Wharekirauponga Underground Mine Water Management Plan

March 2025

Department	Environmental and Underground Mining
Location/Site	Waihi

Approval table

	Position title	Name	Date
Authored by	Consultant	Malcolm Lane	18/11/2024
Reviewed by			
Approved by		Mick Lovely	27/02/25

Document issuance and revision history

Document name: Wharekirauponga Underground Mine

Document id: Doc ID Unassigned

Revision number	Revision date	Section	Page	Description	Effective Date
	7/02/2024	All	All	Initial draft for issue	
	18/11/24	All	All	Draft for consultation	18/11/24
	27/02/25	All	ALL	Final for lodgement	27/02/25

Table of Contents

1 PURPOSE

1.1 Preamble

This Plan is prepared to assist with meeting the groundwater and surface water management conditions of the consents granted for the Wharekirauponga underground mine, hereafter referred to as WUG. A copy of the relevant consent(s) is included as Appendix A.

Geological and hydrogeological studies undertaken prior to the preparation of this Plan indicate that the WUG Dual Tunnel running between Waihi and WUG is highly unlikely to cause a measurable effect on the overlying surface water bodies (and limited effect on the groundwater in the regions through which they are driven). This Plan applies to the mining activities that occur beneath the Wharekirauponga catchment, which will necessitate lowering the deep[1] groundwater level to provide the required working conditions. As applied here, “mining activities” refers to:

- Ore drive development along the EG Vein system; and
- Stoping activities used to extract ore from the EG Vein system employing drill and blast methods of no less than 15m sub-level spacing.

For the purposes of this Plan, the EG Vein refers to any orebody or associated structure the dewatering of which could potentially cause effects on shallow groundwater and surface water.

The Plan applies to the mine area beneath the Wharekirauponga catchment. Its processes are directed at monitoring the groundwater and surface water for the purpose of safeguarding the surface water flows above the mine and, if shown by the monitoring to be necessary, managing any consequential effects.

1.2 Plan Rationale

Many of the streams in the catchment above the mine are noted as being Natural State waterways in the Waikato Regional Plan. As such careful management of potential groundwater losses is required to minimise the effects from mine dewatering on these surface water bodies.

Lowering the deep groundwater level is required to enable mining. Available geological and hydrogeological data infer a limited link between deep groundwater, and the shallow groundwater and surface water. This link therefore raises the potential for dewatering of the deep system to affect the shallow groundwater system. In some areas, the shallow groundwater system contributes to sustaining stream flows within the sub-catchments above WUG.

This Plan identifies a number of practicable actions that can be applied in the event that monitoring identifies effects on the shallow groundwater system that have any potential to reduce surface water flows. By adopting an Adaptive Management Approach designed to anticipate and react to dewatering impacts on shallow groundwater during the mining of WUG, Oceana Gold (NZ) Ltd (OGNZL) can define in advance proactive and preventative actions to be taken under unanticipated conditions to prevent or limit surface water effects.

[1] For this plan, deep groundwater refers to that surrounding the proposed WUG mine that will be drained by the mine workings to enable work to proceed.

This Plan outlines the potential contingency actions that could and may need to be taken in the event that adverse shallow groundwater effects are predicted or detected. The contingency actions are not prioritised, and the introduction of any specific contingency action will depend on the location and cause of any detected dewatering effect. By adopting this proactive approach, the possibility of facing unanticipated and uncontrollable circumstances that could lead to negative consequences is considerably reduced.

1.3 Hydrogeology and Hydrology Overview

WUG lies beneath the Wharekirauponga Stream and its tributaries. The surface water system is dominated by flashy rainfall run-off due to the steep gradients of the incised topography, which limits the surface water recharge volume to groundwater. Where permeable and porous superficial formations are present, rainfall recharge to deeper groundwater is further limited by interflow that occurs within unsaturated and intermittently saturated horizons that discharge preferentially to streams as baseflow.

Shallow perched aquifers occupy valley-fill colluvium within this catchment underlain by fracture-controlled groundwater systems within tight volcanic bedrock at depth. The separation of the two systems by low-permeability, weathered and clay-rich formations offers limited opportunity for interaction between the deep and shallow systems. Observations from piezometry, stream gauging and advanced tracer studies suggest that the shallow and deep aquifers are unlikely to be connected or are connected weakly. Such interconnection is dominated by the limited vertical recharge and the very few distinct fracture-controlled spring occurrences within the catchment.

Groundwater flow in the surficial aquifers and interflow within the valley-fill deposits largely follow topography with short flow paths likely maintaining stream baseflows. This flow regime is confirmed by piezometry to follow the topographic trend influenced by seasonal recharge, with steeper gradients consistent with higher elevations. The maintenance of low pressure heads through this flow mechanism coupled with the lack of connectivity provides little opportunity for recharge to the deep system. Vertical hydraulic gradients between shallow and deep systems, being generally confirmed by piezometry, suggest a lack of evidence for a strong deep groundwater recharge mechanism. Aside from the currently ambiguous explanation for the mechanism of a warm spring occurrence within the Wharekirauponga Stream, indicative of deep groundwater input, there is little opportunity for the deep system to interact at surface.

The deep aquifer system is confined to the vein systems that provide permeable media in a relatively tight host rock. Lack of response in the deep groundwater to rainfall events confirms the observed lack of any distinct interconnectivity.

Groundwater discharge from springs occurs mainly in the lowland sections of the Wharekirauponga Stream with those like the Warm Spring within the catchment limited by distinct structural connections. Other spring occurrences are likely to be dominated by interflow and topographically controlled shallow groundwater discharge. The Warm Spring is likely to have a significant shallow groundwater component with the extent of the deep groundwater component as yet unquantified.

Current uncertainty in the interaction between surface water and groundwater exists that may benefit from further testing and assessment (such as infiltration tests and additional river gauging). Previous radon surveys, though variable, tend to demonstrate losing reaches within the headwaters with streams discharging to groundwater. Gaining reaches do exist downstream of the East Graben Vein (EGV), which identifies the area most prone to potential dewatering effects. Moderate to strong linkages are suggested in the shallow groundwater system as indicated by the relationship between rainfall events and shallow groundwater heads.

Mining at WUG is scheduled to start following an initial period of construction of access tunnels. This provides a considerable time to gather additional baseline data on natural stream flows, wetland water levels, and seasonal variations of both. The accumulated data will provide a substantial database against which to compare ongoing measurements throughout the mining activity, enabling detection of any shallow groundwater or surface water dewatering effects.

1.3.1 Plan Approach

While the objective of this Plan is to ensure protection of the Natural State waterways above WUG from potential dewatering effects, the structure of the Plan focuses first on groundwater inflows to the mine (dewatering), followed by groundwater monitoring particularly of the shallow groundwater above the mine. It is changes to the latter that could potentially impact the surface water flows.

Mining will depress the deep groundwater level, at least close to the mine workings, to provide suitable working conditions. If dewatering is constrained to the deep groundwater system, the inflows into newly mined areas would be expected to reduce measurably within a relatively short period, e.g. one week. Should mining encounter higher permeability structures, an extended period of high inflows may occur and could indicate a broader extent of dewatering. Ongoing groundwater inflow could indicate a possible connection between the deep groundwater system and the overlying shallow system.

