG and contains numerous individual veins not all of which carry anomalous Au. The dominant vein textures are quartz replacing platey calcite and minor chalcedonic quartz.

In this area, the host rhyolites have undergone pervasive hydrothermal alteration, often with complete replacement of primary mineralogy by quartz and adularia with minor illite and/or smectite clay alteration.

2.7.5 Local geology

General setting and lithologic units

Wharekirauponga is hosted by an extensive area of flow banded rhyolite and felsic lithic tuff. NE and NNE trends to vein systems are associated with extensional and oblique extensional faults which imply structural controls to emplacement and formation of the vein systems. Figure 2-18 shows the surface geology and the location of the A - B cross-section displayed subsequently.

The oldest unit of the geological sequence in the project area is early andesite flows, possibly part of the Waipupu Formation or the Whiritoa Andesite, which has been intersected at depth in the western part of the project. These andesite units are blind to the surface beneath the domes and Edmonds Formation and comprise porphyritic plagioclase flows or potentially subvolcanic sills/intrusions. According to (Panterra

Geoservices Inc., 2019), this andesite has a sharp upper contact with the overlying tuff sequence with a gentle dip with an easterly component as shown in Figure 2-19.

Figure 2-18: Surface geology in the Wharekirauponga Area. (From (GWS, 2022) report)

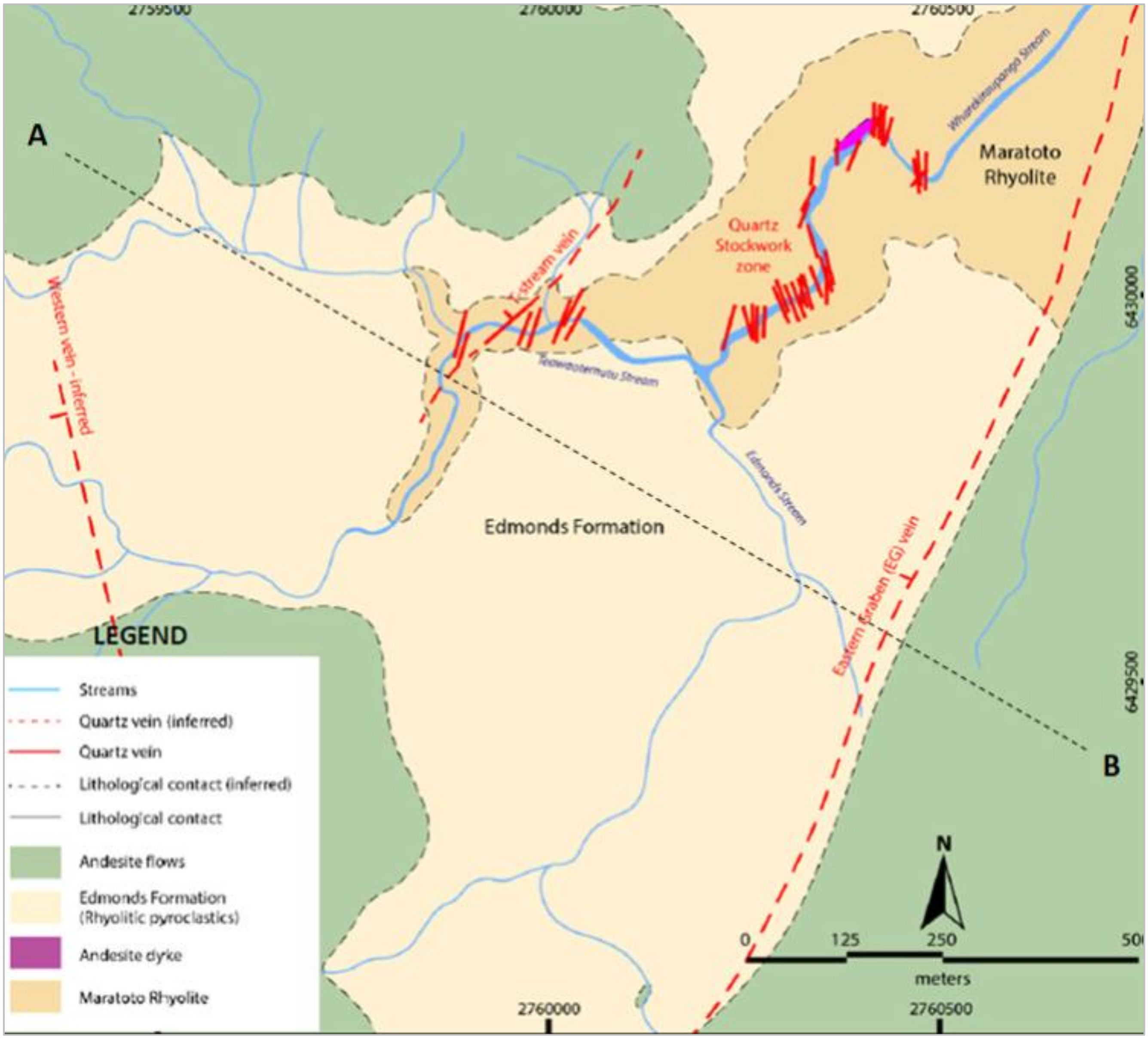
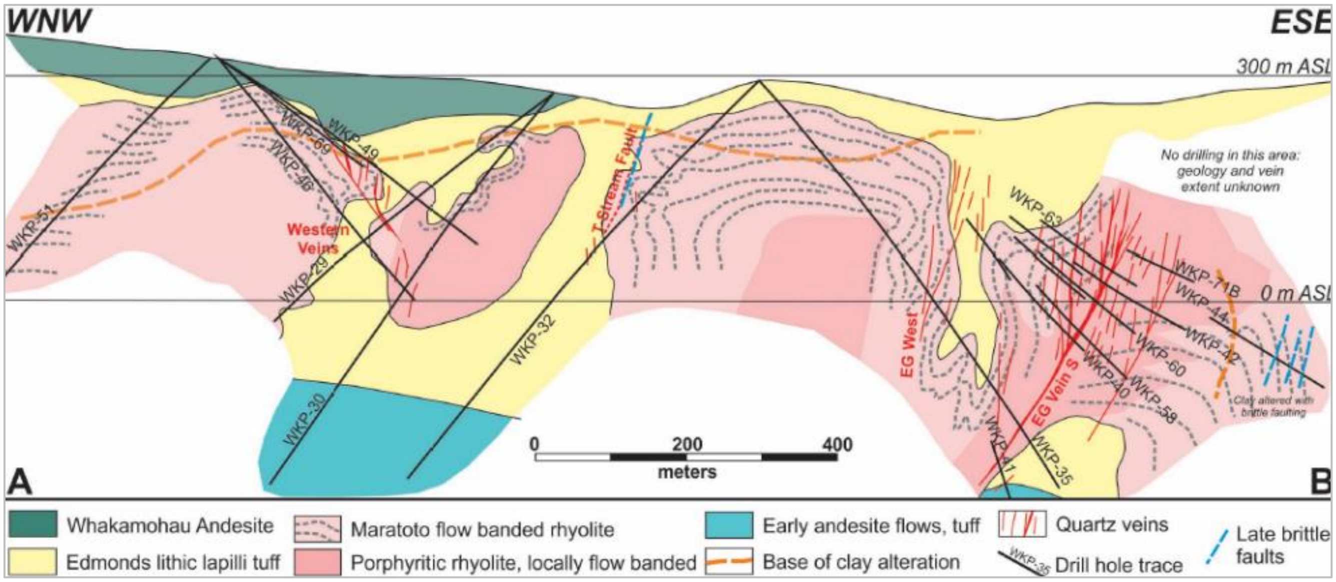


Figure 2-19: Geologic section of the vein system (From (GWS, 2022) report)

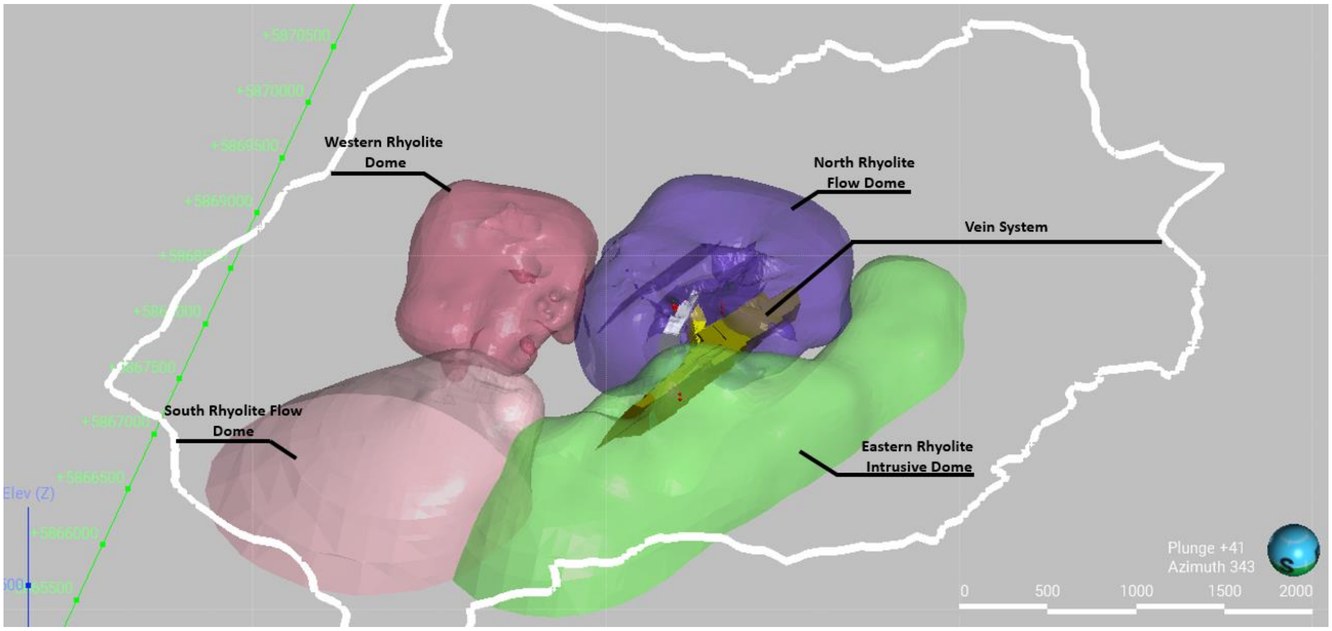


The older andesite units at depth are overlayed by lithic lapilli tuff, generally termed "Rhyolite Volcaniclastics". The tuff is generally massive and unwelded with similar fragment type and size throughout the unit. It usually contains pale grey to cream colored rhyolite fragments, quartz grains in the ash matrix, and a variety of andesite and potential basement - sandstone, mudstone - fragment types). Its textural homogeneity, similarity in fragment types, and the often sub-angular nature of the fragments and fragmented crystal grains in the matrix together suggest that the lithic lapilli tuff at Wharekirauponga it is the product of a limited number of eruptive events, possibly formed during a single large eruptive event or cycle with limited reworking (Panterra Geoservices Inc., 2019). This unit is interpreted as part of the Edmonds Formation.

The Maratoto Rhyolite is the most extensive rock type hosting the vein systems. It occurs as rock bodies within the lithic lapilli tuff sequence at Wharekirauponga. Some portions of the Maratoto Rhyolite vary from flow banded on their margins to massive rhyolite cores which have only crude or weakly developed flow banding and may be both quartz and feldspar porphyritic.

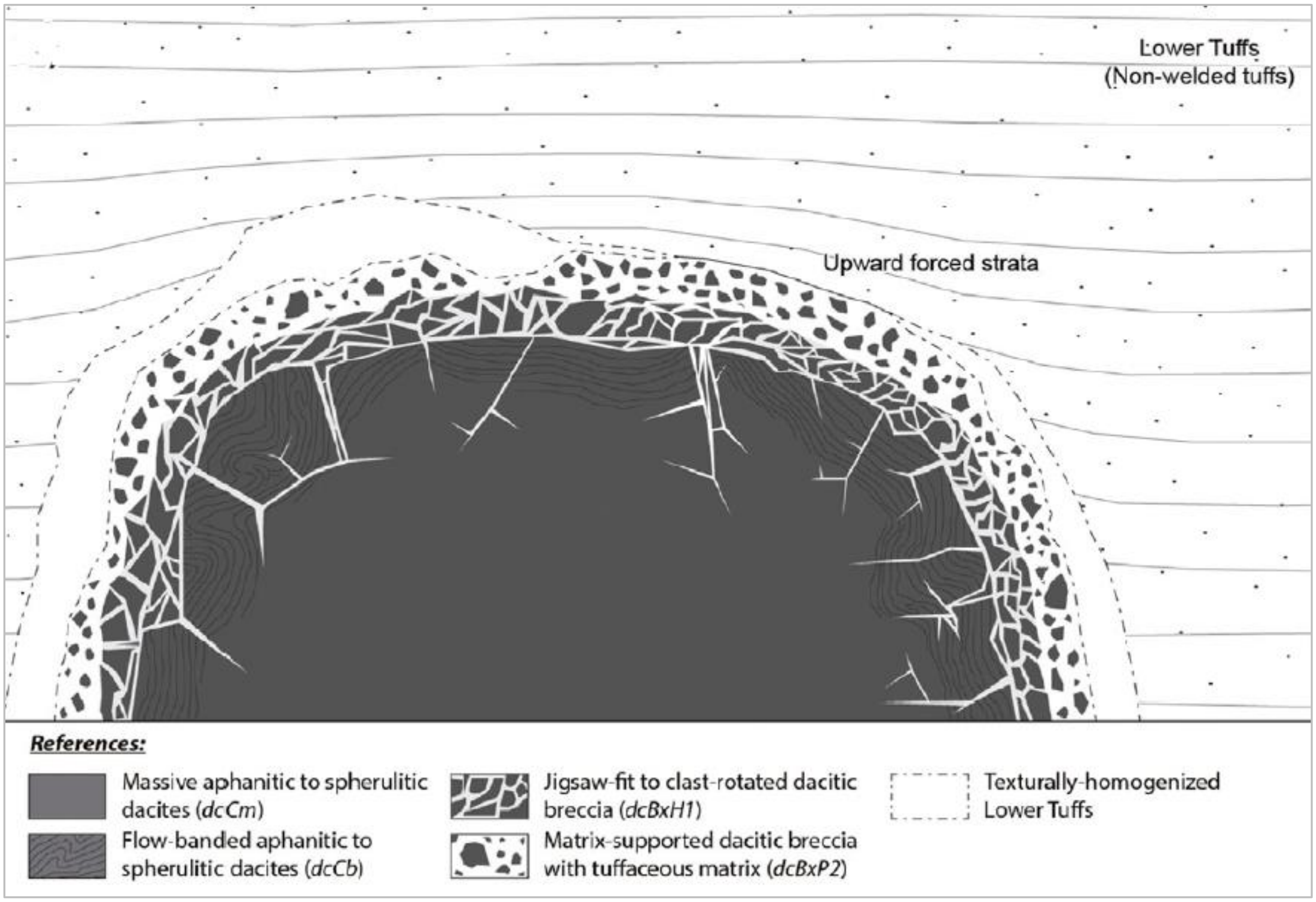
The varying levels of abundance and the distinct textural patterns observed in various rhyolite formations indicate the likely existence of multiple domes, which are likely of similar ages. These domes seem to have formed because of the gradual separation of material from a magma chamber beneath. In the region, Wharekirauponga is encompassed by cryptodomes, as shown in Figure 2-20, where it's evident that both the northern rhyolitic flow dome and the eastern intrusive dome not only contain rhyolitic volcanic materials but also host the Wharekirauponga orebody.

Figure 2-20 Wharekirauponga location in the dome zone



Dome-like intrusive bodies are found within the tuff sequence. These structures can have lobate and elliptical forms, often laterally joining, with contorted or arcuate domains of flow banding that conform to the dome shapes, and record areas of viscous flow folding within them. Areas of brecciation are often present within or on the margins of domes and can include three common, often gradational varieties (Panterra Geoservices Inc., 2019) such as monomictic rhyolite breccias, lithic fragments within massive to low banded rhyolite matrix and polymictic and monomictic breccia on flow dome margins as illustrated in Figure 2-21.

Figure 2-21: Diagram showing textures surrounding a dacite cryptodome. Source: (Panterra Geoservices Inc., 2019)



Apart from the rhyolite bodies, the only other significant intrusion that has been intersected by drilling is an NNE trending and steeply WNW dipping andesitic dike in the northwestern portion of the area. The Dike is dark green-grey andesite speckled with dark mafic and white feldspar phenocrysts, being massive to locally brecciated. The andesite dike is usually cut by mineralized quartz veins, which in some drillholes have significant Au grades, and locally early pyrite veinlets that precede the quartz veins.

Finally, late post-mineral andesite flows and volcaniclastic units lie on hilltops in western, SW and NW portions of the project area (Figure 2-19). The geological contact between these units and the underlying units is interpreted to be an erosional angular unconformity, and weathered zones are observed in drill core at these contacts.

Main Vein Structures

There are three main vein sets onsite; called “Eastern Graben” or EG veins, T-Stream veins, and the Western vein. Figure 2-22 is a cross section parallel to the main vein structures showing orientation.

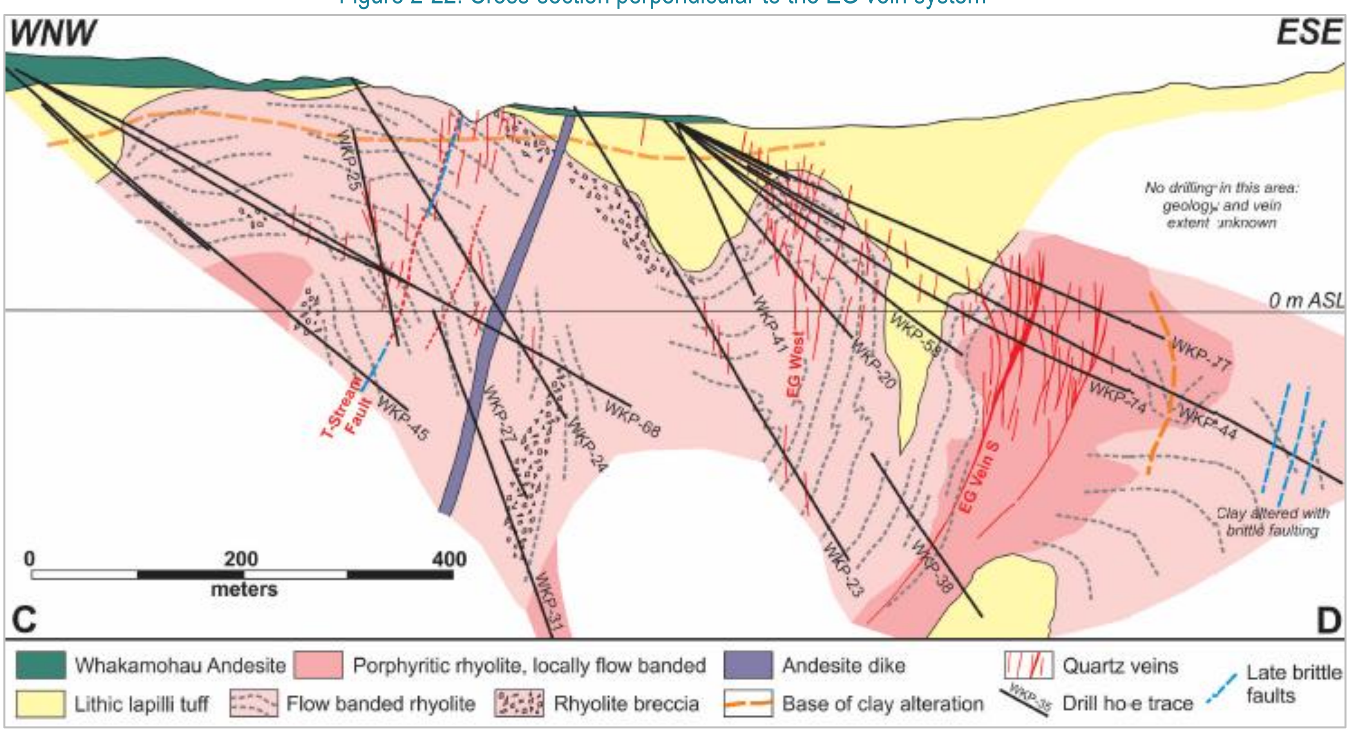
The veins are related to north-east trending, moderately dipping (60-65°) extensional step faults that relate to graben development and are up to 10m wide. Secondary veins are developed between, or adjacent to the main veins that are oriented northerly to north easterly, are moderately to steeply dipping and are up to 1m wide. The vein zones are 90-95% quartz and are highly brittle in nature. Most of the veins are hosted by Rhyolite flow (80%) that exhibit increasing silicification near the veins.

The west-dipping EG-Vein is the largest vein structure at Wharekirauponga and is continuous over a length of at least 1000m (open to the north and south). It holds most of the economic gold mineralization. Up dip the vein becomes thin or absent, ending in clay alteration. In some locations the clay is gold bearing. The EG-Vein can show multiple phases of development and associated textures, although, overall, it presents itself as being massive with little void space e.g., vugs.

West of the main vein is a series of extensional hanging wall veins are oriented more northerly such that they connect the main structures (veins and Andesite dike). These veins are exposed at surface, pinching out to the east and terminating at the Andesite dike in the west. The EG-Vein is known to have at least four main footwall veins; one that is oriented in a north-south direction and three that are subparallel to the main vein. These commonly have a brecciated texture and are interpreted to originate from fault movement.

The T-Stream vein parallels the EG vein, is usually around 5m wide and has a strike length of at least 400 m, although it is yet to be closed out in the north. The vein is observed to be broken, oxidized quartz and quartz breccia. The T-stream vein is lower grade and was not considered as a viable mining target at the time of preparing this report.

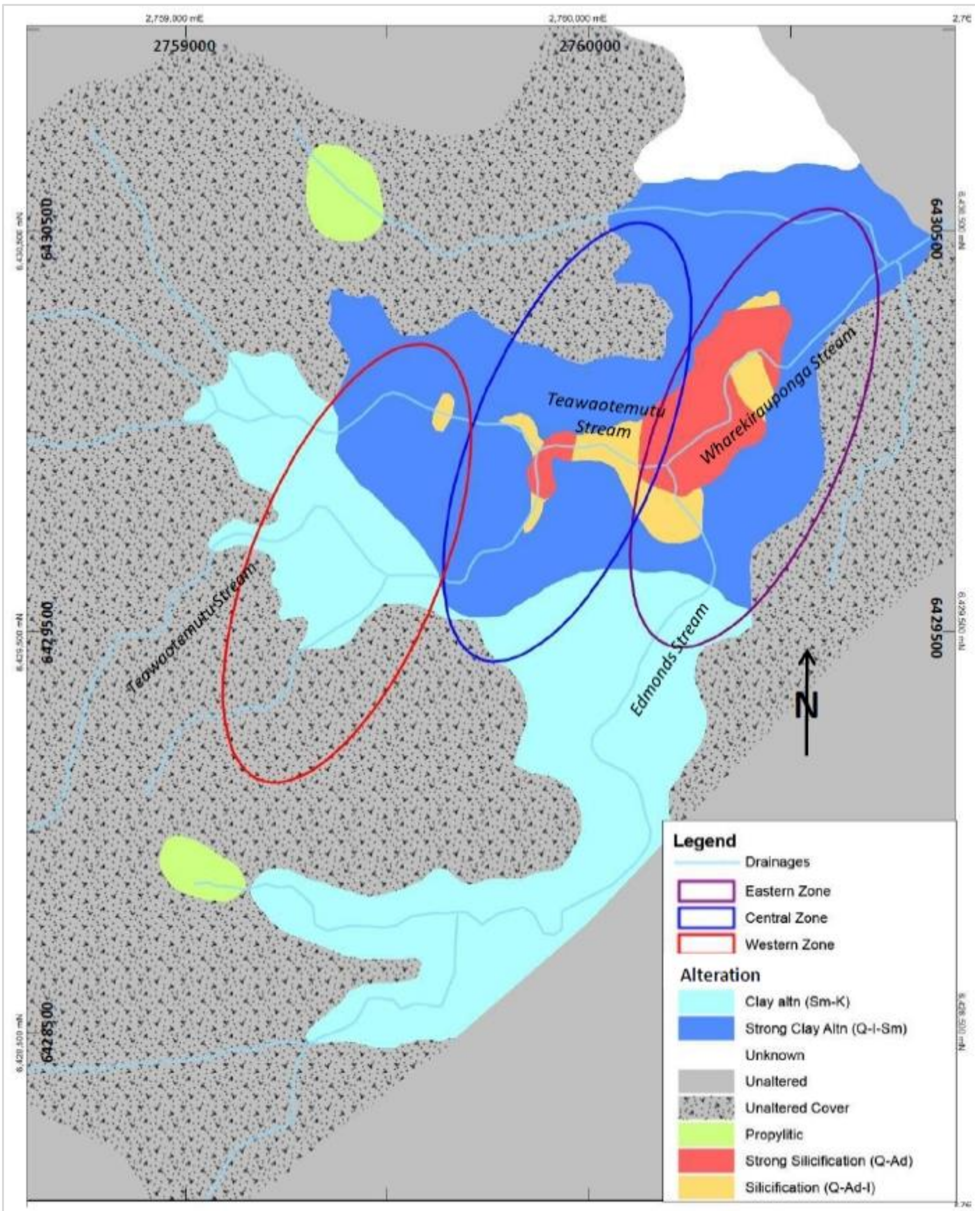
Figure 2-22: Cross-section perpendicular to the EG vein system



Clay Alteration

Geophysics and surface mapping has shown extensive hydrothermal alteration of the host rock mass during the mineralization phase of the deposit's formation. Figure 2-23 shows the distribution of alteration map developed from surface outcrops, which largely consists of moderate to strong clay alteration with a zone of silicification centered around the vein system. The alteration limits were defined by the extent of the exposed host rock; it was not known if alteration continued beneath the post-mineral andesite cover.

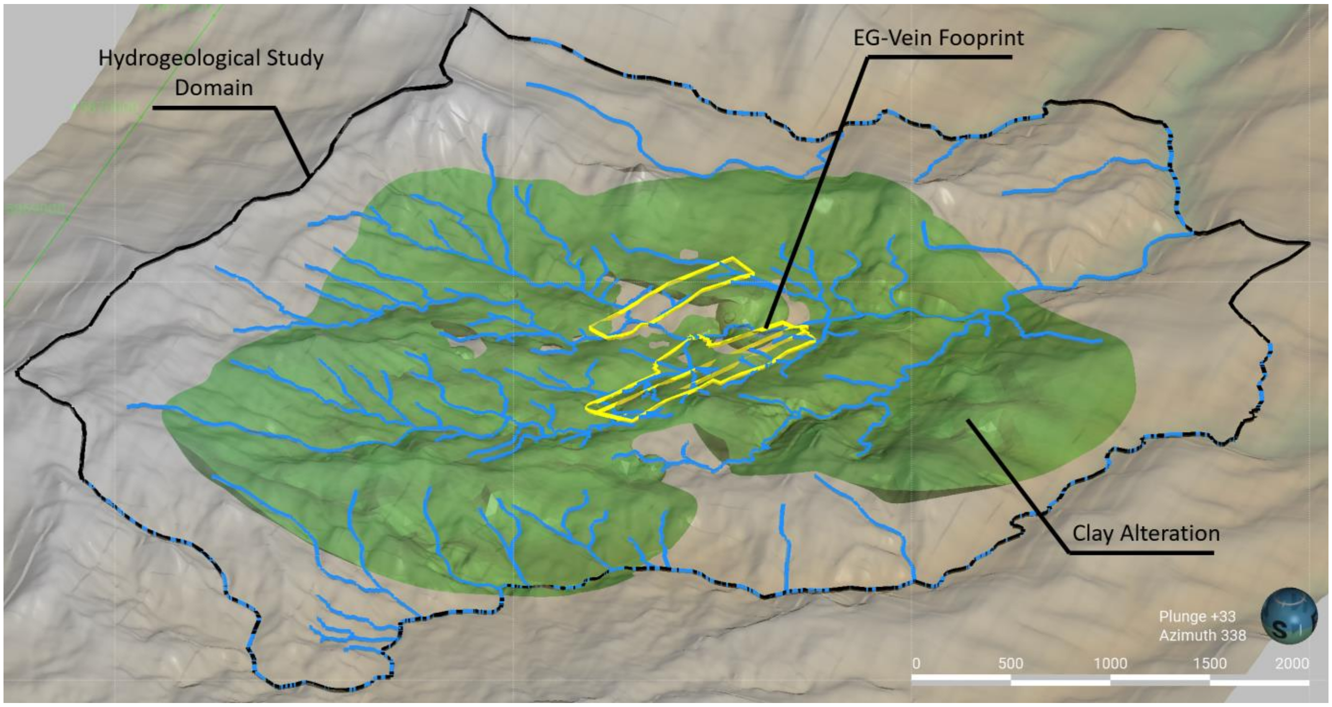
Figure 2-23: Hydrothermal alteration zones (from (GWS, 2022) report)



In March 2023, FloSolutions undertook a study to evaluate the lateral extent of the clay alteration layer, based on available data, to assess if it should be extended beyond the mapped alteration zone in the mine domain during numerical modeling. The available data from 27 peripheral drillholes (bore logs, core photos) and results from several geophysical cross-sections were used to evaluate clay alteration, resulting in development of extended surfaces of the clay alteration zone (FloSolutions 1022310402-R-01).

Figure 2-24 shows the extended clay alteration zone modeled using Leapfrog software.

Figure 2-24: Clay alteration – Leapfrog solid.



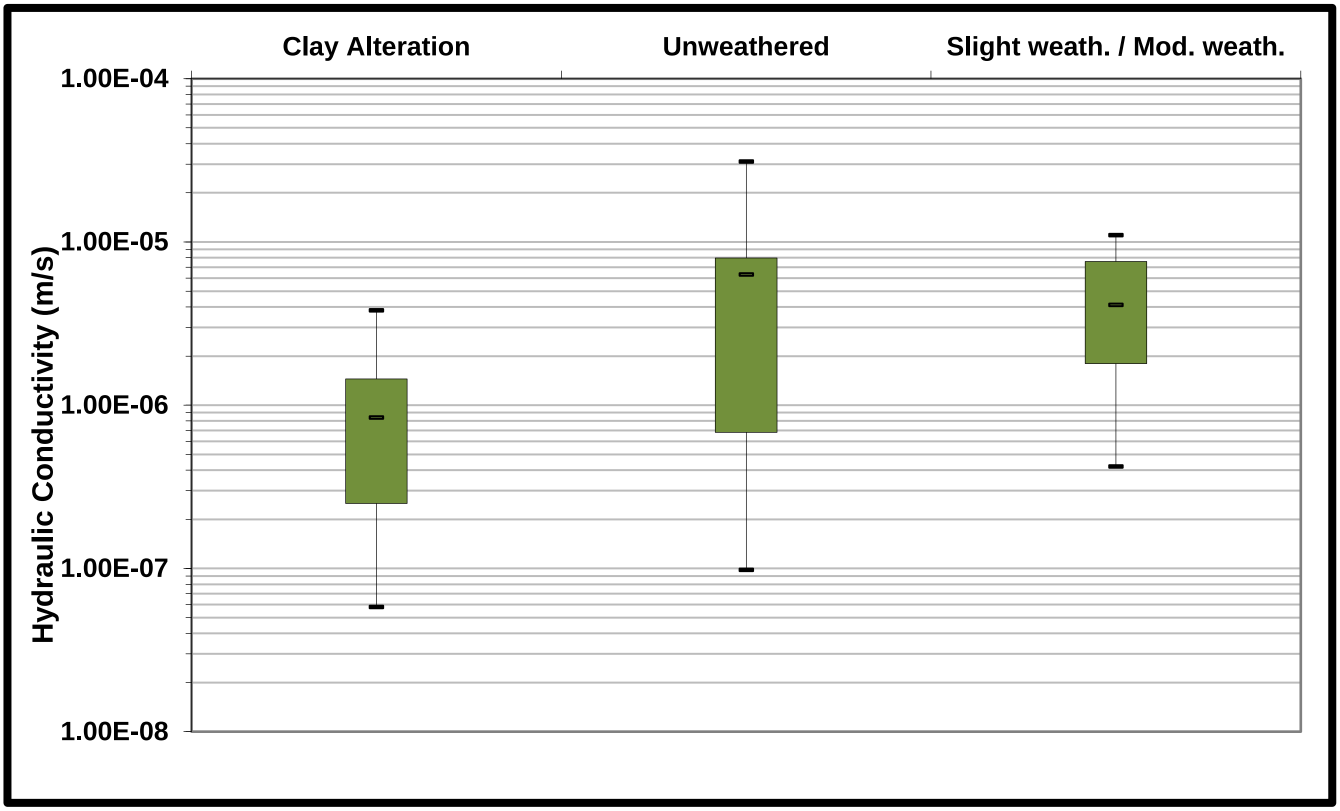
Weathered Zone

The process of rock weathering in an environment with approximately 2000 mm/yr of rainfall can be accelerated, especially under dense vegetation and complex stream channel distribution found on WUG project. Review of data from field investigations have shown that the upper portion of the rock mass (usually around 50m) is often subject to weathering, especially due to the intense fracturing of this zone. An example can be found in Figure 2-25.

