PRiMARY GOLD

Toms Gully Underground Project EIS Supplement

Appendix C – Groundwater Modelling

Primary Gold Limited

Toms Gully EIS - Baseline Studies
Groundwater Assessment & Modelling

March 2018

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1. Introduction

1.1 Project background

Toms Gully Mine, located near Mount Bundey in the Northern Territory, has been in operation since 1988. The Toms Gully resource was discovered in 1986 by the Carpentaria Exploration Company. Following its discovery the project area has been operating intermittently under the ownership of several different operators, most recently Crocodile Gold, until 2010. Then, after a period of Care and Maintenance, it was divested to Primary Gold Ltd. Operating conditions at Toms Gully Mine have been subject to obligations outlined in the Public Environmental Review (PER) and associated documents that were released in 1988 and a series of waste discharge licences (WDLs).

Primary Gold Limited, the new lease owner, proposes to recommence underground mining and ore processing at the Toms Gully Mine. This will include:

- construction of a new process water dam;
- dewatering and refurbishment of the existing workings;
- upgrade of the new Tailings Storage Facility (TSF); and
- refurbishment and upgrade of the processing circuit.

The NT EPA determined that the Project required assessment under the *Environmental Assessment Act* at the level of an Environmental Impact Statement (EIS). A draft EIS document was lodged with the NT EPA in 2015. Subsequently comments were received, and this document contains further work in response to comments raised regarding hydrological conditions at the Toms Gully site.

1.2 Purpose of this report

The purpose of this report is to further define the current baseline hydrogeology of the site and provide a basis from which to identify existing conditions including hydrogeological impacts from previous mining operations, and against which to measure future hydrogeological impacts of the proposed mining operations.

1.3 Scope and limitations

1.3.1 Scope of works

The scope of works for this study includes:

- Review all available previous hydrogeological investigations;
- Identify any gaps in baseline data;
- Address critical data gaps;
- Update the site Conceptual Hydrogeological Model (CHM);
- Develop and calibrate a baseline numerical groundwater flow model to describe current conditions and to provide a basis for simulation of potential impacts.

1.3.2 Limitations

This report has been prepared by GHD for Primary Gold Limited and may only be used and relied on by Primary Gold Limited for the purpose agreed between GHD and the Primary Gold Limited as set out in section 1.3.1 of this report.

GHD otherwise disclaims responsibility to any person other than Primary Gold Limited arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described throughout this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Primary Gold Limited and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

GHD has not been involved in the preparation of the EIS and has had no contribution to, or review of the EIS, other than in the Groundwater Model Report. GHD shall not be liable to any person for any error in, omission from, or false or misleading statement in, any other part of the EIS.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

1.4 Assumptions

GHD has assumed that the spatial hydrogeological, geochemical and other data provided by Primary Gold are accurate and representative of current site conditions. GHD recognises that the near-mine bore elevations have been inferred from LIDAR-derived ground elevations and hand-held GPS coordinates and consequently are not considered to have sub-metre accuracy. Beyond the extent of the LIDAR coverage, the location and elevation accuracy is likely to be even lower. Details of monitoring bore construction were not available for most bores but GHD has assumed they have been appropriately constructed and provide representative water samples and groundwater levels.

1.5 Previous investigations

Based on data presented in previous reports, historical hydrogeological assessments undertaken in the Project Area include the following reports were produced, of which only reports 5, 12 and 13 were available for review for the current baseline study:

1. Coffey & Partners Pty Ltd, (1988) A geotechnical and hydrogeological assessment, including inflow estimates for design of the mine, plant, and tailings storage facilities.
2. Dames & Moore Pty Ltd, (1991) Design and installation of ten groundwater monitoring bores, nine of which were to be incorporated into the water quality monitoring network of 13 groundwater sampling points and seven surface water sites.
3. Dames & Moore Pty Ltd, (1993) Assessment of surface water and groundwater quality data and recommendations for future monitoring of groundwater.
4. Rockwater Pty Ltd (1993) Assessment of the dewatering requirements of the open cut, including a pumping test (DB2) to estimate hydraulic parameters, used to construct a MODFLOWEM model to simulate pit dewatering.
5. Rockwater Pty Ltd (1994a) Initial assessment of the hydrogeology based on existing data and proposed drilling and testing program for developing and testing the groundwater supplies.
6. Rockwater Pty Ltd (1994b) Assessment of pumping requirements required to dewater the existing pit within three months, based on a numerical model to simulate the dewatering requirements.
7. Rockwater Pty Ltd (1995) Installation and testing of 6 groundwater exploration holes (WB1 to WB6), and 4 production bores (WB1P, WB4P, WB5P, and WB6P). Included a 48 hour constant rate pumping test on each production bore to determine aquifer hydraulic properties.
8. Evantech Pty Ltd (1997) provided a short summary of issues surrounding disposal of excess water in the Project Area.
9. Water Studies Pty Ltd (2000). A groundwater inflow assessment for the open pit and water balance simulations to assess the potential to dewater the pit during the 2000 dry season.
10. H2O Pty Ltd (2001) A rehabilitation program on 4 bores, DB2, P62, P68, and P73, which included jetting and surging or airlifting each bore between 4-11 hours.
11. Australasian Groundwater and Environmental Consultants (AGE) Pty Ltd (2004a, and 2004b) Two reports providing a hydrogeological assessment and numerical modelling of dewatering options. Included recommendations for an expanded groundwater monitoring network and testing regime.
12. Coffey. (2015). Toms Gully Gold Mine Water Balance Model.
13. Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) (2015). Review of groundwater inflow data collected since 2005. The previous numerical model was updated to provide groundwater inflow estimates to the existing and proposed underground mine areas.
14. Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) (2015). Groundwater Impact Assessment. Review of previous reports, updating of conceptual hydrogeological model, development of updated monitoring network to define baseline conditions and assess future impacts on water levels and chemistry and assessment of impacts from dewatering, surface water, tailings and waste rock storage. The report included a description of baseline geochemistry and hydraulic properties, upon which this study builds.

2. Site description

2.1 Regional Climate

The Toms Gully Mine project area is within tropical northern Australia and has a tropical monsoonal climate with a pronounced wet season from October to April (Figure 2-1) Long-term rainfall data was available from the Bureau of Meteorology (BoM) weather station located at Wildman Rangers (Station 14275) which is the nearest active BoM rainfall station to the site.

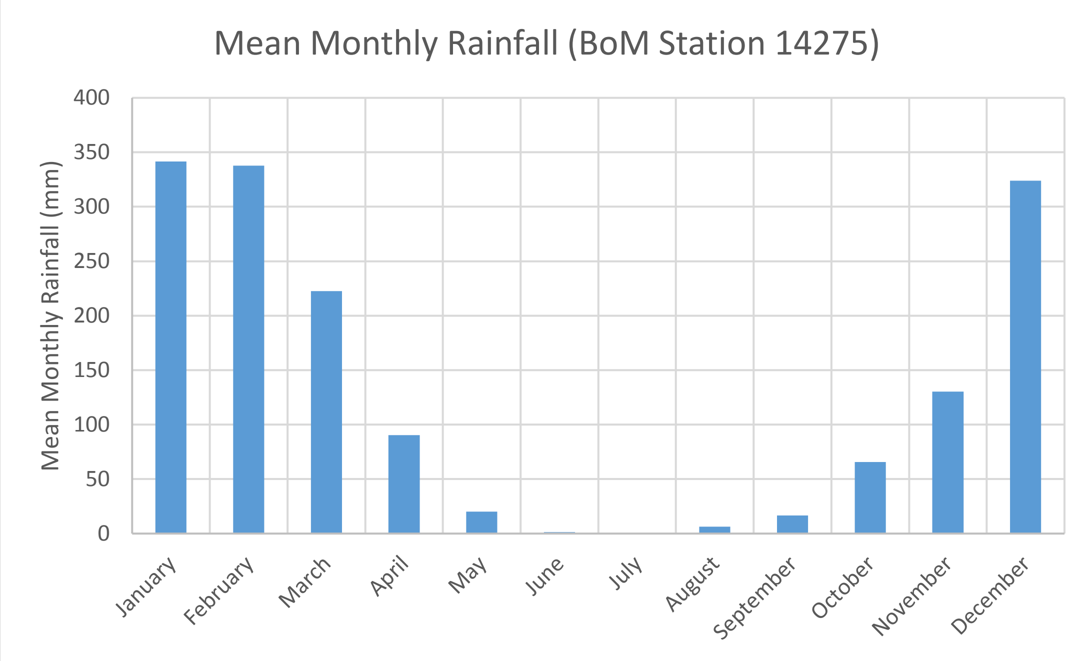

Figure 2-1 Mean monthly rainfall (BoM station 14275)

Water courses in the project area are ephemeral and cease to flow during the late dry season, but have regular flows during the wet season, extending into the early dry season for the major water courses. Some seasonal and semi-permanent waterholes exist in the project area. These are likely to be ecologically important as they likely serve as a refuge for fish and aquatic reptiles during the dry season (GHD, 2015).

2.2 Surface water features

The Toms Gully Mine site is within the Mount Bundy Creek catchment, which comprises a series of small ridges and dissected hills that are drained by small, steep rivulets, which converge into Mount Bundy Creek. The majority of the catchment upstream of the project area consists of outcropping rock with thin soil cover and shallow alluvium drainage lines. The total catchment area upstream from the mine is approximately 117 km^2. Mount Bundy Creek flows west to east along the northern section of the project area. Coulter Creek is a tributary of Mount Bundy Creek and flows southwest to east (to the south of the project area). Coulter Creek flows into Mount Bundy Creek downstream of the project area.

Mount Bundy Creek is approximately 30 km long with approximately 13 km upstream of the mine site. The creek has several tributaries upstream of the project area and ultimately drains into Hardies Creek then the Mary River. The *Water Act* provides a framework for the declaration of beneficial use and objectives in the Northern Territory. Currently Mount Bundy Creek Beneficial Use Declaration (1997) states that: Stock water supply is the beneficial use extending from the Arnhem Highway Crossing approximately 3 km downstream. The remainder of Mount Bundy Creek has aquatic ecosystem protection objectives defined as 'Fresh waters' aquatic ecosystem protection guidelines (ANZECC & ARMCANZ, 1992). However, this guideline has been superseded by ANZECC & ARMCANZ (2000) and these values have been replaced with the 80% species protection level for water quality assessment (GHD, 2015) and 95% species protection level for this report as a conservative approach. Note that both the 80% and 95% protection level offer a greater level of ecosystem protection that the stock watering trigger values. Several small waterholes were observed along Bundy Creek during the dry season, some of which, adjacent to the open cut area, appeared to be spring fed as indicated by damp areas on the creek bank, but significant groundwater discharges were not observed (Wyatt Pers comm 2018).

2.3 Mine Features

In a hydrogeological context, the significant mining features (Figure 2-2) include:

- Flooded open cut pit and connected underground workings;
- Water storage dam (referred to as Lake Bazzamundi);
- Evaporation Ponds (EP1 and EP2)
- Tailings storage facilities (TSF1 and TFS2); and
- Waste rock dumps (Sulphide WRD and Oxide WRD).

LEGEND
- Mine Site Layout
- Water Body Perennial
- Watercourse Intermittent

Paper Size A4
0 250
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 52

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Primary Gold Limited
Toms Gully EIS\Groundwater Assessment

Job Number	43-22623
Revision	0
Date	22 Sep 2017

Mine Site Layout

Figure 2-2

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com W www.ghd.com.au

G:\43\2262304\GIS\Maps\Working\Report\4322623_104_Mine_Site_Layout_RevA.mxd

Data source: Commonwealth of Australia (Geoscience Australia): DTDB, 2015. ESRI: Imagery, 2017. Created by: tmorton

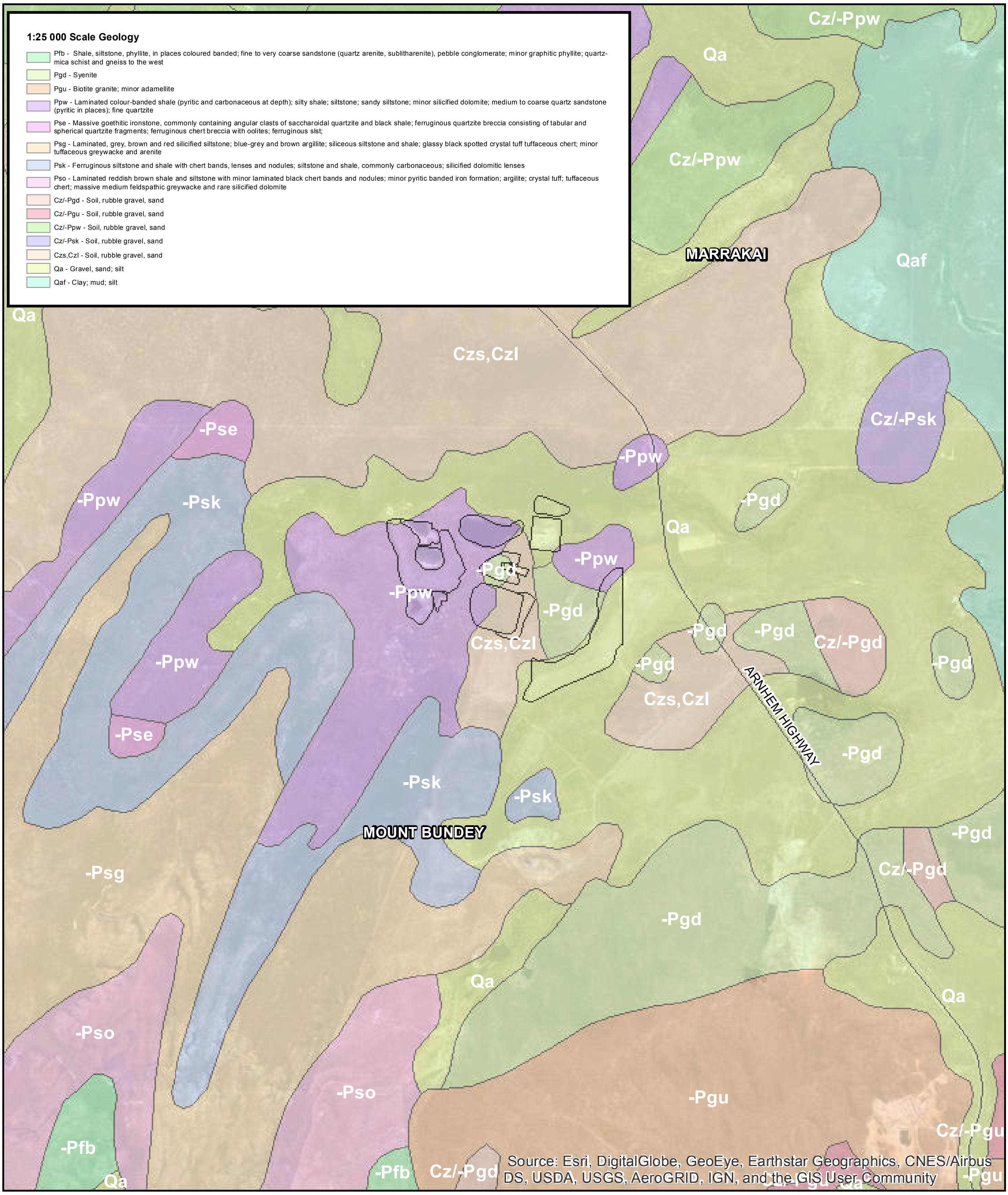
3. Geology and topography

Soil cover is generally thin (0.5 to 4 m) and alluvial sediments are confined to present day drainage features and not laterally extensive. The surface elevation of the Project Site reaches 51 m Australian Height Datum (AHD) in the southwest corner of the mining lease and falls to 16 mAHD in the low-lying areas. The local geology is summarised in Table 3-1 and Figure 3-1 below.

Table 3-1 Summary of Local Geology (compiled from AGEC 2004 and Rockwater 1994)

Area	Description
Geology	
Alluvium	Mount Bundy Creek crosses the Project area approximately 300 m north of the Toms Gully Pit. The thickness or presence of alluvium associated with this water course is unknown. A review of aerial photography suggests, if present, it is confined to the present day channel and not laterally extensive. Rockwater (1994) considered the alluvial sediments to be relatively clayey.
Wildman Siltstone	The Wildman Siltstone part of the Mount Partridge Group and the Woodcutters Supergroup consists of siliceous, predominantly banded, dark grey siltstone, and black, silty shale, with beds of quartz sandstone. The sediments were deposited in a shallow marine, prodelta or mid-shelf depositional setting during the Orosirian (2029 Ma to 1890 Ma) geologic period. It is commonly highly fractured. The Wildman Siltstone is the host rock at the site.
Cullen Supersuite	The Cullen Supersuite comprises of a number of I-type granitic plutons which formed approximately 1835 Ma to 1820 Ma. The Mount Bundey Suite is part of the Cullen Supersuite and comprises of the Mount Bundey Granite and the Mount Goyder Syenite. The Mount Goyder Syenite outcrops to the east of the Open Pit and the Crabb Fault. The intrusion was intersected by the decline. The intrusion has produced an approximately 500 m wide hornfelsed aureole in the siltstone which is generally more resistant to weathering compared to the intrusion. The syenite is not extensively fractured
Lamprophyre Dykes	Lamprophyre dykes have been identified within pre-existing structures at Toms Gully Mine. Although the dykes intrude both members of the Mount Bundey Suite, they are thought to be co-genetically and temporally related to the granitoids.
Geological Structures	
Folding	A series of gentle folds are mapped across the Project site including a fold in the pit wall. The fold axes trend north-northeast and plunge gently to the south, parallel to the plunge of the quartz vein.
Crabb Fault	The Crabb Fault is a south-southwest trending fault which dips to the west at approximately 80 degrees. The Crabb fault intersects the eastern end of Toms Gully Open Pit and represents the eastern extent of gold mineralisation. Although the apparent displacement of the Crabb Fault is small, the quartz vein steepens significantly to the east of the fault and changes in strike from east-west to northeast-southwest. The nature of the Crabb Fault zone is highly variable, at the Open Pit high wall the fault is a fractured rock mass up to 15 m wide and has resulted in slope failures during mining. However, at the low wall there is little evidence of the fault. Where the fault has been intruded by dykes, the material is often highly weathered and of very low strength. It contains sulfides, fractured quarts and laminated black shale.
Williams Fault	The Williams Fault is located approximately 400 m west of the Crabb Fault and is believed to be the western extent of the ore zone. Previous investigations suggest

Area	Description
	that there is approximately 15 m displacement along the Williams Fault at the Project Site. Dyke intrusions have been identified at random locations along the fault trace, with localised quartz infilling.
Ore Zone Fault	The ore zone is in the form of a 0.5-4 m-thick, quartz-filled breccia zone, with associated arsenopyrite and pyrite, along an unnamed thrust fault, dipping at a shallow angle to the south. It extends at least 1500 m down dip from the open cut.



LEGEND

Mine Site Layout

Roads

Paper Size A4

0 0.5 1 1.5 2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 52

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Site Geology

Job Number	43-22623
Revision	0
Date	22 Sep 2017

Figure 3-1

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com W www.ghd.com.au

G:\43\2262304\GIS\Maps\Working\Report\4322623_102_Geology_RevA.mxd

Data source: Commonwealth of Australia (Geoscience Australia): DTDB, 2015. ESRI: Imagery, 2017. Created by: tmorton

4. Hydrogeological characterisation

4.1 Hydrogeological Units

Previous work by AGEC (2004) and Rockwater (1994) has identified three broad groundwater systems/hydrogeological units within the project area. They are:

- Upper weathered profile in the Wildman Siltstone and more distance metasediments and igneous rocks, with relatively low permeability;
- “Fresh” Wildman Siltstone and other fractured rock aquifers with moderate to high permeability; and
- The highly permeable ore body fault zone and the Crabb Fault

The fresh Wildman Siltstone acts as a fractured rock aquifer with little to no primary porosity between fracture zones. Typical of fractured rock aquifers, the permeability is dependent of regional tectonic fracturing, characterised by vertical jointing and the discrete faulting noted above, overprinted with extensive sub-horizontal jointing associated with stress relief as overlying rock is removed by erosion. Fracturing is more intense along fold axes (Coffey, 2015).

In most lithologies, the density of this stress-relief fracturing gradually decreases with depth, typically becoming negligible at around 50-100 m below surface. The fracturing is commonly partially blocked by clayey weathering products at the base of the weathering profile. Although the extent of fracturing will vary with primary lithology, tectonic and erosional history, a typical permeability profile (with approximate depths), which tends to follow topography, may be:

- Shallow extremely weathered rock and soil/alluvium (0-10 m)
- Low to moderate-permeability, partially weathered fractured rock with clay filled stress-relief and tectonic fractures to a depth of 40 m (Coffey, 1988);
- Permeable, fractured rock with open stress-relief and tectonic fractures (40-60 m);
- Deep low-permeability rock with tectonic fracturing only (60-100 m+).

The adjacent syenite and other igneous rock are likely to follow a similar pattern, complicated by the addition of cooling fractures/joints, although it was observed at the site to be significantly less permeable (Rockwater, 1994) .

The ore zone is bounded to the west by the Williams Fault and to the east by the Crabb Fault and is the primary aquifer at the site. It comprises a mylonite and breccia zone around 1-2 m thick, dipping initially at around 30° to the south at the sub/outcropping, northern end (~30 mAHD), and flattening out to less than 10° at the southern end, from around 400 m down-dip, at a depth of around 200 m (-210 to -230 mAHD). Airlifted yields from exploration boreholes drilled in the ore zone were relatively high, at up to 25 L/s with an average of 5 L/s, where recorded (AGEC, 2004).

The Crabb Fault, approximately 15 m wide, is also highly permeable in places (AGEC, 2004) whereas the Williams fault is considered to be a low-permeability flow barrier.

4.2 Groundwater monitoring

Groundwater monitoring is currently undertaken at the project site with the groundwater monitoring network comprising nine bores, the details of which are shown in Table 4-1, in addition to the historical bores not regularly monitored. The location of the bores and the loggers is shown on Figure 4-1. In December 2016, GHD installed groundwater level loggers in three monitoring bores (DB1, WB4P and G9) and a single logger on the Pit to automatically record the fluctuation in groundwater and pit water level. Logger data from 08/12/2016 to 06/07/2017 was available for this study. The bore locations are based on hand-held GPS or historic approximate locations, with elevations based on LIDAR ground surface elevations for near-mine bores and SRTM data for others and some bores show a significant difference between GPS and database location data. Consequently the locations and ground elevations (and resultant groundwater elevations) potentially have significant errors. It is proposed to carry out a differential GPS survey in the next dry season to improve location accuracy.

Table 4-1 Groundwater Monitoring Network

Monitoring Bore	Coordinates		Elevation[a] at TOC (m AHD)*	Depth (m BGL)	Screen Interval (m BTOC)		Date Installed
	Easting	Northing			Top	Bottom	
Currently Monitored Bores (AGE 2015)							
WB1P (Ridge Bore)	777559	8579124	54.2	-	-	-	-
WB5P	776808	8579425	31	106.88	58.8	106.9	19/11/94
BORE 11	777288	8579016	37.1	-	-	-	-
OB11	777186	8580322	20.1	-	-	-	-
G1	777009	8580348	25.3	15.5	13.5	15.5	18/09/91
G2	777683	8579727	42.7	21.5	19.5	21.5	18/09/91
G8	777021	8580019	33.5	26	22	26	20/09/91
G9*	777663	8580478	21.9	30.5	28.5	30.5	21/09/91
RN29694 (WB4P)*	776935	8580080	27.1	95.83	42	95.8	21/11/94
Other Existing and Historical Monitoring Bore							
S01#	777477	8579112	51.29	-	-	-	27/04/15
W6#	777330	8579561	43.85	55	40	55	14/06/88
No. 1#	777330	8579561	43.85	79	67	79	15/11/87
WB2 (Oxide dump bore)#	777680	8579480	45	-	-	-	10/11/94
WB6P (Tailings bore)	777316	8579631	40.1	108.32	60.6	108.3	24/11/94
DB2#	777879	8579910	34	110	95	110	18/07/93
DB1*	777746	8579911	40.4	132	78	132	14/07/93
W7#	776930	8579990	32	93	78	93	16/06/88
W4#	776930	8580160	32	73	63	73	9/06/88
W5#	776930	8580300	27	65	50	65	12/06/88
RN035637#	777580	8580319	28	-	-	-	22/02/07
W01#	778353	8580376	21	-	-	-	17/06/05
W02#	778354	8580441	21	-	-	-	17/06/05
WB3	778340	8580420	18.5	-	-	-	13/11/94
P90	778124	8580051	22.4	-	-	-	-
P62	777751	8580001	44.8	-	-	-	-
P68#	777782	8579972	38	-	-	-	-
P73#	777850	8579991	30	-	-	-	-
Gully Bore#	777385	8579183	48	-	-	-	-
G3	777352	8580420	18.6	18	12	18	18/09/91
G4#	777373	8580051	31	42	30	42	18/09/91
G5#	778253	8579448	32	10.5	8.5	10.5	19/09/91
G6	777182	8579325	35.2	42.5	36.5	42.5	19/09/91
G7a	777246	8580558	22.72	18.5	16.5	18.5	20/09/91
G7b	777246	8580541	22.72	38	32	38	22/09/91

Monitoring Bore	Coordinates		Elevation[a] at TOC (m AHD)*	Depth (m BGL)	Screen Interval (m BTOC)		Date Installed
	Easting	Northing			Top	Bottom	
G10#	777546	8579602	45	-	-	-	21/09/91
OB10	777296	8580330	19.0	~30	-	-	-
RN034537	778581	8579656	37	242	84	242	7/05/05
RN034538	778581	8579656	37	187.7	44	187.7	12/05/05

* Logger installed December 2016

a Elevation based on LIDAR or SRTM.

Not inspected as part of this study and elevations by SRTM hence elevation ± 10 m

4.3 Groundwater usage

The NT groundwater database (accessed 2017) contains 37 registered bores (Table 4-2) within a 4 km radius of the lease boundaries, including 18 registered bores (bold and underlined) included in the monitoring network (Table 4-1). The locations of these bores are shown in Figure 4-2. The bores are used primarily for stock or domestic supplies, with yields ranging from less than 1 L/s to 25 L/s. The high-yielding production bores are generally less than 50 m deep.

The coordinates in the NT database appear to be based on sketched locations from the licence application rather than survey data as they show a significant mismatch (some in the order of 1 km) with the site bores with GPS survey locations.

Table 4-2 Registered Bores

Bore number	Other name	Use	Drilled depth (m)	Water level (mbGL)	Yield (L/s)
RN005881	B 1 MT.BUNDY MINE CAMP SITE	investigation	45.7	10.7	0.94
RN005882	B 2 MT. BUNDY MINE CAMP SITE	not in use	45.7	-	0
RN005912	NO.3 MT BUNDY STN SITE K	production	36.6	7.9	25
RN006924	Mt Bundy Mine No 1	production	54.9	8.8	4.54
RN008712	MT. BUNDY STN. CRUSHER SITE	production	10.6	1.8	1.5
RN024729	BALDWIN T OLD MT BUNDY MINE	production	16	3	0.5
RN024730	BALDWIN T OLD MT BUNDY MINE	production	20	2.5	0.38
RN025598	No. 1	production	79	7	5.1
RN026200	W4	production	73	8	3.12
RN026201	W5	production	65	8	7.2
RN026202	W6	production	55	8	4.5
RN026203	W7	production	93	7	12.5
RN027479	POLICE CADETS BORE MT. BUNDY AREA	production	32	-	10
RN027654	QUARRY INDUSTRIES MT.BUNDY	production	66.7	-	1
RN027956	HOMESTEAD NO.2 OLD MT.BUNDY	production	39	7	3
RN028318	DB2	production	110	57.6	5
RN028319	DB1	observation	132	69.8	3
RN028786	BARRY COULTER 1/93 MOUNT BUNDY	production	78	44.5	1

RN029677	W02	investigation	74.3	-	0
RN029678	W01	investigation	-	-	0
RN029679	S01	investigation	-	-	0
RN029690	WB2	observation	121.6	31.4	2.5
RN029691	WB3	observation	115.5	7.8	0.5
RN029692	WB1P	production	114	39	10
RN029693	WB5P	production	111	12.1	10
RN029694	WB4P	production	96	11.9	15
RN029695	WB6P	production	108	23.6	6
RN033879	CHRISTIAN OUTREACH CENTRE (T. BALDWIN)	not in use	54	-	0
RN033880	CHRISTIAN OUTREACH CENTRE (T. BALDWIN)	production	54	8	12
RN033881	CHRISTIAN OUTREACH CENTRE (T. BALWIN)	production	72	-	13
RN034537	RENERSONS N/L MINE	production	242	-	5
RN034538	RENERSONS N/L MINE	production	187.7	-	4
RN035637	RENISONS	other	265	-	3
RN035786	B.F. COULTER	Irrigation	30	10	16
RN036024	B.F. COULTER	none	60	dry	dry
RN037520	Drill & Fire Pty ltd	production	40	3	0.5
RN038456	B.F. Coulter (Boral Quarries)	production	79	10	1

Paper Size A4

0 40 80 160 240 320 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 52

N

LEGEND

- Groundwater monitoring bores
- Mine Site Layout
- Water Body Perennial
- Watercourse Intermittent
- Drain

Primary Gold Limited
Toms Gully EIS\Groundwater Assessment

Job Number | 43-22623
Revision | A
Date | 14 Mar 2018

Near Mine Groundwater Monitoring Locations

Figure 4-1

G:\43\2262304\GIS\Maps\Working\Report\4322623_103_Near Mine Bores_RevA.mxd

2 Salamanca Square Hobart TAS 7000 Australia T 61 3 6210 0600 F 61 3 6210 0601 E hbamail@ghd.com W www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by: drockliff

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Revision	A
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Registered Bores

Figure 4-2

G:\43\2262304\GIS\Maps\Working\Report\4322623_105_Registered_Bores_RevA.mxd

2 Salamanca Square Hobart TAS 7000 Australia T 61 3 6210 0600 F 61 3 6210 0601 E hbamail@ghd.com W www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by: drockliff

4.4 Groundwater levels and flow

4.4.1 Historical data

Pre-mining groundwater levels in the northern part of the mine ranged from 15 mAHD to 18 mAHD (Coffey, 1988), with the watertable in the pit area at approximately 16 mAHD (Rockwater, 1993). AGE (2015) noted that bore WB3, to the northeast of the open cut, did not show a response during pit dewatering in 2004 (Figure 4-3), suggesting a lack of connection to the faults or mine voids and a low hydraulic conductivity to the east of the Crabb Fault. In contrast DB1 and DB2 showed a direct connection to the pit, plotting along the same curve as the pit water level and P90 showed a partial connection, plotting as a subdued version of the pit water level drop. Primary Gold (2015) presented a cross section schematic representing the contempory groundwater levels relative to the mine features (Figure 4-4).

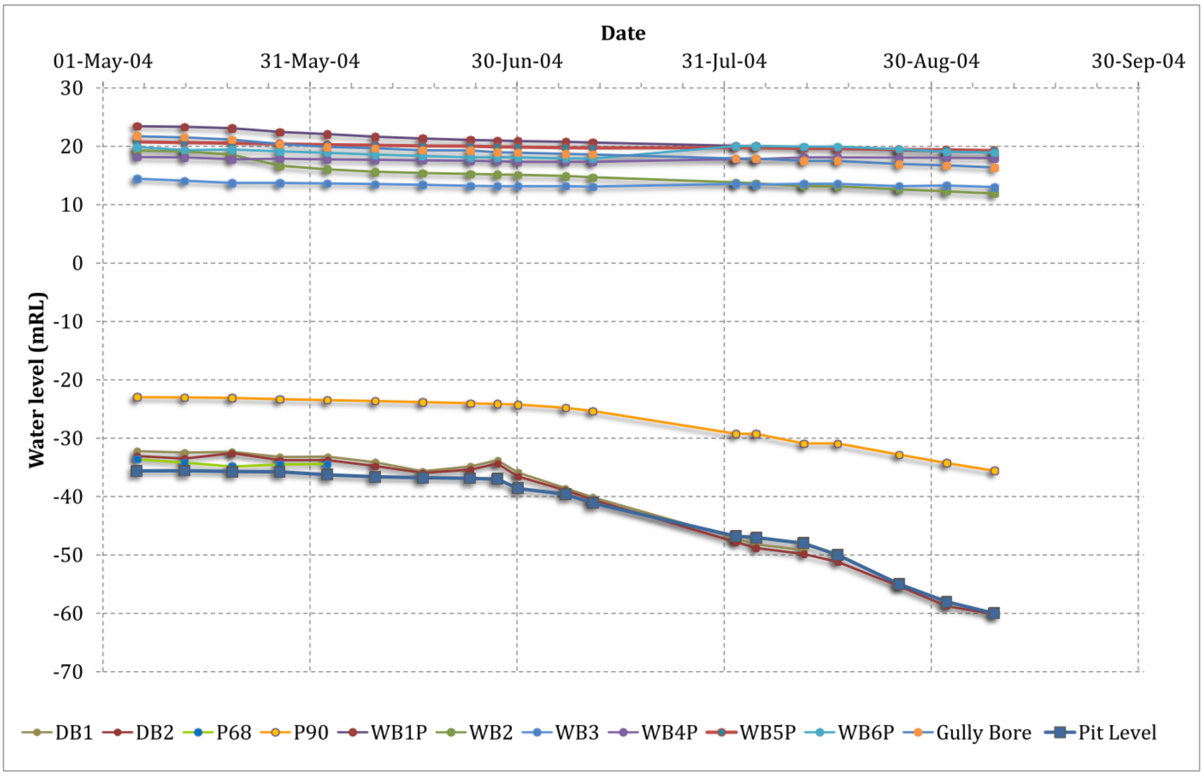

Figure 4-3 Groundwater Hydrographs 2004 (AGE 2015)

4.4.2 Groundwater levels 2016-2017

Groundwater levels in the vicinity of the mine were measured in all accessible bores on 8 December 2016 with water level loggers fitted to bores DB1, WB4P and G9 and the open cut pit lake, along with a barometric logger. The readings, which ranged from 4.10 m to 38.98 m below the top of casing (BToC) or 6.6 to 18.0 mAHD[1], represent end of dry season conditions. Simple Krigged contours of water levels (Figure 4-5), which do not take into account geological or other hydrological conditions, show a hydraulic gradient in December 2016 towards the flooded opencut. The apparent low point is displaced south of the pit due to the lack of monitoring points on the northern perimeter. At the time, the water level in the open cut was approximately 6.8 mAHD and the adjacent bed of Bundy Creek, around 350 m to the north of the pit perimeter, is at an elevation of 13 mAHD. This indicates that the open cut was likely to

[1] Bore collar elevations are based on LIDAR ground elevations lateral coordinates are based on hand-held GPS and consequently are considered to only have metre-order accuracy at best.

be acting as a sink for surrounding groundwater, including that beneath the various waste rock dumps and tailings storage facilities.

