Kumarina Water Supply Project

H3 Level Hydrogeological Assessment

06-June-2018

Level 4, 600 Murray St
West Perth WA 6005
Australia

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1 Introduction

Kalium Lakes Ltd (KLL) has recently completed a resource evaluation and Pre-Feasibility Study for the Beyondie Sulphate of Potash Project (BSOPP) in Western Australia and is in the process of completing a Bankable Feasibility Study (BFS). In order to refine the final SOP product and support operations, a process water supply is required of approximately 1.5 Gigalitres / annum (GL/a) of fresh to brackish water to meet the proposed 150,000 tonne per annum SOP production.

A regional assessment of potential water supply sources has identified alluvial and calcrete aquifers associated with ephemeral creeks in the vicinity of the Upper Gascoyne River (Kumarina) and Ten Mile Lake as being prospective for sustainable water supplies. It is anticipated that the total water supply will be met by a combination of these aquifers. This report focusses on the Kumarina water supply area, in particular the calcrete, alluvial and deformation zone associated with the Jaydinia Syncline to be a reliable source of process water within the vicinity of the Beyondie Project. Figure 1-1 shows the general location of the Kumarina Project in relation to the Beyondie Project

1.1 Purpose of this Report

This report summarises the hydrogeological investigations and results, and assesses the potential impacts of groundwater abstraction from the Kumarina area, in support of KLL's application for a water supply location in this borefield.

1.2 The Kumarina Water Supply Project Area

The Kumarina Water Supply Project area is located on the Kumarina pastoral lease, approximately 80 km to the West of the BSOPP, and is located within the East Murchison groundwater area and the Egerton groundwater subarea. The township of Newman is approximately 150 km to the North along the Great Northern Highway, whilst Wiluna is approximately 240 km to the South. KLL has a pending application for an Miscellaneous Licence (L52/190 and L52/193) covering the Kumarina water supply project area.

The Project plans to abstract fresh to brackish groundwater from the surficial sediments and calcrete associated with the Upper Gascoyne River and the weathered and fractured bedrock zones associated with the Jaydinia Syncline.

The key aspects affecting the groundwater abstraction are:

- The volume and storage of groundwater within the identified aquifers;
- The impacts to groundwater dependent ecosystems; and
- Other users.

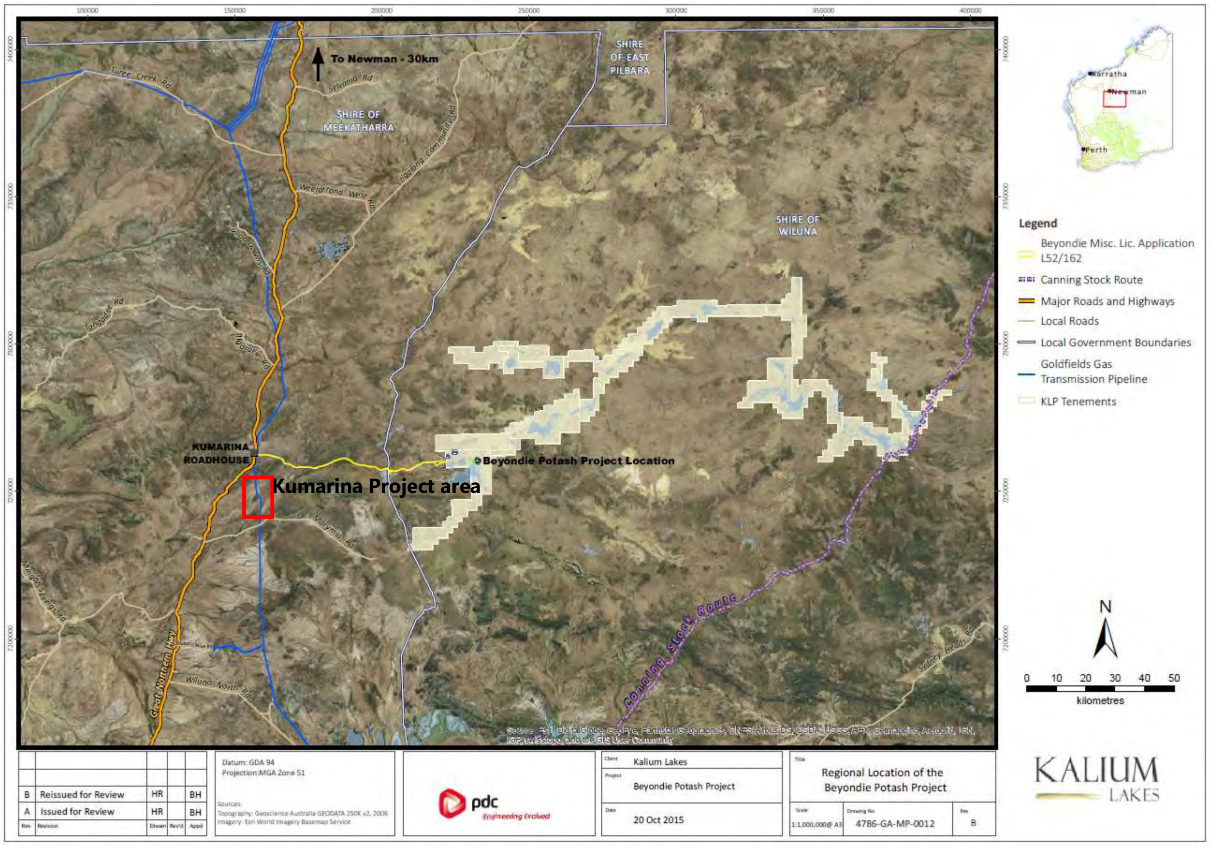


Figure 1-1: Kumarina Project location (red box) in relation to the Beyondie SOP Project where the groundwater will be utilised.

1.2.1 Previous Hydrogeological Work Undertaken

Exploration and mining has been carried out in the region since the 1890's with gold as the main commodity with other volumes of copper and manganese. Copper has been produced from the Kumarina mines, approximately 10 km to the north, with copper also identified at Copper Hills, approximately 15 km to the to the south east. The more recent discoveries of the Plutonic Gold and DeGrussa Copper-Gold deposits are located, approximately 50 km to the south-south east. There has been limited groundwater exploration in the direct vicinity to Kumarina, however there are a number existing stock bores within the investigation area. The Plutonic Mine obtains its process water supply from weathered and fractured bedrock aquifers in the vicinity of the Gascoyne River.

2 Site Characteristics

The Kumarina Project is located on the western edge of the Little Sandy Desert. The topography is gently undulating with an east-west trending scarp line associated with the Jaydinia Syncline. Valley calcrete deposits are preserved on the flanks of the major drainage features of the Gascoyne River which flows through the Project area. Within the Project area transported cover can be up to approximately 5-20 m in thickness; however, much of the surrounding area is covered by a generally thin layer (1-2 m) of transported cover. The southern and eastern margins of the project area are dominated by an erosional regime, and to the north-west the landscape is dominated by the prominent scarp of the Collier Range.

2.1 Climate

The Kumarina Project area falls within the arid desert climate zone, which is characterised by hot summers and warm to cold winters with low annual rainfall. Most of the strongly seasonal rainfall occurs in the period between December and June. A large percentage of the annual total precipitation occurs over short periods, associated with thunderstorm activity and cyclonic lows.

The closest weather station that has publicly available data is the Three Rivers station, approximately 127 km east-southeast of the Project area. Table 2-1 outlines the meteorological conditions for Three Rivers as reported by the Bureau of Meteorology (BOM). The maximum daily temperature (average) at the mine site rises to 39°C in January; the minimum average temperature is measured at 5°C with extremes to -5°C during June. Mean annual rainfall is 238 mm.

Table 2-1: Summary Meteorological Conditions for Three Rivers Station*

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean max temp (°C)	39.3	36.8	35.4	30.3	25.3	21.1	21.0	23.4	27.8	31.9	35.2	38.0	30.5
Mean min temp (°C)	24.1	22.9	20.6	15.7	10.1	6.6	4.8	6.6	9.7	14.0	18.1	22.0	14.6
Mean rainfall	34.9	43.5	36.1	21.2	22.8	23.5	11.4	7.3	2.1	5.7	10.0	18.7	238.4
Mean monthly evaporation	547	473	430	304	186	144	157	203	271	397	451	537	4,100

**Latitude: 25.13°S • Longitude: 119.15°E • Elevation 520 m; BoM, 2018*

2.2 Hydrology

The Kumarina project lies on an ephemeral creek within the Upper Gascoyne River Basin. The area lies within the Arid Interior / North West hydrological zone which is characterised by:

- Low average annual rainfall;
- Frequent flood events resulting from localised thunderstorms or tropical upper air disturbances which cause widespread low intensity rainfall; and
- Flood events are caused by tropical cyclones which produce high intensity rainfalls.

The Kumarina catchment extends to the north of the project over an area of approximately 350 km^2 and is presented in Figure 2-1. A summary of the basic catchment parameters of the Kumarina area is presented in Table 2-2.

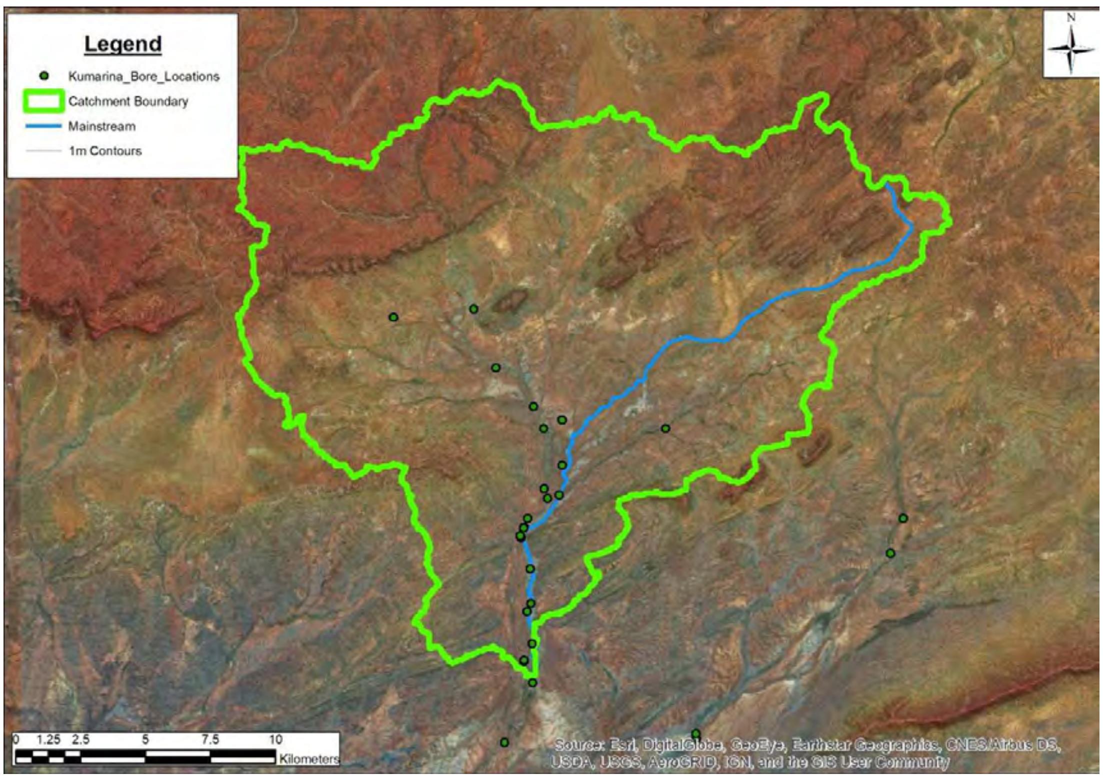


Figure 2-1: Catchment Delineation

Table 2-2: Basic Catchment Parameters

Characteristic	Description
Description	Ephemeral River
Hydrological zone	Rangelands West
Total catchment areas	~350 km^2
Stream Length	29.8 km

2.2.1 Intensity-Frequency-Duration Rainfall Data

The Intensity Frequency Duration (IFD) rainfall depths for the catchment were extracted from the Bureau of Meteorology (BoM) Water Information website and are presented in Table 2-3.

Table 2-3: IFD Rainfall Depths (mm) for Kumarina (BoM 2018)

	Annual Exceedance Probability (AEP)						
Duration	63.20%	50%#	20%*	10%	5%	2%	1%
1 min	1.23	1.48	2.3	2.9	3.52	4.41	5.13
2 min	2.11	2.52	3.95	5.02	6.16	7.86	9.3
3 min	2.92	3.5	5.47	6.95	8.5	10.8	12.7
4 min	3.66	4.39	6.84	8.66	10.6	13.4	15.7
5 min	4.32	5.18	8.06	10.2	12.4	15.6	18.3
10 min	6.84	8.19	12.7	16	19.4	24.2	28.1
15 min	8.57	10.3	15.9	20	24.3	30.3	35.1
30 min	11.8	14.2	22	27.7	33.7	42.1	49
1 hour	15.4	18.4	28.6	36.1	44.1	55.5	65
2 hour	19.4	23.2	35.9	45.5	55.6	70.4	82.8
3 hour	22.1	26.3	40.8	51.6	63.2	79.9	94
6 hour	27.3	32.5	50.3	63.6	77.8	97.9	115
12 hour	33.5	39.9	61.7	78	95	119	138
24 hour	40	48.1	74.9	94.5	115	142	164
48 hour	46.3	56.1	88.7	112	136	168	192
72 hour	49.5	60.5	96.5	122	149	183	210
96 hour	51.7	63.4	102	129	158	194	222
120 hour	53.5	65.6	106	135	165	202	231
144 hour	55.1	67.5	109	139	170	209	239
168 hour	56.7	69.3	111	142	174	214	244

Note:
The 50% AEP IFD **does not** correspond to the 2 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 1.44 ARI.

* The 20% AEP IFD **does not** correspond to the 5 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 4.48 ARI.

Anecdotally the Upper Gascoyne River in the project area is known to flood on an annual basis. The crossing over the Great Northern Highway near the Kumarina Roadhouse has typically been a point of closure for the Highway and has been the stimulus for recent bridge upgrades to allow the flood water to pass with minimal disturbance.

During the 2018 Kumarina investigations the creek was observed to be in flood during January and March 2018 in response to approximately 60 mm of rainfall falling over a 72 hour period in the second week of January as recorded at the DeGrussa Mine Site, approximately 60 km south of the roadhouse. This is considered to equate to an approximate 1 to 2 year event, based on Table 2-3.

2.3 Geology

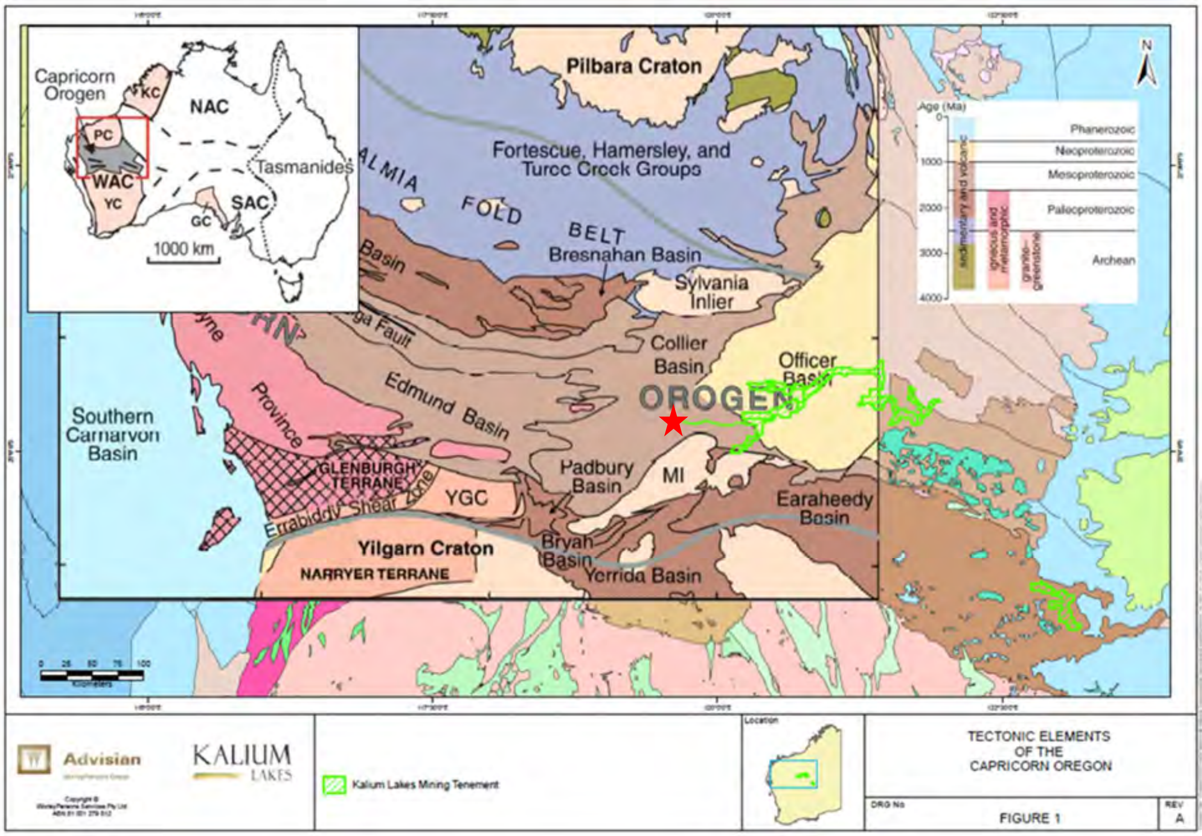
The Kumarina water supply project is in the East Pilbara region, west of the Little Sandy Desert. The area is typified by gently undulating topography dominated by low lying scrub. Around the Gascoyne River, poorly defined drainage features are situated in broad floodplains, where larger trees up to approximately 15 m in height are dominant. Valley alluvium and calcrete occurs locally in many of the Gascoyne river drainage features.

The Kumarina area falls within the 1:250,000 Collier Geological Map produced by the Geological Survey of Western Australia (GSWA) in 1982 (Brakel, 1982) however subsequent work in this area has led to numerous changes in the stratigraphic interpretation in the area (Bullen, 1995). Geological descriptions presented in this report are adopted from previous works undertaken by Kalium and summarised in the BSOPP Pre-Feasibility Study (PFS) Report (Advisian, 2017a).

2.3.1 Tectonic Setting

The Kumarina Project is located within the Collier Basin (Figure 2-2 and Figure 2-3), which post-dates the main regional tectonic event, the Capricorn Orogeny. The Capricorn Orogeny marks the convergence and collision of the Archaean Pilbara and Yilgarn Cratons, and was responsible for widespread granite magmatism, deformation and metamorphism. The Marymia Dome (aged >2660 Ma), located to the southwest of the project, is the only feature associated with this event in the project area.

Intra-cratonic basin sediments including the Scorpion, Collier, and Salvation Basins developed during a period of relative stability following the Capricorn Orogeny, and were filled with sediments comprising the Bangemall Sub-group and Tooloo Group rocks. These sedimentary sequences were subsequently subject to low grade metamorphism, faulting and folding by the Edmundian Orogeny (c. 1030 – 955 Ma) (Figure 2-3). After this event, units of the NW Officer Basin, the Sunbeam Group (c. 1000 – 720 Ma) which represent the youngest basement units within the Project area were deposited.



Note: Craton abbreviations as follows: PC – Pilbara Craton, WAC – West Australian Craton, KC – Kimberley Craton, NAC – South Australian Craton, YC – Yilgarn Craton. Extracted from GSWA, Johnson, 2013. "Birth of Supercontinents and the Proterozoic Assembly of WA.

Figure 2-2: Tectonic Elements of the Capricorn Orogen

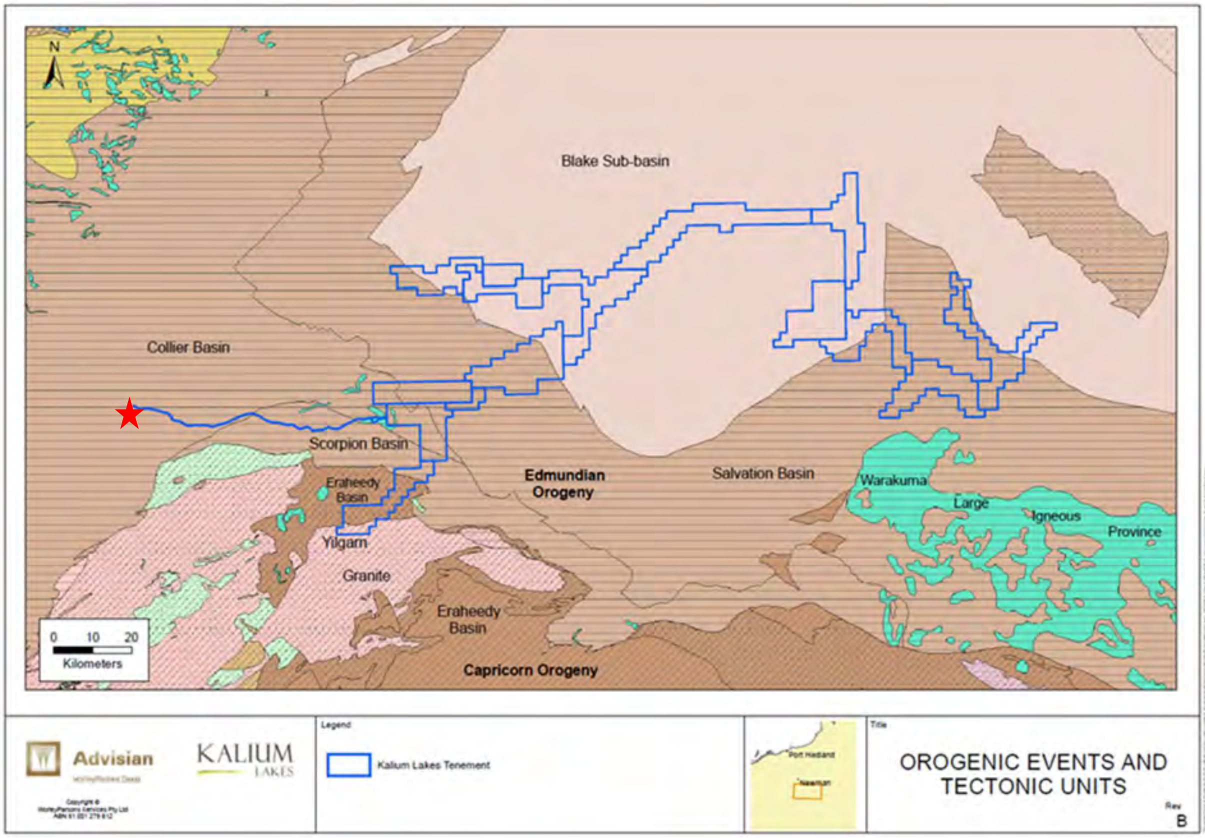


Figure 2-3: Kumarina Water Supply Project location (red star) in relation to the BSOPP area (tenements indicated in blue) Tectonic and Orogenic Regions

2.3.2 Regional Geology

Rock units occurring across the Project area were deposited in the eastern extremities of the Capricorn Orogen, primarily within the intra-cratonic Collier basin, which is bordered by the Salvation and Scorpion basins. Collectively, rocks formed within these basin areas are categorised into stratigraphic groups with naming of these groups often aligned with the basin name.

Rocks of the Collier, Salvation, and Scorpion stratigraphic groups belong within the Bangemall Supergroup. Outside of the Bangemall Supergroup classification, but in an adjacent tectonic unit called the NW Officer Basin, are the younger rocks of the Sunbeam Group.

The oldest outcropping units, which occur between the Beyondie and the Kumarina Project areas, are relicts of the Archean Marymia Dome, and consist of metasediments and granites. Unconformably overlying these elements of the Marymia Dome is the Bangemall Supergroup. All sedimentary units within the Bangemall Supergroup are predominantly shallow marine deposited, with older units of this local stratigraphic sequence being encroached upon and grading into a younger deltaic system (e.g. Jilyili Formation). The age of the basin units is poorly constrained, with an upper age limit set at c.1629 Ma, and a younger limit of c.1070 Ma.

Intruding into units of the Bangemall Supergroup, are mafic intrusions. Dolerite sills and dykes have been identified throughout the Project area, favouring emplacement into the finer grainer units of the Backdoor and Jilyili Formations (Williams, 1995). In addition, occurrences of amygdaloidal, vesicular basalts and fine-grained dolerites have been described from the broader region, and have been intersected at the Beyondie Project.

Simultaneous with the final deposition of the elements of the Collier Group units was the extensional Proterozoic tectonic activity between c.1080 and c.1060, and emplacement of dolerite sills (locally the Kulkatharra Dolerite) and dykes originating from the Warakurna Large Igneous Province, (Johnson et.al. 2013). The Kulkatharra Dolerite occurs within the Beyondie and Kumarina Project area outcropping immediately NW of the Kumarina Roadhouse, and has been intersected in a number of drill holes.

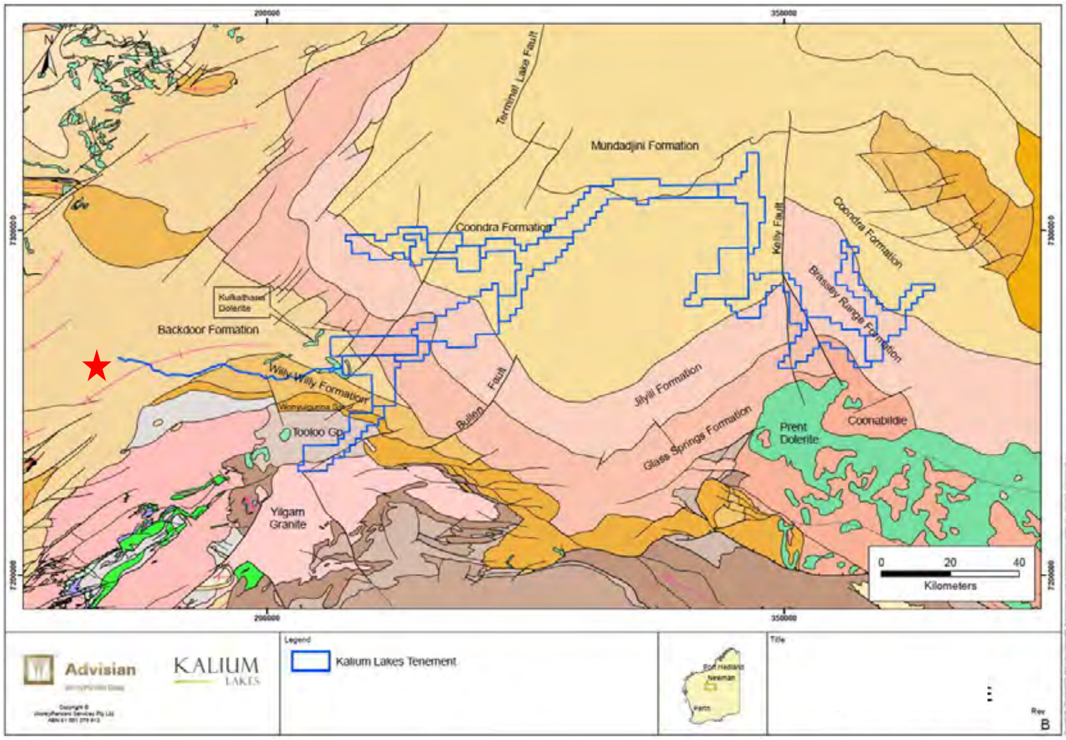


Figure 2-4 Kumarina Project location (red star) in relation to the KLL Beyondie tenements (in blue) with Interpreted Bedrock Geology with Linear Features (Bullen, 1995)

Following the dolerites emplacement into units of the Bangemall Supergroup, c. 1070 Ma, the region was subject to deformation resultant from the Edmundian Orogeny, and later low to medium grade regional metamorphism. Finally, the upper alluvial and colluvial sequence as sedimentation derived from tectonic adjustments. It is varied in nature, and texturally further modified by ferricrete, silcrete and calcrete weathering processes. The major rock units encountered across the Project are summarised below.

Stratigraphic Summary of the Project Area and surrounds:

<u>Marymia Dome (c. 3350 – 2660 Ma)</u>

Archaean Greenstone Metasediments

- Undifferentiated metasediments – schistose, quartzose metasediments

Yilgarn Craton Granite (c. 2720 Ma):

- Granitic units – variably foliated, granite to monzogranitic rocks.

<u>Tooloo Group (c. 1970 – 1600)</u>

- Yelma Formation – sandstone, siltstone, dolomite, and shale
- Frere Formation - granular iron formation, shale, siltstone, minor carbonate

Bangemall Supergroup (c. 1629 – 1070 Ma)

Scorpion Group (C. 1640 – 1200 Ma)

- Wonyulgunna Sandstone - white quartz sandstone, siltstone.
- Willy Willy Formation - stromatolitic dolomite, siltstone and sandstone.

Collier Group (c. 1400 – 1070 Ma)

- Backdoor Formation – shale, siltstone, sandstone, chert, mudstone, dolostone.
- Calyie Formation – recrystallized sandstone, with siltstone, conglomerate, and shale.

Salvation Group (c. 1460 – 1066 Ma)

- Glass Spring Formation – sandstone, pebbly sandstone, siltstone, conglomeratic.
- Jilyili Formation – sandstone, shale, siltstone, mudstone and conglomerate.
- Coonabildie Formation – siltstone, fine sandstone, micaceous siltstone, shale.
- Brassey Range Formation – Quartz sandstone, siltstone, mudstone, conglomerate.

Warakurna Large Igneous Province (c. 1078 – 1070 Ma)

- Kulkatharra Dolerite
- Prenti Dolerite

Cenozoic Deposits (< c.65 Ma)

Palaeogene/Neogene Palaeochannel Deposits (c. 40 – 2.6 Ma)

- Basal sand – fine to coarse grained sand and minor gravel
- Lacustrine sediments – very fine to fine clay and silty clay beds, plastic.
- Alluvial/colluvial sediments – mixed clay, silt, sandy beds with minor fine lacustrine clay
- Secondary deposits – duricrusts comprising silcrete, ferricrete, and calcrete.

Quaternary Deposits (c. <2.6 Ma)

- Aeolian sand, dune deposition, and playa lake development.

2.3.3 Local Geology

The bedrock geologic setting of the Kumarina Project area is one of a relatively undeformed sequence of gently north-dipping Backdoor Formation sediments capped by quartz arenite of the Calyie Formation, and intruded by mafic dykes. The upper quartz sandstone unit, the Calyie Formation, lies conformably over the Backdoor Formation rocks, and is present throughout the Kumarina Project area proximal the Jaydinia Syncline. This formation has ubiquitous cross-bedding and is coarse-grained, and silicified above the contact.

Brakel et al. (1982), estimate the Backdoor Formation is 3,700m thick, and average dip of bedding 15° towards the north. The most common rock-type encountered in the project is generally quartz poor sandstone that is very fine to fine grained, along with siltstone, mudstone and shale. Thin quartz-rich bands or 'quartzites' are commonly interbedded with the sandstones. The Backdoor Formation conformably overlies Scorpion Group rocks and is described as an upward shallowing succession of predominantly deep marine to fluvial-deltaic siliciclastic sedimentary rocks (Johnson, 2013).

Structural folding is generally limited to gentle warping over the scale of 100's of metres. East of the Great Northern Highway, the outcropping Calyie Formation outlines a broad north-east trending anticline. The Jaydinia Syncline (Brakel et al., 1982), is parasitic to this anticline. A number of NE ‐ SE striking shear zones have been identified in remote sensing studies (Meyers, 2012), informally named, from north to south: Collier Fault, Backdoor Fault, Kumarina Fault, Wonyulgunna Fault, Snell Fault and Jadina Fault (Figure 2-5). Mapping by Horseshoe Metals Limit (Horseshoe Metals, 2014) describes these structures to be zones of weak brittle deformation marginal to mafic dykes without any cleavage development and it is recommended that the term 'shear zone' be dropped as it gives a false sense of strong deformation. The Collier, Kumarina, Wonyulgunna and Snell Faults show evidence of hydrothermal activity such as silica ‐ kaolinite alteration, quartz veining, and hydraulic breccias. Notable the brittle nature of these 'shear zones' in the vicinity to the Upper Gascoyne River maybe important for future water supply targeting.

The surficial sequence within the Kumarina water supply area is generally made up of a thin veneer of colluvial sediments that have been deposited on the bedrock geology via insitu weathering and short erosional deposition. In the vicinity of the upper Gascoyne River an alluvial sequence of transported gravel, sand and silt is present up to 20 m think in places, but typically less than 10 m. Calcrete and silcrete has developed throughout the alluvial sequences and can be variably cavernous, vuggy and massive.

Table 2-4: Geological units in the Kumarina Project area

<table>
<tr><th></th><th></th><th>Stratigraphic unit</th><th>Description</th></tr>
<tr><td rowspan="3">Cainozoic</td><td rowspan="2">Quaternary</td><td>Alluvium (Qa)</td><td>Minor silt sand and gravel associated with watercourses</td></tr>
<tr><td>Colluvium (Qc)</td><td>Unconsolidated silt. Sand, gravel and rubble. Minor alluvium</td></tr>
<tr><td></td><td>Calcrete (Czk)</td><td>Limestone in modern and ancient drainage</td></tr>
<tr><td rowspan="5">Middle Proterozoic</td><td></td><td>Dolerite</td><td>Dolerite Gabbro and Basalt sills and dykes.</td></tr>
<tr><td rowspan="4">Bangemall Group</td><td>Ilgarari Beds (PMz)</td><td>White, grey and brown shale, siltstone, claystone and fine-grained sandstone.</td></tr>
<tr><td>Calyie Sandstone (PMy)</td><td>Quartz sandstone , usually medium grained and moderately sorted, with minor shale</td></tr>
<tr><td rowspan="2">Backdoor Formation (PMb) and Backdoor formation Dolomite (PMb[d])</td><td>Shale and siltstone, minor chert and sandstone;</td></tr>
<tr><td>Dolomite unit</td></tr>
</table>

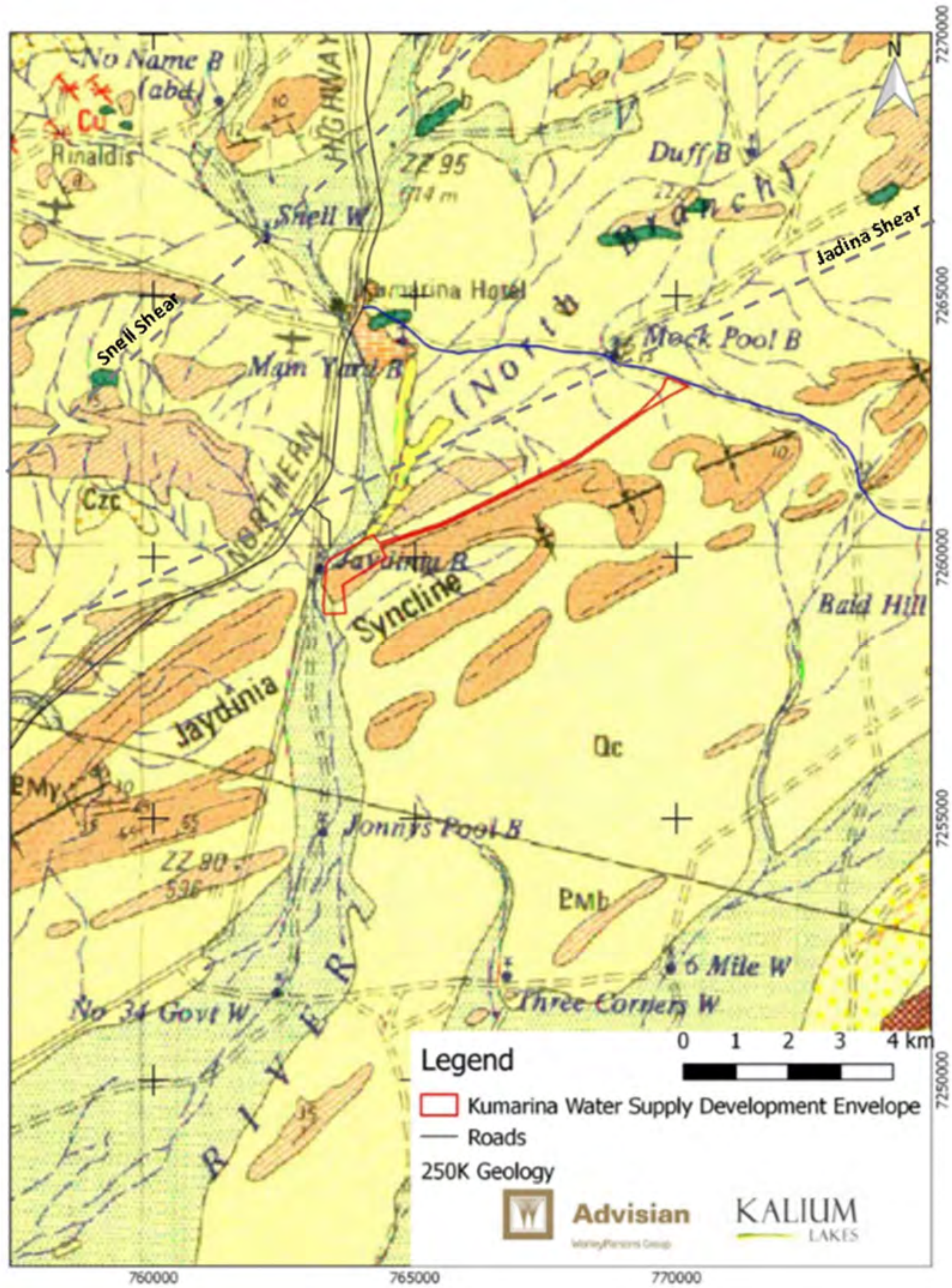


Figure 2-5: 250K Geology over the project area (Source: GSWA, Collier 250K geological map sheet). Refer to Table 2-4 for stratigraphic units.

3 Existing Groundwater Use

The Water Information Reporting (WIR) database of the DWER records 13 registered bores within a search radius of approximately 10 km (DWER 2018a) of the Project. These are generally shallow (between 10 and 56 metres below ground level (mbgl)) low yielding stock bores, and provide limited information on the seasonal groundwater flow regime, abstracted volumes or geology. A plan of the pastoral bores in the project area is presented in Figure 3-1 and detailed in Table 3-2.

There is an existing Main Roads licence (179356) covering an area of approximately 1800 km^2 for a licenced abstraction amount of 0.09 GL (DWER 2018b). This licence utilises existing pastoral bores for public works. At some stage the licencee was using the Jaydinia Pastoral Bore, located within the proposed project development envelope (DE4), however this bore is no longer used for abstraction due to a blockage in the bore casing. Other licences exist ≥10 km to the south are detailed below in Table 3-1.

Table 3-1: Details of groundwater licence near to the project. All licences are located >10km from the Kumarina project, except the Main Roads licence 179356 (DWER 2018b)

Licence Holder	Licence Number	Licenced Amount (GL)	Resource	Comment
Main Roads	179356	0.09	Combined- Fractured Rock West- Fractured Rock	Pastoral (Jaydinia) Bore no longer used for this licence
Billabong Gold Pty Ltd	151450	4.75	Combined- Fractured Rock West- Fractured Rock	Plutonic Minesite
Billabong Gold Pty Ltd	182889	0.09	Combined- Fractured Rock West- Fractured Rock	
Vango Mining Limited	179204	0.6	Combined- Fractured Rock West- Fractured Rock	
Venus Metals	200050	0.005	Combined- Fractured Rock 3-1West- Fractured Rock	

Table 3-2: Pastoral bore summary.

Bore ID	E (mMGA)	N (mMGA)	Elevation (mAHD)	Zone	Source	Total Depth (m bgl)	Diameter (mm)	Material	Date Drilled	Screened Geol Unit
Jaydinia Bore	763424	7259952	598	50J	Survey	~30	150	Steel	unknown	Calcrete, fractured/weathered mudstone
Kumarina Bore South 2	763248	7259604	597	50J	Survey	~30	155	PVC	unknown	Calcrete, fractured/weathered mudstone
Jonnys pool bore exploration hole	763418	7254812	590	50J	Google Earth	~30	155	PVC	unknown	Calcrete, fractured/weathered mudstone
Kumarina Bore South (collapsed)	763405	7259910	597	50J	Survey	~30	155	PVC	unknown	Calcrete, fractured/weathered mudstone
6 MILE BORE	770053	7251793	586	50J	GPS Pickup					
6 MILE WELL	770041	7251987	589	50J	GPS Pickup	20.2				
BALD HILL WELL (ABD)	777533	7258949	613	50J	Google Earth					
COPPER WELL	758383	7268029	627	50J	GPS Pickup					
JOES BORE	778028	7260279	607	50J	GPS Pickup					
JONNYS POOL BORE	763423	7254766	594	50J	GPS Pickup	19.81				
K3 EXP BORE	764877	7264089	604	50J	GPS Pickup					
KUMARINA ROADHOUSE	763781	7264594	612	50J	Google Earth					
KUMARINA STATION	763551	7260274	598	50J	GPS Pickup					
MAIN YARD BORE	764883	7264068	611	50J	GPS Pickup		125mm	Steel		
MOCK POOL BORE	768863	7263748	609	50J	GPS Pickup					
NO 34 GOVT WELL	762670	7251653	589	50J	GPS Pickup	21.25				
NO NAME B (ABD)	761484	7268352	622	50J	Google Earth	24.65				
SNELL WELL	762332	7266085	612	50J	GPS Pickup	9.85				

* Existing pastoral bores - screened from the water table to total depth, exact depth of screened intervals are unknown.

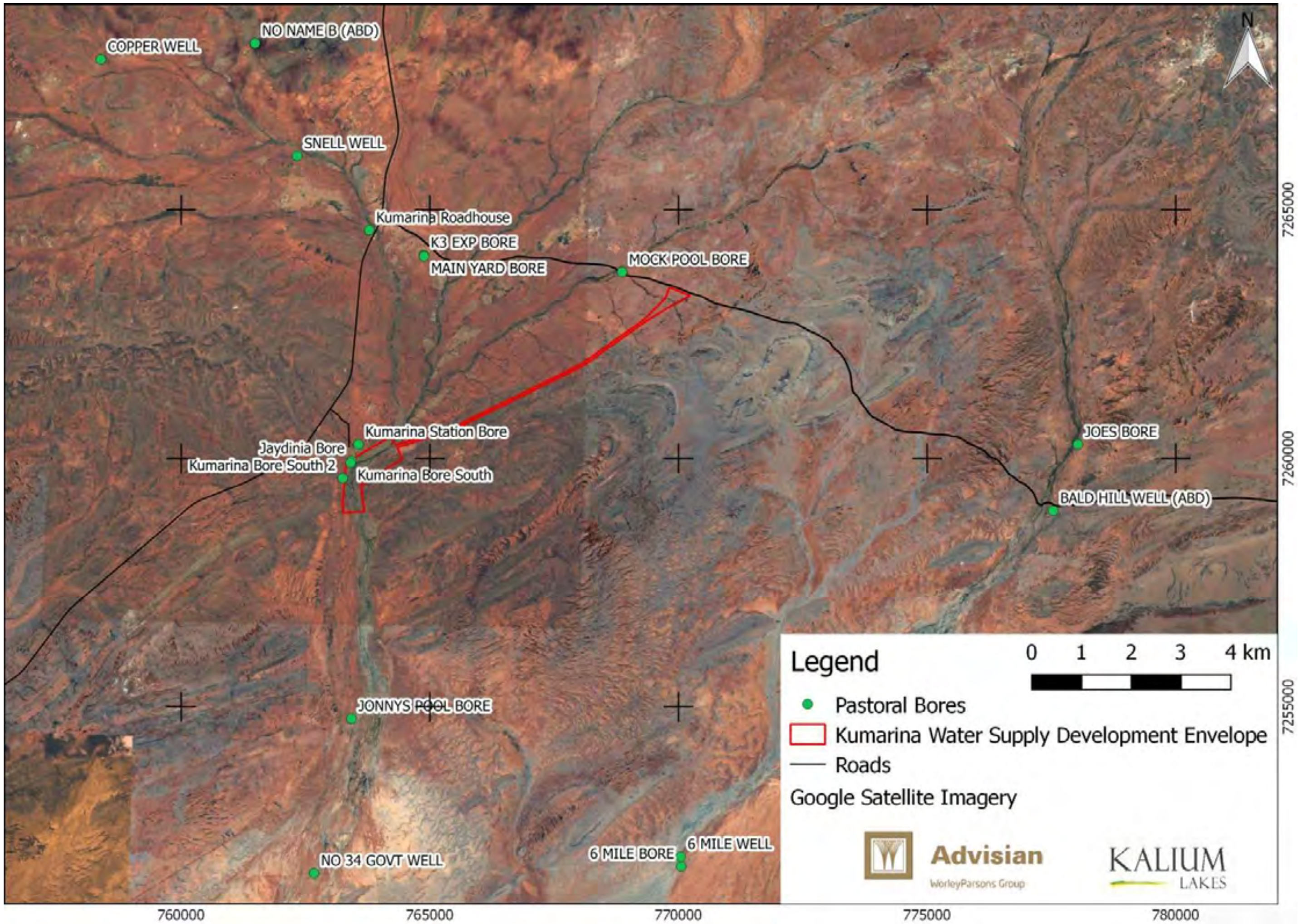


Figure 3-1: Pre-existing pastoral bores in the Kumarina Project Area (from DWER 2018a)

4 Groundwater Dependent Ecosystems

4.1 Vegetation

The vegetation in the Kumarina project area is generally low scrub (Figure 4-1), with *Eucalyptus victrix* trees (up to 15m in height) found along the drainage features (Figure 4-2). The presence of *E. victrix* can indicate that a vegetation community may potentially be dependent on groundwater. *E. victrix* uses soil moisture content derived from surface water drainage into the unsaturated zone but may obtain some of their water requirements from the groundwater table where it is available, particularly large mature trees.