Should there be a connection between the deep and shallow groundwater systems, and if mine inflows do not stabilise, a subsequent lowering of groundwater level/pressure in the shallow system could occur. These “secondary” effects would take some time to transpire and to become measurable as a decrease in the shallow groundwater level. Should the shallow groundwater effects continue for any substantial time, reduction in the surface water flow could eventuate. Preventing this “tertiary” effect is the objective of the Plan.

It is worth noting that any measurable surface water effects from mine dewatering will have a seasonal or timing dimension. Any reduction in stream flows will have a greater environmental impact during stream low flow conditions. At other times, small reductions in stream flow will not necessarily have an adverse environmental outcome and across all conditions may not be measurable. Due to the climate of the Wharekirauponga catchment these low-flow conditions are short and intermittent and are not necessarily consistent seasonally.

1.4 Development Experience

As stated in s1.1, the WUG Dual Tunnel running between Waihi and WUG will have no measurable effect on the overlying surface water (and limited effect on the groundwater in the regions through which they are driven). This Plan does not apply to this phase of the overall project. However, there are likely to be structures encountered during access development that are permeable and that could generate material volumes of inflow. For managing working conditions and for maintenance of this long-term infrastructure, such zones may require grouting prior to or following development to reduce this inflow. The products used and the techniques developed during access tunnel development will provide practical experience that may be applied to the management of groundwater control at WUG.

1.5 Plan Objective

The objective of this Plan is to ensure that monitoring and mitigation procedures are implemented to provide protection of the Natural State waterbodies above WUG from potential dewatering effects during mining activities.

Protection of these streams will ensure protection of their habitat qualities, their natural flow regimes and their natural character.

1.6 General Methods

This WUG Water Management Plan:

- Outlines the monitoring systems in place for surface streams, groundwater and dewatering;
- Identifies trigger limits that will indicate when contingency mitigation and/or monitoring may be necessary;
- Identifies what contingency mitigation and/or additional monitoring could be undertaken in the event that the trigger levels are exceeded and a link between the dewatering activity and the surface water flows is established in order to ensure that adverse effects from dewatering are avoided, remedied or mitigated;
- Outlines the surface water flow monitoring requirements necessary to provide confirmation that mining is not affecting surface water flows, or where necessary that the implemented contingency mitigation actions are effective.

1.7 Baseline and Operational Monitoring Methods

Monitoring will be implemented to measure and record the:

- Daily volume of water pumped from the access drives and WUG;
- Groundwater levels at different depths within the shallow groundwater system above and in the vicinity of WUG and in control monitoring sites outside the Wharekirauponga catchment;
- Daily rainfall data specific to the catchment(s) above WUG;
- Stream flows above and in the vicinity of WUG and in control sites outside the Wharekirauponga catchment; and
- Where applicable, measure and record any supplementary discharges within the Wharekirauponga catchment to maintain either wetlands or stream flows.

2 SCOPE

The Plan applies to the area within the Wharekirauponga catchment potentially impacted by underground mining activities. Its processes are directed at monitoring the groundwater and surface water for the purpose of safeguarding the surface water flows above the mine and, if shown by the monitoring to be necessary, managing any consequential effects.

3 RESPONSIBILITIES AND ACCOUNTABILITIES

Role	Responsibility
Asset President	• Ensure that equipment, resources and training are available to meet the dewatering management and monitoring required by the relevant consent conditions and the measures required by this Plan

Role	Responsibility
Environmental Manager / Superintendent	• Ensure that dewatering, groundwater and surface water monitoring is carried out according to the relevant consent conditions and the methods outlined in this Plan. • Ensure that dewatering and water monitoring reports are produced and supplied to applicable regulators on time as indicated in this Plan. • Ensure that dewatering, groundwater and surface water monitoring data are reviewed according to this Plan, and contingency and mitigation measures are implemented as required. • Ensure applicable regulators are advised of any situations where the trigger levels stated in this Plan are exceeded, or where other unanticipated monitoring results are received. • Ensure that applicable regulators are advised of any situations where contingency mitigation measures are applied to address dewatering that potentially affects surface water flows
WUG Underground Manager	• Ensure dewatering flows, groundwater levels and surface water flows are routinely monitored according to this Plan. • Ensure the actions outlined in this Plan are taken promptly in the event of a trigger level exceedance. • Inform the Environmental Manager / Superintendent of a trigger level activation as soon as practicable.

4 DEWATERING MONITORING

4.1 Background

Dewatering of WUG is necessary to maintain access and working conditions. The proposed maximum depth of mine dewatering will result in the localised lowering of groundwater in the deep groundwater system to -150mamsl, or a total drawdown of around 250m.

Importantly for the protection of the Natural State waterbody surface water flows above the mine, excessive groundwater inflows provide a precursor warning of potential, consequential dewatering of either the shallow groundwater system or of surface waters. Therefore, the initial focus of the Plan is on monitoring the groundwater inflow rates into the mine.

Prior to the start of stoping, drilling and ore drive development must be undertaken. These initial and small-scale activities will provide early warning of potentially large deep groundwater inflows that, if connected to the shallow groundwater system above the mine and not addressed, could adversely affect surface water flows.

Potential connections between the deep and shallow groundwater would be indicated by large or extended-time inflow to the underground workings. Any such early warnings will initiate investigations of the cause of the inflow and likely extent of the resulting dewatering effect. If indicated as necessary, the implementation of remedial works to prevent any detrimental water loss from the overlying streams will be undertaken.

4.2 Scope

This section of the monitoring plan covers:

- Dewatering trigger values and responses;
- Dewatering volume measurement method and frequencies;
- Data recording and storage;
- Reporting.

A description of remediation and mitigation actions to be taken following the exceedance of any trigger limit is provided in s7.

4.3 Dewatering Trigger Values

Probe drilling will be undertaken ahead of all ore development of high uncertainty by either multi-boom jumbos, long-hole drills or diamond drilling methods.

While not the only objective of probe drilling, for the purposes of this Plan such drilling will be undertaken to identify fractured ground that carries substantial volumes of groundwater. Borehole penetration of such zones will result in material increases in groundwater inflow. This outcome is expected and may last for a period of up to a week before reducing to a lesser, stable inflow.

Should a permeable zone encountered by the drilling be in contact with the shallow groundwater system above, ongoing dewatering of that system would continue and could result in reductions in stream flow.

A variation from expected groundwater response is deemed to occur if the:

1. Inflow is materially greater than the prior measured and or modelled range of inflow; and
2. That inflow does not reduce to prior measured and / or modelled range within one week.

If these conditions are encountered, the Mine Manager shall be notified within 24 hours. That notification shall include an explanation of the anomalous results and actions proposed to further investigate and address any issues identified. A flow chart indicating the steps to be followed is shown in Figure 1 overleaf.

