▪ report

Hawkeswood Mining Limited, – Technical Assessment of Proposed Groundwater Take and Discharge

Environmental
Associates Ltd

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Prepared for

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By

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1 Introduction

The following report provides analysis and assessment of a proposed (medium-term) temporary non-consumptive groundwater abstraction for mine pit pond dewatering from an alluvial outwash gravel Aquifer at Millers Flat (Clutha Outwash Gravels), and discharge (and treatment) of any excess pond dewatering water to land, whereby it may enter groundwater and surface water. The requested activities are also in retrospect of, and encompass, some preliminary trial pit dewatering and discharge (of water) to land, previously undertaken at the site.

The proposed Hawkeswood Mining Limited (HML) groundwater abstraction comprises temporary medium-term construction dewatering for the purpose of establishing an excavated mine pit containing an active mine pond. The primary aim of the groundwater abstraction is to maintain the local water level at desired levels to allow temporary (transient) excavation and mine operation. Within the quantum of water that is expected to be pumped from the active mine pond, some additional uses of the water includes: non-consumptive alluvial wash processing and possibly some site dust suppression and rehabilitation. Although any water use for dust suppression and rehabilitation will be within permitted activity rates for water use. It is most likely that excess groundwater from the dewatering process may be discharged to land, where any turbid water may be temporarily contained, potentially flocculated, then discharged as seepage to the local water table prior to migrating to the adjacent surface water source (Clutha River).

This report specifically addresses the following matters with respect to the proposed groundwater take and discharge activities:

- The location, environmental setting and dewatering/discharge targets (levels and responses) required for the proposed activity,
- An assessment of local aquifer hydraulic parameters from site-aquifer testing, trial pit dewatering, and lithology data,
- Assessment of required site dewatering and discharge flows to maintain optimum water levels to enable the mining activity,
- Analysis and discussion of abstractive effects of the groundwater take activity which focuses upon desired (internal) site water level reduction and expected external water level reduction and stream depletion over time and distance,
- Analysis and discussion of effects of the discharge activity, with a focus upon effects of any resultant discharge-seepage to groundwater and surface water resources, and
- Suggested conditions of resource consent for the proposed groundwater take and discharge, to address matters of monitoring and compliance/reporting.

In addition, and in relation to the re-lodgement of HML resource consent applications to the Consent Authority (by MacDonell Consulting Limited, October 2023), this updated application technical report covers the following matters that have been since addressed from the original application(s) that were previously lodged:

- A. The addendum to the original technical report which included:
  - Clarification of retrospective consent activity locations,
  - Augmentation of existing lawful water takes,
  - The need for additional land use bore construction consent,
  - Clarification of the requested discharge activity status,
  - Clarification of mine pit pond consent,
  - Water used for dust suppression and rehabilitation,
  - Augmentation of other water takes,
  - Revision of assessment of effects and mitigation measures.
- B. Responses to Aukaha consultation matters, including:
  - Potential discharge of contaminants to land and water from excavation and processing,
  - Width of the buffer areas in relation to waterways,
  - The impact on mahika kai with respect to the Mata-au and Tima Burn,
  - Impacts on ecology and biodiversity (including aquatic life), and
  - Impact on groundwater and surface water of drawdown and the justification for the groundwater take.
- C. Further s92 information requested which included:
  - Provision of the original log information to confirm site conditions (as mapped),
  - Provision of data points used to confirm the composite piezometric contour map,
  - Provision and quantification of drawdown assessment which otherwise accounts for the barrier boundary (landward extent of aquifer), and in relation to variability of aquifer hydraulic properties,
  - Review of aquifer hydraulic properties and provision of information regarding the trial pit dewatering activity,
  - Review of flow conditions and potential effects upon the Tima Burn in respect of the proposed mining dewatering activity,
  - Provision of assessment of effects on groundwater related aspects in relation to the closed landfill, and
  - Clarification of site conditions in relation to the discharge assessment.

Whilst this updated technical report includes for the additional matters identified above, for any recent documented changes to mining methodology to be employed at the Millers Flat site (as outlined in MacDonell Consulting Limited, 2023), it is confirmed that the scope and scale of activities and related environmental effects for the requested groundwater take and discharge of water to land (for mine dewatering purposes), is consistent with the previously lodged technical assessment report. That is, for this updated technical assessment report, the scope and scale of activities and effects remains unchanged from the previous reporting.

In respect of groundwater take and discharge of water to land, the changes to mining methodology will not provide any material change to the existing assessed dewatering rates and consequent potential environmental effects of the activities. This is primarily as a result of:

- The maximum dimensions (width, length and depth), of the active mine pit pond for dewatering purposes, does not change as a result of the updated mining methodology.
- Whilst there are some subtle changes to the mining stage boundaries and that some areas of existing tailings are to be mined, the overall extent of mine pit pond centroid occurrence remains similar to that previously utilised for assessment of dewatering rates and potential environmental effects.
- The areas of existing tailings to be mined are typically bounded by outwash alluvium, and the area of tailings associated with the predicted maximum mine pit pond dewatering rates (in the southern-most location of the site), will remain intact (they are not included in the change to mining methodology), and
- Whilst the set-back distances (from water features), have reduced in some areas, within the area of predicted maximum mine pit pond dewatering (in the southern-most location of the site), the effective set-back from the Clutha River remains the same.

On the basis of the above items identified in the changes to mining methodology, the scope and scale of dewatering required for mine pit pond management will suitably be contained within the requested resource consent application rate and volumes of groundwater abstraction which were previously assessed and for which potential environmental effects of the activities have been based upon. Additionally, there is deliberate contingency included for within the rate and volumes of requested groundwater abstraction for mine pit pond dewatering purposes, and considering the proposed mine start-up location/area, there will most likely be groundwater volume removal prior to the mine entering areas with an assessed higher potential dewatering requirement.

The resulting environmental effects previously assessed in terms of impacts upon groundwater (including existing wells), and surface water resources, remain unchanged due to:

- The maximum scope and distribution of mine pit pond dewatering requirement does not change with the amended mining methodology, and that the previously assessed scope and scale of dewatering (inclusive of contingency), had been used to inform the assessment of potential environmental effects of the activity.
- The positioning of any resultant mine pit pond centroid considering set-backs, batter slopes and active mine pit pond areas included with the amended mining methodology, remains equivalent to that previously used to predict effects of drawdown and stream depletion, and
- The set-back distance from the Clutha River for the discharge to land activity is retained as 50 m (as a suggested condition of resource consent), and therefore consistent with the scope and scale of required dewatering, the discharge to land will be consistent with the previously assessed environmental effects of the activity.

Additionally, with any increased plant through-put, plant processing water used effectively does not leave the pit and is fully recycled (non-consumptive). Thus, this component of water has no bearing upon site dewatering and discharge to land requirements for HML.

2 Location and Environmental Setting

The proposed HML groundwater take referred to within this report is for (medium-term) temporary non-consumptive mine pit pond dewatering from the Clutha Outwash Alluvium Aquifer at Millers Flat. The proposed groundwater abstraction comprises temporary medium-term construction dewatering for the purpose of establishing an excavated mine pit containing an active mine pond. The primary aim of the groundwater abstraction is to maintain the local water level at desired levels to allow temporary (transient) excavation and mine operation. Figure 2.1 below shows the generalised location and extent of the proposed active mining area (extent of transient mine pond centroid location for purposes of groundwater take). Note that for purposes of consistency, accurate mine location plans showing the total mine footprint area are provided within the MacDonell Consulting Limited AEE Application Report (2023), which should be referred to in conjunction with this technical report.

The generalised mine area (shown within the red outline on Figure 2.1), approximates the extent of the active mining operation (extent of transient mine pond centroid), for resource consent purposes, which may not be inclusive of all excavations, engineering works, stockpiles, infrastructure/formwork and settling-infiltration pond areas.

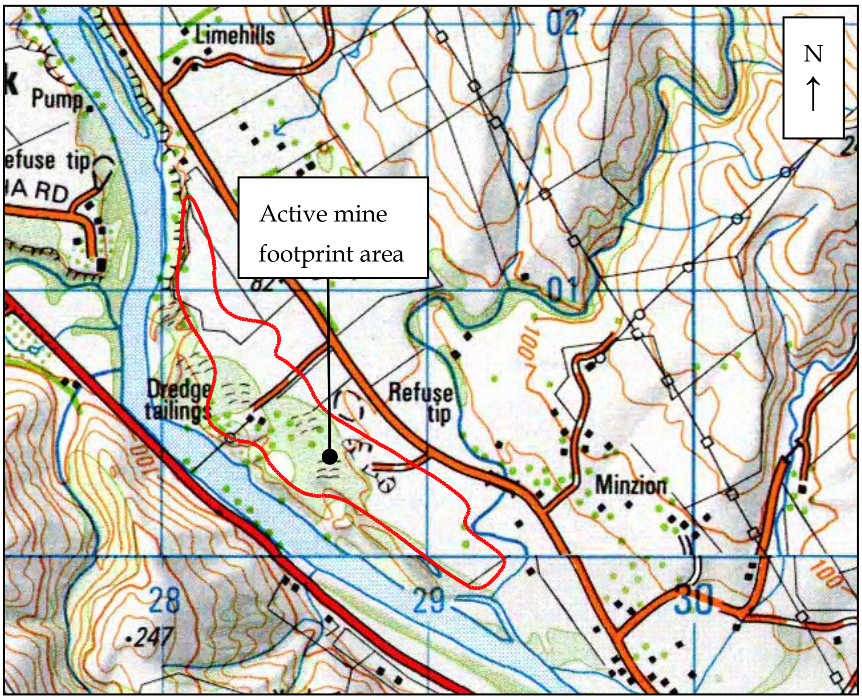


Figure 2.1 General Location of Proposed Active Mine Extent

Mine dewatering discharge settling and infiltration areas (not shown in Figure 2.1), will be located as required at location(s) whereby any net abstracted groundwater (containing sediment), from the advancing mine pit pond may be discharged to land. The discharge encompasses initial settling, polishing and infiltration to groundwater.

Hydrology

The proposed activity is located in the Clutha River catchment and within (in part) the lower sub-catchment of the Tima Burn, immediately prior to the confluence with the Clutha River. The Clutha River is a large waterbody and has significant ecological and recreational values. The Tima Burn, whilst may be perennial in its upper reaches, is an intermittent flowing waterbody in the lower reach adjacent to the Clutha River. Within the lower reach of the Tima Burn, the stream naturally loses water to the unconfined aquifer. The Tima Burn, due to the intermittent nature of flow in its lower reach, and balance of relatively small summer low flow, does not appear to visually support any significant ecological or recreational values. There are two other small ephemeral tributaries of the Clutha River in proximity to the mine footprint area, namely Oven Hill Creek to the south and an unnamed creek to the north. Whilst there are no flow monitoring records or statistics for the Tima Burn, there is a flow monitoring record for the Clutha River at below Roxburgh Hydro. Key hydrological statistics for the Clutha River at below Roxburgh Hydro are provided below in Table 2.1.

Table 2.1

Clutha River below Roxburgh Hydrological Statistics

Statistic	Clutha River below Roxburgh (L/s and L/s/km^2)
Mean /S-Mean	575,000/36.8
7-Day MALF/SMALF	270,000/17.3
Catchment Area	15,606 km^2

Table 2.1 shows that the Clutha River has a large all-year round flow, and this is coupled with a hydro-power generation trend (at below Roxburgh Hydro), to produce variability in daily flow for the river at Millers Flat. The small tributary streams in proximity to the mine footprint area may contain zero flow during the summer months, and may only contain perennial flow during winter and/or heavy rain events. There are two surface water takes from the Clutha River in proximity of the mine footprint area, with one located adjacent to the northern part of the mine area (RM21.291.01 Crawford), and the other being located adjacent to the southern part of the mine area (2004.424 Minzion Station Limited). Both of these aforementioned surface water takes abstract water directly from the Clutha River source.

Hydrogeology

Apart from HML and landowner investigations and reporting, there is very little formally reported information about the hydrogeology of the Clutha Outwash Gravel aquifer that exists within and surrounding the identified mine site extent at Millers Flat. The project area is broadly located between a locally extensive landward hill (relief) formation and the hydrologic boundary of the Clutha River.

The local aquifer (site) is located on a flat to gently sloping terrace adjacent to the Clutha River, which forms the discharging boundary for groundwater to naturally migrate into surface waters. From HML investigation well logs (**Appendix A**), the aquifer materials indicated were a mix of silty sandy gravels (from land surface down to basement), which are typical of the Clutha Outwash Alluvium within the Clutha River valley. Recharge to the aquifer (apart from any reworking of Clutha River water), is sourced from local rainfall and irrigation seepage, along with any side-catchment and local stream flow (losses) contributions.

Generally an unconfined aquifer with a low to moderately high yield exists at the site dependent upon location. The aquifer does not appear to contain any significant quantum of groundwater in its upper extent adjacent to relief and away from the Clutha River. However, higher groundwater yields are possible within the aquifer and are associated with areas of greater saturated thickness and/or in proximity to the Clutha River/old mine tailings areas. Aquifer saturated thickness has been broadly mapped for the mine site area based on information mainly provided by test hole (drilling) results previously undertaken to quantify mineral resource and groundwater conditions. The interpolated contour map is shown in Figure 2.2 below.

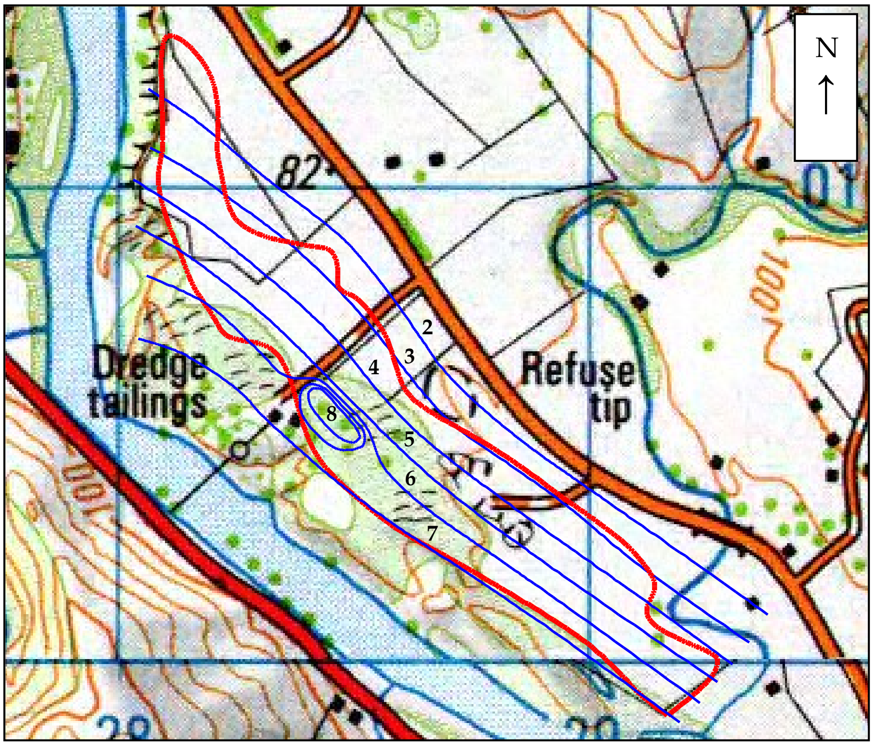


Figure 2.2 Saturated Thickness Contour Map

Note: Saturated thickness contours shown in metres above basement.

The distribution of aquifer saturated thickness shown in Figure 2.2 identifies that the greatest thicknesses are generally encountered toward the Clutha River in the mid to southern extent of the mine site area. Although (Figure 2.2), the maximum saturated thickness (of up to 8 metres), is located in a localised area of the mine site. Aquifer saturated thickness generally increase in a south to south-westerly direction relative to the mine site.

The water table surface of the local aquifer has additionally been mapped from HML investigation well log information relative to estimated land surface levels (Figure 2.3). Whilst the inferred composite water level contours are indicative and idealised, they provide a good indication of the natural direction of groundwater flow relative to boundary features.

