Appendix 3

Groundwater Assessment - Updated

prepared by

Jacobs Group (Australia) Pty Limited

(Total No. of pages including blank pages = 462)

This page has intentionally been left blank

BOWDENS SILVER

Part 5
Groundwater Assessment – Updated

State Significant Development No. 5765

Prepared by:

Jacobs Group (Australia) Pty Limited

June 2021

This page has intentionally been left blank

BOWDENS SILVER

ABN: 37 009 250 051

Groundwater Assessment - Updated

Prepared for: R.W. Corkery & Co. Pty Limited
1st Floor, 12 Dangar Road
PO Box 239
BROOKLYN NSW 2083

Tel: (02) 9985 8511
Email: brooklyn@rwcorkery.com

On behalf of: Bowdens Silver Pty Limited
ABN: 37 009 250 051

Sydney Office
Level 11, 52 Phillip Street
SYDNEY NSW 2000

Tel: (02) 8316 3997
Fax: (02) 8316 3999

Operations Office
68 Maloneys Road
LUE NSW 2850
P.O. Box 1115
MUDGEE NSW 2850

Tel: (02) 6373 6420

Email: information@bowdenssilver.com.au

A Silver Mines Limited company

Prepared by: Jacobs Group (Australia) Pty Limited
177 Pacific Highway
NORTH SYDNEY NSW 2060

Tel: (02) 9032 1284
Email: greg.sheppard@jacobs.com

Ref No: IA132500

June 2021

JACOBS

CONTENTS

Page

CONTENTS

Page

CONTENTS

Page

CONTENTS

FIGURES

CONTENTS

Page

CONTENTS

Page

TABLES

COMMONLY USED ACRONYMS / ABBREVIATIONS

ADWG	Australian Drinking Water Guidelines
AHD	Australian Height Datum
AIP	Aquifer Interference Policy
BGM	bituminous geomembrane
BoM	Bureau of Meteorology
CL&W	NSW Crown Lands & Water (now Lands and Water - NSW Department of Industry)
CRA	CRA Exploration Pty Ltd
CRD	cumulative rainfall deviation
DES	Department of Environment and Science (QLD)
DGRs	Director General's Requirements
DPIE	Department of Planning, Industry and Environment
DPI	Department of Primary Industries
DRE	NSW Department of Resources and Energy (now Department of Regional NSW – Mining, Exploration and Geoscience)
DRN	Drain Cell (MODFLOW)
EC	electrical conductivity
EPA	Environment Protection Authority
EVT	Evapotranspiration Cell (MODFLOW)
FAO	Food and Agricultural Organisation of the United Nations
GDE	groundwater dependent ecosystems
GUI	Graphical User Interface
HFB	horizontal flow boundary
KCN	Kingsgate Consolidated Limited
LiDAR	Light detection and ranging
LTAAELs	Long Term Average Annual Extraction Limits
mbgl	Metres below ground level

ML	Mining Lease
OEH	Office of Environment and Heritage
PAF	potentially acid forming
PEP	Protection of the environment policies
RC	Reverse Circulation
RCH	Recharge (MODFLOW)
RIV	River Cell (MODFLOW)
RMS	root mean square
SCSC	Specialist Consultant Studies Compendium
SEARs	Secretary's Environmental Assessment Requirements
SILO	Scientific Information for Landowners
SKM	Sinclair Knight Merz
SSD	State Significant Development
SWL	Standing Water Level
TDS	total dissolved solids
TSF	tailings storage facility
USGS	United States Geological Survey
WAL	water access licence
WEL	Well Cell (MODFLOW)
WMA	Water Management Act 2000
WRE	waste rock emplacement

FOREWORD

This Groundwater Assessment has been updated to address comments received from the Department of Planning, Industry and Environment - Water's review following public exhibition of the Environmental Impact Statement and Specialist Consultant Studies Compendium for the Project. These comments were supplied on 1 September 2020 and are provided in **Annexure 11**. The principal changes to this report from that which was placed on public exhibition are associated with editorial comment and report re-structuring, whereby technical modelling information has been moved from the main report to **Annexure 9**. The results of this groundwater modelling were used to undertake the impact assessment presented in Section 5.

In addition, a higher resolution groundwater model in the vicinity of the proposed tailings storage facility has been developed to assess the implications of potential seepage from this facility. The results of this additional modelling are presented in this report with technical information presented in **Annexure 10**.

It is also noted that in the period following public exhibition, the following water sharing plans relevant to the original Groundwater Assessment, have been updated, namely:

- NSW Murray Darling Basin Porous Rock Groundwater Sources, 2011; and
- NSW Murray Darling Fractured Rock Groundwater Sources, 2011.

However, the data sources, data ranges, potential groundwater impacts of the Project and the regulatory paradigm, including the Aquifer Interference Policy by which the groundwater impacts of the Project are assessed, remain unchanged from the original assessment.

This page has intentionally been left blank

EXECUTIVE SUMMARY

Bowdens Silver Pty Limited proposes to develop and operate the Bowdens Silver Project (the Project), located approximately 2.5km northeast of Lue and approximately 26km southeast of Mudgee, in New South Wales. The Project would mine epithermal silver deposits hosted in the Rylstone Volcanics and would incorporate a conventional open cut pit where overburden/waste rock is removed from above and around the silver-zinc-lead ore and either used for on-site construction activities or placed in the out-of-pit waste rock emplacement (WRE) or the southern barrier.

Mining operations are planned to be undertaken over 15.5 years. A maximum open cut pit depth at 456m Australian Height Datum (AHD) would be reached in Year 9 of operations. Other sections of the main open cut pit would be developed to a depth of 460m AHD and two satellite open cut pits would be developed to an elevation of 565m AHD and 580m AHD.

The proposed tailings storage facility (TSF) for the Project is a down-valley discharge style of tailings deposition with deposited tailings impounded against a down-stream embankment. The tailings slurry would be pumped from the processing plant via a pipeline to one of three discharge points and would comprise approximately 56% solids, with an average daily discharge of decant water to the TSF of 4 300m^3/day. Decant water would be reclaimed from a decant pond located at the upstream face of the TSF embankment and returned to the processing plant. Seepage control measures at the TSF would include grouting of the rock foundations beneath the TSF embankment, compacted clay lining of the tailings impoundment area with an additional bituminous geomembrane liner applied over the clay liner. It is noted that the final TSF design in terms of extent of bituminous geomembrane liner will differ from that presented in the EIS and will be refined during detailed design.

Water supply for the Project would include a combination of surface water collected on-site, mine dewatering, reuse of water reclaimed from the TSF and water sourced under agreement from the Ulan coal fields and brought to Mine Site via a dedicated pipeline.

Extensive baseline monitoring of groundwater levels and quality have been undertaken for the Project, as have numerous investigations including drilling and monitoring bore installation and hydraulic testing, airlift testing and packer testing of resource exploration holes and test pumping of existing water supply wells.

A numerical groundwater model has been built for the purposes of assessing mine dewatering requirements and informing a groundwater assessment for the project. Model geometry and hydraulic parameters in and around the mining area have been based on extensive drilling and hydraulic testing, with model calibration to the extensive groundwater monitoring data set.

Once mining advances below the water table during the second year of mining, dewatering requirements are predicted to steadily increase until the open cut pit reaches a depth of 525m AHD at the end of Year 4, with average inflows of the order of 3.5ML/day. Predicted dewatering rates then drop off as the open cut pit cuts back and expands at higher elevations. For the remainder of mining, predicted inflows range from 2 to 3ML/day.

Mine dewatering would result in drawdown of groundwater levels in the formations surrounding the open cut pit area. Drawdown propagation would be initially fairly rapid as the pit is mined to its lowest level at the end of Year 9 of mining. Drawdown propagation would then slow down over the remaining mine life. At the end of mining, propagation of drawdown, as represented by the predicted 1m drawdown contour, is typically of the order of 1.5km to the east and south, 2km to the west and 2.2km to the north of the open cut pit. During mining, drawdown to the northwest is attenuated due to mounding beneath the TSF, with maximum mounding of the order of 8m.

Following the completion of mining, a pit lake would form in the mine void. Equilibration of net inflows and evaporative losses from the pit is predicted after approximately 100 years at an elevation of approximately 573.5m AHD, 16.5 to 26.5m below the pre-mining water table. This indicates that the mine void would remain a groundwater sink. A groundwater sink develops when net losses (in this case due to evaporation) are greater than the net inflow and as a result groundwater is continually flowing towards the pit lake. Mine closure management measures include allowance for diverting of surface flows around the pit to ensure that it remains a groundwater sink. The salinity of the pit lake would increase due to evaporative concentration. Salinity is predicted to increase to approximately 2 000mg/L TDS at 100 years post mining and to 5 375mg/L TDS by 500 years post mining. Being a groundwater sink, the resulting saline water would remain captured within the mine void.

Conservative modelling of TSF seepage, considering advective transport and dispersion, has been undertaken for two alternate TSF design options. The conservative assessment does not allow for any degradation, adsorption or precipitation of constituents along the flow path. The assessment indicates that a number of constituents have potential to interact with Lawsons Creek under the conservative conditions simulated. However, it is most likely that the concentration of any constituents emanating from the TSF will be naturally attenuated to below the relevant guideline values or will be commensurate with background concentrations where these are naturally in excess of the default guideline value.

An assessment of potential impacts of the Project has been made against the Minimal Impacts Considerations of the NSW Aquifer Interference Policy. The Project is demonstrated to meet the Level 1 Minimal Impact Considerations, including potential water level and water pressure impacts to other groundwater users and to groundwater dependent ecosystems, and water quality impacts. In accordance with the Aquifer Interference Policy, the predicted impacts of the Project are considered to be acceptable.

Mine dewatering take has been partitioned between the applicable groundwater and surface water sources, including allowance for incidental surface water take through baseflow reduction. The maximum predicted annual take from each of the applicable water sources, and therefore the volume of share components for each of the water sources required to be held during mining are as follows.

- Lachlan Fold Belt Groundwater Source (Other) – 907ML
- Sydney Basin Groundwater Source – 194ML
- Lawsons Creek Water Source – 12.9ML

Groundwater take would occur in perpetuity as groundwater inflow to the pit lake would continue to occur to replace evaporative losses from the main pit lake.

To meet its responsibilities under the NSW Water Management Act, Bowdens Silver has obtained the following:

- 907 unit shares (equivalent to 907ML/year) in the Lachlan Fold Belt Groundwater Source via the option to purchase water access licences through the 2017 Controlled Allocation Order (Various Groundwater Sources);
- 194 unit shares (equivalent to 194ML/year). in the Sydney Basin Groundwater Source via the option to purchase water access licences through the 2017 Controlled Allocation Order (Various Groundwater Sources); and
- 139 unit shares in the Lawsons Creek Water Source.

This is sufficient to cover the peak predicted dewatering requirement over the life of the mine and exceeds the predicted annual average dewatering requirement from each of the groundwater sources.

1. INTRODUCTION

Bowdens Silver Pty Limited (Bowdens Silver) proposes to develop and operate the Bowdens Silver Project (the Project), located approximately 2.5km northeast of Lue and approximately 26km southeast of Mudgee, in New South Wales. The Project would mine epithermal silver deposits hosted in the Rylstone Volcanics and would incorporate a conventional open cut pit where overburden/waste rock is removed from above and around the silver-zinc-lead ore and either used for on-site construction activities, placed in the out-of-pit waste rock emplacement or the southern barrier for later re-use in rehabilitation activities. The mined ore would be transported by haul trucks to the on-site processing plant where it would be crushed, milled and processed to liberate the silver, zinc and lead minerals. These minerals would be collected by conventional froth flotation to produce two concentrates that would be dewatered and transported off site by truck. The residual materials from processing (tailings) would be pumped in the form of a slurry to the TSF located to the west of the open cut pit.

The principal infrastructure supporting the Project would be located within a proposed Mine Site that would cover an area of approximately 1 000 hectares (ha) with the open cut pit, processing area, TSF, waste rock emplacement (WRE) and ancillary components resulting in the disturbance of approximately 420ha. The mine life is expected to be 15.5 years with an annual processing throughput of up to 2 million tonnes.

The proposed Mine Site layout is provided on **Figure 1**. Key components of the Project that would potentially impact on groundwater include:

- open cut mining
- TSF
- WRE

A maximum open cut pit elevation of 456m AHD (approximately 150 to 200m below natural ground level) would be reached in Year 9 of operations. Other sections of the main open cut pit would be developed to a depth of 460m AHD and two satellite open cut pits would be developed to an elevation of 565m AHD and 580m AHD.

For the purposes of this assessment reference is made to the “Mine Site”, as displayed in **Figure 1** and the “study area” comprising the Mine Site and the surrounding area, typically up to 10km from the Mine Site.

The Project would require a site establishment and construction period of approximately 18 months during which the processing plant and all related infrastructure and the initial embankment of the TSF would be constructed. Once operational, Bowdens Silver anticipates the mine would produce concentrates for approximately 15 years. In total, it is proposed the mine life would be approximately 16.5 years, i.e. from the commencement of the site establishment and construction stage to the completion of concentrate production. It is envisaged rehabilitation activities would be completed over a period of approximately 7 years, i.e. from Year 16 to Year 23. **Figure 2** displays the duration of each of the main components throughout the mine life and Project life.

Figure 1 Indicative Mine Site Layout

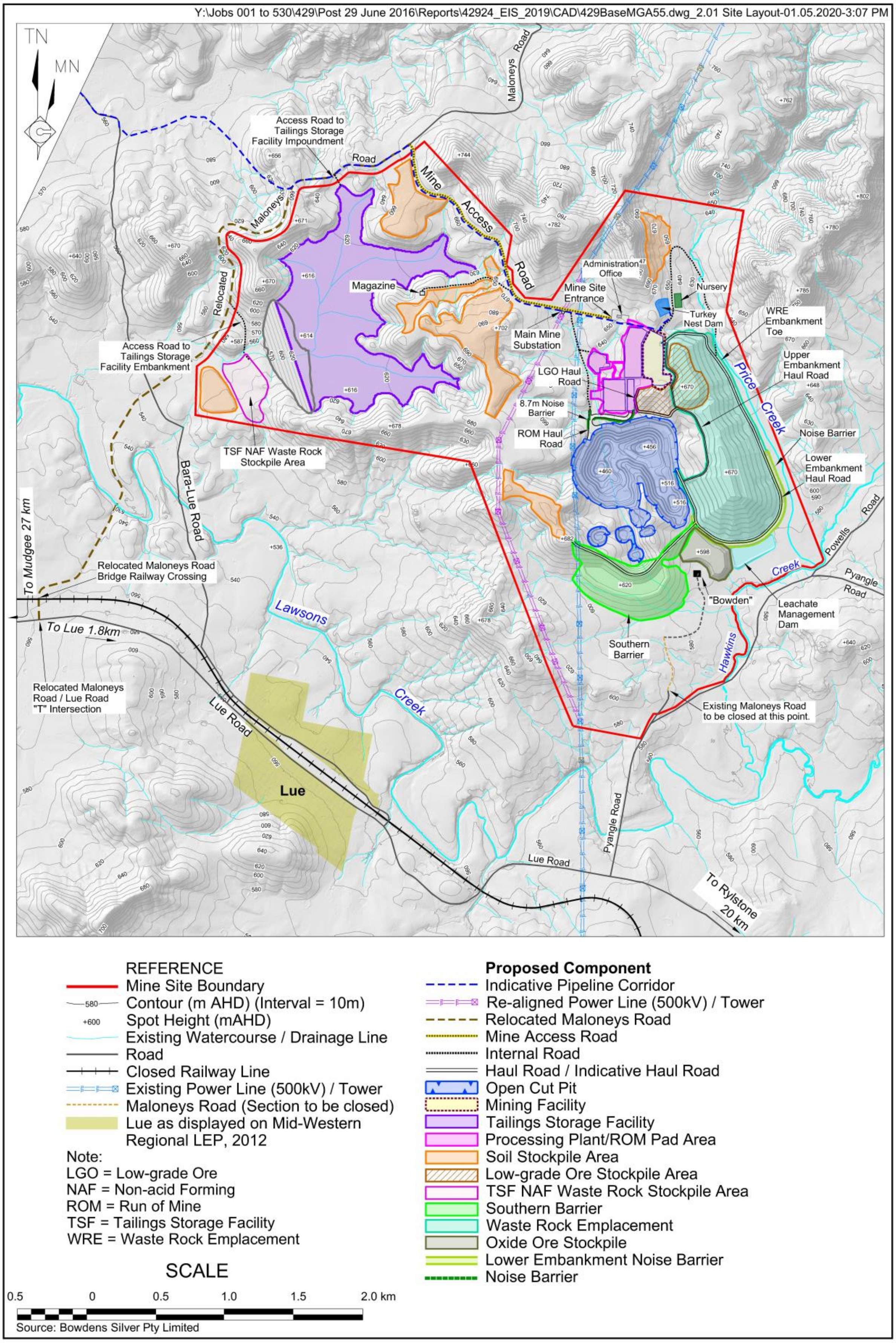
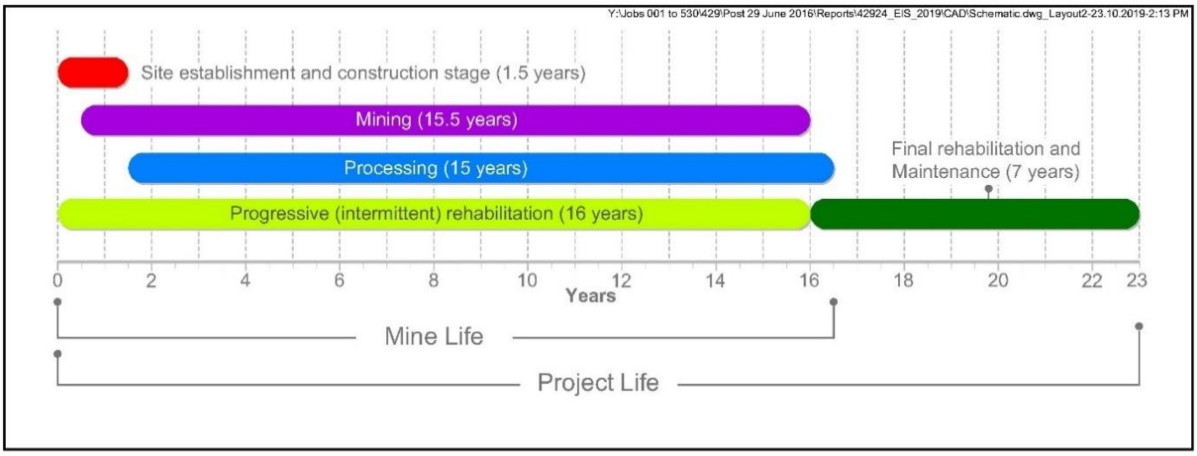


Figure 2 Mine Life and Project Life



Water supply of approximately 0.5ML/d to 1.0ML/d would be required for site establishment and construction, principally for dust suppression and achieving the optimum moisture content in those components or areas where compaction is required. Water during this period would be drawn from on-site groundwater bores and water storages (e.g. harvestable rights dams). During operation, water demand will be required primarily for ore processing and dust suppression, with an average annual daily water demand of approximately 5ML. During operations water would be sourced preferentially from on-site sources such as site dams (e.g. containment zone), return water from the TSF and mine dewatering. Additional make up water would also be sourced from harvestable rights dams and a third party via a purpose-built pipeline.

1.1 HISTORY OF EXPLORATION IN THE AREA

The Bowdens deposit was first discovered in 1989 by CRA Exploration Pty Ltd (CRA) during a regional stream sediment exploration program in which anomalous silver, lead and zinc and high bulk cyanide leachable silver were detected up to 1.5km from the deposit. Although mineralisation is exposed at the surface, it is not visible in the host rocks. Between 1989 and 1992 CRA undertook exploration activities which resulted in the discovery of the Bowdens Gift Zone of outcropping mineralisation, 500m east of the discovery outcrops.

In 1994, GSM Exploration took over the exploration lease, and in 1997 GSM was acquired by Silver Standard Australia Pty Limited (Silver Standard). Silver Standard undertook a detailed geological and resource evaluation of the deposit through an extensive drilling program. At that time, a reserve of 59 million tonnes (Mt) at 49g/t Ag equivalent was established for the reserve.

In October 2011, Kingsgate Consolidated Limited (KCN) purchased the exploration licences for the Bowdens Silver Project from Silver Standard. Open cut optimisation studies were completed and indicated a mineable ore reserve of 46Mt.

In June 2016, Bowdens Silver purchased Kingsgate Bowdens Pty Limited thereby acquiring the Bowdens Silver deposit with a mineable ore reserve of 88Mt including 134 million ounces of silver (64g/t Ag equivalent).

An Ore Reserve Statement, compliant to the 2012 JORC standard, was completed for Bowdens Silver deposit in May 2018 by AMC Consultants Pty Ltd. This Ore Reserve Statement was based upon on data from almost 84 000m of drilling in 653 drill holes that comprised both diamond drill hole (70%) and reverse circulation (30%). This data was obtained from both recent Bowdens Silver and previous drilling undertaken by KCN, GSM Exploration, Silver Standard and CRA. Based on the open cut pit optimisation studies and ultimate open cut pit design studies, the recoverable primary and low grade ore within the proposed open cut pit is estimated to be approximately 29.9million tonnes at an average grade of 69g/t silver, 0.44% zinc and 0.32% lead. This corresponds to total in situ quantities of approximately 66.3 million ounces of silver, 130 000t of zinc and 95 000t of lead.

The Bowdens Silver deposit is currently the largest known undeveloped silver deposit in Australia.

1.2 SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS

All mining projects in NSW must be assessed under the *Environmental Planning and Assessment Act 1979* (EP&A Act 1979). The Project is classified as a State Significant Development (SSD) in accordance with the *State Environmental Planning Policy (State and Regional Development)* 2011. An Environmental Impact Statement must be prepared in response to requirements set out by the Secretary of the NSW Department of Planning, Industry and Environment (DPIE). These requirements are known as the Secretary's Environmental Assessment Requirements (SEARs) and were formerly known as the Director General's Requirements.

The SEARs for the Project (SSD7565), were originally issued to Bowdens Silver on 23 December 2016. The SEARs are prepared in consultation with relevant State and local government agencies and take into consideration concerns and issues raised by community groups and individuals. The SEARs have been modified on two occasions, initially on 15 August 2017, with the most recent version issued on 21 June 2019.

The key issues relating to groundwater, as identified in the SEARs, including relevant agency and individual issues are provided on **Table 1**. **Table 1** also includes direction to the relevant section(s) within this report as to where the issue has been addressed.

Table 1
Coverage of SEARs and Additional Requirements

Page 1 of 10

Relevant Requirement(s)	Coverage in Report
Secretary's Environmental Assessment Requirements	
The EIS must include an assessment of: • the likely impacts of the development on the quantity and quality of the region's surface and groundwater resources (including but not limited to, Lawsons Creek and Price Creek), having regards to EPA's, DPI's and OEH's requirements; and	Section 5, See SCSC – Part 6
• the likely impacts of the development on aquifers, watercourses, riparian land, water-related infrastructure and other water users.	
While not exhaustive, Attachment 1 Extract (below) contains a list of some of the environmental planning instruments, guidelines, policies, and plans that may be relevant to the environmental assessment of this development.	-

Table 1 (Cont'd)
Coverage of SEARs and Additional Requirements

Page 2 of 10

<table>
<tr><th colspan="2">Relevant Requirement(s)</th><th>Coverage in Report</th></tr>
<tr><td colspan="3">Secretary's Environmental Assessment Requirements (Cont'd)</td></tr>
<tr><td colspan="2">Attachment 1 Extract
• Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources</td><td rowspan="3">Section 2.1.2.1</td></tr>
<tr><td colspan="2">• Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources</td></tr>
<tr><td colspan="2">• Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources</td></tr>
<tr><td colspan="2">• Water Sharing Plan for the Macquarie-Cudgegong Regulated Rivers Water Source</td><td>Not relevant</td></tr>
<tr><td colspan="2">• NSW State Groundwater Policy Framework Document (NOW)</td><td>Not relevant</td></tr>
<tr><td colspan="2">• NSW State Groundwater Quality Protection Policy (NOW)</td><td>Section 2.1.5</td></tr>
<tr><td colspan="2">• NSW State Groundwater Quantity Management Policy (NOW)</td><td>Not relevant</td></tr>
<tr><td colspan="2">• NSW Aquifer Interference Policy 2012 (NOW)</td><td>Section 2.1.4
Section 6.6</td></tr>
<tr><td colspan="2">• Australian Groundwater Modelling Guidelines 2012 (Commonwealth)</td><td>Annexure 9</td></tr>
<tr><td colspan="2">• National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (ARMCANZ/ANZECC)</td><td>Section 4.5.14.5</td></tr>
<tr><td colspan="3">Relevant Requirements Nominated by Other Government Agencies</td></tr>
<tr><td rowspan="7">Department of Primary Industry – Water 19/12/14</td><td>Details of the water to be taken (including through inflow and seepage) from each surface and groundwater source as defined by the relevant water sharing plan.</td><td>Section 7</td></tr>
<tr><td>Assessment of any volumetric water licensing requirements (including those for ongoing water take following completion of the project such as evaporative loss from open voids or inflows).</td><td rowspan="2">Section 7</td></tr>
<tr><td>The identification of an adequate and secure water supply for the life of the project. Confirmation that water can be sourced from an appropriately authorised and reliable supply. This is to include an assessment of the current market depth where water entitlement is required to be purchased.</td></tr>
<tr><td>Applicability of any exemptions under the Water Management (General) Regulation 2011 to the project</td><td>N/A</td></tr>
<tr><td>A detailed and consolidated site water balance</td><td>SCSC Part 6</td></tr>
<tr><td>An assessment of impacts on surface and groundwater sources (both quality and quantity), related infrastructure, adjacent licensed users, basic landholder rights, watercourses, riparian land and groundwater dependent ecosystems (GDEs) and measures proposed to reduce and mitigate these impacts</td><td>Section 5 and 8</td></tr>
<tr><td>Full technical details and data of all surface and groundwater modelling and an independent peer review.</td><td>Annexures 9 and 10 and SCSC Part 6</td></tr>
</table>

Table 1 (Cont'd)
Coverage of SEARs and Additional Requirements

Page 3 of 10

Relevant Requirement(s)		**Coverage in Report**
Relevant Requirements Nominated by Other Government Agencies (Cont'd)		
Department of Primary Industry – Water 19/12/14 (Cont'd)	Proposed surface and groundwater monitoring activities and methodologies.	Section 8.2
	Proposed management and disposal of produced or incidental water.	EIS Section 4.7.4.4
	Details surrounding the final landform of the site, including final void management (where relevant) and rehabilitation measures.	EIS Section 2.16 and 4.6.8.5
	Assessment of any potential cumulative impacts on water resources, and any proposed options to manage the cumulative impacts.	Section 6.6
	Consider relevant Legislation, Water Sharing Plans, Policies and Guidelines.	-
	Legislation	
	• *Water Management Act 2000 (WMA)* and *Water Act 1912*. In particular, Objects (s.3) and Water Management Principles (s.5) of the *WMA*.	Section 2.1.2
	Policies and Guidelines	
	• NSW Aquifer Interference Policy (2012) • NSW Water Extraction Monitoring Policy (2007)	Section 2.1.4 Section 6.6
	• NSW Groundwater Policy Framework Document – General (August 1997)	Section 2.1.5
	• NSW Groundwater Quality Protection Policy (1998)	Section *2.1.5*
	• NSW State Groundwater Dependent Ecosystem Policy (2002)	Section 6.2.1.2 and 6.6
	• Australian Groundwater Modelling Guidelines (2012)	**Annexure 9**
	• Risk Assessment Guidelines for Groundwater Dependent Ecosystems (2012)	Section 6.2.1.2 and 6.6
	Water Sharing Plans	
	• Water Sharing Plan for the NSW Murray-Darling Basin Fractured Rock Groundwater Sources	Section 2.1.2.1
	• Water Sharing Plan for the NSW Murray-Darling Basin Porous Rock Groundwater Sources	
	Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources	Section 2.1.2.1
Department of Primary Industry – Water 12/12/16	The EIS is required to include the following issues relating to water: • Identify water demand and determine whether an adequate and secure water supply is available for the Project;	EIS Section 2.10.1 and 4.7.4.6
	• Identify water sources (surface and groundwater), water disposal/discharge methods and water storage structures in the form of a detailed and consolidated water balance.	See SCSC – Part 6

Table 1 (Cont'd)
Coverage of SEARs and Additional Requirements

Page 4 of 10

Relevant Requirement(s)		**Coverage in Report**
Relevant Requirements Nominated by Other Government Agencies (Cont'd)		
Department of Primary Industry – Water 12/12/16 (Cont'd)	• Assessment of any potential cumulative impacts on water resources, and any proposed options to manage the cumulative impacts	Section 6.6
Environment Protection Authority 13/12/16	Identify water sources (surface and groundwater), water disposal/discharge methods and water storage structures in the form of a detailed and consolidated water balance.	See SCSC – Part 6
	Assessment of any potential cumulative impacts on water resources, and any proposed options to manage the cumulative impacts	Section 6.6
	Provide a water balance…including water requirements (quantity, quality and source(s)) and proposed storm and wastewater disposal, including type, volumes, proposed treatment and management methods and re-use options.	SCSC Part 6
	If the discharge requires treatment prior to disposal, any treatment measures should be described and the predicted water quality outcomes documented. Include a detailed process diagram/flowchart of the proposal specifying all water inputs, outputs and discharge points.	Main EIS Section 4.7.4, 4.7.5.4 and SCSC Part 6 Figure 4.2
	Describe the existing surface and groundwater quality. An assessment must be undertaken for any water resource likely to be affected by the project.	Sections 4.5.14 and 5
	Where the proponent intends to undertake the assessment using site specific water quality trigger values, detail the water quality of a reference site that has been selected based on the site specific considerations outlined in ANZECC (2000).	Section 8.3
	State the Water Quality Objectives for the receiving waters relevant to the proposal…Where groundwater may be impacted the assessment should identify appropriate groundwater environmental values.	N/A
	State the indicators and associated trigger values or criteria for the identified environmental values.	Section 8.3
	State any locally specific objectives, criteria of targets which have been endorsed by the NSW Government.	N/A
	Provide detailed water management strategies for all disturbance areas, paying particular attention to the waste rock emplacement areas and potential impacts to groundwater and off site surface water resources including particular reference to the management of channel and overland flows into and within the disturbance area.	EIS Section 4.7.4.4

Table 1 (Cont'd)
Coverage of SEARs and Additional Requirements

Page 5 of 10

Relevant Requirement(s)		**Coverage in Report**
Relevant Requirements Nominated by Other Government Agencies (Cont'd)		
Environment Protection Authority 13/12/16 (Cont'd)	Determine and detail the tailings management and monitoring strategy and dam design to be implemented, including an assessment of the potential impacts of tailings storage on surface and groundwater resources, contingency plans in the event of a leak or seep, rehabilitation and the long term management and feasibility.	EIS Section 2.8, A5.7 and A5.10.7
	Assess any irrigation areas proposed for wastewaters produced in accordance with the EPA Guideline "*The Use of Effluent by Irrigation*".	Not relevant
	Describe how predicted impacts on surface water, groundwater and aquatic ecosystems will be monitored and assessed over time, including monitoring locations, relevant parameters and sampling frequency. The EIS should: • Include a … response management plan, to identify appropriate trigger values and criteria and provide appropriate response actions if impacts are identified through the monitoring program.	Sections 8.2 and 8.3
	• Identify the process for identifying any trends in the monitoring data obtained.	Section 8.3
	This EIS should assess impacts on groundwater and GDEs. The assessment should be guided by the principles in *The NSW State Groundwater Policy Framework Document* (DLWC,1997). *Assessment and Management of Groundwater Contamination* (DEC, 2007) provides guidance on assessing and managing groundwater contamination. Assess impacts against relevant water quality guidelines for: • potentially impacted environmental values and beneficial uses using local Water Quality Objectives;	Section 4.5.5
	• contamination, such as investigation levels specified in *National Environment Protection Measure Guideline on the Investigation Levels for Soil and Groundwater* (EPHC, 1999).	Section 6.4
NSW Division of Resources & Energy 01/03/13	Assess potential impacts to groundwater associated with mine operations and any bore field proposed for water supply purposes. Include long term recovery patterns of groundwater and any bearing these may have on subsequent land use.	Section 6
NSW Division of Resources & Energy 23/01/15	Assess surface water flow and flooding regimes and how these will be impacted and mitigated by the project both during and after mining has ceased. This is to include an evaluation of potential impacts from the final void on both surface and groundwater quality and flow regimes.	See SCSC – Part 6
NSW Division of Resources & Energy 23/12/16	Where a void is proposed to remain as part of the final landform, include…outcomes of the surface and groundwater assessments in relation to the final water level in the void. This should include an assessment of the potential for fill and spill along with measures required to be implemented to minimise associated impacts to the environment and downstream water users.	Section 6.2.5 and 8.5, See SCSC – Part 6

Table 1 (Cont'd)
Coverage of SEARs and Additional Requirements

Page 6 of 10

Relevant Requirement(s)		**Coverage in Report**
Relevant Requirements Nominated by Other Government Agencies (Cont'd)		
Office of Environment and Heritage 13/12/16	The EIS must map the following features relevant to water … including: • Rivers, streams, wetlands, estuaries (as described in Appendix 2 of the Framework for Biodiversity Assessment). • Groundwater. • GDEs • Proposed intake and discharge locations.	See SCSC – Part 6 Section 4.5
	The EIS must map the following features relevant to water … including: • Rivers, streams, wetlands, estuaries (as described in Appendix 2 of the Framework for Biodiversity Assessment).	See SCSC – Part 6
	The EIS must describe background conditions for any water resource likely to be affected by the development, including: • Existing surface and groundwater. • Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations. • Water Quality Objectives (as endorsed by the NSW Government • Including groundwater as appropriate that represent the community's uses and values for the receiving waters. The EIS must assess the impacts of the development on water quality, including: • The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the development protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction.	Section 4.5 Section 6.4 and SCSC – Part 6
Mid-Western Regional Council 14/02/13	Identification of proposed monitoring of water quality	
	Assess the potential impact to water availability during times of drought.	EIS Sections 4.6.8.4, 4.6.9, 4.7.7.2
Mid-Western Regional Council 15/01/15	The assessment clearly identifies the source of water, amount required and proposed method of reticulation to the mine site.	EIS Section 2.10.1 and 4.7.4.6
Department of Primary Industry – Water 19/12/14	A detailed assessment against the NSW *Aquifer Interference Policy 2012*.	Sections 6.6 and **Annexure 1**
	Details on all bores and excavations for the purpose of investigation, extraction, dewatering, testing and monitoring. All predicted groundwater take must be accounted for through adequate licensing.	Section 4.5

Table 1 (Cont'd)
Coverage of SEARs and Additional Requirements

Page 7 of 10

Relevant Requirement(s)		**Coverage in Report**
Relevant Requirements Nominated by Other Government Agencies (Cont'd)		
Department of Primary Industry – Water 19/12/14 (Cont'd)	Where groundwater is expected to be intercepted or impacted, the following requirements should be used to assist the groundwater assessment for the proposal. • The known or predicted highest groundwater table at the site. • Works likely to intercept, connect with or infiltrate the groundwater sources.	Section 4.5
	• Any proposed groundwater extraction, including purpose, location and construction details of all proposed bores and expected annual extraction volumes.	Section 4.5
	• Bore construction information is to be supplied to DPI Water by submitting a "Form A" template. DPI Water will supply "GW" registration numbers (and licence/approval numbers if required) which must be used as consistent and unique bore identifiers for all future reporting.	
	• A description of the water table and groundwater pressure configuration, flow directions and rates and physical and chemical characteristics of the groundwater source (including connectivity with other groundwater and surface water sources).	
	• Sufficient baseline monitoring for groundwater quantity and quality for all aquifers and GDEs to establish a baseline incorporating typical temporal and spatial variations.	
	• The predicted impacts of any final landform on the groundwater regime.	
	• The existing groundwater users within the area (including the environment, any potential impacts on these users and safeguard measures to mitigate impacts.	
	• An assessment of groundwater quality, its beneficial use classification and prediction of any impacts on groundwater quality.	Sections 4.5, 6.4 and 6.7 Section 8
	• An assessment of the potential for groundwater contamination (considering both the impacts of the proposal on groundwater contamination and the impacts of contamination on the proposal).	
	• Measures proposed to protect groundwater quality, both in the short and long term.	
	• Measures for preventing groundwater pollution so that remediation is not required.	
	• Protective measures for any GDEs.	
	• Proposed methods of the disposal of wastewater and approval from the relevant authority.	Not Relevant
	• The results of any models or predictive tools used.	**Annexure 9** and **10**

Table 1 (Cont'd)
Coverage of SEARs and Additional Requirements

Relevant Requirement(s)		**Coverage in Report**
Relevant Requirements Nominated by Other Government Agencies (Cont'd)		
Department of Primary Industry – Water 19/12/14 (Cont'd)	Where potential impact/s are identified the assessment will identify limits to the level of impact and contingency measures that would remediate, reduce or manage potential impacts to the existing groundwater resource and any dependent groundwater environment or water users, including information on: • Any proposed monitoring programs, including water levels and quality data.	Section 8
	• Reporting procedures for any monitoring program including a mechanism for transfer of information.	
	• An assessment of any groundwater source/aquifer that may be sterilised from future use as a water supply as a consequence of the proposal.	
	• Identification of any nominal thresholds as to the level of impact beyond which remedial measures or contingency plans would be initiated (this may entail water level triggers or a beneficial use category).	
	• Description of the remedial measures or contingency plans proposed.	
	• Any funding assurances covering the anticipated post development maintenance cost, for example on-going groundwater monitoring for the nominated period.	Post approval (Rehabilitation Cost Estimate)
Greater Western Area Health Service 24/01/13	Assess potential impacts to groundwater bores from proposal including depth of the open cut mine and effect and disruption to aquifers.	Sections 6.2
	Describe what preventative controls will be put into place to prevent contamination of these aquifers.	Section 8
Department of Education and Communities 13/02/13	Assess the impact to the availability and quality of the school's bore water supply from nearby mining activities during construction and operation periods.	Section 6.2
NSW Office of Water 19/12/14	The EIS must consider the potential impacts on GDEs at the site and in the vicinity of the site and: • Identify any potential impacts on GDEs as a result of the proposal including: – the effect of the proposal on the recharge to groundwater systems; – the potential to adversely affect the water quality of the underlying groundwater system and adjoining groundwater systems in hydraulic connections; and – the effect on the function of GDEs (habitat, groundwater levels, connectivity). • Provide safeguard measures for any GDEs.	Section 4.5.5 and 6.2.1.2

Table 1 (Cont'd)
Coverage of SEARs and Additional Requirements

Page 9 of 10

Relevant Requirement(s)	Coverage in Report
Relevant Requirements Nominated by Lue and District Community	
Groundwater Monitoring	
Baseline levels in groundwater and surface water of the following. • Metals e.g. arsenic. • pH. • Aquatic species populations (using AUSRIVAS).	Sections 4.5.12 and 4.5.14, See SCSC – Part 6
Will background groundwater quality data include concentrations of lead and other heavy metals?	**Annexure 7**
How many bores will be monitored?	Section 4.5.12 and 8.2
Will any private bores be monitored?	
What parameters will be monitored (e.g. pH, metals) and what kind of changes to water quality could be expected?	Sections 4.5.12 and 4.5.14, **Annexure 7**
Baseline levels in groundwater and surface water of metals e.g. arsenic and pH.	
Will groundwater monitoring only occur within the footprint of the mine or will a broader area be considered?	
Will historical groundwater sampling data be made available?	
Will the suitability of groundwater for drinking be assessed in the EIS?	
Will ongoing monitoring of groundwater quality and levels be implemented?	Section 8.2.1
Will groundwater monitoring be self-reported or independent/audited?	Section 8
Will groundwater monitoring results be made available on the website?	See EIS Appendix 5 Table A3.5
Groundwater Modelling	
Will the groundwater model used in the assessment be a "Class 3 Model" under national modelling guidelines?	**Annexure 9**
How rigorous is the groundwater modelling? Is it based on assumptions or real-world data?	
Is 6 years data sufficient to inform assessment and base modelling on?	
How many peer reviews will be conducted?	
How can we be sure groundwater levels and quality are rigorously assessed prior to mining?	
Mine Dewatering	
How much groundwater does Bowdens Silver propose to extract during the developmental and operational phases of the Project? Is this sustainable?	Section 6.1 and 6.2, and See SCSC – Part 6
Where will groundwater entering the pit end up?	
Will mining activities result in the drawdown of groundwater?	
TSF	
Use of a double thickness HDPE liner for the Tailings Storage Facility.	Section 8.4
Is soluble arsenic in groundwater likely to increase from tailings seepage?	

Table 1 (Cont'd)
Coverage of SEARs and Additional Requirements

Page 10 of 10

Relevant Requirement(s)	Coverage in Report
Relevant Requirements Nominated by Lue and District Community (Cont'd)	
Groundwater Impacts – Level and Quality	
Potential impacts to groundwater supplies including impact on any highly productive groundwater (as defined in the Aquifer Interference Policy) and any potential GDEs.	Sections 6.1, 6.4 and 6.6
What effect will there be on local bores? (Effects to the water table)	
What is the area of impact for groundwater levels and quality?	Sections 6.1, 6.4 and 6.6
Will mining activities impact on the quality of groundwater?	
We rely on our groundwater bores – how can we be sure there will be no impacts to our supply?	
We are concerned about groundwater quality and the potential for contamination. How likely is this and what will be done to prevent it?	
Is it likely that there will be a build up of nitrates in the groundwater?	
Potential impacts to groundwater supplies including impact on any highly productive groundwater (as defined in the Aquifer Interference Policy) and any potential groundwater dependent ecosystems.	
Groundwater Impacts – Surface Flows	
What will be the effects of groundwater drawdown on flows in Lawsons Creek, especially during droughts?	Section 6.2.1 and 6.2.6 See SCSC – Part 6
We are concerned about reduced flows in Lawsons Creek as a result of groundwater flowing into the open cut pit	
Will groundwater drawdown impact the flow of Lawsons Creek?	
You will have a drawdown of the groundwater – will it impact on Lawsons Creek?	
Mitigation and Management	
What mitigation strategies will be implemented to reduce impacts to groundwater?	Section 8
Are there any "make good" provisions for surrounding landowners if groundwater becomes unusable or depleted?	Section 6.2.1.1

1.3 OBJECTIVES AND LAYOUT

The purpose of this report is to collate available groundwater data to present the existing groundwater conditions within the vicinity of the Mine Site, assess how these existing conditions may be affected as a result of operating the Project, and predict the potential impacts that may be caused to groundwater receptors.

This groundwater assessment is divided into the following sections.

- Section 1 – Introduction. This section introduces and describes the Project and outlines the objective of this report.
- Section 2 - Legislation and Policy. This section details the relevant legislation regarding management of groundwater in NSW, as it pertains to the Project.

- Section 3 - Previous Investigations. This section provides a summary of investigations and learning as a result of prior groundwater studies undertaken over the history of the Project.
- Section 4 - Existing Environment. This section describes the existing physical environment that has potential to influence and control the groundwater regime, including climate, topography, surface water features, and geology. This section also includes information on local groundwater levels, water quality, and sensitive groundwater receptors, and outlines the monitoring programmes that are in place to provide the relevant baseline groundwater data.
- Section 5 – Conceptual Hydrogeological Model. This section summarises the Conceptual Hydrogeological Model that has been developed to present the real-world groundwater regime in a simplified representation that can be readily applied for the demonstration of potential impacts as well as being transposed numerically in order to quantify and assess the potential regional groundwater impacts that may arise as a consequence of the Project.
- Section 6 - Impact assessment. This section assesses the potential impacts of the predicted groundwater responses with respect to other groundwater users, GDEs, baseflow to surface water features, and water quality. The predicted impacts are then assessed in regard to the minimal impact considerations of the NSW Aquifer Interference Policy and specific SEARs as required.
- Section 7 - Licensing Requirements. The water licensing requirements relating to groundwater inflow to the mining operation are determined including the partitioning of the volumetric water take between the various water sources (groundwater and surface water) as required. It is noted that the water supply for the Project would likely comprise a combination of groundwater inflow to mining operations (addressed in this report), harvesting of surface water (addressed in the Surface Water Assessment – see Volume 2, Part 6 of the Specialist Consultant Studies Compendium (SCSC)), as well as externally sourced water (third party supply). The externally sourced water would comprise a piped water supply from the Ulan Coal Mine and/or Moolarben Coal Mine.
- Section 8 - Monitoring and Management. This section outlines the proposed monitoring network and management measures to address the potential groundwater related impacts during construction and mining as identified in the impact assessment section.

2. LEGISLATION AND POLICY

This section presents relevant legislation regarding management of groundwater in NSW, as it pertains to the Project.

2.1 NEW SOUTH WALES LEGISLATION

2.1.1 Water Management Act 2000

The Water Management Act 2000 (WMA) presents the framework for sustainable and integrated water management in NSW and its objectives are:

- to apply the principles of ecologically sustainable development;
- to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality;
- to recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including:
  - benefits to the environment;
  - benefits to urban communities, agriculture, fisheries, industry and recreation;
  - benefits to culture and heritage; and
  - benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water.
- to recognise the role of the community, as a partner with government, in resolving issues relating to the management of water sources;
- to provide for the orderly, efficient and equitable sharing of water from water sources;
- to integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna;
- to encourage the sharing of responsibility for the sustainable and efficient use of water between the Government and water users; and
- to encourage best practice in the management and use of water.

The primary instruments applied to achieve these objectives are Water Sharing Plans and associated Regulations, guidelines and policies.

2.1.2 Water Sharing Plans

Water Sharing Plans, prepared under Section 50 of the WMA 2000, provide the basis for equitable sharing of surface water and groundwater between water users, including the environment.

The majority of water sources in NSW are covered by a Water Sharing Plan. If an activity leads to a take from a groundwater or surface water source covered by a Water Sharing Plan, then an approval and / or licence is required. In general, the WMA requires:

- a water access licence (WAL) to take water;
- a water supply works approval to construct a work; and
- a water use approval to use the water.

Where an activity leads to a take from a groundwater or surface water source not covered by a Water Sharing Plan or consists of an activity not specifically addressed by the WMA, then the activity is managed through the *Water Act 1912*. In such cases, the *Water Act 1912* requires:

- a licence to extract groundwater or surface water using any type of work; and
- a water supply work approval to construct a work.

It is noted that, as the Project is State Significant Development, under Section 4.41 (1)(g) of the EP&A Act 1979, the authorisation provided by a water use approval under Section 89 of the WMA 2000, a water management work approval under Section 90 of the WMA 2000 or an activity approval (other than an aquifer interference approval) under Section 91 WMA are not required.

2.1.2.1 Relevant Water Sharing Plans

For surface water, the Project is included in the *Water Sharing Plan for the Lawsons Creek Water Source of the Macquarie Bogan Unregulated and Alluvial Water Sources*, 2012.

For groundwater, the Project area is situated within the following water sharing plans:

- Sydney Basin Groundwater Source of the NSW Murray Darling Basin Porous Rock Groundwater Sources Order, 2020; and
- Lachlan Fold Belt Groundwater Source of the NSW Murray Darling Basin Fractured Rock Groundwater Sources Order, 2020.

The Plan Maps for the NSW Murray Darling Basin Porous and Fractured Rock Groundwater Sources or Water Source of the Macquarie Bogan Unregulated and Alluvial Water Sources do not indicate any alluvial sources in the vicinity of the Project. Any small, unmapped alluvial deposits that overlie porous or fractured rocks are subject to the provisions of the porous or fractured rock groundwater source on which they occur.

Water Sharing Plan boundaries relevant to the Project are provided on **Figure 3** and **Figure 4**. The Water Sharing Plans would govern any direct or incidental groundwater or surface water 'take' arising from the Project during construction, operation, and post closure.

Table 2 and **Table 3** present a summary of the Long Term Average Annual Extraction Limits (LTAAELs) for the relevant groundwater source water sharing plans.

Figure 3 Water Sharing Plan Boundaries and Surface Water Sources

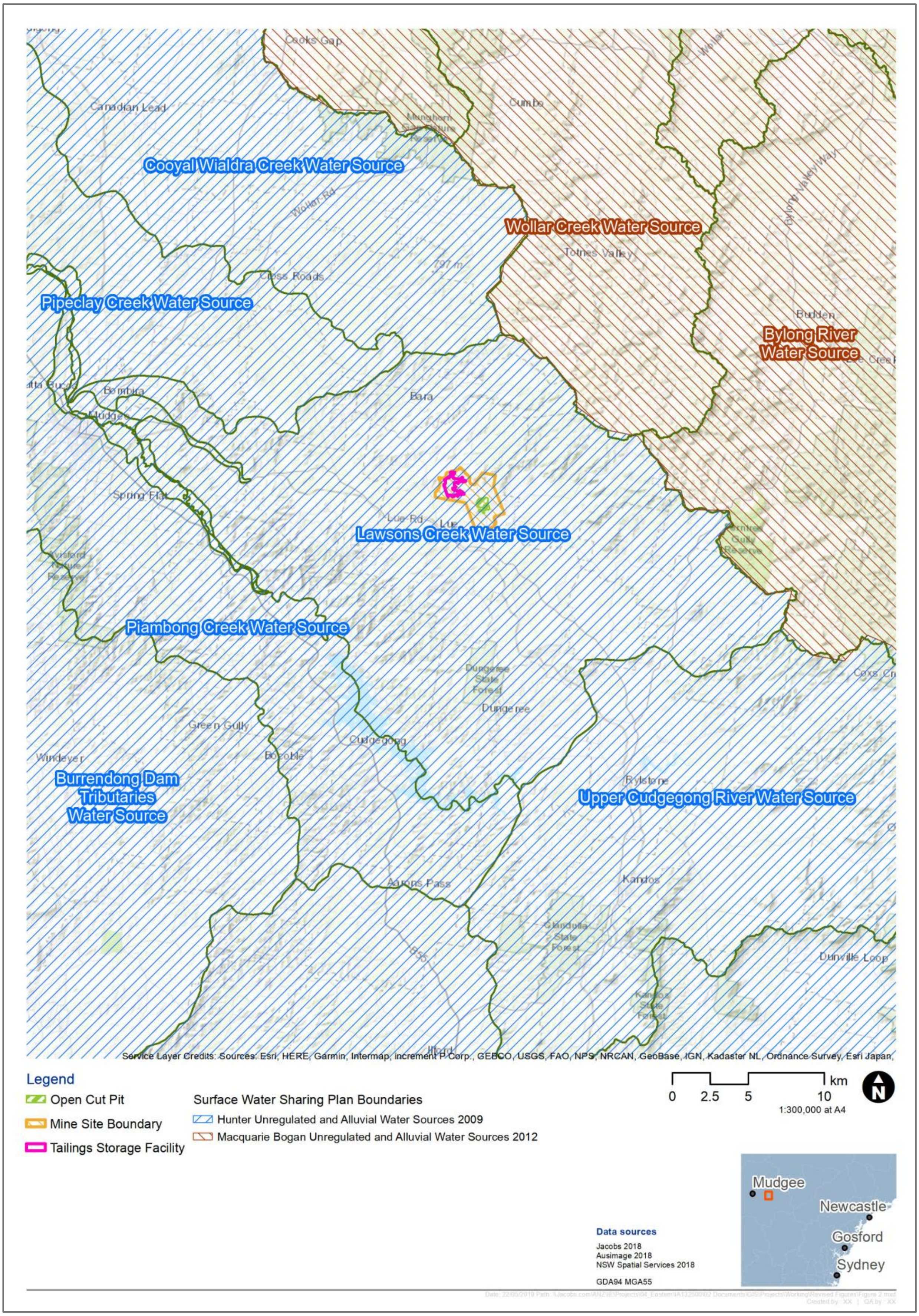


Figure 4 Water Sharing Plan Boundaries and Groundwater Sources

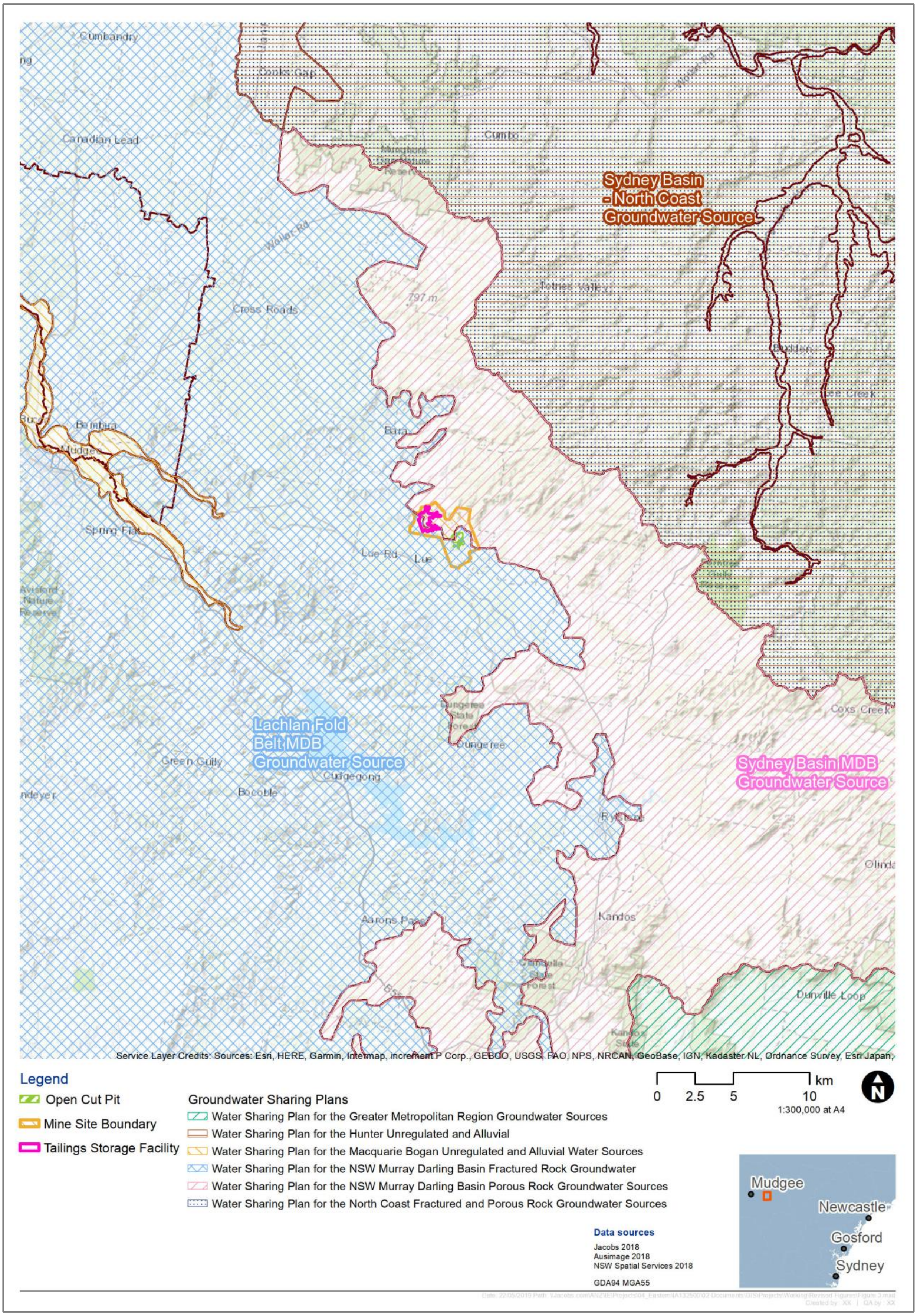


Table 2
Share Component of Unregulated River and Current Allocations (2020/2021)

Water Source and Water Sharing Plan	Share Component (ML/year)	No. WALs	Water made available (ML/year)	Unallocated Water (ML/year)
Lawsons Creek Water Source of the Macquarie Bogan Unregulated and Alluvial Water Sources.	1 443 53	36 (Unregulated River) 12 (Domestic and Stock)	1 443 53	-

Table 3
Groundwater Long Term Extraction Limits and Current Allocations (2020/2021)

Groundwater Source and Water Sharing Plan	LTAAEL (ML/year)	No. WALs	Water Made Available (ML/year)	Unallocated Water (ML/year)
Sydney Basin Groundwater Source of the NSW Murray Darling Basin Porous Rock Groundwater Sources	19 100	33 (Aquifer) 1 (Town Supply)	10 629	8 471
Lachlan Fold Belt Groundwater Source of the NSW Murray Darling Fractured Rock Groundwater Sources	253 788	1 056 (Aquifer) 6 (Town Supply) 38 (Local water Utility) 1 (Salinity Management)	71 842.7 467.4 3 435.5 236.0	177 806.5

There is currently a moratorium in place on issuing new WALs in NSW for commercial purposes. Where WALs are required, they would be purchased on the market, or via controlled allocation orders, as appropriate.

2.1.3 Water Access Licence Rules

Individual Water Sharing Plans contain rules surrounding the granting and management of access licences, as well as rules regarding the access licence dealings. Key rules for each of the Water Sharing Plans are summarised as follows.

2.1.3.1 Sydney Basin Groundwater Source of the NSW Murray Darling Basin Porous Rock Groundwater Sources Order, 2020

Assessment of Average Annual Extraction against the Long-term Average Annual Extraction Limit.

- Growth in extractions would be assessed against the long-term average annual extraction limit over a five year period with a 5 per cent tolerance.

Available Water Determinations

- Available water determinations will be made at the commencement of each water year for:
  - Stock and domestic, local and major water utilities and specific purpose access licences – 100 per cent of share component.
  - Aquifer access licences – 1ML/unit share or lower amount as a result of a growth in extraction response.

Carryover

- Up to 0.25 ML per unit share of the access licence share component can be carried over.

To Minimise Interference between Water Supply Works

- Water supply works (bores) are not to be granted or amended within the following distances of existing bores:
  - 400 metres from an aquifer access licence bore on another landholding.
  - 100 metres from a basic landholder rights bore on another landholding.
  - 500 metres from a local or major water utility access licence bore.
  - 200 metres from a Government monitoring or observation bore.
  - 200 metres from a property boundary.
- The plan lists circumstances in which these distance conditions may be varied.

To Protect Bores Located near Contamination Sources

- Water supply works (bores) are not to be granted or amended within:
  - 500 metres of a contamination source identified within Schedule 2 of the plan.
  - between 250 metres and 500 metres of contamination as identified within the plan unless no drawdown of water will occur within 250 metres of the contamination.
- The plan lists circumstances in which these distance conditions may be varied and exemptions from these rules.

To Protect Bores Located near High Priority Groundwater Dependent Ecosystems (‘GDEs’)

- Water supply works (bores) are not to be granted or amended within:
  - 40 metres of the top of the high bank of a river.
  - 200 metres of a high priority GDE listed in the plan.
  - 500 metres from a high priority karst or escarpment.
- The plan lists circumstances in which these distance conditions may be varied and exemptions to these rules.

To Protect Groundwater Dependent Culturally Significant Areas

- Water supply works (bores) are not to be granted or amended within 200 metres of a groundwater dependent culturally significant site.
- The plan lists circumstances in which these distance conditions may be varied and exemptions from these rules.

Trading into Water Source

- Not permitted.

Trading within Water Source

- Permitted:
  - subject to any applicable local impact management restrictions.

Conversion to another Category of Access Licence

- Not permitted:
  - except those allowed under the Minister's Access Licence Dealing Principles.

Trading between States

- Not permitted unless in accordance with administrative arrangements agreed to, and implemented by, NSW and the other States or Territory.

2.1.3.2 Lachlan Fold Belt Groundwater Source of the NSW Murray Darling Fractured Rock Groundwater Sources Order, 2020

Assessment of Average Annual Extraction against the Long-term Average Annual Extraction Limit

- Growth in extractions would be assessed against the long-term average annual extraction limit over a five year period with a five per cent tolerance.

Available Water Determinations

- Available water determinations would be made at the commencement of each water year for:
  - stock and domestic, local and major water utilities, salinity and water table management access licences – 100 per cent of share component.
  - aquifer access licences – 1 ML per unit share or lower amount as a result of a growth in extraction response.

Carryover

- Allocations for domestic and stock, a local water utility, salinity and water table management access licence or an aquifer access licence in the Peel Fractured Rock Water Source, cannot be carried over from one water year to the next water year.

- Up to 0.1 ML per unit share of the access licence share component can be carried over for the following groundwater sources.
  - Adelaide Fold Belt MDB Groundwater Source.
  - Kanmantoo Fold Belt MDB Groundwater Source.
  - Lachlan Fold Belt MDB Groundwater Source.
  - New England Fold Belt MDB Groundwater Source.
  - Orange Basalt Groundwater Source.
  - Yass Catchment Groundwater Source.
  - Young Granite Groundwater Source.
- Up to 0.2 ML per unit share of the access licence share component can be carried over for the following groundwater sources.
  - Inverell Basalt Groundwater Source.
  - Liverpool Ranges Basalt MDB Groundwater Source.
  - Warrumbungle Basalt Groundwater Source.

Minimising Interference between Neighbouring Water Supply Works

- Water supply works (bores) are not to be granted or amended within the following distances of existing bores:
  - 400 metres from an aquifer access licence bore on another landholding.
  - 200 metres from a basic landholder rights bore on another landholding.
  - 500 metres from a local or major water utility access licence bore.
  - 400 metres from a Government monitoring or observation bore.
  - 200 metres from a property boundary.
- The plan lists circumstances in which these distance conditions may be varied.

Protecting Bores located near Contamination Sources

- Water supply works (bores) are not to be granted or amended within:
  - 500 metres of a contamination source identified within Schedule 2 of the plan.
  - between 250 metres and 500 metres of contamination as identified within the plan unless no drawdown of water will occur within 250 metres of the contamination.
- The plan lists circumstances in which these distance conditions may be varied and exemptions from these rules.

Protecting Bores Located near High Priority Groundwater-Dependent Ecosystems

- Water supply works (bores) are not to be granted or amended within:
  - 40 metres of the top of the high bank of a river.
  - 200 metres of a high priority GDE listed in the plan.
  - 500 metres from a high priority karst or escarpment.

- The plan lists circumstances in which these distance conditions may be varied and exemptions to these rules.

Protecting Groundwater Dependent Culturally Significant Areas

- Water supply works (bores) are not to be granted or amended within 200 metres of a groundwater dependent cultural significant site.
- The plan lists circumstances in which these distance conditions may be varied and exemptions from these rules.

Trading into Water Source

- Not permitted.

Trading within Water Source

- Permitted:
  - subject to any applicable local impact management restrictions.
  - unless the dealing would result in the total extraction authorised under access licences from the Lachlan Fold Belt MDB (Mudgee) Management Zone exceeding 5 216.

Conversion to another Category of Access Licence

- Not permitted:
  - except those allowed under the Minister's Access Licence Dealing Principles.

Trading between States

- Not permitted unless in accordance with administrative arrangements agreed to, and implemented by, NSW and the other States or Territory.

2.1.3.3 Lawsons Creek Water Source of the Macquarie Bogan Unregulated and Alluvial Water Sources, 2012

Cease to Pump

- Pumping is not permitted from natural pools when the water level in the pool is lower than its full capacity.

Trading into Water Source

- Not permitted.

Trading within Water Source

- Permitted within the water source, subject to assessment.

It is noted that, for incidental water take as may result from mine dewatering, the cease to pump rules do not apply. Section 53(1) of the Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources states… *"This clause applies to the taking of water* *under an access licence from the Macquarie Bogan Unregulated Water Sources, excluding the taking of water under an access licence used only to account for the taking of water in association with an aquifer interference activity."*

2.1.4 NSW Aquifer Interference Policy

The NSW Aquifer Interference Policy (AIP) (NSW Office of Water, 2012) presents the requirements of the assessment of aquifer interference activities administered by the WMA 2000.

Key components to the AIP are:

- All water taken must be properly accounted for within the extraction limits set by the relevant Water Sharing Plan. A water licence is required whether water is taken either incidentally or by consumptive use. The AIP also requires consideration of the continued take of groundwater or connected surface waters following cessation of an aquifer interference activity.
- In addition to licensing requirements, the WMA 2000 includes the concept of ensuring "no more than minimal harm", and the AIP establishes a number of minimal impact considerations relating to water level, water pressure, and water quality. Minimal impact considerations are assigned according to the aquifer category and whether the aquifer is "highly productive" or "less productive".
- The AIP also requires planning for contingency or mitigating measures in the event that actual impacts are greater than predicted, including making sure there is sufficient monitoring in place.

Both the Sydney Basin Groundwater Source of the NSW Murray Darling Basin Porous Rock Groundwater Sources and the Lachlan Fold Belt Groundwater Source of the NSW Murray Darling Fractured Rock Groundwater Sources are considered to be highly productive aquifers based on the AIP criteria of:

- has total dissolved solids of less than 1 500mg/L; and
- contains water supply works that can yield water at a rate greater than 5 L/s.

While not detailed in the Plan Maps of the associated Water Sharing Plans, shallow alluvial deposits are present in the vicinity of Hawkins and Lawsons Creeks. Drilling along Hawkins Creek has recorded alluvial thickness ranging up to 4m to 6m with variable saturation, and these alluvial deposits are not considered to be highly productive on the basis of the AIP yield criteria. Notwithstanding, thicker saturated sequences of alluvium still have potential to be highly productive and the alluvial deposits will be considered as such for the purposes of the AIP.

For each of the highly productive and less productive groundwater sources, thresholds for key minimal impact considerations have been developed. These thresholds deal with water table and groundwater pressure drawdown as well as groundwater and surface water quality changes.

Key minimal impact considerations for the highly productive alluvial, porous rock and fractured rock aquifers are provided in **Table 4**.

The minimum impact considerations for water quality refer to the beneficial use category of the groundwater source. Beneficial use categories are outlined in the NSW Groundwater Quality Protection Policy (refer Section 2.1.5 below).

The NSW Government (DPIE-Water) provides a checklist for assessment under the AIP that is provided in **Annexure 1**.

Assessment of the Project against the AIP Minimal Impacts Considerations is provided in Section 6.6.

Table 4
Level 1 Minimum Impact Considerations – Highly Productive Groundwater Sources

Page 1 of 3

Water Source	Water Table	Water Pressure	Water Quality
Alluvial Aquifer	1. Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic post-water sharing plan variations, 40m from any: (a) high priority GDE or (b) high priority culturally significant site listed in the schedule of the relevant water sharing plan, or A maximum of a 2m water table decline cumulatively at any water supply work.	A cumulative pressure head decline of not more than 40% of the post-water sharing plan pressure head above the base of the water source to a maximum of a 2m decline, at any water supply work.	Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity. No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity. No mining activity to be below the natural ground surface within 200m laterally from the top of high bank or 100m vertically beneath (or the three dimensional extent of the alluvial water source - whichever is the lesser distance) of a highly connected surface water source that is defined as a reliable water supply. Not more than 10% cumulatively of the three dimensional extent of the alluvial material in this water source to be excavated by mining activities beyond 200m laterally from the top of high bank and 100m vertically beneath a highly connected surface water source that is defined as a reliable water supply.

Table 4 (Cont'd)
Level 1 Minimum Impact Considerations – Highly Productive Groundwater Sources

Page 2 of 3

Water Source	Water Table	Water Pressure	Water Quality
Porous Rock Water Sources	1. Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any (a) high priority GDE, or (b) high priority culturally significant site, listed in the schedule of the relevant water sharing plan. A maximum of a 2m decline cumulatively at any water supply work. 2. If more than 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any: (a) high priority GDE; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan then appropriate studies (including the hydrogeology, ecological condition and cultural function) would be required to demonstrate to the Minister's satisfaction that the variation would not prevent the long-term viability of the dependent ecosystem or culturally significant site. If more than 2m decline cumulatively at any water supply work then make good provisions should apply.	1. A cumulative pressure head decline of not more than a 2m decline, at any water supply work. 2. If the predicted pressure head decline is greater than requirement 1. above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline would not prevent the long-term viability of the affected water supply works unless make good provisions apply.	1. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity. 2. If condition 1 is not met then appropriate studies would be required to demonstrate to the Minister's satisfaction that the change in groundwater quality would not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.

Table 4 (Cont'd)
Level 1 Minimum Impact Considerations – Highly Productive Groundwater Sources

Page 3 of 3

Water Source	Water Table	Water Pressure	Water Quality
Fractured Rock Water Sources	1. Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any: (a) high priority GDE; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan. A maximum of a 2m decline cumulatively at any water supply work. 2. If more than 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any: (a) high priority GDE; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan then appropriate studies would be required to demonstrate to the Minister's satisfaction that the variation would not prevent the long-term viability of the dependent ecosystem or significant site. If more than 2m decline cumulatively at any water supply work then make good provisions should apply.	1. A cumulative pressure head decline of not more than a 2m decline, at any water supply work. 2. If the predicted pressure head decline is greater than requirement 1.(a) above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline would not prevent the long-term viability of the affected water supply works unless make good provisions apply.	1. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity. 2. If condition 1 is not met then appropriate studies would be required to demonstrate to the Minister's satisfaction that the change in groundwater quality would not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.

2.1.5 NSW Groundwater Quality Protection Policy

The NSW Groundwater Quality Protection Policy (DLWC, 1998) objectives are:

- All groundwater systems should be managed such that their most sensitive identified beneficial use (or environmental value) is maintained.
- Town water supplies should be afforded special protection against contamination.
- Groundwater pollution should be prevented so that future remediation is not required.
- For new developments, the scale and scope of work required to demonstrate adequate groundwater protection shall be commensurate with the risk the development poses to a groundwater system and the value of the groundwater resource.

- A groundwater pumper shall bear the responsibility for environmental damage or degradation caused by using groundwaters that are incompatible with soil, vegetation or receiving waters.
- GDEs will be afforded protection.
- Groundwater quality protection should be integrated with the management of groundwater quantity.
- The cumulative impacts of developments on groundwater quality should be recognised by all those who manage, use, or impact on the resource.
- Where possible and practical, environmentally degraded areas should be rehabilitated and their ecosystem support functions restored.

The following beneficial uses, or environmental values, are adopted by the NSW Groundwater Quality Protection Policy:

- ecosystem protection;
- recreation and aesthetics;
- raw water for drinking water supply;
- agricultural water; and
- industrial water.

Specific water quality characteristics are determined on a case-by-case basis with due consideration of existing site conditions and uses within each beneficial class.

2.1.6 Water Act 1912

The *Water Act 1912* (Water Act) is being progressively phased out across NSW and replaced by the WMA 2000.

The Water Act is relevant where an activity leads to a take from a groundwater or surface water source not currently covered by a Water Sharing Plan, or for aquifer interference activities such as temporary construction dewatering.

There are also some relevant residual provisions under the Water Act such as the requirement under Part 5 to obtain a groundwater licence to install a monitoring piezometer, however, there is an exemption to this requirement through the *Water Management (General) Regulation 2018* for piezometers installed as part of an environmental assessment for consideration under the EP&A Act 1979 and exploration under the Mining Act.

2.1.7 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (PoEO Act 1997) is the key piece of environment protection legislation administered by the NSW Environment Protection Authority (EPA).

Relevant features of this legislation include:

- protection of the environment policies (PEPs);
- integrated environment protection licensing; and
- regulation of scheduled and non-scheduled activities:
  - The EPA is the regulatory authority for scheduled activities (activities declared under Schedule 1 of the PoEO 1997).
  - The EPA is also the regulatory authority for non-scheduled activities, where activities are undertaken by a public authority.

3. PREVIOUS INVESTIGATIONS

A number of previous groundwater investigations have been undertaken at the Mine Site and are briefly summarised below. These investigations collectively form a substantial body of work that has been collated and incorporated into the current assessment. Investigations have included the undertaking of a regional bore census, installation of a groundwater monitoring network, and hydraulic testing, and form the foundation of the available groundwater information for the Project.

Salient information from previous investigations are summarised in the following sections.

3.1 COFFEY, 1998

Bowdens Silver Project Pre-Feasibility Water Supply Study. Undertaken by Coffey Partners International Pty Ltd for Silver Standard.

- Desktop hydrogeological investigation into potential Project water supplies from surface water and groundwater sources.
- No site-specific investigations were undertaken.
- Conclusions of the investigation are summarised as follows.
  - The initial search should be focused on both surface and groundwater supplies in relatively close proximity to the then Bowdens Silver project area.
  - The highest recorded yield from an alluvial aquifer noted as 3.2L/s from a bore in Lawsons Creek.
  - The highest recorded yield from a ‘hard rock’ aquifer noted as 4.6L/s from a 35m deep shale-hosted bore near Lue. However, yields from fractured aquifers in the district were noted to be generally less than 1.1L/s in bores up to about 110m deep.
  - Potential was noted for moderate groundwater yields from alluvial aquifers in the local area.

3.2 HYDROILEX, 2003

Hydrogeological Investigation, Groundwater Supply for the Bowdens Silver Project. Undertaken by Hydroilex Pty Ltd for Silver Standard.

- Desktop hydrogeological investigation into potential project water supplies from groundwater sources. No site-specific investigations were undertaken.
- Identified several areas within the region with the potential of producing moderate to high yields of groundwater and nominated a number of sites within each area for potential drilling and test bores. Target areas included:
  - Hard rock targets in the local area peripheral to the then Bowdens Silver project.
  - Hard rock targets south-southeast of Lue associated with the Walkers Lane Fault system.
  - Alluvial and hard rock targets associated with the Lawsons Creek alluvial system and occurrences of karst limestone between Havilah and Mirrimer approximately 10km west of Lue.

3.3 JEWELL, 2003

Hydrogeological Assessment, Bowdens Silver-Lead-Zinc Deposit. Undertaken by CM Jewell and Associates Pty Ltd for Silver Standard.

- Review of local groundwater and surface water conditions, including pumping tests undertaken on two boreholes (BGR230 and BGR299).
- Key findings were as follows.
  - Groundwater encountered during mineral exploration drilling was predominantly within the Rylstone Volcanics.
  - Groundwater occurrence in the Rylstone Volcanics unit and within the underlying basement rocks of then Bowdens Silver project area is primarily controlled by the presence of secondary porosity due to faulting/fracturing and weathering.
  - Water level survey indicated a general southerly groundwater flow direction.
  - Groundwater quality ranged from neutral to acidic (pH 3.78 to 7.09), with salinity (as electrical conductivity) fresh to brackish (500 to 2 400µS/cm).
  - Surface water quality was found to be acidic to mildly acidic (pH 4.66 to 6.3), with salinity predominantly fresh (130 to 680µS/cm).
  - Groundwater heavy metal concentrations at a number of locations exceeded the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) (the ANZ Guidelines), (95% level of protection for species in freshwater ecosystem) for iron, arsenic, manganese, lead, and zinc, and in surface water for iron, manganese, and zinc.
  - A 2-hour pumping test was completed on BGR299 and a 45.5 hour pumping test was completed on BGR230.
  - Formation permeability estimates ranged from 0.24 to 0.49m/day, with test results indicating an aquifer of limited extent.
  - Initial analytical dewatering estimates indicate that mine inflows would be less than the long term project water requirement.
  - Drawdown impacts were expected to be localised with minimal impacts to regional hydrogeology.
  - Due to potential acid generating materials and increased concentrations of heavy metals, any stored waters, particularly within the tailings dam, should be subjected to treatment prior to discharge.

3.4 MERRICK, 2011

An Assessment of Existing Groundwater conditions at the Bowdens Silver Mine Site near Lue, NSW. Undertaken for KCN.

- Desktop hydrogeological investigation and review of previous groundwater investigations and overview of the current legislation.

- Presented proposed groundwater monitoring network for the collection of baseline monitoring data.
- Key findings are as follows.
  - Distinguished two main aquifer systems: an alluvial colluvial aquifer and a substantial fractured rock aquifer system.
  - The dominant groundwater use from the local aquifers is for stock and domestic purposes. Bores accessing the Limestone at Lue are well represented. Within a 5km radius, 78% of bores are located near the township of Lue, and most likely target the Limestone aquifer in association with the Walkers Lane Fault.
  - Prior inflow estimates of up to 2ML/day considered unlikely to be sustainable with longer term average inflow rates likely to be less than 0.5ML/day.
  - Alternative water supplies would be required to be sourced and alluvial supplies unlikely to be approved.
  - A groundwater monitoring network was proposed comprising of at least seven (7) monitoring bores converted from exploration holes and utilising additional privately-owned registered bores with at least two holes (P7 and BPD2) installed as multi-level vibrating wire piezometers.
  - Recommendation to obtain additional hydraulic data through hydraulic testing of new monitoring bores and undertaking testing on core samples to determine hydraulic conductivity and effective porosity.

3.5 SKM, 2013

Bowdens Groundwater Monitoring Network, Bore Installation. Undertaken by Sinclair Knight Merz Pty Limited for KCN.

- Factual report detailing the installation and testing of a groundwater monitoring network. A total of 24 observation bores at 16 sites were installed as part of the monitoring network with holes ranging in drilled depth from 5m to 198m.
- All of the monitoring bores constructed in the Rylstone Volcanics were found to be of low yield (less than 1L/s), which was consistent with the conclusions of Coffey (1998). The exception was BGW44, which was screened in volcanic breccia and yielded approximately 2L/s during airlift and was expected to be capable of higher yields when pumped.
- Monitoring bores constructed in the fractured rock aquifer associated with the underlying Ordovician shale aquifer were generally also low yielding (less than 1L/s), the exceptions being BGW50, located on the alluvial flat associated with Hopkins Creek and BGW27. These holes indicated yields of approximately 2 to 3L/s during airlift.
- Seven bores were installed to investigate the Shoalhaven Group sediments. Formation thicknesses of 8 to 52m were encountered and in all instances the formation was unsaturated.

- A total of 36 slug tests (useable) were completed and analysed on 14 bores, with the following results.
  - Hydraulic conductivity evaluated in the sandstone/siltstone ranged from 0.21 to 1.9m/day.
  - Hydraulic conductivity of the shale ranged from 0.08 to 1.4m/day, with the exception of BGW46 which is significantly lower.
  - Hydraulic conductivity of the Rylstone Volcanics (undifferentiated) ranged from 5.3×10^{-3} to 1.3m/day.
  - Hydraulic conductivity of the crystal tuff at BGW42 ranged from 0.04 to 0.05m/day.
- Four pumping tests were undertaken, with one test of 2 hours duration and three tests of 4 hours duration. Results are summarised as follows.
  - One of these bores was installed in the Rylstone Volcanics and displayed a range in hydraulic conductivity values of 0.05 to 0.2m/day.
  - Two bores in Ordovician basement returned pumping test results indicating a range in hydraulic conductivity of 1×10^{-3} to 1.7m/day.

3.6 JACOBS, 2014

Bowdens Project Aquifer testing 2014. Undertaken by Jacobs Group (Australia) Pty Ltd for Kingsgate Bowdens Pty Ltd.

- Factual report detailing the long-term test pumping undertaken at two boreholes (BGW10 and BGW108), with tests undertaken for 72 hours duration.
- Key findings and conclusions were as follows.
  - Estimated aquifer parameters at BGW10 suggest a fracture network within the target aquifer with transmissivity values of up to $15m^2$/day. The bulk rock matrix permeability is estimated to be much lower, with transmissivity values as low as $6 \times 10^{-2} m^2$/day. This indicates that the dominant supply of groundwater to the well is transferred through the fracture networks at this test site.
  - Parameters at BGW108 suggest an absence of fracture networks, or an absence of interconnected fracturing within the test area. Estimated permeabilities for the aquifers fractures and bulk matrix are similar in value, suggesting any fractures (if present) are not contributing significantly to the water produced from pumping. Water is therefore conceptualised to be released primarily from matrix storage, a concept which is supported by the slow recovery of water levels after pumping has ceased (up to four weeks for recovery to 10% of original water levels).
  - The aquifer testing program has shown that the aquifer underlying the then Mine Site can be characterised as a dual-porosity fractured rock aquifer, consistent with the existing hydrogeological conceptualisation. The fracture network, where interconnected, may have localised permeabilities of up to four orders of magnitude higher than the bulk rock mass. The testing program has also shown that the fracture network is somewhat discrete within the bulk rock mass.

4. EXISTING ENVIRONMENT

4.1 CLIMATE

The closest Bureau of Meteorology (BoM) rainfall gauge to the study area is gauge 062062 Lue at Bayley Street. The record for this gauge is incomplete, with data available from 1902 to 1927, followed by an extensive data gap from 1927 to 1997, and cessation of the record at 2007.

The meteorological data relied upon for this Project has been obtained from the Scientific Information for Landowners (SILO) database due to the incomplete BoM records. SILO is a climate database hosted by the Science Division of the Queensland Department of Environment and Science (DES). The data is based on historical data obtained from the BOM. SILO data are stored as a grid that is derived by interpolating the BoM's station records. Interpolations are calculated by splining and kriging techniques, such that there are no original meteorological station data left in the grid fields.

Information was obtained for the Mine Site and surrounding locality (collectively referred to as the study area) based on extraction of meteorological data from the SILO grid within the Mine Site (Latitude -32.65 degrees North, Longitude 149.85 degrees East, at an elevation of 594.4m AHD), and included interpolated temperature, rainfall, evaporation and evapotranspiration data. It is noted that while the SILO data set extends back to 1889, only data from 1900 forward has been used due to the limitation in Microsoft Excel in recognising dates prior to 1900. Comparison with the limited Bayley Street rain gauge information indicates the SILO data provides a reasonable set of long-term climate data for the study area.

Bowdens Silver maintains a meteorological station on site, located approximately 600m northeast of the site office (Met 01). Site rainfall data from Met 01 is available from March 2013 and is compared with the SILO data in **Figure 5**. **Figure 5** shows a strong correlation between the Met 01 rainfall observations and SILO data. A brief period of mismatched data from December 2017 to February 2018 is apparent, however, over the 70 month period of observation, there is less than 1% discrepancy in total rainfall between the SILO data and the Met 01 data.

Long term average climate data is summarised in **Table 5**. Rainfall and evaporation both peak during the summer months. The average annual evaporation is approximately 1 514mm/year which is more than twice the average rainfall rate. The average rate of evaporation exceeds the average rate of rainfall in all months of the year except June and July.

Table 5
Long Term Average Climate Data (SILO 1900-2018)

	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Rain (mm)	68.6	63.8	53.8	43.8	43.3	50.0	51.8	50.6	50.8	55.7	64.8	64.8
Daily Min Temp (˚C)	15.0	14.9	12.5	8.3	4.9	2.6	1.4	2.1	4.4	7.7	10.7	13.4
Daily Max Temp (˚C)	29.7	28.7	26.2	22.2	17.7	14.2	13.5	15.2	18.7	22.4	25.7	28.5
Monthly Evap (mm)	222.0	174.8	154.8	101.3	62.4	42.1	46.9	69.5	99.4	143.0	177.9	220.2

Figure 5 Comparison of Site Rainfall Data with SILO

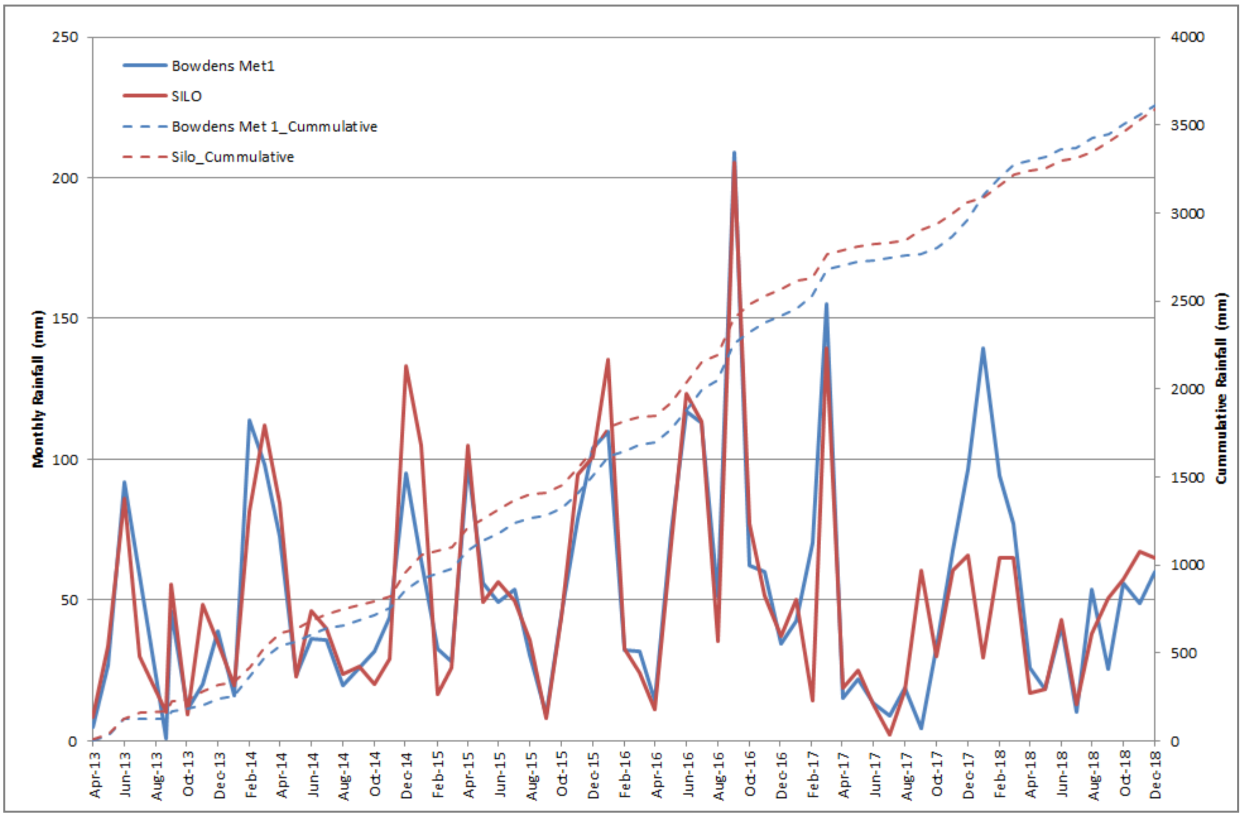


Figure 6 shows the SILO annual rainfall for the study area and indicates a long-term average annual rainfall of approximately 606mm/year and a higher short-term average (i.e. post 2000) of approximately 692mm/year.