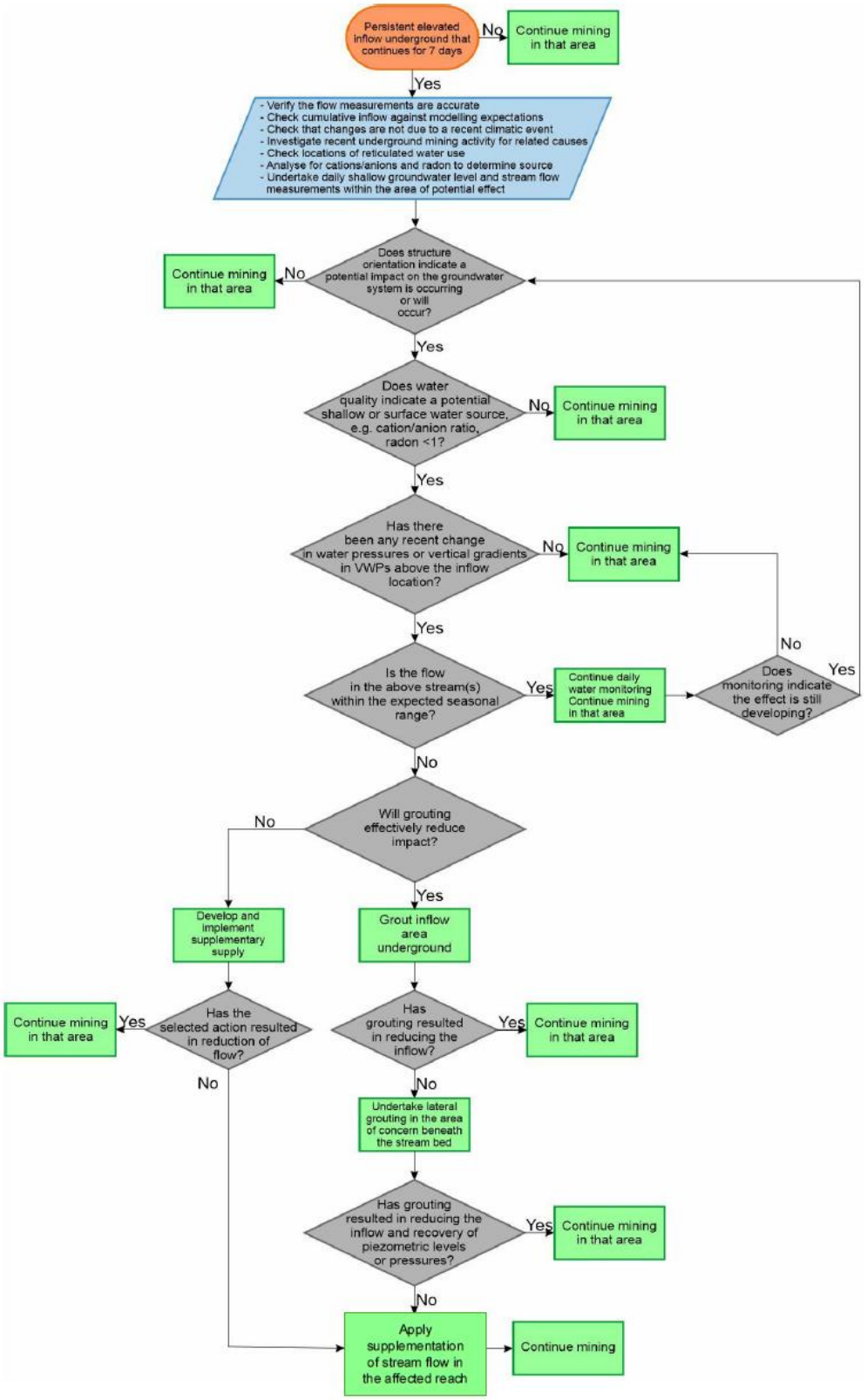

Figure 1: Minewater Inflow Logic Diagram

The need to apply mitigation shall be assessed and, if deemed necessary, undertaken using the most practicable method. Available mitigation options are covered in s7.

All of the information shall be included in the quarterly reports and in the Annual Groundwater and Surface Water Monitoring Report.

4.4 Dewatering Volumes

Total volumes of water pumped from WUG shall be monitored.

4.4.1 Method and Frequency of Measurement

All intercepted groundwater will need to be pumped from the mine to treatment prior to discharge. Flow meters shall be installed such that the volume of dewatering can be monitored and totalled. The total daily mine dewatering volume shall be recorded.

4.4.2 Data Management

Meter readings shall be recorded in a database. If any recording is manually undertaken, the daily volume(s) shall be read and recorded. Manually recorded data shall be added to any automatically recorded volumes.

Total daily pumped volumes shall be compared with previous days' readings to identify anomalies. Where an anomaly is identified, the data sheets are to be checked, and operations personnel consulted. If the anomaly persists, the meters are to be checked for accuracy.

4.5 Dewatering Reporting

A summary of the underground daily dewatering volumes shall be provided quarterly to the WRC and DOC.

4.3All dewatering data and remedial actions (as discussed in section 4.3 above) shall be reported annually in the Annual Groundwater and Surface Water Monitoring Report.

5 GROUNDWATER MONITORING

5.1 Background

Piezometers shall be installed above WUG, with control sites installed in adjacent catchments. The installations comprise pairs of piezometers at each location. Within each pair, one piezometer will monitor the near-surface (shallower) groundwater while the second will be located deeper within the shallow groundwater system. Their purpose is to measure groundwater level/pressure at different depths below the ground surface.

The purpose of these measurements is to:

1. Establish baseline data for the depth to groundwater and natural level variation; and
2. Record the effect, or lack of effect, of mine dewatering on the groundwater level/pressure in the groundwater system.

5.2 Scope

This section of the monitoring plan includes:

- Locations of the monitoring piezometers above WUG;
- Locations of control piezometers outside the Wharekirauponga catchment;
- Piezometer monitoring methods and procedures;
- Monitoring frequencies;
- A description of piezometer network maintenance;
- Trigger limits and mitigation measures for piezometers;
- Guides for recording and managing data; and
- Guides for reporting of the piezometer level data.

A description of remediation and mitigation actions to be taken in the event of trigger limit exceedance is provided in s7.

5.3 Groundwater Drawdown Monitoring Network

5.3.1 Piezometer Locations

The piezometer network to be established is shown in Figure 2. The figure includes several control monitoring sites located in the catchments immediately to the north and south of the Wharekirauponga valley. The coordinates of the monitors are listed in Table 1. Installation shall be undertaken as soon as practicable.

