Appendix 6

Supporting Information:

Keysbrook Mineral Sands Project Annual Groundwater Monitoring Summary 2022

Groundwater Resource Management, March 2023

2022 MONITORING SUMMARY

KEYSBROOK LEUCOXENE PTY LTD

KEYSBROOK MINERAL SANDS PROJECT

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GLOSSARY OF TERMS

Aquifer	A saturated geological unit that is permeable enough to yield economic quantities of water.
Aquitard	A geological unit that is permeable enough to transmit water but not sufficient to yield economic quantities.
Aquiclude	A geological unit that is impermeable, *i.e.* cannot transmit water.
Confined Aquifer	An aquifer bounded above and below by an aquiclude, where the water level in the aquifer extends above the aquifer top and is represented by a pressure head, *i.e.* the aquifer is completely saturated.
Drawdown	The change in hydraulic head observed at a well in an aquifer, typically due to pumping.
Leaky Aquifer or Semi-Confined Aquifer	An aquifer with upper and/or lower boundaries as an aquitard, where the water level in the aquifer extends above the aquifer top and is represented by a pressure head. Pumping from the aquifer induces leakage from the neighbouring aquitard units.
Unconfined or Water table Aquifer	An aquifer that is bounded below by an aquiclude, but is not restricted on its upper boundary, which is represented by the water table.
Hydraulic Conductivity (K) [Permeability]	The volume of water that will flow in a unit time under a unit hydraulic gradient through a unit area. Analogous to the permeability with respect to fresh water (units commonly m/d or m/s).
Transmissivity (T)	The product of the hydraulic conductivity and the saturated aquifer thickness (units commonly $m^3/d/m$ or m^2/d)
Specific Storage (S_s)	The volume of water released from a unit volume of aquifer under a unit decline in hydraulic head, assuming confined aquifer conditions. Water is released because of compaction of the aquifer under effective stress and expansion of the water due to decreasing pressure (units commonly m^{-1}).
Storativity (S)	The volume of water released from a unit area of aquifer, i.e. the aquifer column, per unit decline in hydraulic head (dimensionless parameter).
Specific Yield (S_Y)	The volume of water released from an unconfined aquifer per unit decline in the water table. The release of water is mostly from aquifer draining. Contributions from aquifer compaction are generally small. Analogous with effective porosity (dimensionless parameter).

Terms referenced from Kruseman GP and deRidder NA (1994) 2nd edition, Analysis and Evaluation of Pumping Test Data. ILRI Publication 47 The Netherlands

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1.0 INTRODUCTION

Keysbrook Leucoxene Pty Ltd (KLPL), a wholly owned subsidiary of Doral Mineral Sands Pty Ltd (DMS) owns and operates the Keysbrook Mineral Sands Mine approximately 70 km south of Perth, in the Peel Region of Western Australia (Figure 1). The project lies on the Swan Coastal Plain, within the Serpentine and Murray groundwater management areas, west of the towns of Keysbrook and North Dandalup.

The approved mine area extends over 1,532 ha. Land titles in the Keysbrook area were granted prior to 1899 and consequently are freehold 'minerals to owner', meaning the minerals (other than precious metals) are owned by landowners rather than the State and that mining operations are not subject to the provisions of the Mining Act 1978.

Mining at the Keysbrook Mineral Sands Mine (Keysbrook) commenced in late October 2015 and currently produces approximately 90,000 tonnes per annum of heavy mineral concentrate with an estimated mine life of 10 years.

KLPL has four granted groundwater abstraction (5C) licences, as a result of transfer from the previous project owners MZI. The combined allocation from the four 5C licenses allows for up to 1.8 GL per annum abstraction from the Leederville Aquifer and 0.6 GL per annum from the Superficial Aquifer.

Abstraction from the Leederville Aquifer is permitted under GWL164007(2) expiring in December 2022. Three licences for the Superficial Aquifer relate to the mining areas lying within the Shires of Murray (GWL176404(2)) and Serpentine-Jarrahdale (GWL177296(2) & GWL177336(2)). The three Superficial Aquifer licences, which permit the abstraction of 0.2 GL per annum each, all expire in December 2022.

The DWER have yet to issue new groundwater licences for the project as the existing ones have only recently expired (mid- December 2022). The licences require compliance to the current Groundwater Licence Operating Strategy (GLOS), Version 7, which was approved by DWER in December 2020 (KLPL,2020) and stipulates the following reporting requirements:

- Preparation of an annual groundwater monitoring summary for the period 1 January to 31 December each year, submitted to the Department of Water and Environment Regulation (DWER) before 31 March.
- A triennial monitoring review conducted every three years, the next review is due for submission to the DWER by March 2024.

This report constitutes the annual groundwater monitoring summary for the period January to December 2022.

2.0 BACKGROUND

Background information on Keysbrook, including an overview of the project, monitoring commitments, and an assessment of geological, hydrogeological and climatic conditions are summarised below.

2.1 Project Overview

The mineral sand deposit, which occurs within the Bassendean Sand, contains on average 2.6% heavy minerals; principally leucoxene and zircon. KLPL mine the deposit using conventional dry surface mining methods (i.e. excavator and dump trucks).

The ore is processed in two stages:

- primary processing is carried out in a wet concentrator plant (WCP) at the mine to produce a Heavy Mineral Concentrate (HMC); and then
- the HMC is transported to DMS's mineral separation plant in Picton, for separation into leucoxene and zircon products, which are then exported through the Bunbury and Fremantle Ports.

The site process plant includes a thickener to recover water from clay slimes within the primary process circuit. Tailings from the primary process are discharged into tailings cells constructed in the mine void as a low density slurry, approximately 30% solids by mass. An active mining area of about 30 ha is maintained, with temporary embankments used to separate the mine pit and mine void where tailings are stored. Over the LoM, the pit will extend to depths of between about 0.5 and 8 m and will require dewatering where it extends below the water table, which was originally around 1 to 5 m below ground level (bgl) over the majority of the mining area, and typically exhibits a seasonal variation in the order of about 1 to 2 m.

Pit dewatering happens very infrequently with a sump pump only recently installed in early 2023. It is understood that no dedicated dewatering pump was installed in 2022. When required, the mining area is dewatered using pit sumps, and recovered mine water is used in the primary process. Supernatant water is recovered from the tailings cells using a system of temporary sumps and drains, which channel water away from the tailings beach. Recovered tailings water is also re-used for processing.

Makeup water for the WCP is sourced from two production bores. The bores source water from the Leederville Aquifer, which underlies the superficial deposits at the project. Process water is stored in tanks and a lined dam located near the WCP. Two lined settlement dams have also been constructed to help manage dewatering discharge and recovered tailings water.

2.2 Groundwater Licences and Operating Strategy

Information on the groundwater licences issued for the project are summarised in Table 1 below, with copies of the licences provided in Appendix A.

BACKGROUND

Table 1: Groundwater Licences

GWL	Groundwater Area	Water Resource	Annual Entitlement (kL/annum)	Location of Water Source	Authorised Activities	Date of Issue	Date of Expiry
164007(1)	Murray	Lower Leederville	1,800,000	L62 P739 – V1081 F577	Mineral ore processing and other mining purposes	25 Sep 19	12 Dec 22
176404(1)	Murray	Superficial Swan	200,000	L62 P739 - V1081 F577; L110 D2305 – V118 F133A; LA44 P738 – V1054 F72; L6 D82294 – V1961 F279; L7 D82294 – V1961 F280; L300 P31012 – V2558 F496; L59 P739 – V2004 F874	Mineral ore processing and other mining purposes	26 Aug 19	12 Dec 22
177296(1)	Serpentine	Superficial Swan	200,000	L6 D52395 – V1493 F399; L111 D94183 – V2117 F847; L113 D94183 – V2117 F849; L1 D8916 – V2094 F330; L52 P739 – V1740 F735; L56 P739 – V1015 F594; L57 P739 – V1343 F843; L112 D94183 – V2117 F848; L101 D92169 – V2098 F395; L103 D92169 – V2098 F3956; L104 D92169 – V2098 F397; L105 D92169 – V2098 F398	Mineral ore processing and other mining purposes	20 Nov 19	13 Dec 22
177336(1)	Serpentine	Superficial Swan	200,000	L63 P739 – V1049 F169	Mineral ore processing and other mining purposes	26 Aug 19	12 Dec 22

The project operates in accordance with a Water Management Plan (WMP) and GLOS. The WMP was initially prepared in March 2013 and has undergone several iterations since that time. The current WMP is revision B (MBS, 2015).

2.3 Monitoring Commitments

The project's groundwater monitoring commitments, as outlined in the GLOS are summarised in Table 2. The water quality analysis schedules attached to the monitoring commitments are provided in Table 3 and the bore locations provided in Figure 2. The locations of the surface drainage lines are provided in the WMP (MBS,2015).

Table 2: Operational Monitoring Schedule

Scope	Minimum Frequency	Criteria	Monitoring Sites
Production Bores	Monthly	Abstracted Volume	KL2P & KL3P
	Monthly	Water Level	
	Monthly	Field Parameters (Schedule A)	
	Quarterly	Laboratory Analysis (Schedule B)	
Pit Sumps	Monthly	Abstraction Volume	Operating pits
	Monthly	Field Parameters (Schedule C)	
	Quarterly	Laboratory Analysis (Schedule B & D)	
Production Monitoring Bores	Monthly	Water Level	KL2 Obs & KL3 Obs
	Monthly	Field Parameters (Schedule A)	
Superficial Monitoring Bores	Monthly	Water Level	KS 1, 2, 3, 17, 21, 22, KL1S
	Monthly	Field Parameters (Schedule A)	
Superficial Monitoring Bores (extended)	Monthly	Water Level	KS 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 ,16, 18, 19, 20, 23,24,25,26
	Monthly	Field Parameters (Schedule A)	
	Quarterly	Laboratory Analysis (Schedule B & C)	
Wetland Monitoring Bores	Monthly	Water Level	KWT1A, 1B, 1C, 1D, 1E 1F, 2A, 2B, 2C, 2D, 2E, 2F, 3A, KPD00064
	Monthly	Field Parameters (Schedule A)	
	Quarterly	Laboratory Analysis (Schedule B)	
Leederville Monitoring Bores	Monthly	Water Level	KL 3, 4, 7, 8, KL1 Obs
	Monthly	Field Parameters (Schedule A)	
	Quarterly	Laboratory Analysis (Schedule B)	
DWER Monitoring Bores	Quarterly	DWER Monthly SWL data review	T610, 670, 570, 620

Scope	Minimum Frequency	Criteria	Monitoring Sites
	Annually	Laboratory Analysis (Schedule B)	
Surface Drainage Lines	Monthly	Field Parameters (Schedule D) and Laboratory Analysis (Schedule E) during flow periods	SW 3, 4, 5, 6, 9, 10

Table 3: Water Quality Schedule

Schedule	Type	Application	Analytes
Schedule A	Groundwater	Field Based	pH, electrical conductivity, TDS, temperature
Schedule B	Groundwater	Laboratory Based	pH, electrical conductivity, TDS total acidity, total alkalinity, hardness ($CaCO_3$ equivalent) major ions (K, Ca, Na, Mg, HCO_3, Cl, SO_4) metals (Al, total and soluble Fe)
Schedule C	Groundwater	Laboratory Based	total nitrogen, nitrate soluble reactive phosphorus, total phosphorus
Schedule D	Surface Water	Field Based	pH, electrical conductivity, TDS, temperature, turbidity
Schedule E	Surface Water	Laboratory Based	pH, electrical conductivity, TDS, TSS, turbidity total acidity, total alkalinity total nitrogen, nitrate total phosphorous

2.4 Climate

The region has a temperate climate, characterised by distinctly hot, dry summers with rainfall occurring predominantly during the winter months of June to August.

A desktop assessment of the local rainfall and evaporation data was carried out by GRM (2014). The assessment indicated the most suitable nearby Bureau of Meteorology (BoM) station for long term rainfall and evaporation data was Halls Head (Station 09572) and Medina Research Centre (Station 09194), respectively, whilst the most suitable station representative of annual rainfall data was Mandurah (station 09977). In addition, KLPL installed a site rain gauge (manually read daily) in 2015 to provide additional rainfall data for comparative purposes, and on 1 May 2017 installed a weather station which included a tipping bucket rain gauge.

Rainfall data for the monitoring period from the site rain gauge and Mandurah, along with long term climate data from Mandurah Park and Medina Research Centre is presented in Table 4. The data indicates that annual rainfall during 2022 for Mandurah was 594.8 mm, which is 70% of the long-term average of 874.9 mm. The site weather station rain gauge did not record rainfall data from January to April 2022, and it is assumed that no rain fell onsite for the first four months of the year. However, the highest site recorded monthly rainfall was 180 mm for August and the minimum rainfall was 0.0. mm in January- April 2022. This is consistent with the rainfall peak for Mandurah (125.8 mm) in August and is consistent with the longterm seasonal rainfall patterns for the region. 2021 was the wettest year in the region since 2012.

Table 4: Recorded and Average Climate Data

Month	Long–Term Monthly Data		2022 Monthly Data			
			Site Data	BoM Data		
	Rainfall (mm)	Evaporation (mm)	Rainfall (mm)	Rainfall (mm)	Mean Maximum Temp (°C)	Mean Minimum Temp (°C)
January	9.5	260.4	0	0	31.2	20.1
February	14.1	225.6	0	1.2	32	20.4
March	19.5	195.3	0	7	28.5	19.2
April	43.6	114.0	0	42.6	24.2	15.6
May	125.9	71.3	106	81.8	20.6	12.8
June	188.5	54.0	109	102.6	18.5	12.2
July	175.1	52.7	143	113.2	18.0	11.1
August	126.2	71.3	180	125.8	17.6	10.1
September	84.2	96.0	86	49	19.7	12.0
October	51.4	145.7	20	31.2	20.4	11.9
November	22.7	195.0	22	24.8	24.1	14.4
December	11.6	244.9	15	15.6	28.3	17.6
Total	874.9	1,715.5	681	594.8	23.6	14.8

Notes: Current years' data from Mandurah; long term rainfall and temperature data from Mandurah Park (1889 to 2017); evaporation data from Medina Research Centre (1983 to 2018); NA = Error in the site weather station rainfall recording

2.5 Geology

The following description of the geological setting of the project area is derived from Wilde and Low (1980).

The project lies within the Swan Coastal Plain, approximately 3 km west of the Darling Scarp (which is the surface expression of the Darling Fault). The Darling Fault separates the Precambrian Yilgarn Block sequences from the Phanerozoic strata of the Swan Coastal Plain. The fault has an estimated maximum displacement of 15 km and, as a result of erosion, lies approximately 1 to 2 km west of the present scarp (i.e. 1 to 2 km east of the project area).

The Swan Coastal Plain extends from the Darling Scarp to the Indian Ocean, and ranges up to 75 m above sea level. A narrow piedmont zone occurs at the base of the scarp comprising alluvial fans and remnants of two strand-line deposits: the Ridge Hill Sandstone and the Yoganup Formation. West of the piedmont zone lies an alluvial swathe up to 10 km wide, termed the Pinjarra Plain. The Pinjarra Plain, comprising the Guildford Formation, ranges in elevation from 6 to 50 m and is overlain to the west by a series of coastal sand dunes. The oldest of these sequences is the Pleistocene Bassendean Sand, which hosts the Keysbrook Mineral Sand Deposit.

The Guildford Formation is characterised by clay, loam, sand and gravel of alluvial origin, with variable laterisation and podsolisation. The Bassendean Sand and Guildford Formation have a combined thickness of 10 to 15 m and unconformably overlie about 50 to 130 m of Cretaceous Leederville Formation. In the western portion of the project area the Leederville Formation conformably overlies the Cretaceous South Perth Shale, and in the eastern part it conformably overlies the Jurassic Cattamarra Coal Measures.

2.6 Regional Hydrogeology

The following description of the regional hydrogeological setting of the project area is derived from Wilde and Low (1980).

The main groundwater sources in the inland Swan Coastal Plain are derived from the following aquifer types:

- The unconfined alluvial and colluvial fan material of the piedmont zone which yields local supplies of potable water, predominantly from sands of the Yoganup Formation.
- The unconfined Bassendean Sand (and to a lesser extent the underlying Guildford Formation) contain local supplies of good quality groundwater.
- The unconfined Tamala Limestone, which is stratigraphically equivalent to the Guildford Formation, underlies the coastal strip from Fremantle to Mandurah. This Quaternary aquifer provides local supplies of good quality groundwater, although the salinity can be variable.
- The confined Jurassic and Cretaceous aquifers of the Cockleshell Gully, Yarragadee and Leederville Formations provide large supplies of fresh to brackish groundwater. This confined groundwater system is effectively divided into two parts by the low permeability South Perth Shale. The Cockleshell and Yarragadee Formations lie below the South Perth Shale and are hydraulically connected. The lower aquifers are recharged close to the Darling Fault where the South Perth Shale is absent. The Leederville Formation (overlying the South Perth Shale) is recharged in localised areas (away from the mine area) from the overlying superficial deposits.

2.7 Local Hydrogeology

The following description of the local hydrogeological conditions of the project area is derived from Rockwater (2007).

The main groundwater sources within the project area are:

i. The Superficial Aquifer.

ii. The Leederville Aquifer.

The Superficial Aquifer comprises the Bassendean Sand and the Guildford Formation. The Bassendean Sand is a well sorted, highly permeable unit (estimated hydraulic conductivities in the range of 5 to 10 m/day), with low clay content, whereas the Guildford Formation varies from clay to sand and has a low to modest permeability (0.001 to 2 m/day).

The Bassendean Sand has a variable thickness (up to five metres), thickening to the west. As a result of its shallow base, the unit can be fully unsaturated in summer and autumn and saturated in winter and spring. Although, it is typically saturated all year round where the unit is thickest. The underlying Guildford Formation extends to 9 to 15 m below ground level and is mostly saturated, except for the upper one metre or so where the Bassendean Sand is thinnest. Dewatering to achieve safe, dry mining conditions is necessary where the mine pit intersects saturated, or partially saturated, areas of the Bassendean Sand Formation.

The groundwater level within the Superficial Aquifer varies from zero (surface) to five metres below ground level, and the salinity can be quite variable, ranging from about 200 to 5,000 mg/L total dissolved solids (TDS).

The Leederville Aquifer is a confined groundwater system, separated from the overlying Superficial Aquifer by the confining Guildford Formation. The Leederville Aquifer comprises interbedded sandstones and siltstones and reports a modest to high permeability (0.8 to 5 m/day) in the vicinity of the project. The piezometric level within the Leederville Formation is typically lower than that of the Superficial Aquifer, although some local variability has been reported (Rockwater, 2013). The groundwater quality of the Leederville Formation is fresh to brackish, reporting a salinity of less than 1,500 mg/L TDS. The production bores for the project intersect the Mariginiup Member (the lowest member) of the Leederville Formation.

2.8 Surface Hydrology

The following description of the surface hydrology of the project area is derived from the WMP (MBS,2015). The project area is located within the Peel Harvey Estuary catchment, with surface drainage flowing from the Darling Scarp westward towards the estuary.

Balgobin Brook is the main drainage feature within the project area, passing through the central portion of the site, and flowing southwest into Nambeelup Brook. The DWER maintain a stream

gauging station on Nambeelup Brook, located approximately 10 km downstream (southwest) of the project.

There are several wetlands in the region. The Nambeelup Brook South Tributary wetland and Balgobin Brook South tributary wetland are situated close to the project area and was the subject of a groundwater investigation to characterise the underlying hydrogeological conditions (Rockwater, 2007). In both locations drilling identified that the Bassendean Sand unit is less than 1.5 m thick and underlain by at least 5 m of (low permeability) Guildford Formation. It is expected the wetlands will be recharged following winter rains and that the hydraulic connectivity between the wetlands and the underlying Leederville Formation is limited.

For further information regarding the wetlands, refer to Rockwater (2007) and the WMP (MBS,2015).

2.9 Other Users and Groundwater Environment

A search of the Water Information Reporting (WIR) database on other groundwater users, has identified 551 bores within a 10 km radius of the project. The locations of the identified bores are shown in Figure 3, grouped by aquifer type (where the data is available). The data indicates:

- Two artesian Yarragadee monitoring bores (AM64 and AM66) are located northeast and southwest of the project. The bores form part of the DWER Groundwater Assessment Network.
- A series of Superficial Aquifer monitoring bores are located within and adjacent to the project area. This series of bores (which includes T610, T620, T570 and T660) also forms part of the DWER Groundwater Assessment Network. The data from these bores is reviewed by KLPL as part of the licence conditions (Table 2).
- There are numerous registered bores within and surrounding the project area with little or no information in the WIR database.

The mine area is located within the proposed Karnup-Dandalup Underground Water Pollution Control Area, issued under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909*. As a result of this proclamation, the area of the mine site has a P2 classification, aimed at protecting public drinking water sources from potential pollution. The P2 classification is issued for land where low intensity development is already in place, and the land is managed in accordance with the principle of risk minimisation.

There are several Conservation Category wetlands adjacent to the project area, although none fall within the footprint of the mine. The potential impact to the wetlands from mining has been assessed using groundwater flow modelling (Rockwater, 2007). For further details regarding the wetlands refer to the WMP (MBS,2015).

3.0 SCHEME DESCRIPTION

The following sections discuss the proposed groundwater abstraction scheme.

A water balance was undertaken by GRM (2014) to assess the likely tailings water recovery and the security of the project water supply using a dynamic site-wide model. A schematic diagram of the water balance for the project is presented in Figure 4.

3.1 Mine Dewatering

Dewatering the Superficial Aquifer is necessary during the wetter months to maintain dry mining conditions. During summer months dewatering is minimal, if required at all. Dewatering is generally a passive process, with drains dug to channel the water away in the winter months, and generally no pumping is required especially in the summer months when the water table is lower.

Surface water and any shallow groundwater is diverted around the mine pit with the use of shallow drains. Dewatering in the mine pit, where necessary, is achieved via sumps located at low points on the pit floor. The groundwater is transferred to a settlement pond and process water dam prior to its use for dust suppression or within the processing plant.

Sand and clay tailings are pumped in slurry form to the mined pits and water recycled from the tails to supplement process water.

Groundwater flow modelling (GRM, 2017) indicated that the dewatering requirement for the pits is quite small, up to 11 L/s, whilst seepage from the tailings to the Superficial Aquifer is about 7.5 L/s. The modelling indicates that the impacts to the Superficial Aquifer from dewatering and tailings deposition are short term (i.e. about a month), typically comprising a brief drawdown from dewatering, followed by slight mounding from tailings deposition.

Flow meters should be installed at each pit sump, and a nett dewatering rate is calculated based upon the sum of the pit sump pumping minus tailings infill. This recycling process can result in negative nett dewatering rates when water recovered from the tails exceeds the abstraction rate from the pit sumps. Both the pit sump abstraction and nett dewatering rates are presented in this report.

3.2 Water Supply Bores

Two water supply bores, KL2P and KL3P, (Figure 2) have been installed to provide the make-up water to meet the project's process water demand. The bores were installed into the Leederville Aquifer and test pumping (Rockwater, 2007) indicates the bores can produce 28 L/s each.

The abstracted groundwater is transferred to a process water dam for use by the operation for dust suppression and mineral processing.

3.3 Monitoring Network

A monitoring bore network (Figure 2 and Table 5) has been installed to monitor water levels within both the Leederville Aquifer and the Superficial Aquifer to enable an assessment of the impacts from the production bores and mine dewatering on the groundwater system and the environment.

The monitoring network for the project comprises:

- Two monitoring bores (KL2 Obs and KL3 Obs) installed into the Leederville Aquifer to monitor the impact of groundwater abstraction upon the aquifer in close proximity to the production bores.
- Five monitoring bores (KL1 Obs, KL3, 4, 7 and 8) installed into the Leederville Aquifer to monitor additional regional impacts from groundwater abstraction.
- Thirteen monitoring bores (KWT1A, 1B, 1C, 1D, 1E, 1F, 2A, 2B, 2C, 2D, 2E and 2F, 3A and KPD00064) installed into the Superficial Aquifer to monitor the impacts upon wetlands from groundwater abstraction.
- Twenty seven monitoring bores (KL1S, KS1 to 26) installed into the Superficial Aquifer to monitor regional impacts from groundwater abstraction. Bore KS18 was replaced in 2017 after the casing was damaged. Bores KS23 to KS26 were installed in 2020 to provide monitoring locations for mining activities on Lot 57.
- Four monitoring bores which form part of the DWER's regional Groundwater Assessment Network (T570, T610, T620 and T670). These bores monitor regional impacts from groundwater abstraction.
- Six surface water monitoring points located on water drainage lines (SW3, 4, 5, 6, 9 and 10) to monitor regional surface water quality.

Table 5: Production Bore and Monitoring Bore Schedule

Bore Name	Easting (m) (MGA Zn50)	Northing (m) (MGA Zn50)	Collar RL (mAHD)	Bore Depth (m)	Casing Material	Construction Date	Utilisation
Production Bores							
KL2P	399,190	6,406,893	28.103	139	203 mm uPVC, stainless steel screens	Apr 2007	Production Bore
KL3P	398,779	6,405,436	25.966	122.4	203 mm uPVC, stainless steel screens	May 2007	Production Bore
Superficial Aquifer Monitoring Bores							
KWT1A	400,968	6,405,442	32.222	2	50 mm uPVC	May 2007	Wetland monitoring bore
KWT1B	400,956	6,405,464	32.410	2	50 mm uPVC	May 2007	Wetland monitoring bore
KWT1C	400,948	6,405,487	32.569	2	50 mm uPVC	May 2007	Wetland monitoring bore
KWT1D	400,948	6,405,488	32.702	6	50 mm uPVC	May 2007	Wetland monitoring bore
KWT1E	400965	6,405,441	32.365	4	50 mm uPVC	May 2007	Wetland monitoring bore
KWT1F	400,920	6,405,579	32.250	4	50 mm uPVC	May 2007	Wetland monitoring bore
KWT2A	399,195	6,406,770	27.54	2.4	54 mm uPVC	Jun 2012	Wetland monitoring bore
KWT2B	399,380	6,406,810	27.997	3.5	50 mm uPVC	May 2007	Wetland monitoring bore
KWT2C	399,387	6,406,832	28.099	3	50 mm uPVC	May 2007	Wetland monitoring bore
KWT2D	399,395	6,406,854	28.240	3	50 mm uPVC	May 2007	Wetland monitoring bore
KWT2E	399,395	6,406,856	28.277	6	50 mm uPVC	May 2007	Wetland monitoring bore
KWT2F	399,404	6,406,883	28.717	1.8	50 mm uPVC	May 2007	Wetland monitoring bore
KWT3A	398,784	6,405,459	25.79	4.0	54 mm uPVC	Jun 2012	Wetland monitoring bore
KPD0064	401,300	6,405,439	32.42	3.0	40 mm uPVC	Sep 2013	Wetland monitoring bore
KL1S	401,628	6,406,792	33.856	3	50 mm uPVC	May 2007	Shallow monitoring bore

Bore Name	Easting (m) (MGA Zn50)	Northing (m) (MGA Zn50)	Collar RL (mAHD)	Bore Depth (m)	Casing Material	Construction Date	Utilisation
KS1	401,942	6,409,304	37.79	2.9	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS2	402,440	6,408,426	38.9	2.8	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS3	402,448	6,407,915	38.19	2.8	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS4	402,825	6,407,036	39.51	2.8	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS5	402,449	6,406,517	37.08	2.8	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS6	402,330	6,405,802	36.79	2.9	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS7	401,872	6,405,637	35.26	2.9	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS8	400,269	6,405,426	29.91	2.8	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS9	399,622	6,405,417	28.21	4.0	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS10	398,844	6,406,061	25.95	2.8	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS11	398,069	6,405,835	23.5	4.3	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS12	398,548	6,406,514	27.52	5.8	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS13	397,986	6,406,614	23.8	5.0	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS14	398,691	6,407,014	26.06	4.0	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS15	398,539	6,407,665	26.35	4.0	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS16	398,950	6,407,886	28.01	3.0	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS17	399,580	6,408,635	31.25	3.8	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS18	399,609	6,407,860	30.29	4.0	50 mm uPVC	Mar 2017	Shallow monitoring bore
KS19	400,275	6,407,835	31.77	2.8	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS20	401,653	6,407,879	34.78	2.8	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS21	401,634	6,409,387	37.74	4.1	54 mm uPVC	Jun 2012	Shallow monitoring bore
KS22	402,125	6,409,747	37.79	2.9	54 mm uPVC	Jun 2012	Shallow monitoring bore

Bore Name	Easting (m) (MGA Zn50)	Northing (m) (MGA Zn50)	Collar RL (mAHD)	Bore Depth (m)	Casing Material	Construction Date	Utilisation
KS23*	399,546	6,409,043	31.21	3.0	54 mm uPVC	Mar 2020	Shallow monitoring bore
KS24*	399,546	6,410,213	31.41	3.0	54 mm uPVC	Mar 2020	Shallow monitoring bore
KS25*	401,092	6,410,116	36.07	3.0	54 mm uPVC	Mar 2020	Shallow monitoring bore
KS26*	401,603	6,408,651	35.71	3.0	54 mm uPVC	Mar 2020	Shallow monitoring bore
Leederville Aquifer Monitoring Bores							
KL1 Obs	401,625	6,406,792	33.999	83	67 mm uPVC	Mar 2007	Regional deep monitoring bore
KL2 Obs	399,186	6,406,766	27.635	108	67 mm uPVC	Apr 2007	Production monitoring bore
KL3 Obs	398,778	6,405,465	26.099	150	67 mm uPVC	Jun 2012	Production monitoring bore
KL3	397,639	6,405,465	21.950	24	54 mm uPVC	Jun 2012	Regional deep monitoring bore
KL4	400,850	6,405,529	31.750	30.3	54 mm uPVC	Jun 2012	Regional deep monitoring bore
KL7	397,986	6,406,940	24.150	30	54 mm uPVC	Jun 2012	Regional deep monitoring bore
KL8	400,213	6,407,829	31.740	24.2	54 mm uPVC	Jun 2012	Regional deep monitoring bore

Notes: * new bores installed as part of the revised GLOS (approved December 2020)

4.0 GROUNDWATER ABSTRACTION

In accordance with the licence conditions, KLPL is permitted to abstract up to 1.8 GL per annum from the production bores for water supply, and a further (up to) 0.6 GL per annum for the purpose of mine dewatering. The groundwater abstraction from the various components of the scheme during the reporting period are summarised in Table 6 below and presented as a time-series plot in Figure 5.

Groundwater abstraction during the 2022 reporting period can be summarised as follows:

- A total of 934,295 kL was abstracted from the production bores (KL2P and KL3P) for the purposes of mineral processing. This constitutes 52% of the annual allocation for the 2022 water year, with bore KPL2 recording 469,192 kL and bore KLP3 reporting 465,103 kL.
- A total of 2,361,636 kL was pumped back as recycled water, recovered from tailings backfill to the active mine pits (Section 3.1).
- Mine dewatering has been calculated as a nett value from the site water balance, as pit dewatering is not currently metered. However, it is understood that for most of the year mining was carried out above the water table with minimal overall seepage to the mine pits. Using the water meter data and site water balance a nett loss of 86,248 kL is approximated to the surficial aquifer across the year, suggesting that overall seepage losses to the surficial aquifer may have exceeded the annual mine dewatering.

Table 6: Monthly Groundwater Abstraction

Month	Production Bores			In-Pit Dewatering	
	KL2P	KL3P	Total	Sump*	Nett**
January	34,311	58,172	92,483		
February	67,338	41,148	108,486		
March	63,051	71,971	135,022		
April	42,326	49,828	92,154		
May	40,430	51,277	91,707		
June	29,022	27,195	56,217		
July	12,992	16,295	29,287		
August	3,103	2,341	5,444		
September	92,153	12,499	104,652		
October	29,105	32,762	61,867		
November	42,171	47,599	89,770		
December	13,190	54,016	67,206		
Total 2022	**469,192**	**465,103**	**934,295**	**NA**	**--86,248**

Notes * Sump dewatering represents the total volume of water abstracted from the pit ** Nett pit dewatering is calculated by subtracting the recovered water from the discharged tails (recycled water) from the sump dewatering

5.0 GROUNDWATER LEVEL MONITORING

The GLOS and WMP require the following groundwater level monitoring and assessment:

- Monthly water levels from the production bores, superficial monitoring bores and Leederville monitoring bores.
- Quarterly assessment of water level data from the DWER monitoring bores upon commencement of mining.

5.1 Groundwater Level Monitoring

Groundwater level data collected during the reporting period is provided in Tables 7 and 8 below and presented as time series plots in Figures 6 to 10. Groundwater contours of the Superficial Aquifer and Leederville Aquifer (using December 2015 and 2022 data) are presented as Figures 11 and 12.

The results of the data review can be summarised as follows:

- Monitoring was conducted at the required frequency during 2022. However, several monitoring bores are not accessible for measurement for various reasons. KS6 has been damaged by tree roots and no data has been obtained from the bore since September 2019. This bore should probably be replaced. KWT1F has probably been mined out and should be replaced (if possible) or removed from the monitoring schedule.
- Bores KWT3A, KS14, KS18, KS23 and KS25 missed recordings at various times during the 2022 water year due to access problems or damage (Table 7)
- A further 10 bores (KS1, KS2, KS3, KS15, KS16, KS19, KS20, KS21, KS22 and KL8) could mostly not be monitored for a majority of the 2022 water year due to the local land holder denying KLPL staff access to the bores.
- The groundwater level in the Superficial Aquifer continues to demonstrate cyclical seasonal variability, forming a peak around August to September following the winter rains and a trough around April at the end of the dry season.
- The seasonal variability in the Superficial Aquifer during the reporting period ranges from 0.61 m (KS1) to 3.75 m (KS20), with an overall average variability of 1.53 m. These observations are consistent with previous year's data. Overall, the highest variability is observed near the wetlands, in the KWT series bores (Figure 6 and 7), where recharge during winter and evaporative loss during summer are greater.
- The groundwater level in the Leederville Aquifer also demonstrates a seasonal variability, which also peaks around August to September (Figure 10). The maximum range in water level variation across the reporting period was in bore KL3obs (8.77m) due to abstraction from the adjacent production bore KL3. These observations are consistent with the previous year's data.
- The pattern of seasonal variability in both the Superficial and Leederville Aquifers indicates active rainfall recharge occurs in both aquifers, although the Superficial aquifer is probably recharged more directly.
- The groundwater level contour plots for the Superficial Aquifer during December 2015 and December 2022 are shown in Figure 11. The plots indicate a groundwater flow direction towards the west with a similar hydraulic gradient to the underlying Leederville Aquifer (Figure 12).
- Although a number of the Surficial bores could not be accessed for monitoring, the available monitoring data does not indicate any negative impacts to the Surficial Aquifer associated with pit dewatering and tailings discharge, apart from within the immediate mining areas.

Table 7: Superficial Monitoring Bore Groundwater Levels

Date		Superficial Aquifer Monitoring Bores (m AHD)												
	KL1S	KWT1A	KWT1B	KWT1C	KWT1D	KWT1E	KWT1F	KWT2A	KWT2B	KWT2C	KWT2D	KWT2E	KWT3A	KPD0064
15-Jan-22	NA	30.38	30.43	30.48	NA	30.58	NA	25.70	Dry	25.61	27.02	26.39	24.33	30.76
18-Feb-22	32.10	30.24	30.29	30.36	29.99	30.46	NA	25.75	24.93	Dry	26.28	26.71	24.20	30.64
22-Mar-22	32.04	30.02	30.06	Dry	29.68	30.22	NA	25.57	Dry	Dry	26.01	26.51	24.09	30.34
26-Apr-22	32.01	29.94	29.94	Dry	29.63	30.13	NA	25.40	Dry	Dry	25.95	26.53	24.09	30.22
16-May-22	32.08	Dry	Dry	Dry	29.57	30.20	NA	Dry	24.79	Dry	27.50	26.62	24.17	30.25
26-Jun-22	33.21	30.85	30.61	30.99	30.10	31.03	NA	26.34	27.25	27.25	27.92	27.69	24.72	30.99
22-Jul-22	33.33	31.05	31.33	31.41	30.42	31.25	NA	26.64	27.54	28.00	27.98	27.89	24.88	31.21
15-Aug-22	33.21	31.33	31.63	31.54	31.04	31.57	NA	26.99	NA	27.65	27.92	28.26	NA	32.24
19-Sep-22	33.13	31.00	31.54	31.37	31.05	31.40	NA	26.68	27.35	27.66	27.99	28.08	25.00	31.67
28-Oct-22	32.29	30.72	30.98	30.88	31.65	30.97	NA	26.05	26.58	27.73	27.44	27.49	24.54	31.35
24-Nov-22	32.25	30.98	31.00	31.02	30.62	31.16	NA	26.21	26.77	27.22	27.37	27.40	24.76	31.42
07-Dec-22	32.08	30.52	30.78	30.68	30.46	30.76	NA	25.68	26.18	26.62	27.12	27.26	24.43	31.22

GROUNDWATER LEVEL MONITORING

Date	Superficial Aquifer Monitoring Bores (m AHD)														
	KS1	KS2	KS3	KS4	KS5	KS6	KS7	KS8	KS9	KS10	KS11	KS12	KS13	KS14	KS15
15-Jan-22	35.72	36.88	36.56	36.87	34.66	RD	32.78	28.12	26.24	24.30	21.52	24.53	22.10	24.13	24.43
18-Feb-22	35.52	36.36	36.62	36.67	34.15	RD	32.49	28.14	26.17	24.20	21.37	24.33	21.97	24.06	24.23
22-Mar-22	35.27	35.95	LOA	36.42	Dry	RD	Dry	28.11	25.92	24.03	21.14	24.16	21.85	23.88	24.23
26-Apr-22	35.11	Dry	LOA	36.41	Dry	RD	32.08	28.25	25.93	23.92	21.05	23.92	21.78	23.88	Dry
16-May-22	LOA	35.63	LOA	Dry	Dry	RD	Dry	28.39	25.97	24.00	21.46	23.98	21.89	23.94	24.15
26-Jun-22	LOA	LOA	LOA	Dry	34.87	RD	32.43	29.07	26.72	24.92	22.68	24.35	22.58	24.86	Dry
22-Jul-22	LOA	LOA	LOA	38.04	35.66	RD	32.84	29.21	26.98	25.24	22.79	24.55	22.93	NA	Dry
15-Aug-22	LOA	LOA	LOA	39.01	36.43	RD	34.21	29.27	27.33	25.13	23.06	25.34	23.34	NA	Dry
19-Sep-22	LOA	LOA	LOA	NA	36.20	RD	33.71	29.11	27.14	25.22	22.69	25.09	23.01	NA	25.80
28-Oct-22	LOA	LOA	LOA	NA	35.47	RD	33.31	28.33	26.67	24.75	22.15	24.90	22.38	NA	LOA
24-Nov-22	LOA	LOA	LOA	NA	35.30	RD	33.06	28.50	26.74	24.80	22.17	24.91	22.41	25.02	LOA
07-Dec-22	LOA	LOA	LOA	NA	35.10	RD	32.88	28.24	26.42	24.60	21.99	24.72	22.21	24.63	LOA

Notes: NA = No measurement due to access problems related to either; flooded ground or bogged vehicle, damaged bore or active mining area or bunding; LOA = Access to bore denied by local land owner

GROUNDWATER LEVEL MONITORING

Date	Superficial Aquifer Monitoring Bores (m AHD)										
	KS16	KS17	KS18	KS19	KS20	KS21	KS22	KS23	KS24	KS25	KS26
15-Jan-22	26.17	28.66	28.47	30.34	34.76	34.76	35.76	NA	NA	Dry	Dry
18-Feb-22	28.01	28.65	29.01	30.08	34.46	34.46	35.52	NA	29.49	Dry	Dry
22-Mar-22	25.98	28.48	28.89	30.01	34.15	34.15	34.84	NA	29.28	Dry	Dry
26-Apr-22	25.99	28.38	28.80	29.99	33.91	33.91	34.51	NA	29.18	34.70	33.86
16-May-22	26.12	28.36	28.85	30.07	LOA	LOA	LOA	NA	29.25	NA	NA
26-Jun-22	LOA	29.03	NA	31.17	LOA	LOA	LOA	NA	29.73	NA	34.52
22-Jul-22	LOA	29.21	NA	LOA	LOA	LOA	LOA	NA	30.10	NA	34.89
15-Aug-22	LOA	29.71	NA	LOA	LOA	LOA	LOA	NA	30.68	NA	34.66
19-Sep-22	LOA	29.66	NA	LOA	LOA	LOA	LOA	NA	30.53	NA	34.48
28-Oct-22	LOA	29.43	NA	LOA	LOA	LOA	LOA	NA	29.94	NA	33.99
24-Nov-22	LOA	29.28	29.72	LOA	LOA	LOA	LOA	NA	29.79	34.55	33.88
07-Dec-22	LOA	29.19	29.53	LOA	LOA	LOA	LOA	NA	29.71	34.36	33.76

Notes: NA = No measurement due to access problems related to either; flooded ground or bogged vehicle, damaged bore or active mining area or bunding.
LOA = Access to bore denied by local land owner

Table 8: Leederville Monitoring Bore Groundwater Levels

Date	Leederville Aquifer Monitoring Bores (m AHD)						
	KL1 Obs	KL2 Obs	KL3 Obs	KL 3	KL 4	KL 7	KL 8
15-Jan-22	27.91	22.68	18.66	20.04	25.25	21.44	28.63
18-Feb-22	27.22	22.44	20.21	20.04	24.40	21.32	28.52
22-Mar-22	26.10	21.15	18.56	20.00	23.09	21.15	28.03
26-Apr-22	26.63	21.59	17.67	19.68	23.81	21.10	28.31
16-May-22	26.20	22.16	17.05	19.73	23.61	21.11	28.24
21-Jun-22	27.67	24.84	23.45	20.85	25.11	21.86	29.23
22-Jul-22	28.62	25.68	23.84	21.24	26.02	22.13	LOA
19-Aug-22	29.83	26.66	25.30	21.80	27.41	22.63	LOA
19-Sep-22	30.27	27.38	25.82	21.49	27.85	22.40	LOA
28-Oct-22	28.97	23.35	19.51	21.05	26.30	21.94	LOA
24-Nov-22	28.60	23.87	19.24	21.05	25.82	21.89	LOA
07-Dec-22	28.17	22.59	21.22	20.82	25.30	21.70	LOA

Notes: NA = No measurement due to access problems related to either; flooded ground or bogged vehicle, damaged bore or active mining area or bunding. LOA = Access to bore denied by local land owner

5.2 Groundwater Trigger Limits

Drawdown trigger values are specified in the GLOS for the Superficial and Leederville Aquifer monitoring bores. The values are defined as the maximum permissible drawdown from groundwater abstraction related to mining or processing activities. The trigger values vary depending upon the potential environmental receptor, with lower values applied to vulnerable receptors. For example, the lowest trigger value has been applied to bores in the Superficial Aquifer adjacent to the wetlands.

The drawdown trigger values were initially applied to the minimum pre-mining groundwater level, based upon the available monitoring data, and have subsequently been reviewed on an annual basis as additional baseline data has become available. The trigger values were also reviewed following the groundwater modelling in 2017 (GRM, 2017).

The drawdown triggers are compared with the monitoring data in Figures 14 to 25. A discussion of compliance to the various trigger values is provided in Section 7.1.

5.3 DWER Monitoring Data Review

In accordance with the GLOS and WMP an assessment of water level data from the four nearby DWER monitoring locations (T570, T610, and T620) is required on a quarterly basis upon the commencement of mining. It should be noted that Bore T670 data is no longer required by DWER, as KLPL were advised by DWER that purging of the bore was affecting the medium-term groundwater level due to low permeability.

The DWER bores intercept the Superficial Aquifer and form part of the DWER's Groundwater Assessment Network (GAN). The DWER record water level data from the GAN bores on a regular basis (approximately monthly) and the data is publicly available via the DWER's Water Information Register online database.

The primary purpose of the assessment is to identify any potential regional impacts to the Superficial Aquifer from groundwater abstraction activities. The locations of the bores are shown in Figure 2, and monitoring data collected from the bores during the reporting period is provided in Table 9 and time series plots of the water level data since 2012 is provided in Figure 26.

The results show the following:

- The groundwater level data (Figure 26) continues to demonstrate a cyclical seasonal variability, forming a peak around September following the winter rains and a trough around March to April each year.
- The seasonal variability over the 2022 water year period ranged from about 1.63 m (T610) to 3.13 m (T570), which is in line with the variability observed in the KLPL monitoring bores (0.61 to 3.75m) for the Superficial Aquifer.
- There are no discernible trends in the data over the reporting period which would indicate adverse impacts to the Superficial Aquifer from groundwater abstraction around the project.

Table 9: DWER Monitoring Bore Groundwater Levels

T570		T610		T620	
Date	Water Level (mAHD)	Date	Water Level (mAHD)	Date	Water Level (mAHD)
15-Jan-22	29.96	15-Jan-22	18.62	15-Jan-22	30.75
18-Feb-22	29.64	18-Feb-22	18.48	18-Feb-22	29.98
22-Mar-22	29.32	22-Mar-22	18.27	22-Mar-22	30.61
29-Apr-22	29.08	29-Apr-22	18.12	27-Apr-22	30.56
18-May-22	28.98	18-May-22	18.01	18-May-22	30.63
23-Jun-22	29.88	23-Jun-22	18.64	21-Jun-22	31.42
21-Jul-22	30.14	21-Jul-22	18.83	22-Jul-22	31.75
24-Aug-22	31.18	18-Aug-22	19.64	18-Aug-22	31.70
27-Sep-22	30.99	20-Sep-22	19.60	19-Sep-22	31.70
25-Oct-22	30.40	25-Oct-22	19.20	25-Oct-22	31.37
23-Nov-22	30.51	23-Nov-22	19.21	23-Nov-22	30.86
06-Dec-22	30.15	06-Dec-22	18.90	06-Dec-22	30.75

6.0 GROUNDWATER QUALITY

6.1 Field Parameters

The GLOS requires field parameters (pH, electrical conductivity, TDS and temperature) to be collected from the following locations on a monthly basis:

- Production bores.
- Pit sumps (also including turbidity).
- Superficial Aquifer monitoring bores.
- Leederville Aquifer monitoring bores.
- Surface drainage lines (also including turbidity).

The field measurements data is provided in an *Excel* spreadsheet as Appendix B which accompanies this report as *J2302R01_Appendix B.xlsx* with the salinity measurements graphed as time series plots in Figures 27 to 31.

The data indicates:

- Monitoring was generally conducted in accordance with the frequency outlined in the GLOS during the triennial review period, except for:
  - Bores KWT3A, KS14, KS18, KS23 and KS25 missed recordings mostly across the middle of the 2022 water year due to weather related access problems or damage to the bores (Table 7)
  - A further 10 bores (KS1, KS2, KS3, KS15, KS16, KS19, KS20, KS21, KS22 and KL8) could mostly not be monitored for a majority of the 2022 water year due to the local land holder denying KLPL staff access to the bores.
  - The superficial bore KS6 is damaged from tree roots and not sampled.
- The salinity in the Superficial Aquifer varied from less than 100 mg/L to about 2,500 mg/L TDS, which is consistent with known regional variability.
- A seasonal trend in salinity is apparent in some of the bores (i.e. KWT series bores, Figure 27), which report lower salinity during the winter months and higher salinity during the summer months. This trend correlates to the seasonal water level fluctuations and is likely a function of localised rainfall recharge. This seasonal trend is also observed (although more subdued) in superficial monitoring bore KL1S.
- Apart from seasonal fluctuations, the salinity of the superficial aquifer bores across the 2022 monitoring period is generally consistent with previous years.
- The salinity in the Leederville Aquifer is less than 1,000 mg/L TDS (Figure 31), with a decreasing trend since 2020, probably because of higher annual rainfall across the region in 2022. However, this trend appears to have stabilised in the 2022 water year.
- The salinity of the pit sump has stabilised at around 300mg/L TDS which is lower than the 400 t0 800 mg/L range of recent years.

6.2 Laboratory Analysis

The GLOS requires laboratory analysis of water samples collected from the following locations:

- Production bores (quarterly).
- Pit sumps (quarterly).
- Superficial Aquifer monitoring bores (quarterly).
- Leederville Aquifer monitoring bores (quarterly).
- DWER monitoring bores (annually).
- Surface Drainage lines (monthly when flowing).

Groundwater sampling for laboratory analysis was conducted in accordance with the GLOS. The production bore KL2P was not sampled during 2022 as it was not operational during the sampling rounds. A detailed assessment of compliance is provided in Section 7.0.

Time series plots of pH, chloride, total nitrogen, total phosphorus, and sulphate for a selection of monitoring locations (production bores, Superficial monitoring bores adjacent to the production bores and DWER bores closest to the production bores) are provided in Figures 32 to 34.

The laboratory analysis indicates:

- The Leederville Aquifer groundwater is fresh to brackish (300 to 2,000 mg/L TDS), with a neutral pH, and of sodium chloride type.
- The Superficial Aquifer is fresh to brackish (<100 to 2,500 mg/L TDS), with a neutral to slightly acidic pH and of the sodium chloride type.
- A plot of the salinity fluctuations in the Superficial Aquifer, using the December 2015 and 2022 data is provided in Figure 13 and indicates the overall trend is stable, although some temporal changes occur in areas undergoing active mining, which is to be expected. The maximum salinity has dropped below 3000 mg/L TDS for the first time in several years, which could be related to the reduced monitoring data due to landholder access issues.
- Time series plots of pH, chloride, nitrogen, phosphorus, and sulphate for selected bores are provided in Figures 32 to 34. Overall, the groundwater concentration of these analytes was stable across the reporting period, apart from wetland monitoring bore KWT3A which shows an increasing salinity trend since early 2021. The water quality in this bore shows an overall decreasing trend with salinity rising from less than 200 to around 800 mg/L TDS since early 2021, with chloride and sulphate concentrations also rising, although the pH and total nitrogen and phosphorus has remained stable. KWT3A is in an area that has been previously rehabilitated with a stable groundwater level trend for many years. The cause of the decreasing water quality is possibly not mining related.
- The remainder of the data does not indicate any adverse trends in water quality.

7.0 REGULATORY COMPLIANCE

The level of compliance with the operational monitoring schedule, during the review period is provided in Table 10. The reduced sampling frequency across the year was due to weather related access and landholder restrictions to bores are not being considered a non-compliance, given the reasonable efforts made by KLPL staff to collect the data.

Table 10: Summary of Monitoring Compliance

Scope	Minimum Frequency	Criteria	Compliance
Production Bore (KL2P & KL3P)	Monthly	Abstracted Volume	Yes
	Monthly	Water Level	Yes
	Monthly	Field Parameters (Schedule A)	Yes
	Quarterly	Laboratory Analysis (Schedule B)	Yes
Pit Sumps	Monthly	Abstraction Volume	Yes
	Monthly	Field Parameters (Schedule D)	Yes
	Quarterly	Laboratory Analysis (Schedule B & C)	Yes
Production Monitoring Bores (KL2 Obs & KL3 Obs)	Monthly	Water Level	Yes
	Monthly	Field Parameters (Schedule A)	Yes
Superficial Monitoring Bores (KS 1, 2, 3, 17, 21, 22)	Monthly	Water Level	Yes
	Monthly	Field Parameters (Schedule A)	Yes
Superficial Monitoring Bores (extended) (KS 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 ,16, 18, 19, 20)	Monthly	Water Level	Yes
	Monthly	Field Parameters (Schedule A)	Yes
	Quarterly	Laboratory Analysis (Schedule B & C)	Yes
Wetland Monitoring Bores (KWT1A, 1B, 1C, 1D, 1E 1F, 2A, 2B, 2C, 2D, 2E, 2F, 3A, KPD00064)	Monthly	Water Level	Yes
	Monthly	Field Parameters (Schedule A)	Yes
	Quarterly	Laboratory Analysis (Schedule B)	Yes
Leederville Monitoring Bores (KL 3, 4, 7, 8, KL1 Obs)	Monthly	Water Level	Yes
	Monthly	Field Parameters (Schedule A)	Yes
	Quarterly	Laboratory Analysis (Schedule B)	Yes
DWER Monitoring Bores (T610, 670, 570, 620)	Quarterly	DoW Monthly SWL data review	Yes
	Annually	Laboratory Analysis (Schedule B)	Yes
Surface Drainage Lines (SW 3, 4, 5, 6, 9, 10)	Monthly	Field Parameters (Schedule D)	Yes
	During Flow	Laboratory Analysis (Schedule E)	Yes

7.1 Trigger Level Compliance

Time series plots of the water level data along with trigger groundwater levels are presented in Figures 14 to 25. The Figures show that groundwater levels for all of the monitoring bores across the Keysbrook site were compliant, and above the trigger levels specified in the GLOS during the 2022 water year.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Keysbrook Leucoxene Pty Ltd (KLPL) owns the Keysbrook Mineral Sands Mine (Keysbrook) located approximately 70 km south of Perth, Western Australia. The project lies on the Swan Coastal Plain, within the Serpentine and Murray groundwater management areas, immediately west of the towns of Keysbrook and North Dandalup.

KLPL operate under four groundwater abstraction (5C) licences, sanctioning groundwater production of up to 1.8 GL per annum from the Leederville Aquifer and 0.6 GL per annum from the Superficial Aquifer. Abstraction from the Leederville Aquifer is permitted under GWL 164007(1), issued in December 2012 and expiring in December 2022. The three licences for the Superficial Aquifer relate to the mining areas lying within the Shires of Murray (GWL176404(1)) and Serpentine-Jarrahdale (GWL177296(1) & GWL 177336(1)).

