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KCGM
Hydrogeological review of the Mt Percy Pits

Report Status

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EXECUTIVE SUMMARY

Kalgoorlie Consolidated Gold Mines Pty Ltd (KCGM) is a wholly owned subsidiary of Northern Star Resources Ltd and is responsible for operating the Fimiston Gold Mine Operations, located adjacent to the City of Kalgoorlie-Boulder in the Eastern Goldfields Region of Western Australia. Gold ore from the Fimiston Open Pit and the Mt Charlotte Underground Mine are processed at the Fimiston Processing Plant which is located on the eastern side of the Fimiston Open Pit.

The historical Mt Percy operation is located north of the Mt Charlotte Underground Mine, was operated from 1985 to 1992, and comprises two closed Tailings Storage Facilities (TSFs), several closed Waste Rock Dumps (WRDs), two open pits (the Union Club Pit and the Mystery Pit) and one backfilled pit (the Sir John Pit), see Figure 2. The Mystery and Union Club Pits have permanent water at the base as illustrated in Figure 2 which has been inferred to reflect groundwater in each case. During ongoing mining operations, KCGM are planning to discharge dewatering flows from the Mt Charlotte Underground Mine to the Union Club Pit, and subsequently following settlement of suspended solids, pump these flows back into the saline water system for reuse. As part of ongoing licensing and closure studies, KCGM are investigating any potential influences on the receiving environment associated with the Mt Percy Pits. This report provides a description of the hydrogeology of the pits, quantifies the implications of using the Union Club Pit to settle solids from the Mt Charlotte Underground Mine discharge, and quantifies interactions with the receiving environment in long term closure.

Monitoring data for groundwater elevations and pit lake hydrochemistry at the Mt Percy Pits have been reviewed to develop a conceptual hydrogeological model of the flow regime. Three shallow lakes are present in the Mystery Pit, and a 15 m deep lake is present in the Union Club Pit. These lakes all reflect the combined inflows of pit slope runoff, direct precipitation, groundwater inflow which are being balanced by evaporation. The relative influences of both pit slope runoff and groundwater inflow are clearly defined from the changes in EC, TDS concentrations and pH for the hydrochemistry of the Union Club Pit lake.

A water balance model has been constructed and calibrated for the Union Club Pit lake. It identifies that the lake elevation is stable at around 307 mAHD, due to rates of evaporation (average 0.5 L/s) being matched by rates of groundwater inflow (average 0.2 L/s) and the combined rates of direct precipitation and runoff (total average 0.3 L/s). The pit lake is currently acting as a groundwater sink. Groundwater is flowing from the receiving groundwater system into the lake, and the lake water is not entering the receiving groundwater system.

During closure, under a range of precipitation conditions the Union Club Pit lake is expected to have an elevation in the range 306 mAHD to 309 mAHD. The lake will continue to function as a groundwater sink and there is no potential for discharge into the adjacent Mystery Pit. The TDS concentration of the lake will increase from 50,000 mg/L in 2022 to around 240,000 mg/L in 2055, as a result of evapoconcentration. In the long term the TDS concentration will reach an equilibrium maximum driven by the saturation and precipitation of minerals including gypsum.

There are two apparently permanent lakes in the Mystery Pit and one lake which appears to dry out in some conditions. All three lakes are indicated to be roughly in balance, with evaporation from the lake being of a similar magnitude to the combination of direct precipitation and runoff. However all three lakes may potentially receive low rates of groundwater inflow in some conditions and generate low rates of outflow to groundwater in other conditions. Although the current lake chemistry has not been measured, these shallow lakes are expected to evapoconcentrate in long term closure, driven primarily by the hydrochemistry of pit runoff.

KCGM are planning to discharge dewatering flows from the Mt Charlotte Underground Mine to the Union Club Pit to allow suspended sediment to be settled before pumping the flows on to the Fimiston Processing Plant. The water balance model identifies that:

- The Union Club Pit will provide a maximum residence time (i.e. maximum settling period) in the range 21 days to 162 days.
- The maximum duration for which discharge can continue in the event that pumping out is not occurring ranges from 12 days at a discharge rate of 2,000,000 m^3/year to 59 days at a discharge rate of 400,000 m^3/year, before the nominated maximum pit lake elevation of 312 mAHD is breached.
- Assuming pumping out stops, once pumping out recommences, it is necessary to pump out at a greater rate than pumping in, or the pit lake will not return to the elevation of 307 mAHD.
- The addition of dewatering discharge to the pit lake will rapidly increase TDS concentrations to match the discharge quality. Major ion proportions will remain similar to the existing lake. There will be a proportionally larger increase in nitrate concentrations and in bicarbonate concentrations as these are relatively elevated in dewatering discharge.
- In the long term, the TDS concentrations in the Union Club Pit driven by evapoconcentration will be very similar regardless of whether dewatering flows are discharged to the pit.

Monitoring of the planned discharge system will be required to ensure that the conceptual and numerical models developed for the pit lake remain valid. Recommended monitoring is as follows:

- Monitoring bore CSURCH3140 should continue to be dipped quarterly while access is available.
- The volume of water pumped from the Mt Charlotte Underground Mine dewatering into the Union Club Pit lake should be measured with a flow meter.
- The volume of water pumped from the Union Club Pit lake to the Fimiston Processing Plant should be measured with a flow meter.
- The elevation of the lake in the Union Club Pit should be routinely measured by a survey or by manual measurement of a surveyed marker board.
- The discharge from the Mt Charlotte Underground Mine into the Union Club Pit should be sampled quarterly for laboratory analysis.
- The water pumped from the Union Club Pit to the Fimiston Processing Plant should be sampled quarterly for laboratory analysis.
- The laboratory analysis suite should comprise:
    - pH, EC, TDS, TSS, Total Hardness, Total Alkalinity, Ca, Mg, Na, K, NH_4, Total PO_4, CO_3, HCO_3, Cl, SO_4, NO_3, SiO_2, filterable Al, filterable Fe, filterable Mn, Cation/Anion Balance.

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1. Introduction

1.1 Scope of works

Kalgoorlie Consolidated Gold Mines Pty Ltd (KCGM) is a wholly owned subsidiary of Northern Star Resources Ltd and is responsible for operating the Fimiston Gold Mine Operations, located adjacent to the City of Kalgoorlie-Boulder in the Eastern Goldfields Region of Western Australia. Gold ore from the Fimiston Open Pit and the Mt Charlotte Underground Mine are processed at the Fimiston Processing Plant which is located on the eastern side of the Fimiston Open Pit (Figure 1).

The historical Mt Percy operation is located north of the Mt Charlotte Underground Mine, was operated from 1985 to 1992, and comprises two closed Tailings Storage Facilities (TSFs), several closed Waste Rock Dumps (WRDs) two open pits (the Union Club Pit and the Mystery Pit) and one backfilled pit (the Sir John Pit), see Figure 2. The Mystery and Union Club Pits have permanent water at the base as illustrated in Figure 2 which has been inferred to reflect groundwater in each case. During ongoing mining operations, KCGM are planning to discharge dewatering flows from the Mt Charlotte Underground Mine to the Union Club Pit, and subsequently following settlement of suspended solids, pump these flows back into the saline water system for reuse. As part of ongoing licensing and closure studies, KCGM are investigating any potential influences on the receiving environment associated with the Mt Percy Pits. This report provides a description of the hydrogeology of the pits, quantifies the implications of using the Union Club Pit to settle solids from the Mt Charlotte Underground Mine discharge, and quantifies interactions with the receiving environment in long term closure.

In consultation with KCGM, the scope for the study was agreed to comprise:

1. A desktop review of all available monitoring and mine planning data, with no site works undertaken specifically for this study.
2. Review and interpretation of groundwater elevation, pit lake elevation and pit lake hydrochemistry compiled by KCGM.
3. Compilation of a conceptual model of the hydrogeological and hydrological regime.
4. Development of a water balance model to simulate the elevation and TDS concentrations of the lake in the Union Club Pit under a range of future conditions.

1.2 Objectives

The objectives for the investigations completed by Big Dog Hydrogeology Pty Ltd (BDH) were defined to be:

1. Predict the potential changes in the elevation and hydrochemistry of the lake in the Union Club Pit associated with the temporary storage of Mt Charlotte Underground Mine discharge.
2. Predict the long term pit lake elevations in the Mystery Pit and the Union Club Pit in closure.
3. Identify any interactions with the receiving groundwater environment.

2. Setting

2.1 Rainfall and evaporation

Climate data recorded at the Kalgoorlie Airport Station collected by the Bureau of Meteorology have been used as the primary source to characterise precipitation conditions for the Mt Percy Operations. This station is located within 10 km of the Mt Percy facilities and daily climate records are available from 1939 up to the current date. Pan evaporation data are not currently recorded at Kalgoorlie Airport, and pan evaporation data have been sourced from an interpolation of all available evaporation pans in the region provided from SILO (Scientific Information for Land Owners, Jeffrey et al, 2001).

Analyses of the climate conditions show that the Kalgoorlie area has a semi-arid climate, experiencing warm to hot summers and cold to mild winters. Rain is recorded in Kalgoorlie on average during every month of the year. Summer rains are usually associated with thunderstorms or tropical depressions and tend to be relatively intense. Tropical depressions, often the result of decaying tropical cyclones crossing the coast in northwest Western Australia, can cause widespread rains, whereas rain from thunderstorms is generally localised. Winter rains are usually the result of cold fronts from depressions in the Southern Ocean and tend to be widespread but less intense than summer rains.

Annual rainfall at Kalgoorlie since 1940 has ranged from 109 mm in 1940 to 531 mm in 1992, with a long term average of 267 mm. Monthly averages of precipitation and evaporation calculated from 1996 (i.e. for the period following the completion of mining and closure works at the Mt Percy facilities) are presented in Table 1 and Figure 3. During the Mt Percy closure period monthly evaporation has exceeded monthly precipitation on average in all months, and annual evaporation on average exceeds annual evaporation by a factor of nine.

Temperatures in Kalgoorlie can range from a summer maximum of 46ºC to a winter minimum of –3ºC with occasional frosts experienced during the winter months. Winds are strongest during winter, though not usually exceeding 30 km/h and are mainly from the north, west or northwest. In summer, winds are predominantly from the east. The relative humidity averages less than 30% at 3 pm during summer while the 9 am winter figures are typically around 70%.

Table 1: Average monthly climate conditions since 1996

Month	Average Precipitation	Average Evaporation
	mm	mm
Jan	39	344
Feb	35	270
Mar	35	239
Apr	16	159
May	16	108
Jun	17	80
Jul	21	85
Aug	20	116
Sep	12	168
Oct	15	243
Nov	23	285
Dec	18	339
Annual	266	2436

2.2 Regional hydrogeology

The geological conditions at the KCGM operations are well defined and documented from historical mining operations and resource definition studies over the recent mining period. Prior to mining, the Golden Mile was a south-plunging ridge of mostly mafic and ultramafic rocks forming part of the Kalgoorlie-Kambalda Greenstone Belt. The rock mass in the vicinity of the Mystery Pit largely comprises Hannans Lake Serpentinite, with some Williamstown Dolerite and Devon Consols Basalt present in the upper weathered zone. The Union Club Pit intersects Hannans Lake Serpentinite in the west and Williamstown Dolerite in the east, with intersections of Devon Consols Basalt and Kapai Slate also present. All of these lithologies are expected to have relatively high strength unless significantly altered.

The structure of the Fimiston area is dominated by the large Kalgoorlie Anticline and Kalgoorlie Syncline, the major Golden Mile Fault which strikes sub-parallel to formation boundaries and runs longitudinally through the Fimiston Open Pit, and numerous cross-cutting faults. These cross cutting faults act to disconnect structures within the Fimiston Open Pit from the Mt Charlotte Underground Mine, and act to disconnect structures within the Mt Charlotte Underground Mine from the Mt Percy Pits (BDH, 2022a and BDH, 2022b).

The weathering profile along the Golden Mile consists of a laterite caprock (comprising oxidised and cemented material) with a variable thickness of 5 m to 15 m which overlies the oxide profile. The oxidation depth varies from 0 m to 70 m and averages 40 m.

The greenstones along the Golden Mile are overlain by Tertiary and younger sedimentary deposits to the west, south, and east, which include the presence of palaeodrainages. KCGM´s operations including the closed Mt Percy operations are located within an elevated zone which forms part of the topographic divide between two major palaeodrainage systems that occupy the lower part of the subdued landscape features typical of the Kalgoorlie area.

There are three major active groundwater systems recognised in the KCGM area:

1. Palaeochannel systems; a localised but extensive network of alluvial sands of Tertiary age occurring at up to 60 m below ground level (mBGL). This system is well defined and is exploited by KCGM and by other mining operations as the primary source of process water supply. Closest to the Mt Percy Pits, this system includes a tributary of the Yindarlgooda South palaeochannel located about 10 km south of the Mt Percy Pits beneath Hannan’s Lake, and a tributary of the Yindarlgooda North palaeochannel located 10 km north of the Mt Percy Pits. Groundwater in theses palaeochannels is hypersaline. The palaeochannel groundwater system is not present at the Mt Percy Pits.
2. The ferricrete and alluvial sediments groundwater system; comprising sand, gravel and fractured ferricrete within clay deposits, typically occurring between 5 mBGL and 40 mBGL, and overlying the bedrock. This system is only present in portions of the lower topographic areas around KCGM and is not present at the Mt Percy Pits.
3. The bedrock groundwater system; the zone where groundwater flow occurs in fractured and weathered zones within the basement rocks at depth. Regional investigations undertaken by KCGM and other mining companies in the Eastern Goldfields Region suggest these formations typically have a very low primary permeability and are not expected to store or transmit large quantities of groundwater except through major secondary structures. Groundwater in the Mt Percy Pits is drawn from this groundwater system.

2.3 Mining operations

2.3.1 Mt Percy operations

The Mt Percy Pits are located to the east of the Eastern Bypass Highway and to the north of the Trans Australian Railway, with a Water Corporation owned tank located on a lateritic hill to the west. Mining of the Sir John Pit, Mystery Pit and the Union Club Pit was undertaken from 1985 to 1992. As illustrated in Figure 2, natural surface elevation at the Mt Percy Pits occurs at around 400 m above Australian Height Datum (mAHD), while the Mystery Pit was mined to around 340 mAHD (around 60 m deep) and the Union Cub Pit was mined to 289 mAHD (over 100 m deep). Following mining, the Sir John Pit was backfilled with waste rock. A significant portion of the north western limb of the Mystery Open Pit was backfilled with waste rock to 380 mAHD in order to buttress the western wall adjacent to the water tank. This was done in accordance with the original mining approval agreement between the Water Corporation and Mt Percy Mining Services Pty Limited and was considered a preventative measure rather than a geotechnical necessity.

The Mt Percy TSF comprises two cells which were operated from 1985 to 1997 and were subsequently closed. One to seven metres of alluvium and colluvium are present near surface at the TSF and during operations a perched water table developed within this unit driven by TSF seepage. Seepage was monitored via nine shallow monitoring bores and was managed by pumping from a seepage interception trench. A monitoring review in 2000 identified that most of the monitoring bores had gone dry and most of the seepage had been removed (PCA, 2000).

During the closure period, lakes have been allowed to develop in the Mt Percy Pits, and the pit slopes have been routinely inspected by KCGM geotechnical staff. No large scale failures have occurred, and maintenance has been limited to scaling localised instability and repairing erosional features. No risks to adjacent infrastructure such as the Trans Australia railway have been identified.

2.3.2 Mt Charlotte Underground Mine dewatering

Continuous dewatering at the Mt Charlotte Underground Mine has occurred since the 1960s. The Mt Charlotte headframe is about 4 km south of the Mt Percy Pits, as illustrated in Figure 1, and the underground workings at Mt Charlotte are expected to be hydraulically disconnected from the pits. Dewatering comprises a combination of low rates of groundwater inflow which seeps from structural features and drillholes intersected by the underground workings, and flows which are pumped underground and used for drilling, mining, washdown and dust suppression purposes. Groundwater sources are inferred to make up 30% to 70% of the total dewatering. The combined flows report to sumps within the underground workings and are pumped to surface by a staged pumping system. The lowest pumping system is installed at -795 mAHD, more than 1 km below the base of the Union Club Pit.