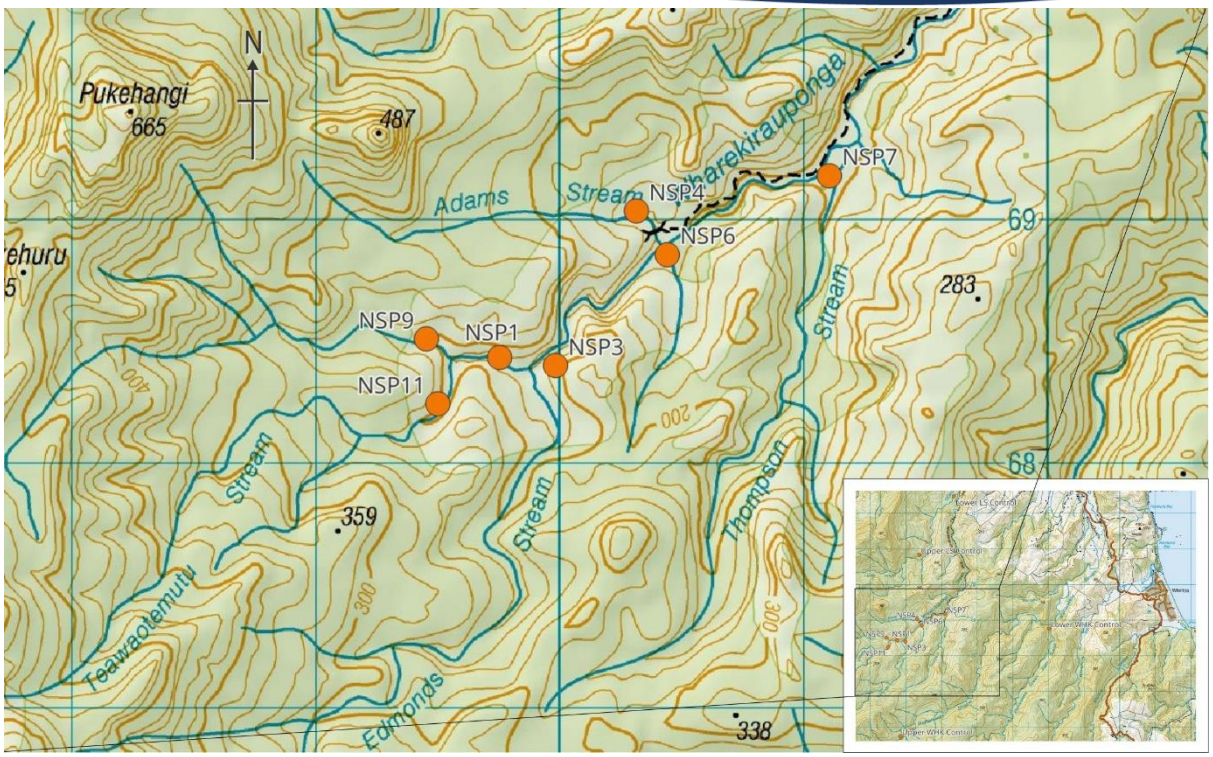

Figure 2: **Wharekirauponga Valley Piezometer Location Plan**
(inset shows Control Sites in neighbouring catchments)

Table 1: **Coordinates of Groundwater Monitoring Piezometers**

Piezometer	Map Reference NZTM2000 (Approximate)
Near Stream Sites, Wharekirauponga Valley	
NSP1	5868435, 1849751
NSP3	5868402, 1849980
NSP4	5869035, 1850311
NSP6	5868856, 1850438
NSP7	5869179, 1851102
NSP9	5868511, 1849451
NSP11	5868245, 1849498
Control Sites	
Lower LS	5872483, 1851338
Upper LS	5870844, 1850369
Lower WHK	5868774, 1854014

Piezometer	Map Reference NZTM2000 (Approximate)
Upper WHK	5865747, 1849835

The purpose of early monitoring is to establish a robust baseline of groundwater levels/pressures well before dewatering effects might be registered at WUG. A total of eight monitoring sites is proposed for monitoring above the underground mine, with four control sites, two in each of the Lignite and Waiharakeke stream catchments.

Should the baseline and/or operational monitoring indicate any requirement for either replacement of existing piezometers or the installation of additional piezometers to provide the data necessary to adequately define the pre-mining and during-mining effects, Figure 2 needs to be updated within a month of completing those installations.

5.3.2 Review and Improvement to the Piezometer Network

Review of the piezometer network will be undertaken routinely to:

- Ensure all areas likely to be affected by mine dewatering are adequately covered and monitored by piezometers; and
- Ensure that all areas likely to be affected by backfilling of stopes and flooding the underground workings following closure are adequately covered and monitored by piezometers.

5.3.3 Monitoring Method

The vibrating wire piezometers and standpipes installed for monitoring groundwater levels are fitted with telemetered transducers for monitoring and transmitting groundwater levels. The transducers are linked to a datalogger and communications system that allows all data to be transmitted at a minimum of 15-minute intervals to be received and saved by OGNZL.

The system shall be set such that activating any trigger level will automatically notify the WUG Mine Superintendent and the operation's Environment Department.

5.3.4 Monitoring Frequencies

Monitoring is undertaken electronically, i.e. automatically, with the level transducers frequently downloading the recorded level data. All results will be reported in the quarterly reports and in the Annual Groundwater and Surface Water Monitoring Report.

5.3.5 Recording and Managing Piezometer Data

The groundwater level data are stored digitally, and all data collected during the development and mining stages of the project are to be managed and maintained by OGNZL.

5.3.6 Routine Network Inspection and Maintenance

A visual inspection of all monitoring locations and installations shall be undertaken biannually. This shall include a calibration to water level for pressure transducers in standpipe piezometers. If this inspection indicates that a piezometer is unreliable, damaged or malfunctioning, then steps are taken to repair, relocate, renew or decommission the monitoring site.

Alternatively, analysis of the monitoring data may identify a monitoring location that is unreliable or dubious. Re-measurement and a thorough inspection of this monitoring location is to be undertaken to ascertain the reliability of the data and the monitoring location.

The inspections coupled with the monitoring results may determine the retention, retirement or a requirement for re-establishment of a monitoring location.

5.3.7 Maintenance of the Piezometer Measurement Equipment

The monitoring units batteries shall be changed as needed, triggered by battery level alarms within the monitoring system.

5.4 Trigger Responses

Mine dewatering will affect levels or pressures in the deep groundwater system. However, such changes need not affect level/pressure in the piezometer pairs installed in the shallow system at the monitoring locations shown in Figure 2.

Change in water level/pressure in the near-stream, deeper piezometer in any pair should not be interpreted as confirming a potential effect and does not require any follow-up response. However, such change may provide an early warning of forthcoming change in the shallow piezometer and as a minimum needs to prompt closer and more frequent examination of groundwater levels generally.

A potential mine dewatering effect on shallow groundwater shall be triggered when groundwater levels in any pair of piezometers shown in Figure 2 indicates:

1. A significant increase in the downward vertical hydraulic gradient compared to that indicated in the baseline monitoring data; or
2. A reversal of vertical hydraulic gradient, i.e. from upwards to downwards.

A significant increase in the downward vertical hydraulic gradient would be a lowering of the:

- Head in a deeper piezometer relative to the head in the adjacent shallower piezometer; or
- Head in a deeper piezometer relative to the baseline monitoring data; or
- Heads in both adjacent shallower and deeper piezometers relative to the baseline monitoring data.

A reversal of hydraulic gradient is indicated when a vertically upward hydraulic gradient changes to be vertically downward, i.e. the head in a deeper piezometer is initially higher than that in the shallower piezometer but then reverses.

It is worth noting that:

- A vertically upward hydraulic gradient adjacent to a stream represents a reach that is gaining, i.e. being fed by groundwater; and
- A vertically downward hydraulic gradient adjacent to a stream represents a reach that is losing.

If a response is triggered, the following actions should be followed:

- Verify that the instrument(s) and data collection is accurate;
- Check that any change is not the result of a recent climatic event;

- Commence daily assessments of the groundwater level measurement recordings at the affected and nearby piezometers;
- Cross check the groundwater level data with any relevant geotechnical observations, including increased groundwater flows into the underground mine;
- Investigate the cause of the anomaly including any recent underground mining activity and any other hydrogeological performance monitors; and
- Advise the WRC and DOC of the anomaly (within 5 working days) and include an explanation of the anomalous results and actions proposed to further investigate or address any issues identified (if needed).

Mitigation options to be taken in the event of any marked decrease in shallow groundwater level are covered in s7.

All trigger level events shall be reported to the WRC and DOC within 40 working days of occurrence. An explanation of the event, the subsequent investigation findings, and the implementation of any required remedial response and its effectiveness shall be reported.

The primary focus of this monitoring is to ensure effects in the near-surface groundwater are adequately monitored, and if monitoring proves it necessary, effectively managed in order to protect the overlying streams from mine-derived dewatering effects.

5.5 Groundwater Monitoring Reporting

5.5.1 General

A summary of the groundwater level data shall be provided quarterly to the WRC and DOC.