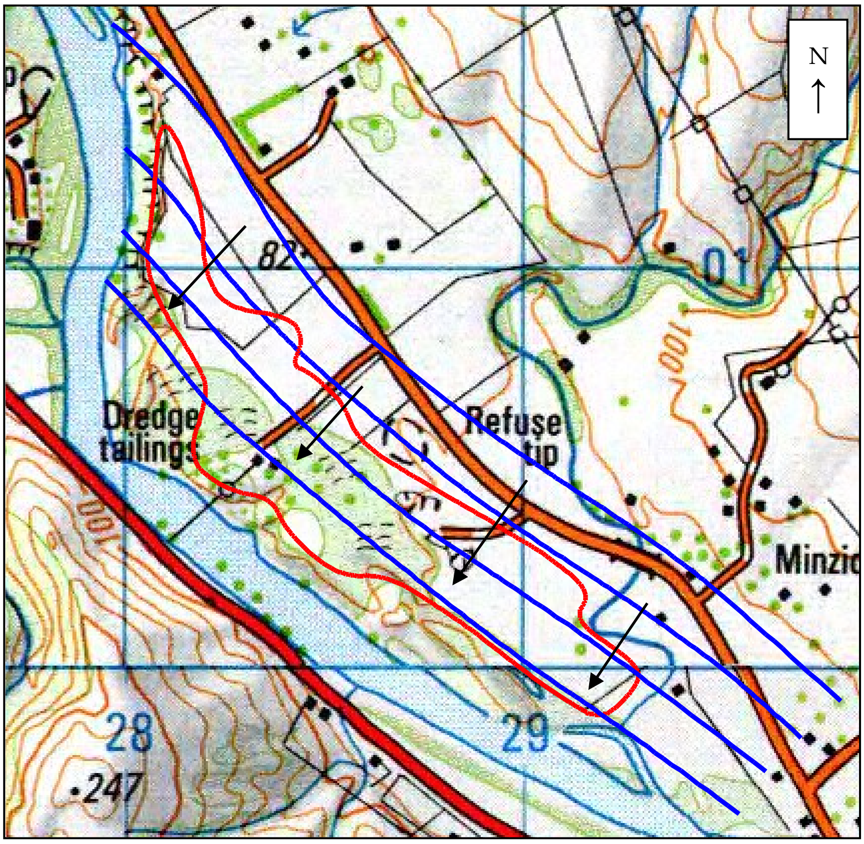


Figure 2.3 Piezometric Contour Map

Notes: Piezometric contours (in blue) at arbitrary relative datum and approximately 1 m intervals.

Arrows infer natural direction of groundwater flow.

The interpolated groundwater contours in Figure 2.3 show a general direction of flow to the south-south west, to the Clutha River. It should be noted also that the groundwater gradient may be locally influenced by stream flow losses from the Tima Burn and any local reworking of water from the Clutha River.

Groundwater use from the local alluvial aquifer consists of domestic household, stock water and irrigation use. Whilst there are few wells located within and adjacent to the mine footprint area, there are a number of wells associated with the township of Millers Flat, to the south of the mine area. There is only one currently authorised groundwater take from the aquifer (RM19.310.01, Parker - Irrigation use), and this site is located adjacent to the mine path area.

Discussion of Hydrogeologic data

Available well logs and resource investigation datasets have been used to provide a general description of the stratigraphic profile and the determination of typical hydrologic conditions at the HML site.

The composite map of aquifer saturated thickness (Figure 2.2), is the product of depth to basement minus depth to the water table. Additionally, the total depth to basement (from land surface), minus the saturated thickness equates to the depth of unsaturated materials or overburden. For the purposes of the assessment of the proposed activities and corresponding environmental effects, the dimension of saturated thickness is of primary importance, as it determines how much dewatering is required for the mining operation to be efficient. Depth to basement and depth to the water table (and thickness of overburden), whilst are the dimensions used to derive saturated thickness, by themselves they are not of any significance in determining activity dewatering rates or associated effects of drawdown (including stream depletion).

Reference site information that informed the composite saturated thickness map (Figure 2.2), and the composite piezometric contour map (Figure 2.3), has been mapped and is shown in **Appendix B** as site ID, depth to the water table, relative water table elevation and saturated thickness. It should be noted that the sum of depth to the water table and saturated thickness provides depth to basement. The site specific information (table) is contained in **Appendix C** which references available borehole and piezometer data alongside adjacent HML resource drill-hole data (where appropriate). Note that zero values denote no data available.

Notwithstanding the above generalised saturated thickness and piezometric contour mapping, specific sites were identified where conditions were relatively known and that the corresponding dewatering rates and environmental effects assessments were based upon.

The composite piezometric contour mapping (Figure 2.3), provides the general determination of relative water table occurrence and the correspondingly expected (general) direction of groundwater flow. Whilst no formal groundwater level survey has been undertaken by HML, the locally available well and piezometer information (including resource investigation holes), were utilised to establish the generalised mapping. Available depth to water table data and scaled land surface contour height information used to derive the piezometric contour mapping is as shown in **Appendix C**. Note that there is no LIDAR information available for the Millers Flat area according to the Otago Regional Council website. The site ID's, depth to water table, and relative water level elevation, are located on the mapping contained in **Appendix B**.

It should be noted that whilst there is a useful amount of site information available to derive the piezometric contour mapping, additional features have also been generally accounted for, including that of the Clutha River boundary, and landward recharge from hillslope catchments and debouching streams. Whilst the general direction of groundwater flow at the site assumes some importance (solely from a down-gradient receiving environment perspective), the overall nature of groundwater flow (in steady state) is invariably to the nearby Clutha River boundary.

On the above basis, the hydrogeologic information provided is deemed to be reasonable and sufficient for the purposes of assessment of the requested HML activities and associated environmental effects.

Proposed Activity

The proposed HML mine pit pond dewatering activity essentially occurs in two stages:

- An initial (start-up) dewatering activity is required where a starting pond is excavated and progressively dewatered to the target dewatering depth or level. This process may incur the greatest dewatering rates and volumes to overcome the initial stored volume within the mine pit pond and to initially lower the water level within the aquifer. However, this is also dependent upon the location of the starting mine pit, and a conservative approach with respect to the starting mine pit has been adopted. The dewatering invert level as assessed within this report is associated with maintaining at least a 3-metre depth where possible (of water level to basement occurrence), within groundwater over the start-up mine pit pond area. The 3-metre depth requirement (as above) provides sufficient depth of water within the mine pit pond to enable installation and operation of a floating resource recovery plant. The initial dewatering down to a 3-metre depth is dependent upon aquifer saturated thickness and proximity to the Clutha River. The rates and volumes of groundwater abstraction assessed for this dewatering stage are provided in Section 5 of this report, and
- On-going transient dewatering is as required to maintain the local groundwater level over the progressing mine pit pond area to a depth of 3-metres.

The rates and volumes of groundwater abstraction during the transient progression of the mine pit pond are expected to be variable (over the medium to long term). Some variability in basement or target depth is anticipated during the progression of the mine, in which short to medium-term variability in abstraction rates may occur. However, it is expected that short term variation in abstraction rates will not exceed expected maximum abstraction rates, and that medium-term or annualised volumes of abstraction would be more moderated. The medium to long-term transient dewatering rates and volumes are assessed and provided in Section 5 of this report.

- Finally, discharge of the transient mine pit dewatering water will most likely be required to be continually or intermittently made to land at location(s) within or adjacent to the mine footprint area. The discharge location(s) take account of the transient mine pit progression and associated mine pit dewatering flow reticulation infrastructure. The discharge will contain only suspended sediment from the mine pit pond which will settle out in the initial discharge settlement pond, before seeping through the local alluvial gravels to the water table and then ultimately flowing into the Clutha River. Similar to the dewatering rates, the discharge rates are expected to be variable, although within an assessed maximum daily volume equivalent to the maximum daily volume of mine pit pond dewatering. Sufficient size, depth, seepage and retention time is provided for in the design of the discharge.

It should also be noted that where the saturated thickness (depth to basement), is less than 3-metres, no dewatering is required. Otherwise, where saturated thicknesses are less than 2-metres, some augmentation may be required for suitable access to resource materials. This is as the required depth of water for the floating recovery plant is optimal at 2 to 3 metres, with the floating plant unable to be utilised at depths of less than 2-metres. Unlike dewatering, augmentation does not affect the local environment in terms of site specific drawdown and stream depletion. Additionally, any augmentation requirement is encapsulated within the predicted dewatering rates and volumes identified within this report.

Consideration of required dewatering to the target depth of 3-metres (saturated thickness) in the aquifer does provide some expected conservatism in long term required yield or volume of abstraction. This is due to dewatering not always being required consistent with the maximum saturated thickness and/or relative proximity to the Clutha River.

However, the basis of the calculation of dewatering rates and volumes, and the environmental effects assessment of local groundwater level decline and discharge of the abstracted groundwater, have been undertaken consistent with a steady-state requirement of maintaining up to a 3-metre depth (saturated thickness) of the aquifer water level at the active mine pit where appropriate.

This target depth otherwise provides for the greatest (required) dewatering and discharge flows for the mining activity. The effects of the water level lowering and the discharge of the abstracted groundwater are discussed in Section 6 of this report.

3 Aquifer Hydraulic Parameters

Previous (relatively recent) aquifer testing had been conducted adjacent to the Clutha River in an area of maximum saturated thickness in close proximity to the south-eastern extent of the proposed HML mine site. The adjacent area of the HML mine site is expected to incur the greatest dewatering rates and volumes to achieve required groundwater levels to enable the mining activity. The previous aquifer testing performed may be described as: variable rate step testing and a constant rate test including recovery to maximise hydraulic information gained. The aquifer layer tested comprised the active water table aquifer consisting of previously mined Clutha Outwash Gravels that occur within the localised groundwater basin and adjacent to the Clutha River. The previously mined gravels may also be referred to as mine tailings areas, which are most likely to be more permeable than the pre-existing outwash gravels.

Additional to previous aquifer testing, HML conducted a "trial pit dewatering test" to gauge or predict actual dewatering rates required for the full mine pit dewatering within pre-existing outwash gravels, considering location and aquifer saturated thickness. Further discussion of the "aquifer test" and "trial pit dewatering test" methodology, and results, is presented below.

Aquifer test

The aquifer testing adjacent to the HML mine site was originally performed to assess a proposed groundwater take for Mr A Parker (the landowner), for irrigation at the property. The testing, analysis and assessment was previously accepted by the Consent Authority and resource consent for the groundwater take was authorised (RM19.310.01). The test was designed by Environmental Associates Ltd, and the owner and contractors undertook piezometer placement, pump placement and operation, installation of monitoring equipment and monitoring during the test. Notwithstanding the trial pit dewatering test undertaken by HML (as discussed below), an additional aquifer test site was investigated further to the north-west in a centralised area of the proposed mine site. However, saturated thicknesses in that area were relatively low and a meaningful test was not considered to be viable.

The Parker production well utilised for the previous aquifer test was existing on the property and unfortunately no well log details are available. The well (CD13/0101) is 4.2 m deep and 1,140 mm in diameter, and is placed within a historical gold dredging area 98.3 m from the Clutha River. The subsurface materials (from exposed excavations and test holes), consist of moderately coarse alluvial gravels and sands. The well location is within a lower dredge cut adjacent to a tailings embankment on the true left bank of the Clutha River (see Figure 3.1). It is now known that the Parker well is actually sited within previously mined outwash gravels (old tailings). The low level of the well (being significantly lower than the surrounding Clutha outwash terrace), provides a depth to static water table level of only approximately 1.1 m below the top of casing.

The water table level is similar to that of the nearby Clutha River water level, which fluctuates due to the variable power generation requirement by Contact Energy. The production well is accompanied by an adjacent excavated gallery, consisting of a shallow "long pond", which allows some improvement to short term peak well yield. However, medium to long term yield is mainly reliant upon Clutha River assisted water levels. With the working drawdown within the production well of approximately 3.1 m, yield is invariably only limited by well depth.

A short term step test was performed from the production well, with abstraction of groundwater at a constant 32 L/s for a three hour period. The drawdown within the well was monitored at 1.5 m, and with application of the Theis pumping calibration model, fitting the drawdown with an aquifer unconfined storage value of 0.1, resulted in an estimated aquifer Transmissivity value of 1,400 m^2/day.

A constant rate aquifer test was conducted from the production well over a pumping-period of 27 hours, with a recovery period of 3 hours. The production well was pumped for seven hours initially at up to 35 L/s for the test. However, the rate of water level decline within the well necessitated a controlled reduction of the rate to approximately 25 L/s for the remainder of the test. The test discharge was monitored by water meter and conveyed into the landowner's irrigation storage pond, located away from the pumping well to avoid any potential recirculation of test waters. Prior to, during and in post-test recovery, periodic level monitoring was carried out for the production well, the long pond gallery water level, an installed piezometer (P1), an adjacent (Parker) house/stockwater well, and the Clutha River. The specifically installed piezometer was located in a similar low level dredge area, as the production well and gallery (refer to Figure 3.1 below).

Additional to the aquifer test detail, Figure 3.1 also presents the location of the trial pit dewatering test and six mine pit pumping scenario locations (including that of the trial pit dewatering test), used to predict maximum dewatering rates for mine dewatering as discussed in Section 4 and Section 5 of this report.

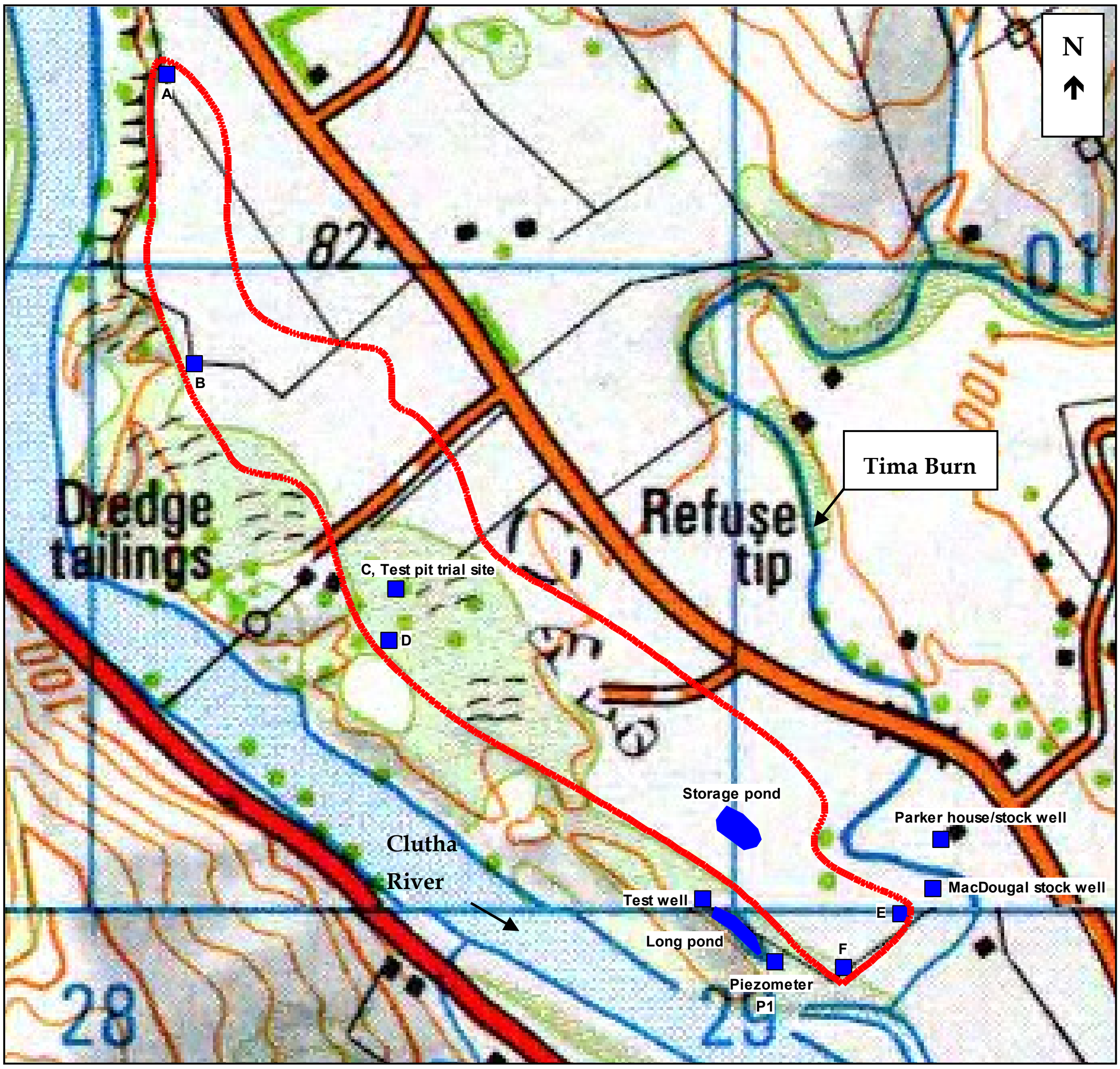


Figure 3.1 Aquifer Test Wells, Trial Dewatering Site and Mine Pit Pumping Scenario Locations (A – F)

An initial analysis of the aquifer test data for the production well (Time Series – Figure 3.2), showed that whilst Clutha River levels remained steady for the initial part of the test, well levels had declined over time, which necessitated the reduction in test-pumping rate. For the remainder of the test, and during the period of declining Clutha River water levels, the rate of production well drawdown was modest. Toward the end of the test, Clutha River water levels had risen and then stabilised, and the corresponding production well levels stabilised to a steady state condition. Upon cessation of pumping, water level recovery was initially rapid (of more than 90% recovery), with a small residual recovery over time, albeit, absolute level change approximately equated to the difference in Clutha River water levels over time.

The test water level information confirmed a connection of production well water levels to that of Clutha River surface water levels, and in particular, the rapid recovery response attributed to the river boundary effect.