Prior to 2020, potable water was pumped into the Mt Charlotte Underground Mine for mining use. In 2020, due to increasing water demand, the system was modified to allow hypersaline water to be directed underground for mining use. As a result, the TDS concentration in dewatering discharge increased from around 40,000 mg/L in 2020 to around 100,000 mg/L in 2021. This dewatering discharge has interacted with drilling operations, underground ore and waste rock stockpiles, and underground heavy vehicle traffic, and therefore contains a significant suspended solids content. KCGM are planning to modify the mine water management circuit to achieve settling of solids from these pumped flows before they enter the saline water system for reuse.

2.3.3 Temporary storage of Mt Charlotte Underground Mine discharge

The design for the planned use of the Union Club Pit to temporarily store dewatering discharge from the Mt Charlotte Underground Mine and allow suspended solids to settle prior to pumping back into the saline water system for reuse comprises:

- Dewatering discharge will be piped to the southern margin of the lake in the Union Club Pit. In 2021 the total pumping from the Mt Charlotte Underground Mine was 400,000 m^3. In order to allow for the planned expansion of the underground drilling and mining operations, the discharge system is intended to be constructed to operate at 800,000 m^3/year, and to have an instantaneous capacity equivalent to with an annual capacity of 2,000,000 m^3/year.
- Water will be removed from the Union Club Pit using a pumping station constructed at the northern end of the pit lake. The capacity of the pumping system is intended to match the rate at which dewatering discharge is pumped in.
- The pumping systems will be managed to prevent the pit lake rising more than 5 m from the current elevation, to minimise any erosion or reduction in stability of the pit slopes associated with movement of the lake elevation (KCGM, 2022).
- The system is expected to be commissioned in 2022 and will operate until the closure of the Mt Charlotte Underground Mine at the end of the KCGM mine life in 2034.

2.4 Closure

The Mt Percy TSF, WRDs and pits have been rehabilitated to their final configuration and no further earthworks are proposed. An abandonment bund has been placed around the pits and the site is fenced. Closure of the Union Club Pit will comprise the removal of all pumping and reticulation equipment used to temporarily store Mt Charlotte Underground Mine dewatering discharge. The pit lakes in the Mystery and Union Club Pits will be allowed to develop to their long term equilibrium configurations.

3. Conceptual hydrogeological model

3.1 Sources of data

Monitoring data provided by KCGM for the hydrogeological review are described as follows:

1. There are two standpipe monitoring bores near the Mt Percy Pits (CSURCH3140 and NSURCH3140 as marked in Figure 2). Collar elevations have been surveyed and dipped groundwater depths are available from 1998. NSURCH3140 was buried in 2015 and current observations are available only from CSURCH3140.
2. The pit lake in the Union Club Pit has been routinely sampled and analysed for field EC and field pH, and samples have been despatched for laboratory analysis approximately quarterly since 2013. However there has been no access to the pit lake since 2018.
3. The lake elevations in the Mt Percy Pits are not routinely measured. However KCGM have analysed an air photo taken in December 2021 and undertaken a drone survey in 2022 to identify the elevation of each lake. BDH has reviewed public source Google Earth images dating back to 2004 and approximately estimated the water elevation in the Union Club Pit lake and in Lake 3 in the Mystery Pit, based on the mapped topography and the apparent lake extent.
4. The Mt Charlotte Underground Mine dewatering discharge is sampled for laboratory analysis quarterly.

3.2 Groundwater elevations

Figure 4 plots groundwater elevations measured in the monitoring bores and estimated for the pit lakes. Monthly precipitation totals are included for comparison. The monitoring bores consistently indicate the groundwater elevation within weathered and fractured bedrock occurs at around 335 mAHD. From 2004 to 2013 the groundwater elevations measured in CSURCH3140 were anomalously low. It is unknown whether these records reflect localised dewatering in this area or anomalous depth measurements. There appears to be some correlation between movement of the groundwater elevation by 1 m to 2 m and periods of unusually high or unusually low precipitation.

The groundwater elevation in the Mt Charlotte Underground Mine around 4 km to the south of the Mt Percy Pits is at -795 mAHD, and the groundwater elevation below the Fimiston Open Pit located around 10 km south of the Mt Percy Pits is at -278 mAHD. Dewatering operations at each of these mines has significantly lowered the groundwater elevations, but due to the presence of cross cutting faults the mining drawdown is not evident at the Mt Percy Pits, where the groundwater elevation is close to the inferred re-mining level.

Three localised small lakes have been present in the Mystery Pit (labelled as Lake 1, Lake 2 and Lake 3 in Figure 2). Lake 1 and Lake 3 appear to have consistently been present in air photos taken in the period 2004 to present. Lake 2 is sometimes present in the images and sometimes has dried out leaving white salt residue in its place. The elevations of the lakes in the Mystery Pit have been in the range 339 mAHD to 342 mAHD, which is slightly higher than the groundwater elevation in the monitoring bores. Lake 2 is indicated to be the highest lake and is also the only lake that appears to drain into the groundwater system. The undisturbed groundwater hydraulic gradient would be expected to be from north to south in this location, in combination these observations suggest the groundwater elevation is at around 340 mAHD, very close to the Mystery Pit Lake elevations. Based on the as mined topography contoured in Figure 2 all three of the Mystery Pit lakes are generally less than 1 m deep.

Since 2004, the single lake in the Union Club Pit has had an elevation of around 305 mAHD, which is at least 30 m below the expected local groundwater elevation. Based on the contoured pit elevations in Figure 2 the maximum lake depth is around 15 m. The relatively low lake elevation is attributed to evaporation from the lake surface. There are insufficient estimates of the lake elevation to identify any direct correlation with precipitation conditions.

3.3 Union Club Pit hydrochemistry

3.3.1 Time series hydrochemistry

Figures 5 to 12 present time series graphs for hydrochemical analytes routinely measured in the Union Club Pit lake. Values below detection have been plotted as half the detection limit. Monthly precipitation totals have been included in each plot to investigate relationships between runoff events and lake hydrochemistry. The data reflect grab samples from the lake surface and may not reflect the fully mixed chemistry of the lake.

Figure 5 identifies that the Electrical Conductivity (EC) of the pit lake is highly variable and correlates with precipitation, being typically 170,000 uS/cm in low precipitation periods and reducing to around 70,000 uS/cm in high precipitation periods. This is attributed to the lake being sourced from a mix of high Total Dissolved Solids (TDS) inputs (groundwater inflow) and lower TDS inputs (direct precipitation and runoff). The pit lake pH has typically been in the range 6.5 to 7.5. However there have been four occasions when the pit lake pH has been recorded around 5. All of these occasions follow high precipitation periods, and correlate with some of the lowest EC measurements. It is evident that as well as contributing lower TDS flows, pit wall runoff can contribute occasionally contribute acidity to the lake. This is attributed to exposed mineralisation in the pit slopes which is potentially oxidised in dry periods, with oxidation products subsequently flushed to the lake in wet periods. The reduced pH in the lake may only apply to the upper waters where low TDS water may be floating on high TDS lake water, and is short lived, being neutralised by the significant alkalinity of the lake once the runoff becomes fully mixed.

Data on TDS and major ion concentrations including sulphate are available at lower frequency than EC but demonstrate similar trends. The TDS concentrations of the grab samples from the upper lake surface vary between 10,000 mg/L and 70,000 mg/L and demonstrate correlation with precipitation conditions. Bicarbonate concentrations follow the major ion trends but reduce to zero on occasions when the pH reduces. Nitrate is consistently present in the lake at around 2.5 mg/L and does not vary with precipitation. The nitrate is attributed to residual influences of blasting material within the pits and the pit slopes. Filterable concentrations of metals are consistent with the influence of mineralisation and are at concentrations similar to groundwater samples collected from the Fimiston Open Pit and the Mt Charlotte Underground Mine.

Concentrations of TDS and selected major ions are compared against the pit lake pH in Figure 13, and only bicarbonate is influenced by pH. A similar comparison for filterable metals is provided in Figure 14. Filterable concentrations of Fe, Al and Cu are strongly controlled by pH, with concentrations increasing by one to two orders of magnitude when the lake pH drops to 5. Filterable concentrations of Mn and Zn demonstrate less variation with pH.

In combination these observations suggest that pit runoff and groundwater inflow potentially have similar hydrochemistry, other than for TDS and major ion concentrations which are significantly lower in runoff, and pH which is occasionally lower in runoff.

3.3.2 Comparison of water types and characteristic chemistries

Table 2 compares the hydrochemistry of the following sources:

1. The average of all pit lake samples from the Union Club Pit from 2013 to 2018. This is expected to reflect a combination of groundwater inflow and pit slope runoff.
2. A sample collected from the Union Club Pit lake in March 2014. This represents an unusually low EC and TDS sample, collected after a large precipitation event, which also has a low pH. The sample is expected to be dominated by the influence of pit slope runoff.
3. A sample collected from the Union Club Pit lake in September 2016. This represents an unusually high EC and TDS sample. It is expected to be dominated by the influence of groundwater inflow.
4. The average hydrochemistry of dewatering discharge from the Mt Charlotte Underground Mine from 2015 to 2020 when potable water was being directed underground for mining use.
5. The average hydrochemistry of dewatering discharge from the Mt Charlotte Underground Mine during 2021 when hypersaline water was being directed underground for mining use.
6. The average hydrochemistry of dewatering flows from the Fimiston Open Pit from 2015 to 2021. The calibrated water balance model for the pit identifies that the dewatering flows are comprised 50% of groundwater and 50% of precipitation infiltration through the pit slopes and pit floor.

Table 2 illustrates that when the Union Club Pit is dominated by pit slope runoff, as well as a lower TDS concentration, lower pH and higher concentrations of Al, Fe and Cu, there is a slight increase in the relative contribution from sulphate. These observations are all consistent with the influence of the oxidation and flushing mineralised zones in the pit slopes. However the average chemistry of the Union Club Pit lake is consistent with groundwater chemistry as measured at the Mt Charlotte Underground Mine and with groundwater chemistry as measured at the Fimiston Open Pit, including the filterable concentrations of Al, Fe and Cu. The influence of runoff from mineralised zones in the pit slopes on the overall lake chemistry is therefore small.

Comparing the current hydrochemistry of discharge from the Mt Charlotte Underground Mine with the average Union Club Pit lake identifies that the chemistry of the lake and the proposed discharge are similar, but that:

1. Dewatering discharge has a higher TDS concentration (100,000 mg/L compared to a lake average of 42,000 mg/L), and hence higher concentrations of all major ions.
2. Proportionally the dewatering discharge has a higher bicarbonate concentration and hence higher alkalinity.
3. The dewatering discharge has elevated nitrate concentrations (60 mg/L) compared to the pit lake (2.5 mg/L).

Discharge of Mt Charlotte Underground Mine dewatering flows to the Union Club Pit is therefore expected to increase TDS and major ion concentrations, increase nitrate concentrations, and make little difference to filterable metals concentrations. Figure 15 provides a Durov plot comparing the two type samples from the Union Club Pit to groundwater from the Fimiston Open Pit and groundwater from Mt Charlotte Underground Mine dewatering. The plot defines the hydrochemical type of each sample based on the relative contribution of major anions and major cations. It also illustrates differences in TDS and pH. The two samples from the Union Club Pit have a relatively similar hydrochemical type, despite the large differences in TDS and pH. Both of the Union Club Pit samples have a slightly different hydrochemical type compared to groundwater from the Mt Charlotte Underground Mine and the Fimiston Open Pit, which likely reflects the different lithologies between the mine areas. However all of the samples are strongly dominated by sodium and chloride, and they can all be described as sodium-chloride type waters, which is consistent with observations of groundwater within weathered and fractured bedrock throughout the Eastern Goldfields.

3.4 Conceptual hydrogeological model

The groundwater elevation and hydrochemistry data described above support a conceptual hydrogeological model for the Mystery Pit and the Union Club Pit in which:

- The small very shallow lakes in the Mystery Pit are created in part by runoff, but the lake elevations and the fact that two of the lakes do not disappear in extended dry periods suggest there is also a small component of groundwater inflow to the lakes.
- The Union Club Pit lake receives inflows from both pit slope runoff and from groundwater, which is clearly demonstrated by the changes in TDS concentrations and EC of the lake. These observed changes are likely exaggerated by the grab samples from the top of the lake, where runoff is likely to be floating on the deeper more saline lake waters prior to full mixing being achieved.
- The Union Club Pit lake has a stable elevation which is around 30 m lower than the measured groundwater elevation, which implies that groundwater inflows to the lake are relatively low compared to evaporation. This is consistent with conditions typically observed in weathered and fractured bedrock in the Eastern Goldfields, and with the fact that there are no records of having to manage significant inflows during mining of the Union Club Pit.
- Because the elevation of the Union Club Pit lake is stable below the local groundwater elevation, the lake acts as a groundwater sink. Groundwater in the receiving environment is travelling towards the pit lake in all locations, and water from the pit lake is not migrating into the receiving groundwater system.

4. Pit lake water balance models

4.1 Background

There are no hydrochemical monitoring data and few lake elevation data available for the shallow lakes in the Mystery Pit. The future behaviour of these lakes has therefore been assessed based on annual average inflows and outflows, using calibrated parameters derived from the model for the Union Club Pit.

A daily water balance model has been constructed to simulate the elevation and TDS concentration of the lake in the Union Club Pit using the Excel platform. On a daily basis all of the inflows to and outflows from the lake are calculated from climate data, and the net change in lake volume is determined. Survey data for the as-mined pit are then used to interpolate the resulting lake elevation on a daily basis. The TDS concentration of the lake is also calculated daily, assuming full mixing, and by calculating the mass of solutes added by each inflow compared to the new lake volume.

4.2 Quantification of model inputs

4.2.1 Precipitation and evaporation

The Union Club Pit lake model simulates the post mining period from 1996 to 2021. It is assumed that the pit was held dry in 1996, and the model simulates the subsequent development of a pit lake from groundwater inflow and runoff. For each day in the model timestep, the amount of precipitation driving inputs is defined from actual monitoring records from Kalgoorlie Airport, and the amount of pan evaporation driving outflows is defined from interpolated SILO data.

4.2.2 Pit stage curve

The relationship between elevation, lake volume and lake area in the Union Club Pit is illustrated in Figure 16. This curve has been developed using a topographic survey flown in 2021, which has the most accurate representation of the actual pit slopes above the pit lake at 307 mAHD (including any localised slumping or erosion). For the portion of the pit which was below the water level in 2021 and could not be surveyed, KCGM records of the as-mined pit have been used. At the current lake elevation of 307 mAHD, the lake has a volume of 113,000 m^3 and an area of 10,000 m^2. For the proposed maximum lake elevation of 312 mAHD (5 m rise from the existing lake) the lake would have a volume of 178,000 m^3. The maximum possible lake volume is 2,800,000 m^3 at 372 mAHD, above which the Union Club Pit would spill into the Mystery Pit.

4.2.3 Direct precipitation

For each daily timestep in the model, the volume of water reaching the lake from direct precipitation is calculated from the lake area, and the precipitation depth, assuming that 100% of incident precipitation enters the lake.

4.2.4 Pit slope runoff

Figure 2 illustrates the area of steep pit slopes from which runoff reports to each pit lake, interpreted from the available survey data. For each daily time step in the model, the runoff from the pit slopes above the pit lake is calculated as:

- The total pit area less the pit lake area to get the contributing area of pit slopes.
- This area multiplied by the daily precipitation depth and a runoff coefficient.

4.2.5 Upgradient runoff

Figure 2 illustrates that the natural surface slopes down to the south, and that some of the facilities north of the open pits therefore potentially drain to the pits. An abandonment bund has been placed around the pits, however large precipitation events would cause runoff to pool against this bund and eventually seep through to the pit. For each daily time step in the model, the runoff from the upgradient area above the pit slopes is calculated as:

- The total catchment less the pit slope area to get the contributing area of upgradient catchment.
- This area multiplied by the daily precipitation depth and a runoff coefficient.
- Taking account that due to the lower topographic gradients and the presence of the bund, this runoff coefficient is expected to be low.