Groundwater levels were elevated around the sulfide waste rock dump (SWRD) and adjacent evaporation ponds (EP1 and EP2). This is consistent with observations of limited capping and surface drainage on the waste rock dump top and side slopes and porous nature of the waste rock, which will result in high levels of recharge. Similar mounding around the SWRD and oxide waste rock dump (OWRD) were noted by Dames and Moore (1993). However, water levels were similar at the two southernmost bores Bore 11 and WB1P Ridge Bore, suggesting localised recharge from the WRD was not the only source of mounding, with seepage from TSF1 and Old Decant Pond being a potential source. It is also possible that the shallow bores such as G1, OB111 and OB10 intercept shallow aquifers.

Water level data, recorded at 6-hourly intervals from 8 December 2016 to 6 July 2017 (date of most recent download) are presented in Figure 4-6 to Figure 4-7. The pit and monitoring bores show a clear increase in water levels over the wet season. Bore DB1 (Figure 4-6) closely mimics the open cut pit water level (Figure 4-7), increasing from around 6.5 mAHD to 8.95 mAHD and dropping to 8.88 mAHD over the remainder of the logged period to 6 July 2017, suggesting near direct connection of the local aquifer with the pit or underground voids. At the end of the logging period, the water level in the pit was still around 4 m below Bundy Creek bed level and the surrounding groundwater, indicating the pit was still acting as an evaporative sink.

G9 and WP4B showed an increase of around 4 to 5 m until the end of March 2017, then a steady decline of around 1.5 to 2 m until July 2017, which is typical of seasonal groundwater recharge and discharge. At all times, the water level in the pit was below the surrounding groundwater level, other than for DB1.

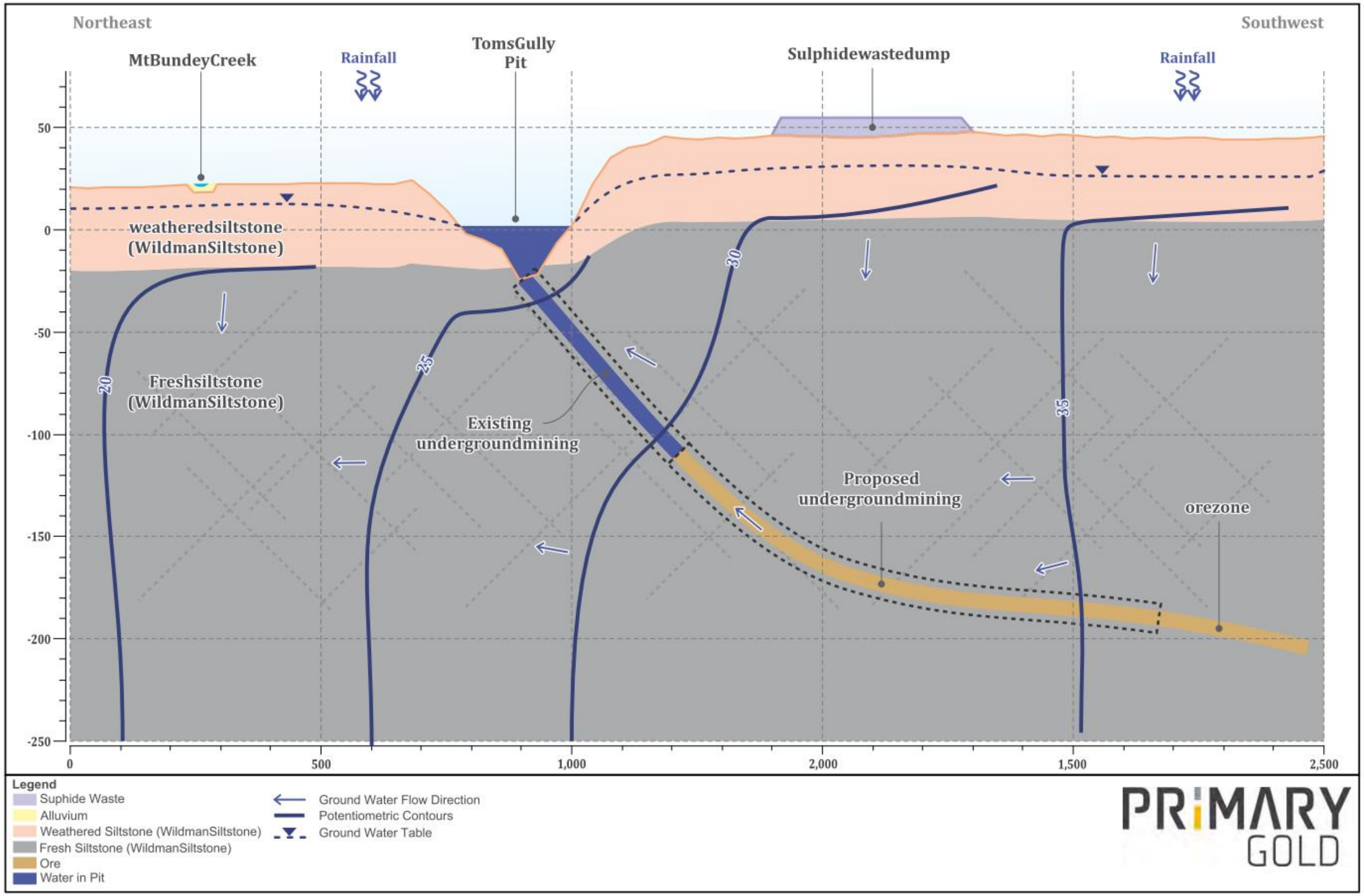

Figure 4-4 Site groundwater cross-section contours in mAHD (Primary Gold, 2015)

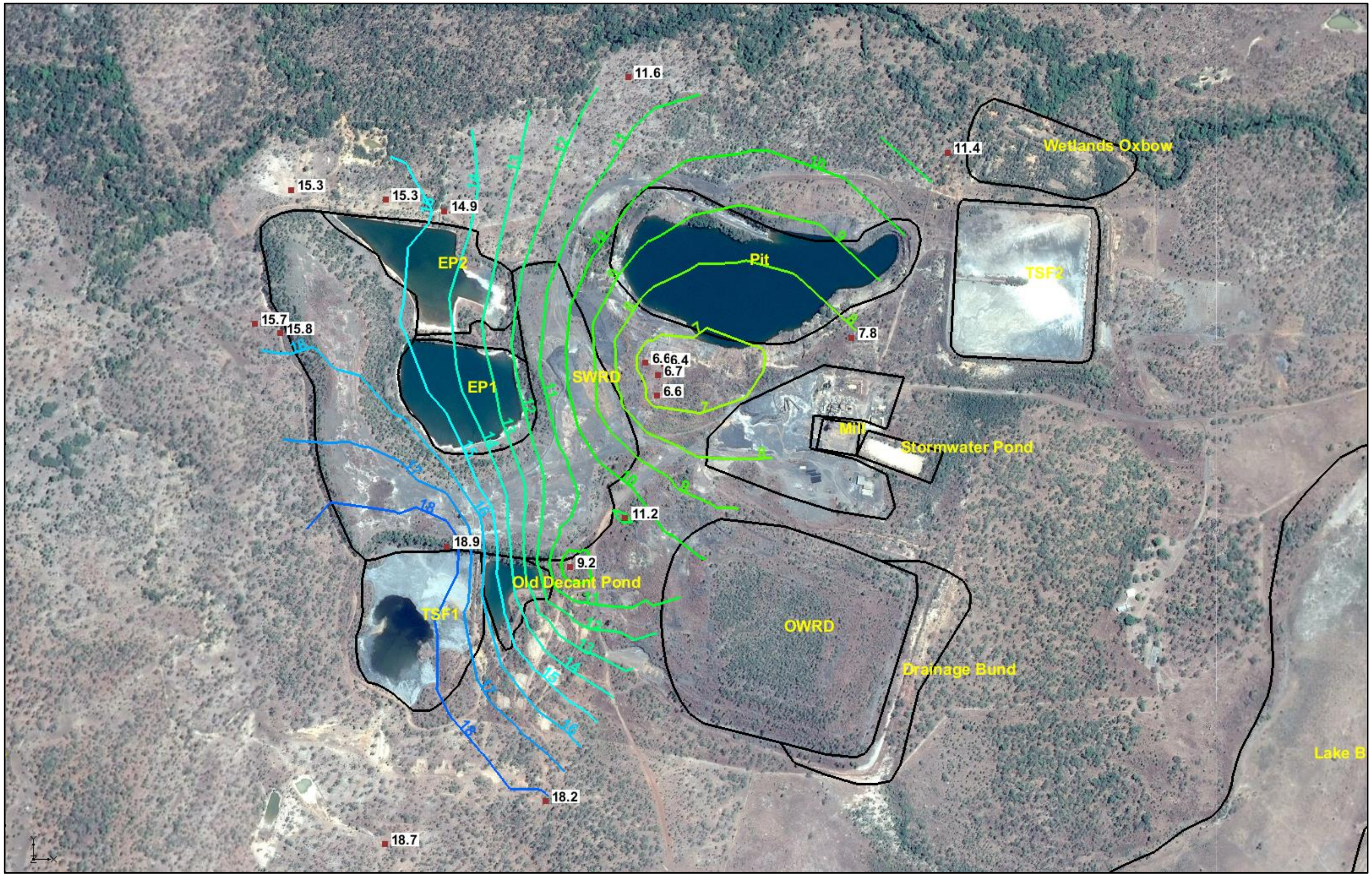

Figure 4-5 December 2016 groundwater levels and contours (mAHD)

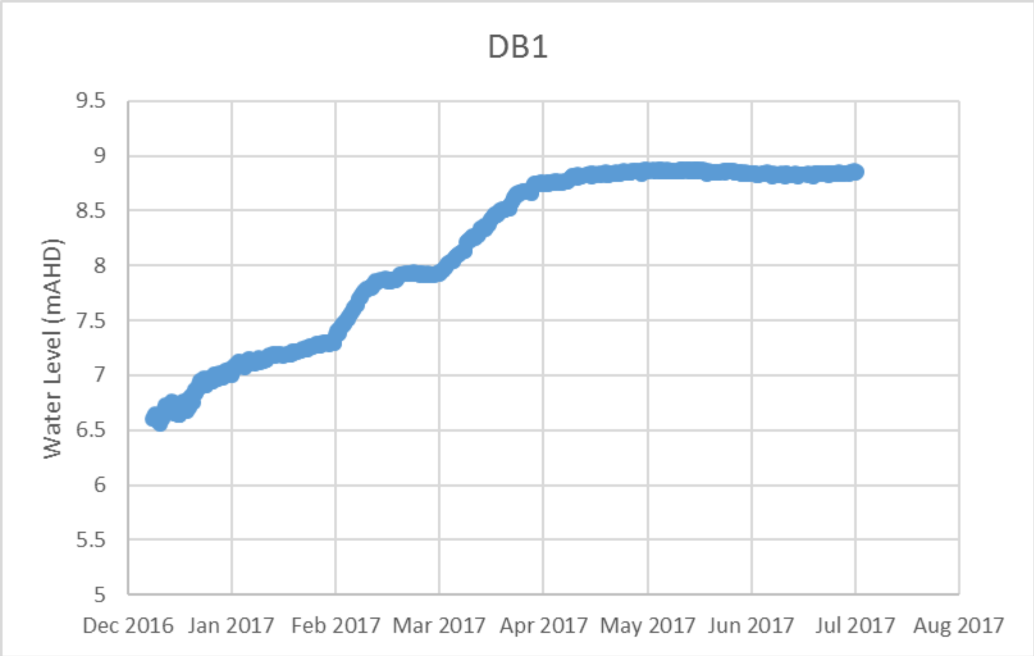

Figure 4-6 Water levels DB1

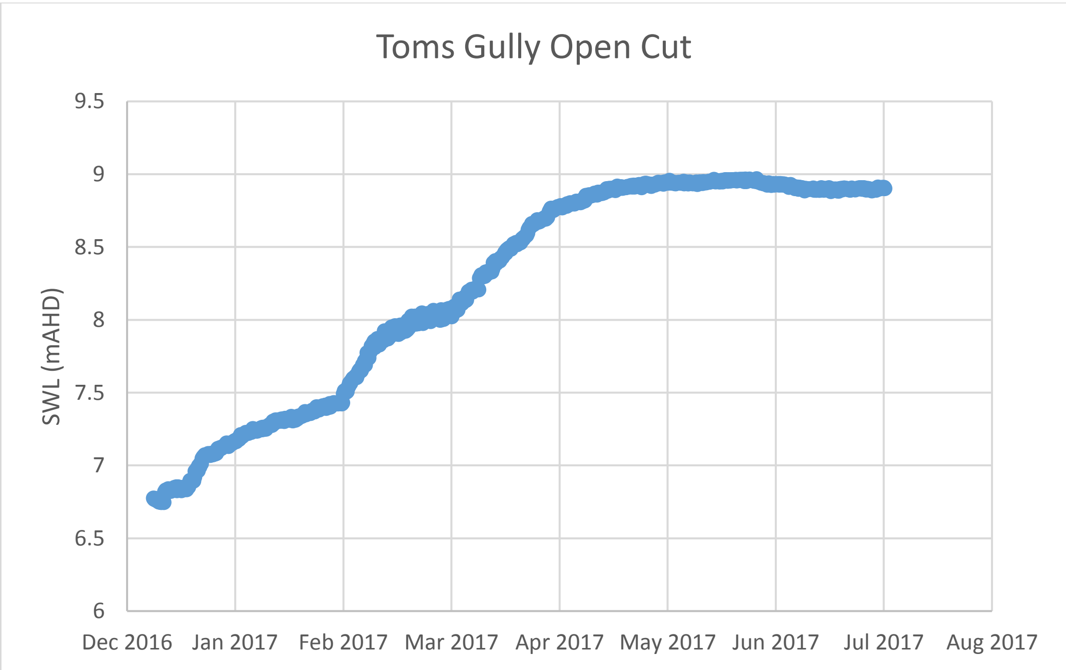

Figure 4-7 Water Levels Open Cut

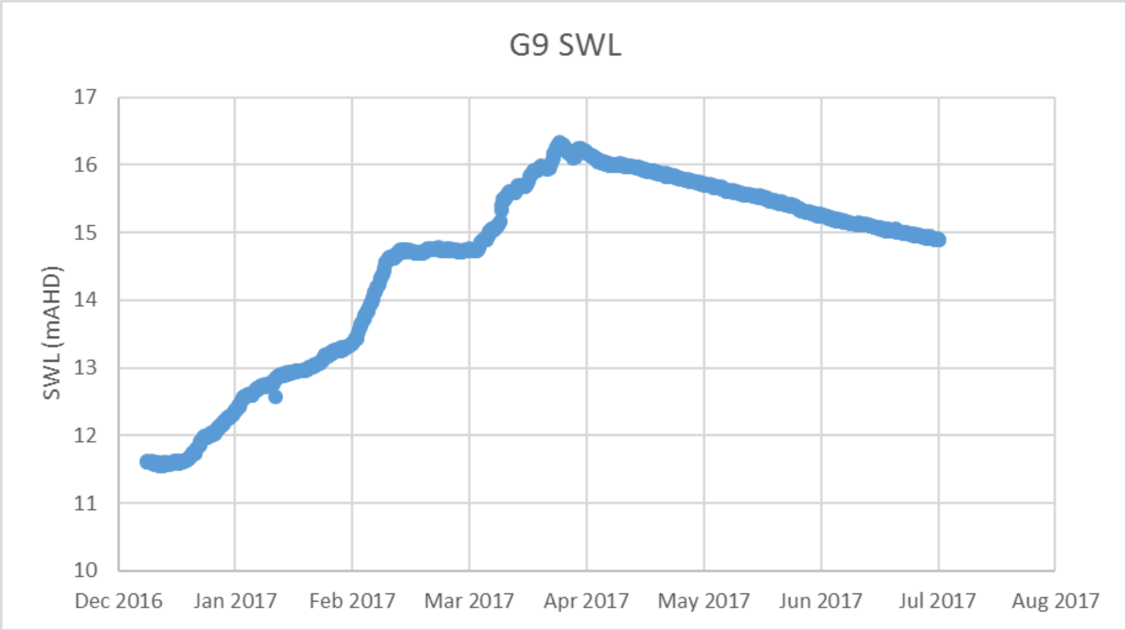

Figure 4-8 Water levels G9

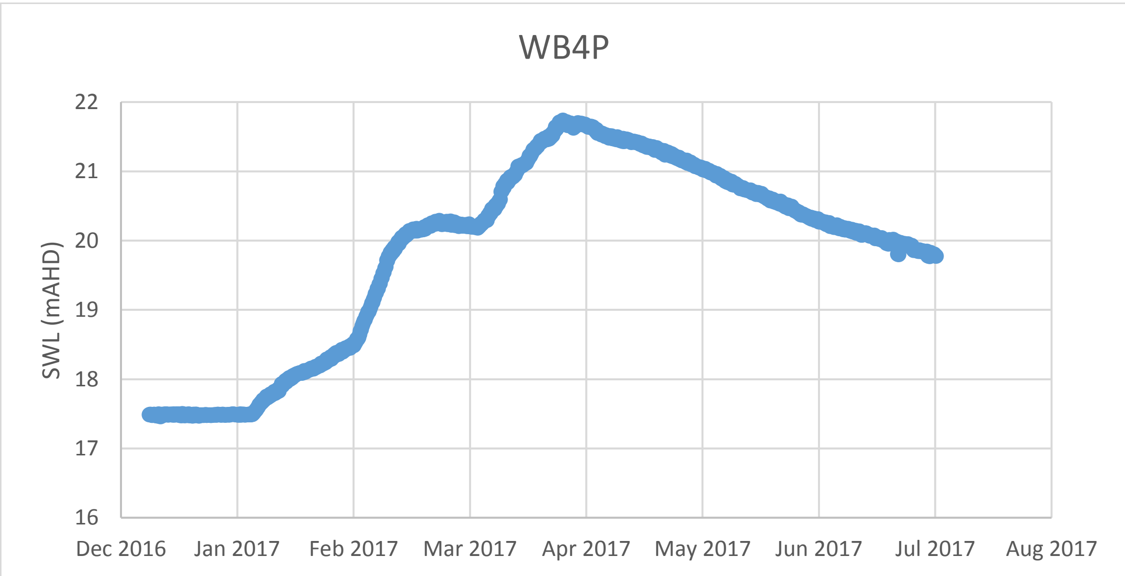

Figure 4-9 Water levels WB4P

4.5 Groundwater recharge and discharge

Recharge to the fractured groundwater system, the ore zone and Crabb Fault, is likely to be via direct infiltration where they outcrop, via seepage from the overlying weathered siltstone and due to direct contact with the mine voids. Other than the immediate pit area, it is unlikely that there is significant recharge from the local creeks given their ephemeral flow and the elevation of the surrounding groundwater above creek level, where measured.

Recharge estimates, for the grid segment at 12.85º S 131.55º E, were derived from the Deep Drainage values from Bureau of Meteorology's Australian Landscape Water Balance web site http://www.bom.gov.au/water/landscape.

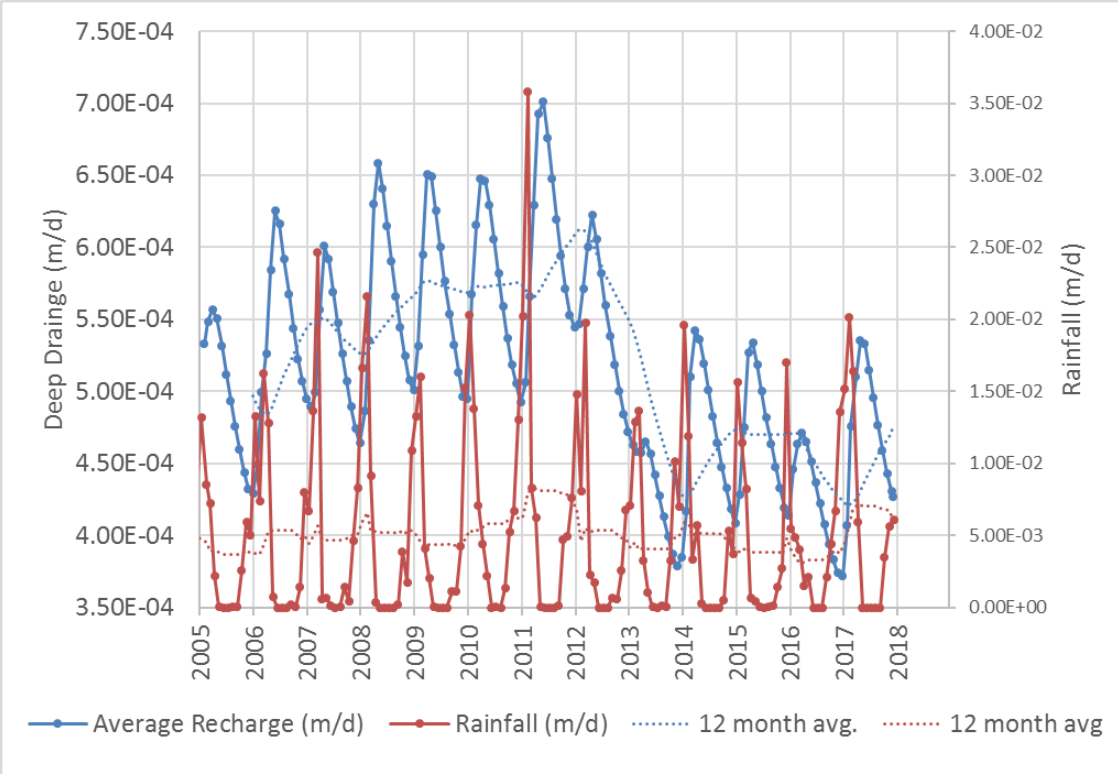

Figure 4-10 Estimated recharge and rainfall (BOM)

The data show recharge is highly seasonal with almost all recharge occurring late in the wet season months from November to April, with a lag between peak rainfall and peak recharge of approximately 3 months. The moisture balance suggests that 20% of annual rainfall recharges the groundwater system. This is high, being at the upper end of the expected range for the northern part of Australia where the soil profile becomes saturated during the wet season promoting deep drainage.

Historical mining data indicates groundwater inflows to the open cut pit were approximately 30 L/s to 40 L/s (Coffey, 2015). This was achieved by a combination of dewatering bores and in-mine pumping. By 2010, the underground mine and pit was dewatered using 3 in-mine pumps discharging a total of 32 L/s (AGE, 2015). No data are available on local creek ephemeral baseflow, including Bundy Creek.

4.6 Groundwater Chemistry

Multiple groundwaters analyses are available for several bores at the site (n = 149) and average results are provided on Figure 4-11. Groundwater ranges from fresh (<500 mg/L TDS or 770 <uS/cm EC) in G9, Bore 11 and Ridge Bore to saline in OB11, which was the only bore to consistently exceed stock watering guidelines for EC and sulfate. G1 consistently exceeded the stock watering guidelines sulfate or pH.

The groundwater results were compared against the Australian Drinking Water Guidelines – Health and Aesthetic (ADWG) (NHMRC, NRMMC, 2011), ANZECC & ARMCANZ Protection of Freshwater Ecosystem Values 80% and 90% (FAE80% and FAE90%) and the ANZECC & ARMCANZ 2000 Livestock Watering guidelines (ANZECC & ARMCANZ, 2000). These results are shown in Table 4-3 - Table 4-6.

LEGEND

- Groundwater monitoring bore
- Mine Site Layout
- Water Body Perennial
- Watercourse Intermittent

Paper Size A4

0 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 52

N

Primary Gold Limited
Toms Gully EIS\Groundwater Assessment

Job Number 43-22623
Revision 1
Date 22 Sep 2017

Summary Geochemistry

Figure 4-11

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com W www.ghd.com.au

G:\43\2262304\GIS\Maps\Working\4322623_106_Summary_Geochem_RevA.mxd

Data source: Commonwealth of Australia (Geoscience Australia): DTDB, 2015. ESRI: Imagery, 2017. Created by: tmorton

Generally, the groundwater was circumneutral to slightly acidic, with the exception of G8, which had a pH between 3.9 and 5.61. The elevated sulfate (and metals where analysed), but neutral pH in the shallow bores OB10 (-8.76 mAHD), OB11 (3 mAHD) and G1 (9.2 mAHD) suggests there has been impact from oxidised sulfides with neutralisation of acidity. This is likely to be due to seepage from the adjacent evaporation pond EP2. Based on the chemistry of these bores and an area of white staining, suggesting a salt scald around G1, it is possible there is some local shallow discharge to Bundy Creek, 100 m to the northwest of G1.

G8 had the highest elevated concentrations of several metals (aluminium, cadmium, cobalt, copper and nickel) in comparison to multiple guidelines as well as the surrounding bores. This suggests groundwater in the area is impacted by the immediately adjacent waste rock dump.

4.6.1 Drinking Water Guidelines

Aesthetic guidelines

Several groundwater bores exceed the ADWG aesthetic guideline values (NHMRC and NRMMC, 2011) for one or more analytes. With the exception of Ridge bore and RN29693, all other bores periodically exceed for sulfate and G8 exceeding the trigger values for aluminium, copper and zinc. In addition, OB11, G8, G9, and P100 periodically exceed triggers for ADWG aesthetic guideline values (NHMRC and NRMMC, 2011) for pH Hardness and iron.

Health guidelines

Bore G8 consistently exceeded the health based guideline values for sulfate, cadmium, manganese, and nickel with the occasional sample exceeding the arsenic guideline value. G9 consistently exceeded the trigger value for lead and, similarly to G8, there were exceedances for manganese and nickel. OB11 consistently exceeded for Cadmium, Manganese and Nickel. Notably, the Ridge Bore also exceeded the health based guideline (NHMRC and NRMMC, 2011) for Manganese.

4.6.2 Aquatic ecosystems and stock watering guidelines

Groundwater bore G8 exceeded the FAE80% and FAE90% trigger values for aluminium, cadmium, copper, nickel, zinc and lead. G9 and OB11 both occasionally exceeded the trigger values for cadmium and copper and more consistently exceeded the trigger values for nickel and zinc.

G8 had correspondingly elevated concentrations of several metals (aluminium, cadmium, cobalt, copper and nickel) above stock watering guidelines.

