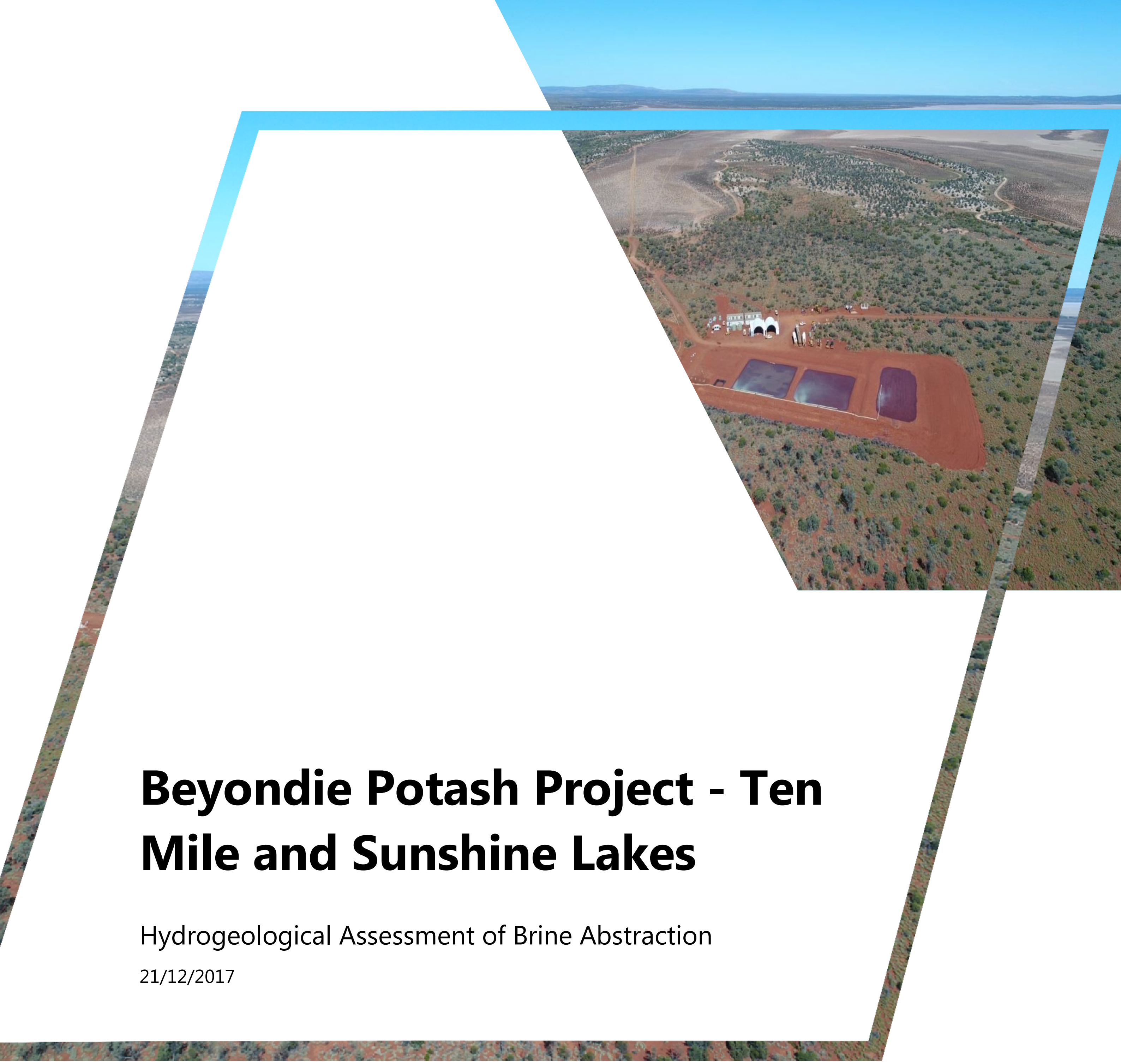

Beyondie Potash Project - Ten Mile and Sunshine Lakes

Hydrogeological Assessment of Brine Abstraction

21/12/2017

Level 4, 600 Murray St
West Perth WA 6005
Australia

201320-14624

Advisian
WorleyParsons Group

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Project No: 201320-14624 – Beyondie Potash Project - Ten Mile and Sunshine Lakes : Hydrogeological Assessment of Brine Abstraction

Rev	Description	Author	Review	Advisian Approval	Date
Rev 0	Issued to Client	J Rothery / L Siraz	A Lloyd	S Atkinson	21/12/2017

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1 Introduction

Kalium Lakes Pty Ltd (KLL) has recently completed a resource evaluation for the Beyondie Lakes, Ten Mile Lake and Lake Sunshine in Western Australia for Sulphate of Potash (SOP) mineralisation. The Beyondie SOP project (BSOPP / the Project) is located in the Eastern Pilbara, between approximately 80 and 280 km east of the Great Northern Highway, extending into the Little Sandy Desert, and covers approximately 2,400 km^2 of granted tenements (Figure 1-1). The township of Newman is approximately 150 km to North along the Great Northern Highway, whilst Wiluna is approximately 240 km to the South along the Great Northern Highway.

The Project comprises a staged approach to development with the initial Stage 1, consisting of abstraction of brine from aquifers in the vicinity of the above lakes to target approximately 75,000 to 150,000 tonnes per annum (tpa) of SOP production.

The brine is to be abstracted from the lake surfaces using a network of trenches and a from deeper palaeochannel aquifers using bores. The brine will be piped from the trenches and bores to the solar evaporation ponds and processed in to the SOP product.

1.1 Tenure

Kalium Lakes Potash Pty Ltd (KLL) has been granted the following Exploration Licences: E69/3306, E69/3309, E69/3339, E69/3340, E69/3341¸ E69/3342, E69/3343, E69/3344, E69/3345, E69/3346, E69/3347, E69/3348, E69/3349, E69/3351 and E69/3352. KLL has also been granted Miscellaneous Licence L52/162 for various activities including Beyondie site Access Road from the Great Northern Highway, Gas Pipeline, Communication and Water Supply. The project traverses the Wiluna / Meekatharra Shire boundary.

Figure 1-2 shows the general location of the KLL exploration tenements and the tenement boundaries of The Project.

1.2 Purpose of this report

It is estimated that abstraction of approximately 15 Gigalitres / annum (GL/a) of potassium rich brine will be required to meet the 150,000 tpa production scenario. KLL currently holds a licence (182768) for up to 1.5 GL under tenement addresses of E69/3309 and E69/3347 and wish to apply to the Department of Water and Environmental Regulation (DWER) for the allocation of the remaining volumes of brine extraction.

This report summarises the hydrogeological investigations and results, and assesses the potential impacts of brine abstraction from the Ten Mile Lake and Lake Sunshine deposits, in support of KLL's applications for licencing the brine extraction and mining of the resource.

1.3 The BSOPP

The BSOPP tenements are located within the East Murchison groundwater area and the Meekatharra groundwater subarea.

The Project plans to abstract potash from the Surficial Lake sediments, deep palaeochannel and bedrock aquifers. Extraction of the potash resource involves abstraction of hypersaline brine contained within these aquifers, solar evaporation and processing. The actual exploitable volumes of brine that can be economically extracted will differ from the total volumes held within the sediments of the palaeochannel and associated lakes and will depend on the aquifer properties and efficiency of the operating borefield or alternative abstraction systems (i.e. trenches).

The key aspects affecting development of brine contained in the palaeovalley sediments and in the playa lakes are:

- The volume and storage of the brine within the sediments,
- The variability of the brine chemistry throughout the aquifer system,
- The ability of the sediments to release brine during abstraction,
- The viability of abstracting the brine at the required rates, and
- The impacts that the brine abstraction will have on the regional hydrogeology.

KLL have produced a Mineral Resource and Ore Reserve estimate to Joint Ore Reserves Committee (2012) and Canadian Institute of Mining standards (KLL ASX announcement 03 Oct 2017). The Mineral Reserve estimate being the volume of SOP that can be economically abstracted after applying mining modifying factors, in the form of brine abstraction, this means the use of detailed groundwater models to simulate the abstraction and the effects on brine grade, production rate and drawdown effects.

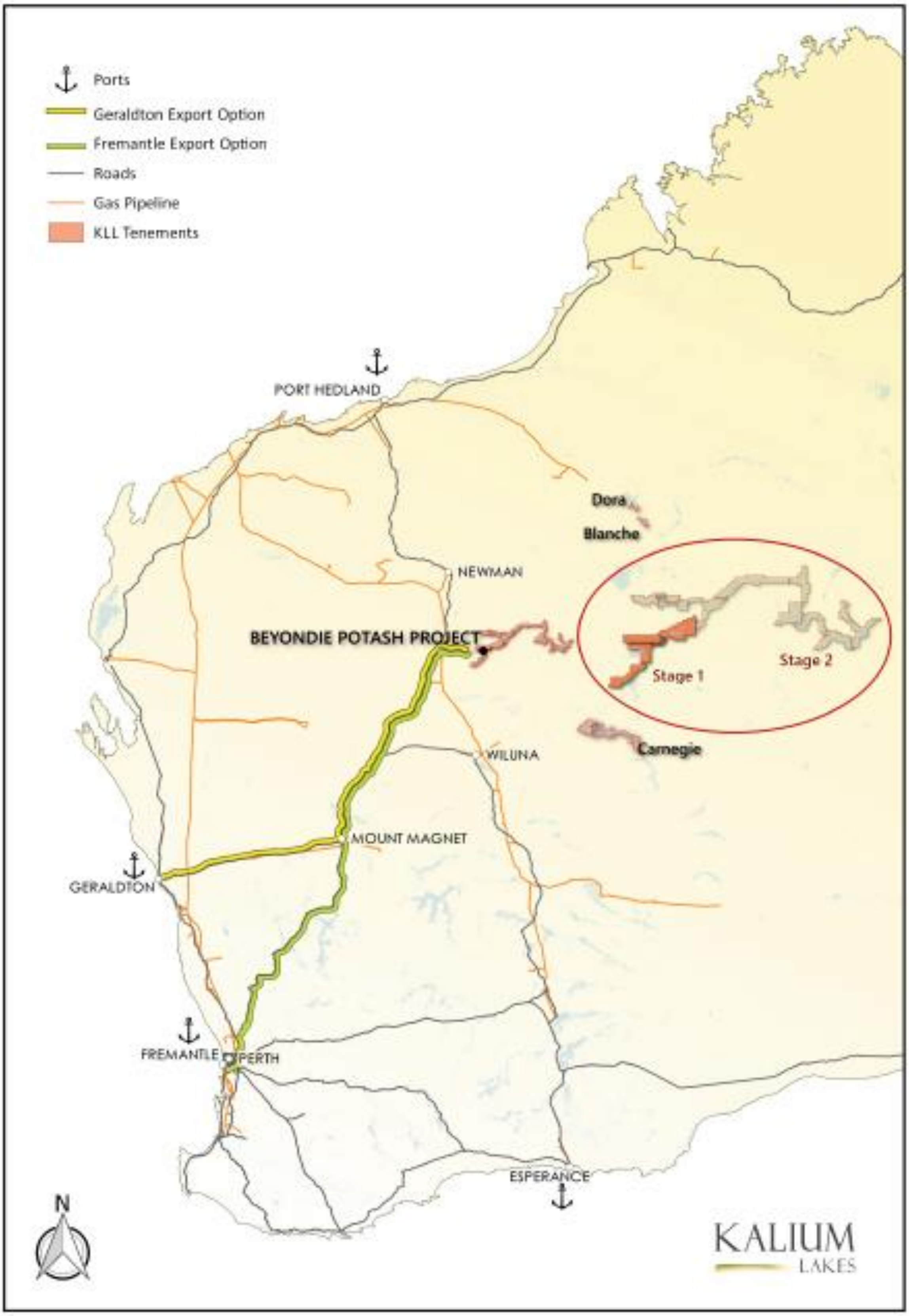


Figure 1-1: Kalium Lakes Project Location Plan

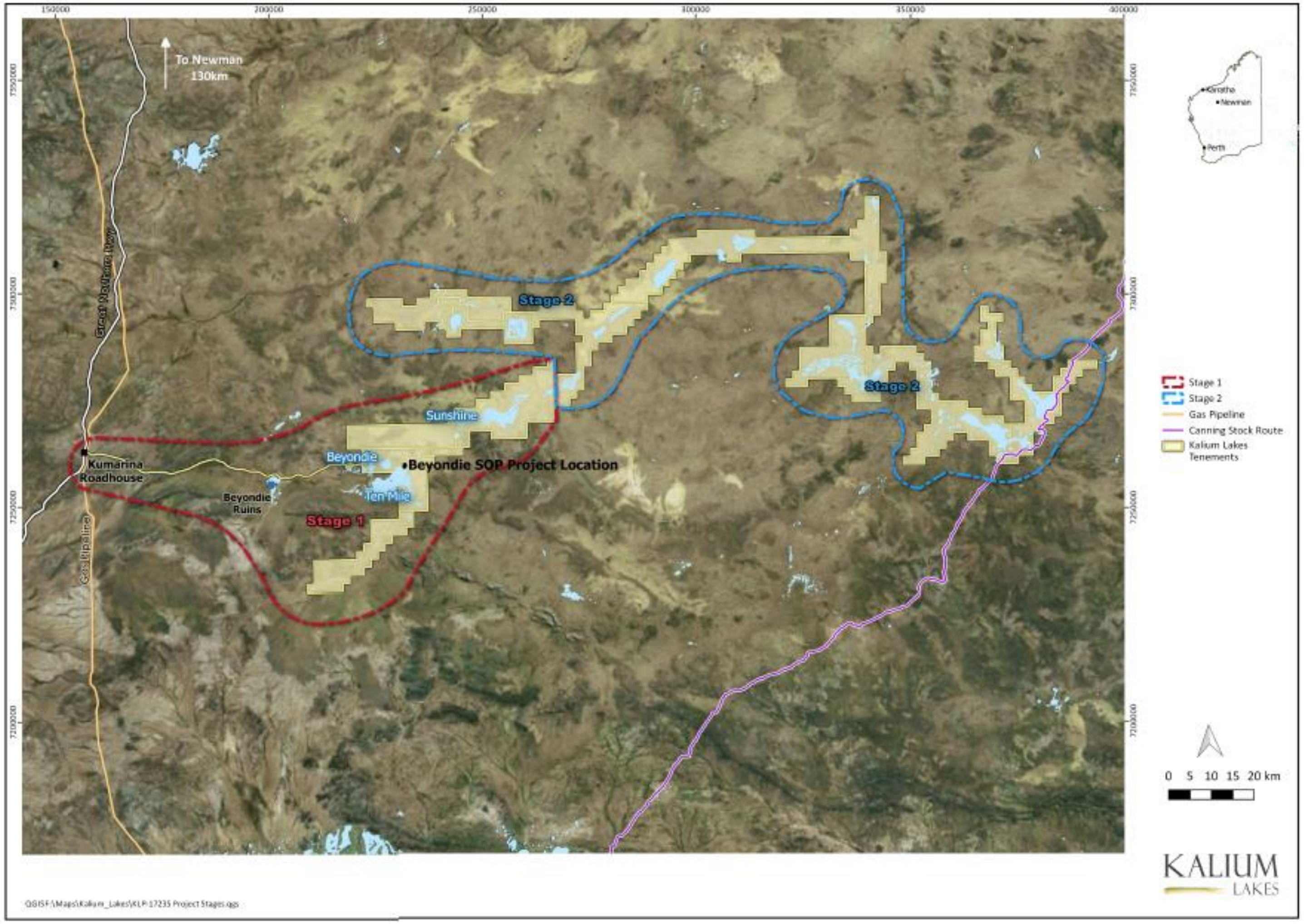


Figure 1-2: KLL Tenements and Project Staging

1.3.1 Previous Hydrogeological Work Undertaken

An initial study into the hydrogeology and resources of the BSOPP was completed in 2015, the results of which are included in *Assessment of the Hydrogeology of the Beyondie Project Saline Lake System – Pre Feasibility Report* (AQ2, 2016). As a part of the 2016 study, a preliminary data collection program comprising geophysics, lake augering, drilling, water sampling and aquifer testing were undertaken. This included the following.

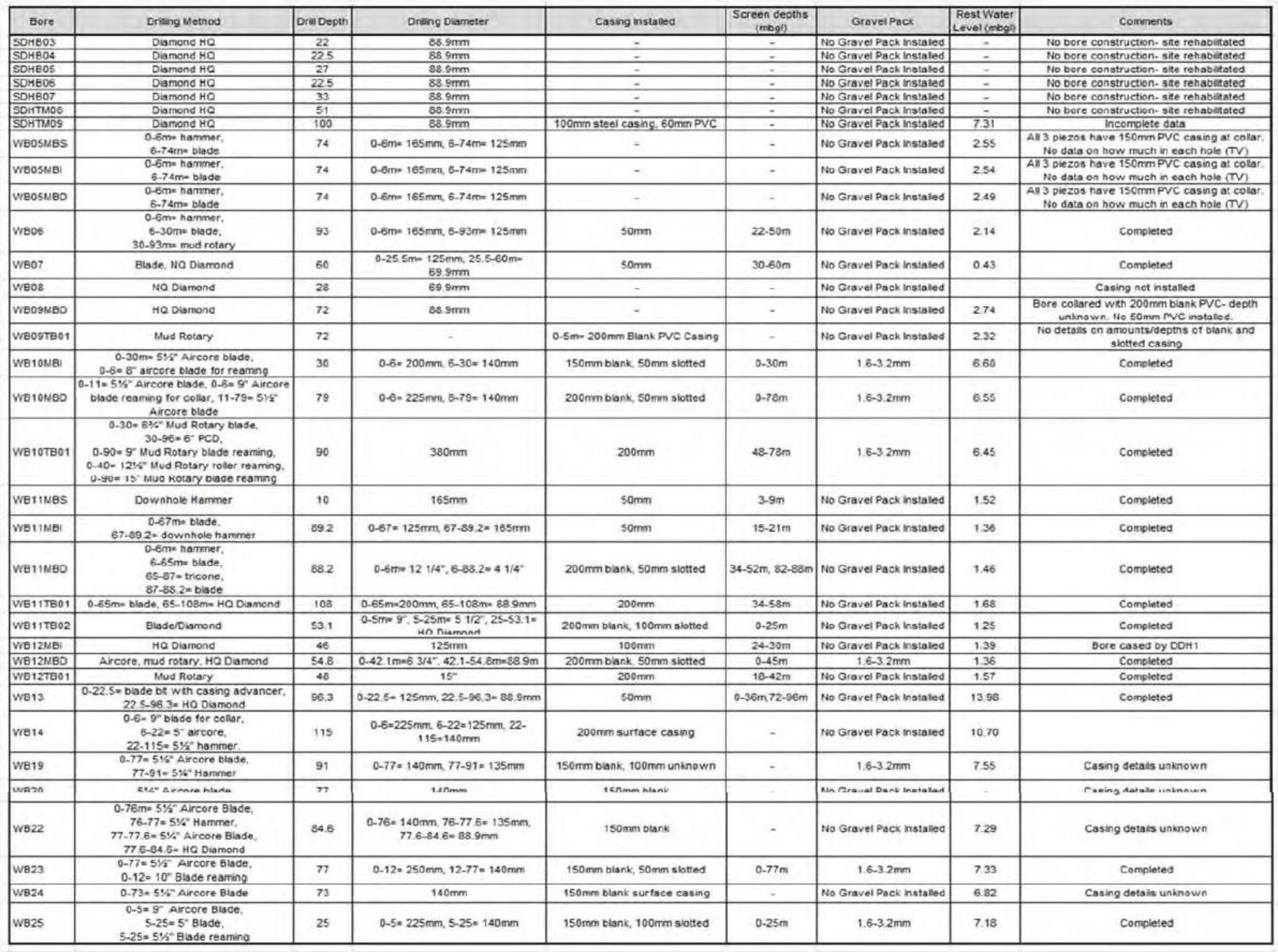
- Six gravity geophysical traverse around Ten Mile Lake and a further twenty-two were carried out between Ten Mile Lake and North TJ Lake;
- Augering at 336 locations across all of the lakes, to a depth of 1.5m to collect information on the geology and to collect groundwater samples;
- Diamond core drilling of 9 holes to collect representative geological samples;
- Installation of 20 monitoring bores;
- Installation of 4 test bores;
- Grain size analysis of 8 sand samples from 6 bores, 2 clay samples from 2 bores and 12 lake bed alluvium samples from 3 different lakes (Lake Beyondie, Ten Mile Lake and Lake Sunshine);
- 13 mini aquifer tests (1hr pumping / 1 hr recovery);
- 3 constant rate / recovery tests; and
- Laboratory analysis of water samples collected from augering (400), during drilling (87) and during the aquifer testing (26).

Details of the bores drilled during the 2016 investigations are reproduced in Figure 1-3.

A subsequent, more recent expanded hydrogeological study consisting of desktop reviews of previous studies and dedicated exploration programs for exploring the extent and grade of SOP mineralisation was undertaken during 2017. The results have been reported in a Pre-Feasibility Study (PFS; Advisian, 2017a). The program consisted of brine samples from 400 auger holes, geological logging and sampling from 9 diamond core holes, 67 Reverse Circulation (RC) holes, 51 monitoring bore holes, 980 m of lake trenches, 11 test production bores, 10 constant rate / recovery aquifer pumping tests, 13 mini aquifer tests, 1,130 km of geophysical traverses and laboratory analysis of grainsize lithology and groundwater chemistry.

The hydrogeological investigations, groundwater modelling (Advisian, 2017b) and assessment associated with the PFS (Advisian 2017a) have provided the data, information, analysis and relevant sections presented in the remaining sections of this report.

Figure 1-3: Summary of Bores Drilled in 2015 (Source: AQ2, 2016)



Bore	Drilling Method	Drill Depth	Drilling Diameter	Casing Installed	Screen depths (mbgl)	Gravel Pack	Rest Water Level (mbgl)	Comments
SDHB03	Diamond HQ	22	88.9mm	-	-	No Gravel Pack Installed	-	No bore construction- site rehabilitated
SDHB04	Diamond HQ	22.5	88.9mm	-	-	No Gravel Pack Installed	-	No bore construction- site rehabilitated
SDHB05	Diamond HQ	27	88.9mm	-	-	No Gravel Pack Installed	-	No bore construction- site rehabilitated
SDHB06	Diamond HQ	22.5	88.9mm	-	-	No Gravel Pack Installed	-	No bore construction- site rehabilitated
SDHB07	Diamond HQ	33	88.9mm	-	-	No Gravel Pack Installed	-	No bore construction- site rehabilitated
SDHTM06	Diamond HQ	51	88.9mm	-	-	No Gravel Pack Installed	-	No bore construction- site rehabilitated
SDHTM09	Diamond HQ	100	88.9mm	100mm steel casing, 60mm PVC	-	No Gravel Pack Installed	7.31	Incomplete data
WB05MBS	0-6m= hammer, 6-74m= blade	74	0-6m= 165mm, 6-74m= 125mm	-	-	No Gravel Pack Installed	2.55	All 3 piezos have 150mm PVC casing at collar. No data on how much in each hole (TV)
WB05MBI	0-6m= hammer, 6-74m= blade	74	0-6m= 165mm, 6-74m= 125mm	-	-	No Gravel Pack Installed	2.54	All 3 piezos have 150mm PVC casing at collar. No data on how much in each hole (TV)
WB05MBD	0-6m= hammer, 6-74m= blade	74	0-6m= 165mm, 6-74m= 125mm	-	-	No Gravel Pack Installed	2.49	All 3 piezos have 150mm PVC casing at collar. No data on how much in each hole (TV)
WB06	0-6m= hammer, 6-30m= blade, 30-93m= mud rotary	93	0-6m= 165mm, 6-93m= 125mm	50mm	22-50m	No Gravel Pack Installed	2.14	Completed
WB07	Blade, NQ Diamond	60	0-25.5m= 125mm, 25.5-60m= 69.9mm	50mm	30-60m	No Gravel Pack Installed	0.43	Completed
WB08	NQ Diamond	28	69.9mm	-	-	No Gravel Pack Installed		Casing not installed
WB09MBD	HQ Diamond	72	88.9mm	-	-	No Gravel Pack Installed	2.74	Bore collared with 200mm blank PVC- depth unknown. No 50mm PVC installed.
WB09TB01	Mud Rotary	72	-	0-5m= 200mm Blank PVC Casing	-	No Gravel Pack Installed	2.32	No details on amounts/depths of blank and slotted casing
WB10MBI	0-30m= 5½" Aircore blade, 0-6= 8" aircore blade for reaming	30	0-6= 200mm, 6-30= 140mm	150mm blank, 50mm slotted	0-30m	1.6-3.2mm	6.60	Completed
WB10MBD	0-11= 5½" Aircore blade, 0-6= 9" Aircore blade reaming for collar, 11-79= 5½" Aircore blade	79	0-6= 225mm, 6-79= 140mm	200mm blank, 50mm slotted	0-78m	1.6-3.2mm	6.55	Completed
WB10TB01	0-30= 8¾" Mud Rotary blade, 30-96= 6" PCD, 0-90= 9" Mud Rotary blade reaming, 0-40= 12¼" Mud Rotary roller reaming, 0-90= 15" Mud Rotary blade reaming	90	380mm	200mm	48-78m	1.6-3.2mm	6.45	Completed
WB11MBS	Downhole Hammer	10	165mm	50mm	3-9m	No Gravel Pack Installed	1.52	Completed
WB11MBI	0-67m= blade, 67-89.2= downhole hammer	89.2	0-67= 125mm, 67-89.2= 165mm	50mm	15-21m	No Gravel Pack Installed	1.36	Completed
WB11MBD	0-6m= hammer, 6-65m= blade, 65-87= tricone, 87-88.2= blade	88.2	0-6m= 12 1/4", 6-88.2= 4 1/4"	200mm blank, 50mm slotted	34-52m, 82-88m	No Gravel Pack Installed	1.46	Completed
WB11TB01	0-65m= blade, 65-108m= HQ Diamond	108	0-65m=200mm, 65-108m= 88.9mm	200mm	34-58m	No Gravel Pack Installed	1.68	Completed
WB11TB02	Blade/Diamond	53.1	0-5m= 9", 5-25m= 5 1/2", 25-53.1= HQ Diamond	200mm blank, 100mm slotted	0-25m	No Gravel Pack Installed	1.25	Completed
WB12MBI	HQ Diamond	46	125mm	100mm	24-30m	No Gravel Pack Installed	1.39	Bore cased by DDH1
WB12MBD	Aircore, mud rotary, HQ Diamond	54.8	0-42.1m=6 3/4", 42.1-54.8m=88.9m	200mm blank, 50mm slotted	0-45m	1.6-3.2mm	1.36	Completed
WB12TB01	Mud Rotary	46	15"	200mm	18-42m	No Gravel Pack Installed	1.57	Completed
WB13	0-22.5= blade bit with casing advancer, 22.5-96.3= HQ Diamond	96.3	0-22.5= 125mm, 22.5-96.3= 88.9mm	50mm	0-36m,72-96m	No Gravel Pack Installed	13.98	Completed
WB14	0-6= 9" blade for collar, 6-22= 5" aircore, 22-115= 5½" hammer.	115	0-6=225mm, 6-22=125mm, 22-115=140mm	200mm surface casing	-	No Gravel Pack Installed	10.70	
WB19	0-77= 5½" Aircore blade, 77-91= 5¼" Hammer	91	0-77= 140mm, 77-91= 135mm	150mm blank, 100mm unknown	-	1.6-3.2mm	7.55	Casing details unknown
WB20	5¼" Aircore blade	77	140mm	150mm blank	-	No Gravel Pack Installed	-	Casing details unknown
WB22	0-76m= 5½" Aircore Blade, 76-77= 5¼" Hammer, 77-77.6= 5¼" Aircore Blade, 77.6-84.6= HQ Diamond	84.6	0-76= 140mm, 76-77.6= 135mm, 77.6-84.6= 88.9mm	150mm blank	-	No Gravel Pack Installed	7.29	Casing details unknown
WB23	0-77= 5½" Aircore Blade, 0-12= 10" Blade reaming	77	0-12= 250mm, 12-77= 140mm	150mm blank, 50mm slotted	0-77m	1.6-3.2mm	7.33	Completed
WB24	0-73= 5½" Aircore Blade	73	140mm	150mm blank surface casing	-	No Gravel Pack Installed	6.82	Casing details unknown
WB25	0-5= 9" Aircore Blade, 5-25= 5" Blade, 5-25= 5½" Blade reaming	25	0-5= 225mm, 5-25= 140mm	150mm blank, 100mm slotted	0-25m	1.6-3.2mm	7.18	Completed

2 Site Characteristics

The Project is located on the edge of and extends into the Little Sandy Desert, characterised by dry salt lakes, extensive sand dunes and flat plains. The playa lakes are located in a broad, easterly trending valley, which hosts a non-perennial water course. The lakes lie within the Ilgarari palaeochannel system (Beard, 2005), which joins into the larger Disappointment palaeochannel system 200kms further to the east.

2.1 Climate

The BSOPP area falls within the arid desert climate zone. The regional climate 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 to the project area is at Three Rivers, approximately 127 km east-southeast of the site. Figure 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.

Figure 2-1: Summary Meteorological Conditions for Three Rivers Station (Latitude: 25.13°S • Longitude: 119.15°E • Elevation 520 m) reported by BOM

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 (mm)	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 (mm)	547	473	430	304	186	144	157	203	271	397	451	537	4,100

Detailed regional meteorological data is currently being collected at the project site with a weather station, established in February 2015.

Figure 2-2 and Figure 2-3 show the Australian Continental Evaporation and Humidity maps with the location of the BSOPP. These figures illustrate the BSOPP is located in an area expected to experience some of the lowest humidity and highest evaporation rates in the country.

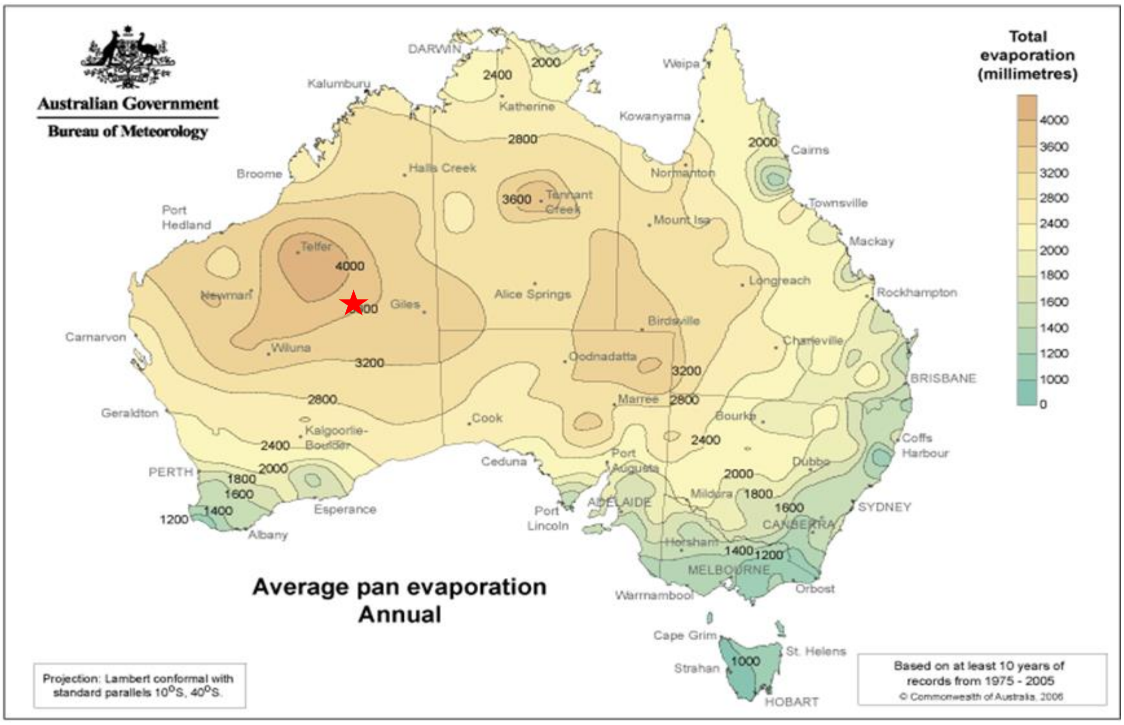


Figure 2-2: Australian Continental Evaporation

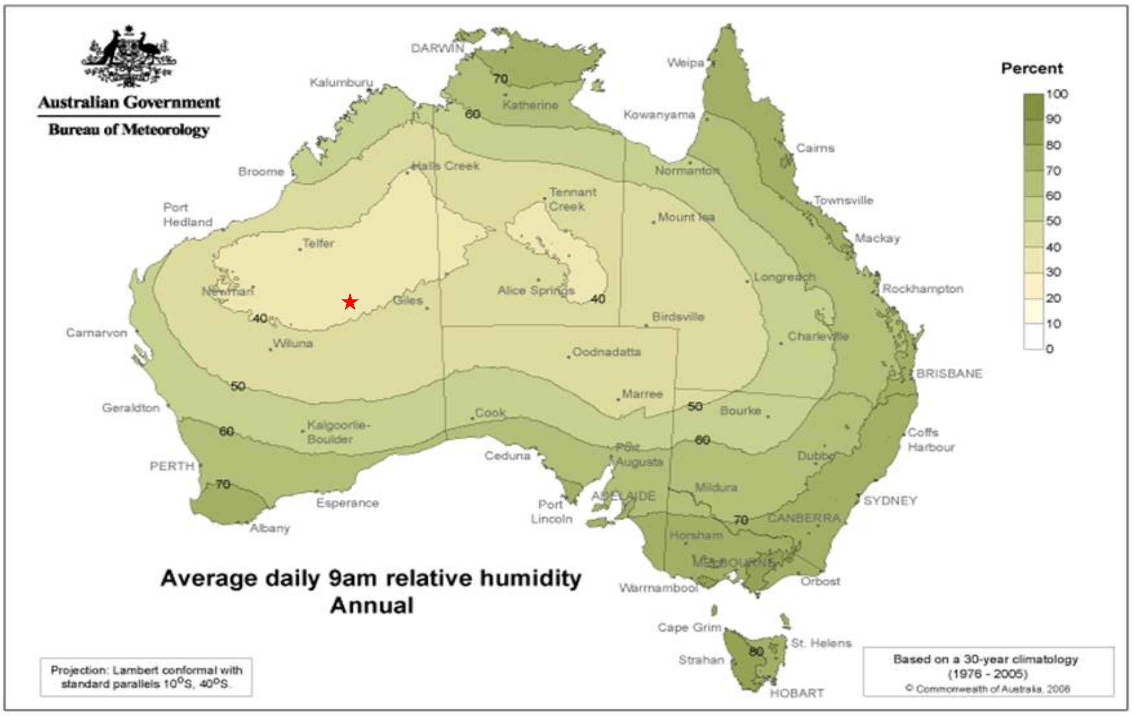


Figure 2-3: Australian Continental Humidity

The wind data from Three Rivers Station shows a predominately eastern direction (see Figure 2-4).

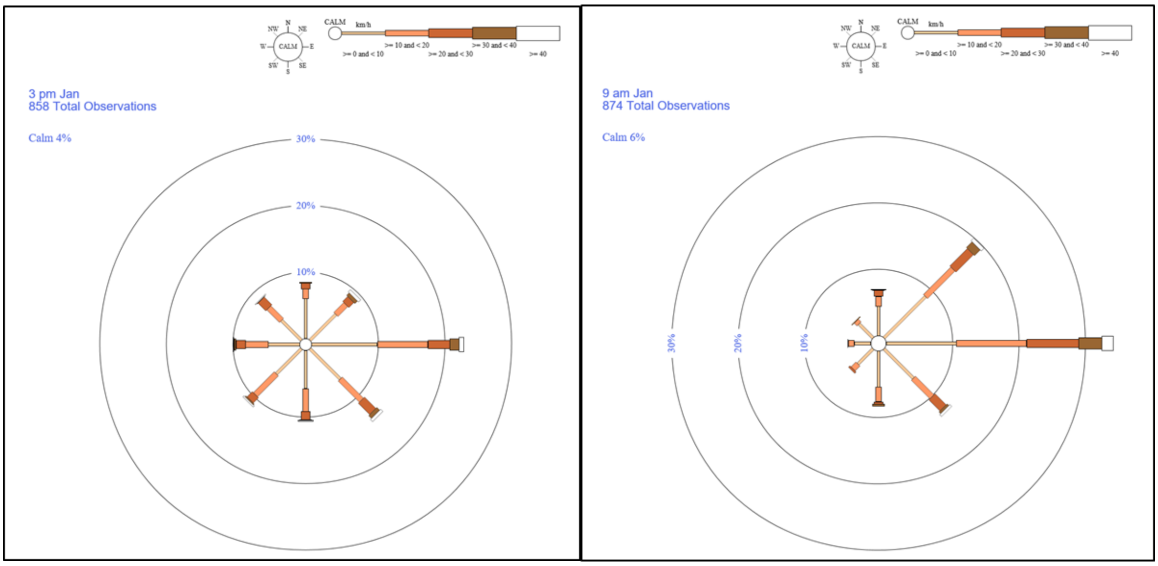


Figure 2-4: Wind Roses from Three Rivers Station (BOM) at 3:00 PM and 9:00 AM

The annual solar exposure for the period of one year from 1 September 2016 to 31 August 2017 was between 20 and 22 MJ/m^2 as shown in Figure 2-5 Due to the climate, the operations will be continuous with solar evaporation occurring all year and the process plant operating full time apart from allowance for maintenance.

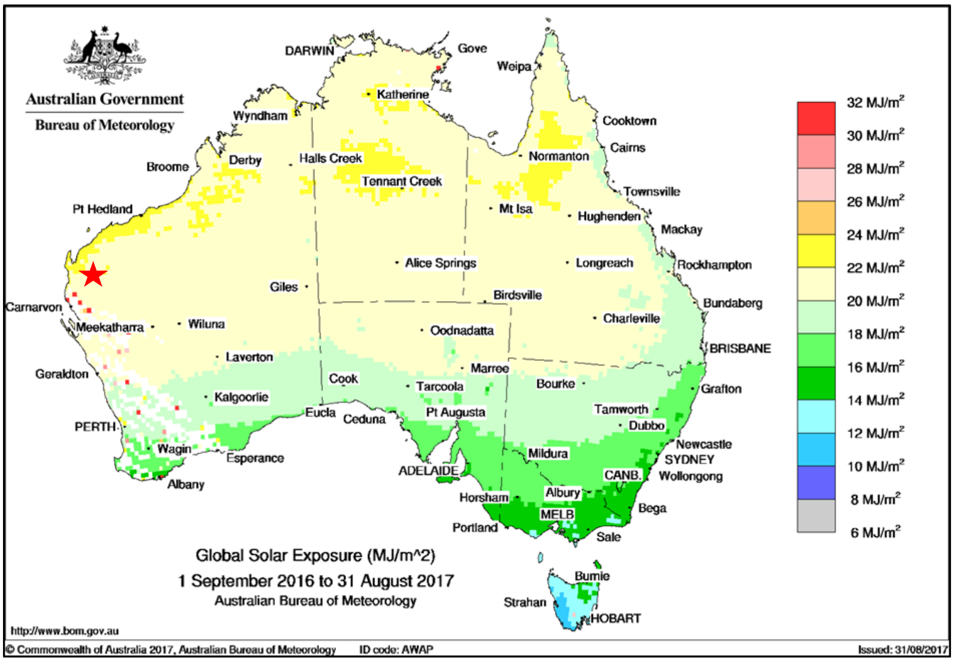


Figure 2-5: Solar Exposure

2.2 Hydrology

The project area comprises numerous ephemeral salt lakes that have individual catchments that sit in the upper reaches of a much greater catchment, which in the geological past used to be linked by a large palaeo-drainage system.

The lakes in the present landscape are a function of the low rainfall and high evaporation the region is currently subject to. Beyondie, Ten Mile and Sunshine lakes are the western most catchment lakes in a chain that stretches for some 220 km west to east. The catchments of the lakes within the PFS area are presented in Figure 2-6

Surface water is present on the lakes for periods of time following heavy rainfall events; the locations of the lakes within the catchment, their size and catchment run off characteristics determine the individual lake surface water regime. It is important to understand these characteristics of the lakes so the magnitude of events impacting on these lakes can be quantified in response to annual and infrequent rainfall events.

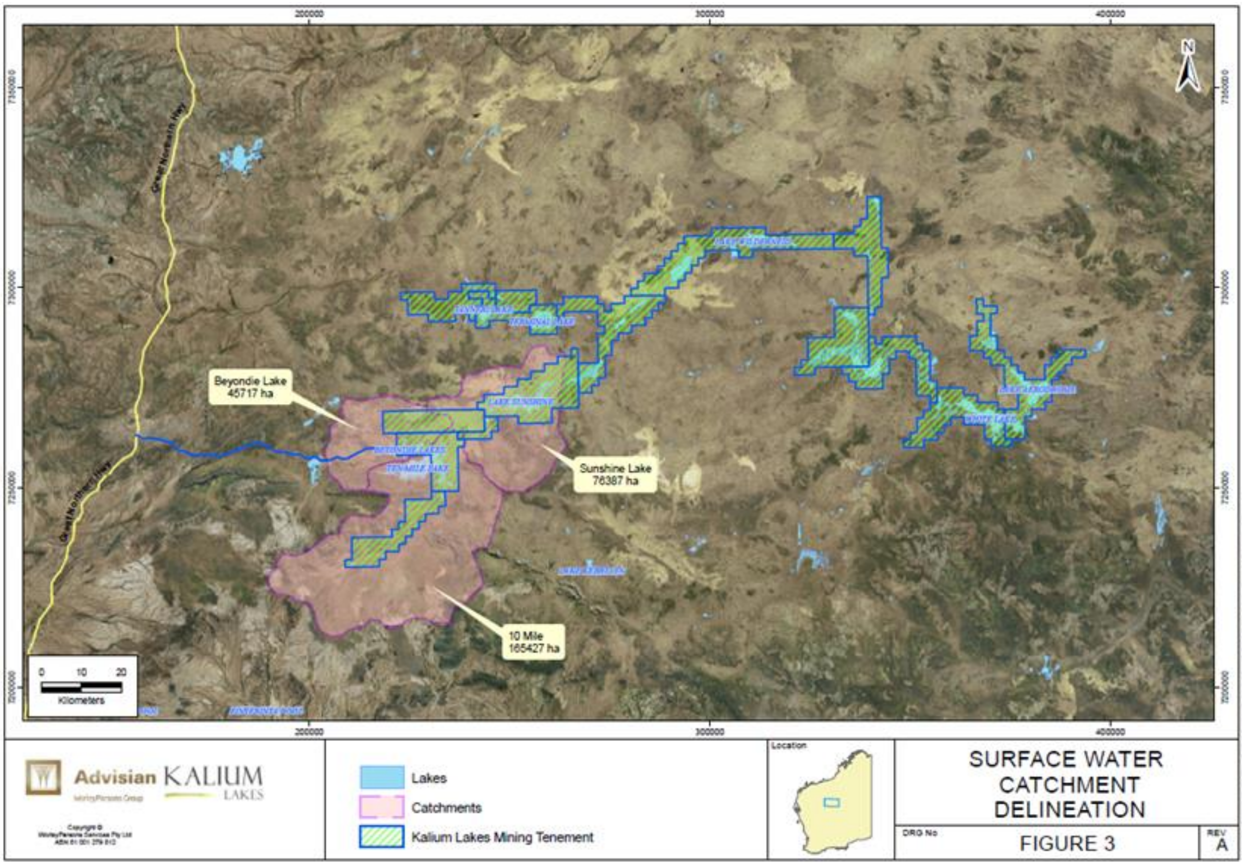


Figure 2-6: Catchment Delineation (Source: Advisian, 2017a)

A summary of the basic catchment parameters of Beyondie, Ten Mile and Sunshine lakes are presented in Figure 2-7 below.

Figure 2-7: Basic Catchment Parameters

Characteristic	Description	
Description	Ephemeral lake	Dry salt lakes, extensive sand dunes and flat plains
Hydrological zone	Arid interior / North West	
Estimated lake surface area (storage)	26 km^2 155 km^2 200 km^2	Beyondie Ten Mile Sunshine
Combined catchment areas from surrounding creek runoff	460 km^2 1,680 km^2 775 km^2	Beyondie Ten Mile Sunshine
Total surface runoff catchment area	486 km^2 1,835 km^2 975 km^2	Beyondie and Ten Mile are likely to become one larger catchment during larger flood events due to overtopping nature of Beyondie Lakes into Ten Mile.

The potential volume of water discharged into Beyondie, Ten Mile and Sunshine Lakes was estimated based on the most probable annual occurrence rate of 63% and presented in the PFS report (Advisian 2017a). The lakes are known to flood on an approximate annual basis. Preliminary estimates of ponding depths derived from rainfall and catchment runoff equations for Beyondie and Ten Mile lakes are 330 millimetres (mm) and 190 mm respectively.

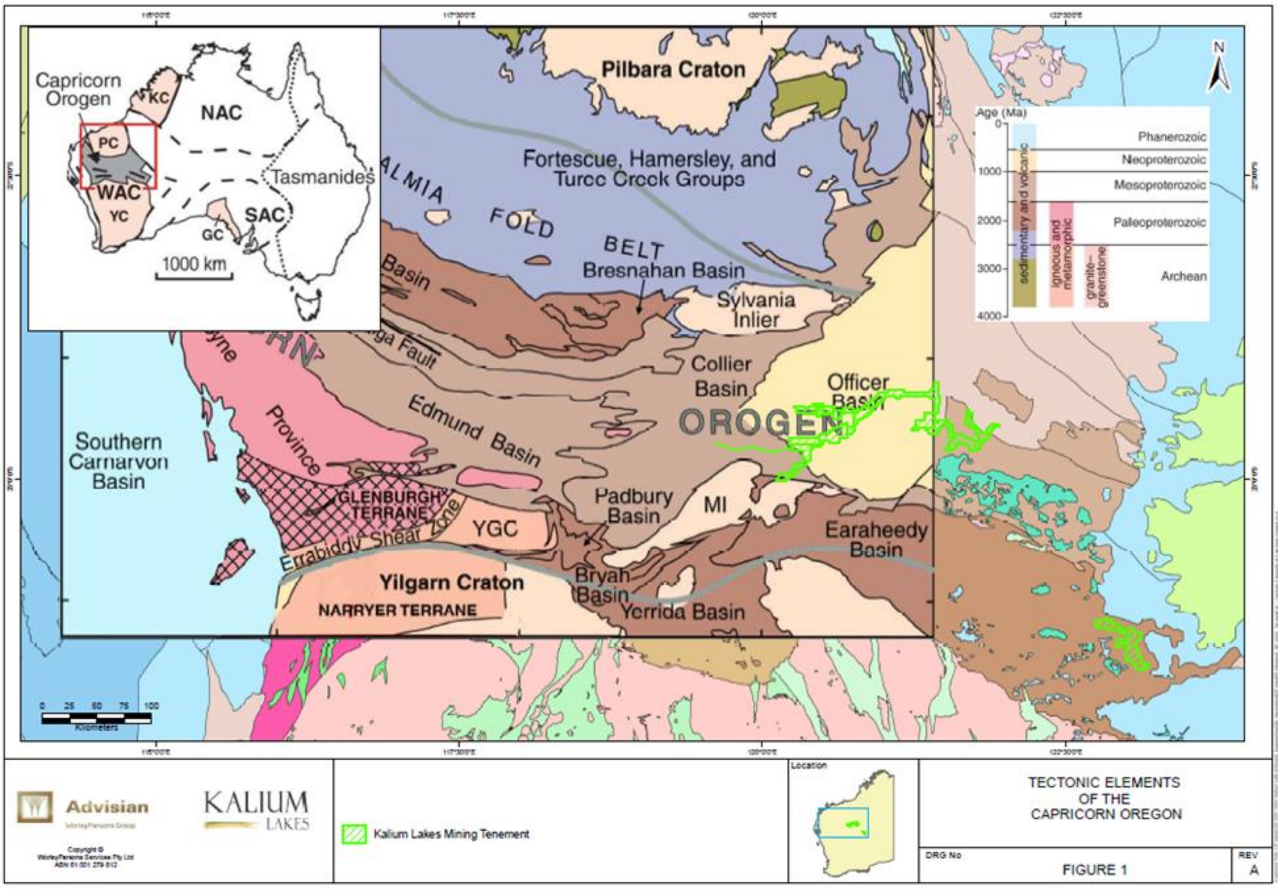
2.3 Geology

The BSOPP is located in the East Pilbara region of the Little Sandy Desert, in an area typified by the presence of dry salt lakes, extensive longitudinal "red" aeolian sand dunes, and broad plains dominated by low hardy saltbush scrub. KLL are exploring the potential for economic extraction of potassium rich sub-surface brines from aquifers hosted primarily in Cenozoic colluvial deposits within this regionally expansive, salt playa lake environment. Identification and targeting of Cenozoic palaeovalley sequences with optimal aquifer conditions and likelihood of containing potassium rich brines have been the primary exploration objectives. It is recognised that the key to mapping the palaeo-geomorphology is a comprehension of the host geology and the palaeo-depositional environment of target aquifers.

The BSOPP area falls within the Bullen 1:250,000 Geological Survey of Western Australia (GSWA) Geological Series map (GSWA, 1995).

2.3.1 Tectonic Setting

Geological descriptions presented in this report are adopted from previous works undertaken by Kalium and summarised in the PFS report (Advisian, 2017a). The Project is located within the Collier, Salvation, Scorpion, and NW Officer Basins (Figure 2-8 and Figure 2-9), which post-date the main regional tectonic event, the Capricorn Orogeny.



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 2-8: Tectonic Elements of the Capricorn Orogen

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. The Marymia Dome is located on the northeast fringe of the Yilgarn Craton and comprises Archaean greenstone belts intruded by granites, and notably monzogranitic rocks. Monzogranites are characterised as potassium rich and composed mostly of quartz and potassium feldspar (alkali-feldspar); their proximity to the BSOPP area, along with other granitic inliers, makes them a suspected source of the potassium enrichment in the region's sub-surface brine deposits.

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 2-9). After this event, units of the NW Officer Basin, the Sunbeam Group (c. 1000 – 720 Ma) which represent the youngest basement units within the BSOPP were deposited.

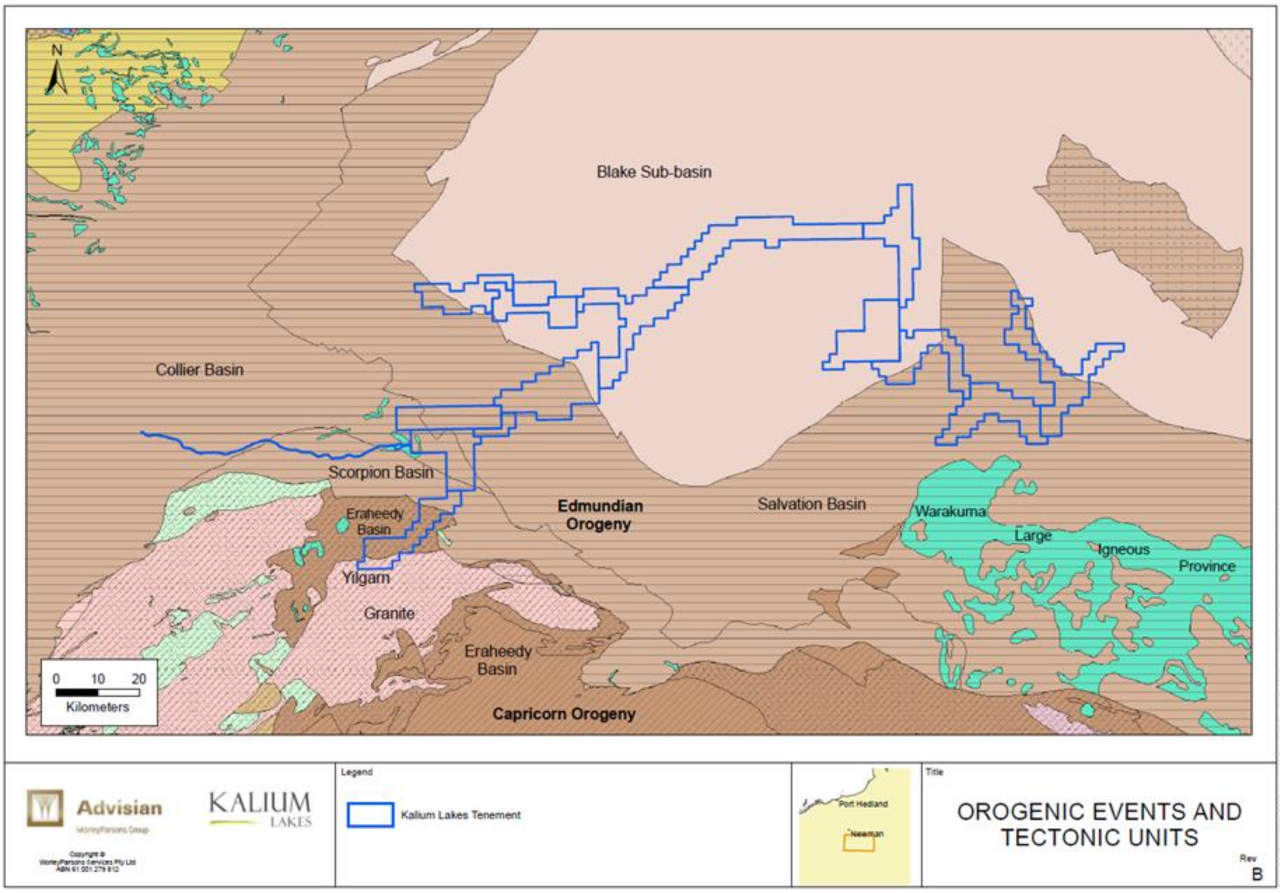


Figure 2-9: Beyondie Project Area Tectonic and Orogenic Regions

Mafic intrusions, belonging to the Warakurna Large Igneous Province, c.1078 – 1070 Ma, (Wingate, *et al*. 2004), outcrop sporadically across the BSOPP area (Figure 10 and Figure 11), and contribute to a growing stratigraphic complexity. Identified as dolerites, they are interpreted as being members of the Kulkatharra Dolerite suite in the western Salvation Basin area, while in the east, they are identified as the Prenti Dolerite.

2.3.2 Geological Structures

Two key regional structural events, the Edmundian Orogeny and the Blake Movement, are identified as having major impact upon basement rocks of the BSOPP. A third event, the Capricorn Orogeny which pre-dates the deposition of basement Bangemall sediments, impacted to some extent on the oldest sediments in the Region, the Tooloo Group units; deposited apparently coeval with the deformation event. The Edmundian Orogeny was responsible for metamorphism and deformation of sedimentary successions of the Scorpion, Collier and Salvation Basins; though metamorphic grade was considered very low. Fold and fault structures generally trend east-west to northwest-southeast, (Cutten *et al*, 2011).

The Blake Movement produced faulting and folding called the Blake Fault and Fold Belt (Figure 2-8). The fault and fold belt is typified by approximately parallel northeast-trending fold axes, and numerous north-northeast to east-northeast trending faults that present a range of normal, steep reverse and strike slip movements (Figure 2-8. Folds are broad and open with shallow to moderate dips. Overall, fold axes have a shallow plunge to the northeast. Local steepening of bedding is apparent adjacent to faulting (Williams, 1992).

The Blake Fault and Fold Belt is a brittle fracture domain. Shear and breccia zones appear confined to mainly the marginal fault systems. Most faults in the belt have sharp contacts, often with well-formed slickensides. Terminal Fault, which transects Beyondie Lakes and lies adjacent to 10 Mile Lake (Figures 3, 4 & 5) has slickensides indicating sinistral strike slip movement. Kelly Fault, which marks the eastern boundary of the Blake Fault and Fold Belt, and separates the tectonic units of the Blake Sub-basin and Salvation Basin, is a major strike slip fault. The SW margin of the Blake Sub-basin, which marks the unconformable contact between Glass Spring Formation sandstones (Salvation Basin), and Backdoor Formation (Collier Basin) shales and siltstones is punctuated by numerous northeast-trending steep dipping faults which have apparent multiple major offsets; some are strike slip faults, though the unconformity offset may be attributed in part to erosion of normal and reverse faults (Williams, 1992). Major faults are labelled on Figure 2-9.

2.3.3 Cenozoic Geology

While most of the current BSOPP basement stratigraphy is greater than c. 700 Ma, the majority of the geology hosting the brine deposit is of Cenozoic age (C. <0.66 Ma), leaving a vast period of weathering and erosion of the Pre-Cambrian surface to derive the palaeo-geomorphology.

One of the key events to impact upon the palaeo-landscape was the Late Carboniferous – Early Permian glaciation. The period stripped the ancient topography through glacial advance, depositing glacial sediments hundreds of kilometres north and west of the Project region. The residual “scoured” landscape following glacial retreat produced during those Palaeozoic times is the palaeo-drainage network. This network has been subject to sedimentation comprising palaeovalley fill of Cenozoic sediments which is the primary host for aquifers containing hypersaline brines. Three phases of Cenozoic sedimentation that make up the palaeovalley sequence are recognised within the project area include:

- Palaeochannel sand – mid to upper Eocene aged

- Lacustrine clay – late Oligocene to mid Miocene aged
- Mixed alluvial and colluvium – Pliocene aged

Derived from palynological aged dating methods, the palaeovalley sedimentary sequence described above is remarkably uniform across the Australian continent (J. Magee 2009). The basal palaeochannel unit is dominated by high energy fluvial sands which formed in braided river depositional environments under wet climatic conditions, typically located in the deepest parts of the palaeovalley. Unconformably overlying the basal sands horizon, are the fine grained, low energy lacustrine clay horizons interpreted as forming within valley lakes and wetlands. More discrete fluvial fine sand sequences are present within the lower clay deposits, associated with lower energy palaeo-stream and channel depositional environments during the drying climate. Finally, the upper alluvial and colluvial sequence is derived from tectonic adjustments. It is varied in nature, and texturally further modified by ferricrete and silcrete weathering and regolith processes.

All three sediment sequences have been intersected in drilling across the BSOPP, and as described by Magee (2009), occur with remarkable regularity. The extent of Cenozoic sediments within the project area is presented in Figure 2-10.

Figure 2-10: Extent of Cenozoic Geology

2.4 Groundwater Conditions

Two regional aquifer units have been identified within the Cenozoic sediments, the palaeochannel sand aquifer of Eocene age that is located at the base of the palaeo-drainage system, and the shallow surficial aquifer comprising Pliocene and Quaternary evaporites, calcrete and silt. These aquifers are considered to be hydrogeologically separated from one another by a thick sequence of stiff lacustrine clay that forms an aquitard.

The regional bedrock is considered to be on the whole of low aquifer potential; however regional structural features described above enhance aquifer transmissivity as linear features due to extensional faulting and fracturing.

Where bedrock aquifers are encountered below lacustrine clay the groundwater system is confined in nature. However, where bedrock is exposed outside of the palaeovalley groundwater is unconfined and would flow according to local groundwater table flow patterns.

The target aquifer is the Palaeogene aged, high energy fluvial basal sand unit, the oldest Cenozoic infill sediment encountered to date across the Project. Unconformably overlying the basal sand unit is a generally thick sequence (~10 – 60 m) of low energy, lacustrine, fine silt and clay with a high degree of plasticity. A third valley infill layer, possibly Pliocene in age, has been logged as <25 m in thickness, and is a highly variable unit, both compositionally and texturally, but which represents a fluctuating fluvial environment. It is important from a project perspective in that it is a second, though poorer quality, brine aquifer.

The Roe Palaeochannel and other Goldfields palaeochannel systems are considered to be of a similar age and depositional environment as the Beyondie Palaeochannel. Magee (2009) presents pumping records of the Roe Palaeochannel located near Kalgoorlie. These records indicate that longer term pumping yields are typically between 3 L/s and 11 L/s from the palaeochannel sand aquifer, but decrease as drawdown hits aquifer boundaries and unconfined conditions became prominent. The 10 years of pumping data presented in Magee (2009) has shown that pumping water levels can stabilise once the piezometric head has reached the base of the lacustrine clay and leakage becomes dominant in the aquifer system.

The preliminary conceptual understanding of the system prior to more detailed investigations detailed in the following sections is presented in Figure 2-11 below.

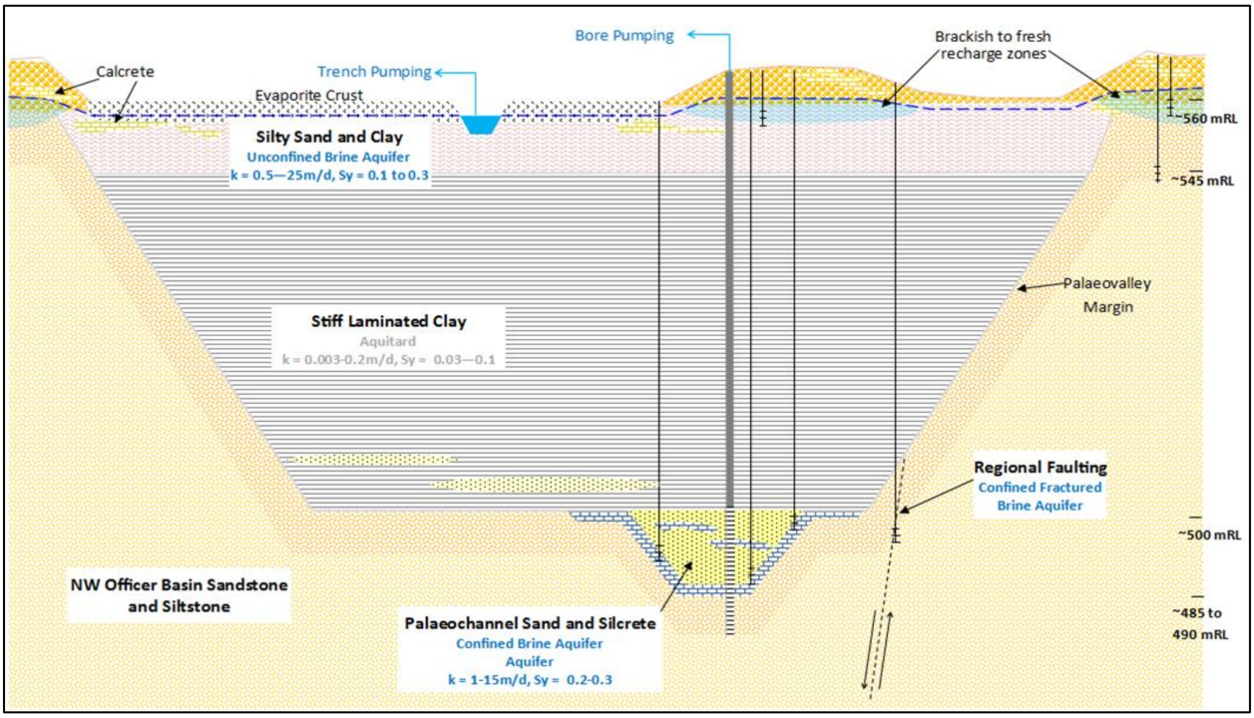


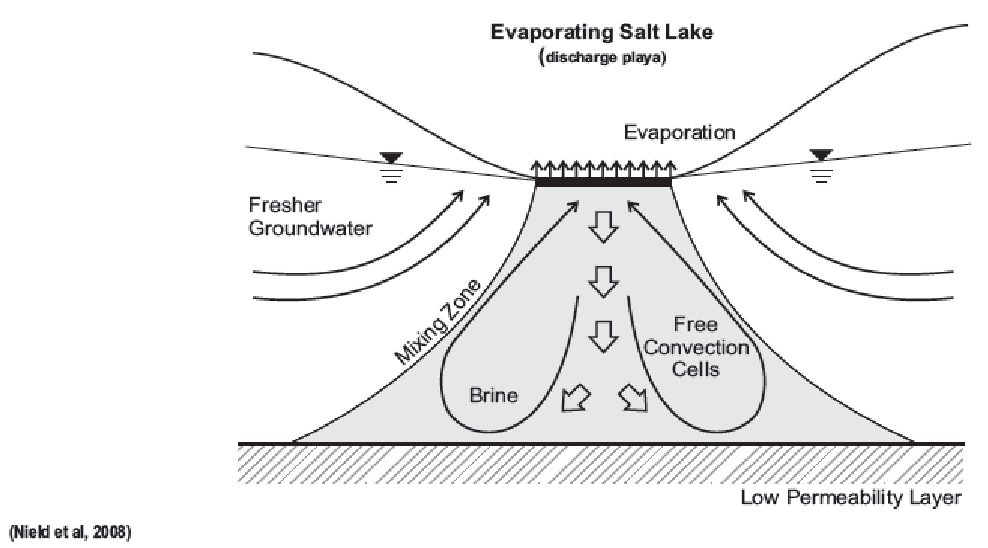
Figure 2-11: Conceptual Hydrogeology (Advisian, 2017a)

2.5 Groundwater - Surface Water Interaction

The relationship between the existing Beyondie and Ten Mile salt lakes (playa lakes) and the palaeochannel is important, as it influences the future abstraction of brine from the palaeochannel system. There are four potential relationships between groundwater flow in the palaeochannels and the playa lake development (Mernagh, 2013):

- A groundwater through-flow system, with flow below the lakebed and limited interaction with the playa.
- Recharge takes place from the lake to the underlying groundwater system, with limited evaporation taking place and minor development of evaporites.
- Groundwater inflow to the lakebed, with evaporation and evaporite minerals development.
- Groundwater inflow to the lake, with the groundwater table being above the surface of the deepest part of a playa lake, so that groundwater input is constant and subaqueous evaporites accumulate.

In the case of Beyondie and Ten Mile lakes, the third case is probable, with flow down the palaeochannel being controlled (on a local playa lake scale) by evaporative discharge. Deflation of exposed lakebeds along palaeovalley (Mernagh, 2013) results in the lowering of the topographic elevation of lakebeds, thereby effectively bringing the groundwater level closer to the surface, promoting evaporation. The evaporative “pumping” increases groundwater discharge at the lake site, thus promoting groundwater flow towards the playa lakes. The evaporative pumping, together with the development of dense brines below the evaporative surface, results in the development of density driven flow circulation of groundwater around the lakes (Figure 2-12). Evaporation at the phreatic surface increases the brine density causing it to sink through the aquifer (CQG, 2014). This sinking results in reduced heads with depth in the centre of the playa lake, promoting inflow from the edge of the playa lake.



(Nield et al, 2008)

Figure 2-12: Density Driven Flow Patterns at a Salt Lake (Source: AQ2, 2016)

3 Existing Groundwater Use

The Water Information Reporting (WIR) database of the DWER records 36 regional bores in the vicinity of the Project, within a search radius of approximately 100 km. These are generally shallow (between 4 and 22 metres below ground level (mbgl), low yielding stock bores, and provide limited information on the seasonal groundwater flow regime. A plan of the groundwater bores in the vicinity of the project area is shown in Figure 3-1 and bore locations are detailed in Appendix A.

There are unlicensed bores within the search area believed to be constructed in the shallow alluvium and calcrete aquifer. Bore construction details, downhole geology, borehole logs and abstraction volumes are mostly unknown.

Phoenix Environmental has monitored some of the regional bores that are on the WIR database as part of the recent subterranean fauna survey. Homestead Well has historically been used for stock watering; however current use or volumes are unknown. It is also understood that Garden well and 4 Mile well supply water to tanks and cattle troughs and that 12 Mile well is currently unused.

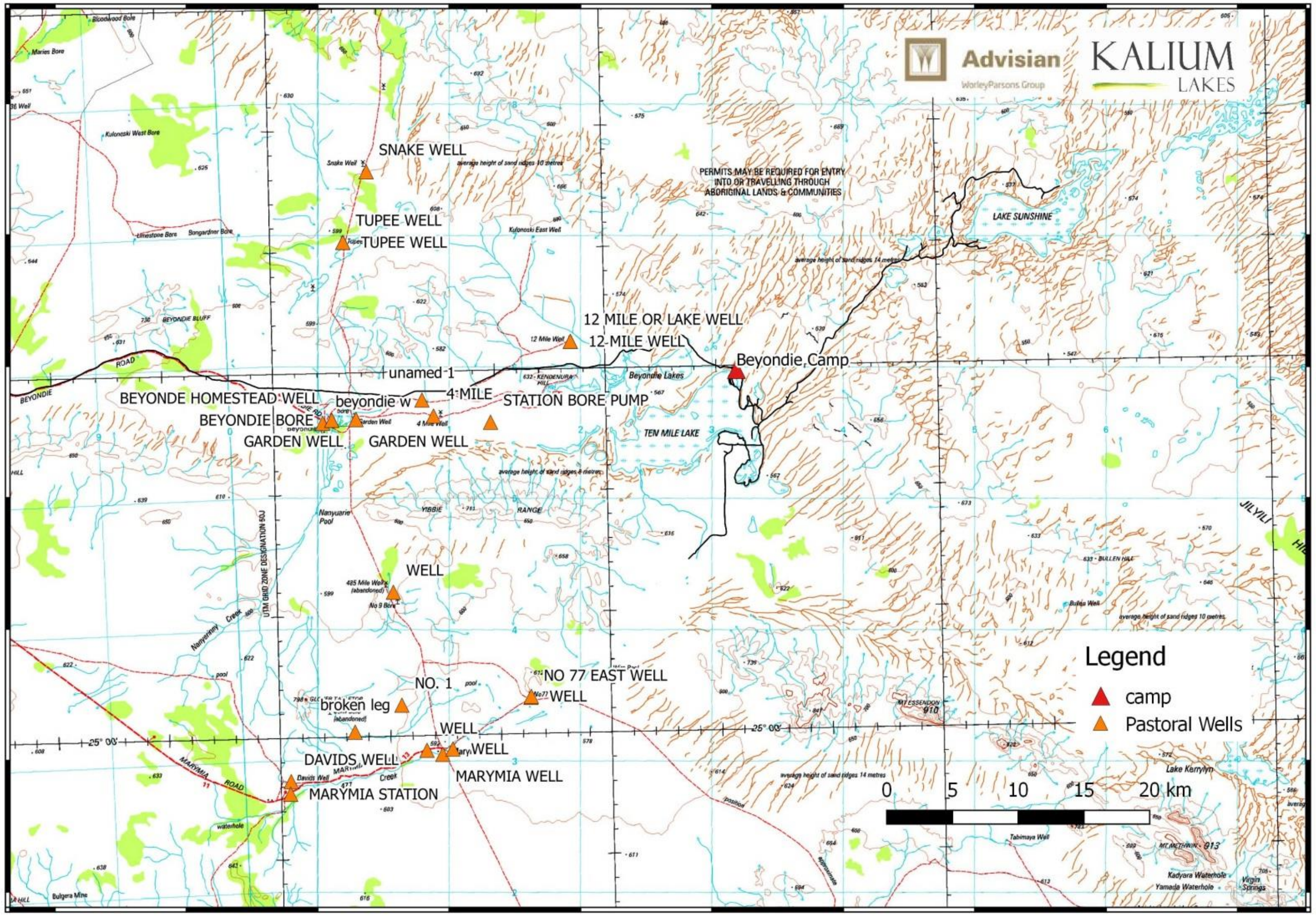


Figure 3-1: Bores in the Vicinity of BSOPP

4 Groundwater Investigations

4.1 Geophysics

The use of multiple independent geophysical techniques has been highly useful in recognizing the palaeovalley dimensions and geometry. Gravity was used as a rapid acquisition reconnaissance tool to quickly identify points of interest and focus the subsequent surveys. Passive seismic horizontal-to-vertical spectral ratio (HVSR) has been used as an infill tool at the most prospective locations, and when compared to drilled depths provides the most reliable modelled depth to bedrock during exploration to date. Resistivity/conductivity surveys have also been completed using the NanoTEM system to resolve some ambiguity in the gravity data at a number of key locations.

All geophysical data and drill hole data has been integrated into a calibrated geophysical model, presented in Figure 4-1, where the interpreted palaeochannel is located in the deepest sections of the bedrock topography.

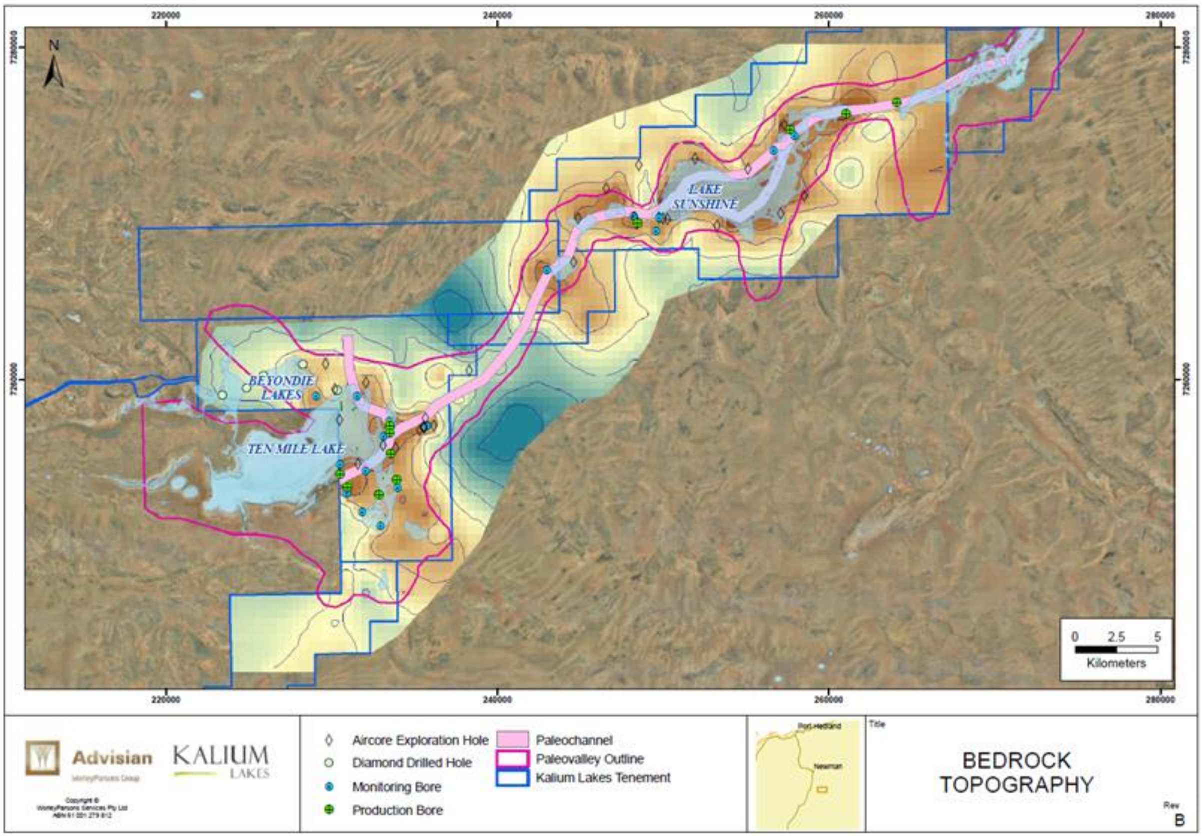


Figure 4-1: Integrated bedrock topography

4.2 Drilling

Exploration drilling has occurred during two field programs, the first conducted in 2015 and the second in 2017. Both programs were completed with the aim of characterising the geology and hydrogeology of the project in conjunction with development of mineral resources.

The 2015 drilling included a number of different methods, such as air percussion and blade, and rotary mud drilling; all with 165 mm diameter bits. In September 2015, it was decided to use the diamond core drilling method and a casing advancer for further exploration drilling. Where basal sand was encountered, the diamond holes were reamed out to 300 mm and 200 mm PVC casing was installed and gravel packed. This technique was employed on bores WB09, WB10, WB11, and WB12.

During the 2017 exploration program a further 22 reverse circulation (RC) and aircore drilled holes were completed at Ten Mile and 25 at Lake Sunshine to explore the palaeochannel aquifer targets, obtain lithological and brine samples and install 50mm PVC monitoring bores. 28 monitoring bores were installed within exploration holes at Ten Mile Lake and 22 monitoring bores were installed within exploration holes at Lake Sunshine. A number of the exploration holes had dual monitoring bores installed to monitor shallow and deep aquifer units, separated by annular bentonite seals.

All geological samples collected during all forms of drilling have been logged at 1 m intervals to gain an understanding of the variability in the aquifer materials hosting the brine. During mud rotary and air drilling, samples were collected, washed and stored in chip trays for future reference. A geological core description with detailed documentation (drill log, soil profile, brine flow observations and field water quality parameters) has been prepared for each borehole and is stored within the geological database.

Eight new production bores were successfully constructed in 2017 using a hybrid mud rotary casing advance system. The installation technique generally mitigated the drilling issues associated with ground conditions experienced in the 2015 program. The production bores were constructed with 225mm CL18 PVC and slotted over the basal sand zones of the palaeochannel; annular bentonite seals were installed in the lacustrine clay zones to prevent connection to the surficial aquifer. Production bore construction details are presented in Table 4-1, full details of the drilling program is presented in the PFS report (Advisian 2017a). All drill hole locations are presented in Figure 4-5 and Figure 4-6 and further details are provided in Appendix A. Test production bore graphic logs are presented in Appendix B.

4.3 Trenching

Trial trenches have been used to investigate the lithology of the top 5 m of lake sediments and test the ability of these sediments to supply brine. Six trial trenches were completed: three at Ten Mile and three at Sunshine. Figure 4-2.

Figure 4-2: Trial Trench Details

Trench ID	Easting	Northing	Width (m)	Depth (m)	Length (m)
TMT01	230586	7258398	1.5	2	500
TMT02	231362	7258232	1.5	2	300
TMT06	233130	7254077	1.5	2	80
SST01 (ESE)	257359	7271673	1.2	5	44
SST02 (ENE)	254765	7270417	4	5	42
SST03 (NE)	260729	7276167	4	5	12

Shallow 2 m deep trenches were constructed at Ten Mile using a small traditionally tracked excavator, whilst 5m deep trenches were constructed at Sunshine with the use of a 12 tonne amphibious excavator. The deeper trenches had slopes at approximate 1 in 2 angles to maintain wall stability. Figure 4-3 shows a trench being excavated.

Water level monitoring pits were dug with the excavator at a number of locations between 5 m and 50 m from the trench to facilitate monitoring of the test pumping.

Figure 4-3: Trench SST02 in Construction

Trenching provided an opportunity to log the bulk geology of the top 5 m of the lake sediments in profile instead of relying on point samples from drill holes. The layered nature of the sediments was evident with lithological zone evident related to different flooding events and subsequent evaporite deposits. Notable brine inflows were evident in the trench walls where coarse gypsum crystals were present as shown in Figure 4-4.

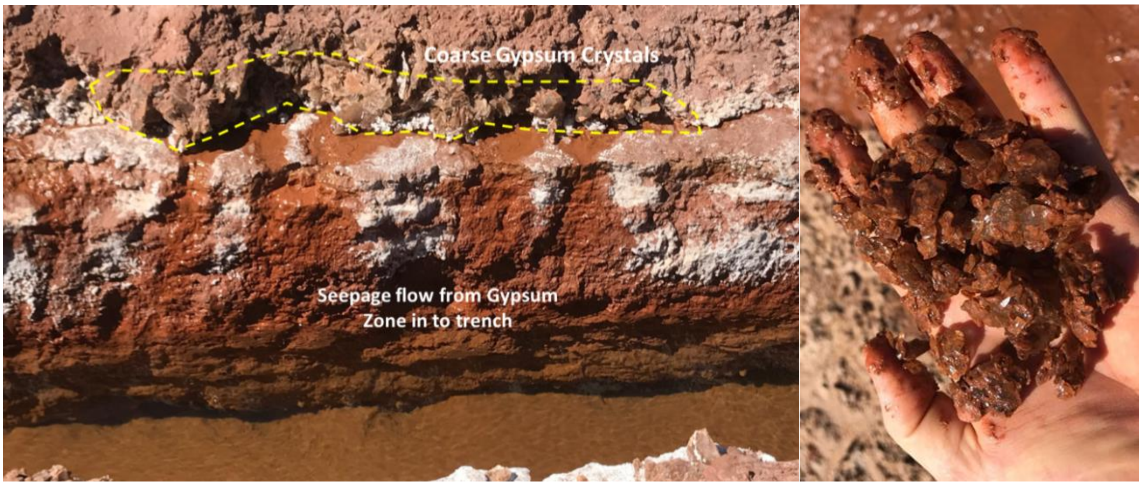


Figure 4-4: Gypsum Crystals in a 2m Long Trench Profile at SST01 (left) and 2 to 4 cm Sized Gypsum (left)

4.4 Aquifer Testing

In December 2015, several pumping tests were conducted in test production bores to obtain information on aquifer parameters such as hydraulic conductivity and specific yield. During 2017 longer duration constant rate tests were completed at seven test production bores and six trial trenches. The durations of these longer tests ranged from three to twenty days.

Other small-scale aquifer tests that have been undertaken including mini constant rate tests (1 hr pumping / 1 hr recovery) and slug testing was performed at cased monitoring bores.

The test pumping procedure at each test 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, and a constant rate and recovery test monitored from all available monitoring bores to determine aquifer parameters.

Test pumping of trial trenches involved reducing the water level in the trench to just above the pump inlet and adjusting the pumping rate to maintain the drawdown at this level. Water level responses were monitored at a number of monitoring pits off-set from the trench at different distances. Pumping continued until drawdown at the monitoring pits stabilised to approximate steady state.

The flow rates from test pumping were monitored using a magflow meter and mechanical paddle wheel type cumulative meter.

4.4.1 Aquifer Parameters

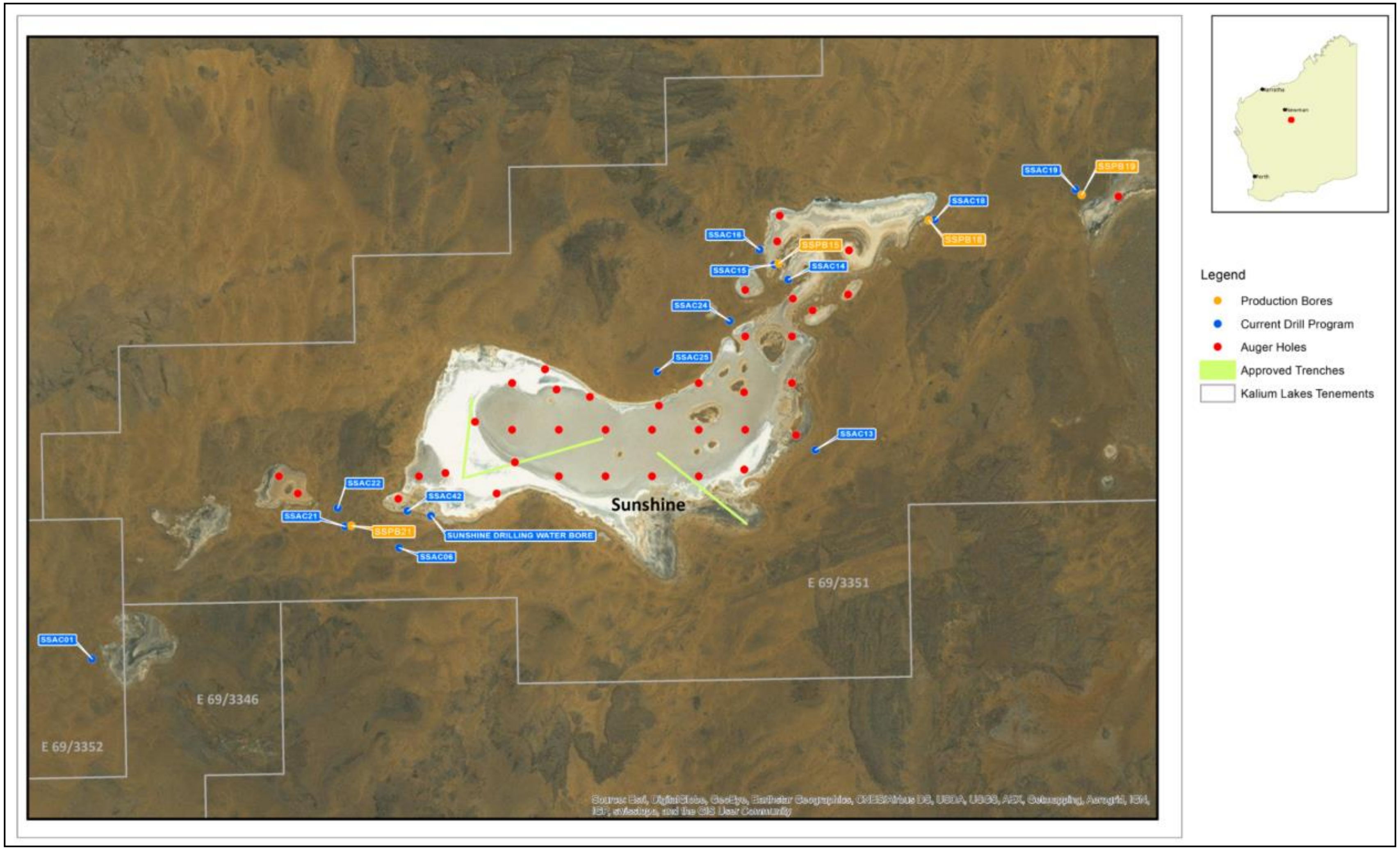
Typically the most reliable method of defining aquifer properties is large scale aquifer test pumping. Test pumping has a larger scale of measurement that determines average conditions over a larger area represented by the drawdown cone of depression. Where aquifer testing is available the derived aquifer properties have been utilised in resource assessment and modelling, supplementary laboratory testing, downhole geophysics and empirical equations are used to support extrapolation and variability across the project where there is no test pumping.

The palaeochannel test pumping interpretation has concluded that the basal sand is extensive and performs as a confined strip aquifer with leakage. Leakage was observed in bore SSPB19 and SSPB18 as a flattening of the drawdown curve during late pumping time. Aquifer properties from the palaeochannel bores have been remarkably consistent, with permeability ranging from 2.1 m/d to 3.4 m/d and confined storage from 0.0002 to 0.0008. A summary of the palaeochannel test pumping results are presented in Table 4-2 and the analytical plots are provided in Appendix C.

Table 4-1: Production Bore Construction Details 2017

Bore ID	Easting (MGA)	Northing (MGA)	Elevation (mAHD)	Depth Drilled (m)	Blank PVC Interval (mbgl)	Slotted PVC Interval (mbgl)	Bentonite Seal Interval (mbgl)	Casing type	Aquifer
WB12TB2	233890.64	7253948.369	560.414	63	0 - 42	42 - 60	5 - 19	10" CL18 uPVC	Palaeochannel Sand
TMPB12	233490.468	7256785.458	565.689	84.4	0 - 66	66 - 84	24 - 30	10" CL18 uPVC	Palaeochannel Sand
TMPB26	232842.919	7253036.609	561.424	72	0 - 42	42 - 66	5 - 19	10" CL18 uPVC	Fractured Rock
TMPB23	230917.705	7253521.88	561.991	96	0 - 58	58 - 94	24 - 30	10" CL18 uPVC	Palaeochannel Sand
SSPB21	248430.76	7269419.488	540.572	55.5	0 - 36	36 - 55	24 - 30	10" CL18 uPVC	Palaeochannel Sand
SSPB15	257633.541	7275044.8	533.421	62	0 - 54	54 - 62	20 - 26	10" CL18 uPVC	Palaeochannel Sand
SSPB18	261021.822	7275999.337	538.147	78	0 - 60	60 - 78	30 - 36	10" CL18 uPVC	Palaeochannel Sand
SSPB19	264083.593	7276672.655	538.304	60	0 - 48	48 - 60	30 - 36	10" CL18 uPVC	Palaeochannel Sand

Figure 4-5: Ten Mile and Beyondie Drill Holes



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 4-6: Lake Sunshine Drill Holes

Table 4-2: Palaeochannel Test Pumping Results Summary

Test	Test Rate (L/s)	Duration	Transmissivity (m2/d)	Hydraulic Conductivity (K) (m/d)	Confined Storage	Comments	Medium Term Yield
WB10	27	5 Days	122 - 168	11.1 - 15.3	8.83E-05 - 1.13E-04	Multiple boundaries evident, production bore WL behaves as unconfined, confined aquifer linked to unconfined providing skewed hydraulic properties and inter bore flow	16 - 22L/s
TMPB12	12	14 Days	25.4	2.3	7.79E-04	Some early time leakage observed between 15 mins and 2.5 hours, follows Theis type curve from then on.	8 - 10 L/s
TMPB23	10	6.5 Days	34 - 62	1.4 - 2.6	1.88E-05 - 1.23E-04	Multiple boundaries evident	4 - 8L/s
TMPB26	3.5	17 Hours	9	0.7	4.75E-04	Screened in weathered sandstone.	2 - 3 L/s
SSPB15	4	3 days	20 - 29	2.81 - 4.11	4.32E-04 - 5.37E-04	Boundary at 200 mins.	Further testing required
SSPB18	10	10 days	18 - 29	1.67 - 2.65	2.89E-04 - 5.24E-04	Boundary at 600 mins, leaky response.	6 - 10 L/s
SSPB19	8	10 days	19 - 28	2.12 - 3.11	2.60E-04 - 2.98E-04	Boundary at 200 minutes, leaky response.	6 – 10 L/s
SSPB21	9.5	12 days	19 - 23	2.33	2.33E-04	Boundaries not observable.	6 – 8 L/s

Lake surface trial trench pumping produced reasonably consistent results. The aquifer performed as an unconfined and unbounded aquifer under the pumping durations completed, with steady state conditions achieved in monitoring pits surrounding the trenches. When trenches were pumped steady state was achieved in monitoring pits located at varying distances away from the pumping trench after between 5 and 20 days of pumping. Aquifer properties were relatively high, with permeability ranging from 7.5 m/d to 24 m/d and Sy ranging from 11% to 25%.

Table 4-3: Trial Trench test Pumping Results

Trench	Length (m)	Horizontal Hydraulic Conductivity (Kh) (m/d)	Vertical Hydraulic Conductivity (Kv) (m/d)	Specific Yield (Sy) (%)
TMT01	500	24.1	0.1	0.11
TMT02	300	8.4	2.9	0.25
TMT06	81	11.2	4.6	0.12
Ten Mile	**Weighted Average**	**17.6**	**1.5**	**0.16**
SST01 (ESE)	40	7.5	0.6	0.19
SST02 (ENE)	44	13.6	1.7	0.15
SST03 (NE)	12	11.6	0.1	0.12
Sunshine	**Weighted Average**	**10.8**	**1.0**	**0.16**

The test results indicate the flow into the trenches is dominated by gypsum zones given the general high fines content of the bulk lithology, and that these zones are generally found throughout the lake sediments. The trenches have performed better than expected and will contribute a large proportion of the abstract-able resources. Aquifer testing results are summarised in Table 4-3 and are presented in the groundwater modelling reports in Appendix D.

Brine samples during test pumping were collected, when possible, at generally daily intervals to assess changes in brine chemistry under pumping conditions. The sampling during test pumping has produced some fluctuating results in bores TMPB23 and SSPB15, and in trenches TMT02 and SSTENE. However, a general rising average trend was observed in most tests.

4.5 Groundwater Chemistry

Total dissolved solids (TDS) content typically range from 100,000 mg/L to 250,000 milligrams / litre (mg/L) in the vicinity of the salt lakes, which decreases slowly away from the lake edges over a number of kilometres. The TDS in the surficial aquifer to the east of Ten Mile decreases from approximately 250,000 mg/L at the lake edge to approximately 20,000 mg/L at approximately 3,000 m away, indicating a salinity gradient of 1:80. Within the deep palaeochannel aquifer the TDS at depth near the lake edge is approximately 250,000 mg/L and 3,000 m away from the lake is approximately 200,000 mg/L at depth indicating a salinity gradient of 1:17, a much shallower gradient than that of the surficial aquifer due to the impacts of lower recharge volumes to the deep system. It is considered that this gradient is flatter in the down gradient groundwater flow direction (east) than the up-gradient direction (west) due to the effects of groundwater flow . The distribution of TDS in the surficial and deep aquifers is presented in Figure 4-7 and Figure 4-8.

The groundwater chemistry of the system is dominated by sodium (Na), chloride (Cl) sulphate (SO_4) and potassium (k) as presented in the trilinear plot in Figure 4-9, increasing salinity is represented by plotting on the right hand side of the diagram.

4.6 Brine Chemistry

Potassium (K) and sulphate ($S0_4$) are the most important parameters in understanding potash generation from brine, therefore the discussions below have centred on K and $S0_4$ concentrations. In addition, the ratio of impurities, mainly sodium (Na) and chloride (Cl), to K is important to understand for the relative waste derived from the process of producing SOP.

4.6.1 Shallow Brine Chemistry

The distribution of K and SO_4 in the groundwater of the surficial aquifer is dominated by the interaction with the salt lakes and any zones of fresher water recharge in the vicinity of active drainages to the lakes. .

At Ten Mile Lake K concentrations on the lake are between 5,000 and 11,000 mg/L. To the south and the east of the lake, where there is good data control away from the lake, the concentrations of K reduce to less than 1,000 mg/l within 2 km of the lake edge. Generally higher concentrations are evident in the centre of the lake whilst lower concentrations are observed on the southern perimeter of the lake where more regular surface water flows are considered to occur, this correlates with TDS distribution.

At Sunshine Lake K concentrations on the lake are between 5,000 and 8,000 mg/L. Away from the lakes there is limited data, however from the data available it is considered concentrations diminishes below 3,000 mg/L typically within 1 km of the lake edge and below 2,000 mg/L up to 3 km away. Generally concentrations are highest in the central and western areas of the lake and become more dilute to the east. This is likely due to the prevailing wind direction that accumulates surface water in times of flood on the flat surface of the lake in the west.

Details of chemical analysis and a contour plot of the K concentration in the surficial aquifer for Ten Mile and Sunshine are presented in Appendix E.

4.6.2 Palaeochannel Aquifer and Bedrock

The palaeochannel and bedrock concentrations of K range from 3,000 mg/l at Ten Mile Lake approximately 2.5 km to the east of the lake, up to 11,000 mg/L in locations adjacent to the lake on its western edges. This trend is reflective of the trend of K concentrations recorded in the surficial aquifer with a general increase in concentration with depth. Generally bedrock samples near the lake have produced the highest concentration of K, with the palaeochannel sand concentrations being of a slightly lower concentration. This trend is likely due to the function of increased hydraulic conductivity in the palaeochannel sand, where the sand is considered to function as a conduit to groundwater flow through the system and as a consequence will have lower residence times. The palaeochannel and bedrock concentrations of K at Sunshine Lake are on average lower than Ten Mile, they range from 4,000 mg/L to 7,000 mg/L. K concentrations of 4,000 mg/L are present up to 3 km to the east and 2 km to the west of the lake.

At both lakes the trend of K distribution is similar to the surficial trend where K concentration reduces away from the lake. However, higher concentrations of K in the deeper palaeochannel and bedrock exist much further from the lake edge than they do in the surficial aquifer. This trend is likely due to the infiltration and recharge of fresher meteoric and surface water which does not interact with the deeper aquifers. A contour plot of the K concentration in the deep palaeochannel and bedrock aquifer for Ten Mile and Sunshine is presented in Figure 4-8.

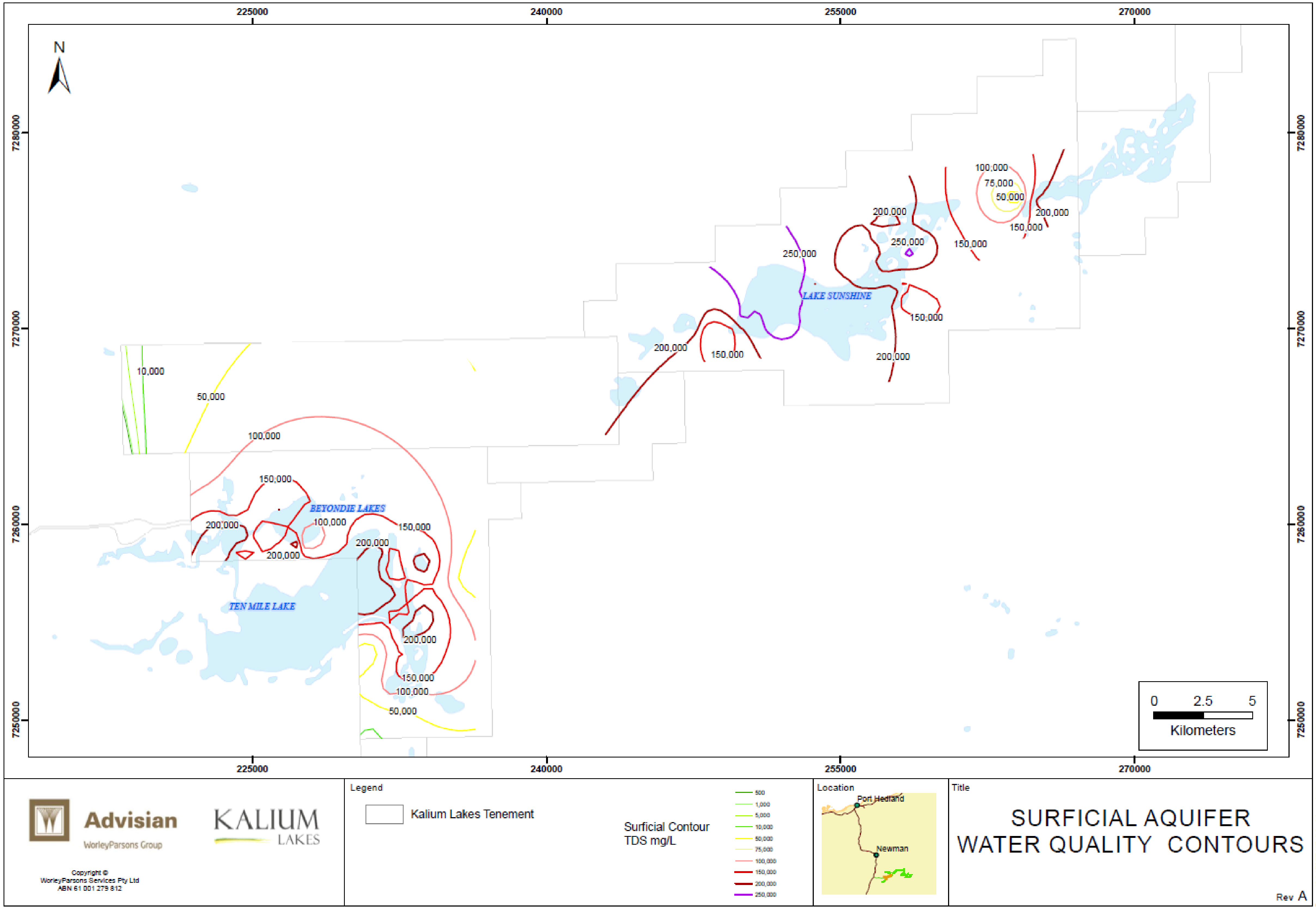


Figure 4-7: Surficial Aquifer TDS Distribution

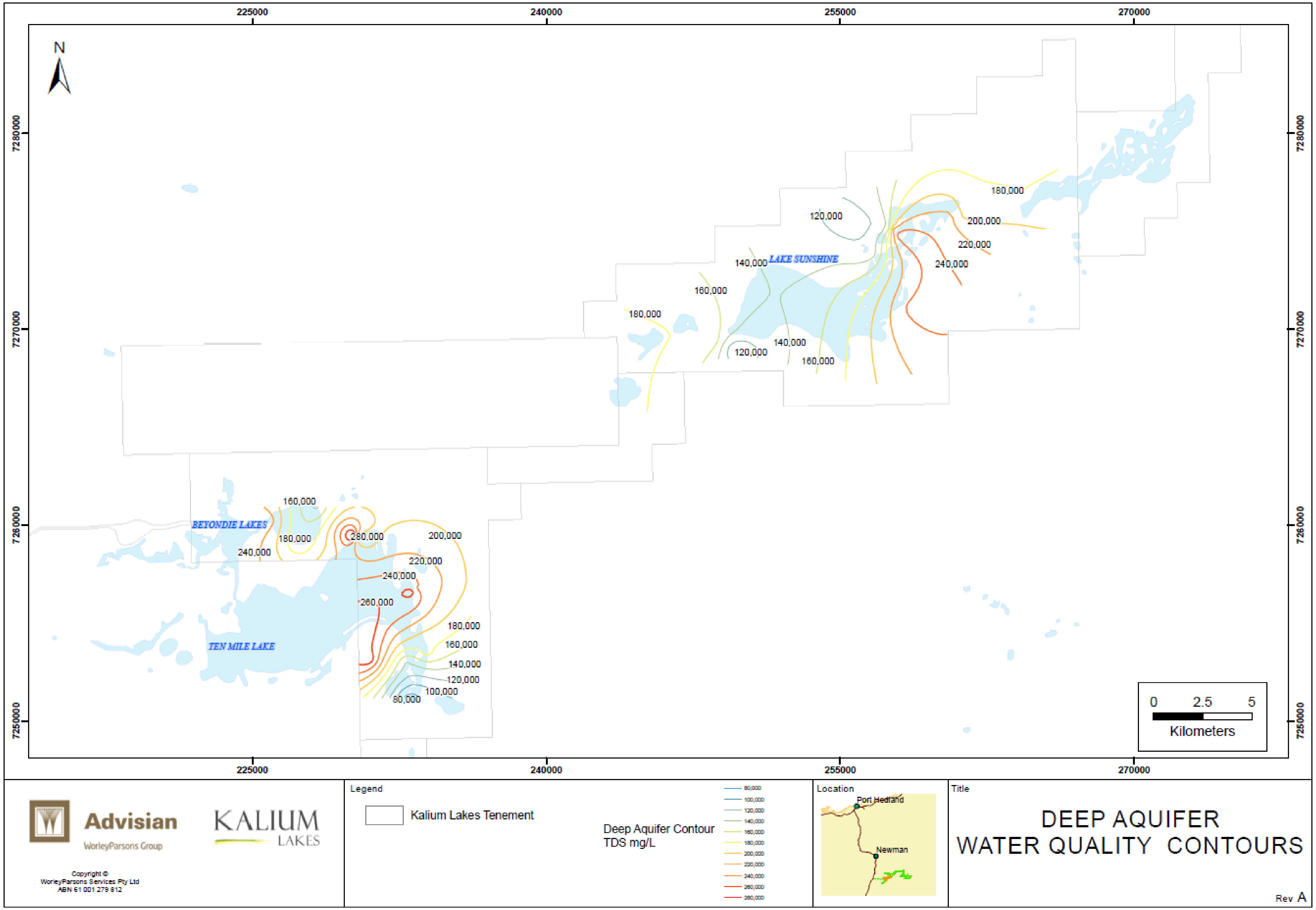


Figure 4-8: Deep Aquifer TDS Distribution

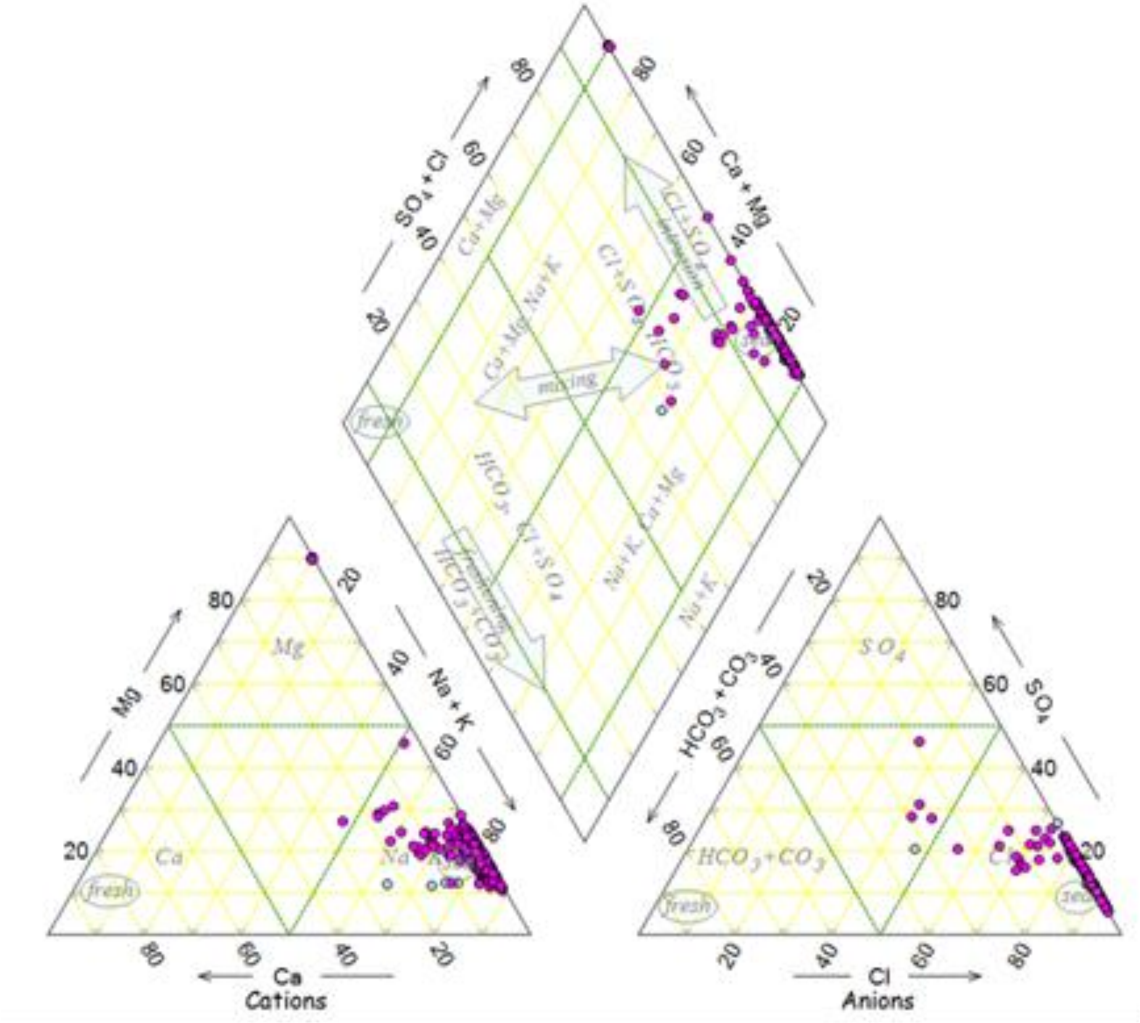


Figure 4-9: Groundwater Chemistry – Piper Trilinear Diagram

5 Hydrogeological Characterisation

5.1 Aquifer conditions

The trenches on lake has indicated a highly layered sequence of silts and evaporites (gypsum) displaying high transmissivity associated with secondary porosity within evaporite zones and lower transmissivity in more silty porous flow dominated zones. A typical unconfined aquifer response with no boundary conditions was evident during test pumping of all trenches indicating a laterally extensive aquifer. Away from the lake the surficial aquifer generally comprises of low transmissivity silt and soft clay unless calcrete is encountered. Calcrete is characterised by secondary porosity with very high transmissivity, but low storage.

The palaeochannel sand aquifer is a confined porous system, laterally bounded by the edges of the palaeochannel system and the poddy nature of the sand sequences. The aquifer can be characterised as behaving as a strip aquifer system where multiple “no-flow” (or reduced hydraulic conductivity) boundaries are evident in pumping data. The confined nature of the aquifer means that pumped water abstracted during practical long-term aquifer testing will originate from confined storage, a pressure response to pumping.

Across the project, silcrete is encountered within the sand sequence; silcrete has a secondary porosity which locally increases transmissivity and can enhance bore yields.

5.2 Water Levels and Hydraulic Gradients

Groundwater levels have been captured by manual dips generally on a weekly basis across the project whilst test pumping has been ongoing and with continuous automated loggers at approximately 15 monitoring bores. Water level data are plotted in hydrographs in Appendix F.

Groundwater flow within the surficial aquifer is generally driven by rainfall and creek flow recharge to the aquifer system. The groundwater flow direction generally follows the surface topography, with recharge and groundwater mounding dominant in the ephemeral creek systems and discharge via evaporation occurring in the playa lakes through evaporation. Groundwater within the surficial aquifer is generally between 0.2 m and 11 m below ground level, with depth to the ground water table determined by location within the catchment and local topographic changes. The groundwater table is presented in Figure 5-1.

Groundwater within the palaeochannel sand aquifer is confined in nature and has a piezometric head that is independent to groundwater flow in the surficial aquifer, where the groundwater table present. The piezometric head is a pressure response of regional scale that flows at a low gradient (0.00008) from southwest to northeast across the Ten Mile and Sunshine Lake areas. The piezometric head is generally between 0.1 m and 0.5 m below the elevation of the water table near the centre of the palaeochannel. This head difference becomes up to 1 m lower at the margins of the palaeovalley. These vertical head gradient differences indicate a degree of downward drainage through the profile and potential mode of recharge from the surficial aquifer to the palaeochannel sand aquifer; this may be directly through the clay zones or potentially at a greater rate at the margins of the palaeovalley through the weathered and fractured bedrock. .

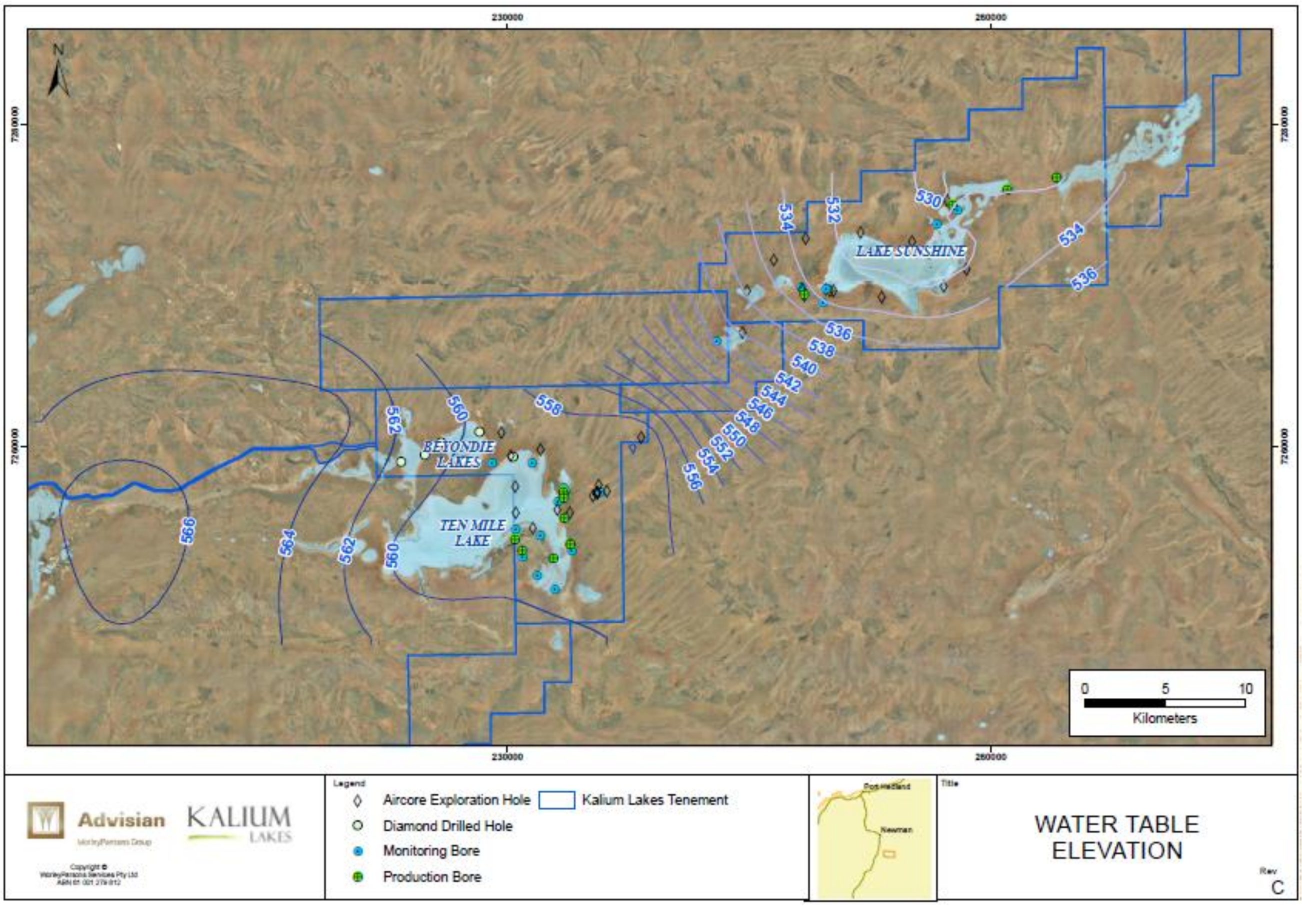


Figure 5-1: Regional Groundwater Table Elevation

5.3 Aquifer Properties

The investigations to date have used multiple techniques to estimate aquifer properties from small scale lab tests and monitoring bore slug tests and mini aquifer tests, to downhole continuous profiles and large scale long duration aquifer testing, each method representing an individual scale of measurement. Estimates of specific yield were determined from laboratory testing and empirical equations derived from grain size analysis. The ranges of aquifer properties by lithology type and test have been summarised in Figure 5-2, Figure 5-3 and Figure 5-4.

There is very good correlation between testing methods for specific yield in the surficial aquifer and palaeochannel. Hydraulic conductivity in the surficial aquifer is more heterogeneous with quite a large variance in test results. The hydraulic conductivity of the palaeochannel is well constrained between 1 and 3 m/d whilst the lacustrine clays display typically confining layer properties with very low permeability and specific yield, meaning groundwater moves very slowly and in low volumes.

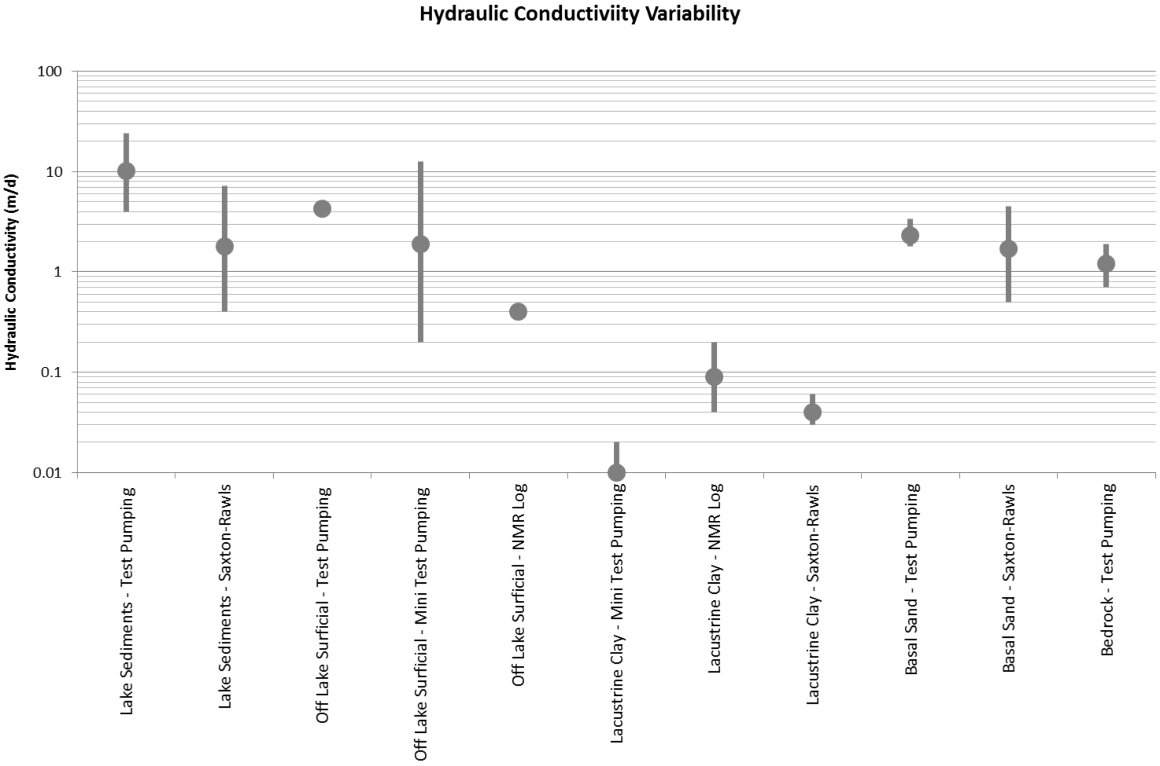


Figure 5-2: Hydraulic Conductivity Variability (minimum, maximum and geometric mean)

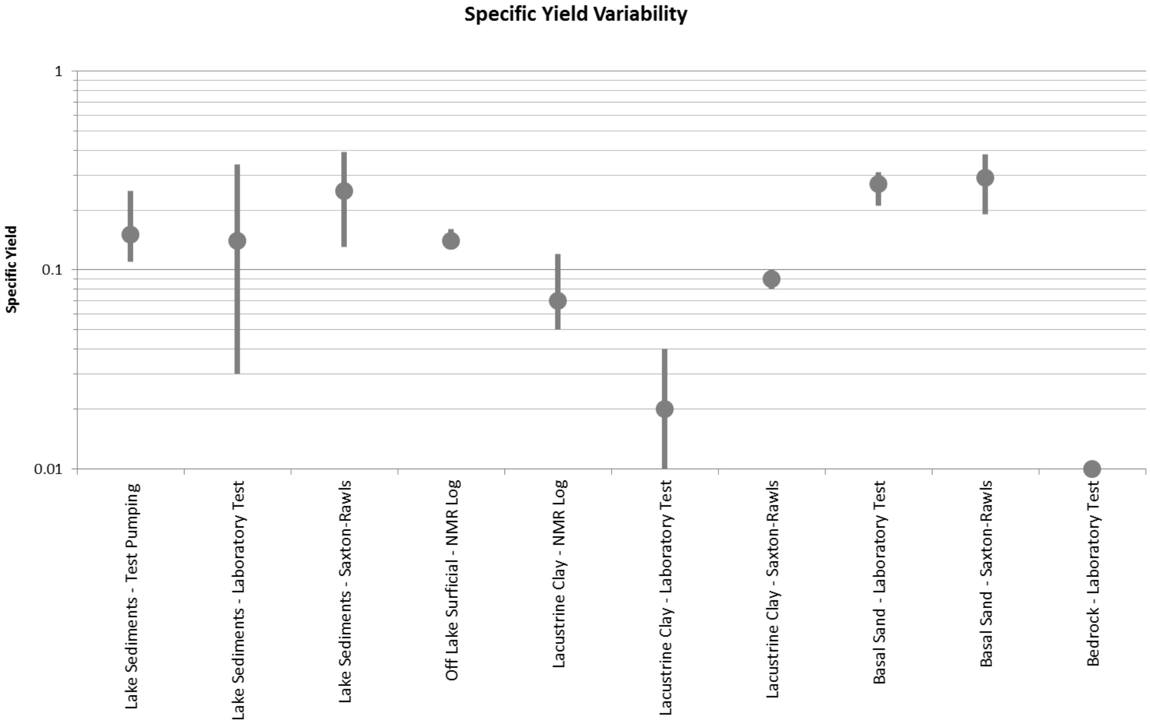


Figure 5-3: Specific Yield Variability (minimum, maximum and geometric mean)

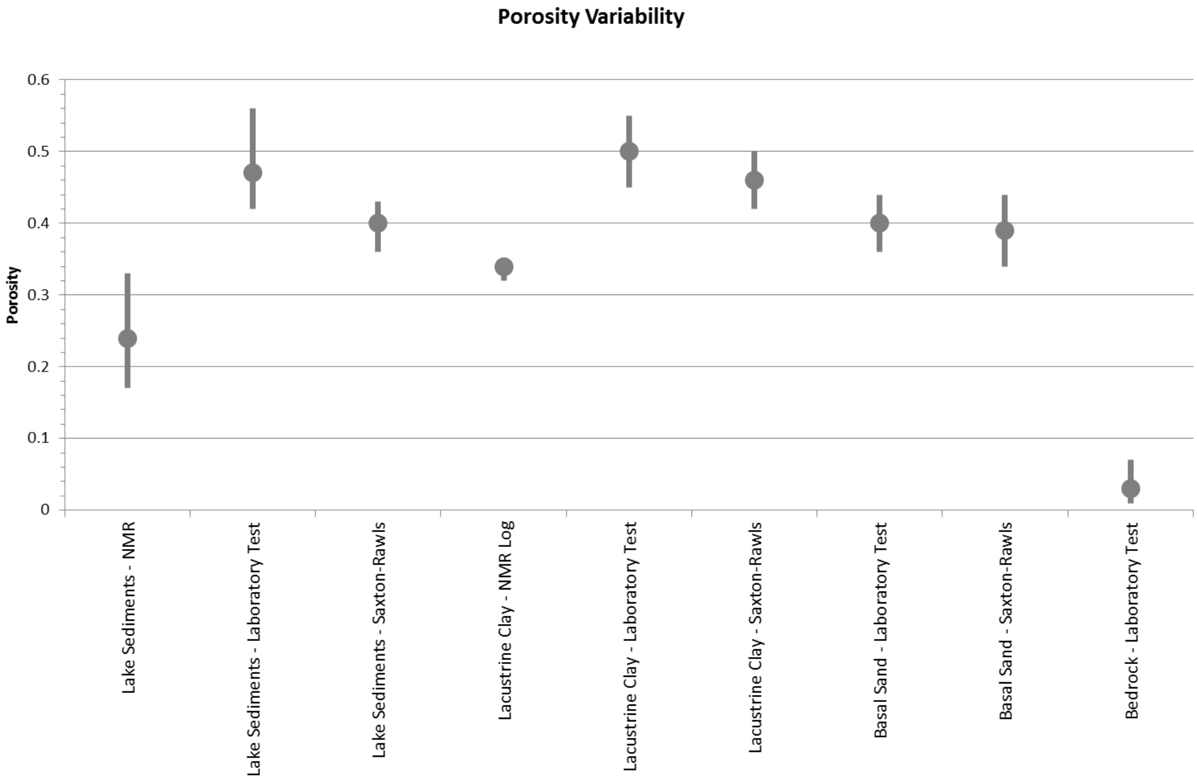


Figure 5-4: Porosity Variability (minimum, maximum and geometric mean)

5.4 Aquifer Geometry

The exploration programs to date have confirmed the conceptual understanding of the Ten Mile and Lake Sunshine palaeodrainage aquifer system as presented in Figure 2-11 and Figure 4-1. A surficial aquifer system is present in the upper 15 to 20 m of sediments which has enhanced hydraulic conductivity where evaporite sediments are present in the profile directly beneath the lakes. Below the lake sediments is a stiff lacustrine clay which has been identified in every drill hole that has been drilled within the palaeodrainage and is a key marker, this layer thins at the margins and is thickest when over the palaeochannel. The transition zone between the stiff lacustrine clay is marked by yellow green softer sandy clay which grades into the basal sand, this transition zone maybe between 2 and 5 m in thickness. The basal sand (palaeochannel) is located within the deepest sections of the palaeodrainage and consists of up to 15 m of fine to coarse grained sand, transects at Ten Mile Lake and Lake Sunshine suggest that the channel is typically between 600 and 800m in width which pinches out at the edge.