The results from the 2022 monitoring can be summarised as follows:

- Annual rainfall from the nearest registered weather station (Mandurah) was 594.8 mm, which represents 68% of the long term average of 874.9mm.
- 2021 was the wettest year in the region since 2012. 2022 recorded 83.6mm less rain across the water year compared with 2021.
- A total of 934,295 kL was abstracted from the production bores (KL2P and KL3P) for the purposes of mineral processing during the reporting period, which constitutes 51.9% of the annual allocation of 1.8 GL.
- A total of 2,361,636 kL was pumped back as recycled water, recovered from tailings backfill to the active mine pits (Section 3.1).
- It is estimated that the nett pit dewatering was around -86,248 kL, representing an overall loss or recharge to the surficial aquifer, as a result of tailings water deposition. No active dewatering from sump pumping took place during 2022.
- The groundwater level in the Superficial Aquifer continues to demonstrate a cyclical seasonal variability, forming a peak around August and September each year, following the winter rains, and a trough around March-April at the end of the dry season.
- The monitoring data for the reporting period does not indicate any adverse impacts to the Superficial Aquifer associated with pit dewatering and tailings discharge.
- Groundwater quality monitoring indicates that the Superficial Aquifer is fresh to brackish, with a neutral to slightly acidic pH and of sodium chloride type. The salinity varied between less than 100 to around 2,500 mg/L TDS across the reporting period. There appears to be a seasonal trend in salinity in some of the bores, which is likely a function of rainfall recharge, whilst variability in other bores appears to be due to the complex hydraulic characteristics of the interbeds of the aquifer.
- Groundwater quality monitoring indicates the Leederville Aquifer is fresh to brackish, with a neutral pH and of sodium chloride type. Groundwater salinity varying from about 300 to 2,000 mg/L TDS.
- The water chemistry analyses do not indicate any adverse trends in pH, chloride, nitrogen, sulphate in the Superficial or Leederville aquifers during the reporting period.
- Groundwater monitoring during the reporting period has met the commitments in the GLOS, which demonstrates KLPL's commitment to managing the water resource.

CONCLUSIONS AND RECOMMENDATIONS

The following recommendations are made as a result of the data review:

- Bores KS6 and KWT1F have been either damaged or mined out and should be replaced or removed from the GLOS at the next revision.
- The DWER bore T670 data is no longer required to be monitored, so the bore should be removed from the monitoring schedule when the GLOS is next revised.
- The monitoring schedule in Table 8 of the GLOS has several errors that will be amended when the GLOS is submitted as part of the current approvals. These errors are:
  - the Schedule C sampling (which relates to field parameter analysis) should not appear in the Laboratory Analysis column and should be corrected, likewise,
  - the in-pit sumps should be monitored with the Schedule C parameters, instead of Schedule B, in the Field analysis column.

Signatures

Groundwater Resource Management Pty Ltd

Peter Mayers

PRINCIPAL HYDROGEOLOGIST

Doc Ref: J2302R01

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FIGURES

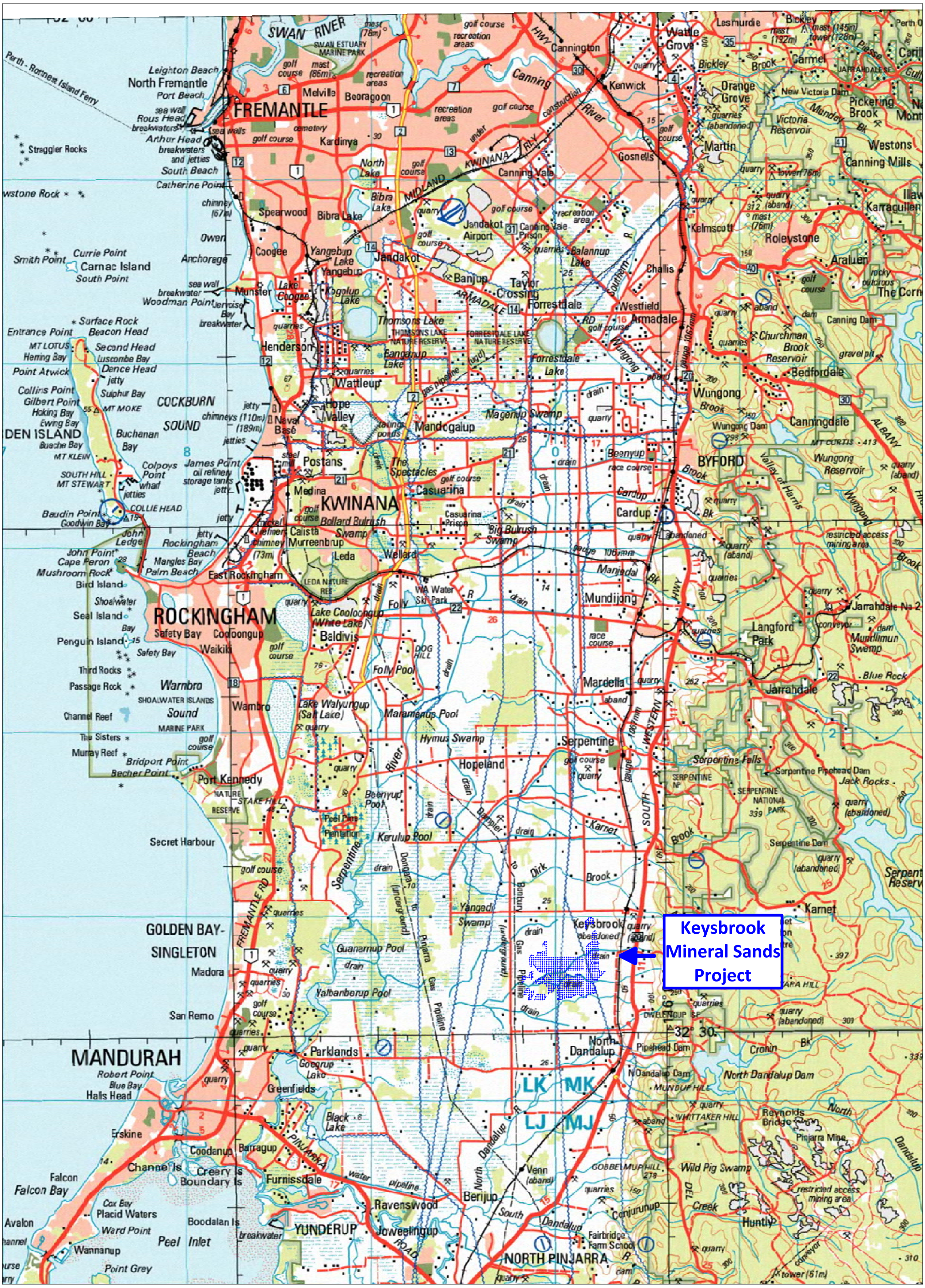
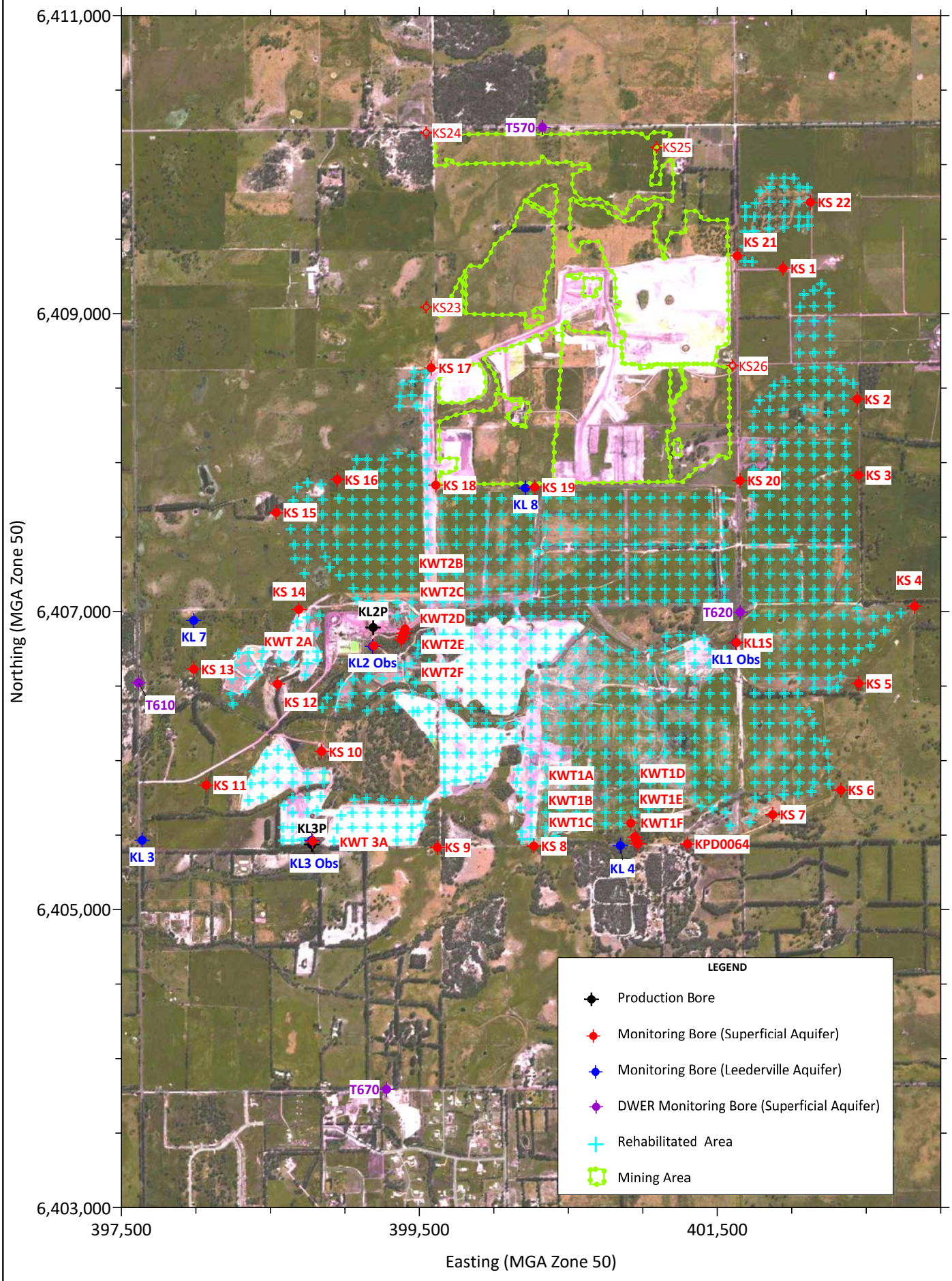


FIGURE 1
LOCATION PLAN

Date Feb 23
Client Keysbrook Leucoxene Pty Ltd
Project 2022 Monitoring Report
Document J2302R01



GROUNDWATER RESOURCE MANAGEMENT

FIGURE 2
BORE LOCATION PLAN

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Coordinate System
GDA94 Zone 50

Data Sources

SCALE 1:35,000
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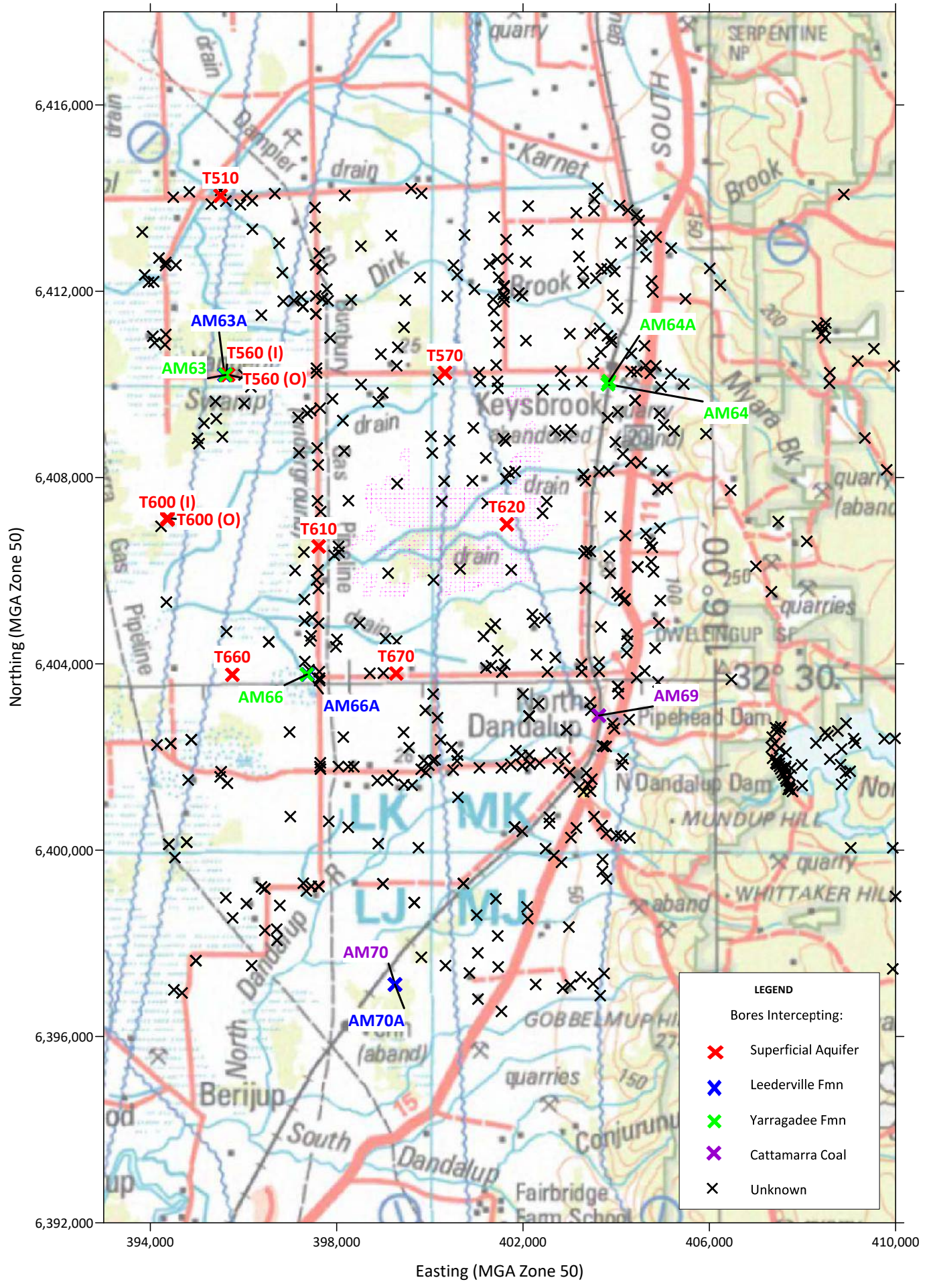
FILE:/Jobs 2023/J2302/figures/surfer/Fig2 Bore location plan.srf



GROUNDWATER RESOURCE MANAGEMENT

FIGURE 3
OTHER GROUNDWATER USERS

Date Feb 23
Client Keysbrook Leucoxene Pty Ltd
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Coordinate System GDA94 Zone 50
Notes

Data Sources

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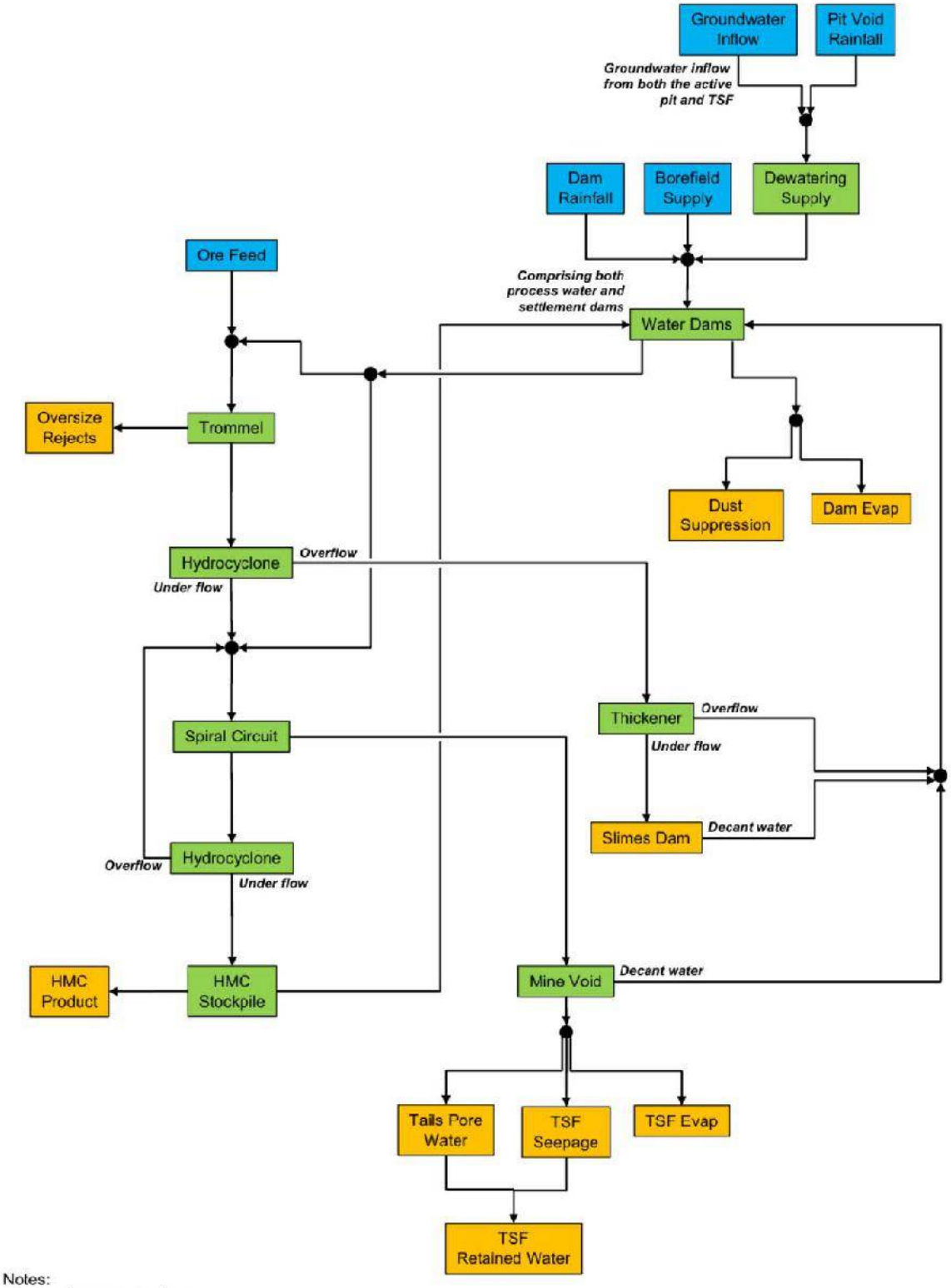

FIGURE 4
WATER BALANCE

Date Feb 22
Client Keysbrook Leucoxene Pty Ltd
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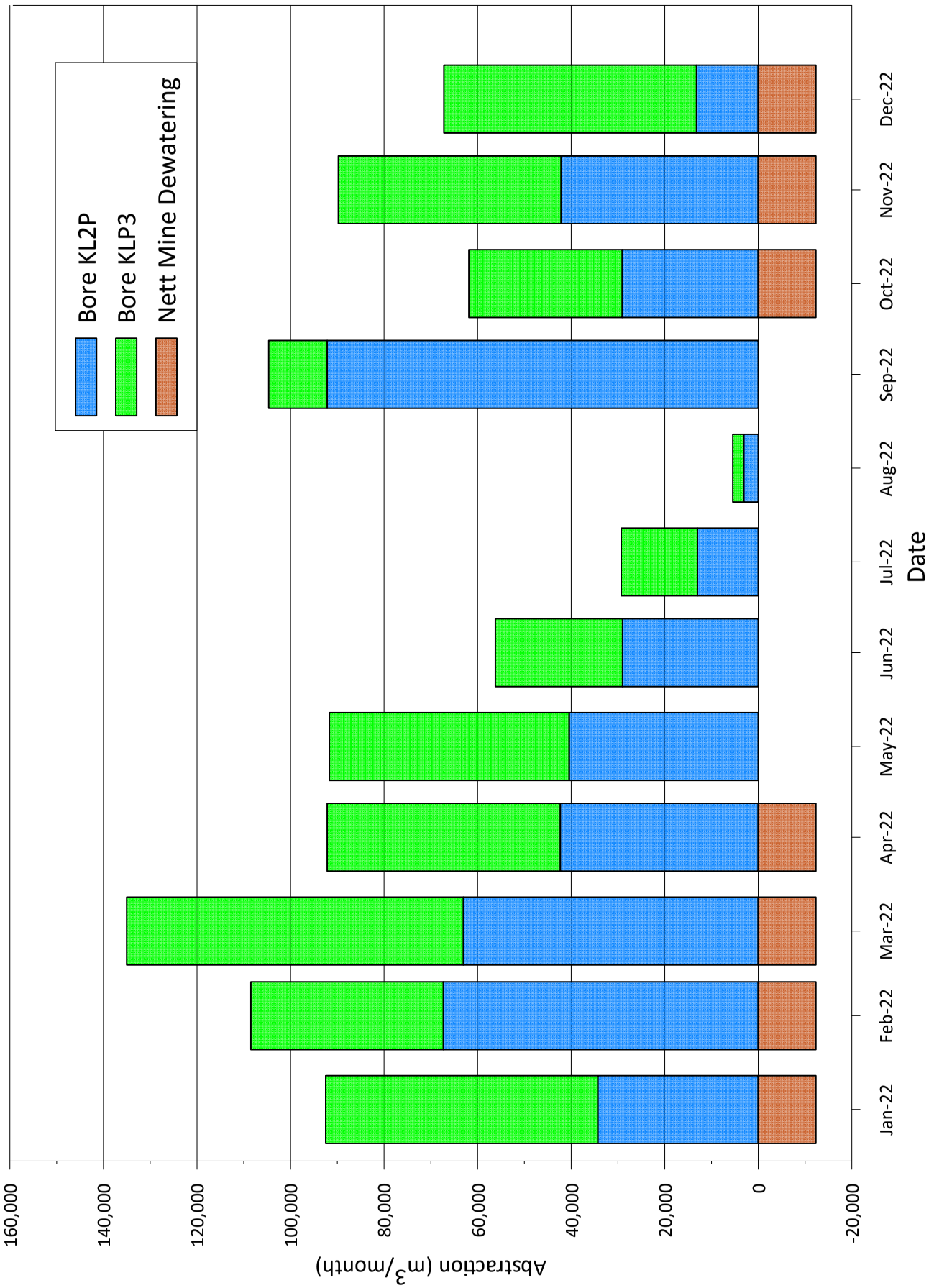

GROUNDWATER RESOURCE MANAGEMENT

FIGURE 5
GROUNDWATER ABSTRACTION

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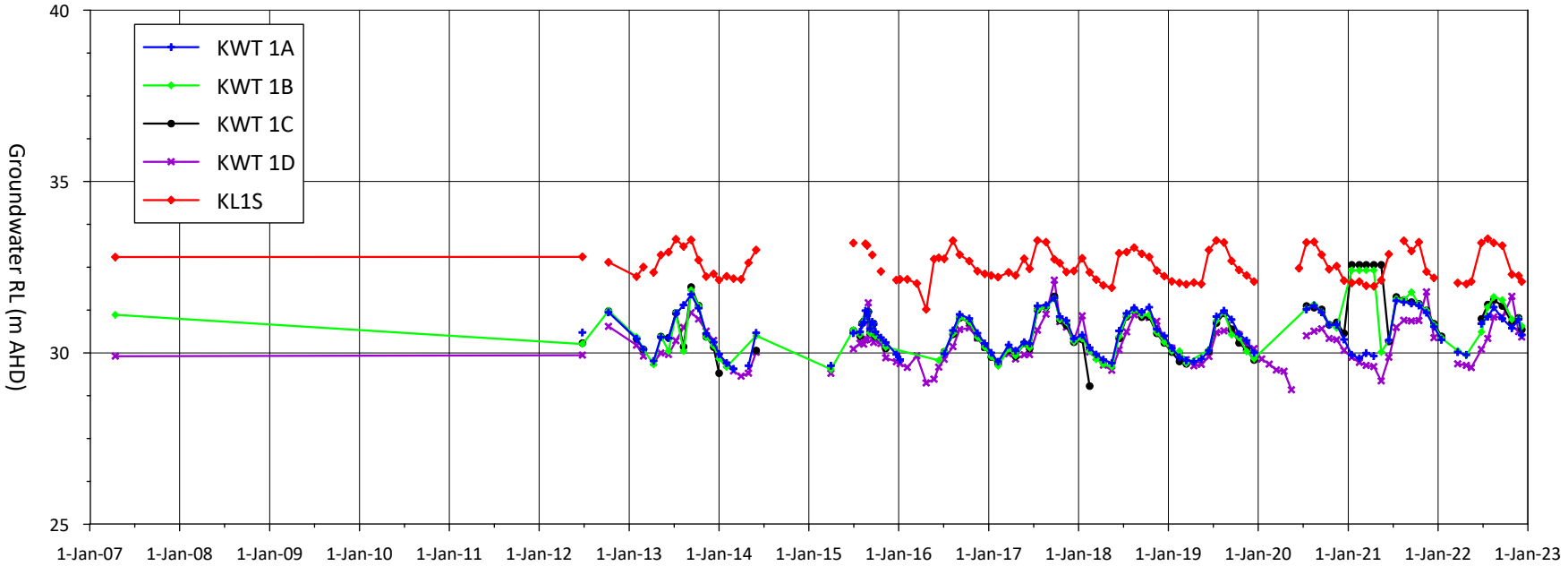
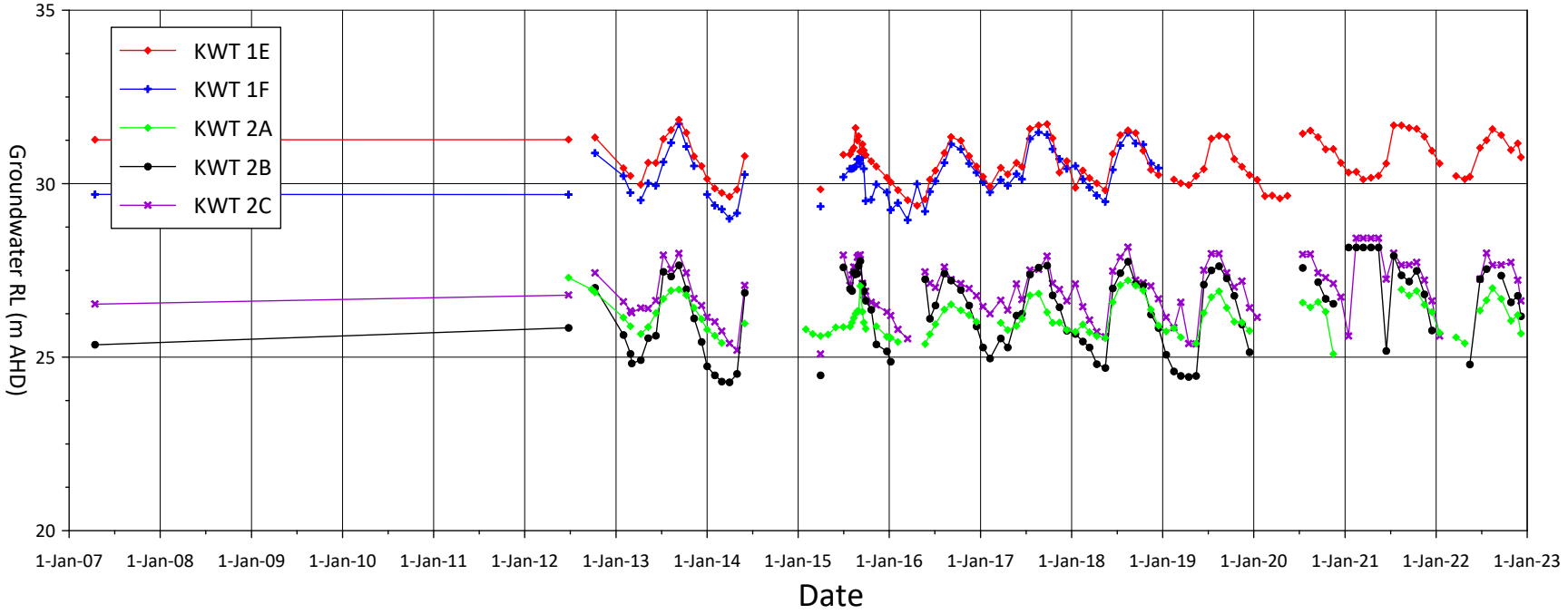
Document J2302R01

D:\GRM Dropbox\GRM Team Folder\Jobs 2023\J2302 Keysbrook monitoring report\figures\grapher\2022_report\Fig5 Groundwater Abstraction.grf

GROUNDWATER RESOURCE MANAGEMENT

FIGURE 6
GROUNDWATER LEVELS
SUPERFICIAL AQUIFER
KLS 1 TO KWT 2C





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GROUNDWATER RESOURCE MANAGEMENT

FIGURE 7
GROUNDWATER LEVELS
SUPERFICIAL AQUIFER
KWT 2D TO KS 6

Date Feb 23
Client Keysbrook Leucoxene Pty Ltd
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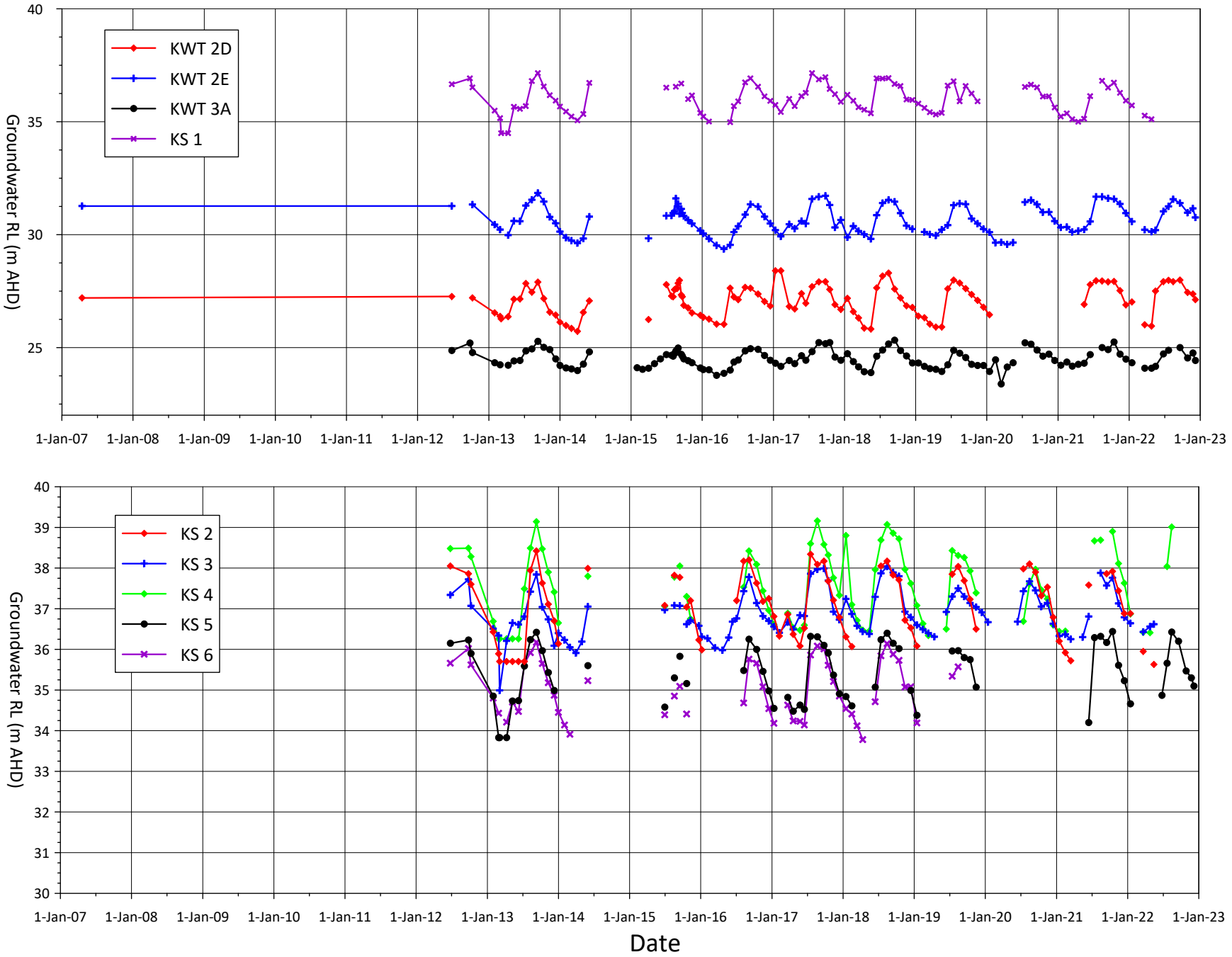
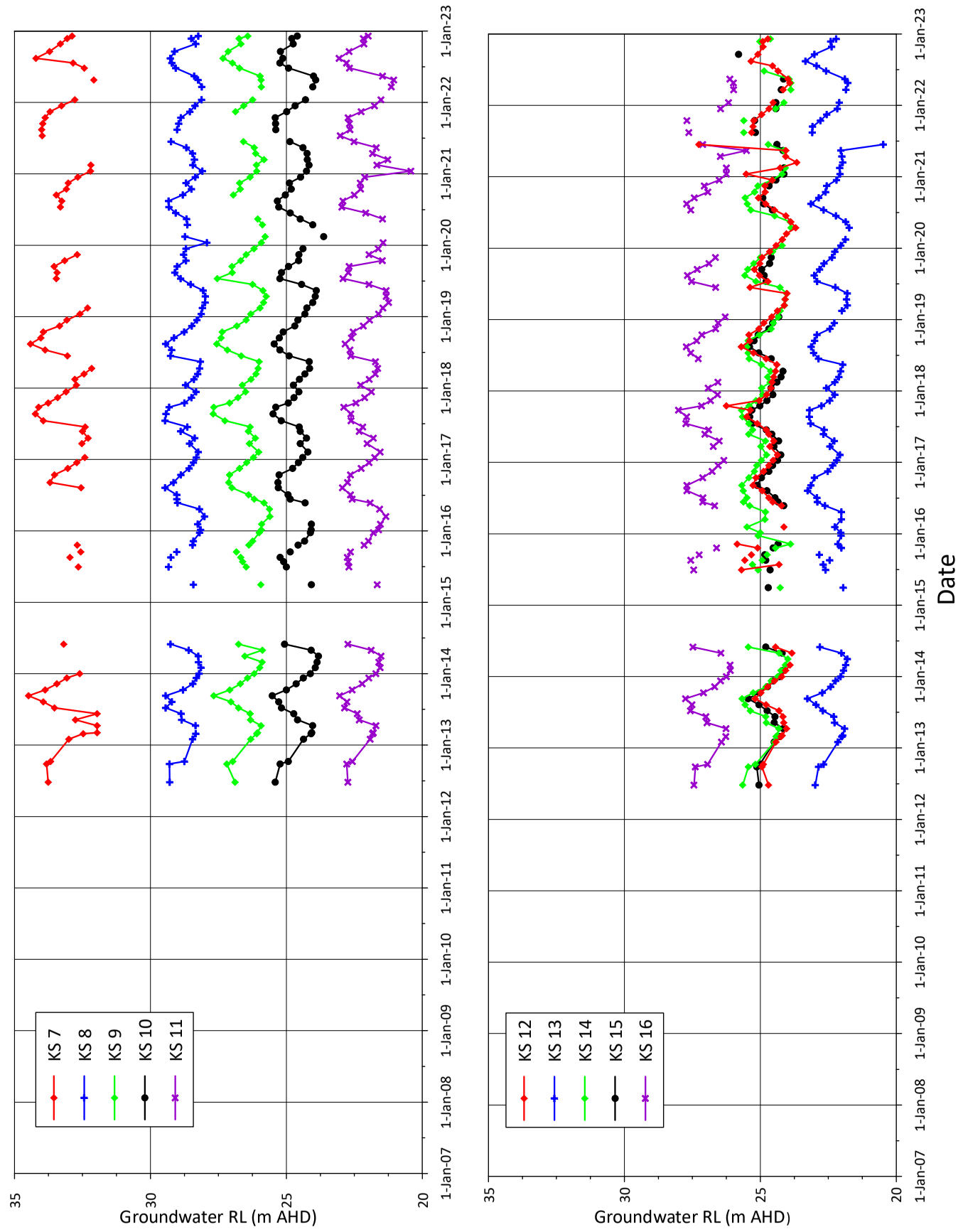
Notes:





GROUNDWATER RESOURCE MANAGEMENT

FIGURE 8
GROUNDWATER LEVELS
SUPERFICIAL AQUIFER
KS 7 TO KS 16

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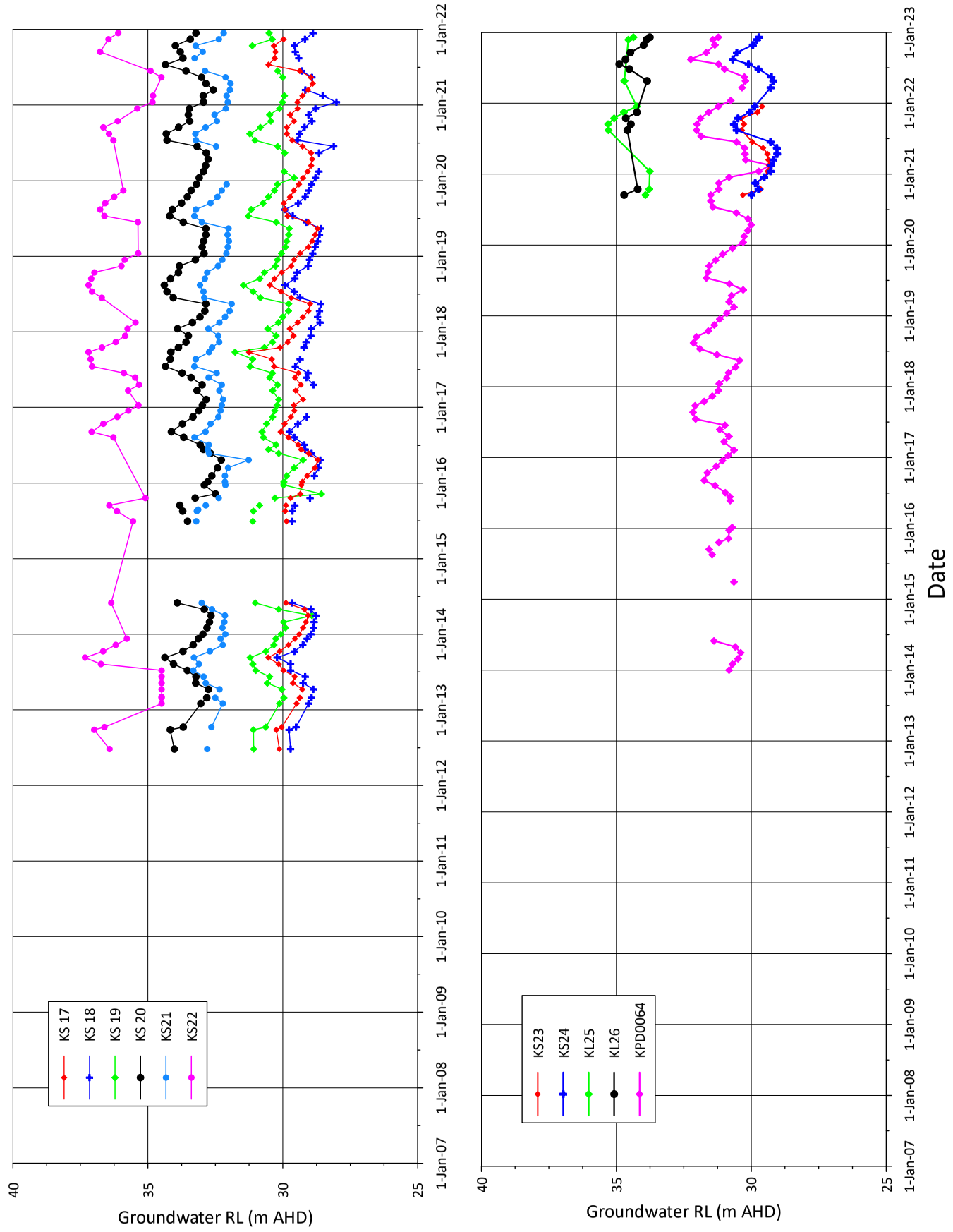

GROUNDWATER RESOURCE MANAGEMENT

FIGURE 9
GROUNDWATER LEVELS
SUPERFICIAL AQUIFER
KS 17 TO KS 22 KPD0064

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Notes:

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GROUNDWATER RESOURCE MANAGEMENT

FIGURE 10
GROUNDWATER LEVELS
LEEDERVILLE AQUIFER
KL1 Obs TO KL 8

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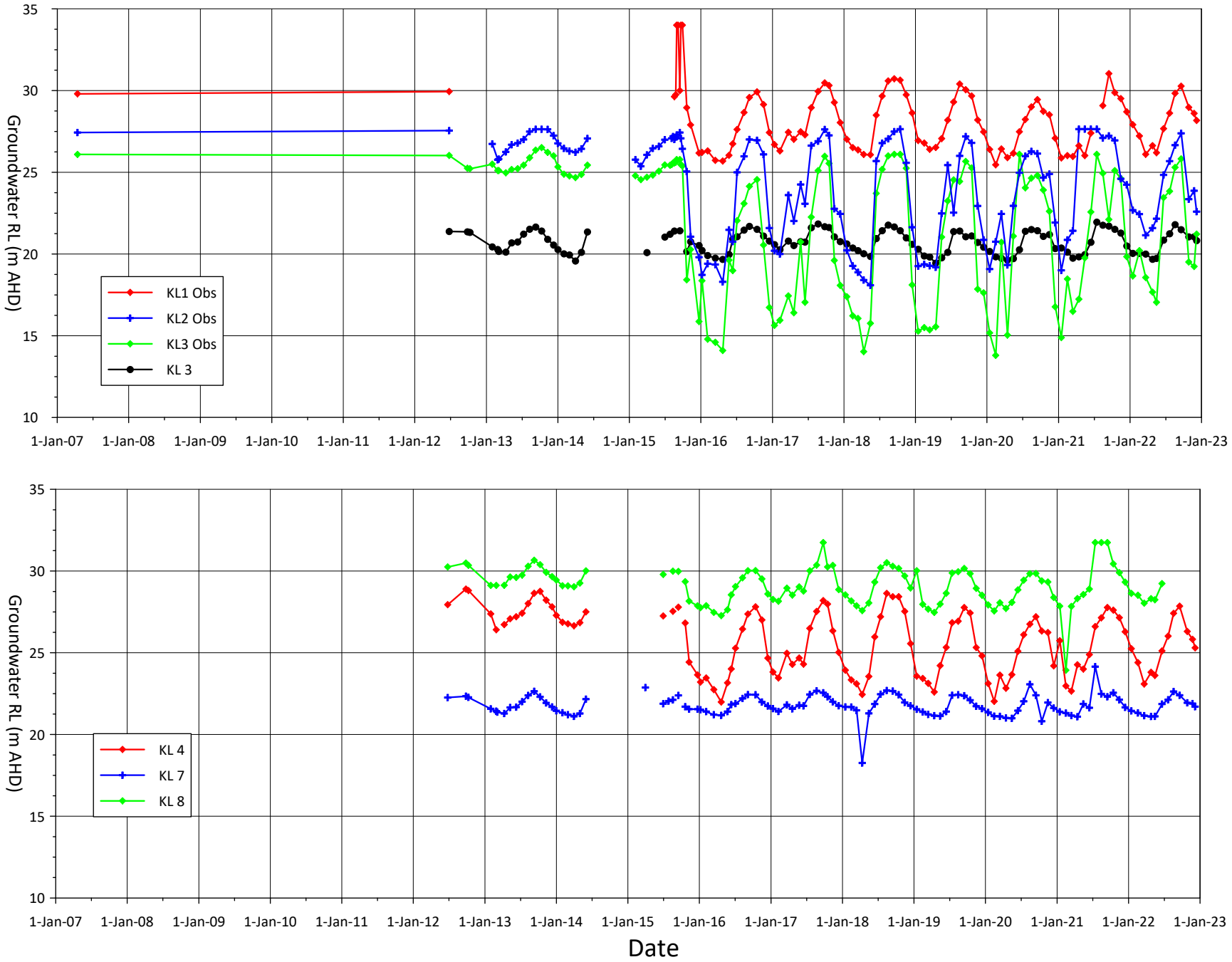
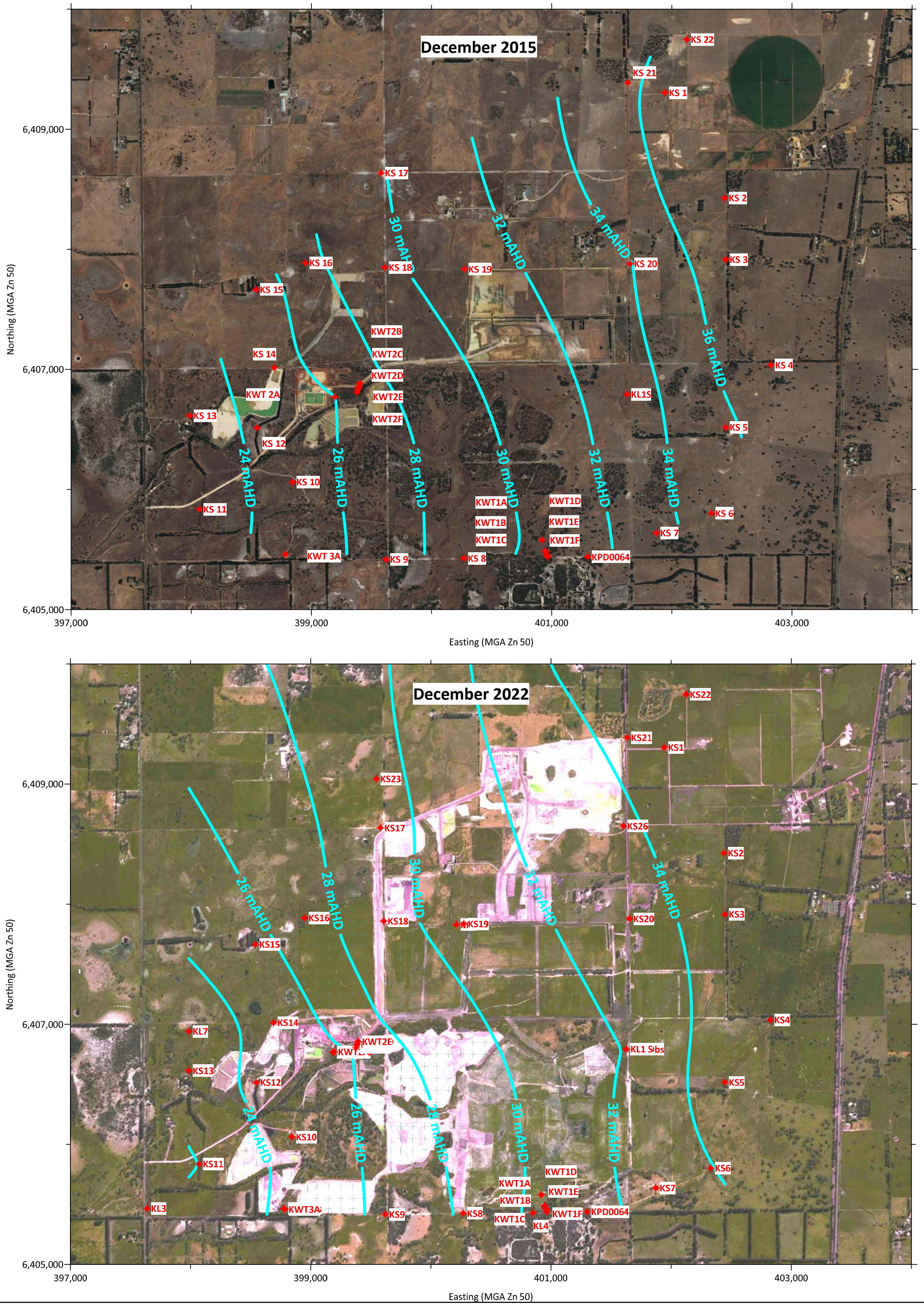
Client Keysbrook Leucoxene Pty Ltd
Project 2022 Monitoring Report
Document J2302R01

Notes:





GROUNDWATER RESOURCE MANAGEMENT

FIGURE 11
SUPERFICIAL AQUIFER WL CONTOURS DEC 2015 & 2022

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Document J2302R01

Coordinate System
GDA94 Zone 51

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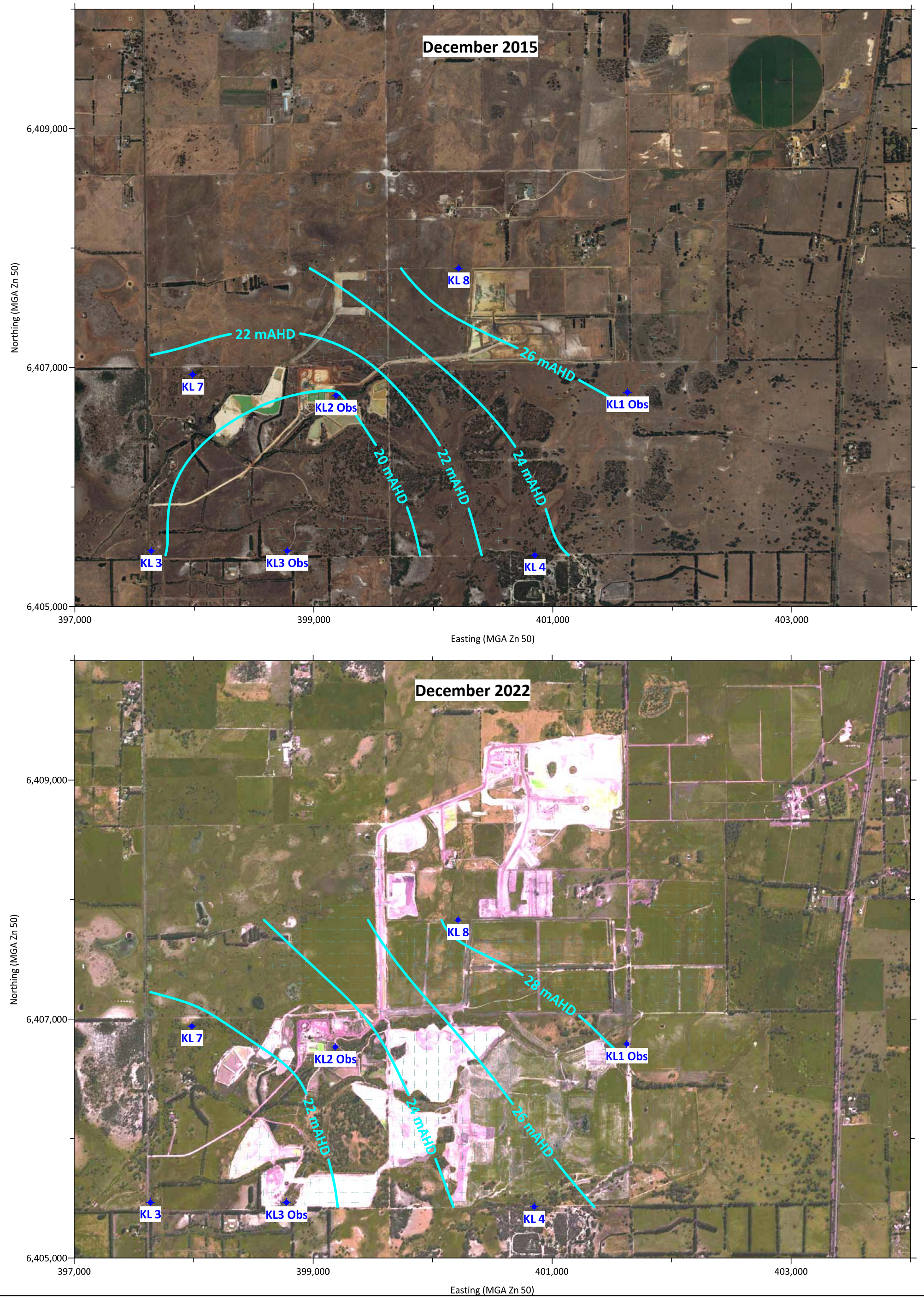

GROUNDWATER RESOURCE MANAGEMENT

FIGURE 12
LEEDERVILLE AQUIFER WL CONTOURS DEC 2015 & 2022

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Client Keysbrook Leucoxene Pty Ltd
Project 2022 Monitoring Report
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Coordinate System
GDA94 Zone 51

Note:- Bore Bore KL8 data averaged for the 2022 year as unable to access bore after June due to landholder