Figure 4-1: Aerial photo showing the vegetation in the project area during the wet season

From an assessment of water level ranges of Pilbara riparian species, it was found that the mean minimum groundwater level depth of *E. victrix* was greater than that for groundwater dependent species *Eucalyptus camaldulensis (River Red Gum)*, providing support for the view that *E. victrix* is found in slightly drier areas than *E. camaldulensis* and may not be as responsive to water table fluctuations (Loomes, 2010). It is considered that water inputs from flooding appears to be important for sustaining *E. victrix* communities in most environments, regardless of the groundwater level. Regular flood events are required to recharge soil moisture in the vadose zone and provide enough soil water to sustain *E. victrix* during lengthy periods of drought that can last many months to years.

Figure 4-2: Eucalyptus trees along Kumarina Creek.

4.2 Stygofauna

Phase 1 and Phase 2 Stygofauna survey has been completed across the KLL Water Supply Areas. However, only one sampling event has been completed at Kumarina, as this area was not considered in the first round of sampling. The results indicated that the stygofauna are likely to be more widespread in comparison to the other water supply areas as evidenced by the differing geologies of the bores recording stygofauna (Phoenix, 2018).

The bores sampled had a range of alluvium, calcrete and fractured bedrock indicating that the species encountered could inhabit multiple lithologies. The saturated thickness of the identified calcrete and alluvium is approximately 10 to 13 m. The aquifer is highly variable with groundwater being produced from different lithological zones in the production bores. some places found to contain voids and others found to be vuggy with gravel horizons, and others had significant fractured bedrock intervals which all yielded groundwater. An absence of significant clay layers indicated that the underlying weathered and fractured bedrock aquifer unit is hydraulically connected to the upper calcrete and alluvium aquifer units and has an additional saturated thickness of between 20 and 25 m. Stygofauna habitat may consist of the entire saturated thickness in this aquifer.

The Gruyere Gold Projects' API Report (MBS Environmental, 2016) will be used as a reference for setting trigger levels associated with stygofauna habitat and aquifer drawdown in the impact assessment. However, the two projects do differ significantly due to the nature of the geology, the type of productive aquifers targeted and the potential stygofauna habitat. Gruyere has triggers set on the basis of the stygofauna existing only within the calcrete, whilst at Kumarina stygofauna has been found to be present within calcrete, alluvium and fractured bedrock and may move between these lithologies. Gruyere has a clay layer at the base of the alluvium and calcrete which forms an aquitard and will not allow migration of stygofauna below this layer. However, at Kumarina there is no low permeability layer and the alluvial sequence is considered connected to the unconfined fractured bedrock system.

5 Groundwater Investigations

5.1 Exploration Drilling and Monitoring Bore Installation

Exploration drilling occurred between December 2017 and May 2018 with the aim of characterising the geology and hydrogeology of the project to identify and determine hydraulic parameters and aquifer extents.

During the 2017 exploration program 13 Air Core (AC) drill holes (KWS01 to 22) were completed in the Kumarina Project area to identify shallow aquifer targets in the vicinity of the major creek lines, and obtain lithological and groundwater samples. A Schramm drill rig using conventional Air Hammer was then used to install three (3) 50mm PVC monitoring bores (KMB01 to 03) and one 155mm PVC test production bore (KPB01) within the exploration holes.

A subsequent drilling program in May 2018, also used a conventional Air Hammer rig to install an additional three (3) monitoring bores (50 mm diameter, PVC) (KMB04 to 06) and one (1) production bore (155 mm diameter, PVC) (KPB02).

A bore construction and drilling summary is presented in Table 5-1, and bore and exploration drill hole locations are presented in Figure 5-1. Detailed lithological logs are provided in Appendix A, and Bore construction diagrams are provided in Appendix B. Further information on the production bore location, construction and development is detailed in Section 5.2

Table 5-1: Summary of Kumarina Project production bores, monitoring bores and exploration drill holes.

Bore ID	Exploration hole ID	E (mMGA)	N (mMGA)	Elevation (mAHD)	Zone	Source	Total Depth (m bgl)	Screens From (m bgl)	Screens To (m bgl)	Sump from-to (m bgl)	Bore Diameter (mm)	Material	Date Drilled	Screened Geol Unit
KPB01	KWS01	763403	7259922	598	50J	Survey	35	5	29	29-35	155	Class 12 PVC	Dec-17	Calcrete, fractured/weathered mudstone
KPB02		763918	7260019	597	50J	Survey	41	6	41	No	155	Class 12 PVC	2-3 May-18	Fractured Mudstone
KMB01	KWS02	763306	7259546	596	50J	Survey	29	5	29	No	50	Class 9 PVC	Dec-17	Calcrete voids, fractured/weathered mudstone
KMB02	KWS03	763648	7258326	594	50J	Survey	29	5	29	No	50	Class 9 PVC	Dec-17	Calcreted alluvium, weathered siltstone
KMB03	KWS11	763737	7255460	591	50J	Survey	29	5	29	No	50	Class 9 PVC	Dec-17	Alluvium, mudstone
KMB04	KWS22	764250	7260273	599	50J	Survey	36	6	36	No	50	Class 12 PVC	1-May-18	Gabbro
KMB05	KWS20	763633	7259729	597	50J	Survey	30	6	30	No	50	Class 12 PVC	1-May-18	Weathered siltstone
KMB06	KWS21	763403	7259922	598	50J	Survey	41	6	41	No	50	Class 12 PVC	1-May-18	Fractured Mudstone
	KWS04a	763693	7257001	592	50J	Survey	23	-	-	-	-	-	Dec-17	
	KWS04b	763539	7256688	592	50J	Survey	21	-	-	-	-	-	Dec-17	
	KWS05	764034	7260248	598	50J	Survey	24	-	-	-	-	-	Dec-17	
	KWS06	764192	7261424	601	50J	Survey	24	-	-	-	-	-	Dec-17	
	KWS07	764885	7262335	605	50J	Survey	30	-	-	-	-	-	Dec-17	
	KWS08	764324	7261062	599	50J	Survey	14	-	-	-	-	-	Dec-17	
	KWS09	764171	7263748	603	50J	Survey	6	-	-	-	-	-	Dec-17	
	KWS11	763737	7255460	591	50J	Survey	26	-	-	-	-	-	Dec-17	
	KWS12	763755	7253942	593	50J	Google Earth	22	-	-	-	-	-	Dec-17	
	KWS19	764764	7261199	600	50J	Survey	12	-	-	-	-	-	Dec-17	

Notes: All holes drilled to refusal

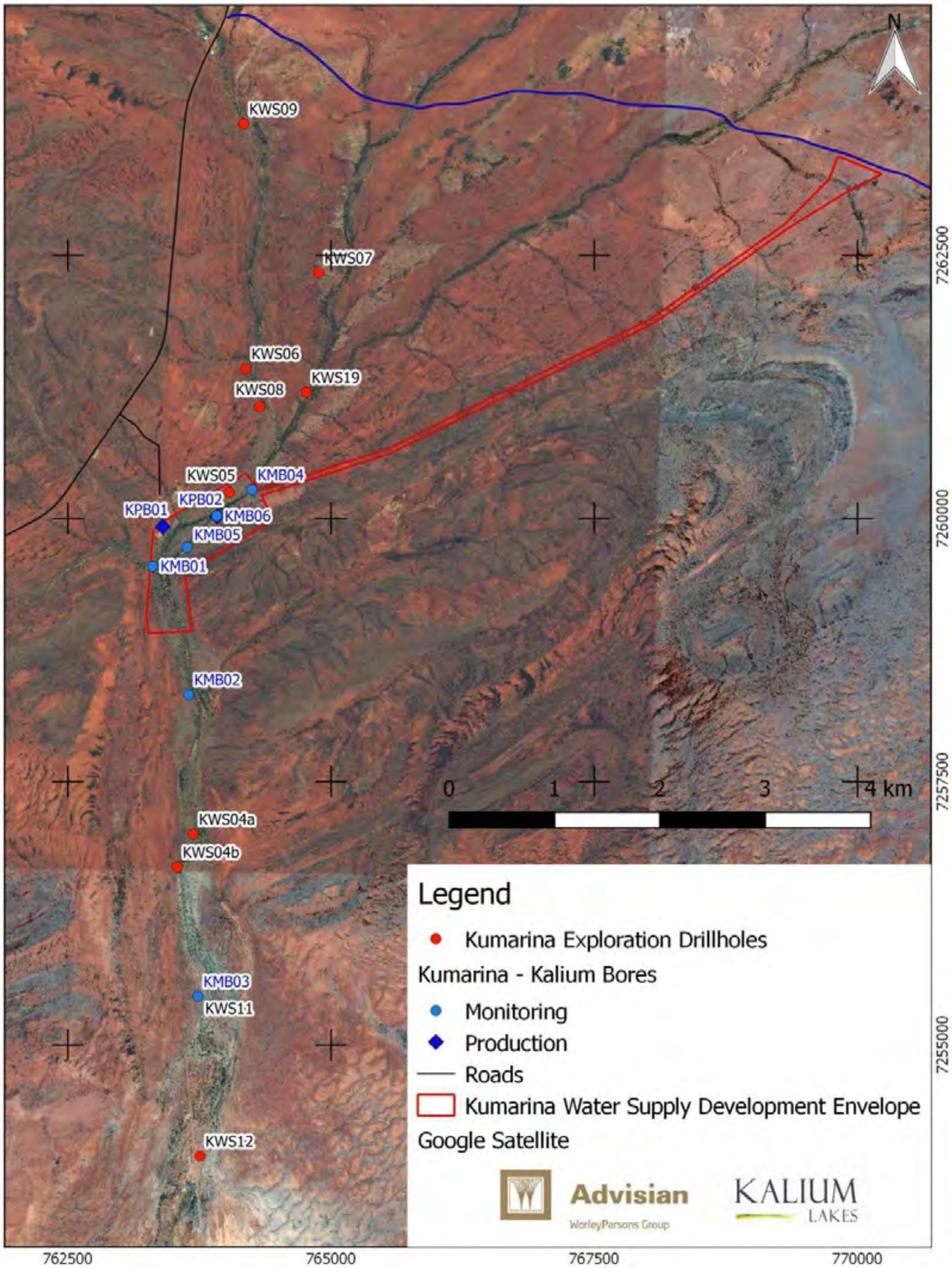


Figure 5-1: Kumarina Water Supply Project Bores and Exploration Drill Holes

Exploration drilling generally encountered a thin sequence of colluvial and alluvial sediments (between 2 m and 12 m thick) with thicker alluvial sequences closer to the Gascoyne River. Calcrete was encountered in pockets surrounding drainage features at the surface, ranging in thickness from 2 to 5 m. Calcrete was also found at the base of the alluvial sequence encountered between 5 m and 26 m.

Groundwater was generally encountered on the contact with bedrock which meant that the majority of exploration holes targeting outcropping calcretes within the vicinity of the creek lines were unsaturated. The only saturated calcrete and reasonable thickness of alluvium was found north of the Jaydinia Syncline, where it appears that groundwater flow is restricted in the alluvium and calcrete behind the outcropping quartzite of the syncline, which results in a higher groundwater table in this area. This greatly reduced the anticipated extent of the saturated alluvium and calcrete north of the Jaydinia Syncline, and restricted shallow groundwater exploration to this area.

Dolerite and Gabbro intrusions were encountered during the December 2017 exploration drilling (in exploration holes KWS04a, KWS04b, KWS05 and KWS09) and in KWS22/KMB04 drilled in May 2018. In these locations there were no visible outcrops. The depth the intrusions were encountered ranged from 2 m below ground level (bgl), in KWS09 in the north, and 19 m bgl in KWS22/KMB04 located on the northern edge of the outcropping northern limb of the Jaydinia Syncline.

The most prospective zones identified in the December 2017 exploration drilling were the calcrete and void zones within the alluvium and deeper fracture zones within the siltstone between 15 and 30 m bgl.

During the May 2018 drilling fractured bedrock zones between 20 and 40 m bgl were identified on the eastern bank of the river at KMB06, possible associated with the 'shear zones' near intrusions as described in Horseshoe Metals (2014).

5.2 Production Bore Drilling

KPB01 and KPB02 were drilled and installed in December 2017 and May 2018 respectively following highly transmissive results from airlift and slug testing of the installed monitoring bores and existing pastoral bores.

KPB01 was constructed to 30 m bgl and screened with slotted casing from the water table to 30 m bgl targeting groundwater abstraction from both the calcreted alluvium and flows from the fractured bedrock at depth. KPB02 was constructed to 42 m bgl and screened from the water table to end of hole with slotted casing. This bore is predominantly targeting the fractured bedrock at depth where substantially higher airlifts were observed in exploration drilling in comparison to shallow depths.

5.3 Groundwater Monitoring

In most bores within the Kumarina project area three to four rounds of water level monitoring was undertaken between August 2017 and May 2018 in the bores and open exploration drill holes.

Figure 5-2 shows the water level contours measured in the bores in March 2018. The data presented in Table 5 2 indicates a seasonal fluctuation of between 0.4 and 1.9 m (between August 2017 and May 2018). Groundwater monitoring was also undertaken during the pump testing in March 2018 when data loggers were installed in the tested production bores and adjacent monitoring bores, details of which are presented in Section 5.4.

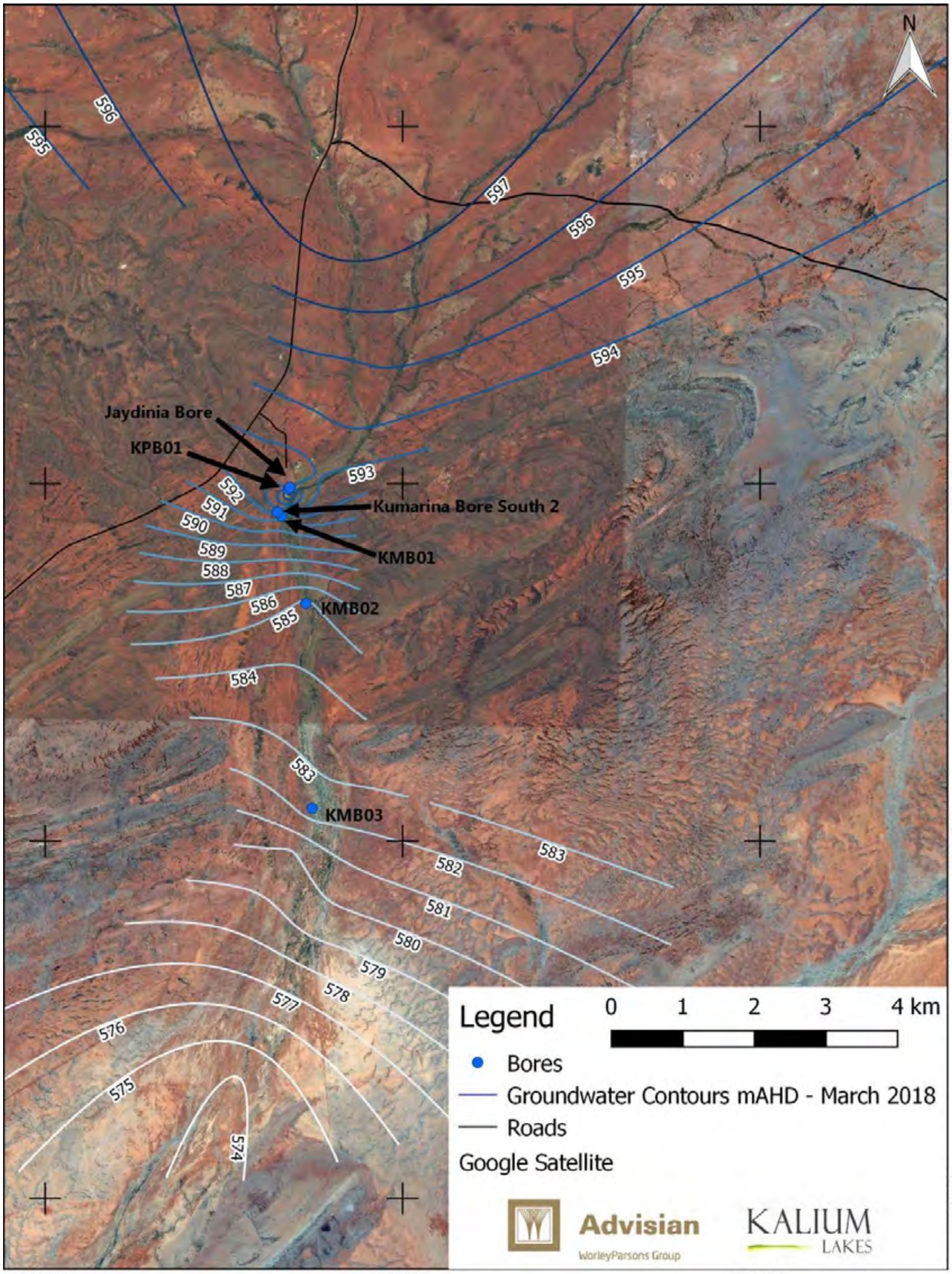


Figure 5-2: Groundwater contours – March 2018

Table 5-2: Groundwater Monitoring Data: 2017 - 2018

Bore ID	Easting	Northing	Elevation (mAHD)*	Source	Date of Measurement	Dip	Ref	Stickup (m agl)	RWL (m AHD*)
Jaydinia Bore	763424.4	7259952.5	597.9	Survey DGPS	11/08/2017	3.9	mbgl	0.95	594.0
					30/08/2017	4.8	mbtoc		592.2
					22/03/2018	4.9	mbtoc		592.1
					02/05/2018	5.2	mbtoc		593.7
Jonnys pool bore exploration hole	763418.0	7254812.0	590.4	Google Earth	30/11/2017	9.8	mbtoc	0.81	581.4
					02/05/2018	9.9	mbtoc		581.3
Kumarina Bore South (collapsed)	763404.8	7259910.5	597.3	Survey	11/08/2017	3.2	mbtoc	0.7	594.1
					30/11/2017	4.0	mbgl		593.3
					30/08/2017	4.1	mbtoc		593.9
Kumarina Bore South 2	763247.5	7259604.4	597.2	Survey DGPS	15/12/2017	4.8	mbtoc	0.78	593.4
					7/03/2018	4.5	mbtoc		593.5
					22/03/2018	4.2	mbtoc		593.9
					02/05/2018	4.6	mbtoc		593.5
KPB01	763402.9	7259922.1	597.6	Survey DGPS	15/12/2017	4.1	mbgl	0.02	593.5
					22/03/2018	3.6	mbgl		593.9
					02/05/2018	4.0	mbgl		593.6
KMB01	763305.7	7259546.5	596.5	Survey DGPS	15/12/2017	5.6	mbgl	1.05	590.9
					7/03/2018	3.5	mbtoc		592.0
					22/03/2018	3.6	mbtoc		591.9
					02/05/2018	4.0	mbtoc		593.5
KMB02	763648.1	7258325.7	593.9	Survey DGPS	7/03/2018	8.0	mbtoc	1.16	584.8
					22/03/2018	7.5	mbtoc		585.3
					02/05/2018	7.8	mbtoc		587.3
KPB02	763918	7260019	597	Survey DGPS	04/05/2018	5.1	mbtoc	1.45	593.5

Bore ID	Easting	Northing	Elevation (mAHD)*	Source	Date of Measurement	Dip	Ref	Stickup (m agl)	RWL (m AHD*)
KMB04	764250	7260273	599	Survey DGPS	02/05/2018	6.2	mbtoc	0.95	593.4
KMB06	763915	7260023	597	Survey DGPS	02/05/2018	3.8	mbtoc	1.3	594.3
KMB05	763633	7259729	597	Survey DGPS	02/05/2018	3.7	mbtoc	0.2	593.4
KWS06	764191.6	7261424.5	600.7	Survey DGPS	15/12/2017	6.0	mbgl		594.7
					7/03/2018	6.2	mbgl		594.5
KWS08	764323.8	7261061.8	599.4	Survey DGPS	15/12/2017	4.8	mbgl		594.5
					7/03/2018	5.1	mbgl		594.3
KWS09	764171.4	7263747.7	603.2	Survey DGPS	15/12/2017	5.3	mbgl		597.9
KMB03	763737.4	7255459.7	590.7	Survey DGPS	15/12/2017	8.1	mbgl	0.54	582.6
					7/03/2018	9.2	mbtoc		581.0
					22/03/2018	8.6	mbtoc		581.6
					02/05/2018	8.8	mbtoc		582.5
KWS12	763755.0	7253942.0	590.3	Google Earth	15/12/2017	13.4	mbgl		577.0
KWS19	764764.3	7261199.1	599.7	Survey DGPS	15/12/2017	5.2	mbgl		594.5

Notes:

- *Not all bores have been surveyed*
- *m AHD = metres above Australian Height datum*
- *m bgl = metres below ground level*
- *m agl = metres above ground level*

5.4 Aquifer Testing

Airlift testing, slug testing and test pumping was used to obtain estimates of aquifer parameters and determine where to install new production bores. Airlift testing was completed on the existing pastoral bores to confirm the initial prospectivity of the shallow aquifer system. Slug testing was completed in the most prospective monitoring bores to obtain and initial estimate of hydraulic conductivity, whilst test pumping was completed on production bores with the aim of obtaining hydraulic conductivity, storage and pumping data to calibrate the numerical model with. The test pumping procedure is described below, with results presented in Section 6.3.

Test pumping was undertaken between November 2017 and March 2018 in KPB01 and Kumarina Bore South 2 to obtain information on aquifer parameters.

In November 2017 a three-day constant rate test was completed in Kumarina South Bore 2. This bore is an unused pastoral considered to be screened over the calcreted alluvium and weathered / fractured bedrock. Jaydinia Bore was used to collect monitoring data during test pumping, the new monitoring bores were not installed until after this test. In March 2018 a three-day constant rate pumping test was completed in KPB01. Monitoring data was collected from Jaydinia Bore, Kumarina Bore South and KMB01 and KMB02 for the duration of the test, these bores are shown in Figure 5-3 below.

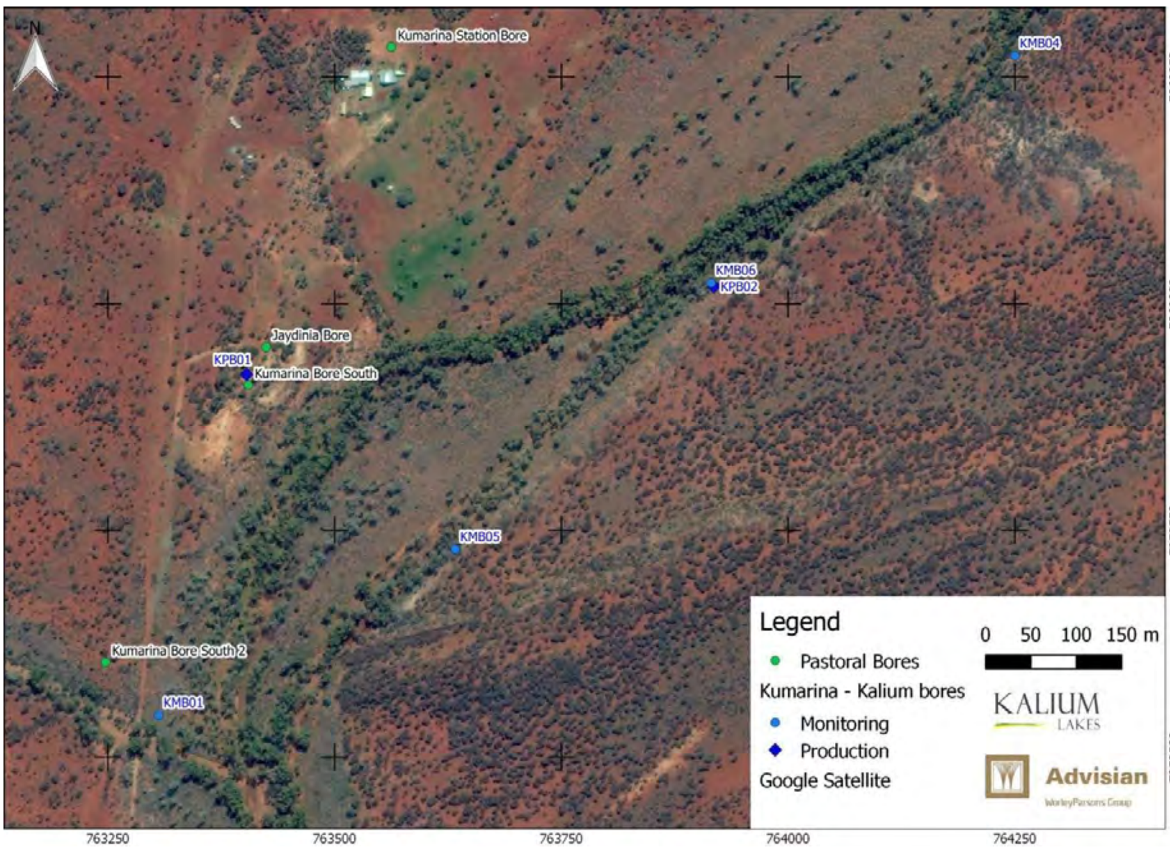


Figure 5-3: Production, monitoring and pastoral bores used for the aquifer testing and monitoring.

The test pumping procedure at each bore consisted of an initial calibration test to determine the range of flow rates possible from the bore, a step rate test to determine well performance and the constant rate pumping rate test with recovery. Monitoring took place in all available monitoring bores to determine aquifer parameters. The flow rates from test pumping were monitored using a magflow meter. The pumped water was piped approximately 300 m away and discharged to the creek.

Falling head tests (slug tests) were conducted in the monitoring bores that were drilling in March and May 2018 respectively. Each test was completed by installing a water level logger in each bore, then dropping a known quantity of water into the bore (20 L in most cases) and recording the rate at which the water level recovered back to the standing water level.

Aquifer parameter results from the aquifer testing are provided in Section 6.3 with further plots provided in Appendix D.

5.5 Groundwater Chemistry

Groundwater quality at the pumping bore (KWS01/KPB01, see location on Figure 5-3) was sampled at the start and end of the constant rate test (CRT) in March 2018. In May 2018 groundwater quality sample was also collected from KPB02 at the end of the airlift development. Further groundwater samples have been collected from KMB04, KMB05 and KMB06 however the results from the laboratory have not yet been received. The groundwater chemistry results received to date are presented in Section 6.4 and further detailed in the laboratory certificates provided in Appendix C.

6 Hydrogeological Characterisation

6.1 Aquifer Geometry

The aquifers in the Kumarina area consist of the upper alluvial and calcrete aquifer and the underlying fractured and weathered bedrock aquifer. Based on available borehole logs presented in Appendix B the upper alluvium comprises sand, gravel, and calcrete and is described as 'calcreted alluvium'. The exploration drilling found that most of the calcreted alluvium within the investigation area was unsaturated and the saturated calcreted alluvium was encountered up hydraulic gradient of the Jaydinia Syncline, which coincided with the zones of permeable fractured bedrock. In this area the calcreted alluvium has approximately 10 to 13 m of saturated thickness and appears to be highly variable with voids and silica replacement encountered in KMB01, whilst KPB01 was vuggier within the gravelly zone higher up the profile. The underlying weathered and fractured bedrock unit has approximately 20 to 25 m of additional saturated thickness, with clear fracture zones encountered in KPB01 and KPB02 at depths between 20 and 34 m. The combined alluvial and bedrock aquifers near the Jaydinia Syncline have a saturated thickness of approximately 20 to 35 m.

The underlying weathered and fractured bedrock appears to be highly productive in the vicinity of the Jaydinia Syncline, dominated by secondary porosity and permeability from structural features associated with the syncline and the weathering of mudstones and interbedded sandstones. A significant resource of groundwater may be stored within the weathered and fractured profile.

The calcreted alluvium and the weathered bedrock units are considered to be hydraulically connected and will likely act as a single connected unconfined aquifer system when pumped. There are no clay layers or a discernible aquitard layer between the two aquifer units. Water availability and longer-term water supply potential will depend on the extent and thickness of these combined units and the annual recharge into this system.

6.2 Groundwater Levels and Flow Direction

Groundwater levels were measured by manual dips across the project, from August 2017 through to March 2018. Continuous monitoring using data loggers was also carried out during test pumping using automated loggers placed in selected monitoring bores. A logger was placed in Kumarina Bore South 2 between November 2017 and April 2018 and set at four hourly monitoring to capture any potential flood events. The continuous water level data is plotted in hydrographs in Appendix D.

Groundwater within the surficial aquifer is generally between 3.5 m and 13 m bgl, with depth to the ground water table determined by position within the catchment and local topographic changes. Monitoring data presented in Table 5-2 indicate that the average rise in water level in the bores between the end of the dry period in November- December 2017 followed by the rainfall event in February 2018 is 0.5m; however, this average includes and is dominated by the >1m fluctuation recorded at KMB01 and Jaydinia Bore. The average across the areas, excluding data from KWS02/KMB01 and Jaydinia Bore is 0.36m between the two seasons.

Groundwater flow contours (Figure 5-2) indicate a southerly flow direction in the surficial aquifer within the creek system, in the direction of surface water flow direction and topography. The contours show a steepening of the hydraulic gradient near the Jaydinia Syncline which supports the consensus of the restriction of groundwater flow and "backing up" of the water table in this area of the creek between 585 and 591 mAHD.

Groundwater flow is assessed to be generally driven by rainfall and creek flow recharge to the aquifer system, with recharge and groundwater mounding dominant in the ephemeral creek systems and discharge via evaporation and evapotranspiration.

6.3 Aquifer Parameters

Aquifer parameters have been assessed from slug testing of monitoring bores and two pumping tests completed in the production bores. Details of the aquifer testing procedures are presented in Section 5.4, and the aquifer test analysis is provided in Appendix D. All bores are screened from the water table to the base of the weathered unit and the parameters are assessed across the entire thickness of aquifer.

6.3.1 Slug testing

Slug testing provides aquifer parameters for the lithology in the immediate surrounds of the screened interval of a bore. The Kumarina monitoring bores where slug testing was conducted (KMB04, KMB05 and KMB06) are screened from the water table to base of the aquifer. The slug test data provides a bulk hydraulic conductivity (K) value (m/d) for the upper calcrete and alluvium aquifer as well and underlying hydraulically connected weathered and fractured bedrock aquifer. KMB04 and KMB05 returned K values of 0.72 and 0.35 m/d respectively. The relatively low values are likely reflective of the lithology surrounding each bore. KMB04 is screened from 6 to 36 m bgl, across saprolite, clay and an underlying intrusion (Gabbro). KMB05 (screened from 6 to 30 m bgl) consists of alluvium, saprolite and calcrete, however each of these horizons were found to be dominated by clay. KMB06, located 2 m away from KPB02, returned an oscillating water level response and significantly higher K of 2639 m/d. This result is reflective of the screened lithology which consisted of fractured mudstone at the base, overlain by ferruginous saprock and gravel.

6.3.2 Test Pumping

The aquifer parameter data, collected from two three-day aquifer tests conducted in Kumarina Bore South 2 and KPB01, reflects both the dry and the wet season. The Kumarina Bore South 2 test pumping took place in December 2017, during the dry season, prior to any significant amounts of rain. The KPB01 test pumping took place during the wet season in March 2018, whilst the creek had approximately 0.5 m of water throughout the upper reaches of the Gascoyne River.

Bulk hydraulic conductivity values of between 40 and 100 m/d are estimated for the screened thickness of the combined calcreted alluvium and fractured bedrock aquifer for both the dry and the wet seasons. Locally higher hydraulic conductivity occurs in areas of well-developed calcretes and increased secondary porosity in the underlying weathered unit. Details of the aquifer parameters assessed are provided in Table 6-1.

In general, the aquifer responses to pumping in both test production bores was fairly complex with multiple boundaries being encountered, which are more difficult where rates were varied in the Kumarina Bore South 2 test. The no flow boundaries observed in early to mid-time are representative of a highly transmissive bounded aquifer, likely to be due to the restricted nature of the calcrete voids and the fractured nature of the bedrock. Recharge boundaries were encountered during late time and is thought to represent leakage from the alluvial or weathered bedrock zones (Figure 6 1). Leakage factors have not been able to be derived due to the early / mid-time no flow boundaries impacting the test pumping data. Generally, the drawdown cones of depression have expanded until they have encountered the edge to the highly transmissive sequence and subsequently steepen as a result of the contrast in hydraulic conductivity. After a period of time of linear drawdown the rate of expansion of the cone of depression slows and recharge boundaries are encountered, which has resulted in a flattening of the drawdown curves.

The aquifer response was one of an unconfined aquifer where specific yield (Sy) is an important parameter to evaluate a sustainable borefield yield. Specific yield in unconfined alluvial, calcrete and fractured aquifers are expected to be highly variable. However, due to the presence of the boundaries observed within the test pumping data it is considered the Sy derived from Late Time interpretations (0.1 – 0.25) is potentially not accurate, but is within the bounds expected of the aquifer type from literature. Literature values cover 0.05 to 0.25 as reported by Johnson et al. in 1999 for calcrete in the Northern Goldfields. Johnson et al (1999) report that in calcrete bodies with no aquifer testing information, an applied specific yield of 0.1 was adopted based on pumping-test results around Wiluna (Sanders, 1973), Depot Springs (Geotechnics, 1972), and at Yeelirrie (Australian Groundwater Consultants, 1981). A highly karstic environment may have values of 0.2 to 0.25 and generally decreases with depth below the water table.

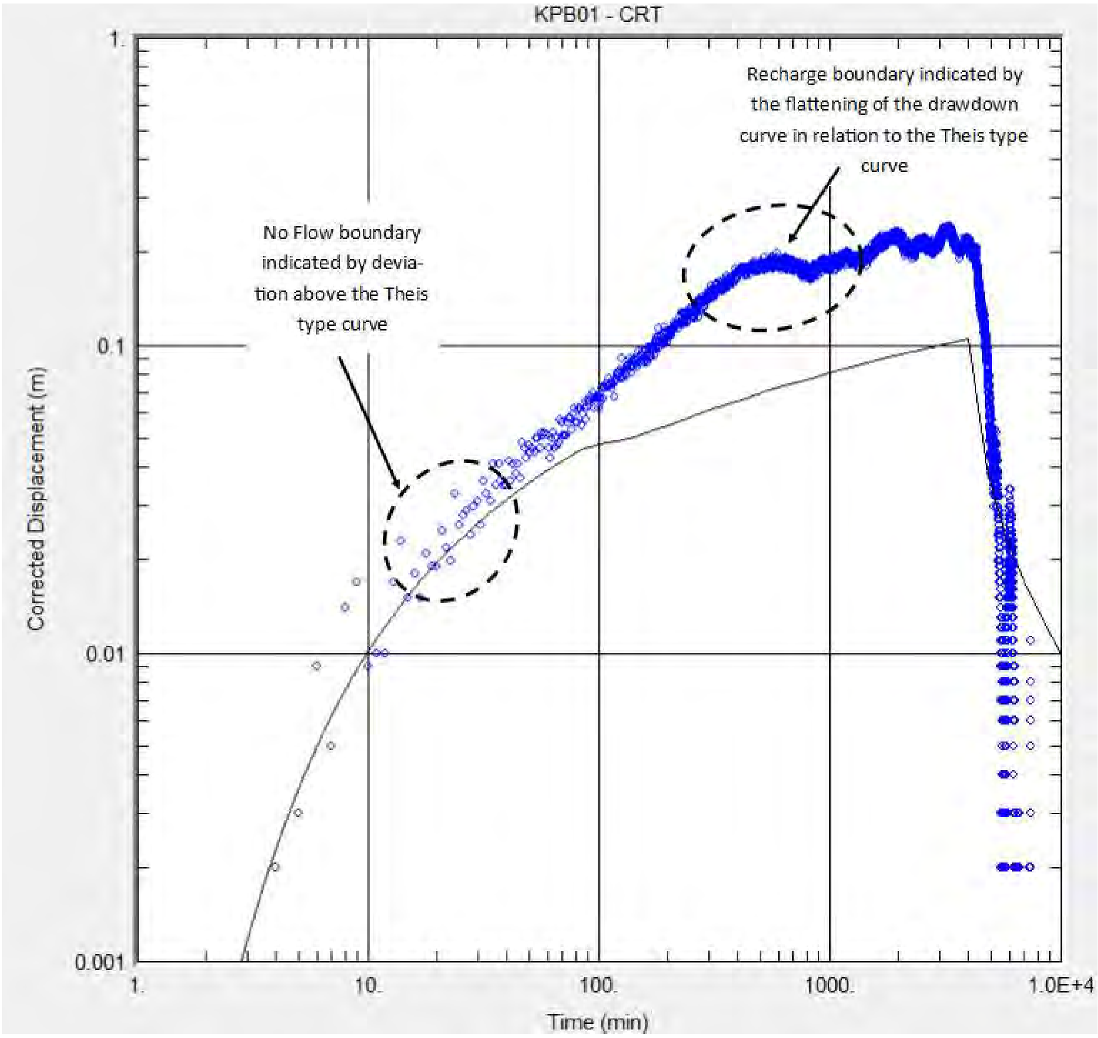


Figure 6-1: Aquifer testing response observed in Jaydinia Bore during the KPB01 test pumping and recovery.

6.4 Groundwater Chemistry

Total dissolved solids (TDS) concentrations at the end of the KPB01 constant rate test (CRT) was measured at 1,750 milligrams / litre (mg/L) with a pH of 8.4. KPB02 sampled at the end of the development measures slightly fresher (1500 mg/L with a pH of 8.13). The results from both bores indicate slightly alkaline and brackish groundwater in the vicinity of the borefield. The groundwater chemistry of the system, based on the limited sampling, is dominated by sodium (Na), chloride (Cl), sulphate (SO4) and Magnesium (Mg). The data is presented in Table 6-2.

Table 6-1: Aquifer Parameters Derived from Aquifer Testing at Kumarina

Test		Test Rate (L/s)	Duration	Adopted Transmissivity (m2/d)	Hydraulic Conductivity (K) (m/d)	Storage	Aquifer	Comments	Medium Term Yield (L/S)
Kumarina Bore South 2 – Constant Rate Test		18.1	3 days	1024	41	0.05	Combined calcrete, alluvium and bedrock aquifer		12
KPB01 – Constant Rate Test	KPB01	22 and 18.5	3 days	1674	76	0.007	Combined calcrete, alluvium and bedrock aquifer		19
	Jaydinia Bore (monitoring)			2273	103	8.8×10^{-9}	Combined calcrete, alluvium and bedrock aquifer	No Flow boundary at ~70 mins, Recharge boundary observed at 600 mins	26
	Kumarina Bore South (monitoring)			2022	91	5×10^{-9}	Combined calcrete, alluvium and bedrock aquifer	No Flow boundary at ~80 mins, Recharge boundary observed at ~600 mins	23

Test	Test Rate (L/s)	Duration	Adopted Transmissivity (m2/d)	Hydraulic Conductivity (K) (m/d)	Storage	Aquifer	Comments	Medium Term Yield (L/S)
KMB04 – Slug Test		200 seconds		0.72		Combined calcrete, alluvium and underlying intrusion	Screened in Gabbro mafic intrusion	-
KMB05 – Slug Test		400 seconds		0.36		Combined calcrete, alluvium and bedrock aquifer	Clay dominated lithology	-
KMB06 – Slug Test		300 seconds	2639.3		-	Combined calcrete, alluvium and bedrock aquifer	High transmissivity bore – Inertial effect observed in data, converted to KPB02	-

Table 6-2: Groundwater Chemistry Laboratory Results

Sample	pH	TDS	Alkalinity	HCO3 Alk	Hardness	Ca	K	Na	Cl	Mg	SO_4	PO_4	Al	Fe	Mn	SiO_2	CO_3	NO_3
UNITS		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
KPB01 CRT START	8.31	1900	460	460	890	106	30	380	550	150	300	-10	1	-1	-0.5	70	-10	20
KPB01 CRT END	8.37	1750	460	460	881	105	30	380	550	150	330	-10	-1	-1	-0.5	70	-10	22
KPB01 dev 01		1600	380	380		83	30	360	600	145	300						-10	
KPB01 dev 02		1850	380	380		82	30	370	550	150	300						-10	
KPB02 end development	8.13	1500	500	500	840	113	19	244	450	Awaiting results	204	-2	0.2	-0.2	-0.1	60	-10	

6.5 Groundwater Recharge

Recharge to the aquifer in the arid zones of Western Australia is episodic and generally considered to be minor. It is likely to occur only if there is rainfall in excess of evaporation over a period sufficient for infiltration. Such recharge may be associated with large rainfall events (cyclones/ rain bearing depressions) or summer thunder storms, and/or with high hydraulic conductivity regolith – such as surficial sands and alluvium, calcrete deposits or fractured and/or weathered rock at outcrop.

There have been several studies on recharge to alluvial systems and calcretes in the northern Goldfields and associated areas. Johnson et al. (1999) as part of their investigations in to palaeochannel systems in the northern Goldfields of Western Australia reviewed the recharge rates estimated in the scientific literature. They summarised research which indicated recharge to calcrete varied between 0.7 and 5% of rainfall. The higher end of recharge is mainly associated with sheet flooding inundating calcrete areas generated from storm events exceeding potentially 50 mm rainfall. Hingston and Gailitis, (1976) and Bestow (1992) calculated recharge to range between 0.9% in areas of low salinity groundwater (<1500 mg/L) and 0.09% in high brackish to saline groundwater (7000 – 14,000 mg/L) in the unconfined calcrete/ alluvial aquifers and weathered profile in the Goldfields. Chapman (1962) estimated recharge rates between 1.3% and 3.3% for calcretes in the Lorna Glen and Wiluna and Sanders estimated rates between 0.7 and 0.79% in the Desert Farms irrigation study in 1971 to 1972 (Sanders, 1972).

Groundwater recharge to the aquifer in the Kumarina area has been observed in the monitoring data between November 2017 and March 2018 at Kumarina Bore South 2. Water levels rose by approximately 0.6 m in response to an approximate two-year flooding event, and supplemented by multiple groups of moderate to high rainfall events. During this time the creek had approximately 0.5 m of water in the creek from February to March 2018. Vertical leakage through the calcreted alluvium into the weathered horizons appears to have occurred in a delayered manner. Regionally calcrete aquifers are considered to be highly responsive to flood events, however in this case there has been a significant lag between the initial flooding and then the slow rise in groundwater levels over the monitoring period, indicating lower vertical hydraulic conductivity. Figure 6-2 displays the groundwater monitoring data in comparison with the daily rainfall (mm) from the Three Rivers and Ten Sixty Six climate stations (BOM, 2018).

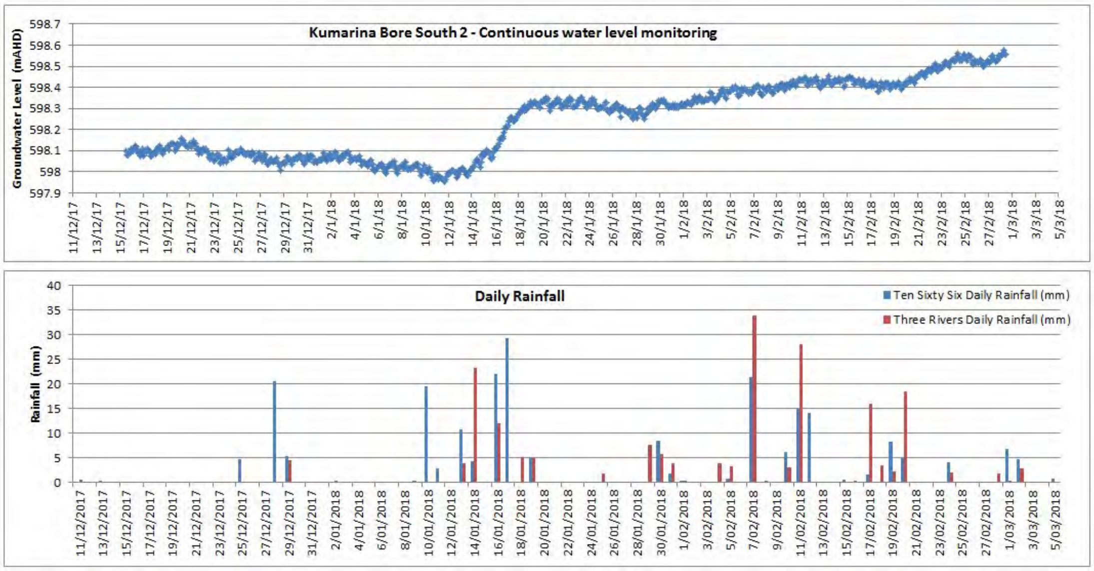


Figure 6-2: Continuous water level monitoring from Kumarina Bore South 2 (763265mE, 7259613mN, Z50J) over a four month duration spanning the wet season. Daily rainfall from the same period is also shown (BoM 2018).