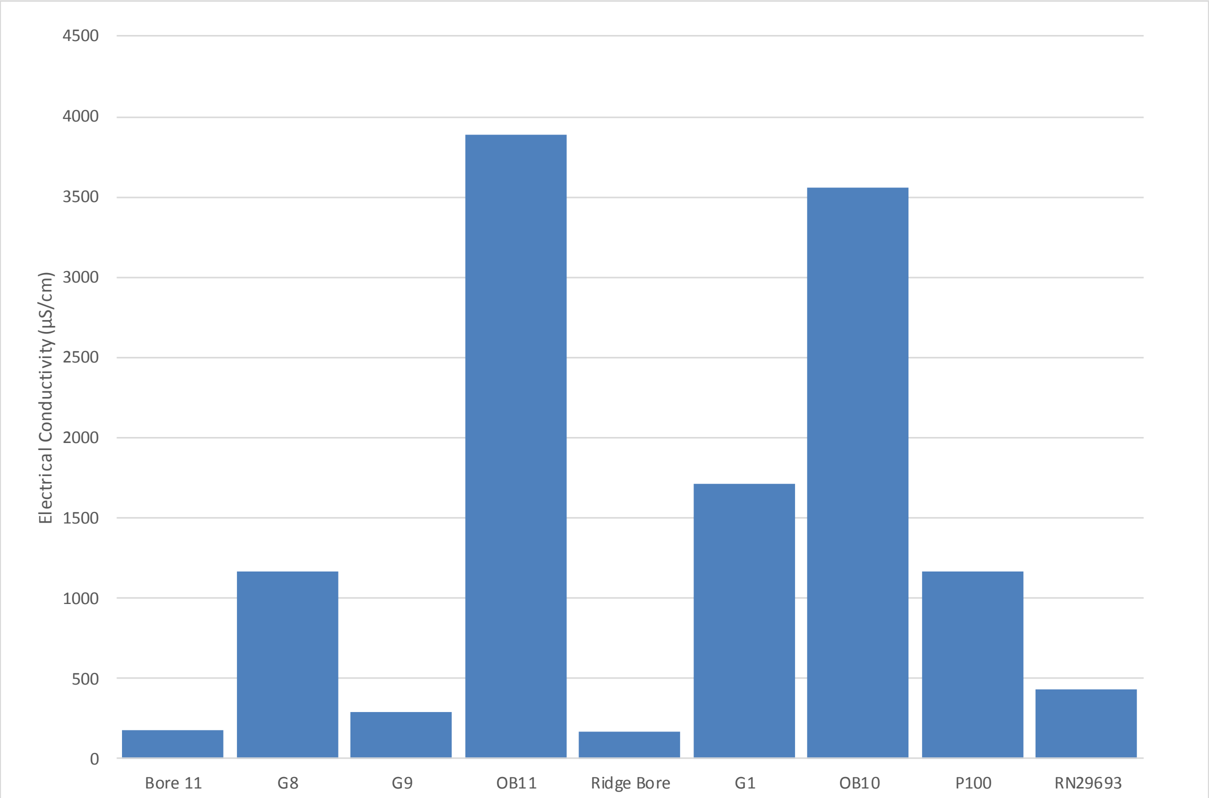

Figure 4-12 Average groundwater EC (uS/cm) to 2018

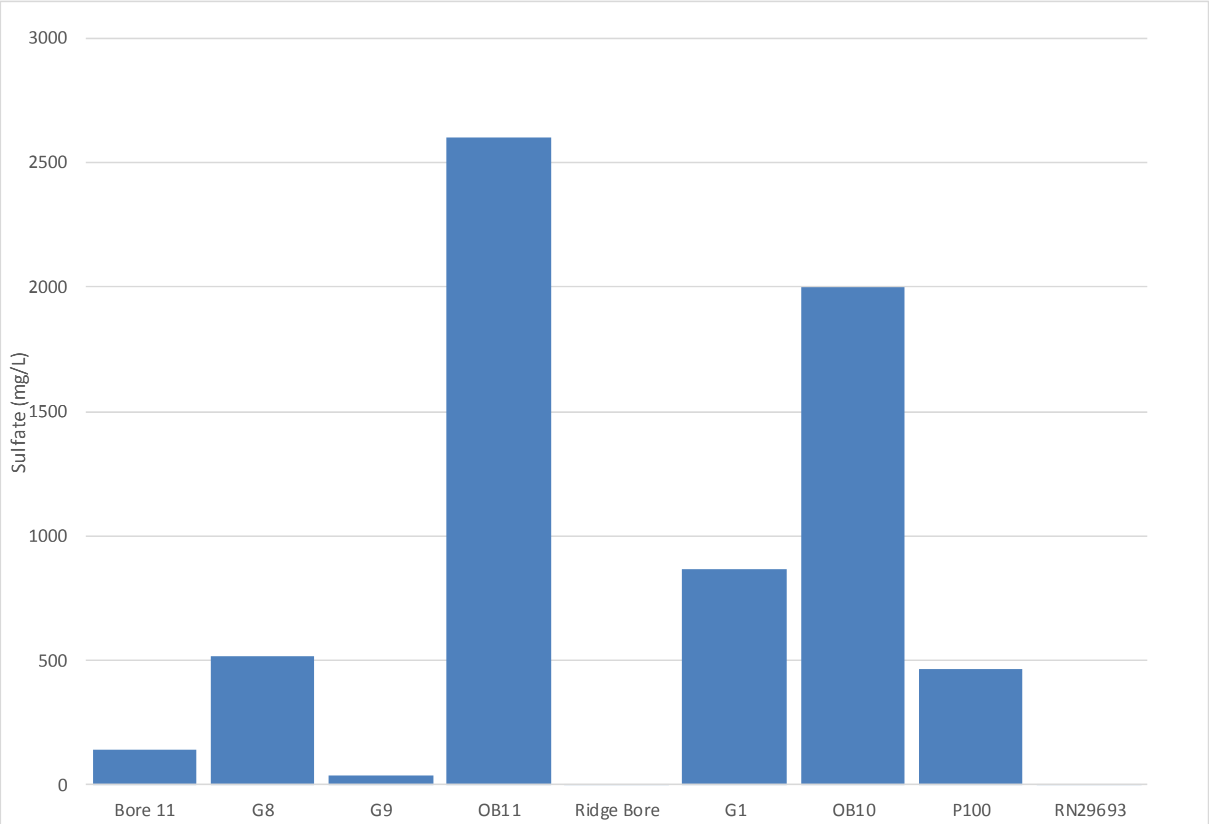

Figure 4-13 Average groundwater SO_4 concentrations (mg/L) to 2018

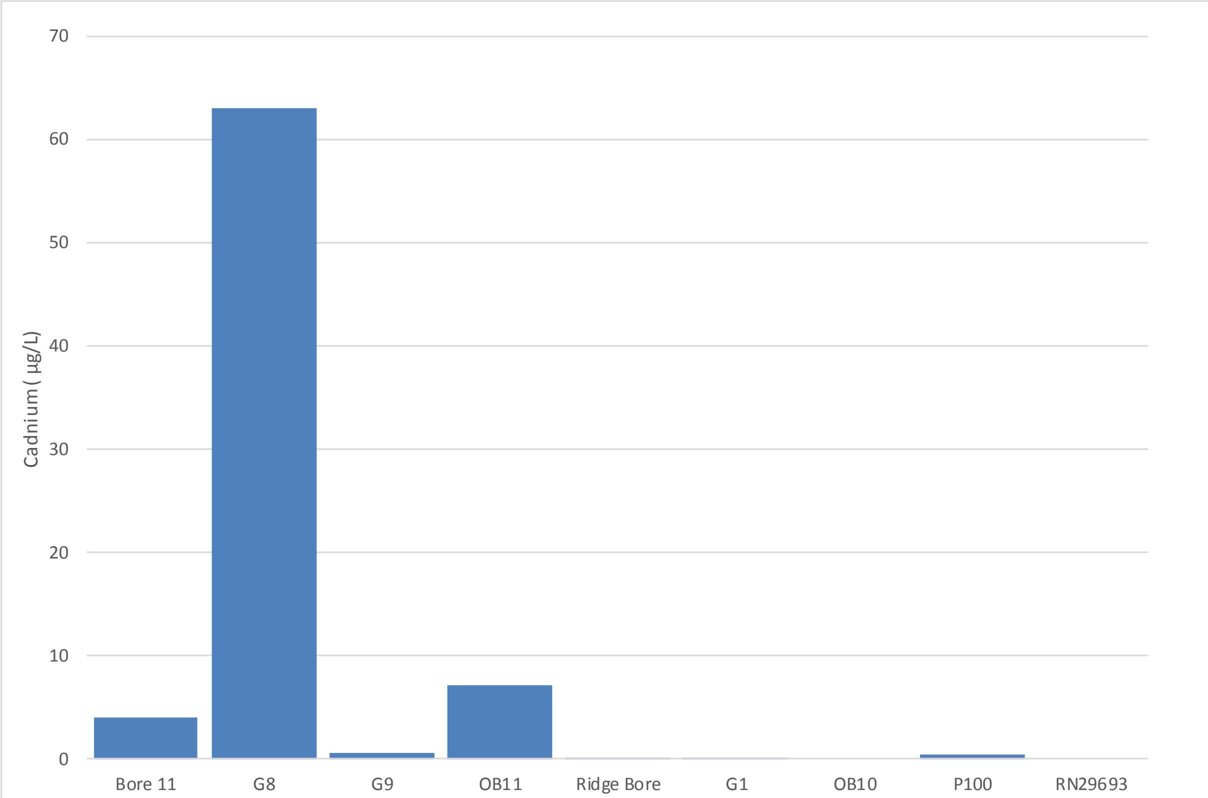

Figure 4-14 Average groundwater Cd concentrations (ug/L) to 2018

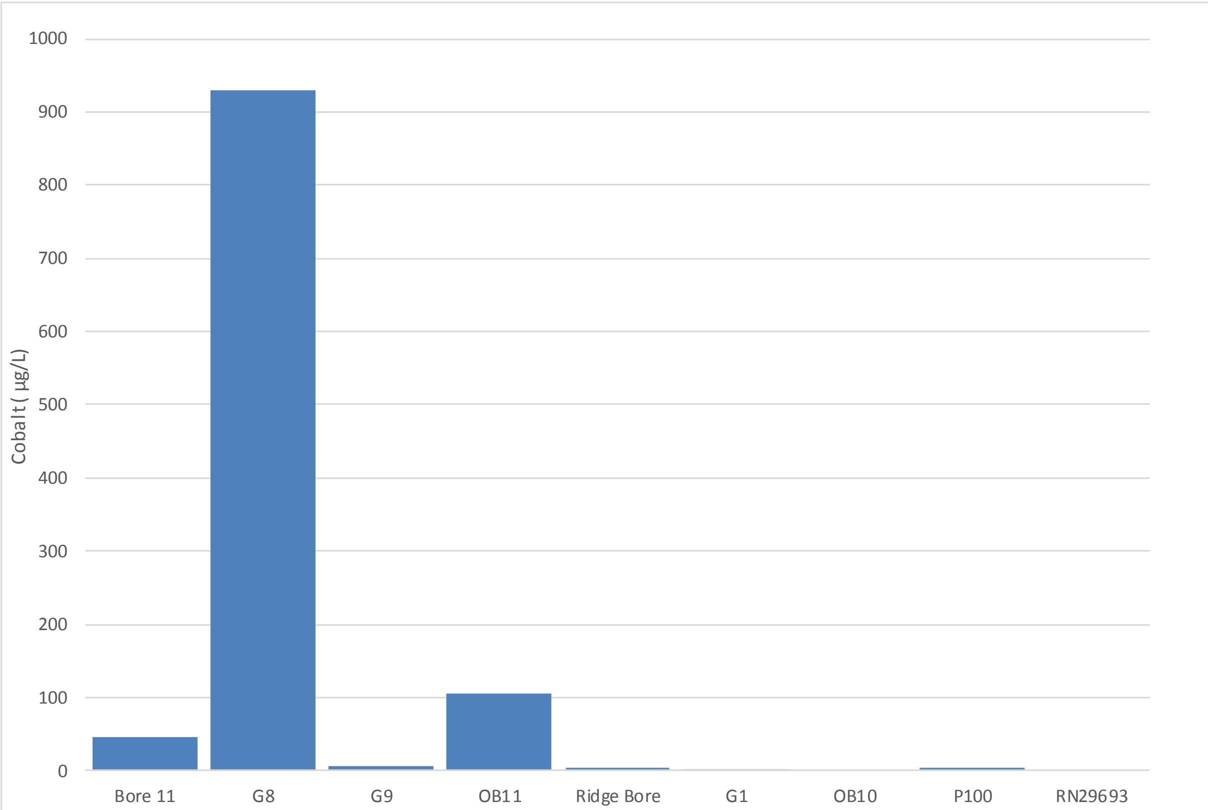

Figure 4-15 Average groundwater Co concentrations (ug/L) to 2018

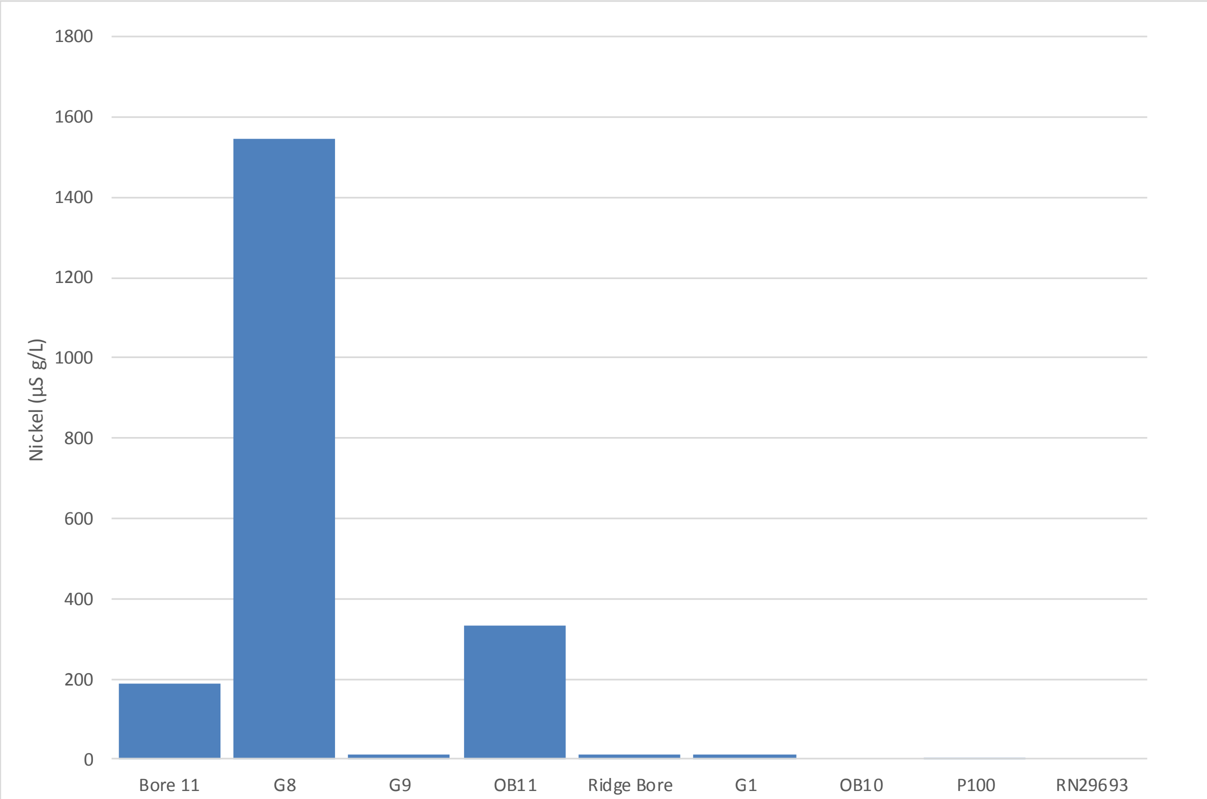

Figure 4-16 Average groundwater Ni, concentrations (ug/L) to 2018

Table 4-3 Groundwater chemistry summary compared against ANZECC Livestock Trigger Values

		Field		Alkalinity					Acidity	Inorganics	Major Ions						Metals										
		Electrical Conductivity (Field)	pH (Field)	Carbonate	Bicarbonate	Alkalinity (total) as CaCO3	Hardness as CaCO3	Hydroxide	Acidity (as CaCO3)	Total Suspended Solids	Calcium (Filtered)	Chloride	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Sulphate	Aluminium (Filtered)	Arsenic (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Cobalt (Filtered)	Copper (Filtered)	Iron (Filtered)	Lead (Filtered)	Manganese (Filtered)	Nickel (Filtered)	Zinc (Filtered)
		µS/cm	pH_Units	mg/L	mg/L	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
ANZECC 2000 - Livestock Trigger		3000	6-8							5000	1000					1000	5000	500	10	1000	1000[#1]	500		100		1000	20000
Bore	Sample Date																										
BORE 11	9/05/2011	4.69	6	<1	180	180	3100	<1	<2	20	480	8	480	6.6	22	3000	440	11	66	<1	760	5	44,000	<1	31,000	1400	3100
	22/11/2011	270	7.12	<1	120	120		<1			21	9	11	5.8	5.9	2											
	30/01/2012	278.4	7.86	<1	120	120	95	<1	<2	18	17	9	13	6.4	6.5	3	<10	<1	<0.1	<1	<1	<1	310	<1	200	<1	<1
	27/04/2012	241.6	6.65	<5	110	110	79	<5	<2	<5	13	7	11	6.8	6.5	<1	3	<1	<0.1	<1	<1	<1	410	<1	250	1	8
	22/08/2012	241.4	8.03	<5	110	110	73	<5	<5	9	11	7	11	6.1	6.3	<1	27	<1	<0.1	<1	<1	<1	32	<1	94	2	1
	3/04/2013	238.1	7.3	<5	100	100	64	<5	<5	9	9.3	7	9.9	7.2	6.9	<1	<10	<1	<0.1	<1	<1	<1	920	<1	210	<1	7
	26/12/2013	175	7.9	11	66	77		<5			6.7	8	8.3	6.1	5.9	<1											
	20/02/2014	164.8	7.3	15	69	83	49	<5	<2	<5	6.7	8	7.9	6.5	6.2	<1	30	<1	<0.1	<1	<1	1	77	<1	80	1	8
	11/04/2014	163.9	7.62	<5	66	66		<5			7.4	8	9.3	6.5	6.9	<1											
	7/12/2014	160	7.4	<1	63	63		<1			6.2	9.4	7.2	6.2	6.2	0.9											
	13/02/2015	146.2	7			60	41.7		<1	<10	5.8	9.8	6.6	6.2	5.9	1.1	5.6	0.1	<0.02	<0.1	0.04	0.06	<2	0.01	17.3	1800	<0.1
	13/03/2015	158.4	7.46			58	41		<1	<10	5.8	10.5	6.5	6.8	6.4	1.3	5.3	0.1	<0.02	<0.1	0.05	0.09	4	<0.01	23.8	0.17	2.9
	10/04/2015	162.3	7.8			67	41.5		<1	<10	5.7	10	6.6	5.8	6	0.7	2.2	0.15	<0.02	<0.1	0.03	0.13	12	<0.01	25.4	0.12	0.9
	1/09/2015	154.4	8.67			59	40.4		<1	<10	5.7		6.4	6.4	6.8	0.8	6	0.15	0.08	0.1	0.06	3.64	14	0.25	22.6	0.58	12.5
	11/12/2015	154	8.1			53	39.4		<1	<10	5.6	10.8	6.2	6.5	6.8	0.9	6.8	0.2	0.02	<0.1	0.08	1.22	8	0.06	17.2	1.49	2.8
	3/02/2016		8.7			51	38.4		<1	<10	5.6	10.9	5.9	6.3	6.1	0.8	7.2	0.15	<0.02	<0.1	0.06	0.57	8	0.03	18.9	0.28	0.9
	11/05/2016	148	8.7			68	38.1		<1	<10	5.6	10.4	5.9	6.1	6.2	0.7	1.8	0.15	<0.02	<0.1	0.05	0.13	28	0.04	24.1	0.21	0.7
	2/09/2016					62	38.4		<1	<10	5.7	9.9	5.9	6.2	5.8	0.7											
	11/01/2017	120	8.8			63	42		<5	6	6.3	9	6.3	6.2	6.1	<1	<10	<1	<0.1	<1	<1	<1	40	<5	32	<1	2
	26/03/2017	150	8.8			66	42		<5	<5	6.7	10	6.2	6.3	5.8	<1	<10	<1	<0.1	<1	<1	<1	30	<1	67	<1	<1
	26/08/2017	230	8.5			73	59		<5	<5	10	10	8.3	6.3	6.2	19	260	<1	<0.1	<1	3	<1	20	<1	230	13	10
	10/09/2017	180	8.7			73	48		<5	<5	7.4	10	7.1	6.5	6.4	1	<10	<1	<0.1	<1	<1	<1	340	<1	60	<1	9
G8	3/12/2010	1568	4.69	<0.1	<0.1	<0.1	680	<0.1	<2	23	98	34	110	5	15	740	9100	12	90	<1	1200	830	1400	8	18,000	1800	6000
	2/11/2010	1630	4.74	<0.1	<0.1	<0.1		<0.1			98	31	110	5.1	16	820											
	25/01/2011	1152	4.75	<0.1	<0.1	<0.1	17	<0.1	130	380	52	47	62	3.7	21	420	8100	<1	46	<1	860	1600	100	83	13,000	1400	4000
	9/05/2011	1166	4.37	<1	<1	<1	420	<1	93	<5	57	50	68	3.8	22	570	11,000	4	45	<1	830	1200	75	5	17,000	1400	3700
	22/11/2011	1167	4.7	<1	<1	<1		<1			61	45	76	3.6	17	510											
	30/01/2012	1098	4.13	<1	<1	<1	430	<1	180	58	57	36	70	3.7	14	460	8000	<1	58	1	770	1500	400	8	14,000	1300	4100
	11/04/2012	1082	5.61	<5	<5	<5		<5			54	34	59	3.1	14	330											
	27/04/2012	1808	4.74	<5	<5	<5	430	<5	170	<5	60	36	68	3.9	17	460	8100	<1	43	<1	810	1700	28	5	14,000	1300	3700
	22/08/2012	1494	4.28	<5	<5	<5	610	<5	240	26	84	24	96	4.9	14	670	13,000	10	74	<1	1100	1500	2200	7	20,000	1900	6400
	3/04/2013	850	3.9	<5	<5	<5	310	<5	100	8	45	31	49	5.1	13	330	5800	4	36	<1	690	1500	89	4	12,000	1200	3300
	26/12/2013	1075	4.3	<5	<5	<5		<5			64	26	74	4.6	14	440											
	11/04/2014	1022	4.64	<5	<5	<5		<5			70	32	84	4.2	18	430											
	7/12/2014	955	5.1	<1	<1	<1		<1			64.5	33.5	77	6.4	16.8	524											
	20/02/2014	930	4.3	<5	<5	<5	390	<5	170	5	53	36	63	3.8	16	370	7500	6	38	<1	720	1300	63	9	13,000	1300	3700
	13/02/2015	1055	5.3			<1	474		117	20	65.1	36.2	75.7	6.5	15.5	529	3440	0.3	54	0.1	905	1310	8	3.9	15,400	1590	4680
	13/03/2015	941	4.96			<1	409		103	<10	57	35.6	64.8	4.1	14.5	486	8400	0.2	48	0.2	835	1480	94	6.95	14,200	1450	4350
	10/04/2015	1008	4.47			<1	425		182	<10	58.6	30.6	67.8	3.4	12.9	481	7880	<0.05	51.6	0.1	867	1230	134	6.05	14,000	1410	4260
	1/09/2015	1206	4.6			<1	559		125	20	82.3		85.9	5.2	13.6	621	7620	1.4	60.6	<1	1070	776	3060	10.9	16,800	1650	5690
	11/12/2015	1120	4.5			<1	560		80	20	83	25.3	85.7	5.4	13	623	6960	0.05	96.8	0.1	1010	1800	38	5.75	16,500	1590	5440
	18/01/2016					48	30.6		1	40	8.5	3.3	2.3	4.7	3	1	7300	<0.05	63.6	0.1	990	306	138	4.55	16,000	1550	5110
	11/05/2016	1020	4.4			<1	474		134	<10	65.6	30.9	75.2	4.1	14.1	518	7730	<0.5	57.2	<1	922	1150	148	6.29	14,800	1470	4460
	2/09/2016					<1	502		125	<10	70.9	27	78.9	4.3	12.1	568											
	11/01/2017	950	4.7			<5	470		140	6	72	25	71	4.1	13	480	6000	5	67	<1	690	340	2300	6	14,000	1400	4800
	26/03/2017	870	4.2			<5	380		120	<5	50	34	63	3.5	15	410	7900	5	44	<1	690	1700	50	5	12,000	1400	4100
	25/06/2017	1400	4.3			<5	700		160	<5	100	28	110	4.8	17	780	12000	50	96	<1	1400	1000	7200	6	26,000	2100	6800
	10/09/2017	1400	4.4			<5	730		210	28	120	28	110	4.9	16	800	16000	12	130	<1	1300	1400	3500	11	23,000	2200	7300
G9	3/12/2010	372	6.51	<0.1	160	160	160	<0.1	<2	27	48	7.4	9.2	2.8	4	8.2	23	5	0.3	<1	3	4	97	12	180	5	25
	2/11/2010	375.2	6.98	<0.1	150	150		<0.1			49	8.2	8.7	2.9	4.1	6.7											
	25/01/2011	356.2	6.5	<0.1	170	170	<5	<0.1	<2	150	46	7.7	7.7	2.8	4	11	16	5	0.3	<1	3	<1	84	18	240	10	25
	22/11/2011	228.3	7	<1	31	31		<1			8.7	4	2.1	1.3	1.1	3											
	30/01/2012	944	7.07	<1	180	180	470	<1	<2	55	92	8	59	2.9	6.2	280	<10	8	0.2	<1	22	<1	500	<1	1400	67	36
	27/04/2012	379	6.06	<5	25	25	97	<5	<2	<5	20	3	12	1.6	1.9	26	17	<1	0.3	<1	<1	2	<10	12	29	5	19
	22/08/2012	889	7.1	<5	190	190	440	<5	<5	13	88	6	53	2.9	6.1	190	12	6	0.2	<1	13	<1	180	<1	1000	54	24
	3/04/2013	90.7	5.06	<5	38	38	23	<5	<5	<5	4.6	4	2.7	1.6	1.1	34	48	1	2.2	<1	10	15	18	140	330	29	120
	26/12/2013	247	6.4	<5	12	12		<5			9.8	3	8.4	1.9	1.7	12											
	20/02/2014	34.5	5.4	<5	10	10		<5			1.6	2	0.5	1.4	1	1											
	11/04/2014	72.7	6.15	<5	25	25		<5			5.2	3	2.9	1.6	1.4	29											
	7/12/2014	285	6.1	<1	21	21		<1			10.5	4.5	5.9	1.9	1.7	26.6											
	13/02/2015	233	7.1			21	41.7		13	<10	8.4	4.8	5.1	2.1	1.6	24.3	3.5	3.45	0.74	<0.1	2.03	5.18	34	83.5	125	5.92	41.1
	13/03/2015	34.3	7.27			16	37.5		6	<10	7.6	4.6	4.5	2	1.5	22.5	6.4	3.5	0.72	<0.1	3.81	4.37	16	145	225	5.59	54.4
	10/04/2015	223	8.6			13	32.8		12	<10	6.5	4.4	4	1.5	1.3	18.9	4.9	3.6	0.8	<0.1	9.3	5.45	48	141	483	7.68	65.9
	1/09/2015	143.2	7.21			22	47.5		8	<10	9.9		5.6	2	2	24.7	5.4	7.65	0.72	0.1	5.7	1.96	854	238	289	9.42	69.3
	11/12/2015	112	7.1			13	42.6		3	<10	8.9	5.8	4.9	2.1	1.9	22.5	8.3	1.75	1.08	<0.1	4.62	3.94	104	305	235	8.21	99.3
	18/01/2016		6.64			28	62.8		7	20	13.2	5.2	7.3	2	2	31.1	5.1	3.15	0.94	<0.1	4.19	1.79	398	158	208	7.63	73.3
	11/05/2016	143	6.7			30	58.4		11	<10	12.6	4.9	6.5	1.7	1.9	26.5	2	0.8	0.38	<0.1	4.08	1.43	16	33.6	275	6.03	40.2
	2/09/2016					89	117		16	<10	30.1	6.2	10.2	2.3	2.9	31.3											
	11/01/2017	310	7.2			160	170			6	51	7	9.5	2.8	4	5	<10	6	<0.1	<1	<1	<1	320	<5	160	<1	2
	26/03/2017	340	7.1			150	160			<5	50	8	9.3	2.7	4	6	<10	5	<0.1	<1	<1	<1	20	<1	180	<1	2
	25/06/2017	320	7.1			160	170			<5	52	8	9.8	2.8	4.2	6	<10	5	<0.1	<1	<1	<1	540	<1	210	1	8
	10/09/2017	340	7.1			160	200			<5	63	8	10	2.7	4.3	4	<10	5	<0.1	<1	<1	<1	300	<1	150	<1	8
OB11	2/11/2010	4593	7.07	<0.1	390	390		<0.1			480	11	570	2.2	38	3200											
	2/11/2010	4593	7.07	<0.1	390	390		<0.1			450	11	530	2.2	38	3300											
	25/01/2011	2682	7.22	<0.1	360	360	22	<0.1	<2	1300	120	7.2	250	1.7	89	1100	16	2	0.2	<1	<1	<1	<10	<1	<5	1	21
	22/11/2011	4370	6.49	<1	470	470		<1			300	11	570	1.6	83	2700											
	30/01/2012	4755	6.57	<1	390	390	3400	<1	<2	970	510	10	510	4.1	30	3100	<10	2	15	<1	240	2	3500	<1	14,000	730	380
	11/04/2012	4360	5.98	<5	350	350		<5			480	6	480	4	20	2000											
	27/04/2012	4300	5.78	<5	350	350	3400	<5	<2	6	450	8	550	5.2	41	3500	93	<1	6.1	<1	81	3	16	<1	7300	230	120
	22/08/2012	4754	6.69	<5	380	380	3400	<5	<5	6	480	8	530	3.1	31	3800	16	1	5.4	<1	130	1	61	<1	11,000	600	210
	3/04/2013	4300	6.1	<5	410	410	3500	<5	<5	19	450	14	570	3.5	55	2800	29	2	4.3	<1	41	6	17	<1	3100	220	89
	26/12/2013	4500	6.47	<5	390	390		<5			520	9	570	3.5	52	2400											
	20/02/2014	256	5.7	<5	36	36	90	<5	<2	6	11	2	15	1.2	2.9	61	50	1	0.3	<1	<1	4	14	<1	13	7	55
	11/04/2014	353	6.19	<5	29	29		<5			13	2	20	1.2	3.5	60											
	11/04/2014			<5	30	30		<5				2				59											
	7/12/2014	4400	5.6	25	334	359		<1			569	7.8	551	2.7	30.8	3200	242	0.65	5.78	<0.5	130	14.9	<10	0.26	7150	536	276
	13/02/2015	4100	5.5			361	3340		81	10	494	8.4	511	2.7	29.2	2920	16.5	2.45	1.34	<0.5	9.07	1.78	<10	0.03	1060	78.9	35.5
	13/03/2015	4210	5.98			349	3300		37	20	486	9.1	506	3.5	31.7	3030	20	3.45	0.76	<1	1.69	4.41	<20	1.1	183	16.3	34.3
	10/04/2015	4070	6.36			356	3220		73	20	472	8.8	496	2.7	29.8	2810	32.2	2.65	4.4	<1	10.2	3.6	<20	<0.1	3050	126	57.1
	15/12/2015	3400	6.88			245	3260		19	20	536	8.1	467	5.5	25.4	2960	3.4	0.35	11.2	<0.5	273	8.7	76	0.16	15700	620	538
	3/02/2016					310	3540		73	<10	537	9	534	3.5	29.1	3140	4.2	0.8	8.42	<1	15.7	2.11	<20	<0.01	2700	327	195
	11/05/2016	2430	7.2			175	1610		36	<10	235	14.2	248	9.9	18.2	1430	15	2.45	6.34	<1	32	3.85	<20	0.11	10800	207	126
	2/09/2016					311	3620		73	40	558	7.9	541	3.3	26.4	3280											
	11/01/2017	4300	6.7			290	3600		110	22	570	9	530	4.7	32	3000	<10	3	9.4	<1	180	1	8000	<5	13000	490	510
	26/03/2017	4500	6.3			220	3900		130	33	590	9	580	6.7	35	3400	<10	<1	23	<1	530	2	6700	<1	27000	880	1600
	26/08/2017	4700	6.4			280	3800		57	39	600	9	570	4	34	3400	<10	<1	8.9	<1	55	9	80	<1	13000	290	260
	26/08/2017	4700	6.5			280						9				3400											
	10/09/2017	4700	6.5			280	4600		110	78	830	9	610	4.3	34	3600	<10	2	8.8	1	67	8	780	<1	13000	300	270
RIDGE BORE	30/01/2012	279.9	6.4	<1	70	70	6	<1	<2	110	1.3	9	0.7	1.2	2.5	1	<10	1	<0.1	<1	4	<1	63,000	<1	630	15	13
	22/11/2011	99.2	6.38	<1	14	14		<1			1.6	8	0.7	1.4	2.4	<1											
	27/04/2012	213.5	5.54	<5	27	27	16	<5	<2	67	4.2	6	1.3	1.6	2.8	2	50	<1	0.3	<1	6	4	30,000	<1	2200	11	71
	22/08/2012	87	6.1	<5	25	25	14	<5	<5	28	3.6	6	1.2	1.3	2.7	<1	24	<1	0.4	<1	5	<1	4300	<1	710	9	36
	3/04/2013	104	6.8	<5	39	39	15	<5	<5	18	3.7	6	1.3	1.6	3	<1	14	<1	<0.1	<1	<1	2	9200	<1	700	2	31
	26/12/2013	82.4	6.3	<5	13	13		<5			3	7	0.9	1.3	2.5	<1											
	20/02/2014	172.2	6	<5	31	31	14	<5	<2	51	3.7	7	1.2	1.2	2.5	<1	40	<1	0.3	<1	6	5	33,000	<1	2800	13	31
	11/04/2014	288	6.47	<5	55	55		<5			3	7	1.2	1.3	3	<1											
	7/12/2014	270	6.4	<1	3	3		<1			1	7.4	0.6	1.1	2.6	0.7	18	3.55	0.16	<0.1	3.89	0.81	81400	0.01	538	7.77	30.2
	13/02/2015	253	6			15	15.7		86	110	4.3	5.5	1.2	1.9	2.8	1.1	0.6	<0.05	0.02	0.4	5.07	0.02	19400	<0.01	677	51.4	7.5
	13/03/2015	260	6.07			27	7.6		56	80	1.6	6.4	0.9	1.5	3	2	1.1	0.05	<0.02	<0.1	1.66	<0.01	33200	<0.01	703	2.39	3.6
	10/04/2015	255	7.33			59	8.5		114	80	2.1	5.8	0.8	1.1	2.7	0.2	0.4	<0.05	<0.02	<0.1	1.41	0.34	18500	<0.01	606	1.91	2.5
	1/09/2015	223.5	6.88			13	5.4		66	80	1.2		0.6	1.3	3.2	0.2	2.9	<0.5	<0.2	<1	1.64	0.35	13100	<0.1	570	5.95	45.1
	11/12/2015	42	6.6			8	5.6		29	100	1.2	6.2	0.6	1.3	3	0.3	<0.1	<0.05	<0.02	<0.1	2.45	<0.01	25700	<0.01	569	16.4	17.3
	3/02/2016		7.42			20	6.7		105	90	1.6	6.5	0.7	1.3	2.9	0.3	0.4	0.1	0.06	<0.1	1.83	0.1	29400	<0.01	679	7.22	11
	11/05/2016	146	6.4			65	7.2		103	70	1.6	5.5	0.7	1.3	3.1	0.4	0.2	0.05	0.02	<0.1	2.96	0.02	31000	0.02	721	5.45	20.1
	2/09/2016					36	5.4		74	60	1.2	5.3	0.6	1.3	2.9	0.4											
	11/01/2017	120	6.3			63	6		100	62	1.3	5	0.6	1.2	3	<1	<10	1	<0.1	<1	2	<1	42000	<5	440	3	12
	26/03/2017	100	6			50	7		85	52	1.7	5	0.7	1.3	3	<1	<10	<1	<0.1	<1	4	<1	25000	<1	990	6	6
	26/08/2017	130	6.2			63	6		56	75	1.3	5	0.6	1.4	2.9	<1	<10	2	0.1	<1	4	<1	48000	<1	600	13	33
	10/09/2017	71	5.7			28	6		85	76	1.2	5	0.7	1.2	3.1	<1	<10	2	<0.1	<1	3	<1	46000	<1	530	10	13
G1	22/11/2011	1876	7.2	<1	390	390		<1			210	9	110	8.8	24	900											
	22/11/2011	247.2	8.1	<1	56	56		<1			12	4	12	3.8	8.1	52											
	30/01/2012	2229	6.92	<1	340	340		<1			270	8	140	8.6	27	1500											
	30/01/2012	268.8	8.38	<1	84	85		<1			19	4	12	3.7	8.3	39											
	22/08/2012	2367	6.75	<5	200	200		<5			280	5	160	8.2	27	1200											
	22/08/2012	175.3	8.74	9	87	96		<5			6.6	3	9.6	3.7	6.6	1											
	1/09/2015	1938	8.26				828		5	40	142		115	29	32.2	300	28.4	19	<0.2	<1	0.38	0.88	128	0.51	56.6	2.45	13.4
	15/12/2015	2201	7.56			788	1160		10	50	240	12.9	136	17.2	26.3	700	16.7	11.5	<0.1	1	1.16	0.25	128	0.1	326	6.46	4.2
	18/01/2016		7.28			592	1230		26	50	257	12	143	17.9	25.9	810	17.3	7.8	<0.2	<1	0.28	0.1	100	<0.1	364	3.3	3.3
	11/05/2016	2210	7.2			412	1360		72	10	292	9.6	153	12.8	24.5	1080	40.1	6.5	<0.2	<1	0.89	0.86	70	<0.1	397	3.82	9.5
	2/09/2016					299	1490		56	50	323	7.9	166	10.7	22.2	1310											
	11/01/2017	2200	6.4			160	1600		75	5	340	6	170	7.7	22	1300	<10	2	<0.1	<1	2	<1	780	<5	290	11	9
	26/03/2017	2200	6.3			150	1500		55	<5	330	7	170	8	22	1300	<10	2	<0.1	<1	2	<1	330	<1	340	19	5
	25/06/2017	2200	6.4			150	1500		58	13	320	7	170	7.6	23	1300	<10	3	<0.1	<1	3	<1	560	<1	520	28	19
	10/09/2017	2200	6.3			150	1800		70	16	420	7	170	8	21	1200	<10	3	<0.1	<1	3	<1	510	<1	500	25	20
OB10	2/11/2010	5113	6.95	<0.1	460	460		<0.1			460	11	660	2.9	35	3500											
	3/12/2010	4309	6.76	<0.1	380	380		<0.1			350	8.9	490	2.7	30	2400											
	3/12/2010	4309	6.76	<0.1	380	380		<0.1			330		480	2.7	28												
	25/01/2011	516	6.95	<0.1	170	170		<0.1			24	1.9	39	1.1	11	98											
	22/11/2011																										
P100	22/11/2011	1001	6.29	<1	63	63		<1			90	14	56	7.4	28	380											
	30/01/2012	1081	6.27	<1	73	73		<1			100	15	60	8	31	450											
	30/01/2012	1081	6.27	<1	75	75		<1			98	15	60	7.8	31	440											
	22/08/2012	1285	6.13	<5	91	91		<5			110	14	62	8.3	31	460											
	22/08/2012	1285	6.13	<5	91	91		<5				14				460											
	1/09/2015	1271	6.53			81	642		36	10	138		72.5	8.9	35	598	4.3	56	0.36	<1	4.85	1.56	6300	0.12	1500	18.2	97.6
RN29693	22/08/2012	125.9	6.34	<5	40	40		<5			5.4	2	2.4	3.2	2.8	<1											
	22/11/2011	1252	8.05	19	42	61		<1			5.3	5	1.5	6.4	3.7	<1											
	30/01/2012	215.7	8.51	4	92	96		<1			13	5	4.8	6.1	3.8	15											
	22/08/2012	138.3	8.91	15	65	80		<5			6.6	4	1.8	6.1	3.5	<1											