The cumulative deviation from mean monthly rainfall (cumulative rainfall residual) provides a good indication of longer-term rainfall trends and is presented on **Figure 7a**. For the rainfall record from 1900, the cumulative rainfall deviation (CRD) plot shows two distinct trends, namely:

- a long period of below average rainfall (downward sloping trend) from 1900 to 1947; and
- a long period of predominantly above average rainfall (upward sloping trend) from 1947 to 2017.

These long-term trends are overprinted by shorter period trends of above- and below- average rainfall, and by brief periods of predominantly average rainfall (horizontal trend) from 1947 to the present day.

The CRD trends from 2012 are also shown in **Figure 7b**. This period is representative of the duration of groundwater monitoring at the Mine Site.

Figure 6 Long Term Annual Rainfall (SILO)

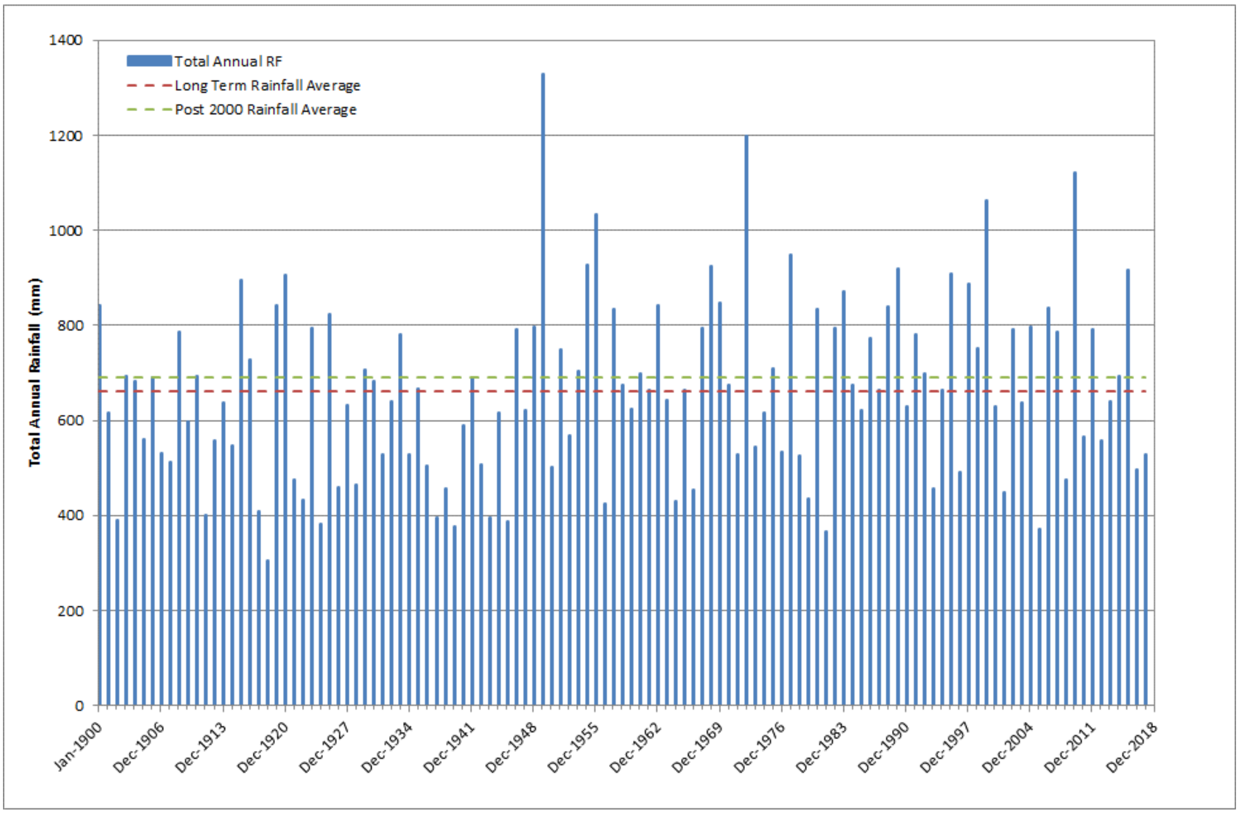


Figure 7a Cumulative Rainfall Deviation with Daily Rainfall

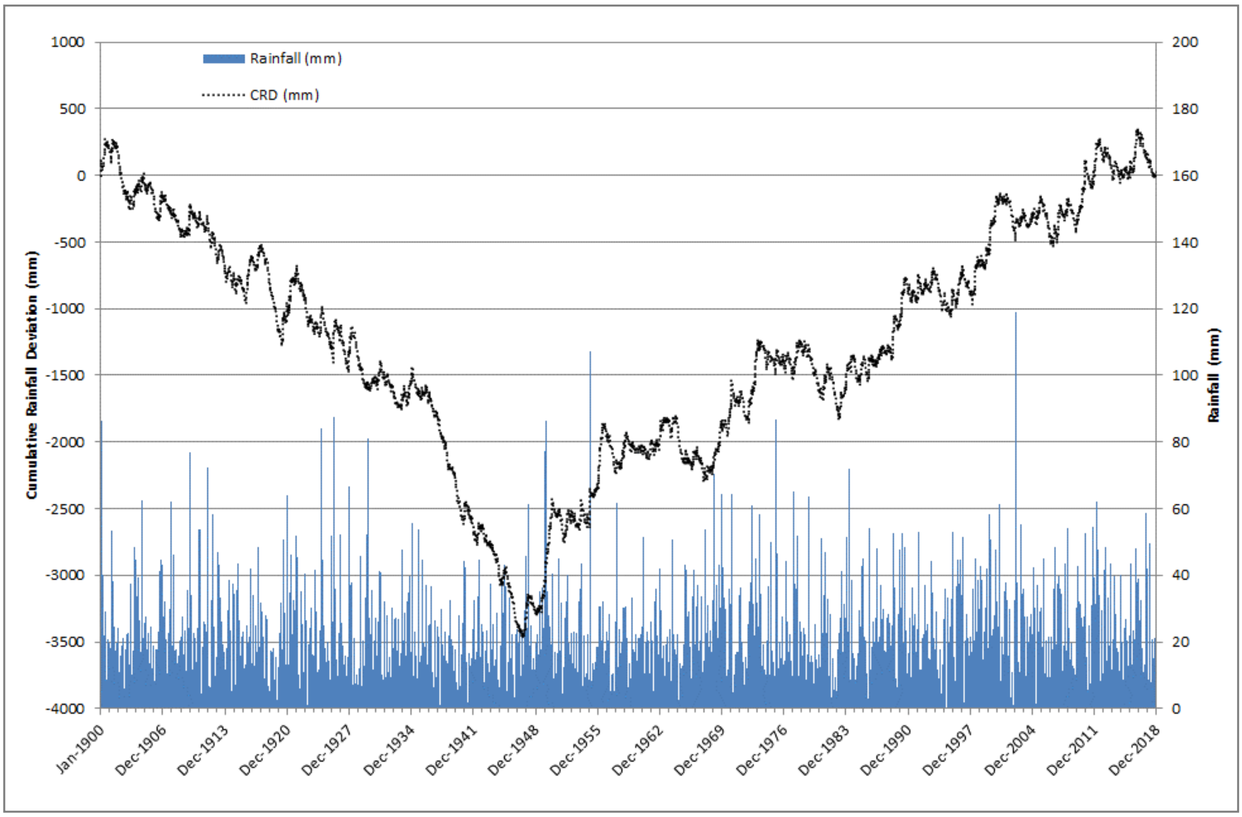
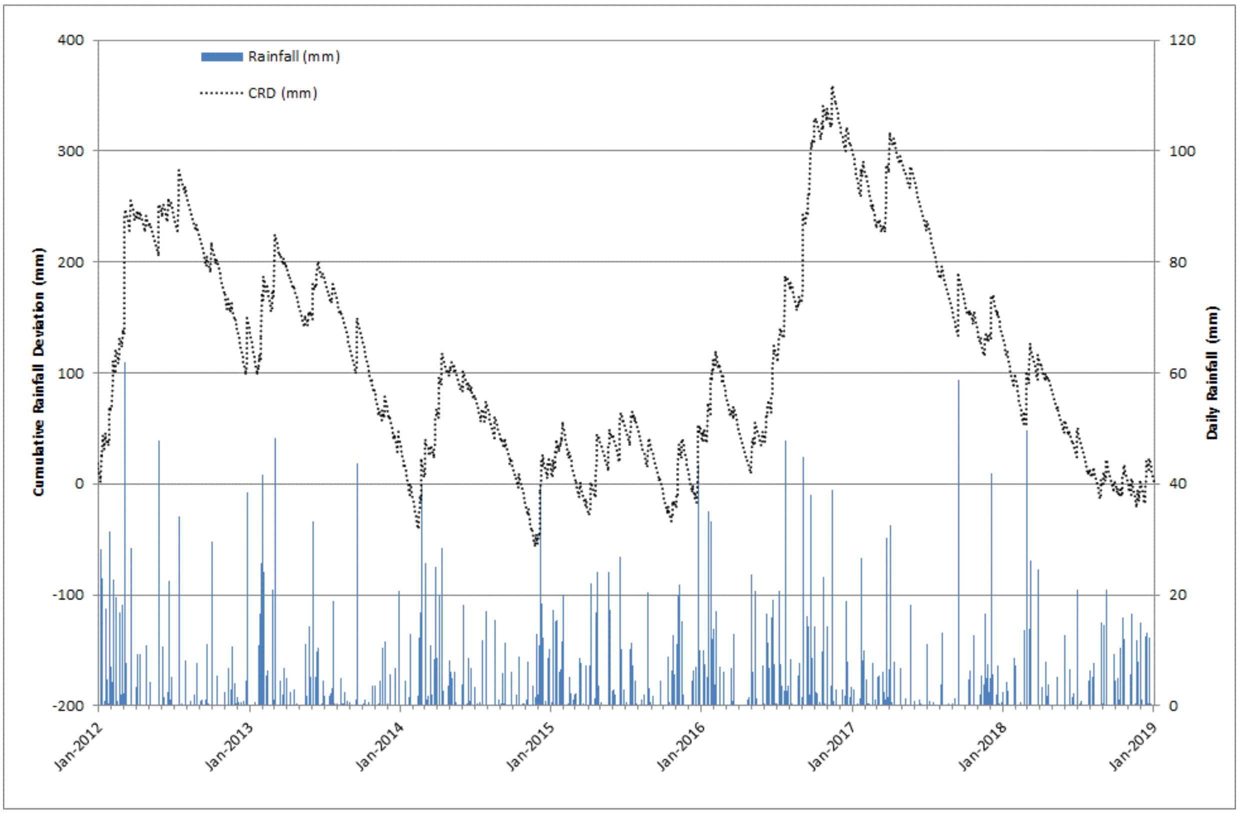


Figure 7b Cumulative Rainfall Deviation with Daily Rainfall



4.2 TOPOGRAPHY AND DRAINAGE

The topography in the vicinity of the Mine Site is primarily influenced by three north-south orientated spurs with small intermediate valleys and a broad, flat valley to the south of the area containing Hawkins Creek (see **Figure 8**).

The eastern spur, adjacent to the north-eastern boundary of the Mine Site, has the highest elevation within the local area with a maximum elevation of approximately 770m AHD. The small valley to the west of this spur, which contains Price Creek and the proposed WRE, falls to an elevation of approximately 600m AHD before rising again to the top of the central spur at an elevation of 660m AHD. Blackmans Gully lies to the west of the central spur in a small valley containing Maloneys Road with elevations between approximately 590m AHD and 620m AHD. The western spur, known as Lydiard Ridge (at an elevation of up to 680m AHD), is located near the western boundary of the Mine Site, directing runoff into either Blackmans Gully or to the west of the Mine Site. Slopes throughout the Mine Site are generally 1:6 to 1:10 (V:H) with the exception of the northeastern corner of the Mine Site that contains relatively steep slopes approaching 1:3 (V:H) to 1:2 (V:H). The drainage lines within the small valleys between these spurs drain to the south where they join differing sections of Hawkins Creek which in turn joins Lawsons Creek approximately 1km from the southernmost point of the Mine Site.

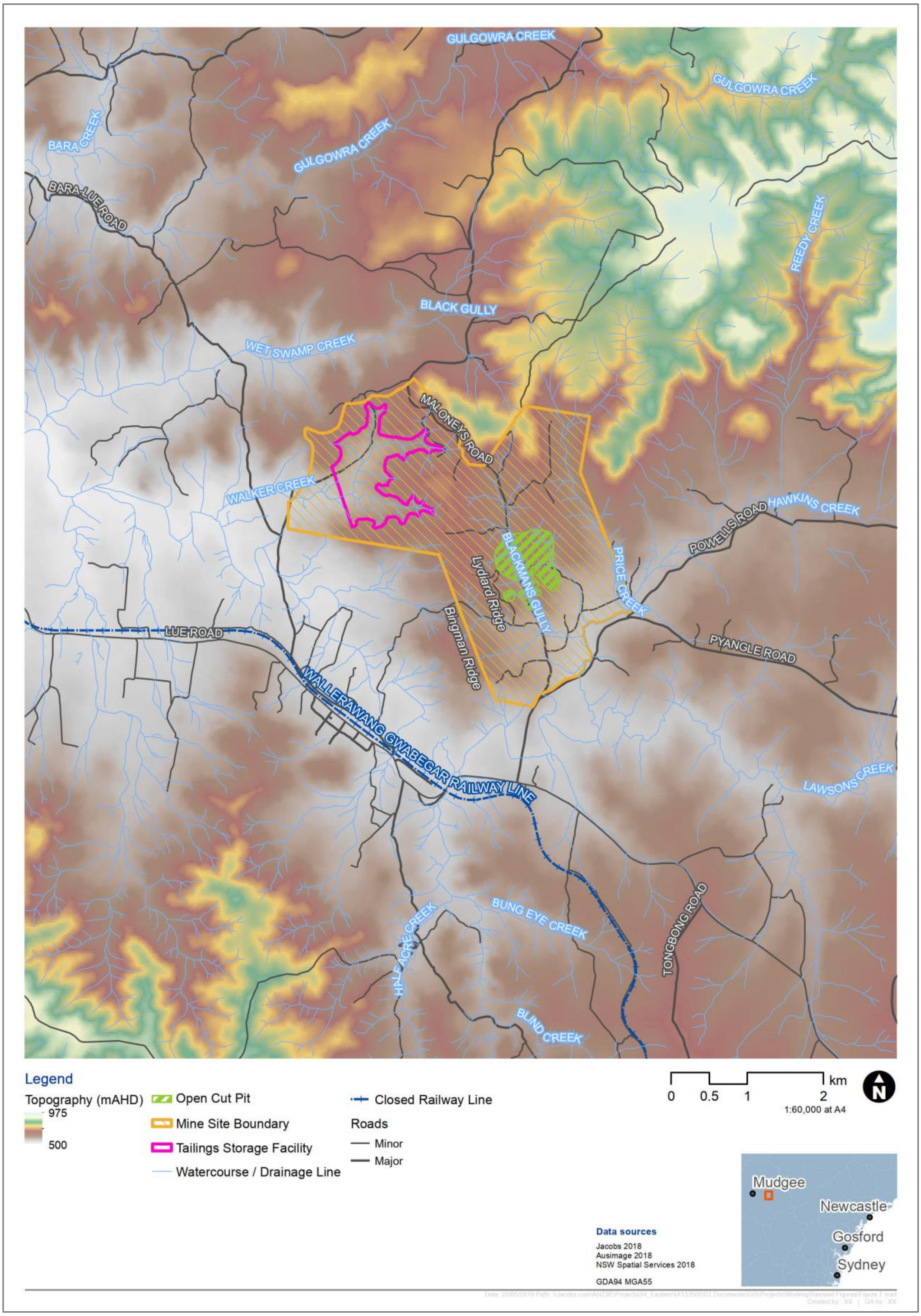
The western ridge extends southwards and joins a near east-west ridge known as the Bingman Ridge and is a prominent local topographic feature between the Mine Site and Lue. Bingman Ridge rises to elevations of between 630m AHD and 678m AHD. Elevations within Lue vary from approximately 550m AHD to 600m AHD.

The Mine Site is located within the Macquarie River Basin. Local drainages are typically ephemeral first order drainages (a stream not fed by a perennial stream). Hawkins Creek is primarily perennial, albeit at low levels and joins Lawsons Creek just south of the Mine Site. Lawsons Creek flows in a northwesterly direction immediately north of Lue, and then westerly until its confluence with the Cudgegong River near Mudgee.

The first order drainage catchments present in the Mine Site are ephemeral in nature with flow regimes indicating dependence upon local rainfall runoff and implying negligible groundwater baseflow. A number of these drainages contain partial swamps in the upper reaches, indicating at least semi-permanent saturation resulting from sub-surface flows (or inter-flow) through the soil profile. These ephemeral swamps and seeps are often developed as farm dams for stock water supply.

Downstream from these first order drainage features, the intermittent Hawkins Creek is likely sustained by groundwater baseflow, as indicated by continued flow (or the presence of ‘water holes’) observed during the drier seasons.

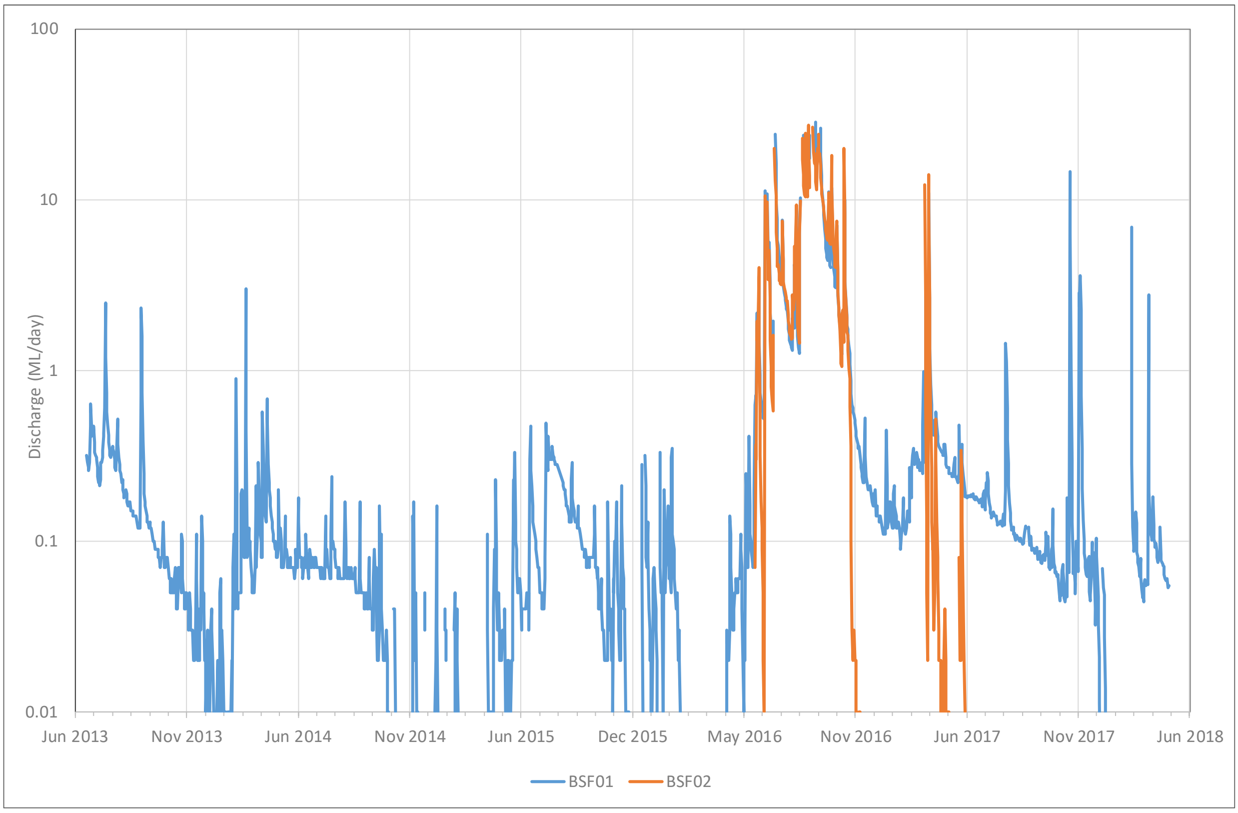
Figure 8 Topography and Drainage of the Study Area and Surrounds



4.2.1 Stream Flow

Bowdens Silver monitor stream flow in Hawkins Creek at two V-notch weirs, BSF01 (downstream) and BSF02 (upstream). Data is available from BSF01 from June 2013, and from BSF02 from June 2016 and are presented on **Figure 9**. The locations of the weirs are shown on **Figure 23**.

Figure 9 Hawkins Creek Flow Gauging (June 2013 to June 2018)

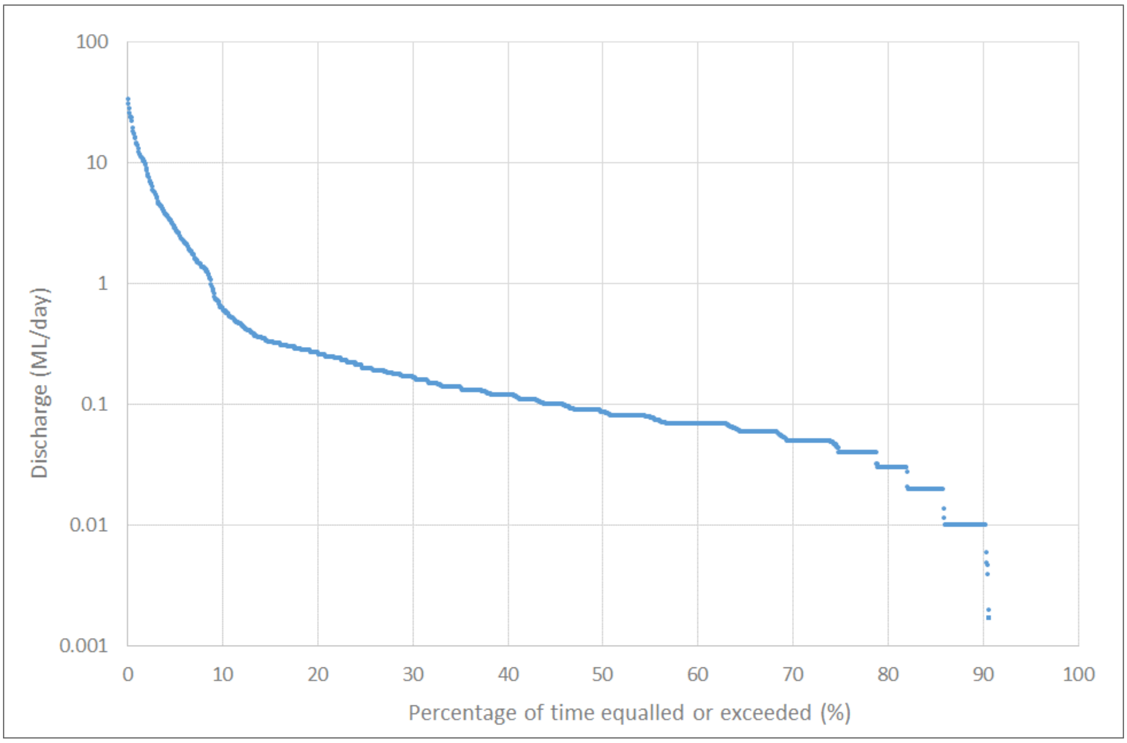


Recorded flows are typically very low, with the exception of a period of high rainfall and runoff from July 2016 through to November 2016. BSF01 displays flow, albeit very low, for the majority of the time with some observed periods of no flow. BSF02 typically displays no flow over the V-notch with the exception of the high-runoff flow events.

There are no local gauging sites for Lawsons Creek, however, WRM (2020) have assessed average flows in Lawsons Creek at approximately 19.5ML/day.

A flow duration curve for BS01 is presented on **Figure 10,** which shows flows at BSF01 to be typically in the range of 0.02 to 0.33ML/day (0.2 to 3.8L/s), with a median flow of 0.09ML/day (1.0L/s).

Figure 10 BSF01 Flow Duration Curve



4.3 GEOLOGY

The surface geology in the vicinity of the Mine Site, from the NSW Seamless Geology dataset (Colquhoun et al, 2019), is shown in **Figure 11** and regional stratigraphy is summarised on **Table 6**. The dataset represents a seamless GIS compilation of the best available vector geology data for New South Wales, and in the vicinity of the Mine Site, is the equivalent of the Mudgee 1:100 000 geological map sheet.

The lithological basement in the area comprises the marine metasediments of the Ordovician Adaminaby Group and Coomber Formation of the Lachlan Orogen. In the vicinity of the Mine Site, the Coomber Formation (approximately 460 million years old) is dominated by poorly bedded mudstones, siltstones and arenites which have been folded and are moderately to strongly cleaved and locally schistose. These rocks outcrop in a south-southeast trending syncline in the west of the Mine Site and as an inlier within a low-lying area to the east of the Bowdens silver deposit. The Coomber Formation is unconformably overlain by the flat lying to gently dipping Early Permian Rylstone Volcanics (approximately 280 million years old), which locally comprises (in order of deposition) crystal tuff, ignimbrite, rhyolite breccia and flow-banded rhyolite, with a combined thickness of up to approximately 200m.

Figure 11 Surface Geology

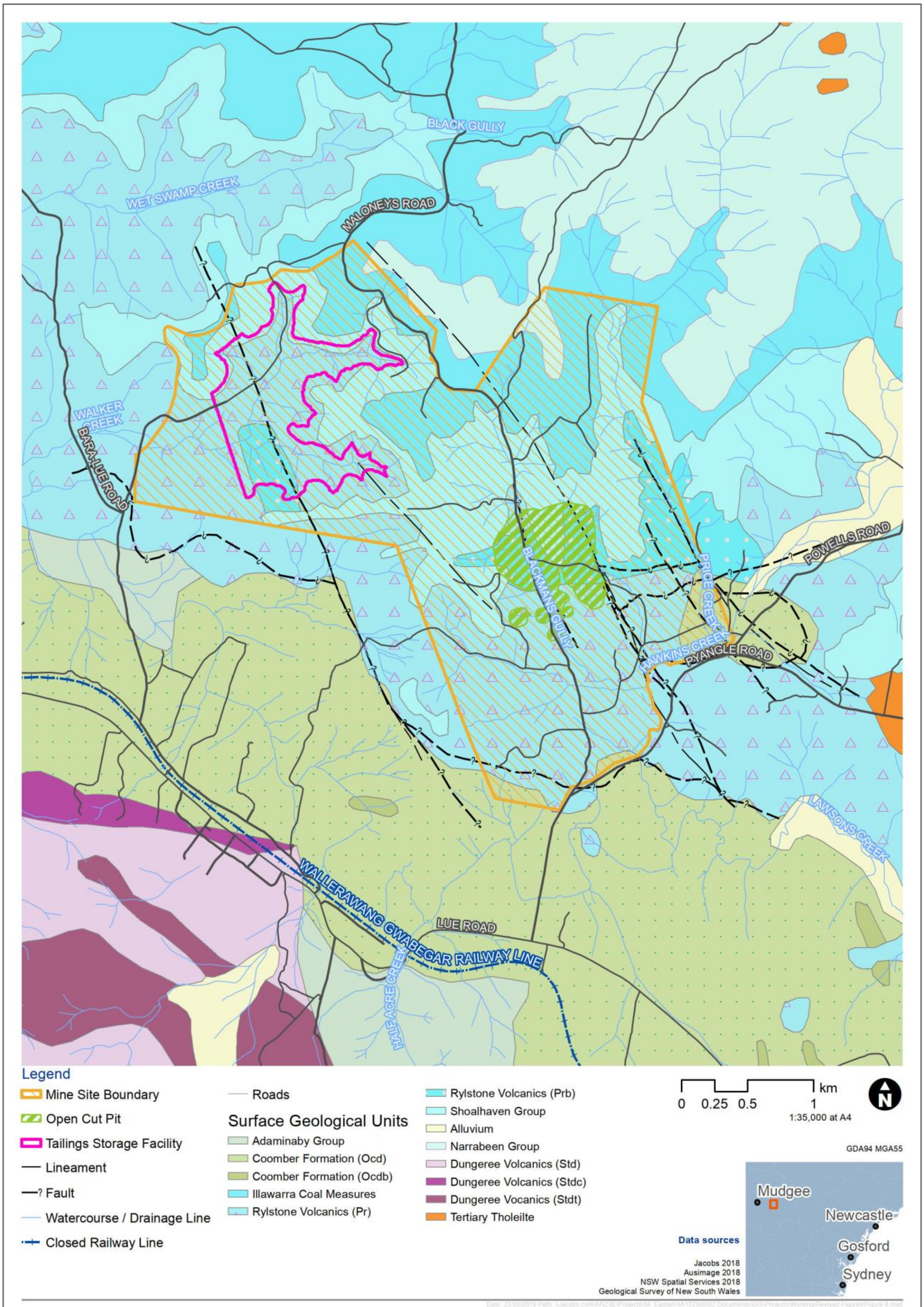


Table 6
Local Stratigraphy

Geologic Province	Stratigraphic Unit	Age	Description
n/a	Undifferentiated alluvium and colluvium	Holocene / Quaternary	Alluvium and colluvium of varying thickness are found at the base of most drainages in the study area. These materials are best developed around Hawkins and Lawsons Creeks. Recent observation bore drilling along Hawkins Creek recorded alluvial thickness ranging from 4m to 6m. The alluvium encountered during this drilling was dominated by silty sandy gravel and clay lithology.
Sydney Basin	Narrabeen Group	Triassic	In the study area the Shoalhaven Group is present as elongated hill-capping and comprises conglomerate, siltstone and shale. It overlies the Rylstone Volcanics only to a minor extent in the proposed open cut pit area and more extensively to the north. The sandstone, mudstone, claystone and coal of the Illawarra Coal Measures overlie the Shoalhaven Group further north and are in turn overlain by the younger sandstone and mudstone of the Narrabeen Group.
	Illawarra Coal Measures	Permian	
	Shoalhaven Group	Permian	
	Rylstone Volcanics	Early Permian	The Rylstone Volcanics primarily consist of felsic volcanic breccias, ignimbrites and tuffs and range in thickness from 10 to 200m. As a result of hydrothermal activity at the site, alteration has occurred causing mineralisation of the Rylstone Volcanics leading to an epithermal-style silver-gold and base metal deposit. The majority of silver mineralisation at the study area is hosted by a thick zone ranging from the surface to depths of approximately 200m below the surface. The Rylstone Volcanics are deposited unconformably on the Coomber Formation. The Rylstone Volcanics are noted as a constituent unit of both the Sydney Basin and the Lachlan Orogen.
Lachlan Fold Belt (Orogen)	Coomber Formation	Ordovician	The Coomber Formation comprises a deep marine sandstone and mudstone sequence, which outcrops extensively around Lue. It conformably overlies the Early Ordovician Adaminaby Group and is disconformably overlain by the Late Silurian Dungeree Volcanics of the Tannabutta Group. Whilst the Dungaree Volcanics are not represented at the Mine Site, they are locally represented around Lue village (refer **Figure 11**).
	Adaminaby Group	Ordovician	The Adaminaby Group comprises turbiditic quartzose sandstones and mudstones, suggestive of a deep marine depositional environment.
Source: after Colqhoun et al. 2000.			

The basal unit of the Rylstone Volcanics is generally represented by a thick zone of crystal tuff up to approximately 170m thick. The crystal tuff is generally well sorted and comprises minor crystals and lithic clasts of altered volcanic glass fragments and rare volcanic glass shards up to 4mm in diameter within a very fine vitric ash groundmass. The crystal tuff consists of abundant feldspar, minor quartz and muscovite, with rare altered mafic minerals and trace primary crystal fragments. The crystal tuffs are overlain by a variable sequence of ignimbrites, rhyolitic breccias and laminated tuffs. The base of this sequence is dominated by ignimbrites which generally directly overly the crystal tuff.

Within the ignimbrites, crystal fragments are consistent with the crystal tuff. However, volcanic glass fragments are more common, locally forming fiamme. These fragments are set in a vitroclastic, locally vesicular groundmass of volcanic glass. The welded nature of the ignimbrite's groundmass results in reduced primary porosity and permeability compared with the crystal tuff and tuff breccia units. The ignimbrites are overlain by air-fall tuffs to the north and east of the Bowdens silver deposit. These units vary from moderately coarse lithic tuffs to crystal lithic and crystal tuffs with rare thin laminated layers of fine ash fall tuffs.

The volcanic breccia units of the Rylstone Volcanics are poorly sorted with sub-angular to sub-rounded clasts of crystal and welded tuff up to 30mm in diameter within a fine grained vitric tuff groundmass.

The Rylstone Volcanics are unconformably overlain by the stratified sandstones and conglomerates of the Shoalhaven Group's Snapper Point Formation of the Sydney Basin. The basal contact of this unit is generally marked by a thin layer of pebbly, fossiliferous sandstone. The Snapper Point Formation is dominated by sandstone with minor zones of conglomeratic interbeds, siltstone, shale and coal.

In the north of the Mine Site, the Shoalhaven Group is in turn overlain by the Illawarra Coal Measures, which are overlain by the Narrabeen Group sediments. The Sydney Basin sediments dip gently to the northeast by approximately 0.5 degrees (DoIR&E, 2016).

Mapped alluvium in the vicinity of the Mine Site on **Figure 11** is limited to Hawkins and Lawsons Creeks upstream from the Mine Site boundary, however, a veneer of alluvium exists within the Mine Site boundary associated with the Hawkins Creek floodplain.

Table 6 provides a description of the stratigraphic units in the study area and the nomenclature adopted for this report.

4.3.1 Mineralisation

The majority of the silver-zinc-lead mineralisation of the Bowdens silver deposit lies within the Rylstone Volcanics where it occurs as zones of disseminations and silicic filling of fractures. Silver mineralisation generally occurs within tennantite, silver sulphosalts, silver sulphides, and as native silver. Higher grade portions are associated with sulphides of iron, arsenic, lead and zinc.

Higher grade silver mineralisation includes rare steeply dipping fracture zones which have been interpreted to potentially represent feeder zones to the dominant flat lying disseminated mineralisation.

Mineralisation occurs within all units of the Rylstone Volcanics including crystal tuff, volcanic breccia and ignimbrites. The style of mineralisation varies between rock types. Mineralisation is interpreted to be generally fracture controlled in ignimbrite units, fracture controlled and locally disseminated in crystal tuff units, and mainly disseminated in volcanic breccias.

The bulk of the mineralisation within the Bowdens silver deposit occurs as a thick zone extending from surface, and near surface, to vertical depths of approximately 200m. The deposit is not well defined below this level as existing drilling data below this is limited.

Broadly spaced deeper drilling has intersected mineralisation within the basement Coomber Formation metasediments which commonly show abundant quartz veining.

Depth of weathering is typically shallow within the main mineralised area and saprolite is poorly developed with hard competent lithology encountered at shallow depths. The base of oxidation from drilling results ranges in the order of 1 to 35m below surface with an average depth of approximately 9m.

4.4 STRUCTURAL GEOLOGY

The geology of the Mine Site is heavily fractured, with six major fracture sets, two of which (a north-northwesterly trending set and an easterly trending set) primarily control the distribution of mineralisation. Major geological structures are shown on **Figure 11**.

The most dominant faulting in the area is associated with the north-northwesterly structures that are aligned with Blackmans Gully. The Blackmans Gully fault can be traced for at least two kilometres via aerial photography and strikes parallel to the valley floor along Maloneys Road and the low ground east of the Bowdens silver deposit.

The major fault that bounds the eastern side of the Bowdens silver deposit is not well exposed in the vicinity of the deposit but is marked by quartz float, argillic alteration and manganese - iron oxide filled fractures and breccias can be traced for several hundreds of metres.

A number of similarly oriented, less prominent faults have been identified which crosscut the Rylstone Volcanics but do not persist into the Shoalhaven Group sediments. These faults are interpreted to offset the main units of the Rylstone Volcanics units by up to approximately 100m vertically. However, they appear to predate mineralising events and have little influence on the distribution of mineralisation.

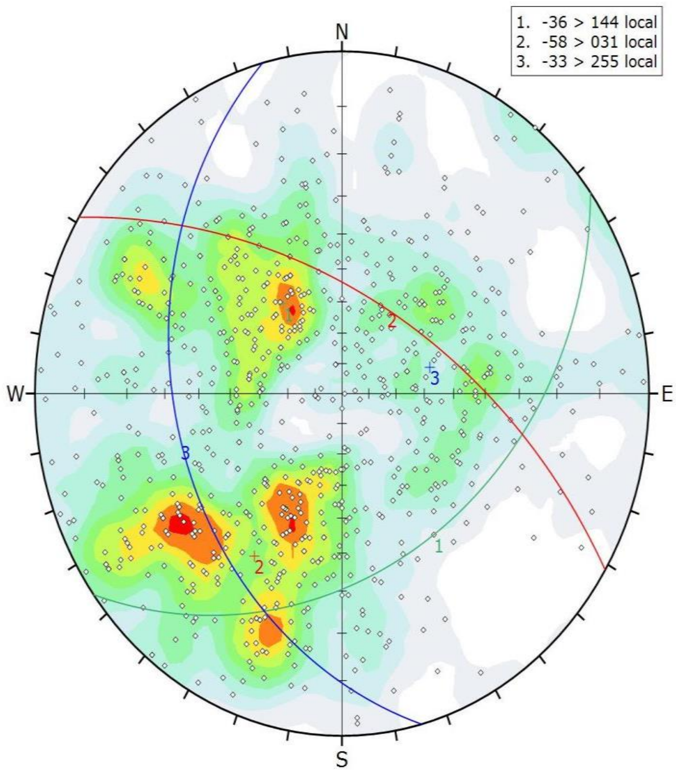
4.4.1 Fracture Orientation

In fractured rock aquifers, uniformly distributed fracture sets can behave as a pseudo-porous rock aquifer with relatively uniform and isotropic groundwater flow. However, if there is a dominant fracture orientation this can result in a preferred groundwater flow direction, or flow anisotropy.

Dominant fracture and vein orientations derived from core logging are presented on stereonet plots on **Figure 12** and **Figure 13**. It is noted that the stereonet plots are presented in mine grid. The mine grid is rotated -18 degrees (counterclockwise) from true north.

The stereonet plots the poles to the plane of the fractures, which are then contoured by concentrations and a centroid or representative pole selected for each concentration. From **Figure 12**, two dominant clusters are apparent, one in the northwestern sector (Cluster 1), and one in the southwestern sector (Cluster 2 – comprising three sub-clusters), a third smaller concentration (Cluster 3) is apparent to the east.

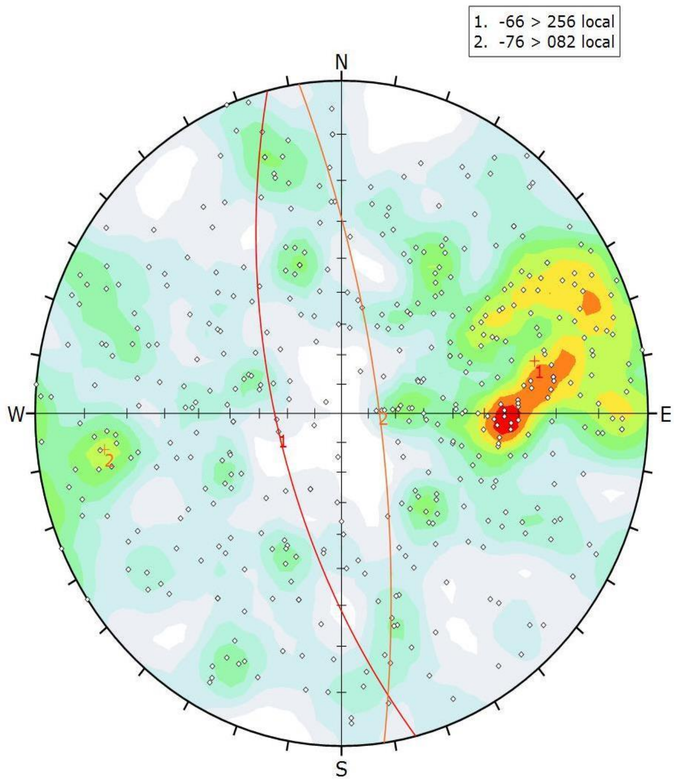
Figure 12 Stereonet Representation of Fractures



Symbol	Feature
◇	Pole Vectors

Color	Density Concentrations
	0.00 - 0.30
	0.30 - 0.60
	0.60 - 0.90
	0.90 - 1.20
	1.20 - 1.50
	1.50 - 1.80
	1.80 - 2.10
	2.10 - 2.40
	2.40 - 2.70
	2.70 - 3.00
Contour Data	Pole Vectors
Maximum Density	2.81%
Contour Distribution	Fisher
Counting Circle Size	1.0%
Plot Mode	Pole Vectors
Vector Count	774 (774 Entries)
Hemisphere	Lower
Projection	Equal Angle

Figure 13 Stereonet Representation of Veins



Symbol	Feature
◇	Pole Vectors

Color	Density Concentrations
	0.00 - 0.35
	0.35 - 0.70
	0.70 - 1.05
	1.05 - 1.40
	1.40 - 1.75
	1.75 - 2.10
	2.10 - 2.45
	2.45 - 2.80
	2.80 - 3.15
	3.15 - 3.50
Contour Data	Pole Vectors
Maximum Density	3.45%
Contour Distribution	Fisher
Counting Circle Size	1.0%
Plot Mode	Pole Vectors
Vector Count	441 (441 Entries)
Hemisphere	Lower
Projection	Equal Angle

The two main fracture orientations cross-cut and intersect at approximately 67 degrees and are described as follows.

- Cluster 1: One main concentration
  - Typical strike ranges from 20 to 85 degrees local, dipping 20 to 50 degrees to the southeast.
  - Average strike of 54 degrees local, dipping 36 degrees southeast.
  - Average strike of 36 degrees from true north, dipping 36 degrees southeast
- Cluster 2: Three concentrations
  - Typical strike ranges from 100 to 150 degrees local, dipping 30 to 75 degrees to the southwest to south-southwest.
  - Average strike of 121 degrees local, dipping 58 degrees southeast.
  - Average strike of 103 degrees from true north, dipping 58 degrees south.

4.4.2 Vein Orientation

From **Figure 13**, vein orientations are highly variable, and outside of the main cluster, show a fairly uniform distribution across the stereonet. One dominant concentration (Cluster 1) is apparent, and while a second concentration (Cluster 2) is plotted, on closer inspection, Cluster 2 is interpreted as being the over-vertical continuation of Cluster 1.

The main vein orientation is described as follows.

- Cluster 1
  - Typical strike ranges from 140 to 190 degrees local, dipping 50 degrees west to 70 degrees east.
  - Average strike of 166 degrees local, dipping 66 degrees west.
  - Average strike of 148 degrees local, dipping 66 degrees southwest.

4.4.3 Nature of Fractures

From review of drill core, it is apparent that the nature of the fractures and veins vary widely. For the most part veins and fractures appear moderately welded and tight. Some veins however show varying degrees of clayey alteration and/or the presence of minor dissolution cavities or vugs, and some fractures display weathering or precipitation deposits suggesting movement of groundwater.

4.5 HYDROGEOLOGY

The Mine Site is situated in the eastern extent of the Macquarie-Bogan surface water catchment. Regional hydrogeology is dominated by three main aquifer groups: alluvial deposits of Quaternary age typically associated with the major drainages, the underlying basement lithologies of the Lachlan Fold Belt, and, overlying the Lachlan Fold Belt to the east, the sedimentary rocks of the Sydney Basin.

Throughout the Macquarie-Bogan catchment, the dominant surface drainage direction is to the northwest toward the Darling River, and this will also be the case for shallow groundwater within the regolith profile. More locally shallow groundwater flow will mimic topography, initially to the south toward Hawkins and Lawsons Creeks and then in a northwesterly direction immediately north of Lue.

Deeper groundwater flow within the Ordovician basement is likely to be more structurally controlled with the dominant structures trending in a north-northwesterly direction, locally inducing groundwater flow to the south.

To the east of the Mine Site, regional groundwater flow within the overlying Sydney Basin sediments are more likely to be bedding controlled with downward infiltration inhibited by lower permeability strata. Regional groundwater flow will therefore be dominated by down-dip flow to the northeast, consistent with regional bedding dip on the western flank of the Sydney Basin. Localised flow towards the southwest and seepage faces at outcrop from the Sydney Basin sediments is also likely.

4.5.1 Aquifer Types

Within the study area, five key aquifer types have potential to exist or have been identified in the vicinity of the Mine Site, these being:

- Alluvial / Colluvial Aquifers – Unconsolidated sedimentary / detrital aquifers
- Porous Rock Aquifers – Consolidated sedimentary / detrital rock with connected primary porosity
- Fractured Rock Aquifers – Consolidated rock with secondary fracture controlled permeability
- Shear / Fault Controlled Aquifer – Typically linear/planar fractured aquifer of defined width and extent
- Regolith Transition Zone Aquifers – In situ weathered rock with permeability enhanced by chemical weathering processes

Within each of these aquifer types, there are potentially very broad variations in hydraulic properties.

Alluvial aquifers are poorly developed in the vicinity of the proposed open cut pit, however more substantial alluvial deposits are associated with Hawkins and Lawsons Creeks and have the potential to be within the area of groundwater drawdown resulting from the development of the open cut pit. Groundwater occurs in all of the hard rock formations encountered beneath the Mine Site, these being the Rylstone Volcanics, the overlying Sydney Basin sedimentary rocks, and the underlying Ordovician basement lithologies.

4.5.2 Main Hydrostratigraphic units

The regional lithologies and stratigraphic units encountered at, or in the vicinity of the Mine Site (refer Section 4.3 and **Table 6**) each have various aquifer potential and may include one or a number of the potential aquifer types identified in Section 4.5.1. For the purposes of groundwater investigations, it is useful to re-assign these conventional geological lithological or stratigraphic units into hydrostratigraphic units based on similar or grouped hydraulic properties.

From a regional context, there are four main hydrostratigraphic units in the Mine Site which can be further divided in sub-units. The key hydrostratigraphic units and sub-units (including water source of the relevant water sharing plan) that have been adopted for this groundwater assessment are as follows.

1. Alluvium (Lawsons Creek Water Source)
2. Sydney Basin sediments (Sydney Basin Groundwater Source)
   a) Narrabeen Group
   b) Illawarra Coal Measures
   c) Shoalhaven Group
3. Rylstone Volcanics (Lachlan Fold Belt Groundwater Source)
   a) Rhyolite Breccia
   b) Welded Tuff / Ignimbrite
   c) Crystal Tuff
4. Lachlan Fold Belt / Coomber Formation (Lachlan Fold Belt Groundwater Source)

4.5.3 Existing Groundwater Users

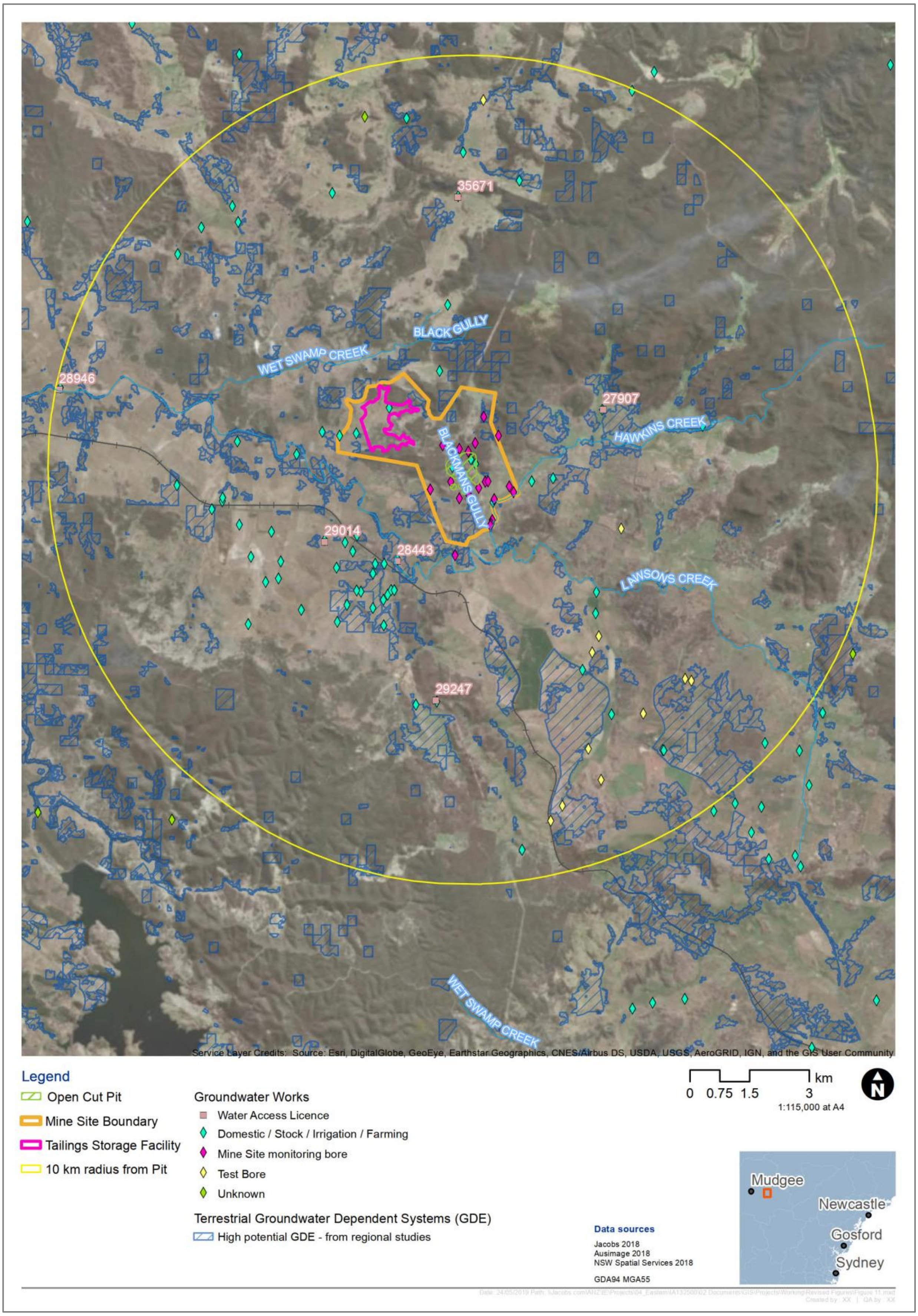
A search of the WaterNSW database has been undertaken within a notional 10km radius of the proposed pit. Bore construction, geology and drilling information was sourced from database and surface geology maps to identify potential aquifers, bore depths and approximate aquifer yields. The locations of groundwater works are presented on **Figure 14**.

Approximately 106 groundwater bores are registered within the 10km search radius, with 24 of those being monitoring bores currently utilised by Bowdens Silver. The majority of private bores are used for stock, domestic and irrigation purposes.

The closest town, Lue, has approximately 23 private bores (within a 2km radius from the centre of town) that are used for stock, domestic and irrigation purposes. These bores extract groundwater from Lachlan Fold Belt lithologies such as the Coomber Formation, Tannabutta Group (Dungeree Volcanics) and Adaminaby Group as well as alluvium at depths ranging from 3.65 to 60m and yields ranging from 0.05 to 7.00 L/s.

A summary of existing groundwater works is provided in **Annexure 2**.

Figure 14 Registered Groundwater Bores and Groundwater Dependent Ecosystems



4.5.4 Water Access Licences

Of the 106 bores within a 10km radius, 6 bores are associated with WALs. Authorised extraction limits range from 6 to 60ML/year. Yields from the associated groundwater work range from 0.06 to 5.00L/sec. Two of these WALs are located within Lue.

Details of the WALs are summarised in **Table 7**. The locations of the groundwater works associated with the WALs are also provided in **Figure 14**. A summary of WALs within 20km of the Project, for consideration in the groundwater modelling, is provided in **Annexure 3**.

Table 7
Summary of Groundwater WALs within a 10km radius of the Mine Site

WAL	Associated Groundwater Work	Use	Water Source	Extraction Limit (ML)
27907	GW011493	Stock, Irrigation, Domestic	Sydney Basin Murray Darling Basin Porous Rock Groundwater Source	50
35671	GW065121	Irrigation	Sydney Basin Murray Darling Basin Porous Rock Groundwater Source	60
28443	GW802732	Irrigation	Lachlan Fold Belt Murray Darling Basin Fractured Rock Groundwater Source	19
28946	GW042966	Stock, Irrigation, Domestic	Lachlan Fold Belt Murray Darling Basin Fractured Rock Groundwater Source	35
29014	GW066291	Stock, Irrigation, Domestic	Lachlan Fold Belt Murray Darling Basin Fractured Rock Groundwater Source	6
29247	GW062111	Industrial	Lachlan Fold Belt Murray Darling Basin Fractured Rock Groundwater Source	30

4.5.5 Groundwater Dependent Ecosystems

4.5.5.1 Bureau of Meteorology

A review of the Bureau of Meteorology (BoM) Groundwater Dependent Ecosystem Atlas (GDE Atlas) (http://www.bom.gov.au/water/groundwater/gde/map.shtml) indicates no previously identified GDEs in the vicinity of the Mine Site. The Atlas does however indicate rivers, springs, or wetlands with moderate to high potential for groundwater interaction, as well as vegetation with moderate to high potential for groundwater interaction are present within the Mine Site. The locations of high potential GDEs are presented on **Figure 14**.

4.5.5.2 High Priority Groundwater Dependent Ecosystems

High priority GDEs are identified in the Water Sharing Plan for the water source in which they are situated. The included high priority GDEs in the Water Sharing Plans relevant to the Project are summarised as follows.

Macquarie Bogan Unregulated and Alluvial Water Sources 2012

No high priority GDEs are identified in the Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources.

NSW Murray Darling Basin Fractured Rock Groundwater Sources Order 2020

The *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Ground Water Sources Order 2020*, Schedule 2, identifies 94 individual springs and wetlands and 57 karst environments as being high priority GDEs.

The closest high priority spring to the Project is Bailey Spring, located approximately 35km to the north-northwest of the Mine Site.

High priority karst environments are located at Apple Tree Flat and Cudgegong, approximately 14km west to 20km south of the Mine Site.

NSW Murray Darling Basin Porous Rock Groundwater Sources Order 2020

The *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Ground Water Sources Order 2020*, Schedule 2, identifies 13 individual springs and wetlands and one karst environment as being high priority GDEs.

The closest high priority springs to the Mine Site is Kellys Springs, located approximately 60km to the north of the Mine Site.

The only high priority karst environment is located at Ilford, approximately 36km south of the Mine Site.

4.5.5.3 Other Potential GDEs

The former DPI Water (DPI Water, 2016) defined ecosystems that depend on groundwater as those ecosystems that require access to groundwater to meet all or some of their water requirements so as to maintain their communities of plants and animals, and ecological processes.

Within the Mine Site, a number of potential GDEs have been identified including springs and seeps, terrestrial vegetation, and river baseflow systems.

River Baseflow Systems

As identified in the GDE Atlas, there is a high potential for GDEs to be associated with the drainages in the vicinity of the Mine Site. In particular, Wet Swamp Creek and Black Gully, Blackmans Creek, Hawkins and Lawsons Creeks are identified on the GDE Atlas in the vicinity of the Project. The locations of these drainages are shown on **Figure 8**.

Riverine baseflow systems include ecosystems that are dependent on groundwater derived baseflow in streams and rivers (Dresel et al., 2010). Baseflow is that part of stream flow derived from groundwater discharge and bank storage. Baseflow is considered likely to contribute year round to flows in Hawkins and Lawsons Creeks.

Ecosystems that exist in baseflow dependent streams can themselves be groundwater dependent and differentiating between groundwater dependent terrestrial vegetation, wetlands, and base flow systems can be difficult, as the different communities can represent a spectrum of habitat and groundwater dependency (Dresel et al., 2010). Groundwater levels can be important in maintaining flows or pools that sustain ecosystems, particularly during times of drought.

Springs and Seeps

In addition to those drainages identified in the GDE Atlas, a number of ephemeral seeps and partial wetlands are also present, particularly in the upper reaches of the minor drainages. These ephemeral swamps and seeps are often developed as farm dams for stock water supply. Typical vegetation comprises grasses and sedges.

For the most part, these seeps are inferred to be the ephemeral expression of a saturated soil profile and result from sub-surface flows (or inter-flow) through the soil profile expressing at surface either due to a break in slope or a barrier to flow such as sub-cropping bedrock. This inference is supported by water level observations near KCN Spring at monitoring bores BGW29 and BGW38 (**Figure 27**) that show deep groundwater levels to be substantially below shallow groundwater levels associated with this spring (Section 4.5.13.1).

As discussed in Section 4.5.14, from the springs that have been included in the water quality sampling, there does not appear to be a close correlation in water quality with regional groundwater. As such, the majority of these areas are inferred to be reliant on rainfall recharge and sub-flow, rather than regional groundwater.

At least one spring, Battery Creek Spring that is located adjacent to the northwest boundary of the Mine Site is inferred to be sourced from groundwater. Monitoring bore BGW16 located adjacent, and slightly up gradient, from the spring has also been observed to display intermittent artesian conditions. BGW16 is installed in the Rylstone Volcanics down gradient of the contact with the overlying Shoalhaven Group.

Terrestrial Vegetation

Terrestrial vegetation GDEs include vegetation which has seasonal or episodic dependence on groundwater.

An aquatic ecology assessment (Cardno, 2020) undertaken for the Project has noted the presence of occasional eucalypts (River Red Gums) associated with Hawkins and Lawsons Creeks. Eucalypts are not necessarily obligate phreatophytes, but typically root below the water table and benefit from frequent replenishment of soil moisture. Studies have noted that River Red Gums may rely on groundwater to maintain ecosystem function between river flow or flooding events. In drainages such Hawkins and Lawsons Creeks it is likely that the Red Gums would be dependent on groundwater only during times of drought and no-flow.

Cardno (2020) also note the presence of two ecological communities that are listed as endangered under the *Biodiversity Conservation Act 2016*. These being, Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions and Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions. These ecological communities are known to occur in, or directly adjacent to, the study area (Cardno, 2020) and may be reliant on groundwater and would therefore be considered to be potential GDEs.

In the Terrestrial Ecology Assessment, EnviroKey (2020) suggest that none of the terrestrial vegetation present within the study area are likely to be wholly groundwater dependent (obligate phreatophytes).

Stygofauna

The aquatic ecology assessment for the Project (Cardno, 2020) has also identified a number of stygofauna assemblages in the vicinity of the Mine Site.

Only one stygofauna taxa (*Psammaspides sp*.) was identified from the 6 groundwater bores located either within, or in relatively close proximity to, the proposed open cut pit. All remaining stygofauna were sampled from groundwater bores located either some distance to the west of the proposed open cut pit (BGW16 and 17), or from those associated with Hawkins and Lawsons creeks (BGW39, 48, 50 and 51).

All stygofauna taxa identified are typical of alluvial aquifers in eastern Australia and are not endemic to the area.

4.5.6 Groundwater Occurrence on Site

Extensive mineral exploration drilling, utilising Reverse Circulation (RC) and Diamond Core drilling, has been undertaken on the Mine Site. Both of these drilling methods provide an opportunity to identify areas of potentially elevated permeability and groundwater occurrence; RC drilling through the production of water during drilling, and Diamond Core drilling through loss of drilling fluids to the formation. Groundwater intercepts have not been consistently documented in historical drilling campaigns, however, the available data and accumulated knowledge is beneficial.

Figure 15 presents a map of recorded water strikes from RC drilling showing the depth of the first water strike. Yield information is not available, however, a number of drill holes are noted as having been abandoned due to groundwater.

Seventy percent of the water strikes occur shallower than 60 metres below ground level (mbgl), and no significant correlation is apparent between the depth of water strike and the drill collar elevation.

While the water strike map suggests a concentration of water strikes in the southeastern open cut pit area, anecdotal evidence suggests that the wettest part of the ore body is in the northern open cut pit area and to the west of the structure that runs along Maloneys Road.

4.5.7 Groundwater Monitoring Bore Drilling

During the drilling undertaken during 2013 for the installation of the groundwater monitoring network (SKM, 2013), airlift yields were recorded during drilling and again during bore development where a monitoring bore was established. Results are summarised in **Table 8** with locations shown in **Figure 16**.

Figure 15 Exploration Drilling Water Strikes

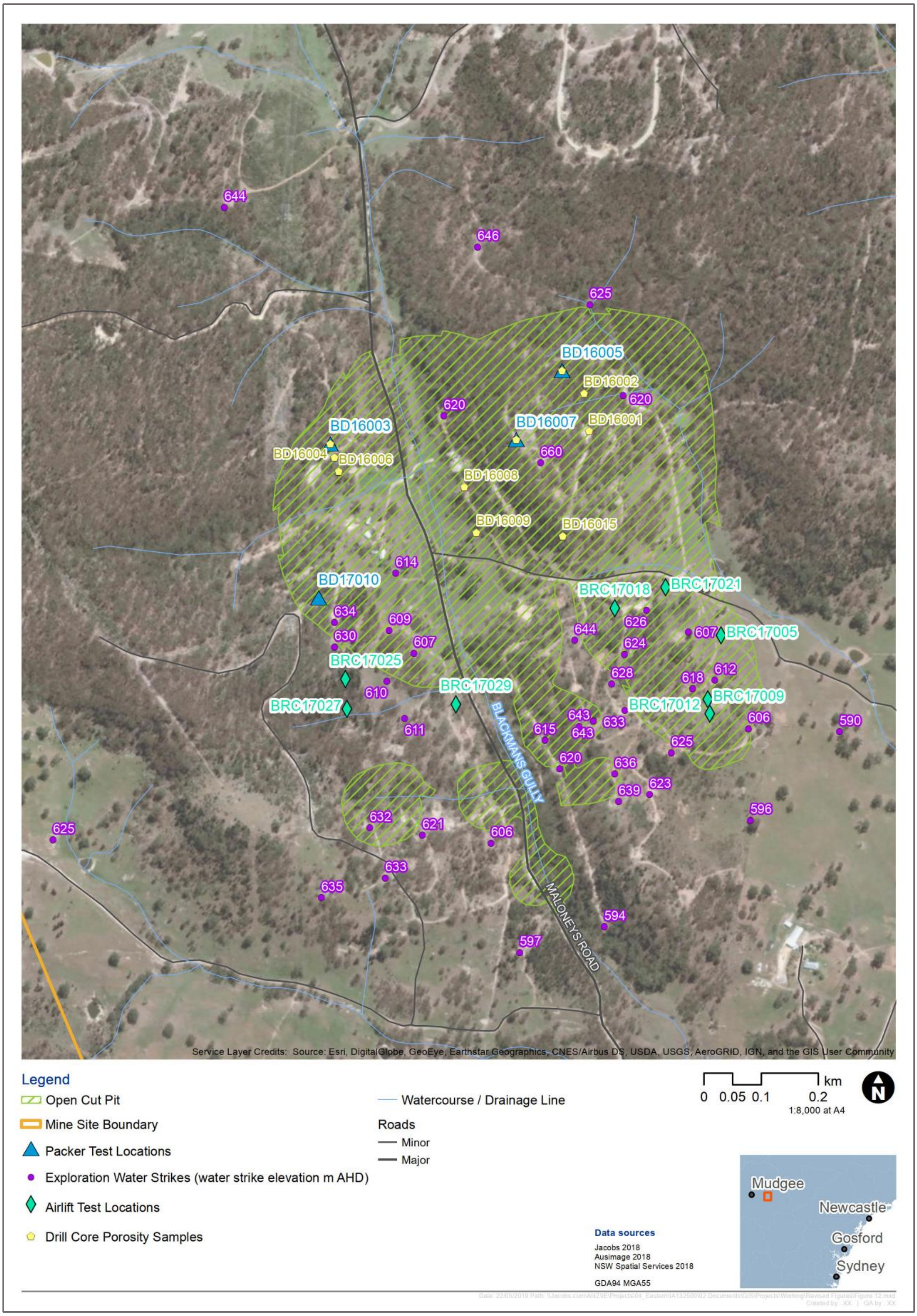
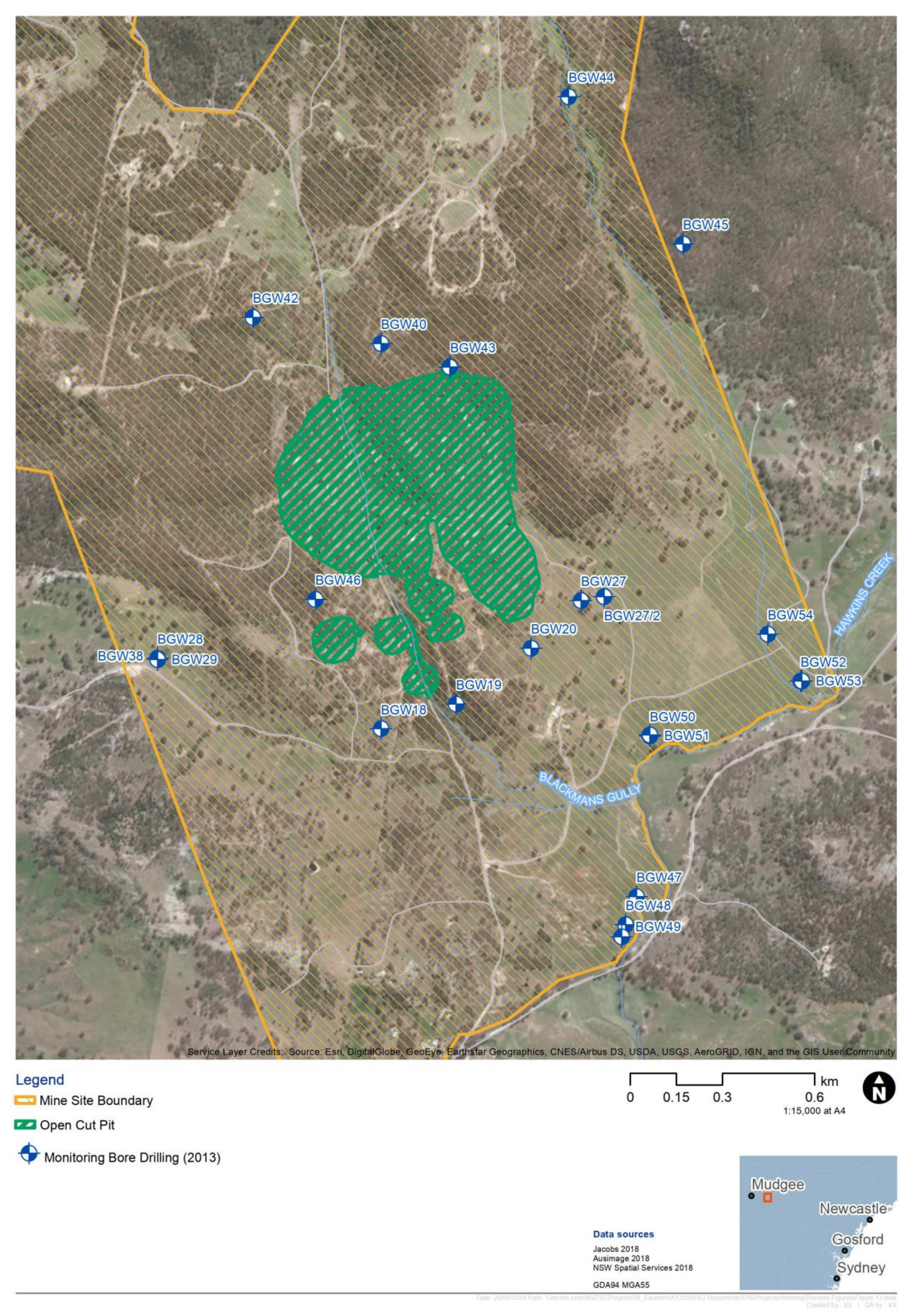


Table 8
Monitoring Network Drilling Summary

Bore ID	Drilled Depth (mbgl)	Screened Interval (mbgl)	Screened Formation	Airlift Yield (L/s)		Comment
				Drilling	Development	
BGW18	100	45-48	Crystal Tuff	<0.1	0.06	
BGW19	120	90-96	Coomber Formation	<1	0.3	
BGW20	96	42-48	Coomber Formation	<1	0.3	
BGW27	90	58-70	Coomber Formation	2	1.8	Water strike at 30m increasing at 57m in Ordovician Basement
BGW27/2	48	30-36	Coomber Formation	<1	-	
BGW28	6	0-6	Alluvium	-	-	Water strike 2-3m, no airlift
BGW29	6.5	1.5-6.5	Volcanic Breccia	Dry[1]	-	Bore not developed
BGW38	100	88-94	Volcanic Breccia	Dry[1]	-	Bore not developed
BGW39	48	30-42	Coomber Formation	<1	1.5	Water strike at 36m in Ordovician Basement
BGW40	145	127-139	Volcanic Breccia	<1	0.3	
BGW41	198	186-192	Crystal Tuff	<1	0.2	
BGW42	120	36-42, 108-114	Crystal Tuff	<1	0.6	Water after 36m top of Rylstone Volcanics
BGW43	120	92-98	Crystal Tuff	<1	0.2	
BGW44	84	73-79	Volcanic Breccia	2	2	Water struck at 76-78m in Rylstone Volcanics
BGW45	78	66-72	Crystal Tuff	<0.1	no flow	
BGW46	180	168-174	Coomber Formation	<0.1	no flow	
BGW47	48	36-42	Rylstone Volcanics	<0.1	no flow	
BGW48	6	1-6	Alluvium	<0.1	0.2	Alluvium
BGW49	5	1.5-3.5	Alluvium	<0.1	0.5	Alluvium
BGW50	28	21-27	Coomber Formation	3	3	Water strike at 25m in Ordovician Basement
BGW51	12	3-9	Alluvium	<1	0.3	Alluvium
BGW52	30	17-23	Coomber Formation	<1	0.6	Water strike at 18m in Ordovician Basement
BGW53	12	3-9	Alluvium	<1	0.6	Alluvium
BGW54	8	2.5-6.5	Alluvium	<1	0.5	Alluvium

Note [1] - BGW29 and BGW38, no significant water during drilling but subsequently used for monitoring – refer **Figure 24**.

Figure 16 Monitoring Bore Drilling and Installation



The majority of holes returned yields of less than 0.1L/s during drilling, although some of these holes returned modest yields following completion, illustrating the RC drilling method's tendency to limit water ingress to the hole during drilling. On completion, only 4 out of the 24 holes returned airlift yields in excess of 1L/s, these being BGW27, BGW39, BGW44, and BGW50. Three of these holes returned yields from the Ordovician Basement with one hole (BGW44) striking water in the Rylstone Volcanics. The yields were all from generally shallow depths, ranging from 18 to 78mbgl.

From assessment of the monitoring bore locations against geological sections, it has been determined that none of the monitoring bores intercepted any of the major structures on site.

4.5.8 Previous Hydraulic Testing

Following completion of drilling and construction, the monitoring bores were subject to permeability testing (SKM, 2013). Data derived from these tests have been re-assessed for the current assessment and the derived representative hydraulic conductivity values are provided on **Table 9**.

Table 9
Monitoring Bore Hydraulic Testing Summary

Bore ID	Screened Depth (mbgl)	Screened Formation	Representative Hydraulic Conductivity (m/day)
BGW48	1-6	Alluvium	9.2
BGW51	3-9	Alluvium	1.15
BGW53	3-9	Alluvium	6.4
BGW54	2.5-6.5	Alluvium	7.2
BGW42	36-42	Crystal Tuff	0.09
BGW42 Pump test	36-42	Crystal Tuff	0.05
BGW47	36-42	Rylstone Volcanics (un diff.)	0.01
BGW18	45-48	Crystal Tuff	1.07
BGW19	90-96	Coomber Formation	0.27
BGW19 Pump test	90-96	Coomber Formation	0.001
BGW20	42-48	Coomber Formation	0.22
BGW27	58-70	Coomber Formation	3.3
BGW27 Pump test	58-70	Coomber Formation	0.15
BGW27A	30-36	Coomber Formation	6.5
BGW39	30-42	Coomber Formation	0.45
BGW46	168-174	Coomber Formation	0.0014
BGW50	21-27	Coomber Formation	1.14
BGW50 Pump test	21-27	Coomber Formation	0.55
BGW52	17-23	Coomber Formation	1.04

A number of these bores were also subject to short term (2 to 4 hour) pumping tests (SKM, 2013). This data has also been reviewed and the derived representative hydraulic conductivity values are also provided on **Table 9**.

From **Table 9**, it is apparent that the majority of tests have been undertaken on bores screened within the Ordovician basement, or Coomber Formation. Test results are summarised as follows.

- Hydraulic conductivity values derived from four bores installed in the Alluvium range from 1.1 to 9.2m/day.
- Hydraulic conductivity values derived from four bores installed in the Rylstone Volcanics range from 0.01 to 1.07m/day.
- Hydraulic conductivity values derived from eight bores installed in the Coomber Formation range from 0.001 to 6.5m/day.

Within the Coomber Formation, there is a significant variation in permeability determinations, and this variation displays a reasonable correlation with depth as shown on **Figure 19**. Results from the Rylstone Volcanics (including the result for the Crystal Tuff) also show significant variation but are derived from similar depths.

4.5.9 Pumping Tests

Pumping tests of 72 hours duration were undertaken on BGW10 and BGW108 during November and December 2014 (Jacobs, 2014). Data for these tests has been reviewed and re-assessed as part of the current Project.

BGW10 is located approximately 500m to the southeast of the open cut pit area and is the water supply bore for the Bowdens homestead. Lithological information is not available, however, ignimbrite is mapped at surface and the bore is close to the mapped Coomber Formation. The position of the bore also coincides with a number of mapped lineaments. BGW10 is recorded as being 100m deep and screened from 90 to 100mbgl. It is assumed that at this depth the bore would be within the Coomber Formation.

BGW108 is located within the open cut pit area and is screened from 24 to 96mbgl and is installed within the ignimbrite unit.

Locations of the pumping bores and associated monitoring bores are shown on **Figure 17**. Drawdown and recovery plots for the tests at BGW10 and BGW108 are provided in **Annexure 4**.

BGW10

BGW10 was pumped at a rate of 467kL/day (5.4L/s) for a period of 72 hours. Drawdown was monitored at the pumping well and at three observation bores, WAP16, BGW50, and BGW51 (**Figure 16**).

Analytical results of the pumping test are summarised on **Table 10**. Results derived from the pumping well (BGW10) and the adjacent observation well, WAP16 located at a distance of 22m, indicate a good hydraulic connection between the two bores.

Figure 17 BGW10 and BGW108 Pumping Test Locations

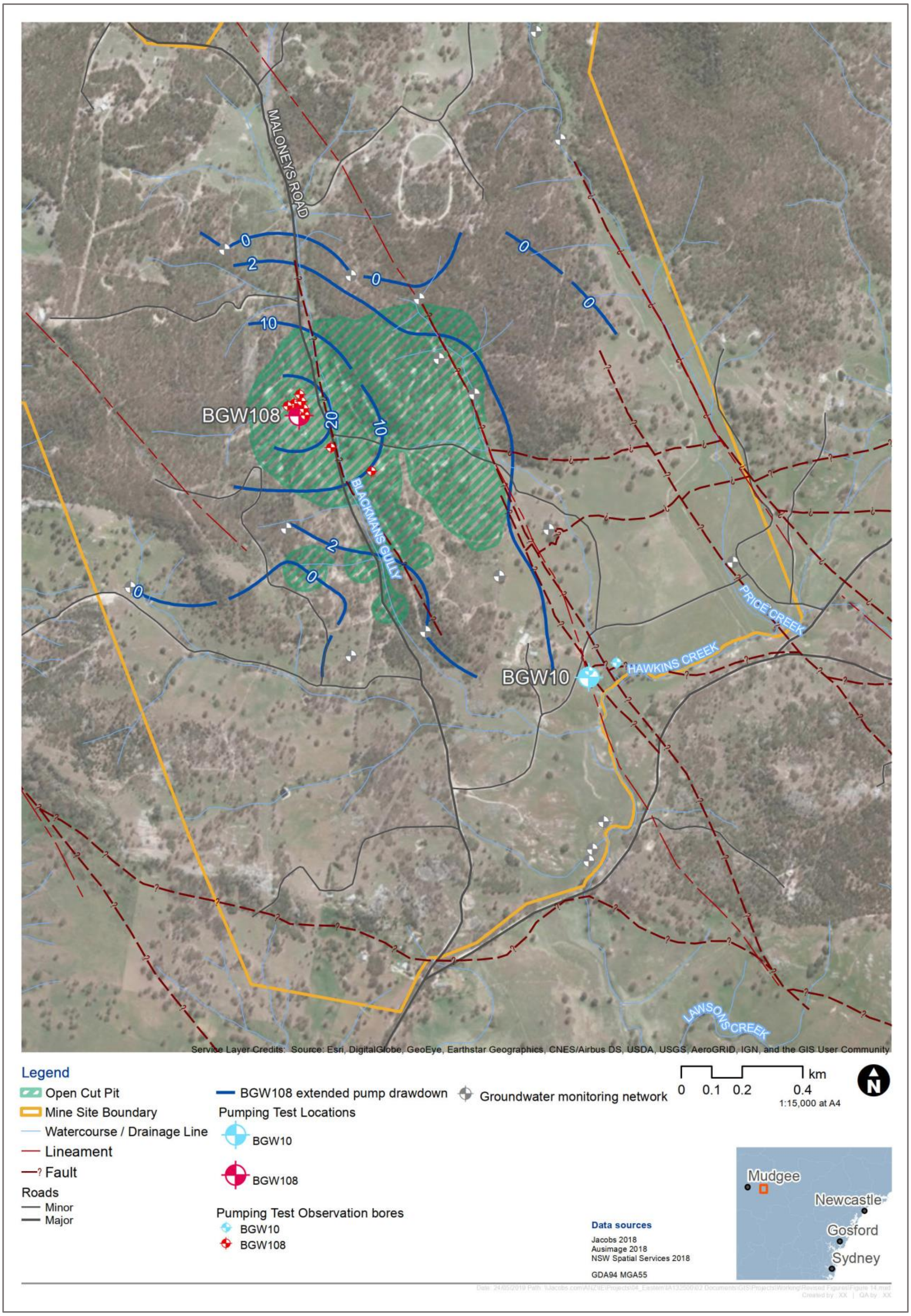


Table 10
BGW10 Pumping Test – Summary of Results

	Distance	**Transmissivity**	**Hydraulic Conductivity**	**Storativity**	**Specific Storage**
ID	**m**	**m^2/day**	**m/day**	**-**	**m^{-1}**
Early Time (<30 min)					
BGW10	-	81.5	1.07	-	-
WAP16	20.5	81.5	1.07	8.04x10-05	1.06x10^{-06}
Mid Time (0.5-1 day)					
BGW10	-	13.2	0.17	-	-
WAP16	20.5	13.2	0.17	9.79x10-4	1.29x10-5
Late Time (2-3days)					
BGW10	-	6.3	0.08	-	-
WAP16	20.5	6.3	0.08	6.06x10-3	7.98x10-5
BGW50	102.8	111.0	1.46	1.64x10-2	2.16x10-4
BGW51	103	276.0	3.63	4.39x10-2	5.78x10-4
Recovery					
BGW10	-	10.9	0.14	-	-

Derived transmissivity estimates assume a saturated formation thickness of 76m, however, it is noted that the screened interval of the bore is only 10m. Partial penetration of an aquifer induces vertical flow components in the vicinity of the well, and the general assumption that the well receives water from horizontal flow is not valid. Partial penetration can cause the flow velocity in the immediate vicinity of the well to be higher than it would be otherwise, leading to an extra loss of head. It is noted however, that the effects of this are not readily apparent in the data.

Initial transmissivity estimates of the order of 80m^2/day decline to 13m^2/day mid test, and by the end of testing have dropped off to 6m^2/day. The results are indicative of a moderate yielding aquifer of limited extent.

The elevated transmissivity values derived from observation wells BGW50 and BGW51 (as well as limited drawdown response) located at a distance of approximately 103m, suggest poor hydraulic connection with the pumping well, indicating that the fracture network intercepted by the pumping well is not highly connected to a regional fracture network. It is noted that BGW50 and BGW51 are isolated from the pumping well by the main sub north-south lineament that runs along the eastern margin of the Bowdens silver deposit.

Indicative values of aquifer storage derived from observation bore WAP16 are initially consistent with a confined aquifer, transitioning to more partially confined leaky conditions by end of test. Derived aquifer storage values at late time range from 6.1x10^{-3} to 4.4x10^{-2}, with an average value of 2.2x10^{-2}.

Given the poor hydraulic connection, values derived from BGW50 and BGW51 observations are not considered to be representative.

Jacobs (2014) indicated that the estimated aquifer parameters at BGW10 suggest a fracture network within the target aquifer with transmissivity values of up to 15m^2/day. The bulk rock matrix permeability was estimated to be much lower, with transmissivity values as low as 6x10^{-2}m^2/day, indicating that the dominant supply of groundwater to BGW10 was transferred through the fracture networks at this test site. While this assessment is generally agreed with, it is noted that the bulk of the groundwater storage will be within the bulk rock matrix and will be released more slowly.

Flow characteristic, or diagnostic, plots of the BGW10 pumping test indicate a dominance of bi-linear (double porosity) flow and suggest the presence of parallel no-flow boundaries.

BGW108

BGW108 was pumped at a rate of 432kL/day (5.0L/s) for a period of 72 hours. Drawdown was monitored at the pumping well and at eight observation bores as indicated on **Table 11** and **Figure 16**.

Table 11
BGW108 Pumping Test – Summary of Results

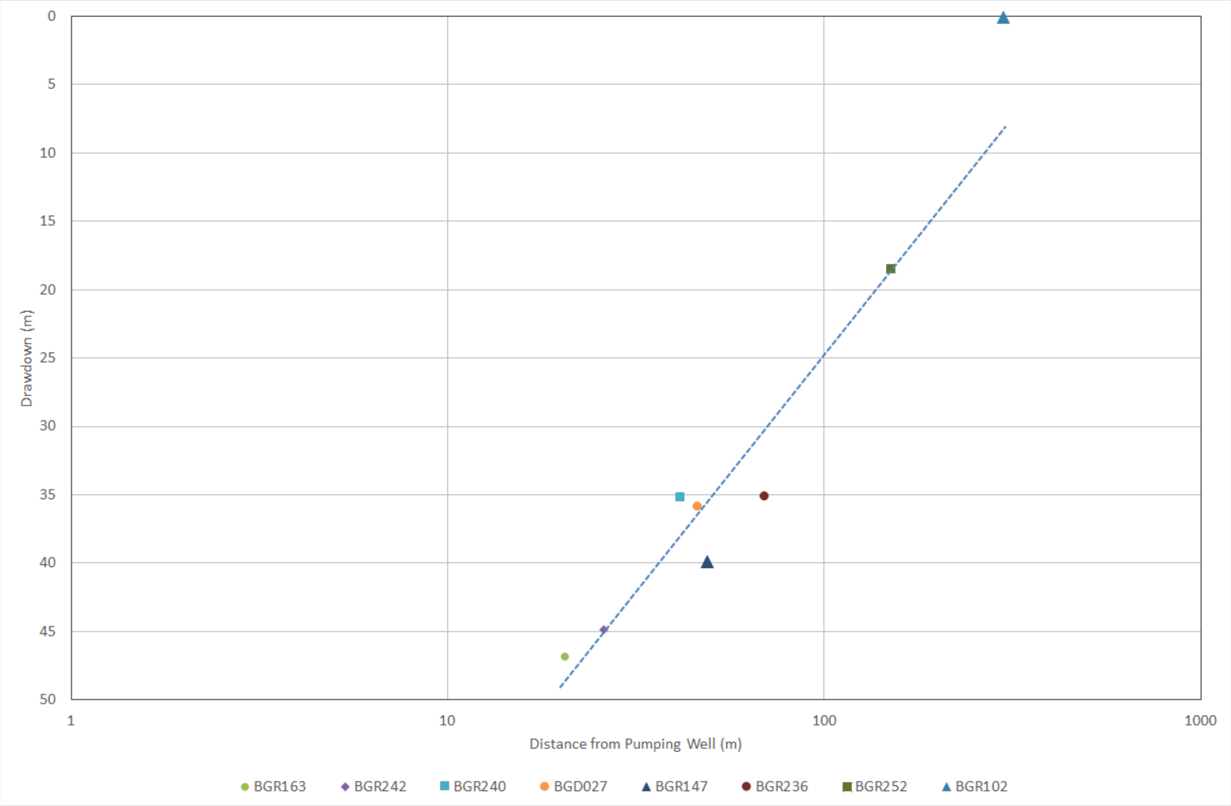
	Distance	**Transmissivity**	**Hydraulic Conductivity**	**Storativity**	**Specific Storage**
ID	**m**	**m^2/day**	**m/d**	**-**	**m^{-1}**
Early Time (<100 min)					
BGW108	-	45.2	0.63	-	-
BGR163	20.5	45.2	0.63	4.20x10-4	5.83x10-6
BGD027	46.3	79.1	1.10	4.03x10-4	5.60x10-6
Late Time (2-3 days)					
BGW108	-	2.1	0.03	-	-
BGR163	20.5	2.1	0.03	5.24x10-3	7.28x10-5
BGR242	26	2.4	0.03	2.76x10-3	3.83x10-5
BGR240	41.6	3.9	0.05	1.46x10-3	2.03x10-5
BGD027	46.3	2.3	0.03	1.70x10-3	2.35x10-5
BGR147	48.8	3.0	0.04	1.06x10-3	1.47x10-5
BGR236	69.5	2.8	0.04	6.55x10-4	9.10x10-6
BGR252	150.5	3.3	0.05	1.18x10-4	1.64x10-6
BGR102	300	-	-	--	-
Recovery					
BGW108	-	6.5	0.09	-	-
Distance Drawdown					
End of test	-	4.8	0.06	1.03x10-4	1.07x10-6

Analytical results of the pumping test are summarised on **Table 11**. Results derived from the pumping well (BGW108) and the adjacent observation well, BGR163 at a distance of 20m, indicate a good hydraulic connection between the two bores.

All derived transmissivity values at late time are very consistent, ranging from 2.14 to 3.95m^2/day, indicating a good hydraulic connection between the majority of the observation wells, and indicating consistent hydraulic connection between the ignimbrite, breccia, and crystal tuff.