The March 2023 study by FloSolutions (FloSolutions 1022310402-TM-07) described four levels of rock zone alteration: the clay alteration zone (a result of hydrothermal alteration), a weathered zone, a slightly to moderately weathered zone, and un-weathered zone (fresh rock). Evaluation of available hydraulic testing data indicates that the degree of alteration and weathering have impacts on host rock hydraulic conductivity. This is illustrated in Figure 2-26 for available tests [clay alteration n=11; un-weathered n=12; slightly/moderately weathered n=5; weathered zone n=0].

Figure 2-25: WKP-07S core photos – showing transition from weathered to fresh un-weathered rock.

Figure 2-26: Hydraulic conductivity distribution per alteration and weathering type. Source: FloSolutions TM-07

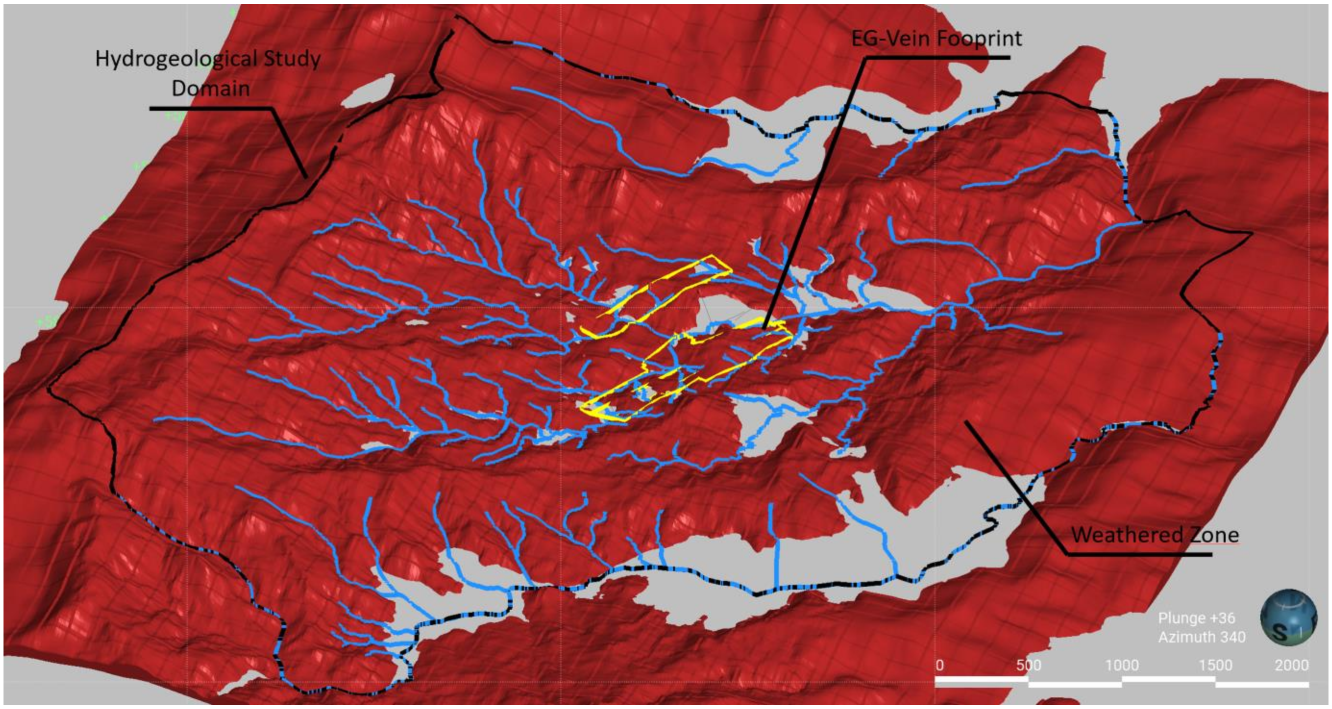


The broader range of K values for un-weathered rocks reflects the expected influence of fractures on host rock permeability. In weathered rocks, the K variation tends to be lower, with low K values dropping out (K increases due to weathering, as expected).

Because these zones have different hydraulic properties, it was important to assess the spatial distribution for incorporation into numerical modeling. Extents of the weathered zone have been modeled in Leapfrog (Figure 2-27) using all available drilling data and CSAMT cross sections.

Despite the significant uncertainty generated by lack of data outside of the immediate area of exploration, it is expected that observed weathering patterns in the vicinity of the orebody extend to most of the study domain – due to the similar geological and environmental conditions throughout the site that are responsible for weathering effects.

Figure 2-27: Weathered zone – Leapfrog solid



Silicified Contact Zones

During the site visit in February 2023, FloSolutions reviewed core logs from recent exploration, and identified the presence of a strongly silicified zone at the contact between a rhyolite flow dome and the rhyolite volcaniclastic units that they intruded. By inspecting and probing the core log (at site) with some hammer blows, it was easy to verify the difference between the natural geological unit (with no silica flooding) and the altered, silicified zones. In the latter, rock is usually much harder and more resistant Figure 2-28.

It was not clear if this silicification was due to fluid percolation during original dome emplacement or a result of later hydrothermal fluids associated with ore body development, that may have ascended along the contact zones if they were preferential fluid flow pathways. The latter was suspected due to abundant quartz veining in the orebody.

To confirm this hypothesis, detailed core review was conducted for all drillholes that penetrated a rhyolite flow dome / rhyolite volcaniclastic contact zone. The review confirmed that only contacts relatively near to the orebody were silicified. This specific characteristic is quite localized to the contact zones near to the EG-Vein and surrounding intrusive domes and/or rhyolite volcaniclastics, where a significant amount of silica has precipitated during ore body development.

The silicified contacts are (presumed) much lower permeability than host rocks due to porosity occlusion and may restrict groundwater flow to the mine during development. These contacts were mapped in 3D and plotted on Leapfrog to be further used in development of 3D numerical groundwater flow models. Figure 2-29.

Figure 2-28: Core photo review – Silicified contact along 66.7m to 85.7m.

Legend:

Silicified Zone (Start)

Silicified Zone (End)

Not in Scale
Schematic Figure Only

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CLIENT: Oceana Gold New Zealand

TITLE: Silicified Contact – WKP-116 (66.7 to 85.7m)

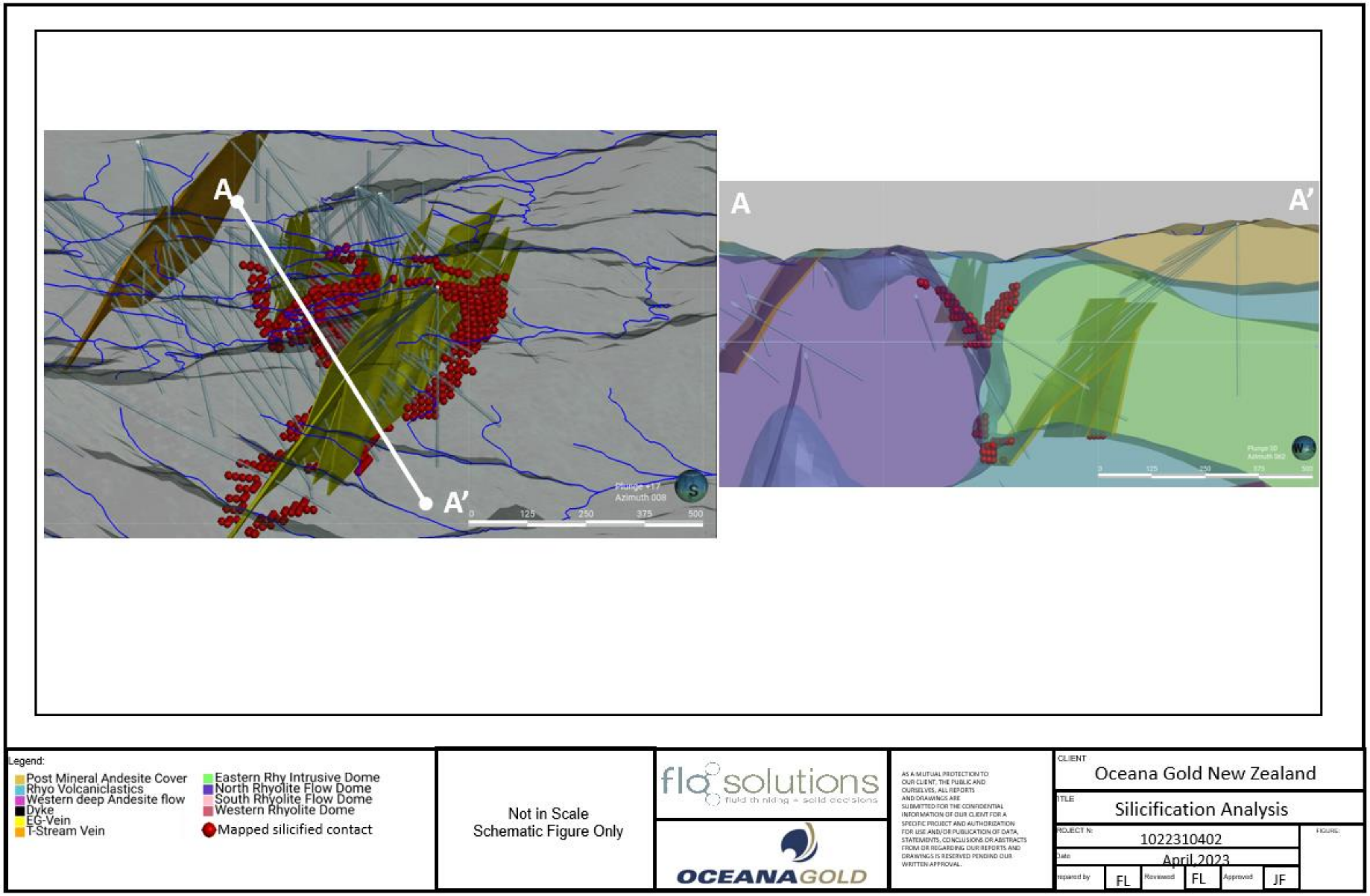
PROJECT N: 1022310402

FIGURE:

Date: April 2023

Prepared by: FL | Reviewed: FL | Approved: JF

Figure 2-29: 3D mapping of silicified contacts.



2.7.6 Geological model

OGNZL is continually developing and updating a full 3D geological model in Leapfrog, utilizing more than 60000m of exploration drilling that has been completed on the project to date.

The geological block model covers an area of approximately 6.2 km^2 with a maximum elevation of 750m and the base of the model at an elevation of -500m. The model is very well discretized around the vein system, where abundant exploration drilling data is available (Figure 2-30). However, due to access limitations, regional drilling has not been undertaken outside of the general vicinity of the orebody. As a result, the geology within the vicinity of the orebody is extrapolated to a much broader area (Figure 2-31) and is considered somewhat speculative with increasing distance away from the orebody.

Some of the key geological units defined in the model include the following:

- **Western deep Andesite flow**: This is the deepest unit in the geologic model. It is associated with the Waipupu formation and is composed of porphyritic plagioclase flows or potentially sills/subvolcanic intrusions, in the area the andesite has a sharp upper contact with the overlying tuff sequence with a gentle dip with an easterly component.
- **Rhyolite Volcaniclastics (RV)**: Associated with the Edmonds Formation, consisting of polylithic lapilli tuff containing rhyolite fragments, quartz grains in the ash matrix, and a variety of andesite and potential basement fragment types (sandstone, mudstone) showing textural homogeneity and similarities in fragment types. This unit is assumed to underly most of the model domain.
- **Eastern Rhyolite Intrusive dome, North, South Rhyolite flow dome, Western Rhyolite Dome**: Each of these subunits represented in the model as individual geologic features are part of the Maratoto Rhyolite Formation. These dome-shaped intrusive bodies are intruded into the tuff sequence and represent probable cryptodomes that may have lobate and elliptical shapes. These domes host the vein systems and the orebody at Wharekirauponga.
- **Dyke:** Corresponds to a single identified dark greenish-gray andesite intrusion with an NNE trending speckled with phenocrysts of dark and white mafic feldspar, that is cut by mineralized quartz veins.
- **Post-mineral Andesite cover:** late andesite flows and volcaniclastic units that lie on hilltops in western, SW and NW portions of the project area lie in probable erosional angular unconformity with underlying host Maratoto rhyolite and Edmonds tuff units.

The figures below show the 3D geological model, while the Figure 2-32 shows a cross section along the central portion of the model. The position of the ore-hosting vein systems relative to the key surface water catchments is shown in Figure 2-33.

Figure 2-30: Drilling information and study domain

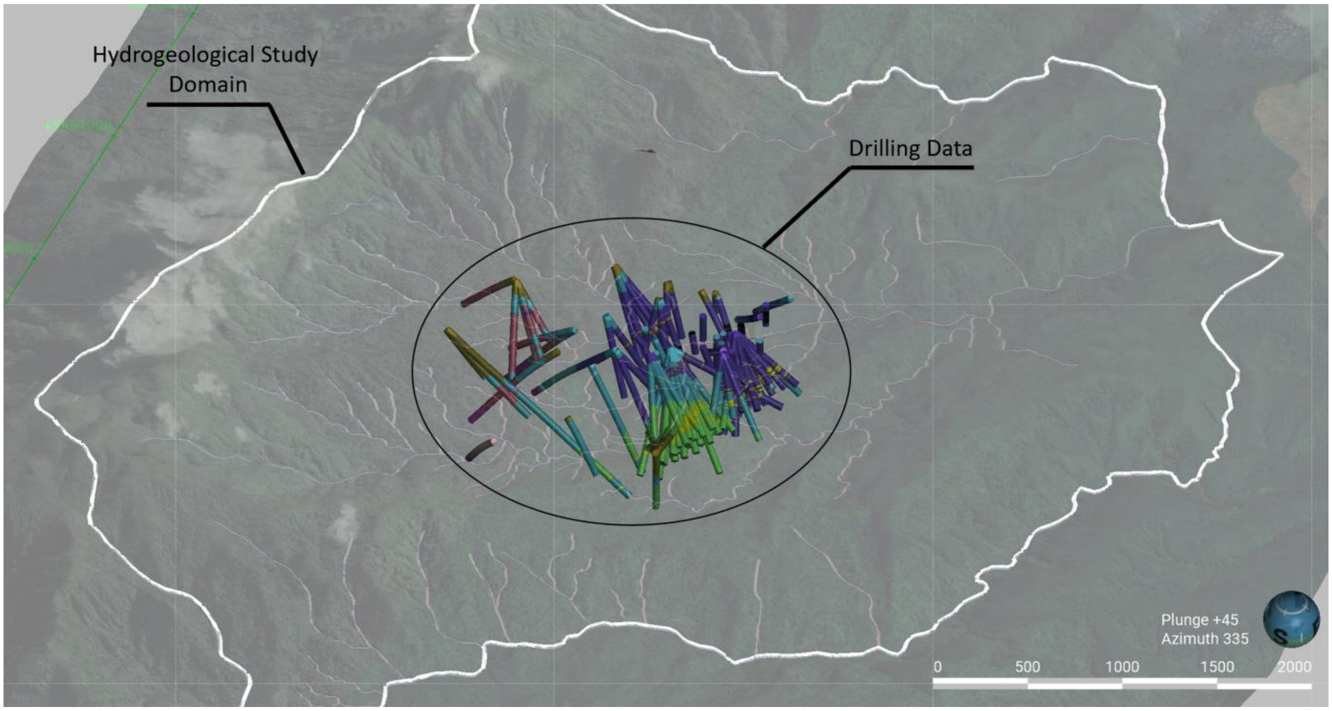


Figure 2-31: Geological block model – Leapfrog.

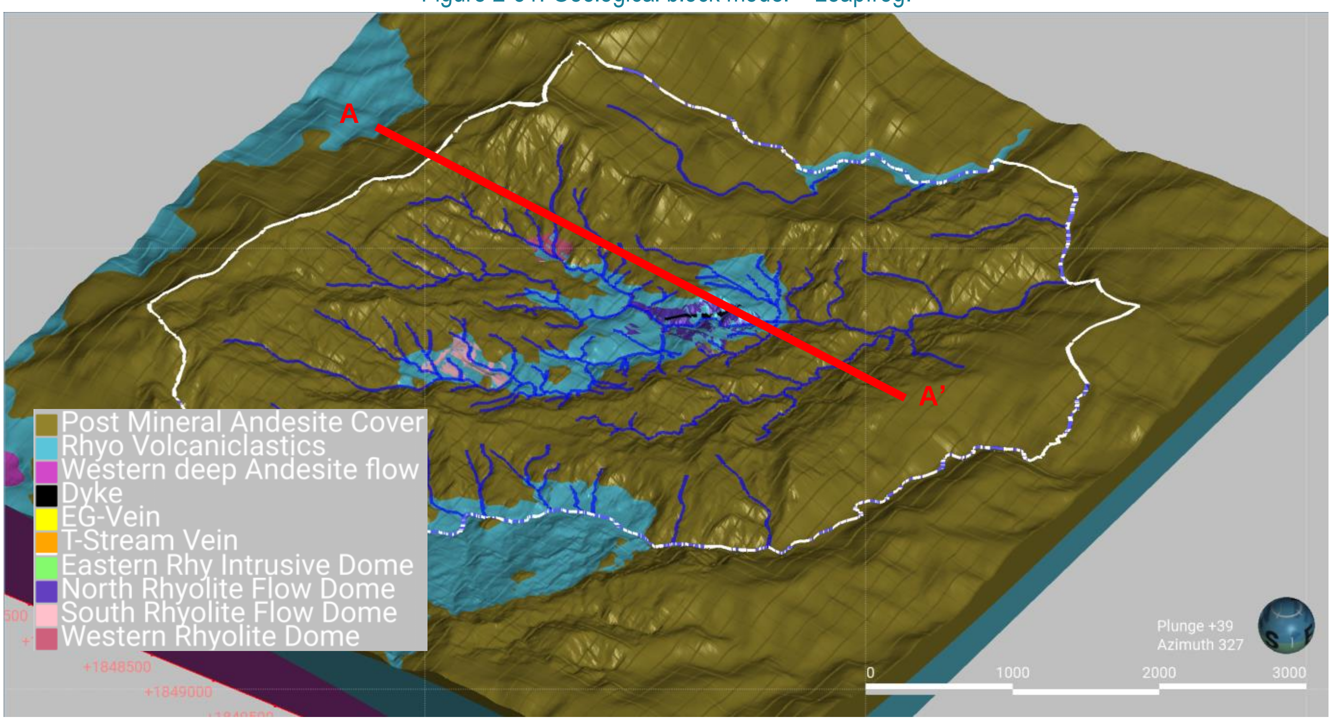


Figure 2-32: Cross section along the central portion of the geological model.

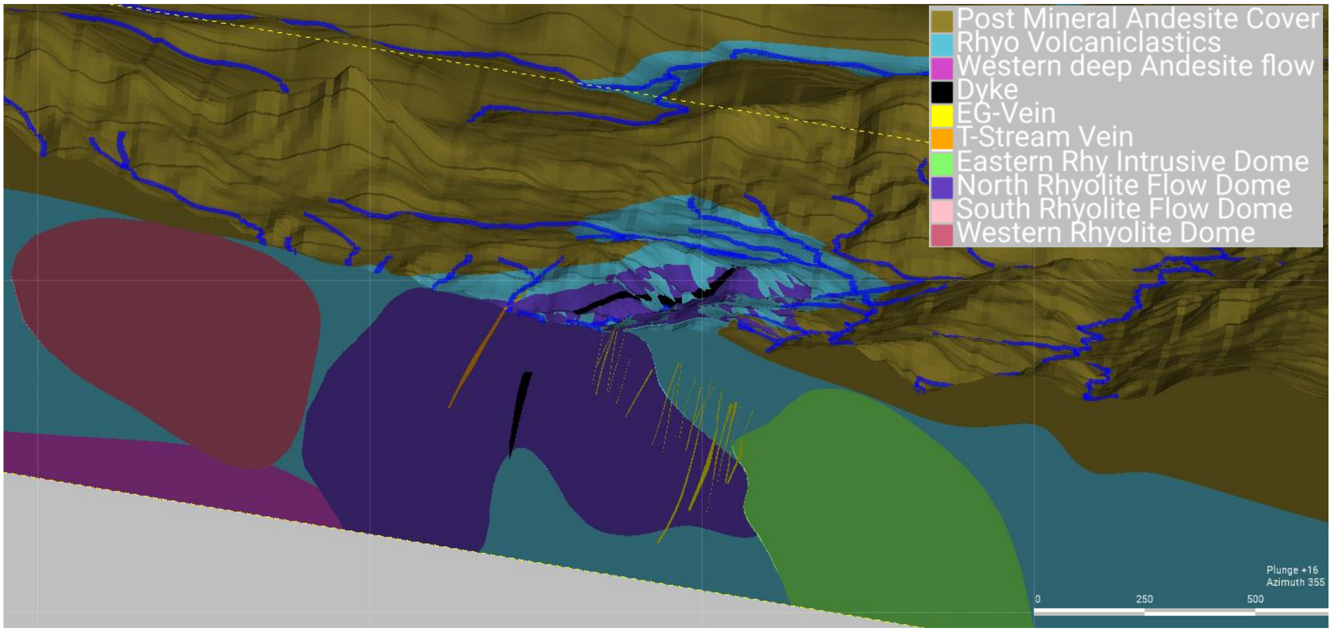
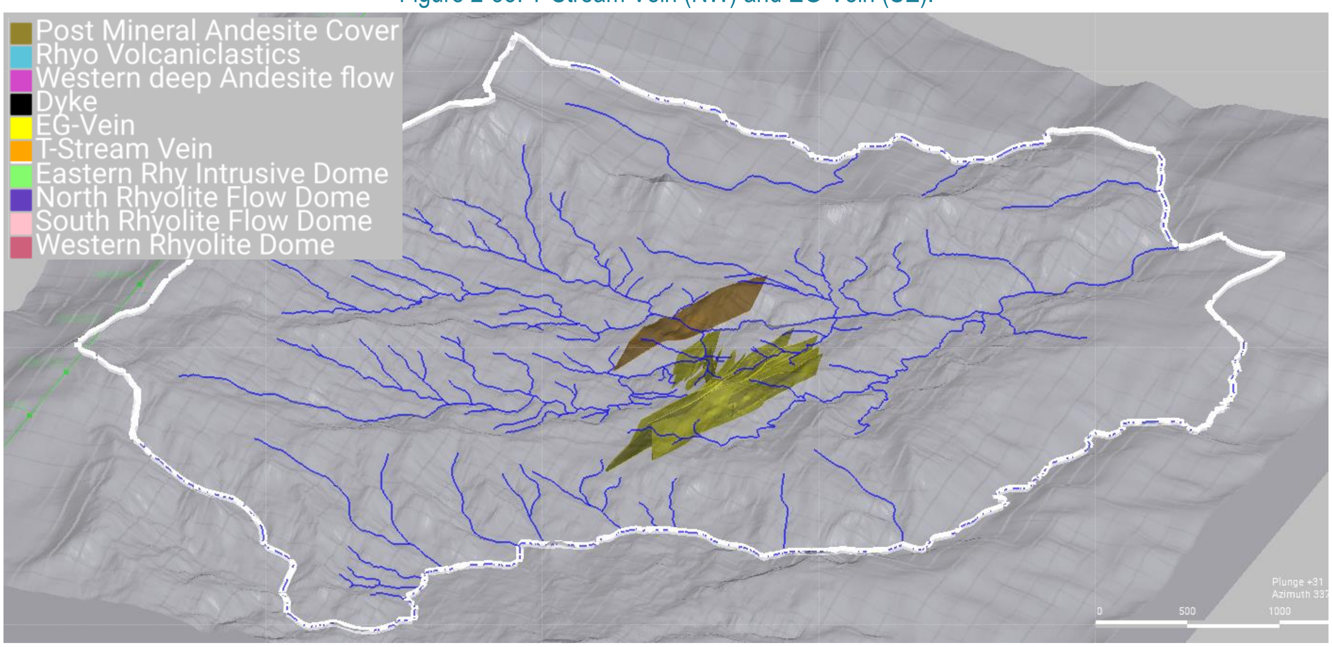


Figure 2-33: T-Stream Vein (NW) and EG-Vein (SE).



3. PROJECT DESCRIPTION AND PLANNED INFRASTRUCTURE

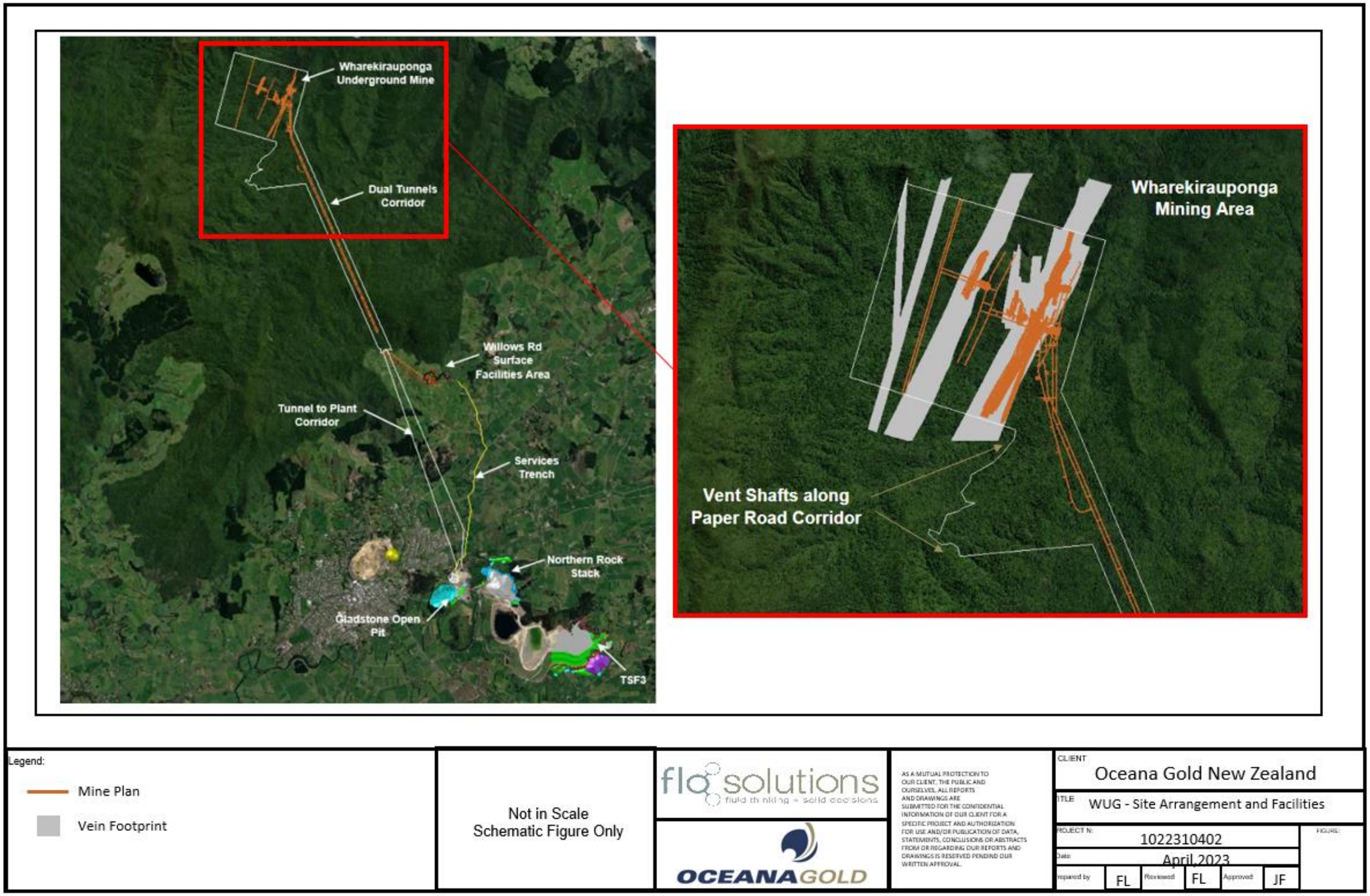
The WUG orebody is located 10 km north of Waihi town (Figure 3-1). Due to the sensitivity of the DOC lands (Section 2.3), two long tunnels have been planned by OGZNL to access the orebody. The tunnels will advance from the Willows Road Surface Facilities Area located outside of DOC lands and be used as the main access for the mine and for transportation of production and all mining materials.

The current design includes tunnels with dimensions of 6 m high and 6 m wide. A ventilation shaft located at Willows Road property is planned to serve as an exhaust during tunnel construction and later, as an air intake during mining operations.

Additional ventilation shafts will be built inside the DOC lands and will have a small local footprint at surface (OceanaGold, 2021). Cross cuts will be constructed to provide a connection between the intake and the exhaust tunnels. An ore transfer tunnel, about 5 km long, will be built from Willows Road surface facilities area to the Processing Plant.

The mine will be supported by infrastructure situated on land located at the end of Willows Road, OGNZL property. The top of the mine and the mining activity will be over 65 m below the ground level to keep the surface effects at low levels.

Figure 3-1: Site arrangement and Wharekirauponga mine area (OceanaGold, 2021).