For any significant changes in the groundwater levels recorded in the piezometers, the identified cause and the remedial actions taken shall be reported to the WRC and DOC as detailed in s5.4.

All dewatering data and remedial actions shall be reported annually in the Annual Groundwater and Surface Water Monitoring Report.

5.5.2 Annual Summary Analysis and Reporting

A report and summary of the groundwater level data is to be produced annually and issued to the WRC and DOC; the Annual Groundwater and Surface Water Monitoring Report. This report will include analysis and evaluation of the data undertaken during the year.

The annual report shall include:

- A description of the installed monitoring instruments and any pre-development testing undertaken;
- A description of any new tunnels and stopes created during the year, including their location, depth and volume;
- A description of any dewatering that has occurred, including the method of dewatering and the daily flow rates, volume and chemistry of the water;
- The data from monitoring undertaken during the year including groundwater contour plans (derived from the data) in respect of the piezometer network;
- Identification of any important trends in dewatering/rewatering behaviour;
- Interpretation and analysis of any change in groundwater profile over the previous year, and any contingency or mitigation actions taken in response to groundwater level/pressure changes.

- A description of any other methods in place or proposed for addressing dewatering effects;
- Comment on compliance with all relevant conditions of consent;
- Any reasons for non-compliance or difficulties in achieving conformance with consent conditions;
- Any works undertaken to improve environmental performance or that are proposed to be undertaken in the forthcoming year to improve environmental performance in relation to activities authorised by the consent, e.g. a description of any grouting or alternative mitigation undertaken or proposed to control the ingress of groundwater; and
- Recommendations from the Expert Groundwater Management Panel (being a panel to review and provide recommendations on the adequacy and appropriateness of the various reports, and management and monitoring plans associated with WUG groundwater and surface water management and monitoring, as required by the conditions appended to this report) resulting from the most recent review and reference to how these recommendations will or have been addressed.

6 SURFACE WATER AND WETLAND MONITORING

6.1 Background

The purpose of in-stream and wetland measurements is to confirm that mine dewatering is not materially affecting surface water flows or wetland water levels. These measurements are supplementary to the dewatering and groundwater monitoring detailed in s3 and s5. Ideally, any changes in groundwater levels/pressures would be detected prior to the occurrence of measurable effects in the surface water flows. However, as the protection of surface water flows is the primary objective of this Plan, stream and wetland monitoring is essential to demonstrate that the objective is achieved.

6.2 Scope

This section of the monitoring plan includes:

- Locations of all stream flow gauges;
- Locations of all wetland water level monitors;
- Monitoring methods and procedures;
- Monitoring frequencies;
- Stream and wetland water level gauge network maintenance;
- Trigger limits and mitigation measures for stream flows;
- Guides for recording and managing data; and
- Guides for reporting of the data.

A description of remediation and mitigation actions to be taken in the event of unacceptable changes in stream flows or wetland water levels is provided in s7.

6.3 Monitoring

6.3.1 Surface Water Sites

Stream level monitoring instruments were installed in the streams above WUG starting in 2019, and associated flow gauging has been undertaken quarterly since that time. Flow and stage level relationships have been developed for these sites to enable real-time estimation of flow.

Following grant of consents for WUG, stream level monitoring stations shall be installed in the locations shown in Figure 3, map references for which are listed in Table 2. Quarterly stream flow gauging using a handheld FlowTracker will be required prior to the commencement of underground mining, and throughout the life of project to build and maintain stream rating relationships to allow real-time estimation of flow.

Table 2 also contains the location of the four stream flow control sites against which to compare changes in flow recorded at those above WUG. Two of the control sites are located in the Lignite Stream catchment to the north of Wharekirauponga Valley, and two in the Waiharakeke Stream catchment to the south.

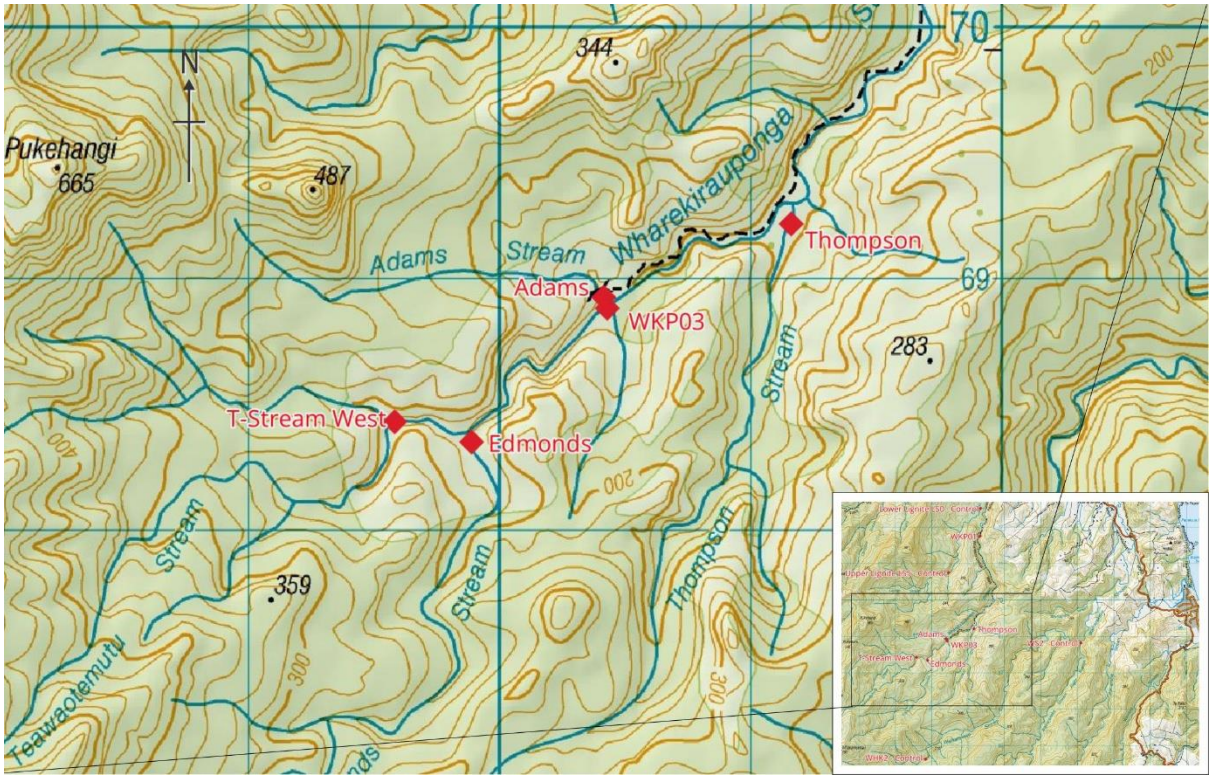

Figure 3: **Stream Gauging Station Locations**
(inset shows WKP01 farther downstream and Control Sites)

Table 2: **Map References for Stream Gauging Stations**

Location Name	Map Reference NZTM2000 (Approximate)
WKP01	1851376, 5871977
WKP3	1850400, 5868874
T-Stream West	1849598, 5868439
Edmonds Stream	1849983, 5868181
Thompson Stream	1851165, 5869253
Adams Stream	1850384, 5868980

Control Gauging Stations	
LS1	1851389, 5872531
LS6	1850462, 5870689
WS2	1854088, 5868829
WHK2	1849832, 5865641

Permanent monitoring stations such as weirs have been discounted due to resulting effects on the Natural State waterways.