An assessment of distance drawdown has also been undertaken for the end of the pumping test and is presented on **Figure 18**. The distance drawdown analysis indicates an aquifer transmissivity of the order of 4.8m^2/day (K = 0.06m/day). One observation well, BGR102, did not display significant drawdown and is a distinct outlier on the distance drawdown plot, with approximately 10m less drawdown than would be anticipated. It is noted that all bores, with the exception of BGR102, are located within the same fault block, while BGR102 is isolated from the pumping well by a major north-south trending fault.

Figure 18 BGW108 Pumping Test - Distance Drawdown Plot



Derived values for aquifer storage at late time range from 1.2x10^{-4} to 5.2x10^{-3}, with an average value of 1.8x10^{-3}.

BGW108 displays a similar increase in rate of drawdown as pumping progresses as seen at BGW10, however the transition is more abrupt. Flow characteristic or diagnostic plots of the BGW108 pumping test indicate a dominance of linear (fracture) flow and suggest the presence of a closed boundary at late time.

Summary

From the pumping test at BGW108, it is indicated that within the Bowdens silver deposit, fracture flow is the dominant groundwater flow mechanism, however on a broader scale and with consideration for the fracture orientations (Section 4.4.1) groundwater flow can be expected to behave in a pseudo-porous media flow fashion.

Both BGW10 and BGW108 pumping tests, highlight the presence of low permeability flow boundaries. These boundaries are inferred to be represented by the major regional structures (refer **Figure 11**) which act to retard, but not completely restrict, groundwater flow across these structures. Given that the highest groundwater yields (Section 4.5.7) have also been associated with these structures, it is possible that zones of enhanced fracturing exist bounding these structures and resulting in elevated permeability along strike (and potentially up and down dip) of these structures.

4.5.10 Extended Pumping

From review of the groundwater level hydrographs (**Figure 26**, Section 4.5.13) it is apparent that extended pumping occurred at BGW108 during the period December 2013 through to February 2014. Although this abstraction is not documented, the response to abstraction is apparent at a number of the monitoring bores. The groundwater level monitoring data has been reviewed to assess the response to pumping (drawdown) observed at individual monitoring locations over the duration of the abstraction. This response has been contoured and is plotted on **Figure 17**. It is noted that abstraction during this period is also likely to have occurred from BGW10 for stock and domestic purposes, and the pumping response will also be overprinted by climatic effects. The CRD curve (**Figure 26a**) shows the pumping to occur towards the end of an extended dry period, however hydrographs from monitoring bores outside the area of influence of BGW108 demonstrate that the climatic influence over the period is not significant.

The drawdown response to this extended period of pumping (**Figure 17**), highlighted by the interpreted 2m drawdown contour, suggests that groundwater flow is constrained by the two major north-south trending structures, with preferential drawdown within the fault block between the two structures. There is also a suggestion that drawdown is restricted northwards towards BGW40 and southwards towards BGW46.

4.5.11 Recent Investigations

Additional groundwater investigations have been recently undertaken in conjunction with ongoing resource definition drilling. The investigations included packer injection testing on four deep Diamond Core drill holes, and airlift recovery testing undertaken on a number of RC drill holes to investigate formation permeability around some of the major structures and at depth.

The recent investigation sites are presented on **Figure 15** and discussed in the following sections.

4.5.11.1 Airlift Testing

A programme of airlift recovery testing was undertaken on site from 5th to 10th June 2017. Airlift recovery testing was undertaken on eight (8) RC drill holes as shown on **Figure 15** and in **Table 12.** Test results are provided in **Annexure 5** with test holes and results summarised in **Table 13**.

Holes for airlift testing were selected based on proximity to major geological structures and specifically included a number of drill holes with noted groundwater intersections during drilling.

Table 12
Airlift Test Hole Details

Hole ID	Easting	Northing	Dip (deg)	Hole Depth (mbgl)	Primary Lithology	Water Intersections during Drilling
BRC17005	769323	6385453	65	102	Welded Tuff / Structure intercept	N/A
BRC17009	769300	6385341	65	180	Welded Tuff in vicinity of structure	N/A
BRC17012	769303	6385316	65	102	Crystal Tuff / Welded Tuff contact in vicinity of structure	Hole abandoned due to excess water
BRC17018	769137	6385500	65	180	Welded Tuff	Water strike at 60m
BRC17021	769226	6385537	65	72	Welded Tuff / Structure intercept	N/A
BRC17025	768666	6385376	65	102	Welded Tuff in vicinity of east dipping structure	Hole abandoned due to excess water. Water strike at 90m
BRC17027	768669	6385324	60	174	Welded Tuff in vicinity of east dipping structure	N/A
BRC17029	768859	6385332	60	150	Welded Tuff / Structure intercept	Water strike at 24m

Table 13
Airlift Testing Results

Hole ID	SWL (m vert)	Hole Depth (m down hole)	Airline Depth (m down hole)	Average Airlift Yield (L/s)	Airlift Duration (mins)	Transmissivity (m^2/day)	Hydraulic Conductivity (m/day)
BRC17005	6.5	102	94	0.49	52	0.26	$3.0x10^{-3}$
BRC17009	15.8	180	120	0.01	16	1.21	$3.0x10^{-5}$
BRC17012	23.3	102	96	3.32	122	42.0	0.61
BRC17018	34.6	180	120	0.13	37	0.04	$3.0x10^{-4}$
BRC17021	NA	72	54	0.40	12	NA	NA
BRC17025	26.2	102	94	1.96	121	3.89	$5.9x10^{-2}$
BRC17027	26.9	174	120	0.12	36	0.03	$2.0x10^{-4}$
BRC17029	9.1	150	136	0.82	122	3.52	$2.8x10^{-2}$

Airlifting was undertaken utilising the RC drill string as the airline. Airlift durations ranged from 30 minutes to 2 hours, with the duration of airlifting generally being proportional to the airlift yield. Airlift yields were measured throughout the duration of airlifting by a combination of V-notch weir and timed bucket. Field water quality parameters were also monitored during the airlifting. On completion of airlifting, the recovery in water level was monitored through the inner tube of the RC drill string. As the testing was undertaken on angled drill holes all water depth measurements were converted to vertical depths prior to analysis using the Theis recovery method.

The airlift testing returned a wide range of results. Airlift yield ranged from negligible (0.01L/s) at BRC17009 to 3.3L/s at BRC17012. BRC17009 and BRC17012 highlight the highly variable and anisotropic nature of the formations and fracturing. These two holes are drilled in similar orientations, approximately 25m apart, with BRC17009 drilled 78m deeper than BRC17012. BRC17009 and BRC17012 returned the lowest and highest airlift yields and corresponding hydraulic conductivities, respectively.

A summary of individual airlift tests is provided in **Table 13**. Plots of the airlift recovery tests are provided in **Annexure 5**.

4.5.11.2 Packer Testing

Packer testing was undertaken on four (4) deep diamond core drill holes, during April and May 2017. The test locations are shown in **Figure 15**. Packer testing flow plots are provided in **Annexure 6** with results presented below and summarised in **Table 14** and **Table 15**. The testing was undertaken once drilling of all four test holes had been completed.

The packer testing was generally undertaken using a single packer configuration on the completed drill hole. Several straddle packer tests were attempted; however, these resulted in a number of blown elements due to difficulty in locating a suitable unbroken borehole for seating both packer elements. Two successful straddle tests were completed with the results provided in **Table 15**.

For the single packer tests, the NQ drill string was run to the base of the drill hole and the drill hole was flushed by pumping clean water through the rods. The aim of flushing was to remove drilling fluids and sediment from the drill hole that could act to reduce the formation hydraulic conductivity and block fractures. It is noted that following approximately 30 minutes of flushing at each drill hole, only BD16005 returned flows at the surface and could be considered to have been successfully flushed, and the effects of blocked fractures were observed in a number of tests at other drill holes, however, this was taken into account when assessing representative values of hydraulic conductivity. Given the relatively low permeability results returned at depth, it is considered that the bulk of the lost circulation and lack of returns during flushing may have been through loss of water in the shallower unsaturated formation.

Core photos from each of the drill holes to be tested had first been assessed to identify suitable locations (depth) for packer placement that would maximise the potential for sealing of the drill hole and minimise potential for damage to the packer element. Testing comprised Lugeon injection testing which involves injecting water at a series of increasing pressure steps and recording the flow to the formation at each pressure. The pressure is stepped upwards for 3 to 5 pressure steps and then cycled back through the same sequence of pressures to assess for changes in the formation properties, either through blocking or through fracture dilation.

Testing for each drill hole proceeded in a cumulative fashion with the packer being placed at lithological boundaries or selected intervals as successive tests at increasing elevations (decreasing depth) were conducted on the way out of the drill hole. In testing this way each successive test zone incorporates the test zone of the preceding test. The tests provide a bulk hydraulic conductivity value for the entire formation from the packer to the base of the drill hole, but it is also possible to derive the incremental bulk hydraulic conductivity attributable to each successive test.

Table 14
Packer Testing Summary – Bulk Permeability

Depth From (m down hole)	Depth To (m down hole)	Dominant Formation	Derived Formation Hydraulic Conductivity (m/day)
BD16003			
85.2	109.2	Volcanic Breccia	N/A
109.2	139.2	Rylstone Volcanics (undifferentiated)	N/A
139.2	241.2	Welded Tuff / Ignimbrite	1.14×10^{-2}
241.2	278.2	Crystal Tuff	N/A
278.2	393.2	Coomber Formation	1.31×10^{-3}
393.2	456.7	Coomber Formation	8.02×10^{-4}
BD16005			
53.7	91.7	Rylstone Volcanics (undifferentiated)	2.29×10^{-5}
91.7	151.7	Volcanic Breccia	N/A
151.7	220.7	Welded Tuff / Ignimbrite	N/A
220.7	283.7	Welded Tuff / Ignimbrite	1.94×10^{-4}
283.7	316.7	Crystal Tuff	N/A
316.7	351.9	Coomber Formation	3.26×10^{-4}
BD16007			
88.2	154.2	Welded Tuff / Ignimbrite	1.49×10^{-2}
154.2	211.2	Welded Tuff / Ignimbrite	N/A
211.2	281.2	Crystal Tuff	1.15×10^{-2}
281.2	312.2	Crystal Tuff	N/A
312.2	342.8	Coomber Formation	7.52×10^{-4}
BD17010			
88.2	142.2	Volcanic Breccia plus Welded Tuff / Ignimbrite	6.03×10^{-5}
142.2	166.2	Welded Tuff / Ignimbrite	N/A
166.2	226.2	Crystal Tuff	1.53×10^{-5}
226.2	240.1	Coomber Formation	6.70×10^{-4}

Table 15
Packer Testing Summary – Discrete Permeability

Depth From (m down hole)	Depth To (m down hole)	Structure / Formation	Lugeon Value	Derived Hydraulic Conductivity (m/day)
BD16007				
213.7	218.7	Fracture Zone Crystal Tuff	0.2	2.7×10^{-3}
331.2	336.2	Fracture Zone Coomber Formation	15.4	0.19

4.5.11.3 Geotechnical Investigations

As part of the geotechnical investigations in the TSF embankment footprint, ATC Williams (2017) installed and tested three boreholes (TSF BH01 to TSF BH03) to depths ranging from 25m to 33m. Permeability testing included packer testing and falling head tests. Two piezometers were installed at the TSF BH02 locations (TSF BH02 and TSF-BH02-2, also known as BGW60 and BGW61). Reported permeabilities ranged from 0.6m/day in shallow regolith to 1.4×10^{-5}m/day in fresh bedrock.

4.5.11.4 Hydraulic Conductivity Summary

Hydraulic conductivity values derived from airlift testing are presented alongside the packer testing results and previous hydraulic testing results against depth in **Figure 19** and **Figure 20**. In **Figure 19** the packer testing and airlift testing derived hydraulic conductivity values are presented as the bulk hydraulic conductivity over the depth interval tested. In **Figure 20** the results are plotted at the average depth tested.

Figure 19 presents test results by test type. No bias due to test methodology is indicated, and the airlift testing results fall within previously measured hydraulic conductivity values. **Figure 20** presents the test results grouped according to dominant lithology, again no strong bias due to lithology is indicated, although as expected, alluvial results are fairly consistently elevated. It is noted that the very lowest permeability values are associated with the volcanic units and not the Coomber Formation, however, this may be due to the deeper packer testing locations within the Coomber Formation being targeted in the vicinity of the major north-south trending structures.

Tested drill holes that are known to intersect, or are inferred to intersect, one of the major north-south trending structures are also indicated. The results show that the presence of these structures does not always equate with increased permeability, although it is still considered that proximity to these structures will increase the chance of encountering increased fracturing and permeability.

4.5.11.5 Porosity

Estimates of formation porosity have been derived from the core samples that were used for determining specific gravity. The porosity estimate has been determined from the total sample volume and saturated water content (saturated weight less dry weight) of the core sample.

Porosity determinations have been made from 244 core samples from 10 drill holes. The results are presented on **Figure 21** and **Figure 22**, and are summarised on **Table 16**.

Table 16
Formation Porosity Determinations

Statistics	Coomber Formation	Volcanic Breccia	Crystal Tuff	Ignimbrite	Rylstone Volcanics (undifferentiated)	Shoalhaven Group
Total. Samples	24	53	48	51	20	6
Mean	0.5%	2.2%	1.3%	1.9%	1.8%	5.1%
Median	0.5%	2.1%	1.2%	1.4%	1.2%	3.9%

Figure 19 Hydraulic Conductivity vs Depth by Test Type

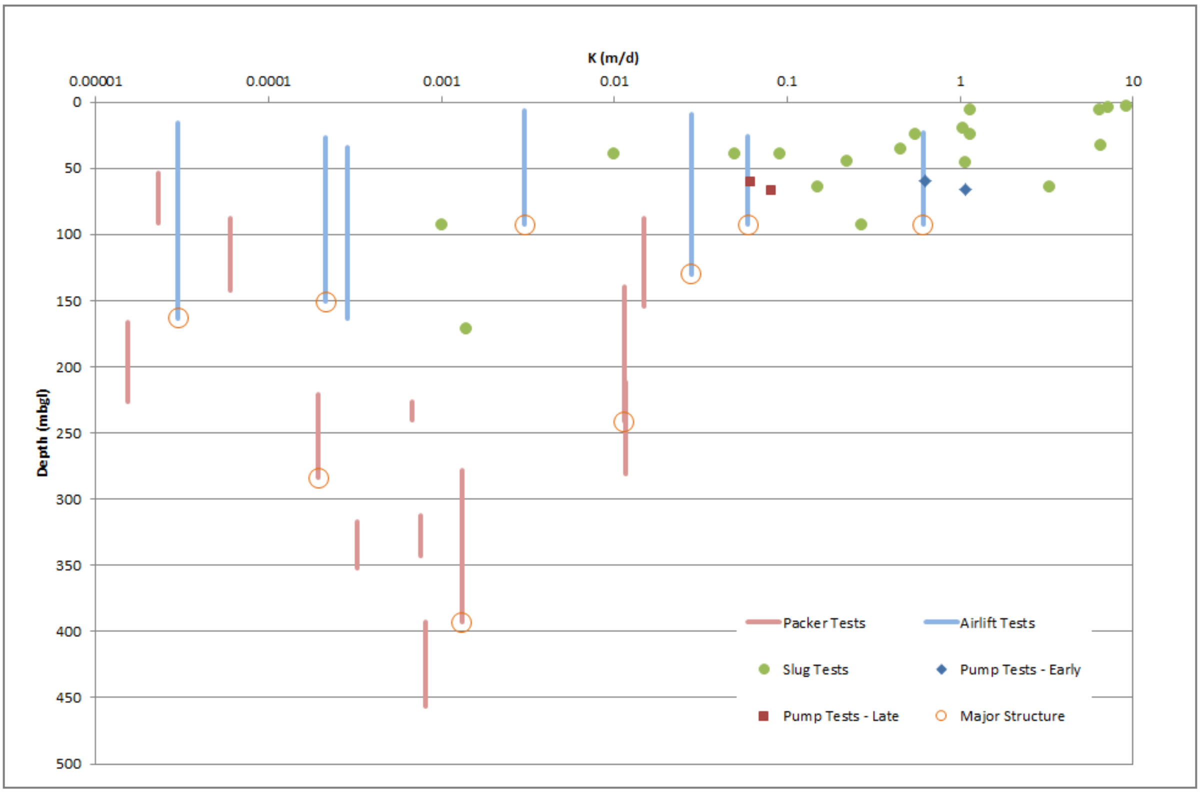


Figure 20 Hydraulic Conductivity vs Average Depth by Lithology

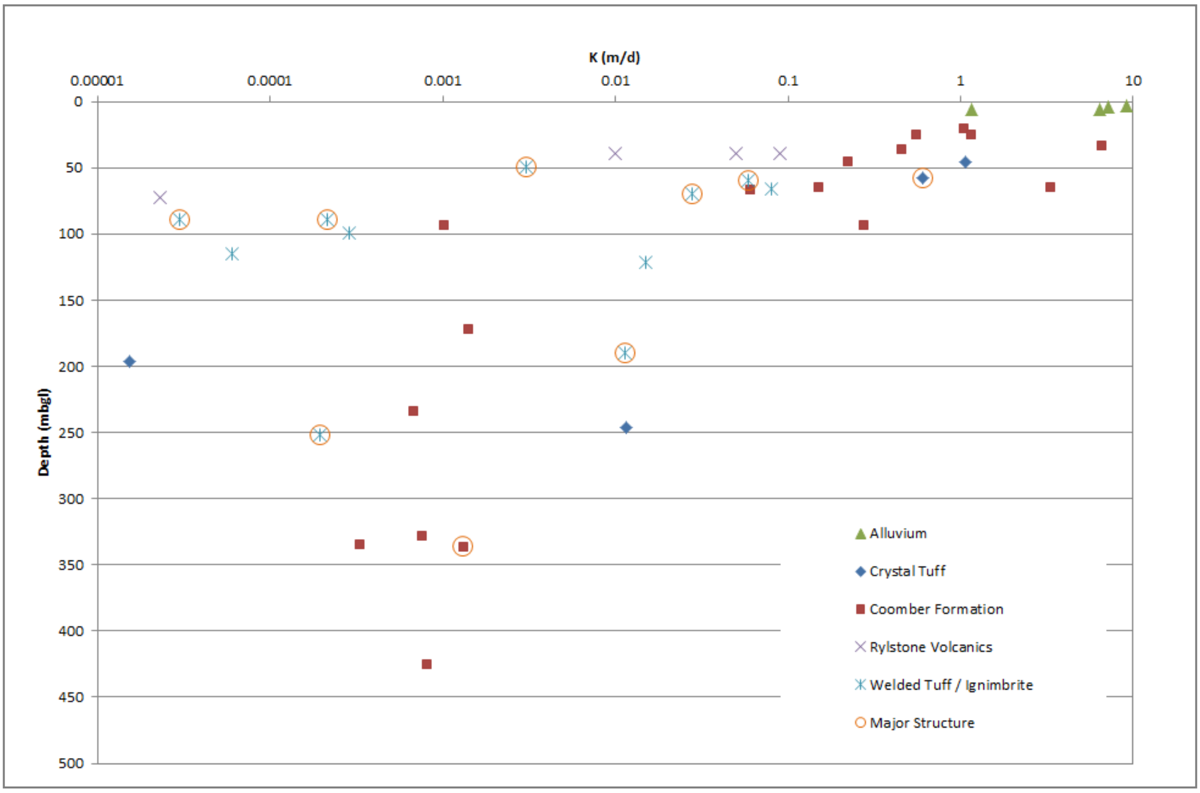


Figure 21 Porosity Determination by Drill Hole

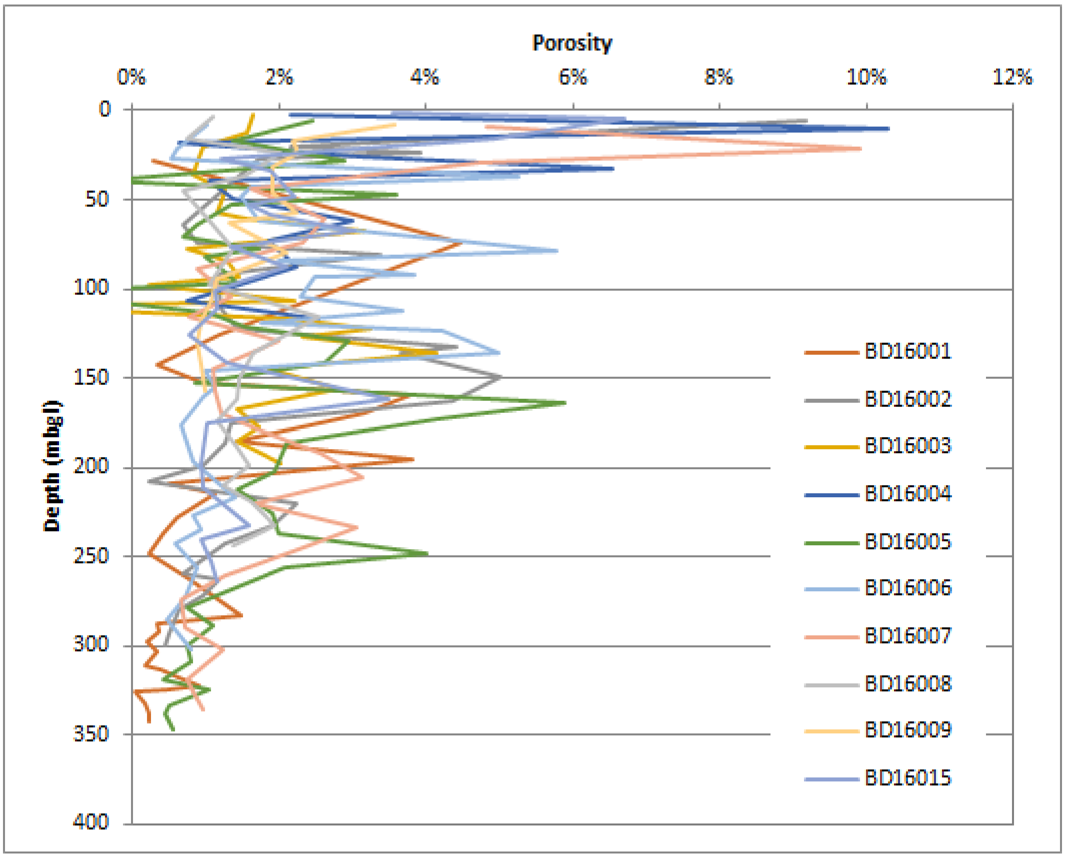
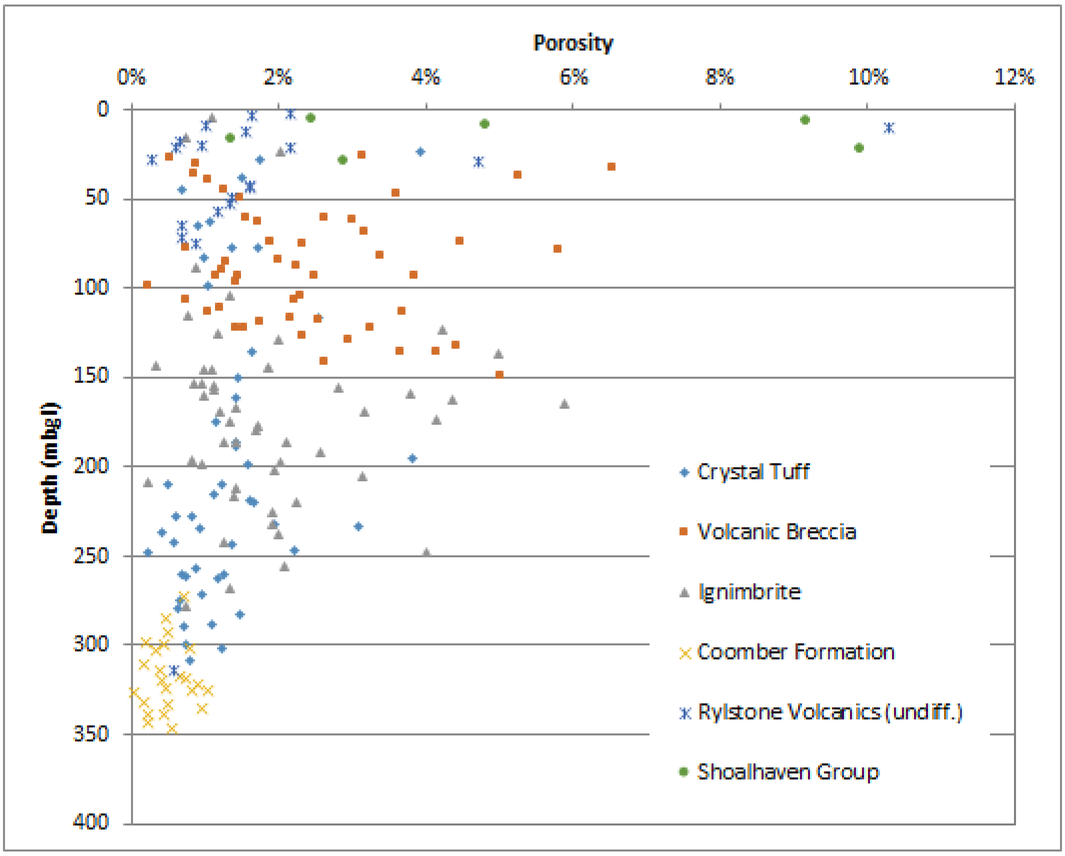


Figure 22 Porosity Determination by Lithology



It is noted that the selection process of the core samples for analysis specifically avoids noticeable discontinuities. As such the values provided can be considered applicable for the intact, unfractured and non-jointed lithology and are indicative of the minimum likely porosity values for the bulk formation.

From **Figure 21** and **Figure 22** a reasonable correlation of porosity with both depth of sample and lithology is apparent, with a reduction in the range of porosity values with depth.

The formation with the least variation and lowest observed porosity is the Coomber Formation. Results for the Coomber Formation are considered to be more indicative of deeper fresh occurrences of this formation. Where this formation outcrops to the south of the Mine Site at shallower depths porosities are likely to be higher, enhanced by weathering and unloading, as is observed with the shallow samples and elevated porosity of the Shoalhaven Group.

Of the volcanic formations the Crystal Tuff returned the lowest average porosity of 1.3%, and the Volcanic Breccia the highest at 2.2%.

4.5.11.6 Specific Storage

Storage coefficients have been derived from the respective constant rate pumping tests for the ignimbrite (BGW108) and Coomber Formation (BGW10).

It is also possible to derive values for specific storage from rock strength data, including Young's Modulus, also known as the modulus of elasticity, and Poisson's Ratio. Young's Modulus is a measure of the stiffness of a solid material, while Poisson's Ratio is a measure of lateral expansion divided by axial compression under load.

Specific storage is determined as the product of rock compressibility and the unit weight of water, where rock compressibility is a function of Poisson's Ratio and Young's Modulus.

Poisson's Ratio and Young's Modulus have been determined from laboratory testing of core samples that were undertaken for geotechnical investigations completed in 2012 (AMC, 2012). The testing is undertaken on intact core samples and the resultant values of specific storage are of the intact rock mass and do not take into account any fractures or discontinuities. As such, the values derived are indicative of the minimum likely values for the bulk formation.

The determination of specific storage has been undertaken by applying the average values of Poisson's Ratio and Young's Modulus for each lithology type to derive a representative specific storage value for the particular lithology. Results are presented in **Table 17**.

Table 17
Specific storage determinations

Lithology	No. Samples	Average Youngs Modulus (GPa)	Average Poisson's ratio	Compressibility (LT2/m)	Calculated Specific Storage (m^{-1})
Ignimbrite	5	31.1	0.25	$4.8x10^{-8}$	$4.7x10^{-7}$
Breccia	5	6.0	0.25	$2.5x10^{-7}$	$2.5x10^{-6}$
Crystal Lithic Tuff	6	14.1	0.26	$1.1x10^{-7}$	$1.1x10^{-6}$
Sandstone	2	13.8	0.22	$1.0x10^{-7}$	$1.0x10^{-6}$

The result derived for the ignimbrite unit of $4.7x10^{-7}m^{-1}$ is two orders of magnitude lower than the average value derived at late time from the BGW108 pumping test of $2.6x10^{-5}m^{-1}$, demonstrating the significant influence that fracturing has on the availability of groundwater released from storage. The elevated values derived from test pumping are also likely influenced by gravity drainage of groundwater from the fracture network in the host rock.

4.5.12 Representative Hydraulic Parameters

Based on Sections 4.5.6 to 4.5.11, representative hydraulic parameters for applicable stratigraphic units are presented in **Table 18**.

Table 18
Representative Hydraulic Parameters

Unit	Indicative Hydraulic Conductivity (m/day)	Kv / Kh Ratio	Indicative Specific Storage m^{-1}	Indicative Specific Yield
Alluvium	0.1 to 10	0.1	-	0.2
Narrabeen Group	0.15	0.1	$5.0x10^{-5}$	0.05
Illawarra Coal Measures	0.15	0.1	$5.0x10^{-5}$	0.05
Shoalhaven Group	0.05	0.1	$2.0x10^{-5}$	0.05
Rhyolite Breccia	0.01 to 0.1	0.5	$5.0x10^{-5}$	0.02 to 0.05
Welded Tuff / Ignimbrite	0.05	0.5	$1.0x10^{-5}$	0.02 to 0.05
Crystal Tuff	0.10	0.5	$5.0x10^{-5}$	0.02 to 0.05
Ordovician Basement	0.001 to 1 (up to 10 in shallow, weathered zones)	0.5	$2.0x10^{-5}$	0.01 (up to 0.05 in shallow, weathered zones)

4.5.13 Groundwater Levels

Comprehensive groundwater monitoring has been undertaken on site and throughout the surrounding area since March 2012. The monitoring network includes a network of private bores in addition to the site monitoring bores as described in Section 4.5.7. The layout of the groundwater monitoring network is provided on **Figure 23**.

Groundwater level hydrographs for the period from April 2012 to October 2018 are presented in **Figure 24** to **Figure 26**. The hydrographs are separated into monitoring bores identified as intersecting alluvium (**Figure 24**), regional monitoring bores (**Figure 25a** and **b**), and Mine Site monitoring bores (**Figure 26a** and **b**). The CRD is also presented on the hydrographs for comparison. The distinction between Mine Site and regional monitoring is based on the Mine Site boundary, with those monitoring bores within, or close to, the Mine Site boundary falling into the Mine Site monitoring bore category. It is noted that half of the alluvial monitoring bores (BGW48, BGW49, BGW51, BGW53, BGW54, and BGW61) are within the Mine Site boundary.

Water levels in alluvial monitoring bores, as shown in **Figure 24**, show significant fluctuation with longer term trends showing a close correlation to the CRD.

Water levels in the regional monitoring bores in **Figure 25** also show a correlation with CRD, although at the scale plotted this is less apparent, particularly in those monitoring bores that are situated in hard rock. Monitoring bores with water level less than 10mbgl, generally show similar magnitude in water level fluctuations to the alluvial monitoring bores, with this fluctuation decreasing with an increasing depth to water.

BGW36 (**Figure 25**) displays an exaggerated response with close correlation to the CRD, with in excess of 30m variation in water level over the period of monitoring. BGW36 is located approximately 2.4km to the east-southeast of the open cut pit area and 100m from a private residence. It is inferred that the exaggerated water level fluctuations are most likely due to local groundwater use, such as irrigation, exacerbating dry period water level decline. Two other bores, BGW33 and BGW35, both located in the township of Lue, also show the influence of intermittent abstraction.

The Mine Site hard rock monitoring bore hydrographs (**Figure 26**) generally display similar trends to those of the regional hard rock monitoring bores. The majority of Mine Site monitoring bores show a response to a recharge event in mid-2016.

Apparent in **Figure 26a** is the drawdown and recovery at BGW108 in response to the pumping test that was undertaken in November 2014 (Section 4.5.9). BGW108 also shows another significant period of pumping from December 2013 through to February 2014, as discussed previously in Section 4.5.10. During this period of abstraction responses are observed in a number of other Mine Site monitoring bores, as discussed in Section 4.5.10. BGW108 displays a very slow recovery, indicative of a limited hydraulic connection with the regional groundwater system.

Figure 23 Bowdens Silver Groundwater Monitoring Network

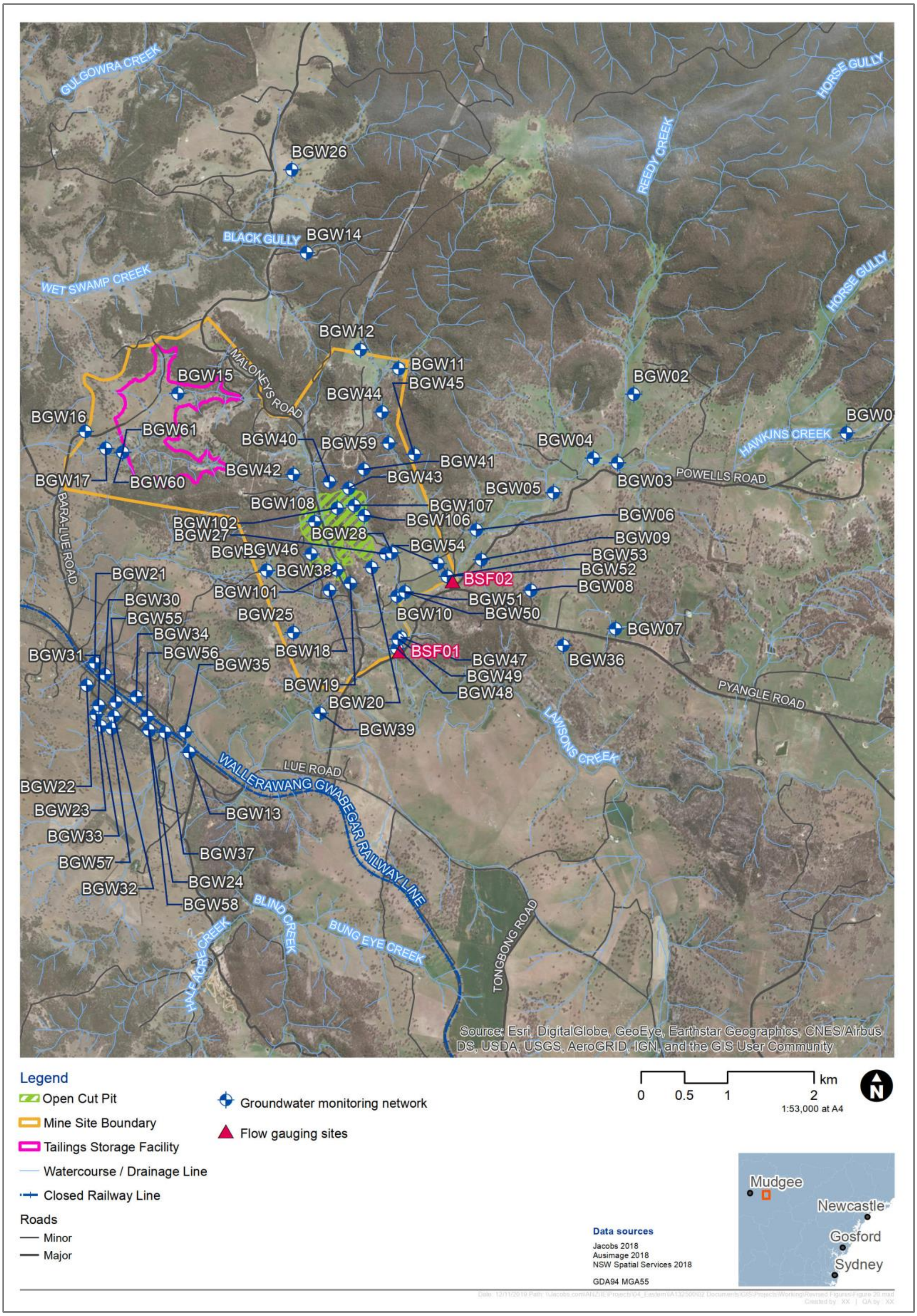
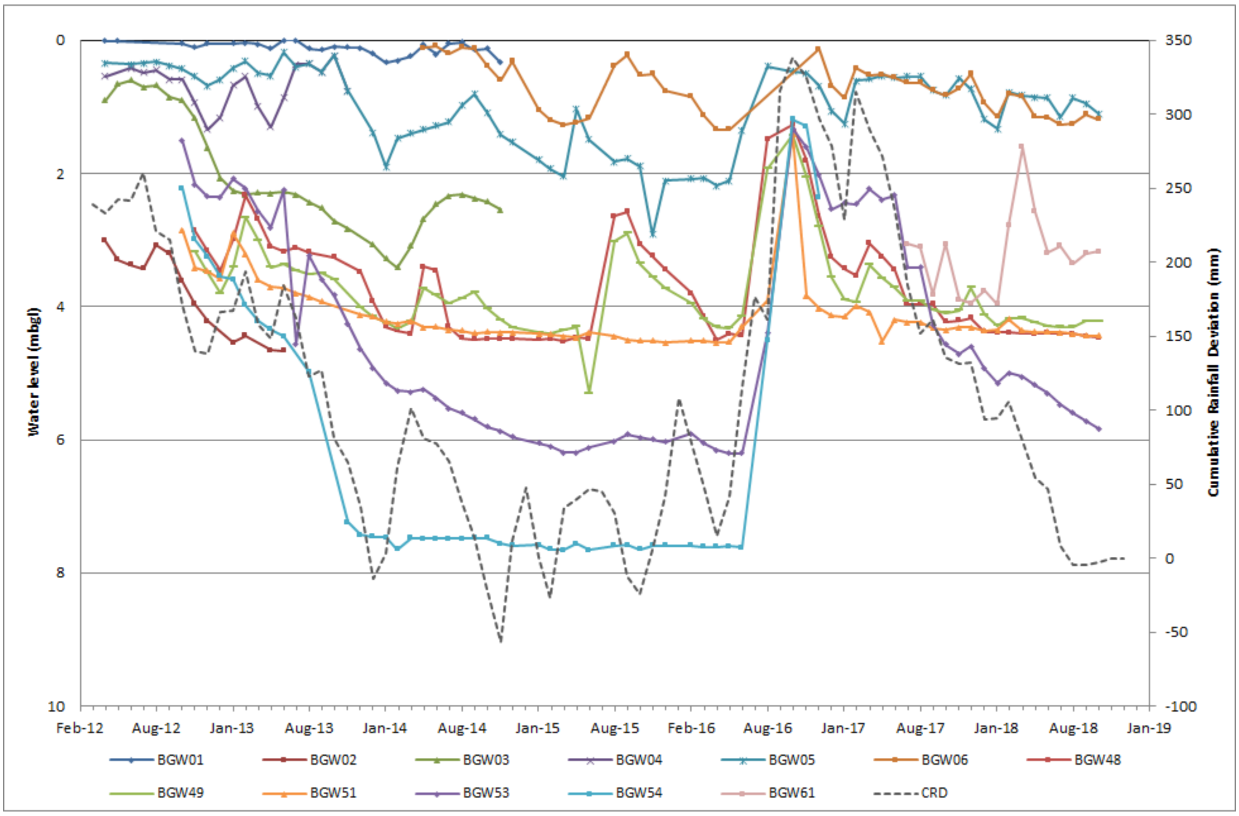


Figure 24 Alluvial Monitoring Bore Hydrographs (April 2012 to October 2018)



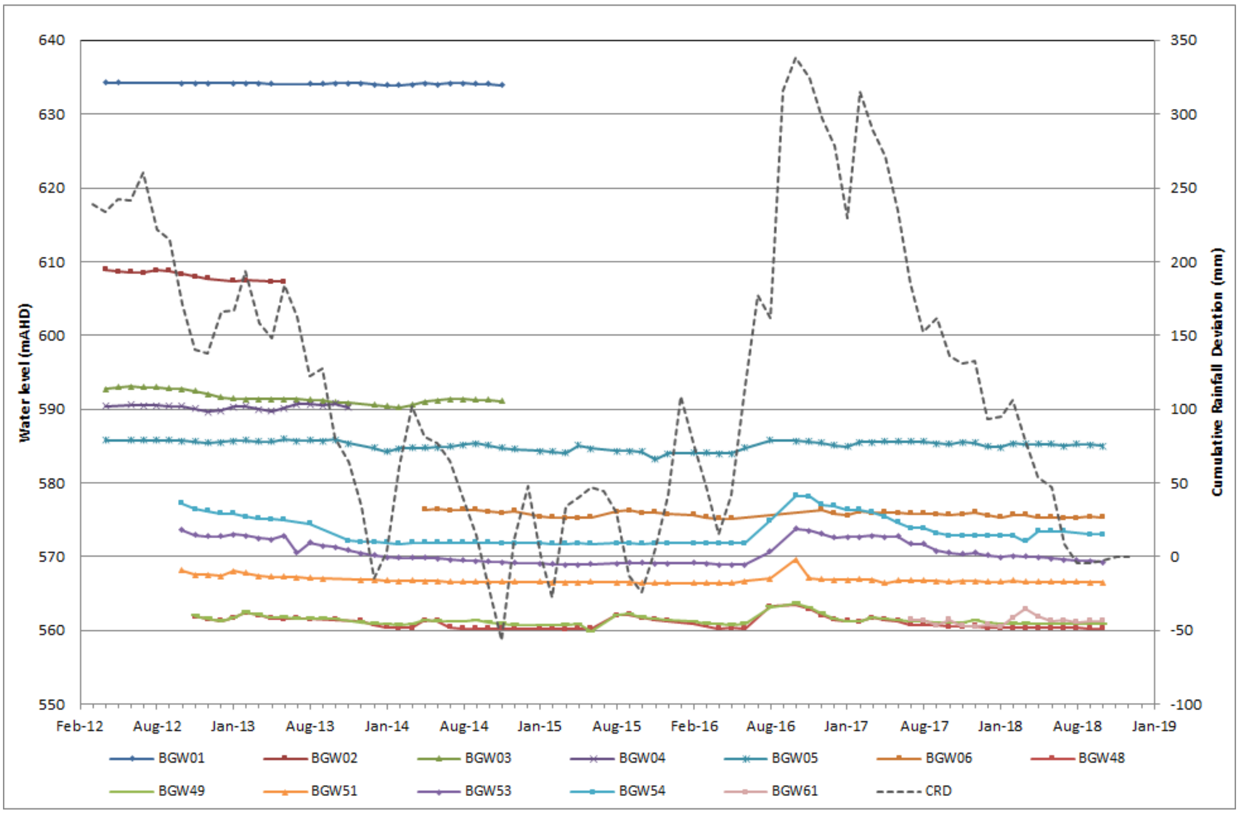
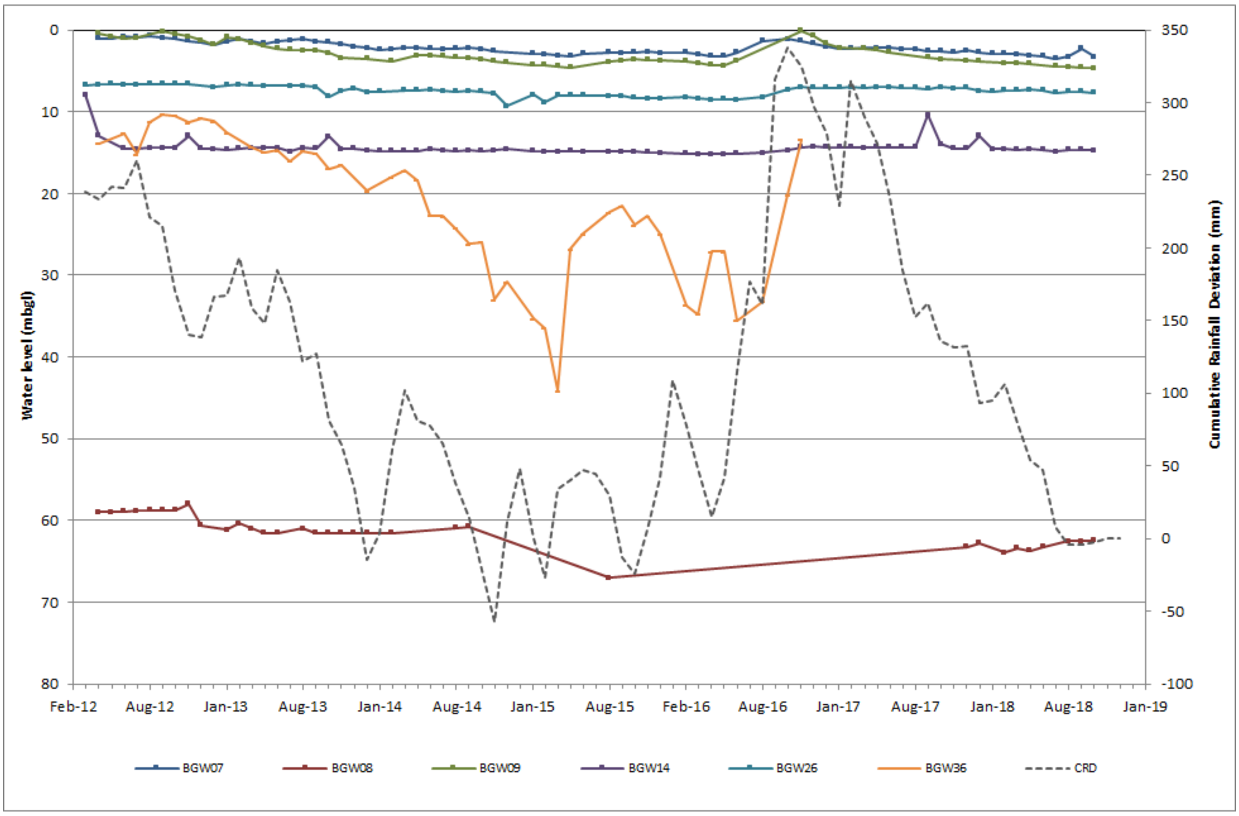


Figure 25a Regional Monitoring Bore Hydrographs



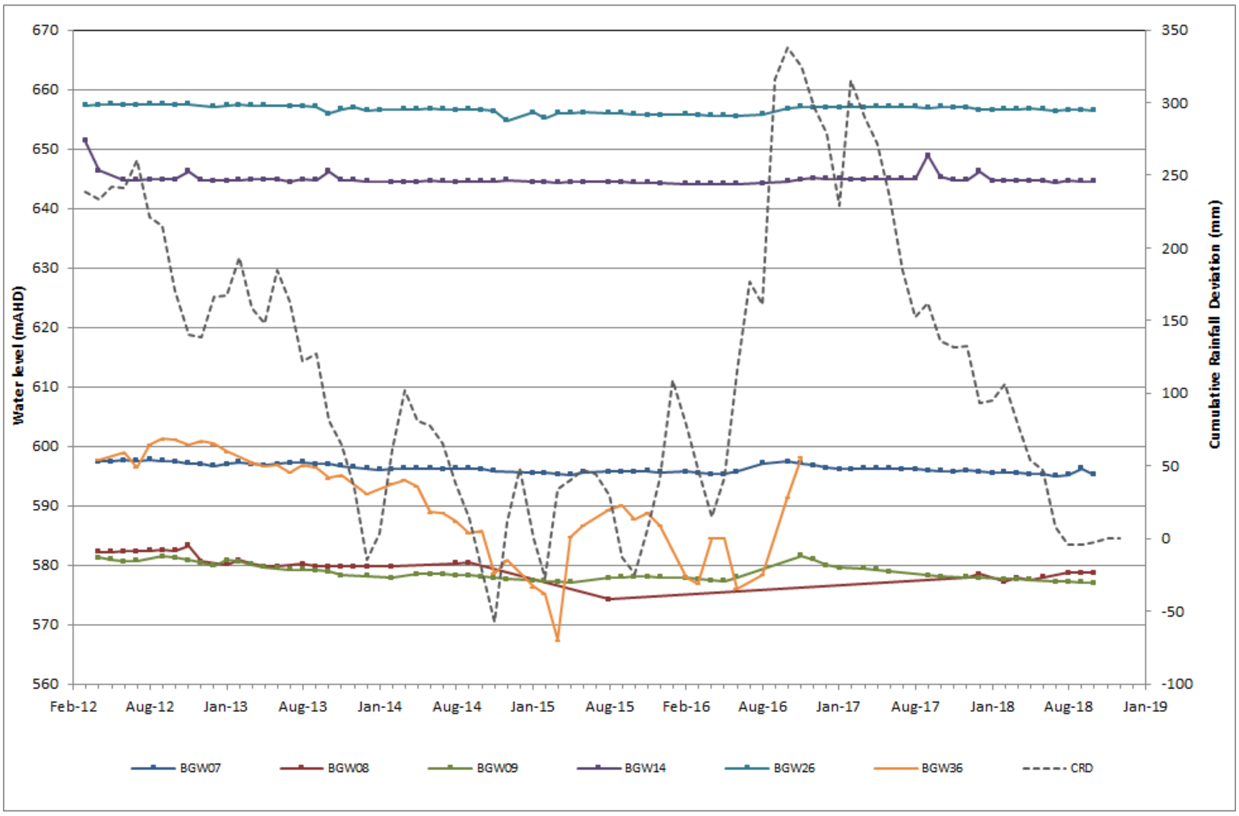
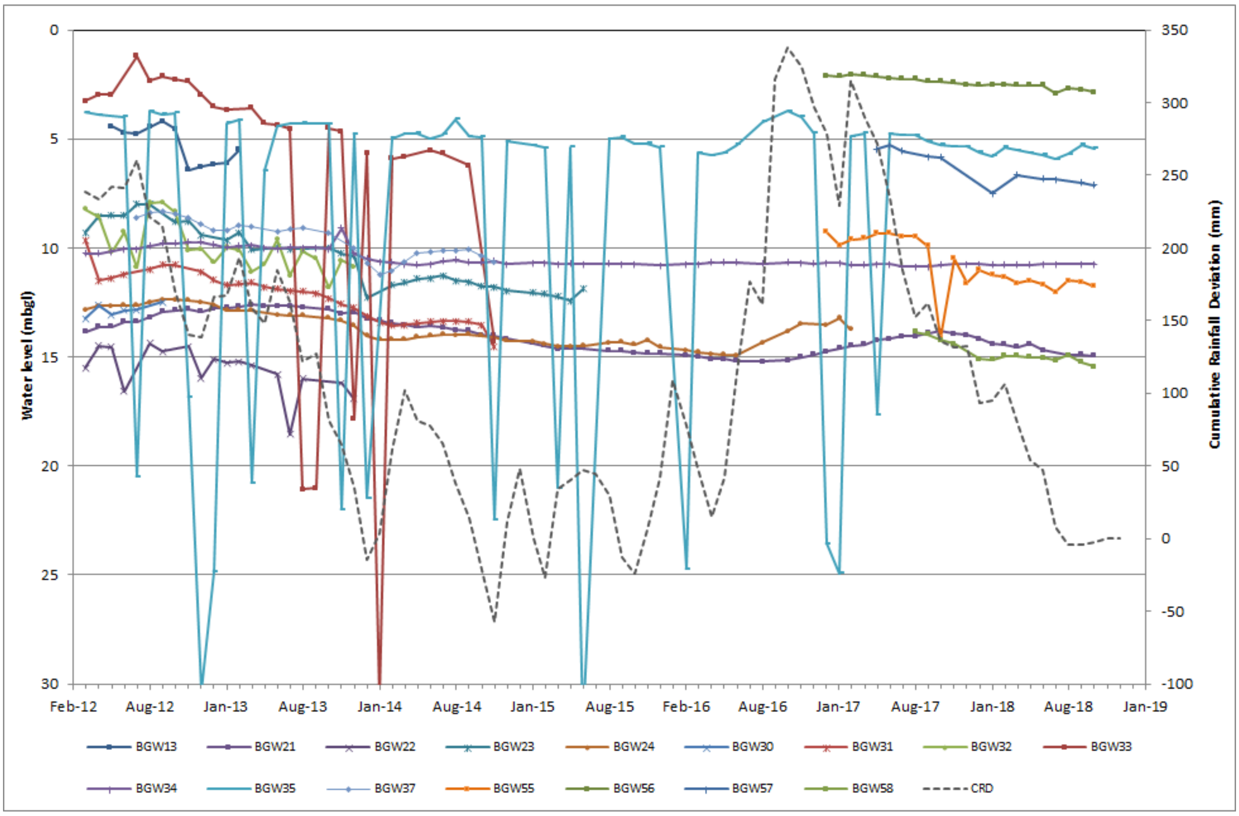


Figure 25b Regional Monitoring Bore Hydrographs (Lue)



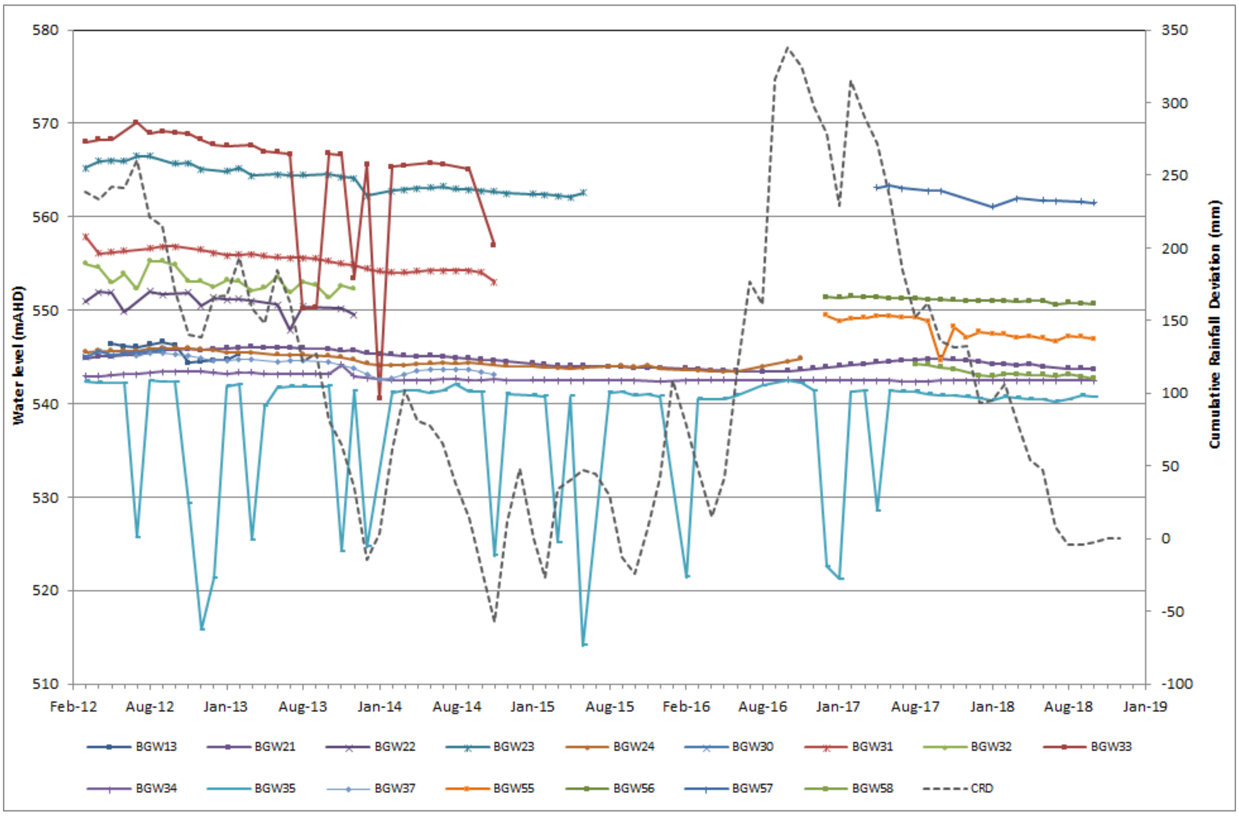
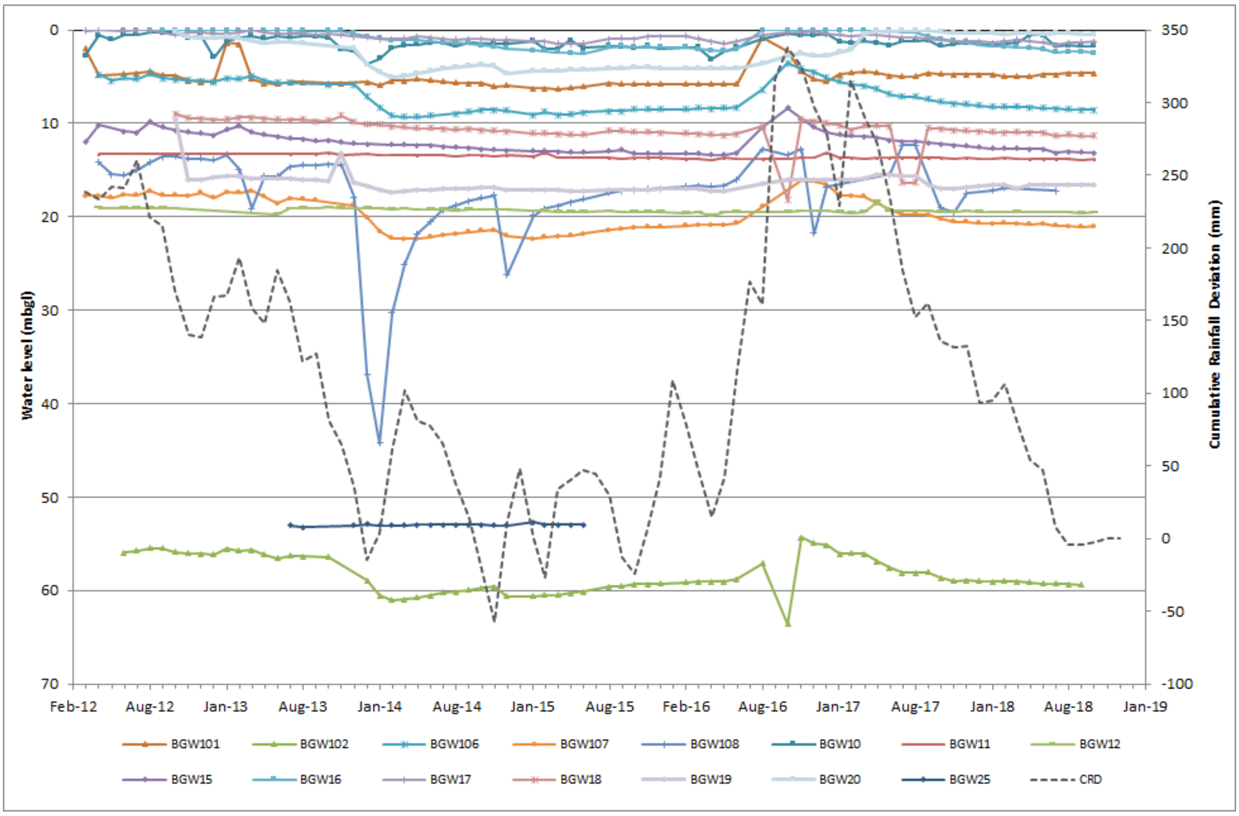


Figure 26a Mine Site Monitoring Bore Hydrographs



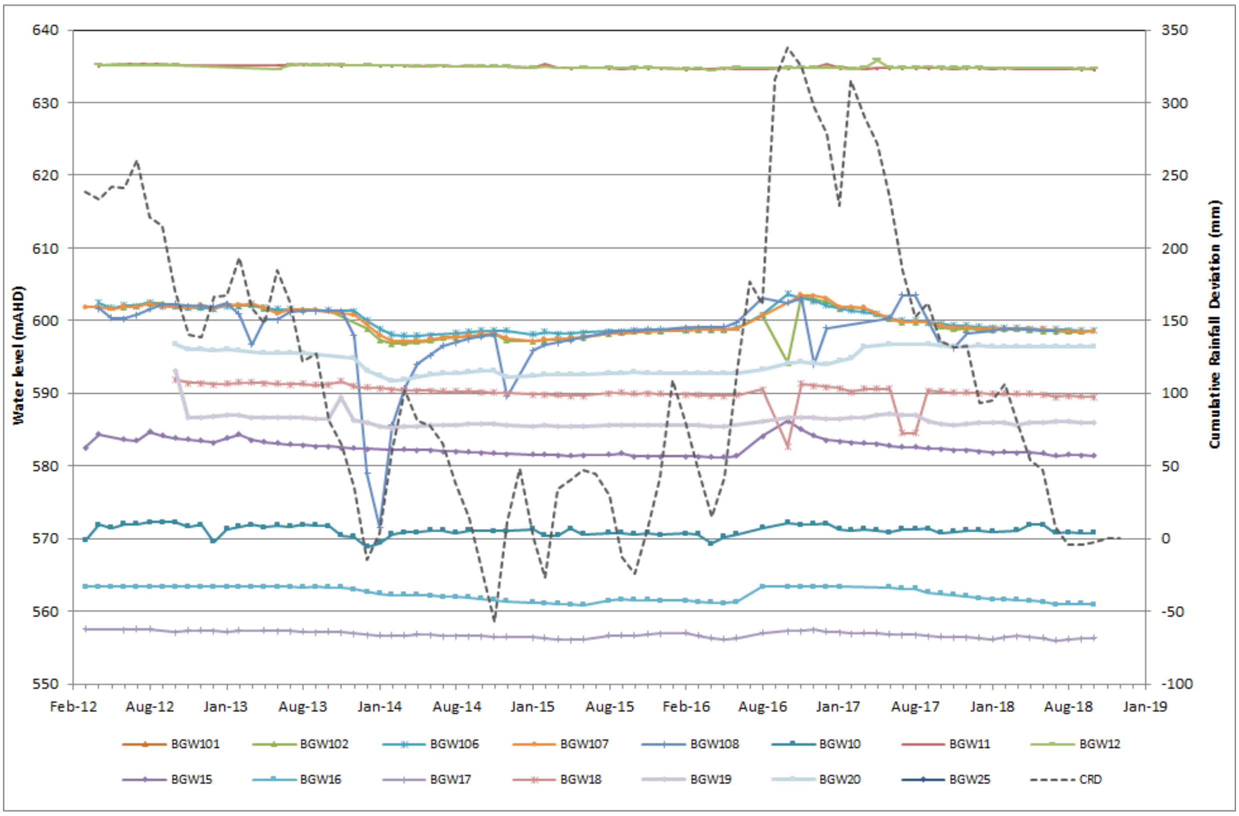
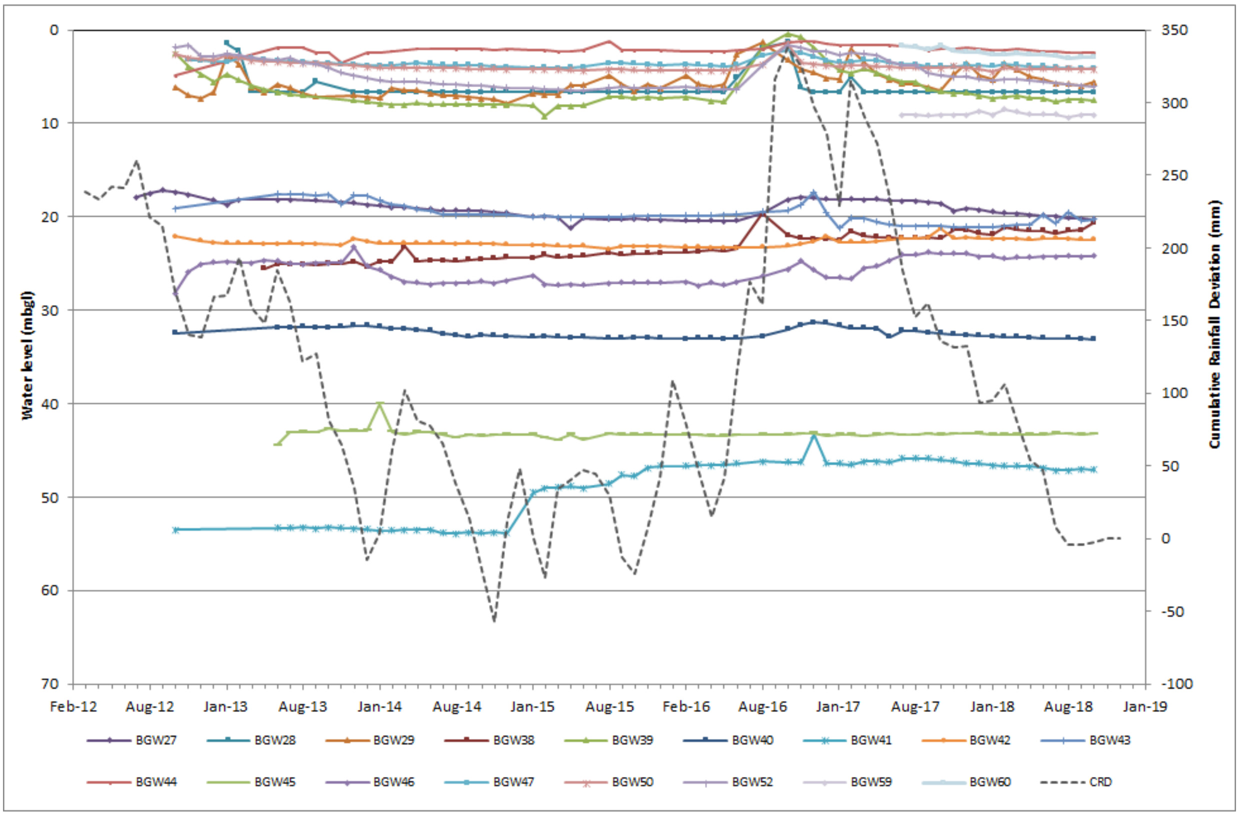
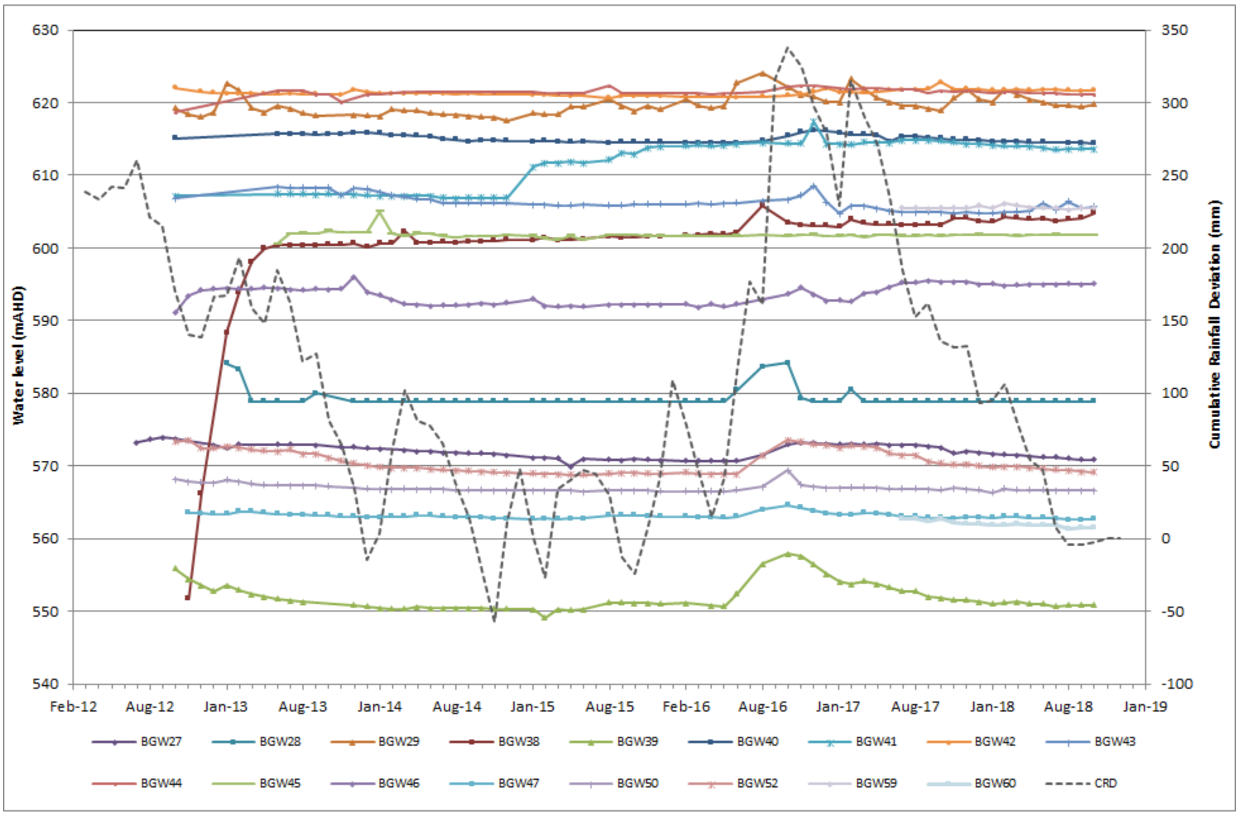


Figure 26b Mine Site Monitoring Bore Hydrographs





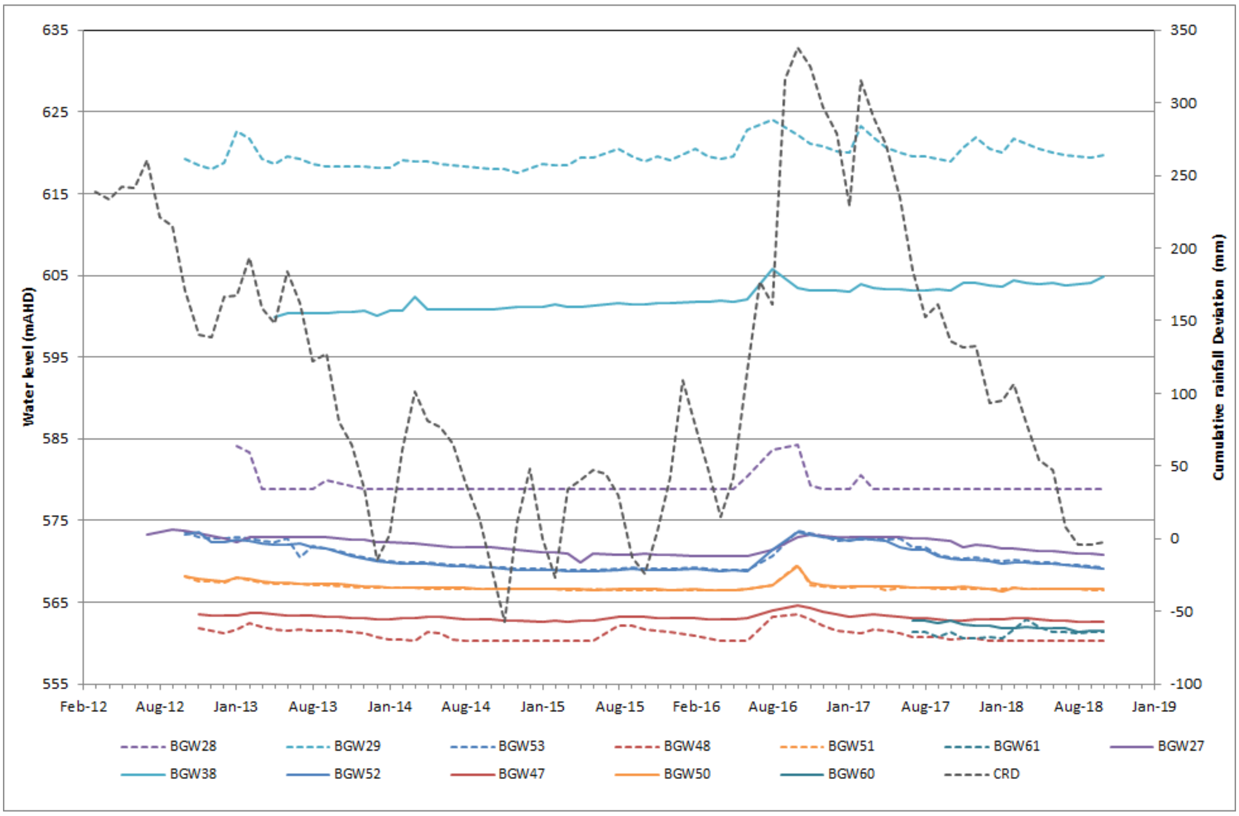
4.5.13.1 Paired Monitoring Bore Locations

A number of monitoring locations include paired, deep and shallow monitoring bores. These locations are summarised in **Table 19** and hydrographs are presented in **Figure 27**. The monitoring locations are provided on **Figure 23**. While it is noted that BGW47 and BGW48 are not immediately adjacent to each other (they are separated by approximately 98m), they are considered close enough to derive indicative vertical hydraulic gradients.

Table 19
Paired Monitoring Locations

Location	Bore ID	Drilled Depth (mbgl)	Screened Interval (mbgl)	Screened Formation
Pit South	BGW28	6	0-6	Alluvium
	BGW27	90	58-70	Coomber Formation
KCN Spring	BGW29	6.5	1.5-6.5	Volcanic Breccia
	BGW38	100	88-94	Volcanic Breccia
Hawkins Creek (upstream)	BGW53	12	3-9	Alluvium
	BGW52	30	17-23	Coomber Formation
Hawkins Creek (downstream)	BGW48	6	1-6	Alluvium
	BGW47	48	36-42	Rylstone Volcanics
Hawkins Creek (mid-chainage)	BGW51	12	3-9	Alluvium
	BGW50	28	21-27	Coomber Formation
TSF	BGW61	5	1-5	Alluvium
	BGW60	33	21-33	Rylstone Volcanics

Figure 27 Paired Monitoring Bore Hydrographs



From **Figure 27** the following trends are apparent.

- South of the open cut pit area at BGW27/BGW28 (Pit South) there is an approximately 8 to 10m head (water level) difference between the groundwater level in the Coomber Formation and the shallow alluvial groundwater system. This shows net downward hydraulic gradient (although the two systems are likely disconnected) and indicates the potential for recharge/leakage from the alluvium to the deeper groundwater. The predominantly flat response at BGW28 suggests that for the majority of the time the shallow water level is below the level of the screen, at approximately 578m AHD, with only intermittent responses to rainfall events.
- A similar but more marked difference is observed at BGW29/BGW38 in the vicinity of KCN Spring, located on the southeastern flank of Lydiard Ridge. At this location, the head difference is of the order of 18m. This difference in water levels indicates that the spring is likely to be the surface expression of a shallow water table and unlikely to be connected to the deeper groundwater system.
- At sites BGW50/BGW51, and BGW52/BGW53, the deep and shallow groundwater systems show relatively uniform levels and responses, indicating hydraulic connectivity. This is likely an area of seasonal recharge and discharge. Upstream at BGW52/BGW53, shallow alluvial groundwater levels are marginally higher than deeper groundwater levels, indicating a net downwards gradient, albeit very minor. At BGW50/BGW51, the opposite is true, with deep groundwater levels typically slightly elevated above shallow groundwater levels, indicating a net upwards gradient. Average groundwater levels at BGW51 and BGW53 are at a similar elevation to the bed of Hawkins Creek, indicating a seasonal variation between groundwater discharge to baseflow and groundwater recharge conditions.
- BGW47 and BGW48, while not paired, are located in close proximity to each other in the vicinity of Hawkins Creek. The deep groundwater levels observed at BGW47 are consistently elevated above the shallow groundwater levels of BGW48, indicating a zone of permanent upward hydraulic gradient and discharge from deep groundwater to shallow groundwater. At BGW48, average groundwater elevations are slightly below the inferred creek bed elevation of Hawkins Creek, indicating a predominantly losing stream at that location, with groundwater discharge as baseflow after sustained recharge events.
- At BGW60/BGW61 in the area of the TSF, the water levels of the deeper groundwater system are generally elevated above the shallow alluvial water level. Prior to April 2018, the deeper water level was elevated by approximately 1 to 1.5m over the shallow water level. Following high rainfall and corresponding rise in CRD in the preceding months, the shallow water level in BGW61 briefly exceeded the deeper water level before receding and remaining approximately 0.5m below BGW60 for the remainder of the observation data.

4.5.13.2 Groundwater Contours and Flow Direction

Composite groundwater level contours derived from the results obtained from the groundwater monitoring network are provided in **Figure 28**. The groundwater contours plotted are generated from average water levels from all available data between February 2012 and October 2018. Where obvious influences of groundwater pumping are apparent, such as at BGW35 and BGW55, an equivalent natural water level has been approximated.

The composite groundwater elevation map provides a good overview of groundwater flow in the study area. The groundwater contours indicate lines of equal groundwater elevation. Groundwater flow direction is inferred as being directly down gradient, perpendicular to the contours.

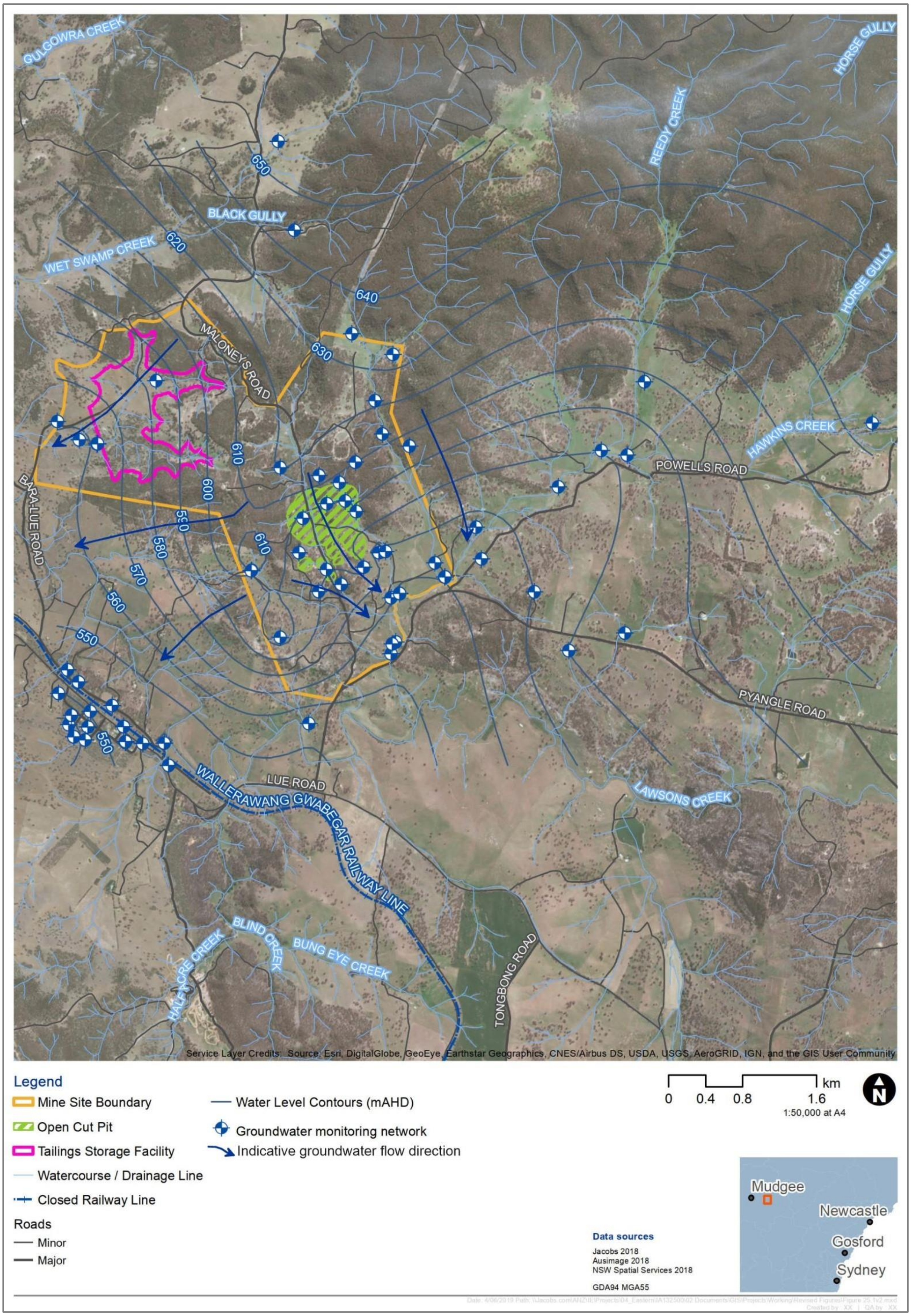
From **Figure 28,** the following key flow characteristics are apparent.

- The groundwater contours show a good correlation with topography and indicate groundwater flow is generally from areas of higher elevation to areas of lower elevation.
- Groundwater flow directions are variable. In the TSF and open cut pit areas however, general southwesterly and southeasterly flow directions are indicated.
- Through the central Mine Site area, the hydraulic gradient is typically 1:40 or 0.025.
- Groundwater contours indicate that Hawkins Creek is a groundwater sink and as such the creek and associated alluvial areas (valley fill) are likely a point of regional groundwater discharge. This is consistent with the upwards head gradients observed between BGW47 and BGW48.
- Groundwater contours in the open cut pit area are disrupted compared to the relatively uniform contours intervals elsewhere and indicate a general flattening of the water table in the southern open cut pit area. This could be indicative of a highly connected fracture network and proximity to the major fault structures or may be artificially induced by the high density of drill holes in the area.
- Groundwater elevations in the open cut pit area range from around 610m AHD in the north to 590m AHD in the south to southeast. Depth below ground level is highly variable and dependant on topography, but typically ranges from approximately 2mbgl in the lower reaches of Blackmans Gully to 60mbgl beneath the elevated ridges in the central mining area.
- Groundwater elevation beneath the TSF area ranges from approximately 600m AHD beneath the upper valley areas (10 to 60mbgl) to approximately 560m AHD beneath the lower embankment, which is near ground level in the middle of the valley.

4.5.14 Groundwater Quality

Comprehensive groundwater quality sampling has been undertaken on the regional monitoring network on a quarterly basis since January 2014. The layout of the groundwater monitoring network is provided in **Figure 23**.

Figure 28 Composite Groundwater Contours



The monitoring network for water quality includes alluvial and hard rock groundwater systems, springs, and surface water. The full comprehensive water quality sampling results for the period between January 2014 and August 2018 are summarised in **Annexure 7**. The dataset provides a comprehensive water quality baseline for comparison to any results of future water quality monitoring. For the purposes of this assessment of water quality, the key parameters of electrical conductivity and pH are discussed, as are the major ions for the purposes of water type characterisation and an indication of groundwater recharge processes.

It is noted that groundwater sampling was rationalised following September 2016, including cessation of monitoring at spring locations which were deemed not to be connected to the regional water table.

4.5.14.1 Electrical Conductivity

Electrical conductivity (EC) is presented on **Figure 29** to **Figure 31**. For reference, measured EC from spring monitoring points are provided on **Figure 32**. A statistical summary of EC results is provided on **Table 20**.

Table 20
Electrical Conductivity Monitoring Summary (µS/cm)

Statistics	Alluvium	Site	Regional	Springs
Total results	123	518	184	44
Mean	802.0	1 420.3	1 819.9	150.3
Median	654.0	1 260.0	1 640.0	151.0
Min	121.0	153.0	310.0	71.0
Max	2 620.0	5 680.0	4 060.0	252.0
20th Percentile	330.8	938.8	1 276.0	102.2
80th Percentile	1 316.0	1 820.0	2 644.0	189.0

The alluvial groundwater EC is typically less than 1 000µS/cm, with two sites (BGW51 and BGW53) displaying higher but variable EC. The recharge event evident in the alluvial water levels in mid-2016 (**Figure 24**) is also observed in the water quality results at several monitoring locations. At BGW51 and BGW53 this response is apparent as a distinct decrease in EC due to the influx of rainfall recharge, whereas at BGW05 and BGW06 the response is an increase in EC due to the flushing of salts within the soil profile and unsaturated aquifer material. BGW48, BGW49 and BGW54 show no significant response.

Regional hard rock aquifer groundwater salinity (**Figure 30**) is typically in the range of between 1 000 to 3 000µS/cm. BGW56, located in the Rail Reserve in Lue, is notably fresher at approximately 300µS/cm, and may be associated with Lawsons Creek alluvium, rather than the hard rock aquifer. Most monitoring locations display relatively stable trends, however, BGW07 displays a decrease from 3 350µS/cm to 1 350µS/cm between October 2015 and February 2016, which is unexplained, however, the subsequent data is more consistent with other regional monitoring results.