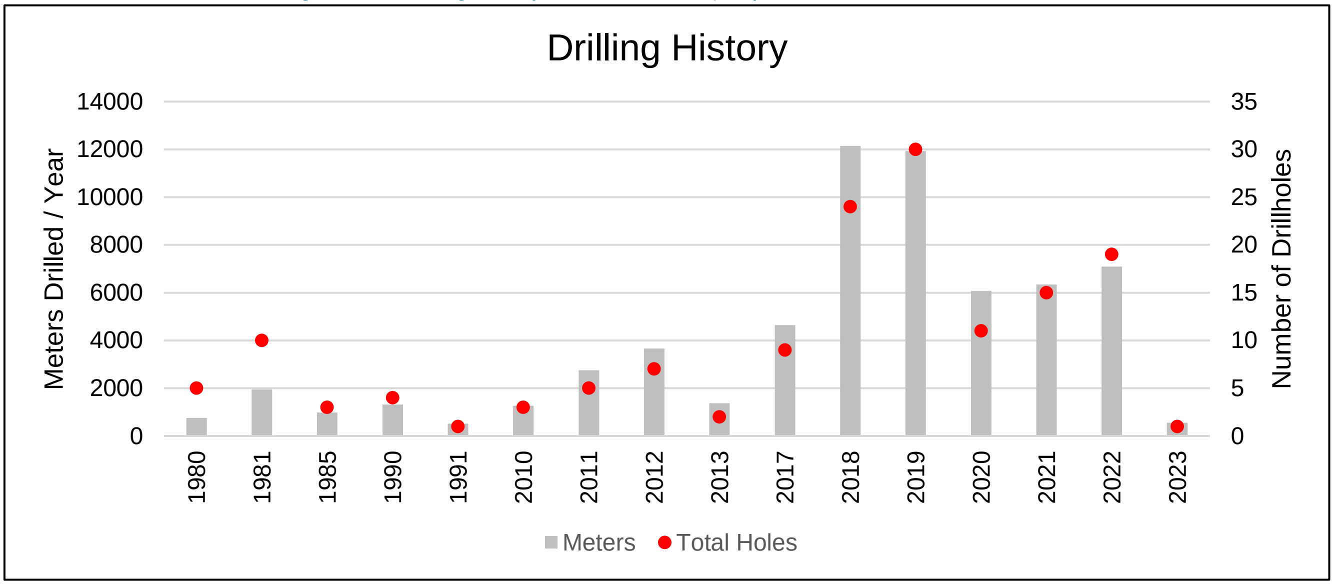


4. AVAILABLE DATA

4.1 Geologic / drilling data

OGNZL and previous owners have been conducting exploration drilling at the WUG project site intermittently since 1980, and continuously since 2017. During this time, a total of 149 drillholes and more than 6000m of drilling have been completed (Figure 4-1).

Figure 4-1: Drilling history – meters drilled per year and number of drillholes.



Due to access restrictions and consenting processes, surface disturbance must be kept to a minimum. A total of 8 drilling pads have been used along with two helipads as summarized in Table 4-1. These locations are shown in Figure 4-2.

In most cases, drill pad locations do not directly overlie the vein systems, which are steeply dipping. Most of the pads are located above the hanging wall side of the orebody. Exploration drilling is conducted by advancing bores at shallow to steep angles (~20-75o) from the drill pads towards the orebody. The compiled drill traces are shown in Figure 4-3.

Information compiled during drilling includes drilling rates, water losses, total depth, and specifics of instrumentation construction. The continuous core from drilling is taken to the core shed in Waihi, where it is cleaned, logged for geology, geotechnical properties, and alteration, and photographed prior to any sampling and assaying. Bore logs and core logging sheets are stored electronically by OGNZL and were provided as part of the CSM update.

Table 4-1: Drilling pads coordinates.

Name	X	Y	Z
Drill site 1	1849830	5868329	182
Drill site 2	1849342	5868713	235
Drill site 3	1848913	5868367	275
Drill site 4	1850097	5868579	178
Drill site 5 / South Helipad	1850111	5868371	226
Drill Site 6	1850119	5867495	273
Drill Site 7	1848763	5867818	332
Drill Site 8	1849756	5868232	206
North Camp	1849641	5868713	261
Northern Helipad	1849912	5868743	255

4.2 Geophysical data

The only geophysical data available for the site is from a controlled source audio-frequency magnetotellurics (CSMAT) survey program completed by Zonge Engineering in 2022.

CSMAT is a geophysical investigation method for obtaining information about subsurface resistivity. Resistivity values calculated from the CSAMT data relate to geology. Primary factors affecting resistivity include rock or sediment porosity, pore fluids, and the presence of certain mineral assemblages.

For mineral applications, CSAMT data can provide critical information about geologic structure, lithology, water-table trends, pore fluid salinity, and contaminant concentrations (Zonge, 1992).

At Wharekirauponga, a total of 26 CSAMT lines have been completed, totaling approximately 30,000m, covering an area of approximately 7 Km2 (as a reference, the hydrogeological model covers an area of approx. 22 Km2). The spatial distribution of the geophysical lines is shown in Figure 4-4.

Figure 4-2: Drilling pads - spatial distribution

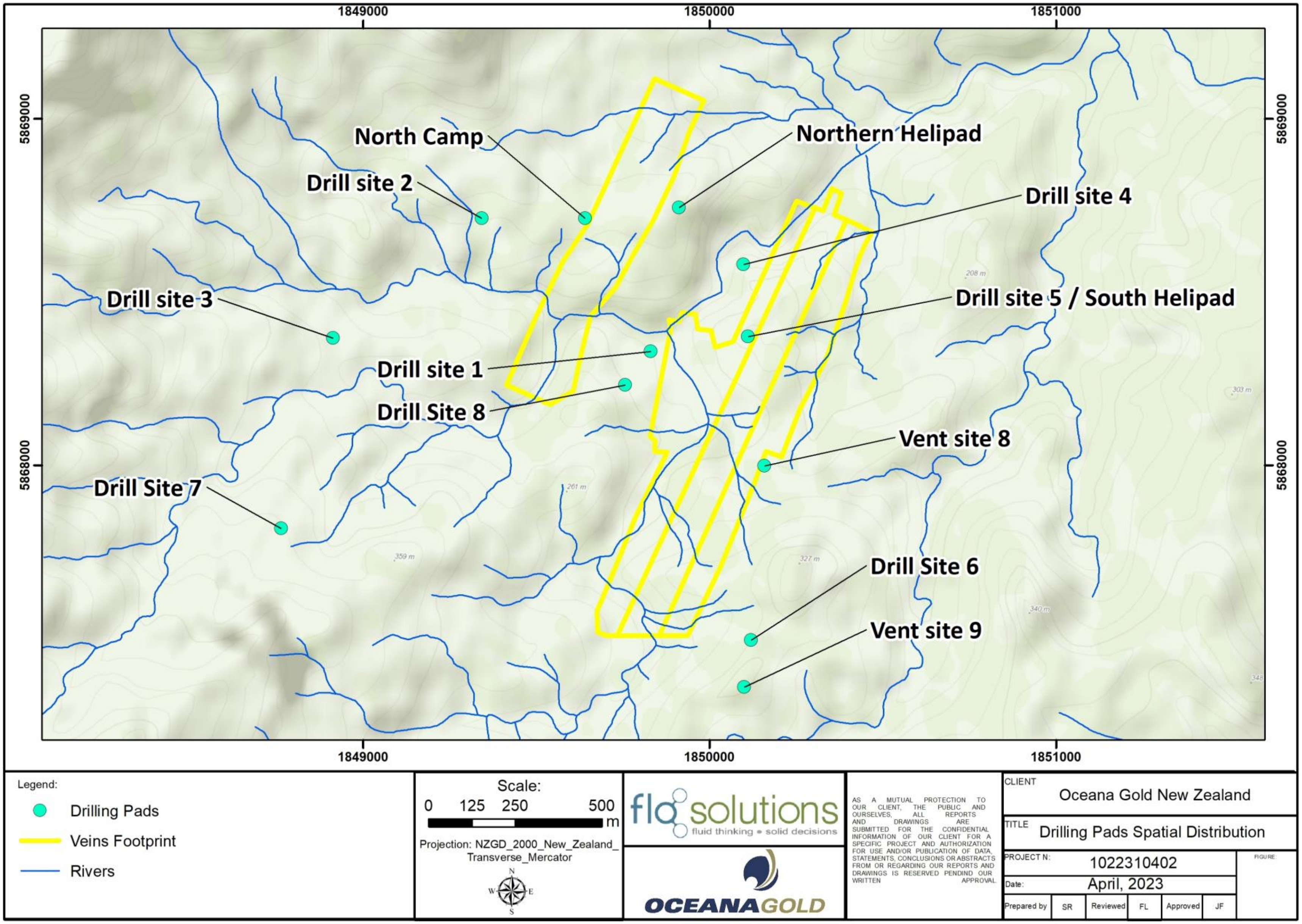


Figure 4-3: Drill traces – spatial distribution.

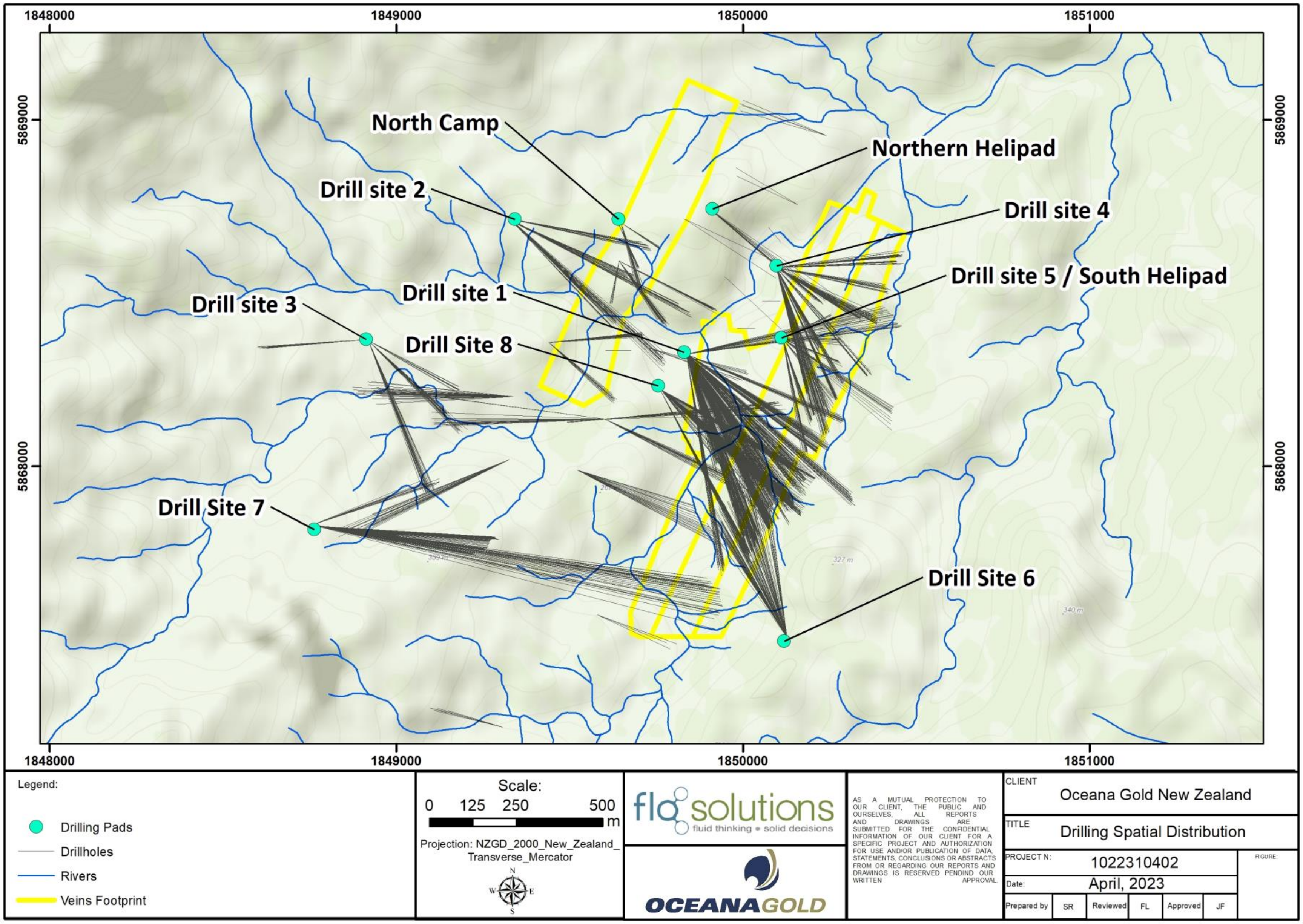
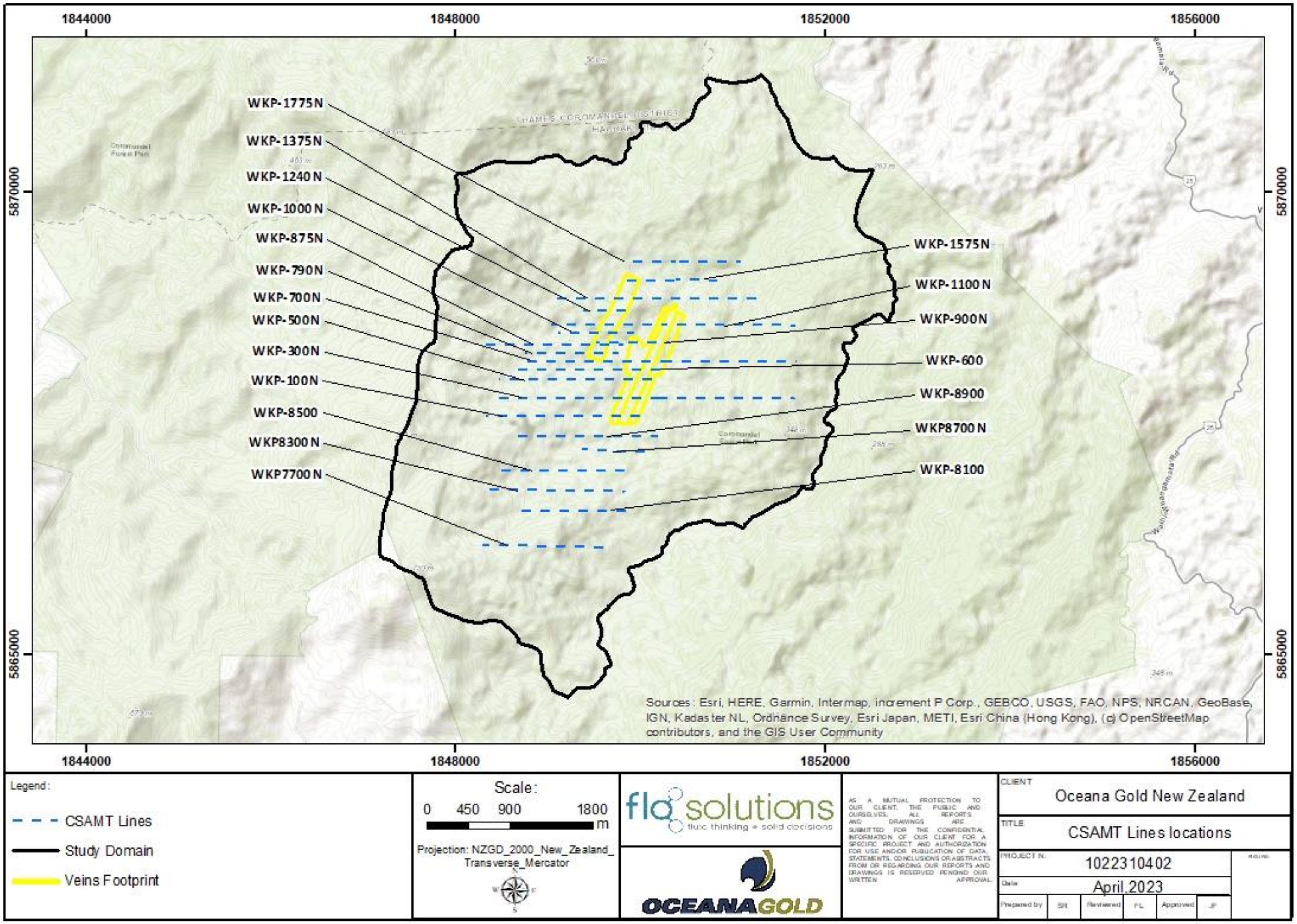


Figure 4-4: CSAMT lines – spatial distribution.



4.3 Surface water monitoring network and data

OGNZL established a rainfall monitoring station at the site in July 2019 providing continuous rainfall data GHD has used this information to establish a relationship with a more extensive 100yr record with Waihi (GHD, 2023).

Table 4-2 summarizes the location (coordinates) of the surface water gauging stations and reports the number of flow measurements taken at each station also, more detailed information, including dates of data record, is provided in Appendix B - .

Gauging stations are shown in Figure 4-5. Flow gauging is usually quite dependent on field programs and site conditions. While there are a significant number of gauging stations along the Wharekirauponga river and its tributaries, regular monitoring (with pressure transducers installed) has only been conducted on stations WKP1, WKP2, WKP3, T-Stream east and T-Stream west. Pressure transducers installed in 2019 are currently in operation (at the date of report preparation). River elevation is converted to flow rates by GHD to be used for modeling and estimation purposes. A summary of the gauging data can be found in Appendix B - Graphs of flow rates and precipitation for the continuously monitoring stations are shown in Figure 4-6 through Figure 4-10.

Table 4-2 Surface water gauging stations

Point	X	Y	Number of flow measurements
WKP0	1851477	5872440	1
WKP1	1851349	5871842	Continuous
WKP2	1850856	5869136	Continuous
WKP3	1850436	5868898	Continuous
T Stream East	1849690	5868440	Continuous
T Stream West	1849600	5868431	Continuous
Adams Stream	1850441	5868970	5
Edmonds Stream	1849899	5868369	3
ES1	1849362	5866930	2
ES2	1849343	5867261	2
ES3	1849359	5867098	2
ES4	1848989	5866955	2
ES5	1848980	5866924	1
Lignite Stream (LS0)	1851415	5872507	1
TStream West - upstream North branch	1849545	5868477	5
T Stream West - upstream South branch	1849549	5868356	5
Thompson ds trib	1851223	5869642	4
Thompson S2	1850908	5868298	2

Point	X	Y	Number of flow measurements
Thompson S3	1850947	5868296	2
Thompson Stream	1851165	5869310	6
Trib R (unnamed)	1850385	5868839	6
Trib S	1851301	5869639	1
Trib T	1851426	5869732	1
Trib U	1851452	5869807	1
Trib V	1851602	5869864	1
Trib W	1851672	5869990	1
Trib X	1851655	5870163	1
Trib Y	1851474	5870894	1
WS1/WS1a	1854181	5868903	3
WS2	1854082	5868819	1
WS3	1853606	5868996	1
WS4	1853648	5869045	1
WS5	1851895	5866931	1
WS6	1850926	5866929	1
WS10	1850449	5868906	1
WS8	1850398	5868860	1
Warm Spring	1850320	5868757	7
TSW1	1848790	5868640	2
TSW2	1848680	5868600	2
TSW3	1848660	5868470	2
TSW4	1849090	5868170	2
TSW5	1849120	5868020	1
THS1	1850920	5868310	1
WS	1850270	5868710	2
LS1	1851390	5872550	1
LS2	1850750	5871930	1
LS3	1850770	5871790	1
LS4	1850630	5871200	1
LS5	1850750	5871100	1
LS6	1850480	5870630	1
LS7	1850380	5870700	1
LS8	1849940	5870600	1
LS9	1849910	5870350	1
LS10	1849580	5870360	1

Figure 4-5: Gauging stations – spatial distribution.

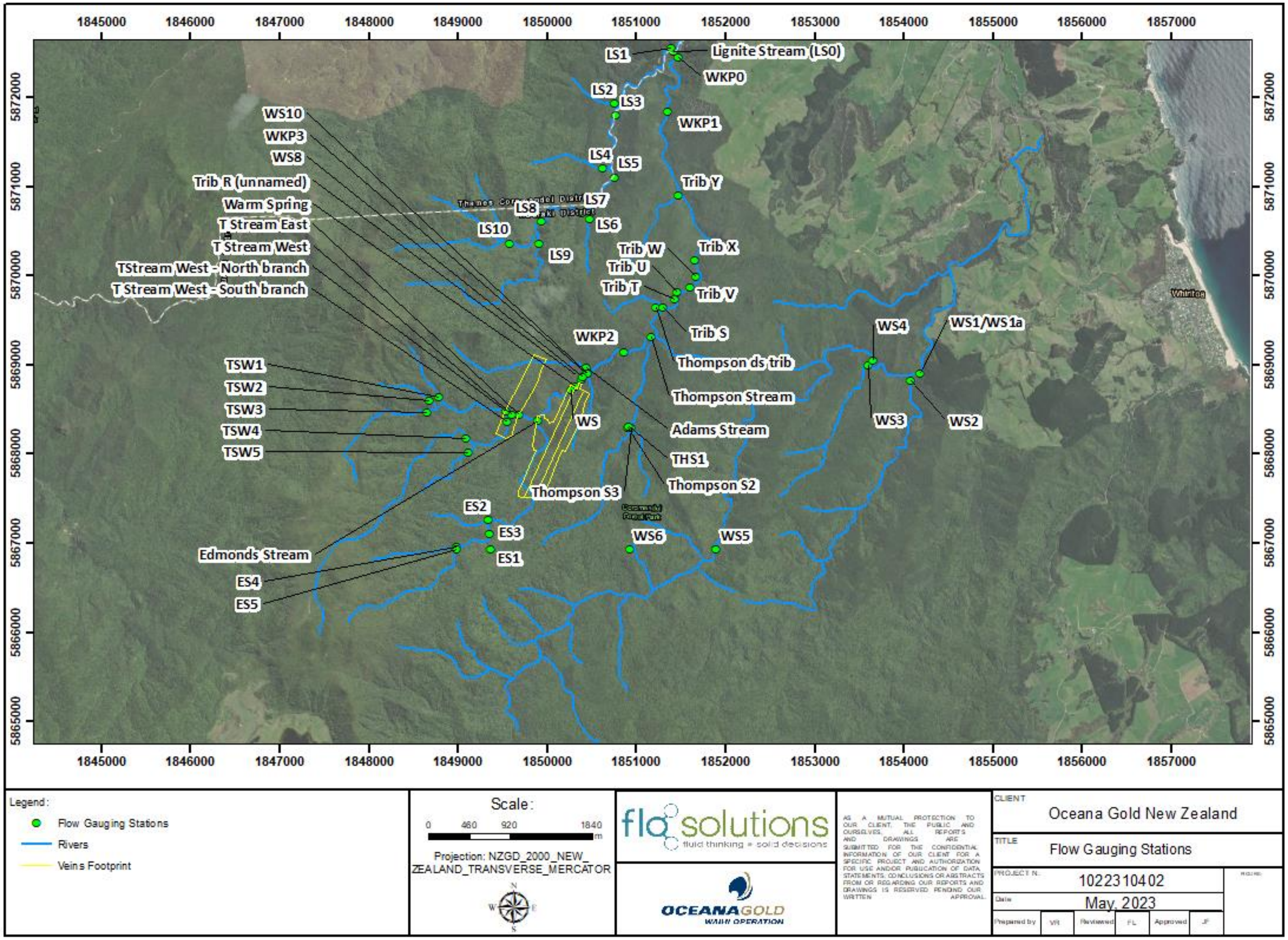


Figure 4-6: Flow rate and rainfall at WKP01 from 08/2021 to 08/2022.

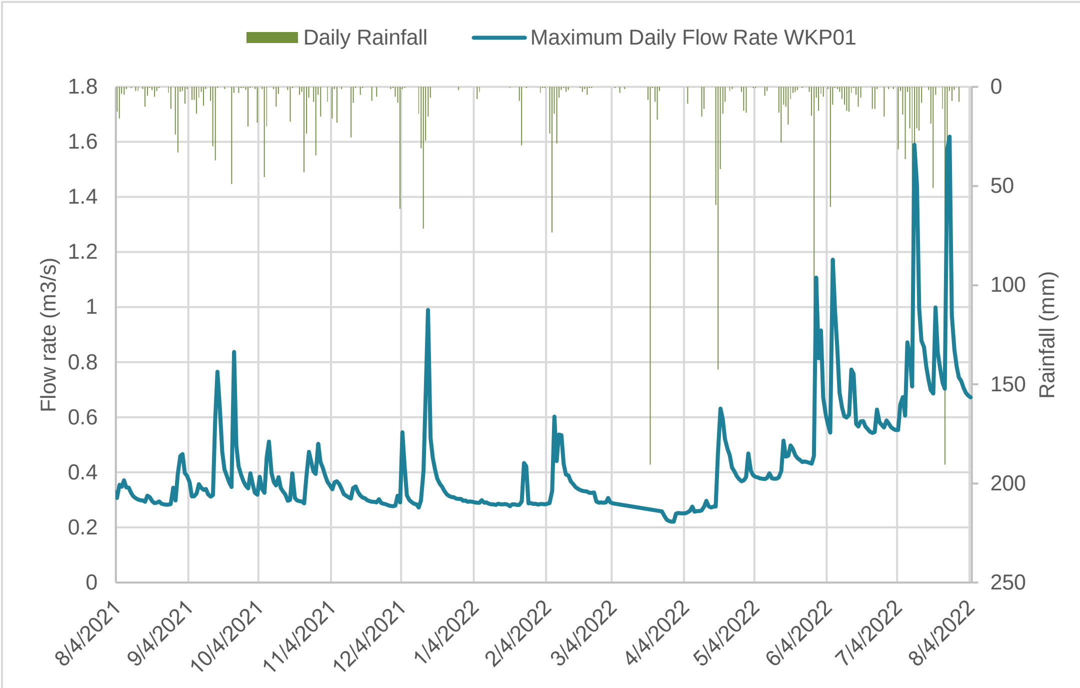


Figure 4-7: Flow rate and rainfall at WKP02 from 08/2021 to 08/2022.

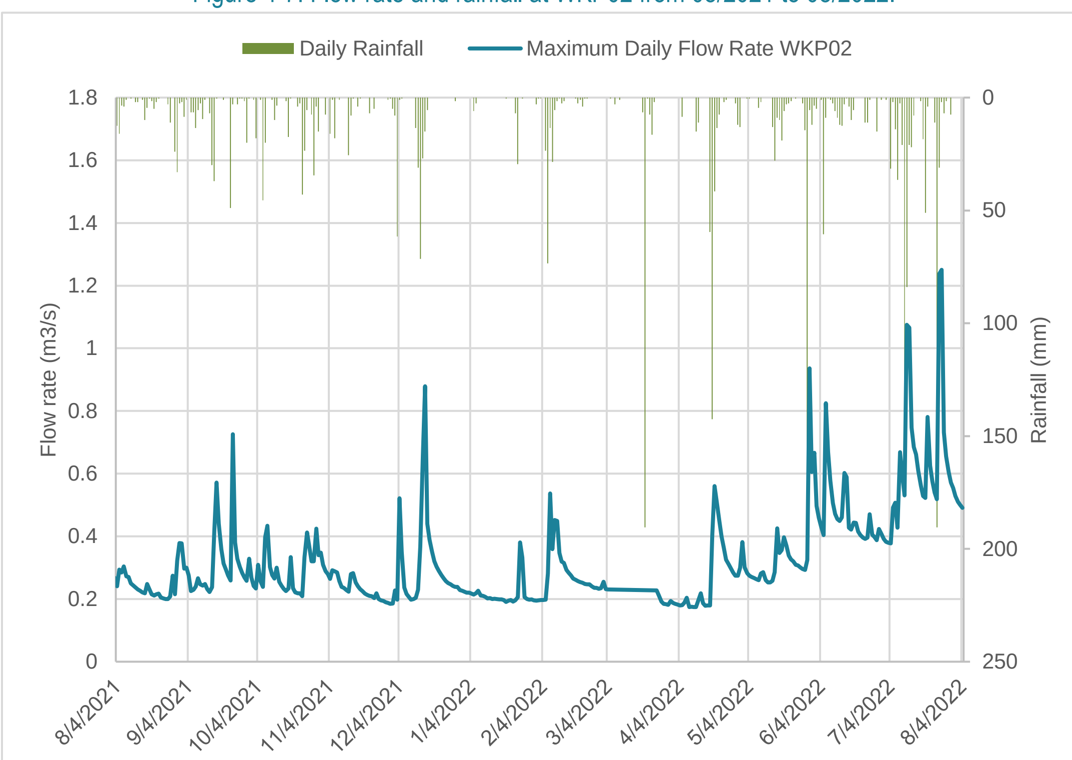


Figure 4-8: Flow rate and rainfall at WKP03 from 08/2021 to 08/2022.

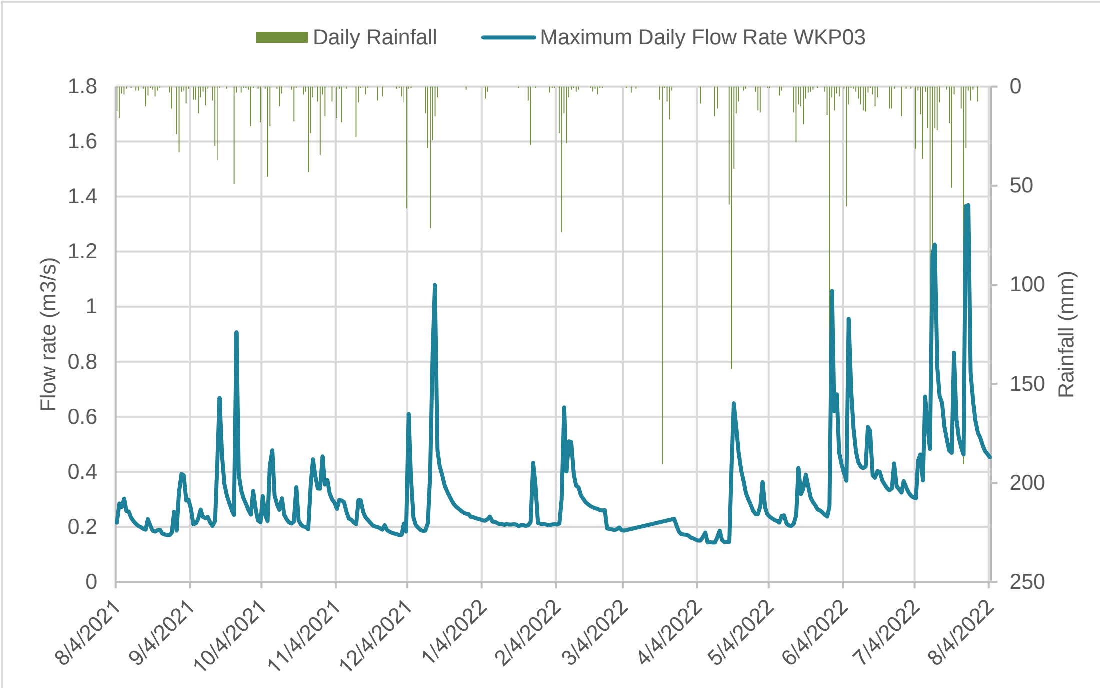


Figure 4-9: Flow rate and rainfall at T-Stream East from 08/2021 to 08/2022.