6.3.2 Wetland Sites

Following grant of consents for WUG, wetland monitoring stations shall be installed in the locations shown in Figure 4 overleaf at or near the map references listed in Table 3. Table 3 also contains the location of the monitoring control site against which to compare changes in water level recorded at those above WUG.

Table 3: Map References for Wetland Monitoring Sites

Location Name	Map Reference NZTM2000 (Approximate)
Edmonds 16	5867471,1849962
Edmonds 17	5867407,1849822
Edmonds 18	5867447,1849887
Edmonds 20	5867359,1849779
Edmonds 22	5867243,1849708
Adams 3	5869204,1850260
Adams 4	5869249,1850028
Adams 9	5869173,1849853
Adams 10	5869131,1849859
Control Site	
Waiharakeke	5864926, 1848909

6.3.3 Monitoring Method

The surface water flow monitoring system comprises a pressure transducer at each of the surface water monitoring sites shown in Figure 3 and listed in Table 2.

For monitoring the wetlands, two pressure transducer installations are installed at each feature shown in Figure 4 and listed in Table 3, one within the wetland with the second mounted outside and adjacent to the wetland for the purpose of monitoring the shallow groundwater level.

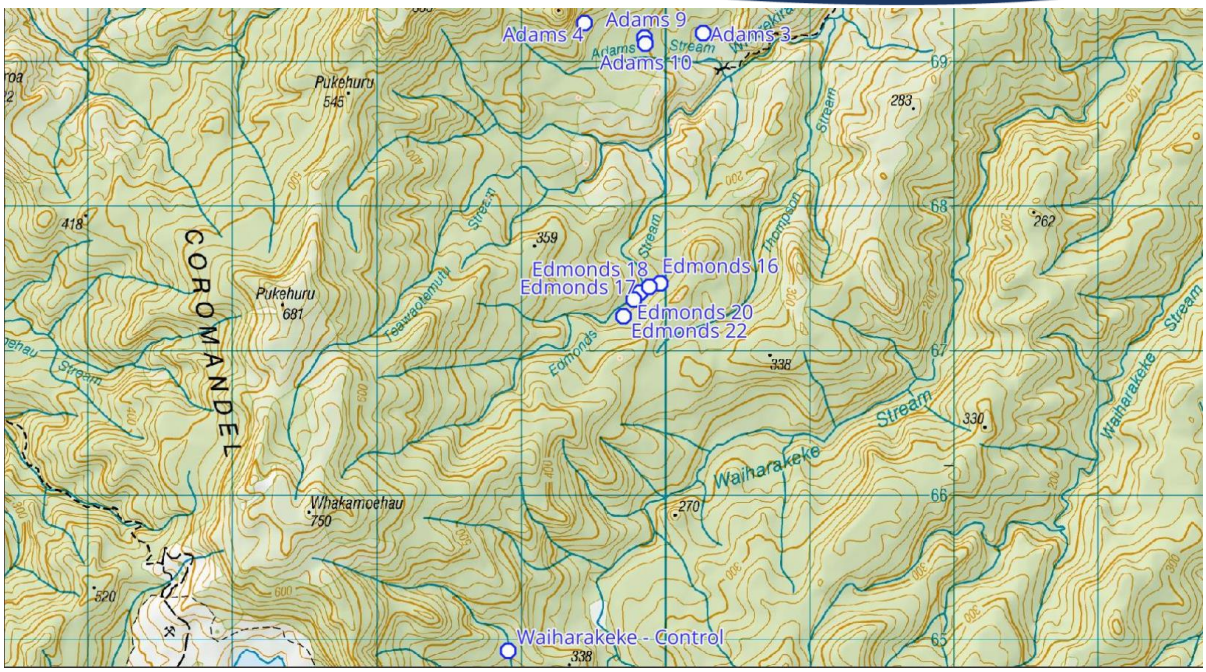

Figure 4: Wetland Monitoring Locations

Each of the level loggers is installed in a pipe to provide a stilling well, mounted on a waratah driven into the streambed, the wetland, and adjacent to each wetland. Each transducer is fitted with an internal datalogger. Any alternate water level monitoring system shall be approved by WRC and DOC prior to installation.

The level loggers are connected to a system that automatically transmits the recorded water level data to OGNZL system where the data are saved. The system shall convert water level data to a flow in real-time, using the rating relationship developed between flow and water level.

The system shall be set such that activating any trigger level will automatically notify the WUG Environmental Manager and the operation's Environment Department.

The flashy nature of the streams above WUG necessitate quarterly calibration of the in-stream pressure transducers to water level and stream flow, subject to site accessibility. This will entail a waded river flow gauging, a reference water level measurement, and an instrumentation check at each visit. In addition, calibration shall be checked after high rainfall/stream flow occurrences and, if necessary, any affected installation shall be recalibrated or reinstalled.

Calibration/recalibration of the stream monitors shall be undertaken quarterly when stream flow conditions provide for safe access for personnel

Manual checking of the wetland and adjacent water level monitors shall be undertaken at annual intervals.

6.3.4 Monitoring Frequency

The installed level loggers are fitted with telemetered transducers for monitoring and transmitting stream, wetland and groundwater water levels. The level loggers record water level in the stilling well and transmit the level/flow data at 15-minute intervals to be received and saved by OGNZL.

Table 4 Outside the occurrence of trigger events, the flow and level monitoring data shall be reviewed monthly by OGNZL, with data provided to the WRC and DOC quarterly and all results being reported on in an Annual Groundwater and Surface Water Monitoring Report.

6.3.5 Review and Improvement to the Flow Monitoring Network

Review of the gauging station network will be undertaken routinely to:

- Ensure that all areas potentially affected by dewatering during operations are adequately monitored;
- Ensure that all areas likely to be affected by backfilling of stopes and flooding the underground workings following closure are adequately monitored to determine any changes in the post-closure flow regime;
- Address any requests received from the Expert Groundwater Management Panel.

Any shortcomings identified during these reviews shall be remedied as soon as practicable. Any potential improvements to the methods of monitoring surface flows, or to the monitoring network, shall be reported to WRC and DOC and, subject to its acceptance of the proposed changes, be implemented as soon as practicable.

6.3.6 Recording and Managing Data

All flow and water level data collected during the development and mining stages of the project are to be managed, stored and maintained by OGNZL and provided to WRC and DOC in routine reports or at any other time upon request.

6.3.7 Routine Network Inspection and Maintenance

A visual inspection of all monitoring locations and installations shall be undertaken quarterly. If this inspection indicates that a flow or water level gauge is unreliable, damaged or malfunctioning, then steps are taken to repair, relocate, renew or decommission the monitoring site.

Analysis of the monitoring data may identify a monitoring location that is unreliable or generating dubious results. Re-measurement and a thorough inspection of any such monitoring location is to be undertaken to ascertain the reliability of the data and the suitability of the monitoring location.

The inspections coupled with the monitoring results may determine the retention or retirement of a monitoring location.

6.4 Surface Water Flow Triggers

The primary focus of monitoring surface water flows is to ensure material flow reductions in the streams overlying WUG are avoided in order to protect the Natural State values of the streams.

The natural stream flows can vary considerably throughout a year, a season, or even a day. This makes setting meaningful trigger levels challenging. Nevertheless, the requirement to monitor stream

flows prior to any development at WUG will provide an improved basis for detecting unusual changes once mining starts.