SCALE 1:30,000
0m 2,000m

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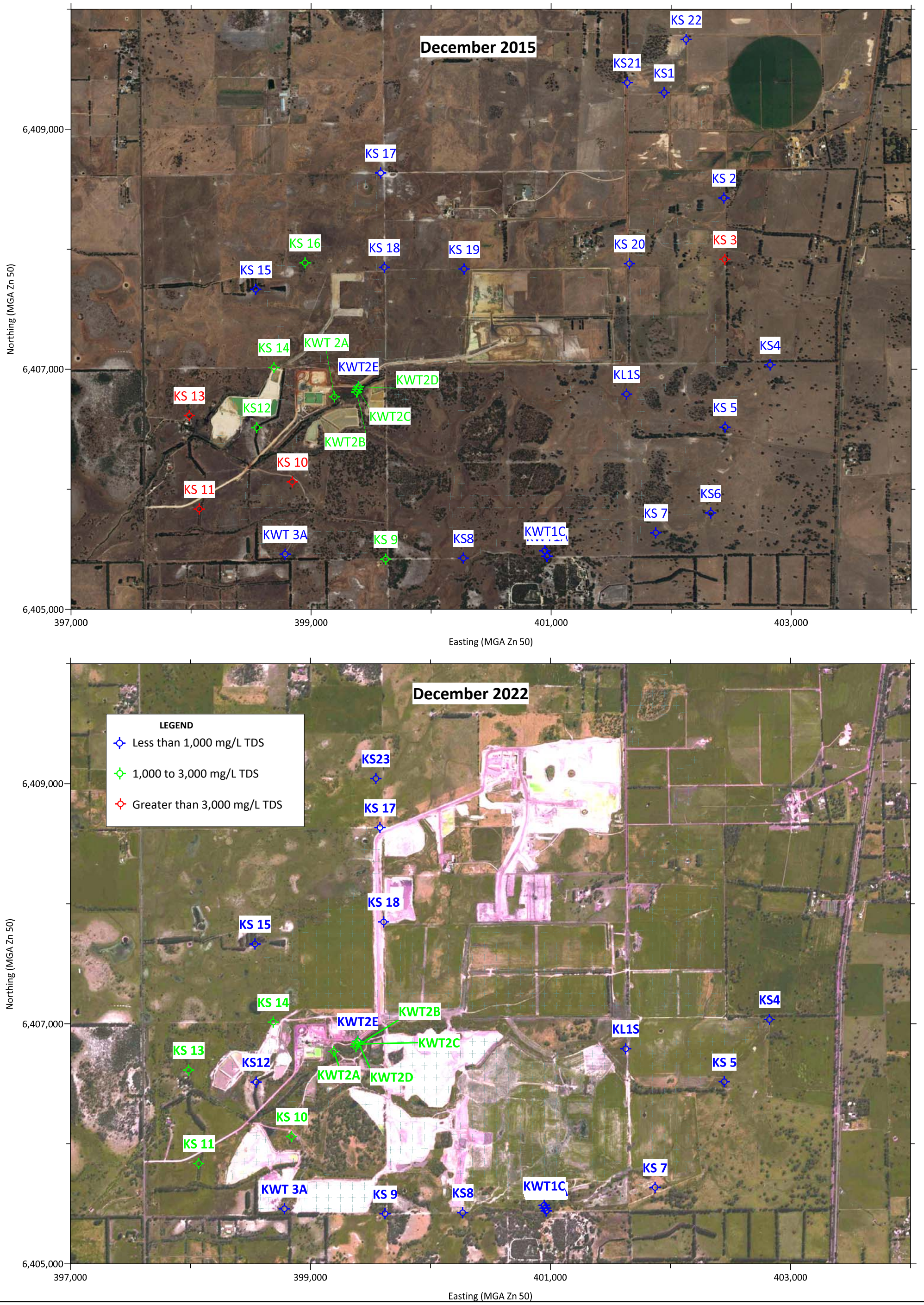

GROUNDWATER RESOURCE MANAGEMENT

FIGURE 13
SURFICIAL AQUIFER SALINITY DISTRIBUTION DEC 2015 & 2022

Date Feb 23
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Project 2022 Monitoring Report
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Coordinate System
GDA94 Zone 51

Note:- Bore Bore KL8 data averaged for the 2022 year as unable to access bore after June due to landholder

SCALE 1:30,000
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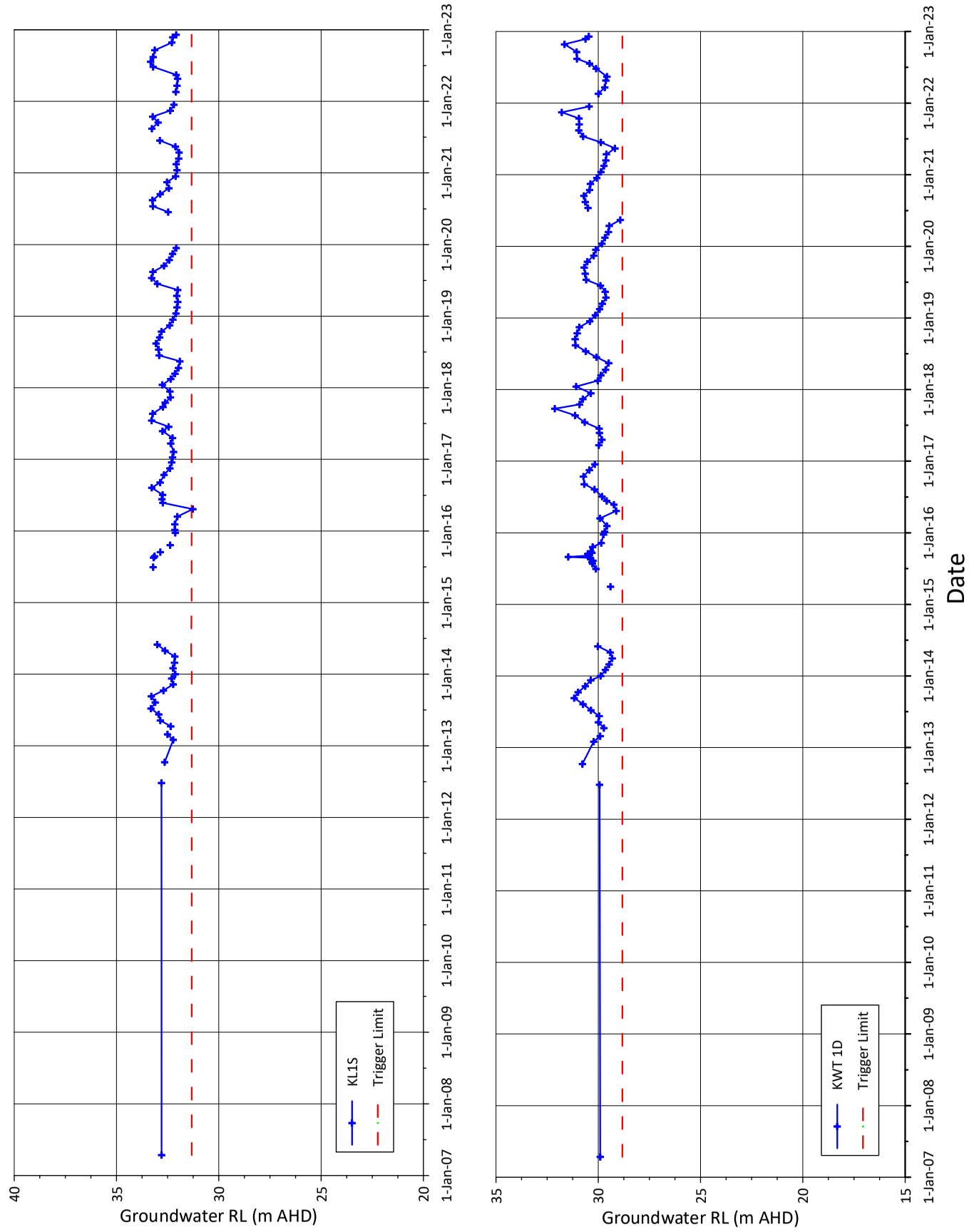

GROUNDWATER RESOURCE MANAGEMENT

FIGURE 14
TRIGGER LIMITS
SUPERFICIAL AQUIFER
KL1S & KWT 1D

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Notes:

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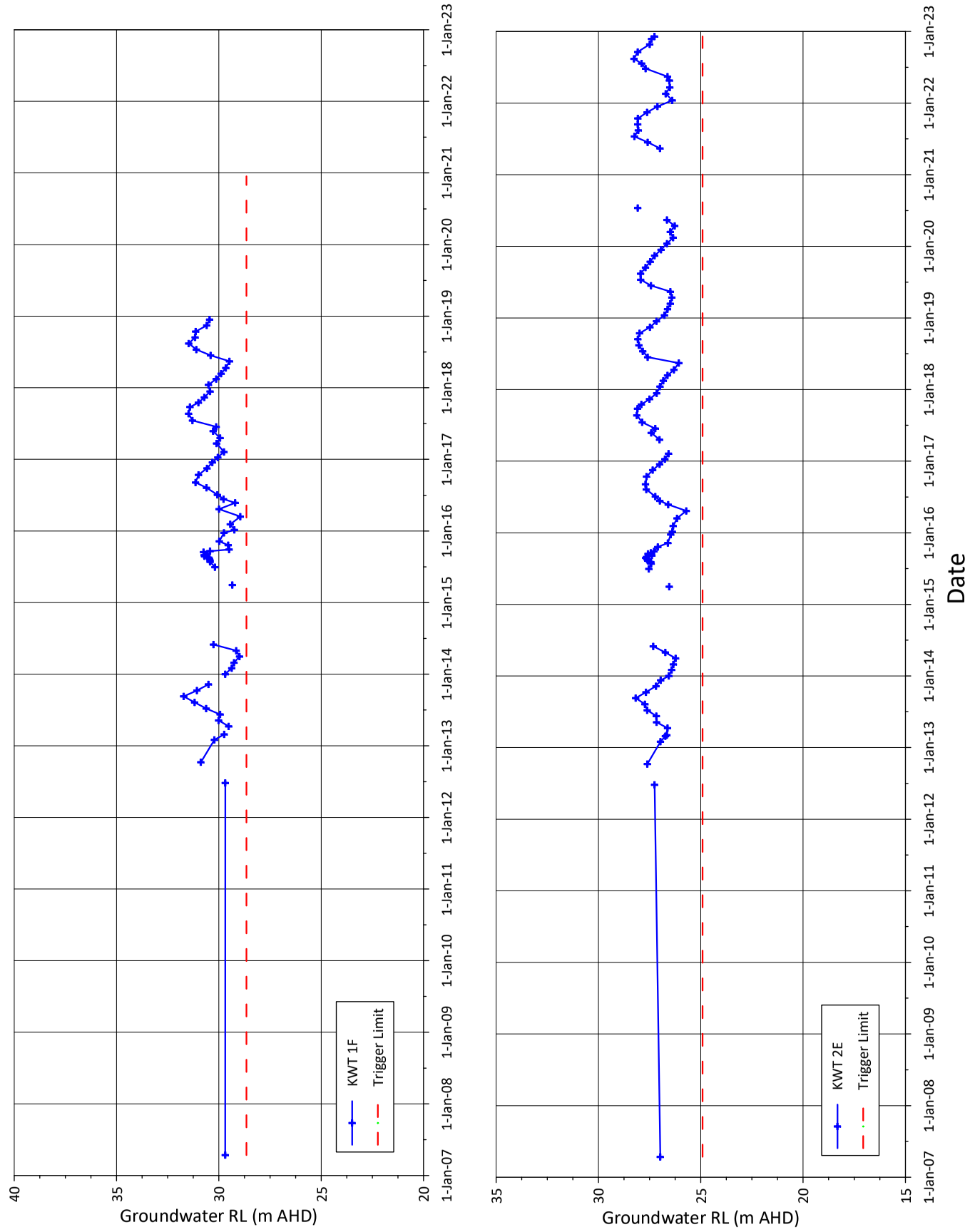

GROUNDWATER RESOURCE MANAGEMENT

FIGURE 15
TRIGGER LIMITS
SUPERFICIAL AQUIFER
KWT 1F & KWT 2E

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Client Keysbrook Leucoxene Pty Ltd
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Notes:

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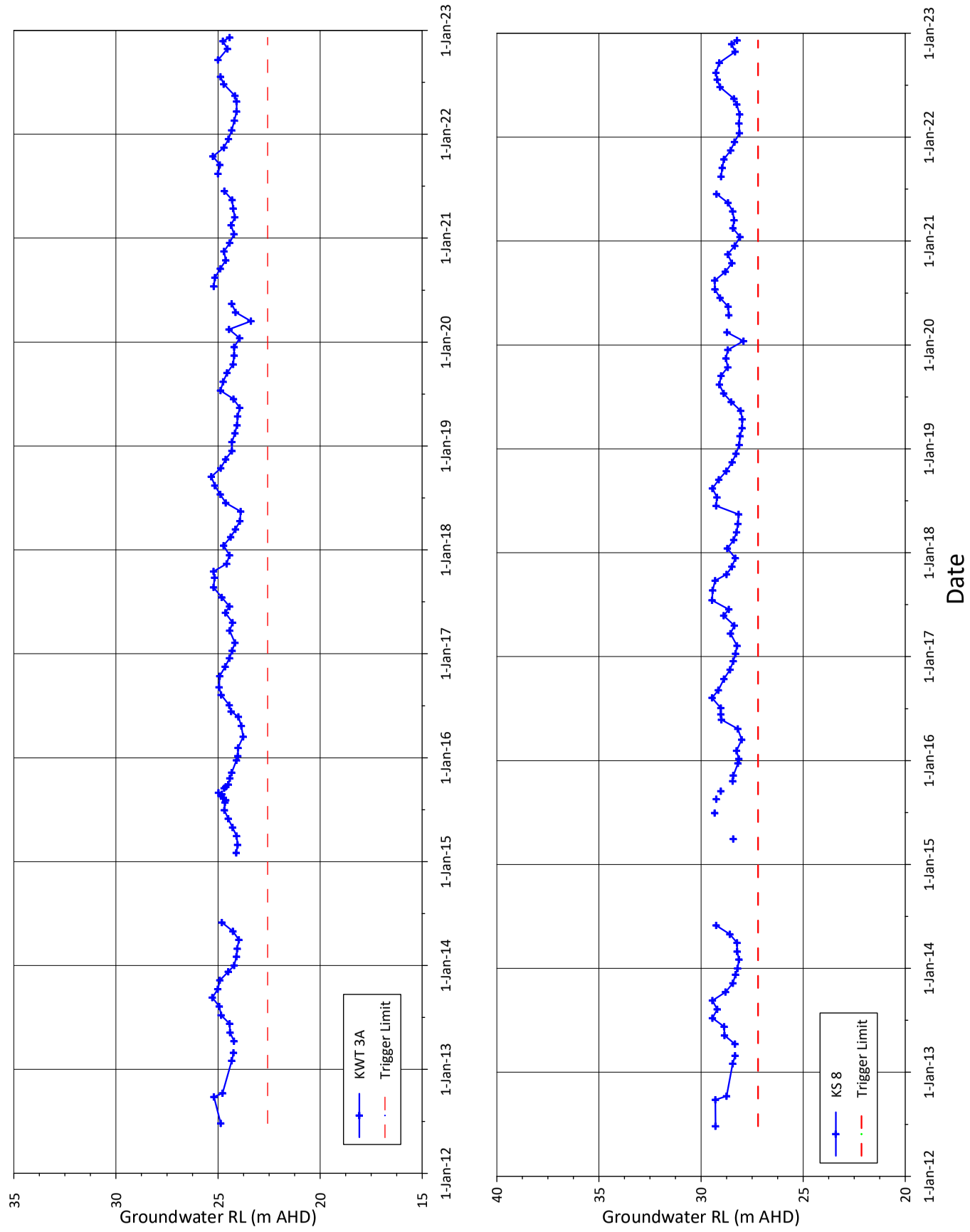

GROUNDWATER RESOURCE MANAGEMENT

FIGURE 16
TRIGGER LIMITS
SUPERFICIAL AQUIFER
KWT 3A & KS 8

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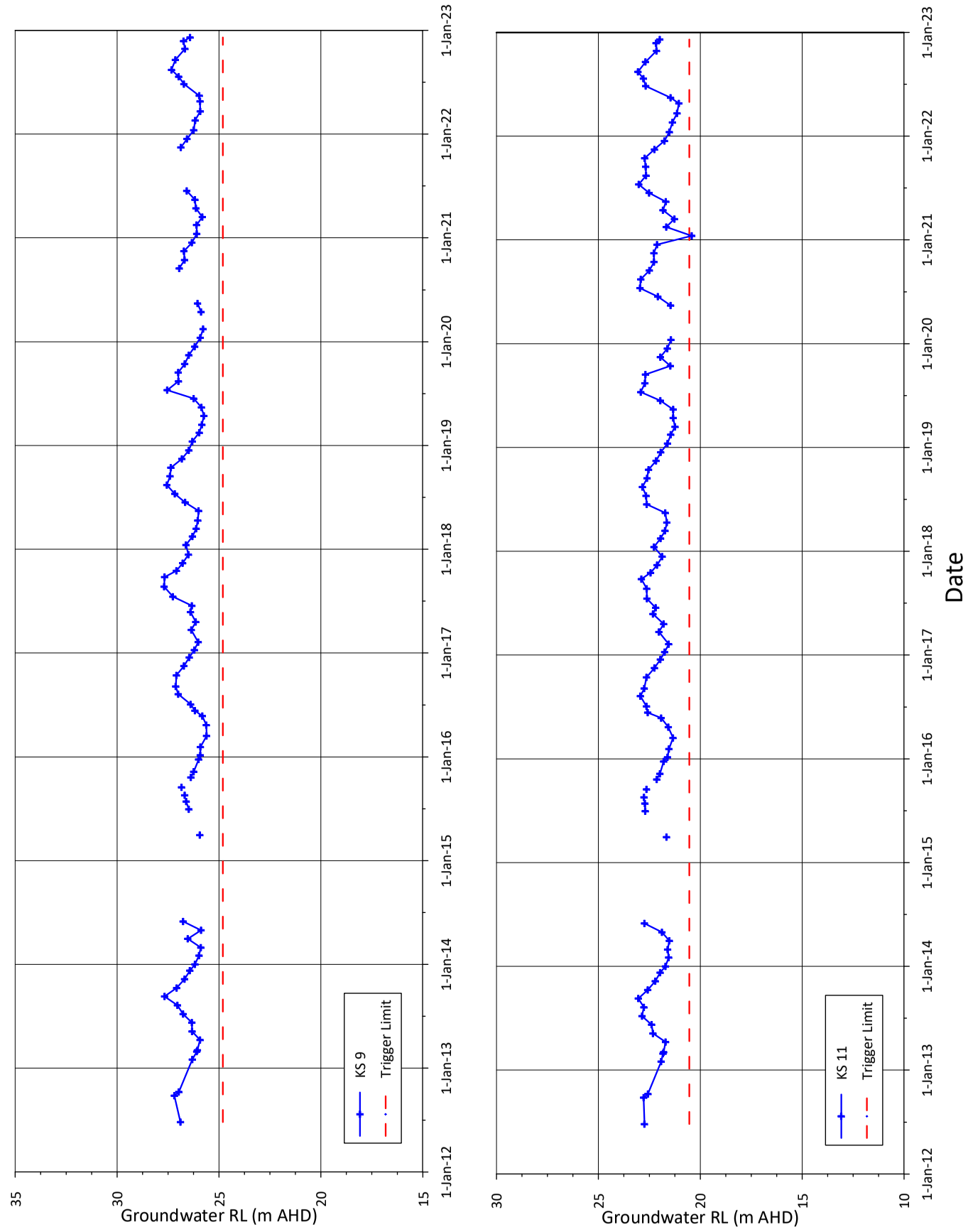

GROUNDWATER RESOURCE MANAGEMENT

FIGURE 17
TRIGGER LIMITS
SUPERFICIAL AQUIFER
KS 9 & KS 11

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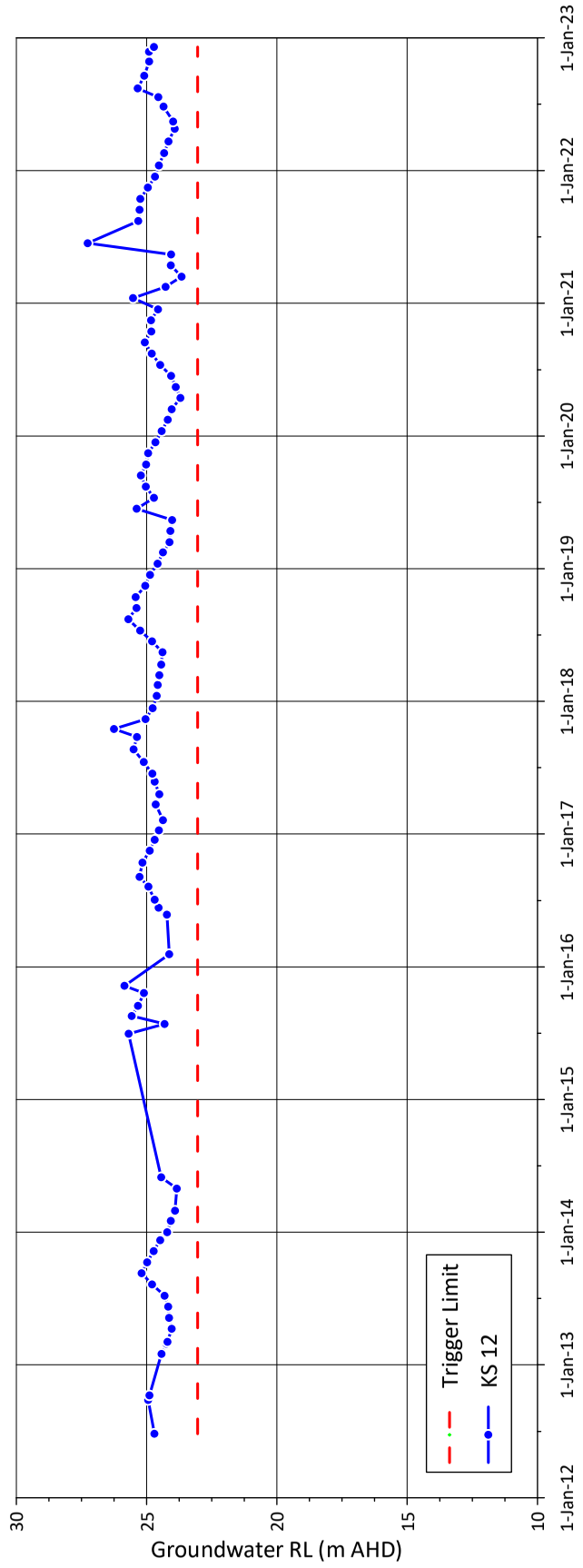

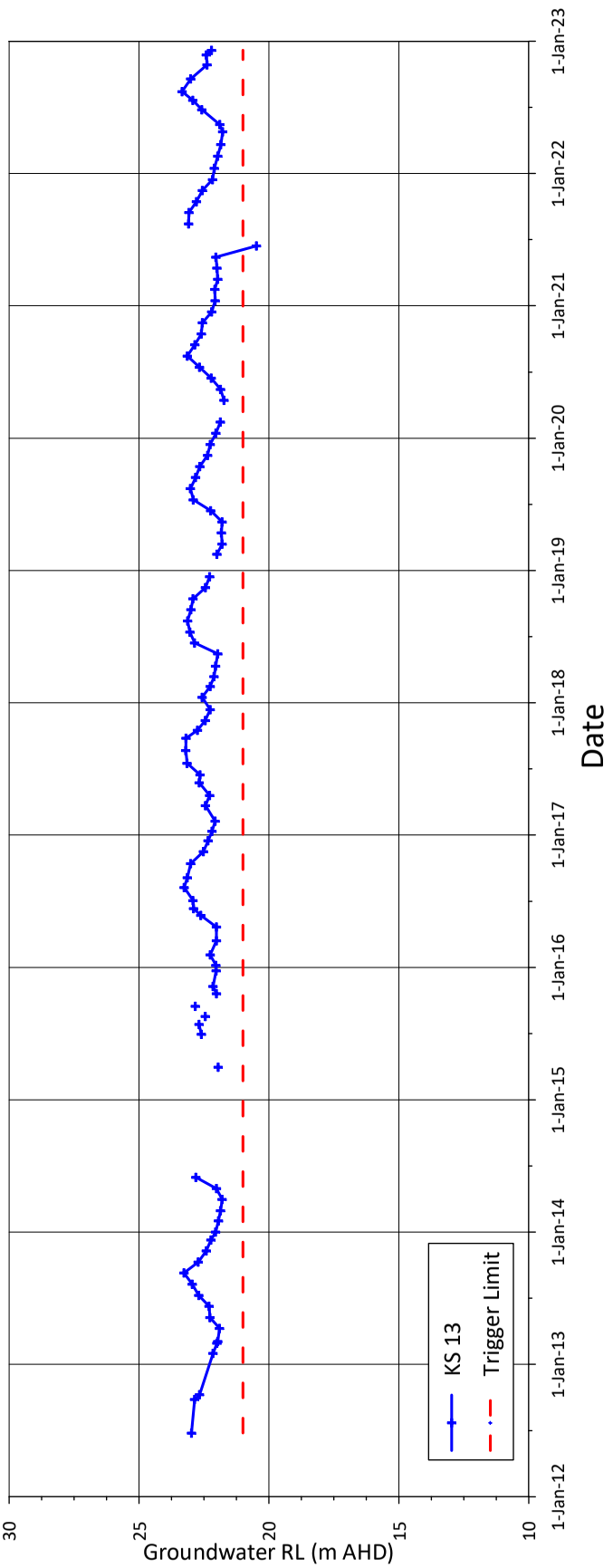

GROUNDWATER RESOURCE MANAGEMENT

FIGURE 18
TRIGGER LIMITS
SUPERFICIAL AQUIFER
KS 12 & KS 13

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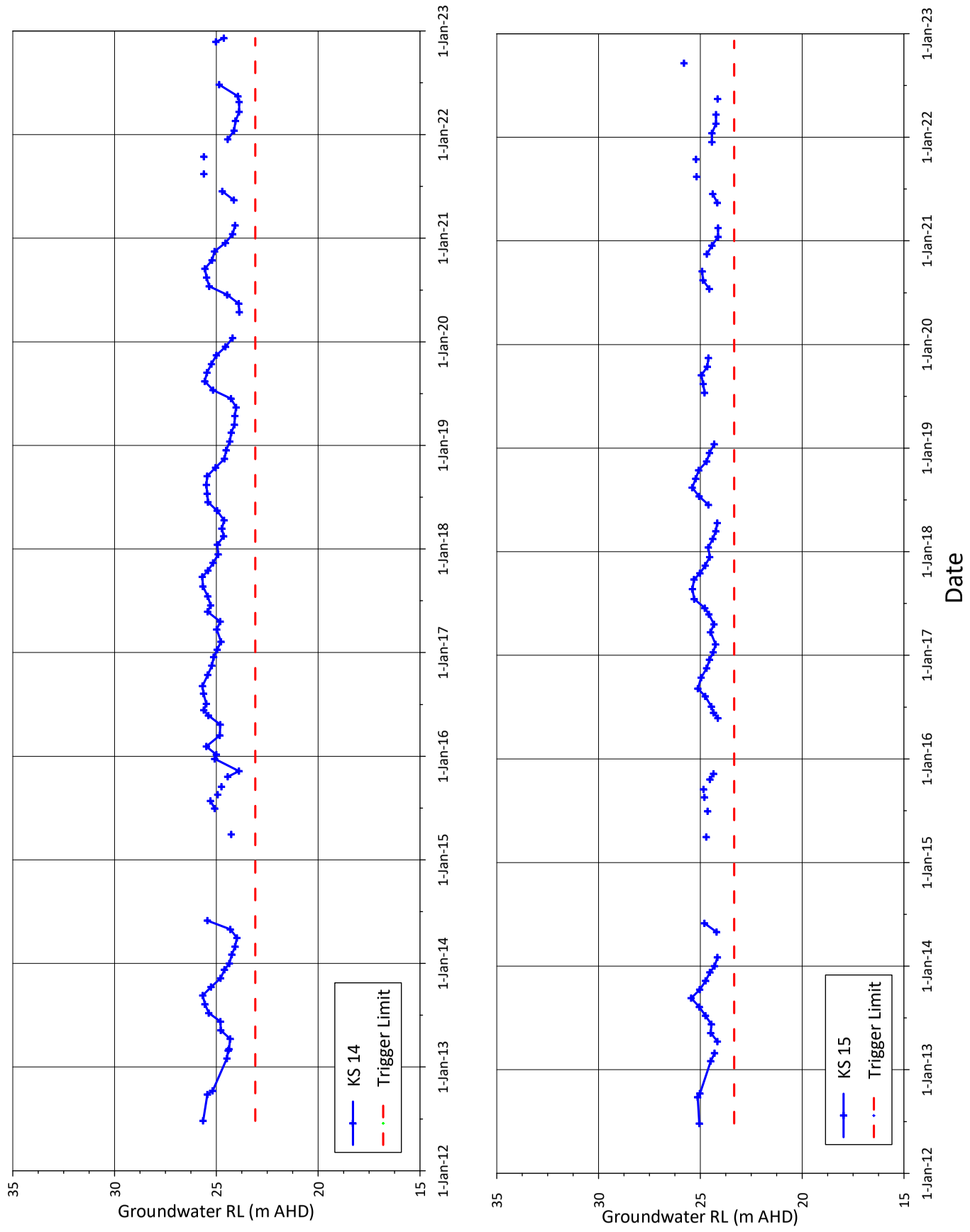
D:\GRM Dropbox\GRM Team Folder\Jobs 2023\J2302 Keysbrook monitoring report\figures\grapher\2022_report\Fig18 Trigger WLs Surficial KS 12 & KS 13.grf



GROUNDWATER RESOURCE MANAGEMENT

FIGURE 19
TRIGGER LIMITS
SUPERFICIAL AQUIFER
KS 14 & KS 15

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Client Keysbrook Leucoxene Pty Ltd
Project 2022 Monitoring Report
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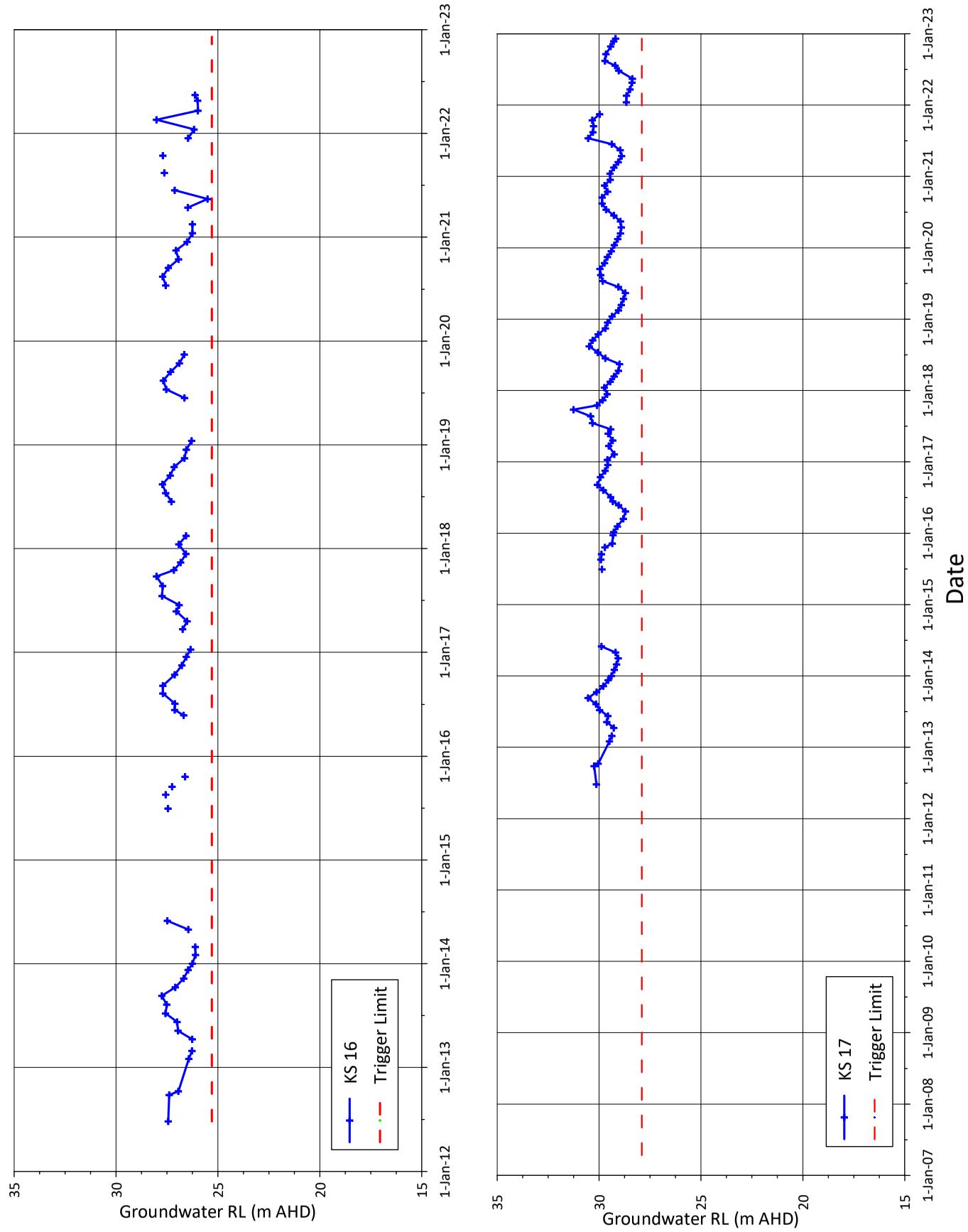

GROUNDWATER RESOURCE MANAGEMENT

FIGURE 20
TRIGGER LIMITS
SUPERFICIAL AQUIFER
KS 16 & KS 17

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Notes:

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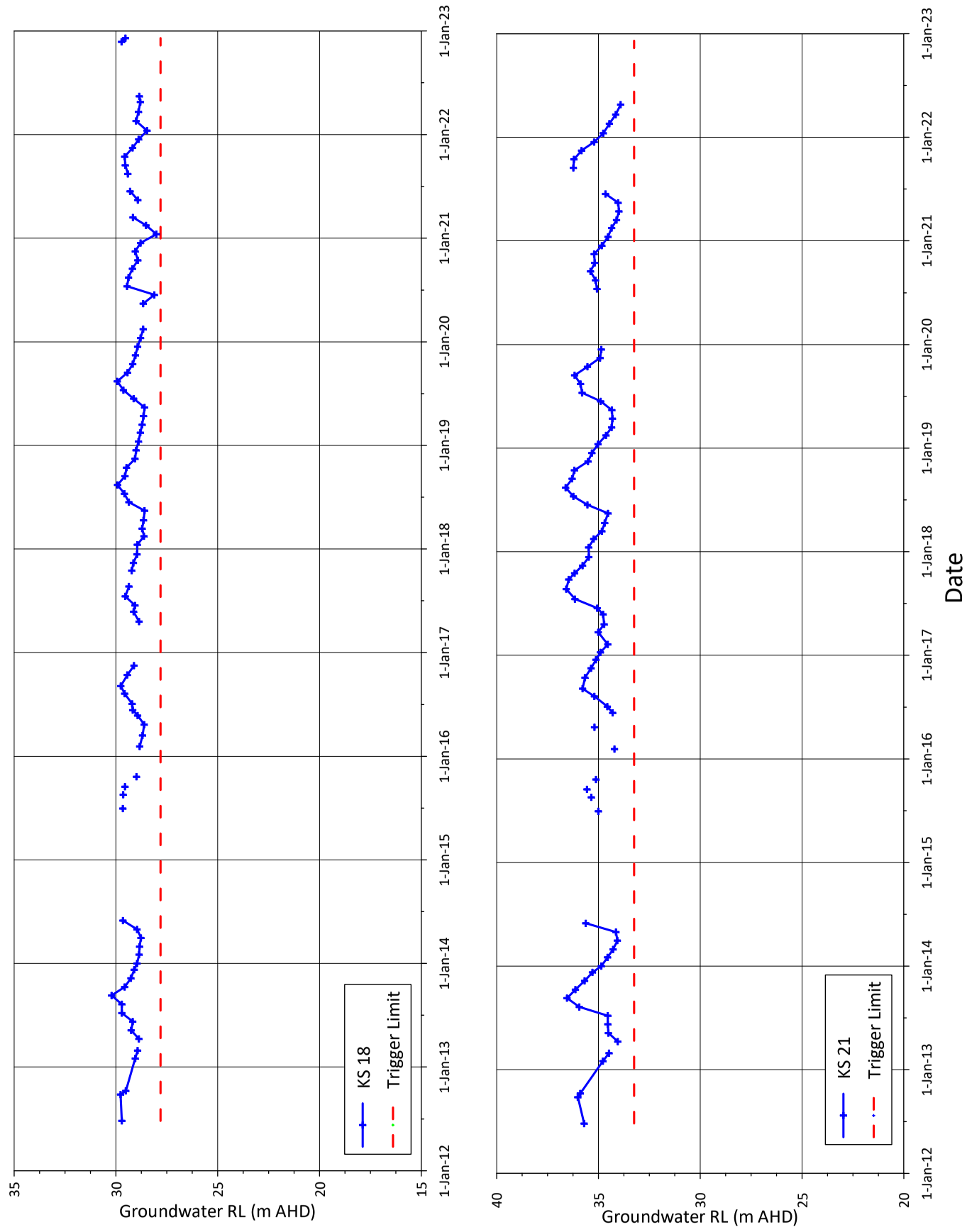

GROUNDWATER RESOURCE MANAGEMENT

FIGURE 21
TRIGGER LIMITS
SUPERFICIAL AQUIFER
KS 18 & KS 21

Date Mar 23
Client Keysbrook Leucoxene Pty Ltd
Project 2022 Monitoring Report
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Notes:

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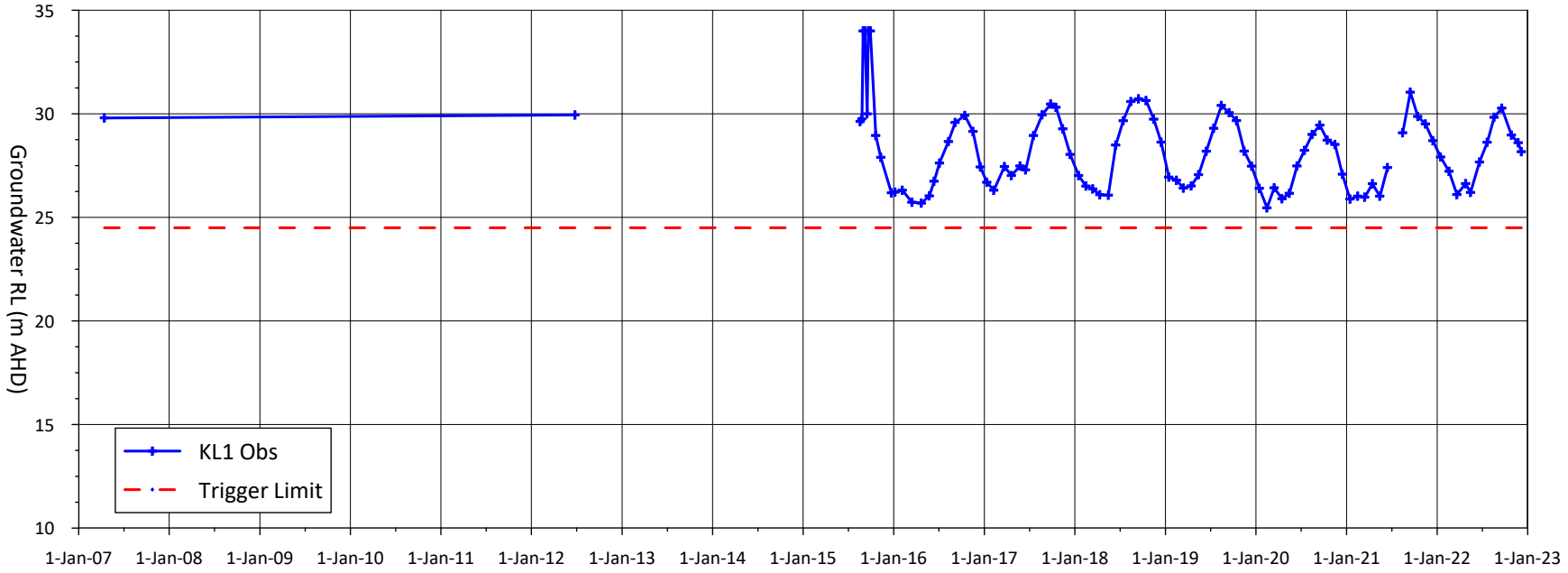
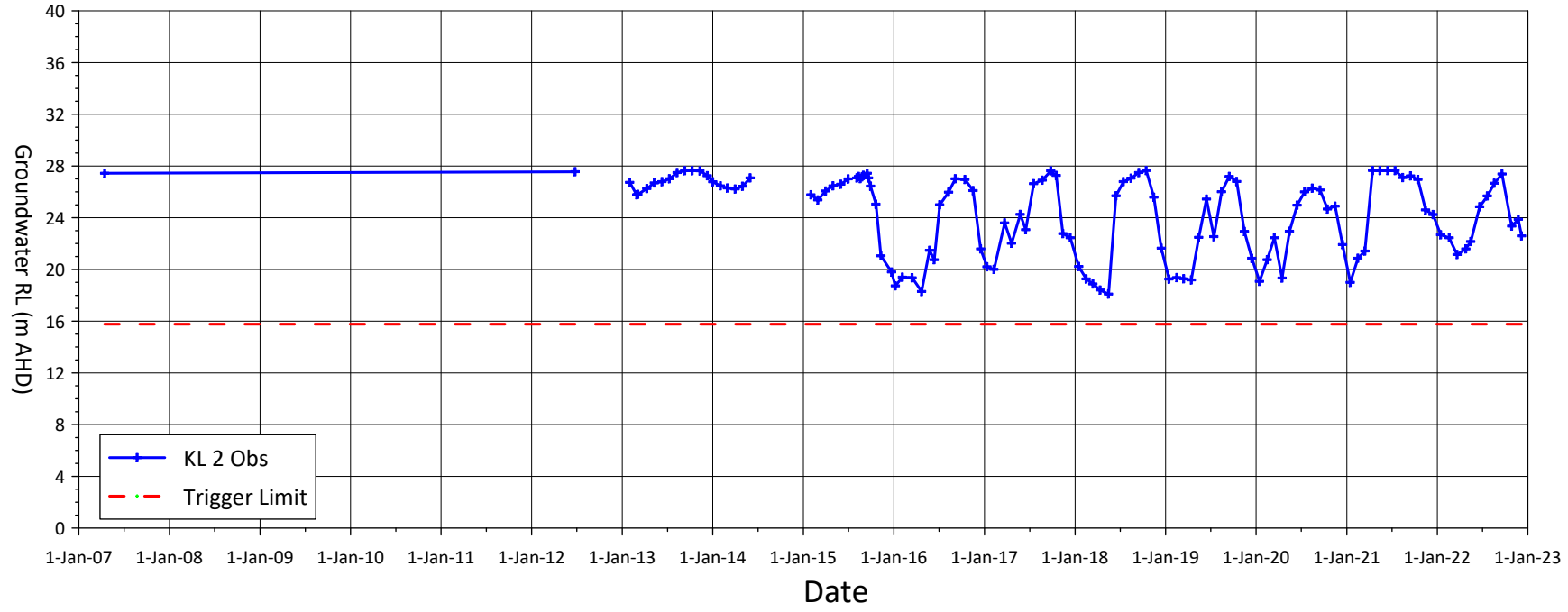
GROUNDWATER RESOURCE MANAGEMENT

FIGURE 22
TRIGGER LIMITS
LEEDERVILLE AQUIFER
KL1 Obs & KL2 Obs





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Client Keysbrook Leucoxene Pty Ltd
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GROUNDWATER RESOURCE MANAGEMENT

FIGURE 23
TRIGGER LIMITS
LEEDERVILLE AQUIFER
KL3 Obs & KL 3

Date Mar 23
Client Keysbrook Leucoxene Pty Ltd
Project 2022 Monitoring Report
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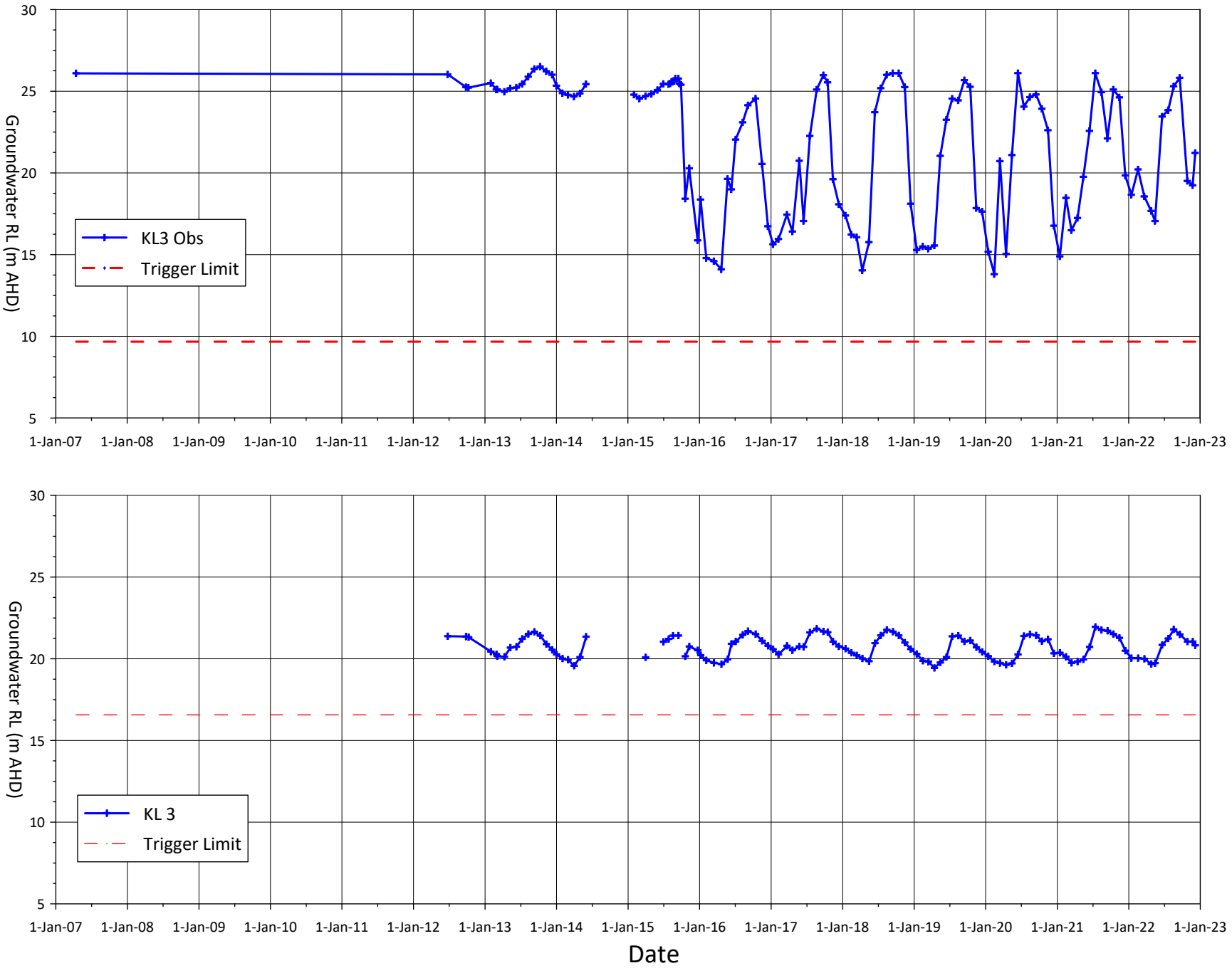
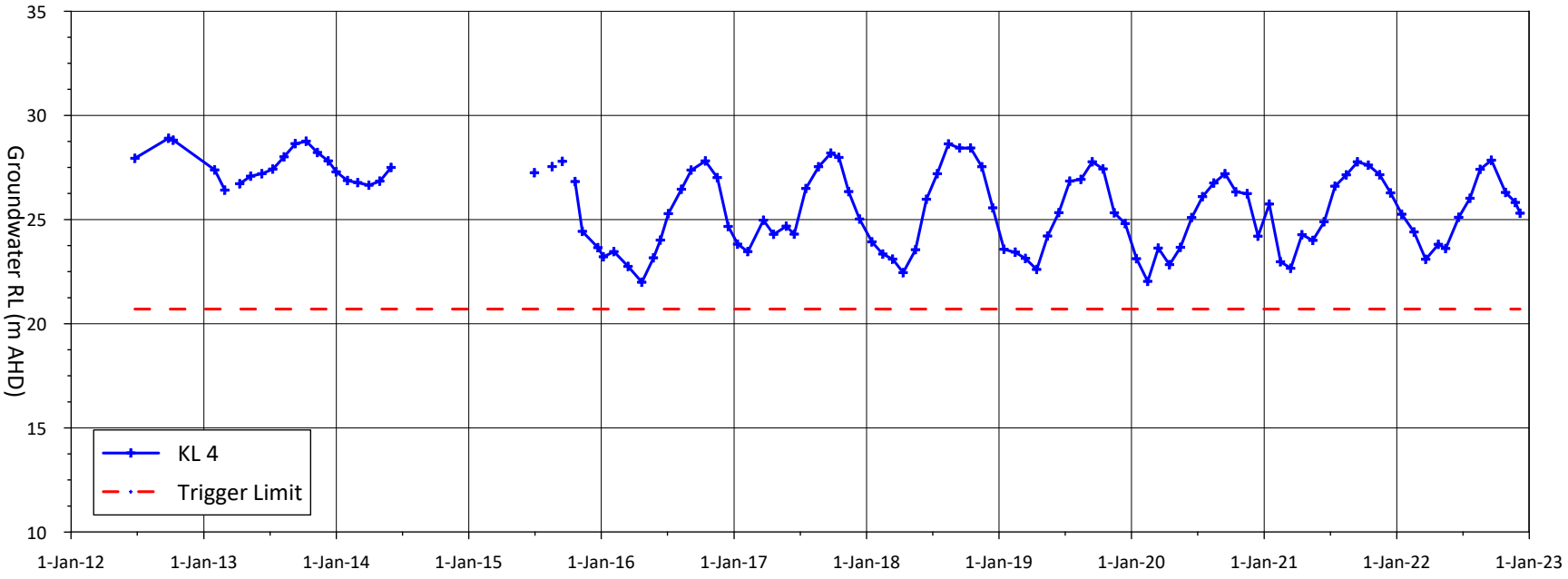
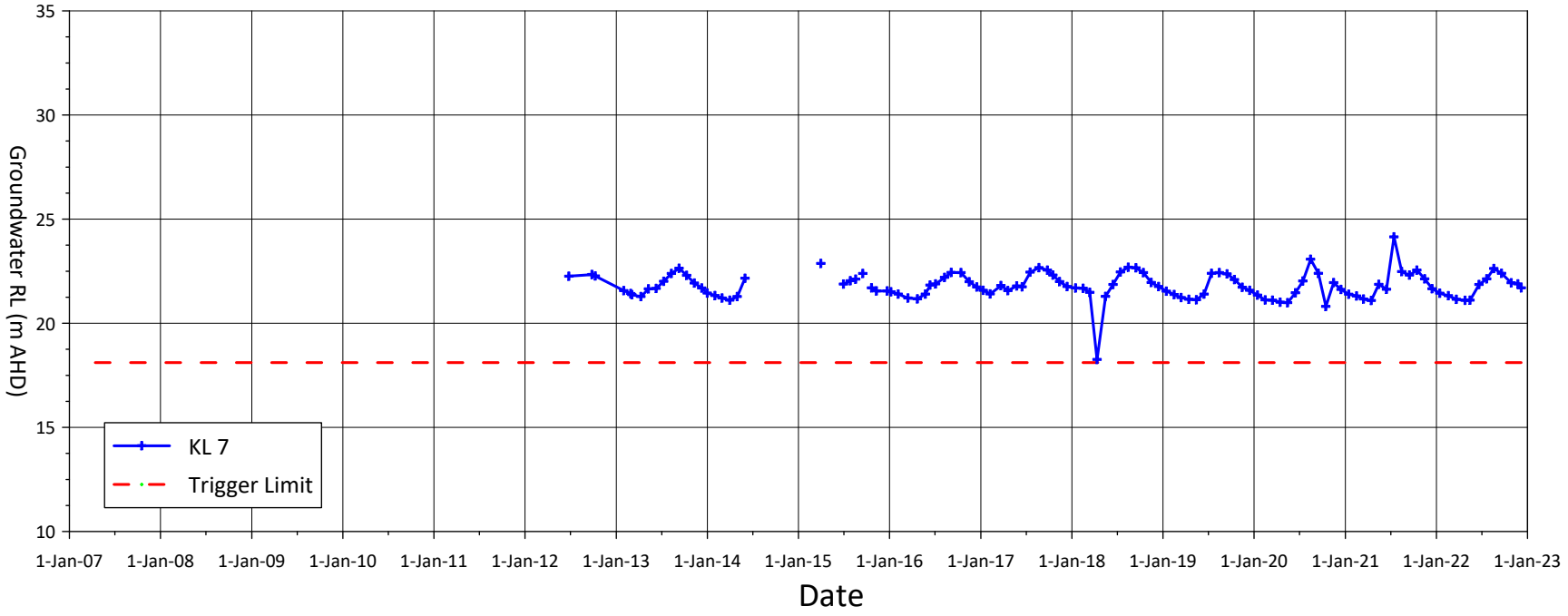


GROUNDWATER RESOURCE MANAGEMENT

FIGURE 24
TRIGGER LIMITS
LEEDERVILLE AQUIFER
KL 4 & KL 7





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Client Keysbrook Leucoxene Pty Ltd
Project 2022 Monitoring Report
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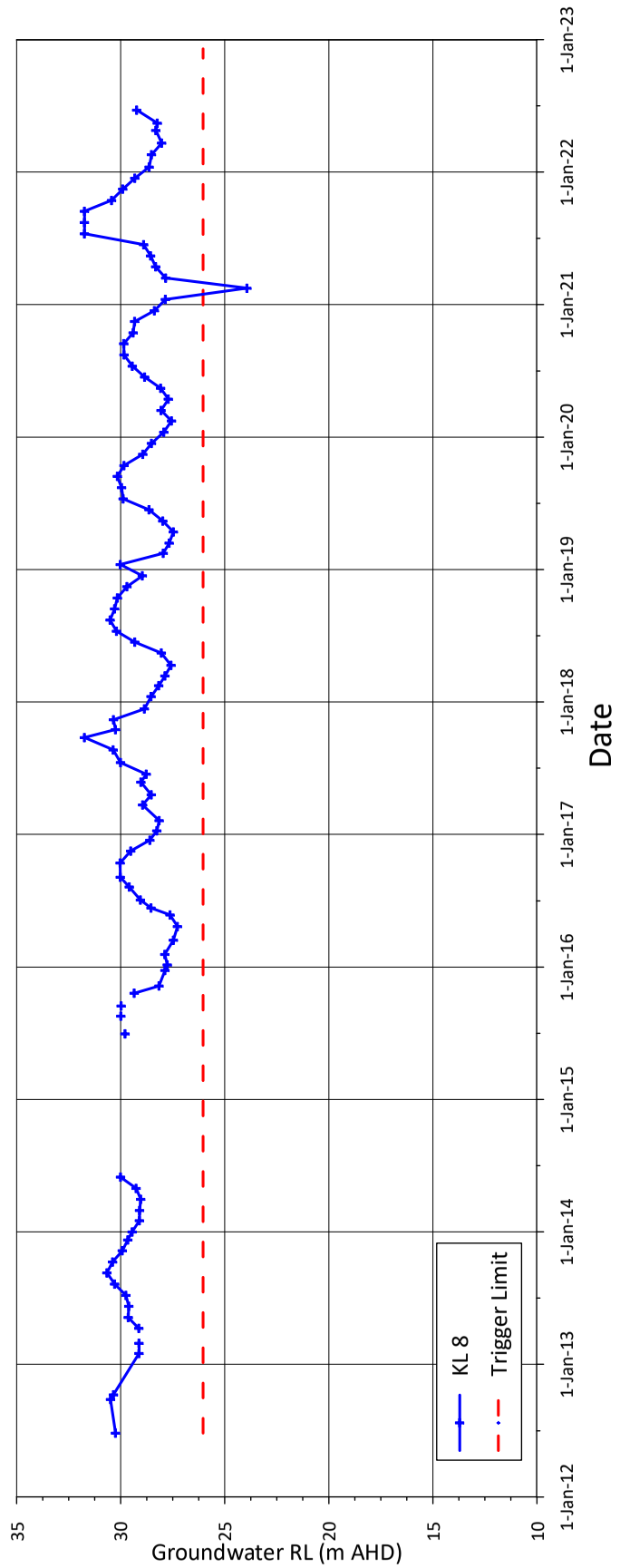