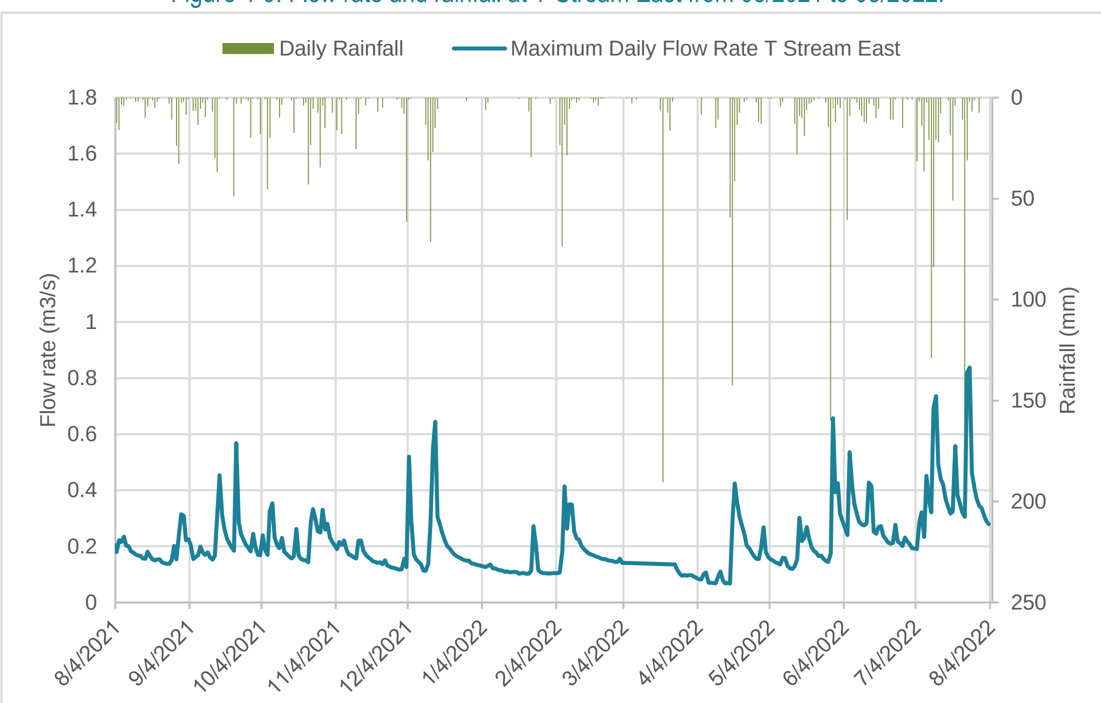
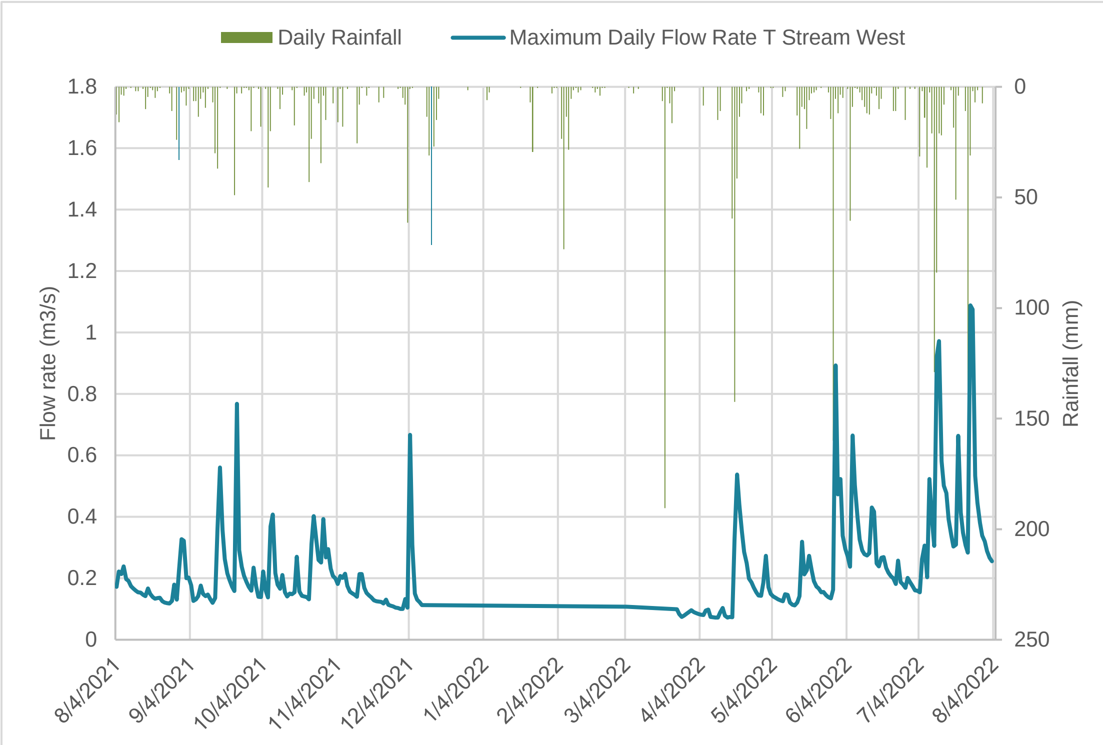


Figure 4-10: Flow rate and rainfall at T-Stream West from 08/2021 to 08/2022.



As shown in the graphs above, rainfall, despite being quite regular and constant throughout the year, still shows some seasonality (higher precipitation during the winter and lower precipitation during the summer).

A strong correlation can also be observed between rain peaks and flow peaks. River flow rates also show a positive trend when rainfall is high and constant, showing that the soil absorption capacity reaches a top limit from which all additional rainfall should be completely converted into stream flow. All details related to hydrology analysis should be part of the GHD report under development.

4.4 Groundwater monitoring network

Installation of the WUG project groundwater monitoring system started in 2019 with some localized standpipe piezometers, constructed of open PVC blank casing, with a single specific interval of slotted screen. The piezometer network at the site consists of 5 pairs of co-located standpipe piezometers installed at different depth intervals.

In June 2021 OGNZL started a program of installation of vibrating wire piezometers (VWPs) in angled exploration boreholes to provide more information on water pressures and to improve the overall groundwater level monitoring system. VWPs are equipped with continuous data recording.

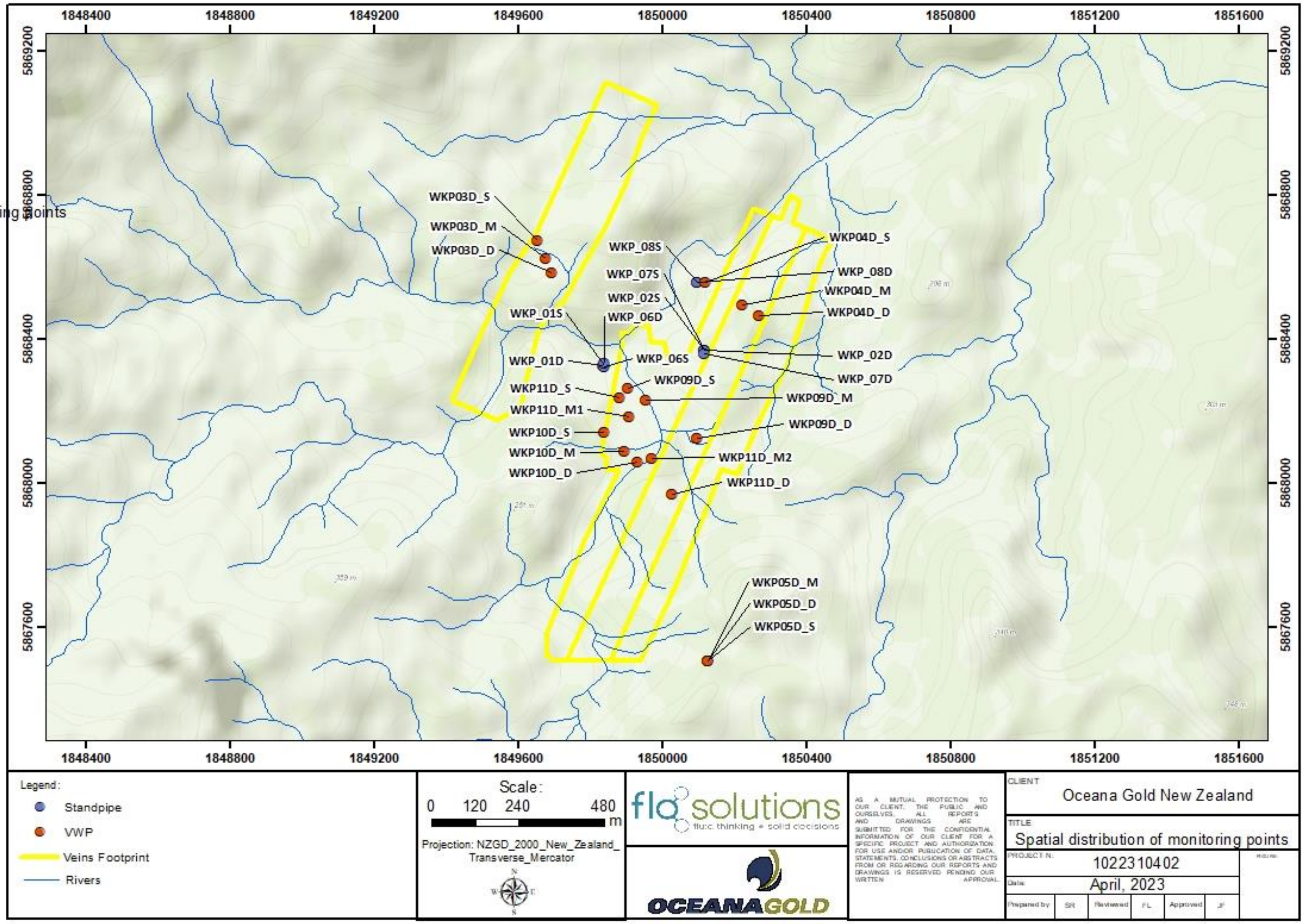
Currently, there are a total of 29 VWPs and piezometers installed at site, which in general have been monitored since their installation. The spatial distribution at site is still a limitation, mainly due to environmental restrictions to drill outside of licensed drilling pads. Table 4-3 provides information on location and elevation of monitoring points. Figure 4-11 presents the spatial distribution of the monitoring points.

Table 4-3: Monitoring points installed in the project area.

Name	X	Y	Type	Dip	Azimuth	Pad	Installation Date	Tip / screen (mamsl)	Model Geology
WKP_01S	1849837	5868326	Standpipe	90	0	Drill Site 1	Sep-19	166.0	Rhyolite Volcaniclastics
WKP_01D	1849835	5868326	Standpipe	90	0	Drill Site 1	Sep-19	136.0	Rhyolite Volcaniclastics
WKP_02S	1850115	5868370	Standpipe	90	0	Drill Site 5 / South Helipad	Oct-19	185.0	North Rhyolite Flow Dome
WKP_02D	1850116	5868370	Standpipe	90	0	Drill Site 5 / South Helipad	Oct-19	158.0	North Rhyolite Flow Dome
WKP_06S	1849837	5868324	Standpipe	90	0	Drill Site 1	Oct-22	66.1	Rhyolite Volcaniclastics
WKP_06D	1849837	5868335	Standpipe	90	0	Drill Site 1	Oct-22	-14.4	North Rhyolite Flow Dome
WKP_07S	1850116	5868369	Standpipe	90	0	Drill Site 5 / South Helipad	Sep-22	120.4	North Rhyolite Flow Dome
WKP_07D	1850116	5868359	Standpipe	78	106	Drill Site 5 / South Helipad	Sep-22	40.3	Main EG Vein
WKP_08S	1850095	5868559	Standpipe	90	0	Drill Site 4	Sep-22	163.2	North Rhyolite Flow Dome
WKP_08D	1850095	5868559	Standpipe	90	0	Drill Site 4	Sep-22	139.6	North Rhyolite Flow Dome
WKP03D_S	1849653	5868673	VWP	50	156	North Camp	Jun-21	222.9	Post Mineral Andesite Cover
WKP03D_M	1849675	5868625	VWP	50	156	North Camp	Jun-21	162.7	North Rhyolite Flow Dome
WKP03D_D	1849693	5868585	VWP	50	156	North Camp	Jun-21	110.6	T-Stream Vein
WKP04D_S	1850120	5868560	VWP	60	122	Drill Site 4	Sep-21	131.4	North Rhyolite Flow Dome
WKP04D_M	1850221	5868497	VWP	60	122	Drill Site 4	Sep-21	-49.6	Main EG Vein
WKP04D_D	1850267	5868467	VWP	60	122	Drill Site 4	Sep-21	-120.5	Main EG Vein
WKP05D_S	1850126	5867507	VWP	90	0	Drill Site 6	Feb-22	139.0	Post Mineral Andesite Cover
WKP05D_M	1850126	5867507	VWP	90	0	Drill Site 6	Feb-22	69.0	Rhyolite Volcaniclastics
WKP05D_D	1850126	5867507	VWP	90	0	Drill Site 6	Feb-22	9.0	Eastern Rhyolite Intrusive Dome
WKP09D_S	1849905	5868266	VWP	22	127	Drill Site 1	Sep-22	148.2	Western EG veins
WKP09D_M	1849952	5868232	VWP	22	127	Drill Site 1	Sep-22	126.3	North Rhyolite Flow Dome
WKP09D_D	1850095	5868125	VWP	22	127	Drill Site 1	Sep-22	57.7	Main EG Vein
WKP10D_S	1849836	5868142	VWP	44	131	Drill Site 8	Oct-22	137.3	Rhyolite Volcaniclastics
WKP10D_M	1849894	5868090	VWP	44	131	Drill Site 8	Oct-22	83.4	Western EG veins

Name	X	Y	Type	Dip	Azimuth	Pad	Installation Date	Tip / screen (mamsl)	Model Geology
WKP10D_D	1849929	5868059	VWP	44	131	Drill Site 8	Oct-22	44.7	Rhyolite Volcaniclastics
WKP11D_S	1849881	5868238	VWP	27	152	Drill Site 1	Nov-22	134.8	Western EG veins
WKP11D_M1	1849907	5868185	VWP	27	152	Drill Site 1	Nov-22	105.7	Western EG veins_North Rhyolite Flow Dome
WKP11D_M2	1849969	5868070	VWP	27	152	Drill Site 1	Nov-22	40.0	Rhyolite Volcaniclastics_Eastern Rhyolite Intrusive Dome
WKP11D_D	1850026	5867971	VWP	27	152	Drill Site 1	Nov-22	-20.3	Main EG Vein

Figure 4-11: Spatial distribution of monitoring points.



4.5 Hydraulic testing data

A hydraulic testing program was implemented in 2021 and continued in 2022. In general, two types of tests have been conducted 1) packer tests in open exploration boreholes and 2) falling head tests in constructed piezometers. The hydraulic testing program is summarized in Table 4-4.

Table 4-4: Hydraulic testing summary by year

Test conducted by	Year	Test Type	Number of Tests
Golder	2021	Packer	36
WSP	2022	Packer	11
OGNZL	2022	Falling Head	10

Most tests are packer tests conducted in angled exploration boreholes targeting the EG-Vein system. As a result, much of the hydraulic testing data is in the hanging wall, or in the EG vein system itself. Additional tests were conducted on vent shaft locations and the T-stream veins. Table 4-5 provides details of the hydraulic testing locations and results, more detailed information is presented in Section 5.3

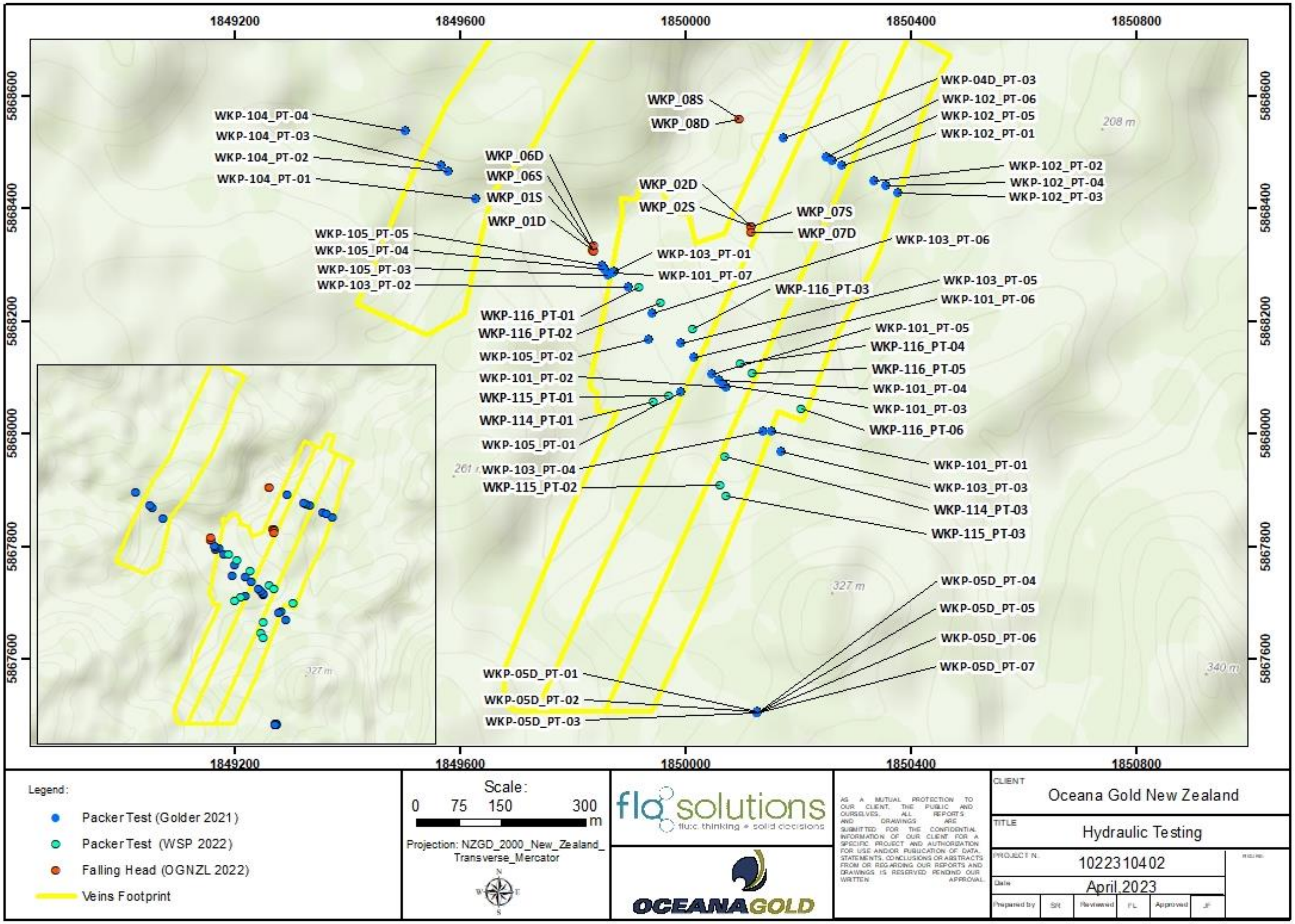
Table 4-5: Hydraulic testing locations and results

Test ID	Year	Tested by	X (m)	Y (m)	From (mbgs)	To (mbgs)	Type	Test El. (mamsl)	K (m/s)	Unit / Lithology
WKP-101_PT-01	2021	Golder	1850151	5868006	468.3	480.9	PT	16.8	2.5E-06	Eastern Rhyolite Intrusive Dome
WKP-101_PT-02	2021	Golder	1850072	5868083	354.1	359.6	PT	58.0	6.9E-06	Main EG Vein
WKP-101_PT-03	2021	Golder	1850068	5868087	348.7	354.2	PT	59.9	7.8E-06	Main EG Vein
WKP-101_PT-04	2021	Golder	1850058	5868097	333.1	339.6	PT	65.2	8.0E-07	Eastern Rhyolite Intrusive Dome
WKP-101_PT-05	2021	Golder	1850047	5868107	318.1	323.6	PT	70.6	1.3E-06	Contact: Rhyolite Volcaniclastics / Eastern Rhyolite Intrusive Dome
WKP-101_PT-06	2021	Golder	1850015	5868137	270.1	276.6	PT	86.7	3.8E-06	Rhyolite Volcaniclastics
WKP-101_PT-07	2021	Golder	1849871	5868286	50.0	55.5	PT	162.8	3.3E-06	Rhyolite Volcaniclastics
WKP-102_PT-01	2021	Golder	1850276	5868477	214.6	231.3	PT	91.3	3.5E-06	Main EG Vein
WKP-102_PT-02	2021	Golder	1850334	5868449	289.6	300.6	PT	58.9	7.8E-07	North Rhyolite Flow Dome
WKP-102_PT-03	2021	Golder	1850377	5868428	340.0	360.6	PT	32.3	3.3E-07	North Rhyolite Flow Dome
WKP-102_PT-04	2021	Golder	1850354	5868440	289.0	360.6	PT	46.9	8.4E-07	North Rhyolite Flow Dome
WKP-102_PT-05	2021	Golder	1850259	5868486	199.0	204.5	PT	100.2	8.6E-06	North Rhyolite Flow Dome
WKP-102_PT-06	2021	Golder	1850249	5868491	187.0	192.5	PT	105.2	9.1E-06	North Rhyolite Flow Dome
WKP-103_PT-01	2021	Golder	1849872	5868288	53.6	62.0	PT	157.5	5.8E-08	Rhyolite Volcaniclastics
WKP-103_PT-02	2021	Golder	1849897	5868261	96.3	100.3	PT	138.4	4.2E-07	Contact: Western veins / Rhyolite Volcaniclastics
WKP-103_PT-03	2021	Golder	1850169	5867968	531.5	555.1	PT	-54.9	7.6E-06	Eastern Rhyolite Intrusive Dome
WKP-103_PT-04	2021	Golder	1850137	5868004	488.0	491.5	PT	-31.8	3.1E-05	Main EG Vein

Test ID	Year	Tested by	X (m)	Y (m)	From (mbgs)	To (mbgs)	Type	Test El. (mamsl)	K (m/s)	Unit / Lithology
WKP-103_PT-05	2021	Golder	1849992	5868161	251.0	254.5	PT	70.2	1.5E-06	Rhyolite Volcaniclastics
WKP-103_PT-06	2021	Golder	1849941	5868214	170.0	172.5	PT	105.6	1.1E-05	Contact: North Rhyolite Flow Dome / Western veins
WKP-104_PT-01	2021	Golder	1849627	5868418	445.6	450.4	PT	65.4	4.1E-06	North Rhyolite Flow Dome
WKP-104_PT-02	2021	Golder	1849578	5868466	372.2	375.7	PT	92.3	1.1E-07	North Rhyolite Flow Dome
WKP-104_PT-03	2021	Golder	1849566	5868478	354.2	358.7	PT	98.8	3.2E-07	North Rhyolite Flow Dome
WKP-104_PT-04	2021	Golder	1849502	5868539	258.2	261.7	PT	137.3	9.8E-08	North Rhyolite Flow Dome
WKP-105_PT-01	2021	Golder	1849991	5868075	385.5	390.0	PT	-73.0	5.7E-06	Eastern Rhyolite Intrusive Dome
WKP-105_PT-02	2021	Golder	1849933	5868167	244.8	248.3	PT	17.7	7.5E-06	North Rhyolite Flow Dome
WKP-105_PT-03	2021	Golder	1849861	5868283	61.3	66.3	PT	138.3	1.7E-07	Rhyolite Volcaniclastics
WKP-105_PT-04	2021	Golder	1849856	5868292	48.2	52.2	PT	147.6	1.4E-06	Rhyolite Volcaniclastics
WKP-105_PT-05	2021	Golder	1849852	5868299	37.3	41.3	PT	155.0	9.9E-08	Rhyolite Volcaniclastics
WKP-04D_PT-03	2021	Golder	1850174	5868526	174.4	179.9	PT	28.5	1.6E-06	North Rhyolite Flow Dome
WKP-05D_PT-01	2021	Golder	1850126	5867507	36.7	69.1	PT	221.1	2.1E-07	Post Mineral Andesite Cover
WKP-05D_PT-02	2021	Golder	1850127	5867507	65.5	117.2	PT	182.7	2.0E-08	Post Mineral Andesite Cover
WKP-05D_PT-03	2021	Golder	1850127	5867506	121.7	173.4	PT	126.5	7.9E-09	Contact: Rhyolite Volcaniclastics / Post Mineral Andesite Cover
WKP-05D_PT-04	2021	Golder	1850127	5867506	176.9	202.6	PT	84.3	2.4E-09	Rhyolite Volcaniclastics
WKP-05D_PT-05	2021	Golder	1850126	5867506	223.9	249.9	PT	37.1	3.2E-09	Eastern Rhyolite Intrusive Dome
WKP-05D_PT-06	2021	Golder	1850126	5867506	270.1	298.8	PT	-10.4	3.8E-09	Eastern Rhyolite Intrusive Dome
WKP-05D_PT-07	2021	Golder	1850126	5867505	303.1	380.8	PT	-67.9	3.8E-10	Eastern Rhyolite Intrusive Dome
WKP-116_PT-01	2022	WSP	1849917	5868262	103.3	109.0	PT	144.0	4.8E-07	Western EG veins
WKP-116_PT-02	2022	WSP	1849954	5868234	155.2	156.7	PT	126.3	1.0E-10	Contact: North Rhyolite Flow Dome / Rhyolite Volcaniclastics
WKP-116_PT-03	2022	WSP	1850012	5868188	233.2	236.7	PT	98.5	3.6E-07	EG Stockwork zone
WKP-116_PT-04	2022	WSP	1850096	5868125	343.7	349.2	PT	57.3	1.8E-06	Main EG Vein
WKP-116_PT-05	2022	WSP	1850118	5868108	376.7	379.2	PT	46.4	1.4E-06	Main EG Vein
WKP-116_PT-06	2022	WSP	1850205	5868045	484.3	501.9	PT	4.3	4.9E-07	Eastern Rhyolite Intrusive Dome
WKP-115_PT-01	2022	WSP	1849969	5868069	316.5	322.0	PT	39.0	2.3E-07	Eastern Rhyolite Intrusive Dome
WKP-115_PT-02	2022	WSP	1850061	5867909	525.3	529.8	PT	-57.0	2.6E-06	Main EG Vein
WKP-115_PT-03	2022	WSP	1850072	5867890	539.7	562.4	PT	-70.0	4.8E-07	Main EG Vein
WKP-114_PT-01	2022	WSP	1849942	5868057	298.3	301.8	PT	34.0	3.2E-06	Contact: EG stockwork / Rhyolite Volcaniclastics
WKP-114_PT-03	2022	WSP	1850069	5867961	511.3	526.6	PT	-115.7	7.6E-07	Main EG Vein
WKP_01S	2022	OGNZL	1849837	5868326	15.4	15.5	FH	166.0	4.6E-10	Rhyolite Volcaniclastics
WKP_01D	2022	OGNZL	1849835	5868326	45.4	45.5	FH	136.0	6.6E-10	Rhyolite Volcaniclastics
WKP_02S	2022	OGNZL	1850115	5868370	40.0	40.5	FH	185.0	6.0E-10	North Rhyolite Flow Dome
WKP_02D	2022	OGNZL	1850116	5868370	60.0	67.5	FH	158.0	4.0E-09	North Rhyolite Flow Dome
WKP_06S	2022	OGNZL	1849837	5868324	119.5	117.5	FH	66.1	3.9E-10	Rhyolite Volcaniclastics

Test ID	Year	Tested by	X (m)	Y (m)	From (mbgs)	To (mbgs)	Type	Test El. (mamsl)	K (m/s)	Unit / Lithology
WKP_06D	2022	OGNZL	1849837	5868335	200.0	198.0	FH	-14.4	3.8E-08	North Rhyolite Flow Dome
WKP_07S	2022	OGNZL	1850116	5868369	105.0	103.5	FH	120.4	3.7E-10	North Rhyolite Flow Dome
WKP_07D	2022	OGNZL	1850116	5868359	184.4	183.6	FH	40.3	2.8E-07	Main EG Vein
WKP_08S	2022	OGNZL	1850095	5868559	16.0	15.0	FH	163.2	1.3E-07	North Rhyolite Flow Dome
WKP_08D	2022	OGNZL	1850095	5868559	39.6	38.6	FH	139.6	6.2E-08	North Rhyolite Flow Dome

Figure 4-12: Spatial distribution of hydraulic tests.



5. HYDROGEOLOGY

5.1 Hydrostratigraphic units

A hydrostratigraphic unit refers to a group of adjacent rocks or units that have similar properties with respect to groundwater occurrence and flow. In a review of the concept, (Seaber, 1988) redefined the term as "a body of rock distinguished and characterized by its porosity and permeability". While this division may be related to lithology, it is possible for rocks of different lithologies to form a single hydrostratigraphic unit – for example in a fractured rock aquifer, where the host rocks have low primary permeability and water movement is controlled by fractures. Delineation of these hydrostratigraphic units subdivides the geologic framework into relatively more or less permeable portions and thus aids in definition of the flow system.

An aquifer is a geological unit, or series of hydraulically connected geological units, which has sufficient porosity and permeability to store and transmit (yield) significant amounts of groundwater (definition modified from (Krešić & Mikszewski, 2013), p. 49)

The terms aquitard and aquifuge have all been used to describe the relative transmission properties of less permeable confining beds. An aquitard is a saturated unit that retards but does not prevent flow and is able to transmit small quantities of water. Sandy clay is an example of an aquitard unit. An aquifuge is an impermeable geologic formation that is neither porous nor permeable, meaning that it cannot store or transmit water. Compact basement rock that is both unfractured and un-weathered is an example of an aquifuge. In modern hydrogeology, the term aquitard is usually preferred, recognizing that all rocks have permeability at some scale.

The main hydrostratigraphic units are described below.

Unsaturated zone

This hydrostratigraphic unit includes the upper, near surface zone including soil regolith and weathered bedrock above the static water table, where saturation is variable, and flow processes are dominated by interflow. Interflow, also known as subsurface runoff, is a type of rapid water movement occurring in the partially saturated zone above the water table. It involves shallow percolation into fractured rock after rainfall events, followed by lateral to subvertical flow towards nearby discharge points (stream channels). This combination of infiltration, subsurface runoff, and discharge may leak some water vertically, providing recharge to the underlying shallow groundwater system. Interflow is common at sites with thin soil cover, fractured bedrock host rock, and relatively high vertical relief.

The unsaturated zone is considered a type of variably or intermittently saturated zone and may be dry during parts of the year. As such, it is neither an ‘aquifer’ nor ‘aquitard’ by standard definition.

Interflow has been observed in the in this unit at site, and is most evident in steeply incised stream canyons, where water can be observed seeping out of fractures in canyon walls – even in the absence of recent rain events. Information around this zone is quite restricted due to spatial distribution of drillings. The available data, and interpretations from the overall hydrological setting, suggest that the surface water bodies at the site are very dependent on this shallow zone for recharge.

Some very shallow hydraulic tests have resulted in very low interpreted K values in this zone, probably because the zone was not fully saturated when tested using falling head tests.

Shallow groundwater aquifer

The shallow groundwater aquifer is the zone of constant saturation in the upper ~50 m below ground surface, where the processes of fracturing and weathering have increased the permeability of the host rocks. It appears to be present across most of the site, irrespective of the underlying geology. Notwithstanding this observation, it is important to note that the aquifer may be hosted in two distinct rock types:

- Rhyolite volcaniclastics / rhyolite flow domes – these are the dominant rock type in the mine domain.
- Post-mineral andesite cover – this is the dominant exposed rock type outside the mine domain, which hosts the shallow aquifer in much of the project area.

Where post-mineral andesite cover is thick (10’s of meters), the un-weathered zone may substantially restrict vertical groundwater movement between the shallow aquifer and deeper aquifers, as regional andesites are known to be low permeability and not water bearing from past mining at Waihi. This has potential implications for predictions of mining impacts. However, at present, the hydraulic properties of un-weathered andesite in the WUG project area have not been established. The few hydraulic tests in this unit in WKP-05D are within the ranges obtained for the RV and RFD units.

It is important to note that both the ‘unsaturated zone and ‘shallow groundwater zone’ are hosted by the same weathered bedrock lithology. The characterization as two hydrostratigraphic units reflects the level of saturation and dominant flow processes. Groundwater levels measured in the unsaturated zone have variable saturation and show a rapid and significant response to rainfall events, confirming that this unit is recharged by direct rainfall recharge or, more likely, vertical percolation and recharge during interflow processes following rain events. Piezometers a little deeper, in the shallow groundwater aquifer, have more stable water levels (although they still fluctuate), and this zone remains saturated year-round.

Surface water – groundwater interactions are discussed in subsequent sections.

Clay alteration zone - Aquitard

The clay alteration zone is a zone of hydrothermal alteration, as described in Section 2.7.3 that directly overlies most of the EG vein area. Based on the core and geophysical review carried out by FloSolutions in March 2023 (1022310402-R-01), this zone is expected to be low permeability, acting as a natural flow barrier between the shallow groundwater system and the deeper groundwater system described below. Recent work by FloSolutions has extended the footprint of this alteration zone beyond areas previously mapped, as discussed previously (see Figure 2-24: Clay alteration – Leapfrog solid.)