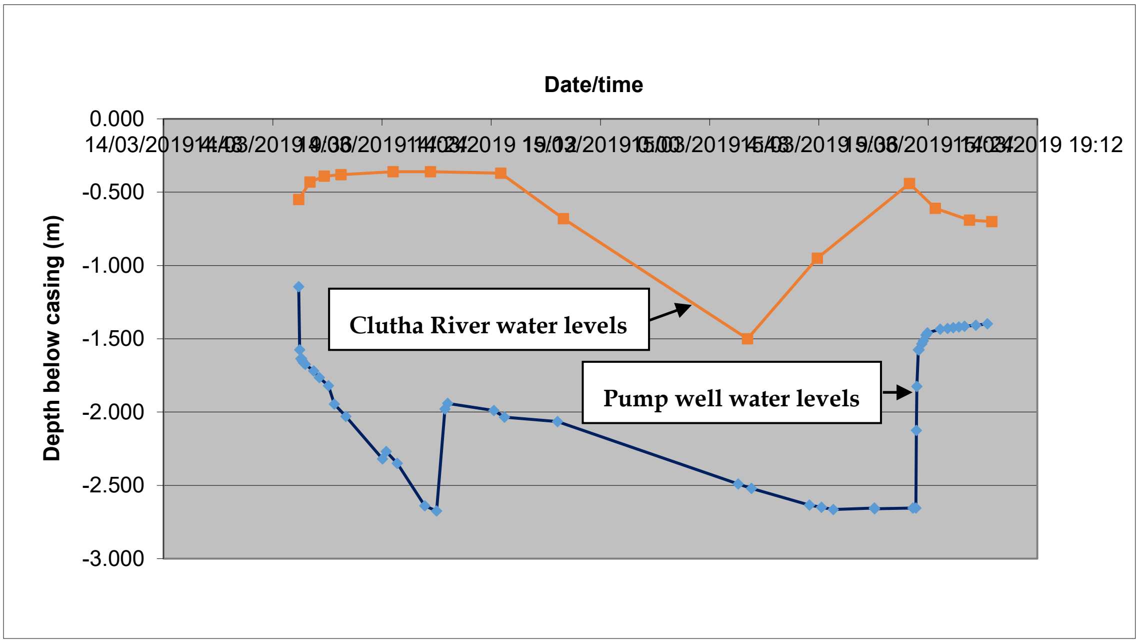


Figure 3.2 Pumped Well Time Series

The monitoring data for the additional level measurement sites, including that of the piezometer (P1), is as shown on Figure 3.3 below.

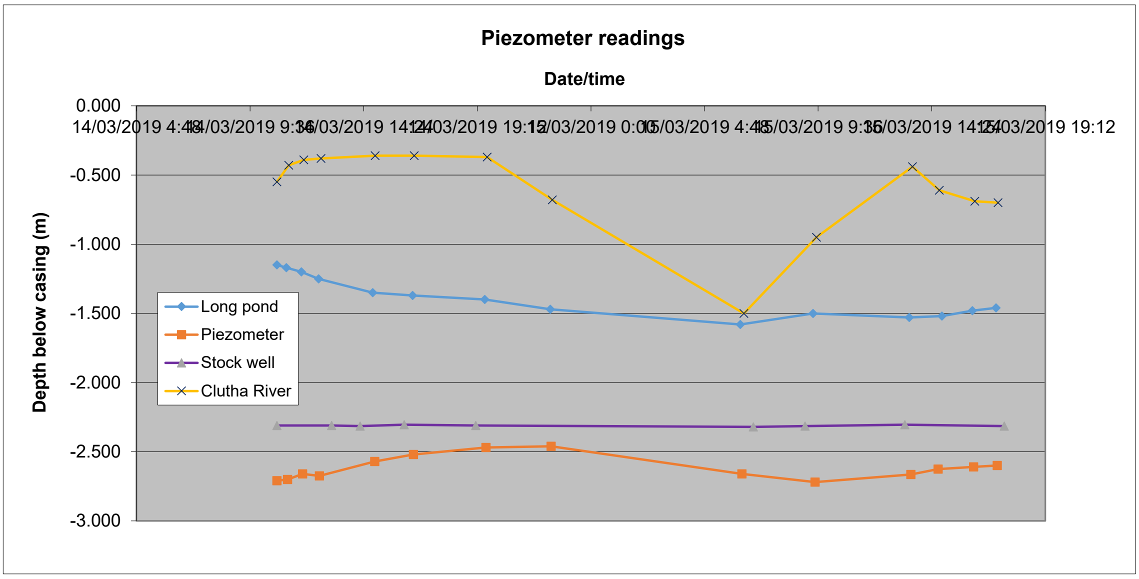


Figure 3.3 Piezometer(s)/Level Measurement Time Series

During the aquifer test and as discussed above, the Clutha River level was initially relatively stable, which then declined by approximately 1 m, and then increased to a relatively stable level regime, approximately 250 mm lower than at the beginning of the time series (Figure 3.2). This variation in Clutha River level is due to the power generation requirement by Contact Energy, and is more or less repeated over each daily time step for peak power demand.

Water levels measured in the piezometer (P1) showed an initial increase, with a decline and then an increase, similar to that of Clutha River levels. There was no apparent effect of abstraction from the pumping well for the duration of the test, albeit, it is difficult to quantify such a response. Water table levels within the stockwater well were quite stable during the test with no apparent response from either the pumping well or from Clutha River level variation. The long pond/gallery did show an initial response from the pumping well, and also declined in level over the period of Clutha River water level decline. However, during increasing Clutha River water levels, the pond/gallery water level remained steady or showed a slight increase in static water level.

From the aquifer test data, there was an inherent difficulty at the site to achieve "normal" responses to pump-well abstraction, as the nearby Clutha River provides for a boundary effect upon local water table levels. Coupling that to the need for power generation and the daily variability in Clutha River water levels as a result (being in excess of 1 m, which is a significant change in flow for the large waterbody), it is impossible to conduct a "typical" aquifer test.

However, notwithstanding a request to halt peak national power generation (unlikely), sufficient monitoring and assessment had been undertaken, consistent with aquifer test guidelines, to portray local aquifer conditions, as best as practicably possible. Additionally, as discussed below, in accounting for the Clutha River boundary and level variation effects, useful aquifer Transmissivity and Storage values have been derived from the aquifer test data for the corresponding previously mined gravel tailings area.

Analysis of the aquifer test data was performed within the AQTESOLV PRO (Hydrosolve Inc, 2010) aquifer test software package. As part of the analysis and in assessment of local aquifer conditions, the unconfined Theis methodology was used to analyse the test. It was assessed that unconfined conditions prevail within the aquifer as indicated by water level measurements, responses to abstraction and Clutha River water levels, and an appreciation of the historic mining development that had taken place at the site. As the Clutha River boundary and associated variability in water levels had skewed test water level measurements, the test solutions encompassed a conservative Theis curve match to maximum pump well displacement and non-pumped well recovery displacement trend. The aquifer test information is provided in **Appendix A**, and the input data for AQTESOLV PRO is contained in **Appendix D.**

The Theis aquifer test analyses and curve matches are provided in **Appendix E**, and the summary hydraulic parameters obtained are as shown in Table 3.1 below.

Table 3.1

Summary Aquifer Hydraulic Parameters from Theis Displacement and Recovery Curve Matching

Measurement well and boundary condition	Matched Transmissivity (m^2/day)	Matched Storage	Comment
Pump well inclusive of Clutha River boundary within the model	1,290	0.1	Good match to peak displacement and recovery trend data. Overestimates interim displacement during test due to variable Clutha River levels.
Pump well without Clutha River boundary	1,400	0.05	Good match to peak displacement and recovery trend data. Overestimates displacement during test due to variable Clutha River levels. Storage value considered too low for aquifer type and in replication of boundary assisted recovery.

On the basis of the aquifer test analyses, the following aquifer parameters are as resulting for the test:

- **Naturally occurring aquifer parameters - Transmissivity = 1,290 m^2/day , and Storage (Sy) = 0.1, and**
- **Boundary assisted aquifer parameters – Transmissivity = 1,400 m^2/day, and Storage (Sy) = 0.05.**

The outcome of the aquifer test analysis indicates that the Transmissivity value (1,290 m^2/day) and Storage (0.1) is consistent with the site aquifer hydraulic properties. That is, resultant pumped water levels are a function of the hydraulic parameters, plus the nearby Clutha River boundary offset (effect). Whilst a Transmissivity of 1,400 m^2/day and Storage of 0.05 (inclusive of boundary effect), replicates the levels of maximum displacement measured at the pump well, and also replicates the rapid recovery observed.

The effect of the Clutha River boundary as resulting from the assessment of aquifer test information for the Parker production well test, was also compared to a modelled image well analysis for the same test scenario. Utilising the site aquifer parameters with an image well placed at the correct distance to replicate Clutha River input, resulted in a 3.33-times over-estimate of negative displacement resulting from the Clutha River boundary. In assessment of maximum mine dewatering rates (refer to Section 4 and Section 5 of this report), with the use of image well analysis to determine mine pit pond drawdown pumping rates, a conservative calibration of resulting negative displacement of 30% (from the Clutha River boundary effect), has been incorporated into such assessments. However, whilst the negative displacement effect upon mine pit pond dewatering normal to the Clutha River boundary is measured to be less than expected, with the length and size of the Clutha River (boundary), lateral negative displacement (drawdown) is expected to be more consistent with image well theory. The negative displacement calibration is included solely in assessment of mine pit pond drawdown normal to the Clutha River boundary, so as to not result in any unwarranted overestimation of mine pit pond dewatering rates or any corresponding underestimation of mine pit pond drawdown.

Trial pit dewatering test

With consideration of the Parker aquifer test results (discussed above), and inspection of available well logs (**Appendix A**), it was assessed that given the location of old mine tailings, the Parker test data would most likely <u>not</u> be reflective of the majority of the proposed mine dewatering area. Well logs for the area show (apart from variability in saturated thicknesses), the make-up of the aquifer away from old mine tailings areas, is that of consolidated alluvial gravels and silts, being of lesser permeability than the re-worked alluvial tailings.

With the above finding, a trial pit dewatering test was undertaken by HML during December 2022 and consisted of an excavated pit located distal from old tailings areas and 320 m from the Clutha River (for centre of pit). The location of the trial test pit is shown on Figure 3.1 above, which is also Site C, used for assessment of an operational mine pit dewatering/pumping scenario (discussed in Section 5 of this report).

The test was planned to include for trial dewatering within the permitted activity rules of the Regional Plan: Water for Otago, being within 2,000,000 L/day for a continuous period of 3-days. The initial test pit was dug to the water table and groundwater was abstracted, noting change to water table levels as a result. During the initial test activity it was found that dewatering rates were lower than expected and as a consequence, drawdown within the trial pit was much greater than expected. Continuation of the test resulted in full dewatering of the initial pit, which was increased over time to a size of 50 m X 70 m with an effective radius of 23.6 m.

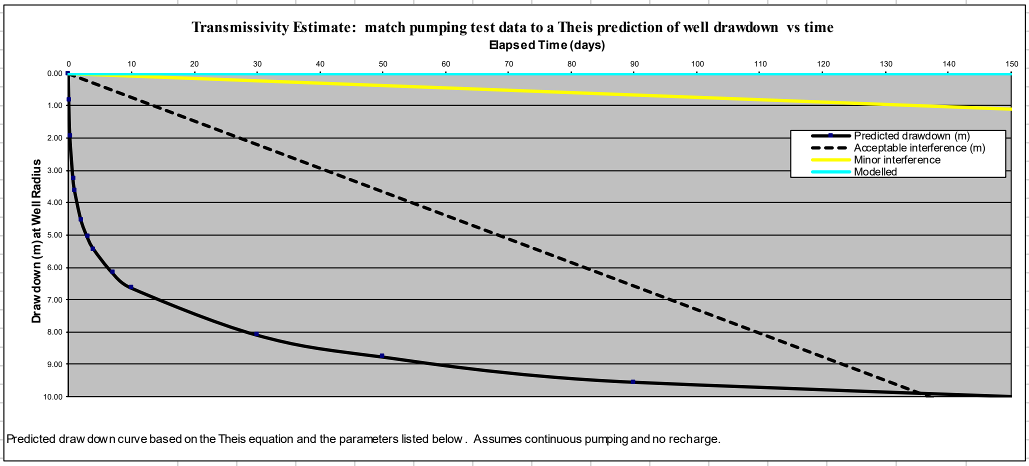
However, due to eventual pit enlargement, dewatering flow rates increased, and rather than submerging plant and materials, HML continued to dewater to allow safe removal over time of equipment, whist continuing to monitor water level and dewatering/pumping rate.

The final outcome of the trial pit dewatering test, was that full dewatering of the pit was achieved, and was maintained as a drawdown of 8 m within the pit (from static water level to basement), with a dewatering rate of 70.5 L/s (approximately 3-times the average daily rate within the permitted activity). It was also observed that a steeper water table level gradient existed further laterally (parallel to the Clutha River) from the trial pit, than normally from the trial pit. This observation from HML supports the premise that the effect of the Clutha River boundary is of lesser consequence directly normal to the river, which is also supported by aquifer and trial pit testing analyses. Otherwise, in a distal lateral direction (parallel with the Clutha River), it is expected that the Clutha River boundary effect is more pronounced and consistent with that of image well theory.

The acknowledgement of the above circumstances in relation to the trial pit dewatering test is also encapsulated within the application suite for the proposed mining activity (as retrospective and inclusive of the test). It was noted that during the test there were no effects resulting upon any lawful take of water (either groundwater or surface water), and the corresponding discharge to land of pit water resulted in no apparent discolouration of the Clutha River, or any run-off of any water from the soakage area. Invariably the test undertaken by HML provided valuable information around likely mine pit dewatering rates, lateral drawdown, and the performance of dewatering flow discharge soakage areas.

Hydraulic analysis of the trial pit dewatering test was undertaken using Theis, with a conservative assumption of steady state dewatering at the trial pit site being an 8 m drawdown with resulting groundwater abstraction of 70.5 L/s after 30-days (see Figure 3.4 and Figure 3.5). The Theis analysis also predicts resultant pit (aquifer) drawdown inclusive of the Clutha River boundary effect from image well negative displacement, calculated consistent with the discussion of the results from the Parker aquifer test as above. The conservative assumption period of dewatering of 30-days, provides for the 8 m drawdown achieved during the test (and corresponding pumping rate achieved of 70.5 L/s), not actually being truly reflective of steady-state conditions. The conservatism also allows for a resulting higher Transmissivity value obtained from analysis of the test, which is reflected in the couched site dewatering flows that are identified below in Section 5 of this report.

Theis Drawdown Analysis

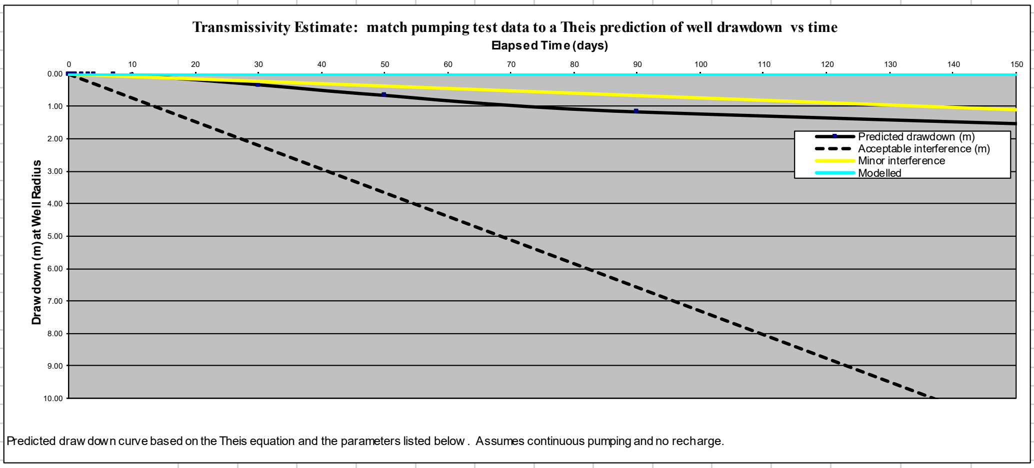


Distance (m)	23.6	Aquifer type	unconfined	Storativity estimate (specific yield)	0.1
Pumping rate (l/s)	70.5	Transmissivity (m2/day)	365	Acceptable interference rate (m/day)	0.073
				Minor interference rate (m/day)	0.0073

Elapsed time (days)	0.01	0.08333	0.25	0.75	1	2	3	4	7	10	30	50	90	365
Predicted drawdown (m)	0.01	0.82	1.93	3.2557	3.6213	4.52	5.05	5.42	6.16	6.63	8.09	8.77	**9.55**	**11.41**
Acceptable interference (m)	0.001	0.006	0.018	0.055	0.073	0.146	0.219	0.292	0.511	0.730	2.190	3.650	6.570	26.645
Difference (m)	-0.01	-0.81	-1.91	-3.20	-3.55	-4.37	-4.83	-5.13	-5.65	-5.90	-5.90	-5.12	-2.98	15.24
Minor interference	0.000	0.001	0.002	0.005	0.007	0.015	0.022	0.029	0.051	0.073	0.219	0.365	0.657	2.665

Figure 3.4 Dewatered Test Pit Drawdown

Theis Drawdown Analysis



Distance (m)	640	Aquifer type	unconfined	Storativity estimate (specific yield)	0.1
Pumping rate (l/s)	70.5	Transmissivity (m2/day)	365	Acceptable interference rate (m/day)	0.073
				Minor interference rate (m/day)	0.0073

Elapsed time (days)	0.01	0.08333	0.25	0.75	1	2	3	4	7	10	30	50	90	365
Predicted drawdown (m)	#NUM!	0.00	0.00	0.0000	0.0000	0.00	0.00	0.00	0.00	0.02	0.33	0.65	**1.17**	**2.74**
Acceptable interference (m)	0.001	0.006	0.018	0.055	0.073	0.146	0.219	0.292	0.511	0.730	2.190	3.650	6.570	26.645
Difference (m)	#NUM!	0.01	0.02	0.05	0.07	0.15	0.22	0.29	0.51	0.71	1.86	3.00	5.40	23.90
Minor interference	0.000	0.001	0.002	0.005	0.007	0.015	0.022	0.029	0.051	0.073	0.219	0.365	0.657	2.665

Figure 3.5 River Bound Offset

Notes: 30-day aquifer drawdown at radius = 8.09 m.