GROUNDWATER RESOURCE MANAGEMENT

FIGURE 25
TRIGGER LIMITS
LEEDERVILLE AQUIFER
KL 8

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Project 2022 Monitoring Report
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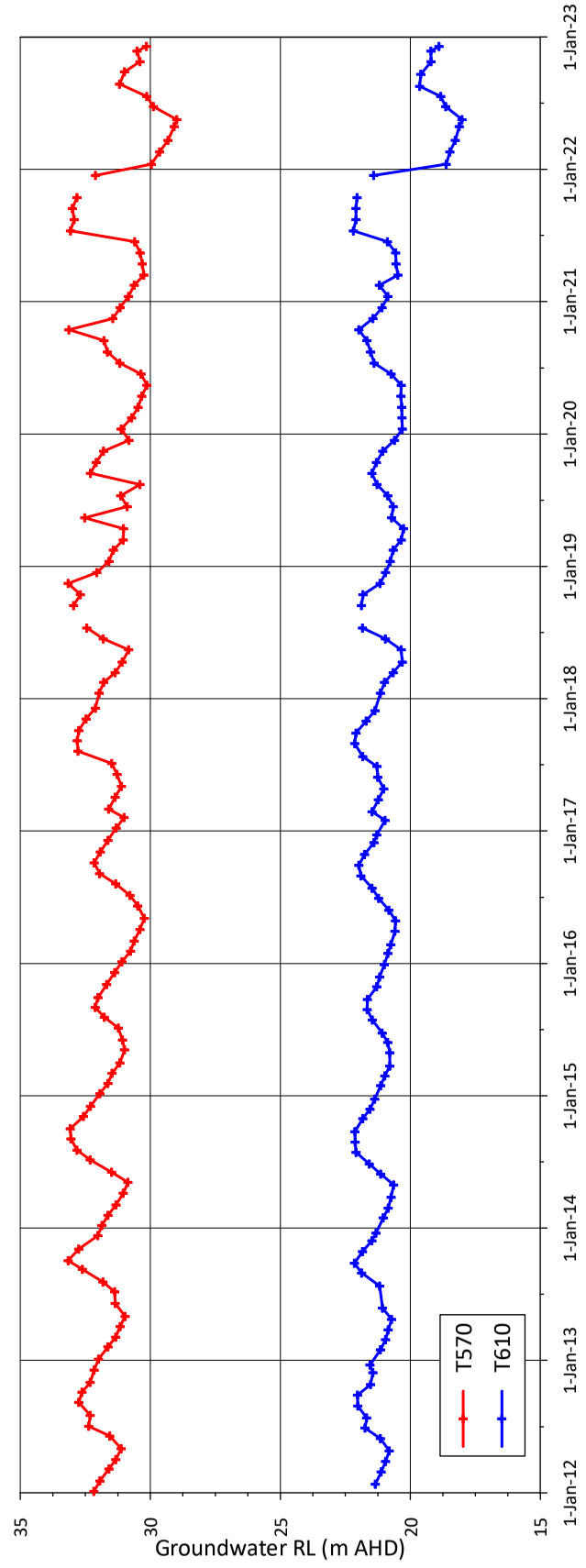

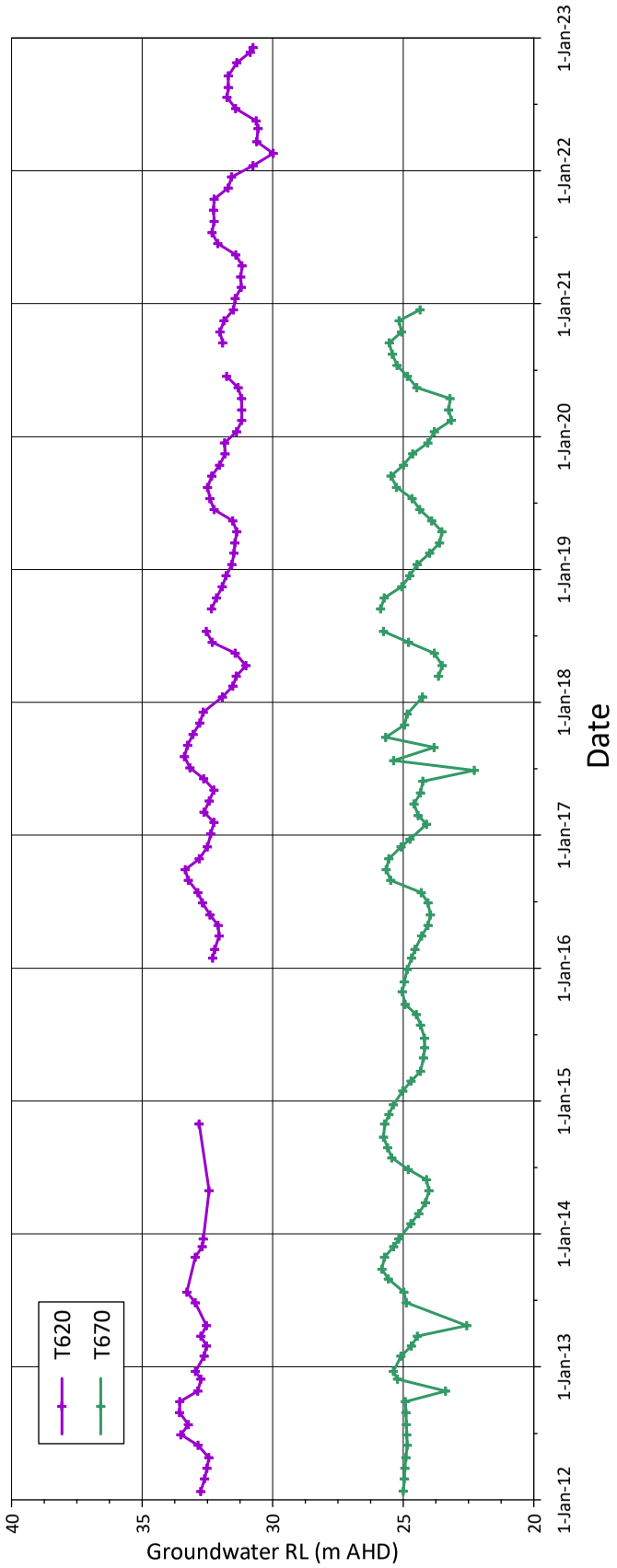

GROUNDWATER RESOURCE MANAGEMENT

FIGURE 26
DWER MONITORING BORES

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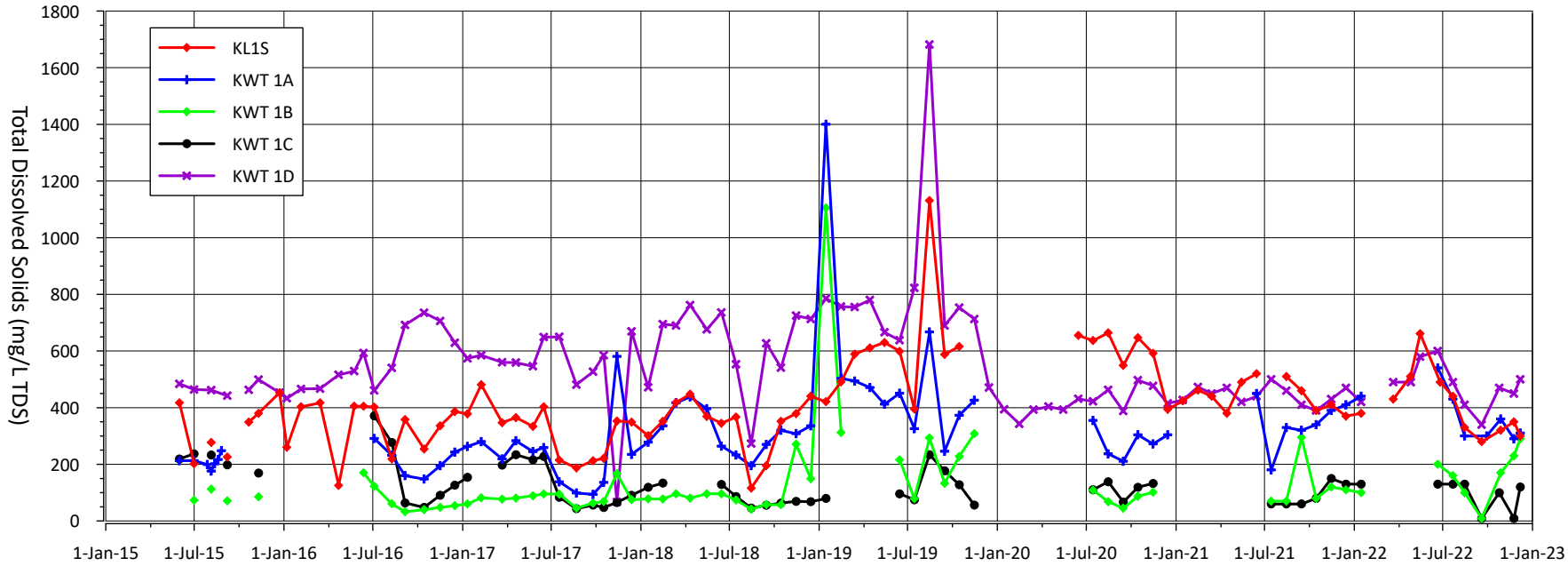
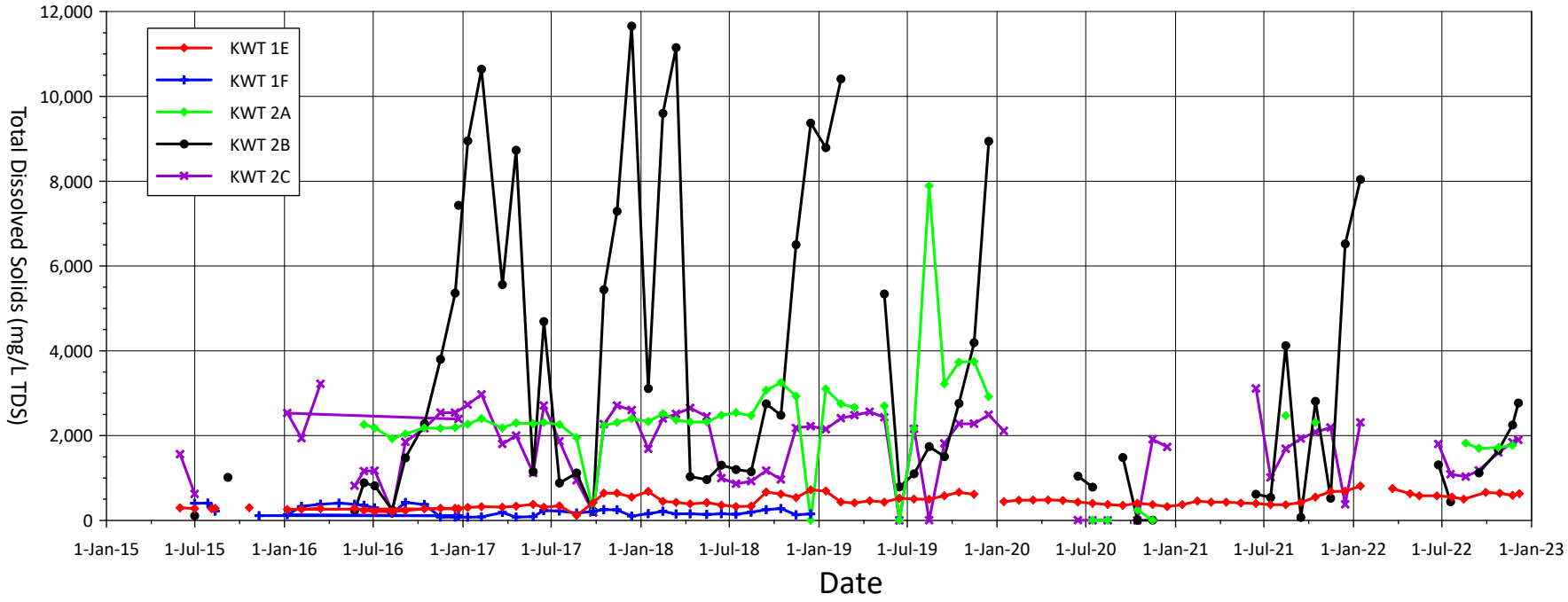
GROUNDWATER RESOURCE MANAGEMENT

FIGURE 27
GROUNDWATER QUALITY
SUPERFICIAL AQUIFER
KLS1 TO KWT 2C





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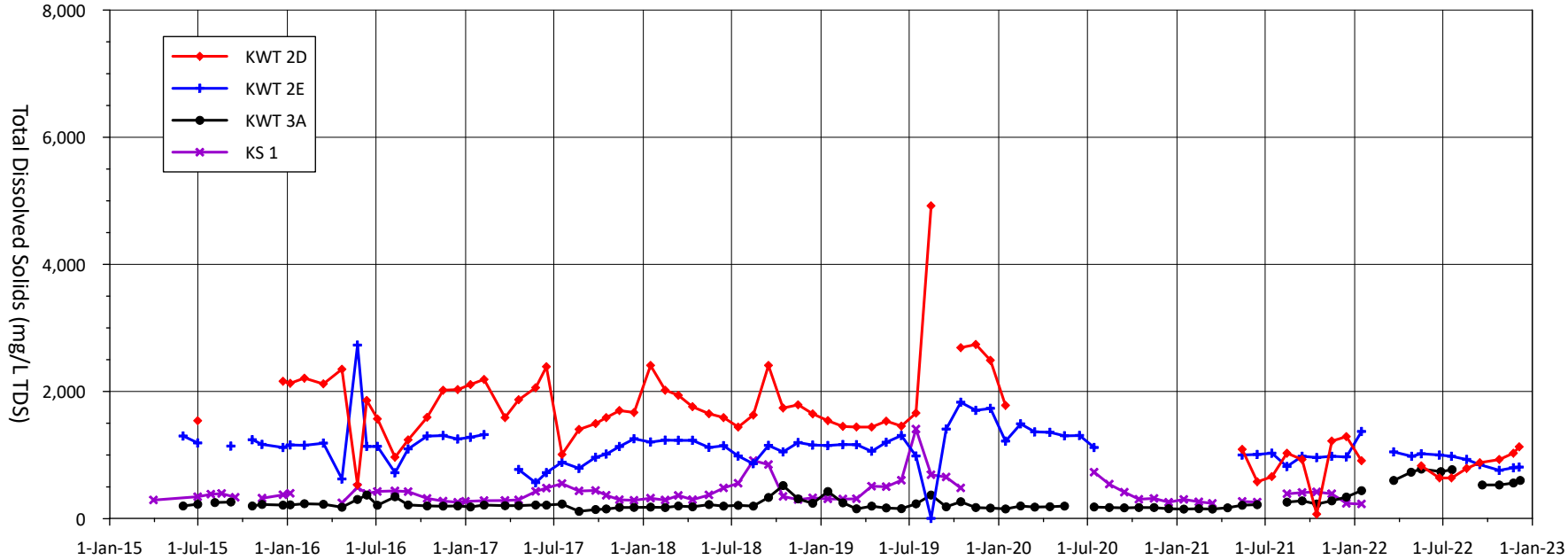
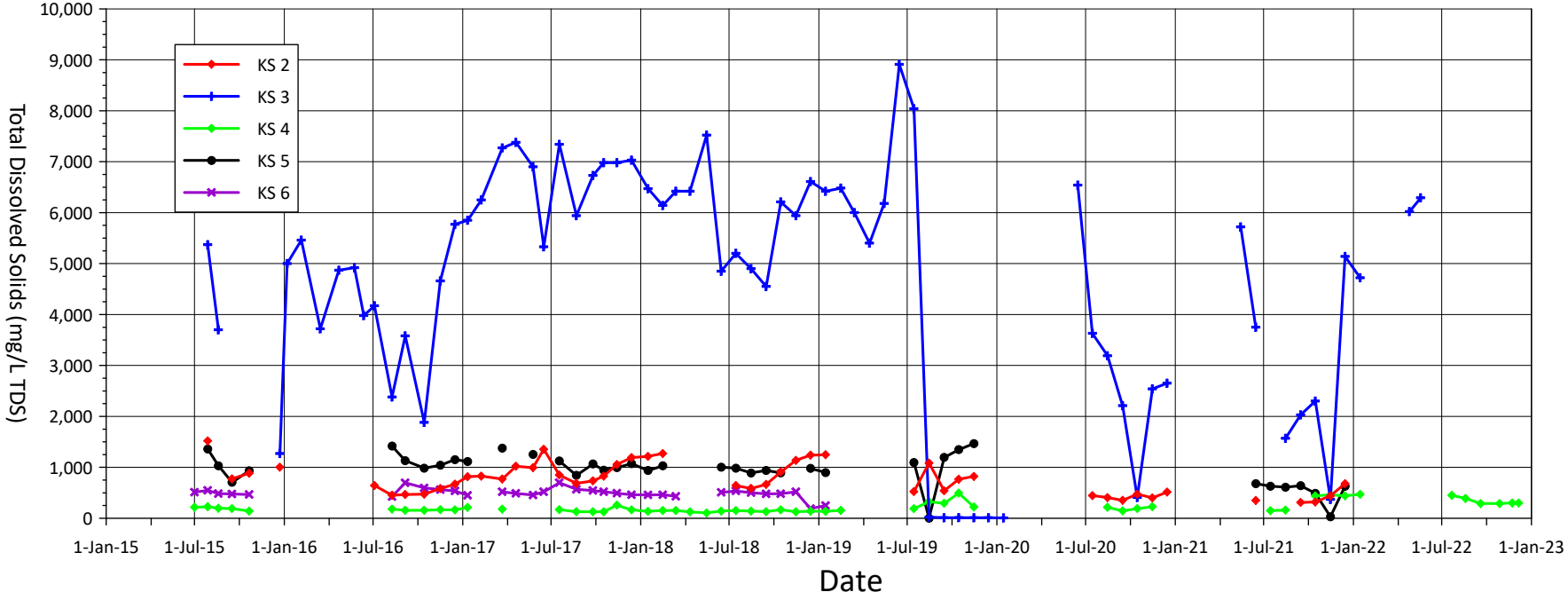
GROUNDWATER RESOURCE MANAGEMENT

FIGURE 28
GROUNDWATER QUALITY
SUPERFICIAL AQUIFER
KWT 2D TO KS 6





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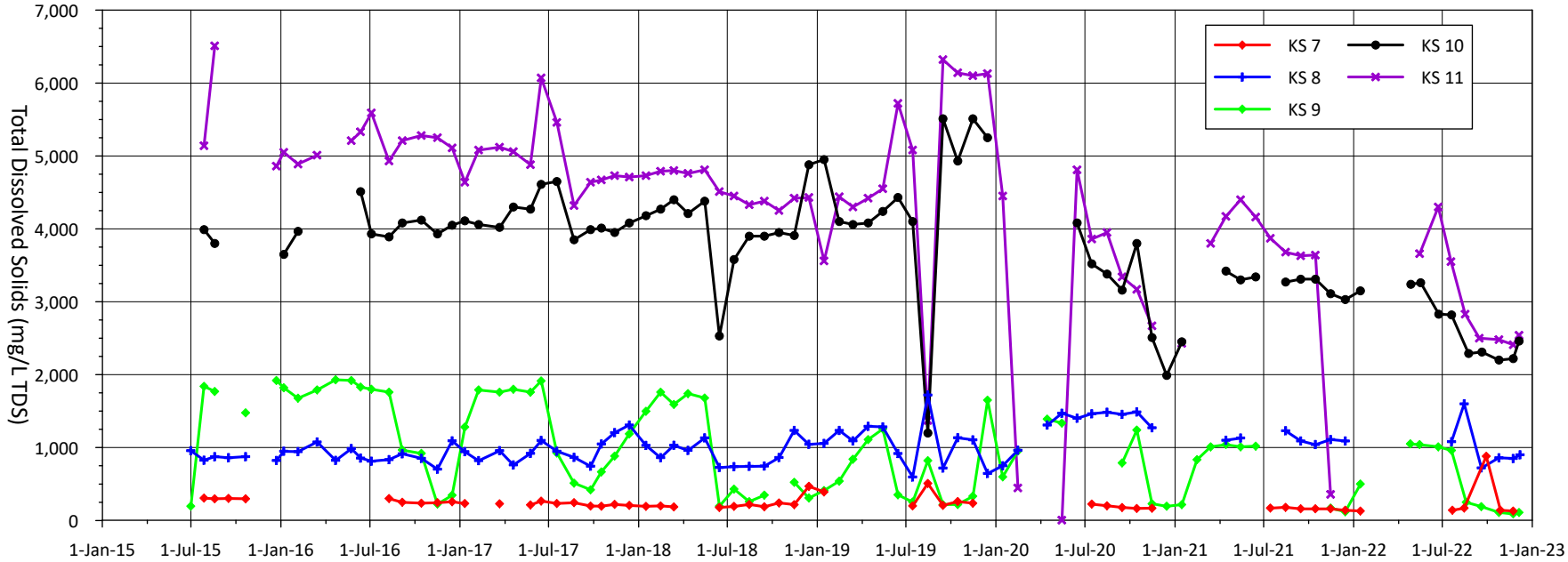
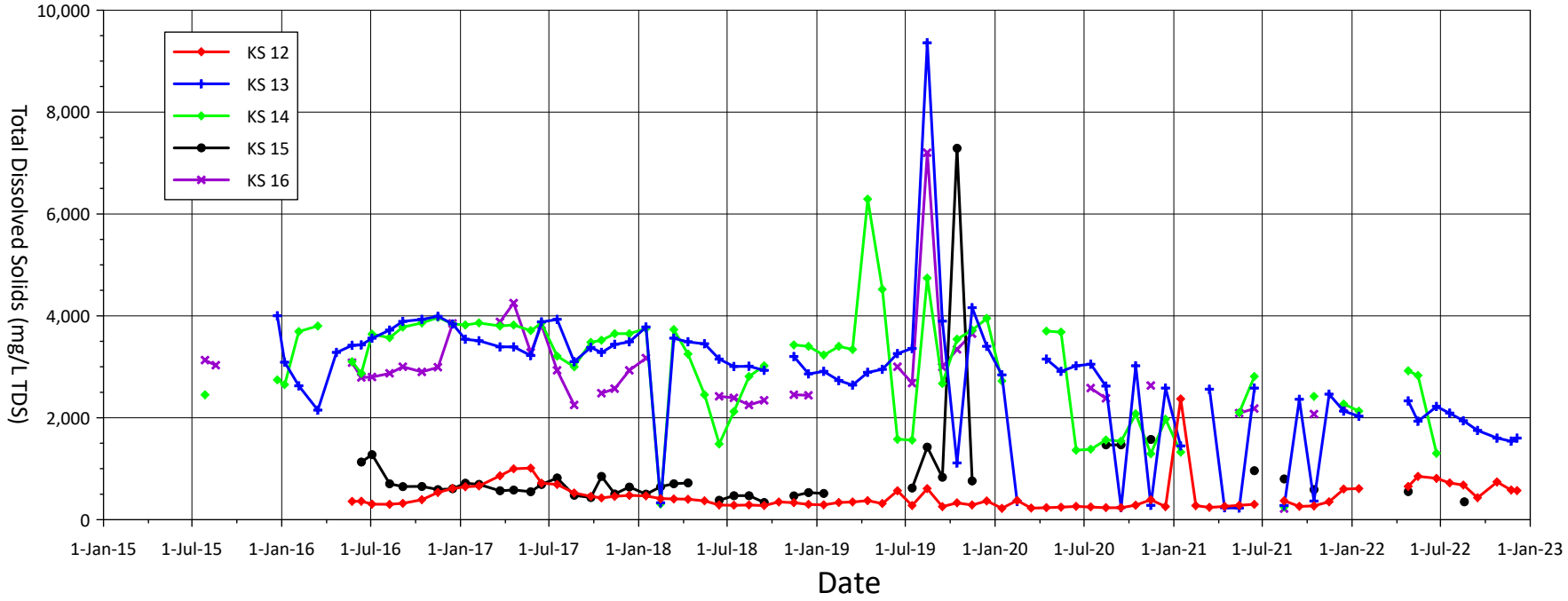
GROUNDWATER RESOURCE MANAGEMENT

FIGURE 29
GROUNDWATER QUALITY
SUPERFICIAL AQUIFER
KS 7 TO KS 16





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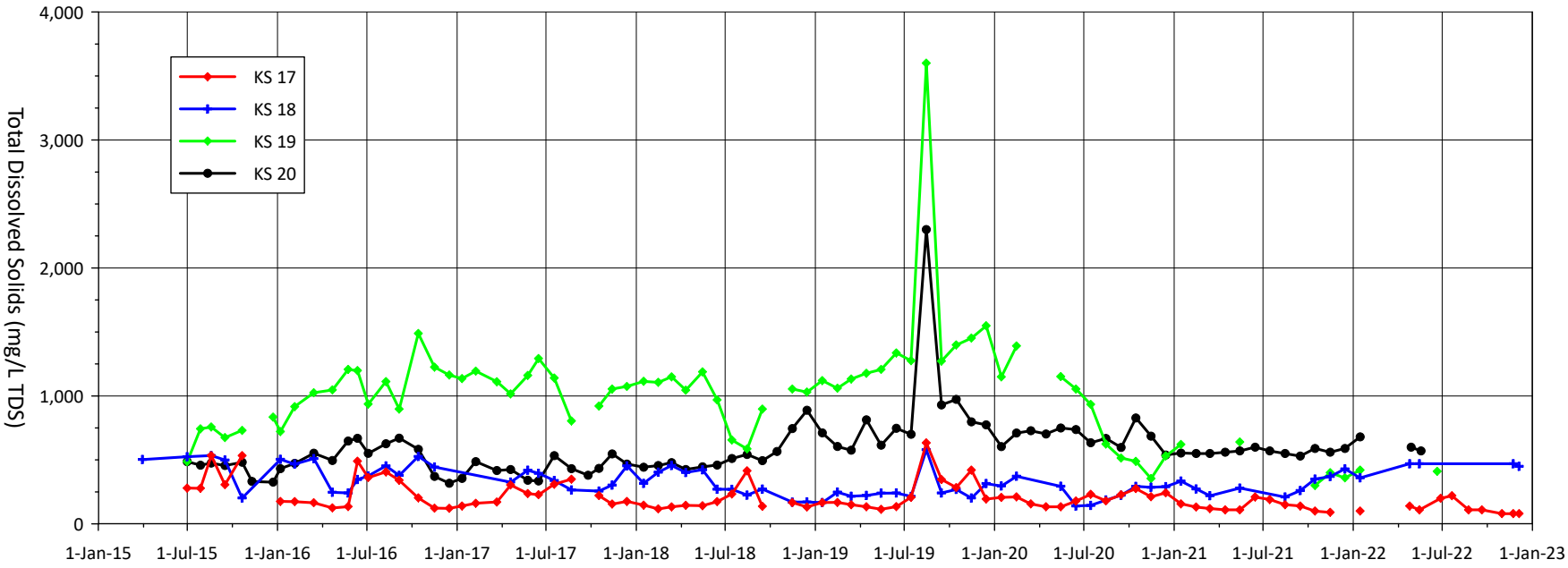
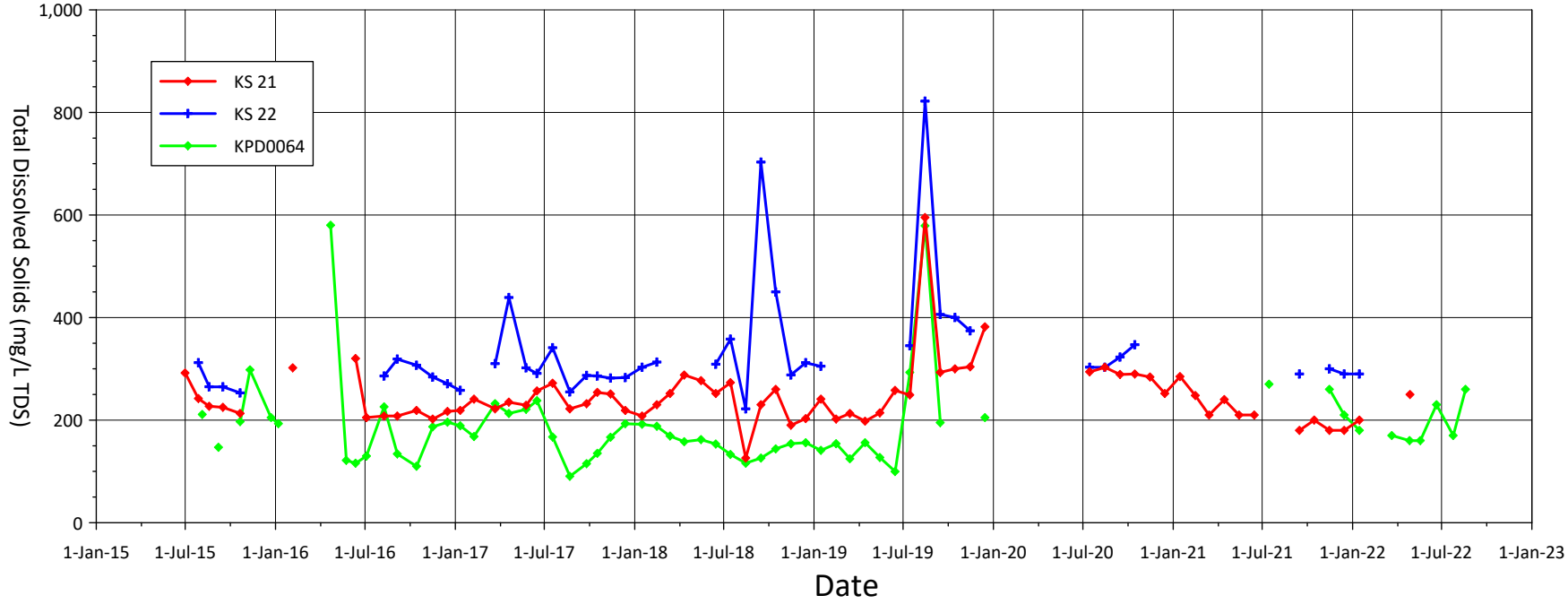
GROUNDWATER RESOURCE MANAGEMENT

FIGURE 30
GROUNDWATER QUALITY
SUPERFICIAL AQUIFER
KS 17 TO KPD0064





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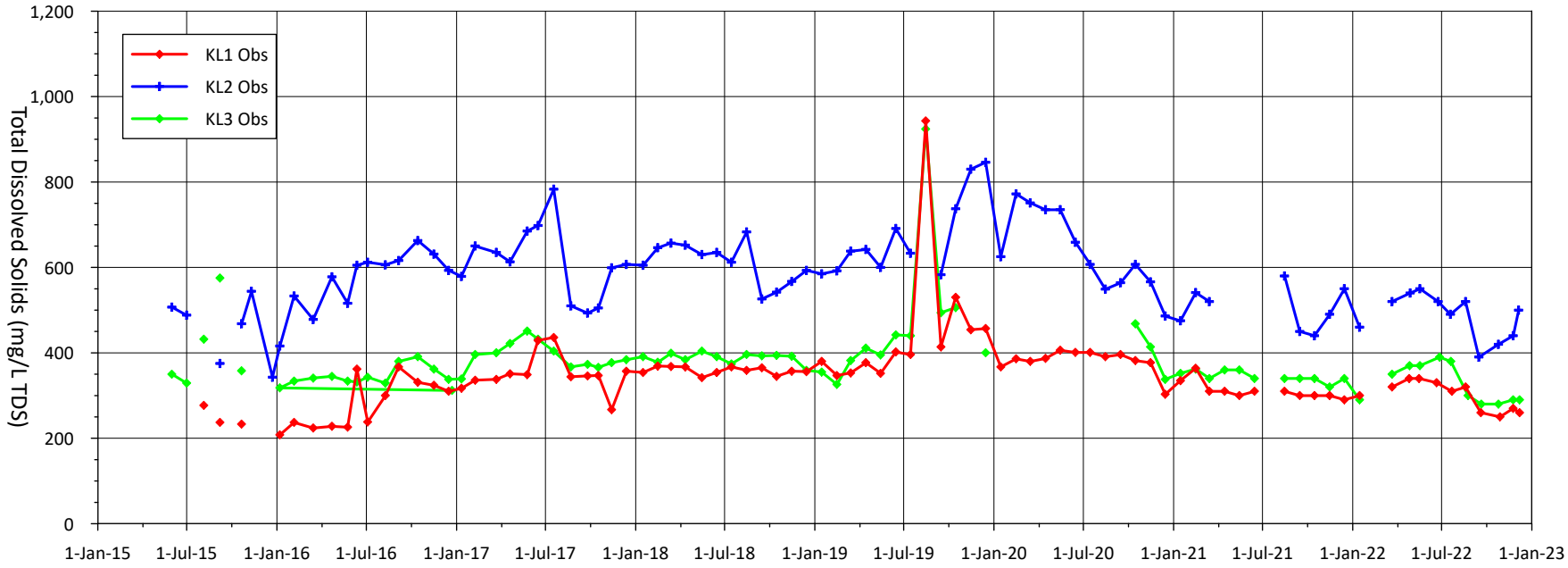
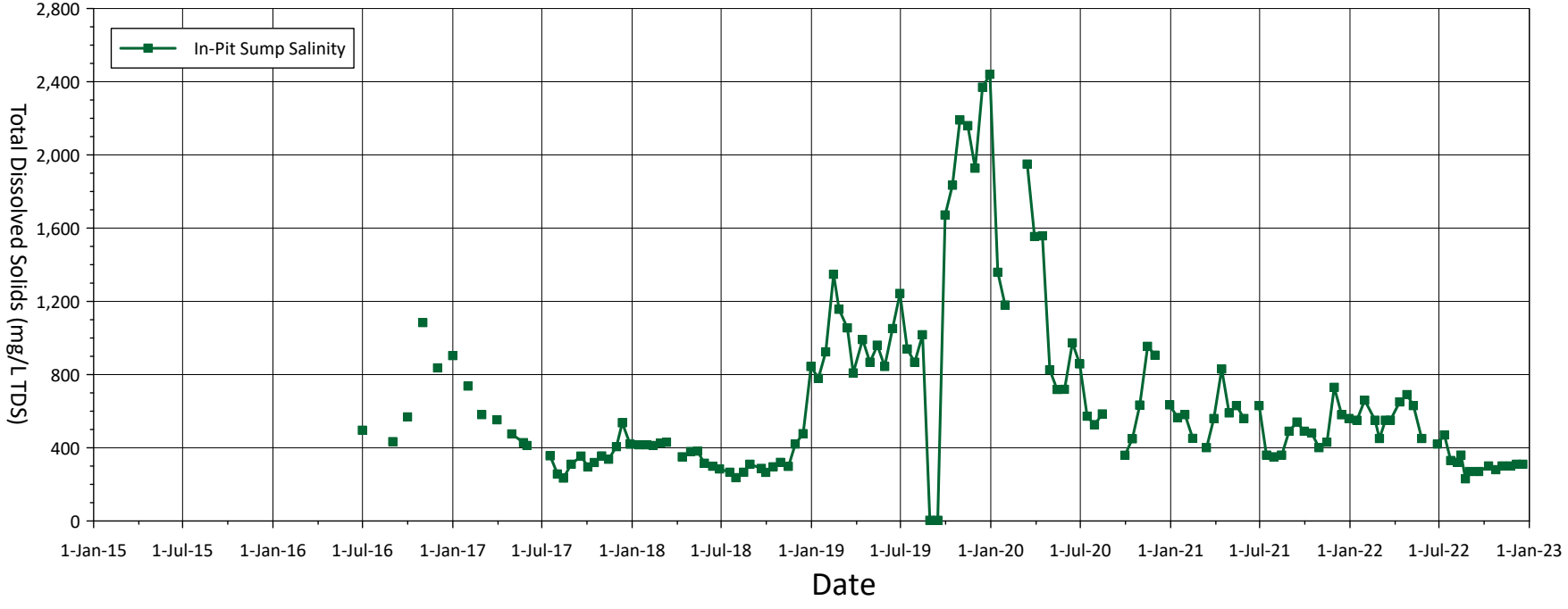
GROUNDWATER RESOURCE MANAGEMENT

FIGURE 31
GROUNDWATER QUALITY
LEEDERVILLE AQUIFER
& IN PIT SUMP





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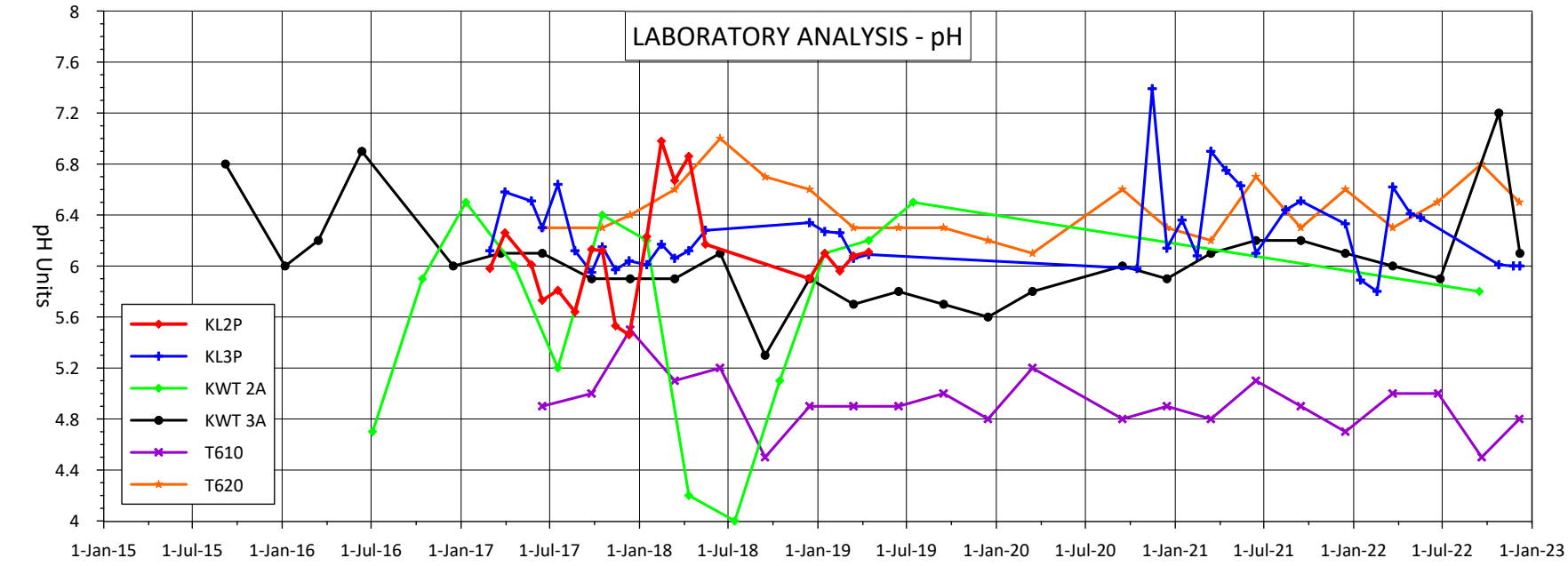
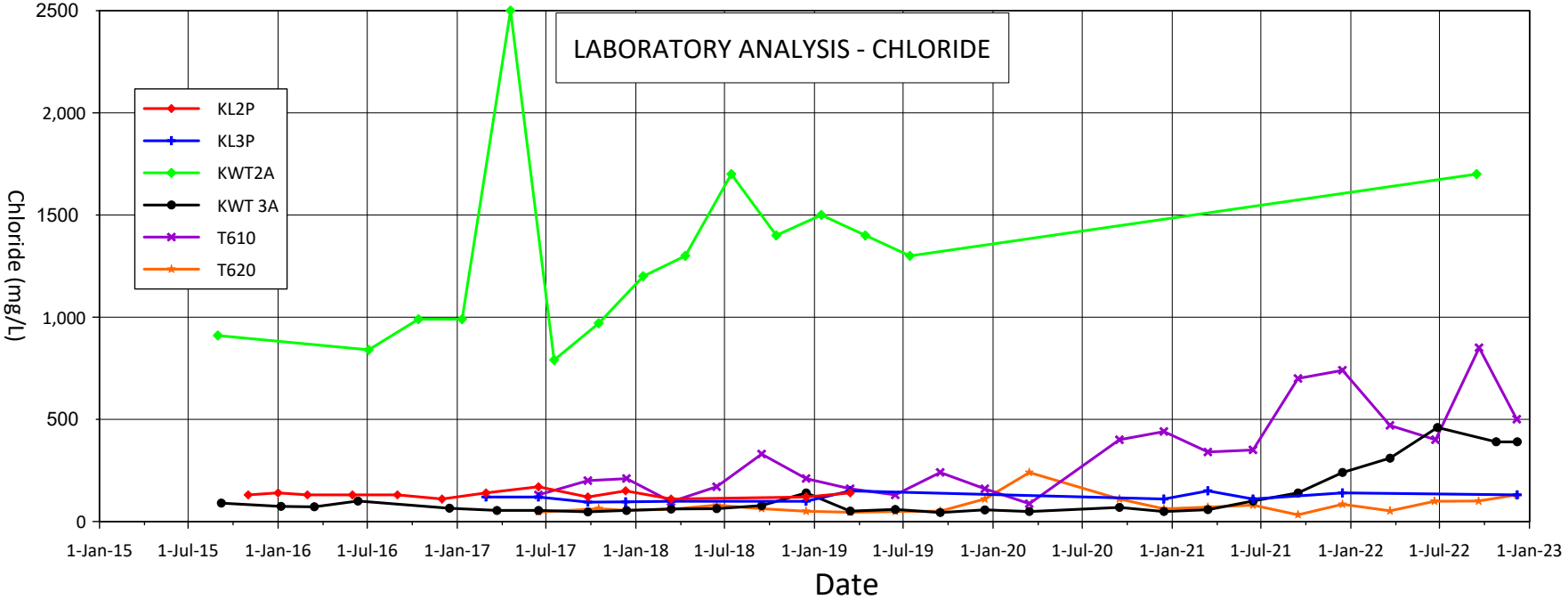
GROUNDWATER RESOURCE MANAGEMENT

FIGURE 32
LABORATORY ANALYSIS
PH & CHLORIDE





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GROUNDWATER RESOURCE MANAGEMENT

FIGURE 33
LABORATORY ANALYSIS TOTAL NITROGEN & TOTAL PHOSPHORUS

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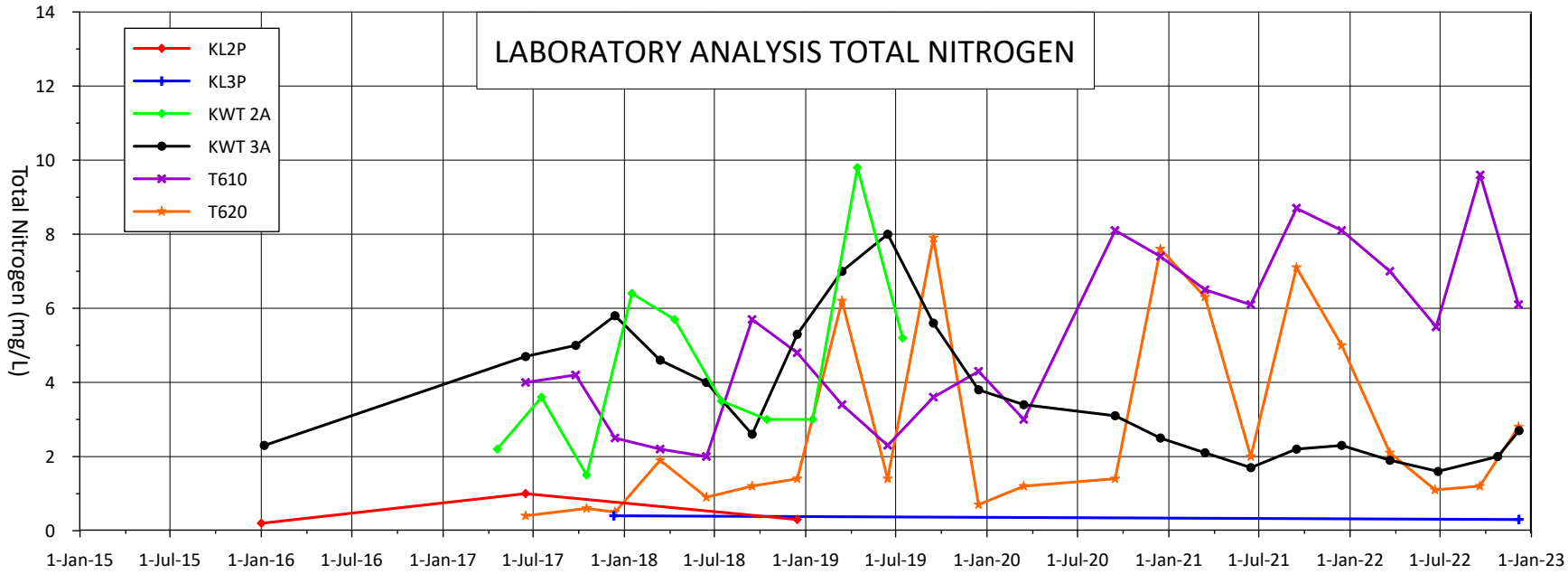

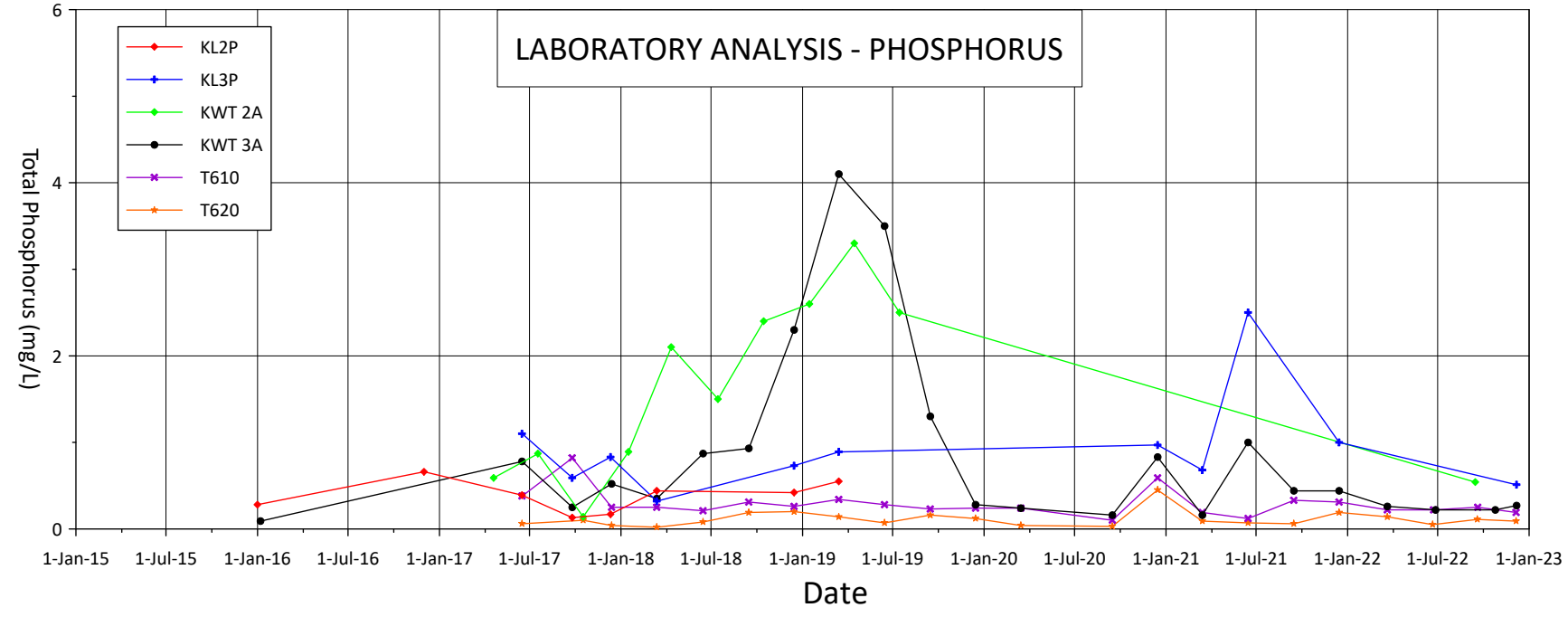

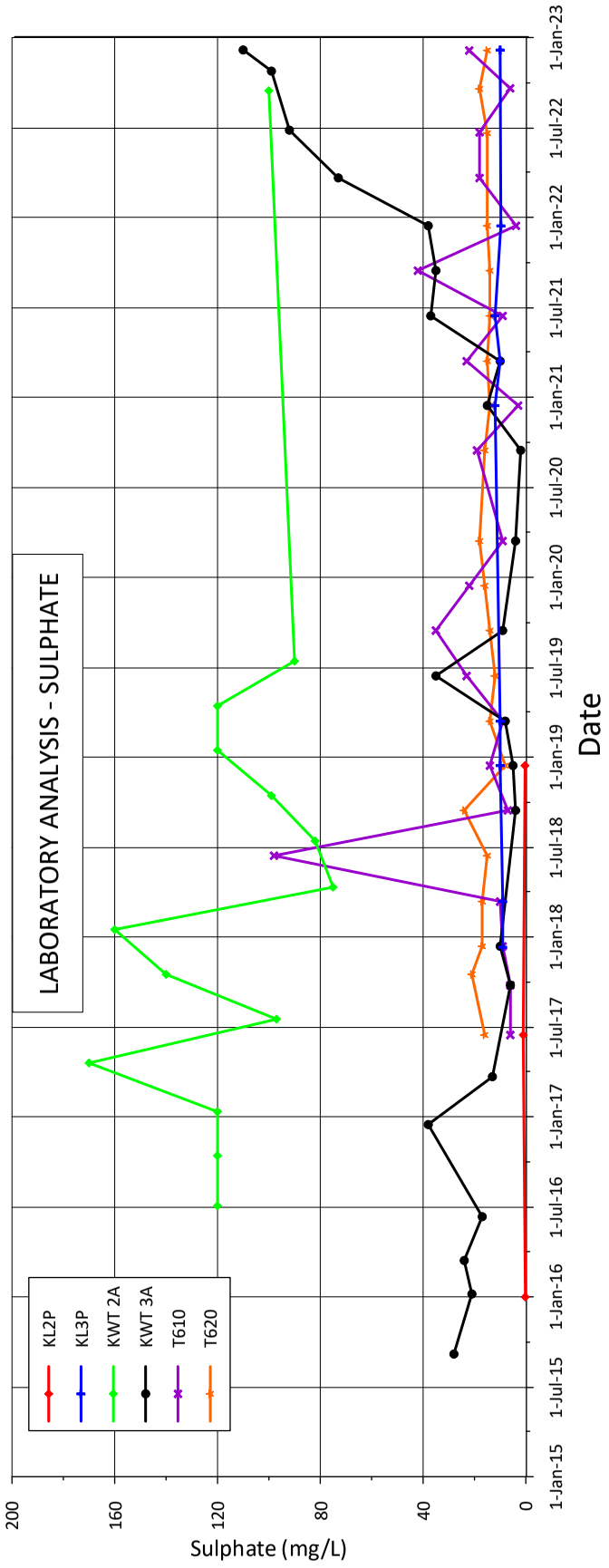

GROUNDWATER RESOURCE MANAGEMENT

FIGURE 34
LABORATORY ANALYSIS
SULPHATE

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Appendix A: Groundwater Well Licences

Government of **Western Australia**
Department of **Water and Environmental Regulation**

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

Licensee(s)	Keysbrook Leucoxene Pty Ltd		
Description of Water Resource	Murray Perth - Lower Leederville.	**Annual Water Entitlement**	1,800,000kL
Location of Water Source	LOT 34 ON PLAN 408493 - Volume/Folio 2932/231 - Lot 34 HOPELAND RD NORTH DANDALUP Lot 63 On Plan 739 Volume/Folio 1049/169 Lot 63 Hopeland Rd Keysbrook		

Authorised Activities	**Taking of water for**	**Location of Activity**
	Mineral ore processing and other mining purposes	LOT 31 ON PLAN 408493 - Volume/Folio 2932/228 - Lot 31 NORTH DANDALUP LOT 32 ON PLAN 408493 - Volume/Folio 2932/229 - Lot 32 NORTH DANDALUP LOT 33 ON PLAN 408493 - Volume/Folio 2932/230 - Lot 33 NORTH DANDALUP LOT 34 ON PLAN 408493 - Volume/Folio 2932/231 - Lot 34 HOPELAND RD NORTH DANDALUP Lot 63 On Plan 739 Volume/Folio 1049/169 Lot 63 Hopeland Rd Keysbrook
Duration of Licence	From 25 September 2019 to 12 December 2022	

This Licence is subject to the following terms, conditions and restrictions:

1. The annual water year for water taken under this licence is defined as 1 January to 31 December.

2. The licensee shall comply with the commitments of the operating strategy currently in effect, as prepared by MZI resources - Keysbrook Mineral Sands Project and approved by the Department of Water and Environmental Regulation on 02/04/2013 including any modifications to the commitments as approved during the term of the licence.