This hydrostratigraphic unit is an important local aquitard. Strong water level fluctuations in the shallow aquifer in response to rainfall, and the lack of these responses in the deeper aquifer are attributed, in part, to the presence of this layer and its role in limiting connections between them. This low-permeability aquitard also plays an important role in maintaining strong downward vertical gradients between the shallow and deeper EG Vein aquifer.

EG-Vein - Aquifer

The west-dipping EG-Vein is the largest vein structure at Wharekirauponga, as described in Section 2.7.3 . The quartz veins were deposited from silica-saturated hydrothermal fluids due to typical ore-forming processes (e.g. boiling, etc). These fluids travelled upwards along zones of weakness like the Edmunds fault and formation contacts, forming veins via precipitation of quartz, frequently accompanied by silica flooding in surrounding host rocks. The main vein contains “a complex variety of textures indicating multiple episodes of formation”, including brecciated intervals (Panterra Geoservices Inc., 2019), and has been overprinted by later hydrothermal alteration. The resulting vein systems are brittle and subject to fracturing, with significant secondary porosity. As a result, aquifer tests in the EG vein system consistently return higher hydraulic conductivity values than most other hydrostratigraphic units (discussed below).

Because exploration drilling has explicitly targeted the EG-Vein, there is more information on the geologic and hydrogeologic properties of this unit than other hydrostratigraphic units. Drilling information and hydraulic testing show an important fracturing grade and regular existence of voids (both related to strong secondary porosity development). However, while hydraulic testing and water levels in the EG-Vein aquifer suggest a single aquifer system, the scale and degree of the hydraulic connections along strike in this aquifer have not been established.

Despite of lacking a long-term pumping test in this aquifer – to improve the understanding about how a hydraulic stress would propagate along the vein strike – available information including hydraulic tests suggests that the vein zone hosts the deep aquifer at the site (major capacity to store and transmit a significant amount of groundwater in the deep aquifer system). Across most of the Wharekirauponga area, groundwater levels in the EG-vein show little to no hydraulic connection with overlying streams

T-Stream Vein

The T-Stream vein has been investigated, but not to the same extent as the EG-Vein. Review of core logs indicates intermittent oxidation and staining in the vein at depth (hundreds of meters), suggesting variable saturation, but VWPs installed in and around the vein system are dry – or show pressure heads equivalent to the VWP elevation. The T-Stream vein does not appear to be in hydraulic connection with the overlying T-Stream.

The role of this unit in the site groundwater flow system is not clear, but it is not expected to be significant.

Intrusive Domes - Aquitard

The Eastern rhyolite intrusive dome, North and South Rhyolite flow domes, and Western Rhyolite Dome are dome-shaped intrusive igneous bodies that were intruded into the tuff sequence at WUG. Primary porosity of these intrusions is low, but may be locally enhanced due to alteration and fracturing.

Since the porosity (secondary porosity) would be expected to be limited to the zones where fracturing systems are more prominent, these zones are considered aquitards surrounding the main aquifer system.

However, the North Rhyolite Flow Dome hosts a significant part of the EG vein system and has been subject to more significant fracturing and hydrothermal alteration than other units. As a result, it exhibits higher permeability than other intrusive domes (discussed below) and is likely connected hydraulically to the EG vein system, at least locally.

Rhyolite Volcaniclastics – Aquitard

The Rhyolite volcaniclastics (RV) unit is one of the main geological units forming the lithological framework of the site. As discussed in earlier sections, it is relatively uniform in composition, and although different compositional variations have been identified, they have similar RQD values and permeabilities (FloSolutions, Clay Alteration Review and Rhyolite Volcaniclastics differentiation, 2022). The RV unit is the host rock for the majority of the domes, veins and dykes identified onsite, and based on its massive nature is assumed to extend beyond the immediate project area.

Based on the overall conditions of the unit (massive, sometimes banded, low to mid fracturing) it is expected for this unit to act as an aquitard, with local variations. The widest range of K values has been identified in this unit – ranging over 4 orders of magnitude – due primarily to post-emplacement alteration and fracturing. For example, in the areas subject to the EG-Vein development, alteration and fracturing has occurred, increasing the overall K. Areas distal from the vein systems have lower K values.

5.2 Distribution of Hydrostratigraphic units

The known extent of geologic units is relatively limited, and is based on mapping, drilling, and geophysics in the immediate WUG development area. Using the regional framework, geologic principles, and available data, OGNZL exploration geologists have extended these units to the edges of the geological model domain. The geological model domain encompasses an area of 48 km^2, while the study domain, covering the Wharekirauponga catchment, covers an area of approximately 22.5 km^2.

The extents of hydrostratigraphic units have been compiled from:

- OGNZL Geological Model.
- Alteration Model

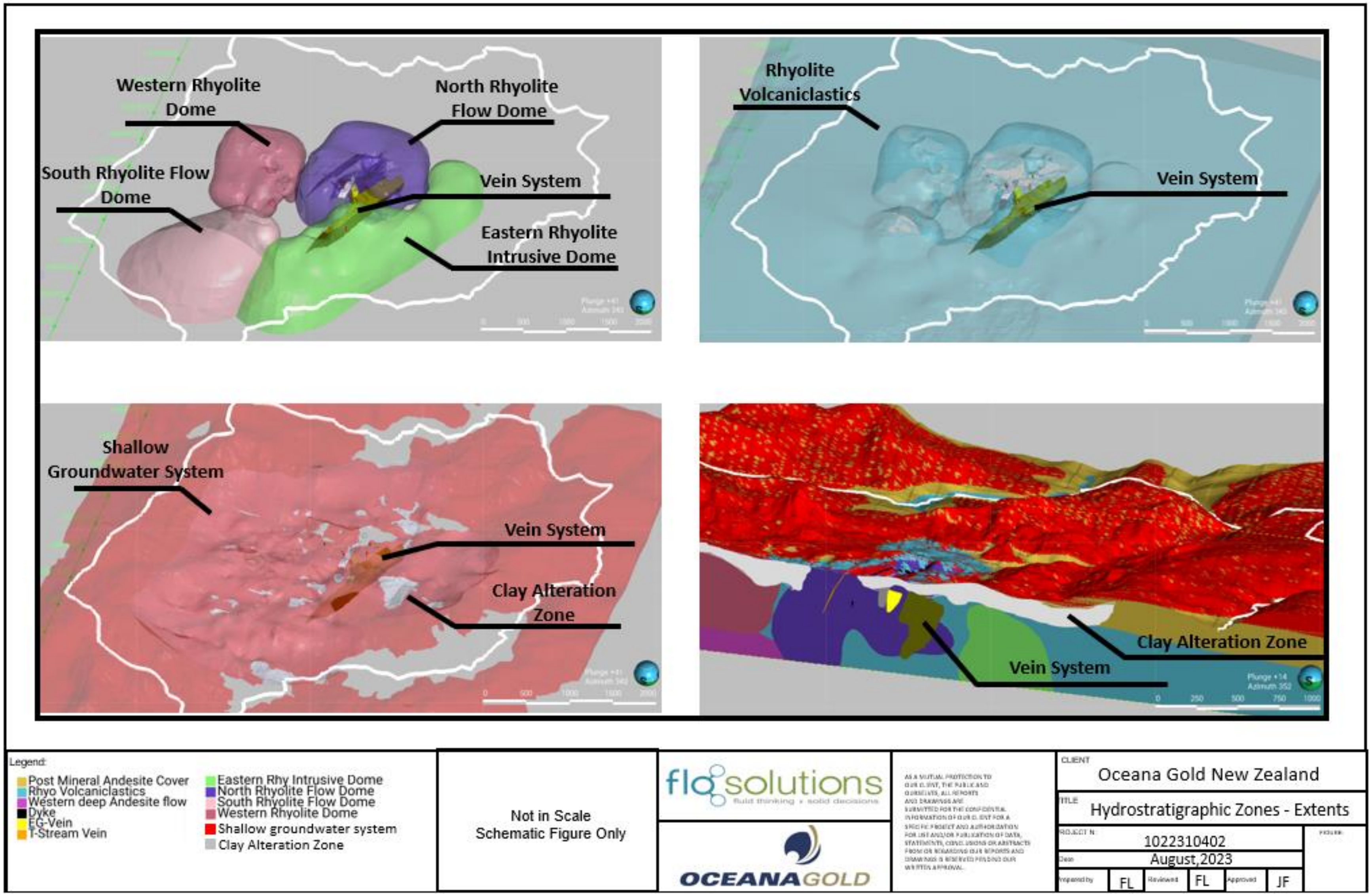
Table 5-1 summarizes approximate unit dimensions. Thicknesses can be quite variable depending on the geometry of each unit; values presented were based on a representative section along the EG-Vein / T-Stream Vein area while the extent of the hydrostratigraphic units is illustrated in Figure 5-1.

Table 5-1: Hydrostratigraphic unit extents

Hydrostratigrafic Unit		Type	Length (m)	Width (m)	Thickness (m)
Unsaturated zone		Variable	6600	4200	10
Shallow groundwater system		Aquifer	6600	4000	50
Clay alteration zone		Aquitard	4500	3100	40
EG-Vein		Aquifer	1370	420	470
T-Stream Vein		?	970	13	370
Intrusive Domes	Eastern Rhyolite Intrusive Dome	Aquitard	3400	1100	530
	North Rhyolite Flow Dome	Aquitard*	1900	1600	600
	South Rhyolite Flow Dome	Aquitard	1900	1700	560
	Western Rhyolite Dome	Aquitard	1400	1000	500
Rhyolite Volcaniclastics		Aquitard*	6600	4200	520

*Local aquifer with higher hydraulic conductivity close to the EG Vein system.

Figure 5-1: Distribution of main hydrostratigraphic units



5.3 Hydrostratigraphic units – hydraulic properties

Details of hydraulic testing are presented in Section 4.5 ; 57 hydraulic tests completed at the site (47 Packer Tests and 10 Falling Head Tests). The spatial distribution is limited due to drilling pads arrangement and so the limitation of hydraulic tests in geological units and zones outside the EG-Vein area.

Hydraulic tests have been classified according to the Hydrostratigraphic unit where they have been completed in order to develop property ranges. The Table 5-2 below summarizes the results calculated from the statistical analysis.

Table 5-2: Summary of hydraulic parameters by hydrostratigraphic unit.

<table>
<tr><th colspan="2">Hydrostratigraphic Unit</th><th>Type</th><th>Number of Tests</th><th>Average K (m/s)</th><th>Geomean K (m/s)</th><th>Max K (m/s)</th><th>Min K (m/s)</th></tr>
<tr><td colspan="2">Unsaturated zone</td><td>Variable</td><td>3</td><td>6.4E-08</td><td>1.5E-08</td><td>1.3E-07</td><td>4.6E-10</td></tr>
<tr><td colspan="2">Shallow groundwater aquifer</td><td>Aquifer</td><td>11</td><td>4.8E-07</td><td>2.9E-08</td><td>3.3E-06</td><td>3.7E-10</td></tr>
<tr><td colspan="2">Clay alteration zone</td><td>Aquitard</td><td>0</td><td colspan="4">-</td></tr>
<tr><td colspan="2">EG-Vein</td><td>Aquifer</td><td>12</td><td>4.8E-06</td><td>1.7E-06</td><td>3.1E-05</td><td>2.8E-07</td></tr>
<tr><td colspan="2">T-Stream Vein</td><td>Aquitard</td><td>0</td><td colspan="4">-</td></tr>
<tr><td rowspan="4">Intrusive Domes</td><td>Eastern Rhyolite Intrusive Dome</td><td>Aquitard</td><td>9</td><td>1.9E-06</td><td>1.4E-07</td><td>7.6E-06</td><td>3.8E-10</td></tr>
<tr><td>North Rhyolite Flow Dome</td><td>Aquitard*</td><td>12</td><td>3.1E-06</td><td>3.5E-06</td><td>9.1E-06</td><td>9.8E-08</td></tr>
<tr><td>South Rhyolite Flow Dome</td><td>Aquitard</td><td>0</td><td colspan="4">-</td></tr>
<tr><td>Western Rhyolite Dome</td><td>Aquitard</td><td>0</td><td colspan="4">-</td></tr>
<tr><td colspan="2">Rhyolite Volcaniclastics</td><td>Aquitard*</td><td>4</td><td>1.3E-06</td><td>4.8E-08</td><td>3.8E-06</td><td>3.9E-10</td></tr>
</table>

*Locally an aquifer with higher hydraulic conductivity close to the EG Vein system

- **Unsaturated zone:** There is very little information in the unsaturated zone. A few standpipe piezometers are interpreted to be installed along this unit, where falling head tests have been completed (WKP-01S, WKP-08 S/D). Hydraulic conductivity is usually low (around 1E-8 m/s), probably due to the influence of the unsaturated zone on test results.
- **Shallow groundwater aquifer:** Most of the tests completed in the shallow aquifer are at depths of 35 to 60m below ground surface. Hydraulic conductivity can be quite variable, ranging from 3E-6 to 1E-8 m/s.
- **Clay alteration zone:** There is no direct information of hydraulic parameters of the clay alteration zone. Considering the composition of the unit, it's expected to be low permeability with low K. The properties of this unit will be evaluated during numerical model sensitivity analyses.
- **EG-Vein:** Tests in the EG-Vein form the most comprehensive dataset of hydraulic testing. This unit has the narrowest range in permeability, with relatively high K values of approximately 3E-05 to 3E-07 m/s. Considering that this unit is highly fractured, this is expected.

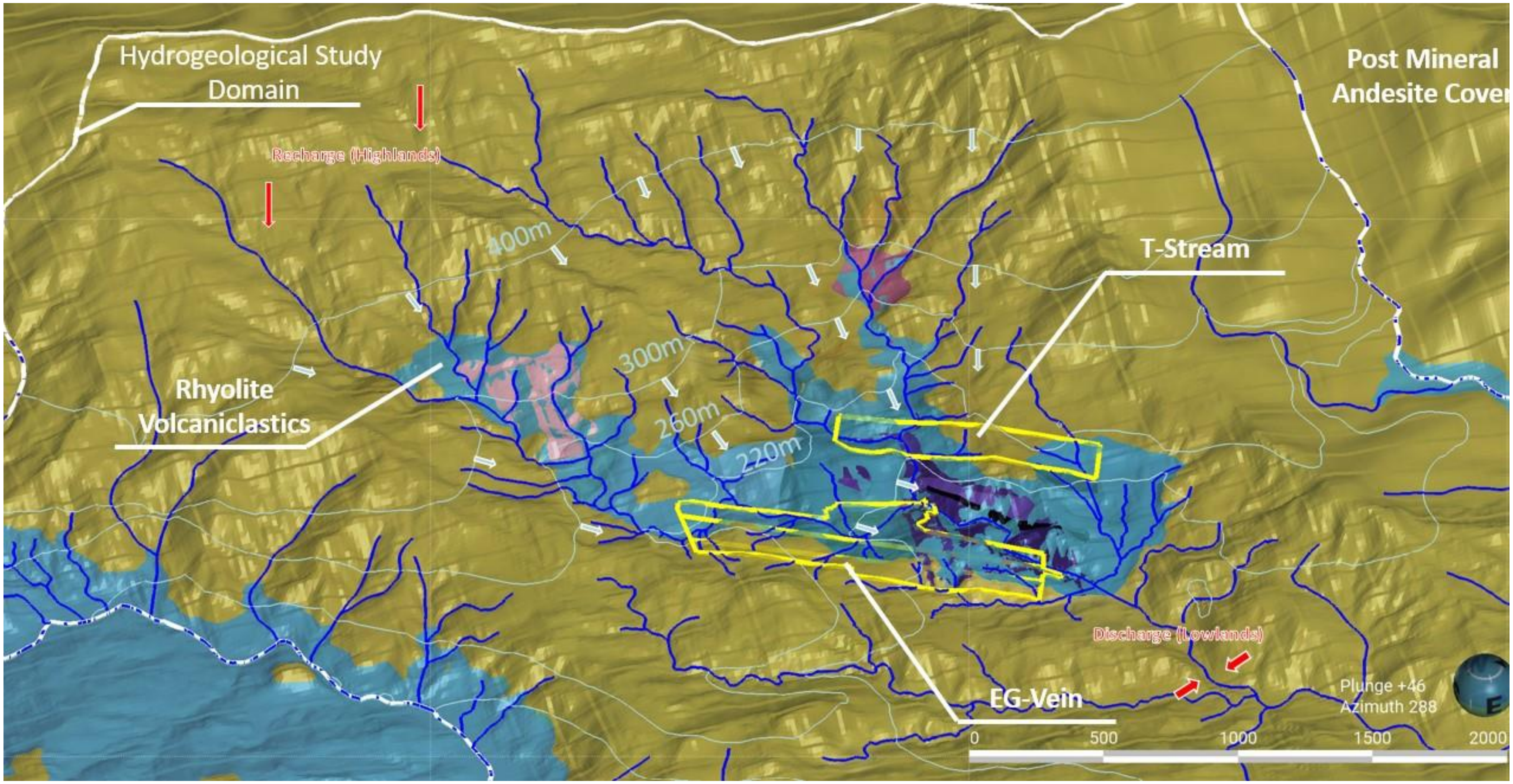
- **T-Stream Vein:** From the dataset analyzed, there is not much information in the zone of the EG-Vein, as previously mentioned. Of all 4 packer tests completed in the zone of the T-Stream, none has been completed in the Vein itself. The closest test is around 25m away from the vein and has resulted in a K value of 1.1E-7 m/s.
- **Intrusive Domes:** In total 21 tests were performed in domes. These were restricted to the North Rhyolite Flow Dome and Eastern Rhyolite Intrusive Dome. Hydraulic conductivities can be quite low in these units where they are intact and unfractured, with tests as low as 3.8E-10 m/s. However, where fractured near the EG vein system, K values are orders of magnitude higher, resulting in geomean values close to the EG vein aquifer geomean values. By extension, the South and Western rhyolite flow domes, which do not host the EG vein system, are expected to be low permeability.
- **Rhyolite Volcaniclastics:** Hydraulic conductivity of the RV unit can be quite variable depending on where the test has been completed. The test completed in the tunnel area, for example, has shown a very low K (2.4E-9 m/s), while tests completed in the region of VWP-09 have resulted in high hydraulic conductivities around 1E-6 m/s. This difference is likely related to the difference of fracturing near the EG vein, where it is more fractured and permeable, relative to rock quality outside the vein area (less fractured and permeable).

5.4 Regional groundwater flow

Regional groundwater flow follows roughly the main alignment of the Wharekirauponga catchment, flowing from the highlands in the SW portion of the study area to the lowlands at the NE zone (Figure 5-2). (GWS, 2022) interprets the regional groundwater flow to be perpendicular to the T-Stream vein in the western portion to the catchment, whereas the EG-Vein is near parallel to the groundwater through-flow direction.

Radon testing (GWS, 2022) suggests that aquifer discharge should be more significant in the lowlands along the main channel of the Wharekirauponga Stream.

Figure 5-2: Interpreted regional groundwater flow (in red: recharge and discharge zones; light blue: head contours.



5.5 Water levels and potentiometric surface

As discussed in Section 5.1 , there are two primary aquifers at site:

- The shallow aquifer, which is hosted in fractured bedrock, and generally occurs in the upper ~50m bgs
  - In the mine domain, the shallow aquifer is hosted in rhyolite volcaniclastics and rhyolite flow domes.
  - Outside of the mine domain, the shallow aquifer is hosted in post-mineral andesite cover, which may restrict interactions with deeper groundwater.
- The deeper 'EG Vein aquifer', which is hosted primarily by the EG vein system, extends locally into the immediately surrounding RV and north rhyolite flow dome where they are highly fractured adjacent to the vein system.

The water levels in these aquifers are substantially different, with the potentiometric surface in the shallow aquifer largely following topography, and the water levels in the deeper aquifer relatively flat to gently sloping. The deeper EG vein aquifer is believed to be drained to the north by the Edmonds Fault.

Water levels from shallow and deeper piezometers and VWPs were used to generate potentiometric surface contours for each aquifer. Because many of these instruments were installed in late 2022, data from January / February 2023 are used to generate these contours, when the most complete data set is available. These contours represent 'wet season' conditions and seasonal highs in the shallow groundwater table.

5.5.1 Shallow Aquifer

The water level data used to develop shallow aquifer piezometric contours is summarized in Table 5-3. The shallow aquifer contour map is presented as Figure 5-3. Due to data limitations, contours were generally constructed to reflect topography, keeping the water level surface below ground level by ~20 m.

Table 5-3: Piezometer water levels – shallow aquifer

Point	X	Y	Point elevation* (mamsl)	Water level (mamsl)**
WKP-P01S	1849840	5868330	166.0	171.8
WKP-P07S	1850116	5868369	120.4	180.4
WKP-P08S	1850095	5868559	163.2	166.6
WKP-03D_S	1849653	5868559	222.9	237.4
WKP-05D_S	1850126	5867507	139.0	243.1
WKP-09D_S	1849905	5868266	148.2	149.2
WKP-11D_S	1849881	5868238	134.8	135.27

* VWP elevation. For piezometers, the midpoint elevation of the screen is listed.
** The water levels are the estimated average from water levels of January 13th of 2023.

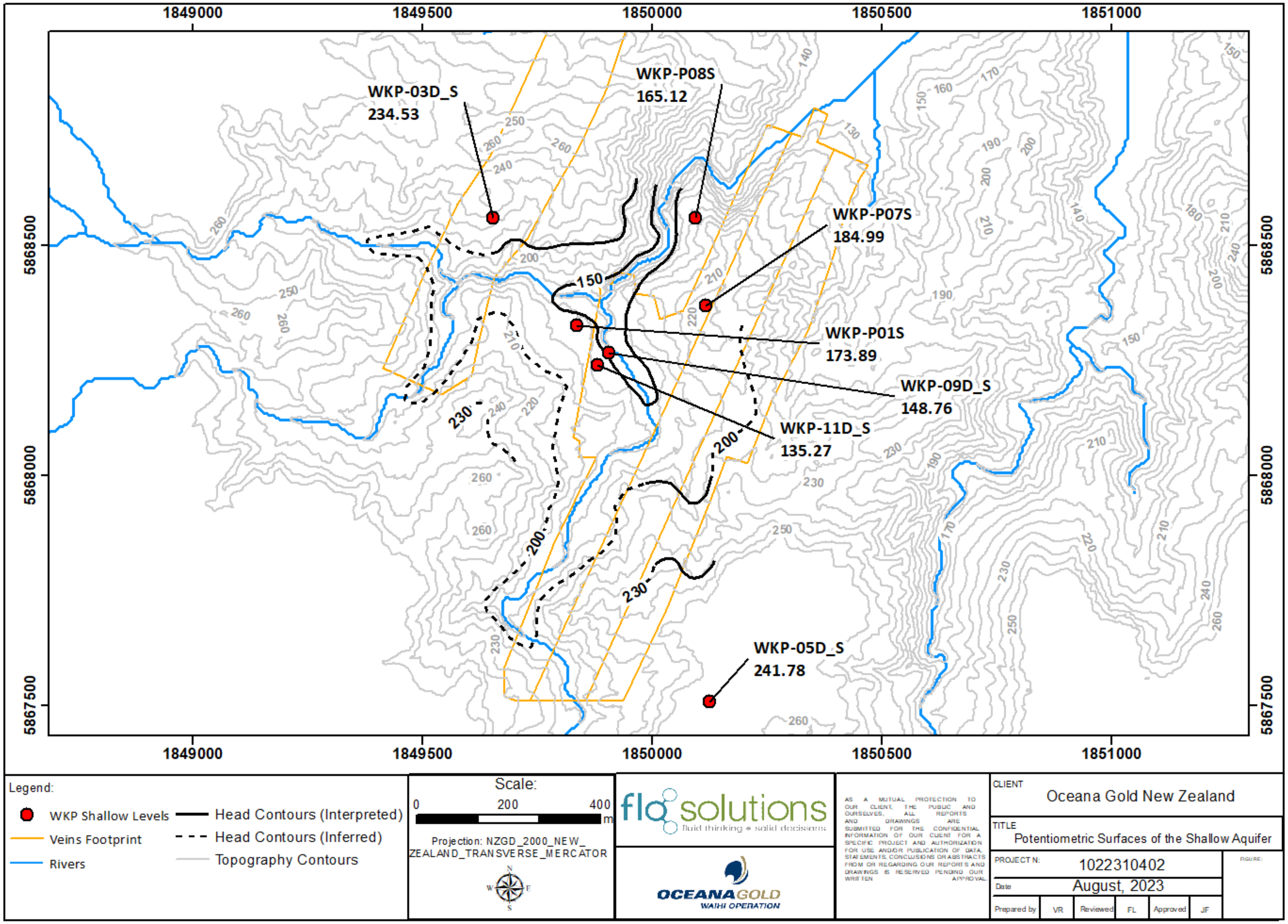
The following data observations and exclusions are considered:

- WKP-08S (screened at 16m) has a higher head than co-located WKP-04D (screened at 60m), likely due to downward vertical gradients; WKP-04D is not considered during contour construction
- WKP09D_S (screened at 23.8m) has a higher head than nearby WKP-10D_S (screened at 65.7m), likely due to downward vertical gradients; WKP-10D_S is not considered during contouring

WKP-P02S and WKP06S have anomalous water level measurements distant from values in other shallow piezometers due to local effects, and therefore these were excluded from the construction of shallow aquifer contours.

As shown in Figure 5-3, the water level contours generally follow topography, with highest water levels in the southwest and lowest water levels in the northeast.

Figure 5-3: Estimated potentiometric surface – shallow aquifer.



5.5.2 EG Vein aquifer

The data used to develop EG Vein aquifer piezometric contours is summarized in Table 5-4. The EG Vein aquifer contour map is presented as Figure 5-4.

Table 5-4: Piezometers and control points – deep aquifer.

Point	X	Y	Point elevation* (mamsl)	Water level** (mamsl)
WKP-P06D	1849837	5868335	-14.4	110.1
WKP-P07D	1850116	5868359	40.3	110.4
WKP-P08D	1850095	5868559	139.6	145.5
WKP-03D_D	1849693	5868585	110.6	112.0
WKP-04D_D	1850267	5868467	-120.5	117.5
WKP-05D_D	1850126	5867507	9.0	165.2
WKP-09D_D	1850095	5868125	57.7	115.5
WKP-10D_D	1849929	5868059	44.7	111.3

* Spring or VWP elevation. For piezometers, the midpoint elevation of the screen is listed.
** The water levels are the estimated average from water levels of January 13th of 2023.

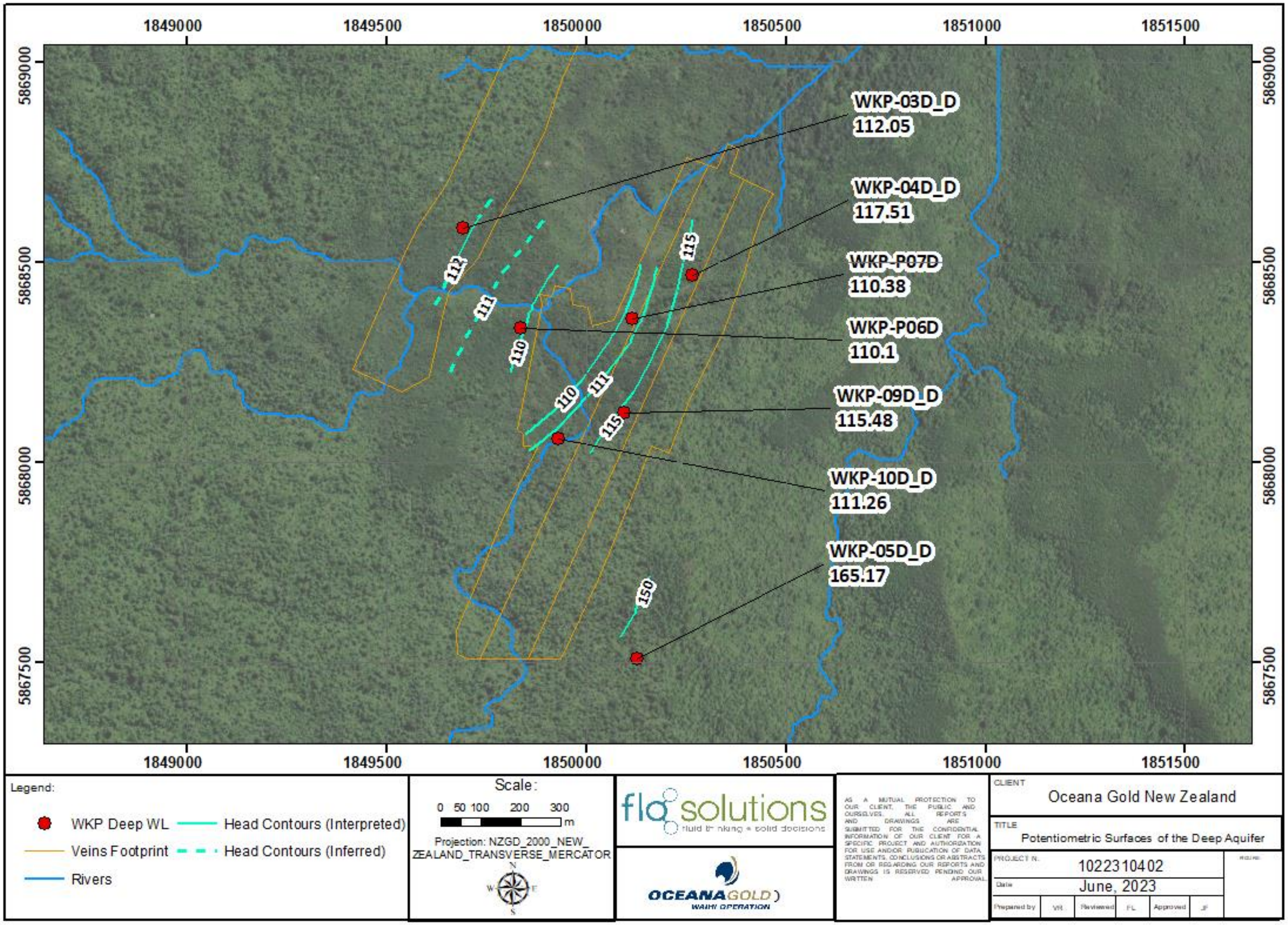
As shown in Figure 5-4, the groundwater table in the deep aquifer is relatively flat in the mine domain, with an apparent low point around 110m coincident with the downdip extension of the central EG Vein system, which appears to serve as a drain on the surrounding host rocks.

As discussed in Section 5.5.1 the highest water level in the shallow aquifer can get up to 300 mamsl during wet season – with strong correlation between the streams and the aquifer, especially in the western highlands (where some springs have been mapped by OGNZL). In terms of the deep groundwater system, the highest water level is ranging around 150 mamsl located in the southern / southeastern portion of the aquifer, but most of the ground water is found around the level 111 mamsl.

The deepest groundwater levels are found to be in the NE portion of both aquifers (with levels of 140.5 and 110 mamsl respectively) – suggesting that the flow direction has a regional trend from SW to NE.

It is also possible to observe that the water level contours are more uniform in the deep aquifer when compared to the shallow aquifer. This is likely due to higher transmissivity in the deeper aquifer but could also be a function of the strong influence of rainfall and rivers on the shallow groundwater system, while the deep groundwater system is more isolated from shallow variations.

Figure 5-4: Potentiometric surfaces – deep aquifer.



5.6 Groundwater gradients and flow directions

Multiple lines of evidence suggest that the shallow and deeper aquifers may not be connected or are connected weakly, including potentiometric levels, vertical gradients, and water level fluctuations. These lines of evidence are discussed below.