Table 4-4 Groundwater chemistry summary compared against ANZECC Freshwater Aquatic Ecosystem 80 % Values

		Field		Alkalinity					Acidity	Inorganics	Major Ions						Metals										
		Electrical Conductivity (Field)	pH (Field)	Carbonate	Bicarbonate	Alkalinity (total) as CaCO3	Hardness as CaCO3	Hydroxide	Acidity (as CaCO3)	Total Suspended Solids	Calcium (Filtered)	Chloride	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Sulphate	Aluminium (Filtered)	Arsenic (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Cobalt (Filtered)	Copper (Filtered)	Iron (Filtered)	Lead (Filtered)	Manganese (Filtered)	Nickel (Filtered)	Zinc (Filtered)
		µS/cm	pH_Units	mg/L	mg/L	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
ANZECC FAE80%																	150	360	0.8	40		2.5		9.4	3600	17	31
Bore	**Sample Date**																										
BORE 11	9/05/2011	4.69	6	<1	180	180	3100	<1	<2	20	480	8	480	6.6	22	3000	440	11	66	<1	760	5	44,000	<1	31,000	1400	3100
	22/11/2011	270	7.12	<1	120	120		<1			21	9	11	5.8	5.9	2											
	30/01/2012	278.4	7.86	<1	120	120	95	<1	<2	18	17	9	13	6.4	6.5	3	<10	<1	<0.1	<1	<1	<1	310	<1	200	<1	<1
	27/04/2012	241.6	6.65	<5	110	110	79	<5	<2	<5	13	7	11	6.8	6.5	<1	3	<1	<0.1	<1	<1	<1	410	<1	250	1	8
	22/08/2012	241.4	8.03	<5	110	110	73	<5	<5	9	11	7	11	6.1	6.3	<1	27	<1	<0.1	<1	<1	<1	32	<1	94	2	1
	3/04/2013	238.1	7.3	<5	100	100	64	<5	<5	9	9.3	7	9.9	7.2	6.9	<1	<10	<1	<0.1	<1	<1	<1	920	<1	210	<1	7
	26/12/2013	175	7.9	11	66	77		<5			6.7	8	8.3	6.1	5.9	<1											
	20/02/2014	164.8	7.3	15	69	83	49	<5	<2	<5	6.7	8	7.9	6.5	6.2	<1	30	<1	<0.1	<1	<1	1	77	<1	80	1	8
	11/04/2014	163.9	7.62	<5	66	66		<5			7.4	8	9.3	6.5	6.9	<1											
	7/12/2014	160	7.4	<1	63	63		<1			6.2	9.4	7.2	6.2	6.2	0.9											
	13/02/2015	146.2	7			60	41.7		<1	<10	5.8	9.8	6.6	6.2	5.9	1.1	5.6	0.1	<0.02	<0.1	0.04	0.06	<2	0.01	17.3	1800	<0.1
	13/03/2015	158.4	7.46			58	41		<1	<10	5.8	10.5	6.5	6.8	6.4	1.3	5.3	0.1	<0.02	<0.1	0.05	0.09	4	<0.01	23.8	0.17	2.9
	10/04/2015	162.3	7.8			67	41.5		<1	<10	5.7	10	6.6	5.8	6	0.7	2.2	0.15	<0.02	<0.1	0.03	0.13	12	<0.01	25.4	0.12	0.9
	1/09/2015	154.4	8.67			59	40.4		<1	<10	5.7		6.4	6.4	6.8	0.8	6	0.15	0.08	0.1	0.06	3.64	14	0.25	22.6	0.58	12.5
	11/12/2015	154	8.1			53	39.4		<1	<10	5.6	10.8	6.2	6.5	6.8	0.9	6.8	0.2	0.02	<0.1	0.08	1.22	8	0.06	17.2	1.49	2.8
	3/02/2016		8.7			51	38.4		<1	<10	5.6	10.9	5.9	6.3	6.1	0.8	7.2	0.15	<0.02	<0.1	0.06	0.57	8	0.03	18.9	0.28	0.9
	11/05/2016	148	8.7			68	38.1		<1	<10	5.6	10.4	5.9	6.1	6.2	0.7	1.8	0.15	<0.02	<0.1	0.05	0.13	28	0.04	24.1	0.21	0.7
	2/09/2016					62	38.4		<1	<10	5.7	9.9	5.9	6.2	5.8	0.7											
	11/01/2017	120	8.8			63	42		<5	6	6.3	9	6.3	6.2	6.1	<1	<10	<1	<0.1	<1	<1	<1	40	<5	32	<1	2
	26/03/2017	150	8.8			66	42		<5	<5	6.7	10	6.2	6.3	5.8	<1	<10	<1	<0.1	<1	<1	<1	30	<1	67	<1	<1
	26/08/2017	230	8.5			73	59		<5	<5	10	10	8.3	6.3	6.2	19	260	<1	<0.1	<1	3	<1	20	<1	230	13	10
	10/09/2017	180	8.7			73	48		<5	<5	7.4	10	7.1	6.5	6.4	1	<10	<1	<0.1	<1	<1	<1	340	<1	60	<1	9
G8	3/12/2010	1568	4.69	<0.1	<0.1	<0.1	680	<0.1	<2	23	98	34	110	5	15	740	9100	12	90	<1	1200	830	1400	8	18,000	1800	6000
	2/11/2010	1630	4.74	<0.1	<0.1	<0.1		<0.1			98	31	110	5.1	16	820											
	25/01/2011	1152	4.75	<0.1	<0.1	<0.1	17	<0.1	130	380	52	47	62	3.7	21	420	8100	<1	46	<1	860	1600	100	83	13,000	1400	4000
	9/05/2011	1166	4.37	<1	<1	<1	420	<1	93	<5	57	50	68	3.8	22	570	11,000	4	45	<1	830	1200	75	5	17,000	1400	3700
	22/11/2011	1167	4.7	<1	<1	<1		<1			61	45	76	3.6	17	510											
	30/01/2012	1098	4.13	<1	<1	<1	430	<1	180	58	57	36	70	3.7	14	460	8000	<1	58	1	770	1500	400	8	14,000	1300	4100
	11/04/2012	1082	5.61	<5	<5	<5		<5			54	34	59	3.1	14	330											
	27/04/2012	1808	4.74	<5	<5	<5	430	<5	170	<5	60	36	68	3.9	17	460	8100	<1	43	<1	810	1700	28	5	14,000	1300	3700
	22/08/2012	1494	4.28	<5	<5	<5	610	<5	240	26	84	24	96	4.9	14	670	13,000	10	74	<1	1100	1500	2200	7	20,000	1900	6400
	3/04/2013	850	3.9	<5	<5	<5	310	<5	100	8	45	31	49	5.1	13	330	5800	4	36	<1	690	1500	89	4	12,000	1200	3300
	26/12/2013	1075	4.3	<5	<5	<5		<5			64	26	74	4.6	14	440											
	11/04/2014	1022	4.64	<5	<5	<5		<5			70	32	84	4.2	18	430											
	7/12/2014	955	5.1	<1	<1	<1		<1			64.5	33.5	77	6.4	16.8	524											
	20/02/2014	930	4.3	<5	<5	<5	390	<5	170	5	53	36	63	3.8	16	370	7500	6	38	<1	720	1300	63	9	13,000	1300	3700
	13/02/2015	1055	5.3			<1	474		117	20	65.1	36.2	75.7	6.5	15.5	529	3440	0.3	54	0.1	905	1310	8	3.9	15,400	1590	4680
	13/03/2015	941	4.96			<1	409		103	<10	57	35.6	64.8	4.1	14.5	486	8400	0.2	48	0.2	835	1480	94	6.95	14,200	1450	4350
	10/04/2015	1008	4.47			<1	425		182	<10	58.6	30.6	67.8	3.4	12.9	481	7880	<0.05	51.6	0.1	867	1230	134	6.05	14,000	1410	4260
	1/09/2015	1206	4.6			<1	559		125	20	82.3		85.9	5.2	13.6	621	7620	1.4	60.6	<1	1070	776	3060	10.9	16,800	1650	5690
	11/12/2015	1120	4.5			<1	560		80	20	83	25.3	85.7	5.4	13	623	6960	0.05	96.8	0.1	1010	1800	38	5.75	16,500	1590	5440
	18/01/2016					48	30.6		1	40	8.5	3.3	2.3	4.7	3	1	7300	<0.05	63.6	0.1	990	306	138	4.55	16,000	1550	5110
	11/05/2016	1020	4.4			<1	474		134	<10	65.6	30.9	75.2	4.1	14.1	518	7730	<0.5	57.2	<1	922	1150	148	6.29	14,800	1470	4460
	2/09/2016					<1	502		125	<10	70.9	27	78.9	4.3	12.1	568											
	11/01/2017	950	4.7			<5	470		140	6	72	25	71	4.1	13	480	6000	5	67	<1	690	340	2300	6	14,000	1400	4800
	26/03/2017	870	4.2			<5	380		120	<5	50	34	63	3.5	15	410	7900	5	44	<1	690	1700	50	5	12,000	1400	4100
	25/06/2017	1400	4.3			<5	700		160	<5	100	28	110	4.8	17	780	12000	50	96	<1	1400	1000	7200	6	26,000	2100	6800
	10/09/2017	1400	4.4			<5	730		210	28	120	28	110	4.9	16	800	16000	12	130	<1	1300	1400	3500	11	23,000	2200	7300
G9	3/12/2010	372	6.51	<0.1	160	160	160	<0.1	<2	27	48	7.4	9.2	2.8	4	8.2	23	5	0.3	<1	3	4	97	12	180	5	25
	2/11/2010	375.2	6.98	<0.1	150	150		<0.1			49	8.2	8.7	2.9	4.1	6.7											
	25/01/2011	356.2	6.5	<0.1	170	170	<5	<0.1	<2	150	46	7.7	7.7	2.8	4	11	16	5	0.3	<1	3	<1	84	18	240	10	25
	22/11/2011	228.3	7	<1	31	31		<1			8.7	4	2.1	1.3	1.1	3											
	30/01/2012	944	7.07	<1	180	180	470	<1	<2	55	92	8	59	2.9	6.2	280	<10	8	0.2	<1	22	<1	500	<1	1400	67	36
	27/04/2012	379	6.06	<5	25	25	97	<5	<2	<5	20	3	12	1.6	1.9	26	17	<1	0.3	<1	<1	2	<10	12	29	5	19
	22/08/2012	889	7.1	<5	190	190	440	<5	<5	13	88	6	53	2.9	6.1	190	12	6	0.2	<1	13	<1	180	<1	1000	54	24
	3/04/2013	90.7	5.06	<5	38	38	23	<5	<5	<5	4.6	4	2.7	1.6	1.1	34	48	1	2.2	<1	10	15	18	140	330	29	120
	26/12/2013	247	6.4	<5	12	12		<5			9.8	3	8.4	1.9	1.7	12											
	20/02/2014	34.5	5.4	<5	10	10		<5			1.6	2	0.5	1.4	1	1											
	11/04/2014	72.7	6.15	<5	25	25		<5			5.2	3	2.9	1.6	1.4	29											
	7/12/2014	285	6.1	<1	21	21		<1			10.5	4.5	5.9	1.9	1.7	26.6											
	13/02/2015	233	7.1			21	41.7		13	<10	8.4	4.8	5.1	2.1	1.6	24.3	3.5	3.45	0.74	<0.1	2.03	5.18	34	83.5	125	5.92	41.1
	13/03/2015	34.3	7.27			16	37.5		6	<10	7.6	4.6	4.5	2	1.5	22.5	6.4	3.5	0.72	<0.1	3.81	4.37	16	145	225	5.59	54.4
	10/04/2015	223	8.6			13	32.8		12	<10	6.5	4.4	4	1.5	1.3	18.9	4.9	3.6	0.8	<0.1	9.3	5.45	48	141	483	7.68	65.9
	1/09/2015	143.2	7.21			22	47.5		8	<10	9.9		5.6	2	2	24.7	5.4	7.65	0.72	0.1	5.7	1.96	854	238	289	9.42	69.3
	11/12/2015	112	7.1			13	42.6		3	<10	8.9	5.8	4.9	2.1	1.9	22.5	8.3	1.75	1.08	<0.1	4.62	3.94	104	305	235	8.21	99.3
	18/01/2016		6.64			28	62.8		7	20	13.2	5.2	7.3	2	2	31.1	5.1	3.15	0.94	<0.1	4.19	1.79	398	158	208	7.63	73.3
	11/05/2016	143	6.7			30	58.4		11	<10	12.6	4.9	6.5	1.7	1.9	26.5	2	0.8	0.38	<0.1	4.08	1.43	16	33.6	275	6.03	40.2
	2/09/2016					89	117		16	<10	30.1	6.2	10.2	2.3	2.9	31.3											
	11/01/2017	310	7.2			160	170			6	51	7	9.5	2.8	4	5	<10	6	<0.1	<1	<1	<1	320	<5	160	<1	2
	26/03/2017	340	7.1			150	160			<5	50	8	9.3	2.7	4	6	<10	5	<0.1	<1	<1	<1	20	<1	180	<1	2
	25/06/2017	320	7.1			160	170			<5	52	8	9.8	2.8	4.2	6	<10	5	<0.1	<1	<1	<1	540	<1	210	1	8
	10/09/2017	340	7.1			160	200			<5	63	8	10	2.7	4.3	4	<10	5	<0.1	<1	<1	<1	300	<1	150	<1	8
OB11	2/11/2010	4593	7.07	<0.1	390	390		<0.1			480	11	570	2.2	38	3200											
	2/11/2010	4593	7.07	<0.1	390	390		<0.1			450	11	530	2.2	38	3300											
	25/01/2011	2682	7.22	<0.1	360	360	22	<0.1	<2	1300	120	7.2	250	1.7	89	1100	16	2	0.2	<1	<1	<1	<10	<1	<5	1	21
	22/11/2011	4370	6.49	<1	470	470		<1			300	11	570	1.6	83	2700											
	30/01/2012	4755	6.57	<1	390	390	3400	<1	<2	970	510	10	510	4.1	30	3100	<10	2	15	<1	240	2	3500	<1	14,000	730	380
	11/04/2012	4360	5.98	<5	350	350		<5			480	6	480	4	20	2000											
	27/04/2012	4300	5.78	<5	350	350	3400	<5	<2	6	450	8	550	5.2	41	3500	93	<1	6.1	<1	81	3	16	<1	7300	230	120
	22/08/2012	4754	6.69	<5	380	380	3400	<5	<5	6	480	8	530	3.1	31	3800	16	1	5.4	<1	130	1	61	<1	11,000	600	210
	3/04/2013	4300	6.1	<5	410	410	3500	<5	<5	19	450	14	570	3.5	55	2800	29	2	4.3	<1	41	6	17	<1	3100	220	89
	26/12/2013	4500	6.47	<5	390	390		<5			520	9	570	3.5	52	2400											
	20/02/2014	256	5.7	<5	36	36	90	<5	<2	6	11	2	15	1.2	2.9	61	50	1	0.3	<1	<1	4	14	<1	13	7	55
	11/04/2014	353	6.19	<5	29	29		<5			13	2	20	1.2	3.5	60											
	11/04/2014			<5	30	30		<5				2				59											
	7/12/2014	4400	5.6	25	334	359		<1			569	7.8	551	2.7	30.8	3200	242	0.65	5.78	<0.5	130	14.9	<10	0.26	7150	536	276
	13/02/2015	4100	5.5			361	3340		81	10	494	8.4	511	2.7	29.2	2920	16.5	2.45	1.34	<0.5	9.07	1.78	<10	0.03	1060	78.9	35.5
	13/03/2015	4210	5.98			349	3300		37	20	486	9.1	506	3.5	31.7	3030	20	3.45	0.76	<1	1.69	4.41	<20	1.1	183	16.3	34.3
	10/04/2015	4070	6.36			356	3220		73	20	472	8.8	496	2.7	29.8	2810	32.2	2.65	4.4	<1	10.2	3.6	<20	<0.1	3050	126	57.1
	15/12/2015	3400	6.88			245	3260		19	20	536	8.1	467	5.5	25.4	2960	3.4	0.35	11.2	<0.5	273	8.7	76	0.16	15700	620	538
	3/02/2016					310	3540		73	<10	537	9	534	3.5	29.1	3140	4.2	0.8	8.42	<1	15.7	2.11	<20	<0.01	2700	327	195
	11/05/2016	2430	7.2			175	1610		36	<10	235	14.2	248	9.9	18.2	1430	15	2.45	6.34	<1	32	3.85	<20	0.11	10800	207	126
	2/09/2016					311	3620		73	40	558	7.9	541	3.3	26.4	3280											
	11/01/2017	4300	6.7			290	3600		110	22	570	9	530	4.7	32	3000	<10	3	9.4	<1	180	1	8000	<5	13000	490	510
	26/03/2017	4500	6.3			220	3900		130	33	590	9	580	6.7	35	3400	<10	<1	23	<1	530	2	6700	<1	27000	880	1600
	26/08/2017	4700	6.4			280	3800		57	39	600	9	570	4	34	3400	<10	<1	8.9	<1	55	9	80	<1	13000	290	260
	26/08/2017	4700	6.5			280						9				3400											
	10/09/2017	4700	6.5			280	4600		110	78	830	9	610	4.3	34	3600	<10	2	8.8	1	67	8	780	<1	13000	300	270
RIDGE BORE	30/01/2012	279.9	6.4	<1	70	70	6	<1	<2	110	1.3	9	0.7	1.2	2.5	1	<10	1	<0.1	<1	4	<1	63,000	<1	630	15	13
	22/11/2011	99.2	6.38	<1	14	14		<1			1.6	8	0.7	1.4	2.4	<1											
	27/04/2012	213.5	5.54	<5	27	27	16	<5	<2	67	4.2	6	1.3	1.6	2.8	2	50	<1	0.3	<1	6	4	30,000	<1	2200	11	71
	22/08/2012	87	6.1	<5	25	25	14	<5	<5	28	3.6	6	1.2	1.3	2.7	<1	24	<1	0.4	<1	5	<1	4300	<1	710	9	36
	3/04/2013	104	6.8	<5	39	39	15	<5	<5	18	3.7	6	1.3	1.6	3	<1	14	<1	<0.1	<1	<1	2	9200	<1	700	2	31
	26/12/2013	82.4	6.3	<5	13	13		<5			3	7	0.9	1.3	2.5	<1											
	20/02/2014	172.2	6	<5	31	31	14	<5	<2	51	3.7	7	1.2	1.2	2.5	<1	40	<1	0.3	<1	6	5	33,000	<1	2800	13	31
	11/04/2014	288	6.47	<5	55	55		<5			3	7	1.2	1.3	3	<1											
	7/12/2014	270	6.4	<1	3	3		<1			1	7.4	0.6	1.1	2.6	0.7	18	3.55	0.16	<0.1	3.89	0.81	81400	0.01	538	7.77	30.2
	13/02/2015	253	6			15	15.7		86	110	4.3	5.5	1.2	1.9	2.8	1.1	0.6	<0.05	0.02	0.4	5.07	0.02	19400	<0.01	677	51.4	7.5
	13/03/2015	260	6.07			27	7.6		56	80	1.6	6.4	0.9	1.5	3	2	1.1	0.05	<0.02	<0.1	1.66	<0.01	33200	<0.01	703	2.39	3.6
	10/04/2015	255	7.33			59	8.5		114	80	2.1	5.8	0.8	1.1	2.7	0.2	0.4	<0.05	<0.02	<0.1	1.41	0.34	18500	<0.01	606	1.91	2.5
	1/09/2015	223.5	6.88			13	5.4		66	80	1.2		0.6	1.3	3.2	0.2	2.9	<0.5	<0.2	<1	1.64	0.35	13100	<0.1	570	5.95	45.1
	11/12/2015	42	6.6			8	5.6		29	100	1.2	6.2	0.6	1.3	3	0.3	<0.1	<0.05	<0.02	<0.1	2.45	<0.01	25700	<0.01	569	16.4	17.3
	3/02/2016		7.42			20	6.7		105	90	1.6	6.5	0.7	1.3	2.9	0.3	0.4	0.1	0.06	<0.1	1.83	0.1	29400	<0.01	679	7.22	11
	11/05/2016	146	6.4			65	7.2		103	70	1.6	5.5	0.7	1.3	3.1	0.4	0.2	0.05	0.02	<0.1	2.96	0.02	31000	0.02	721	5.45	20.1
	2/09/2016					36	5.4		74	60	1.2	5.3	0.6	1.3	2.9	0.4											
	11/01/2017	120	6.3			63	6		100	62	1.3	5	0.6	1.2	3	<1	<10	1	<0.1	<1	2	<1	42000	<5	440	3	12
	26/03/2017	100	6			50	7		85	52	1.7	5	0.7	1.3	3	<1	<10	<1	<0.1	<1	4	<1	25000	<1	990	6	6
	26/08/2017	130	6.2			63	6		56	75	1.3	5	0.6	1.4	2.9	<1	<10	2	0.1	<1	4	<1	48000	<1	600	13	33
	10/09/2017	71	5.7			28	6		85	76	1.2	5	0.7	1.2	3.1	<1	<10	2	<0.1	<1	3	<1	46000	<1	530	10	13
G1	22/11/2011	1876	7.2	<1	390	390		<1			210	9	110	8.8	24	900											
	22/11/2011	247.2	8.1	<1	56	56		<1			12	4	12	3.8	8.1	52											
	30/01/2012	2229	6.92	<1	340	340		<1			270	8	140	8.6	27	1500											
	30/01/2012	268.8	8.38	<1	84	85		<1			19	4	12	3.7	8.3	39											
	22/08/2012	2367	6.75	<5	200	200		<5			280	5	160	8.2	27	1200											
	22/08/2012	175.3	8.74	9	87	96		<5			6.6	3	9.6	3.7	6.6	1											
	1/09/2015	1938	8.26				828		5	40	142		115	29	32.2	300	28.4	19	<0.2	<1	0.38	0.88	128	0.51	56.6	2.45	13.4
	15/12/2015	2201	7.56			788	1160		10	50	240	12.9	136	17.2	26.3	700	16.7	11.5	<0.1	1	1.16	0.25	128	0.1	326	6.46	4.2
	18/01/2016		7.28			592	1230		26	50	257	12	143	17.9	25.9	810	17.3	7.8	<0.2	<1	0.28	0.1	100	<0.1	364	3.3	3.3
	11/05/2016	2210	7.2			412	1360		72	10	292	9.6	153	12.8	24.5	1080	40.1	6.5	<0.2	<1	0.89	0.86	70	<0.1	397	3.82	9.5
	2/09/2016					299	1490		56	50	323	7.9	166	10.7	22.2	1310											
	11/01/2017	2200	6.4			160	1600		75	5	340	6	170	7.7	22	1300	<10	2	<0.1	<1	2	<1	780	<5	290	11	9
	26/03/2017	2200	6.3			150	1500		55	<5	330	7	170	8	22	1300	<10	2	<0.1	<1	2	<1	330	<1	340	19	5
	25/06/2017	2200	6.4			150	1500		58	13	320	7	170	7.6	23	1300	<10	3	<0.1	<1	3	<1	560	<1	520	28	19
	10/09/2017	2200	6.3			150	1800		70	16	420	7	170	8	21	1200	<10	3	<0.1	<1	3	<1	510	<1	500	25	20
OB10	2/11/2010	5113	6.95	<0.1	460	460		<0.1			460	11	660	2.9	35	3500											
	3/12/2010	4309	6.76	<0.1	380	380		<0.1			350	8.9	490	2.7	30	2400											
	3/12/2010	4309	6.76	<0.1	380	380		<0.1			330		480	2.7	28												
	25/01/2011	516	6.95	<0.1	170	170		<0.1			24	1.9	39	1.1	11	98											
	22/11/2011																										
P100	22/11/2011	1001	6.29	<1	63	63		<1			90	14	56	7.4	28	380											
	30/01/2012	1081	6.27	<1	73	73		<1			100	15	60	8	31	450											
	30/01/2012	1081	6.27	<1	75	75		<1			98	15	60	7.8	31	440											
	22/08/2012	1285	6.13	<5	91	91		<5			110	14	62	8.3	31	460											
	22/08/2012	1285	6.13	<5	91	91		<5				14				460											
	1/09/2015	1271	6.53			81	642		36	10	138		72.5	8.9	35	598	4.3	56	0.36	<1	4.85	1.56	6300	0.12	1500	18.2	97.6
RN29693	22/08/2012	125.9	6.34	<5	40	40		<5			5.4	2	2.4	3.2	2.8	<1											
	22/11/2011	1252	8.05	19	42	61		<1			5.3	5	1.5	6.4	3.7	<1											
	30/01/2012	215.7	8.51	4	92	96		<1			13	5	4.8	6.1	3.8	15											
	22/08/2012	138.3	8.91	15	65	80		<5			6.6	4	1.8	6.1	3.5	<1											

Table 4-5 Groundwater chemistry summary compared against ANZECC Freshwater Aquatic Ecosystem 90 % Values