Flows equal to or less than the trigger levels listed in **Table 4** shall initiate the actions set out below in ss0 and 6.4.2. All trigger events shall be included in the quarterly reports and in the Annual Groundwater and Surface Water Monitoring Report.

Table 4: Stream Flow Trigger Levels

Flow Gauge	Alert Trigger Level, m^3/day	Respond Trigger Level, m^3/day
WKP01	10,200	2213 x $R_{30'}$ + 4285
WKP03	4,800	1106 x $R_{30'}$ + 1864
T-Stream West	2,700	626 x $R_{30'}$ + 919
Edmonds	2,200	447 x $R_{30'}$ + 930
Thompson	1,600	299 x $R_{30'}$ + 856
Adams	1,000	145 x $R_{30'}$ + 577

where $R_{30'}$ is the rolling 30-day mean rainfall in mm, i.e. the total rainfall in the past 30 days expressed in mm divided by 30.

6.4.1 Alert Trigger Events

A flow of less than the Alert trigger level indicates low flow conditions in the streams. At any flow equal to or less that the Alert trigger level, OGNZL shall undertake daily reviews of the flows at each of the stream flow monitoring and control sites and shall:

- Check the stream flow data for the sites listed above in **Table 4** and the groundwater level from piezometers nearby these sites for the period leading up to the trigger event for accuracy and inconsistencies;
- Check the surface water flow and groundwater levels at the control sites or similar, suitable locations for evidence of similar or trending flow patterns and/or alignment with the expected rainfall/flow trends, and potential climatic drivers of the observed data; and
- Check the wetland water level monitoring data for evidence of similar water level patterns, and potential climatic drivers of the observed data.

If the low flow event is not attributable to a measuring inaccuracy or to any potential climatic driver, it shall be assumed to be caused by mine dewatering, subject to confirmation. WRC and DOC are to be notified as soon as practicable, but within a timeframe not exceeding five working days of making such a finding. The appropriate mitigation measure(s) shall be developed and presented to WRC and DOC within 40 working days of the low flow event occurrence. The mitigation shall be implemented as soon as practicable.

If the low flow event is attributable to monitoring inaccuracy or to a potential climatic driver, OGNZL will report the event and the findings from its subsequent actions and investigations to WRC and DOC within 40 working days of the event occurrence.

6.4.2 Respond Trigger Events

A flow of less than the Respond trigger level may indicate a loss of water due to mine dewatering that necessitates immediate investigation and may require the implementation of a mitigation response. At any flow equal to or less than the Respond trigger level, OGNZL shall commission a suitably qualified

and experienced professional approved by WRC and DOC to examine and evaluate the flow data from each of the stream flow monitoring and control sites and to provide a report on the findings.

The objective of the examination and evaluation is to determine whether or not the low flow event is or could be caused by mine dewatering.

In preparing the report, the author shall undertake the steps outlined above in response to an Alert trigger. If the event cannot be confirmed as the result of a natural event, the following additional measure should be considered:

- Arrange for visual inspection of the recording devices to ensure they are measuring accurately;
- Re-analyse historical baseline data for evidence of similar flow patterns, and potential climatic drivers of the observed data;
- Conduct a round of out-of-cycle manual flow gauging to ensure stream flow gauges are appropriately calibrated;
- Analyse data collected by shallow piezometers; and
- Undertake visual inspection and gauging at other locations with particular focus on known groundwater seeps/springs.

The resulting report shall set out the investigations undertaken, the data reviewed, an explanation of the triggering event, and recommendations for implementing mitigation required to address any loss of stream flow. The report shall be provided to WRC and DOC as soon as practical, and no later than 40 working days after occurrence of the flow trigger unless otherwise agreed with WRC and DOC.

In the event that the report recommends mitigation, the proposed mitigation action shall be developed by OGNZL and presented to WRC and DOC within 40 working days of receipt. Potential mitigation options are covered in s7. The adopted mitigation action shall be implemented as soon as practicable.

6.5 Wetland Water Level Trigger

The groundwater levels outside the wetland may vary seasonally and in response to antecedent rainfall. Water levels in the adjacent wetlands will also vary in response to season and rainfall but to a lesser extent.

A wetland water level trigger is activated when:

1. The groundwater level of the piezometer adjacent to a wetland drops to a level below the base of the wetland; and
2. The wetland water level drops below the lowest level previously recorded in the baseline monitoring database for that wetland.

Should a wetland trigger occur, OGNZL shall undertake daily reviews of the water levels in each of the wetlands and adjacent groundwater monitors listed in Table 3 above, and of the flows from each of the stream flow monitoring and control sites listed in Table 4, and shall:

- Check the wetland water level monitoring data for evidence of similar water level patterns, and potential climatic drivers of the observed data;
- Check the stream flow data for evidence of inconsistencies; and
- Check the surface water flow and groundwater levels at the control sites or similar, suitable locations for evidence of similar or trending flow patterns and/or alignment with the expected rainfall/flow trends, and potential climatic drivers of the observed data.

If the triggering event is not attributable to any potential climatic driver, it shall be assumed to be caused by potential mine dewatering. WRC and DOC are to be notified within five working days of making such a finding. The appropriate mitigation measure(s) shall be developed and presented to WRC and DOC within 40 working days of the low flow event occurrence. The mitigation shall be implemented as soon as practicable.

If the low water levels in both the wetland and groundwater monitors are attributable to any monitoring inaccuracy or potential climatic driver, OGNZL will report the event and the findings from its subsequent actions and investigations to WRC and DOC within 40 working days of the event occurrence.

A lowering of groundwater without any corresponding decrease in water level within the adjacent wetland does not constitute a trigger event.

6.6 Surface Water and Wetland Monitoring Reporting

6.6.1 General

A summary of the collected stream flow and wetland and groundwater level data shall be provided quarterly to the WRC and DOC.

Any significant changes recorded in the stream flows or both wetland and groundwater levels, the identified cause, and the remedial actions taken shall be reported to the WRC and DOC as detailed in s6.4 and/or s6.5.

All measured flow and water level data and remedial actions shall be reported annually the Annual Groundwater and Surface Water Monitoring Report.

6.6.2 Annual Summary Analysis and Reporting

A report and summary of the stream flow data and the level data in shallow groundwater and wetlands is to be produced annually and issued to the WRC and DOC; the Annual Groundwater and Surface Water Monitoring Report. This report will include any analysis and evaluation of the data undertaken during the year.

The annual report shall include:
The data from monitoring undertaken during the previous year;

- A description of the installed monitoring instruments;
- Data from all the surface water flow and wetland water level monitoring undertaken during the year;
- A summary of all the collected surface water flow and wetland water level data;
- Identification of any effects or trends resulting from mine dewatering activities in the flow regimes of natural state waterbodies and/or water levels within wetlands which are potentially affected by stoping or mine dewatering activities;
- Interpretation and analysis of any change in surface flows or wetland water levels during the previous year, and any contingency or mitigation actions taken in response to those changes;
- Comment on compliance and/or non-compliance with all relevant conditions of the consent;
- Any reasons for non-compliance or difficulties in achieving compliance with the consent conditions;
- Any works undertaken to improve environmental performance or that are proposed to be undertaken in the forthcoming year to improve environmental performance in relation to activities permitted by the consent; and

- Peer review recommendations from the most recent review with reference to how they will or have been addressed.