5.6.1 Horizontal gradients

Hydraulic gradient is the slope of the water table or potentiometric surface, that is, the change in water level per unit of distance along the direction of maximum head decrease. It is estimated by measuring the water level in several wells. The hydraulic gradient is the driving force that causes groundwater to move in the direction of maximum decreasing total head (Cheremisinoff, 1998).

Horizontal hydraulic gradients have been estimated from the potentiometric surfaces generated in Section 5.5 and the gradients results can be found in the Figure 5-5 and Figure 5-6.

Table 5-5: Gradients of shallow aquifer.

Zone	Gradient	Flow Direction
East Edmonds	21.4%	Southeast to northwest
Central Wharekirauponga	60.1%	Northwest to southeast

As illustrated in Table 5-5 and Figure 5-5, gradients in the shallow aquifer are highly variable, with the highest gradients where the Wharekirauponga Stream is deeply incised through silicified bedrock, with gradients as high as 60%. In the area along the Edmonds stream, which flows over clay-altered RV, the gradients are not as steep. It is likely that steep gradients exist in the highlands to the southwest, although there is insufficient data to calculate gradients in this area. The higher recharge and saturation of the shallow groundwater system in the wet season can probably lead to a highest gradient in the SW portion of the zone due to the fluxes coming from the highlands to lowlands and crossing the zone of the EG-Vein (probably a preferential flow pathway).

Table 5-6: Gradients of the deep aquifer.

Zone	Gradient	Flow Direction
EG north	4.9%	East to west
T stream	0.9%	West to east

Table 5-6 illustrates that the deep aquifer, as expected, shows smoother and flatter gradients when compared to the shallow aquifer, potentially due to higher transmissivity or lower flux in the deeper aquifer. The highest gradient is around 5% in the north EG vein area, which underlies a steep hill. The relatively high elevation at WKP-05D suggests that steeper gradients may be present in the southern area, but there are insufficient water level data to test this.

Figure 5-5: Estimated gradients in the shallow aquifer.

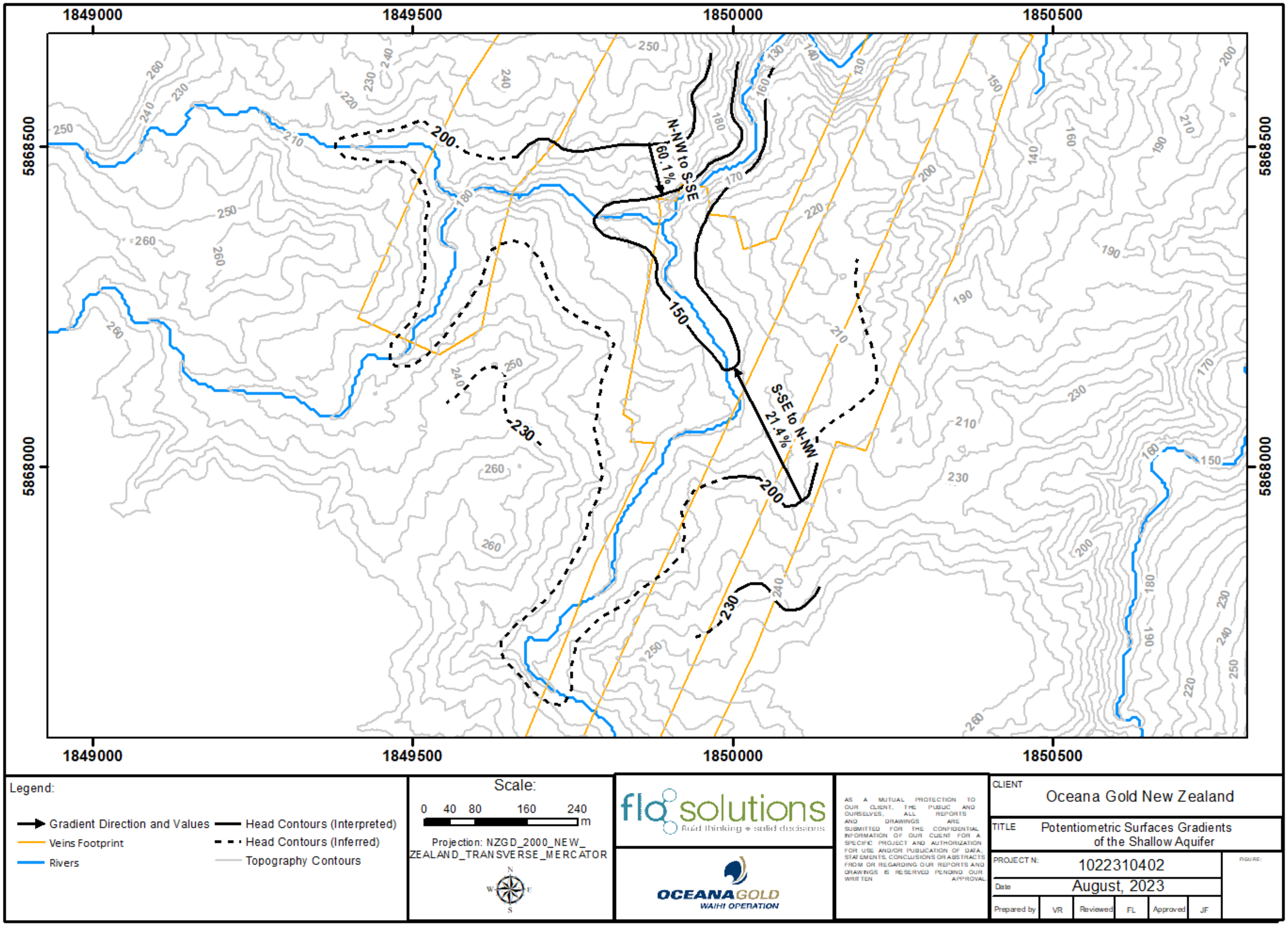
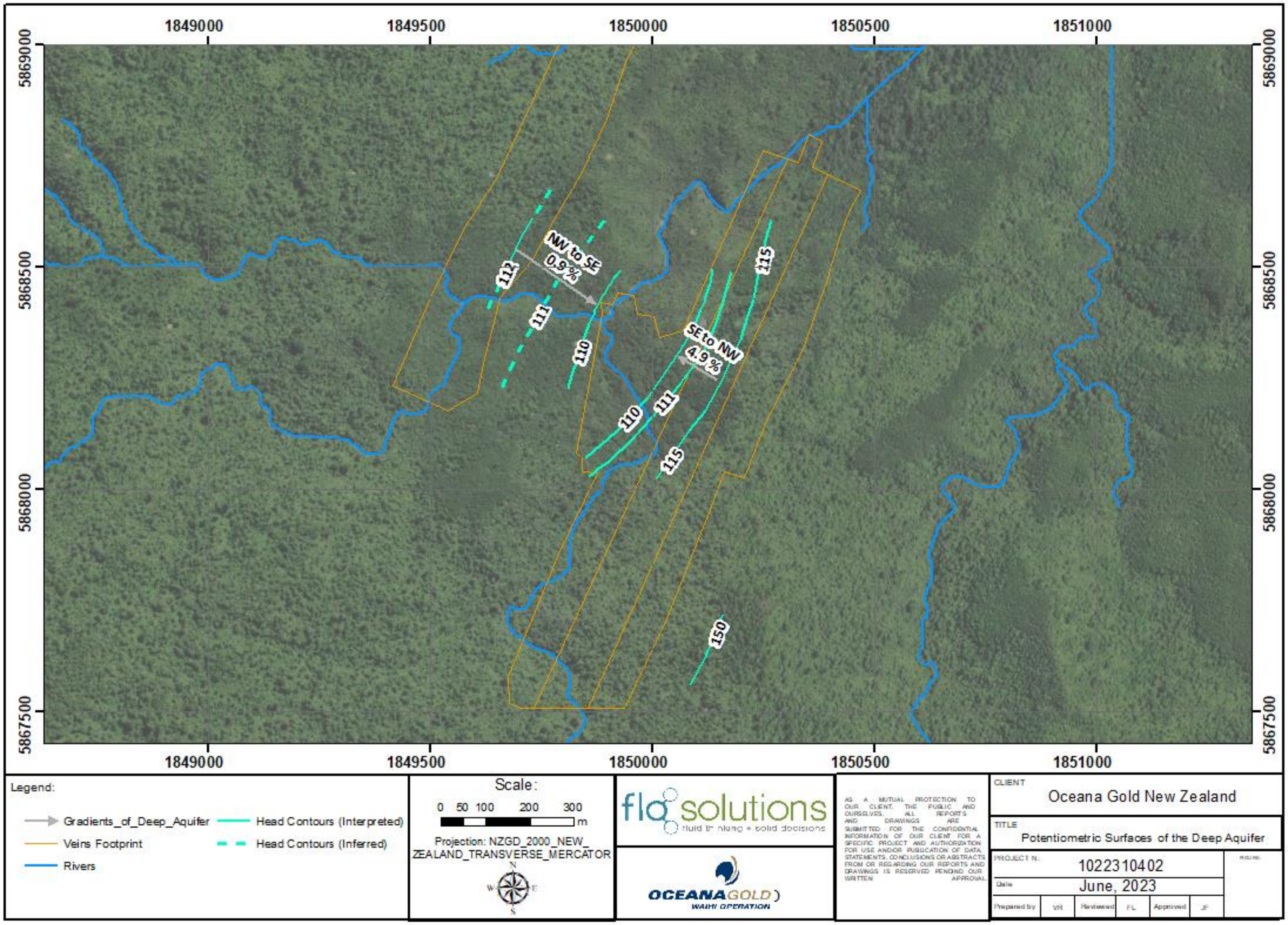


Figure 5-6: Gradients the deep aquifer.



5.6.2 Vertical gradients

Vertical gradient calculations help to understand the potentiometric head differential and preferred flow directions between aquifers, whether downward or upward – although they do not necessarily indicate that flow is occurring.

Although generalized gradients can be calculated from potentiometric surface maps, water levels in co-located or nested piezometers clusters are more accurate, as they are point measurements at a specific location.

Vertical gradient calculation was completed for the available co-located instrument pairs. Instruments and parameters used for calculation are summarized in Table 5-7.

Figure 5-7 shows the locations of several of these instruments in cross-section, with their relative positions. Calculated gradients are summarized in Table 5-8.

Table 5-7: Parameters used for vertical gradient calculation.

Piezometer	Surface Elevation (mamsl)	Depth of Instrument	Screen Top (Bgl)	Screen Bottom (Bgl)	Screen Length (m)	Depth to Water (Bgl)
WKP_01S	182	15.5	12.0	15.0	3.0	2.0
WKP_01D	182	46.1	42.0	45.0	3.0	42.7
WKP_06S	182	122.8	115.5	119.5	4.0	68.8
WKP_06D	182	200.0	196.0	200.0	4.0	68.7
WKP_02S	226	40.9	37.0	40.0	3.0	34.7
WKP_02D	226	67.6	67.0	70.0	3.0	50.5
WKP_07S	226	96.1	102.0	105.0	3.0	49.6
WKP_07D	226	187.0	182.8	184.4	1.6	116.7
WKP_08S	179	18.1	16.1	18.1	2.0	15.3
WKP_08D	179	42.0	40.0	42.0	2.0	34.7

Figure 5-7: Nested piezometers used to calculate vertical gradients (blue points – water elevation or pressure head)

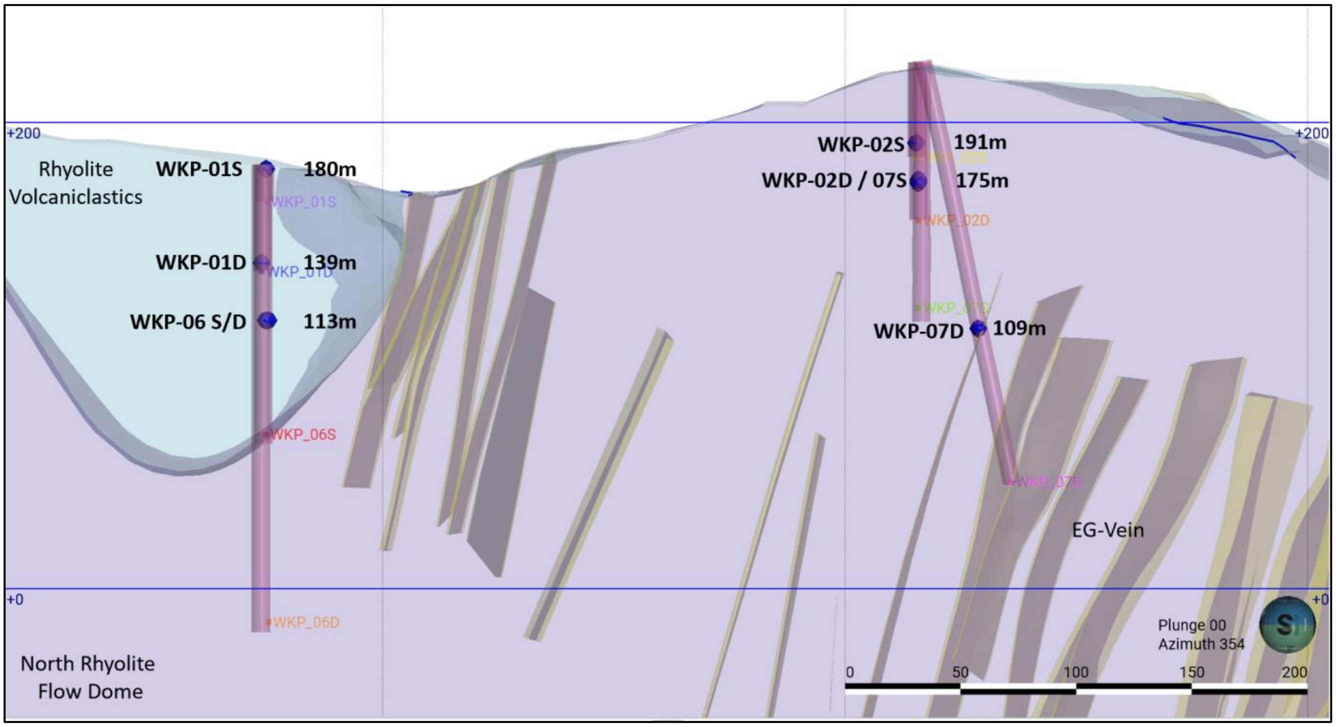


Table 5-8: Calculated vertical gradients

From	To	Vertical gradient (m/m)	Direction
WKP_01S	WKP_01D	1.33	Down
WKP_01D	WKP_06S	0.34	Down
WKP_06S	WKP_06D	0	Down
WKP_02S	WKP_02D	0.59	Down
WKP_02D	WKP_07D	0.55	Down
WKP_07S	WKP_07D	0.74	Down
WKP_08S	WKP_08D	1.05	Down

As shown in Table 5-8, there are downward vertical gradients in nearly all locations, with the strongest gradients between WKP-01S and WKP-01D and WKP-08S and 08-D. In both cases, shallow piezometers are screened in the upper 20 m and lower piezometers are screened around 42-46m in the shallow aquifer. These gradients are likely indicative of gravity-driven vertical flow in the fractured, weathered zone.

There is no vertical gradient between 06S and 06D, both of which are screened in the North Rhyolite Flow Dome. It is likely that deeper groundwater in this area is compartmentalized (confined) by the hanging wall veins to the east (Figure 5-7) consistent with previous conceptualizations for this area based on hydraulic testing and other evidence. This could result in pressure readings at both 6S and 6D reflecting the confined pressure in the NRFD in this area.

Groundwater gradients between the shallow aquifer and deeper aquifer (01D-06S, 02D-07D, 07S-07D) range from 0.34 to 0.74 m/m. Strong vertical gradients between aquifers may signify that they are only weakly connected or are not connected at all. This is usually due to low permeability materials between aquifers, which allows them to sustain different pressure heads and strong upward or downward gradients.

5.7 Recharge and discharge

Groundwater recharge depends on several factors such as temporal and spatial variability of hydrometeorological factors especially rainfall and temperature, lithology and subsurface geology, infiltration capacity and climate factors (Sen, 2014).

5.7.1 Shallow aquifer

(GWS, 2022) describes the recharge as due to direct rainfall infiltration on the hills, soaking the soil regolith and then the rockmass. Where fractured rock outcrops, recharge may infiltrate directly to the underlying groundwater table. Part of the water moves laterally as interflow and discharges to streams. Preliminary calculations by GWS have shown that aquifer recharge should correspond to approximately 10% of the AAP (annual average precipitation) or something around 15,407,000 m3/year. The amount of recharge reaching the deep aquifer in the EG vein area is likely substantially less. However, the EG Vein may be connected to fractured rocks higher in the catchment by the southern extent of the Edmonds fault.

The shallow groundwater system discharges to the Wharekirauponga Stream and tributaries, as is discussed in detail in Section 6.

5.7.2 E-G Vein aquifer

Recharge and discharge mechanisms for the deeper EG Vein aquifer are less well understood. Based on groundwater contour maps, it is likely that the EG Vein aquifer receives considerably less recharge than the shallow aquifer within the mine domain. Conceptually, some shallow groundwater may infiltrate to deeper groundwater, with more recharge occurring outside the mine domain (upgradient) where outcrops may be exposed. However, there is uncertainty in geologic and structural controls on groundwater movement in these areas.

Recent 3D numerical flow modeling by FloSolutions (in progress) has shed new light on potential discharge from the EG Vein aquifer. Put simply, modeling cannot reproduce the piezometric head separation and strong vertical gradients between the shallow and deep aquifers without some sort of drain or outlet for the EG Vein aquifer on the downstream side.

Conceptually, the EG Veins were emplaced in an existing, regional scale, steeply dipping normal fault structure (the Edmonds Fault). It is possible and perhaps likely that this structure has secondary permeability sufficient to transmit water from the EG Vein system to downgradient discharge points. Representation of this process in the numerical model is the only way to achieve an acceptable model calibration. Under this scenario, deeper groundwater travels far downstream before it eventually discharges to shallow groundwater and surface water, potentially outside of the Wharekirauponga catchment. Modeling suggests that flow along the Edmonds fault does not discharge to shallow groundwater within the mine domain, likely due to both the low permeability layers between the aquifers (potentially including post-mineral andesite cover), and the lack of any driving upward gradient. Additional work will be required to confirm this hypothesis, as discussed in Section 9.

5.8 Water level fluctuations

The shallow aquifer responds rapidly to rainfall events, as evidenced by water levels measured in shallow piezometers (Figure 5-8 and Figure 5-9). The degree of response is variable depending on piezometer location, depth, and formation hydraulic properties, but nearly all shallow piezometers show responses to significant rain events. This indicates that the shallow aquifer is unconfined, and infiltration and recharges processes are relatively rapid.

In contrast, most piezometers in the EG Vein aquifer are unresponsive to rainfall events or respond only weakly to heavy rain events, suggesting a degree of isolation from the shallow aquifer system (Figure 5-10).

Figure 5-8: Water Level x Rainfall – WKP-03S and WKP-05S.

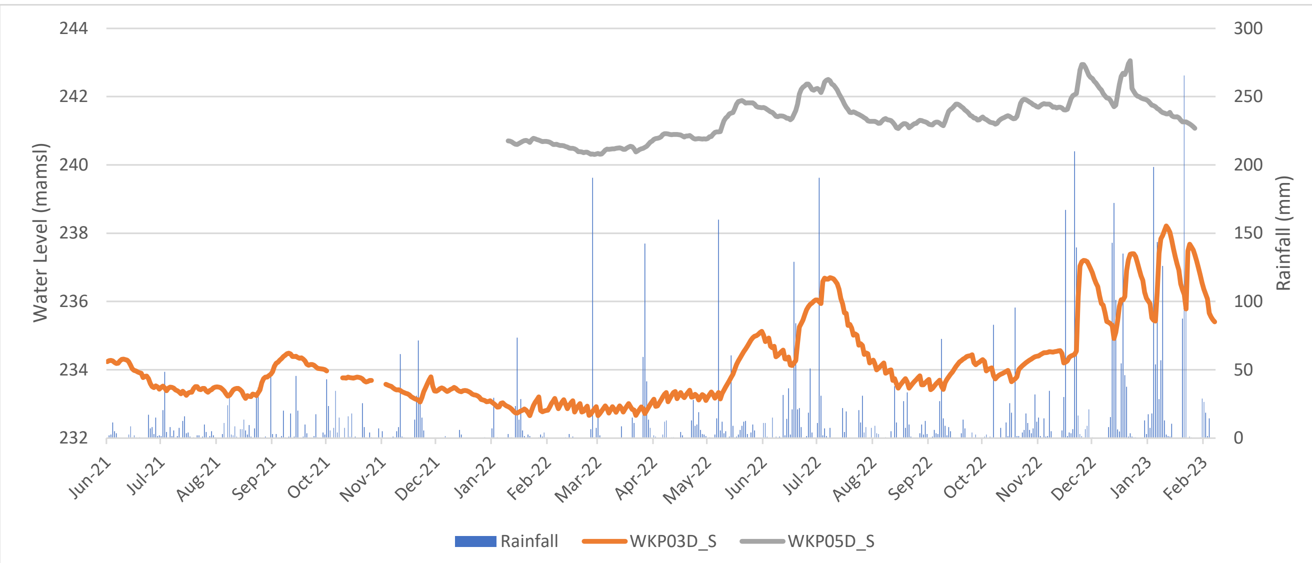


Figure 5-9: Water Level x Rainfall – WKP-04S,WKP-09S, WKP-10S and WKP-11S.

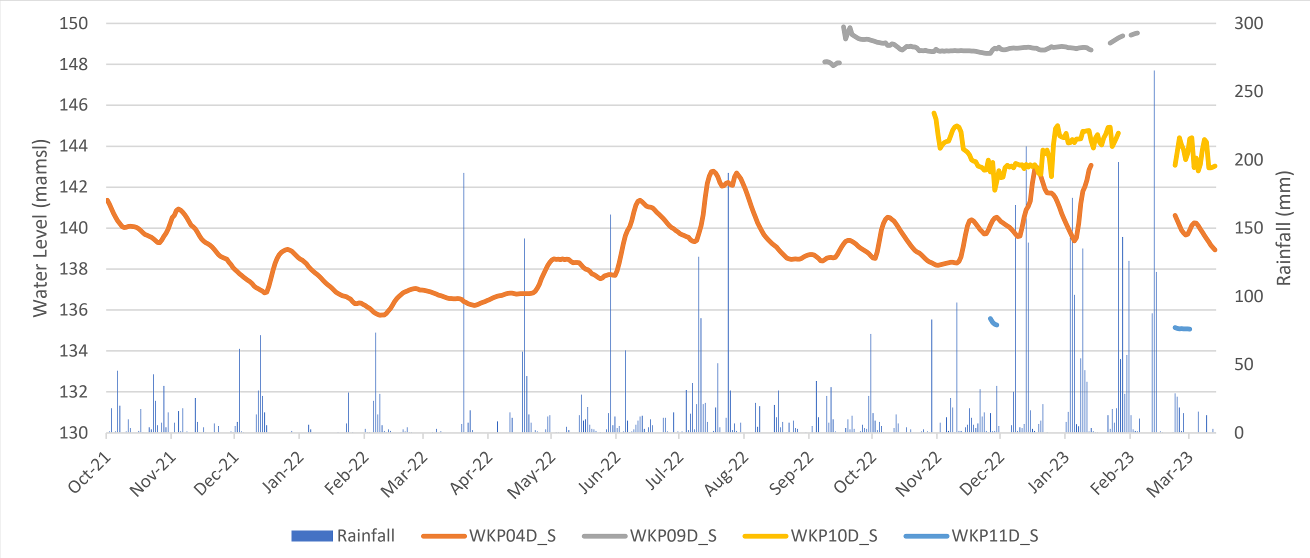
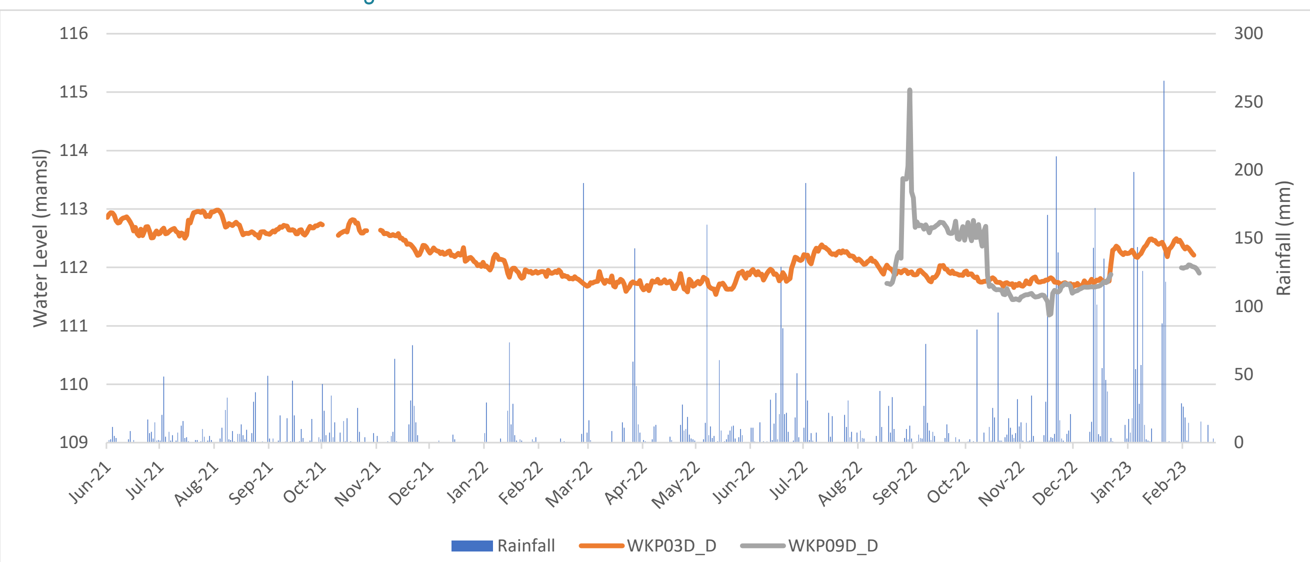


Figure 5-10: Water Level x Rainfall – WKP-03D and WKP-09D



5.9 Shallow-deep aquifer interactions

Multiple lines of evidence suggest that the shallow and deeper aquifers may not be connected or are connected weakly. In addition to the evidence described above (potentiometric levels, vertical gradients, water level fluctuations, etc.), there is additional information from drilling.

Relationships between the shallow and deep groundwater systems were initially described by (FloSolutions, 2022) from a series of observations based on several packer tests, water losses and geological setting. Consistent water losses during drilling have been reported in a relatively narrow depth range between the base of the weathered zone and the underlying EG Vein aquifer system (Figure 5-11). Although water losses can occur any time that a permeable zone is encountered and the hydraulic head of the drilling fluid is substantially higher than the formation, they are more common in unsaturated zone. For example, drilling fluid losses are not generally observed in the shallow aquifer, despite relatively high permeability.

Moreover, some shallow packer tests have shown water levels at or above ground level (measured using pressure transducers), indicating likely confined conditions in the shallow aquifer. These water levels are notably higher than those observed in packer tests conducted deeper in the well (Figure 5-12), implying that the shallow aquifer might be compartmentalized or separated from the EG Vein aquifer by the Western Zone Veins and Hanging Wall veins in certain areas.

Figure 5-11: Water losses (pink dots) along the interface between shallow groundwater system and deep groundwater system.