30-day river offset = 0.33 X 0.3 = 0.09 m.

Resulting (actual) drawdown = 8.0 m.

The outcome of the trial pit dewatering test analysis indicates that the site Transmissivity value (**365 m²/day**) is lesser (considering saturated thicknesses), than the resulting Transmissivity value obtained from the Parker aquifer test (**of 1,290 m²/day**). Also, whilst the resultant pumped water levels are a function of the hydraulic parameters, plus the nearby Clutha River boundary offset (effect), the river bound effect at the site is much diminished due to the distance from the river. Further discussion of applicable aquifer hydraulic properties to the proposed mine site is presented below.

Hydraulic conductivity

In reference to the Parker aquifer test and the trial pit dewatering test discussed above, the following aquifer hydraulic conductivity results are derived in comparison to site saturated thicknesses:

- Parker aquifer test b = 7.56 m, T = 1,290 m²/day, and therefore K = 170.6 m/day,
- Trial pit test b = 8.0 m, T = 365 m²/day, therefore K = 45.6 m/day.

The above differences in hydraulic conductivity (K of 170.6 m/day and 45.6 m/day), are as resulting from the abstraction of groundwater from old mine tailings and outwash gravels respectively. This indicates that outwash gravels exhibit a K of approximately 27% of that of old mine tailings.

The mining proposal is for excavation of materials in areas generally outside of any old mine tailings areas, as the tailings areas contain much less mineral deposit than those areas that have not yet already been mined. In that instance, the hydraulic nature of the aquifer materials is more closely associated with a K of 45.6 m/day and being similar to the trial pit dewatering test conditions. There are limited mining areas that protrude into old mine tailings areas. However, in some instances, mine excavation and dewatering progresses close to or into old mine tailings, and some potentially increased aquifer permeability may result as a consequence.

To allow for assessment of mine dewatering rates and effects of drawdown where the mine progresses close to (at least within 50 m of), an old mine tailings area, a conservative approach has been taken to balance the resulting aquifer hydraulic conductivity commensurate with 80% outwash gravels and 20% mine tailings, as a bulk parameter. The resulting K for those mining areas that are in vicinity of old mine tailings, is derived as 70.6 m/day, as a bulk weighted value.

Assessment of required dewatering rates and drawdown impact upon the local aquifer based upon the aquifer parameters presented above, is detailed in the following sections of this report.

Trial pit dewatering activity discussion

The hydraulic assessment of the trial dewatering activity has been made consistent with and in appreciation of, the monitoring data provided by HML. However, the primary aim of the trial dewatering activity was to gauge the actual dewatering rates needed for the mine dewatering proposal.

Notwithstanding any hydraulic assessment, the trial dewatering activity clearly showed the relative scope and scale of dewatering flow that would most likely be encountered for the mine dewatering activity. In effect, the trial dewatering activity presents the actual solution (albeit in a relative sense), to understanding what dewatering flows are most likely for the proposed activity. As above, this was the primary aim of the trial, with hydraulic analysis being somewhat secondary.

However, the hydraulic analysis of the trial dewatering activity did help to understand the difference between dewatering at or in proximity to old tailings, and otherwise, at a location distal from the tailings areas. Needless to say, the results of the trial clearly show that lesser dewatering rates are needed away from the tailings areas and that coincides with a much lesser relative Transmissivity value (or hydraulic conductivity in consideration of saturated thickness), to that for the tailings area in appreciation of the "Parker" aquifer test results at well CD13/0101.

Whilst the trial dewatering activity was invaluable to understanding the "actual" resulting dewatering flow and how that compared to a predicted dewatering flow (using initial hydraulic parameters from the Parker aquifer test), the information gathered was essentially limited to that which had been provided by HML. It is understood that although the activity was a dewatering trial, it was not specifically an aquifer test. However, from the trial observations and limited monitoring data, a very useful hydraulic assessment can be made in comparison to the results of the Parker aquifer test.

The hydraulic analysis used Theis to replicate the trial dewatering test using the effective radius of the saturated open pit, and not the total (maximum) radius or extent of the pit (as discussed above). The Theis methodology was therefore used in a way that limits any underestimate of the Transmissivity value gained from analyses. Additionally, the underestimation of Transmissivity within a "pumped well analysis" stems from the differences between internal (down-well) and external water levels caused by head losses. The open trial pit does not incur head losses and the pit water level is exactly the same as the aquifer water level measured immediately beyond the pit.

It is acknowledged that the trial dewatering activity and resulting hydraulic information (as gained), is not as conventional as a standard aquifer test procedure using a typical steel cased pumping well and piezometers. However, the trade-off with the trial dewatering activity is that much greater volumes of abstraction can be undertaken with the use of a larger scale excavated pit than any drilled well could produce.

As above, the primary aim of the dewatering trial was to best replicate the actual mine dewatering activity, which it does, and as a consequence, provides inherently greater value to understanding the mining proposal than any modest rate aquifer test could provide. Additionally, given the replication provided by the trial dewatering activity, greater reliance on the results is afforded. On this basis and in consideration of the associated hydraulic analysis, the hydraulic values obtained (as reported above), are considered to be reasonable and appropriate.

4 Site Dewatering Assessment Methodology

This section provides some discussion of the HML site dewatering considerations and the methodology utilised to derive target dewatering flow rates and volumes for the proposed activity.

The proposed HML mine pit pond will be located within the local aquifer and be of a transient nature. That is, the active mine pond will move in the direction of the advancing mine, although the form and function of the pond will be kept relatively consistent over time. The dewatering requirement at the position of the mine pond is to enable access for the floating plant to a 3-metre depth of water above basement. Otherwise, at depths of less than 2-metres, augmentation of the profile may be required. Therefore, abstraction of the majority of groundwater will be required where the saturated thickness of the aquifer is greater than 3-metres. Figure 2.2 in Section 2 of this report provides a contour map showing generally the expected aquifer saturated thickness. The maximum aquifer saturated thickness is located in the mid-area of the mine site and is assessed as 8 m. Therefore, the approximate maximum expected lowering of the water table is up to approximately 5 m. In general, greater saturated thicknesses of approximately up to 7 m will be encountered in the mid to southern extents of the mine site, toward the Clutha River. Subsequent analysis of spatial mine pit pond dewatering (within this report) is premised upon the distribution of aquifer saturated thickness identified in Figure 2.2.

The aquifer hydraulics assessed from the Parker well (CD13/0101) aquifer test (as presented above in Section 3 of this report), provides for hydraulic values (mainly Transmissivity of 1,290 m^2/day), which represents that of the 7.56 m saturated thickness occurring within old mining tailings. The trial pit test which was conducted in 8 m of saturated outwash alluvium (also refer to Section 3 of this report), resulted in an aquifer Transmissivity of 365 m^2/day. The associated aquifer hydraulic conductivities for both tests was 170.6 m/day and 45.6 m/day respectively. The aquifer storage value for both tests was conservatively determined as 0.1, which has been used for the purposes of the mine dewatering and effects assessments.

Whilst the mining activity includes for limited progression into old mine tailings areas (as those areas contain limited recoverable resource), active mine pit ponds may occur in close proximity to tailings areas (particularly in closer proximity to the Clutha River). It is also these areas that generally contain the greater aquifer saturated thicknesses. To account for any proximal effects of adjacent mine tailings areas, where appropriate, analysis of mine dewatering and related effects incorporates an 80:20 ratio of aquifer hydraulic conductivity (bulk of 70.6 m/day), for outwash alluvium and mine tailings respectively. This is considered to be an appropriately conservative approach.

In determination of the spatial distribution of mine pit pond dewatering rates and volumes, the Transmissivity value at identified locations has been adjusted according to saturated thickness (referring to Figure 2.2 above), maintaining an aquifer hydraulic conductivity of 45.6 m/day, or otherwise for use in proximity of old mine tailings areas, 70.6 m/day.

The dimensions of the proposed mine pit pond (being active within groundwater), are for a 150 m by 100 m nominal cut. The required dewatering of the mine pit pond is associated with drawdown of the water table level to the equivalent weighted nominal radius of 48.9 m. Assessment of groundwater abstraction associated with water table drawdown at that radius is considered appropriately conservative for the purposes of the requested HML activity.

Assessment of mine pit pond dewatering rates and volumes must also take account of the Clutha River recharging boundary. That is, the closer the proximity of the mine to the Clutha River, the greater the boundary inflow effect, notwithstanding required dewatering depths. For the analysis, the Clutha River boundary effect is modelling using the method of images or image well theory, whereby a duplicate calibrated recharging image well is appropriately placed (modelled) at distance from the mine pit pond (centroid) groundwater abstraction (well), to simulate the effect of head offset within the pond due to Clutha River inflow. The methodology also expects a gradient to develop from the boundary to the dewatered mine pit pond, of which in some instances (more distal from the river), will result in conservative outcomes. The image well theory is also inherently conservative as the methodology expects a perfect uniform connection between the boundary and the dewatered (groundwater) feature.

The calibration and use of image well methodology for assessment of mine pit pond dewatering rates and volumes at the Millers Flat outwash gravel aquifer, has been kept consistent with the results of the aquifer test information from the Parker well test (CD13/0101 refer to Section 3 of this report). Application of the Clutha River boundary head offset effect consistent with the results of the Parker well aquifer test should provide usefully conservative boundary inflows and not result in any unwarranted overestimation of mine pit pond dewatering rates.

5 Required Site Dewatering and Discharge Flows

This section provides an assessment of required mine pit dewatering flow rates and volumes to achieve target on-site drawdown in order to enable construction of, and to maintain resource recovery abstraction. The target flow rates are also conservatively indicated as a potential discharge flow that may be required to be removed from the site. The aquifer hydraulic parameters utilised for the assessment are consistent with that as identified by on-site aquifer and trial pit testing and which has been presented in Section 3 of this report.

As identified in Section 2 of this report, dewatering is required to reduce water levels adjacent to and within the mine pit pond to a nominal maximum of 3 metres above basement. That is to allow operation and resource recovery with a floating plant. Alternatively, where water levels are less than 2 metres above basement, augmentation of the profile may be required. The mine pit pond dimensions are for a nominal 150 m by 100 m cut void, which will require dewatering over the duration of the active mining operation. The likely period of construction of the initial mine pit pond may range from 5 to 30 days, and the transient movement of the mine pond is likely to be more associated with an annual “steady state” time period for the purposes of assessment of maximum required (annual) yield. The 5-day initial mine pit pond construction period recognises that the activity is of a progressive nature with incremental dewatering required over a minimum 5-day period to achieve the drawdown required for the initial mine pit pond.

The methodology in calculation of required dewatering rates uses the unconfined Theis drawdown model, to identify required abstraction rates to maintain drawdown over time within the mine pit area. That is, the target water level reduction at the effective radius is attributed to an abstraction rate (from a single central abstraction well), over the required dewatering period, in order to achieve the required drawdown within the mine pit. Additionally, as the mine pond location is transient, the progression of the pond over time serves to reduce abstraction as a result of storage volumes already removed from the aquifer. Consistent with the discussion of Clutha River boundary effect, additional drawdown offset has been calculated and combined with abstractive drawdown, resulting in the actual net drawdown achieved. Additionally, as discussed in Section 4 of this report, where the mine pit traverses to within proximity of old mine tailings (within 50-metres), added conservatism has been incorporated into the calculation of dewatering rates and volumes. Table 5.1 contains the groundwater yield requirements summary for dewatering of the mine pit pond (inclusive of Clutha River boundary effects), over selected pumping periods at selected locations within the mine footprint area (also refer to Figure 3.1 for location of mine dewatering scenarios).

Table 5.1

Predicted Mine Pond Yield*

Location (distance from mine centroid to Clutha River)	Saturated thickness (m), Transmissivity (m^2/day) and Storage	Maximum required drawdown (m)	5-day abstraction rate (L/s)	30-day abstraction rate (L/s)	365-day abstraction rate (L/s)
A. Northerly quadrant requiring nil profile dewatering closest to Clutha River (95 m)	2, 91.2 and 0.1	0	0	0	0
B. Northerly quadrant closest to Clutha River (140 m)	5, 228 and 0.1	2	28	17	12
C. Centrally located further from Clutha River at trial pit location (320 m)	8, 365 and 0.1	5	93	58	41
D. Centrally located in proximity of tailings and closest to Clutha River (165 m)	7, 494 and 0.1	4	93	63	45
E. Southerly quadrant centred further from Clutha River (300 m)	4.5, 205 and 0.1	1.5	20	12	8
F. Southerly quadrant in proximity of tailings and closest to Clutha River (115 m)	7, 494 and 0.1	4	96	66	48

*Flow rate required for the pumping period to maintain average drawdown within the 150 m X 100 m mine pit/pond (conservatively modelled equivalent to drawdown at 48.9 m radius excluding any initial surface storage volume). Yields are rounded up to the nearest L/s.

In practice, mine pit dewatering will be carried out by a combination of dewatering pumps placed within the active mine pit pond. As the mine pit is progressively deepened the initial storage of the pond is effectively negated, however, some consideration must be given to a small amount of initial storage to be removed by pumping.

As shown in Table 5.1, the required mine pond dewatering yield noticeably declines from the initial dewatering mine start-up period, to that required in an annual time period or as close to steady-state dewatering.

Also, it is unlikely that the start-up mine pit pond would be initialised at a position within the mine footprint area that is of maximum saturated thickness for the aquifer, and is concurrently close to the adjacent Clutha River. However, this has to be balanced against the maximum daily dewatering rate to consider the maximum predicted monthly and annual volumes (as calculated and shown below).

Table 5.2 provides a summary of required dewatering rates and volumes for resource consenting purposes, which includes that of any discharge of the mine pit dewatering water. The required rates are considered to be suitably conservative to allow for the initial and on-going dewatering phases associated with maintaining appropriate mine pit pond levels to allow the mining activity to efficiently operate. The dewatering rates also include for a nominal 30% contingency in allowance for any operational flexibility and ongoing variability in site groundwater conditions encountered.

Table 5.2

Required Dewatering Rates and Volumes

Rate or Volume	Quantity	Effective rate	Basis
Maximum instantaneous rate	124.8.0 L/s	96 + 28.8 = 124.8 L/s	Rate achievable for maximum 5-day dewatering + 30% contingency for operational purposes
Maximum daily volume	10,783 m^3	124.8.0 L/s	Maximum volume with peak rate employed
Maximum monthly volume	222,394 m^3	66 + 19.8 = 85.8 L/s	Maximum 30-day rate modelled + 30% contingency
Maximum annual volume	1,967,846 m^3	48 + 14.4 = 62.4 L/s	Maximum 365-day rate modelled + 30% contingency

As is shown by the calculations provided in Table 5.1, the Table 5.2 (maximum) required site dewatering flow rates and volumes are borne from the resulting maximum 5-day, 30-day and 365-day values (from Table 5.1). In all other cases the required mine pit dewatering rate and volumes will be less than those presented in Table 5.2, and particularly in locations that are more distal from the Clutha River.

Additional mine pit pond water abstraction (over and above groundwater storage removal), will be from initial surface water storage within the start-up excavated pond, and intermittent stormwater input (rainfall) to the mine pit area. It is considered that for the purposes of determining required dewatering rates and volumes, stormwater sources are negligible in the context of required aquifer storage removal. The 30% contingency (Table 5.2) adopted for the maximum daily, monthly (30-day) and annual volume of aquifer storage removal, conservatively includes for any stormwater input.

However, the contingency mainly recognises any potential unknown variability in aquifer hydraulic parameters that may be encountered and the consequent impact upon predicted dewatering volumes.

It is expected that upon initial mine pit dewatering, including storage removal, that the ongoing dewatering flows from the transient mine pit pond will be lesser than the annual steady state rate of 62.4 L/s (Table 5.2) and nominally lesser than 48 L/s (Table 5.1). That is, the higher dewatering flows predicted are essentially for initial dewatering, storage removal, and short term contingency, with inherently a much lower maintenance abstraction required to maintain internal pit pond water levels to a satisfactory operational requirement.

6 Effects of Mine Pit Dewatering and Discharge

Given the above mine pit dewatering proposal and information regarding aquifer hydraulics, consideration of the potential environmental effects of the proposed activity (for the abstraction of groundwater for dewatering, and the discharge of that water to land whereby it may enter water), has been undertaken in the following section.

Effect of Water Level Decline upon Local Wells

The unconfined Theis drawdown model has been used to simply predict the potential reduction in groundwater levels external to the transient HML mine pit pond progression. This is reflective of the required dewatering rates and duration to achieve desired water levels within the active mine pond.