7 CONTINGENCY/REMEDIAL ACTIONS

7.1 Preamble

The potential contingency and/or remedial actions described in this section have no priority or preference given to them. The adoption of any action must be preceded by a confirmed link between dewatering and at least a measurable impact on shallow groundwater levels that, if not mitigated, would likely lead to a material reduction in stream flow. Selection of the adopted remedial action(s) will depend on the assessment of both the cause of the potential stream flow loss and the most appropriate remedy.

With experience gained through developing the access drives to and at WUG, some of the following options may be proven more practicable and successful. Once development reaches WUG, priorities may be assigned to preferred options, or new and preferable options may be developed.

7.2 Options

7.2.1 Supplementary Water

There are several options for providing supplementary water to maintain stream flows and/or wetlands. Supplementary water would be added only during low summer flow periods that typically occur for a short period during summer to ensure protection of aquatic organisms during these periods of stress.

Beyond those low flow periods, any reduction of stream flow is expected to be unmeasurable and would have no effect on aquatic organisms.

7.2.1.1 Local borehole pumping

Existing borehole pumps near affected streams or wetlands could be utilised to make up any local low flow losses using nearby groundwater.

A key consideration for this option is to avoid the pumped supply causing or exacerbating stream flow reduction or drying of wetlands.

7.2.1.2 Mine-intercepted groundwater

A make-up supply from the groundwater that passively reports to the underground mine would provide more than sufficient volume. Pumping from underground of a sufficient quantity to supplement the low stream flow would be required.

Treatment of the make-up water may be required depending on source location and associated water quality. Any discharge of water shall be of a quality that does not cause harm to the aquatic life of the receiving environment.

7.2.2 Grouting

The concept involves sealing cracks and fissures through which shallow groundwater reports to the mine. The grouting aims at producing a low permeability blanket across a sufficiently wide aerial extent to maintain shallow groundwater levels above the grouted area and hence to maintain flows to streams sustained by shallow groundwater.

7.2.2.1 Introduction

Pre-development, cover-grouting can and may be applied ahead of the advancing development to create an “umbrella” encircling the drives/shafts. This comprises injection of a grout halo around the development profile prior to excavating the drive. If elevated groundwater inflows continue following pre-development grouting, additional grouting can be applied up to 50m ahead of development.

Within WUG, grouting to provide sealing of permeable zones may also be undertaken from access drives, cuddies and stopes.

7.2.2.2 Grout Materials

Cement-based grout is widely used and offers a lower-cost option. However, it has limitations where the permeable zones include apertures that are larger than about 1mm in dimension and/or smaller than about 10µm.

For applications where cement-based grout is not appropriate, the use of dual cement/polymer grouts is applicable. The use of chemical or polymer grouts also provides advantages of being quick-setting. Slow setting resins can be used to grout in advance for distances up to 50m.

7.2.3 Reinjection

This option would involve capturing the groundwater inflowing to the mine as part of normal operations, and reinjecting a portion back into selected locations of an affected overlying aquifer. The viability and effectiveness of reinjection would need to be confirmed prior to being implemented.

8 AUDIT AND REVIEW

This procedure shall be reviewed every 2 years as a minimum and/or in any of the following circumstances:

- Following any event or investigation that impacts on this procedure
- Any amendments to the site risk register
- Any amendments to legislation

9 REFERENCES

1. FloSolutions S.A.S. FY2023 Hydrogeology Support for WUG, Hydrogeologic Conceptual Site Model. 13 September 2023.
2. FloSolutions S.A.S. FY2023 Hydrogeology Support for WUG, Numerical Groundwater Model. 16 November 2023.
3. GHD. Wharekirauponga Hydrology Modelling Report - DRAFT. 17 August 2023.
4. GWS Limited. Waihi North Project, Assessment of Groundwater Effects – Wharekirauponga Deposit. 4 February 2024.
5. GWS Limited. Waihi North Project, Assessment of Groundwater Effects – Tunnel Elements. 14 June 2022.
6. GWS Limited. Waihi North Project, Summary of Potential Effects on Groundwater. 21 June 2022.
7. Ministry for the Environment, National Policy Statement for Freshwater Management 2020. 25 January 2024.
8. OceanaGold (NZ) Ltd. Dewatering Management and Monitoring Plan. June 2023.
9. OceanaGold (NZ) Ltd. Proposed Waikato Regional Council Conditions – 4 February 2025 DRAFT.
10. OceanaGold (NZ) Ltd. Hauraki District Council – OceanaGold (New Zealand) Limited – Land Use Conditions – 3 February 2025 DRAFT.

10 APPENDIX A – EXPERT GROUNDWATER MANAGEMENT PANEL CONDITIONS

UG.30	The Consent Holder must engage, at its cost, an Expert Groundwater Management Panel.
UG.31	The role of the Expert Groundwater Management Panel is to review and provide recommendations to Waikato Regional Council, the Department of Conservation, and the Consent Holder on the adequacy and appropriateness of the following: a. Quarterly Access Tunnel Reports required by Condition UG.5; b. Any review of the Wharekirauponga Underground Mine Water Management Plan under Conditions C.8 and UG.21 – UG.24, prior to its provision to Council for certification; c. Quarterly Report required by Condition UG.25; d. The Annual Groundwater and Surface Water Monitoring Report required by Condition UG.26; and e. Any Compliance Report required by Condition UG.27.
UG.32	The Consent Holder must address any recommendations from the Expert Groundwater Management Panel in finalising the Wharekirauponga Underground Mine Water Management Plan and any document referred to in this condition that is submitted to the Waikato Regional Council must identify any recommendations that have not been adopted and the reasons for this.
UG.33	The Expert Groundwater Management Panel must comprise technical specialists who between them have demonstrated expertise in the following fields: a. Hydrology; b. Hydrogeology, including demonstratable experience in assessment of surface water-groundwater interactions; c. Geotechnical engineering; d. The use of grouting techniques to manage groundwater inflows; and e. Underground mining. There may be any number of individuals on the Expert Groundwater Management Panel, so long as the necessary areas of expertise are covered. Members of this Expert Groundwater Management Panel may also be members of any Peer Review Panel required under any other consents held by Consent Holder in relation to its Waihi Operation.
UG.34	The members of the Expert Groundwater Management Panel, and their defined field(s) of expertise, must be approved by the Waikato Regional Council prior to appointment to the Panel.

UG.35	The Expert Groundwater Management Panel may co-opt other specialist members to assist in any of its functions for specified tasks and periods, subject to the prior approval of the Waikato Regional Council.
UG.36	The Consent Holder must provide the Expert Groundwater Management Panel with all records, plans, designs, etc, that the Panel requests, and must afford the Panel reasonable access as is necessary and consistent with health and safety procedures.
UG.37	a. If there is disagreement between the Consent Holder and the Expert Groundwater Management Panel about a Panel recommendation, in the first instance the Consent Holder must invite the Expert Groundwater Management Panel and Waikato Regional Council to a collaborative workshop to determine a process of resolution. b. If a resolution cannot be agreed under (a) within 10 working days, the matter shall be referred to an independent appropriately qualified expert, acceptable to both parties ('expert'), setting out the details of the matter to be referred for determination and the reasons the parties do not agree. c. The expert shall, as soon as possible, issue a recommendation on the matter. Within 5 working days of receipt of the recommendation from the expert the Waikato Regional Council must advise the Consent Holder on whether the recommendation of the Expert Groundwater Management Panel which was in dispute shall be implemented or an alternative course of action may be taken.