Figure 29 Alluvial Monitoring Bore Electrical Conductivity (January 2014 to August 2018)

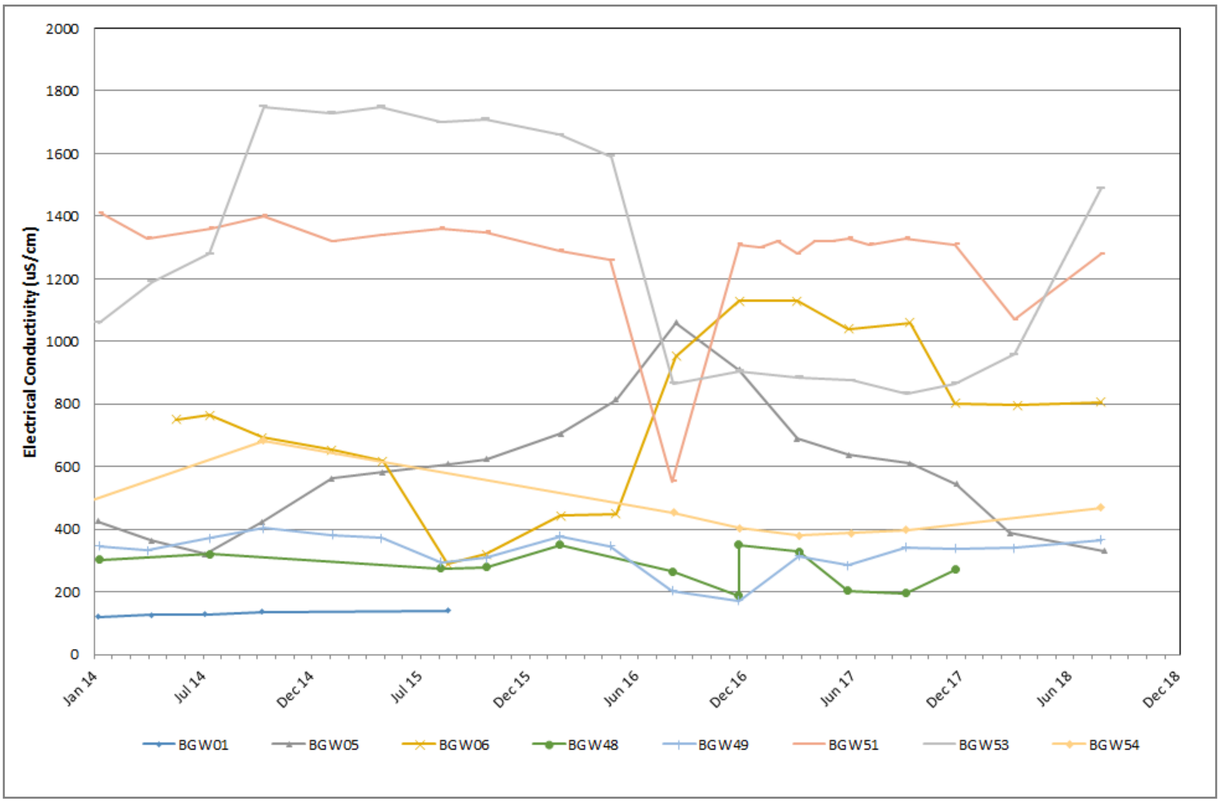


Figure 30 Regional Monitoring Bore Electrical Conductivity (January 2014 to August 2018)

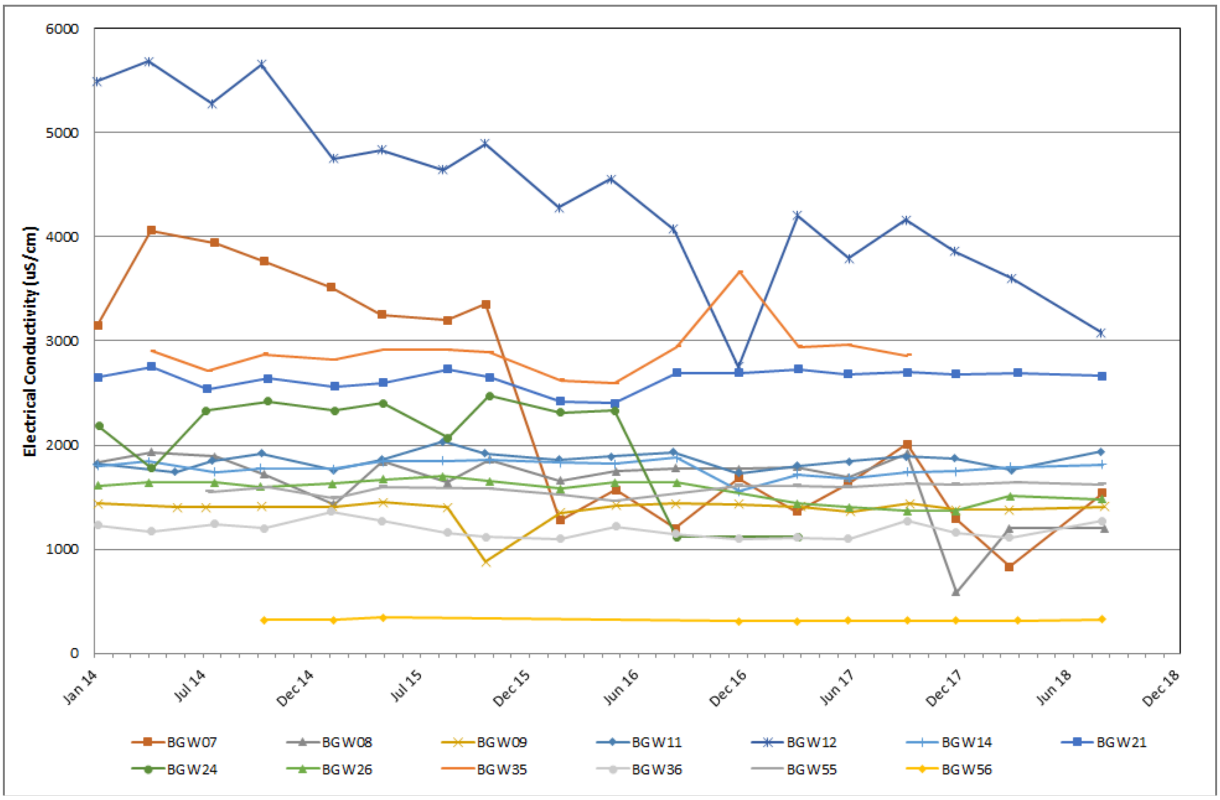


Figure 31a Site Monitoring Bore Electrical Conductivity (January 2014 to August 2018)

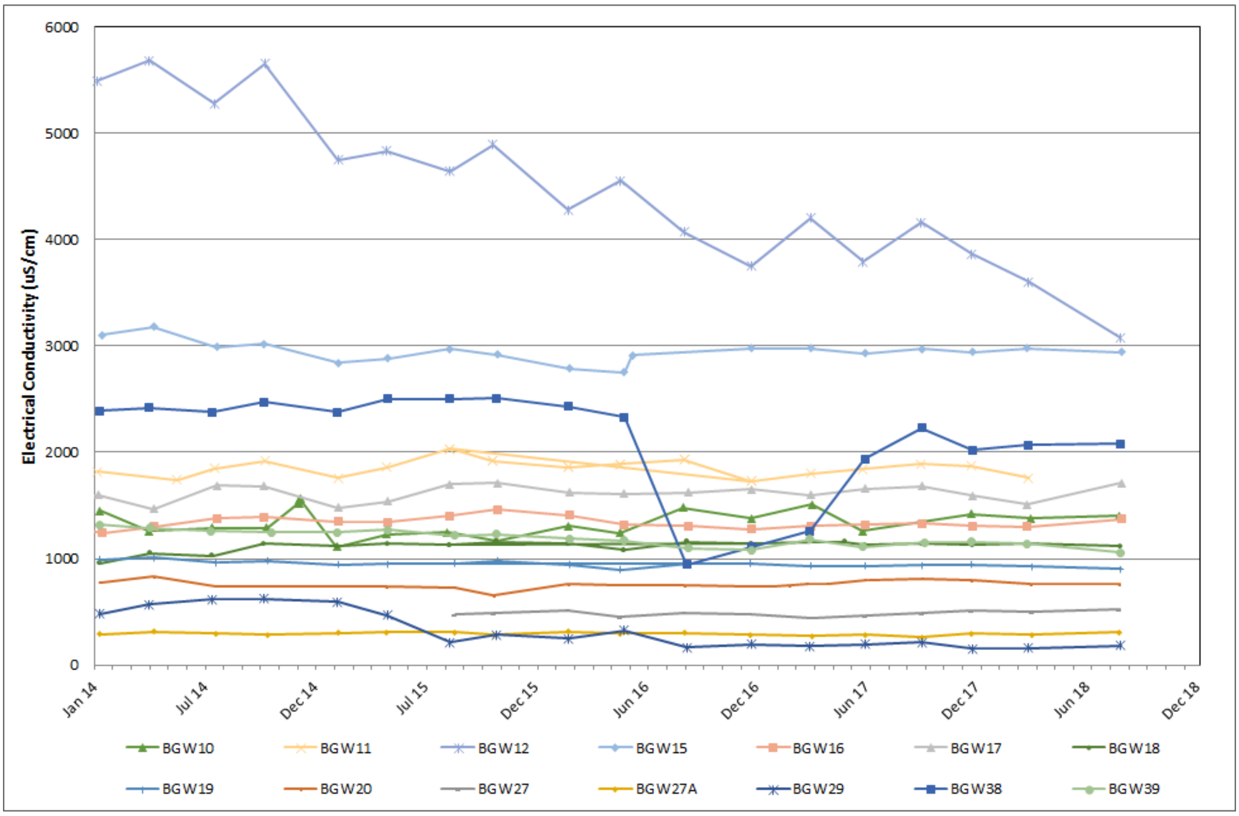


Figure 31b Site Monitoring Bore Electrical Conductivity (January 2014 to August 2018)

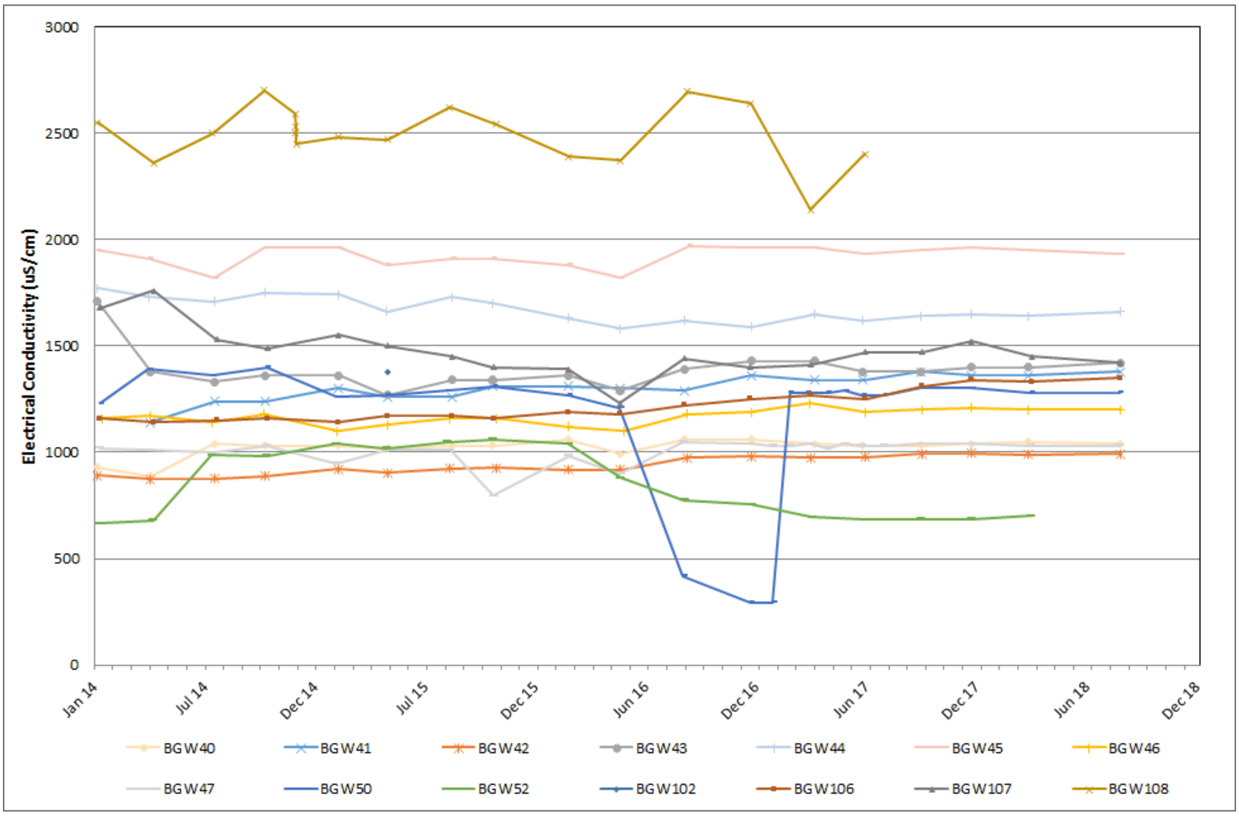
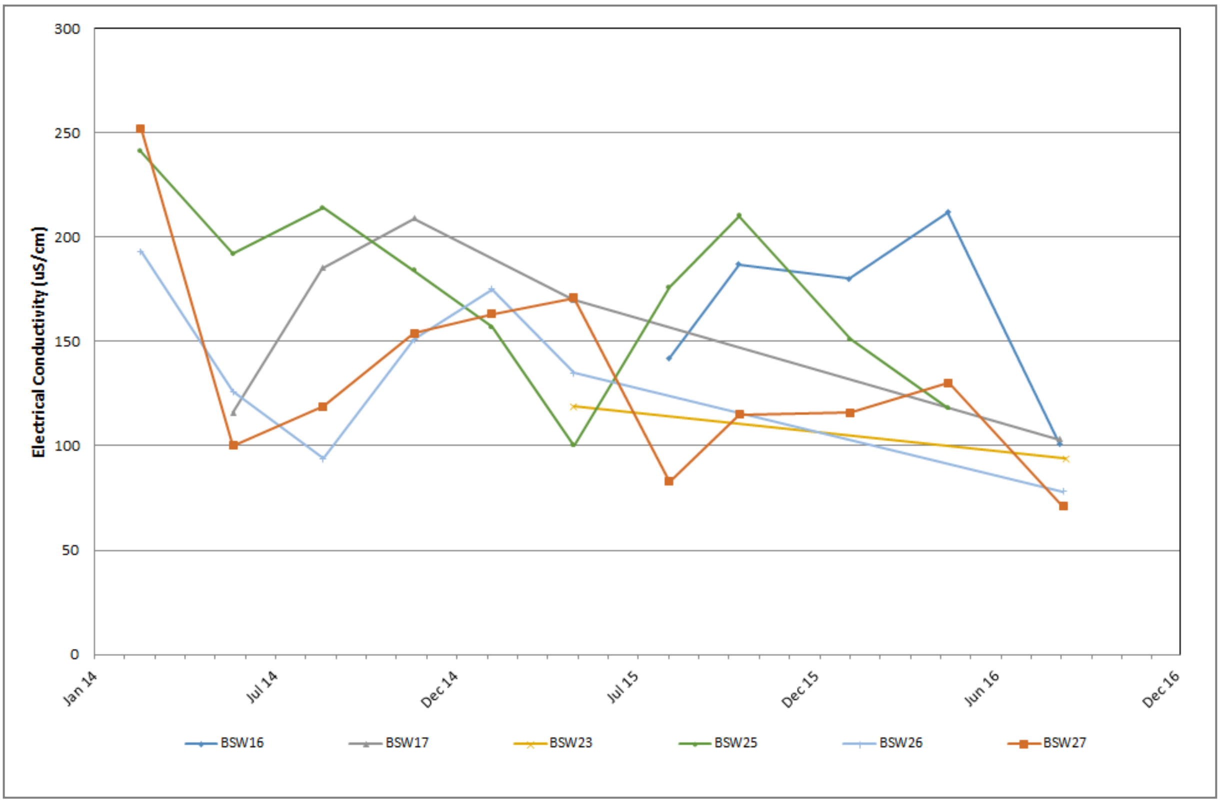


Figure 32 Spring Electrical Conductivity (January 2014 to September 2016)



The EC at Mine Site monitoring bores (**Figure 31**) is typically below 2 000 µS/cm, with an average value of 1 420µS/cm (**Table 20**). BGW15, BGW38, and BGW108 show elevated EC, typically in the range 2 000 to 3 000µS/cm. Historic EC results at BGW12 were anomalously elevated and in excess of 5 000µS/cm, however EC at BGW12 has been consistently declining and is currently approximately 3 000µS/cm. BGW38 and BGW50 also display a strong decrease in EC, and subsequent recovery to background levels, following the mid-2016 recharge event.

The EC results at the spring monitoring locations are considerably fresher than both the alluvial and hard rock aquifer water quality. This indicates that the springs are derived from seepage and surface expression of recent rainfall recharge and interflow within the soil profile rather than groundwater, as is discussed further in Section 4.5.14.4. Spring water EC ranges from 71 to 252µS/cm, with an average of 150µS/cm.

4.5.14.2 pH

Groundwater monitoring results for pH are presented on **Figure 33** to **Figure 35**. For reference pH from spring monitoring points are also provided on **Figure 36**. A statistical summary of pH results is provided on **Table 21**.

The majority of pH measurements from groundwater samples fall in the range 6.8 to 7.6. Groundwater pH results for Mine Site monitoring bores show the greatest range, from 5.2 to 8.9, with the alluvial bores showing the lowest range, from 5.6 to 7.7. Median pH values from all groundwater and spring samples were within a similar range, from 6.7 to 7.1.

Figure 33 Alluvial Monitoring Bore pH (January 2014 to August 2018)

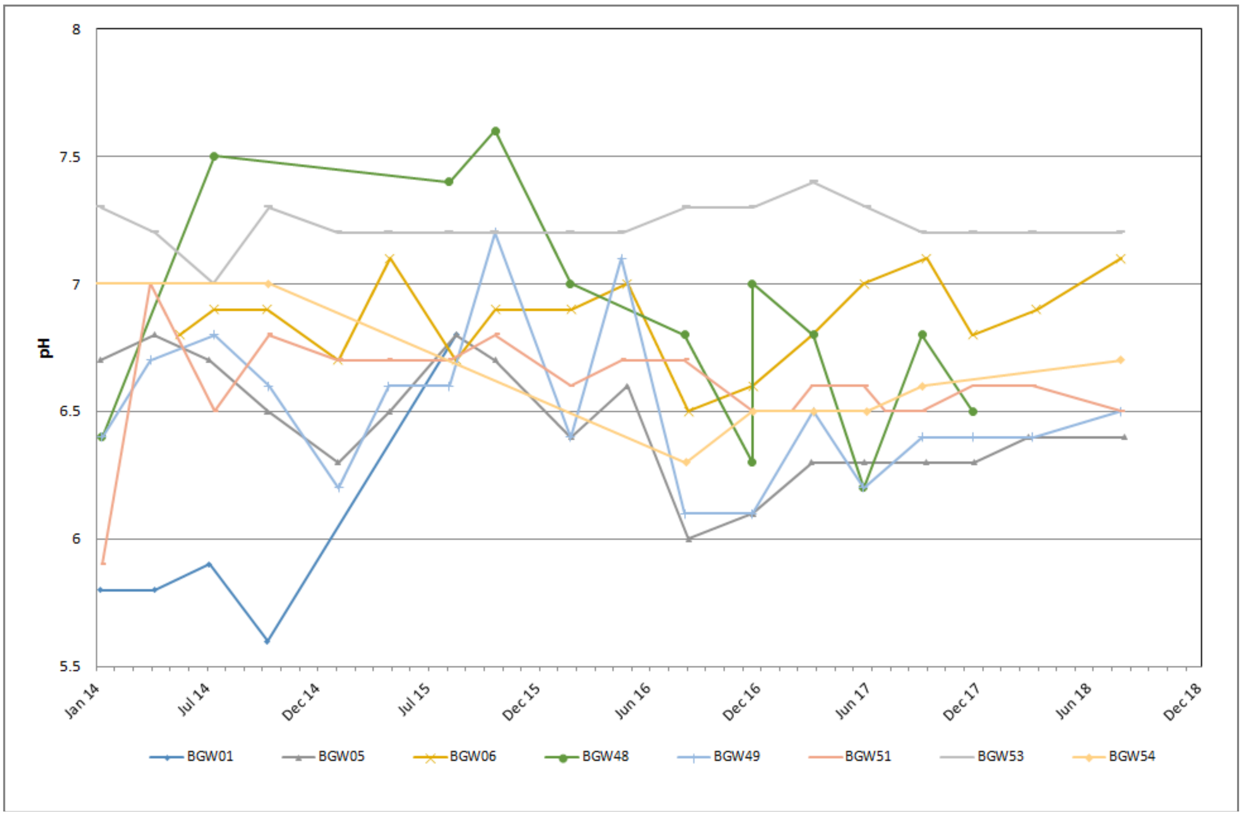


Figure 34 Regional Monitoring Bore pH (January 2014 to August 2018)

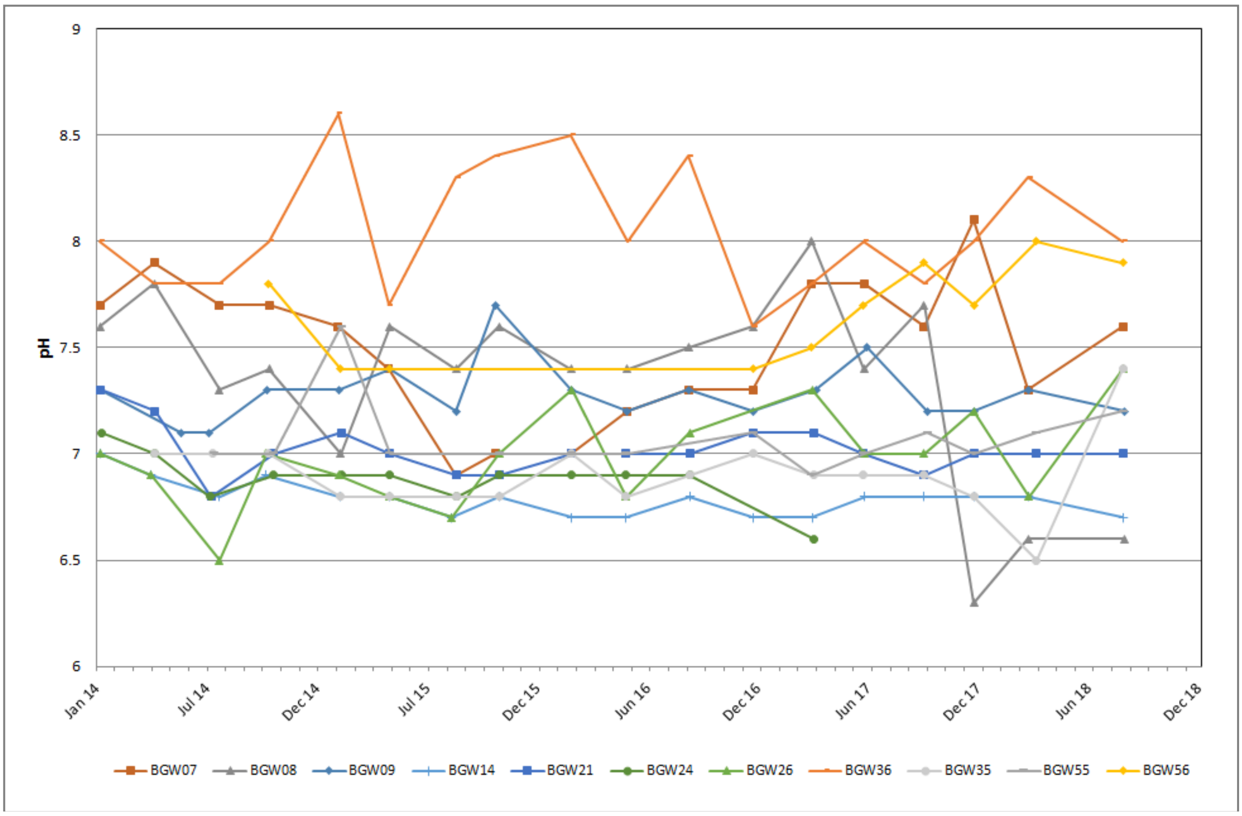


Figure 35a Mine Site Monitoring Bore pH (January 2014 to August 2018)

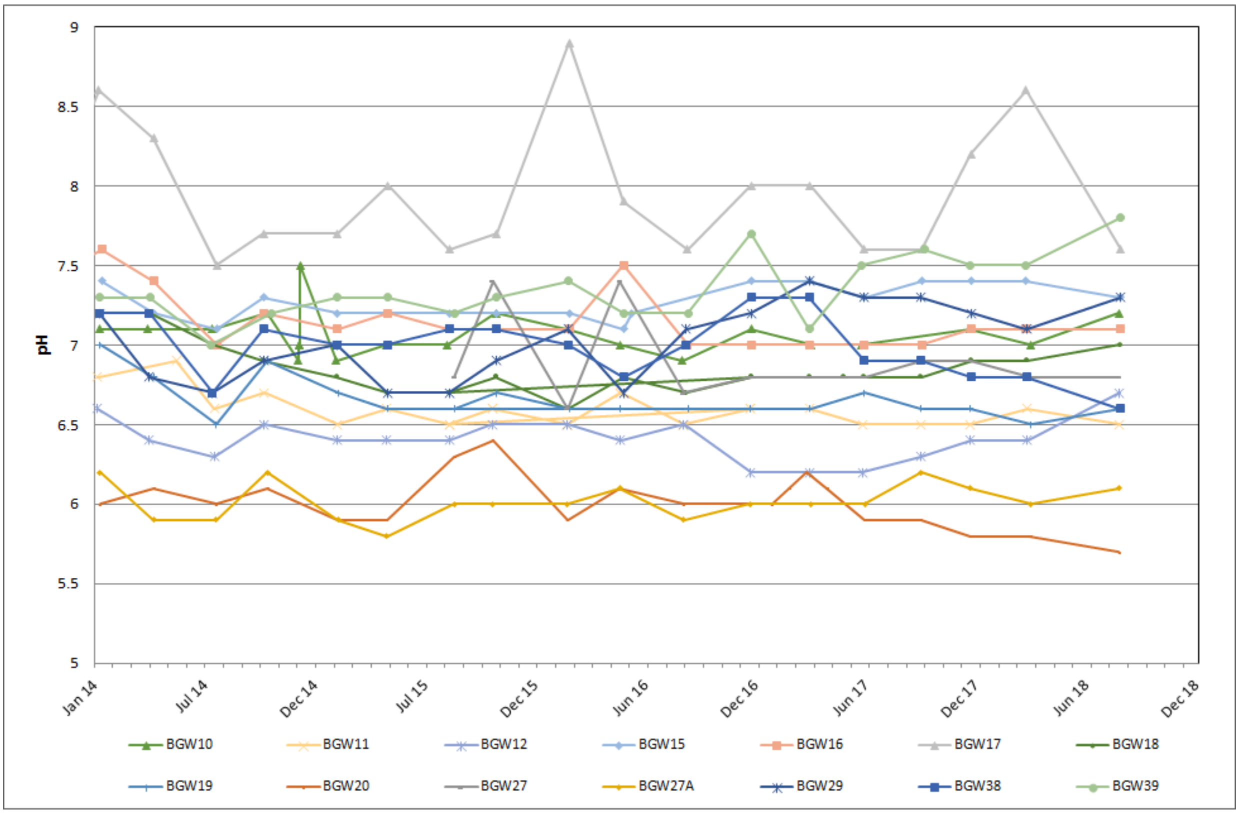


Figure 35b Mine Site Monitoring Bore pH (January 2014 to August 2018)

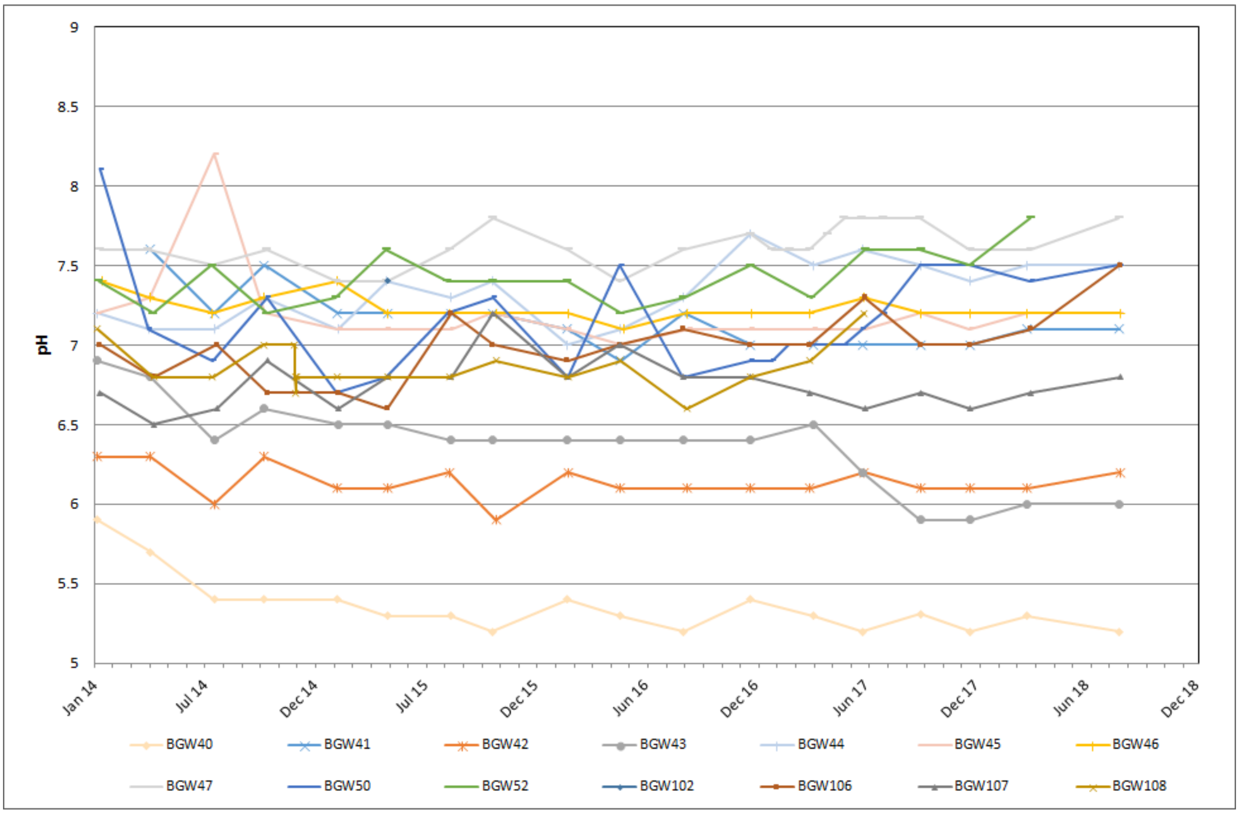


Figure 36 Spring pH (January 2014 to September 2016)

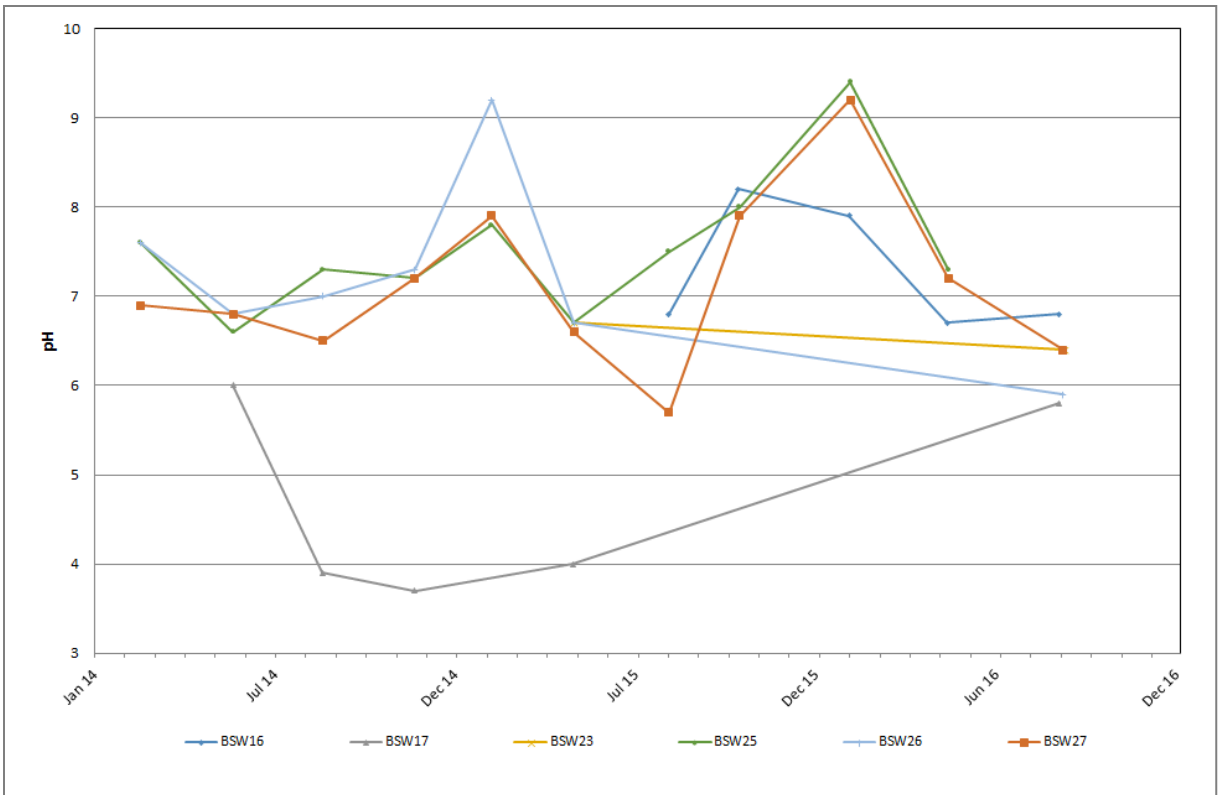


Table 21
pH Monitoring Summary

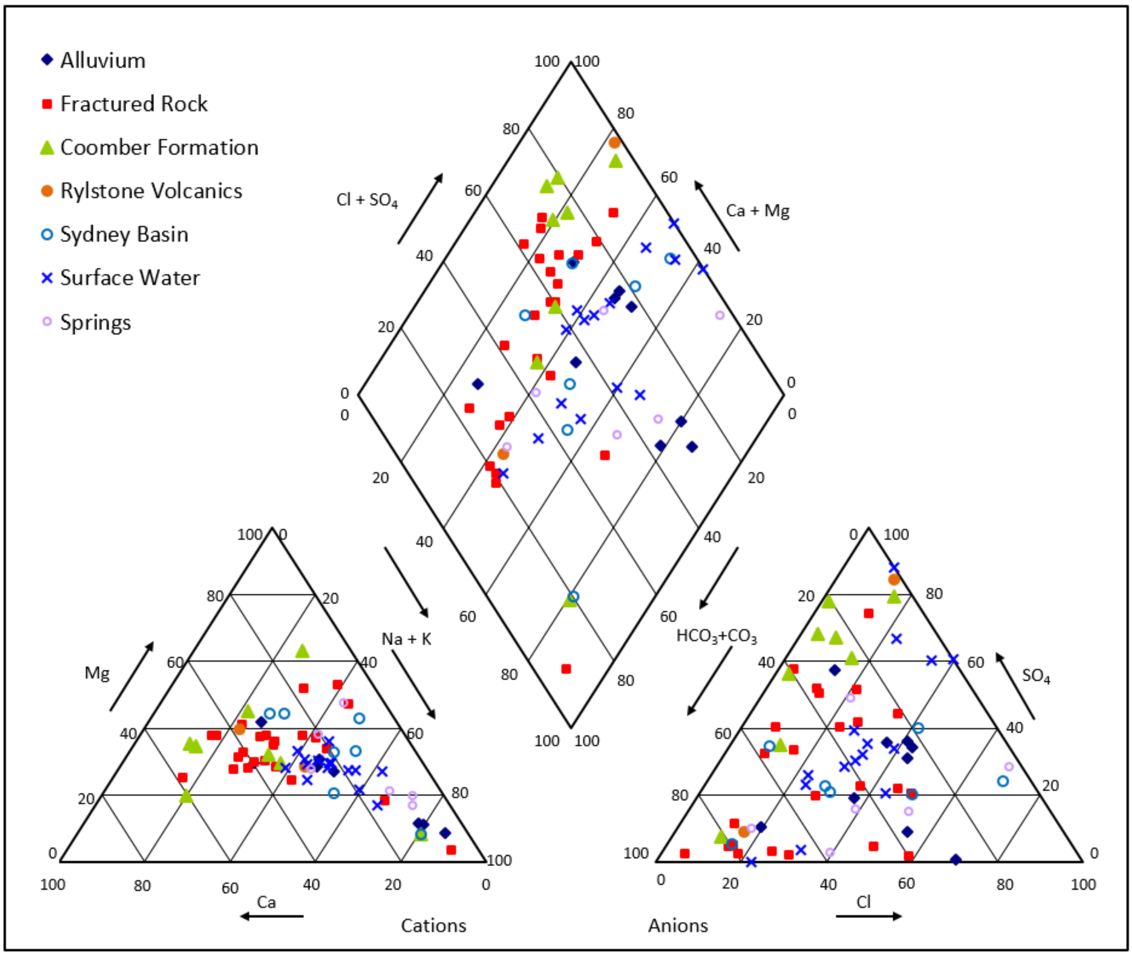
Statistics	Alluvium	Site	Regional	Springs
Count	123	518	187	44
Mean	6.7	6.9	7.2	6.8
Median	6.7	7.0	7.1	6.8
Min	5.6	5.2	6.3	3.7
Max	7.7	8.9	8.6	9.4
20th Percentile	6.4	6.5	6.9	6.0
80th Percentile	7.1	7.3	7.6	7.7

Individual groundwater monitoring locations show some variation in pH, however these variations are typically less than one pH unit. The pH levels from the spring samples show the largest total range, from 3.7 to 9.4, and also the highest variability with individual samples varying by 2 to 3 pH units. The lowest spring pH is attributed to BSW17, excluding this site the other spring pH values range from 5.7 to 9.4. Rainfall is typically mildly acidic, with pH in the range of 5 to 6. The highly variable acidity observed in the spring samples is attributed to varying soil properties, with abundance of CO_2 resulting in more acidic groundwater and HCO_3 generating more alkaline groundwater.

4.5.14.3 Water Types

Major anion and cation concentrations from the water samples are presented on a Piper Diagram in **Figure 37**. The Piper Diagram (Piper, 1944) can be used to identify different water types, or hydrochemical facies.

Figure 37 Piper Diagram



Normalised anion and cation concentrations (as milliequivalents per litre) are plotted in the corresponding ternary fields and are then projected into the rhomboid field to aid in the classification and comparison between water samples of different ionic compositions.

Given the extremely large water quality data base, it is not feasible to plot all individual samples. To aid in the identification of different hydrochemical facies, the average ionic compositions from all sampling events have been applied for each monitoring location.

It is noted that the samples grouped as Coomber Formation, Rylstone Volcanics or Sydney Basin, typically correlates with the Mine Site monitoring bores where lithology is known. The Sydney Basin samples related to bores installed in either the Illawarra Coal Measures or the Shoalhaven Group. Fractured rock monitoring bores are from the non-alluvial regional monitoring bores where detailed lithology is not known.

The dominant water types are summarised in **Table 22**. From **Table 22** and **Figure 37** there are a broad range of water types represented within the monitoring network, with no one sample group displaying distinct characteristics.

Table 22
Water Types

Sample Group	Cation Type	Anion Type
Alluvium	Typically no dominant cation. Three bores (BGW01, BGW03, and BGW06) plot as sodium plus potassium dominant.	Typically no dominant anion. BGW54 plots as bicarbonate dominant with BGW03 chloride dominant and BGW51 sulphate dominant.
Fractured Rock	No dominant cation, three bores (BGW8, BGW15 and BGW17) sodium plus potassium dominant.	Bicarbonate dominant to no dominant anion.
Coomber Formation	No dominant cation. Minor magnesium (BGW47) or sodium plus potassium dominant (BGW41).	Bicarbonate dominant to sulphate dominant.
Rylstone Volcanics	No dominant cations.	Bicarbonate to sulphate dominant.
Sydney Basin	No dominant cations.	Bicarbonate to chloride dominant.
Surface Water	Tending towards sodium plus potassium dominant.	No dominant anion to sulphate dominant.
Springs	Sodium plus potassium, or no dominant cation.	Bicarbonate dominant or no dominant anion.

In the cation field most of the hard rock aquifer samples (Fractured Rock, Coomber Formation, Rylstone Volcanics and Sydney Basin), all plot within a similar range and display a trend from no dominant cation through to sodium and potassium dominant, with those samples in the sodium plus potassium range representing more mature groundwaters. Groundwater typically undergoes a compositional change, moving from calcium dominant to sodium dominant as it matures while flowing through the aquifer. All of the other samples (Alluvium, Surface water, and Springs) also lie within this range.

Within the anion field there is generally a fairly even distribution throughout, with the exception of a general lack of any strongly chloride dominant samples. Within the hard rock aquifer system, the Coomber Formation, Rylstone Volcanics and Fractured Rock samples tend to be more bicarbonate to sulphate orientated, while the Sydney Basin samples trend from bicarbonate to chloride dominated. Surface water samples show a relatively narrow range of chloride (20-40%) but also show a distinct trend from bicarbonate dominant to sulphate dominant.

Elevated sulphate concentrations may result due to dissolution of naturally occurring gypsum in the soil profile or from sulphide minerals within the aquifers. Waste characterisation was undertaken of samples from the proposed open cut pit, comprising sandstone, crystal tuff, and volcanic breccia (GCA, 2020). GCA (2020) noted samples, particularly those from the volcanic breccia, as being a source of sulphate and manganese, with the latter associated with manganese carbonates (e.g. rhodochrosite).

The distribution of springs' samples suggests more of a trend from bicarbonate to chloride dominance.

4.5.14.4 Major Hydrogeochemical Processes

Several factors control the development of groundwater chemistry. Key influences can be related to the physical situation of the aquifer (e.g. confined or unconfined, proximity to sources of recharge or evapotranspiration etc), formation mineralogy and climate. Gibbs (1970) correlated the relative dominance of major cations and anions against total dissolved solids (TDS) to illustrate the major natural mechanisms influencing groundwater chemistry, with the three major influences being either: rainfall dominance, resulting in recharge and dilution; rock weathering, resulting in ion exchange of sodium and chloride; and evaporative concentration.

Gibbs diagrams for cations (sodium, potassium and calcium) and anions (chloride and bicarbonate) are provided in **Figure 38** and **Figure 39** respectively. Similarly to the Piper Diagram (**Figure 37**), due to the very large data set, the average ionic compositions have been applied for each sampling location.

It is noted that since the anion diagram does not include sulphate, which is shown to be a significant constituent of groundwater (Section 4.5.14.3), less emphasis should be placed on the anion interpretation compared to the cations.

Figure 38 Gibbs Diagram – Na + K / Na + K + Ca

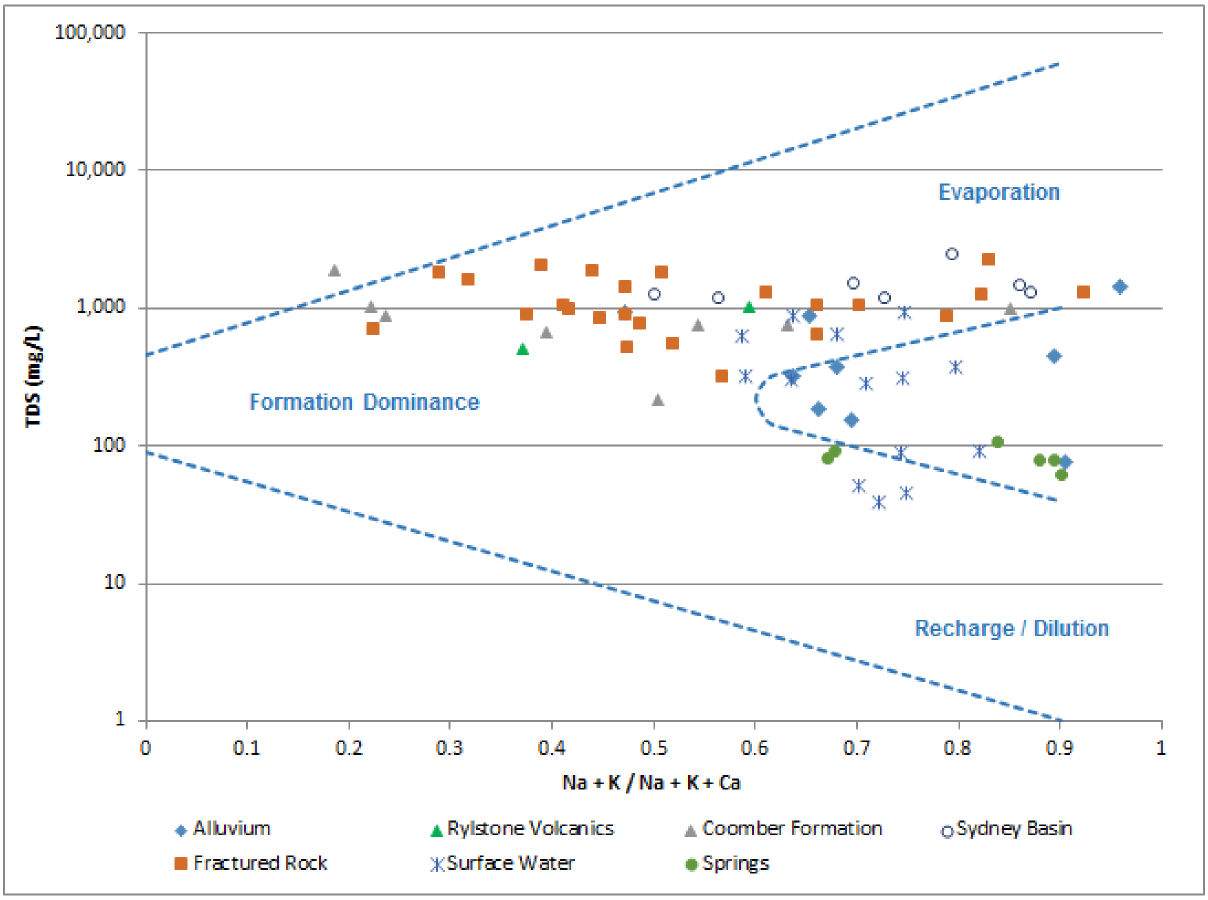
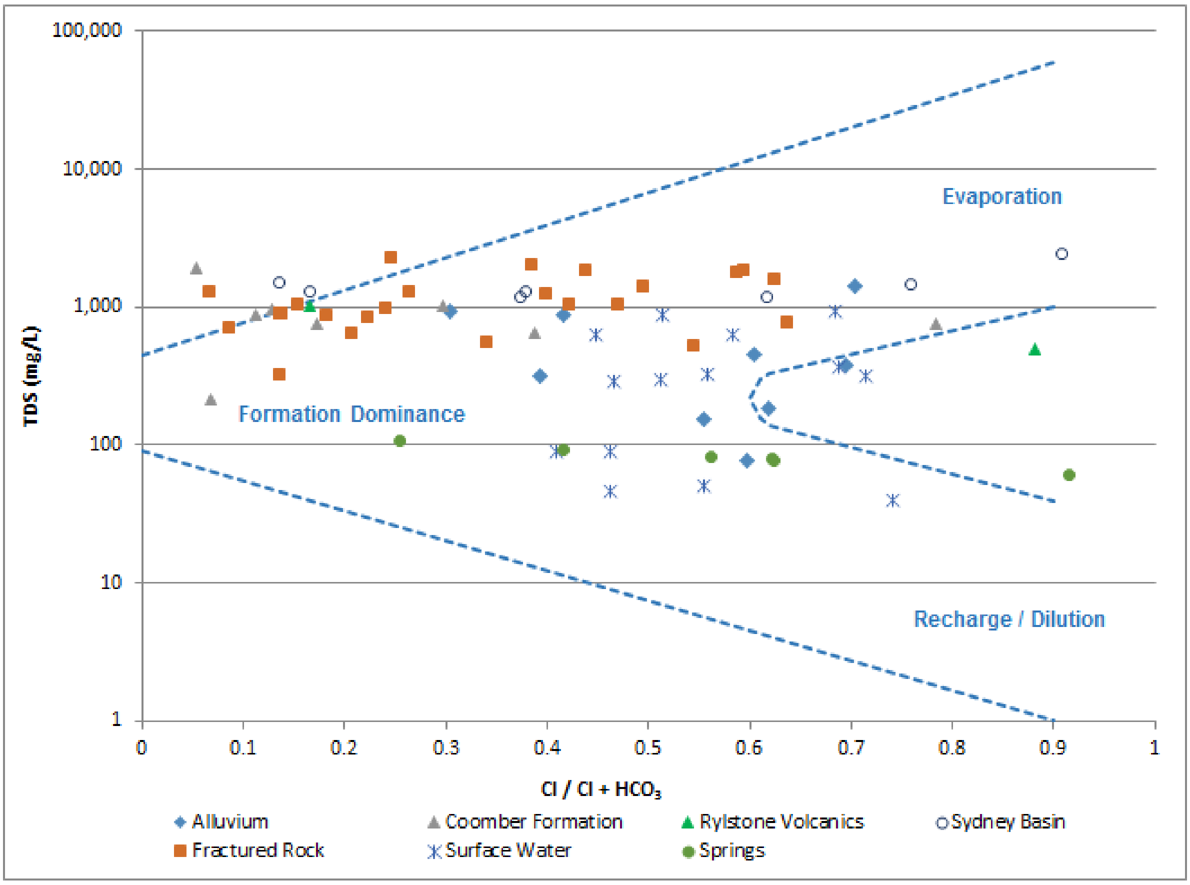


Figure 39 Gibbs Diagram – Cl / Cl + HCO_3



From **Figure 38** and **Figure 39** the following can be determined.

Groundwater

- The majority of groundwater monitoring locations show a formation influence on groundwater chemistry. However, a number of monitoring locations suggest an evaporative influence. In particular BGW03 and BGW06 (alluvial), BGW15, BGW17, and BGW31 (Fractured Rock), BGW41 (Coomber Formation), BGW07, BGW08 and BGW12 (Sydney Basin), suggest evaporative influences. This indicates that groundwater at these locations has received evaporatively enriched water from either a surface water source or shallow groundwater.
- A number of the alluvial monitoring locations (BGW05, BGW53 and BGW54) are formation dominant with mixing influences from recharge apparent at BGW48 and BGW49. BGW03 and BGW06 show evaporative influences, and BGW01 plots as strongly rainfall dominant. The formation influences may be indicative of the alluvial aquifer receiving through flow from the hard rock aquifers in those locations

Surface Water

- Several surface water monitoring locations (BSW07, BSW11, BSW12, BSW19, BSW21, and BSW22) are closely associated with formation dominant groundwater suggesting a significant groundwater contribution to surface water upstream of these monitoring locations. Five sites (BSW03, BSW05, BSW06, BSW08, and BSW15) plot as strongly influenced by rainfall. The remainder of the surface water monitoring locations plot closely to the rainfall dominance zone and suggest a mixing of rainfall and groundwater influences. It is noted that two of the surface water monitoring locations (BSW07 and BSW11, correspond to adjacent alluvial monitoring location (BGW51 and BGW53 respectively), but are offset in the direction of dilution by rainfall.

- In addition, two monitoring locations (BSW13 and BSW20) display evaporative influences.

Springs

- None of the springs sampled display a strong correlation with formation groundwater, although BSW16 and BSW23 may be indicative of mixing of water sources. Rather, the results suggest a dominance of rainfall recharge influences and it is likely that these springs result from interflow through the soil profile as opposed to groundwater discharge from aquifers.

4.5.14.5 Water Quality Guidelines

The results of comprehensive hydrochemical analyses of water quality samples (**Annexure 7**) have been compared against relevant guideline values to identify any elements or physical parameters which may be of concern in terms of either an aquatic ecosystem toxicity or human health perspective. The relevant guidelines include the Australian and New Zealand Guidelines (ANZG, 2018), and the Australian Drinking Water Guidelines (ADWG, 2011) (the Drinking Water Guidelines).

Individual exceedances of the relevant guideline value for individual samples are highlighted in **Annexure 7**. For simplicity, only exceedances by mean constituent concentrations from all samples are discussed in the following sections. Guideline values calculated mean concentrations for all monitoring locations and the identification of results where the calculated mean exceeds guideline values are summarised in **Table 23**.

ANZ Guidelines

The ANZ Guidelines provide guidelines for the protection of aquatic ecosystems. For this assessment, trigger values for physical and chemical stressors for slightly disturbed ecosystems - upland rivers (above 150m AHD) have been applied, and for potentially toxic constituents, such as dissolved metals, the trigger values for 95% protection of freshwater aquatic ecosystems have been applied.

It is noted that due to the number of exceedances of the ANZ Guidelines within the baseline data, for operational purposes, it is recommended that site specific trigger values, reflecting the formation influences on groundwater chemistry, be developed using the methodology prescribed in the ANZ Guidelines.

Physical and Chemical Stressors

Concentrations of total nitrogen, total phosphorus, nitrates of nitrogen, and EC consistently exceed trigger values for slightly disturbed ecosystems - upland rivers. Key exceptions with regard to EC are for surface water samples from BSW03, BSW04, BSW05, BSW06, BSW08 and BSW15, where mean EC was below the 350 µS/cm trigger value, as were groundwater samples from BGW01, BGW27A, BGW29, BGW48 and BGW49, and all of the spring samples.

Table 23
Comparison of Mean Concentrations with Guideline Values

Monitoring Location	Physical and Chemical Stressors						Toxicants								
	Electrical Conductivity @ 25°C µS/cm	pH Value pH Unit	Nitrate as N mg/L	Nitrite as N mg/L	Total Nitrogen as N mg/L	Total Phosphorus as P mg/L	Arsenic - Dissolved mg/L	Cadmium - Dissolved mg/L	Chromium - Dissolved mg/L	Copper - Dissolved mg/L	Lead - Dissolved mg/L	Lithium - Dissolved mg/L	Manganese - Dissolved mg/L	Nickel - Dissolved mg/L	Zinc - Dissolved mg/L
ANZG	350	6.5-7.5	0.015	0.015	0.25	0.02	0.013	0.0002	0.001	0.0014	0.0034	0.0025	1.9	0.0011	0.008
ADWG	-	6.5-8.51	50	-	-	-	0.01	0.002	0.05	2	0.01	-	0.5	0.02	-
Alluvial Monitoring Bore															
BGW01	131	5.98	0.584		1.200	0.066				0.001		0.002	0.006	0.002	0.016
BGW03	2320	7.18	0.040	0.050	1.150	0.050				0.002	0.003	0.704	0.314		0.018
BGW05	638	6.45	0.093		0.345	0.052		0.0001		0.012		0.003	1.916	0.006	0.025
BGW48	278	6.86	0.615	0.420	4.250	0.570	0.004	0.0004	0.001	0.015	0.004	0.004	0.356	0.003	0.022
BGW49	328	6.51	0.548	0.017	1.824	0.807	0.020	0.0002		0.002	0.002	0.004	0.210	0.002	0.021
BGW51	1281	6.60	0.106		0.578	0.642	0.002	0.0008		0.004	0.007	0.086	0.629	0.004	0.039
BGW53	1283	7.23	3.407	0.020	4.006	0.110		0.0002		0.003		0.004	0.008	0.001	0.009
BGW54	453	6.64	0.985	0.030	5.288	3.839	0.002			0.001		0.001	0.611	0.005	0.006
Mine Site Monitoring Bore															
BGW102	1380	7.40			0.850	0.180	0.078	0.0003		0.013	0.014	0.360	2.847	0.003	0.126
BGW106	1219	6.99	0.148	0.020	0.488	0.033	0.002	0.0002	0.001	0.003	0.003	0.166	0.851	0.004	0.150
BGW107	1476	6.76	0.033	0.020	0.306	0.100	0.009			0.003	0.016	0.326	1.752	0.003	0.060
BGW108	2363	6.86	0.125		0.607	0.217	0.290	0.0002		0.002	0.016	0.483	1.478	0.003	0.373
BGW10	1349	7.06	0.164		0.883	0.045	0.015			0.002		0.073	0.326	0.002	0.008
BGW11	1865	6.59	0.056	0.010	0.455	0.067	0.002			0.001		0.136	0.106	0.003	0.020
BGW12	4364	6.41	0.576	0.059	1.679	0.189	0.001	0.0001		0.003		0.131	0.422	0.042	0.214
BGW15	2933	7.26	0.333	0.043	0.536	0.158	0.001	0.0001		0.002	0.003	0.656	0.097	0.001	0.012

(Blue) Indicates exceedance of ANZ Guideline trigger values

(Purple) Indicates exceeds both ANZ Guideline and Drinking Water Guidelines

(Red) Indicates exceedance of Drinking Water Guidelines health based value

Table 23 (Cont'd)
Comparison of Mean Concentrations with Guideline Values

Monitoring Location	Physical and Chemical Stressors						Toxicants								
	Electrical Conductivity @ 25°C µS/cm	pH Value pH Unit	Nitrate as N mg/L	Nitrite as N mg/L	Total Nitrogen as N mg/L	Total Phosphorus as P mg/L	Arsenic - Dissolved mg/L	Cadmium - Dissolved mg/L	Chromium - Dissolved mg/L	Copper - Dissolved mg/L	Lead - Dissolved mg/L	Lithium - Dissolved mg/L	Manganese - Dissolved mg/L	Nickel - Dissolved mg/L	Zinc - Dissolved mg/L
ANZG	350	6.5-7.5	0.015	0.015	0.25	0.02	0.013	0.0002	0.001	0.0014	0.0034	0.0025	1.9	0.0011	0.008
ADWG	-	6.5-8.51	50	-	-	-	0.01	0.002	0.05	2	0.01	-	0.5	0.02	-
Mine Site Monitoring Bore (Cont'd)															
BGW16	1347	7.15	0.658	0.090	0.812	0.048				0.001		0.068	0.014		0.007
BGW17	1624	7.94	0.778	0.090	0.971	0.082	0.002			0.002		0.214	0.079		0.007
BGW18	1121	6.82	0.051		0.365	0.051	0.003			0.001		0.065	23.392	0.004	0.075
BGW19	950	6.65	0.045	0.020	0.760	0.320	0.085	0.0002		0.002	0.002	0.065	3.895	0.001	0.015
BGW20	774	6.13	0.237		0.631	0.135	0.033	0.0001		0.002	0.002	0.046	29.495	0.004	0.078
BGW27	486	6.89	0.508		0.700	0.286	0.008						0.765	0.002	0.045
BGW27A	294	6.02	0.062		0.350	0.456	0.053	0.0001		0.003			7.230	0.013	1.112
BGW29	326	7.03	2.708	0.020	3.433	0.203		0.0002		0.002		0.002	0.024	0.002	0.031
BGW38	2109	6.99	1.266	0.025	1.839	0.169	0.002	0.0001		0.002		0.073	2.076	0.003	0.039
BGW39	1191	7.36	0.185	0.010	0.444	0.082				0.002		0.073	0.029	0.008	0.013
BGW40	1043	5.40	0.059	0.052	0.789	0.035	0.005		0.002	0.003	0.002	0.050	8.918	0.250	0.885
BGW41	1304	7.15	0.138		0.447	0.176	0.004			0.001		0.618	0.200	0.003	0.061
BGW42	940	6.14	0.063	0.020	0.422	0.042	0.015	0.0001	0.001	0.002		0.047	1.243	0.040	0.056
BGW43	1366	6.32	0.157	0.030	0.500	0.065	0.008	0.0002				0.138	2.639	0.022	0.165
BGW44	1671	7.33	0.344	0.270	0.628	0.069	0.001			0.005		0.225	0.156	0.003	0.012
BGW45	1923	7.20	0.043	0.020	0.667	0.041	0.002			0.002	0.005	0.408	0.258	0.002	0.017
BGW46	1168	7.23	0.090	0.015	0.744	0.137	0.105				0.001	0.601	1.602	0.001	0.012
BGW47	1007	7.63	0.302	0.028	0.457	0.069	0.002			0.002		0.078	0.135		0.009
BGW50	1166	7.15	0.394	0.010	0.775	0.043	0.002			0.002		0.085	0.218	0.003	0.027
BGW52	836	7.43	1.136		1.583	0.020	0.001	0.0001		0.003		0.014	0.004	0.002	0.030

(Blue) Indicates exceedance of ANZ Guideline trigger values; (Purple) Indicates exceeds both ANZ Guideline and Drinking Water Guidelines; (Red) Indicates exceedance of Drinking Water Guidelines health based value

Table 23 (Cont'd)
Comparison of Mean Concentrations with Guideline Values

Monitoring Location	Physical and Chemical Stressors						Toxicants								
	Electrical Conductivity @ 25°C µS/cm	pH Value pH Unit	Nitrate as N mg/L	Nitrite as N mg/L	Total Nitrogen as N mg/L	Total Phosphorus as P mg/L	Arsenic - Dissolved mg/L	Cadmium - Dissolved mg/L	Chromium - Dissolved mg/L	Copper - Dissolved mg/L	Lead - Dissolved mg/L	Lithium - Dissolved mg/L	Manganese - Dissolved mg/L	Nickel - Dissolved mg/L	Zinc - Dissolved mg/L
ANZG	350	6.5-7.5	0.015	0.015	0.25	0.02	0.013	0.0002	0.001	0.0014	0.0034	0.0025	1.9	0.0011	0.008
ADWG	-	6.5-8.51	50	-	-	-	0.01	0.002	0.05	2	0.01	-	0.5	0.02	-
Regional Monitoring Bore															
BGW06	708	6.84	0.105	0.020	2.239	0.248	0.002		0.001	0.006	0.003		0.223	0.004	0.021
BGW07	2287	7.40	0.474	0.040	1.271	0.045				0.002		0.040	0.290	0.001	0.065
BGW08	1665	7.38	0.110		1.425	0.239	0.005			0.005	0.005	0.287	0.098	0.003	0.037
BGW09	1364	7.29	0.117	0.010	0.791	0.066	0.003			0.015		0.108	0.063	0.016	0.285
BGW14	1786	6.78	0.150	0.020	0.483	0.100				0.002		0.234	0.029	0.003	0.017
BGW21	2627	7.01	0.523	0.010	0.600	0.074	0.002			0.009	0.002	0.021	1.354	0.002	0.044
BGW24	2068	6.88	2.842	0.064	3.524	0.052		0.0002		0.027			0.273	0.003	0.112
BGW26	1563	6.98	0.377	0.015	0.594	0.065		0.0042		0.006		0.054	0.005	0.002	0.019
BGW32	3095	7.10	5.530		6.000	0.090		0.0002		0.068	0.003		0.023	0.002	0.054
BGW33	921	8.13	1.823		2.433	0.035	0.001		0.003	0.011	0.001	0.007	0.004	0.002	0.132
BGW35	2415	6.90	5.080	0.033	5.947	0.028		0.0007		0.010	0.001	0.006	0.005	0.003	0.258
BGW36	1186	8.06	0.136	0.010	0.446	0.046	0.001	0.0003		0.007	0.021	0.081	0.084	0.002	0.264
BGW37	2703	6.93	10.878	0.020	11.925	0.030		0.0001		0.052		0.007	0.030	0.002	0.071
BGW32	3095	7.10	5.530		6.000	0.090	0.020		0.0002		0.068	0.003	0.017	0.023	0.054
BGW33	921	8.13	1.823		2.433	0.035	0.070	0.001		0.003	0.011	0.001	0.007	0.004	0.132
BGW35	2893	6.90	5.549	0.038	6.727	0.037	0.055				0.012	0.001	0.011	0.006	0.128
BGW36	1193	8.09	0.171		0.475	0.058	0.062	0.001	0.0003		0.008	0.029	0.081	0.038	0.263
BGW37	2703	6.93	10.878	0.020	11.925	0.030	0.020		0.0001		0.042		0.007	0.026	0.071

(blue)	Indicates exceedance of ANZ Guideline trigger values
(purple)	Indicates exceeds both ANZ Guideline and Drinking Water Guidelines
(red)	Indicates exceedance of Drinking Water Guidelines health based value

Table 23 (Cont'd)
Comparison of Mean Concentrations with Guideline Values

Monitoring Location	Physical and Chemical Stressors						Toxicants								
	Electrical Conductivity @ 25°C µS/cm	pH Value pH Unit	Nitrate as N mg/L	Nitrite as N mg/L	Total Nitrogen as N mg/L	Total Phosphorus as P mg/L	Arsenic - Dissolved mg/L	Cadmium - Dissolved mg/L	Chromium - Dissolved mg/L	Copper - Dissolved mg/L	Lead - Dissolved mg/L	Lithium - Dissolved mg/L	Manganese - Dissolved mg/L	Nickel - Dissolved mg/L	Zinc - Dissolved mg/L
ANZG	350	6.5-7.5	0.015	0.015	0.25	0.02	0.013	0.0002	0.001	0.0014	0.0034	0.0025	1.9	0.0011	0.008
ADWG	-	6.5-8.51	50	-	-	-	0.01	0.002	0.05	2	0.01	-	0.5	0.02	-
Springs															
BSW16	164	7.28	0.153		0.400	0.063	0.028	0.001			0.002			0.050	0.018
BSW17	157	4.68	0.720		2.280	0.063	0.110				0.007		0.001	0.032	0.054
BSW23	107	6.55	0.020		2.200	0.285	0.030	0.002			0.005	0.008		0.423	0.023
BSW25	174	7.54	0.105		0.970	0.078	0.078	0.003			0.002	0.002		0.077	0.013
BSW26	136	7.21	0.213		2.329	0.083	0.048	0.004			0.001	0.001		0.074	0.016
BSW27	134	7.12	0.379		3.736	0.200	0.235	0.007			0.003	0.003		0.073	0.019

(blue)	Indicates exceedance of ANZ Guideline trigger values	(purple)	Indicates exceeds both ANZ Guideline and Drinking Water Guidelines	(red)	Indicates exceedance of Drinking Water Guidelines health based value

The consistency of these exceedances throughout groundwater and surface water samples would suggest that the elevated levels are a representation of the predominantly disturbed local catchment, and are likely to be anthropogenic in origin, resulting from land uses such as grazing, horticulture, and pasture improvement, which have disrupted the natural hydrologic regime.

Dissolved Metals

The trigger values for the dissolved metals; copper, lithium, nickel and zinc, are consistently exceeded by median concentrations in most groundwater samples, with regular exceedances of cadmium, lead and manganese in most groundwater groups (with the exception of cadmium and manganese at the springs).

Mean concentrations of chromium occasionally exceed trigger levels when the samples return positive values (greater than the limit of reporting). It is noted that positive results for chromium are only returned for groundwater samples.

Hardness Modified Trigger Values

The bio-availability of certain dissolved metals can be dependent on the hardness of the water due to complexation with carbonate ions. The ANZ Guidelines specify algorithms and factors for modifying trigger values according to water hardness for cadmium, chromium III, copper, lead, nickel, and zinc.

With the application of the calculated hardness modified trigger values, the frequency of trigger exceedances are significantly reduced for the groundwater samples. Given that the springs are typically soft (a maximum hardness of 42mg/L as $CaCO_3$ at BSW25) the hardness modified trigger values have no influence. **Table 24** lists the comparison against hardness modified trigger levels for the alluvial, Mine Site and regional monitoring bores.

- Alluvial Monitoring Bores
  - BGW48 consistently exceeded the calculated hardness modified trigger values for cadmium, chromium, copper, lead, nickel and zinc.
  - Occasional exceedances of copper, nickel and zinc.
- Mine Site Monitoring Bores
  - 12 exceedances of zinc (BGW12, BGW18, BGW20, BGW27, BGW27A, BGW29, BGW40, BGW41, BGW43, BGW102, BGW106 and BGW108), and 2 exceedances of nickel (BGW27A and BGW40).
- Regional Monitoring Bores
  - Moderate exceedances of zinc (BGW06, BGW08, BGW09, BGW24, BGW33, BGW35 and BGW36), copper (BGW06, BGW09, BGW24, BGW32 and BGW37), and two exceedances of nickel (BGW06 and BGW09), and one of cadmium (BGW26).

Australian Drinking Water Guidelines

The Drinking Water Guidelines are not mandatory standards; however, they are intended to provide a framework for good management of drinking water supplies that, if implemented, would assure safety at point of use.

Table 24
Comparison Against Hardness Modified Trigger Values

Page 1 of 2

Monitoring Location	Hardness as $CaCO_3$ (mg/L)	Cadmium - Dissolved mg/L	Chromium - Dissolved mg/L	Copper - Dissolved mg/L	Lead - Dissolved mg/L	Nickel - Dissolved mg/L	Zinc - Dissolved mg/L
Alluvial Monitoring Bore							
BGW01	10.8			0.0013		0.0020	0.0160
BGW03	115.7			0.0015	0.0030		0.0180
BGW05	156.0	0.0001		0.0119		0.0062	0.0248
BGW48	56.2	0.0004	0.0010	0.0150	0.0040	0.0033	0.0223
BGW49	73.8	0.0002		0.0020	0.0020	0.0024	0.0210
BGW51	468.1	0.0008		0.0043	0.0070	0.0036	0.0386
BGW53	352.6	0.0002		0.0026		0.0010	0.0092
BGW54	117.4			0.0010		0.0045	0.0060
Mine Site Monitoring Bore							
BGW102	625.2	0.0003		0.0125	0.0140	0.0030	0.1263
BGW106	405.1	0.0002	0.0010	0.0032	0.0025	0.0037	0.1503
BGW107	577.1			0.0025	0.0160	0.0030	0.0597
BGW108	992.2	0.0002		0.0023	0.0158	0.0025	0.3727
BGW10	542.0			0.0016		0.0016	0.0079
BGW11	657.2			0.0010		0.0026	0.0199
BGW12	977.4	0.0001		0.0029		0.0425	0.2143
BGW15	516.3	0.0001		0.0020	0.0030	0.0010	0.0118
BGW16	438.7			0.0010			0.0071
BGW17	98.5			0.0016			0.0070
BGW18	469.0			0.0010		0.0035	0.0749
BGW19	425.4	0.0002		0.0018	0.0020	0.0010	0.0149
BGW20	222.7	0.0001		0.0021	0.0020	0.0035	0.0777
BGW27	132.4					0.0018	0.0450
BGW27A	87.2	0.0001		0.0030		0.0125	1.1116
BGW29	103.3	0.0002		0.0023		0.0015	0.0310
BGW38	1215.7	0.0001		0.0018		0.0030	0.0387
BGW39	475.9			0.0021		0.0084	0.0127
BGW40	229.6		0.0020	0.0030	0.0020	0.2499	0.8845
BGW41	156.7			0.0013		0.0029	0.0608
BGW42	378.2	0.0001	0.0010	0.0017		0.0397	0.0564
BGW43	637.7	0.0002				0.0216	0.1652
BGW44	434.4				0.0052		0.0025
BGW45	463.6				0.0015	0.0050	0.0023
BGW46	474.5					0.0010	0.0010
BGW47	337.5				0.0018		
BGW50	432.2				0.0021		0.0033
BGW52	268.8		0.0001		0.0025		0.0020

(Shaded) Indicates exceedance of ANZ Guideline hardness modified trigger values

Table 24 (Cont'd)
Comparison Against Hardness Modified Trigger Values

Page 2 of 2

Monitoring Location	Hardness as $CaCO_3$ (mg/L)	Cadmium - Dissolved mg/L	Chromium - Dissolved mg/L	Copper - Dissolved mg/L	Lead - Dissolved mg/L	Nickel - Dissolved mg/L	Zinc - Dissolved mg/L
Regional Monitoring Bore							
BGW06	69.1		0.0010	0.0058	0.0026	0.0043	0.0205
BGW07	602.1			0.0021		0.0014	0.0650
BGW08	195.4			0.0053	0.0048	0.0030	0.0370
BGW09	428.3			0.0152		0.0158	0.2847
BGW14	712.8			0.0017		0.0027	0.0174
BGW21	1256.4			0.0085	0.0020	0.0018	0.0444
BGW24	807.9	0.0002		0.0267		0.0026	0.1125
BGW26	559.6	0.0042		0.0058		0.0020	0.0189
BGW32	1062.5	0.0002		0.0675	0.0030	0.0020	0.0535
BGW33	311.6		0.0025	0.0107	0.0010	0.0020	0.1317
BGW35	1121.1	0.0007		0.0097	0.0010	0.0034	0.2583
BGW36	393.9	0.0003		0.0065	0.0211	0.0020	0.2644
BGW37	1169.4	0.0001		0.0523		0.0020	0.0705
Springs							
BSW16	36.9			0.0024		0.0034	0.0225
BSW17	13.9			0.0065		0.0030	0.0803
BSW23	29.4			0.0045	0.0080	0.0100	0.0225
BSW25	42.1			0.0019	0.0015		0.0126
BSW26	15.7			0.0013	0.0010		0.0150
BSW27	16.3			0.0027	0.0028		0.0235
	Indicates exceedance of ANZ Guideline hardness modified trigger values						

The following exceedances of the health-based Drinking Water Guidelines are noted.

- Arsenic – exceedance in eight Mine Site monitoring bores and one alluvial monitoring bore.
- Cadmium – one exceedance in regional monitoring bore (BGW26).
- Lead – exceedance in three Mine Site monitoring bores and one regional monitoring bore.
- Manganese - numerous exceedances in Mine Site monitoring bores, with occasional exceedance from alluvial and regional monitoring. As noted in Section 4.5.14.3, GCA (2020) identified the presence of manganese carbonates in ore and waste rock material as a source of manganese.

4.6 GROUNDWATER SUPPLY POTENTIAL

In addition to mine dewatering (whether via in-pit sump pumping or perimeter dewatering bores), there is potential to access supplementary groundwater supply, if required, via the installation of additional groundwater bores within the Mine Site and surrounds. Previous investigations have identified that enhanced permeability and useful yields are possible from fractured rock aquifers in the vicinity of the major geological structures. In addition, deeper exploration drilling at the Mine Site and beyond 600m in depth has confirmed large regional structures with significant porosity that have the potential to accommodate productive aquifers. It is understood that Bowdens Silver are not seeking to source water from groundwater bores for operational requirements (groundwater bores would be used for water supply during site establishment and construction). Water that cannot be sourced from Mine Site water storage, TSF return water or dewatering of the open cut pit would be supplied externally from either the Ulan Coal Mine and/or Moolarben Coal Mine via a dedicated water pipeline. The following overview of groundwater supply potential is theoretical and is provided for the purpose of highlighting the potential for alternative sources of water should they be required.

Any groundwater that may be sourced from bores within the Mine Site or nearby land would require additional investigation to identify sources of sufficient and sustained supply. Some indications of groundwater potential have been identified during exploration activities. However, it is worth noting that potential groundwater yields as indicated by airlift yields during exploratory drilling are not always representative of long-term sustainable yields, particularly in fractured rock aquifers. Fractured rock aquifers typically have significantly reduced storage capacity and recharge when compared to sedimentary aquifers with equivalent permeability. This characteristic is demonstrated by early exploration drilling and bore construction at the Mine Site, where two particularly high yielding exploration holes were converted to water supply bores. Exploration holes BGR166 and WAP015 recorded airlift yields as high as 15.0L/s and 19.7L/s, respectively. These holes were subsequently converted to test bores BGW108 and BGW10. Test pumping at BGW108 and BGW10 (refer Section 4.5.9) showed that the short-term sustainable pumping yields of the bores was approximately 5L/s, substantially lower than the initial airlift yields. Notwithstanding, when managed accordingly, such bores can provide a useful groundwater resource and it is anticipated that BGW108 and BGW10 will provide the bulk of the initial water demand during construction.

Prospective groundwater supply bores located within the Mine Site may provide an opportunity for advanced mine dewatering (that is, supply of groundwater via groundwater bores consistent with the licenced entitlement held by Bowdens Silver to account for future dewatering requirements). However, advanced mine dewatering can only be relied upon until the open cut pit is developed. Ongoing supplementary water supplies may also be sourced from similar hydrogeological environments within land surrounding the Mine Site or at depth in deeply seated aquifers. Potential groundwater supply bores would need to be located away from the open cut pit area such that drawdown due to mine dewatering does not significantly reduce the available drawdown and supply capacity at the bore. The predicted drawdown due to mine dewatering is presented in Section 6.1. Water supply via these bores would be subject to licensing and assessment to ensure that the cumulative water use is not impacting water supply at registered groundwater bores (in accordance with the AIP).

The siting of any prospective water supply bores would be dependent on successful investigation results and would be subject to the appropriate water supply works and water use approvals administered under Section 92 of the WMA 2000.

5. CONCEPTUAL HYDROGEOLOGICAL MODEL

A conceptual hydrogeological model is a descriptive representation of a groundwater system based on the interpretation of geological and hydrological conditions. Such a model is used to synthesise current understanding of the groundwater system and its key processes including the influence of stresses, to assist in quantifying the impacts of possible future changes.

Key elements of the conceptual hydrogeological model for the hydrostratigraphic units identified in Section 4.5.2 are summarised in the following sub-sections and shown In **Figure 40** and **Figure 41**. Further information on the conceptual hydrogeological model and its implementation within the numerical groundwater model developed to inform the impact assessment is provided in **Annexure 9**.

5.1 GROUNDWATER RECHARGE

Groundwater recharge is conceptualised as being dominated by the infiltration of rainfall runoff, ephemeral streamflow on areas of outcropping and sub-cropping hard rock lithologies (and regolith) and directly onto the alluvium. In addition, formations underlying the sediments are also considered to receive a small component of vertical leakage from this hydrostratigraphic unit.

The major drainage features, such as Hawkins and Lawsons Creeks, are also likely to alternate between being zones of groundwater recharge or discharge to their surrounding alluvium at various reach sections. This localised gaining or losing system condition would be contingent upon the streamflow at that time as well as local topography.

5.2 GROUNDWATER FLOW

The primary geological provinces within the study area are the Lachlan Fold Belt and the Sydney Basin. Each of these provinces also contain limited areas of Quaternary alluvium which are associated with major surface water drainage features.

These geological provinces also host two distinct groundwater systems with the following regional flow characteristics:

- Lachlan Fold Belt system is largely controlled by topography and surface water drainage with groundwater flow and discharge to the northwest; and
- Sydney Basin system is largely controlled by the bedding planes of the various units with groundwater flow and discharge to the northeast.

The flow characteristics of the respective hydrostratigraphic units within the Mine Site and study area are summarised below.

Alluvium

Alluvial deposits are mostly developed in association with Hawkins and Lawsons Creeks. Within the Mine Site there is a veneer of alluvium associated with the Hawkins Creek floodplain. Groundwater flow in these localised systems is associated with primary porosity and generally expected to be a sub-surface reflection of the associated surface water system.

Sydney Basin Sediments

Whilst the Sydney Basin sediments contain significant sandstone units, limited primary porosity and permeability remains within these units as the original interstitial pore spaces has been largely infilled during diagenesis. The Illawarra Coal Measures are typically the main aquifer of the Sydney Basin Sediments due to the development of cleats within the coal seams. Furthermore, the typically low permeability Shoalhaven Group likely acts as an aquitard to impede vertical groundwater flow from the Sydney Basin sediments to underlying formations, such as the Rylstone Volcanics.

In summary, groundwater flow within the Sydney Basin sediments is typically dominated by fracture flows, with some occurring via relict primary porosity. Regional flow is largely sub-horizontal, controlled by bedding planes and cleats, with stratification and low permeability layers acting to impede vertical groundwater flow.

Rylstone Volcanics

Within this hydrostratigraphic unit the individual sub-units display differing hydraulic properties. Whilst the welded tuff / ignimbrite sub-unit typically displayed lower primary porosity and permeability, investigations undertaken on the Mine Site did not indicate a significant distinction in porosity between these sub-units.

Regionally, groundwater flow within the Rylstone Volcanics is dominated by fracture flow. However, within the open cut pit the high density and nature of fracturing means that on an intermediate scale, groundwater flow behaves in a similar manner to a porous rock aquifer.

Lachlan Fold Belt / Coomber Formation

The Coomber Formation is considered as the hydrogeological basement for the regional groundwater systems in which the Mine Site is situated. However, this unit still has potential to have reasonably high permeability in the vicinity of major structures.

Regionally, the meta-sedimentary and meta-volcaniclastic formations of the Lachlan Fold Belt are highly structurally deformed with minor primary porosity. This deformation has resulted in variable bedding orientation that is typically moderately dipping to steeply dipping. Where this hydrostratigraphic unit outcrops, to the west and south of the Mine Site, there is a prevailing cleavage orientation which trends northwest-southeast, to north-south, consistent with the prevailing structural orientation. These cleavage planes dip variably to the east and west.

As groundwater flow in this hydrostratigraphic unit will be controlled by fracture flow, there is likely to be a preferred flow direction that is consistent with cleavage and fracturing. However, shallower groundwater flow within the weathered zones (typically in the upper 20m to 30m), will be more topographically controlled.

5.2.1 Local Influence of Major Structures

Pumping test data from BGW10 and BGW108 (refer Section 4.5.9) suggests that the two major sub north-south trending structures in the vicinity of the open cut pit inhibit, but not completely prevent, groundwater flow. However, drilling results suggest that relatively high groundwater yields can be obtained in the vicinity of the structures.

These major structures are therefore conceptualised as inhibiting groundwater flow across the structure while locally enhancing permeability in the vicinity of the structure.

5.3 GROUNDWATER DISCHARGE

As noted in Section 5.1, periodic and local groundwater discharge is expected to the alluvium aquifers adjacent to drainage features. Additional groundwater discharge would also occur via evapotranspiration from riparian and deep-rooted terrestrial vegetation.

Regionally, groundwater discharge (throughflow) from the Coomber Formation and wider Lachlan Fold Belt will be to the northwest. Within the Sydney Basin sediments regional groundwater discharge is to the drainage features in the northeast, such as those in the Totnes, Barigan and Bylong Valleys, with minor vertical leakage to underlying formations.

Groundwater abstraction by other groundwater users is also considered as a mechanism of groundwater discharge from the conceptual hydrogeological model.

Figure 40 Conceptual Hydrogeological Model – Pre-Mining

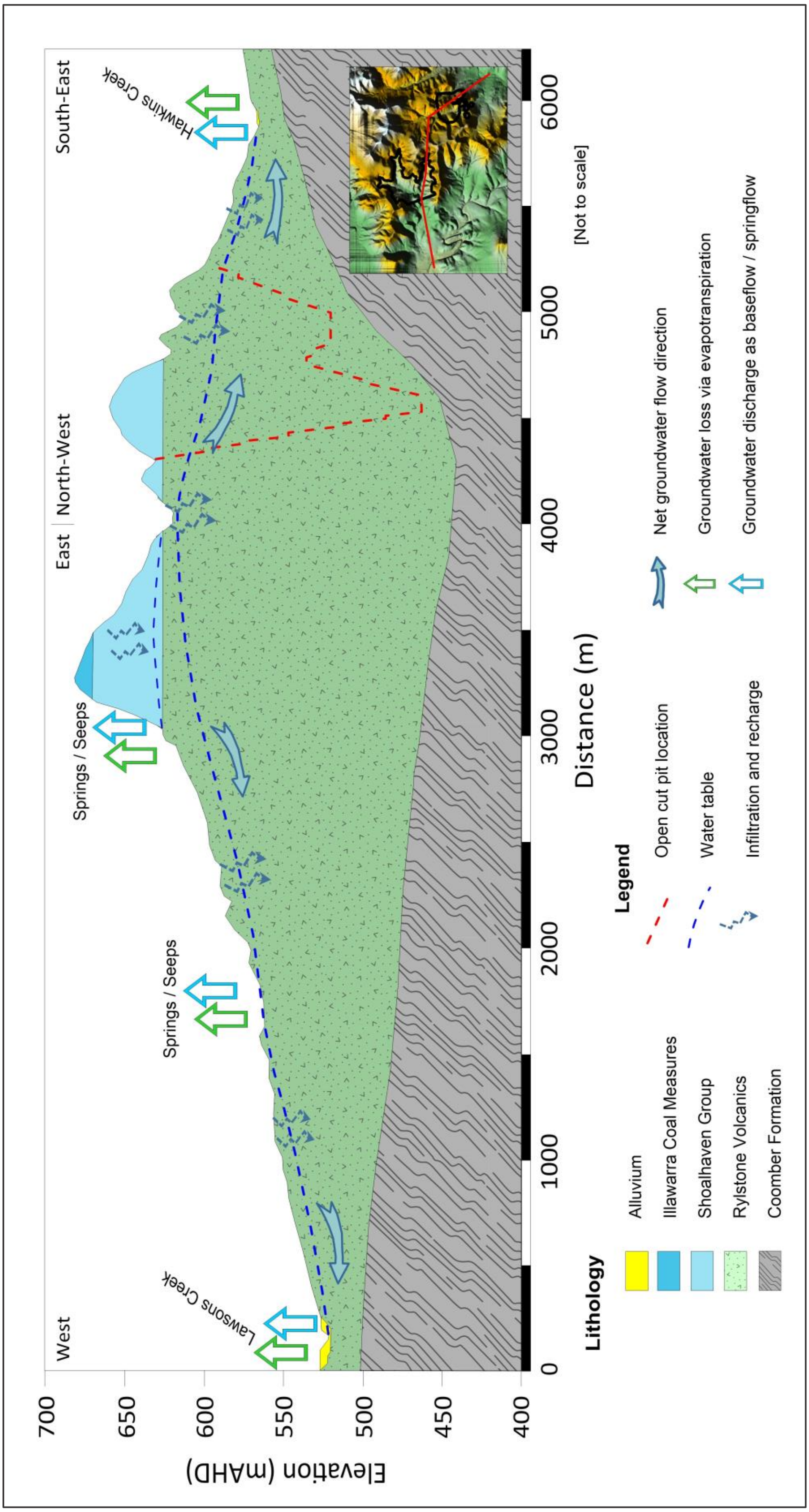
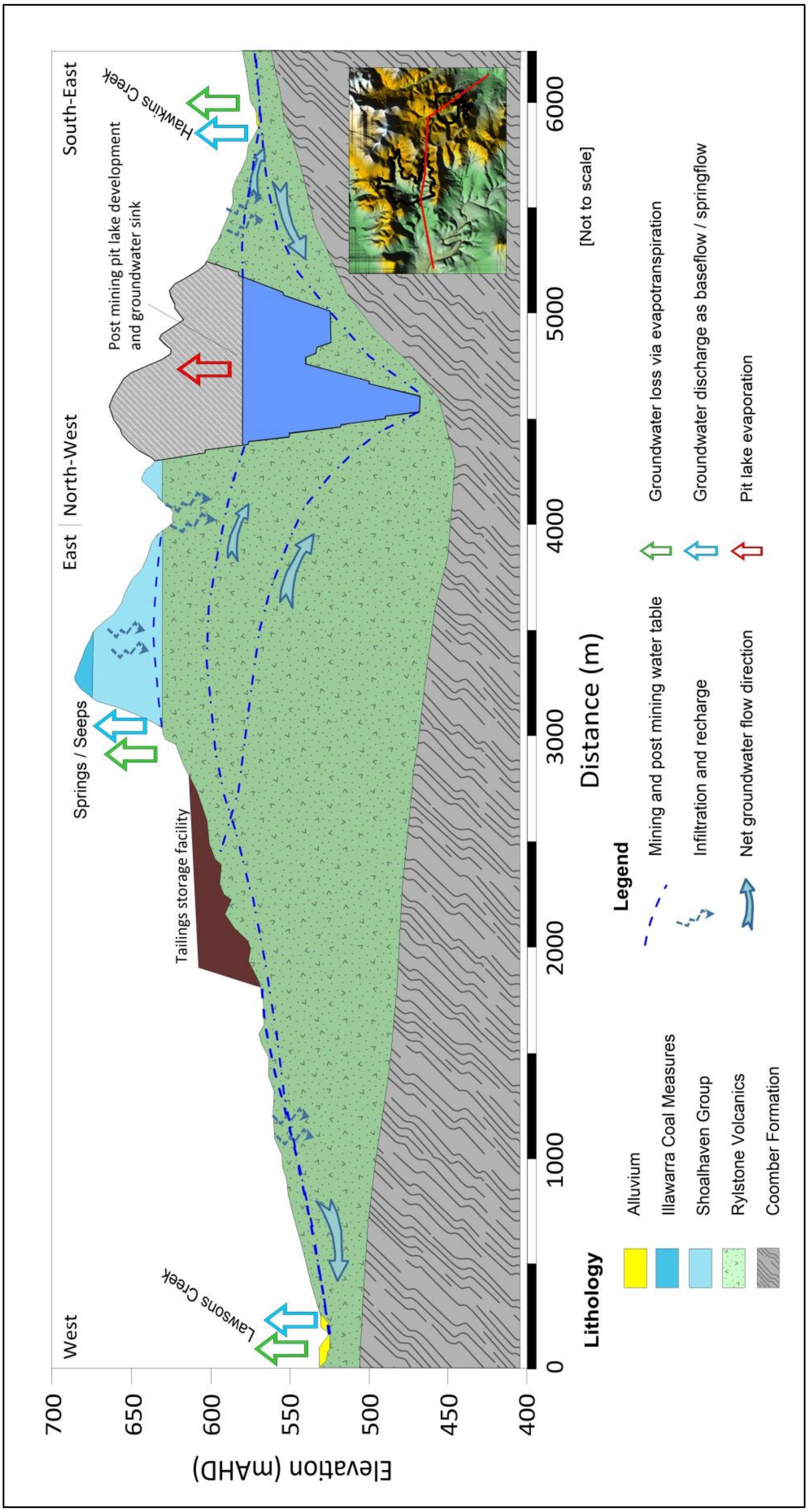


Figure 41 Conceptual Hydrogeological Model – Post-Mining



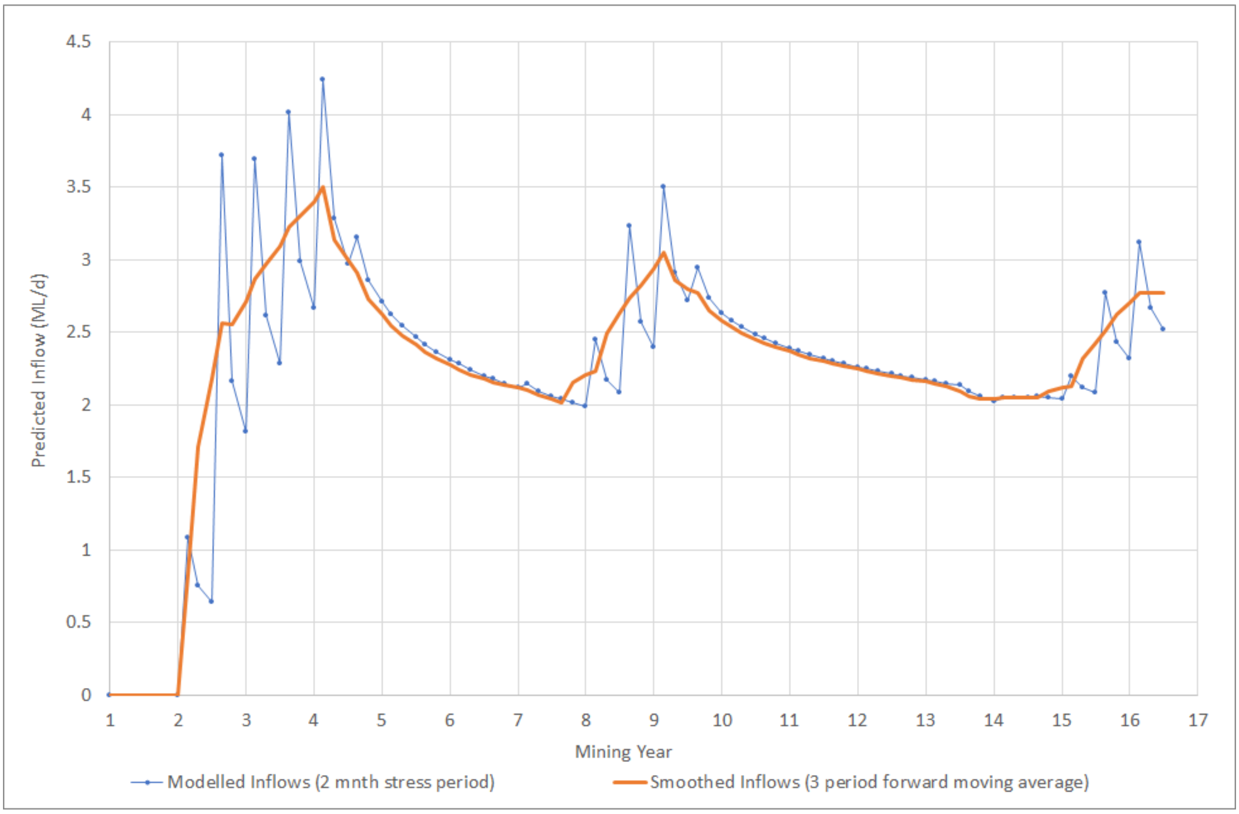
6. IMPACT ASSESSMENT

6.1 MINE DEWATERING

Numerical groundwater modelling detailed in **Annexure 9** predicted groundwater inflow rates to the open cut pit as shown in **Figure 42**. The modelling predicted annual dewatering volumes as shown in **Figure 43**.