4.2.6 Evaporation

Evaporation from the surface of the pit lake in each daily timestep of the model has been calculated from:

- The lake area defined from the curve in Figure 16.
- The pan evaporation depth interpolated for the location of the Union Club Pit from SILO data on that day.
- A factor of 70% to account for the reduced amount of evaporation from the lake compared to an evaporation pan. Much of this reduction is due to the reduced wind run across the lake compared to a pan.
- A factor of 95% to account for the reduced amount of evaporation from a hypersaline pit lake compared to fresh water in a pan.

4.2.7 Groundwater inflow

Groundwater inflow to the pit lake has been estimated assuming:

- A maximum groundwater inflow rate in 1996 when the pit was dry to 289 mAHD.
- Zero groundwater inflow if the lake rises to the assumed equilibrium groundwater elevation in the location of the pit of 340 mAHD.
- A linear reduction in the groundwater inflow rate as the lake elevation rises from 289 mAHD to 340 mAHD.

4.3 Calibration of Union Club Pit model

The model predicted pit lake elevation is compared against the available observations in Figure 17. The daily precipitation sequence used as input to the model is also presented, along with annual average inflow and outflow rates for the lake. Due to the limited number of pit lake elevation observations, and the lack of observations in the early filling period, the calibration is not unique. The current lake elevation could equally be simulated by higher runoff combined with lower groundwater inflow, or by lower runoff combined with higher groundwater inflow. However the adopted model calibration which has relatively similar rates of runoff and groundwater inflow is most consistent with the conceptual model and with the observed lake hydrochemistry.

The adopted calibration parameters are:

- Runoff coefficient for upgradient runoff reaching the lake 1%.
- Runoff coefficient for pit slope runoff reaching the pit lake 20%.
- Maximum groundwater inflow rate 0.4 L/s.

These calibrated parameters are consistent with other pit lake studies in the Eastern Goldfields. The relatively low runoff coefficients result from the excess of evaporation over precipitation, and from runoff pooling on the pit slope benches and evaporating before reaching the pit lake.

Based on the model calibration, Figure 17 indicates that the current stable lake elevation at 307 mAHD is due to evaporation at an average rate of 0.5 L/s being balanced by average groundwater inflow of 0.2 L/s and by runoff and direct precipitation at a total average of 0.3 L/s.

4.4 Closure predictions

4.4.1 Union Club Pit

The behaviour of the lake in the Union Club Pit from 2022 onwards has been predicted assuming that there is no temporary storage of Mt Charlotte Underground Mine dewatering discharge. Catchment areas and runoff coefficients have been held the same as applied in the calibration model. The model has been run to the year 2055. The average pan monthly evaporation rates in Table 1 are applied in all years. At the start of the model in 2022 the lake elevation is assumed to be 307 mAHD and the TDS concentration is assumed to be 50,000 mg/L. Three separate daily precipitation sequences have been applied, which have been selected to stress the pit lake by varying amounts in the first four years of the model. The precipitation sequences applied are:

1. Average conditions. From 1 July 2022, actual daily precipitation commencing on 1 July 1941 were applied. The annual average precipitation in the first four years of this record is 260 mm and the maximum daily precipitation in that period is 42 mm.
2. Wet conditions. From 1 July 2022, actual daily precipitation commencing on 1 July 1966 were applied. The annual average precipitation in the first four years for this sequence is 320 mm and it includes a weekly precipitation total in that period of 180 mm.
3. Very wet conditions. From 1 July 2022, actual daily precipitation commencing on 1 July 1991 were applied. The annual average precipitation in the first four years for this sequence is 388 mm, and includes the influence of Cyclone Bobby which produced a weekly precipitation total of 161 mm.

Figure 18 illustrates the closure predictions. Under the range of average to very wet conditions simulated, the pit lake elevation will remain in the range 306 mAHD to 309 mAHD, and there will be no substantial inundation of the pit slopes above the existing lake. There is no potential for the lake to spill into the Mystery Pit (lake elevation 272 mAHD), or for the lake to no longer function as a hydraulic sink (lake elevation above 340 mAHD). The TDS concentration of the lake will increase steadily from 50,000 mg/L in 2022 to 240,000 mg/L in 2055 and is not strongly affected by the precipitation assumptions. The rising TDS concentrations are consistent with the observed behaviour of pit lakes in the Eastern Goldfields which are subject to evapoconcentration due to solutes being added with each input while water is removed by evaporation. In the long term the TDS concentration will reach an equilibrium maximum driven by saturation and precipitation of minerals including gypsum.

4.4.2 Mystery Pit

Table 2 summarises average annual water balances calculated for the lakes in the Mystery Pit using the calibrated parameters derived from the Union Club Pit. All three lakes are indicated to be roughly in balance, with evaporation from the lake being of a similar magnitude to the combination of direct precipitation and runoff. The calculations suggest the lakes could also be maintained by groundwater inflow and outflow at low rates, typically less than 0.05 L/s. Lake 2 is implied to act as a groundwater source on average, while Lake 1 and Lake 3 which have a permanent presence are implied to act as groundwater sinks or as groundwater flowthrough pit lakes on average. However all three lakes may potentially receive low rates of groundwater inflow in some conditions and generate low rates of outflow to groundwater in other conditions. Although the current lake chemistry has not been measured, these shallow lakes are expected to evapoconcentrate in long term closure, driven primarily by the hydrochemistry of pit runoff.

Table 2: Average water balances for Mystery Pit lakes

Parameter	Unit	Lake 1	Lake 2	Lake 3
Lake area	m^2	1,325	1,759	3,459
Annual precipitation	mm	266	266	266
Annual pan evaporation	mm	2,436	2,436	2,436
Pit slope catchment	m^2	62,525	32,142	78,388
Upgradient catchment	m^2	99,706	40,585	100,505
Average direct precipitation	L/s	0.01	0.01	0.03
Average pit slope runoff	L/s	0.10	0.05	0.13
Average upgradient runoff	L/s	0.00	0.00	0.00
Average evaporation	L/s	0.07	0.06	0.18
Inferred groundwater inflow	L/s	-0.049	-0.003	0.021

4.5 Operational predictions

The current plan for managing dewatering discharge from the Mt Charlotte Underground Mine is to temporarily store the flows in the Union Club Pit to allow suspended solids to be settled. This is planned to be undertaken from 2022 to 2034. The rate of pumping out of the pit is planned to be the same as the rate of pumping in, which would have no effect on the pit lake elevations predicted in Figure 18. However in the event of an imbalance condition, for example due to the pumping out system failing while pumping in was continuing, there would be an effect on the lake elevation. In 2021 the total volume pumped from the Mt Charlotte Underground Mine was 400,000 m^3. KCGM anticipate that expansion of underground mining water use will increase total pumping to 800,000 m^3 per year. The capacity of the system is planned to be 2,000,000 m^3/year. These annual volumes reflect average pumping rates in the range 13 L/s to 63 L/s. These rates far exceed the current inputs to the pit lake as plotted in Figure 17, and the operational changes in lake elevation will therefore effectively be independent of climate conditions. Table 3 examines the influence of these operational pumping rates on the pit lake.

Table 3: Operational pumping influences on the Union Club Pit lake

Parameter	Unit	Current	Future	Maximum
Annual discharge	m^3	400,000	800,000	2,000,000
Average discharge	L/s	13	25	63
Lake volume at 307 mAHD	m^3	113,000	113,000	113,000
Lake volume at 312 mAHD	m^3	178,000	178,000	178,000
Residence time at 307 mAHD	days	103	52	21
Residence time at 312 mAHD	days	162	81	32
Time to breach maximum elevation	days	59	30	12

The calculations in Table 3 identify that:

- The residence time within the pit lake (the time taken for the dewatering discharge to completely displace the existing volume of the lake, and hence the maximum possible settling time) ranges from 162 days for a dewatering discharge of 400,000 m^3/year and a lake elevation at 312 mAHD, to 21 days for a dewatering discharge of 2,000,000 m^3/year and a lake elevation of 307 mAHD.
- The maximum duration for which pumping in could be continued without breaching the nominated maximum pit lake elevation of 312 mAHD in the absence of pumping out, ranges from 12 days to 59 days.

Figure 19 provides model predictions for the Union Club Pit lake assuming Mt Charlotte Underground Mine dewatering continues at the current rate of 400,000 m^3/year until the year 2034, and assuming that the pumping out system fails for 60 days commencing 1 January 2026. The model results confirm that:

- During the period of the pump failure, the elevation of the pit lake rises by 5 m, regardless of the precipitation conditions assumed. This is due to the pumping rates being by far the greatest components in the water balance.
- Once pumping out re-commences, it takes around 10 years for the pit lake to recover to the natural level, and the lake has not yet returned to 307 mAHD when the pumping terminates in 2034.
- Once dewatering discharge is directed to the pit lake, the TDS concentration of the pit lake very rapidly rises from 50,000 mg/L to 100,000 mg/L and remains at that concentration during operations. In closure evapoconcentration of the lake occurs. In combination, these result in the TDS concentration of the lake in 2055 being very similar to the predictions in Figure 18 for the case where dewatering discharge does not occur.

5. Summary and recommendations

Monitoring data for groundwater elevations and pit lake hydrochemistry at the Mt Percy Pits have been reviewed to develop a conceptual hydrogeological model of the flow regime. Three shallow lakes are present in the Mystery Pit, and a 15 m deep lake is present in the Union Club Pit. These lakes all reflect the combined inflows of pit slope runoff, direct precipitation, groundwater inflow which are being balanced by evaporation. The relative influences of both pit slope runoff and groundwater inflow are clearly defined from the changes in EC, TDS concentrations and pH for the hydrochemistry of the Union Club Pit lake.

A water balance model has been constructed and calibrated for the Union Club Pit lake. It identifies that the lake elevation is stable at around 307 mAHD, due to rates of evaporation (average 0.5 L/s) being matched by rates of groundwater inflow (average 0.2 L/s) and the combined rates of direct precipitation and runoff (total average 0.3 L/s). The pit lake is currently acting as a groundwater sink. Groundwater is flowing from the receiving groundwater system into the lake, and the lake water is not entering the receiving groundwater system.

During closure, under a range of precipitation conditions the Union Club Pit lake is expected to have an elevation in the range 306 mAHD to 309 mAHD. The lake will continue to function as a groundwater sink and there is no potential for discharge into the adjacent Mystery Pit. The TDS concentration of the lake will increase from 50,000 mg/L in 2022 to around 240,000 mg/L in 2055, as a result of evapoconcentration. In the long term the TDS concentration will reach an equilibrium maximum driven by the saturation and precipitation of minerals including gypsum.

There are two apparently permanent lakes in the Mystery Pit (Lake 1 and Lake 3 in Figure 2) and one lake which appears to dry out in some conditions (Lake 2). All three lakes are indicated to be roughly in balance, with evaporation from the lake being of a similar magnitude to the combination of direct precipitation and runoff. However all three lakes may potentially receive low rates of groundwater inflow in some conditions and generate low rates of outflow to groundwater in other conditions. Although the current lake chemistry has not been measured, these shallow lakes are expected to evapoconcentrate in long term closure, driven primarily by the hydrochemistry of pit runoff.

KCGM are planning to discharge dewatering flows from the Mt Charlotte Underground Mine to the Union Club Pit to allow suspended sediment to be settled before pumping the flows back into the saline water system for reuse. The dewatering discharge rate is expected to be in the range 400,000 m^3/year to 800,000 m^3/year, with a maximum system capacity of 2,000,000 m^3/year, and the flows are planned to be pumped out at the same rate. KCGM plan to manage the Union Club Pit to prevent the pit lake rising by more than 5 m (from the current elevation of 307 mAHD to a maximum elevation of 312 mAHD). Dewatering discharge is expected to occur from 2022 to 2034. The water balance model identifies that:

- The Union Club Pit will provide a maximum residence time (i.e. maximum settling period) in the range 21 days to 162 days.
- The maximum duration for which discharge can continue in the event that pumping out is not occurring ranges from 12 days at a discharge rate of 2,000,000 m^3/year to 59 days at a discharge rate of 400,000 m^3/year, before the nominated maximum pit lake elevation is breached.
- Assuming pumping out stops, once pumping out recommences, it is necessary to pump out at a greater rate than pumping in, or the pit lake will not return to the elevation of 307 mAHD. The mine water management design should therefore allow sufficient capacity in the pumping out system to make up any deficit due to temporary cessation of pumping.
- These observations are independent of the precipitation conditions assumed due to the pumping rates being much larger than the other inputs in the model.

- The addition of dewatering discharge to the pit lake will rapidly increase TDS concentrations to match the discharge quality. Major ion proportions will remain similar to the existing lake. There will be a proportionally larger increase in nitrate concentrations and in bicarbonate concentrations as these are relatively elevated in dewatering discharge. The increased bicarbonate concentrations will provide additional alkalinity to neutralise any future acidity generated from mineralised zones exposed in the pit slopes.
- In the long term, the TDS concentrations in the Union Club Pit driven by evapoconcentration will be very similar regardless of whether dewatering flows are discharged to the pit.

Monitoring of the planned discharge system will be required to ensure that the conceptual and numerical models developed for the pit lake remain valid. Recommended monitoring is as follows:

- Monitoring bore CSURCH3140 should continue to be dipped quarterly while access is available.
- The volume of water pumped from the Mt Charlotte Underground Mine dewatering into the Union Club Pit lake should be measured with a flow meter. At a discharge rate of 400,000 m^3/year, the volume should be recorded monthly. At a discharge rate of 2,000,000 m^3/year, the volume should be recorded weekly.
- The volume of water pumped from the Union Club Pit lake back into the saline water system for reuse should be measured with a flow meter. At a discharge rate of 400,000 m^3/year, the volume should be recorded monthly. At a discharge rate of 2,000,000 m^3/year, the volume should be recorded weekly.
- The elevation of the lake in the Union Club Pit should be routinely measured by a survey or by manual measurement of a surveyed marker board. At a discharge rate of 400,000 m^3/year, the elevation should be recorded monthly. At a discharge rate of 2,000,000 m^3/year, the elevation should be recorded weekly.
- The discharge from the Mt Charlotte Underground Mine into the Union Club Pit should be sampled quarterly for laboratory analysis.
- The water pumped from the Union Club Pit back into the saline water system for reuse should be sampled quarterly for laboratory analysis.
- The laboratory analysis suite should be consistent with that already included in the Mt Charlotte Underground Mine dewatering operating strategy, but with the addition of Total Suspended Solids (TSS), i.e. the suite should comprise:
  - pH, EC, TDS, TSS, Total Hardness, Total Alkalinity, Ca, Mg, Na, K, NH_4, Total PO_4, CO_3, HCO_3, Cl, SO_4, NO_3, SiO_2, filterable Al, filterable Fe, filterable Mn, Cation/Anion Balance.