6.6 Groundwater Discharge

Evaporation and evapotranspiration are inferred to be the main groundwater discharge mechanisms in the Kumarina area. In the lower parts of the catchment during rainfall events there may be a component of discharge to the River and the main point of discharge will be downgradient to the sedimentary units associated with the Gascoyne River.

6.7 Conceptual Hydrogeology

Two aquifer units have been identified within the Kumarina Project area. The surficial aquifer consists of calcrete and alluvial sediments underlain by the Middle Proterozoic age weathered or fractured mudstone and siltstones of the Backdoor Formation, associated with the Jaydinia Syncline. These units are considered to be hydraulically connected to one another and recharged by episodic rainfall events and vertical leakage from the surface, therefore acting as a single continuous system.

The regional bedrock is considered to be, on the whole, of low aquifer potential; however regional structural features may have enhanced hydraulic connectivity along linear open fractures due to faulting and fracturing. During the site investigations the weathered and fractured mudstone, within and peripheral to the Jaydinia Syncline, was found to hold significant amounts of fresh to brackish groundwater. Therefore, the aquifer is considered to be hydraulically connected and a vertically continuous unconfined system to the base of the weathered horizon, with lateral continuity and extent confined to areas where calcretes and alluvium are present in discernible thickness to receive episodic recharge. In the Kumarina area, it is inferred that these units abutting against the Jaydinia synclinal axis running SW-NE makes it a localised discrete aquifer unit with higher recharge and water availability, with relatively high hydraulic conductivity and storage.

The preliminary conceptual understanding of the system is presented in Figure 6-3 below.

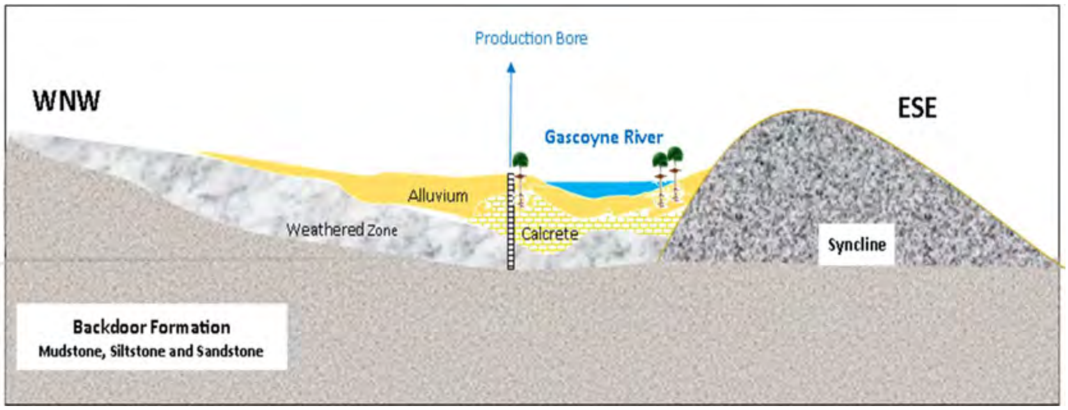


Figure 6-3: Conceptual Hydrogeological Section (Not to Scale)

7 Groundwater Modelling

Numerical groundwater modelling was undertaken for the surficial sediment and the underlying weathered and fractured rock aquifer in the Jaydinia Syncline area. This was the area where test pumping of the unconfined sediments was carried out during groundwater exploration (Section 5.4). The groundwater model was calibrated to steady state water levels and then to transient state utilising the drawdown and recovery responses observed in test pumping. The calibrated model was then then used to predict the proposed abstraction using existing production bores. The results of the calibration and predictive model are discussed below.

7.1 Model Code Selection

The modelling was undertaken using the finite-difference model MODFLOW NWT version 1.0.9 (Niswonger et al., 2011) which is based on the MODFLOW 2005 version 1.11.00 (Harbaugh, 2005). This was selected because it handles the transition between wet and dry cells better, especially since the shallow aquifer is regional but patchy and the saturation of the layer over a larger area is unknown. The model was constructed using the Visual MODFLOW Classic Interface (SWS, 2011).

7.2 Model Design and Discretisation

The groundwater model was developed using the hydrogeological conceptualisation and initial input parameters described in Section 6.

The model domain extended from the upper areas of the surficial drainage to the confluence of the drainages north of the syncline and to the south, where the drainage channel broadens south of the syncline and takes a south westerly direction. The model area extends approximately 20 x 20km. The model used a rectangular grid, with the maximum cell size being 500 m x 500 m. This cell size was successively refined near the Kumarina abstraction area, with a cell size of 100 m x 100 m regionally, refining down to 0.5 m x 0.5 m in the areas of pumping. The horizontal discretisation of the domain is shown in Figure 7-1 with the inset map showing the refinement in the study area.

The model is subdivided into four layers. The aquifer layers have been divided into three layers to represent the alluvium, calcreted alluvium and the weathered and fractured bedrock units. The basement is represented as Layer 4. The surveyed Relative Levels (RLs) from the monitoring bores and exploration holes were gridded along with elevations from SRTM, to arrive at the topographic surface used in the model. Layer elevations and thicknesses were originally extrapolated from the available downhole information (see Section 2.3.3)). However, due to limited information being available outside the immediate area of interest, and the variable geology, the spatial coverage was not considered adequate to refine the geological model. Therefore the layer thickness was considered to be uniform with the variations within each unit represented by the differences in aquifer parameter and storage parameters (see Section 7.4) within the model.

Table 7-1: Summary of Modelled Layers

<table>
<tr><th>Layer</th><th>Hydrostratigraphic Unit</th><th>Lithology</th><th>Aquifer</th></tr>
<tr><td>1</td><td rowspan="2">Surficial Aquifer - Quaternary Alluvium (Qa) and Colluvium (Qc) and calcrete</td><td>Alluvium Minor silt sand and gravel associated with watercourses and unconsolidated silt, sand, gravel and rubble. Minor colluvium</td><td rowspan="3">Combined unconfined aquifer</td></tr>
<tr><td>2</td><td>Calcrete / Calcreted alluvium calcareous /limestone in modern and ancient drainage channels</td></tr>
<tr><td>3</td><td>Weathered or fractured aquifer</td><td>Weathered sandstone and mudstone</td></tr>
<tr><td>4</td><td>Bedrock of the Middle Proterozoic Bangemall Group</td><td>Bedrock</td><td>Non-aquifer</td></tr>
</table>

Topographic surface for the modelled area is shown in Figure 7-2.

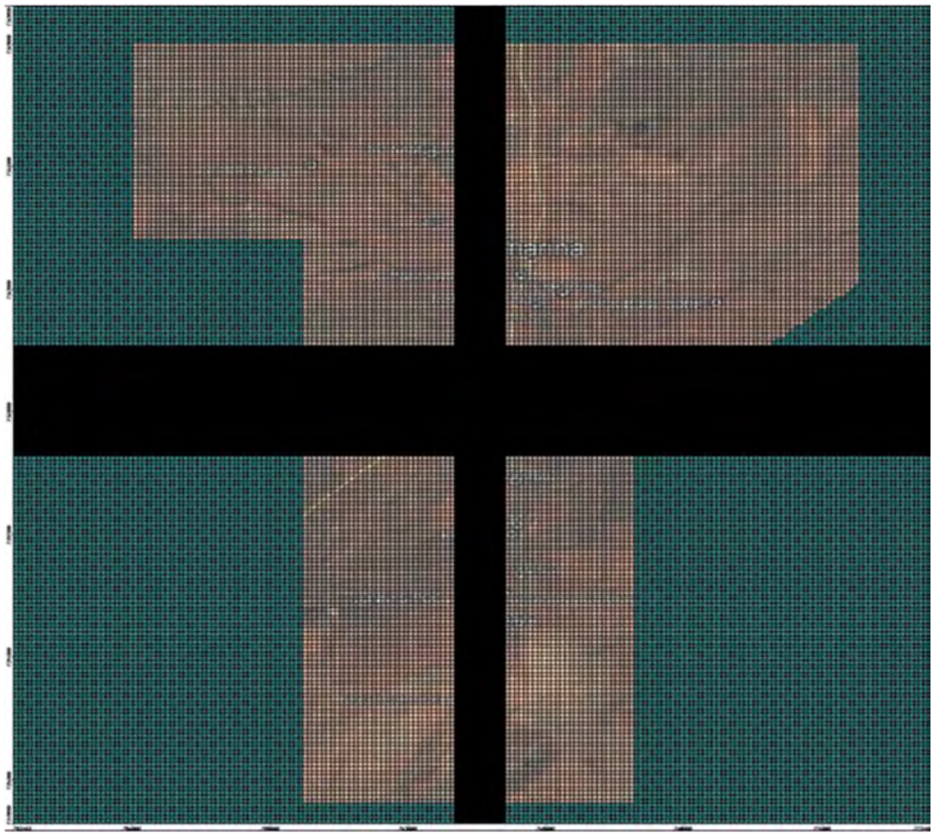


Figure 7-1: Model Domain and Grid Resolution

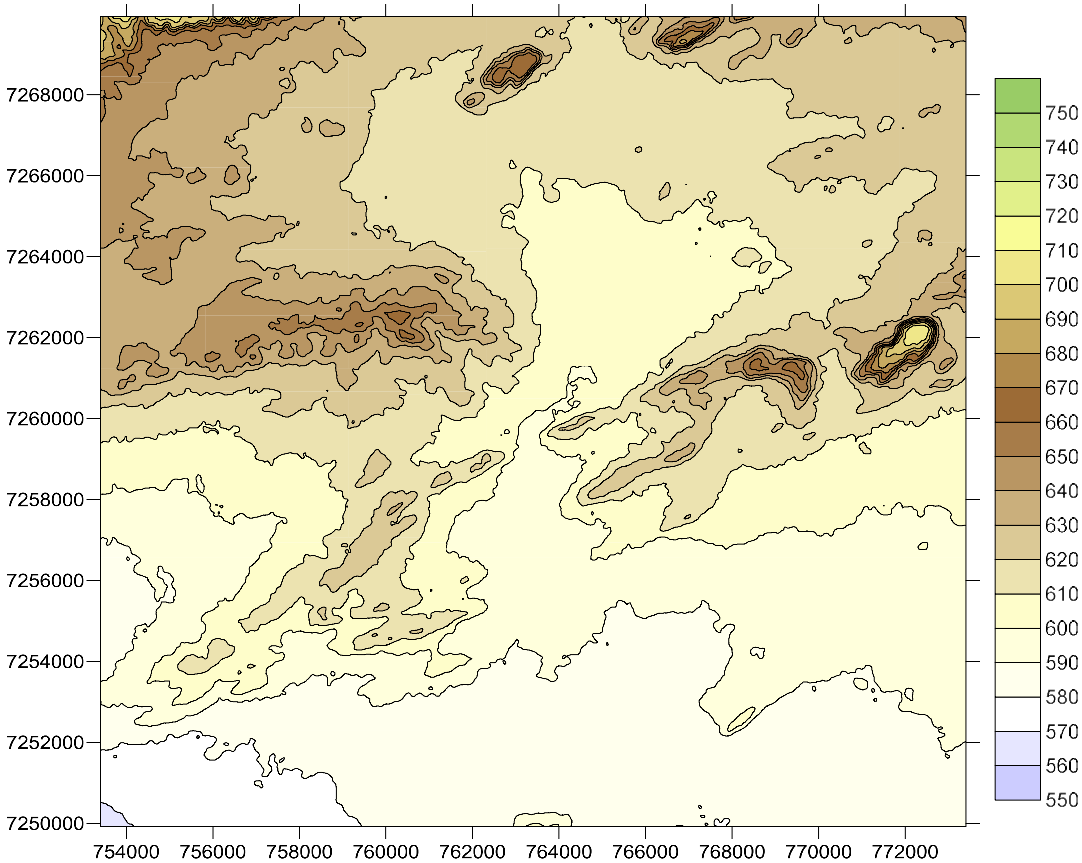


Figure 7-2: Topographic Surface as Modelled

7.3 Boundary Conditions

Boundary conditions were inferred from the regional groundwater flow gradient. General Head Boundaries (GHB) were used in the eastern upgradient and southwestern boundaries of the domain. The north-eastern boundary used an external head of 625 mAHD applied in layer 3. The south-eastern boundary used heads between 570 and 574 mAHD. Boundary condition locations are shown in Figure 7-3. The bedrock areas were simulated as no flow boundaries.

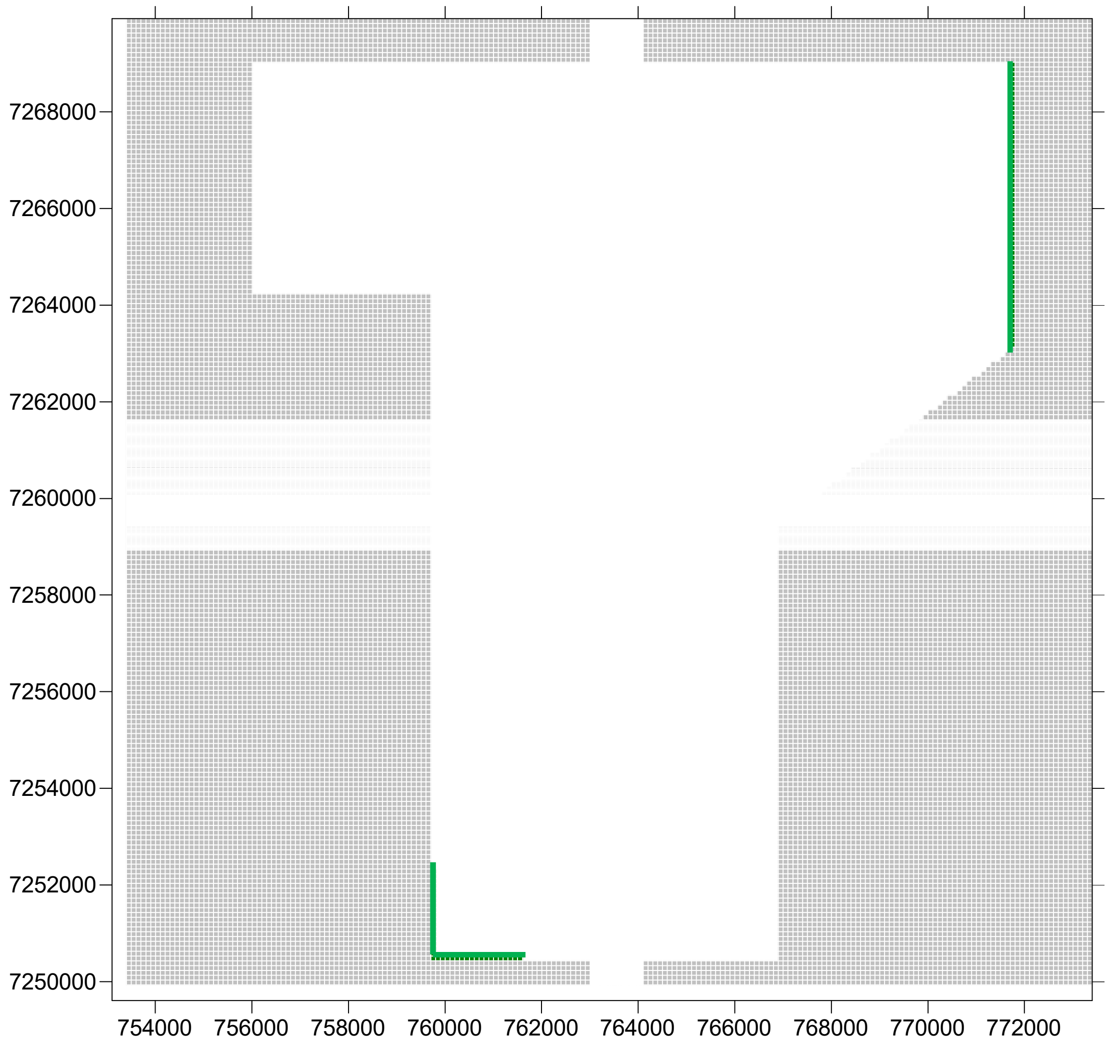


Figure 7-3: General Head Boundary Conditions (in Green)

Groundwater recharge from the surface was included in the simulation for the dry pumping test calibration run (representing November 2017 conditions) at 2 mm/a (approximately 1% of the average annual rainfall). Evapotranspiration was excluded from this run as it was assumed that the influence from this would be low due to the nature of the surficial materials and depth of the water table between 3.5 m and 13 m below ground level.

For the second pumping test after a rainfall event (March 2018) 3% of the measured daily rainfall was used for the transient wet condition run. Literature values have suggested 0.7 and 5% of rainfall, with the higher end of recharge interpreted to be mainly associated with sheet flooding inundating vuggy calcretes. Instead, the higher end of recharge values reported for the Wiluna area (see Section 6.5) was considered a closer representation for the calcreted alluvium in the Kumarina area. Recharge zones applied are shown in Figure 7-4.

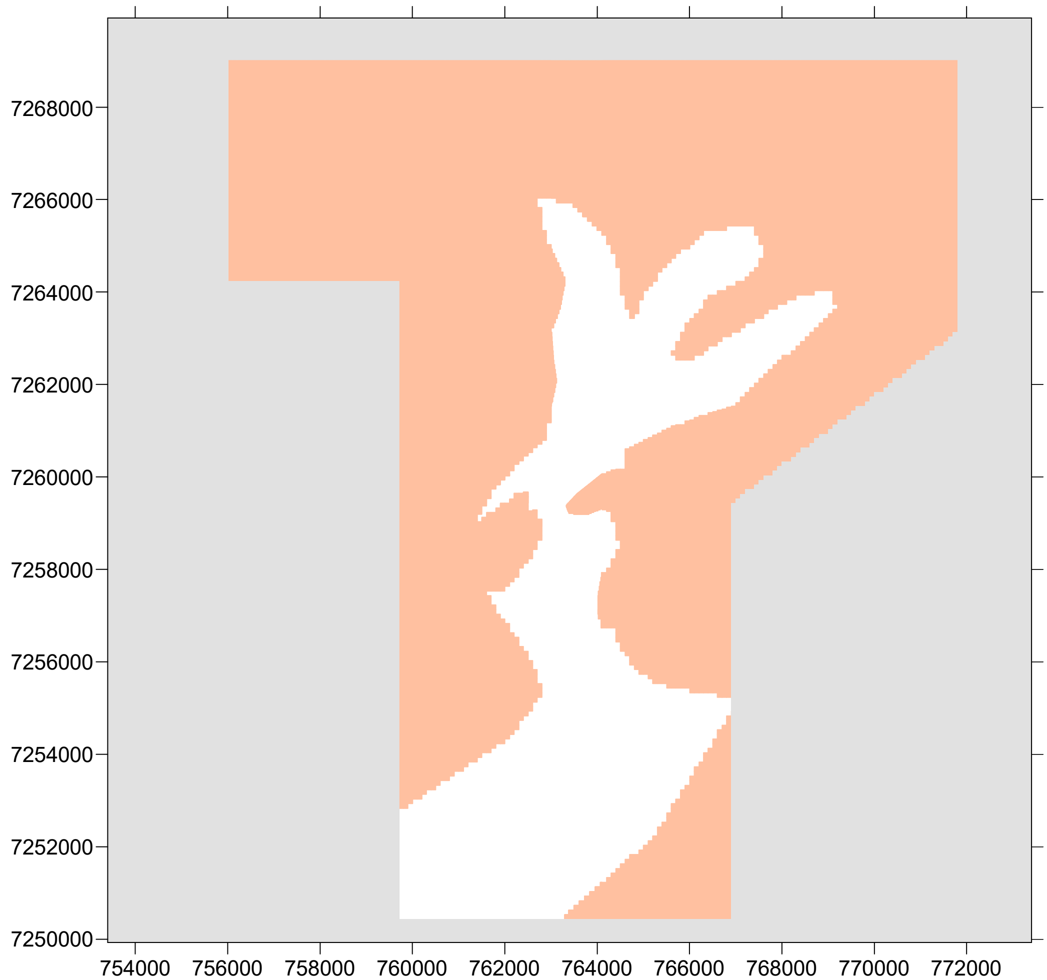


Figure 7-4: Recharge Boundary Zones

A drain boundary condition was used across the length of the creek to allow for effective flux from the model cell by maintaining heads 0.2 to 0.3 m below the top of the drain boundary cell, with a unit conductance of the drain boundary assumed to be 0.01 m/d and the unit area conductance within each cell calculated within the model based on cell dimensions is represented in Figure 7-5..

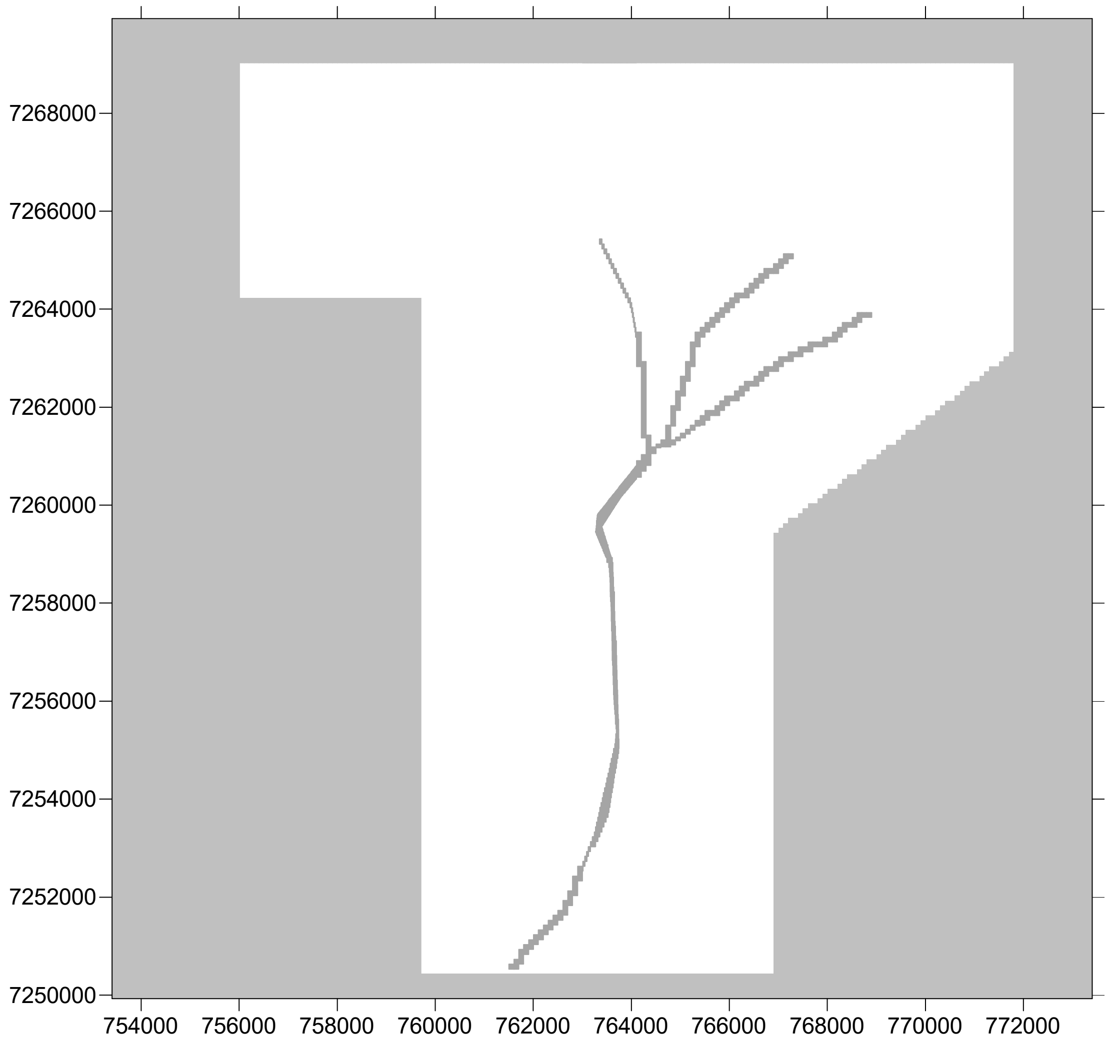


Figure 7-5: Drain Boundary Condition

7.4 Modelled Initial Conditions

Two sets of calibrations were carried out to represent firstly the test pumping at Kumarina Bore South 2, which was undertaken during the dry period in November 2017 (referred to below as the 'Dry Simulation'). And secondly, the pumping test carried out at KPB01 in March 2018, undertaken after a major rainfall event in March 2018 with the creek inundated with surface water (referred to as the 'Wet Simulation').

Initial conditions were specified using data from observation wells in the vicinity of the Kumarina borefield (Section 6). These were a combination of bores from DWER WIR database and from Kalium's observation network. The initial heads used were those immediately prior to November 2017 or, if the initial reading was after this date, the first reading for each observation well. These were interpolated over the domain using kriging with the default parameters in Surfer (Golden Software, 2012). The same initial heads distribution was used for each layer. This initial head distribution is assumed to represent the pre-test water table conditions. The initial heads are shown in Figure 7-6.

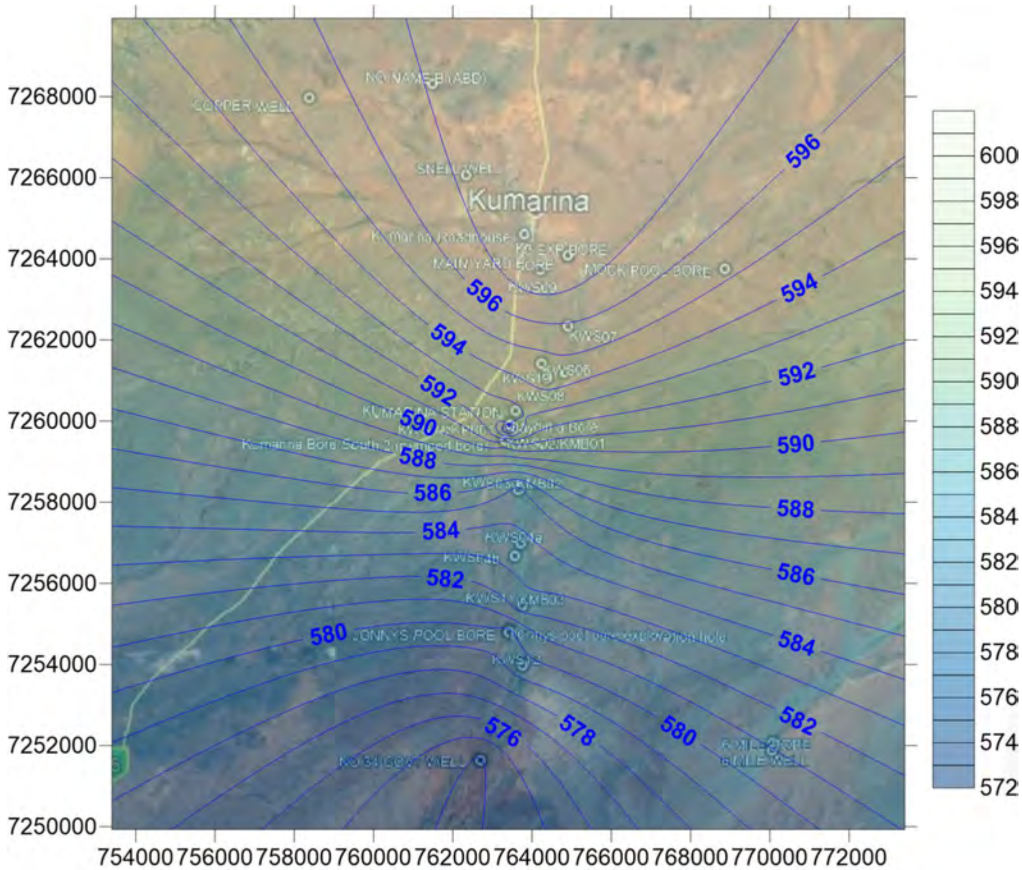


Figure 7-6: Initial Head Distribution

7.5 Aquifer Property Zones

The aquifer property zones derived from the mapped geology and drilling is applied to the model domain by the zones presented in Figure 7-7.

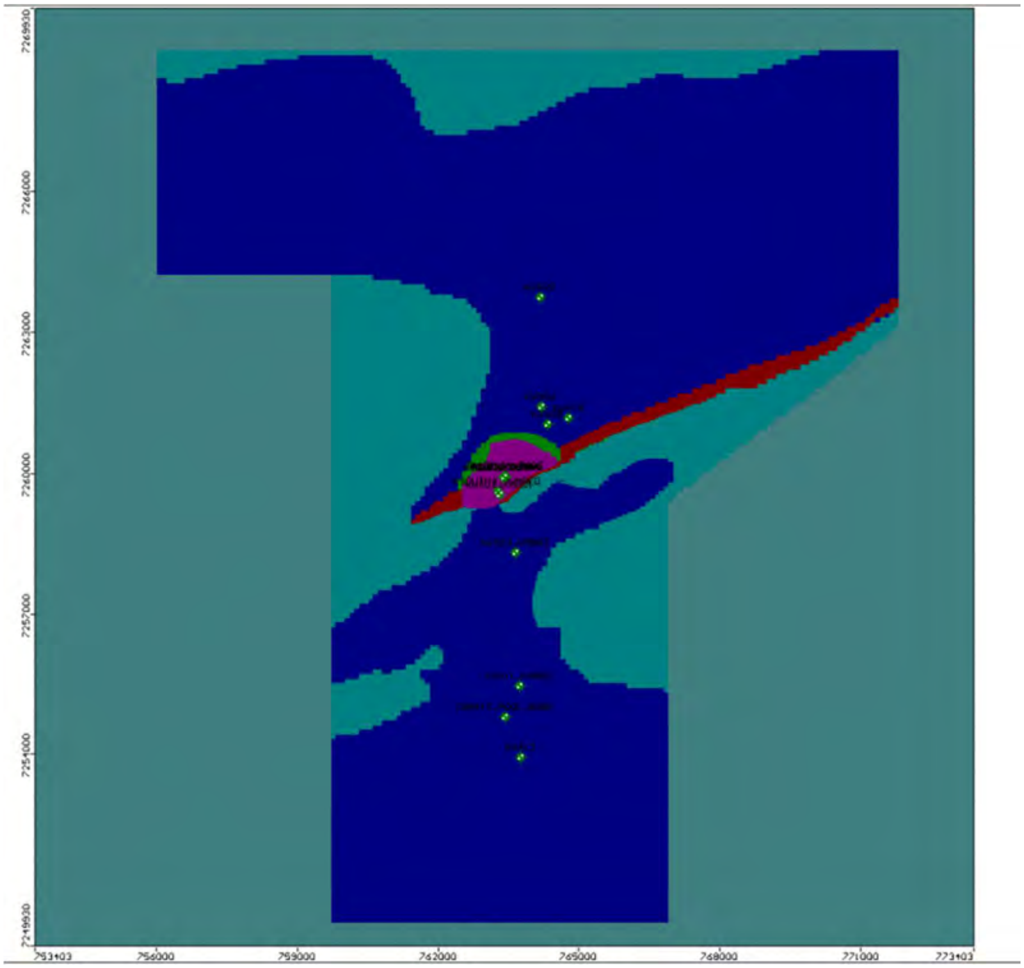


Figure 7-7: Aquifer Parameter Zones in the Model (Blue = alluvium in the valley, Purple = Alluvium/Calcrete, Green = weathered/calcrete, Red = fracture zones)

7.6 Model Calibration

The calibration was performed using PEST (Watermark Numerical Computing, 2010; 2013; 2014a;b). The calibration was based on the following assumptions:

- Vertical hydraulic conductivity was 10% of the horizontal hydraulic conductivity in all zones; and
- The hydraulic conductivity for the bedrock sandstone and mudstones layers was the same for all layers.

The targets for the calibration were the water level observations at bores in the vicinity of the proposed borefield (Table 7-2). The locations of the bores are shown in Figure 5-3 and Figure 5-3.

The recently completed monitoring and production bore from May 2018 were not part of the current modelling.

Table 7-2: Bores used in Calibration

Bore ID	E (mMGA) Z50	N (mMGA) Z50
KPB01	763403	7259922
New PB02*	763329E	7259574
KMB01	763306	7259546
KMB02	763737	7255460
KMB03	763737	7255460
Kumarina Bore South 2	763265	7259613
Jaydinia Bore	763424	7259952
Johnny's Pool Exploration hole	763418	7254812

**Assumed second production bore for modelling purposes*

7.6.1 Steady State Calibration

Steady state simulations used the initial head distribution shown in Figure 7-6. Calibration was achieved by varying horizontal and vertical hydraulic conductivity values. The parameters derived from the steady state calibration are listed in Table 7-3. These are considered a reasonable representation of the average aquifer parameters derived from the test pumping analysis.

The graphical and statistical results indicate a good correlation, with the Scaled Root Mean Square (SRMS) error of 9.6%, less than the recommended value of 10% in the Australian Groundwater Modelling Guidelines (Barnett et al., 2012). The model calibration was most sensitive to the hydraulic conductivity at the boundaries and edges between the simulated borefield area and the bedrock areas. The calibrated (simulated) and observed heads in the vicinity of the study area are shown in Figure 6-8. Statistics from the calibration are presented in Table 6-3.

The major differences between the model and the observation were for KWS09 and KWS19, four and two km north of the study area respectively. These bores are not in the considered calibration target bores in the vicinity of the Kumarina pumping area.

Table 7-3: Summary of Calibrated parameters (Steady State)

Lithology	Layer(s)	Horizontal Hydraulic Conductivity (m/day)	Vertical Hydraulic Conductivity (m/day)
Alluvium/colluvium	1	0.9	0.09
Alluvium /calcrete	2	1.4	0.14
Weathered/calcrete	3	80	8
Bedrock	4	1 x 10^{-3} to 1 x 10^{-4}	1 x 10^{-4} to 1 x 10^{-4}

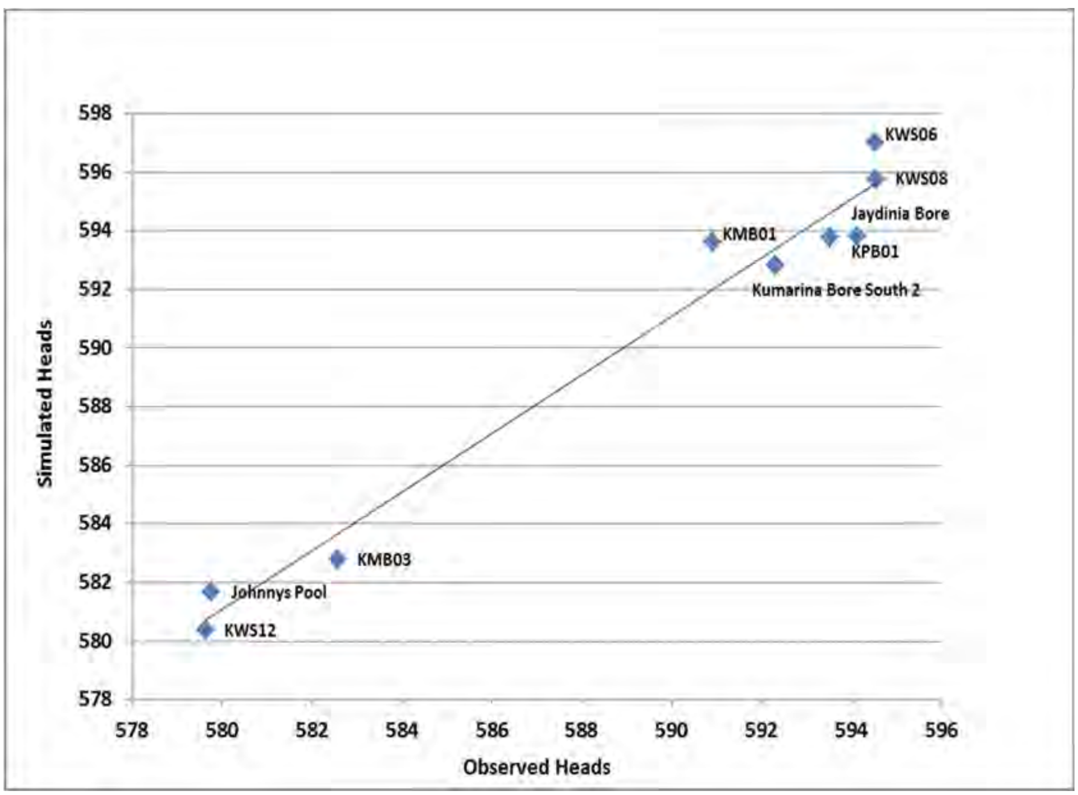


Figure 7-8: Comparison of Simulated and Observed Heads – Steady State

Table 7-4: Statistical Measures of Calibration

Statistical Measure	Value
Count	8
Minimum Observed	579.6mAHD
Maximum Observed	595.31mAHD
Minimum Simulated	580.4mAHD
Maximum Simulated	594.3AHD
MSR: Mean SR	0.449m
RMS: sqrt(MSSQ)	1.18m
SRMS: Scaled RMS	7.53%

7.6.2 Transient Calibration

Independent pumping tests were conducted for approximately three days at Kumarina Bore South 2 in November 2017 and KPB01 in March 2018. Drawdown data was recorded in observation wells nearby during the tests as detailed in Section 6.3. The data collected during the pumping tests provide a means of estimating conductivity and specific yield for the aquifer. Reasonable estimates of these parameters are important for representing the aquifer response under pumping conditions.

The transient calibration was performed by adding abstraction bores and observation wells to the model domain based on their arrangement in the field. The mesh was finely discretised (up to 0.5m) locally between the abstraction bores and observation wells to ensure the results were independent of discretisation. The abstraction bore details and rates of pumping are as detailed in Section 5.4. The bores are screened from the water table to the base of the weathered, unconfined zones. Accordingly, the storage in this entire zone was the focus of the calibration.

7.6.2.1 Kumarina Bore South 2 – Dry Conditions

The parameters arising from the transient calibration for the dry conditions, to the first pumping test carried out in November 2017 at Kumarina Bore South 2 are listed in Table 7-5. For the dry condition, a recharge rate of 2 mm/a (approximately 1% of the average annual rainfall) was applied across the model domain.

The calibration results showing a comparison of the simulated and observed heads in the vicinity of the study area are shown in Figure 7 10. Statistics from the calibration are presented in Table 7 5. The graphical and statistical results indicate an acceptable correlation, with the Scaled Root Mean Square (SRMS) of below the recommended value of 10% in the Australian Groundwater Modelling Guidelines (Barnett et al., 2012).

Table 7-5: Parameters from Transient Calibration – Dry Conditions

Lithology	Layer(s)	Horizontal Hydraulic Conductivity (m/day)	Vertical Hydraulic Conductivity (m/day)	Specific Storage (/m)	Specific Yield (-)
Alluvium/colluvium	1	0.9	0.09	n.a	0.05
Alluvium/Calcrete	2 & 3	2	0.2	n.a	0.05 to 0.12
Transition zone of the weathered / calcrete zones and alluvium	2 & 3	20	2	n.a	0.12
Weathered/calcrete	2 & 3	59	5.9	n.a	0.12
Synclinal axis	1,2 & 3	0.1	0.01	1 x 10-3	n.a
Bedrock/ synclinal axis	4	0.001	0.001	1 x 10-3	n.a

A major difference between the modelled and observed heads was for KMB02, 1.3 km south of the study area. This bore is not considered as a calibration target bore in the vicinity of the Kumarina pumping area.

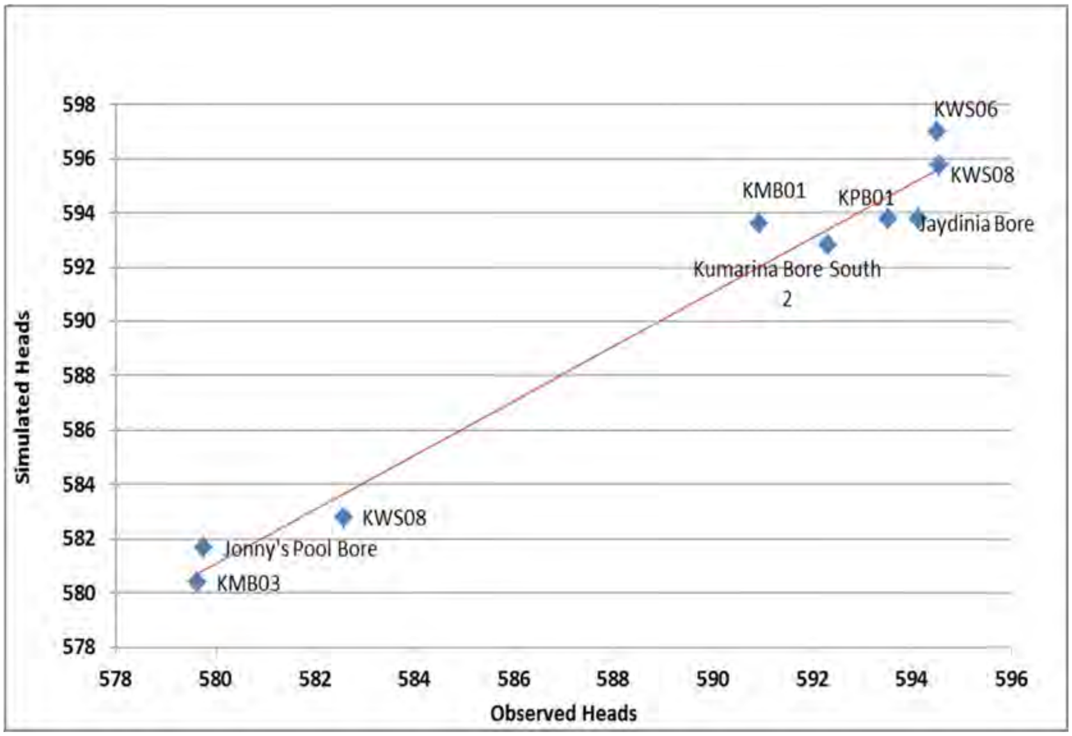


Figure 7-9: Comparison of Simulated and Observed Heads – Dry Conditions

Table 7-6: Statistical Measures of Calibration

Statistical Measure	Value
Count	9
Minimum Observed	579.6m
Maximum Observed	594. 5m
Minimum Simulated	580.4m
Maximum Simulated	597.0m
MSR: Mean SR	0.54m
RMS: sqrt(MSSQ)	1.48m
SRMS: Scaled RMS	9.9%

The observed versus calculated heads for Jaydinia bore to the November 2017 pumping test data are shown in Figure 7-10.

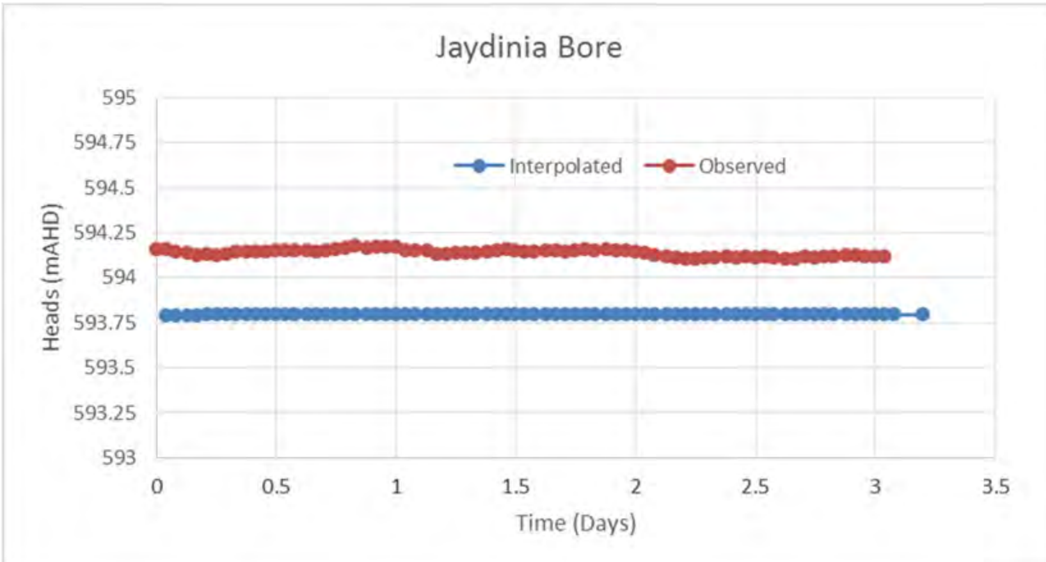


Figure 7-10: Observed vs. simulated hydrographs at the Observation Well (Jaydinia Bore)

7.6.2.2 KPB01 - Wet Conditions

The second pumping test at KPB01 was conducted in March 2018, soon after a rainfall period in February 2018, with a full creek approximately 200m to the east of the bore. To calibrate the model to the wet conditions, 3% of the recorded daily rainfall between November and March was assumed as surface recharge across the model domain and therefore this is considered to be a higher end estimation of volume of groundwater available for abstraction in above average rainfall years (Chapman, 1962). The model was run for this four-month period, with the observations during the three-day test pumping in March used for calibration. To allow for adequate drainage and vertical leakage from the surficial sediments the drain boundary condition was simulated along the river, maintaining the drain boundary heads 3m below the top of the cell with a conductance of unit length at 0.01m/d. The conductance value per unit length/area of the Drain grid cells is calculated within the model, based on unit length of the drain in each grid cell. The calibration was run for a period of four months, between November and end of March, from dry to wet conditions, including the February 2018 rainfall events. The calibrated parameters from the dry state simulation were used for initial parameters, to enable comparison against the dry conditions. The wet condition calibration was also performed separately using PEST.