With respect to **Figure 42,** as explained in **Annexure 9**, the smoothed inflow rates are considered to be more representative of the likely actual inflow rates.

Figure 42 Predicted Dewatering Rates

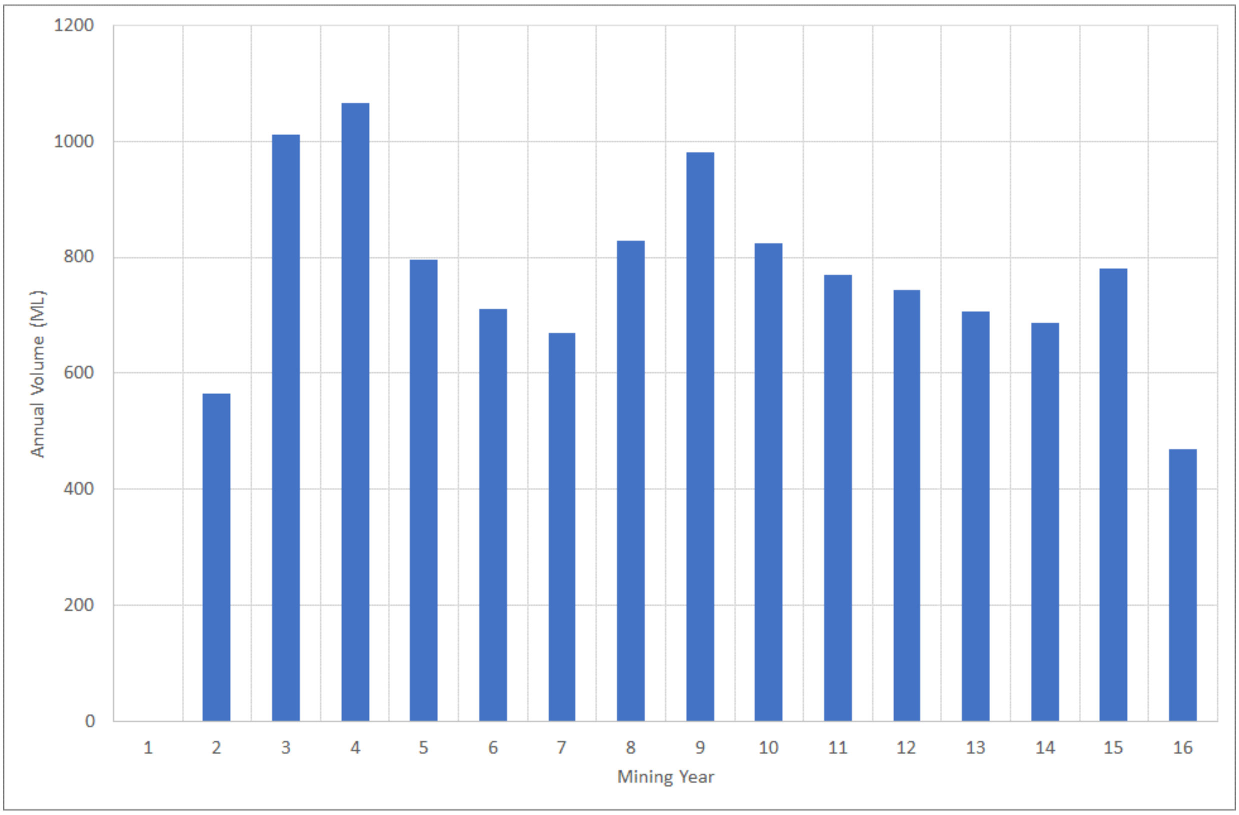


Once mining advances below the water table during the second year of mining, dewatering requirements steadily increase until the open cut pit reaches a depth of 525m AHD at the end of Year 4, with average inflows of the order of 3.5ML/day.

Dewatering rates then drop off as cutbacks expand the open cut pit at higher elevations. Inflows start to increase again mining advances below 525m AHD during Year 7, peaking at approximately 3ML/day as the open cut pit reaches its maximum depth of 456m AHD at the end of Year 9.

Subsequent open cut pit development is initially another expansion to the west at shallower depths, resulting in diminishing dewatering requirements until Year 15. In the last year and a half of mining, dewatering requirements are predicted to increase again as the eastern pit advances towards its final depth of 460m AHD.

Figure 43 Predicted Annual Dewatering Volumes



Average inflows over the life of mining are of the order of 2.4ML/day. The stages of the satellite open cut pits do not significantly influence overall mine dewatering requirements.

Rapid vertical advancement of the open cut pit means that the dewatering requirements increase rapidly once mining proceeds below the water table. The peak annual dewatering requirement is during Year 4 with a predicted annual volume of approximately 1 066ML. The average annual dewatering requirement, once dewatering commences, is approximately 800ML.

It is noted that as dewatering will be achieved via pumping from sumps within the open cut pit, there is potential for significant evaporative losses as groundwater seeps from exposed faces or is directed around active work areas towards dewatering sumps. While these evaporative losses cannot be readily quantified, there is potential that the volume of active dewatering required, may be somewhat less than the predicted dewatering requirement.

6.2 WATER LEVELS

6.2.1 Groundwater drawdown

Inflow of groundwater over the duration of mining would result in drawdown of groundwater levels in the formations surrounding the open cut pit area. Predicted drawdown at the water table at the end of Year 9 and at the completion of mining in Stage 6 (15.5 years) is shown in **Figure 44** and **Figure 45** respectively.

Figure 44 Predicted Drawdown at End of Stage 3 (Year 9)

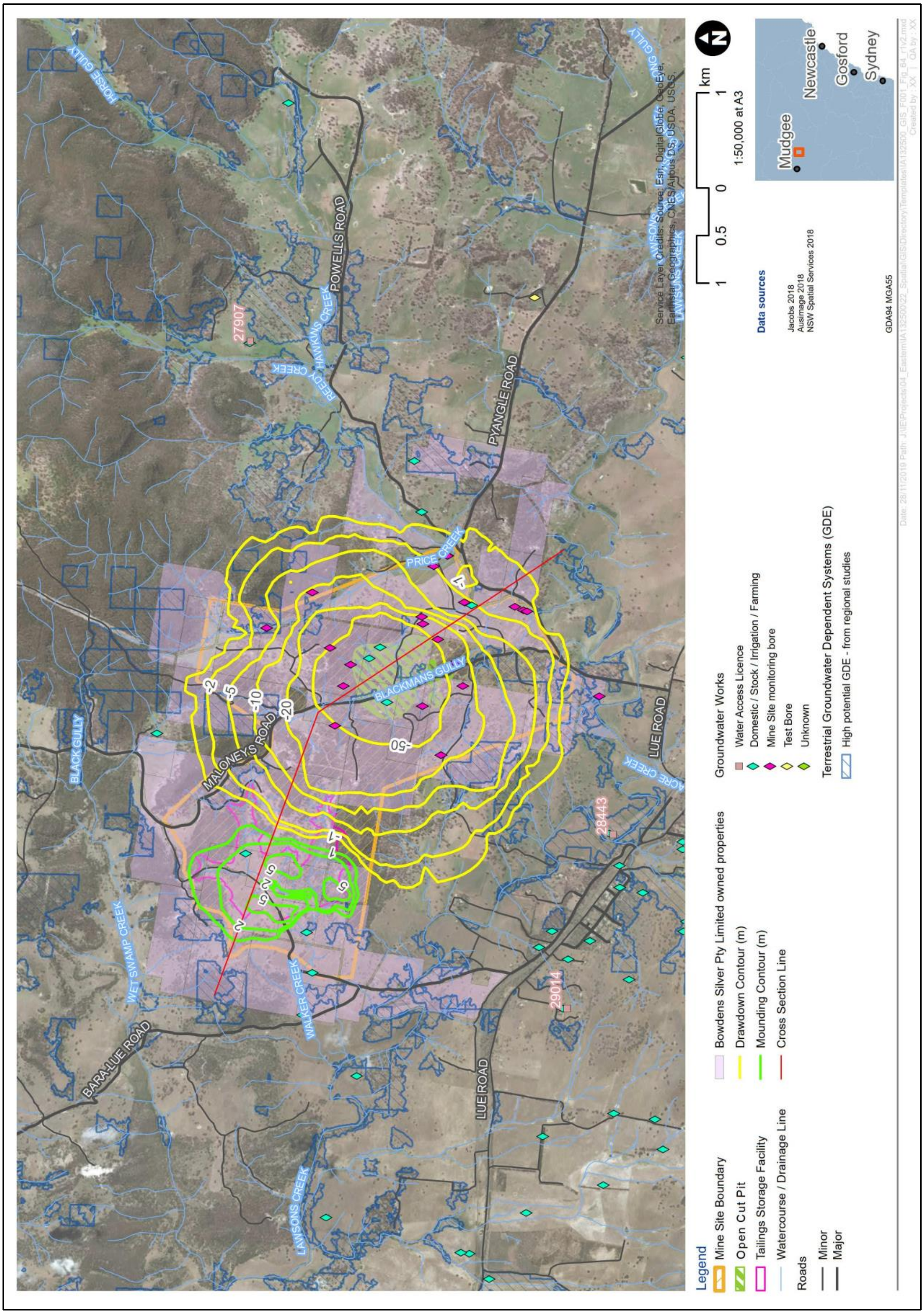
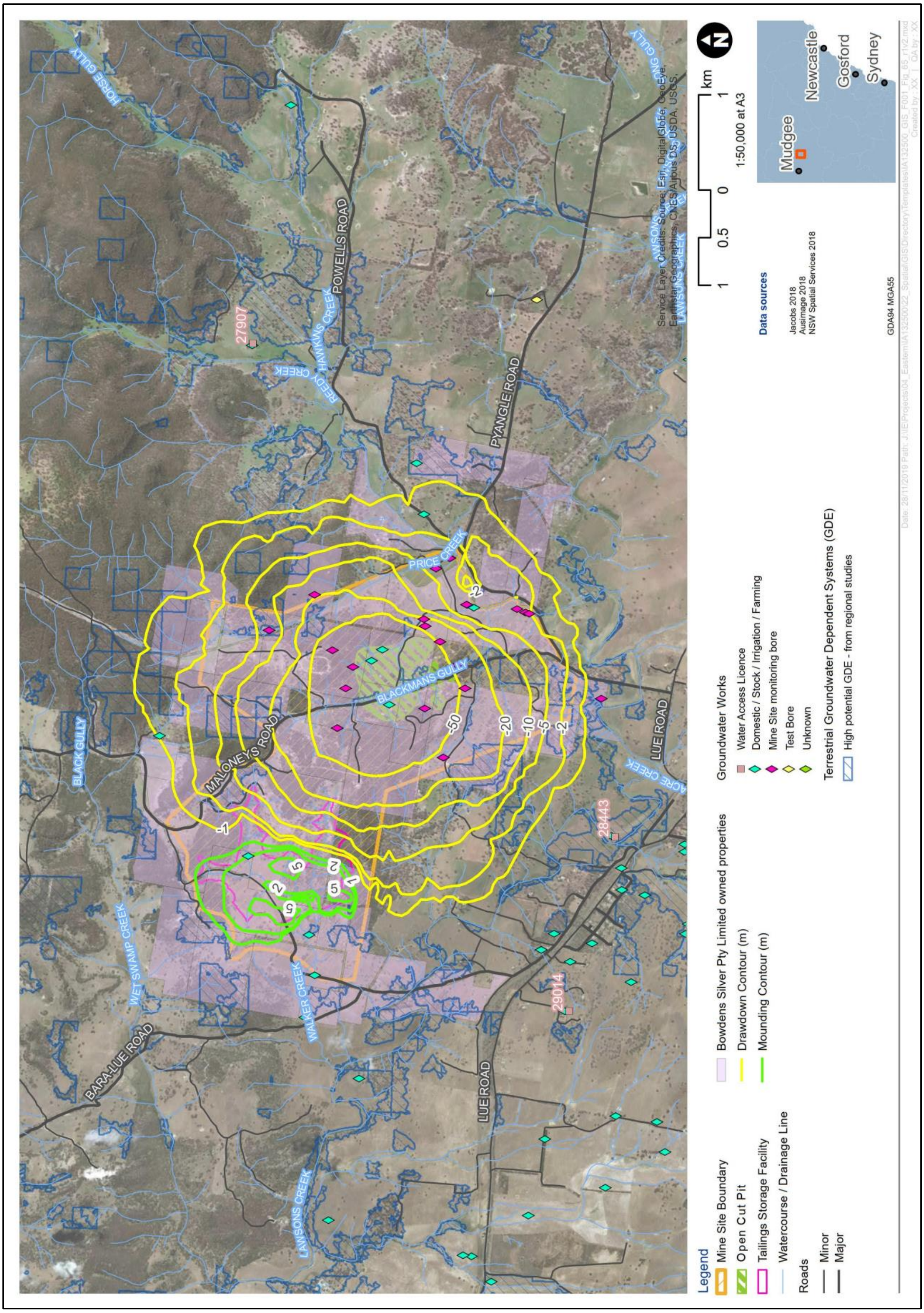


Figure 45 Predicted Drawdown at End of Mining (Year 15.5)



The extent of drawdown was noted to extend to Hawkins Creek, with drawdown of the order of 1 to 2m at Hawkins Creek at the end of Year 9 over a 1.9km section of the creek (**Figure 44**) and typically of the order of 2m at the end of mining over a 2.8km section of the creek (**Figure 45**).

Figure 46 shows a section though the pit and TSF with water table after 9 years of mining (black line) and 15.5 years of mining (blue line). As mining has reached its maximum depth by the end of Year 9, there is not a significant difference in water levels between Year 9 and Year 15.5 in the vicinity of the mine.

At the end of mining propagation of drawdown, as represented by the predicted 1m drawdown contour is typically in the order of 1.5km to the east and south, 2km to the west and 2.2km to the north. Drawdown to the northwest is attenuated due to mounding beneath the TSF, with maximum mounding of the order of 8m.

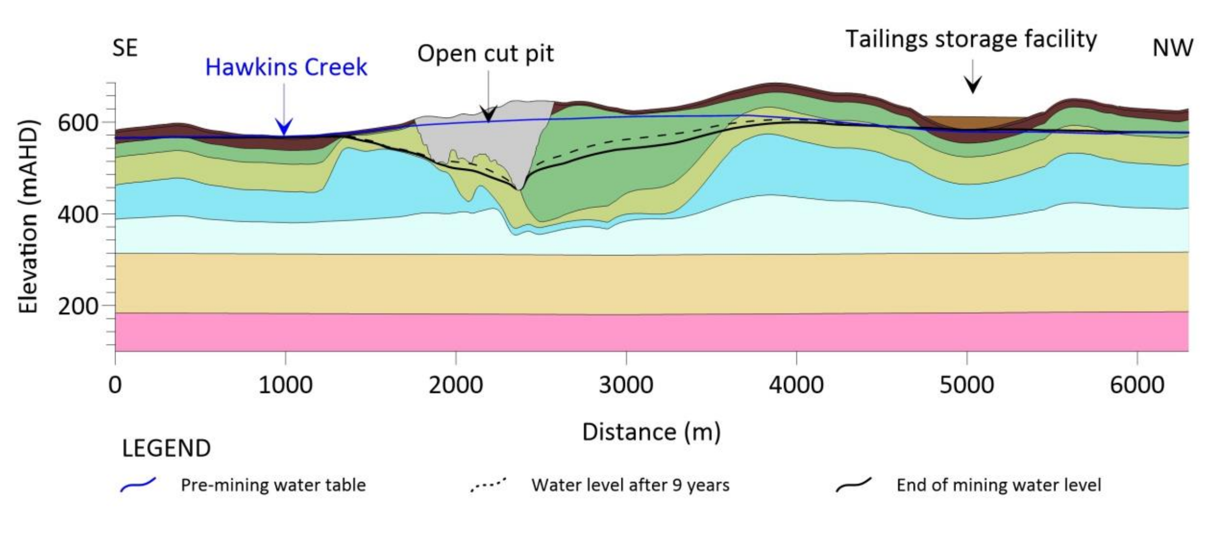
It is noted that the model is conservative with respect to predicted drawdowns within the Sydney Basin lithologies that overlie the Rylstone Volcanics. In reality, hydraulic connection between mining related drawdown in the Rylstone Volcanics and Coomber Formation of the Lachlan Orogen, and the Sydney Basin lithologies is likely to be limited. This is due to the highly stratified nature of the Sydney Basins sediments and the presence of low permeability siltstone and shale horizons. These low permeability layers are not specifically represented in the model but will act to inhibit vertical migration of groundwater and thus isolate the Sydney Basin lithologies from the mining induced depressurisation in the underlying formations. Therefore, the drawdowns as predicted within the Sydney Basin, are unlikely to be realised to the full extent predicted.

6.2.1.1 Groundwater Users

Potential groundwater drawdown is noted at 11 registered groundwater works that are recorded as being for water supply (domestic, stock, irrigation, or farming). Of these works, 9 are located on properties owned by Bowdens Silver. Potential impacts to the remaining works are noted as follows.

- **GW061475**. Located to the north of the Mine Site on the property identified as “17” on EIS Figure 4.1.10. The bore is recorded as being 15m deep utilising supply from the Illawarra Coal Measures. Predicted drawdown at the end of mining is approximately 1m, with maximum potential drawdown of the order of 2 to 5m predicted. If the upper range of drawdown is realised, there is potential for groundwater supply from this bore to be compromised. It is noted that this bore is elevated significantly above the main open cut pit, and within the Sydney Basin sediments. As noted in Section 6.2.1, the groundwater model is considered to be conservative with respect to predicted drawdowns within the Sydney Basin lithologies, and it is considered unlikely that that drawdowns as predicted would eventuate at that location.
- **GW802888**. Located to the east of the Mine Site on the property identified as “4” on EIS Figure 4.1.10. The bore is recorded as being 51m deep and is inferred to be utilising supply from the Coomber Formation. Maximum predicted drawdown is of the order of 1 to 2m. Post-mining drawdown of this magnitude is not expected to significantly impact supply from the well.

Figure 46 Sections showing predicted water levels at Year 9 and Year 15.5 of mining



The above notwithstanding, if water supplies to these groundwater users are compromised due to mining induced water level drawdown, then "make good" provisions would apply.

6.2.1.2 Groundwater Dependent Ecosystems

There are no high priority GDEs within the area of predicted groundwater drawdown.

The predicted area of drawdown encompasses a number of areas mapped as having a high potential for terrestrial GDEs and GDEs associated with river baseflow systems. These areas are predominantly associated with Hawkins and Lawsons Creeks.

Predicted maximum drawdown beneath Hawkins Creek is typically in the range of 1m to 2m, with some localised areas of increased drawdown (3 to 4m). Predicted maximum drawdown beneath Lawsons Creek is typically of the order of 1m or less.

Predicted drawdowns in areas adjacent to Hawkins Creek are not anticipated to have detrimental effect on terrestrial vegetation. Vegetation has been largely cleared for pasture. Where remnant vegetation does exist, it is expected that this would be sustained by soil moisture and intermittent wetting by rainfall, elevated creek flows, and flooding.

There is potential that any terrestrial GDEs within areas of drawdown greater than 2m, and away from Hawkins Creek may have potential to deteriorate due to reduced access to water, however, as noted by EnviroKey (2020), none of the terrestrial vegetation within the Project area is considered to be reliant on access to groundwater and therefore no terrestrial GDEs have been identified.

Springs and swamp meadow areas that are maintained by rainfall fed sub-flow within the soil profile are not anticipated to be impacted by mine dewatering as they are not inferred to be groundwater dependant. Springs associated with discharge from bedding planes within the Sydney Basin sediments are also unlikely to be impacted by drawdown.

6.2.2 Tailings Storage Facility

It is noted that the TSF preliminary design, as described in ATC Williams (2020) and simulated in the regional groundwater model has been updated at the direction of Bowdens Silver, with additional seepage mitigation measures. These updates have increased the area of bituminous geomembrane liner (BGM) overlying the clay liner. As such the regional groundwater model is likely to overestimate potential mounding beneath the TSF. An assessment of potential seepage from the TSF, based on the updated TSF design elements, is provided in **Annexure 10** and discussed in Section 6.5.

From the regional groundwater modelling, the groundwater level is predicted to rise in the vicinity of the TSF and form a mound beneath the TSF impoundment area. The groundwater mounding in the aquifer at the end of 9 years and 15.5 years of mining is presented in **Figure 44** and **Figure 45** respectively. A total maximum rise of 8m was predicted beneath the TSF area due to higher recharge from the TSF. Post mining, with the cessation of active deposition and the draining down of the TSF materials the mounding is predicted to dissipate to background water levels. The mounding is not readily apparent in **Figure 46** due to the vertical scale of the section.

6.2.3 Waste Rock Emplacement

As the WRE is to be fully lined and encapsulated, it has not been simulated via modelling during mining. In the post mining period, the WRE has been modelled as an area of reduced recharge consistent with the design of the structure (that is, design to maximise runoff and minimise infiltration).

6.2.4 Post Mining Recovery

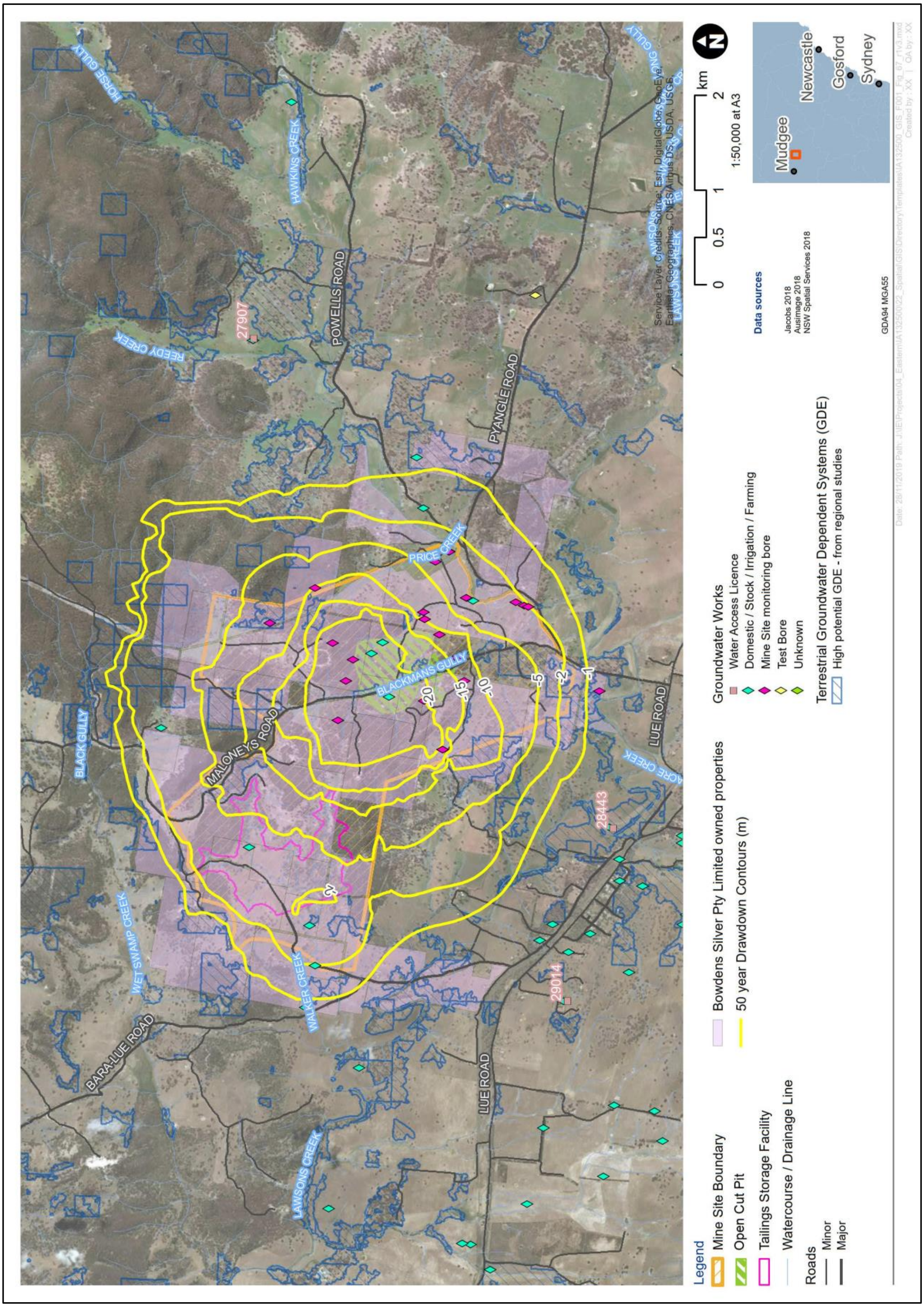
Post mining, the drawdown cone from the end of mining is initially predicted to expand until equilibrium is reached between the total groundwater inflows towards the open cut pit and the final losses from the open cut pit. The cone of drawdown is predicted to approach its maximum extent 16 years post closure with further minor increases occurring until approximately 50 years post closure. Predicted residual drawdown at this time is shown in **Figure 47**.

In the post mining period, mounding beneath the TSF diminishes and the TSF area is encompassed by the cone of drawdown.

Drawdown propagation at 50 years post mining, as represented by the predicted 1m drawdown contour is typically less than 2km to the east and south, up to 3km to the west and 2.5km to the north. Drawdown to the south is largely attenuated due to Lawsons Creek. Predicted drawdown at Lawsons Creek is typically less than 1m, with approximately 2m maximum drawdown at Hawkins Creek.

The residual drawdown as predicted at 50 years post mining is indicative of the long-term residual drawdown representing the new post-mining equilibrium with the final void acting as a groundwater sink. Some very minor continued recovery is likely before complete dynamic equilibrium is achieved. However, any variations in residual drawdown at greater than 50 years post mining are insignificant with respect to the inherent uncertainty of the model and time span of predictions.

Figure 47 Predicted 50 Year Post Mining Residual Drawdown



6.2.5 Final Void

The predictive model scenario was continued through to 200 years post mine closure to inform the final void water and salt balance being undertaken by WRM (WRM, 2020). Because the Project's mining activities result in excavations to below the regional water table level, the model predicts the formation of a pit lake in the final void once mining and water removal from the void ceases. A final void recovery scenario was undertaken without fluxes of rainfall or evaporation over the open cut pit area, to develop a groundwater inflow vs pit lake elevation relationship to inform the final void water balance (WRM, 2020).

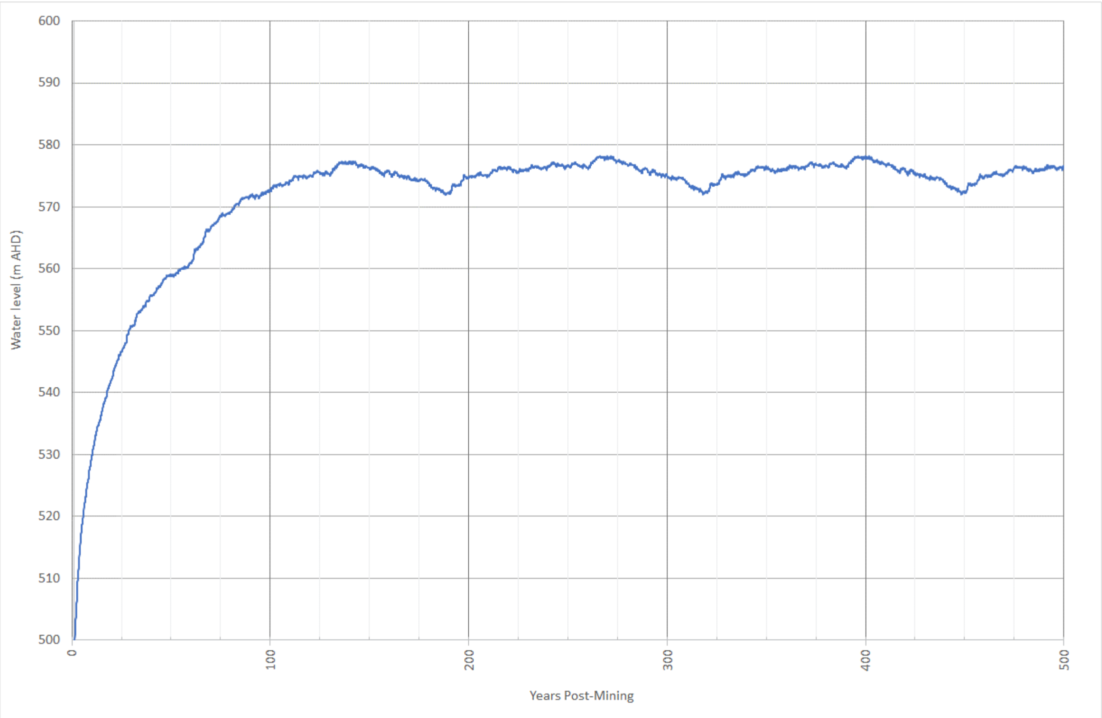
Residual inflows to the mine void were supplied to WRM for inclusion in the final void water balance (WRM, 2020**). Figure 48** shows the predicted long-term equilibrium water level in the pit lake fluctuating between approximately 571 and 577m AHD after approximately 100 years, with an average of approximately 574m AHD. This is approximately 16 to 26m below the pre-mining water table, and 23m below the pit crest spill height of 597m AHD.

The salt balance undertaken for the final void (WRM, 2020) indicates that salts would gradually accumulate within the pit lake due to evaporative concentration. Based on an indicative groundwater inflow electrical conductivity of 1 420µS/cm the following pit lake salinities are predicted to develop over time:

- 100 years – 2 000µS/cm
- 200 years – 2 880µS/cm
- 300 years – 3 725µS/cm
- 400 years – 4 375µS/cm
- 500 years – 5 375µS/cm

Further detail on the final void water balance, including pit lake water quality is provided in Section 7 of the Surface Water Assessment (WRM, 2020).

Figure 48 Pit Lake Equilibrium Level



6.2.6 Post Mining Water Levels and Flow Directions

To assess the potential long term impacts of the post mining void water levels, long term water levels were assessed in the groundwater model by simulating the pit lake water level as a constant head boundary with a head of 574m AHD. The resulting long term water levels are plotted on **Figure 49**.

From **Figure 49** it can be seen that that from the final void, groundwater flow direction is generally to the southeast toward Hawkins Creek, with no direct flow towards Lawsons Creek or Lue village. The hydraulic gradient towards Hawkins Creek is less than 1% (1m elevation for every 100m distance). Based on this gradient over an approximate distance of 800m and applying conservative indicative hydraulic parameters (Kh = 0.1m/day and effective porosity of 5%) a potential groundwater travel time in excess of 100 years is indicated.

Given the distance to Hawkins Creek and indicative travel times, and including allowance for dilution and attenuation of any seepage constituents along the flow path. Degradation of water quality in Hawkins Creek or surrounding groundwater due to seepage from the final void is considered unlikely.

6.3 BASEFLOW

Groundwater drawdown has potential to reduce streamflow through either direct stream depletion or through intercepting groundwater that would otherwise discharge to surface water. Baseflow reductions to Hawkins and Lawsons Creeks have been calculated using the groundwater model using the change in flux from either River boundaries (Lawsons Creek) or Drain boundaries (Hawkins Creek) between the two modelled scenarios (mining and no-mining). These flux calculations included reaches of Hawkins and Lawsons Creeks extending beyond the predicted area of drawdown. For Hawkins Creek the reach considered extended upstream from the confluence with Lawsons Creek to approximately 6km to the northeast of the Mine Site (**Figure 8**). For Lawsons Creek, the reach extended from approximately 3.5km southeast of the Mine Site downstream to 4km west of the Mine Site.

During mining, numerical groundwater modelling (**Annexure 9**) predicts that baseflow to both Hawkins and Lawsons Creeks will reduce with the expansion of the cone of drawdown. From **Figure 50** and **Figure 51** it can be seen that baseflow reductions attributed to the Project continue to increase beyond the end of mining, peaking at approximately 28 to 34 years from the commencement of mining (12 to 18 years post mining). The long term baseflow reduction due to the Project is likely to reach equilibrium at around the values of 0.024ML/day for Hawkins Creek and 0.018ML/day for Lawsons Creek approximately 34 years post mining as indicated on **Figure 50** and **Figure 51**.

A maximum baseflow reduction of approximately 30m^3/day (0.030ML/day) is predicted for Hawkins Creek and 24m^3/day (0.024ML/day) for Lawsons Creek within 100 years from commencement of mining. However, as noted above, actual baseflow reduction attributable to the Project is likely to be less.

Figure 49 Long Term Post Mining Water Levels

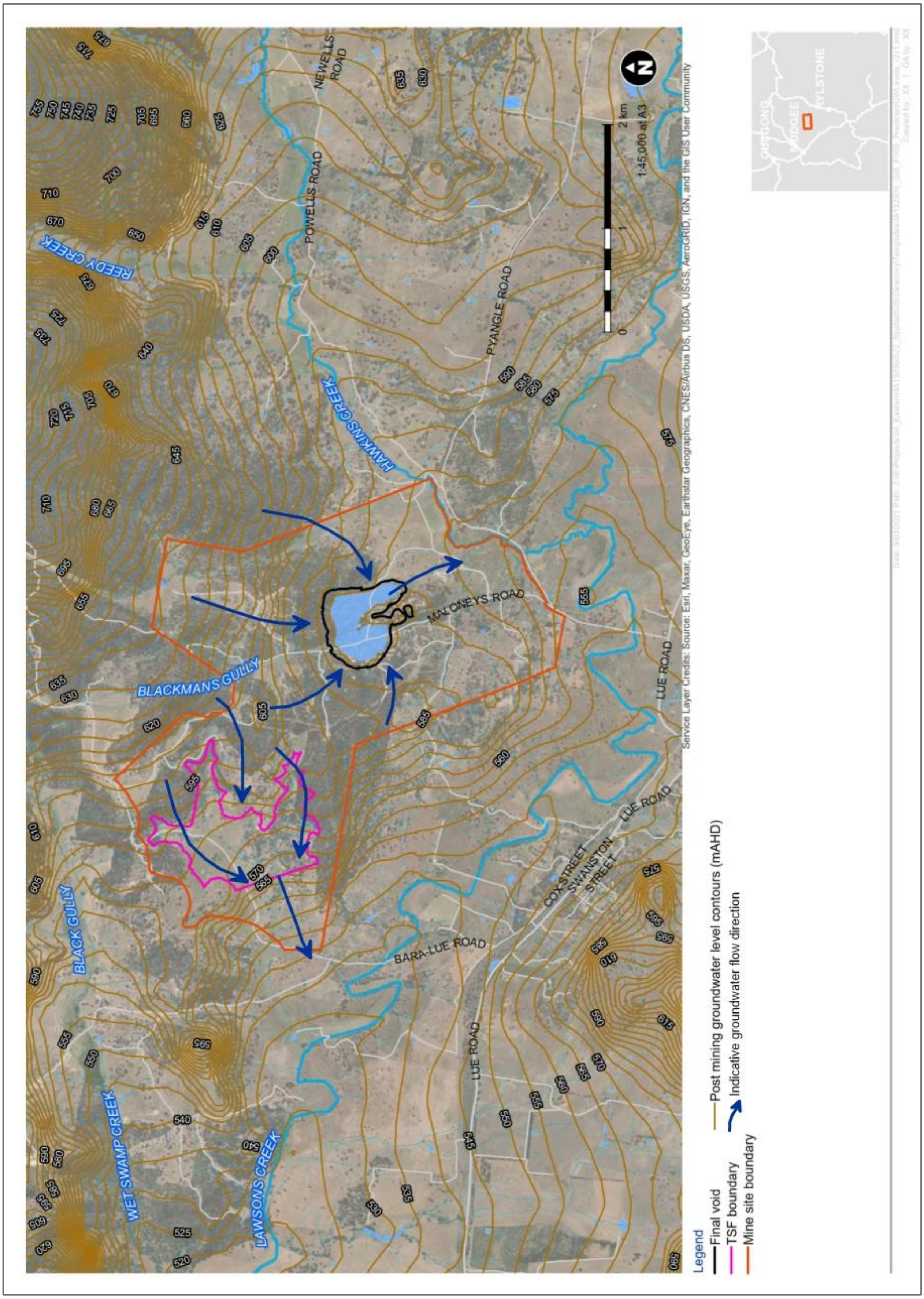


Figure 50 Predicted Baseflow Reduction at Hawkins Creek

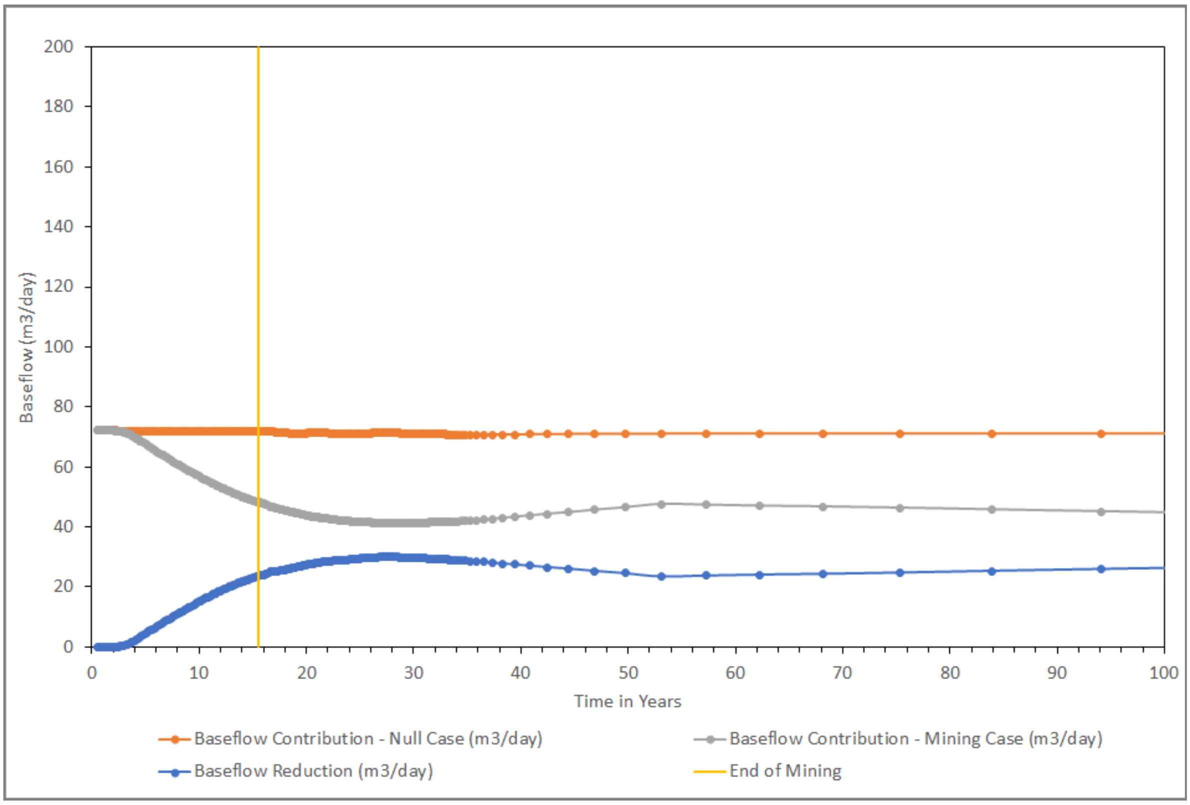
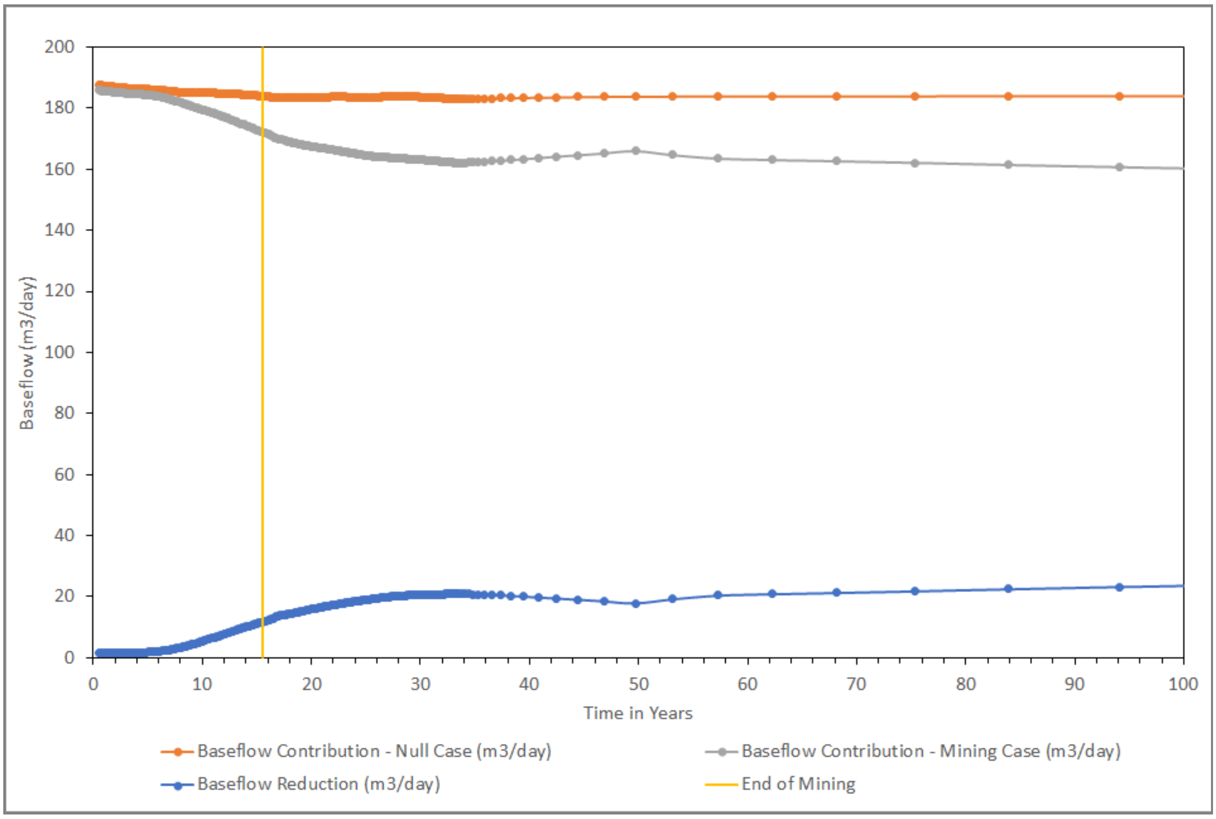


Figure 51 Predicted Baseflow Reduction at Lawsons Creek



6.4 GROUNDWATER QUALITY

6.4.1 Mining

Excavation below the water table would expose potentially acid forming material in the open cut pit walls. Oxidation of acid forming materials and subsequent mobilisation by groundwater inflows or rainfall runoff has the potential to generate low pH drainage within the open cut pit. During mining, any generated drainage would be captured by the dewatering system and pumped to the processing plant for use in processing.

6.4.2 Post Mining

Salinification of the pit lake due to evaporative concentration is expected to occur gradually over time as indicated in Section 6.2.5, with pit lake salinity reaching approximately 2 000mg/L TDS after 100 years and 5 375mg/L TDS after 500 years.

However, as discussed in Section 6.2.5, the final mine void is also predicted to remain a groundwater sink, with final equilibrium levels predicted to be below the pre-mining groundwater level and ongoing evaporative losses from the pit of the order 500kL/day (0.5ML/day). This means that the direction of net groundwater flow would be towards the final mine void and any saline water that develops within the pit lake would not be able to escape or impact on local water quality.

While not considered in the post-mining simulations, water that is captured in the TSF following the completion of processing activities would be pumped to the final mine void. There is also potential for runoff captured within the Blackmans Gully catchment to be initially diverted into the final mine void. These additional inflows would expedite equilibration of the pit lake with groundwater levels and help mitigate any post mining drawdown expansion. Once the pit lake approaches equilibrium, runoff from Blackmans Gully would be re-directed around the final mine void.

6.5 TSF SEEPAGE ASSESSMENT

Refined modelling, including solute transport modelling, has been undertaken in the vicinity of the TSF to assess additional design elements, seepage rates and potential impacts. The refined TSF model is based on the regional groundwater flow model however, the grid and geometry of the alluvium and shallow regolith layers in the vicinity of the TSF were refined. The TSF modelling report is provided in **Annexure 10**.

A conservative approach to modelling seepage with the refined TSF model has been undertaken, considering the advective transport and dispersion of potential seepage only. As such, this approach is likely to over predict groundwater concentrations arriving at Lawsons Creek as it does not consider the mitigating influence of degradation of adsorption to aquifer materials.

The refined TSF seepage modelling has assessed two alternative TSF Designs as follows.

- **TSF Design Option1**

  The entire TSF impoundment area is underlain with a low permeability BGM liner overlying the clay liner design included in the preliminary design. Other than the BGM, staged TSF development and decant pond levels remain as per the preliminary design presented in the EIS.

- **TSF Design Option 2**

  The decant pond area is underlain by a low permeability BGM liner, overlying the clay liner. The remainder of the TSF impoundment remains underlain by the clay liner as per the TSF preliminary design. In this option, heads within tailings are managed by a network of underdrains, installed above the BGM to limit the development of pressure heads above the BGM. The influence of this underdrainage network is simulated as a 10m head overlying the BGM. Outside of the BGM and underdrain area, overlying the clay liner, a residual head of 2m has been simulated.

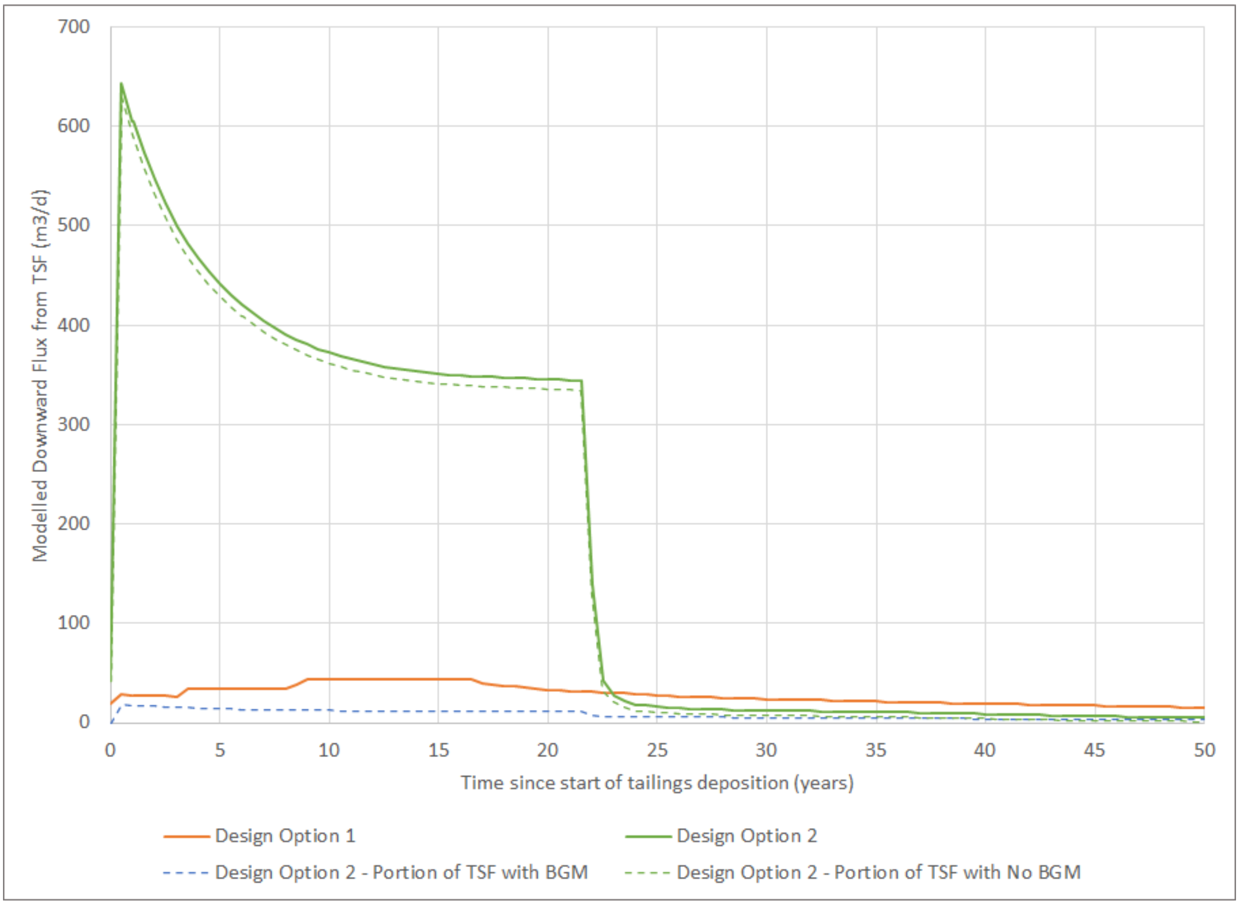
Solute transport was used to forecast the blending ratio of water originating at the TSF. Prescribed concentration boundaries were assigned to all model cells representing the decant pond or managed head zones. This approach does not simulate a specific solute, instead, the model simulates the percentage of groundwater originating at the TSF along the flow path (i.e. blending ratio). Results from this analysis should not be confused with projected plume concentrations. An assessment of potential seepage concentrations reaching Lawsons Creek is provided in Section 6.5.1.

Predicted seepage fluxes through the base of the TSF for both design options are presented in **Figure 52**. The seepage flux for TSF Design Option 2 is significantly greater, but as can be seen from **Figure 52**, the bulk of this seepage originates from the upgradient area of the TSF without the BGM liner. This comprises a considerable saturated area (approximately 594 000m^2) in the model. However, in reality, the entire extent of the TSF, particularly the upgradient areas, is unlikely to be saturated.

Outputs from the refined TSF modelling, both as contoured blending ratios and percentages of TSF seepage reporting to simulated monitoring bores are provided in **Figure 53** and **Figure 54**, respectively.

From **Figure 53** the extent of influence and percentage of groundwater originating at the TSF for TSF Design Option 1 is considerably less than that for TSF Design Option 2. This is due to the reduced seepage flux of TSF Design Option 1. For TSF Design Option 1, the percentage of groundwater originating at the TSF does not exceed 10%. More detail on percentages of groundwater originating at the TSF is provided at the virtual monitoring bores presented on **Figure 54**. At each of the four virtual monitoring locations, forecast percentages of groundwater originating at the TSF are presented for shallow (representing shallow regolith at approximately 10m bgl) and deep (representing deeper weathered lithologies at approximately 20m bgl) virtual monitoring bores.

Figure 52 Predicted TSF Seepage



Groundwater adjacent to Lawsons Creek is represented by monitoring locations MW-3 (downstream) and MW-4 (upstream). Total flux and percentage of groundwater originating at the TSF that reports to the reach of Lawsons Creek influenced by seepage are presented on **Figure 55**. **Figure 55** identifies that TSF Design Option 2 results in slightly increased baseflow to Lawsons Creek due to the greater seepage flux whilst there is no significant change in baseflow for TSF Design Option 1. The minor decline in baseflow, apparent after 20 years, is consistent with that presented in **Figure 51** and is attributed to mine dewatering.

The refined TSF modelling identifies the first arrival of groundwater at Lawsons Creek originating from the TSF occurs after 60 years. However, the percentages of groundwater originating at the TSF and subsequently reporting to Lawsons Creek peak at approximately 2.5% at 150 years for TSF Design Option 1 and 14% after 180 years for TSF Design Option 2.

6.5.1 Potential seepage concentrations reporting to Lawsons Creek

An assessment of concentrations in groundwater reporting to Lawsons Creek has been undertaken based on the refined TSF model outcomes as presented in Section 6.5 and **Annexure 10**.

Figure 53 Percent groundwater originating at TSF

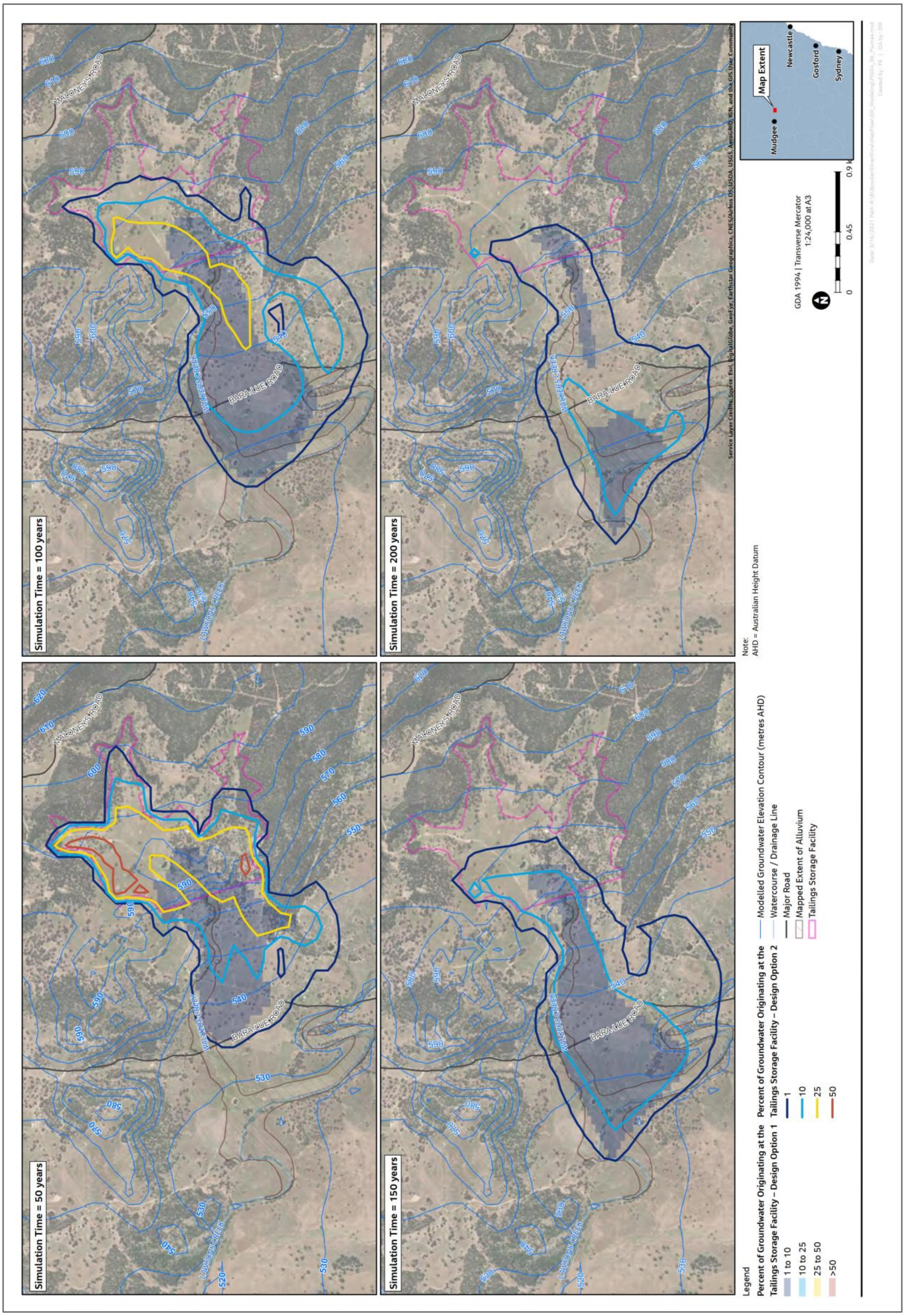


Figure 54 Percentage of groundwater originating from TSF at virtual monitoring locations

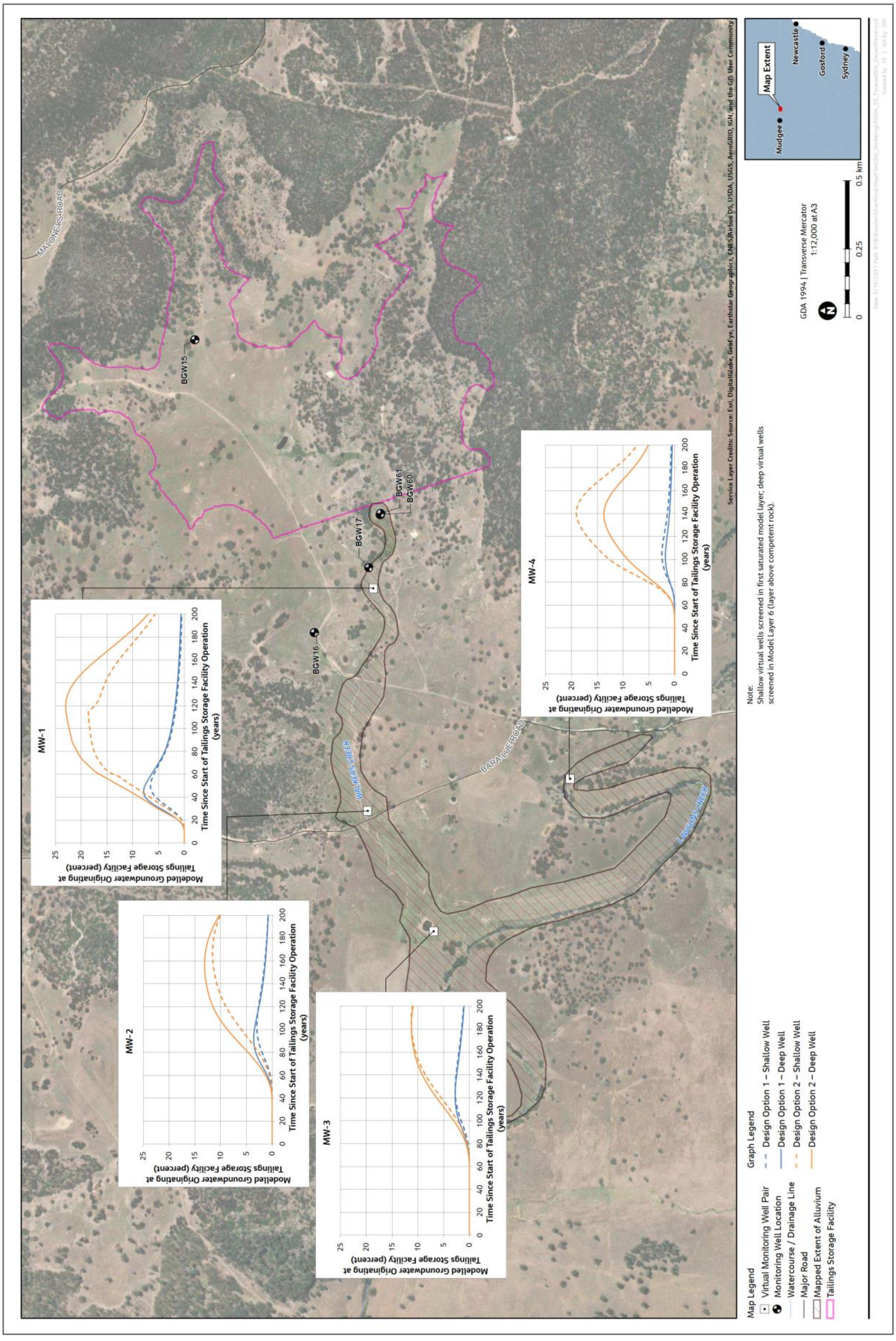
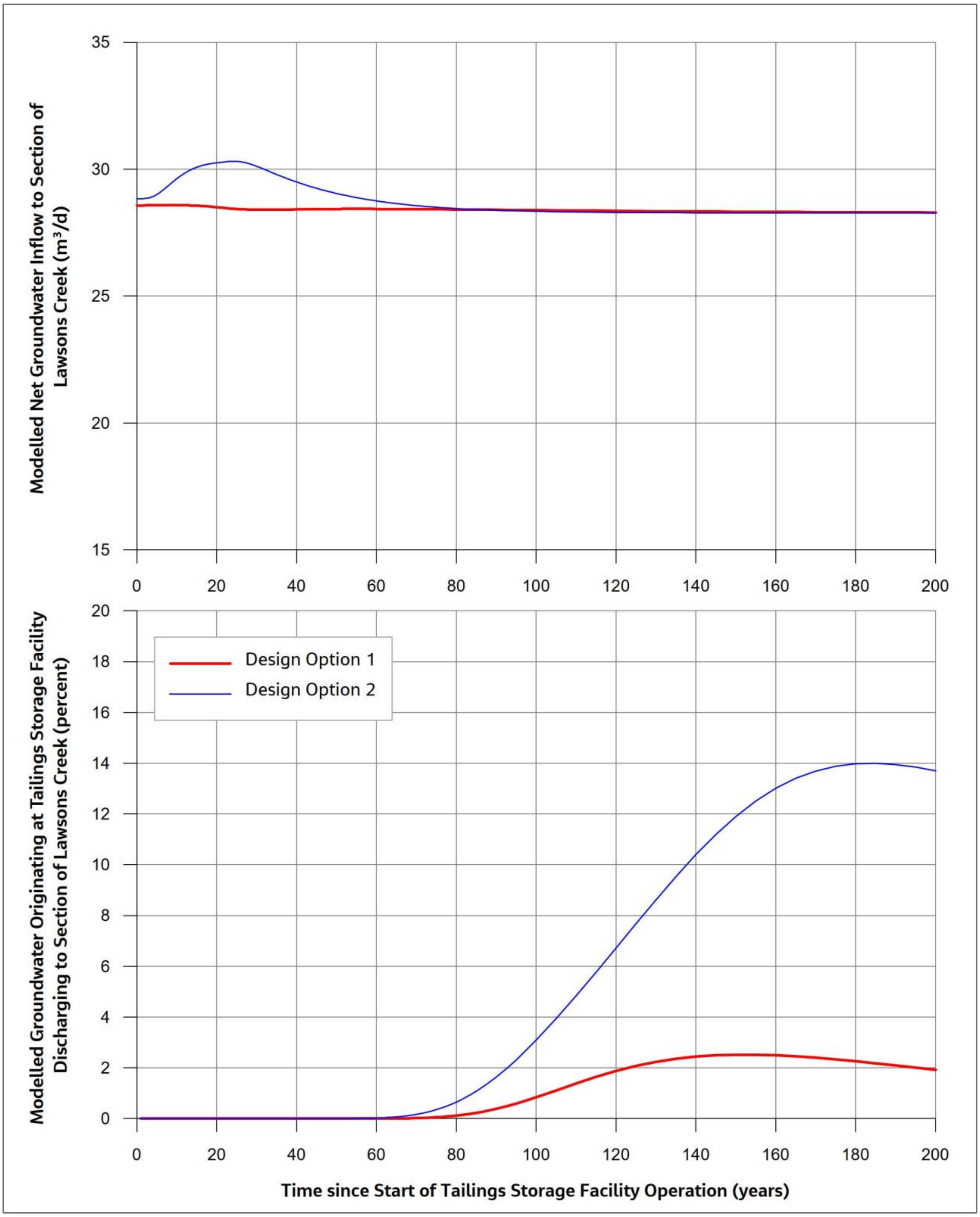


Figure 55 **Percentage of groundwater originating from TSF and flux at Lawsons Creek**



The fluxes and percentage of groundwater originating at the TSF reporting to Lawsons Creek predicted by the refined TSF model were applied to the concentrations of tailings slurry (GCA, 2020), background surface and groundwater and mixed using the modelled Lawsons Creek low (90th percentile) and median (50th percentile) flow conditions (WRM, 2020). This was undertaken to assess the range of potential surface water concentrations within Lawsons Creek following mixing and dilution with host groundwater and surface water. The results for each TSF design option are presented in **Table 25** and compared against the ANZ guideline value for 95% protection of freshwater aquatic ecosystems (ANZG, 2018). This assessment is deliberately conservative and likely overpredicts potential impacts as it assumes no natural degradation or reduction in concentrations, either within the TSF or via physical (e.g. adsorption) or biogeochemical (e.g. bacterial) processes as the groundwater moves through the aquifer. For example, when considering cyanide, this compound will be subjected to volatilisation processes, such that up to 90% of cyanide present may be lost from the TSF decant pond (NICNAS, 2010). It is also apparent that background concentrations of phosphorous and zinc in groundwater exceed the guideline values, as do the concentrations of copper and zinc in Lawsons Creek.

Table 25
Seepage Dilution and Mixing Concentrations

Analyte	Tailings slurry concentration (mg/L)[1]	Groundwater (background) concentration (mg/L)[2]	Groundwater (modelled) concentration at Lawsons Creek (mg/L)	Lawsons Creek (background) concentration (mg/L)[3]	Lawsons Creek modelled concentration (mg/L)		ANZG 2018 Guideline Value (mg/L)
					Low flow (90th %ile)	Median flow (50th %ile	
TSF Design Option 1							
Aluminium	0.08	nd[4]	0.002	nd[4]	$4.0x10^{-4}$	$9.2x10^{-6}$	*0.055*
Arsenic	0.033	0.002	0.003	0.002	0.002	0.002	*0.013*
Cadmium	0.006	nd[4]	$1.6x10^{-4}$	$1.0x10^{-4}$	$1.1x10^{-4}$	$1.0x10^{-4}$	*0.0002*
Chromium	0.02	nd[4]	$5.0x10^{-4}$	nd[4]	$9.5x10^{-5}$	$2.3x10^{-6}$	*0.001*
Copper	0.17	0.001	0.005	0.002	0.003	0.002	*0.0014*
Cyanide	0.53	nd[4]	0.013	nd[4]	0.002	$6.1x10^{-5}$	*0.007*
Lead	0.051	nd[4]	0.001	0.002	0.002	0.002	*0.0034*
Manganese	19	0.01	0.488	0.132	0.199	0.134	*1.9*
Phosphorous	0.1	0.075	0.076	nd[4]	0.014	$3.5x10^{-4}$	*0.02*
Zinc	1.1	0.01	0.037	0.009	0.014	0.009	*0.008*
TSF Design Option 2							
Aluminium	0.08	nd[4]	0.011	nd[4]	0.002	$5.1x10^{-6}$	*0.055*
Arsenic	0.033	0.002	0.006	0.002	0.003	0.002	*0.013*
Cadmium	0.006	nd[4]	$8.7x10^{-4}$	$1.0x10^{-4}$	$2.5x10^{-4}$	$1.0x10^{-4}$	*0.0002*
Chromium	0.02	nd[4]	0.003	nd[4]	5.3x10-4	$1.3x10^{-5}$	*0.001*
Copper	0.17	0.001	0.025	0.002	0.006	0.002	*0.0014*
Cyanide	0.53	nd[4]	0.074	nd[4]	0.014	$3.4x10^{-4}$	*0.007*
Lead	0.051	nd[4]	0.007	0.002	0.003	0.002	*0.0034*
Manganese	19	0.01	2.668	0.132	0.612	0.143	*1.9*
Phosphorous	0.1	0.075	0.078	nd[4]	0.015	$3.7x10^{-4}$	*0.02*
Zinc	1.1	0.01	0.162	0.009	0.038	0.010	*0.008*

Note: Grey shading indicates exceedance of ANZG 2018.
1: data from GCA (2020)
2: Groundwater background concentrations are median values from BGW16 and BGW17.
3: Lawsons Creek background concentrations are median values from BSW28 (WRM, 2020).
4: where no data (nd) is available, background concentrations assumed negligible.

The relative percentage flow contributions of total flow volume for each TSF design option at the time of predicted peak arrival at Lawsons Creek from groundwater originating at the TSF, natural groundwater (baseflow), 90th percentile and 50th percentile (median) surface flows are presented in **Figure 56** and **Figure 57**. The forecast peak arrival time for TSF Design Option 1 is approximately 150 years and 180 years for TSF Design Option 2.

Figure 56 Percentage of total flow (m^3/day) at peak arrival time – TSF Design Option 1

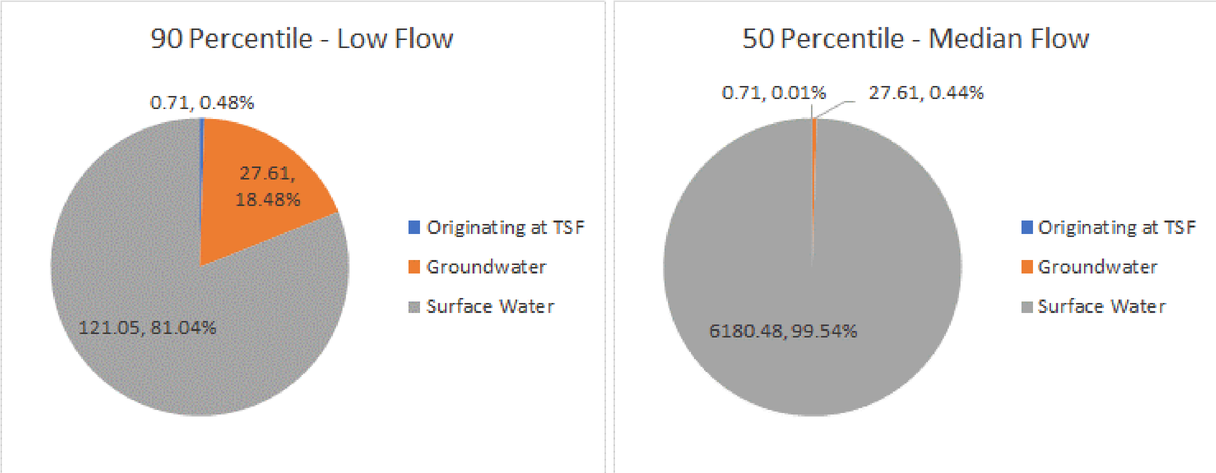
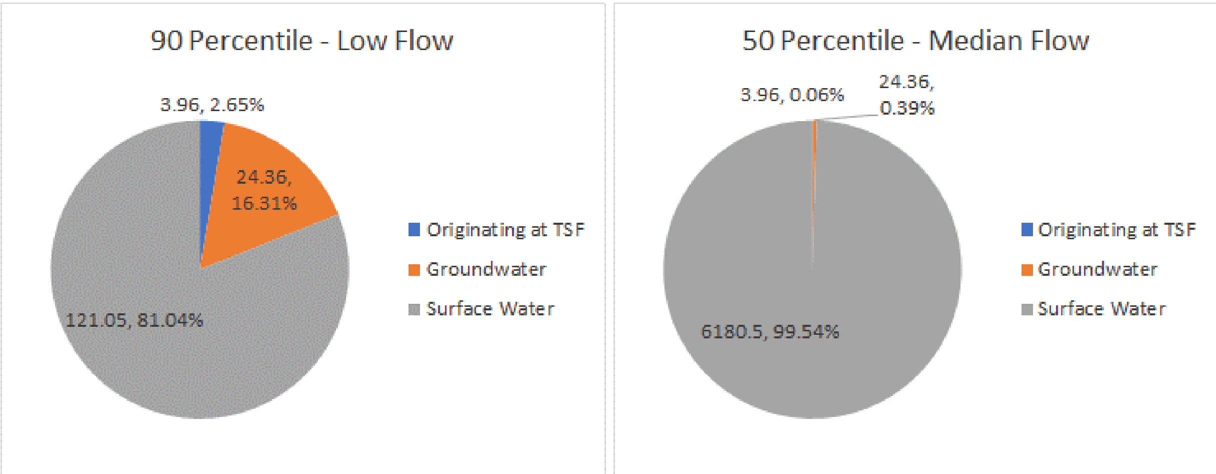


Figure 57 Percentage of total flow (m^3/day) at peak arrival time – TSF Design Option 2



From **Table 25** there is the potential for some concentrations greater than the ANZ guideline values to arrive at Lawsons Creek. However, it is noted that these concentrations are likely overpredicted by the conservative approach taken.

For TSF Design Option 1, copper, zinc, cyanide and phosphorous are predicted to exceed guideline values in groundwater arriving at Lawsons Creek, whilst cadmium, chromium, lead and manganese are also added for TSF Design Option 2. When dilution with surface flows in Lawsons Creek is considered for low and median flows, only copper and zinc remain above guideline values for TSF Design Option 1. It is noted that for TSF Design Option 1, the median flow concentrations for copper and zinc marginally exceed the guideline values and are commensurate with background concentrations. For TSF Design Option 2, at low flow, cadmium, copper, cyanide and zinc exceed the respective guideline values, with only copper and zinc persisting above guideline values at median flow, again due to the elevated background concentrations.

With respect to cyanide, this compound and any associated cyanide-metal complexes within the TSF will be subjected to UV photodegradation and oxidation processes, with further biodegradation of any remaining cyanide entering the groundwater system likely to occur.

It is noted that the actual flow and transport processes are not conservative. Considering the overall distances and transit times involved, significant natural attenuation of concentrations will take place prior to any interaction with Lawsons Creek.

For example, the likes of copper, zinc, and phosphorous, adsorption to calcium and iron oxides and precipitation within the aquifer will act to significantly reduce any concentrations remaining in groundwater.

Further design and seepage mitigation measures are discussed in Section 8.4.

6.6 CUMULATIVE IMPACTS

The potential for cumulative impacts with other significant mining operations has also been considered. The other mining operations in the region are summarised in **Table 26**, however, it is noted that none of these operations fall within the study area or hydrogeological model domain.

Table 26
Other Mining Operations

Mine	Approximate Distance from Bowdens Silver Project	Description
Wilpinjong	32km to the north	Open cut coal mine.
Moolarben	38km to the north	Open cut and underground coal mine.
Ulan	44km to the north	Open cut and underground coal mine.

It is noted that predicted maximum drawdown propagation from Moolarben Coal Mine in the mined Ulan Coal Seam is of the order of 8km from the extracted longwall panels (Peter Dundon and Associates, 2006) and is significantly less in the overlying formations. At Wilpinjong, the Ulan Seam is unsaturated south of the mine and predicted depressurisation propagation is to the north (Hydrosimulations, 2013). These drawdowns are significantly less than the separating distance between the coal mine and the Project, and as such, cumulative groundwater related impacts will not occur.

6.7 AIP MINIMAL IMPACTS CONSIDERATIONS

The AIP minimal impact considerations for highly productive alluvial, fractured rock and porous rock aquifers are outlined in Section 2.1.4. A detailed assessment against the AIP minimal impacts considerations, along with a completed AIP framework checklist, is provided in **Annexure 1**.

In general, the Project would meet with the Level 1 Minimal Impact Considerations for highly productive, alluvial, porous rock and fractured rock aquifers, meaning that under the AIP, the predicted impacts of the Project are considered to be acceptable.

7. LICENSING REQUIREMENTS

7.1 PREDICTED DEWATERING AND AQUIFER PARTITIONING

The modelled groundwater inflow to the main open cut pit is contributed from the two following groundwater sources:

- Sydney Basin Groundwater Source of the NSW Murray Darling Basin Porous Rock Groundwater Sources Order, 2020; and
- Lachlan Fold Belt Groundwater Source of the NSW Murray Darling Fractured Rock Groundwater Sources Order, 2020.

The predicted mine dewatering volumes derived from modelling have been partitioned to determine the water take (either direct or induced) from the relevant groundwater and surface water sources.

During drilling and testing within and close to the proposed open cut pits, it was noticed that the Sydney Basin sediments remain largely unsaturated. Hence, the lateral inflow from Sydney Basin at the Mine Site is negligible. However, the Sydney Basin sediments would become saturated away from the Mine Site and would contribute indirectly to mine inflows via vertical leakage to the volcanic units. To predict the component of contribution from the Sydney Basin Groundwater Source the vertical water loss from the Sydney Basin sediments was estimated using a zone budget of the model within the area of influence of drawdown within Sydney Basin. The annualised inflow volumes from the relevant water sharing plans are presented in **Table 27**.

Baseflow reduction from Hawkins and Lawsons Creeks, as a result of mining activity, is considered as take from the Lawsons Creek Water Source of the Macquarie Bogan Unregulated and Alluvial Water Source 2012.

The partitioning has been balanced such that the sum of the partitioned takes, does not exceed the total dewatering volume. Any modelled take from a surface water source, resulting from reduced baseflow contribution, has been deducted from the total take of the underlying groundwater source. It is noted that the reduced take in the final year of mining is due to active dewatering not being undertaken for the full year.

From **Table 27**, the maximum predicted take from each of the applicable water sources, and therefore the volume of share components for each of the water sources required to be held during mining are as follows.

- Lachlan Fold Belt Groundwater Source (Other) – 907ML
- Sydney Basin Groundwater Source – 194ML
- Lawsons Creek Water Source – 12.9ML

7.2 ONGOING WATER TAKE

Post mining water take resulting from residual drawdown and ongoing evaporative losses from the pit lake have been partitioned to determine the water take (either direct or induced) from the relevant groundwater and surface water sources. Partitioned post-mining water takes are provided on **Table 28**.

Table 27
Partitioned Water Take – During Mining

Mine Year	Total Annual Dewatering Volume (ML/year)	Partitioned Water Take (ML/year)		
		Lachlan Fold Belt Groundwater Source (Other)	Sydney Basin Groundwater Source	Lawsons Creek Water Source
1				
2	566	496	70	0.7
3	1012	883	127	1.1
4	**1066**	**907**	157	1.9
5	797	636	158	2.8
6	710	579	128	3.8
7	669	540	124	4.8
8	830	661	162	5.9
9	981	780	**194**	7.0
10	825	645	171	8.1
11	770	602	159	9.2
12	743	569	164	10.2
13	707	516	180	11.2
14	686	504	170	12.1
15	780	582	186	**12.9**
16	469	338	119	11.3
Maximum		907	194	12.9
Average		616	151	6.9
Note: Bold/red = maximum predicted take				

Table 28
Partitioned Water Take – Post Mining

Post Mine Year	Total Water Take (residual inflow) (ML/year)	Partitioned Water Take (ML/year)		
		Lachlan Fold Belt Groundwater Source	Sydney Basin Groundwater Source	Lawsons Creek Water Source
5	**626**	**386**	**223**	17
10	554	330	206	18
15	520	371	131	18
45	240	108	116	16
90	147	69	59	19
200	133	59	52	**22**
Note: Bold/red = maximum predicted take				

The predicted ongoing equilibrium water take for the final void is approximately 133ML/year, comprising 59ML from the Lachlan Fold Belt Groundwater Source, 52ML from the Sydney Basin Groundwater Source, and 22ML from the Lawsons Creek Water Source.

Takes from the Sydney Basin Groundwater Source and the Lawsons Creek Water Source are predicted to peak in the post mining period at 223ML/year and 22ML/year, respectively. However, as discussed in Section 6.3, baseflow reduction attributable to the Project is likely to be less than the 22ML/year indicated above. It is recommended that only the predicted take during mining be covered by water access licences with the post mining residual takes to be confirmed during mining operation and ongoing validation of the groundwater model.

7.3 2017 CONTROLLED ALLOCATION

Bowdens Silver has acquired the right to apply for an aquifer water access licence pursuant to the Controlled Allocation Order (Various Groundwater Sources) 2017, gazetted on 5 May 2017, and subsequently amended on 1 June 2018 in respect of the Sydney Basin Groundwater Source of the NSW Murray Darling Basin Porous Rock Groundwater Sources, 2011 and the Lachlan Fold Belt Groundwater Source of the NSW Murray Darling Fractured Rock Groundwater Sources, 2011. Bowdens Silver has secured groundwater allocations in both the 2018 and 2019 registration of interest periods totalling 194 unit shares in the Sydney Basin MDB Groundwater Source and 907 unit shares in the Lachlan Fold Belt MDB Groundwater Source. Bowdens Silver has deferral contracts for the full volume of unit shares, allowing the deferral of payment of the total purchase price for these rights. Details of the registration are provided on **Table 29**.

Table 29
Registration of Interest – 2017 Controlled Allocation

Groundwater Source / Management Zone	Registration of Interest Number	Number of Unit Shares	Total
Sydney Basin MDB Groundwater Source	ROI2-18-111	118	194
	ROI3-19-097	76	
Lachlan Fold Belt MDB Groundwater Source - (Other) Management Zone	ROI2-18-112	885	907
	ROI3-19-096	22	

7.4 SUMMARY – REQUIRED VS SECURED WALS

7.4.1 Mining

From **Table 29**, the Project has secured the option to purchase WALs to the value of 907 unit shares in the Lachlan Fold Belt Groundwater Source (equivalent to 907ML/year) and 194 unit shares in the Sydney Basin Groundwater Source (equivalent to 194ML/year). This is sufficient to cover the peak predicted dewatering requirement over the life of the mine and is significantly greater than the predicted annual average take of 616ML from the Lachlan Fold Belt Groundwater Source and 151ML from the Sydney Basin Groundwater Source.

Bowdens Silver has also secured two WAL's with a total unit share entitlement of 139ML from the Lawsons Creek Water Source which is sufficient to cover the partitioned maximum groundwater take of 12.9ML from this water source.

It is recommended that groundwater modelling be revisited during the first two years of mining below the water table to validate or revise predicted inflows and water take as required. The results of this modelling can be used to confirm the required future entitlement.

7.4.2 Post Mining

The secured options to purchase WALs as outlined in **Table 29** and Section 7.4.1 are more than sufficient to account for predicted long-term water take from the Lawsons Creek Water Source and the Lachlan Fold Belt and Sydney Basin Groundwater Sources.

8. MONITORING AND MANAGEMENT

A dedicated Groundwater Management Plan detailing proposed groundwater monitoring and management during mine operations would be prepared prior to the commencement of mining. The following outlines the key monitoring and management components that would be required.