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List of Figures

Figures

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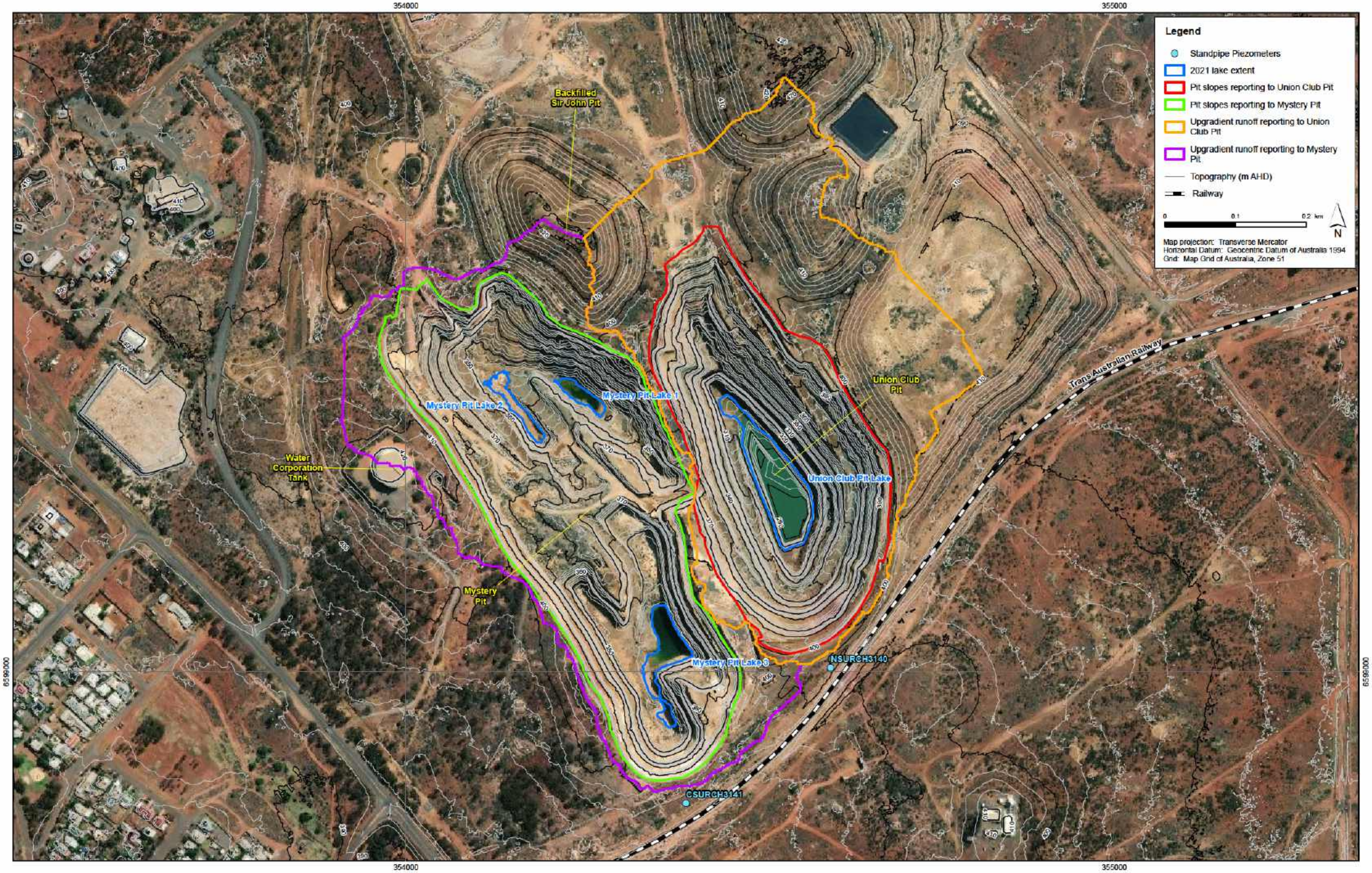
BIG DOG HYDROGEOLOGY

Regional setting

Figure 1

Date: April 2022

Report: Mt Percy Hydrogeological Review



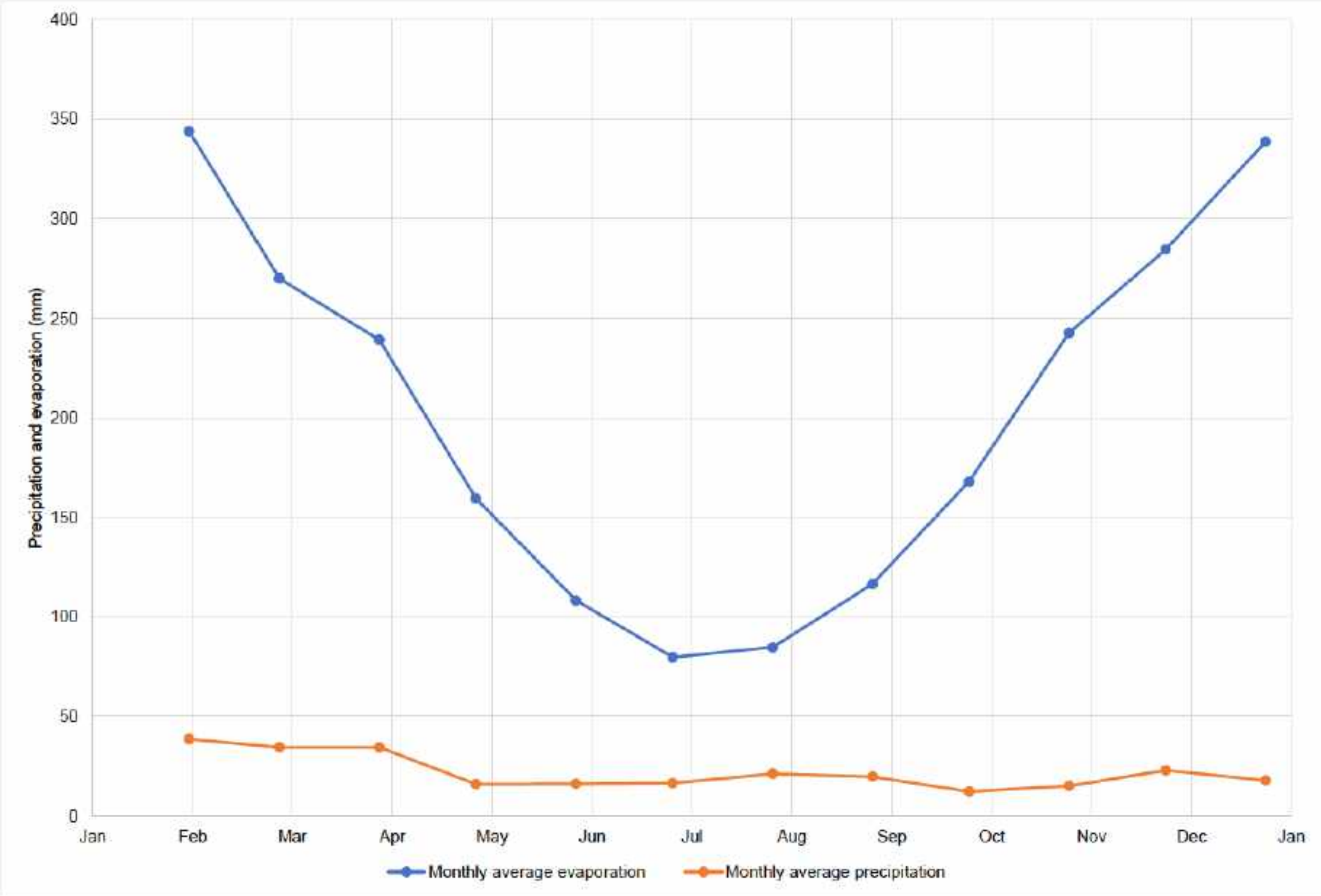
BIG DOG HYDROGEOLOGY

Closed Mt Percy mine facilities

Figure 2

Date: April 2022

Report: Mt Percy Hydrogeological Review



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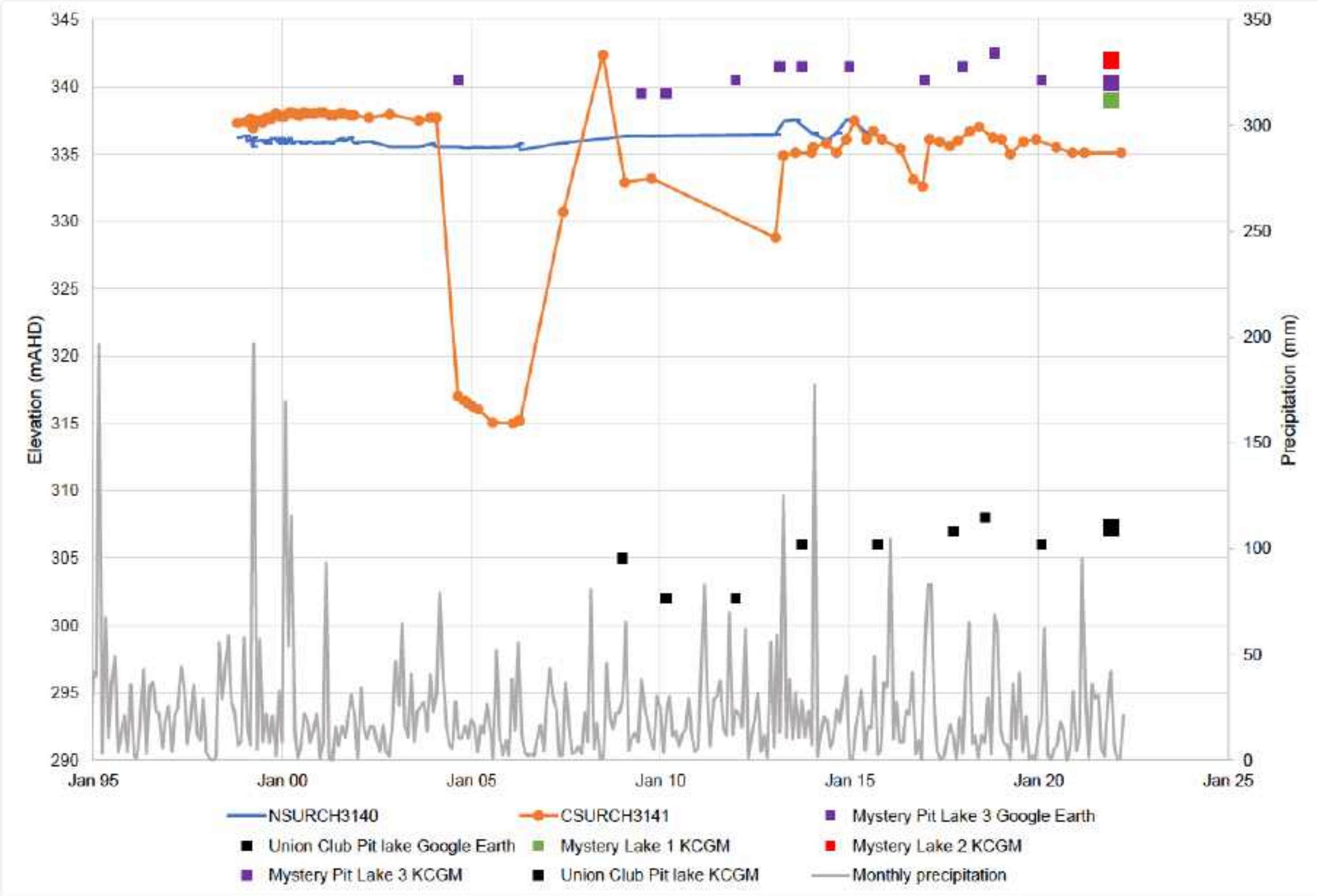
BIG DOG HYDROGEOLOGY