3. The licensee shall provide a revised operating strategy to the Department of Water and Environmental Regulation for approval by 25/11/2019. The strategy shall be prepared in accordance with Operational Policy 5.08 'Use of Operating Strategies in the water licensing process'.

End of terms, conditions and restrictions

Government of **Western Australia**
Department of **Water and Environmental Regulation**

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

Licensee(s)	Keysbrook Leucoxene Pty Ltd		
Description of Water Resource	Murray Perth - Superficial Swan	**Annual Water Entitlement**	200,000kL
Location of Water Source	Lot 300 On Plan 31012 Volume/Folio 2558/496 Lot 300 North Dandalup LOT 34 ON PLAN 408493 - Volume/Folio 2932/231 - Lot 34 HOPELAND RD NORTH DANDALUP Lot 59 On Plan 739 Volume/Folio 2004/874 Lot 59 North Dandalup		

Authorised Activities	**Taking of water for**	**Location of Activity**
	Mineral ore processing and other mining purposes	Lot 300 On Plan 31012 Volume/Folio 2558/496 Lot 300 North Dandalup LOT 31 ON PLAN 408493 - Volume/Folio 2932/228 - Lot 31 NORTH DANDALUP LOT 32 ON PLAN 408493 - Volume/Folio 2932/229 - Lot 32 NORTH DANDALUP LOT 33 ON PLAN 408493 - Volume/Folio 2932/230 - Lot 33 NORTH DANDALUP LOT 34 ON PLAN 408493 - Volume/Folio 2932/231 - Lot 34 HOPELAND RD NORTH DANDALUP Lot 59 On Plan 739 Volume/Folio 2004/874 Lot 59 North Dandalup
Duration of Licence	From 26 August 2019 to 12 December 2022	

This Licence is subject to the following terms, conditions and restrictions:

1. The annual water year for water taken under this licence is defined as 12:00 pm at 1st January to 12:00 pm at 31st December.

2. The licensee shall comply with the commitments of the operating strategy currently in effect, as prepared by MZI Resources - Keysbrook Mineral Sands Project and approved by the Department of Water and Environmental Regulation on 02/04/2013 including any modifications to the commitments as approved during the term of the licence.

3. The licensee shall provide a revised operating strategy to the Department of Water and Environmental Regulation for approval by 25/11/2019. The strategy shall be prepared in accordance with Operational Policy 5.08 'Use of Operating Strategies in the water licensing process'.

End of terms, conditions and restrictions

Government of **Western Australia**
Department of **Water and Environmental Regulation**

Instrument No. GWL177296(2)

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

Licensee(s)	Keysbrook Leucoxene Pty Ltd		
Description of Water Resource	Serpentine Perth - Superficial Swan	**Annual Water Entitlement**	200,000kL
Location of Water Source	Lot 1 On Diagram 8916 - Volume/Folio 2094/330 - Lot 1 Elliott Rd Keysbrook Lot 111 On Diagram 94183 Volume/Folio 2117/847 Lot 111 Westcott Rd Keysbrook Lot 112 On Diagram 94183 Volume/Folio 2117/848 Lot 112 Westcott Rd Keysbrook Lot 113 On Diagram 94183 Volume/Folio 2117/849 Lot 113 Westcott Rd Keysbrook Lot 52 On Plan 739 - Volume/Folio 1740/735 - Lot 52 Atkins Rd Keysbrook Lot 57 On Plan 739 Volume/Folio 1343/483 Lot 57 Elliott Rd Keysbrook Lot 6 On Diagram 52395 - Volume/Folio 1493/399 - Lot 6 Westcott Rd Keysbrook		

Authorised Activities	**Taking of water for**	**Location of Activity**
	Mineral ore processing and other mining purposes	Lot 1 On Diagram 8916 - Volume/Folio 2094/330 - Lot 1 Elliott Rd Keysbrook Lot 111 On Diagram 94183 Volume/Folio 2117/847 Lot 111 Westcott Rd Keysbrook Lot 112 On Diagram 94183 Volume/Folio 2117/848 Lot 112 Westcott Rd Keysbrook Lot 113 On Diagram 94183 Volume/Folio 2117/849 Lot 113 Westcott Rd Keysbrook Lot 52 On Plan 739 - Volume/Folio 1740/735 - Lot 52 Atkins Rd Keysbrook Lot 57 On Plan 739 Volume/Folio 1343/483 Lot 57 Elliott Rd Keysbrook Lot 6 On Diagram 52395 - Volume/Folio 1493/399 - Lot 6 Westcott Rd Keysbrook
Duration of Licence	From 20 November 2019 to 13 December 2022	

This Licence is subject to the following terms, conditions and restrictions:

1. The annual water year for water taken under this licence is defined as 1 January to 31 December.

2. The licensee shall comply with the commitments of the operating strategy currently in effect, as prepared by MZI Resources - Keysbrook Mineral Sands Project and approved by the Department of Water and Environmental Regulation on 02/04/2013 including any modifications to the commitments as approved during the term of the licence.

3. The licensee shall provide a revised operating strategy to the Department of Water and Environmental Regulation for approval by 25/11/2019. The strategy shall be prepared in accordance with Operational Policy 5.08 'Use of Operating Strategies in the water licensing process'.

End of terms, conditions and restrictions

Government of **Western Australia**
Department of **Water and Environmental Regulation**

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

Licensee(s)	Keysbrook Leucoxene Pty Ltd		
Description of Water Resource	Serpentine Perth - Superficial Swan	**Annual Water Entitlement**	200,000kL
Location of Water Source	Lot 63 On Plan 739 Volume/Folio 1049/169 Lot 63 Hopeland Rd Keysbrook		

Authorised Activities	**Taking of water for**	**Location of Activity**
	Mineral ore processing and other mining purposes	Lot 63 On Plan 739 Volume/Folio 1049/169 Lot 63 Hopeland Rd Keysbrook
Duration of Licence	From 26 August 2019 to 12 December 2022	

This Licence is subject to the following terms, conditions and restrictions:

1. The annual water year for water taken under this licence is defined as 12:00 pm at 1st January to 12:00 pm at 31st December.

2. The licensee shall comply with the commitments of the operating strategy currently in effect, as prepared by MZI Resources - Keysbrook Mineral Sands and approved by the Department of Water and Environmental Regulation on 02/04/2013 including any modifications to the commitments as approved during the term of the licence.

3. The licensee shall provide a revised operating strategy to the Department of Water and Environmental Regulation for approval by 25/11/2019. The strategy shall be prepared in accordance with Operational Policy 5.08 'Use of Operating Strategies in the water licensing process'.

End of terms, conditions and restrictions

APPENDIX B

Appendix B: Field Water Quality Data

Excel Attachment *J2302R01_Appendix B.xlsx*

Field Monitoring Results 2022

KS1 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Jan-22	6.12	480	230	626	22.6
Feb-22	No recharge				
Mar-22	No recharge				
Apr-22	No recharge				
May-22	No recharge				
Jun-22	No access by owner				
Jul-22	No access by owner				
Aug-22	No access by owner				
Sep-22	No access by owner				
Oct-22	No access by owner				
Nov-22	No access by owner				
Dec-22	No access by owner				

KS2 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Jan-22	No recharge				
Feb-22	No recharge				
Mar-22	Bore Dry				
Apr-22	Bore Dry				
May-22	Bore Dry				
Jun-22	No access by owner				
Jul-22	No access by owner				
Aug-22	No access by owner				
Sep-22	No access by owner				
Oct-22	No access by owner				
Nov-22	No access by owner				
Dec-22	No access by owner				

KS3 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Jan-22	6.5	9450	4720	197	22.3
Feb-22	6.38	9730	4870	62.9	24
Mar-22	6.66	1090	5470	406	25.1
Apr-22	6.43	1253	6020	86.1	20.1
May-22	6.74	1255	6290	78	20.5
Jun-22	No access by owner				
Jul-22	No access by owner				
Aug-22	No access by owner				
Sep-22	No access by owner				
Oct-22	No access by owner				
Nov-22	No access by owner				
Dec-22	No access by owner				

KS4 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Jan-22	5.52	950	470	236	23.3
Feb-22	Bore Dry				
Mar-22	Bore Dry				
Apr-22	Bore Dry				
May-22	Bore Dry				
Jun-22	Bore Dry				
Jul-22	6.41	910	450		17.8
Aug-22	6.37	790	390		18
Sep-22	5.78	580	290		18.1
Oct-22	5.65	590	290		18.9
Nov-22	5.71	590	300		20.6
Dec-22	5.46	600	300		21.1

KS5 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Jan-22	6.23	1490	740	7.26	23.3
Feb-22	Bore Dry				
Mar-22	Bore Dry				
Apr-22	Bore Dry				
May-22	Bore Dry				
Jun-22	6.14	1300	650		19.2
Jul-22	6.62	950	470		17.6
Aug-22	6.68	1050	530		16.3
Sep-22	6.27	960	480		17
Oct-22	6.17	860	430		18.2
Nov-22	6.3	990	500		20
Dec-22	6.15	1040	520		20.2

KS6 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Jan-22	No longer Monitored				
Feb-22					
Mar-22					
Apr-22					
May-22					
Jun-22					
Jul-22					
Aug-22					
Sep-22					
Oct-22					
Nov-22					
Dec-22					

KS7 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Jan-22	6.09	270	130	133	25.8
Feb-22	No recharge				
Mar-22	Bore Dry				
Apr-22	Bore Dry				
May-22	Bore Dry				
Jun-22	Bore Dry				
Jul-22	6.18	290	140		17.4
Aug-22	6.57	340	170		17.2
Sep-22	6.29	140	880		19.5
Oct-22	5.89	280	140		19.4
Nov-22	6.01	260	130		23.4
Dec-22	Bore Dry				

KS8 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Jan-22	No recharge				
Feb-22	No recharge				
Mar-22	No recharge				
Apr-22	No recharge				
May-22	No recharge				
Jun-22	No recharge				
Jul-22	5.65	2160	1080		16.9
Aug-22	5.96	2000	1600		17.1
Sep-22	5.34	1450	720		15.8
Oct-22	5.77	1710	860		19.5
Nov-22	5.47	1680	850		23.7
Dec-22	5.49	1800	900		21.4

KS9 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Jan-22	5.59	1010	500	890	26.6
Feb-22	5.96	1640	820	77.3	25.2
Mar-22	5.72	1970	990	137.2	24.2
Apr-22	5.76	2090	1050	30.6	22.3
May-22	5.85	2080	1040	80.3	21.8
Jun-22	5.91	2030	1010		19.7
Jul-22	6.24	1910	960		19.4
Aug-22	6.56	500	250		17.6
Sep-22	5.93	380	190		18.6
Oct-22	5.85	210	110		19.6
Nov-22	5.26	180	90		21.3
Dec-22	5.48	220	110		20.6

Field Monitoring Results 2022

KS10 Field data	pH	EC	TDS	Turbidity	Temp
Date		µS/cm	ppm	NTU	(°C)
Jan-22	6	6340	3150	155	31.6
Feb-22	6.27	5970	2980	0.2	25.3
Mar-22	6.33	6470	3260	14.4	22.2
Apr-22	6.41	6450	3240	3.3	16.5
May-22	6.51	6530	3260		20.6
Jun-22	6.58	5660	2830		19.1
Jul-22	7.09	5640	2820		16.6
Aug-22	6.54	4590	2290		19.1
Sep-22	6.68	4630	2310		17.6
Oct-22	6.73	4390	2200		20
Nov-22	6.17	4420	2220		23.4
Dec-22	6.11	4900	2460		22.3

KS11 Field data	pH	EC	TDS	Turbidity	Temp
Date		µS/cm	ppm	NTU	(°C)
Jan-22	No recharge				
Feb-22	No recharge				
Mar-22	6.32	6920	3470	34.7	21.9
Apr-22	No recharge				
May-22	6.23	7330	3660	41	19.1
Jun-22	6.16	8600	4300		19.3
Jul-22	6.6	7100	3550		18.9
Aug-22	6.34	5660	2830		16.7
Sep-22	6.36	4990	2500		17.2
Oct-22	6.48	4960	2480		18.3
Nov-22	6.11	4860	2410		20.4
Dec-22	6.11	5080	2540		19.7

KS12 Field data	pH	EC	TDS	Turbidity	Temp
Date		µS/cm	ppm	NTU	(°C)
Jan-22	6.02	1220	610	497	21.8
Feb-22	6.07	900	450	526	22.5
Mar-22	6.1	1290	650	209	21.2
Apr-22	5.98	1380	650	374	21.1
May-22	6.08	1690	850	157	19.1
Jun-22	6.11	1620	810		19.5
Jul-22	6.45	1440	720		18.3
Aug-22	6.3	1360	680		18.5
Sep-22	6.31	860	430		18.5
Oct-22	6.15	1480	740		18.6
Nov-22	6	1160	580		19.2
Dec-22	6.01	1160	570		19.8

KS13 Field data	pH	EC	TDS	Turbidity	Temp
Date		µS/cm	ppm	NTU	(°C)
Jan-22	5.63	3990	2030	157	27.8
Feb-22	5.87	4840	2420	105	26.1
Mar-22	5.87	3950	1970	130	21.7
Apr-22	6.13	4660	2330	620	20.8
May-22	5.83	3860	1930	64	19.9
Jun-22	5.29	4450	2220		18.8
Jul-22	5.74	4190	2090		18.5
Aug-22	6.51	3900	1940		17.6
Sep-22	5.41	3500	1750		16.8
Oct-22	5.74	3210	1600		18.2
Nov-22	5.31	3080	1540		23.1
Dec-22	5.61	3200	1600		19.8

KS14 Field data	pH	EC	TDS	Turbidity	Temp
Date		µS/cm	ppm	NTU	(°C)
Jan-22	5.82	4270	2130	496	23.7
Feb-22	5.57	5920	2960	530	25.3
Mar-22	5.66	5300	2680	348	22.9
Apr-22	5.93	5740	2920	546	22.3
May-22	5.79	5670	2830	142	20.3
Jun-22	5.55	2610	1300		18.7
Jul-22	No access due to flooding				
Aug-22	No access due to flooding				
Sep-22	No access due to flooding				
Oct-22	No access due to flooding				
Nov-22	5.88	3100	1550		24.2
Dec-22	5.47	3950	1980		20.7

KS15 Field data	pH	EC	TDS	Turbidity	Temp
Date		µS/cm	ppm	NTU	(°C)
Jan-22	No recharge				
Feb-22	No recharge				
Mar-22	Bore Dry				
Apr-22	6.78	1120	550	146	2.1
May-22	Bore Dry				
Jun-22	No access by owner				
Jul-22	No access by owner				
Aug-22	5.52	700	350		16.1
Sep-22	No access by owner				
Oct-22	No access by owner				
Nov-22	No access by owner				
Dec-22	No access by owner				

KS16 Field data	pH	EC	TDS	Turbidity	Temp
Date		µS/cm	ppm	NTU	(°C)
Jan-22	5.8	4040	2020	272	24.1
Feb-22	5.8	4040	2020	270	24.1
Mar-22	5.61	4560	2300	658	23.5
Apr-22	5.86	4490	2240	386	21.1
May-22	5.78	4420	2210	168	19.4
Jun-22	No access by owner				
Jul-22	No access by owner				
Aug-22	No access by owner				
Sep-22	No access by owner				
Oct-22	No access by owner				
Nov-22	No access by owner				
Dec-22	No access by owner				

KS17 Field data	pH	EC	TDS	Turbidity	Temp
Date		µS/cm	ppm	NTU	(°C)
Jan-22	3.89	210	100	48.9	22.4
Feb-22	4.64	180	90	52.4	25.1
Mar-22	4.46	200	100	96.2	22.9
Apr-22	5.29	290	140	82.7	21.5
May-22	4.51	220	110	43	20.7
Jun-22	3.48	400	200		17.9
Jul-22	3.69	430	220		17.2
Aug-22	3.77	220	110		18.8
Sep-22	3.63	220	110		16.8
Oct-22	3.46	160	80		17.5
Nov-22	3.88	160	80		20.5
Dec-22	3.98	160	80		19.9

KS18 Field data	pH	EC	TDS	Turbidity	Temp
Date		µS/cm	ppm	NTU	(°C)
Jan-22	6.23	780	360	525	22.1
Feb-22	5.97	990	490	469	27.8
Mar-22	6.17	910	460	179.7	25.7
Apr-22	6.11	940	470	141.1	21.6
May-22	5.85	940	470	145	20.6
Jun-22	No access due to flooding				
Jul-22	No access due to flooding				
Aug-22	No access due to flooding				
Sep-22	No access due to flooding				
Oct-22	No access due to flooding				
Nov-22	6.2	940	470		18
Dec-22	6	910	450		19.4

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KS19 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	6.37	830	420	219	25
Feb-22	6.26	790	390	197	26.9
Mar-22	6.74	1150	600	178.6	25.1
Apr-22	No recharge				
May-22	No recharge				
Jun-22	6.13	820	410		18
Jul-22	No access by owner				
Aug-22	No access by owner				
Sep-22	No access by owner				
Oct-22	No access by owner				
Nov-22	No access by owner				
Dec-22	No access by owner				

KS20 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	5.57	1350	680	51.2	24.3
Feb-22	5.74	1380	690	17.2	23..9
Mar-22	5.46	1390	690	20.4	25.4
Apr-22	5.66	1190	600	93.1	20.1
May-22	5.46	1140	570		21.8
Jun-22	No access by owner				
Jul-22	No access by owner				
Aug-22	No access by owner				
Sep-22	No access by owner				
Oct-22	No access by owner				
Nov-22	No access by owner				
Dec-22	No access by owner				

KS21 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	5.88	390	200	571	22
Feb-22	5.9	470	240	93.9	22.7
Mar-22	6.11	1270	660	407	26.3
Apr-22	5.51	500	250	395	21.3
May-22	Bore Dry				
Jun-22	No access by owner				
Jul-22	No access by owner				
Aug-22	No access by owner				
Sep-22	No access by owner				
Oct-22	No access by owner				
Nov-22	No access by owner				
Dec-22	No access by owner				

KS22 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	6.15	570	290	471	23.1
Feb-22	6.17	650	330	889	23.9
Mar-22	No recharge				
Apr-22	Bore Dry				
May-22	Bore Dry				
Jun-22	No access by owner				
Jul-22	No access by owner				
Aug-22	No access by owner				
Sep-22	No access by owner				
Oct-22	No access by owner				
Nov-22	No access by owner				
Dec-22	No access by owner				

KS23 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	Not tested				
Feb-22	5.13	1460	710	417	31.1
Mar-22	5.34	1360	680	278	27
Apr-22	5.09	1330	660	173.9	23.6
May-22	4.13	990	500		21.1
Jun-22	4.67	910	450		16.8
Jul-22	4.53	880	440		15.5
Aug-22	4.37	570	2290		16.7
Sep-22	4.3	720	360		16.6
Oct-22	4.71	680	340		17.5
Nov-22	4.72	760	380		20.8
Dec-22	4.08	780	390		21.4

KS24 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	Not tested				
Feb-22	5.59	510	250	820	32.1
Mar-22	5.51	440	230	129.5	26.6
Apr-22	5.8	440	220	386	22.7
May-22	5.4	410	210		21.5
Jun-22	4.58	520	260		17
Jul-22	4.67	340	170		16
Aug-22	4.6	240	120		17.1
Sep-22	4.48	260	130		16.8
Oct-22	4.95	300	150		18.2
Nov-22	5.6	290	150		22.8
Dec-22	5	310	160		23

KS25 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	Bore Dry				
Feb-22	Bore Dry				
Mar-22	Bore Dry				
Apr-22	Bore Dry				
May-22	Bore Dry				
Jun-22	No access due to being in active mining area				
Jul-22	No access due to being in active mining area				
Aug-22	No access due to being in active mining area				
Sep-22	No access Bundt in the way				
Oct-22	No access Bundt in the way				
Nov-22	5.83	260	130		24.7
Dec-22	No recharge				

KS26 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	Bore Dry				
Feb-22	Bore Dry				
Mar-22	Bore Dry				
Apr-22	Bore Dry				
May-22	Bore Dry				
Jun-22	No recharge				
Jul-22	6.78	230	110		16.9
Aug-22	6.45	300	150		14.8
Sep-22	No recharge				
Oct-22	No recharge				
Nov-22	No recharge				
Dec-22	No recharge				

KS27 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	New monitoring bore as of 1st April 2022				
Feb-22	New monitoring bore as of 1st April 2022				
Mar-22	New monitoring bore as of 1st April 2022				
Apr-22	Bailer did not fit				
May-22	6.02	400	200		21.9
Jun-22	5.85	360	180		20.1
Jul-22	Bore damaged				
Aug-22	Bore damaged				
Sep-22	Bore damaged				
Oct-22	Bore damaged				
Nov-22	Bore damaged				
Dec-22	Bore damaged				

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KS28 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	New monitoring bore as of 1st April 2022				
Feb-22	New monitoring bore as of 1st April 2022				
Mar-22	New monitoring bore as of 1st April 2022				
Apr-22	6.18	170	80	417	20.3
May-22	5.74	180	90		22
Jun-22	5.53	170	80		21.8
Jul-22	6.36	180	90		19.9
Aug-22	6.05	350	170		18.4
Sep-22	6.3	160	80		19.8
Oct-22	6	150	70		18.5
Nov-22	6.18	160	80		20.7
Dec-22	6.02	150	70		19.8

KS29 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	New monitoring bore as of 1st April 2022				
Feb-22	New monitoring bore as of 1st April 2022				
Mar-22	New monitoring bore as of 1st April 2022				
Apr-22	6.69	890	450	752	20.1
May-22	6.21	660	330		20.5
Jun-22	6.17	760	380		21
Jul-22	6.7	670	3440		18.5
Aug-22	6.21	510	260		17.7
Sep-22	6.22	460	230		19.5
Oct-22	5.97	440	220		18.5
Nov-22	6.19	480	240		22.1
Dec-22	5.96	460	230		22

KS30 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	New monitoring bore as of 1st April 2022				
Feb-22	New monitoring bore as of 1st April 2022				
Mar-22	New monitoring bore as of 1st April 2022				
Apr-22	6.55	1010	500	801	20.7
May-22	6.4	1000	500		21.2
Jun-22	6.15	970	480		21.8
Jul-22	66.71	960	480		20.2
Aug-22	6.2	890	440		19.6
Sep-22	6.59	740	370		19.7
Oct-22	6.29	730	370		19.5
Nov-22	6.41	780	390		21.3
Dec-22	6.15	780	390		20.5

KS31 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	New monitoring bore as of 1st April 2022				
Feb-22	New monitoring bore as of 1st April 2022				
Mar-22	New monitoring bore as of 1st April 2022				
Apr-22	6.68	600	300	526	20.8
May-22	6.33	530	260		20.7
Jun-22	6.14	480	240		21.6
Jul-22	6.61	440	220		19.1
Aug-22	5.9	500	250		20.1
Sep-22	6.02	400	200		20.2
Oct-22	5.9	390	190		18.9
Nov-22	6.19	370	180		22.1
Dec-22	5.84	360	180		21.1

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KL1S Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	5.83	760	380	821	24.2
Feb-22	5.97	840	420	359	25.1
Mar-22	5.92	870	430	669	25.6
Apr-22	6.38	1030	510	68.2	23.6
May-22	6.15	1230	661	291	21.8
Jun-22	4.51	990	490		18.1
Jul-22	4.77	870	440		16.2
Aug-22	4.61	660	330		19.8
Sep-22	4.66	550	280		16.3
Oct-22	5.18	630	320		19.3
Nov-22	5.82	700	350		21.3
Dec-22	5.73	590	300		20.5

KWT1A Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	5.5	870	440	94.3	27
Feb-22	5.83	930	470	88.2	26.4
Mar-22	No recharge				
Apr-22	Bore Dry				
May-22	Bore Dry				
Jun-22	5.05	1080	540		18.8
Jul-22	5.23	860	430		15
Aug-22	5.12	600	300		16.1
Sep-22	5.14	600	300		18.8
Oct-22	5.02	720	360		18.9
Nov-22	4.7	570	290		22.5
Dec-22	4.78	630	310		20.5

KWT1B Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	5.64	210	100	424	27.5
Feb-22	5.94	1050	520	398	26.2
Mar-22	No recharge				
Apr-22	Bore Dry				
May-22	Bore Dry				
Jun-22	5.31	400	200		18.7
Jul-22	5.46	320	160		16
Aug-22	6.11	210	100		16.1
Sep-22	5.51	190	9		16.2
Oct-22	5.21	330	170		19.6
Nov-22	5.32	460	230		22.1
Dec-22	5.08	590	290		21.5

KWT1C Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	5.58	250	130	651	25.9
Feb-22	No recharge				
Mar-22	Bore Dry				
Apr-22	Bore Dry				
May-22	Bore Dry				
Jun-22	5.25	260	130		18.9
Jul-22	5.62	250	130		16.7
Aug-22	6.13	270	130		16.5
Sep-22	5.38	180	9		16.6
Oct-22	5.46	200	100		19.6
Nov-22	5.26	180	9		23.5
Dec-22	5.43	240	120		21.5

KWT1D Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	5.68	830	420	71.2	22.1
Feb-22	5.79	890	440	58.8	23.3
Mar-22	5.55	990	490	105	23.4
Apr-22	5.43	990	490	86	20.9
May-22	5.52	1160	580	168	22.1
Jun-22	5.11	1190	600		21.1
Jul-22	5.77	980	490		19.3
Aug-22	5.66	820	410		19.8
Sep-22	5.66	670	340		18.2
Oct-22	5.52	940	470		19.2
Nov-22	5.19	900	450		20.4
Dec-22	5.44	1000	500		19.7

KWT1E Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	5.56	1620	810	271	25.3
Feb-22	5.62	1610	800	43.3	25.4
Mar-22	5.49	1510	750	85.5	26.8
Apr-22	5.54	1260	630	11.1	23.5
May-22	5.68	1160	580	65.8	22.1
Jun-22	5.46	1150	580		19.8
Jul-22	5.76	1100	550		16.7
Aug-22	5.82	1010	500		17.5
Sep-22	5.97	1330	660		17.9
Oct-22	5.61	1280	640		18.6
Nov-22	5.09	1180	590		20
Dec-22	5.37	1250	630		19.9

KWT1F Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	No longer Monitored				
Feb-22					
Mar-22					
Apr-22					
May-22					
Jun-22					
Jul-22					
Aug-22					
Sep-22					
Oct-22					
Nov-22					
Dec-22					

KWT2A Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	No recharge				
Feb-22	No recharge				
Mar-22	No recharge				
Apr-22	No recharge				
May-22	Bore Dry				
Jun-22	No recharge				
Jul-22	No recharge				
Aug-22	6.06	3064	1820		17.6
Sep-22	5.78	3400	1700		17.8
Oct-22	6.6	3450	1720		19.5
Nov-22	6	3540	1770		26.4
Dec-22	No recharge				

KWT2B Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	6.02	16130	8040	21.6	23.1
Feb-22	No recharge				
Mar-22	Bore Dry				
Apr-22	Bore Dry				
May-22	No recharge				
Jun-22	6.28	2620	1310		17.4
Jul-22	6.65	880	440	69.9	17.8
Aug-22	No access due to flooding				
Sep-22	5.95	2240	1120		16.1
Oct-22	6.21	3300	1650		19
Nov-22	5.94	4510	2250		22
Dec-22	5.66	5540	2770		21.2

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KWT2C Field data	pH	EC	TDS	Turbidity	Temp
Date		µS/cm	ppm	NTU	(°C)
Jan-22	6.41	4620	2310		22.6
Feb-22	6.28	4830	2420	413	25.1
Mar-22	Bore Dry				
Apr-22	Bore Dry				
May-22	Bore Dry				
Jun-22	6.48	3610	1800		18.5
Jul-22	7.52	2160	1090	17.5	15.6
Aug-22	7.03	2060	1030		15.4
Sep-22	6.18	2330	1180		16.1
Oct-22	6.52	3210	1600		18.9
Nov-22	6.42	3660	1840		21.7
Dec-22	6.27	3800	1900		21.5

KWT2D Field data	pH	EC	TDS	Turbidity	Temp
Date		µS/cm	ppm	NTU	(°C)
Jan-22	5.91	1820	910	18.4	22.5
Feb-22	5.69	3400	1680	9.5	29.5
Mar-22	No recharge				
Apr-22	No recharge				
May-22	6.04	1660	830	326	18.5
Jun-22	5.96	1280	640		18.5
Jul-22	6.37	1280	640		17.5
Aug-22	6.27	1580	790		15.2
Sep-22	5.91	1750	880		16.5
Oct-22	6.07	1850	930		18.8
Nov-22	5.92	2050	1030		22.8
Dec-22	5.81	2250	1130		21.7

KWT2E Field data	pH	EC	TDS	Turbidity	Temp
Date		µS/cm	ppm	NTU	(°C)
Jan-22	5.77	2720	1370		24.6
Feb-22	5.83	2080	1030	6.4	23.4
Mar-22	5.9	2080	1050	7.9	20.7
Apr-22	5.92	1970	980	-7.6	20.1
May-22	6.11	2050	1020	-13.2	20.6
Jun-22	5.83	2000	1000		20.5
Jul-22	6.35	1970	980		19.4
Aug-22	6.16	1870	930		19.3
Sep-22	5.43	1700	850		19.3
Oct-22	5.98	1530	760		19.5
Nov-22	6.06	1590	800		20.7
Dec-22	5.91	1620	810		20.7

KWT3A Field data	pH	EC	TDS	Turbidity	Temp
Date		µS/cm	ppm	NTU	(°C)
Jan-22	5.73	890	440	314	23.5
Feb-22	6.05	960	480	79.4	23.9
Mar-22	5.78	1190	600	99.3	23.5
Apr-22	5.85	1450	730	82.8	21.1
May-22	5.78	1550	780		21.5
Jun-22	5.78	1480	740		19.4
Jul-22	6.19	1540	770		18.1
Aug-22	5.73	1160	570		17.8
Sep-22	5.89	1060	530		18.3
Oct-22	5.72	1050	530		19.1
Nov-22	5.06	1130	560		20.6
Dec-22	5.61	1190	600		20.4

KPD0064 Field data	pH	EC	TDS	Turbidity	Temp
Date		µS/cm	ppm	NTU	(°C)
Jan-22	6.21	360	180	-17.2	21.7
Feb-22	6.15	390	195	-5.6	23.2
Mar-22	6.23	340	170	759	24.1
Apr-22	6.15	320	160	641	20.7
May-22	6.04	320	160		21.5
Jun-22	5.57	460	230		19.9
Jul-22	6.62	350	170		17.9
Aug-22	6.12	520	260		16.3
Sep-22	6.21	420	210		18
Oct-22	5.98	410	200		18
Nov-22	6.34	450	230		19
Dec-22	6.05	400	200		18.3

KL1Obs Field data	pH	EC	TDS	Turbidity	Temp
Date		µS/cm	ppm	NTU	(°C)
Jan-22	5.7	590	300	-2.8	212
Feb-22	5.74	580	290	-6.8	21.3
Mar-22	5.69	640	320	19.7	21.6
Apr-22	5.83	670	340	-4.2	20
May-22	5.6	680	340	-5.5	20.3
Jun-22	5.52	650	330		20.4
Jul-22	5.94	630	310		19.5
Aug-22	5.89	640	320		19.7
Sep-22	5.76	520	260		18.3
Oct-22	5.65	500	250		20
Nov-22	5.68	520	270		21.3
Dec-22	5.71	530	260		19.5

KL2Obs Field data	pH	EC	TDS	Turbidity	Temp
Date		µS/cm	ppm	NTU	(°C)
Jan-22	5.86	930	460	-4.8	21.5
Feb-22	5.8	1060	520	-6.1	22.4
Mar-22	5.95	1050	520	16.5	20.7
Apr-22	5.94	1080	540	-8.9	19.6
May-22	5.87	1100	550	-7.5	19.9
Jun-22	5.95	1050	520		19.6
Jul-22	6.25	990	490		20.3
Aug-22	6.29	1050	520		19.5
Sep-22	6.05	780	390		19.6
Oct-22	6.03	840	420		20.4
Nov-22	5.97	890	440		22.1
Dec-22	5.91	990	500		21.2

KL3Obs Field data	pH	EC	TDS	Turbidity	Temp
Date		µS/cm	ppm	NTU	(°C)
Jan-22	6.19	590	290	234	22.4
Feb-22	6.08	640	320	-4.5	22.4
Mar-22	5.99	710	350	3.3	22.9
Apr-22	6.01	740	370	-4.2	21.5
May-22	6.01	750	370		20.8
Jun-22	6.14	780	390		20
Jul-22	6.54	750	380		20.3
Aug-22	6.14	600	300		20.2
Sep-22	6.24	560	280		20.4
Oct-22	6.21	570	280		20.8
Nov-22	5.77	570	290		21.8
Dec-22	6.04	590	290		20.8

KL3 Field data	pH	EC	TDS	Turbidity	Temp
Date		µS/cm	ppm	NTU	(°C)
Jan-22	6.07	1980	980	-1.9	23.3
Feb-22	6.04	2230	1120	-1.3	21.1
Mar-22	6.24	2100	1050	-1.3	21.1
Apr-22	6.21	2150	1080	-7.7	19.5
May-22	6.23	2170	1080	-4.9	20.5
Jun-22	6.16	2140	1070		20.6
Jul-22	6.6	2160	1080		20.5
Aug-22	6.51	2050	1030		19.7
Sep-22	6.37	1660	830		19
Oct-22	6.3	1630	820		21
Nov-22	6.11	1650	820		21.3
Dec-22	6.15	1780	890		21.5

Field Monitoring Results 2022

KL4 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	6	2140	1070	25.9	22.2
Feb-22	5.96	2120	1060	-6.7	21.5
Mar-22	6.03	2230	1110	45.9	21.4
Apr-22	5.87	2300	1150	-7.4	20
May-22	5.96	2260	1130	-13.2	20.3
Jun-22	5.91	2120	1060		20.4
Jul-22	6.31	2170	1080		19.5
Aug-22	6.2	2100	1050		19.2
Sep-22	6.08	1720	860		18.9
Oct-22	6.2	1590	790		20.3
Nov-22	5.68	1690	850		21.4
Dec-22	5.85	1790	900		20.2

KL7 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	5.94	2040	1010	-1.8	21.4
Feb-22	5.85	2300	1170	-7.6	20.7
Mar-22	5.98	2240	1110	2.5	19.3
Apr-22	5.95	2360	1180	-2.4	19.4
May-22	5.96	2320	1160	-8.8	18.8
Jun-22	5.94	2240	1120		19.1
Jul-22	6.29	2180	1090		18.7
Aug-22	6.22	2160	1080		18
Sep-22	6.07	1850	930		18.5
Oct-22	6.05	1750	870		19.1
Nov-22	5.95	1770	890		21.4
Dec-22	5.91	1870	930		20.4

KL8 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	5.94	1990	990	-2.9	23
Feb-22	5.8	1950	980	-4.3	22.3
Mar-22	5.8	2200	1100	-4.5	22
Apr-22	5.81	2310	1150	-4.8	20.4
May-22	5.82	2210	1100	-5.7	20.1
Jun-22	5.74	2130	1060		19.8
Jul-22	No access by owner				
Aug-22	No access by owner				
Sep-22	No access by owner				
Oct-22	No access by owner				
Nov-22	No access by owner				
Dec-22	No access by owner				

KL2P Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	No longer Monitored				
Feb-22					
Mar-22					
Apr-22					
May-22					
Jun-22					
Jul-22					
Aug-22					
Sep-22					
Oct-22					
Nov-22					
Dec-22					

T610 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	4.58	2130	1060	-1.7	24.5
Feb-22	4.85	2110	1060	-2.8	25.4
Mar-22	5.07	1650	830	125	23.5
Apr-22	4.96	1560	780	-5.7	22.9
May-22	5.02	1550	780		23
Jun-22	5.06	1450	730		20.6
Jul-22	5.13	1590	790		19.5
Aug-22	4.74	1960	980		17.4
Sep-22	4.58	1880	940		18.5
Oct-22	4.8	1230	620		19.2
Nov-22	4.9	1270	640		22.5
Dec-22	4.65	1270	640		20.5

T570 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	6.41	170	90	-4.5	21.8
Feb-22	6.07	210	100	3.5	23
Mar-22	6.06	190	100	5.7	22.4
Apr-22	6.13	210	100	4.9	20.6
May-22	6.1	220	110		21.1
Jun-22	5.87	230	110		20.8
Jul-22	6.39	210	100		20.9
Aug-22	6.23	190	100		20.4
Sep-22	6.31	170	80		22.2
Oct-22	6.13	170	80		20.3
Nov-22	6.1	150	80		22.4
Dec-22	5.8	150	80		20.7

T620 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date					
Jan-22	6.07	390	190	-2.3	22.7
Feb-22	6.36	370	180	6.6	23.5
Mar-22	6.09	400	200	11.9	23.7
Apr-22	6.06	440	210	-3.8	21.2
May-22	6.1	550	270		21.1
Jun-22	5.64	430	210		19.4
Jul-22	6.38	420	210		18.3
Aug-22	6.36	450	230		18.4
Sep-22	5.58	380	190		17.7
Oct-22	5.5	460	150		20.1
Nov-22	6.09	390	190		20.4
Dec-22	6.07	390	200		20.4

T670 Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date	No longer Monitored				
Jan-22					
Feb-22					
Mar-22					
Apr-22					
May-22					
Jun-22					
Jul-22					
Aug-22					
Sep-22					
Oct-22					
Nov-22					
Dec-22					

KL3P Field data	pH	EC µS/cm	TDS ppm	Turbidity NTU	Temp (°C)
Date	No longer Monitored				
Jan-22					
Feb-22					
Mar-22					
Apr-22					
May-22					
Jun-22					
Jul-22					
Aug-22					
Sep-22					
Oct-22					
Nov-22					
Dec-22					

Appendix 7

Supporting Information:

Keysbrook Mineral Sands Mine

Rehabilitation Management Plan Implementation Select Photographic Evidence

Plate 1: Selection of Native Plants during the propagation process at Hamel's Nursery, West Coolup.

Plate 2: 2023 Local Provenance Native Seed dispersal in prepared ground. Weed Control implemented and 30mm deep rip lines.

Plate 3: 2023 Native revegetation planting – Mechanical Planter and local Contractors (June 2023)

Plate 4: 2023 Native revegetation planting – Mechanical Planting (June 2023)

Plate 5: 2023 Native revegetation planting – Serpentine/ Jarrahdale Landcare (July 2023)

Plate 6: 2023 Native revegetation planting – Serpentine/ Jarrahdale Landcare planting into rip lines that fringe the seasonal creaks throughout the native revegetation areas (July 2023)

Plate 7: 2023 Season 2 Pasture Rehabilitation Lot 104 (Oct 2023)

Plate 8: 2023 Season 2 Pasture Rehabilitation Lot 101 (Oct 2023)

Plate 9: 2023 Season 2 Pasture Rehabilitation Lot 57 (Oct 2023)

Plate 10: 2023 Season 1, Dust mitigation Crop lot 105 (Oct 2023)

Appendix 8

Supporting Information:

Keysbrook Mineral Sands Mine

Annual Environmental Noise Compliance Report 2023

DORAL KEYSBROOK ENVIRONMENTAL NOISE MONITORING COMPLIANCE REPORTING 2023

DORAL MINERAL SANDS

Rpt01-AU01928-Rev0-17.Oct.2023

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Item	Page	Section	Comments

** Use after Rev. 0*

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EXECUTIVE SUMMARY

Keysbrook Leucoxene Pty Ltd (KLPL), a subsidiary of Doral Mineral Sands Pty Ltd (Doral), operate the Keysbrook Mineral Sands Mine, located approximately 70 km south of Perth. Mineral sands processing operations at Keysbrook are continuous, 24 hours per day, 7 days per week. Mining of mineral sands and rehabilitation of existing pits occur from 7am to 7pm, Monday to Saturday, and 9am to 7pm on Sundays and Public Holidays. Operations occur on private freehold land, which is predominantly used for pastoral grazing and small rural lots.

Environmental approval for the mine is granted through Ministerial Statement No. 810 (MS810). Related to noise management, Ministerial Statement No. 1089 (MS1089) [1] replaces condition 14 (C14) in MS810.

MS1089 C14-1 stipulates separation distances required to be maintained between mining operations and noise-sensitive areas, where an amenity agreement is not in place. Doral maintain these separation distances for mine operations.

This report has been prepared pursuant to Condition 14-9 of MS1089 and aims to assess noise emissions from operations against the MS1089 14-2 indoor noise limits, for receivers with an agreement.

In addition to the MS1089 requirements, compliance with the *Environmental Protection (Noise) Regulations 1997* (the Regulations) [2] is also assessed at residences outside of the separation distances that do not require an amenity agreement.

This report covers mining operations between 19 July 2022 to 19 July 2023 (the reporting period for the EPA's compliance assessment report). Assessed noise data was captured from two monitors across three locations.

Noise monitoring at Keysbrook is undertaken by KLPL, including the set-up and maintenance of noise monitors. Collected noise data is streamed to and held on the Envirosuite Sentinel cloud system. Noise monitoring was undertaken by KLPL throughout the reporting period.

During the reporting period, mining was undertaken at various blocks within Lots 57, 101, and 103. Excavated ore was transported to the MFU4 for initial screening before being pumped as a slurry to the Wet Concentrator Plant (WCP). The WCP continued to operate on a 24/7 basis during the reporting period, with downtime for scheduled maintenance.

Wood has undertaken an assessment of noise levels focussed on noise monitors representative of the highest risk residences without an agreement. Noise monitoring data collected during the reporting period was screened through a process that aimed to identify day, evening and night periods where mining noise levels were at their highest, there was minimal extraneous noise, and weather conditions were characterised by low wind speeds.

For the reporting period, noise emissions from mining were generally low and not of significant concern. Often mining noise was low and masked by extraneous noise, under such conditions mining noise cannot be accurately quantified.

However, there were two (2) evening periods and six (6) night-time periods identified with a medium risk of non-compliance, due to risk of exceeding indoor noise levels at the receiver with an agreement (adjacent to the noise monitor). Of the eight (8) periods, three (3) occurred during September 2022. It is likely combined noise sources (e.g. McCloskey screen, in-pit mobile screening unit, and loaders) from mining have contributed to elevated noise during the periods identified.

KLPL advised that one noise related complaint was received during the reporting period. This was investigated by KLPL and followed by an outcome that was satisfactory to the resident. Additionally, in response to this complaint, Doral moved the noise monitor NMT3 to a revised location (NMT3B) to monitor noise near the complainant's residence. While monitoring at NMT3B, no periods were identified to have an elevated risk of exceedance.

There were no instances where operations were required to be shut down due to excessive noise emissions.

TABLE OF CONTENTS

1 INTRODUCTION

Keysbrook Leucoxene Pty Ltd (KLPL), a subsidiary of Doral Mineral Sands Pty Ltd (Doral), operates the Keysbrook Mineral Sands Mine, located approximately 70 km south of Perth.

Keysbrook mine operations commenced on 22 October 2015. Mineral sands processing operations are continuous, 24 hours per day, 7 days per week. Mining of mineral sands and rehabilitation of existing pits occur from 7am to 7pm, Monday to Saturday, and 9am to 7pm on Sundays and Public Holidays.

Operations occur on private freehold land, which is predominantly used for pastoral grazing and small rural lots Appendix Figure A-1 presents an aerial view of the mine area and surrounds, including the closest residences. Currently, mining operations at Keysbrook are underway in Lot 57.

Environmental approval for the mine is granted through Ministerial Statement No. 810 (MS810). Related to noise management, Ministerial Statement No. 1089 (MS1089) [1] replaces condition 14 (C14) in MS810.

Wood has been commissioned by KLPL to prepare an annual compliance report for noise monitoring undertaken. The report applies a similar methodology for data analysis and assessment demonstrated in previous compliance reports.

This report has been prepared according to Condition 14-9 of MS1089, which requires an annual noise report that *"shall address operations, noise management, and noise emissions for each time period (Day, Evening and Night) for the purpose of demonstrating compliance with condition 14-1, 14-2 and 14-3 (as applicable) and shall include the following:*

1) *A description of the equipment and methods used for monitoring and modelling of operational noise emissions, to a level of detail that would enable them to be independently reproduced by an acoustic expert;*

2) *An assessment prepared by an independent acoustic expert which demonstrates to a reasonable and practical extent (or otherwise satisfactorily to the CEO) the level of compliance with applicable noise levels at all nearby noise sensitive premises; and,*

3) *A description of the noise management measures employed during the period."*

MS1089 C14-1 stipulates separation distances required to be maintained between mining operations and noise-sensitive areas, where an amenity agreement is not in place. Doral maintain these separation distances for mine operations.

MS1089 C14-2 stipulates, for noise-sensitive areas where an amenity agreement is in place, indoor noise limits during evening periods, night-time, and Sundays/Public Holidays. For Keysbrook operations, this is relevant to minerals processing during the evening and night times, and mining activity on Sundays/Public Holidays.

MS1089 C14-3 stipulates that a NMMP (Noise Monitoring and Management Plan) is required to be submitted if the conditions in C14-1 need to be varied. A NMMP was not required within the reporting period.

In addition to the MS1089 requirements, compliance with the *Environmental Protection (Noise) Regulations 1997* (the Regulations) [2] is also assessed at residences outside of the separation distances that do not have an amenity agreement.

This report covers mining operations between 19 July 2022 and 19 July 2023 (end of the reporting period for KLPL's compliance assessment report, submitted to the EPA (Environmental Protection Authority)).

Noise monitoring at Keysbrook is undertaken by KLPL, including the set-up and maintenance of noise monitors. Collected noise data is streamed to and held on the Envirosuite Sentinel cloud system. Noise monitoring was undertaken by KLPL throughout the reporting period.

2 REFERENCES

[1] State of Western Australia, "Ministerial Statement No. 1089, Statement to Amend Conditions Applying to a Proposal (Pursuant to the Provisions of Section 46 of the Environmental Protection Act 1986).".

[2] *Environmental Protection (Noise) Regulations 1997,* Western Australia: Government of Western Australia, 24 Jan 2017.

[3] Wood, "Keysbrook Internal Residence Noise Risk Assessment," 1404025-5-200-RevB-19.May.2020.

[4] State of Western Australia, "Environmental Protection Act 1986".

3 ASSESSMENT CRITERIA

Appendix A presents an aerial view of the approved project area and surrounding land and includes the closest Noise Sensitive Receptors (NSR).

3.1 Receivers with an Agreement

For receivers within the separation distances outlined in MS1089 C14-1 [1], Doral has amenity agreements in place and the indoor limits provided in MS1089 C14-2 are applicable during evening periods, night-time, and Sundays/public holidays. These are provided in Table 3-1.

Table 3-1: Indoor Allowable Levels (L_{A10})

Location	Time of Day	Indoor Allowable Levels L_{A10} in dB(A)
All sensitive receptors with an agreement	Evening: 0900 to 1900 hours Sunday and public holidays and1900 to 2200 hours all days	30 + Influencing factor
	Night: 2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays	25 + Influencing factor

Wood was previously engaged to prepare a *Risk Assessment for Internal Dwelling Noise* [3], where the potential of mining noise exceeding the indoor allowable levels is risk assessed. A literature review was undertaken which found that the noise reduction for a dwelling of standard construction and design that has received no special acoustic treatment is approximately 15-25 dB. This reduction assumes that all windows and doors are shut, and that the dwelling and facades are in reasonable condition. Based on this, the following risk criteria were determined:

- **Low Risk** – Compliance with limits requires an outdoor-to-indoor sound reduction of 15 dB(A) (achievable by most dwellings)
- **Medium Risk** – Compliance with limits requires an outdoor-to-indoor sound reduction of 20 dB(A) (achievable by most houses with a solid air sealed construction)
- **High Risk** – Compliance with limits requires an outdoor-to-indoor sound reduction greater than 20 dB(A) (achievable by houses with high performing acoustical construction)

Table 3-2 presents the exterior allowable level for noise-sensitive premises with an amenity agreement. These values include an adjustment for tonality (5 dB) and predicted noise reduction due to transmission loss for a standard dwelling with closed windows and doors.

Table 3-2 Risk Ratings for Exceeding Indoor Noise Levels

Location	Time of Day	Exterior Allowable Levels dB(A)		
		Low Risk	Medium Risk	High Risk
All sensitive receptors with an agreement	Evening: 0900 to 1900 hours Sunday and public holidays and 1900 to 2200 hours all days	<40	40-45	>45
	Night: 2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays	<35	35-40	>40

3.2 Assigned Levels

Although not required under the conditions of MS1089 where defined separation distances are maintained, noise at receivers without an agreement has been assessed against the Regulations [2], which operate under the *Environmental Protection Act 1986* [4]. The Regulations specify maximum noise levels (assigned levels) which are the highest noise levels that can be received at noise-sensitive residential, commercial, and industrial premises (NSRs).

The Regulations provide for the application of an influencing factor, which can cause the adjustment of assigned levels depending on designated land zoning and land use within 450m of an NSR. In the area around the Keysbrook site, none of the noise-sensitive receivers without an amenity agreement have influencing factors.

APPENDIX C provides a summary of the noise regulations and information on the determination of the assigned levels.

Table 3-3 presents the L_{A10} assigned levels for NSRs without a noise agreement. The L_{A10} assigned level is quoted in the table as this is considered the most stringent for operations as the noise emissions are relatively constant. The L_{A1} and L_{AMAX} assigned levels also apply to the Keysbrook site, although based on extensive attended and unattended noise monitoring, these levels are rarely approached.

Table 3-3: Assigned Levels (L_{A10})

Location	Influencing Factor	Assigned levels (L_{A10}) in dB(A)		
		Weekday[1]	Evening and Sunday[2]	Night[3]
All sensitive receptors without an agreement	-	45	40	35

[1]Weekday: 0700 to 1900 hours Monday to Saturday.
[2]Evening and Sunday: 1900 to 2200 hours all days, and 0900 to 1900 hours Sunday and public holidays.
[3]Night: 2200 hours on any day to 0700 hours Monday to Sunday and 0900 hours Sunday and public holidays.

The *Regulations* allow for an assessment period of between 15 minutes and 4 hours (a period normally determined by the regulator). A longer period, such as three to four hours, is more appropriate for assessing noise emissions on the basis that, given the nature of operations, levels can vary from hour to hour and a longer assessment period will be more representative of the long-term LA10 noise levels.

For assessment of the unattended logged noise data in post-processing, where it is possible to assess noise on a 4-hour basis, without the period being compromised by effects such as weather, fauna, or external anthropogenic related noise, a 4-hour period is used. If a 4-hour assessment is not possible because of these effects, a 3-hour period is considered.

3.2.1 Corrections for Characteristics of Noise

MS1089 C14-4(1) requires that tonal characteristics must be assumed to be present at all times if preparing a NMMP (Noise Management and Monitoring Plan). According to the Regulations, a +5dB adjustment for tonality applies to the noise received at a noise sensitive receiver. In this assessment, it is assumed that tonality is present in the received noise emissions at noise sensitive receivers.

4 NOISE MONITORING

Table 4-1 lists the noise monitors in place during the reporting period. Table 4-2 contains the coordinates for each monitor at the end of the quarter. The location of the noise monitors is presented in Table 4-1.

Table 4-1 Noise Monitors in Place During the Reporting Period

Name	Location Relative to Mining Operations	Time Period
NMT3	North	19th July 2022 - 19th July 2023[4] All time other than period below for NMT3B
NMT3B	South-West	31st August 2022 - 14st September 2022
NMT4	East	19th July 2022 – 19th July 2023

Table 4-2 Noise Monitor Coordinates

Logger	Easting	Northing	Latitude	Longitude
NMT3	401229.05 m E	6410983.94 m S	-32.4339	115.949358
NMT3B	398885.96 m E	6408941.24 m S	-32.4521	115.924219
NMT4	402125.55 m E	6409481.03 m S	-32.4475	115.958737

[4] It is noted that NMT3 experienced battery related issues between the 18th November 2022, which resulted in monitor outages in November and December. The battery was later changed out on the 9th December 2022 which resolved the issue.

5 SUMMARY OF ACTIVITIES WITHIN REPORTING PERIOD

5.1 Mine Operations for the Reporting Period

Within the reporting period, mining occurred during daytime periods only. Excavated ore was transported to MFU4 for initial screening before being pumped as a slurry to the Wet Concentrator Plant (WCP). Ore was loaded into the screen using a CAT 988K loader. Excess ore was stockpiled at MFU4, which was used to feed the MFU during periods when no mining occurred. The McCloskey screen, an in-pit mobile screening unit, was also used at times which was in Lot 57, and when used being fed by a loader.

The WCP continued to operate on a 24/7 basis during the reporting period, with downtime for scheduled maintenance.

During the reporting period, mining was undertaken at various blocks within Lots 57, 101, and 103. Table 5-1 shows the mining locations and mining activities for each month of the monitoring period. APPENDIX B presents an aerial view of the Keysbrook Sand Mine Block Numbers and highlights the blocks mined within the reporting period.