		Field		Alkalinity					Acidity	Inorganics	Major Ions						Metals										
		Electrical Conductivity (Field)	pH (Field)	Carbonate	Bicarbonate	Alkalinity (total) as CaCO3	Hardness as CaCO3	Hydroxide	Acidity (as CaCO3)	Total Suspended Solids	Calcium (Filtered)	Chloride	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Sulphate	Aluminium (Filtered)	Arsenic (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Cobalt (Filtered)	Copper (Filtered)	Iron (Filtered)	Lead (Filtered)	Manganese (Filtered)	Nickel (Filtered)	Zinc (Filtered)
		µS/cm	pH_Units	mg/L	mg/L	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
ANZECC FAE80%																	80	94	0.4	6		1.8		5.6	2500	13	15
Bore	**Sample Date**																										
BORE 11	9/05/2011	4.69	6	<1	180	180	3100	<1	<2	20	480	8	480	6.6	22	3000	440	11	66	<1	760	5	44,000	<1	31,000	1400	3100
	22/11/2011	270	7.12	<1	120	120		<1			21	9	11	5.8	5.9	2											
	30/01/2012	278.4	7.86	<1	120	120	95	<1	<2	18	17	9	13	6.4	6.5	3	<10	<1	<0.1	<1	<1	<1	310	<1	200	<1	<1
	27/04/2012	241.6	6.65	<5	110	110	79	<5	<2	<5	13	7	11	6.8	6.5	<1	3	<1	<0.1	<1	<1	<1	410	<1	250	1	8
	22/08/2012	241.4	8.03	<5	110	110	73	<5	<5	9	11	7	11	6.1	6.3	<1	27	<1	<0.1	<1	<1	<1	32	<1	94	2	1
	3/04/2013	238.1	7.3	<5	100	100	64	<5	<5	9	9.3	7	9.9	7.2	6.9	<1	<10	<1	<0.1	<1	<1	<1	920	<1	210	<1	7
	26/12/2013	175	7.9	11	66	77		<5			6.7	8	8.3	6.1	5.9	<1											
	20/02/2014	164.8	7.3	15	69	83	49	<5	<2	<5	6.7	8	7.9	6.5	6.2	<1	30	<1	<0.1	<1	<1	1	77	<1	80	1	8
	11/04/2014	163.9	7.62	<5	66	66		<5			7.4	8	9.3	6.5	6.9	<1											
	7/12/2014	160	7.4	<1	63	63		<1			6.2	9.4	7.2	6.2	6.2	0.9											
	13/02/2015	146.2	7			60	41.7		<1	<10	5.8	9.8	6.6	6.2	5.9	1.1	5.6	0.1	<0.02	<0.1	0.04	0.06	<2	0.01	17.3	1800	<0.1
	13/03/2015	158.4	7.46			58	41		<1	<10	5.8	10.5	6.5	6.8	6.4	1.3	5.3	0.1	<0.02	<0.1	0.05	0.09	4	<0.01	23.8	0.17	2.9
	10/04/2015	162.3	7.8			67	41.5		<1	<10	5.7	10	6.6	5.8	6	0.7	2.2	0.15	<0.02	<0.1	0.03	0.13	12	<0.01	25.4	0.12	0.9
	1/09/2015	154.4	8.67			59	40.4		<1	<10	5.7		6.4	6.4	6.8	0.8	6	0.15	0.08	0.1	0.06	3.64	14	0.25	22.6	0.58	12.5
	11/12/2015	154	8.1			53	39.4		<1	<10	5.6	10.8	6.2	6.5	6.8	0.9	6.8	0.2	0.02	<0.1	0.08	1.22	8	0.06	17.2	1.49	2.8
	3/02/2016		8.7			51	38.4		<1	<10	5.6	10.9	5.9	6.3	6.1	0.8	7.2	0.15	<0.02	<0.1	0.06	0.57	8	0.03	18.9	0.28	0.9
	11/05/2016	148	8.7			68	38.1		<1	<10	5.6	10.4	5.9	6.1	6.2	0.7	1.8	0.15	<0.02	<0.1	0.05	0.13	28	0.04	24.1	0.21	0.7
	2/09/2016					62	38.4		<1	<10	5.7	9.9	5.9	6.2	5.8	0.7											
	11/01/2017	120	8.8			63	42		<5	6	6.3	9	6.3	6.2	6.1	<1	<10	<1	<0.1	<1	<1	<1	40	<5	32	<1	2
	26/03/2017	150	8.8			66	42		<5	<5	6.7	10	6.2	6.3	5.8	<1	<10	<1	<0.1	<1	<1	<1	30	<1	67	<1	<1
	26/08/2017	230	8.5			73	59		<5	<5	10	10	8.3	6.3	6.2	19	260	<1	<0.1	<1	3	<1	20	<1	230	13	10
	10/09/2017	180	8.7			73	48		<5	<5	7.4	10	7.1	6.5	6.4	1	<10	<1	<0.1	<1	<1	<1	340	<1	60	<1	9
G8	3/12/2010	1568	4.69	<0.1	<0.1	<0.1	680	<0.1	<2	23	98	34	110	5	15	740	9100	12	90	<1	1200	830	1400	8	18,000	1800	6000
	2/11/2010	1630	4.74	<0.1	<0.1	<0.1		<0.1			98	31	110	5.1	16	820											
	25/01/2011	1152	4.75	<0.1	<0.1	<0.1	17	<0.1	130	380	52	47	62	3.7	21	420	8100	<1	46	<1	860	1600	100	83	13,000	1400	4000
	9/05/2011	1166	4.37	<1	<1	<1	420	<1	93	<5	57	50	68	3.8	22	570	11,000	4	45	<1	830	1200	75	5	17,000	1400	3700
	22/11/2011	1167	4.7	<1	<1	<1		<1			61	45	76	3.6	17	510											
	30/01/2012	1098	4.13	<1	<1	<1	430	<1	180	58	57	36	70	3.7	14	460	8000	<1	58	1	770	1500	400	8	14,000	1300	4100
	11/04/2012	1082	5.61	<5	<5	<5		<5			54	34	59	3.1	14	330											
	27/04/2012	1808	4.74	<5	<5	<5	430	<5	170	<5	60	36	68	3.9	17	460	8100	<1	43	<1	810	1700	28	5	14,000	1300	3700
	22/08/2012	1494	4.28	<5	<5	<5	610	<5	240	26	84	24	96	4.9	14	670	13,000	10	74	<1	1100	1500	2200	7	20,000	1900	6400
	3/04/2013	850	3.9	<5	<5	<5	310	<5	100	8	45	31	49	5.1	13	330	5800	4	36	<1	690	1500	89	4	12,000	1200	3300
	26/12/2013	1075	4.3	<5	<5	<5		<5			64	26	74	4.6	14	440											
	11/04/2014	1022	4.64	<5	<5	<5		<5			70	32	84	4.2	18	430											
	7/12/2014	955	5.1	<1	<1	<1		<1			64.5	33.5	77	6.4	16.8	524											
	20/02/2014	930	4.3	<5	<5	<5	390	<5	170	5	53	36	63	3.8	16	370	7500	6	38	<1	720	1300	63	9	13,000	1300	3700
	13/02/2015	1055	5.3			<1	474		117	20	65.1	36.2	75.7	6.5	15.5	529	3440	0.3	54	0.1	905	1310	8	3.9	15,400	1590	4680
	13/03/2015	941	4.96			<1	409		103	<10	57	35.6	64.8	4.1	14.5	486	8400	0.2	48	0.2	835	1480	94	6.95	14,200	1450	4350
	10/04/2015	1008	4.47			<1	425		182	<10	58.6	30.6	67.8	3.4	12.9	481	7880	<0.05	51.6	0.1	867	1230	134	6.05	14,000	1410	4260
	1/09/2015	1206	4.6			<1	559		125	20	82.3		85.9	5.2	13.6	621	7620	1.4	60.6	<1	1070	776	3060	10.9	16,800	1650	5690
	11/12/2015	1120	4.5			<1	560		80	20	83	25.3	85.7	5.4	13	623	6960	0.05	96.8	0.1	1010	1800	38	5.75	16,500	1590	5440
	18/01/2016					48	30.6		1	40	8.5	3.3	2.3	4.7	3	1	7300	<0.05	63.6	0.1	990	306	138	4.55	16,000	1550	5110
	11/05/2016	1020	4.4			<1	474		134	<10	65.6	30.9	75.2	4.1	14.1	518	7730	<0.5	57.2	<1	922	1150	148	6.29	14,800	1470	4460
	2/09/2016					<1	502		125	<10	70.9	27	78.9	4.3	12.1	568											
	11/01/2017	950	4.7			<5	470		140	6	72	25	71	4.1	13	480	6000	5	67	<1	690	340	2300	6	14,000	1400	4800
	26/03/2017	870	4.2			<5	380		120	<5	50	34	63	3.5	15	410	7900	5	44	<1	690	1700	50	5	12,000	1400	4100
	25/06/2017	1400	4.3			<5	700		160	<5	100	28	110	4.8	17	780	12000	50	96	<1	1400	1000	7200	6	26,000	2100	6800
	10/09/2017	1400	4.4			<5	730		210	28	120	28	110	4.9	16	800	16000	12	130	<1	1300	1400	3500	11	23,000	2200	7300
G9	3/12/2010	372	6.51	<0.1	160	160	160	<0.1	<2	27	48	7.4	9.2	2.8	4	8.2	23	5	0.3	<1	3	4	97	12	180	5	25
	2/11/2010	375.2	6.98	<0.1	150	150		<0.1			49	8.2	8.7	2.9	4.1	6.7											
	25/01/2011	356.2	6.5	<0.1	170	170	<5	<0.1	<2	150	46	7.7	7.7	2.8	4	11	16	5	0.3	<1	3	<1	84	18	240	10	25
	22/11/2011	228.3	7	<1	31	31		<1			8.7	4	2.1	1.3	1.1	3											
	30/01/2012	944	7.07	<1	180	180	470	<1	<2	55	92	8	59	2.9	6.2	280	<10	8	0.2	<1	22	<1	500	<1	1400	67	36
	27/04/2012	379	6.06	<5	25	25	97	<5	<2	<5	20	3	12	1.6	1.9	26	17	<1	0.3	<1	<1	2	<10	12	29	5	19
	22/08/2012	889	7.1	<5	190	190	440	<5	<5	13	88	6	53	2.9	6.1	190	12	6	0.2	<1	13	<1	180	<1	1000	54	24
	3/04/2013	90.7	5.06	<5	38	38	23	<5	<5	<5	4.6	4	2.7	1.6	1.1	34	48	1	2.2	<1	10	15	18	140	330	29	120
	26/12/2013	247	6.4	<5	12	12		<5			9.8	3	8.4	1.9	1.7	12											
	20/02/2014	34.5	5.4	<5	10	10		<5			1.6	2	0.5	1.4	1	1											
	11/04/2014	72.7	6.15	<5	25	25		<5			5.2	3	2.9	1.6	1.4	29											
	7/12/2014	285	6.1	<1	21	21		<1			10.5	4.5	5.9	1.9	1.7	26.6											
	13/02/2015	233	7.1			21	41.7		13	<10	8.4	4.8	5.1	2.1	1.6	24.3	3.5	3.45	0.74	<0.1	2.03	5.18	34	83.5	125	5.92	41.1
	13/03/2015	34.3	7.27			16	37.5		6	<10	7.6	4.6	4.5	2	1.5	22.5	6.4	3.5	0.72	<0.1	3.81	4.37	16	145	225	5.59	54.4
	10/04/2015	223	8.6			13	32.8		12	<10	6.5	4.4	4	1.5	1.3	18.9	4.9	3.6	0.8	<0.1	9.3	5.45	48	141	483	7.68	65.9
	1/09/2015	143.2	7.21			22	47.5		8	<10	9.9		5.6	2	2	24.7	5.4	7.65	0.72	0.1	5.7	1.96	854	238	289	9.42	69.3
	11/12/2015	112	7.1			13	42.6		3	<10	8.9	5.8	4.9	2.1	1.9	22.5	8.3	1.75	1.08	<0.1	4.62	3.94	104	305	235	8.21	99.3
	18/01/2016		6.64			28	62.8		7	20	13.2	5.2	7.3	2	2	31.1	5.1	3.15	0.94	<0.1	4.19	1.79	398	158	208	7.63	73.3
	11/05/2016	143	6.7			30	58.4		11	<10	12.6	4.9	6.5	1.7	1.9	26.5	2	0.8	0.38	<0.1	4.08	1.43	16	33.6	275	6.03	40.2
	2/09/2016					89	117		16	<10	30.1	6.2	10.2	2.3	2.9	31.3											
	11/01/2017	310	7.2			160	170			6	51	7	9.5	2.8	4	5	<10	6	<0.1	<1	<1	<1	320	<5	160	<1	2
	26/03/2017	340	7.1			150	160			<5	50	8	9.3	2.7	4	6	<10	5	<0.1	<1	<1	<1	20	<1	180	<1	2
	25/06/2017	320	7.1			160	170			<5	52	8	9.8	2.8	4.2	6	<10	5	<0.1	<1	<1	<1	540	<1	210	1	8
	10/09/2017	340	7.1			160	200			<5	63	8	10	2.7	4.3	4	<10	5	<0.1	<1	<1	<1	300	<1	150	<1	8
OB11	2/11/2010	4593	7.07	<0.1	390	390		<0.1			480	11	570	2.2	38	3200											
	2/11/2010	4593	7.07	<0.1	390	390		<0.1			450	11	530	2.2	38	3300											
	25/01/2011	2682	7.22	<0.1	360	360	22	<0.1	<2	1300	120	7.2	250	1.7	89	1100	16	2	0.2	<1	<1	<1	<10	<1	<5	1	21
	22/11/2011	4370	6.49	<1	470	470		<1			300	11	570	1.6	83	2700											
	30/01/2012	4755	6.57	<1	390	390	3400	<1	<2	970	510	10	510	4.1	30	3100	<10	2	15	<1	240	2	3500	<1	14,000	730	380
	11/04/2012	4360	5.98	<5	350	350		<5			480	6	480	4	20	2000											
	27/04/2012	4300	5.78	<5	350	350	3400	<5	<2	6	450	8	550	5.2	41	3500	93	<1	6.1	<1	81	3	16	<1	7300	230	120
	22/08/2012	4754	6.69	<5	380	380	3400	<5	<5	6	480	8	530	3.1	31	3800	16	1	5.4	<1	130	1	61	<1	11,000	600	210
	3/04/2013	4300	6.1	<5	410	410	3500	<5	<5	19	450	14	570	3.5	55	2800	29	2	4.3	<1	41	6	17	<1	3100	220	89
	26/12/2013	4500	6.47	<5	390	390		<5			520	9	570	3.5	52	2400											
	20/02/2014	256	5.7	<5	36	36	90	<5	<2	6	11	2	15	1.2	2.9	61	50	1	0.3	<1	<1	4	14	<1	13	7	55
	11/04/2014	353	6.19	<5	29	29		<5			13	2	20	1.2	3.5	60											
	11/04/2014			<5	30	30		<5				2				59											
	7/12/2014	4400	5.6	25	334	359		<1			569	7.8	551	2.7	30.8	3200	242	0.65	5.78	<0.5	130	14.9	<10	0.26	7150	536	276
	13/02/2015	4100	5.5			361	3340		81	10	494	8.4	511	2.7	29.2	2920	16.5	2.45	1.34	<0.5	9.07	1.78	<10	0.03	1060	78.9	35.5
	13/03/2015	4210	5.98			349	3300		37	20	486	9.1	506	3.5	31.7	3030	20	3.45	0.76	<1	1.69	4.41	<20	1.1	183	16.3	34.3
	10/04/2015	4070	6.36			356	3220		73	20	472	8.8	496	2.7	29.8	2810	32.2	2.65	4.4	<1	10.2	3.6	<20	<0.1	3050	126	57.1
	15/12/2015	3400	6.88			245	3260		19	20	536	8.1	467	5.5	25.4	2960	3.4	0.35	11.2	<0.5	273	8.7	76	0.16	15700	620	538
	3/02/2016					310	3540		73	<10	537	9	534	3.5	29.1	3140	4.2	0.8	8.42	<1	15.7	2.11	<20	<0.01	2700	327	195
	11/05/2016	2430	7.2			175	1610		36	<10	235	14.2	248	9.9	18.2	1430	15	2.45	6.34	<1	32	3.85	<20	0.11	10800	207	126
	2/09/2016					311	3620		73	40	558	7.9	541	3.3	26.4	3280											
	11/01/2017	4300	6.7			290	3600		110	22	570	9	530	4.7	32	3000	<10	3	9.4	<1	180	1	8000	<5	13000	490	510
	26/03/2017	4500	6.3			220	3900		130	33	590	9	580	6.7	35	3400	<10	<1	23	<1	530	2	6700	<1	27000	880	1600
	26/08/2017	4700	6.4			280	3800		57	39	600	9	570	4	34	3400	<10	<1	8.9	<1	55	9	80	<1	13000	290	260
	26/08/2017	4700	6.5			280						9				3400											
	10/09/2017	4700	6.5			280	4600		110	78	830	9	610	4.3	34	3600	<10	2	8.8	1	67	8	780	<1	13000	300	270
RIDGE BORE	30/01/2012	279.9	6.4	<1	70	70	6	<1	<2	110	1.3	9	0.7	1.2	2.5	1	<10	1	<0.1	<1	4	<1	63,000	<1	630	15	13
	22/11/2011	99.2	6.38	<1	14	14		<1			1.6	8	0.7	1.4	2.4	<1											
	27/04/2012	213.5	5.54	<5	27	27	16	<5	<2	67	4.2	6	1.3	1.6	2.8	2	50	<1	0.3	<1	6	4	30,000	<1	2200	11	71
	22/08/2012	87	6.1	<5	25	25	14	<5	<5	28	3.6	6	1.2	1.3	2.7	<1	24	<1	0.4	<1	5	<1	4300	<1	710	9	36
	3/04/2013	104	6.8	<5	39	39	15	<5	<5	18	3.7	6	1.3	1.6	3	<1	14	<1	<0.1	<1	<1	2	9200	<1	700	2	31
	26/12/2013	82.4	6.3	<5	13	13		<5			3	7	0.9	1.3	2.5	<1											
	20/02/2014	172.2	6	<5	31	31	14	<5	<2	51	3.7	7	1.2	1.2	2.5	<1	40	<1	0.3	<1	6	5	33,000	<1	2800	13	31
	11/04/2014	288	6.47	<5	55	55		<5			3	7	1.2	1.3	3	<1											
	7/12/2014	270	6.4	<1	3	3		<1			1	7.4	0.6	1.1	2.6	0.7	18	3.55	0.16	<0.1	3.89	0.81	81400	0.01	538	7.77	30.2
	13/02/2015	253	6			15	15.7		86	110	4.3	5.5	1.2	1.9	2.8	1.1	0.6	<0.05	0.02	0.4	5.07	0.02	19400	<0.01	677	51.4	7.5
	13/03/2015	260	6.07			27	7.6		56	80	1.6	6.4	0.9	1.5	3	2	1.1	0.05	<0.02	<0.1	1.66	<0.01	33200	<0.01	703	2.39	3.6
	10/04/2015	255	7.33			59	8.5		114	80	2.1	5.8	0.8	1.1	2.7	0.2	0.4	<0.05	<0.02	<0.1	1.41	0.34	18500	<0.01	606	1.91	2.5
	1/09/2015	223.5	6.88			13	5.4		66	80	1.2		0.6	1.3	3.2	0.2	2.9	<0.5	<0.2	<1	1.64	0.35	13100	<0.1	570	5.95	45.1
	11/12/2015	42	6.6			8	5.6		29	100	1.2	6.2	0.6	1.3	3	0.3	<0.1	<0.05	<0.02	<0.1	2.45	<0.01	25700	<0.01	569	16.4	17.3
	3/02/2016		7.42			20	6.7		105	90	1.6	6.5	0.7	1.3	2.9	0.3	0.4	0.1	0.06	<0.1	1.83	0.1	29400	<0.01	679	7.22	11
	11/05/2016	146	6.4			65	7.2		103	70	1.6	5.5	0.7	1.3	3.1	0.4	0.2	0.05	0.02	<0.1	2.96	0.02	31000	0.02	721	5.45	20.1
	2/09/2016					36	5.4		74	60	1.2	5.3	0.6	1.3	2.9	0.4											
	11/01/2017	120	6.3			63	6		100	62	1.3	5	0.6	1.2	3	<1	<10	1	<0.1	<1	2	<1	42000	<5	440	3	12
	26/03/2017	100	6			50	7		85	52	1.7	5	0.7	1.3	3	<1	<10	<1	<0.1	<1	4	<1	25000	<1	990	6	6
	26/08/2017	130	6.2			63	6		56	75	1.3	5	0.6	1.4	2.9	<1	<10	2	0.1	<1	4	<1	48000	<1	600	13	33
	10/09/2017	71	5.7			28	6		85	76	1.2	5	0.7	1.2	3.1	<1	<10	2	<0.1	<1	3	<1	46000	<1	530	10	13
G1	22/11/2011	1876	7.2	<1	390	390		<1			210	9	110	8.8	24	900											
	22/11/2011	247.2	8.1	<1	56	56		<1			12	4	12	3.8	8.1	52											
	30/01/2012	2229	6.92	<1	340	340		<1			270	8	140	8.6	27	1500											
	30/01/2012	268.8	8.38	<1	84	85		<1			19	4	12	3.7	8.3	39											
	22/08/2012	2367	6.75	<5	200	200		<5			280	5	160	8.2	27	1200											
	22/08/2012	175.3	8.74	9	87	96		<5			6.6	3	9.6	3.7	6.6	1											
	1/09/2015	1938	8.26				828		5	40	142		115	29	32.2	300	28.4	19	<0.2	<1	0.38	0.88	128	0.51	56.6	2.45	13.4
	15/12/2015	2201	7.56			788	1160		10	50	240	12.9	136	17.2	26.3	700	16.7	11.5	<0.1	1	1.16	0.25	128	0.1	326	6.46	4.2
	18/01/2016		7.28			592	1230		26	50	257	12	143	17.9	25.9	810	17.3	7.8	<0.2	<1	0.28	0.1	100	<0.1	364	3.3	3.3
	11/05/2016	2210	7.2			412	1360		72	10	292	9.6	153	12.8	24.5	1080	40.1	6.5	<0.2	<1	0.89	0.86	70	<0.1	397	3.82	9.5
	2/09/2016					299	1490		56	50	323	7.9	166	10.7	22.2	1310											
	11/01/2017	2200	6.4			160	1600		75	5	340	6	170	7.7	22	1300	<10	2	<0.1	<1	2	<1	780	<5	290	11	9
	26/03/2017	2200	6.3			150	1500		55	<5	330	7	170	8	22	1300	<10	2	<0.1	<1	2	<1	330	<1	340	19	5
	25/06/2017	2200	6.4			150	1500		58	13	320	7	170	7.6	23	1300	<10	3	<0.1	<1	3	<1	560	<1	520	28	19
	10/09/2017	2200	6.3			150	1800		70	16	420	7	170	8	21	1200	<10	3	<0.1	<1	3	<1	510	<1	500	25	20
OB10	2/11/2010	5113	6.95	<0.1	460	460		<0.1			460	11	660	2.9	35	3500											
	3/12/2010	4309	6.76	<0.1	380	380		<0.1			350	8.9	490	2.7	30	2400											
	3/12/2010	4309	6.76	<0.1	380	380		<0.1			330		480	2.7	28												
	25/01/2011	516	6.95	<0.1	170	170		<0.1			24	1.9	39	1.1	11	98											
	22/11/2011																										
P100	22/11/2011	1001	6.29	<1	63	63		<1			90	14	56	7.4	28	380											
	30/01/2012	1081	6.27	<1	73	73		<1			100	15	60	8	31	450											
	30/01/2012	1081	6.27	<1	75	75		<1			98	15	60	7.8	31	440											
	22/08/2012	1285	6.13	<5	91	91		<5			110	14	62	8.3	31	460											
	22/08/2012	1285	6.13	<5	91	91		<5				14				460											
	1/09/2015	1271	6.53			81	642		36	10	138		72.5	8.9	35	598	4.3	56	0.36	<1	4.85	1.56	6300	0.12	1500	18.2	97.6
RN29693	22/08/2012	125.9	6.34	<5	40	40		<5			5.4	2	2.4	3.2	2.8	<1											
	22/11/2011	1252	8.05	19	42	61		<1			5.3	5	1.5	6.4	3.7	<1											
	30/01/2012	215.7	8.51	4	92	96		<1			13	5	4.8	6.1	3.8	15											
	22/08/2012	138.3	8.91	15	65	80		<5			6.6	4	1.8	6.1	3.5	<1											

Table 4-6 Groundwater chemistry summary compared against Australian Drinking Water Guidelines (*Health & Aesthetic*)

		Field		Alkalinity					Acidity	Inorganics	Major Ions						Metals										
		Electrical Conductivity (Field)	pH (Field)	Carbonate	Bicarbonate	Alkalinity (total) as CaCO3	Hardness as CaCO3	Hydroxide	Acidity (as CaCO3)	Total Suspended Solids	Calcium (Filtered)	Chloride	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Sulfate	Aluminium (Filtered)	Arsenic (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Cobalt (Filtered)	Copper (Filtered)	Iron (Filtered)	Lead (Filtered)	Manganese (Filtered)	Nickel (Filtered)	Zinc (Filtered)
		µS/cm	pH_Units	mg/L	mg/L	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
ADWG 2011 - Health																500		10	2	50		2000		10	500	20	
ADWG 2011 - Aesthetic			6.5 - 8.5				200					250			180	250	200					1000	300				3000
Bore	Sample Date																										
BORE 11	9/05/2011	4.69	6	<1	180	180	3100	<1	<2	20	480	8	480	6.6	22	3000	440	11	66	<1	760	5	44,000	<1	31,000	1400	3100
	22/11/2011	270	7.12	<1	120	120		<1			21	9	11	5.8	5.9	2											
	30/01/2012	278.4	7.86	<1	120	120	95	<1	<2	18	17	9	13	6.4	6.5	3	<10	<1	<0.1	<1	<1	<1	310	<1	200	<1	<1
	27/04/2012	241.6	6.65	<5	110	110	79	<5	<2	<5	13	7	11	6.8	6.5	<1	3	<1	<0.1	<1	<1	<1	410	<1	250	1	8
	22/08/2012	241.4	8.03	<5	110	110	73	<5	<5	9	11	7	11	6.1	6.3	<1	27	<1	<0.1	<1	<1	<1	32	<1	94	2	1
	3/04/2013	238.1	7.3	<5	100	100	64	<5	<5	9	9.3	7	9.9	7.2	6.9	<1	<10	<1	<0.1	<1	<1	<1	920	<1	210	<1	7
	26/12/2013	175	7.9	11	66	77		<5			6.7	8	8.3	6.1	5.9	<1											
	20/02/2014	164.8	7.3	15	69	83	49	<5	<2	<5	6.7	8	7.9	6.5	6.2	<1	30	<1	<0.1	<1	<1	1	77	<1	80	1	8
	11/04/2014	163.9	7.62	<5	66	66		<5			7.4	8	9.3	6.5	6.9	<1											
	7/12/2014	160	7.4	<1	63	63		<1			6.2	9.4	7.2	6.2	6.2	0.9											
	13/02/2015	146.2	7			60	41.7		<1	<10	5.8	9.8	6.6	6.2	5.9	1.1	5.6	0.1	<0.02	<0.1	0.04	0.06	<2	0.01	17.3	1800	<0.1
	13/03/2015	158.4	7.46			58	41		<1	<10	5.8	10.5	6.5	6.8	6.4	1.3	5.3	0.1	<0.02	<0.1	0.05	0.09	4	<0.01	23.8	0.17	2.9
	10/04/2015	162.3	7.8			67	41.5		<1	<10	5.7	10	6.6	5.8	6	0.7	2.2	0.15	<0.02	<0.1	0.03	0.13	12	<0.01	25.4	0.12	0.9
	1/09/2015	154.4	8.67			59	40.4		<1	<10	5.7		6.4	6.4	6.8	0.8	6	0.15	0.08	0.1	0.06	3.64	14	0.25	22.6	0.58	12.5
	11/12/2015	154	8.1			53	39.4		<1	<10	5.6	10.8	6.2	6.5	6.8	0.9	6.8	0.2	0.02	<0.1	0.08	1.22	8	0.06	17.2	1.49	2.8
	3/02/2016		8.7			51	38.4		<1	<10	5.6	10.9	5.9	6.3	6.1	0.8	7.2	0.15	<0.02	<0.1	0.06	0.57	8	0.03	18.9	0.28	0.9
	11/05/2016	148	8.7			68	38.1		<1	<10	5.6	10.4	5.9	6.1	6.2	0.7	1.8	0.15	<0.02	<0.1	0.05	0.13	28	0.04	24.1	0.21	0.7
	2/09/2016					62	38.4		<1	<10	5.7	9.9	5.9	6.2	5.8	0.7											
	11/01/2017	120	8.8			63	42		<5	6	6.3	9	6.3	6.2	6.1	<1	<10	<1	<0.1	<1	<1	<1	40	<5	32	<1	2
	26/03/2017	150	8.8			66	42		<5	<5	6.7	10	6.2	6.3	5.8	<1	<10	<1	<0.1	<1	<1	<1	30	<1	67	<1	<1
	26/08/2017	230	8.5			73	59		<5	<5	10	10	8.3	6.3	6.2	19	260	<1	<0.1	<1	3	<1	20	<1	230	13	10
	10/09/2017	180	8.7			73	48		<5	<5	7.4	10	7.1	6.5	6.4	1	<10	<1	<0.1	<1	<1	<1	340	<1	60	<1	9
G8	3/12/2010	1568	4.69	<0.1	<0.1	<0.1	680	<0.1	<2	23	98	34	110	5	15	740	9100	12	90	<1	1200	830	1400	8	18,000	1800	6000
	2/11/2010	1630	4.74	<0.1	<0.1	<0.1		<0.1			98	31	110	5.1	16	820											
	25/01/2011	1152	4.75	<0.1	<0.1	<0.1	17	<0.1	130	380	52	47	62	3.7	21	420	8100	<1	46	<1	860	1600	100	83	13,000	1400	4000
	9/05/2011	1166	4.37	<1	<1	<1	420	<1	93	<5	57	50	68	3.8	22	570	11,000	4	45	<1	830	1200	75	5	17,000	1400	3700
	22/11/2011	1167	4.7	<1	<1	<1		<1			61	45	76	3.6	17	510											
	30/01/2012	1098	4.13	<1	<1	<1	430	<1	180	58	57	36	70	3.7	14	460	8000	<1	58	1	770	1500	400	8	14,000	1300	4100
	11/04/2012	1082	5.61	<5	<5	<5		<5			54	34	59	3.1	14	330											
	27/04/2012	1808	4.74	<5	<5	<5	430	<5	170	<5	60	36	68	3.9	17	460	8100	<1	43	<1	810	1700	28	5	14,000	1300	3700
	22/08/2012	1494	4.28	<5	<5	<5	610	<5	240	26	84	24	96	4.9	14	670	13000	10	74	<1	1100	1500	2200	7	20,000	1900	6400
	3/04/2013	850	3.9	<5	<5	<5	310	<5	100	8	45	31	49	5.1	13	330	5800	4	36	<1	690	1500	89	4	12,000	1200	3300
	26/12/2013	1075	4.3	<5	<5	<5		<5			64	26	74	4.6	14	440											
	11/04/2014	1022	4.64	<5	<5	<5		<5			70	32	84	4.2	18	430											
	7/12/2014	955	5.1	<1	<1	<1		<1			64.5	33.5	77	6.4	16.8	524											
	20/02/2014	930	4.3	<5	<5	<5	390	<5	170	5	53	36	63	3.8	16	370	7500	6	38	<1	720	1300	63	9	13,000	1300	3700
	13/02/2015	1055	5.3			<1	474		117	20	65.1	36.2	75.7	6.5	15.5	529	3440	0.3	54	0.1	905	1310	8	3.9	15,400	1590	4680
	13/03/2015	941	4.96			<1	409		103	<10	57	35.6	64.8	4.1	14.5	486	8400	0.2	48	0.2	835	1480	94	6.95	14,200	1450	4350
	10/04/2015	1008	4.47			<1	425		182	<10	58.6	30.6	67.8	3.4	12.9	481	7880	<0.05	51.6	0.1	867	1230	134	6.05	14,000	1410	4260
	1/09/2015	1206	4.6			<1	559		125	20	82.3		85.9	5.2	13.6	621	7620	1.4	60.6	<1	1070	776	3060	10.9	16,800	1650	5690
	11/12/2015	1120	4.5			<1	560		80	20	83	25.3	85.7	5.4	13	623	6960	0.05	96.8	0.1	1010	1800	38	5.75	16,500	1590	5440
	18/01/2016					48	30.6		1	40	8.5	3.3	2.3	4.7	3	1	7300	<0.05	63.6	0.1	990	306	138	4.55	16,000	1550	5110
	11/05/2016	1020	4.4			<1	474		134	<10	65.6	30.9	75.2	4.1	14.1	518	7730	<0.5	57.2	<1	922	1150	148	6.29	14,800	1470	4460
	2/09/2016					<1	502		125	<10	70.9	27	78.9	4.3	12.1	568											
	11/01/2017	950	4.7			<5	470		140	6	72	25	71	4.1	13	480	6000	5	67	<1	690	340	2300	6	14,000	1400	4800
	26/03/2017	870	4.2			<5	380		120	<5	50	34	63	3.5	15	410	7900	5	44	<1	690	1700	50	5	12,000	1400	4100
	25/06/2017	1400	4.3			<5	700		160	<5	100	28	110	4.8	17	780	12000	50	96	<1	1400	1000	7200	6	26,000	2100	6800
	10/09/2017	1400	4.4			<5	730		210	28	120	28	110	4.9	16	800	16000	12	130	<1	1300	1400	3500	11	23,000	2200	7300
G9	3/12/2010	372	6.51	<0.1	160	160	160	<0.1	<2	27	48	7.4	9.2	2.8	4	8.2	23	5	0.3	<1	3	4	97	12	180	5	25
	2/11/2010	375.2	6.98	<0.1	150	150		<0.1			49	8.2	8.7	2.9	4.1	6.7											
	25/01/2011	356.2	6.5	<0.1	170	170	<5	<0.1	<2	150	46	7.7	7.7	2.8	4	11	16	5	0.3	<1	3	<1	84	18	240	10	25
	22/11/2011	228.3	7	<1	31	31		<1			8.7	4	2.1	1.3	1.1	3											
	30/01/2012	944	7.07	<1	180	180	470	<1	<2	55	92	8	59	2.9	6.2	280	<10	8	0.2	<1	22	<1	500	<1	1400	67	36
	27/04/2012	379	6.06	<5	25	25	97	<5	<2	<5	20	3	12	1.6	1.9	26	17	<1	0.3	<1	<1	2	<10	12	29	5	19
	22/08/2012	889	7.1	<5	190	190	440	<5	<5	13	88	6	53	2.9	6.1	190	12	6	0.2	<1	13	<1	180	<1	1000	54	24
	3/04/2013	90.7	5.06	<5	38	38	23	<5	<5	<5	4.6	4	2.7	1.6	1.1	34	48	1	2.2	<1	10	15	18	140	330	29	120
	26/12/2013	247	6.4	<5	12	12		<5			9.8	3	8.4	1.9	1.7	12											
	20/02/2014	34.5	5.4	<5	10	10		<5			1.6	2	0.5	1.4	1	1											
	11/04/2014	72.7	6.15	<5	25	25		<5			5.2	3	2.9	1.6	1.4	29											
	7/12/2014	285	6.1	<1	21	21		<1			10.5	4.5	5.9	1.9	1.7	26.6											
	13/02/2015	233	7.1			21	41.7		13	<10	8.4	4.8	5.1	2.1	1.6	24.3	3.5	3.45	0.74	<0.1	2.03	5.18	34	83.5	125	5.92	41.1
	13/03/2015	34.3	7.27			16	37.5		6	<10	7.6	4.6	4.5	2	1.5	22.5	6.4	3.5	0.72	<0.1	3.81	4.37	16	145	225	5.59	54.4
	10/04/2015	223	8.6			13	32.8		12	<10	6.5	4.4	4	1.5	1.3	18.9	4.9	3.6	0.8	<0.1	9.3	5.45	48	141	483	7.68	65.9
	1/09/2015	143.2	7.21			22	47.5		8	<10	9.9		5.6	2	2	24.7	5.4	7.65	0.72	0.1	5.7	1.96	854	238	289	9.42	69.3
	11/12/2015	112	7.1			13	42.6		3	<10	8.9	5.8	4.9	2.1	1.9	22.5	8.3	1.75	1.08	<0.1	4.62	3.94	104	305	235	8.21	99.3
	18/01/2016		6.64			28	62.8		7	20	13.2	5.2	7.3	2	2	31.1	5.1	3.15	0.94	<0.1	4.19	1.79	398	158	208	7.63	73.3
	11/05/2016	143	6.7			30	58.4		11	<10	12.6	4.9	6.5	1.7	1.9	26.5	2	0.8	0.38	<0.1	4.08	1.43	16	33.6	275	6.03	40.2
	2/09/2016					89	117		16	<10	30.1	6.2	10.2	2.3	2.9	31.3											
	11/01/2017	310	7.2			160	170			6	51	7	9.5	2.8	4	5	<10	6	<0.1	<1	<1	<1	320	<5	160	<1	2
	26/03/2017	340	7.1			150	160			<5	50	8	9.3	2.7	4	6	<10	5	<0.1	<1	<1	<1	20	<1	180	<1	2
	25/06/2017	320	7.1			160	170			<5	52	8	9.8	2.8	4.2	6	<10	5	<0.1	<1	<1	<1	540	<1	210	1	8
	10/09/2017	340	7.1			160	200			<5	63	8	10	2.7	4.3	4	<10	5	<0.1	<1	<1	<1	300	<1	150	<1	8
OB11	2/11/2010	4593	7.07	<0.1	390	390		<0.1			480	11	570	2.2	38	3200											
	2/11/2010	4593	7.07	<0.1	390	390		<0.1			450	11	530	2.2	38	3300											
	25/01/2011	2682	7.22	<0.1	360	360	22	<0.1	<2	1300	120	7.2	250	1.7	89	1100	16	2	0.2	<1	<1	<1	<10	<1	<5	1	21
	22/11/2011	4370	6.49	<1	470	470		<1			300	11	570	1.6	83	2700											
	30/01/2012	4755	6.57	<1	390	390	3400	<1	<2	970	510	10	510	4.1	30	3100	<10	2	15	<1	240	2	3500	<1	14,000	730	380
	11/04/2012	4360	5.98	<5	350	350		<5			480	6	480	4	20	2000											
	27/04/2012	4300	5.78	<5	350	350	3400	<5	<2	6	450	8	550	5.2	41	3500	93	<1	6.1	<1	81	3	16	<1	7300	230	120
	22/08/2012	4754	6.69	<5	380	380	3400	<5	<5	6	480	8	530	3.1	31	3800	16	1	5.4	<1	130	1	61	<1	11,000	600	210
	3/04/2013	4300	6.1	<5	410	410	3500	<5	<5	19	450	14	570	3.5	55	2800	29	2	4.3	<1	41	6	17	<1	3100	220	89
	26/12/2013	4500	6.47	<5	390	390		<5			520	9	570	3.5	52	2400											
	20/02/2014	256	5.7	<5	36	36	90	<5	<2	6	11	2	15	1.2	2.9	61	50	1	0.3	<1	<1	4	14	<1	13	7	55
	11/04/2014	353	6.19	<5	29	29		<5			13	2	20	1.2	3.5	60											
	11/04/2014			<5	30	30		<5				2				59											
	7/12/2014	4400	5.6	25	334	359		<1			569	7.8	551	2.7	30.8	3200	242	0.65	5.78	<0.5	130	14.9	<10	0.26	7150	536	276
	13/02/2015	4100	5.5			361	3340		81	10	494	8.4	511	2.7	29.2	2920	16.5	2.45	1.34	<0.5	9.07	1.78	<10	0.03	1060	78.9	35.5
	13/03/2015	4210	5.98			349	3300		37	20	486	9.1	506	3.5	31.7	3030	20	3.45	0.76	<1	1.69	4.41	<20	1.1	183	16.3	34.3
	10/04/2015	4070	6.36			356	3220		73	20	472	8.8	496	2.7	29.8	2810	32.2	2.65	4.4	<1	10.2	3.6	<20	<0.1	3050	126	57.1
	15/12/2015	3400	6.88			245	3260		19	20	536	8.1	467	5.5	25.4	2960	3.4	0.35	11.2	<0.5	273	8.7	76	0.16	15700	620	538
	3/02/2016					310	3540		73	<10	537	9	534	3.5	29.1	3140	4.2	0.8	8.42	<1	15.7	2.11	<20	<0.01	2700	327	195
	11/05/2016	2430	7.2			175	1610		36	<10	235	14.2	248	9.9	18.2	1430	15	2.45	6.34	<1	32	3.85	<20	0.11	10800	207	126
	2/09/2016					311	3620		73	40	558	7.9	541	3.3	26.4	3280											
	11/01/2017	4300	6.7			290	3600		110	22	570	9	530	4.7	32	3000	<10	3	9.4	<1	180	1	8000	<5	13000	490	510
	26/03/2017	4500	6.3			220	3900		130	33	590	9	580	6.7	35	3400	<10	<1	23	<1	530	2	6700	<1	27000	880	1600
	26/08/2017	4700	6.4			280	3800		57	39	600	9	570	4	34	3400	<10	<1	8.9	<1	55	9	80	<1	13000	290	260
	26/08/2017	4700	6.5			280						9				3400											
	10/09/2017	4700	6.5			280	4600		110	78	830	9	610	4.3	34	3600	<10	2	8.8	1	67	8	780	<1	13000	300	270
RIDGE BORE	30/01/2012	279.9	6.4	<1	70	70	6	<1	<2	110	1.3	9	0.7	1.2	2.5	1	<10	1	<0.1	<1	4	<1	63,000	<1	630	15	13
	22/11/2011	99.2	6.38	<1	14	14		<1			1.6	8	0.7	1.4	2.4	<1											
	27/04/2012	213.5	5.54	<5	27	27	16	<5	<2	67	4.2	6	1.3	1.6	2.8	2	50	<1	0.3	<1	6	4	30,000	<1	2200	11	71
	22/08/2012	87	6.1	<5	25	25	14	<5	<5	28	3.6	6	1.2	1.3	2.7	<1	24	<1	0.4	<1	5	<1	4300	<1	710	9	36
	3/04/2013	104	6.8	<5	39	39	15	<5	<5	18	3.7	6	1.3	1.6	3	<1	14	<1	<0.1	<1	<1	2	9200	<1	700	2	31
	26/12/2013	82.4	6.3	<5	13	13		<5			3	7	0.9	1.3	2.5	<1											
	20/02/2014	172.2	6	<5	31	31	14	<5	<2	51	3.7	7	1.2	1.2	2.5	<1	40	<1	0.3	<1	6	5	33,000	<1	2800	13	31
	11/04/2014	288	6.47	<5	55	55		<5			3	7	1.2	1.3	3	<1											
	7/12/2014	270	6.4	<1	3	3		<1			1	7.4	0.6	1.1	2.6	0.7	18	3.55	0.16	<0.1	3.89	0.81	81400	0.01	538	7.77	30.2
	13/02/2015	253	6			15	15.7		86	110	4.3	5.5	1.2	1.9	2.8	1.1	0.6	<0.05	0.02	0.4	5.07	0.02	19400	<0.01	677	51.4	7.5
	13/03/2015	260	6.07			27	7.6		56	80	1.6	6.4	0.9	1.5	3	2	1.1	0.05	<0.02	<0.1	1.66	<0.01	33200	<0.01	703	2.39	3.6
	10/04/2015	255	7.33			59	8.5		114	80	2.1	5.8	0.8	1.1	2.7	0.2	0.4	<0.05	<0.02	<0.1	1.41	0.34	18500	<0.01	606	1.91	2.5
	1/09/2015	223.5	6.88			13	5.4		66	80	1.2		0.6	1.3	3.2	0.2	2.9	<0.5	<0.2	<1	1.64	0.35	13100	<0.1	570	5.95	45.1
	11/12/2015	42	6.6			8	5.6		29	100	1.2	6.2	0.6	1.3	3	0.3	<0.1	<0.05	<0.02	<0.1	2.45	<0.01	25700	<0.01	569	16.4	17.3
	3/02/2016		7.42			20	6.7		105	90	1.6	6.5	0.7	1.3	2.9	0.3	0.4	0.1	0.06	<0.1	1.83	0.1	29400	<0.01	679	7.22	11
	11/05/2016	146	6.4			65	7.2		103	70	1.6	5.5	0.7	1.3	3.1	0.4	0.2	0.05	0.02	<0.1	2.96	0.02	31000	0.02	721	5.45	20.1
	2/09/2016					36	5.4		74	60	1.2	5.3	0.6	1.3	2.9	0.4											
	11/01/2017	120	6.3			63	6		100	62	1.3	5	0.6	1.2	3	<1	<10	1	<0.1	<1	2	<1	42000	<5	440	3	12
	26/03/2017	100	6			50	7		85	52	1.7	5	0.7	1.3	3	<1	<10	<1	<0.1	<1	4	<1	25000	<1	990	6	6
	26/08/2017	130	6.2			63	6		56	75	1.3	5	0.6	1.4	2.9	<1	<10	2	0.1	<1	4	<1	48000	<1	600	13	33
	10/09/2017	71	5.7			28	6		85	76	1.2	5	0.7	1.2	3.1	<1	<10	2	<0.1	<1	3	<1	46000	<1	530	10	13
G1	22/11/2011	1876	7.2	<1	390	390		<1			210	9	110	8.8	24	900											
	22/11/2011	247.2	8.1	<1	56	56		<1			12	4	12	3.8	8.1	52											
	30/01/2012	2229	6.92	<1	340	340		<1			270	8	140	8.6	27	1500											
	30/01/2012	268.8	8.38	<1	84	85		<1			19	4	12	3.7	8.3	39											
	22/08/2012	2367	6.75	<5	200	200		<5			280	5	160	8.2	27	1200											
	22/08/2012	175.3	8.74	9	87	96		<5			6.6	3	9.6	3.7	6.6	1											
	1/09/2015	1938	8.26				828		5	40	142		115	29	32.2	300	28.4	19	<0.2	<1	0.38	0.88	128	0.51	56.6	2.45	13.4
	15/12/2015	2201	7.56			788	1160		10	50	240	12.9	136	17.2	26.3	700	16.7	11.5	<0.1	1	1.16	0.25	128	0.1	326	6.46	4.2
	18/01/2016		7.28			592	1230		26	50	257	12	143	17.9	25.9	810	17.3	7.8	<0.2	<1	0.28	0.1	100	<0.1	364	3.3	3.3
	11/05/2016	2210	7.2			412	1360		72	10	292	9.6	153	12.8	24.5	1080	40.1	6.5	<0.2	<1	0.89	0.86	70	<0.1	397	3.82	9.5
	2/09/2016					299	1490		56	50	323	7.9	166	10.7	22.2	1310											
	11/01/2017	2200	6.4			160	1600		75	5	340	6	170	7.7	22	1300	<10	2	<0.1	<1	2	<1	780	<5	290	11	9
	26/03/2017	2200	6.3			150	1500		55	<5	330	7	170	8	22	1300	<10	2	<0.1	<1	2	<1	330	<1	340	19	5
	25/06/2017	2200	6.4			150	1500		58	13	320	7	170	7.6	23	1300	<10	3	<0.1	<1	3	<1	560	<1	520	28	19
	10/09/2017	2200	6.3			150	1800		70	16	420	7	170	8	21	1200	<10	3	<0.1	<1	3	<1	510	<1	500	25	20
OB10	2/11/2010	5113	6.95	<0.1	460	460		<0.1			460	11	660	2.9	35	3500											
	3/12/2010	4309	6.76	<0.1	380	380		<0.1			350	8.9	490	2.7	30	2400											
	3/12/2010	4309	6.76	<0.1	380	380		<0.1			330		480	2.7	28												
	25/01/2011	516	6.95	<0.1	170	170		<0.1			24	1.9	39	1.1	11	98											
	22/11/2011																										
P100	22/11/2011	1001	6.29	<1	63	63		<1			90	14	56	7.4	28	380											
	30/01/2012	1081	6.27	<1	73	73		<1			100	15	60	8	31	450											
	30/01/2012	1081	6.27	<1	75	75		<1			98	15	60	7.8	31	440											
	22/08/2012	1285	6.13	<5	91	91		<5			110	14	62	8.3	31	460											
	22/08/2012	1285	6.13	<5	91	91		<5				14				460											
	1/09/2015	1271	6.53			81	642		36	10	138		72.5	8.9	35	598	4.3	56	0.36	<1	4.85	1.56	6300	0.12	1500	18.2	97.6
RN29693	22/08/2012	125.9	6.34	<5	40	40		<5			5.4	2	2.4	3.2	2.8	<1											
	22/11/2011	1252	8.05	19	42	61		<1			5.3	5	1.5	6.4	3.7	<1											
	30/01/2012	215.7	8.51	4	92	96		<1			13	5	4.8	6.1	3.8	15											
	22/08/2012	138.3	8.91	15	65	80		<5			6.6	4	1.8	6.1	3.5	<1											