Average monthly climate data

Figure 3

Date: April 2022

Report: KCGM Mt Percy Hydrogeological Review



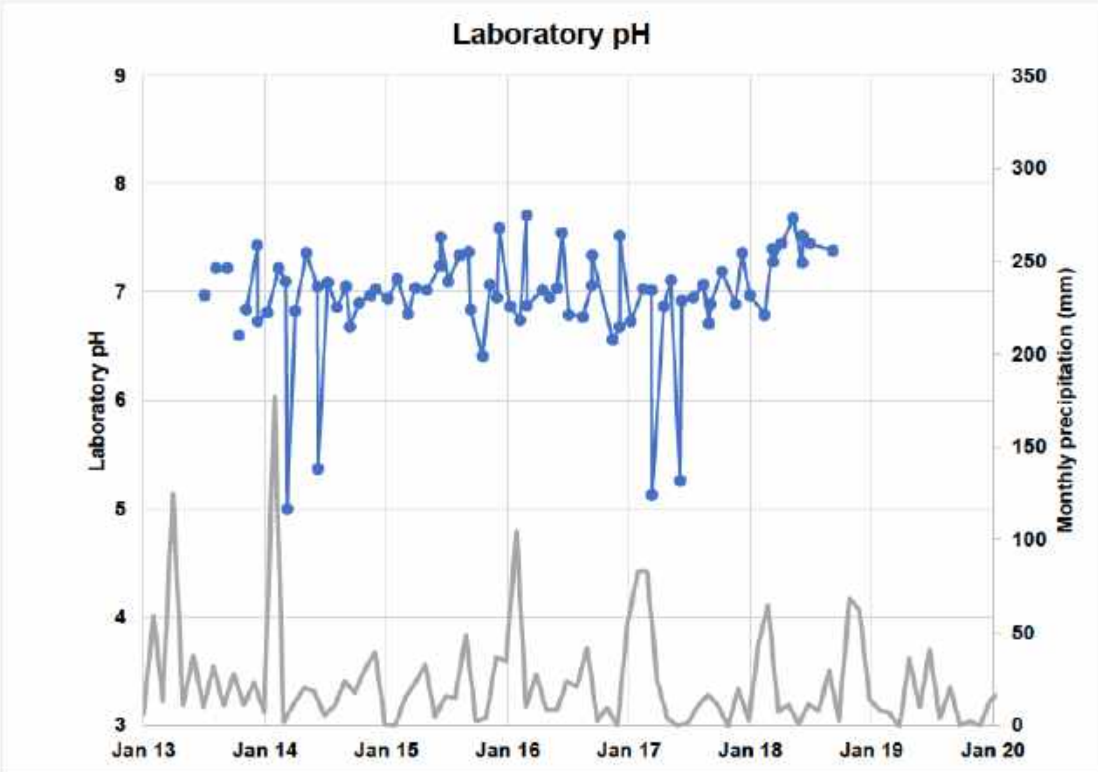
BIG DOG HYDROGEOLOGY

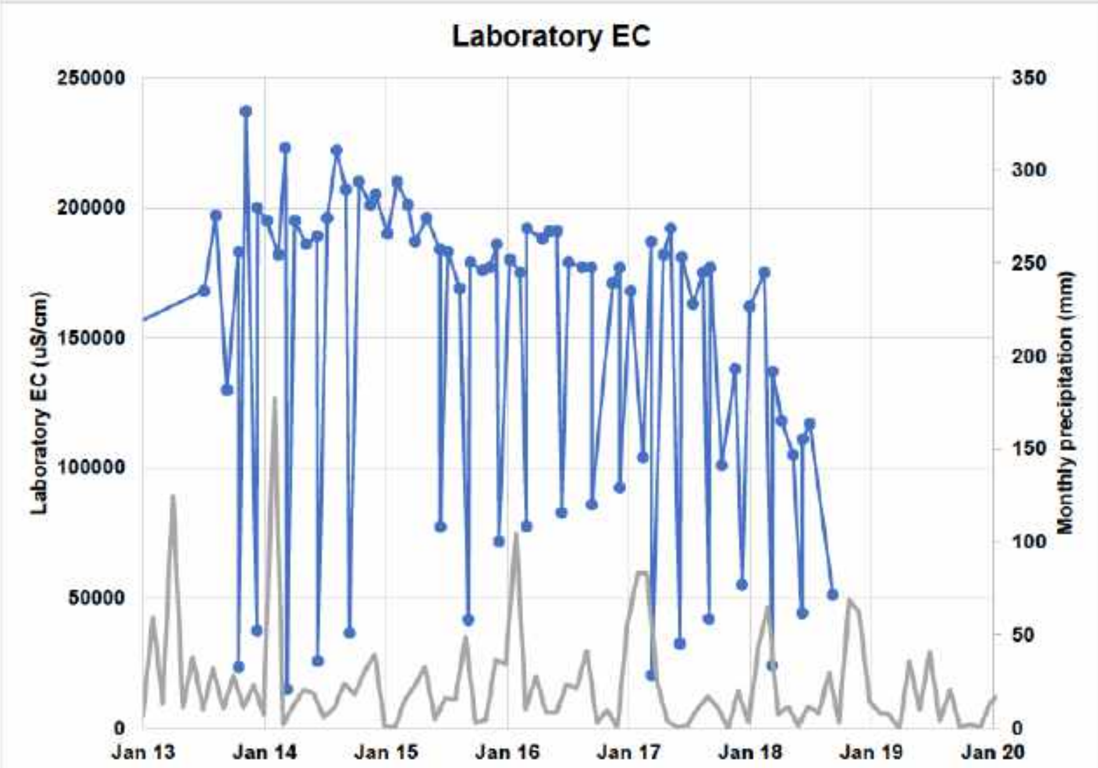
Groundwater elevations

Figure 4

Date: April 2022

Report: KCGM Mt Percy Hydrogeological Review





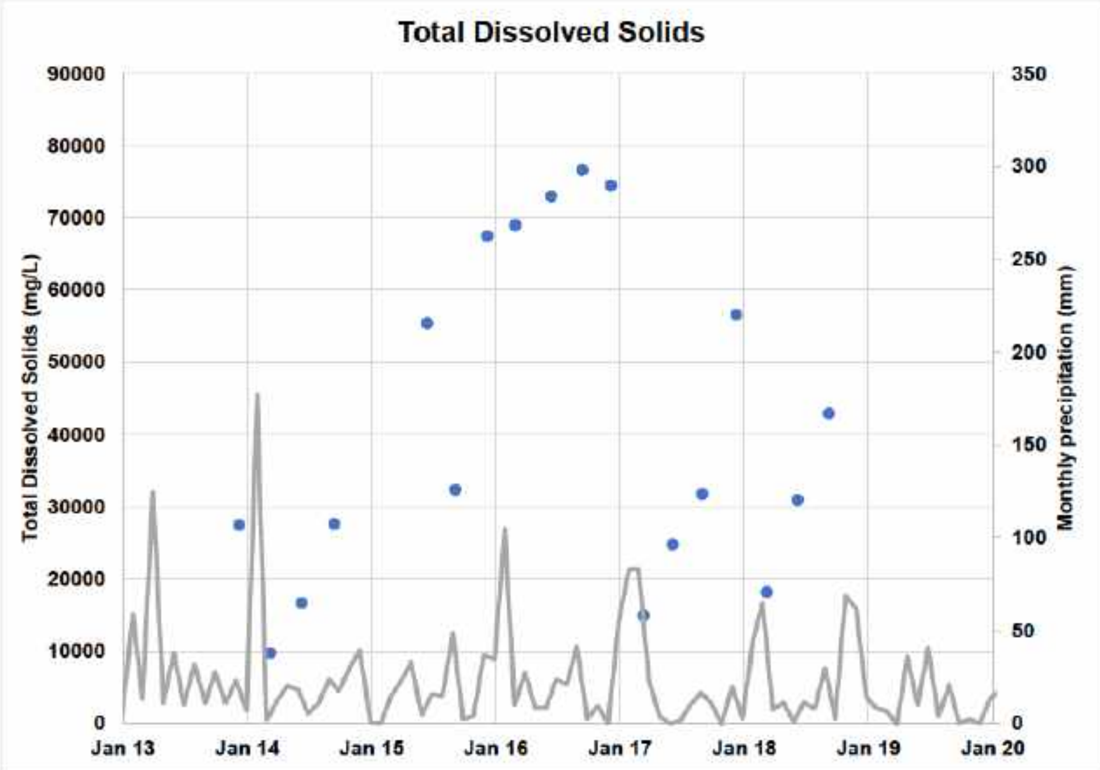
BIG DOG HYDROGEOLOGY

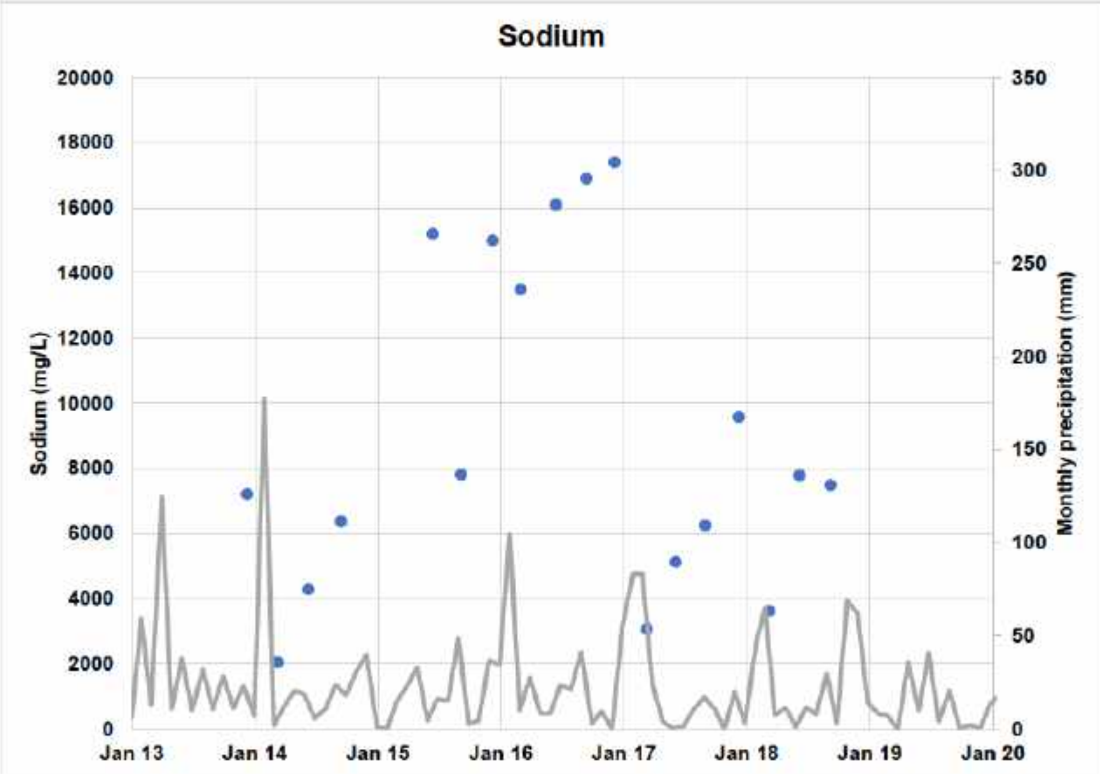
Union Club Pit - EC and pH

Figure 5

Date: April 2022

Report: KCGM Mt Percy Hydrogeological Review





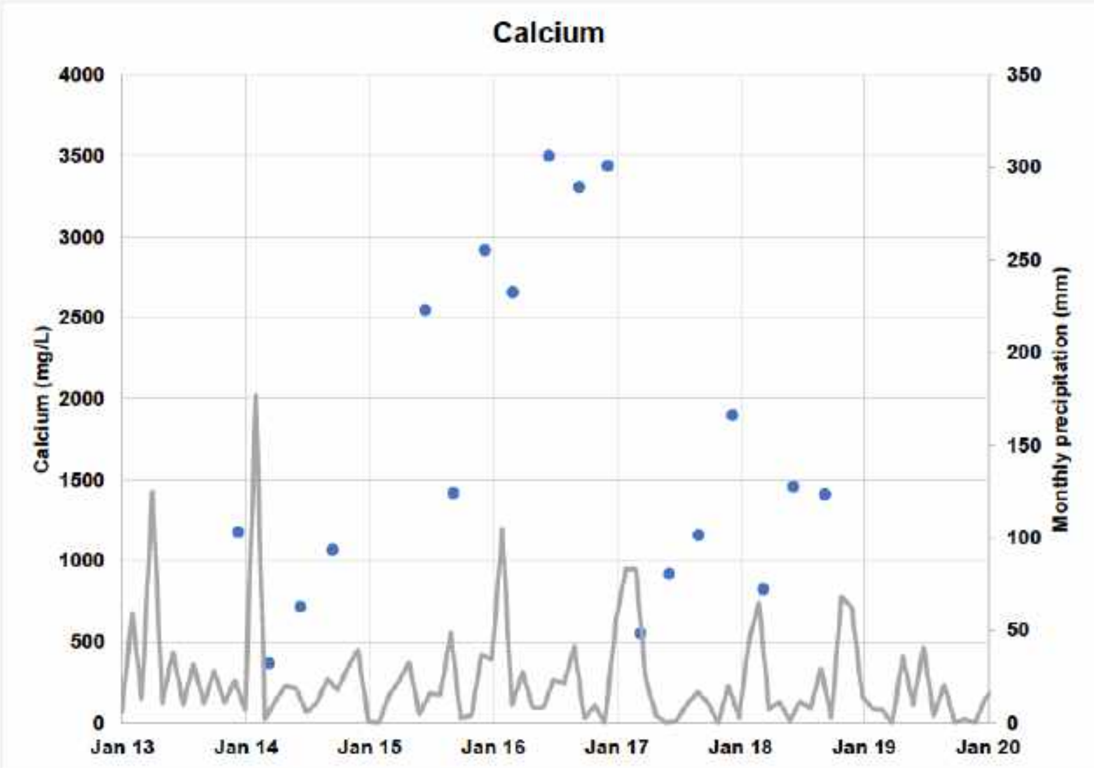
BIG DOG HYDROGEOLOGY

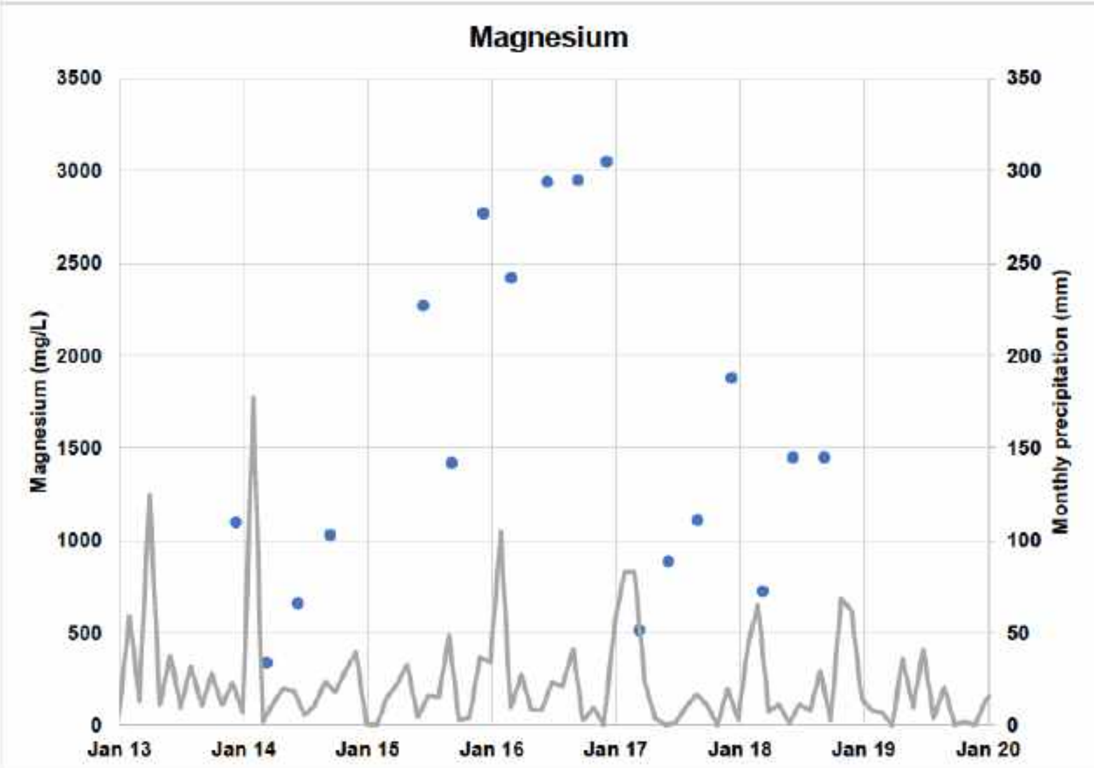
Union Club Pit - TDS and Na

Figure 6

Date: April 2022

Report: KCGM Mt Percy Hydrogeological Review





BIG DOG HYDROGEOLOGY

Union Club Pit - Ca and Mg

Figure 7

Date: April 2022

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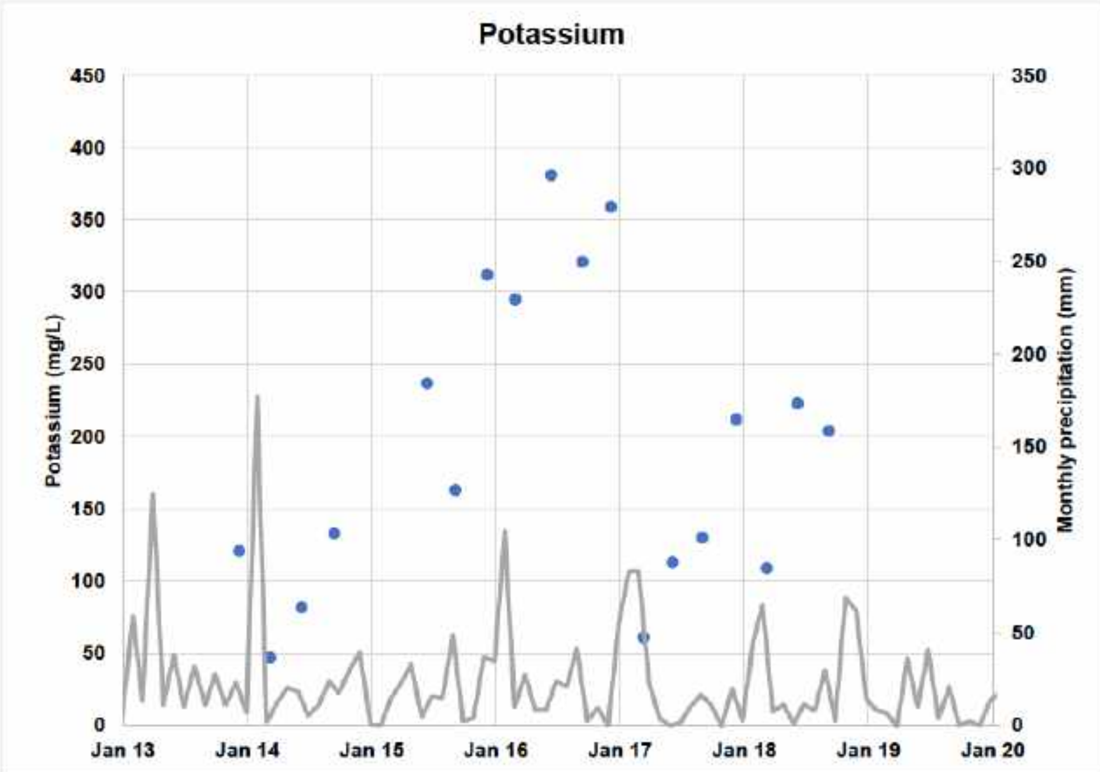