Table 5-1 Mining Operations and Monitoring Locations for Each Month

Month	Mining Location	Comments
Jul 22	Mining in blocks 60, 74, 105, 106, 118, 119, 131, 132, 103, 104, 87, and 117.	Tailing in blocks 150 and 141. Pushing out tails in Lot 101 and 57.
Aug 22	Mining in blocks 60, 61, 74, 92, 103, 108, 109, 110, 111, 112, and 103.	Tailing in blocks 129, 116, 103, and 87. Push tails in Lot 57, 101 and 105.
Sept 22	Mining blocks 34, 49, 60, 74, 110, 111	Tailing in blocks 130, 117, 104. Pushing tails in block 150, Lot 105, 101 and 57N.
Oct 22	Mining block 34, 49, 50, 60, 61, 74, 89, 110	Tailing in blocks 103, 104 and 87. Pushing tails in block 150, 65, Lot 101, and 57.
Nov 22	Mining block 45, 57, 49, 61, 75, 108, 109, 110	Tailing in blocks 131, 118, 105 and 89. Push tails in Lot 57N.
Dec 22	Mining block 29, 45,57, 62, 72, 75, 87, 109, 119, 122, 129, 132	Tailing in blocks 131, 118, 105 and 89. Push tails in block 150, block 74, Lot 57S and 57N.
Jan 23	Mining in blocks 62, 119, 57, 72, 76, 77, 87, 90, 103, 108, 150, 116 and 104	Tailing in blocks 131, 118, 105 and 89. Pushing tails in block 74, 150, 141, Lot 57, 101 and 105.
Feb 23	Mining in blocks 29, 30, 31, 47, 58, 72, 87, 63, 76, 75, 77	Tailing in blocks 87 and 72. Push tails in Lot 101, 105, 57, block 141, 150
Mar 23	Mining in blocks 30, 46, 58, 59, 123, 135, 136, 61, 62, 63, 75, 76, 77	Tailing in blocks 87, 72 and 57. Push tails in Lot 57, 105, 103

Month	Mining Location	Comments
Apr 23	Mining in blocks 88, 90, 92, 104, 30, 31, 46, 47, 58, 73, 87, 62, 63, 76, 77	Tailing in blocks 57 and 45. Push tails in Lot 101, 57, 105, 103, blocks 121, 73,
May 23	Mining in blocks 74, 33, 73, 74, 88, 31, 32, 33, 47, 48, 59, 73, 63, 121, 122	Tailiing in block 29. Push tails in Lot 57, blocks 77, 121,
Jun 23	Mining in blocks 36, 74, 89, 90, 106, 50, 51, 32, 48, 59, 108, 121, 122	Tailing in blocks 58 and 73. Push tails in Lot 57, 105,
Jul 23	Mining block 48, 51, 35, 52, 36, 35, 73, 88, 92	Tailing and pushing tails in the vicinity block 46 and 30

5.2 Noise Management Measures Undertaken by KLPL

The following noise mitigation and management measures have been maintained by KLPL during the reporting period:

- Compliance with the separation distances provided in MS1089 C14-1;
- No mining during night time periods; and
- Continuous noise monitoring.

During the reporting period, there were no instances where operations shut down due to excessive noise emissions.

There was one complaint received with regards to noise, summarised in Table 5-2.

Table 5-2: Noise Complaints Received

Date	Nature of complaint	Actions taken and outcome
31/08/2021	Text message received from a Keysbrook community member advising of noise seeming loud overnight. It is noted that this was the first time the community member had stayed at the property for some time.	In response to the notification, KLPL relocated the noise monitor near to the community member's property to investigate the complaint further. It is noted that relatively less equipment has been used overnight relevant to the complaint as the mobile feed unit was down. Operations for the night consisted of one loader at the MFU and a truck at the WCP carting oversize 100m to the stockpile. Based on recent annual noise surveys, site is likely compliant at the receptor, but resident can hear noise from time to time. The actions taken by KLPL were explained to the community member.

6 LOGGING NOISE DATA ANALYSIS

6.1 Logging System Technical Details

6.1.1 Equipment and Calibration

Noise monitors and field calibrators are owned/leased, operated and maintained by KLPL. The equipment meets the requirements specified in Schedule 4 of the Environmental Protection (Noise) Regulations 1997.

KLPL advises that the noise monitoring systems have been regularly calibrated at intervals compliant with regulatory requirements and manufacturer's recommendations.

KLPL advises that laboratory calibration of B&K 2250/2270 sound level meters used in the monitors, and field calibrators meets the relevant provisions set out in Schedule 4 of the Environmental Protection (Noise) Regulations 1997.

6.1.2 Noise Monitor Data

The noise monitor systems meet the requirements set out in section 6.1.1. The monitors are connected to the Envirosuite Sentinel system, facilitating 24/7 and real-time access to the recorded data. Noise monitors were configured to capture audio clips during periods of elevated noise.

6.1.3 Meteorological Data

KLPL provided the weather data used throughout the analysis, which was recorded at the central weather station on site (KLPAWS). The data source is summarised in Table 6-1.

Table 6-1 Sources of Meteorological Data

Source of Meteorological Data	Location	Height
KLPAWS	Located centrally, near to the site's administration buildings	10 m

The weather data is logged and averaged over 5-minute samples and time-stamped for the start of the logged period.

Wind conditions, including direction and velocity, have historically been observed to frequently vary significantly across the 5km east-west extent of the project area.

6.2 Monitoring Data Analysis Methodology

6.2.1 Data Screening

In order to focus the assessment effort on periods which are more likely to exhibit elevated operational noise levels, high-level screening of all of the monitoring data in the reporting period was first conducted. The screening was designed to identify periods with the highest mining noise levels and where meteorological conditions were conducive to un-masked operational noise levels recorded at the monitor. 15-minute resolution data was used within the screening process. Noise data for selected high noise periods identified through screening were further reviewed. The following outlines the screening process:

- Weather data was reviewed to identify any periods where there were both elevated noise levels and appropriate meteorological conditions. The following post processing criteria was applied to allow a determination of periods for further analysis:
    - Wind speeds below 3 m/s (10.8 km/hr);
    - Favourable wind direction for noise propagation between mining and noise monitor; and
    - No rain events.
- A frequency filter was applied to $L_{A10,15\text{-minute}}$ noise levels to remove noise 1.6 kHz and above, to reduce the contribution of insect and high frequency noise.
- The highest risk daytime, evening and night-time periods throughout the year were determined based on a count of 15-minute samples that met the weather screening criteria and where the $L_{A10,15\text{-minute}}$ noise levels were elevated.
- Audio recordings of high-risk periods were reviewed to determine if mining noise was audible.
- The available data from the screening process, and also considering locations of noise monitors, mining and NSRs, was reviewed to assess the risk of the period being either:
    - Non-compliant with the assigned levels for receivers without a noise agreement; or
    - Exceeding the indoor noise limits for receivers without an agreement.

For any periods with an elevated risk of exceedance, further investigation was undertaken, such as extrapolation of noise levels (to account for differences in distances between the monitors and residences in relation to the mining activities) and/or detailed review of 1 second logged monitored data against noise audio alerts to better determine the level of mining noise. Extrapolation of levels was first estimated due to geometric spreading (6dB reduction for doubling of distance), and, where required, estimated based on noise contours generated from previous noise modelling of similar operating scenarios, considering distances between the noise source, monitor and receiver.

6.2.2 Limitations of Monitoring Data Analysis

Limitations of the Keysbrook noise monitoring analysis include:

- Locations of monitors, which only capture the noise risk at receivers nearby or in a similar direction to receivers as the monitors.
- When noise monitors are not located at the receiver, extrapolating the results to predict the level at the receiver is less accurate.
- At times, recorded weather data does not correlate with noise monitoring observations. This is likely due to inconsistent, time and space varying local weather conditions, particularly with regards to temperature and wind gradients (changing with height) and local influences.

6.3 Analysis Results and Compliance Assessment

Table 6-2 presents the number of periods identified during screening with potential as being elevated risk (100 total). APPENDIX D provides details of each of these periods, including the results at the noise monitor and assessment of compliance risk. The sections below summarise periods where a compliance risk has been identified.

Table 6-2: Number of potential elevated risk periods identified in screening

	Daytime	Evening	Night-time
NMT3	0	4	34
NMT3B	0	0	1
NMT4	3	10	48

6.3.1 Daytime Results

The 3 periods identified at NMT4 in screening which had the potential for a risk of exceedance of the assigned noise levels were reviewed and were found to be low risk due to dominant wind noise.

6.3.2 Evening Results

Most screened periods during the evening had no audible mining noise in recordings, which were typically dominated by insects, wind, and traffic noise.

All evening periods assessed for NMT3 were found to have no risk of non-compliance.

For NMT4, two (2) evening periods were identified with a medium risk of non-compliance due to risk of exceeding indoor noise levels at the receiver with an agreement (Adjacent to the monitor). When accounting for noise attenuation over distance, there is a small risk of exceeding at the nearest receiver without an agreement, although it is more likely that wind (or other extraneous noise) would mask mine noise at distant locations.

The periods are summarised in Table 6-3.

Table 6-3: Evening periods identified with a Meidum Risk of non-compliance

Monitor, Date & Period	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Comment
NMT4 18/08/2022 7PM - 10PM	38.9 - 47.5	Clearly audible mobile equipment and fixed mining sources. Intermittent aircraft and train noise. Persistent high-frequency insect noise.	Mining operations were audible with instantaneous L_{Aeq} levels of 37-43 dB(A). There is a medium risk of non-compliance with the indoor allowable levels for the receiver with an agreement adjacent to the noise monitor. Extrapolated to the nearest receiver without an agreement, an 8-10 dB adjustment is expected, and therefore received levels are expected to be up to 29 – 35 dB(A) which may exceed the assigned levels with the presence of tonality.
NMT4 15/07/2023 7PM - 8PM	43.6 - 44.4	Audible fixed plan mining noise with faint mobile equipment. Intermittent train noise.	Mining operations audible with instantaneous L_{Aeq} levels of 38-42 dB(A). There is a medium risk of non-compliance with the indoor allowable levels for the receiver with an agreement adjacent to the noise monitor. Extrapolated to the nearest receiver without an agreement, an 8-10 dB adjustment is expected, and therefore received levels are expected to be up to 30 – 34 dB(A) which may exceed the assigned levels with the presence of tonality.

6.3.3 Night Results

Most screened periods during the evening had no audible mining noise in recordings, which were typically dominated by insects, wind, and traffic noise. Most night periods were assessed as having low or no risk of non-compliance.

A total of six (6) night-time periods were identified to have a medium risk of non-compliance due to risk of exceeding indoor noise levels at the receiver with an agreement (adjacent to the monitor). This included four (4) night-time periods at NMT3 and three (2) periods at NMT4. When extrapolated, there is a small risk of exceeding at the nearest receiver without an agreement, although it is more likely that wind (or other extraneous noise) would mask mine noise at distant locations.

The periods are summarised in Table 6-4.

Table 6-4: Night-time periods identified with a Medium Risk of non-compliance

Monitor, Date & Period	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Comment
NMT3 21/07/2022 10PM - 4AM	24.0 - 60.5	Mobile equipment clearly audible throughout night (revving/working). Insects faintly audible throughout.	Mining operations were audible with instantaneous L_{Aeq} levels of 27-42 dB(A). Exceedances of 40 dB(A) were observed to be infrequent, lasting short periods, and associated with revving mobile equipment. Mining noise was observed to predominantly fall between 35-40 dB(A). There is a medium risk of non-compliance with the indoor allowable levels for the receiver with an agreement adjacent to the noise monitor. Extrapolated to the nearest receiver without an agreement, a 6-8 dB adjustment is expected, and therefore received levels are expected to be up to 29 – 34 dB(A) (with brief periods up to 36 dBA), which may exceed the assigned levels with the presence of tonality.
NMT3 16/09/2022 4AM - 7AM	36.7 - 45.8	Mining noise clearly audible between intermittent bird calls. Mining noise levels appear steady indicating fixed plant sources. Faint mobile equipment noise audible.	Mining operations were audible with instantaneous L_{Aeq} levels of 36-40 dB(A). There is a medium risk of non-compliance with the indoor allowable levels for the receiver with an agreement adjacent to the noise monitor. Extrapolated to the nearest receiver without an agreement, a 6-8 dB adjustment is expected, and therefore received levels are expected to be up to 30 – 34 dB(A) which may exceed the assigned levels with the presence of tonality.
NMT4 20/09/2022 5AM - 7AM	39.6-48.4	Mobile equipment clearly audible throughout night (revving/working). Insects faintly audible throughout.	Mining operations audible with instantaneous L_{Aeq} levels of 28-45 dB(A). Exceedances of 40 dB(A) were observed to be infrequent, lasting short periods, and associated with revving mobile equipment. Mining noise was observed to predominantly fall between 35-40dB(A). There is a medium risk of non-compliance with the indoor allowable levels for the receiver with an agreement adjacent to the noise monitor. Extrapolated to the nearest receiver without an agreement, an 8-10 dB adjustment is expected, and therefore received levels are expected to be up to 20 – 32 dB(A) (with brief periods up to 37 dBA), which may exceed the assigned levels with the presence of tonality.

Monitor, Date & Period	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Comment
NMT3 23/09/2022 10PM - 2AM	34.8 - 42.6	Mobile equipment noise clearly audible (revving/working) with presence of steady fixed noise source. Intermittent fauna/dogs barking throughout. Dominant rain/wind towards the end of the period.	Mining operations audible with instantaneous L_{Aeq} levels of 34-40 dB(A). There is a medium risk of non-compliance with the indoor allowable levels for the receiver with an agreement adjacent to the noise monitor. Extrapolated to the nearest receiver without an agreement, a 6-8 dB adjustment is expected, and therefore received levels are expected to be up to 28 – 34 dB(A) which may exceed the assigned levels with the presence of tonality.
NMT4 11/06/2023 10PM - 12AM	35.7 - 39.2	Audible fixed-plant mining source with occasional faint mobile equipment noise. Distant high pitch creaking noise throughout.	Mining operations audible with instantaneous L_{Aeq} levels of 31-38 dB(A). There is a medium risk of non-compliance with the indoor allowable levels for the receiver with an agreement adjacent to the noise monitor. Extrapolated to the nearest receiver without an agreement, an 8-10 dB adjustment is expected, and therefore received levels are expected to be up to 23 – 30 dB(A) which may exceed the assigned levels with the presence of tonality.
NMT3 9/10/2022 10PM - 7AM	35.5 - 43.7	Faint mining noise audible. Mining noise levels appear steady indicating fixed plant sources. Fauna faintly audible. Intermittent cows during period.	Mining operations audible with instantaneous L_{Aeq} levels of 34-36 dB(A). There is a medium risk of non-compliance with the indoor allowable levels for the receiver with an agreement adjacent to the noise monitor. Extrapolated to the nearest receiver without an agreement, an 6-8 dB adjustment is expected, and therefore received levels are expected to be up to 28 – 30 dB(A) which may exceed the assigned levels with the presence of tonality.

7 CONCLUSION AND RECOMMENDATIONS

Wood has undertaken an analysis of the noise monitoring data collected during the period 19th July 2022 – 19th July 2023. Assessed noise data was captured from two monitors across three locations. A screening process was used, aimed to identify day, evening and night periods where mining noise levels were the highest, there was minimal extraneous noise, and weather conditions indicated worst case conditions. Following this process, the screened periods were reviewed in further detail to determine risk of non-compliance.

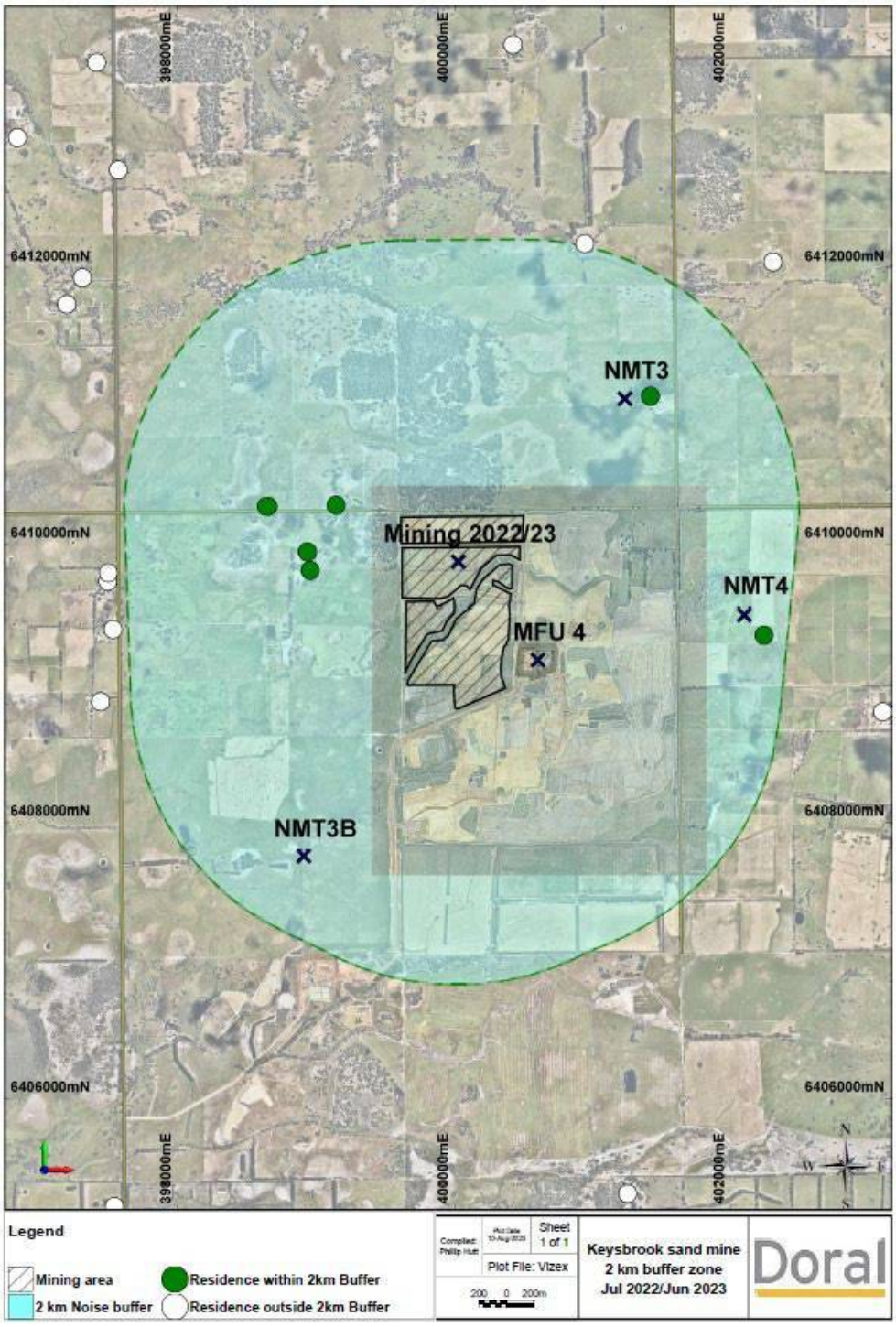
For the reporting period, noise emissions from mining were generally low and not of significant concern. Often mining noise was low and masked by extraneous noise, under such conditions mining noise cannot be accurately quantified.

However, there were two (2) evening periods and six (6) night-time periods identified with a medium risk of non-compliance, due to risk of exceeding indoor noise levels at the receiver with an agreement (adjacent to the noise monitor). Of the eight (8) periods, three (3) occurred during September. It is likely combined noise sources (e.g. McCloskey screen, in-pit mobile screening unit, and loaders) from mining have contributed to elevated noise during the periods identified.

KLPL advised that one noise related complaint was received during the reporting period. This was investigated by KLPL and followed by an outcome that was satisfactory to the resident. Additionally, in response to this complaint, Doral moved the noise monitor NMT3 to a revised location (NMT3B) to monitor noise near the complainant's residence. While monitoring at NMT3B, no periods were identified to have an elevated risk of exceedance.

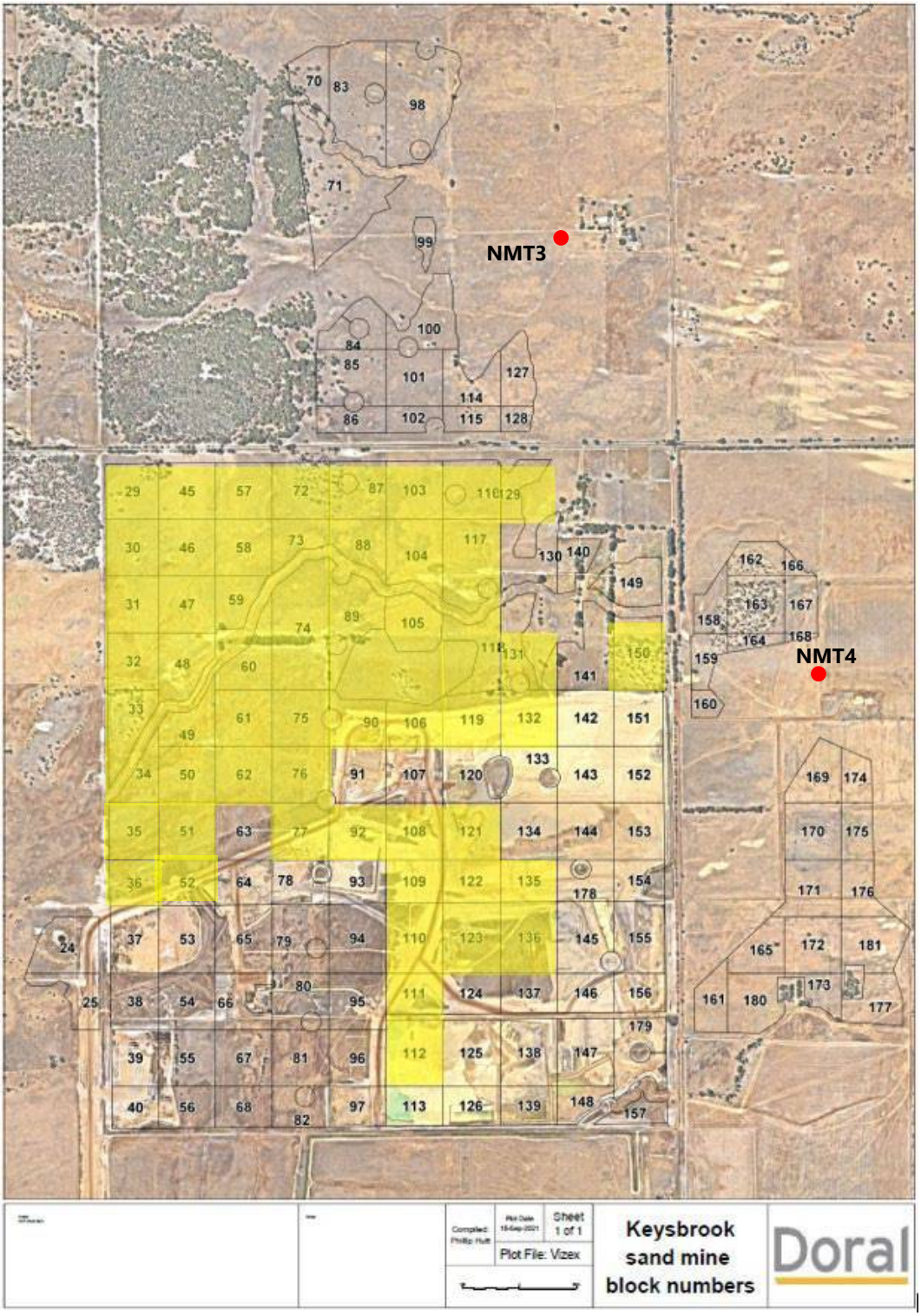
There were no instances where operations were required to be shut down due to excessive noise emissions.

APPENDIX A NOISE MONITORING NETWORK AND SURROUNDS



Appendix Figure A-1: Aerial view of the Keysbrook mine site, surrounding area, location of noise monitors and residents in the reporting period

APPENDIX B KEYSBROOK SAND MINE BLOCK NUMBERS



Appendix Figure B-1: Active Mining Block Locations During Reporting Period

APPENDIX C SUMMARY OF NOISE REGULATIONS

Management of industrial noise in Western Australia is implemented through the WA *Environmental Protection (Noise) Regulations 1997* which operate under the *Environmental Protection Act 1986*. The *Regulations* specify maximum noise levels (Assigned Noise Levels) which are the highest noise levels that can be received at noise-sensitive (residential), commercial and industrial premises.

For noise sensitive premises (i.e. residences), an "influencing factor" is incorporated into the assigned noise levels. The influencing factor depends on land use zonings within circles of 100 metres and 450 metres radius from the noise receiver, including:

- the proportion of industrial land use zonings;
- the proportion of commercial zonings; and
- the presence of major roads.

The presence of major roads or industrial developments (or zoning for those developments) can result in influencing factors in a range from 0 to 20dB.

The regulations categorise "land on which a mining operation is carried on" as industrial premises for the purposes of calculating the influencing factor.

For noise sensitive residences, the time of day also affects the assigned levels.

The regulations define three types of assigned noise level:

- L_{Amax} Assigned Noise Level means a noise level which is not to be exceeded at any time;
- L_{A1} Assigned Noise Level which is not to be exceeded for more than 1% of the time; and
- L_{A10} Assigned Noise Level which is not to be exceeded for more than 10% of the time.

Appendix Table C-1 below presents the generic Assigned Noise Levels for noise sensitive premises defined in the regulations.

Appendix Table C-1 Assigned Noise Levels

Type of premises receiving noise	Time of day	Assigned Noise Levels dBA		
		$L_{A\ 10}$	$L_{A\ 1}$	$L_{A\ max}$
Noise sensitive premises: highly sensitive area	0700 to 1900 hours Monday to Saturday	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sundays and public holidays	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours all days	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 - 0700 hours on any day Monday to Saturday & 2200 - 0900 hours Sunday and public holidays	35 + influencing factor	45 + influencing factor	55 + influencing factor
Noise sensitive premises: any area other than highly sensitive area	All hours	60	75	80

APPENDIX D PERIODS ASSESSED

A.1 NMT3/3B

A.1.1 Night Periods

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
NMT3 21/07/2022 10PM - 4AM	24.0 - 60.5	Mobile equipment clearly audible throughout night (revving/working). Insects faintly audible throughout.	**Medium Risk**	Mining operations were audible with instantaneous L_{Aeq} levels of 27-42 dB(A). Exceedances of 40 dB(A) were observed to be infrequent, lasting short periods, and associated with revving mobile equipment. Mining noise was observed to predominantly fall between 35-40 dB(A). There is a medium risk of non-compliance with the indoor allowable levels for the receiver with an agreement adjacent to the noise monitor. Extrapolated to the nearest receiver without an agreement, a 6-8 dB adjustment is expected, and therefore received levels are expected to be up to 29 – 34 dB(A) (with brief periods up to 36 dBA), which may exceed the assigned levels with the presence of tonality.
NMT3 22/07/2022 10PM - 2AM	32.9 - 57.8	Wind dominant throughout the night	No	Mining operations did not contribute to the elevated noise levels.
NMT3 24/07/2022 1AM - 7AM	29.8 - 43.7	Wind dominant throughout the night	No	Mining operations did not contribute to the elevated noise levels.
NMT3 27/07/2022	30.9 - 45.8	Insects audible throughout. Persistent wind and periodic trains.	No	Mining operations did not contribute to the elevated noise levels.

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
12AM - 7AM				
NMT3 28/07/2022 12AM - 6AM	27.6 - 62.9	Wind dominant throughout the night	No	Mining operations did not contribute to the elevated noise levels.
NMT3 31/07/2022 12AM - 6AM	25.7 - 57.8	Wind dominant throughout the night	No	Mining operations did not contribute to the elevated noise levels.
NMT3 6/08/2022 10PM - 5AM	35.5 - 60.1	Wind dominant throughout the night. Rain towards the end of the night	No	Mining operations did not contribute to the elevated noise levels.
NMT3 14/08/2022 10PM - 7AM	33.0 - 59.8	Wind dominant throughout the night. Fauna audible intermittently.	No	Mining operations did not contribute to the elevated noise levels.
NMT3B 13/09/2022 10PM - 7AM	34.8 - 47.8	Wind, fauna and electrical noise dominant throughout. Distant traffic audible occasionally.	No	Mining operations did not contribute to the elevated noise levels.
NMT3 16/09/2022 4AM - 7AM	36.7 - 45.8	Mining noise clearly audible between intermittent bird calls. Mining noise levels appear steady indicating fixed plant sources. Faint mobile equipment noise audible.	**Medium Risk**	Mining operations were audible with instantaneous L_{Aeq} levels of 36-40 dB(A). There is a medium risk of non-compliance with the indoor allowable levels for the receiver with an agreement adjacent to the noise monitor. Extrapolated to the nearest receiver without an agreement, a 6-8 dB adjustment is expected, and therefore received levels are expected to be up to 30 – 34 dB(A) which may exceed the assigned levels with the presence of tonality.
NMT3	26.2 - 42.0		No	Mining operations did not contribute to the elevated noise levels.

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
19/09/2022 10PM - 7AM		Wind and rain dominant throughout the night. Fauna towards the end of the night		
NMT3 20/09/2022 5AM - 7AM	35.2 - 43.9	Fauna and wind dominant throughout the night	No	Mining operations did not contribute to the elevated noise levels.
NMT3 22/09/2022 1AM - 7AM	29.6 - 56.4	Wind dominant throughout. Fauna dominant towards the end of the night	No	Mining operations did not contribute to the elevated noise levels.
NMT3 23/09/2022 10PM - 2AM	34.8 - 42.6	Mobile equipment noise clearly audible (revving/working) with presence of steady fixed noise source. Intermittent fauna/dogs barking throughout. Dominant rain/wind towards the end of the period.	**Medium Risk**	Mining operations were audible with instantaneous L_{Aeq} levels of 34-40 dB(A). There is a medium risk of non-compliance with the indoor allowable levels for the receiver with an agreement adjacent to the noise monitor. Extrapolated to the nearest receiver without an agreement, a 6-8 dB adjustment is expected, and therefore received levels are expected to be up to 28 – 34 dB(A) which may exceed the assigned levels with the presence of tonality.
NMT3 9/10/2022 10PM - 7AM	35.5 - 43.7	Faint mining noise audible. Mining noise levels appear steady indicating fixed plant sources. Fauna faintly audible. Intermittent cows during period.	**Medium Risk**	Mining operations were audible with instantaneous L_{Aeq} levels of 34-36 dB(A). There is a medium risk of non-compliance with the indoor allowable levels for the receiver with an agreement adjacent to the noise monitor. Extrapolated to the nearest receiver without an agreement, a 6-8 dB adjustment is expected, and therefore received levels are expected to be up to 28 – 30 dB(A) which may exceed the assigned levels with the presence of tonality.
NMT3 30/10/2022 4AM - 7AM	37.2 - 48.5	Frequent dominant fauna noise. Mining noise from mobile equipment and fixed sources faintly audible throughout, masked by fauna. Short instance of local mechanical noise near microphone, possibly from nearby passing vehicle.	Low Risk	Mining operations is faintly audible and predominantly masked by extraneous noise. Noise levels present a low risk of non-compliance with the indoor allowable levels for the adjacent receiver with an agreement.

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
NMT3 14/01/2023 10PM - 7AM	37.5 - 71.0	Wind dominant throughout. Fauna audible towards the end of the night.	No	Mining operations did not contribute to the elevated noise levels.
NMT3 19/01/2023 11PM - 6AM	26.4 - 58.7	Wind dominant throughout	No	Mining operations did not contribute to the elevated noise levels.
NMT3 25/01/2023 10PM - 7AM	44.7 - 64.8	Wind dominant throughout	No	Mining operations did not contribute to the elevated noise levels.
NMT3 27/01/2023 11PM - 7AM	29.3 - 48.8	Wind dominant at the beginning of the night. Fauna dominant towards the end.	No	Mining operations did not contribute to the elevated noise levels.
NMT3 29/01/2023 11PM - 7AM	43.3 - 63.5	Wind dominant throughout	No	Mining operations did not contribute to the elevated noise levels.
NMT3 9/05/2023 2AM - 7AM	28.8 - 54.3	Wind dominant throughout	No	Mining operations did not contribute to the elevated noise levels.
NMT3 29/05/2023 1AM - 7AM	33.7 - 45.4	Wind dominant throughout. Fauna towards the end of the night	No	Mining operations did not contribute to the elevated noise levels.
NMT3 4/06/2023	31.0 - 58.2	Wind dominant throughout	No	Mining operations did not contribute to the elevated noise levels.

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
2AM - 7AM				
NMT3 9/06/2023 2AM - 7AM	37.0 - 54.7	Wind and rain dominant throughout	No	Mining operations did not contribute to the elevated noise levels.
NMT3 13/06/2023 10PM - 2AM	38.4 - 42.5	Dominant wind during periods, masking faint mobile equipment noise. Low frequency noise notable at 50Hz	No	Mining operations did not contribute to the elevated noise levels.
NMT3 19/06/2023 11PM - 3AM	37.6 - 51.6	No audio available to review. Noise plot indicates typical bird/wind noise pattern.	No	Mining operations did not contribute to the elevated noise levels.
NMT3 20/06/2023 1AM - 5AM	31.9 - 47.8	Wind and rain dominant throughout	No	Mining operations did not contribute to the elevated noise levels.
NMT3 1/07/2023 1AM - 9AM	28.2 - 48.5	Wind and fauna dominant throughout	No	Mining operations did not contribute to the elevated noise levels.
NMT3 2/07/2023 10PM - 2AM	25.8 - 56.0	Wind dominant throughout	No	Mining operations did not contribute to the elevated noise levels.
NMT3 8/07/2023 1AM - 9AM	25.4 - 46.8	Wind and fauna dominant throughout	No	Mining operations did not contribute to the elevated noise levels.
NMT3	33.1 - 4.5	Wind dominant throughout	No	Mining operations did not contribute to the elevated noise levels.

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
9/07/2023 10PM - 12PM				
NMT3 11/07/2023 12AM - 7AM	26.7 - 54.2	Wind dominant throughout	No	Mining operations did not contribute to the elevated noise levels.
NMT3 16/07/2023 3AM - 7AM	31.6 - 54.9	Traffic/Plane dominant throughout	No	Mining operations did not contribute to the elevated noise levels.
NMT3 17/07/2023 11PM - 4AM	27.1 - 43.8	Wind dominant throughout	No	Mining operations did not contribute to the elevated noise levels.

A.1.2 NMT4

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
NMT4 27/07/2022 12AM - 7AM	35.6 - 49.6	Wind dominant throughout the night.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 9/08/2022 12AM - 7AM	36.5 - 50.1	Frequent dominant fauna noise and intermittent trains. Mining noise from mobile equipment and fixed sources faintly audible throughout, masked by fauna.	Low Risk	Mining operations is faintly audible and predominantly masked by extraneous noise. Noise levels present a low risk of non-compliance with the indoor allowable levels for the adjacent receiver with an agreement.

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
NMT4 11/08/2022 10PM - 7AM	24.5 - 54.4	Intermittent trains throughout the period.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 14/08/2022 10PM - 7AM	30.4 - 48.9	Intermittent trains throughout the period.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 17/08/2022 1AM - 7AM	39.7 - 49.1	Noise from mobile equipment faintly audibly throughout. Masked by dominant noise from insects & intermittent trains.	Low Risk	Mining operations is faintly audible and predominantly masked by extraneous noise. Noise levels present a low risk of non-compliance with the indoor allowable levels for the adjacent receiver with an agreement.
NMT4 23/08/2022 11PM - 7AM	27.9 - 46	Intermittent trains throughout the period.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 24/08/2022 12AM - 7AM	39 - 55.8	Wind dominant throughout the night. Birds making noise from 6-7am.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 3/09/2022 2AM - 7AM	39 - 54.5	Dominant wind noise throughout the period, some audible noise from passing train.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 5/09/2022 2AM - 7AM	32.1 - 49.9	Mining noise from mobile equipment and fixed sources faintly audible between periods of heavy rain, masked by strong winds during the night, and by insects towards the end of the night.	Low Risk	Mining operations is faintly audible and predominantly masked by extraneous noise. Noise levels present a low risk of non-compliance with the indoor allowable levels for the adjacent receiver with an agreement.
NMT4	37.7 - 46		No	Mining operations did not contribute to the elevated noise levels.

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
6/09/2022 2AM - 7AM		Intermittent trains throughout the period.		
NMT4 8/09/2022 11PM - 7AM	29.1 - 48.3	Fauna and Intermittent trains dominant throughout the period.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 16/09/2022 11PM - 6AM	36.6 - 48.1	Mining noise very faintly audible. Masked by fauna and intermittent trains.	Low Risk	Mining operations is faintly audible and predominantly masked by extraneous noise. Noise levels present a low risk of non-compliance with the indoor allowable levels for the adjacent receiver with an agreement.
NMT4 18/09/2022 10PM - 12AM	35.3 - 46	Frequent extraneous noise throughout the night. Short period in which mining noise was clearly audiable, reaching up to 40 db(A). Early morning period (2:00-7:00 am) dominated by high winds.	Low Risk	Mining operations is faintly audible and predominantly masked by extraneous noise. Short period in which mining noise was clearly audiable reaching up to 40 dB(A). Outside of this occasion, minimal mining noise present, and levels were primarily below 30 dBA when uninfluenced by extraneous noise. Noise levels present a low risk of non-compliance with the indoor allowable levels for the adjacent receiver with an agreement.
NMT4 19/09/2022 5AM - 7AM	38.1 - 51.2	Fauna and Intermittent trains dominant throughout the period.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 20/09/2022 5AM - 7AM	39.6-48.4	Mobile equipment clearly audible throughout night (revving/working). Insects faintly audible throughout.	**Medium Risk**	Mining operations were audible with instantaneous L_{Aeq} levels of 28-45 dB(A). Exceedances of 40 dB(A) were observed to be infrequent, lasting short periods, and associated with revving mobile equipment. Mining noise was observed to predominantly fall between 35-40dB(A). There is a medium risk of non-compliance with the indoor allowable levels for the receiver with an agreement adjacent to the noise monitor. Extrapolated to the nearest receiver without an agreement, an 8-10 dB adjustment is expected, and therefore received levels are expected to be up to 20 – 32 dB(A) (with brief periods up to 37 dBA), which may exceed the assigned levels with the presence of tonality.
NMT4 22/09/2022	32.3 - 51.2		Unsure	Mining operations did not contribute to the elevated noise levels.

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
1AM - 6AM		Fauna and wind dominant throughout the night. Some audible noise from passing train.		
NMT4 23/09/2022 10PM - 2AM	38.2 - 45.4	Frequent dominant fauna noise. Mining noise from mobile equipment and fixed sources audible when not masked by fauna.	Low Risk	Mining operations is faintly audible up to levels of 35 dB(A), and predominantly masked by extraneous noise. Noise levels present a low risk of non-compliance with the indoor allowable levels for the adjacent receiver with an agreement.
NMT4 3/10/2022 10PM - 3AM	46.5 - 60.3	Wind dominant throughout the night.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 13/10/2022 11PM - 3AM	35.2 - 46.2	Wind dominant throughout the night. Intermittent trains.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 1/11/2022 4AM - 7AM	42.7 - 54.9	Wind dominant throughout the night.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 3/11/2022 5AM - 7AM	38.1 - 45.5	Mining noise very faintly audible during morning period (6:00-7:00 am). Masked by fauna.	Low Risk	Mining operations is faintly audible and predominantly masked by extraneous noise. Noise levels present a low risk of non-compliance with the indoor allowable levels for the adjacent receiver with an agreement.
NMT4 9/11/2022 5AM - 7AM	40.8 - 46.1	Mining noise very faintly audible. Masked by fauna and insects.	Low Risk	Mining operations is faintly audible and predominantly masked by extraneous noise. Noise levels present a low risk of non-compliance with the indoor allowable levels for the adjacent receiver with an agreement.
NMT4 16/11/2022 2AM - 7AM	37.2 - 43.6	Frequent dominant fauna noise and intermittent trains. Mining noise from mobile equipment and fixed sources faintly audible throughout, masked by fauna.	Low Risk	Mining operations is faintly audible and predominantly masked by extraneous noise. Noise levels present a low risk of non-compliance with the indoor allowable levels for the adjacent receiver with an agreement.

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
NMT4 24/11/2022 6AM - 7AM	39.8 - 48.7	Fauna and Intermittent trains dominant throughout the period.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 27/11/2022 4AM - 7AM	61.7 - 69.6	Wind dominant throughout the night.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 27/12/2022 12AM - 7AM	36.3 - 49.2	Wind dominant throughout the night.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 28/12/2022 1AM - 6AM	55.4 - 65.5	Wind dominant throughout the night.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 14/01/2023 11PM - 9AM	37.5 - 71	Wind dominant throughout the night.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 19/01/2023 1AM - 6AM	38.1 - 58.7	Wind dominant throughout the night.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 25/01/2023 10PM - 7AM	44.7 - 64.8	Wind dominant throughout the night.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 27/01/2023	29.3 - 48.8		No	Mining operations did not contribute to the elevated noise levels.

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
11PM - 7AM		Wind dominant throughout the night. Some audible noise from passing trains.		
NMT4 29/01/2023 11PM - 7AM	43.3 - 63.5	Wind dominant throughout the night.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 31/01/2023 3AM - 7AM	44.4 - 70.1	Wind dominant throughout the night.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 2/02/2023 1AM - 7AM	61.4 - 73.4	Wind dominant throughout the night.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 7/02/2023 11PM - 7AM	33.1 - 55	Fauna and Intermittent trains dominant throughout the period.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 8/02/2023 1AM - 7AM	35 - 59.1	Wind dominant throughout the night. Some audible noise from passing trains.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 23/02/2023 10PM - 7AM	30.2 - 46.3	Wind dominant throughout the night. Some audible noise from passing trains.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 24/02/2023 1AM - 7AM	34.6 - 63.6	Wind dominant throughout the night. Some audible noise from passing trains.	No	Mining operations did not contribute to the elevated noise levels.
NMT4	50.3 - 52.7		No	Mining operations did not contribute to the elevated noise levels.

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
31/03/2023 1AM - 2AM		Audible wind noise, dominant rain noise		
NMT4 17/04/2023 5AM - 7AM	44.7 - 45.5	Dominant high-level wind throughout the period, occasional fauna	No	Mining operations did not contribute to the elevated noise levels.
NMT4 18/04/2023 2AM - 7AM	46.3 - 58.8	Dominant high-level wind throughout the period	No	Mining operations did not contribute to the elevated noise levels.
NMT4 19/04/2023 10PM - 12AM	38.0 - 46.3	Dominant train noise at the start of the period, dominant wind noise for the rest of the period	No	Mining operations did not contribute to the elevated noise levels.
NMT4 5/05/2023 1AM - 3AM	64.2 - 73.7	Dominant high-level wind noise throughout the period	No	Mining operations did not contribute to the elevated noise levels.
NMT4 6/05/2023 10PM - 12AM	51.3 - 60.2	Dominant high-level wind noise throughout the period	No	Mining operations did not contribute to the elevated noise levels.
NMT4 17/05/2023 12AM - 7AM	57.2 - 64.0	Dominant high-level wind noise throughout the period	No	Mining operations did not contribute to the elevated noise levels.
NMT4 18/05/2023 10PM - 12AM	48.4 - 54.5	Dominant high-level wind noise throughout the period	No	Mining operations did not contribute to the elevated noise levels.

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
NMT4 11/06/2023 10PM - 12AM	35.7 - 39.2	Audible fixed-plant mining source with occasional faint mobile equipment noise. Distant high-pitch creaking noise throughout.	**Medium Risk**	Mining operations were audible with instantaneous L_{Aeq} levels of 31-48 dB(A). There is a medium risk of non-compliance with the indoor allowable levels for the receiver with an agreement adjacent to the noise monitor. Extrapolated to the nearest receiver without an agreement, an 8-10 dB adjustment is expected, and therefore received levels are expected to be up to 23 – 30 dB(A) which may exceed the assigned levels with the presence of tonality.
NMT4 21/06/2023 10PM - 12AM	35.6 - 39.7	Audible wind noise, dominant rain noise. Periodic train noise.	No	Mining operations did not contribute to the elevated noise levels.

A.2 Evening Periods

A.2.1 NMT3

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
NMT3 25/07/2022 7PM - 9PM	41.9 - 59.6	Dominant wind noise throughout the period	No	Mining operations did not contribute to the elevated noise levels.
NMT3 15/08/2022 8PM - 10PM	35.9 - 48.6	High-level rain noise at the start of the period, occasional traffic (motorbike) noise, dominant wind noise at the end of the period	No	Mining operations did not contribute to the elevated noise levels.

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
NMT3 13/09/2022 7PM - 10PM	38.6 - 49.0	Dominant wind noise throughout the period, occasional dog barking noise, occasional high-level traffic noise	No	Mining operations did not contribute to the elevated noise levels.
NMT3 23/05/2023 7PM - 10PM	39.1 - 50.7	Dominant high-level wind noise throughout the period	No	Mining operations did not contribute to the elevated noise levels.

A.3 NMT4

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
NMT4 19/07/2022 7PM - 9PM	41.2 - 48.6	Dominant wind throughout the period.	No	Mining operations did not contribute to the elevated noise levels.
NMT4 12/08/2022 8PM - 10PM	44.1 - 49.4	Dominant wind throughout the period, audible train noise at the start of the period, occasional traffic throughout the period	No	Mining operations did not contribute to the elevated noise levels.
NMT4	38.9 - 47.5		**Medium Risk**	

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
18/08/2022 7PM - 10PM		Clearly audible mobile equipment and fixed mining sources. Intermittent aircraft and train noise. Persistent high-frequency insect noise.		Mining operations audible with instantaneous L_{Aeq} levels of 37-43 dB(A). There is a medium risk of non-compliance with the indoor allowable levels for the receiver with an agreement adjacent to the noise monitor. Extrapolated to the nearest receiver without an agreement, an 8-10 dB adjustment is expected, and therefore received levels are expected to be up to 29 – 35 dB(A) which may exceed the assigned levels with the presence of tonality.
NMT4 12/09/2022 7PM - 10PM	33.9 - 54.1	Dominant wind noise throughout the period, occasional train noise at the end of the period	No	Mining operations did not contribute to the elevated noise levels.
NMT4 13/12/2022 9PM - 10PM	54.2 - 64.7	Dominant high-level wind noise throughout the period, occasional thunder	No	Mining operations did not contribute to the elevated noise levels.
NMT4 1/02/2023 8PM - 10PM	51.0 - 59.9	Dominant wind noise throughout the period	No	Mining operations did not contribute to the elevated noise levels.
NMT4 28/02/2023 7PM - 10PM	40.4 - 56.2	Dominant wind noise throughout the period	No	Mining operations did not contribute to the elevated noise levels.
NMT4 6/05/2023 7PM - 10PM	59.2 - 65.9	Dominant high-level wind noise throughout the period	No	Mining operations did not contribute to the elevated noise levels.
NMT4 8/05/2023 8PM - 10PM	46.4 - 60.5	Dominant high-level wind noise throughout the period	No	Mining operations did not contribute to the elevated noise levels.

Date Time Monitor	$L_{A10(25Hz-1.6kHz)}$ [dBA]	Review Comments	Compliance Risk	Compliance Comment
NMT4 15/07/2023 7PM - 8PM	43.6 - 44.4	Audible fixed plan mining noise with faint mobile equipment. Intermittent train noise.	**Medium Risk**	Mining operations audible with instantaneous L_{Aeq} levels of 38-42 dB(A). There is a medium risk of non-compliance with the indoor allowable levels for the receiver with an agreement adjacent to the noise monitor. Extrapolated to the nearest receiver without an agreement, an 8-10 dB adjustment is expected, and therefore received levels are expected to be up to 30 – 34 dB(A) which may exceed the assigned levels with the presence of tonality.

Appendix 9

Supporting Information:

Keysbrook Mineral Sands Mine

Wetland Vegetation Monitoring Autumn & Spring 2022

July 2023

KEYSBROOK PROJECT

WETLAND VEGETATION MONITORING

(AUTUMN & SPRING 2022)

REPORT FOR
DORAL PTY LTD

JULY 2023

Report No. 321.0/23/01 Rev1

Rockwater
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Rev 0	NE	NE	NE	14/06/2023
Rev 1	NE	AT (Doral)	NE	21/07/2023

1 INTRODUCTION

The Keysbrook Leucoxene Project (the Project) is operated by Doral Mineral Sands Pty Ltd (Doral). The Project was acquired by Doral from MZI Resources (MZI) in July 2019. The Project is located approximately 55 km south of Perth near the small townships of Keysbrook and North Dandalup (Figure 1). A condition of the mining development is to monitor the effects of mining (e.g. groundwater extraction) on the environment, including potentially groundwater dependent ecosystems (GDEs) in nearby Conservation Category wetlands. Following an initial survey of wetland vegetation in autumn 2015 (Rockwater 2015), Rockwater has been commissioned to undertake annual vegetation condition surveys of certain wetlands of the project area, in accordance with Doral's environmental commitments.

This report presents the results of the spring 2022 monitoring at three Conservation Category wetland sites and data from photographic monitoring points (PMPs) established to monitor wetland vegetation condition around the Project.

The report also presents the results of an autumn 2022 survey of Conservation Category wetland 14887, located at Lot 56 (440 Elliot Rd) Keysbrook, in the Shire of Serpentine-Jarrahdale. The Lot 56 survey was undertaken as a pre-mining baseline survey for an approved northern mining area.

2 PROJECT MONITORING COMMITMENTS AND OBJECTIVES

Groundwater and vegetation monitoring commitments for the Keysbrook Mineral Sands Project (the Project) are outlined in a Water Management Plan (WMP) (MBS 2015) and Groundwater Licence Operating Strategy (GLOS) (Rockwater 2013). Additional groundwater monitoring conditions are contained in the Works Approval (L8918/2015/1) for the Project.

The focus of the wetland vegetation health monitoring programme is on Conservation Category wetlands in the vicinity of the project area. The locations of Conservation Category wetlands are shown in Figure 2.

Two water management objectives in the WMP are directly relevant to Conservation Category wetlands in the area. Those objectives and the respective monitoring targets are outlined in Table 1.

Table 1: Water Management Objectives and Targets

Objective	Target
Abstraction of water does not cause adverse, long-term impacts to the water quality or levels of Conservation Category wetlands	Monitoring indicates water quality and levels are within trigger levels
Abstraction of groundwater does not adversely impact on the health and condition of native vegetation associated with Conservation Category wetlands	Monitoring indicates no adverse, long-term impact on native vegetation or groundwater dependant ecosystems

Vegetation health assessments in spring 2022 were required for three of the vegetation monitoring quadrat sites at Keysbrook. The remaining previously surveyed sites only require re-assessment by trigger of either a decline in water level beyond an acceptable value at adjacent groundwater monitoring bores, or a decline in the health (vigour) of remnant vegetation at wetlands immediately to the north.

Specific commitments within the WMP and GLOS relevant to the 2022 spring survey are detailed below and relate to wetland locations shown in Figure 2.

- Pre-operational baseline survey and six-monthly (spring and autumn) vegetation health assessments in Conservation Category Wetlands (UFI nos.) 14472, 14473 and 14465;
- Annual photographic monitoring in spring (previously spring and autumn) for (5 of 12) sites listed in the WMP; and
- Vegetation health assessments are to be conducted in spring (previously spring and autumn).

Specific commitments within the WMP and GLOS relevant to the survey of wetland vegetation within Lot 56 Keysbrook include:

- Baseline survey and 6-monthly (spring and autumn) vegetation health assessments in Conservation Category Wetland UFI 14887, with the baseline conducted 12 months prior to mining of lot 56, and monitoring continuing for one year post completion of mining this area; and
- Six-monthly photographic monitoring programme for one site (PMP 12) listed in the WMP;

3 REGIONAL CONTEXT OF THE STUDY AREA

A baseline survey report by Rockwater (2015) outlined aspects of the Keysbrook Project setting, including climate, geology, hydrogeology, geomorphology and soils, vegetation and conservation-significant wetlands. Background information from that report is provided in the following section for context.

3.1 CLIMATE

Keysbrook has a Mediterranean-type climate with hot dry summers and mild, moderately wet winters. Monthly rainfall observations for the November 2021 to November 2022 period and long-term average climate data for nearby BoM stations are presented in Table 2. The long-term rainfall averages for nearby BoM stations at Hopelands and Medina (both closed) are 604.5 mm and 746.0 mm respectively. Rainfall averages for BOM stations further afield at Cloon and Karnet are 851.8 and 1,144 mm respectively.

Table 2: Average Monthly Rainfall and Dam Evaporation for Jandakot Airport, Karnet Compared with Rainfall Data from Hopelands and Pinjarra, November 2021 – October 2022

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Total[1]
	2021		2022											
Annual Rainfall (mm)														
Keysbrook[2]	3.2	2.2	-	-	-	-	-	-	-	-	-	-	-	-
Cloon[3]	4.6	3.8	0.0	3.0	9.4	*66.8*	116.4	140.6	189.8	*189.4*	*83.0*	*28.2*	*38.8*	*869.2*
Karnet[4]	3.8	9.4	0.0	2.2	*12.0*	*61.4*	*98.1*	*45.3*	*217.4*	*123.4*	*81.1*	*17.8*	*12.6*	*680.7*
Average Rainfall (mm)														
Cloon[2]	30.4	13.3	17.3	11.2	21.9	43.2	106.5	144.8	178.2	143.4	97.8	47.2	30.4	851.8
Karnet[4]	44.7	18.1	18.1	20.9	25.4	64.8	137.7	205.1	220.3	182.7	131.1	74.7	44.7	1,144
Evaporation (mm)														
Karnet (1973-2016)	159	207.7	232.5	193.9	158.1	90	65.1	51	55.8	65.1	78	114.7	159	1,460
Medina[5]	195	244.9	260.4	224.8	195.3	114	71.3	54	52.7	71.3	96	145.7	195	1,715

[1]Total for Dec 2021 – Nov 2022; [2]Doral Keysbrook Minesite Weather station not operational for 2022;
[3]Cloon (Station 9242, 1994 to 2022); [4]Karnet (Station 9111, 1963 to 2021); [5]Medina (Station 9194, 1983 to 2018);
N.B. Data shaded are above average values; Data in italics represent observations which have not been fully quality controlled by Bureau of Meteorology.

Rainfall at nearby Cloon station presented in Table 2 indicates that the area received slightly above average rainfall for the period of review. The weather station at the Keysbrook mine was replaced in May 2021; however no observations were made in 2022.

The nearest BoM station to record evaporation is Medina Research Centre (station 009194, now closed). Average monthly evaporation data are presented for comparative purposes. The average monthly evaporation at Medina exceeds average rainfall rates from spring (September) to mid-autumn (April), with an average annual total evaporation of about 1,715 mm. Evaporation at Karnet, in the hills about 9 km to the east of Keysbrook is about 15% lower (Table 2).

3.2 GEOLOGY

The Project is located in the Perth (sedimentary) Basin and is underlain by about 10 to 15 m of superficial formations (Quaternary age), comprising the Bassendean Sand and the underlying Guildford Formation. These formations unconformably overlie about 50 to 130 m of the Leederville Formation – Wanneroo and Mariginiup Members – of Cretaceous age. The Mariginiup Member underlies most of the project area whereas the Wanneroo Member, up to 25 m in thickness, is present only in the very western part. The Leederville Formation unconformably overlies the Cattamarra Coal Measures in the east and conformably overlies the South Perth Shale in the west.