The percent fines analysed by the laboratory in each hole shows a sequence of finer sediments at the top of the layer and two coarser bands near the base of the. This sequence is represented in each basal sand interval and supports the palaeochannel aquifer concept with higher energy fluvial environments associated with the coarser lower fines content bands that are likely associated with wetter periods in the Eocene. Mapping the palaeochannel route within the Lake Sunshine area with the cross section of percent fines content and elevation of the top and bottom of the interval has concluded that the palaeochannel fluvial flow direction was from west to east in correlation with the regional flow to the east. Further testing is required at Ten Mile Lake to determine the sequence. Ten Mile Lake appears to be a terminal palaeochannel fluvial system, with potentially multiple channels flowing from multiple directions to a terminal basin not far from the current eastern margin of the Ten Mile Lake Area. .

Numerous upper more minor sand channels have been encountered in both Lake Sunshine and Ten Mile, the extent of these channels is not well understood, but are considered to be smaller and representative of channels flowing into the start of the palaeo-lake system that is responsible for the deposition of the lacustrine clay and the onset of the drying climate. These upper sand deposits will likely be a source for leakage to the deeper system.

5.5 Recharge

Recharge to the aquifer in the arid zones of Western Australia is episodic. 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.

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 the alluvium in palaeochannel systems varied between 0.09 and 1% of the rainfall, and recharge to calcrete varied between 0.7 and 5% of rainfall. Johnson et al. (1999) also indicated that recharge to shallow groundwater areas in the northern goldfields, and by extension, into the BSOPP area, are likely to be episodic.

The results from the hydrogeological investigations indicate that the difference between the heads in the basal sand aquifer and the groundwater flow in the surficial groundwater table show a degree of vertical downward drainage through the profile and potential mode of recharge from the surficial aquifer to the palaeochannel sand aquifer. This maybe directly through the clay zones or, more likely, at the margins of the palaeovalley through weathered and fractured bedrock. More regional, distal recharge occurs up-hydraulic gradient of the palaeo-drainage systems where the clay thins and meteoric water can enter the system, at the head-waters of the catchment.

5.6 Discharge

Groundwater is discharged into the lakes and brine concentration occurs in the playa lakes (Figure 2-12) through evaporation.

6 Groundwater Modelling

Numerical groundwater models were constructed and calibrated for the surficial (lake) and the confined palaeochannel aquifer at Ten Mile Lake and Sunshine Lake. These models were constructed in the industry standard finite element modelling code, FeFLOW (DHI, 2015) and used to quantify the available brine from trenches across the lake surface and abstraction bores within the palaeochannel over a life of-mine of 23 years. Details of the modelling are presented in the modelling reports (Advisian, 2017b and c) in Appendix D.

The models have been calibrated to steady state water levels and then to transient state utilising the drawdown and recovery responses observed from test pumping. The calibrated models are then used to predict the brine abstraction using existing production bores and then additional bores if the aquifer permitted.

To determine potassium grade variability the distribution within the upper and lower aquifers was represented by particle tracking. Where particles were placed within the model at distances away from abstraction points and their movement towards the abstraction point recorded.

6.1.1 Ten Mile Lake

The predictive modelling indicated that using the calibrated models and conservative assumptions and recharge volumes, the brine recovery from the trenches would decline from 170 L/s in the first year to 70 L/s by year 10 and 46 L/s by year 20. The potassium grade recovered from within the Ten Mile Lake area was estimated to be 9,160 mg/L in the first year, 8,200 mg/L in Year 5, 6,500 mg/L in Year 10 and 6,000 mg/L in Year 20. An additional simulation used a recharge of 165 mm over the lake surface for a single day each year to simulate the effects of inundation over the lake, and indicative of inundation level over the lake surface for an event with an annual exceedance probability of 63.2%). It showed the brine recovery from the trenches increased to an average of 134 L/s over the first 5 years, and had average rates of 93, 86 and 84 L/s over the subsequent 5 year periods. This simulation is considered representative of annual on lake flooding events.

The model indicated that an average 30 L/s of brine recovery from the confined palaeochannel aquifer was sustainable over 20 years. The potassium grade recovered from the indicated resource zone was 7,300 mg/L in the first year, declining to 6,900 mg/L in Year 5, 6,300 mg/L in Year 10 and 4,500 mg/L in Year 20.

6.1.2 Sunshine

The modelling at Lake Sunshine indicated that using similar conservative assumptions for the brine recovery as Ten Mile Lake that production from the trenches would decline from an average of 217 L/s over the first five years to 58 L/s over the next 5 years and 50 L/s over the next 10 years. The potassium grade recovered from within the Sunshine Lake area was estimated to be 6,810 mg/L in the first year, 5,970 mg/L in Year 5, 4,780 mg/L in Year 10 and 4,040 mg/L in Year 20. An additional simulation used a recharge of 60 mm over the lake surface for a single day each year to simulate the effects of inundation over the lake, indicative of inundation level over the lake surface for an event with an annual exceedance probability of 63.2%. It showed the brine recovery from the trenches increased to an average of 233 L/s over the first 5 years, and had average rates of 96, 62 and 61 L/s over the subsequent 5 year periods.

The modelling also indicated that brine recovery from the confined aquifer reduced from an average of 53 L/s in the first year, to 45 L/s by year 5, 44 L/s by year 10 and 41 L/s by year 20. The potassium grade recovered from the indicated resource zone was 4,600 mg/L in the first year, 4,400 mg/L in years 5 and 10 and 4,000 mg/L in Year 20.

At Ten Mile Lake aquifer drawdown over the mine life is up to 55 m in the confined aquifer and 6.5 m in the unconfined aquifer. At Lake Sunshine aquifer drawdown over the mine life is up to 52 m in the confined aquifer and 8 m in the unconfined aquifer. Aquifer drawdown at the end of mine life is presented in Figure 6-1 and Figure 6-2.

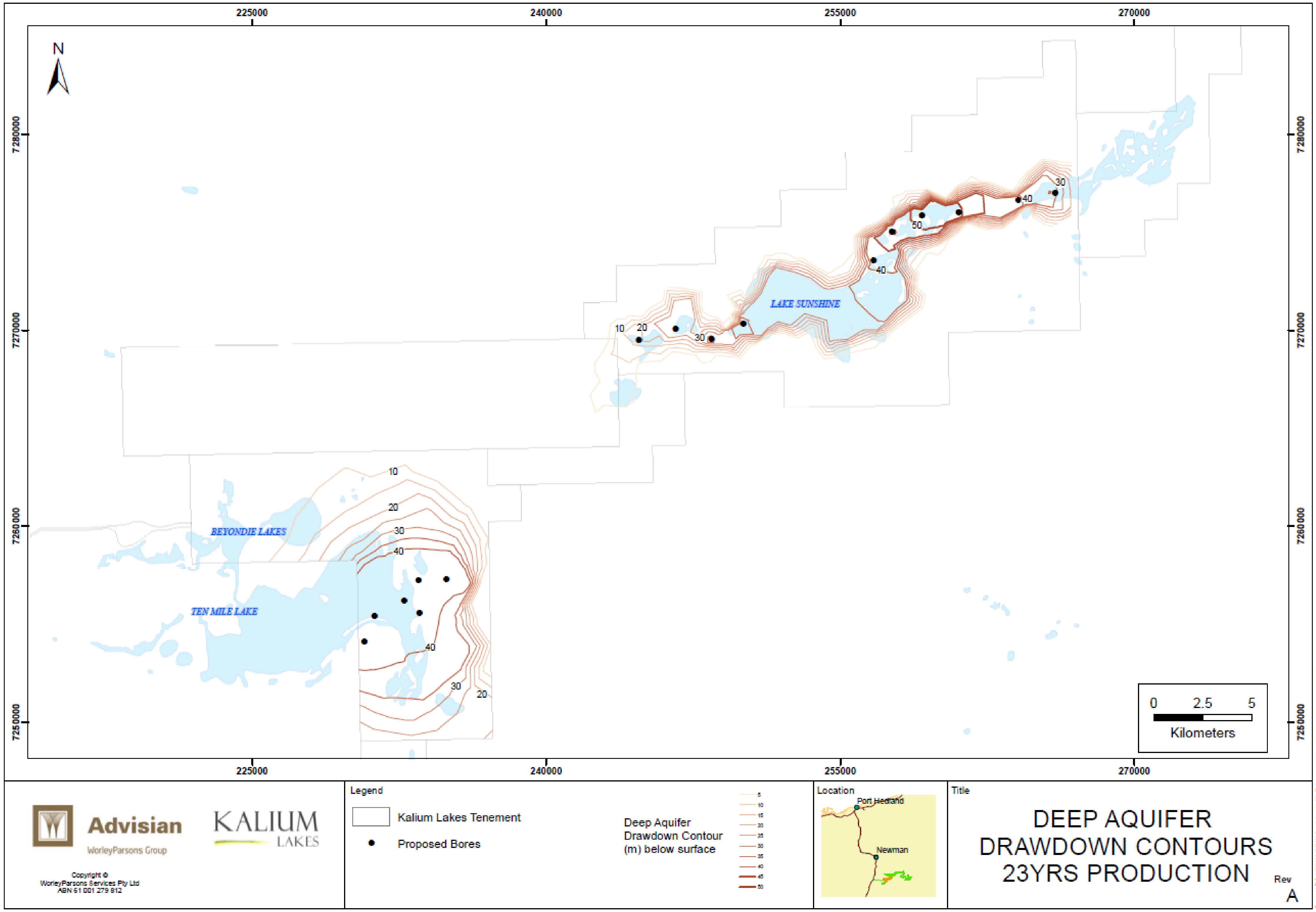


Figure 6-1: Drawdown after 23 Years Abstraction from the Confined Aquifer

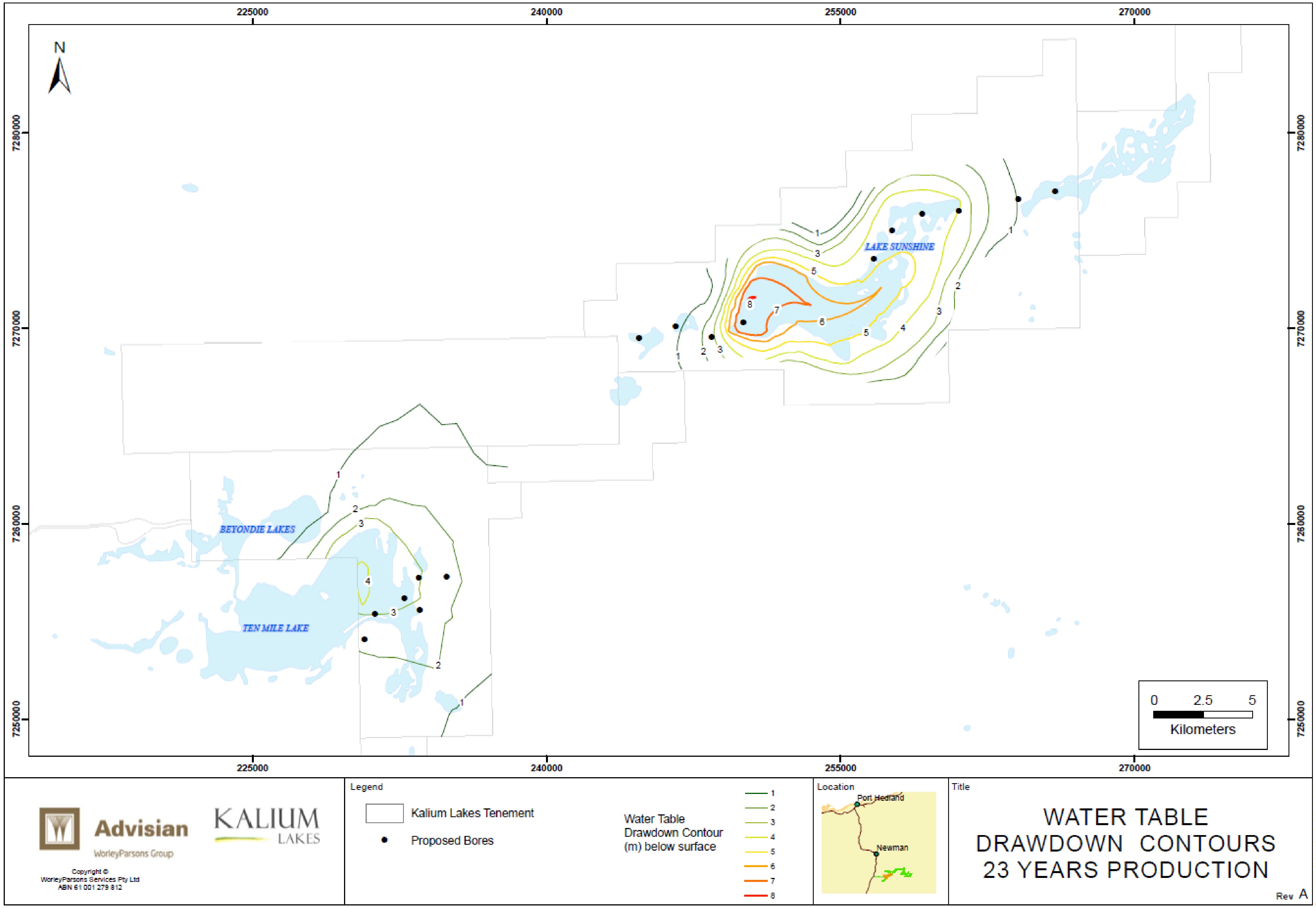


Figure 6-2: Drawdown after 23 Years Abstraction from the Surficial Aquifer

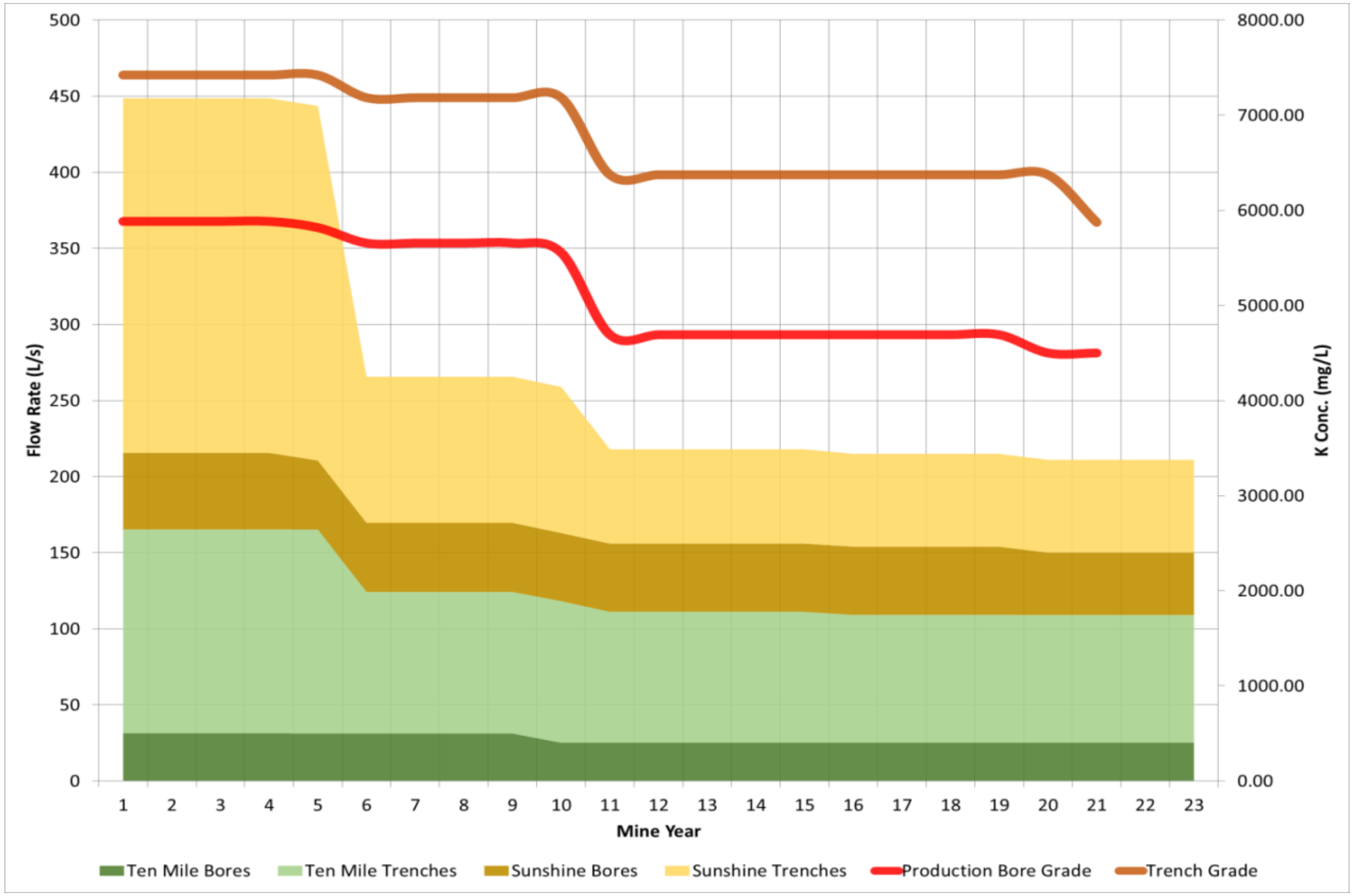


Figure 6-3: Modelling Outputs (150,000 t/a SOP production scenario)

7 Proposed Brine Extraction Plan and Potential Impacts

7.1 Brine Extraction

There are two principal methods applicable to extract the brine:

- Pumping from production bores in the basal sand and fractured/ weathered bedrock (lower aquifer);
- Pumping from trenches on the playa lake surface (upper aquifer) up to 8 m depth.

Both methods will be used during operations because of the properties of the different aquifers. The design of the bore field and trenches will be based on the brine demand and aquifer conditions.

The proposed site infrastructure including trench and bore locations are shown in Figure 7-1 to Figure 7-3.

Three scenarios of mine planning encompassing all lakes in the Project area have been developed as part of the PFS:

- 150,000 tonnes/annum (tpa) SOP (mine life of ~29 years at the production rate);
- 75,000 – 150,000 tpa SOP (5 years production of 75,000 tpa followed by ~29 years at 150,000 tpa); and
- 75,000 tpa SOP (mine life of ~70 years at the production rate

The predictive groundwater modelling covered a life of mine of 23 years for Ten Mile, Beyondie and Sunshine lakes. Results show that both aquifers can support abstraction over the proposed 23 year mine life with production and SOP grade diminishing over time. Only the 75,000 tpa scenario can be sustained from Beyondie, Ten Mile and Sunshine aquifer systems, with the current level of understanding. Additional lakes and palaeochannel resources are required to be brought online throughout the life of mine to meet the production rates of 150,000 tpa after year 5 of the mine plan.

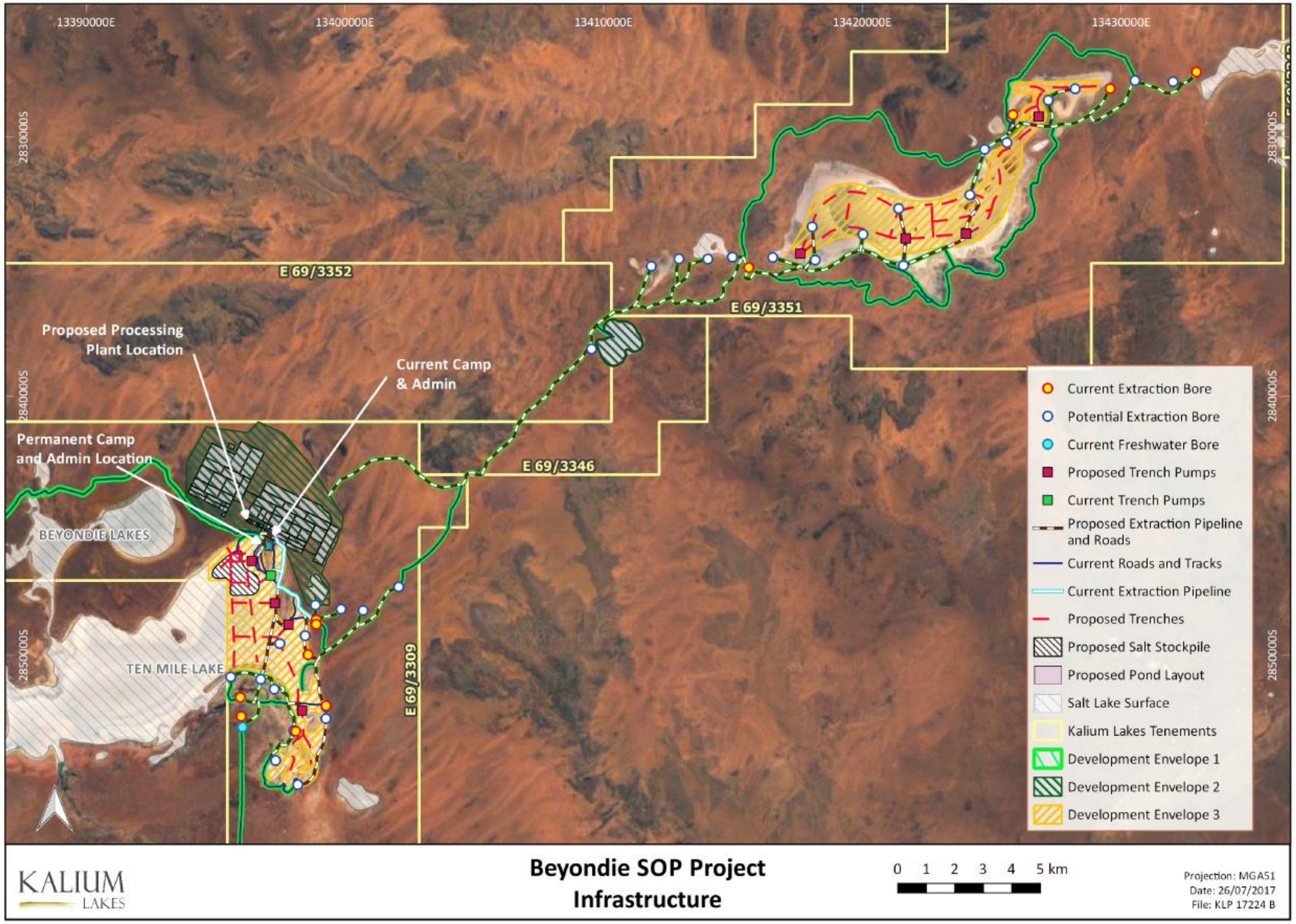


Figure 7-1: BSOPP Proposed Infrastructure

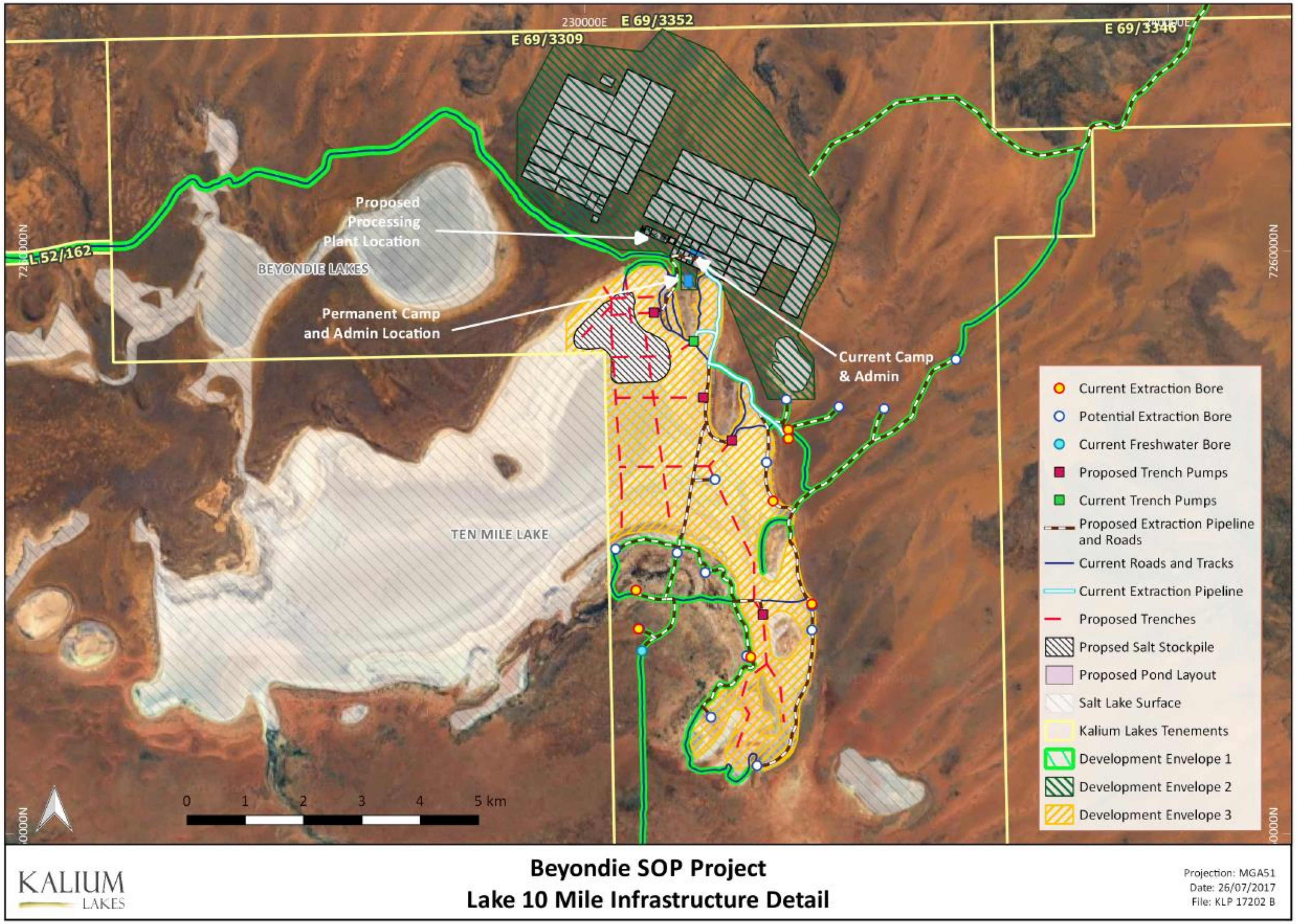


Figure 7-2: BSOPP Proposed Infrastructure – Ten Mile

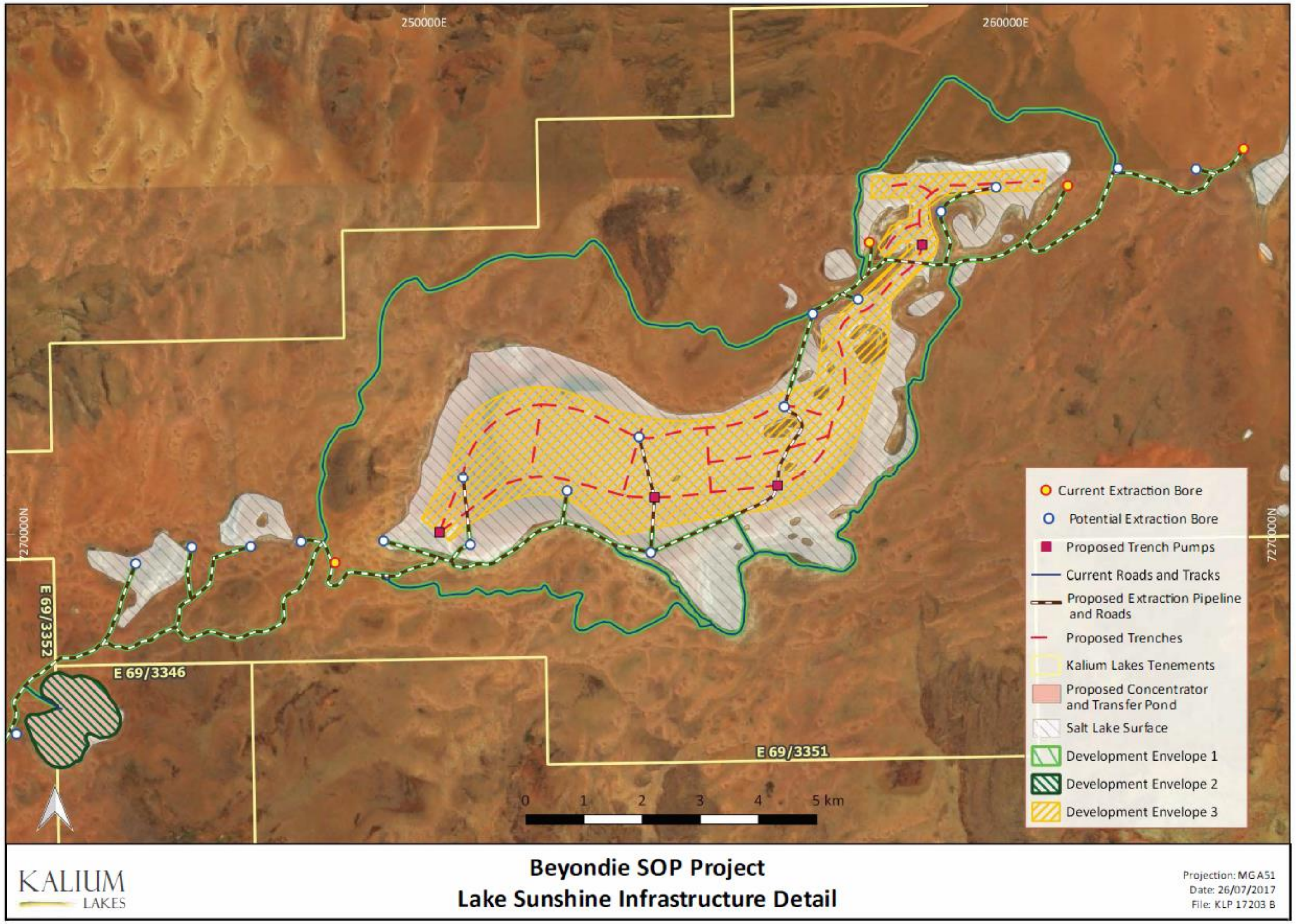


Figure 7-3: BSOPP Proposed Infrastructure - Sunshine

Predicted volumetric extraction rates for all the KLL lakes are shown in Figure 7-4 and Figure 7-5. The peak volume is estimated to be approximately 20 GL/a, which is the volume of abstraction to be licenced under a dewatering licence associated with this H3 hydrogeological assessment report for brine extraction.

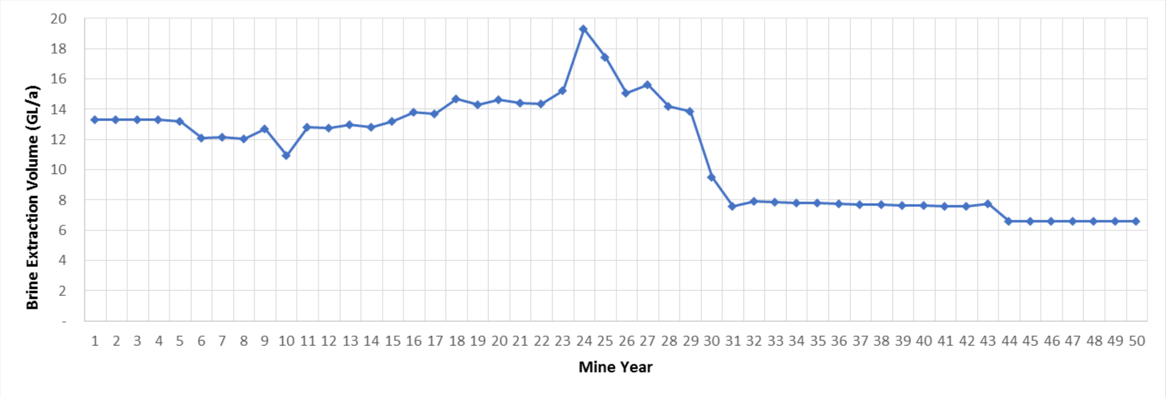


Figure 7-4: Predicted Total Extraction Volumes over the Mining Periods (Base Case - 150 ktpa)

7.2 Assessment of Potential Impacts

Extraction of the mineralised brine will induce changes in the hydrostatic-heads within the aquifer horizons, inducing inflow from the aquifer zones adjacent to the lakes. There are no existing groundwater users in the immediate vicinity of the BSOPP and groundwater drawdown is not predicted to extend towards other groundwater users in the vicinity of the Project. The nearest licensed users are outside the modelled drawdown related to the Project.

Shallow calcrete aquifers which may contain relatively fresher groundwater are the only horizons which may be potentially impacted. The results of the shallow aquifer drilling carried out as a part of the project water supply investigations (Section 4.2 and Appendix A) were used to map the saturated thickness of calcrete aquifer encountered during drilling. These are shown on Figure 7-6. The extent of mapped calcretes in the surface geological map from Department of Mines, Industry Regulation and Safety (DMIRS; previously Department of Mines and Petroleum [DMP]) GeoView database has been updated using the drilled data in Figure 7-6. Modelled maximum drawdowns from brine extraction have been overlaid on the mapped calcrete extents. The drawdowns in the saturated horizons of calcrete extend between 3m (in close proximity to Ten Mile creek) to no or zero impact at a distance of approximately 14km to the south of the Lake.

Measured TDS values in the shallow aquifer have also been mapped in and around the Lakes and are presented in Figure 7-7. In the southern extent of the mapped calcretes, the TDS values range between 3,000 mg/L to 180 mg/L. Any potential impacts may be limited to the southernmost extent of the calcrete horizons between 8 and 14 km from the lake. KLL propose to undertake regular monitoring as outlined in Section 8 to mitigate impacts arising from drawdown of the shallow aquifer.

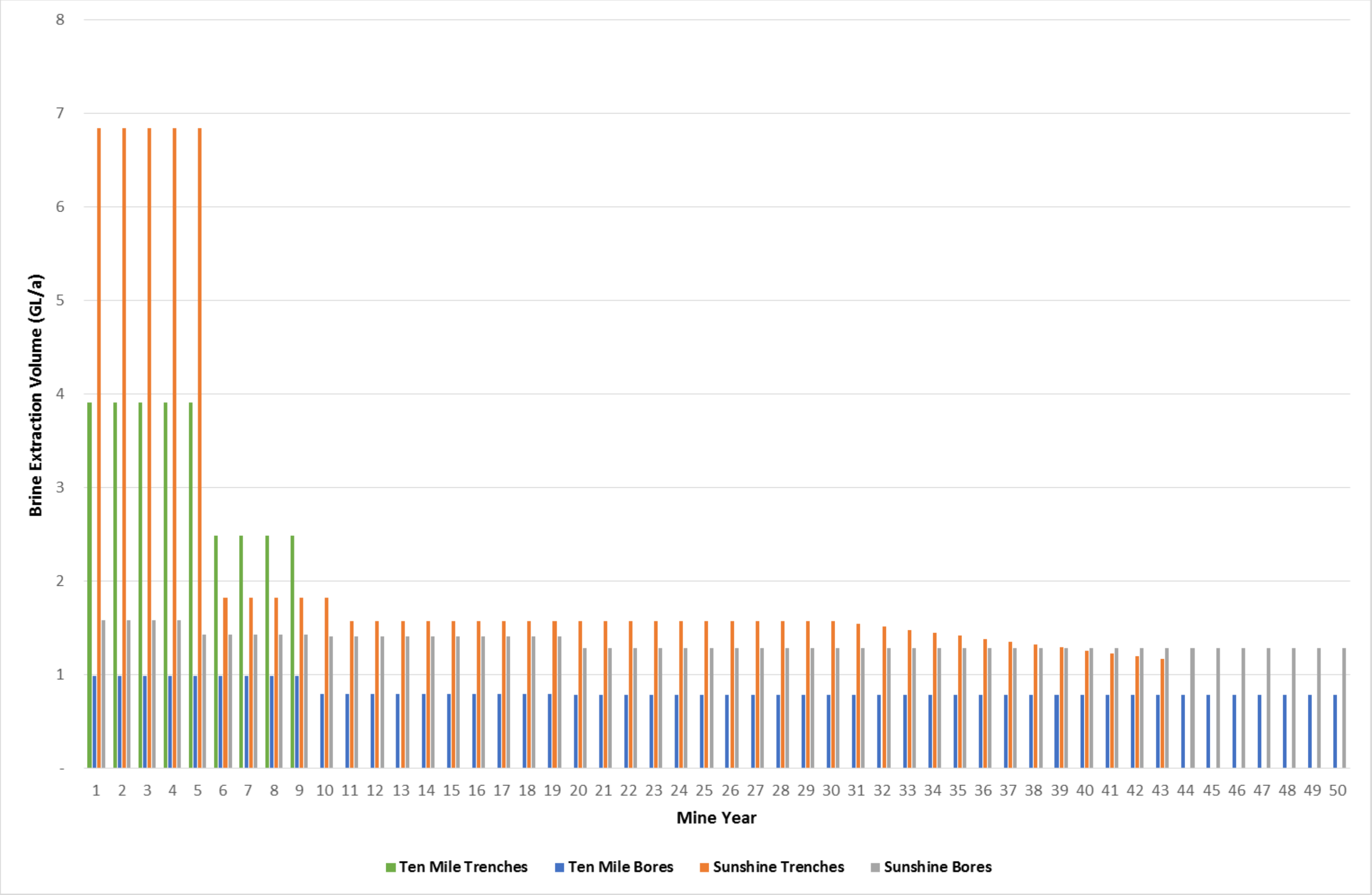


Figure 7-5: Predicted Extraction Volumes for Individual Lakes over the Mining Periods (Base Case -150 ktpa)

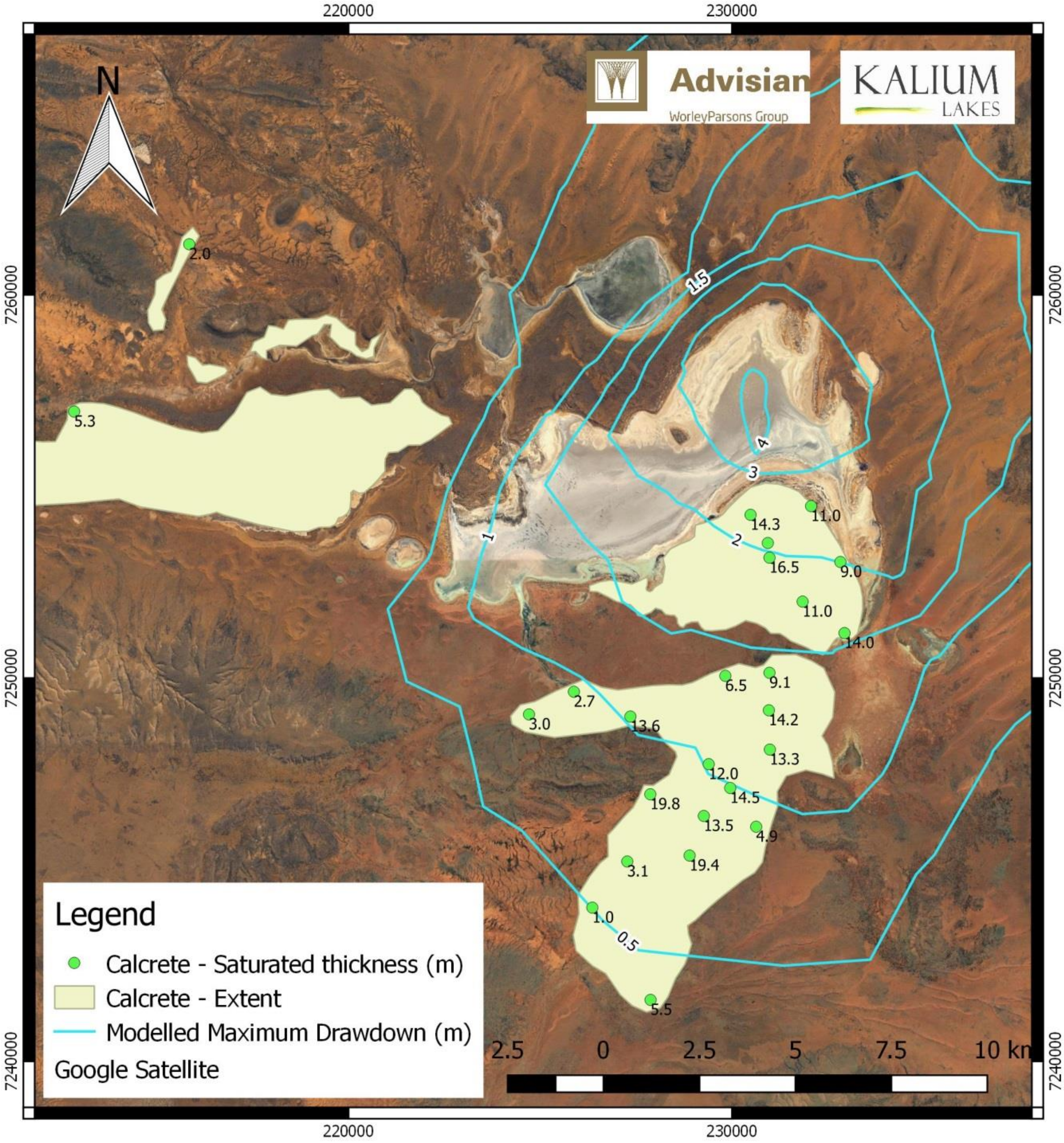


Figure 7-6: Modelled maximum drawdowns over mapped extent of calcrete

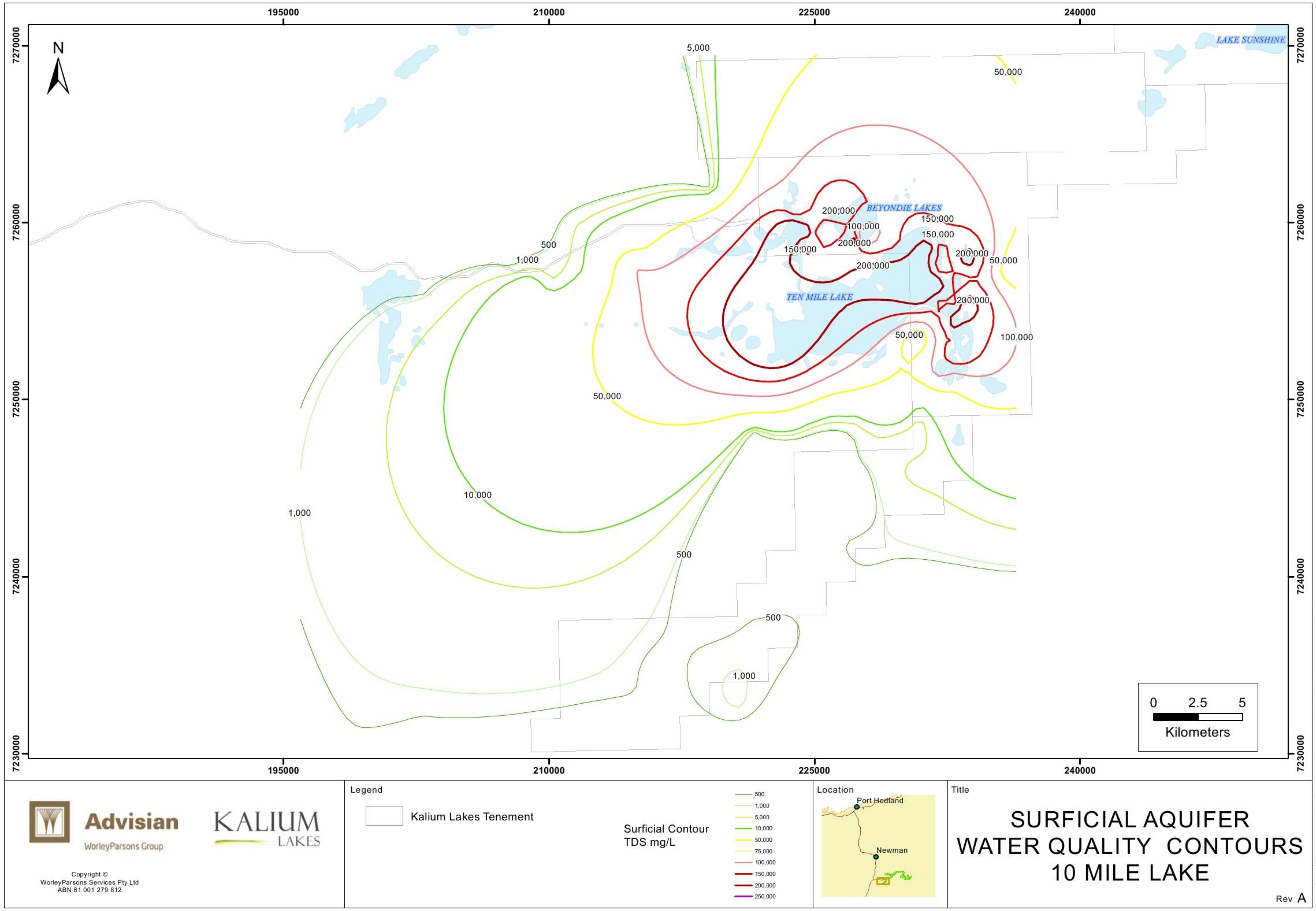


Figure 7-7: Water quality contours – Surficial aquifer

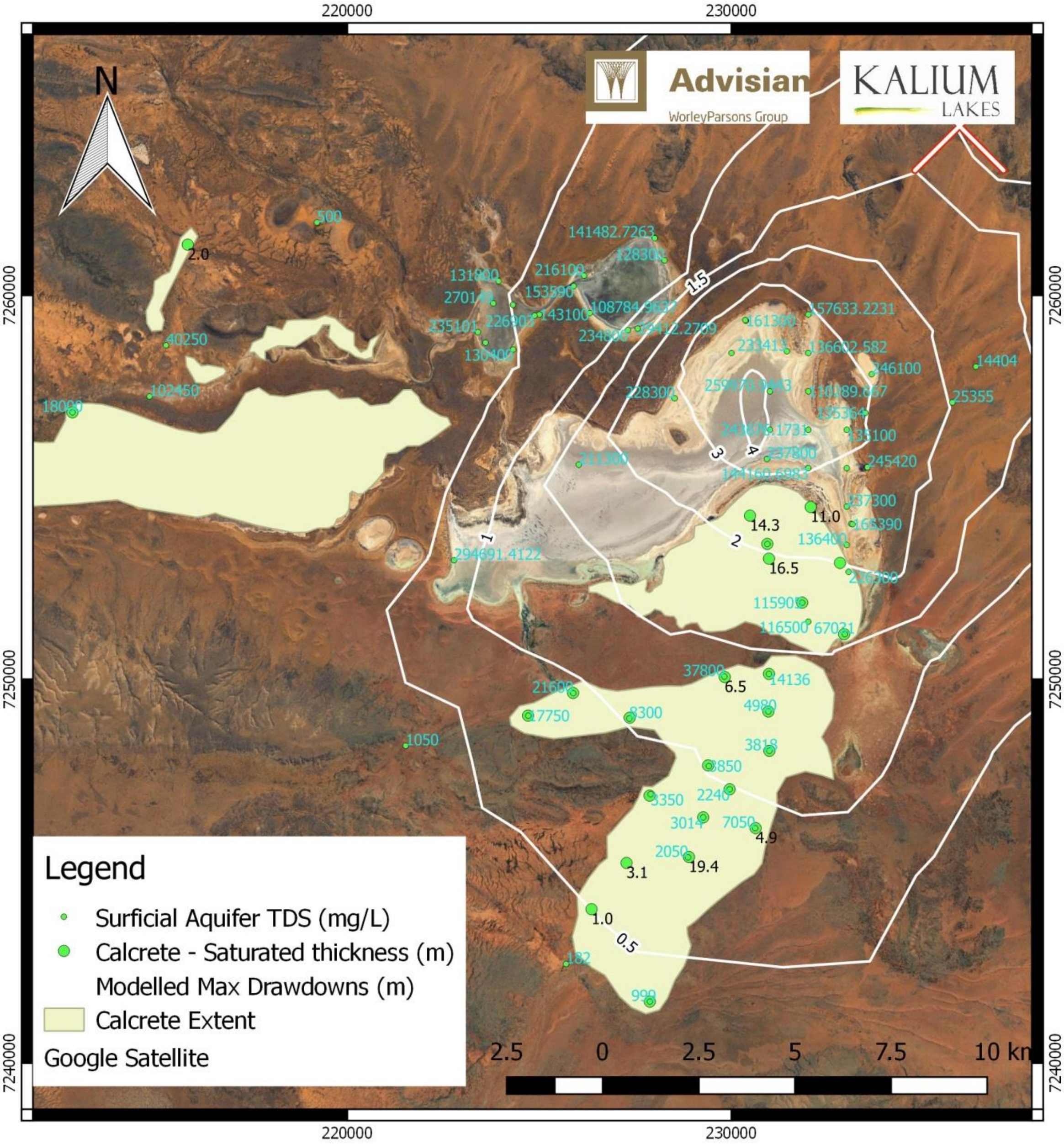


Figure 7-8: Modelled maximum drawdown with calcrete and surficial aquifer water quality mapped

There are no known ecosystems dependent on the surface expression of groundwater within 30 km radius from the Project; therefore, the proposed pumping from the basal sand aquifer and shallow surficial aquifers are unlikely to have any adverse impacts on groundwater dependent ecosystems.

Groundwater drawdown has the potential to impact on subterranean fauna where discrete calcrete aquifers are present in fresher water quality zones greater than approximately 15 km the south and west of Ten Mile. The only likely potential for impacts from brine extraction is away from the lakes at the extremity of the calcrete aquifers, where water quality is fresh to brackish and calcrete saturated thickness is less than 1m. These zones are only likely to become impacted by drawdown in late mine life >15 years. Any potential drawdown impacts to calcrete aquifers will be monitored and managed through the course of the BSOPP. Management and monitoring approaches are outlined in Section 8.

Potential Impacts and contamination from on-going site operations are expected to be minimal; however, management approaches for these are also outlined in Section 8.

8 Management Strategies

KLL's management approach for minimising potential impacts is outlined in Table 8-1:

Table 8-1: Summary of Management Strategies

Potential Impact Identified	Recommendation	Management Strategy
Calcrete aquifer - Drawdown monitoring	▪ Set trigger levels, in discussion with the DWER ▪ Continue baseline monitoring ▪ Undertake monthly monitoring of all completed monitoring bores ▪ Undertake continuous monitoring of selected monitoring bores ▪ Set trigger levels ▪ Validate and if necessary, re-calibrate the numerical model after two years of operation or large deviations from the model and revise drawdown predictions and reset trigger levels.	Alter extraction volumes and schedules to control drawdowns
Impact to other groundwater users	▪ Undertake regional monitoring or pastoral wells and monitoring bores	Provide alternate stock watering sources
Contaminant risks to shallow calcrete aquifer and the environment from site operations	▪ 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

8.1 Ongoing Monitoring and Management Plan

The monitoring program shall be designed as outlined in Table 8-2 and Table 8-3.

Table 8-2: 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

Management Activity	Description
	undertaken in line with licence conditions and brine extraction operating strategy.
Establish trigger Levels	Trigger levels for water levels and chemistry shall be developed for key monitoring locations in consultation with DWER. Trigger levels may include up to 70% allowable reduction water levels in selected saturated calcrete monitoring bores. This needs to be finalised in discussion with DWER.
Maintain stability of trench sides and efficacy of bores	Maintain efficacy of dewatering systems to maintain volumes and control dewatering.
Update and validate numerical models and undertake recalibration if deemed necessary	The groundwater models shall be validated and updated after the first 2 years of operations and every 5 years thereafter.

Table 8-3: Proposed Preliminary Monitoring Locations

Monitoring	Location	Frequency
Groundwater Level	All bores on site	Monthly
	Continuous logger monitoring	Selected bores on site - between 15 and 30 locations
Field water quality (EC, pH and temperature)	All shallow aquifer monitoring bores	Monthly
Laboratory Analysis of Groundwater chemistry	TMPB23, TMPB12, TMPB26, WB12, WB10, WB09, SSPB18, SSPB19, SSPB21, SSPB15, Additional production bores to be added when drilled	Monthly
Groundwater Levels – Regional Bores	12 mile well, Tupee Well, Garden well, Beyondie well, Davids Well, No 77 East well	Monthly
Laboratory Analysis of Major ion chemistry, TDS – Regional Bores	12 mile well, Tupee Well, Garden well, Beyondie well, Davids Well, No 77 East well	Bi-annual

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Appendix A Bore Database

ID	Easting	Northing	Zone	Deep (M1)/Shallow (M2)	Stickup	Topo Elevation (mAHD)	TOC Elevation (mAHD)	Base of Surficial Elevation (mAHD)	Bedrock Elevation (mAHD)	Water Table	Confined Water Level
TMAC06	233138.60	7256566.04	51	N/A	0.14	559.53	559.67	541.53	484.53	558.40	
TMAC09	232950.85	7251175.51	51	M1	0.44	560.67	561.11	544.67	529.67	558.962	558.752
TMAC09	232950.85	7251175.51	51	M2	0.41	560.67	561.08				
TMAC11	230974.51	7253144.57	51	M1	0.44	561.88	562.32	541.88	484.88	559.56	560.15
TMAC11	230974.51	7253144.57	51	M2	0.5	561.88	562.38				
TMAC12	233485.01	7256791.36	51	M1	0.59	565.21	565.80	542.21	481.21	558.632	558.902
TMAC12	233485.01	7256791.36	51	M2	0.61	565.21	565.82				
TMPB12	233490.47	7256785.46	51	PB	0.2	565.69	565.89				
TMAC13	233485.68	7256939.24	51	M1	0.55	564.29	564.84	546.29	480.29	558.727	558.59
TMAC13	233485.68	7256939.24	51	M2	0.45	564.29	564.74				
TMAC14	233452.94	7257458.17	51	M1	0.5	563.30	563.80	545.30	488.30	558.23	557.039
TMAC14	233452.94	7257458.17	51	M2	0.72	563.30	564.02				
TMAC15	235751.70	7257213.48	51	M1	0.4	567.19	567.59	547.19	505.19	558.29	
TMAC16	232061.80	7254489.05	51	M1	0.41	561.24	561.65	545.24	502.24	558.781	
TMAC16	232061.80	7254489.05	51	M2	0.43	561.24	561.67				
TMAC21	233892.02	7253503.52	51	M1	0.51	560.21	560.72	546.21	511.21	558.919	558.519
TMAC21	233892.02	7253503.52	51	M2	0.53	560.21	560.74				
TMAC22	230515.94	7254835.90	51	M1	0.5	560.18	560.68	552.18	484.18	558.668	558.718
TMAC22	230515.94	7254835.90	51	M2	0.8	560.18	560.98				
TMAC23	230934.47	7253522.73	51	M1	0.31	561.69	562.00	544.69	483.69	558.811	556.481
TMAC23	230934.47	7253522.73	51	M2	0.42	561.69	562.11				
TMPB23	230917.705	7253521.88	51		0.35	561.70	562.05				
TMAC24	231839.62	7251993.85	51	M1	0.45	560.22	560.67	544.22	519.22	558.934	558.95
TMAC24	231839.62	7251993.85	51	M2	0.48	560.22	560.70				
TMAC26	232824.98	7253031.60	51	M1	0.17	561.42	561.59	545.42	516.42	558.836	557.806
TMAC26	232824.98	7253031.60	51	M2	0.52	561.42	561.94				
TMPB26	232842.919	7253036.609	51		0.45	561.13	561.58				
TMAC27	229050.22	7258970.30	51		0.48	561.79	562.27	547.79	497.79	558.819	558.836
TMAC27	229050.22	7258970.30			0.57	561.79	562.36				
TMAC28	231526.28	7258961.45	51		0.4	560.71	561.11	546.71	489.71	558.725	557.805
TMAC28	231526.28	7258961.45			0.5	560.71	561.21				
TMAC30	236365.04	7258144.19	51			569.76	569.76	545.76	515.76		
WB05	229624.82	7260943.82	51			562.22	562.22	547.51	520.51	559.73	
WB06	230190.43	7259421.54	51			559.86	559.86	553.16	532.16	557.72	
WB07	230474.96	7257584.05	51			558.63	558.63	549.00	519.00	558.20	
WB09MBD	230482.93	7254261.80	51		0.48	560.82	561.30	543.11	508.11	558.68	
WB10MBD	233468.38	7257248.80	51		0.38	565.20	565.58	541.53	498.53		
WB10MBI	233486.81	7257251.40	51		0.93	565.26	566.19				
WB11MBD	233545.35	7255521.71	51		0.08	559.98	560.06	537.38	496.00		
WB11MBI	233542.22	7255523.76	51		0.72	559.98	560.70			558.78	
WB12MBD	233894.37	7253900.99	51			560.40	560.40	549.40	511.40	558.70	
WB12MBI	233887.75	7253922.72	51		0.14	560.45	560.59				
WB12TB1	233891.51	7253931.38	51		0.22	560.49	560.71				
WB12TB2	233890.64	7253948.37	51		0.2	560.41	560.61				
WB13	236153.67	7257231.73	51			573.87	573.87	547.16	501.16	559.89	
WB14	238291.94	7260572.32	51			570.84	570.84	551.13	551.13	560.14	
WB19	235565.18	7257150.52	51			567.22	567.22	550.50	489.50	559.67	
WB22	235583.24	7257162.26	51			567.11	567.11	547.40	489.80	559.82	
WB23	235582.33	7257149.78	51			566.95	566.95	547.24	491.24	559.62	
WB24	235648.23	7257070.23	51			566.71	566.71	546.00	501.00		
WB25	235579.23	7257152.19	51			566.94	566.94	547.37		559.76	
FWB	230966.40	7253134.56	51		0.4	562.08	562.48				
WB10	233477.25	7257243.57				565.107					

ID	N	E	Zone	Topo Elevation (mAHD)	Deep (M1) /Shallow (M2)	Stickup	Elevation TOC	Depth (m)
SSAC01	242988.6	7266582	51	543.466	M1	0.5	543.97	144
SSAC01	242988.6	7266582		543.466	M2	0.515	543.98	
SSAC02	244606	7267087	51	546			546.00	78
SSAC03	244872	7269735	51	543			543.00	50
SSAC04	246540	7271580	51	548			548.00	55
SSAC05	248513	7272971	51	550			550.00	47
SSAC06	249573.5	7268965	51	545.419	M1	0.14	545.56	53
SSAC06	249573.5	7268965	51	545.419	M2	0.14	545.56	
SSAC07	253251.6	7269260	51	541.201			541.20	54
SSAC08	251921	7273353	51	538			538.00	69
SSAC10	257098	7270011	51	537			537.00	54
SSAC13	258504.1	7271068	51	540.269	M1	0.15	540.42	65
SSAC13	258504.1	7271068	51	540.269	M2	0.35	540.62	
SSAC14	257922	7274721	51	535.675			535.68	53
SSAC15	257617.5	7275041	51	533.035	M1	0.31	533.35	63
SSAC15	257617.5	7275041	51	533.035	M2	0.4	533.44	
SSAC16	257301.1	7275361	51	533.432	M1	0.3	533.73	55
SSAC16	257301.1	7275361	51	533.432	M2	0.34	533.77	
SSAC18	261061.8	7276002	51	540.47	M1	0.16	540.63	101
SSAC18	261061.8	7276002	51	540.47	M2	0.16	540.63	
SSAC19	264077.6	7276655	51	537.967	M1	0.35	538.32	59
SSAC19	264077.6	7276655	51	537.967	M2	0.41	538.38	
SSAC21	248414.4	7269423	51	541.115	M1	0.25	541.37	57
SSAC21	248414.4	7269423	51	541.115	M2	0.29	541.41	
SSAC21a	248426	7269473	51	546			546.00	53
SSAC22	248217	7269871	51	546			546.00	67
SSAC22a	248258.2	7269820	51	539.745	M1	0.32	540.07	?
SSAC22a	248258.2	7269820	51	539.745	M2	0.34	540.09	
SSAC24	256659.9	7273834	51	536.211	M1	0.3	536.51	?
SSAC24	256659.9	7273834	51	536.211	M2	0.3	536.51	
SSAC25	255111.5	7272747	51	539.628	M1	0.36	539.99	?
SSAC25	255111.5	7272747	51	539.628	M2	0.38	540.01	
SSAC28	250238	7269661	51	537			537.00	32
SSAC42	249755.5	7269754	51	533.866	M1	0.29	534.16	37
SSAC42	249755.5	7269754	51	533.866	M2	0.265	534.13	
SSAC29	250002	7269725	51	539			539.00	29
SSAC30	249753	7269810	51	539			539.00	17
SSPB15	257633.5	7275045	51	533.421		0.36	533.78	62
SSPB18	261021.8	7275999	51	538.147		0.03	538.18	78
SSPB19	264083.6	7276673	51	538.304		0.4	538.70	60
SSPB21	248430.8	7269419	51	540.572		0.23	540.80	55.5

Site Name	Source	Easting	Northing	Depth	SWL	TDS
No. 7 Well Canning S R	DoW_WIR	327592.4	7216433	21.49	10.5	50
Marymia Well	DoW_WIR	209504.9	7230468		6.53	340
No. 10 Well Canning S R	DoW_WIR	363908.5	7250325	21.49	9.22	549
Piccaninny Bore	DoW_WIR	356836.9	7240395			550
Snake Well	DoW_WIR	203670.9	7274811	11.7	8	570
Joes Well	DoW_WIR	355200.3	7242372	16.46	5	580
Bullen Water Bore - 2	DoW_WIR	288543.3	7240572	50		630
Bullen Water Bore - 5	DoW_WIR	287720.2	7245950	20	3.1	840
Willy Willy Bore	DoW_WIR	331765.4	7219090			860
Bullen Water Bore - 4	DoW_WIR	320308.5	7248179	44.5	4.45	1050
Snells Bore	DoW_WIR	345516.3	7252012			1200
No. 12 Well Canning S R	DoW_WIR	385798.7	7279428	7.77	2.75	2090
12 Mile Or Lake Well	DoW_WIR	219208.7	7261900		7.25	2370
No 8 Well Canning S R	DoW_WIR	337270.4	7222372	18.29	3.9	2650
Lake Bore	DoW_WIR	336072.3	7229937			2840
No. 11 Well Canning S R	DoW_WIR	371888.2	7261587	2	1.7	3270
4 Mile	DoW_WIR	208797.9	7256222		6.13	4500
Beyonde Homestead Well	DoW_WIR	201051.9	7255893	14.1	13.5	
Bore	DoW_WIR	343118.4	7229104	3.66		
Bore	DoW_WIR	343362.3	7237370	3.66		
Bore	DoW_WIR	344318.3	7244472	3.66		
Bore	DoW_WIR	351121.1	7245983	3.66		
Bore	DoW_WIR	354352.4	7246129	3.66		
Bullen Water Bore - 1	DoW_WIR	287719.2	7245982			
Bullen Water Bore - 3	DoW_WIR	305889.4	7239589		4.3	
No. 1	DoW_WIR	206394.9	7234210	27.43		
No. 13 Well Canning S R	DoW_WIR	398219.2	7298018	7.77		
Private	DoW_WIR	233891.4	7253931	48		
Well	DoW_WIR	205742.8	7242803	10.7	1.07	
Well	DoW_WIR	208306	7230774	10.7	1.07	
Well	DoW_WIR	210273.9	7230874	10.7	1.07	
Well	DoW_WIR	216244.9	7234887	10.7	1.07	
Well	DoW_WIR	371888.2	7261587	10.7	1.07	
No 77 East Well	Phoenix_DB	216216.6	7234800	9.8	1	96
Beyondie Bore	Phoenix_DB	201051.9	7255893	24.43	10.95	369
Davids Well	Phoenix_DB	197968.6	7228384	20.7	5.5	463
Garden Well	Phoenix_DB	202895.6	7255953	22.24	9.5	500
Broken Leg	Phoenix_DB	202835	7232154	41.8	16	650
12 Mile Well	Phoenix_DB	219208.7	7261900	11.2	5.2	2072
Unamed 1	Phoenix_DB	207916.8	7257437	19.8	4.2	2084
Tmac23	Phoenix_DB	230929	7253520	11.53	2.92	3800
Tupee Well	Phoenix_DB	201893.4	7269434	13	8.1	3827
Wb25	Phoenix_DB	235581	7257148	29.15	7.18	17056
Wb05mbs	Phoenix_DB	229624	7260943	53	2.5	60882
Wb09mbs	Phoenix_DB	230482.1	7254262	31	2.5	61507
Wb09mbd	Phoenix_DB	230482.1	7254262	33.9	1.05	92278
Beyondie W	Phoenix_DB	200360.1	7255657			
Tmac09	Phoenix_DB	232932	7251174			
Tmac11	Phoenix_DB	230920	7253138			
Tmac15	Phoenix_DB	235748	7257207			
Tmac16	Phoenix_DB	232037	7254479			
Tmac22	Phoenix_DB	230509	7254896			
Tmac24	Phoenix_DB	232122	7251935			
Tmac26	Phoenix_DB	232760	7253061			
Wb10tb01	Phoenix_DB	233476	7257242			
Wb12mbi	Phoenix_DB	233887.6	7253922			

BSOPP - Shallow Aquifer Drilling and Bore Construction

Bore Name:	GPS Easting:	GPSNorthing:	GPS Elevation (mAHD):	Drilled depth:	50mm screens	50mm blank Casing	SWL (mbtoc):	measured stick up (magl)	SWL (m bgl)
EH-S27	213729	7232728	589	38	37m to 13m	13m			0.00
EH-S4	229826	7250058	593	18	18m to 6m	6m			0.00
EH-S6	221530	7248256	583	44	44m to 12m	12m	1	0.8	0.20
EH-S9 rev	227350	7248998	557	32	32m to 8m	8m	2.32	0.89	1.43
EH-W11 re	214851	7257368	565	26	26m to 14m	14m	3	0.83	2.17
EH-S1 rev	225876	7249644	556	47	46m to 10m	10	3.29	0.95	2.34
EH-S7	228893	7245370	557	28	28m to 6m	6m	3.44	0.86	2.58
EH-S15	227875	7241604	541	18	5m to 3.6m	3.6m	4.65	1.13	3.52
EH-W1 Rev	212845	7256955	563	32	30m to 12m	12m	4.66	0.93	3.73
EH-S20	230960	7249161	561	18	18m to 6m	6m	4.97	1.15	3.82
EH-S10	227268	7245215	564	18	18m to 6m	6m	4.84	0.97	3.87
EH-S29rev	220667	7232776	581	38	38m to 8m	8m	4.99	1.07	3.92
EH-S19	230976	7250139	561	13	13m to 1m	1m	4.79	0.84	3.95
EH-S24	218721	7235017	564	38	38m to 10m	10m	4.48	0.5	3.98
EH-S8	227869	7246970	536	30	29m to 11m	11m	4.93	0.73	4.20
EH-S17	221596	7237576	570	25	25 to 7m	7m	5.22	0.82	4.40
EH-S22	229953	7247134	563	20	19m to 7m	7m	5.38	0.87	4.51
EH-S21	230986	7248136	562	24	24m to 6m	6m	5.53	0.85	4.68
EH-W2	215282	7258699	564	26	26m to 14m	14m	5.84	0.93	4.91
EH-S12	230629	7246122	568	18	17m to 5m	5m	5.97	0.91	5.06
EH-W10	210142	7256485	572	19	19m to 7m	7m	6.02	0.8	5.22
EH-W9	208674	7256235	572	24	24m to 12m	12m	6.61	1.2	5.41
EH-S16	223240	7237395	569	17	17 to 5m	5m	7.03	0.81	6.22
EH-W5	211352	7259955	572	33	33m to 15m	15m	8.65	0.34	8.31
EH-S23	229264	7246403	557	17	6m	N/A	not measured	0.8	
EH-S11	226357	7244011	567	13	N/A	N/A	N/A	N/A	
EH-S13	225693	7242584	536	21	N/A	N/A	N/A	N/A	
EH-S15A	227843	7241611	541	18	N/A	N/A	N/A	N/A	
EH-S14	226377	7241732	539	21	N/A	N/A	N/A	N/A	
EH-S18	223484	7240048	567	37	N/A	N/A	N/A	N/A	
EH-S18A	223449	7240101	566	31	N/A	N/A	N/A	N/A	
EH-S30rev	219671	7237954	576	27	N/A	N/A	N/A	N/A	
EH-S26	214523	7233745	578	50	N/A	N/A	N/A	N/A	
EH-S25	216044	7234608	583	40	N/A	N/A	N/A	N/A	
EH-S28	212703	7232777	589	38	N/A	N/A	N/A	N/A	
EH-S3	229391	7247755	569	50	N/A	N/A	N/A	N/A	
EH-S2	224705	7249053	572	34	N/A	N/A	N/A	N/A	
EH-W4 Rev	202319	7253511	577	30	N/A	N/A	N/A	N/A	
EH-W15 Re	201614	7253077	578	32	N/A	N/A	N/A	N/A	
EH-W6	215845	7261321	571	26	N/A	N/A	N/A	N/A	
EH-W8	207077	7256502	571	20	N/A	N/A	N/A	N/A	
EH-W3 rev	204278	7256595	583	23	N/A	N/A	N/A	N/A	

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Appendix B Borehole Logs

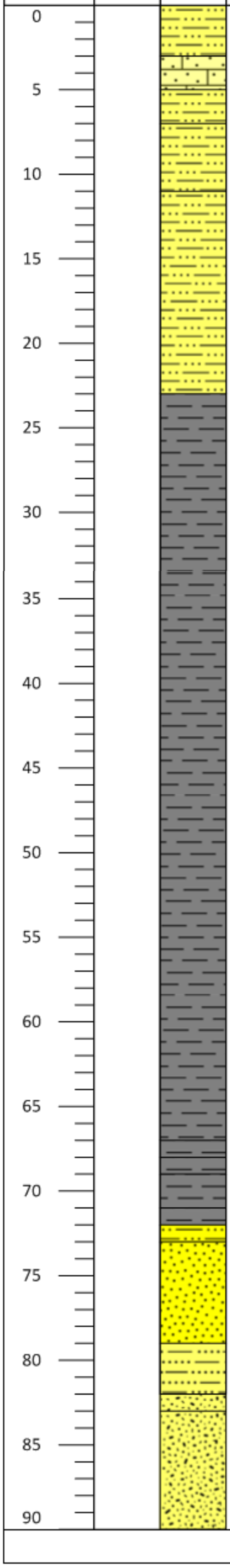
BORE CONSTRUCTION DIAGRAM, TEN MILE TMPB12

Project	Beyondie Potash Project	**Grid/Zone**	AMG Zone 51	**TDS**	155000 mg/L
Date Drilled	March 2017	**Easting**	233490.5	**pH**	7.07
SWL	6.6 mbgl	**Northing**	7256785	**K**	6620 mg/L
		Elevation	565.7 mAHD	**Na**	49600 mg/L
				Mg	5410 mg/L
				Cl	86650 mg/L
				SO4	18600 mg/L

KALIUM LAKES

Advisian
WorleyParsons Group

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



ALLUVIUM; Red brown aeolian sands with calcrete and clays introduced at depth.

ALLUVIUM + CALCRETE; Red brown sands, clays and calcrete material (~20%).

ALLUVIUM; Light brown clay with sands, mionr calcrete and silcrete (<5%).

ALLUVIUM; Light green brown clays with sands and fine gravels (<20%). Minor silcrete alluvium.

ALLUVIUM; Brown and light brown clays, minor (<10cm) hardpanised bands and coarser fragments of alluvium.

CLAY; Lacustrine laminated clays with sand sized particles and color changes throughout.

CLAY; Yellow green clays with poorly rounded residual alluvium fragments.

CLAY; Yellow clays with courser alluvium and ferruginous fragments (20%).

CLAY; Olive green and purple brown clays with silcrete and ferruginous bands. Micro vugs and opaline silica cavity infill observed in silcrete fragments.

CLAY; Yellow clay band within a stratified clay and silcrete zone.

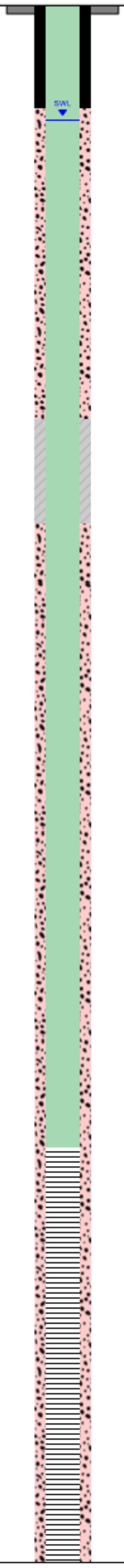
SILCRETE; Alluvium silcrete band with light yellow green and creamy clays.

SAND; White, light grey, cream colored alluvium sands (>80%). Sands are very fine to 3mm, spheroidal and moderately rounded.

CLAYEY SAND; light pink grey clays with significant quantities of quartz sands (30-50%) and larger silcreted quartz fragments.

SILCRETE and CLAY; Yellow green clays with possible siliceous material. Large fragments of siltstone/sandstone with micro vugs (<5%).

SANDSTONE; Light yellow brown oxidised quartz sandstone.



Lockable Cover (Steel) and cemented headworks

18" (457 mm) Mild steel surface casing - cemented - to 6m

Static Water Level - 6.6 mbgl

16" (406 mm) Bore

Gravel Pack - 1.6-3.2 mm size -30 to 90 mbgl

Cement Bentonite Grout Seal - 24 to 30m

Blank Casing - 10" 225 mm - CL18uPVC - 0 to 66 mbgl (11 lengths)

Slotted Casing- 10" 225 mm - CL18uPVC - 66 to 90 mbgl (4 lengths), custom slotted

End Cap - 10" (225 mm) uPVC

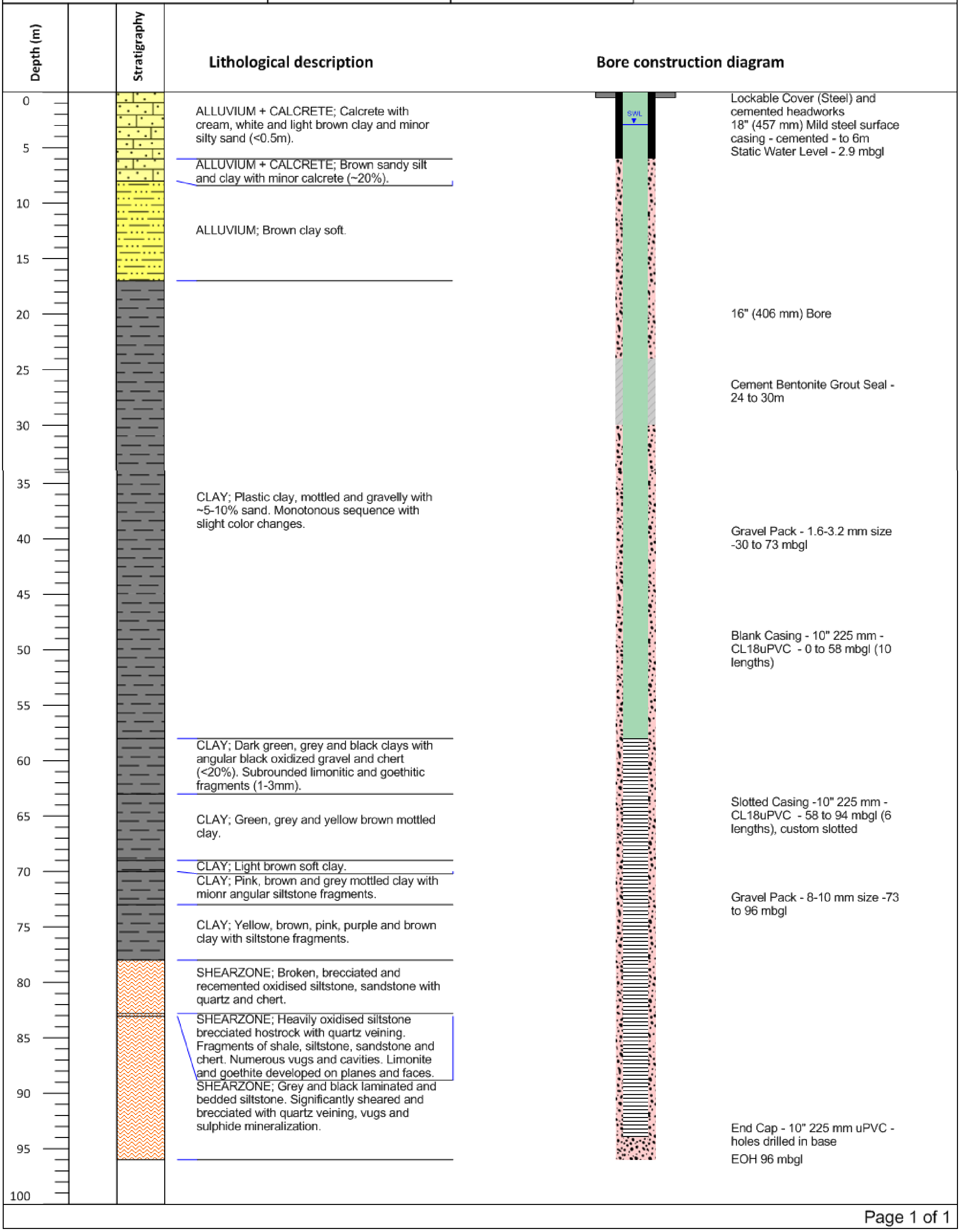
EOH 90 mbgl

BORE CONSTRUCTION DIAGRAM, TEN MILE TMPB23

Project	Beyondie Potash Project	**Grid/Zone**	AMG Zone 51	**TDS**	195100 mg/L
				pH	7.08
Date Drilled	March 2017	**Easting**	230917.7	**K**	9990 mg/L
				Na	66400 mg/L
SWL	2.9 mbgl	**Northing**	7253522	**Mg**	5780 mg/L
				Cl	114300 mg/L
		Elevation	561.9 mAHD	**SO4**	21000 mg/L

KALIUM LAKES

Advisian
WorleyParsons Group



Lithological description

ALLUVIUM + CALCRETE; Calcrete with cream, white and light brown clay and minor silty sand (<0.5m).

ALLUVIUM + CALCRETE; Brown sandy silt and clay with minor calcrete (~20%).

ALLUVIUM; Brown clay soft.

CLAY; Plastic clay, mottled and gravelly with ~5-10% sand. Monotonous sequence with slight color changes.

CLAY; Dark green, grey and black clays with angular black oxidized gravel and chert (<20%). Subrounded limonitic and goethitic fragments (1-3mm).

CLAY; Green, grey and yellow brown mottled clay.

CLAY; Light brown soft clay.

CLAY; Pink, brown and grey mottled clay with mionr angular siltstone fragments.

CLAY; Yellow, brown, pink, purple and brown clay with siltstone fragments.

SHEARZONE; Broken, brecciated and recemented oxidised siltstone, sandstone with quartz and chert.

SHEARZONE; Heavily oxidised siltstone brecciated hostrock with quartz veining. Fragments of shale, siltstone, sandstone and chert. Numerous vugs and cavities. Limonite and goethite developed on planes and faces.

SHEARZONE; Grey and black laminated and bedded siltstone. Significantly sheared and brecciated with quartz veining, vugs and sulphide mineralization.

Bore construction diagram

Lockable Cover (Steel) and cemented headworks
18" (457 mm) Mild steel surface casing - cemented - to 6m
Static Water Level - 2.9 mbgl

16" (406 mm) Bore

Cement Bentonite Grout Seal - 24 to 30m

Gravel Pack - 1.6-3.2 mm size -30 to 73 mbgl

Blank Casing - 10" 225 mm - CL18uPVC - 0 to 58 mbgl (10 lengths)

Slotted Casing -10" 225 mm - CL18uPVC - 58 to 94 mbgl (6 lengths), custom slotted

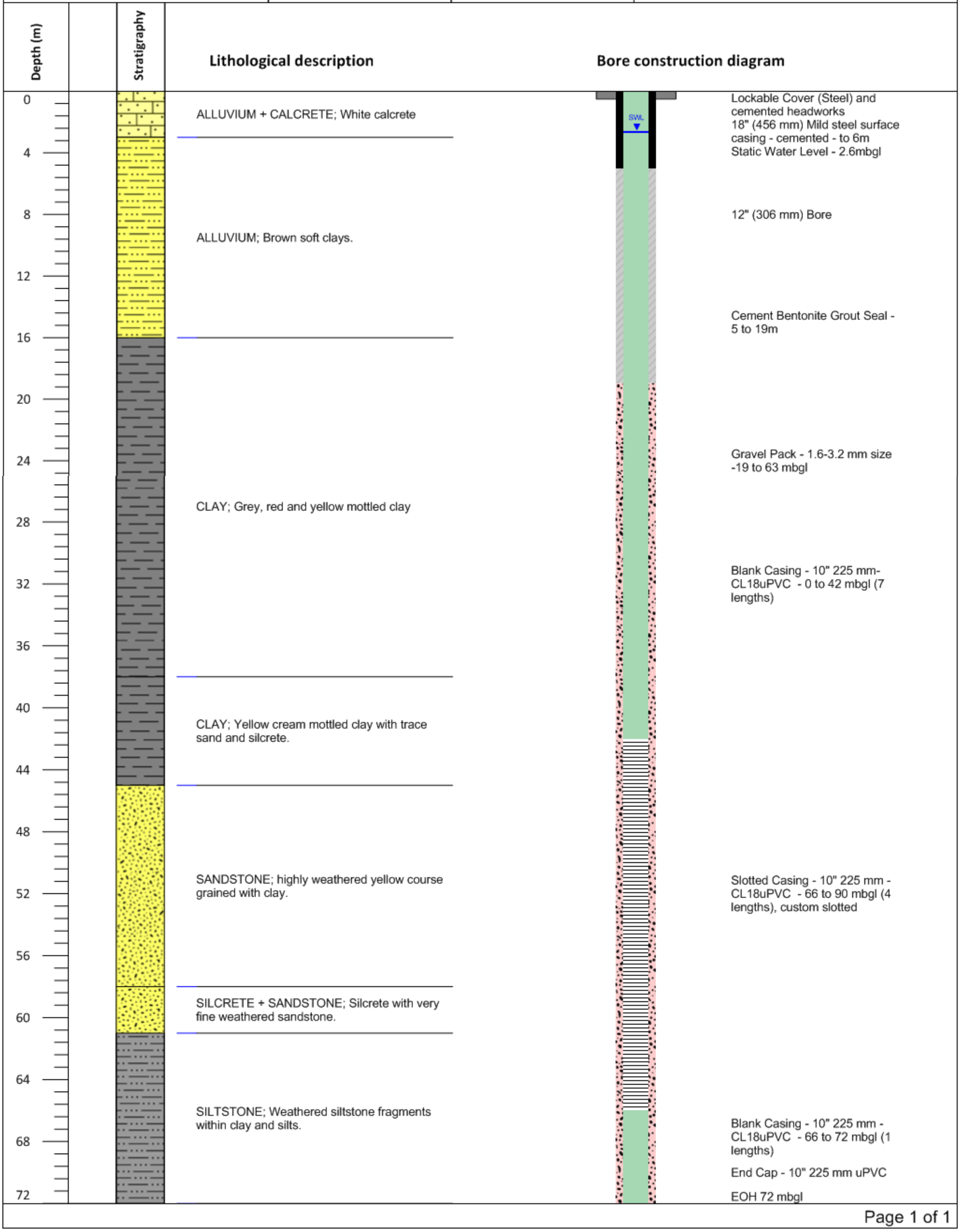
Gravel Pack - 8-10 mm size -73 to 96 mbgl

End Cap - 10" 225 mm uPVC - holes drilled in base

EOH 96 mbgl

BORE CONSTRUCTION DIAGRAM, TEN MILE TMPB26

Project	Beyondie Potash Project	**Grid/Zone**	AMG Zone 51	**TDS**	141498 mg/L
Date Drilled	March 2017	**Easting**	232842.9	**pH**	7.41
SWL	2.6 mbgl	**Northing**	7253037	**K**	5390 mg/L
		Elevation	558.8 mAHD	**Na**	39800 mg/L
				Mg	5070 mg/L
				Cl	72050 mg/L
				SO4	18300 mg/L



Lithological description

ALLUVIUM + CALCRETE; White calcrete

ALLUVIUM; Brown soft clays.

CLAY; Grey, red and yellow mottled clay

CLAY; Yellow cream mottled clay with trace sand and silcrete.

SANDSTONE; highly weathered yellow course grained with clay.

SILCRETE + SANDSTONE; Silcrete with very fine weathered sandstone.

SILTSTONE; Weathered siltstone fragments within clay and silts.

Bore construction diagram

Lockable Cover (Steel) and cemented headworks

18" (456 mm) Mild steel surface casing - cemented - to 6m

Static Water Level - 2.6mbgl

12" (306 mm) Bore

Cement Bentonite Grout Seal - 5 to 19m

Gravel Pack - 1.6-3.2 mm size -19 to 63 mbgl

Blank Casing - 10" 225 mm- CL18uPVC - 0 to 42 mbgl (7 lengths)

Slotted Casing - 10" 225 mm - CL18uPVC - 66 to 90 mbgl (4 lengths), custom slotted

Blank Casing - 10" 225 mm - CL18uPVC - 66 to 72 mbgl (1 lengths)

End Cap - 10" 225 mm uPVC

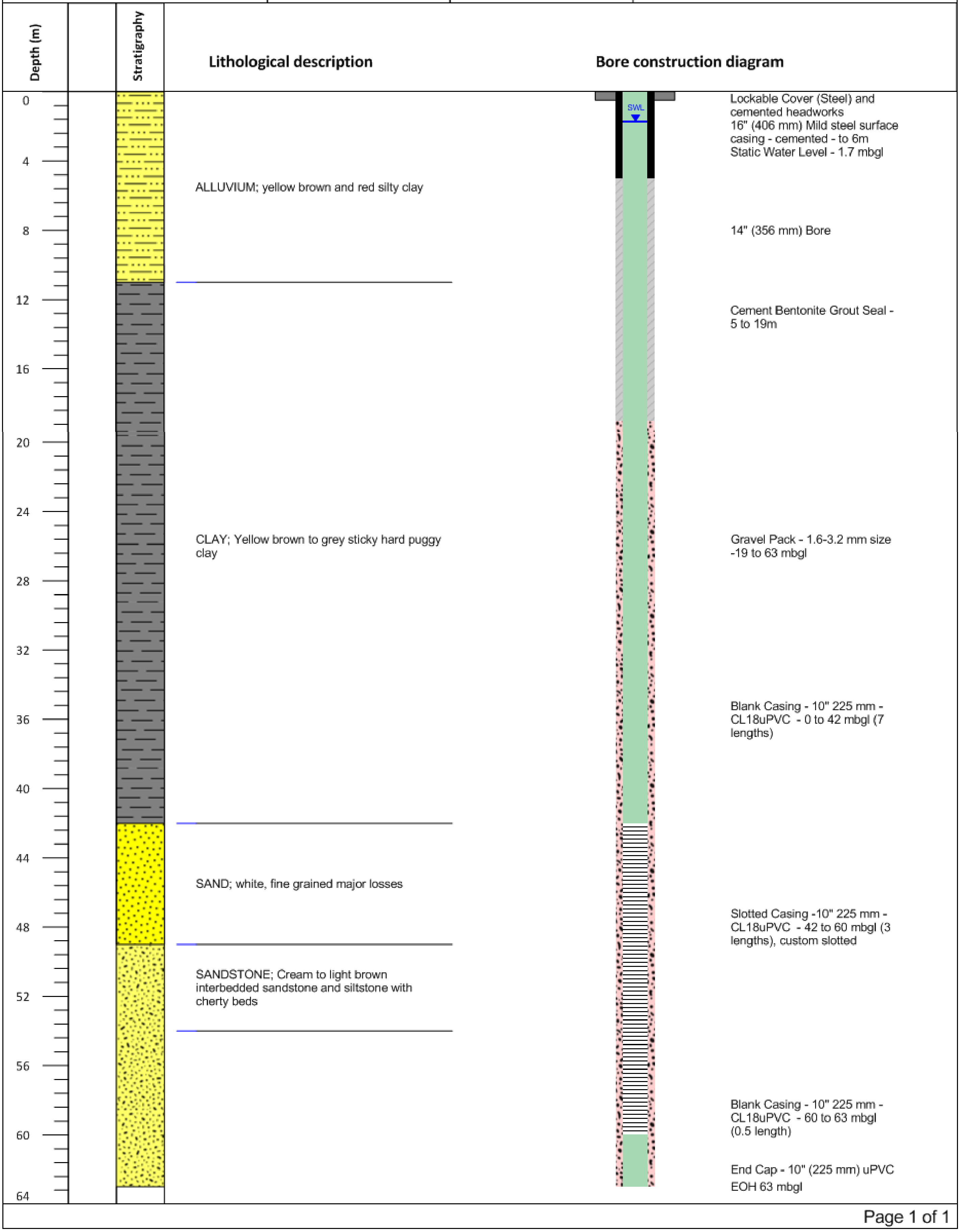
EOH 72 mbgl

BORE CONSTRUCTION DIAGRAM, TEN MILE WB12-TB2

Project	Beyondie Potash Project	**Grid/Zone**	AMG Zone 51	**TDS**	181996 mg/L
				pH	
Date Drilled	March 2017	**Easting**	233890.6	**K**	6440 mg/L
				Na	52000 mg/L
SWL	1.7 mbgl	**Northing**	7253948	**Mg**	6910 mg/L
				Cl	92600 mg/L
		Elevation	560.4 mAHD	**SO4**	23400 mg/L

KALIUM LAKES

Advisian
WorleyParsons Group



ALLUVIUM; yellow brown and red silty clay

CLAY; Yellow brown to grey sticky hard puggy clay

SAND; white, fine grained major losses

SANDSTONE; Cream to light brown interbedded sandstone and siltstone with cherty beds

Lockable Cover (Steel) and cemented headworks
16" (406 mm) Mild steel surface casing - cemented - to 6m
Static Water Level - 1.7 mbgl

14" (356 mm) Bore

Cement Bentonite Grout Seal - 5 to 19m

Gravel Pack - 1.6-3.2 mm size -19 to 63 mbgl

Blank Casing - 10" 225 mm - CL18uPVC - 0 to 42 mbgl (7 lengths)

Slotted Casing -10" 225 mm - CL18uPVC - 42 to 60 mbgl (3 lengths), custom slotted

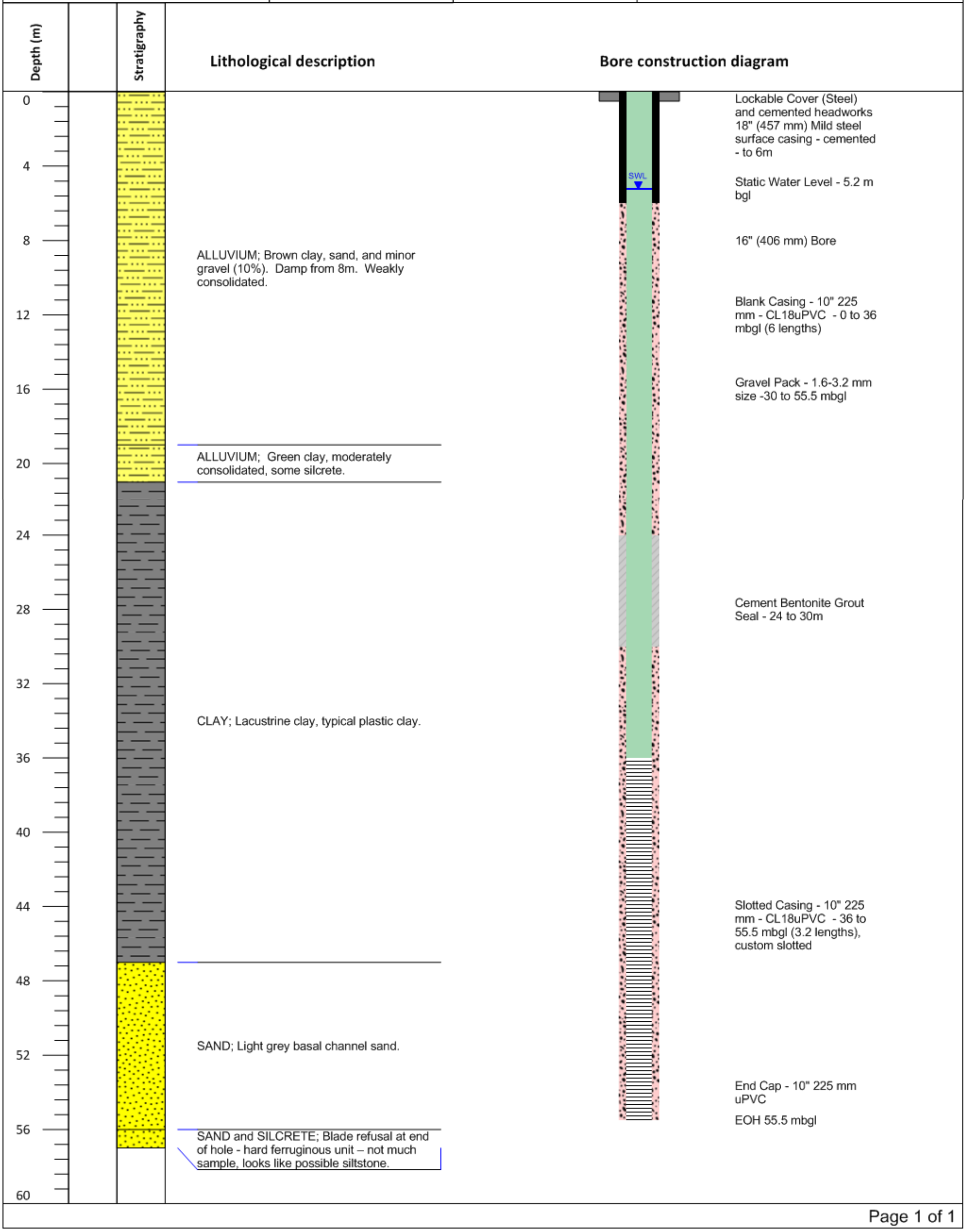
Blank Casing - 10" 225 mm - CL18uPVC - 60 to 63 mbgl (0.5 length)

End Cap - 10" (225 mm) uPVC
EOH 63 mbgl

BORE CONSTRUCTION DIAGRAM, SUNSHINE

SSPB21

Project	Beyondie Potash Project	**Grid/Zone**	AMG Zone 51	**TDS**	175900 mg/L
Date Drilled	March 2017	**Easting**	248430.8	**pH**	7.16
SWL	5.2 mbgl	**Northing**	7269419	**K**	5010 mg/L
		Elevation	540.6 mAHD	**Na**	45200 mg/L
				Mg	5150 mg/L
				Cl	79200 mg/L
				SO4	16300 mg/L



Lithological description

ALLUVIUM; Brown clay, sand, and minor gravel (10%). Damp from 8m. Weakly consolidated.

ALLUVIUM; Green clay, moderately consolidated, some silcrete.

CLAY; Lacustrine clay, typical plastic clay.

SAND; Light grey basal channel sand.

SAND and SILCRETE; Blade refusal at end of hole - hard ferruginous unit – not much sample, looks like possible siltstone.

Bore construction diagram

Lockable Cover (Steel) and cemented headworks 18" (457 mm) Mild steel surface casing - cemented - to 6m

Static Water Level - 5.2 m bgl

16" (406 mm) Bore

Blank Casing - 10" 225 mm - CL18uPVC - 0 to 36 mbgl (6 lengths)

Gravel Pack - 1.6-3.2 mm size -30 to 55.5 mbgl

Cement Bentonite Grout Seal - 24 to 30m

Slotted Casing - 10" 225 mm - CL18uPVC - 36 to 55.5 mbgl (3.2 lengths), custom slotted

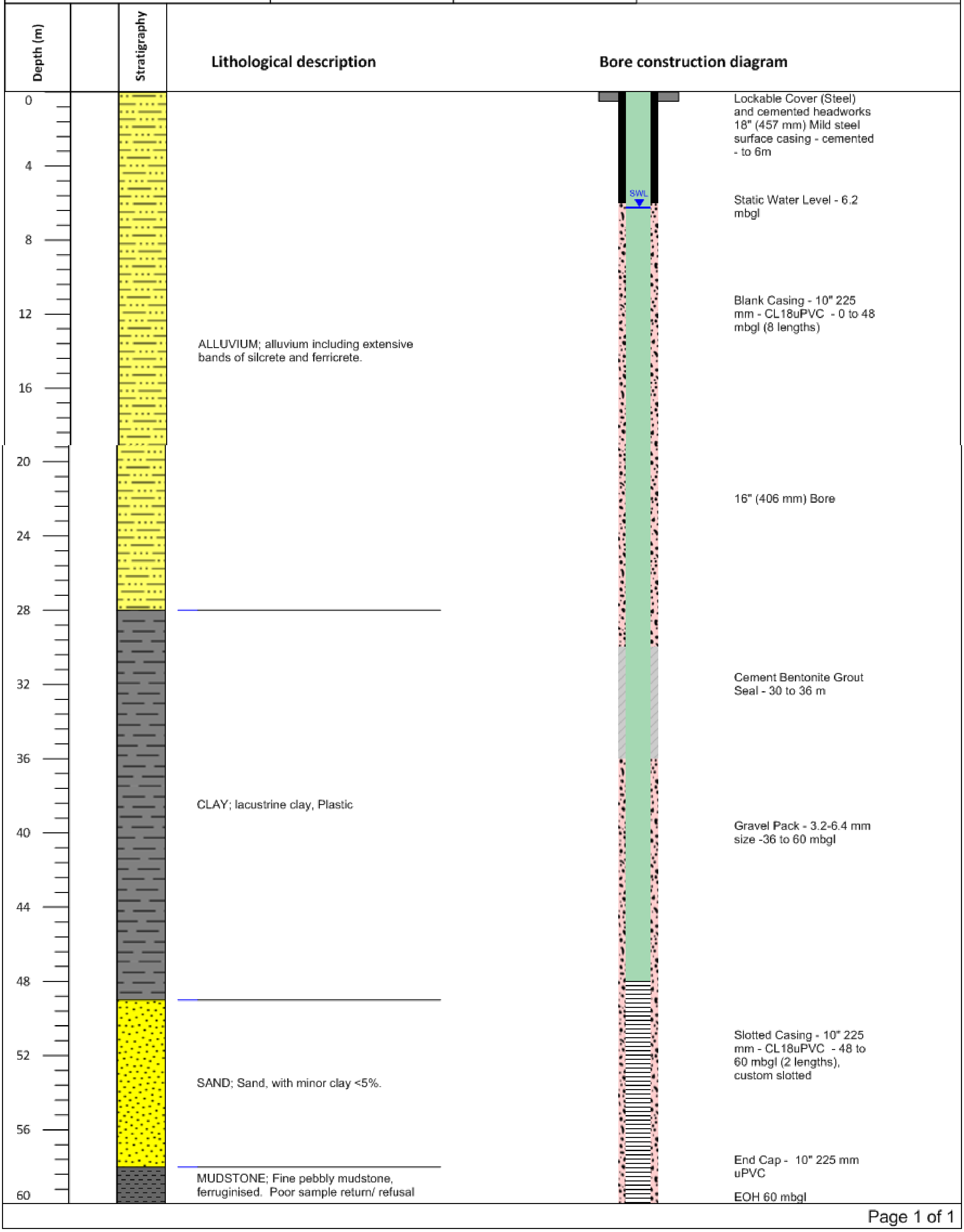
End Cap - 10" 225 mm uPVC

EOH 55.5 mbgl

BORE CONSTRUCTION DIAGRAM, SUNSHINE SSPB19

Project	Beyondie Potash Project	**Grid/Zone**	AMG Zone 51
Date Drilled	March 2017	**Easting**	264083.6
SWL	6.2 mbgl	**Northing**	7276673
		Elevation	531.8 mAHD

TDS	179250 mg/L
pH	6.75
K	4880 mg/L
Na	54200 mg/L
Mg	5000 mg/L
Cl	90600 mg/L
SO4	15400 mg/L



ALLUVIUM; alluvium including extensive bands of silcrete and ferricrete.

CLAY; lacustrine clay, Plastic

SAND; Sand, with minor clay <5%.

MUDSTONE; Fine pebbly mudstone, ferruginised. Poor sample return/ refusal

Lockable Cover (Steel) and cemented headworks 18" (457 mm) Mild steel surface casing - cemented - to 6m

Static Water Level - 6.2 mbgl

Blank Casing - 10" 225 mm - CL18uPVC - 0 to 48 mbgl (8 lengths)

16" (406 mm) Bore

Cement Bentonite Grout Seal - 30 to 36 m

Gravel Pack - 3.2-6.4 mm size -36 to 60 mbgl

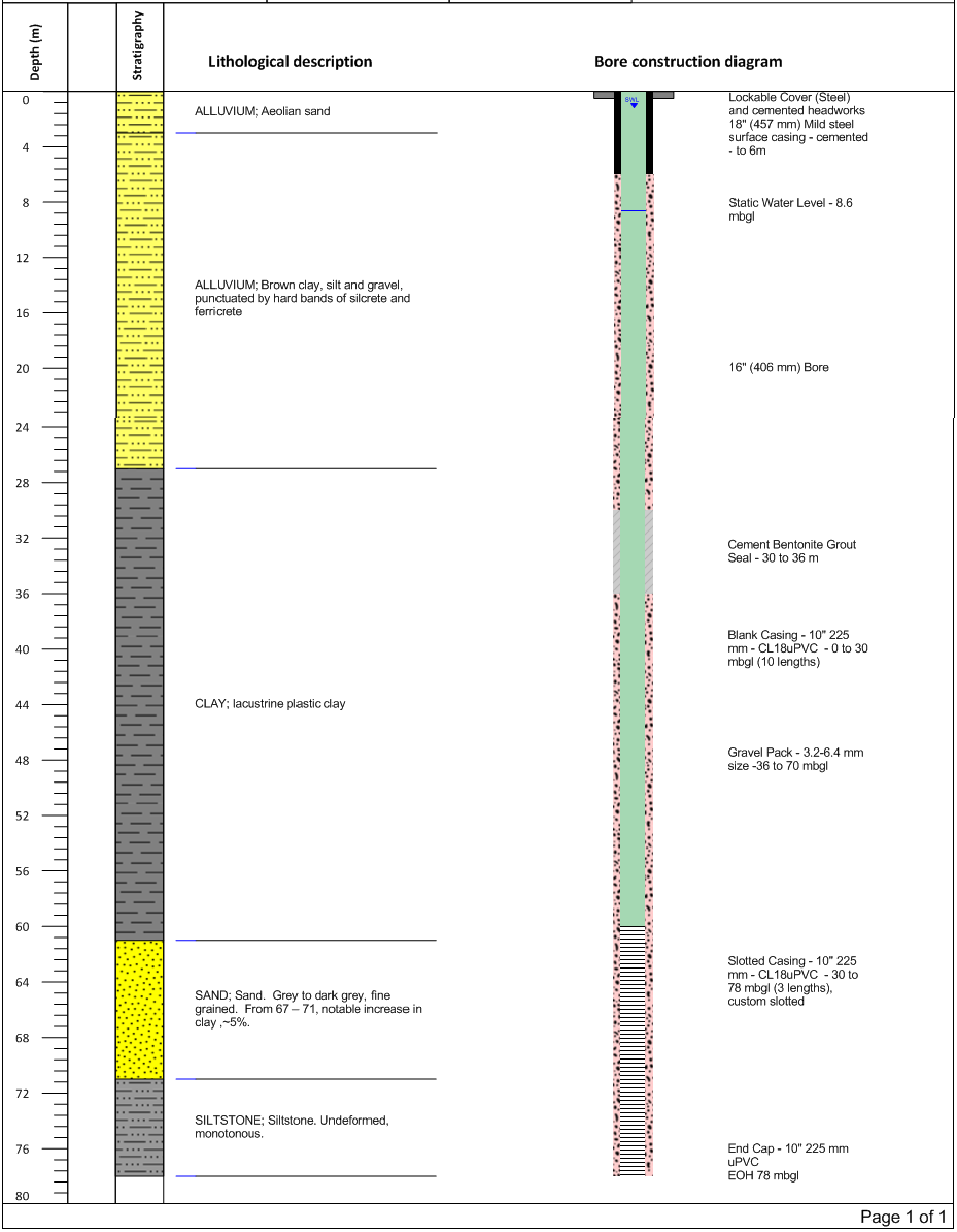
Slotted Casing - 10" 225 mm - CL18uPVC - 48 to 60 mbgl (2 lengths), custom slotted

End Cap - 10" 225 mm uPVC

EOH 60 mbgl

BORE CONSTRUCTION DIAGRAM, SUNSHINE SSPB18

Project	Beyondie Potash Project	**Grid/Zone**	AMG Zone 51	**TDS**	218000 mg/L
Date Drilled	March 2017	**Easting**	261021.8	**pH**	6.55
SWL	8.6 mbgl	**Northing**	7275999	**K**	6750 mg/L
		Elevation	531.8 mAHD	**Na**	64400 mg/L
				Mg	5720 mg/L
				Cl	113550 mg/L
				SO4	16000 mg/L



ALLUVIUM; Aeolian sand

ALLUVIUM; Brown clay, silt and gravel, punctuated by hard bands of silcrete and ferricrete

CLAY; lacustrine plastic clay

SAND; Sand. Grey to dark grey, fine grained. From 67 – 71, notable increase in clay ,~5%.

SILTSTONE; Siltstone. Undeformed, monotonous.

Lockable Cover (Steel) and cemented headworks 18" (457 mm) Mild steel surface casing - cemented - to 6m

Static Water Level - 8.6 mbgl

16" (406 mm) Bore

Cement Bentonite Grout Seal - 30 to 36 m

Blank Casing - 10" 225 mm - CL18uPVC - 0 to 30 mbgl (10 lengths)

Gravel Pack - 3.2-6.4 mm size -36 to 70 mbgl

Slotted Casing - 10" 225 mm - CL18uPVC - 30 to 78 mbgl (3 lengths), custom slotted

End Cap - 10" 225 mm uPVC
EOH 78 mbgl

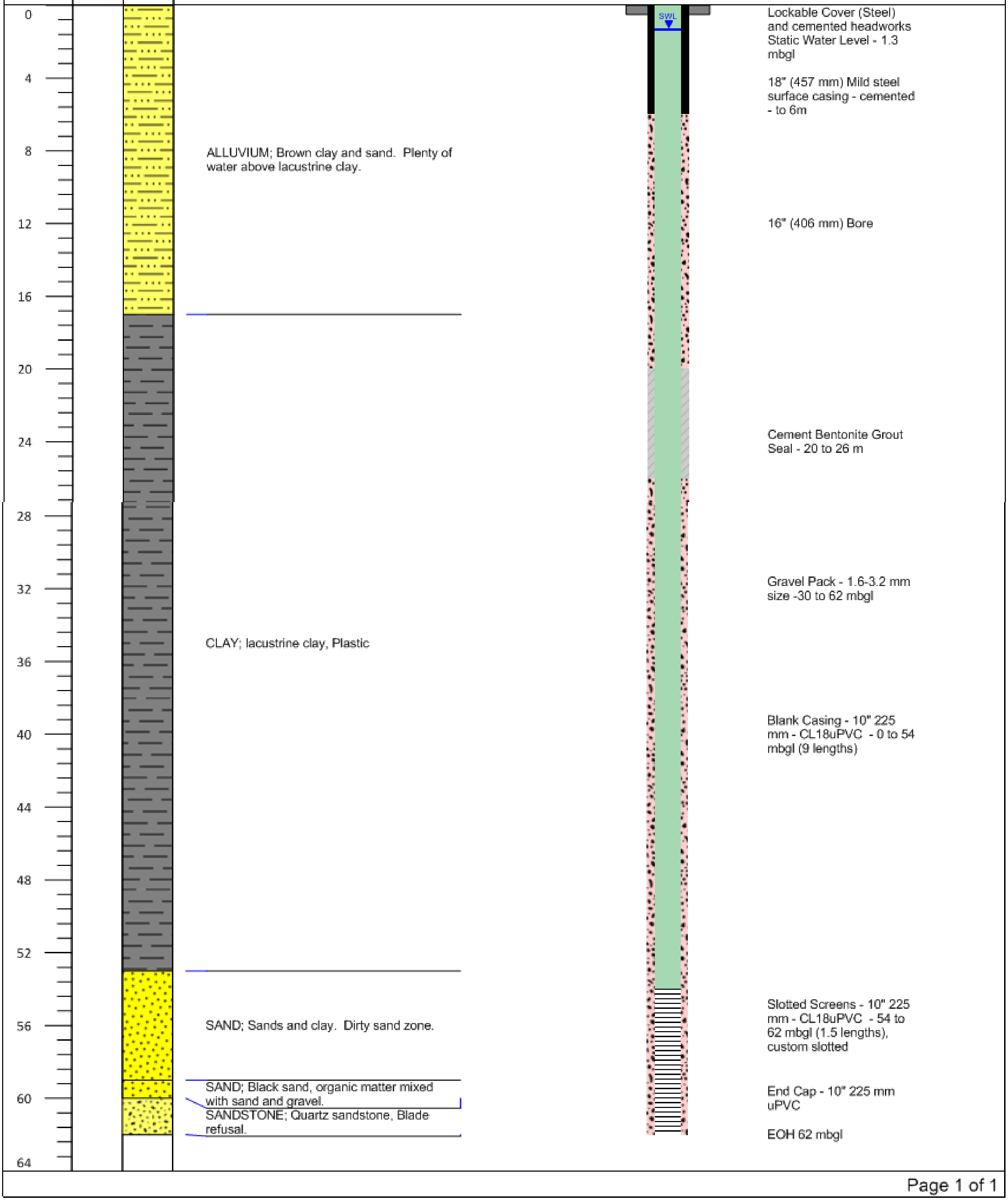
BORE CONSTRUCTION DIAGRAM, SUNSHINE SSPB15

Project	Beyondie Potash Project	**Grid/Zone**	AMG Zone 51	**TDS**	212300 mg/L
Date Drilled	March 2017	**Easting**	257633.5	**pH**	6.59
SWL	1.3 mbgl	**Northing**	7275045	**K**	6310 mg/L
		Elevation	533.4 mAHD	**Na**	66700 mg/L
				Mg	5880 mg/L
				Cl	110250 mg/L
				SO4	17800 mg/L

KALIUM LAKES

Advisian
WorleyParsons Group

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



ALLUVIUM; Brown clay and sand. Plenty of water above lacustrine clay.

CLAY; lacustrine clay, Plastic

SAND; Sands and clay. Dirty sand zone.

SAND; Black sand, organic matter mixed with sand and gravel.

SANDSTONE; Quartz sandstone, Blade refusal.