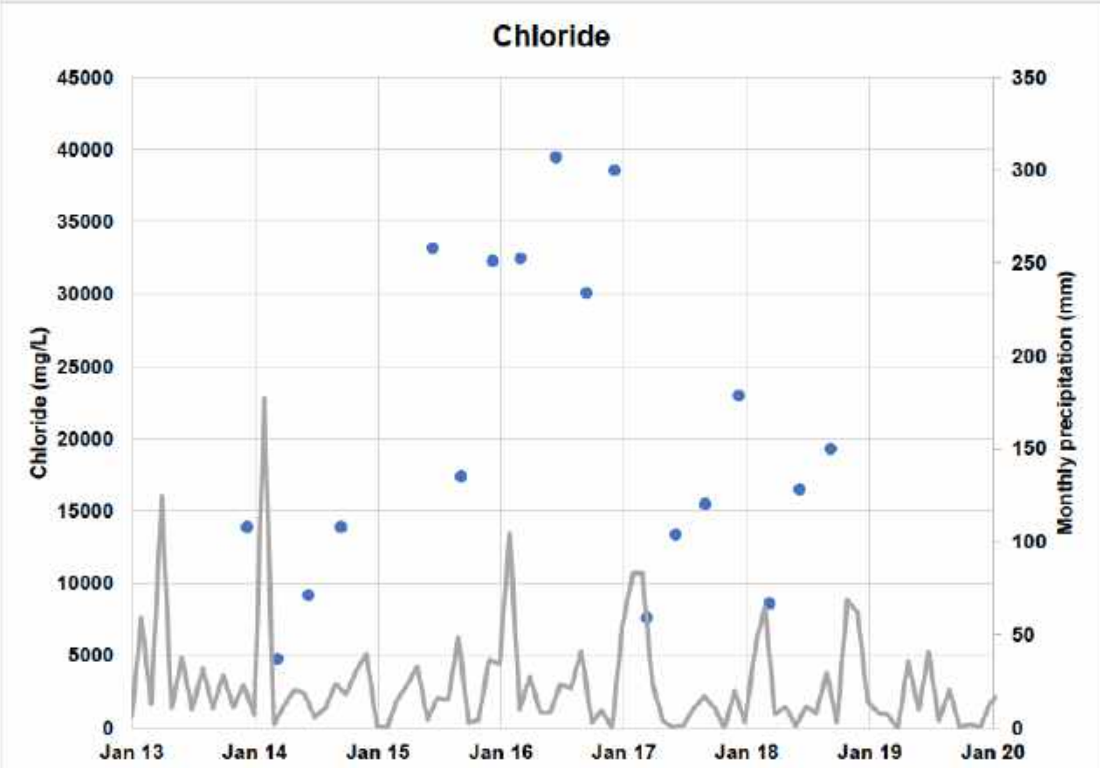

BIG DOG HYDROGEOLOGY

Union Club Pit - K and Cl

Figure 8

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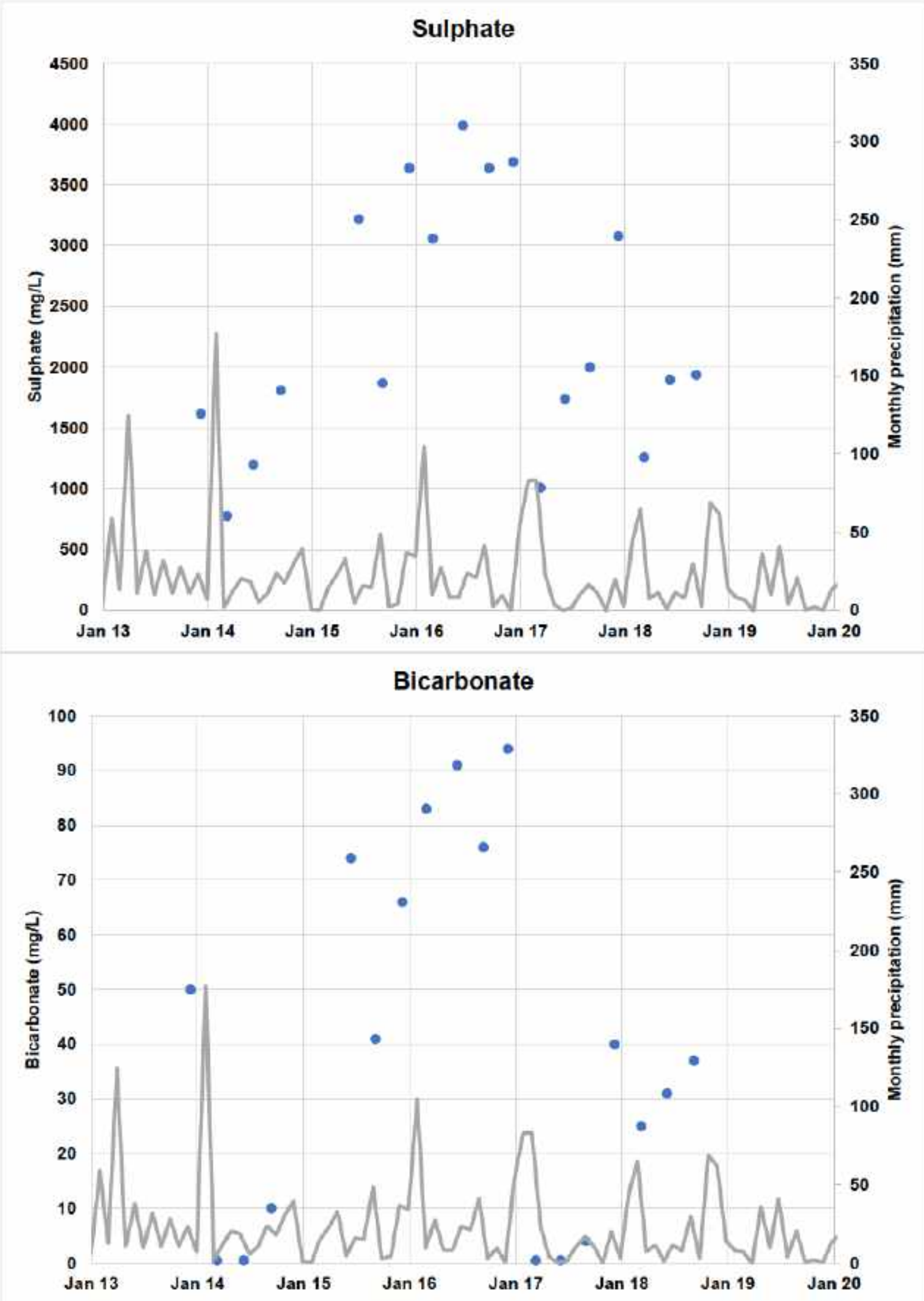

BIG DOG HYDROGEOLOGY

Union Club Pit - sulphate and bicarbonate

Figure 9

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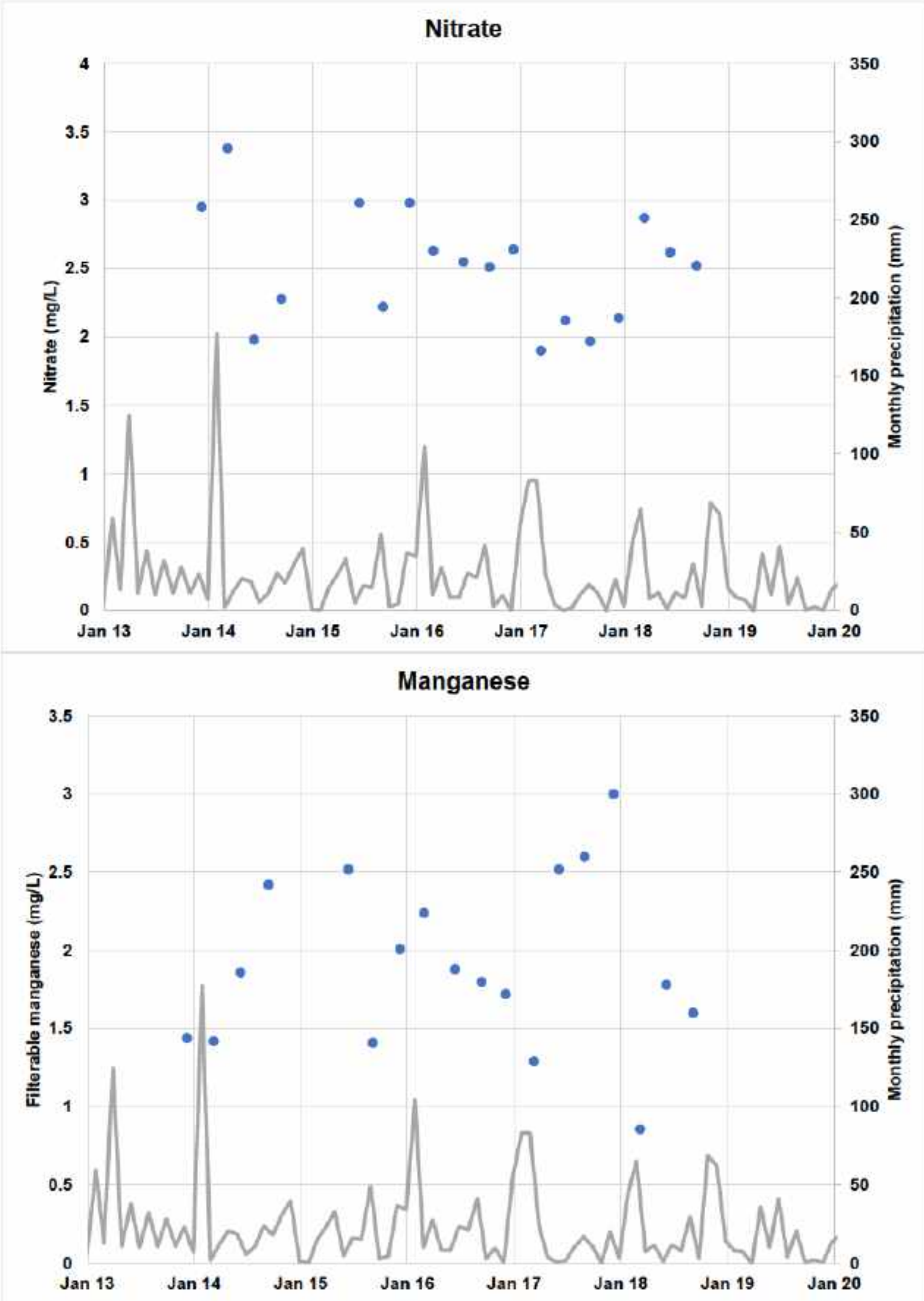

BIG DOG HYDROGEOLOGY

Union Club Pit - nitrate and Mn

Figure 10

Date: April 2022

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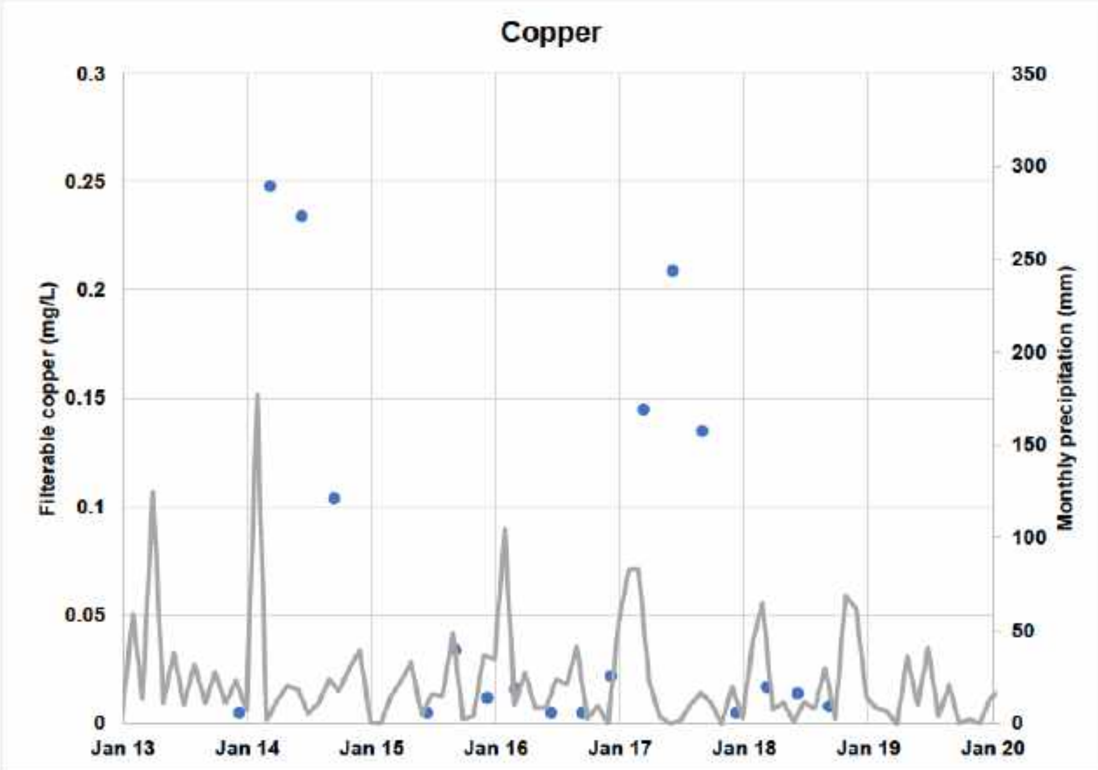

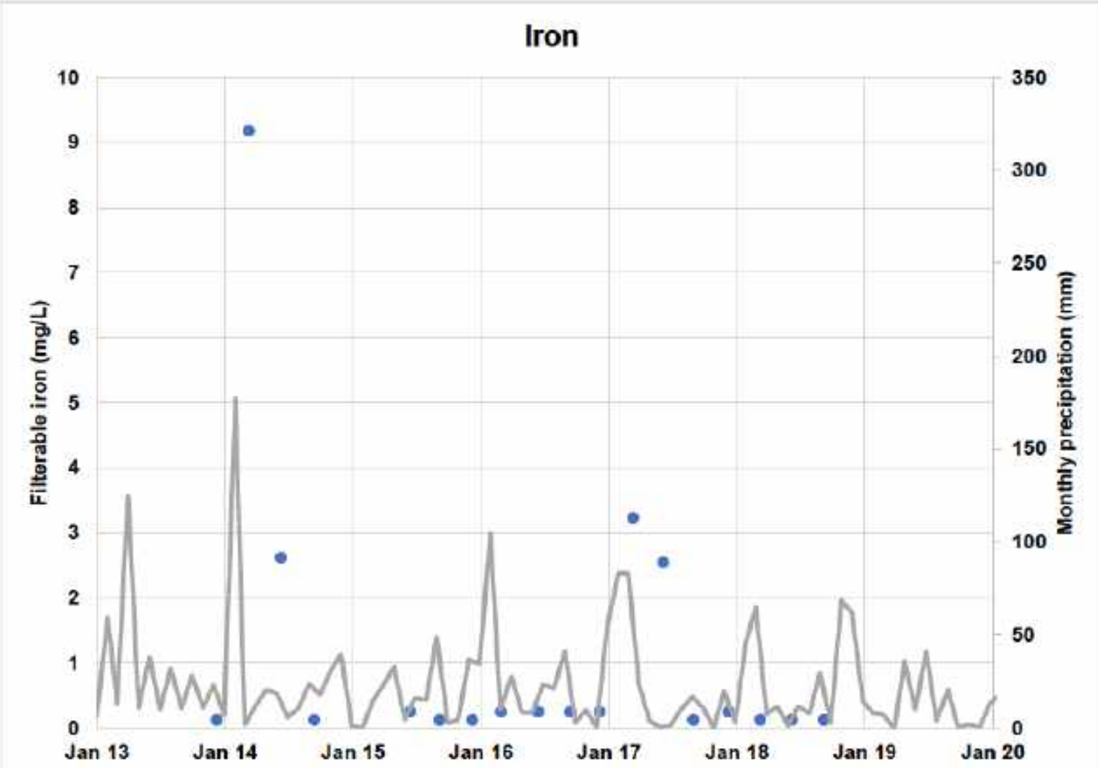

BIG DOG HYDROGEOLOGY

Union Club Pit - Cu and Fe

Figure 11

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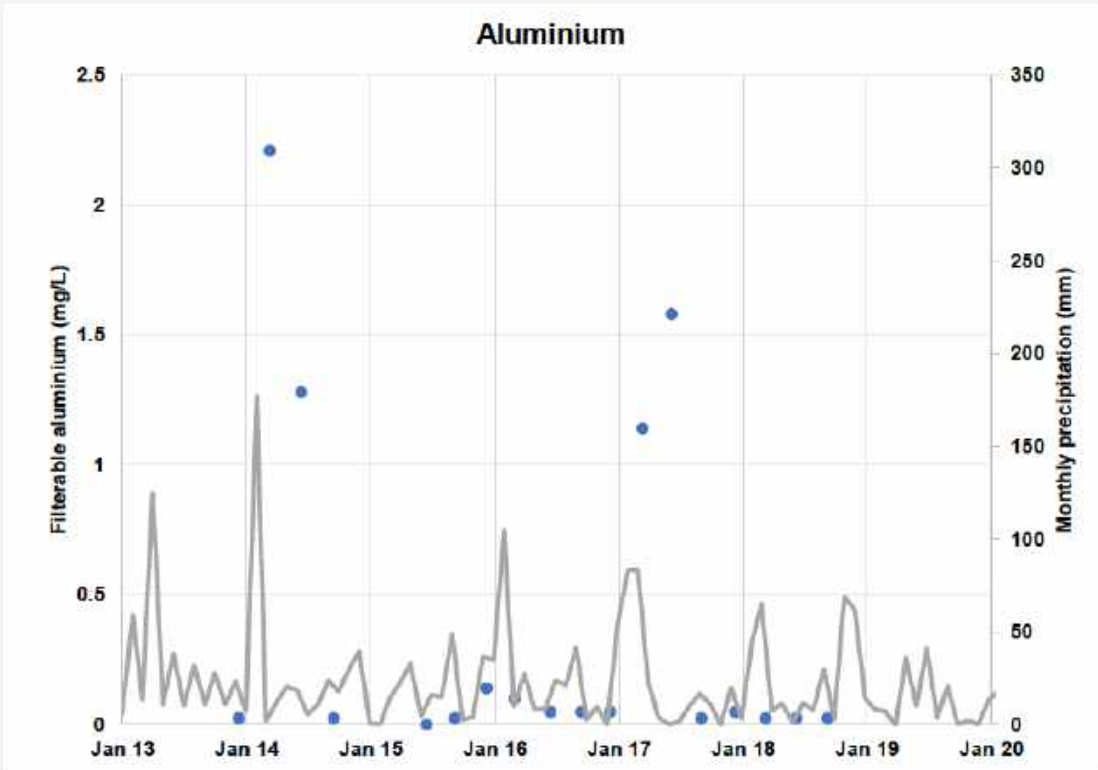