The parameters arising from the transient calibration for the wet conditions, to the second pumping test carried out in March 2018 at KPB01 are listed in Table 7-7.

The main difference in the calibrated parameters between the wet and the dry conditions was the hydraulic conductivity value for the transition zone between the alluvium and the zone representing the synclinal axis, which calibrated at 40 m/d, compared to the 20 m/d in the dry condition. The calibration results showing a comparison of the simulated and observed heads in the vicinity of the study area are shown in Figure 7 13.

Table 7-7: Parameters from Transient Calibration – Wet Conditions

Lithology	Layer(s)	Horizontal Hydraulic Conductivity (m/day)	Vertical Hydraulic Conductivity (m/day)	Storage (/m)	Specific Yield (-)
Alluvium/colluvium	1	1.4	0.14	n.a.	0.05
Alluvium/Calcrete	2 & 3	1.8	0.18	n.a	0.1
Transition zone of the weathered / calcrete zones and alluvium	2 & 3	40	4	n.a	0.1
Weathered/calcrete	2 & 3	57 to 59	4.4	n.a	0.1
Synclinal axis	1,2 & 3	0.01	0.001	1 x 10-3	n.a
Bedrock/ synclinal axis	4	0.0025	0.001	2.5 x 10-3	n.a

Statistics from the calibration are presented in Table 7-8. The graphical and statistical results indicate an acceptable correlation, with the Scaled Root Mean Square (SRMS) of below the recommended value of 10% in the Australian Groundwater Modelling Guidelines (Barnett et al., 2012). A comparison of simulated vs observed heads is shown in Figure 7-11.

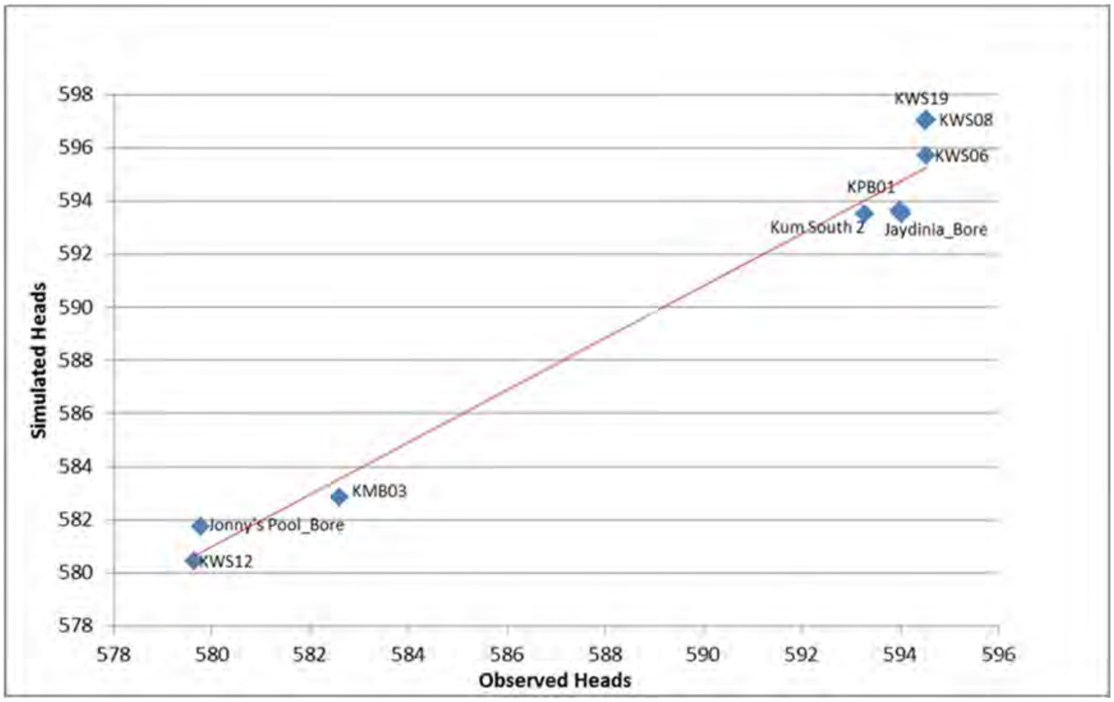


Figure 7-11: Comparison of Simulated and Observed Heads – Wet Conditions

Table 7-8: Statistical Measures of Calibration

Statistical Measure	Value
Count	10
Minimum Observed	579.63
Maximum Observed	594.56
Minimum Simulated	580.49
Maximum Simulated	597.03
MSR: Mean SR	0.849
RMS: sqrt(MSSQ)	1.399
SRMS: Scaled RMS	9.38%

The observed versus calculated heads for the calibration to the November 2018 pumping test data are shown in Figure 7-12.

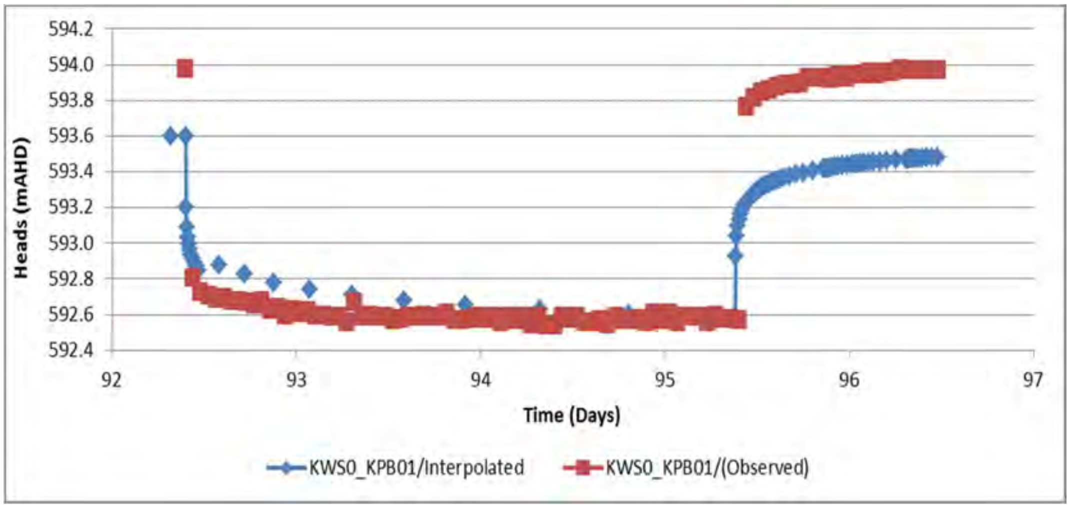


Figure 7-12: Calibrated Hydrograph – Pumping bore

The observed versus calculated heads for Jaydinia bore to the November 2017 pumping test data are shown in Figure 7-13.

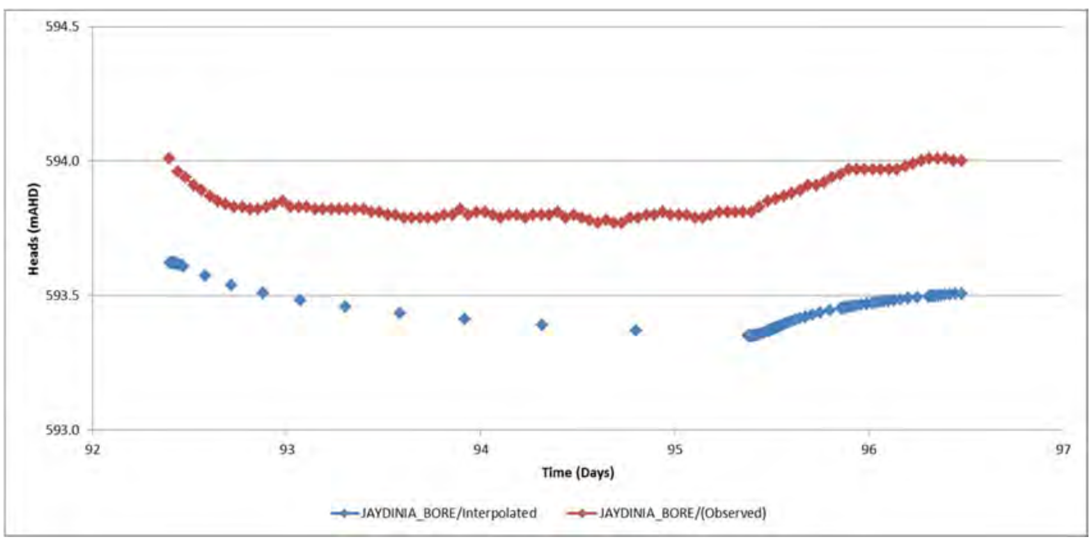


Figure 7-13: Observed vs. simulated hydrographs at the Observation Well (Jaydinia Bore)

7.7 Model Confidence

The only groundwater monitoring data available in the immediate vicinity of the study area is from the newly drilled project site bores and recent monitoring. Therefore, the Kumarina groundwater model is classified as a Level 1 model as per the classification system set out by the Australian Groundwater modelling guidelines (Barnett et al., 2012) with regard to data availability, this is typical of a greenfields project.

The results from the steady-state and transient calibration in the immediate vicinity of the study area give confidence that the model can represent the aquifer prior to abstraction. However, there is no data outside the modelled area and therefore is consistent with a Class 1 calibration within the Barnett et al. (2012) guidelines.

The model was designed and constructed as a regional model to:

- Ensure that the applied Head dependent boundary conditions are sufficiently away from the Kumarina borefield area; and
- Ensure that the downgradient bores and Johnny's pool formed a part of the drawdown impact assessment.

Although site specific data is available in the immediate area of interest only, the model calibrated reasonably well to the observed aquifer responses during the pumping tests and therefore the model is considered to be adequate for predictive scenario modelling of proposed groundwater abstraction.

7.8 Predictive Modelling Scenarios

Predictive modelling runs for the planned abstraction were simulated under dry and wet conditions, as detailed below.

7.8.1 Scenario 1: Dry Conditions – Conservative Scenario

The calibrated Dry Scenario model was set up for 23 years, which is the planned demand duration. As stated in Section 7.6.2.1 1% of the average annual rainfall was used as overland recharge across the model domain and therefore is considered to be conservative. An evaporation rate of 1,500mm /annum with extinction depth of 4.8 m in the valleys areas and 2 m in the bedrock areas was initially adopted in the model. However, as drawdowns reach the base of Layer 1, the model was highly unstable and therefore evaporation had to be removed as a boundary condition in the model. This does not significantly affect the prediction scenarios as drawdowns quickly reach the base of Layer 1 which is within the maximum simulated extinction depth.

The predictive scenarios initially considered a water demand of 1 GL/a to be the maximum abstraction volume to be extracted using two production bores (KPB01 and a new PB02 at 763329E and 7259574N, adjacent to Kumarina South 2, to the east of the pipeline), abstracting equal volumes. Post abstraction heads and drawdown simulations were run for a period up to 100 years in total, 17 years after the cessation of abstraction at yearly stress periods and a single stress period representing 40 to 100 years. Drawdowns at the end of the 23 year abstraction period are represented in Figure 7-14 and drawdowns at the end of approximately every 10 years are presented in Appendix E.

Simulated drawdowns at key observation bores at the end of the abstraction period (maximum drawdown) are shown in Figure 7-14.

Table 7-9: Simulated Drawdowns at Key Observation Bores at different Periods- Dry Conditions

Bore ID	Approximate Distance from Pumping Bore KPB01 (m)	Approximate Distance from Proposed Bore New-PB02 (m)	Drawdown (m) after 5 Years	Drawdown (m) after 10 Years	Drawdown (m) after 23 Years
New PB02	350	0	6.6	11	23.1
KMB01	390	40	6.1	10.3	21.6
Kumarina Bore South	340	70	5.9	10.1	21
Kumarina Bore South (collapsed)	20	340	6	10.2	21.5
KPB01	0	360	6.3	10.6	22.9
Jaydinia Bore	40	390	5.8	9.9	20.6
Kumarina Station	380	740	5.1	9	18.1
KMB02	1620	1290	0	0	1.3
KMB03	4530	4180	0	0	0
Johnny's Pool Bore	5170	4790	0	0	0

The drawdown impacts during dry conditions from groundwater abstraction of 1 GL/a extends 2.2 km to the south and 2.5 km to the north of the borefield.

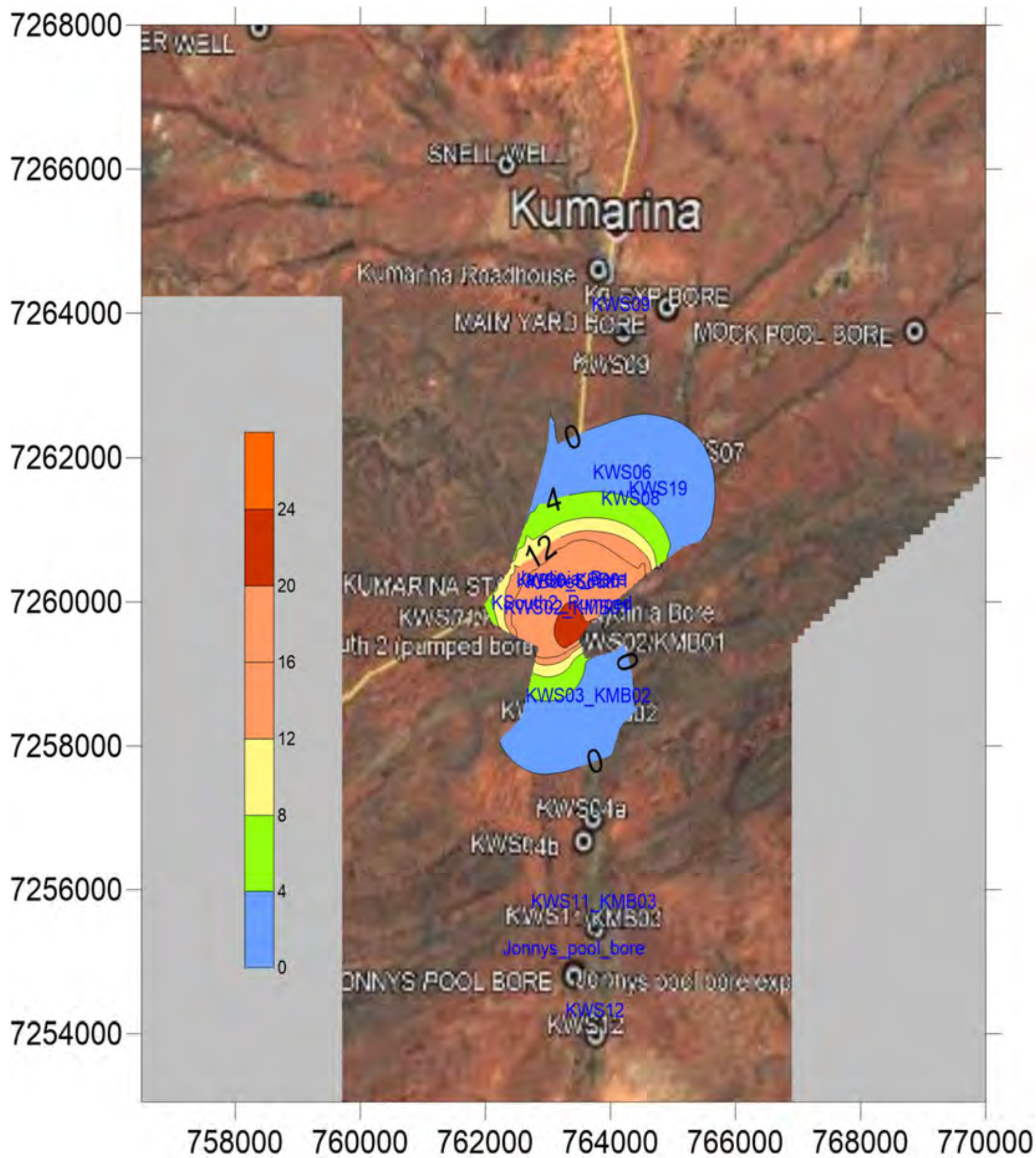


Figure 7-14: Drawdown after 23 Years Abstraction

7.8.2 Scenario 2: Wet Conditions - Base Case Scenario

The Wet conditions scenario was run for the planned duration for mining and groundwater abstraction from the Kumarina borefield (23 years) and recovery was simulated to a total of 100years.

As in the case of the Dry case, the water abstraction of 1 GL/a was assumed to be the maximum abstraction volume to be extracted using two production bores (KPB01 and New PB02 at 763329E and 7259574N, adjacent to Kumarina Bore South 2, to the east of the pipeline, abstracting equal volumes.

Post abstraction heads and drawdown simulations were run for a period up to 100 year in total, 27 years after the cessation of abstraction at yearly stress periods up to 50 years and a single stress period representing 50 to 100 years. Drawdowns at the end of the 23 year abstraction period are represented in Figure 7-15 and drawdowns at the end of approximately every 5 years are presented in Appendix E.

Simulated drawdowns at key observation bores at the end of the abstraction period (maximum drawdown) are shown in Table 7-10.

Table 7-10: Simulated Drawdowns at Key Observation Bores at different Periods – Wet Conditions

Bore ID	Approximate Distance from Pumping Bore KPB01 (m)	Approximate Distance Proposed Pumping Bore New-PB02 (m)	Drawdown (m) after 5 Years	Drawdown (m) after 10 Years	Drawdown (m) after 23 Years
New PB02	350	0	6.7	10.9	21.8
KMB01	390	40	6.2	10.3	20.6
Kumarina Bore South 2	340	70	6	10	20
Kumarina Bore South	20	340	6.1	10.1	20.3
KPB01	0	360	6.7	10.9	20.6
Jaydinia Bore	40	390	5.8	9.8	16.7
Kumarina Station	380	740	5.1	8.8	16.4
MB02	1620	1290	0	0	0.97
KMB03	4530	4180	0	0	0
Johnny's Pool Bore	5170	4790	0	0	0

The drawdown impacts from groundwater abstraction of 1GL/a extends 2.1km to the south and 2.4km to the north of the borefield.

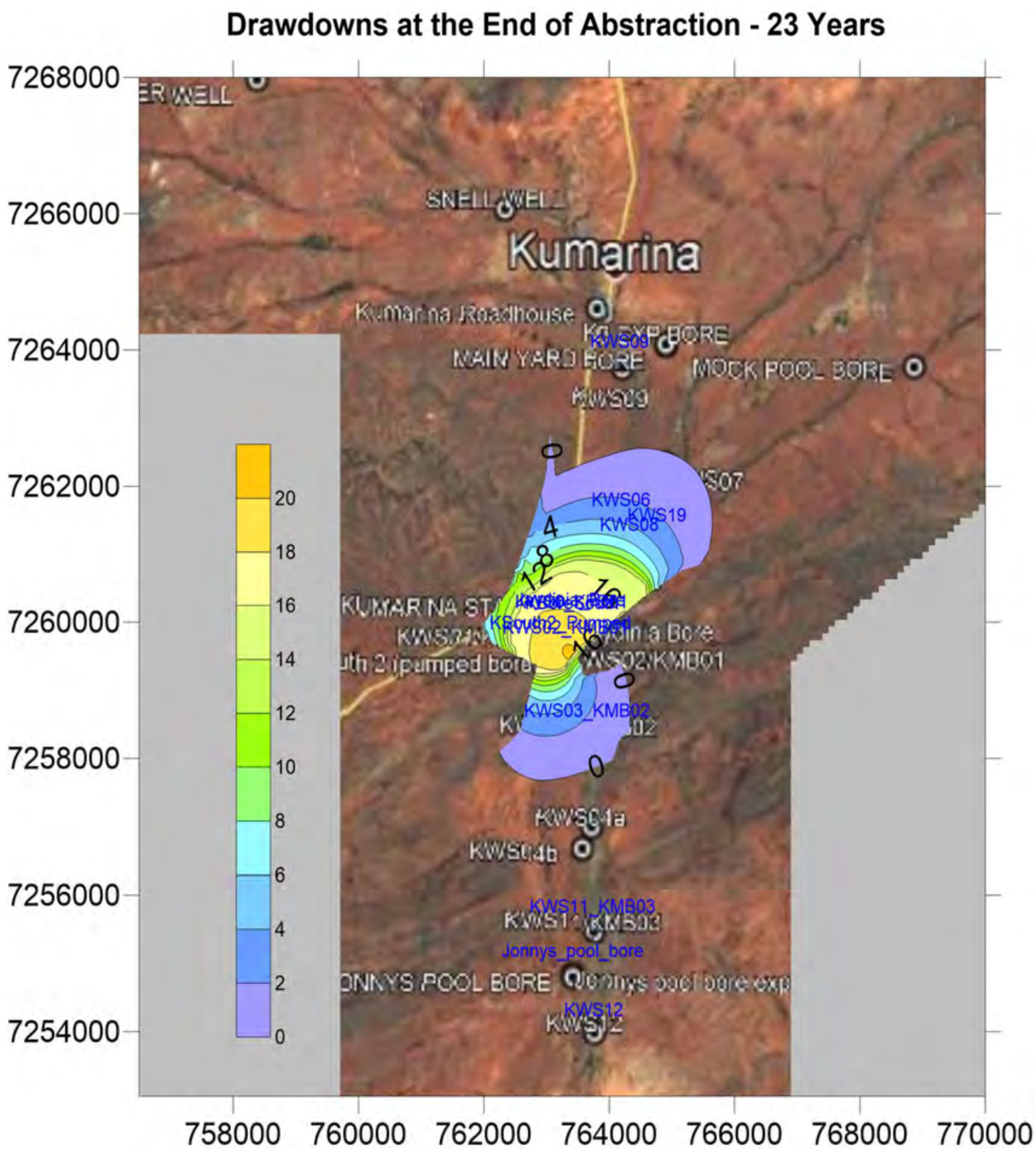


Figure 7-15 : Simulated Drawdowns at the End of Pumping

A comparison of the cumulative water balance between the dry and wet scenarios at the end of the 23 year pumping period is shown in Figure 7-16. The mass imbalance (discrepancy) was recorded below 1%.

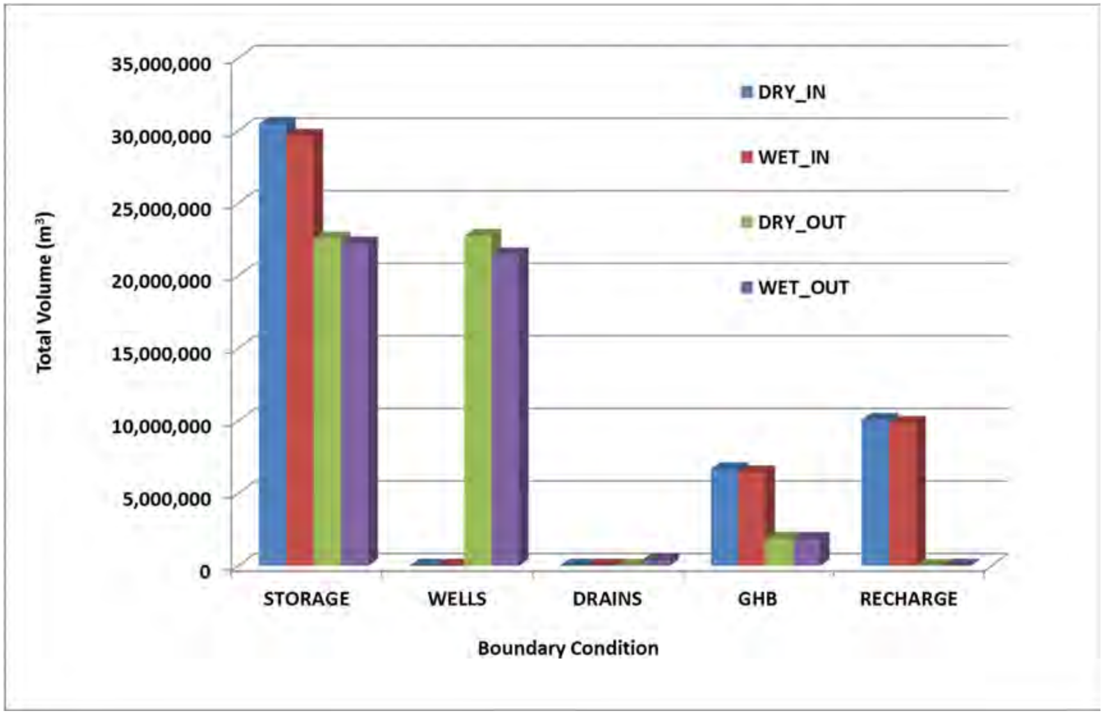


Figure 7-16: Cumulative Water Balance

7.8.3 Scenario 3: Probable Rainfall – Recharge Scenario

The model was run to simulate probable event based recharge events to a peak 1 in 50 year intensity rainfall event based on the frequency duration (IFD) information for the catchment (see Section 2.2). The actual groundwater recharge was varied between approximately 1 to 7% of the rainfall through the 100 year period, inclusive of 5 year, 10 year and 20 year events, with the peak event occurring every 50 years and 1% of rainfall as groundwater recharge during average years.

The difference between the recharge simulated in Scenario 2 and Scenario 3 are illustrated in Figure 7-17 and show that the recharge modelled with peak occurrences (Scenario 3) is approximately 65% of the rainfall recharge across the 100 year period when a uniform 3% is applied across the period.

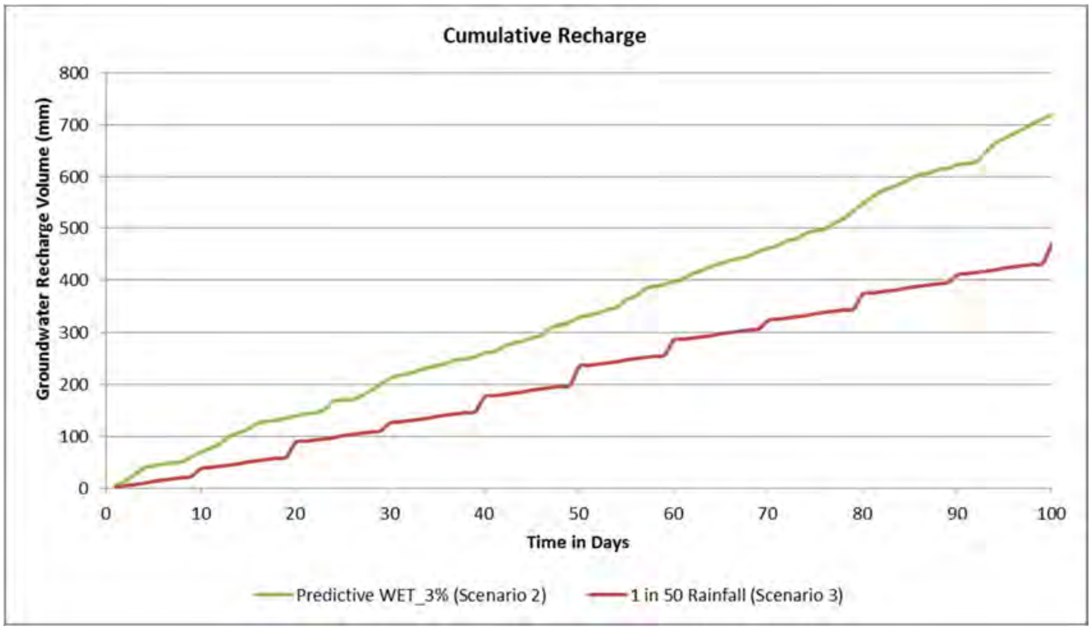


Figure 7-17: Modelled Cumulative Recharge

The absolute drawdowns at the end of the 23 year period are shown in Figure 7-20. An overall reduction in drawdown by approximately 2 m at the end of the 23 year pumping scenario is observed in the higher rainfall intensity scenario.

The difference between the modelled heads and (drawdowns and recovery) in the model cells containing the two pumping wells are represented in Figure 7-18 and Figure 7-19. The figures show that there is only a marginal decrease in drawdowns between the base wet case and the 1 in 50 rainfall recharge case. This is because in the wet case a 3% rainfall recharge is applied across the modelled area through the simulation period whereas in the latter, episodic rainfall events with 1 in 50 (highest recharge rate occurring only after the cessation of pumping, during periods of recovery. The 1 in 50 wet scenario (Scenario 3) may be adopted as the Base Case for future scenarios, as this is considered a more realistic representation of rainfall recharge.

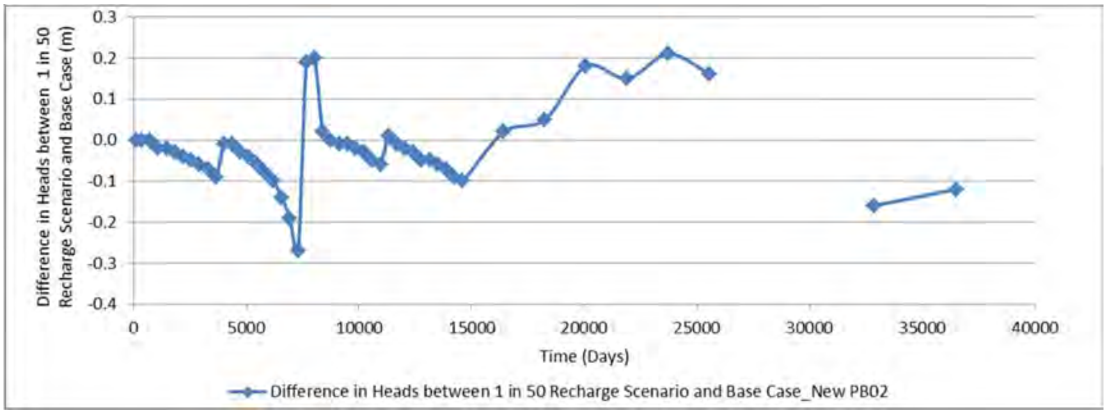


Figure 7-18: Difference in Heads between Base Wet Scenario and the 1 in 50 Recharge Scenario at New PB02

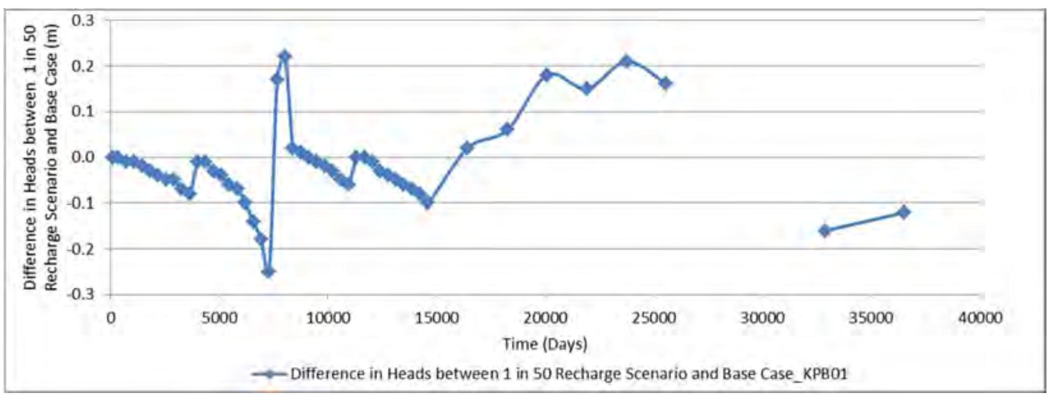


Figure 7-19: Difference in Heads between Base Wet Scenario and the 1 in 50 Recharge Scenario at KWS01 / KPB01

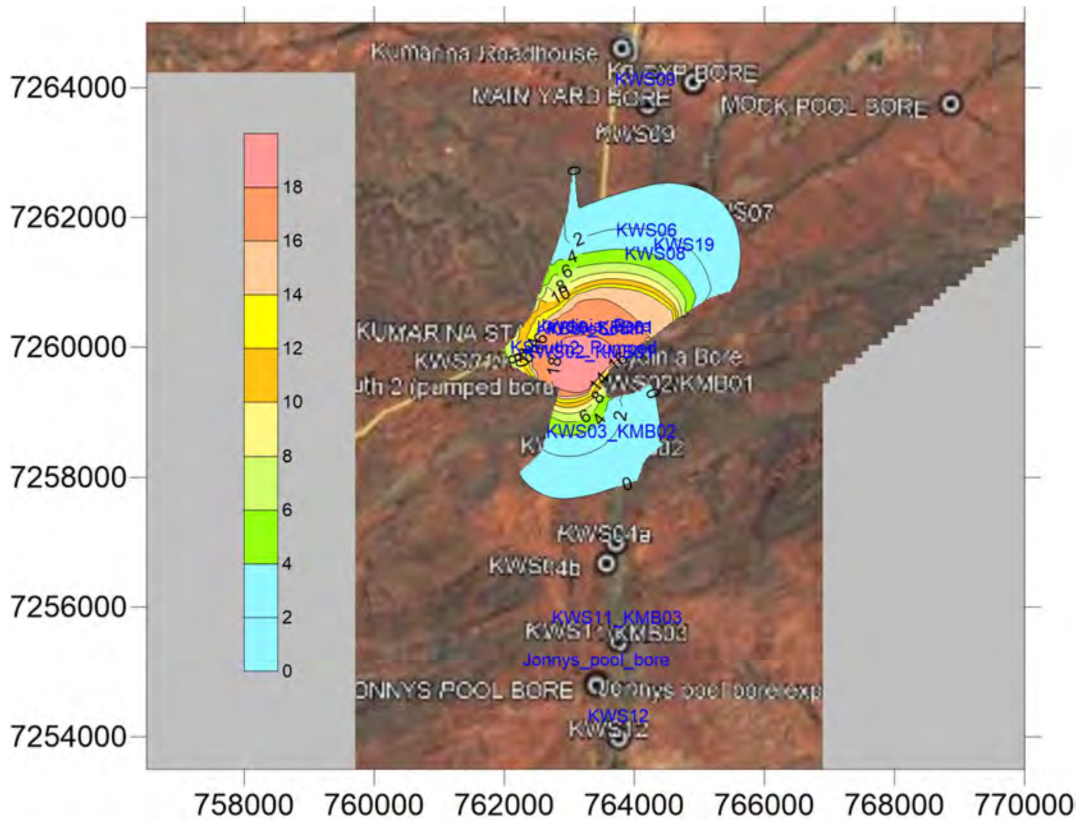


Figure 7-20: Drawdowns at the End of Pumping (1 in 50 Rainfall Scenarios)

7.8.4 Scenario 4: Reduced Abstraction Scenario

An additional scenario was run where the abstraction volume was reduced by 25% where 0.75 GL/a was assumed between the two production bores. Recharge from scenario 3 was used as a basis for Scenario 4 as episodic rainfall represented by 5 year, 10 year and 20 year events and the periods in between by an average 1% of rainfall recharge is considered to be more representative of naturally occurring conditions rather than a 3% yearly recharge for every year over a 100 year period.

An abstraction volume of 0.75 GL/a was modelled, this volume accounts for the Stage 1 water demand for the process water supply at 75 ktpa SOP production. The drawdown results at the end of 5 years, 10 years and 23 year simulations are presented in Table 7-11. Drawdown contours are presented in Appendix E.

Table 7-11: Simulated Drawdowns at Key Observation Bores at different Periods – Scenario 4 (0.75 GL/a)

Bore ID	Distance from Pumping Bore KPB01 (m)	Distance Proposed Pumping Bore New-PB02 (m)	Drawdown (m) after 5 Years	Drawdown (m) after 10 Years	Drawdown (m) after 23 Years
New PB02	350	0	4.9	7.4	11.6
KMB01	390	40	4.4	6.8	11.5
Kumarina Bore South 2	340	70	4.3	6.7	11.4
Kumarina Bore South	20	340	4.3	6.7	11.3
KPB01	0	360	4.7	7.1	11.3
Jaydinia Bore	40	390	4.1	6.5	11.2
Kumarina Station	380	740	3.6	5.9	10.4
MB02	1620	1290	0	0	0
KMB03	4530	4180	0	0	0
Johnny's Pool Bore	5170	4790	0	0	0

A comparison of results at the two production bores represented as a change in drawdown between the base case of abstraction of 1 GL/a over the 0.75 GL/a at periods between 5 and 10 years since commencement of abstraction is represented in Figure 7-21. The results indicate that the drawdown is within approximately 7 m in the first ten years and progressively increases to the end of the borefield operational period.

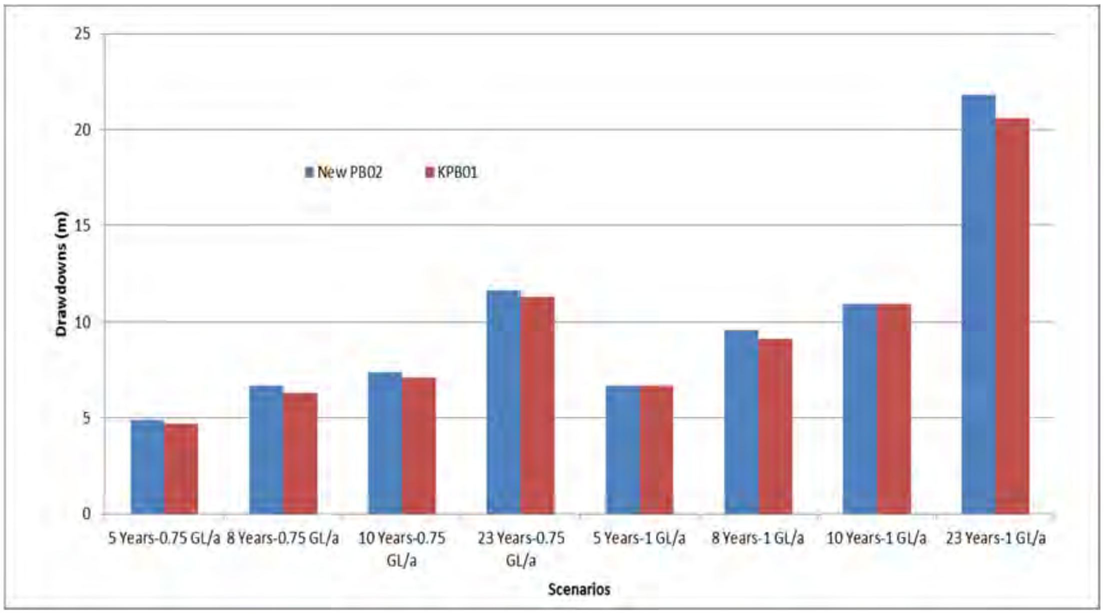


Figure 7-21: Comparison of Drawdowns

7.8.5 Predictive Uncertainty Analysis

Sensitivity to Drain Boundary Conditions

The sensitivity of the modelled results to the drain boundary condition used in the model was assessed by undertaking additional scenarios where the drain boundary conductance was changed by an order of magnitude greater and lesser values on either side of the conductance used in the scenario for the wet case (Section 7.8.2). The distribution of heads at the two production wells between the base case (wet case scenario) and the two ends of drain conductance values are shown in Figure 7-22 and the very marginal difference in modelled heads and drawdowns indicate that model is not sensitive to the drain conductance condition active in Layer 1.

Sensitivity to Specific Yield

The sensitivity of the model to variations in specific yield was assessed by running additional simulations by increasing the specific yield to values between 0.12 and 0.15.

Results shown as a change in drawdown (gain in storage volume) in Figure 7-23 indicate that there is an overall reduction in drawdown (2.1 to 2.4m) across the period of abstraction of 23 years between the calibrated specific yield value of 0.1 and the tested values between 0.12 and 0.15. This indicates that the modelled results are sensitive to aquifer specific yield values and available aquifer storage is dependent on the lithology and the extent of the lithological unit/s. This is expected as the aquifer acts as a discrete bucket of water recharged episodically and controlled by the lithological variations within. If any additional information on geology is obtained, it may be prudent validate the model and if necessary recalibrate. This may be undertaken at the stage of the initial 2 year review post commencement of operations.

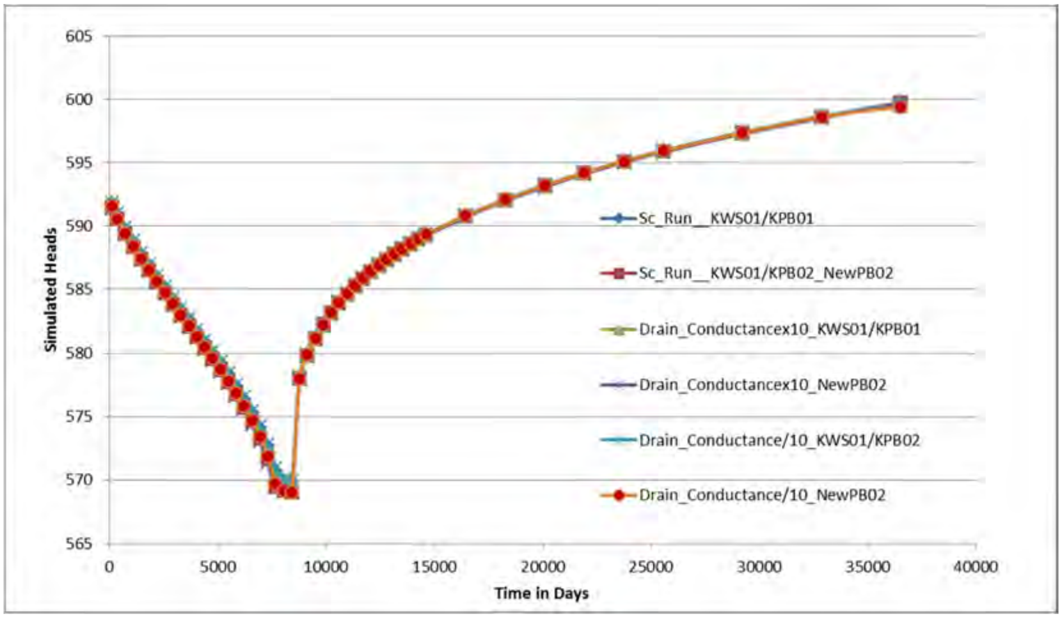


Figure 7-22: Model Sensitivity to Drain Conductance

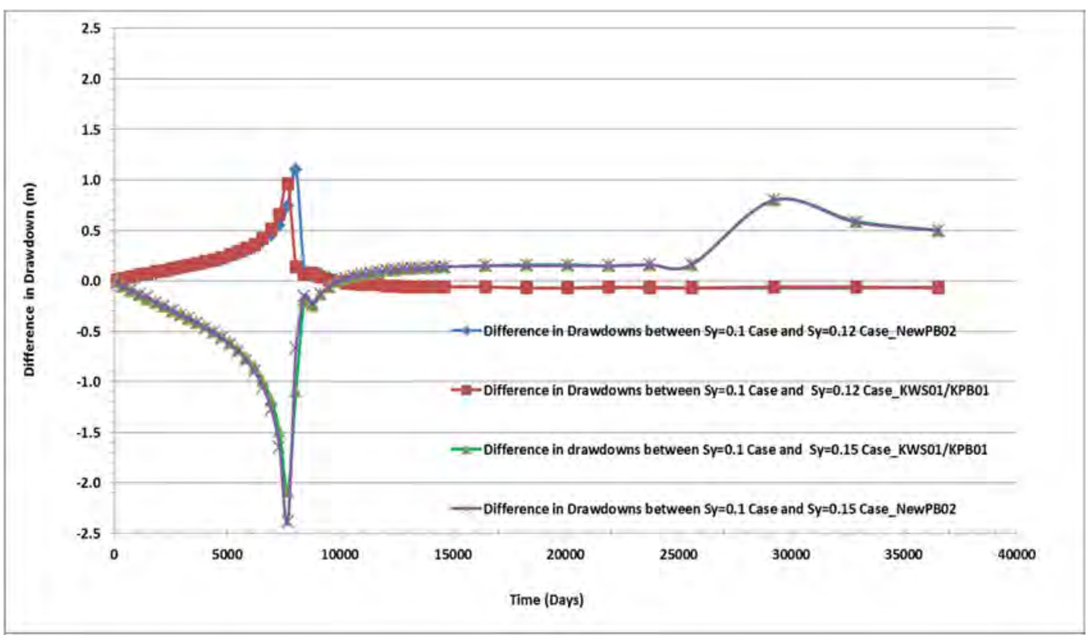


Figure 7-23: Difference in drawdowns modelled at varying specific yields

7.9 Model Summary

The aim of reducing the modelled volume was to maintain groundwater levels within the calcreted alluvial sediments which have a thickness of 11 to 13 m in the modelled area, with saturation between 7 and 11 m. Modelled results indicate that the saturated thickness of the calcreted alluvium is maintained at greater than 50% for:

- the first ten years of projected operations for an abstraction volume of 0.75 GLpa; and
- the first 8 years for an abstraction volume of 1 GLpa.