8.1 MINE DEWATERING VOLUMES

Monitoring and reporting of mine dewatering volumes would include the following.

- Mine Dewatering - accumulating flow meters at all dewatering points – weekly record
- Emergency and / or temporary dewatering – minimum record of hours run vs pump capacity – daily record

8.2 GROUNDWATER MONITORING NETWORK

The groundwater monitoring network would comprise a combination of existing and proposed monitoring bores and vibrating wire piezometer installations to facilitate both operational, and environmental and compliance monitoring requirements. The existing groundwater monitoring network would be utilised for monitoring during mine operation and identification of potential impacts. Additional monitoring bores would be installed downgradient of the WRE and TSF to monitor for potential seepage migration. The monitoring bores would be installed downgradient of any seepage detection and interception measures (to be confirmed during detailed design), and between the WRE/TSF and sensitive receptors such as Hawkins and Lawsons Creeks and their associated alluvial aquifers.

Operational groundwater monitoring would likely comprise both standpipe piezometers and vibrating wire piezometers to monitor dewatering effectiveness and open cut pit slope depressurisation. Individual monitoring sites would be installed on an as-required basis.

It is proposed that the current monthly water levels and quarterly comprehensive water quality monitoring be continued. Selected monitoring bores would be equipped with water level data loggers for the collection of high frequency/continuous water level data.

8.2.1 Ongoing Monitoring Post Mining

The requirement for ongoing monitoring during the post mining and final rehabilitation phase will be determined at the mine closure planning stage and in consultation with the relevant authorities. Initial post mining monitoring will likely be a rationalised version of the operational monitoring network paired back to focussing on key areas such as the TSF and mine void.

8.3 TRIGGER LEVELS AND THRESHOLDS

Trigger levels and thresholds would be developed with regard to water level and water quality prior to the commencement of mining.

Groundwater level thresholds would be based on predicted water level decline and identification of potential impacts at sensitive groundwater receptors such as other groundwater users, and baseflow contributions to Hawkins and Lawsons Creeks.

Groundwater quality guideline values or trigger values would be adopted or developed to identify potential deleterious impacts particularly arising from potential acid rock drainage, TSF seepage or salinification. Triggers for selected parameters would be developed in accordance with ANZG (2018) or accepted guidance applicable at the time of formulation.

8.4 TSF SEEPAGE MANAGEMENT

A TSF Seepage Management Plan would be developed in tandem with the TSF detailed design process that would be undertaken prior to construction (ATC Williams, 2020) and in conjunction the NSW Dam Safety Committee. Potential seepage control and mitigation measures would be optimised during the detailed design phase. Detailed design will also include further assessment of potential seepage, including reactive transport modelling.

Key components of the TSF seepage management measures are likely to include:

- A low permeability geomembrane/clay zone and a low permeability (1 x 10^{-13}m/s) bituminous geomembrane (BGM) liner beneath the TSF. Details of the liner design and extent will be confirmed during detailed design.
- A concrete plinth connected to a 40m deep foundation curtain grouting beneath the upstream toe of the TSF embankment (ATC Williams, 2020 – Section 22.1).
- Seepage interception measures involving seepage collection drains at the TSF embankment downstream toe, and ponds (ATC Williams, 2020 – Section 23.1).
- Embankment pore pressure monitoring.
- Groundwater monitoring bores down gradient and adjacent to the TSF. In addition to existing monitoring locations, additional short and long term monitoring locations will be identified during detailed design. Short term monitoring locations will be optimised for the early detection (during TSF operation) of any seepage migration.

8.5 FINAL VOID MANAGEMENT

Detailed management of the final mine void would be outlined in an approved Mining Operations Plan. Preliminary mine closure plans include allowance for diverting up-catchment surface water flows and run-off around the final mine void. There is also potential for surface water to be utilised to accelerate the pit lake recovery with diversion once water levels approach equilibrium.

Ongoing validation of the groundwater model during mine operation, with recalibration to observed inflows, would allow a more detailed assessment of final void conditions to be undertaken, with the subsequent refinement of management measures as required.

8.6 GROUNDWATER MODEL REVIEW

It is recommended that the groundwater model be reviewed within the first two years of mining below the water table to validate and update predicted mine inflows and impacts as required.

9. REFERENCES

AMC, 2012. Bowdens Open Pit Geotechnical Study. Consultants report prepared for Kingsgate Consolidated Limited by AMC Consultants.

ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. The 2018 revision of the Water Quality Guidelines is presented as an online platform, to improve usability and facilitate updates as new information becomes available (http://www.waterquality.gov.au/anz-guidelines).

ATC Williams, 2017. Tailings Storage Facility Dam and Water Storage Dam Preliminary Geotechnical Investigations. Report prepared for Bowdens Silver Pty Ltd. Reference 116217.05 R01. October 2017.

ATC Williams, 2019. Bowdens Silver Project TSF Liner and Seepage. Letter report prepared for Bowdens Silver Pty Ltd. Reference 116217.07L001 Rev 0. 18 March 2019.

ATC Williams, 2020. Tailings Storage Facility Preliminary Design. Report prepared for Bowdens Silver Pty Ltd. Reference 116217.01 R02 Rev5. May 2020.

Barnett, B., Townley, L.R., Post, V., Evans, R.E., Hunt, R.J., Peeters, I., Richardson, S., Werner, A.D., Knapton, A., and Boronkay, A. 2012. Australian groundwater modelling guidelines. Sinclair Knight Merz and National Centre for Groundwater Research and Training. Waterlines Report Series No. 82, June 2012.

Bish, S., 1999. Hydrogeological Assessment for Coxs River Catchment, Sydney – South Coast Region, NSW. Department of Land and Water Conservation. October 1999.

Cardno, 2020. Bowdens Silver Mine Aquatic Ecology Assessment. Part 10 of the Specialist Consultant Studies Compendium. Prepared on behalf of Bowdens Silver Pty Limited . Job No. EL1112038. May 2020.

Chapman, T., 1999. A comparison of algorithms for stream flow recession and baseflow separation. Hydrol. Processes 13, 701–714.

Coffey, 1998. Bowdens Silver Project Pre-Feasibility Water Supply Study. Consultant report prepared by Coffey Partners International Pty Ltd for Silver Standard Australia Pty Ltd.

Colqhoun G.P., Hughes K.S., Deyssing L., Ballard J.C., Phillips G., Troedson A.L., Folkes C.B. & Fitzherbert J.A. 2019. New South Wales Seamless Geology dataset, version 1.1 [Digital Dataset]. Geological Survey of New South Wales, NSW Department of Planning and Environment, Maitland.

Colqhoun G.P., Meakin N.S., Henderson G.A.M., Krynen J.P., Jagodzinski E.A., Watkins J.J. and Yoo E.K., 2000, Mudgee 1:100 000 Geological Sheet 8832, 1st edition. Geological Survey of New South Wales, Sydney & Geoscience Australia, Canberra.

Doherty, J. 2018. PEST, Model-Independent Parameter Estimation – User Manual. 7th Edition published in 2018.

DoIR&E, 2016. Western Coalfield Geological Modelling Project. Department of Industry, Resources and Energy. 16 December 2016.

DPI Water, 2016. Methods for the identification of high probability groundwater dependent vegetation ecosystems. Department of Primary Industries. ISBN 978-1-74256-967-3. September 2016.

Dresel, P. E., Clark, R. Cheng, X., Reid, M., Fawcett, J., and Cochraine, D. (2010) Mapping Terrestrial Groundwater Dependent Ecosystems: Method Development and Example Output. Victoria Department of Primary Industries, Melbourne VIC. 66 pp

Dresel, P. E., Clark, R. Cheng, X., Reid, M., Fawcett, J., and Cochraine, D. (2010) Mapping Terrestrial Groundwater Dependent Ecosystems: Method Development and Example Output. Victoria Department of Primary Industries, Melbourne VIC. 66 pp

Dresel, P.E., Clark, R., Cheng, X., Reid, M.,Fawcett, J.,Cochraine, D. 2010. Mapping Terrestrial Groundwater Dependent Ecosystems: Method Development and Example Output. Victoria Department of Primary Industries, Melbourne, VIC. 66 pp.

DRET, 2008. Cyanide Management - Leading Practise Sustainable Development Program for the Mining Industry. Australian Government, Department of Resources, Energy and Trade. May 2008.

EnviroKey, 2020. Terrestrial Ecology Assessment, Part 9a of the Specialist Consultant Studies Compendium. Prepared on behalf of Bowdens Silver Pty Limited.

GCA, 2020. Materials Characterisation, Part 3 of the Specialist Consultant Studies Compendium. Prepared on behalf of Bowdens Silver Pty Limited.

Gibbs, R.J., 1970. Mechanisms controlling world water chemistry. Science 170 (3962), 1088-1090.

Hydroilex, 2003. Hydrogeological Investigation, Groundwater Supply for Bowdens Silver Project. Consultant report prepared by Hydroilex (Geological Services Division of Panorama Drilling Company Pty Ltd) for Silver Standard Australia Pty Ltd. Report No. HG03.5.3. 5th May 2003.

Hydrosimulations, 2013. Wilpinjong Coal Mine Modification Groundwater Assessment. Consultant report prepared by Hydrosimulations for Peabody Energy Australia Pty Limited. Report HC2013/11. July 2013.

Jacobs, 2014. Bowdens Project: Aquifer Testing. Consultant memo report prepared by Jacobs (Australia) Pty Ltd for Kingsgate Consolidated Limited. Project No. IA035500.03. 12 January 2015.

Jewell, 2003. Hydrogeological Assessment, Bowdens Silver-lead-Zinc Deposit. Consultant report prepared by C. M. Jewell and Associates Pty Ltd for Silver Standard Australia Pty Ltd. Report No. J0824.3. September 2003.

Merrick, 2011. An Assessment of Existing Groundwater Conditions at the Bowdens Silver Mine Project Site near Lue, NSW. Consultant report prepared by Heritage Computing Pty Ltd for Kingsgate Consolidated Limited. Report HC2011/14. November 2011.

NSW Office of Water, 2012. NSW Aquifer Interference Policy. NSW Government policy for the licensing and assessment of aquifer Interference activities. NSW Department of Primary Industries, Publication number: 11445. First published: September 2012.

NHMRC, 2011. Australian Drinking Water Guidelines, Paper 6. National Water Quality Management Strategy. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.

Peter Dundon and Associates, 2006. Moolarben Coal Project Groundwater Assessment. Report prepared for Moolarbe Coal Mines Pty Ltd. Reference 05-0158-R01J. 8 September 2006.

Piper A.M., 1944. A graphic procedure in the geochemical interpretation of water analysis [M]. Trans. AM Geophys. Union. 25, 914–923.

SKM, 2013. Bowdens Groundwater Monitoring Network, Bore Construction and Aquifer Testing. Consultant report prepared by Sinclair Knight Merz Pty Ltd for Kingsgate Consolidated Limited. 11 February 2013.

WaterNSW, 2019. NSW Water Register - https://waterregister.waternsw.com.au/water-register-frame#

WRM, 2020. Surface Water Assessment, Part 6 of the Specialist Consultant Studies Compendium. Prepared on behalf of Bowdens Silver Pty Limited.

This page has intentionally been left blank

Annexures

(Total No. of pages including blank pages = 300)

* This Annexure is only available on the digital version of this document

This page has intentionally been left blank

Annexure 1

Aquifer Interference Policy Checklist

(Total No. of pages including blank pages = 14)

This page has intentionally been left blank

NSW GOVERNMENT | Department of Primary Industries Office of Water

AQUIFER INTERFERENCE ASSESSMENT FRAMEWORK

Assessing a proposal against the NSW Aquifer Interference Policy – step by step guide

Note for proponents

This is the basic framework which the NSW Office of Water uses to assess project proposals against the **NSW Aquifer Interference Policy (AIP).**

The NSW Aquifer Interference Policy can be downloaded from the NSW Office of Water website (www.water.nsw.gov.au under Water management > Law and policy > Key policies > Aquifer interference).

While you are not required to use this framework, you may find it a useful tool to aid the development of a proposal or an **Environmental Impact Statement (EIS).**

We suggest that you summarise your response to each AIP requirement in the tables following and provide a reference to the section of your EIS that addresses that particular requirement. Using this tool can help to ensure that all necessary factors are considered, and will help you understand the requirements of the AIP.

Table 1. Does the activity require detailed assessment under the AIP?

	Consideration	Response
1	Is the activity defined as an aquifer interference activity?	If **NO,** then no assessment is required under the AIP. If **YES,** continue to Question 2.
2	Is the activity a defined minimal impact aquifer interference activity according to section 3.3 of the AIP?	If **YES**, then no further assessment against this policy is required. Volumetric licensing still required for any water taken, unless exempt. If **NO**, then continue on for a full assessment of the activity.

Note for proponents

Section 3.2 of the AIP defines the framework for assessing impacts. These are addressed here under the following headings:

1. Accounting for or preventing the take of water
2. Addressing the minimal impact considerations
3. Proposed remedial actions where impacts are greater than predicted.

www.dpi.nsw.gov.au

1. Accounting for, or preventing the take of water

Where a proposed activity will take water, adequate arrangements must be in place to account for this water. It is the proponent's responsibility to ensure that the necessary licences are held. These requirements are detailed in Section 2 of the AIP, with the specific considerations in Section 2.1 addressed systematically below.

Where a proponent is unable to demonstrate that they will be able to meet the requirements for the licensing of the take of water, consideration should be given to modification of the proposal to prevent the take of water.

Table 2. Has the proponent:

	AIP requirement	Proponent response	NSW Office of Water comment
1	Described the water source(s) the activity will take water from?	Refer Section 2.1.2	
2	Predicted the total amount of water that will be taken from each connected groundwater or surface water source on an annual basis as a result of the activity?	Refer Section 7.1	
3	Predicted the total amount of water that will be taken from each connected groundwater or surface water source after the closure of the activity?	Refer Section 7.2	
4	Made these predictions in accordance with Section 3.2.3 of the AIP? (refer to Table 3, below)	Yes	
5	Described how and in what proportions this take will be assigned to the affected aquifers and connected surface water sources?	Take will be apportioned on a pro-rata bases from mine dewatering based on modelling predictions. The groundwater model will be re-calibrated and updated as required throughout mining to confirm assigned proportions.	
6	Described how any licence exemptions might apply?	No exemptions apply.	
7	Described the characteristics of the water requirements?	Direct and incidental takes for mine dewatering.	
8	Determined if there are sufficient water entitlements and water allocations that are able to be obtained for the activity?	The proponent has secured substantial entitlement equal to the predicted water take.	

	AIP requirement	Proponent response	NSW Office of Water comment
9	Considered the rules of the relevant water sharing plan and if it can meet these rules?	The project can meet the rules of the relevant WSPs.	
10	Determined how it will obtain the required water?	Water requirements over and above mine dewatering volumes will be secured from the Ulan coal field via a financial arrangement.	
11	Considered the effect that activation of existing entitlement may have on future available water determinations?	Ongoing water take diminishes post mining with a long term take of approximately 133ML/yr anticipated. Given that this constitutes less than 0.3% and 0.02% of the LTAAELs for the Sydney Basin and Lachlan Fold Belt groundwater sources respectively, it is not anticipated that this will significantly affect future available water determinations.	
12	Considered actions required both during and post-closure to minimize the risk of inflows to a mine void as a result of flooding?	Mine closure management includes the diversion of surface water around the mine void.	
13	Developed a strategy to account for any water taken beyond the life of the operation of the project?	Ongoing water take has been assessed as outlined at Item 3. WALs for ongoing water take to be held in perpetuity.	
Will uncertainty in the predicted inflows have a significant impact on the environment or other authorised water users? If **YES,** items 14-16 must be addressed. **No –** sensitivity has shown that variations in hydraulic parameters outside of the adopted calibration model will not result in significantly greater impacts. As mine dewatering is not the primary water supply for the project, variation in inflows will not significantly affect operations.			
14	Considered any potential for causing or enhancing hydraulic connections, and quantified the risk?	Not considered to be applicable.	
15	Quantified any other uncertainties in the groundwater or surface water impact modelling conducted for the activity?	Refer Annexure 9	
16	Considered strategies for monitoring actual and reassessing any predicted take of water throughout the life of the project, and how these requirements will be accounted for?	Ongoing monitoring and modelling updates will be undertaken to verify modelling predictions.	

Table 3. Determining water predictions in accordance with Section 3.2.3
(complete one row only – consider both during and following completion of activity)

	AIP requirement	Proponent response	NSW Office of Water comment
1	**For the Gateway process**, is the estimate based on a simple modelling platform, using suitable baseline data, that is, fit-for-purpose?	N/A	
2	**For State Significant Development or mining or coal seam gas production**, is the estimate based on a complex modelling platform that is: • Calibrated against suitable baseline data, and in the case of a **reliable water source,** over at least two years? • Consistent with the Australian Modelling Guidelines? • Independently reviewed, robust and reliable, and deemed fit-for-purpose?	Yes	
3	In all other processes, estimate based on a desk-top analysis that is: • Developed using the available baseline data that has been collected at an appropriate frequency and scale; and • Fit-for-purpose?	N/A	

Other requirements to be reported on under Section 3.2.3

Table 4. Has the proponent provided details on:

	AIP requirement	Proponent response	NSW Office of Water comment
1	Establishment of baseline groundwater conditions?	Yes – refer Section 4.6	
2	A strategy for complying with any water access rules?	Refer Section 7.5. The project will operate within water access rules without need for a specific strategy.	
3	Potential water level, quality or pressure drawdown impacts on nearby basic landholder rights water users?	Yes – refer Section 5.3.5.2, 6.2 and 6.4	
4	Potential water level, quality or pressure drawdown impacts on nearby licensed water users in connected groundwater and surface water sources?	Yes – refer Section 5.3.5.2, 6.2, 6.4 and 6.5	
5	Potential water level, quality or pressure drawdown impacts on groundwater dependent ecosystems?	Yes – refer Section 5.3.5.2, 6.2, 6.4 and 6.5	
6	Potential for increased saline or contaminated water inflows to aquifers and highly connected river systems?	Yes – refer Section 6.4 and 6.5	
7	Potential to cause or enhance hydraulic connection between aquifers?	Other than direct excavation of the mine void, the project will not cause or enhance hydraulic connection between aquifers.	
8	Potential for river bank instability, or high wall instability or failure to occur?	The project will not undermine or encroach on any major drainages.	
9	Details of the method for disposing of extracted activities (for coal seam gas activities)?	N/A	

2. Addressing the minimal impact considerations

Note for proponents

Section 3.2.1 of the AIP describes how aquifer impact assessment should be undertaken.

1. Identify all water sources that will be impacted, referring to the water sources defined in the relevant water sharing plan(s). Assessment against the minimal impact considerations of the AIP should be undertaken for each ground water source.
2. Determine if each water source is defined as 'highly productive' or 'less productive'. If the water source is named in then it is defined as highly productive, all other water sources are defined as less productive.
3. With reference to pages 13-14 of the Aquifer Interference Policy, determine the sub-grouping of each water source (eg alluvial, porous rock, fractured rock, coastal sands).
4. Determine whether the predicted impacts fall within Level 1 or Level 2 of the minimal impact considerations defined in Table 1 of the AIP, for each water source, for each of water table, water pressure, and water quality attributes. The tables below may assist with the assessment. There is a separate table for each sub-grouping of water source – only use the tables that apply to the water source(s) you are assessing, and delete the others.
5. If unable to determine any of these impacts, identify what further information will be required to make this assessment.
6. Where the assessment determines that the impacts fall within the Level 1 impacts, the assessment should be 'Level 1 – Acceptable'
7. Where the assessment falls outside the Level 1 impacts, the assessment should be 'Level 2'. The assessment should further note the reasons the assessment is Level 2, and any additional requirements that are triggered by falling into Level 2.
8. If water table or water pressure assessment is not applicable due to the nature of the water source, the assessment should be recorded as 'N/A – reason for N/A'.

Table 5. Minimal impact considerations

Aquifer	Alluvial aquifer
Category	Highly Productive
Level 1 Minimal Impact Consideration	**Assessment**
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic post-water sharing plan variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	Level 1 – Acceptable No significant drawdown predicted at Alluvial water supply works that are not owned by the project.
Water pressure A cumulative pressure head decline of not more than 40% of the post-water sharing plan pressure head above the base of the water source to a maximum of a 2 metre decline, at any water supply work.	N/A – alluvial aquifer is very shallow
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity. No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity. No mining activity to be below the natural ground surface within 200 metres laterally from the top of high bank or 100 metres vertically beneath (or the three dimensional extent of the alluvial water source - whichever is the lesser distance) of a highly connected surface water source that is defined as a reliable water supply. Not more than 10% cumulatively of the three dimensional extent of the alluvial material in this water source to be excavated by mining activities beyond 200 metres laterally from the top of high bank and 100 metres vertically beneath a highly connected surface water source that is defined as a reliable water supply.	Level 1 – Acceptable. Potential for seepage has been assessed and is unlikely to lower the beneficial use category of the alluvial aquifers Level 1 – Acceptable. Level 1 – Acceptable. Level 1 – Acceptable.

Aquifer	Porous Rock – except Great Artesian Basin
Category	Highly Productive
Level 1 Minimal Impact Consideration	**Assessment**
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	Level 1 – Acceptable It is noted that in excess of 2m decline is predicted at GW061475, however, given the elevation of the water supply work and it's installation within the Illawarra Coal Measures, predicted impacts are considered to be conservative and unlikely to be realised. Notwithstanding, in the event that water supply is compromised and attributed to drawdown associated with the Project, make good provisions will apply.
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	Level 1 – Acceptable
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	Level 1 – Acceptable

Aquifer	Fractured Rock
Category	**Highly Productive**

Level 1 Minimal Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem; or • high priority culturally significant site; listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	Level 1 – Acceptable It is noted that of the order of 1 to 2m decline in water table is predicted at GW802888. Given the bore is recorded as being 51m deep, a drawdown of this magnitude is not expected to impact on supply from the well. Notwithstanding, in the event that water supply is compromised and attributed to drawdown associated with the Project, make good provisions will apply.
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	Level 1 – Acceptable
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	Level 1 – Acceptable Given baseline groundwater conditions seepage from the TSF is not expected to lower the beneficial use of the aquifer (current use is livestock watering) beyond 40 m from the Mine Site boundary. The post mining void will remain a groundwater sink. Salinification within the pit lake due to evaporative concentration will be retained within the void. Some downgradient migration may occur but with dilution and attenuation is unlikely to change the beneficial use category.

3. Proposed remedial actions where impacts are greater than predicted.

Note for proponents

Point 3 of section 3.2 of the AIP provides a basic framework for considerations to consider when assessing a proponent's proposed remedial actions.

Table 6. Has the proponent:

AIP requirement		Proponent response	NSW Office of Water comment
1	Considered types, scale, and likelihood of unforeseen impacts *during operation*?		
2	Considered types, scale, and likelihood of unforeseen impacts *post closure*?		
3	Proposed mitigation, prevention or avoidance strategies for each of these potential impacts?		
4	Proposed remedial actions should the risk minimization strategies fail?		
5	Considered what further mitigation, prevention, avoidance or remedial actions might be required?		
6	Considered what conditions might be appropriate?		

4. Other considerations

Note for proponents

These considerations are not included in the assessment framework outlined within the AIP, however are discussed elsewhere in the document and are useful considerations when assessing a proposal.

Table 7: Has the proponent:

AIP requirement		Proponent response	NSW Office of Water comment
1	Addressed how it will measure and monitor volumetric take? (page 4 of the AIP)		
2	Outlined a reporting framework for volumetric take? (page 4 of the AIP)		

More information

www.water.nsw.gov.au

Disclaimer:

This is a draft document produced as a guide for discussion, and to aid interpretation and application of the NSW Aquifer Interference Policy (2012). All information in this document is drawn from that policy, and where there is any inconsistency, the policy prevails over anything contained in this document.
Any omissions from this framework do not remove the need to meet any other requirements listed under the Policy.

The information contained in this publication is based on knowledge and understanding at the time of writing (June 2021). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of the Department of Primary Industries or the users independent adviser.

Published by the NSW Department of Primary Industries.

Reference 12279.1

This page has intentionally been left blank

Annexure 2

Groundwater Works Summary

(Total No. of pages including blank pages = 12)

Note: This Annexure is only available on the digital version of this document

This page has intentionally been left blank

GW#	Easting	Northing	Date	Final Depth (mBGL)	Screen Top (mBGL)	Screen Bottom (mBGL)	Screened Unit	Water Level (mBGL)	Salinity	Yield (L/s)
GW005408	788992.4	6402272.9	1/01/1914	28.7	16.5	28.7	Basalt decomposed	13.1	Hard	0.63
GW005409	789071.8	6401407.0						n/a		
GW005410	787921.6	6404123.2	1/01/1914	46.9	42.7	46.9	Limestone	10.7	Hard	1.05
GW005434	755036.0	6395703.0	1/01/1914	16.1	10.9	16.1	Rock Slate Water Supply	6	Brackish	0.63
GW005435	755192.0	6399769.0						n/a		
GW005436	753134.0	6406171.0	1/01/1914	22.8	9.1	22.8	Rock Slate Water Supply	6	Brackish	0.63
GW011434	766985.0	6381672.0						n/a		
GW011606	767792.0	6379677.0	1/01/1948	18.2	11.8	18.2	Rock Hard	4.5		0.13
GW011607	767084.0	6382440.0	1/01/1926	10.6	3.04	10.66	Gravel Wash/Slate	3		
GW011608	767166.0	6382561.0	1/01/1936	12.1	6	12.1		4.5	Hard	
GW011609	766977.0	6382319.0						n/a		
GW011610	765814.0	6381765.0	1/01/1948	7.6	6.09	7.62	Rock Water Supply	1.5		
GW011611	763570.0	6381701.0						n/a		
GW011612	764016.0	6382768.0	1/01/1935	9.1	0	9.1	Gravel Nominal Water Supply	3		
GW011613	764153.0	6384029.0	1/01/1936	10.6	0	10.6	Gravel Wash Nominal Water Supply	6		0.13
GW011614	763349.0	6384204.0	1/01/1935	18.2	11.8	18.2		7.6		0.13
GW011615	762922.0	6384801.0						n/a		
GW011616	765798.0	6383122.0	1/01/1948	12.1	5.7	12.1		6		0.05
GW011617	762655.0	6384592.0	1/01/1936	9.1	0	9.1	Gravel Wash Nominal Water Supply	3		
GW013110	766985.0	6381672.0	1/05/1957	36.5	18.2	24.2	Slate Water Supply	9.1	Good	0.61
GW013215	788646.2	6391181.7						n/a		
GW013218	789539.3	6390446.1						n/a		
GW014168	757657.0	6403158.0						n/a		

GW#	Easting	Northing	Date	Final Depth (mBGL)	Screen Top (mBGL)	Screen Bottom (mBGL)	Screened Unit	Water Level (mBGL)	Salinity	Yield (L/s)
GW014538	760106.0	6401893.0	1/09/1960	18.8	14	18.8	Rock Water Supply	6.7	2000	0.51
GW014540	762186.0	6403503.0	1/10/1960	26.2	17.9	26.2	Rock Water Supply	17.6	2000	0.51
GW017060	755979.0	6402955.0	1/01/1958	22.8	17.2	22.8	Slate	18.5	750	1.14
GW017461	784050.9	6368340.4	1/12/1957	12.2	11	12.2	Shale Black Water Supply	6.1		
GW018929	791063.7	6382753.8						n/a		
GW019500	789160.7	6394527.4						n/a		
GW021844	789733.6	6398982.6						n/a		
GW021845	789979.8	6397557.4	1/05/1964	5.5	0	5.5	Sand Gravel Water Supply	2.4	Good	10.1
GW021900	788325.6	6390913.3	1/05/1964	14.6	0	14.6	Sand Gravel Water Supply	12.2		
GW023075	790137.0	6395763.5	1/08/1965	4.3	0	4.3	Sand	2.1		2.53
GW023104	789945.1	6399963.4						n/a		
GW023337	755621.0	6401207.0						n/a		
GW023618	755612.0	6401885.0						n/a		
GW023756	758624.0	6404212.0	1/04/1966	42.6	24.6	42.6	Sandstone Grey Water Supply	18.2	2000	0.4
GW024015	761102.0	6400017.0	1/04/1966	36.5	14.3	36.5	Sandstone Grey Water Supply	9.1	2000	
GW025796	773239.0	6372036.0	1/04/1966	9.4	5.5	9.5	Alluvium	4.8	Good	4.17
GW025814	762012.0	6404833.0		18.2	18.2	18.3	Rock Slightly Soft Slatey Water Supply	2.7	Good Stock	0.19
GW025820	773738.0	6372176.0	unknown	5.5	0	5.4	Alluvium	0.7	Good	3.79
GW026422	770456.0	6376028.0						n/a		
GW026583	792598.1	6383510.5	1/05/1966	6.7	0	6.7	Sand Water Supply	2.4	Good	
GW026726	760991.0	6399742.0	1/03/1967	45.7	23.9	45.7	Basalt Black Hard Slightly Fractured Water Supply	16.7		0.38
GW026783	748603.0	6391088.0	1/12/1966	5.4	0	5.4	Gravel Clay Water Supply	3.6		7.58
GW027701	751701.0	6388729.0	1/07/1967	3.6	0	3.6	Gravel Water Supply	1.5		18.95
GW027960	761232.0	6399983.0						n/a		
GW028676	790586.9	6392358.3						n/a		
GW028811	751701.0	6395973.0	1/02/1968	3.6	0	3.6	Gravel Water Supply	2.1	Hard	3.79
GW028890	789630.2	6398090.9						n/a		
GW029487	790368.2	6392919.6						n/a		

GW#	Easting	Northing	Date	Final Depth (mBGL)	Screen Top (mBGL)	Screen Bottom (mBGL)	Screened Unit	Water Level (mBGL)	Salinity	Yield (L/s)
GW029488	790260.8	6394619.5						n/a		
GW029489	790418.9	6393782.2						n/a		
GW029543	777329.0	6405778.0	1/02/1968	11.8	7.3	11.8	Gravel Sandy Water Supply	7		0.63
GW031053	750870.0	6384711.0		9.7	0	9.6		6		12.63
GW031201	759540.0	6405268.0						n/a		
GW031324	760879.0	6397464.0						n/a		
GW031325	760347.0	6397077.0						n/a		
GW031594	764910.0	6382066.0						n/a		
GW031595	761785.0	6385201.0						n/a		
GW031597	766408.0	6382520.0						n/a		
GW031598	766305.0	6382553.0						n/a		
GW031600	766710.0	6382111.0						n/a		
GW031601	763641.0	6383395.0						n/a		
GW031602	767244.0	6382559.0						n/a		
GW031603	764331.0	6382852.0						n/a		
GW032084	763301.0	6386302.0	1/08/1968	76.2	7.7	76.2	Basalt, Sandstone, Slate, Shale	6	Fresh	3.16
GW032259	752806.0	6402480.0						n/a		
GW042766	758496.0	6405325.0						n/a		
GW042767	758247.0	6404777.0						n/a		
GW042767	758247.0	6404777.0						n/a		
GW042966	758849.0	6387652.0						n/a		
GW045103	772328.0	6382514.0						n/a		
GW045422	760017.0	6400477.0						n/a		
GW045433	753114.0	6399174.0	1/05/1976	28.1	10.5	28.1	Basalt Water Supply	8.2	2000	
GW045434	753963.0	6398659.0						n/a		
GW045445	789350.5	6401090.8						n/a		
GW045450	751113.0	6389175.0						n/a		
GW047371	772868.0	6400381.0	1/08/1979	16.8	10.7	16.5	Coal/Shale Water Supply	10.7		0.15
GW047410	773450.0	6400643.0						n/a		

GW#	Easting	Northing	Date	Final Depth (mBGL)	Screen Top (mBGL)	Screen Bottom (mBGL)	Screened Unit	Water Level (mBGL)	Salinity	Yield (L/s)
GW047609	790064.4	6395950.9	1/12/1979	9	4	9	Gravel Sandstone Water Supply	5		34.1
GW047612	790141.1	6396812.0						n/a		
GW047613	790021.9	6397185.4						n/a		
GW047614	772864.0	6400227.0						n/a		
GW047766	779368.0	6372235.0						n/a		
GW048149	771847.0	6367819.0						n/a		
GW048618	767707.0	6404745.0						n/a		
GW048812	786141.6	6403125.6						n/a		
GW048879	763604.0	6398780.0	1/01/1979	20	6	20	Schist Dark Grey Very Hard Water Supply	6		0.46
GW049674	773004.0	6400563.0	1/09/1979	15.2	9.1	14.6	Sand Very Fine Water Supply	11.6	Good	0.19
GW051109	754132.0	6396066.0	1/06/1980	31.7	16.5	31.7	Shale Hard Water Supply	5.5	Good	0.38
GW051992	774999.0	6386695.0						n/a		
GW052605	760653.0	6396823.0		20	10	20		9		0.67
GW053097	789549.0	6389890.6						n/a		
GW053263	780452.0	6406215.0		6.4	0	6.4		3.3		8.84
GW053717	789626.0	6400681.6						n/a		
GW053718	789695.6	6400371.1						n/a		
GW053788	754084.0	6403434.0						n/a		
GW053838	779734.0	6401117.0						n/a		
GW054125	751532.0	6398597.0	1/01/1981	23.6	4.3	23.6	Granite Bands Water Supply	17.8	2000	1.1
GW054498	777437.0	6405929.0	1/09/1981	18.3	9	12	Sand Gravel Water Supply	5	Good	
GW054519	768064.0	6405382.0						n/a		
GW054670	774549.0	6372277.0						n/a		
GW055553	762399.0	6391690.0	1/07/1982	54.4	18.4	54.4	Slate Water Supply	17.8		0.07
GW055992	766293.0	6404628.0	1/07/1981	51.8	25.9	51.8	Granite Hard Water Supply	6.1	Good	4.54
GW056328	765685.0	6392559.0	1/04/1981	53	10.7	12.2	Clay Sandy Water Supply	4.5		0.33
GW056368	761805.0	6399906.0						n/a		

GW#	Easting	Northing	Date	Final Depth (mBGL)	Screen Top (mBGL)	Screen Bottom (mBGL)	Screened Unit	Water Level (mBGL)	Salinity	Yield (L/s)
GW056738	764634.0	6405165.0						n/a		
GW056762	766137.0	6384068.0						n/a		
GW056911	768585.0	6389737.0						n/a		
GW057059	779942.0	6381531.0	1/01/1983	31.1	13.7	31.1	Shale Black	9.1	Good	1.14
GW057061	752197.0	6387699.0	1/02/1983	34.4	24.6	30	Shale Water Supply	13.8		1.1
GW057083	763170.0	6392225.0		30.5	6.1	6.7	Dolomite Water Supply	4.6		0.25
GW058386	763515.0	6404362.0	1/02/1983	30.5	24.4	30.5	Shale Grey Water Supply	4.6		2.27
GW058394	781227.8	6372583.4	1/04/1983	30.50	10.00	30.00	Weathered Shale	8	2000	0.51
GW058417	782306.9	6380292.7	1/07/1983	30.5	24.4	30.5	Sandstone	3.9	Good	0.31
GW058996	770795.0	6403922.0						n/a		
GW059652	773881.0	6401094.0						n/a		
GW060769	755816.0	6400647.0	1/05/1985	61.5	49	60	Shale Decomposed Water Supply	32	Fresh	0.63
GW060850	773783.0	6395608.0	1/02/1985	69	12	69	Sandstone Pink Water Supply	21		0.55
GW061320	753090.0	6387923.0						n/a		
GW061475	768383.0	6388078.0	1/02/1986	15.2	13.7	15.2	Granite Water Supply	6.7		0.1
GW062111	768316.0	6379755.0						n/a		
GW062206	765202.0	6397998.0						n/a		
GW062357	790638.5	6385172.0						n/a		
GW062492	788206.4	6386784.1						n/a		
GW063804	779191.0	6402242.0						n/a		
GW064010	781578.4	6377599.6	1/02/1987	47.2	16.1	47.2	Shale Black Water Supply	2.4	Good	1.77
GW064265	785866.8	6401714.8						n/a		
GW064288	766428.0	6396948.0	1/01/1987	16.3	12.3	16.3	Shale Black Broken Bands	6.5	Fresh	1.75
GW065121	768849.0	6392477.0	29/03/1983	78	39	78		5	Good	3
GW065219	764608.0	6398229.0	10/06/1988	49.2	3.1	49.2	Granite	8.6	Fresh	1.63
GW065918	752874.0	6381485.0						n/a		
GW066291	765493.0	6383815.0	23/02/1989	60.3	33.5	48.7	Broken Shale and Quartz	30.4		1.25
GW066763	766998.0	6404609.0	18/06/1991	32	16.7	32	Fractured	3.3		0.63
GW070892	761980.0	6405605.0	12/05/1993	47.2	30.5	47.2	Grey Shale	7.6	Good	0.21

GW#	Easting	Northing	Date	Final Depth (mBGL)	Screen Top (mBGL)	Screen Bottom (mBGL)	Screened Unit	Water Level (mBGL)	Salinity	Yield (L/s)
GW073023	788459.8	6391373.5	29/06/1994	61	31	37	Shale	16	Fresh	1.25
GW078051	789452.2	6389277.0						n/a		
GW200185	789721.4	6391435.5						n/a		
GW200369	788396.4	6388301.9	15/09/2005	48	36	45	Shale (grey)	20		1.7
GW800047	755353.0	6400936.0						n/a		
GW800071	752524.0	6382080.0	3/12/1991	29	9.5	29	Basalt	3	Very Good	1.9
GW800095	763349.0	6396043.0	18/11/1995	37	14	20	Basalt	5	Good	2.44
GW800115	769484.0	6394897.0	21/03/1996	51	42	48	Sandstone	11		6.67
GW800122	777433.0	6378518.0	4/05/1996	27.4	12.2	27.4	Blue Shale	1.8	Poor	0.51
GW800269	769868.0	6404698.0	5/10/1995	59	14	59	Shale	27	Good	2.575
GW800273	764213.0	6406040.0						n/a		
GW800468	757812.0	6379879.0						n/a		
GW800509	774721.0	6380280.0						n/a		
GW800548	773513.0	6379458.0	15/06/1997	63.1	1.52	63.1	Granite	1		0.12
GW800579	774563.0	6380333.0	16/06/1997	99.1	4.57	99.1	Granite	10		0.13
GW800642	775283.0	6377003.0	3/11/1998	37	34	35	Sandstone	8		0.63
GW800763	763588.0	6404308.0	24/07/1995	32	6	32	Shale, blue	6	Good	1.4
GW800764	764101.0	6404018.0	13/05/1995	32	9.1	32	Shale, blue	3	Good	1.25
GW800765	764013.0	6404133.0						n/a		
GW801005	766013.0	6383763.0						n/a		
GW801106	757183.0	6379983.0	24/09/1999	30	15	30	Shale, blue	9		0.98
GW801199	756680.0	6405713.0						n/a		
GW801306	777673.0	6377653.0						n/a		insufficient
GW801307	758115.0	6400296.0	3/07/2000	90	35	90	Granite	60		1.2
GW801423	771978.0	6380558.0	18/05/2000	70	15	43	Siltstones/Shales	5.5		0.4
GW801424	772311.0	6381973.0	22/05/2000	51	4	7.5	Gravel	1	Fresh	3
GW801425	771181.0	6376751.0						n/a		abandoned, dry
GW801426	772451.0	6377788.0						n/a		abandoned, dry

GW#	Easting	Northing	Date	Final Depth (mBGL)	Screen Top (mBGL)	Screen Bottom (mBGL)	Screened Unit	Water Level (mBGL)	Salinity	Yield (L/s)
GW801427	771468.0	6377133.0						n/a		
GW801432	778023.0	6379473.0	1/01/1980					3		1
GW801435	766995.0	6383223.0	3/09/2001	24	18	24	Basalt	8		2.5
GW801536	764633.0	6398173.0	23/04/2002	48	46	48	Decomposed Sandstone	8		0.01
GW801723	783655.6	6376643.5	22/11/2002	40	35	39	Sandstone	22		0.315
GW801737	770753.0	6403883.0						n/a		
GW801739	772958.0	6384113.0	3/10/2002	72	48	61	Limestone	20		0.315
GW801745	777323.0	6375883.0	9/10/2002	80	56	56.5	Limestone	20		0.227
GW801866	763953.0	6403673.0						n/a		
GW801884	777463.0	6375603.0	4/10/2002	48	36	38	Limestone	6		2.527
GW801915	764253.0	6404223.0						n/a		
GW801955	772708.0	6379431.0	5/06/2000	52	6	9	Volcanics - Weathered	0.71	793.6	4
GW801957	772123.0	6378563.0	2/06/2000	21	5	21	Siltstone and Slate	0.85	1408	5
GW801959	772222.0	6380990.0	28/02/2002	23	12	23	Siltstone	11.01	Fresh	5
GW801986	776568.0	6378713.0	30/01/2003	80	23	25	Granite	5.5		0.315
GW802015	751643.0	6398929.0	29/09/1997	60.96	51.82	57.91	Shale & Quartz	27.43		2.27
GW802124	756393.0	6403894.0						n/a		
GW802232	766293.0	6386504.0						n/a		
GW802253	757658.0	6400254.0	24/09/2004	35	11	23	Shale	15		5
GW802265	766307.0	6383930.0						n/a		
GW802328	770388.0	6392863.0	8/12/2004	56	38	56	Siltstone	36		0.3
GW802370	785941.1	6371923.2	11/03/1998	37	27.4	33.4	Basalt	4		
GW802414	773998.0	6378538.0						n/a		
GW802427	769827.0	6404721.0						n/a		
GW802481	760605.0	6405390.0						n/a		
GW802482	764628.0	6403613.0						n/a		
GW802487	775813.0	6377195.0	29/01/2003	40	26	33	Granite	3.5		2.275
GW802489	764543.0	6404583.0						n/a		
GW802732	767333.0	6383330.0	21/10/2003	7.5	0	7.5	Alluvial	5.3		
GW802734	785686.0	6378623.8	22/12/2003	48	41	48	Alluvium	16		1.26

GW#	Easting	Northing	Date	Final Depth (mBGL)	Screen Top (mBGL)	Screen Bottom (mBGL)	Screened Unit	Water Level (mBGL)	Salinity	Yield (L/s)
GW802799	767121.0	6387145.0	19/11/2003	100	4.8	66		10.5		0.5
GW802814	754189.0	6387676.0	14/02/2004	66	54	66	Shale, soft, grey	28		2.5
GW802846	756468.0	6404825.0						n/a		
GW802864	784675.4	6379720.8	22/06/2004	80	45	49	Sandstone	32		0.063
GW802902	776668.0	6375790.0						n/a		
GW802931	776222.0	6376460.0	9/09/2003	40	30	40	Sandstone	14		0.442
GW802987	768298.0	6405445.0	30/07/1995	64	21.7	65	Shale, hard, brittle, grey	21.34	Slightly Brackish	0.15
GW802998	767093.0	6403700.0						n/a		
GW803070	766973.0	6403910.0						n/a		
GW803075	758678.0	6400285.0	5/01/2007	35	17	35	Shale	26		1
GW803149	761796.0	6391019.0		15				7		1
GW803161	764730.0	6398408.0						n/a		
GW803217	772911.0	6362570.0	23/08/2006	66	36	60	Diorite	10		1.82
GW803249	765008.0	6404683.0	16/02/2006	42	10	36	Shale, blue/Sandstone & Coal bands	4		1.39
GW803261	752815.0	6400979.0	30/03/2007	50	20	50	Basalt, Granite	10		0.379
GW803263	751180.0	6385050.0	22/01/2007	35	17	35	Shale	19		0.6
GW803280	768595.0	6404300.0	11/04/2007	50	15	50	Shale	15		0.4
GW803280	768595.0	6404300.0						n/a		
GW803497	748318.0	6388492.0	7/12/2006	60	20	60	Shale, blue	22.5	481	0.5
GW803522	758220.0	6400073.0	17/11/2007	49	24	49	Shale	15		0.9
GW803598	785475.0	6369888.0						n/a		
GW803613	753728.0	6406021.0						n/a		
GW803707	782668.0	6384357.0	4/02/2000	76.2	18.29	76.2	Shale and Basalt	22.86		12.61
GW803786	769748.0	6397329.0	10/12/2008	20	0	20		12		0.2
GW803824	766530.0	6404570.0	1/02/1995	26	16.7	26	Shale, blue	8	Slightly Brackish	1.26
GW804060	767555.0	6394430.0						n/a		
GW804203	765225.0	6404730.0						n/a		
GW804217	751020.0	6385801.0	11/09/2009	107	89	101	Shale, blue; Quartz	10	Good	1.26

GW#	Easting	Northing	Date	Final Depth (mBGL)	Screen Top (mBGL)	Screen Bottom (mBGL)	Screened Unit	Water Level (mBGL)	Salinity	Yield (L/s)
GW804297	776480.0	6377110.0						n/a		
GW804302	756690.0	6405713.0						n/a		
GW804303	766711.0	6382980.0						n/a		
GW804351	777999.0	6366819.0	22/07/2010	7.5	4.5	7.5	Sand	4.39		
GW804354	777983.0	6366788.0	22/07/2010	5.8	2.8	5.8	Sandy Clay	4.27		
GW804360	767560.0	6397100.0	2/07/2009	33	24	33	Shale, black	8		0.758
GW804404	766395.0	6404885.0						n/a		
GW804433	756760.0	6403730.0						n/a		
GW804557	748195.0	6388665.0	1/07/1991	35				15		0.8
GW804951	768772.0	6383438.0	12/09/2012	48	30	42	Shale	1.51		0.6
GW805002	760280.0	6406115.0	13/11/2012	42	16	22	Shale, brown	10		1.2
GW805120	784800.5	6376536.5	17/03/2013	60	27	41	Sandstone	20		0.217
GW805155	784950.0	6374040.0						n/a		

This page has intentionally been left blank

Annexure 3

WAL Summary

(Total No. of pages including blank pages = 6)

This page has intentionally been left blank

Water Access Licence	Bore ID	Easting	Northing	Geology form logs	Unit/ Formation	Depth	License	Licence Status	Authorised Purpose	Authorised Quantity (ML)
17710	GW062492	225206	6387163			8	20BL131613	CONVERTED	STOCK, IRRIGATION, DOMESTIC, FARMING	90
17717	GW013215	225397	6391578				20BL004858	CONVERTED	STOCK, IRRIGATION	240
23879	GW026411	225610	6386681	Sand		5.49	20BL017082	CONVERTED	STOCK, IRRIGATION, DOMESTIC	5
27800	GW015524	292117	6562130	Gravel		7.92	90BL010004	CONVERTED	IRRIGATION	19
27891	GW803707	782668	6384357	Sandstone/Shale/Basalt	Narrabeen Group	76.2	80BL238940	CONVERTED	STOCK, IRRIGATION, FARMING	41
27895	GW062206	765202	6397998		Cainzoic units	5	80BL134844	CONVERTED	IRRIGATION, DOMESTIC, STOCK	96
27904	GW802427	769827	6404721	Shale	Narrabeen Group	83.92	80BL242302	CONVERTED	IRRIGATION, PISCICULTURE, STOCK, DOMESTIC	30
27907	GW011493	772480	6387103	Sandstone	Illawarra coal measures	19.5	80BL005330	CONVERTED	STOCK, IRRIGATION, DOMESTIC	50
28443	GW802732	767333	6383330	sand/gravel	Coomber Formation	7.5	80BL241925	CONVERTED	IRRIGATION	19
28475	GW053730	755082	6379148	Sandstone	Buckaroo Conglomerate	49.99	80BL120882	CONVERTED	STOCK, IRRIGATION, DOMESTIC	92
28540	GW801307	758115	6400296	Granite	Adaminaby Group	90	80BL238631	CONVERTED	IRRIGATION	19
28806	GW803075	758678	6400285	Shale	Adaminaby Group	35	80BL243057	CONVERTED	IRRIGATION	23
28887	GW801026	749513	6384084	Shale	Windamere Volcanics	53.4	80BL237311	CONVERTED	IRRIGATION, DOMESTIC, STOCK	210
28946	GW042966	758849	6387652		Coomber Formation		80BL106727	CONVERTED	STOCK, DOMESTIC, IRRIGATION	35

Water Access Licence	Bore ID	Easting	Northing	Geology form logs	Unit/ Formation	Depth	License	Licence Status	Authorised Purpose	Authorised Quantity (ML)
29014	GW066291	765493	6383815	Slate	Coomber Formation	60.3	80BL237544	CONVERTED	STOCK, DOMESTIC, IRRIGATION	6
29247	GW062111	768316	6379755	Volcanics	Adaminaby Group	180	80BL133125	CONVERTED	INDUSTRIAL	30
30035	GW025810	773738	6372176	Gravel/Clay	Cainzoic units	5.4	80BL017263	CONVERTED	IRRIGATION	50
30617	GW053837	779681	6401057		Illawarra coal measures	6	20BL122969	CONVERTED	IRRIGATION, DOMESTIC, STOCK	90
30617	GW053838	779734	6401117		Illawarra coal measures	6	20BL122970	CONVERTED	IRRIGATION, DOMESTIC, STOCK	90
30617	GW053839	779785	6401054		Illawarra coal measures	6	20BL122971	CONVERTED	IRRIGATION, DOMESTIC, STOCK	90
30617	GW053836	779731	6400994		Illawarra coal measures	6	20BL122968	CONVERTED	IRRIGATION, DOMESTIC, STOCK	90
34129	GW065919	753132	6381386		Cainzoic units	6	80BL133816	CONVERTED	IRRIGATION	150
34129	GW065918	752874	6381485		Cainzoic units	5	80BL133814	CONVERTED	IRRIGATION	150
34137	GW800450	749194	6386032		Cainzoic units	8	80BL133027	CONVERTED	IRRIGATION	130
34137	GW800449	748868	6386307		Cainzoic units	8	80BL133026	CONVERTED	IRRIGATION	130
34144	GW023362	750997	6383537		Cainzoic units	6.7	80BL017018	CONVERTED	IRRIGATION	59
34144	GW062189	750821	6383819		Cainzoic units	5.5	80BL133036	CONVERTED	IRRIGATION, DOMESTIC, STOCK	59
34148	GW044583	749406	6385642		Cainzoic units	12.2	80BL238328	CONVERTED	IRRIGATION, DOMESTIC, STOCK	105
34148	GW800426	749619	6385907		Cainzoic units	7.2	80BL236534	CONVERTED	IRRIGATION	105
34148	GW804739	749495	6386015		Cainzoic units	6.8	80BL242669	CONVERTED	IRRIGATION	105
34150	GW802861	750773	6384337	Gravel/Clay	Cainzoic units	13	80BL242242	CONVERTED	IRRIGATION	35

Water Access Licence	Bore ID	Easting	Northing	Geology form logs	Unit/ Formation	Depth	License	Licence Status	Authorised Purpose	Authorised Quantity (ML)
34161	GW802186	749304	6390453	Gravel	Cainzoic units	6	80BL238163	CONVERTED	IRRIGATION, DOMESTIC, STOCK	16
34182	GW063099	751455	6383124		Cainzoic units	6.1	80BL133041	CONVERTED	IRRIGATION, DOMESTIC, STOCK	290
34182	GW029158	751068	6383288	Gravel	Cainzoic units	5.49	80BL022058	CONVERTED	IRRIGATION, DOMESTIC, STOCK	290
34196	GW800459	748800	6386594		Cainzoic units	8	80BL133031	CONVERTED	IRRIGATION	137
34196	GW019438	748815	6386727	Gravel	Cainzoic units	7	80BL011833	CONVERTED	IRRIGATION	137
34199	GW800453	748523	6386100		Cainzoic units	9.1	80BL133028	CONVERTED	IRRIGATION	238
34199	GW800457	748568	6386633		Cainzoic units	7.3	80BL133030	CONVERTED	IRRIGATION	238
34204	GW031052	751030	6384862		Cainzoic units	8.5	80BL022931	CONVERTED	IRRIGATION	42
34205	GW021926	749728	6385736	Gravel	Cainzoic units	5.7	80BL014451	CONVERTED	IRRIGATION	170
34208	GW804672	750129	6385088	Gravel/Clay	Cainzoic units	12	80BL238744	CONVERTED	IRRIGATION	67
34210	GW027701	751701	6388729	Gravel	Cainzoic units	3.66	80BL020966	CONVERTED	IRRIGATION, STOCK	68
34211	GW029471	749702	6385974	Gravel	Cainzoic units	8.7	80BL019095	CONVERTED	IRRIGATION	130
34211	GW800472	749644	6386032		Cainzoic units	9.7	80BL133049	CONVERTED	IRRIGATION, STOCK	130
34211	GW800474	749744	6386082		Cainzoic units	9.1	80BL133050	CONVERTED	IRRIGATION, STOCK	130
34211	GW029472	749311	6385984	Gravel	Cainzoic units	12.4	80BL022618	CONVERTED	IRRIGATION	130
35671	GW065121	768849	6392477		Illawarra coal measures		80BL144189	CONVERTED	IRRIGATION	60

This page has intentionally been left blank

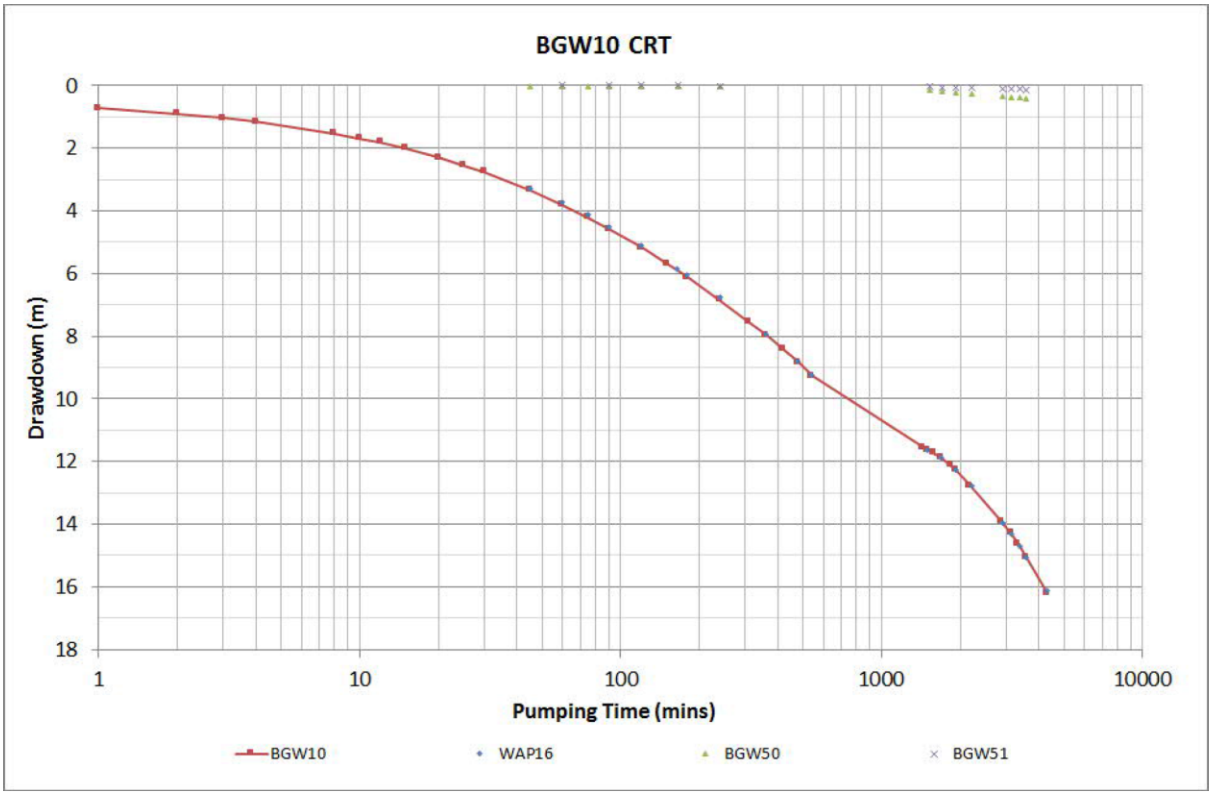
Annexure 4

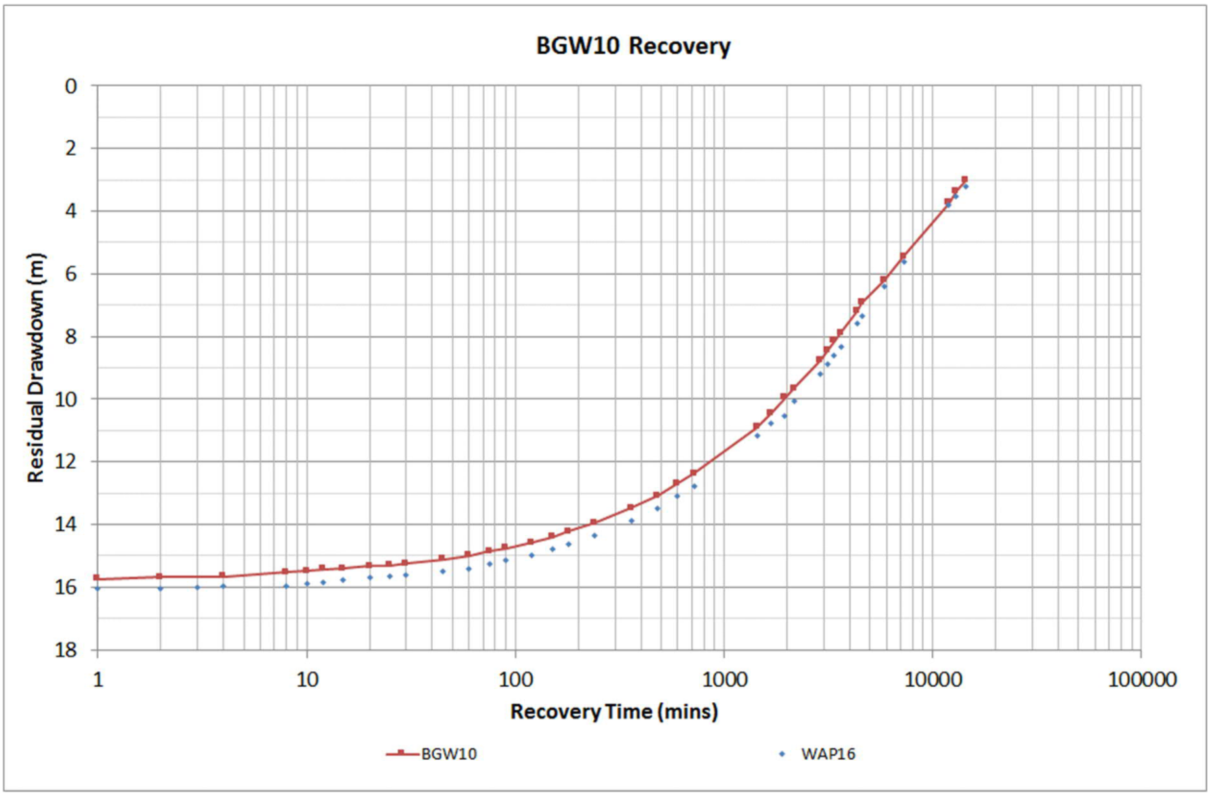
BGW10, BGW108 Pumping Tests

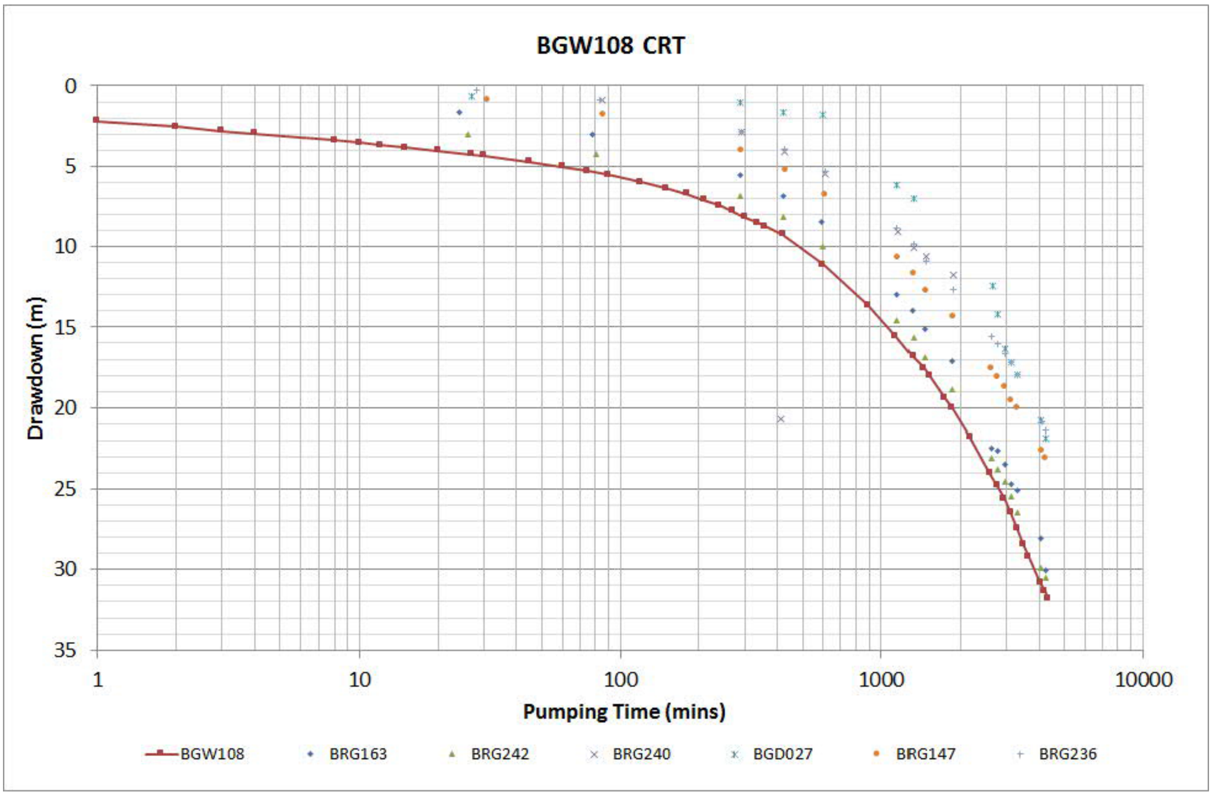
(Total No. of pages including blank pages = 4)

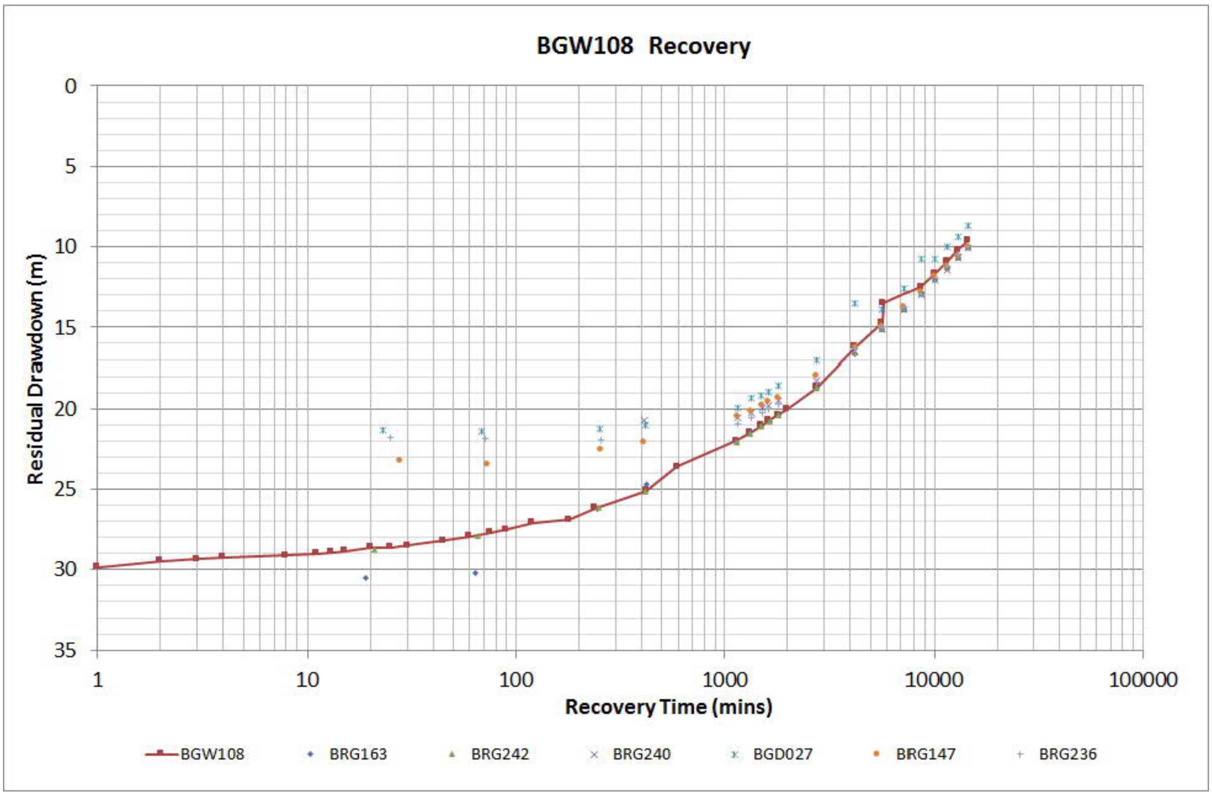
Note: This Annexure is only available on the digital version of this document

This page has intentionally been left blank


BGW10 CRT
Drawdown (m)
0
2
4
6
8
10
12
14
16
18
1
10
100
1000
10000
Pumping Time (mins)
BGW10
WAP16
BGW50
BGW51


BGW10 Recovery
Residual Drawdown (m)
0
2
4
6
8
10
12
14
16
18
1
10
100
1000
10000
100000
Recovery Time (mins)
BGW10
WAP16


BGW108 CRT
Drawdown (m)
0
5
10
15
20
25
30
35
1
10
100
1000
10000
Pumping Time (mins)
BGW108
BRG163
BRG242
BRG240
BGD027
BRG147
BRG236


BGW108 Recovery
Residual Drawdown (m)
0
5
10
15
20
25
30
35
1
10
100
1000
10000
100000
Recovery Time (mins)
BGW108
BRG163
BRG242
BRG240
BGD027
BRG147
BRG236

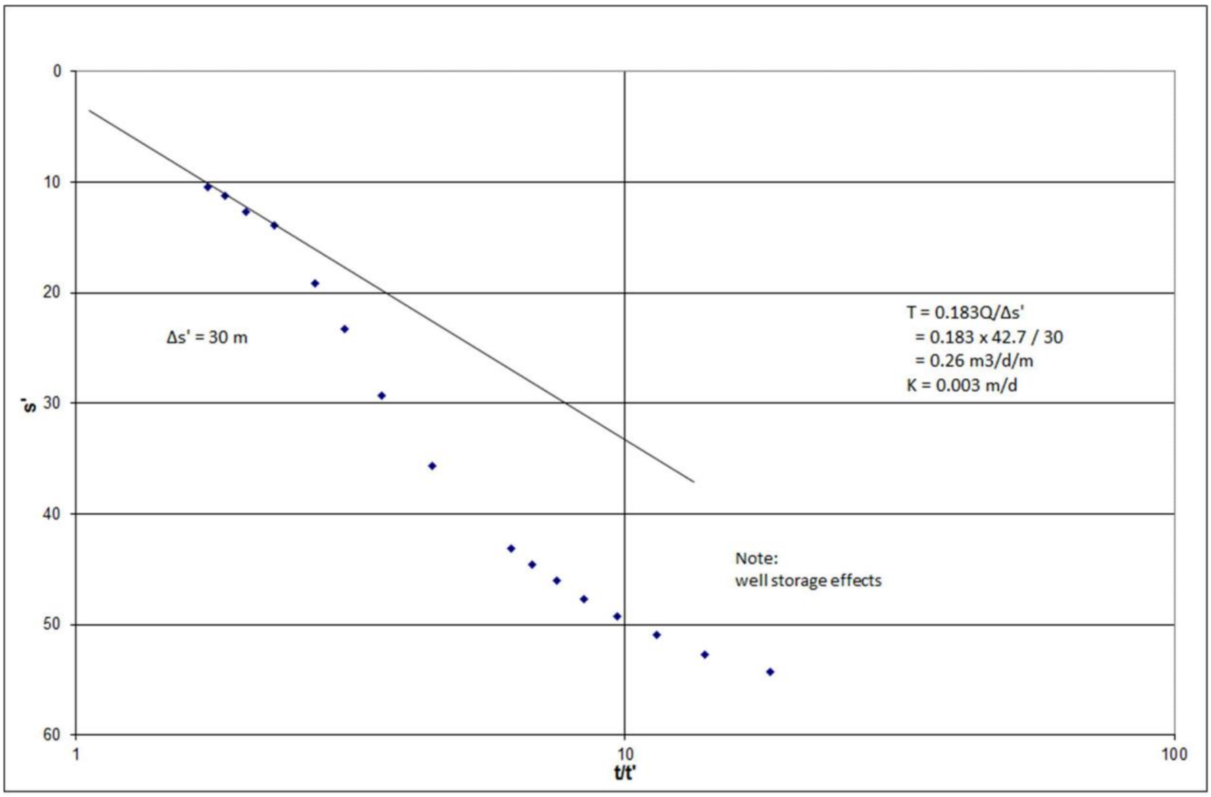
Annexure 5

Airlift Recovery Tests

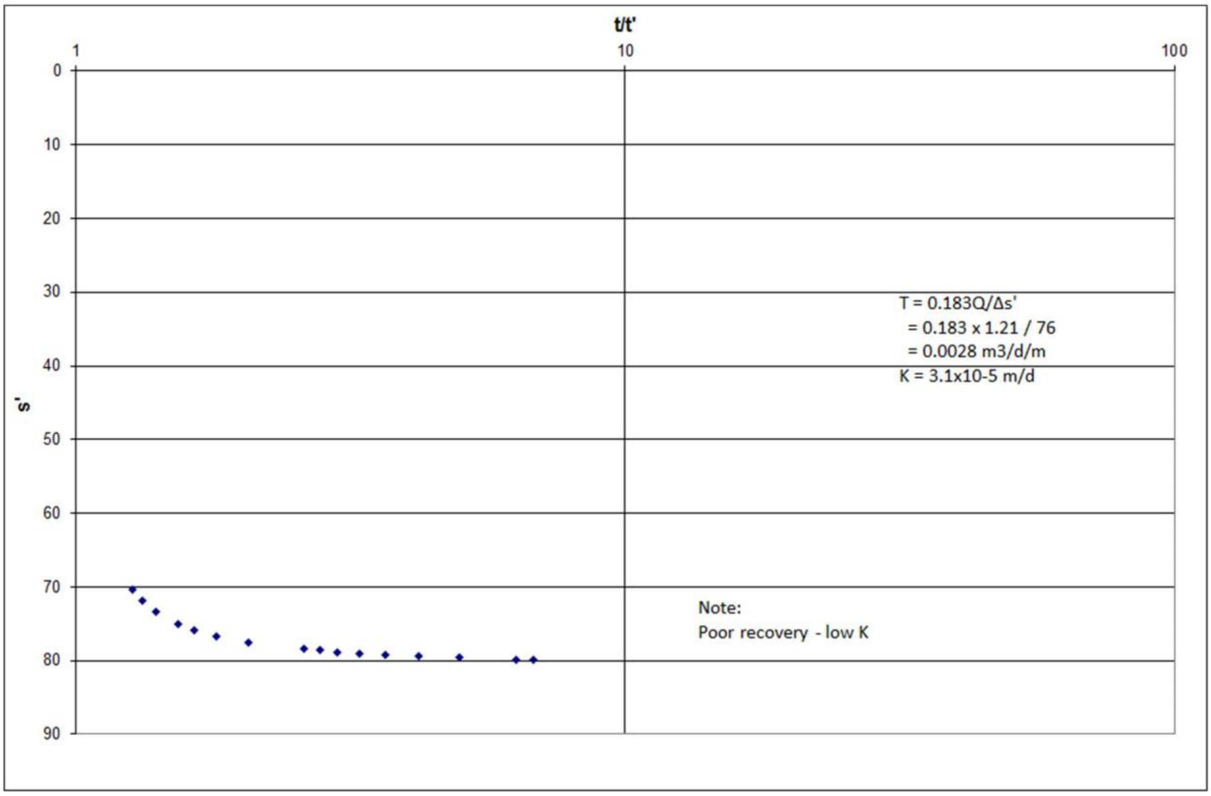
(Total No. of pages including blank pages = 6)

Note: This Annexure is only available on the digital version of this document

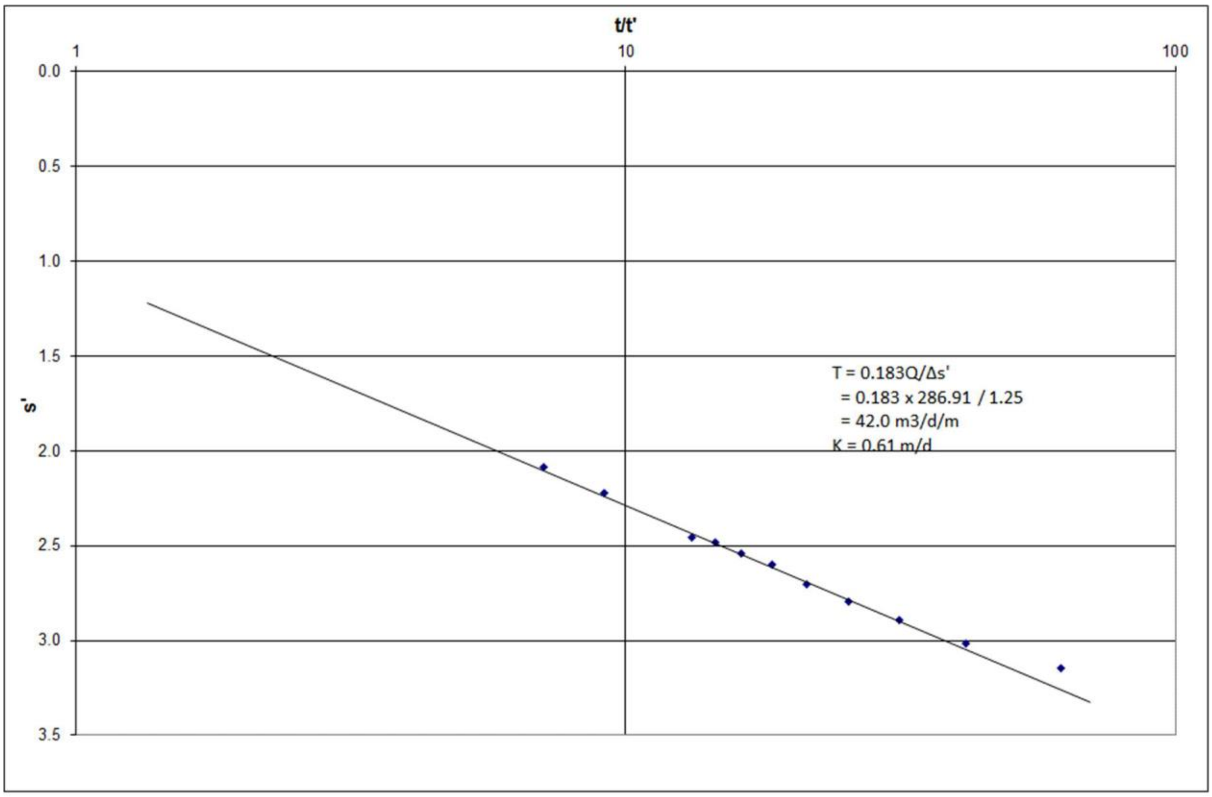
This page has intentionally been left blank



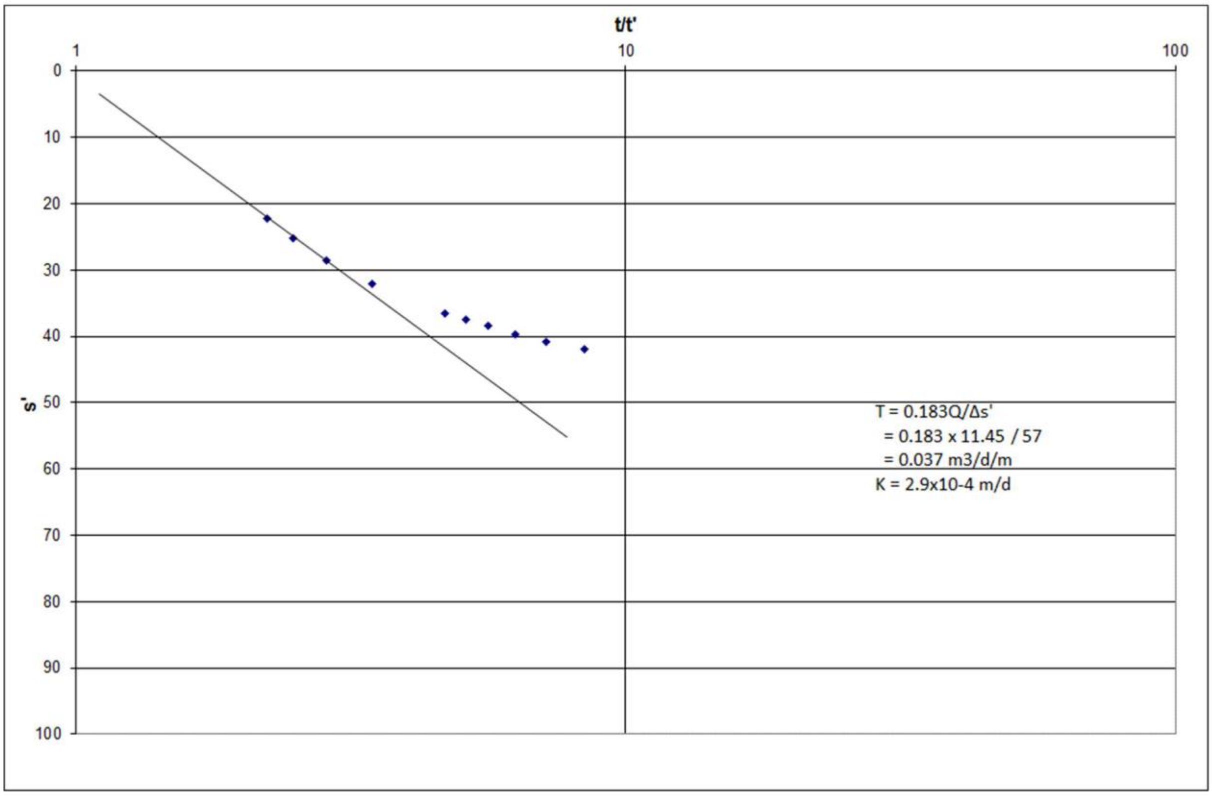
BRC17005



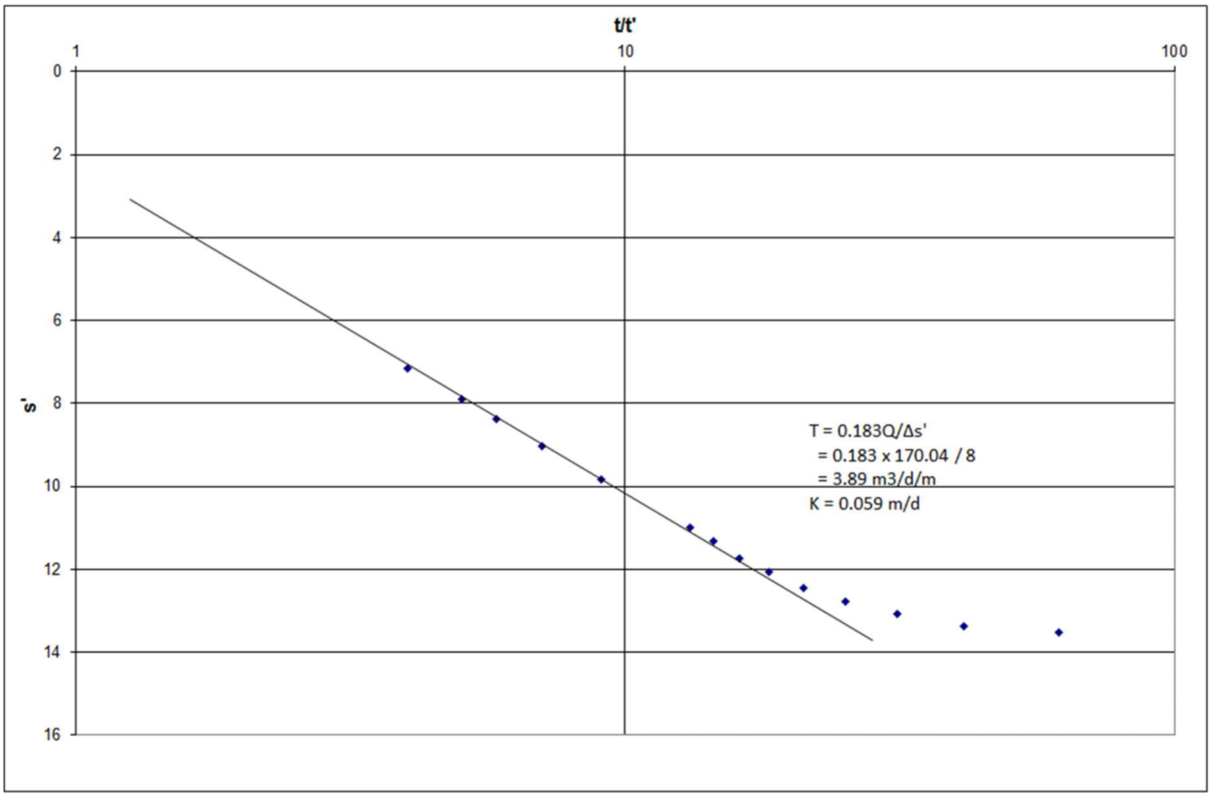
BRC17009



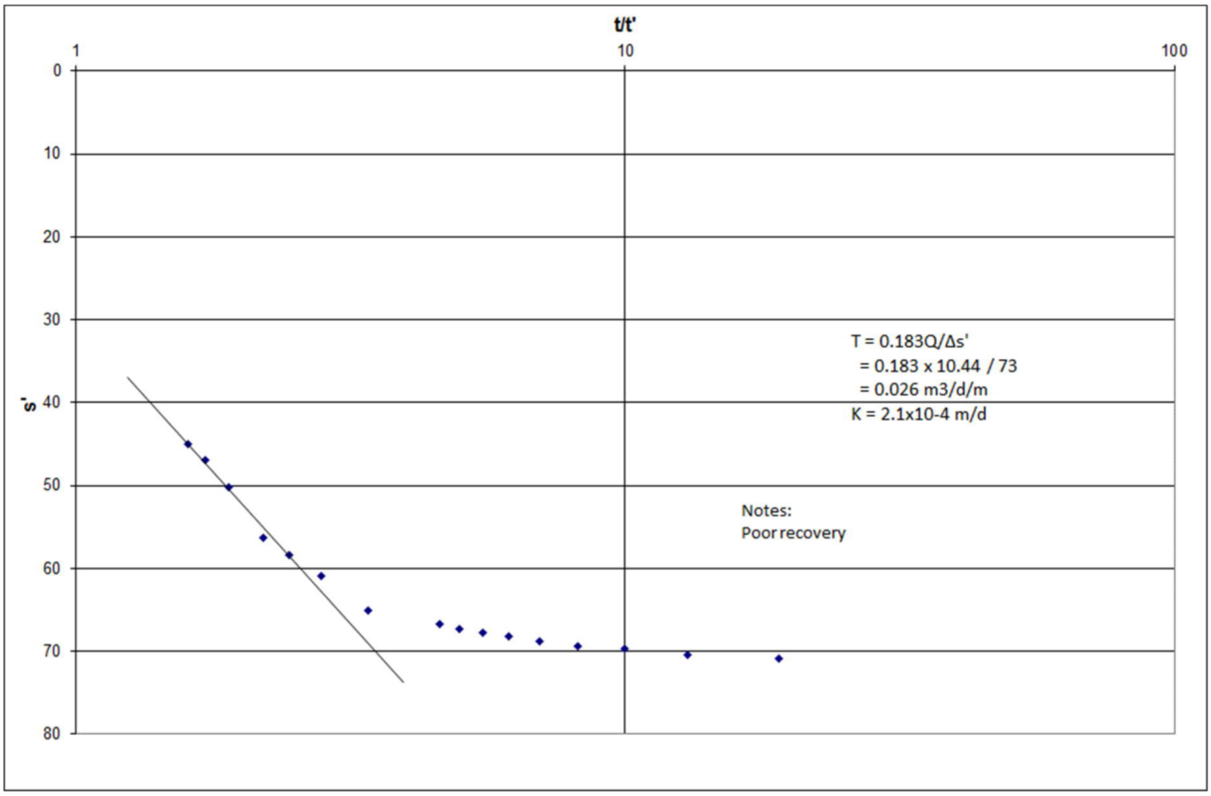
BRC17012



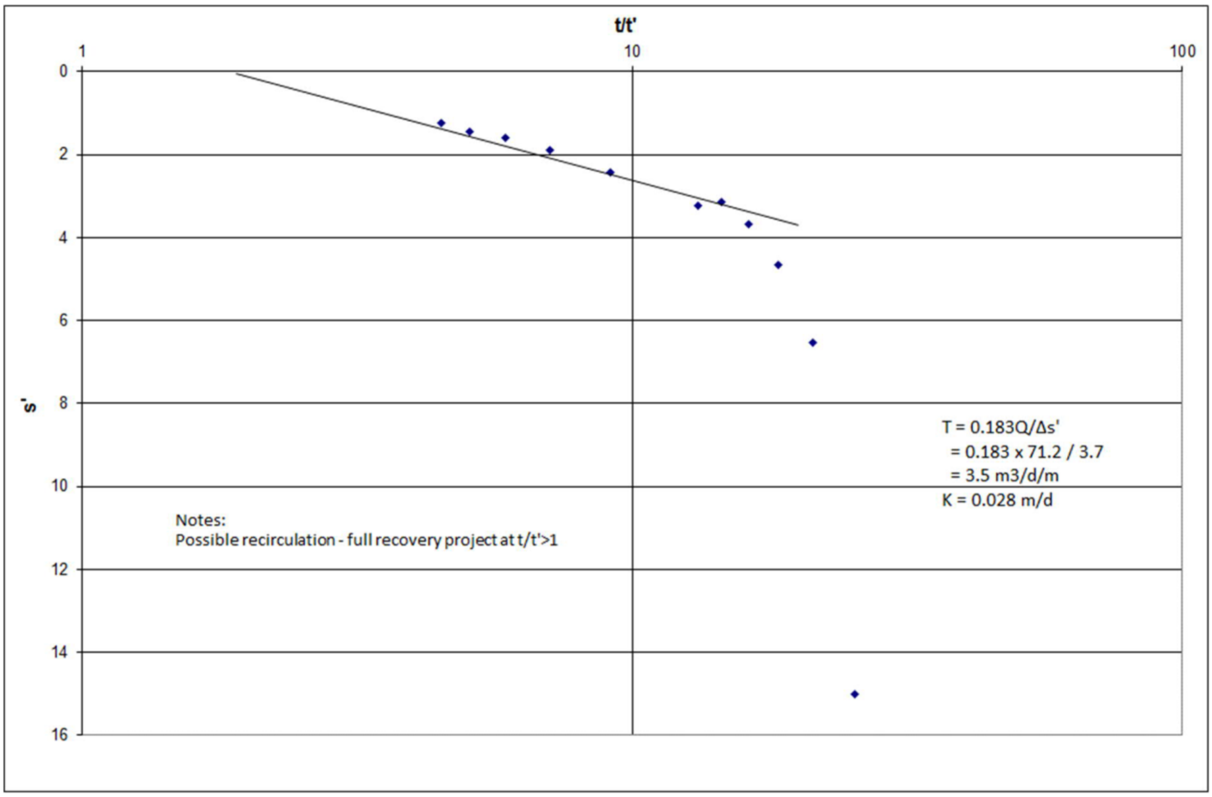
BRC17018



BRC17025



BRC17027


t/t'
1
10
100
s'
0
2
4
6
8
10
12
14
16
T = 0.183Q/Δs'
= 0.183 x 71.2 / 3.7
= 3.5 m3/d/m
K = 0.028 m/d
Notes:
Possible recirculation - full recovery project at t/t'>1