Lockable Cover (Steel) and cemented headworks

Static Water Level - 1.3 mbgl

18" (457 mm) Mild steel surface casing - cemented - to 6m

16" (406 mm) Bore

Cement Bentonite Grout Seal - 20 to 26 m

Gravel Pack - 1.6-3.2 mm size -30 to 62 mbgl

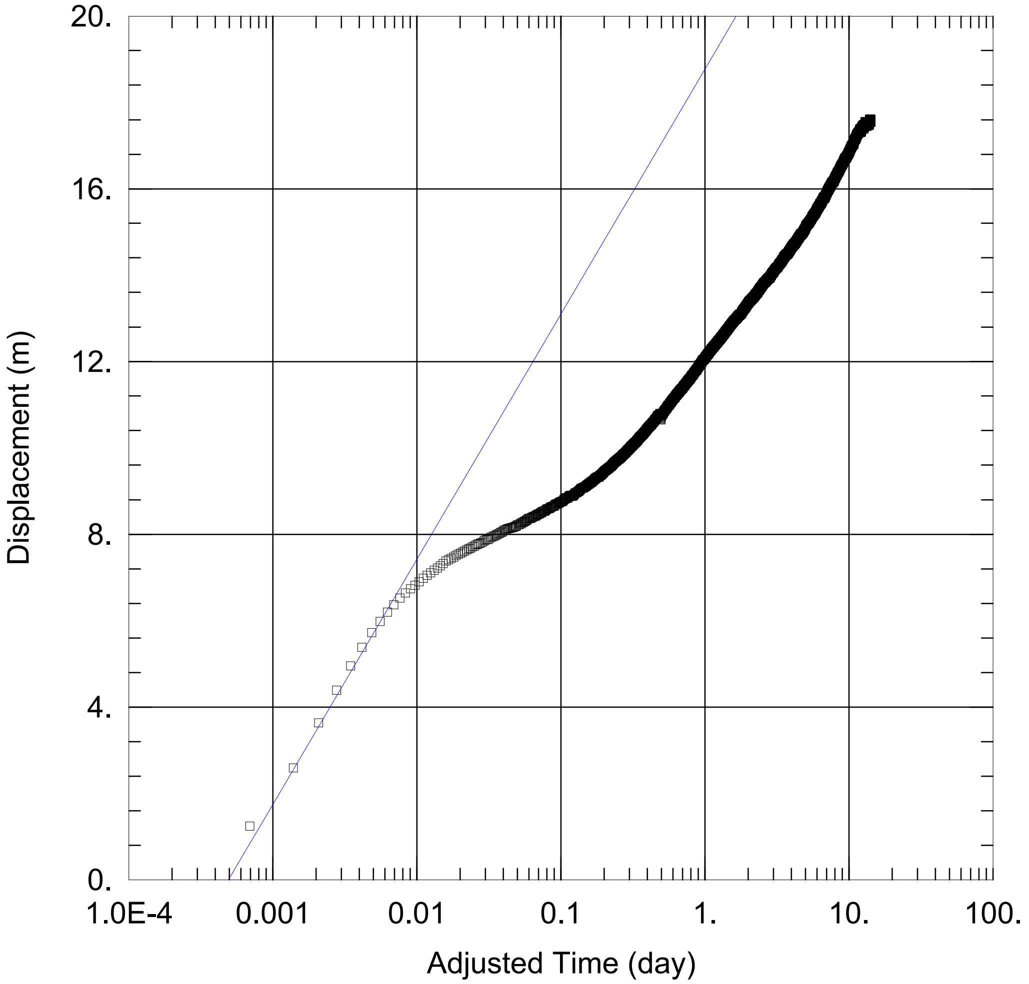
Blank Casing - 10" 225 mm - CL18uPVC - 0 to 54 mbgl (9 lengths)

Slotted Screens - 10" 225 mm - CL18uPVC - 54 to 62 mbgl (1.5 lengths), custom slotted

End Cap - 10" 225 mm uPVC

EOH 62 mbgl

Appendix C Test Pumping Analysis



WELL TEST ANALYSIS

Data Set:
Date: 09/08/17

Time: 15:01:33

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile Lake
Test Well: TMPB12
Test Date: June 2017

AQUIFER DATA

Saturated Thickness: 11. m

Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TMPB12	233490.468	7256785.458

Observation Wells

Well Name	X (m)	Y (m)
□ TMAC12M1	233485.012	7256791.363

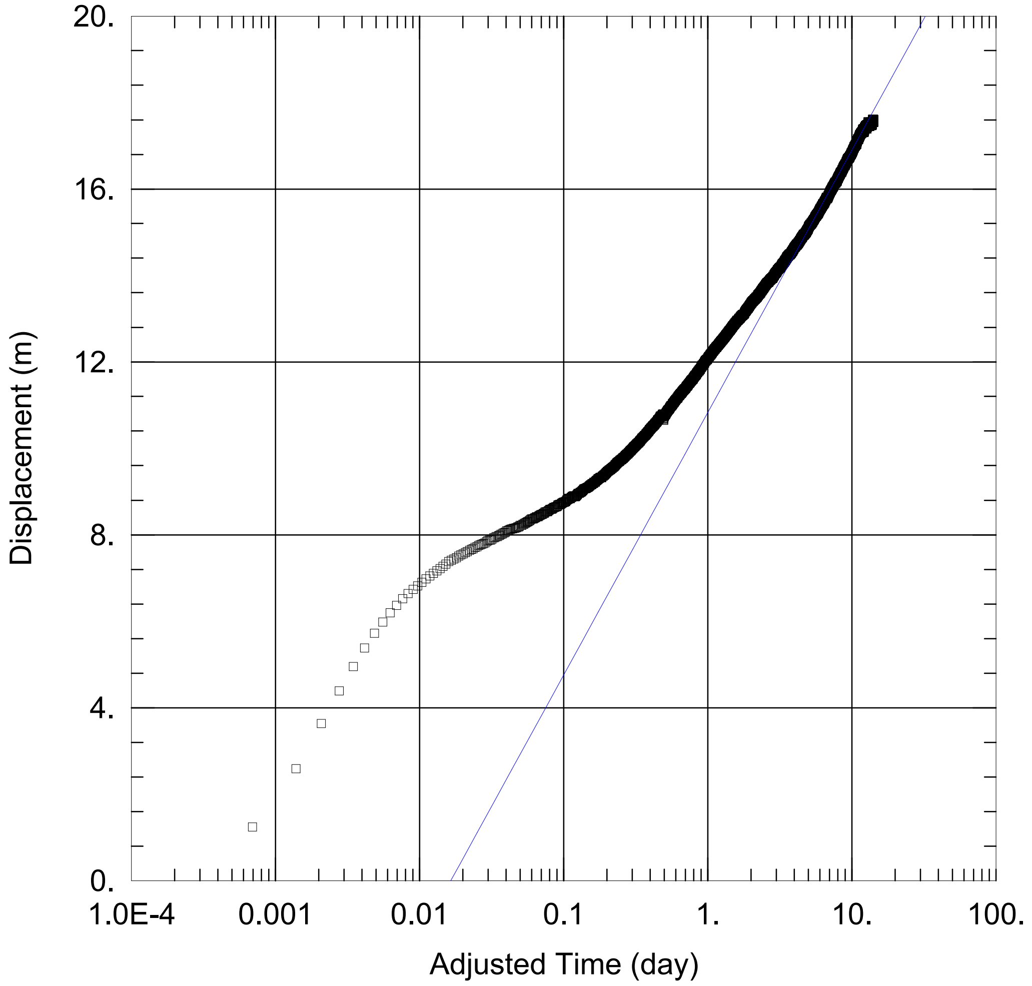
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

T = 33.47 m^2/day

S = 0.0005729



WELL TEST ANALYSIS

Data Set: I:\...\TMPB12.aqt
Date: 09/08/17 Time: 15:05:42

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile Lake
Test Well: TMPB12
Test Date: June 2017

AQUIFER DATA

Saturated Thickness: 11. m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TMPB12	233490.468	7256785.458

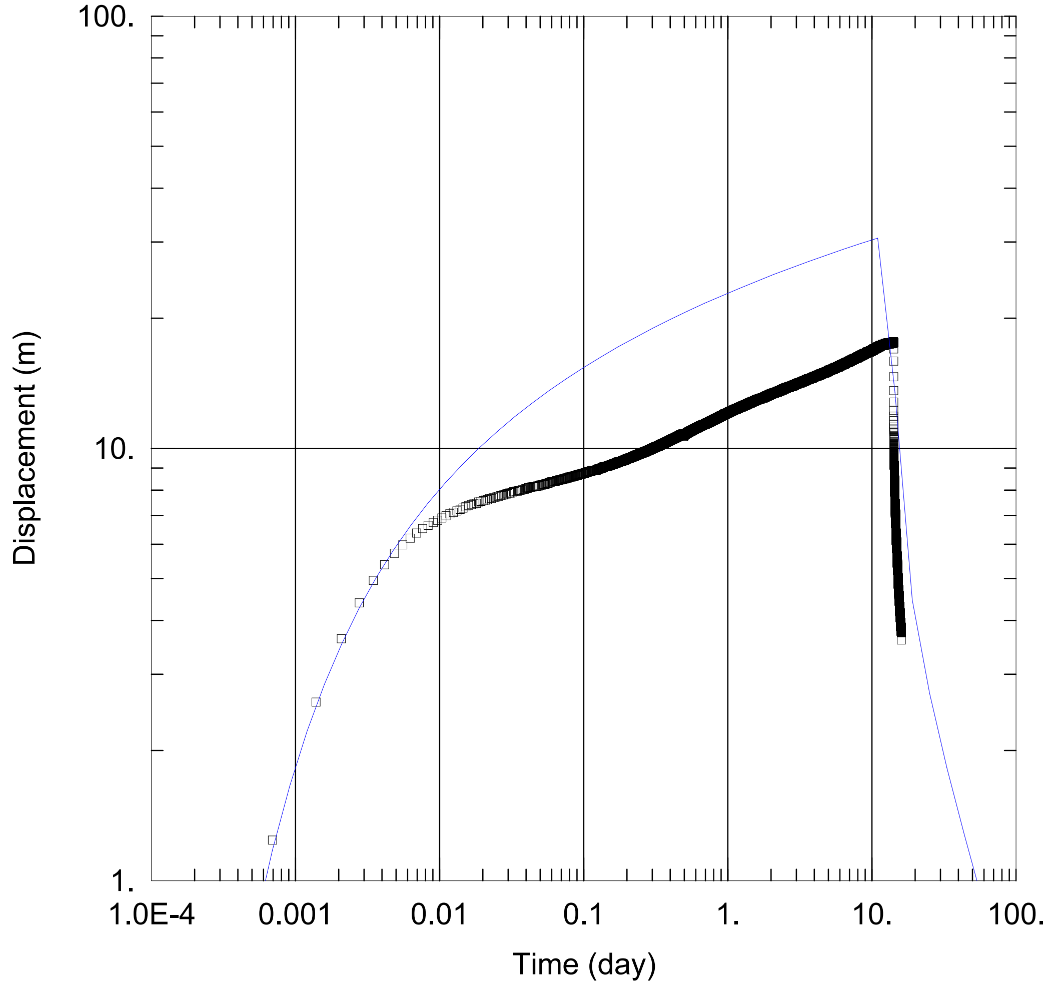
Observation Wells

Well Name	X (m)	Y (m)
□ TMAC12M1	233485.012	7256791.363

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Jacob

T = 31.28 m^2/day
S = 0.0179



WELL TEST ANALYSIS

Data Set:
Date: 09/08/17 Time: 14:20:16

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile Lake
Test Well: TMPB12
Test Date: June 2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TMPB12	233490.468	7256785.458

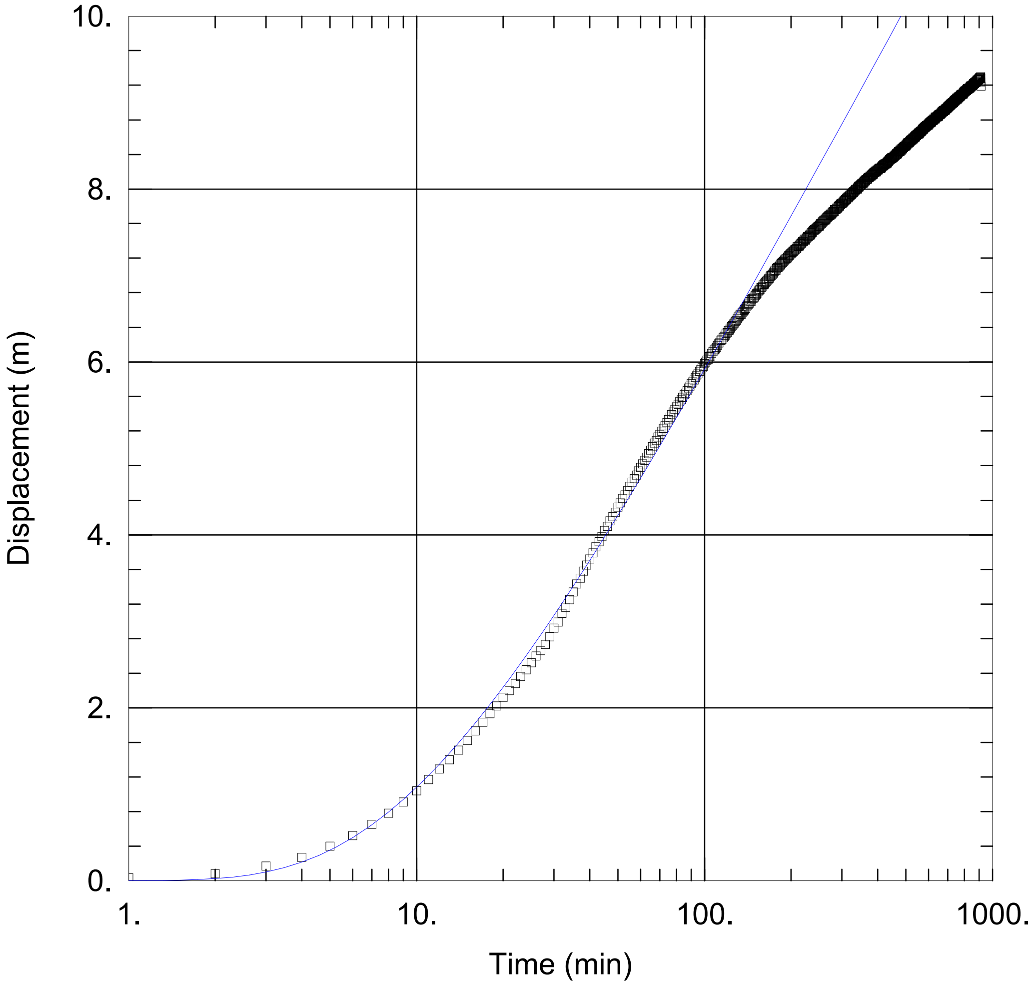
Observation Wells

Well Name	X (m)	Y (m)
□ TMAC12M1	233485.012	7256791.363

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 25.38 m^2/day
S = 0.0007793
Kz/Kr = 0.1
b = 11. m



TMPB26 CRT

Data Set:
Date: 06/02/17 Time: 12:56:17

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile Lake
Test Well: TMPB26
Test Date: 04/05/2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TMPB26	232842.91	7253036.6

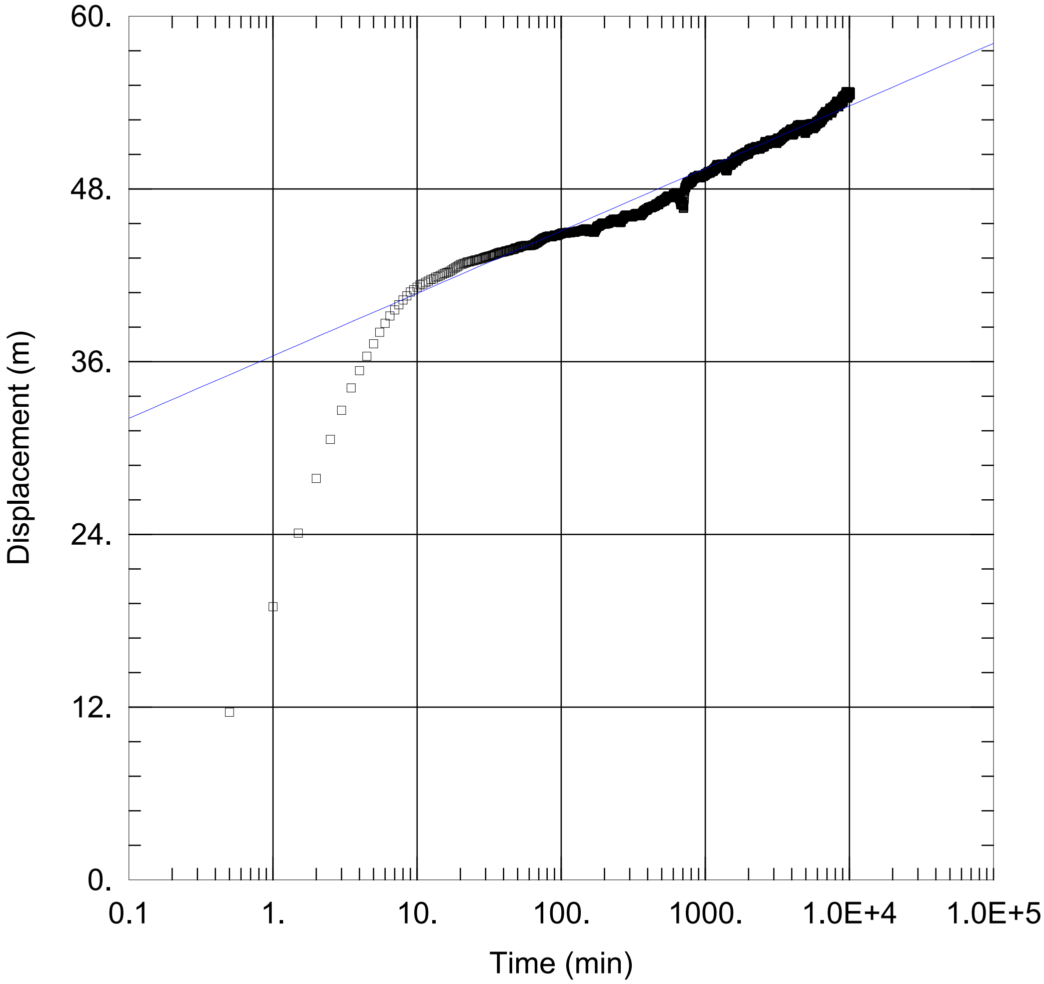
Observation Wells

Well Name	X (m)	Y (m)
□ TMAC26M1	232824.98	7253031.59

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 8.956 m^2/day
S = 0.0004752
Kz/Kr = 1.
b = 13. m



WELL TEST ANALYSIS

Data Set: C:\...\TMPB12.aqt
Date: 06/22/17 Time: 10:52:07

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile
Test Well: TMPB12
Test Date: 10/06/2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TMPB12	0	0

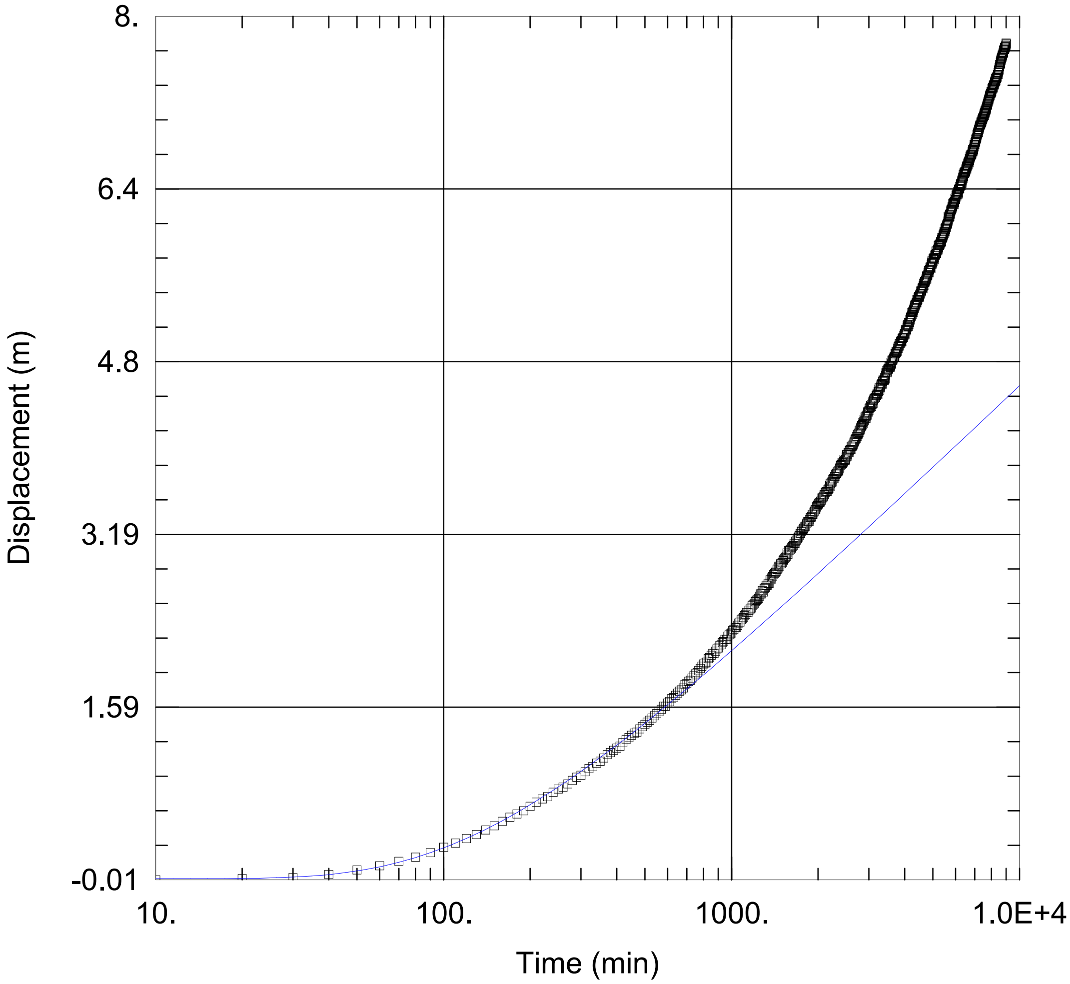
Observation Wells

Well Name	X (m)	Y (m)
□ TMPB12	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 43.76 m^2/day
S = 2.829E-8
Kz/Kr = 1.
b = 15. m



TMPB23 - CONSTANT RATE TEST

Data Set: I:\...\TMPB23 CRT TMAC22.aqt
Date: 05/31/17 Time: 15:17:16

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile Lake
Test Well: TMPB23
Test Date: 04/05/2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TMPB23	230917.705	7253521.88

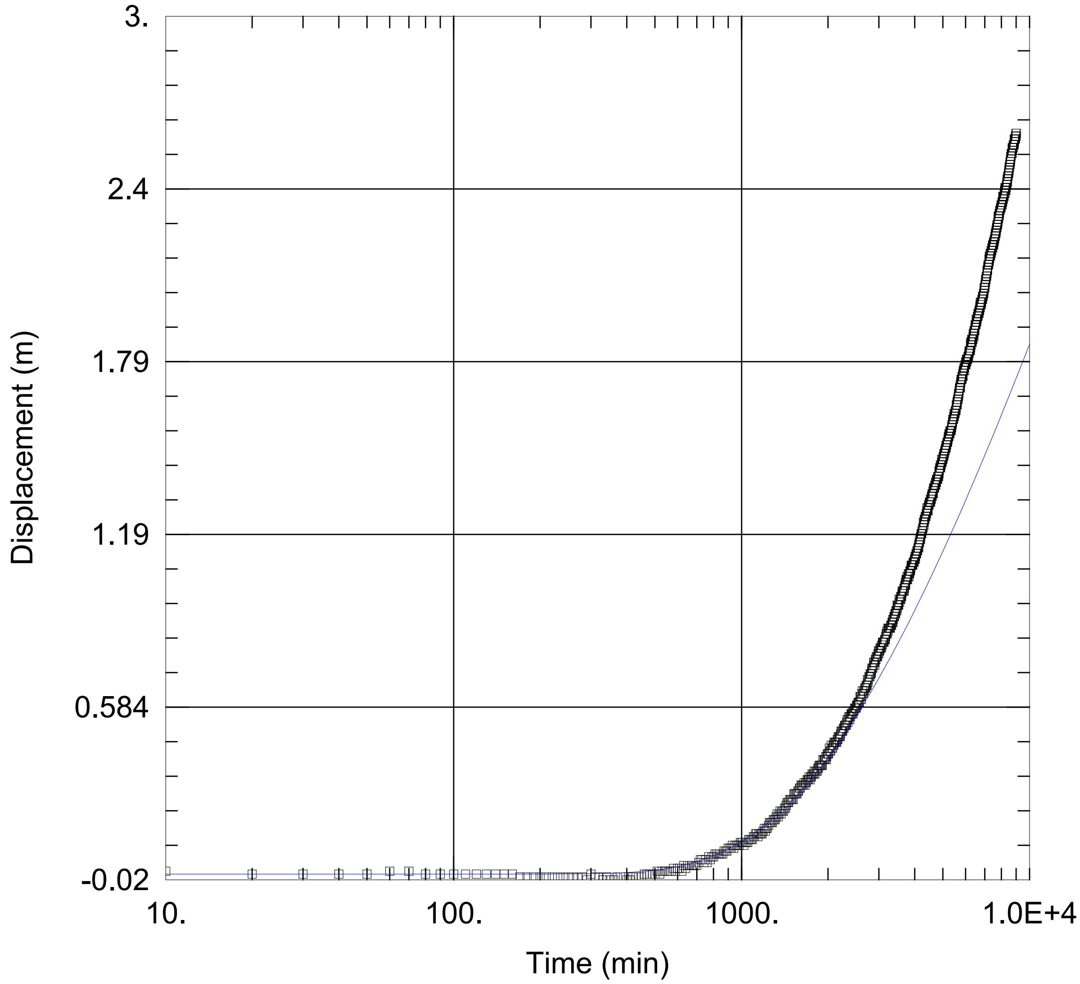
Observation Wells

Well Name	X (m)	Y (m)
□ TMAC11M1	230974.5	7253144.57

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 62.19 m^2/day
S = 0.0001075
Kz/Kr = 1.
b = 24. m



TMPB23 - CONSTANT RATE TEST

Data Set: I:\...\TMPB23 CRT.aqt
Date: 05/31/17 Time: 14:54:00

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile Lake
Test Well: TMPB23
Test Date: 04/05/2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TMPB23	230917.705	7253521.88

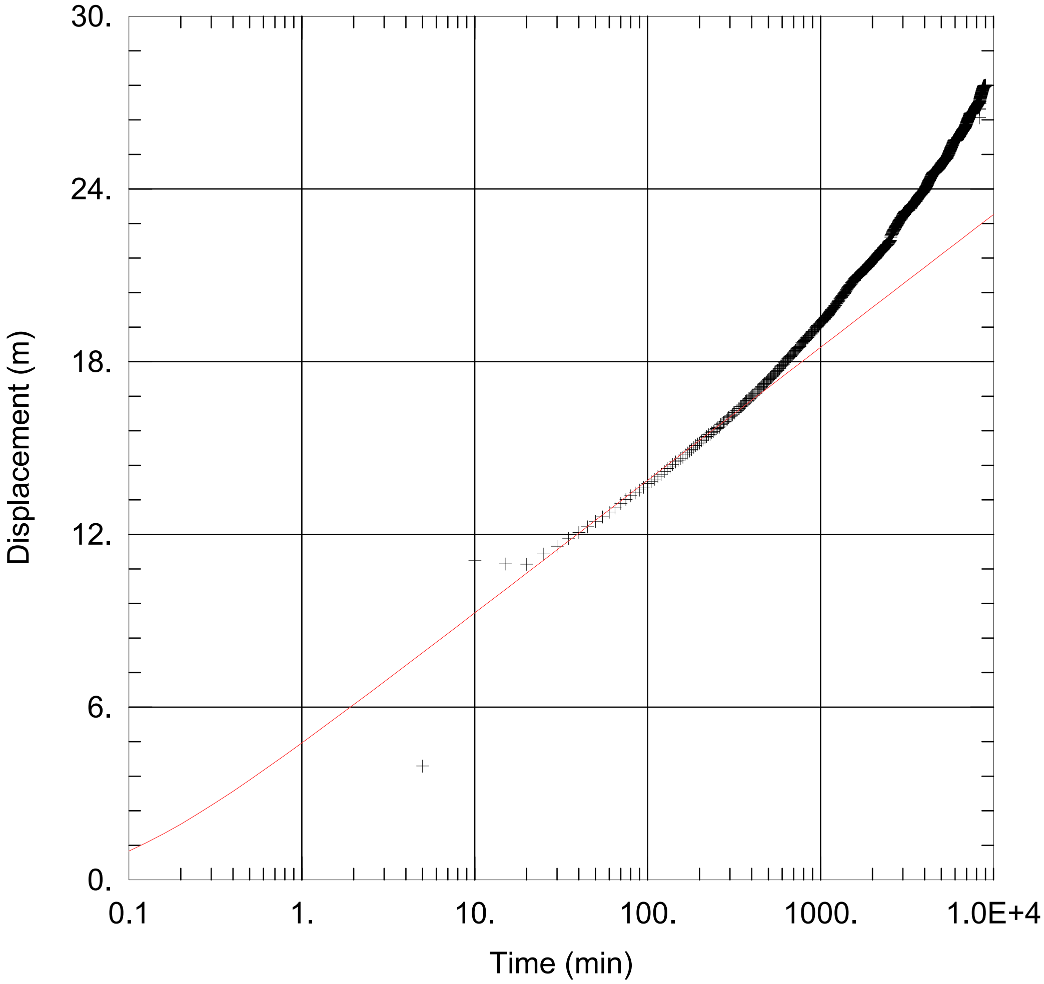
Observation Wells

Well Name	X (m)	Y (m)
□ TMAC22M1	230515.94	7254835.89

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 52.28 m^2/day
S = 0.0001232
Kz/Kr = 1.
b = 24. m



TMPB23 - CONSTANT RATE TEST

Data Set: I:\...\TMPB23 CRT.aqt
Date: 05/30/17 Time: 14:27:30

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile Lake
Test Well: TMPB23
Test Date: 04/05/2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TMPB23	230917.705	7253521.88

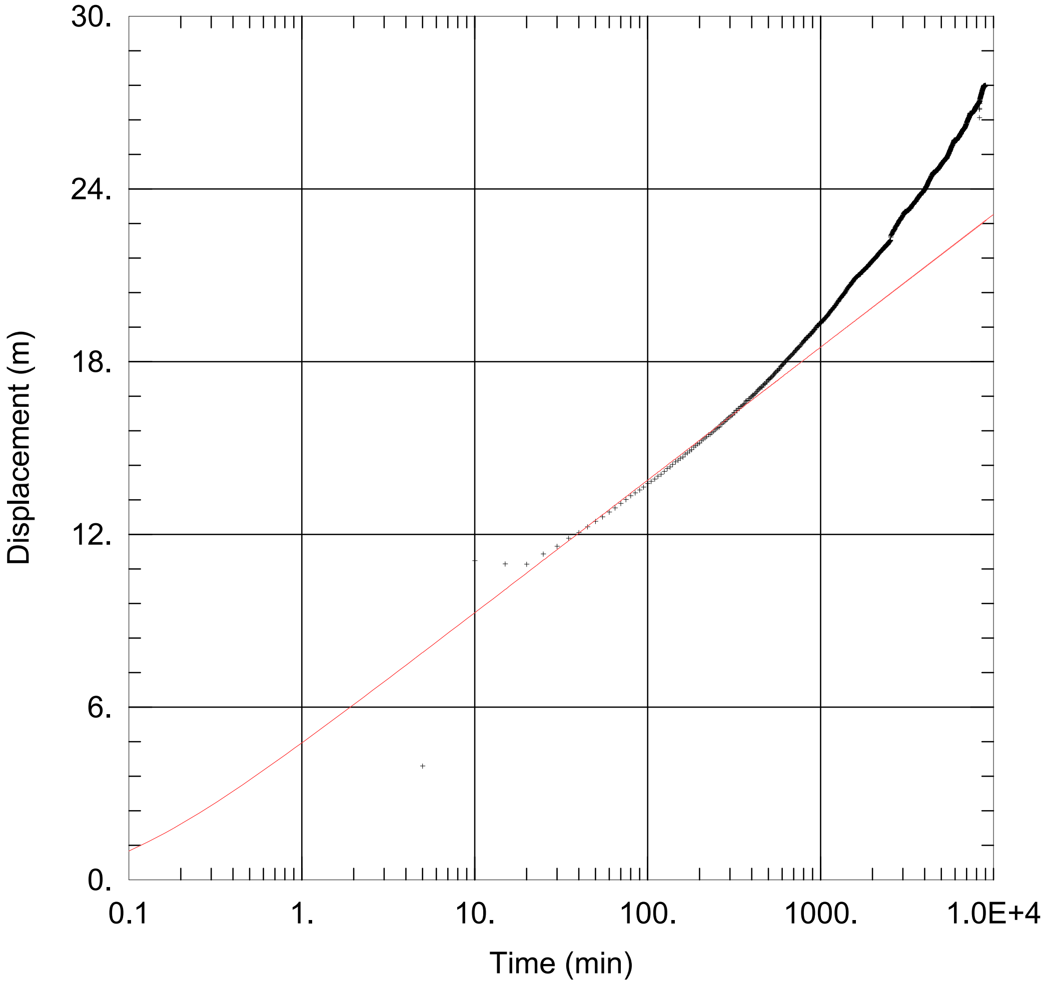
Observation Wells

Well Name	X (m)	Y (m)
+ TMAC23M1	230934.474	7253522.728

SOLUTION

Aquifer Model: Confined Solution Method: Theis

T = 34.28 m^2/day
S = 1.875E-5
Kz/Kr = 1.
b = 24. m



TMPB23 - CONSTANT RATE TEST

Data Set: I:\...\TMPB23 CRT.aqt

Date: 05/30/17 Time: 14:12:49

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile Lake
Test Well: TMPB23
Test Date: 04/05/2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TMPB23	230917.705	7253521.88

Observation Wells

Well Name	X (m)	Y (m)
+ TMAC23M1	230934.474	7253522.72

SOLUTION

Aquifer Model: Confined

Solution Method: Theis

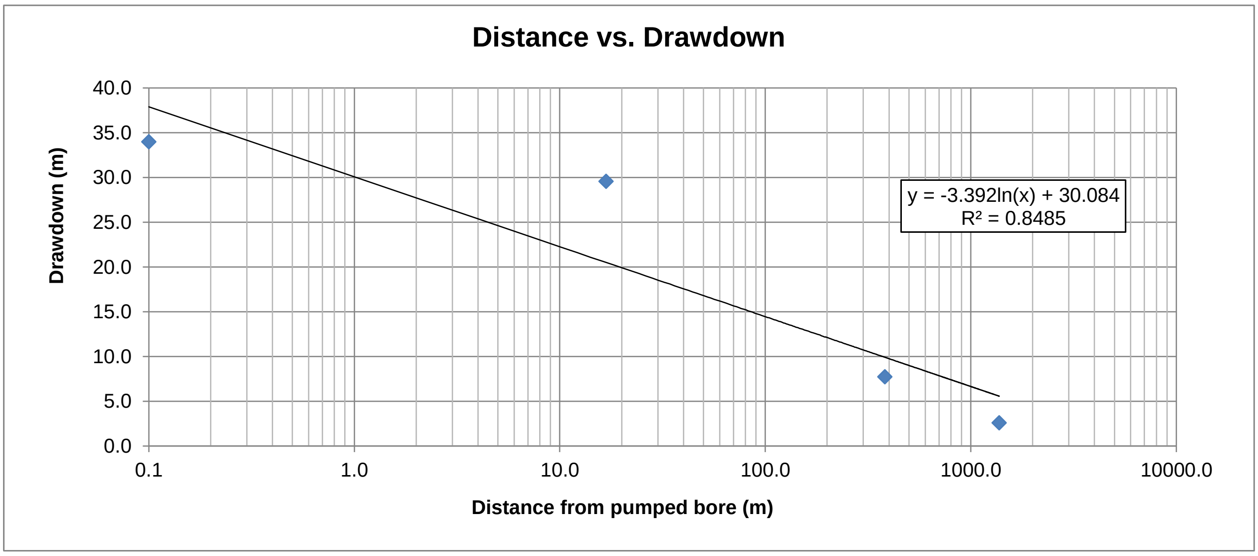
T = 34.28 m^2/day

S = 1.875E-5

Kz/Kr = 1.

b = 24. m

Thiem Analysis - Distance/Drawdown - TMPB23



Bore Name	Distance (m)	Drawdown (m)
TMPB23	0.1	34
TMAC23M1	16.8	29.57
TMAC11M1	381.6	7.75
TMAC22M1	1374.1	2.59

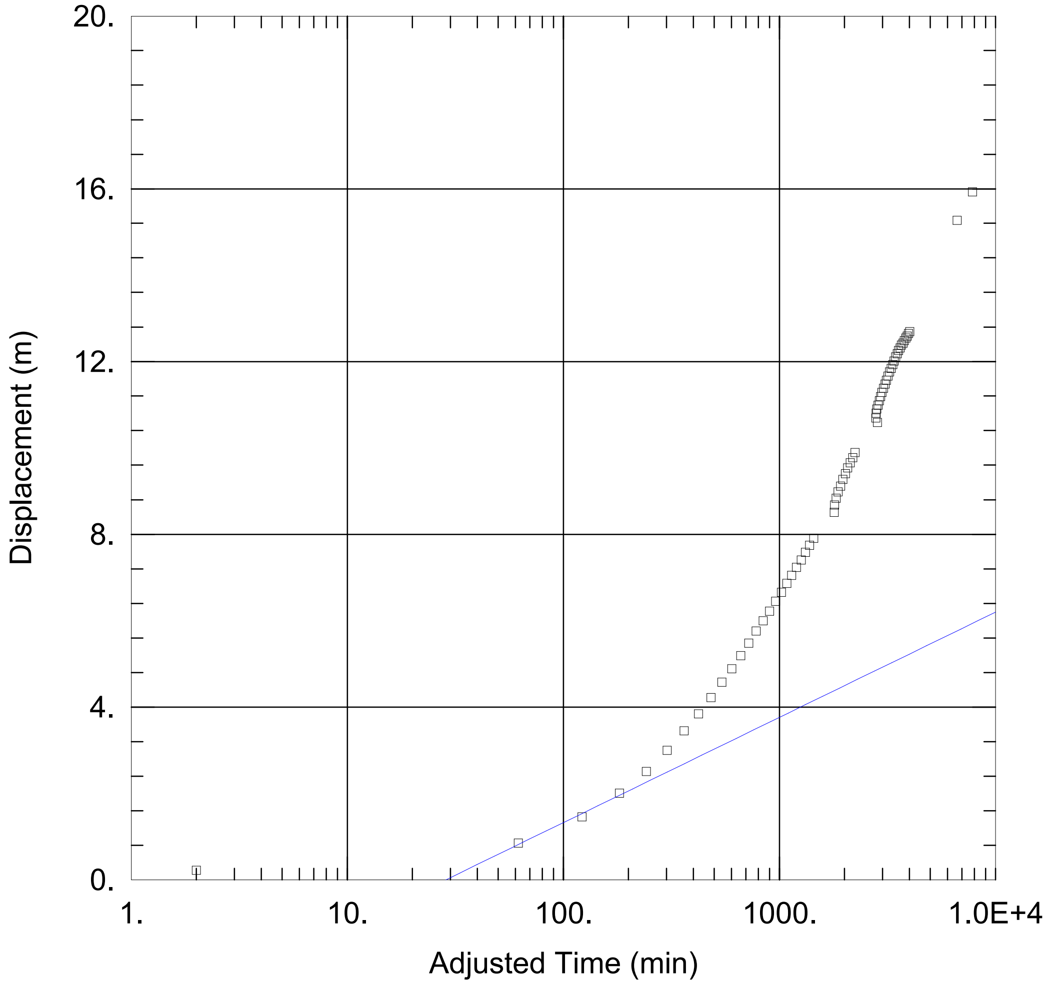
- (assumed from well losses)

Thiem Equation

$$s - s_0 = \left(\frac{Q}{2\pi Kb}\right) ln\left(\frac{r_0}{r}\right)$$

Assumes steady state conditions.

Production Bore		TMPB23	
Pump Rate		10	L/s
Time Pumped		150	hrs
Pump Rate	Q	864	m3/d
Aquifer Thickness	B	24	m
loglin gradient	m	-3.392	From graph
loglin intercept	c	30.084	From graph
Drawdown	Δs	7.81	m
Transmissivity	T	40.49	m2/d
Hydraulic Conductivity	K	1.69	m/d



WB10 - VARIABLE RATE TEST

Data Set: I:\...\WB10 CoopJacTMAC12M1.aqt
Date: 06/02/17 Time: 11:30:01

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile Lake
Test Well: WB10
Test Date: 04/05/2017

AQUIFER DATA

Saturated Thickness: 11. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
WB10	233477.25	7257243.57

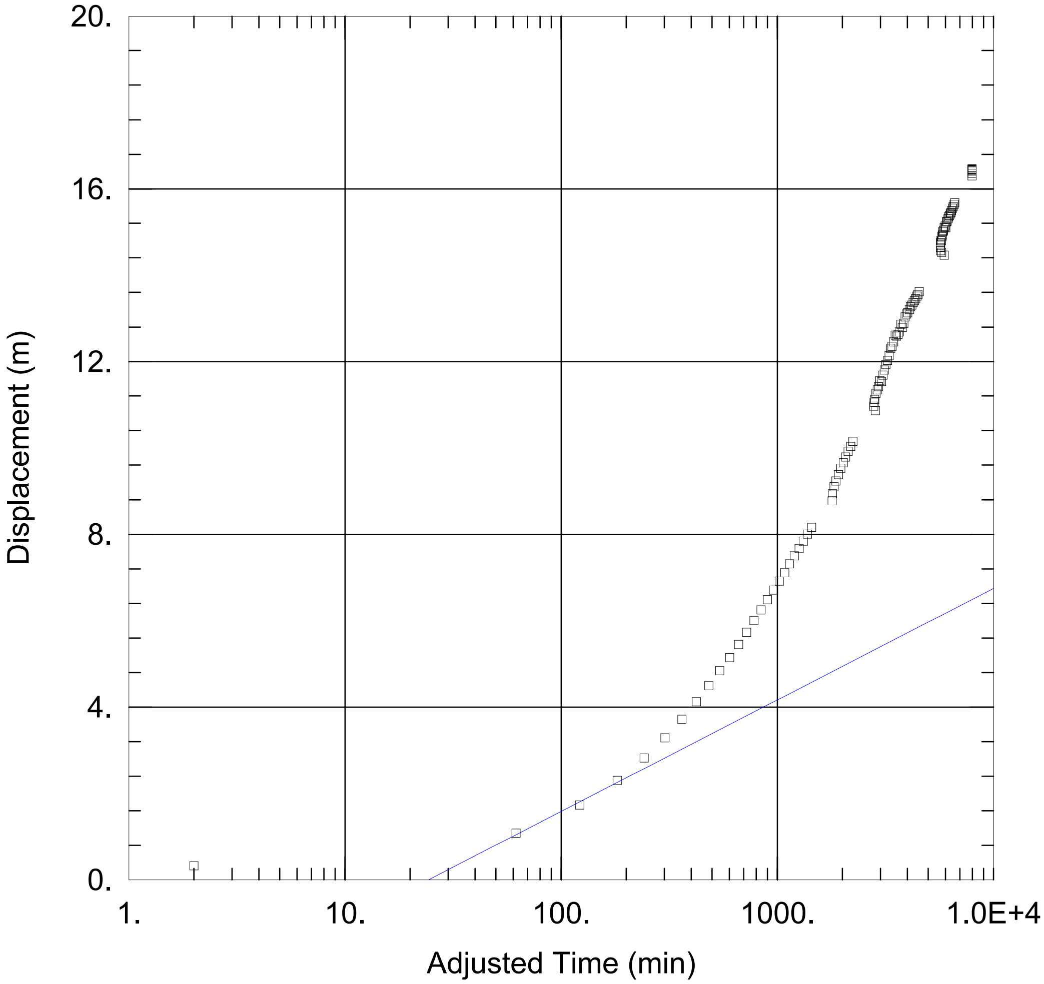
Observation Wells

Well Name	X (m)	Y (m)
□ TMAC12M1	233485.01	7256791.36

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob

T = 168. m^2/day S = 3.667E-5



WB10 - CONSTANT RATE TEST

Data Set: I:\...\WB10 CRT TMAC13M1.aqt
Date: 06/02/17 Time: 11:37:17

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile Lake
Test Well: WB10
Test Date: 04/05/2017

AQUIFER DATA

Saturated Thickness: 11. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
New Well	233477.25	7257243.57

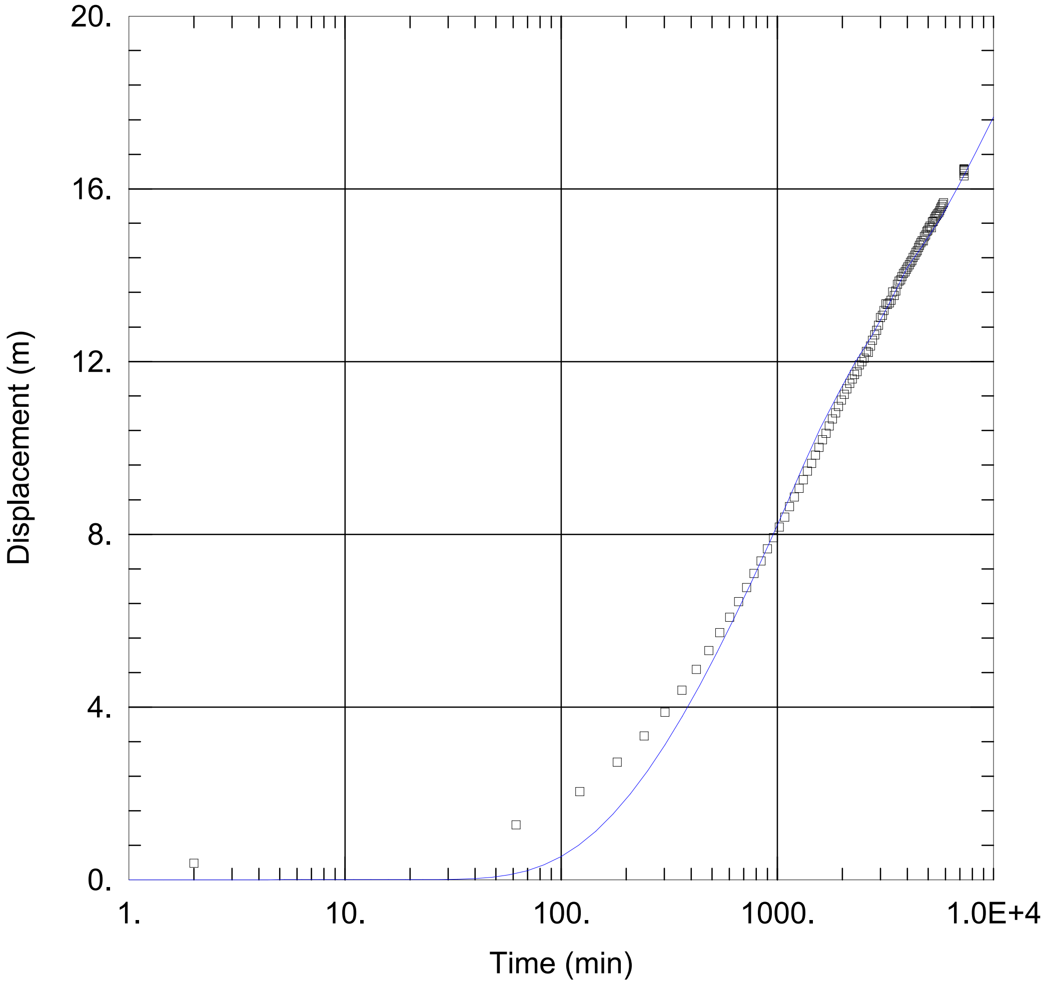
Observation Wells

Well Name	X (m)	Y (m)
□ TMAC13M1	233485.67	7256939.23

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob

T = 158.5 m^2/day S = 6.506E-5



WB10 - CONSTANT RATE TEST

Data Set:
Date: 06/01/17 Time: 11:08:08

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile Lake
Test Well: WB10
Test Date: 04/05/2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
New Well	233477.25	7257243.57

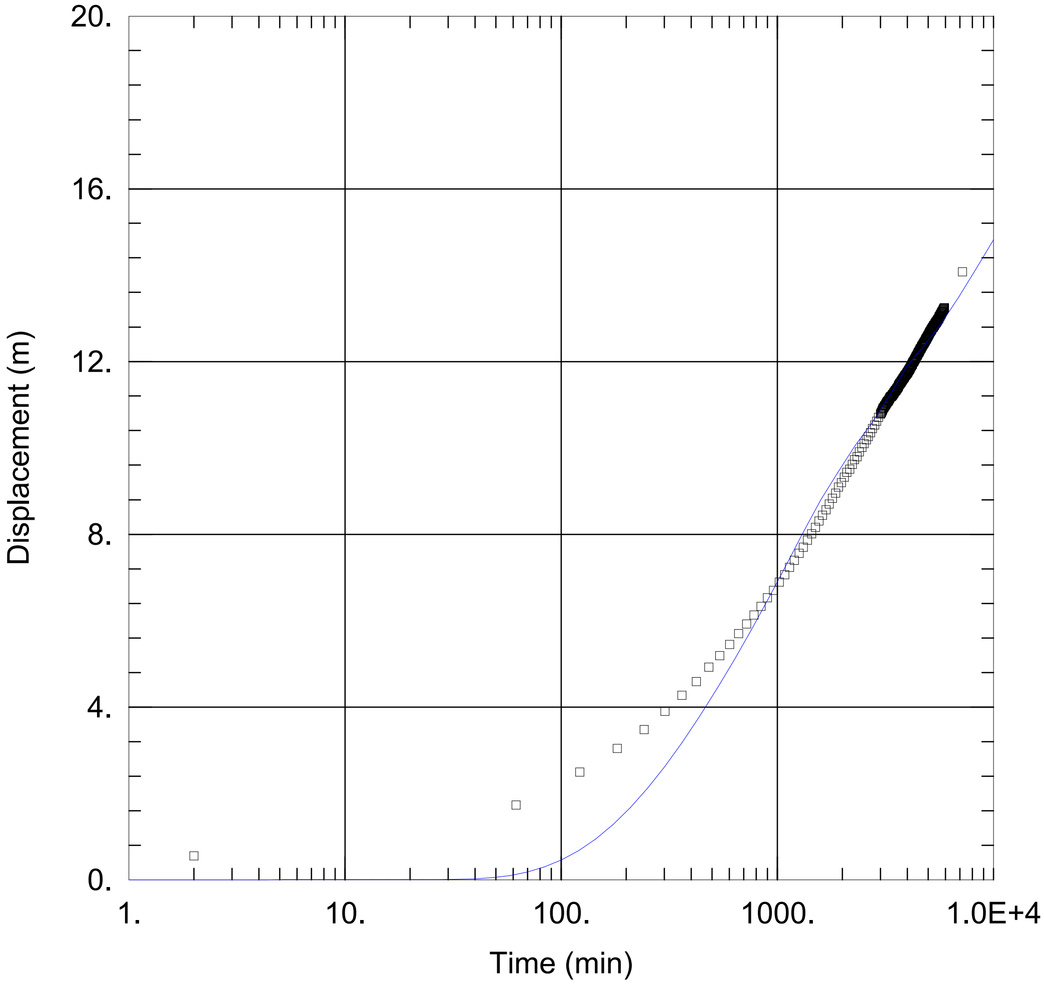
Observation Wells

Well Name	X (m)	Y (m)
□ TMAC13M1	233485.67	7256939.23

SOLUTION

Aquifer Model: Confined Solution Method: Theis

T = 36.92 m^2/day S = 0.00017
Kz/Kr = 1. b = 11. m



WB10 - CONSTANT RATE TEST

Data Set: I:\...\WB10 CRT TMAC14M1.aqt
Date: 06/01/17 Time: 11:45:31

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile Lake
Test Well: WB10
Test Date: 04/05/2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
WB10	233477.25	7257243.57

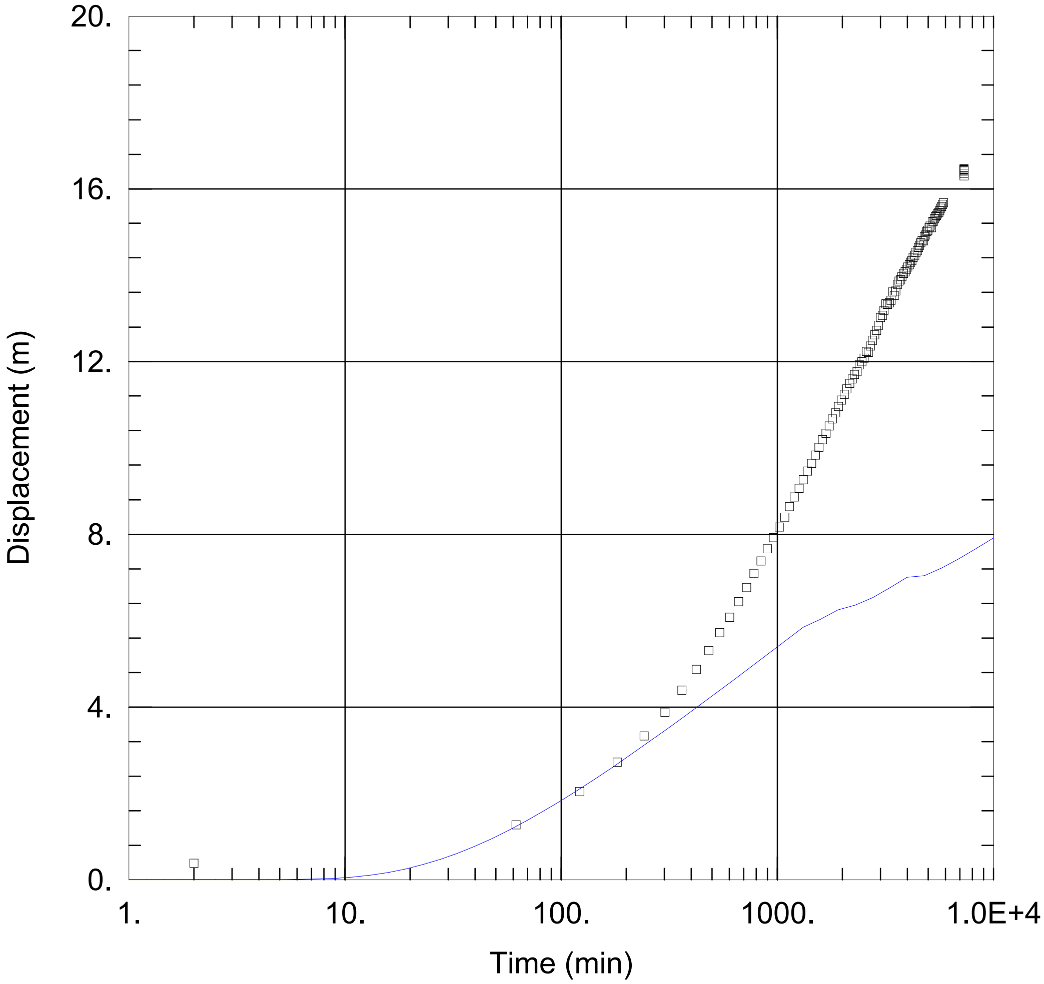
Observation Wells

Well Name	X (m)	Y (m)
□ TMAC14M1	233452.94	7257458.16

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 44.03 m^2/day
S = 0.0004018
Kz/Kr = 1.
b = 11. m



WB10 - CONSTANT RATE TEST

Data Set: I:\...\WB10 CRT TMAC13M1.aqt
Date: 06/02/17 Time: 11:34:40

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile Lake
Test Well: WB10
Test Date: 04/05/2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
New Well	233477.25	7257243.57

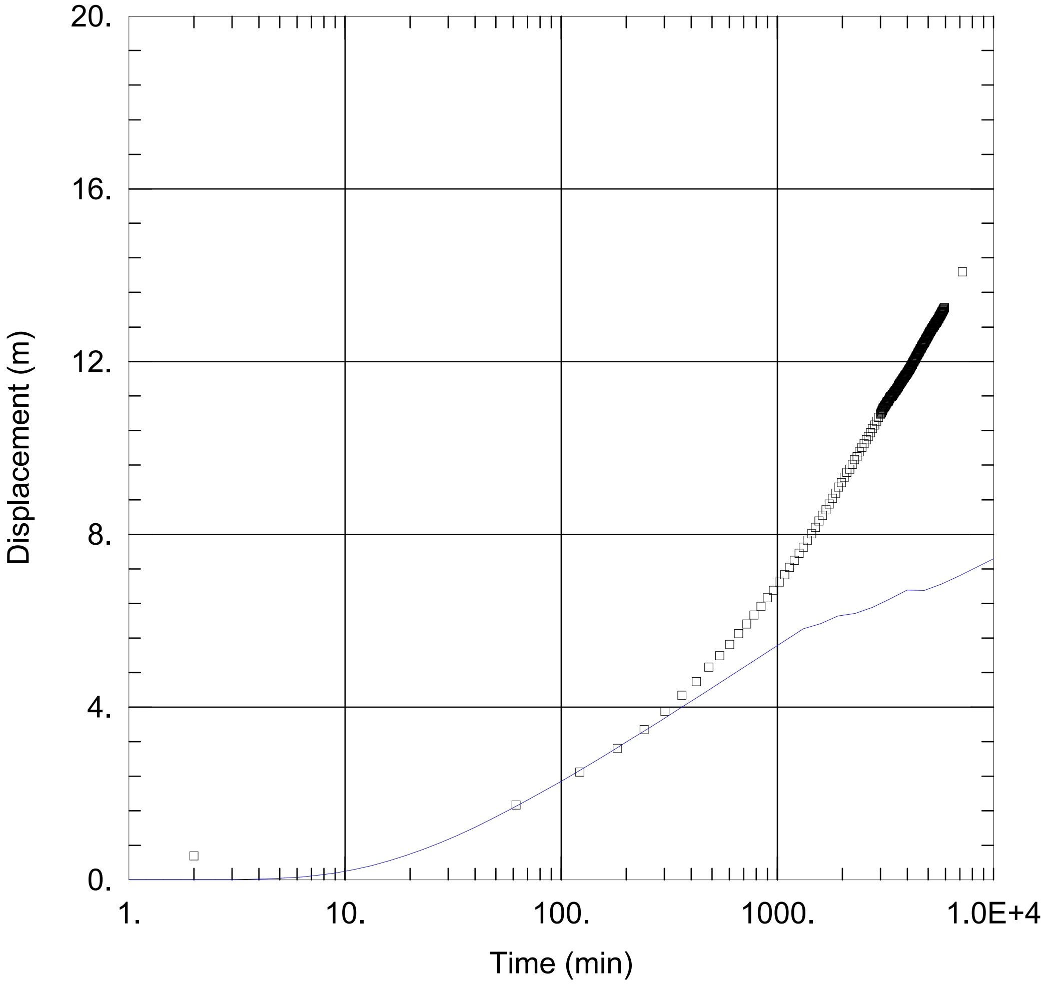
Observation Wells

Well Name	X (m)	Y (m)
□ TMAC13M1	233485.67	7256939.23

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 124.1 m^2/day
S = 8.832E-5
Kz/Kr = 1.
b = 11. m



WB10 - CONSTANT RATE TEST

Data Set: I:\...\WB10 CRT TMAC14M1.aqt
Date: 06/02/17 Time: 11:43:20

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile Lake
Test Well: WB10
Test Date: 04/05/2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
WB10	233477.25	7257243.57

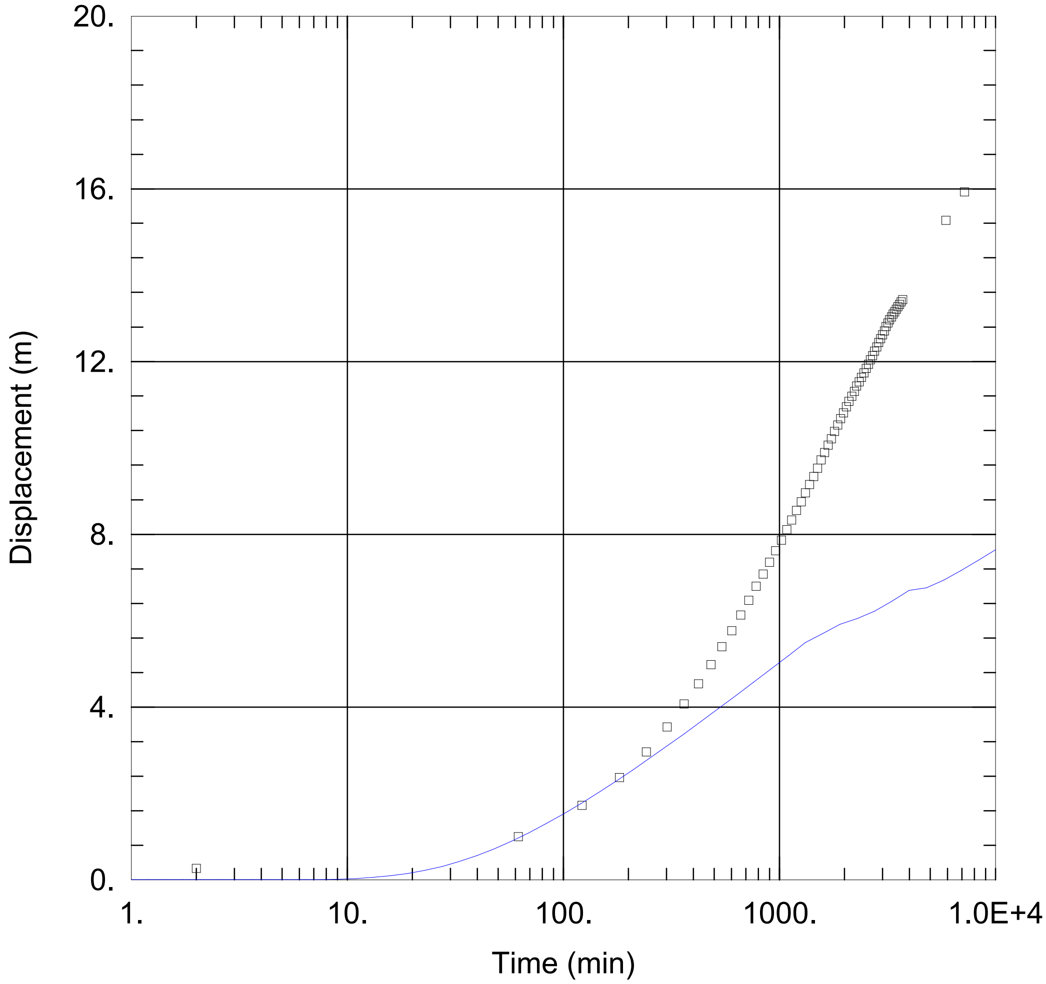
Observation Wells

Well Name	X (m)	Y (m)
□ TMAC14M1	233452.94	7257458.16

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 146.5 m^2/day
S = 0.0001131
Kz/Kr = 1.
b = 11. m



WB10 - VARIABLE RATE TEST

Data Set: I:\...\WB10 CoopJacTMAC12M1.aqt
Date: 06/02/17 Time: 11:28:52

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile Lake
Test Well: WB10
Test Date: 04/05/2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
WB10	233477.25	7257243.57

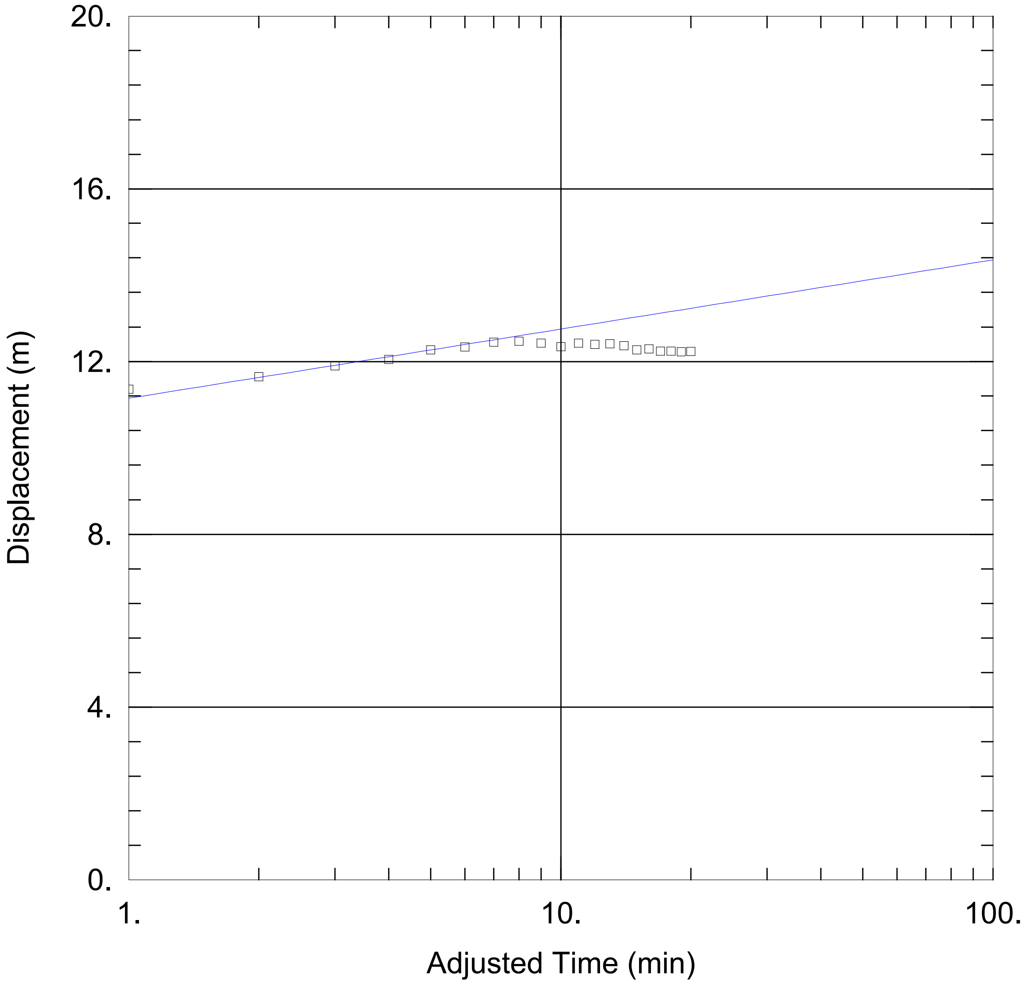
Observation Wells

Well Name	X (m)	Y (m)
□ TMAC12M1	233485.01	7256791.36

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 122.6 m^2/day
S = 5.111E-5
Kz/Kr = 1.
b = 11. m



WELL TEST ANALYSIS

Data Set:
Date: 06/02/17 Time: 16:41:02

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile Lake
Test Well: TMPB12
Test Date: 22/04/2017

AQUIFER DATA

Saturated Thickness: 7. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
WB12TB2	233890.64	7253948.36

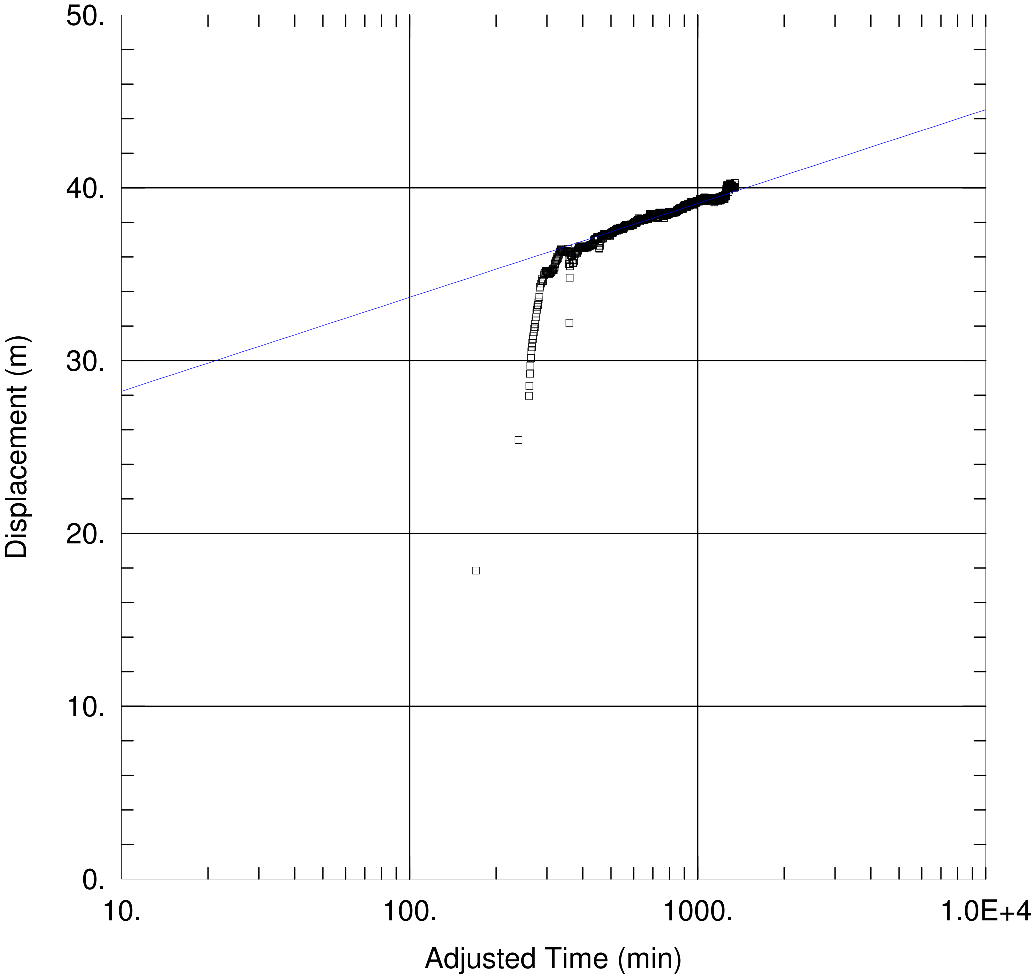
Observation Wells

Well Name	X (m)	Y (m)
□ WB12TB2	233890.64	7253948.36

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob

T = 12.35 m^2/day S = 3.393E-8



SUNSHINE-SSAC18 - CONSTANT RATE TEST

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: SunShine Lakes
Test Well: SSAC18
Test Date: 15/08/2017

AQUIFER DATA

Saturated Thickness: 11. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSAC18	261021.822	7275999.337

Observation Wells

Well Name	X (m)	Y (m)
□ SSAC18	261021.822	7275999.337

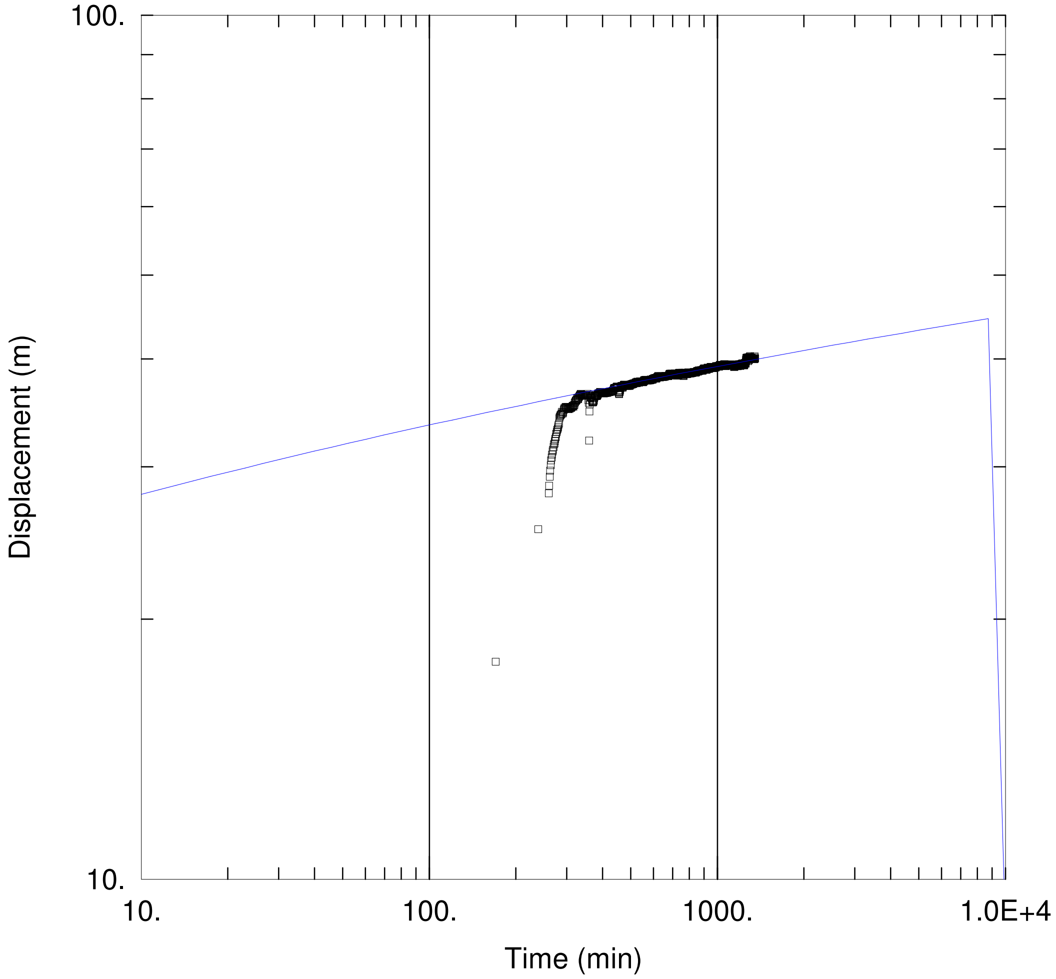
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

T = 29.16 m^2/day

S = 0.0002885



SUNSHINE-SSAC18 - CONSTANT RATE TEST

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: SunShine Lakes
Test Well: SSAC18
Test Date: 15/08/2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSAC18	261021.822	7275999.337

Observation Wells

Well Name	X (m)	Y (m)
□ SSAC18	261021.822	7275999.337

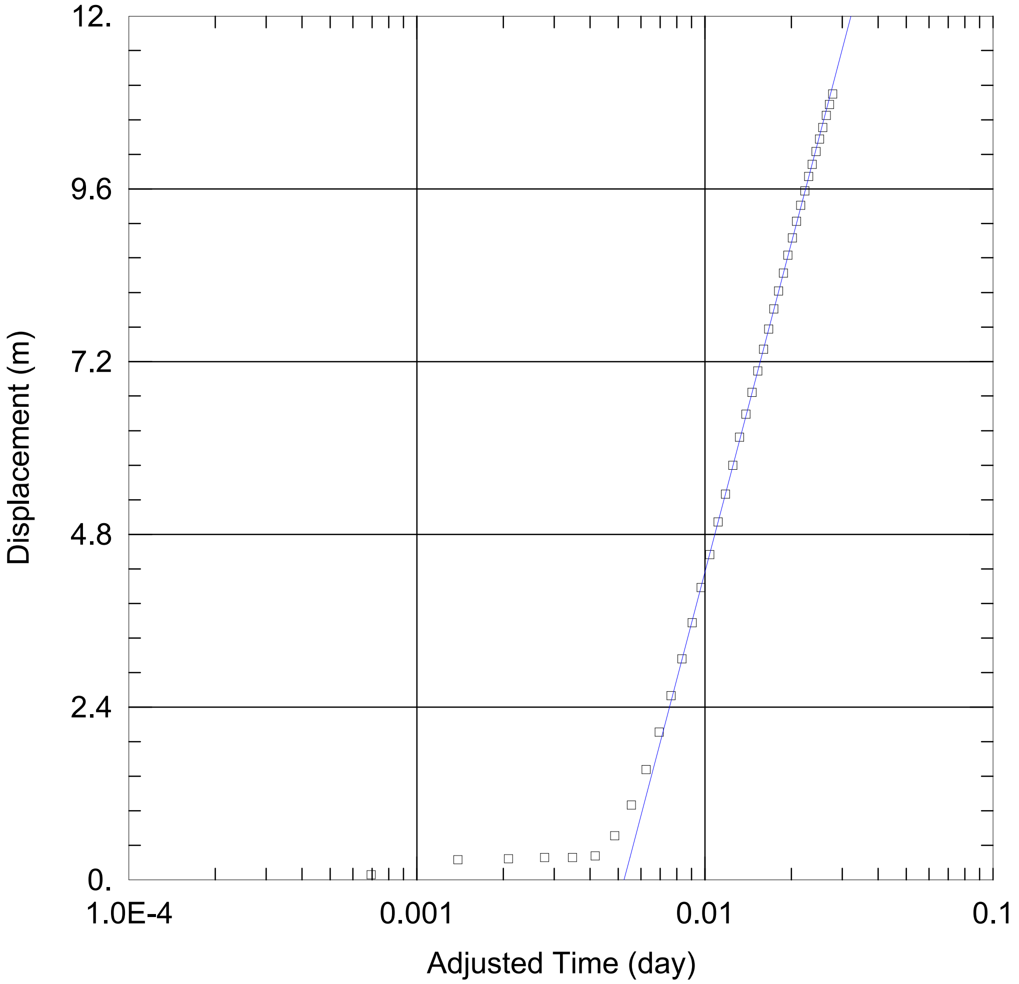
SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 27.94 m^2/day
Kz/Kr = 1.

S = 0.0005241
b = 11. m



SSPB18 CRT

Data Set: I:\...\SSAC18M1 Theis.aqt
Date: 09/10/17 Time: 11:18:11

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile Lake
Test Well: SSPB18
Test Date: July 2017

AQUIFER DATA

Saturated Thickness: 10. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSPB18	261021.822	7275999.337

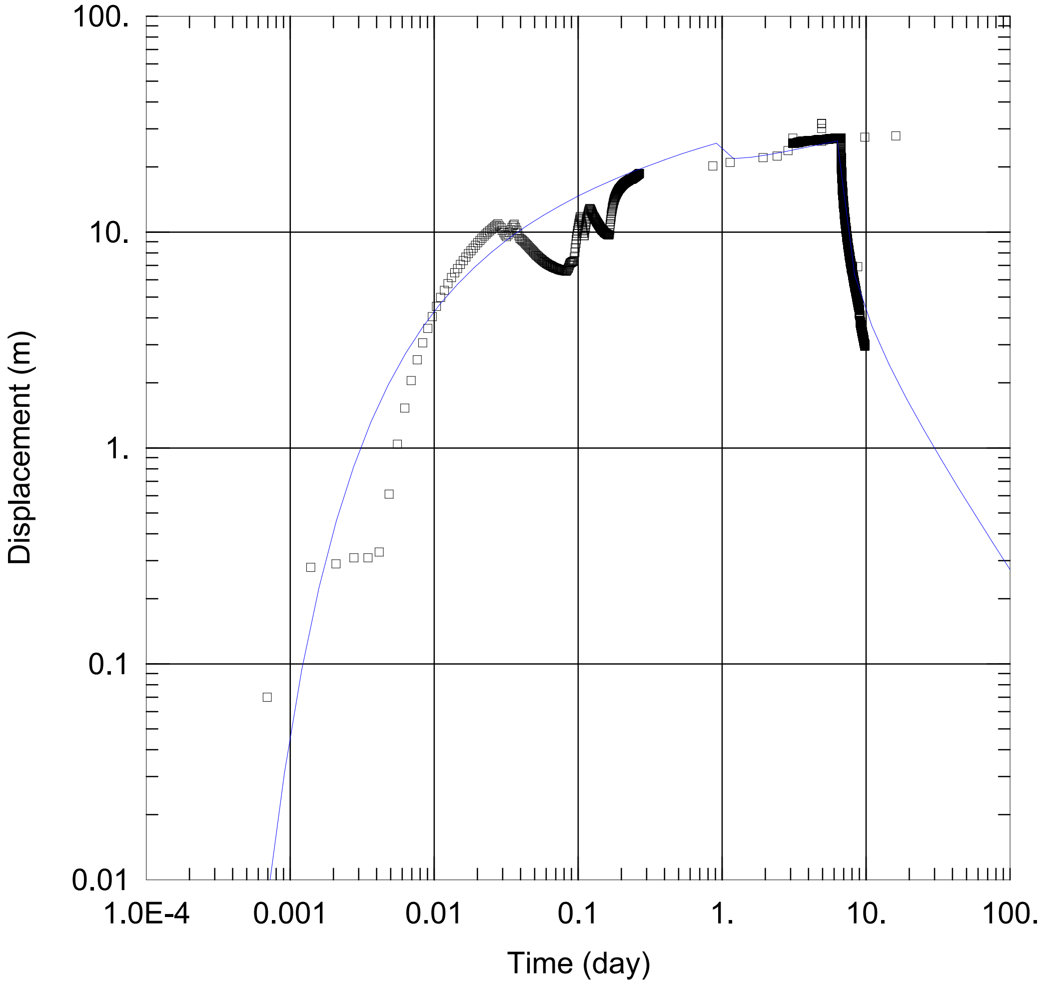
Observation Wells

Well Name	X (m)	Y (m)
□ SSAC18M1	261061.818	7276001.668

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob

T = 15.58 m^2/day S = 0.0001143



SSPB18 CRT

Data Set:
Date: 09/10/17 Time: 11:11:40

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: 10 Mile Lake
Test Well: SSPB18
Test Date: July 2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSPB18	261021.822	7275999.337

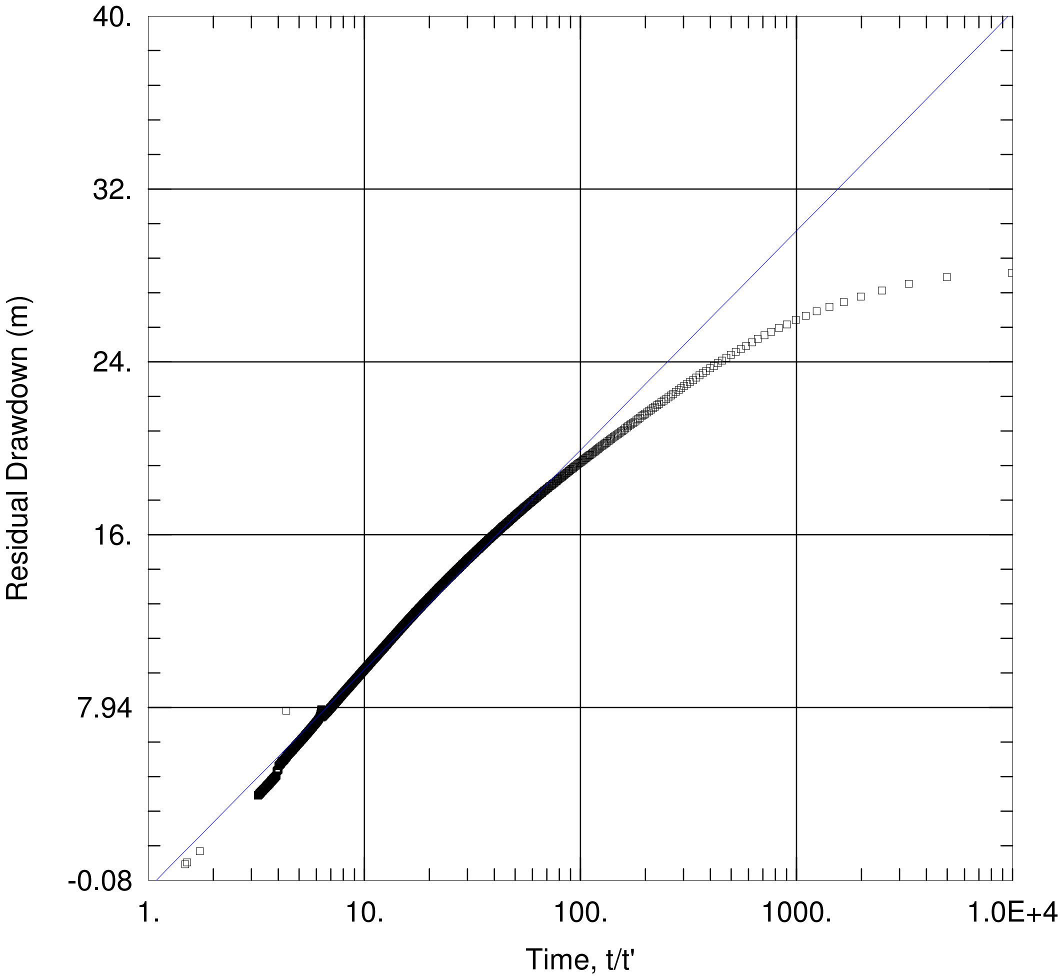
Observation Wells

Well Name	X (m)	Y (m)
□ SSAC18M1	261061.818	7276001.668

SOLUTION

Aquifer Model: Confined Solution Method: Theis

T = 20.2 m^2/day
S = 0.0001654
Kz/Kr = 1.
b = 10. m



SUNSHINE-SSAC18 - CONSTANT RATE TEST

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: SunShine Lakes
Test Well: SSAC18
Test Date: 15/08/2017

AQUIFER DATA

Saturated Thickness: 18. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSAC18	261021.822	7275999.337

Observation Wells

Well Name	X (m)	Y (m)
□ M1	261026.822	7275999.337

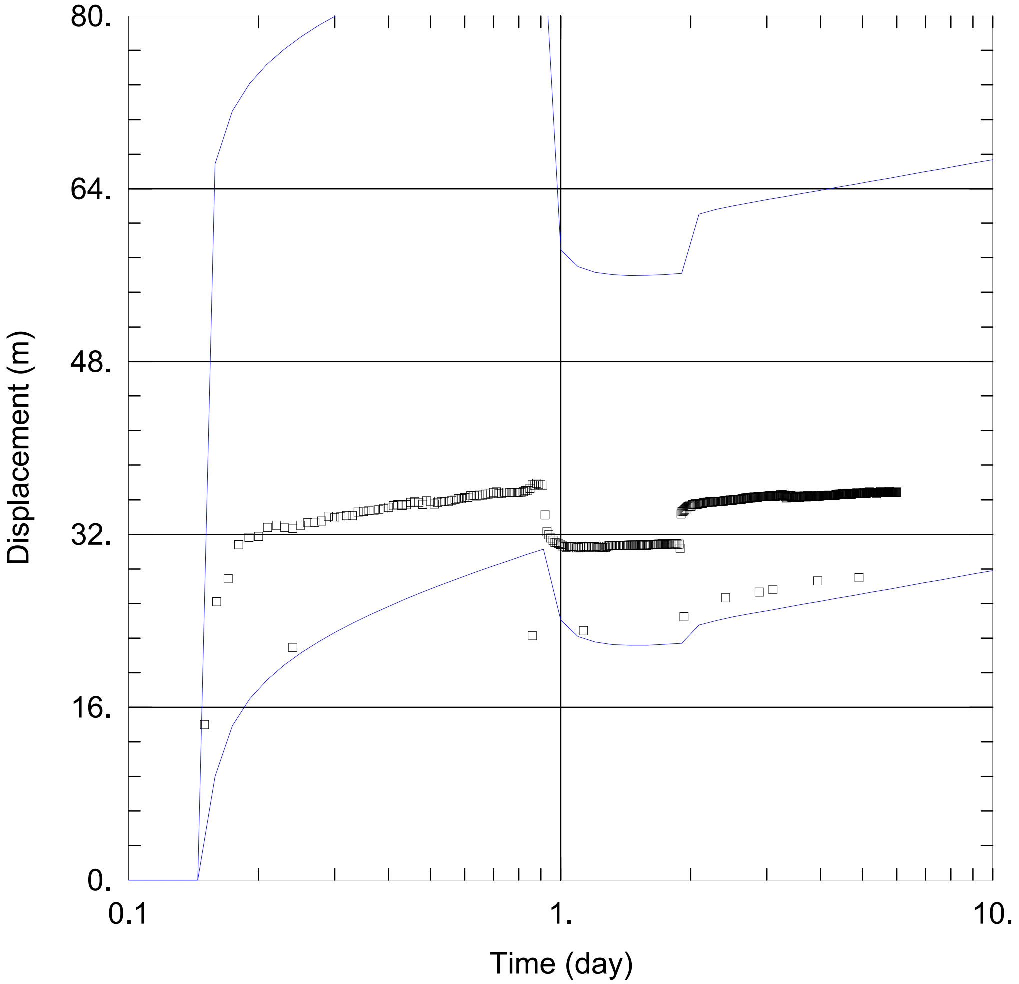
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

T = 15.58 m^2/day

S/S' = 1.109



WELL TEST ANALYSIS

Data Set:
Date: 08/23/17 Time: 09:58:27

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: Sunshine
Test Well: SSPB18

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSPB18	261021.822	7275999.337

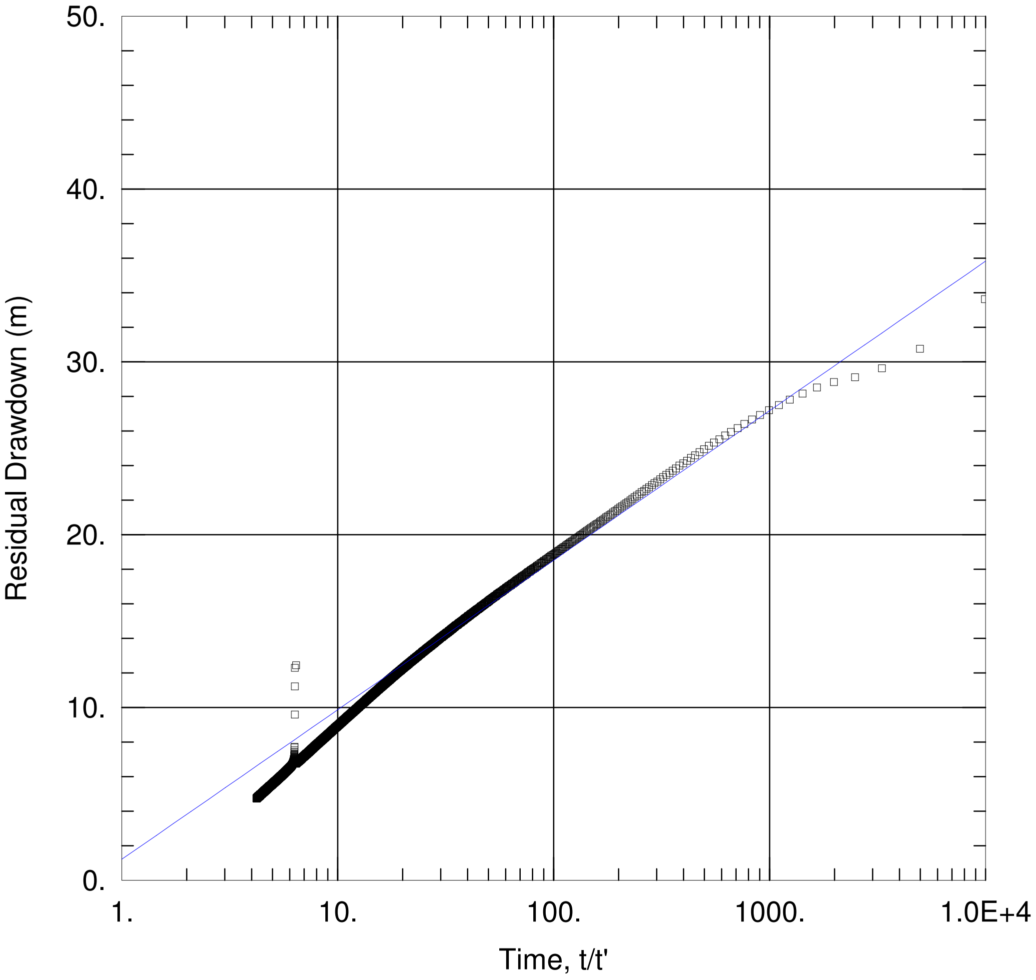
Observation Wells

Well Name	X (m)	Y (m)
□ SSPB18	261021.822	7275999.337
□ New Well	261061.818	7276001.668

SOLUTION

Aquifer Model: Confined Solution Method: Theis

T = 21.66 m^2/day
S = 3.711E-5
Kz/Kr = 0.1
b = 10. m



SUNSHINE-SSAC18 - CONSTANT RATE TEST

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: SunShine Lakes
Test Well: SSAC18
Test Date: 15/08/2017

AQUIFER DATA

Saturated Thickness: 18. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSAC18	261021.822	7275999.337

Observation Wells

Well Name	X (m)	Y (m)
□ SSAC18	261021.822	7275999.337

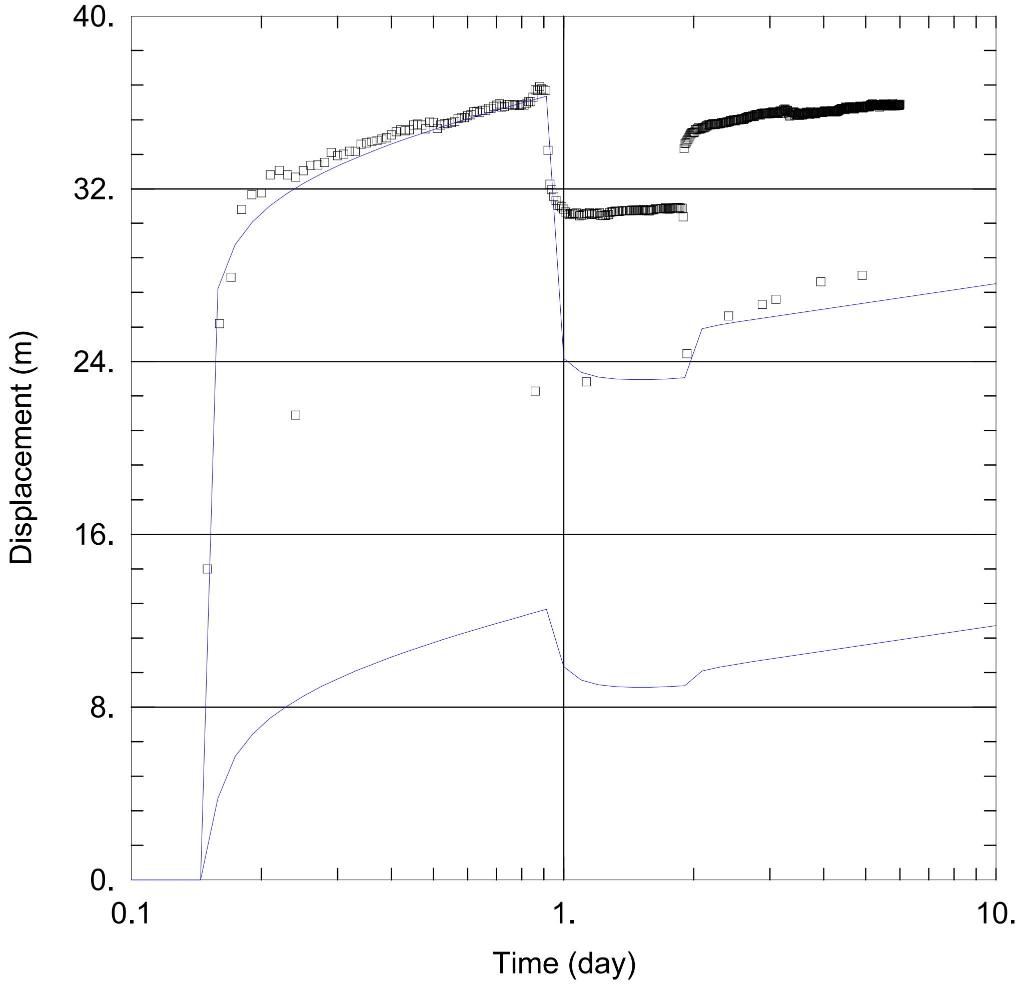
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

T = 18.3 m^2/day

S/S' = 0.7257



WELL TEST ANALYSIS

Data Set:
Date: 08/23/17

Time: 10:00:41

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: Sunshine
Test Well: SSPB18

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSPB18	261021.822	7275999.337

Observation Wells

Well Name	X (m)	Y (m)
□ SSPB18	261021.822	7275999.337
□ New Well	261061.818	7276001.668

SOLUTION

Aquifer Model: Confined

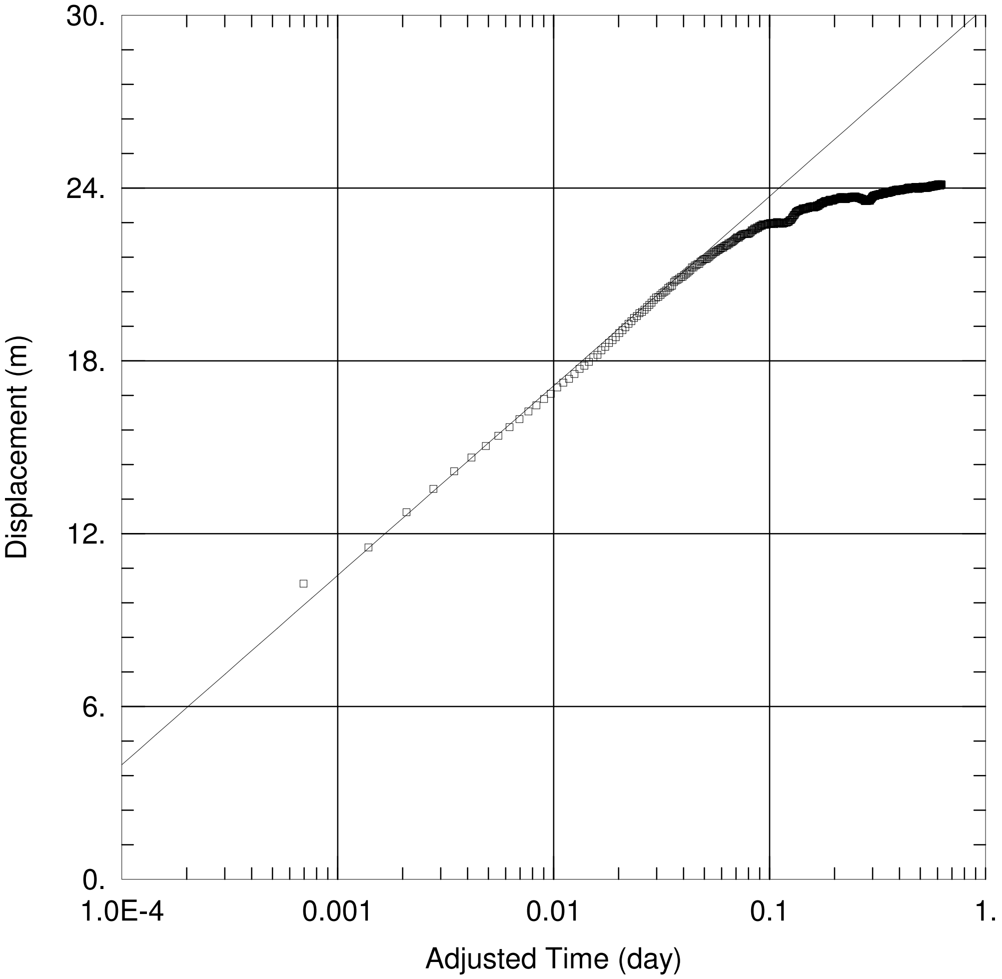
Solution Method: Theis

T = 52.01 m^2/day

S = 0.0001006

Kz/Kr = 0.1

b = 10. m



SUNSHINE-SSAC19 - CONSTANT RATE TEST

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: SunShine Lakes
Test Well: SSAC15
Test Date: 15/08/2017

AQUIFER DATA

Saturated Thickness: 9. m

Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSAC19	264077.559	7276655.006

Observation Wells

Well Name	X (m)	Y (m)
□ SSAC19	264077.559	7276655.006

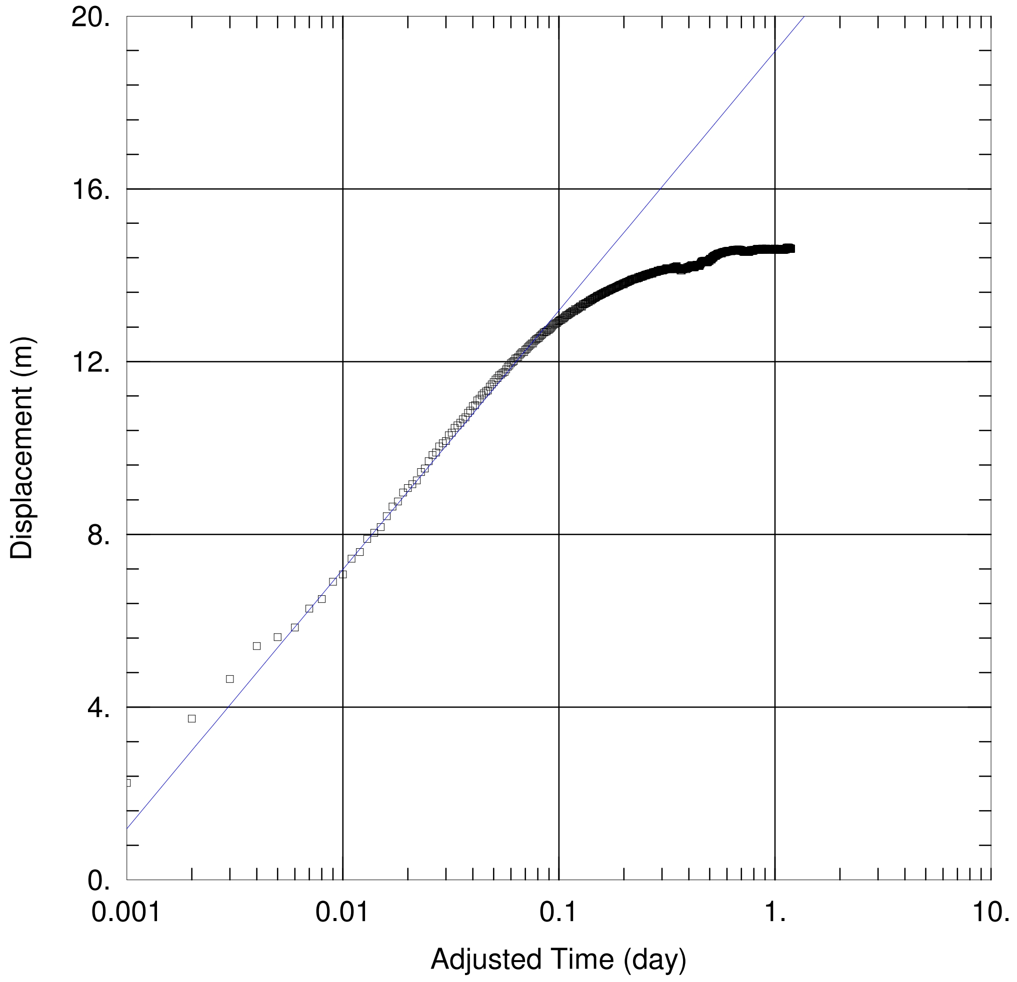
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

T = 19.25 m^2/day

S = 0.01722



SUNSHINE-SSAC19 - CONSTANT RATE TEST

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: SunShine Lakes
Test Well: SSAC15
Test Date: 15/08/2017

AQUIFER DATA

Saturated Thickness: 9. m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSAC19	264077.559	7276655.006

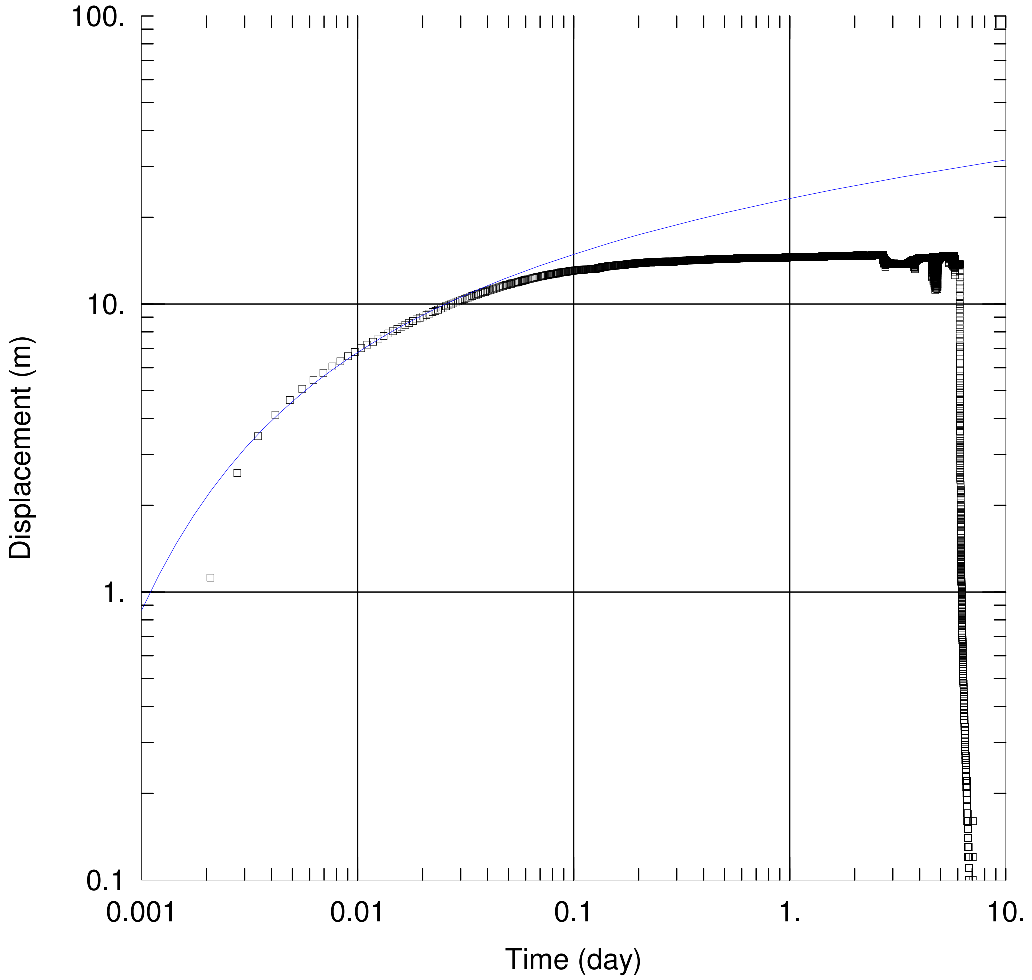
Observation Wells

Well Name	X (m)	Y (m)
□ M1	264087.559	7276654.006

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Jacob

T = 21.11 m^2/day
S = 0.0002979



SUNSHINE-SSAC19 - CONSTANT RATE TEST

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: SunShine Lakes
Test Well: SSAC15
Test Date: 15/08/2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSAC19	264077.559	7276655.006

Observation Wells

Well Name	X (m)	Y (m)
□ M1	264087.559	7276654.006

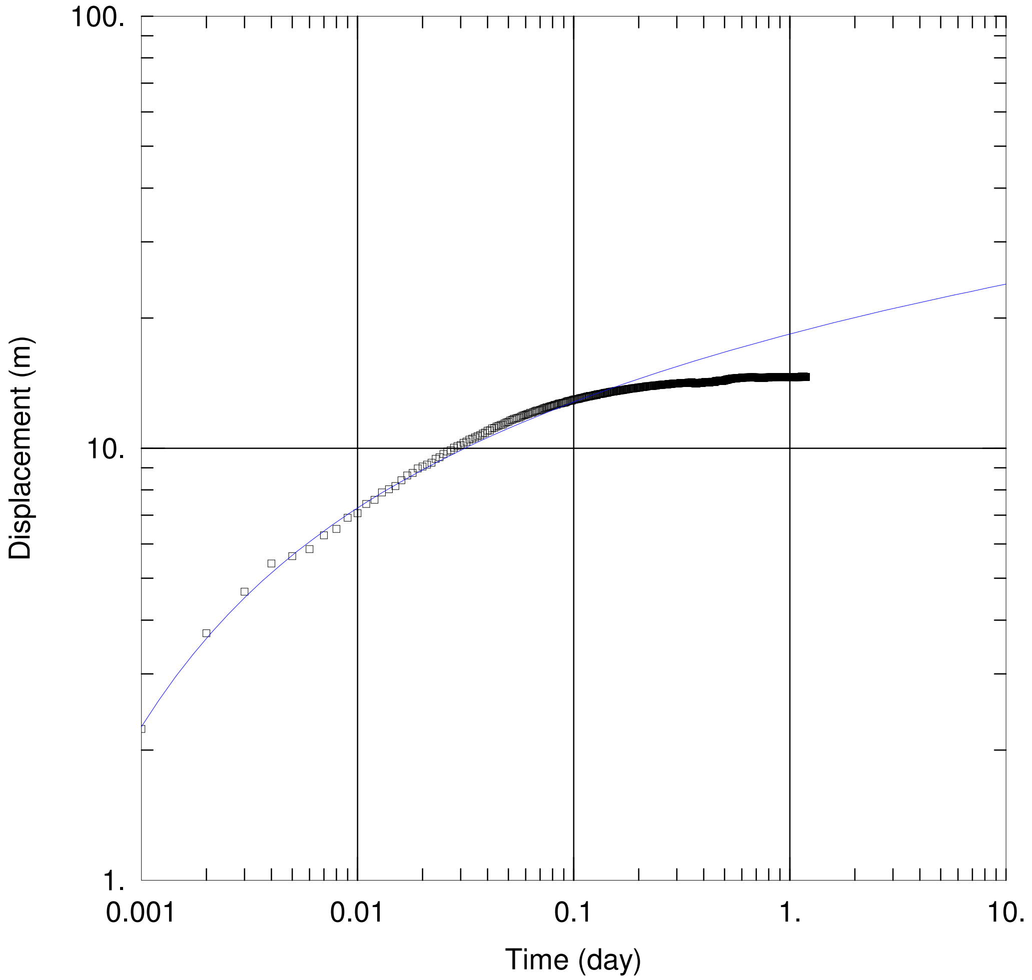
SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 15.12 m^2/day
Kz/Kr = 0.1

S = 0.0005713
b = 9. m



SUNSHINE-SSAC19 - CONSTANT RATE TEST

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: SunShine Lakes
Test Well: SSAC15
Test Date: 15/08/2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSAC19	264077.559	7276655.006

Observation Wells

Well Name	X (m)	Y (m)
□ M1	264087.559	7276654.006

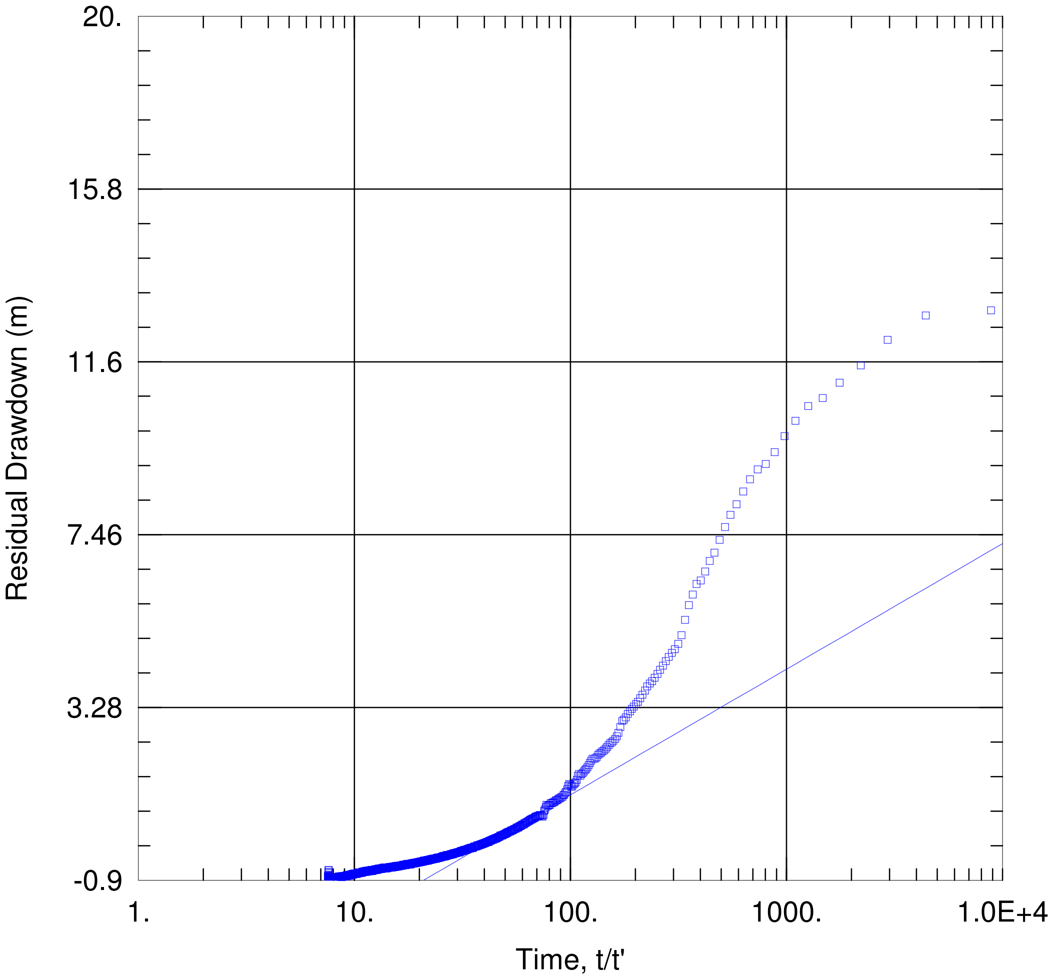
SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 22.67 m^2/day
Kz/Kr = 0.1

S = 0.0002596
b = 9. m



SUNSHINE-SSAC19 - CONSTANT RATE TEST

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: SunShine Lakes
Test Well: SSAC15
Test Date: 15/08/2017

AQUIFER DATA

Saturated Thickness: 9. m

Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSAC19	264077.559	7276655.006

Observation Wells

Well Name	X (m)	Y (m)
▫ M1	264087.559	7276654.006

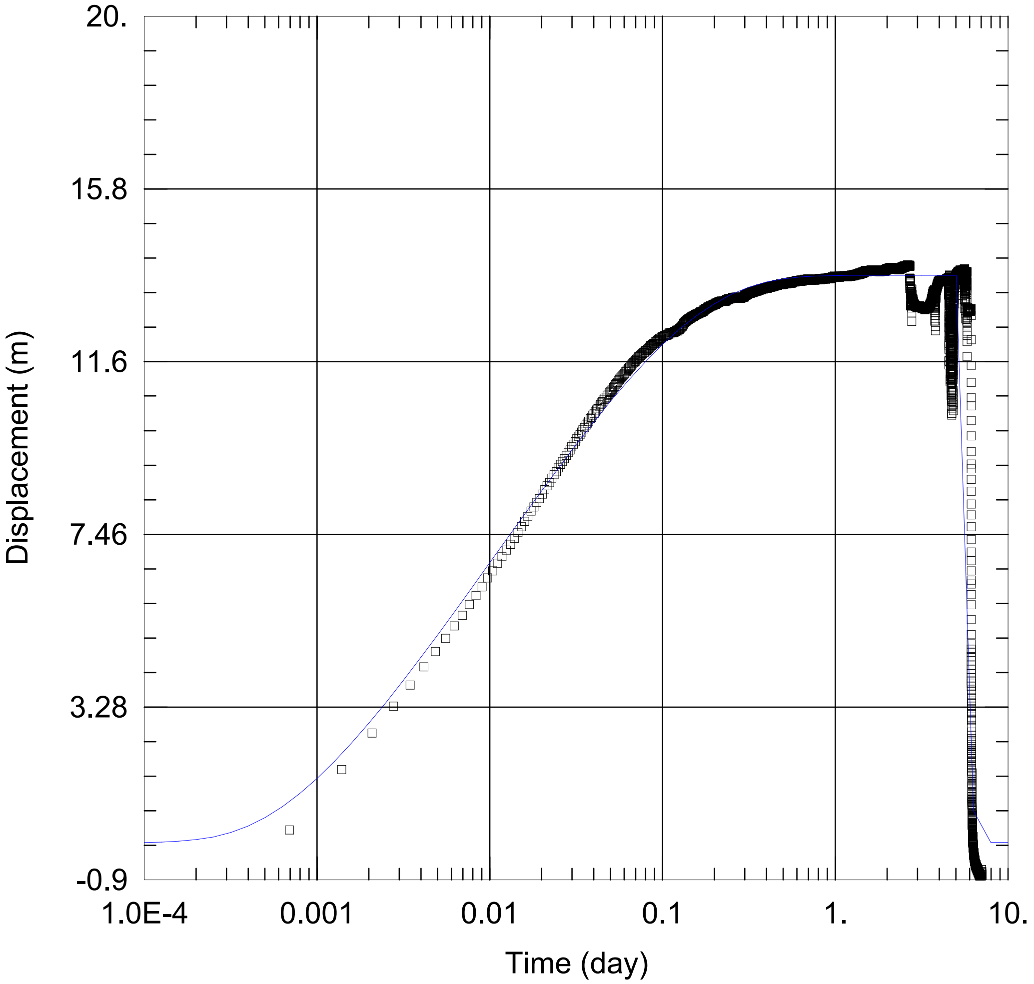
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

T = 20.85 m^2/day

S/S' = 41.4



SUNSHINE-SSAC19 - CONSTANT RATE TEST

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: SunShine Lakes
Test Well: SSAC15
Test Date: 15/08/2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSPB19	264077.559	7276655.006

Observation Wells

Well Name	X (m)	Y (m)
□ M1	264087.559	7276654.006

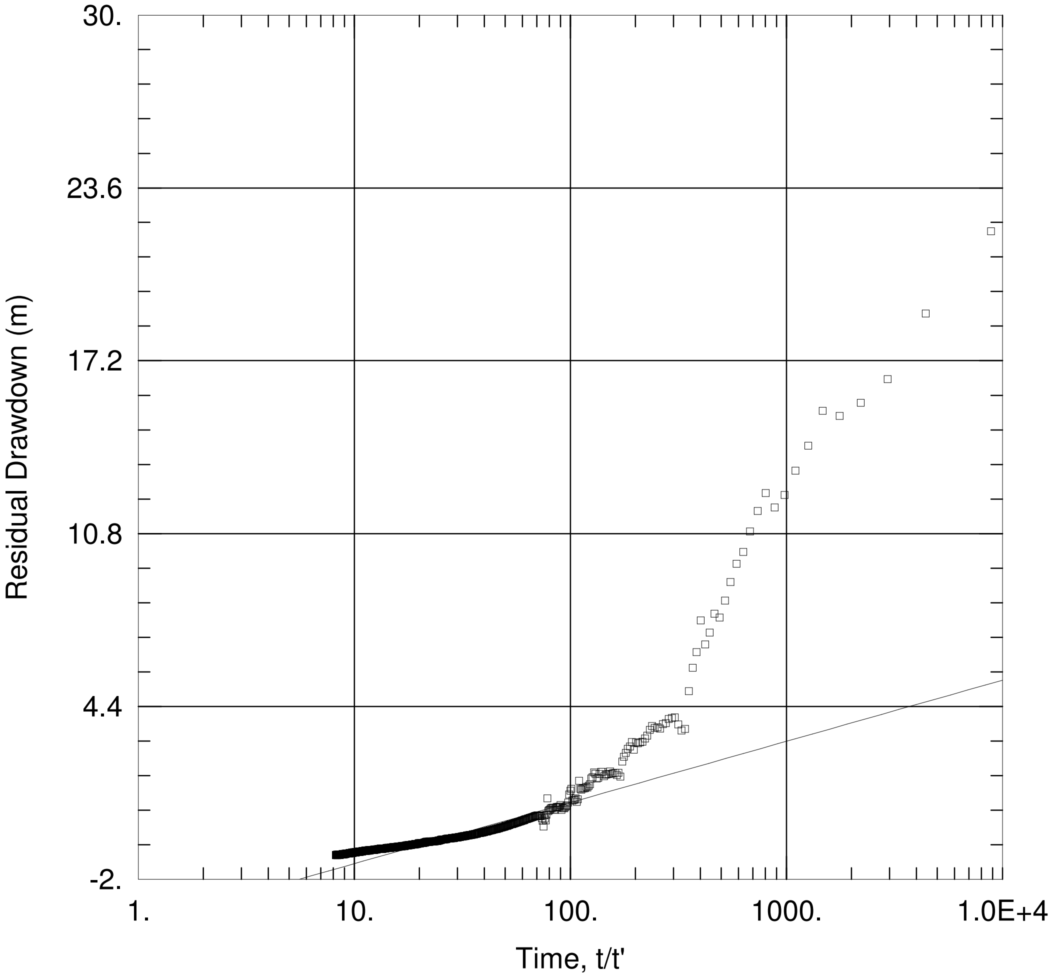
SOLUTION

Aquifer Model: Leaky

Solution Method: Hantush-Jacob

T = 19.69 m^2/day
r/B = 0.09704
b = 9. m

S = 0.0003922
Kz/Kr = 1.



SUNSHINE-SSAC19 - CONSTANT RATE TEST

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: SunShine Lakes
Test Well: SSAC15
Test Date: 15/08/2017

AQUIFER DATA

Saturated Thickness: 9. m

Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSAC19	264077.559	7276655.006

Observation Wells

Well Name	X (m)	Y (m)
□ SSAC19	264077.559	7276655.006

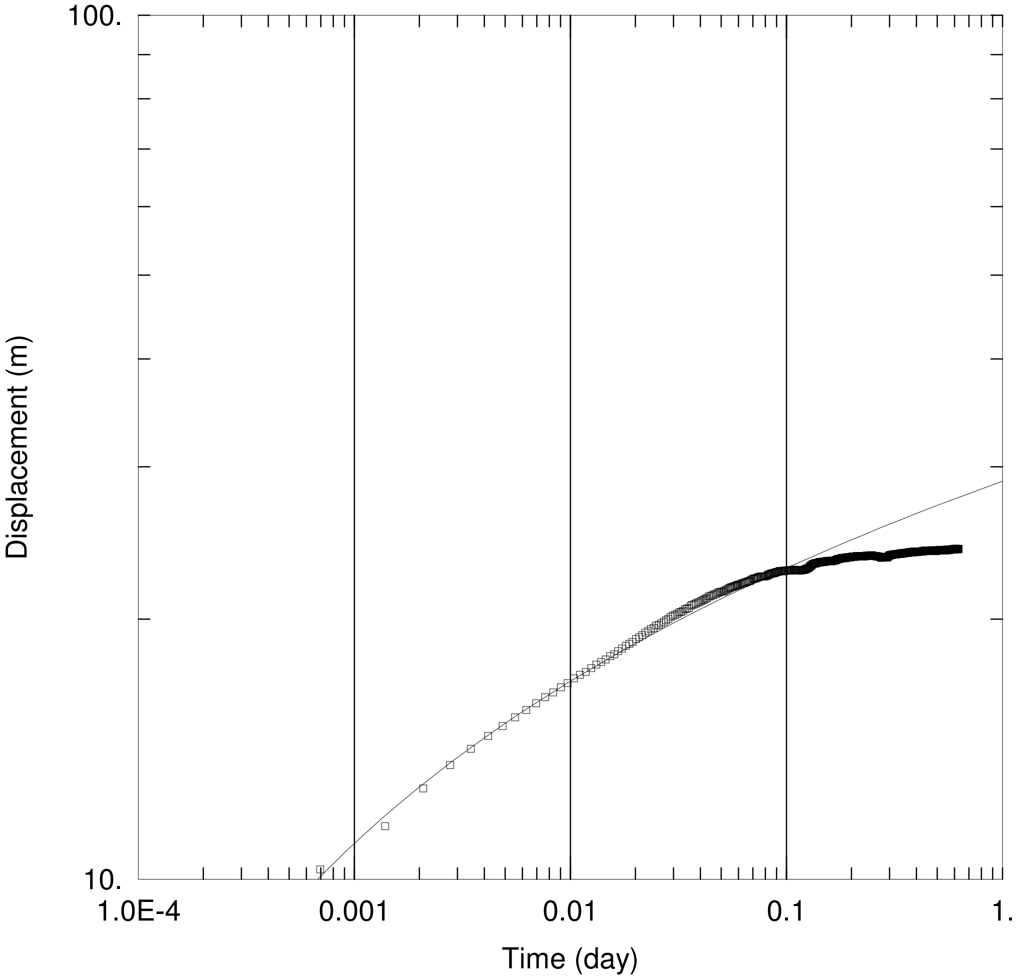
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

T = 27.97 m^2/day

S/S' = 42.56



SUNSHINE-SSAC19 - CONSTANT RATE TEST

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: SunShine Lakes
Test Well: SSAC15
Test Date: 15/08/2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSAC19	264077.559	7276655.006

Observation Wells

Well Name	X (m)	Y (m)
□ SSAC19	264077.559	7276655.006

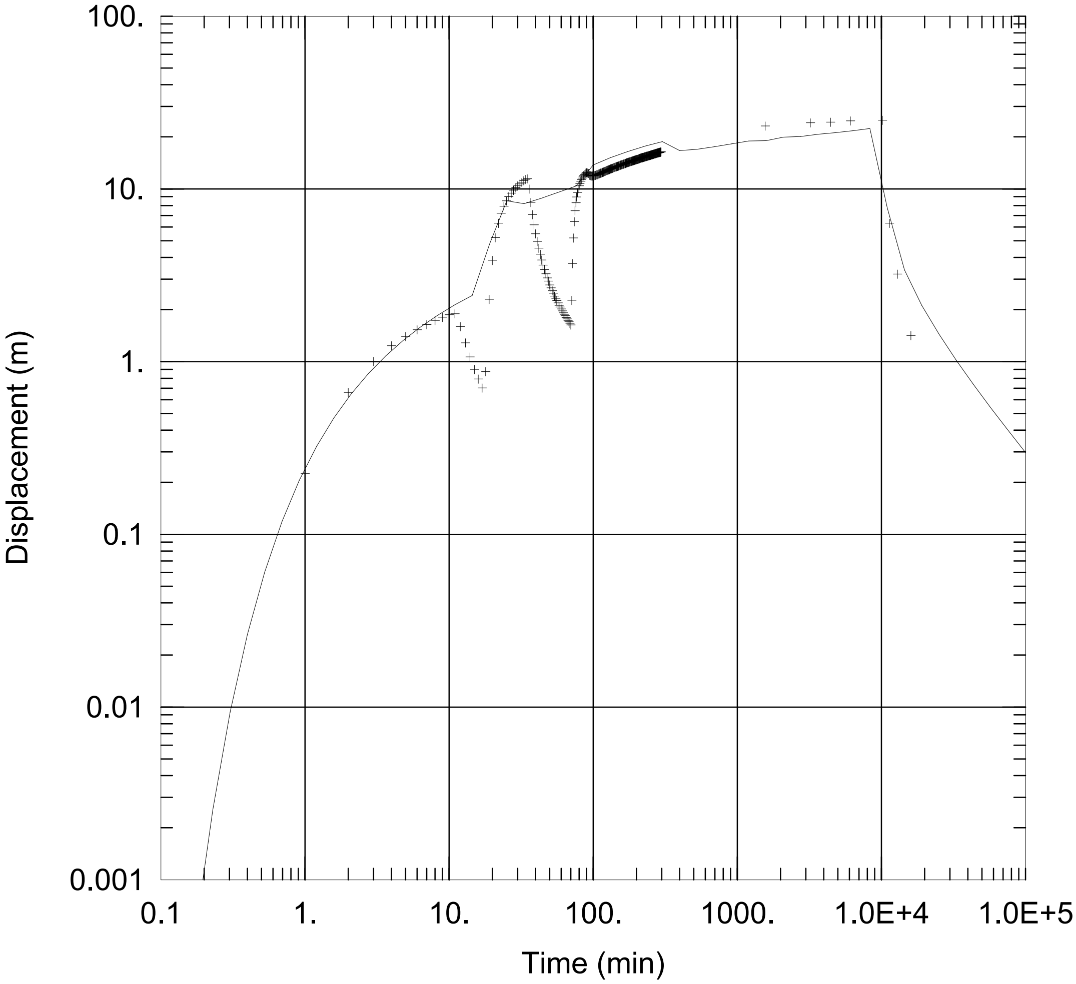
SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 21.24 m^2/day
Kz/Kr = 0.1

S = 0.011
b = 9. m



SUNSHINE-SSPB21 - CONSTANT RATE TEST

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: Lake Sunshine
Test Well: SSPB21
Test Date: 15/08/2017

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSPB21	248430.76	7269419.488

Observation Wells

Well Name	X (m)	Y (m)
+ SSAC21M1	248414.43	7269423.144

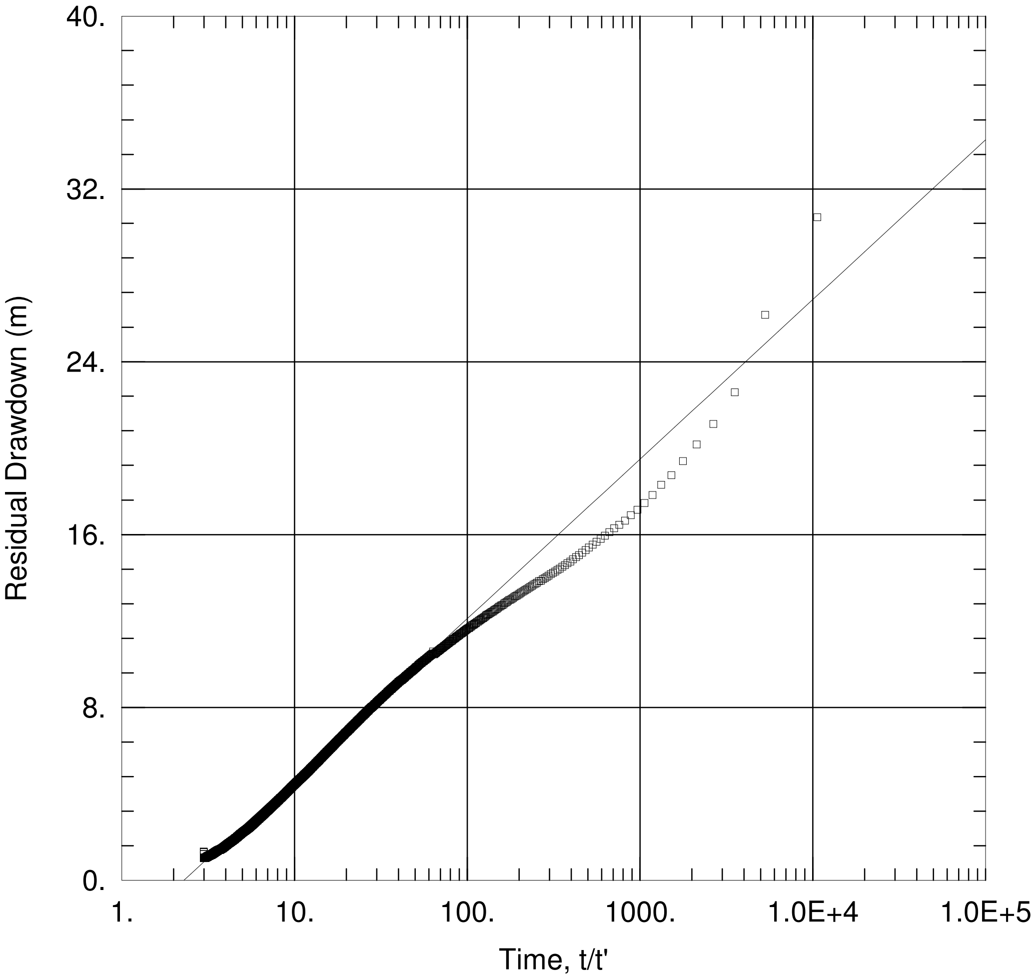
SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 23.25 m^2/day
Kz/Kr = 1.