When assuming the whole saturated profile as the aquifer thickness the results show that the above scenarios have saturated thicknesses after ten years of approximately >70% and >60% respectively and at the end of the proposed project life (23 years) of 50% and 15% respectively.

Therefore, it may be concluded that the Kumarina borefield could operate at the above abstraction volumes for a period between 8 and 10 years, with adequate management measures to mitigate any potential impacts to potential groundwater dependent vegetation and / or stygofauna. In addition, with provisions being made for alternate water supplies to the Kumarina homestead, if their water supply is impacted.

Annual verification of the modelled outputs will help improve the modelled simulations as more monitoring data becomes available for drawdown and recharge and the estimates maybe refined during borefield operations.

7.10 Borefield Operations

KPB01 and the newly drilled KPB02 will be used as the main abstraction bores. Additionally, prior to commencement of operations it is proposed to construct a new bore adjacent to KMB01. This will enable the abstraction to be spread over three production bores and provide additional redundancy in the borefield capacity. This new bore will be at the location that the New Bore PB02 has been modelled within the predictive scenarios.

The borefield will operate in conjunction with other Kalium operated borefields in the vicinity of Ten Mile Lake to share the process water demand and provide further redundancy and contingency if any one of the proposed borefields under performs. A future operating strategy will outline the proposed BSOPP water supply adaptive management procedures.

8 Discussion of Potential Impacts and Management Strategy

The BSOPP process water supply demand is 0.75 GLpa for the initial 75 ktpa SOP production rate and up to 1.5 GLpa for the 150 ktpa SOP production rate. This process water supply is to be met from a combination of borefields within the project area. The Kumarina Borefield is proposed to meet a maximum of 0.75 GLpa of the demand, with borefields at Ten Mile South and Beyondie West, located nearer the processing facility, making up the remaining demand. At the time of reporting these additional borefields are still being assessed and will be reported on separately.

The below sections are focussed on discussing the potential for impacts and management as a result of drawdown and / or water quality change in relation to the proposed 0.75 GLpa abstraction from the Kumarina Borefield. The following receptors have been considered:

- Other groundwater users, including pastoral wells and licensed users;
- Subterranean Fauna; and
- Potentially groundwater dependent vegetation.

8.1 Other Groundwater Users

Licenced groundwater users in the vicinity of the proposed Kumarina borefield are detailed in Section 3. There is only one nearby existing Groundwater Well Licence (GWL) (179356), issued to Main Roads for a licenced abstraction volume of 0.09 GL. This licence appears to cover a large corridor of the Great Northern Highway in relation to road maintenance of which this abstraction is considered to be spread over a number of bores in this corridor. In consultation with the Pastoral owner of Kumarina Station it is understood that Main Roads has in the past used Jaydinia Bore for road maintenance. However, this bore is now defunct due to their being an obstruction within the bore at the water table (appears to be 50mm casing within the bore) therefore a pump can no longer be lowered below the water table making the bore redundant (See Appendix F)

Other potential groundwater users in the immediate vicinity to the modelled radius of influence of the proposed pumping are the Kumarina Homestead Bore and Kumarina Bore South 2, these pastoral bores are presented in Figure 3-1. Due to the proximity of the proposed borefield, these bores are almost certain to be impacted by the proposed abstraction; the modelled drawdowns are presented in Table 8-1 below.

Kumarina Bore South 2 is not used by the station (see Appendix F) and abstraction volumes at the Homestead Bores are considered to be minor. Therefore, KLL shall make provisions for alternate sources if the homestead bore yield or quality is negatively impacted by the proposed Kumarina Borefield abstraction. This may be in the form of constructing a new bore or maintain supplies via an offtake from the proposed borefield.

Table 8-1: Modelled Drawdowns at pastoral bores in close vicinity of the borefield (0.75GLpa)

Bore ID	Drawdown (m) after 5 Years	Drawdown (m) after 10 Years	Drawdown (m) after 23 Years
Kumarina Bore South 2	4.3	6.7	11.4
Kumarina Station	3.6	5.9	10.4

8.2 Subterranean Fauna

Groundwater drawdown and water quality change has the potential to impact on subterranean fauna when communities are restricted to a restricted aquifer. Stygofauna surveys have been completed by Phoenix Environmental (Phoenix, 2018) as discussed in Section 4. The surveys found that there were three species found in the Kumarina Borefield area from bores KMB01 and KPB01. Limited sampling has been completed, but that stygofauna are likely to be widespread as evidenced by the different geologies of the two bores recording stygofauna. Surface geology data, and localised drill log data suggests that these species are likely to be more widespread than the extent of the area sampled. The Phoenix report has concluded that although the logs for KPB01 and KMB01 suggest that while calcrete is present, it is not necessarily a constraint to either the larger species or the more mobile smaller species and that the species may exist in calcrete, alluvium and fractured bedrock. It is therefore considered that the Kumarina Borefield is of low risk for impacts to stygofauna due to the potential for species to move between lithologies, however a degree of saturation must remain and has been the driving factor for reducing the potential abstraction from 1 GLpa to 0.75 GLpa.

As discussed above, it is considered that stygofauna habitat may represent the entire saturated thickness of the combined alluvial, calcrete and fractured bedrock profile. Therefore, the impact assessment will ensure that a portion of each of these aquifers is maintained. Based on the procedures for trigger levels set in the Gruyere Gold Project API Report (MBS Environmental, 2016) and taking into account the variable geology in the Kumarina Borefield Area, preliminary trigger levels associated with the calcreted alluvium have been proposed.

Modelled saturated thicknesses of the calcreted alluvium at the end of 5, 8, 10 and 23 years for the tested bore KPB01 are presented in Table 8-2. The results indicate that the drawdown is confined to the upper alluvium and calcrete horizons in the first ten years of projected operations for 0.75 GLpa abstraction. It is considered that 50% and 25% of calcreted alluvium is present after five years and ten years of abstraction respectively (see Table 8-2).

Table 8-2: Modelled Saturated total aquifer thickness and calcreted alluvium at the end of different periods of abstraction (KPB01)

	Year 5	Year 8	Year 10	Year 23
Saturated Thickness in the calcreted alluvium at the end of modelled period at 0.75 GL/a	5	3	2	0
Total saturated Thickness in the alluvium and calcreted alluvium and the fractured aquifer combined at the end of modelled period at 0.75 GL/a	14	12	11	7
% of saturated calcreted alluvium	50	33	25	0

The depth to which the water table is predicted to be drawn down in the two monitoring bores adjacent to the modelled production bores in comparison to the depth of the calcreted alluvium is presented in Figure 8-1, Figure 8-2 and Figure 8-3.

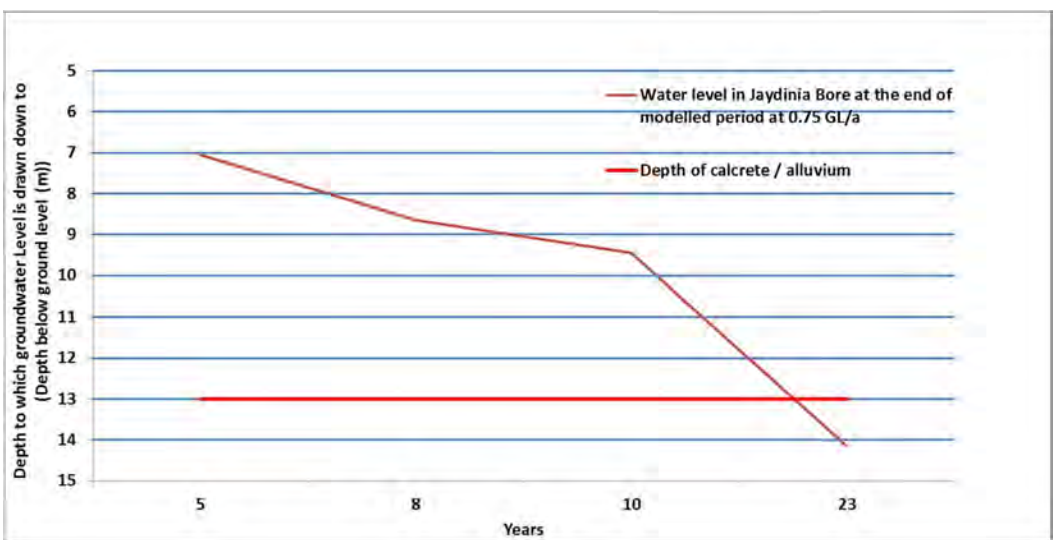


Figure 8-1: Depth to water (bgl) at modelled intervals (Jaydinia Bore)

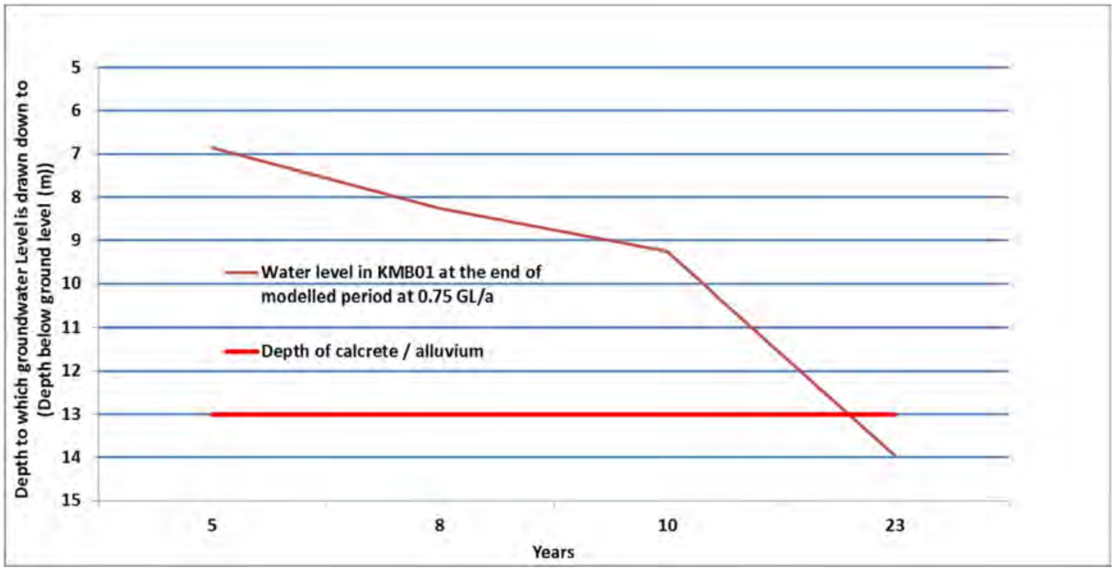


Figure 8-2: Depth to water (bgl) at modelled intervals (KMB01)

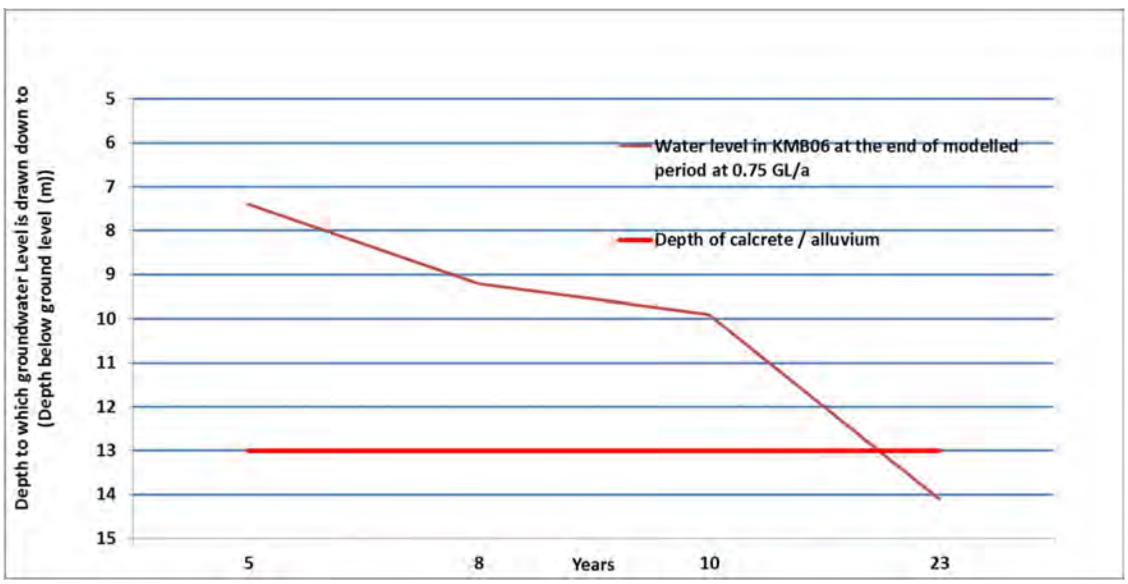


Figure 8-3: Depth to water (bgl) at modelled intervals (KMB06)

Abstraction is predicted to result in approximately 50% of stygofauna habitat remaining within the calcreted alluvium in the vicinity of the borefield. Based on the modelled groundwater levels and the percentage of saturated thickness remaining in the calcreted alluvium it can be concluded that the borefield may be operated at 0.75 GL/a in the first 10 years of operation without significantly depleting the available stygofauna habitat in the calcreted alluvium and fractured bedrock.

For effective management it is proposed that the production bores be managed by limiting drawdowns with the use of trigger levels set for key observation bores. Two levels of triggers have been proposed for Jaydinia bore, KMB01 and KMB06 (Figure 8-4); the closest monitoring bores to the production bores. These are:

- A management trigger set at 50% of the alluvial and calcrete saturated thickness to reduce and manage abstraction; and
- A 'stop pumping trigger' set at 30% of the saturated alluvial and calcrete aquifer where pumping should cease at the adjacent production bore and aquifer allowed to recover to the management trigger or higher.

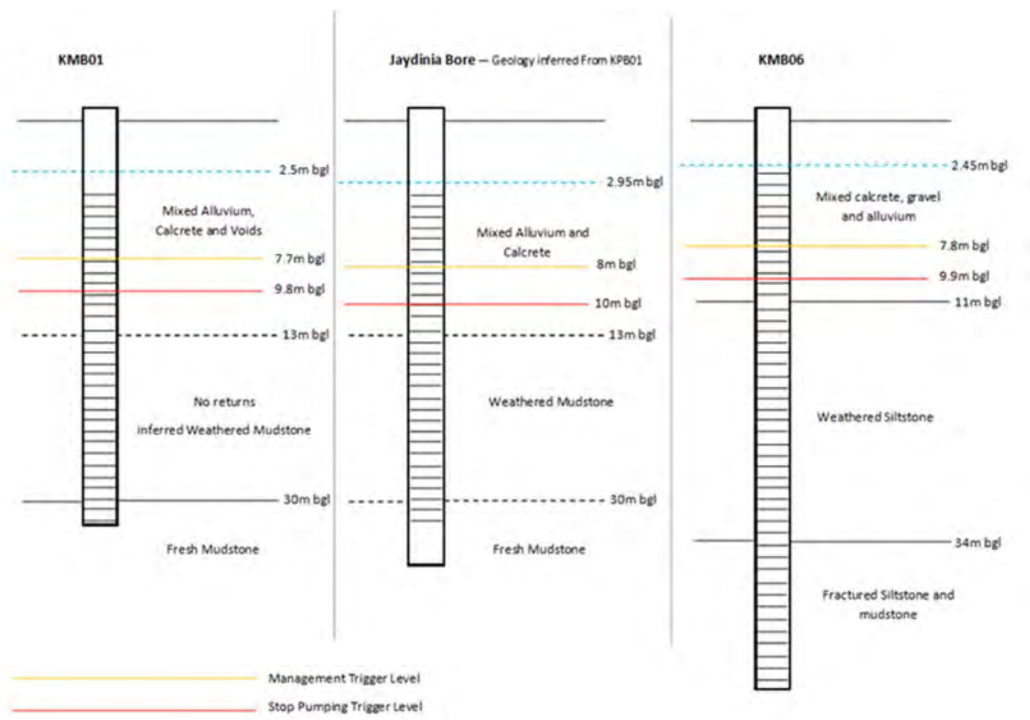


Figure 8-4: Borefield management trigger levels.

Due to the relatively localised potential impact on the aquifer in response to planned groundwater abstraction, it is unlikely that the Kumarina borefield operation for the Project will have unacceptable impacts on the more regional subterranean fauna species. An effective adaptation of a combined borefield management program of two hydraulically disconnected borefields such as Kumarina borefield and the proposed Ten Mile and Beyondie borefields will help manage potential project impacts and minimise the loss of subterranean fauna habitat and stygofauna species. The proposed triggers are considered conservative when the stygofauna habitat is considered to include the fractured bedrock, which also is considered to provide a large portion of the groundwater to the production bores.

8.3 Potential Groundwater Dependent Vegetation

The vegetation in the Kumarina project area is generally low scrub (Figure 4-1), with *Eucalyptus Victrix* trees (up to 15m in height) found along the drainage features (Figure 4-2). *E. Victrix* is a potentially groundwater dependent species and therefore maybe considered sensitive to the depth to groundwater and the rate at which groundwater levels change. However, it is considered that moisture inputs from flooding appear to be important for sustaining *E. victrix* communities in most environments, regardless of the groundwater level.

It is considered unlikely that the drawdown effects from abstraction will significantly affect the health of *E. Victrix* over the first ten years of abstraction as the trees roots should be able to adapt to the changing water level, predicted to fall between 0.59 and 0.74 m/annum (see Table 7-11) and will likely be more reliant on regular flood event that recharge soil moisture in the vadose zone. However, rates of groundwater level change will be monitored with an appropriate monitoring and management strategy put in place, as detailed in Section 8.5**.** If increased rates of drawdown are observed then actions to monitor tree health and / or mitigate the drawdown might be required to protect the health of these species.

8.4 Management Strategies

KLL's management approach for minimising potential impacts is outlined in Table 8-3.

Table 8-3: Summary of Management Strategies

<table>
<tr><th>Potential Impact Identified</th><th>Recommendation</th><th>Management Strategy</th></tr>
<tr><td>Calcrete / weathered aquifer - Drawdown</td><td>- Complete baseline monitoring
- Undertake continuous monitoring of selected monitoring bores
- Undertake monthly monitoring of all completed monitoring bores
- Set trigger levels
- Verify and re-calibrate the numerical model after one or two years of operation and revise drawdown predictions and reset trigger levels</td><td rowspan="2">- Alter extraction volumes and schedules to manage drawdowns
- Use the Kumarina borefield in parallel with the Ten Mile South and Beyondie Borefields to optimise abstraction strategy
- Provide alternate water supplies to the homestead, if the yield or quality is negatively impacted</td></tr>
<tr><td>Groundwater availability and / or impacts to other groundwater users</td><td>- Undertake further baseline monitoring and delineation of the aquifer extent
- Undertake regional monitoring of station bores</td></tr>
</table>

Potential Impact Identified	Recommendation	Management Strategy
	- Re-calibrate the numerical model after 2 years of operation and revise drawdown predictions	
Subterranean fauna	- Set trigger levels - Undertake on-going monitoring program - Validate and if necessary, re-calibrate the numerical model after two years of operation of the borefield and revise drawdown predictions and reset trigger levels, if needed	- Monitoring and sampling Plan - Use the Kumarina borefield in parallel with the Ten Mile South and Beyondie Borefields to optimise abstraction strategy
Groundwater Dependent Vegetation	- Set trigger levels - Undertake on-going vegetation condition monitoring program - Validate and if necessary, re-calibrate the numerical model after one or two years of operation of the borefield and revise drawdown predictions and reset trigger levels, if needed	- Monitoring and sampling Plan - Use the Kumarina borefield in parallel with the Ten Mile South and Beyondie Borefields to optimise abstraction strategy - optimise abstraction strategy
Contaminant risks to shallow aquifer and the environment from site operations	- Appropriately contained and bunded fuel storage - Implement a spill- prevention and spill-response strategy - Include hydrocarbon- indicator analytes in the monitoring program near potential fuel storage areas - Assess contamination at regular intervals and analyse for indicator analytes in the vicinity of potential anthropogenic activities	- Contamination response plan - Spill response strategies

8.5 Ongoing Monitoring and Management Plan

The monitoring program shall be designed as outlined in Table 8-4 and Table 8-5.

Table 8-4: Recommended Monitoring Plan

Management Activity	Description
Undertake baseline monitoring	▪ A baseline monitoring network has been established for the site. Monthly monitoring of water levels and field chemistry shall be undertaken in line with licence conditions. ▪ Continuous water level monitoring loggers should be used at key monitoring locations.
Establish trigger Levels	▪ Trigger levels for water levels and chemistry should be developed for key monitoring locations in consultation with DWER. ▪ Trigger levels should be implemented for key regional monitoring locations. ▪ Trigger levels should be documented in a Groundwater Licence Operating Strategy. ▪ Preliminary trigger levels are presented below based on the percent of aquifer saturated thickness of the calcreted alluvium available in monitoring bores adjacent to production bores. A management trigger is set at 50% of the alluvial and calcrete saturated thickness and would mean that abstraction has to be reduced at this location. A stop pumping trigger is set at 30% of the saturated alluvial and calcrete where pumping should cease at the adjacent production bore and water levels are allowed to recover to above the management trigger. Jaydinia Bore ▪ Management Trigger – 8m bgl ▪ Stop Pumping Trigger – 10m bgl KMB06 ▪ Management Trigger – 7.8m bgl ▪ Stop Pumping Trigger – 9.9m bgl KMB01 ▪ Management Trigger – 7.7m bgl ▪ Stop Pumping Trigger – 9.8m bgl
Update and validate numerical models and undertake recalibration if deemed necessary	▪ The groundwater models shall be updated, recalibrated if more exploration data is obtained ▪ The model shall be validated after the first one or two years of operations and every five years thereafter, or when additional monitoring data becomes available to consolidate the conceptual model and also recalibrate, if necessary.

Table 8-5: Proposed Preliminary Monitoring Locations

Monitoring	Location	Frequency
Groundwater Level	KPB01, KPB02, KMB01, KMB02, KMB03, KMB04, KMB05, KMB06, Jaydinia Bore, Jonny's pool bore, Kumarina Bore South 2, Kumarina Homestead bore, Main Yard Bore	Monthly
	Continuous logger monitoring: KPB01, KPB02, Jaydinia Bore, KMB01, KMB06,	Continuous
Creek water level	Continuous logger monitoring: location TBD	Continuous
Field water quality – EC, TDS, pH	KPB01, KPB02, Kumarina Homestead Bore	Monthly
Laboratory Analysis of Groundwater chemistry	KPB01, KPB02, Kumarina Homestead Bore	Quarterly
Laboratory Analysis of Groundwater chemistry	Jonny's Pool Bore, Main Yard Bore	Annual

9 Summary and Conclusions

Groundwater investigations have targeted a shallow calcrete and alluvial aquifer in conjunction with fractured bedrock associated with structural features in the vicinity of the Jaydinia Syncline. Two production bores have been installed, one of these bores (KPB01) has been test pumped, whilst an existing pastoral bore (Kumarina Bore South 2) was also tested. Both aquifer tests have been pumped at relatively high rates of approximately 18 L/s for three days with minimal drawdown (less than 3m in the production bores). Water level drawdown responses during the test pumping encountered local no flow boundaries and recharge boundaries meaning a highly transmissive, relatively complex unconfined aquifer system exists. Monitoring of water levels in bores over the 2018 wet season measured a recharge event associated with an approximate annual to two-year recurrence flood event in the upper Gascoyne River, this resulted in measured recharge to the aquifer.

A groundwater model has been developed and appropriately calibrated to regional water levels, the recharge event, and test pumping. A number of predictive abstraction scenarios and sensitivity analysis were completed to understand the most optimal scenario for the borefield yield and impact assessment. The 0.75 GLpa scenario was used to complete the impact assessment as this was considered a more conservative abstraction rate and would meet the Stage 1 process water supply requirements for the project.

The results of the impact assessment suggest that potential groundwater drawdown impacts to stygofauna and potential groundwater dependent vegetation can be managed through the use of water level management trigger levels. The triggers adopted are in reference to those adopted at the Gruyere Project (MBS Environmental), but taking into account the variable nature of the host aquifer and where stygofauna has been found. At Kumarina the stygofauna are likely to inhabit the alluvial, calcrete and fractured bedrock zones and are considered to be able to migrate between these lithologies. Therefore the 50% management trigger and 30% shut off trigger are considered conservative as they only consider the calcreted alluvial portion of the aquifer.

The 0.75 GLpa abstraction scenario predicts that the 50% management trigger levels set within the calcreted alluvium will not be triggered within the first five years of abstraction, whilst the 30% shut off triggers will not be triggered during the first ten years of abstraction. Therefore, the proposed borefield could meet the initial Stage 1 abstraction of 0.75 GLpa for up to Ten Years. When the proposed Kumarina borefield is operated in-conjunction with the other proposed KLL water supply borefields, these combinations are anticipated to be able to meet the Stage 2 abstraction for up to 1.5 GLpa and will be detailed in future reporting and an operating strategy for the project.

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Appendix A Lithological Logs

Expl. Hole ID	Bore ID	Date	From	To	Colour	Lithology	Description
KWS02	KMB01	Mar-18	0	2		Gravel and Sand	Dark red brown to grey rounded to sub angular gravel and sand
KWS02	KMB01	Apr-18	2	8		Sand and Gravel	Cream clayey calcrete, sand and gravel
KWS02	KMB01	May-18	8	11		Sand with Silcrete	Light grey silcrete and sand, opeline silica
KWS02	KMB01	Jun-18	11	30		no returns (voids)	No drilling returns, void at 11m
KWS01	KPB01	Dec-17	0	5		Calcrete	Cream to red brown calcrete, vuggy with stained faces
KWS01	KPB01	Dec-17	5	8		Calcreted alluvium	red brown silty gravel with calcrete
KWS01	KPB01	Dec-17	8	10		Alluvium	Red brown gravel and cobbles with silt and sand
KWS01	KPB01	Dec-17	10	13		Weathered mudstone and calcrete	Light grey to cream finely laminated mudstone, with clay and calcrete
KWS01	KPB01	Dec-17	13	30		Weathered mudstone	Cream to light grey finely laminated mudstone with broken zones at 20m and 24m, very wet at 17m.
KWS01	KPB01	Dec-17	30	31		Mudstone	Dark grey fresh mudstone
KWS03	KMB02	Dec-17	0	3		Alluvium	Red brown gravel with sand and silt
KWS03	KMB02	Dec-17	3	6		Calcreted alluvium	Red to cream calcreted gravel and clay, damp at 6m
KWS03	KMB02	Dec-17	6	8		Clay	red brown sand clay
KWS03	KMB02	Dec-17	8	11		Alluvium	Gravel with silt and clay, trace sand, wet from 11m
KWS03	KMB02	Dec-17	11	14		Weathered Siltstone	Reddish brown to light grey weathered siltstone
KWS03	KMB02	Dec-17	14	23		Siltstone	Light grey to dark grey finely laminated fresh siltstone with interbedded sandstone
KWS04a		Dec-17	0	7		Alluvium	Red to brown gravel with silt and sand, gravel is siltstone sub angular to rounded
KWS04a		Dec-17	7	21		Weathered dolerite	Green to brown weathered dolerite
KWS04a		Dec-17	21	23		Dolerite	Dark grey medium grained fresh dolerite, refusal
KWS04b		Dec-17	0	6		Alluvium	red brown to grey silty gravel and cobbles, gravel is rounded to sub angular, ferricreted from 4m
KWS04b		Dec-17	6	12		Calcreted alluvium	Cream to red calcreted silty gravel, damp from 8m
KWS04b		Dec-17	12	20		Weathered dolerite	Dark brown to green moderately weathered dolerite
KWS04b		Dec-17	20	21		Dolerite	Fresh dark grey to green dolerite, blade refusal
KWS05		Dec-17	0	6		Calcreted alluvium	Cream to dark brown calcrete and gravelly sand, calcrete is generally massive, vuggy at 3m.
KWS05		Dec-17	6	22		Weathered dolerite	Dark grey green highly weathered dolerite with discrete silcrete and calcrete bands throughout
KWS05		Dec-17	22	24		Dolerite	Dark grey moderately weathered dolerite fine grained, large blocky chips with iron stained faces
KWS06		Dec-17	0	3		Alluvium	Light cream to light brown silty gravel with sand and minor calcrete
KWS06		Dec-17	3	6		Calcrete	Light cream calcrete, massive.
KWS06		Dec-17	6	21		Weathered mudstone	Green to dark grey fine grained altered mudstone, finely laminated and blocky with clay
KWS06		Dec-17	21	24		Mudstone	Dark grey metamorphosed mudstone
KWS07		Jan-18	0	18		Alluvium	Dry alluvials and calcrete
KWS07		Feb-18	18	30		Bedrock	Bedrock
KWS08		Dec-17	0	3		Alluvium	red to brown gravel and cobbles with silt
KWS08		Dec-17	3	13		Weathered mudstone	Light cream to grey finely laminated mudstone
KWS08		Dec-17	13	14		Mudstone	Dark grey metamorphic mudstone
KWS09		Dec-17	0	2		Alluvium	Dark red brown silt and gravel
KWS09		Dec-17	2	6		Dolerite	Green to cream highly weathered dolerite with iron stained faces
KWS11	KMB03	Dec-17	0	9		Alluvium	Red to brown gravel and cobbles with silt and sand, becoming more silty with depth
KWS11	KMB03	Dec-17	9	20		Alluvium	red brown sandy gravelly silt, with gravel bands at 18 and 20m calcrete nodules at 17m
KWS11	KMB03	Dec-17	20	26		Mudstone	Light grey to cream finely laminated mudstone
KWS12		Dec-17	0	3		Alluvium	Red brown sandy silt with gravel
KWS12		Dec-17	3	5		Alluvium	Red to dark brown sub angular to angular gravel
KWS12		Dec-17	5	19		Highly weathered siltstone	Grey to cream finely laminated weathered siltstone, with iron stained faces
KWS12		Dec-17	19	21		Highly weathered siltstone	Purple to red weathered siltstone with clay
KWS12		Dec-17	21	22		Weathered Siltstone	Green to cream finely bedded siltstone
KWS19		Dec-17	0	3		Alluvium	Red to dark brown silt and gravel, minor calcrete at 3m
KWS19		Dec-17	3	12		Weathered Siltstone	Light grey to cream weathered siltstone, becoming less weathered and darker with depth
KWS21	KMB06 and KPB02	May-18	0	2	RDCM	Calcrete/Ferrigenous Gravel	
KWS21	KMB06 and KPB02	May-18	2	11	RDBN	Weathered ferrigenous gravel	weathered zone - ferrigenous gravel (Fe alteration) minor calcrete
KWS21	KMB06 and KPB02	May-18	11	22	LBN	Ferrigenous Saprock	Weatherd zone - Ferrigenous saprock - haematite rich
KWS21	KMB06 and KPB02	May-18	22	26	LGYRD	Gravel/Saprock	Less weathered - Gravel/Saprock
KWS21	KMB06 and KPB02	May-18	26	29	LGY	Shale/siltstone/gravel	Less weathered - Shale/siltstone/gravel - He alteration on surfaces
KWS21	KMB06 and KPB02	May-18	29	31	LBN	Clay	Clay rich zone - Light brown - Potential fracture zone
KWS21	KMB06 and KPB02	May-18	31	34	LGYBN	Siltstone	

Expl. Hole ID	Bore ID	Date	From	To	Colour	Lithology	Description
KWS21	KMB06 and KPB02	May-18	34	41	DGY	Mudstone	Dark grey with red brown weathered surfaces. Some large chips up to 2cm in size. Subangular with flat, smooth bedding surfaces. Visible fine veining
KWS20	KMB05	May-18	0	6	GYL	Calcrete	
KWS20	KMB05	May-18	6	12	BRN	Weathered Seds and minor calcrete	Brown alluvium, sand gravel and clay with minor calcrete
KWS20	KMB05	May-18	12	21	GYL	Saprolite	Light Grey, somewhat weathered
KWS20	KMB05	May-18	21	23		Saprolite	more wheatherd than previous interval
KWS20	KMB05	May-18	23	26		Calcrete	calcrete with clay
KWS20	KMB05	May-18	26	30		Weathered siltstone	
KWS22	KMB04	May-18	0	2	RDCM	Alluvium and Calcrete	
KWS22	KMB04	May-18	2	4	CM	Calcrete	Vuggy with stained faces
KWS22	KMB04	May-18	4	14	LGYBN	Saprolite	Weathered Siltstone
KWS22	KMB04	May-18	14	19	LBN	Clay and Saprock	
KWS22	KMB04	May-18	19	26	LGY	Weathered Gabbro	Transition zone
KWS22	KMB04	May-18	26	36	DGY	Gabbro	Fresh Gabbro - Plagioclase phenocrysts (pink, up to 1 mm in size) and Pyroxene (black) with Olivine (green), and possible amphibole (black crystals)

Appendix B Bore Construction Diagrams

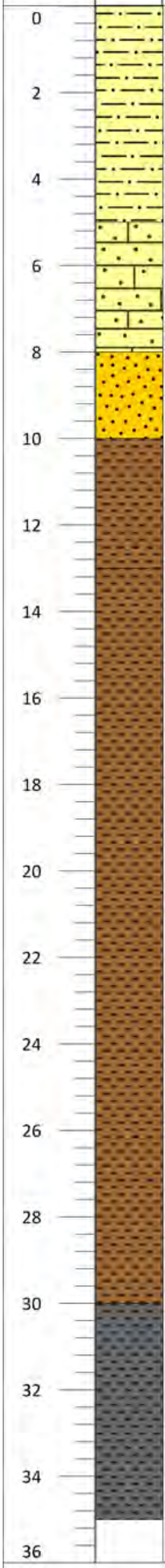
BORE CONSTRUCTION DIAGRAM, KUMARINA — KPB01

Drilling company	Austral Drilling Services	**Grid/Zone**	AMG Zone 50	**SWL**	3.95 m bgl 593.6 mAHD (02/05/2018)
Logged by	Adam Lloyd	**Easting**	763403		
Date	Dec-2017	**Northing**	7259922	**TDS**	1800 mg/L
		Elevation	597.6 mAHD	**pH**	8.3

Advisian WorleyParsons Group

KALIUM LAKES

Depth (m)	Lithology	Lithological description
0–5		CALCRETE - Cream to red brown calcrete, vuggy with stained faces
5–8		CALCRETED ALLUVIUM - red brown silty gravel with calcrete
8–10		ALLUVIUM - Red brown gravel and cobbles with silt and sand
10–13		WEATHERED MUDSTONE AND CALCRETE - Light grey to cream finely laminated mudstone, with clay and calcrete
13–30		WEATHERED MUDSTONE - Cream to light grey finely laminated mudstone with broken zones at 20m and 24m, very wet at 17m.
30–35		MUDSTONE - Dark grey fresh mudstone



Bore construction diagram

BORE CONSTRUCTION DIAGRAM, KUMARINA — KPB02

Drilling company	Austral Drilling Services	**Grid/Zone**	AMG Zone 50	**SWL**	3.68 m bgl 593.5 mAHD (04/05/2018)
Logged by	A. Turner	**Easting**	763918		
Date	May-2018	**Northing**	7260019	**TDS**	1500 mg/L
		Elevation	597 mAHD	**pH**	8.1

Advisian WorleyParsons Group — KALIUM LAKES

Depth (m)	Lithological description	Airlift Yield
0 – 2	CALCRETE AND GRAVEL - Red cream ferrigenous gravel with calcrete	
2 – 11	GRAVEL - Red brown weathered ferrigenous gravel (Fe alteration) minor calcrete	0.3 L/s
11 – 22	SAPROCK - Light brown Ferrigenous saprock - weathered siltstone, and haematite rich gravel (possible transported, rounded edges)	
22 – 26	SAPROCK - Light grey red, Less weathered	
26 – 29	SILTSTONE - light grey - some Iron alteration on surfaces	
29 – 31	CLAY - Clay rich zone - Light brown - Potential fracture zone	
31 – 34	SILTSTONE - light grey brown	4 L/s
34 – 41	MUDSTONE - dark grey with red brown weathered surfaces. Some large chips up to 2cm in size. Subangular with flat, smooth bedding surfaces. Visible fine veining	5 L/s

Bore construction diagram

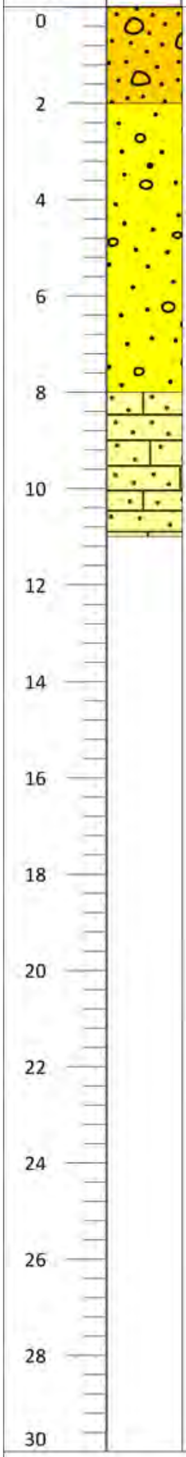
- Concrete block
- 10" PVC Surface casing - cemented - 0 to 5m
- Cement Bentonite Grout Seal - approx 2 to 4 m bgl
- Static Water Level - 3.68 mbgl
- Blank Casing - 155 mm - CL12uPVC - 0 to 6 mbgl (1 length)
- 8.5" drill hole diameter
- Gravel Pack - 0 to 2 and 4 to 41 mbgl
- Slotted Casing- 155 mm - CL12uPVC - 6 to 41 mbgl (5.8 lengths) 1 mm aperture
- EOH 41 mbgl

BORE CONSTRUCTION DIAGRAM, KUMARINA — KMB01

Drilling company	Austral Drilling Services	**Grid/Zone**	AMG Zone 50	**SWL**	2.94 m bgl 593.5 mAHD (02/05/2018)
Logged by	Adam Lloyd	**Easting**	763306		
Date	Dec-2017	**Northing**	7259546		
		Elevation	596.5 mAHD		

Advisian WorleyParsons Group — KALIUM LAKES

Depth (m)	Lithology	Lithological description
0–2		GRAVEL AND SAND - Dark red brown to grey rounded to sub angular gravel and sand
2–8		SAND AND GRAVEL - Cream clayey calcrete, sand and gravel
8–11		SAND WITH SILCRETE - Light grey silcrete and sand, opeline silica
11–30		No drilling returns, void at 11m



Bore construction diagram

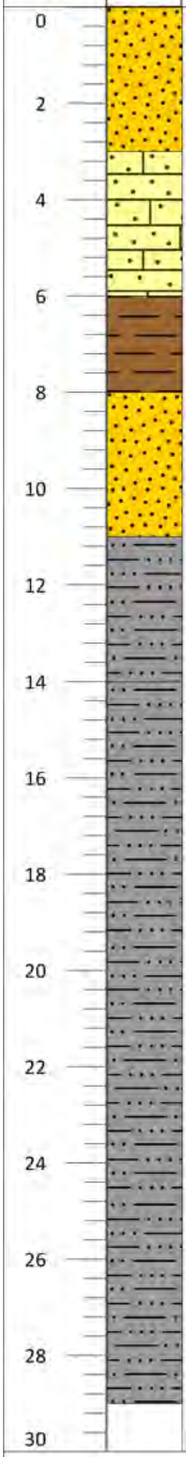
- Cement Bentonite Grout Seal - approx 1-1.5 m bgl
- Static Water Level - 2.94 mbgl
- Blank Casing - 50 mm - CL9uPVC - 0 to 5 mbgl (0.8 lengths)
- 6" drill hole diameter
- Slotted Casing- 50 mm - CL9uPVC - 5 to 29 mbgl (4 lengths) 1 mm aperture
- Gravel Pack - 0 to 29 mbgl
- EOH 29 mbgl

BORE CONSTRUCTION DIAGRAM, KUMARINA — KMB02

Drilling company	Austral Drilling Services	**Grid/Zone**	AMG Zone 50	**SWL**	6.64 m bgl 587.3 mAHD (02/05/2018)
Logged by	Adam Lloyd	**Easting**	763648		
Date	Dec-2017	**Northing**	7258326		
		Elevation	593.9 mAHD		

Advisian WorleyParsons Group — KALIUM LAKES

Depth (m)	Lithology	Lithological description	Bore construction diagram



ALLUVIUM - Red brown gravel with sand and silt

CALCRETED ALLUVIUM - Red to cream calcreted gravel and clay, damp at 6m

CLAY - red brown sand clay

ALLUVIUM - Gravel with silt and clay, trace sand, wet from 11m

WEATHERED SILTSTONE - Reddish brown to light grey weathered siltstone

SILTSTONE - Light grey to dark grey finely laminated fresh siltstone with interbedded sandstone

Cement Bentonite Grout Seal - approx 1-1.5 m bgl

Blank Casing - 50 mm - CL9uPVC - 0 to 5 mbgl (0.8 lengths)

Static Water Level - 6.64 mbgl

6" drill hole diameter

Slotted Casing- 50 mm - CL9uPVC - 5 to 29 mbgl (4 lengths) 1 mm aperture

Gravel Pack - 0 to 29 mbgl

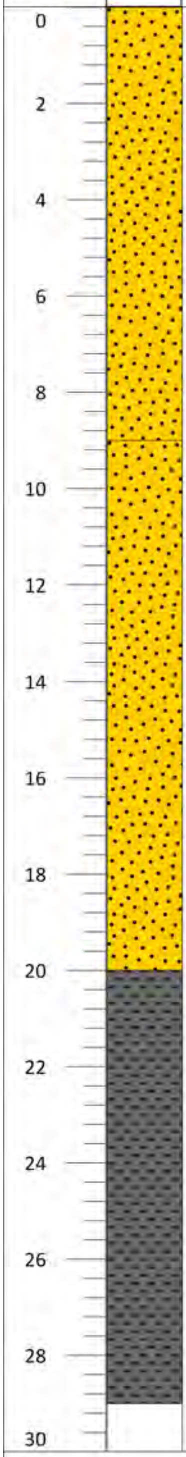
EOH 29 mbgl

BORE CONSTRUCTION DIAGRAM, KUMARINA — KMB03

Drilling company	Austral Drilling Services	**Grid/Zone**	AMG Zone 50	**SWL**	8.21 m bgl 582.5 mAHD (02/05/2018)
Logged by	Adam Lloyd	**Easting**	763737		
Date	Dec-2017	**Northing**	7255460		
		Elevation	590.7 mAHD		

Advisian WorleyParsons Group — KALIUM LAKES

Depth (m) | **Lithology** | **Lithological description** | **Bore construction diagram**



ALLUVIUM - Red to brown gravel and cobbles with silt and sand, becoming more silty with depth

ALLUVIUM - red brown sandy gravelly silt, with gravel bands at 18 and 20m calcrete nodules at 17m

MUDSTONE - Light grey to cream finely laminated mudstone

Cement Bentonite Grout Seal - approx 1-1.5 m bgl

Blank Casing - 50 mm - CL9uPVC - 0 to 5 mbgl (0.8 lengths)

Static Water Level - 8.21 mbgl

6" drill hole diameter

Slotted Casing- 50 mm - CL9uPVC - 5 to 29 mbgl (4 lengths) 1 mm aperture

Gravel Pack - 0 to 29 mbgl

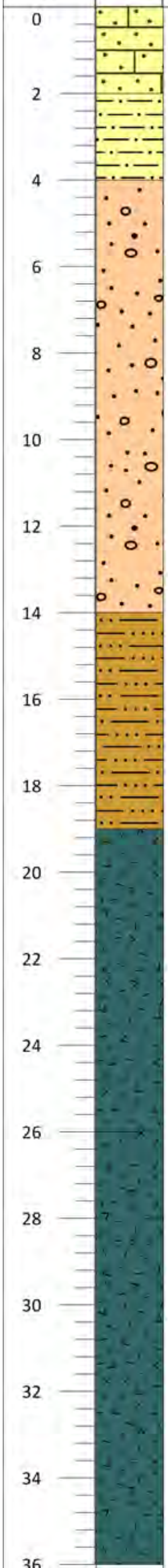
EOH 29 mbgl

BORE CONSTRUCTION DIAGRAM, KUMARINA — KMB04

Drilling company	Austral Drilling Services	**Grid/Zone**	AMG Zone 50	**SWL**	5.29 m bgl 593.4 mAHD (02/05/2018)
Logged by	A. Turner	**Easting**	764250		
Date	May-2018	**Northing**	7260273		
		Elevation	599 mAHD		