4.7 Aquifer hydraulic properties

As indicated by the airlift yield discussed in Section 4.1, the fractured rock around the site ranges from relatively impermeable syenite and Williams Fault, through moderately permeable fractured metasiltstones, to the highly permeable Crabb Fault and ore zone fault.

Measured ore zone parameters, derived by AGEC (2004) from pumping tests, are summarised below (Table 4-7).

Table 4-7 AGEC (2004) pumping test results

Airlift bore	Airlift rate (m^3/d)	Obser-vation bore	Dist-ance from airlift bore (m)	Ore zone thick-ness (m)	Max draw-down (m)	Hydraulic Parameters			
						T (m^2/d)	K (m/d)	S	Ss
TG379	328 (3.8 L/s)	TG381	90	2	1.8	20.2	10.1	1.32E-03	6.6E-04
		TG385	121	2	0.29	176	88.3	3.68E-03	1.8E-03
		TG400	180	1	0.24	474	474	7.86E-04	7.9E-04
		TG410	162	1	0.06	272	272	1.17E-03	1.2E-03
		TG371	269	1	0.23	286	286	7.50E-04	7.5E-04
		W82	220		0.28				
TG410	207 (2.4 L/s)	TGG385	39	2	3.85	21.2	10.6	1.54E-04	7.7E-05
		TG387	43	1	2.8	21.4	21.4	5.45E-04	5.5E-04
		TG408	83	2	3.25	19.1	9.6	1.87E-04	9.4E-05
		WB2	60	1	2	28.7	28.7	3.99E-04	4.0E-04
		TG371	146	1	2.5				
		TG409	121	1	0.65				

Previous calibrated models (AGEC, 2004) used Kh of 2-200 m/d for the ore zone fault or reef, decreasing with depth. Unfractured rock to the west of the Williams Fault was assigned a Kh of 0.5 m/d. Storage coefficients are typical of confined and unconfined fractured rock aquifers

The modelled (AGE, 2015) properties are summarised in Table 4-8.

Table 4-8 Modelled Hydraulic properties (AGEC 2015)

Groundwater unit	Transmissivity (m^2/day)		Hydraulic conductivity (m/day)		Storativity	
	range	geomean	range	geomean	range	geomean
weathered siltstone	no data available					
Fractured and jointed siltstone	6 - 48	24	0.1 - 1	0.5	no data available	
Ore zone and Crabb Fault zone	220 - 915	323	6 - 14	9.5	2×10^{-4} 1×10^{-5}	6.1×10^{-5}
Siltstone and ore zone (open holes)	15 - 915	71	-	-	1×10^{-3} 3×10^{-5}	2.8×10^{-4}

5. Conceptual hydrogeological model

Based on the historical investigations and the recent groundwater elevation and chemical data the hydrogeological system at the site can be conceptually described as follows.

- The ore zone and mineralisation occupies a highly permeable, southwards-dipping fault zone, in the order of 1 to 2 m thick, confined by overlying fractured metasediments with low to moderate permeability.
- It is bounded from moderately permeable fractured metasediments, to the west by the relatively impermeable Williams Fault, which potentially acts as a partial horizontal flow barrier and to the east by the highly permeable Crabb Fault.
- Metasediment and Syenite to the east of the Crabb fault are less permeable that those to the west, above or below the ore zone.
- Groundwater through-flow along more permeable zones is likely to be relatively rapid, based on the low salinity.
- Contamination, of at least shallow groundwater, has occurred around waste rock dumps, evaporation ponds and tailings dams, based on monitoring exhibiting localised areas of elevated sulfate or low pH and elevated metals. It is possible that contamination to the northwest of the SWRD and EP2, observed in bores G1 and G8, extends through shallow aquifers to Mt Bundy Creek, approximately 130-300 m to the northwest.
- Recharge is likely to be higher over the waste rock dumps than the natural surface, due to their lack of capping and vegetation.
- Storage is within fractures and joints, making up, in the order of, 1% of the rock volume.
- Recharge is by deep drainage through the overlying soils and fractured rock, with direct recharge to outcropping fault, ore zones and open pit. Recharge is seasonal, reflecting the highly seasonal rainfall, representing in the order of 2 - 20% of rainfall. Given the short-term nature of flow in adjacent creeks and their elevation below surrounding groundwater levels (away from the pit area), they are considered to be sinks or discharge areas, with water being removed by evapotranspiration by riparian vegetation or as baseflow (albeit minor volumes). Average daily calibrated recharge to the entire model domain of 6520 ha is in the order of 7000 m^3.

- The various tailings and water storage dams act as sources or sinks, depending on their water levels relative to surrounding groundwater, with exchange constrained by clayey lining materials.
- Other than in the near-mine area, groundwater is likely to discharge to local creeks.
- The open cut and connected underground workings provide a direct pathway for surface water to the ore zone, with water removed from the system by evaporation from the pit lake surface or added via captured runoff reporting to the pit.
- Based on current relative groundwater elevations, the hydraulic gradient is inwards to the pit, which is likely to capture groundwater flow from beneath the various mine–related contamination sources, such as the tailings and waste rock storage facilities.

6. Numerical Groundwater Model

6.1 Model rationale

A numerical model was constructed to describe existing conditions, including groundwater recharge and discharge areas, groundwater flow paths, and to provide a framework for future impact modelling. The previous modelling for the EIS (AGE, 2015) was limited to 2D modelling and earlier inflow modelling did not include areas to the east of the Crabb Fault and did not extend sufficiently to intersect potential areas of surface-groundwater interaction (AGEC, 2004). To address these issues, a new 3D model was constructed to include the orebody, overlying and underlying materials, and the surrounding units extending to likely hydrogeological flow boundaries at least 3 km from the mine voids.

6.2 Model Construction

6.2.1 Modelling software

The model was constructed using the Groundwater Modelling System (GMS) interface and MODFLOW NWT used with the Upstream Weighting package and Newtonian (NWT) solver. The default “complex” convergence settings were generally used to improve convergence success, albeit for longer run times.

6.2.2 Structure and materials

A 4-layer model was constructed to focus on the mine area and extending at least 3 km to terminate along likely groundwater flow lines along rivers or divides along major topographic divides (indicated in red in Figure 6-1). A grid spacing of 5 m was used in the mine area, expanding to 50 m in the outer areas of the model (Figure 6-5). Cell aspect ratios were 10 or less with a maximum change in adjacent cell relative dimension of 1.5. The model was broadly subdivided into upper fractured and weathered rock (Layer 1 and 2), a middle layer of fractured fresh rock (Layer 3) and a deep layer of weakly fractured rock (Layer 4). The ore zone was modelled in Layer 3, a 2 m-thick zone, with morphology based on digitised contours presented in AGE (2004) and the historical mine layout provided as a DXF by Primary Gold Limited.

Different properties were assigned depending on their parent lithology, depth and location east or west of the Crabb Fault, to reflect the historical observations of aquifer properties and conceptual hydrogeological model. The materials for each layer are shown on Figure 6-3 to Figure 6-6. Initial, pre-calibration material properties were based on the historical data discussed in section 4. No horizontal anisotropy was used and vertical anisotropy ranged from

1 in the deeper materials to 3 in the shallow (upper to middle) materials which are likely to have a higher density of sub-horizontal stress-relief fracturing.

The Williams Fault (Figure 6-2) was modelled as a horizontal flow barrier over its known extent, with a hydraulic characteristic of 0.001. This acts to reduce lateral flow but does not stop it entirely.

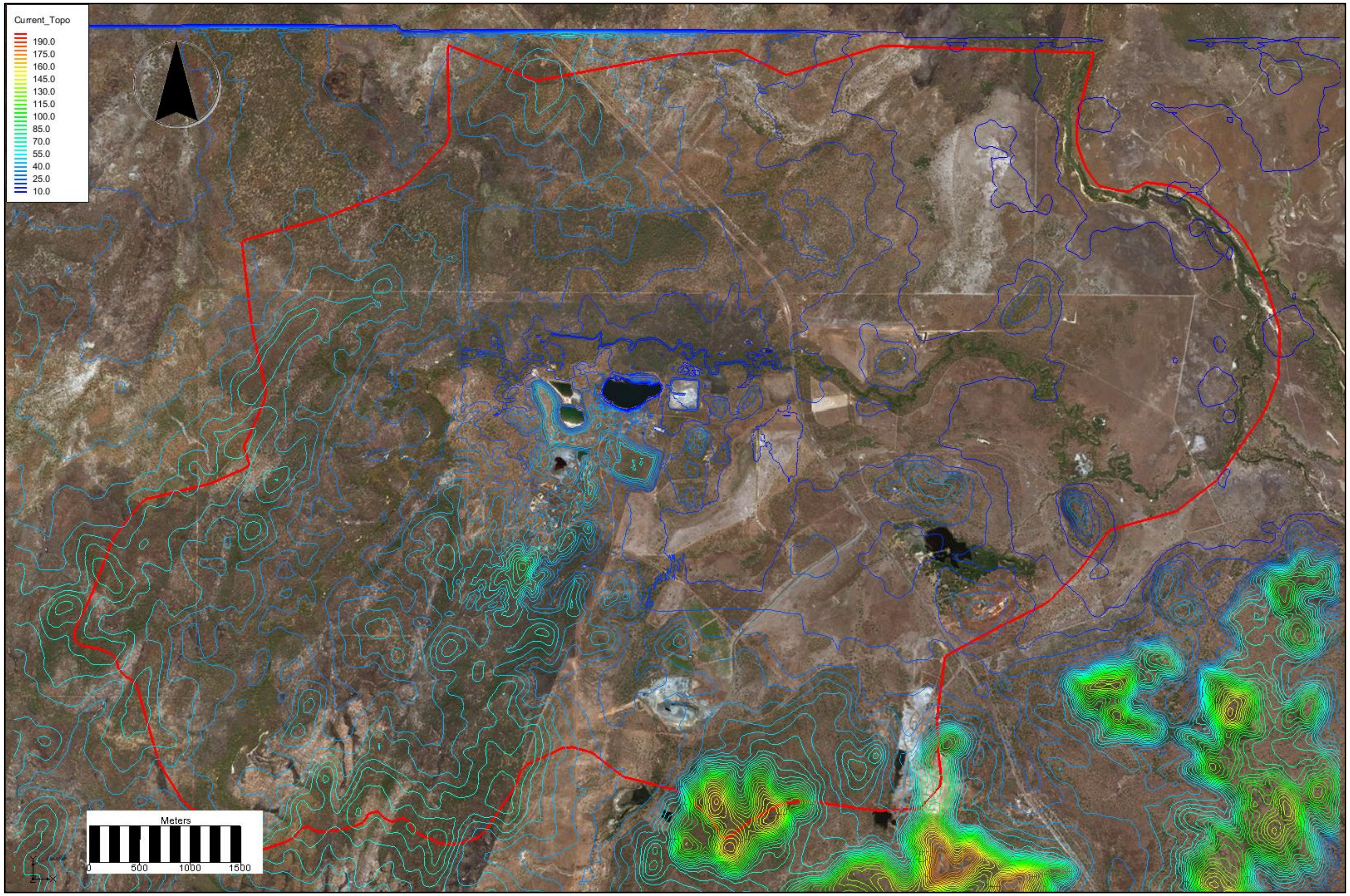

Figure 6-1 Groundwater model extent

Figure 6-2 Williams Fault horizontal flow barrier (brown line)