S = 0.0002339
b = 10. m



SUNSHINE-SSAC15 - CONSTANT RATE TEST

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: SunShine Lakes
Test Well: SSAC15
Test Date: 15/08/2017

AQUIFER DATA

Saturated Thickness: 10. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSAC21	248430.76	7269419.488

Observation Wells

Well Name	X (m)	Y (m)
□ SSAC21	248430.76	7269419.488

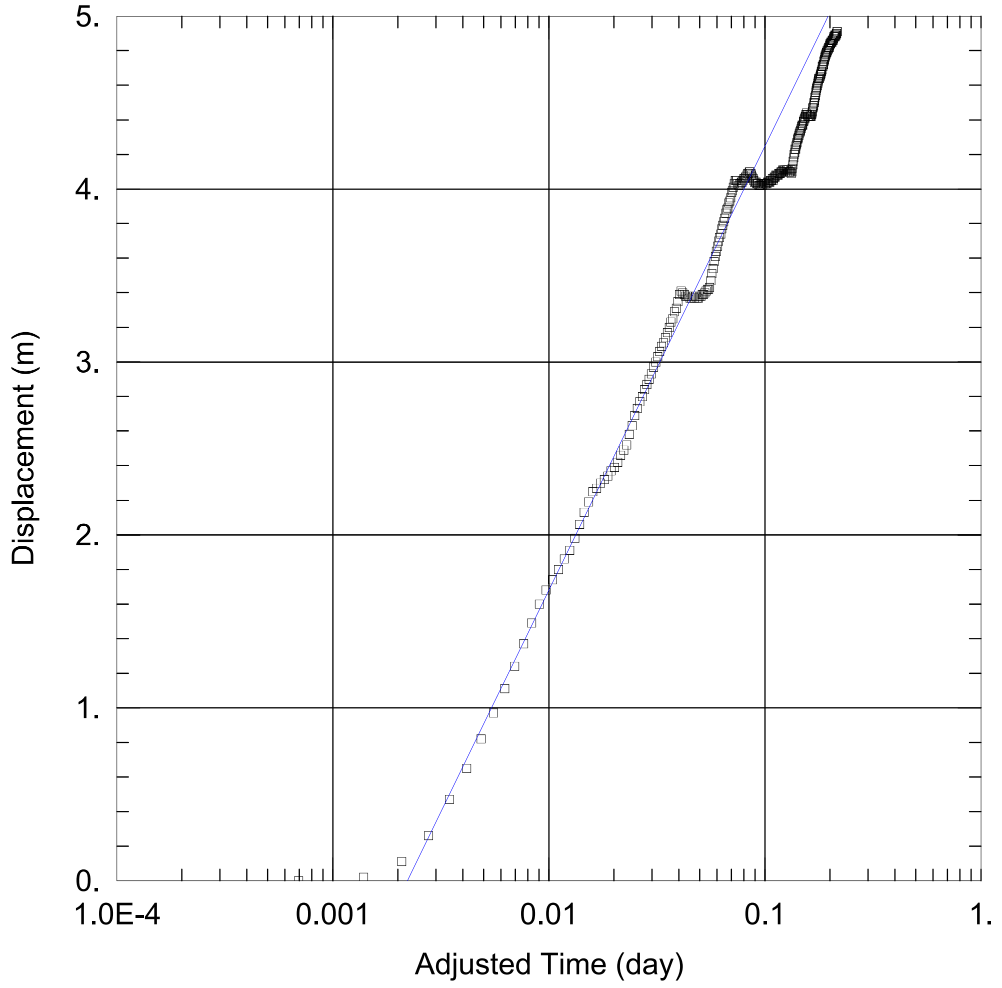
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

T = 19.3 m^2/day

S/S' = 2.295



WELL TEST ANALYSIS

Data Set:
Date: 08/23/17 Time: 18:08:31

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: Sunshine
Test Well: SSPB15

AQUIFER DATA

Saturated Thickness: 7. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSPB15	257633.541	7275044.8

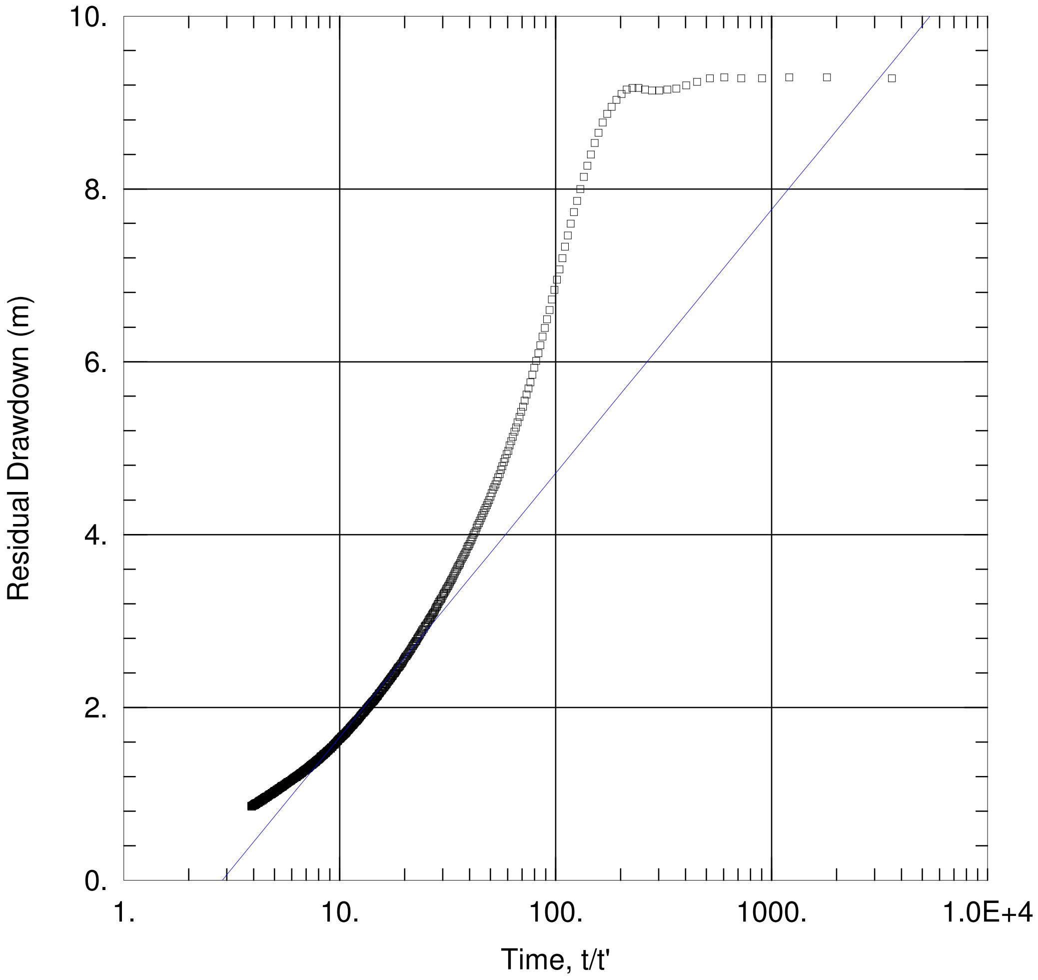
Observation Wells

Well Name	X (m)	Y (m)
□ SSAC15M1	257617.456	7275040.57

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob

T = 24.66 m^2/day S = 0.0004435



SUNSHINE-SSAC15 - CONSTANT RATE TEST

PROJECT INFORMATION

Company: Advisian
Client: Kalium Lakes
Project: 201320-14624
Location: SunShine Lakes
Test Well: SSAC15
Test Date: 15/08/2017

AQUIFER DATA

Saturated Thickness: 10. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
SSAC15	257617.456	7275040.575

Observation Wells

Well Name	X (m)	Y (m)
□ M1	257630.456	7275041.575

SOLUTION

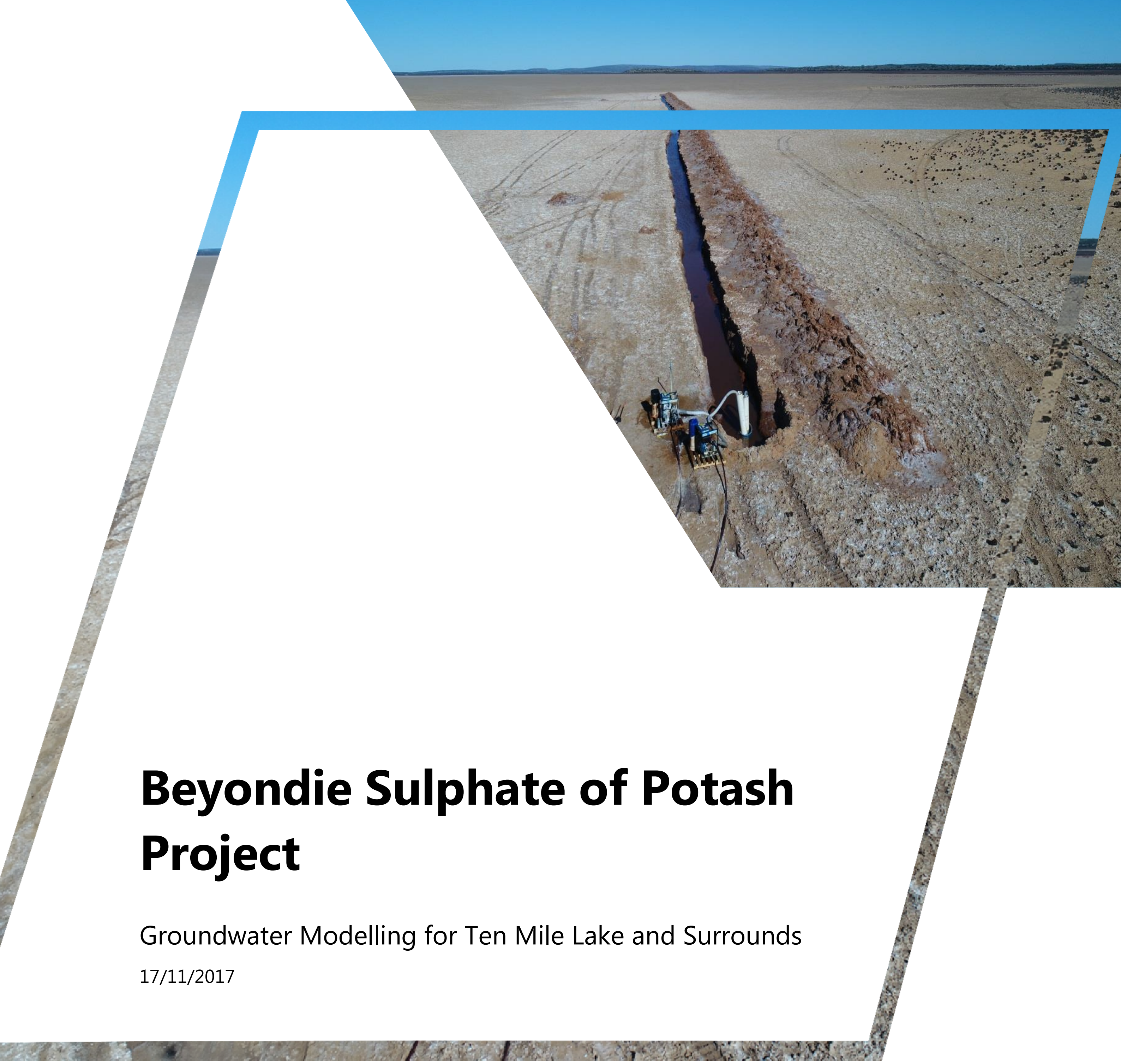
Aquifer Model: Confined

Solution Method: Theis (Recovery)

T = 25.95 m^2/day

S/S' = 2.86

Appendix D Groundwater Modelling Reports



Beyondie Sulphate of Potash Project

Groundwater Modelling for Ten Mile Lake and Surrounds

17/11/2017

Level 4, 600 Murray St
West Perth WA 6005
Australia

201320-14624

www.**advisian**.com

Disclaimer

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Project No: 201320-14624 – Beyondie Sulphate of Potash Project: Groundwater Modelling for Ten Mile Lake and Surrounds

Rev	Description	Author	Review	Advisian Approval	Date
0	Issued to Client	A. Barr	A. Lloyd	S. Atkinson	17/11/2017

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Executive Summary

A hydrogeological model was constructed and calibrated for the surficial (lake) and the confined palaeochannel aquifer at 10 Mile Lake. These models were used to quantify the brine available from trenches across the lake surface and abstraction bores within the palaeochannel over a life-of-mine of 23 years.

The modelling indicated that using conservative assumptions the brine recovery from the trenches would decline from 170 L/s in the first year to 70 L/s by year 10 and 46 L/s by year 20. The potassium grade recovered from within the 10 Mile Lake area was estimated to be 9,160 mg/L in the first year, 8,200 mg/L in Year 5, 6,500 mg/L in Year 10 and 6,000 mg/L in Year 20. An additional simulation used a recharge of 165 mm over the lake surface for a single day each year to simulate the effects of inundation over the lake. It showed the brine recovery from the trenches increased to an average of 134 L/s over the first 5 years, and had average rates of 93, 86 and 84 L/s over the subsequent 5 year periods.

The modelling also indicated that 30 L/s brine recovery from the confined aquifer was sustainable over 20 years. The potassium grade recovered from the indicated resource zone was 7,300 mg/L in the first year, declining to 6,900 mg/L in Year 5, 6,300 mg/L in Year 10 and 4,500 mg/L in Year 20.

The results indicate that the resource recovery is most sensitive to the horizontal hydraulic conductivity in the lake sediments. Greater overall brine recovery is associated with higher horizontal hydraulic conductivity in the lake sediments and adjacent surficial units, and specific yield in the lake sediments and calcrete.

The model has been constructed to the Australian Groundwater Modelling Guidelines (AGMG) (Barnett et al., 2012) and its class and confidence level judged by these guiding principles. The model is assigned an intermediate Class 2 level. The confidence level could be improved with additional longer-term monitoring, however it is considered reasonable for the current status of the project.

1 Introduction

Kalium Lakes Limited (KLL) is a public company, listed on the Australian Stock Exchange (ASX), with ~ 2,400 km^2 of granted tenements at the eastern margin of the East Pilbara region of Western Australia. KLL is looking to develop a sub-surface brine deposit to produce 150 kilo-tonnes per annum (ktpa) of Sulphate of Potash (SOP) product via evaporation and processing within the Beyondie, 10 Mile and Sunshine tenement holdings, comprising part of the tenements of the Beyondie Sulphate of Potash Project (BSOPP).

KLL engaged Advisian to plan and execute an exploration and assessment program with the aim of upgrading the existing SOP Resources at 10 Mile and Beyondie Lakes to a level of understanding for inclusion into a Reserve estimate. The upgrade will take into account new resource exploration at Kalium's Lake Sunshine tenements. The Resource upgrade is to be developed in line with current accepted guidance according to the JORC Code 2012, with reference to the Canadian Institute of Mining (CIM) Best Practice Guidelines for Resource and Reserve Estimation for Lithium Brines and the Association of Mining draft Guideline for Potash and Lithium Brines.

A major part of the Ore Reserve assessment and application of Mining Modifying Factors for a brine deposit is a numerical groundwater model. This report presents the modelling that was completed for the Beyondie and 10 Mile Lake portions of the BSOPP.

This study has been carried out with reference to the Australian Groundwater Modelling Guidelines (AGMG) (Barnett et al., 2012) in a staged approach. A summary of the approach to groundwater model development used in this study (adopted from Barnett et al., 2012) is provided in Figure 1-1.

In accordance with the AGMG (Barnett et al., 2012), the model development involved initial phases of planning and conceptualisation, through to design and construction, calibration and sensitivity analysis, predictive modelling, and uncertainty analysis. These stages are outlined as follows:

- Development of a conceptual model of the site and surrounding region using the latest available datasets of geology and hydrogeology to form a basis for understanding of the regional groundwater hydrodynamics;
- Construction of a numerical groundwater model based on data collected during conceptualisation such as the selection of the extent, stratigraphy, structure, tops and bottoms of formation(s), initial aquifer parameters and boundary conditions;
- Calibration of the groundwater model using an iterative process of manual and automated calibration to reduce residual error between observed data and simulated data;
- Sensitivity analysis to "compare model outputs with different sets of reasonable parameter estimates, both during the period of calibration (the past) and during predictions (in the future)" (Barnett et al., 2012, p.57);
- Predictive modelling of the resource recovery;
- Uncertainty analysis to quantify uncertainty in the predictions and illustrate the sensitivity of the results to variations in the assumptions of the model; and

- Analysis, mapping and assessment of predictive model results and estimates of associated uncertainty to quantify the potential impacts and limits of production.

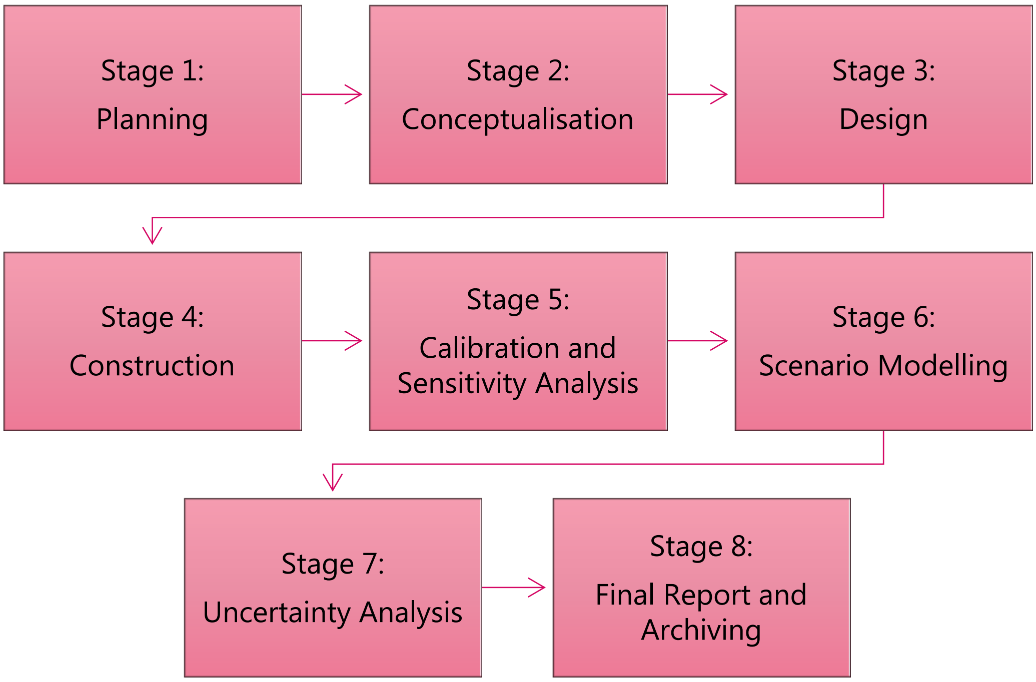

Figure 1-1: Schematic of Stages of Modelling Process (Barnett et al., 2012)

1.1 Report Content

This report broadly follows the structure recommended by the AGMG (Barnett et al., 2012):

- Chapter 3 describes the conceptual model of the study area based on the available datasets of geology, hydrogeological processes and anthropogenic stresses;
- Chapter 4 describes the numerical implementation of the conceptual model through the model design and construction;
- Chapter 5 provides the calibration and sensitivity analysis of the numerical groundwater flow model;
- Chapter 6 provides an assessment of the recoverable resource;
- Chapter 7 describes the uncertainty in the resource assessment; and
- Chapter 8 summarises the main findings from this study.

2 Scope of Work

The scope of work for this groundwater modelling is to create a hydrogeological model of the 10 Mile and Beyondie Lakes area, calibrate the model to available data and use this model to evaluate the recoverable resource for the BSOPP. This investigation examined the surface (lake) resources and the deep (palaeochannel/fractured rock) resources.

3 Conceptual Hydrogeology

3.1 Climate

The climate for the area of BSOPP is arid. Nearby Bureau of Meteorology stations with long-term data sets include Meekatharra and Newman. Monthly evaporation data at BSOPP and nearby Bureau of Meteorology sites are listed in Table 3-1. Average rainfall at selected Bureau of Meteorology sites is listed in Table 3-2, with the location of the sites shown in Figure 3-1. The average annual rainfall at the BSOPP is approximately 230 mm. Table 3-2 also contains the average annual excess rainfall. This was calculated as the sum of the daily rainfall events in excess of the average monthly evaporation rates. For the purpose of this calculation the evaporation rates for the BSOPP were used as this was the smallest (most conservative) annual excess rainfall.

Table 3-1: Daily Average Monthly Evaporation Rates

Month	Meekatharra Airport (007045)	Wittenoom (005026)	BSOPP (K-UTEC, 2016)
January (mm/day)	15.8	11.3	17.6
February (mm/day)	14.1	9.8	16.7
March (mm/day)	11.7	9	13.8
April (mm/day)	8.2	7.7	10.1
May (mm/day)	5.4	5.7	6
June (mm/day)	3.8	4.5	4.8
July (mm/day)	3.9	4.8	5.1
August (mm/day)	5.4	6.1	6.5
September (mm/day)	8	8.6	9
October (mm/day)	11	11.1	12.8
November (mm/day)	13.3	12.4	15
December (mm/day)	14.9	12.4	17.3
Annual (mm)	**3506**	**3141**	**4100**

Table 3-2: Average Rainfall Data

Site	Distance from BSOPP (km)	Annual Rainfall (mm)	Annual Excess Rainfall (mm)
Doolgunna (007023)	154	248.9	94.4
Illgararie (007033)	90	228.3	85.6
Neds Creek (007103)	107	240.1	93.7
Kumarina (007152)	75	218.5	77.8
Mary Mia (007180)	47	260.8	93.3
Rpf 477 mile (013008)	37	253.9	100.3
Rpf 510 mile (013010)	34	224.6	94.9
Three Rivers (007080)	128	227.1	82.3

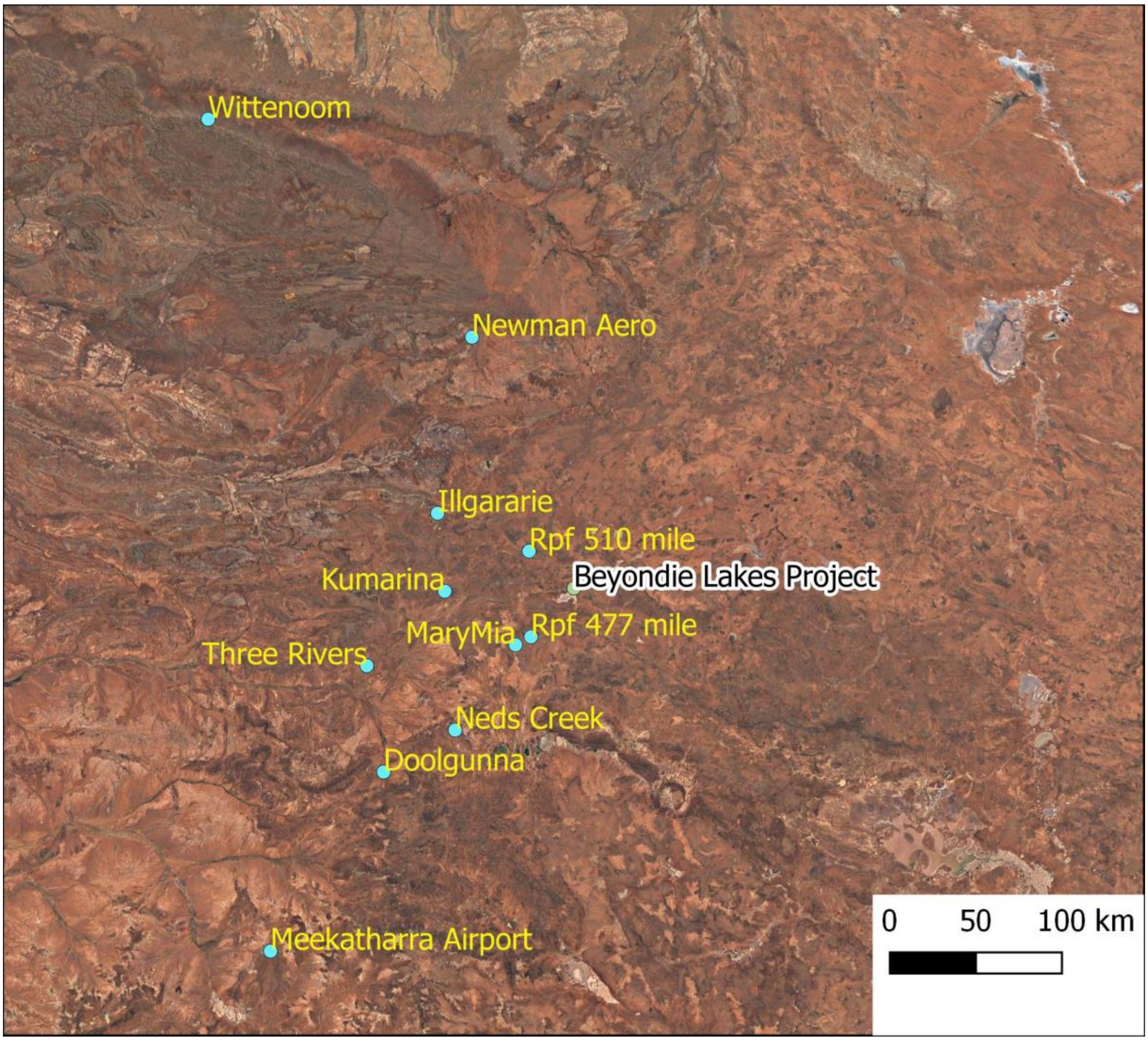

Figure 3-1: Location of Bureaus of Meteorology Climate Stations

3.2 Recharge

Recharge to the aquifer in the arid zones of Western Australia is episodic. 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.

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 the alluvium in palaeochannel systems varied between 0.09 and 1% of the rainfall, and recharge to calcrete varied between 0.7 and 5% of rainfall. Johnson et al. (1999) also indicated that recharge to shallow groundwater areas in the northern goldfields, and by extension, into the BSOPP area, are likely to be episodic.

3.3 Evapotranspiration

Evapotranspiration removes water from the aquifer either directly through evaporation from shallow water table areas or through uptake from roots and transpiration through leaves of the vegetation. This generally occurs where the water table is in close proximity to the surface. Hydrogeologically it is assumed that any groundwater at the surface is subject to the full evaporation rate, and the evapotranspiration decreases with depth of the water table until it reaches zero at the ‘extinction depth’. Within the BSOPP area, evapotranspiration from the water table is expected to occur in the lower topographical areas, where the water table is relatively close to the surface. In the vicinity of the lakes, transpiration is expected to occur in the fringing vegetation, in calcrete areas and along the creek lines.

The evaporation rates in Table 3-1 are pan evaporation rates, which use a standard 120 cm diameter, 30 cm deep, metal pan containing an initial 25 cm of water at the start of the recording day. Actual evaporation from larger expanses of water may be less than pan evaporation due to lower water temperatures and increased humidity along wind runs. Higher salinity also reduces the effective evaporation rate.

Direct evaporation from soil depends on the soil water moisture and the soil hydraulic characteristics and the albedo of the surface.

Transpiration rates depend on the availability of water to the root systems of the plants, the depth it is available, the plant canopy configuration, the leaf area index (ratio of leaf area to canopy area of the ground), and the stomatal resistance in the leaves amongst other factors. The transpiration rate may be higher than the pan evaporation rate for sparse vegetation with good access to groundwater, but is usually lower than the pan evaporation.

3.4 Palaeo-drainage System

The conceptual palaeo-drainage system consists of a surficial unconfined aquifer, overlying a thick lacustrine clay layer with a confined palaeochannel aquifer in the thalweg of the palaeo-drainage. The palaeo-drainage system can be divided into two hydraulic systems:

- Surficial unconfined aquifer; and
- Confined palaeochannel aquifer.

These two systems will be discussed separately below. However it is noted that such systems may or may not be separated or present along the whole palaeo-drainage system. It is likely that in the upper reaches of the palaeo-drainage systems, these two aquifers are in contact, i.e. the intermediate clay layer is either absent or non-continuous.

3.4.1 Surficial Unconfined Aquifer

The surficial unconfined system consists of more recent Quaternary deposits including calcretes and includes individual and chains of salt lakes. The source of water is generally direct recharge from rainfall or surface expressions of water such as ephemeral creeks, ephemeral lakes and salt lakes. Water may also be sourced (groundwater gradients permitting) from adjacent bedrock (including weathered bedrock, fractures and fresh bedrock) and upward flow from the confined aquifer system.

Water can be lost from the surficial aquifer through evapotranspiration or through groundwater flow to deeper aquifers or into the adjacent bedrock.

3.4.2 Confined Palaeochannel Aquifer

The confined palaeochannel aquifer generally occurs in the deeper parts of the palaeo-drainage system. The source of water can be direct flow from the surficial aquifer in the upper reaches and tributaries of the palaeo-drainage system, from vertical leakage through the lacustrine clayey sediments, or from inflow from the adjacent bedrock. The inflow from the adjacent bedrock may include groundwater flow from fractures and weathered bedrock, and also may include flow from the surficial aquifer via weathered bedrock.

Outflows from the confined aquifer may be to the surrounding bedrock or upwards through the confining clay. Upward flow through the clay is likely to occur in the central areas of salt lakes due to the prevailing hydraulic gradient.

Interaction with adjacent aquifers including the surficial and bedrock are contingent on appropriate groundwater gradients.

4 Model Construction

The groundwater model constructed for this area has the following purposes:

- To evaluate the recoverable resource (brine) from the surficial and confined aquifers in the vicinity of 10 Mile Lake; and
- Simulate the effects of the resource abstraction over Life-of-Mine (LoM) on nearby users of groundwater, including existing bores and groundwater dependent ecosystems.

Potential future uses may include:

- To simulate the impacts of a water supply borefield within the catchments for 10 Mile Lake and Beyondie Lakes; and
- To examine the impacts of long-term disposal of non-economic resources.

Details of the model selection, construction and calibration follow in subsequent sections.

4.1 Model Selection

As outlined in the conceptual geology, the underlying hydrogeology is quite complex with a combination of linear features (fractures and dykes) and palaeochannels. The palaeochannels typically contain sands but may also contain clays and silcretes.

The conceptual hydrogeology contains numerous linear features that are not necessarily perpendicular to each other such as dolerite dykes and palaeochannel axes. This effectively rules out perpendicular meshes such as traditional MODFLOW. The remaining choices are FEFLOW (DHI, 2015) and the unstructured grid version of MODFLOW - MODFLOW-USG (Panday et al., 2013). Due to the better graphical tools and interface available for FEFLOW, it was selected for this work.

An additional advantage of FEFLOW is that it allows refinement of the mesh at a later time (if necessary).

4.2 Model Domain

The model domain is shown in Figure 4-1. It is based on the surface water catchments for 10 Mile Lake and Beyondie Lakes, and extends to include the exposed bedrock highs.

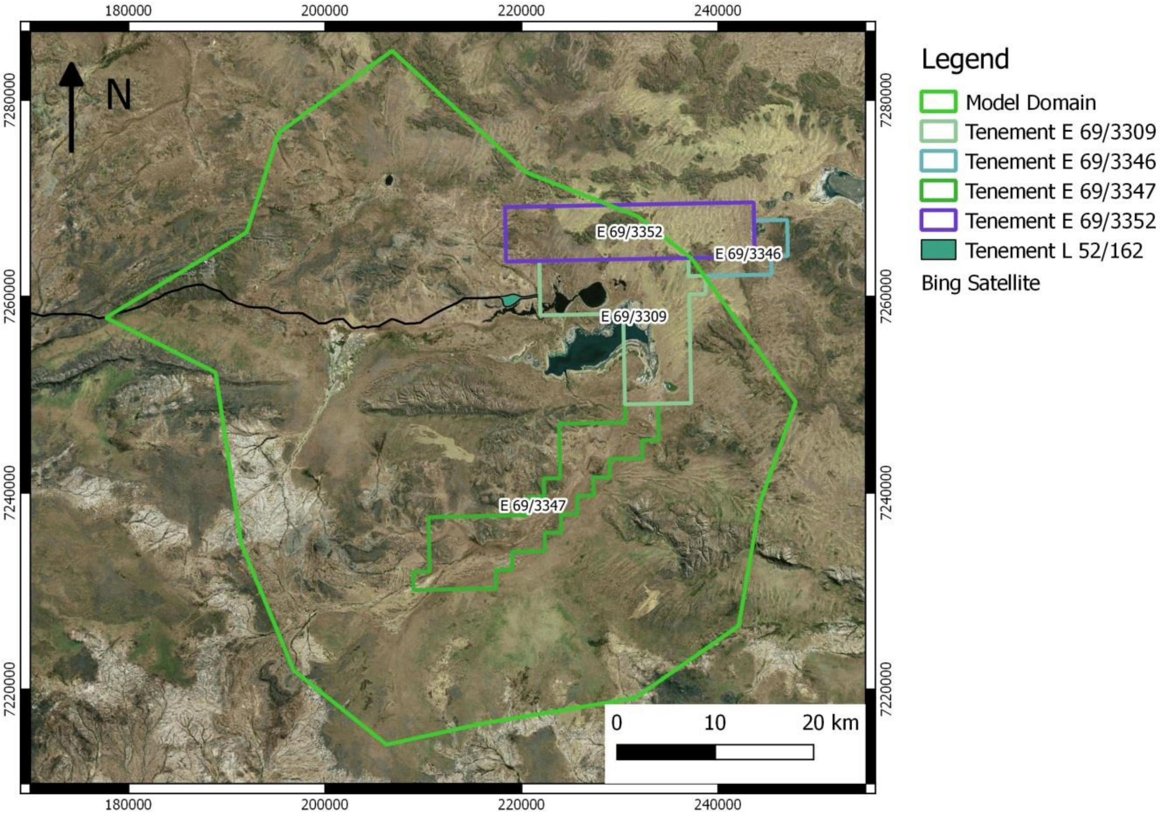

Figure 4-1: Domain for 10 Mile Lake Model and Kalium Potash Limited Tenements (as at May 2017)

4.2.1 Horizontal Discretisation

The outline was imported into FEFLOW and used to create meshes.

The initial mesh created for the regional steady-state model used the Advancing Front Method in FEFLOW. The mesh was then refined using the elements selections in the vicinity of 10 Mile Lake and eastwards towards the domain boundary. The resulting mesh is shown in Figure 4-2.

A refined mesh in the vicinity of bores used for pump testing of the confined aquifer. The ethos of refining the mesh was to create elements of dimensions similar to the well diameter at the locations of the pumping wells, and to ensure at least three elements between any pumping bores and associated observation bores. The bores used for the calibration are listed in Section 5.1. The resultant mesh is shown in Figure 4-3.

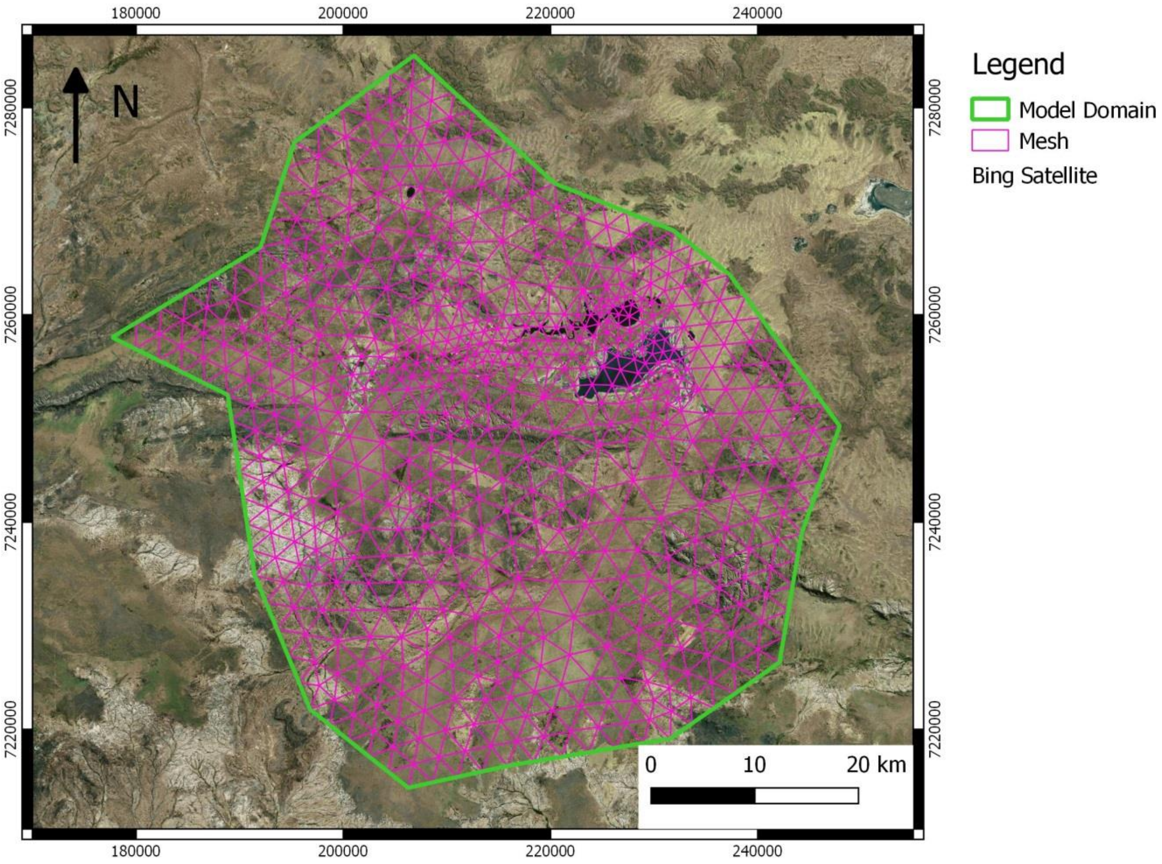

Figure 4-2: Mesh for Steady-State Calibration

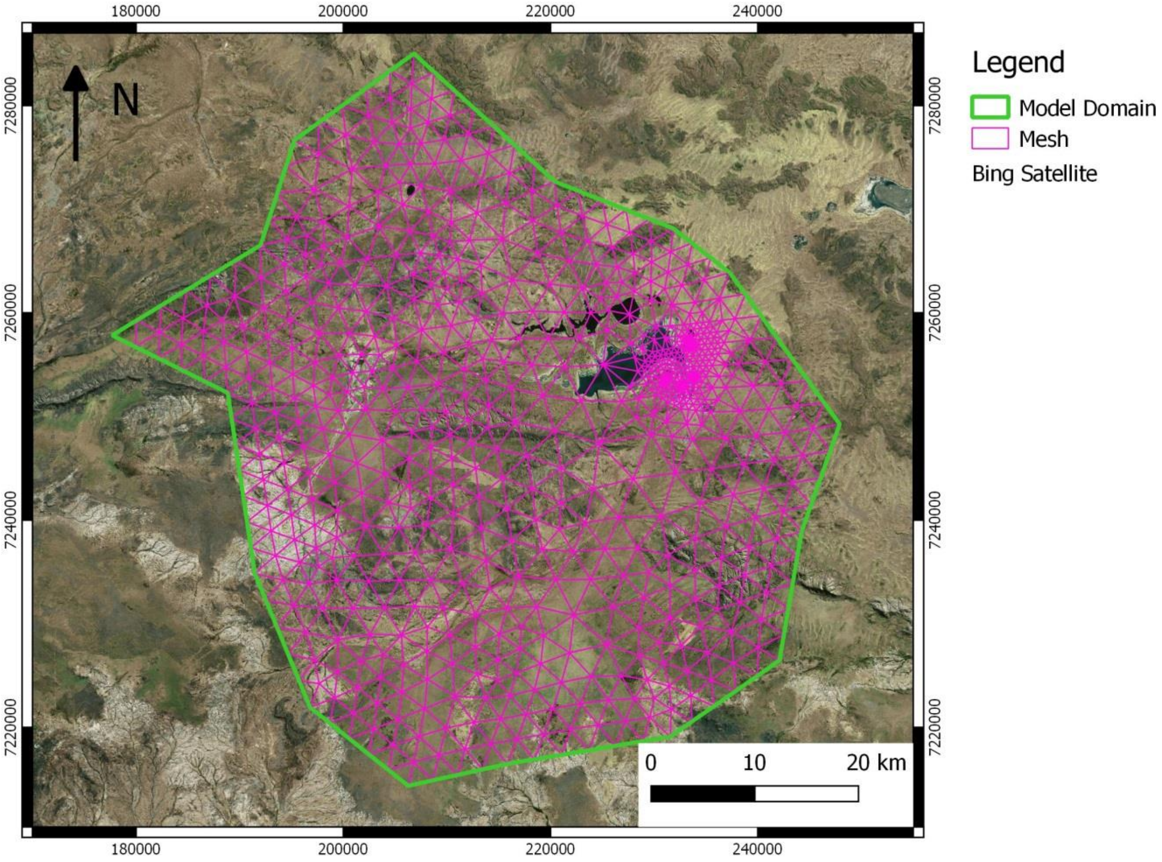

Figure 4-3: Mesh for Confined Aquifer Transient Calibration

4.2.2 Vertical Discretisation

The vertical discretisation in the palaeochannel areas used the following layers as a basis:

- Surficial layer, including upper lake sediments (aquifer, 1 layer);
- Intermediate lacustrine clays associated with palaeo-drainage systems (aquitard, 3 layers);
- Palaeochannel, contains palaeochannel sands but may be clay where sands are absent and may also contain weathered bedrock, conductive/non-conductive fracture systems and dolerite dykes (potential aquifer, 2 layers); and
- Bedrock (1 layer).

Areas away from the palaeo-drainage use the following layering:

- Weathered rock (aquifer, 1-2 layers); and
- Bedrock (remaining layers).

4.2.3 Layer Elevations

The surface elevation was created using the 1-second Shuttle Radar Topography Mission (SRTM) data for Australia (Gallant et al., 2011) matched to the centre points of the elements in the mesh.

The base of the surficial, intermediate and palaeochannel layers were based on elevations from the bore logs, and, in the case of the base of the lower palaeochannel layer from the results of the calibrated Tromino geophysical survey. These elevations were extrapolated over the remainder of the domain.

The base of the model was based on the thickness of the bottom layer (bedrock) being 10 m.

The data used for the surfaces is listed and the layer elevations and thicknesses are plotted in Appendix A.

4.3 Model Properties

The model properties vary according to the geology and the layer of the model. The zones in each layer are discussed below.

4.3.1 Surficial Aquifer

The surficial geology is divided into zones based on the surface geology. Four regional scale zones were identified from surficial geology data downloaded from GeoMap.WA (Department of Mines and Petroleum (DMP) (2014)) (Figure 4-4): These were:

- Ql – lake deposits;
- Qa, Qs – alluvium deposits and sediments;
- Czl: Calcrete deposits (outcrops); and
- PLMw – outcropping (and sub-cropping) weathered rock.

Sanders (1972) investigated the calcrete in the Paroo sub-basin near Wiluna. He found the calcrete was highly variable, with hydraulic conductivity between 800 and 4,000 m/day. The value of 800 m/day is used in the current model for horizontal hydraulic conductivity, and a value of 8 m/day (vertical anisotropy of 0.01) for the vertical hydraulic conductivity. The specific yield of calcrete deposits is highly variable, depending on the karstic nature of individual deposits. Johnson et al. (1999) found estimates of specific yield of between 5 and 25%, and recommended using 10% where no testing has been undertaken. This value (10%) is used in the current model.

Johnson et al. (1999) indicate alluvium has low hydraulic conductivity, less than 2.5 m/day, and a specific yield in the range of 0.03-0.05. A value of 0.04 is used in the models for the specific yield for the alluvium. No guidance is available for lake deposits, and the parameters for the alluvium have been adopted.

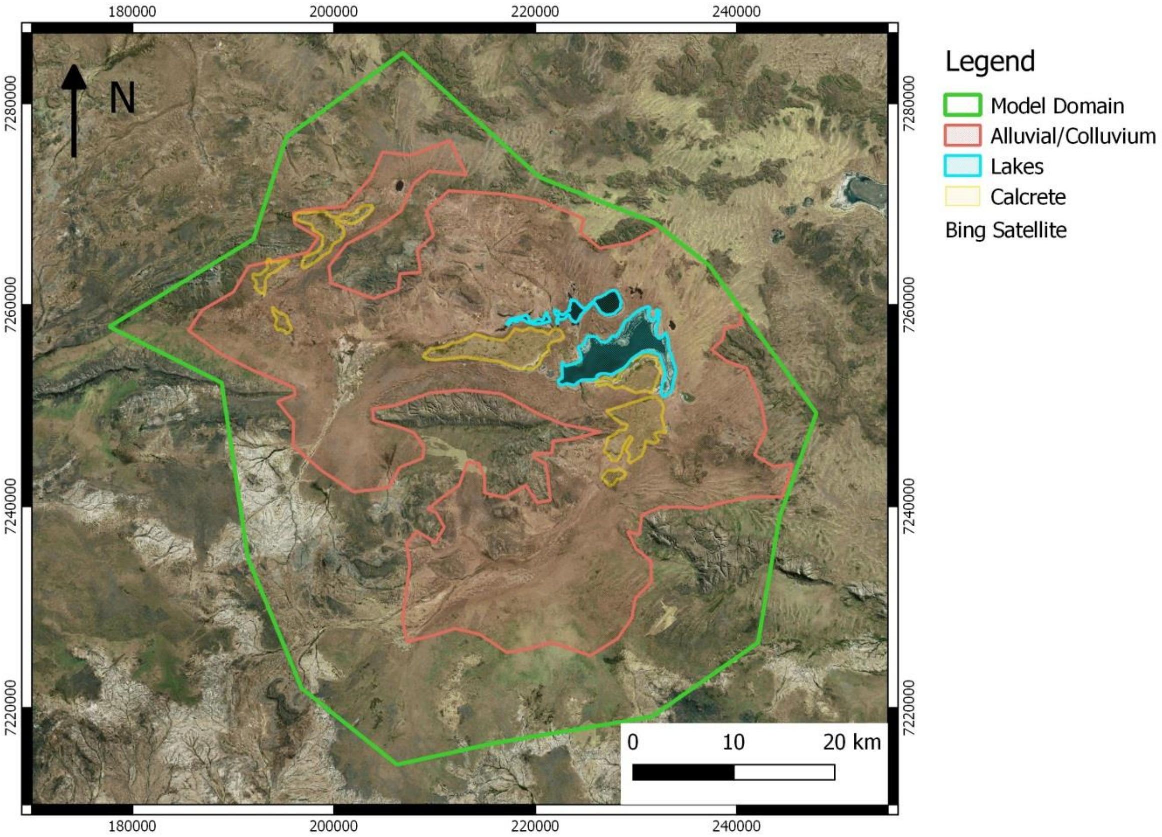

Figure 4-4: Surficial Property Zones

The alluvial, calcrete and lake sediments all occur in the lower topographic areas of the region, and are likely to have shallow water tables. Thus recharge to these units is likely to be episodic (see Section 3.2).

4.3.2 Surficial to Intermediate

The intermediate layer was subdivided into lacustrine clays and bedrock/weathered bedrock outside of the palaeo-drainage. Bedrock was assigned beneath surficial weathered rock. The extent of the palaeochannel clays is shown in Figure 4-5.

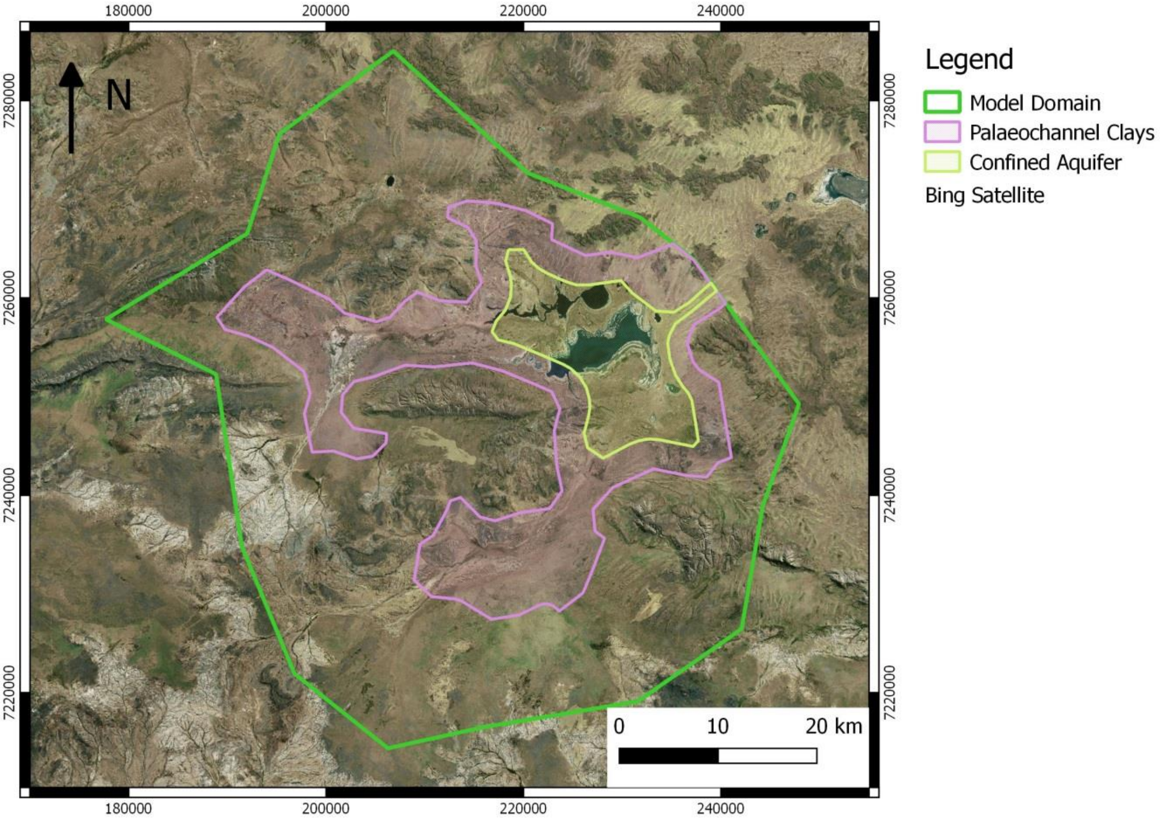

Figure 4-5: Subsurface Property Zones

4.3.3 Confined Aquifer

This layer consists of the palaeochannel sand, weathered and unweathered bedrock in the palaeo-drainage system, and bedrock outside the palaeo-drainage. The modelled extent of the confined aquifer is shown in Figure 4-5.

Johnson et al. (1999) found the hydraulic conductivity of palaeochannel sands to be in the range 1-40 m/day with an average of 10 m/day. They used a specific yield of 20% to estimate the groundwater storage within the palaeochannels, but do not attribute a source for this value.

Analysis of site pump test results indicated horizontal hydraulic conductivities of between 0.7 m/day and 13.3 m/day, with specific storativity of between 6.3 x 10^{-5} and 7.8 x 10^{-4} /m.

4.3.4 Bedrock

Bedrock is treated as a single hydrogeological unit due to limited data regarding regional distribution of properties in the vicinity of the model.

Johnson et al. (1999) provide no guidance for hydraulic conductivity in bedrock, indicating that it is likely to be highly variable. They provide some guidance for specific yield, listing indicative values of 0.1% for weathered bedrock, 1% for fractured fresh bedrock, and 5% for fractured oxidised bedrock.

4.4 Boundary Conditions

Boundary conditions control the inflow and outflow of water from the model domain. These can be divided into lateral boundary conditions, which are associated with the linkages to aquifers in the areas surrounding the model domain, surficial boundary conditions, which specify the interactions of the model domain with the overlying and underlying zones, and internal boundary conditions which evaluate abstraction within the domain. The overlying zones may consist of the unsaturated zone and atmospheric processes such as recharge, rainfall, evaporation and evapotranspiration, whilst the underlying boundary conditions specify leakage both to and from underlying formations.

4.4.1 Lateral Boundaries

Lateral boundary conditions are the boundary conditions that occur on the edge of the model domain. These can consist of specified heads (1st type, Dirichlet), specified fluxes, which includes zero or natural fluxes (2nd type, Neumann), or a mixture of the two (3rd (mixed) type, Cauchy).

These can represent inflows or outflows at the boundary quantifying interaction with adjacent hydrogeological areas.

The current conceptual model for the area indicates that 10 Mile Lake is a terminal lake for all but the largest (and most infrequent) of rainfall events. Similarly the bedrock elevation and piezometric head observations indicate hydraulic gradients are towards 10 Mile Lake, indicating it is a terminal sink for groundwater. Thus natural or no-flow boundary conditions were used on the boundary of the model.

It is noted that the observations are for the overlying sediments and do not include the bedrock. However it is thought that flows through the bedrock are likely to be small and thus insignificant in the overall water balance on the area.

4.4.2 Surficial Boundary Conditions

Surficial boundaries quantify the interaction of the aquifer with the atmosphere (recharge and evaporation) and surface water. This is discussed conceptually in Section 3. In the FEFLOW model, this is specified as a net flux to the model surface. In the current model, recharge, evaporation rates and extinction depth for evaporation are specified for each surficial lithological unit, and FEFLOW dynamically calculates the net flux to each cell based on these parameters and the water table elevation. The model evaporation rate was calculated using the supplied evaporation rate if the water table was at or above the land surface, with the model rate decreasing linearly to zero at the extinction depth below the land surface.

The initial parameters used for the lithological zones are listed in Table 4-1. Evaporation is assumed to be constant over the whole domain, with extinction depths specified based on assumed vegetation (root) depth or effective depth of evaporation. It was assumed that the extinction depth was 2 m for the valley floor, 0.5 m for the salt lakes, and 4 m for the weathered rock outcrops.

Table 4-1: Surficial Boundary Conditions for Different Surficial Units

Unit	Recharge (mm/annum)	Evaporation (mm/annum)	Extinction Depth (m)
Weathered Bedrock	0.3	4,100	4.0
Alluvium over Weathered Bedrock	2.4	4,100	3.0
Alluvium over Clay	2.4	4,100	2.0
Calcrete	2.4	4,100	2.0
Salt lake	2.4	4,100	0.5

4.4.3 Internal Boundary Conditions (Abstraction)

Internal boundary conditions quantify inflows and outflows internal to the model. These indicate abstraction from the aquifers. In the current model these were the abstraction used for the aquifer testing (calibration) or brine processing (production). Individual programs and tests carried out at 10 Mile Lake are discussed below.

2015 Field Program

Due to the uncertainty in this data, the 2015 field program data was not used in the model calibration.

2017 Field Program

A summary of the abstraction program at 10 Mile Lake used for the calibration, and the associated observation wells are in Table 4-2. A graphical timeline of the abstraction and data loggers are in Table 4-3 and Table 4-4. The full testing period was not used for the calibration as some abstraction records were not available.

Table 4-2: Abstraction from Confined Aquifer

Abstraction Well	Start Abstraction	End Abstraction	Observation Bores (distance [m])
WB10	21/04/2017 10:00	25/04/2017 17:47	TMAC12 (475), TMAC13 (320), TMAC14 (250), WB10MB (10)
WB12	22/04/2017 10:15	22/04/2017 13:28	TMAC21 (400)
TMPB26	22/04/2017 16:47	23/04/2017 07:53	TMAC26 (19)
TMPB23	29/04/2017 07:20 04/05/2017 13:30	01/05/2017 20:29 10/05/2017 19:40	TMAC23 (17), TMAC11 (382), TMAC22 (1,374)
TMPB12	12/05/2017 20:55 27/05/2017 13:38 12/06/2017 14:30	13/05/2017 00:21 27/05/2017 21:28 26/06/2017 19:55	TMAC12 (8)

Table 4-3: Abstraction Time Line

	April												May																															June																													
Bore	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
TMPB26				🟦	🟦																																																																				
WB10			🟦	🟦	🟦	🟦	🟦	🟦																																																																
WB12			▨	🟩																																																																					
TMPB23											🟨	🟦	🟦			🟦	🟦	🟦	🟦	🟦	🟦	🟦																																																					
TMPB12																							▨	🟨	🟨					▨	▨	▨	▨	▨					🟨	▨	▨					▨	▨								🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦				
	Legend				🟨 Step			🟦 CRT			🟩 Step & CRT					▨ Calibration testing/Trial pond filling																																																											

Table 4-4: Monitoring and Abstraction Bore Data Logging

	April												May																															June																													
Bore	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
TMAC11M1										🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																																							
TMAC12M1	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩													🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩						🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		
TMAC12M2																										🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		
TMPB12																							🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩							🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		
TMAC13M1	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩													🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩						🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		
TMAC14M1	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩														🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		
TMAC15M1																								🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		
TMAC21M1			🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																																																																
TMAC22M1										🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																																							
TMAC23M1										🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																																
TMAC23M2			🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																																																			
TMPB23										🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																																																			
TMAC24M1										🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																																																			
TMAC26M1				🟩	🟩	🟩	🟩	🟩	🟩	🟩																																																															
TMPB26				🟩	🟩	🟩	🟩			🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																																																			
WB10MBD			🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																																																														
WB10MBI			🟩	🟩	🟩																																																																			
WB12MBD	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																																																															
WB12MBI	🟩	🟩	🟩																																																																					
WB12B				🟩																																																																				

WB12TB2

This site is located close to the western edge of 10 Mile Lake (Figure 4-6). The water levels recorded during a step test and a short constant rate test (CRT) (<2 hours) were within the abstraction bore and nearby monitoring bores (WB12MBD and WB12MBI). Logged water levels were available for the recovery at the observation bore TMAC21, approximately 400 m away. The WB12 monitoring bores were screened over the confined and surficial aquifers and were not used in the calibration.

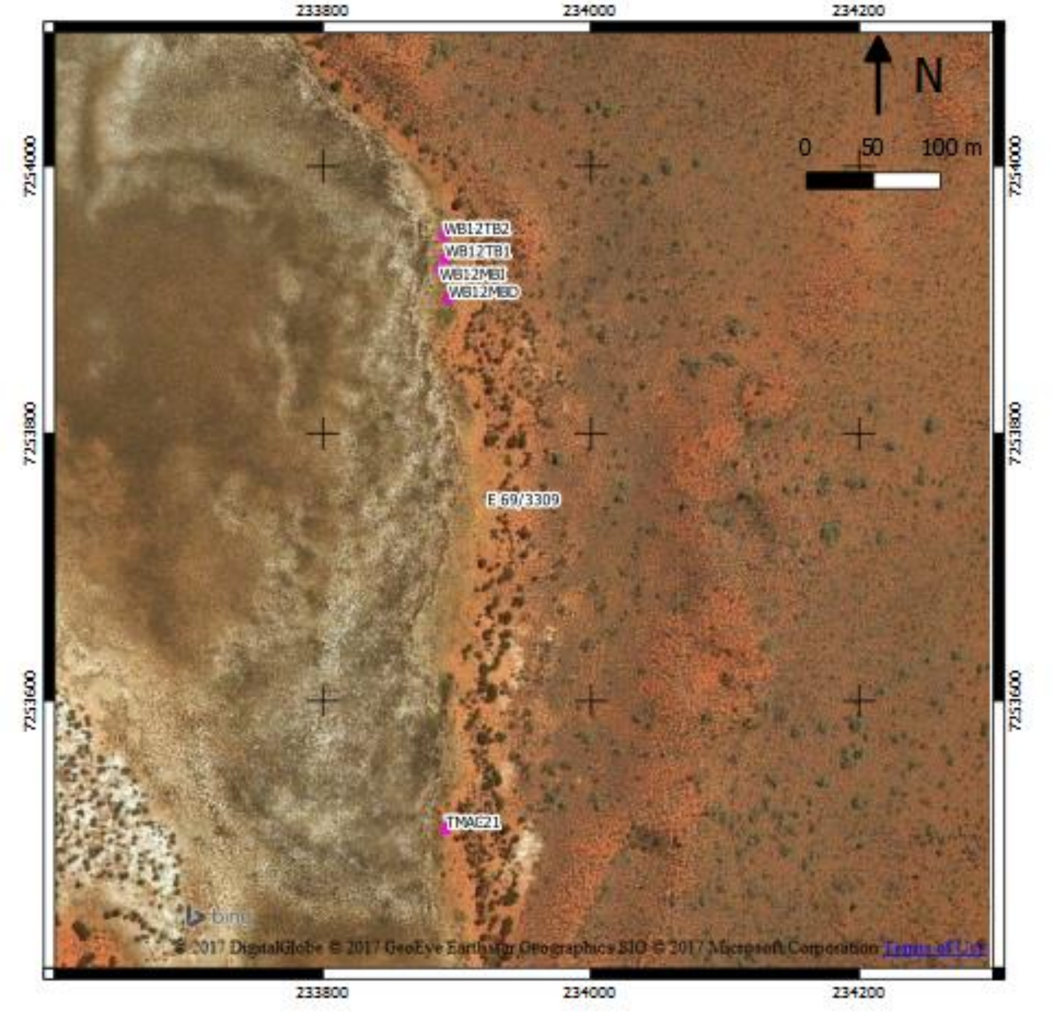

Figure 4-6: WB12 pump test location and monitoring bores

TMPB12

At this bore two step tests and a constant rate test were undertaken.

In the first step test, three hourly steps were used with rates of 6.3 L/s, 10 L/s, and 15 L/s, with a final step of 16 L/s for approximately 25 minutes. The maximum observed drawdown was 63 m.

In the second step test, four were used with rates of 7 L/s (90 minutes), 10 L/s (120 minutes), 12 L/s (90 minutes) and 14 L/s (150 minutes). The maximum observed drawdown was 62 m.

The constant rate test ran for 14 days using an abstraction rate of 12 L/s. The maximum observed drawdown was 52 m.

Analysis indicated a transmissivity of 25 m^2/day, equivalent to 2.3 m/day hydraulic conductivity for an aquifer thickness of 11 m. Analysis using the Theis method indicated a potential storativity of 7.79×10^{-4} for the aquifer.

Monitoring was carried out at the nearby TMAC12M1 bore (8.0 m distant). The location of this bore relative to the abstraction bore is shown in Figure 4-7. A logger was installed and started at 11 May 2017 12:00 and showed a number of drawdown occurrences of up to six meters before the step rate test was started In TMPB12 at 12 May 2017 20:55. No information exists for the abstraction rates or durations for these events, which is likely to have been the calibration testing prior to the step rate test. Data from the start of the step rate test for TMPB12 was used for the calibration. It is noted that the water level observed in TMAC12M1 has a minimum of 550 mAHD, which occurs during the second step of the step rate test. This indicates that the piezometer may not have been positioned deep enough. For the calibration, the logged observations below the minimum level were omitted.

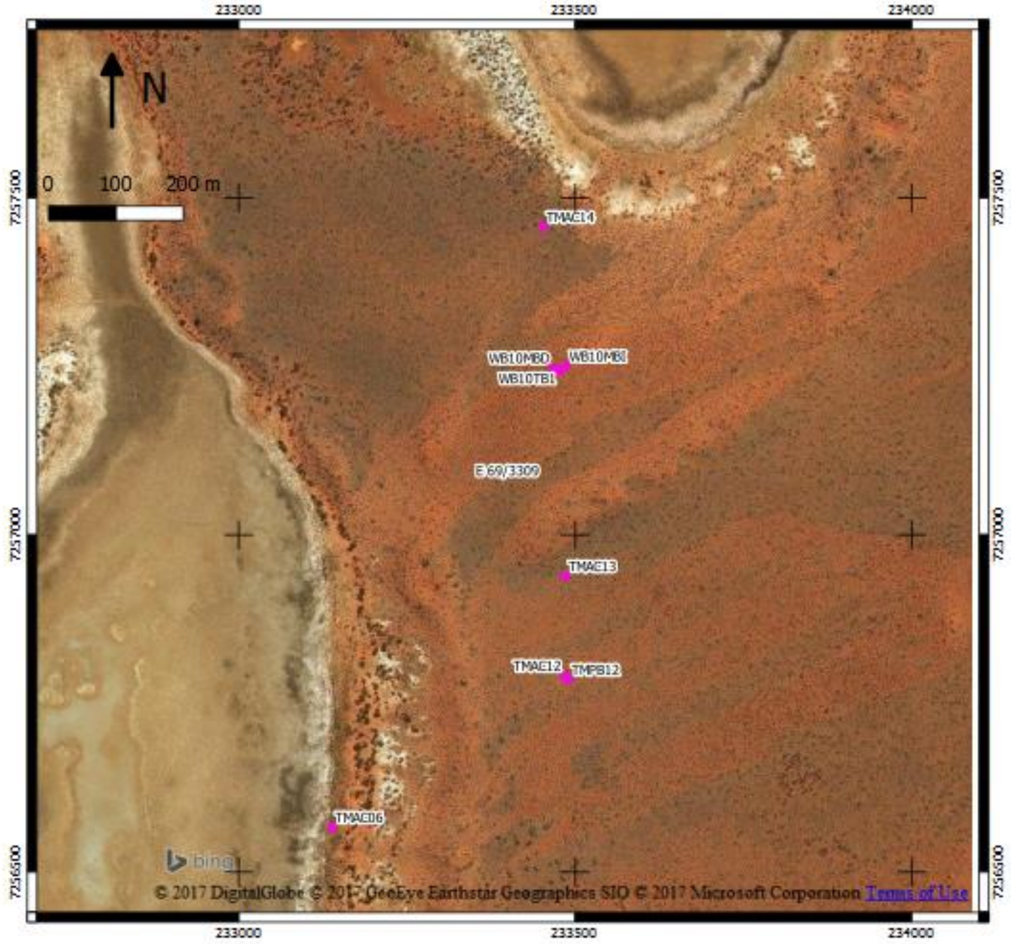

Figure 4-7: WB10 and TMPB12 pump test locations and monitoring bores

TMPB23

Two constant rate tests were carried out at this site. The first test had inconsistent pumping rates and was stopped after 2.5 days. The second constant rate test was for 6.5 days at 10 L/s. Three monitoring bores were also logged and dipped during the test. The monitoring bores and their distances to abstraction bore are listed in Table 4-2. The location of the monitoring bores relative to the abstraction bore is shown in Figure 4-8.

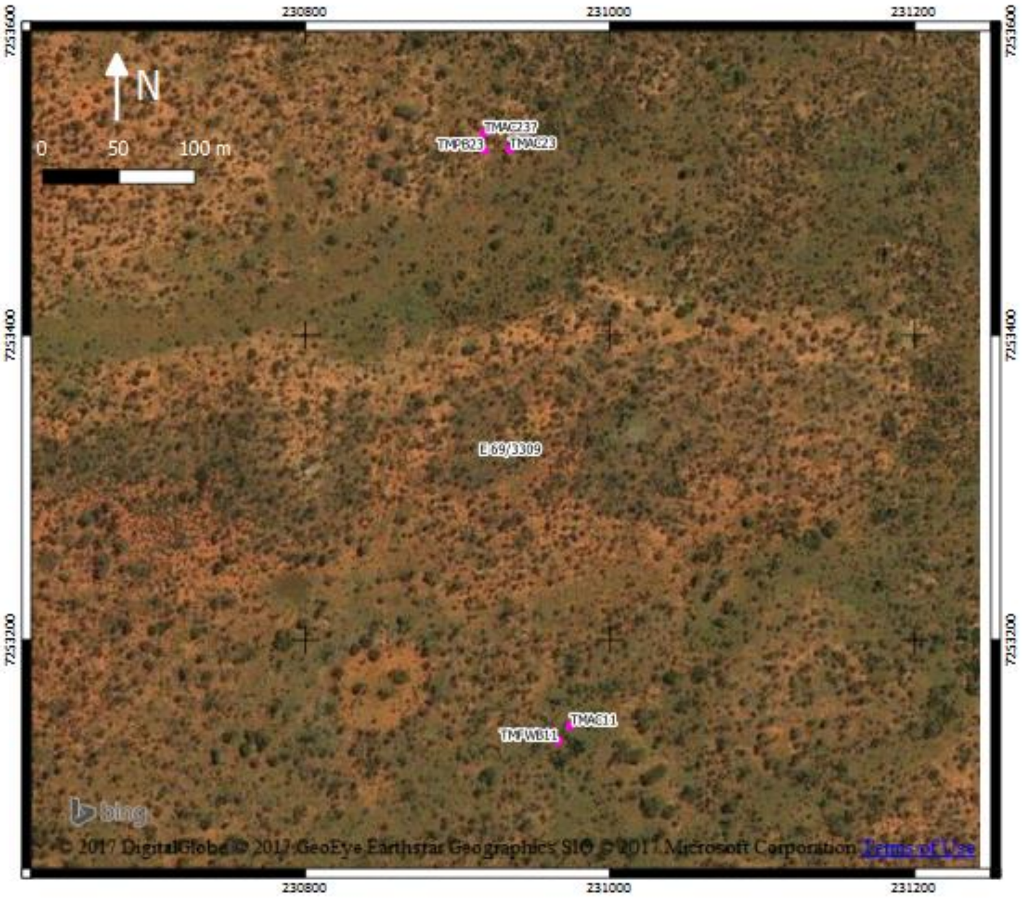

Figure 4-8: TMPB23 pump test location and monitoring bores

TMPB26

A single 15 hour overnight constant-rate test was recorded at this site along with responses at nearby observation bores. The location of these bores is shown in Figure 4-9.

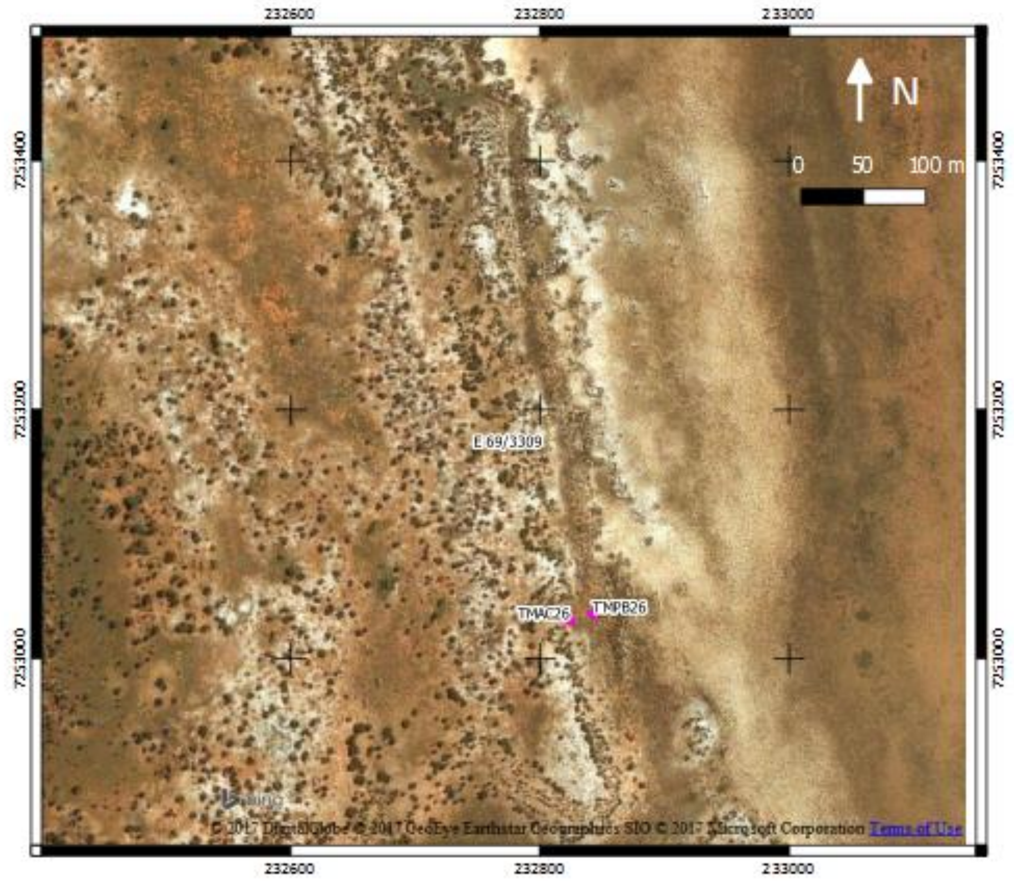

Figure 4-9: TMPB26 pump test location and monitoring bores

A summary of the abstraction periods for each abstraction bore and observation bores associated with each abstraction bore as used for the regional transient calibration are in Table 4-2. Details of the available manual observations are listed in Table 4-5, and available logged observations are listed in Table 4-6 for the transient model.

Table 4-5: Manual Observations

Observation Well	Layer	First Observation	Range (mAHD)	Comment
TMAC06	Surficial	22/4/2017	558.38-558.41	Little variation, 400m southwest TMPB12
TMAC09M1	Deep (siltstone)	23/4/2017	558.70-558.77	Little variation, 2km south of TMPB26
TMAC09M2	Surficial	23/4/2017	558.93-558.98	Upwards gradient

Observation Well	Layer	First Observation	Range (mAHD)	Comment
TMAC11M1	Deep (Palaeochannel)	28/4/2017	550.86-561.04	Drawn down 30/4-10/5, then recovers
TMAC11M2	Surficial	27/04/2017	559.55-559.60	Natural downward gradient
TMAC12M1	Deep (Palaeochannel)	20/4/2017	538.55-558.90	Response to numerous abstraction intervals
TMAC12M2	Surficial	20/4/2017	558.53-558.93	Response to long-term constant rate test
TMAC13M1	Deep (Palaeochannel)	20/4/2017	539.32-558.84	Initial readings high compared with all. Shows response to numerous abstraction intervals
TMAC13M2	Surficial	22/4/2017	558.65-558.83	Small responses to abstraction events
TMAC14M1	Deep (Palaeochannel)	20/4/2017	542.75-557.07	Response to numerous abstraction intervals
TMAC14M2	Surficial	20/4/2017	558.22-559.37	Declines over record period due to initial rise from WB10 test discharge infiltration
TMAC15M1	Deep (siltstone)	22/4/2017	554.82-558.36	> 2km east WB10, TMPB12, small response to both CRTs
TMAC16M1	Deep (dolerite)	23/4/2017	558.75-558.80	1.5km northeast TMPB23, 2km northwest WB12, 3km southwest TMPB12
TMAC16M2	Surficial	23/4/2017	558.71-558.82	No response
TMAC21M1	Deep (dolerite)	21/4/2017	557.74-558.82	Rising – slow recovery from drilling
TMAC21M2	Surficial	21/4/2017	558.86-558.97	400m south of WB12TB
TMAC22M1	Deep (siltstone)	25/4/2017	554.51-558.72	Recovery higher than initial level, response to CRT2 TMPB23 (1.3km south)
TMAC22M2	Surficial	25/4/2017	558.58-558.83	Maximum could be anomalous, Some response to CRT2
TMAC23M1	Deep (siltstone)	27/4/2017	528.28-556.58	Strong response
TMAC23M2	Surficial	27/4/2017	558.80-558.94	No response
TMPB23	Deep (siltstone)	27/4/2017	546.88-563.61	Recovery levels are slightly erratic

Observation Well	Layer	First Observation	Range (mAHD)	Comment
TMAC24M1	Deep (siltstone)	24/4/2017	558.89-558.96	1.4km southwest of TMPB26, Within observation error
TMAC24M2	Shallow	24/4/2017	558.91-559.00	Within observation error
TMAC26M1	Bedrock (siltstone)	22/4/2017	549.54-557.81	Initial reading below recovery water level
TMAC26M2	Surficial	22/4/2017	558.81-558.87	No response
TMPB26	Deep (sandstone)	13/5/2017	557.21-557.32	Post pump test
TMAC27M1	Deep (palaeochannel)	12/5/2017	558.30-558.39	No response, 4.7 km northwest of WB10
TMAC27M2	Shallow	12/5/2017	558.80-558.84	No response
TMAC28M1	Deep (palaeochannel)	9/5/2017	557.05-558.02	Initially recovering from drilling, test at WB10 (2.6km southwest)
TMAC28M2	Shallow	9/5/2017	558.64-558.73	No response, downward gradient
WB09MBD	Deep (palaeochannel)	29/4/2017	558.54-558.72	Small response, 850m northwest of TMPB23
WB10MBD	Deep (palaeochannel)	21/4/2017	557.21-558.84	Response to both WB10 and TMPB12
WB10MBI	Intermediate (clay)	20/4/2017	558.12-559.4	Downward gradient, responds to same
WB11MBD	Deep (palaeochannel)	22/4/2017	557.79(558.66)-558.84	1.3km south of TMPB12, no response
WB11MBI	Intermediate (clay)	24/4/2017	558.73-(558.80)559.50	Highest possibly anomalous
WB12MBD	Deep (palaeochannel)	21/4/2017	556.22-558.97	
WB12MBI	Intermediate (clay)	24/4/2017	558.88-559.35	After test
WB12TB1	Deep (palaeochannel)	24/4/2017	558.95-559.10	After test
WB12TB2	Deep (palaeochannel)	24/4/2017	558.63-559.06	After test
FWB	Surficial (calcrete)	28/4/2017	559.22-559.30	Some unknown dates

Table 4-6: Logged Observations

Observation Well	Layer	Logged Interval(s)	Range (mAHD)	Comment
TMAC11M1	Deep (siltstone)	28/4 – 22/5	541.91-560.90	Full recovery not monitored
TMAC12M1	Deep (palaeochannel)	19/4 – 28/4, 11/5 - 5/6, 11/6 - 28/6	526.04 – 558.95	Response to numerous abstraction intervals
TMAC12M2	Surficial	14/5 - 28/6	551.82 – 558.79	Response to long-term constant rate test
TMPB12	Deep (palaeochannel)	11/5 – 4/6, 11/6 – 28/6	501.53 – 570.26	Pumping water levels
TMAC13M1	Deep (palaeochannel)	19/4 – 28/4 12/5 – 5/6 11/6 – 28/6	(530.26) 538.97 – 555.94	
TMAC14M1	Deep (palaeochannel)	19/4 – 28/4 12/5 – 28/6	542.06 – 557.31	
TMAC15M1	Deep (siltstone)	12/5 – 28/6	554.87 – 557.26	
TMAC21M1	Deep (dolerite)	21/4 - 28/4	557.79 - 558.10	Recovery from drilling
TMAC22M1	Deep (siltstone)	28/4-22/5	553.75 - 556.98	Some differences in later times with observed levels (greater logged drawdown) likely due to logger drift
TMAC23M1	Deep (siltstone)	28/4-29/5	525.03-557.00	Still recovering when logger removed rely on dip data onwards
TMAC23M2	Surficial	28/4-11/5	550.28-558.90	No response
TMPB23	Deep (palaeochannel)	28/4-11/5	518.75-555.98	High recovery rate when logger removed
TMAC24M1	Deep (siltstone)	28/4-11/5	558.87-558.98	No response
TMAC26M1	Deep (sandstone)	22/4-28/4	544.33-557.40	Initial reading below recovery water level
TMPB26	Deep (sandstone)	22/4-25/4 28/4-11/5	514.28-557.44	Logger corrupt 24th-28th, inconsistent over gap in record (25-28th), Initial reading below recovery water level
WB10MBD	Deep (palaeochannel)	21/4-28/4	556.93-558.63	Stopped midway through recovery
WB10MBI	Intermediate (clay)	21/4-23/4	558.33-558.88	Stopped before end of test

Observation Well	Layer	Logged Interval(s)	Range (mAHD)	Comment
WB12MBD	Deep (palaeochannel)	19/4-25/4	(533.80)546.89-559.11	Covers known pumping interval, Low anomalous level, Falls during step test, no response (recovery) during CRT
WB12MBI	Intermediate (palaeochannel)	19/4-21/4	18.664-19.792 (not surveyed)	Finished before test
WB12TB2	Deep (palaeochannel)	22/4	520.56-558.73	Production bore, indicates other tests (step test prior)

4.4.4 Trenching

A number of trenches were excavated and tested on 10 Mile Lake. These tests consisted of a straight length of trench to a depth of 2 m on the surface of the lake, with the water in the trench pumped. These tests included pits at different distances from the trench to evaluate the drawdown in the surficial lake sediments. Three tests were analysed. These are listed in Table 4-7. The locations of these tests are shown in Figure 4-10.

Table 4-7: Trench Test Details

Trench ID	Length (m)	Start Test	End Test	Number of Pits
6	81	25/05/2017 10:00	24/06/2017 17:47	2 (1 line)
2	300	25/05/2017 10:15	06/06/2017 13:28	4 (2 lines of 2)
1	500	29/07/2017 16:47	05/04/2017 07:53	12 (4 lines of 3)

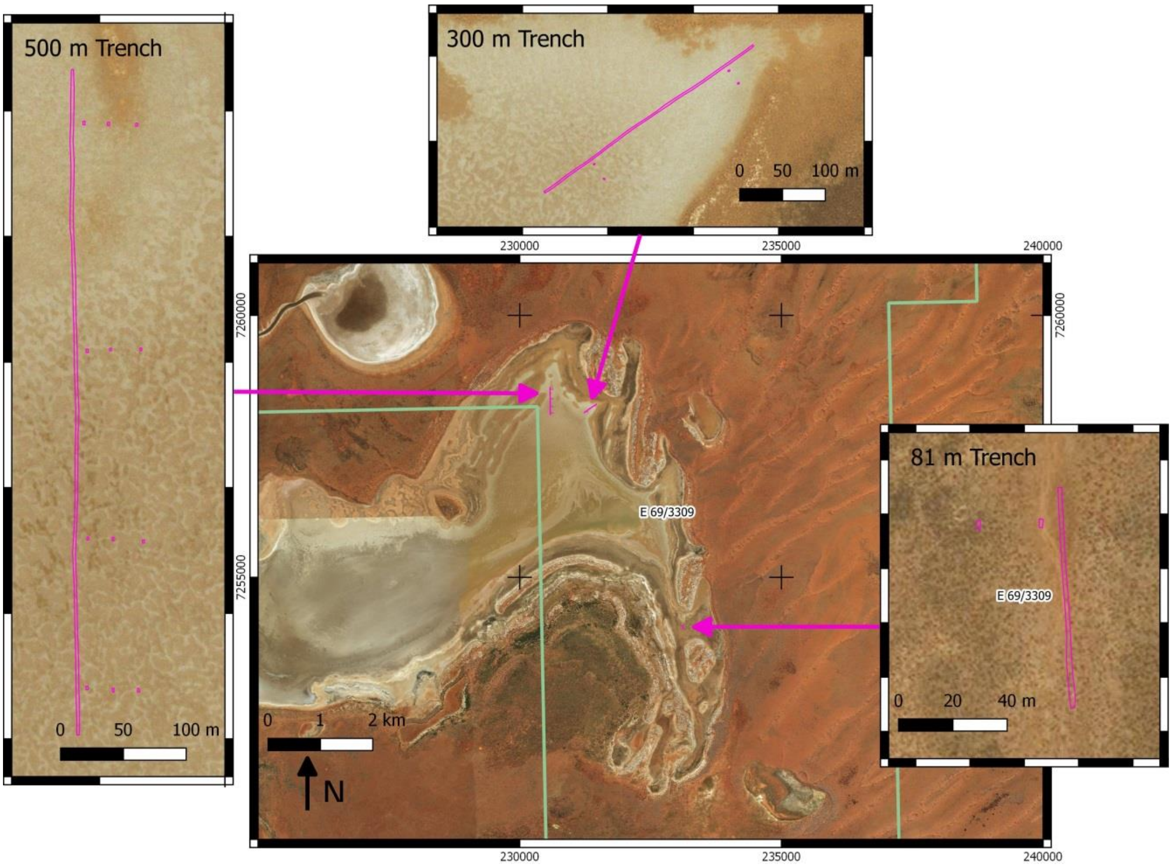

Figure 4-10: Location of Test Trenches on 10 Mile Lake

4.5 Laboratory Derived Aquifer Properties

The specific yield of the clays and deep aquifer cannot be calibrated using the current water level monitoring data as the system is insufficiently stressed. These are instead specified based on laboratory data presented in hydrogeological report. Laboratory derived values of specific yield for bedrock range from 0.0001 based on an analysis of a recovered core section and 0.18 to 0.33 based on drainage from re-moulded drill cuttings. The value of 0.001 is likely to be an underestimate as it is based on a sample of coherent rock recovered and does not take into account fractures, vughs and other features that lead to other core recovery being inconsistent. The value of 0.3 for the remoulded cuttings is likely to be an overestimate as it is based on recovered drill spoils and would be missing some of the smaller constituents of the matrix.

Thus for the purposes of modelling a specific yield of 3% was assumed for the clays, and 10% for the deep aquifer.

4.6 Classification of Available Data for Groundwater Modelling

The AGMG (Barnett et al., 2012) provides confidence classification for various stages of the development of groundwater models. They rank the confidence of the model stage between low (Class 1) and high (Class 3). One of the confidence classification stages is for the data available to build a model.

The 10 Mile Lake model has a mix of historical data available from the Water Information Reporting (WIR) system (Department of Water (DoW), 2016) and data collected between 2015 and 2017 as part of field programs undertaken for the BSOPP. The data collected consists of both manual and automatic data collection from groundwater bores, including responses to aquifer testing (pumping). In terms of the immediate area in the BSOPP tenement (E69/3309) on the eastern side of 10 Mile Lake, there is extensive data available. In this area there is reasonable confidence in the data collected during the 2017 site program. However the length of the record and the immediate area affected, compared with the proposed plans for the area, mean that confidence level for the data is the intermediate Class 2. The remainder of the area has very sparse data, gleaned from either regional surface maps with no hydrogeological depths, or a small number of groundwater bores with single observations. The data for this area has a low confidence level (Class 1). Overall as the BSOPP is focussed on the eastern side of 10 Mile Lake, the confidence rating for the data is Class 2.

5 Model Calibration

The model calibration consisted of a multi-stage process. These processes were:

- An initial steady-state calibration of the regional model;
- A transient calibration of the regional model to the results from the aquifer testing; and
- Independent calibrations of the three trench tests carried out on 10 Mile Lake.

The steady-state calibration is assumed to represent the pre-mining aquifer conditions. Thus the head distribution results from the steady-state calibration will be used as the initial conditions in the transient calibration and for the subsequent simulations.

The steady-state and transient calibration runs were performed in series for each calibration parameter set.

5.1 Calibration Targets

The steady-state calibration used a combination of water levels from the Department of Water and Environmental Regulation Water Information Reporting (WIR) database and initial head observations from bores drilled as part of the BSOPP investigations. Table 5-1 summarises the WIR data available in the vicinity of the model area and Table 5-2 summarises the heads used from the current investigation.

The transient calibration used the measured abstraction rates and drawdowns in various abstraction and monitoring bores during the field investigation. A summary of the data logger information is presented in Table 5-3.

Table 5-1: Piezometric Heads derived from Water Information Reporting (WIR) database

Bore name	Easting	Northing	Elevation (mAHD)	Water Level (mAHD)
BEYONDE HOMESTEAD WELL	201052	7255893	578.0	564.5
TUPEE WELL	201893	7269434	598.0	589.9
GARDEN WELL	202896	7255953	578.0	568.5
SNAKE WELL	203671	7274811	602.9	594.9
WELL	205743	7242803	597.6	596.5
WELL	208306	7230774	597.3	596.2
4 MILE	208798	7256222	572.1	566.0
MARYMIA WELL	209505	7230468	596.7	590.2
WELL	210274	7230874	592.7	591.6
WELL	216245	7234887	583.3	582.2
12 MILE OR LAKE WELL	219209	7261900	570.3	563.0

Table 5-2: Initial Heads in Bores from Manual Dips

Bore name	Easting	Northing	Observation Date	Water Depth (m)	Elevation (mAHD)
TMAC06	233139	7256566	22/04/2017	1.29	558.38
TMAC09M1	232951	7251176	23/04/2017	2.38	558.73
TMAC09M2	232951	7251176	23/04/2017	2.13	558.95
TMAC11M1	230975	7253145	27/04/2017	1.28	561.04
TMAC11M2	230975	7253145	27/04/2017	2.80	559.58
TMAC12M1	233485	7256791	20/04/2017	6.90	558.90
TMAC12M2	233485	7256791	20/04/2017	7.19	558.63
TMPB12PB	233490	7256785	11/05/2017		565.69
TMAC13M1	233486	7256939	20/04/2017	6.00	558.84
TMAC13M2	233486	7256939	22/04/2017	6.01	558.73
TMAC14M1	233453	7257458	20/04/2017	8.77	555.03
TMAC14M2	233453	7257458	20/04/2017	5.79	558.23
TMAC15M1	235752	7257213	22/04/2017	9.30	558.29
TMAC16M1	232062	7254489	23/04/2017	2.90	558.75
TMAC16M2	232062	7254489	23/04/2017	2.96	558.71
TMAC21M1	233892	7253504	21/04/2017	2.98	557.74
TMAC21M2	233892	7253504	21/04/2017	1.87	558.87
TMAC22M1	230516	7254836	25/04/2017	3.99	556.69

Bore name	Easting	Northing	Observation Date	Water Depth (m)	Elevation (mAHD)
TMAC22M2	230516	7254836	25/04/2017	2.30	558.68
TMAC23M1	230934	7253523	27/04/2017	5.52	556.48
TMAC23M2	230934	7253523	27/04/2017	3.30	558.81
TMPB23	230918	7253522	27/04/2017	3.35	558.70
TMAC24M1	231840	7251994	24/04/2017	1.72	558.95
TMAC24M2	231840	7251994	24/04/2017	1.77	558.93
TMAC26M1	232825	7253032	22/04/2017	9.20[1]	552.39[1]
TMAC26M2	232825	7253032	22/04/2017	3.12	558.82
TMPB26	232843	7253037	13/05/2017	4.37[2]	557.21[2]
TMAC27M1	229050	7258970	12/05/2017	3.97	558.30
TMAC27M2	229050	7258970	12/05/2017	3.54	558.82
TMAC28M1	231526	7258961	9/05/2017	4.06	557.05
TMAC28M2	231526	7258961	9/05/2017	2.57	558.64
WB09MBD	230483	7254262	29/04/2017	2.69	558.61
WB10MBD	233468	7257249	21/04/2017	6.89	558.69
WB10MBI	233487	7257251	20/04/2017	7.22	558.97
WB11MBD	233545	7255522	22/04/2017	1.28	558.78
WB11MBI	233542	7255524	24/04/2017	1.93	558.77
WB12MBD	233894	7253901	21/04/2017	1.70	558.70
WB12MBI	233888	7253923	24/04/2017	1.30	559.29
WB12TB1	233892	7253931	24/04/2017	1.70	559.01
WB12TB2	233891	7253948	24/04/2017	1.98	558.63
FWB	230966	7253135	Not recorded	3.22	559.26

1 - Observation during pumping, not included in calibration

2 - Observation post-pumping

Table 5-3: Bore Logger Data for 10 Mile Lake

Bore Name	Start Record	End Record	Number Observations	Observation Frequency (minutes)
TMAC11M1	28/4/2017	22/5/2017	3432	10
TMAC12M1	19/4/2017	24/4/2017	104	60
	26/4/2017	28/4/2017	2945	1
	11/5/2017	5/6/2017	36124	1
	11/6/2017	28/6/2017	24886	1
TMAC12M2	14/5/2017	28/6/2017	65082	1
TMPB12	11/5/2017	4/6/2017	34299	1
	11/6/2017	16/6/2017	14486	0.5
	16/6/2017	26/6/2017	7416	2

Bore Name	Start Record	End Record	Number Observations	Observation Frequency (minutes)
	26/6/2017	28/6/2017	2862	1
TMAC13M1	19/4/2017	25/4/2017	140	60
	26/4/2017	28/4/2017	2944	1
	12/5/2017	14/5/2017	565	5
	14/5/2017	5/6/2017	31833	1
	11/6/2017	28/6/2017	24778	1
TMAC14M1	19/4/2017	23/4/2017	92	60
	23/4/2017	25/4/2017	294	10
TMAC15M1	12/5/2017	28/6/2017	13583	5
TMAC21M1	21/4/2017	25/4/2017	559	10
	25/4/2017	28/4/2017	71	60
TMAC22M1	28/4/2017	22/5/2017	3429	10
TMAC23M1	28/4/2017	29/5/2017	8887	5
TMAC23M2	28/4/2017	11/5/2017	3692	5
TMPB23	28/4/2017	11/5/2017	18367	1
TMAC24M1	28/4/2017	11/5/2017	311	60
TMAC26M1	22/4/2017	23/4/2017	1112	1
	25/4/2017	28/4/2017	78	60
TMPB26	22/4/2017	25/4/2017	4297	1
	28/4/2017	11/5/2017	1912	10
WB10MBD	21/4/2017	23/4/2017	302	10
	23/4/2017	28/4/2017	1386	5
WB10MBI	21/4/2017	23/4/2017	302	10
WB12MBD	19/4/2017	21/4/2017	41	60
	21/4/2017	23/4/2017	2771	1
	23/4/2017	28/4/2017	106	60
WB12MBI	19/4/2017	21/4/2017	41	60
WB12B	22/4/2017	22/4/2017	390	1

5.2 Calibration Methodology

Each calibration process was used to evaluate different parameters in the model. Results from the steady-state calibration were used for the deep aquifer calibration. Greater details about the methodology used for each of the calibration processes are described below.

5.2.1 Steady-state Regional Calibration

The steady-state regional calibration was used to evaluate regional hydraulic conductivities of identified lithological units. The calibration used PEST (Watermark Numerical Computing, 2010) to vary the parameter values specified in Table 5-4 with the aim to minimise the difference between the observed and the simulated piezometric heads.

It is always problematic to calibrate a groundwater model for both hydraulic conductivity and recharge without prior knowledge of one of these parameters or knowledge of an independent system variable such as a flux. This is because simultaneous calibration of recharge and hydraulic conductivity can generate non-unique parameter values for a set of specified heads. Therefore the focus of the steady-state calibration was to modify the hydraulic conductivity in preference to the recharge rates. Thus the recharge rates and evapotranspiration parameters in Table 4-1 were adopted as valid and not modified in the calibration procedure.

Table 5-4: Initial Value and Parameter Ranges for Calibration of the Steady-State Model

Unit	Horizontal Hydraulic Conductivity (m/day)	Vertical Hydraulic Conductivity (m/day)
Weathered Rock	0.01 (1.0 x 10^{-6}- 1000)	0.01 (1.0 x 10^{-8}- 1000)
Bedrock	0.001 (1.0 x 10^{-6}- 1000)	0.001 (1.0 x 10^{-8}- 1000)
Alluvium	3.0 (1.0 x 10^{-6}- 1000)	0.03 (1.0 x 10^{-8}- 1000)
Calcrete	3.0 (1.0 x 10^{-6}- 1000)	0.03 (1.0 x 10^{-8}- 1000)
Lake Sediment	3.0 (1.0 x 10^{-6}- 1000)	0.03 (1.0 x 10^{-8}- 1000)
Palaeochannel Clays	1.0 x 10^{-4} (1.0 x 10^{-6}- 1000)	1.0 x 10^{-5} (1.0 x 10^{-8}- 1000)
Deep Aquifer	2.0 (1.0 x 10^{-6}- 1000)	0.02 (1.0 x 10^{-8}- 1000)

5.2.2 Confined Aquifer Calibration

The majority of the water level data collected in the project is in the vicinity of 10 Mile Lake and as such covers only a small percentage of the model domain. Thus these values are supplemented by regional data from the WIR database, which were observed at different times. It was assumed for the purposes of calibration that these observations represented regional groundwater levels.

The purpose of the calibration is to match the initial heads to minimise the residual (difference between observed and simulated values) of the regional piezometric heads and the observed drawdowns associated with the aquifer testing. A summary of the available piezometric heads recorded by data logger was presented in Table 4-6. The observations used for the calibration are listed in Table 5-5, together with the overall weights for each set of observations. The weights were assigned using the following rules:

- A weight of 1 was assigned to the combined observations in the surficial layer. The hydrogeological properties in the surficial and the clay layers were not the subject of this part of the calibration procedure;

- A weight of 100 was assigned to observations in the confined aquifer; and
- A weight of zero was assigned in the production bore used for abstraction during the observation period, or, in the case of WB10, where the bore construction issues meant that multiple aquifers are linked and thus the bores water levels are responding to an average of the heads in the surficial and confined aquifers.

As the number of observations for each bore and period differed, the overall weight above was divided by the number of observations for each individual observation.

A number of different periods are used for the calibration for different bores. These correspond to either different aquifer tests or different periods when logger data was available.

Table 5-5: Observations used for Confined Aquifer Calibration

Bore name	Type Observation	Start Date	End Date	Number Observations	Overall Weight
TMAC11M1	Logger	4/05/2017	10/05/2017	900	100
TMAC12M1	Logger	21/04/2017	24/04/2017	63	100
TMAC12M1	Logger	26/04/2017	28/04/2017	99	100
TMAC12M1	Logger	12/05/2017	14/05/2017	100	100
TMAC12M1	Logger	11/06/2017	28/06/2017	100	100
TMAC12M2	Logger	11/06/2017	28/06/2017	101	1
TMAC13M1	Logger	21/04/2017	25/04/2017	99	100
TMAC13M1	Logger	26/04/2017	28/04/2017	99	100
TMAC13M1	Logger	11/06/2017	28/06/2017	100	100
TMAC13M2	Manual	24/04/2017	18/05/2017	21	1
TMAC13M2	Manual	11/06/2017	28/06/2017	13	1
TMAC14M1	Logger	21/04/2017	25/04/2017	345	100
TMAC14M1	Logger	26/04/2017	28/04/2017	98	100
TMAC14M1	Logger	11/06/2017	28/06/2017	99	100
TMAC14M2	Manual	11/06/2017	28/06/2017	14	1
TMAC15M1	Manual	23/04/2017	15/05/2017	22	1
TMAC15M1	Logger	11/06/2017	28/06/2017	99	100
TMAC22M1	Logger	4/05/2017	22/05/2017	101	100
TMAC22M2	Manual	6/05/2017	18/05/2017	10	1
TMAC23M1	Logger	4/05/2017	26/05/2017	108	100
TMAC26M1	Logger	22/04/2017	28/04/2017	99	100
TMPB12	Logger	12/05/2017	12/05/2017	212	0
WB10MBD	Logger	21/04/2017	28/04/2017	100	0
WB10MBD	Manual	28/04/2017	16/05/2017	9	0
WB10MBD	Manual	11/06/2017	28/06/2017	13	0
WB10MBI	Logger	21/04/2017	23/04/2017	301	0
WB10MBI	Manual	23/04/2017	14/05/2017	10	0
WB10MBI	Manual	11/06/2017	28/06/2017	13	0

The confined aquifer transient calibration was performed for the region of aquifer testing and observation bores. This region was arbitrarily defined as the area with reasonable confidence for the aquifer testing results. As the bore logs from the drilling program and results from the pump tests identified that the confined aquifer is geologically complex, the calibration was carried out only for the local area using an interpolation/extrapolation method (kriging) based on data at pilot points. The kriging method used the PEST (Watermark Numerical Computing, 2010; 2013; 2014a;b) routines and the default parameters provided in FEPEST (DHI, 2015).

This region and the location of the pilot points are shown in Figure 5-1. The hydraulic conductivity parameters for the remaining lithological units were those derived from the steady-state calibration, with the storage coefficients defined in Table 5-6. In this area, horizontal hydraulic conductivity is independent for x and y directions.

Table 5-6: Initial Parameter Values for Pilot Points in Confined Aquifer Calibration

Parameter	Initial Value	Bounds
Kx (m/day)	2	(0.1 - 20)
Ky (m/day)	2	(0.1 - 20)
Kz (m/day)	2	(0.001 - 20)
Ss (/m)	1.0×10^{-7}	1.0×10^{-7}
Sy (-)	0.2	-

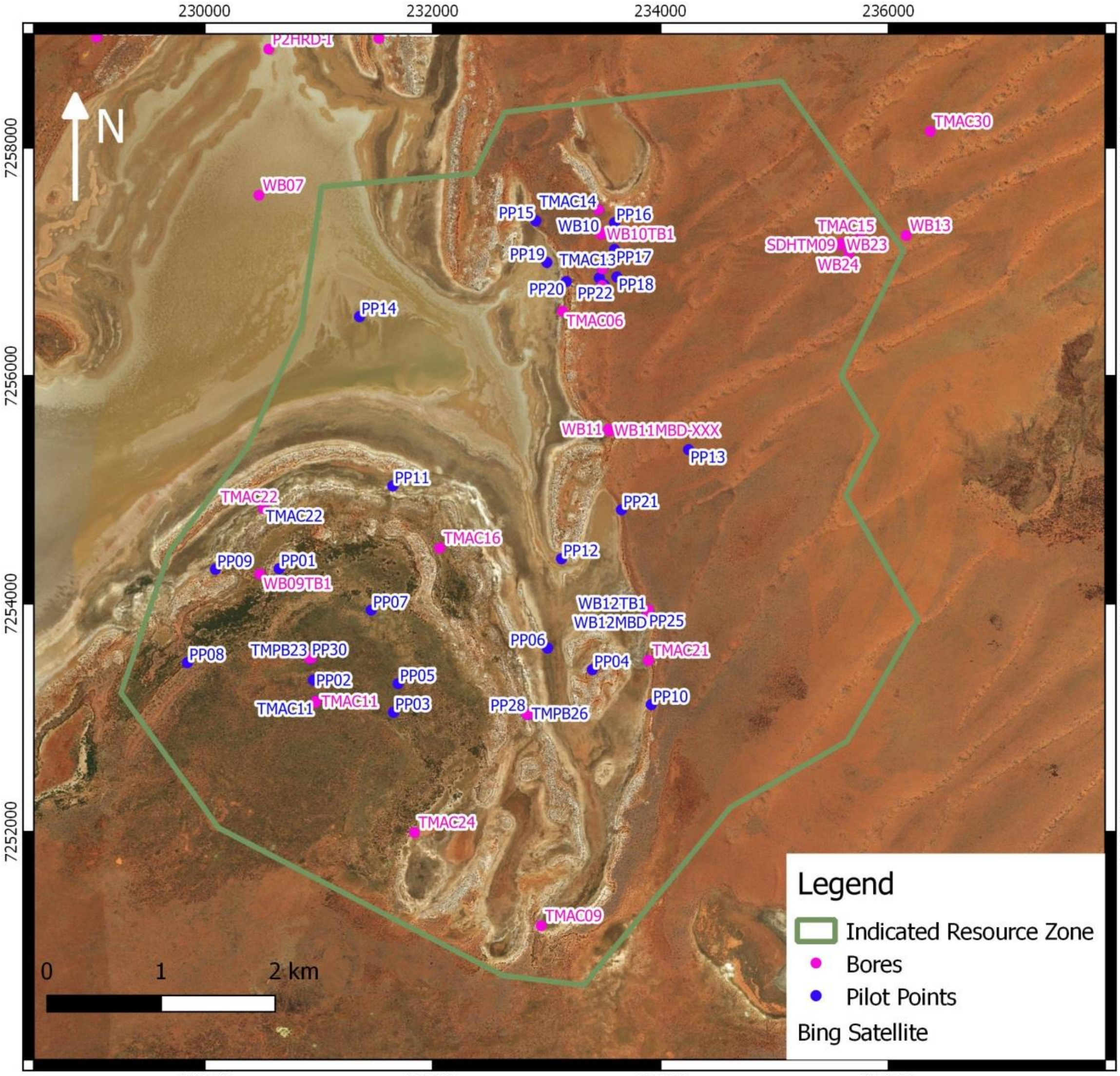

Figure 5-1: Location of Pilot Points for Indicated Resource Zone

5.2.3 Trench Calibrations

The abstraction for the transient calibration simulations was based on the available field data from the site. The flow rates from the trenches were based on the flow records. These were entered into the models as step changes in the rates.

The purpose of calibration was to minimise the difference between the observed drawdown in the pits, including the trench and the simulated drawdowns.

For the calibration, a local surficial model was used to assess the conductivity and specific yield of the surficial system. An individual model was constructed for each trench. The model consisted of

4 layers (5 slices) in FEFLOW extending over an area with a buffer of 2 km around the trench and pits. The shape file of the buffer was smoothed to ensure a reasonable spacing between all nodes of the shape. The surveyed bounds of the pits and trenches were converted to points with a separation of approximately 0.5m. The triangle mesh generator within FEFLOW was used to generate the mesh.

The models had a total thickness of 15 m of surficial sediments. The layer thicknesses in descending order were 1.9 m, 0.1 m, 2 m and 11 m.

The trenches and pits were assumed to be excavated on average to 2 m with vertical sides. The trench and pit areas remained constant during the simulations, i.e. any slumping that occurred was ignored. The initial parameters for each trench model are listed in Table 5-7.

Abstraction for Trench 1 (500 m) in pump 1 was intermittent due to low water around the intake of the high flow rate pump. Therefore abstraction rates for this pump were averaged over the intervals between observations of the cumulative flow meters associated with each pump. The abstraction from each pump is shown in Figure 5-2. The abstraction in the other trench tests was based on the instantaneous flow rates specified in the test logs (Figure 5-3, Figure 5-4).

Table 5-7: Lake Surficial Sediments and Trenches and Pits: Initial Parameterisation and Calibration Bounds

Parameter	Lake Sediment (Bounds)	Trench/Pit
Kh (m/day)	2 (0.1 - 20)	1.0×10^{6}
Kz (m/day)	2 (0.001 – 20)	1.0×10^{6}
Ss (/m)	1.0×10^{-7}	1.0×10^{-7}
Sy (-)	0.2 (0.05 – 0.3)	0.9999

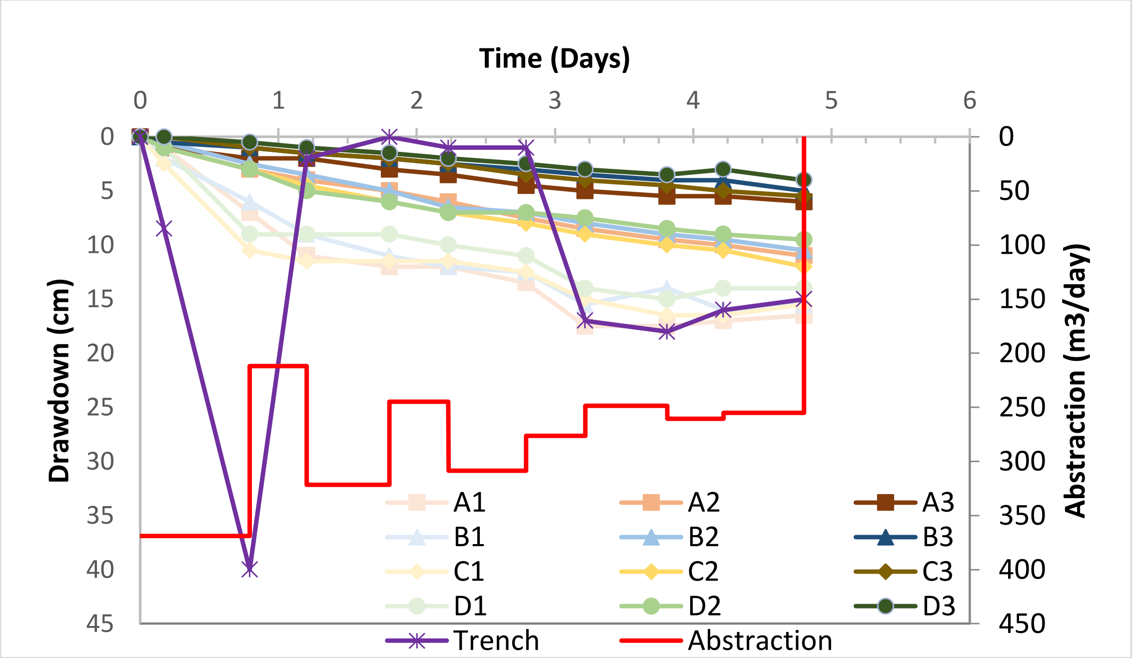

Figure 5-2: Abstraction Trench 1 (500m)

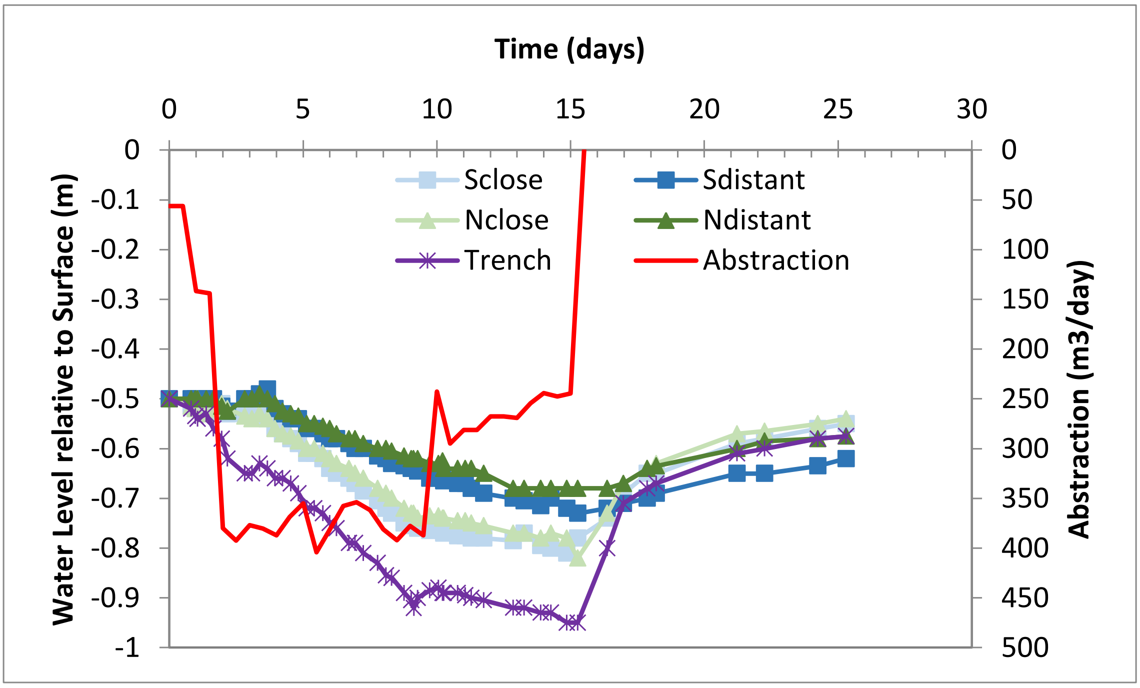

Figure 5-3: Abstraction Trench 2 (300m)

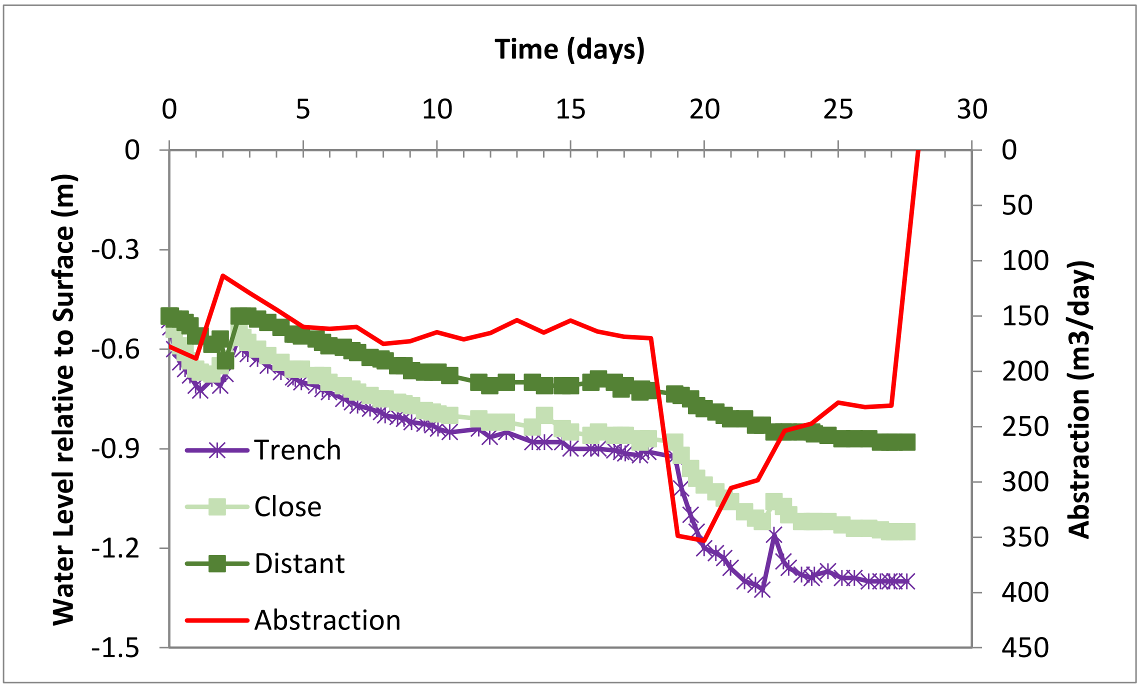

Figure 5-4: Abstraction Trench 6 (81m)

For all models the initial head was assumed to be 0.5 m below the surface. All observations of drawdown in the trenches and pits were modified to use this datum for the calibration procedure. The heads in slices 2-5 around the boundary of the model were also set to 0.5 m below the land surface. No rainfall or evaporation was simulated in the testing. It is noted that there was a rainfall event during the testing for the 80 and 300 m trenches, but accurate measurement was not available at the time, and surrounding Bureau of Meteorology sites had inconsistent records.

Observations of water level were recorded at least twice daily for the trenches and the observation/test pits. These are shown in Figure 5-2 to Figure 5-4 for the three trenches.

Each model was calibrated in PEST, using constant (zonal) values for the horizontal and vertical hydraulic conductivity and the specific yield for the surficial formation. The initial parameter values for each of the trenches are shown in Table 5-7.

5.3 Calibration Results

The results of the different calibrations are presented individually below.

5.3.1 Steady-State Regional

The resulting hydraulic conductivities for different lithological units from the steady-state calibration are presented in Table 5-8, together with 95% confidence intervals. The large size of these 95% confidence intervals indicates that there is insufficient data to confidently calibrate the model over the whole domain. The greatest confidence in the model is in the vicinity of the test program around 10 Mile Lake, where the majority of the data was available. The calibration achieved a Scaled Root-Mean Square (SRMS) value of 10.2%. This indicates reasonable results bearing in mind the zonal nature of the model, the geographical sparseness of the data, uncertainties in the observed data and the 95% confidence interval. Additional results and discussion from the calibration are in Appendix B. The distribution of residuals in the calibration is shown in Figure 5-5.

Table 5-8: Steady-State Calibration Results (95% confidence limits)

Lithological Unit	Kh (m/day)	Kz (m/day)
Bedrock	1.8×10^{-3} (3×10^{-69}-1×10^{63})	4.3×10^{-3} (4×10^{-303}-4×10^{297})
Weathered rock	6.6×10^{-3} (2×10^{-44}-2×10^{39})	9.8×10^{-4} (7×10^{-107}-1×10^{63})
Surficial Alluvium	3.0 (0.11-80)	0.36 (4×10^{-301}-4×10^{299})
Calcrete	2.4 (0.06-90)	0.065 (7×10^{-302}-7×10^{298})
Clays	1.3×10^{-4} (1×10^{-304}-1×10^{296})	1.2×10^{-5} (3×10^{-26}-4×10^{15})
Deep Aquifer	2.1 (3×10^{-23}-1×10^{23})	0.085 (3×10^{-69}-1×10^{63})

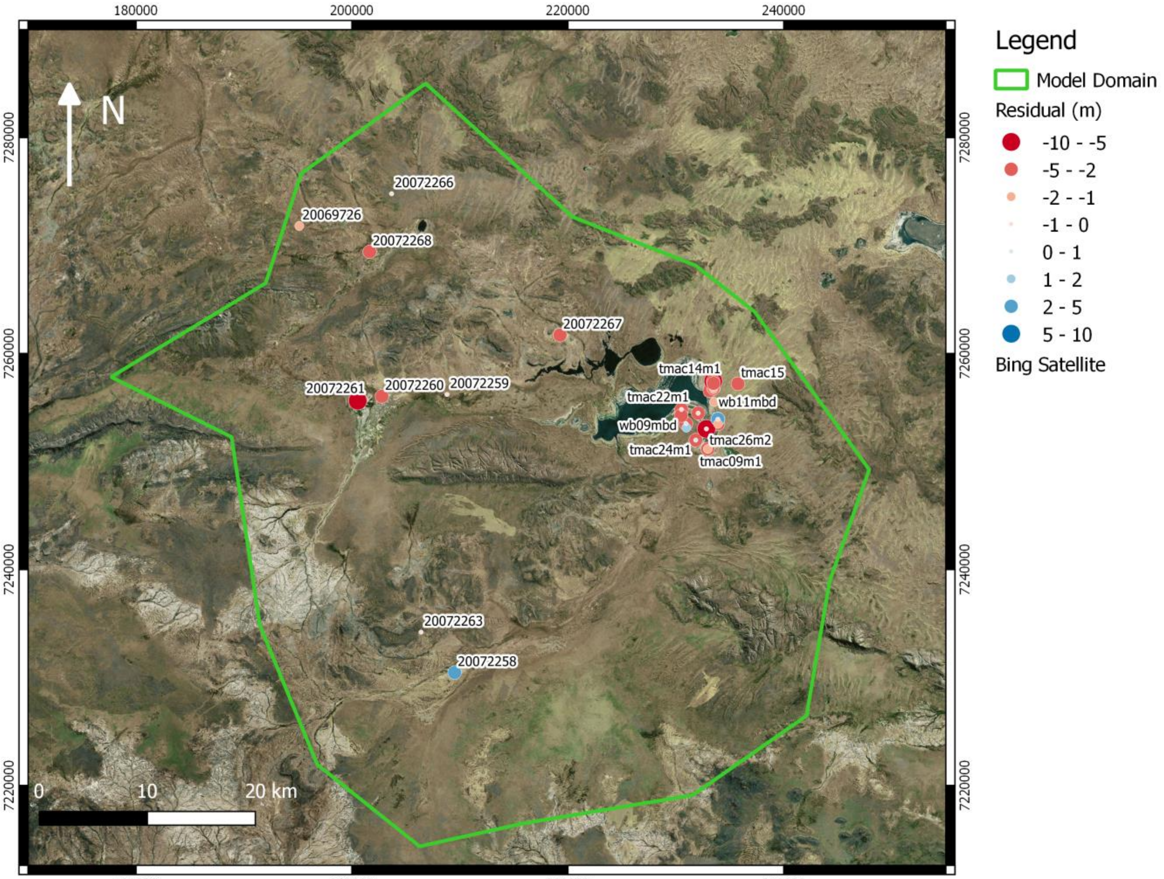

Figure 5-5: Residual Distribution for Steady-State Model

Table 5-9: Water Budget for Steady-state Calibration

Flux	Inflow (m^3/day)	OutFlow (m^3/day)	Net Flow (m^3/day)
Specified Head	0	31.9	-31.9
Recharge	945.2	0	945.2
Evapotranspiration	0	913.3	-913.3
Total	**945.2**	**945.2**	**0.0**
Imbalance (FEFLOW)		0.02	-0.02
%Imbalance		0.00%	

5.3.2 Confined Aquifer

A summary of the results from the transient calibration are presented in Table 5-10. The full results from the deep aquifer calibration are in Appendix B. Figure 5-6 shows the distribution of transmissivity, Figure 5-7 and Figure 5-8 show the distribution of the two horizontal hydraulic conductivity components, Figure 5-9 shows the distribution of vertical hydraulic conductivity and Figure 5-10 shows the distribution of specific storage in the indicated resource area together with the bore and pilot point locations. The higher transmissivity zone running northwest-southeast across the indicated resource area may be indicative of a dyke, whilst the high conductivity in east-west directions may be indicative of palaeochannel sands.

A statistical analysis of the calibration results found that the SRMS error was 2.7% for all drawdowns which were weighted in the calibration. A comparison of the calibrated versus weighted observed piezometric heads is in Figure 5-11, and an example simulated hydrograph with four distinct intervals of logged observations for bore TMAC12 is in Figure 5-12. Additional statistical analysis and comparisons of simulated and observed piezometric heads are presented in Appendix B.

The range of hydraulic conductivity values found in the calibration exceeded those found in the field testing. This may be because the effective aquifer thickness was different from that in the model, and the calibration was to the transmissivity rather than the hydraulic conductivity.