Advisian WorleyParsons Group — KALIUM LAKES

Depth (m)	Lithology	Lithological description
0–2		ALLUVIUM AND CALCRETE - red cream
2–4		CALCRETE - Cream to red brown calcrete, vuggy with stained faces
4–14		SAPROLITE - Light grey brown weathered Siltstone
14–19		CLAY AND SAPROCK - light brown
19–26		WEATHERED GABBRO - Light grey, Transition zone
26–36		GABBRO - Dark grey fresh gabbro - Plagioclase phenocrysts (pink, up to 1 mm in size) and Pyroxene (black) with Olivine (green), and possible amphibole (black crystals)



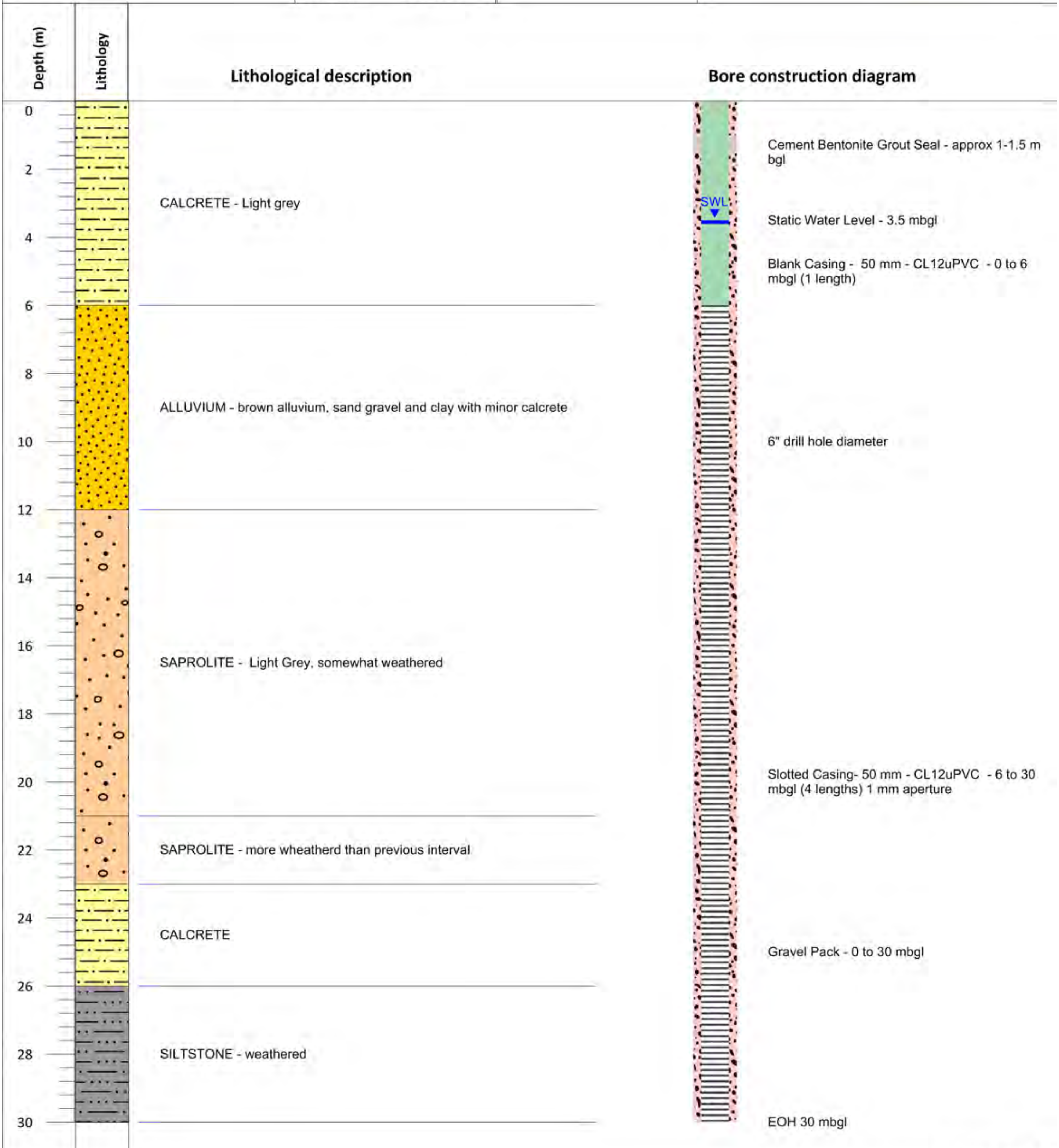
Bore construction diagram

- Cement Bentonite Grout Seal - approx 1-1.5 m bgl
- Blank Casing - 50 mm - CL12uPVC - 0 to 6 mbgl (1 length)
- Static Water Level - 5.29 mbgl
- 6" drill hole diameter
- Slotted Casing- 50 mm - CL12uPVC - 6 to 36 mbgl (5 lengths) 1 mm aperture
- Gravel Pack - 0 to 36 mbgl
- EOH 36 mbgl

BORE CONSTRUCTION DIAGRAM, KUMARINA — KMB05

Drilling company	Austral Drilling Services	**Grid/Zone**	AMG Zone 50	**SWL**	3.5 m bgl 593.4 mAHD (02/05/2018)
Logged by	A. Turner	**Easting**	763633		
Date	May-2018	**Northing**	7259729		
		Elevation	597 mAHD		

Advisian WorleyParsons Group — KALIUM LAKES



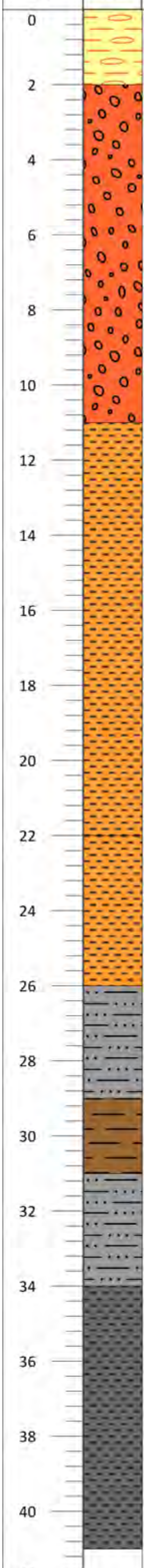
BORE CONSTRUCTION DIAGRAM, KUMARINA KMB06

Drilling company	Austral Drilling Services	**Grid/Zone**	AMG Zone 50	**SWL**	2.54 m bgl 594.3 mAHD (02/05/2018)
Logged by	A. Turner	**Easting**	763915		
Date	May-2018	**Northing**	7260023		
		Elevation	597 mAHD		

Advisian WorleyParsons Group

KALIUM LAKES

Lithological description



CALCRETE AND GRAVEL - Red cream ferrigenous gravel with calcrete

GRAVEL - Red brown weathered ferrigenous gravel (Fe alteration) minor calcrete

SAPROCK - Light brown Ferrigenous saprock - weathered siltstone, and haematite rich gravel (possible transported, rounded edges)

SAPROCK - Light grey red, Less weathered

SILTSTONE - light grey - some Iron alteration on surfaces

CLAY - Clay rich zone - Light brown - Potential fracture zone

SILTSTONE - light grey brown

MUDSTONE - dark grey with red brown weathered surfaces. Some large chips up to 2cm in size (subangular with flat, smooth bedding surfaces). Visible fine veining.

Bore construction diagram

Cement Bentonite Grout Seal - approx 1-1.5 m bgl

Static Water Level - 2.54 mbgl

Blank Casing - 50 mm - CL12uPVC - 0 to 6 mbgl (1 length)

6" drill hole diameter

Slotted Casing- 50 mm - CL12uPVC - 6 to 41 mbgl (5,8 lengths) 1 mm aperture

Gravel Pack - 0 to 41 mbgl

EOH 41 mbgl

Appendix C Groundwater Chemistry

Bureau Veritas Minerals Pty Ltd
MINERAL TESTING & LABORATORY SERVICES

ABN: 30 008 127 802
58 Sorbonne Crescent Canning Vale
Perth WA 6155 Australia
Telephone (08) 9456 0404
Facsimile (08) 9456 0403

Reference: **u285000**
Date Finished: 26/03/2018
Order:
Project: BRAD CRIBB
Date Received: 09/03/2018
Samples Analysed: **2**

FINAL ANALYSIS REPORT

Analysis of Mineral Samples

for

Kalium Lakes Potash Pty Ltd

1 Sylvania Station Access Road Accs Newman WA 6753

Attention: Mr B Cribb

Authorised By:

Tom Lowther
Operations Manager
Bureau Veritas Minerals Pty Ltd

Bureau Veritas Minerals Pty Ltd
MINERAL TESTING & LABORATORY SERVICES

ABN: 30 008 127 802
58 Sorbonne Crescent Canning Vale
Perth WA 6155 Australia
Telephone (08) 9456 0404
Facsimile (08) 9456 0403

Reference: u285000 **Order Number:**

	Ca mg/L	K mg/L	Na mg/L	Mg mg/L
Detection Limit	1	10	10	5
CRT START	106	30	380	150
CRT START Rpt	102	30	370	145
CRT END	105	30	380	150
CRT END Rpt	104	30	380	145
Std Nominal	100	50	2300	105
Determined	104	60	2390	105
Std Nominal	1000	<10	<10	1000
Determined	1020	<10	<10	1010
Std Nominal	2		<10	10000
Determined	2	20	<10	9990
Std Nominal		24400		
Determined	<1	24100	<10	<5
Std Nominal	2000	9750	20000	2000
Determined	1970	10000	21000	1900
Std Nominal	<1	<10	10000	<5
Determined	<1	<10	10000	<5
Std Nominal			100000	
Determined	<1	20	100000	<5

****

Bureau Veritas Minerals Pty Ltd
MINERAL TESTING & LABORATORY SERVICES

ABN: 30 008 127 802
58 Sorbonne Crescent Canning Vale
Perth WA 6155 Australia
Telephone (08) 9456 0404
Facsimile (08) 9456 0403

Reference: u285000 **Order Number:**

	SO4 mg/L	PO4 mg/L	Al mg/L	Fe mg/L
Detection Limit	10	10	1	1
CRT START	300	<10	1	<1
CRT START Rpt	330	<10	1	<1
CRT END	330	<10	<1	<1
CRT END Rpt	330	<10	1	<1
Std Nominal	210		100	200
Determined	210	60	101	205
Std Nominal			<1	<1
Determined	<10	<10	<1	<1
Std Nominal			4	2
Determined	<10	<10	3	2
Std Nominal	30000			
Determined	30600	<10	2	<1
Std Nominal	12000			
Determined	12100	<10	<1	1
Std Nominal	<10		<1	<1
Determined	<10	<10	<1	<1
Std Nominal				
Determined	<10	<10	1	2

****

ABN: 30 008 127 802
58 Sorbonne Crescent Canning Vale
Perth WA 6155 Australia
Telephone (08) 9456 0404
Facsimile (08) 9456 0403

Reference: u285000 **Order Number:**

	Mn mg/L	SiO2 mg/L	Hardness mg/L	TDS mg/L
Detection Limit	0.5	10	1	50
CRT START	<0.5	70	890	A1.900000
CRT START Rpt	<0.5	70	859	A1.750000
CRT END	<0.5	70	881	A1.750000
CRT END Rpt	<0.5	80	863	A1.950000
Std Nominal	20.0	110		
Determined	20.5	110	1700	A150.6000
Std Nominal	<0.5	<10		
Determined	<0.5	<10	6700	A250.5500
Std Nominal	1.5	<10		
Determined	2.0	<10	41200	NR
Std Nominal				
Determined	<0.5	<10	11	NR
Std Nominal				
Determined	<0.5	<10	NR	NR
Std Nominal	<0.5	<10		
Determined	<0.5	<10	NR	NR
Std Nominal				
Determined	<0.5	<10	NR	NR

****

Bureau Veritas Minerals Pty Ltd
MINERAL TESTING & LABORATORY SERVICES

ABN: 30 008 127 802
58 Sorbonne Crescent Canning Vale
Perth WA 6155 Australia
Telephone (08) 9456 0404
Facsimile (08) 9456 0403

Reference: u285000 **Order Number:**

	pH	Alkalinity mg/L	CO3 mg/L	HCO3 Alk mg/L
Detection Limit	0.01	10	10	10
CRT START	8.31	460	<10	460
CRT START Rpt	8.31	460	<10	460
CRT END	8.37	460	<10	460
CRT END Rpt	8.40	460	<10	460
Std Nominal				
Determined	3.96	160	<10	160
Std Nominal				
Determined	7.01	420	40	380
Std Nominal				
Determined	9.99	NR	NR	NR
Std Nominal				
Determined	NR	NR	NR	NR
Std Nominal				
Determined	NR	NR	NR	NR
Std Nominal				
Determined	NR	NR	NR	NR
Std Nominal				
Determined	NR	NR	NR	NR

****

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MINERAL TESTING & LABORATORY SERVICES

ABN: 30 008 127 802
58 Sorbonne Crescent Canning Vale
Perth WA 6155 Australia
Telephone (08) 9456 0404
Facsimile (08) 9456 0403

Reference: u285000 **Order Number:**

	OH Alk mg/L	NO3 mg/L	Cl mg/L	Cond mS/cm
Detection Limit	10	1	50	0.01
CRT START	<10	20	550	2.96
CRT START Rpt	<10	20	550	2.97
CRT END	<10	22	550	2.99
CRT END Rpt	<10	22	550	2.99
Std Nominal				
Determined	<10	9	500	1.42
Std Nominal				
Determined	<10	19	950	2.78
Std Nominal				
Determined	NR	NR	NR	NR
Std Nominal				
Determined	NR	NR	NR	NR
Std Nominal				
Determined	NR	NR	NR	NR
Std Nominal				
Determined	NR	NR	NR	NR
Std Nominal				
Determined	NR	NR	NR	NR

****

****

These results pertain to the samples as received at this laboratory.
Where standards are reported, the nominal value for the element is reported above the result found.

"NR" Implies result is not required for this determination

Sample Storage
****

The excess material (Residue) will be held after 30 days

The pulp samples (Pulp) will be held after 60 days as per instructions.

Sample Preparation
****

Digest and Analysis:
****

Conductivity has been determined by direct measurement with a conductivity meter.

Cond
have been determined using a conductivity meter.

ABN: 30 008 127 802
58 Sorbonne Crescent Canning Vale
Perth WA 6155 Australia
Telephone (08) 9456 0404
Facsimile (08) 9456 0403

Reference: u285000 **Order Number:**

Hardness has been calculated from the analysis of Calcium, Magnesium, Strontium, Iron, Aluminium, Zinc and Manganese.

pH has been determined by direct measurement with a pH meter.

pH
have been determined using a pH meter.

Test for Alkalinity

Alkalinity,CO3,HCO3,Alk,OH,Alk
have been determined volumetrically.

Samples have been evaporated to constant dryness at 180C. The remaining salt is cooled and analysed gravimetrically.

TDS
have been Gravimetric

Chloride in solution

Cl
have been determined volumetrically.

The solutions have not been treated other than by dilution.

Al,Ca,Fe,K,Mg,Mn,Na,PO4,SiO2,SO4
have been determined by Inductively Coupled Plasma (ICP) Optical Emission Spectrometry.
NO3
have been determined colourimetrically.

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MINERAL TESTING & LABORATORY SERVICES

ABN: 30 008 127 802
58 Sorbonne Crescent Canning Vale
Perth WA 6155 Australia
Telephone (08) 9456 0404
Facsimile (08) 9456 0403

Reference: **u286989.b**
Date Finished: 22/05/2018
Order:
Project: BRAD CRIBB
Date Received: 15/05/2018
Samples Analysed: **1**

FINAL ANALYSIS REPORT

Analysis of Mineral Samples

for

Kalium Lakes Potash Pty Ltd

1 Sylvania Station Access Road Accs Newman WA 6753

Attention: Mr B Cribb

Authorised By:

Tom Lowther
Operations Manager
Bureau Veritas Minerals Pty Ltd

Bureau Veritas Minerals Pty Ltd
MINERAL TESTING & LABORATORY SERVICES

ABN: 30 008 127 802
58 Sorbonne Crescent Canning Vale
Perth WA 6155 Australia
Telephone (08) 9456 0404
Facsimile (08) 9456 0403

Reference: u286989.b **Order Number:**

	Ca mg/L	K mg/L	Na mg/L	SO4 mg/L
Detection Limit	0.5	1	1	2
KPB02-end-development	113	19	244	204
KPB02-end-development Rpt	112	19	243	204
Std Nominal	16.5	2	65	16
Determined	16.5	3	64	16
Std Nominal	100	130	125	300
Determined	103	132	126	306
Std Nominal	100	54	2300	210
Determined	100	54	2280	210
Std Nominal				
Determined	NR	NR	NR	NR
Std Nominal				
Determined	NR	NR	NR	NR
Std Nominal				
Determined	NR	NR	NR	NR
Std Nominal				
Determined	NR	NR	NR	NR

****

Bureau Veritas Minerals Pty Ltd
MINERAL TESTING & LABORATORY SERVICES

ABN: 30 008 127 802
58 Sorbonne Crescent Canning Vale
Perth WA 6155 Australia
Telephone (08) 9456 0404
Facsimile (08) 9456 0403

Reference: u286989.b **Order Number:**

	PO4 mg/L	Al mg/L	Fe mg/L	Mn mg/L
Detection Limit	2	0.2	0.2	0.1
KPB02-end-development	<2	0.2	<0.2	<0.1
KPB02-end-development Rpt	<2	<0.2	<0.2	<0.1
Std Nominal		<0.2	<0.2	<0.1
Determined	<2	<0.2	<0.2	<0.1
Std Nominal		5.0	5.0	5.0
Determined	312	5.2	5.2	5.1
Std Nominal		100	200	20.0
Determined	64	98.0	199	19.8
Std Nominal				
Determined	NR	NR	NR	NR
Std Nominal				
Determined	NR	NR	NR	NR
Std Nominal				
Determined	NR	NR	NR	NR
Std Nominal				
Determined	NR	NR	NR	NR

****

ABN: 30 008 127 802
58 Sorbonne Crescent Canning Vale
Perth WA 6155 Australia
Telephone (08) 9456 0404
Facsimile (08) 9456 0403

Reference: u286989.b **Order Number:**

	SiO2 mg/L	Hardness mg/L	TDS mg/L	pH
Detection Limit	2	5	50	0.01
KPB02-end-development	60	840	1500A	8.13
KPB02-end-development Rpt	60	835	1600A	8.11
Std Nominal	4			
Determined	4	NR	151000A	4.00
Std Nominal	12			
Determined	10	NR	254000A	6.99
Std Nominal	108			
Determined	106	NR	<50	10.0
Std Nominal				
Determined	NR	NR	<50	NR
Std Nominal				
Determined	NR	NR	<50	NR
Std Nominal				
Determined	NR	NR	<50	NR
Std Nominal				
Determined	NR	NR	<50	NR

****

Bureau Veritas Minerals Pty Ltd
MINERAL TESTING & LABORATORY SERVICES

ABN: 30 008 127 802
58 Sorbonne Crescent Canning Vale
Perth WA 6155 Australia
Telephone (08) 9456 0404
Facsimile (08) 9456 0403

Reference: u286989.b **Order Number:**

	Alkalinity mg/L	CO3 mg/L	HCO3 Alk mg/L	Cl mg/L
Detection Limit	10	10	10	50
KPB02-end-development	500	<10	500	450
KPB02-end-development Rpt	500	<10	500	450
Std Nominal				
Determined	170	<10	170	100
Std Nominal				
Determined	830	60	770	1050
Std Nominal				
Determined	NR	NR	NR	NR
Std Nominal				
Determined	NR	NR	NR	NR
Std Nominal				
Determined	NR	NR	NR	NR
Std Nominal				
Determined	NR	NR	NR	NR
Std Nominal				
Determined	NR	NR	NR	NR

****

ABN: 30 008 127 802
58 Sorbonne Crescent Canning Vale
Perth WA 6155 Australia
Telephone (08) 9456 0404
Facsimile (08) 9456 0403

Reference: u286989.b **Order Number:**

	SG gm/cc	NO3 mg/L
Detection Limit	0.01	1
KPB02-end-development	0.99	10
KPB02-end-development Rpt	1.00	10
Std Nominal		
Determined	1.09	4
Std Nominal		
Determined	1.16	9
Std Nominal		
Determined	NR	NR
Std Nominal		
Determined	NR	NR
Std Nominal		
Determined	NR	NR
Std Nominal		
Determined	NR	NR
Std Nominal		
Determined	NR	NR

****

****

These results pertain to the samples as received at this laboratory.
Where standards are reported, the nominal value for the element is reported above the result found.

"NR" Implies result is not required for this determination

"A" Implies this result reported in g/L

Sample Storage
****

The excess material (Residue) will be held after 30 days

The pulp samples (Pulp) will be held after 60 days as per instructions.

Sample Preparation
****

Digest and Analysis:
****

Hardness has been calculated from the analysis of Calcium, Magnesium, Strontium, Iron, Aluminium, Zinc and Manganese.

ABN: 30 008 127 802
58 Sorbonne Crescent Canning Vale
Perth WA 6155 Australia
Telephone (08) 9456 0404
Facsimile (08) 9456 0403

Reference: u286989.b **Order Number:**

pH has been determined by direct measurement with a pH meter.

pH
have been determined using a pH meter.

Test for Alkalinity

Alkalinity,CO3,HCO3,Alk
have been determined volumetrically.

Samples have been evaporated to constant dryness at 180C. The remaining salt is cooled and analysed gravimetrically.

TDS
have been Gravimetric

Chloride in solution

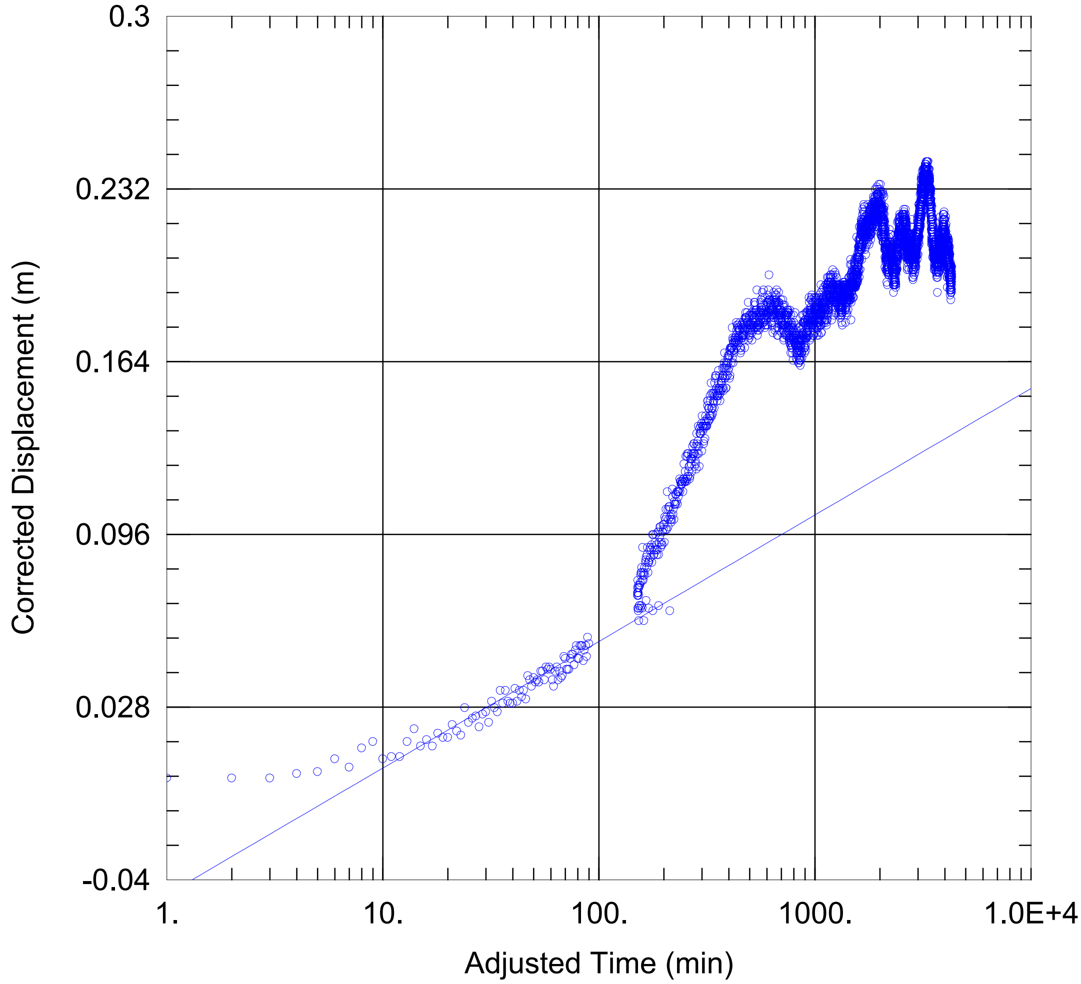
Cl
have been determined volumetrically.

Density of the sample has been determined by liquid pycnometry. Density has been expressed in units of grams per cubic centimeter.

The solutions have not been treated other than by dilution.

Al,Ca,Fe,K,Mn,Na,PO4,SiO2,SO4
have been determined by Inductively Coupled Plasma (ICP) Optical Emission Spectrometry.
NO3
have been determined colourimetrically.

Appendix D Aquifer Test Analysis



KPB01 - CRT - EARLY TIME

Data Set: \...\KPB01_Jaydinia.aqt
Date: 05/24/18 Time: 13:18:30

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: Kumarina
Test Well: KPB01
Test Date: 3/03/2018

AQUIFER DATA

Saturated Thickness: 22. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
KPB01	673404.764	7259910.497

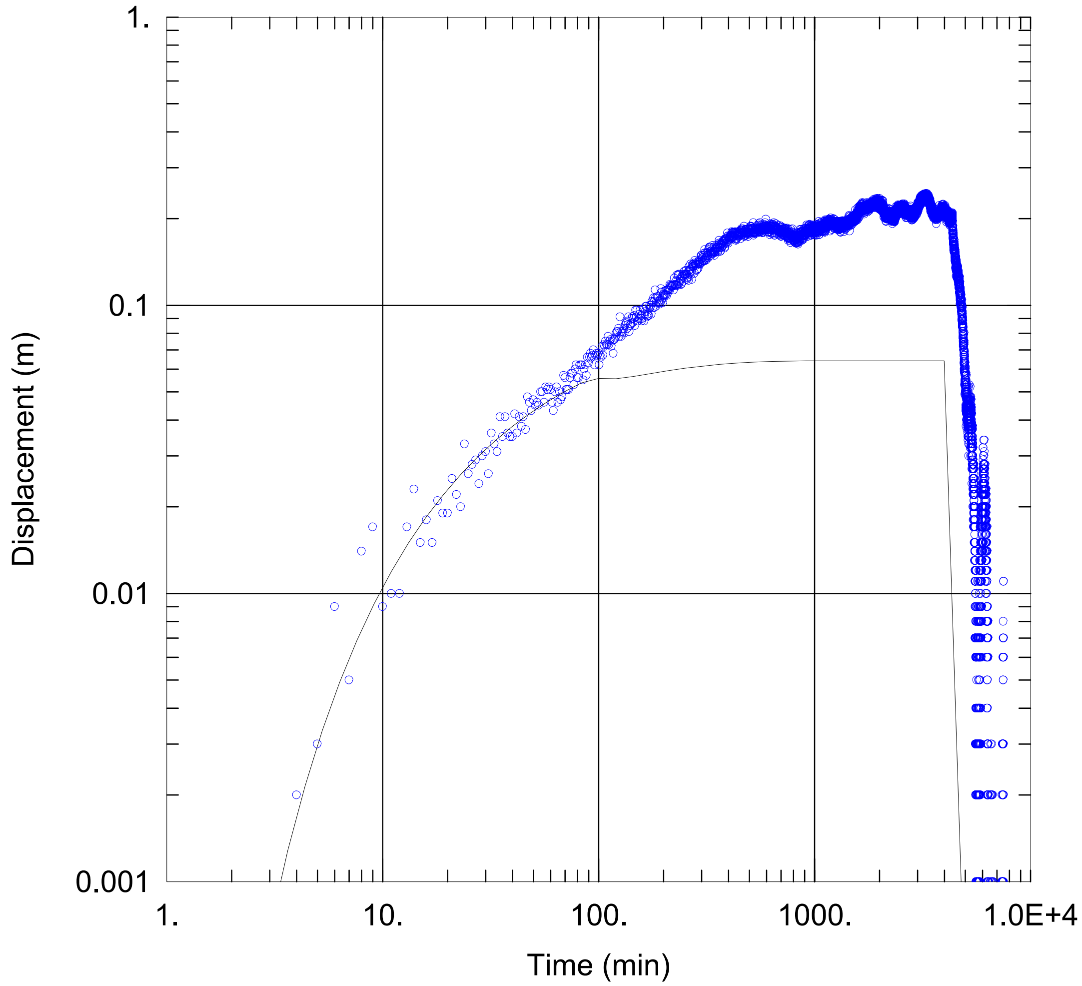
Observation Wells

Well Name	X (m)	Y (m)
○ Jaydinia Bore	763424	7259952

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 5878.9 m^2/day S = 9.42E-9



KPB01 - CRT - EARLY TIME

Data Set: \...\KPB01_Jaydinia.aqt
Date: 05/24/18 Time: 16:20:28

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: Kumarina
Test Well: KPB01
Test Date: 3/03/2018

AQUIFER DATA

Saturated Thickness: 22. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
KPB01	673404.764	7259910.497

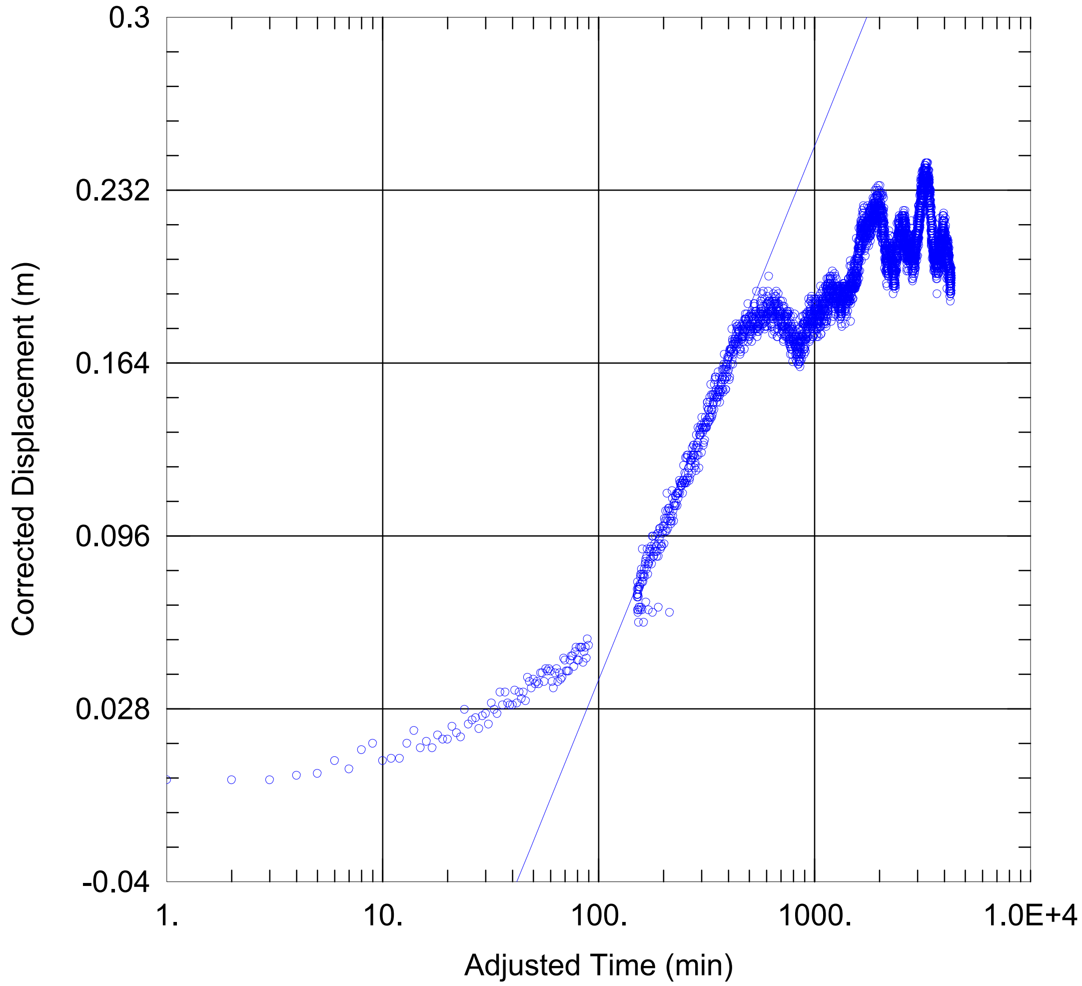
Observation Wells

Well Name	X (m)	Y (m)
○ Jaydinia Bore	763424	7259952

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 3833.5 m^2/day
S = 1.07E-8
Sy = 0.5
ß = 0.06



KPB01 - CRT - MID TIME

Data Set: \...\KPB01_Jaydinia.aqt
Date: 05/24/18 Time: 12:58:13

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: Kumarina
Test Well: KPB01
Test Date: 3/03/2018

AQUIFER DATA

Saturated Thickness: 22. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
KPB01	673404.764	7259910.497

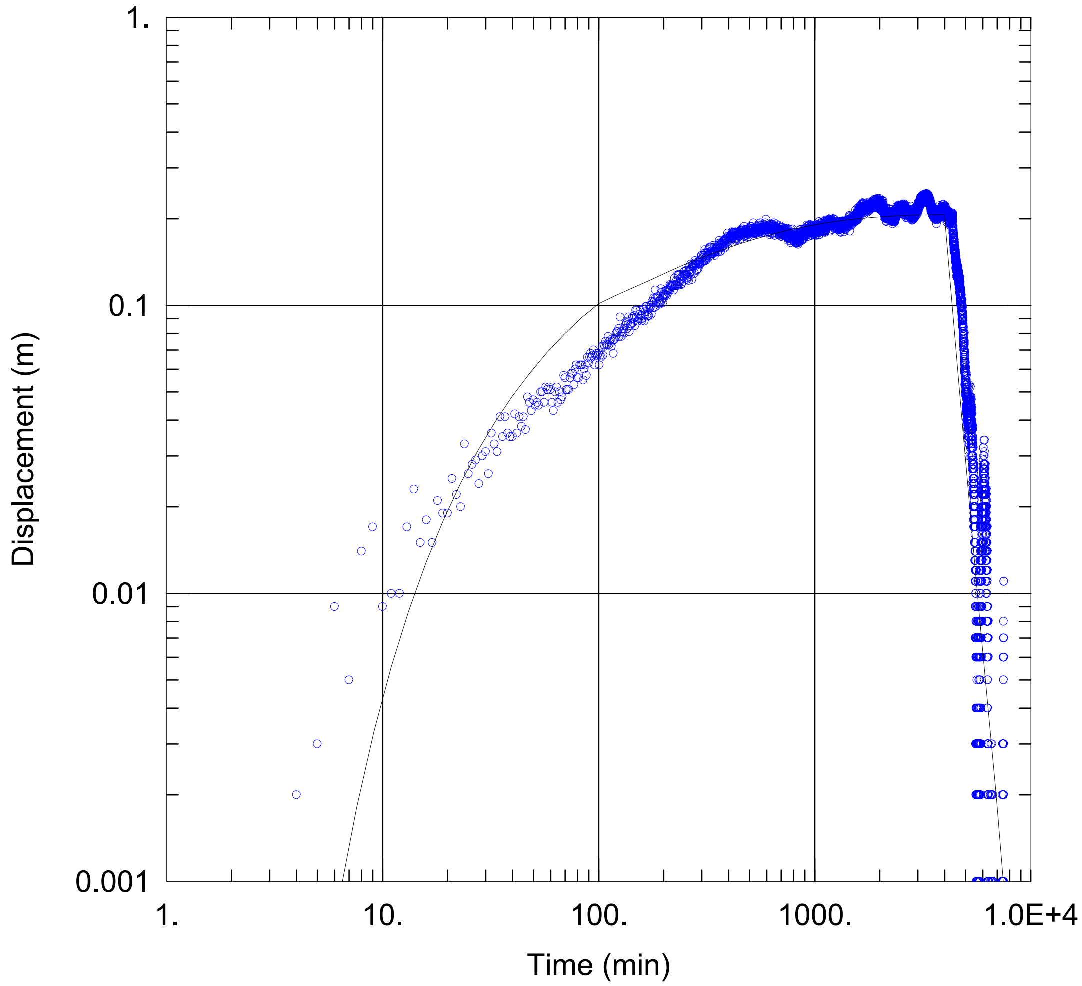
Observation Wells

Well Name	X (m)	Y (m)
○ Jaydinia Bore	763424	7259952

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 1395.3 m^2/day S = 1.744E-8



KPB01 - CRT - LATE TIME

Data Set: \...\KPB01_Jaydinia.aqt
Date: 05/24/18 Time: 16:24:17

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: Kumarina
Test Well: KPB01
Test Date: 3/03/2018

AQUIFER DATA

Saturated Thickness: 22. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
KPB01	673404.764	7259910.497

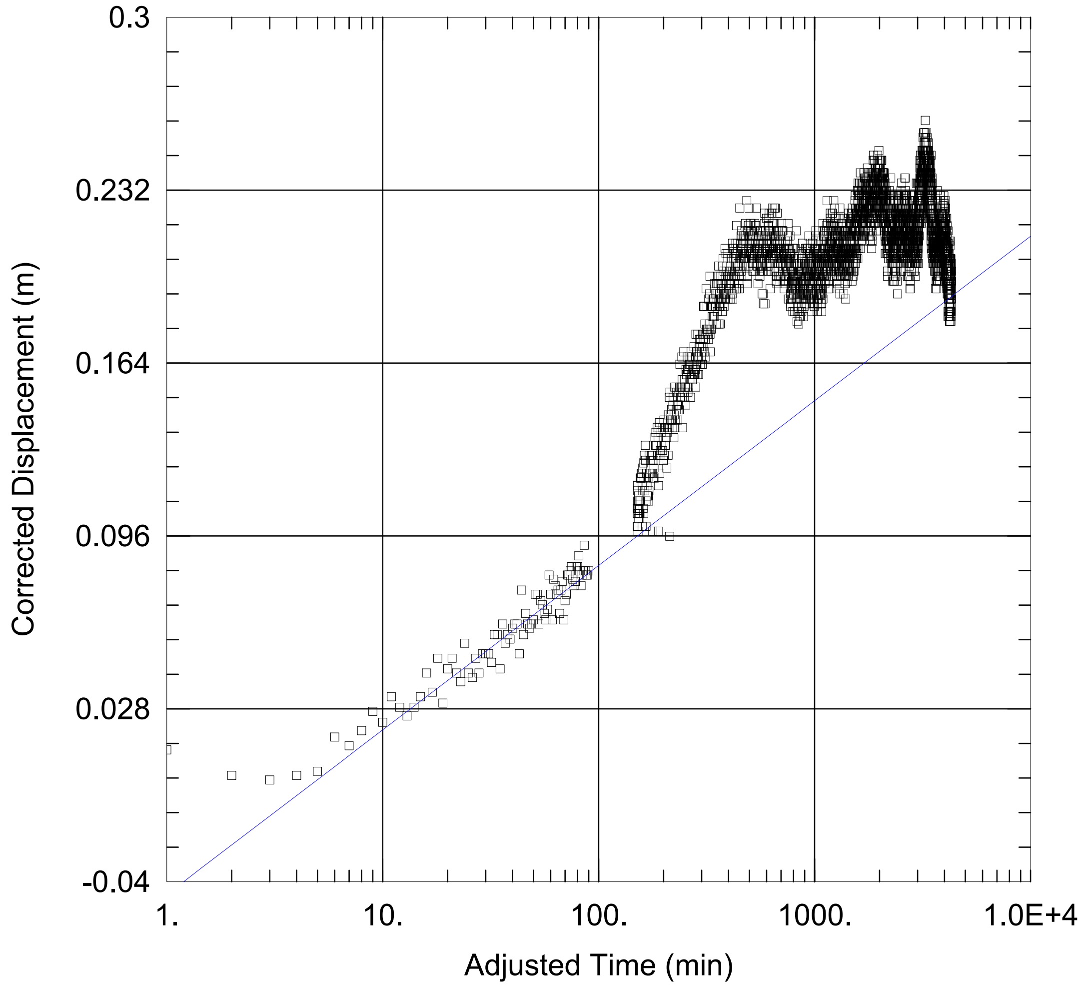
Observation Wells

Well Name	X (m)	Y (m)
○ Jaydinia Bore	763424	7259952

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 1532.6 m^2/day
S = 1.07E-8
Sy = 0.1483
ß = 0.03



KPB01 - CRT - EARLY TIME

Data Set: \...\KPB01_KBSouth.aqt
Date: 05/24/18 Time: 14:32:04

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: Kumarina
Test Well: KPB01
Test Date: 3/03/2018

AQUIFER DATA

Saturated Thickness: 22. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
KPB01	673404.764	7259910.497

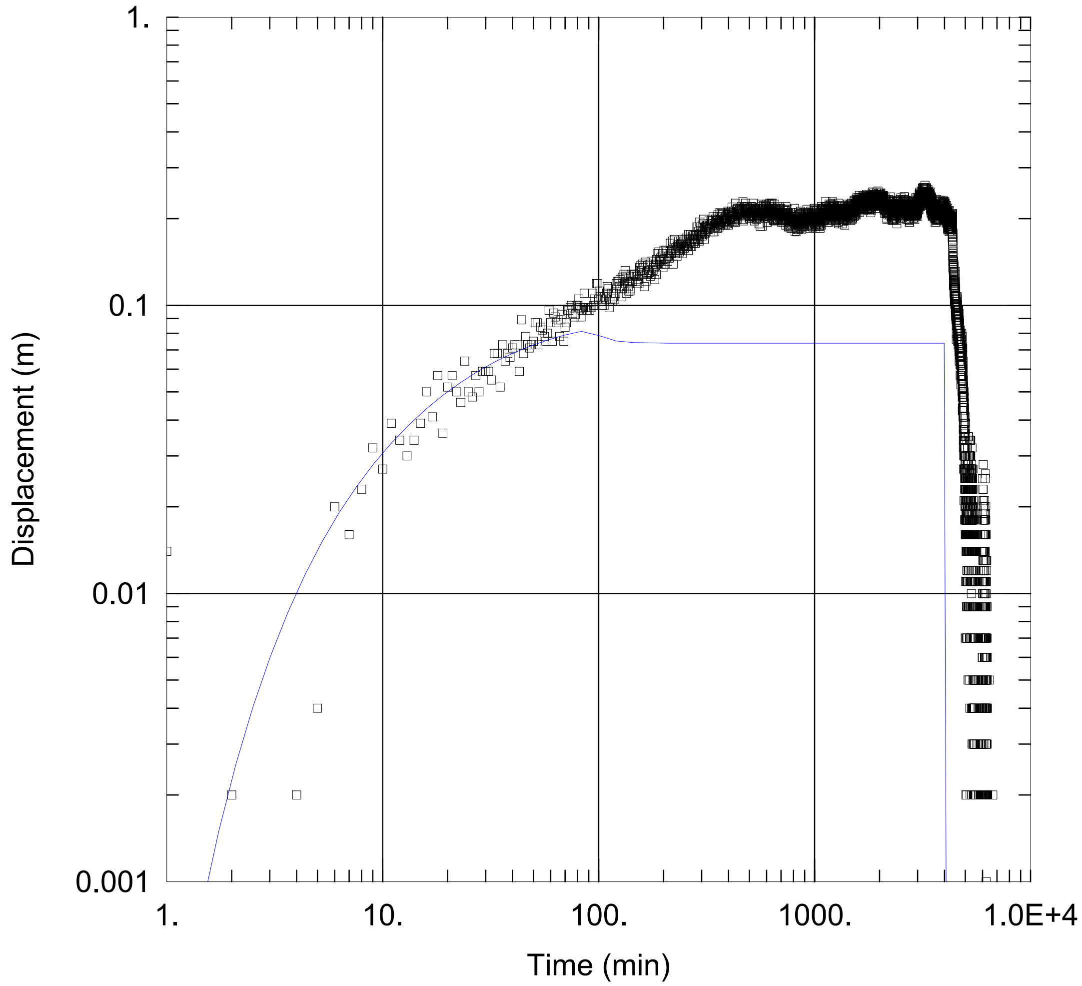
Observation Wells

Well Name	X (m)	Y (m)
□ Kumarina Bore South	763408	7259909

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 4525.4 m^2/day S = 4.33E-9



KPB01 - CRT - EARLY TIME

Data Set: \...\KPB01_KBSouth.aqt
Date: 05/24/18 Time: 16:06:13

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: Kumarina
Test Well: KPB01
Test Date: 3/03/2018