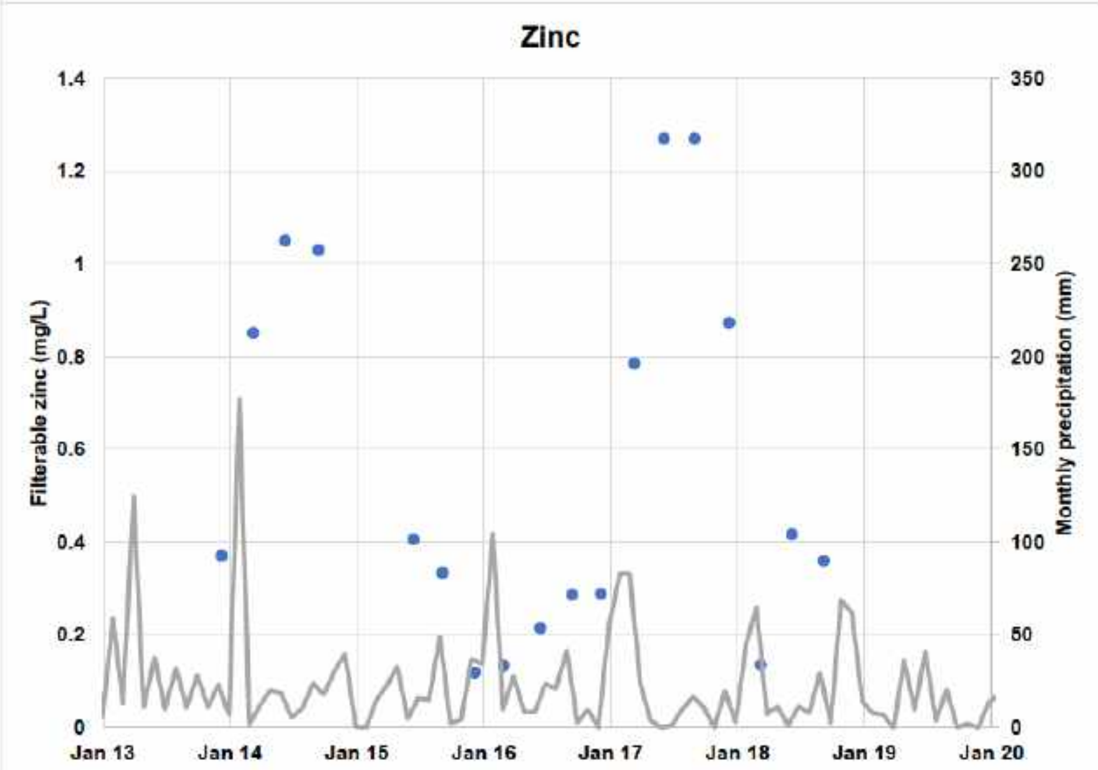

BIG DOG HYDROGEOLOGY

Union Club Pit - Al and Zn

Figure 12

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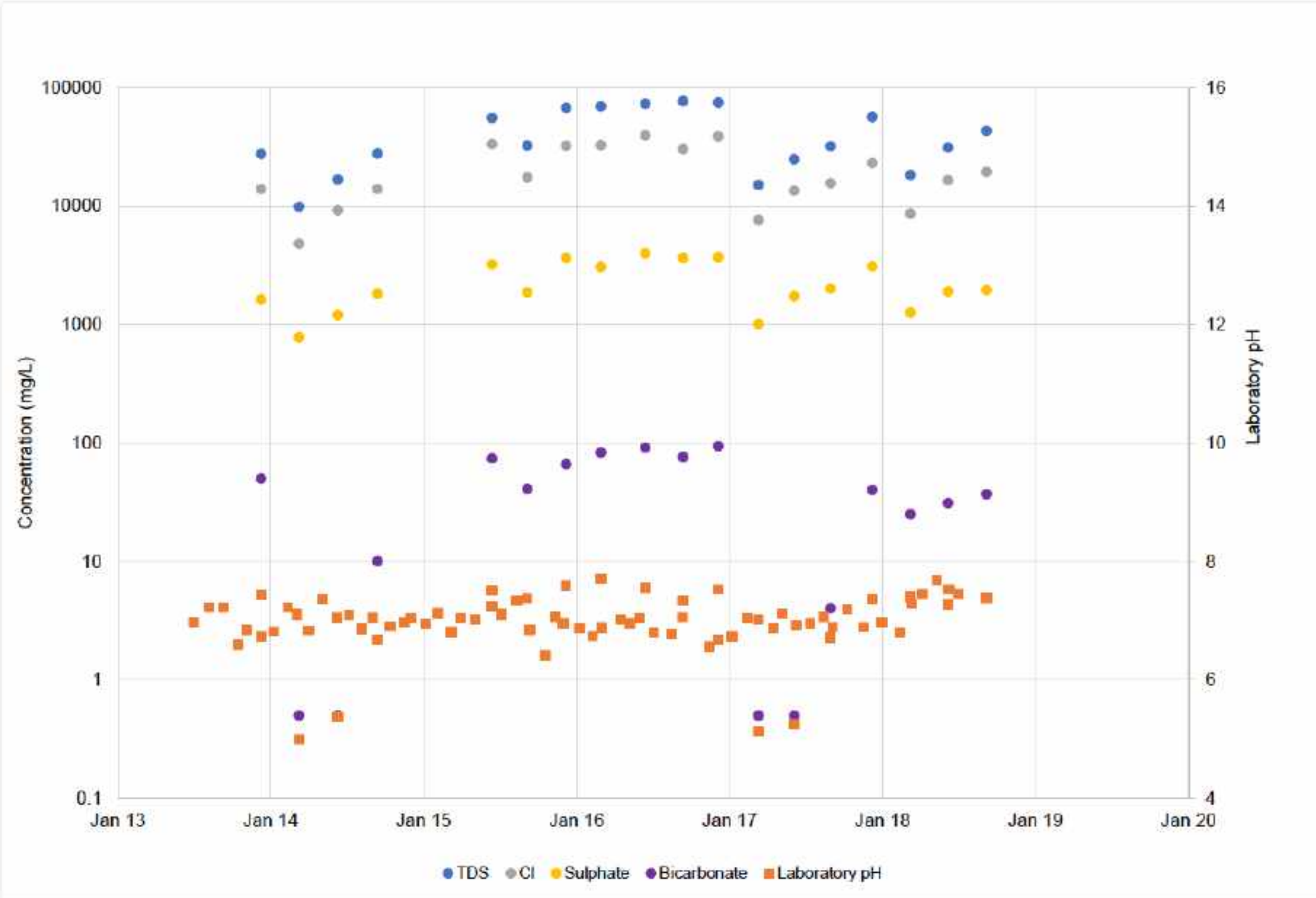

BIG DOG HYDROGEOLOGY

Union Club Pit - major ions vs pH

Figure 13	
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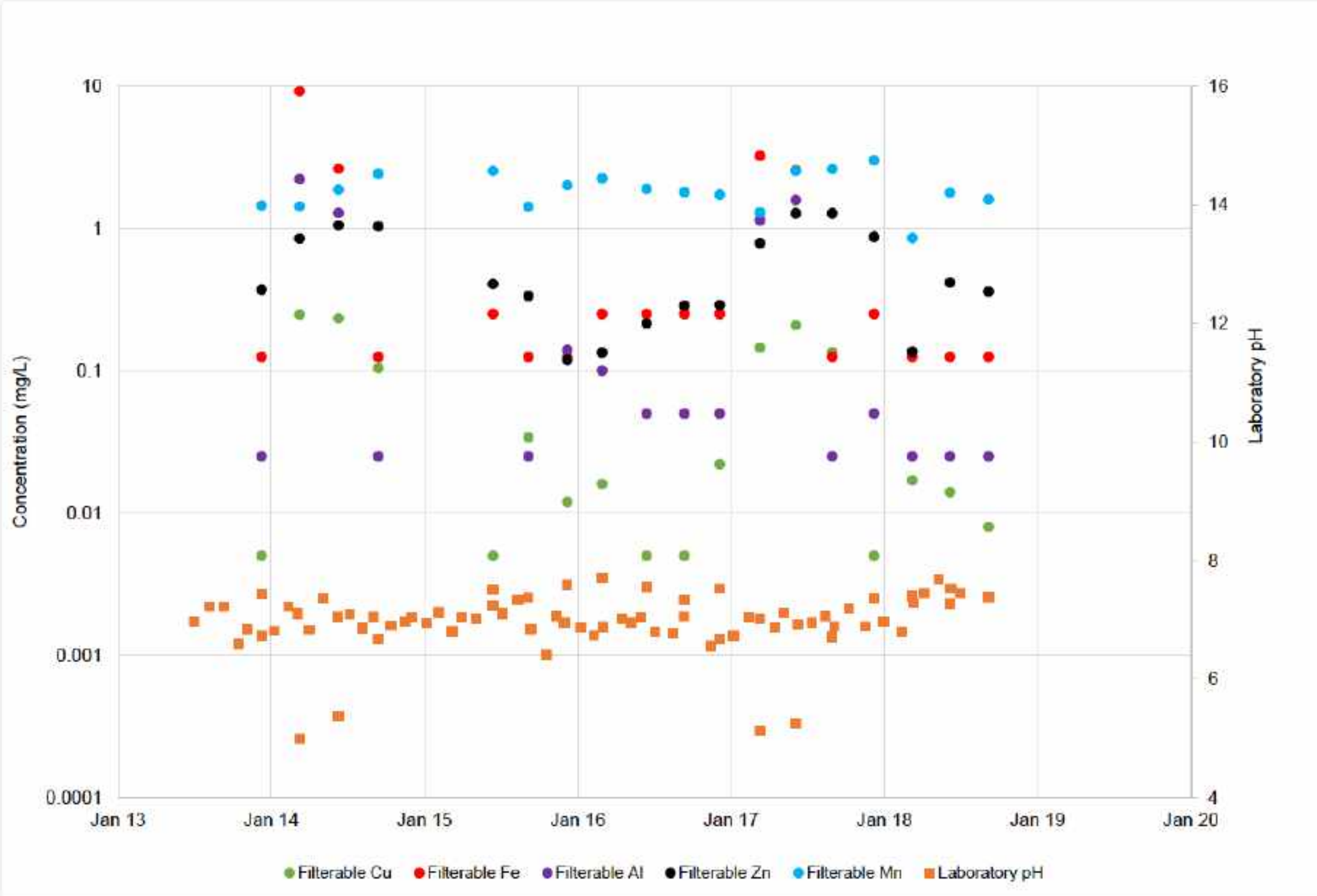

BIG DOG HYDROGEOLOGY

Union Club Pit - metals vs pH

Figure 14

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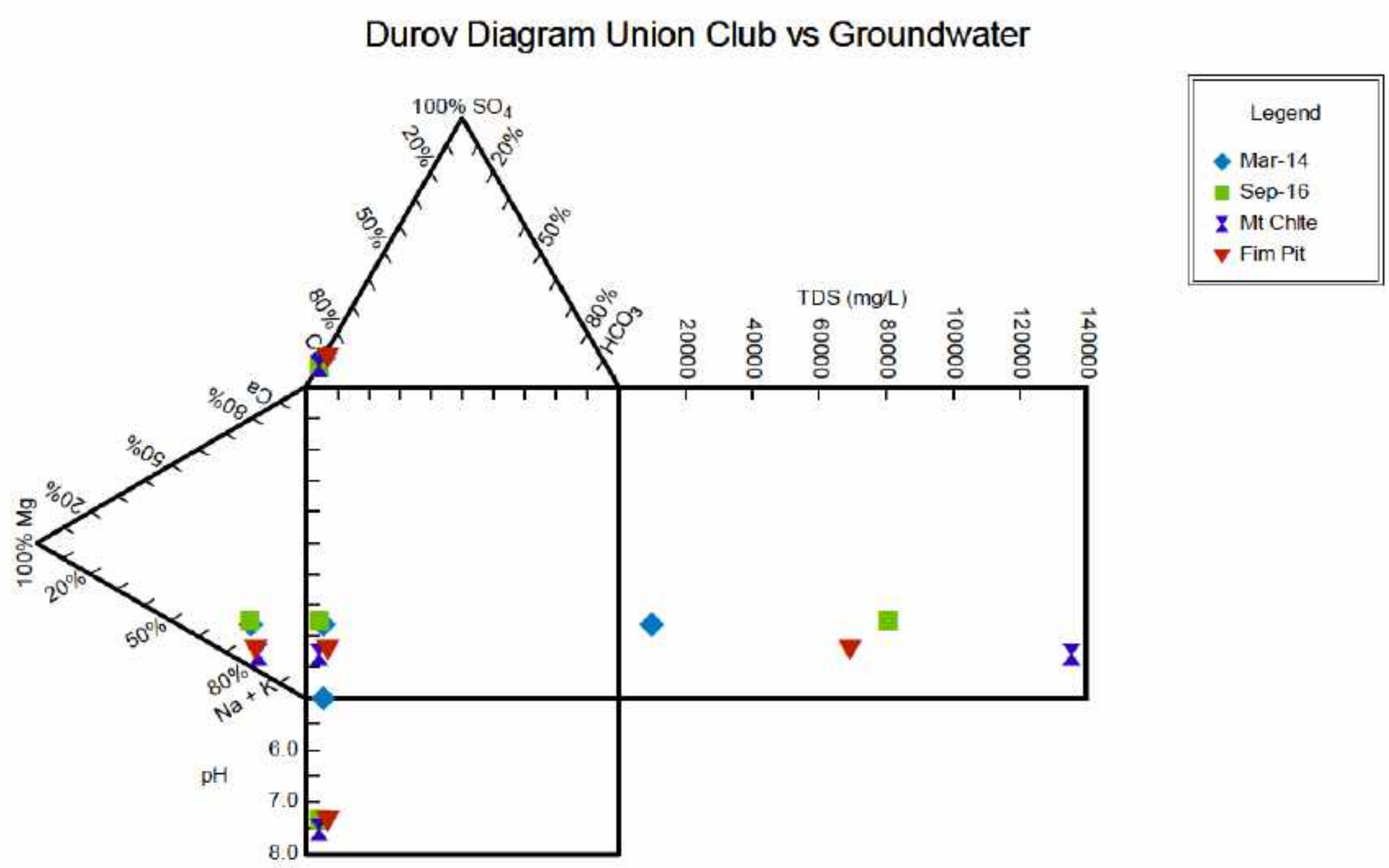
Report: KCGM Mt Percy Hydrogeological Review