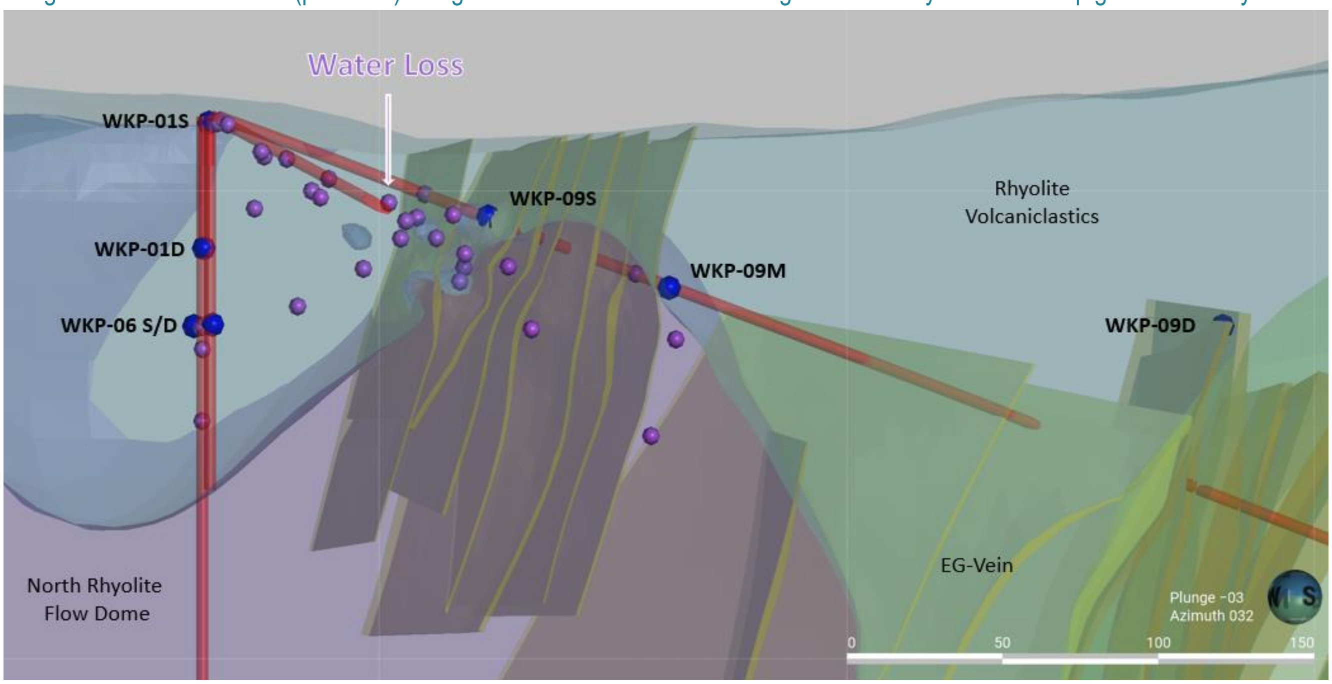
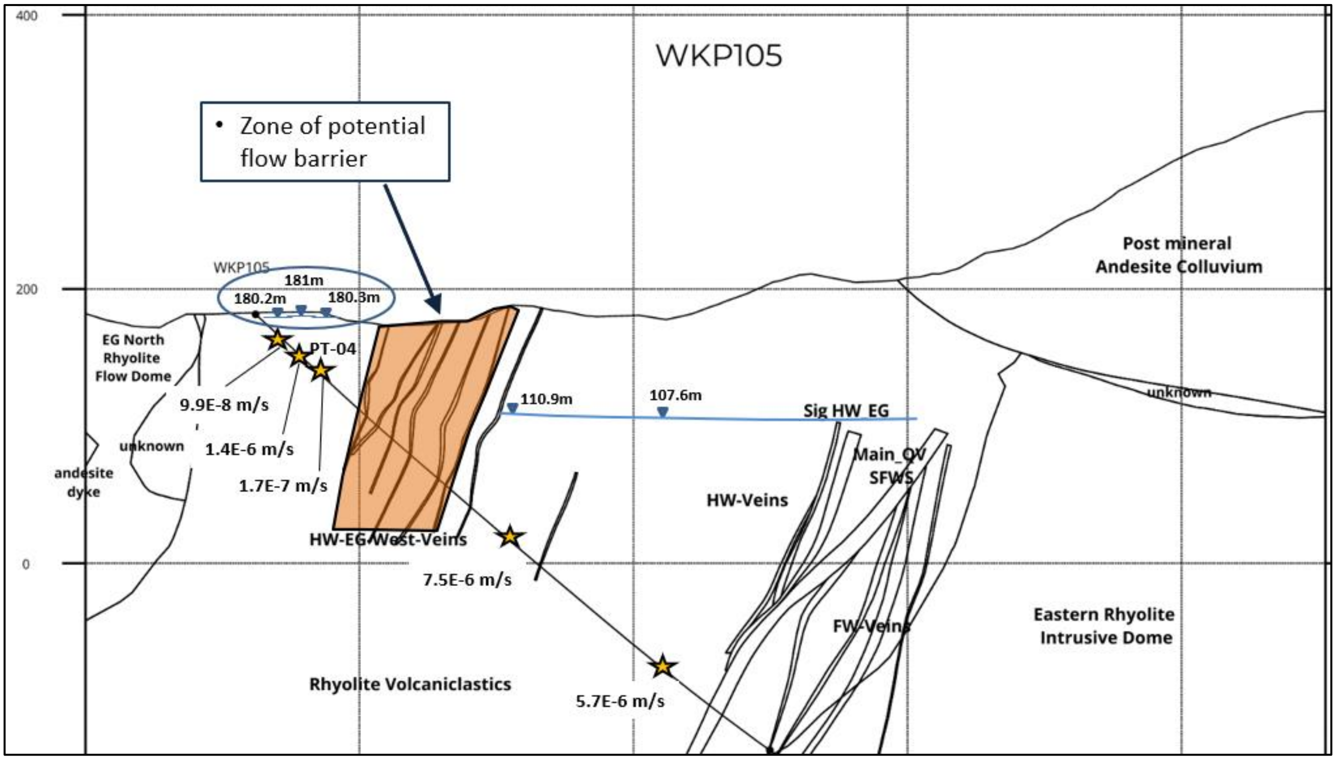


Figure 5-12: Compartmentalization in the groundwater system inferred from packer testing data (modified from FloSolutions, 2022)

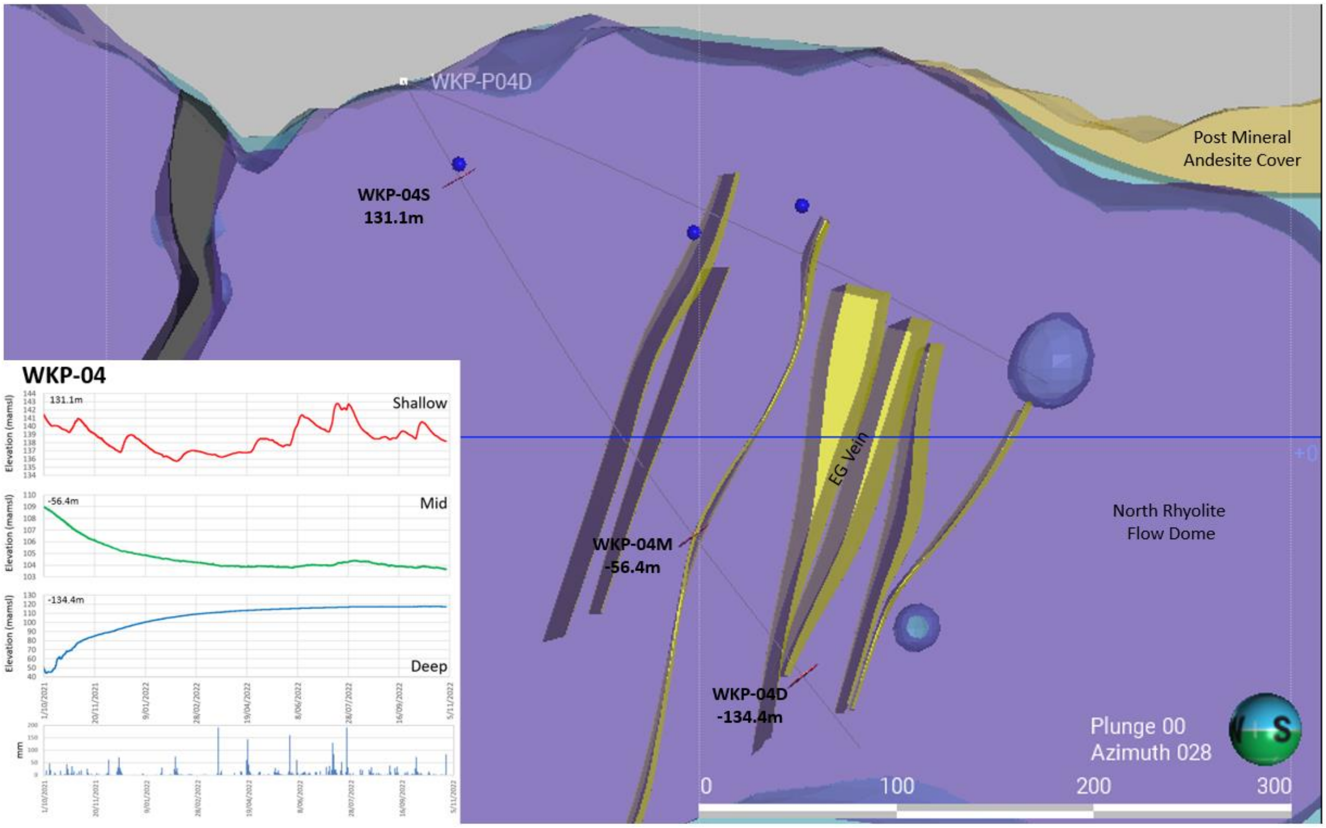


Although there are still uncertainties in the degree of connection between shallow and deeper groundwater aquifers, some general comments can be made:

- The shallow groundwater system is quite responsive to rainfall events, with little temporal delay between rain events and the subsequent water level rises in the piezometric cell.
- While the deeper EG Vein aquifer system is not particularly responsive to rainfall, some instrumentation shows slight variations in response to storm events, suggesting local connections between the shallow groundwater system and deeper zones may be possible (Figure 5-13).
- Strong downward gradients between the aquifers suggest the presence of low permeability materials and weak hydraulic connections between them.
- Conceptually, recharge from shallow zones to the deeper aquifer through vertical leakance in the area of the EG Vein system is suspected throughout the mine domain, although not yet well documented.

A full summary of the current conceptual model understanding is presented in Section 8.

Figure 5-13: Groundwater variations in response to rainfall in the VWP - WKP-04.



6. SURFACE WATER – GROUNDWATER INTERACTIONS

Groundwater and surface water physically overlap at the groundwater/surface water interface through the exchange of water and chemicals. This exchange is a critical part of the hydrologic cycle. Surface water supplies recharge to the underlying aquifer, where the groundwater can remain in storage for days, months, years, centuries, or even millennia. Eventually the groundwater is lost to evapotranspiration or discharges back into streams, rivers, or the ocean. Depending on how much time the water spends underground, and the geochemical conditions within the aquifer, the quality of the original recharge water can undergo profound changes before it discharges at the surface (USGS, 2019).

Fundamental to these interactions is the concept of interflow – temporary water storage in the shallow subsurface that does not infiltrate completely to the water table but is eventually discharged back to surface water. (GWS, 2022) explains this interaction as due to absorption of direct rainfall into the regolith, followed by water flow out of regolith pores to surface water streams over time.

6.1 Available data and limitations

Surface water - groundwater interactions can be quite complex to decipher due to the amount of information required to fully understand flux directions and rate. In 2022, FloSolutions prepared a technical memorandum (10222110401-TM-03_RevB - Data Gaps and Field Program Recommendations – WUG Conceptual Mode) describing the data needed to understand these relations at site:

- Review of streambed morphology and features, and division of streams into ‘zones’ or ‘reaches’ with similar features for further study.
- Direct streambed seepage measurements combined with stream channel geometry survey to compute river conductance (Cousquer, 2017). This work could be done in each reach or zone with similar properties, to generate a range of conductance values.
- Surface water sampling and use of natural tracers to further elucidate groundwater inputs to baseflow in gaining reaches of the streams.
- Preparation of a map illustrating gaining and losing reaches of each stream, along with inflow/outflow rates from seepage measurements or other estimation techniques.

‘In addition, direct measurements of infiltration rates and vertical hydraulic conductivity of soils should be completed in key areas of the site to inform the potential for infiltration and recharge to the shallow groundwater system. Key areas that should be tested include:

- Areas adjacent to streams.
- Areas with identified ‘argillic alteration’ that, conceptually, may limit vertical infiltration to the shallow groundwater table.

The tasks recommended by FloSolutions are still planned, but site access to conduct these works is subject to an ongoing consenting process. Therefore, no new information is available to describe relations between surface water / groundwater. The descriptions in this section are largely based on work conducted prior to the 2022 review.

Based on current information, two sets of data were analyzed to help to understand these interactions:

- Results of surface water sampling for radon
- Comparison of responses in surface water flows and shallow groundwater levels to rainfall events.

6.2 Surface water sampling for radon

Sampling for radon in surface was conducted by GNS (GNS, 2021). In general, radon in natural surface waters is very low, while groundwater in contact with bedrock will have higher radon concentration. The sampling was conducted to try and identify gaining and losing reaches of various onsite streams, under the premise that radon concentrations should be higher where groundwater is contributing to baseflow.

Three rounds of surface water sampling were completed, in December 2020, March 2021 and May 2021. Samples were collected along with stream gauging event. In total 55 points were sampled for radon. The distribution of sampling points along with results from the three events are shown in Figure 6-1 through Figure 6-3. Results for all sampling events are contained in Appendix E.

Based on the data presented:

- Results are, in general, quite variable, with points of low radon concentrations (absence of groundwater inputs and/or dilution) and higher radon concentrations (groundwater discharge to streams) present in all stream reaches.
- Most headwater sampling points have low radon concentrations (Figure 6-1) consistent with the conceptualization of stream reaches in the upstream parts of the catchments being losing streams (stream discharge to groundwater).
- Most sampling points downstream of the EG vein system have intermediate to high radon concentrations, consistent with the conceptualization of stream reaches in the lower parts of the Wharekirauponga catchment being gaining streams (groundwater discharge to surface water).
- In general, the highest radon concentrations for the points sampled in all three sampling rounds were related to the May 2021 campaign – likely related to the dry season and lower precipitation rates in that period (groundwater influence on surface water radon signatures is more evident).

Standpipe shallow piezometers show a variation in radon values throughout all three sampling rounds, suggesting that an interaction between groundwater and surface water occurs.

Figure 6-1Distribution of sampling points and radon results (December 2020).

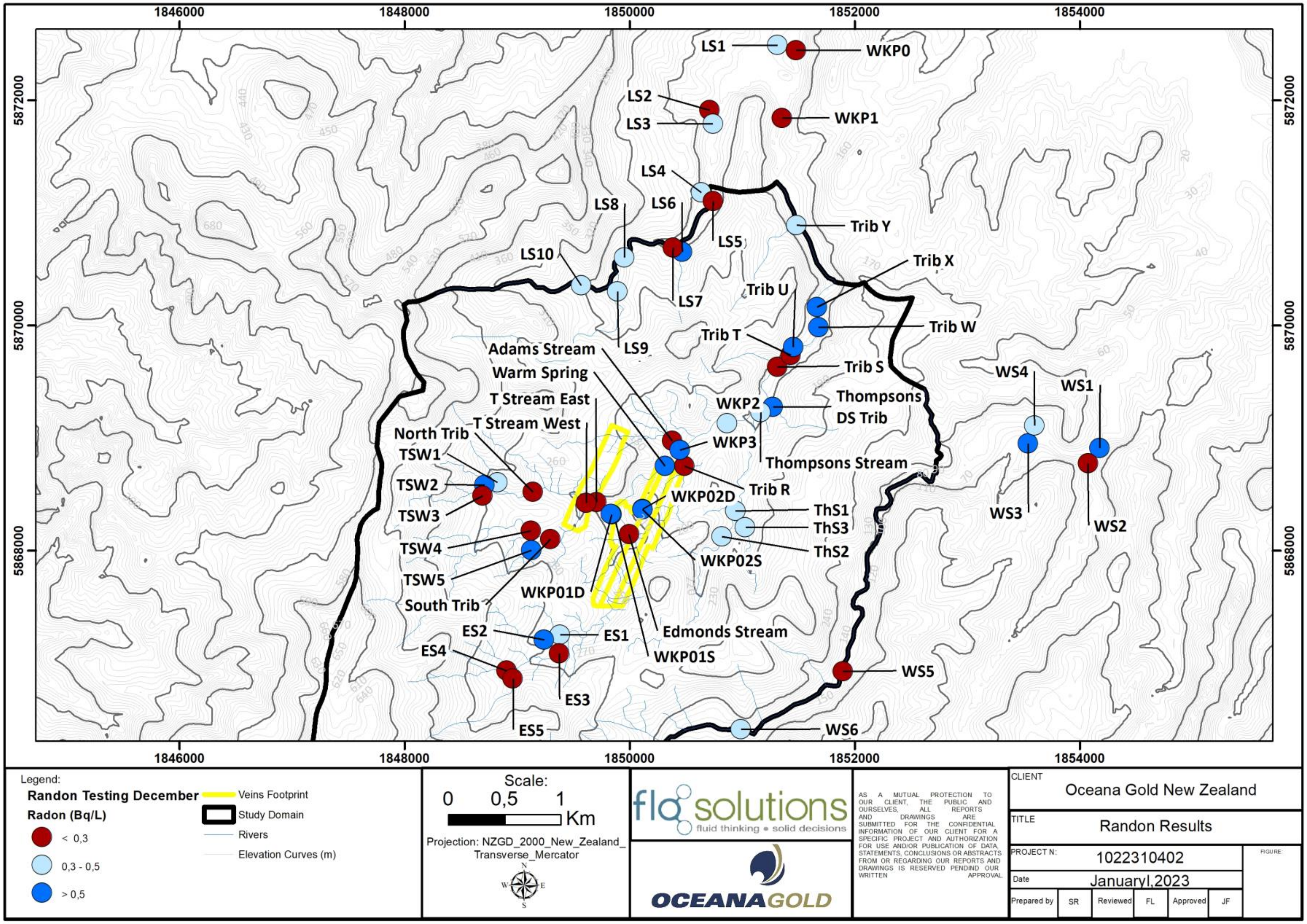


Figure 6-2 Distribution of sampling points and radon results (March 2021).

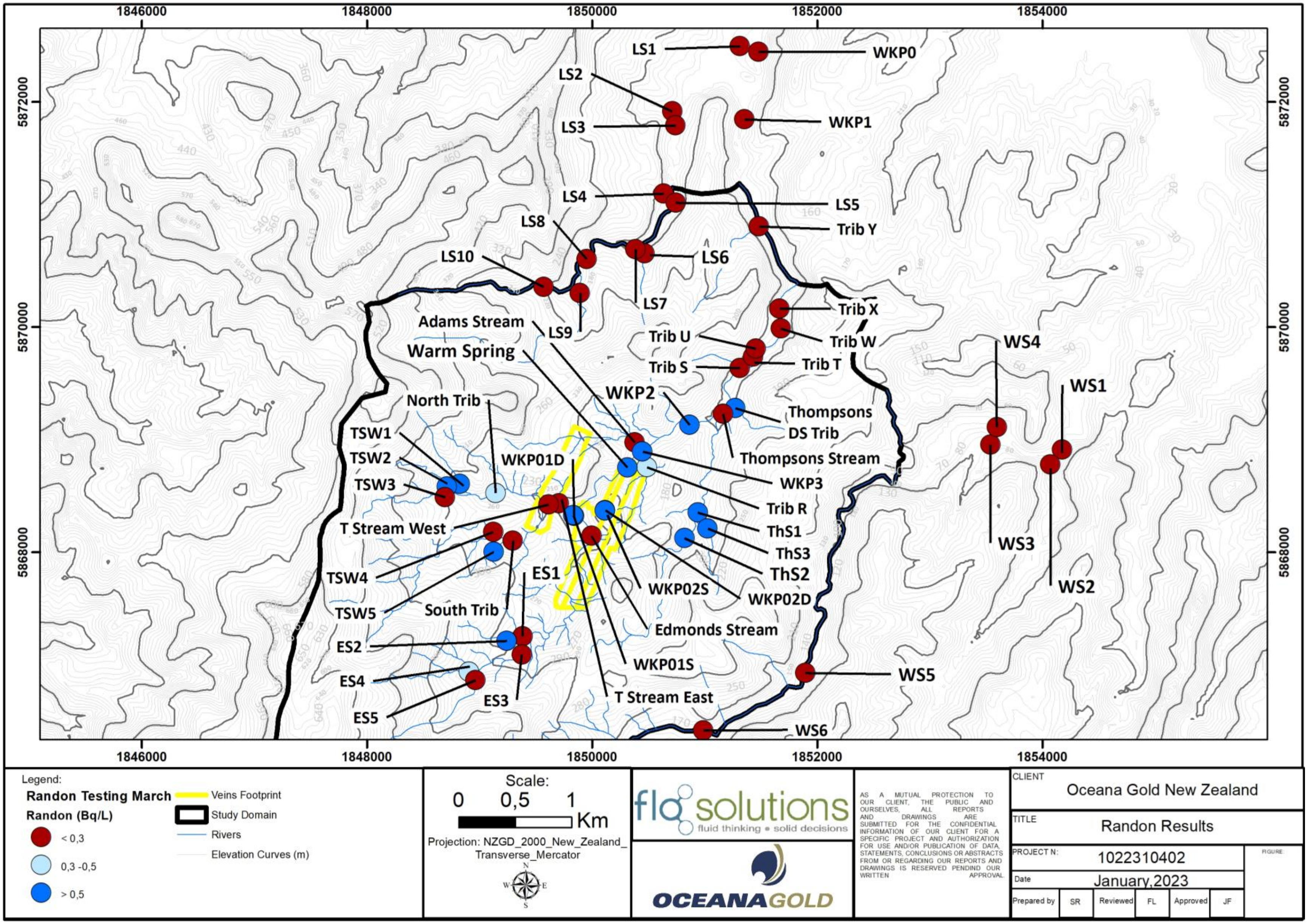
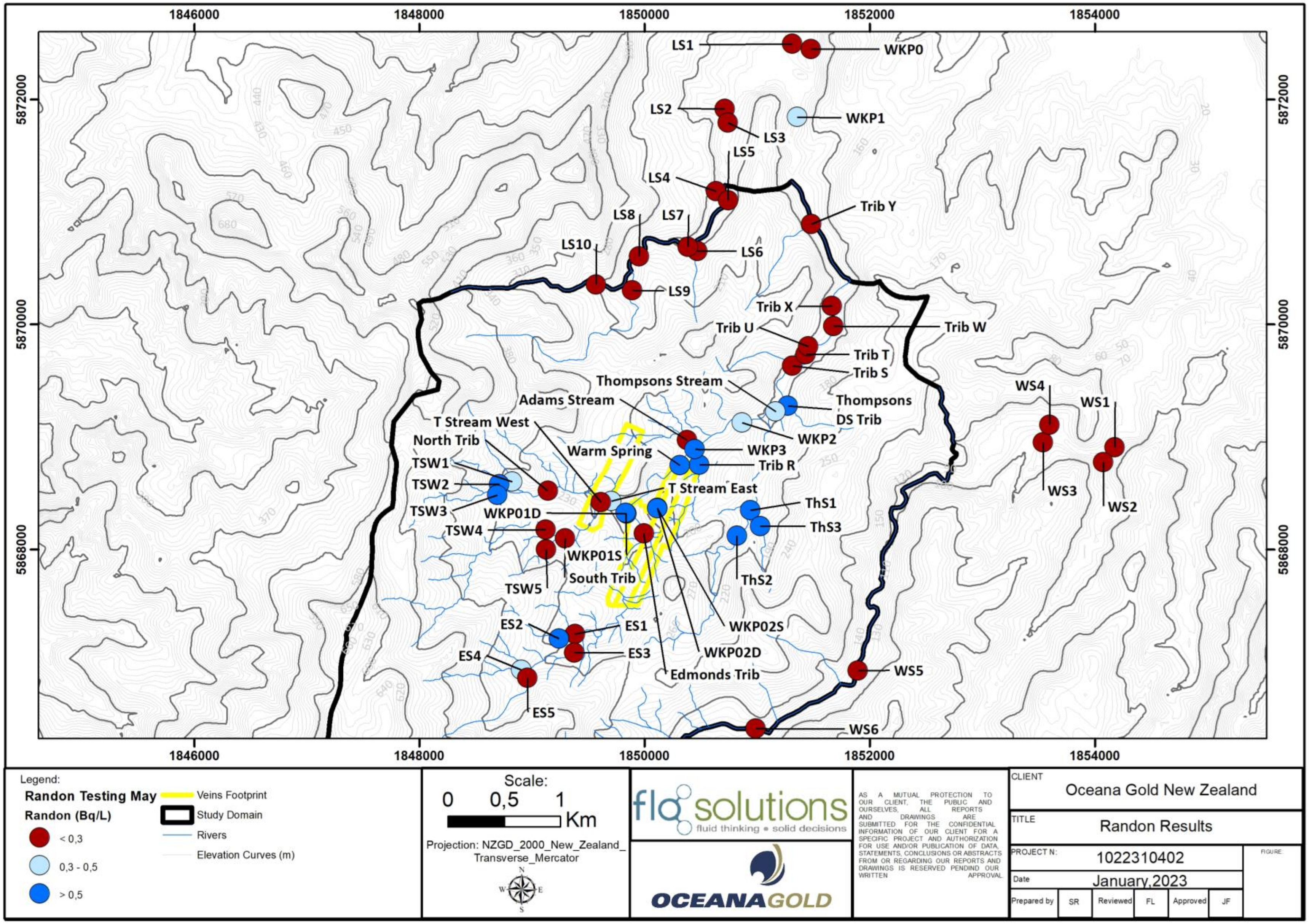


Figure 6-3 Distribution of sampling points and radon results (May 2021).



6.3 Effects of rainfall on stream flows and groundwater heads

The response to rainfall in stream flows and shallow groundwater heads can be compared to assess the degree of connection between the shallow aquifer and streams. When rainfall events cause stream flow increases, but little change in water levels in nearby piezometers, near-surface flow is dominated by runoff and interflow. When stream flow increases are accompanied by water level increases in piezometers, vertical infiltration and recharge occurs, and the rate of infiltration between surface waters and underlying aquifers are expected to be more significant in these areas.

Graphs were prepared to provide a visual comparison of the effects of rainfall on stream flows and shallow groundwater heads from the following data:

- Flow rates obtained in surface water gauging station WKP-3, located just downstream of the mineralized ore body (closest gauging station to the EG-Vein).
- Groundwater levels from piezometers: WKP-01 S/D, WKP-02 S/D, WKP-04 S.
- Rainfall records from Waitekauri River Station.

Graphs were prepared for 2021, a relatively dry year, and 2022, a relatively wet year by comparison. These graphs are included as Figure 6-4 and Figure 6-5. These graphs indicate the following:

- Measured stream flows at WKP-3 show that the stream responds almost immediately to rainfall, suggesting that runoff in the area is rapid and significant (high runoff coefficient).
- Instruments WKP-01S and WKP-02S/D show strong response to flow / rainfall increase (as can be observed in Jul-2021 and Jul-2022) – suggesting that connections between river or direct infiltration seems to be substantial.
- Despite being slightly less responsive to rainfall, WKP-04S (fully grouted vibrating wire piezometer) shows responses to significant rainfall events, as in June, July, and August 2022.
- During 2021, few significant rain events over 50mm were recorded. While changes in stream flow to small rain events are instantaneous, changes in shallow groundwater levels are less apparent, especially in the first half of the year. This indicates that during low rainfall periods, infiltration is contributing to soil saturation rather than direct aquifer recharge.
- Following a rainy month in June 2021, piezometers begin to respond to small rain events, suggesting that the soil as been fully saturated and infiltration is reaching deeper levels and contributing to aquifer recharge.

These observations suggest moderate to strong linkages between surface water and shallow groundwater, although they are based on limited information. Additional field studies and further analysis on surface / groundwater interactions may help quantify these relationships.

Figure 6-4: Rainfall, river flow, and shallow water levels – 2021.

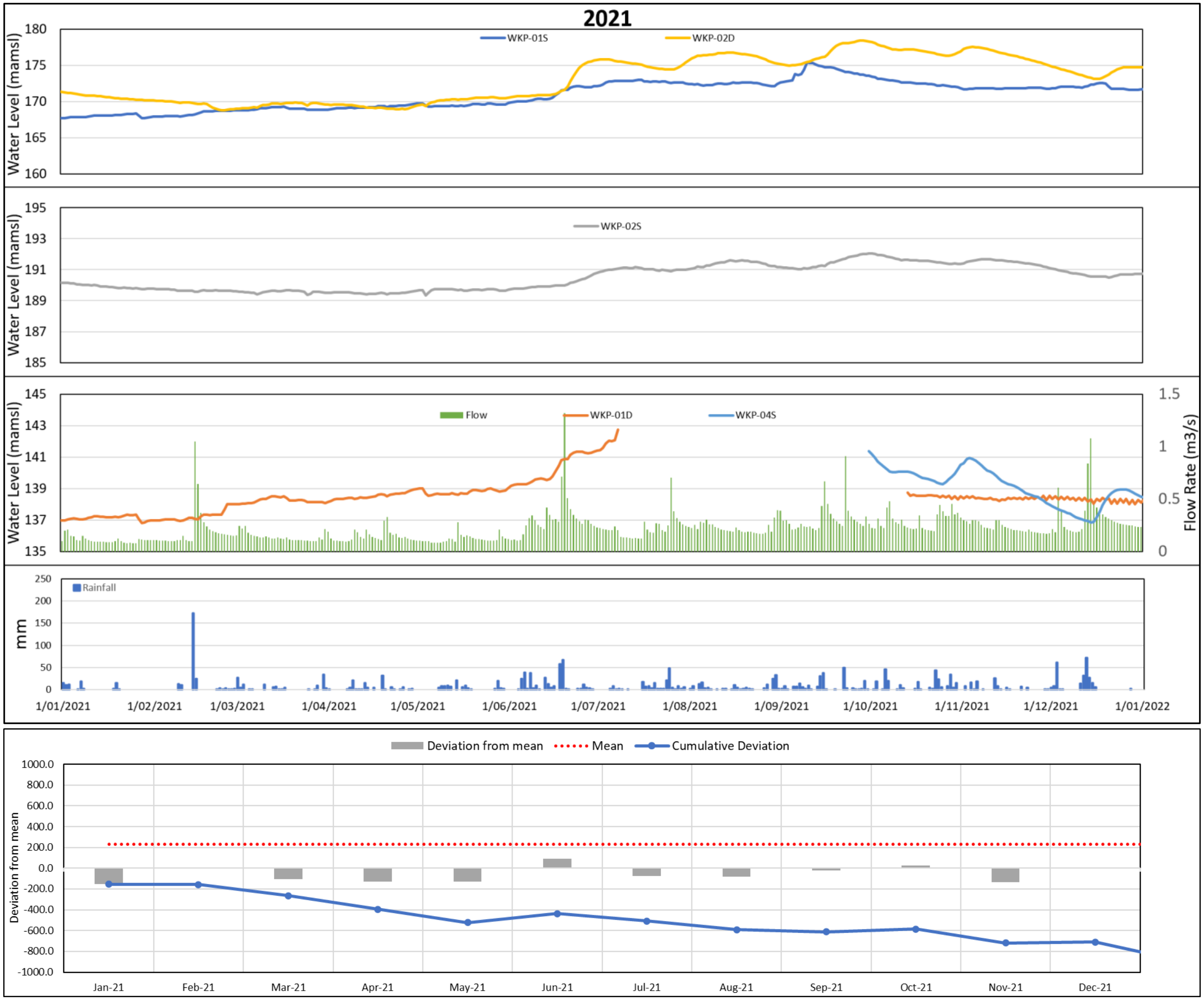
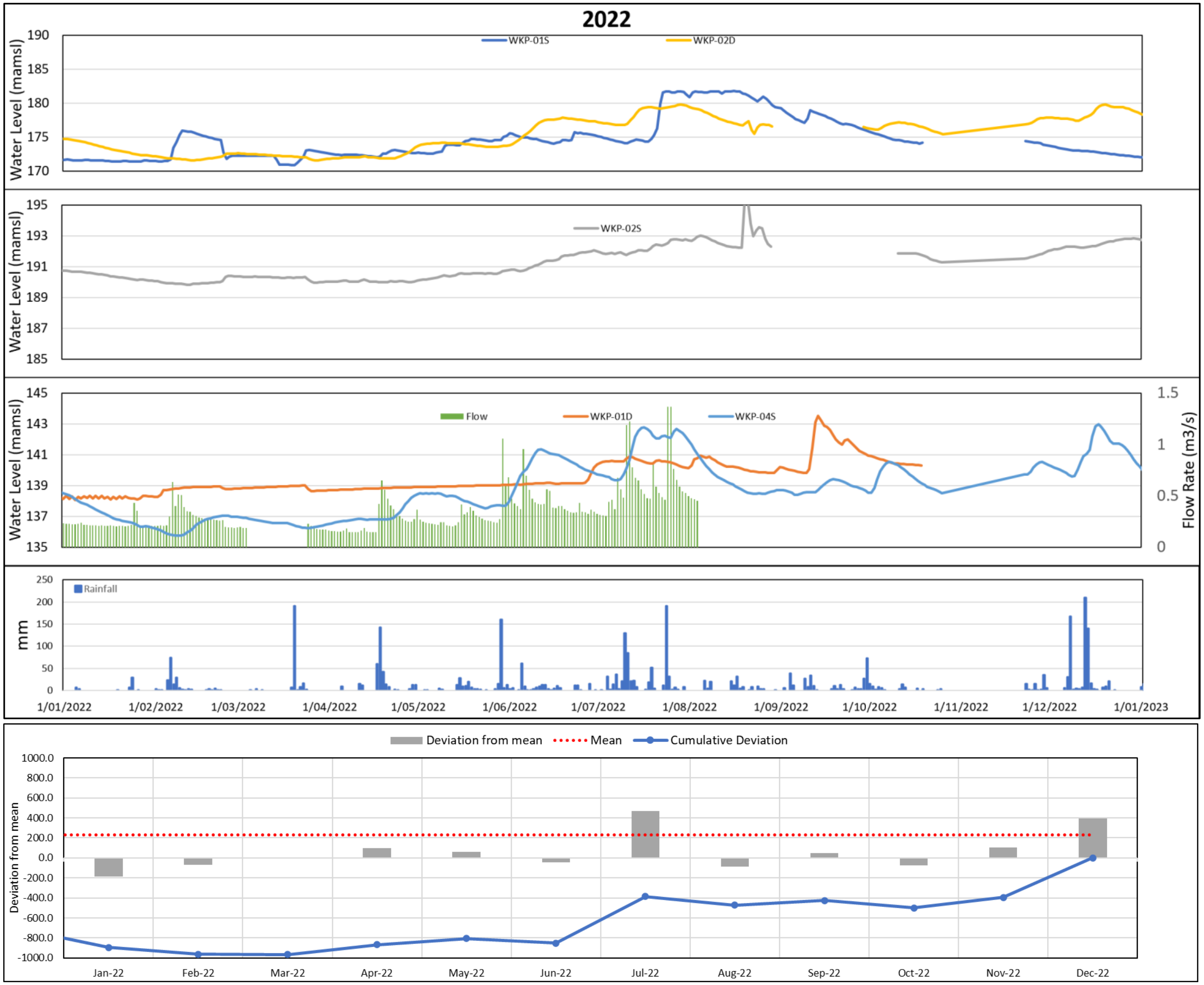


Figure 6-5: Rainfall, river flow, and shallow water levels - 2022



7. PROJECT DEVELOPMENT PLAN AND POTENTIAL IMPACTS

7.1 Underground mine plan

According to the report developed by (OceanaGold, 2021) the current plan for development of the WUG will occur in two phases:

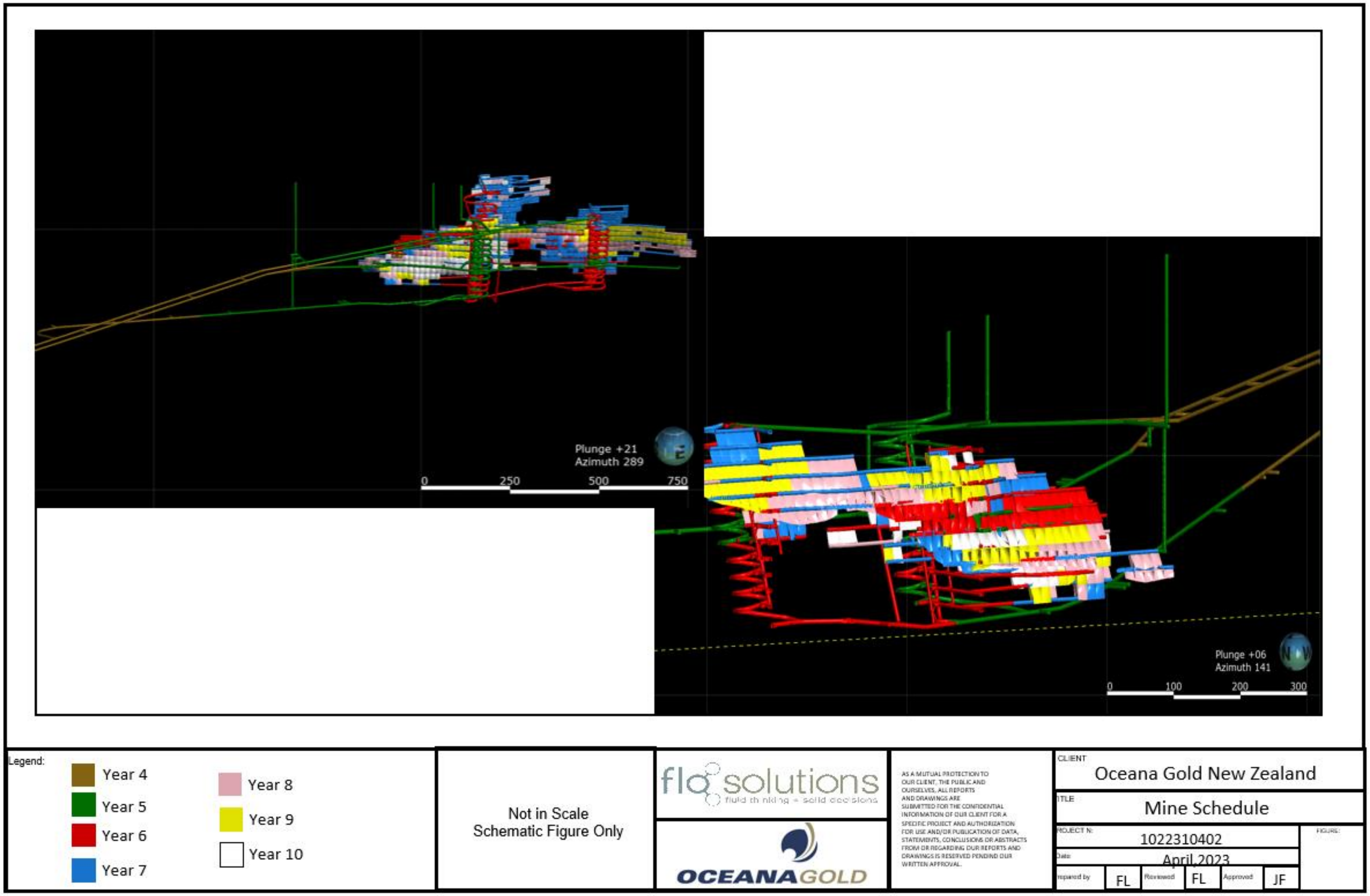
- First phase (years 1-4): Pre-mining access tunnelling from Willows Farm to the orebody. This phase includes additional definition drilling of the resource and the respective trend extensions, as well as geotechnical drilling, within the mining permit area.
- Second phase (years 5-10): The second phase will be carried out once the tunnel reaches the deposit and appropriate ventilation is established. The second phase consists of mine development and ore extraction.