AQUIFER DATA

Saturated Thickness: 22. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
KPB01	673404.764	7259910.497

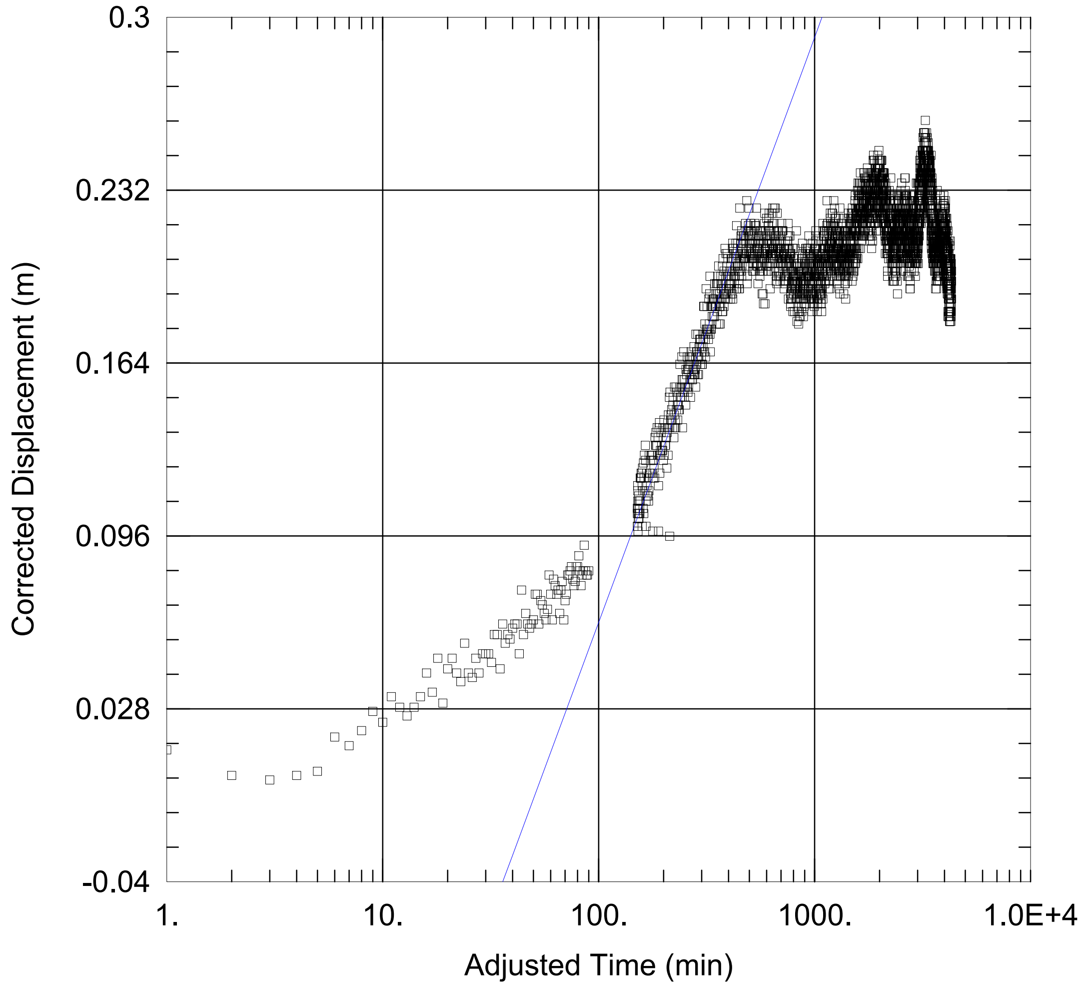
Observation Wells

Well Name	X (m)	Y (m)
□ Kumarina Bore South	763408	7259909

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 2669.6 m^2/day
S = 3.786E-9
Sy = 0.4133
ß = 0.1



KPB01 - CRT - MID TIME

Data Set: \...\KPB01_KBSouth.aqt
Date: 05/24/18
Time: 14:33:23

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: Kumarina
Test Well: KPB01
Test Date: 3/03/2018

AQUIFER DATA

Saturated Thickness: 22. m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
KPB01	673404.764	7259910.497

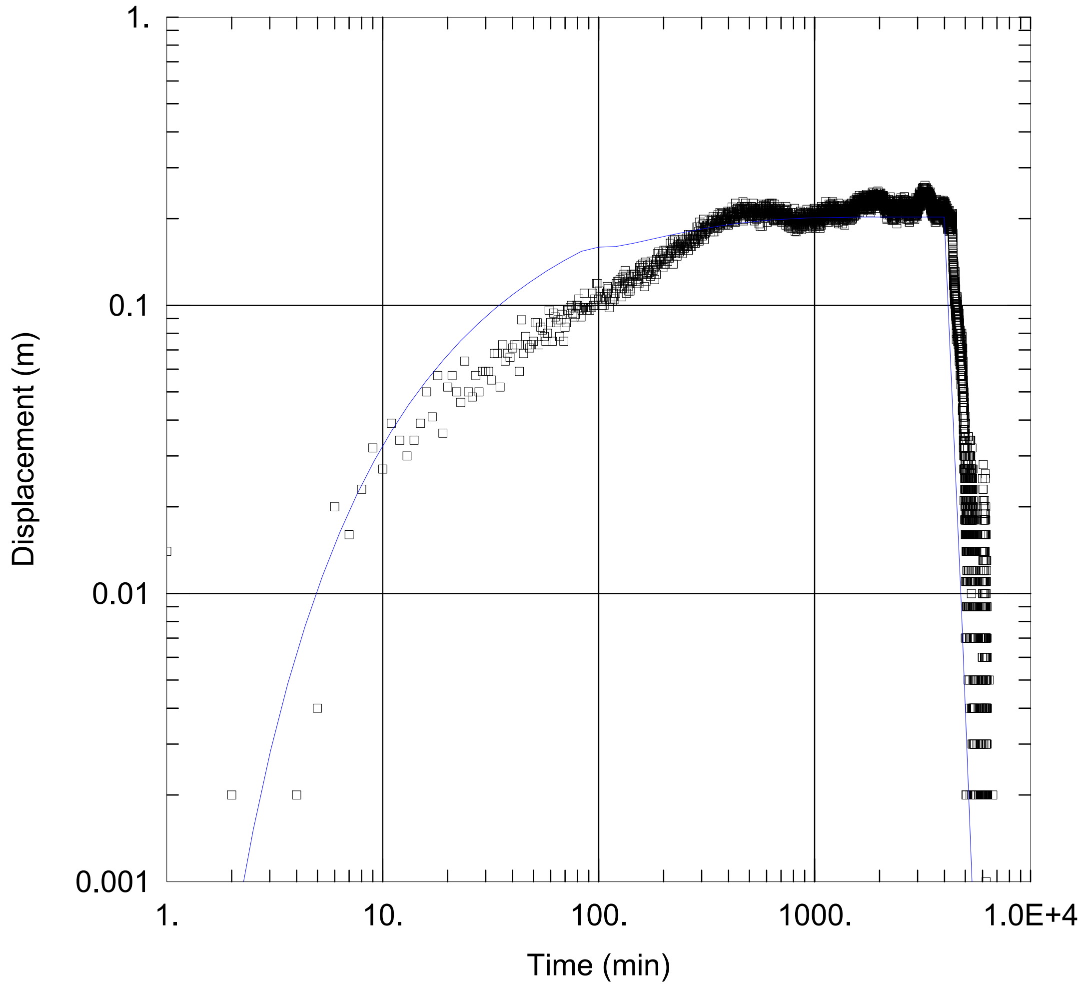
Observation Wells

Well Name	X (m)	Y (m)
□ Kumarina Bore South	763408	7259909

SOLUTION

Aquifer Model: Unconfined
Solution Method: Cooper-Jacob

T = 1274.1 m^2/day
S = 1.319E-8



KPB01 - CRT - LATE TIME

Data Set: \...\KPB01_KBSouth.aqt
Date: 05/24/18 Time: 16:09:11

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: Kumarina
Test Well: KPB01
Test Date: 3/03/2018

AQUIFER DATA

Saturated Thickness: 22. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
KPB01	673404.764	7259910.497

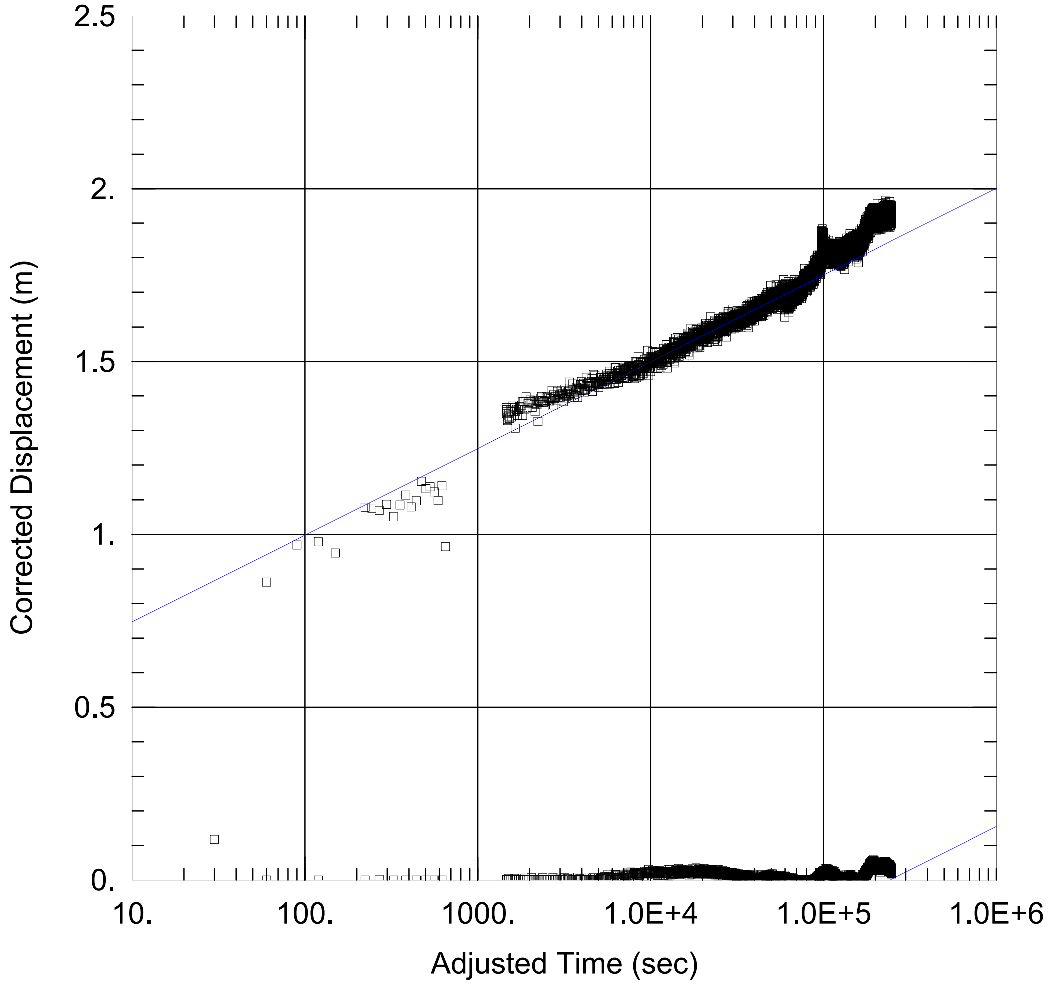
Observation Wells

Well Name	X (m)	Y (m)
□ Kumarina Bore South	763408	7259909

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 1566.6 m^2/day
S = 3.786E-9
Sy = 0.2531
ß = 0.03



K BORE SOUTH CRT

Data Set: C:\Users\Adam.lloyd\Desktop\K Bore South 2 CRT.aqt
Date: 11/30/17 Time: 19:43:13

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: Kumarina
Test Well: K Bore S 2
Test Date: 30/11/2017

AQUIFER DATA

Saturated Thickness: 25. m Anisotropy Ratio (Kz/Kr): 1.111E+4

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
K Bore South 2	763265	7259613

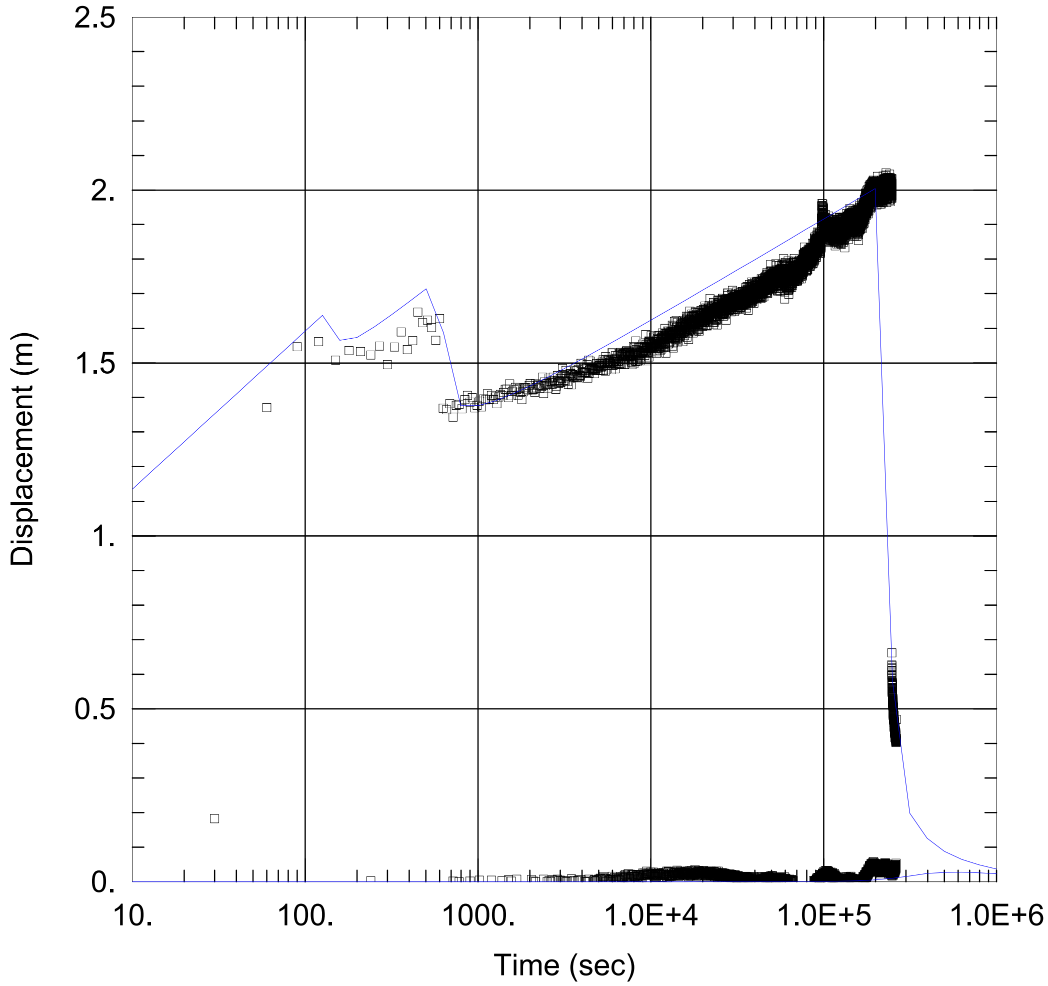
Observation Wells

Well Name	X (m)	Y (m)
□ K Bore South 2	763265	7259613
□ Jaydinia Bore	763428	7259934

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 1142.4 m^2/day S = 0.05582



K BORE SOUTH CRT

Data Set: C:\Users\Adam.lloyd\Desktop\K Bore South 2 CRT.aqt
Date: 11/30/17 Time: 19:44:03

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: Kumarina
Test Well: K Bore S 2
Test Date: 30/11/2017

AQUIFER DATA

Saturated Thickness: 25. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
K Bore South 2	763265	7259613

Observation Wells

Well Name	X (m)	Y (m)
K Bore South 2	763265	7259613
Jaydinia Bore	763428	7259934

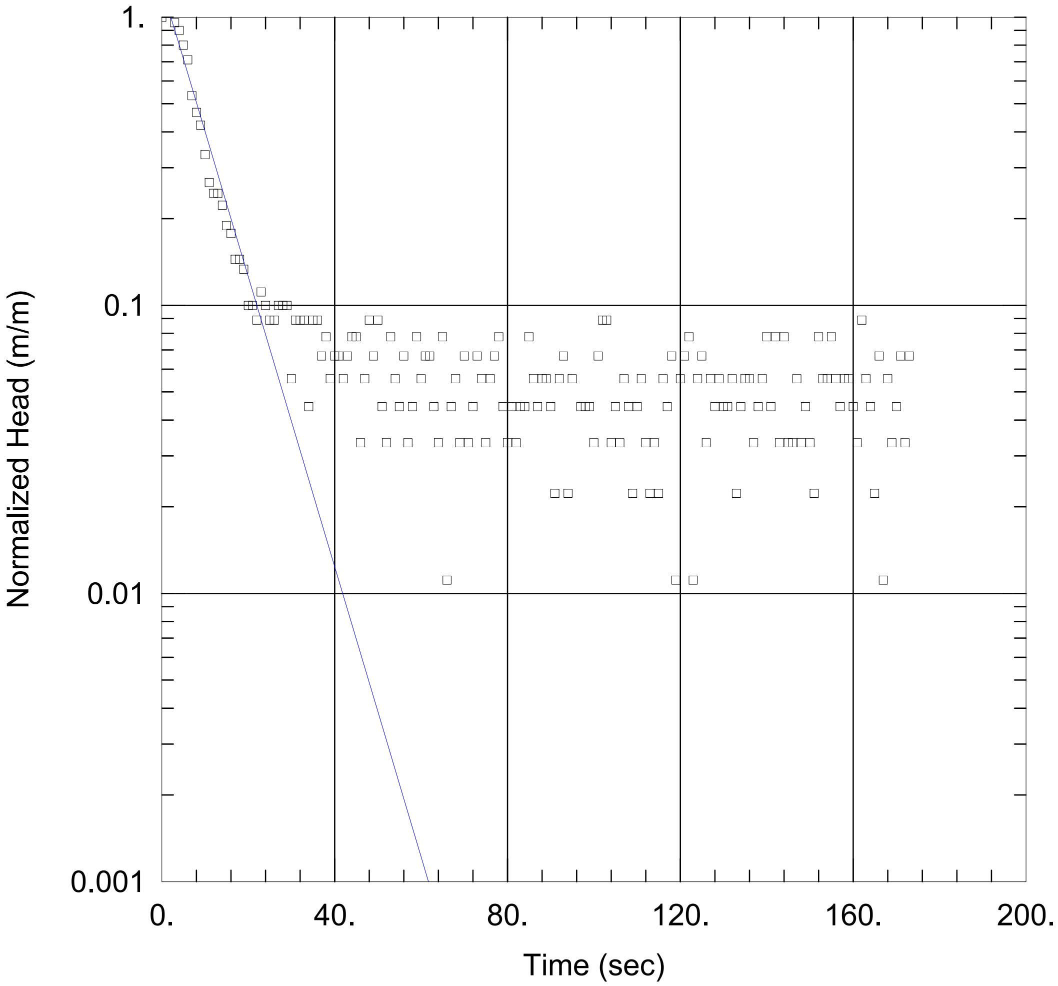
SOLUTION

Aquifer Model: Unconfined

Solution Method: Neuman

T = 969.9 m^2/day
Sy = 0.1

S = 0.04739
Kz/Kr = 1.111E+4



KMB04 SLUG TEST

Data Set: \...\KMB04.aqt
Date: 05/21/18 Time: 15:28:01

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14324
Location: Kumarina
Test Well: KMB04
Test Date: 02/05/2018

AQUIFER DATA

Saturated Thickness: 20. m Anisotropy Ratio (Kz/Kr): 1.

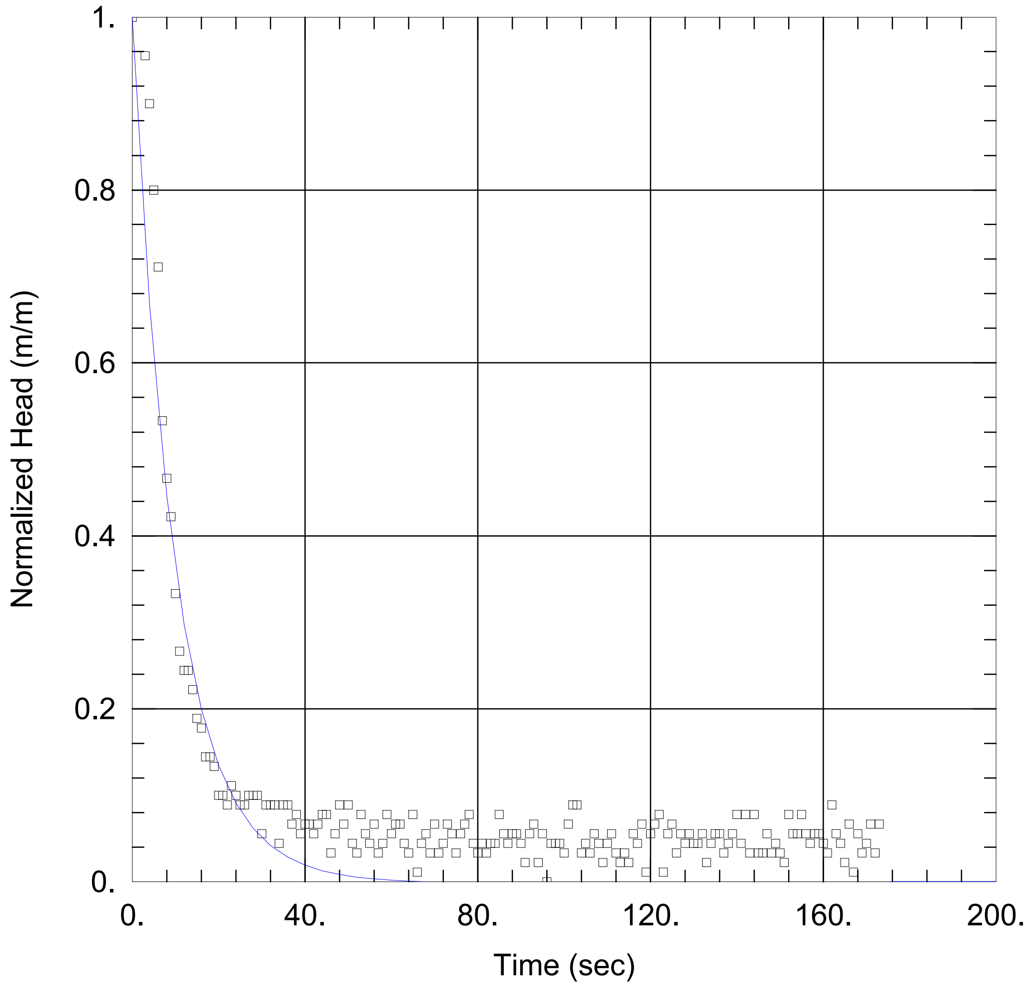
WELL DATA (KMB04)

Initial Displacement: 0.09 m Static Water Column Height: 20. m
Total Well Penetration Depth: 31. m Screen Length: 30. m
Casing Radius: 0.025 m Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.6324 m/day y0 = 0.115 m



KMB04 SLUG TEST

Data Set: \...\KMB04.aqt
Date: 05/21/18
Time: 15:30:24

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14324
Location: Kumarina
Test Well: KMB04
Test Date: 02/05/2018

AQUIFER DATA

Saturated Thickness: 20. m

WELL DATA (KMB04)

Initial Displacement: 0.09 m
Total Well Penetration Depth: 31. m
Casing Radius: 0.025 m

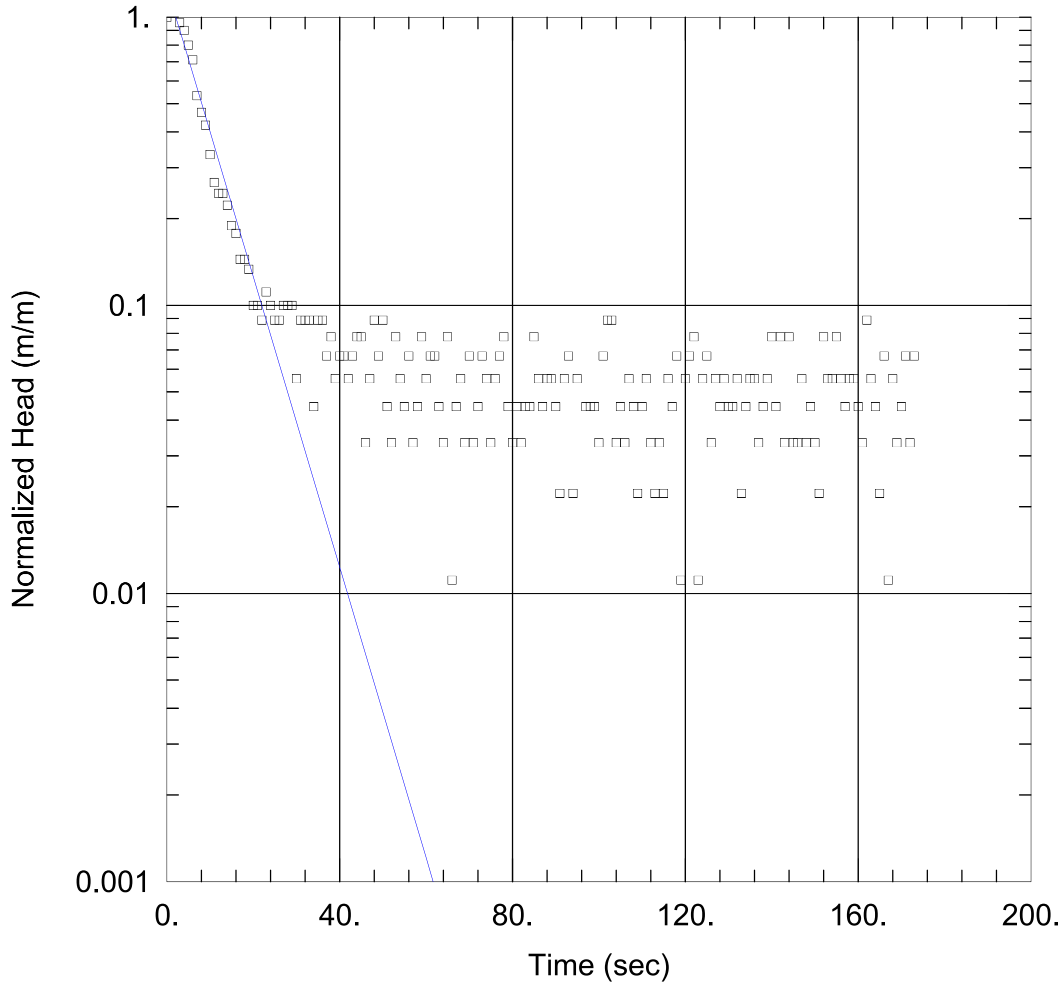
Static Water Column Height: 20. m
Screen Length: 30. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.9842 m/day
Kz/Kr = 1.

Ss = 3.333E-12 m^{-1}



KMB04 SLUG TEST

Data Set: \...\KMB04.aqt
Date: 05/21/18 | Time: 15:29:12

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14324
Location: Kumarina
Test Well: KMB04
Test Date: 02/05/2018

AQUIFER DATA

Saturated Thickness: 20. m | Anisotropy Ratio (Kz/Kr): 1.

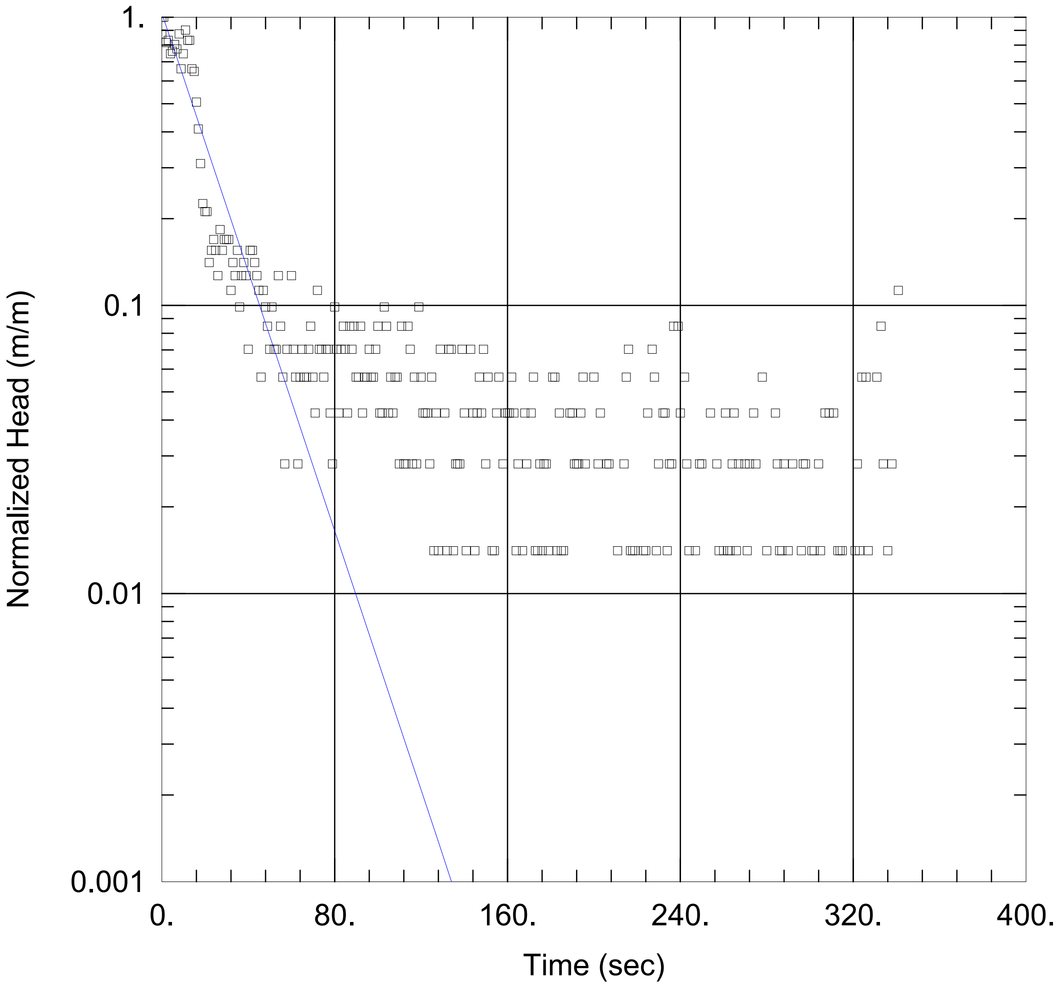
WELL DATA (KMB04)

Initial Displacement: 0.09 m | Static Water Column Height: 20. m
Total Well Penetration Depth: 31. m | Screen Length: 30. m
Casing Radius: 0.025 m | Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined | Solution Method: Hvorslev

K = 0.5532 m/day | y0 = 0.115 m



KMB05 SLUG TEST

Data Set: \...\KMB05.aqt
Date: 05/21/18
Time: 15:32:10

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14324
Location: Kumarina
Test Well: KMB05
Test Date: 02/05/2018

AQUIFER DATA

Saturated Thickness: 30. m
Anisotropy Ratio (Kz/Kr): 1.

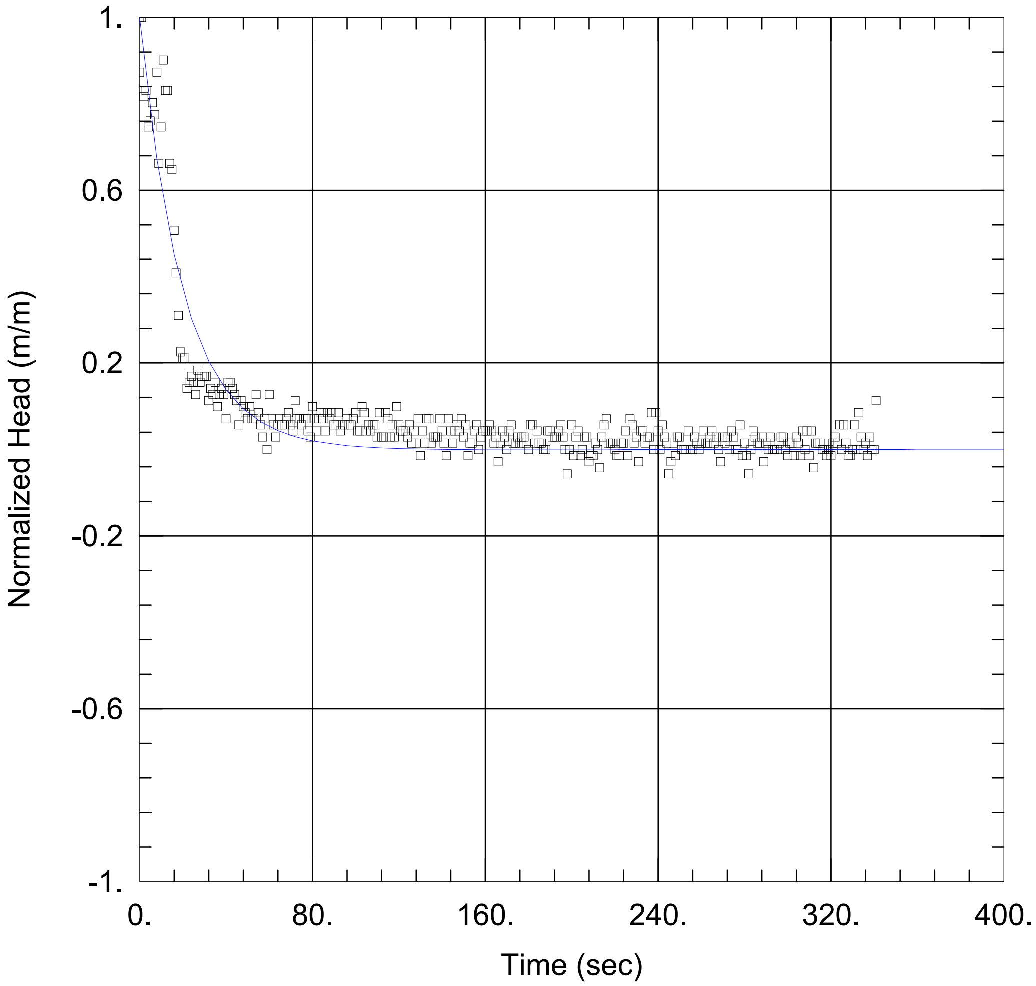
WELL DATA (KMB05)

Initial Displacement: 0.071 m
Static Water Column Height: 30. m
Total Well Penetration Depth: 26. m
Screen Length: 24. m
Casing Radius: 0.025 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.3189 m/day
y0 = 0.07373 m



KMB05 SLUG TEST

Data Set: \...\KMB05.aqt
Date: 05/21/18 Time: 15:31:22

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14324
Location: Kumarina
Test Well: KMB05
Test Date: 02/05/2018

AQUIFER DATA

Saturated Thickness: 30. m

WELL DATA (KMB05)

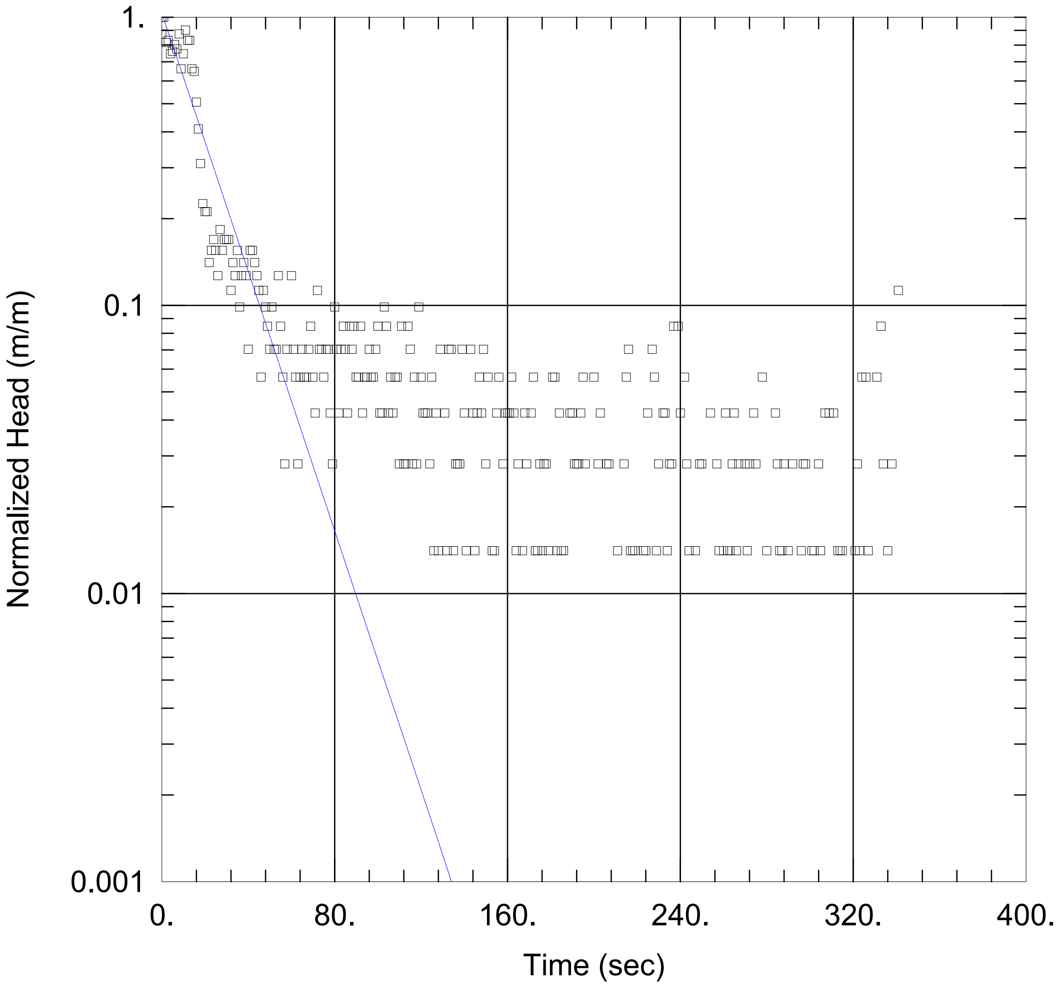
Initial Displacement: 0.071 m
Total Well Penetration Depth: 26. m
Casing Radius: 0.025 m

Static Water Column Height: 30. m
Screen Length: 24. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.3462 m/day
Kz/Kr = 1.
Ss = 3.333E-12 m^{-1}



KMB05 SLUG TEST

Data Set: \...\KMB05.aqt
Date: 05/21/18
Time: 15:32:52

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14324
Location: Kumarina
Test Well: KMB05
Test Date: 02/05/2018

AQUIFER DATA

Saturated Thickness: 30. m
Anisotropy Ratio (Kz/Kr): 1.