The maximum predicted mine pit pond drawdown is approximately 5 m as discussed in the previous section of this report. This level of drawdown and associated dewatering rate is at about the maximum assessed for the proposed mining activity and has been calculated on the basis of the mine pit pond configuration achieving at least a 3 m (depth to basement), water level. The derived aquifer Transmissivity and Storage values (see Section 3 of this report), have been appropriately applied to the predicted annual volume of abstraction at set locations of the mine pit pond to conservatively predict the maximum drawdown external to the mine at any point in time. Additionally, any offset from the Clutha River boundary to lateral (parallel with the river), drawdown from mine pit pond dewatering, has been included for where and as appropriate, and according to image well theory. Any Clutha River boundary offset, normal (landward and away from the river), has been calculated consistent with the conservative calibration displacement of 30% (of that provided by image well theory and as discussed in Section 3 of this report). It should be noted however, that as the mine is transient, the predicted maximum external drawdown will be of a temporary (relatively short term), nature, and only occur to the predicted quantum, when the mine pit pond traverses to within vicinity of the extremities of the mining area or to the area of maximum dewatering requirement.

Table 6.1 provides assessment of maximum lateral drawdown (external to the active mine pit pond), for required annual dewatering rates (inclusive of contingency). The maximum drawdown is presented as the linear distance external of the mine footprint area to a seasonal or annual quantum of drawdown of 1.0 m and 0.2 m.

Table 6.1

Maximum Predicted External Drawdown (m) from Mine Pond Dewatering

Drawdown effect of mine dewatering	Transmissivity (m^2/day), storage and abstraction rate (L/s) modelled	1.0 m laterally parallel to Clutha River boundary (m)	0.2 m laterally parallel to Clutha River boundary (m)	1.0 m normally landward away from Clutha River boundary (m)
Northern extent (distance) to (a) drawdown effect from mine pond centroid and (b) external of mine area (m)	228, 0.1 and 15.6*	(a) 95 m** Mine drawdown = 2.510 m River bound offset (277 m) = -1.510 m (b) N/A	(a) 350 m** Mine drawdown = 1.300 m River offset (435 m) = -1.100 m (b) N/A	Conservatively exceeds extent of aquifer
Southern extent (distance) to (a) drawdown effect from mine pond centroid and (b) external of mine area (m)	494, 0.1 and 62.4*	(a) 196 m Mine drawdown = 4.050 m River offset (350 m) = -3.050 m (b) 147.1 m	(a) 460 m Mine drawdown = 2.590 m River offset (518 m) = -2.390 m (b) 411.1 m	Exceeds extent of aquifer

Notes: Resultant from 365-days seasonal abstraction inclusive of boundary effects and nil recharge. Modelled from mine pond centroid with an effective radius of 48.9 m. *Abstraction rate includes 30% contingency. **May not extend beyond mine footprint area (taken from mine pond centroid at Site B, see Figure 3.1).

The maximum predicted external drawdown from the mine footprint area (Table 6.1) represents the largest calculated water table level displacement at either extremity (for northern and southern extents), of the mine dewatering area. Also, the maximum displacement distance (for either a 1 m or 0.2 m drawdown effect), from mine dewatering, was derived from the lateral distance or radius of displacement impact occurring for the greatest mine dewatering requirement (and hence, the greatest groundwater abstraction needed).

The duration of 365-days used for the drawdown assessment in Table 6.1 above, represents a full annual or seasonal effect of mine pit pond dewatering for any dewatering location within the mine footprint area. The annual time period is considered conservative, as any specific position of the active mine has a limited duration, and in general, the mine would be completely relocated to a new position in a different sub-section of the mine footprint area within approximately an 8-month duration.

Figure 6.1 below presents the maximum externally predicted drawdown impact (and as referenced in Table 6.1), as resulting from the transient progression of the mine pit pond. It should be noted that the predicted drawdown consists entirely of unconfined water table displacement that is additionally offset by the Clutha River recharging boundary.

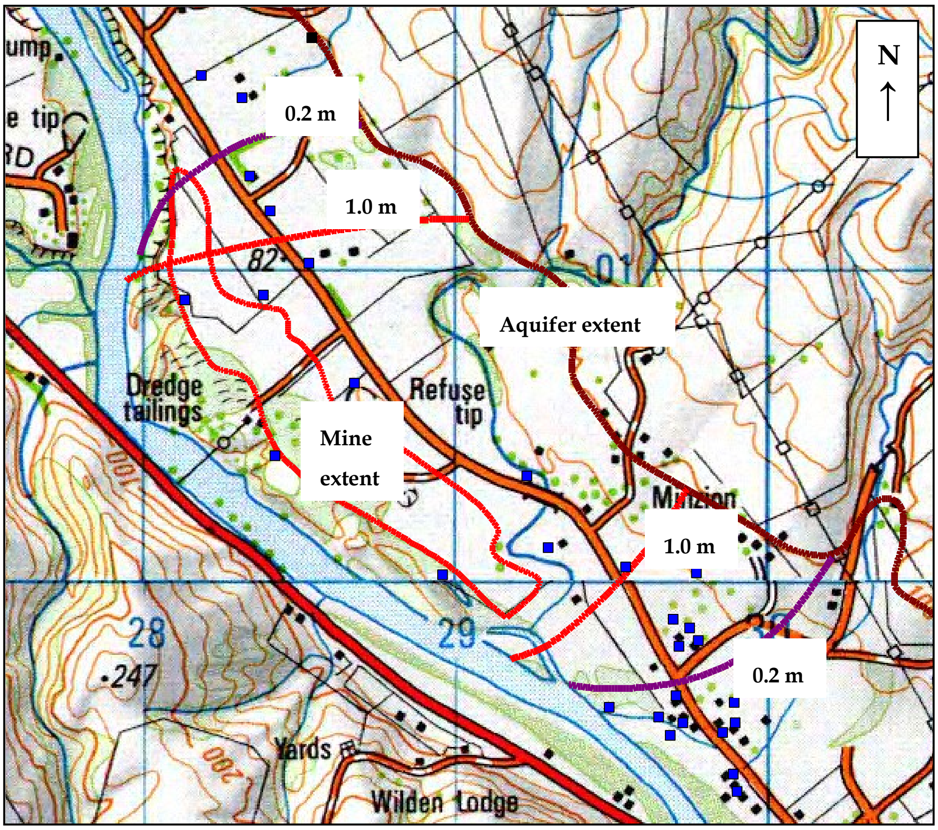


Figure 6.1 Potential Extent of Maximum Transient Drawdown External to the Mining Area

Notes: Aquifer boundary = brown contour.

Drawdown to 1.0 m = red contour.

Drawdown to 0.2 m = purple contour.

All wells that occur in the area are shown as light blue squares.

The estimated extent of the local aquifer as shown in Figure 6.1 represents any likelihood of saturated sediments or gravels being present within the topographic and/or geologic confines of the locality. Additionally, the aquifer extent incorporates the locations of all known wells in the area. The maximum transient drawdown resulting from the mine pit pond dewatering (as shown on Figure 6.1 above), indicates that a majority of the aquifer may be potentially affected at any point in time. It is contended that whilst the appropriate methodology has been followed to predict potential drawdown, the results are considered to be conservative.

The highest dewatering rates are envisaged in the southern quadrant of the mine path extent and hence, lateral drawdown to the south of the mine into the Millers Flat area is greatest.

However, to the north and including some of the mine path extent, lateral drawdown is minimal due to decreasing mine pit dewatering rates (to zero over some of the extent). Although, due to lowered saturated thickness, Transmissivity in this area is reduced, which in-turn extends the quantum of interference drawdown. As above, the landward (normal) drawdown effect indicates a significant displacement (>1 m), over the entire aquifer extent.

Alternative 2D or 3D modelling approaches may be employed to achieve similar outcomes in this instance. However, with the use of the Theis model a much simpler and transparent process and outcome can be achieved. In any case, the methodology is considered to be conservative for the purposes of the prediction of groundwater level reduction and effects upon the aquifer. In consideration of the mapped drawdown assessment in Figure 6.1 above, Table 6.2 (below) provides a list of potentially affected existing wells to the mine pit pond dewatering activity. The well information has been obtained from the online Otago Regional Council GIS consultant tools mapping facility.

Table 6.2

Maximum Predicted Drawdown (m*) Upon Existing Water Supply Wells in the Millers Flat Area

Well number	Owner	Well use	Predicted drawdown (m)
G43/0183	Edwards	Domestic	<1 m and >0.2 m
G43/0219	Liyawarachahi	Domestic	<1 m and >0.2 m
CD13/0101	Parker	Irrigation	>1 m
G43/0193	Parker	Domestic	>1 m
G43/0142	Liyawarachahi	Domestic	>1 m
G43/0187	Cubitt	Domestic	>1 m
G43/0132	Cubitt	Domestic	>1 m
G44/0132	Cubitt	Domestic	<1 m and >0.2 m
G43/0079	Boag	Domestic	<1 m and >0.2 m
G44/0041	Boag	Domestic	<1 m and >0.2 m
G44/0111	Affleck	Domestic	<1 m and >0.2 m
G44/0040	Moore	Unknown	<1 m and >0.2 m

Note: Resultant from 365-days seasonal abstraction inclusive of boundary effects and nil recharge.

Of the 12 potentially affected water supply wells in Table 6.2 above, there is one irrigation well, with the balance (11) being used for domestic water supply. The one well of unknown use has been included for as potentially domestic use. There are seven domestic water supply wells that may incur a drawdown of between 1 m and 0.2 m, of which may not necessarily compromise the water supply.

However, there are also five water supply wells that may incur an interference drawdown of greater than 1 m which may potentially compromise the water supply given the limited saturated thickness of the aquifer in the location of those wells. The one irrigation (well) water take is within or close to the mine path extent which will most likely require an alternative irrigation supply well to be established during or post mining activities.

On the basis of the identified wells that are potentially affected by the HML mine pit dewatering proposal (Table 6.2), written approvals and/or agreements between affected well owners and HML are potentially able to be gained, which would otherwise result in any more than a minor drawdown effect upon individual wells being accepted. Additionally, alternative water supplies are proposed to be provided by HML if and when existing groundwater supply arrangements are to be compromised by the mine pit pond dewatering. Along with any arrangements between HML and local well owners, a condition of consent is proffered to address such alternative water supply requirements (refer to Section 7 of this report). It should be noted that there are options available to HML to provide alternate water supplies to affected well owners, such as deepening or relocation of wells, or providing an appropriate temporary external groundwater or other water source, taken as a permitted activity if within 100 m of the Clutha River.

The Millers Flat community water supply scheme (discussed below), may also be a viable alternative water supply for those wells that may be adversely affected by the proposed mine dewatering.

The augmentation of existing lawful water takes as proposed with the application for resource consents by HML, is one option for activity or effects mitigation if and when, there is any reasonable requirement. Other options to provide for temporary alternate water supplies to existing landholders includes connection to the Millers Flat Community Water Scheme and/or repositioning/deepening existing water takes. At this time, any augmentation requirement (for any supply of water from HML), is envisaged to be undertaken if there is reasonable need, and within the permitted activity framework of the Regional Plan: Water for Otago. That framework allows for up to 1,000 m^3/day that can be taken for any purpose from groundwater or surface water in proximity of the Clutha River/Mata-Au.

If and when there is requirement (as other options may be undertaken), the applicant may take this water as of right under the relevant permitted activity, without the need for resource consent, with any associated effects upon the environment being commensurate with the permitted baseline.

Within the HML application documents, resource consent (Land Use Bore Permit), was applied for in relation to the active mine pit pond that will traverse the applicant's site. In all respects of the proposed activity, the LU Bore provision is the most appropriate and considered mechanism for which to authorise the process of "digging or drilling that otherwise intercepts groundwater" and "creation of a well or device for which groundwater may be abstracted from". The quotations reflect relevant discussions within the Regional Plan: Water for Otago in respect of obtaining Land Use Consent for a "bore, well or mechanism to take groundwater". As part of previously authorised mining activities of a similar nature to the HML proposal, the consent authority has processed the transient active open mine pit pond as a Land Use Bore Permit, consistent with the Regional Plan: Water for Otago. Other consent authorities such as Environment Southland have followed suite with respect to mining activities involving excavations into groundwater. As identified, the LU Bore consent process is most appropriate and has been applied for, as the requested activity does not involve any damming or diversion of water identified by Rule 12.3.2.1 or Rule 12.3.4.1, and pursuant to the description of activities provided by the Regional Plan: Water for Otago. There is nothing to suggest that any provision of the Regional Plan: Water for Otago has sufficiently changed in order for the requested transient open mine pit (pond) activity to be classified as a dam.

In summary, the predicted temporary effects of transient mine pit pond drawdown upon local water supply wells (that are identified in Table 6.2 above), are considered to be potentially more than minor. That is, either the progression of the mine itself, or the unconfined drawdown at any point in time, may exceed the 0.2 m drawdown threshold or permitted baseline provided within the Regional Plan Water for Otago. Although, as identified above and in relation to proposed conditions of consent(s) going forward, HML has sufficiency to fully mitigate any affected wells by providing an alternative temporary water supply arrangement (if and as when required).

Drawdown Assessment Discussion

The HML mine dewatering and drawdown assessment contained above, provides a focus on the Clutha River boundary in determining maximum potential dewatering flows (and drawdown) for the proposed activity. Such that the Clutha River boundary is by far the dominant boundary effect, particularly for mine areas closer to the river, where aquifer saturated thickness (and Transmissivity) is greatest. Both the maximum extent (scope and scale) of predicted mine dewatering flow and associated drawdown occur for the mine dewatering activity in close proximity to the Clutha River.

Whilst a potential effect of the lateral (landward) aquifer extent may result in some cases with lesser mine dewatering flows and consequently lesser drawdown impact, for areas associated with maximum predicted dewatering in proximity to the Clutha River, that effect is regarded as being negligible due to the Clutha River boundary. For the purposes of determining conservative mine dewatering flows, no effect of the aquifer extent was included for, which is otherwise non-existent in proximity of the Clutha River, or would result in lesser moderate landward dewatering flows and drawdown (away from the Clutha River). Diffuse through-flow or recharge from debouching streams and adjacent catchments associated with the landward extent of the aquifer have been generally taken into consideration with the current Theis mine dewatering and drawdown assessment.

Whilst it is most unlikely that a general "barrier" or no flow boundary exists at the aquifer extent (and particularly at all times), it is preferred that otherwise (for purposes of conservatism in the assessment), the predicted mine dewatering flows are based mainly upon aquifer hydraulics and the Clutha River recharging boundary. On this basis and considering that the maximum extent of regional drawdown is incurred from the maximum mine dewatering flows (in proximity of the Clutha River), it is not necessary to include a "barrier" boundary at the extent of the aquifer for analysis purposes. It is considered that an established (and previously accepted by council), hydraulic assessment has been followed and provided to the Consent Authority to allow an otherwise conservative albeit reasonable dewatering and drawdown assessment.

The drawdown assessment provided above, has identified zones or drawdown thresholds consistent with Schedule 5 of the Regional Plan: Water for Otago. Referring to Table 6.1 and Figure 6.1, it should be noted that all of the appropriate lateral (landward) drawdown response from mine dewatering is assessed to be at least greater than 1 m, and this includes all existing wells completed within the aquifer occurrence or beyond the extent of the aquifer.

Whilst the actual seasonal drawdown response in any part of that zone will range from 1 m up to no more than 5 m (maximum dewatering drawdown), for the purposes of identifying effects upon existing wells or the aquifer, inclusion of a "barrier" boundary into the calculations would not change that outcome. As discussed above, for the maximum dewatering and associated drawdown, any effect of the aquifer extent is negligible compared to that of the Clutha River boundary. Additionally, for longitudinal drawdown assessment (to the south and north of the mine extent), dependent upon location, the effect of the Clutha River boundary dominates the extent to which potential effects of drawdown may occur. Any effect of the aquifer extent (as identified above), would only serve to reduce dewatering rates with a commensurate reduction in drawdown. Given the nature of the aquifer and in consideration of the Clutha River boundary, the drawdown assessment (to be conservative and consistent), does not include for a "barrier" boundary on that basis.

The overall 0.2 m drawdown threshold for identification of potentially affected parties (Figure 6.1) is therefore deemed to be appropriately quantified and is considered to be conservative and appropriate for the purposes of balancing the scope and scale of activity and associated effects upon the environment.

Ultimately, inclusion of a "barrier" boundary into the hydraulic assessment would result in an unnecessary reduction to mine dewatering rates and consequent drawdown. Non-inclusion of the barrier boundary means that any uncertainty around that feature is negated with respect to dewatering rates and associated drawdown. As above, it is preferred from a mine planning perspective, to provide for appropriately conservative dewatering rates and associated drawdown impact. Additional to that required conservatism is that a 30% mine dewatering contingency is provided for in respect of any predicted drawdown response.

The current assessment provides examples of assessed mine dewatering and regional drawdown at all locations surrounding the mine extent as shown on Figure 6.1. Both the obvious (Clutha River) boundary effects, variability in aquifer hydraulics and occurrence, and any associated wells have been taken into account to provide a sufficiently accurate effects assessment which is suitably conservative and reasonable in terms of the scope and scale of the requested activity. HML reserves the right to discuss with the Consent Authority the requirement or basis for, and resulting anticipated outcomes of, any modification to the current mine dewatering and drawdown assessment provided within this report.