Table 5-10: Calibrated Value Ranges from Confined Aquifer Calibration

Parameter	Range of Values	Mean	Median	Areal Average
Kx (m/day)	0.1 - 200	37	9.6	13.2
Ky (m/day)	0.1 - 200	48	8.8	13.1
Kz (m/day)	0.058 - 42	2.2	0.54	1.01
Ss (/m)	$2.4 \times 10^{-9} – 1 \times 10^{-4}$	6.0×10^{-5}	7.2×10^{-5}	4.9×10^{-5}

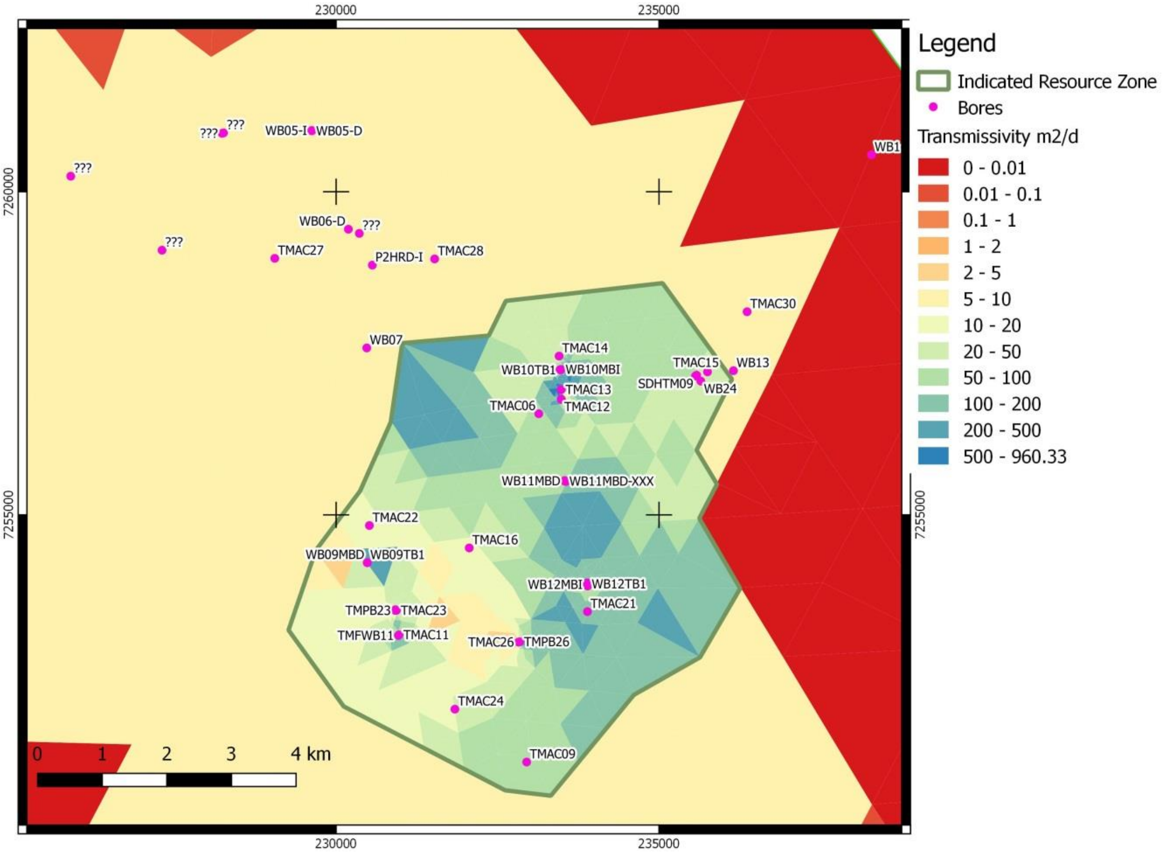

Figure 5-6: Distribution of Transmissivity in Confined Aquifer within Indicated Resource Zone

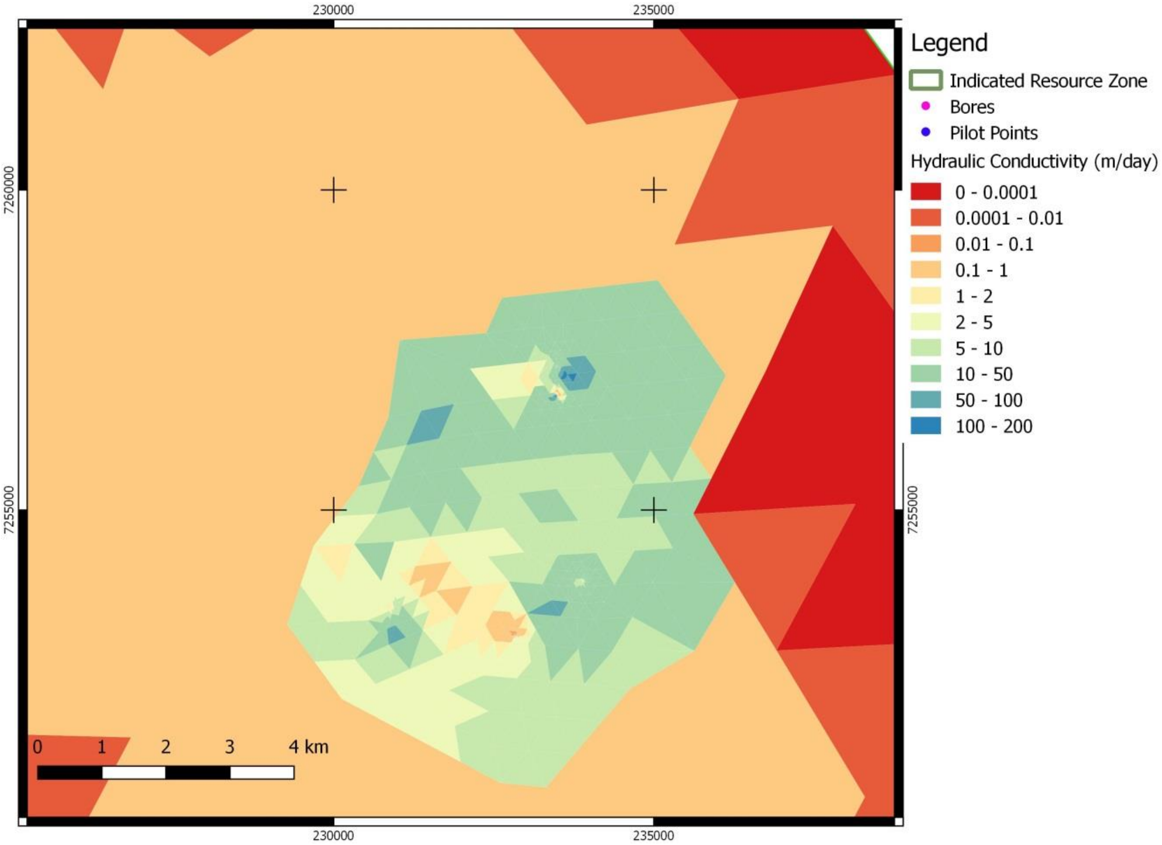

Figure 5-7: Distribution of East-West (x) Horizontal Hydraulic Conductivity in Confined Aquifer within the Indicated Resource Zone

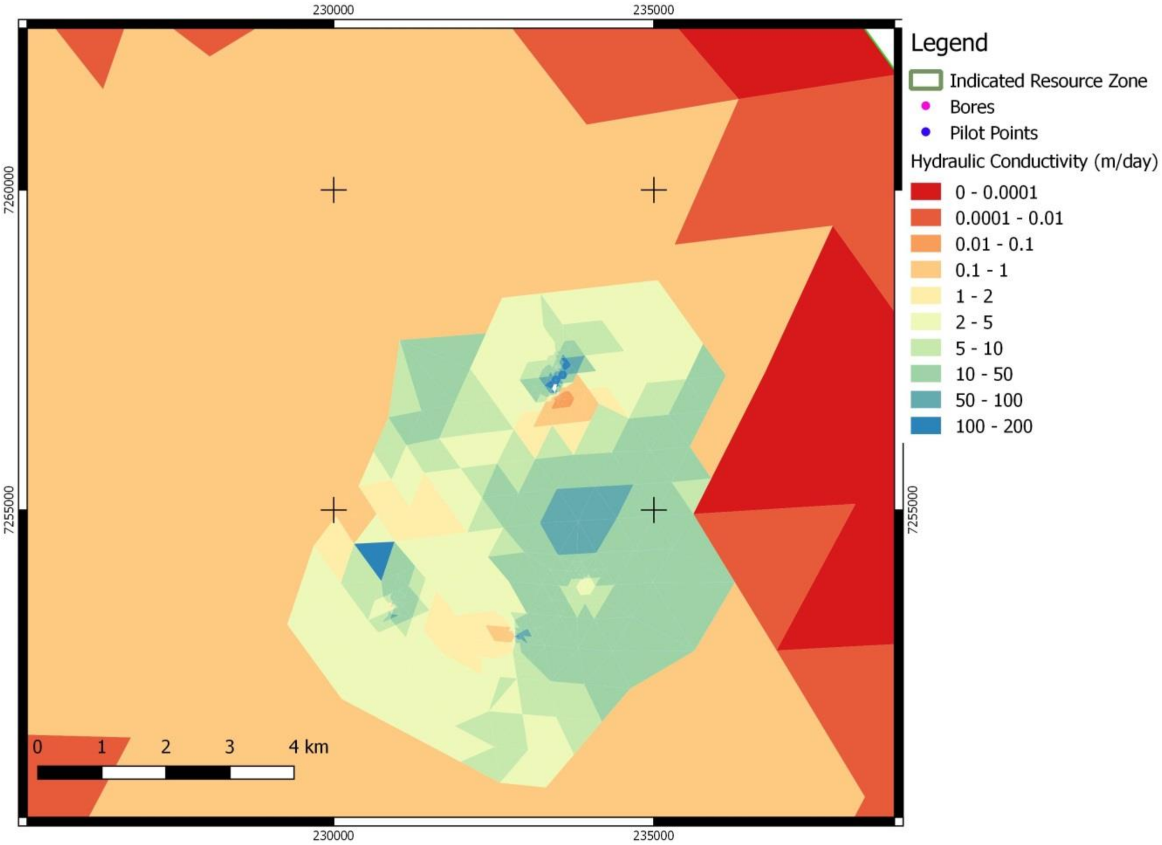

Figure 5-8: Distribution of North-South (y) Horizontal Hydraulic Conductivity in Confined Aquifer within the Indicated Resource Zone

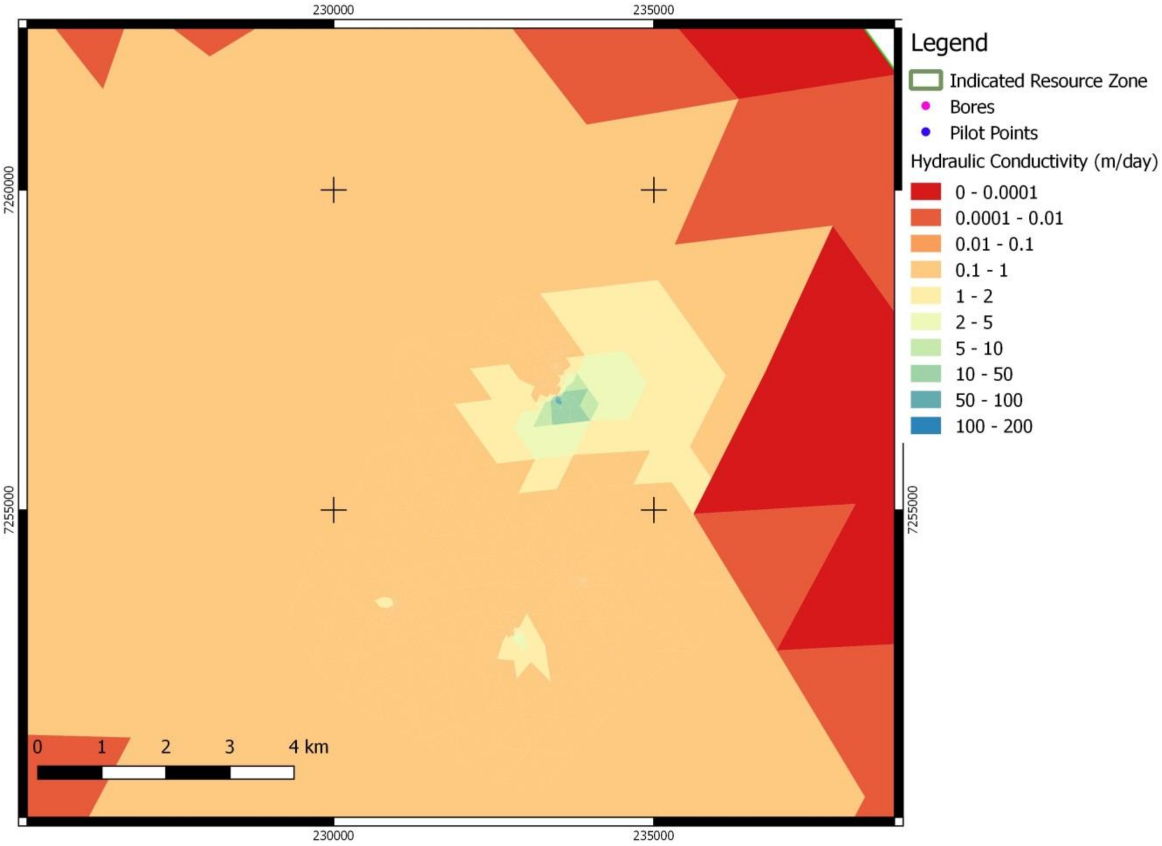

Figure 5-9: Distribution of Vertical Hydraulic Conductivity in Confined Aquifer within the Indicated Resource Zone

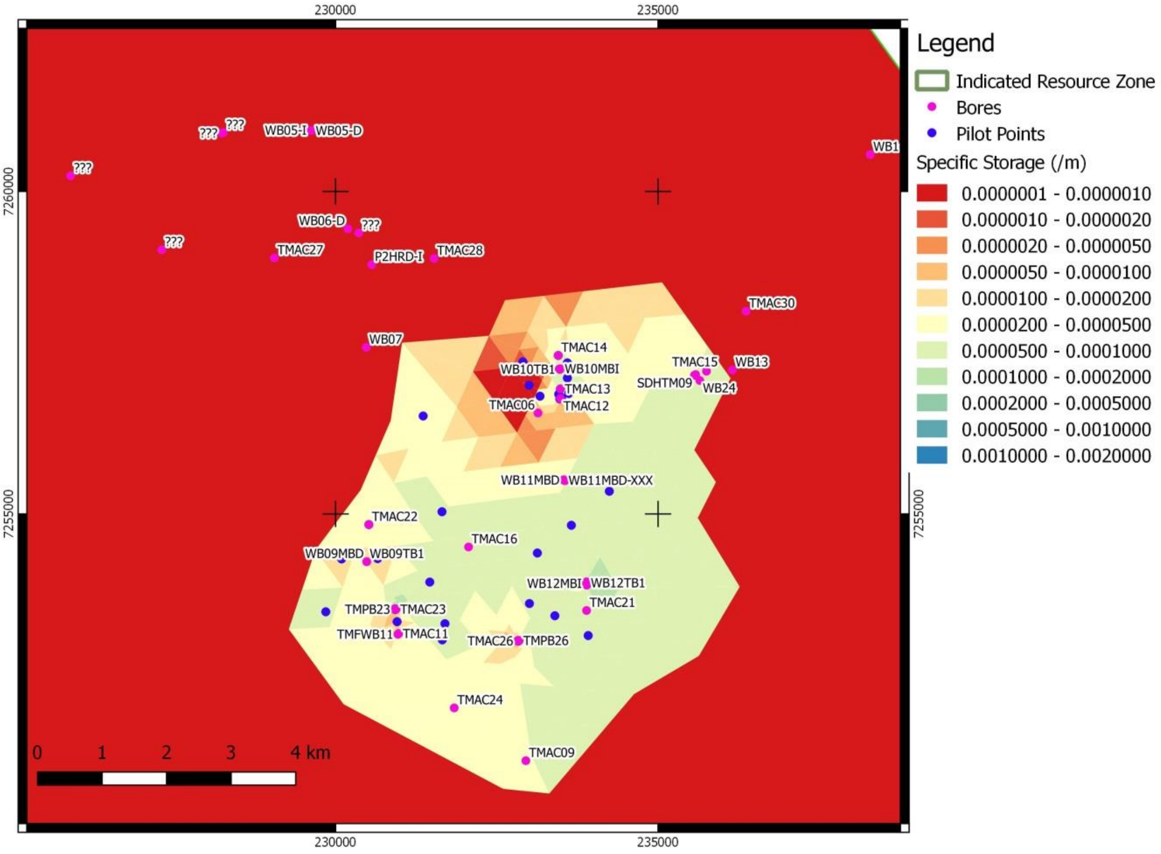

Figure 5-10: Distribution of Specific Storage in Confined Aquifer

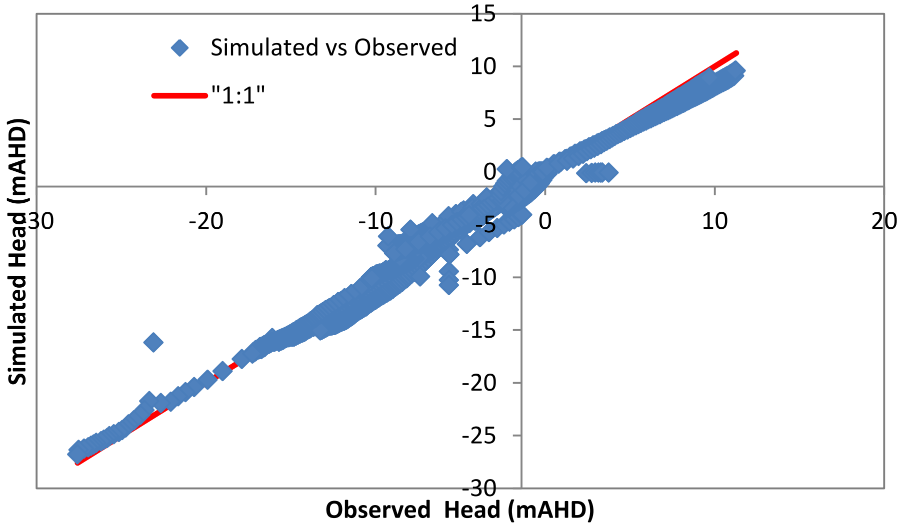

Figure 5-11: Confined Aquifer Model: Simulated vs Observed Heads (all weighted)

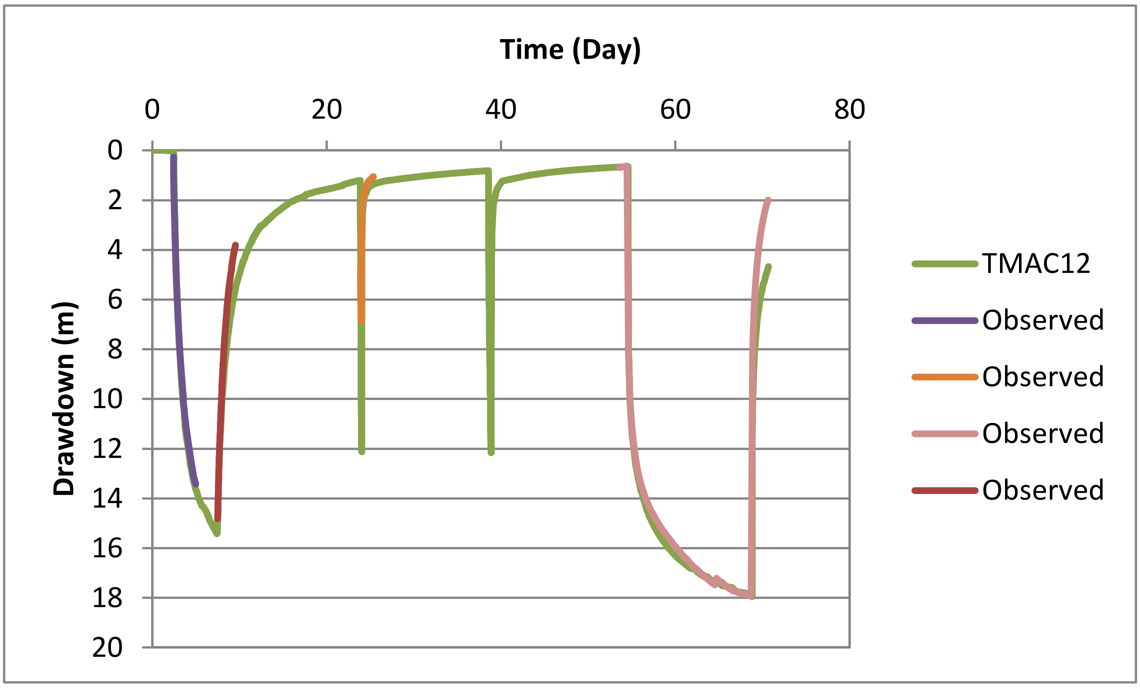

Figure 5-12: Observed and Calibrated Drawdown Hydrograph for Bore TMAC12

5.3.2.1 Sensitivity of Confined Aquifer Calibration

All parameters had a maximum uncertainty range of 600 (which is the maximum value used by the PEST software). These show that the calibration is not well constrained, particularly for the vertical hydraulic conductivity. The range of 95% confidence intervals is shown in Table 5-11. The distribution of the order of magnitude is shown in Appendix B.

Table 5-11: 95% Order of Magnitude Confidence Ranges from Confined Aquifer Calibration

Parameter	Minimum	Mean	Count < 10	Count < 100
Kx (m/day)	2.8	402	4	8
Ky (m/day)	2.6	415	1	9
Kz (m/day)	52	520	0	4
Ss (/m)	5.2	402	1	6

Therefore using a similar methodology to the sensitivity analysis for the steady-state calibration, the response of the calibration of the model to variations in three orders of magnitude in variation of the parameters is analysed. These sensitivity runs are analysed using a SRMS to examine the impact of changes in the parameters on calibrated results. The results are presented in Table 5-12.

The results in this table are raw comparisons of the drawdowns at sites with calibration weights of greater than zero. The results have not been weighted individually and as such some of the results may be better than the base/calibrated SRMS. No results were obtained from the lower values of horizontal hydraulic conductivity in the confined aquifer as simulated abstraction levels resulted in failure of the model due to drawdowns well below the base of the pumps. The results in this table indicate that the calibration was quite sensitive to changes in horizontal hydraulic conductivity, specific storativity and lower than calibrated values of vertical hydraulic conductivity. The model seems to be relatively insensitive to higher values of vertical hydraulic conductivity. However due to the relative thinness of the confined aquifer, it is unlikely this relative insensitivity will have much impact on the resource assessment.

Table 5-12: Percentage Change in SRMS for Order of magnitude change in Confined Aquifer Transient Calibration

Parameter	-3	-2	-1	1	2	3
East-West Hydraulic Conductivity	n.a.	n.a.	20.98%	27.99%	77.42%	99.39%
North-South Hydraulic Conductivity	n.a.	18.72%	17.54%	10.67%	84.39%	120.11%
Vertical Conductivity	127.05%	25.00%	6.78%	-0.68%	-0.73%	-0.81%
Specific Storativity	181.29%	176.32%	144.18%	63.10%	121.56%	136.56%

The water balance for the confined aquifer transient calibration is in Table 5-13. It shows the total inflows and outflows in the model domain for each of the listed fluxes. Thus the storage component includes both loss of storage (inflow to the model) during abstraction and storage gain (outflow from model) during recovery. The percentage imbalance is calculated using the FEFLOW imbalance and an average of the total inflow and outflow. The low percentage imbalance shows the model is performing well.

Table 5-13: Water Balance for Confined Aquifer Calibration

Flux	Inflow (m^3)	OutFlow (m^3)	Net Flow (m^3)
Specified Head	0	1129.6	-1129.6
Recharge	66.135	0	66.135
Evapotranspiration	0	1157.3	-1157.3
Abstraction	0	33783	-33783
Storage	2.938×10^5	2.5782×10^5	35980

Flux	Inflow (m^3)	OutFlow (m^3)	Net Flow (m^3)
Total (includes net storage)	**36046**	**36070**	**24**
Imbalance (FEFLOW)		24.921	-24.921
%Imbalance		0.07%	

5.3.3 Trenches

The calibration of the trenches was undertaken with often variable pumping and potential trench slumping causing reductions in pumping rates. Therefore if water levels in the trench approached the base, the observed response in the trench may exceed the simulated response. This may be because of unevenness of the basal elevations and potential slumping dividing the trench into separate water bodies, meaning the pumping was applicable to only part of the trench. In terms of the calibration, this may lead to an underestimate of the hydraulic conductivity and the specific yield. However for the purposes of the calibration these effects were neglected and the calibration is considered conservative in nature.

The calibrated parameter values from the three trench tests are in Table 5-14. This table includes the 95% confidence level parameter values. This found that the horizontal hydraulic conductivity was between 8 and 24 m/day and the specific yield was between 0.11 and 0.3. It is noticeable that high specific yield estimates coincided with low horizontal hydraulic conductivities. This could be a function of secondary porosity. The 95% confidence interval estimated in PEST is a linear extrapolation based on results from individual calibration simulations. Confidence in these ranges decreases the larger the found range.

A comparison of the observed and simulated hydrographs for the Trench 6 (81 m) is shown in Figure 5-13. There are some differences between both the trench and the pit water levels, particularly early in the test. However the data was well fitted towards the end of the test. The SRMS values for the trenches were 7.86%, 8.74% and 9.4% for Trench 6 (81 m), Trench 1 (300 m) and Trench 2 (500 m) respectively. Scatter plot comparisons of the results for the three trenches are in Figure 5-14 to Figure 5-16. For the 500 m trench in Figure 5-16, the comparison is for the sets of pits (series A-D) rather that individual pits. These show a reasonable calibration for Trench 6 (81 m) and 1 (300 m), but a number of outliers, particularly for the water level in Trench 2 (500 m). This may be due to greater than recorded variation in pump rates, or possible isolation of the water level meter and a pump from other sections of the trench for short intervals.

Additional plots and statistical analysis of the calibration results are in Appendix B.

Table 5-14: Trench Lake Surficial Sediment Calibration Results

Parameter	Trench 6 (81 m)	Trench 1 (300 m)	Trench 2 (500 m)
Kh (m/day)	11.2 (8.9-14.0)	8.4 (6.7-10.5)	24.2 (11.9-49)
Kz (m/day)	4.6 (2.4-8.6)	2.9 (1.5-5.5)	0.1 (0.011-0.96)
Sy (-)	0.12 (0.07-0.17)	0.3 (0.25-0.35)	0.11 (0.066-0.15)

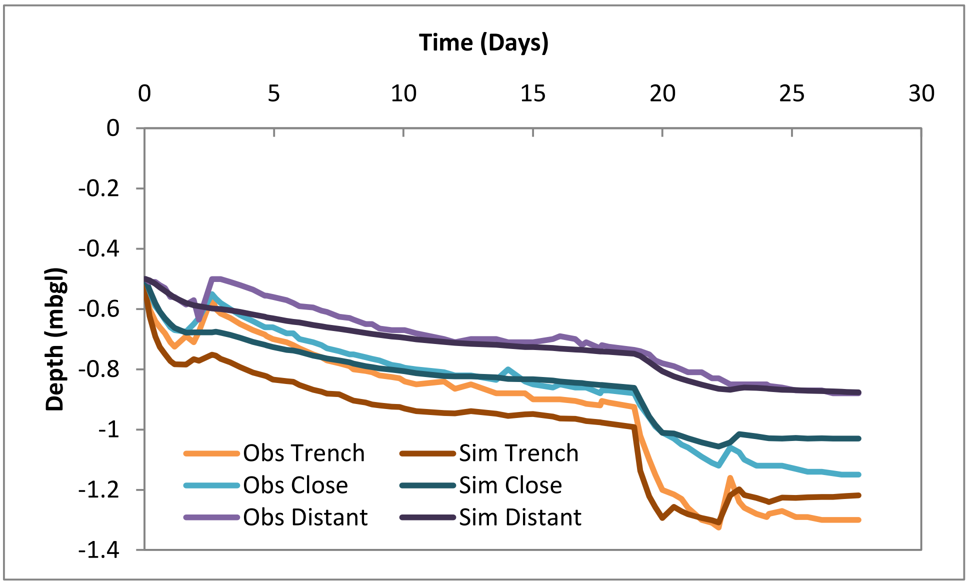

Figure 5-13: Comparison of Observed and Calibrated Trench 6 (81 m) Water levels

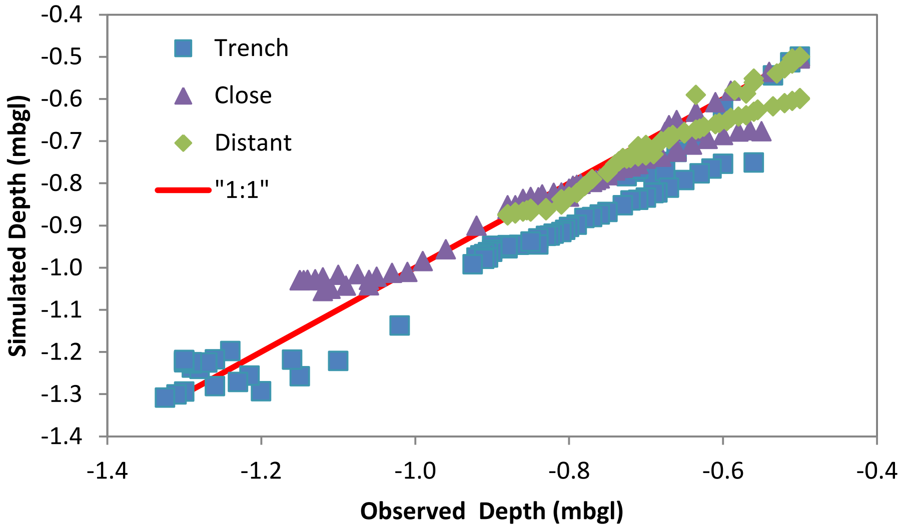

Figure 5-14: Calibration Comparison for Trench 6 (81 m)

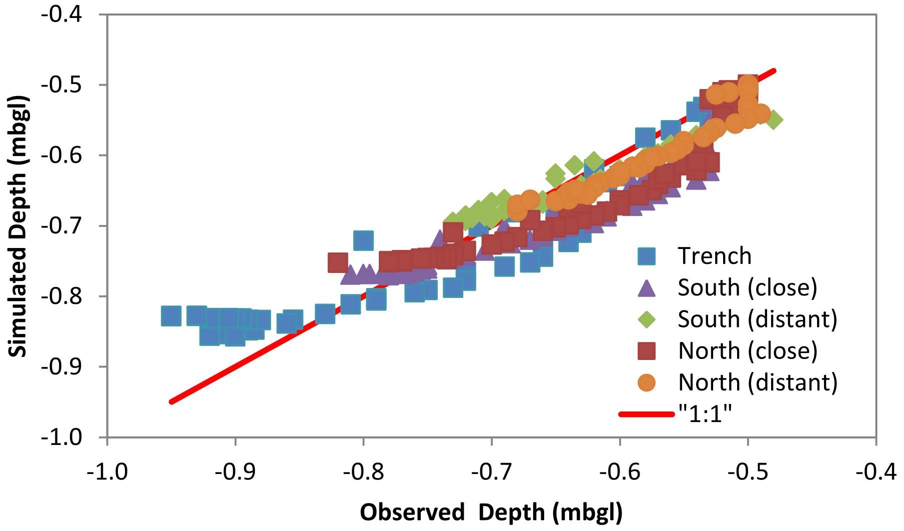

Figure 5-15: Calibration Comparison for Trench 2 (300 m)

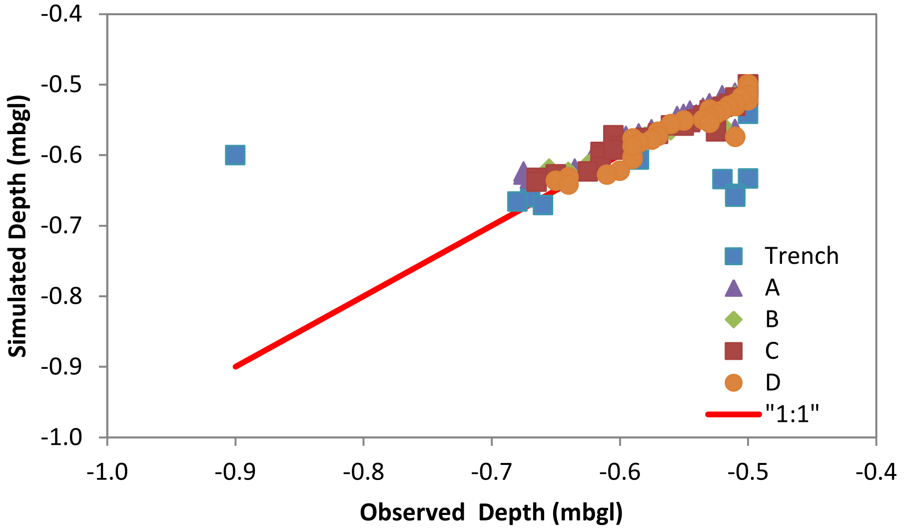

Figure 5-16: Simulated versus Observed Depths for Trench 1 (500 m)

Table 5-15: Water Balance for Trench 6 (81 m) Calibration

Flux	Inflow (m^3)	OutFlow (m^3)	Net Flow (m^3)
Specified Head	0.001694	0.0017686	-0.0000746
Abstraction	0	5331.9	-5331.9

Flux	**Inflow (m^3)**	**OutFlow (m^3)**	**Net Flow (m^3)**
Storage	5507.7	175.93	5331.77
Total (includes net storage)	5331.771694	5331.901769	-0.1300746
Imbalance (FEFLOW)		0.089337	-0.089337
%Imbalance		0.00%	

Table 5-16: Water Balance for Trench 2 (300 m) Calibration

Flux	**Inflow (m^3)**	**OutFlow (m^3)**	**Net Flow (m^3)**
Specified Head	0.00056081	0.00070361	-0.0001428
Abstraction	0	4573.5	-4573.5
Storage	5858.1	1284.6	4573.5
Total (includes net storage)	4573.500561	4573.500704	-0.0001428
Imbalance (FEFLOW)		0.029973	-0.029973
%Imbalance		0.00%	

Table 5-17: Water Balance for Trench 1 (500 m) Calibration

Flux	**Inflow (m^3)**	**OutFlow (m^3)**	**Net Flow (m^3)**
Specified Head	0.0071675	0.00024847	0.00691903
Abstraction	0	1369.7	-1369.7
Storage	1419.8	50.923	1368.877
Total (includes net storage)	1368.884168	1369.700248	-0.81608097
Imbalance (FEFLOW)		0.18381	-0.18381
%Imbalance		0.01%	

5.4 Calibration Confidence Levels

No validation has been undertaken for any of these calibrations. The AGMG (Barnett et al., 2012) suggest that verification should only be undertaken when sufficient data is available. There is not currently sufficient data to perform model validation for the BSOPP.

5.4.1 Regional Steady-State

The confidence in the calibration for the regional model is low-intermediate (Class1 – Class2). It is based on a high density of information in the immediate area of the BSOPP, with low density of data for the remainder of the domain. The calibration statistics show that the model has a reasonable fit to the available data, but there exist some outliers that indicate the model may be improved by additional information. The high level of uncertainty in the calibration parameters indicated that additional regional groundwater levels may be needed to get a better regional calibration, but the model was reasonable in the vicinity of 10 Mile Lake.

5.4.2 Confined Aquifer

The modelling for the confined aquifer shows a good fit to the available data for the majority of the aquifer testing. The fitting to the transient responses are good. The overall statistics for the comparison of the model results to the weighted observations are satisfactory (SRMS < 3%), with few outliers. The length of the aquifer tests in this hydrogeological environment and the absence of definable response to external fluxes other than the abstraction (i.e. to recharge/flood events) limit the confidence level to intermediate (Class 2).

5.4.3 Trenches

The calibration to the trench testing shows similar characteristics to the confined aquifer calibration in terms of confidence levels. The model results generally match the observations, with the only major outliers occurring for the 500 m trench. These outliers were in the trench and were associated with large changes in abstraction rates that were not simulated. The overall statistics are satisfactory, with the SRMS error less than 10%. However the limited duration of the testing and the lack of definable response to recharge events mean the confidence level in the calibration is intermediate (Class 2). The confidence in the model predictions could be improved using longer testing in additional feasibility studies and/or results from the initial production. This level of confidence is good for a green-field site. Increasing the confidence level would require testing and monitoring over periods approaching the lifetime of the operation.

5.4.4 Overall

The confidence level (low-intermediate) for the modelling associated with the regional model indicates additional information may be needed from regional investigations. Overall the intermediate confidence levels for the trench and confined aquifer calibrations, the two zones of greatest interest for the BSOPP, indicate that the modelling has an overall confidence level consistent with these results – i.e. an intermediate Class 2 confidence level.

The confidence level could be improved with additional longer-term monitoring, however it is reasonable for the current status of the project. To increase the confidence level to class 3 would require observations within an order of magnitude of the proposed activities, which is unfeasible at this stage of feasibility studies for a green field site.

6 Resource Assessment

Two independent resource assessments were simulated. These were:

- Simulation of brine recovery from trenches; and
- Simulation of brine recovery from the confined aquifer.

These were undertaken independently as it was thought that the clay layer within the palaeochannel sediments would effectively isolate the two systems from each other, and combining the two simulations with their independent discretisations would result in excessive model run times.

6.1 Recovery from Confined Aquifer

The brine recovery from the confined aquifer was simulated in the indicated resource zone identified in the confined aquifer calibration. A number of bores were located in the mapped palaeochannel and fractured bedrock within the Indicated Resources zone and the model mesh was refined around these locations (see Figure 6-1).

The recovery of the resource was assessed over 23 years, and it was assumed that all wells would remain active for that period. A number of simulations were conducted, varying active wells and well rates before the proposed configuration was found. This analysis found that a steady long-term rate for abstraction from the indicated resource zone of the confined aquifer was 30 L/s.

Figure 6-1 shows the distribution of active wells and their associated abstraction rates. This configuration allowed a constant rate of recovery for the duration of the Life-of-Mine (LoM) of 30 L/s (0.95 GL/a).

Particle tracking was used to determine the flow paths of brine to each production bore over the LoM. Figure 6-2 shows the 30 m drawdown contour around the bore field for selected times and the originating points for particle tracks to the active bores for selected times. The particle tracks were calculated in reverse from each active bore, with 24 particles arranged spherically around the bore. The originating points indicate the likely capture zone for individual wells at those times.

The 30 m drawdown contour after the first year indicates that the modelled cone of depression in the confined aquifer spreads very fast initially. This is an indication that the model may be using conservative parameters for the confined aquifer.

The small changes in location of the 30 m drawdown contour in the confined aquifer between year 5 and year 20 in the simulation indicate that the abstracted brine may potentially be coming from other units in the model. There are two possible sources. The first is slow release from storage in the overlying clays. This flow is induced by the lowered heads within the confined aquifer and is slow due to the low vertical (and horizontal) hydraulic conductivity in the clays. The second potential source is through the weathered bedrock at the margins of the palaeochannel system. This system has higher hydraulic conductivity than the clay and may be connected to the surface system. Model results indicate a zone of water table drawdown to the east of 10 Mile Lake of up to 2 m by year 20.

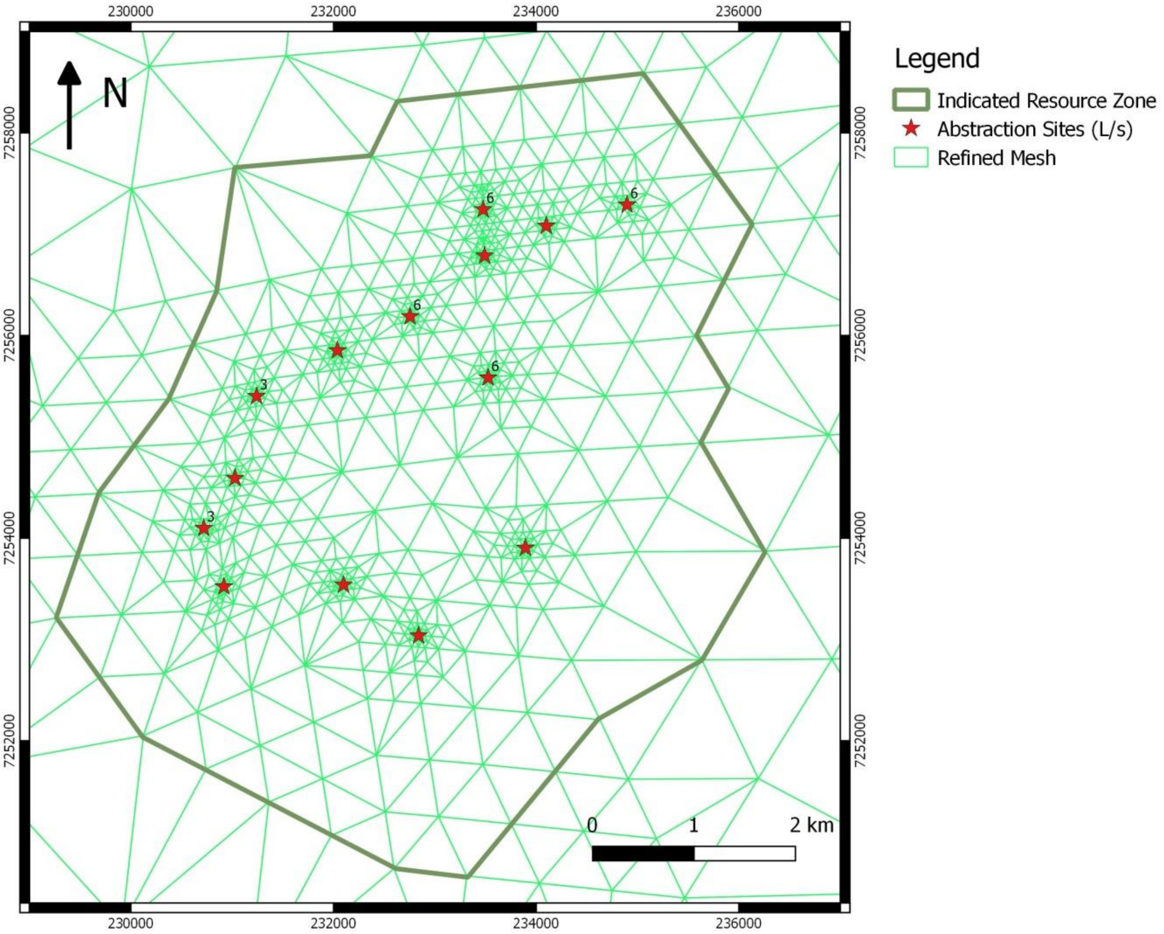

Figure 6-1: Refined Mesh in Vicinity of 10 Mile Lake Confined Borefield

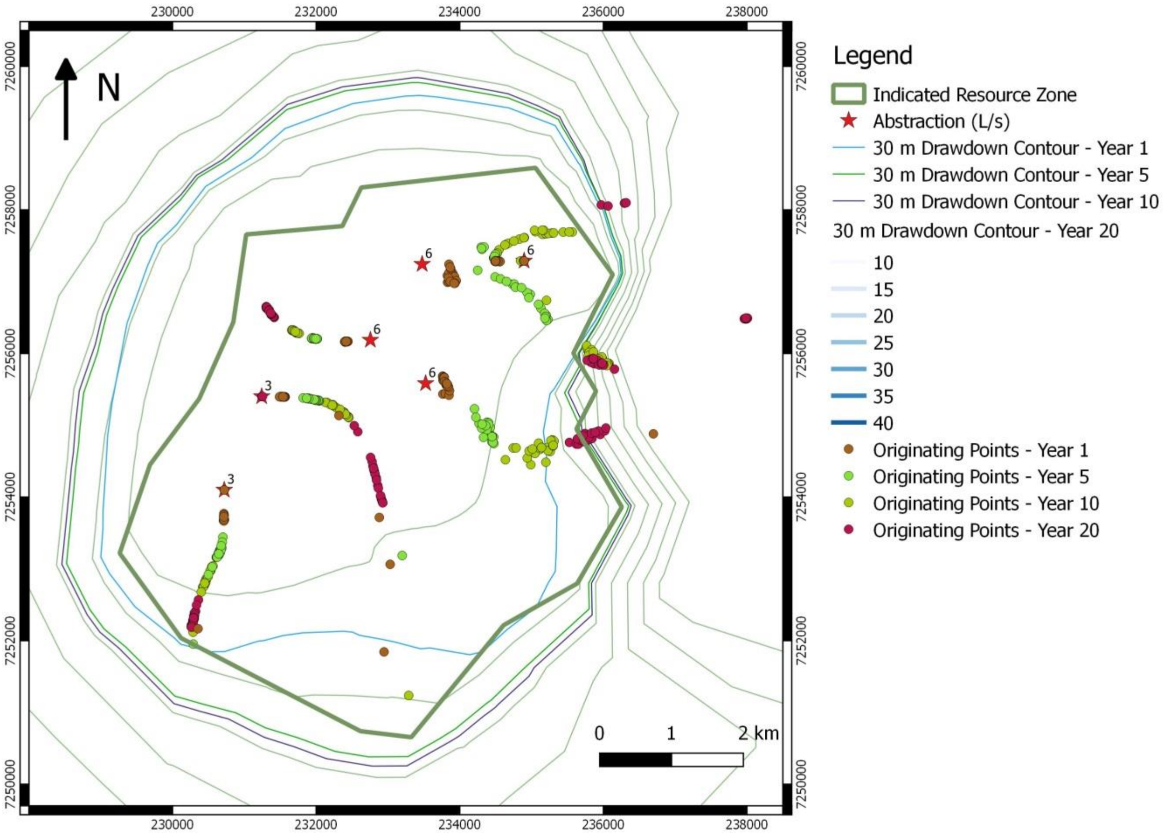

Figure 6-2: Drawdown Contours around Indicated Resource Zone with Source Locations for Abstraction

These particle tracks were overlain on the distribution of potassium grade in the confined aquifer. Two results were obtained:

- The first results uses all particles and evaluates the weighted concentration based on the number of particles and the abstraction rates at individual bores; and
- The second uses all particles with the particles originating within the indicated resource zone assigned the concentration at the originating location, and those outside the zone assigned a zero concentration.

The distribution of potassium grade does not cover the distribution of starting points for the particle tracking. All starting points outside the brine distribution were assigned zero concentration for each of the results. In the second set of results, the particle tracks originating outside the indicated resource zone were also assigned a zero concentration. The results of this analysis are listed in Table 6-1. This shows the potassium grade in the abstraction from the deep wells at 10 Mile Lake is expected to exceed 6,000 mg/L for the first ten years of operation. The simulated lower concentrations after the first ten years are a function of the uncertainty in the concentrations of potassium away from the well field.

Table 6-1: Predicted Concentration (mg/L) of Abstraction from Confined Aquifer

Year	All Concentration (Zero points, % total points)	Concentration from within Indicated Resources Zone (Zero points, % total points)
1	7,340 (1, 0.7%)	7,290 (2, 1.4%)
5	6,870 (3, 2.1%)	6,870 (3, 2.1%)
10	7,090 (2, 1.4%)	6,290 (21, 14.6%)
20	6,450 (16, 11.1%)	4,500 (60, 41.7%)

6.1.1 Predictive Uncertainty

The critical parameters for the inflow to the confined aquifer wells are the hydraulic conductivity and the storage coefficients of the surrounding lithological units. To assess how critical these are to the overall recovery from the system, key parameters were altered by specified multipliers or amounts, and the results evaluated to estimate the volume of the recoverable resource.

To perform this analysis, the abstraction from the wells was altered to ensure maximum productivity over 20 Years. The wells were represented by specified head boundary conditions, with maximum flows of 10 L/s and no inflows. The specified heads were set 5 m above the base of the deep aquifer to ensure brine is present in the bores. Table 6-2 presents the results from the predictive uncertainty analysis. The results indicate that pumping the 14 bores in Figure 6-1 at 10 L/s results in the abstraction decreasing rapidly to close to the steady-state yield as discussed above. The hydrogeological parameters which have the most effect on the steady-state yield are the vertical hydraulic conductivity in the clay and the horizontal hydraulic conductivity of the pumped aquifer.

Table 6-2: Predictive Uncertainty of Total Abstraction and Abstraction Rates from Confined Aquifer to variations in Hydrogeological Parameters

Simulation	Total Abstraction (GL)	Abstraction Rate (L/s) Year 1	Abstraction Rate (L/s) Year 5	Abstraction Rate (L/s) Year 10	Abstraction Rate (L/s) Year 20
Base	18.7	30.2	29.4	28.9	28.2
Kz Clay x10	32.1	51.6	51.0	50.4	49.4
Kz Clay /10	15.6	25.8	24.4	23.9	23.2
Sy Clay 4%	18.7	30.2	29.4	28.9	28.2
Sy Clay 2%	18.7	30.2	29.4	28.9	28.2
Kh Clay x10	18.7	30.2	29.3	28.9	28.2
Kh Clay /10	18.7	30.2	29.3	28.9	28.2
Ss Clay x10	22.1	60.8	35.0	30.3	28.5
Ss Clay /10	18.7	30.2	29.4	28.9	28.2

Simulation	Total Abstraction (GL)	Abstraction Rate (L/s) Year 1	Abstraction Rate (L/s) Year 5	Abstraction Rate (L/s) Year 10	Abstraction Rate (L/s) Year 20
Kh DpAq x10	40.7	60.5	48.6	52.0	62.4
Kh DpAq /10	6.7	11.4	10.4	10.4	10.4
Kz DpAq x10	19.1	30.9	30.0	29.5	28.7
Kz DpAq /10	18.1	29.4	28.5	28.0	27.4
Ss DpAq x10	47.3	122.6	96.0	67.8	42.9
Ss DpAq /10	18.7	30.2	29.4	28.9	28.2
Kh WRck x10	19.4	31.4	30.6	30.1	29.4
Kh WRck /10	18.6	30.1	29.2	28.7	28.0
Kz WRck x10	22.3	40.5	36.3	34.0	32.0
Kz WRck /10	13.4	20.8	20.6	20.5	20.4
Ss WRck x10	18.7	30.3	29.4	28.9	28.2
Ss WRck /10	18.7	30.2	29.3	28.9	28.2
Kh BRck x10	18.7	30.3	29.4	28.9	28.2
Kh BRck /10	18.7	30.2	29.3	28.9	28.2
Kz BRck x10	18.7	30.3	29.4	28.9	28.3
Kz BRck /10	18.6	30.1	29.3	28.8	28.1
Ss BRck x10	18.9	32.1	29.4	28.9	28.2
Ss BRck /10	18.6	30.2	29.3	28.9	28.2
Kh DpA2 x10	41.2	68.2	66.1	64.8	62.7
Kh DpA2 /10	10.5	17.0	16.1	15.8	15.3
Kz DpA2 x10	18.8	30.4	29.5	29.0	28.3
Kz DpA2 /10	18.7	30.2	29.4	28.9	28.2
Ss DpA2 x10	18.8	30.9	29.4	28.9	28.2
Ss DpA2 /10	18.7	30.2	29.4	28.9	28.2

6.2 Recovery from Trenches

6.2.1 Model Construction

The trenches were simulated over the surface of 10 Mile Lake within the E69/3309 tenement area (see Figure 6-3). The mesh was highly discretised around the trenches such that the trenches consisted of at least two rows of cells, with a total trench width of 3-5 m.

The surficial layer of the model was divided into three sub-layers, with the base of sub-layer 1 0.5 m above the base of the trench, and the base of sub-layer 2 at the depth of the trench. Sub-layer 3 consisted of the remainder of the surficial sediments.

The trenches were simulated with a hydraulic conductivity of 1x10^{6} m/day in all directions, and a specific yield of 0.99 to ensure the model behaved as a trench. Abstraction from the trenches was simulated using constant head nodes. These were placed at the lowest points in the trenches. The constant head was specified as 1 m above the base of the trench, and the outflow through the boundary condition was limited to a specified rate equivalent to a total rate from the trench of 30 L/s/km. A total of 6 km of trenches were constructed in the model, with the mesh refined to a spacing of 5 m along the trench length (see Figure 6-3).

Initial heads, recharge and evaporation rates were the same as the steady-state calibration.

Figure 6-3: Mesh Refinement in 10 Mile Lake for Trench Model

6.2.2 Results

The trench configuration is shown in Figure 6-3, together with the 69/3309 tenement area. Simulations were performed with trench depths of 6 m and 8 m.

Abstraction volumes from the simulations are in Table 6-3, and Figure 6-4shows the 3 m drawdown contours around the trenches for various times for the 6 m trench depth.

Table 6-3: Simulated brine recovery rates and total abstraction from two different trench depth operations on 10 Mile Lake

Year	6 m Trenches m^3/day (L/s)	8 m Trenches m^3/day (L/s)
1	13,600 (158)	14,700 (170)
5	5,040 (58)	6,600 (77)
10	3,980 (46)	6,030 (70)
20	3,540 (41)	4,010 (46)
TOTAL (GL)	**35.8**	**55.2**

The particle tracks in Figure 6-4 were overlain on the distribution of potassium grade in the surficial sediments. Two results were obtained:

- The first results uses all particles and evaluates the weighted concentration based on the number of particles and the abstraction rates from individual trenches; and
- The second uses all particles with the particles originating within the lake assigned the concentration at the originating location, and those outside the lake assigned a zero concentration.

The results of this analysis are listed in Table 6-4. This shows the concentration of potassium in the brine abstracted from the 8 m deep trenches in 10 Mile Lake are expected to exceed 6,000 mg/L for the first ten years of operation. The simulated lower concentrations after the first ten years are a result of the uncertainty in the potassium concentration away from the well field.

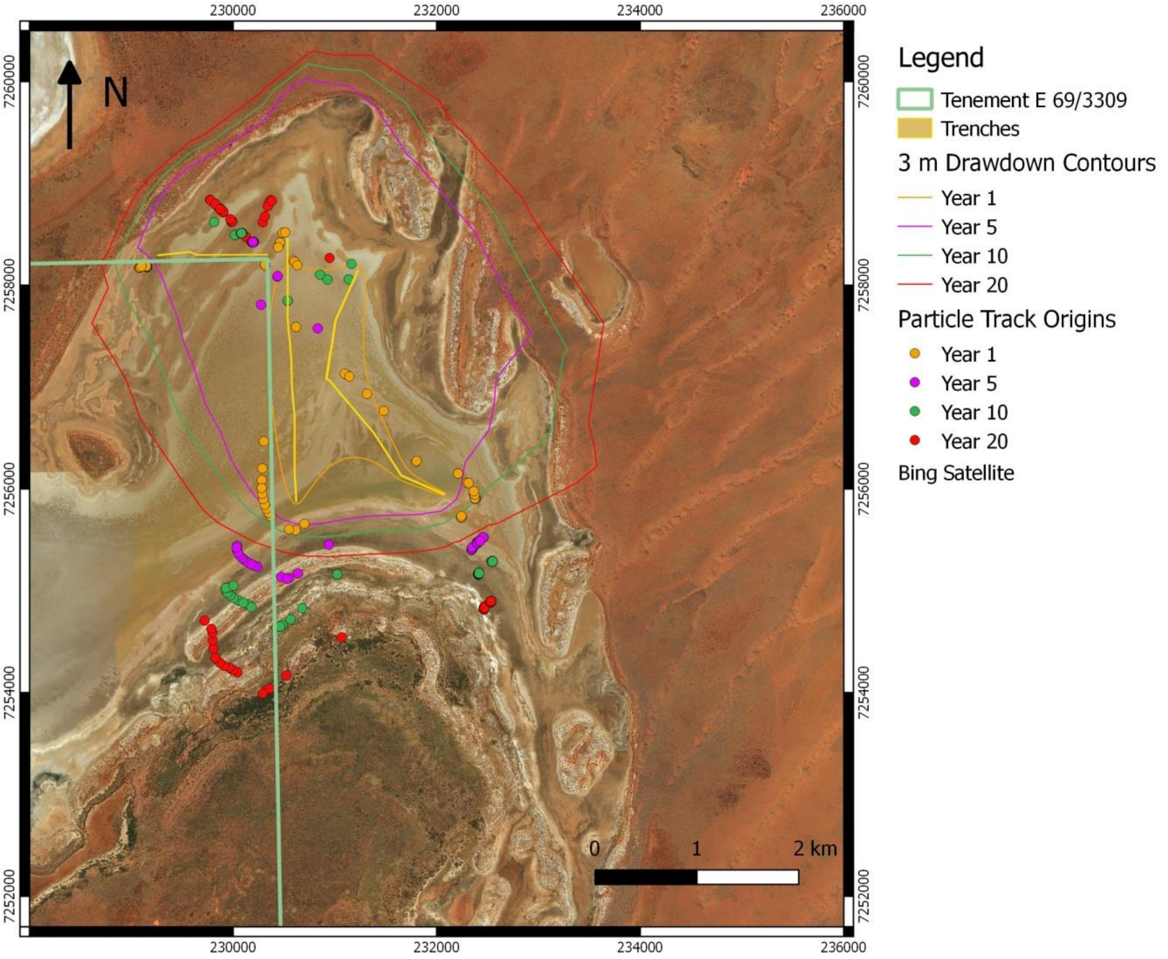

Figure 6-4: Particle Tracks and Drawdown Contours for 6 m Deep Trenches in 10 Mile Lake

Table 6-4: Predicted Concentration (mg/L) of Abstraction from Trench System

Year	All Concentrations (Zero points, % total points)	Concentrations within Lake (Zero points, % total points)
1	9,160 (0, 0.0%)	9,160 (0, 0.0%)
5	8,420 (0, 0.0%)	8,220 (2, 4.3%)
10	7,270 (0, 0.0%)	6,510 (9, 19.1%)
20	6,750 (0, 0.0%)	5,970 (12, 25.5%)

6.2.3 Predictive Uncertainty

One of the parameters identified that may alter the recovery of the brine from the lake sediments was the recharge to the lake. The existing calibration used a recharge rate of 0.8% of average annual rainfall. A simulation was run for the same configurations of the model with a recharge rate of 10% of annual average rainfall (24 mm/annum). It found very little difference in the inflows into the trench. This was because the net recharge (recharge – evapotranspiration) barely changed as the evapotranspiration rate greatly exceeded the recharge rate. It was realised that recharge is most likely on the lake surface when it is inundated (Advisian, 2017). Therefore an alternate simulation was performed with the recharge over the lake surface equivalent to the calculated depth of water (165 mm) over 10 Mile Lake for a 24 hour event with an annual exceedance probability (AEP) of 63.2% (Advisian, 2017). This quantity was added as recharge to the lake on the last day of each year.

The impacts of different hydrogeological parameter values on the volumes and rates of recoverable brine were assessed by varying the parameters individually by an order of magnitude for the hydraulic conductivity and a specified amount for the specific yield.

The results for the variations in recharge and hydrogeological parameters are presented in Table 6-5.

This shows an increased volume of brine may be recoverable for the increase in recharge associated with the 1 day inundation.

The changes in hydrogeological parameters are used to assess potential changes in recoverable brine associated with uncertainty in the model. The results indicate that the resource recovery is most sensitive to the horizontal hydraulic conductivity in the lake sediments. Greater overall brine recovery is associated with higher horizontal hydraulic conductivity in the lake sediments and adjacent surficial units, and specific yield in the lake sediments and calcrete.

This predictive uncertainty analysis does not consider the quality of the recovered brine.

Table 6-5: Results from predictive uncertainty analysis for Trench Abstraction

Simulation	Total Abstraction (GL)	Average Abstraction Rate (L/s) Year 1	Average Abstraction Rate (L/s) Years 2-5	Average Abstraction Rate (L/s) Years 5-10	Average Abstraction Rate (L/s) Years 10-20
Base	55.2	170	115	77	62
1 Day Recharge	70.3	170	125	92	86
Kh Lake Sediment x10	96.6	170	155	150	146
Kh Lake Sediment /10	41.7	139	104	63	56
Kz Lake Sediment x10	60.7	170	118	81	73
Kz Lake Sediment /10	57.2	170	110	76	68
Sy Lake Sediment 22%	62.8	170	135	83	73
Sy Lake Sediment 8%	45.5	164	88	61	51
Kh Calcrete x10	66.3	170	125	89	80
Kh Calcrete /10	43.8	170	104	55	44
Kz Calcrete x10	52.3	170	115	69	57
Kz Calcrete /10	57.9	170	115	77	70

Simulation	Total Abstraction (GL)	Average Abstraction Rate (L/s) Year 1	Average Abstraction Rate (L/s) Years 2-5	Average Abstraction Rate (L/s) Years 5-10	Average Abstraction Rate (L/s) Years 10-20
Sy Calcrete 15%	60.4	170	115	78	71
Sy Calcrete 5%	53.5	170	113	75	63
Kh Alluvium x10	73.7	170	137	99	91
Kh Alluvium /10	49.0	170	101	61	63
Kz Alluvium x10	60.0	170	115	78	71
Kz Alluvium /10	51.9	170	114	69	56
Sy Alluvium 5%	59.3	170	118	79	71
Sy Alluvium 1%	56.6	170	111	75	69
Kh Clay x10	52.2	170	114	69	57
Kh Clay /10	52.1	170	114	69	57
Kz Clay x10	57.3	170	115	77	70
Kz Clay /10	52.1	170	114	69	57
Ss Clay x10	57.6	170	115	77	70
Ss Clay /10	55.2	170	115	77	62

7 Impact of Mining

7.1 Uncertainty of impact

7.1.1 Confined aquifer

The current confined aquifer recovery testing has included a number of continuous rate tests. However the testing period was short compared with the proposed life of mine, and the certainty of the predictions from models based on the test programs decreases with increasing multiples of the test period. Therefore it is essential monitoring of impacts from the abstraction occur during the production phase of the project. These observations should be compared with the predictions from the model. If major differences occur between the observed and predicted, and particularly if the impacts are greater than predicted, then the modelling should be revised to enable greater confidence in model predictions. However the model results were based on reasonable conservative assumptions. Thus the likelihood is that the model is under-predicting the recoverable resource.

7.1.2 Trenches

The deeper the trench, the greater the potential drawdown associated with the trench, and the greater the potential thickness of sediments for inflow into the trenches. The testing data available at the time of calibration was limited to a depth of 2 m below the lake surface, and as such, the calibration may only be accurate for this depth.

Deeper layers in the lake sediments may be of higher or lower hydraulic conductivity and thus may have different impacts than that predicted. Higher field hydraulic conductivities may increase the area affected by low-level drawdowns and decrease the drawdowns in the immediate area of the trenches. This may have the effect of increasing the period over which the trench can be used, or enabling an increase in the production from the trench. Conversely lower field hydraulic conductivities may reduce the area of low impact from the trench and dewater the immediate area surrounding the trench faster. Thus the recovery rate may be smaller or the period of use for the trench shorter and more trenches will be required to abstract the equivalent volume of brine.

Another aspect of the trench utility for recovering brine is the stability of the sides of the trench. As has been found in the testing program, the sides of the trench may become unstable when excavated and/or dewatered. This may affect the depth of the trench, the connectivity of the trench (i.e. may isolate the pump from parts of the trench), and the connectivity between the lake sediments and the trench by clogging the pore space with fines. Therefore some analysis should occur looking at stability of trench sides for maximising the recovery of brine and maintaining the brine flow, including continuous monitoring to ascertain continuity of flow in the trench system to the pumps and ensuring good connection between the trench and the surrounding aquifer in the lake sediments.

8 Conclusions and Recommendations

The modelling has indicated that the indicated resources available from the existing tenement at 10 Mile Lake are sufficient to recover 19 GL at 30 L/s from the confined aquifer and 55 GL from the trench system, with the rate of recovery dropping from an initial 170 L/s to 62 L/s for a period of 20 years. . This has been based on what is thought to be conservative assumptions about the hydrogeological parameters and extent of the available resource.

This assessment is preliminary and may be modified if observations from resource recovery operations differ significantly from current field observations.

The following recommendations for maximising the recoverable resource:

- Ongoing monitoring and potentially analysis of the stability of trench sides, including the effects of slumping and silting around the base and sides of the trench. This may include scheduling of remediation activities to maintain the efficacy of the trench system; and
- Ongoing monitoring of both piezometric heads and chemistry of both recovered water and at observation locations distant from recovery to identify changes in the flow and chemistry of the recoverable resource. These observations should be periodically compared with the predicted effects.

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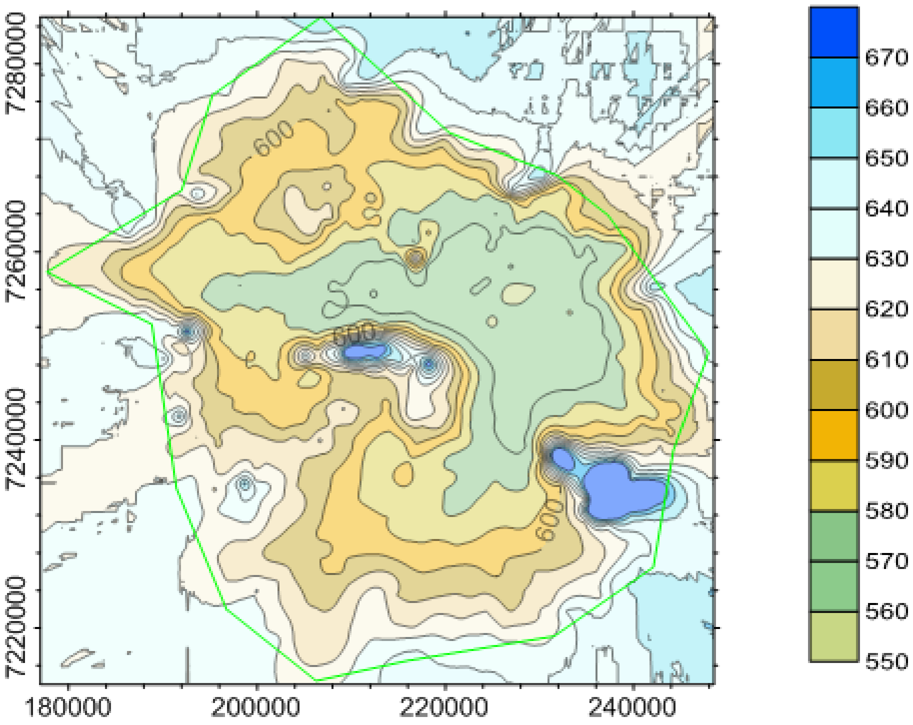
Watermark Numerical Computing 2014b. Groundwater Data Utilities Part B: Program Descriptions, 381pp.

Appendix A Model Surface Elevations and Layer Thickness

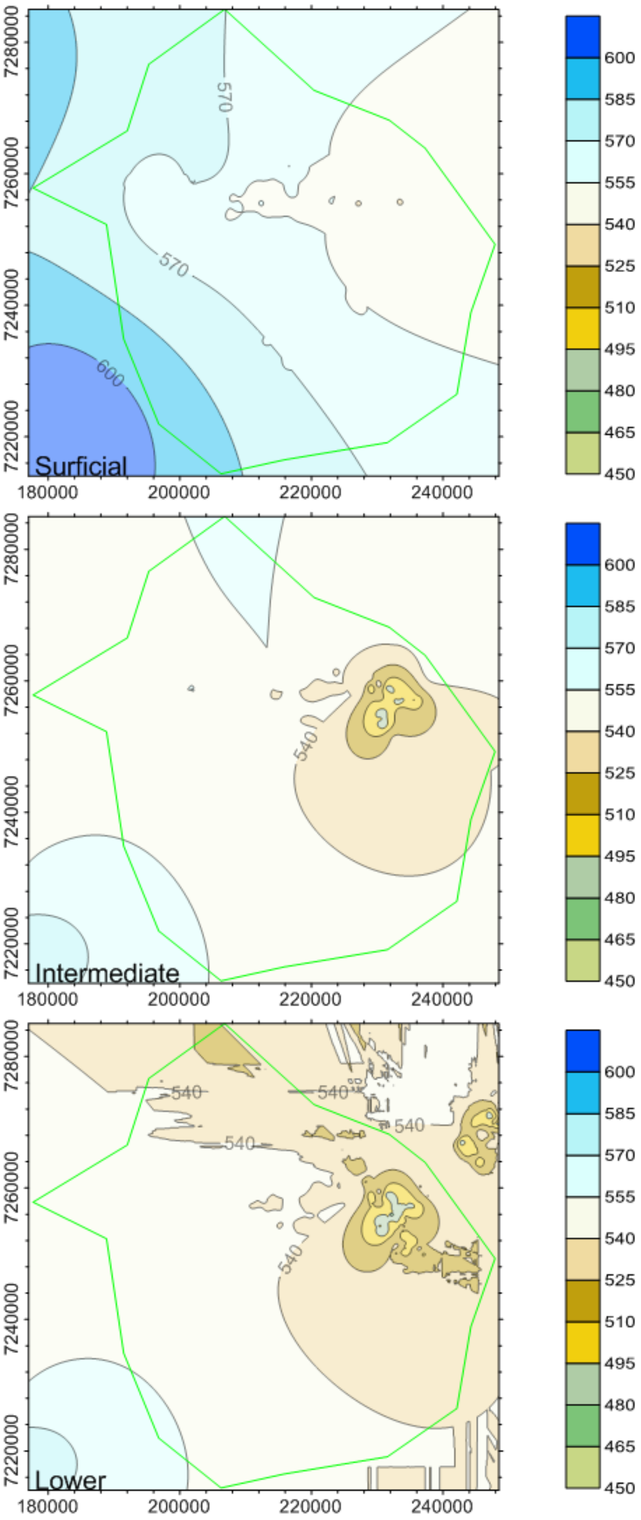
The surface elevation was derived from the 1 second SRTM (Gallant et al., 2011). It is plotted in Figure A-1. Table A-1 contains the elevations from various bore logs for different layers. These were used to construct the surfaces for the base of the surficial and clay layers. The base of the confined aquifer was based on the data in Table A-1 and data from the Tromino geophysics. These elevations were then adjusted downwards to ensure there were at least 15 m thickness for the surficial layer, 10 m thickness for the intermediate clay layer and 2 m thickness for the confined aquifer. The elevations for these are plotted in Figure A-1 and the thickness of these layers is plotted in Figure A-2. The underlying bedrock layer was assigned a thickness of 10 m.

Table A-1: Elevations of Layers

Layer	Minimum Elevation (mAHD)	Maximum Elevation (mAHD)
Surficial	557.8	730.6
Clay/Weathered rock	491.3	597.6
Confined Aquifer/Weathered rock	486.2	559.6
Bedrock	476.2	557.6



FigureA-1: Surface Elevation


Surficial
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600
Intermediate
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Lower
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Figure A-2: Base Elevations of Layers

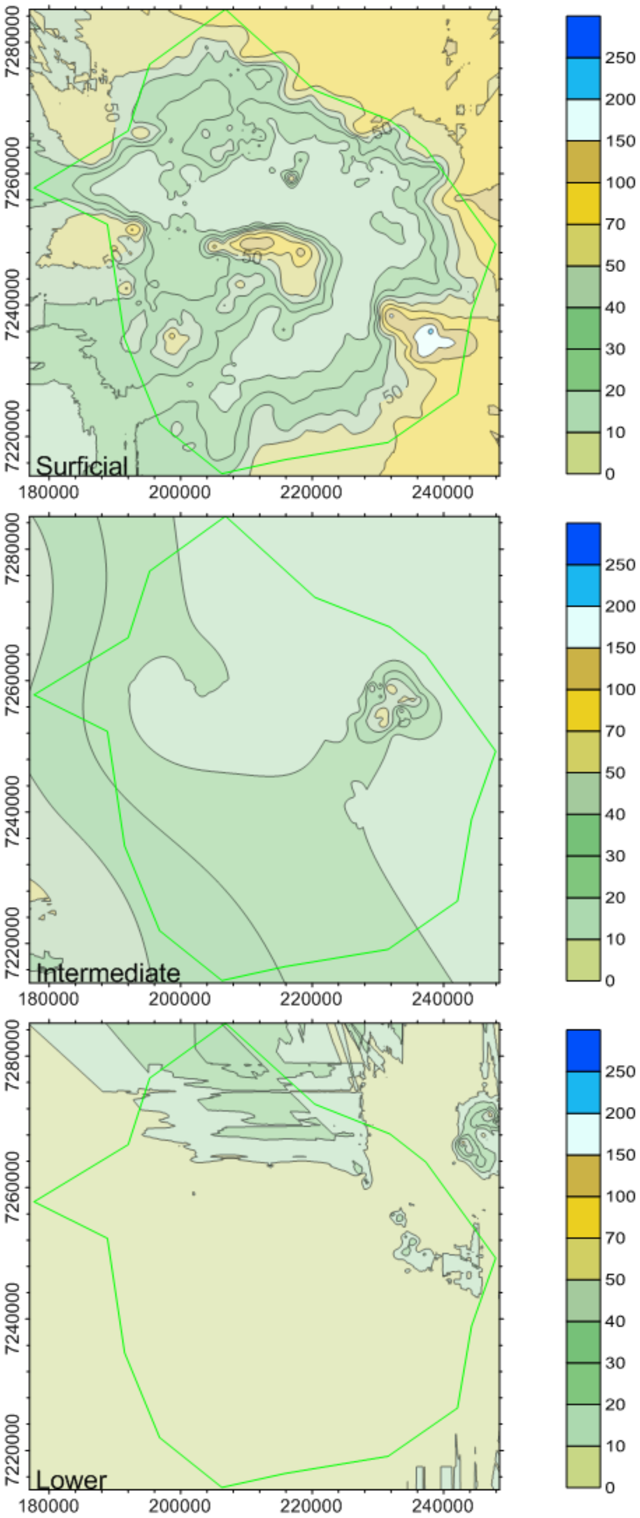

Figure A-3: Thickness of Layers

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Appendix B Calibration Results and Statistics

This Appendix contains a more detailed description of the calibration results than the summary of results presented in Section 5.3. The calibration results are again divided into the three parts of the calibration procedure:

- Steady-state regional calibration
- Confined aquifer response to aquifer testing in vicinity of 10 Mile Lake; and
- Trench testing on 10 Mile Lake.

B.1 Steady-State Regional Calibration

The full results for the steady-state calibration are presented in Table B-1. The statistics for the calibration are in Table B-2. Figure B-1 shows a comparison between the Calibrated (simulated) heads and the head observations, whilst Figure B-2 shows the residuals (Simulated – Observed) against the simulated heads.

These indicate that the observed heads can be divided into two groups.

The first group (Observed Heads > 575 mAHD) comprise of the observations from the upper parts of the catchment. All these observations are from the WIR (DoW, 2017) and represent recorded values at different times. All these sites had single observations and it is not known what conditions these observations were taken under. These could be obtained when the well was being constructed, in wet or dry conditions or after well use. Thus there is a high degree of uncertainty with these observations.

The second group consists of observations on the alluvial areas of the model domain. These are a combination of data from the WIR (DoW, 2017) and surveyed levels from the current project. The data from the WIR is subject to the same uncertainties associated with the first group of data. The data used from this project was the first observed level in that particular bore. For some bores this observed level may have been obtained post-abstraction from other bores in the vicinity and may not represent a long-term water table elevation/piezo metric head. Thus these bores too have some uncertainty associated with the observed values.

The distribution of the residuals shows there may be a slight over estimate of heads in the calibrated model in the vicinity of 10 Mile Lake. There is no discernible trend in the overall distribution of residuals indicating no overall bias in the model.

Table B-1: Steady-State Calibration Results

Bore	Slice	Easting	Northing	Observed	Simulated	Residual
20072261	2	200527.8	7255636	559.726	569.6556	-9.92964
TMAC26M1	5	232825	7253032	552.216	561.0656	-8.84956
TMAC14M1	5	233452.9	7257458	554.529	560.5868	-6.0578
TMAC22M1	5	230515.9	7254836	556.188	560.7313	-4.5433
20072268	2	201635.8	7269437	584.806	589.1042	-4.29819
20072267	2	219267.9	7261721	562.047	565.4928	-3.44579
TMAC09M1	5	232950.8	7251176	558.292	561.4711	-3.17912
TMAC21M1	5	233892	7253504	558.019	561.0443	-3.02529
WB12TB2	2	233890.6	7253948	558.142	560.9316	-2.78957
WB09MBD	5	230482.9	7254262	558.126	560.7556	-2.62959
WB12MBD	5	233894.4	7253901	558.407	560.9442	-2.53716
TMAC23PB	2	230934.5	7253523	558.341	560.8587	-2.51765
20072260	2	202766.8	7256049	566.45	568.9617	-2.51166
WB12TB1	2	233891.5	7253931	558.493	560.9361	-2.44311
TMAC24M1	5	231839.6	7251994	558.764	561.2032	-2.43922
TMAC15	5	235751.7	7257213	557.889	560.3231	-2.43411
TMAC16M1	5	232061.8	7254489	558.341	560.7563	-2.41534
TMAC14M2	2	233452.9	7257458	557.509	559.8863	-2.37728
TMAC06	5	233138.6	7256566	558.242	560.6135	-2.37154
TMAC13M1	5	233485.7	7256939	558.287	560.5763	-2.28929
WB10MBD	5	233468.4	7257249	558.306	560.5824	-2.27642
TMAC12M1	5	233485	7256791	558.312	560.5784	-2.26636
WB10MBI	2	233486.8	7257251	557.748	559.8419	-2.09386
WB11MBD	5	233539.2	7255526	558.695	560.6718	-1.97678
20069726	2	195116.9	7271828	593.977	595.8387	-1.8617
TMAC12M2	2	233485	7256791	558.022	559.7294	-1.70744
TMAC13M2	2	233485.7	7256939	558.277	559.7691	-1.49211
WB11MBI	2	233545.3	7255522	558.066	559.3028	-1.23684
TMAC21M2	2	233892	7253504	558.339	559.5483	-1.20929
TMAC09M2	2	232950.8	7251176	558.542	559.7095	-1.16745
20072266	2	203670.8	7274811	594.885	595.5835	-0.69853
TMAC22M2	2	230515.9	7254836	557.878	558.516	-0.63795
WB12MBI	2	233887.8	7253923	558.857	559.4902	-0.63316
20072259	2	208797.8	7256222	565.973	566.5975	-0.62451
TMAC26M2	2	232825	7253032	558.296	558.9033	-0.60732
TMAC16M2	2	232061.8	7254489	558.281	558.6299	-0.34889
TMAC11M1	5	230974.5	7253145	560.6	560.9186	-0.3186
20072263	2	206394.9	7234210	591.52	591.6779	-0.15785
TMAC23PB	2	230934.5	7253523	558.341	557.7869	0.554116
TMAC24M2	2	231839.6	7251994	559.204	558.4004	0.803641

Bore	Slice	Easting	Northing	Observed	Simulated	Residual
TMAC11M2	2	230974.5	7253145	559.08	557.6322	1.447756
20072258	2	209505	7230468	590.153	587.6599	2.493143
23086540	2	233891.5	7253931	562.068	559.4907	2.577313

Table B-2: Steady-State Calibration Statistics

Quantity	Value	Unit
Count	43	
Minimum Observed	552.2	m
Maximum Observed	594.9	m
Minimum Simulated	560.4	m
Maximum Simulated	596.8	m
SR: Sum of Residuals	141.4	m
MSR: Mean SR	2.43	m
SMSR: Scaled MSR	5.69	%
SSQ: Sum of Squares of Residuals	819.7	m^2
MSSQ: Mean SSQ	19.06	m^2
RMS: Square Root of MSSQ	4.37	m
RMFS: Root Mean Fraction Square	0.76	%
SRFMS: Scaled RMFS	10.1	%
SRMS: Scaled RMS	10.2	%
CoD: Coefficient of Determination	1.13	
r: Correlation Coefficient	0.94	
N-S epsilon	0.83	

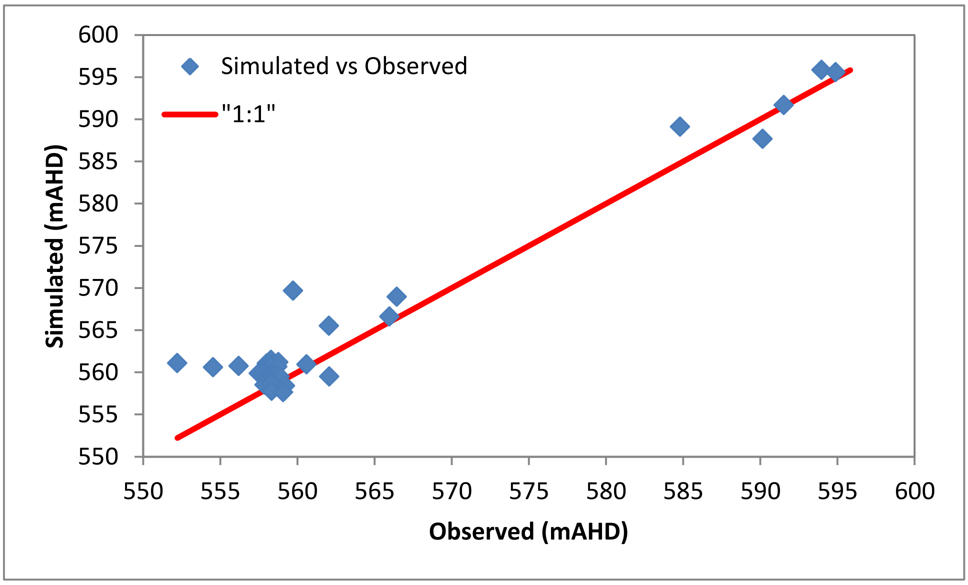


Figure B-1: Simulated vs Observed for Steady-State Calibration

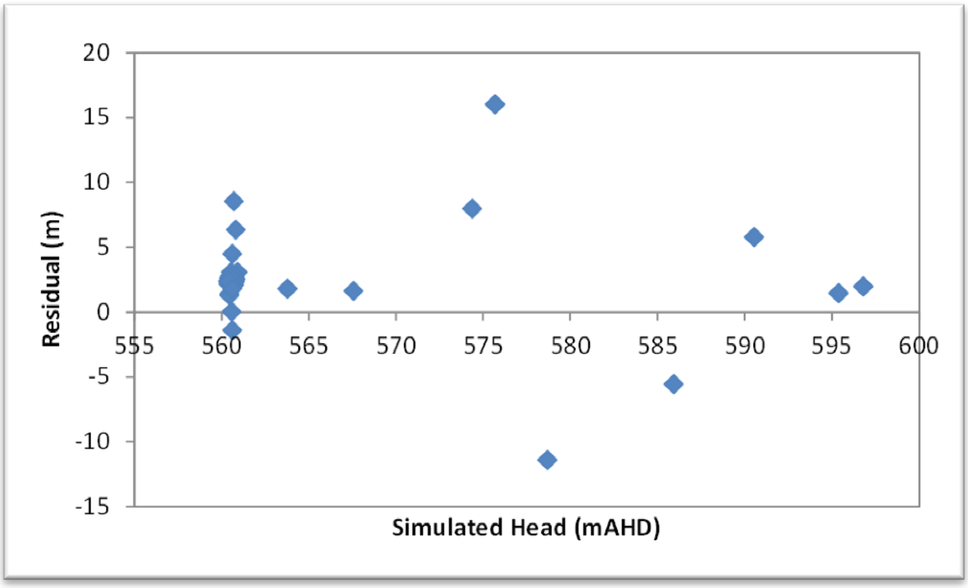


Figure B-2: Residuals (Simulated – Observed Heads) versus Simulated Heads for Steady-State Calibration

B.2 Confined Aquifer Calibration

The calibration procedure for the confined aquifer testing at 10 Mile Lake was described in Section 5.2. This explained that although the majority of available observations were used, some observations were ignored in the calibration procedure as there was a lack of confidence in the information available. An overview of the calibration results was reported in Section 5.3.2.

The statistics for the calibration are in Table B-3. The calibration procedure used the weighting for the observations, with an unweighted analysis included for completeness. The SRMS for unweighted drawdowns was 8.3% compared to the 2.7% for the weighted observations. Figure B-3 shows the distribution of residuals versus the simulated head changes. The majority of the residuals are close to zero, but there are some clear trends, especially for the positive head changes, with tracks of residuals for different aquifer tests. Although AGMG (Barnett et al., 2011) states ideally there should not be clear trends in these residuals, differences in observed and simulated heads from aquifer testing will generally exhibit trends and the differences between the simulated and observed are not great.

Figure B-4 shows a comparison between all observations and simulated results (including those given a weighting of zero) and Figure B-5 shows the distribution of residuals for the same results. Compared with the weighted results (Figure 5-11), it shows greater differences between the observed and simulated piezometric heads, with some aquifer test showing greater simulated responses than those observed. This is thought to be due to well construction of the original bores not separately screening the upper and lower aquifers.

Figure 5-12 and Figures B-6 to B-18 show the head change hydrographs at all observation bores. The bores which are screened outside the confined aquifer and those that were excluded from the calibration (i.e. given a zero weighting in the calibration) are noted. The differences between the head changes in the confined aquifer bores are minor except for TMAC26, where the initial observed head was probably recorded after the aquifer test was started.

Table B.3: Statistics for Weighted and Unweighted Analysis of Confined Aquifer Calibration

Quantity	Value (weighted)	Value (unweighted)	Unit
Count	2690	3348	
Minimum Observed	-27.6	-48.8	m
Maximum Observed	11.27	11.27	m
Minimum Simulated	-26.8	-31.8	m
Maximum Simulated	9.60	9.60	m
SR: Sum of Residuals	2031	6208	m
MSR: Mean SR	-0.27	-0.60	m
SMSR: Scaled MSR	-0.69	-1.01	%
SSQ: Sum of Squares of Residuals	2922	83504	m^2

Quantity	Value (weighted)	Value (unweighted)	Unit
MSSQ: Mean SSQ	1.09	24.94	m^2
RMS: Square Root of MSSQ	1.04	4.99	m
RMFS: Root Mean Fraction Square	114038	352761	%
SRFMS: Scaled RMFS	-6444	-28483	%
SRMS: Scaled RMS	2.7	8.3	%
CoD: Coefficient of Determination	0.98	1.02	
r: Correlation Coefficient	0.80	0.77	
N-S epsilon	0.97	0.54	

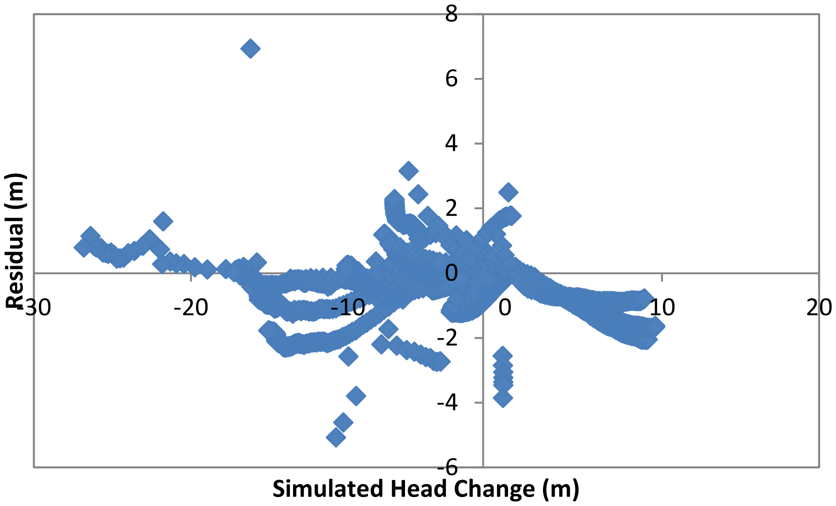


Figure B-3: Residual Distribution of Weighted Observations for Confined Aquifer Calibration

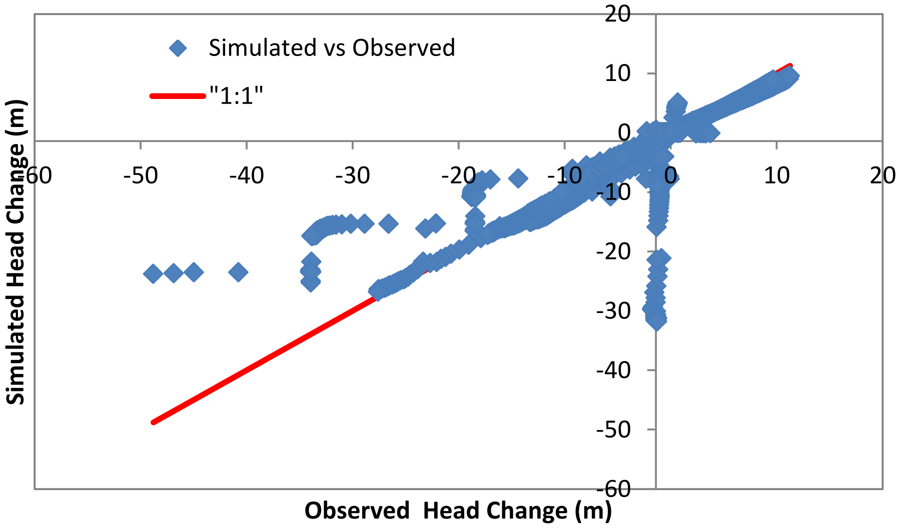


Figure B-4: Comparison of Simulated and Observed Head Changes for Confined Aquifer Calibration (All)

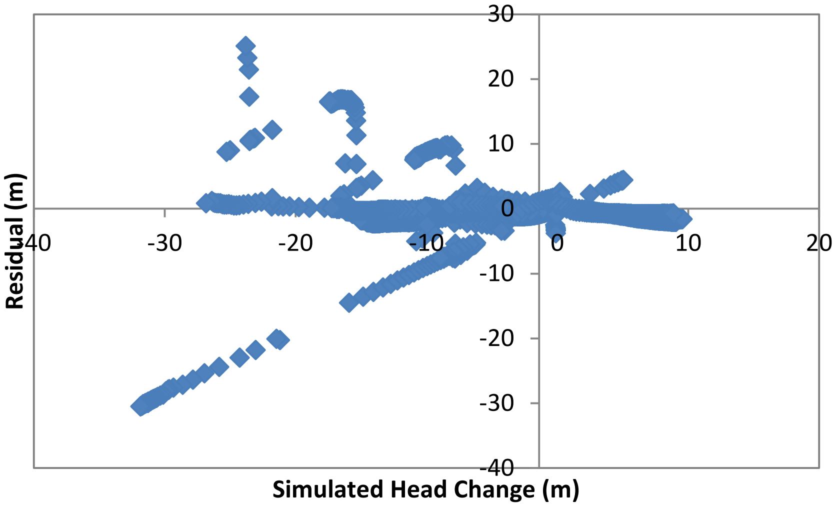


Figure B-5: Distribution of All Observations for Confined Aquifer Calibration

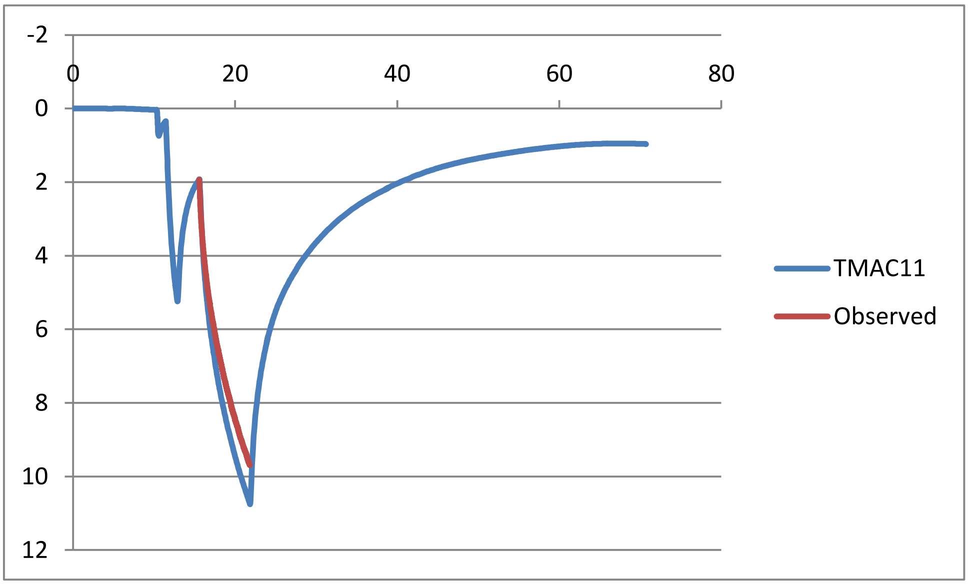


Figure B-6: Observed and Simulated Drawdowns for Bore TMAC11

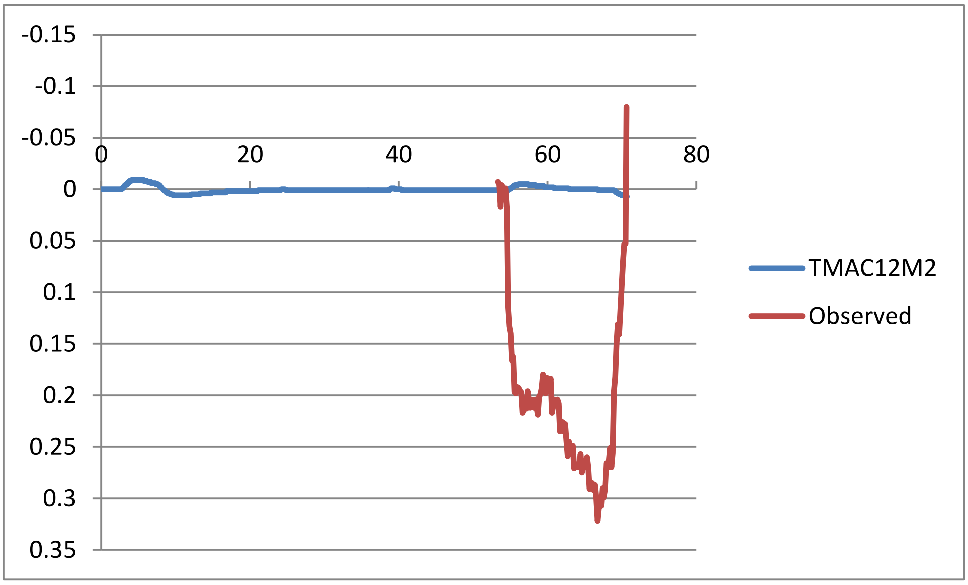


Figure B-7: Observed and Simulated Drawdowns for Bore TMAC12M2 (Shallow aquifer, zero weight)

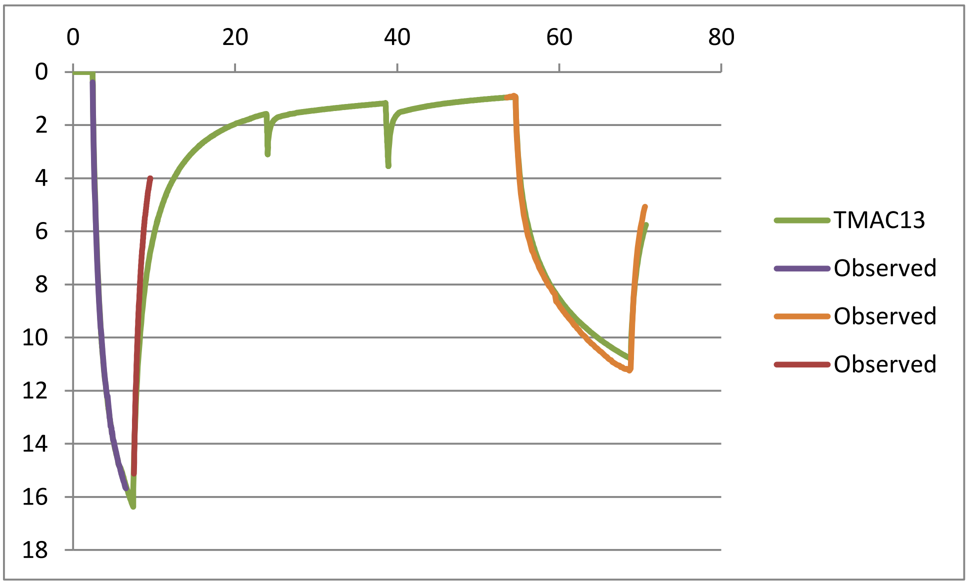


Figure B-8: Observed and Simulated Drawdowns for Bore TMAC13

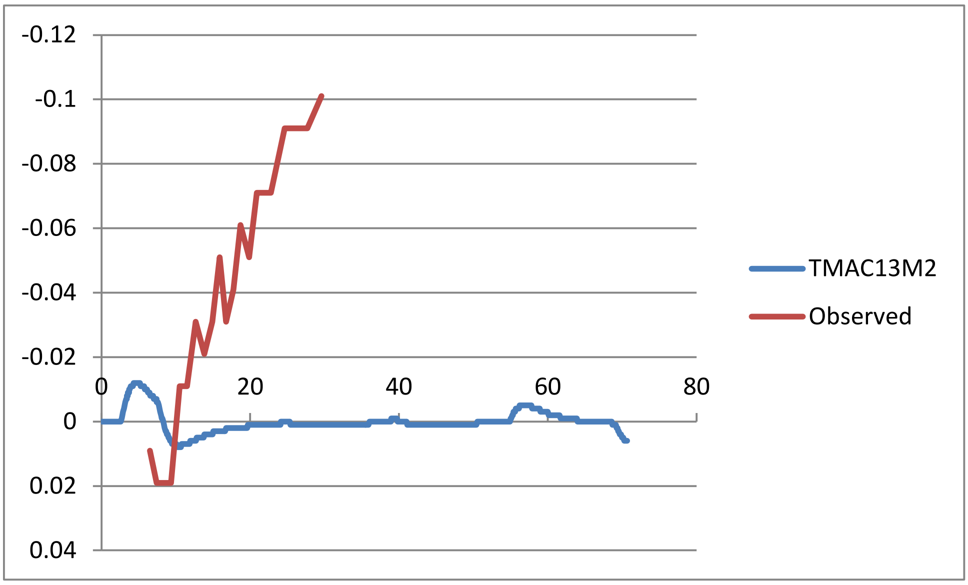


Figure B-9: Observed and Simulated Drawdowns for Bore TMAC13M2 (Shallow aquifer, zero weight)

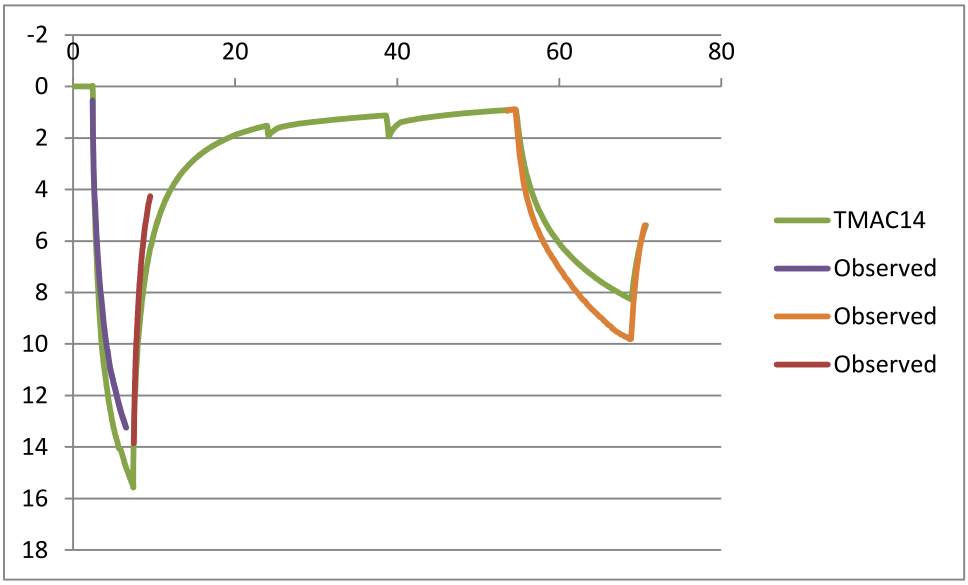


Figure B-10: Observed and Simulated Drawdowns for Bore TMAC14

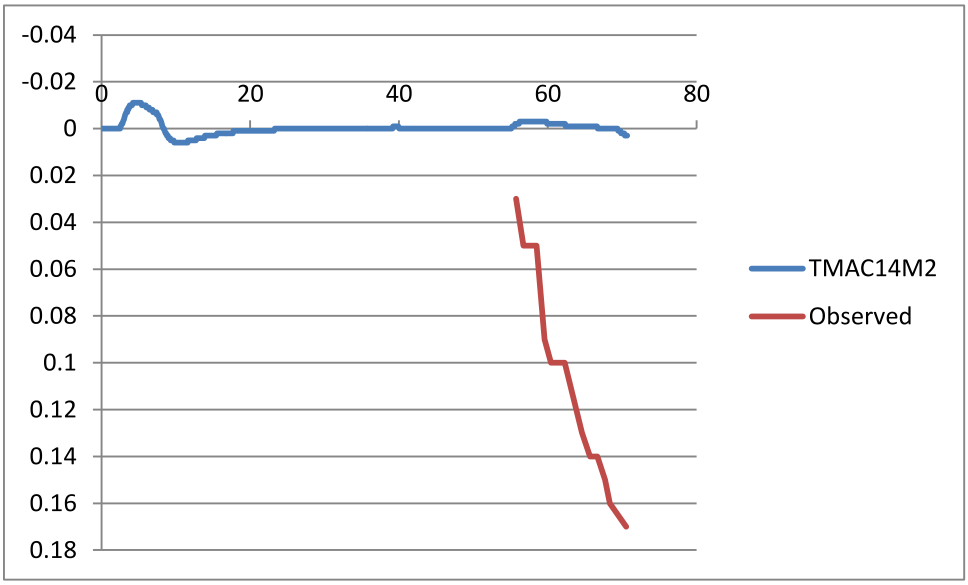


Figure B-11: Observed and Simulated Drawdowns for Bore TMAC14M2 (Shallow aquifer, zero weight)

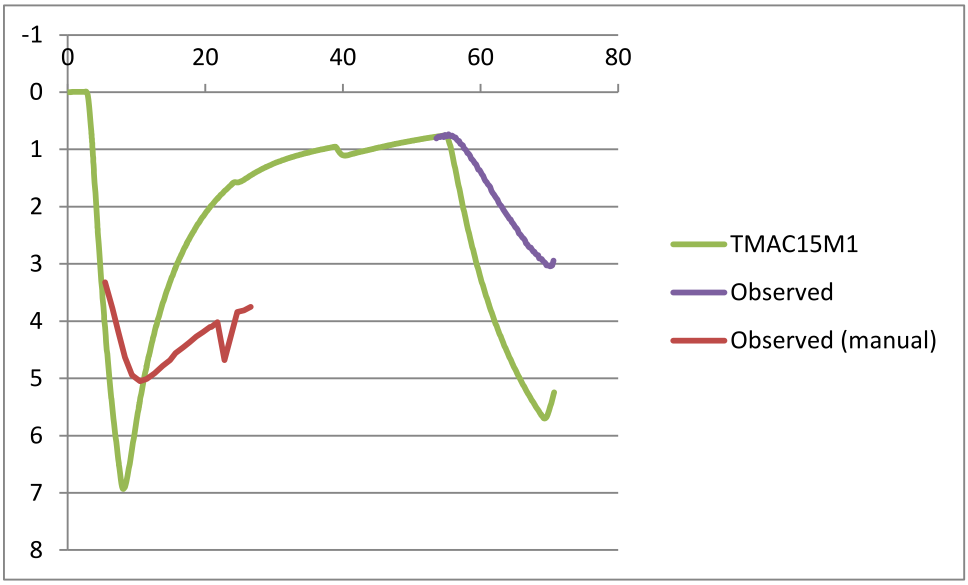


Figure B-12: Observed and Simulated Drawdowns for Bore

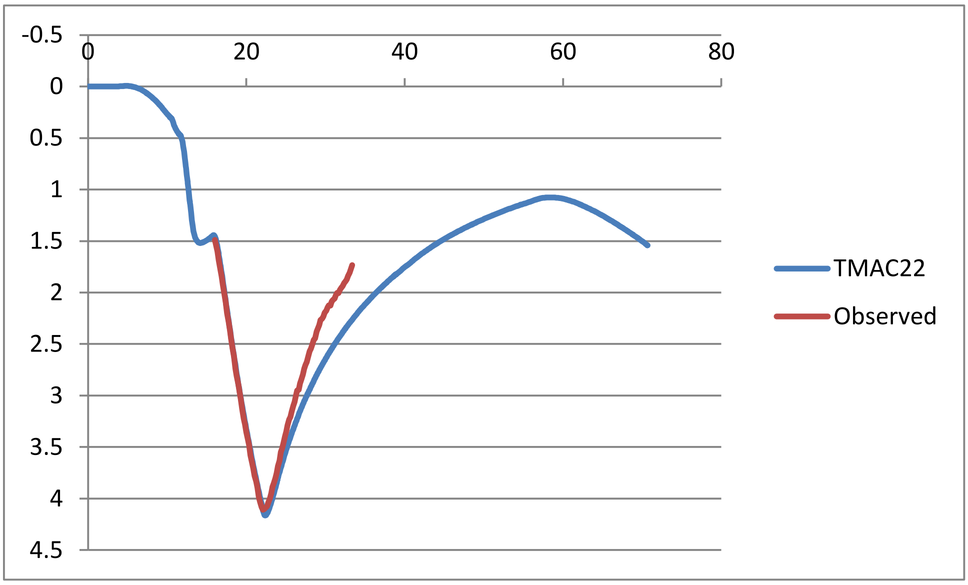


Figure B-13: Observed and Simulated Drawdowns for Bore TMAC22

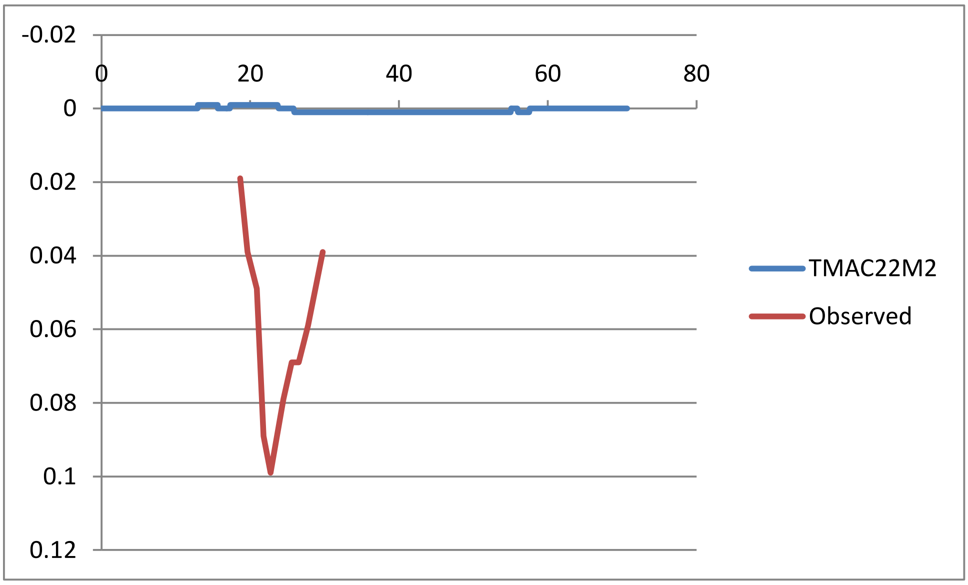


Figure B-14: Observed and Simulated Drawdowns for Bore TMAC22M2 (Shallow aquifer, zero weight)

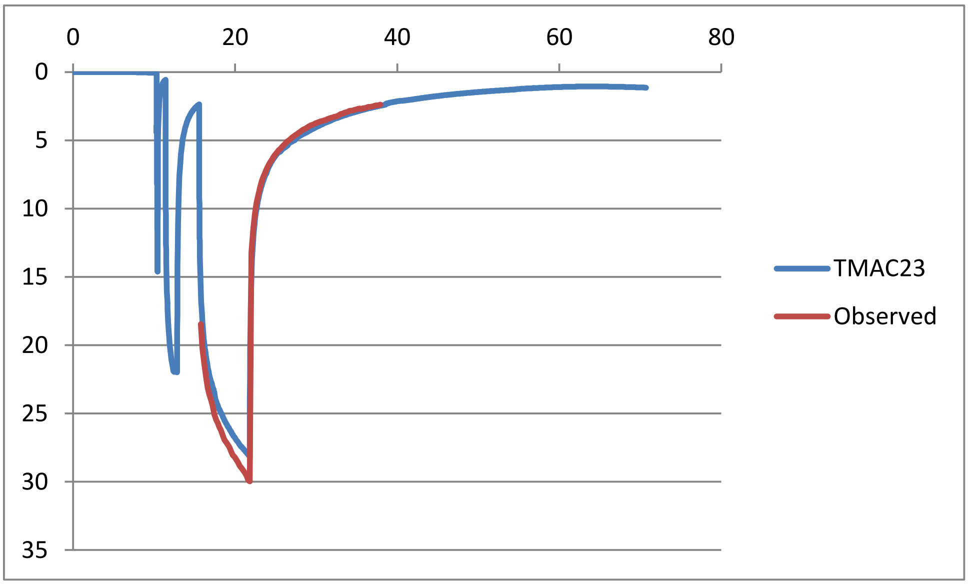


Figure B-15: Observed and Simulated Drawdowns for Bore TMAC23

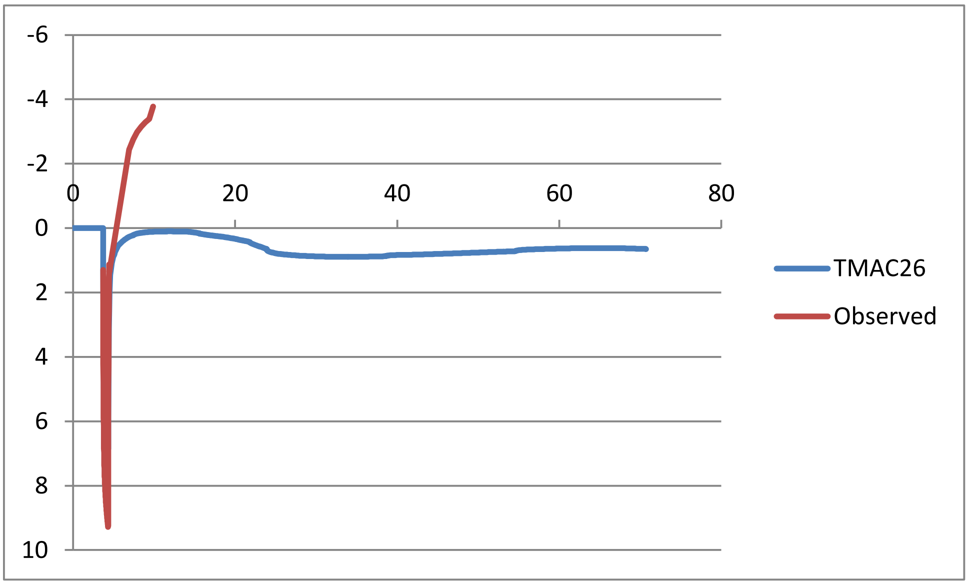


Figure B-16: Observed and Simulated Drawdowns for Bore TMAC26

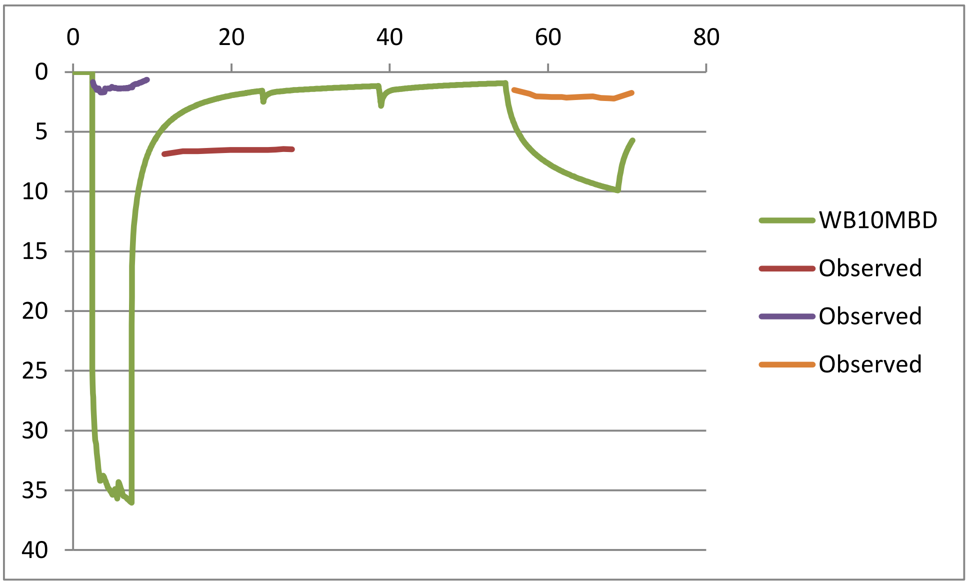


Figure B-17: Observed and Simulated Drawdowns for Bore WB10MBD (Screened across confined and surficial aquifers, zero weight)

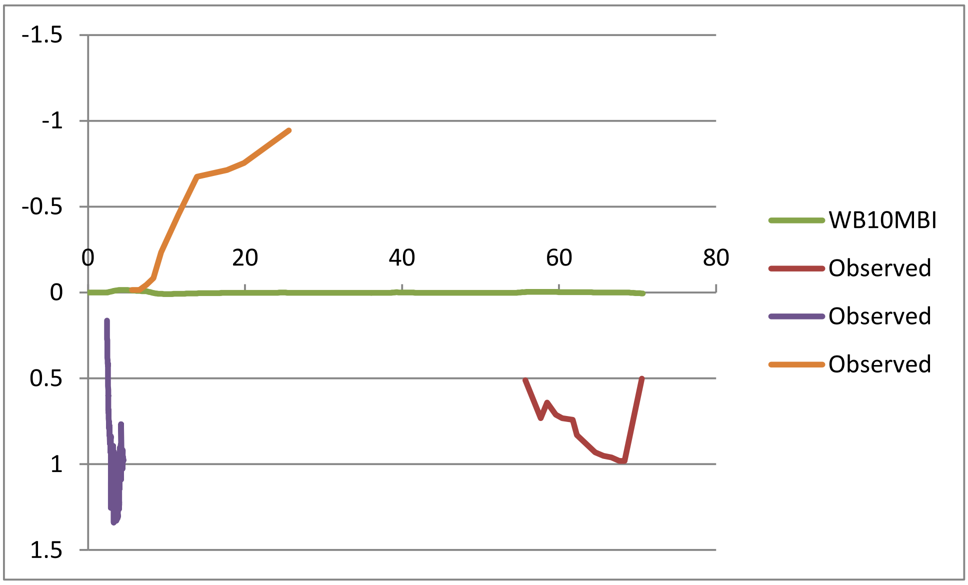


Figure B-18: Observed and Simulated Drawdowns for Bore WB10MBI (Screened across clay aquitard and surficial aquifer, zero weight)

Table B-4: Calibrated Hydraulic Conductivity and Specific Storage Values from Transient Calibration of Confined Aquifer

Pilot Point	Kxx	Kyy	Kz	Ss
1	0.86(1.1E-03-700)	16(0.80-300)	66 (9.0E-42-4.8E+44)	2.0E-05 (8.4E-22-4.8E+11)
2	5.0 (5.0E-300-1.0E+300)	0.62 (6.2E-301-6.2E+299)	0.65 (6.5E-301-6.5E+299)	1.8E-05 (1.8E-305-1.8E+295)
3	0.10 (1.0E-301-1.0E+299)	2.4 (2.4E-300-1.0E+300)	0.37 (3.7E-301-3.7E+299)	1.0E-04 (1.0E-304-1.0E+296)
4	0.25 (5.9E-238-1.0E+236)	94 (3.0E-35-2.9E+38)	11 (3.8E-98-3.0E+99)	8.8E-05 (4.6E-13-1.7E+04)
5	0.79 (7.5E-99-8.2E+97)	2.7 (1.2E-235-6.0E+235)	0.78 (2.7E-94-2.2E+93)	1.3E-05 (1.3E-305-1.3E+295)
6	58 (5.8E-299-1.0E+300)	0.37 (3.7E-301-3.7E+299)	0.83 (8.3E-301-8.3E+299)	3.2E-05 (3.2E-305-3.2E+295)
7	198 (8.1-4800)	86 (7.7E-36-9.6E+38)	0.20 (2.7E-34-1.4E+32)	1.0E-04 (1.4E-75-7.3E+66)
8	12 (9.1E-40-1.7E+41)	159 (2.7E-53-9.2E+56)	1.6 (1.6E-300-1.0E+300)	1.0E-04 (4.7E-65-2.1E+56)
9	0.77 (1.4E-69-4.4E+68)	9.0 (5.4E-38-1.5E+39)	0.40 (4.0E-301-4.0E+299)	6.0E-05 (1.0E-39-3.5E+30)
10	6.4	0.45	0.50	1.0E-04

Pilot Point	Kxx	Kyy	Kz	Ss
	(6.4E-300-1.0E+300)	(4.5E-301-4.5E+299)	(5.0E-301-5.0E+299)	(1.0E-304-1.0E+296)
11	19 (1.9E-299-1.0E+300)	11 (1.1E-299-1.0E+300)	0.45 (4.5E-301-4.5E+299)	4.1E-05 (4.1E-305-4.1E+295)
12	1.7 (1.0E-114-2.9E+114)	0.10 (7.2E-79-1.4E+76)	0.15 (1.5E-301-1.5E+299)	2.1E-06 (2.1E-194-2.1E+182)
13	51 (4.3E-04-6.1E+06)	0.34 (3.6E-96-3.2E+94)	3.5 (2.3E-26-5.3E+26)	2.6E-07 (3.2E-174-2.1E+160)
14	19 (1.9E-299-1.0E+300)	148 (1.5E-298-1.0E+300)	0.76 (7.6E-301-7.6E+299)	3.2E-06 (3.2E-306-3.2E+294)
15	14 (1.4E-299-1.0E+300)	14 (1.4E-299-1.0E+300)	0.69 (6.9E-301-6.9E+299)	2.2E-06 (2.2E-306-2.2E+294)
16	3.2 (3.2E-300-1.0E+300)	0.10 (1.0E-301-1.0E+299)	0.50 (5.0E-301-5.0E+299)	1.0E-04 (1.0E-304-1.0E+296)
17	9.5 (9.5E-300-1.0E+300)	0.50 (5.0E-301-5.0E+299)	0.14 (1.4E-301-1.4E+299)	1.0E-04 (1.0E-304-1.0E+296)
18	3.6 (3.6E-300-1.0E+300)	0.59 (5.9E-301-5.9E+299)	0.40 (4.0E-301-4.0E+299)	1.0E-04 (1.0E-304-1.0E+296)
19	7.1 (7.1E-300-1.0E+300)	2.0 (2.0E-300-1.0E+300)	0.13 (1.3E-301-1.3E+299)	1.4E-05 (1.4E-305-1.4E+295)
20	0.97 (9.7E-301-9.7E+299)	2.5 (2.5E-300-1.0E+300)	0.68 (6.8E-301-6.8E+299)	1.0E-04 (1.0E-304-1.0E+296)
21	1.9 (1.9E-300-1.0E+300)	1.6 (1.6E-300-1.0E+300)	0.36 (3.6E-301-3.6E+299)	1.0E-04 (1.0E-304-1.0E+296)
22	2.8 (2.8E-300-1.0E+300)	1.4 (1.4E-300-1.0E+300)	0.53 (5.3E-301-5.3E+299)	4.2E-05 (4.2E-305-4.2E+295)
23	155 (1.5E-298-1.0E+300)	2.2 (2.2E-300-1.0E+300)	0.37 (3.7E-301-3.7E+299)	3.2E-05 (3.2E-305-3.2E+295)
24	11 (1.1E-299-1.0E+300)	1.5 (1.5E-300-1.0E+300)	0.38 (3.8E-301-3.8E+299)	3.9E-05 (3.9E-305-3.9E+295)
25	4.1 (4.1E-300-1.0E+300)	15 (1.5E-299-1.0E+300)	0.66 (6.6E-301-6.6E+299)	1.0E-04 (1.0E-304-1.0E+296)
26	1.6 (4.0E-69-6.2E+68)	2.7 (3.0E-185-2.4E+185)	0.48 (4.8E-301-4.8E+299)	1.0E-04 (2.0E-79-5.1E+70)
27	200 (2.0E-298-1.0E+300)	200 (2.0E-298-1.0E+300)	0.63 (6.3E-301-6.3E+299)	1.0E-04 (7.0E-33-1.4E+24)
28	200 (1.4E-161-2.9E+165)	0.34 (3.4E-301-3.4E+299)	0.34 (3.4E-301-3.4E+299)	1.8E-05 (2.3E-203-1.3E+193)
29	192 (7.2E-75-5.1E+78)	38 (3.7E-22-3.9E+24)	0.058 (5.8E-302-5.8E+298)	8.4E-05 (1.1E-72-6.5E+63)
30	200 (4.9E-55-8.2E+58)	200 (1.8E-64-2.2E+68)	1.9 (1.9E-300-1.0E+300)	1.0E-04 (1.2E-100-8.2E+91)
31	200	0.22	0.14	5.2E-05

Pilot Point	Kxx	Kyy	Kz	Ss
	(1.0E-26-3.9E+30)	(2.0E-173-2.3E+171)	(1.4E-301-1.4E+299)	(2.4E-55-1.2E+46)
32	0.27 (3.2E-239-2.3E+237)	2.2 (2.2E-300-1.0E+300)	0.75 (7.5E-301-7.5E+299)	7.7E-08 (3.2E-248-1.9E+233)
33	102 (1.8E-44-5.9E+47)	9.7 (3.1E-139-3.0E+140)	1.2 (1.2E-300-1.0E+300)	5.8E-05 (1.9E-17-1.7E+08)
34	12 (1.2E-299-1.0E+300)	150 (1.5E-298-1.0E+300)	0.44 (4.4E-301-4.4E+299)	1.0E-04 (1.0E-304-1.0E+296)
35	0.10 (1.2E-06-8300)	0.10 (1.2E-48-8.5E+45)	0.27 (1.2E-33-6.1E+31)	1.4E-05 (1.5E-117-1.3E+107)
36	127 (1.5E-03-1.1E+07)	0.10 (1.5E-34-6.8E+31)	1.1 (2.9E-66-4.3E+65)	6.4E-05 (1.7E-07-0.024)
37	1.5 (9.0E-59-2.6E+58)	200 (2.2E-09-1.8E+13)	0.047 (4.7E-302-4.7E+298)	1.0E-04 (9.8E-80-1.0E+71)
38	2.7 (2.7E-300-1.0E+300)	4.8 (4.8E-300-1.0E+300)	0.59 (5.9E-301-5.9E+299)	1.0E-04 (1.0E-304-1.0E+296)
39	5.2 (5.2E-300-1.0E+300)	1.2 (1.2E-300-1.0E+300)	0.62 (6.2E-301-6.2E+299)	1.0E-04 (1.0E-304-1.0E+296)
40	177 (3.7E-134-8.5E+137)	196 (1.2E-32-3.3E+36)	2.6 (2.6E-300-1.0E+300)	8.7E-05 (4.9E-131-1.6E+122)
41	2.4 (2.4E-300-1.0E+300)	68 (4.8E-144-9.7E+146)	3.5 (3.5E-300-1.0E+300)	2.4E-05 (2.2E-109-2.5E+99)
42	17 (1.7E-299-1.0E+300)	1.9 (1.9E-300-1.0E+300)	0.53 (5.3E-301-5.3E+299)	1.1E-05 (1.1E-305-1.1E+295)
43	36 (3.6E-299-1.0E+300)	12 (1.2E-299-1.0E+300)	0.73 (7.3E-301-7.3E+299)	1.0E-04 (1.0E-304-1.0E+296)

NOTE: The 95% range is based on linear extrapolation from calibration procedure. It is an indicative range rather than a calculated range

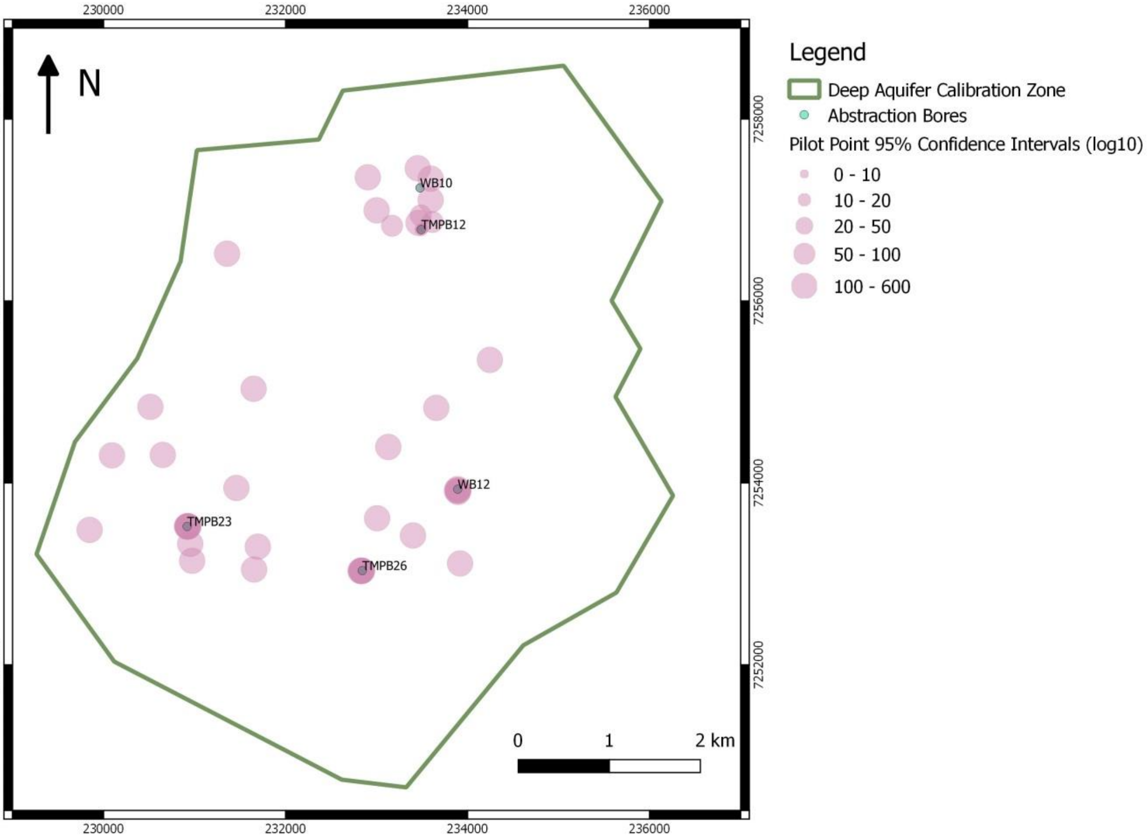


Figure B-19: Distribution of Order of Magnitude of 95% confidence interval for Horizontal Hydraulic Conductivity (x-direction)

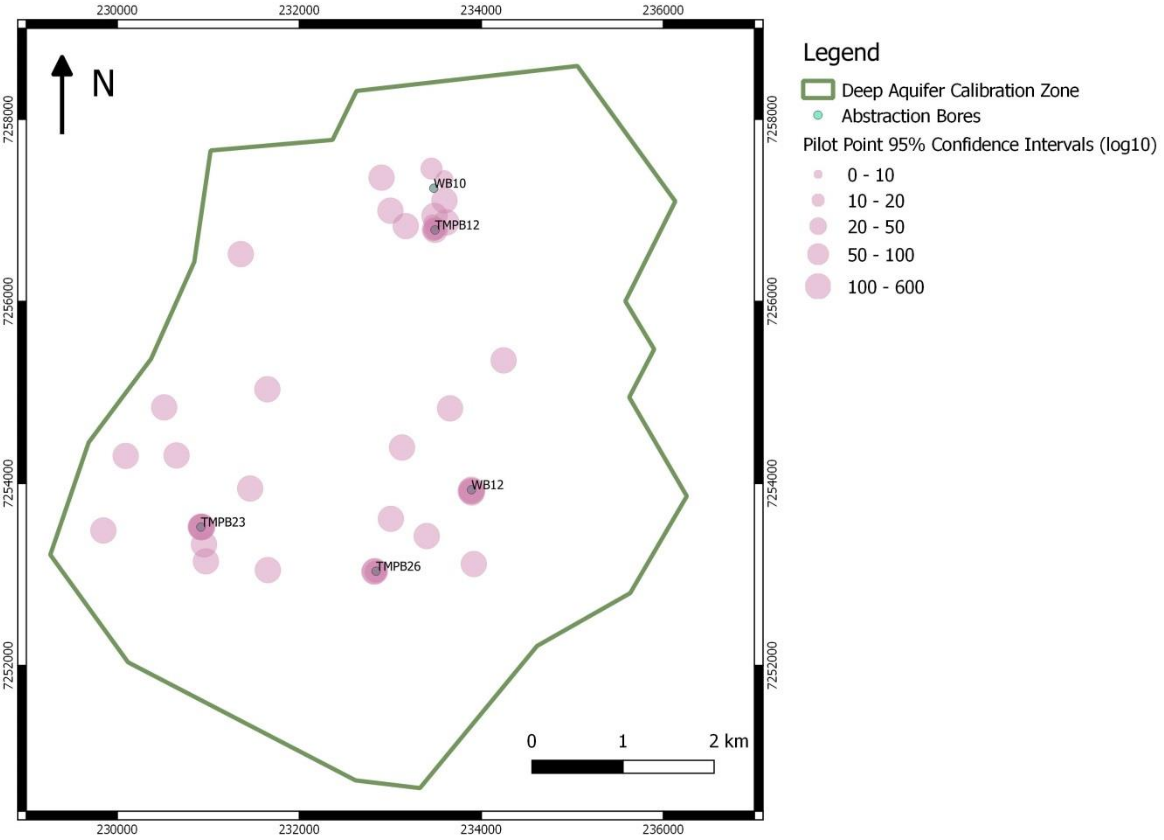


Figure B-20: Distribution of Order of Magnitude of 95% confidence interval for Horizontal Hydraulic Conductivity (y-direction)

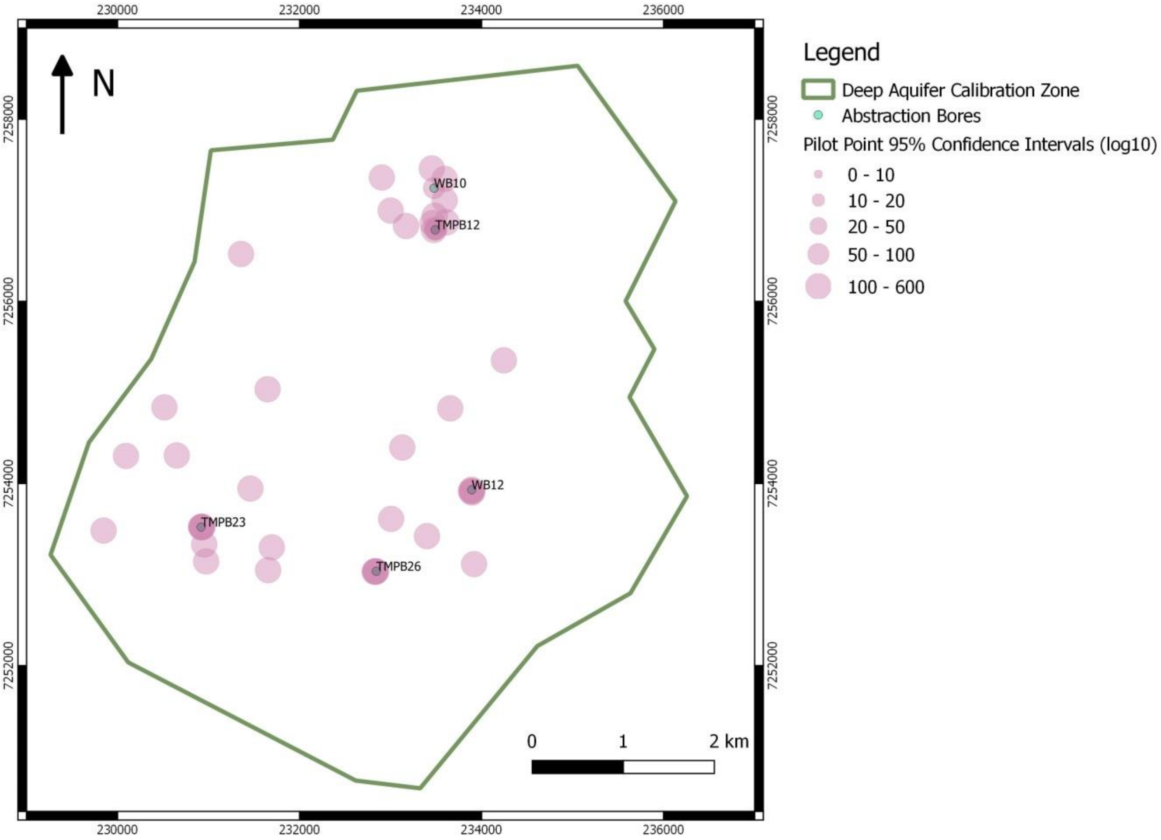


Figure B-21: Distribution of Order of Magnitude of 95% confidence interval for Vertical Hydraulic Conductivity

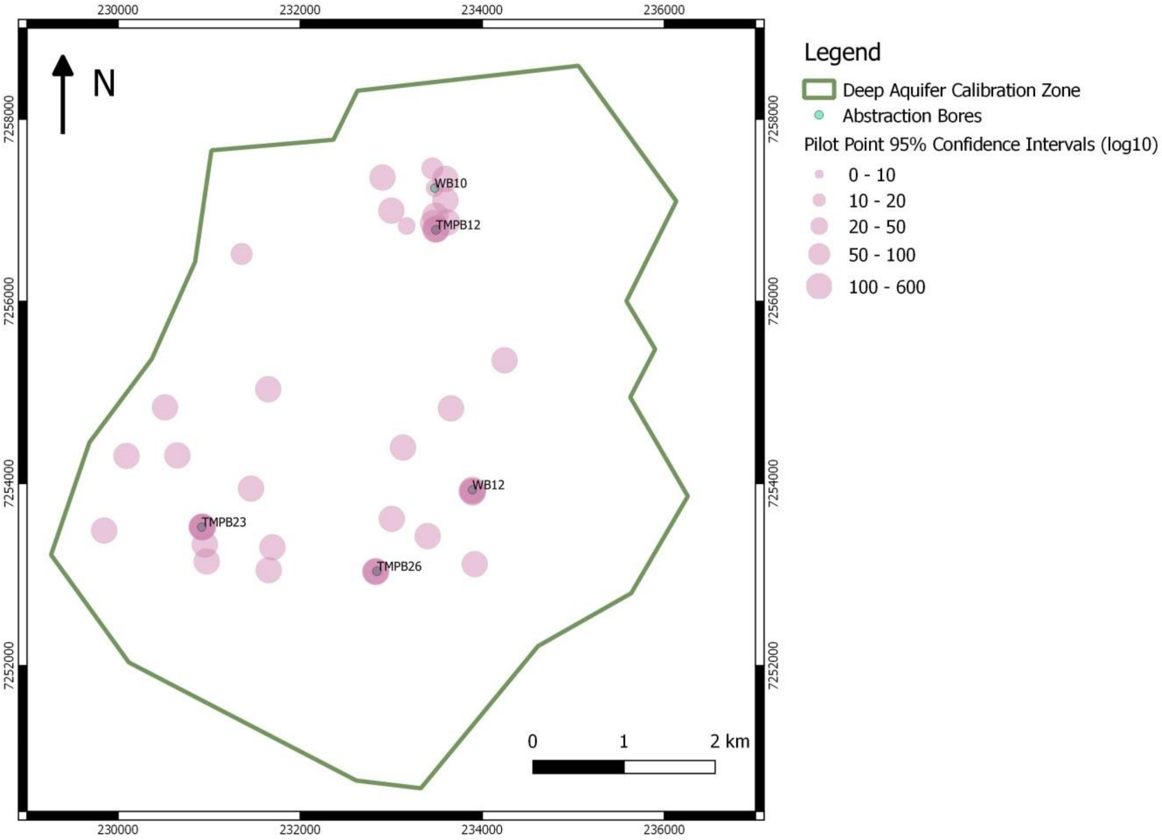


Figure B-22: Distribution of Order of Magnitude of 95% confidence interval for Specific Storage

B.3 10 Mile Lake Trench Calibrations

Three trench tests were carried out on 10 Mile Lake. The lengths of the trenches were 81 m, 300 m and 500 m. Each was calibrated independently using the procedure described in Section 5.2.