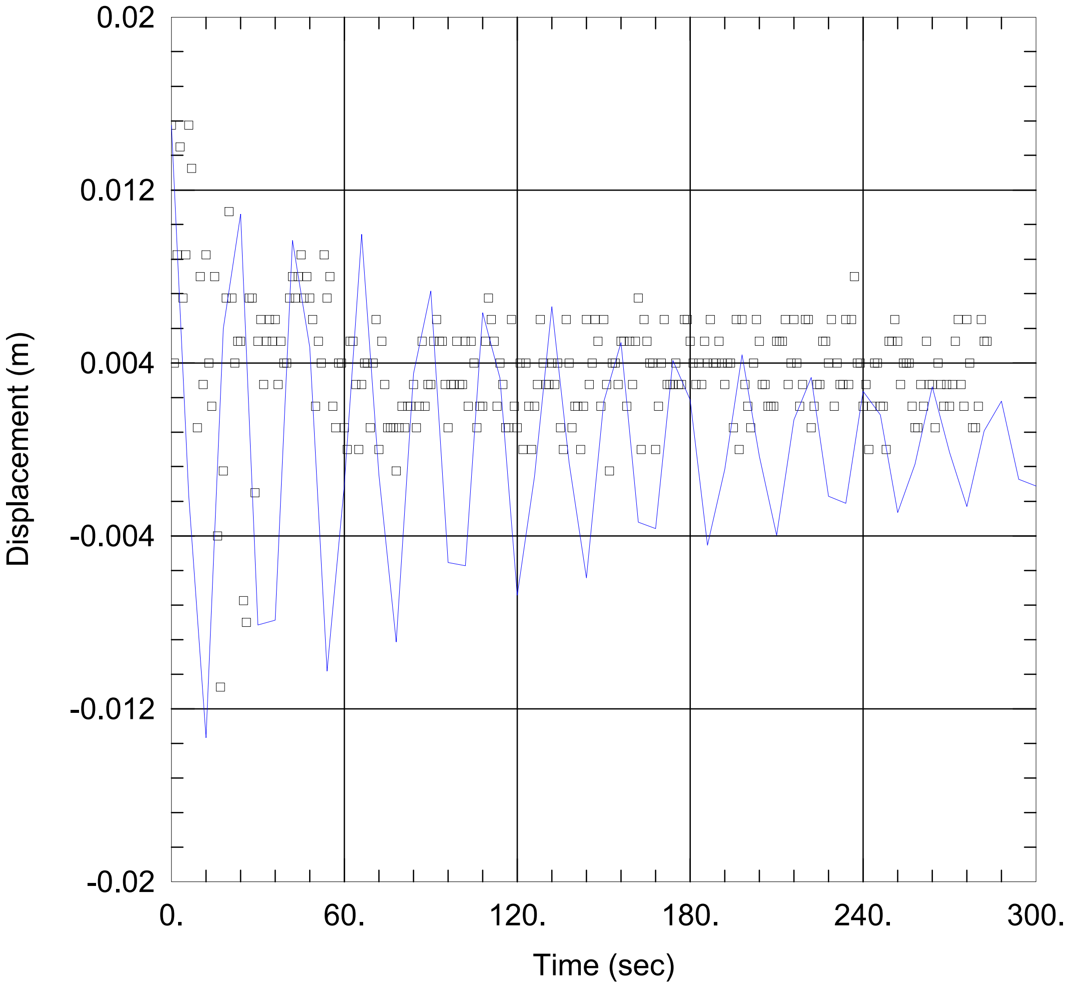
WELL DATA (KMB05)

Initial Displacement: 0.071 m
Total Well Penetration Depth: 26. m
Casing Radius: 0.025 m
Static Water Column Height: 30. m
Screen Length: 24. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 0.4 m/day
y0 = 0.07372 m



KMB06 SLUG TEST

Data Set: \...\KMB06.aqt
Date: 05/21/18

Time: 15:11:44

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14324
Location: Kumarina
Test Well: KMB06
Test Date: 02/05/2018

AQUIFER DATA

Saturated Thickness: 30. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (KMB06)

Initial Displacement: 0.015 m
Total Well Penetration Depth: 37. m
Casing Radius: 0.025 m

Static Water Column Height: 30. m
Screen Length: 35. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined

Solution Method: Springer-Gelhar

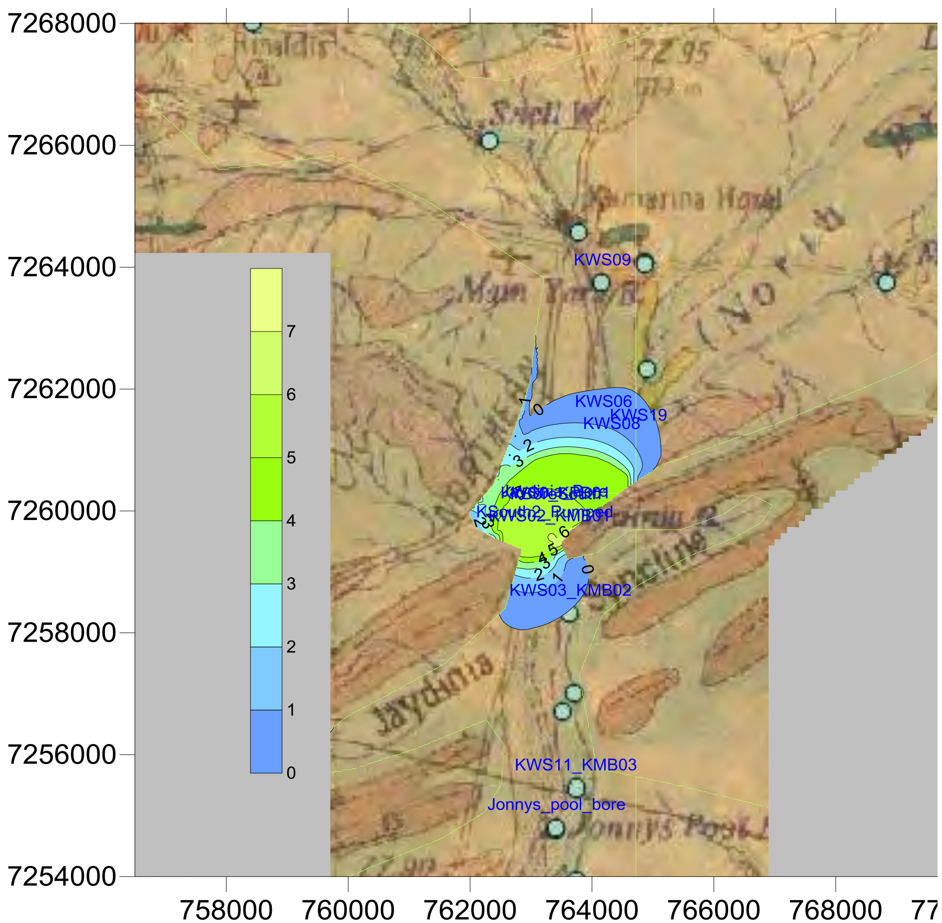
K = 2639.3 m/day

Le = 16.89 m

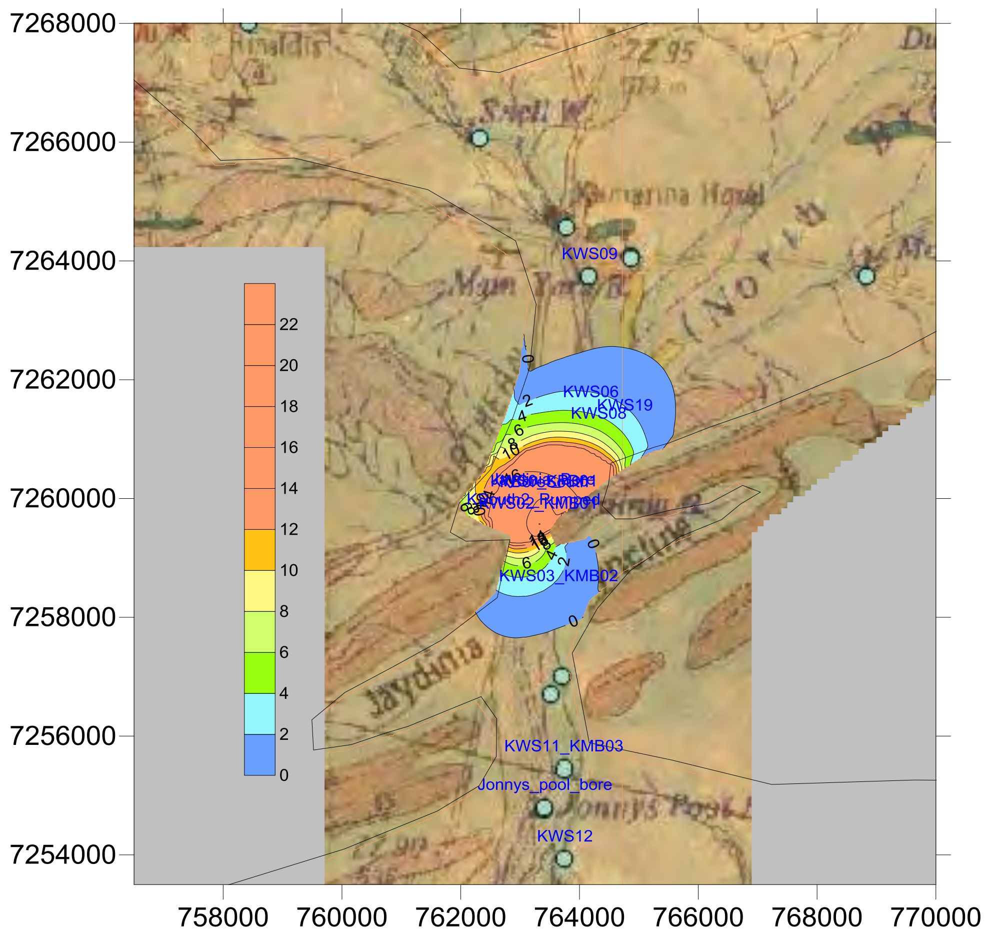
Appendix E Groundwater Model Results

Scenario 1 – Dry

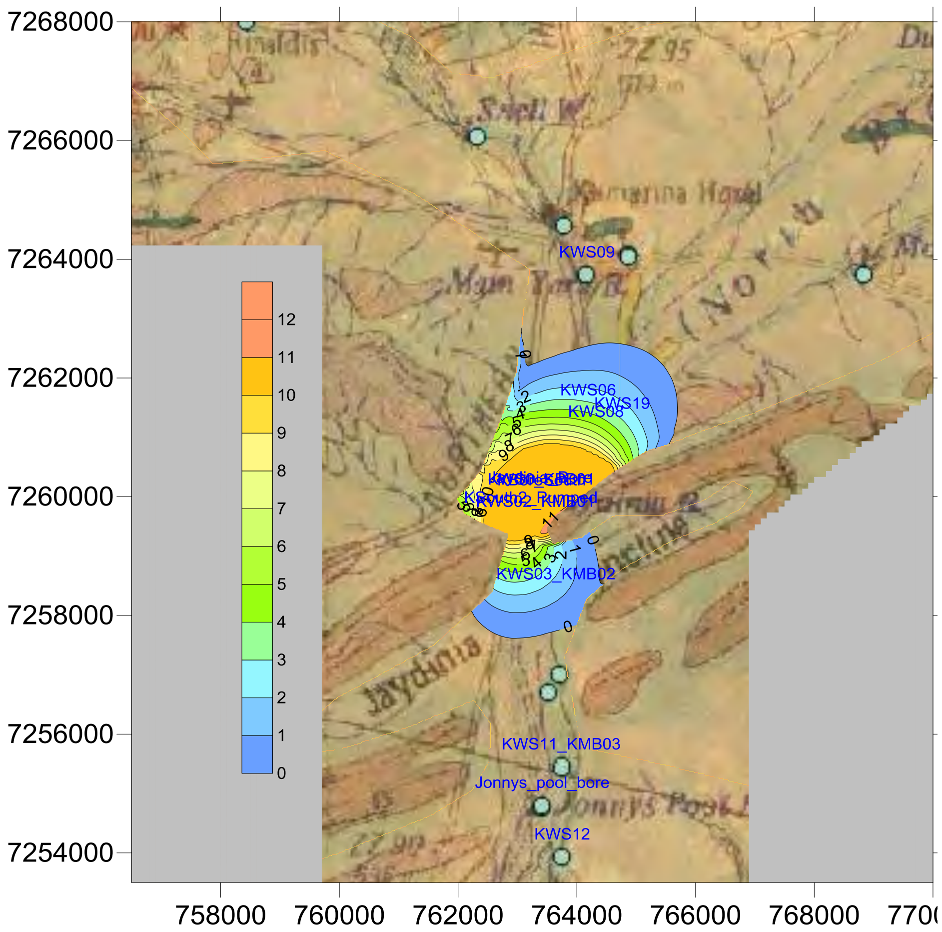
Drawdowns at the End of Year 5



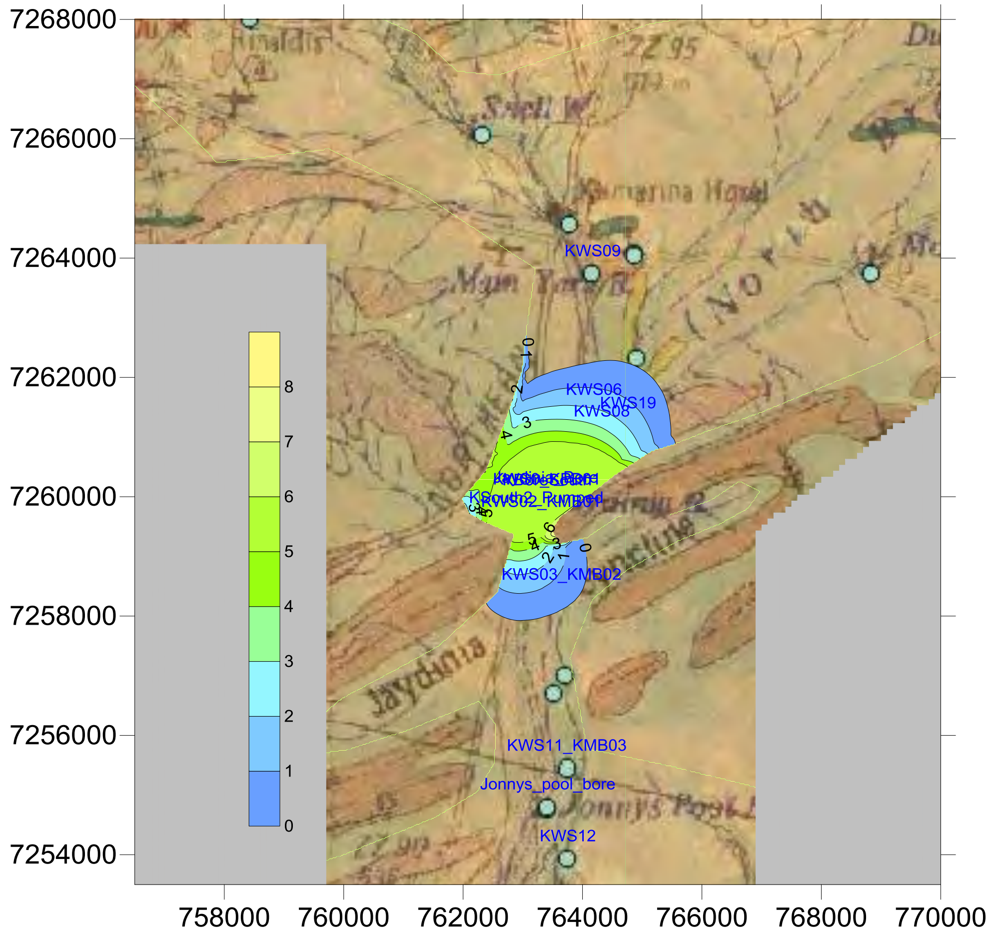
Drawdowns at the End of Year 20



Drawdowns at the End of Year 30



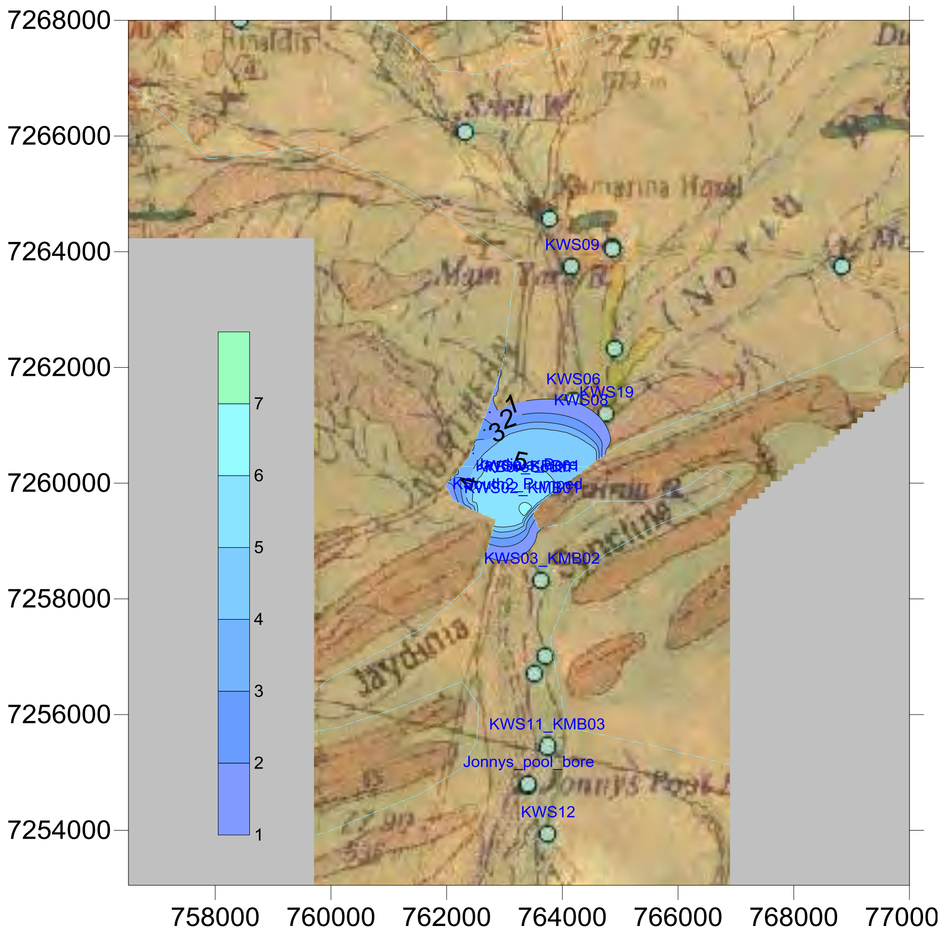
Drawdowns at the End of Year 40



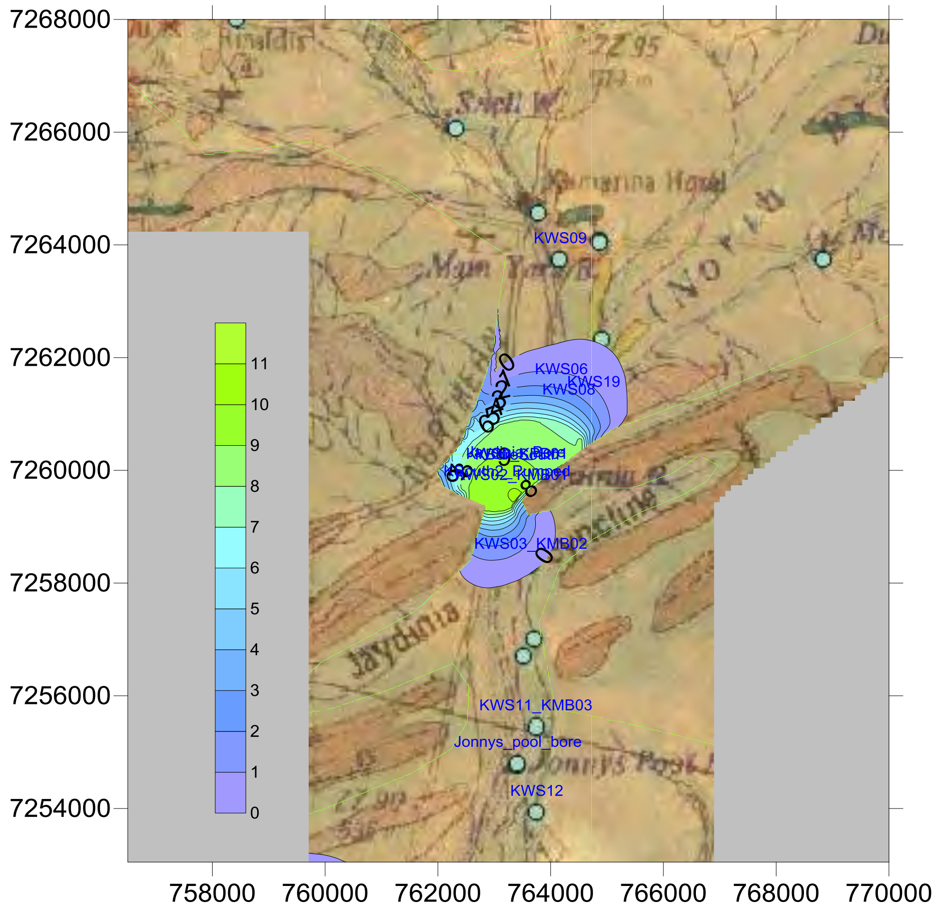
Scenario 1

Scenario 2 – Wet Case

Drawdowns at the End of 5 Year Abstraction



Drawdowns at the End of Abstraction - 10 Years



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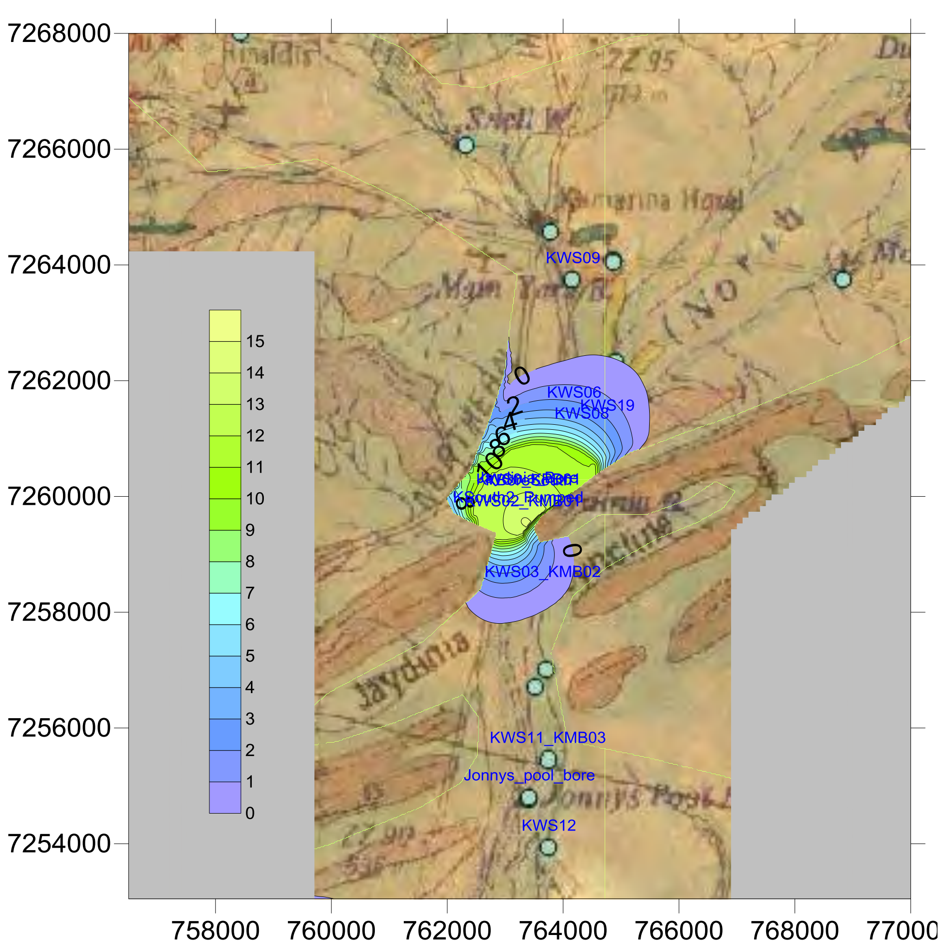
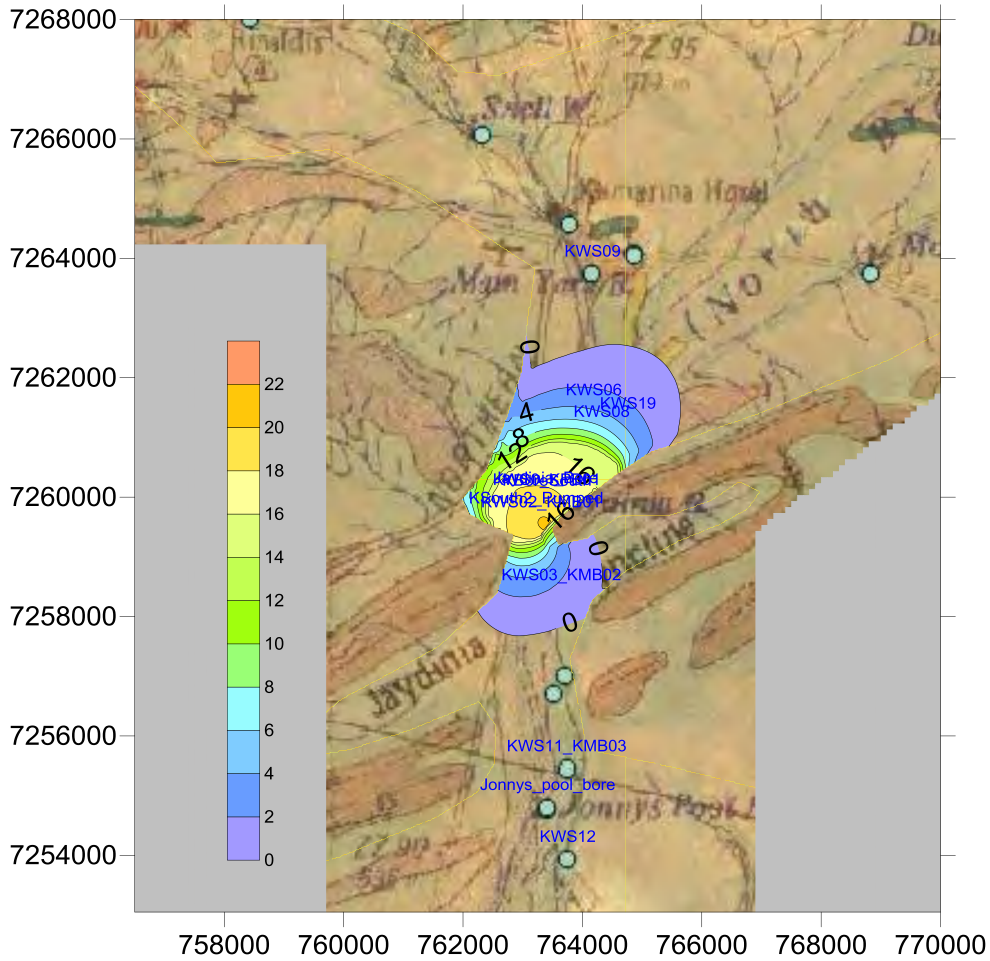
Drawdowns at the End of Abstraction - 15 Years



Drawdowns at the End of Abstraction - 23 Years



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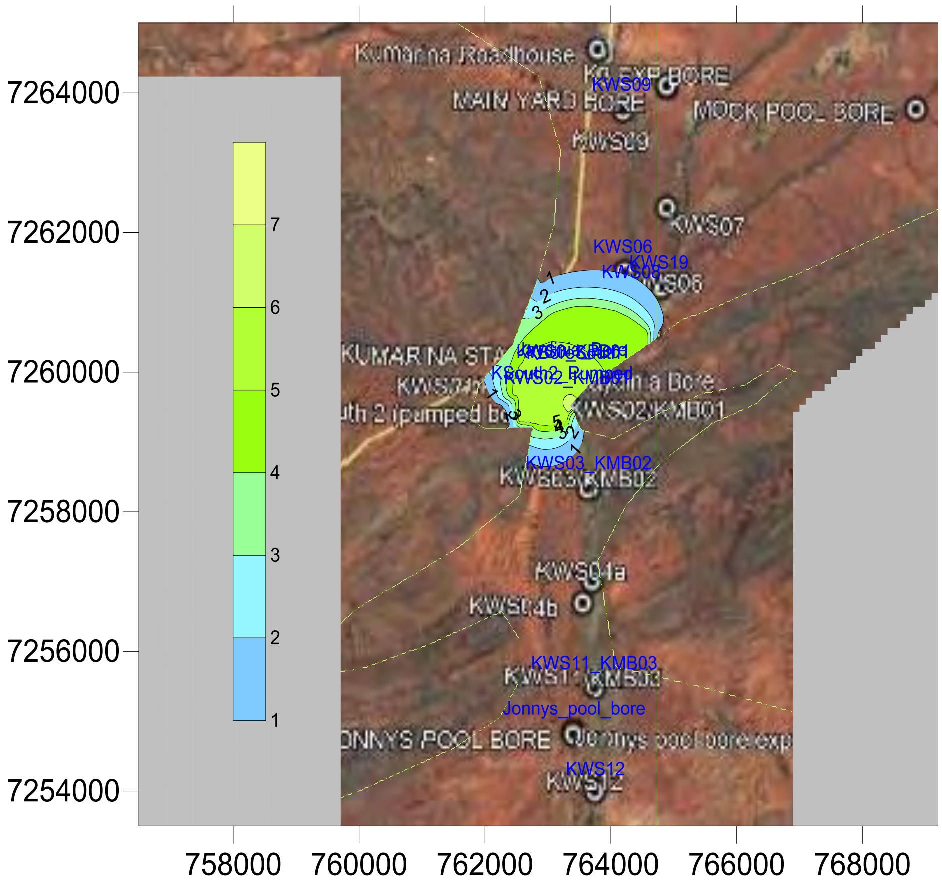
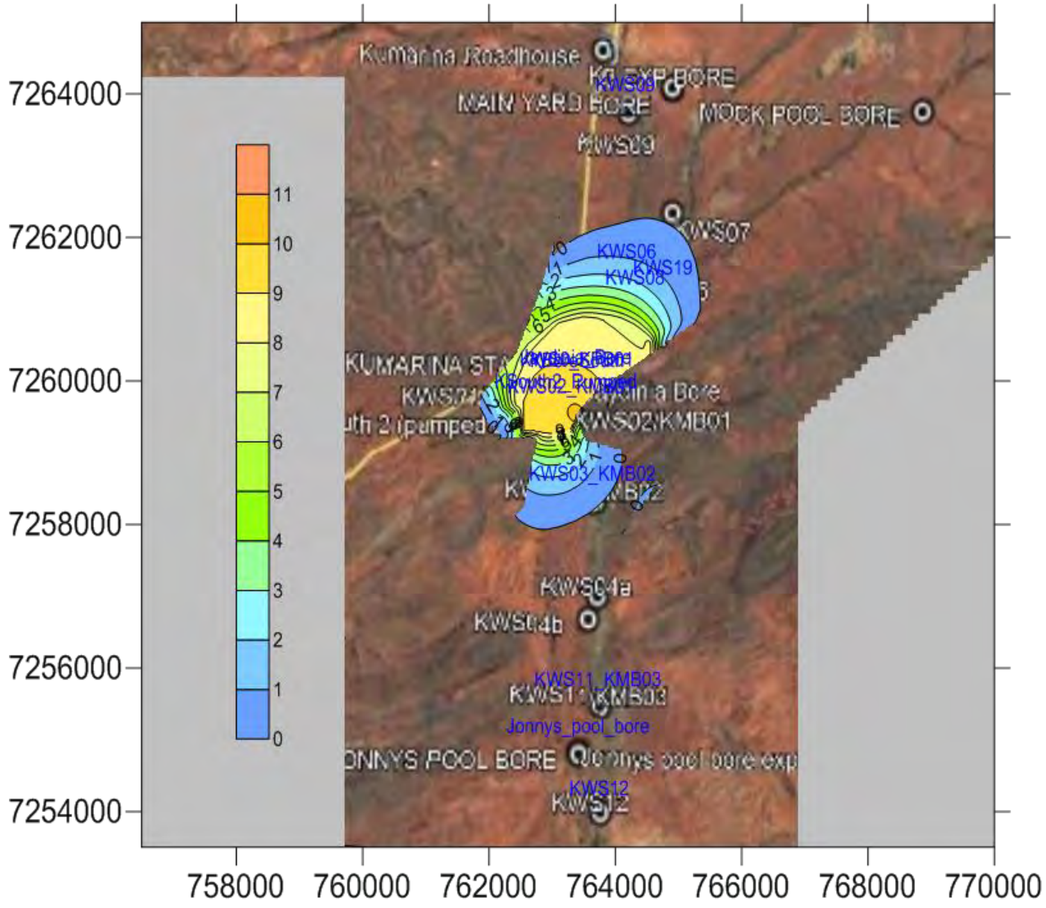
Scenario 2

Scenario 3 – Wet Case – 1in 50

Drawdowns at the End of Year 5



Drawdowns at the End of Year 10



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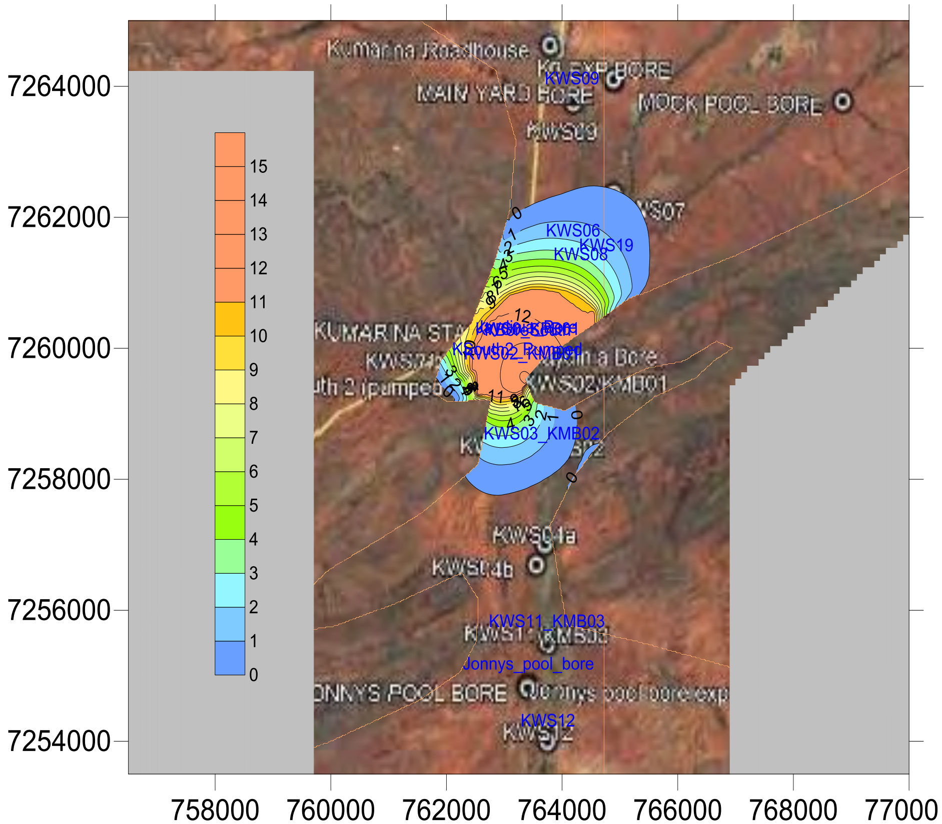
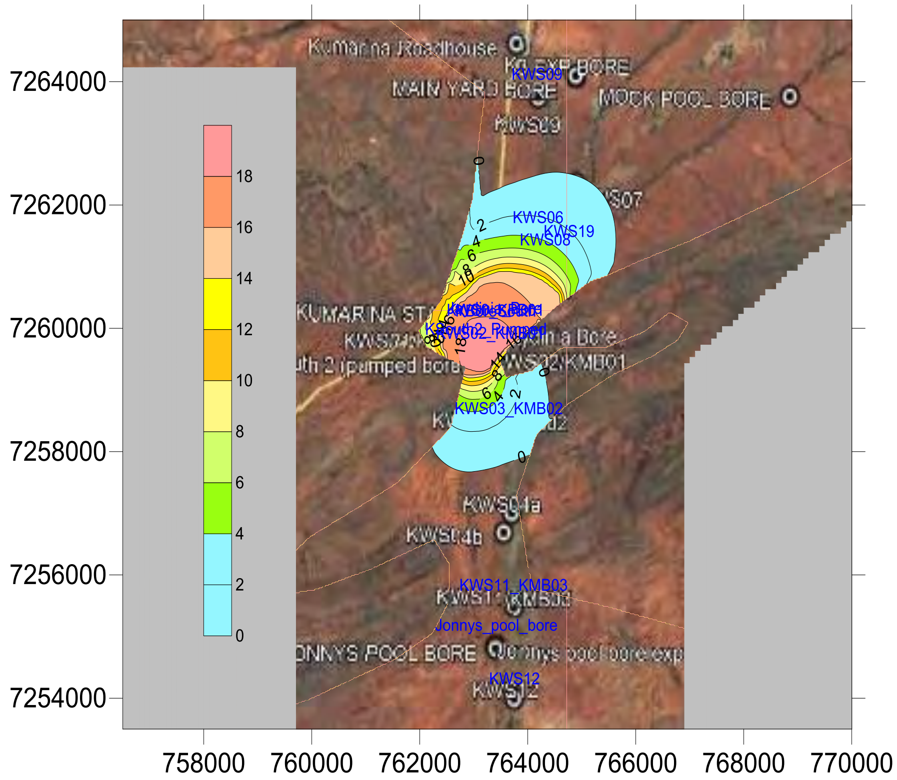
Drawdowns at the End of Year 15



Drawdowns at the End of Year 23



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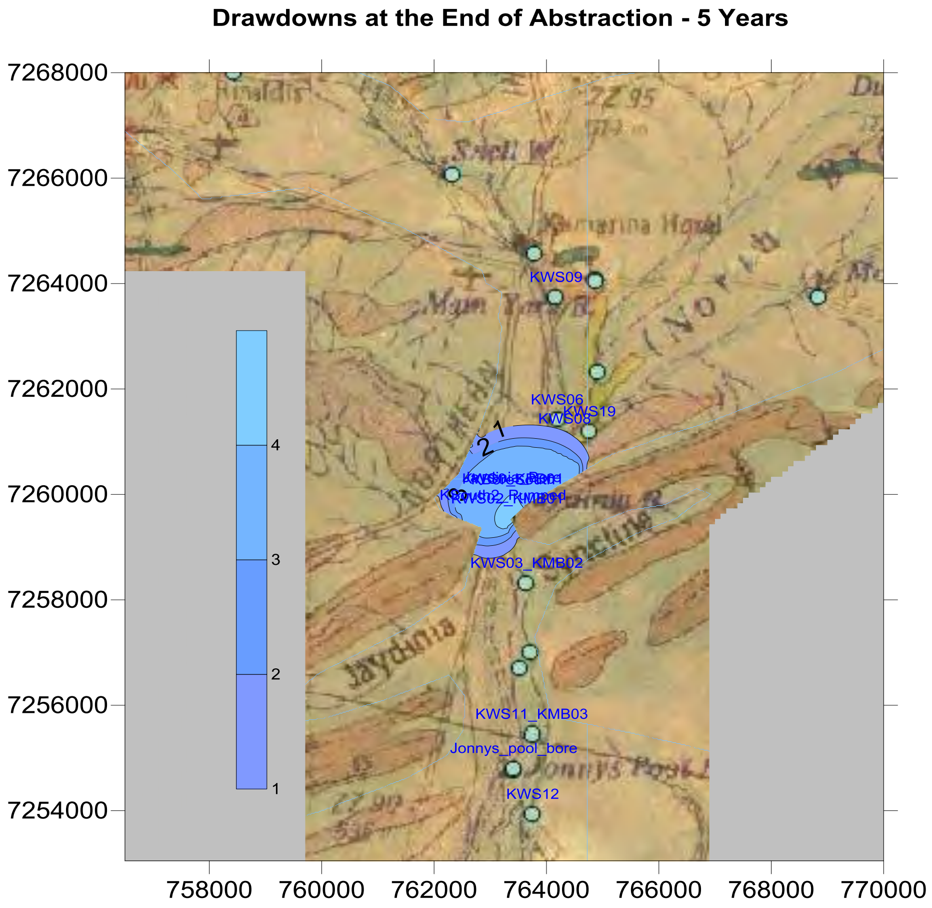
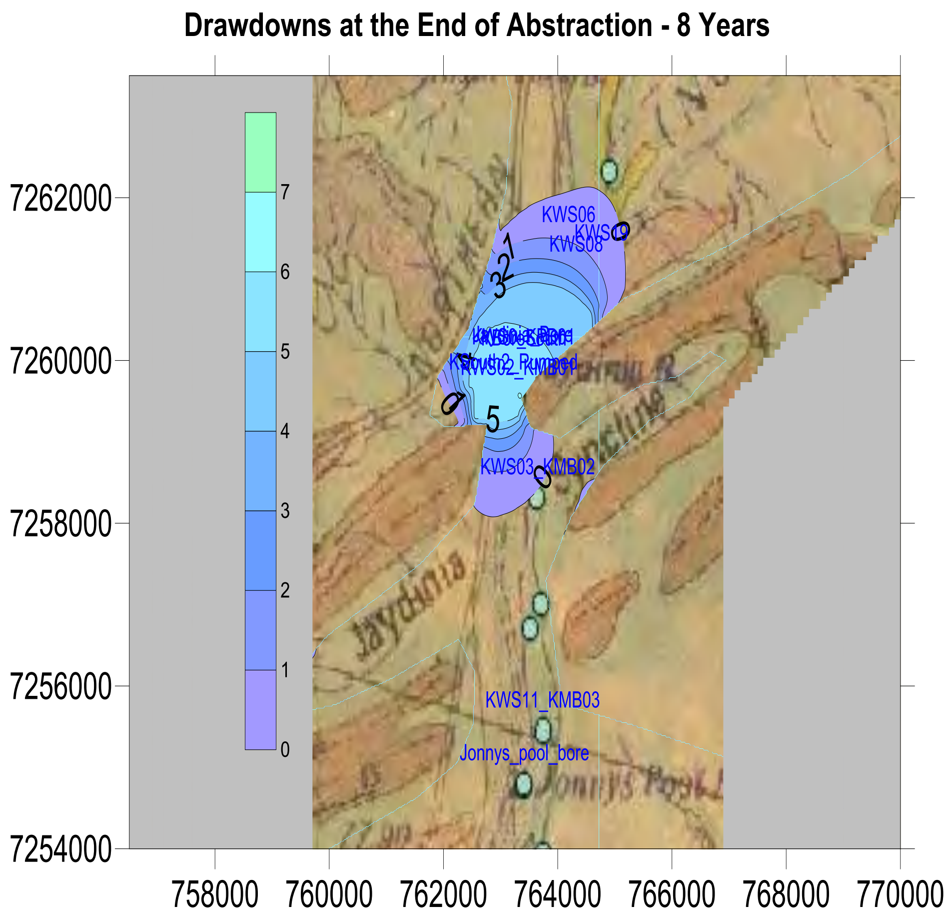
Scenario 4 – Wet Case – 1 in 50 at 0.75Gpa





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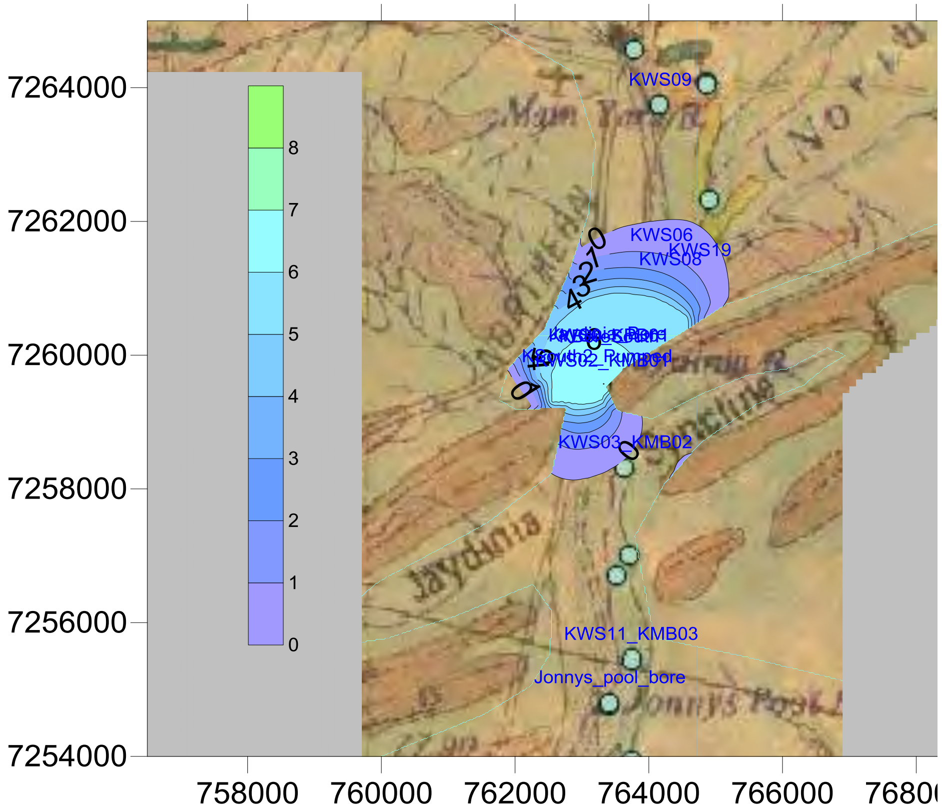
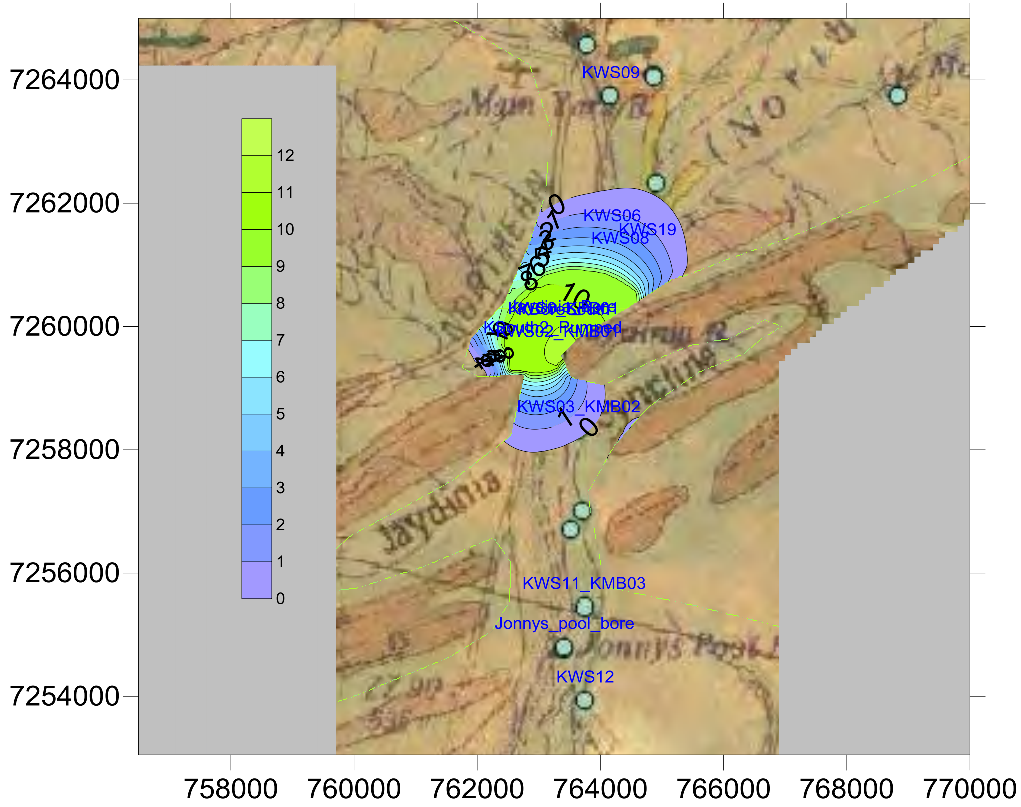
Drawdowns at the End of Abstraction -10 Years



Drawdowns at the End of Abstraction - 23 Years



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Appendix F Kumarina Pastoral Station Letter

Rachlan Holdings Pty Ltd

ABN: 90 938 606 204
PO Box 582
NEWMAN WA 6753
Mobile: 0419 472 561
Ph/Fax: (08) 9175 7007
Email: smoothyhelicopters@harboursat.com.au

30 May 2018
Kalium Lakes Potash Pty Ltd
PO Box 610
BALCATTA WA 6914

Att: Brett Hazelden – CEO/MD

Dear Brett Hazelden

PERMISSION TO ABSTRACT WATER FROM KUMARINA HOMESTEAD

Further to recent discussions, we as directors of Rachlan Holdings Pty Ltd permit Kalium Lakes Potash Pty Ltd to withdraw water from the bores immediately surrounding the Kumarina Homestead for its planned mining activities at the Beyondie Sulphate of Potash Project. That is, the bores you refer to as ‘Jaydinia’ and ‘Kumarina Bore South’. No other bores are permitted for dewatering as they are currently in use for pastoral activities. The ‘Jaydinia’ bore was recently decommissioned by us, and we have no immediate or foreseeable plans for usage of the ‘Kumarina Bore South’ bore.

Rachlan Holdings Pty Ltd requests that the ongoing operation and maintenance of these bores be handled by Kalium Lakes Potash Pty Ltd, and that they are returned to their current condition at the conclusion of use.

Regards

Brent Smoothy and Rachel Burn