Effect of Stream Depletion

The only apparent perennial surface water resource in proximity of the HML mine footprint area, is the Clutha River. There are intermittent side-streams that occur within or adjacent to the proposed mining area, of which are likely to be dry during the summer months. The intermittent streams otherwise naturally lose water to the aquifer, as their respective stream beds are generally (significantly) perched above the adjacent aquifer water table level.

Given the intermittent nature of the side-streams and that they otherwise naturally lose water to the adjacent aquifer, it is most unlikely that any additional aquifer drawdown in vicinity of the streams will result in any increased stream flow (reach) losses or any increase to the magnitude of losses. Albeit, the current low flow (of zero) for the streams cannot be reduced any further than that which already naturally occurs.

A stream depletion assessment has been carried out for the adjacent Clutha River to determine the potential maximum impact of flow loss attributed to the proposed site dewatering activity.

In this case, the maximum annual dewatering rate incurred (as assessed in Section 5 of this report), is 62.4 L/s at a pumping centroid distance of 115 m from the Clutha River. The associated 5-day and 30-day peak abstraction rates are 124.8 L/s and 85.8 L/s respectively. These abstraction rates are also associated with the area of the mine which incurs the greatest saturated thickness located in proximity to the Clutha River.

The Theis-Jenkins stream depletion model for the unconfined aquifer has been applied as a conservative assessment of stream depletion for the activity (**Appendix F**). The predicted stream depletion effect (Table 6.3) for the proposed mine pit pond dewatering, models the maximum 5-day, 30-day and 365-day groundwater abstraction (as requested), on the basis of the derived aquifer hydraulic parameters applicable to the site and that hydraulic connection exists between the dewatered aquifer and the river (as has already been shown from test results).

Table 6.3

Maximum Predicted Stream Depletion

Stream Depletion Scenario	**Applicable aquifer hydraulic parameters**	**Results for 115 m from Clutha River to centroid of abstraction (L/s) and (% depletion)**
Stream depletion after 5-days @ 124.8 L/s	Transmissivity 494 m^2/day Storage 0.1	75 L/s or 60%
Stream depletion after 30-days @ 85.8 L/s	Transmissivity 494 m^2/day Storage 0.1	71 L/s or 83%
Stream depletion after 365-days @ 62.4 L/s	Transmissivity 494 m^2/day Storage 0.1	59 L/s or 95%

The predicted stream depletion (Table 6.3) from the Theis-Jenkins model, suggests that up to approximately 75 L/s may potentially be depleted from the adjacent Clutha River for a short duration during when mine pit dewatering is in close proximity. However, this result is very conservative as it is most likely that short term stream depletion of the Clutha River would be associated with initial site dewatering that was located away from the area of maximum saturated thickness. The most likely maximum quantum of stream depletion may be more associated with dewatering that has occurred for a reasonable length of time, moving through the area of maximum saturated thickness in proximity to the Clutha River.

The predicted maximum stream depletion (75 L/s in Table 6.3 above), is 0.03% of the 7-day MALF for the Clutha River, and would otherwise not be measureable. Additionally, full discharge of any net dewatering flow is required to be made to discharge-seepage area(s) adjacent to the Clutha River in the same reach that may incur any stream depletion effect. This will serve to offset any stream depletion effect that may occur, and is in regard to the non-consumptive nature of the requested groundwater take.

Considering the level of potential stream depletion and the non-consumptive and temporary nature of the requested activity, the effect upon stream depletion is considered to be nil to not measureable.

Discussion of Tima Burn flow conditions and specific effects

The Tima Burn has been observed on occasion by HML staff to be seasonally dry at above and below the Tima Burn Bridge on Teviot Road. Additionally, previously undertaken Otago Regional Council low flow investigations have resulted in observations of the Tima Burn being dry at Teviot Road (or unable to be measured).

Whilst there appears to be no photographic evidence available to confirm the visual zero flow sightings, the adjacent landowner (Mr Matt Hunter) has provided independent written confirmation of his account of periodically or seasonally zero stream flow at the Tima Burn Bridge on Teviot Road (**Appendix G**). There is sufficiently strong evidence (from consistent zero flow sightings), that the Tima Burn at Teviot Road experiences seasonally low flows of at or approaching zero flow during the summer months. This is consistent with the assessment of Tima Burn low flow given (above) within this report.

For an evaluation of the effects of a new groundwater take (such as that proposed by HML), Schedule 5 of the Regional Plan: Water for Otago identifies that stream depletion effects upon surface waters is unlikely for streams that are ephemeral or dry for periods of time. The schedule also recognises that disconnect of aquifers from perched streams (above the aquifer), exists which limits or prevents such effects of stream depletion. Additionally, in recognition of the periodically dry status of the Tima Burn, the proposed HML groundwater take is effectively not within 100 m of any “perennial” surface water body associated with the Tima Burn. Given the periodic zero flow attributable to the Tima Burn, along with visual inspection of the stream bed, very little aquatic ecology and biodiversity values appear to visually exist.

Notwithstanding the above discussion, the hydrogeologic information presented in **Appendix B** confirms that for the majority of the Tima Burn where it debouches onto the alluvial aquifer area, the depth to the water table is approximately at least in excess of 5 m.

Well G43/0193 is a domestic/stock water well for Mr Parker (landowner), and is located a modest distance downstream (distal from the true left bank), of the Tima Burn Bridge on Teviot Road. The depth of the well is quite shallow at 6.5 m and the recorded static water level is -2.5 m (2.5 m below top of well head). The well is located in a low elevation area although it is consistent with the adjacent elevation of the bed of the Tima Burn.

The shallow depth to water table at that site (G43/0193) may be due to a localised perched water table in that area, as the balance of the depth to water table information (**Appendix B**) suggests that the Tima Burn bed at Teviot Road is generally at least 5 m above the local water table level. The lower reach of the Tima Burn will most likely incur a declining depth to water table as the waterway becomes part of the Clutha River backwater (boundary), which as resulting from power generation activities, has a diurnal level fluctuation of over 1 m.

Apart from the lower reach of the Tima Burn which is affected by Clutha River power generation level fluctuation, for the balance of the waterway (and particularly at or above where the waterway is observed to be intermittent), any local drawdown from the proposed HML mine dewatering activity upon the naturally occurring depth to the water table, is most unlikely to affect natural stream flow losses from the Tima Burn.

On this basis any existing aquatic ecology and biodiversity values (which in the case of the ephemeral waterway is very limited due to periodic zero flow), associated with the Tima Burn, will be otherwise maintained during any groundwater take activities associated with the proposed mine dewatering operation. The localised and temporary effect of groundwater level decline, will also provide a non measureable effect upon physical flow and water quality impact for the Tima Burn.

In addition to the above discussion, and to eliminate any otherwise small risk of induced stream flow losses from the Tima Burn as a result of the temporary and transient mine pit pond dewatering activity (particularly in the reach downstream of the Teviot Road Bridge), the following mitigation measures are presented (as conditions of resource consent):

- The mitigation measures are based on maintaining an environmental flow at/below the Millers Flat road bridge down to the confluence with the Clutha River. This is as the depth to the water table at/above the Bridge will be naturally greater than a few metres and consequently any mine dewatering drawdown is most unlikely to affect the natural losses above the Bridge. However, further down below the bridge it is plausible that the drawdown impact <u>could</u> affect stream flows as the depth to the water table diminishes.

- The environmental flow augmentation is for up to a conservative 21 L/s (natural MALF) to bolster stream flows if/when needed. However, it does not consider any natural flow losses in the lower reach. Otherwise, an option for the consent holder is to undertake additional work and verify flow losses and more accurately define the environmental flow augmentation.
- The 0.2 m drawdown trigger level approach between the mine pit pond and the stream as per Schedule 5 of the RPW has been utilised (for consistency). The monitoring, reporting and assessment of groundwater levels external to the mine is as provided in the proposed set of conditions. That allows for the Tima Burn monitoring/trigger condition.
- The metering of the flow augmentation will be done in conjunction with metering of mine dewatering flows as provided for in the existing proposed conditions set.

The above elements of the Tima Burn flow augmentation condition (as provided in proposed conditions of consent), have been previously agreed by the independent consultant employed by the Consent Authority in review of the previous HML application for resource consent(s).

It is anticipated that together with the adoption of the proposed Tim Burn flow augmentation condition, that the potential effects of the mine pit pond dewatering activity upon Tima Burn flow, water quality and ecology, will be no more than minor.

Effect on Groundwater Allocation

Whilst there is currently no specific or formal groundwater allocation for the Clutha Outwash Aquifer surrounding Millers Flat or in the area of the proposed HML mining activity, it is expected that the requested maximum annual mine pit pond dewatering volume would technically not exceed such an allocation. The default maximum groundwater allocation for the Clutha Outwash Gravel Aquifer is of up to 50% of mean annual recharge, which includes rainfall, irrigation infiltration and surface water contribution. Allocation of groundwater beyond such a limit should be avoided, unless it encompasses a non-consumptive take, or is for construction or repair of a structure, or is located within a rock formation having low permeability for mineral extraction purposes (Otago Regional Council, 2021).

Any water taken for the proposed mine pit pond dewatering is essentially non-consumptive. That is, the groundwater taken (unless provided as alternate water supply to affected neighbouring takes which are existing with a lawfully established independent water allocation), does not utilise the water for any consumptive means (e.g. irrigation). The dewatering abstraction is essentially returned to the receiving waterbody (water table aquifer and/or Clutha River), within a very short timeframe and in a location consistent with the existing aquifer and Clutha River surface water feature.

This activity would meet the requirement or description provided within the Regional Plan Water for Otago of non-consumptive takes that is otherwise defined within the National Environmental Standard for water metering.

Any water provided to existing lawful uses (as potential mitigation where required), incurs a nil effect upon aquifer allocation, as the water is inherently encapsulated within an existing use allocation (i.e. permitted use or consented activity). The mine pit pond water used for alluvial wash processing is entirely recirculated within the active mine pond, having a nil effect upon any water taken for dewatering purposes. A small component of the requested groundwater abstraction would also be intermittently required for the purposes of site dust suppression and rehabilitation. The water for this purpose would be sprayed over "bare-land" and stockpile areas to minimise dust from the mining operation. As the water is to be applied to mainly non-vegetative land, it is expected that small applications would only be required to maintain a sufficient upper horizon soil moisture content to prevent dust and to establish pasture. It is anticipated that water used for dust suppression and rehabilitation would be minimal (<1% of abstraction), and be well within the accuracy of flow measurement, in relation to the volume of water requested to be abstracted for the purposes of mine pit pond dewatering and level control.

From analysis (above) of the maximum requested annual mine pit pond groundwater abstraction, whilst the potential water table drawdown effects may likely modify water levels within the majority of the immediate aquifer extent (as a hydraulic response to groundwater abstraction), the majority of the groundwater inflow is ultimately sourced from the Clutha River. In any area(s) significantly away from the Clutha River boundary effect, a much reduced mine pit pond dewatering component is required, which will also be due to a lesser required reduction in water table level.

Considering the non-consumptive and temporary nature of the requested activity, and that effects upon any other groundwater takes (inclusive of proposed mitigation), will be nil to no more than minor, the effect upon overall groundwater allocation is considered also to be nil to no more than minor.

Effect on Aquifer Integrity

The proposed dewatering of the mine pit pond is anticipated to be for a maximum nominal lowering of the immediate water level within the mine pond (from natural water table level), of up to approximately 5 m. This is to allow access for excavation of materials at depth for minerals processing. The existing maximum saturated thickness of the gravels that make up the aquifer is approximately 8 m, which is generally overlain by about 10 m of permeable sediments and gravels. Thus, the nominal water table level associated with the aquifer is about 10 m below land surface. The modest required maximum (nominal) aquifer drawdown of 5 m occurs at the location of the transient (open) mine pit pond, with a lesser displacement effect away from the mine location.

Thus, the lowering (in general) of the aquifer head presents a nil to low risk of any aquifer compression or loss of potential storage capability in that regard.

The local aquifer serves a purpose for current water supply requirement, both for domestic and irrigation needs. The excavation of the aquifer-gravel sequence may potentially provide a change to aquifer integrity, post mining. It is impractical and inefficient (regardless of difficulty), to replace all of the in-situ materials in exactly the same position as excavated as part of the mining process. Materials excavated will however, be able to be stockpiled in general depth sequence, with top soil and overburden being able to be replaced as part of the site remediation process. The lower (deeper) materials including in-situ gravels will be replaced as the mine pit progresses, providing for an albeit, modified aquifer sequence, although containing a similar average permeability due to the mixing of the in-situ gravels and adjacent materials. Overall, the aquifer Transmissivity may be of a similar order to that previously encountered, prior to mining. Although, post mining, the aquifer itself may become more homogenous.

An additional effect of the transient mine pit excavation and dewatering activity, is that sediment-laden groundwater is constantly abstracted to sediment settling ponds prior to final discharge.

The abstraction of the sediment-laden groundwater removes finer (silty) materials from the aquifer and deposits these materials onto the land surface (above the aquifer water table). This has a small effect of reducing the silt content within the saturated aquifer strata, increasing the pore spacing between larger deposited gravels, and improving (albeit slightly) the storage capability within the aquifer. This effect, whilst is seen as positive, represents no more than a minor change to potential storage capability and functioning within the aquifer.

Overall, whilst there is an obvious modification to the local aquifer from the mining process itself, the materials replacement from the mining will result in no obvious change to the general hydraulic nature and functioning of the aquifer and adjacent materials, and incur no effect upon any use of the aquifer or any environmental value.

Effect upon Aquifer Water Quality

The implications for aquifer water quality change resulting from the proposed mine pit pond dewatering are limited to contaminants associated with excavation and water abstraction. Excavation of the mine pit pond and then for transient advance of the mine, results in sedimentation of the mine pit pond. No other contaminants are envisaged to be introduced to the mine pit pond through excavation, apart from the potential use of biodegradable flocculants to address sedimentation within the pond.

Some storm-water from the immediate mine footprint may enter the mine pond, however, the volume of stormwater introduced is considered to be very small compared to the required dewatering volume over time.

As a general mine pit pond operational requirement, constant dewatering of the pond is required to maintain the pond at a desired water level, thus essentially providing a positive head within the aquifer toward the mine pond. The abstraction of the sediment-laden mine pit pond water (including possible flocculent - to settling ponds), is replaced by recharge from the aquifer, and this process occurs over time and provides regulation of abstraction rates consistent with desired dewatering levels. As sediment laden waters are pumped, clean groundwater is introduced into the mine pond, and this process ensures that a positive head or flow toward the mine pond is achieved at all times. Such that with this process occurring, there is no potential for any of the sediment-laden pond water, or stormwater, to be introduced into the aquifer, or contribute to any flow within the aquifer that regresses away from the mine pit pond.

There is potentially a small area in the northern part of the mine site where the aquifer saturated thickness may be marginally less than 2 m, and hence, augmentation to enable the floating plant to successfully operate may be required. In this case, it is expected that relatively small augmentation flow rates (compared to dewatering rates), would be required to maintain at least a 2 m depth of water within the mine pit pond. However, in this situation, a modest negative head or pond outflow to the aquifer, would likely result.

This may in turn, introduce some sediment laden water to the saturated gravels surrounding the mine pit pond, and temporarily result in a small preferential increase to finer materials deposited locally in pre-existing pore spaces. However, the advancing mine pit over time would consume any small deposits of locally preferential finer materials as part of the ongoing mining process. Notwithstanding the advancing mine excavation of any small augmented pit pond areas, any area potentially requiring augmentation is relatively small in comparison to the overall mine site. All currently located water supply wells are positioned significantly up-groundwater gradient of any small potentially augmented pit pond area(s), and hence, are most unlikely to be affected by the activity, and particularly over the short period of any potential augmentation.

A small amount of sediment laden water my progress into the aquifer at the conclusion of the mining activity at the final terminal mine pond area. However, this can be overcome by continuation of water abstraction during infilling to again provide a positive head toward the mine pit pond and to remove the majority of any sediment-laden water. Under these circumstances, it is considered that the potential environmental effect upon aquifer water quality as a result of the proposed activity will be no more than minor.

Hydraulic Effect of Discharge

The proposed discharge of mine pit pond dewatering water to land provides an efficient means of firstly, settling the majority of any suspended sediment within a primary settling pond area, and then allowing the resulting or residual volume of discharge to infiltrate back to groundwater and eventually merge with surface waters (Clutha River). The discharge contains (solely) suspended sediments, of which are expected to be either settled out, or with residual turbidity, infiltrate (with groundwater seepage), to the local alluvial gravel aquifer, and then ultimately laterally merge with water flow from the Clutha River.

It is envisaged that the location of final discharge seepage areas will coincide with, or be in close proximity to, old alluvial mine tailings areas. These areas will provide the greatest efficiency with respect to vertical seepage potential to the water table and will otherwise resist possible clogging over time. Notwithstanding any pre-treatment area used for the settling out of suspended sediments from the discharge, designed infiltration areas or ponds will allow for vertical seepage, and then horizontal flow of the infiltrating water. A typical infiltration pond(s) area design (post pre-treatment) may be of the order of 1,000 m^2 with a 2 m potential depth or available head. The potential vertical seepage rate from the infiltration pond, with up to a 1 m depth or head, given the hydraulic conductivity of gravels associated with the old alluvial mine tailings areas (identified by aquifer testing), equates to 170.6 m/day.