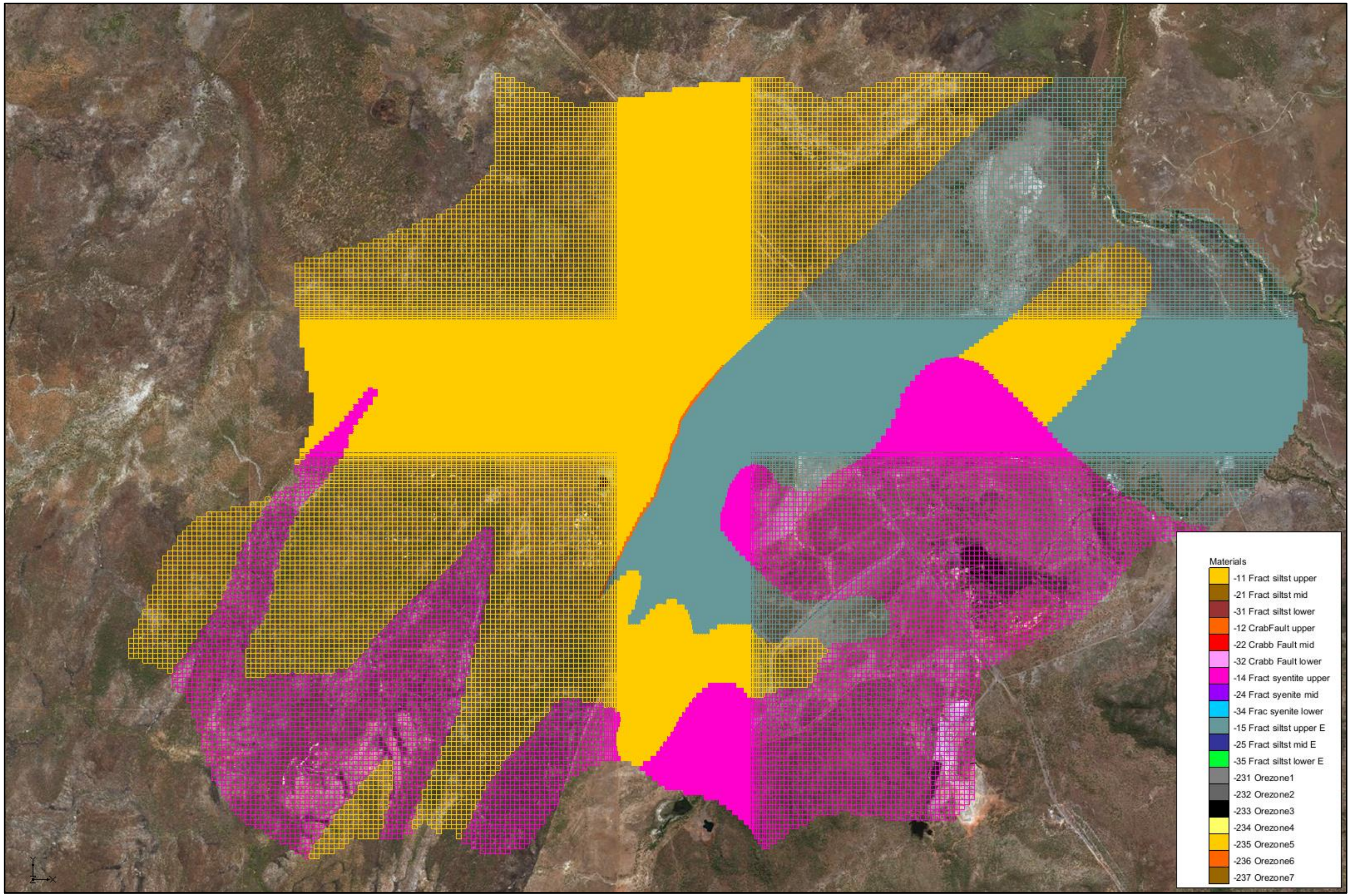

Figure 6-3 Model grid layout – Layer 1

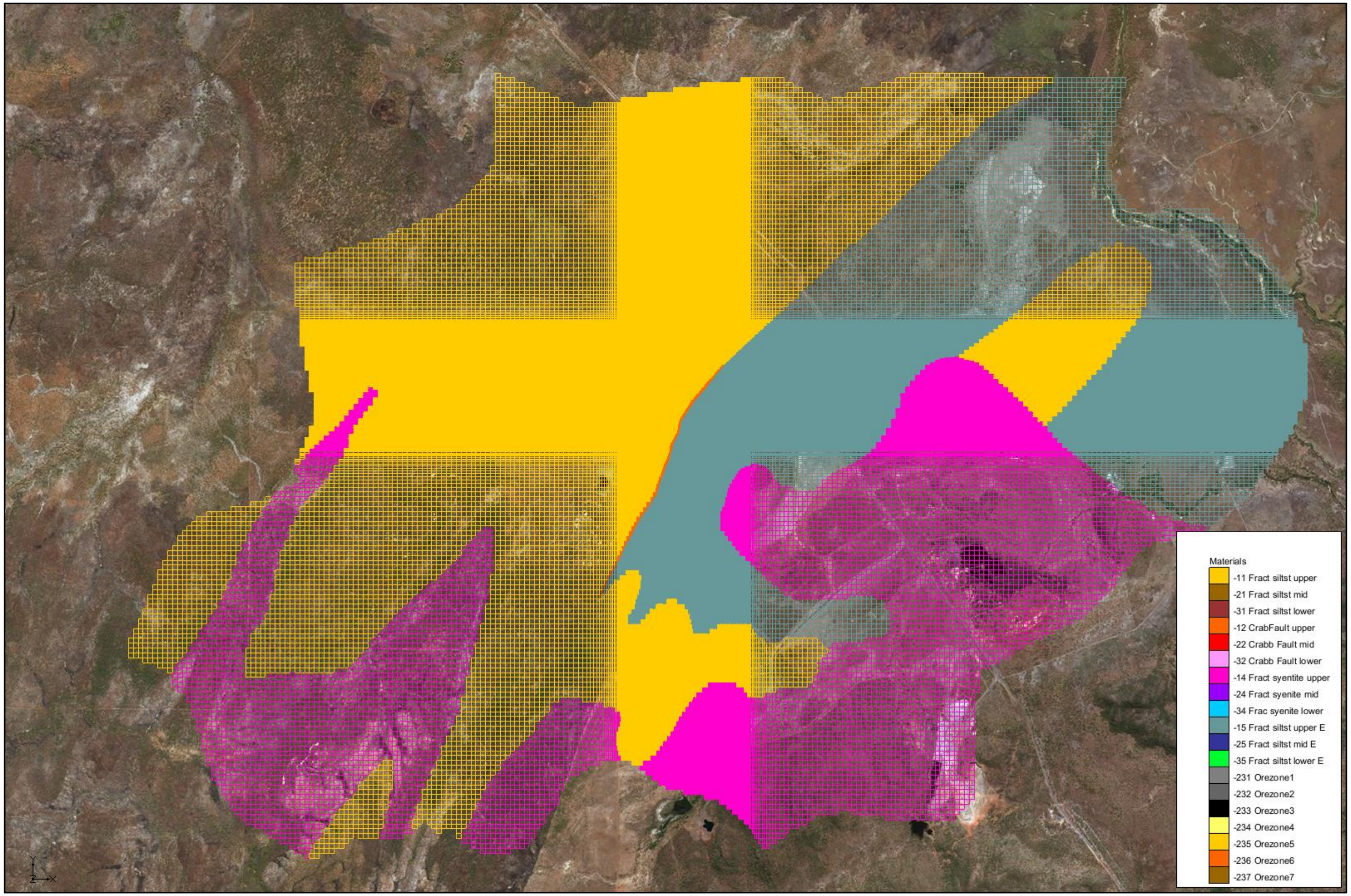

Figure 6-4 Model grid layout – Layer 2

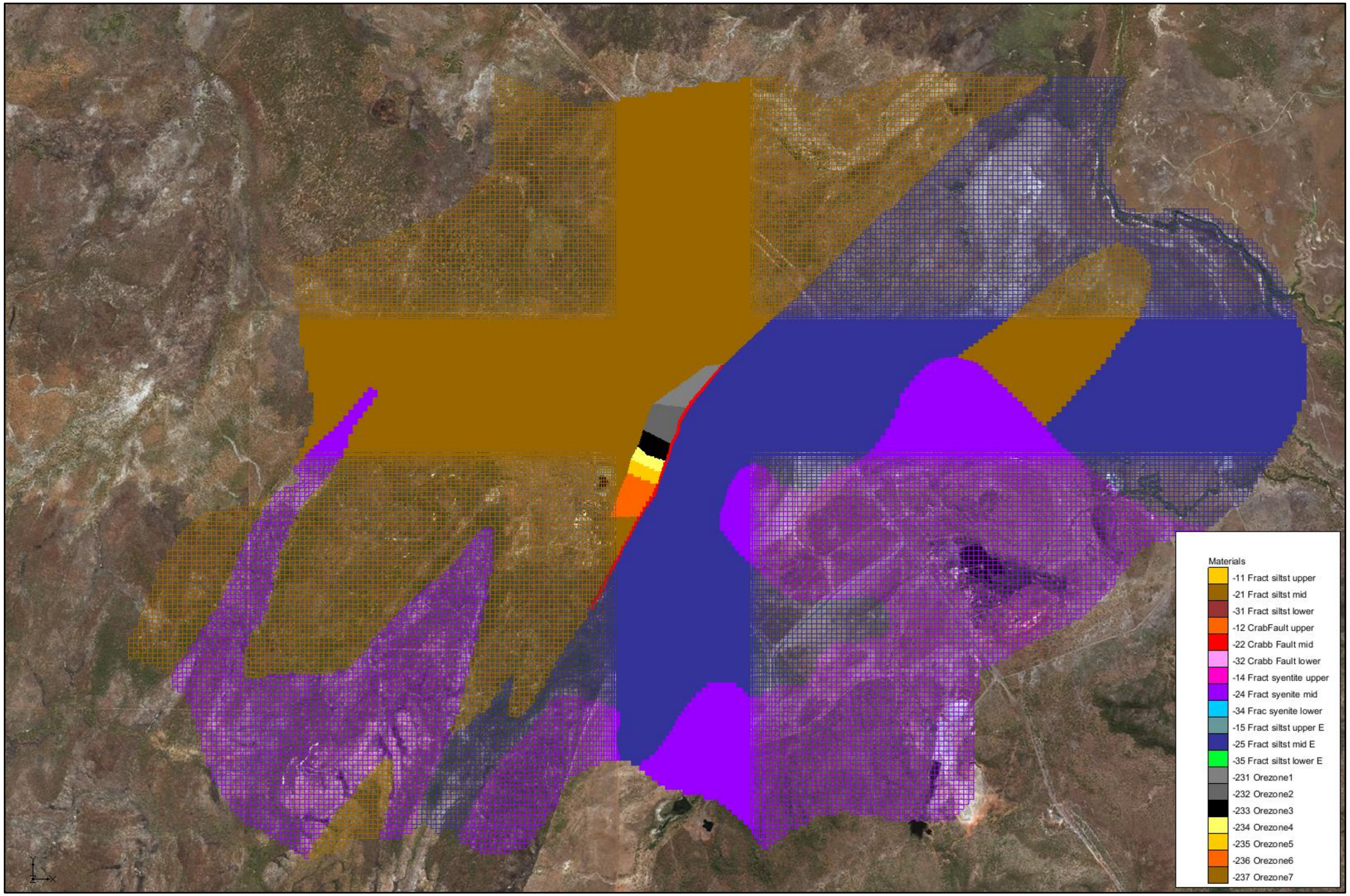

Figure 6-5 Model grid layout – Layer 3

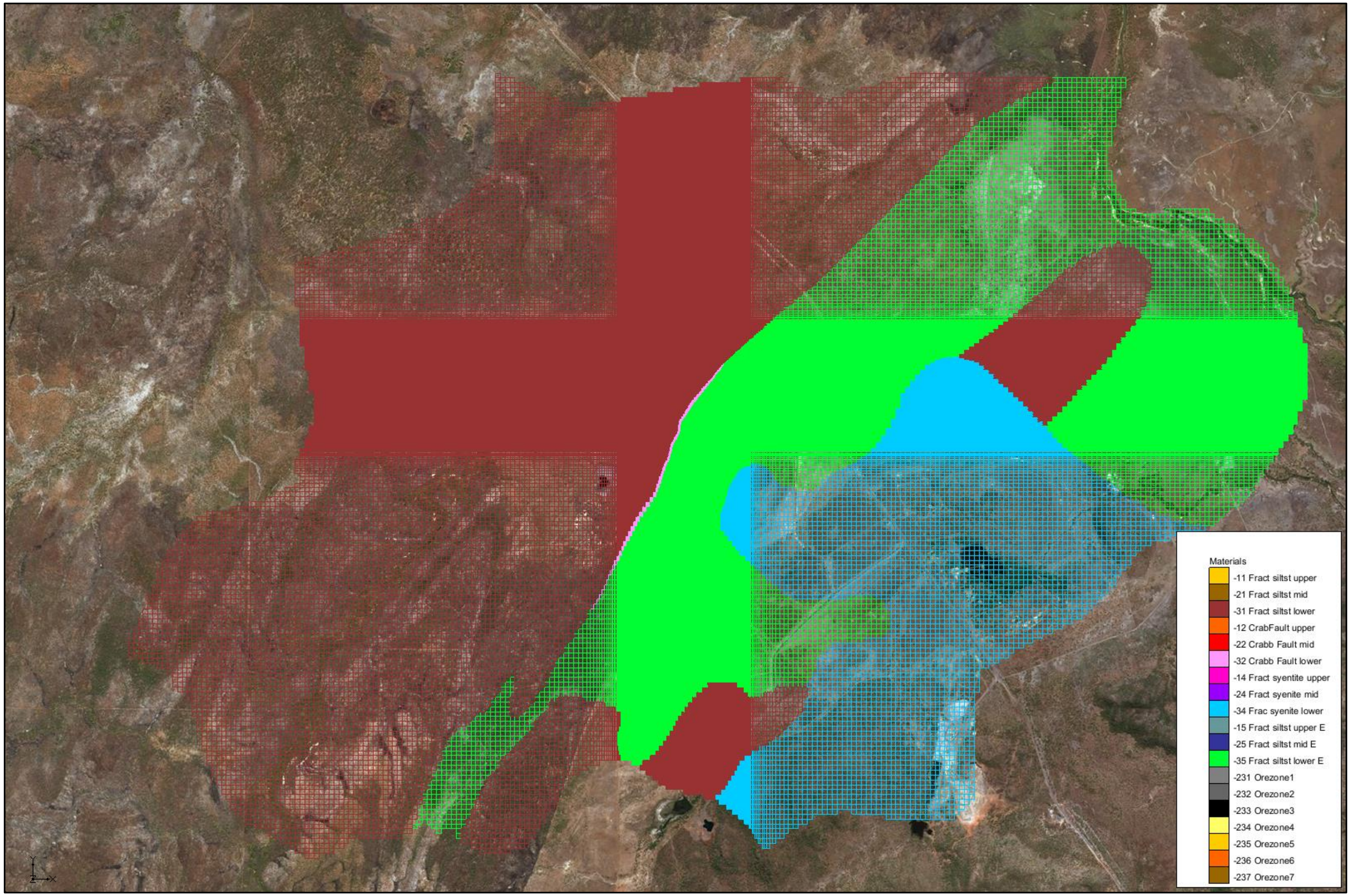

Figure 6-6 Model grid layout – Layer 4

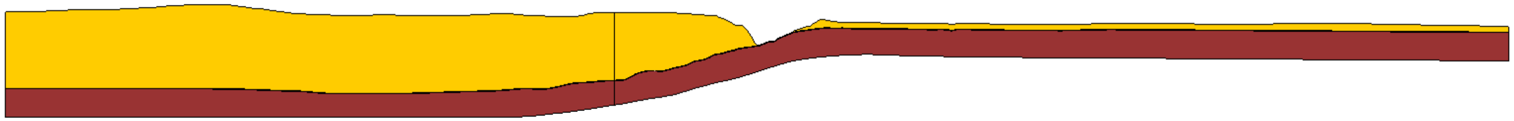

Figure 6-7 Model cross section along ore zone axis

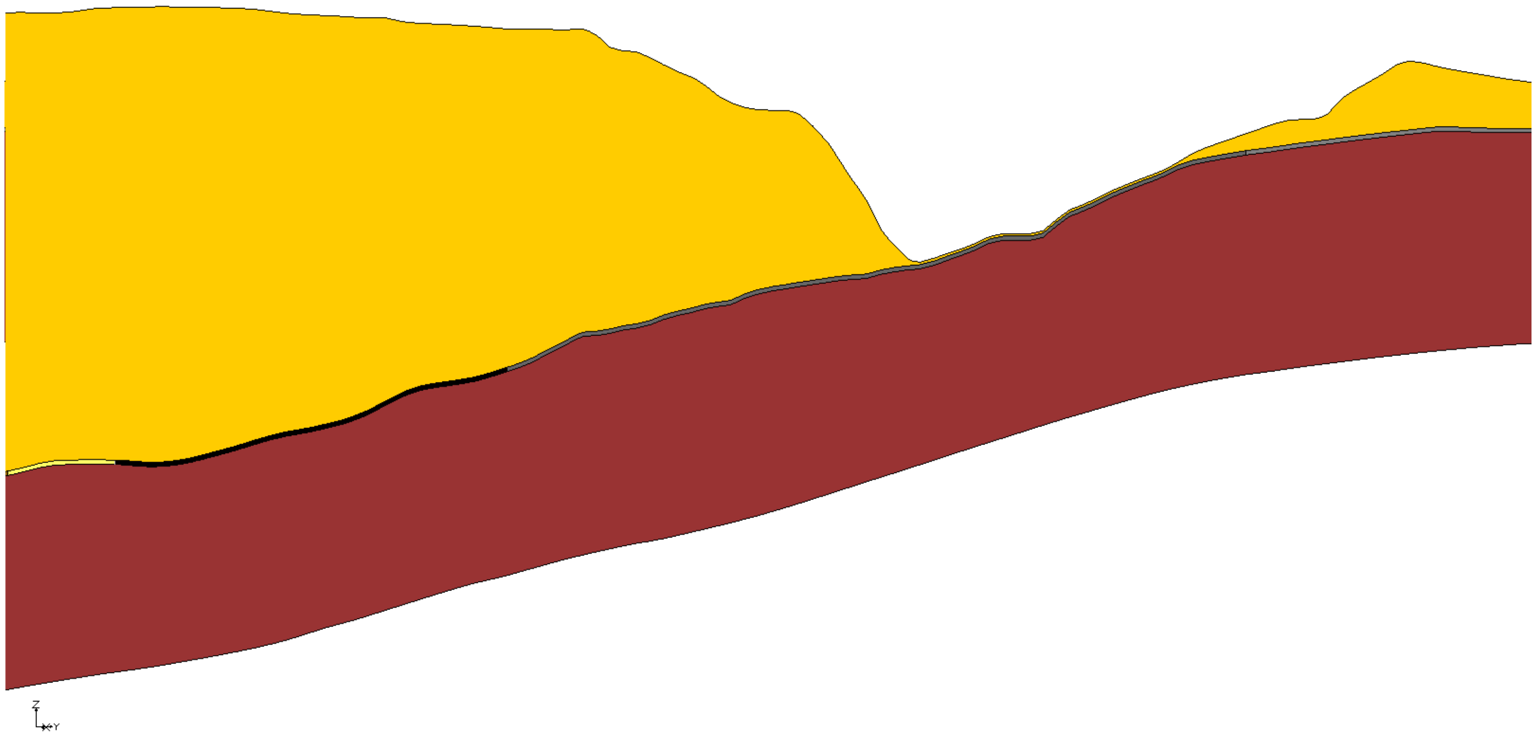

Figure 6-8 Cross section in mine area

6.2.3 Sources and sinks

Internal drainage lines were modelled as Drain (DRN) cells with bed elevations based on the surface topography (green in Figure 6-9).

Large water bodies, including the mine pit lake, TSFs and evaporation ponds modelled as General Head Boundaries (GHB) (brown in Figure 6-9). The underground working were modelled as GHB cells (Figure 6-10), although only the drives were modelled as stope/panel extents were not provided. Given the extent of the drives, however, they are considered adequate for the current modelling. Other than the mine workings, all GHB elevations were static, based on LIDAR levels indicated by shorelines (of mine water features) in the Google Earth (date unknown) aerial photography. The open cut and underground mine GHB elevation was based on the water level logger data (Figure 4-7). GHB conductances were set at 0.001 $m^2/d/m^2$ in the TSF and other water storages, to reflect a thin clay liner, and 1 $m^2/d/m^2$ for the mine void to simulate direct connection with the aquifer.

Recharge was applied over the entire model, initially using the rates indicated in Figure 4-10. Separate recharge zones (Figure 6-11) were provided over the waste rock dumps, to allow for potentially higher recharge due to water being retained in the waste rock dump profile.

All sources and sinks were automatically applied to the appropriate layer based on their elevation, with the exception of the underground workings which were applied to the ore zone in Layer 3.

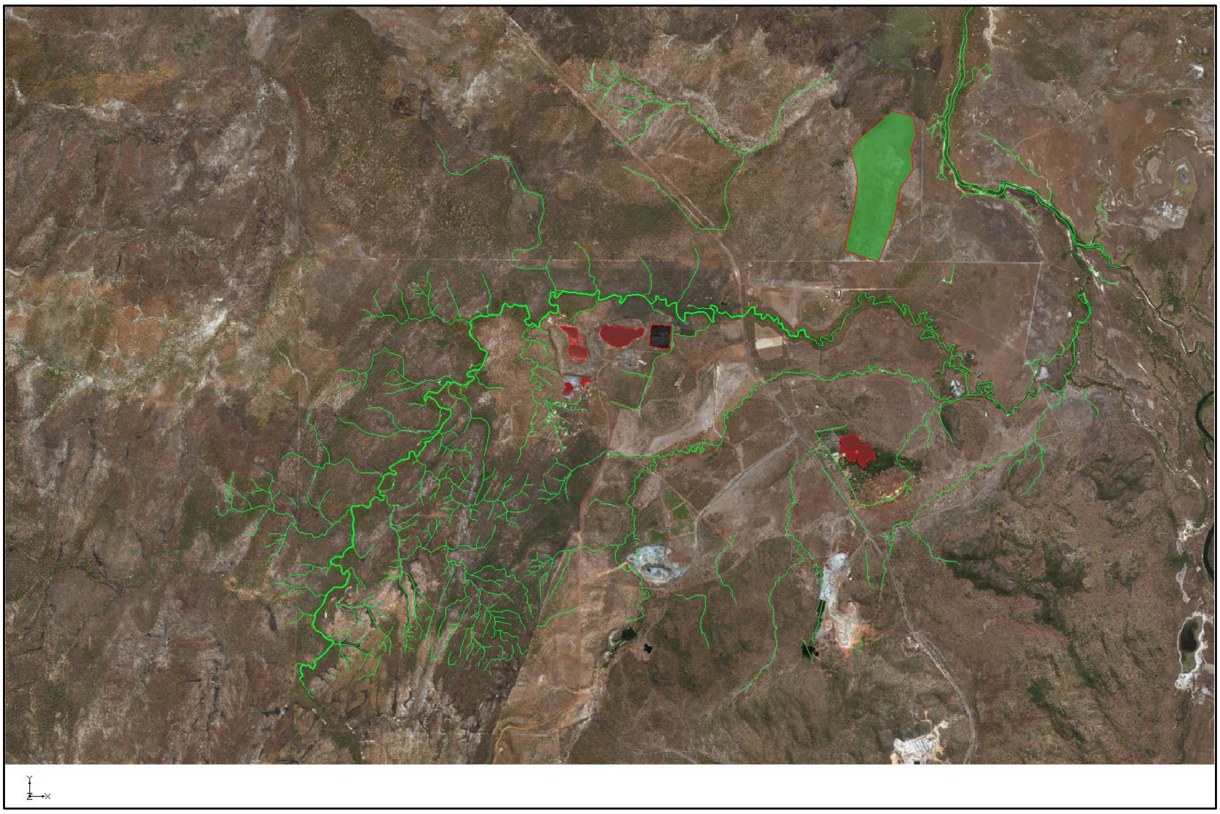

Figure 6-9 Model internal boundary conditions (green = DRN, brown = GHB)

Figure 6-10 Underground workings GHB

Figure 6-11 WRD recharge zones

6.2.4 Observations

Water level observations were input for all bores were levels were recorded and acceptable location data were available Figure 6-12. The observations were assigned to the appropriate layer, based on the bottom of hole data or a default depth of 100 m.

Figure 6-12 Water level observation points

6.3 Model Calibration

6.3.1 Calibration approach

Initial manual calibration of steady-state and transient models was undertaken by adjusting hydraulic conductivity (and storage coefficients for transient models) within the observed range to minimise the root-mean-squared (RMS) residual between observed and modelled groundwater levels. This was followed by automatic parameter estimation using PEST.

6.3.2 Steady State

Steady – state modelling was calibrated against water levels from 8 December 2016 and transient calibration from 8 December 2016 to 6 July 2017.

The best steady-state calibration was achieved in model TG_2017_0040 (Figure 6-13), with the following statistics:

- Mean Residual (Head) -0.39 m
- Mean Absolute Residual (Head) 1.30 m
- Root Mean Squared Residual (Head) 1.48 m
- Scaled RMS (Head) 12%

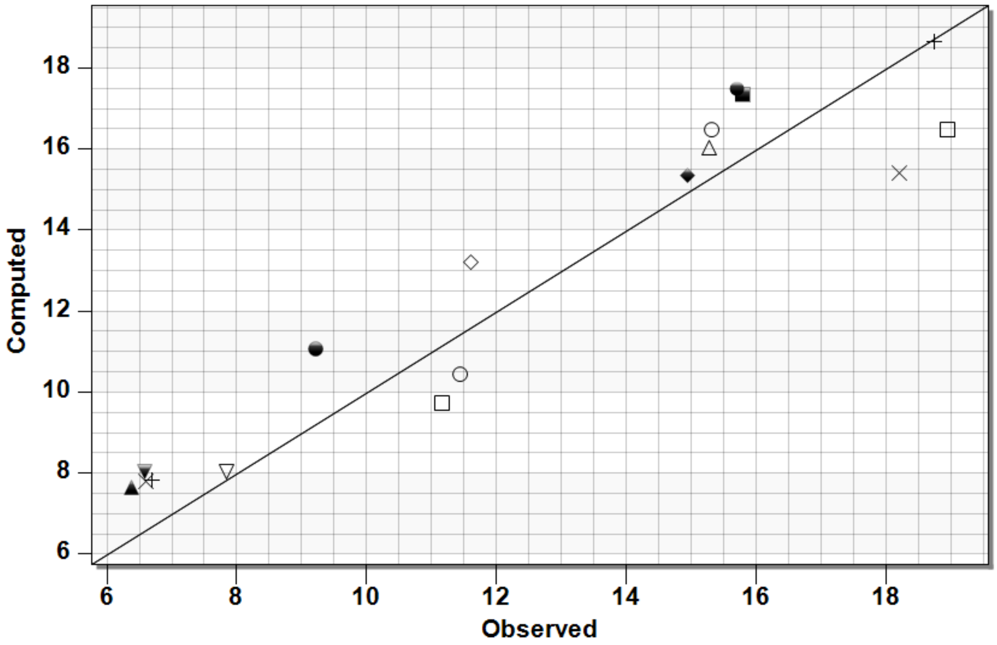

Figure 6-13 Scatter Plot of computed Vs observed head TG_2017_0040

The observed heads and contoured modelled heads are shown in Figure 6-16 to Figure 6-18 for the uppermost layer (Layer 1) and the ore zone layer (Layer 3), along with graphical calibration targets. A green symbol (Figure 6-14) means the residual was less than 2 m and orange indicates a residual between 2 and 4 m. A symbol above the target line indicates the modelled head was greater than the observed head.

The optimum hydraulic conductivity values are presented in below in Table 6-1 and recharge was 0.0001 m/d over the main model area with 0.00011 over the waste rock dumps.

A particle tracking model (Figure 6-19) shows that groundwater from beneath the most likely sources of contamination on site is highly likely to be captured by the open cut pit lake. Travel time are in the order of 50 to hundreds of years outside of the ore and fault zones, but within 10 -20 years within the ore zone.

Table 6-1 TG_2017_0040 Calibrated parameters.

Material	Horizontal K (m/d)	Vertical Anisotropy (Kh/Kv)
-11 Upper fractured siltstone	1.0	3.0
-21 Middle fractured siltstone	1.0	3.0
-31 Lower fractured siltstone	0.447	1.0
-12 Upper Crabb Fault	0.1	1.0
-22 Middle Crab Fault	0.1	1.0
-32 Lower Crab Fault	0.1	1.0
-14 Upper Fractured Syenite	0.005	3.0
-24 Middle Fractured Syenite	1.0	3.0
-34 Lower Fractured syenite	0.080097	1.0
-15 Upper Fractured Siltstone E of Crabb Fault	0.011506	1.0
-25 Middle Fractured Siltstone E of Crabb Fault	1.0	1.0
-35 Lower Fractured Siltstone E of Crabb Fault	0.19972	1.0
-231 Ore zone 1	100.0	3.0
-232 Ore zone 2	300.0	3.0
-233 Ore zone 3	200.0	3.0
-234 Ore zone 4	59.341	3.0
-235 Ore zone 5	10.0	3.0
-236 Ore zone 6	1.0	3.0
-237 Ore zone 7	10.0	3.0

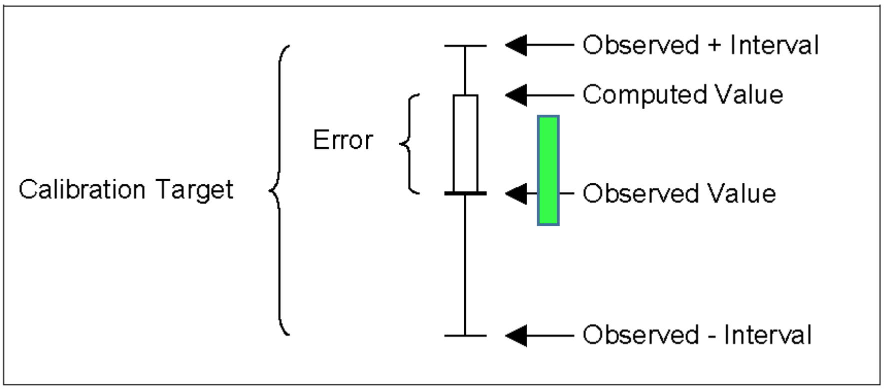

Figure 6-14 Calibration key (for following figures)