BIG DOG HYDROGEOLOGY

Durov diagram - Union Club vs groundwater

Figure 15

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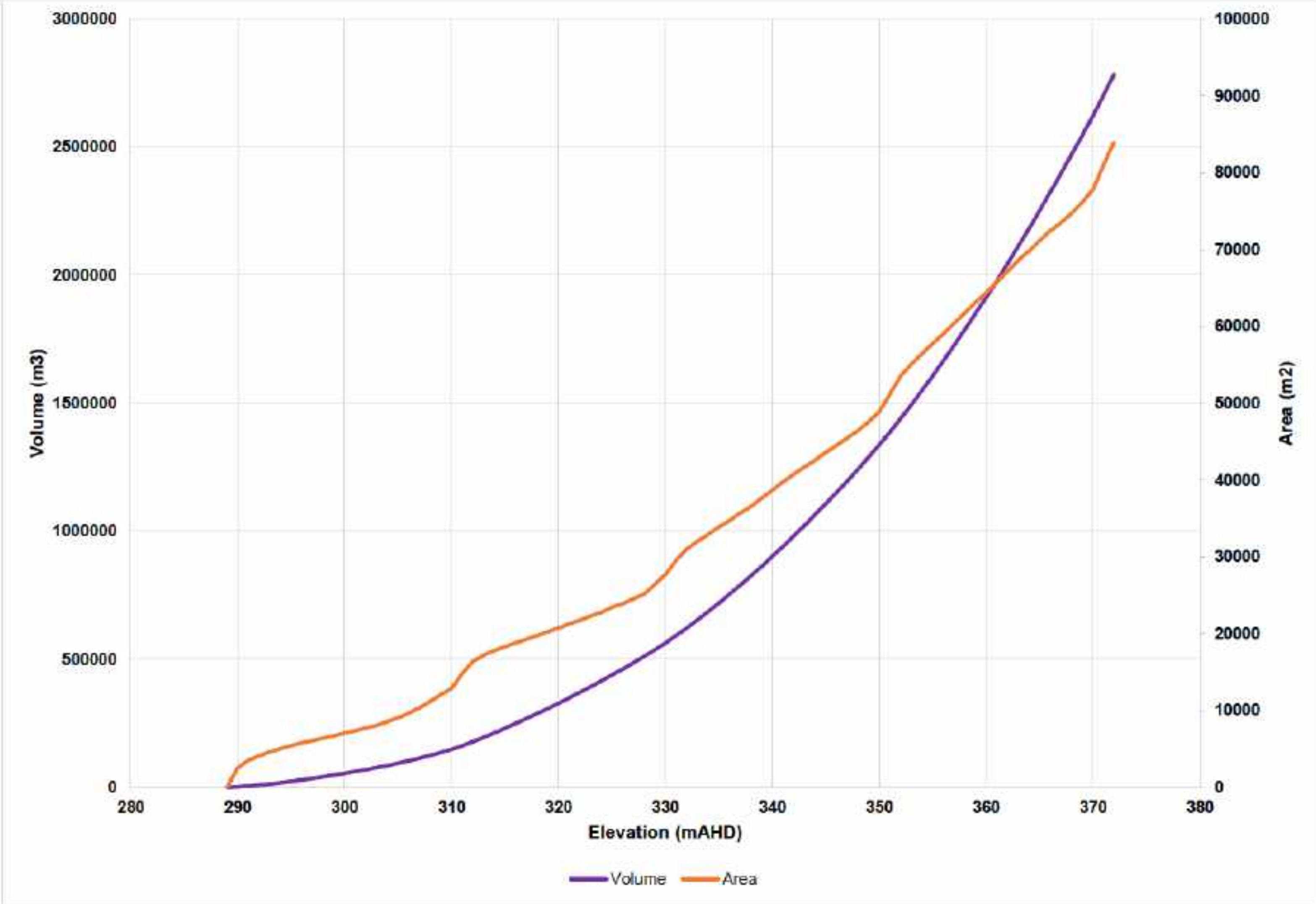

BIG DOG HYDROGEOLOGY

Union Club Pit stage curve

Figure 16	
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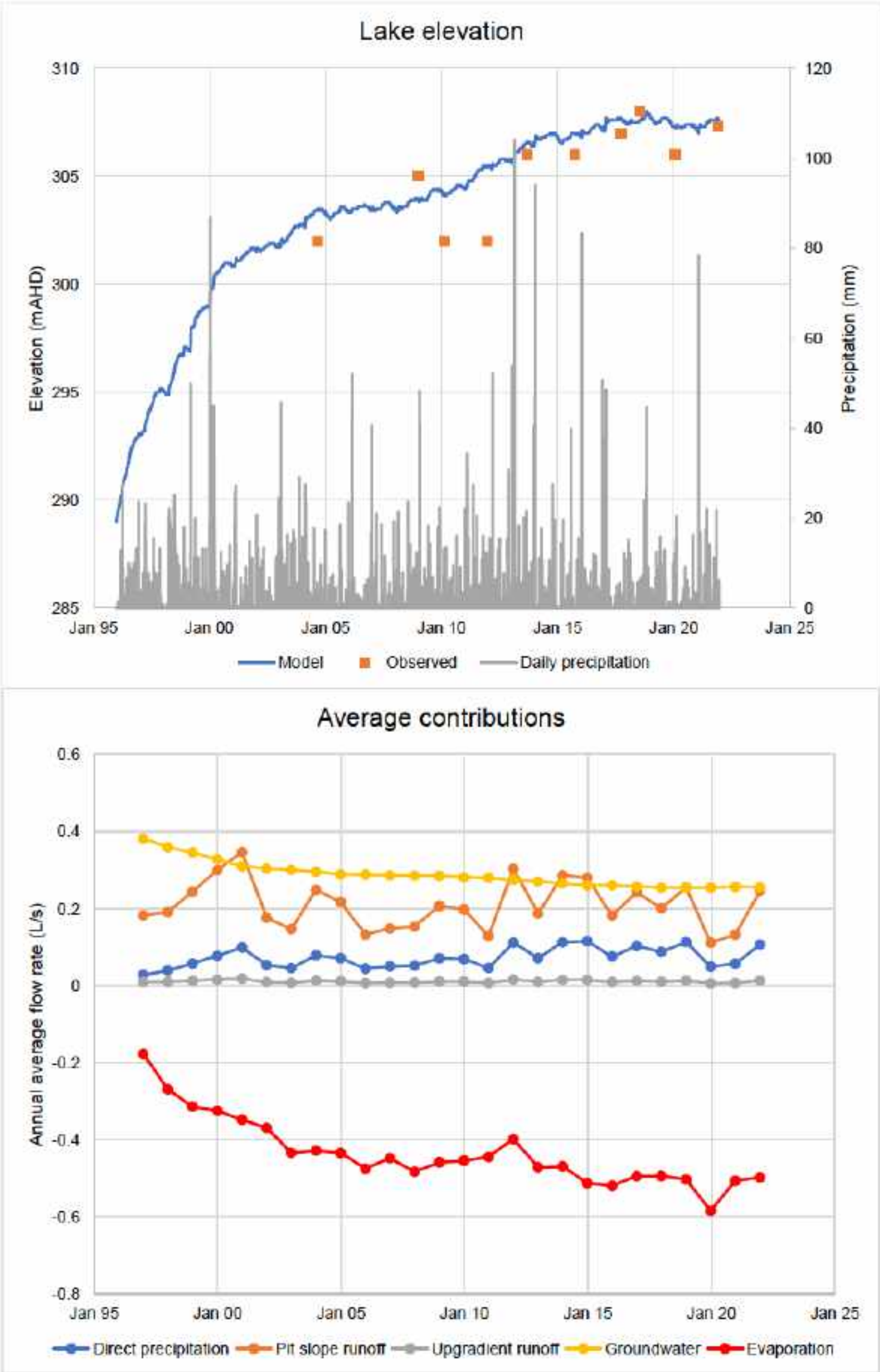

Union Club Pit lake model calibration

Figure 17

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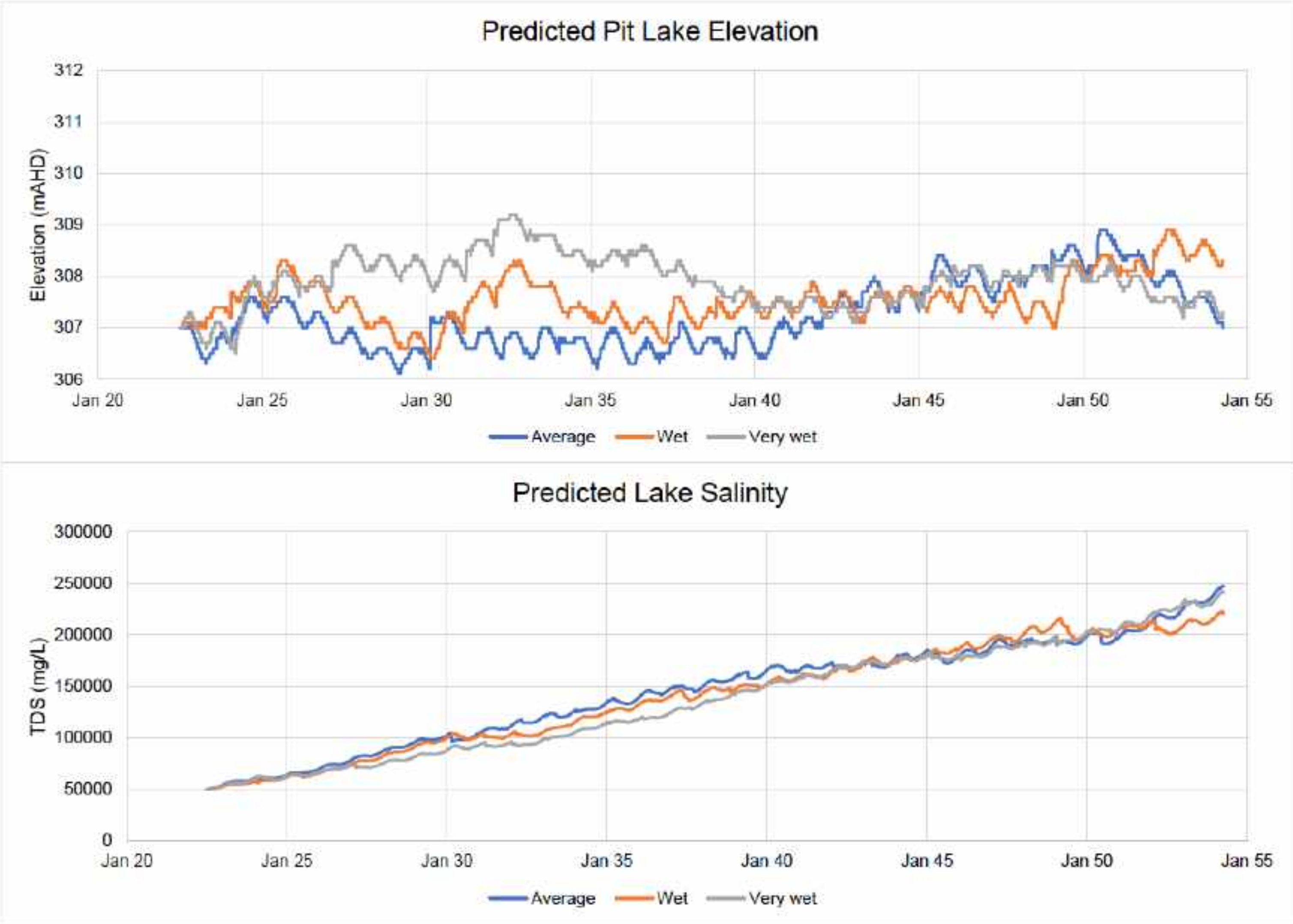
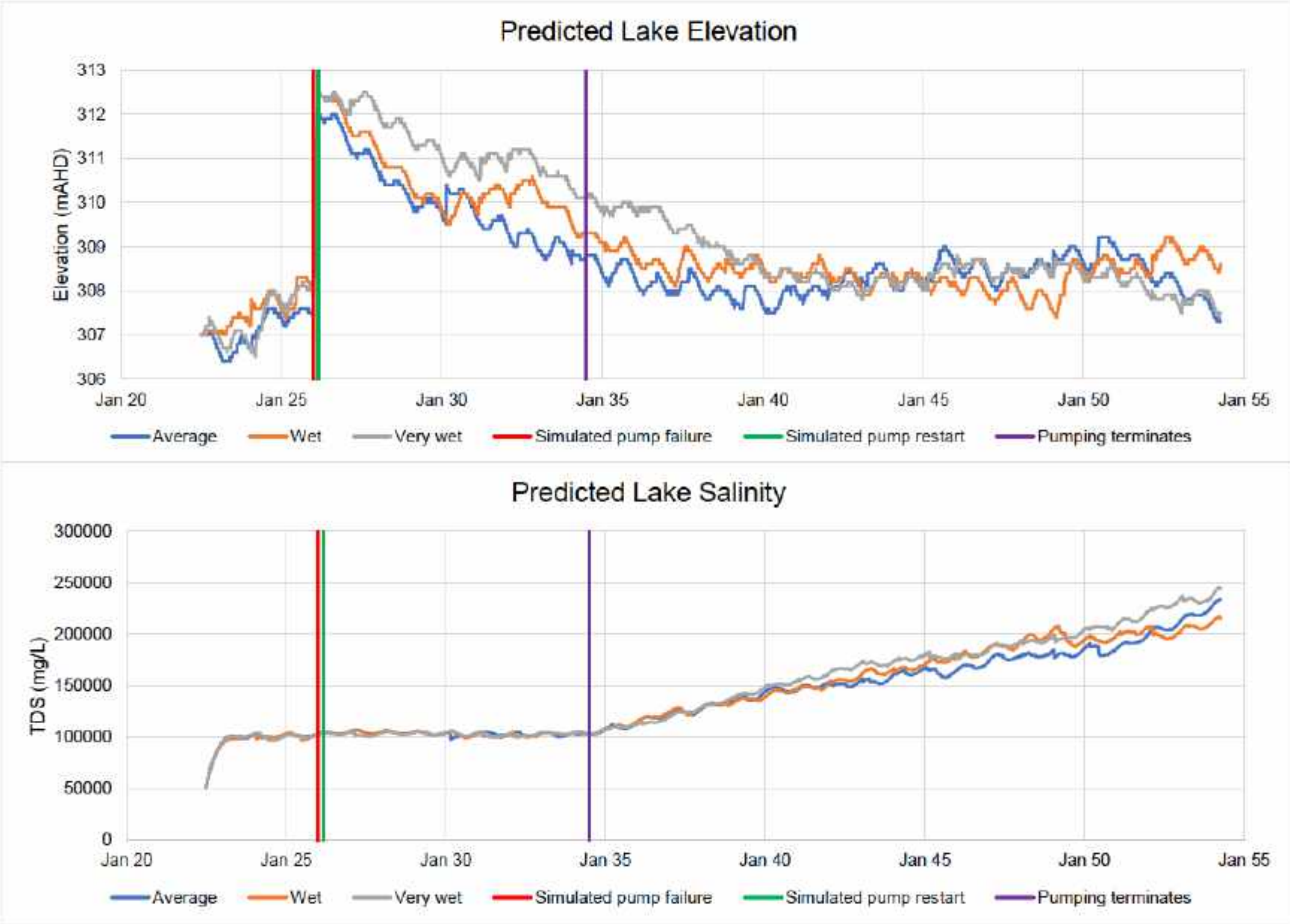


Predicted Pit Lake Elevation
Elevation (mAHD)
312
311
310
309
308
307
306
Jan 20
Jan 25
Jan 30
Jan 35
Jan 40
Jan 45
Jan 50
Jan 55
Average
Wet
Very wet
Predicted Lake Salinity
TDS (mg/L)
300000
250000
200000
150000
100000
50000
0
Jan 20
Jan 25
Jan 30
Jan 35
Jan 40
Jan 45
Jan 50
Jan 55
Average
Wet
Very wet



Union Club Pit lake prediction with dewatering discharge

Figure 19

Date: April 2022

Report: KCGM Mt Percy Hydrogeological Review