A conservatively couched infiltration rate of 10% of the calculated infiltration rate, provides for a seepage rate of at least 17 m/day (approximately 0.7 m/hour). This provides a 17,000 m^3/day vertical discharge potential from the infiltration pond(s) area alone. This discharge potential is greater than the maximum required mine pit pond dewatering rate (and discharge) of 10,783 m^3/day at a peak pumping rate of 124.8 L/s.

It is expected that combined with pre-treatment sediment reduction areas and infiltration pond areas, effective vertical seepage of the peak and steady state mine pit pond water discharge will be able to be comfortably achieved.

Horizontal groundwater flow from the infiltration pond areas is expected to be increased by the seepage water arising from the discharge through local alluvial gravels, albeit old mine tailings. The gravels identified are permeable and reflect the saturated hydraulic properties of that found by aquifer testing (of the Parker irrigation well), discussed above in Section 3 of this report. The discharge to the local gravel aquifer would provide an increase to the gradient of flow and to the current water table level surrounding the Clutha River. The local water table level would be occurring typically at up to about 10 m below land surface in areas where discharge to land would be feasible for HML.

Utilising the conservative infiltration pond area example above, the maximum (peak) discharge of 124.8 L/s could be conservatively maintained for more than 365 days without overwhelming the discharge area and increasing the water table level to above land surface. It is highly unlikely that the peak daily discharge rate would be required over any modest length of time and alternatively, additional infiltration ponds could be constructed to alleviate any short term impact.

The expected maximum steady state discharge (62.4 L/s from dewatering in Table 5.2 above), would restrict the water table level to well below land surface over an annual time period, solely with the adoption of a single infiltration pond as in the above example.

It is considered that the potential environmental effect of the hydraulic nature of the discharge will be no more than minor upon the receiving environment. The discharge will maintain the local water levels to below existing land surface, and the additional aquifer through-flow generated by the discharge will not affect any environmental value and otherwise be of a temporary nature.

Effect of Discharge upon Aquifer and Surface Water Quality

As above, the implication for aquifer (and/or surface waters), water quality change resulting from the proposed mine pit pond dewatering is essentially limited to suspended sediments contamination within the identified discharge to land.

Whilst the majority of suspended sediment is expected to be settled out within the discharge in a primary settling pond area, some associated residual turbidity is most likely to infiltrate (with groundwater seepage), to the unconfined outwash gravel aquifer, and then laterally merge with the Clutha River.

The existing local water table aquifer groundwater contours (Figure 2.3), indicates a general conservative direction of groundwater flow as being to the south-west to the Clutha River. Based upon the hydraulic parameters gained from aquifer testing, and in relation to old alluvial tailings areas and the maximum daily volume of proposed HML discharge to land, an average groundwater velocity (with an effective gradient of flow of 0.06), toward the Clutha River, is conservatively in the order of 10 m/day. The gradient of groundwater flow reflects the inclusion of the requested discharge to land and subsequent infiltration to local gravels associated with the unconfined aquifer. The modified gradient of groundwater flow is conservatively ten-times that of the natural gradient of 0.006.

Based upon the above, there would be a worst case retention time in the outwash alluvium of up to 5-days for the discharge, prior to discharge to the Clutha River (with adoption of a 50 m discharge buffer zone to the river). Additionally, this finding is conservative with the use of only one infiltration pond (with a set radius), which may be otherwise located laterally parallel to the Clutha River, providing for a much lesser mounding effect and improved interface with the river.

The discharge area(s) are proposed to be located approximately at least 50 m (in the direction of groundwater flow), from the flowing Clutha River. The conservative assessment (above) of discharge retention within alluvial gravels and groundwater provides for at least a 5-day buffer prior to discharge to the Clutha River. Additionally, the discharge to the Clutha River is of a diffuse nature, and at 50 m from the infiltration pond(s) any increased turbidity from mine pit pond dewatering and subsequent pre-treatment and discharge to land, would be sufficiently remediated by the in-situ gravels, to a level that is not considered to be of any measureable impact upon surface waters.

The HML application documents in respect of the requested discharge to land whereby it may enter water, seek resource consent for a discretionary activity pursuant to Rule 12.C.3.2 (and not restricted discretionary under Rule 12.C.2.1), of the Regional Plan: Water for Otago. Rule 12.B.4.1 specifies where the discharge of water (excluding stormwater), or any contaminant from an industrial or trade premises or a consented dam, is to water or to land, it is a discretionary activity unless it is permitted by appropriate rules/authorisations. The requested activity is not permitted and is not from a dam. However, the discharge does contain a small proportion of stormwater collected by the open active mine pit and immediate surrounds. Additionally, the definition provided in respect of the discharge from industrial or trade premises within the Regional Plan: Water for Otago, is inconsistent with the requested mining activity and associated discharge content. The requested resource consent for the proposed HML discharge to land is not wastewater from an industrial or trade process, and is therefore unlikely to be considered under Rule 12.B.4.1 of the Regional Plan: Water for Otago. However, in each case, the activity status is invariably discretionary.

On the basis of the discharge of turbid groundwater to land proposal, it is considered that the potential environmental effect upon aquifer and surface water quality as a result of the proposed activity, will be no more than minor. Environmental monitoring and compliance requirements to satisfactorily manage and report on the proposed discharge of turbid groundwater to land, have been included as suggested conditions of resource consent(s) in Section 7 of this report.

Discussion of site Conditions in relation to the Discharge to Land Assessment

The proposed mine dewatering (water) discharge to land (as above) will be to areas which are on the higher elevated alluvial terrace (normal landform) in proximity to (although at least 50 m from), the Clutha River. There are no specific locations provided in the application documentation for discharge to land, although co-ordinate extents for the activity are provided.

This is as HML require flexibility with activities to establish the location, nature and size of sediment ponds and associated discharge to land for any associated mine pit dewatering. Needless to say, any established location for discharge to land on the normal landform terrace within the co-ordinates given, in proximity of existing mine tailings areas (and at least 50 m from the Clutha River), will have sufficient overburden and adequately permeable materials for which to undertake the activity. Typically in the areas previously mentioned, there is approximately 10 m of unsaturated alluvial materials above the water table. The hydrogeologic information provided within this report confirms the extent and quantum of depth to the water table (in **Appendix B**) in vicinity of the above discussed area(s) in relation to the proposed discharge to land.

The hydraulic functioning of the discharge is as explained by the assessment provided above, where based on the conservative hydraulic calculations, there was more than sufficiency with respect to unsaturated overburden and material permeability, to discharge the maximum requested dewatering volume over time to a modest sized infiltration feature. Additionally, at all times the discharge to land must be made to a down-gradient and relatively distal location in relation to the mine dewatering activity to avoid any excessive recirculation of water (as best as practically possible). This then limits the location of any discharge to land to areas as discussed above. Any authorised discharge permit can provide a description of the discharge location envelope within the co-ordinates provided and consistent with the above discussion.

The trial dewatering and discharge activities have been discussed above within this report, where the outcome for discharge to land of the trial dewatering water, reflected suitably high infiltration rates and comfortable sufficiency in dealing with the discharge.

Whilst (as above) there was limited monitoring of the trial activities, the real-time exercise provided a good working representation of the adequacy of the proposed mine dewatering discharge activity and that the proposition and related hydraulic calculations, are conservatively suitable and reasonable.

It is understood that the initial mine pit would start in an area (in the mid-quadrant of the HML site), which has a depth to the water table (thickness of overburden), of approximately 10 m. It was previously thought the initial mine pit would start in the Northern quadrant of the HML site, which has a thickness of overburden of approximately 6 m.

Effect upon Community Water Supplies

There are no community water supply abstractions (either from surface water or groundwater), located within 1 km of the extent of the proposed mine dewatering and discharge site. The nearest community water supply site is that of the Millers Flat Water Supply Scheme (MFWSS), which abstracts groundwater from well G44/0225 adjacent to the Clutha River, at below the Millers Flat (Clutha) Bridge on the true left bank of the river. The site (well) is 16.9 m deep and is located approximately 1,570 m to the south east of the lower mine site extent, and is positioned approximately 36 m from the Clutha River.

The static water level at well G44/0225 is 8 m below the well head at land surface, and the pumped drawdown is no greater than 1.6 m. This indicates that the water supply well has hydraulic connection (albeit for maintenance of groundwater level), to the Clutha River (boundary). Consistent with provisions within the Regional Plan: Water for Otago the MFWSS abstracts groundwater under permitted activity and reticulates the water to consumers at or about the Millers Flat area. The private water supply scheme also provides water to consumers across the Clutha Bridge on the true left bank of the river.

Given the positioning and make-up of well G44/0225, and based on the seasonal drawdown effect of the mine dewatering activity (as assessed above), the MFWSS will not be affected by abstraction of groundwater at the mine site. The maximum seasonal drawdown effect upon well G44/0225 is calculated to be less than 0.2 m, and otherwise being nil to not-measureable.

Additionally, as the direction of groundwater flow at the mine site is predominantly from north east to south west to the Clutha River, there is no hydraulic (groundwater) connection of activities proposed to be undertaken at the site, to that of the MFWSS at well G44/0225. Essentially, the resulting groundwater head and flow direction at the mine site is toward the Clutha River. There is no indication of any parallel groundwater flow to that of the Clutha River. Thus, the effect of activities at the mine site with regard to any hydraulic connection, will be nil upon the MFWSS.

Discharge of mine pit groundwater to land will occur at the mine site, located at or in proximity to old mine tailings areas. As assessed above, the main contaminant resulting from the mine pit groundwater abstraction is suspended solids or turbidity.

Settling ponds will enable removal of most if not all of the suspended solids within the discharge, otherwise any residual turbidity will be removed with final infiltration through the unsaturated zone (of approximately 10 m), to the water table. Additional removal of turbidity may also occur within groundwater flow over a distance of at least 50 m, before merging with the Clutha River. As assessed above, and given the large flow of the Clutha River, any change to river turbidity as a result of the discharge will be no more than minor.

Also, environmental monitoring and compliance requirements to satisfactorily manage and report on the proposed discharge of turbid groundwater to land, have been included as suggested conditions of resource consent(s) in Section 7 of this report.

As well G44/0225 provides for at least 36 m of bank filtration for any abstracted component of Clutha River water, and that any Clutha River turbidity change as a result of mine site discharge to land will be no more than minor (particularly at 1.5 km downstream of the mine site), the effect of any discharge upon the MFWSS is regarded as being less than minor or not measureable.

Effect of Terminal Mine Pit Void

At the conclusion of the proposed mining activity a terminal depression will result from the void created over the duration of mining. The terminal void will be located distal (and be isolated), from the Clutha River. As has been the case with other similar mining activities of this nature, typically the effects of the terminal void creation are virtually nil in comparison to the active mining process.

As detailed above within this report, during the mining process, dewatering of the aquifer creates a net head toward the mine pit (excavation), resulting in discharge (of mainly suspended solids), to adjacent land and then to surface waters with no apparent progression of mine pit water into the adjacent aquifer. A small amount of sediment laden water my progress into the aquifer at the conclusion of the mining activity at the final terminal mine pit pond area. However, this can be overcome by a relatively short continuation of water abstraction during infilling to again provide a positive head toward the mine pit (pond) and to remove the majority of any initial sediment-laden water.

The final excavation void will be sufficiently contoured and rehabilitated, and in any case, any resultant invert will be most likely above the local water table level. Any effect of stock grazing near the terminal void and surrounds will also be no greater than any existing effect of stock grazing upon the local water table aquifer.

Overall it is considered that the potential environmental effects of the resulting terminal mine pit excavation void will be of a De-Minimis nature upon groundwater and/or surface waters.

Retrospective Consent Activities Discussion

In relation to the HML consent application(s), included within the proposal location, scope and scale, is retrospective consent for the trial dewatering and discharge activities that had previously occurred at the site, of which were unknown at the time to be arguably outside that of the permitted activity framework in the Regional Plan: Water for Otago.

The trial activities are completely within and are fully encapsulated by the HML application for requested resource recovery (mining) activities. Land Use consent had previously been applied for, and was authorised by the consent authority, in relation to the trial dewatering site and activities (RM23.097.01 and Bore tag CD13/0149). That Land Use consent is relevant to, and is in the same location, as the trial dewatering activity that was undertaken.

The groundwater analyses provided within the previous HML application documents (as mentioned above and consistent with this technical report), included for the trial dewatering site and activities, as that component was completely within and was fully encapsulated by (in terms of location, scope and scale of activities and effects), the overall application assessment. The more comprehensive analysis of activities and effects provided within the previous HML application documents (and this report), is more detailed and includes for, although greatly outweighs that of just the trial dewatering activities.

As discussed above, the HML consent application documents have clearly identified that the requested consents for the taking of groundwater and discharge of water to land (where it may enter water), will also retrospectively cover (in terms of location, scope and scale), the trial dewatering activities that had been undertaken at the site. The trial activities were unknown at the time to be arguably outside that of the permitted activity framework in the Regional Plan: Water for Otago.

Water for Dust Suppression and Rehabilitation

As explained within the HML consent application documents, any rate and volume of water taken for dust suppression and/or rehabilitation requirements at the applicant's site, will be relatively small. Such that it is envisaged the water requirement may also be taken and used under the permitted activity provisions of the Regional Plan: Water for Otago.

It is not expected that any cumulative rate or daily volume of water taken for dust suppression/rehabilitation and/or for any possible water take augmentation purposes, would exceed permitted activity authorisations of the Regional Plan: Water for Otago. That water may be taken as of right, without the need for resource consent, with any associated effects upon the environment being commensurate with the permitted baseline.

Augmentation of other Water Takes

As discussed above, any augmentation of existing water takes is part of a suite of options that may be employed to mitigate potential HML activities or effects, if and when that is reasonably required. The option of HML providing augmented water to any existing lawful water take, will be on the basis of the provision of water under the relevant permitted activity within the Regional Plan: Water for Otago. Under that provision, the water may be taken as of right, with no resource consent being required, and any associated effects upon the environment are deemed to be commensurate with the permitted baseline.

Effects of Discharge Activities upon Iwi Values

The requested discharge to land activity and the related effects upon the environment are as described above in this technical report. This includes for all of the excess dewatering and processing water attributable to the mining/dewatering activities. It should be noted that there is no proposed direct discharge to water. The discharge is completely to land as is the main preference for discharges within applicable Iwi Resource Management Plans. Additionally, consistent with Iwi Resource Management Plans, the discharge does not contain any biological effluent or contaminants, it is specifically (only) turbid water.

As discussed above in this report, an assessment of the discharge to land activity has been made which includes hydraulic calculations for discharge infiltration, seepage retention and resultant impact upon surface waters (Mata-au). The outcome of the assessment is that with the use of settling pond areas to settle out the majority of any suspended sediment in the discharge water, and then allowing the residual discharge to infiltrate back to groundwater and then to the Mata-au, the impact upon water quality (turbidity) of the Mata-au will not be measureable and/or visually detectable. A 50 m buffer/protection zone to the Mata-au has been set for that purpose and environmental monitoring and compliance have been included in proposed conditions of resource consent to manage and report discharge performance.

The resulting impact of the proposed discharge upon mana whenua values associated with the Mata-au will not be discernible, or otherwise of any offensive nature to local Iwi. The nature and methodology of the discharge (and resulting non-measureable effect upon water quality), will maintain the mauri of the Mata-au, and the activity itself will give effect to Te Mana o te Wai, with respect to the importance of the waterbody and in maintaining the health and wellbeing of that environment. Cultural and spiritual values associated with the Mata-au, including historic and traditional association with local Iwi, will not be affected by the proposed discharge to land, as there are no effects of the activity that would otherwise alter or detract from those values which currently apply. Additionally, there is no cultural or spiritual change with respect to the mauri of the Mata-au waters, as there is no inter-catchment mixing of waters in relation to the discharge activity.

The trial dewatering and discharge activity as discussed in Section 3 of this report, showed no identifiable impact of the discharge upon the Mata-au. This was with the use of a limited discharge settling area and rapid infiltration of turbid water to land. The trial activity results provide for additional confidence around the overall assessment of discharge performance and resulting (non-measureable) effects upon the environment.

Impact on mahika kai, ecology and biodiversity with respect to the Mata-au and Tima Burn

In relation to the abstraction of groundwater for mining dewatering purposes and the discharge to land of excess turbid water (together with the proposed mitigation as part of conditions of resource consents), the physical flow and water quality effects upon the Mata-au and Tima Burn are invariably so small as to be not measureable. This report (above) presents the assessment of the groundwater take and discharge activities (effects) upon surface water and groundwater resources. Whilst no measureable effects are assessed to occur upon surface water resources (Mata-au and Tima Burn), there will be a temporary drawdown effect within the immediate aquifer extent, and some adjacent water supply wells may be adversely affected.

Notwithstanding the assessed effect of localised and temporary groundwater level decline, the balance of effect (being very small to not measureable), upon the Mata-au and Tima Burn, represents a nil impact upon mahika kai. As a result of the assessment of effects for the proposed activities, the existing value of food resources and ecosystems within the Mata-au and Tima Burn for local Iwi will be maintained.