3.3 HYDROGEOLOGICAL SETTING

Descriptions of the local hydrogeological setting of the Project are given by Rockwater (2006, 2007). Two aquifers of the Perth Basin are relevant to the project. The first is the shallow Superficial aquifer, comprising the Bassendean Sand and Guildford Formation. The upper four to eight metres of Bassendean Sand are moderately permeable and contain the water table at depths that range from zero to 10 m below ground surface. The underlying Guildford Formation generally has low permeability. The saturated thickness above

the base of the Bassendean Sand ranges from zero to about two metres depending on the season and the local aquifer geometry. This Bassendean Sand section of the Superficial aquifer contains the mineral sand deposit and is influenced by mining operations at Keysbrook.

The second relevant aquifer is the Leederville aquifer, which extends to at least 130 m below ground surface. The Leederville aquifer is utilised as a water source for the mining operation.

Water salinities in the Superficial aquifer range from 200 to 1,000 milligrams per litre total dissolved solids (mg/L TDS), while in the Leederville aquifer they are generally less than 1,000 mg/L TDS.

Mining operations during the winter will result in the groundwater levels in the Bassendean Sand being temporarily lowered to the base of the unit, in and around individual mining cells. Water levels will start recovering as mining moves to new cells, excavated cells are backfilled, and rainfall recharges the reconstituted aquifer.

It is noteworthy that Superficial aquifer water levels in the vicinity of wetland UF 14472 in the southern mining block are below the base of the ore (as indicated by nearby monitoring bores KWT1A to KWT1E). Consequently, several Conservation Category wetlands in this vicinity (Fig. 2) are unlikely to be subjected to dewatering effects.

3.4 GEOMORPHOLOGY AND SOILS

The Project is situated on the Swan Coastal Plain, about three kilometres west of the Darling Scarp. The mineral sands deposit occurs in Superficial deposits (Bassendean Sand) of the Bassendean Dune System, which is the oldest of three generations of dunes on the Swan Coastal Plain. Sands from recent dune and shoreline deposits form a gently undulating aeolian sand plain that has been leached of carbonate leaving mostly quartz sand.

The Bassendean Sand overlies the finer-textured soils of the Guildford Formation (Pinjarra Plain), which typically consist of clayey sand or sandy clay in the Keysbrook area. The upper surface of the Guildford Formation is partially ferruginised at some locations (Rockwater 2006).

Several wetlands occur in the low undulating topography of the Bassendean Dune System and in poorly defined drainages of the coastal plain in the vicinity of the Project.

Soil mapping of the Bassendean Dune System indicates that the project area corresponds to an area of Bassendean Dune Phase soils (B1, 1a, 2 and 5) and minor Pinjarra Phase soils (P1b, 2 and 7) (MBS 2011). The area is characterised by well- to moderately-bleached grey sands sometimes with a pale yellow B horizon or a weak iron-organic hardpan.

3.5 VEGETATION

The Project area is located within the SWA02 sub-region of the Swan Coastal Plain IBRA (Interim Bioregionalisation of Australia region). The IBRA recognises 89 large geographically distinct bioregions within Australia, based on climate, geology, landform, native vegetation and species information (DoE 2014). These bioregions are further divided into 419 geomorphological units as sub-regions.

The Swan Coastal Plain is situated in the South West Botanical Province of Western Australia which is recognised as one of the world's biodiversity hotspots (DPaW 2014). The South West Botanical Province supports forests, woodlands, shrublands and heath which are characterised by high species endemism.

Vegetation associated with the project area was mapped by Bennett Environmental Consulting (2004), although access to all listed wetlands on some areas of private land was not possible at the time. In the vicinity of the wetlands, vegetation was primarily described as Tall Open Scrub dominated by *Kunzea glabrescens* with scattered trees of *Banksia ilicifolia* over scattered low shrubs and sedges. This description relates to vegetation in parts of dampland 7604 (Fig. 2). No declared rare flora (DRF) or Priority-listed flora was recorded in vegetation of the site by the 2005 survey, or during subsequent surveys to date.

The vegetation of Bushland Forever Site No. 77 within the West Kingia property was surveyed by Trudgen and Archer (2001). Twenty-two vegetation units were described during the survey and these were grouped on the basis of the dominant upper stratum species, which included *Eucalyptus marginata* (Jarrah), *Allocasuarina fraseriana* (Sheoak) and Banksia species. Vegetation units with Banksia overstoreys were most common at the site and were further divided into groups according to the composition of shrub layers. Two previous surveys of vegetation in the vicinity of wetland 14807 have been reported by Hart Simpson and Associates (1990) and Masters and Associates (1992). These are referenced in the Bush Forever Directory, but have not been reviewed for the current survey.

GHD (2010) surveyed wetlands within Bushland Forever Site No. 77, referred to as the Elliot Rd wetlands, as part of the Murray Drainage and Water Management Plan. The survey report included related studies of ecological water requirements for wetlands in the Murray Drainage and Water Management Plan area.

3.6 CONSERVATION CATEGORY WETLANDS

The geomorphic classification system (Semeniuk 1987; Semeniuk and Semeniuk 1995), which allocates wetlands into types based on the fundamental characteristics of the shape of the host landform and the wetland's hydrological regime, has been adopted as the primary classification system for mapping wetlands in Western Australia (DPaW 2013). Table 3 outlines the geomorphic classification system.

Table 3: Geomorphic Classification System for Mapping Wetlands

	Basin	Flat	Channel	Slope	Highland
Permanently inundated	Lake	-	River	-	-
Seasonally inundated	Sumpland	Floodplain	Creek	-	-
Intermittent inundation	Playa	Barlkarra	Wadi	-	-
Seasonally waterlogged	Dampland	Palusplain	Trough	Paluslope	Palusmont

Semeniuk and Semeniuk (2001) suggest that wetlands of the Swan Coastal Plain are unique in a global context. On the Swan Coastal Plain, the geomorphic wetland types of the Bassendean Dunes are typically round to irregular basin-type wetlands (sumplands and damplands) and on the Pinjarra Plain they are flats and channel wetlands (palusplains and creeks) (DPaW 2014).

Semeniuk (1988) developed the concept of consanguineous suites of wetlands for the Swan Coastal Plain. The concept of consanguineous suites refers to grouping wetlands based on similarities in classification, geometry, stratigraphy, inferred origin and hydrology. In the vicinity of the Keysbrook Mineral Sands Project, the wetlands belong to the Keysbrook Consanguineous Suite.

Wetlands of the Swan Coastal Plain have been evaluated to determine their environmental values, and each wetland has been assigned to one of three wetland management categories (DPaW 2013):

1. Conservation – Wetlands which support a high level of attributes and functions.

2. Rehabilitation Potential – Wetlands which may have been modified or degraded, but still support substantial attributes and functions.

3. Multiple Use – Wetlands with few remaining important attributes and functions.

Only about 5.7% of the original extent of dampland in the Keysbrook consanguineous suite still supports a high level of values, attributes and functions; indicated by a "Conservation" management category (DPaW 2014).

There are no conservation category wetlands within the approved mining boundary or within the project footprint. However, several Conservation category wetlands occur immediately south of the project area and these are the focus of the wetland vegetation health monitoring programme. The locations of Conservation category wetlands are shown in Figure 2. Whilst these wetlands do not occur in the mining footprint (i.e. these wetlands will not be directly disturbed by mining), there are processes associated with mining activities that may affect the health of these ecosystems.

4 FIELD SURVEY METHODOLOGY

4.1 SPRING 2022

Following four years of baseline data collection, the frequency of wetland monitoring was amended in 2018 to annual monitoring for the assessment of changes to the health and condition of GDEs covered by the Wetland Vegetation Health Monitoring Programme. In addition, the Photographic monitoring has also been undertaken annually since 2018, to align with timing of other GDE monitoring within this programme.

Vegetation monitoring is undertaken as part of Doral's monitoring obligations and commitments to maintain compliance with legislative requirements for the Project. Doral's community monitoring programme has also continued in spring 2022 with two regional wetland sites surveyed.

Assessment of vegetation health was required at Conservation Category Wetlands 14472, 14473 and 14465 (Fig. 2) on a six-monthly basis for the first three years of operation, followed by annual assessments for as long as groundwater is extracted from production bores KLP2 and KLP3.

The spring 2022 vegetation monitoring was undertaken on 16th November 2022. Tree canopy assessments within three of seven previously established vegetation monitoring quadrats to the south of the proposed mining area were undertaken at Conservation Category wetlands 14465, 14472 and 14473, and assessment of vegetation health at five photographic monitoring points (PMPs) was undertaken. PMP sites were assessed using the data sheet provided in the project Water Management Plan (WMP) (MBS 2011). The PMP and monitoring quadrats are combined at some sites. Two of three additional vegetation monitoring sites established to the northwest of the Project, within Bush Forever site 77 (Yangedi Swamp), were also re-surveyed in November 2022. Details of the wetlands and vegetation monitoring sites surveyed in 2022 at Keysbrook are listed in Table 4. Site locations are shown in Figures 3 and 4.

Table 4: Details for 2022 Vegetation Monitoring Sites Surveyed in the Keysbrook Project Area

Wetland Number	Classification	Management Category	Area (ha)	PMP	Quadrat
14465	Dampland	Conservation	1.03	PMP09	KVMQ4
14473	Dampland	Conservation	1.33	PMP08	KVMQ5
14472	Dampland	Conservation	0.52	-	KVMQ6
14807	Sumpland	Conservation	9.06	PMP13	KVMQ9
-	Remnant vegetation	N/A	-	PMP10	-
-	Remnant vegetation	N/A	-	PMP11	-
14887[1]		Conservation		PMP12	KVMQ10, KVMQ11

[1] Site sampled in Autumn 2022 (see section 4.2)

At each quadrat site, vegetation was assessed as follows:

- Vegetation condition was assessed using the condition scale of Keighery (1994) (Appendix I);
- Projected foliar cover (%) of tree species was estimated for tagged individual trees;
- Diameter at breast height (DBH) was measured for all trees. In the case of individual trees with multiple stems, all stems were measured at breast height;
- Crown condition and general health of each tree was assessed; and
- Other relevant observations (such as evidence of drought or dieback, disturbance from human activities, feral animal impacts and insect damage) were recorded.

Assessment of individual tree crowns at quadrat sites was undertaken using the subjective three-part scales of Wilson and Froend (2010); whereby scores are recorded for crown density and dead branches (9, 7, 5, 3 or 1), and epicormic growth (5, 4, 3, 2 or 1). A tree health assessment score was calculated by adding the scores for each component of the tree crown assessment. Tree health was classified as poor (1−5), moderate (6−11), good (12−17) or very good (18−23). Individual scores for each tree were combined and mean values for each species within each transect were calculated. Comparisons of annual changes in condition (health) between spring 2021 and spring 2022 were made.

4.2 AUTUMN 2022

An autumn 2022 vegetation survey of Conservation Category wetland 14887, located at Lot 56 (440 Elliot Rd) Keysbrook in the Shire of Serpentine-Jarrahdale, was undertaken on 26th May 2022. The vegetation monitoring methodology followed that of Rockwater (2015). Two 10 x 10 m quadrats and one photographic monitoring point (PMP) were established in remnant vegetation within Wetland 14887. Details of the vegetation monitoring sites surveyed in autumn 2022 at Keysbrook are listed in Table 4. A locality plan for the Lot 56 survey and site locations are shown in Figures 5 and 6 respectively.

At each quadrat site, vegetation was assessed as follows:

- A structural description of vegetation noting characteristic/dominant species was made using the method of Muir (1977);
- Vegetation condition was assessed using the condition scale of Keighery (1994) (Appendix I);

- Species cover was estimated using the Domin-Krajina scale of cover and abundance (Kent & Coker, 1992);
- Diameter at breast height (DBH) was measured. In the case of individual trees with multiple stems, all stems were measured at breast height (1.4 m);
- General tree health and crown condition of each tree was assessed (condition assessed using the subjective three part scale of Wilson and Froend (2010));
- Other relevant observations (such as evidence of drought or dieback, disturbance from human activities, observable direct impacts from mining, feral animal impacts and insect damage) were recorded.

Tree crown (canopy) assessments were carried out using the subjective three-part scales of Wilson and Froend (2010) listed in section 4.1 above. The scores for individual trees will be compared with those from future assessments.

Based on the floristic data collected, a weediness index was calculated for each plot by dividing the cover of exotic species by the cover of natives and adding the number of exotics divided by the number of natives (Ladd 1996).

The additional PMP site on Lot 56 was assessed using the data sheet provided in the WMP (MBS 2015).

5 RESULTS

5.1 VEGETATION MONITORING

The 2022 spring survey covered four vegetation-monitoring quadrat sites and five photographic monitoring points (PMPs), in accordance with the current monitoring programme. The four quadrat sites provide data for three wetlands listed in the Water Management Plan (MBS 2015) and one reference wetland site (KVMQ9/14807) to the northwest of the Project that is monitored as part of Doral's community monitoring programme. A summary of 2022 quadrat monitoring data for the upper stratum (measurements of DBH, health and density) is provided in Table 5 together with the spring 2021 data for comparison.

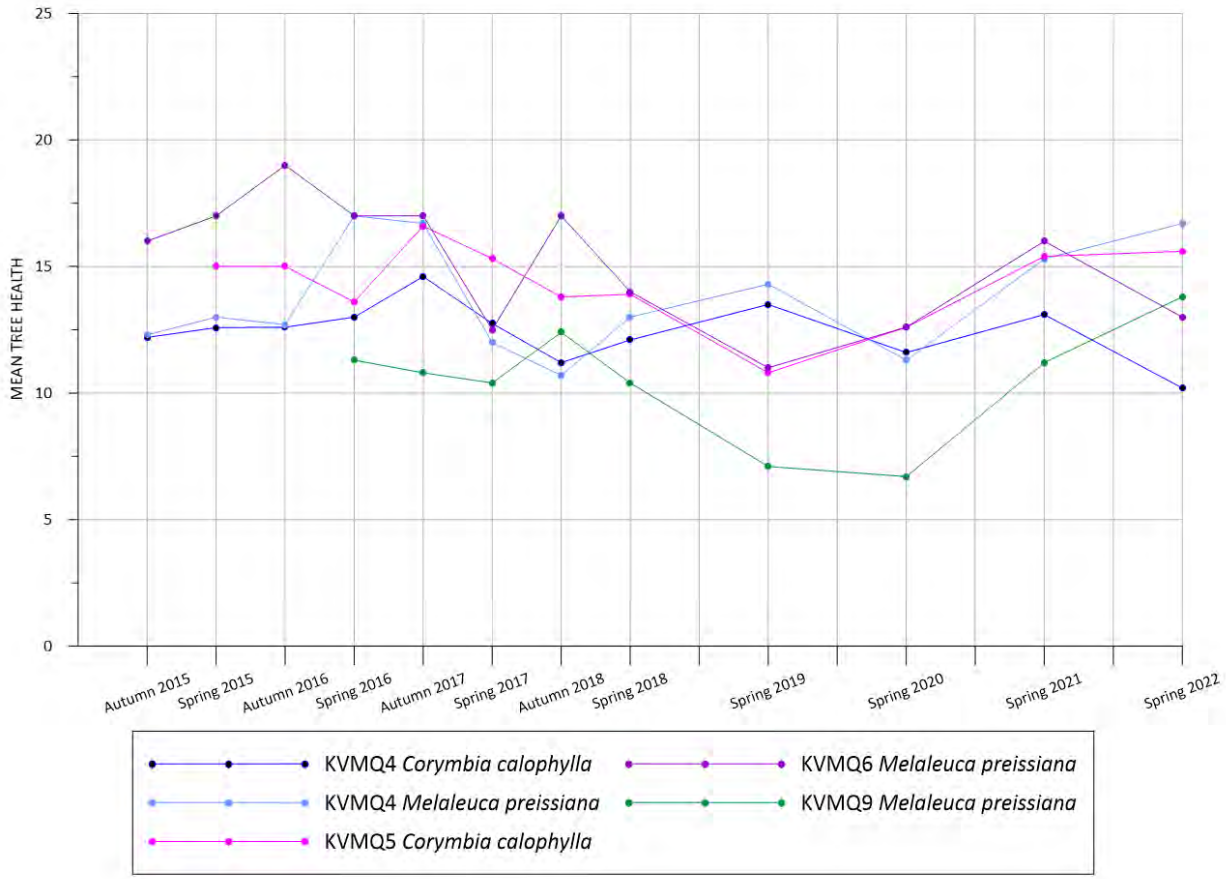
Table 5: Spring 2021–2022 Vegetation Monitoring Quadrat Data for Upper Stratum (Tree) Species

	Species[1]	KVMQ4 (Wetland 14465)		KVMQ5B (Wetland 14473)		KVMQ6 (Wetland 14472)		KVMQ9 (Wetland 14807)	
		2021	2022	2021	2022	2021	2022	2021	2022
DBH Range[2]	C.c.	4.4-36.4	4.4-51.8	3-38.7	1.8-38.7	-	-	-	-
	M.p.	7.2-31	7.2-31.0	-	-	2.2-35.5	2.2-35.5	5.6-35.9	5.6-35.9
Health Mean[3]	C.c.	13.1	12.0	15.4	16.3	-	-	-	-
	M.p.	15.3	16.6	-	-	16	13	11.2	13.8
Health Range	C.c.	5-21	3-21	9-20	10-20	-	-	-	-
	M.p.	12-19	13-19	-	-	16	13	6-16	9-16
Density[4]	C.c.	11 (2)	11 (2)	16	16	-	-	-	-
	M.p.	3	3	-	-	2	2	6 (4)	6 (4)

[1]Overstorey species - C.c. = *Corymbia calophylla*; M.p. = *Melaleuca preissiana*
[2]Diameter Range is the range in individual stem diameters (cm) at breast height (1.3m)
[3]Mean health rating for overstorey species. Tree health scale: poor (1–5), moderate (6–11), good (12–17) or very good (18–23).
[4]Density is number of trees in each plot + saplings/seedlings, figures in parenthesis represent the number of dead trees in the plot

Following improvements in vegetation health across all sites for the two canopy species (*Melaleuca preissiana* and *Corymbia calophylla*) in 2021, there were mixed results for 2022. *Corymbia calophylla* improved slightly in overall health at KVMQ5 and declined at KVMQ4. The health of *Melaleuca preissiana* (n=2) declined at KVMQ6 and improved at KVMQ4 and KVMQ9. Mean health for tree species at each site is plotted in Text-Figure 1 below, together with survey results from previous assessments. The 2022 health means for *Melaleuca preissiana* and *Corymbia calophylla* at all wetland sites listed within the WMP were within historical ranges.

Health ratings for individual trees within the four quadrats surveyed are discussed in section 5.2 and the spring 2022 tree data are presented in Appendix II. Monitoring data sheets for each of the four sites are presented in Appendix III.



Text-Figure 1 - Mean tree health for wetland vegetation quadrats at Keysbrook, 2015-2022

Vegetation condition was assessed using the scale of Keighery (1994) at each quadrat site, with consideration of vegetation structure, disturbance at each structural layer and the ability of the vegetation unit to regenerate. The condition of vegetation in spring 2021 ranged from good to completely degraded (Table 6) and only minor change in condition was noted for one quadrat since the spring 2021 assessment. Further comments on vegetation condition at individual monitoring sites are provided under section 5.2.

Table 6: Spring 2022 Vegetation Condition Assessment for Wetland Quadrats

Wetland Number	Quadrat	Rating[1]	Description
14465	KVMQ4	4	Good
14473	KVMQ5A	5	Degraded
14473	KVMQ5B	4	Good
14472	KVMQ6	5	Completely Degraded
14807	KVMQ9	2	Good to Excellent

[1]Vegetation condition based on Keighery (1994)

5.2 QUADRATS IN CONSERVATION CATEGORY WETLANDS

5.2.1 KVMQ4

This site is located in parkland-cleared farmland on Lot 59 North Dandalup, to the south of the approved mining boundary at Keysbrook. The site has been mapped as a Conservation Category wetland (no. 14465); however, vegetation of the site is not representative of a typical wetland vegetation community for the area. Vegetation consists of a disturbed Low Forest of *Corymbia calophylla* and *Melaleuca preissiana* over Open Low Sedges (*Tetraria capillaris* and *Mesomelaena tetragona*). There are limited understorey species present and *Melaleuca preissiana and Juncus pallidus* are the only two recorded species that are indicative of a wetland vegetation community.

The structure of vegetation has been significantly altered by historical grazing. During 2021 the site was fenced to exclude Kangaroos and cattle. In addition, a range of understorey species were planted as a conservation initiative.

The general health of *Melaleuca preissiana* at the site improved over the review period, from 15.3 in 2021 to 16.6 in 2022. Conversely, the mean health of *Corymbia calophylla* declined, from 13.1 in 2021 to 12.0 in 2022 (Table 5). The mean health classification of tree canopies for both *Melaleuca preissiana* and *Corymbia calophylla* was unchanged in 2022 and remained "good" using the scale of Wilson and Froend (2010). The health range of these two species was similar for the period of review.

General vegetation condition in 2022 was ranked as good using the scale of Keighery (1994). This improved from degraded in 2021 due to the regeneration of understorey species as a result of fencing around the site, which was undertaken to exclude cattle and kangaroos. Comparative photographs for spring 2021 and spring 2022 at KVMQ4 are shown in Plate 1 and vegetation health assessment data for the site are presented in Appendix III.

SPRING 2021

SPRING 2022

SPRING 2021

SPRING 2022

SPRING 2021

SPRING 2022

SPRING 2021

SPRING 2022

Plate 1: Vegetation monitoring photographs at KVMQ4 for spring 2021and spring 2022, wetland 14465.

5.2.2 KVMQ5

This site is located on Lot 506 North Dandalup, on private property to the south of the Keysbrook approved mining boundary. The 20 x 10 m quadrat at the site is positioned in a disturbed remnant of native vegetation within wetland 14473. The quadrat is divided into a 10 m x 10m quadrat centred on a degraded ephemeral creekline (KVMQ5A) and two 5 x 10 m extensions on KVMQ5B (one to the north and one to the south).

5.2.3 KVMQ5A

Vegetation at KVMQ5A was initially described as Open Low Scrub of *Astartea scoparia* over Very Open Tall Sedges of *Lepidosperma longitudinale* and *Juncus pallidus* over Open Low Grasses dominated by exotic species (*Cynodon dactylon*, *Paspalum dilatatum* and indeterminate grasses) and Very Open Herbs (*Lotus subbiflorus* and *Rumex crispus*) (Rockwater 2015).

In subsequent assessments, the understorey condition has deteriorated due to ongoing grazing, which has resulted in the proliferation of exotic species at the site. Signs of active grazing by horses and/or sheep throughout the creekline and riparian vegetation have been recorded during most monitoring events and understorey vegetation has been significantly altered as a result. Stock appear to have been excluded from this stand of vegetation in 2022.

Annual and perennial exotic grasses and herbs continue to dominate the understorey along the southern bank of the creekline through the site, with emergent native shrubs of *Astartea scoparia* and native sedges including *Lepidosperma longitudinale and Desmocladus fasciculatus.* Soil in the central portion of the drainage line was still wet after recent rainfall and the channel was largely covered by annual weeds.

The spring 2022 vegetative cover for the understorey appeared to be similar to the 2021 assessment based on site inspection and representative photos presented in Plate 2. The vegetation condition at the site was unchanged from 2021 to 2022 and remained as degraded (Table 6).

SPRING 2021

SPRING 2022

SPRING 2021

SPRING 2022

SPRING 2021

SPRING 2022

SPRING 2021

SPRING 2022

Plate 2: Spring 2022 vegetation monitoring photographs for wetland 14473, KVMQ5A

5.2.4 KVMQ5B

The original (2015) vegetation description at KVMQ5B was a dense Low Forest A of *Corymbia calophylla* over Open Low Scrub A of *Astartea scoparia* over Open Tall Sedges of *Lepidosperma longitudinale* and *Juncus pallidus* over Very Open Herbs (*Tetraria octandra* and *Lotus subbiflorus*) over Open Low Grasses dominated by exotic species (*Cynodon dactylon*, and indeterminate grasses) and Very Open Herbs (*Lotus subbiflorus* and *Rumex crispus*) (Rockwater 2015).

The cover of native species remains significantly higher on the northern bank of the creekline, where remnant understorey vegetation is intact. This has restricted the establishment of exotic species within a narrow strip between the creek and the property firebreak. Annual grasses dominate the understorey in the southern portion of the quadrat. This area has preferentially been grazed by foraging livestock in the past due to the abundance of palatable pasture grasses. This area has >95% cover of exotic species, as shown in the second and third paired images in Plate 3.

Corymbia calophylla is the dominant tree species at the site and the health of *C calophylla* trees in the quadrat improved (based on mean health scores) from 15.4 to 16.3 over the review period (Table 5). The health range of trees also improved slightly, from 9-20 in 2021 to 10-20 in 2022. Individual tree data presented in Appendix II shows that 75% of trees in the quadrat either showed an improvement in canopy condition or remained unchanged for 2020; remaining trees declined in condition (25%) over the period of review (Appendix II).

SPRING 2021

SPRING 2022

SPRING 2021

SPRING 2022

SPRING 2021

SPRING 2022

SPRING 2021

SPRING 2022

Plate 3: Spring 2022 vegetation monitoring photographs for wetland 14473, KVMQ5B

5.2.5 KVMQ6

Quadrat KVMQ6 is also located on Lot 506 North Dandalup, within a drainage line at wetland 14472. The site is at the northern end of Lot 506, slightly to the east of KVMQ5 (Fig. 3). Vegetation of the site is parkland-cleared and was initially described as Low Forest A of *Melaleuca preissiana* with occasional emergent *Corymbia calophylla* over Very Open Tall Sedges of *Juncus pallidus* over Very Open Low Grasses (indeterminate exotic species) and herbaceous weeds (Rockwater 2015). Very few native species remain in the understorey at the site due to historical disturbance through grazing. The vegetation is completely degraded using the condition scale of Keighery (1994) and there was no change in vegetation condition between 2020 and 2021 (Table 6).

The two mature *Melaleuca preissiana* trees within the quadrat declined slightly in health in 2022, with mean health shifting from 16 to 13 over the review period (Table 5, Appendix II. Several fallen branches from one of the *M. preissiana* trees in the quadrat affected the assessment of canopy cover (dead branches) for this species at the site. Despite a slight decline in canopy condition of *M.preissiana* trees, there were no apparent signs of stress in the trees.

The cover of both native and exotic understorey species had increased, with *Juncus pallidus* cover estimated to be approximately 7 %. This is likely due to the reduced grazing pressure by livestock and horses, following their removal from this part of the property. Site photographs presented in Plate 4 show the higher cover of exotic grasses and herbs in the understorey in 2022. Soil in the central channel of the creek was moist during the spring assessment

SPRING 2021

SPRING 2022

SPRING 2021

SPRING 2022

SPRING 2021

SPRING 2022

SPRING 2021

SPRING 2022

Plate 4: Spring 2022 vegetation monitoring photographs for KVMQ6, within wetland 14472

5.2.6 KVMQ9

Site KVMQ9 is located at Lot 501 Elliot Rd Keysbrook on the western margin of wetland 14807 (Fig. 4). Remnant vegetation within the property is part of Bushland Forever Site No. 77. Access to the site was undertaken through the neighbouring property (Lot 1) of Alan Elliott. The wetland is categorised as a sumpland in the Geomorphic Wetlands, Swan Coastal Plain database and is part of a broader chain of sumpland wetlands in the Keysbrook area.

Vegetation of the site was initially described as *Melaleuca preissiana* low woodland to low open forest over *Astartea scoparia* low scrub over *Alternanthera nodiflora* and exotic open herbs (Rockwater 2015). The site was completely inundated during the 2022 spring survey, following similar conditions in 2021. Representative photographs taken during 2021 and 2022 monitoring are presented as Plate 5 and show a thin sheet of aquatic herbs and algae covering surface water within the site for both years. The water depth was slightly lower in 2022, measured at 0.16 m at the north eastern corner peg.

General vegetation condition fluctuates at the site in response to the presence of aggressive weed species in drier years and at different stage in the wetland hydroperiod (inundation suppresses germination of many exotic terrestrial herbs). In 2021, the condition of vegetation at the site was rated as 'good' using the scale of Keighery (1994). In 2022 the condition was considered Good to Excellent.

The health mean for *M. preissiana* was higher in 2022 (Table 5), with 83% of all *M. preissiana* trees at the site in equal or better condition in 2022. Mean health increased from 11.2 to 13.8, and the overall health of *M. preissiana* improved from moderate to good, using the rating framework of Wilson and Froend (2010). The range in health values also increased; from 6-16 to 9-16 (Table 5).

SPRING 2021

SPRING 2022

SPRING 2021

SPRING 2022

SPRING 2021

SPRING 2022

SPRING 2021

SPRING 2022

Plate 5: Spring 2022 vegetation monitoring photographs for quadrat KVMQ9 within wetland 14807

5.3 COMPARISON OF ANNUAL SPRING VEGETATION AT PHOTO-MONITORING POINTS

The health of wetland vegetation was recorded at selected photo-monitoring points (PMP) in spring 2022, in accordance with the WMP. PMP sites are listed in Table 4 and site locations are shown in Figures 3 and 4. Site photographs for spring 2021 and 2022 are presented for each site in Plates 6-10. The representative photo for an additional site (PMP012) set up on Lot 56 is presented in Plate 11. Vegetation health assessment data sheets for each of the photo-monitoring point (PMP) sites are presented in Appendix IV.

5.3.1 PMP08

PMP08 is located at the northwestern corner of Lot 506 North Dandalup within Conservation Category Wetland 14473 (Fig. 3). The site is paired with vegetation monitoring quadrat KVMQ5, which was established within the channel of a surface drainage feature running through the northern end of the property (see s5.2). Native vegetation was initially described as heath of *Astartea scoparia* over *Lepidosperma longitudinale* and *Juncus pallidus* open tall sedges over low grasses dominated by exotic species. Vegetation surrounding the site is largely parkland-cleared; however the photopoint at this site is centred on a remnant with high cover and abundance of native understorey species (Plate 6).

There is a clear improvement in canopy condition of *Corymbia calophylla* trees from 2020 to 2021, as outlined in s5.2.4 for quadrat KVMQ5B. There were no tree deaths observed for *C. calophylla* trees in the vicinity of the monitoring point.

SPRING 2021

SPRING 2022

Plate 6: **Spring 2022 vegetation monitoring photographs for PMP08**

5.3.2 PMP09

PMP09 is located at Lot 59 North Dandalup within an isolated remnant of parkland-cleared *Corymbia calophylla* and *Melaleuca preissiana* low forest. During the review period this remnant was fenced for conservation purposes. The site is mapped as Conservation Category Wetland 14465 (Fig. 3); however, the wetland mapping dataset used in mapping is thought to be inaccurate given the largely dryland characteristics and terrestrial vegetation of the site. The cover of exotic and native understorey species increased over the period of review, which is likely due to a number of factors, including:

- exclusion of livestock and kangaroos from the site via a 2 m tall mesh wire fence;
- higher than average winter rainfall; and
- planting of native tubestock throughout the understorey of the area.

All *Melaleuca preissiana* trees and most *C. calophylla* trees showed improved canopy condition in 2022 compared with the previous period.

SPRING 2021

SPRING 2022

Plate 7: Spring 2022 vegetation monitoring photographs for PMP09

5.3.3 PMP10

PMP10 is located at Lot 34 Hopelands Road within a Conservation Covenant Area adjacent to the approved mining boundary. Vegetation at this site is parkland-cleared *Corymbia calophylla, Eucalyptus marginata* and *Persoonia elliptica* low woodland vegetation over *Kingia australis* open low scrub. Native grasses and herbs are absent within the lower strata and the understorey is dominated by exotic grasses and herbs. Vegetation of the site is representative of terrestrial rather than wetland vegetation. Site photographs comparing Spring 2021 and spring 2022 are presented in Plate 8. There were no signs of stress in mature trees at the site in spring 2022.

SPRING 2021

SPRING 2022

Plate 8: Spring 2022 vegetation monitoring photograph for PMP10

5.3.4 PMP11

PMP11 is situated on fallow land outside the licensed premises on the edge of resource enhancement category wetland 14457 (Fig. 3). Vegetation of the site is a completely degraded remnant of *Melaleuca preissiana* low forest over pasture grasses and other exotics (Plate 9). The understorey at this site contains no apparent native species. *M*. *preissiana* trees were in good health at the time of the spring 2022 survey and the understorey contained nearly 100% cover of exotic grasses.

SPRING 2021

SPRING 2022

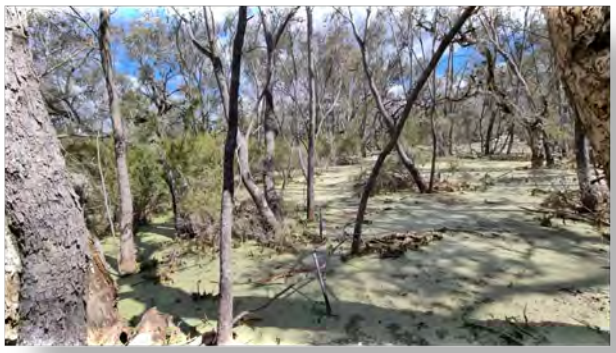
Plate 9: Spring 2022 vegetation monitoring photographs for PMP11

5.3.5 PMP13

PMP13 is located at Lot 501 Elliot Rd Keysbrook, within Bushland Forever Site No. 77 (Yangedi Swamp). The site is situated in the southern portion of conservation category wetland 14807 (formerly 7028) (Fig. 3). Vegetation of the site is historically grazed and parkland-cleared *Corymbia calophylla* low woodland upslope to the west, and *Melaleuca preissiana* and *Eucalyptus rudis* forest over *Kunzea ericifolia* and *Astartea scoparia* low scrub on lower-lying ground to the east.

The site was under water in spring 2022 and a thin sheet of aquatic herbs and algae covered areas of open water throughout the wetland. This was similar to the 2021 survey, as shown in photos for spring 2021 and 2022 in Plate 10. Site monitoring data are presented in Appendix IV.

There continues to be very low cover (<1%) of native and exotic species in the understorey at the site, and mature Flooded Gum (*E.rudis*) trees appeared to be in good condition.



SPRING 2021

SPRING 2022

Plate 10: Spring 2022 vegetation monitoring photographs for PMP13

5.4 REVIEW OF GROUNDWATER DATA

Routine water level monitoring and water quality measurements form part of Doral's licensing requirements under a variety of legislative instruments. Thirteen Superficial Aquifer monitoring bores (KWT1A, 1B, 1C, 1D, 1E, 1F, 2A, 2B, 2C, 2D, 2E, 2F, 3A and KPD00064) monitor potential impacts associated with mining (groundwater abstraction) on specific wetlands in the vicinity of mining areas at Keysbrook. Groundwater monitoring at superficial aquifer monitoring bores in 2022 indicates that groundwater levels for all of the monitoring bores across the Keysbrook site were compliant, and above the trigger levels specified in the GLOS (GRM 2023).There were no breaches of the groundwater level trigger values that would require a management response in accordance with the Water Management Plan.

Assessment of superficial aquifer groundwater levels was undertaken to compare current levels with pre-mining levels at all superficial bores in the vicinity of vegetation monitoring points specified in the WMP. These are the 13 (KWT-series) bores referred to above. Data reported by GRM (2023) confirms that water levels in the superficial aquifer are at or near the pre-mining levels at all sites near to conservation significant wetlands in the rehabilitated southern mining area. It is also apparent that water levels at the nearest bores to vegetation monitoring sites PMP10 and PMP11 are similar to pre-mining levels (see Fig. 11 in GRM 2023). Consideration should be given to removing these sites from the annual monitoring program.

5.5 BASELINE SURVEY OF LOT 56 KEYSBROOK

The Lot 56 Elliot Rd Keysbrook survey established two quadrat sites and one photographic monitoring point (PMP) to monitor vegetation condition at the site. Locations of the survey sites are provided in Figure 6. The survey was undertaken as part of Doral's monitoring obligations and commitments, to maintain compliance with legislative requirements listed in the Project Water Management Plan (WMP, MBS 2015). The quadrat and PMP sites were established to monitor vegetation condition at the site.

5.5.1 KVMQ10

Site KVMQ10 is located at Lot 56 Elliot Rd Keysbrook. Vegetation of the site forms a narrow continuous strip of riparian vegetation along a southern tributary of Dirk Brook (Fig. 5). The vegetated section of this tributary within the north-west portion of Lot 56 has been gazetted as Conservation Category Wetland 14887. Native vegetation to the north of the creekline has historically been cleared and is actively grazed by cattle, which were observed traversing remnant vegetation within and to the south of the creekline at the time of the survey.

The site is situated within Marri/Jarrah open woodland to 10 m height with occasional *Nuytsia floribunda*, over Kingia and assorted exotic herbs and grasses. Seven native species and nine exotics were recorded in the understorey of this site. Site data are presented in Appendix III and representative photos of the quadrat are presented in Plate 11.

AUTUMN 2022

AUTUMN 2022

AUTUMN 2022

AUTUMN 2022

Plate 11: Autumn 2022 vegetation monitoring photographs for KVMQ10

5.5.2 KVMQ11

KVMQ11 is the second vegetation monitoring quadrat established within Conservation Category Wetland 14887 in 2022. This site is approximately 200 m west of quadrat KVMQ10. Vegetation of the site is *Corymbia calophylla* woodland in a parkland cleared remnant, and the understorey is very open with limited native species present. Fifteen native species and 10 exotics were recorded with very limited cover and evidence of active grazing by livestock. Site data are presented in Appendix III and representative photos of the quadrat are presented in Plate 12.

AUTUMN 2022

AUTUMN 2022

AUTUMN 2022

AUTUMN 2022

Plate 12: Autumn 2022 vegetation monitoring photographs for KVMQ11

5.5.3 PMP12

PMP was established on the banks of an ephemeral tributary of Dirk Brook in Autumn 2022. The site is within Conservation Wetland 14887. Vegetation of the site is a narrow strip of remnant Marri/Jarrah open woodland to 10 m height, over Kingia and assorted exotic herbs and grasses. The site photo in Plate 13 is looking northwest across the creekline towards cleared pasture in the distance. The site data sheet is presented in Appendix IV.

AUTUMN 2022

Plate 13: Autumn 2022 vegetation monitoring photograph for PMP12

6 DISCUSSION

Monitoring of wetland vegetation at Doral's Keysbrook mineral sands project is a requirement of the Project's Water Management Plan (WMP, MBS 2015) and Groundwater Licence Operating Strategy (GLOS, Rockwater 2013). Wetland monitoring at the site was undertaken in late November 2022 in accordance with the amended Wetland Vegetation Health Monitoring Programme. In addition, a pre-mining baseline study was undertaken at wetland 14887 on Lot 56 Elliot Rd Keysbrook.

Wetland vegetation monitoring sites include quadrats and photographic monitoring points within bushland remnants on farmland and privately owned rural residential land. Monitoring of three quadrat sites was required in 2022 to assess vegetation health in accordance with monitoring commitments in the WMP (s5.2.2). One additional (reference) wetland site on private land to the northwest of the Project was also monitored in 2022.

Tree canopy health surveys at quadrat sites in spring 2022 showed mixed results for dominant tree species over the period of review. The overall health of *Corymbia calophylla* improved at one site (KVMQ5) and declined at another (KVMQ4). The health of *Melaleuca preissiana* improved at two sites (KVMQ4 and KVMQ9) and declined at a third (KVMQ6). The 2022 spring survey mean health of *Melaleuca preissiana* and *Corymbia calophylla* at all wetland sites listed within the WMP were within historical ranges. Two thirds (64%) of individual *M. preissiana* trees showed either an improvement in health or no change from the previous assessment in 2021. The trend for *C. calophylla* was similar, with the health of 67% of trees improving or remaining stable. *Eucalyptus rudis* is only present at one photo monitoring point within wetland 14807 and it appeared to be in good overall health in 2022.

Photographic monitoring at five sites in 2022 has not indicated any negative trends in vegetation health that could require a management response in accordance with the WMP. One additional site (PMP12) was established at Lot 56 Elliot Rd Keysbrook, in advance of future mining in the area.

Photographic monitoring sites PMP 3, 5, 6 and 7 have previously been removed from the survey programme as they no longer fall within the 1 km mining buffer that triggers the requirement to monitor them. The spring 2021 survey (Rockwater 2022) noted that additional PMP sites (sites 8, 9, 10 and 11) could potentially be removed from the monitoring programme, as they are also beyond the 1km mining buffer specified in the WMP. The continuation of monitoring at these sites is conditional on groundwater levels in the superficial aquifer being affected by mining.

The 2022 groundwater monitoring data for superficial aquifer bores indicate that groundwater across the Keysbrook site were compliant, and above the trigger levels specified in the GLOS (GRM 2023). Further analysis of the data confirms that water levels in the superficial aquifer are at or near the pre-mining levels at all sites near to conservation significant wetlands in the rehabilitated southern mining area. It is also apparent that water levels at the nearest bores to vegetation monitoring sites PMP10 and PMP11 are similar to pre-mining levels, meaning that these sites can be removed from the annual monitoring program, in accordance with the WMP.

The overall condition of vegetation (using the Keighery 1994 scale) at three wetlands immediately south of the approved mining boundary was generally unchanged over the period of review and ranged from completely degraded (wetland 14472) to degraded (wetlands 14473, 14465). The exception being at wetland 14473, where vegetation condition in a small portion of the site remains in good condition as a result of a largely intact understorey, and at wetland 14465, where the condition changed from degraded to good due to regeneration of understorey species as a result of fencing around the site, to exclude grazing.

Vegetation condition within wetland 14807 (Yangedi Swamp) to the northwest of the project area improved from good to excellent in 2022. At this site, vegetation condition improves during wetter periods when surface water suppresses germination of many exotic terrestrial herbs, and declines in response to the presence of aggressive weed species in drier years and during drier stages in the wetland hydroperiod.

Multiple disturbances from rural development and agricultural land uses at all monitoring sites within and adjacent to the Keysbrook mining areas have resulted in much of the remnant vegetation in the area being fragmented. Livestock (horses and cattle) and kangaroos have grazed much of the remnant bushland within the properties surveyed and understorey vegetation in most bushland areas is limited. Clearing and other development at all locations has resulted in a landscape of degraded, parkland-cleared vegetation. Exceptions are at monitoring sites within Bushland Forever Site 77 (Yangedi Swamp), where vegetation on freehold land is managed for conservation purposes. Monitoring of vegetation monitoring sites within conservation areas is undertaken through Doral's community monitoring programme and there are no compliance criteria or trigger/management actions associated with these sites.

Rainfall data from nearby BoM station at Cloon (Station 9242) indicate that rainfall of 869.2 mm was received over the period of review, which is 2% above average (1994-2022).

Groundwater levels in the superficial aquifer at the site fluctuate seasonally, as a result of rainfall and streamflow recharge, with water levels generally peaking around August to September (following winter rainfall) and then reaching a low point around March to April each year. For 2022, the average fluctuation was 1.53 m across all superficial aquifer bores, with the highest variability observed near the wetlands where recharge during winter is higher and evaporative losses during summer/autumn are greater (GRM

2022). The groundwater level in the Leederville Aquifer also demonstrates a seasonal variability, indicating active rainfall recharge is also occurring in the deeper aquifer.

Soil moisture at the southern wetland sites (14472, 14473 and 14465) is influenced more by rainfall and surface water than by groundwater, as the Superficial aquifer water levels in the vicinity of the southern mining block are below the base of the ore. Consequently, several Conservation Category wetlands in this vicinity (Fig. 2) are unlikely to be subjected to dewatering effects.

Doral is permitted to abstract up to 1.8 GL per annum from its Leederville Aquifer production bores for water supply, and up to a further 0.6 GL per annum from the Superficial Aquifer for the purpose of mine dewatering. During 2022, extraction from the Leederville Aquifer was 51.9% of the licensed annual allocation, and the volume of water added to the pits in tailings represented annual nett recharge to the superficial aquifer (GRM 2023). No active dewatering from pit sump pumping took place during 2022.

Annual monitoring of wetland monitoring bores was undertaken in accordance with regulatory requirements, apart from several bores that could not be accessed (GRM 2023). Monitoring for the reporting period does not indicate any impacts to the Superficial Aquifer associated with pit dewatering and tailings discharge (GRM 2022). Groundwater monitoring data for the review period do not indicate trends that would indicate adverse impacts to the Superficial Aquifer due to groundwater abstraction from the Leederville Aquifer for project water supply.

7 CONCLUSION

Wetland vegetation at Doral's Keysbrook mine was monitored in spring 2022, in accordance with commitments within the Project Water Management Plan (WMP) and Groundwater Licence Operating Strategy (GLOS).

The wetlands monitored by Doral are approximately 2.4 km south of any active mining areas, as at May 2022. As mining moves further north into new areas, the risk of mining impacts to wetland vegetation in several Conservation category wetlands immediately south of the Keysbrook project area continues to decline. Groundwater monitoring indicates that superficial aquifer groundwater levels across the site continue to comply with trigger levels specified in the GLOS, and the water levels in most of these bores are at or near pre-mining levels. There were no breaches of the groundwater level trigger values or vegetation health that would require a management response in accordance with the Water Management Plan.

Four additional photographic monitoring sites (PMP 8, 9, 10 and 11) can be removed from the Wetland Vegetation Health Monitoring Programme in accordance with the WMP.

Dated: 21 July 2023

Nick Evelegh
Principal Environmental Scientist

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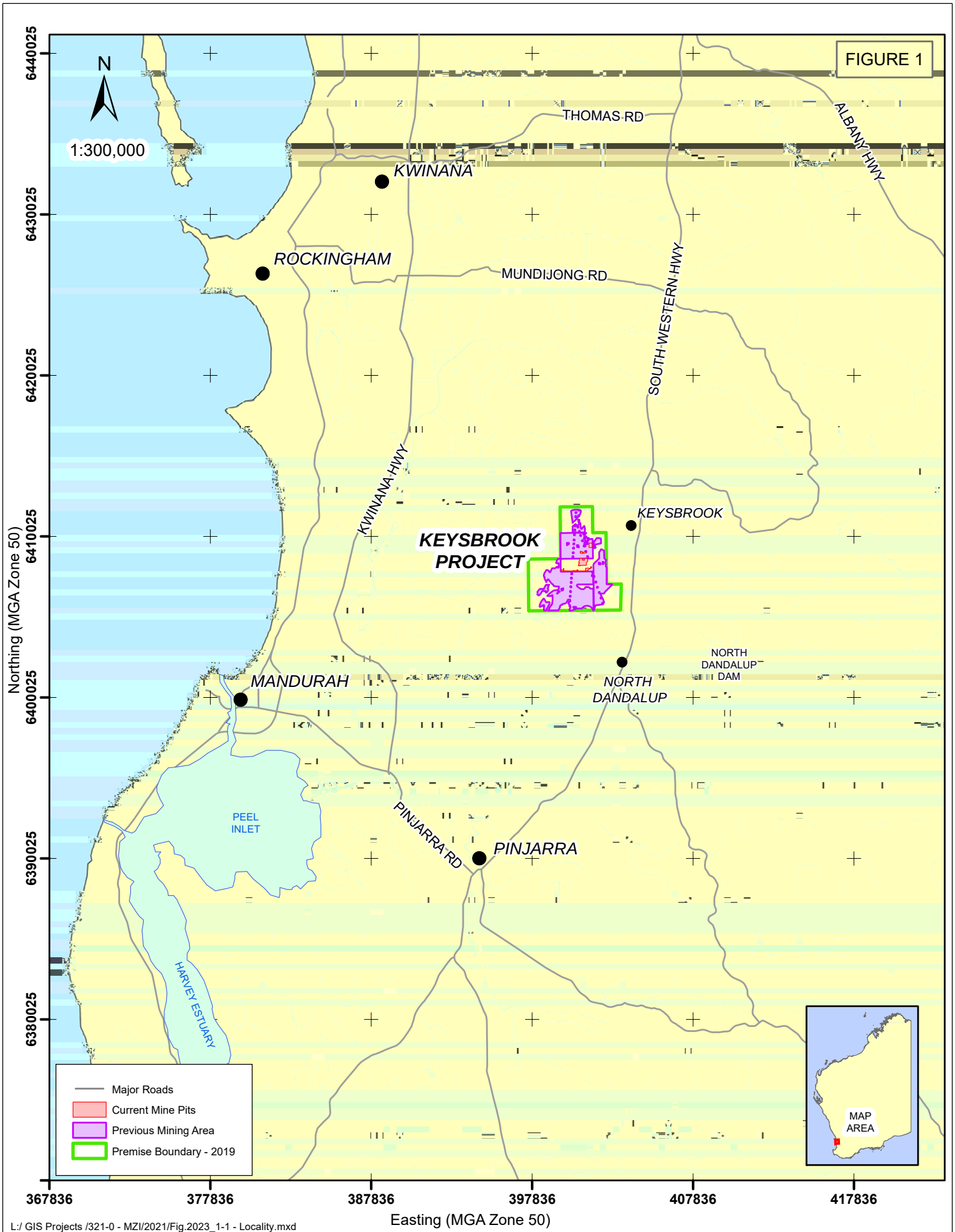
FIGURES

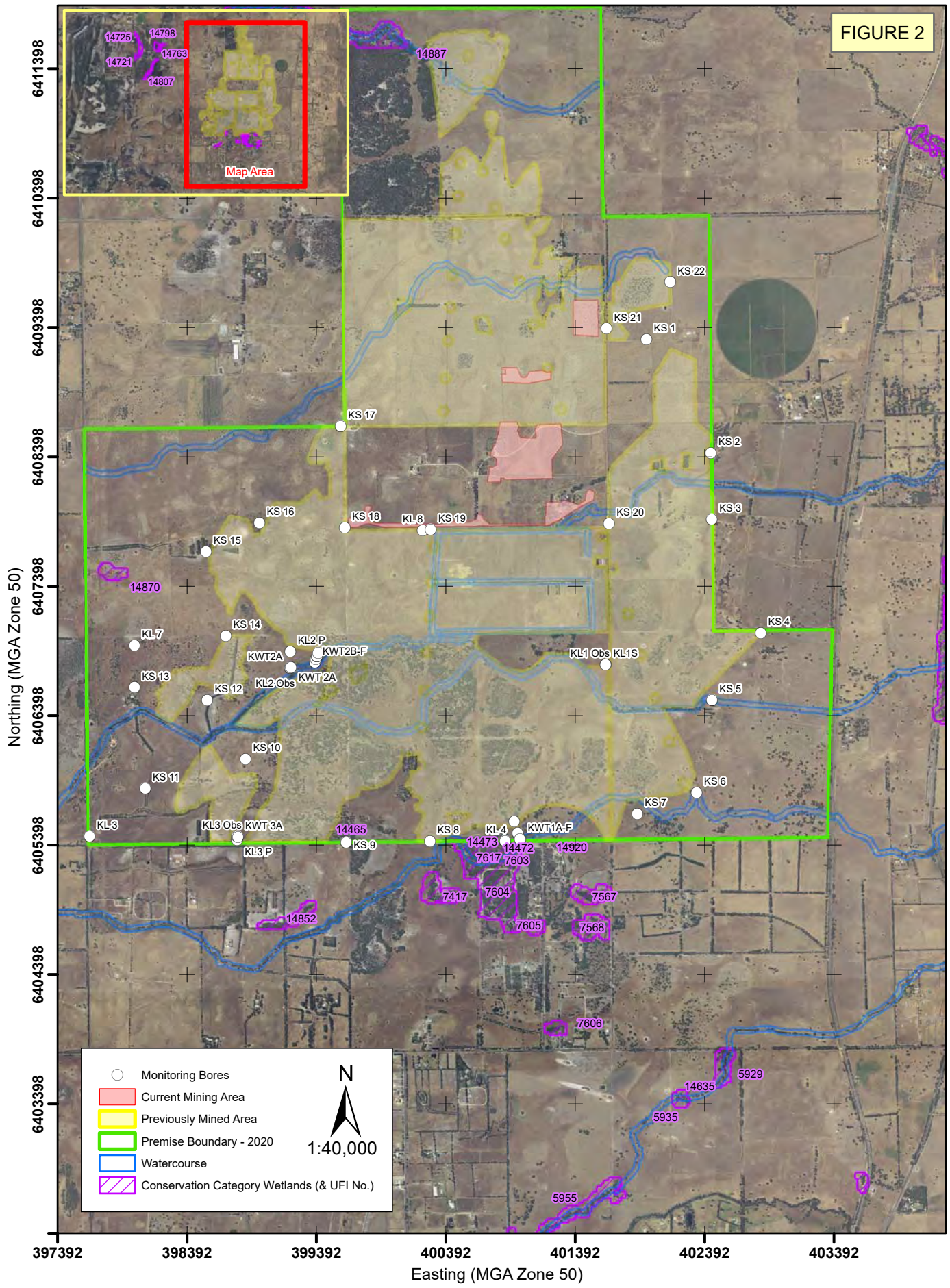


L:/ GIS Projects /321-0 - MZI/2021/Fig.2023_1-1 - Locality.mxd

CLIENT:	Doral Pty Ltd
PROJECT:	Keysbrook Minerals Sands
DATE:	June 2023
DWG NO:	321-0/23/01-1