B.3.1 Trench 6 (81 m)

The statistics for Trench 6 (81 m) calibration are listed in Table B-5. This shows a reasonable result from the calibration with the SRMS error being 7.9%, less than the 10% suggested by the AGMG (Barnett et al., 2011).

Figure 5-14 showed the comparison between simulated and observed water depths. Figure B-23 shows the residuals versus the simulated values. There are a number of trends evident in the residuals plot however these are consistent with the data being from aquifer testing.

Table B-5: Calibration Statistics for Trench 6 (81 m)

Quantity	Value	Unit
Count	231	
Minimum Observed	-1.33	m
Maximum Observed	-0.50	m
Minimum Simulated	-1.31	m
Maximum Simulated	-0.50	m
SR: Sum of Residuals	11.58	m
MSR: Mean SR	-0.03	m
SMSR: Scaled MSR	-3.20	%
SSQ: Sum of Squares of Residuals	0.97	m^2
MSSQ: Mean SSQ	0.00	m^2
RMS: Square Root of MSSQ	0.06	m
RMFS: Root Mean Fraction Square	7.79	%
SRFMS: Scaled RMFS	-7.66	%
SRMS: Scaled RMS	7.86	%
CoD: Coefficient of Determination	1.24	
r: Correlation Coefficient	0.97	
N-S epsilon	0.91	

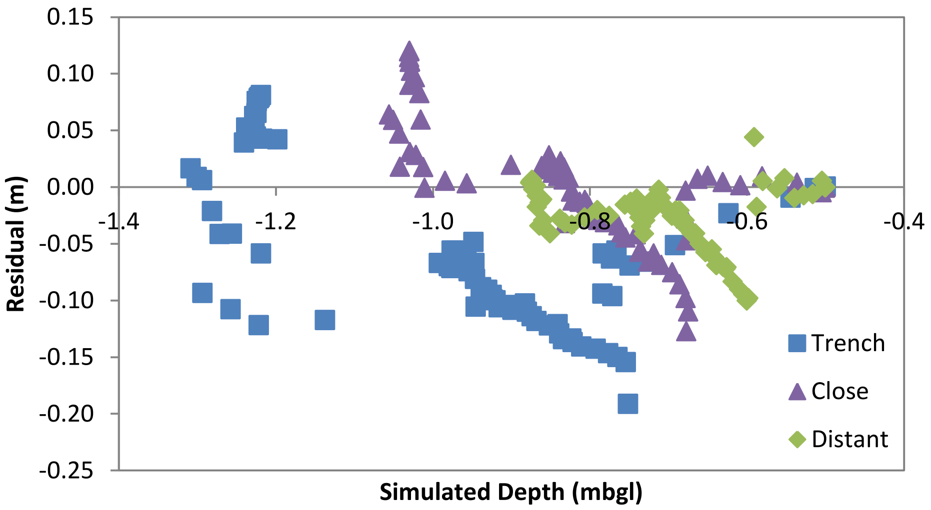


Figure B-23: Residuals versus Simulated Water Depths for Trench 6 (81 m)

B.3.2 Trench 2 (300 m)

The statistics for the Trench 2 calibration are listed in Table B-6. This shows a reasonable result from the calibration with the SRMS error being 8.7%, less than the 10% suggested by the AGMG (Barnett et al., 2011).

Figure 5-15 and Figure B-24 show the comparison between simulated and observed water depths. Figure B-25 shows the residuals versus the simulated values. There are a number of trends evident in the residuals however these are consistent with the data being from aquifer testing. Figure B-26 compares the observed and simulated hydrographs in the trench and observation pits. These show the model is providing a good representation of the behaviour in the trench and pits.

Table B-6: Trench 2 (300 m) Calibration Statistics

Quantity	Value	Unit
Count	265	
Minimum Observed	-0.95	m
Maximum Observed	-0.50	m
Minimum Simulated	-0.86	m
Maximum Simulated	-0.50	m
SR: Sum of Residuals	8.34	m
MSR: Mean SR	-0.01	m
SMSR: Scaled MSR	-2.99	%
SSQ: Sum of Squares of Residuals	0.45	m^2
MSSQ: Mean SSQ	0.00	m^2
RMS: Square Root of MSSQ	0.04	m
RMFS: Root Mean Fraction Square	6.01	%
SRFMS: Scaled RMFS	-8.30	%
SRMS: Scaled RMS	8.74	%
CoD: Coefficient of Determination	1.43	
r: Correlation Coefficient	0.95	
N-S epsilon	0.87	

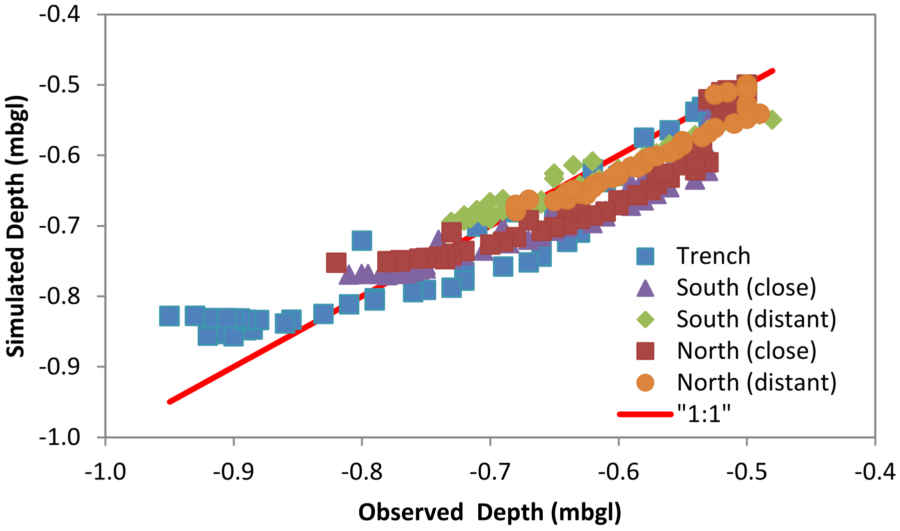


Figure B-24: Simulated vs Observed Heads doe Trench 2 (300 m)

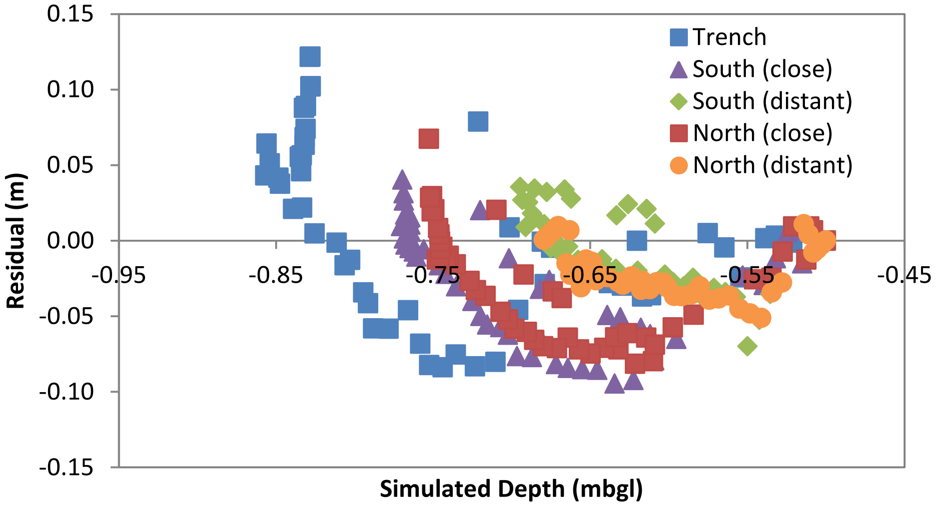


Figure B-25: Residuals versus Simulated Water Depths for Trench 2 (300 m)

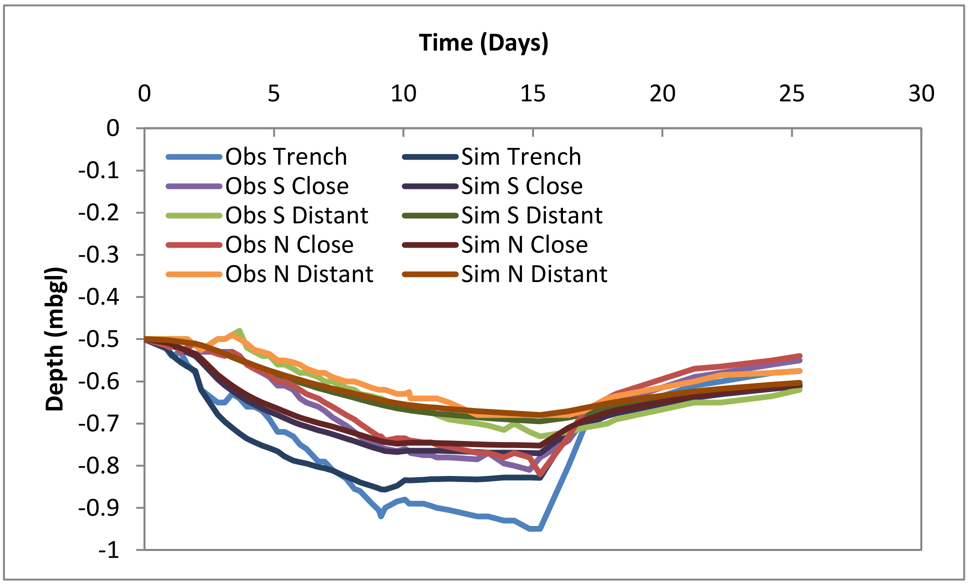


Figure B-26: Comparison of Hydrographs for Trench 2 (300 m)

B.3.3 Trench 1 (500 m)

The statistics for the Trench 1 calibration are listed in Table B-7. This shows a reasonable result from the calibration with the SRMS error being 9.4%, less than the 10% suggested by the AGMG (Barnett et al., 2011).

Figure 5-16 shows a comparison between simulated and observed water depths. Figure B-27 shows the residuals versus the simulated values. There are a number of trends evident in the residuals however these are consistent with the data being from aquifer testing. Figure B-28 compares the observed and simulated hydrographs in the trench. These show the model is providing a good representation of the overall behaviour in the trench.

Table B-7: Trench 1 (500 m) Calibration Statistics

Quantity	Value	Unit
Count	143	
Minimum Observed	-0.90	m
Maximum Observed	-0.50	m
Minimum Simulated	-0.67	m
Maximum Simulated	-0.50	m
SR: Sum of Residuals	2.48	m
MSR: Mean SR	0.00	m

Quantity	Value	Unit
SMSR: Scaled MSR	-0.69	%
SSQ: Sum of Squares of Residuals	0.20	m^2
MSSQ: Mean SSQ	0.00	m^2
RMS: sqrt(MSSQ)	0.04	m
RMFS: Root Mean Fraction Square	6.15	%
SRFMS: Scaled RMFS	-8.6	%
SRMS: Scaled RMS	9.4	%
CoD: Coefficient of Determination	1.73	
r: Correlation Coefficient	0.78	
N-S epsilon	0.60	

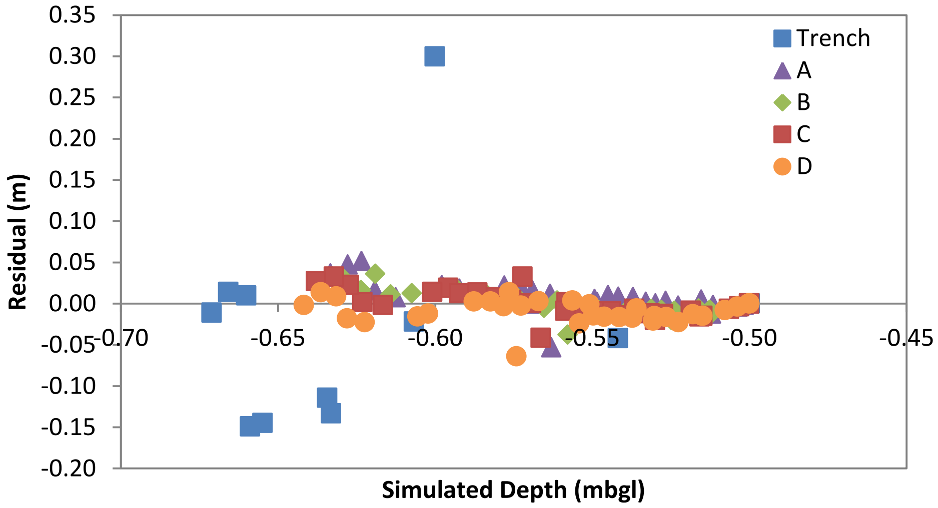


Figure B-27: Residuals for Calibration of Trench 1 (500 m)

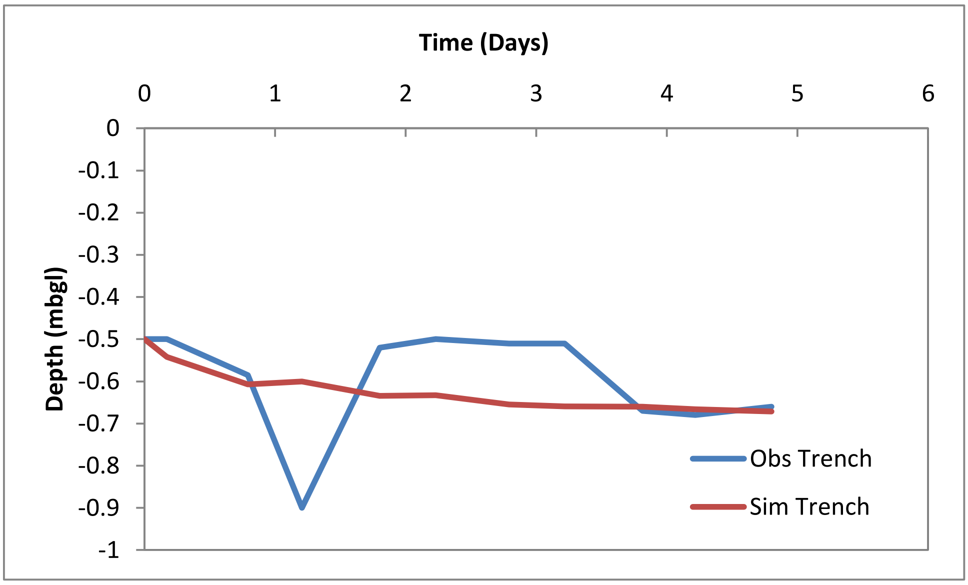
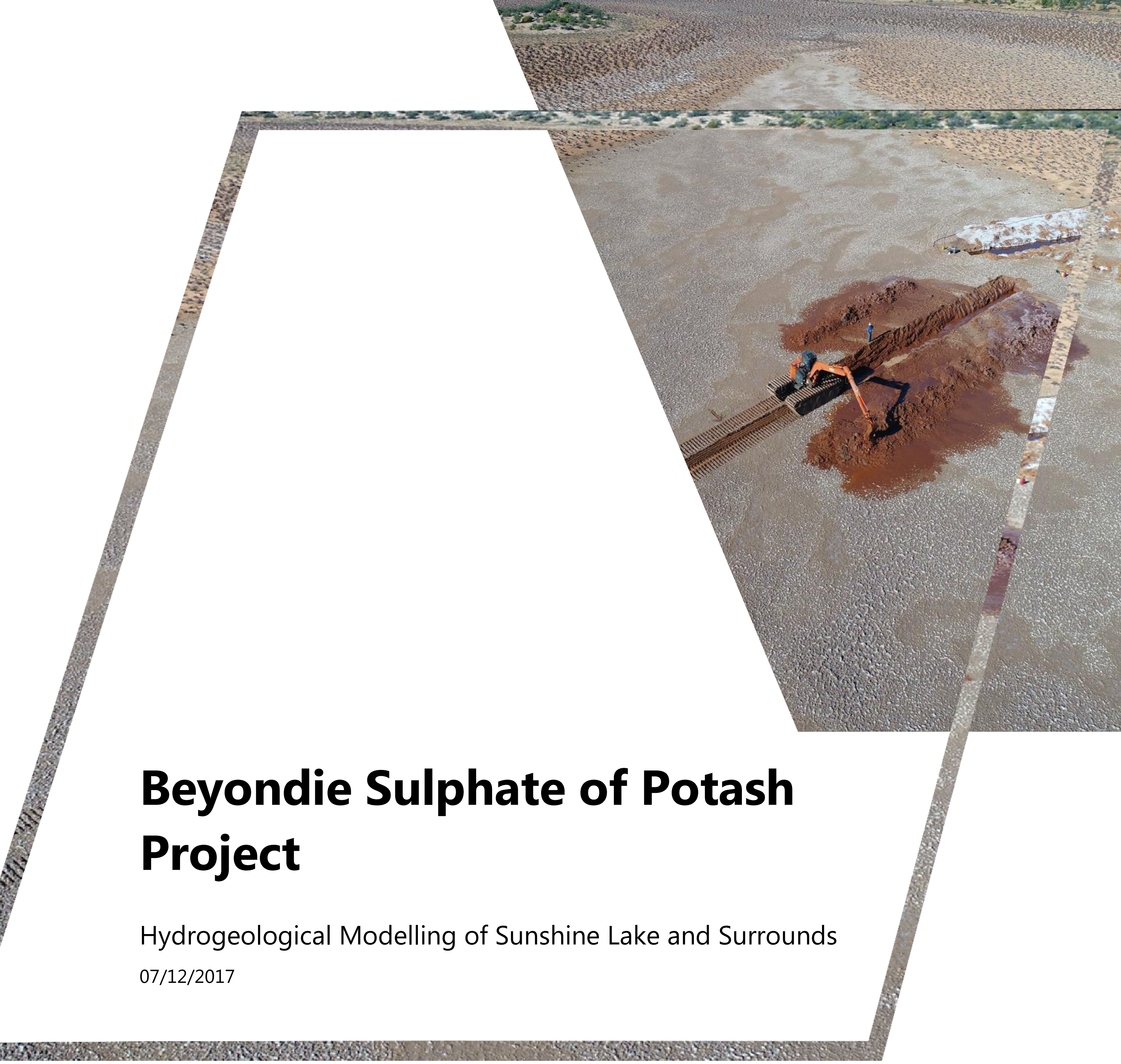


Figure B-28: Observed and Simulated Hydrographs for Trench 1 (500 m)



Beyondie Sulphate of Potash Project

Hydrogeological Modelling of Sunshine Lake and Surrounds

07/12/2017

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201320-14624

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Project No: 201320-14624 – Beyondie Sulphate of Potash Project: Hydrogeological Modelling of Sunshine Lake and Surrounds

Rev	Description	Author	Review	Advisian Approval	Date
0	Issued to Client	A. Barr	A Lloyd	pp S Atkinson	07/12/2017

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Executive Summary

Models were constructed and calibrated for the surficial (lake) and the confined palaeochannel aquifer systems at Sunshine Lake. These models were calibrated to available pumping water level data and used to quantify the brine available from trenches across the lake surface and abstraction bores within the palaeochannel over a life-of-mine of 23 years.

The modelling has indicated that using conservative assumptions the brine recovery from the trenches would decline from an average of 217 L/s over the first five years to 58 L/s over the next 5 years and 50 L/s over the next 10 years. The potassium grade recovered from within the Sunshine Lake area was estimated to be 6,800 mg/L in the first year, 6,000 mg/L in Year 5, 4,800 mg/L in Year 10 and 4,000 mg/L in Year 20. An additional simulation used a recharge of 60 mm (indicative of inundation level over the lake surface for an event with an annual exceedance probability of 63.2%) over the lake surface for a single day each year to simulate the effects of inundation over the lake. It showed the brine recovery from the trenches was up to 233 L/s over the first 5 years and had increased average rates of up to 96, 62 and 61 L/s over the subsequent 5 year periods.

The modelling of the deep confined palaeochannel aquifer indicated that brine recovery from the reduced from an average of 53 L/s in the first year, to 45 L/s by year 5, 44 L/s by year 10 and 41 L/s by year 20. The potassium grade recovered from the indicated resource zone was 4,600 mg/L in the first year, 4,400 mg/L in years 5 and 10 and 4,000 mg/L in Year 20.

1 Introduction

Kalium Lakes Limited (KLL) is a public company, listed on the Australian Stock Exchange (ASX), with ~ 2,400 km^2 of granted tenements at the eastern margin of the East Pilbara region of Western Australia. KLL is looking to develop a sub-surface brine deposit to produce 150 kilo-tonnes per annum (ktpa) of Sulphate of Potash (SOP) product via evaporation and processing within the Beyondie, Ten Mile and Sunshine tenement holdings, comprising part of the tenements Beyondie Sulphate of Potash Project (BSOPP).

KLL engaged Advisian to plan and execute an exploration and assessment program with the aim of upgrading the existing SOP Resources at Ten Mile and Beyondie Lakes to a level of understanding for inclusion into a Reserve estimate. The upgrade will take into account new resource exploration at Kalium's Lake Sunshine tenements. The Resource upgrade is to be developed in line with current accepted guidance according to the JORC Code 2012, with reference to the Canadian Institute of Mining (CIM) Best Practice Guidelines for Resource and Reserve Estimation for Lithium Brines and the Association of Mining draft Guideline for Potash and Lithium Brines.

A major part of the Ore Reserve assessment and application of Mining Modifying Factors for a brine deposit is a comprehensive numerical groundwater model. This report presents the modelling that was completed for the Sunshine Lake area of the BSOPP.

This study has been carried out with reference to the Australian Groundwater Modelling Guidelines (Barnett et al., 2012) in a staged approach. A summary of the approach to groundwater model development used in this study (adopted from Barnett et al., 2012) is provided in Figure 1-1.

In accordance with the Australian Groundwater Modelling Guidelines (Barnett et al., 2012), the model development involved initial phases of planning and conceptualisation, through to design and construction, calibration and sensitivity analysis, predictive modelling, and uncertainty analysis. These stages are outlined as follows:

- Development of a conceptual model of the site and surrounding region using the latest available datasets of geology and hydrogeology to form a basis for understanding of the regional groundwater hydrodynamics;
- Construction of a numerical groundwater model based on data collect during conceptualisation such as the selection of the extent, stratigraphy, structure, tops and bottoms of formation(s), initial aquifer parameters and boundary conditions;
- Calibration of the groundwater model using an iterative process of manual and automated calibration to reduce residual error between observed data and simulated data;
- Sensitivity analysis to "compare model outputs with different sets of reasonable parameter estimates, both during the period of calibration (the past) and during predictions (in the future)" (Barnett et al., 2012, p.57);
- Predictive modelling of the resource recovery;
- Uncertainty analysis to quantify uncertainty in the predictions and illustrate the sensitivity of the results to variations in the assumptions of the model; and

- Analysis, mapping and assessment of predictive model results and estimates of associated uncertainty to quantify the potential impacts and limits of production.

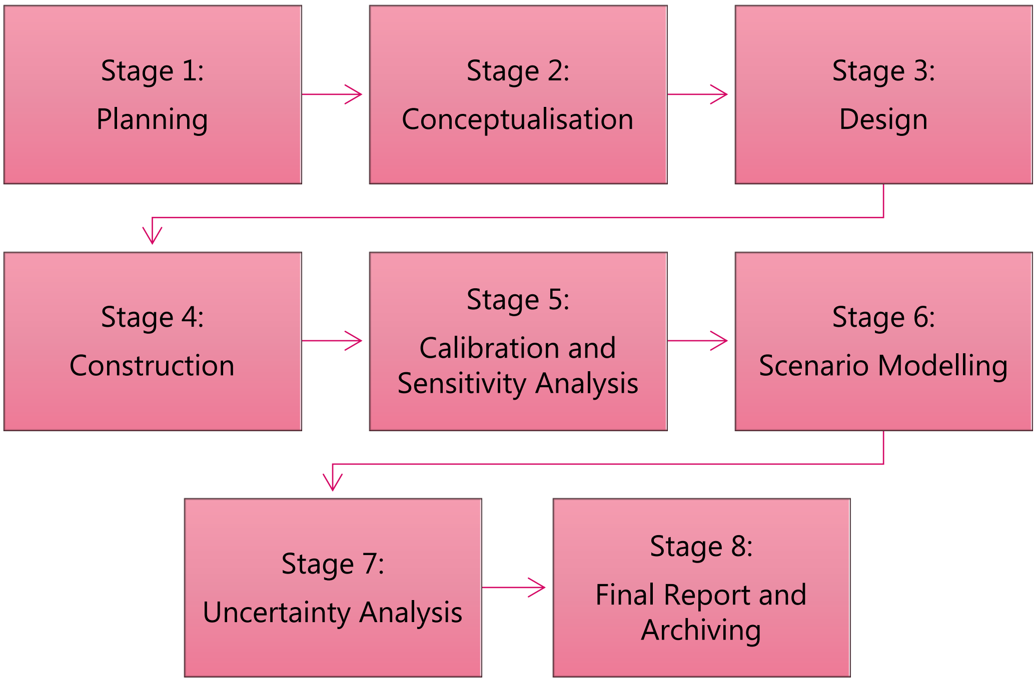


Figure 1-1: Schematic of Stages of Modelling Process (Barnett et al., 2012)

1.1 Report Content

This report broadly follows the structure recommended by the Australian Groundwater Modelling Guidelines (AGMG) (Barnett et al., 2012):

- Chapter 3 describes the conceptual model of the study area based on the available datasets of geology, hydrogeological processes and anthropogenic stresses;
- Chapter 4 describes the numerical implementation of the conceptual model through the model design and construction;
- Chapter 5 provides the calibration and sensitivity analysis of the numerical groundwater flow model;
- Chapter 6 provides an assessment of the recoverable resource;
- Chapter 7 summarises the main findings from this study.

2 Scope of Work

The scope of work for this groundwater modelling is to create a hydrogeological model of the Sunshine Lake area, and use this model to evaluate the recoverable resource for the Beyondie Sulphate of Potash Project (BSOPP). This investigation examines the surface (lake) resources and the deep (palaeochannel) resources.

3 Conceptual Hydrogeology

3.1 Climate

The climate for the area of BSOPP is arid. Nearby Bureau of Meteorology stations with long-term data sets include Meekatharra and Newman. Monthly evaporation data at BSOPP and nearby Bureau of Meteorology sites are listed in Table 3-1. Average rainfall at selected Bureau of Meteorology sites is listed in Table 3-2, with the sites shown in Figure 3-1. The average annual rainfall at the BSOPP is approximately 230 mm. Table 3-2 also contains the average annual excess rainfall. This was calculated as the sum of the daily rainfall events in excess of the average monthly evaporation rates. For the purpose of this calculation the evaporation rates for the BSOPP were used as this was the smallest (most conservative) annual excess rainfall.

Table 3-1: Daily Average Monthly Evaporation Rates

Month	Meekatharra Airport (007045)	Wittenoom (005026)	BSOPP (K-UTEC, 2016)
January (mm/day)	15.8	11.3	17.6
February (mm/day)	14.1	9.8	16.7
March (mm/day)	11.7	9	13.8
April (mm/day)	8.2	7.7	10.1
May (mm/day)	5.4	5.7	6
June (mm/day)	3.8	4.5	4.8
July (mm/day)	3.9	4.8	5.1
August (mm/day)	5.4	6.1	6.5
September (mm/day)	8	8.6	9
October (mm/day)	11	11.1	12.8
November (mm/day)	13.3	12.4	15
December (mm/day)	14.9	12.4	17.3
Annual (mm)	**3506**	**3141**	**4100**

Table 3-2: Average Rainfall Data

Site	Distance from BPP (km)	Annual Rainfall (mm)	Annual Excess Rainfall (mm)
Doolgunna (007023)	154	248.9	94.4
Illgararie (007033)	90	228.3	85.6
Neds Creek (007103)	107	240.1	93.7
Kumarina (007152)	75	218.5	77.8
MaryMia (007180)	47	260.8	93.3
Rpf 477 mile (013008)	37	253.9	100.3
Rpf 5Ten Mile (013010)	34	224.6	94.9
Three Rivers (007080)	128	227.1	82.3

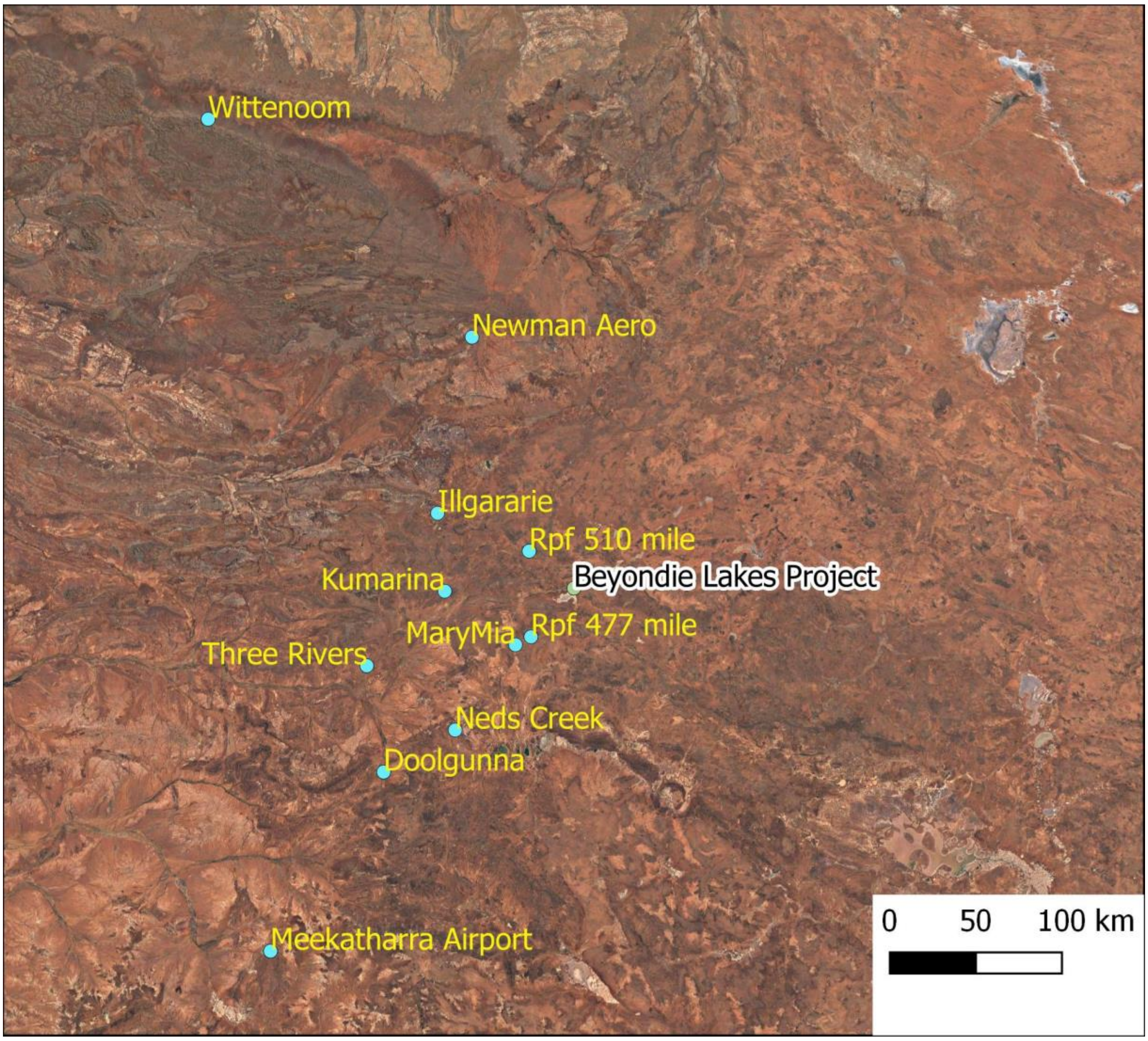


Figure 3-1: Location of Bureaus of Meteorology Climate Stations

3.2 Recharge

Recharge to the aquifer in the arid zones of Western Australia is episodic. It is likely to occur only if there is rainfall in excess of evaporation over a period sufficient for infiltration to reach beyond the vegetation root zones. 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.

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 the alluvium in palaeochannel systems varied between 0.09 and 1% of the rainfall, and recharge to calcrete varied between 0.7 and 5% of rainfall.

3.3 Evapo-transpiration

Evapo-transpiration removes water from the aquifer either directly through evaporation from shallow water table areas or through uptake from roots and transpiration through leaves of the vegetation. This generally occurs where the water table is in close proximity to the surface. Hydrogeologically it is assumed that any groundwater at the surface is subject to the full evaporation rate, and the evapo-transpiration decreases with depth of the water table until it reaches zero at the ‘extinction depth’. Within the BSOPP area, evapo-transpiration is expected to occur in the lower topographical areas, where the water table is relatively close to the surface. In the vicinity of the lakes, transpiration is expected to occur in the fringing vegetation, in calcrete areas and along the creek lines.

It is noted that the evaporation rates in Table 3-1 are pan evaporation rates, which use a standard 120 cm diameter 30 cm deep metal pan containing an initial 25 cm of water at the start of the recording day. Actual evaporation rates from larger expanses water may be less than pan-evaporation due to lower water temperatures and increased humidity along wind runs. Higher salinity of water also reduces the effective evaporation rate.

Direct evaporation from soil depends on the soil water moisture and the soil hydraulic characteristics and the albedo of the surface. The soil evaporation can be affected by the surface albedo, which may be a function of the surficial moisture content.

Transpiration rates depend on the availability of water to the root systems of the plants, the depth it is available, the plant canopy configuration, the leaf area index (ratio of leaf area to canopy area of the ground), and the stomatal resistance in the leaves amongst other factors. The transpiration rate may be higher than the pan evaporation rate for sparse vegetation with good access to groundwater, but is usually lower than the pan evaporation.

3.4 Palaeo-drainage System

For a conceptual palaeo-drainage system consists of a surficial unconfined aquifer, overlying a thick lacustrine clay layer with a confined palaeochannel aquifer in the thalweg of the palaeo-drainage. The palaeo-drainage system can be divided into two hydraulic systems:

- Surficial unconfined aquifer; and
- Confined palaeochannel aquifer.

These two systems will be discussed separately below. However it is noted that such systems are linked, and may not be separated or present along the whole palaeo-drainage system. It is likely that in the upper reaches of the palaeo-drainage system, these two aquifers are in contact, i.e. the intermediate clay layer is either absent or non-continuous.

3.4.1 Surficial Unconfined Aquifer

The surficial unconfined system consists of more recent Quaternary deposits including calcretes and includes individual and chains of salt lakes. The source of water is generally direct recharge from rainfall or surface expressions of water such as ephemeral creeks, ephemeral lakes and salt lakes. Water may also be sourced (groundwater gradients permitting) from adjacent rock (including weathered rock, fractures and fresh bedrock) and upward flow from the confined aquifer system.

Water can be lost from the surficial palaeochannel system through evapo-transpiration or through groundwater flow to deeper aquifers or into the adjacent bedrock.

3.4.2 Confined Palaeochannel Aquifer

The confined palaeochannel aquifer generally occurs in the deeper parts of the palaeo-drainage system. The source of water can be direct flow from the surficial aquifer in the upper reaches and tributaries of the palaeo-drainage system, from leakage through the lacustrine clayey sediments, or from inflow from the adjacent bedrock. The inflow from the adjacent bedrock may include flow from fractures and weathered bedrock, and also may include flow from the surficial aquifer via weathered bedrock.

Outflows from the confined aquifer may be to the surrounding bedrock or upwards through the confining clay. Upward flow through the clay is likely to occur in the central areas of salt lakes due to the prevailing hydraulic gradient.

Interaction with adjacent aquifers including the surficial and bedrock are contingent on appropriate groundwater gradients.

4 Model Construction

The groundwater model constructed for this area has the following purposes:

- To evaluate the recoverable resource (brine) from the surficial and confined aquifers in the vicinity of Sunshine Lake; and

- Simulate the effects of the resource abstraction over Life-of-Mine (LoM) on nearby users of groundwater, including existing bores and groundwater dependent ecosystems.

Details of the model selection, construction and calibration follow in subsequent sections.

4.1 Model Selection

To maintain compatibility with models used for other hydrogeological systems in the KLL tenements, notably the Ten Mile Lake modelling (Advisian, 2017) FEFLOW was selected for this work. An advantage of FEFLOW is that it allows refinement of the mesh at later times (if necessary).

4.2 Model Domain

The model domain is shown in Figure 4-1. It is aligned along the major axis of Sunshine Lake and was designed to include the lake and its surroundings.

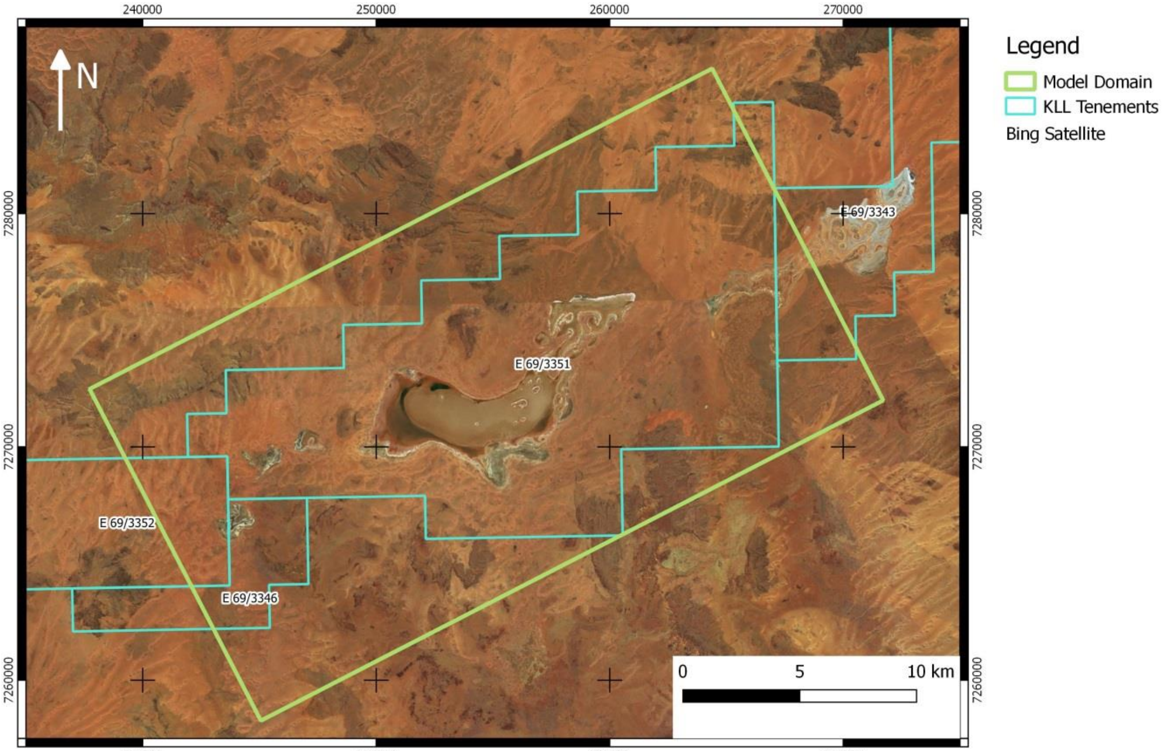


Figure 4-1: Domain for Sunshine Lake Model and BSOPP Tenements (as at May 2017)

4.2.1 Horizontal Discretisation

The FEFLOW mesh used for the steady-state calibration is shown in Figure 4-2. This mesh consisted of 68,902 elements per layer and 34,580 nodes per slice. A coarser mesh was used for the transient calibration (Figure 4-3) to enable faster model runs to reduce calibration run times. This mesh consisted of 2,343 elements per layer and 1,217 nodes per slice.

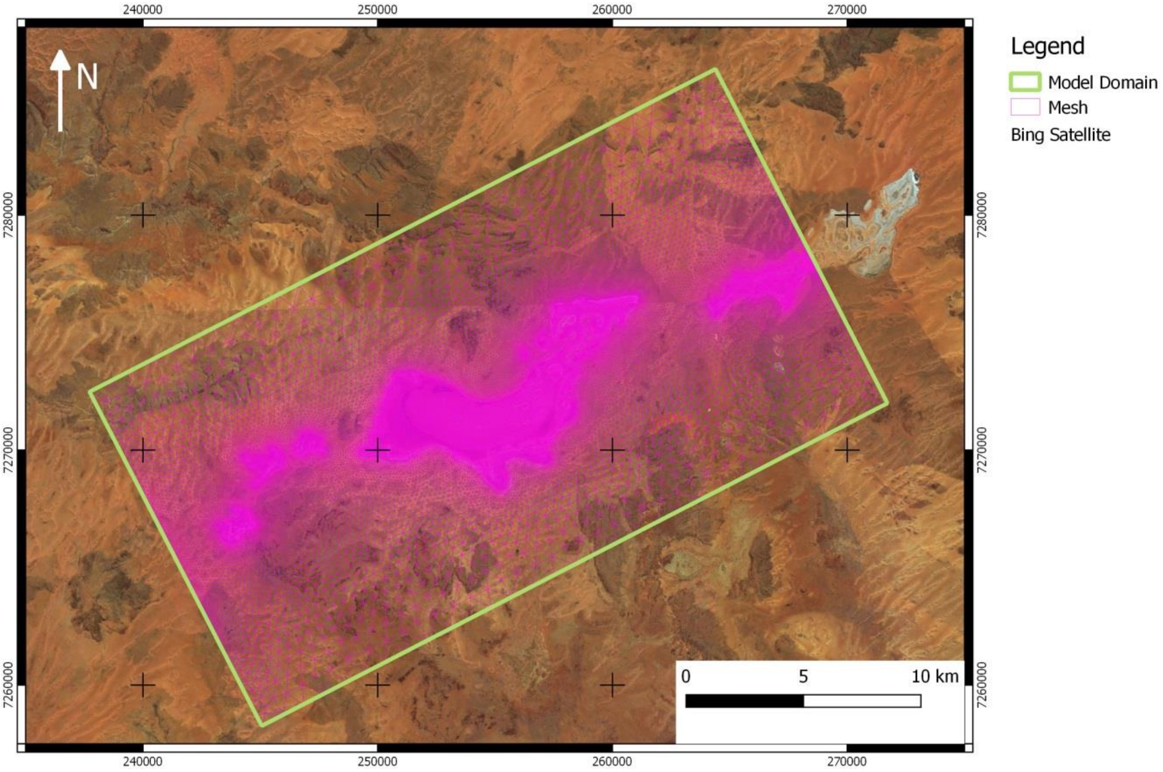


Figure 4-2: Mesh for Steady-state Sunshine Lake Model

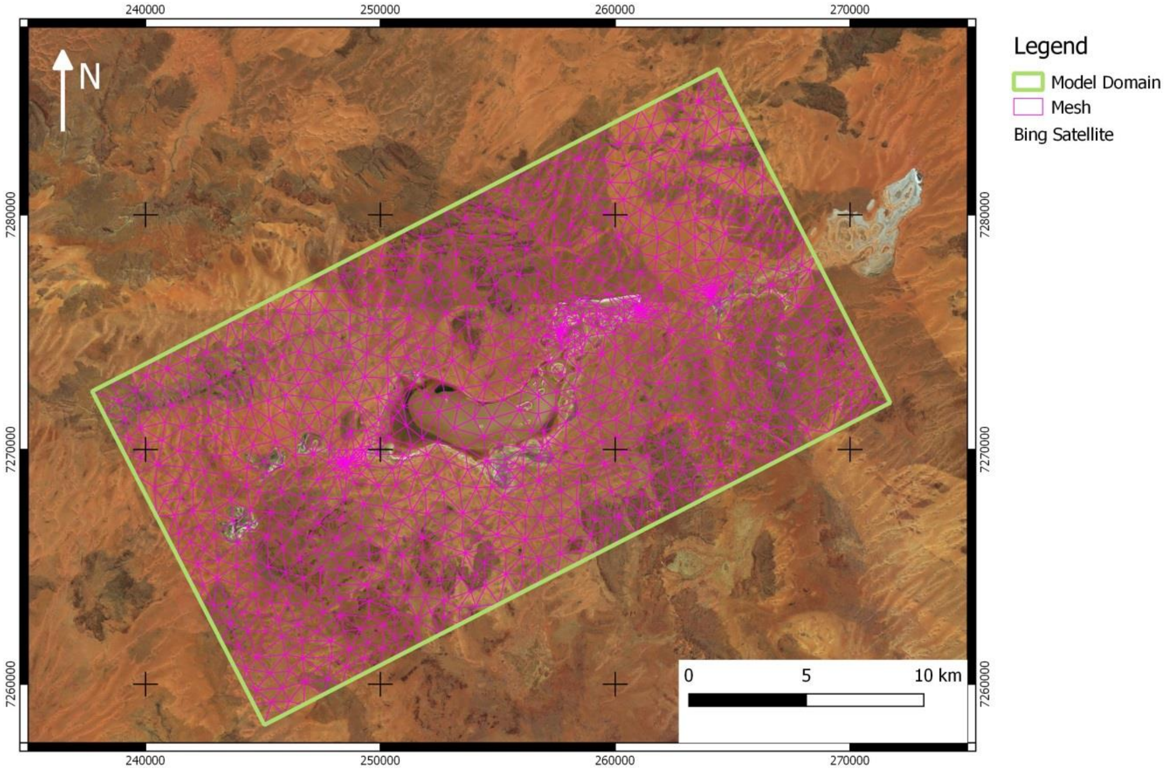


Figure 4-3: Mesh used for Palaeochannel Calibration

4.2.2 Vertical Discretisation

The vertical discretisation in the palaeochannel areas used the following as a basis:

- Surficial layer in palaeochannel systems, including lake sediments (aquifer, 1 layer);
- Intermediate lacustrine clays associated with palaeo-drainage system (aquitard, 3 layers);
- Palaeochannel, –contains palaeochannel sands but may be clay where sands are absent and also contains weathered basement rock, conductive/non-conductive fracture systems and dolerite dykes (aquifer, 1 layer); and
- Bedrock (1 layer).

Areas away from the palaeochannel used the following layering:

- Weathered rock (aquifer, 5 layers); and
- Bedrock (bottom layer).

A cross-section through the model is shown in Figure 4-4.

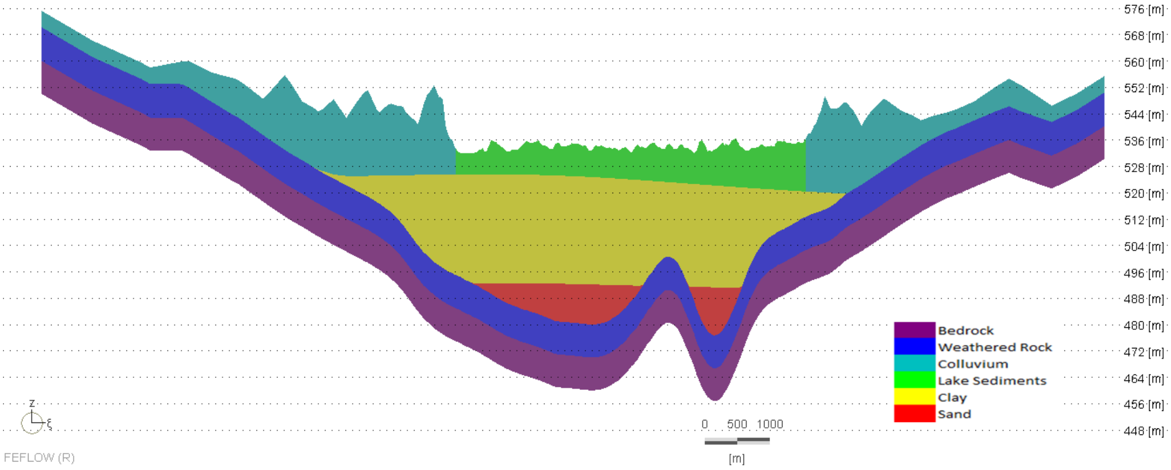


Figure 4-4: Cross-section through palaeochannel (50x Vertical Exaggeration)

4.2.3 Layer Elevations

The surface elevation was created using the 1-second SRTM data for Australia (Gallant et al., 2011) matched to the centre points of the elements in the mesh.

The base of the surficial, intermediate and lower palaeochannel layers were based on elevations from the bore logs, and, in the case of the base of the lower palaeochannel layer from geophysical survey data. These elevations were extrapolated over the remainder of the domain.

The data used for the surfaces is listed and the layer elevations and thicknesses are plotted in Appendix A.

4.3 Model Properties

The model properties vary according to the geology and the layer of the model. The zones used in the model are shown in Figure 4-5 and are discussed below.

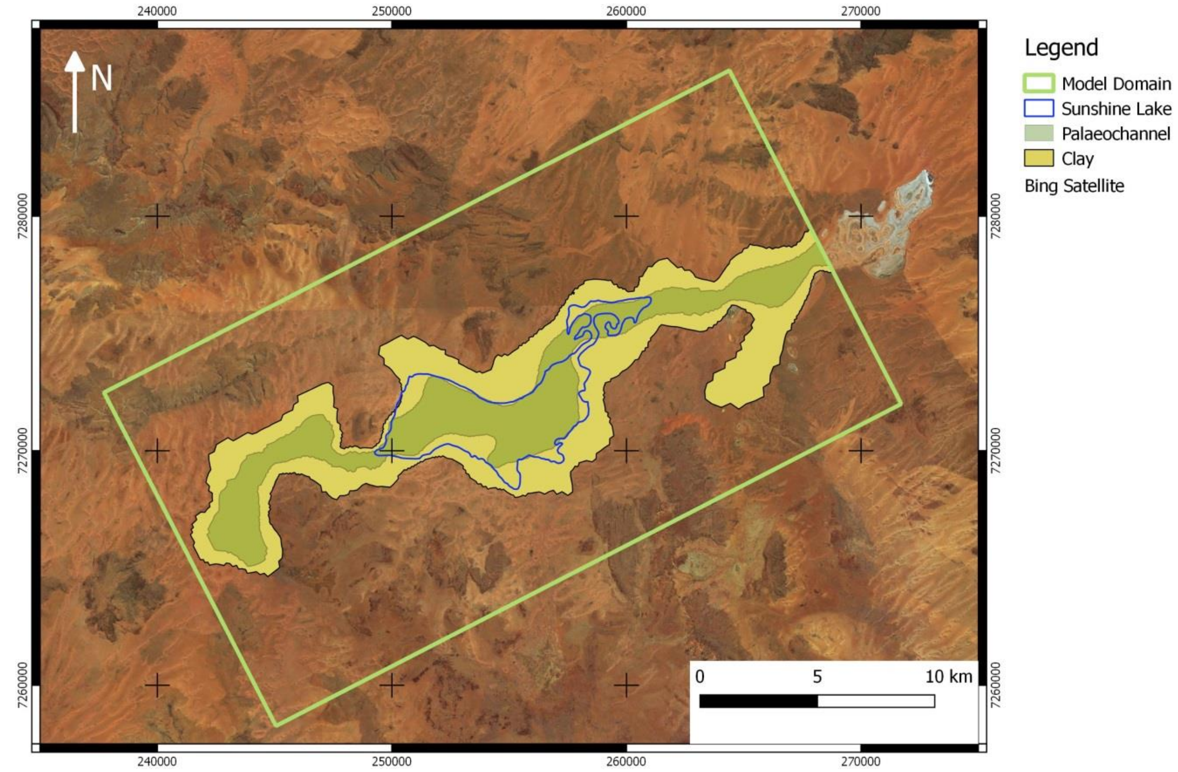


Figure 4-5: Property Zone Areas for Sunshine Model

4.3.1 Surficial Aquifer

The surface layer was divided into two zones based on the surface geology. These were Sunshine Lake (interpreted from satellite imagery) and colluvial/alluvial deposits.

Johnson et al. (1999) indicate alluvium has low hydraulic conductivity, less than 2.5 m/day, and a specific yield in the range of 0.03-0.05. No guidance is available for lake deposits, and the parameters for the alluvium have been adopted.

4.3.2 Surficial to Intermediate

The intermediate zone is subdivided into lacustrine clays and bedrock/weathered bedrock outside of the palaeochannel. Bedrock was assigned beneath surficial weathered rock.

Johnson et al. (1999) examined fractured and weathered rock as part of their palaeochannel investigation. They divided the weathered zone into three:

- An upper semi-confining clayey layer consisting of between 0 and 60 m typically 40 m saturated thickness with a storativity of 0.1%;

- An upper aquifer of fractured and oxidised bedrock ("saprock"). This may be 10-30 m thick, with a specific yield of up to 10% in vuggy ultramafics. Typically a value of 5% is used for this zone; and
- A lower fresh fractured rock zone, with groundwater present in fractures. Johnson et al. (1999) estimate a saturated thickness of 30 m with a representative specific yield of 1%.

No hydraulic conductivity values were given for these zones, with the note that the hydraulic conductivity is likely to be highly variable, depending on parent rock, degree of weathering and geological history amongst other factors.

4.3.3 Lower Confined Aquifer

This layer consists of the deep sand in the palaeochannel system, and bedrock outside the palaeochannel.

Johnson et al. (1999) found the hydraulic conductivity of palaeochannel sands to be in the range 1-40 m/day with an average of 10 m/day. They used a specific yield of 20% to estimate the groundwater storage within the palaeochannels, but do not attribute a source for this value.

4.3.4 Bedrock

Bedrock is treated as a single hydrogeological unit due to lack of information regarding distribution of properties in the vicinity of the model.

Johnson et al. (1999) provide no guidance for hydraulic conductivity in bedrock, indicating that it is likely to be highly variable. They provide some guidance for specific yield, listing indicative values of 0.1% for weathered bedrock, 01% for fractured fresh bedrock, and 5% for fractured oxidised bedrock.

4.4 Boundary Conditions

Boundary conditions control the inflow and outflow of water from the model domain. These can be divided into lateral boundary conditions, which are associated with the linkages to aquifers in the areas surrounding the model domain, surficial boundary conditions, which specify the interactions of the model domain with the overlying and underlying zones, and internal boundary conditions which evaluate abstraction within the domain. The overlying zones may consist of the unsaturated zone and atmospheric processes such as recharge, rainfall, evaporation and evapo-transpiration, whilst the underlying boundary conditions specify leakage both to and from underlying formations.

4.4.1 Lateral Boundaries

Lateral boundary conditions are the boundary conditions that occur on the edge of the model domain. These can consist of specified heads (1st type, Dirichlet), specified fluxes, which includes zero or natural fluxes (2nd type, Neumann), or a mixture of the two (3rd (mixed) type, Cauchy).

These can represent inflows or outflows at the boundary quantifying interaction with adjacent hydrogeological areas.

The current conceptual model for the area indicates that Sunshine Lake is the upstream lake of a chain of lakes along a palaeochannel system that is not connected hydrologically to Ten Mile Lake. These lakes are generally isolated surface features which may become connected by surface flows during very large events. However hydrogeologically, there may or may not be connections between Sunshine Lake and Ten Mile Lake. It is also possible that the deeper palaeochannel system is a series of sub-basins rather than inter-connected palaeochannel systems.

The current model has been constructed as a flow-through domain with a gradient from the southwest to the northeast. Specified heads have been used for these boundaries with 542.2 mAHD in the southwest and 529.85 mAHD in the northeast. The northwest and southeast boundaries were specified as no-flow, as flows through the bedrock are likely to be small and thus insignificant in the overall water balance on the area.

4.4.2 Surficial Boundary Conditions

Surficial Boundaries quantify the interaction of the aquifer with the atmosphere (recharge and evaporation) and surface water. This is discussed conceptually in Section 3. In the model, recharge and evapotranspiration are applied to the top of the saturated zone.

Recharge is applied at a constant rate over the whole domain. The rate used in the Sunshine model was 0.2 mm/a. Evaporation is assumed to occur only in the vicinity of salt lakes in the domain, and it was assigned an average flux of 3.15 mm/a. The recharge and evapotranspiration rates for the model were specified for calibration.

4.4.3 Internal Boundary Conditions (Abstraction)

Internal boundary conditions quantify inflows and outflows internal to the model. These indicate abstraction from the aquifers. In the current model these were the abstraction used for the aquifer testing (calibration) or brine processing (production).

2017 Field Program

A summary of the abstraction program for the confined aquifer at Sunshine Lake used for the calibration, and the associated observation wells are in Table 4-1. A graphical timeline of the abstraction and data loggers are in Table 4-2 and Table 4-3 respectively. The complete record for the testing period was not used as some abstraction records were not available at the time of the calibration. The location of all the bores is shown in Figure 4-6.

Table 4-1: Abstraction from Confined Aquifer

Abstraction Well	Start Abstraction	End Abstraction	Observation Bores (distance [m])
SSPB15	15/08/2017 12:10	18/08/2017 11:26	SSAC15M1, M2 (17) SSAC14 (430),

Abstraction Well	Start Abstraction	End Abstraction	Observation Bores (distance [m])
			SSAC16M1, M2 (460)
SSPB18	26/07/2017 12:22	2/08/2017 04:47	SSAC18M1,M2 (40)
SSPB19	4/08/2017 11:01 5/08/2017 10:17 7/08/2017 11:05	4/08/2017 18:48 7/08/2017 06:02 13/08/2017 14:02	SSAC19M1,M2 (19)
SSPB21	5/07/2017 10:03 14/07/2017 12:00	05/07/2017 17:47 21/07/2017 17:54	SSAC21M1, M2 (17) SSAC22 (500)

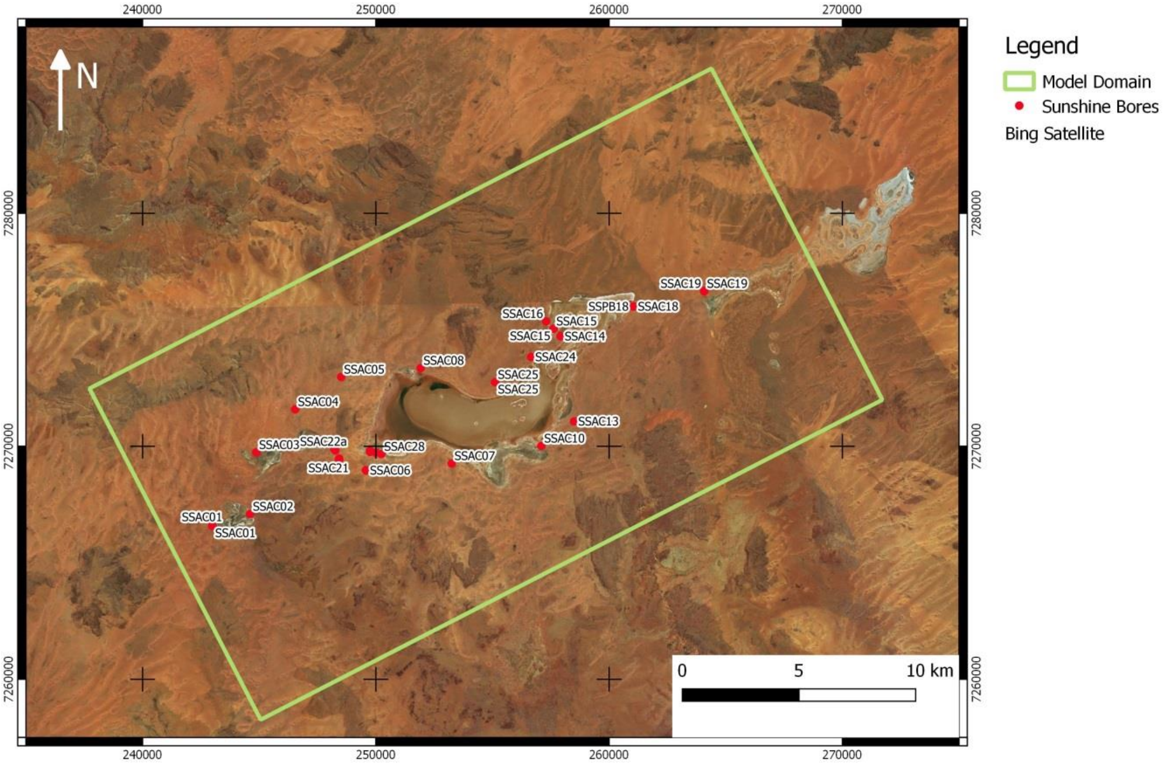
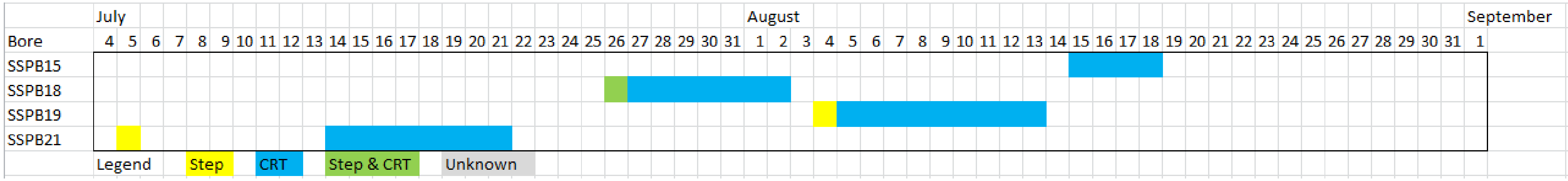


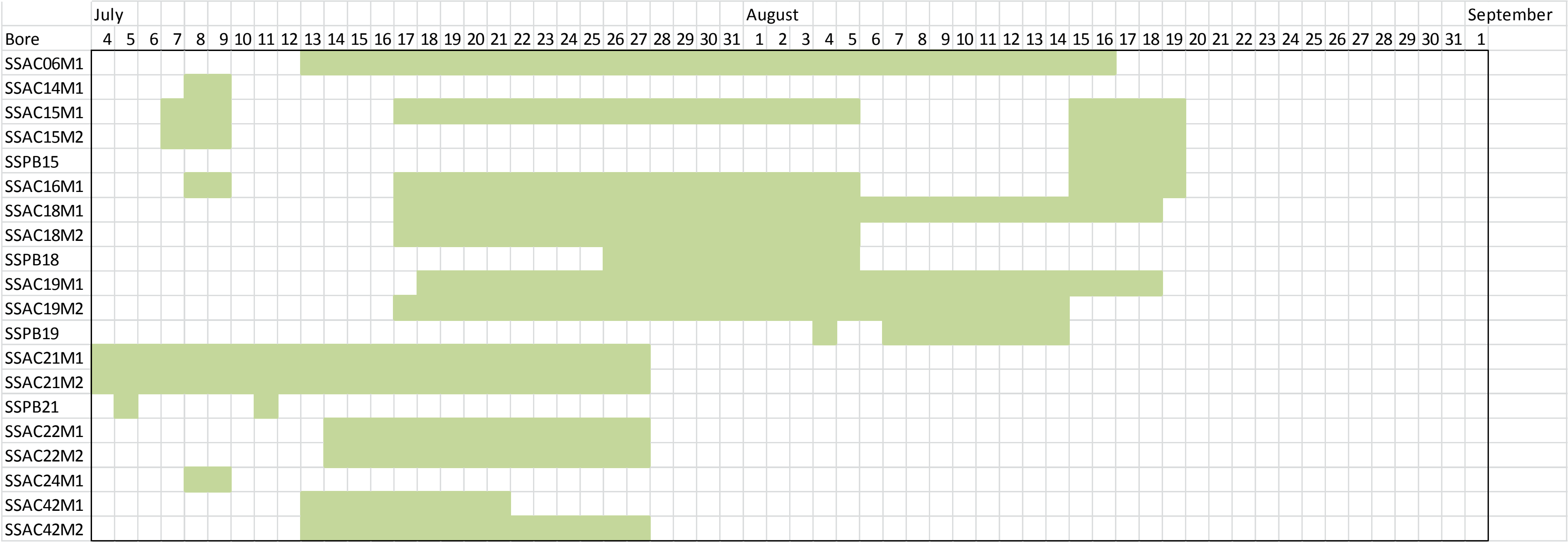
Figure 4-6: Bores around Sunshine Lake

Table 4-2: Abstraction Time Line



	July																												August																															September
Bore	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1
SSPB15																																											🟦	🟦	🟦	🟦														
SSPB18																							🟩	🟦	🟦	🟦	🟦	🟦	🟦	🟦																														
SSPB19																																🟨	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦																			
SSPB21		🟨									🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦																																										
	Legend				🟨 Step			🟦 CRT			🟩 Step & CRT					Unknown																																												

Table 4-3: Monitoring and Abstraction Bore Data Logging



	July																												August																															September
Bore	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1
SSAC06M1										🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																
SSAC14M1					🟩	🟩																																																						
SSAC15M1				🟩	🟩	🟩								🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩										🟩	🟩	🟩	🟩	🟩													
SSAC15M2				🟩	🟩	🟩																																					🟩	🟩	🟩	🟩	🟩													
SSPB15																																											🟩	🟩	🟩	🟩	🟩													
SSAC16M1					🟩	🟩								🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩										🟩	🟩	🟩	🟩	🟩													
SSAC18M1														🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩														
SSAC18M2														🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																											
SSPB18																							🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																											
SSAC19M1															🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩														
SSAC19M2														🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																		
SSPB19																																🟩			🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																		
SSAC21M1	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																																				
SSAC21M2	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																																				
SSPB21		🟩						🟩																																																				
SSAC22M1											🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																																				
SSAC22M2											🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																																				
SSAC24M1					🟩	🟩																																																						
SSAC42M1										🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																																										
SSAC42M2										🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩																																				

SSPB15

This site is located close to the western edge the northern lobe of Sunshine Lake (Figure 4-7). The water levels recorded during a constant rate test (CRT) were within the abstraction bore and nearby monitoring bores (SSAC15M1, SSAC15M2, and SSAC16M1). The abstraction rate during the CRT was adjusted during the test to increase from 4 L/s to 5 L/s. The records indicate there was additional testing in the vicinity of 8 July 2017, but no records were available for the rates or duration of this test.

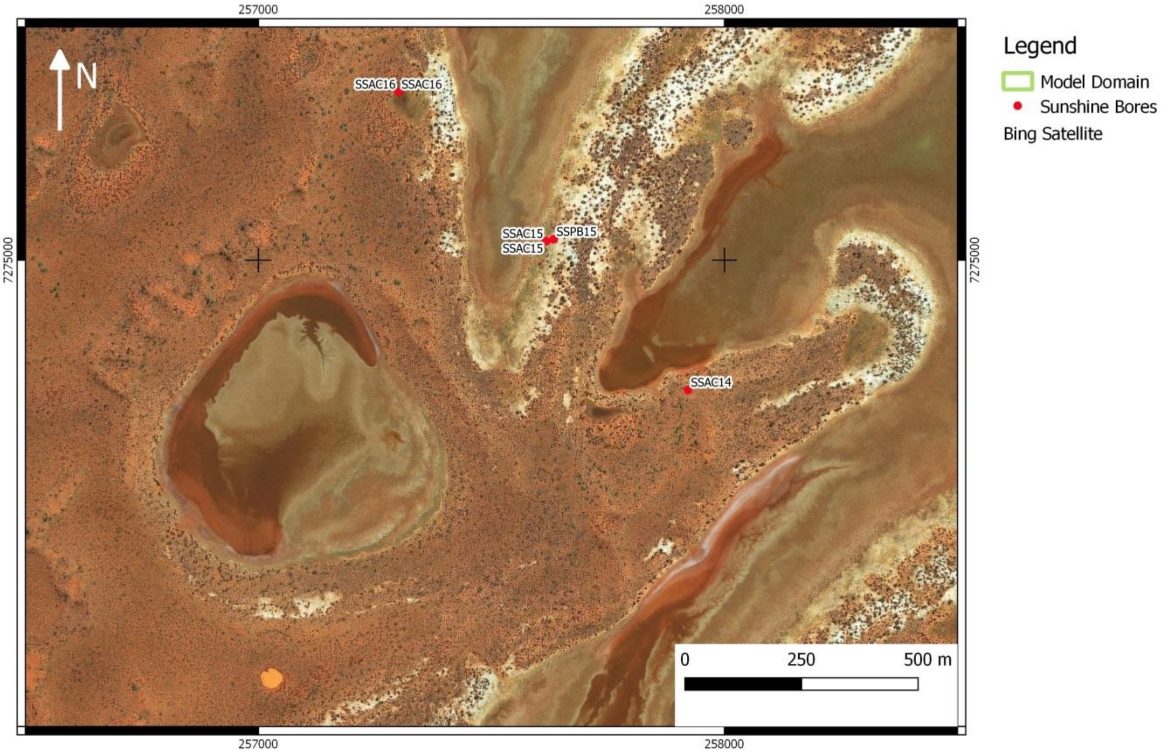


Figure 4-7: SSPB15 pump test location and nearby monitoring bores

SSPB18

The location of this bore is shown in Figure 4-8, together with the local monitoring bores. No other monitoring bores were within 1 km of the production bore. Records in the monitoring bores indicate some preliminary abstraction occurred on 18 July, but no records were available for this event. The water levels logged in the production bore also indicated abstraction was intermittently operated at the start of the testing period on 26 July. Due to the uncertainty in the rates this was not included in the calibration.

Figure 4-8: SSPB18 pump test location and SSAC18 monitoring bores

SSPB19

A step test and a constant rate test were carried out at this site. The step test was performed on 4 August 2017, and the constant rate test was from 5August to 13August, with a five hour interruption on 7 August. The monitoring bores and their distances to abstraction bore are listed in Table 4-1. The location of the monitoring bores relative to the abstraction bore is shown in Figure 4-9.

Figure 4-9: SSPB19 pump test location and monitoring bores

SSPB21

The layout of the production and monitoring bores at Sunshine site 21 is shown in Figure 4-10. The abstraction data available for the SSPB21 bore consists of a step test on 5 July 2017, and a constant rate test between 14 July and 21 July 2017. The logger data in the production bore also indicates additional abstraction on 4 July, between 8 and 9 July, and on 11 July, but no abstraction records were available for the calibration.

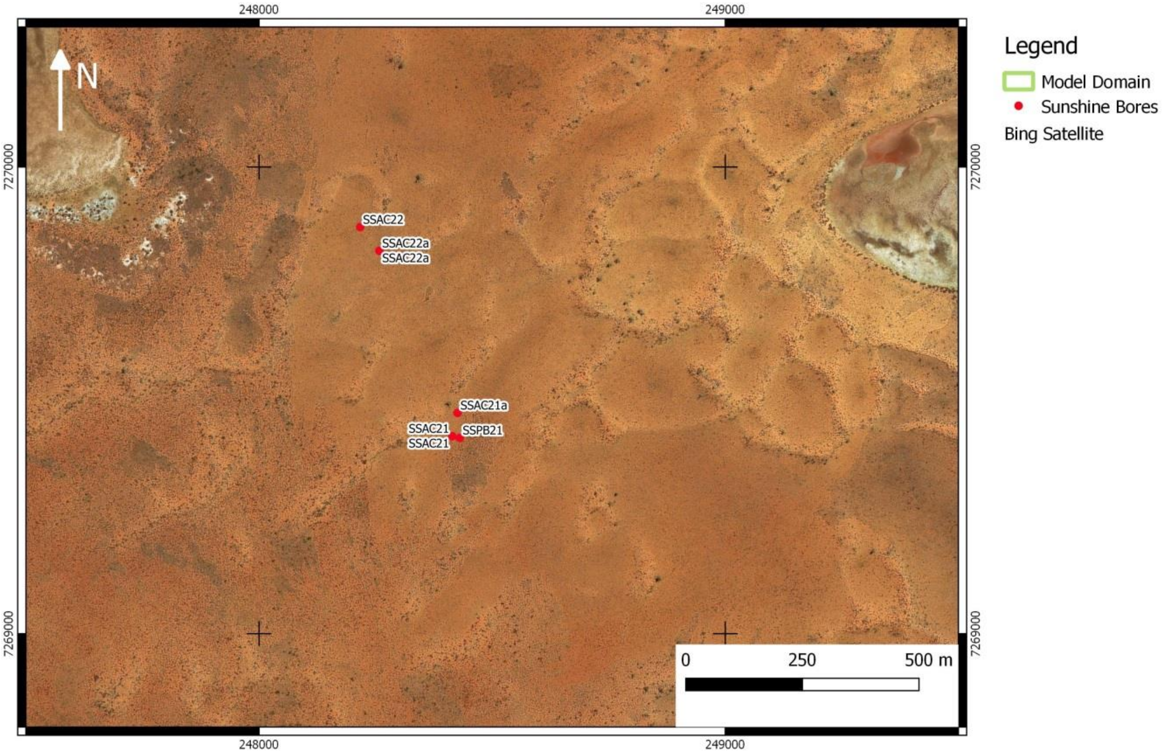


Figure 4-10: SSPB21 pump test location and monitoring bores

Table 4-4: Manual Observations

Observation Well	Layer	First Observation	Range (mAHD)	Comment
SSAC01M1	Deep	19/05/2017	537.06-538.93	Initial reading low, upward trend
SSAC01M2	Shallow	19/05/2017	541.38-541.88	Initial reading high, Small changes
SSAC06M1	Deep	20/05/2017	532.76-533.42	Initial reading high, 1.2 km from SSPB21, Response to testing
SSAC06M2	Shallow	20/05/2017	533.88-534.06	Initial reading low, remainder constant, 1.2 km from SSPB21
SSAC07M1	Deep	21/07/2017	533.22-533.25	Only small changes
SSAC13M1	Deep	15/07/2017	531.88-532.00	Only small changes
SSAC13M2	Shallow	15/07/2017	531.96-531.98	Only small changes
SSAC14M1	Deep	17/07/2017	533.76-533.86	Downward trend, 430 m SE of SSPB15, Limited response

Observation Well	Layer	First Observation	Range (mAHD)	Comment
SSAC15M1	Deep	10/06/2017	528.10-531.76	17 m from SSPB15, 1 reading during testing, 1 reading post-testing
SSAC15M2	Shallow	10/06/2017	531.26-531.70	17 m from SSPB15, 1 reading during testing, 1 reading post-testing, Limited response
SSPB15	Deep	10/06/2017	531.26-531.70	1 reading pre-testing, 1 reading post-testing, Limited response
SSAC16M1	Deep	10/06/2017	530.41-530.92	460 m NW of SSPB15, High initial reading, downward trend, 1 reading during testing, 1 reading post-testing Limited response
SSAC16M2	Shallow	10/06/2017	528.22-529.46	460 m NW of SSPB15, 1 anomalous reading prior to testing, no response to testing
SSAC18M1	Deep	10/06/2017	502.25-532.09	40 m from SSPB18, Good response to testing
SSAC18M2	Shallow	10/06/2017	531.84-532.08	40 m from SSPB18, No response to testing
SSPB18	Deep	5/08/2017	526.78-530.76	Rising trend, Initial reading during recovery from testing
SSAC19M1	Deep	10/06/2017	515.57-531.39	19 m from SSPB19, 2 readings during testing, 4 readings post-testing, Good response to test
SSAC19M2	Shallow	10/06/2017	531.44-531.82	19 m from SSPB19, 2 readings during testing, 4 readings post-testing, Small response to test
SSPB19	Deep	15/08/2017	533.07-533.29	Rising trend, Initial reading post-testing
SSAC21M1	Deep	14/07/2017	507.82-534.03	17 m from SSPB21, Good response to testing
SSAC21M2	Shallow	14/07/2017	533.37-535.00	17 m from SSPB21, Small response to testing
SSPB21	Deep	10/08/2017	535.58-535.65	Initial reading after testing

Observation Well	Layer	First Observation	Range (mAHD)	Comment
SSAC22M1	Deep	13/07/2017	533.12-534.98	500 m NW of SSPB21, Initial falling trend, followed by rising trend, Response to SSPB21 testing
SSAC22M2	Shallow	13/07/2017	534.74-535.02	500 m NW of SSPB21, Initial falling trend, followed by rising trend, Small response to SSPB21 testing
SSAC24M1	Deep	11/06/2017	531.62-532.12	1.5 km SW of SSPB15 Low initial reading, Remainder had downward trend
SSAC24M2	Shallow	13/06/2017	531.35-531.41	1.5 km SW of SSPB15, Small downward trend
SSAC25M1	Deep	13/06/2017	531.44-531.46	Two readings only
SSAC25M2	Shallow	13/06/2017	531.47-531.51	Two readings only
SSAC42M1	Deep	13/07/2017	532.22-532.46	1.4 km E of SSPB21 Small response to testing
SSAC42M2	Shallow	13/07/2017	532.31-532.44	1.4 km E of SSPB21 Small overall downward trend

Table 4-5: Logged Observations

Observation Well	Layer	Logged Interval(s)	Range (mAHD)	Comment
SSAC06M1	Deep	13/07 - 16/08	532.67-533.10	1.2 km from SSPB21, Good response to testing
SSAC14M1	Deep	08/07 - 09/07	533.83-533.88	430 m SE of SSPB15, Limited response
SSAC15M1	Deep	07/07 - 09/07 17/07 - 05/08 15/08 - 19/08	529.23-531.21 531.13-531.27 522.40-530.84	17 m from SSPB15, Good response to testing
SSAC15M2	Shallow	07/07 - 09/07 15/08 - 19/08	531.29-531.63 530.94-531.56	17 m from SSPB15, Small response to testing
SSPB15	Deep	15/08 - 19/08	514.87-531.28	Good response to testing, Logger is above deepest depth
SSAC16M1	Deep	08/07 - 09/07	530.61-530.66	460 m NW of SSPB15,

Observation Well	Layer	Logged Interval(s)	Range (mAHD)	Comment
		17/07 - 19/08	530.33-530.65	Good response to testing
SSAC18M1	Deep	17/07 – 18/08	497.79-530.55	40 m from SSPB18, Good response to testing, Logger is above deepest depth for initial test
SSAC18M2	Shallow	17/07 - 05/08	531.98-532.22	40 m from SSPB18, No response to testing
SSPB18	Deep	26/07 - 05/08	476.73-527.00	Good response to testing
SSAC19M1	Deep	18/07 – 18/08	515.64-531.37	19 m from SSPB19, Good response to testing
SSAC19M2	Shallow	17/07 - 14/08	531.51-531.86	19 m from SSPB19, Small response to testing
SSPB19	Deep	04/08 - 04/08 07/08 - 14/08	491.82-531.00 491.38-532.47	Good response to tests
SSAC21M1	Deep	03/07 - 27/07	502.48-532.19	17 m from SSPB21, Good response to testing
SSAC21M2	Shallow	03/07 - 27/07	525.40-535.13	17 m from SSPB21, Good response to testing
SSPB21	Deep	05/07 - 05/07 11/07 - 11/07	505.49-535.58 507.56-535.61	Good response to some tests, not logged for others
SSAC22M1	Deep	14/07 - 27/07	533.45-533.84	500 m NW of SSPB21, Responds to CRT
SSAC22M2	Shallow	14/07 - 27/07	534.15-535.01	500 m NW of SSPB21, Small response to CRT
SSAC24M1	Deep	08/07 - 09/07	532.12-532.22	1.5 km SW of SSPB15 No test response
SSAC42M1	Deep	13/07 - 21/07	532.16-532.40	1.4 km E of SSPB21 Downward trend, Small test response
SSAC42M2	Shallow	13/07 - 27/07	532.27-532.47	1.4 km E of SSPB21 Small response to testing

4.4.4 Trenching

A number of trenches were excavated and tested on Sunshine Lake. These trenches consisted of varying lengths at different locations to a depth of approximately 2 m on the surface of the lake. Additional small excavations (pits) were made at various distances from the trench. Water was pumped from these trenches and the response in the trench and nearby pits was recorded. Three trenches were tested. These are listed in Table 4-6. The locations of these tests are shown in

Figure 4-11. Each trench had two associated pits located different distances from the trench in a direction perpendicular to the long length of the trench.

Table 4-6: Trench Test Details

ID	Trench Length (m)	Start Test	End Test	Number of Pits (Distance (m))
ESE	42	27/07/2017 21:15	13/08/2017 08:00	2 (11, 25)
ENE	44	27/07/2017 20:45	09/08/2017 10:05	2 (10, 25)
NE	11	18/07/2017 15:38	25/07/2017 15:22	2 (5, 20)

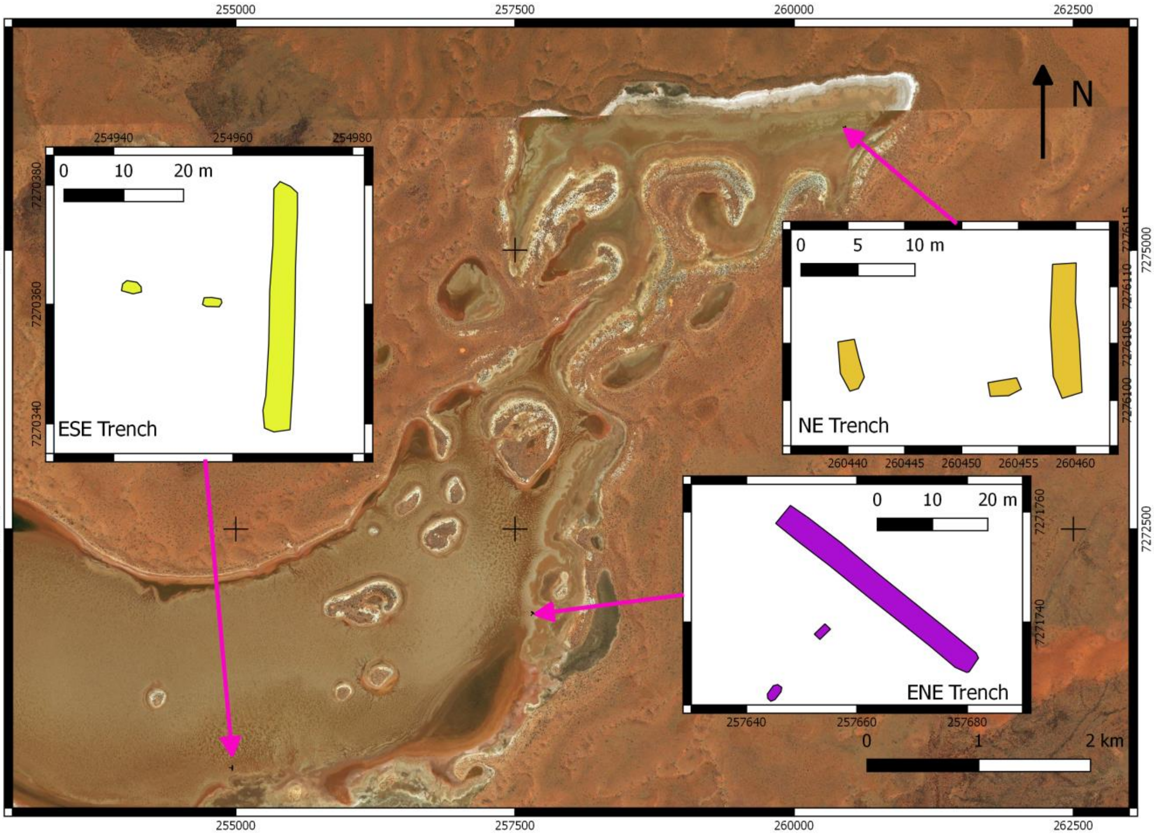


Figure 4-11: Location of trenches used for calibration with survey outlines

4.5 Laboratory Derived Aquifer Properties

The specific yield of the clays and deep aquifer cannot be calibrated using the current water level monitoring data as the system is insufficiently stressed. These are instead specified based on field investigations listed in the main report. Indicative values of specific yield range from 0.0001 based on gravity drainage analysis of a recovered core section and between 0.21 and 0.30 based on drainage tests from remoulded drill cuttings of basal sand. The value of 0.001 is likely to be an underestimate as it is based on a sample of coherent rock recovered by diamond core and does not take into account fractures, vughs and other features that lead to other core recovery being inconsistent. The value of 0.30 for the basal sand is likely to be an overestimate as it is based on recovered drill spoils and would be missing dome of the finer constituents of the matrix or cement.

4.6 Classification of Available Data for Groundwater Modelling

The AGMG (Barnett et al., 2012) provides confidence classification for various stages of the development of groundwater models. They rank the confidence of the model stage between low (Class 1) and high (Class 3). One of the confidence classification stages is attributed to data available to build a model.

The Sunshine Lake model used data collected in 2017 as part of field programs undertaken for the BSOPP. The data collected consists of both manual and automatic (loggers) data collection from groundwater bores, including responses to aquifer testing (pumping). There is extensive data available for the tenement E69/3351 which included Sunshine Lake. In this area there is reasonable confidence in the data collected during the 2017 site program. However the length of the record and the immediate area affected, compared with the proposed mine plan for the area, mean that confidence levels for the data is the intermediate Class 2. The remainder of the area has very sparse data, obtained from geophysical surveying and regional surface maps with no hydrogeological depths. The data for this area has a low confidence level (Class 1). Overall as the model for Sunshine Lake is focussed over the location of the lake, the confidence rating for the data is Class 2.

5 Model Calibration

The model calibration consisted of a multi-stage process. These processes were:

- An initial steady-state calibration of the regional model;
- A transient calibration of the regional model to the results of the aquifer testing of production bores; and
- Independent calibrations of three trench tests performed on Sunshine Lake.

The steady-state calibration is assumed to represent the pre-mining aquifer conditions. Thus the head distribution results from the steady-state calibration will be used as the initial conditions in the transient calibration and for the subsequent predictive simulations.

5.1 Calibration Targets

The calibration targets differed for the steady-state and the transient calibrations.

The steady-state calibration used initial head observations from bores drilled as part of the BSOPP Sunshine Lake investigation. Table 5-1 summarises the heads used.

The transient calibration used the measured abstraction rates and drawdowns in various abstraction and monitoring bores during the field investigation. A summary of the data logger information is presented in Table 5-2 (Table 4-5).

Table 5-1: Initial Heads in Bores from Manual Dips

Bore Name	Easting	Northing	Observation Date	Water Depth (m)	Elevation (mAHD)
SSAC01M1	242989	7266582	19/05/2017	6.91	537.06
SSAC01M2	242989	7266582	19/05/2017	2.10	541.88
SSAC06M1	249574	7268965	20/05/2017	12.14	533.42
SSAC06M2	249574	7268965	20/05/2017	11.68	533.88
SSAC07	253252	7269260	21/07/2017	7.95	533.25
SSAC13M1	258504	7271068	15/07/2017	8.42	532.00
SSAC13M2	258504	7271068	15/07/2017	8.64	531.98
SSAC14	257922	7274721	17/07/2017	1.82	533.86
SSAC15M1	257617	7275041	10/06/2017	1.59	531.76
SSAC15M2	257617	7275041	10/06/2017	1.74	531.70
SSAC16M1	257301	7275361	10/06/2017	2.81	530.92
SSAC16M2	257301	7275361	10/06/2017	4.31	529.46
SSAC18M1	261062	7276002	10/06/2017	8.54	532.09
SSAC18M2	261062	7276002	10/06/2017	8.79	531.84
SSAC19M1	264078	7276655	10/06/2017	7.13	531.19
SSAC19M2	264078	7276655	10/06/2017	6.60	531.78
SSAC21M1	248414	7269423	14/07/2017	7.90	533.47
SSAC21M2	248414	7269423	14/07/2017	6.43	534.98
SSAC22M1	248217	7269871	13/07/2017	6.27	533.83
SSAC22M2	248217	7269871	13/07/2017	5.13	535.02
SSAC24M1	256660	7273834	11/06/2017	4.89	531.62
SSAC24M2	256660	7273834	13/06/2017	5.10	531.41
SSAC25M1	255111	7272747	13/06/2017	8.54	531.44
SSAC25M2	255111	7272747	13/06/2017	8.52	531.51
SSAC42M1	249756	7269754	13/07/2017	1.80	532.36
SSAC42M2	249756	7269754	13/07/2017	1.70	532.43
SSPB15	257634	7275045	3/08/2017	2.36	531.26
SSPB18	261022	7275999	5/08/2017	11.40	526.78
SSPB19	264084	7276673	15/08/2017	7.73	533.07
SSPB21	248431	7269419	10/08/2017	5.22	535.58

Table 5-2: Logger Bore Data for Sunshine Lake

Bore Name	Start Record	End Record	Number Observations	Observation Frequency (minutes)
SSAC06M1	13/07/2017	16/08/2017	814	60
SSAC14M1	8/07/2017	9/07/2017	1629	1
SSAC15M1	7/07/2017	9/07/2017	2928	1
	17/07/2017	5/08/2017	455	60
	15/08/2017	19/08/2017	5548	1
SSAC15M2	7/07/2017	9/07/2017	2918	1
	15/08/2017	19/08/2017	5542	1
SSAC16M1	8/07/2017	9/07/2017	1619	1
	17/07/2017	5/08/2017	451	60
	15/08/2017	19/08/2017	5591	1
SSAC18M1	17/07/2017	5/08/2017	22961	1
	5/08/2017	18/08/2017	313	60
SSAC18M2	17/07/2017	5/08/2017	451	60
SSAC19M1	18/07/2017	5/08/2017	437	60
	5/08/2017	14/08/2017	13114	1
	15/08/2017	18/08/2017	4084	1
SSAC19M2	17/07/2017	5/08/2017	450	60
	5/08/2017	14/08/2017	218	60
SSAC21M1	3/07/2017	27/07/2017	34287	1
SSAC21M2	3/07/2017	27/07/2017	34283	1
SSAC22M1	14/07/2017	27/07/2017	313	60
SSAC22M2	14/07/2017	27/07/2017	313	60
SSAC24M1	8/07/2017	9/07/2017	1655	1
SSAC42M1	13/07/2017	21/07/2017	189	60
SSAC42M2	13/07/2017	27/07/2017	333	60
SSPB15	15/08/2017	19/08/2017	5558	1
SSPB18	26/07/2017	5/08/2017	14306	1
SSPB19	4/08/2017	4/08/2017	477	1
	7/08/2017	14/08/2017	10201	1
SSPB21	5/07/2017	5/07/2017	470	1
	11/07/2017	11/07/2017	468	1

5.2 Calibration Methodology

Each calibration process was used to evaluate different parameters in the model. Results from the steady-state calibration were used for the deep aquifer calibration. Greater details about the methodology used for each of the calibration processes are described below.

5.2.1 Steady-state Regional

The steady-state regional calibration was used to evaluate the regional hydrogeological parameters. These measurements were the first observations available from bores in the vicinity of Sunshine Lake. The calibration used PEST (Watermark Numerical Computing, 2010) to vary the parameter values specified in Table 5-3 with the aim to minimise the difference between the observed and the simulated piezometric heads.

No abstraction was simulated in the steady-state, and both evapo-transpiration and recharge were specified as average quantities.

Table 5-3: Initial Value and Parameter Ranges for Calibration of the Steady-State Model

Unit	Horizontal Hydraulic Conductivity (m/day)	Vertical Hydraulic Conductivity (m/day)
Bedrock	0.001 (1.0 x 10^{-6}- 1000)	0.001 (1.0 x 10^{-8}- 1000)
Weathered Rock	0.01 (1.0 x 10^{-6}- 1000)	0.01 (1.0 x 10^{-8}- 1000)
Colluvium	3.0 (1.0 x 10^{-6}- 1000)	0.03 (1.0 x 10^{-8}- 1000)
Lake	3.0 (1.0 x 10^{-6}- 1000)	0.03 (1.0 x 10^{-8}- 1000)
Clay	1.0 x 10^{-4} (1.0 x 10^{-6}- 1000)	1.0 x 10^{-5} (1.0 x 10^{-8}- 1000)
Palaeochannel Sand	3.0 (1.0 x 10^{-6}- 1000)	0.03 (1.0 x 10^{-8}- 1000)

5.2.2 Confined Aquifer

The water level data collected in the project was in the vicinity of Sunshine Lake (Figure 4-6), with no data available for areas distant from the lake/palaeochannel system. The calibration used PEST (Watermark Numerical Computing, 2010) to vary the parameter values within the confined aquifer as specified in Table 5-5. These values were allowed to vary independently at 56 specified pilot points within the confined aquifer (Figure 5-1). The distribution of these parameters through the deep aquifer was extrapolated from these pilot point values using kriging. The purpose of the deep aquifer calibration was to match the observed drawdowns in order to minimise the residual (difference between observed and simulated values). A summary of the piezometric heads recorded by data logger was presented in Table 4-5. The observations used for the calibration are listed in Table 5-5, together with the overall weights for each set of observations. The weights were assigned using the following rules:

- A weight of zero was assigned to abstraction bores;
- A weight of 1 was assigned to sets of observations in the surficial layer (M2 bores). The hydrogeological properties in the surficial and the clay layers were not the subject of this part of the calibration procedure;
- A weight of 10 was assigned to manual (dipped) observations in the deep aquifer.

- A weight of 100 was assigned to logged observations in the deep aquifer corresponding to known abstraction. A weight of zero was assigned to observations associated with unknown abstraction rates.

As the number of observations for each bore and period differed, the overall weight for each observation set was divided by the number of observations in the set.

A number of different periods are used for the calibration for different bores. These correspond to either different aquifer tests or different periods when logger data was available.

Table 5-4: Observations used for Deep Aquifer Calibration

Bore name	Type Observation	Start Date	End Date	Number Observations	Overall Weight
SSAC01M1	Manual	19/05/2017	1/09/2017	9	10
SSAC01M2	Manual	19/05/2017	1/09/2017	9	1
SSAC06M1	Manual	20/05/2017	1/09/2017	14	10
SSAC06M1	Logger	13/07/2017	16/08/2017	103	100
SSAC06M2	Manual	20/05/2017	1/09/2017	13	1
SSAC07M1	Manual	21/07/2017	16/08/2017	4	10
SSAC13M1	Manual	15/07/2017	1/09/2017	6	10
SSAC13M2	Manual	15/07/2017	1/09/2017	6	1
SSAC14M1	Manual	17/07/2017	16/08/2017	9	10
SSAC14M1	Logger	8/07/2017	9/07/2017	103	1
SSAC15M1	Manual	10/06/2017	1/09/2017	12	1
SSAC15M1	Logger	7/07/2017	9/07/2017	102	0
SSAC15M1	Logger	17/07/2017	5/08/2017	92	1
SSAC15M1	Logger	15/08/2017	19/08/2017	102	100
SSAC15M2	Manual	10/06/2017	1/09/2017	12	1
SSAC15M2	Logger	7/07/2017	9/07/2017	102	0
SSAC15M2	Logger	15/08/2017	19/08/2017	102	1
SSPB15	Manual	10/06/2017	1/09/2017	12	0
SSPB15	Logger	15/08/2017	19/08/2017	100	0
SSAC16M1	Manual	10/06/2017	1/09/2017	13	10
SSAC16M1	Logger	8/07/2017	9/07/2017	102	0
SSAC16M1	Logger	17/07/2017	5/08/2017	91	1
SSAC16M1	Logger	15/08/2017	19/08/2017	101	100
SSAC16M2	Manual	10/06/2017	1/09/2017	13	1
SSAC18M1	Manual	10/06/2017	1/09/2017	20	10
SSAC18M1	Logger	17/07/2017	25/07/2017	102	0
SSAC18M1	Logger	25/07/2017	5/08/2017	101	100
SSAC18M1	Logger	5/08/2017	18/08/2017	105	10
SSAC18M2	Manual	10/06/2017	1/09/2017	9	1
SSAC18M2	Logger	17/07/2017	5/08/2017	91	1

Bore name	Type Observation	Start Date	End Date	Number Observations	Overall Weight
SSPB18	Manual	5/08/2017	1/09/2017	5	0
SSPB18	Logger	26/07/2017	5/08/2017	101	0
SSAC19M1	Manual	10/06/2017	1/09/2017	14	10
SSAC19M1	Logger	18/07/2017	30/07/2017	95	0
SSAC19M1	Logger	30/07/2017	5/08/2017	77	100
SSAC19M1	Logger	5/08/2017	14/08/2017	101	100
SSAC19M1	Logger	15/08/2017	18/08/2017	101	10
SSAC19M2	Manual	10/06/2017	1/09/2017	14	1
SSAC19M2	Logger	17/07/2017	5/08/2017	91	1
SSAC19M2	Logger	5/08/2017	14/08/2017	110	1
SSPB19	Manual	15/08/2017	1/09/2017	3	0
SSPB19	Logger	4/08/2017	4/08/2017	97	0
SSPB19	Logger	7/08/2017	14/08/2017	101	0
SSAC21M1	Manual	14/07/2017	1/09/2017	14	10
SSAC21M1	Logger	3/07/2017	5/07/2017	71	0
SSAC21M1	Logger	5/07/2017	8/07/2017	102	10
SSAC21M1	Logger	8/07/2017	13/07/2017	101	0
SSAC21M1	Logger	13/07/2017	27/07/2017	101	100
SSAC21M2	Manual	14/07/2017	1/09/2017	14	1
SSAC21M2	Logger	3/07/2017	5/07/2017	71	0
SSAC21M2	Logger	5/07/2017	8/07/2017	102	1
SSAC21M2	Logger	8/07/2017	13/07/2017	101	0
SSAC21M2	Logger	13/07/2017	27/07/2017	101	1
SSPB21	Manual	10/08/2017	1/09/2017	3	0
SSPB21	Logger	5/07/2017	5/07/2017	95	0
SSPB21	Logger	11/07/2017	11/07/2017	95	0
SSAC22M1	Manual	13/07/2017	1/09/2017	15	1
SSAC22M1	Logger	14/07/2017	27/07/2017	105	100
SSAC22M2	Manual	13/07/2017	1/09/2017	15	1
SSAC22M2	Logger	14/07/2017	27/07/2017	105	1
SSAC24M1	Manual	11/06/2017	1/09/2017	6	1
SSAC24M1	Logger	8/07/2017	9/07/2017	99	0
SSAC24M2	Manual	13/06/2017	1/09/2017	6	1
SSAC25M1	Manual	13/06/2017	23/07/2017	2	1
SSAC25M2	Manual	13/06/2017	23/07/2017	2	1
SSAC42M1	Manual	13/07/2017	1/09/2017	15	1
SSAC42M1	Logger	13/07/2017	21/07/2017	95	10
SSAC42M2	Manual	13/07/2017	1/09/2017	15	1
SSAC42M2	Logger	13/07/2017	27/07/2017	112	1

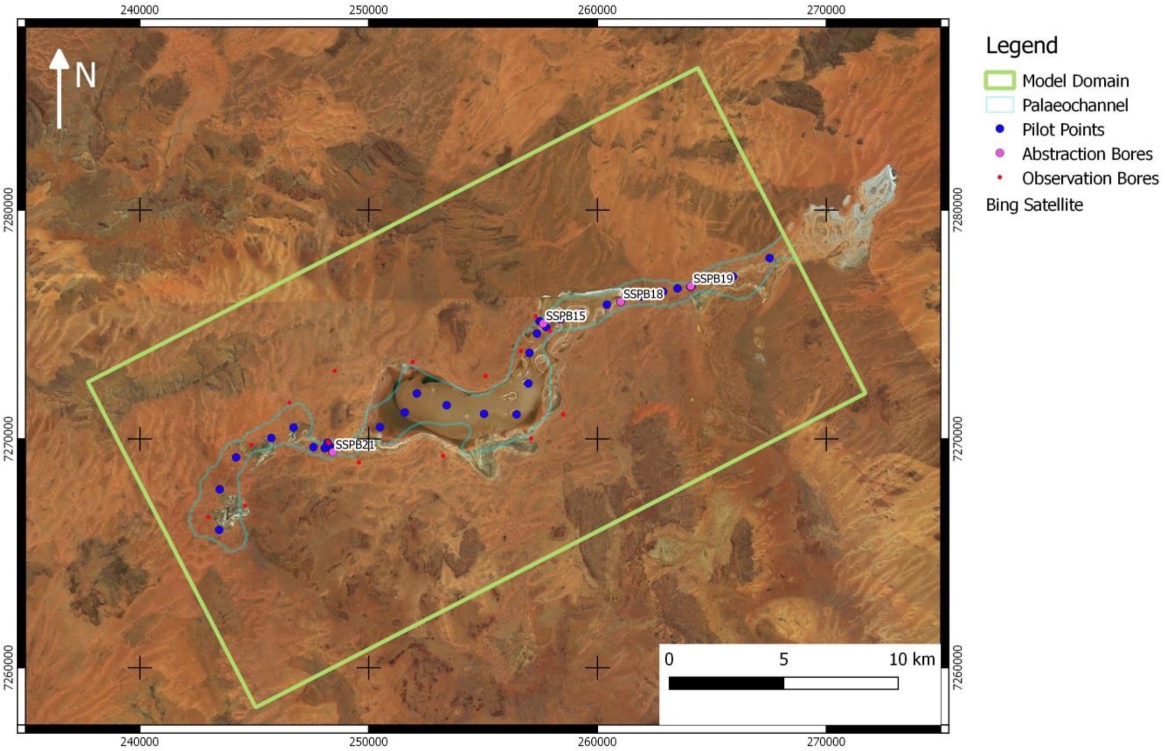


Figure 5-1: Pilot point locations for confined aquifer

Table 5-5: Initial Parameter Values and Parameter Bounds for Palaeochannel Sands Calibration

Parameter	Horizontal Hydraulic Conductivity (m/day) (Bounds)	Vertical Hydraulic Conductivity (m/day) (Bounds)	Specific Storage (/m) (Bounds)
Sand (Palaeochannel)	10 (1.0×10^{-8} - 1000)	1 (1.0×10^{-8} - 1000)	1.0×10^{-4} (1.0×10^{-8} - 1)

5.2.3 Trenches

The abstraction for the trench calibration simulations was based on the available flow records. Each trench was individually calibrated using PEST (Watermark Numerical Computing, 2010) to minimise the difference between the observed drawdown in the pits and trench and the simulated drawdowns.

The calibration was used to evaluate the horizontal and vertical hydraulic conductivity and specific yield of the lake sediments. An individual model was constructed for each trench. The model consisted of 4 layers (5 slices) in FEFLOW extending over an area with a buffer of 1 km around the trench and pits.

The models had a total thickness of 15 m of surficial sediments. The layer thickness was (from the surface) 1.9 m, 0.1 m, 2 m and 11 m.

The trenches and pits were assumed to be excavated to 2 m with vertical sides. The trench and pit areas remained constant during the simulations, i.e. any slumping that occurred was ignored. The initial parameters for each trench model are listed in Table 5-6.

For the calibration, the initial water level was specified as 0.5 m below the lake sediment surface. All observed water levels were adjusted so initial levels corresponded to this assumption. The abstraction rates and observed water levels for each of the trenches are shown in Figure 5-2 to Figure 5-4.

Table 5-6: Lake Surficial Sediments and Trenches and Pits: Initial Parameterisation and Calibration Bounds

Parameter	Lake Sediment (Bounds)	Trench/Pit
Kh (m/day)	10 (0.01 -100)	1.0 x 10^{6}
Kz (m/day)	0.1 (0.0001 – 100)	1.0 x 10^{6}
Ss (/m)	1.0 x 10^{-7}	1.0 x 10^{-7}
Sy (-)	0.1 (0.01 – 0.3)	0.9999

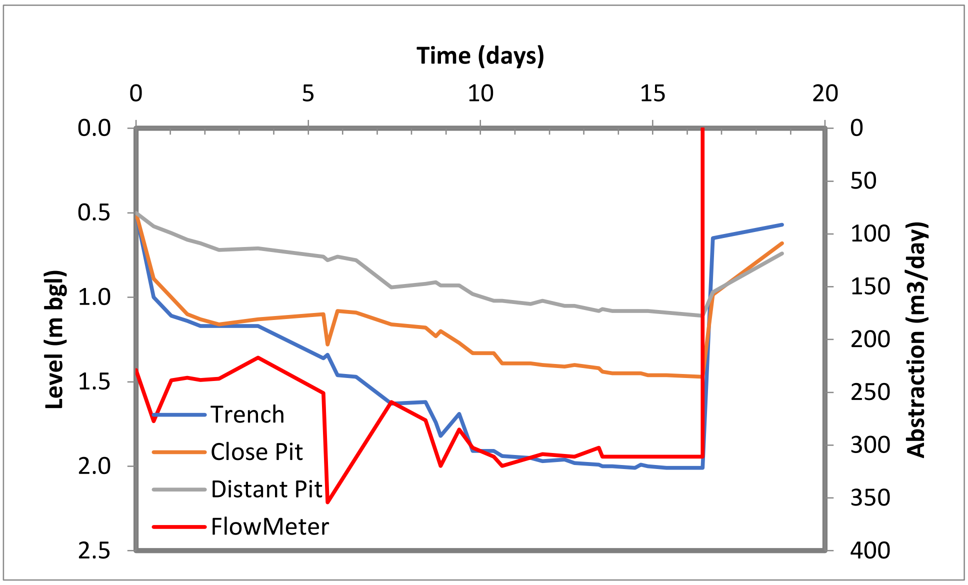


Figure 5-2: Abstraction and Observed Water Levels - ESE Trench and Associated Pits

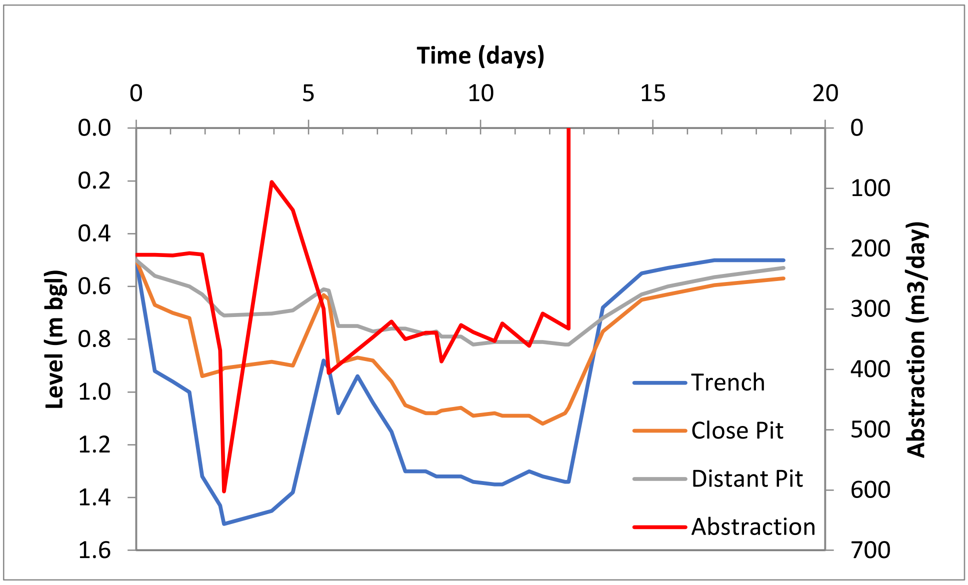


Figure 5-3: Abstraction and Observed Water Levels - ENE Trench and Associated Pits

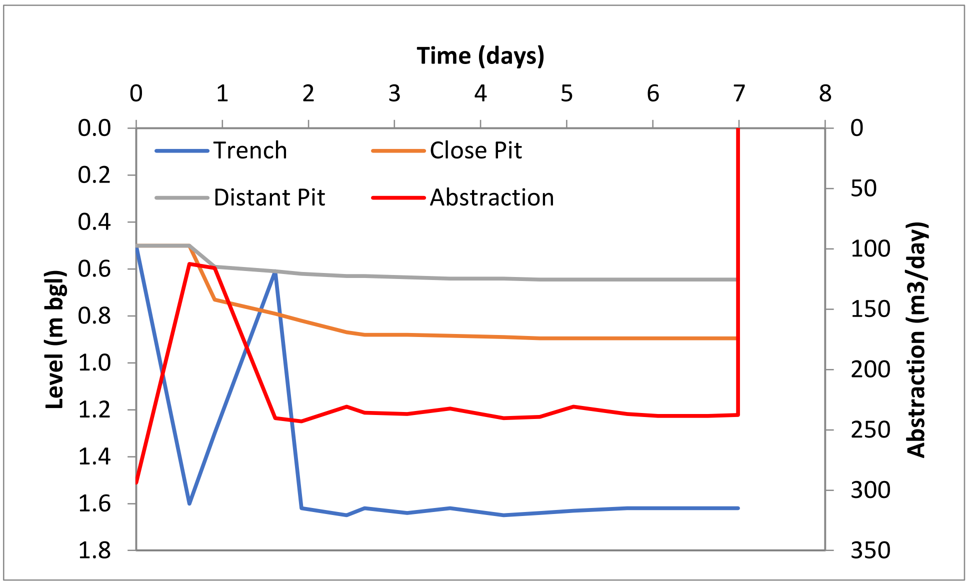


Figure 5-4: Abstraction and Observed Water Levels - NE Trench and Associated Pits

The heads around the boundary of the model were specified as 0.5 m below the land surface. No rainfall or evaporation was simulated in the calibration.

It was noted in the records that there was some problems with the metering in the NE Trench, with the meter readings possibly being incorrect due to the meter sticking. The meter readings indicated a large spike in the flow rate. The calibration for this test used the flow meter rates.

5.3 Calibration Results

The results of the different calibrations are presented below for each calibration procedure.

5.3.1 Steady-State Regional

The results of the initial steady-state calibration are presented in Table 5-7, together with the inferred 95% confidence interval (three standard deviations). These confidence intervals are generated by linear extrapolation from calibration results and may not be accurate. However the range of the confidence interval indicates the potential values of the parameter that satisfies the calibration, larger ranges indicating less confidence in the found values.

Figure 5-5 shows the comparison between the simulated and observed piezometric heads. The statistical analysis of the results found a Scaled Root Mean Square (SRMS) error of 11.6%. This shows a satisfactory calibration was achieved. Additional calibration statistics and plots are in Appendix B.

Due to the wide ranges of the 95% confidence intervals for the parameters found in the calibration, a manual sensitivity analysis was performed. This sensitivity analysis used manual variation of parameters by three orders of magnitude and calculated the change in the SRMS error. The results of this sensitivity analysis are presented in Table 5-8. These results indicate that the model is sensitive to:

- Higher horizontal hydraulic conductivity in the bedrock;
- Higher horizontal hydraulic conductivity in the weathered rock;
- Horizontal and lower vertical hydraulic conductivity in the colluvium;
- Horizontal hydraulic conductivity in the lake sediments;
- Higher vertical hydraulic conductivity in the lacustrine clays; and
- Horizontal hydraulic conductivity in the confined aquifer sands.