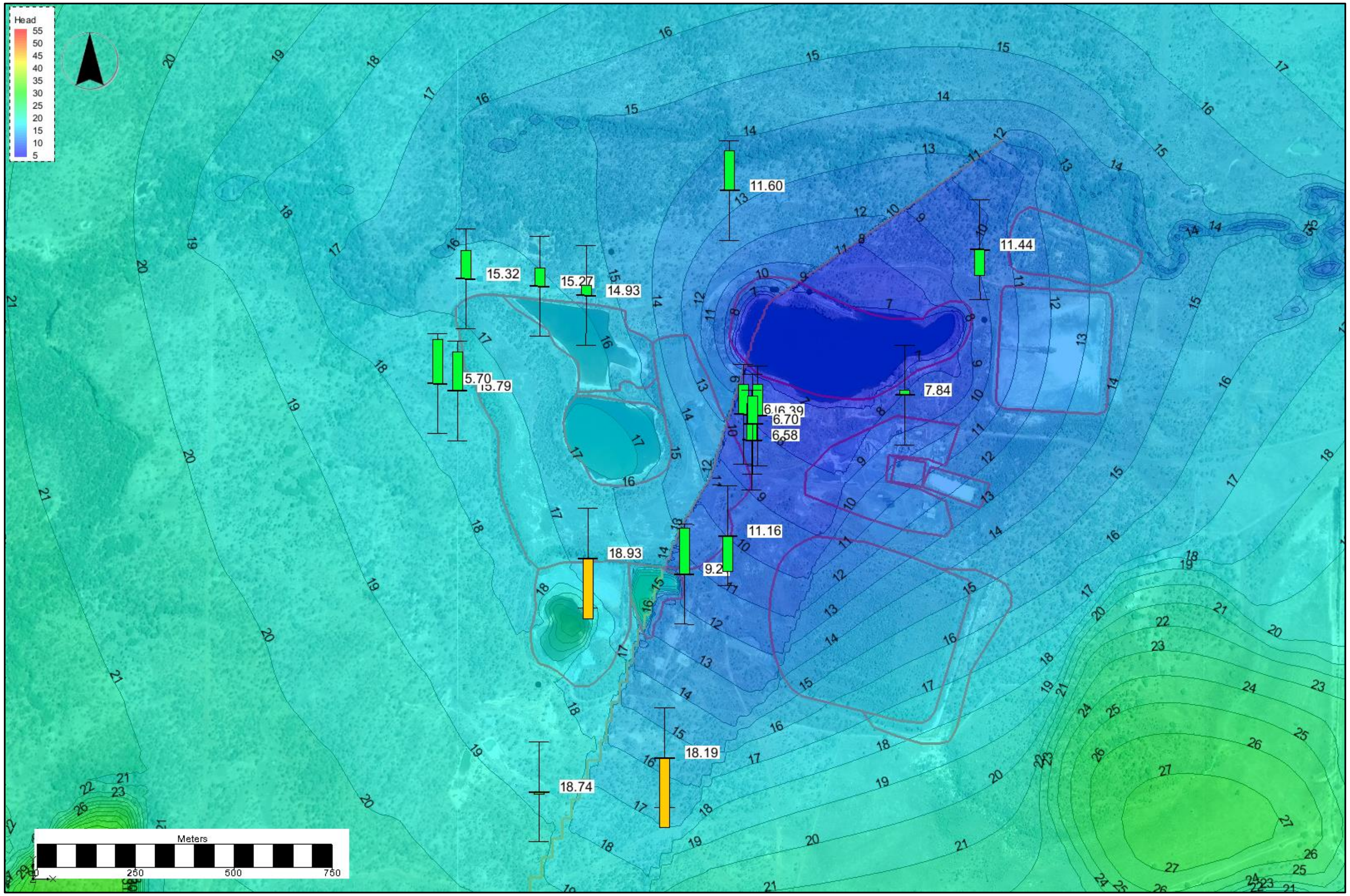

Figure 6-15 Steady-state calibration TG_2017_0040 mine area Layer 1

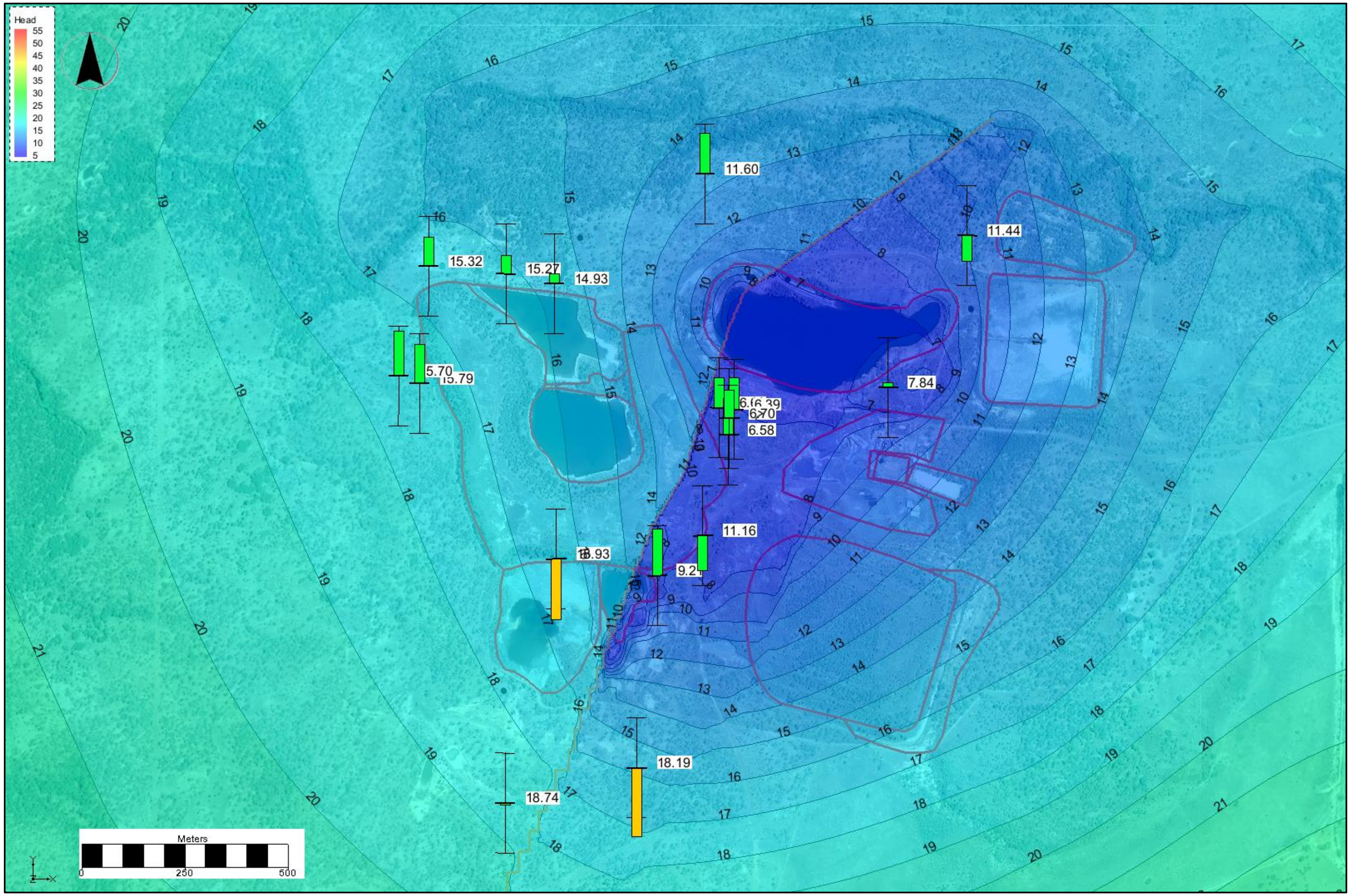

Figure 6-16 Steady-state calibration TG_2017_0040 Mine area Layer 3

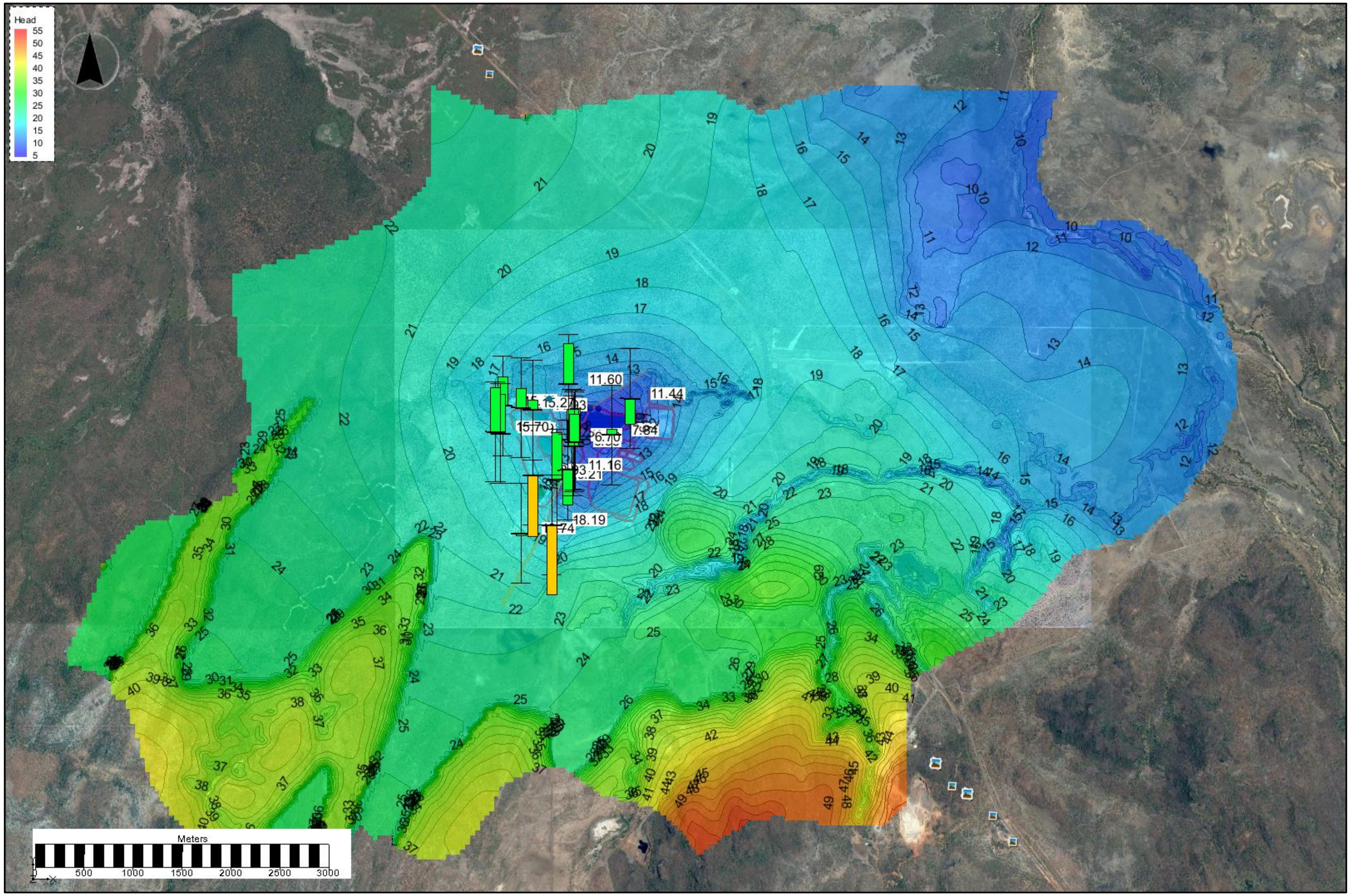

Figure 6-17 Steady-state calibration TG_2017_0040, model-wide area Layer 1

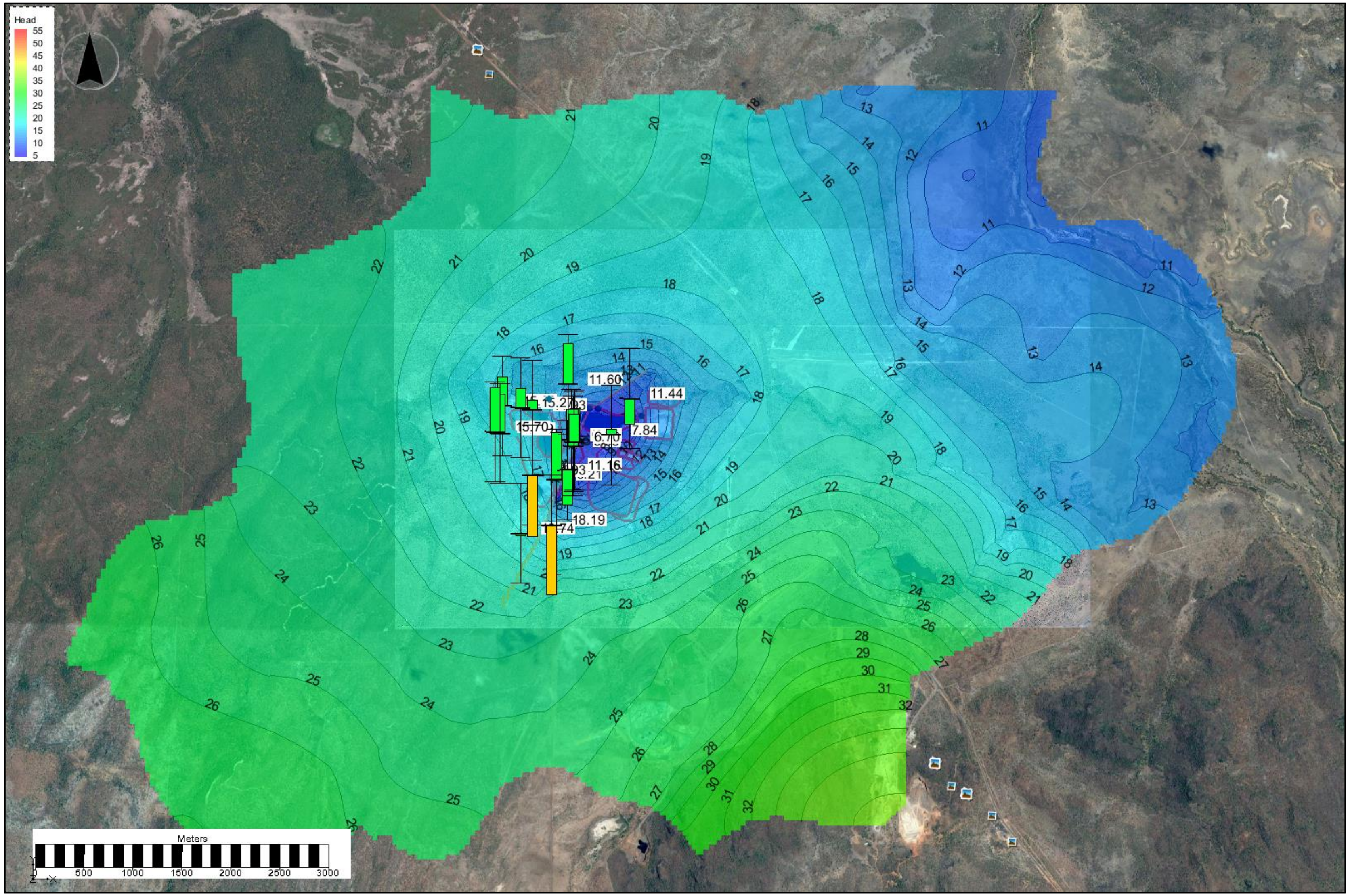

Figure 6-18 Steady-state calibration TG_2017_0040, model wide, Layer 3

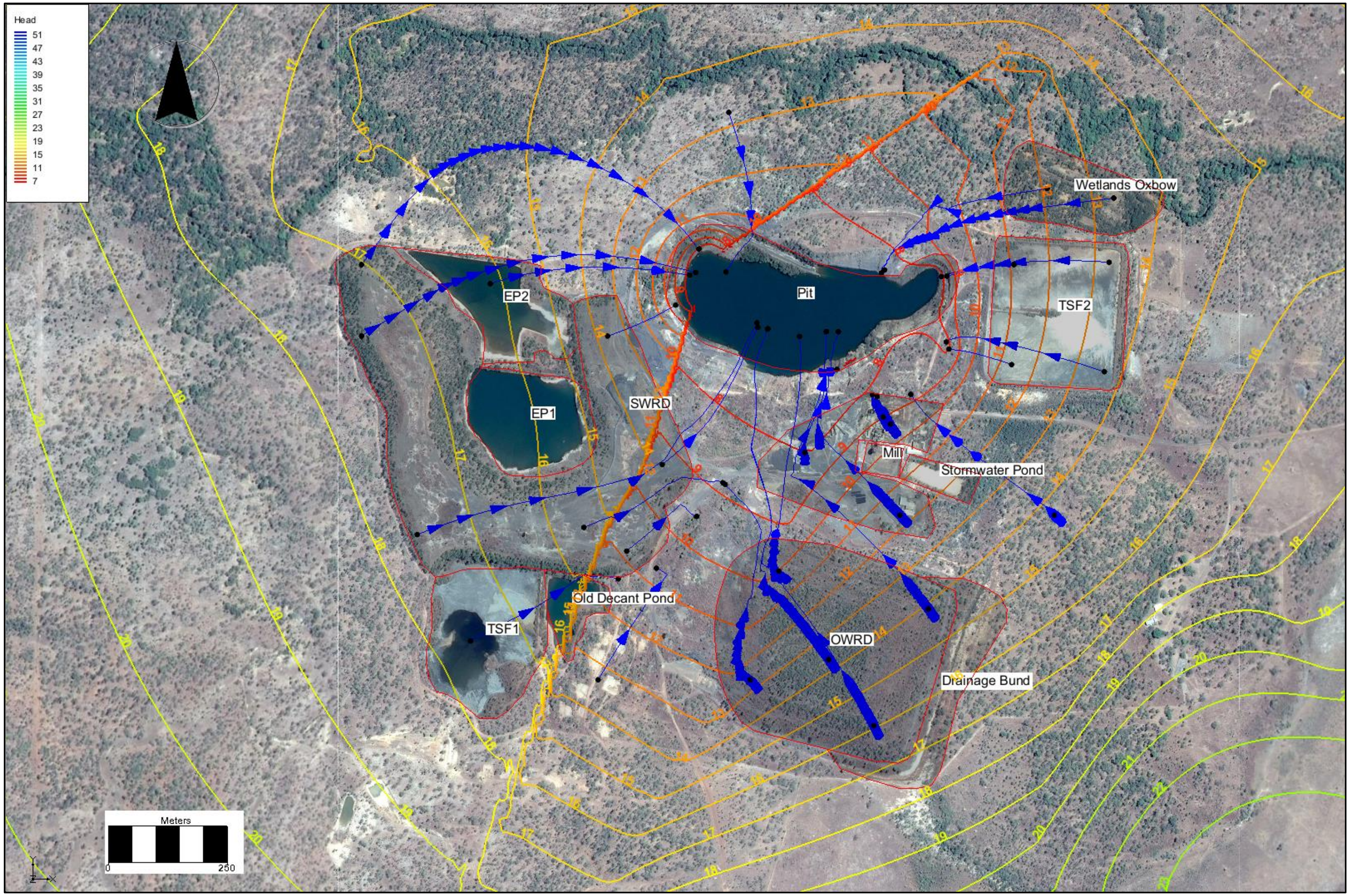

Figure 6-19 Particle Tracking TG_2017_0040 (arrow interval 10 years)

6.3.3 Steady-state sensitivity

Given that there can be many combinations of hydraulic conductivity and recharge that can achieve similar head distributions, TG_2017_0040 was re-run with recharge and hydraulic conductivity divided by a factor of 5 (TG_2017_0044) and 10 (TG_2017_0046).

They achieved RMS values of 1.7 m and 1.22 m, which were only slightly higher the TG_2017_0040 and produced almost identical head distributions. Although formal predictive modelling was not carried out, the model was modified to actively drain the open cut and underground working and the three models achieved inflows of between 3212 m^3/d (TG_2017_0046) and 14937 m3/d (TG_2017_0040). The lowest, from TG_2017_0046, at 37 L/s is close to the estimated historical inflows. This suggests that the average hydraulic conductivity of the bulk of the surrounding area is at the lower end of the measured range.

6.3.4 Transient

Model TG_2017_0040 was run as a transient model, TG_2017_0041 for the period 7 December 2016 to 25 June 2017, using stress periods of 4 days with 4 time steps in each stress period. The heads from TG_20170040 were used as the starting heads. Storage coefficients were consistent in all materials, being 0.0001 (1/m) for Specific Storage “Ss” and 0.01 for Specific Yield “Sy”.

Calibration statistics are summarised as:

- Mean Residual (Head) 0.47 m
- Mean Absolute Residual (Head) 1.77 m
- Root Mean Squared Residual (Head) 1.98 m
- Scaled RMS (Head) 12%

Calibration time series plots are shown for the bores equipped with loggers in Figure 6-20 to Figure 6-22 and modelled head for the near-mine area at the peak water level on 29 March 2017 are shown for Layer 1 in Figure 6-23 and for Layer 3 in Figure 6-24. The bore, DB1 (Figure 6-20) shows a good calibration in terms of the water level trend although the model over predicts heads consistently by around 1.5 m, which is well within the potential datum error. The calibrations for the other bores G9 (Figure 6-21) and WB4P (Figure 6-22) show a broad agreement between observed and modelled overall head levels but variations in modelled heads are less reflective the observed seasonal variations (with the notable exception of DB1 next to the pit). This is likely to be due to overestimation of storage coefficients. No further transient calibration was completed as it was considered to be more appropriate to continue with this phase when additional seasonal data are available after the next data download (following the next/current wet season). This would be further aided by the provision of historical pumping test data, mine dewatering data and historical drawdown data if it were to become available.

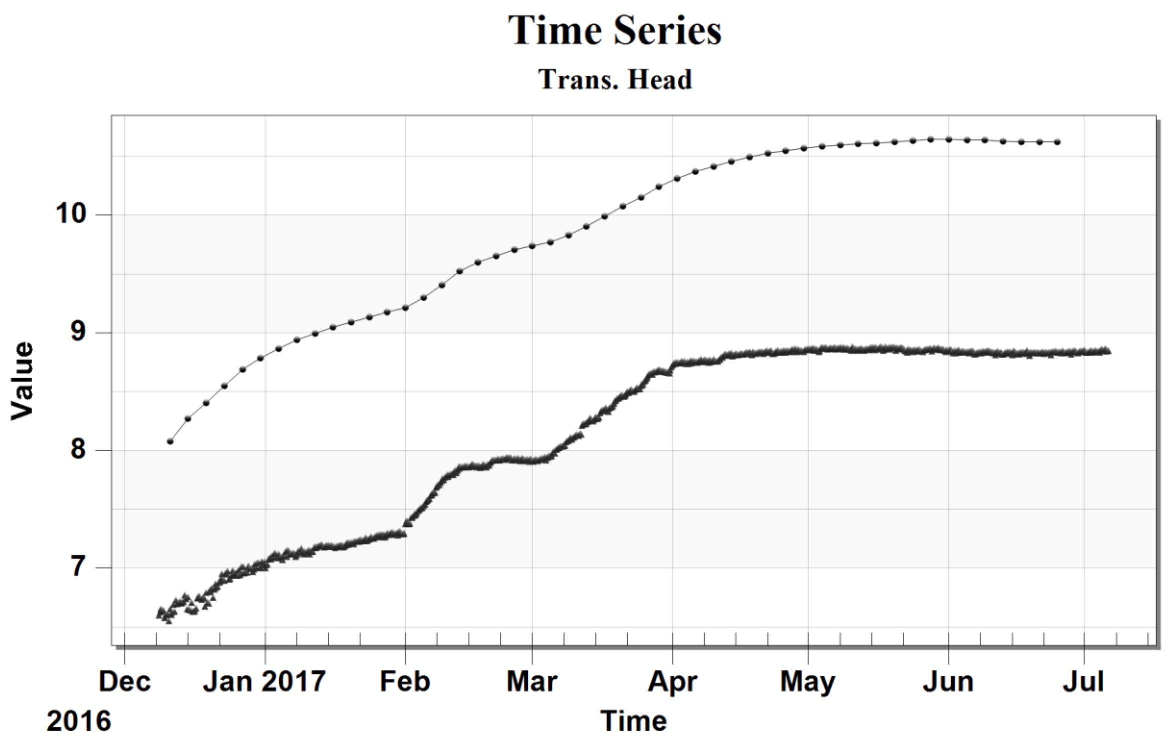

Figure 6-20 DB1 Time series of measured and observed heads (mAHD)

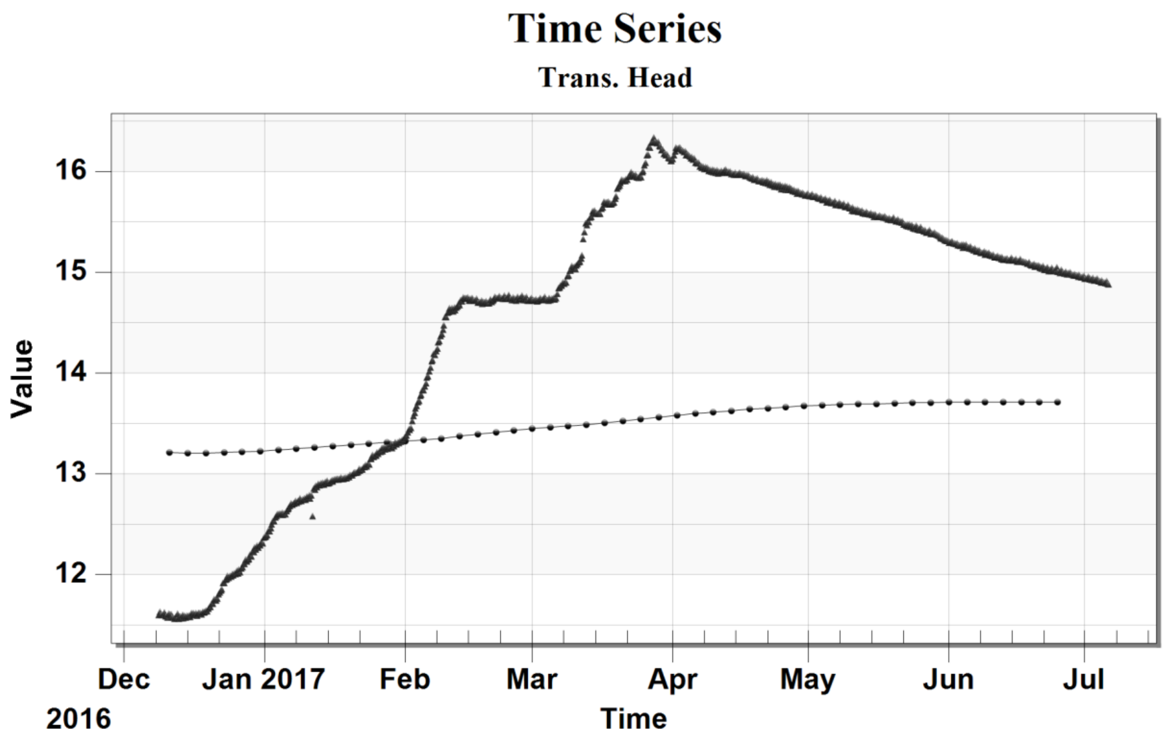

Figure 6-21 G9 Time series of measured and observed heads (mAHD)

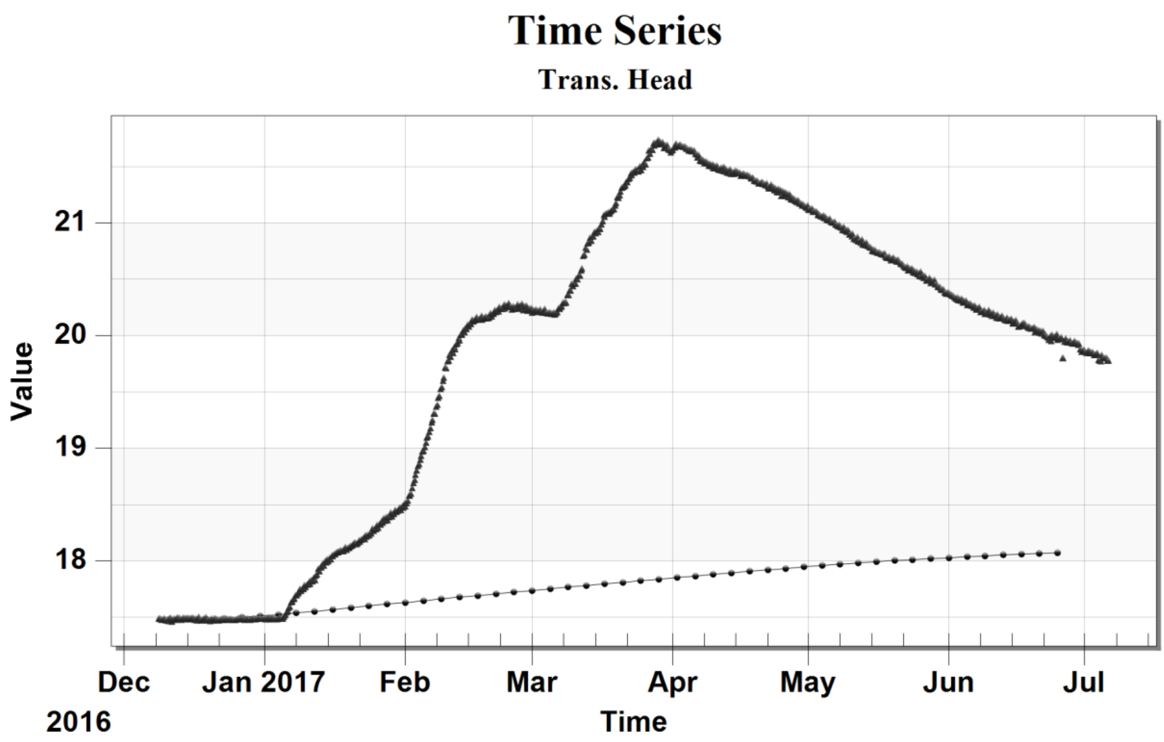

Figure 6-22 WB4P Time series of measured and observed heads (mAHD)

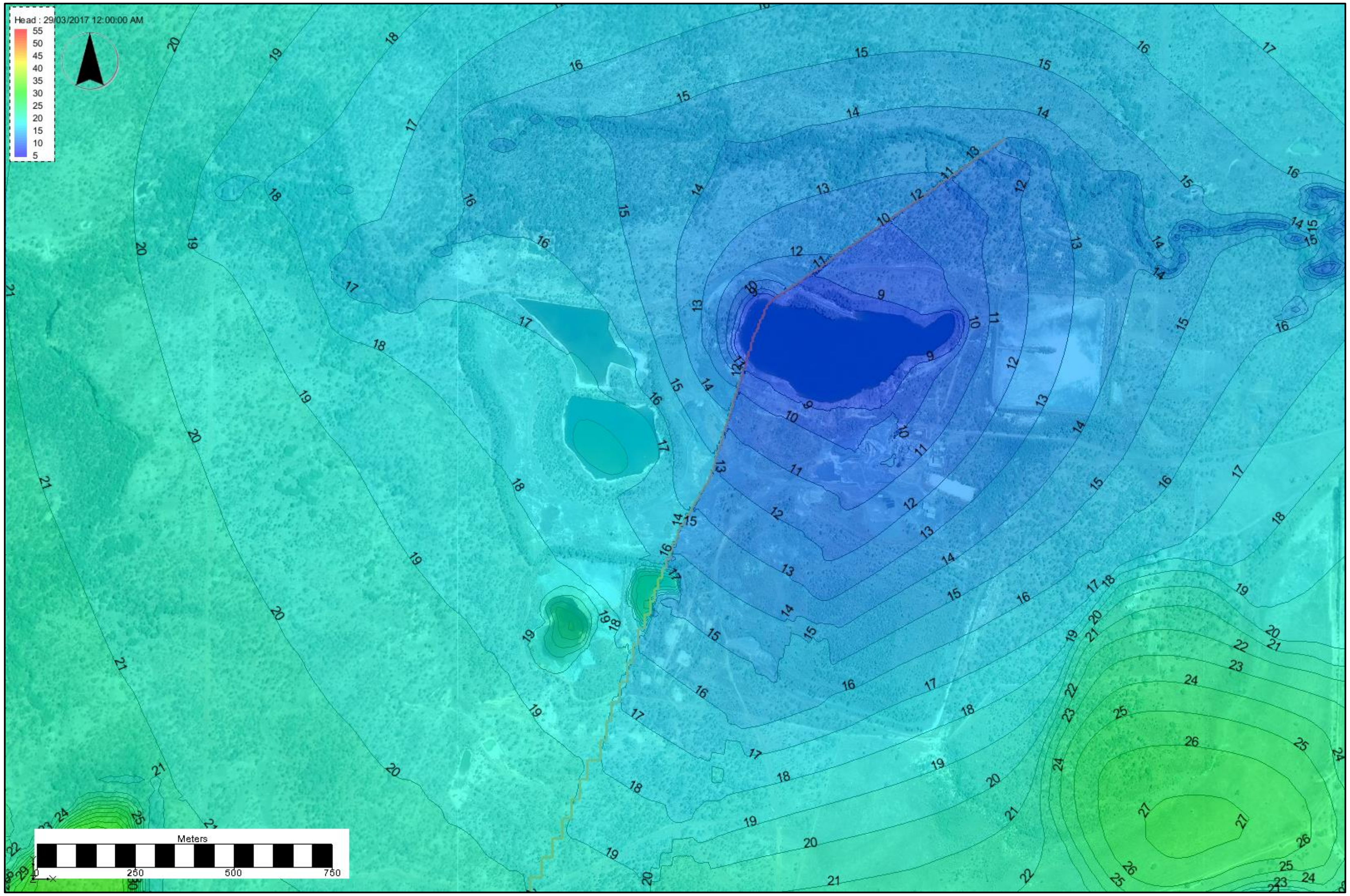

Figure 6-23 Modelled head TG_2017_41 Layer 1 9/03/2017

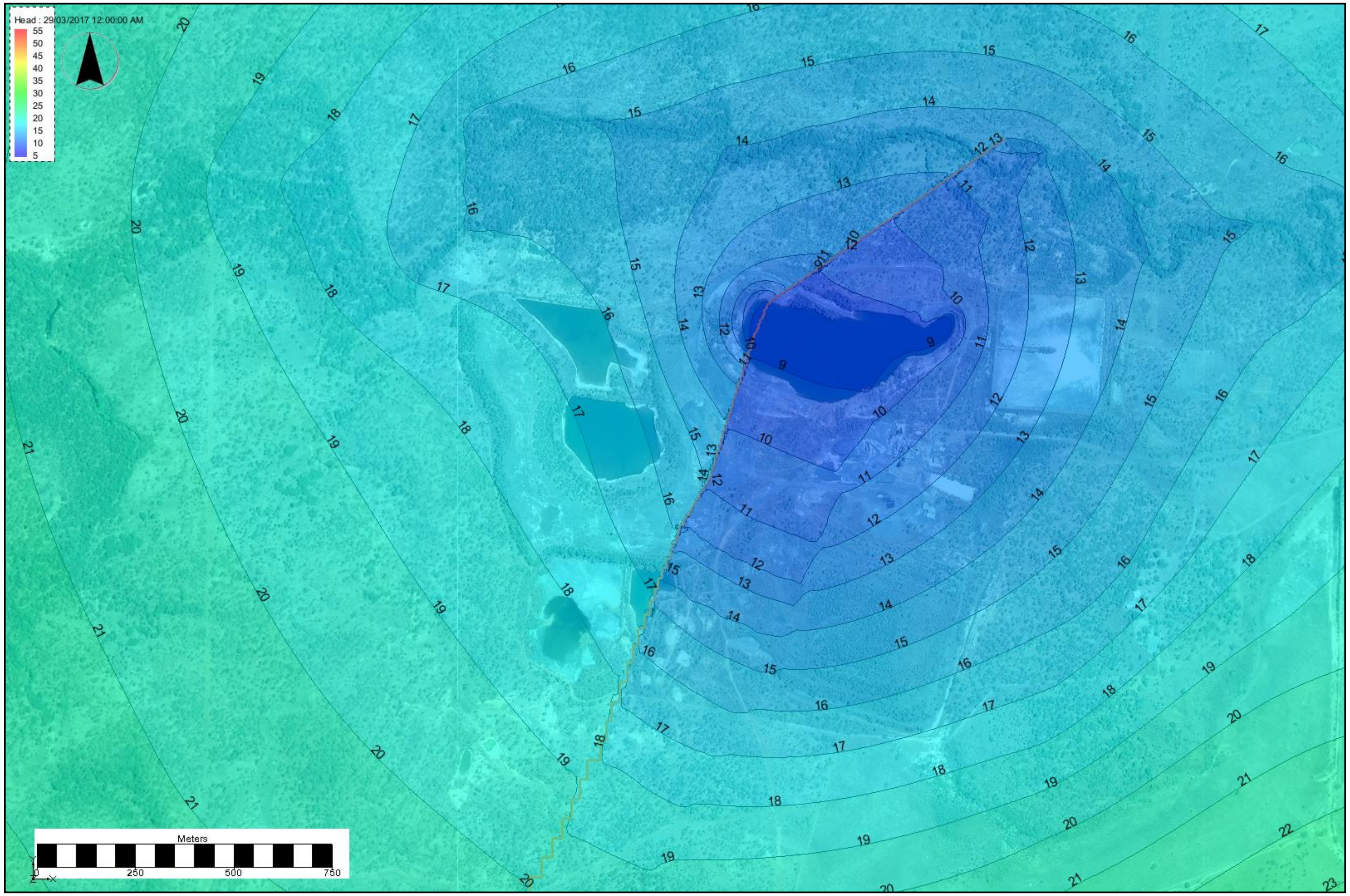

Figure 6-24 Modelled head TG_2017_41 Layer 3 9/03/2017

6.4 Model Observations

As the scope of works for this study was primarily to define baseline conditions and prepare a model for ongoing assessment, predictive modelling has not been carried out. However, the following key observations can be made:

- The modelled heads indicate that the mine pit and connected underground workings remain a groundwater sink through evaporative losses from the pit surface.
- This is likely to result in capture of groundwater contamination from the various site sources such as the TSFs and WRDs.
- The modelled water level in the mine workings have a strong, rapid influence on water levels within the ore zone but have significantly less effect on groundwater outside of the zone between the two faults.
- There is room for improvement in transient calibration by further varying storage coefficients.
- Water levels in the various water storages, including the TSFs and evaporations ponds, are likely to have a significant impact on nearby groundwater levels.

7. Recommendations

7.1 Monitoring

Although the existing network is mostly adequate to detect contamination migration under current conditions, with groundwater migration towards the pit, additional monitoring is recommended to monitor conditions under potential future water management scenarios (as shown in Figure 7-1).

- An additional location (MB_A) is recommended as WB4P and G8 are close enough to the WRD to be contaminated and affected by local elevated recharge through the WRD.
- Prior to commencement of dewatering and new mining operations, additional bores should be installed within the ore zone (MB_B) and to the west (MB_C) and east (MB_D) of the ore zone, immediately southwest of the proposed extent of mining. At each location, a bore targeting the ore zone elevation (~-240 mAHD and around midway up in the overlying rock (~0 m AHD) should be installed.
- Additional shallow bores, nominally to around 0 mAHD or 20 m below surface, recommended to the east of TSF2 (MB_E) and to the immediate NE of the Wetlands Oxbow (MB_F).
- A shallow bore (MB_G) should be installed in the area between the two faults, between the open cut and Bundy Creek.
- All bores should be subjected to regular airlift testing (if percussion drilled) or packer testing (if diamond cored) during drilling and the completed bore subjected to a slug test or constant rate pumping test depending on the yield.
- Given their potential impact on groundwater levels and chemistry, water levels and chemistry in major surface water bodies should be monitored. If data can not be regularly collected by personnel, it is recommended that automatic water level and physico-chemical data loggers are installed.

- Any water discharges, either from surface water storages or from mine dewatering should be metred and recorded to provide regular cumulative flow data.
- In addition to the bores currently fitted with water levels loggers, level loggers are recommended to be fitted to bores Bore11 and G10 to provide a better understanding or seasonal variations. Discharge flow rate frequency measurement will depend on the activity at the site and discharge rates, but daily data should be recorded for active mine dewatering.
- Given the shallow depth of bore G1 and the potential shallow contamination, a deep bore intercepting the deep fractured rock at around -70 mAHD.

7.2 Survey

As accurate groundwater levels are critical for understanding groundwater flow directions and for model calibration, as part of the ongoing model refinement/improvements bore collars and surrounding ground levels should be surveyed for all key monitoring and registered production bores with 5 km of the mine using differential GPS.

For many of the bores, construction details, primarily screen and seal intervals are not known and assumptions have been made on the aquifer intercepted. To improve future modelling accuracy, if the construction details cannot be found with further searching, the monitored bores should be subjected to down-hole geophysical and/or camera inspection to confirm seal and screen intervals.

7.3 Modelling

As noted in the modelling discussion, there is room for improvement in transient calibration once the additional water level data become available after the next data download (following the next/current wet season).

The locations of some mine structures, such as the underground workings and geological structures such as the two major faults, are uncertain, due to lack of accurate grid transformations between local historical surveys and models and a common AHD/MGA94 datum system. The updated mine resource model should be interrogated to provide updated locations of the existing and proposed workings as well as the structure of the ore zone and faults, to provide DXF input of the features (in AHD MGA94) to the model.

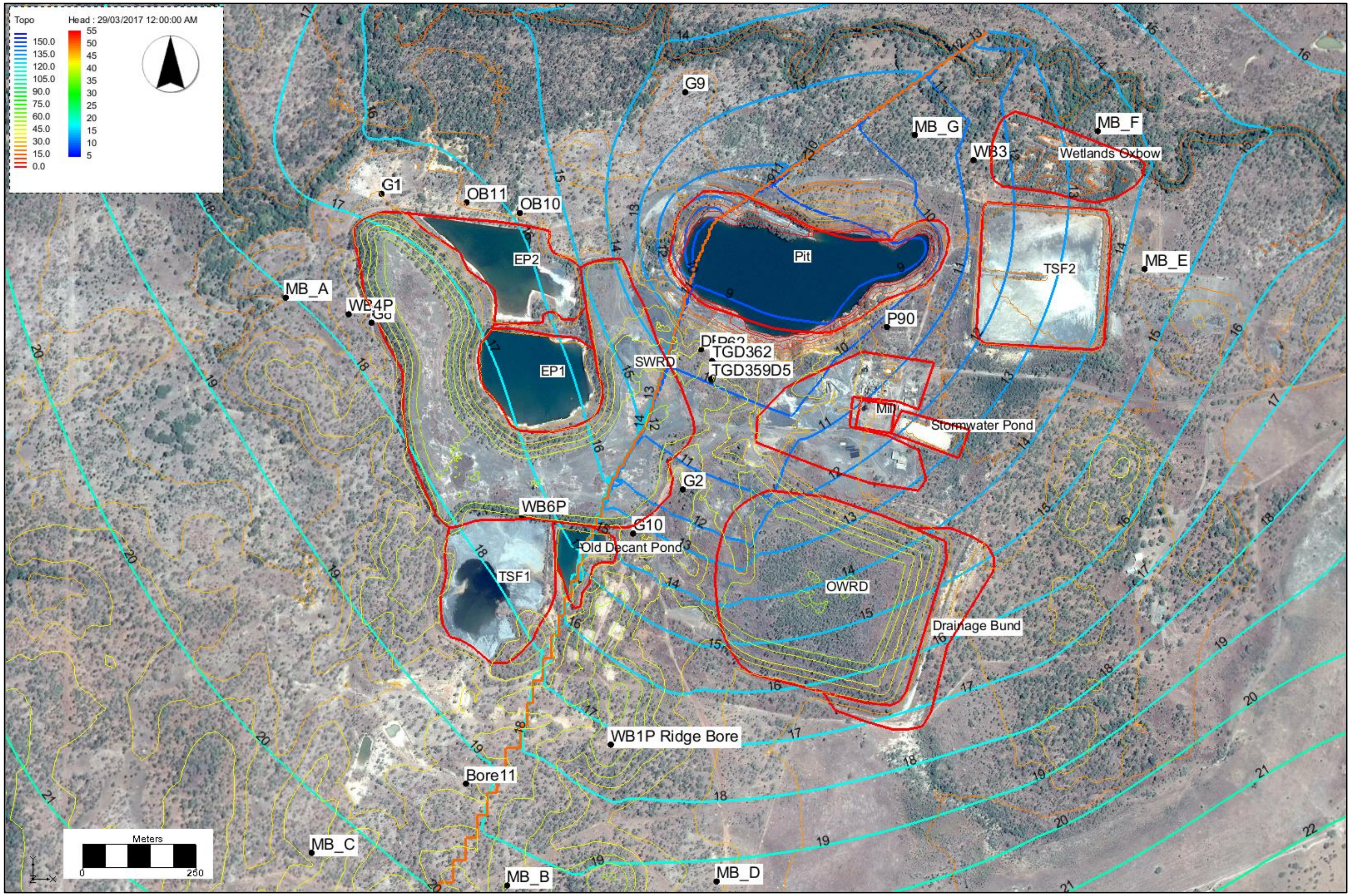

Figure 7-1 Existing and proposed groundwater monitoring locations

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