LOCALITY PLAN

Rockwater PROPRIETARY LIMITED

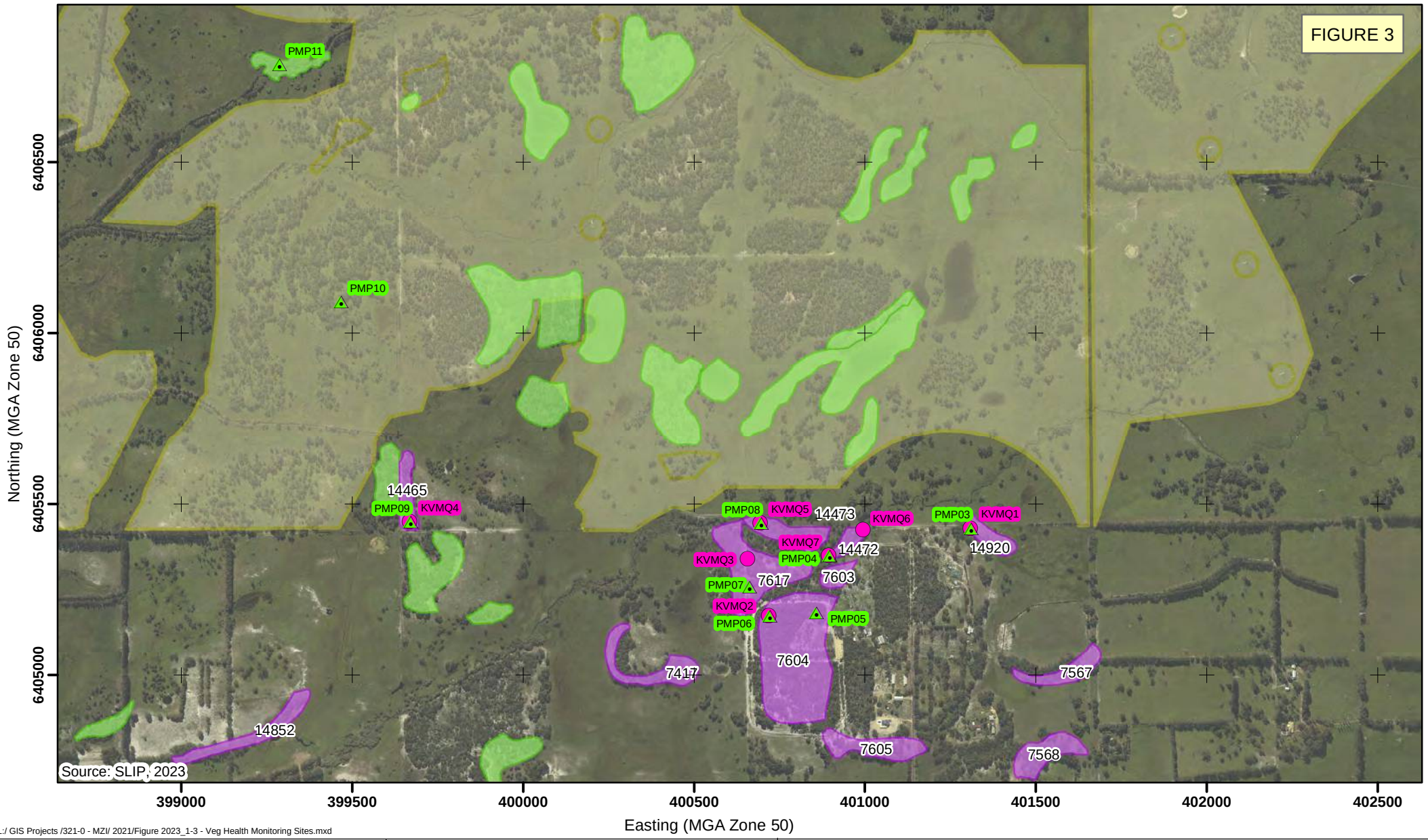


L:/ GIS Projects /321-0 - MZI/2021/ Fig.2023_1-2 - Conservation Categoy Wetlands.mxd

CLIENT:	Doral Pty Ltd
PROJECT:	Keysbrook Minerals Sands
DATE:	June 2023
DWG NO:	321-0/23/01-2

CONSERVATION CATEGORY WETLANDS

Rockwater PROPRIETARY LIMITED



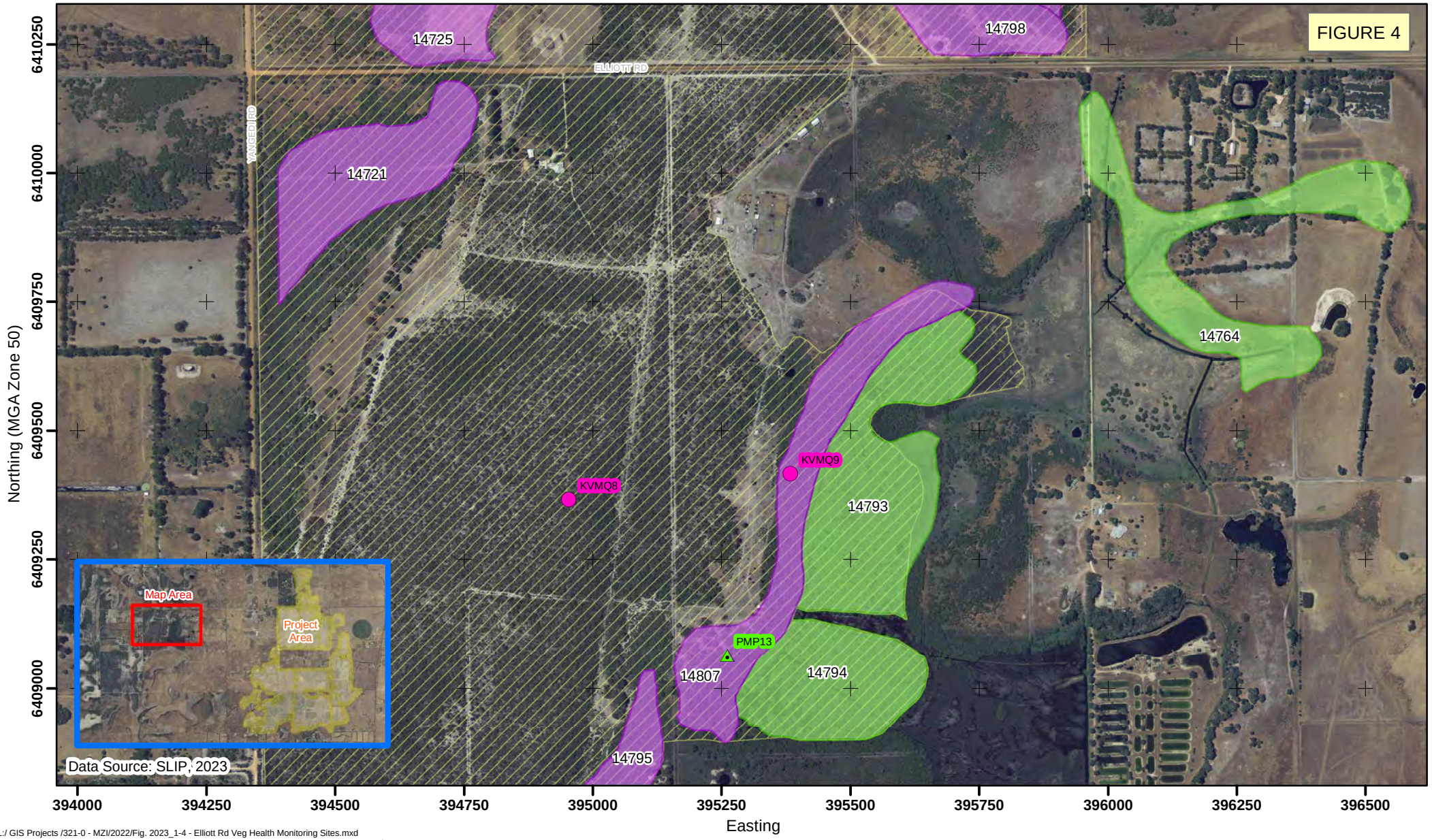
L:/ GIS Projects /321-0 - MZI/ 2021/Figure 2023_1-3 - Veg Health Monitoring Sites.mxd

CLIENT:	Doral Pty Ltd
PROJECT:	Keysbrook Minerals Sands
DATE:	June 2023
DWG NO:	321-0/23/01-3

Geomorphic Wetland (DPAW, 2020)
- Conservation (& UFI No.)
- Resource Enhancement
- Mining Area

- Photo Monitoring Point
- Quadrat
- N
- MGA Zone 50
- 1:15,000 (A4)

VEGETATION HEALTH MONITORING SITES AND PHOTOGRAPHIC MONITORING POINTS



L:/ GIS Projects /321-0 - MZI/2022/Fig. 2023_1-4 - Elliott Rd Veg Health Monitoring Sites.mxd

CLIENT:	Doral Pty Ltd
PROJECT:	Keysbrook Minerals Sands
DATE:	June 2023
DWG NO:	321-0/23/01-4

Quadrat

Bush Forever Site 77

Geomorphic Wetland (DPAW, 2020)

Conservation

Resource Enhancement

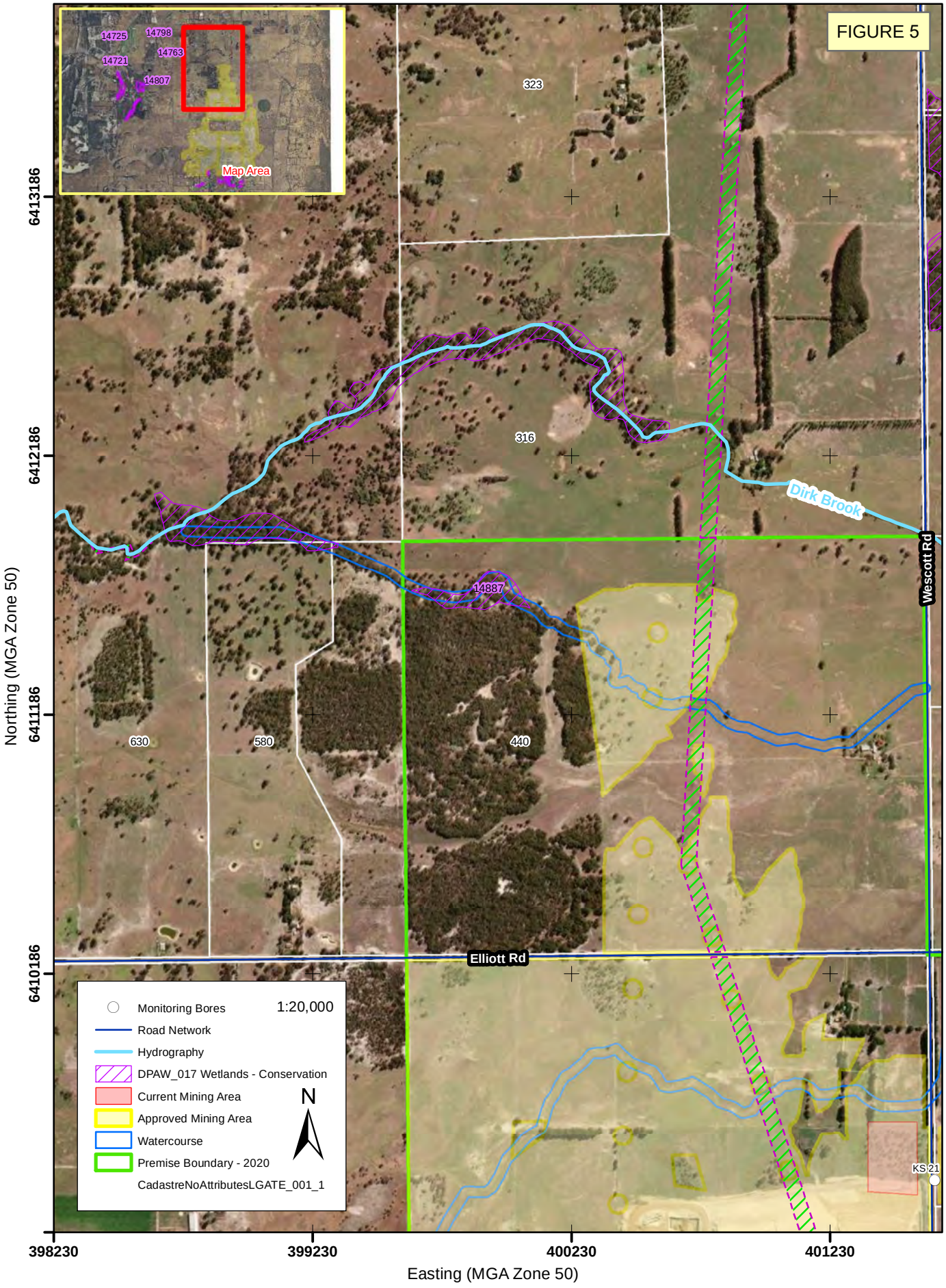
N

MGA Zone 50

1:10,000

A4

ADDITIONAL VEGETATION HEALTH MONITORING SITES AND PHOTOGRAPHIC MONITORING POINTS AT ELLIOTT RD

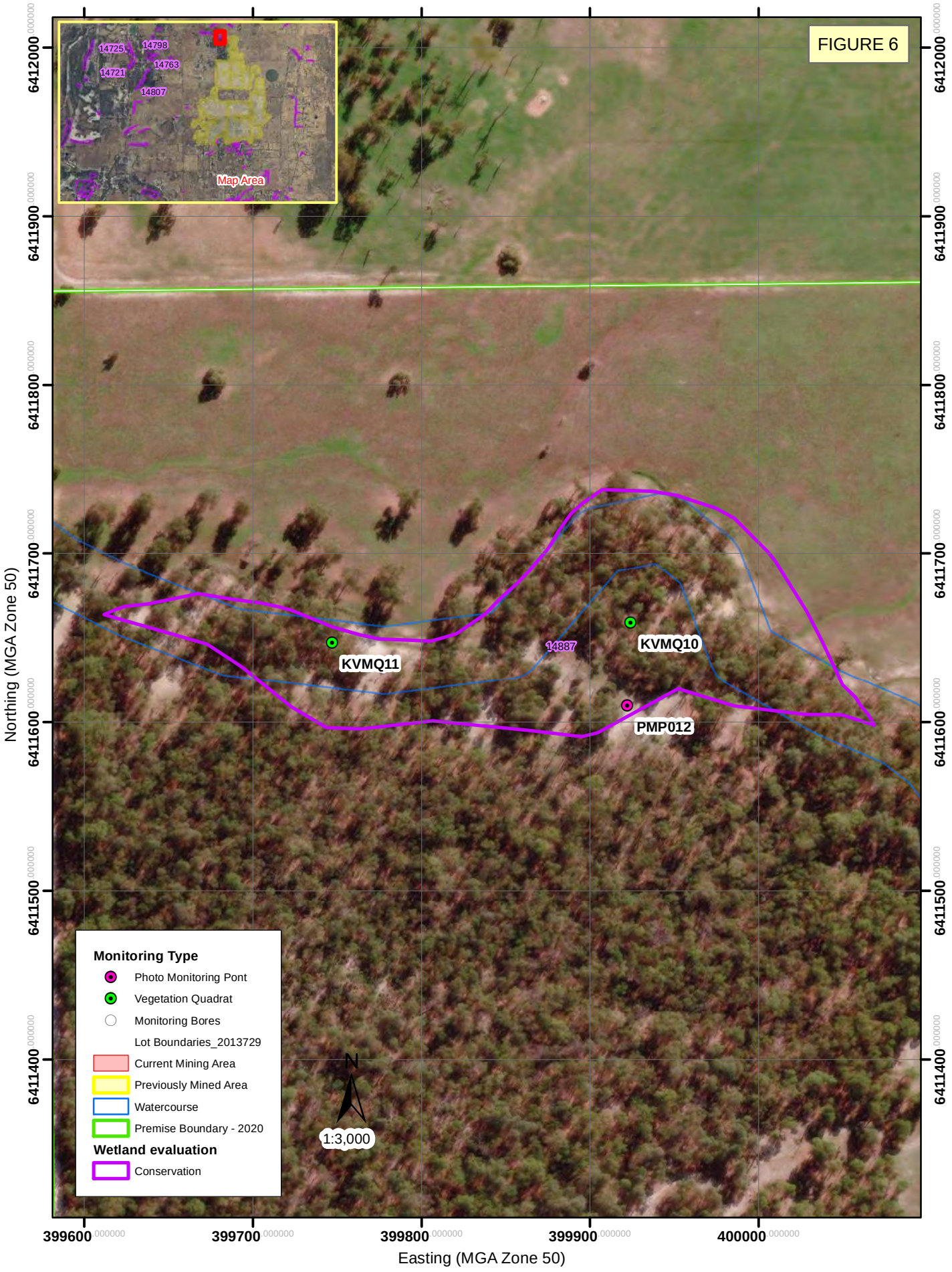


L:/ GIS Projects /321-0 - MZI/2021/ Fig.2023_1-5 - Lot 56.mxd

CLIENT:	Doral Pty Ltd
PROJECT:	Keysbrook Minerals Sands
DATE:	June 2023
DWG NO:	321-0/23/01-5

LOT 56 LOCALITY

Rockwater PROPRIETARY LIMITED



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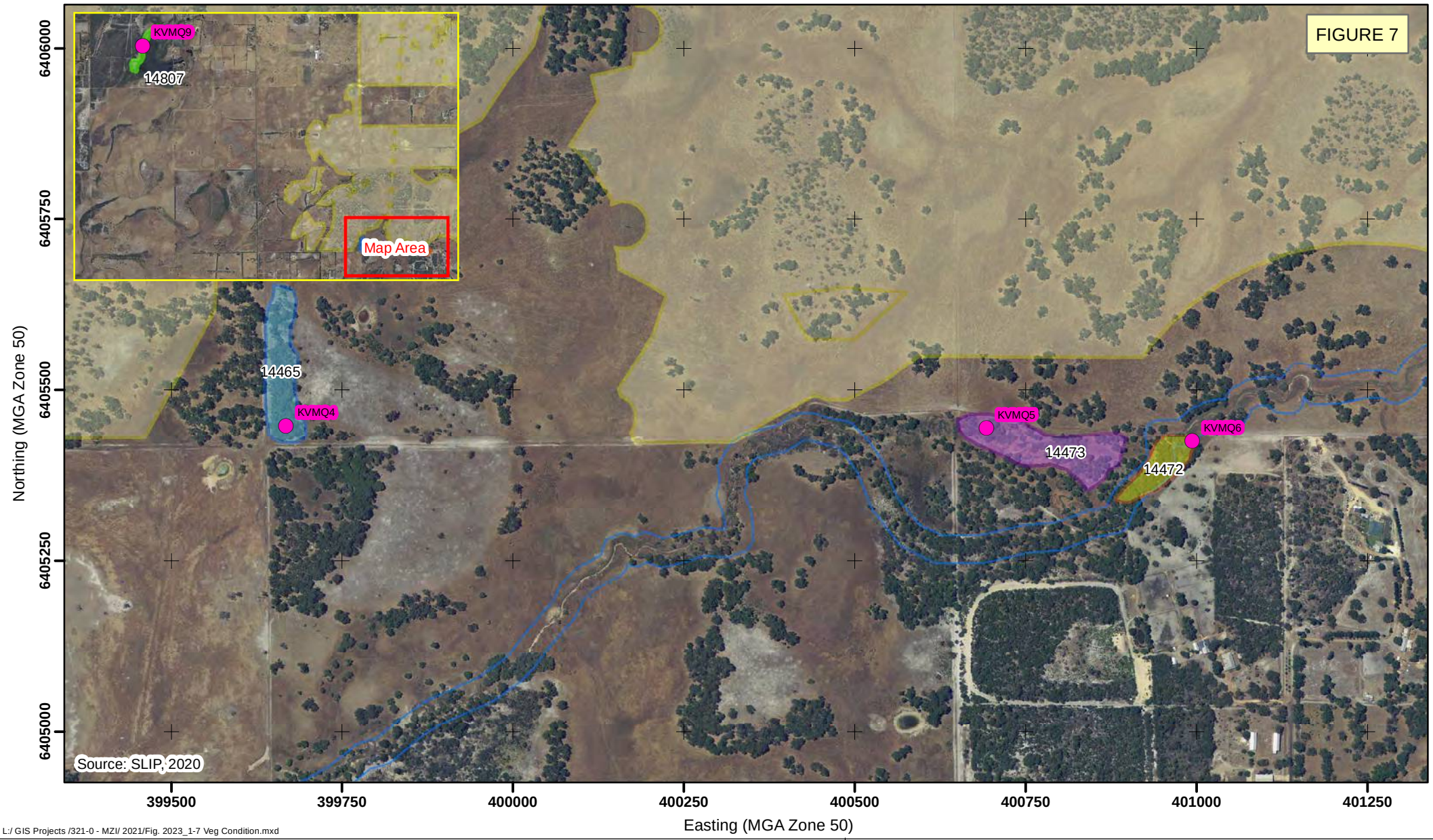
CLIENT:	Doral Pty Ltd
PROJECT:	Keysbrook Minerals Sands
DATE:	June 2023
DWG NO:	321-0/23/01-6

LOT 56 SURVEY SITES

Rockwater PROPRIETARY LIMITED



L:/ GIS Projects /321-0 - MZI/ 2021/Fig. 2023_1-7 Veg Condition.mxd

CLIENT:	Doral Pty Ltd
PROJECT:	Keysbrook Minerals Sands
DATE:	June 2023
DWG NO:	321-0/23/01-7

Spring 2021 Quadrat
Mining Area
Watercourse

1:7,500

Conservation Category Wetlands (& UFI No.)
(Condition Scale of Keighery, 1994)
Very Good
Good
Degraded
Completely Degraded

N

CONSERVATION CATEGORY WETLANDS SPRING 2022 VEGETATION CONDITION

APPENDIX I:

Vegetation Condition Scale (Keighery 1994)

Appendix I: Condition Scale (Keighery 1994)

1. Pristine	Pristine or nearly so, no obvious signs of disturbance
2. Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species
3. Very Good	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing
4. Good	Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
5. Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
6. Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as "parkland cleared" with the flora comprising weed or crop species with isolated native trees or shrubs.

APPENDIX II

Individual Tree Health Ratings for Spring & Autumn 2022

Appendix II: Individual Tree Health Ratings for Spring & Autumn 2022

Plot	Species	Tag Number	DBH, 2021 (cm)	Health							
				Spring 2015	Spring 2016	Spring 2017	Spring 2018	Spring 2019	Spring 2020	Spring 2021	Spring 2022
KVMQ4	*Melaleuca preissiana*	1	11.0, 7.2, 31.0	5, 5, 5 – 15	7, 7, 5 – 19	5, 5, 4 – 14	5, 5, 4 – 14	5, 5, 4 – 14	5, 5, 4 – 14	5, 7, 5 – 17	7,7,5–19
		2	12.2	3, 3, 5 – 11	5, 5, 5 – 15	3, 3, 4 – 10	3, 3, 5 – 11	5, 5, 4 – 14	3,3, 4 – 10	9, 7, 4 – 20	5,5,3–13
		3	17.7	5, 3, 5 – 13	7, 5, 5 – 17	3, 5, 4 – 12	5, 5, 4 – 14	5, 5, 5 – 15	3,3, 4 – 10	3, 5, 4 – 12	7,7,4–18
	Corymbia calophylla	4	4.4	3, 3, 3 – 9	5, 5, 3 – 13	3, 5, 3 – 11	3, 3, 3 – 9	3, 5, 4 – 12	1, 3, 2 – 6	3, 3, 3 – 9	1,1,1–3
		5	31.2	7, 7, 5 – 19	7, 7, 4 – 18	7, 7, 4 – 18	5, 7, 3 – 15	7, 7, 4 – 18	7, 7, 4 – 18	9, 7, 5 – 21	9,7,5–21
		6	15.2	5, 3, 5 – 13	7, 5, 3 – 15	7, 5, 3 – 15	7, 5, 4 – 16	5, 5, 3 – 13	3, 5, 3 – 11	3, 5, 3 – 11	3,3,2–8
		7	10.6	3, 3, 4 – 10	3, 3, 4 – 12	3, 3, 4 – 10	3, 3, 4 – 10	7, 5, 4 – 16	1, 1, 3 – 5	1, 1, 3 – 5	1,1,1–3
		8	20.7	7, 5, 4 – 16	7, 5, 3 – 15	7, 7, 4 – 18	7, 7, 4 – 18	7, 5, 4 – 16	7, 5, 4 – 16	7, 7, 4 – 18	9,7,5–21
		9	26.5	5, 3, 2 – 10	7, 5, 2 – 14	5, 5, 3 – 13	5, 3, 2 – 10	7, 5, 3 – 15	5, 5, 2 – 12	5, 5, 3 – 13	7,5,4–16
		10	10.0	3, 3, 4 – 10	5, 5, 3 – 13	5, 5, 4 – 14	5, 5, 4 – 14	5, 3, 4 – 12	3, 3, 2 – 8	5, 5, 3 – 13	5,5,4–14
		11	51.8	7, 3, 5 – 15	5, 5, 4 – 14	5, 3, 3 – 11	7, 5, 3 – 15	5, 5, 3 – 13	7, 5, 3 – 15	7, 7, 4 – 18	7,5,3–15
		12	19.2	5, 5, 3 – 13	5, 3, 3 – 11	3, 3, 2 – 8	5, 3, 3 – 11	3, 3, 3 – 9	5, 3, 3 – 11	5, 5, 3 – 13	3,1,2–6
		13	Dead								
		14	8.0	5, 5, 3 – 13	5, 3, 2 – 10	5, 3, 2 – 10	3, 1, 2 – 6	3, 3, 3 – 9	1, 1, 2 – 4	3, 3, 2 – 8	1,1,2–4
		15	Dead	3, 3, 1 – 7	3, 1, 2 – 6	3, 5, 2 – 10	1, 3, 2 - 6	Dead			
		16	12.1, 36.4, 20.5	7, 5, 4 -16	7, 5, 4 -16	7, 5, 3 – 15	7, 5, 3 - 15	7, 5, 4 - 16	7, 5, 3 - 15	7, 5, 3 – 15	9,7,5–21
KVMQ5B	*Corymbia calophylla*	1	9.2, 9.7, 38.7	7, 7, 4 – 18	7, 7, 3 – 17	7, 7, 5 – 19	5, 5, 4 – 14	5, 7, 4 – 16	5, 7, 4 – 16	5, 7, 4 – 16	5,5,2–10
		2	17.1, 31	7, 5, 7 – 19	7, 5, 4 – 16	7, 7, 4 – 18	5, 7, 4 – 16	5, 7, 4 – 16	7, 5, 4 – 16	9, 7, 4 – 20	7,7,4–18
		3	8.2	5, 5, 3 – 13	5, 5, 3 – 14	5, 5, 4 – 14	3, 3, 3 – 9	3, 5, 4 – 12	3, 5, 4 – 12	5, 5, 4 – 14	7,9,4–20
		4	29.5	7, 5, 4 – 16	5, 3, 4 – 12	7, 5, 4 – 16	7, 5, 4 – 16	5, 5, 4 – 14	7, 5, 4 – 16	9, 7, 4 – 20	7,7,4–18
		5	10.9	7, 7, 4 – 18	7, 5, 3 – 15	7, 7, 5 – 19	5, 5, 3 – 13	5, 5, 4 – 14	5, 5, 4 – 14	7, 5, 3 – 14	7,7,4–18
		6	3.9	3, 5, 3 – 11	5, 5, 3 – 13	5, 5, 4 – 14	3, 5, 3 – 11	1, 1, 2 – 4	3, 3, 3 – 9	5, 5, 4 – 14	5,7,5–17
		7	7.9	3, 3, 2 – 8	3, 3, 2 – 8	5, 3, 3 – 11	3, 3, 3 – 9	1, 1, 2 – 4	3, 1, 2 – 6	5, 3, 3 – 11	5,5,3–13
		8	10	7, 5, 4 – 16	5, 3, 4 – 12	5, 5, 4 – 14	5, 5, 4 – 14	3, 3, 3 – 9	3, 5, 3 – 11	5, 5, 4 – 14	5,5,3–13
		9	1.8	5, 3, 3 – 11	3, 3, 3 – 9	3, 3, 5 – 11	3, 3, 3 – 9	1, 1, 1 – 3	1, 1, 3 – 5	3, 3, 3 – 9	5,5,3–13
		10	17.4	9, 7, 4 – 20	7, 5, 4 – 16	9, 7, 5 - 21	7, 5, 5 – 17	3, 3, 3 – 9	5, 5, 4 – 14	7, 7, 5 – 19	7,7,5–19
		11	21.3	7, 7, 4 – 18	7, 5, 3 – 15	5, 7, 4 – 16	7, 5, 4 – 16	7, 5, 4 – 16	7, 5, 4 – 16	7, 7, 4 – 18	9,7,4–20
		12	38.2	9, 7, 5 – 21	9, 7, 5 – 21	9, 7, 5 – 19	9, 7, 5 – 21	7, 5, 4 – 16	7, 7, 5 – 19	7, 7, 4 – 18	9,7,4–20
		13	11.9	7, 7, 4 – 18	7, 5, 5 – 17	5, 5, 4 – 14	7, 5, 4 – 18	3, 3, 3 – 9	5, 5, 3 – 13	7, 7, 4 – 18	7,7,4–18
		14	11.6	5, 5, 3 – 13	5, 3, 3 – 11	5, 3, 3 – 11	5, 5, 3 – 13	3, 3, 3 – 9	5, 3, 3 – 11	5, 5, 3 – 13	5,5,4–14
		15	38.6	7, 3, 2 – 12	5, 3, 3 – 11	5, 3, 3 – 11	7, 3, 4 – 14	5, 5, 3 – 13	7, 5, 3 – 15	7, 5, 3 – 15	7,5,4–16
		16	3.0	3, 3, 2 – 8	5, 3, 3 – 11	5, 5, 5 – 15	5, 5, 5 – 15	3, 1, 2 – 6	3, 3, 3 – 9	5, 5, 3 – 13	5,5,3–13

Plot	Species	Tag Number	DBH, 2021 (cm)	Health							
				Spring 2015	Spring 2016	Spring 2017	Spring 2018	Spring 2019	Spring 2020	Spring 2021	Spring 2022
KVMQ6	*Melaleuca preissiana*	1	35.5, 22, 27.2	7, 5, 5 – 17	5, 5, 5 – 15	5, 5, 4 – 14	5, 5, 4 – 14	5, 5, 3 – 13	7, 5, 4 – 16	7, 5, 4 – 16	5,5,3–13
		2	6.8, 5.3, 2.2	7, 5, 5 – 17	7, 7, 5 – 19	3, 5, 3 – 11	5, 5, 4 – 14	3, 3, 3 – 9	5, 5, 4 – 14	7, 5, 4 – 16	5,5,3–13
KVMQ9	*Melaleuca preissiana*	1	5.6	-	3, 1, 5 – 9	3, 1, 4 – 8	1, 1, 2 – 4	1, 1, 1 – 3	1, 1, 1 – 3	3, 1, 2 – 6	3,3,3–9
		2	14.7	-	3, 3, 5 – 11	5, 3, 4 – 12	3, 5, 3 – 11	3, 3, 2 – 8	3, 5, 3 – 11	5, 7, 4 – 16	5,5,4–14
		3	35.9	-	5, 3, 5 – 13	3, 3, 3 – 9	5, 5, 4 – 14	3, 3, 3 – 9	3, 1, 2 – 6	5, 3, 3 – 11	7,5,4–16
		4	12.2	-	5, 3, 5 – 13	5, 3, 4 – 12	5, 5, 4 – 14	3, 3, 3 – 9	3, 3, 2 – 8	5, 3, 5 – 13	5,5,3–13
		5	20.1	-	5, 5, 5 – 15	5, 5, 4 – 14	3, 5, 4 – 12	5, 3, 3 – 11	3, 3, 3 – 9	5, 5, 3 – 13	5,7,3–15
		6	Dead								
		7	Dead	-	3, 3, 5 – 11	3, 3, 4 – 10	3, 3, 3 - 9	3, 1, 2 - 6	3, 1, 2 - 6	Dead	
		8	Dead	-	1, 1, 5 – 7	Dead					
		9	Dead								
		10	6.1	-	3, 3, 5 – 11	1, 3, 4 – 8	3, 3, 3 - 9	1, 1, 2 - 4	1, 1, 2 - 4	3, 2, 3 - 8	7,5,4–16
KVMQ10	*Eucalyptus marginata*	3	49.3	9,7,4 – 20	KVMQ10	*Eucalyptus marginata*	3	49.3	9,7,4 – 20	KVMQ10	*Eucalyptus marginata*
		3	49.3	9,7,4 – 20							
		7	14.1	7,7,4 – 18							
		1	4.4	3, 3, 3 – 9							
		2	31.2	7, 7, 5 – 19							
		4	15.2	5, 3, 5 – 13							
		6	10.6	3, 3, 4 – 10							
		8	20.7	7, 5, 4 – 16							
		9	26.5	5, 3, 2 – 10							
		10	10.0	3, 3, 4 – 10							
	Nuytsia floribunda	5	51.8	7, 3, 5 – 15							
KVMQ11	*Corymbia calophylla*	1	9.2, 9.7, 38.7	7, 7, 4 – 18							
		2	17.1, 31	7, 5, 7 – 19							
		3	8.2	5, 5, 3 – 13							
		4	29.5	7, 5, 4 – 16							
		5	10.9	7, 7, 4 – 18							
		6	3.9	3, 5, 3 – 11							
		7	7.9	3, 3, 2 – 8							
		8	10	7, 5, 4 – 16							
		9	1.8	5, 3, 3 – 11							
		10	17.4	9, 7, 4 – 20							
		11	21.3	7, 7, 4 – 18							

APPENDIX III

Autumn & Spring 2022 Vegetation Quadrat Monitoring Data Sheets

Appendix III: Vegetation Quadrat Data Sheets

Vegetation Health Assessment							
PROJECT DETAILS							
Client: MZI	Client #: 321-0				Date: 16/11/2022		
Project: Keysbrook	R/W Personnel: N.E.						
QUADRAT DETAILS							
Site #:**KVMQ5**							
Location description: NW Corner Property							
MGA coordinates: (50) 400 693 mE 640 5444 mN					Elevation (mAHD:)		
Conservation Category Wetland UFI No: 14473							
Topography: Creekline							
Soil: -							
Litter %	Bark:<1%	Branches: 1 %		Leaves: 5 %			
Vegetation Description: Heath of *Astartea scoparia* over open tall sedges of *Lepidosperma longitudinale* and *Juncus pallidus* over low grasses dominated by exotic species (*Cynodon dactylon and Paspalum dilatatum*)							
Vegetation Condition: Degraded							
DRF/Priority Flora & Number of Plants:							
Fire Age: -							
NOTES: (Dieback, Insect/Disease, Other of Interest)							
PHOTOGRAPHY							
Photo numbers:							
TAGGED TREES (10 X 10 m)							
Tag Number	Species	Crown Density	Dead Branches	Epicormic cover	DBH	Height (m)	% Cover
KVMQ5-1	*Corymbia calophylla*	5	5	2	8.65, 9.6 38.5	11.5	10
KVMQ5-2	*Corymbia calophylla*	7	7	4	8.1	12	<1
KVMQ5-3	*Corymbia calophylla*	7	9	4	17.15, 30	4.5	8
KVMQ5-4	*Corymbia calophylla*	7	7	4	29.2	~30	7
KVMQ5-5	*Corymbia calophylla*	7	7	4	11.1	6.5	1
KVMQ5-6	*Corymbia calophylla*	5	7	5	3.9	2.5	<1
KVMQ5-7	*Corymbia calophylla*	5	5	3	7.85	4.5	<1
KVMQ5-8	*Corymbia calophylla*	5	5	3	9.7	7.5	<1
KVMQ5-9	*Corymbia calophylla*	3	3	3	1.8	1.9	<1
KVMQ5-10	*Corymbia calophylla*	7	7	5	17.4	10.5	1.5
KVMQ5-11	*Corymbia calophylla*	9	7	4	20.15	8.5	4
KVMQ5-12	*Corymbia calophylla*	9	7	4	37.4	16	12
KVMQ5-13	*Corymbia calophylla*	7	7	4	11.1	9.5	1
KVMQ5-14	*Corymbia calophylla*	5	5	4	11	9.5	1.5
KVMQ5-15	*Corymbia calophylla*	7	5	4	39.2	11	1.5
KVMQ5-16	*Corymbia calophylla*	5	5	3	2.5	1.6	<1
COMMENTS							
General condition of trees: Tree KVMQ5-1 looking sick (stagging, insect attach etc.) Good, some trees have evidence of termites (5 – 15 heavy) Creek bed- damp Tree tags missing from KVMQ5-1 to KVMQ5-4							

Appendix III: Vegetation Quadrat Data Sheets (cont.)

Vegetation Health Assessment							
PROJECT DETAILS							
Client: MZI	Client #: 321-0				Date: 16/11/2022		
Project: Keysbrook	R/W Personnel: N.E. & D.S.						
QUADRAT DETAILS							
Site #:**KVMQ6**							
Location description: North corner horse paddock							
MGA coordinates: (50) 400 994 mE 640 5425 mN					Elevation (mAHD:)		
Conservation Category Wetland UFI No: 14472							
Topography: Drainage Line							
Soil: Sandy Loam							
Litter: 8 %	Bark: 1%	Branches: 1 %		Leaves: 6 %			
Vegetation Description: Low Forest of *Melaleuca preissiana* over open tall sedges of *Juncus pallidus* over open low grasses and weeds.							
Vegetation Condition:							
DRF/Priority Flora & Number of Plants: -							
Fire Age: -							
NOTES: (Dieback, Insect/Disease, Other of Interest)							
PHOTOGRAPHY							
Photo numbers:							
TAGGED TREES (10 X 10 m)							
Tag Number	Species	Crown Density	Dead Branches	Epicormic cover	DBH	Height (m)	% Cover
KVMQ6-1	*Melaleuca preissiana*	5	5	3	7.2	5.2	<1
KVMQ6-2	*Melaleuca preissiana*	5	5	3	28.1, 34.85, 23.1	6.2	12.5
Comments: General condition of trees: (stagging, insect attach etc.) Several fallen branches on KVMQ6-1 have reduced cover. Higher weed and native cover in understorey Soil damp in creekline Juncus pallidus cover increased (~7%)							

Appendix III: Vegetation Quadrat Data Sheets (cont.)

Vegetation Health Assessment							
PROJECT DETAILS							
Client: MZI	Client #: 321-0				Date: 16/11/2022		
Project: Keysbrook	R/W Personnel: N.E. & D.S.						
QUADRAT DETAILS							
Site #:**KVMQ9**							
Location description: On neighboring property to KVMQ8, on wetland edge							
MGA coordinates: (50) 395 383 mE 640 9416 mN					Elevation (mAHD:) 23		
Conservation Category Wetland UFI No: 14807 'Sumpland' "Conservation'							
Topography: Flat (very slight slope towards east)							
Litter (%)	Bark: %	Branches: %		Leaves: %			
Vegetation Description: *M. Preissiana* >30% cover over *Astartea scoparia* 10-30% up to 3 m over *Astartea scoparia* 40% 1-2 m over *Astartea scoparia* and weeds, over aquatic herbs (covering 80% of quadrat							
Vegetation Condition: Excellent							
DRF/Priority Flora & Number of Plants: 0							
Fire Age: long unburnt							
NOTES: (Dieback, Insect/Disease, Other of Interest)							
PHOTOGRAPHY							
Photo numbers:							
TAGGED TREES (10 X 10 m)							

Tag Number	Species	Crown Density	Dead Branches	Epicormic cover	DBH (cm)	Height (m)	% Cover
KVMQ9-1	*Melaleuca preissiana*	3	3	3	5.55	3.3	<1
KVMQ9-2	*Melaleuca preissiana*	5	5	4	14.1		1.5
KVMQ9-3	*Melaleuca preissiana*	7	5	4	34.8		9
KVMQ9-4	*Melaleuca preissiana*	5	5	3	12.6		
KVMQ9-5	*Melaleuca preissiana*	5	7	3	19.0		3
KVMQ9-6	*Melaleuca preissiana*	Dead					
KVMQ9-7	*Melaleuca preissiana*	Dead					
KVMQ9-8	*Melaleuca preissiana*	Dead					
KVMQ9-9	*Melaleuca preissiana*	Dead					
KVMQ9-10	*Melaleuca preissiana*	7	5	4	6.0		<1

General condition of trees: (stagging, insect attach etc.)
Water depth 16 cm north east corner peg.
Site under water

Appendix III: Vegetation Quadrat Data Sheets (cont.)

Vegetation Health Assessment							
PROJECT DETAILS							
Client: MZI / Doral		Client #: 321-0			Date: 26/05/2022		
Project: Keysbrook		R/W Personnel: NE , FO					
QUADRAT DETAILS							
Site #:**KVMQ10**							
Location description: Northern portion of Lot 56 Keysbrook.							
MGA coordinates: (50) 399 924 mE 641 1659 mN					Elevation (mAHD:) 37 m		
Conservation Category Wetland UFI No: 14887							
Topography: creek margin							
Litter: 65%	Bark: 1 %	Branches: 1 %		Leaves: 63 %			
Vegetation Description: Open Woodland of of *Corymbia calophylla* and *Eucalyptus marginata* over very open *Kingia australis* and exotics							
Vegetation Condition: Degraded							
DRF/Priority Flora & Number of Plants: nil							
Fire Age: >10 Old burnt sections (still black)							
NOTES: (Dieback, Insect/Disease, Other of Interest)							
PHOTOGRAPHY							
Photo numbers:							
TAGGED TREES (10 X 10 m)							
Tag Number	Species	Crown Density	Dead Branches	Epicormic cover	DBH	Height (m)	% Cover
KVMQ10-1	*Corymbia calophylla*	7	7	4	18.4,23.5	9.3	20
KVMQ10-2	*Corymbia calophylla*	5	5	5	18.3	9.3	3
KVMQ10-3	*Eucalyptus marginata*	9	7	4	49.3	11.8	30
KVMQ10-4	*Corymbia calophylla*	9	7	4	23.9	6	8
KVMQ10-5	*Nuytsia floribunda*	9	9	5	55.9	8.5	15
KVMQ10-6	*Corymbia calophylla (mat)*	9	9	4	17.8	9.3	5
KVMQ10-7	*Eucalyptus marginata*	7	7	4	14.1	7.8	3.5
KVMQ10-8	*Corymbia calophylla (mat)*	9	7	4	32.6	10.8	<1
KVMQ10-9	*Corymbia calophylla (mat)*	9	7	4	16.4	9.3	<1
KVMQ10-10	*Corymbia calophylla (mat)*	9	7	4	1.8	2.0	<1
COMMENTS							
Eucalyptus rudis on creekline 30 m east of quadrat Quadrat associated species: Acacia stenoptera, Briza minor, Melaleuca preissiana, Bromnus diandrus, Mesomelaena tetragona, Drosera erythrorhiza, Schoenus sp. (10-5 opp.)							

LIST OF SPECIES					
Species:	Flower Colour	Height (m)	% Alive	% Dead	No. of Plants
Desmocladus fascicularis	-	0.1	<1	-	-
*Romulea rosea**	-	0.2	<1*	-	-
*Briza maxima**	-	0.2	<1	-	-
*Lolium rigidum**	-	<0.1	<1	-	-
*Hypochaeris glabra**	-	<0.1	<1	-	-
*Ursinia anthemoides**	-	<0.1	<1	-	-
*Lotus or Trifolium sp.**	-	<0.1	<1	-	-
Corymbia calophylla	-	0.05	12	-	-
Nuytsia floribunda	-	-	10	-	-
Kingia australis	-	0.9	5	-	-
Eucalyptus marginata	-		8	-	-
*Aira caryophylla**	-	<0.1	<1	-	-
Hypolaena exsulca		<0.1	<1		
Lomandra caespitosa		<0.1	<1		
*Poaceae (exotic)**		0.1	<1		
Austrostipa sp.		0.3	<1		
Dasypogon obliquifolius		0.1	<1		
*Bromus diandrus**		0.4	<1		
Lagenophora huegellii			0.2	<1	
OPPORTUNISTIC					
Acacia stenoptera	-	-	-	-	-
Briza minor	-	-	-	-	-
Melaleuca preissiana	-	-	-	-	-
Mesomelaena tetragona	-	-	-	-	-
Drosera erythrorhiza					
Schoenus rigens					
*Pentameris airoides ssp. Airoides**					
Comments:					

Vegetation Health Assessment

PROJECT DETAILS		
Client: MZI / Doral	Client #: 321-0	Date: 26/05/2022
Project: Keysbrook	R/W Personnel: NE , FO	

QUADRAT DETAILS			
Site #:**KVMQ11**			
Location description: Lot 56 Keysbrook (north of Elliot Rd). Margin of creekline, southern side			
MGA coordinates: (50) 399 747 mE 641 1647 mN			Elevation (mAHD:) 40 m
Conservation Category Wetland UFI No: 14887			
Topography: Flat/sloping toward creekline			
Litter: 82%	Bark: 1 %	Branches: 1 %	Leaves: 80 %
Vegetation Description: Woodland of *Corymbia calophylla*			
Vegetation Condition: Good			
DRF/Priority Flora & Number of Plants: nil			
Fire Age: >10 Old burnt sections (still black)			
NOTES: (Dieback, Insect/Disease, Other of Interest)			

PHOTOGRAPHY

Photo numbers:

TAGGED TREES (10 X 10 m)

Tag Number	Species	Crown Density	Dead Branches	Epicormic cover	DBH	Height (m)	% Cover
KVMQ11-1	*Corymbia calophylla (mat)*	DEAD	-	-	14.8	7.5	-
KVMQ11-2	*Corymbia calophylla (mat)*	7	5	4	20.2	18.6	3.5
KVMQ11-3	*Corymbia calophylla (mat)*	5	5	3	10.3	50	1.5
KVMQ11-4	*Corymbia calophylla (mat)*	5	5	3	19.3	11.8	1.5
KVMQ11-5	*Corymbia calophylla (mat)*	7	7	5	26.4	14.1	3
KVMQ11-6	*Corymbia calophylla (mat)*	7	7	7	30.9	20.6	6.5
KVMQ11-7	*Corymbia calophylla (mat)*	7	5	4	14.6	8.0	1
KVMQ11-8	*Corymbia calophylla (mat)*	5	5	3	17.2	7.6	1
KVMQ11-9	*Corymbia calophylla (mat)*	7	7	5	38.5	16.1	30
KVMQ11-10	*Corymbia calophylla (mat)*	9	7	5	43.9	15.1	15
KVMQ11-11	*Corymbia calophylla (mat)*	5	5	5	9.8	5.6	<1

COMMENTS

1 *Corymbia calophylla* seedling
Cattle in paddock and grazing through creekline
Creek not flowing but several pools present along creek.

KVMQ11 LIST OF SPECIES					
Species:	Flower Colour	Height (m)	% Alive	% Dead	No. of Plants
*Romulea rosea**	-	0.2	<1		-
Corymbia calophylla	-		60	-	10
*Watsonia bulbelifera**	-	0.3	<1	-	-
Dasypogon obliquifolius	-	0.1	<1	-	-
*Hypochaeris glabra**	-	<0.1	<1*	-	-
*Annual grasses (indet.)**	-	0.2	1.5	-	-
Hypolaena exsulca	-	0.2	<1	-	-
*Brachypodium distachyon**	-	0.2	<1*	-	-
Schoenus rigens	-	0.3	<1	-	-
Desmocladus fascicularis	-	0.1	<1	-	-
Cyathochaeta avenacea	-	0.3	<1	-	-
Thysanotus manglesii	-	0.2	<1	-	-
Lepidosperma pubisquameum	-	0.25	<1		
Lepidosperma longitudinale		0.3	<1		
Machaerina juncea		0.4	<1		
Laganophora huegellii		0.1	<1		
*Briza maxima**		0.2	<1		
*Aira caryophylla**		0.2	<1		
*Ursinia anthemoides**		0.1	<1		
Hibbertia hypericoides		0.15	<1		
Drosera erythrorhiza		<0.1	<1		
*Bromus diandrus**		0.1	<1		
?Astartea		0.1	<1		
Lomandra caespitosa		0.2	<1		
*Briza minor**	-	0.1	<1	-	-
Conostylis aculeata		0.2	<1		
OPPORTUNISTIC/ASSOCIATED SPECIES	-	-	-	-	-
Kingia australis	-	-	-	-	-
Eucalyptus marginata	-	-	-	-	-
	-	-	-	-	-
Solanum nigrum					
Melaleuca viminea					
Juncus pallidus					
Melaleuca preissiana					
Xylomelum occidentale					
Banksia menziesii					
Allocasuarina fraseriana					
Thelymitra crinata					
Chamaescilla corymbosa					
Leptocarpus decipiens					
Comments:					

APPENDIX IV

2022 Photographic Monitoring Point Data Sheets

Appendix IV: Photographic Monitoring Point Data Sheets

Vegetation Health Assessment		
PROJECT DETAILS		
Client: MZI	Client #: 321-0	
Project: Keysbrook	R/W Personnel: N.E.	
Date: 16/11/2022	Time:	
SITE DETAILS		
MGA coordinates: (50) 400 693 mE 640 5444 mN		
Photographic Monitoring Point (PMP): **PMP08**		
Conservation Category Wetland UFI No: 14465		
Photographs Taken: 1		
Notes: Photo taken north-west corner KVMQ5A		
HEALTH ASSESSMENT		
Parameter	Description	Result
% Herbaceous Cover	Percentage of ground covered by native grasses and herbs (incl. sedges)	30
% Weed Species	Percentage of ground covered by weeds	20
Recent Plant Deaths	Number of dead plants in quadrat (if any)	0
Plant Stress	Number of plants showing signs of stress (dead branches etc)	5
Insects	Evidence of insect pests on the trees and shrubs. Minor, Moderate or Severe	Minor

Vegetation Health Assessment		
PROJECT DETAILS		
Client: Doral	Client #: 321-0	
Project: Keysbrook	R/W Personnel: N.E.	
Date: 16/11/2022	Time:	
SITE DETAILS		
MGA coordinates: (50) 399 668 mE 640 5447 mN		
Photographic Monitoring Point (PMP): **PMP09**		
Conservation Category Wetland UFI No: 14465		
Photographs Taken:		
Notes: Recently fenced off, tubestock planted throughout site.		
HEALTH ASSESSMENT		
Parameter	Description	Result
% Herbaceous Cover	Percentage of ground covered by native grasses and herbs (incl. sedges)	12.5%
% Weed Species	Percentage of ground covered by weeds	<1%
Recent Plant Deaths	Number of dead plants in quadrat (if any)	0
Plant Stress	Number of plants showing signs of stress (dead branches etc)	A few *Corymbia calophylla* with epicormic growth
Insects	Evidence of insect pests on the trees and shrubs. Minor, Moderate or Severe	Moderate

Appendix IV: Photographic Monitoring Point Data Sheets

Vegetation Health Assessment		
PROJECT DETAILS		
Client: Doral	Client #: 321-0	
Project: Keysbrook	R/W Personnel: N.E.	
Date: 16/11/2022	Time:	
SITE DETAILS		
MGA coordinates: (50) 399 465 mE 640 6091 mN		
Photographic Monitoring Point (PMP): **PMP10**		
Photographs Taken:		
Notes:		
HEALTH ASSESSMENT		
Parameter	Description	Result
% Herbaceous Cover	Percentage of ground covered by native grasses and herbs (incl. sedges)	0
% Weed Species	Percentage of ground covered by weeds	95%
Recent Plant Deaths	Number of dead plants in quadrat (if any)	0
Plant Stress	Number of plants showing signs of stress (dead branches etc)	0
Insects	Evidence of insect pests on the trees and shrubs. Minor, Moderate or Severe	Minor

Vegetation Health Assessment		
PROJECT DETAILS		
Client: Doral	Client #: 321-0	
Project: Keysbrook	R/W Personnel: N.E. & D.S.	
Date: 16/11/2022	Time:	
SITE DETAILS		
MGA coordinates: (50) 399 284 mE 640 6785 mN		
Photographic Monitoring Point (PMP): **PMP11**		
Photographs Taken:		
Notes:		
HEALTH ASSESSMENT		
Parameter	Description	Result
% Herbaceous Cover	Percentage of ground covered by native grasses and herbs (incl. sedges)	0
% Weed Species	Percentage of ground covered by weeds	100%
Recent Plant Deaths	Number of dead plants in quadrat (if any)	0
Plant Stress	Number of plants showing signs of stress (dead branches etc)	2
Insects	Evidence of insect pests on the trees and shrubs. Minor, Moderate or Severe	Minor

Appendix IV: Photographic Monitoring Point Data Sheets (cont.)

Vegetation Health Assessment		
PROJECT DETAILS		
Client: Doral	Client #: 321-0	
Project: Keysbrook	R/W Personnel: N.E.	
Date: 26/05/2022	Time:	
SITE DETAILS		
MGA coordinates: (50) 399 922 mE 641 1610 mN		
Photographic Monitoring Point (PMP): **PMP012**		
Conservation Category Wetland UFI No: 14887		
Photographs Taken: 1 facing north-west		
Notes:		
HEALTH ASSESSMENT		
Parameter	Description	Result
% Herbaceous Cover	Percentage of ground covered by native grasses and herbs (incl. sedges)	<1% *Kingia australis* 3-4%
% Weed Species	Percentage of ground covered by weeds	40%
Recent Plant Deaths	Number of dead plants in quadrat (if any)	No
Plant Stress	Number of plants showing signs of stress (dead branches etc)	Some epicormic growth on *Corymbia calophylla*. 3 or 4 tress. No significant stress
Insects	Evidence of insect pests on the trees and shrubs. Minor, Moderate or Severe	Yes, minor

Vegetation Health Assessment			
PROJECT DETAILS			
Client: Doral	Client #: 321-0		
Project: Keysbrook	R/W Personnel: N.E. & D.S.		
Date: 16/11/2022	Time: 14:40		
SITE DETAILS			
MGA coordinates: (50) 395 259 mE	640 9064 mN	Elevation (mAHD): 34	
Photographic Monitoring Point (PMP): **PMP13**			
Conservation Category Wetland UFI No: 14807 'Sumpland' "Conservation'			
Photographs Taken:			
Notes: Conservation Category Wetland number 7028 Mostly under water			
HEALTH ASSESSMENT			
Parameter	Description	Result	
% Herbaceous Cover	Percentage of ground covered by native grasses and herbs (incl. sedges)	80% aquatic herbs	
% Weed Species	Percentage of ground covered by weeds	<1	
Recent Plant Deaths	Number of dead plants in quadrat (if any)	1 x *Corymbia calophylla* nearby	
Plant Stress	Number of plants showing signs of stress (dead branches etc)	Several Eucalyptus and Corymbia trees	
Insects	Evidence of insect pests on the trees and shrubs. Minor, Moderate or Severe	Moderate	