It also indicates that the model is insensitive to

- Vertical hydraulic conductivity in the bedrock;
- Vertical hydraulic conductivity in the weathered rock;
- Vertical hydraulic conductivity in the lake sediments;
- Vertical hydraulic conductivity in the deep confined sands; and
- Horizontal hydraulic conductivity and lower vertical hydraulic conductivity in the clays.

Table 5-7: Parameter Values (95% confidence intervals) from Steady-State Calibration

Lithological Unit	Horizontal Hydraulic Conductivity (m/day)	Vertical Hydraulic Conductivity (m/day)
Bedrock	0.0020 (2.0E-303-2.0E+297)	0.00053 (5.3E-304-5.3E+296)
Weathered rock	0.088 (1.2E-179-6.5E+176)	0.0019 (1.9E-303-1.9E+297)

Lithological Unit	Horizontal Hydraulic Conductivity (m/day)	Vertical Hydraulic Conductivity (m/day)
Surficial Alluvium	2.0 (3.5E-004-1.1E+004)	0.02 (9.0E-256-4.4E+251)
Lake Sediments	5.2 (4.5E-022-6.0E+022)	0.75 (7.5E-301-7.5E+299)
Clays	0.017 (5.1E-189-6.0E+184)	9.0E-05 (4.4E-028-1.9E+019)
Palaeochannel Sands	4.6 (2.0E-021-1.1E+022)	1.6 (1.6E-300-1.0E+300)

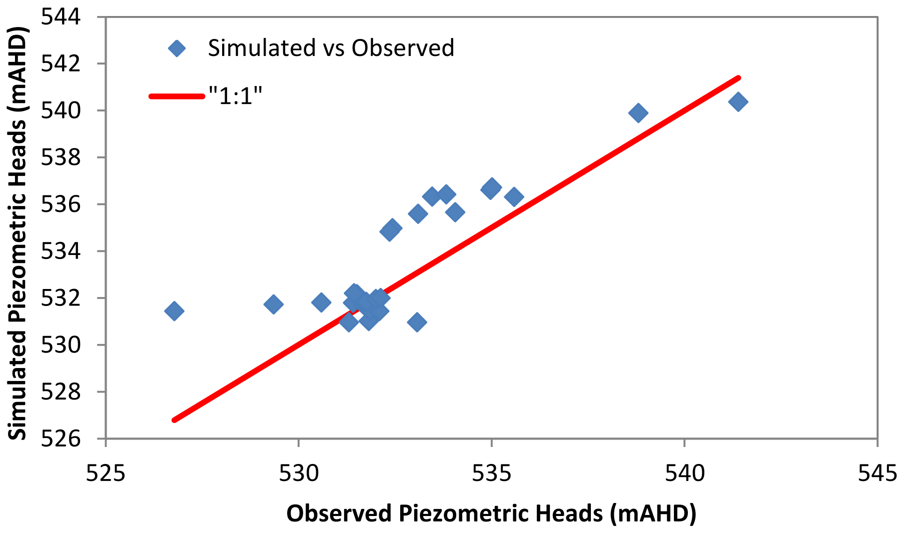


Figure 5-5: Comparison of Simulated and Observed Piezometric Heads from Steady-state Calibration

Table 5-8: Manual Sensitivity Analysis for Steady-State Model

Lithological Unit	Parameter	Change (order of Magnitude)					
		-3	-2	-1	1	2	3
Bedrock	Kh	-2%	-2%	-2%	15%	69%	101%
Bedrock	Kz	0%	0%	0%	0%	0%	0%
Weathered rock	Kh	-6%	-6%	-5%	31%	70%	71%
Weathered rock	Kz	-3%	-2%	-1%	0%	0%	0%
Colluvium	Kh	433%	398%	200%	101%	123%	128%
Colluvium	Kz	-14%	-8%	-2%	0%	1%	1%
Lake	Kh	24%	23%	19%	-13%	-14%	-14%
Lake	Kz	0%	0%	0%	0%	0%	0%
Clay	Kh	0%	0%	0%	0%	1%	-2%
Clay	Kz	0%	0%	-1%	4%	7%	7%
Sand	Kh	2%	2%	2%	-5%	40%	98%

Lithological	Parameter	Change (order of Magnitude)					
Sand	Kz	0%	0%	0%	0%	0%	0%

5.3.2 Confined Aquifer

The calibration of the transient deep aquifer found the ranges of values for the parameters in Table 5-9. The distributions of these parameters are shown in Figure 5-6 to Figure 5-8.

Table 5-9: Ranges of Calibrated Parameters for Deep Aquifer

Parameter	Minimum	Maximum	Mean	Median
Horizontal Hydraulic Conductivity (m/day)	0.1	31.6	12.6	10.4
Vertical Hydraulic Conductivity (m/day)	0.60	3.77	1.84	1.64
Specific Storage (/m)	1.93E-05	1.13E-03	1.62E-04	1.04E-04

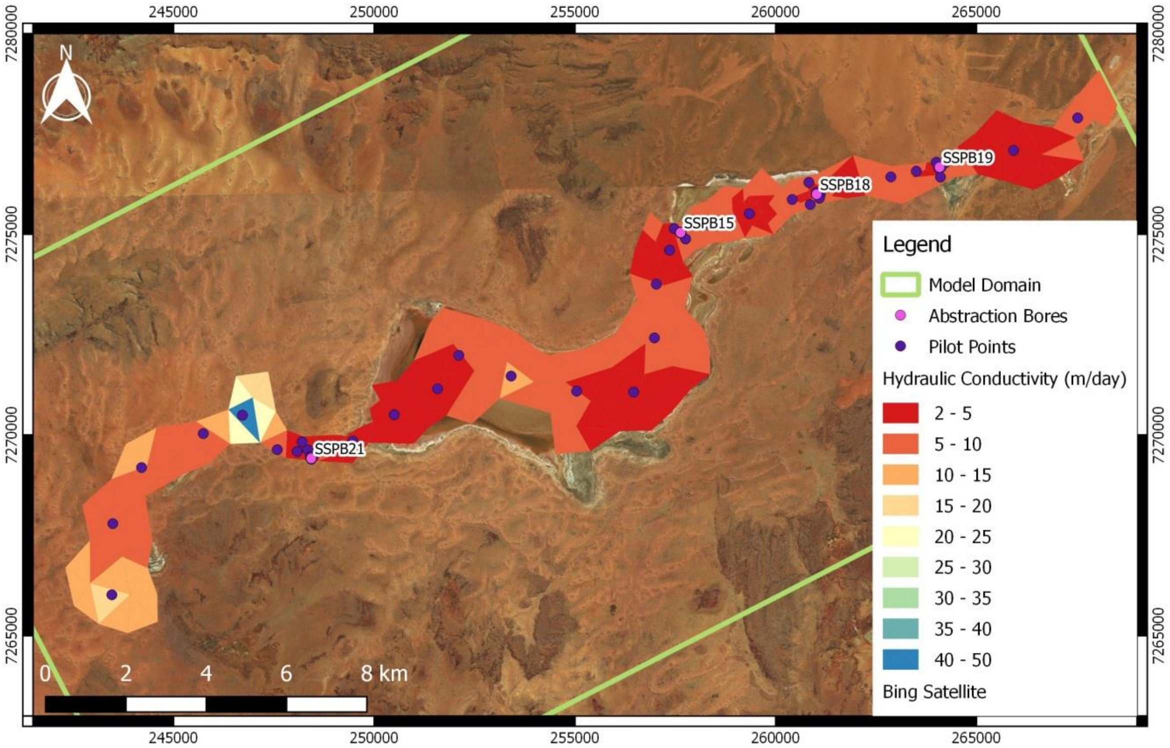


Figure 5-6: Calibrated distribution of horizontal hydraulic conductivity in confined aquifer

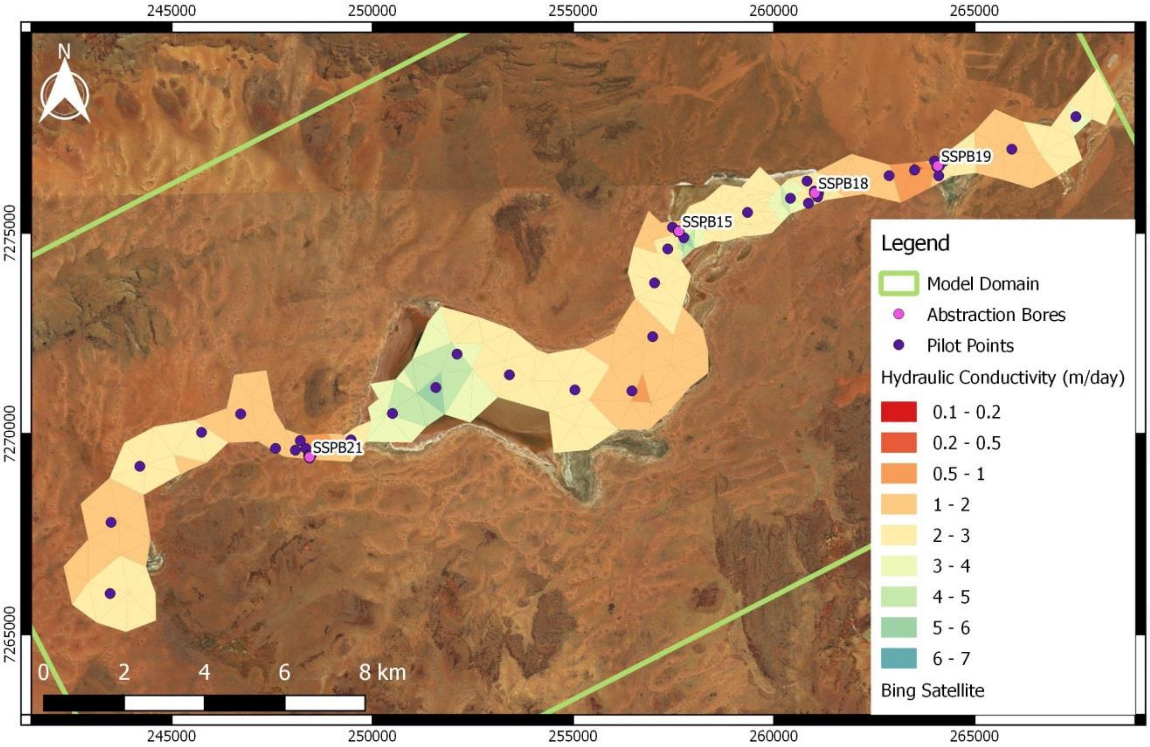


Figure 5-7: Calibrated distribution of vertical hydraulic conductivity in confined aquifer

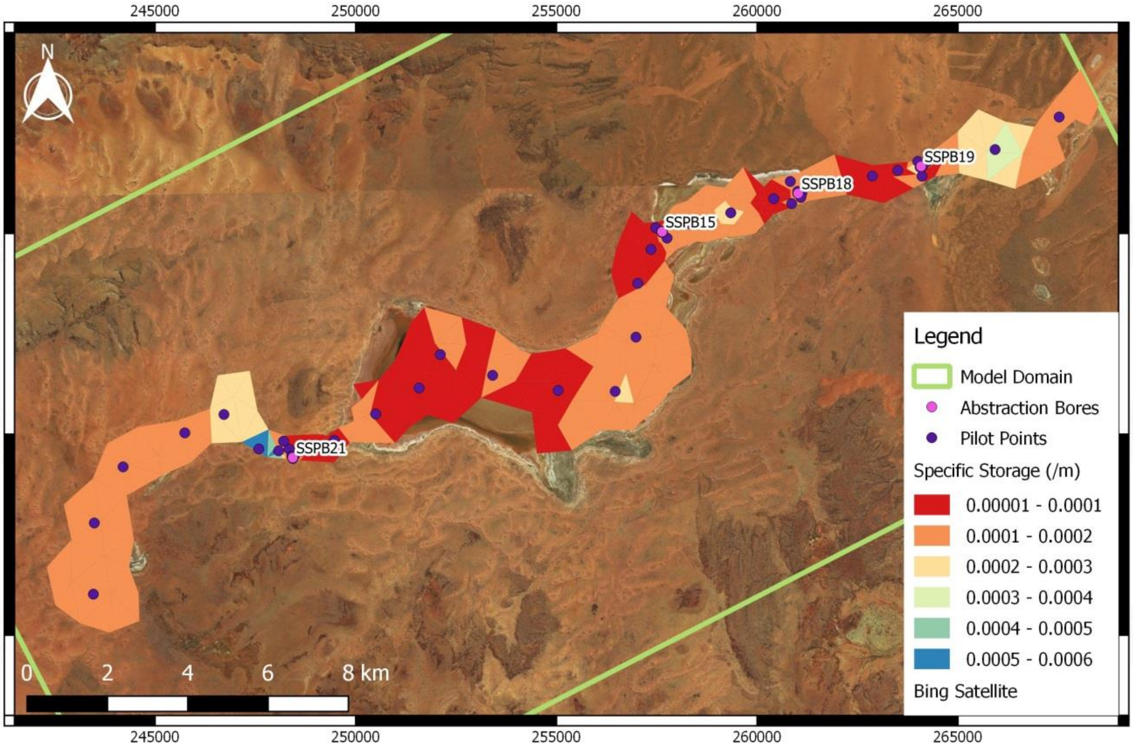


Figure 5-8: Calibrated distribution of specific storage in confined aquifer

The modelling for the deep aquifer shows a reasonable fit to the available data for the majority of the aquifer testing. The fitting to the transient responses are good. The overall statistics for the comparison of the model results to the weighted observations are satisfactory (SRMS error < 9%). The short-term nature of the tests and the absence of definable response to external forcing other than the abstraction (i.e. to recharge/flood events) limit the confidence level to intermediate (Class 2). An example of the fit to the drawdown in the SSAC21M1 bore is shown in Figure 5-9.

The full results from the deep aquifer calibration are shown in Appendix B.

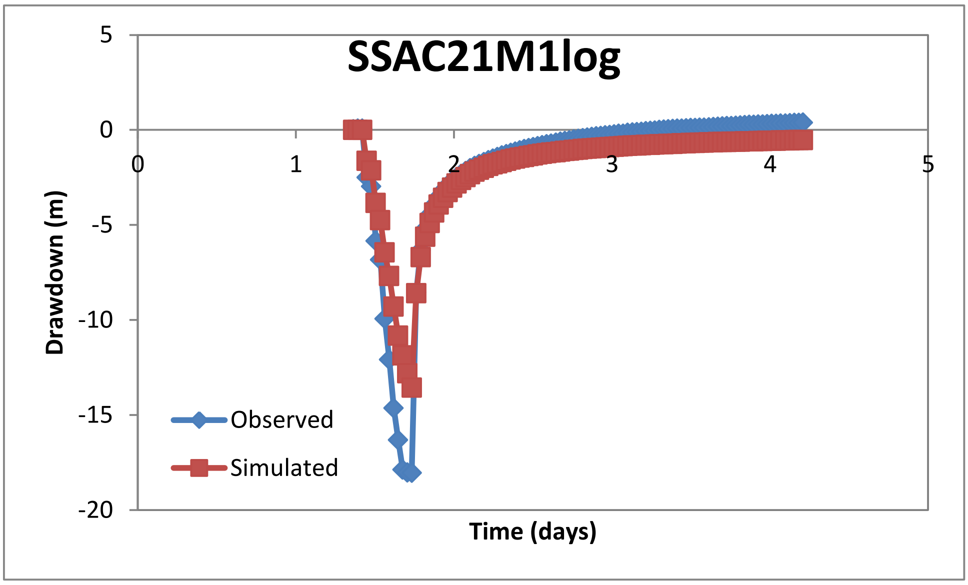


Figure 5-9: Observed and Calibrated Drawdown Hydrograph for Bore SSAC21M1

The sensitivity of the model was assessed by modifying specified parameters by three orders of magnitude. Table 5-10 presents the changes in the SRMS error for the model calibration as a proxy for the sensitivity of the model.

This shows the calibrated model for abstraction from the confined aquifer is most sensitive to:

- Hydraulic conductivity (horizontal and vertical) in the sand;
- Lower horizontal and higher vertical hydraulic conductivity in the lacustrine clays;
- Higher horizontal and all vertical hydraulic conductivity in the weathered rock;
- Specific storage in the sands; and
- Higher specific storage in the clays, weathered rock and bedrock.

The abstraction from the model is relatively insensitive to:

- Higher horizontal and lower vertical hydraulic conductivity in the lacustrine clays;
- Lower horizontal hydraulic conductivity in the weathered rock;
- Hydraulic conductivity in the bedrock; and
- Lower specific storage in the clays, weathered rock and bedrock.

Table 5-10: Sensitivity Confined Aquifer

Lithological Unit	Parameter	Change (order of Magnitude)					
		-3	-2	-1	1	2	3
Sand	Kh	n.a.	n.a.	n.a.	60.3%	83.2%	87.3%
Sand	Kz	n.a.	n.a.	n.a.	1.62%	1.63%	1.64%
Sand	Ss	n.a.	n.a.	n.a.	28.5%	60.5%	81.9%
Clay	Kh	1497%	423%	-2.68%	-0.10%	-0.69%	-2.62%
Clay	Kz	-0.43%	-0.45%	-0.55%	-4.01%	1301%	1301%
Clay	Ss	-0.09%	-0.09%	-0.05%	-1.98%	-4.30%	-1.54%
Weathered Rock	Kh	0.37%	0.37%	0.32%	-1.31%	-1.18%	29.2%
Weathered Rock	Kz	6.17%	5.42%	3.08%	-2.68%	-3.20%	-3.34%
Weathered Rock	Ss	0.43%	0.42%	0.36%	1302%	17.0%	42.8%
Bedrock	Kh	0.03%	0.03%	0.02%	-0.19%	-0.97%	-2.56%
Bedrock	Kz	-0.03%	-0.13%	-0.11%	0.01%	0.02%	0.02%
Bedrock	Ss	0.26%	0.25%	0.23%	-1.60%	-2.64%	-2.30%

5.3.3 Trenches

The results of the calibrations to the individual trench tests are in Table 5-11. These show the horizontal hydraulic conductivity in the lake bed is between 7 and 14 m/d, the vertical hydraulic conductivity is between 0.1 and 2 m/day and the specific yield is between 10 and 20%. The Scaled Root Mean Square (SRMS) errors for the individual calibrations were 9.9, 14 and 27% respectively for the ESE, ENE and NE trenches. The high SRMS percentage error for the NE trench was due to the difference between the simulated and observed levels in the pit, with the model under-predicting the fall in the water level. This trench was the shortest tested, and any differences between the simulated and trench bathymetry would result in large errors in the calibrated levels. In the ENE trench, there is some discrepancy in the levels early in the test. This may be due to the spike in the flow rate (see Figure 5-3) at this time occurring for longer than simulated in the calibration.

If the water levels in a trench approach the base of the trench, due to the unevenness of the basal elevations and potential slumping dividing the trench into separate water bodies, the observed response in the trenches may exceed the simulated response. In terms of the calibration, this may lead to an underestimate of the hydraulic conductivity and the specific yield.

Table 5-11: Trench Lake Surficial Sediment Calibration Results and Confidence Intervals

Parameter	ESE Trench	ENE Trench	NE Trench
Kh (m/day)	7.5 (6.5–8.6)	13.6 (10.1-18.3)	11.6 (9.0-14.9)
Kz (m/day)	0.60 (0.35-1.04)	1.7 (0.54-5.3)	0.10 (0.079-0.13)
Sy (-)	0.19 (0.14-0.27)	0.15 (0.069-0.31)	0.12 (0.087-0.16)

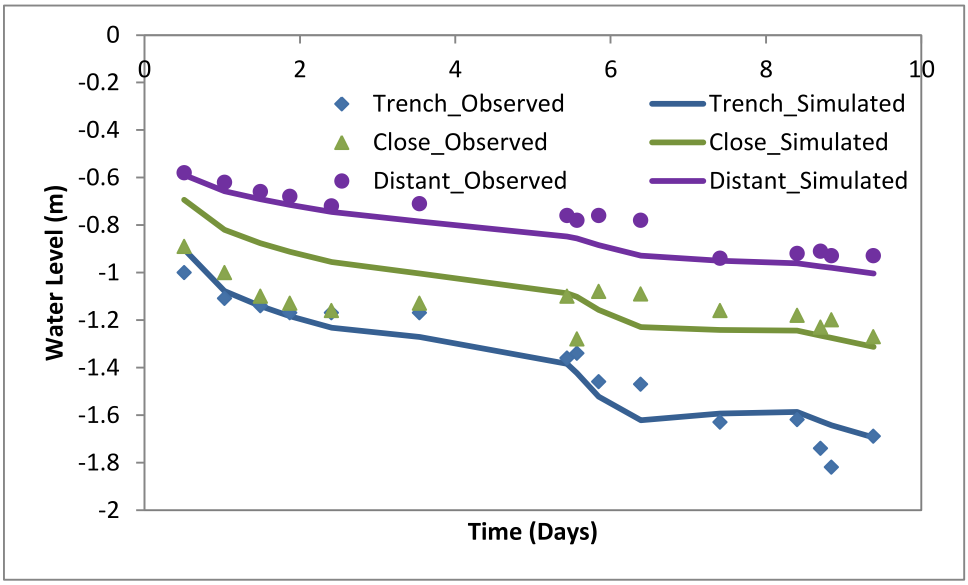


Figure 5-10: ESE Trench Calibration Hydrographs

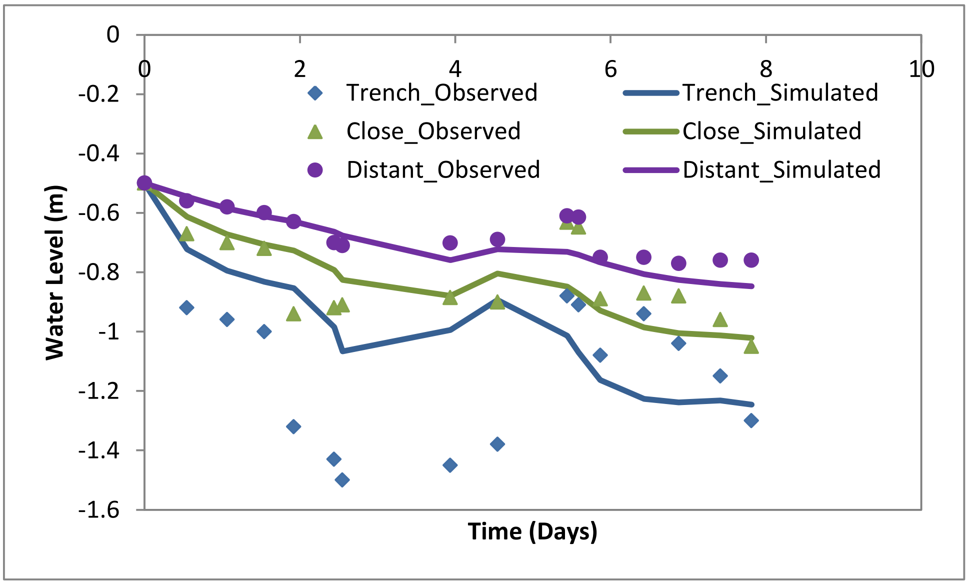


Figure 5-11: ENE Trench Calibration Hydrographs

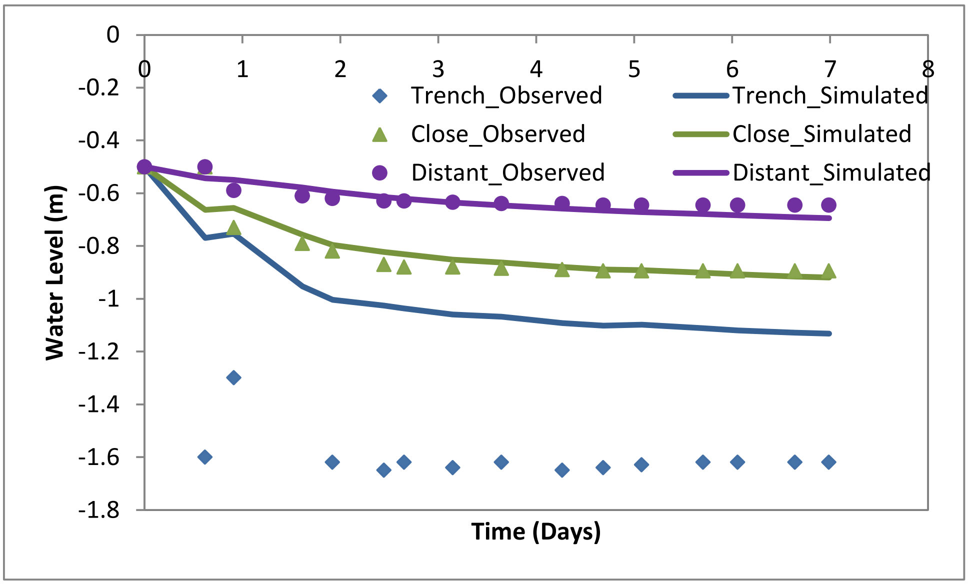


Figure 5-12: NE Trench Calibration Hydrographs

6 Resource Assessment

The resource assessment was conducted in two parts. These were the assessment of the resources in the confined aquifer palaeochannel sands, and the assessment of the resources in the lake sediments through the use of trenches. These two assessments are discussed in separate sections below.

6.1 Recovery from Confined Aquifer

6.1.1 Volumetric Recovery

The recovery from the confined aquifer was simulated in the indicated resource zone. Ten (10) bores were located in the mapped palaeochannel and fractured bedrock within the Indicated Resources zones (Figure 6-1). All bores operated at a maximum capacity of 8 L/s, with the well ceasing operation if the water level in the well fell below 5 m of head. The results from the simulation are shown in Table 6-1, with drawdowns around the well field shown in Figure 6-1 for selected times.

Table 6-1: Annual Average Rate and Cumulative Abstraction for Confined Aquifer

Year	Annual Average Rate Abstraction (L/s)	Cumulative Abstraction (GL)
1	47.2	2.1
2	42.0	3.6
3	39.8	4.9
4	44.9	6.2
5	44.5	7.3
10	43.8	13.3
15	42.4	18.9
20	40.8	24.6

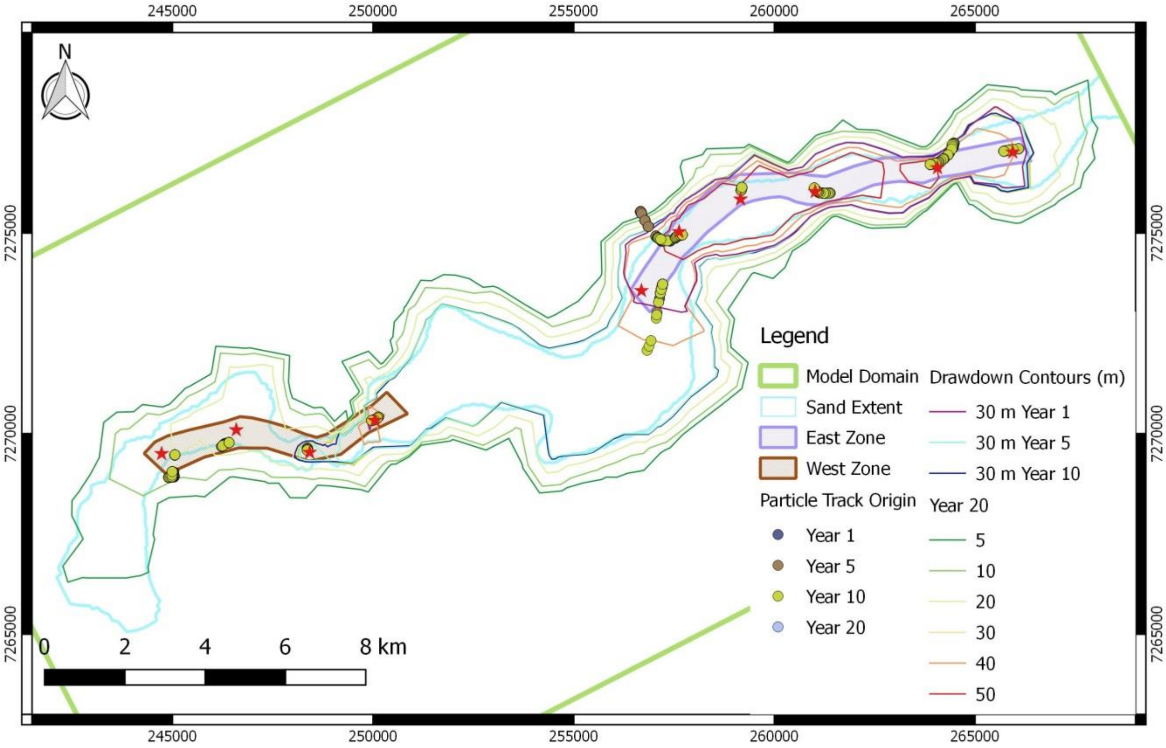


Figure 6-1: Drawdowns and Particle Track Origins for Confined Aquifer Abstraction

6.1.2 Brine Concentration

Particle tracking was used to determine the flow paths of brine to each production bore over the LoM. Figure 6-1 shows the 30 m drawdown contour around the bore field for selected times and the originating points for particle tracks to the active bores for selected times. The particle tracks were calculated in reverse from each active bore, with 24 particles arranged spherically around the bore. The originating points indicate the likely capture zone for individual wells at those times.

These particle tracks were overlain on the distribution of potassium grade in the confined aquifer. Two results were obtained:

- The first results uses all particles and evaluates the weighted concentration based on the number of particles and the abstraction rates at individual bores; and
- The second uses all particles with the particles originating within the indicated resource zone assigned the concentration at the originating location, and those outside the zone assigned a zero concentration.

The distribution of potassium grade does not cover the distribution of starting points for the particle tracking. All starting points outside the brine distribution were assigned zero concentration for each of the results. In the second set of results, the particle tracks originating outside the indicated resource zones were also assigned a zero concentration. The results of this analysis are listed in Table 6-2. This shows the potassium grade in the abstraction from the deep wells at Sunshine Lake is expected to exceed 4,300 mg/L for the first ten years of operation. The simulated lower concentrations after the first ten years are a function of the reduction in particles originating where the concentration was reasonably inferred.

Table 6-2: Predicted Concentration (mg/L) of Abstraction from Confined Aquifer

Year	All Concentration (Zero points, % total points)	Concentration from within Indicated Resources Zone (Zero points, % total points)
1	5,170 (0, 0.0%)	4,630 (33, 13.8%)
5	5,140 (0, 0.0%)	4,390 (44, 18.3%)
10	5,150 (0, 0.0%)	4,410 (44, 18.3%)
20	5,000 (8, 3.3%)	4,000 (66, 27.5%)

6.1.3 Predictive Uncertainty

To assess the uncertainty in the predictions, hydraulic conductivity and specific storage parameters were varied by an order of magnitude, and specific yields were halved and doubled in the clay, and the effect on the total recoverable resource was assessed. A further simulation with the calibrated parameters was performed with an additional four (4) wells located in the palaeochannel sands between the two indicated resource areas (see Figure 6-2).

The results from the predictive uncertainty simulations are presented in Table 6-3. These indicate that the recoverable resource is strongly dependent on:

- the horizontal hydraulic conductivity in the confined sands;
- the vertical hydraulic conductivity of the overlying clays;

- the horizontal hydraulic conductivity in the weathered rock; and
- the specific storage of the confined sands.

If these parameters vary markedly from the calibrated parameters, the volume of recoverable resource may change.

Table 6-3: Predictive Uncertainty of Total Abstraction and Abstraction Rates from Deep Aquifer to variations in Hydrogeological Parameters

Simulation	Total Abstraction (GL)	Average Abstraction Rate (L/s) Years 1-5	Average Abstraction Rate (L/s) Years 6-10	Average Abstraction Rate (L/s) Years 11-20
Base	24.6	46.6	36.7	36.1
Kh Clay x10	24.6	46.3	36.5	36.4
Kh Clay /10	24.7	46.4	38.1	35.9
Kz Clay x10	50.5	80.0	80.0	80.0
Kz Clay x3	31.6	55.7	48.6	48.1
Kz Clay /3	22.2	42.5	33.2	31.6
Kz Clay /10	19.8	40.7	30.6	27.5
Sy Clay 4%	24.7	46.7	36.8	36.2
Sy Clay 2%	24.6	46.7	36.8	36.2
Ss Clay x10	25.0	51.7	38.6	33.6
Ss Clay /10	24.2	45.0	36.1	35.9
Kh Sand x10	48.5	79.7	79.5	74.4
Kh Sand /10	12.1	23.3	18.1	17.8
Kz Sand x10	24.7	46.1	37.2	36.5
Kz Sand /10	25.1	47.6	37.8	36.1
Ss Sand x10	31.9	73.7	49.7	37.1
Ss Sand /10	22.2	37.7	34.7	34.0
Kh WRock x10	39.3	67.2	61.9	60.0
Kh WRock /10	24.1	45.6	36.7	35.2
Kz WRock x10	24.8	47.1	37.4	35.7
Kz WRock/10	22.7	44.6	36.9	30.9
Ss WRock x10	24.9	53.4	35.8	34.3
Ss WRock/10	25.1	45.9	38.3	37.5
Additional (Infill) Wells	29.1	53.7	45.0	41.8

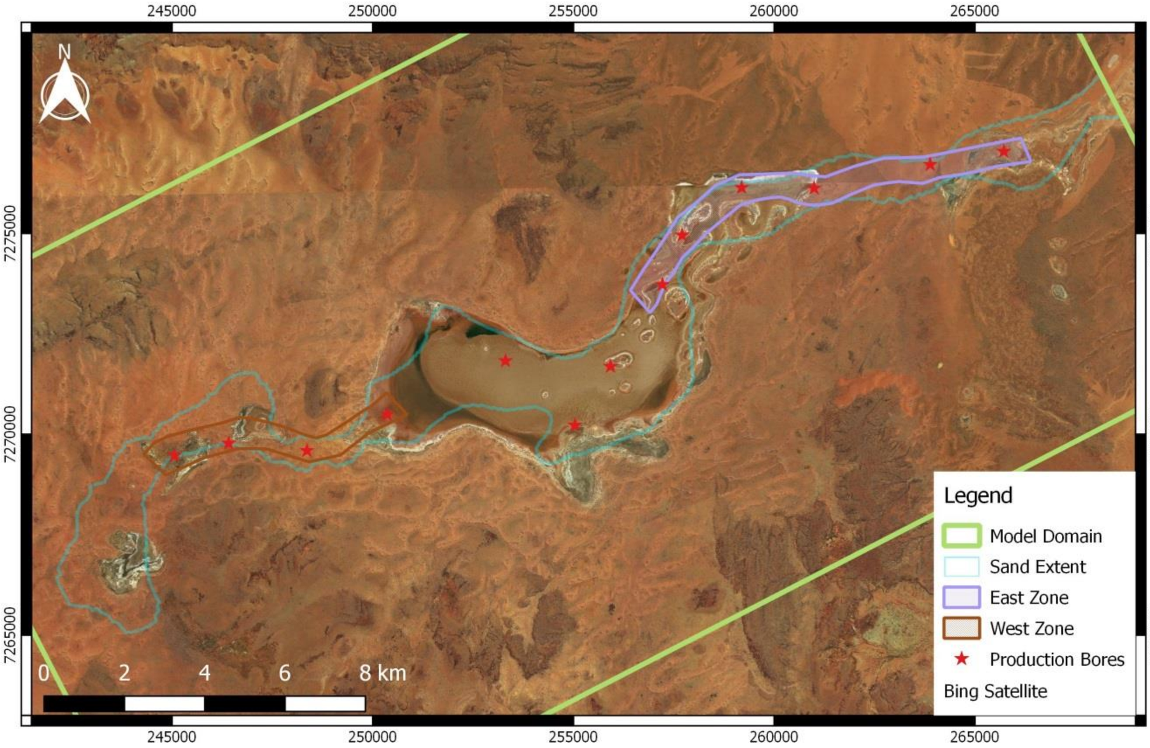


Figure 6-2: Production Wells for Confined Aquifer including Infill Wells

6.2 Recovery from Trenches

6.2.1 Model Construction

The trenches were assessed using the parameter values from the steady-state and trench calibrations. An intermediate value of the horizontal hydraulic conductivity was used for the lake of 10 m/day, with a vertical conductivity of 0.6 m/day. Both these were slightly less than the average value from the calibration of the three trenches. The specific yield was specified as 17% which was slightly higher than the average calibration results but consistent with the weighted mean in the inferred resources.

6.2.2 Volumetric Recovery

Three trenches were simulated in the model. These are shown in Figure 6-3. The mesh on the lake was refined in the vicinity of the trenches as shown in a representative section in Figure 6-4. The Trenches consist of a double line of elements with approximately 6 m sides (12 m wide trench). The vertical discretisation of the lake was similar to that used for the trench calibration comprising of 3 layers. The third (deepest) layer extended between the base of the lake and the base of the trench (simulated at 8 m depth from the surface). The intermediate layer was 0.5 m thick (between

7 and 8 m below lake surface), and the uppermost layer consisted of the upper 7.5 m of the lake sediments.

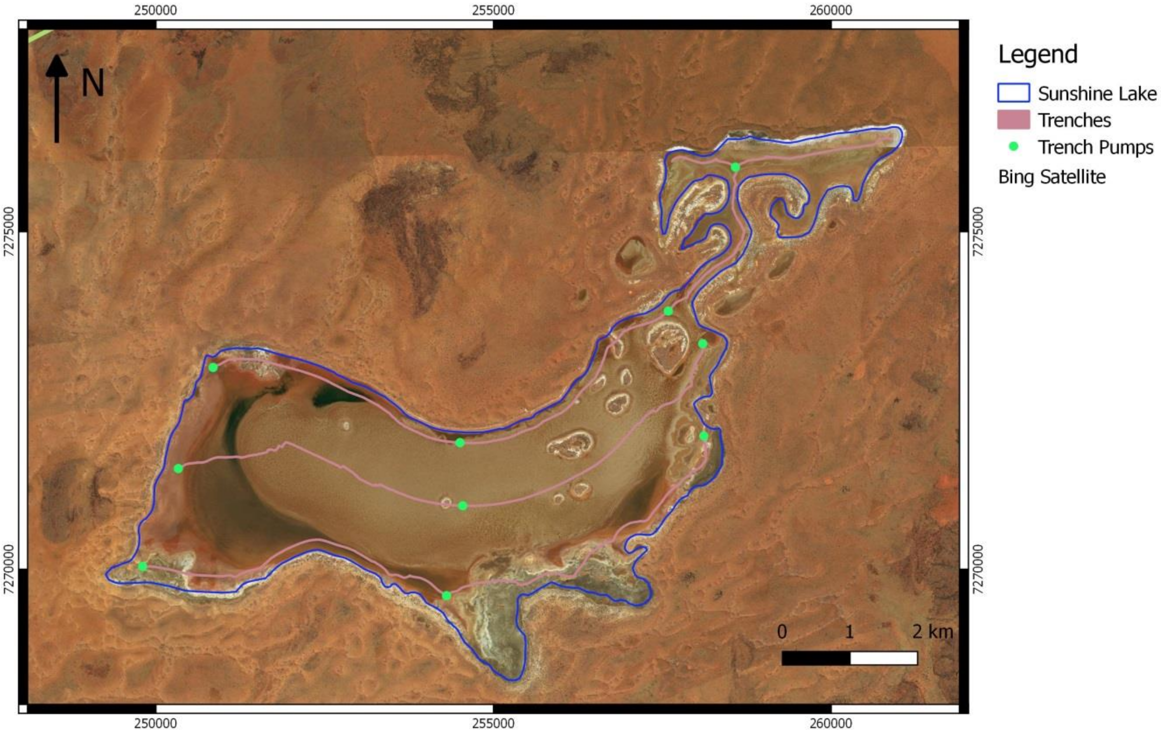


Figure 6-3: Trench and Pump Locations for Sunshine Lake

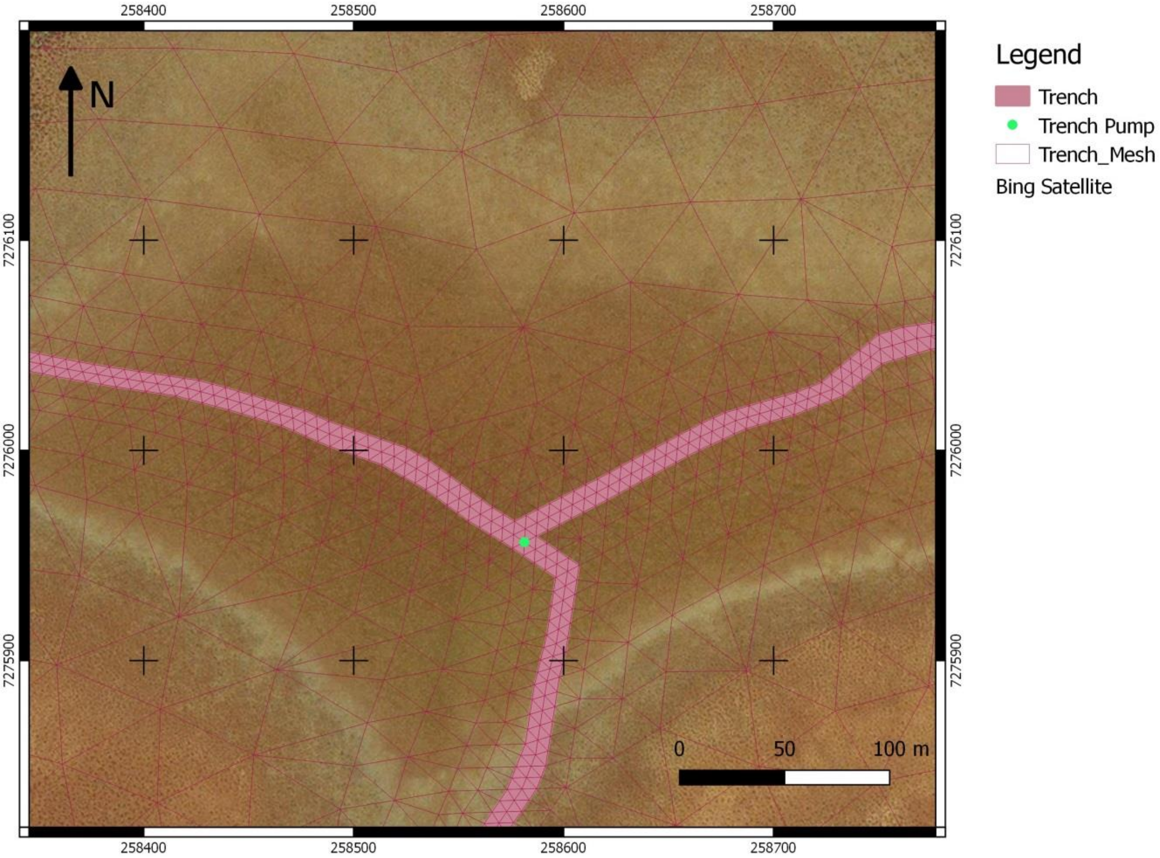


Figure 6-4: Mesh refinement in vicinity of Trench on Sunshine Lake

The properties in the trench were adjusted to simulate the removal of the lake sediments. The hydraulic conductivity (all directions) was specified as $1x10^6$ m/d and the specific yield as 0.999. This adjustment was made for the two top layers in the lake. Within the northern trench, four pump locations were simulated, whilst in the southern and central trenches three pump locations were simulated. These locations are shown in Figure 6-3. All pumps had a capacity of 50 L/s giving a maximum abstraction rate of 500 L/s.

The cumulative abstraction from the trenches is shown in Figure 6-5 over 20 years. It declines from an average of 217 L/s during the first 5 years to 50 L/s during years 16-20. Figure 6-6 shows the drawdowns in and around the lake at the 5 year intervals. It shows the greatest drawdowns occur on the western side of the lake. The drawdown cone around the lake, as signified by the 1 m contour line, continues to expand during the trench abstraction.

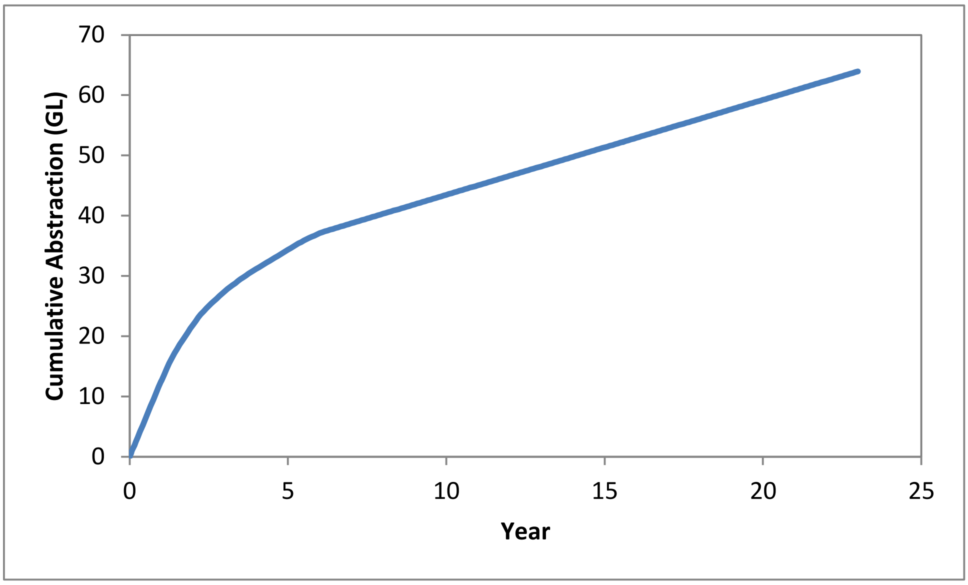


Figure 6-5: Simulated Cumulative Abstraction from Trenches

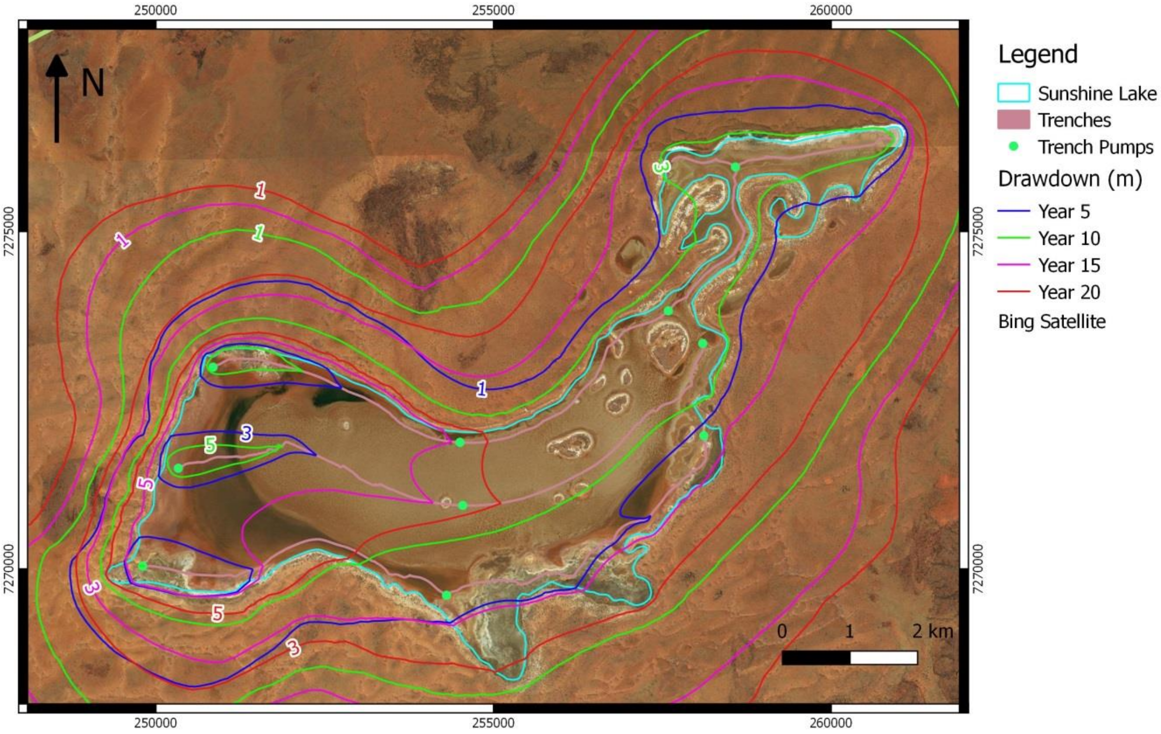


Figure 6-6: Simulated Drawdowns for Trenching at Sunshine Lake

6.2.3 Brine Content

To ascertain grades of potassium during the abstraction, particle tracking was employed to trace back the origin of water in the trench pumps at specified times. The times investigated were Year 1 (initial concentration), Year 5, Year 10 and Year 20. FEFLOW (DHI, 2015) particle tracking was performed for the head distribution at each specified time (i.e. it assumed that the head distribution existed for the period of track calculation).

The starting points for the particle tracking were randomly selected on each side of the trenches at up to approximately 1 km spacing. The same origin points were used for each set of particle tracks. Figure 6-7 shows the distribution of starting points on the lake. There are 41 particles for the north trench, 30 for the central trench and 47 for the southern trench.

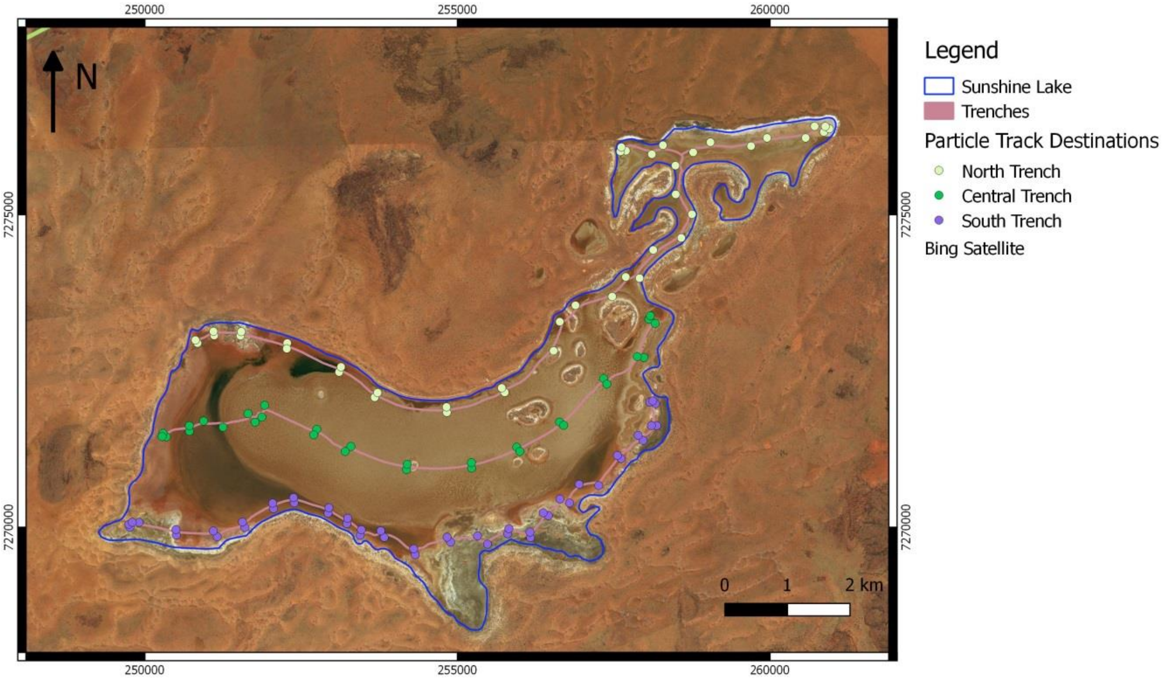


Figure 6-7: Destination of Particle Tracks to the Trenches

The resulting particle point origins at different times are shown in Figure 6-8. The potassium concentration distribution was overlain on these origin locations and the flow-weighted concentration for the trenches calculated using two methods:

- Method 1 used only the concentrations within the lake footprint (Indicated Resource) as shown in Figure 6-8. All particles originating outside the footprint were given a concentration of zero; and
- Method 2 used the concentrations for all particles.

The resulting average trench flows and concentrations from Lake Sunshine are in Table 6-4 for both methods. These show both the flow and the concentrations decline with time. The flow declines with time as the trenches lower the water table within the lake. The closeness of the origins of the particle tracks to the lake indicates that flow velocities in the surrounding areas are low and combined with the low storage coefficients shows that not much water is entering the lake.

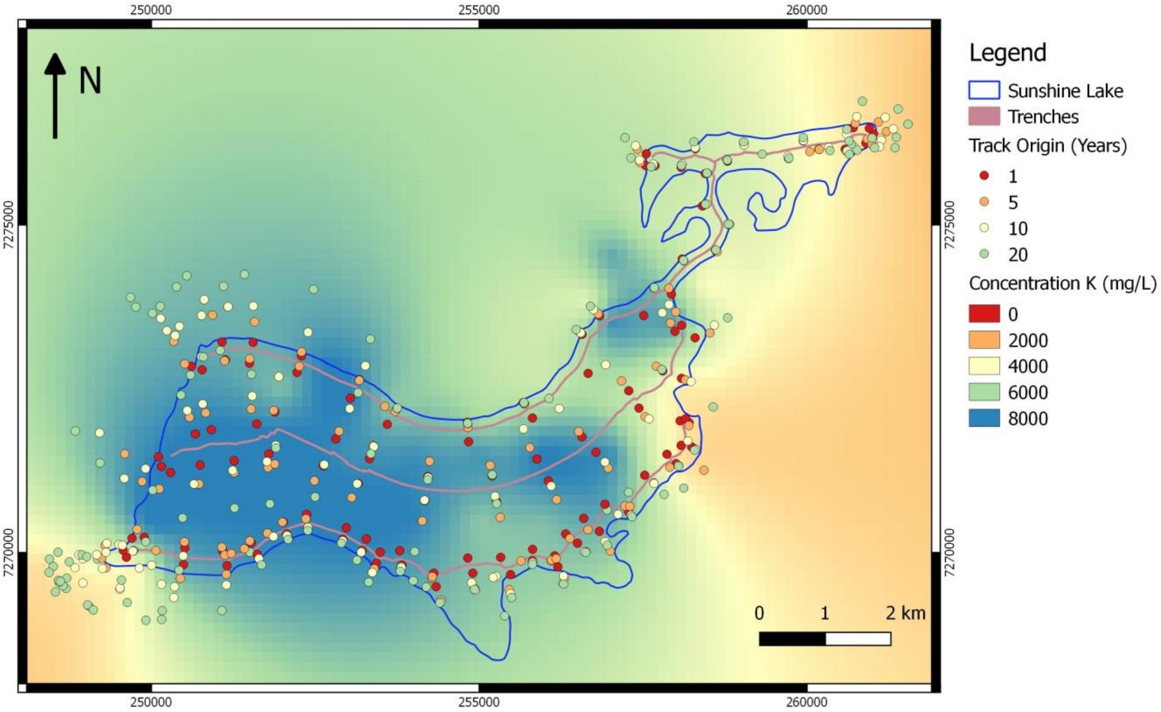


Figure 6-8: Particle Track Source Locations for Different Years

Table 6-4: Concentration for Trenches

Year	Flow (L/s)	Average Concentration (Lake Only)	Average Concentration (All)
1 (initial)	398	6808	6852
5	217	5969	6786
10	58	4775	6403
20	50	4036	5871

6.2.4 Predictive Uncertainty

The predictive flows and concentrations are subject to considerable uncertainty. This uncertainty is associated with the sensitivity of the model to hydrogeological parameters, as discussed in Section

5.3, and to other factors, which were not part of the calibration procedure. The impacts of some of these factors on the predictions made in the model are discussed separately for the trench and palaeochannel resources below.

The results of the trench calibration indicated the model has considerable range of hydrogeological parameters which it is sensitive to. The 95% certainty limit for the calibrated parameters was listed in Table 5-11. In addition, the recharge rate and the depth of the trench were not part of the calibration procedure, but may affect the flow rates and grade to the trenches. The hydrogeological parameters for the lake sediments are varied by an order of magnitude to examine the effects on the predicted flow into the trenches. In addition the horizontal hydraulic conductivity is halved and doubled, the trench depth reduced by 2 m and the effects of an annual one day flood event on the lake evaluated. It is noted in the companion report for Ten Mile Lake hydrogeological modelling (Advisian, 2017b) that predictive uncertainty of changing the average recharge rate results in no discernible changes in the flow to the trenches, as the additional recharge was small compared to the evaporation rate.

Advisian (2017a) evaluated potential levels in the lake based on different recurrence intervals of different length rainfall events. They found that a one-day event that would cover the whole lake surface to a depth of 50 mm would occur with a 63.2% probability in each year. This event was chosen to recur annually in the model to simulate effects of recharge on the trench flow volumes.

Table 6-5: Predictive Uncertainty for Trench Simulations (20 year flow)

Simulation	Total Abstraction (20 years, GL)	Abstraction Rate (L/s) Year 5	Abstraction Rate (L/s) Year 10	Abstraction Rate (L/s) Year 20
Base	59.1	219	59	50
Kh lake x10	60.4	232	50	50
Kh lake x2	56.8	178	93	39
Kh lake /2	59.3	225	51	50
Kh lake /10	60.2	212	72	47
Kz lake x10	58.9	215	68	50
Kz lake /10	59.6	216	62	50
Sy Lake 0.12	53.1	186	50	50
Sy Lake 0.22	65.7	244	72	50
Trench Depth 6 m	45.5	139	50	50
Recharge 1 day event (0.05 m)	71.3	233	96	61

The effects of rainfall events may vary depending on the frequency and amounts of rainfall. Inundation of the lakes will dissolve surficial salts and recharge the surface aquifer. This may increase the gradient towards the trenches. Rainfall and any surficial flow into the trenches may dilute the salt solution within the trench, this is considered a short-term effect.

7 Conclusions and Recommendations

The modelling has indicated that the indicated resources available from the tenements at Sunshine Lake are sufficient to recover 25 GL at an initial rate of 47 L/s declining to 41 L/s from the confined aquifer and 59 GL from the trench system, with the rate of recovery dropping from an initial 217 L/s to 50 L/s over a period of 20 years. This has been based on what is thought to be conservative assumptions about the hydrogeological parameters and extent of currently explored available resources.

This assessment is based on currently available data and may be modified if observations from further testing, baseline monitoring or resource recovery operations differ significantly from current field observations. Additional modelling showed that if wells were added to the confined aquifer between the east and west zones (within the Inferred Resource area), abstraction over the initial five years would increase to 53 L/s, and be maintained at a rate 42 L/s for over 20 years. Similarly, the modelling indicated that the inclusion of an annual inundation event on Sunshine Lake would increase the trenches average yield over the first five years to 233 L/s, and lead to a long-term long-term sustainable abstraction of 61 L/s.

The following recommendations for maximising the recoverable resource:

- Ongoing monitoring and potentially analysis of the stability of trench sides, including the effects of slumping and silting around the base and sides of the trench. This may include scheduling of remediation activities to maintain the efficacy of the trench system; and
- Ongoing monitoring of both piezometric heads and chemistry of both recovered water and at observation locations distant from recovery to identify changes in the flow and chemistry of the recoverable resource. These observations should be periodically compared with the predicted effects and include event based recharge.

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Appendix A Model Surface Elevations and Layer Thickness

The surface elevation was derived from the 1 second SRTM (Gallant et al., 2011). It is plotted in Figure A-1. Data from the bore logs were used to construct the surfaces for the base of the surficial and clay layers. The base of the confined aquifer was based on the bore log data and the Tromino geophysics. These elevations were then adjusted downwards to ensure there were at least 15 m thickness for the surficial layer, 10 m thickness for the intermediate clay layer and 2 m thickness for the confined aquifer. The base elevations for the surficial, clay and sand in the palaeo-drainage are plotted in Figures A-2 to A-4 respectively. Figures A-5 and A-6 display the base elevations for the weathered rock and bedrock. The thickness of the surficial, clay and sand layers are in Figures A-7 to A-9. The underlying weathered and bedrock layers were assigned thicknesses of 10 m. Figure A-10 shows a three-dimensional plot of the elevation of the model domain.

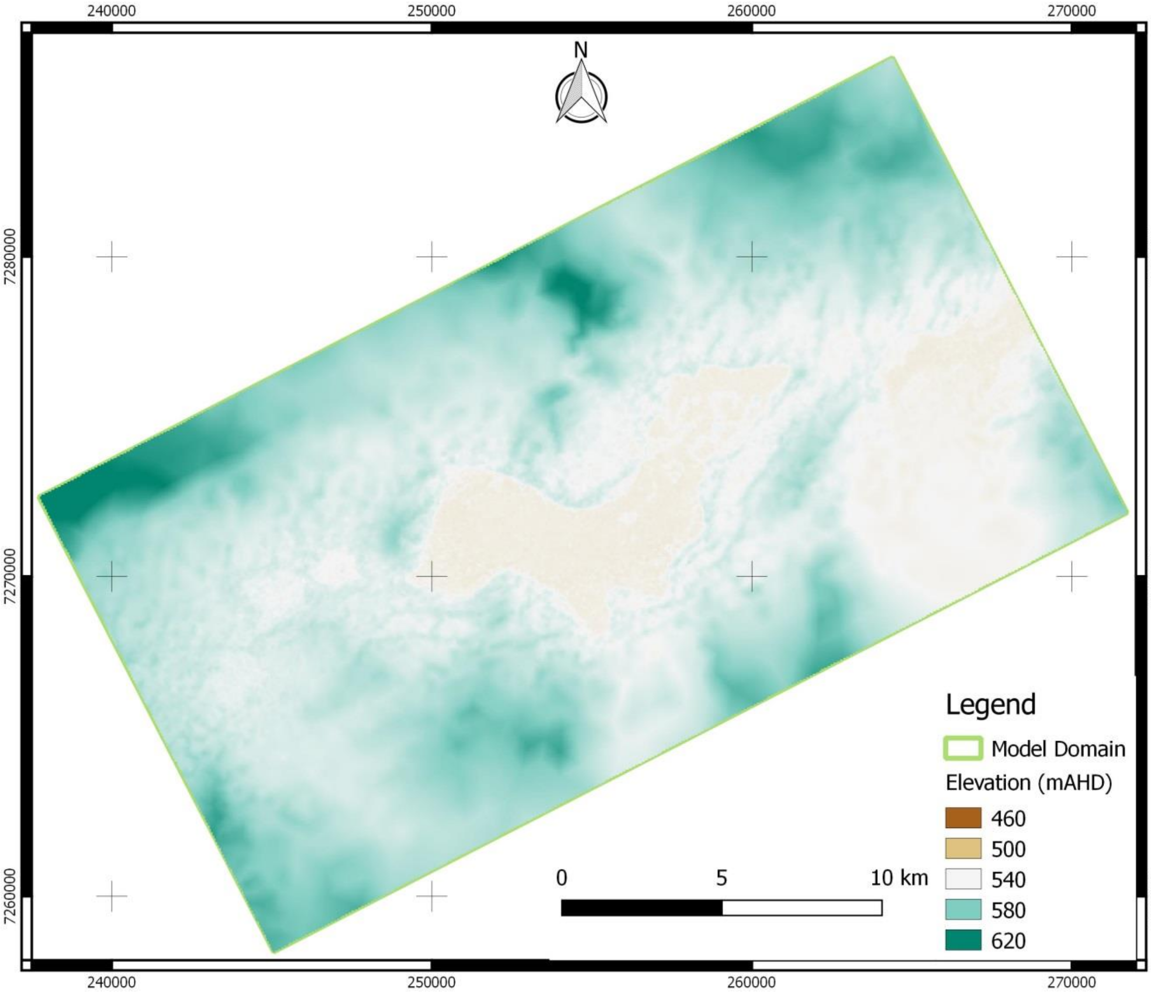


Figure A-1: Surface Elevation

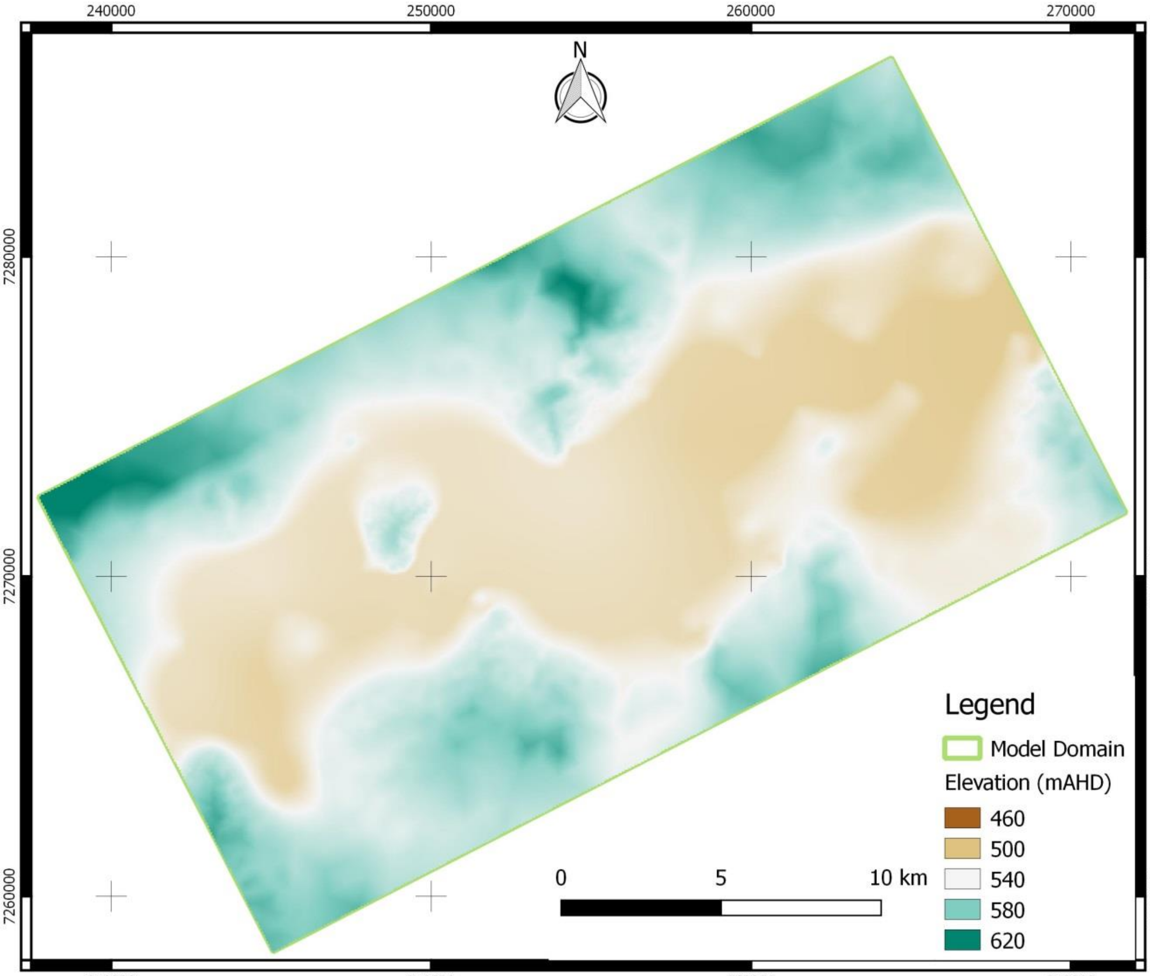


Figure A-2: Slice 2 Elevation- Base of Surficial Sediments in Palaeo-drainage

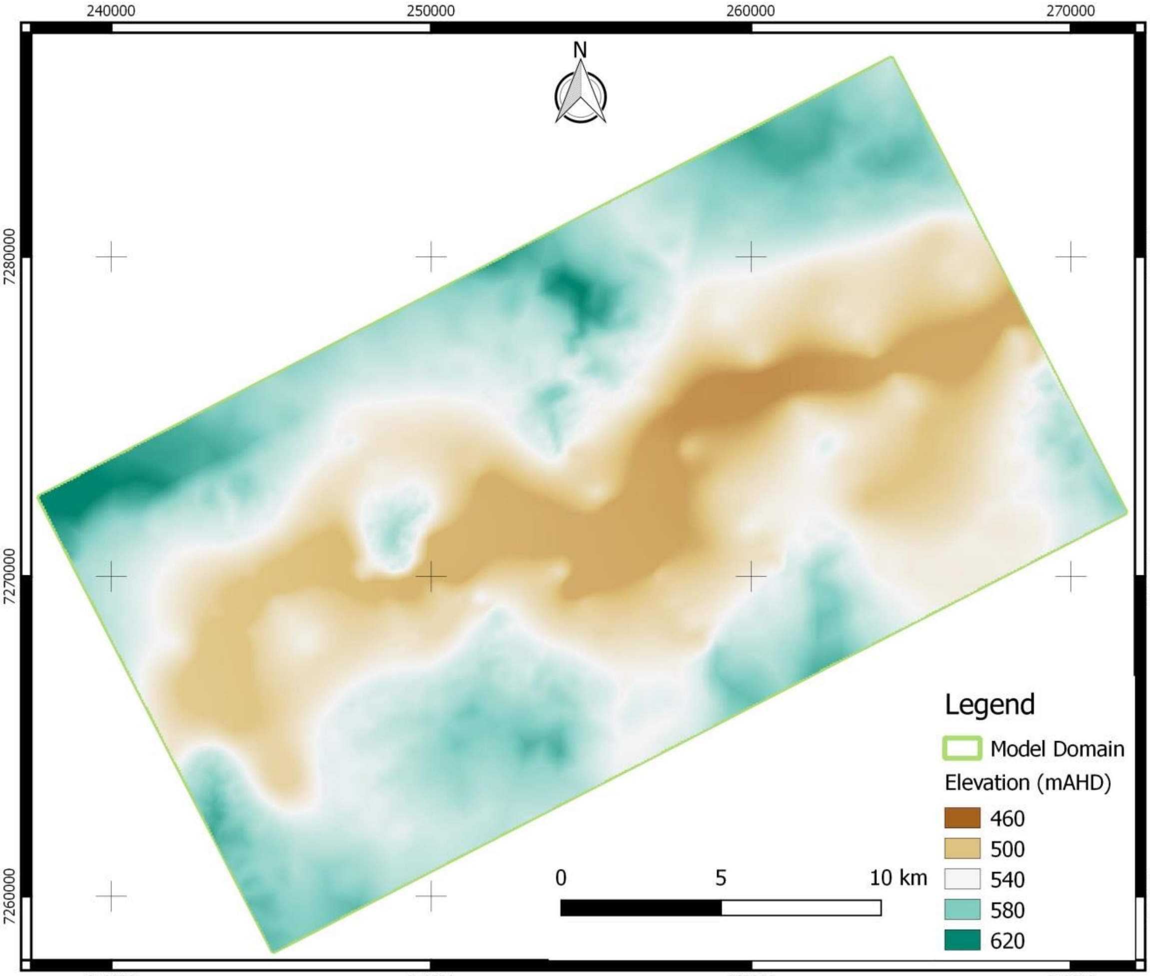


Figure A-3: Slice 5 Elevation – Base of Lacustrine Clays in Palaeo-drainage

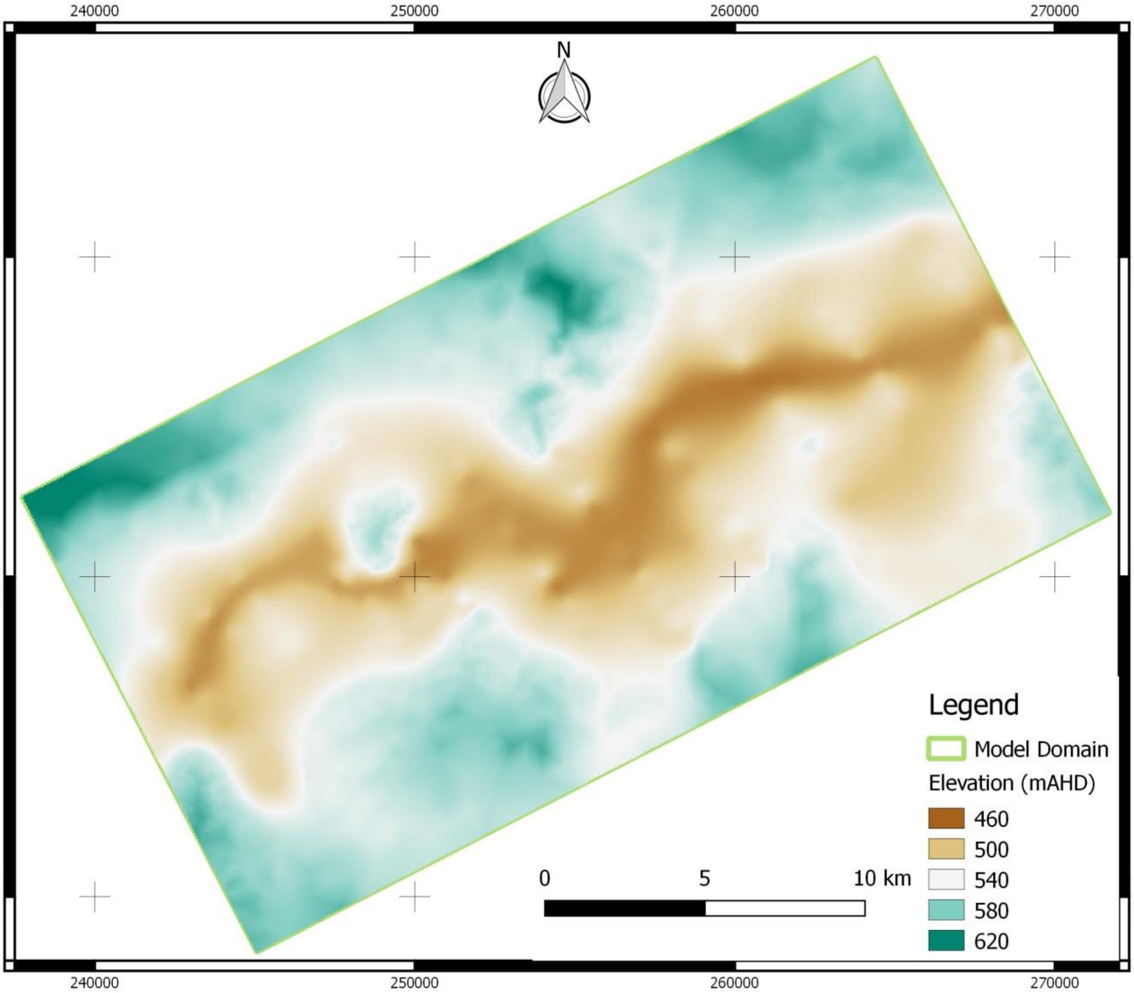


Figure A-4: Slice 6 Elevation – Base of Sands in Palaeo-drainage

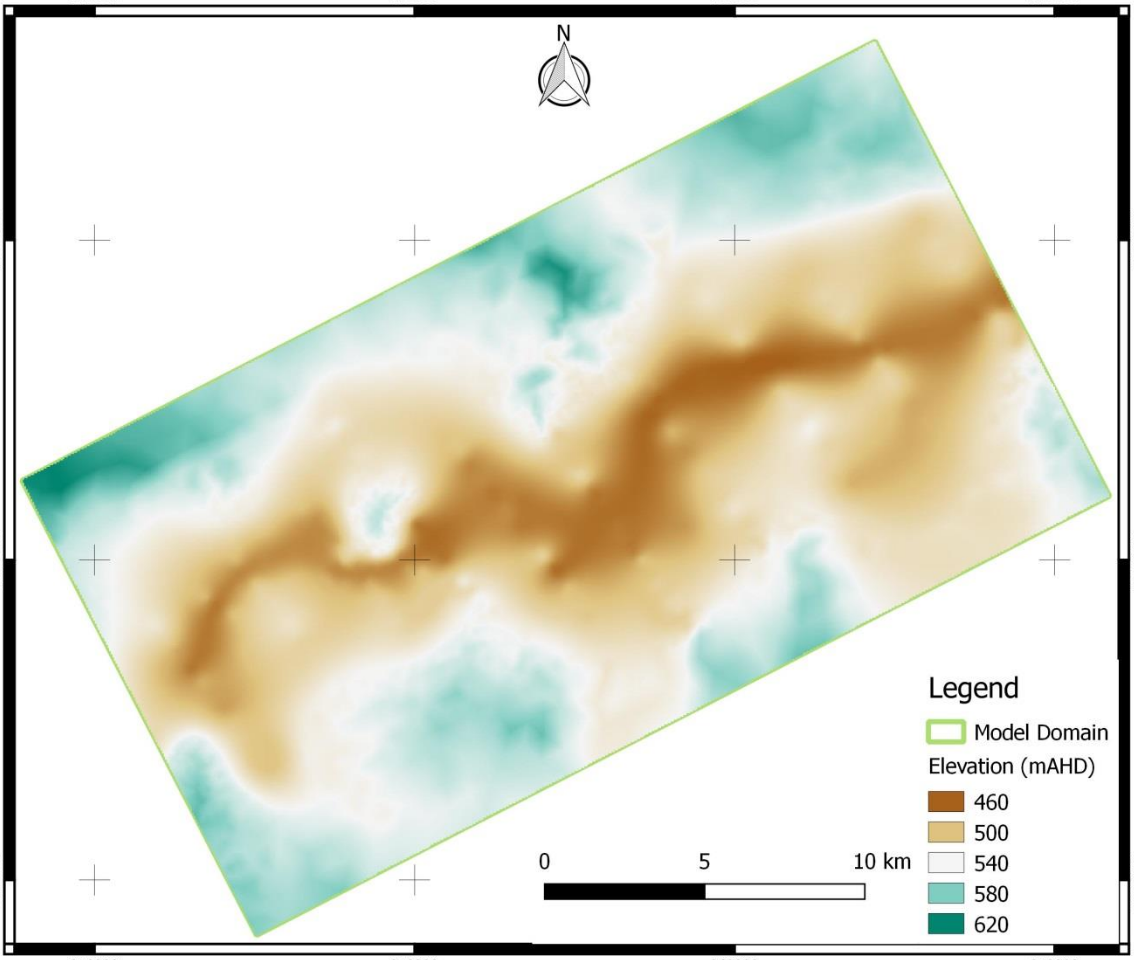


Figure A-5: Slice 7 Elevation – Base of Weathered Rock in Palaeo-drainage

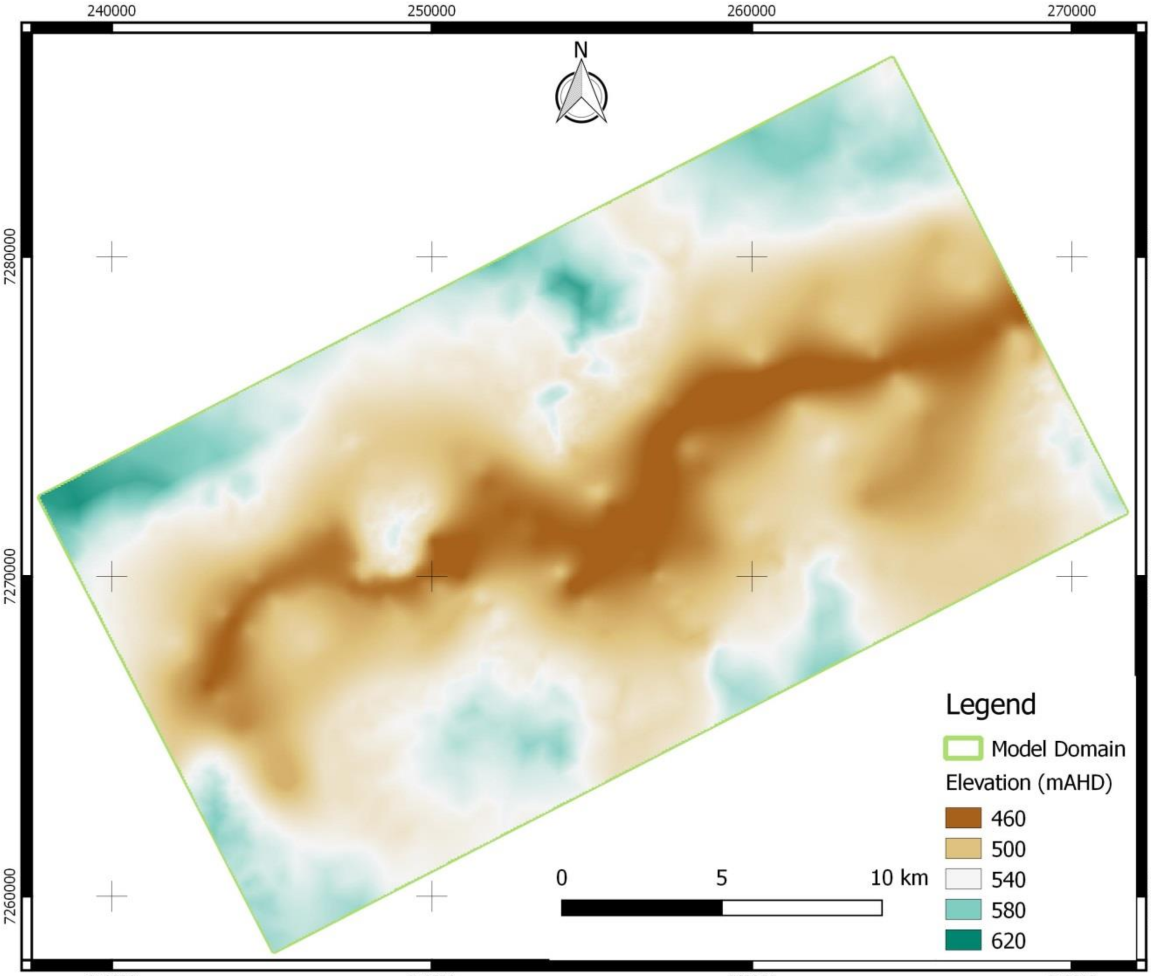


Figure A-6: Slice 8 Elevation – Base of Model

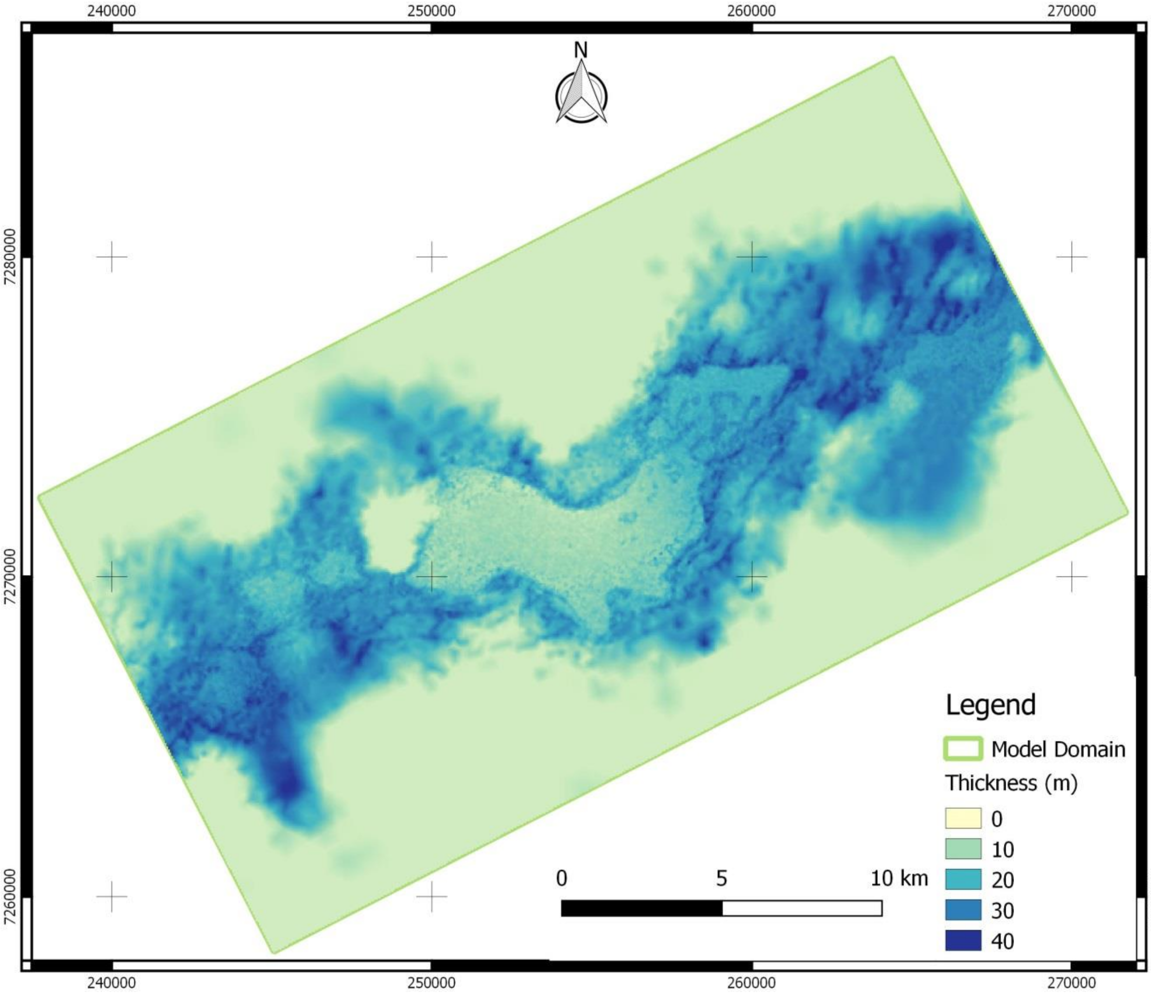


Figure A-7: Layer 1 Surficial Thickness

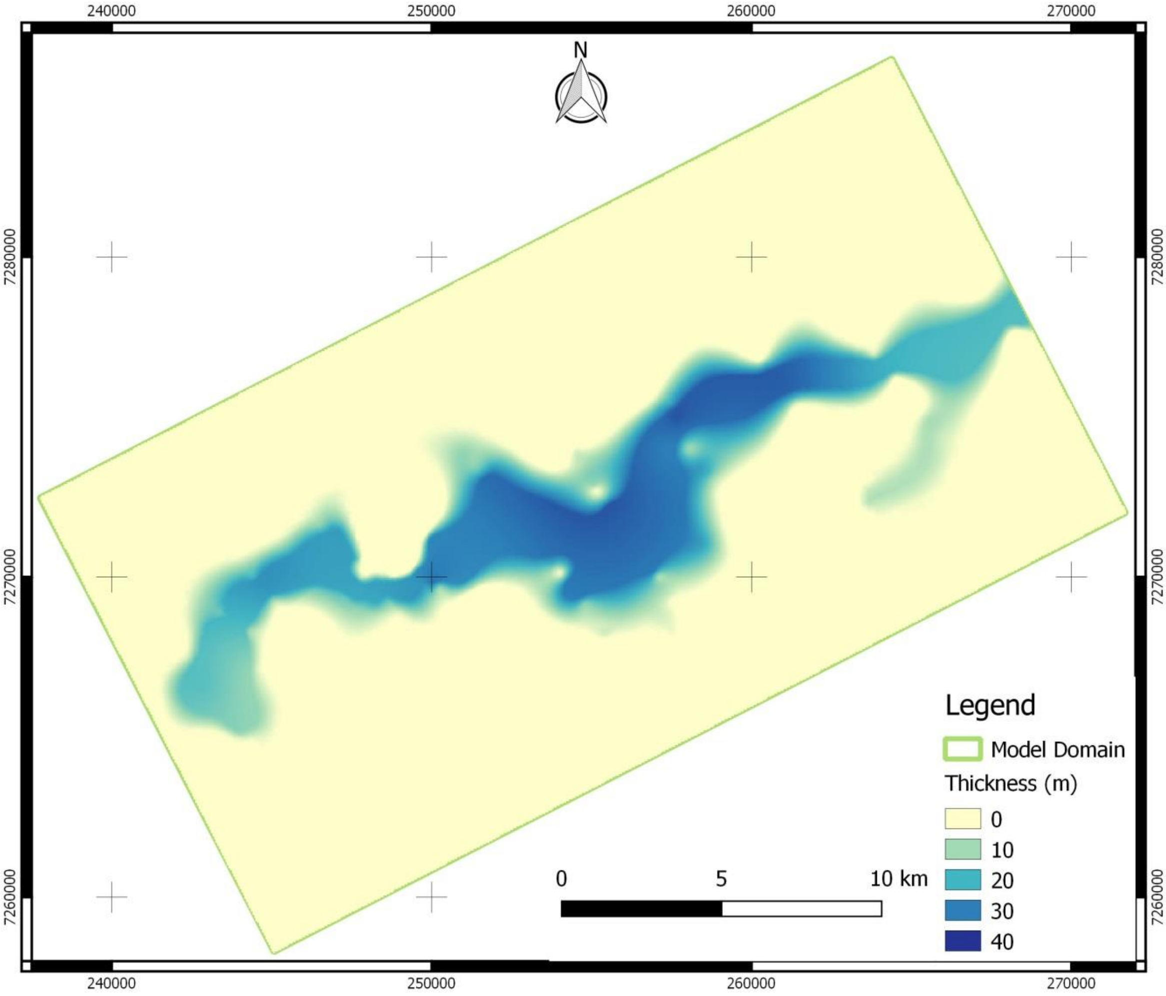


Figure A-8: Clay Thickness (Layers 2-4) in Palaeo-drainage

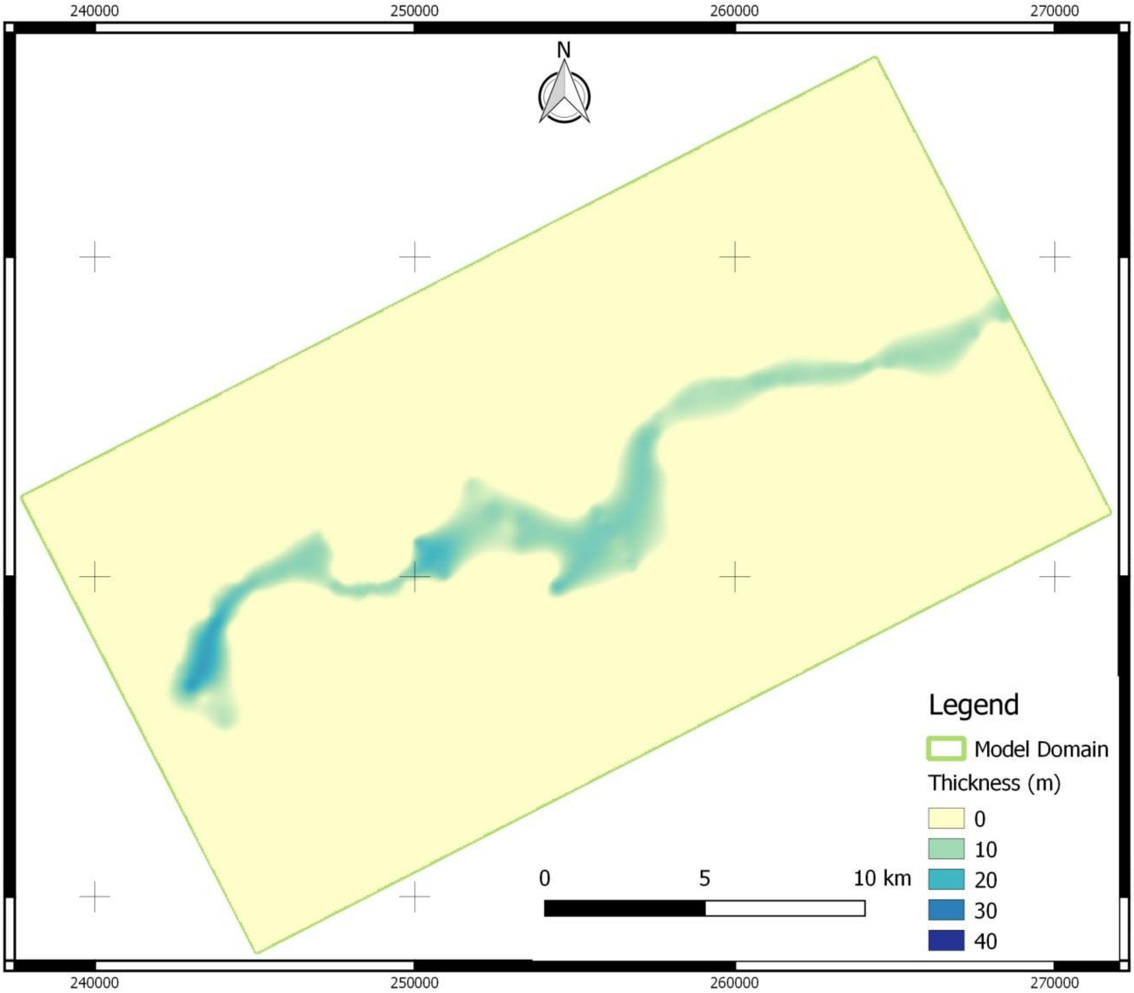


Figure A-9: Layer 5 Thickness – Sand in Palaeo-drainage

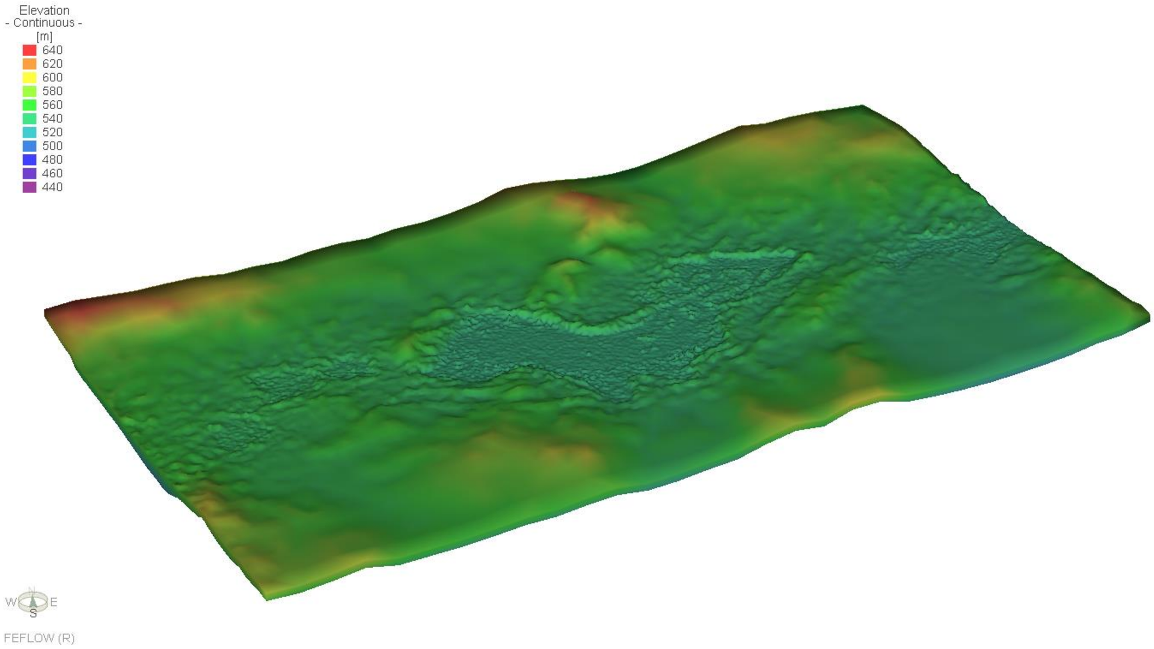


Figure A-10: Three-dimensional view of Sunshine Lake Model (10x vertical exaggeration)

Appendix B Calibration Results and Statistics

The Calibration procedure was a three-stage process:

- Initial steady-state regional calibration to initial head observations at all bores;
- Confined aquifer; and
- Three trench test calibrations for lake sediment properties.

Results from the three calibration procedures were discussed briefly in the main text (Section 5) with greater details included below.

B.1 Steady-state Regional Calibration

The full statistics from the steady-state regional calibration are in Table B-1. A plot of the simulated versus observed piezometric heads is in Figure 5-5, with the residuals plotted versus the simulated values in Figure B-1 and the spatial distribution of the residuals shown in Figure B-2. These show that a wide scatter in the residuals around the eastern (lower head) end of Sunshine Lake, indicating that the initial heads used may not be representative of steady-state conditions.

Table B-1: Steady-State Calibration Statistics for Sunshine Lake

Quantity	Value	Unit
Count	28	
Minimum Observed	526.8	m
Maximum Observed	541.4	m
Minimum Simulated	531.0	m
Maximum Simulated	540.4	m
SR: Sum of Residuals	35.5	m
MSR: Mean SR	0.87	m
SMSR: Scaled MSR	5.93	%
SSQ: Sum of Squares of Residuals	80.2	m^2
MSSQ: Mean SSQ	2.86	m^2
RMS: square root(MSSQ)	1.69	m
RMFS: Root Mean Fraction Square	0.32	%
SRFMS: Scaled RMFS	11.55	%
SRMS: Scaled RMS	11.58	%
CoD: Coefficient of Determination	0.88	
r: Correlation Coefficient	0.85	
N-S epsilon	0.60	

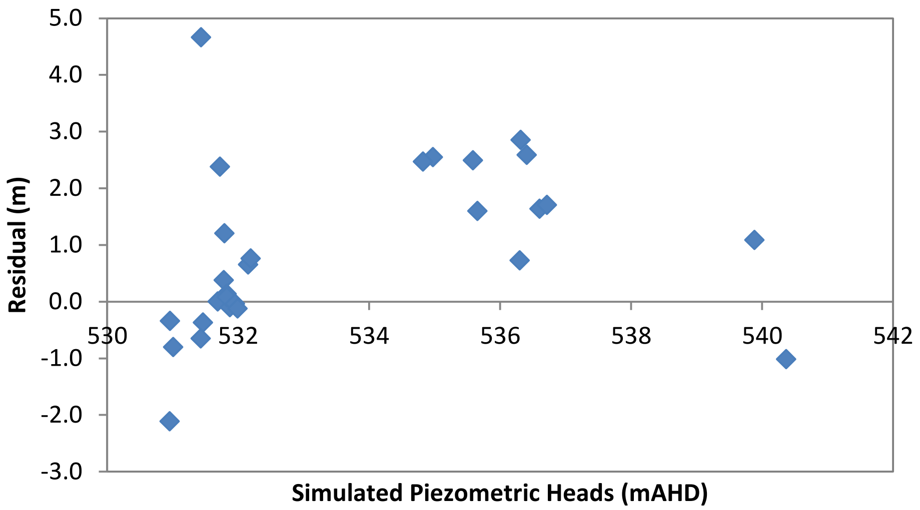


Figure B-1: Residual Distribution of Weighted Observations for Steady-State Calibration

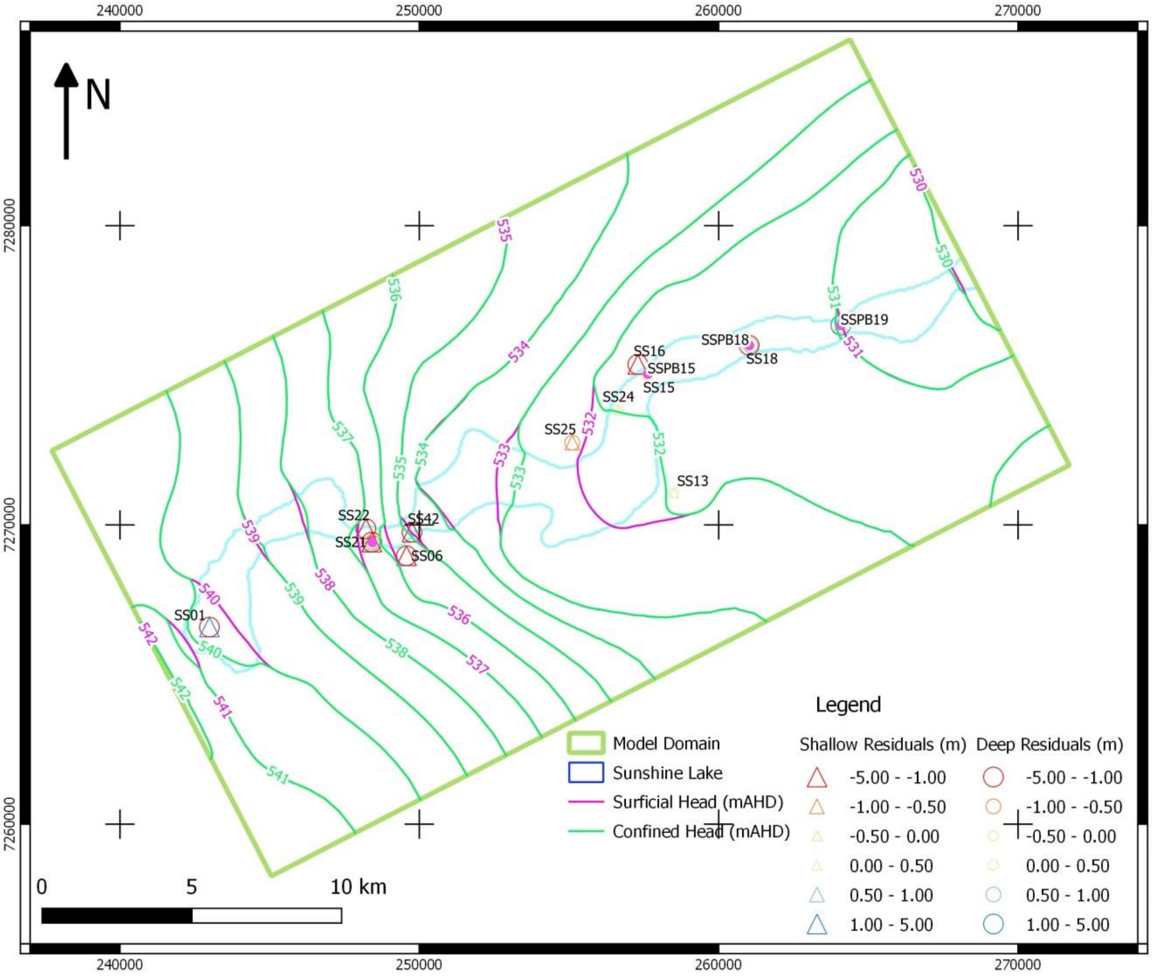


Figure B-2: Distribution of Residuals for Steady-State Calibration

B.2 Confined Aquifer Calibration

The distribution of properties from the confined aquifer calibration were shown in Figure 5-6 for horizontal hydraulic conductivity, Figure 5-7 for vertical hydraulic conductivity and in Figure 5-8 for specific storage. Table B-2 lists full results of the calibration procedure. The range of the 95% confidence for a particular parameter is inversely proportional to changes in the calibration statistic to changes of the parameter. The large range of 95% confidence intervals indicates that the calibration process needs additional data to constrain the parameters. The full statistics from the confined aquifer calibration are in Table B-3. A plot of the simulated versus observed piezometric heads is in Figure B-3, with the residuals plotted versus the simulated values in Figure B-4. These plots include drawdowns in the production bores that were not used in the calibration target. The majority of the residuals are close to zero, but there are some clear trends, especially for the positive head changes, with tracks of residuals for different aquifer tests. Although AGMG (Barnett et al., 2011) states ideally there should not be clear trends in these residuals, differences in observed and simulated heads from aquifer testing will generally exhibit trends and the differences between the simulated and observed are not great.

Table B-2: Calibrated Hydraulic Conductivity and Specific Storage Values at Pilot Points from Transient Calibration of Deep Aquifer

Pilot Point	Horizontal Hydraulic Conductivity (m/day)	Vertical Hydraulic Conductivity (m/day)	Specific Storage (/m)
1	21 (2.1E-299-5.0E+299)	2.7 (2.7E-300-1.0E+300)	1.2E-04 (1.2E-304-1.2E+296)
2	2.8 (2.8E-300-5.0E+299)	1.03 (1.0E-300-1.0E+300)	1.7E-04 (1.7E-304-1.7E+296)
3	13.1 (1.3E-299-5.0E+299)	3.1 (3.1E-300-1.0E+300)	1.4E-04 (1.4E-304-1.4E+296)
4	4.7 (4.7E-300-5.0E+299)	2.8 (2.8E-300-1.0E+300)	9.5E-05 (9.5E-305-9.5E+295)
5	95 (9.5E-299-5.0E+299)	1.15 (1.1E-300-1.0E+300)	2.5E-04 (2.5E-304-2.5E+296)
6	4.0 (4.0E-300-5.0E+299)	1.9 (1.9E-300-1.0E+300)	1.0E-03 (1.0E-303-1.0E+297)
7	3.0 (3.6E-152-2.5E+152)	1.37 (1.4E-300-1.0E+300)	4.9E-04 (4.9E-304-4.9E+296)
8	8.7 (2.9E-239-2.6E+240)	0.83 (8.3E-301-8.3E+299)	3.4E-05 (3.4E-305-3.4E+295)
9	4.0 (2.8E-264-5.6E+264)	2.4 (2.4E-300-1.0E+300)	5.2E-04 (5.2E-304-5.2E+296)
10	3.8 (9.4E-88-1.6E+88)	0.66 (6.6E-301-6.6E+299)	4.4E-05 (4.4E-305-4.4E+295)
11	4.3 (5.8E-55-3.3E+55)	2.5 (2.5E-300-1.0E+300)	5.2E-05 (5.2E-305-5.2E+295)
12	3.8 (1.7E-153-8.6E+153)	4.3 (4.3E-300-1.0E+300)	1.4E-03 (1.4E-303-1.4E+297)
13	3.9 (3.9E-300-5.0E+299)	6.8 (6.8E-300-1.0E+300)	6.0E-06 (6.0E-306-6.0E+294)
14	4.7 (4.7E-300-5.0E+299)	4.0 (4.0E-300-1.0E+300)	1.9E-04 (1.9E-304-1.9E+296)
15	15 (1.5E-299-5.0E+299)	2.2 (2.2E-300-1.0E+300)	1.2E-04 (1.2E-304-1.2E+296)
16	5.4 (5.4E-300-5.0E+299)	3.5 (3.5E-300-1.0E+300)	5.8E-05 (5.8E-305-5.8E+295)
17	1.1	0.51	3.2E-04

Pilot Point	Horizontal Hydraulic Conductivity (m/day)	Vertical Hydraulic Conductivity (m/day)	Specific Storage (/m)
	(1.1E-300-5.0E+299)	(5.1E-301-5.1E+299)	(3.2E-304-3.2E+296)
18	13.5 (2.5E-269-7.4E+270)	0.88 (6.9E-31-1.1E+30)	3.6E-04 (3.6E-304-3.6E+296)
19	4.2 (5.4E-178-3.2E+178)	5.9 (5.9E-300-1.0E+300)	5.8E-05 (5.8E-305-5.8E+295)
20	4.8 (3.1E-59-7.5E+59)	2.4 (2.4E-300-1.0E+300)	8.2E-05 (8.2E-305-8.2E+295)
21	5.3 (6.3E-45-4.5E+45)	9.7 (9.7E-300-1.0E+300)	1.2E-04 (1.2E-304-1.2E+296)
22	4.8 (2.8E-48-8.2E+48)	1.36 (1.4E-300-1.0E+300)	6.5E-05 (1.3E-291-3.2E+282)
23	4.7 (8.6E-21-2.6E+21)	2.4 (2.5E-222-2.3E+222)	1.1E-04 (5.5E-35-2.0E+26)
24	5.8 (1.4E-102-2.5E+103)	1.8 (1.8E-300-1.0E+300)	9.6E-05 (9.6E-305-9.6E+295)
25	4.7 (1.1E-181-2.0E+182)	1.9 (1.9E-300-1.0E+300)	3.4E-04 (3.4E-304-3.4E+296)
26	5.1 (1.9E-156-1.4E+157)	7.7 (7.7E-300-1.0E+300)	2.7E-05 (2.7E-305-2.7E+295)
27	5.9 (4.0E-94-8.8E+94)	0.14 (1.4E-301-1.4E+299)	1.8E-04 (1.8E-304-1.8E+296)
28	3.2 (1.6E-152-6.2E+152)	1.9 (1.9E-300-1.0E+300)	5.9E-04 (5.9E-304-5.9E+296)
29	7.9 (2.8E-123-2.3E+124)	0.80 (8.0E-301-8.0E+299)	1.2E-05 (1.2E-305-1.2E+295)
30	5.3 (5.6E-73-5.1E+73)	0.39 (3.9E-301-3.9E+299)	3.2E-05 (3.2E-305-3.2E+295)
31	5.5 (1.8E-24-1.7E+25)	0.63 (6.3E-301-6.3E+299)	3.1E-05 (3.1E-305-3.1E+295)
32	2.5 (2.5E-300-5.0E+299)	1.7 (1.7E-300-1.0E+300)	9.0E-04 (9.0E-304-9.0E+296)
33	6.9 (6.9E-300-5.0E+299)	4.1 (4.1E-300-1.0E+300)	1.0E-04 (1.0E-304-1.0E+296)
34	5.6 (5.5E-151-5.8E+151)	3.3 (3.3E-300-1.0E+300)	2.0E-04 (8.3E-156-4.7E+147)
35	2.5 (2.5E-300-5.0E+299)	3.3 (3.3E-300-1.0E+300)	1.4E-05 (1.4E-305-1.4E+295)
36	9.4 (9.2E-177-9.7E+177)	0.78 (7.8E-301-7.8E+299)	6.1E-05 (6.1E-305-6.1E+295)
37	8.4 (8.4E-300-5.0E+299)	0.18 (1.8E-301-1.8E+299)	1.2E-04 (1.2E-304-1.2E+296)
38	4.8	1.02	1.3E-04

Pilot Point	Horizontal Hydraulic Conductivity (m/day)	Vertical Hydraulic Conductivity (m/day)	Specific Storage (/m)
	(2.8E-130-7.9E+130)	(1.0E-300-1.0E+300)	(1.3E-304-1.3E+296)
39	3.6 (3.3E-199-3.9E+199)	0.75 (7.5E-301-7.5E+299)	1.1E-03 (4.9E-216-2.5E+209)
40	7.1 (9.8E-235-5.2E+235)	2.9 (2.9E-300-1.0E+300)	9.5E-06 (9.5E-306-9.5E+294)

NOTE: The 95% range is based on linear extrapolation from calibration procedure. It is an indicative range rather than a calculated range

Table B-3: Deep Aquifer Transient Calibration Statistics

Quantity	Value	Unit
Count	2413	
Minimum Observed	-32.5	m
Maximum Observed	5.4	m
Minimum Simulated	-25.7	m
Maximum Simulated	2.4	m
SR: Sum of Residuals	3471.3	m
MSR: Mean SR	-0.1	m
SMSR: Scaled MSR	-0.2	%
SSQ: Sum of Squares of Residuals	24830.6	m^2
MSSQ: Mean SSQ	10.3	m^2
RMS: square root(MSSQ)	3.2	m
RMFS: Root Mean Fraction Square	59255.1	%
SRFMS: Scaled RMFS	-2940.6	%
SRMS: Scaled RMS	8.5	%
CoD: Coefficient of Determination	1.6	
r: Correlation Coefficient	0.83	
N-S epsilon	0.69	

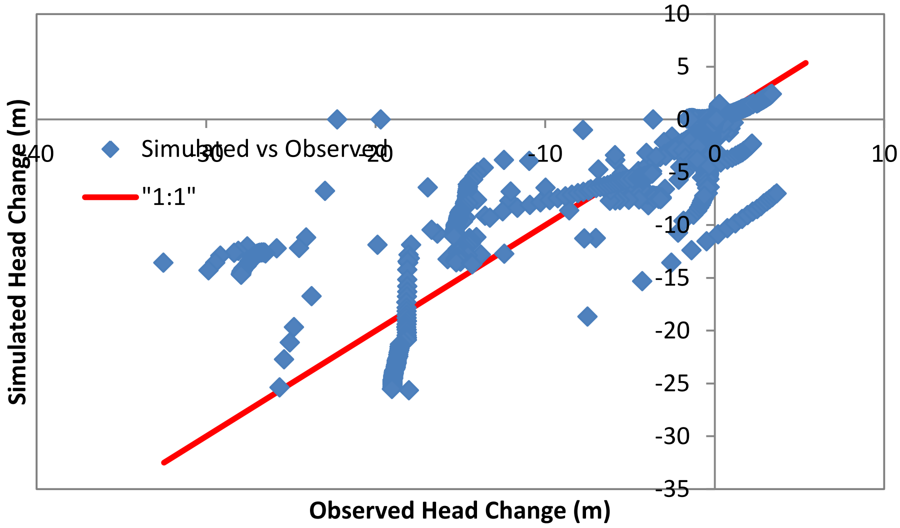


Figure B-3: Comparison of Simulated and Observed Head Changes for Deep Aquifer Calibration

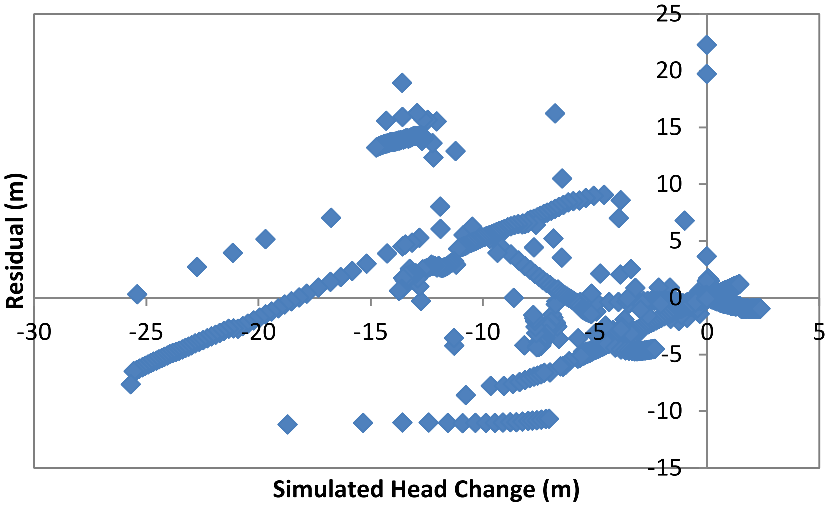


Figure B-4: Residual Distribution of Weighted Observations for Deep Aquifer Calibration

B.3 Trench Calibrations

Three trench tests were carried out on Sunshine Lake. The locations of the tests were shown in Figure 4-11. The lengths of the trenches were 42 m in the ESE, 44 m in the ENE and 11 m in the NE. Each was calibrated independently using the procedure described in Section 5.2.

B.3.1 ESE Trench (42 m)

The statistics for ESE Trench calibration are listed in Table B-4. This shows a reasonable result from the calibration with the SRMS error being 9.9%, just less than the 10% suggested by the AGMG (Barnett et al., 2011).

Figure 5-10 showed hydrographs comparing observed and simulated heads. Figure B-5 shows the comparison for individual depths. Figure B-6 shows the residuals versus the simulated values. There are a number of trends evident in the residuals plot however these are consistent with the data being from aquifer testing. The results of the comparison indicate the model is well calibrated at this location.

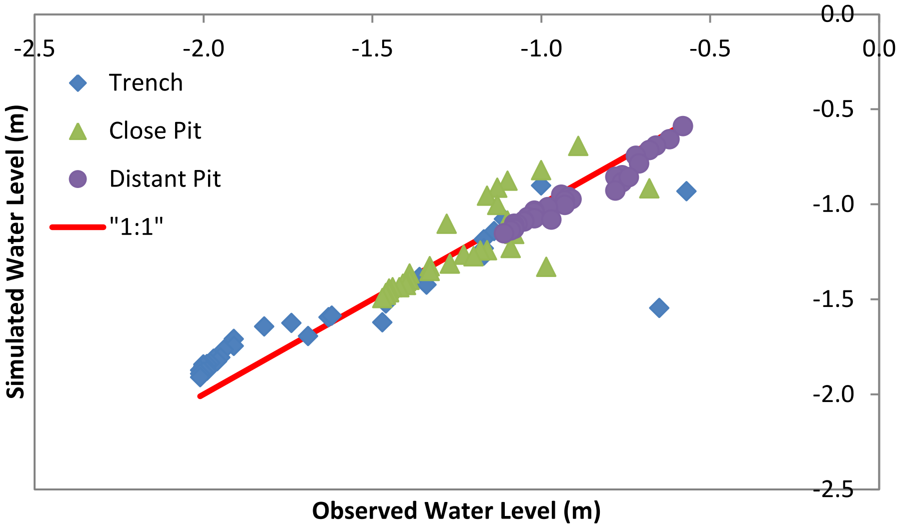


Figure B-5: Comparison of Simulated and Observed Head Changes for ESE Trench

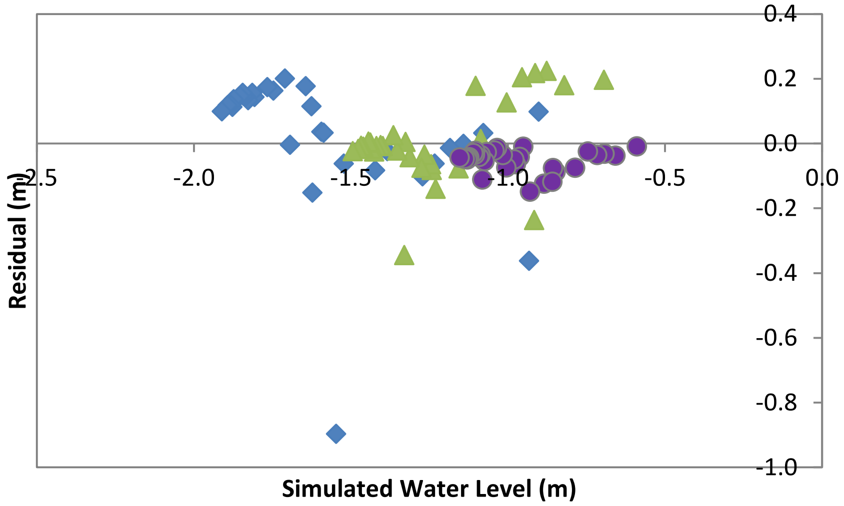


Figure B-6: Residual Distribution of Weighted Observations for ESE Trench Calibration

Table B-4: ESE Trench Calibration Statistics

Quantity	Value	Unit
Count	96	
Minimum Observed	-2.01	m
Maximum Observed	-0.57	m
Minimum Simulated	-1.91	m
Maximum Simulated	-0.59	m
SR: Sum of Residuals	8.71	m
MSR: Mean SR	-0.01	m
SMSR: Scaled MSR	-0.49	%
SSQ: Sum of Squares of Residuals	1.96	m^2
MSSQ: Mean SSQ	0.02	m^2
RMS: square root(MSSQ)	0.14	m
RMFS: Root Mean Fraction Square	11.6	%
SRFMS: Scaled RMFS	-10.1	%
SRMS: Scaled RMS	9.93	%
CoD: Coefficient of Determination	1.37	
r: Correlation Coefficient	0.94	
N-S epsilon	0.87	

B.3.2 ENE Trench (44 m)

The statistics for ENE Trench calibration are listed in Table B-5. This shows a reasonable result from the calibration with the SRMS error being 14%, which is slightly greater than the 10% suggested by the AGMG (Barnett et al., 2011). Figure 5-11 compared the observed and simulated hydrographs at the site, and Figures B-7 and B-8 show comparisons of the observed and simulated results, and distribution of residuals respectively. The greatest discrepancies between the observations and simulation occurred in the trench, particularly associated with the lowest water levels. Low water levels close to the base of the trench may not be simulated accurately in the model as it assumes the trench is a rectangular prism cut into the lake sediments. Low water levels may not be accurately simulated due to the unevenness of the basal elevations and potential slumping dividing the trench into separate water bodies. In terms of the calibration, this may lead to an underestimate of the hydraulic conductivity and the specific yield.