This is shown in Figure 7-1 below.

Development design profiles vary from 5.5mWx6.0mH to 4.5mWx4.5mH. All development was designed at a maximum 1:7 gradient. Declines and capital development requiring truck access were planned to be developed at a 5.0mW x 5.5mH. Development required for infrastructure includes sumps, pump/dewatering cuddies, crib rooms, electrical infrastructure, refuge chambers, underground workshop, and underground magazine (OceanaGold, 2021).

Preliminary total groundwater inflow volumes for the Wharekirauponga project have been estimated as a maximum average rate of 17,000 m3/day (tunnel drainage, country rock and vein development). A mine water usage of 3,000 m3/day is assumed for drilling etc. The mine dewatering system has been designed to handle water inflows up to 30,000 m3/day, which is considered conservative due to current uncertainties regarding the hydraulic characteristics of the vein system (OceanaGold, 2021). The management of total water inflows into the mine will consist of three primary pumping stations and five interim pumping stations. Due to the length of tunnel development and head difference to reach the portal, a combination of centrifugal horizontal slurry pumps and vertical pumps will be required to dewater the mine.

Figure 7-1: Planned mine development sequence by year.



7.2 Mine inflows and dewatering

Initial calculations carried out by (GWS, 2022) using a two-dimensional (2D) flow model have estimated groundwater inflows in the range of 5200 m^3/d (215 m^3/h). These values were reported to be similar to the volumes in the Favona deposit (in Waihi) – Favona reports flows around 4500 m3/d, reducing to 1500 m3/d. Some limitations with this initial approach:

- 2D analysis in SEEP/W involves necessary simplifications and does not represent full three-dimensional flow processes
- Rockmass hydraulic conductivity was assumed to be 1E-8 m/s, which is lower than ranges determined from more recent hydraulic testing.
- Comparing groundwater inflows to Waihi can be a conservative approach considering that, in Waihi, deposits are hosted by Andesites - less permeable than the intrusive domes and Rhyolite Volcaniclastics encountered in the zone of Wharekirauponga.

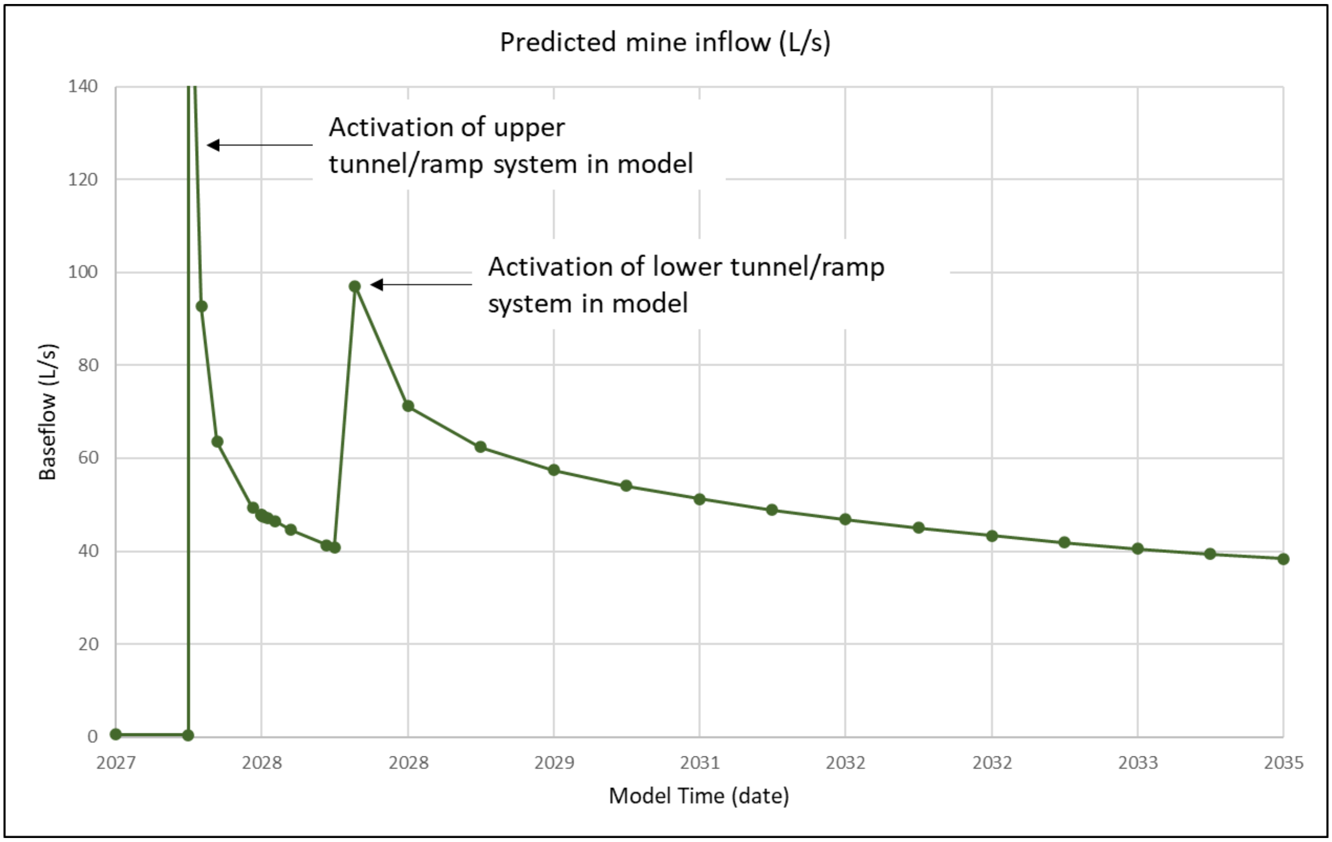
As part of ongoing work, FloSolutions is currently developing a 3D numerical groundwater flow model, in Modflow USG, to provide more accurate estimates of potential mine inflows and dewatering requirements. Parameters used during ongoing modeling are informed by more recent data and information collected since the original GWS estimates.

Preliminary modeling analysis carried out by FloSolutions have shown that:

- Expected dewatering will be significant in the deep groundwater system due to mine dimensions and total depth (galleries mainly distributed along the EG-Vein - recognized to be a high permeable unit and main aquifer of the area) – drawdowns in the range of 250m are expected to occur in the main area of the mine galleries – where total depth goes down to -150 mamsl.
- Extent of drawdown will slightly affect the shallow groundwater system (in the order of a few meters).
- Mine inflows, considering an annual based simulation will have a peak in the first year of mining then gradually reducing over time as water is released from rock storage.
- Current mining simulations suggest that initial inflows during underground mine development will be up to 150 l/s and will stabilize between 40 and 60l/s during the life of mine (without mitigation), Figure 7-2.

It's important to emphasize that FloSolutions is currently preparing the final numerical model report presenting and summarizing all model details and result (the report will be submitted for OGNZL review by the end of Sepetmebr-2023)

Figure 7-2: June 2023 mine inflow predictions - work in progress.

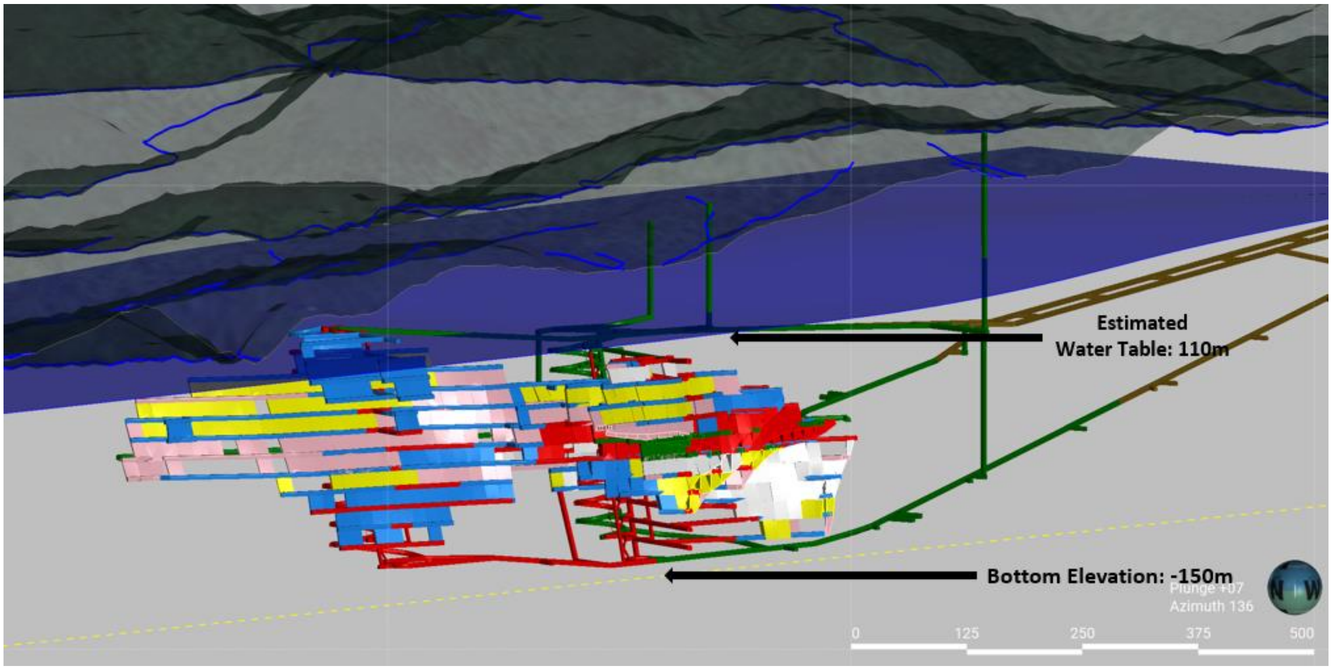


7.3 Potential interactions with groundwater

The current mine plan includes development of an underground network of tunnels with the lowest elevation at approximately -150 mamsl. The average groundwater elevation in the EG Vein aquifer is approximately110 mamsl in the mine domain, resulting in an elevation head difference of approximately 260 m between the static water table and the deepest mine tunnel.

For the mine development, the deep groundwater system will be dewatered and depressurized to allow for mine construction. Considering aquifer anisotropy and surrounding lithological units, it would be expected for the drawdown to propagate along the vein strike and outward around the mine domain, generating an ellipsoidal drawdown with the major axis along the strike NE/SW.

Figure 7-3: Mine plan and main elevations (deep aquifer and bottom of the mine galleries).



The real drawdown extent and propagation will be highly dependent on hydraulic conductivities, anisotropies and storativity of the aquifer system and surrounding units. Ongoing groundwater modeling will assess the interactions between the mine development and groundwater in more detail.

The degree of impact to the shallow groundwater system will be dependent on the nature of the hydraulic connections between the shallow and deep aquifers. These connections, and vertical flow, is limited by the low permeability units in between them. Because the hydraulic head in the deeper EG Vein aquifer is already tens to hundreds of meters below the shallow aquifer, increasing this hydraulic gradient through deep dewatering should have limited effect on the shallow system, except where drawdown can propagate along specific higher permeability zones (like structures).

Because these aquifers may be weakly connected in some areas, some shallow impacts may occur, particularly in areas close to the mine development.

7.4 Potential interactions with surface water

7.4.1 General interactions

The shallow groundwater system and surface water have an intrinsic behavior very dependent on rainfall and recharge. This close relation means that any changes to shallow groundwater levels may impact on surface water, by reducing baseflow. Ongoing modeling suggests baseflow reductions will be in the range of 0-10% for the various stream reaches. These assessments continue.

Some downstream areas of the catchment that are in contact with the Edmonds fault could see slight reductions in baseflow. This structure is conceptualized as a drain on the EG Vein aquifer and the entire hydrostratigraphy, with deep groundwater flows traveling far downgradient, and eventually reporting to shallow groundwater or surface water outside the mine domain and potentially outside the Wharekirauponga catchment. Downstream stream reaches which are currently interpreted to be gaining reaches (based on radon sampling – Section 6.2), may see some baseflow reduction if the flux of water exiting the EG Vein aquifer via the Edmonds Fault is reduced.

(GWS, 2022) interprets additional impacts in the headwater springs of the Teawaotemutu Stream and Edmonds Streams considering both are related to Rhyolite exposure and contacts between the Rhyolite dome and the overlying post mineralization Andesite. The depressurization of the EG-Vein could affect overall gradients, therefore affecting upstream headwaters. These assumptions rely on high K values for the Rhyolite Volcaniclastics and surrounding domes. Although there are a few packer tests results that confirm higher K values for the North Rhyolite Flow Dome and Rhyolite Volcaniclastics, knowledge of hydraulic parameters outside the EG-Vein domain are limited. The only hole tested in the southern portion of the area, slightly outside of the main EG-Vein domain (WKP-05D) has shown permeability values in the range of 1E-9 m/s for the Rhyolite Volcaniclastics (Table 4-5), suggesting that overall hydraulic conductivity of the hosting rocks can be lower when not directly affected by veining, therefore impacts should be localized to the mine domain.

7.4.2 Warm spring

(GWS, 2022), expects that flow to the warm spring will cease during mining, considering the extent of the dewatering of the deep groundwater system.

Radon values from samples taken from the warm spring indicate a deep source. However, the structural and hydrothermal controls causing formation of the warm spring are not clear, nor is the extent of mixing of the warm spring source flows with the EG Vein aquifer. Therefore, the potential effects of EG vein aquifer dewatering on the warm spring cannot be accurately predicted at this time.

Further evaluation of the spring, potentially including structural analysis and hydrochemistry (including isotopes) may help refine conceptualization of the warm spring.

7.5 Closure concepts

This section describes closure concepts specifically relevant to the WUG development area. It does not include closure concepts for the Waihi facilities. Information presented here has been compiled from (OceanaGold, 2021) report.

7.5.1 Ventilation shafts

All fencing and vent/egress surface infrastructure (vent chimneys) will be removed. Ventilation shaft one (Willows Road farm) will be backfilled from the surface (on Oceana Gold land) while the ventilation shafts on the paper roads within the DOC estate will be backfilled from underground via pumping of a low strength cementitious grout.

Shaft collars will be filled with imported clean topsoil and covered with manuka slash to allow natural revegetation.

7.5.2 Post-closure groundwater system

Ongoing groundwater modeling by FloSolutions indicates that, withing several years of completion of mining, the groundwater system will recover to pre-mining levels and will return to a flow-through aquifer system. However, the dynamics of the local flow system around the former underground mine may be altered. The nature of the localized flow system will depend, in part, on how lateral excavations and vertical stopes are rehabilitated.

The excavations will be backfilled with loose rock, resulting in higher permeability in the closed mine excavations than the original EG vein system. Under these conditions, the former mining zone will become a slow drain for the surrounding host rocks. Water will flow into this convergent zone from surrounding rocks, before discharging downstream via permeable conduits like the Edmonds fault.

Additional modeling scenarios are planned to guide the post-closure rehabilitation planning for the underground mine.

7.5.3 Post-closure geochemical impacts

AECOM is currently conducting a detailed hydrogeochemical assessment of post-closure scenarios to evaluate whether ambient groundwater flow through workings, tunnels, and development drives has the potential to impact on downgradient receptors. This will include use of flow paths and travel times from the FloSolutions numerical model to inform geochemical mixing models. This works is ongoing, and preliminary results are not yet available.

8. SUMMARY OF CONCEPTUAL MODEL

This current report covers the review and analysis of a significant amount of information provided by OGNZL, subconsultants, and previous reports developed by FloSolutions.

The following observations can be made from the current conceptual model report:

- The Wharekirauponga deposits are found within Coromandel Forest Park, which is managed by the Department of Conservation (DOC), 10 km north from Waihi town. Forest, scrub and grass cover most of the site land.
- The region presents a steep topography with highest elevations in the SW portion of the area decreasing towards the NE. Slope gradients vary from 0 to 60 degrees, but the mean gradient is estimated to be around 22 degrees.
- In terms of climate, this region of New Zealand presents a conventional sub-tropical climate, with regular and constant rainfall all year. Highest precipitations usually occur during winter. The maximum temperature can reach the 30°C in summer and the minimum can get down to 6°C in winter.
- The annual average precipitation (AAP) usually exceeds 2000 mm with really wet years ranging around 3000 mm. Highest precipitations are usually recorded during winter (May to Aug) and lower precipitations occur during summer. Evapotranspiration, on the other hand, is higher during summer and lower during winter. Evapotranspiration usually ranges around 400 mm.
- The WUG project is within the Wharekirauponga Stream Catchment. This catchment covers a total area of 14.5 km^2. Subcatchment base flows range from ~14 L/s in the Thompson stream to >100 L/s at monitoring point WKP01 on the main Wharekirauponga Stream.
- Some cold and warm springs have been identified by the OGNZL technical team. Warm spring genesis is still uncertain due to the lack of information to develop a proper conceptual model of that specific spring. Cold springs, on the other hand, have been interpreted by (GWS, 2022) to be located along the geological contact between the post mineral andesite cover and underlying intrusive domes and rhyolite volcaniclastics.
- Water quality sampling for radon has been carried out and reported by (GWS, 2022) to help understand the relation between groundwater and surface water. This sampling has shown that there are numerous local zones of gaining and losing, with the downstream part of the catchment having more groundwater inputs to surface water. River discharges and rainfall variations were presented in section 4.3. In general, higher Radon results were observed in May-2021 (except for WKP-02). This is aligned with the measured flows these same months (May-21 recorded lower flow rates when compared to the other 2 months). Whenever the influence of rainfall on stream fluxes is lower, higher Radon concentrations were observed.
- The site shows a complex geological setting. In the central portion of the project area a highly structured and fractured quartz vein relies on hosted by volcanic rocks and intrusive domes. A post mineral andesite cover is currently overlying the whole geological framework.

- Additional assessments to further discretize the weathering zone and the underlaying clay alteration zone have been completed by FloSolutions in March,2023. The geological modeling of these zones helped the generation of new 3D solids to be further implemented in the 3D groundwater numerical model.

- The site wide 3D geological have been generated by OGNZL with an extensive drilling database (more than 60000m of drilling). The model covers an area of 6.2 km^2 with elevations varying between 750m at the top and -500m at the model base. Main discretize geological units are: Post Mineral Andesite Cover, EG-Vein, T-Stream Vein, North Rhyolite Flow Dome, Eastern Rhyolite Intrusive Dome and Rhyolite Volcaniclastics.
- The Waihi North project includes two tunnels to be developed to connect the WUG orebody to the Waihi processing plant. The first one is a dual tunnel with 5500m from the orebody to Willows Road, and the second one (a single tunnel of 5000m) from the dual tunnel to the processing plant.
- As discussed in this report, a significative amount of data is available and has been discussed / interpreted (despite limitations on spatial distribution). There are, currently:
  - 12 drilling pads, from which 149 drillholes have been completed, generating an amount of drilling of around 60000m.
  - 26 CSAMT (Controlled source audio-frequency magnetotellurics) lines, covering an area of 7 Km2.
  - 54 gauging points, of which 5 present regular flow gauging (pressure transducers): WKP-01, WKP-02, WKP-03, T-Stream East and T-Stream West.
  - A total of 29 water level points: 5 pairs of double level standpipe piezometers (10 in total) and 6 VWP locations (usually with 3 sensors) – WKP11 has been installed with 4 sensors – 19 VWPs.
  - 57 hydraulic tests completed between 2021 to 2022 (WSP, Golder and OGNZL).
- Hydrostratigraphic units have been characterized as:
  - Unsaturated zone: Zone of variable saturation where the subsurface runoff occurs. This zone is usually responsible for receiving the rainfall recharge and, in part, flowing back to rivers and part feeding the shallow groundwater system.
  - Shallow groundwater system (Aquifer): The shallow groundwater system comprises geological units in the shallow portion of the area, where the process of weathering has been significantly developed. Despite being quite restrictive in terms of overall thickness (ranging around 50m), it could be quite relevant for shallow groundwater/surface water interactions.
  - Clay Alteration Zone (Aquitard): The clay alteration zone that covers most part of the vein area has not been fully detailed in terms of hydraulic properties up to the current date. The zone is expected to be quite impermeable with very low K (due to its composition). Further K field assessment should focus on the data acquisition of this unit.
  - EG-Vein (Aquifer): The EG-Vein is the deeper aquifer at the site, and has the highest density of testing data. Drilling information and hydraulic testing show an important fracturing grade and regular existence of voids (both related to strong secondary porosity development).

- T-Stream Vein (Aquifer): The T-Stream vein has been investigated, but not in the same proportion as the EG-Vein. There is, currently, just one monitoring point at this location and hydraulic parameters are also quite restricted to a few tests, but none in the vein itself.
- Intrusive Domes (Aquitard): Rocks surrounding portions of the EG Vein system. These units are generally low permeability but can be more permeable depending on the fracturing framework. Since the enhanced permeability would be expected to be limited to the zones where fracturing systems are more developed, these domes are generally classified as aquitards surrounding the main aquifer system.
- Rhyolite Volcaniclastics (Aquitard): Rhyolite volcaniclastics is the main geological unit forming the lithological framework of the site. It hosts most of the domes, veins and dykes that have been later intruded. This unit can be quite variable depending on its surrounding conditions.(K values can range from 1E-6 m/s closer to the vein system, to 1E-9 m/s, away from the vein).

- Regional groundwater flow follows roughly the main alignment of the Wharekirauponga catchment SW to NE. In the zone of the T-Stream vein, head contours are expected to be perpendicular to the T-Stream vein, while in the EG-Vein, flow is parallel to the vein strike.
- The potentiometric surface shows smooth hydraulic gradients (horizontal) in the deep groundwater system (around 1-5%). The shallow groundwater system, on the other hand, is steeper (up to 12%), potentially due to lower K and / or the strong influence of rivers and recharge on the generation of the shallow heads.
- Vertical gradients have been calculated using nested piezometers. All calculated flows show a downward direction with strong gradients. This overall direction suggests, again, that the shallow groundwater system is slowly drained by the deep groundwater system through aquifer leakance.
- Recharge have been estimated by (GWS, 2022) as 10% of the AAP. Recharge is interpreted to be a result of direct rainfall infiltration on the surface, soaking the soil regolith or exposed rock fractures, and then percolating vertically through the rockmass down to the water table.
- Some rainfall that is absorbed into soil regolith or fractures moves laterally as interflow and discharges into nearby streams, and does not recharge the underlying groundwater table.
- Surface – groundwater interaction is an important piece of uncertainty. OGNZL is currently working on consenting to complete several tests including infiltration tests and additional river gauging. A preliminary assessment was presented in this report, showing that:
  - Measured flows at WKP-3 responds almost immediately to rainy peaks, suggesting that runoff is significant in the area (high runoff coefficient).
  - Instruments WKP-01S/D and WKP-02S/D show strong response to flow / rainfall increase (as can be observed in Aug-2020, Jul-2021 and Jul-2022 – suggesting that connections between river or direct infiltration seems to be substantial.
  - WKP04S, which is also a shallow grouted vibrating wire piezometer, is slightly less responsive to rainfall than WKP01S/D, but still shows some response to rainfall events.

- Shallow-deep aquifer interactions: Multiple lines of evidence suggest that the shallow and deeper aquifers may not be connected or are connected weakly. These include potentiometric levels, vertical gradients, water level fluctuations, water losses and other information from drilling.
- The underground mine will be developed over 10 years.
  - The modified Avoca method has been selected as the mining method.
  - For the vertical development to surface a bottom-up method will be employed.
  - Groundwater pumping is planned to handle inflows up to 30,000 m3/d.
- In terms of dewatering and inflows, preliminary estimates completed with 3D modeling suggest peak flows of around 150L/sec (12,960 m3/day) from the model domain, and stabilized flows around 45 L/sec.
- The mine plan is expected to have its lowest elevation around -150 mamsl, while the water table in the deep aquifer is ranging around 110m (this is a difference of 260m to be dewatered). Significative interactions between the mine and the groundwater are expected to occur. Considering the strike of the vein aligned with the axis NE/SW, the model predicts that the drawdown will propagate in these directions (preferentially).
- Shallow groundwater impacts are expected to be much less significant when compared to deep groundwater drawdown. Some localized water reduction will be expected to occur, especially in those areas where the deep groundwater drawdown will be more prominent, generating a substantial difference between the shallow groundwater level and the deep groundwater level.
- The warm spring may be impacted, but the spring architecture is not fully understood so this is currently difficult to assess. GWS interprets this spring source to be connected to the deep groundwater system, therefore, some impacts will be expected.
- Mitigation planning and conceptual design is ongoing. Mitigation measures will be numerically simulated to assess whether proposed methods will be effective.
- Closure concepts were presented in (OceanaGold, 2021) report:
  - Surface infrastructure planned to be removed and all footprint areas will be completely rehabilitated to return to pre-mining state.
  - Ventilation shafts structures will be removed and further backfilled from surface.
  - Underground mine rehabilitation is currently being assessed.

9. ONGOING AND PLANNED STUDIES

The WUG project has been extensively studied and explored for resource definition and mining purposes, specifically around the zone of the EG-Vein. The broader hydrogeological and hydrological setting has been investigated intensely only in the last few years (since 2019 with the installation of the first standpipe piezometers and then completion of initial packer tests).

OGNZL is continuing this process, with several additional studies ongoing or planned to be completed at the site, subject primarily to consenting processes.

- 3D Groundwater Modeling: The main hydrogeological study, currently under development, is a site-wide numerical model, developed in Modflow USG by FloSolutions and followed by peer-reviewers of Malurus.
- Regional Geology / Fault analyses: GWS is currently reviewing all available regional data, including borehole logs, to assess whether the Edmonds fault continues beyond the mine domain as speculated by FloSolutions.
- GoldSim Surface Water Model: GHD NZ have been developing a hydrological assessment for the site, with a surface water balance model in GoldSim. This work is ongoing, with preliminary results recently completed.
- Mitigation Plan: Valenza Engineering has prepared an extensive assessment of underground engineered mitigation measures to avoid impact on surface water systems. The report covers the analysis of the information provided by OGNZL and other parties, the conceptual mitigation factors and provision of advice on the data requirements. This preliminary work will be updated following the simulation of mitigation scenarios by FloSolutions in the 3D groundwater model.
- Infiltration Tests: FloSolutions has recommended that infiltration tests should be completed at the site to inform the potential for infiltration and recharge to the shallow groundwater system (providing direct measurements that could be used in predictive modeling). OGNZL is awaiting access permissions to conduct this testing.
- River Analysis: FloSolutions has recommended that the streambed morphology and features should be reviewed, and streams then divided into zones or reaches with similar features for further study. In addition, direct streambed seepage combined with stream channel geometry should also be analyzed for river conductance assessment. Flow gauging along river segments (with no tributary inflow) when completed will also provide valuable information of baseflow (gaining or losing rivers). This work is currently under planning and consenting by OGNZL.
- Pumping Tests: OGNZL has been considering options for pumping tests for several years, subject to various limitations, planning and consenting is ongoing.
- Piezometer Replacement: Following the site visit (held in Feb-2023), FloSolutions has issued recommendations to replace some groundwater instruments observed to be damaged at the site. OGNZL is currently evaluating their internal requirements to complete a new round of groundwater instruments installation.

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Appendix A - Data and Information Sources

Appendix B - Flow Gauging

Appendix C - Packer Tests Results

Appendix D - Water Levels

Appendix E - Radon Testing Results