Additional to the discussion provided above, notwithstanding the localised and temporary effect of groundwater level decline, the small to non measureable physical flow and water quality impact upon surface water resources, will not affect any existing aquatic ecology and biodiversity values associated with the Mata-au and the Tima Burn.

The current aquatic ecology and biodiversity values associated with the Mata-au and Tima Burn will be maintained during any groundwater take and discharge to land activities associated with the proposed mine operation. Physical surface water flow and water quality effects of the mining proposal are identified in this technical report, where the small to non measureable nature of those effects, directly results in a nil impact upon aquatic ecology and biodiversity.

The nature of the assessed groundwater abstraction and associated discharge to land, whilst results in an associated non measureable impact upon surface waters, the effect of temporary water table decline and discharge to the aquifer, will not impact upon any aquatic ecology and biodiversity values.

Watertable Drawdown Impacts and Justification upon Iwi Values

The impacts of the proposed mining dewatering activity have been presented above in this technical report. This included for hydraulic assessment of the response to mine dewatering upon local water table (groundwater) levels and the connection with the Mata-au (or amount of resulting stream depletion). No stream depletion of the Tima Burn is otherwise assessed to occur, which is due to either the waterway being generally ephemeral (containing zero flow), or there being limited hydraulic connection of the waterway to the proposed groundwater take for dewatering purposes. However, as part of the resource consent application proposal, mitigation (flow augmentation) of the Tima Burn is presented within conditions of resource consent, to offset any potential for Tima Burn flow losses as a direct result of mine dewatering activities.

The impact on groundwater levels for the proposed dewatering activity is variable, although as identified above within this report, there are existing water supply wells which have been assessed as being potentially affected by the activity. The assessment shows the extents to which a maximum seasonal 1.0 m and 0.2 m drawdown effect may develop within the aquifer over time. However, the maximum drawdown extent is temporary and only occurs when the mine is in relative proximity. No other hydraulic or water quality effect upon the aquifer from mine excavation and dewatering is assessed to occur. The hydraulic and water quality effects upon the aquifer from the mining activity have been additionally presented above within this report.

Notwithstanding that most well owners which are deemed to be potentially affected, have already provided written approval for resource consenting purposes, to address any impact upon local water supply wells, alternative water supply arrangements are proposed. Sufficient monitoring of water levels and alternative water supply arrangements (as required), are provided within proposed conditions of resource consent.

As above, stream depletion effects have been evaluated for the non-consumptive groundwater take (for mine dewatering purposes). The hydraulic analyses show that there is a connection between local groundwater occurrence and the Mata-au. However, it is identified that stream depletion effects (inclusive of mitigation), upon the Tima Burn will be nil (as discussed above). The amount of water depleted from the Mata-au is a very small component of river flow (is not measureable in terms of river flow), and due to the non-consumptive nature of the activity, all water is returned to the aquifer and the Mata-au via diffuse discharge over a relatively short to moderate period of time.

The impacts of drawdown in relation to local groundwater supply (with alternate supply), maintaining long term integrity of the aquifer, and in maintaining Mata-au flow and aquifer connection, will not be any more than minor and will be temporary in nature. At all times, the mauri of the Mata-au including the connection to the adjacent aquifer will be maintained. There is no change to the overall flow of the Mata-au from the non-consumptive dewatering activity and as above, there is no inter-catchment transfer of water attributable to the activity.

The justification for the groundwater take is provided above in relation to predicted abstraction rates required in order to temporarily maintain mine pit pond water levels at a height to enable efficient resource recovery. The discussion within this report (above) provides the methodology and quantum (scope and scale), of the required dewatering flows (groundwater take), to maintain mine pit pond water levels sufficiently low enough to enable the mining activity to occur. Without some dewatering (which is variable depending upon transient mine pit location), the floating processing plant would be unable to efficiently operate.

Buffer Areas in relation to Waterways

There are two waterways that are in proximity of the proposed mine site, namely the Mata-au and the Tima Burn. The proposed discharge to land activity occurs parallel to the Mata-au and does not occur within proximity of the Tima Burn. Such that a discharge buffer/protection zone has been provided from the Mata-au in respect of that activity.

The proposed resource consent conditions for discharge to land specify a discharge buffer/protection zone of at least 50 m to be maintained between the discharge to land and the Clutha River/Mata-au at all times. As discussed above with respect to potential effects of the discharge to land, the 50 m buffer/protection zone will be sufficient to mitigate any measureable and/or visual change to water quality and preserve the mauri of the Mata-au.

Otherwise in respect of the general mining activities, buffer distances from waterways have been set at a minimum of 20 m (HML, October 2023). It is expected that for the mining/excavation activity, a 20 m buffer distance from the Mata-au and Tima Burn is workable for the mining proposal. However, there are other limitations on buffer distances to waterways, such as the presence of old mine tailings areas, that in some cases will provide a buffer distance (to the Mata-au), of in excess of 50 m.

Impact of groundwater levels upon the CODC Closed Landfill

The closed landfill area adjacent to the HML site was investigated by EC Otago in June 2022. The resulting outcome of the site investigation was that at or beyond the buffer zone set for mining purposes, there was no contamination present (from the landfill) that exceeded natural background levels. Thus, any associated physical mining activity impact upon contaminated land was found to be most unlikely.

As part of landfill monitoring, well G43/0112 static water levels (from the specific landfill monitoring well), were assessed to range from 10.8 m to 11.62 m below land surface. The assessment made by the Otago Regional Council is that the aquifer static water level in vicinity of the landfill is at least 6 m below the base of the landfill (EC Otago, 2022). On this basis, any groundwater abstraction and associated drawdown for adjacent mine dewatering will not induce any additional landfill drainage to that which currently occurs.

As a result of the above two findings, and considering that any groundwater abstraction for mine dewatering purposes draws upon a moderately large aerial extent of the aquifer (and/or from the Clutha River), significant dilution of any naturally (currently) occurring landfill drainage will result. The aforementioned effects are considered to be not measureable upon the environment or any person with regard to any potential contamination occurrence or difference in naturally occurring contaminant flux resulting from the (capped) closed landfill.

Scale and Appropriateness of Effects and Mitigation Measures

In relation to technical items raised (as above) with the HML application(s), it is confirmed that the scope and scale of activities and related potential effects upon the environment provided by the application for resource consents, are reasonable and appropriate. The assessments provided within the HML application documents fully encompass all requested activities and provide for sufficient type, scope and scale in relation to the assessment of any related potential effects upon the environment. Subsequently, the mitigation measures identified within the HML application documents are reasonable and appropriate in relation to the requested activities.

7 Conditions of Resource Consent

The following resource consent conditions template(s) are provided to assist with technical scope and scale, and to allow for appropriate monitoring and compliance-reporting for the requested groundwater take and discharge activities for the purposes of mine pond dewatering and groundwater level control:

- Consent RM23.XXXX.01, Hawkeswood Mining Limited.
- To non-consumptively take and use groundwater from a Clutha Outwash Gravel Aquifer for the purpose of site dewatering (and/or augmentation purposes), including plant processing water use, to enable construction and operation of a transient mine pit pond for resource recovery. To additionally use the groundwater for dust suppression and rehabilitation purposes and to augment any existing lawful use where this is required and appropriate due to interference drawdown from the mine operation.
- For a term expiring XX XXXX XXXX.

Conditions

Specific

1. (a) If this consent is not given effect to within a period of XX years from the date of commencement of this consent, this consent shall lapse under section 125 of the Resource Management Act 1991.

   (b) The taking of groundwater authorised by this resource consent shall be for the primary purpose of non-consumptive abstraction for transient mine pit pond dewatering and/or augmentation purposes, including plant processing water use, and shall occur on land as shown on the attached Plan RM23.XXXX.XX (extent of mine area), which forms part of this resource consent. The water may also be used for site dust suppression and rehabilitation purposes, and to augment any existing lawful use where this is required and appropriate due to interference drawdown from the mine operation.

2. The cumulative rate of abstraction for the purpose of transient mine pit pond dewatering and/or augmentation shall not exceed:
   (a) 124.8 litres per second
   (b) 10,783 cubic metres per day;
   (c) 222,394 cubic metres per month;
   (d) 1,967,846 cubic metres between 1 July and 30 June the following year as a rolling average over three consecutive years.

Performance Monitoring

3.

(a) The consent holder shall install a water measuring station(s), consisting of a water measuring device and a datalogger with at least 24 months data storage, and shall maintain a continuous record of the cumulative rate of groundwater take and the date and time the water was taken. Flow rate shall be recorded at a minimum of 15 minute time increments to appropriate metering or measurement accuracy while the take is being exercised.

(b) Data shall be provided to the Consent Authority on an annual basis by 31 July each year and as requested in writing. The consent holder shall ensure data compatibility with the Consent Authority's time-series database.

(c) The water measuring station(s) shall be installed as close as is practicable to the cumulative point of take.

(d) The consent holder shall ensure the full operation of the water measuring station(s) at all times during the exercise of this consent. All malfunctions of the water measuring station(s) during the exercise of this consent shall be reported to the Consent Authority within 5 working days of observation and appropriate repairs shall be performed within 5 working days. Once the malfunction has been remedied, an appropriate Water Measuring Device Verification Form completed with photographic evidence must be submitted to the Consent Authority within 5 working days of the completion of repairs.

(e) The installation of the water measuring station(s) shall be completed to full and accurate operation prior to the exercise of the consent. The consent holder shall obtain and complete the appropriate Water Measuring Device and Datalogger Installation Form and Water Measuring Device Verification Form and submit them to the Consent Authority within 5 working days of the completion of installation and verification of the water measuring device and datalogger.

(f) The water measuring station(s) shall be calibrated by a suitably qualified operator applying International Standards methodology. Calibration documents shall be supplied to the Consent Authority by 31 July each year and upon request.

Note: The water measuring station and datalogger unit should be safely accessible by the Consent Authority and its contractors at all times.

4. (a) The consent holder shall monitor groundwater levels within the lateral boundaries of the advancing mine pit pond. The consent holder shall monitor groundwater levels (at least) on a weekly basis, commencing one month prior to the commencement of any site dewatering. Once temporary site dewatering is complete, groundwater monitoring shall then be undertaken until such time that steady state conditions are reached and verified within the aquifer.

(b) Piezometric water level records as required by this monitoring condition, shall be provided to the Consent Authority on an annual basis by 31 July each year and as requested in writing.

General

5. Copies of the results of any water quality analyses or aquifer testing performed on the groundwater shall be forwarded to the Consent Authority within four weeks of the analysis or testing being undertaken.

6. The consent holder shall take all practicable steps to ensure that as a result of the groundwater take:

(a) There is no unintended leakage from pipes and structures;

(b) There is no unintended run-off of abstracted groundwater either on site or off site

(c) There is no flooding of other person's property, including erosion, land instability, sedimentation or property damage.

7. Unless otherwise remedied, if as a result of the mine pit pond dewatering authorised by this resource consent, the direct drawdown effect upon any adjacent well that is utilised for the purposes of water supply, reduces the water level to the extent that the water supply is no longer viable, then the consent holder shall, at the request of any affected well owner(s), provide a satisfactory alternative water supply to users for those wells deemed to be affected. All affected wells requiring provision for alternate water supply shall be remedied by the consent holder in consultation with the consent authority.

8. During any period of groundwater abstraction for mine dewatering purposes and where any water table level decline as a result of mine dewatering exceeds 0.2 m adjacent to the reach of the Tima Burn from Millers Flat Road Bridge to the confluence with the Clutha River:

(a) The consent holder shall provide environmental flow augmentation to the Tima Burn to maintain either:

(i) A minimum of 21 L/s of stream flow throughout the reach from Millers Flat Road Bridge to the confluence with the Clutha River, or

(ii) The assessed natural flow in the Tima Burn at/downstream of Millers Flat Road Bridge to the confluence with the Clutha River corresponding to an upstream catchment natural MALF of 21 L/s (i.e. inclusive of any natural stream leakage).

(b) The non-consumptive flow augmentation to the Tima Burn shall be abstracted from groundwater sources and form part of the dewatering allocation to this resource consent.

(c) Any non-consumptive flow augmentation from groundwater sources to the Tima Burn shall be fresh (clean) water to fresh water, and be undertaken within the requirements of the relevant permitted activity in the Regional Plan: Water for Otago.

(d) Any flow augmentation to the Tima Burn shall be reasonably oxygenated by aerating the water using a diffuser and/or riffles or similar approach, and shall not cause scour or bank erosion.

9. Prior to the exercise of this consent, the consent holder may provide to the satisfaction of the Consent Authority, an assessment of natural flow (losses) within the lower reaches of the Tima Burn, to confirm the assessed natural flow in Condition 8 (a) (ii).

10. During the exercise of this consent, the consent holder shall (as practicable):

(a) Assess the flow in the Tima Burn at or above the Millers Flat Road Bridge on a weekly basis, or otherwise,

(b) When the flow in the Tima Burn reduces to at or below the environmental flow augmentation requirement in Condition 8 (a) (i) or (ii) as appropriate, it shall be assessed on a daily basis.

(c) All Tima Burn flow assessments shall be recorded and kept in a log book and/or electronic device specifically for that purpose and shall be made available to the Consent Authority upon request.

11. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within 3 months of each anniversary of the commencement of this consent for the purpose of:

(a) Adjusting the consented rate or volume of water abstracted, should applicable monitoring of the abstraction indicate that the consented rate or volume is inappropriate for the consented activity,

(b) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage,

(c) Ensuring the conditions of this consent are consistent with any National Environmental Standards Regulations, relevant plans and/or the Regional Policy Statement, and

(d) Adjusting or altering the method of water take data recording and transmission.

Notes to Consent Holder

1. *If you require a replacement permit upon the expiry date of this permit, any new application should be lodged at least 6 months prior to the expiry date of this permit. Applying at least 6 months before the expiry date may enable you to continue to exercise this permit until a decision is made, and any appeals are resolved, on the replacement application.*

- Consent RM23.XXXX.02, Hawkeswood Mining Limited.
- To discharge excess groundwater from site dewatering containing sediment onto or into land, whereby it may enter water, to enable construction and operation of a transient mine pit pond.
- For a term expiring XX XXXX XXXX.

Conditions

Specific

1. This consent authorises the discharge of groundwater containing sediment to land, whereby it may enter water at locations adjacent to the transient mine pit pond between grid coordinates NZTM E 1,318,240 m, N 4,939,570 m and NZTM E 1,319,440 m, N 4,938,130 m.

2. A discharge buffer/protection zone of at least 50 m shall be maintained between the discharge to land and the Clutha River at all times.

3. If this consent is not given effect to within a period of XX years from the date of commencement of this consent, this consent shall lapse under section 125 of the Resource Management Act 1991.

4. The cumulative rate of discharge for the purpose of transient mine pit pond dewatering shall not exceed 124.8 litres per second and 10,783 cubic metres per day.

5. No other contaminants (other than sediment or flocculants), shall be discharged to land under this resource consent whereby they may enter water.

6. There shall be no direct discharge, or run-off via tile or open drain, of any sediment laden groundwater from the site.

7. *Performance Monitoring*
During any period of potential discharge to surface water (Clutha River), from mine pond dewatering within the term of this consent, quarterly (4 per year) monitoring (water sampling) for total suspended solids and turbidity shall be undertaken at the following sites:
   - Final operational infiltration pond/area discharge to land,
   - Clutha River true left bank at within 100 m upstream of final infiltration pond/area discharge, and
   - Clutha River true left bank at within 500 m downstream of final infiltration pond/area discharge.

8. Copies of the results of any water quality analyses undertaken as a requirement of this resource consent shall be forwarded to the Consent Authority within four weeks of the analysis being undertaken.

9. At the boundary of any reasonable mixing zone for the Clutha River, the discharge shall not give rise to any or all of the following effects:

(a) The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials; or

(b) Any conspicuous change in visual clarity; or

(c) Any significant adverse effects on aquatic life.

General

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within 3 months of each anniversary of the commencement of this consent for the purposes of:

(a) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage,

(b) Ensuring the conditions of this consent are consistent with any National Environmental Standards Regulations, relevant plans and/or the Regional Policy Statement, and

(c) Determining any additional monitoring or compliance limits.

Notes to Consent Holder

1. *If you require a replacement permit upon the expiry date of this permit, any new application should be lodged at least 6 months prior to the expiry date of this permit. Applying at least 6 months before the expiry date may enable you to continue to exercise this permit until a decision is made, and any appeals are resolved, on the replacement application.*

8 References

EC Otago (2022)	*Preliminary Site Investigation – 1484 Teviot Road, Millers Flat.*
Hydrosolve Inc. (2010)	*AQTESOLV for Windows V4.5 Professional.*
MacDonell Consulting Ltd (2023)	*AEE Application Planning Report for Hawkeswood Mining Limited.*
New Zealand Government (2010)	*Measurement and Reporting of Water Takes: Regulations.*
Otago Regional Council (2021)	*Regional Plan Water for Otago.*
Otago Regional Council (2022)	*Online GIS Consultant Tools Mapping Facility.*

▪ Appendix A
Investigation Well Logs and Test Data

▪ Appendix B
Site Information Mapping

▪ Appendix C
Site Information Data

▪ Appendix D
Aquifer Test Input Data

▪ Appendix E
Aquifer Test Analyses

▪ Appendix F
Stream Depletion Analyses

▪ Appendix G
Matt Hunter, Tima Burn