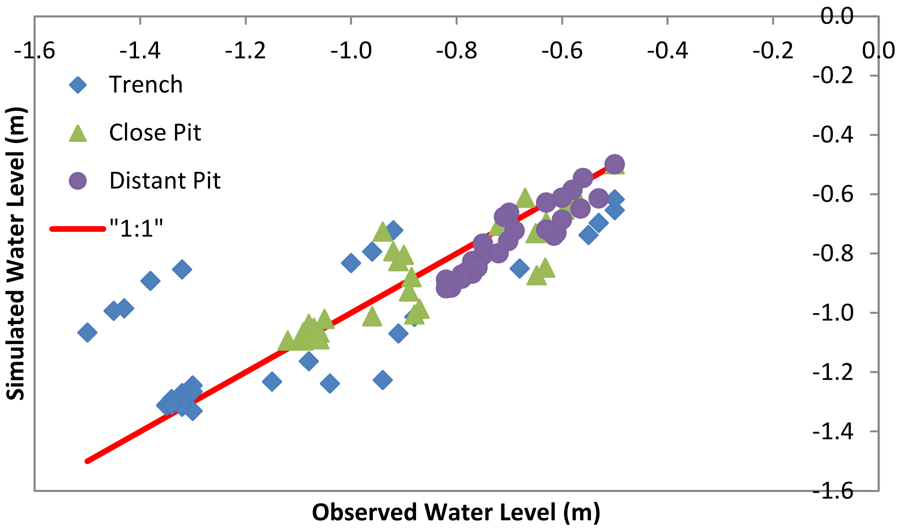


Figure B-7: Comparison of Simulated and Observed Head Changes for ENE Trench

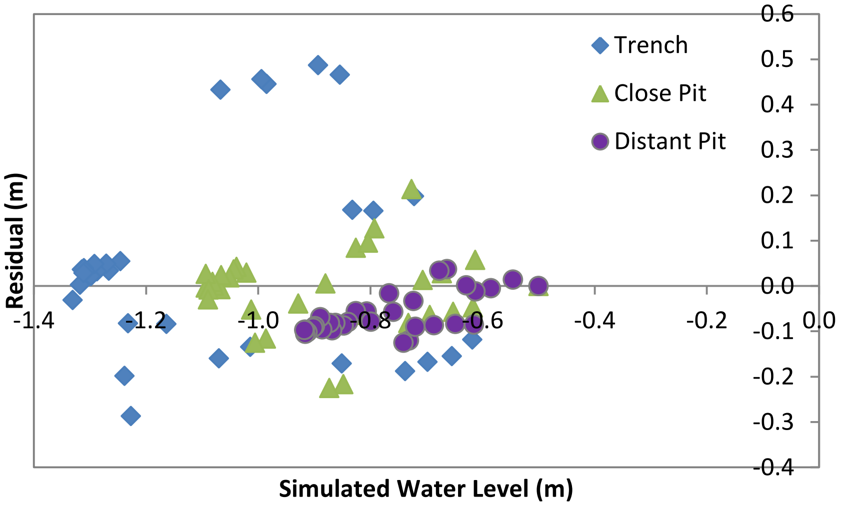


Figure B-8: Residual Distribution of Weighted Observations for ENE Trench Calibration

Table B-5: ENE Trench Calibration Statistics

Quantity	Value	Unit
Count	96	
Minimum Observed	-1.50	m
Maximum Observed	-0.50	m
Minimum Simulated	-1.33	m
Maximum Simulated	-0.50	m
SR: Sum of Residuals	9.09	m
MSR: Mean SR	-0.01	m
SMSR: Scaled MSR	-0.94	%
SSQ: Sum of Squares of Residuals	1.90	m^2
MSSQ: Mean SSQ	0.02	m^2
RMS: square root(MSSQ)	0.14	m
RMFS: Root Mean Fraction Square	15.75	%
SRFMS: Scaled RMFS	-14.09	%
SRMS: Scaled RMS	14.05	%
CoD: Coefficient of Determination	1.48	
r: Correlation Coefficient	0.86	
N-S epsilon	0.73	

B.3.3 NE Trench (11 m)

The statistics for NE Trench calibration are listed in Table B-6. This shows potential problems with the calibration as the SRMS error is 27%, which is substantially greater than the 10% suggested by the AGMG (Barnett et al., 2011). Figure 5-11 compared the observed and simulated hydrographs at the site, and Figures B-9 and B-10 show comparisons of the observed and simulated results, and distribution of residuals respectively. The greatest discrepancies between the observations and simulation occurred in the trench, and were again associated with the lowest water levels. Low water levels close to the base of the trench may not be simulated accurately in the model as it assumes the trench is a rectangular prism cut into the lake sediments. Low water levels may not be accurately simulated due to the unevenness of the basal elevations and potential slumping dividing the trench into separate water bodies. For this relatively short trench these effects may cause major differences between observed and simulated water levels in the trench. In terms of the calibration, this may lead to an underestimate of the hydraulic conductivity and the specific yield. The water level changes in the observation pits were comparable and this provided confidence in the model calibration.

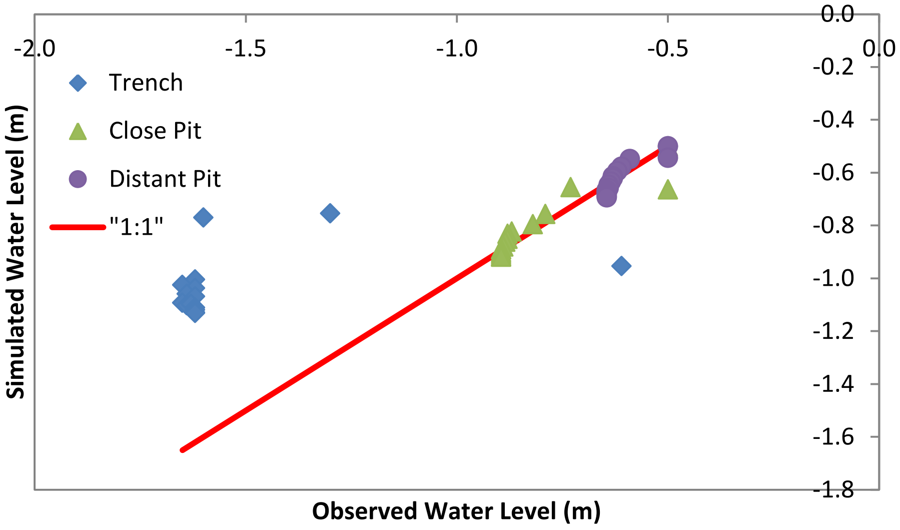


Figure B-9: Comparison of Simulated and Observed Head Changes for NE Trench

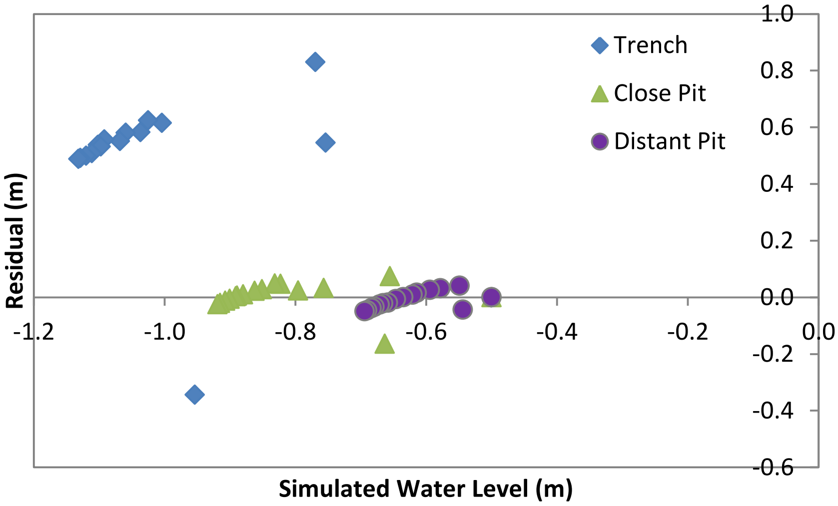


Figure B-10: Residual Distribution of Weighted Observations for NE Trench Calibration

Table B-6: NE Trench Calibration Statistics

Quantity	Value	Unit
Count	48	
Minimum Observed	-1.65	m
Maximum Observed	-0.50	m
Minimum Simulated	-1.13	m
Maximum Simulated	-0.50	m
SR: Sum of Residuals	9.22	m
MSR: Mean SR	0.16	m
SMSR: Scaled MSR	13.62	%
SSQ: Sum of Squares of Residuals	4.78	m^2
MSSQ: Mean SSQ	0.10	m^2
RMS: square root(MSSQ)	0.32	m
RMFS: Root Mean Fraction Square	32.57	%
SRFMS: Scaled RMFS	-27.46	%
SRMS: Scaled RMS	27.45	%
CoD: Coefficient of Determination	2.91	
r: Correlation Coefficient	0.87	
N-S epsilon	0.45	

Appendix E Chemical Analysis

Assays and Drill Hole Details

(A) Drill Hole Assays

Sample ID	Point Reference	Location	Easting	Northing	RL (m)	Description	Depth	Representative Aquifer	Dip	Azimuth	Assay					
											Ca	Mg	Na	K	Cl	SO4
											mg/L					
SDHTM - 08 (48 m)	SDHTM08	10 Mile	230359	7259357	560	Drilling	48	Bedrock	-90	0	745	5,585	53,350	7,850	89,150	23,397
SDHTM - 08 #1 (0 m)	SDHTM08	10 Mile	228257	7260913	560	Drilling	0	Surficial	-90	0	737	5,450	51,250	7,780	88,000	23,367
SDHTM - 08 #10 (27 m)	SDHTM08	10 Mile	230359	7259357	560	Drilling	27	Bedrock	-90	0	742	5,430	54,100	7,640	88,000	23,068
SDHTM - 08 #11 (30 m)	SDHTM08	10 Mile	230359	7259357	560	Drilling	30	Bedrock	-90	0	763	5,600	54,800	7,900	88,000	23,936
SDHTM - 08 #12 (33 m)	SDHTM08	10 Mile	230359	7259357	560	Drilling	33	Bedrock	-90	0	766	5,590	53,800	7,860	88,300	23,397
SDHTM - 08 #13 (36 m)	SDHTM08	10 Mile	230359	7259357	560	Drilling	36	Bedrock	-90	0	745	5,585	51,500	7,670	88,150	22,993
SDHTM - 08 #14 (39 m)	SDHTM08	10 Mile	230359	7259357	560	Drilling	39	Bedrock	-90	0	760	5,550	53,600	7,780	88,200	23,457
SDHTM - 08 #15 (42 m)	SDHTM08	10 Mile	230359	7259357	560	Drilling	42	Bedrock	-90	0	748	5,570	53,300	7,820	87,800	23,217
SDHTM - 08 #16 (45 m)	SDHTM08	10 Mile	230359	7259357	560	Drilling	45	Bedrock	-90	0	752	5,640	54,600	7,940	89,600	23,457
SDHTM - 08 #2 (3 m)	SDHTM08	10 Mile	230359	7259357	560	Drilling	3	Surficial	-90	0	746	5,540	51,800	7,800	88,900	23,068
SDHTM - 08 #3 (6 m)	SDHTM08	10 Mile	230359	7259357	560	Drilling	6	Surficial	-90	0	742	5,510	52,800	7,780	90,400	23,098
SDHTM - 08 #4 (9 m)	SDHTM08	10 Mile	230359	7259357	560	Drilling	9	Surficial	-90	0	735	5,480	52,900	7,760	89,200	23,128
SDHTM - 08 #5 (12 m)	SDHTM08	10 Mile	230359	7259357	560	Drilling	12	Surficial	-90	0	731	5,370	51,800	7,630	88,000	22,858
SDHTM - 08 #6 (15 m)	SDHTM08	10 Mile	230359	7259357	560	Drilling	15	Surficial	-90	0	746	5,380	50,600	7,550	87,100	22,798
SDHTM - 08 #7 (18 m)	SDHTM08	10 Mile	230359	7259357	560	Drilling	18	Clay	-90	0	758	5,430	51,900	7,670	86,900	22,858
SDHTM - 08 #8 (21 m)	SDHTM08	10 Mile	230359	7259357	560	Drilling	21	Bedrock	-90	0	758	5,480	52,600	7,700	86,900	23,367
SDHTM - 08 #9 (24 m)	SDHTM08	10 Mile	230359	7259357	560	Drilling	24	Bedrock	-90	0	735	5,340	53,700	7,540	86,900	22,948
TMAC 06 2dm	TMAC06	10 Mile	233139	7256566	538.147	Drilling	42	Surficial	-90	0	737	6330	50100	6030	85900	21600
TMAC 06 75m Fx	TMAC06	10 Mile	233139	7256566	538.147	Drilling	75	Basal Sand	-90	0	453	9370	78300	9990	136000	30300
TMAC 06-62m	TMAC06	10 Mile	233139	7256566	538.147	Drilling	62	Clay	-90	0	762	6050	47900	6050	85100	21700
TMAC9-39	TMAC09	10 Mile	232951	7251176	538.147	Drilling	39	Surficial	-90	0	831	2490	19300	2400	32000	31800
TMAC 11-77	TMAC11	10 Mile	230975	7253145	538.147	Drilling	77	Clay	-90	0	427	9050	80900	11200	140000	32400
TMAC 11-79	TMAC11	10 Mile	230975	7253145	538.147	Drilling	79	Bedrock	-90	0	416	9060	81900	11300	139000	25400
TMAC 12-72	TMAC11	10 Mile	233485	7256791	538.147	Drilling	72	Clay	-90	0	519	7130	66900	9070	120000	27300
TMAC 12-84	TMAC12	10 Mile	233485	7256791	538.147	Drilling	84	Basal Sand	-90	0	514	7630	70200	9290	121000	18800
TMAC 13 78m	TMAC13	10 Mile	233486	7256939	538.147	Drilling	78	Basal Sand	-90	0	641	5560	47000	6200	82300	18700
TMAC 13 78m Rpt	TMAC13	10 Mile	233486	7256939	538.147	Drilling	78	Basal Sand	-90	0	638	5560	47200	6200	82400	16300
TMAC 13 16m	TMAC13	10 Mile	233486	7256939	538.147	Drilling	16	Surficial	-90	0	634	4640	40100	5120	68500	16200
TMAC 13 16m Rpt	TMAC13	10 Mile	233486	7256939	538.147	Drilling	16	Surficial	-90	0	637	4600	40400	5130	68200	27000
TMAC 13-72	TMAC13	10 Mile	233486	7256939	538.147	Drilling	72	Clay	-90	0	518	7270	68400	9220	121000	27800
TMAC 13-84	TMAC13	10 Mile	233486	7256939	538.147	Drilling	84	Bedrock	-90	0	523	7820	70000	9260	123000	27600
TMAC 13-84 Rpt	TMAC13	10 Mile	233486	7256939	538.147	Drilling	84	Bedrock	-90	0	519	7780	69800	9200	123000	26300
TMAC 14A-72	TMAC14	10 Mile	233453	7257458	538.147	Drilling	72	Basal Sand	-90	0	519	7180	68300	9200	118000	27300
TMAC 14A-75	TMAC14	10 Mile	233453	7257458	538.147	Drilling	75	Basal Sand	-90	0	500	7590	68900	9200	121000	23500
TMAC15-17	TMAC15	10 Mile	235752	7257213	538.147	Drilling	17	Surficial	-90	0	400	645	7500	1190	12950	12800
TMAC15-17 Rpt	TMAC15	10 Mile	235752	7257213	538.147	Drilling	17	Surficial	-90	0	410	640	7490	1190	12950	12600
TMAC15-71	TMAC15	10 Mile	235752	7257213	538.147	Drilling	71	Bedrock	-90	0	519	6430	57600	7730	103400	2610

Appendix 3.01 - Assays and Details

Sample ID	Point Reference	Location	Easting	Northing	RL (m)	Description	Depth	Representative Aquifer	Dip	Azimuth	Assay					
											Ca	Mg	Na	K	Cl	SO4
											mg/L					
TMAC15-78	TMAC15	10 Mile	235752	7257213	538.147	Drilling	78	Bedrock	-90	0	541	6600	61300	8340	108300	2640
TMAC16-71	TMAC16	10 Mile	232062	7254489	538.147	Drilling	71	Bedrock	-90	0	493	7880	66800	7880	117500	23200
TMAC 21-59	TMAC21	10 Mile	233892	7253504	538.147	Drilling	59	Bedrock	-90	0	589	6930	56600	7300	99300	23900
TMAC 21-61	TMAC21	10 Mile	233892	7253504	538.147	Drilling	61	Bedrock	-90	0	890	3430	30000	3840	52700	28800
TMAC 21-61 Rpt	TMAC21	10 Mile	233892	7253504	538.147	Drilling	61	Bedrock	-90	0	883	3420	29400	3810	52800	30300
TMAC22-65	TMAC22	10 Mile	230516	7254836	538.147	Drilling	65	Clay	-90	0	392	9160	81900	11300	144000	30300
TMAC22-65 Rpt	TMAC22	10 Mile	230516	7254836	538.147	Drilling	65	Clay	-90	0	393	9210	81700	11300	144000	30300
TMAC22-77	TMAC22	10 Mile	230516	7254836	538.147	Drilling	77	Bedrock	-90	0	400	9050	82100	11400	144000	30000
TMAC22-79	TMAC22	10 Mile	230516	7254836	538.147	Drilling	79	Bedrock	-90	0	391	9050	82400	11500	146000	630
TMAC23-29	TMAC23	10 Mile	230934	7253523	538.147	Drilling	29	Surficial	-90	0	126	165	940	140	1500	21700
TMAC23-82	TMAC23	10 Mile	230934	7253523	538.147	Drilling	82	Bedrock	-90	0	320	6180	55900	7550	96700	13100
TMAC24 M 1	TMAC24M1	10 Mile	231840	7251994	538.147	Re-development	58.7	Bedrock	-90	0	751	3180	25300	2940	40300	18000
TMAC24 M 2	TMAC24M2	10 Mile	231840	7251994	538.147	Re-development	58.7	Surficial	-90	0	745	4480	33100	3960	55450	18300
TMAC26-64	TMAC26	10 Mile	232825	7253032	538.147	Drilling	64	Bedrock	-90	0	808	5070	39800	5390	72050	17900
TMAC26-64 Rpt	TMAC26	10 Mile	232825	7253032	538.147	Drilling	64	Bedrock	-90	0	813	5020	39800	5370	71700	24900
TMAC27-69	TMAC27	10 Mile	229050	7258970	538.147	Drilling	69	Bedrock	-90	0	520	6360	61800	8810	104350	25200
TMAC28-74	TMAC28	10 Mile	231526	7258961	538.147	Drilling	74	Bedrock	-90	0	469	6450	60300	8310	103800	25100
TMAC28-74 Rpt	TMAC28	10 Mile	231526	7258961	538.147	Drilling	74	Bedrock	-90	0	473	6430	60900	8380	104150	1020
TMAC30 at 24m	TMAC30	10 Mile	236365	7258144	538.147	Drilling	24	Surficial	-90	0	59	345	4450	770	7700	9780
WB10	WB10	10 Mile	233468	7257249	538.147	Airlift development	72	Basal Sand	-90	0	700	4530	41900	5700	43800	13400
WB10 Air Lift 2	WB10	10 Mile	233468	7257249	538.147	Airlift development	72	Basal Sand	-90	0	557	7200	64600	8630	72,000	134300
WB11 TB2	WB11	10 Mile	233540	7255533	538.147	Airlift development	91	Surficial	-90	0	803	4560	37000	4480	108,000	25080
WB11 MB01	WB11MBI	10 Mile	233539	7255526	538.147	Re-development	91	Upper Sand	-90	0	716	5900	43600	5100	61,200	20200
WB11 TB01	WB11TB01	10 Mile	233559	7255517	560.144	Re-development	91	Surficial	-90	0	877	4880	39000	4560	72650	16800
WB12 1 hr	WB12	10 Mile	233894	7253901	538.147	Airlift development		Surficial	-90	0	989	4300	37000	4540	64600	117900
WB12 3 hr	WB12	10 Mile	233894	7253901	538.147	Airlift development		Basal Sand	-90	0	668	6805	51700	6205	61,500	116400
WB12 I	WB12	10 Mile	233894	7253901	538.147	Airlift development		Clay	-90	0	940	4150	35700	4400	86,500	163100
WB13	WB13	10 Mile	236154	7257232	538.147	Airlift development		Bedrock	-90	0	686	7320	57100	7755	61,000	115400
SDHB - 3 #1 (1.5 m)	SDHB3	Beyondie	223400	7259044	559	Drilling	1.5	Bedrock	-90	0	530	6,440	69,400	11,000	400	176750
SDHB - 3 #16 (51 m)	SDHB3	Beyondie	223400	7259044	559	Drilling	51	Bedrock	-90	0	545	6,590	69,200	10,900	119,000	24,596
SDHB - 3 #19 (60 m)	SDHB3	Beyondie	223400	7259044	559	Drilling	60	Bedrock	-90	0	565	6,500	69,800	11,200	125,000	25,554
SDHB - 3 #3 (9 m)	SDHB3	Beyondie	223400	7259044	559	Drilling	9	Bedrock	-90	0	520	6,460	68,000	10,900	125,000	25,315
SDHB - 3 #4 (12 m)	SDHB3	Beyondie	223400	7259044	559	Drilling	12	Bedrock	-90	0	525	6,350	66,800	10,800	122,000	24,326
SDHB - 3 #5 (15 m)	SDHB3	Beyondie	223400	7259044	559	Drilling	15	Bedrock	-90	0	525	6,390	66,200	10,800	126,000	24,626
SDHB - 3 #6 (18 m)	SDHB3	Beyondie	223400	7259044	559	Drilling	18	Bedrock	-90	0	525	6,610	66,500	10,900	125,000	24,835
SDHB - 3 #7 (21 m)	SDHB3	Beyondie	223400	7259044	559	Drilling	21	Bedrock	-90	0	525	6,370	65,700	10,800	125,000	25,015
SDHB - 4 #1 (3 m)	SDHB4	Beyondie	223400	7259044	559	Drilling	3	Surficial	-90	0	860	4,650	45,200	6,300	123,000	24,566

Appendix 3.01 - Assays and Details

Sample ID	Point Reference	Location	Easting	Northing	RL (m)	Description	Depth	Representative Aquifer	Dip	Azimuth	Assay					
											Ca	Mg	Na	K	Cl	SO4
											mg/L					
SDHB - 4 #2 (2 m)	SDHB4	Beyondie	225891	7260242	560	Drilling	2	Surficial	-90	0	870	4,720	45,800	6,280	78,200	18,214
SDHB - 4 #3 (9 m)	SDHB4	Beyondie	225891	7260242	560	Drilling	9	Surficial	-90	0	845	4,520	44,400	6,170	78,700	18,963
SDHB - 4 #4 (12 m)	SDHB4	Beyondie	225891	7260242	560	Drilling	12	Bedrock	-90	0	858	4,590	43,400	6,210	78,700	17,675
SDHB - 4 #5 (15 m)	SDHB4	Beyondie	225891	7260242	560	Drilling	15	Bedrock	-90	0	835	4,590	44,800	6,080	79,050	18,005
SDHB - 4 #6 (18 m)	SDHB4	Beyondie	225891	7260242	560	Drilling	18	Bedrock	-90	0	840	4,810	45,900	6,270	79,400	17,885
SDHB - 4 #7 (21 m)	SDHB4	Beyondie	225891	7260242	560	Drilling	21	Bedrock	-90	0	820	4,540	44,600	6,130	80,400	18,724
SDHB - 5 #1 (1 m)	SDHB5	Beyondie	225891	7260242	560	Drilling	1	Surficial	-90	0	565	7,660	59,100	9,500	79,800	18,155
SDHB - 5 #2 (2 m)	SDHB5	Beyondie	224874	7259474	559	Drilling	2	Surficial	-90	0	580	7,890	58,800	9,600	109,000	28,880
SDHB - 5 #3 (9 m)	SDHB5	Beyondie	224874	7259474	559	Drilling	9	Surficial	-90	0	560	7,200	60,100	9,440	110,000	29,209
SDHB - 5 #4 (12 m)	SDHB5	Beyondie	224874	7259474	559	Drilling	12	Surficial	-90	0	560	7,600	61,800	9,440	112,000	26,962
SDHB - 5 #5 (15 m)	SDHB5	Beyondie	224874	7259474	559	Drilling	15	Bedrock	-90	0	565	7,780	63,000	9,740	112,000	29,898
SDHB - 5 #6 (15 m)	SDHB5	Beyondie	224874	7259474	559	Drilling	15	Bedrock	-90	0	575	7,940	65,600	10,000	110,000	30,857
SDHB - 5 #7 (18 m)	SDHB5	Beyondie	224874	7259474	559	Drilling	18	Bedrock	-90	0	535	7,710	64,100	9,900	114,000	30,557
SDHB - 5 #8 (21 m)	SDHB5	Beyondie	224874	7259474	559	Drilling	21	Bedrock	-90	0	545	8,220	65,200	10,100	115,000	29,658
SDHB - 5 #9 (27 m)	SDHB5	Beyondie	224874	7259474	559	Drilling	27	Bedrock	-90	0	545	7,760	62,400	9,950	115,000	31,156
SDHB - 6 #1 (3 m)	SDHB6	Beyondie	224874	7259474	559	Drilling	3	Surficial	-90	0	880	4,310	45,700	6,690	118,000	29,359
SDHB - 6 #2 (6 m)	SDHB6	Beyondie	227305	7259097	560	Drilling	6	Surficial	-90	0	870	4,240	45,200	6,590	79,100	17,645
SDHB - 6 #3 (9 m)	SDHB6	Beyondie	227305	7259097	560	Drilling	9	Surficial	-90	0	870	4,270	45,350	6,585	78,500	17,286
SDHB - 6 #4 (12 m)	SDHB6	Beyondie	227305	7259097	560	Drilling	12	Surficial	-90	0	855	4,250	43,400	6,560	79,400	17,406
SDHB - 6 #5 (15 m)	SDHB6	Beyondie	227305	7259097	560	Drilling	15	Bedrock	-90	0	860	4,360	44,600	6,710	78,000	17,046
SDHB - 6 #6 (18 m)	SDHB6	Beyondie	227305	7259097	560	Drilling	18	Bedrock	-90	0	850	4,290	45,800	6,610	79,900	17,166
SDHB - 6 #7 (21 m)	SDHB6	Beyondie	227305	7259097	560	Drilling	21	Bedrock	-90	0	860	4,580	46,600	7,010	79,500	17,525
SDHB - 7 #1 (3 m)	SDHB7	Beyondie	227305	7259097	560	Drilling	3	Surficial	-90	0	905	3,990	39,400	5,190	83,100	17,615
SDHB - 7 #10 (30 m)	SDHB7	Beyondie	228257	7260913	560	Drilling	30	Bedrock	-90	0	915	4,060	38,100	5,240	66,200	15,968
SDHB - 7 #11 (33 m)	SDHB7	Beyondie	228257	7260913	560	Drilling	33	Bedrock	-90	0	910	4,030	37,900	5,210	66,200	16,177
SDHB - 7 #2 (6 m)	SDHB7	Beyondie	227305	7259097	560	Drilling	6	Surficial	-90	0	915	4,020	38,900	5,190	66,200	15,608
SDHB - 7 #3 (9 m)	SDHB7	Beyondie	228257	7260913	560	Drilling	9	Surficial	-90	0	905	4,020	38,900	5,180	66,800	15,758
SDHB - 7 #4 (12 m)	SDHB7	Beyondie	228257	7260913	560	Drilling	12	Surficial	-90	0	915	4,020	39,000	5,170	64,600	15,548
SDHB - 7 #5 (15 m)	SDHB7	Beyondie	228257	7260913	560	Drilling	15	Bedrock	-90	0	930	3,990	38,100	5,200	65,900	15,938
SDHB - 7 #6 (18 m)	SDHB7	Beyondie	228257	7260913	560	Drilling	18	Bedrock	-90	0	940	4,020	39,200	5,300	66,900	16,058
SDHB - 7 #7 (21 m)	SDHB7	Beyondie	228257	7260913	560	Drilling	21	Bedrock	-90	0	940	4,030	38,600	5,260	65,700	15,998
SDHB - 7 #8 (24 m)	SDHB7	Beyondie	228257	7260913	560	Drilling	24	Bedrock	-90	0	940	4,100	38,700	5,330	65,800	16,117
SDHB - 7 #9 (27 m)	SDHB7	Beyondie	228257	7260913	560	Drilling	27	Bedrock	-90	0	950	4,140	39,300	5,360	66,400	16,177
SS01 140m	SSAC01	Sunshine	242989	7266582	543.466	Drilling	140	Bedrock	-90	0	635	5790	57400	6780	80,650	16,327
SS01 90m	SSAC01	Sunshine	242989	7266582	543.466	Drilling	90	Bedrock	-90	0	244	1610	15300	1800	96600	20700
SS01 90m Rpt	SSAC01	Sunshine	242989	7266582	543.466	Drilling	90	Bedrock	-90	0	243	1590	15300	1800	25550	5250
SSAC01 at 18m	SSAC01	Sunshine	242989	7266582	543.466	Drilling	18	Surficial	-90	0	86	405	4050	520	25400	5310
SSAC01 at 18m Rpt	SSAC01	Sunshine	242989	7266582	543.466	Drilling	18	Surficial	-90	0	88	410	4090	540	6950	1320

Appendix 3.01 - Assays and Details

Sample ID	Point Reference	Location	Easting	Northing	RL (m)	Description	Depth	Representative Aquifer	Dip	Azimuth	Assay					
											Ca	Mg	Na	K	Cl	SO4
											mg/L					
SSAC01 at 36m	SSAC01	Sunshine	242989	7266582	543.466	Drilling	36	Clay	-90	0	55	200	2130	300	7000	1350
SSAC06 at 53m	SSAC06	Sunshine	249574	7268965	545.419	Drilling	53	Bedrock	-90	0	366	5030	48400	4780	3450	660
SSAC13_41	SSAC13	Sunshine	258504	7271068	540.269	Drilling	41	Clay	-90	0	392	4390	43600	3580	83150	16900
SSAC13_59	SSAC13	Sunshine	258504	7271068	540.269	Drilling	59	Bedrock	-90	0	392	4320	42600	3530	74050	11500
SSAC14 at 47m	SSAC14	Sunshine	257922	7274721	535.675	Drilling	47	Bedrock	-90	0	585	6480	73700	6990	73350	11500
SSAC15 at 24m	SSAC15	Sunshine	257617	7275041	533.035	Drilling	24	Surficial	-90	0	505	6050	69200	6290	123950	19200
SSAC15 at 24m Rpt	SSAC15	Sunshine	257617	7275041	533.035	Drilling	24	Surficial	-90	0	511	6130	68900	6300	114350	19400
SSAC15 at 59m	SSAC15	Sunshine	257617	7275041	533.035	Drilling	59	Basal Sand	-90	0	702	5610	65700	6030	114150	19500
SSAC18_101	SSAC18	Sunshine	261062	7276002	540.47	Drilling	101	Bedrock	-90	0	755	5640	67100	6520	107000	17100
SSAC18_54	SSAC18	Sunshine	261062	7276002	540.47	Drilling	54	Basal Sand	-90	0	766	5580	66000	6530	112900	16500
SSAC18_54 Rpt	SSAC18	Sunshine	261062	7276002	540.47	Drilling	54	Clay	-90	0	768	5550	66200	6530	111500	16200
SSAC18_77	SSAC18	Sunshine	261062	7276002	540.47	Drilling	77	Basal Sand	-90	0	760	5590	66900	6550	111550	15900
SSAC19 at 47m	SSAC19	Sunshine	264078	7276655	537.967	Drilling	47	Clay	-90	0	652	4360	50200	4280	113450	16300
SSAC21-53	SSAC21	Sunshine	248414	7269423	541.115	Drilling	53	Basal Sand	-90	0	640	6000	51600	5240	82100	14000
SSAC22-24	SSAC22	Sunshine	248258	7269820	539.745	Drilling	24	Surficial	-90	0	1100	2780	23800	3270	88600	19300
SSAC22-37	SSAC22	Sunshine	248258	7269820	539.745	Drilling	37	Surficial	-90	0	1080	2800	24300	3300	44500	9450
SSAC41-53	SSAC25	Sunshine	255111	7272747	539.628	Drilling	53	Bedrock	-90	0	547	7560	76300	7470	43950	9360
SSAC42-37	SSAC42	Sunshine	249756	7269754	533.866	Drilling	37	Bedrock	-90	0	448	3740	33700	3680	132200	21500

Appendix 3.01 - Assays and Details

(B) Auger Hole Assays

Sample ID	Point Reference	Easting	Northing	RL (m)	Data Source	Aquifer	Sample Date	Drill Type	Dip	Azimuth	Down Hole Width (m)	Depth (m)	Assay					
													Ca	Mg	Na	K	Cl	SO4
													mg/L					
10 Mile	B1	230925	7255738	563	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	699	7180	57800	7660	120000	21504
10 Mile	B2	233648	7257946	563	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1080	2470	32100	5380	56100	11441
10 Mile	32	230000	7258500	563	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	785	4390	46700	7470	79500	19677
10 Mile	33	231000	7259500	565	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	816	4010	36700	5310	63300	18509
10 Mile	34	231000	7258500	561	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	776	4490	48400	8450	84400	19827
10 Mile	35	231000	7257500	562	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	463	6730	73000	11000	133000	26745
10 Mile	36	231000	7256500	562	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	513	6750	70800	10650	127000	26431
10 Mile	43	232000	7259500	564	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	936	4100	45100	7400	84000	15904
10 Mile	44	232000	7258500	563	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	839	3880	40000	6240	68500	17072
10 Mile	45	232000	7257500	563	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1000	2820	31300	4920	53400	12579
10 Mile	46	232000	7256500	561	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	537	7650	67200	10000	125000	24889
10 Mile	47	232000	7255500	564	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	832	5180	39100	5200	68400	18958
10 Mile	51	232000	7251500	564	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	932	3070	25200	3520	43300	14077
10 Mile	60	233000	7256500	563	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	860	4390	37700	4900	63500	16742
10 Mile	61	233000	7255500	563	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	853	5090	44200	5880	78800	17161
10 Mile	62	233000	7254500	563	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	877	4870	46300	6560	82300	16413
10 Mile	TML1	223799	7259792	561	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	457	7967	73701	11392	132800	32850
10 Mile	TMBH 1	226025	7255591	560	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	600	2660	21600	2910	35600	11084
10 Mile	TMBH 2	228521	7257319	561	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	635	2660	21700	2930	34800	11714
10 Mile	TME	233050	7252797	565	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	480	9300	75400	10400	147000	24026
10 Mile	TMW	222778	7253100	565	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	415	8760	79500	12800	144000	36848
10 Mile	H7	230375	7259340	564	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	903	2790	29400	4530	49300	13777
Aerodrome 1 Auger	Aerodrome 1	380000	7272500		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	544	6950	75300	8320	133500	22600
Aerodrome 2 Auger	Aerodrome 2	384000	7275500		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	654	7000	71600	7710	131950	17700
Aerodrome 3 Auger	Aerodrome 3	377000	7277500		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	652	7000	71400	7690	132450	17400
Aerodrome North 4 Auger	Aerodrome North 4	370000	7285500		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	1150	7760	47800	6000	96550	12600
Aerodrome	A1	378955	7276704	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	439	8610	82300	7960	138000	26326
Aerodrome	A2	377806	7275416	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	480	8590	88200	8420	148000	23511
Aerodrome	506	375378	7279311	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	398	8270	76200	9075	136000	21923
Aerodrome	508	376000	7278500	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	453	8500	85300	9220	153000	23271
Aerodrome	508 (1)	376000	7278500	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	459	8620	84300	9280	151000	22762
Aerodrome	513	376842	7278311	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	498	7710	82500	7580	143000	21594
Aerodrome	514	377000	7277500	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	461	8610	86100	9130	154000	22043
Aerodrome	519	377284	7276752	479	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	553	6515	78300	8795	135000	20156
Aerodrome	520	378000	7277500	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	458	7590	83900	7640	149000	22522
Aerodrome	527	379000	7275500	478	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	720	6000	63500	6740	113000	17431

Appendix 3.01 - Assays and Details

Sample ID	Point Reference	Easting	Northing	RL (m)	Data Source	Aquifer	Sample Date	Drill Type	Dip	Azimuth	Down Hole Width (m)	Depth (m)	Assay					
													Ca	Mg	Na	K	Cl	SO4
													mg/L					
Aerodrome	528	379000	7274500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	431	7870	81600	8510	149000	23301
Aerodrome	529	379000	7273500	481	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	401	8720	83500	9060	157000	23601
Aerodrome	530	379158	7272500	479	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	370	8190	88200	10300	161000	25757
Aerodrome	531	379189	7271563	481	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	561	7000	71800	7820	128000	20875
Aerodrome	532	379653	7276248	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	390	9580	84100	8260	150000	27494
Aerodrome	533	380000	7275500	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	415	9730	82500	7660	147000	26236
Aerodrome	534	380000	7274500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	916	5390	47600	4370	81500	15544
Aerodrome	535	380000	7273500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	535	7050	78000	7910	135000	20935
Aerodrome	536	380000	7272500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	578	6410	73600	7620	126000	21444
Aerodrome	538	380000	7271099	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	456	8515	83150	8000	147000	24290
Aerodrome	540	381095	7274996	478	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1050	4070	40100	3740	68400	12369
Aerodrome	541	381000	7274500	478	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	667	5880	70000	7460	116000	20097
Aerodrome	542 (1)	381000	7273500	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	567	5220	75100	7670	125000	22313
Aerodrome	542	381000	7273500	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	554	5100	75900	7740	125000	22223
Aerodrome	543	381000	7272500	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	588	6760	79500	8200	132000	21564
Aerodrome	544	381000	7271500	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	676	7020	68200	6920	117000	19228
Aerodrome	546	382000	7275500	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	717	6840	68300	6680	117000	19408
Aerodrome	546 (1)	382000	7275500	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	695	6880	69300	6750	118000	19003
Aerodrome	547	382000	7274500	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	663	6230	69900	7830	117000	20546
Aerodrome	548	382000	7273500	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	631	5720	73200	7370	123000	19737
Aerodrome	549	381874	7272595	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	778	7230	64400	5820	112000	17251
Aerodrome	550	381527	7271878	478	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	794	5580	48900	4230	81700	17311
Aerodrome	552	383000	7275500	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	631	6520	73700	7760	125000	20815
Aerodrome	553	383000	7274500	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	651	6220	72700	7850	126000	18869
Aerodrome	557	384000	7275500	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	529	9320	83400	7840	144000	22103
Aerodrome	559	383685	7273658	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	410	9640	78600	8890	137000	21923
Aerodrome	A	381187	7273011	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	564	6690	71600	7880	133000	21660
Aerodrome (NW)	A3	370281	7286454	483	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1290	5480	33200	3880	64800	10243
Aerodrome (NW)	A4	370831	7286573	485	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1070	5800	37500	4530	72600	11531
Aerodrome (NW)	461	368000	7286500	485	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1100	6470	39100	4420	80800	11890
Aerodrome (NW)	467	369000	7285500	483	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1160	6570	42900	5210	87800	11381
Aerodrome (NW)	467 (1)	369000	7285500	483	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1170	6640	43800	5320	89000	11531
Aerodrome (NW)	468	369347	7285288	483	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1360	5500	37300	4330	74500	10093
Aerodrome (NW)	469	369000	7286500	485	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1200	5710	38000	4610	74000	11052
Aerodrome (NW)	471	370701	7284847	484	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1230	5890	40200	4650	78200	10752
Aerodrome (NW)	479	370000	7285500	483	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1240	6050	37700	4640	74800	10692
Aerodrome (NW)	480	370063	7284847	484	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1220	5900	40300	4860	77600	11231
Aerodrome (NW)	488	370496	7287689	484	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1360	4750	28300	3340	57100	9105
Aerodrome (NW)	490	371000	7285500	483	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1270	5640	37500	4490	71700	10572

Appendix 3.01 - Assays and Details

Sample ID	Point Reference	Easting	Northing	RL (m)	Data Source	Aquifer	Sample Date	Drill Type	Dip	Azimuth	Down Hole Width (m)	Depth (m)	Assay					
													Ca	Mg	Na	K	Cl	SO4
													mg/L					
Aerodrome (NW)	491	371284	7285067	484	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1160	5430	36800	4060	68900	11800
Beyondie	B3	226163	7260513	563	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	604	2070	20700	3140	33500	10662
Beyondie	B4	223939	7260371	563	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1020	2950	26200	3530	47400	11351
Beyondie	B5	226314	7259540	563	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	959	2920	30400	4620	52300	13088
Beyondie	B6	227558	7259135	562	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	969	713	7590	1180	12500	4762
Beyondie	11	225000	7259500	563	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	790	2510	25400	3700	32700	12010
Beyondie	11 (1)	225000	7259500	563	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	747	2220	23100	3360	38800	10812
Beyondie	23	228000	7261500	566	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	862	3940	40100	6020	73600	16862
Beyondie	BL2	223597	7258770	561	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	510	6740	69800	10100	123000	23966
Beyondie	BL1	224311	7259754	561	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	567	7741	66291	8882	108300	29189
Beyondie Stream	BS1	217112	7257953	565	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	880	2225	21950	3130	40050	7310
Beyondie/10 Mile	N2	232811	7251800	563	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	959	2830	28200	4100	46600	12789
Beyondie/10 Mile	N4	224317	7258591	563	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	906	3800	35700	4980	59800	15993
Beyondie/10 Mile	N6	228003	7261488	565	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	870	4000	43500	6240	73500	17012
Beyondie/10 Mile	N7	233000	7253500	562	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	861	4560	41500	5570	71900	16712
Central (E)	EC1	357345	7270169	480	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	807	7070	39500	5400	73000	20785
Central (E)	425	354473	7281618	478	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	322	10500	79800	10900	141000	39534
Central (E)	426	354284	7281217	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	337	8520	78200	11300	131000	44326
Central (E)	427	354630	7280847	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	472	9940	66200	8350	120000	29052
Central (E)	429	353937	7278666	478	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	803	3920	22400	2630	40200	12729
Central (E)	430	354315	7277351	479	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	791	6220	37800	4500	68400	18449
Central (E)	430 (1)	354315	7277351	479	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	800	6290	37600	4500	67900	19018
Central (E)	431	354630	7279690	480	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	696	6040	51400	8300	93900	21894
Central (E)	434	357575	7271067	481	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	851	5780	33300	4700	63300	16622
Central (E)	436	352913	7277918	480	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	800	4880	29500	2980	52000	17311
Central (E)	442	358284	7271193	482	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	789	6230	37500	5200	67900	19498
Central (E)	443	359000	7270500	481	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	629	7365	46600	7620	86900	25592
Central (E)	443 (1)	359000	7270500	481	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	627	7350	47200	7630	87900	25038
Central (N)	PC6	335180	7292778	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	463	12000	74400	10100	155000	25554
Central (S)	PC8	336052	7281468	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	621	9710	82400	5400	163000	15518
Central (W)	WC1	335403	7281884	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1220	4750	31700	2570	59100	10902
Central (W)	WC2	336869	7282657	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	387	12000	93700	6360	173000	20965
Central (W)	WC3	334065	7292685	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1030	3840	25000	3770	44700	12429
Central (W)	WC4	335913	7293437	478	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	640	7380	49300	6260	93700	16892
Central (W)	WC5	337097	7291603	478	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1880	5780	32900	4310	70400	6679
Central (W)	WC6	336861	7290535	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1310	2880	17400	2240	34600	6020
Central (W)	WC7	339841	7280505	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	386	14800	83500	6820	166000	23870
Central (W)	319	329000	7282500	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1010	1440	8590	1330	16200	5541
Central (W)	320 (1)	328811	7281847	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1040	1560	10700	1300	20000	5900

Appendix 3.01 - Assays and Details

Sample ID	Point Reference	Easting	Northing	RL (m)	Data Source	Aquifer	Sample Date	Drill Type	Dip	Azimuth	Down Hole Width (m)	Depth (m)	Assay					
													Ca	Mg	Na	K	Cl	SO4
													mg/L					
Central (W)	320	328811	7281847	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1030	1570	10800	1290	20000	6080
Central (W)	321	329401	7284807	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	980	1500	10300	1420	18000	6319
Central (W)	323	330000	7283500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1085	3400	20650	3175	42300	9419
Central (W)	324	330000	7282500	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1100	3300	21300	2910	40800	9404
Central (W)	325	330622	7284902	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	966	4950	29100	3780	56500	13178
Central (W)	325 (1)	330622	7284902	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	961	5110	29000	3820	56700	13418
Central (W)	327	331000	7283500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	898	6150	40500	5760	80700	14705
Central (W)	328	330779	7283067	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	999	5510	34700	4850	68500	13148
Central (W)	329	332347	7284839	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	812	6940	41700	5420	82600	16682
Central (W)	330	332000	7284500	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	665	7500	49900	7070	98600	20486
Central (W)	331	332000	7283500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	966	5050	32200	4470	66400	12819
Central (W)	332	340412	7294346	479	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1580	2180	11700	1610	26600	4253
Central (W)	332 (1)	340412	7294346	479	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1550	2150	11600	1580	26600	4103
Central (W)	333	333063	7285217	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	773	5550	37200	4800	74600	16802
Central (W)	334	333000	7284500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	890	5090	31900	4730	65100	13987
Central (W)	335	333000	7283500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1010	5270	34900	4720	69100	12669
Central (W)	338	333158	7283036	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	917	4640	29200	3560	57300	13328
Central (W)	339	334126	7285185	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	722	5830	42500	5780	85400	17730
Central (W)	340	334000	7284500	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	930	4650	36800	5810	73400	12968
Central (W)	341	334000	7283500	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1110	4490	32500	3990	67800	10992
Central (W)	342 (1)	334000	7293500	479	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1070	4180	28300	3830	56100	11591
Central (W)	342	334000	7293500	479	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1080	4210	28800	3840	56200	11740
Central (W)	344	340333	7293548	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1570	2480	11700	1400	26800	4582
Central (W)	345	334252	7282784	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	908	6150	40100	4600	78300	16023
Central (W)	346	335000	7285500	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1100	4230	32400	4730	61200	12160
Central (W)	347	335000	7284500	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1240	3580	25100	2770	48600	9584
Central (W)	347 (1)	335000	7284500	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1230	3540	25300	2750	48300	9524
Central (W)	348	335000	7283500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	550	9610	76500	6640	146000	19378
Central (W)	349	335315	7282689	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1080	7740	48000	4280	95700	13238
Central (W)	351	335819	7281036	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	690	8990	80900	5090	153000	15185
Central (W)	352	335000	7293500	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	636	11200	62700	7790	125000	22822
Central (W)	353	335000	7292500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	416	12600	80200	11200	155000	27075
Central (W)	354	335032	7291752	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	468	10200	74200	10100	137000	29830
Central (W)	356	336000	7292500	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	545	13100	81800	12600	163000	19378
Central (W)	357	336000	7291500	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1600	6710	44600	5870	89000	8596
Central (W)	358	336000	7290500	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	660	2230	15100	2030	28100	5361
Central (W)	359	336819	7290004	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1320	6740	38500	4780	75600	11141
Central (W)	360	336630	7288847	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	636	12200	76600	10000	153000	17341
Central (W)	361	336158	7287343	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	873	8250	58600	7040	115000	15754

Appendix 3.01 - Assays and Details

Sample ID	Point Reference	Easting	Northing	RL (m)	Data Source	Aquifer	Sample Date	Drill Type	Dip	Azimuth	Down Hole Width (m)	Depth (m)	Assay					
													Ca	Mg	Na	K	Cl	SO4
													mg/L					
Central (W)	362	336189	7286185	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1070	5195	40000	5215	73400	14286
Central (W)	363	336000	7285500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1210	3930	33700	4100	58000	12369
Central (W)	364	336000	7284500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1250	5720	40400	3410	73500	12354
Central (W)	365	336000	7283500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	731	13100	64600	5790	128000	19917
Central (W)	366	336000	7282500	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	452	13400	98900	7240	178000	21894
Central (W)	367	336000	7281500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	714	9220	84600	5440	152000	16293
Central (W)	368	336000	7280500	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	330	17100	90900	7690	181000	24799
Central (W)	370	337000	7289500	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	622	10600	74100	9020	146000	17102
Central (W)	371	337000	7288500	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	554	13750	80850	9835	170000	15559
Central (W)	372	337000	7287500	477	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	700	13100	71700	10200	153000	13987
Central (W)	373	336779	7286343	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1030	7950	42800	4410	86500	13807
Central (W)	374	337000	7285500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	723	8580	59200	6390	115000	17850
Central (W)	374(1)	337000	7285500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	732	8790	60300	6500	115000	18210
Central (W)	375	337000	7284500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	490	11500	78200	6350	145000	23691
Central (W)	378	337000	7281500	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	588	9950	83000	5440	154000	16682
Central (W)	378 (1)	337000	7281500	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	585	9720	82400	5360	155000	16592
Central (W)	380	338544	7291363	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1880	6950	37300	4800	83100	6619
Central (W)	381	336370	7292311	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	673	11900	72000	9500	149000	15245
Central (W)	383	337905	7285248	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	915	7580	49000	4700	97200	14406
Central (W)	384	338000	7284500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1220	6000	35000	3080	67900	11171
Central (W)	385	337811	7283784	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	538	12100	73200	6090	145000	20097
Central (W)	386	337811	7282658	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1020	5870	30900	2300	61900	13208
Central (W)	387	337622	7282036	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	593	13400	71100	5710	146000	17910
Central (W)	388	338000	7280500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	565	10900	89400	5320	167000	15484
Central (W)	389	338095	7279784	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	582	12100	75500	5950	154000	16443
Central (W)	390	336141	7279666	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1260	6180	35700	2610	73900	9674
Central (W)	391	339544	7278949	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	384	14800	88300	5920	174000	20576
Central (W)	392	338811	7281343	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	590	8110	77300	5020	143000	16982
Central (W)	393	339000	7280500	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	553	9990	83300	5470	158000	16383
Central (W)	394	339284	7280036	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	418	12100	90200	6090	174000	19228
Central (W)	398	340000	7279500	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	728	8800	71200	4560	133000	15634
Central (W)	398 (1)	340000	7279500	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	703	8930	70300	4640	135000	15634
Central (W)	399	340000	7278500	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	440	12100	94800	5810	177000	17910
Central (W)	400	339937	7277973	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	407	13700	94200	5620	180000	18869
Central (W)	401	341378	7281059	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	681	9160	68900	4650	129000	17551
Central (W)	402	341000	7280500	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	696	8810	76700	4950	137000	16053
Central (W)	403	341000	7279500	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	237	20600	90900	9850	191000	31448
Central (W)	404	341000	7278500	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	622	10000	84600	5250	154000	15963
Central (W)	408	342189	7282059	474	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	649	9900	74700	4880	138000	17641

Appendix 3.01 - Assays and Details

Sample ID	Point Reference	Easting	Northing	RL (m)	Data Source	Aquifer	Sample Date	Drill Type	Dip	Azimuth	Down Hole Width (m)	Depth (m)	Assay					
													Ca	Mg	Na	K	Cl	SO4
													mg/L					
Central (W)	409	342000	7281500	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	714	9650	69600	4590	133000	16263
Central (W)	410	342000	7280500	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	491	13000	79900	5500	155000	20636
Central (W)	411	342000	7279500	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	612	9720	80800	4810	149000	16503
Central (W)	412	342000	7278500	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	363	14400	94400	5980	181000	21265
Central (W)	420	341622	7278036	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	380	15650	92850	5860	181000	21115
Central (W)	422	342811	7282217	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1001	5995	38200	3095	72100	13612
Central (W)	422 (1)	342811	7282217	476	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1020	6000	39100	3100	69300	13627
Central (W)	423	342685	7280689	475	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	601	10200	78900	4960	146000	17341
Central (W)	424	342559	7279752	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	431	13400	80800	5560	157000	21654
Central (W)	379	337000	7280500	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	973	8130	52800	3595	96300	14032
Central (W)	PC7	333703	7284444	473	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	550	11000	65300	9900	139000	22229
Central 1 Auger	Central 1	335000	7292500		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	418	12700	82100	11600	161750	22900
Central 2 Auger	Central 2	337000	7288500		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	676	13500	77900	10200	161200	13600
Central 3 Auger	Central 3	337000	7284500		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	551	10800	76600	6530	150350	18300
Central 3 Auger Rpt	Central 3	337000	7284500		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	555	11000	75400	6500	149800	18700
Central 3 Dup Auger	Central 3	337000	7284500		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	576	11000	78300	6750	149300	18900
Central 4 Auger	Central 4	333703	7284444		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	485	11500	71900	11400	141950	25300
Central 4 Dup Auger	Central 4	333703	7284444		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	481	11500	71000	11500	141750	25600
Central 5 Auger	Central 5	338000	7280500		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	664	8850	78300	5140	146300	15400
Central 6 Auger	Central 6	341000	7279500		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	633	9670	79500	5200	150700	16200
Central North 1 Auger	Central North 1	340333	7293548		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	412	12600	80900	11500	161050	22900
Diamond Pit 1 (10 mile South)	Diamond Pit				2017_Auger	Surficial		Auger	-90	0	0.25	2	60	115	360	230	650	-10
Lake Wilderness 1 Auger	Lake Wilderness 1	310000	7312500		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	746	9030	58400	7330	111250	18800
Lake Wilderness 1 Auger Rpt	Lake Wilderness 1	310000	7312500		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	737	8950	58000	7260	111250	18900
Lake Wilderness 2 Auger	Lake Wilderness 2	312000	7311500		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	776	8300	57000	7770	110200	16400
Lake Wilderness South 2 Auger	Lake Wilderness South 2	305633	7310032		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	1170	3660	28700	3740	53600	10200
North Sunshine Auger	North Sunshine	265000	7276500		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	1130	4960	35400	3600	66250	11400
North Sunshine 3 Auger	North Sunshine 3	272010	7280857		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	1160	4890	36300	3510	64300	12400
North Sunshine East Auger	North Sunshine East	271524	7278932		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	1160	4930	36500	3610	66050	12200
North T-Junction 1 Auger	North T-Junction 1	292000	7303500		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	958	7860	55900	5880	108650	13000
North T-Junction 2 Auger	North T-Junction 2	294658	7307222		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	927	7850	50900	6930	99350	14900
Northern	406	341252	7322626	501	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1150	2220	13400	1530	24900	6739
Northern	407	341000	7321500	501	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1140	7460	42700	5120	84600	12280
Northern	413	341433	7321933	500	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1010	6430	41700	5550	80600	13867
Northern	414	342000	7321500	500	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1310	4060	26600	3870	52400	8775
Northern	415	342000	7320500	502	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1430	4970	31800	4100	62500	9374
Northern	416	342000	7319500	501	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1560	4120	21600	2720	45700	7008
Northern	416 (1)	342000	7319500	501	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1560	4080	21500	2680	45900	6918

Appendix 3.01 - Assays and Details

Sample ID	Point Reference	Easting	Northing	RL (m)	Data Source	Aquifer	Sample Date	Drill Type	Dip	Azimuth	Down Hole Width (m)	Depth (m)	Assay					
													Ca	Mg	Na	K	Cl	SO4
													mg/L					
Northern	418	342000	7317500	500	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1470	2670	13200	1790	27400	5481
Northern	419	341590	7316689	501	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1130	1630	7770	1090	16000	4433
Northern 1 Auger	Northern 1	341433	7321933		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	894	8740	57000	8320	109700	15200
Northern 1 Auger Rpt	Northern 1	341433	7321933		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	893	8710	56900	8320	110400	15400
Northern 2 Auger	Northern 2	342000	7317500		2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	432	12700	81700	11600	160700	23000
Sunshine	LS1	250567	7270569	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	465	8099	74071	7938	127700	19117
Sunshine	SL5	250567	7270569	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	425	8920	79600	13000	140000	37448
Sunshine	S1	251204	7271670	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	515	8510	82300	8350	144000	21474
Sunshine	S2	252058	7270801	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	620	6620	72000	8070	127000	19767
Sunshine	S2(1)	252058	7270801	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	621	6830	73700	8200	129000	20246
Sunshine	S3	252953	7272362	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	547	7540	80000	8250	140000	20366
Sunshine	S4	256979	7270642	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	557	7750	79000	7210	141000	19767
Sunshine	S5	256972	7272301	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	838	5360	54700	5690	100000	15454
Sunshine	S6	258021	7274313	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	841	4640	53900	5570	91800	16503
Sunshine	S7	258088	7271383	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1070	3710	36450	3265	62600	11890
Sunshine	S8	259202	7274397	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1120	3670	42400	4520	72300	11651
Sunshine	S9	259221	7275346	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	978	3840	47800	4850	79300	13897
Sunshine	S10	257681	7275541	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1070	4450	53100	5380	89800	12998
Sunshine	S10(1)	257681	7275541	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1045	4255	51400	5325	91200	12324
Sunshine	124	249558	7270017	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	786	5290	45500	5270	81900	13987
Sunshine	126	250000	7270500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	512	8350	83100	8410	145000	21354
Sunshine	134	252000	7272500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	760	7110	65800	6630	130000	15814
Sunshine	135	252000	7271500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	473	6910	78300	8510	137000	23062
Sunshine	137	251666	7270132	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	515	8190	76600	7840	137000	20785
Sunshine	138	252703	7272794	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	379	11000	84200	8200	151000	26326
Sunshine	140	253000	7271500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	593	6350	71400	7650	126000	20246
Sunshine	141	253000	7270500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	580	7330	77600	8210	136000	19677
Sunshine	143	253666	7272203	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	769	5820	60600	6440	106000	16622
Sunshine	144	254000	7271500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	604	6160	72000	7720	125000	18659
Sunshine	145	254000	7270500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	571	6450	73100	7990	128000	21624
Sunshine	150	255149	7272017	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	721	4400	56400	5890	96200	17850
Sunshine	151	255000	7271500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	661	6020	69600	7570	119000	19168
Sunshine	152	255000	7270500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	634	7550	69700	6460	124000	19408
Sunshine	156	256000	7272500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	832	5010	51400	5220	85200	16862
Sunshine	157	256000	7271500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	556	5460	75800	8250	123000	22103
Sunshine	158	256000	7270500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	685	6540	69600	6710	119000	17521
Sunshine	158 (1)	256000	7270500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	671	6530	69200	6660	124000	17341
Sunshine	167	257000	7273500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	666	5450	71800	7690	124000	18988
Sunshine	169	257000	7271500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	612	5840	71600	7800	124000	20396

Appendix 3.01 - Assays and Details

Sample ID	Point Reference	Easting	Northing	RL (m)	Data Source	Aquifer	Sample Date	Drill Type	Dip	Azimuth	Down Hole Width (m)	Depth (m)	Assay					
													Ca	Mg	Na	K	Cl	SO4
													mg/L					
Sunshine	177	257000	7274500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	691	6320	69600	7200	126000	17940
Sunshine	179	257740	7276091	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	814	5700	58600	5560	104000	16952
Sunshine	182	258000	7273500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	489	8230	78500	7380	141000	23271
Sunshine	183	258000	7272500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1020	3980	38300	3530	68400	13358
Sunshine	195	258443	7274058	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1190	3080	39000	4040	67700	10932
Sunshine (N)	PC1	272010	7280857	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1130	5980	42500	4300	87400	11863
Sunshine (NE)	TJ1	269298	7279748	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	978	5650	44500	3610	79200	15005
Sunshine (NE)	TJ2	271524	7278932	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1050	5040	38900	3900	70900	13418
Sunshine (NE)	218	265000	7276500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1100	3100	22800	2340	40500	10273
Sunshine (NE)	224	267777	7276946	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1060	4310	33500	3610	60000	13298
Sunshine (NE)	224 (1)	267777	7276946	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1060	4320	34300	3610	60500	13388
Sunshine (NE)	229	269703	7280017	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1610	5350	35900	2620	71800	8146
Sunshine (NE)	233	271000	7280500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1220	5500	40700	3680	77200	11591
Sunshine (NE)	236	271000	7277500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1055	4815	39100	3930	69900	14121
Sunshine (NE)	237	272000	7280500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1260	4280	34400	3280	63100	10453
Sunshine (NE)	240	271443	7277909	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1180	4960	38700	3780	69400	12429
Sunshine (NE)	241	272284	7281437	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1440	4640	33500	2780	62300	9464
Sunshine (NE)	243	273000	7280500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1140	4280	36900	3360	64000	12309
Sunshine (NE)	243 (1)	273000	7280500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1160	4340	36700	3420	64500	12429
Sunshine (NE)	244	272182	7280058	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1060	5750	44700	4370	80700	14077
Sunshine (NE)	238	272000	7279500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1090	5040	40200	3870	68700	12938
Sunshine (SW)	120	247000	7270500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1050	4770	37500	4140	66500	15095
Sunshine (SW)	123	247405	7270132	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1100	3570	32300	4140	54600	11651
Terminal	T1	258296	7291599	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	841	4810	40600	5350	73000	16952
Terminal	171	257000	7293500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	859	5350	44600	5890	82300	17221
Terminal	186	258000	7293500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	686	6800	49400	6010	92000	22672
Terminal	187	258000	7292500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1020	3230	27900	3580	47100	12579
Terminal	191	257546	7293754	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	716	6070	44700	5090	77400	21175
Terminal	196	259000	7293500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	752	6470	52900	7090	94500	21414
Terminal	196 (1)	259000	7293500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	728	6290	51200	6920	92700	21115
Terminal	199	259000	7290500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	928	4150	34800	4570	62800	15305
Terminal	201	258562	7293835	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	773	6290	47800	5440	85100	20815
Terminal	204	260000	7293500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	822	6020	44300	5840	81400	20007
Terminal	205	260000	7292500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	969	5020	42400	5760	77400	15095
Terminal	206	260000	7291500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1100	3730	30300	3900	55800	11890
Terminal	209	259481	7293819	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	960	4930	38900	4640	67500	15724
Terminal	211	260189	7293170	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	979	4390	36100	4800	62500	15095
Terminal	215	260465	7292673	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1095	3905	33100	4385	59000	13103
Terminal	172	257000	7292500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	973	6740	50500	6660	90400	14825

Appendix 3.01 - Assays and Details

Sample ID	Point Reference	Easting	Northing	RL (m)	Data Source	Aquifer	Sample Date	Drill Type	Dip	Azimuth	Down Hole Width (m)	Depth (m)	Assay					
													Ca	Mg	Na	K	Cl	SO4
													mg/L					
Terminal	IL2	255695	7294630	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	315	14100	80700	16400	153000	51228
Terminal 1 Auger	Terminal 1	257000	7293500	538.15	2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	939	5730	44900	5670	85000	14500
Terminal 2 Auger	Terminal 2	260000	7291500	538.15	2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	939	5810	47200	5860	86550	14800
TJ	PC3	293407	7306315	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	822	7270	48400	6490	99200	14679
TJ	TJ	295133	7307154	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1050	5070	41100	5650	76800	12849
TJ (N)	267	291000	7303500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1070	6440	46200	5350	85800	14346
TJ (N)	268	291000	7302500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1330	6020	42500	4470	80500	11082
TJ (N)	272	292000	7303500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1000	6380	45500	5650	85600	14316
TJ (N)	274	293000	7306500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1220	3300	24000	3030	44000	8895
TJ (N)	275	293000	7305500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	884	4640	30800	4080	57800	9584
TJ (N)	276	293000	7304500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1140	6190	40100	5140	76700	13178
TJ (N)	277	293000	7303500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1350	4750	31300	3280	57100	10123
TJ (N)	279	294000	7307500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1040	5890	43800	5815	81550	13957
TJ (N)	281	294000	7305500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	979	7330	51100	6110	96200	15185
TJ (N)	281 (1)	294000	7305500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	979	7350	50500	6090	96200	14975
TJ (N)	282	294000	7304500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1150	5880	40600	4640	75700	12729
TJ (N)	283	295000	7307500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1000	5250	44800	7120	84900	14316
TJ (N)	284	295000	7306500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	931	5720	41400	5090	75500	16293
TJ (N)	285	294703	7305723	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1090	5560	37200	4310	67500	13478
TJ (N)	PC4	294658	7307222	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	984	6500	48600	6580	96700	13960
TJ (S)	258	282000	7295500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1590	4220	32000	3440	59700	8296
TJ (S)	259	283000	7296500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1525	4480	32100	3250	59200	9255
TJ (S)	260	282907	7295593	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1490	2890	21400	2400	41100	7278
TJ (S)	261	284000	7296500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1520	4410	32900	3470	62300	9195
TJ (S)	PC2	290985	7302991	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1055	7635	51350	5600	108000	12448
T-Junction 1 Auger	T-Junction 1	282000	7295500	538.15	2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	1430	4200	30700	3310	60300	8400
T-Junction 2 Auger	T-Junction 2	284000	7296500	538.15	2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	1430	4190	31100	3230	58850	8430
T-Junction South Auger	T-Junction South	277152	7290635	538.15	2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	1510	4250	31000	3300	109150	8400
White Lake	WL1	362764	7271645	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	602	4840	46200	5690	73500	20486
White Lake	WL2	362828	7270349	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	380	9750	75800	9760	137000	34143
White Lake	WL3	364119	7271740	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	402	7540	73900	9000	125000	29082
White Lake	WL4	364959	7271231	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	384	8370	79600	9280	137000	30849
White Lake	WL5	364755	7269083	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	303	10600	84000	9950	147000	38037
White Lake	WL6	368055	7268763	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	388	7940	80700	9550	141000	31448
White Lake	WL6(1)	368055	7268763	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	393	8070	80900	9530	143000	32047
White Lake	WL7	370287	7265617	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	811	3920	38800	4130	64500	18240
White Lake	WL8	369960	7269333	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	464	6985	73600	8420	129000	26745
White Lake	WL9	371107	7268655	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	478	8190	76300	7800	142000	27464
White Lake	WL10	376247	7266387	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	841	4060	41100	3730	68400	16982

Appendix 3.01 - Assays and Details

Sample ID	Point Reference	Easting	Northing	RL (m)	Data Source	Aquifer	Sample Date	Drill Type	Dip	Azimuth	Down Hole Width (m)	Depth (m)	Assay					
													Ca	Mg	Na	K	Cl	SO4
													mg/L					
White Lake	WL10(1)	376247	7266387	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	842	4030	40400	3730	68000	17281
White Lake	446	362110	7271020	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	508	7830	58200	7640	106000	25278
White Lake	449	364000	7269500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	397	12600	69400	8470	128000	35341
White Lake	453	365779	7270248	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	324	8980	83000	9140	150000	32945
White Lake	456	366842	7269154	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	277	10700	83900	9690	151000	38336
White Lake	457	367000	7268500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	263	11800	86600	11300	163000	38336
White Lake	458	367347	7267910	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	319	8550	81900	10100	149000	33844
White Lake	463	369000	7269500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	437	6800	64000	8010	114000	26176
White Lake	466	369000	7266500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	458	6940	67000	8300	122000	27374
White Lake	481	370748	7269059	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	392	8460	77000	8790	135000	29052
White Lake	481 (1)	370748	7269059	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	391	8375	76050	8600	134000	28527
White Lake	483	371000	7267500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	479	5050	71100	8090	114000	31448
White Lake	484	371000	7266500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	493	5590	65900	8500	107000	28662
White Lake	485	371000	7265500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	420	5900	81800	9320	125000	33544
White Lake	486	371000	7264500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	474	5890	73300	8990	121000	29052
White Lake	487	371000	7263500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	725	5860	58100	6380	102000	19348
White Lake	493	372000	7267500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	535	6280	67500	7950	117000	24230
White Lake	494	371716	7266626	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	645	5120	56100	6640	91900	23391
White Lake	495	372000	7265500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	479	6195	74800	8925	122000	30220
White Lake	496	372000	7264500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	878	5670	52700	5840	92300	16652
White Lake	496 (1)	372000	7264500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	868	5600	53600	5730	92800	16772
White Lake	498	372496	7268248	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	482	8400	75100	8090	131000	27434
White Lake	499	372401	7267500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	964	3730	36500	3760	62800	14226
White Lake	500	372905	7266847	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	802	4220	50100	6160	82900	18958
White Lake	501	373000	7265500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	478	5700	75300	8700	121000	29621
White Lake	502	373095	7263744	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	914	4850	44000	4840	75700	15574
White Lake	503	373905	7265847	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	631	6470	66000	7000	114000	21205
White Lake	504	375567	7266721	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	831	5080	49100	4630	81100	18000
White Lake	505	374969	7265878	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	452	8790	77300	7000	130000	27704
White Lake	510	376000	7265500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	504	7400	75300	8210	127000	25547
White Lake	515	377000	7266500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	372	10200	84500	9890	155000	27135
White Lake	515 (1)	377000	7266500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	364	10100	84400	9800	156000	27255
White Lake	516	377000	7265500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	413	7660	78800	8490	135000	29621
White Lake	517	377000	7264500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	777	5480	52500	5210	90400	17940
White Lake	518	375834	7264981	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	507	7470	70400	7350	119000	25727
White Lake	523	377779	7265406	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	927	4190	35700	3620	61100	14466
White Lake	524	378000	7264500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	788	5250	42400	4380	72100	19078
White Lake	WL	370802	7266910	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	511	6600	75200	9130	126000	30258
White Lake 1 Auger	White Lake 1	357345	7270169	538.15	2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	821	6640	34900	4700	66250	19400

Appendix 3.01 - Assays and Details

Sample ID	Point Reference	Easting	Northing	RL (m)	Data Source	Aquifer	Sample Date	Drill Type	Dip	Azimuth	Down Hole Width (m)	Depth (m)	Assay					
													Ca	Mg	Na	K	Cl	SO4
													mg/L					
White Lake 2 Auger	White Lake 2	365779	7270248	538.15	2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	486	7100	73000	8980	124050	30000
White Lake 3 Auger	White Lake 3	370802	7266910	538.15	2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	458	6810	72800	8840	124250	29500
White Lake 4 Auger	White Lake 4	377000	7265500	538.15	2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	408	7820	80800	9070	142450	29800
White Lake W Auger	White Lake W	354284	7281217	538.15	2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	327	12900	84200	10800	158200	33900
White Lake W Dup Auger	White Lake W	354284	7281217	538.15	2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	324	12800	85200	10800	157850	33600
Wilderness	PC5	309577	7311102	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	765	8340	56600	7390	121000	17885
Wilderness	U1	320586	7310804	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	2570	2560	11200	1400	26200	3115
Wilderness	289	309000	7311500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1030	4160	30800	3920	57600	11471
Wilderness	290	309158	7310689	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	745	4490	33800	4480	62600	10572
Wilderness	291	310000	7313500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	615	7190	45100	5590	88000	15814
Wilderness	292	310000	7312500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1300	3820	22500	3400	44300	9075
Wilderness	293	310000	7311500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	908	6900	46000	6220	85400	17850
Wilderness	294	310000	7310500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	969	6370	47500	5940	88500	15305
Wilderness	295	310158	7310193	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	404	5420	34500	4490	68000	11411
Wilderness	296	311000	7312500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1230	4380	30100	4170	57900	10932
Wilderness	297	311000	7311500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	960	6810	45900	6520	86600	15724
Wilderness	298	311000	7310500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	861	6740	52400	6950	99000	16413
Wilderness	298 (1)	311000	7310500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	858	6710	51800	6930	96200	16323
Wilderness	299	312000	7312500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1125	6030	43200	5915	84250	13343
Wilderness	300	312000	7311500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	870	8920	58500	6790	117000	14196
Wilderness	301	311842	7310721	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	763	2980	20000	2260	38600	7008
Wilderness	302	313000	7312500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	723	6715	47050	6560	96000	9225
Wilderness	303	312685	7311815	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	1240	5540	34300	3540	67400	10273
Yanerie 1 2 Auger	Yanerie 1	243334	7294635	538.15	2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	429	11600	62700	10800	112650	40200
Yanerie 2 Auger	Yanerie 2	247630	7297225	538.15	2017_Auger	Surficial	2017	Auger	-90	0	0.25	2	527	8160	55900	9160	96000	33300
Yanneri	IL1	243334	7294635	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	425	9420	57100	10600	101000	38945
Yanneri	IL3	241573	7298445	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	693	7200	52550	6535	97250	22963
Yanneri	Y1	242442	7297381	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	613	10900	52700	9220	98500	37737
Yanneri	Y2	245664	7295084	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	865	5030	39200	6880	70100	17970
Yanneri	Y3	244852	7295411	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	744	6340	38500	6420	71500	22552
Yanneri	Y4	242844	7294628	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	686	7400	39500	6830	68500	27524
Yanneri	Y5	242453	7293438	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	665	7470	38500	5870	67800	28273
Yanneri	Y6	242549	7292557	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	827	6380	38900	6640	71800	19857
Yanneri	Y7	243821	7292698	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	767	7280	40200	6040	73600	20935
Yanneri	Y8	242840	7291276	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	827	6090	35300	5120	64000	19557
Yanneri	Y8(1)	242840	7291276	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	835	6110	35200	5090	63100	19647
Yanneri	Y9	242397	7291525	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	723	6895	43500	7345	78000	24409
Yanneri	86	240441	7298445	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	861	3320	16100	2710	29200	11980
Yanneri	104	245000	7294500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	794	6640	39900	6870	76400	19887

Appendix 3.01 - Assays and Details

Sample ID	Point Reference	Easting	Northing	RL (m)	Data Source	Aquifer	Sample Date	Drill Type	Dip	Azimuth	Down Hole Width (m)	Depth (m)	Assay					
													Ca	Mg	Na	K	Cl	SO4
													mg/L					
Yanneri	104 (1)	245000	7294500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	798	6530	39900	6810	75550	19872
Yanneri	105	245000	7293500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	819	5640	37700	6750	68500	19138
Yanneri	106	245000	7292500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	824	6820	41900	5620	77800	19737
Yanneri	110	246158	7297658	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	676	6380	35900	4880	61600	25008
Yanneri	111	246000	7296500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	530	7810	46600	8470	86100	26356
Yanneri	113	246000	7294500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	900	4940	39500	6990	73800	15604
Yanneri	117	247000	7297500	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	598	7550	47000	6620	79900	30549
Yanneri	118	247347	7296563	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	643	6840	49200	7360	81100	25907
Yanneri	119	246811	7295721	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	766	5970	44600	6990	75250	21265
Yanneri	119 (1)	246811	7295721	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	755	5885	43100	6830	75100	20875
Yanneri	121	247842	7297374	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	642	7180	45400	6140	74400	27913
Yanneri	122	248032	7296815	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	714	6150	42300	6210	71800	22822
Yanneri Feed	YLF1	235010	7295291	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	935	3860	17391	2768	30100	12478
Yanneri/Terminal	YT1	254096	7296955	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	811	4910	37700	5440	67000	19827
Yanneri/Terminal	YT1	247630	7297225	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	615	7600	47600	7180	90900	28310
Yanneri/Terminal	YT2	254232	7297072	538.15	2015_Auger	Surficial	2015	Auger	-90	0	0.25	<1.5m	794	5390	41600	5730	74700	19413

Appendix 3.01 - Assays and Details

(C) Test Pumping Assays

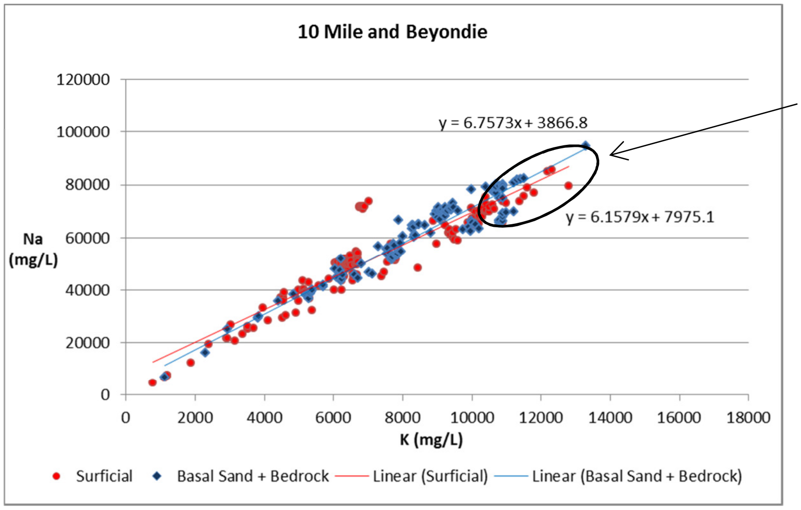
Point ID	Description	Location	Easting	Northing	Representative Aquifer	Date	Assay					
							Ca	K	Mg	Na	Cl	SO_4
							mg/L					
SDHTM08	Test pump	10 Mile	230359	7259357	Bedrock	2015	731	5,480	53,300	7680	22918	88,600
SDHTM08	Test pump	10 Mile	230359	7259357	Bedrock	2015	759	5,460	53,500	7860	23667	89,300
SDHTM09	12v Pumping	10 Mile	235582	7257149	Whole profile	2015	156	600	6750	1110	12000	23360
TMPB12	Test pumping	10 Mile	233490	7256785	Basal Sand	12-Jun-17	489	7730	69000	8930	120550	25500
TMPB12	Test pumping	10 Mile	233490	7256785	Basal Sand	13-Jun-17	487	7770	70100	9000	119850	25100
TMPB12	Test pumping	10 Mile	233490	7256785	Basal Sand	14-Jun-17	481	7730	70200	8980	120550	25600
TMPB12	Test pumping	10 Mile	233490	7256785	Basal Sand	15-Jun-17	479	7880	69900	9130	120900	26300
TMPB12	Test pumping	10 Mile	233490	7256785	Basal Sand	16-Jun-17	474	7990	71500	9220	120700	26500
TMPB12	Test pumping	10 Mile	233490	7256785	Basal Sand	17-Jun-17	485	7800	67700	9000	121250	25200
TMPB12	Test pumping	10 Mile	233490	7256785	Basal Sand	18-Jun-17	493	7800	71400	9020	120900	25700
TMPB12	Test pumping	10 Mile	233490	7256785	Basal Sand	19-Jun-17	495	7840	70100	9000	121400	25600
TMPB12	Test pumping	10 Mile	233490	7256785	Basal Sand	20-Jun-17	494	7860	70500	9150	121050	25800
TMPB12	Test pumping	10 Mile	233486	7256791	Basal Sand	04-Jun-17	496	9080	70100	7730	118500	27300
TMPB12	Test pumping	10 Mile	233486	7256791	Basal Sand	22-Jun-17	805	5410	49600	6620	86650	18600
TMPB12	Test pumping	10 Mile	233486	7256791	Basal Sand	23-Jun-17	512	8150	70400	9390	121650	27100
TMPB12	Test pumping	10 Mile	233486	7256791	Basal Sand	24-Jun-17	507	8070	71600	9380	123450	27200
TMPB12	Test pumping	10 Mile	233486	7256791	Basal Sand	25-Jun-17	505	8090	73000	9450	125900	27300
TMPB12	Test pumping	10 Mile	233486	7256791	Basal Sand	26-Jun-17	501	8060	71100	9400	127000	26600
TMPB12	Test pumping	10 Mile	233486	7256791	Basal Sand	26-Jun-17	508	8100	71600	9480	127000	26700
TMPB23	Test pumping	10 Mile	230918	7253522	Fractured Bedrock	01-May-17	403	10900	78500	8890	136350	32100
TMPB23	Test pumping	10 Mile	230918	7253522	Fractured Bedrock	06-May-17	413	10800	75000	8610	129700	30600
TMPB23	Test pumping	10 Mile	230918	7253522	Fractured Bedrock	07-May-17	398	10700	78100	8890	137050	31500
TMPB23	Test pumping	10 Mile	230918	7253522	Fractured Bedrock	07-May-17	407	10600	78200	9070	137050	30900
TMPB23	Test pumping	10 Mile	230918	7253522	Fractured Bedrock	08-May-17	405	8840	77700	10600	137400	29900
TMPB23	Test pumping	10 Mile	230918	7253522	Fractured Bedrock	08-May-17	400	8860	78000	10700	137600	29600
TMPB23	Test pumping	10 Mile	230918	7253522	Fractured Bedrock	09-May-17	400	10600	79000	9000	136350	31500
TMPB23	Test pumping	10 Mile	230918	7253522	Fractured Bedrock	04-May-17	651	5780	66400	9990	114300	21000
TMPB23	Test pumping	10 Mile	230918	7253522	Fractured Bedrock	05-May-17	411	8960	80100	10900	137950	29900
TMPB23	Test pumping	10 Mile	230918	7253522	Fractured Bedrock	05-May-17	413	8930	79700	10700	138450	29900
TMPB23	Test pumping	10 Mile	230918	7253522	Fractured Bedrock	06-May-17	410	8940	79400	10900	137950	29600
TMPB23	Test pumping	10 Mile	230918	7253522	Fractured Bedrock	07-May-17	405	8800	79400	10800	138100	29900
TMPB23	Test pumping	10 Mile	230918	7253522	Fractured Bedrock	08-May-17	407	8970	78900	10700	138650	29900
TMPB23	Test pumping	10 Mile	230918	7253522	Fractured Bedrock	09-May-17	408	8990	80300	10700	137600	30000
TMPB23	Test pumping	10 Mile	230918	7253522	Fractured Bedrock	09-May-17	405	8930	79100	10700	137750	30000
TMPB23	Test pumping	10 Mile	230918	7253522	Fractured Bedrock	28-Apr-17	404	10700	77100	9000	133200	30900
TMPB23	Test pumping	10 Mile	230918	7253522	Fractured Bedrock	02-May-17	391	10400	79300	8930	136700	31500
TMPB23	Test pumping	10 Mile	230918	7253522	Fractured Bedrock	28-Apr-17	413	10900	74900	8390	129200	30300
WB06D	12v Pumping	10 Mile	230190	7259422	Bedrock	2015	378	8360	94700	13300	152000	255500
WB07	12v Pumping	10 Mile	230475	7257584	Bedrock	2015	524	7660	70200	9600	124000	213100
WB10	Test pumping	10 Mile	233468	7257249	Basal Sand	19-Dec-15	594	6600	58100	7930	101000	22620
WB10	Test pumping	10 Mile	233468	7257249	Basal Sand	24-Apr-17	521	8440	65000	6990	109400	25600
WB10	Test pumping	10 Mile	233468	7257249	Basal Sand	25-Apr-17	517	8320	64200	6930	109250	24800
WB10	Test pumping	10 Mile	233468	7257249	Basal Sand	25-Apr-17	518	8290	64700	7180	108900	25100
WB10	Test pumping	10 Mile	233468	7257249	Basal Sand	26-Apr-17	516	8260	63500	7000	109400	25400
WB10	Test pumping	10 Mile	233468	7257249	Basal Sand	26-Apr-17	516	8260	64600	6940	109050	25400
WB10	Test pumping	10 Mile	233468	7257249	Basal Sand	24-Apr-17	523	8470	65200	7040	109050	24900
WB10	Test pumping	10 Mile	233468	7257249	Basal Sand	Dec-15	595	5590	49900	6790	86800	18870
WB10	Test pumping	10 Mile	233468	7257249	Basal Sand	Dec-15	587	6330	55700	7530	96500	21600

Appendix 3.01 - Assays and Details

Point ID	Description	Location	Easting	Northing	Representative Aquifer	Date	Assay					
							Ca	K	Mg	Na	Cl	SO_4
							mg/L					
WB10	Test pumping	10 Mile	233468	7257249	Basal Sand	Dec-15	560	6770	60700	7990	104000	23310
WB10MBD	12v Pumping	10 Mile	233468	7257249	Basal Sand	2015	707	4050	36800	5280	65300	117800
WB10MBI	12v Pumping	10 Mile	233487	7257251	Clay	2015	699	4550	41200	5690	72900	131900
WB11MBI	12v Pumping	10 Mile	233539	7255526	Surficial	2015	842	4510	35900	4550	62600	116900
WB11MBS	12v Pumping	10 Mile	233539	7255524	Surficial	2015	830	5100	39800	4990	67500	127200
WB12	Test pumping	10 Mile	233894	7253901	Upper Sand	15-Dec-15	648	6780	50800	6355	90450	23385
WB12	Test pumping	10 Mile	233894	7253901	Upper Sand	14-Dec-15	651	6700	49800	6210	89800	22890
WB12	Test pumping	10 Mile	233894	7253901	Upper Sand	Dec-15	657	6650	49900	6080	85300	22590
WB12	Test pumping	10 Mile	233894	7253901	Upper Sand	Dec-15	689	7080	53000	6490	89100	23310
WB12	Test pumping	10 Mile	233894	7253901	Upper Sand	Dec-15	696	7050	51800	6480	88100	23580
WB12	Test pumping	10 Mile	233894	7253901	Upper Sand	Dec-15	672	6890	51000	6380	88600	22770
WB12	Test pumping	10 Mile	233894	7253901	Upper Sand	Dec-15	678	7140	54800	6660	92100	23940
WB12	Test pumping	10 Mile	233894	7253901	Upper Sand	Dec-15	646	6910	52000	6440	92600	23400
WB12	Test pumping	10 Mile	233894	7253901	Upper Sand	Dec-15	691	7205	53400	6700	89450	23475
WB12	Test pumping	10 Mile	233894	7253901	Upper Sand	Dec-15	676	6900	51800	6300	89600	23730
WB12	Test pumping	10 Mile	233894	7253901	Upper Sand	Dec-15	660	7090	54200	6700	93800	23610
WB12MBD	12v Pumping	10 Mile	233894	7253901	Upper Sand	2015	729	5475	42800	5270	74200	139900
WB12MBI	12v Pumping	10 Mile	233888	7253923	Clay	2015	999	4470	38300	4840	64600	121700
WB19	12v Pumping	10 Mile	235565	7257151	Surficial	2015	230	1130	12400	1870	21900	42200
WB23	12v Pumping	10 Mile	235582	7257150	Surficial	2015	265	1590	16000	2290	27500	53460
WB25	12v Pumping	10 Mile	235579	7257152	Surficial	2015	476	560	6575	1120	10800	22540
ESE Trench	Test Pumping	Sunshine	260414	7276115	Surficial	01-Aug-17	848	6080	65000	6480	115500	14800
ESE Trench	Test Pumping	Sunshine	260414	7276115	Surficial	27-Jul-17	828	5900	65600	6390	116200	14600
ESE Trench	Test Pumping	Sunshine	260414	7276115	Surficial	28-Jul-17	687	6890	73500	6990	130700	15700
ESE Trench	Test Pumping	Sunshine	260414	7276115	Surficial	29-Jul-17	695	6930	74700	7040	130700	16100
ESE Trench	Test Pumping	Sunshine	260414	7276115	Surficial	30-Jul-17	1000	4900	52700	5010	92500	13100
ESE Trench	Test Pumping	Sunshine	260414	7276115	Surficial	31-Jul-17	707	6980	73300	7040	131050	16400
ESE Trench	Test Pumping	Sunshine	257690	7271774	Surficial	01-Aug-17	630	7960	73200	7080	127150	19900
ESE Trench	Test Pumping	Sunshine	257690	7271774	Surficial	01-Aug-17	617	7850	73600	7000	127700	19400
ESE Trench	Test Pumping	Sunshine	257690	7271774	Surficial	27-Jul-17	673	8010	72900	7130	129100	20300
ESE Trench	Test Pumping	Sunshine	257690	7271774	Surficial	28-Jul-17	630	7850	70800	6960	127700	19500
ESE Trench	Test Pumping	Sunshine	257690	7271774	Surficial	29-Jul-17	631	7960	72800	7090	127500	19800
ESE Trench	Test Pumping	Sunshine	257690	7271774	Surficial	30-Jul-17	621	7850	72200	6980	128200	19200
ESE Trench	Test Pumping	Sunshine	257690	7271774	Surficial	31-Jul-17	623	7910	72200	7040	127500	19500
SSAC15M1	Slug test	Sunshine	257617	7275041	Basal Sand	10-Jun-17	784	5830	60200	5860	103900	17900
SSAC15M2	Slug test	Sunshine	257617	7275041	Surficial	10-Jun-17	837	5480	55200	5160	95050	16300
SSAC16M1	Slug test	Sunshine	257301	7275361	Basal Sand	10-Jun-17	333	4670	41400	4250	73100	14000
SSAC16M2	Slug test	Sunshine	257301	7275361	Surficial	10-Jun-17	798	5110	56400	5440	98600	14900
SSAC19M1	Slug test	Sunshine	264078	7276655	Basal Sand	10-Jun-17	325	4630	41100	4210	72150	13000
SSAC19M2	Slug test	Sunshine	264078	7276655	Surficial	10-Jun-17	201	880	8890	860	15050	2550
SSAC24M1	Slug test	Sunshine	256660	7273834	Basal Sand	10-Jun-17	330	4650	41500	4240	73800	13500
SSAC24M2	Slug test	Sunshine	256660	7273834	Surficial	10-Jun-17	472	5130	46800	4650	80150	14400
SSPB15	Test pumping	Sunshine	257634	7275045	Basal Sand	08-Jul-17	747	6000	63000	7960	120200	17900
SSPB15	Test pumping	Sunshine	257634	7275045	Basal Sand	08-Jul-17	794	5560	59200	6350	104600	16700
SSPB15	Test pumping	Sunshine	257634	7275045	Basal Sand	15-Aug-17	707	5880	66700	6310	110250	17800
SSPB15	Test pumping	Sunshine	257634	7275045	Basal Sand	15-Aug-17	707	5850	66200	6280	109550	17600
SSPB15	Test pumping	Sunshine	257634	7275045	Basal Sand	18-Aug-17	660	6600	70000	7170		18700
SSPB15	Test pumping	Sunshine	257634	7275045	Basal Sand	18-Aug-17	680	6700	71100	7250		19100
SSPB18	Test pumping	Sunshine	261022	7275999	Basal Sand	01-Aug-17	761	5720	65600	6760	113550	16000
SSPB18	Test pumping	Sunshine	261022	7275999	Basal Sand	17-Jul-17	765	5440	59500	6770	107600	15600

Appendix 3.01 - Assays and Details

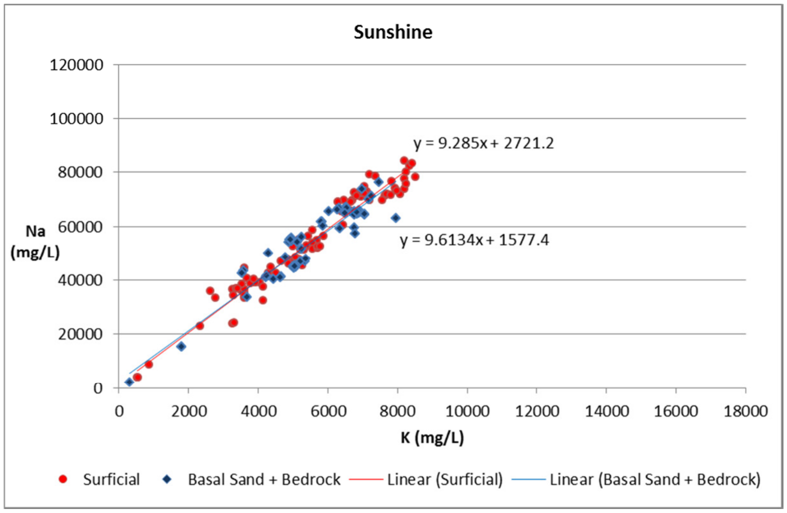
Point ID	Description	Location	Easting	Northing	Representative Aquifer	Date	Assay					
							Ca	K	Mg	Na	Cl	SO_4
							mg/L					
SSPB18	Test pumping	Sunshine	261022	7275999	Basal Sand	27-Jul-17	763	5890	65800	6870	114400	16300
SSPB18	Test pumping	Sunshine	261022	7275999	Basal Sand	28-Jul-17	757	5920	65700	6930	113550	16200
SSPB18	Test pumping	Sunshine	261022	7275999	Basal Sand	29-Jul-17	755	5820	64600	6830	113350	16100
SSPB18	Test pumping	Sunshine	261022	7275999	Basal Sand	29-Jul-17	784	5900	64900	6880	113550	16300
SSPB18	Test pumping	Sunshine	261022	7275999	Basal Sand	30-Jul-17	782	5930	65100	6900	114050	16200
SSPB18	Test pumping	Sunshine	261022	7275999	Basal Sand	31-Jul-17	768	5720	64400	6750	113550	16000
SSPB18	Test pumping	Sunshine	261022	7275999	Basal Sand	04-Aug-17	769	5880	65300	6840	113700	16300
SSPB18	Test pumping	Sunshine	261022	7275999	Basal Sand	04-Aug-17	791	5880	64400	7040		16300
SSPB19	Test pumping	Sunshine	264084	7276673	Basal Sand	10-Aug-17	692	5000	54200	4880	90600	15400
SSPB19	Test pumping	Sunshine	264084	7276673	Basal Sand	11-Aug-17	680	5100	55300	4890	93250	15500
SSPB19	Test pumping	Sunshine	264084	7276673	Basal Sand	12-Aug-17	692	5150	55700	4950	91850	15600
SSPB19	Test pumping	Sunshine	264084	7276673	Basal Sand	13-Aug-17	690	5210	54500	4960	93950	15800
SSPB19	Test pumping	Sunshine	264084	7276673	Basal Sand	13-Aug-17	684	5200	55000	4930	93250	15600
SSPB19	Test pumping	Sunshine	264084	7276673	Basal Sand	04-Aug-17	717	5410	56000	5250		16400
SSPB19	Test pumping	Sunshine	264084	7276673	Basal Sand	04-Aug-17	802	5930	64600	7050		16700
SSPB19	Test pumping	Sunshine	264084	7276673	Basal Sand	04-Aug-17	698	5280	54200	5120		16100
SSPB21	Test pumping	Sunshine	248431	7269419	Basal Sand	20-Jul-17	529	6040	61800	5830	104150	16700
SSPB21	Test pumping	Sunshine	248431	7269419	Basal Sand	20-Jul-17	524	5960	61700	5800	103950	16700
SSPB21	Test pumping	Sunshine	248431	7269419	Basal Sand	08-Jul-17	607	5460	46800	5330	83950	17100
SSPB21	Test pumping	Sunshine	248431	7269419	Basal Sand	04-Jul-17	563	5260	44900	5040	80800	16400
SSPB21	Test pumping	Sunshine	248431	7269419	Basal Sand	04-Jul-17	580	4720	40300	4440	71500	15000
SSPB21	Test pumping	Sunshine	248431	7269419	Basal Sand	05-Jul-17	580	5370	47100	5220	82700	17300
SSPB21	Test pumping	Sunshine	248431	7269419	Basal Sand	06-Jul-17	565	4780	41200	4650	72350	15200
SSPB21	Test pumping	Sunshine	248431	7269419	Basal Sand	06-Jul-17	555	4720	41000	4630	72000	14900
SSPB21	Test pumping	Sunshine	248431	7269419	Basal Sand	11-Jul-17	604	5510	47900	5370	84100	17600
SSPB21	Test pumping	Sunshine	248431	7269419	Basal Sand	15-Jul-17	563	5150	45200	5010	79200	16300
SSPB21	Test pumping	Sunshine	248431	7269419	Basal Sand	16-Jul-17	565	5170	44500	5030	80050	16500
SSPB21	Test pumping	Sunshine	248431	7269419	Basal Sand	17-Jul-17	567	5210	45300	5040	80600	16500
SSPB21	Test pumping	Sunshine	248431	7269419	Basal Sand	18-Jul-17	572	5250	44600	5060	80250	16400
SSPB21	Test pumping	Sunshine	248431	7269419	Basal Sand	20-Jul-17	574	5290	45200	5070	79900	16700
SSPB21	Test pumping	Sunshine	248431	7269419	Basal Sand	20-Jul-17	572	5300	45100	5040	80600	16400
Trench NE	Test pumping	Sunshine	260451	7276110	Surficial	18-Jul-17	1070	4170	46700	5000		12500
Trench NE	Test pumping	Sunshine	260451	7276110	Surficial	19-Jul-17	1100	4170	46400	4950		12500
Trench NE	Test pumping	Sunshine	260451	7276110	Surficial	20-Jul-17	1050	4260	47900	5160		12600
Trench NE	Test pumping	Sunshine	260451	7276110	Surficial	21-Jul-17	1030	4190	48400	5080		12700
Trench NE	Test pumping	Sunshine	260451	7276110	Surficial	22-Jul-17	1060	4050	46000	4880		12200
Trench NE	Test pumping	Sunshine	260451	7276110	Surficial	23-Jul-17	1020	4600	51600	5550		13200
Trench NE	Test pumping	Sunshine	260451	7276110	Surficial	24-Jul-17	1060	4810	52100	5700		13300
Trench NE	Test pumping	Sunshine	260451	7276110	Surficial	25-Jul-17	1050	4810	52600	5710		13400
Trench NE	Test pumping	Sunshine	260451	7276110	Surficial	25-Jul-17	1060	4830	52600	5780		13400



Comments

Higest grades measured from bedrock aquifers TMAC22, TMAC11, TMAC23 on the souther side of Ten Mile Lake and lake sediments

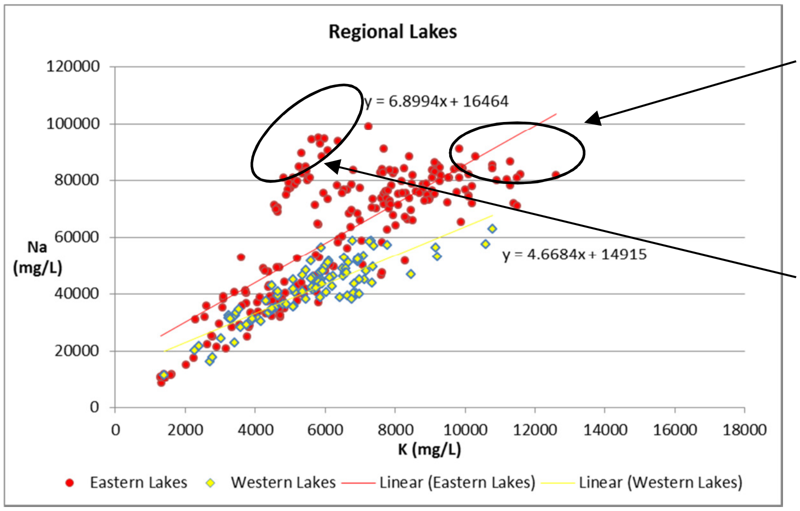
Shallow gradient indicating higher grade and lower impurities



Steeper gradient showing marginally higer impurities than Ten Mile and Beyondie.

Reasonable cluster of data points indicating a more constrained mineralisation range.

No discernible trend between deep and shallow aquifers.



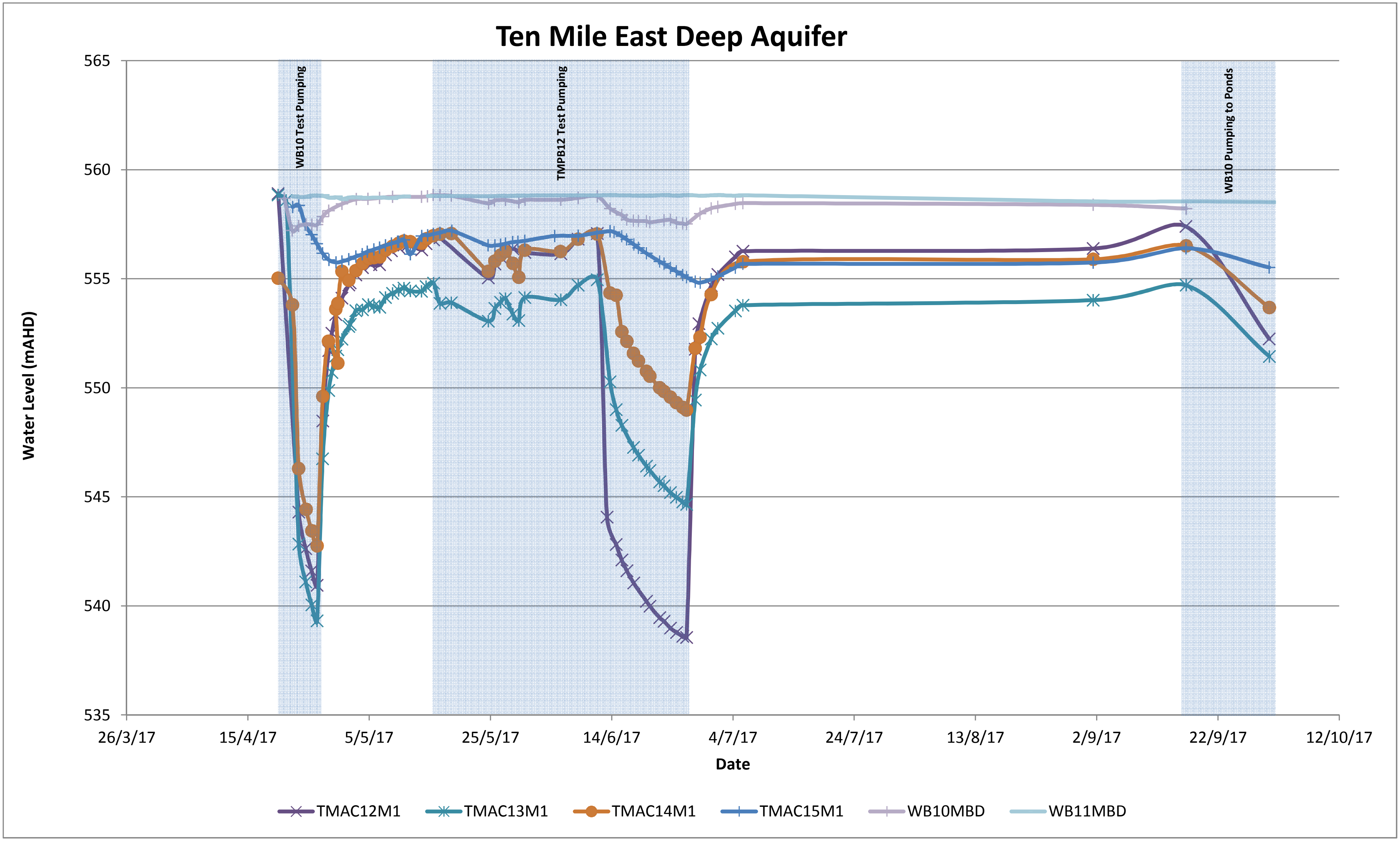
Eastern lakes plot predominantly at a higher grade.

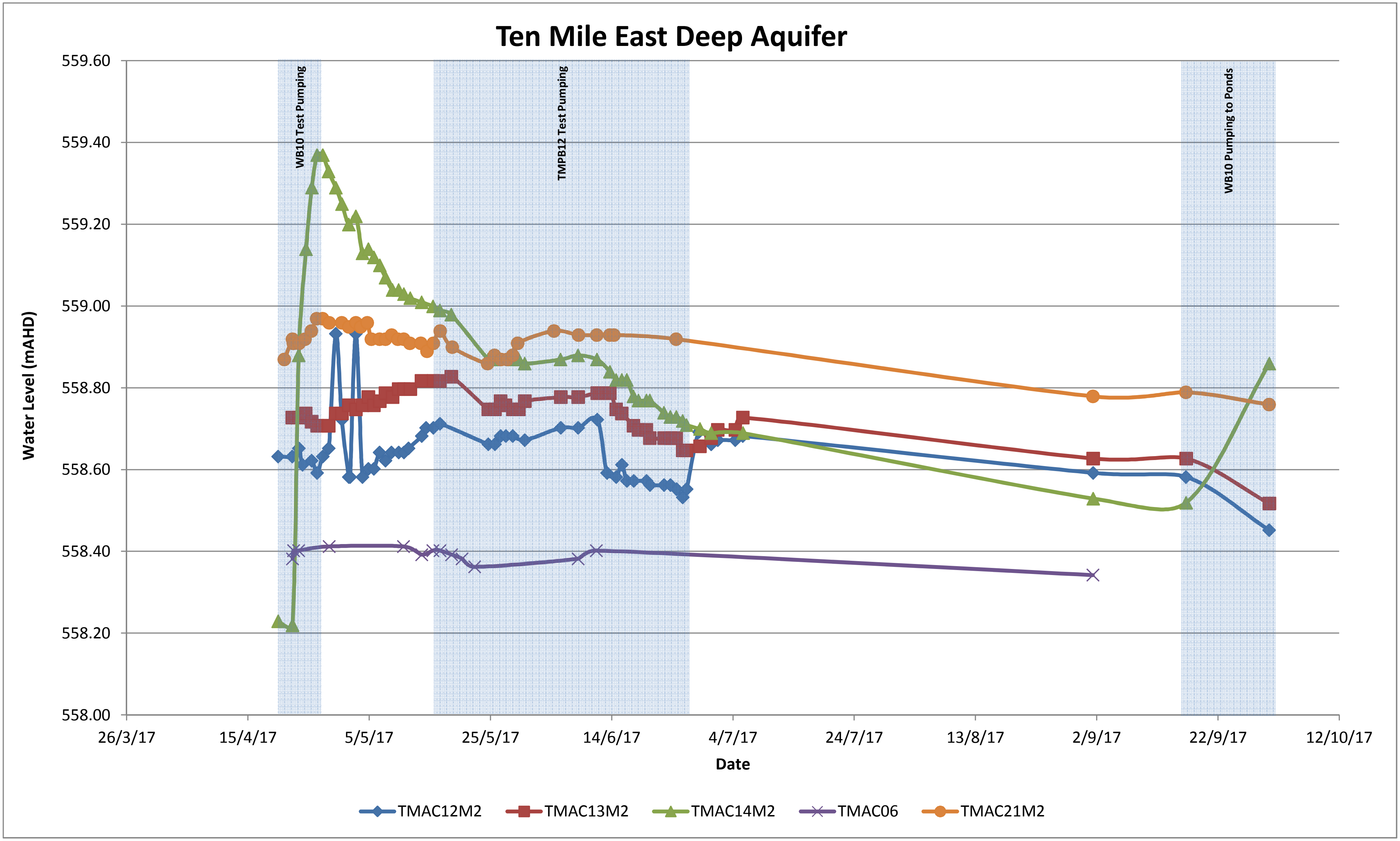
Slightly less impurities at Central and White Lake.

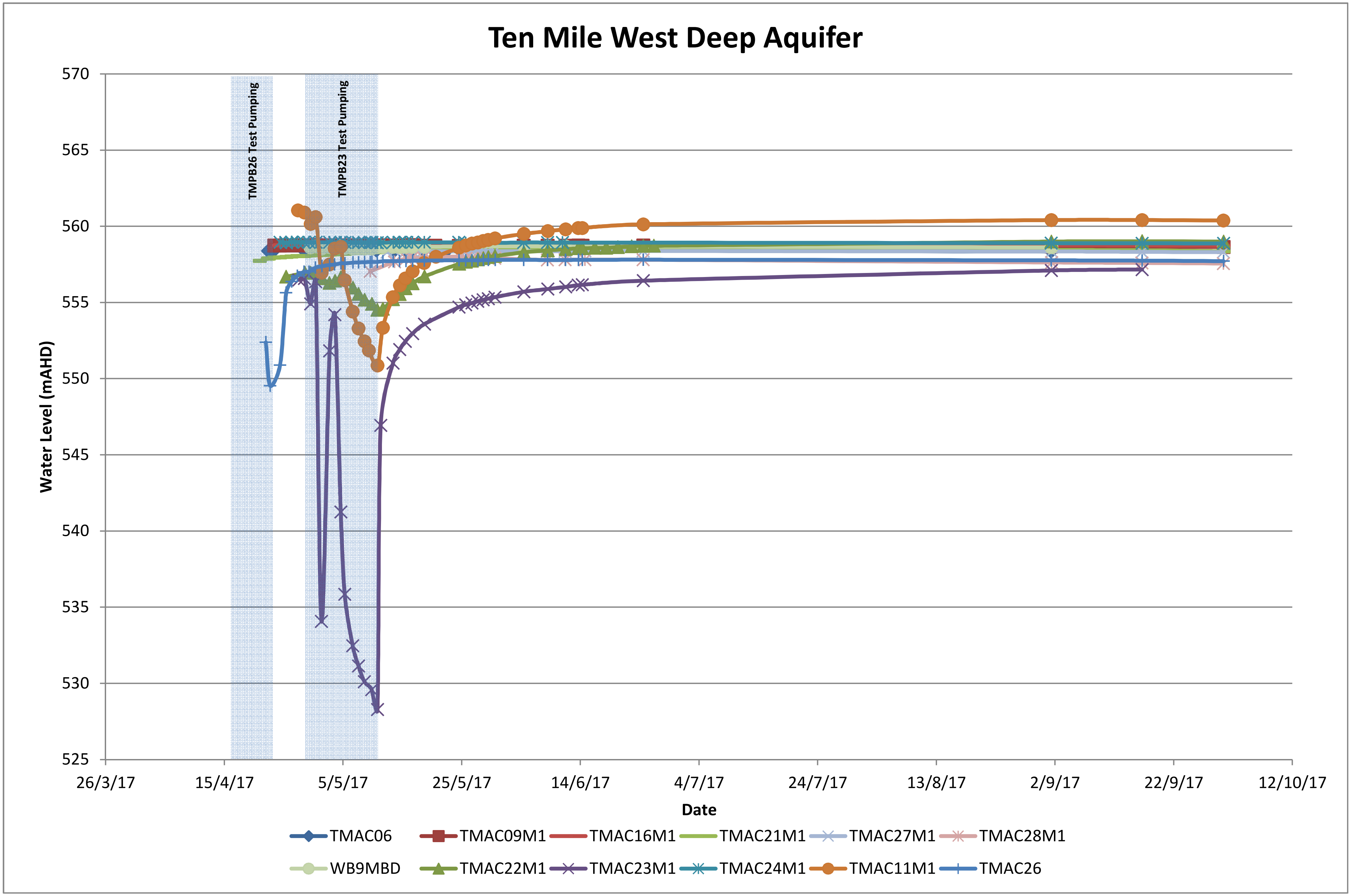
Greater impurities on the western side of Central***.

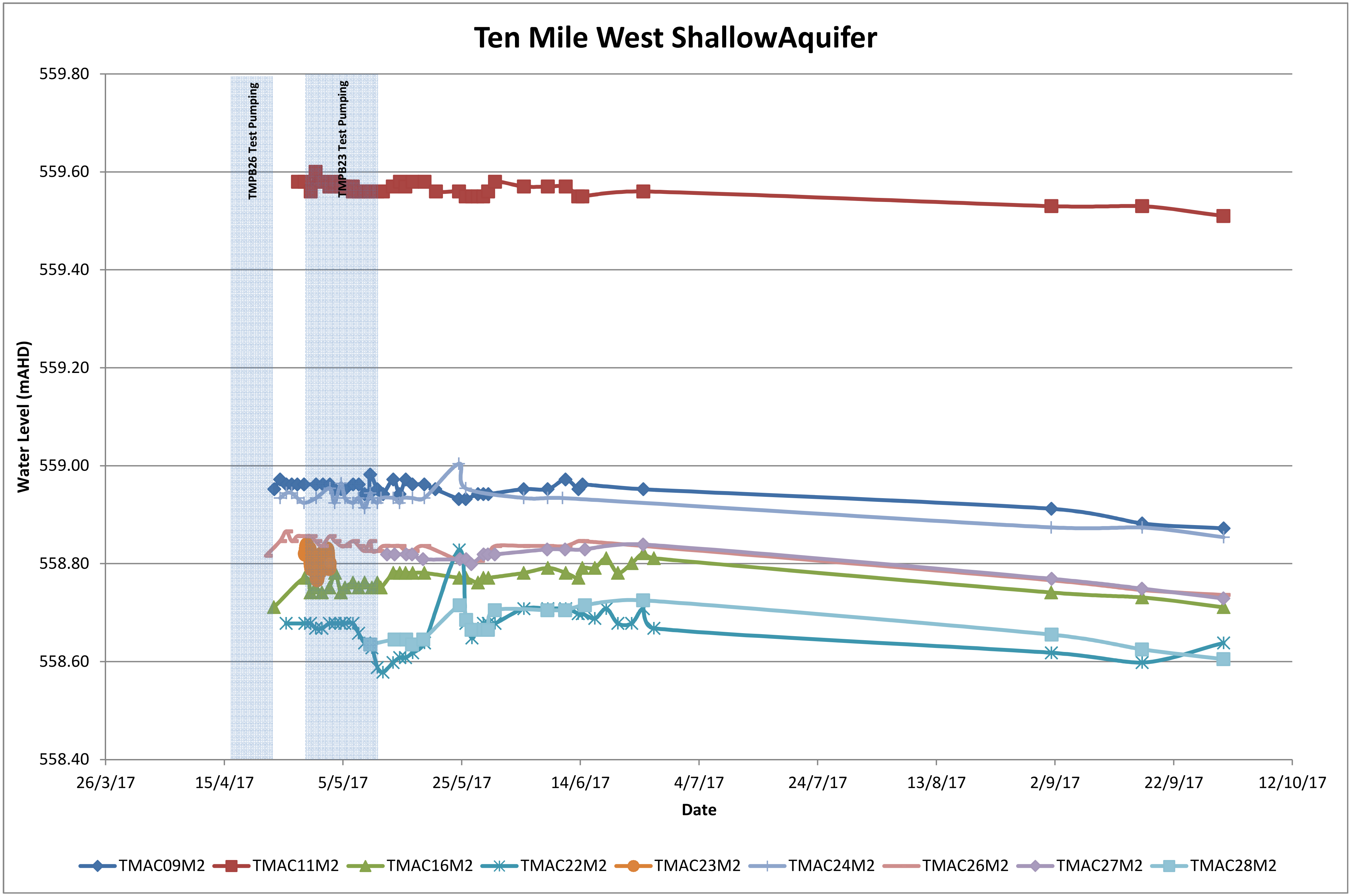
Appendix C: Figure C-3: Plots of Potassium and Sodium

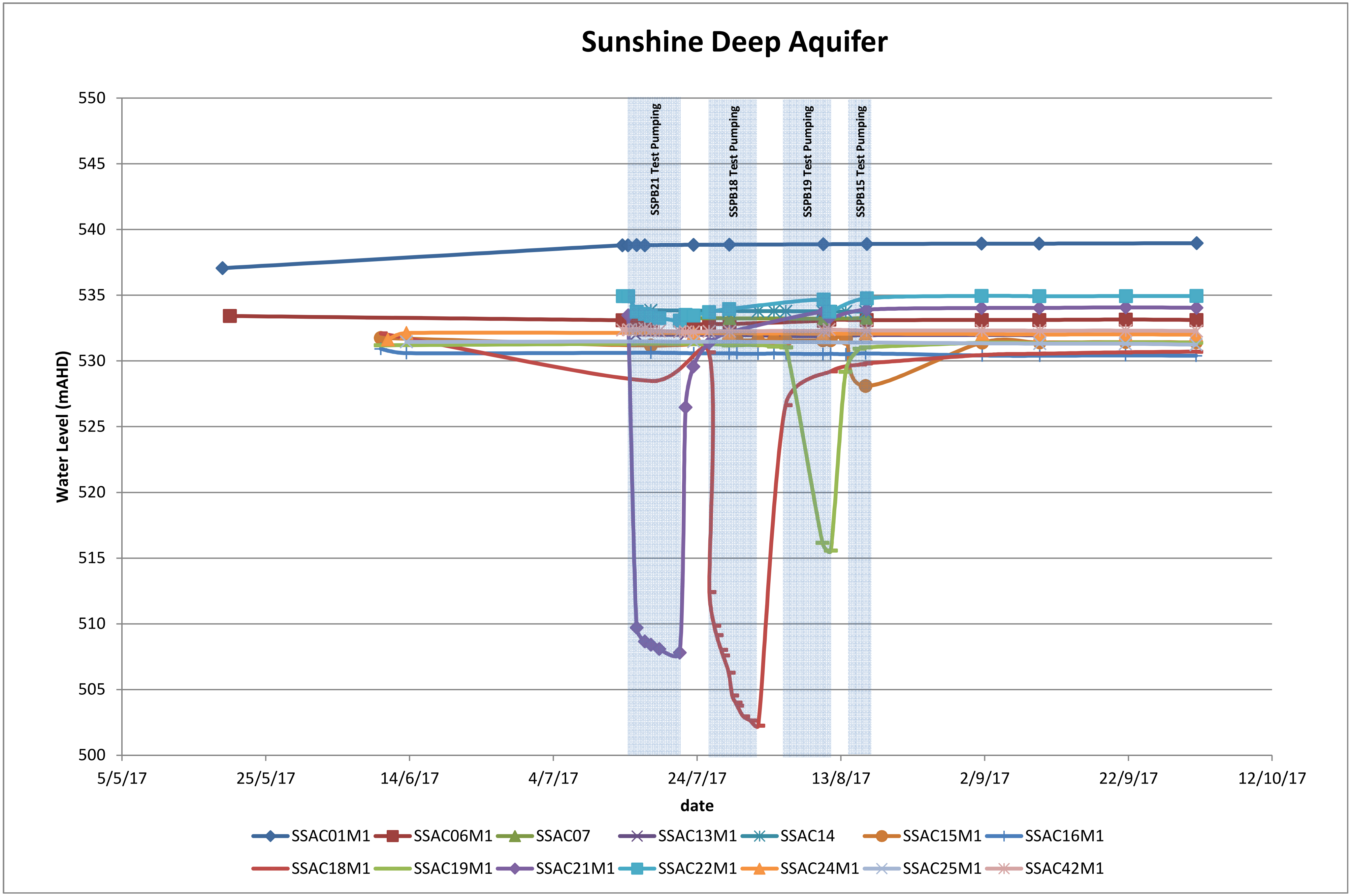
Appendix F Groundwater Level Hydrographs

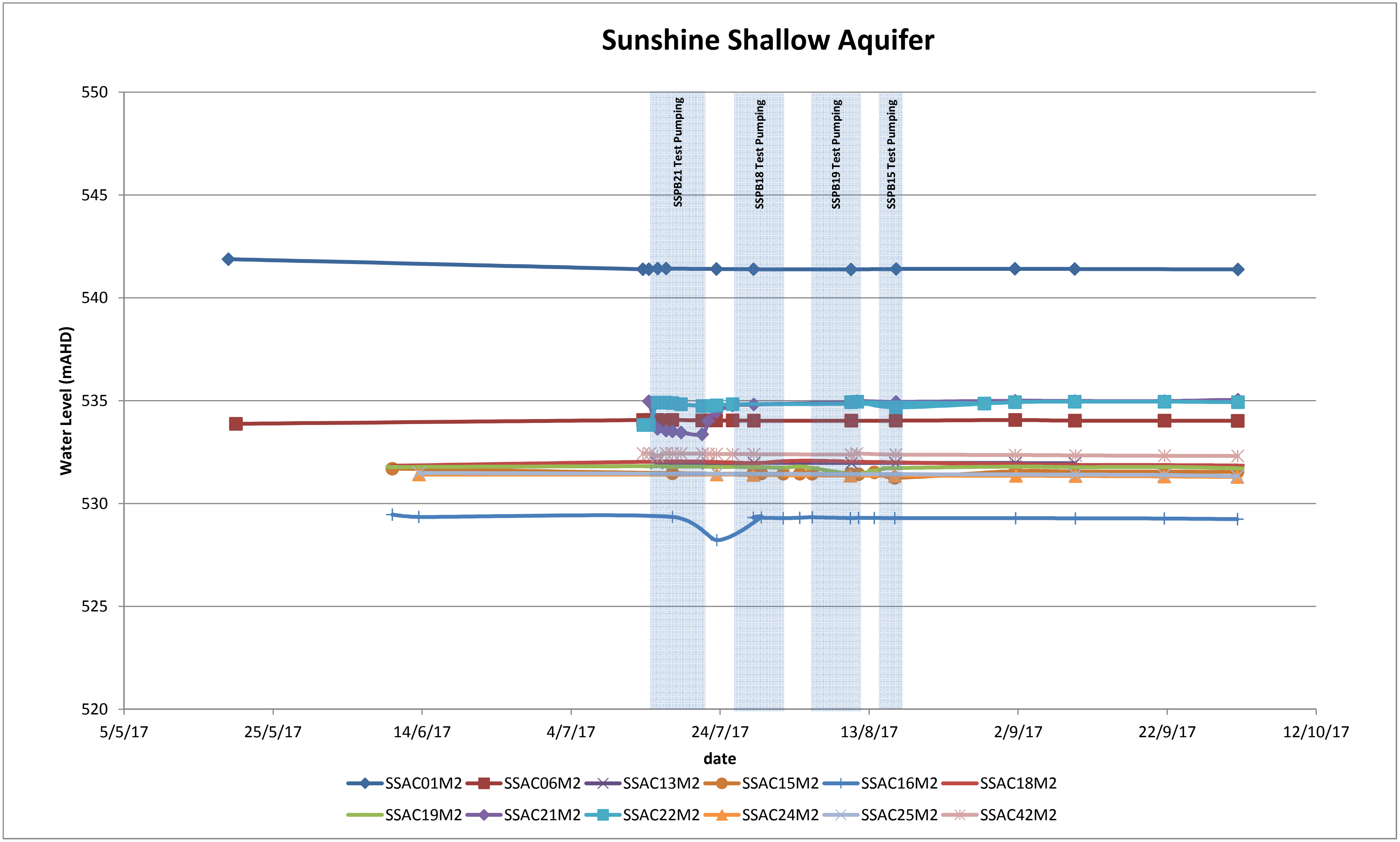

Ten Mile East Deep Aquifer
Water Level (mAHD)
565
560
555
550
545
540
535
WB10 Test Pumping
TMPB12 Test Pumping
WB10 Pumping to Ponds
26/3/17
15/4/17
5/5/17
25/5/17
14/6/17
4/7/17
24/7/17
13/8/17
2/9/17
22/9/17
12/10/17
Date
TMAC12M1
TMAC13M1
TMAC14M1
TMAC15M1
WB10MBD
WB11MBD


Ten Mile East Deep Aquifer
Water Level (mAHD)
559.60
559.40
559.20
559.00
558.80
558.60
558.40
558.20
558.00
WB10 Test Pumping
TMPB12 Test Pumping
WB10 Pumping to Ponds
26/3/17
15/4/17
5/5/17
25/5/17
14/6/17
4/7/17
24/7/17
13/8/17
2/9/17
22/9/17
12/10/17
Date
TMAC12M2
TMAC13M2
TMAC14M2
TMAC06
TMAC21M2


Ten Mile West Deep Aquifer
Water Level (mAHD)
570
565
560
555
550
545
540
535
530
525
TMPB26 Test Pumping
TMPB23 Test Pumping
26/3/17
15/4/17
5/5/17
25/5/17
14/6/17
4/7/17
24/7/17
13/8/17
2/9/17
22/9/17
12/10/17
Date
TMAC06
TMAC09M1
TMAC16M1
TMAC21M1
TMAC27M1
TMAC28M1
WB9MBD
TMAC22M1
TMAC23M1
TMAC24M1
TMAC11M1
TMAC26


Ten Mile West ShallowAquifer
559.80
559.60
559.40
559.20
559.00
558.80
558.60
558.40
Water Level (mAHD)
TMPB26 Test Pumping
TMPB23 Test Pumping
26/3/17
15/4/17
5/5/17
25/5/17
14/6/17
4/7/17
24/7/17
13/8/17
2/9/17
22/9/17
12/10/17
Date
TMAC09M2
TMAC11M2
TMAC16M2
TMAC22M2
TMAC23M2
TMAC24M2
TMAC26M2
TMAC27M2
TMAC28M2


Sunshine Deep Aquifer
Water Level (mAHD)
550
545
540
535
530
525
520
515
510
505
500
5/5/17
25/5/17
14/6/17
4/7/17
24/7/17
13/8/17
2/9/17
22/9/17
12/10/17
date
SSPB21 Test Pumping
SSPB18 Test Pumping
SSPB19 Test Pumping
SSPB15 Test Pumping
SSAC01M1
SSAC06M1
SSAC07
SSAC13M1
SSAC14
SSAC15M1
SSAC16M1
SSAC18M1
SSAC19M1
SSAC21M1
SSAC22M1
SSAC24M1
SSAC25M1
SSAC42M1


Sunshine Shallow Aquifer
Water Level (mAHD)
550
545
540
535
530
525
520
5/5/17
25/5/17
14/6/17
4/7/17
24/7/17
13/8/17
2/9/17
22/9/17
12/10/17
date
SSPB21 Test Pumping
SSPB18 Test Pumping
SSPB19 Test Pumping
SSPB15 Test Pumping
SSAC01M2
SSAC06M2
SSAC13M2
SSAC15M2
SSAC16M2
SSAC18M2
SSAC19M2
SSAC21M2
SSAC22M2
SSAC24M2
SSAC25M2
SSAC42M2