BRC17029

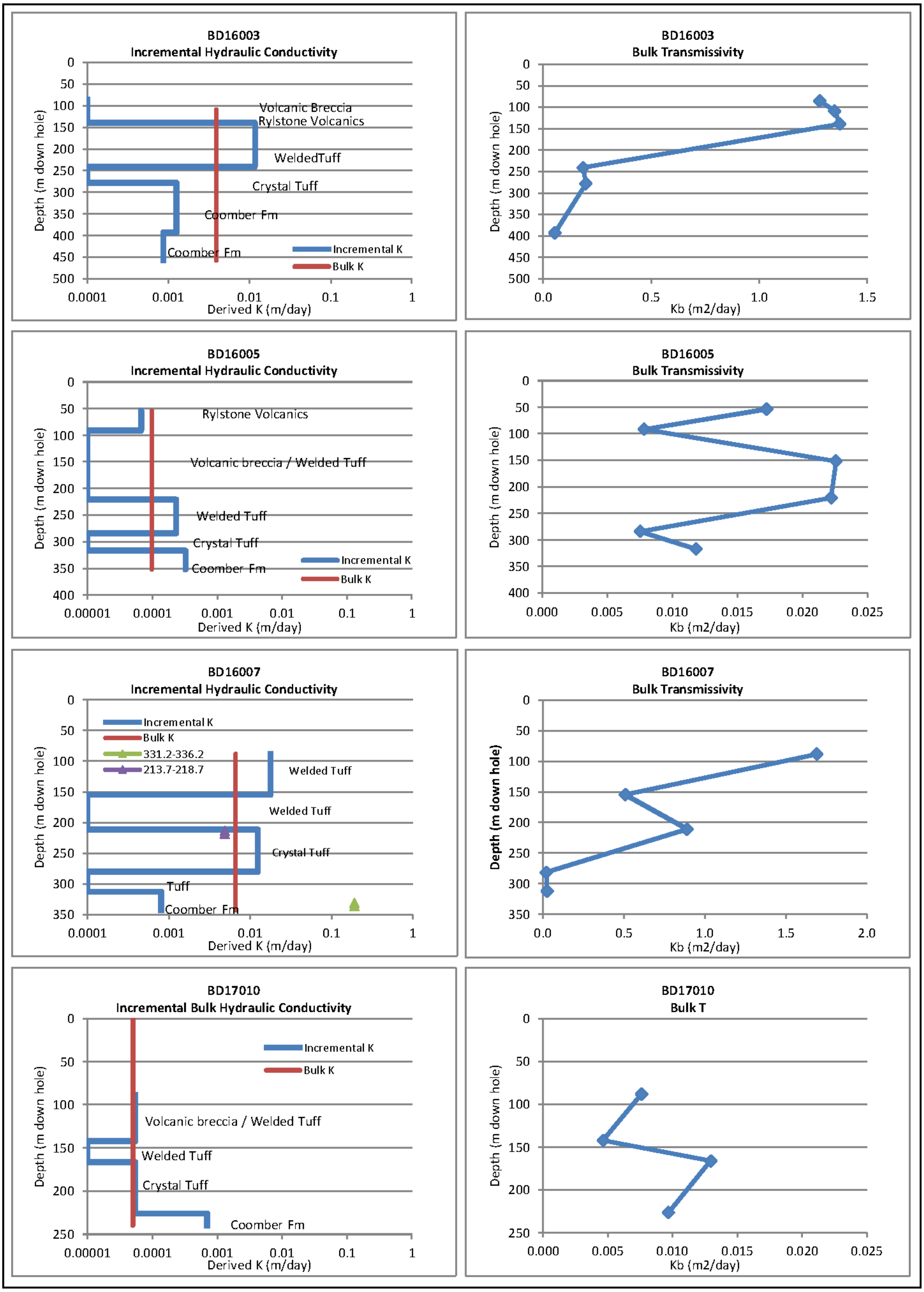
Annexure 6

Packer Injection Tests

(Total No. of pages including blank pages = 28)

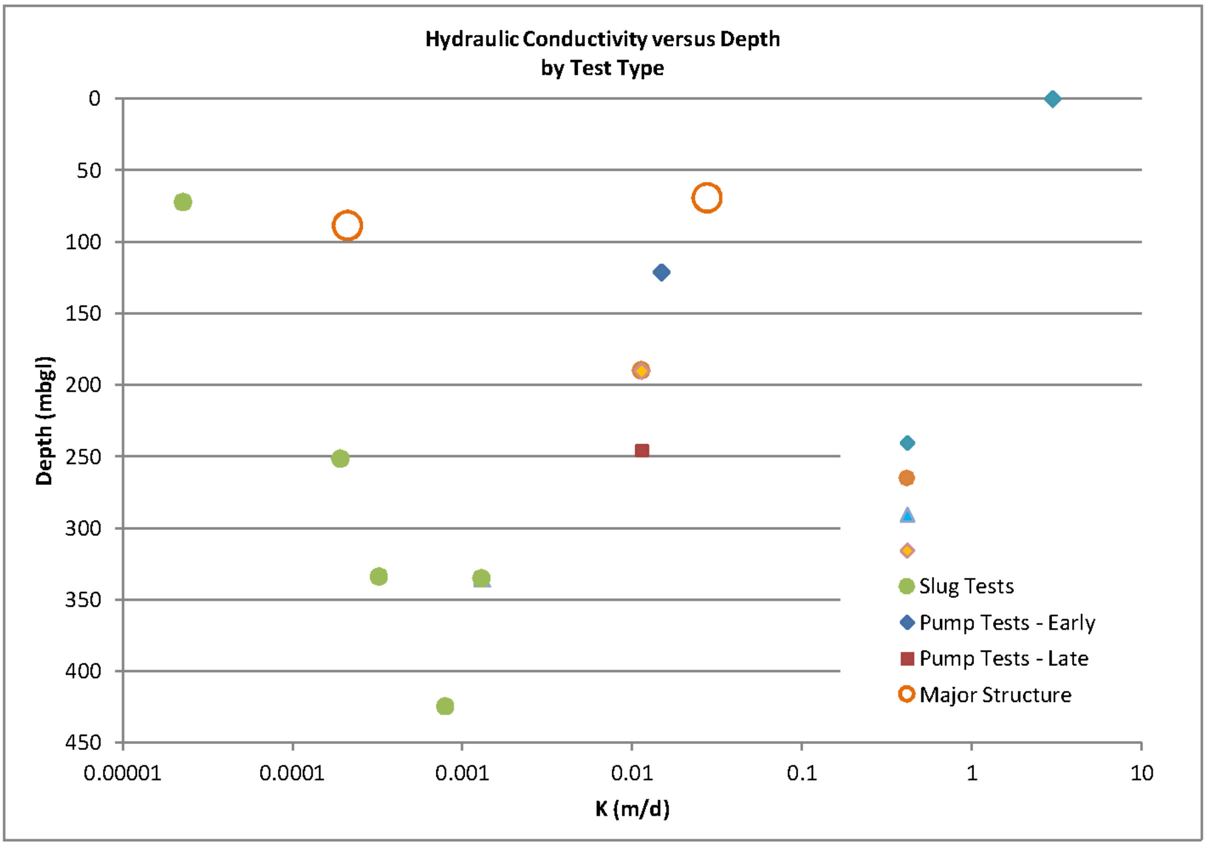
Note: This Annexure is only available on the digital version of this document

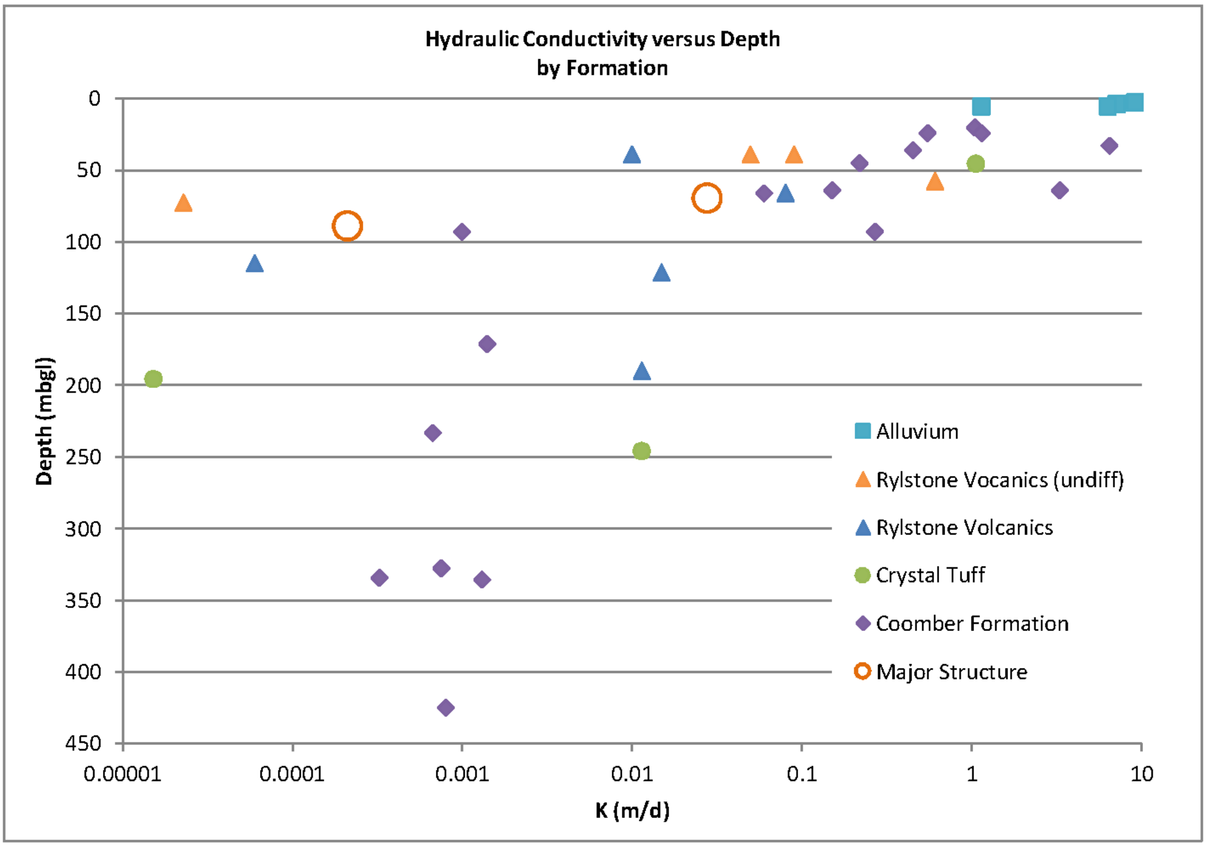
This page has intentionally been left blank



Packer Testing Results

J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\Packer Testing Summary





JACOBS

Figure 5 - Hydraulic Conductivity versus Depth

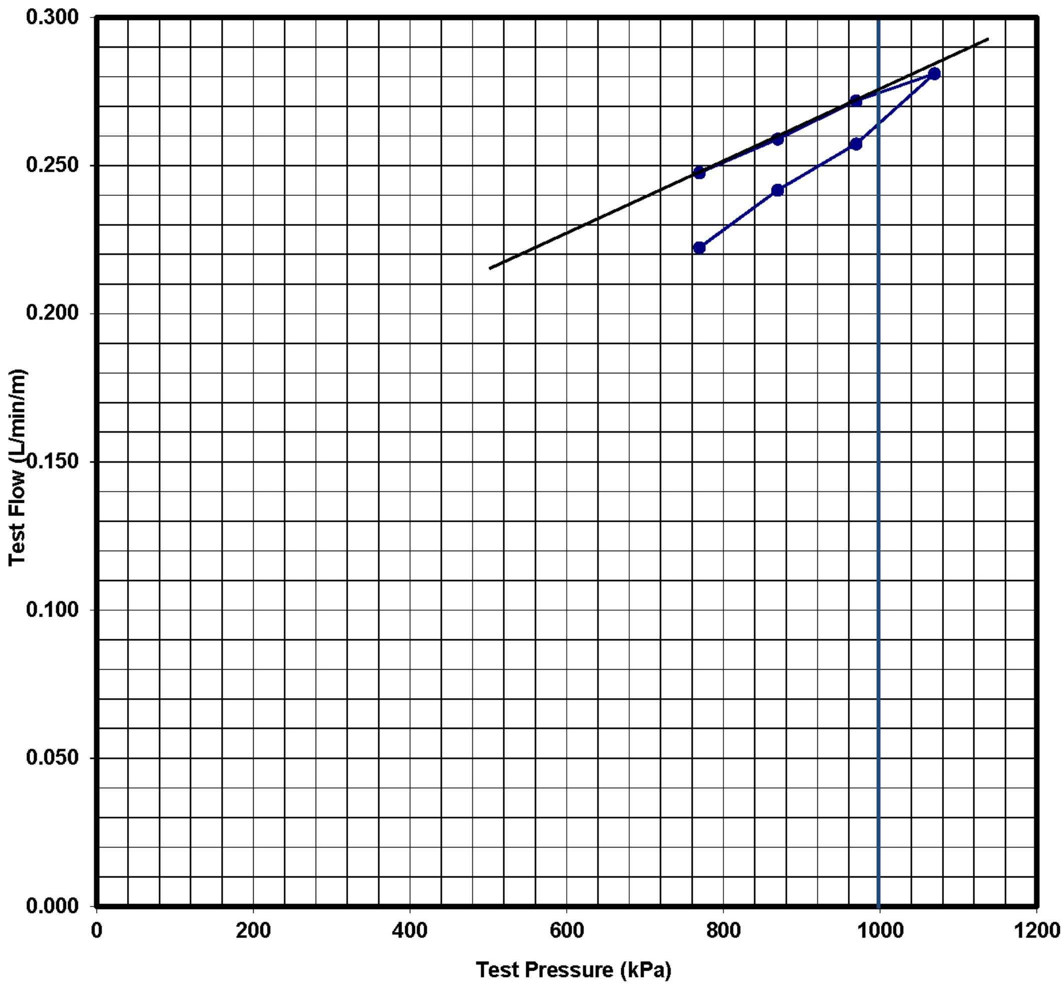
J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\Packer Testing Summary

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:** IA132800		
Hole No:	BD16003	**Test No:**	Single No. 2	Date:12/5/2017	Operator:	JT
Test Depth (m)	85.2	Location:	Easting (m)		Azimuth:	
			Northing (m)			

Summary

Test Pressure (Kpa)	769	869	969	1069	969	869	769	
Flow Rate (L/min/m)	0.248	0.259	0.272	0.281	0.257	0.242	0.222	



Lugeon units = Test Flow (L/min/m) at 1000kPa =	0.275
Permeability (m/day) =	**3.45E-03**
Permeability (m/s) =	**3.99E-08**

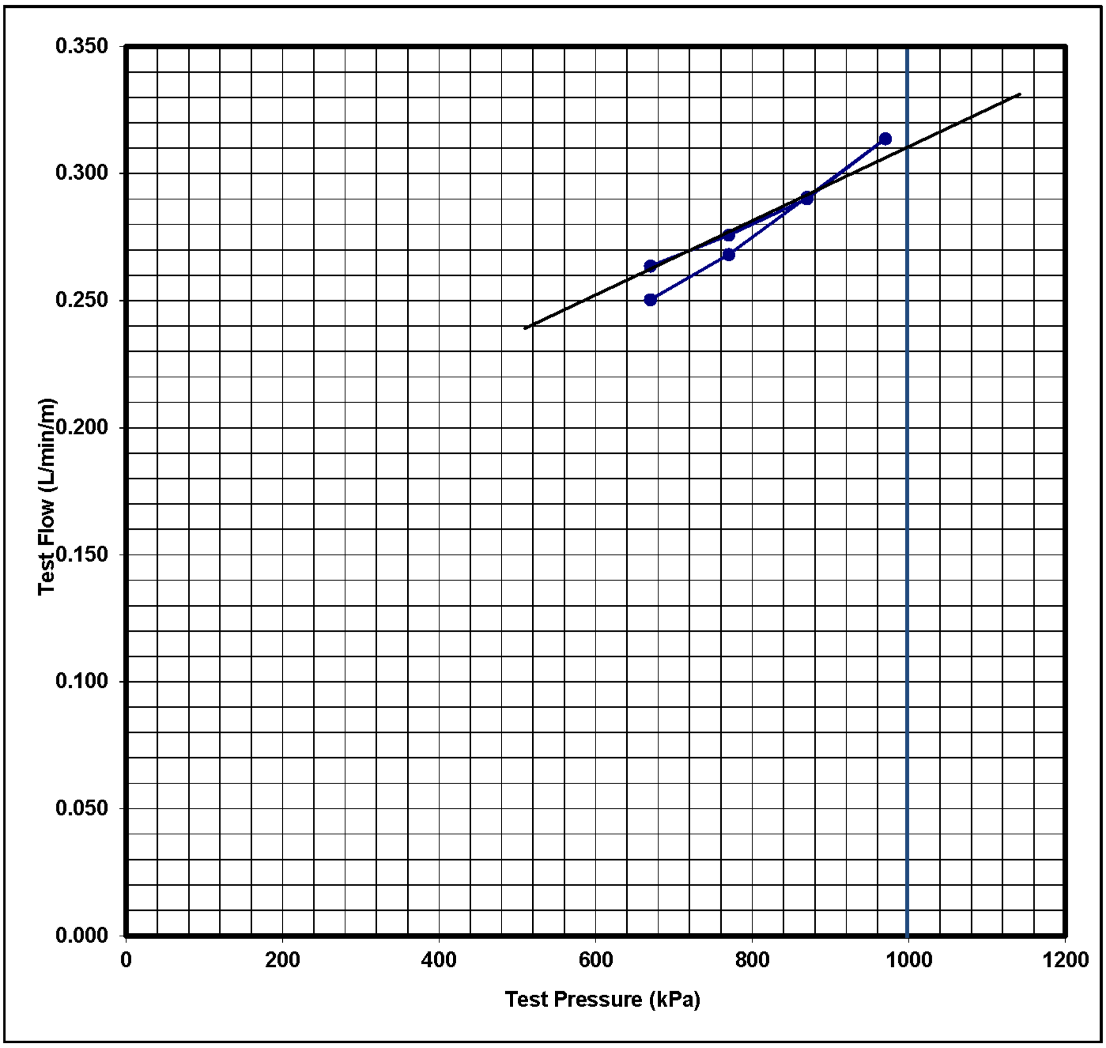
J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16003_JT.xls]85.2

Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:**	IA132800		
Hole No:	BD16003	**Test No:**	Single No. 2	Date:12/5/2017		Operator:	JT
Test Depth (m)	109.2	Location:	Easting (m)			Azimuth:	
			Northing (m)				

Summary								
Test Pressure (Kpa)	670	770	870	970	870	770	670	
Flow Rate (L/min/m)	0.264	0.276	0.290	0.314	0.291	0.268	0.250	



Lugeon units = Test Flow (L/min/m) at 1000kPa =	0.31
Permeability (m/day) =	**3.88E-03**
Permeability (m/s) =	**4.50E-08**

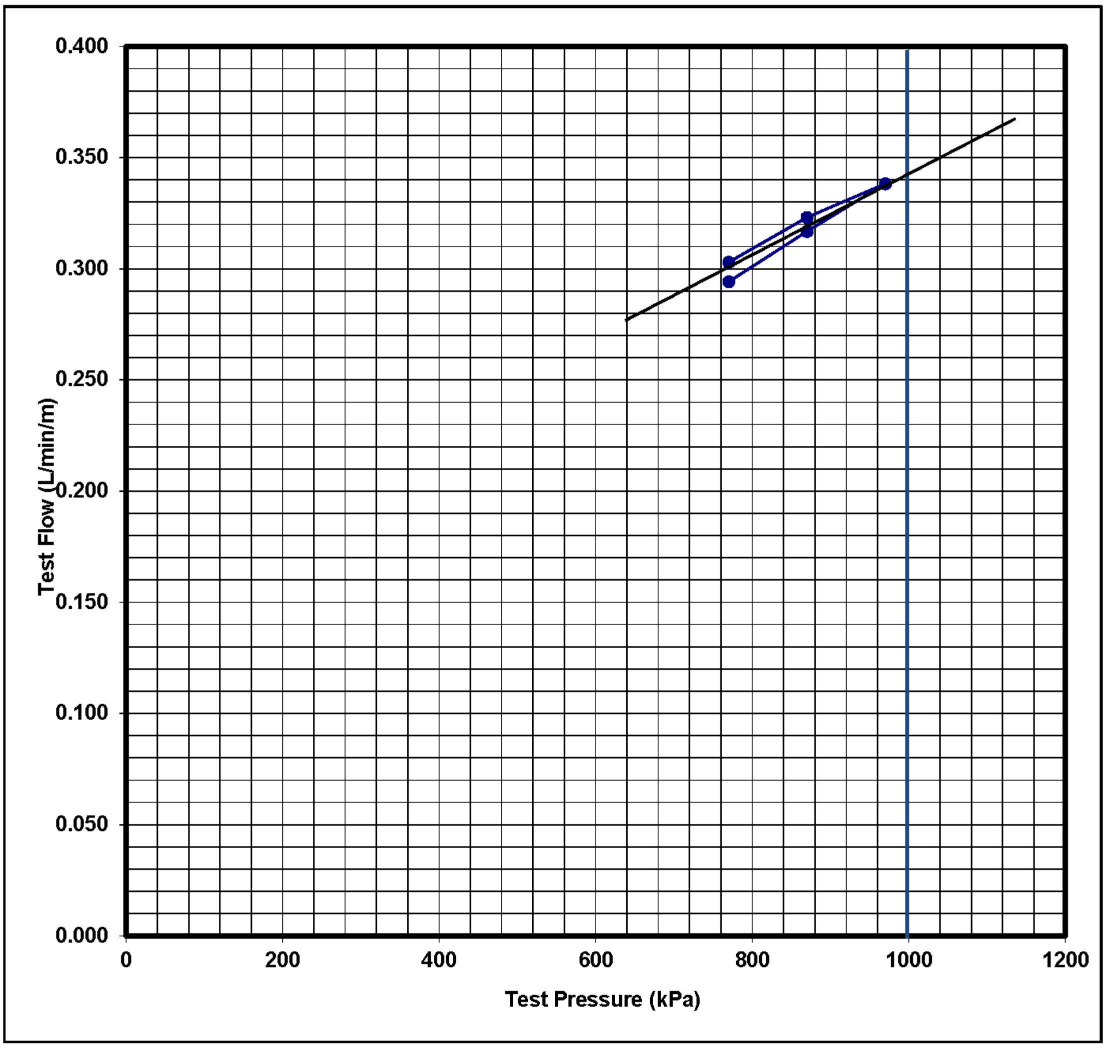
J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16003_JT.xls]109.2

Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:** IA132800		
Hole No:	BD16003	**Test No:**	Single No. 2	Date:12/5/2017	Operator:	JT
Test Depth (m)	139.2	Location:	Easting (m)		Azimuth:	
			Northing (m)			

Summary								
Test Pressure (Kpa)	770	870	970	870	770			
Flow Rate (L/min/m)	0.303	0.323	0.338	0.317	0.294			



Lugeon units = Test Flow (L/min/m) at 1000kPa =	0.345
Permeability (m/day) =	**4.32E-03**
Permeability (m/s) =	**5.00E-08**

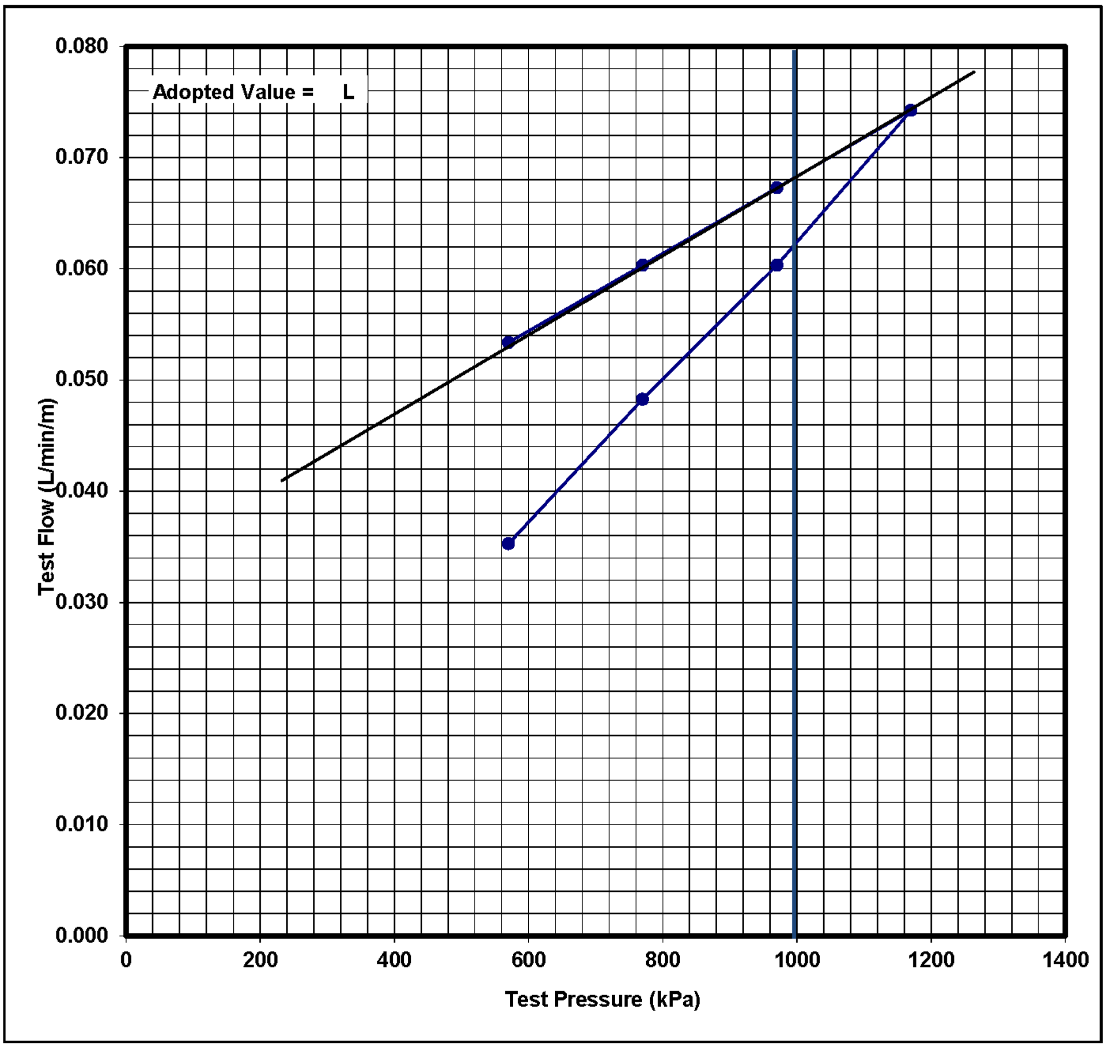
J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16003_JT.xls]139.2

Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:** IA132800			
Hole No:	BD16003	**Test No:**	Single No. 2	Date:12/5/2017	Operator:	JT	
Test Depth (m)	241.2	Location:	Easting (m)		Azimuth:		
			Northing (m)				

Summary								
Test Pressure (Kpa)	570	770	970	1170	970	770	570	
Flow Rate (L/min/m)	0.053	0.060	0.067	0.074	0.060	0.048	0.035	



Lugeon units = Test Flow (L/min/m) at 1000kPa =	0.069
Permeability (m/day) =	**8.65E-04**
Permeability (m/s) =	**1.00E-08**

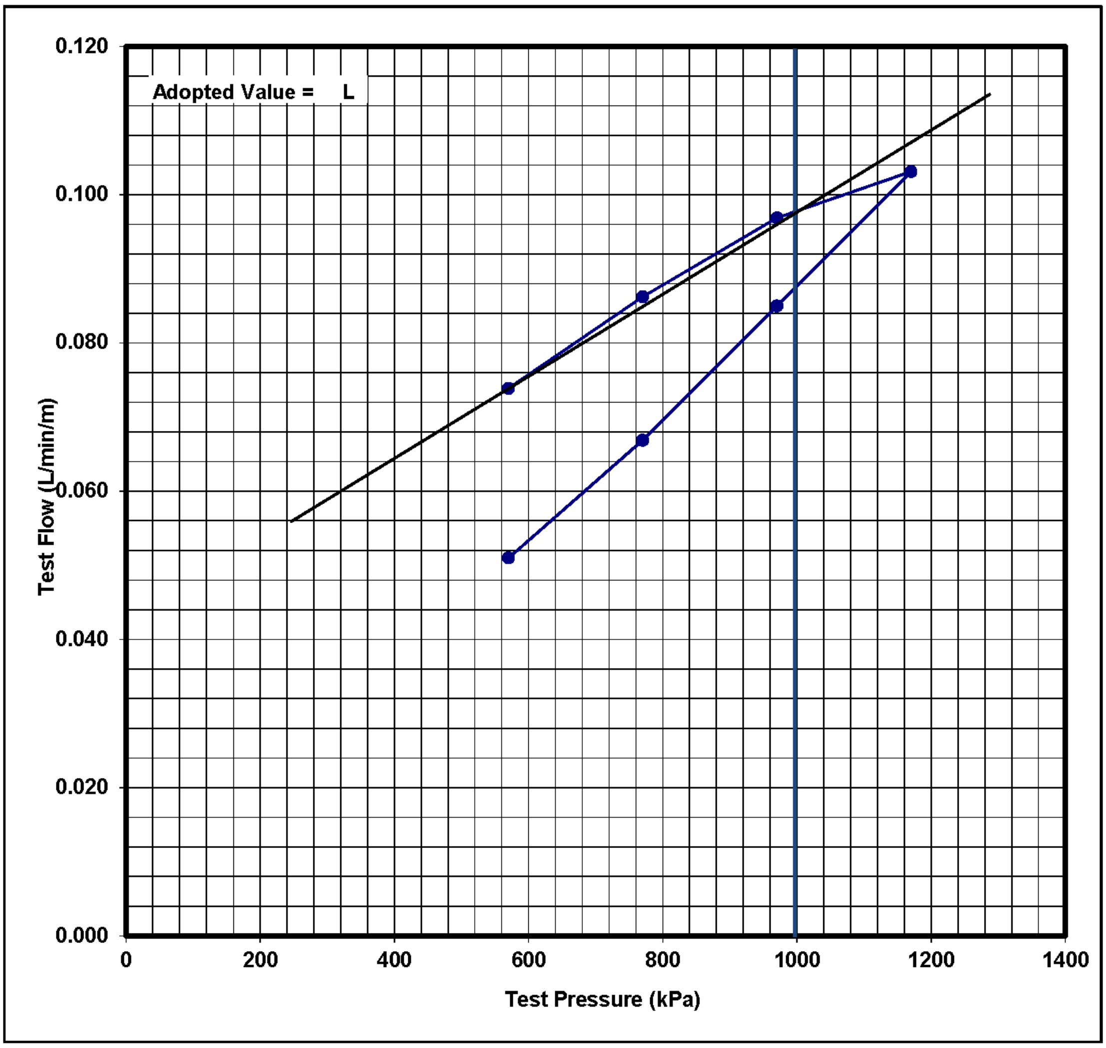
J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16003_JT.xls]241.2

Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:** IA132800		
Hole No:	BD16003	**Test No:**	Single No. 2	Date:12/5/2017	Operator:	JT
Test Depth (m)	280.2	Location:	Easting (m)		Azimuth:	
			Northing (m)			

Summary								
Test Pressure (Kpa)	570	770	970	1170	970	770	570	
Flow Rate (L/min/m)	0.074	0.086	0.097	0.103	0.085	0.067	0.051	



Lugeon units = Test Flow (L/min/m) at 1000kPa =	0.09
Permeability (m/day) =	**1.13E-03**
Permeability (m/s) =	**1.31E-08**

J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16003_JT.xls]280.2

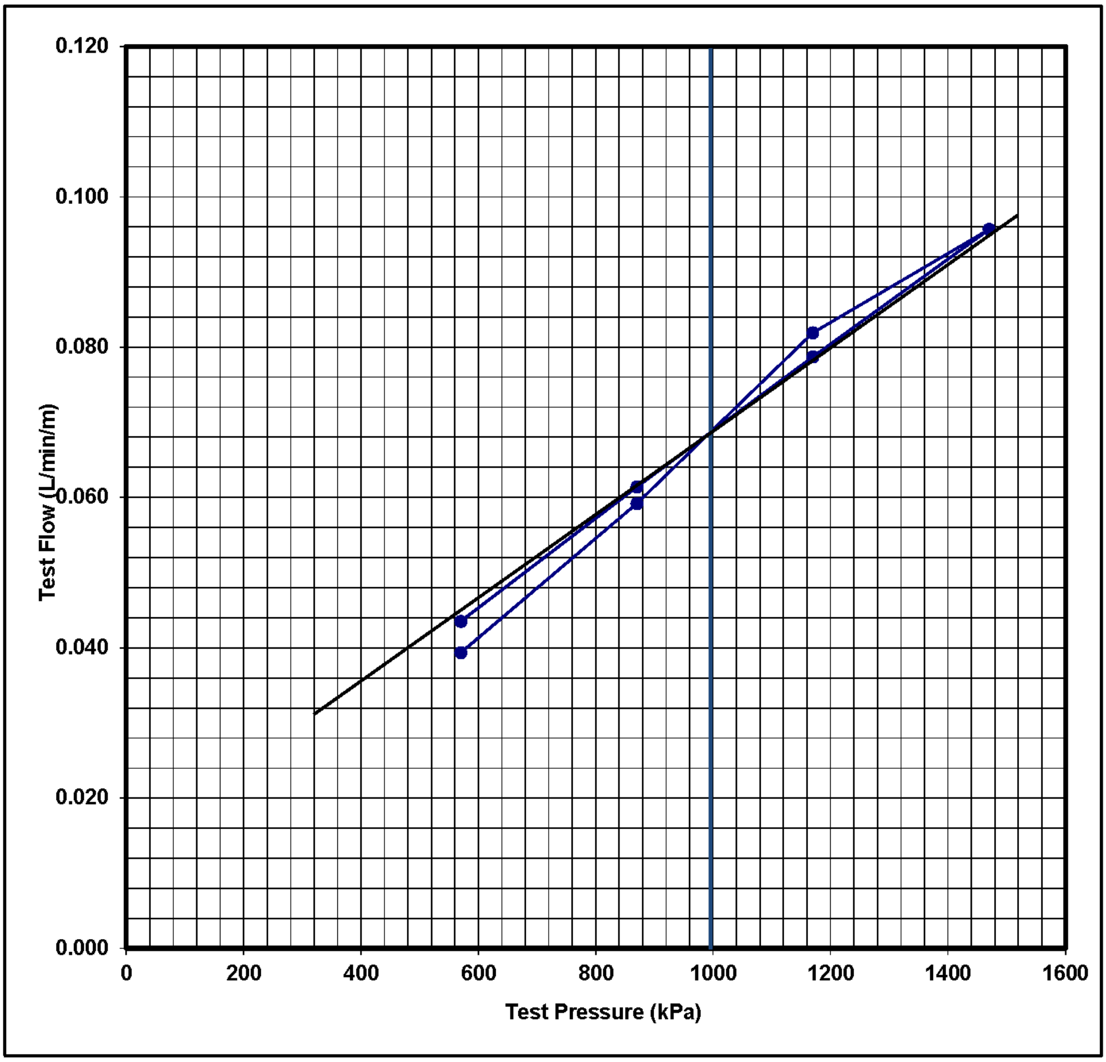
Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:** IA132800	
Hole No:	BD16003	**Test No:**	Single No. 2	Date:12/5/2017	Operator: JT
Test Depth (m)	394.2	Location:	Easting (m)		Azimuth:
			Northing (m)		

Summary

Test Pressure (Kpa)	570	870	1170	1470	1170	870	570	
Flow Rate (L/min/m)	0.039	0.059	0.082	0.096	0.079	0.061	0.044	



Lugeon units = Test Flow (L/min/m) at 1000kPa =	0.069
Permeability (m/day) =	**8.65E-04**
Permeability (m/s) =	**1.00E-08**

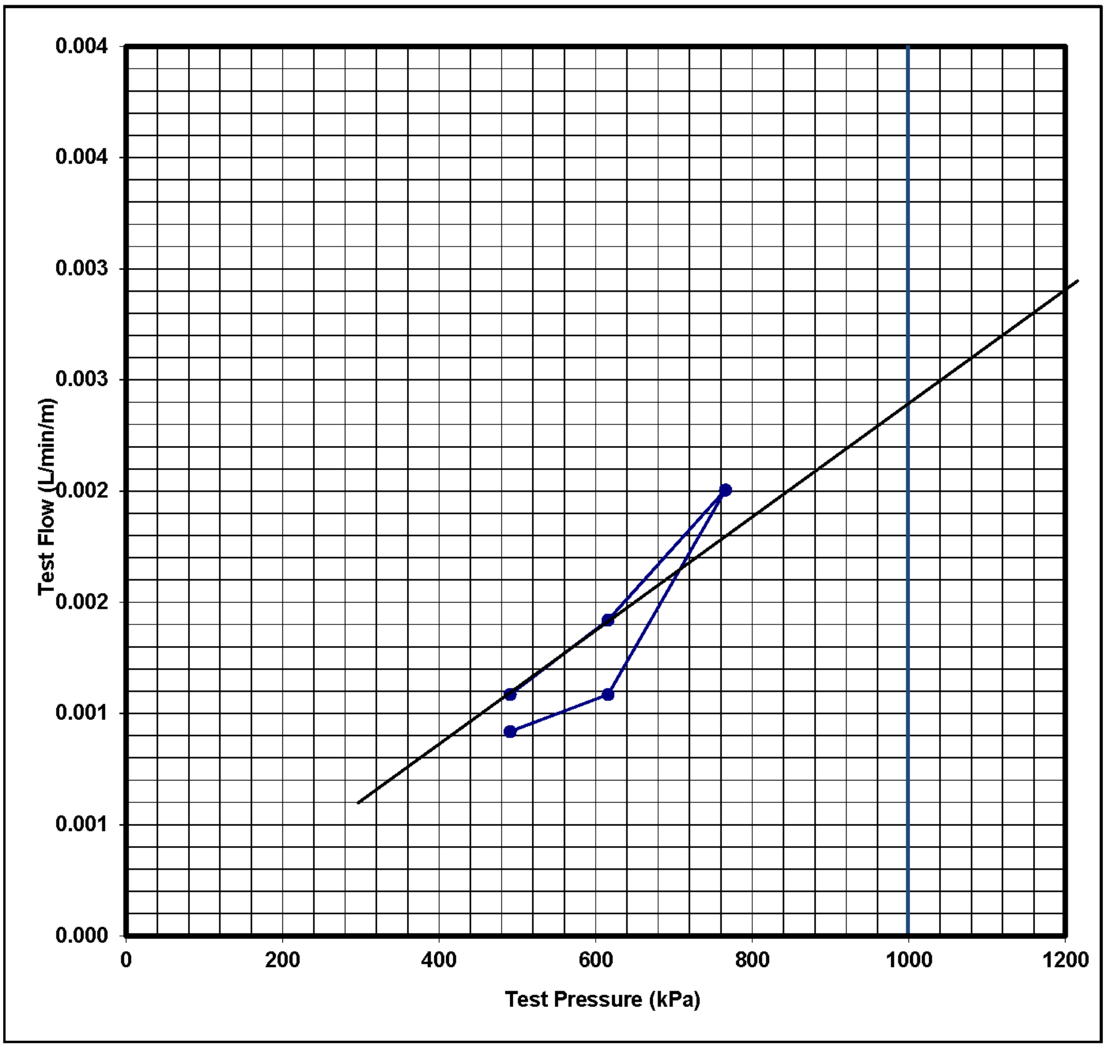
J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16003_JT.xls]394.2

Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:**	IA132800		
Hole No:	BD16005	**Test No:**	6	Date:	1-May-17	Operator:	JT
Test Depth (m)	53.7	Location:	Easting (m)	769044.7		Azimuth:	200
			Northing (m)	6385916.4			

Summary								
Test Pressure (Kpa)	491	616	766	616	491			
Flow Rate (L/min/m)	0.001	0.001	0.002	0.001	0.001			



Lugeon units = Test Flow (L/min/m) at 1000kPa =	0.0024
Permeability (m/day) =	**3.01E-05**
Permeability (m/s) =	**3.48E-10**

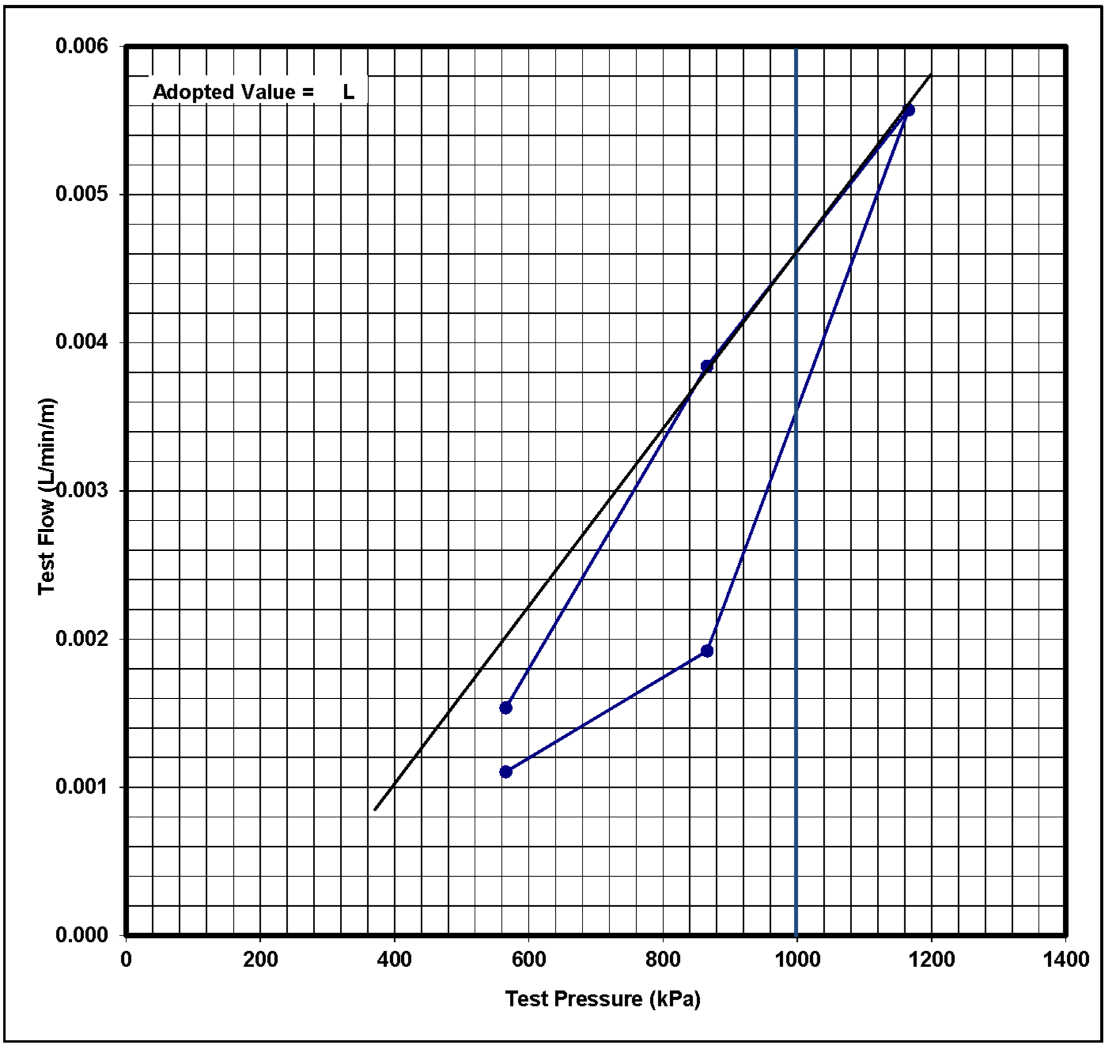
J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16005_JT.xls]53.7

Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:**	IA132800		
Hole No:	BD16005	**Test No:**	6	Date:	1-May-17	Operator:	JT
Test Depth (m)	91.7	Location:	Easting (m)	769044.7		Azimuth:	200
			Northing (m)	6385916.4			

Summary								
Test Pressure (Kpa)	566	866	1166	866	566			
Flow Rate (L/min/m)	0.002	0.004	0.006	0.002	0.001			



Lugeon units = Test Flow (L/min/m) at 1000kPa =	0.0046
Permeability (m/day) =	**5.76E-05**
Permeability (m/s) =	**6.67E-10**

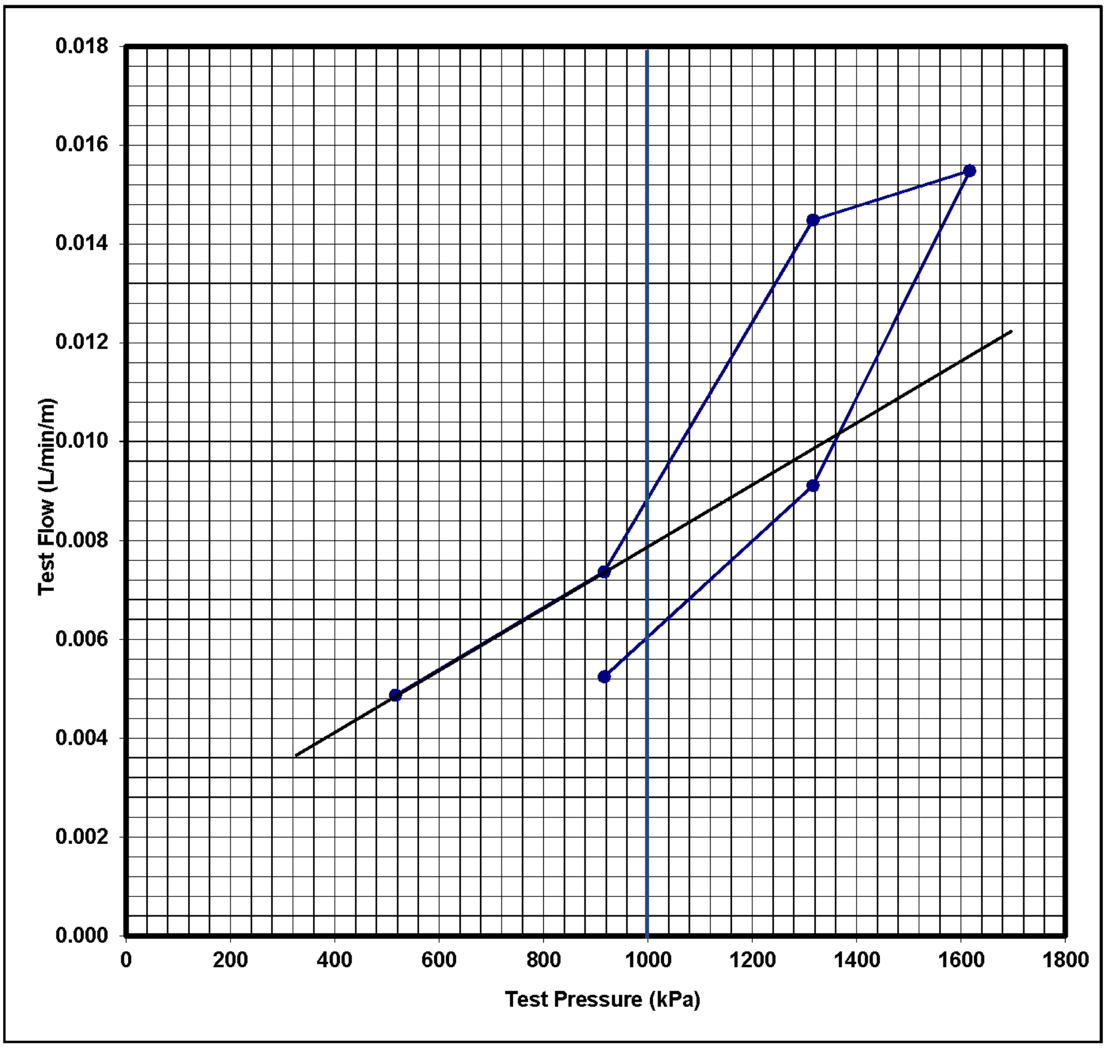
J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16005_JT.xls]91.7

Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:**	IA132800		
Hole No:	BD16005	**Test No:**	6	Date:	1-May-17	Operator:	JT
Test Depth (m)	151.7	Location:	Easting (m)	769044.7		Azimuth:	200
			Northing (m)	6385916.4			

Summary								
Test Pressure (Kpa)	517	917	1317	1617	1317	917		
Flow Rate (L/min/m)	0.005	0.007	0.014	0.015	0.009	0.005		



Lugeon units = Test Flow (L/min/m) at 1000kPa =	0.009
Permeability (m/day) =	**1.13E-04**
Permeability (m/s) =	**1.31E-09**

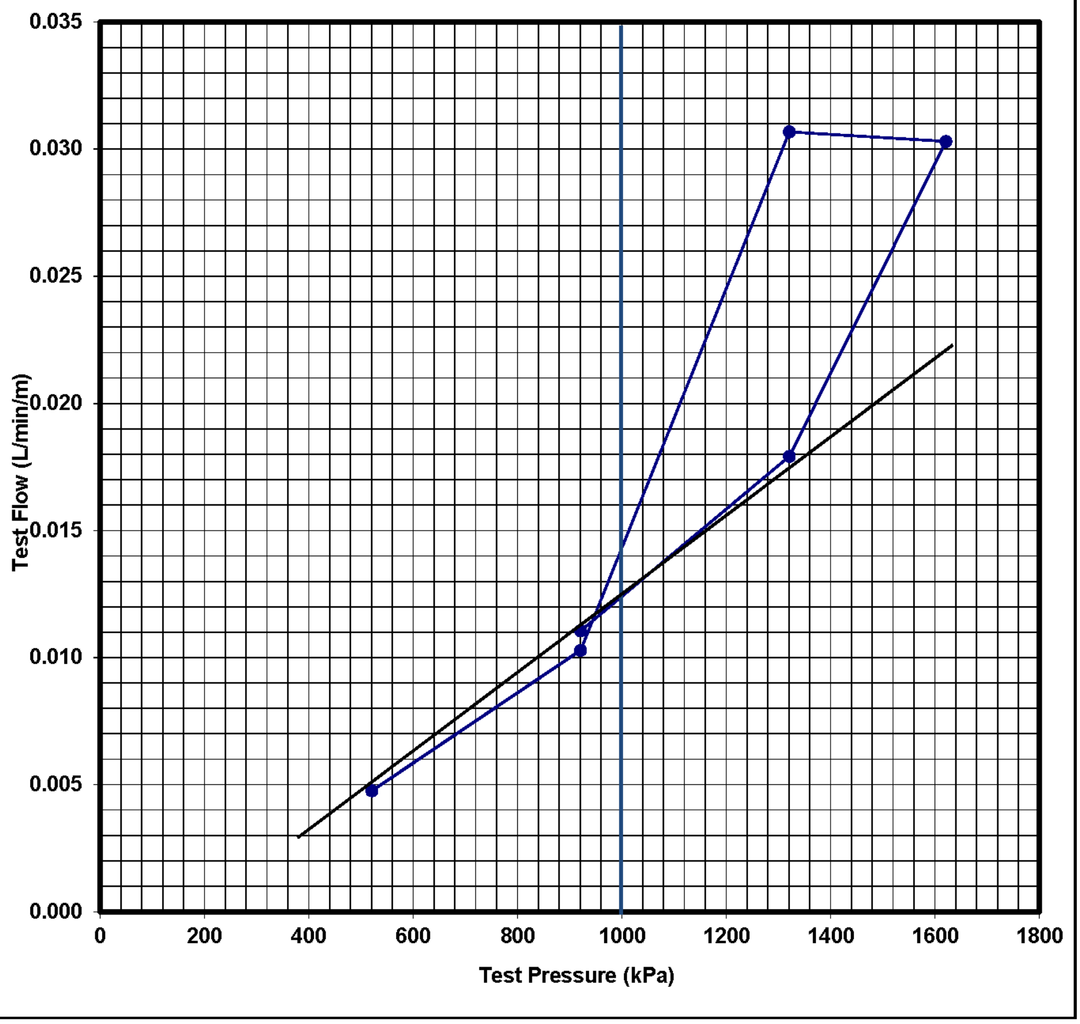
J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16005_JT.xls]151.7

Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:**	IA132800		
Hole No:	BD16005	**Test No:**	6	Date:	1-May-17	Operator:	JT
Test Depth (m)	220.7	Location:	Easting (m)	769044.7		Azimuth:	200
			Northing (m)	6385916.4			

Summary								
Test Pressure (Kpa)	521	921	1321	1621	1321	921		
Flow Rate (L/min/m)	0.005	0.010	0.031	0.030	0.018	0.011		



Lugeon units = Test Flow (L/min/m) at 1000kPa = 0.0135
Permeability (m/day) = 1.69E-04
Permeability (m/s) = 1.96E-09

J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16005_JT.xls]220.7

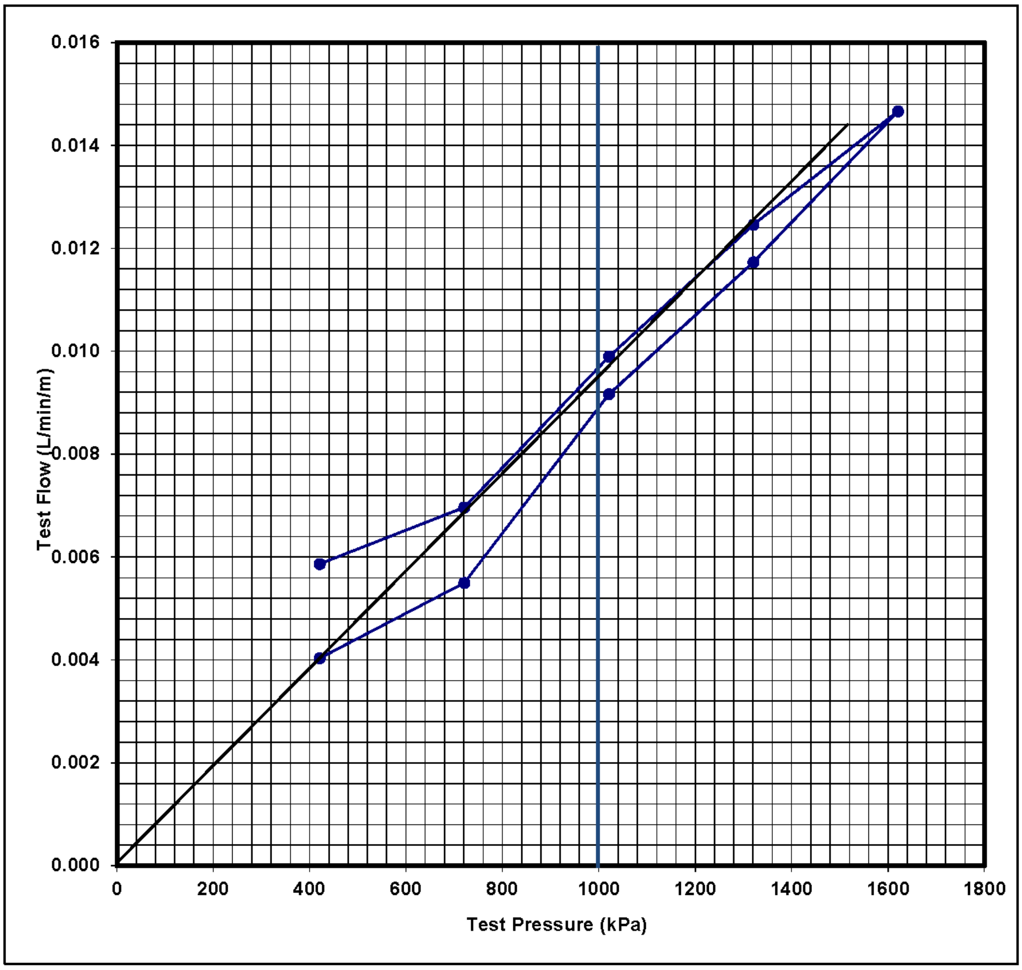
Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:**	IA132800			
Hole No:	BD16005	**Test No:**	6	Date:	1-May-17	Operator:	JT	
Test Depth (m)	283.7	Location:	Easting (m)	769044.7		Azimuth:	200	
			Northing (m)	6385916.4				

Summary

Test Pressure (Kpa)	421	721	1021	1321	1621	1321	1021	721	421
Flow Rate (L/min/m)	0.006	0.007	0.010	0.012	0.015	0.012	0.009	0.005	0.004



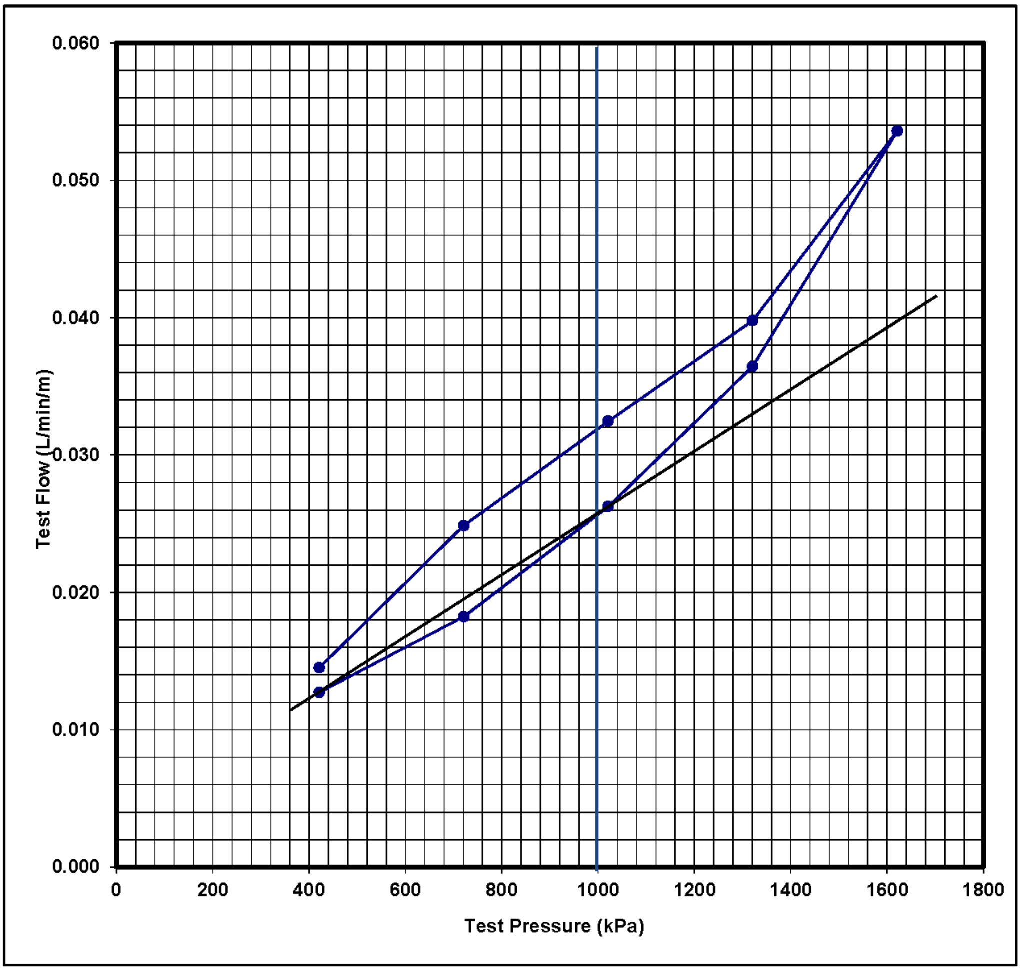
Lugeon units = Test Flow (L/min/m) at 1000kPa = 0.0088
Permeability (m/day) = **1.10E-04**
Permeability (m/s) = **1.28E-09**
J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16005_JT.xls]283.7

Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:**	IA132800		
Hole No:	BD16005	**Test No:**	6	Date:	1-May-17	Operator:	JT
Test Depth (m)	316.7	Location:	Easting (m)	769044.7		Azimuth:	200
			Northing (m)	6385916.4			

Summary									
Test Pressure (Kpa)	421	721	1021	1321	1621	1321	1021	721	421
Flow Rate (L/min/m)	0.013	0.018	0.026	0.036	0.054	0.040	0.032	0.025	0.015



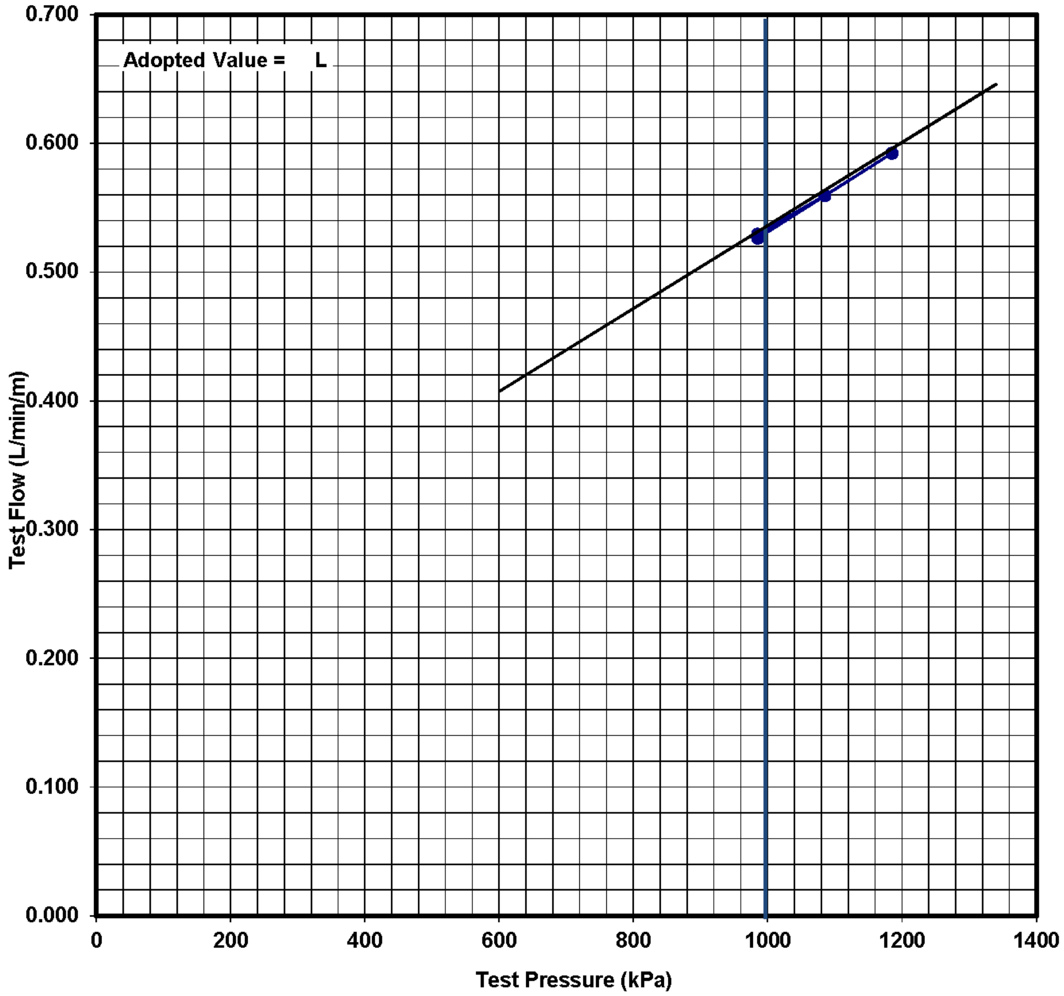
Lugeon units = Test Flow (L/min/m) at 1000kPa = 0.026
Permeability (m/day) = 3.26E-04
Permeability (m/s) = 3.77E-09
J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16005_JT.xls]316.7

Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:**	IA132800		
Hole No:	**BD160057**	**Test No:**	Single No. 5	Date:		Operator:	JT
Test Depth (m)	88.2	Location:	Easting (m)	768965		Azimuth:	60.5
			Northing (m)	6385795			

Summary								
Test Pressure (Kpa)	985	1085	1185	1085	985			
Flow Rate (L/min/m)	0.526	0.559	0.592	0.559	0.529			



Lugeon units = Test Flow (L/min/m) at 1000kPa =	0.53
Permeability (m/day) =	**6.64E-03**
Permeability (m/s) =	**7.69E-08**

J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16007_JT.xls]88.2

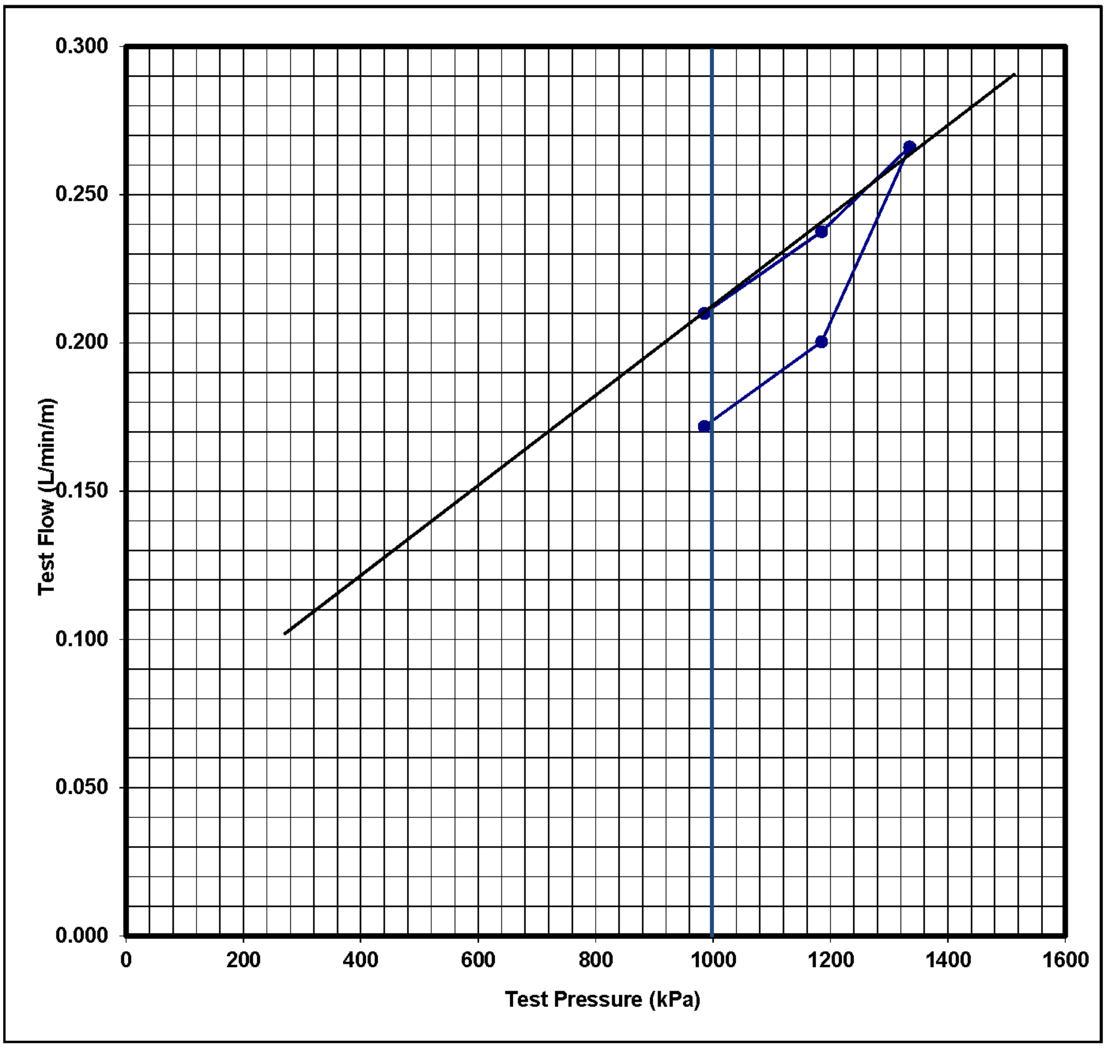
Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:**	IA132800		
Hole No:	**BD160057**	**Test No:**	Single No. 4	Date:		Operator:	JT
Test Depth (m)	154.2	Location:	Easting (m)	768965		Azimuth:	60.5
			Northing (m)	6385795			

Summary

Test Pressure (Kpa)	985	1185	1335	1185	985			
Flow Rate (L/min/m)	0.172	0.200	0.266	0.238	0.210			



Lugeon units = Test Flow (L/min/m) at 1000kPa =	0.215
Permeability (m/day) =	**2.69E-03**
Permeability (m/s) =	**3.12E-08**

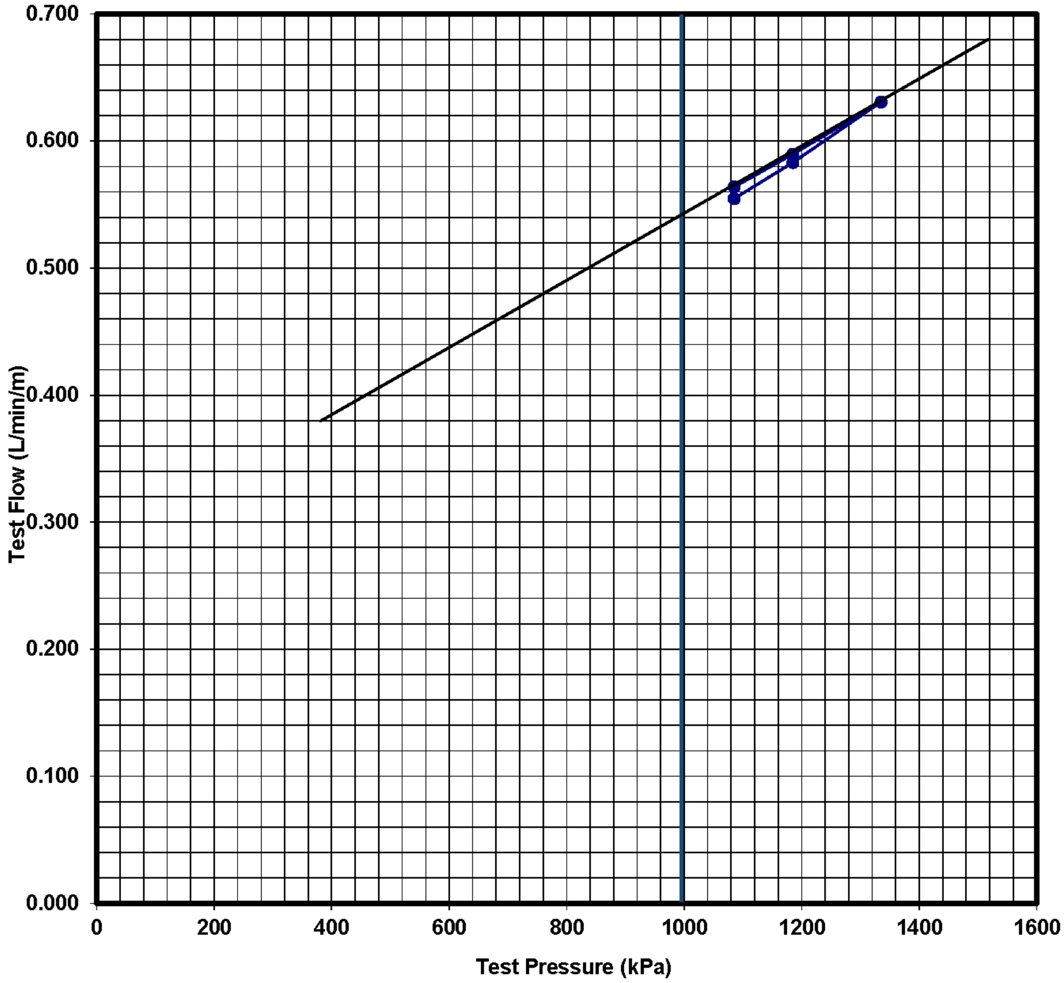
J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16007_JT.xls]154.2

Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:**	IA132800		
Hole No:	**BD160057**	**Test No:**	Single No. 3	Date:		Operator:	JT
Test Depth (m)	211.2	Location:	Easting (m)	768965		Azimuth:	60.5
			Northing (m)	6385795			

Summary								
Test Pressure (Kpa)	1085	1185	1335	1185	1085			
Flow Rate (L/min/m)	0.564	0.590	0.631	0.583	0.555			



Lugeon units = Test Flow (L/min/m) at 1000kPa =	0.54
Permeability (m/day) =	**6.77E-03**
Permeability (m/s) =	**7.83E-08**

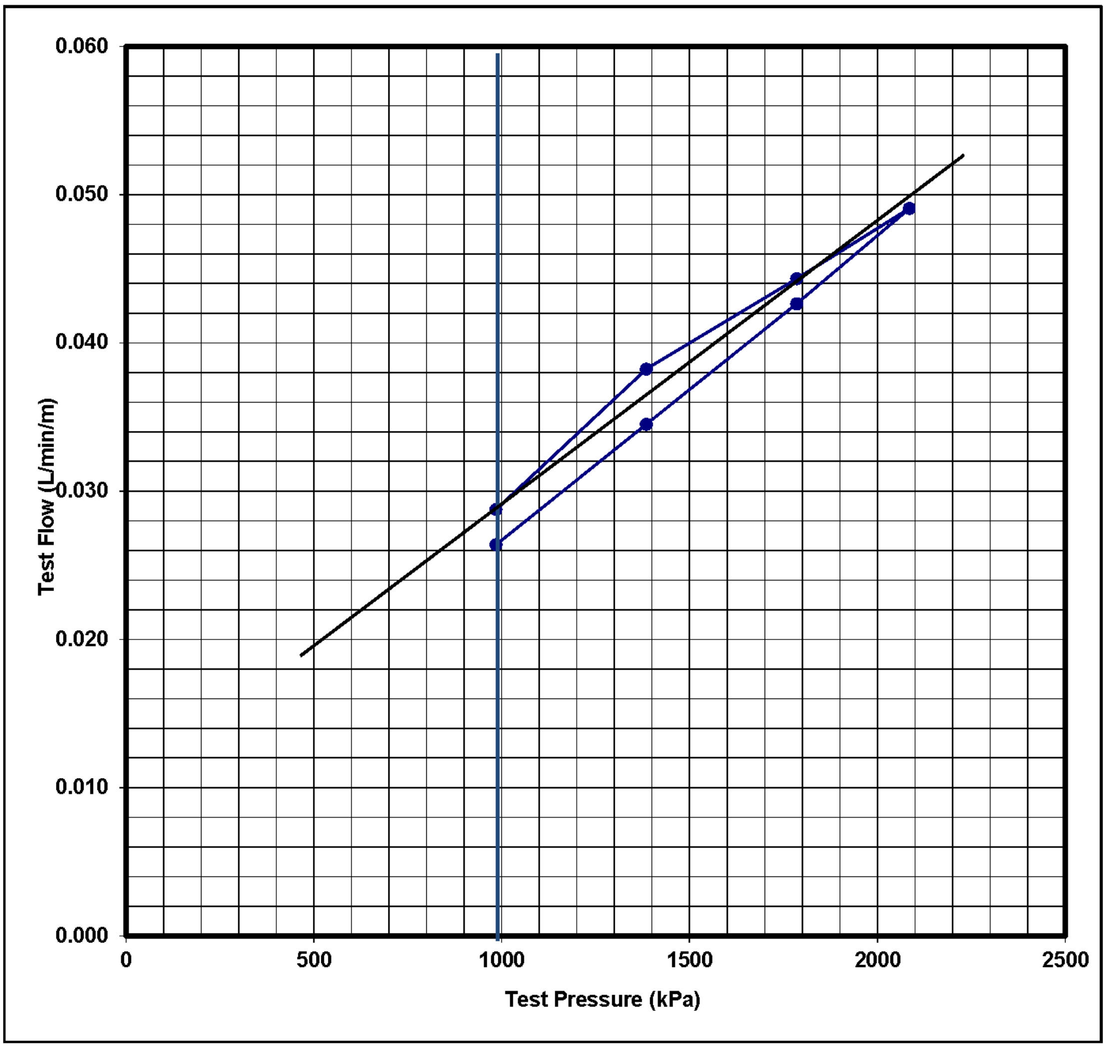
J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16007_JT.xls]211.2

Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:**	IA132800		
Hole No:	**BD160057**	**Test No:**	Single No. 2	Date:		Operator:	JT
Test Depth (m)	280.2	Location:	Easting (m)	768965		Azimuth:	60.5
			Northing (m)	6385795			

Summary								
Test Pressure (Kpa)	985	1385	1785	2085	1785	1385	985	
Flow Rate (L/min/m)	0.029	0.038	0.044	0.049	0.043	0.035	0.026	



Lugeon units = Test Flow (L/min/m) at 1000kPa =	0.029
Permeability (m/day) =	**3.63E-04**
Permeability (m/s) =	**4.21E-09**

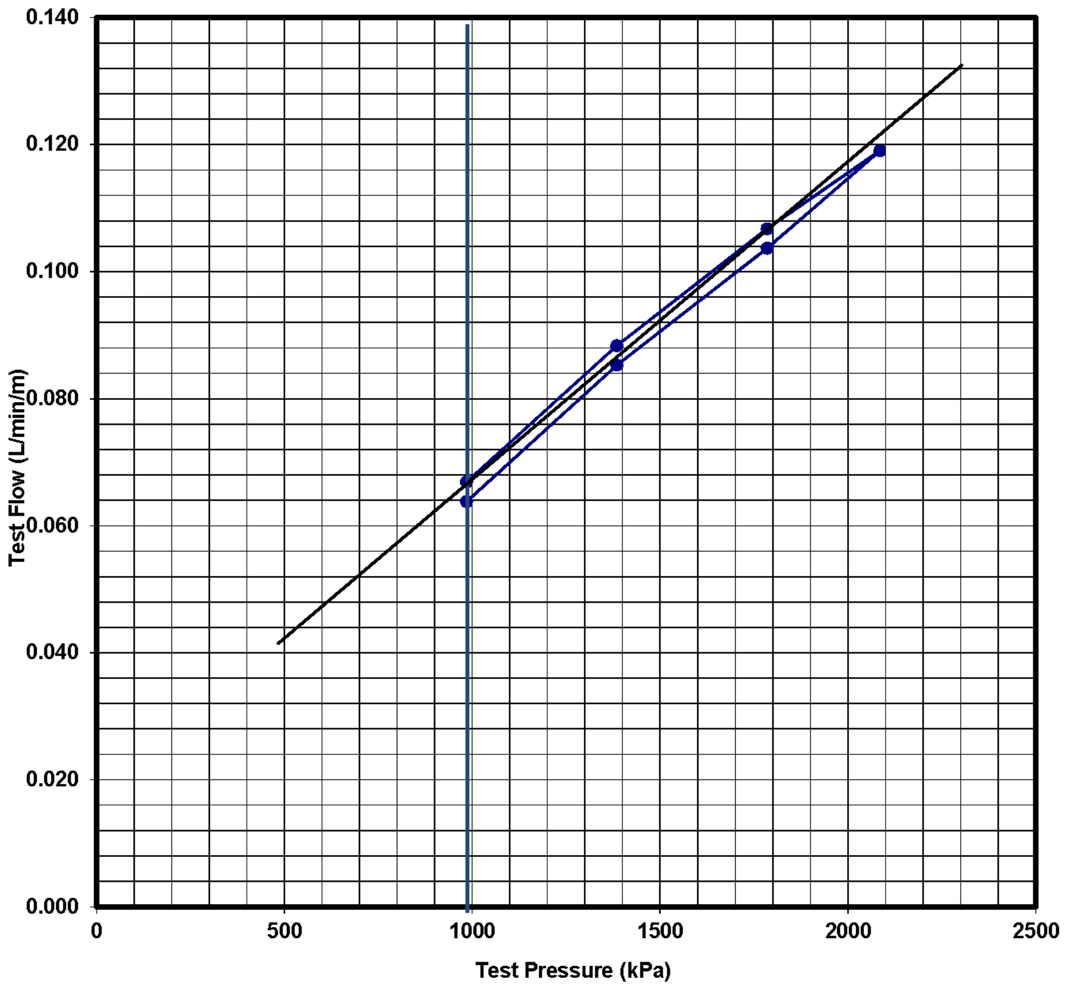
J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16007_JT.xls]280.2

Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:**	IA132800		
Hole No:	**BD160057**	**Test No:**	Single No. 1	Date:		Operator:	JT
Test Depth (m)	310.2	Location:	Easting (m)	768965		Azimuth:	60.5
			Northing (m)	6385795			

Summary								
Test Pressure (Kpa)	985	1385	1785	2085	1785	1385	985	
Flow Rate (L/min/m)	0.064	0.085	0.104	0.119	0.107	0.088	0.067	



Lugeon units = Test Flow (L/min/m) at 1000kPa =	0.064
Permeability (m/day) =	**8.02E-04**
Permeability (m/s) =	**9.28E-09**

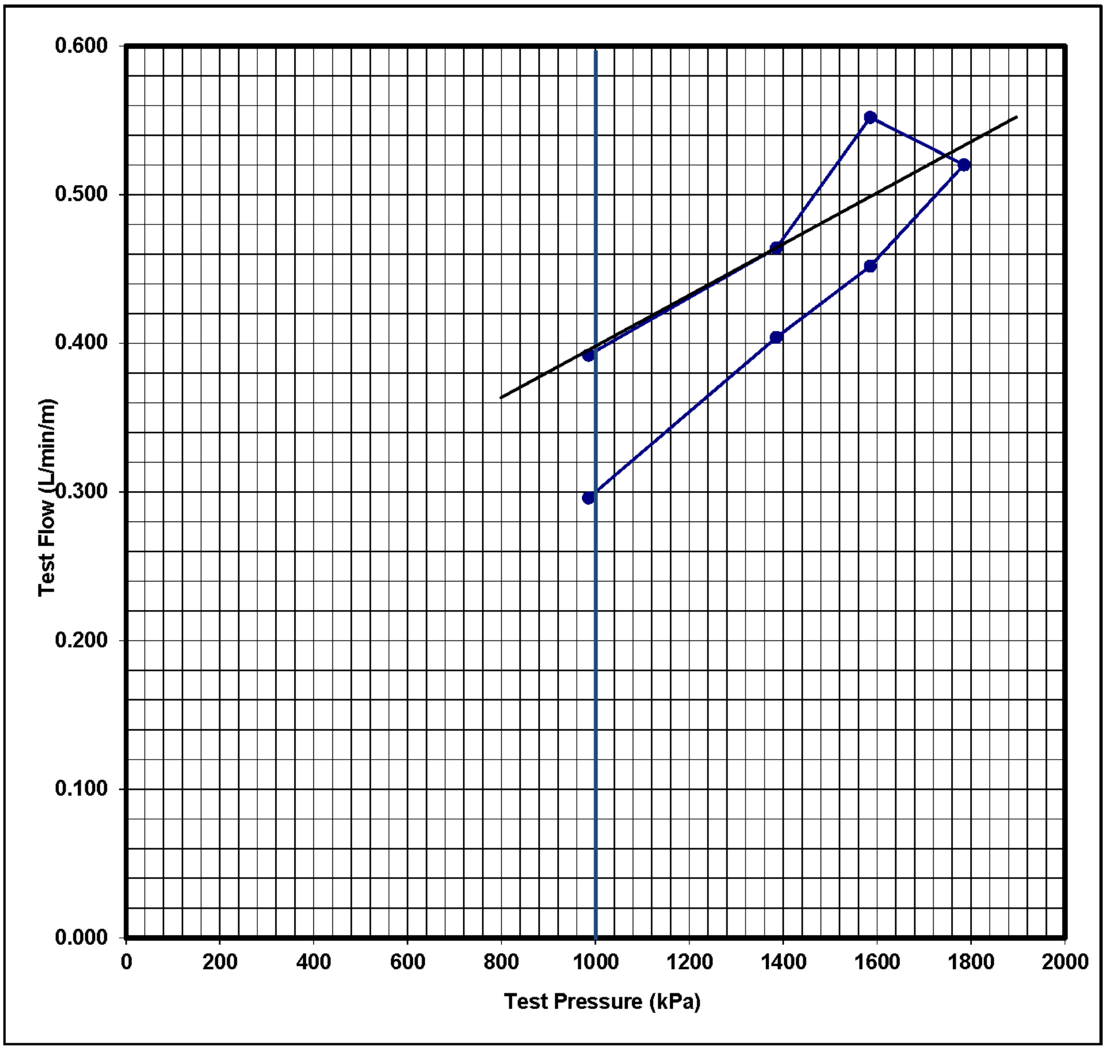
J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16007_JT.xls]310.2

Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:**	IA132800		
Hole No:	**BD160057**	**Test No:**	Stradle No. 2	Date:		Operator:	JT
Test Depth (m)	213.7 - 218.7	Location:	Easting (m)	768965		Azimuth:	60.5
			Northing (m)	6385795			

Summary								
Test Pressure (Kpa)	985	1385	1585	1785	1585	1385	985	
Flow Rate (L/min/m)	0.392	0.464	0.552	0.520	0.452	0.404	0.296	



Lugeon units = Test Flow (L/min/m) at 1000kPa =	0.39
Permeability (m/day) =	**4.89E-03**
Permeability (m/s) =	**5.66E-08**

J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16007_JT.xls]213.7 - 218.7

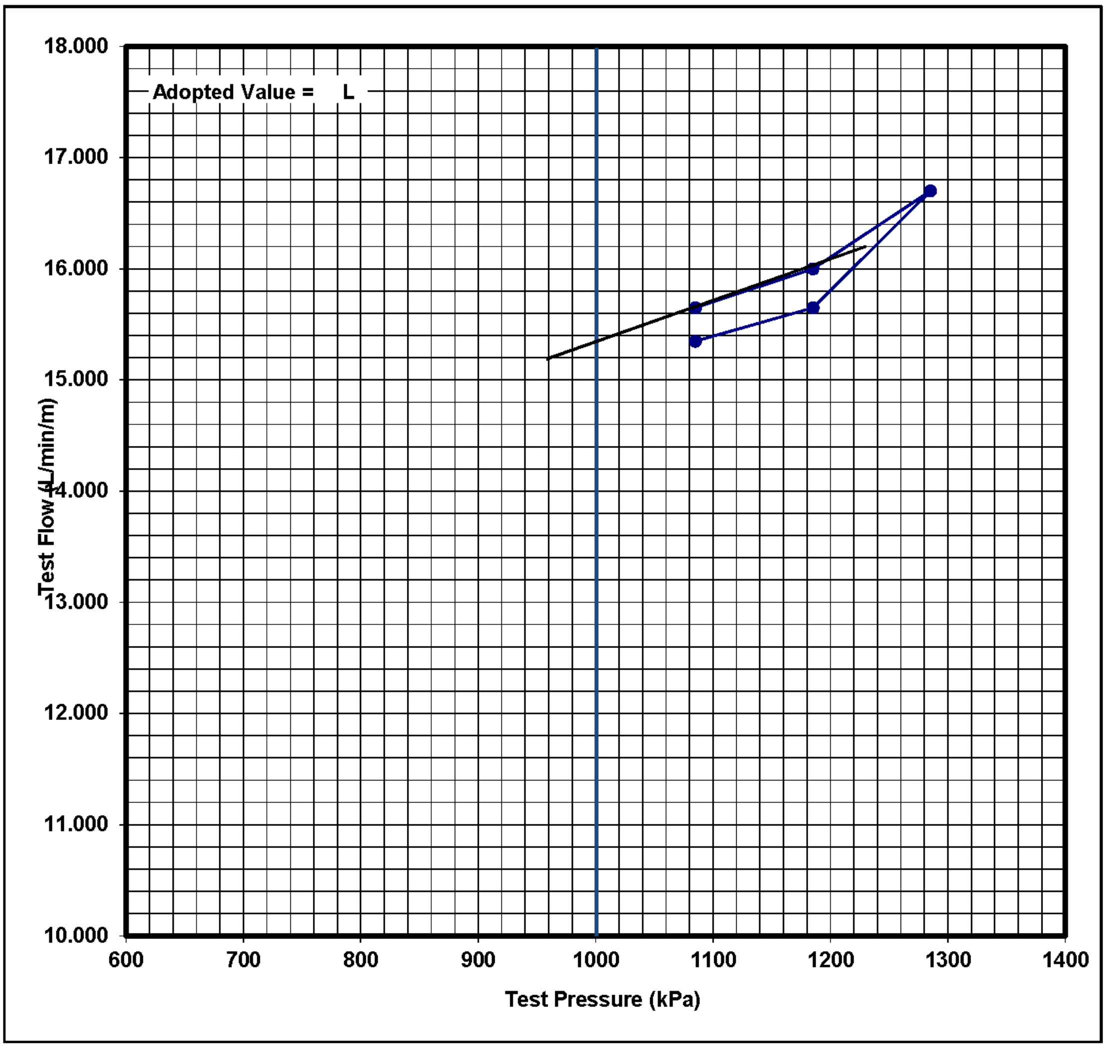
Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver DFS			**Project No.:**	IA132800		
Hole No:	**BD160057**	**Test No:**	Stradle No. 1	Date:		Operator:	JT
Test Depth (m)	331.2 - 336.2	Location:	Easting (m)	768965		Azimuth:	60.5
			Northing (m)	6385795			

Summary

Test Pressure (Kpa)	1085	1185	1285	1185	1085			
Flow Rate (L/min/m)	15.650	16.000	16.700	15.650	15.350			



Lugeon units = Test Flow (L/min/m) at 1000kPa =	15.35
Permeability (m/day) =	**1.92E-01**
Permeability (m/s) =	**2.23E-06**

J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD16007_JT.xls]331.2 - 336.2

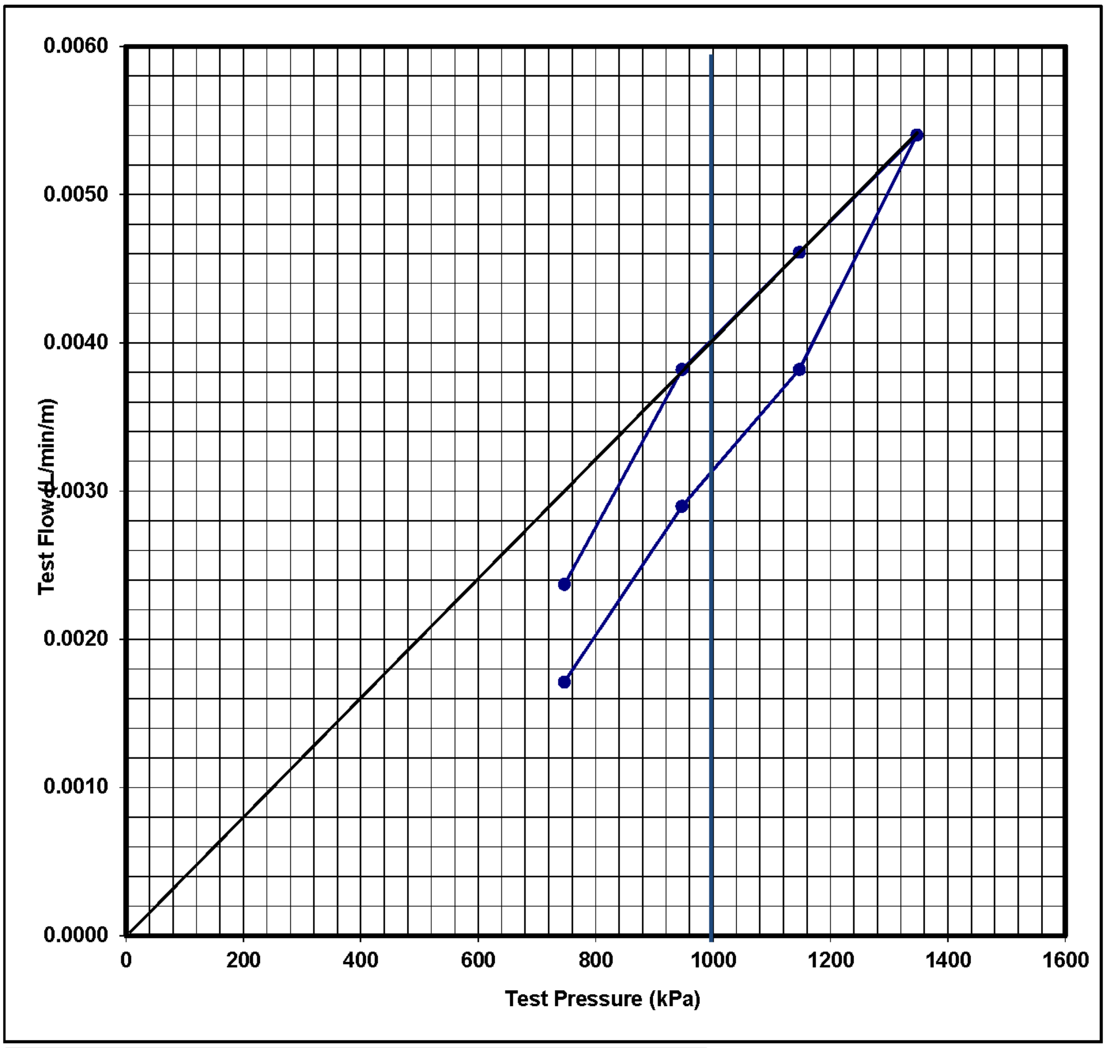
Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver			**Project No.:**	IA132800		
Hole No:	**BD17010**	**Test No:**	Single No. 4	Date:	9-May-17	Operator:	JT
Test Depth (m)	88.2	Location:	Easting (m)	768619.2		Azimuth:	60.5
			Northing (m)	6385518.3			

Summary

Test Pressure (Kpa)	747	947	1147	1347	1147	947	747	
Flow Rate (L/min/m)	0.0024	0.0038	0.0046	0.0054	0.0038	0.0029	0.0017	



Lugeon units = Test Flow (L/min/m) at 1000kPa =	0.004
Permeability (m/day) =	**5.01E-05**
Permeability (m/s) =	**5.80E-10**

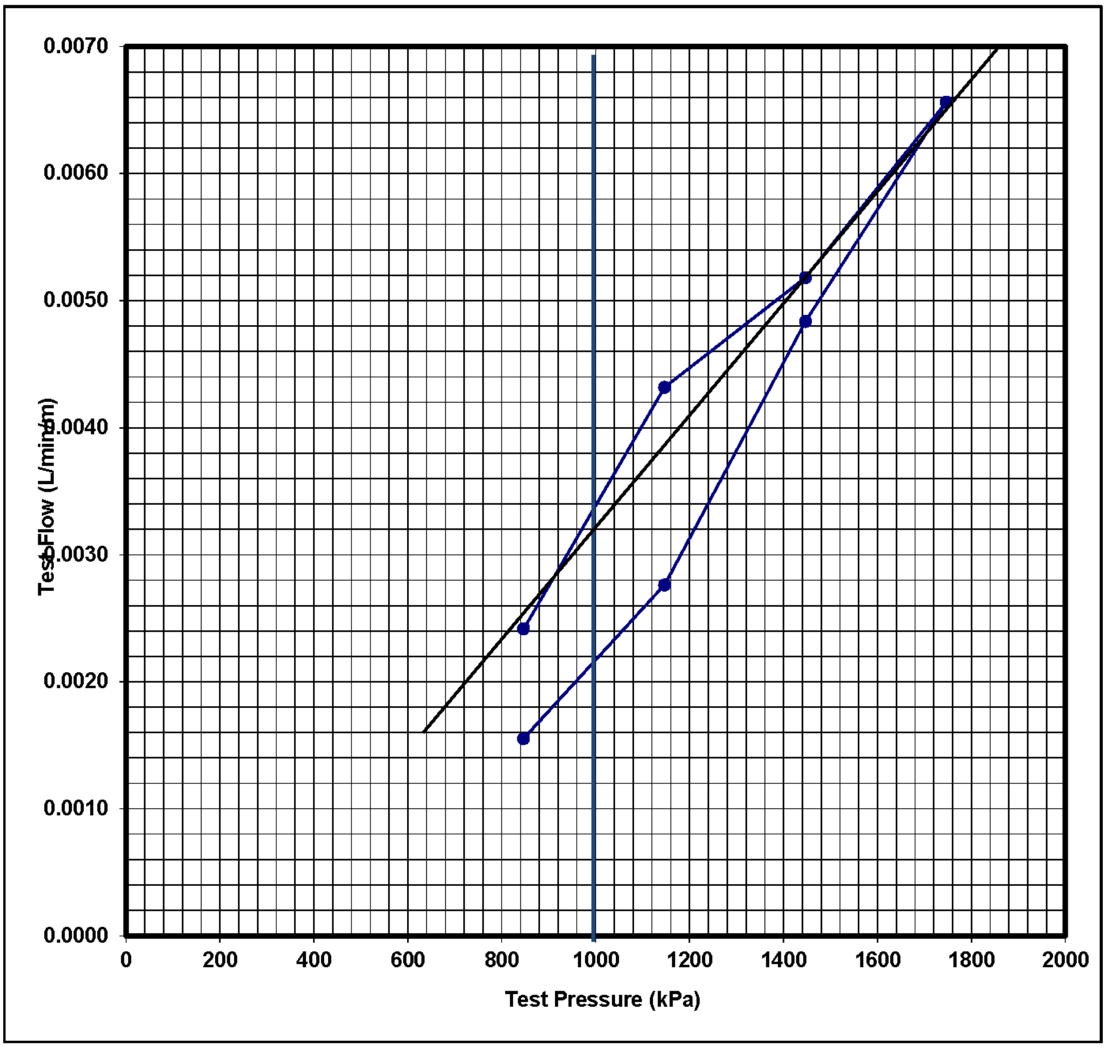
J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD17010_JT.xls]88.2

Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver			**Project No.:**	IA132800		
Hole No:	**BD17010**	**Test No:**	Single No. 4	Date:	9-May-17	Operator:	JT
Test Depth (m)	142.2	Location:	Easting (m)	768619.2		Azimuth:	60.5
			Northing (m)	6385518.3			

Summary								
Test Pressure (Kpa)	847	1147	1447	1747	1447	1147	847	
Flow Rate (L/min/m)	0.0024	0.0043	0.0052	0.0066	0.0048	0.0028	0.0016	



Lugeon units = Test Flow (L/min/m) at 1000kPa = 0.0032
Permeability (m/day) = 4.01E-05
Permeability (m/s) = 4.64E-10

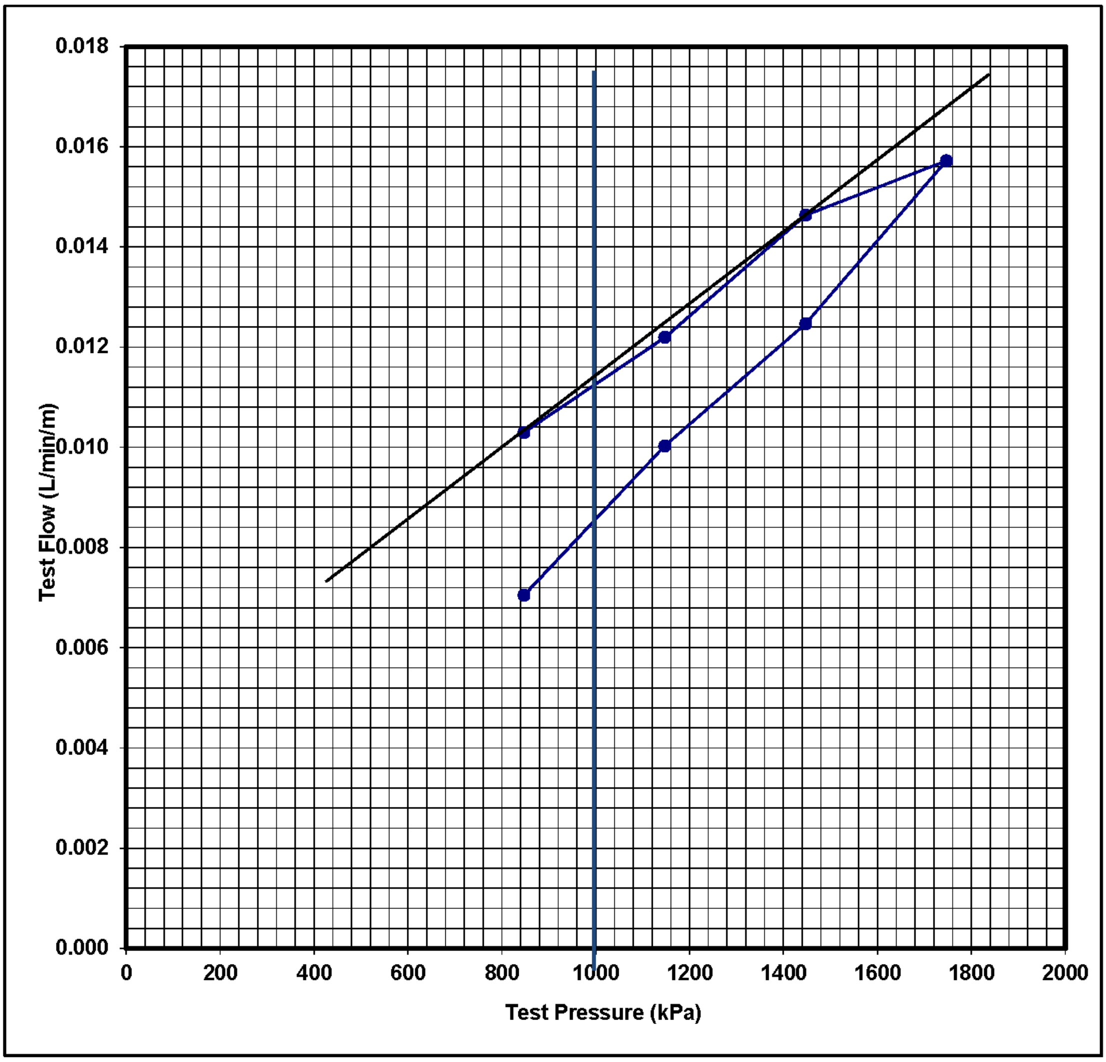
J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD17010_JT.xls]142.2

Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver			**Project No.:**	IA132800		
Hole No:	**BD17010**	**Test No:**	Single No. 4	Date:	9-May-17	Operator:	JT
Test Depth (m)	166.2	Location:	Easting (m)	768619.2		Azimuth:	60.5
			Northing (m)	6385518.3			

Summary								
Test Pressure (Kpa)	847	1147	1447	1747	1447	1147	847	
Flow Rate (L/min/m)	0.0103	0.0122	0.0146	0.0157	0.0125	0.0100	0.0070	



Lugeon units = Test Flow (L/min/m) at 1000kPa =	0.014
Permeability (m/day) =	**1.75E-04**
Permeability (m/s) =	**2.03E-09**

J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD17010_JT.xls]166.2

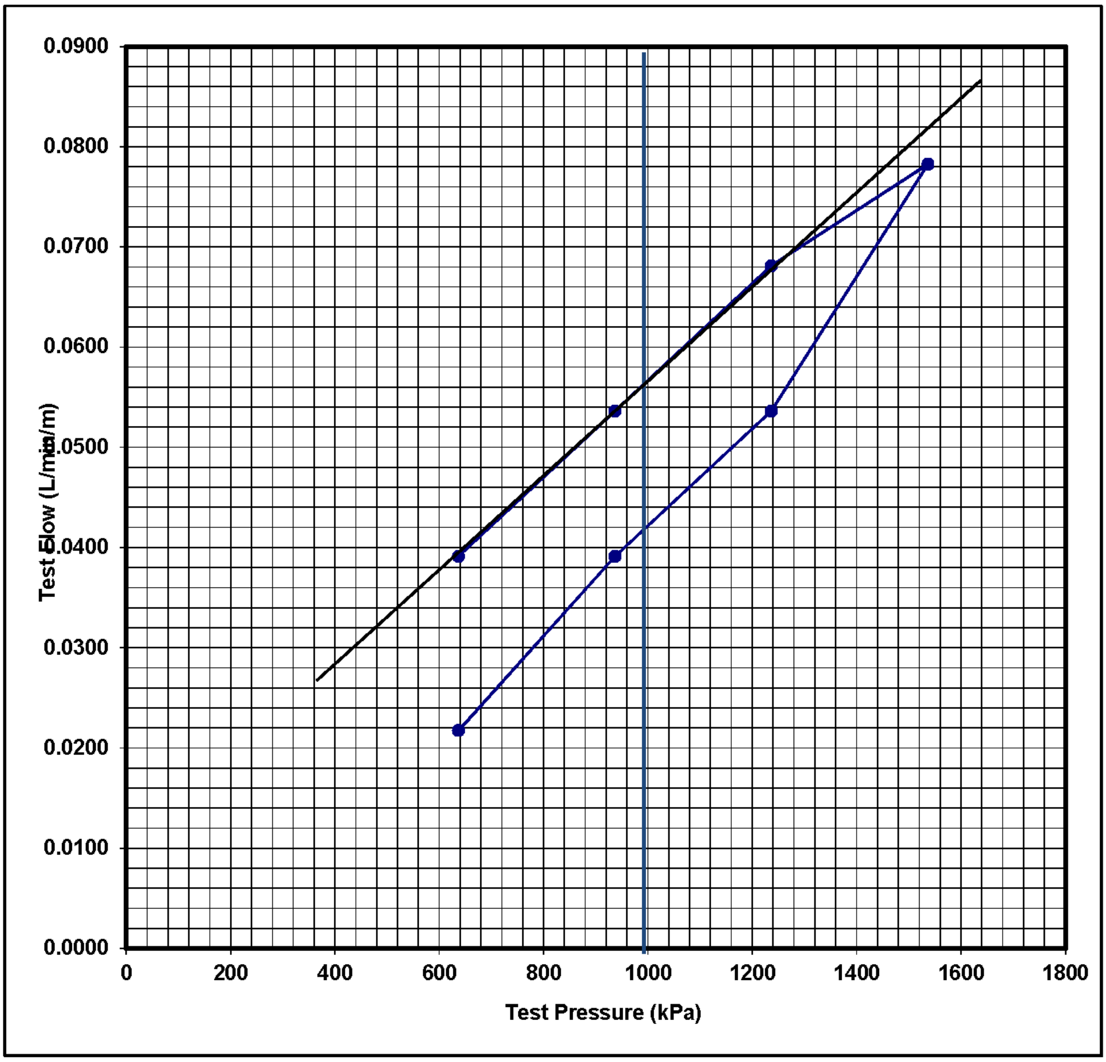
Test No. 9

Packer Test Data Sheet

Project:	Bowdens Silver			**Project No.:**	IA132800		
Hole No:	**BD17010**	**Test No:**	Single No. 4	Date:	9-May-17	Operator:	JT
Test Depth (m)	225.2	Location:	Easting (m)	768619.2		Azimuth:	60.5
			Northing (m)	6385518.3			

Summary

Test Pressure (Kpa)	637	937	1237	1537	1237	937	637	
Flow Rate (L/min/m)	0.0391	0.0536	0.0681	0.0783	0.0536	0.0391	0.0217	



Lugeon units = Test Flow (L/min/m) at 1000kPa =	0.056
Permeability (m/day) =	**7.02E-04**
Permeability (m/s) =	**8.12E-09**

J:\IE\Projects\04_Eastern\IA132800\02 Documents\Data\Packer Testing\[BD17010_JT.xls]226.2

Test No. 9

This page has intentionally been left blank

Annexure 7

Comprehensive Water Quality Analyses

(Total No. of pages including blank pages = 30)

Note: This Annexure is only available on the digital version of this document

This page has intentionally been left blank

Sample Location	Sampling Date	Sample Num	Electrical Conductivity @ 25°C µS/cm	pH Value pH Unit	Total Suspended Solids mg/L	TDS (mg/L) Calc	Total Anions meq/L	Total Cations meq/L	Ionic Balance %	Ammonia as N mg/L	Antimony - Dissolved mg/L	Arsenic - Dissolved mg/L	Bicarbonate Alkalinity as CaCO3 mg/L	Cadmium - Dissolved mg/L	Calcium - Dissolved mg/L	Carbonate Alkalinity as CaCO3 mg/L	Chloride mg/L	Chromium - Dissolved mg/L	Cobalt - Dissolved mg/L	Copper - Dissolved mg/L	Hydroxide Alkalinity as CaCO3 mg/L	Iron - Dissolved mg/L
BGW01	7/01/2014	ME1400079002	121	5.8	5	67	1.01	1.02		0.02	0	<0.001	22	<0.0001	2	<1	15	<0.001	<0.001	0.001	<1	<0.05
BGW01	7/04/2014	ME1400540001	127	5.8	3	82	1.29	1.17		0.13	0	<0.001	26	<0.0001	1	<1	22	<0.001	<0.001	0.002	<1	0.14
BGW01	7/07/2014	ME1401051001	129	5.9	6	77	1.18	1.15		<0.01	0	<0.001	30	<0.0001	2	<1	19	<0.001	<0.001	0.001	<1	0.06
BGW01	10/10/2014	ME1401512001	136	5.6	4	85	1.42	1.19		0.04	<0.001	<0.001	16	<0.0001	2	<1	28	<0.001	<0.001	<0.001	<1	0.06
BGW01	18/08/2015	ME1510328024	141	6.8	2	74	0	0	0	0.02	0	<0.001	24	<0.0001	3	<1	18	0	<0.001	<0.001	<1	0.06
BGW03	7/01/2014	ME1400079003	2620	7.7	29	1631	24.2	26.3	4.09	0.35	0	<0.001	585	<0.0001	9	<1	441	<0.001	<0.001	0.001	<1	0.78
BGW03	7/04/2014	ME1400540002	2140	6.6	132	1136	18.5	17.2	3.62	1.68	0	<0.001	178	<0.0001	20	<1	523	<0.001	<0.001	<0.001	<1	43.8
BGW03	7/07/2014	ME1401051002	2240	6.9	70	1346	22.4	20.4	4.66	0.6	0	<0.001	303	<0.0001	24	<1	575	<0.001	<0.001	0.002	<1	11.4
BGW03	10/10/2014	ME1401512002	2280	7.5	47	1592	24.7	26	2.52	0.35	<0.001	<0.001	450	<0.0001	17	<1	551	<0.001	<0.001	<0.001	<1	1.79
BGW05	7/01/2014	ME1400079004	426	6.7	6	251	3.85	3.82	0.43	0.07	0	<0.001	90	<0.0001	11	<1	49	<0.001	0.005	<0.001	<1	0.13
BGW05	7/04/2014	ME1400540003	365	6.8	27	229	3.55	3.52	0.44	0.04	0	<0.001	81	<0.0001	12	<1	44	<0.001	<0.001	0.002	<1	0.15
BGW05	7/07/2014	ME1401051003	321	6.7	15	207	3.09	3.18	1.45	0.02	0	<0.001	92	<0.0001	12	<1	28	<0.001	<0.001	<0.016	<1	<0.05
BGW05	10/10/2014	ME1401512003	423	6.5	8	254	3.97	3.87	1.34	0.04	<0.001	<0.001	68	<0.0001	15	<1	49	<0.001	0.006	0.002	<1	0.92
BGW05	4/02/2015	ME1500221013	562	6.3	27	325	5.14	5.26	1.14	0.08	0	<0.001	68	<0.0001	25	<1	81	0	0.006	0.004	<1	0.08
BGW05	1/05/2015	ME1500659001	583	6.5	10	327	4.99	5.76	7.09	0.04	0	<0.001	62	<0.0001	26	<1	77	0	0.001	0.024	<1	<0.05
BGW05	18/08/2015	ME1510328020	608	6.8	22	313	0	0	0	0.02	0	<0.001	63	<0.0001	28	<1	62	0	0.002	0.024	<1	<0.05
BGW05	22/10/2015	ME1510717010	624	6.7	5	348	0	0	0	0.08	0	<0.001	73	<0.0001	30	<1	90	0	0.003	0.009	<1	<0.05
BGW05	24/02/2016	ME1600265029	705	6.4	4	438	7.09	7.05	0.26	0.06	0	<0.001	75	<0.0001	36	<1	117	0	0.009	0.001	<1	<0.05
BGW05	27/05/2016	ME1600733001	815	6.6	2	472	7.95	7.19	5	0.02	0	<0.001	61	0.0001	40	<1	133	0	<0.001	0.034	<1	<0.05
BGW05	5/09/2016	ME1601226041	1060	6	18	629	10.4	9.9	2.68	0.14	0	<0.001	43	<0.0001	48	<1	190	0	0.023	<0.001	<1	<0.05
BGW05	20/12/2016	ME1601793015	909	6.1	10	564	9.44	8.27	6.6	0.04	0	<0.001	55	<0.0001	38	<1	160	0	<0.017	<0.001	<1	1.08
BGW06	19/05/2014	ME1400741013	751	6.8	65	458	6.81	7.01	1.41	0.24	0	<0.001	86	<0.0001	10	<1	86	<0.001	0.001	<0.01	<1	2.24
BGW06	14/07/2014	ME1401051004	765	6.9	14	503	7.62	7.33	2	<0.01	0	0.001	105	<0.0001	10	<1	91	<0.001	<0.001	0.008	<1	3.28
BGW06	10/10/2014	ME1401512004	694	6.9	9	471	7.06	7.36	2.09	0.04	<0.001	0.001	101	<0.0001	8	<1	87	0.001	<0.001	0.006	<1	2.86
BGW06	4/02/2015	ME1500221014	654	6.7	36	383	5.77	5.83	0.48	0.2	0	0.001	84	<0.0001	9	<1	77	0	<0.001	0.004	<1	1.22
BGW06	1/05/2015	ME1500659002	618	7.1	44	400	5.68	6.54	7.01	<0.01	0	0.002	111	<0.0001	12	<1	65	0	<0.001	0.004	<1	2.4
BGW06	18/08/2015	ME1510328021	289	6.7	34	197	0	0	0	0.18	0	0.002	41	<0.0001	7	<1	22	0	0.002	<0.012	<1	2.49
BGW06	22/10/2015	ME1510717011	320	6.9	454	206	0	0	0	0.19	0	0.002	52	<0.0001	8	<1	27	0	0.002	0.006	<1	4.19
BGW06	24/02/2016	ME1600265030	444	6.9	55	292	4.16	4.54	4.31	0.43	0	0.003	75	<0.0001	7	<1	48	0	0.001	<0.013	<1	4.45
BGW06	27/05/2016	ME1600733002	450	7	33	283	4.38	3.96	4.97	0.48	0	<0.001	90	<0.0001	7	<1	56	0	<0.001	0.004	<1	2.1
BGW06	5/09/2016	ME1601226042	952	6.5	38	621	9.11	9.28	0.9	0.17	0	<0.001	158	<0.0001	20	<1	82	0	0.002	<0.001	<1	4.16
BGW06	20/12/2016	ME1601793016	1130	6.6	24	742	11.6	10.6	4.25	0.18	0	<0.001	158	<0.0001	26	<1	147	0	0.002	<0.001	<1	3.98
BGW07	7/01/2014	ME1400079005	3150	7.7	110	1982	31.2	33.3	3.21	0.02	0	<0.001	459	<0.0001	52	<1	480	<0.001	<0.001	0.002	<1	0.84
BGW07	7/04/2014	ME1400540004	4060	7.9	41	2569	41.8	42	0.2	0.07	0	<0.001	390	<0.0001	66	<1	635	<0.001	<0.001	<0.001	<1	0.27
BGW07	23/07/2014	ME1401051005	3940	7.7	80	2878	46.8	46.5	0.33	0.19	0	<0.001	506	<0.0001	66	<1	700	<0.001	<0.001	0.002	<1	0.38
BGW07	14/10/2014	ME1401512005	3760	7.7	90	2800	43.9	48.3	4.79	0.31	<0.001	<0.001	542	<0.0001	70	<1	681	<0.001	<0.001	<0.001	<1	1.69
BGW07	4/02/2015	ME1500221015	3510	7.6	61	2429	39.2	39.3	0.07	0.25	0	<0.001	435	<0.0001	57	30	589	0	<0.001	0.002	<1	0.49
BGW07	29/04/2015	ME1500659003	3250	7.4	81	2211	34.7	37.8	4.33	0.38	0	<0.001	318	<0.0001	48	<1	513	0	<0.001	0.004	<1	9.02
BGW07	18/08/2015	ME1510328022	3200	6.9	272	2080	0	0	0	0.4	0	<0.001	115	<0.0001	53	<1	388	0	<0.001	<0.001	<1	0.89
BGW07	22/10/2015	ME1510717012	3350	7	116	1972	0	0	0	0.37	0	<0.001	111	<0.0001	59	<1	419	0	<0.001	<0.001	<1	0.71
BGW07	24/02/2016	ME1600265031	1280	7	53	879	14	13.9	0.06	0.18	0	<0.001	86	<0.0001	26	<1	160	0	<0.001	<0.001	<1	2.62
BGW07	27/05/2016	ME1600733003	1570	7.2	49	988	16.7	14	8.96	0.88	0	<0.001	122	<0.0001	33	<1	226	0	<0.001	<0.001	<1	<0.05
BGW07	5/09/2016	ME1601226043	1200	7.3	42	763	12	12.4	1.26	0.12	0	<0.001	52	<0.0001	22	<1	130	0	<0.001	0.002	<1	1.57
BGW07	20/12/2016	ME1601793017	1680	7.3	152	1059	17.5	16.3	3.4	0.3	0	<0.001	107	<0.0001	45	<1	244	0	<0.001	<0.001	<1	1.98
BGW08	7/01/2014	ME1400079006	1830	7.6	11	1351	18.5	20.5	4.87	0.04	0	<0.001	766	<0.0001	25	<1	88	<0.001	<0.001	0.005	<1	<0.05
BGW08	7/04/2014	ME1400540005	1930	7.8	3	1314	19	18.1	2.42	<0.01	0	<0.001	774	<0.0001	22	<1	98	<0.001	<0.001	0.006	<1	<0.05
BGW08	23/07/2014	ME1401051006	1890	7.3	43	1613	22.7	23.2	1.06	<<0.01	0	<0.001	964	<0.0001	38	<1	94	<0.001	<0.001	0.008	<1	<0.05
BGW08	14/10/2014	ME1401512006	1720	7.4	2	1484	20.5	23	5.88	0.02	<0.001	<0.001	818	<0.0001	51	<1	109	<0.001	<0.001	0.002	<1	<0.05
BGW08	8/02/2015	ME1500221016	1430	7	13	1040	15.1	15.5	1.31	0.08	0	<0.001	551	<0.0001	60	<1	105	0	<0.001	<0.001	<1	0.47
BGW08	1/05/2015	ME1500659004	1840	7.6	12	1489	20.4	22.8	5.58	<<0.01	0	0.001	860	<0.0001	43	<1	76	0	<0.001	0.002	<1	<0.05

Sample Location	Sampling Date	Sample Num	Electrical Conductivity @ 25°C µS/cm	pH Value pH Unit	Total Suspended Solids mg/L	TDS (mg/L) Calc	Total Anions meq/L	Total Cations meq/L	Ionic Balance %	Ammonia as N mg/L	Antimony - Dissolved mg/L	Arsenic - Dissolved mg/L	Bicarbonate Alkalinity as CaCO3 mg/L	Cadmium - Dissolved mg/L	Calcium - Dissolved mg/L	Carbonate Alkalinity as CaCO3 mg/L	Chloride mg/L	Chromium - Dissolved mg/L	Cobalt - Dissolved mg/L	Copper - Dissolved mg/L	Hydroxide Alkalinity as CaCO3 mg/L	Iron - Dissolved mg/L
BGW08	18/08/2015	ME1510328023	1640	7.4	126	1247	0	0	0	0.43	0	<0.001	696	<0.0001	49	<1	59	0	<0.001	<0.001	<1	0.23
BGW08	28/10/2015	ME1510717013	1860	7.6	<1	1477	0	0	0	0.21	0	<0.001	904	<0.0001	33	<1	84	0	<0.001	0.001	<1	0.1
BGW08	24/02/2016	ME1600265032	1660	7.4	12	1339	18.6	19.9	3.24	0.02	0	<0.001	784	<0.0001	45	<1	75	0	<0.001	0.002	<1	<0.05
BGW08	27/05/2016	ME1600733004	1750	7.4	2	1385	19.8	19.4	1.23	<<0.01	0	<0.001	830	<0.0001	41	<1	84	0	<0.001	0.001	<1	<0.05
BGW08	5/09/2016	ME1601226044	1780	7.5	32	1340	18.2	20.5	5.9	0.2	0	0.005	766	<0.0001	47	<1	78	0	<0.001	0.02	<1	12
BGW08	20/12/2016	ME1601793018	1770	7.6	38	1343	18.9	20	2.79	<0.01	0	<0.001	762	<0.0001	42	<1	102	0	<0.001	<0.001	<1	<0.05
BGW09	7/01/2014	ME1400079007	1440	7.3	4	1062	15.8	15.7	0.16	0.08	0	<0.001	654	<0.0001	57	<1	75	<0.001	<0.001	0.001	<1	0.66
BGW09	21/05/2014	ME1400741014	1400	7.1	12	1017	14.9	15.6	2.26	0.06	0	0.007	597	<0.0001	60	<1	76	<0.001	0.004	<0.001	<1	1.28
BGW09	7/07/2014	ME1401051007	1400	7.1	117	1123	16.9	16.1	2.4	<0.01	0	<0.001	685	<0.0001	65	<1	79	<0.001	<0.001	0.001	<1	2.04
BGW09	10/10/2014	ME1401512007	1410	7.3	5	1072	16.8	13.7	10.2	<<0.01	<0.001	<0.001	696	<0.0001	52	<1	77	<0.001	<0.001	<0.001	<1	2.11
BGW09	6/02/2015	ME1500221017	1410	7.3	24	1039	15.4	15.9	1.45	0.03	0	<0.001	628	<0.0001	61	4	78	0	<0.001	0.004	<1	0.43
BGW09	1/05/2015	ME1500659005	1450	7.4	12	1095	15.5	18.2	8	<<0.01	0	0.001	661	<0.0001	73	<1	64	0	<0.001	<0.001	<1	0.4
BGW09	18/08/2015	ME1510328025	1400	7.2	22	1067	0	0	0	0.05	0	<0.001	640	<0.0001	72	<1	50	0	<0.001	<0.001	<1	1.7
BGW09	22/10/2015	ME1510717014	877	7.7	48	943	0	0	0	0.02	0	<0.001	510	<0.0001	66	15	64	0	<0.001	<0.001	<1	0.95
BGW09	24/02/2016	ME1600265033	1350	7.3	4	1089	15.8	16.9	3.39	0.03	0	<0.001	671	<0.0001	67	<1	63	0	<0.001	<0.001	<1	0.48
BGW09	27/05/2016	ME1600733005	1420	7.2	4	1098	16.7	15.3	4.63	0.03	0	<0.001	705	<0.0001	66	<1	71	0	<0.001	<0.001	<1	1.21
BGW09	5/09/2016	ME1601226045	1440	7.3	49	1077	15.5	17.2	5.12	0.02	0	<0.001	651	<0.0001	73	<1	68	0	<0.001	0.035	<1	0.06
BGW09	20/12/2016	ME1601793019	1430	7.2	2	1024	15	15.8	2.71	0.03	0	<0.001	624	<0.0001	70	<1	69	0	<0.001	<0.001	<1	0.66
BGW10	10/01/2014	ME1400079008	1450	7.1	6	1042	15.8	15.6	0.49	0.02	0	<0.014	307	<0.0001	118	<1	66	<0.001	<0.001	0.001	<1	1.26
BGW10	31/03/2014	ME1400540006	1260	7.1	8	882	12.9	14.2	4.62	0.06	0	<0.016	270	<0.0001	108	<1	54	<0.001	<0.001	<0.001	<1	1.19
BGW10	15/07/2014	ME1401051008	1290	7.1	<2	954	14.2	14.8	2.37	0.02	0	<0.01	316	<0.0001	116	<1	57	<0.001	<0.001	<0.001	<1	0.72
BGW10	13/10/2014	ME1401512008	1290	7.2	5	916	14.3	12.5	6.62	0.03	<0.001	<0.015	324	<0.0001	96	<1	56	<0.001	<0.001	<0.001	<1	1.04
BGW10	4/12/2014	ME1401772005	1520	6.9	5	1243	18.5	19.7	3.16	0.005	0	0	360	<0.0001	168	<1	82	0	0.001	0.002	<1	<0.05
BGW10	5/12/2014	ME1401772006	1520	7	5	1252	18.6	19.9	3.36	0.008	0	0	366	<0.0001	167	<1	80	0	0.001	<0.001	<1	<0.05
BGW10	6/12/2014	ME1401772007	1550	7	3	1275	19	20.2	2.97	0.008	0	0	366	<0.0001	169	<1	81	0	0.001	<0.001	<1	<0.05
BGW10	7/12/2014	ME1401772008	1560	7.5	3	1284	19.1	20.4	3.2	0.006	0	0	370	<0.0001	174	<1	82	0	0.001	0.002	<1	<0.05
BGW10	5/02/2015	ME1500221018	1110	6.9	5	826	12.3	12.7	1.64	0.03	0	0.02	262	<0.0001	99	<1	39	0	<0.001	0.001	<1	0.98
BGW10	29/04/2015	ME1500659006	1230	7	8	912	13.4	14.3	3.06	0.04	0	<0.018	281	<0.0001	113	<1	43	0	<0.001	0.002	<1	1.01
BGW10	7/08/2015	ME1510328026	1250	7	4	917	0	0	0	0.06	0	<0.016	288	<0.0001	110	<1	36	0	<0.001	<0.001	<1	0.92
BGW10	27/10/2015	ME1510717015	1170	7.2	2	846	0	0	0	0.06	0	<0.012	302	<0.0001	90	<1	44	0	<0.001	<0.001	<1	<0.05
BGW10	23/02/2016	ME1600265017	1310	7.1	4	1008	15.2	14.9	0.94	0.03	0	0.02	317	<0.0001	119	<1	48	0	<0.001	<0.001	<1	1.17
BGW10	18/05/2016	ME1600733006	1240	7	4	801	12.4	11.4	4.18	<<0.01	0	<0.016	242	<0.0001	82	<1	54	0	<0.001	<0.001	<1	1.18
BGW10	30/08/2016	ME1601226001	1480	6.9	2	1096	16.2	17.2	3.04	0.04	0	0.008	332	<0.0001	134	<1	62	0	<0.001	<0.001	<1	0.74
BGW10	21/12/2016	ME1601793032	1380	7.1	4	997	15.2	14.5	2.29	0.04	0	<0.017	296	<0.0001	119	<1	60	0	<0.001	<0.001	<1	1.21
BGW102	10/01/2014	ME1400079053				7				0.21	0	0.048		0.0002				<0.001	0.001	0.02		1.86
BGW102	10/01/2014	ME1400079053				7				0.21	0	0.048		0.0002				<0.001	0.001	0.02		1.86
BGW102	14/10/2014	ME1401512051				332					<0.001	0.079		<0.0001	151			<0.001	0.001	<0.001		1.32
BGW102	14/10/2014	ME1401512051				332					<0.001	0.079		<0.0001	151			<0.001	0.001	<0.001		1.32
BGW102	30/04/2015	ME1500659043	1380	7.4		1040	15.3	16.1	2.74	0.17	0	0.106	283	0.0003	142	<1	51	0	0.003	0.005	<1	2.47
BGW102	30/04/2015	ME1500659043	1380	7.4		1040	15.3	16.1	2.74	0.17	0	0.106	283	0.0003	142	<1	51	0	0.003	0.005	<1	2.47
BGW106	10/01/2014	ME1400079045	1160	7	16	728	11.3	11.2	0.29	0.96	0	<0.001	151	0.0002	77	<1	126	0.001	<0.001	<0.01	<1	0.77
BGW106	9/04/2014	ME1400540043	1140	6.8	9	741	11.3	12	3.07	1.03	0	<0.001	144	<0.0001	87	<1	138	<0.001	<0.001	<0.001	<1	0.18
BGW106	22/07/2014	ME1401051046	1150	7	2	798	12.5	12	2.05	0.68	0	<0.001	168	<0.0001	84	<1	140	<0.001	<0.001	<0.001	<1	0.13
BGW106	14/10/2014	ME1401512048	1160	6.7	8	781	12.1	12.3	0.66	0.85	<0.001	0.002	163	<0.0001	85	<1	147	<0.001	<0.001	<0.001	<1	<0.05
BGW106	8/02/2015	ME1500221020	1140	6.7	11	736	11.5	11.6	0.46	0.1	0	0.005	138	<0.0001	82	<1	132	0	0.001	0.002	<1	<0.05
BGW106	30/04/2015	ME1500659044	1170	6.6	6	792	12.3	12.6	1	0.03	0	0.005	146	<0.0001	91	<1	151	0	0.001	0.003	<1	0.09
BGW106	14/08/2015	ME1510328027	1170	7.2	12	742	0	0	0	0.02	0	0.003	141	<0.0001	86	<1	114	0	<0.001	<0.001	<1	<0.05
BGW106	22/10/2015	ME1510717051	1160	7	2	709	0	0	0	0.02	0	<0.001	109	<0.0001	91	<1	120	0	<0.001	0.003	<1	<0.05
BGW106	22/02/2016	ME1600265001	1190	6.9	3	782	12.1	12.4	1.17	<0.01	0	0.001	138	<0.0001	94	<1	145	0	<0.001	0.004	<1	<0.05
BGW106	18/05/2016	ME1600733007	1180	7	4	689	11.2	10.4	3.66	<<0.01	0	0.001	122	<0.0001	73	<1	148	0	<0.001	0.002	<1	<0.05

Sample Location	Sampling Date	Sample Num	Electrical Conductivity @ 25°C µS/cm	pH Value pH Unit	Total Suspended Solids mg/L	TDS (mg/L) Calc	Total Anions meq/L	Total Cations meq/L	Ionic Balance %	Ammonia as N mg/L	Antimony - Dissolved mg/L	Arsenic - Dissolved mg/L	Bicarbonate Alkalinity as CaCO3 mg/L	Cadmium - Dissolved mg/L	Calcium - Dissolved mg/L	Carbonate Alkalinity as CaCO3 mg/L	Chloride mg/L	Chromium - Dissolved mg/L	Cobalt - Dissolved mg/L	Copper - Dissolved mg/L	Hydroxide Alkalinity as CaCO3 mg/L	Iron - Dissolved mg/L
BGW106	1/09/2016	ME1601226020	1220	7.1	1	824	13	12.6	1.75	0.08	0	<0.001	165	<0.0001	92	<1	147	0	<0.001	0.008	<1	<0.05
BGW106	19/12/2016	ME1601793001	1250	7	2	766	12.2	11.9	1.02	<<0.01	0	0.001	146	<0.0001	92	<1	154	0	<0.001	0.003	<1	<0.05
BGW107	10/01/2014	ME1400079046	1680	6.7	96	1109	17.4	17.4	0.06	0.25	0	0.008	232	<0.0001	145	<1	216	<0.001	0.002	<0.001	<1	6.62
BGW107	9/04/2014	ME1400540044	1760	6.5	48	1155	18.1	19.2	3.13	0.13	0	<0.011	195	<0.0001	168	<1	277	<0.001	0.004	<0.001	<1	7.88
BGW107	22/07/2014	ME1401051049	1530	6.6	34	1136	17.8	16.5	3.7	0.19	0	0.008	328	<0.0001	128	<1	166	<0.001	0.002	0.003	<1	4.12
BGW107	14/10/2014	ME1401512049	1490	6.9	35	1109	16.8	17.2	1.19	0.18	<0.001	<0.011	347	<0.0001	140	<1	139	<0.001	<0.001	<0.001	<1	3.48
BGW107	8/02/2015	ME1500221021	1550	6.6	63	1111	17.2	17.7	1.59	0.3	0	0.008	273	<0.0001	148	<1	182	0	0.001	<0.001	<1	3.77
BGW107	30/04/2015	ME1500659045	1500	6.8	55	1103	17	16.7	0.69	0.2	0	0.06	315	<0.0001	141	<1	150	0	<0.001	0.002	<1	7.43
BGW107	14/08/2015	ME1510328028	1450	6.8	21	993	0	0	0	0.2	0	0.006	316	<0.0001	132	<1	63	0	<0.001	<0.001	<1	2.17
BGW107	22/10/2015	ME1510717052	1400	7.2	52	1015	0	0	0	0.21	0	0.003	300	<0.0001	132	<1	74	0	<0.001	<0.001	<1	1.44
BGW107	22/02/2016	ME1600265002	1390	6.8	22	1011	15	15.7	2.39	0.22	0	0.003	319	<0.0001	135	<1	82	0	<0.001	<0.001	<1	1.6
BGW107	18/05/2016	ME1600733008	1230	7	20	873	12.3	14.8	9.2	0.05	0	0.003	285	<0.0001	128	<1	54	0	<0.001	<0.001	<1	1.36
BGW107	1/09/2016	ME1601226021	1440	6.8	25	1094	16.6	16	1.62	0.29	0	0.004	386	<0.0001	132	<1	86	0	<0.001	<0.001	<1	1.42
BGW107	19/12/2016	ME1601793002	1400	6.8	16	991	14.8	15.1	1.25	0.17	0	0.002	356	<0.0001	128	<1	87	0	<0.001	<0.001	<1	0.7
BGW108	6/01/2014	ME1400079047	2550	7.1	8	1956	29.8	29.9	0.14	0.48	0	0.118	461	0.0003	218	<1	207	<0.001	<0.001	0.006	<1	0.92
BGW108	9/04/2014	ME1400540045	2360	6.8	22	1784	27.2	27.2	0.05	0.42	0	0.112	460	0.0002	218	<1	191	<0.001	<0.001	<0.001	<1	2.14
BGW108	15/07/2014	ME1401051050	2500	6.8	26	2098	32.4	30.9	2.29	0.34	0	0.036	512	0.0001	214	<1	229	<0.001	<0.001	<0.001	<1	4.16
BGW108	8/10/2014	ME1401512050	2700	7	32	2121	32.2	33.5	2.03	0.44	0.008	0.248	489	0.0002	242	<1	262	<0.001	<0.001	<0.001	<1	1.92
BGW108	28/11/2014	ME1401772001	2590	7	3	2188	32.9	35.1	3.17	0.299	0	0	493	0.0001	284	<1	245	0	<0.001	0.001	<1	<0.05
BGW108	29/11/2014	ME1401772002	2530	6.8	6	2147	32.1	34.6	3.82	0.205	0	0	490	0.0002	288	<1	228	0	<0.001	<0.001	<1	<0.05
BGW108	30/11/2014	ME1401772003	2500	6.7	<2	2116	31.7	33.9	3.31	0.127	0	0	488	0.0001	276	<1	224	0	<0.001	0.002	<1	<0.05
BGW108	1/12/2014	ME1401772004	2450	6.8	<2	2072	31.1	33	3	0.096	0	0	486	0.0001	276	<1	221	0	<0.001	0.002	<1	<0.05
BGW108	7/02/2015	ME1500221022	2480	6.8	41	1933	29.8	29.5	0.46	0.31	0	0.185	454	0.0002	218	<1	223	0	<0.001	0.002	<1	1.15
BGW108	30/04/2015	ME1500659046	2470	6.8	36	2053	31	32.8	2.79	0.43	0	0.247	480	0.0002	249	<1	235	0	<0.001	<0.001	<1	1.79
BGW108	11/08/2015	ME1510328029	2620	6.8	16	1957	0	0	0	0.41	0	0.161	409	0.0003	251	<1	190	0	<0.001	0.002	<1	0.94
BGW108	27/10/2015	ME1510717053	2540	6.9	12	2003	0	0	0	0.38	0	0.227	481	0.0002	213	<1	233	0	<0.001	<0.001	<1	1.26
BGW108	23/02/2016	ME1600265018	2390	6.8	8	2021	31.3	29.6	2.68	0.47	0	0.225	504	<0.0001	228	<1	204	0	<0.001	<0.001	<1	1.39
BGW108	19/05/2016	ME1600733009	2370	6.9	6	1997	30.9	28.8	3.57	0.36	0	0.233	542	0.0001	221	<1	186	0	<0.001	<0.001	<1	1.61
BGW108	6/09/2016	ME1601226056	295	6.6	4	192	2.86	2.84	0	<<0.01	0	0.036	51	0.0002	19	<1	21	0	<0.001	0.001	<1	0.06
BGW108	19/12/2016	ME1601793003	2640	6.8	4	1955	30	30.1	0.17	0.43	0	0.235	439	0.0009	239	<1	228	0	<0.001	<0.001	<1	0.9
BGW11	6/01/2014	ME1400079009	1820	6.8	22	1105	18	18.2	0.33	0.08	0	<0.001	328	<0.0001	84	<1	293	<0.001	<0.001	<0.001	<1	<0.05
BGW11	17/05/2014	ME1400741015	1740	6.9	1110	1123	18	19	2.75	0.05	0	<0.001	365	<0.0001	113	<1	283	<0.001	<0.001	0.001	<1	0.06
BGW11	18/07/2014	ME1401051009	1850	6.6	55	1268	21.4	19.6	4.35	0.04	0	<0.001	352	<0.0001	98	<1	360	<0.001	<0.001	<0.001	<1	<0.05
BGW11	9/10/2014	ME1401512009	1920	6.7	28	1313	21.2	22.9	3.87	0.05	<0.001	<0.001	355	<0.0001	95	<1	378	<0.001	<0.001	<0.001	<1	0.08
BGW11	7/02/2015	ME1500221023	1760	6.5	32	1134	19.2	17.6	4.58	0.09	0	<0.001	285	<0.0001	87	<1	328	0	<0.001	0.001	<1	0.31
BGW11	29/04/2015	ME1500659007	1860	6.6	38	1226	19.8	21.2	3.38	0.05	0	0.001	348	<0.0001	102	<1	328	0	<0.001	0.001	<1	0.17
BGW11	11/08/2015	ME1510328030	2030	6.5	32	1163	0	0	0	0.07	0	<0.001	310	<0.0001	95	<1	281	0	<0.001	0.001	<1	<0.05
BGW11	21/10/2015	ME1510717016	1920	6.6	25	1218	0	0	0	0.1	0	<0.001	329	<0.0001	102	<1	321	0	<0.001	<0.001	<1	<0.05
BGW11	22/02/2016	ME1600265003	1860	6.5	22	1179	19.1	20.2	2.82	0.06	0	<0.001	317	<0.0001	100	<1	331	0	<0.001	<0.001	<1	0.16
BGW11	19/05/2016	ME1600733010	1890	6.7	11	1258	21.2	19.5	4.1	0.04	0	<0.001	365	<0.0001	94	<1	343	0	<0.001	<0.001	<1	0.08
BGW11	1/09/2016	ME1601226022	1930	6.5	12	1274	21	20.6	1.19	<<0.01	0	<0.001	370	<0.0001	99	<1	343	0	<0.001	<0.001	<1	0.17
BGW11	20/12/2016	ME1601793020	1730	6.6	19	1110	18.7	16.8	5.24	0.1	0	<0.001	348	<0.0001	92	<1	305	0	<0.001	<0.001	<1	0.82
BGW12	6/01/2014	ME1400079010	5490	6.6	13	2917	47.6	52.5	4.93	0.05	0	<0.001	204	<0.0001	137	<1	1130	<0.001	0.002	0.002	<1	0.05
BGW12	2/04/2014	ME1400540008	5680	6.4	51	3179	52.9	56.8	3.58	0.04	0	<0.001	179	0.0002	152	<1	1310	<0.001	0.002	0.002	<1	<0.05
BGW12	18/07/2014	ME1401051010	5280	6.3	6	3319	56.7	56.6	0.08	0.23	0	<0.001	210	0.0001	156	<1	1420	<0.001	0.003	0.002	<1	<0.05
BGW12	9/10/2014	ME1401512010	5650	6.5	13	2963	51.6	48.1	3.6	0.03	<0.001	<0.001	200	0.0001	126	<1	1250	<0.001	0.003	0.004	<1	<0.05
BGW12	7/02/2015	ME1500221024	4750	6.4	43	2908	48.7	51.3	2.59	0.64	0	0.001	168	<0.0001	131	<1	1220	0	0.009	0.003	<1	0.21
BGW12	29/04/2015	ME1500659008	4830	6.4	39	2799	46.2	49.9	3.82	0.61	0	0.002	168	<0.0001	135	<1	1120	0	0.006	0.002	<1	0.9
BGW12	11/08/2015	ME1510328031	4640	6.4	10	2258	0	0	0	0.1	0	0.001	158	<0.0001	126	<1	772	0	0.004	0.004	<1	<0.05
BGW12	21/10/2015	ME1510717017	4890	6.5	6	2695	0	0	0	0.32	0	<0.001	178	<0.0001	129	<1	1050	0	0.002	0.005	<1	<0.05

Sample Location	Sampling Date	Sample Num	Electrical Conductivity @ 25°C µS/cm	pH Value pH Unit	Total Suspended Solids mg/L	TDS (mg/L) Calc	Total Anions meq/L	Total Cations meq/L	Ionic Balance %	Ammonia as N mg/L	Antimony - Dissolved mg/L	Arsenic - Dissolved mg/L	Bicarbonate Alkalinity as CaCO3 mg/L	Cadmium - Dissolved mg/L	Calcium - Dissolved mg/L	Carbonate Alkalinity as CaCO3 mg/L	Chloride mg/L	Chromium - Dissolved mg/L	Cobalt - Dissolved mg/L	Copper - Dissolved mg/L	Hydroxide Alkalinity as CaCO3 mg/L	Iron - Dissolved mg/L
BGW12	22/02/2016	ME1600265004	4280	6.5	10	2522	42	44.9	3.31	0.91	0	<0.001	158	<0.0001	127	<1	1040	0	0.004	<0.001	<1	0.34
BGW12	19/05/2016	ME1600733011	4550	6.4	10	2699	44	47.9	4.18	0.37	0	<0.001	195	<0.0001	127	<1	1020	0	0.002	<0.001	<1	<0.05
BGW12	1/09/2016	ME1601226023	4070	6.5	10	2334	38.7	41.5	3.5	0.57	0	0.001	189	<0.0001	119	<1	946	0	0.003	<0.001	<1	1.02
BGW12	20/12/2016	ME1601793021	2750	6.2	10	1599	27.8	25.1	5.19	0.06	0	<0.001	134	<0.0001	84	<1	664	0	0.003	<0.001	<1	0.32
BGW14	8/01/2014	ME1400079011	1800	7	494	1248	19.3	20	1.77	0.02	0	<0.001	513	<0.0001	106	<1	176	<0.001	<0.001	0.001	<1	<0.05
BGW14	2/04/2014	ME1400540007	1840	6.9	480	1252	19.6	19.6	0.05	0.04	0	<0.001	513	<0.0001	105	<1	188	<0.001	<0.001	0.001	<1	<0.05
BGW14	23/07/2014	ME1401051011	1740	6.8	217	1264	19.6	19.9	0.72	<0.01	0	<0.001	564	<0.0001	110	<1	188	<0.001	<0.001	0.002	<1	<0.05
BGW14	8/10/2014	ME1401512011	1780	6.9	189	1264	20.6	17.7	7.75	<<0.01	<0.001	<0.001	566	<0.0001	95	<1	197	<0.001	<0.001	0.001	<1	<0.05
BGW14	7/02/2015	ME1500221025	1770	6.8	261	1257	19.6	19.9	0.78	0.03	0	<0.001	508	<0.0001	110	<1	183	0	<0.001	0.002	<1	<0.05
BGW14	1/05/2015	ME1500659009	1840	6.8	185	1345	20.5	22.6	4.79	<<0.01	0	<0.001	544	<0.0001	121	<1	186	0	<0.001	0.003	<1	<0.05
BGW14	11/08/2015	ME1510328032	1850	6.7	274	1338	0	0	0	0.07	0	<0.001	603	<0.0001	121	<1	154	0	<0.001	0.002	<1	<0.05
BGW14	28/10/2015	ME1510717018	1860	6.8	61	1344	0	0	0	0.02	0	<0.001	580	<0.0001	116	<1	175	0	<0.001	0.001	<1	<0.05
BGW14	25/02/2016	ME1600265036	1830	6.7	19	1310	20.2	21.4	2.87	<<0.01	0	<0.001	503	<0.0001	121	<1	191	0	<0.001	<0.001	<1	<0.05
BGW14	25/05/2016	ME1600733012	1820	6.7	57	1428	22.9	21.1	4.05	0.08	0	<0.001	618	<0.0001	126	<1	215	0	<0.001	0.002	<1	<0.05
BGW14	7/09/2016	ME1601226057	1880	6.8	44	1381	21.4	22.2	2.02	<<0.01	0	<0.001	542	<0.0001	128	<1	195	0	<0.001	<0.001	<1	<0.05
BGW14	21/12/2016	ME1601793033	1560	6.7	201	1030	16.6	15.8	2.53	0.18	0	<0.001	391	<0.0001	86	<1	209	0	<0.001	<0.001	<1	<0.05
BGW15	13/01/2014	ME1400079012	3100	7.4	30	2412	34.6	37.1	3.42	0.06	0	<0.001	860	<0.0001	101	<1	181	<0.001	<0.001	<0.001	<1	<0.05
BGW15	9/04/2014	ME1400540009	3180	7.2	11	2294	34.1	33.2	1.41	0.08	0	0.001	848	<0.0001	98	<1	195	<0.001	<0.001	<0.001	<1	<0.05
BGW15	22/07/2014	ME1401051012	2990	7.1	4	2463	36.3	35.4	1.3	0.06	0	0.001	1030	<0.0001	99	<1	187	<0.001	<0.001	<0.001	<1	<0.05
BGW15	8/10/2014	ME1401512012	3020	7.3	17	2508	35.1	39.8	6.23	0.06	<0.001	0.001	1030	<0.0001	92	<1	186	<0.001	<0.001	<0.001	<1	<0.05
BGW15	7/02/2015	ME1500221026	2840	7.2	30	2225	32.5	32.3	0.36	0.11	0	0.002	931	<0.0001	83	<1	155	0	<0.001	0.002	<1	<0.05
BGW15	1/05/2015	ME1500659010	2880	7.2	23	2312	33.1	35.1	2.85	0.08	0	0.002	954	<0.0001	98	<1	160	0	<0.001	0.002	<1	<0.05
BGW15	11/08/2015	ME1510328033	2970	7.2	38	2205	0	0	0	0.09	0	0.001	907	<0.0001	100	<1	138	0	<0.001	0.002	<1	<0.05
BGW15	28/10/2015	ME1510717019	2920	7.2	8	2262	0	0	0	0.1	0	0.001	982	<0.0001	90	<1	151	0	<0.001	<0.001	<1	<0.05
BGW15	25/02/2016	ME1600265037	2790	7.2	5	2201	31.5	33.4	2.89	0.06	0	0.001	862	<0.0001	92	<1	158	0	<0.001	<0.001	<1	<0.05
BGW15	25/05/2016	ME1600733013	2750	7.1	11	2363	34.2	34.3	0.09	0.06	0	<0.001	1030	0.0001	87	<1	156	0	<0.001	<0.001	<1	<0.05
BGW15	7/06/2016	ME1601226058	2910	7.2	6	2296	32.6	35.8	4.71	0.09	0	<0.001	913	<0.0001	101	<1	168	0	<0.001	<0.001	<1	<0.05
BGW15	21/12/2016	ME1601793034	2980	7.4	15	2194	32.1	32.7	0.9	<<0.01	0	<0.001	840	<0.0001	93	<1	191	0	<0.001	<0.001	<1	<0.05
BGW16	14/10/2013	ME1400079054	1380	7.4	16	956	14	14.3	0.78	<<0.01	0	<0.001	556	<0.0001	76	<1	69	<0.001	<0.001	<0.001	<1	<0.05
BGW16	13/01/2014	ME1400079013	1240	7.6	5	897	13.1	13.6	2.02	0.02	0	<0.001	500	<0.0001	51	<1	74	<0.001	<0.001	<0.001	<1	<0.05
BGW16	9/04/2014	ME1400540010	1300	7.4	8	888	13.2	13.2	0.14	0.49	0	<0.001	494	<0.0001	55	<1	81	<0.001	<0.001	<0.001	<1	<0.05
BGW16	22/07/2014	ME1401051013	1380	7	<2	1077	16	15.5	1.63	<<0.01	0	<0.001	646	<0.0001	89	<1	77	<0.001	<0.001	<0.001	<1	<0.05
BGW16	8/10/2014	ME1401512013	1390	7.2	3	1119	16.4	16.6	0.54	0.08	<0.001	<0.001	657	<0.0001	83	<1	76	<0.001	<0.001	<0.001	<1	<0.05
BGW16	7/02/2015	ME1500221027	1350	7.1	18	930	13.5	14.7	4.29	0.05	0	<0.001	512	<0.0001	80	<1	72	0	<0.001	0.001	<1	<0.05
BGW16	1/05/2015	ME1500659011	1340	7.2	13	1031	14.7	16.4	5.45	<<0.01	0	<0.001	586	<0.0001	91	<1	63	0	<0.001	0.001	<1	<0.05
BGW16	11/08/2015	ME1510328034	1400	7.1	10	981	0	0	0	0.02	0	<0.001	564	<0.0001	110	<1	46	0	<0.001	<0.001	<1	<0.05
BGW16	28/10/2015	ME1510717020	1460	7.1	6	1129	0	0	0	0.02	0	<0.001	642	<0.0001	112	<1	77	0	<0.001	<0.001	<1	<0.05
BGW16	25/02/2016	ME1600265038	1410	7.1	4	1028	14.6	17.2	8.4	0.07	0	<0.001	547	<0.0001	104	<1	80	0	<0.001	<0.001	<1	<0.05
BGW16	25/05/2016	ME1600733014	1320	7.5	4	1052	15.8	15.2	1.69	<<0.01	0	<0.001	607	<0.0001	76	<1	79	0	<0.001	<0.001	<1	<0.05
BGW16	7/09/2016	ME1601226059	1310	7	<1	1008	14.1	16.7	8.51	<<0.01	0	<0.001	584	<0.0001	106	<1	62	0	<0.001	<0.001	<1	<0.05
BGW16	21/12/2016	ME1601793035	1280	7	<1	944	13.4	15	5.59	<<0.01	0	<0.001	549	<0.0001	97	<1	57	0	<0.001	<0.001	<1	<0.05
BGW17	14/10/2013	ME1400079055	1580	7.8	27	1278	17.7	17.8	0.38	<0.01	0	0.002	814	<0.0001	22	<1	34	<0.001	<0.001	0.002	<1	<0.05
BGW17	8/01/2014	ME1400079014	1600	8.6	8	1264	16.9	18.7	4.78	<<0.01	0	0.003	696	<0.0001	8	88	32	<0.001	<0.001	0.003	<1	<0.05
BGW17	9/04/2014	ME1400540011	1470	8.3	5	1064	15	14.2	2.91	0.03	0	0.002	632	<0.0001	6	47	37	<0.001	<0.001	0.002	<1	0.07
BGW17	22/07/2014	ME1401051014	1690	7.5	<2	1452	20.1	20.2	0.19	<0.01	0	0.001	934	<0.0001	9	<1	35	<0.001	<0.001	0.001	<1	<0.05
BGW17	8/10/2014	ME1401512014	1680	7.7	2	1530	20.4	22.9	5.64	<<0.01	<0.001	<0.001	919	<0.0001	30	24	33	<0.001	<0.001	<0.001	<1	<0.05
BGW17	7/02/2015	ME1500221028	1480	7.7	7	1166	16.1	16.5	1.17	0.76	0	0.005	649	<0.0001	22	91	31	0	<0.001	0.001	<1	<0.05
BGW17	1/05/2015	ME1500659012	1540	8	5	1298	17.2	19.8	7.07	<0.01	0	0.006	798	<0.0001	31	<1	29	0	<0.001	0.002	<1	<0.05
BGW17	11/08/2015	ME1510328035	1700	7.6	7	1328	0	0	0	0.12	0	0.002	854	<0.0001	41	<1	26	0	<0.001	0.001	<1	<0.05
BGW17	28/10/2015	ME1510717021	1710	7.7	3	1369	0	0	0	0.1	0	0.002	889	<0.0001	33	<1	35	0	<0.001	<0.001	<1	0.1

Sample Location	Sampling Date	Sample Num	Electrical Conductivity @ 25°C µS/cm	pH Value pH Unit	Total Suspended Solids mg/L	TDS (mg/L) Calc	Total Anions meq/L	Total Cations meq/L	Ionic Balance %	Ammonia as N mg/L	Antimony - Dissolved mg/L	Arsenic - Dissolved mg/L	Bicarbonate Alkalinity as CaCO3 mg/L	Cadmium - Dissolved mg/L	Calcium - Dissolved mg/L	Carbonate Alkalinity as CaCO3 mg/L	Chloride mg/L	Chromium - Dissolved mg/L	Cobalt - Dissolved mg/L	Copper - Dissolved mg/L	Hydroxide Alkalinity as CaCO3 mg/L	Iron - Dissolved mg/L
BGW17	25/02/2016	ME1600265039	1620	8.9	<1	1214	16.1	18.6	7.24	<<0.01	0	0.003	606	<0.0001	10	130	37	0	<0.001	<0.001	<1	<0.05
BGW17	25/05/2016	ME1600733015	1610	7.9	2	1412	19.5	19.9	1.04	<<0.01	0	0.002	911	<0.0001	29	<1	35	0	<0.001	<0.001	<1	<0.05
BGW17	7/09/2016	ME1601226060	1620	7.6	2	1352	18.4	19.8	3.6	0.05	0	<0.001	854	<0.0001	39	<1	35	0	<0.001	<0.001	<1	<0.05
BGW17	21/12/2016	ME1601793036	1650	8	1	1297	17.6	19	3.65	0.02	0	0.001	766	<0.0001	36	51	34	0	<0.001	<0.001	<1	<0.05
BGW18	9/01/2014	ME1400079015	956	7.2	17	716	9.82	10.2	2.01	0.02	0	0.003	160	<0.0001	94	<1	19	<0.001	<0.001	<0.001	<1	0.35
BGW18	3/04/2014	ME1400540012	1050	7.2	21	792	11.7	12.5	3.17	0.1	0	<0.001	248	<0.0001	110	<1	20	<0.001	<0.001	<0.001	<1	0.1
BGW18	15/07/2014	ME1401051015	1030	7	6	858	11.9	11.2	3.18	0.2	0	<0.001	254	<0.0001	128	<1	14	<0.001	<0.001	<0.001	<1	0.08
BGW18	8/10/2014	ME1401512015	1140	6.9	25	877	12.4	11.7	2.64	0.18	<0.001	<0.001	213	<0.0001	138	<1	20	<0.001	<0.001	<0.001	<1	7.25
BGW18	6/02/2015	ME1500221029	1120	6.8	36	901	13.3	12.3	3.68	0.17	0	<0.001	182	<0.0001	130	<1	12	0	<0.001	0.001	<1	10.5
BGW18	30/04/2015	ME1500659013	1140	6.7	39	895	12.6	12.1	2.29	0.21	0	<0.001	176	<0.0001	146	<1	13	0	0.002	<0.001	<1	10.9
BGW18	11/08/2015	ME1510328036	1130	6.7	50	845	0	0	0	0.17	0	<0.001	165	<0.0001	145	<1	11	0	0.002	<0.001	<1	11.8
BGW18	27/10/2015	ME1510717022	1160	6.8	26	898	0	0	0	0.16	0	<0.001	185	<0.0001	152	<1	14	0	<0.001	<0.001	<1	10.9
BGW18	23/02/2016	ME1600265019	1140	6.6	24	925	13.2	12.4	2.97	0.18	0	<0.001	186	<0.0001	154	<1	13	0	<0.001	<0.001	<1	12
BGW18	25/05/2016	ME1600733016	1080	6.8	24	919	13.4	11.6	7.2	0.13	0	<0.001	198	<0.0001	145	<1	15	0	<0.001	<0.001	<1	10.3
BGW18	5/09/2016	ME1601226046	1160	6.7	16	906	12.9	12.5	1.54	0.14	0	<0.001	178	<0.0001	155	<1	14	0	<0.001	<0.001	<1	8.96
BGW18	21/12/2016	ME1601793037	1140	6.8	23	831	11.8	11.6	0.69	0.11	0	<0.001	162	<0.0001	146	<1	14	0	<0.001	<0.001	<1	8.54
BGW19	10/01/2014	ME1400079016	994	7	26	708	10.1	10.3	0.9	0.12	0	0.088	226	<0.0001	116	<1	11	<0.001	<0.001	0.002	<1	3.38
BGW19	9/04/2014	ME1400540013	1010	6.8	22	729	10.2	11.1	4	0.17	0	0.087	229	<0.0001	127	<1	11	<0.001	<0.001	<0.001	<1	4.17
BGW19	21/07/2014	ME1401051016	964	6.5	12	776	11.3	10.9	1.64	0.11	0	0.089	260	<0.0001	128	<1	12	<0.001	<0.001	<0.001	<1	4.43
BGW19	14/10/2014	ME1401512016	978	6.9	23	727	10.6	10.1	2.18	0.11	<0.001	0.093	254	<0.0001	116	<1	11	<0.001	<0.001	<0.001	<1	4.85
BGW19	8/02/2015	ME1500221030	944	6.7	40	723	10.5	10.3	0.99	0.06	0	0.094	219	<0.0001	120	<1	12	0	<0.001	<0.001	<1	4.66
BGW19	30/04/2015	ME1500659014	951	6.6	25	752	10.7	11.2	2.46	0.1	0	0.115	224	<0.0001	129	<1	12	0	<0.001	0.003	<1	5.86
BGW19	19/08/2015	ME1510328037	957	6.6	18	732	0	0	0	0.11	0	0.084	234	<0.0001	126	<1	11	0	<0.001	<0.001	<1	4.95
BGW19	28/10/2015	ME1510717023	980	6.7	14	731	0	0	0	0.12	0	0.091	236	<0.0001	120	<1	12	0	<0.001	<0.001	<1	4.69
BGW19	25/02/2016	ME1600265040	943	6.6	12	730	10.5	10.8	1.61	0.09	0	0.085	203	<0.0001	126	<1	13	0	<0.001	0.001	<1	4.9
BGW19	19/05/2016	ME1600733017	899	6.6	16	745	11	10.2	3.96	0.08	0	0.084	230	0.0002	120	<1	13	0	<0.001	<0.001	<1	4.9
BGW19	8/09/2016	ME1601226073	954	6.6	18	694	9.8	10.4	2.92	0.07	0	0.087	212	<0.0001	120	<1	12	0	<0.001	<0.001	<1	5.28
BGW19	19/12/2016	ME1601793004	957	6.6	17	684	9.86	9.75	0.58	0.09	0	0.086	222	<0.0001	116	<1	13	0	<0.001	<0.001	<1	5.29
BGW20	10/01/2014	ME1400079017	780	6	50	538	7.28	7.51	1.57	0.22	0	0.065	41	<0.0001	47	<1	15	<0.001	<0.001	0.001	<1	20.6
BGW20	9/04/2014	ME1400540014	832	6.1	18	553	7.81	7.8	0.03	0.15	0	0.066	45	<0.0001	48	<1	21	<0.001	<0.001	<0.001	<1	21.9
BGW20	21/07/2014	ME1401051017	744	6	18	578	8.07	7.69	2.4	<<0.01	0	<0.001	25	<0.0001	57	<1	16	<0.001	0.002	<0.001	<1	<0.05
BGW20	14/10/2014	ME1401512017	744	6.1	4	512	7.18	6.56	4.54	<<0.01	<0.001	<0.001	25	<0.0001	42	<1	17	<0.001	<0.001	<0.001	<1	<0.05
BGW20	8/02/2015	ME1500221031	745	5.9	16	536	7.76	7.65	0.7	<<0.01	0	<0.001	32	0.0001	48	<1	20	0	<0.001	0.004	<1	0.32
BGW20	29/04/2015	ME1500659015	739	5.9	8	483	7.41	6.25	8.44	0.04	0	<0.001	25	0.0001	46	<1	16	0	<0.001	<0.016	<1	0.06
BGW20	19/08/2015	ME1510328038	732	6.3	9	499	0	0	0	0.04	0	<0.001	26	<0.0001	45	<1	14	0	<0.001	0.001	<1	<0.05
BGW20	22/10/2015	ME1510717024	653	6.4	3	507	0	0	0	0.03	0	<0.001	27	<0.0001	46	<1	18	0	<0.001	<0.001	<1	<0.05
BGW20	22/02/2016	ME1600265005	760	5.9	12	521	7.41	6.44	6.98	1.02	0	<0.001	32	<0.0001	46	<1	20	0	<0.001	0.003	<1	0.06
BGW20	25/02/2016	ME1600265047	1350	8.7	9	863	14.1	14.1	0.16	<<0.01	0	0.002	112	<0.0001	32	13	227	0	<0.001	0.002	<1	<0.05
BGW20	18/05/2016	ME1600733018	755	6.1	25	464	6.68	6.11	4.44	0.11	0	<0.014	30	<0.0001	44	<1	20	0	<0.001	<0.001	<1	13.1
BGW20	1/09/2016	ME1601226024	750	6	6	542	7.96	6.24	12	<<0.01	0	<0.001	28	<0.0001	43	<1	18	0	<0.001	<0.001	<1	<0.05
BGW20	19/12/2016	ME1601793005	745	6	2	485	6.91	5.85	8.34	<<0.01	0	0.001	36	<0.0001	44	<1	18	0	<0.001	<0.001	<1	<0.05
BGW21	8/01/2014	ME1400079018	2650	7.3	2	2025	31.4	32.6	1.79	0.08	0	<0.001	627	<0.0001	222	<1	239	<0.001	<0.001	<0.018	<1	0.15
BGW21	8/04/2014	ME1400540015	2750	7.2	2	1942	30.5	31	0.73	<0.01	0	<0.001	577	<0.0001	220	<1	255	<0.001	<0.001	<0.001	<1	0.46
BGW21	10/07/2014	ME1401051018	2540	6.8	<2	2265	35.4	35.6	0.3	<<0.01	0	<0.001	723	<0.0001	251	<1	273	<0.001	<0.001	<0.012	<1	<0.05
BGW21	21/10/2014	ME1401512018	2640	7	<2	2138	34.7	31.1	5.53	0.02	<0.001	<0.001	722	<0.0001	222	<1	284	<0.001	<0.001	<0.011	<1	<0.05
BGW21	9/02/2015	ME1500221032	2560	7.1	5	2053	32.3	32.4	0.16	0.02	0	<0.001	628	<0.0001	226	<1	261	0	<0.001	0.024	<1	<0.05
BGW21	1/05/2015	ME1500659016	2600	7	4	2160	32.9	34.7	2.62	<<0.01	0	0.002	664	<0.0001	257	<1	253	0	<0.001	0.004	<1	0.76
BGW21	19/08/2015	ME1510328039	2730	6.9	<1	2075	0	0	0	0.03	0	<0.001	632	<0.0001	286	<1	208	0	<0.001	0.009	<1	<0.05
BGW21	28/10/2015	ME1510717025	2650	6.9	<1	1620	0	0	0	<<0.01	0	<0.001	692	<0.0001	253	<1	88	0	<0.001	0.009	<1	<0.05
BGW21	25/02/2016	ME1600265041	2420	7	<1	2107	33	33.7	1.06	<<0.01	0	<0.001	607	<0.0001	238	<1	257	0	<0.001	<0.014	<1	0.07

Sample Location	Sampling Date	Sample Num	Electrical Conductivity @ 25°C µS/cm	pH Value pH Unit	Total Suspended Solids mg/L	TDS (mg/L) Calc	Total Anions meq/L	Total Cations meq/L	Ionic Balance %	Ammonia as N mg/L	Antimony - Dissolved mg/L	Arsenic - Dissolved mg/L	Bicarbonate Alkalinity as CaCO3 mg/L	Cadmium - Dissolved mg/L	Calcium - Dissolved mg/L	Carbonate Alkalinity as CaCO3 mg/L	Chloride mg/L	Chromium - Dissolved mg/L	Cobalt - Dissolved mg/L	Copper - Dissolved mg/L	Hydroxide Alkalinity as CaCO3 mg/L	Iron - Dissolved mg/L
BGW21	25/05/2016	ME1600733019	2400	7	1	2205	34.9	32.8	3.2	<<0.01	0	<0.001	731	<0.0001	226	<1	247	0	<0.001	0.009	<1	0.07
BGW21	7/09/2016	ME1601226061	2690	7	<1	2187	34.4	33.8	0.86	<<0.01	0	<0.001	664	<0.0001	244	<1	252	0	<0.001	0.007	<1	0.07
BGW21	21/12/2016	ME1601793038	2690	7.1	1	2059	32.5	32.1	0.53	<<0.01	0	<0.001	645	<0.0001	240	<1	274	0	<0.001	0.008	<1	0.06
BGW24	9/01/2014	ME1400079020	2180	7.1	27	1413	22.4	23.5	2.46	0.05	0	<0.001	610	<0.0001	137	<1	329	<0.001	0.006	0.02	<1	<0.05
BGW24	8/04/2014	ME1400540017	1780	7	20	1126	17.7	18.2	1.4	0.61	0	<0.001	545	<0.0001	121	<1	210	<0.001	0.003	0.026	<1	<0.05
BGW24	8/07/2014	ME1401051020	2330	6.8	17	1669	27.6	25.8	3.52	0.02	0	<0.001	719	<0.0001	164	<1	443	<0.001	0.004	0.02	<1	<0.05
BGW24	21/10/2014	ME1401512020	2420	6.9	17	1762	28.8	28.4	0.59	0.03	<0.001	<0.001	710	<0.0001	156	<1	476	<0.001	0.004	0.026	<1	<0.05
BGW24	9/02/2015	ME1500221034	2330	6.9	24	1561	25.4	26.1	1.31	0.04	0	<0.001	601	<0.0001	160	<1	432	0	0.004	0.023	<1	<0.05
BGW24	1/05/2015	ME1500659018	2400	6.9	24	1660	26.2	28.7	4.5	<<0.01	0	<0.001	658	<0.0001	178	<1	422	0	0.003	0.025	<1	<0.05
BGW24	19/08/2015	ME1510328040	2070	6.8	23	1326	0	0	0	0.77	0	<0.001	580	<0.0001	177	<1	281	0	0.004	<0.017	<1	0.11
BGW24	28/10/2015	ME1510717026	2470	6.9	6	1604	0	0	0	<<0.01	0	<0.001	688	<0.0001	163	<1	412	0	0.003	0.031	<1	<0.05
BGW24	25/02/2016	ME1600265042	2310	6.9	8	1622	26	28.3	4.24	<<0.01	0	<0.001	594	<0.0001	179	<1	461	0	0.003	0.033	<1	<0.05
BGW24	25/05/2016	ME1600733020	2330	6.9	12	1783	28.6	29.3	1.1	<<0.01	0	<0.001	745	0.0002	172	<1	449	0	0.002	0.033	<1	<0.05
BGW24	7/09/2016	ME1601226062	1120	6.9	5	742	11	13.1	8.64	<<0.01	0	<0.001	368	<0.0001	101	<1	112	0	<0.001	0.028	<1	<0.05
BGW26	8/01/2014	ME1400079022	1610	7	2	1051	16.6	17.6	2.79	0.04	0	<0.001	390	<0.0001	54	<1	198	<0.001	<0.001	0.007	<1	<0.05
BGW26	2/04/2014	ME1400540019	1640	6.9	10	1052	17	17.2	0.81	0.02	0	<0.001	380	<0.0001	56	<1	214	<0.001	<0.001	0.008	<1	<0.05
BGW26	23/07/2014	ME1401051022	1640	6.5	4	1177	19.4	17.8	4.15	0.02	0	<0.001	449	<0.0001	62	<1	228	<0.001	<0.001	0.024	<1	<0.05
BGW26	8/10/2014	ME1401512022	1600	7	2	1086	18.1	16.2	5.5	<0.01	<0.001	<0.001	420	<0.0001	52	<1	220	<0.001	<0.001	<0.012	<1	<0.05
BGW26	5/02/2015	ME1500221036	1630	6.9	5	1094	17.7	17.6	0.24	0.02	0	<0.001	394	<0.0001	59	<1	220	0	<0.001	0.007	<1	<0.05
BGW26	1/05/2015	ME1500659020	1670	6.8	2	1155	18.2	19.7	3.75	<<0.01	0	<0.001	414	<0.0001	66	<1	224	0	<0.001	0.006	<1	<0.05
BGW26	11/08/2015	ME1510328041	1700	6.7	1	1163	0	0	0	0.05	0	<0.001	462	<0.0001	63	<1	188	0	<0.001	0.003	<1	<0.05
BGW26	28/10/2015	ME1510717027	1650	7	<1	1108	0	0	0	0.02	0	<0.001	418	<0.0001	57	<1	210	0	<0.001	0.006	<1	<0.05
BGW26	25/02/2016	ME1600265043	1580	7.3	<1	1112	17.7	18.8	2.81	<<0.01	0	<0.001	358	<0.0001	61	<1	225	0	<0.001	0.004	<1	<0.05
BGW26	25/05/2016	ME1600733021	1640	6.8	<1	1185	19.4	18.1	3.51	<<0.01	0	<0.001	449	0.0042	58	<1	223	0	<0.001	0.005	<1	<0.05
BGW26	7/09/2016	ME1601226063	1640	7.1	<1	1143	18.2	18.8	1.75	<<0.01	0	<0.001	399	<0.0001	63	<1	218	0	<0.001	0.001	<1	<0.05
BGW27	19/08/2015	ME1510328042	477	6.8	23	324	0	0	0	0.04	0	<0.01	130	<0.0001	33	<1	9	0	<0.001	<0.001	<1	1.86
BGW27	22/10/2015	ME1510717028	486	7.4	24	345	0	0	0	0.03	0	0.008	144	<0.0001	36	<1	11	0	<0.001	<0.001	<1	1.65
BGW27	22/02/2016	ME1600265006	518	6.6	21	338	4.72	5.22	5.05	0.04	0	<0.015	129	<0.0001	34	<1	14	0	<0.001	<0.001	<1	2.56
BGW27	18/05/2016	ME1600733022	452	7.4	47	313	4.6	4.29	3.49	<<0.01	0	<0.011	132	<0.0001	27	<1	12	0	<0.001	<0.001	<1	2.28
BGW27	1/09/2016	ME1601226025	494	6.7	18	345	4.93	4.92	0.19	0.08	0	<0.012	146	<0.0001	32	<1	11	0	<0.001	<0.001	<1	2.64
BGW27	19/12/2016	ME1601793006	479	6.8	10	304	4.4	4.35	0.49	0.03	0	<0.01	127	<0.0001	30	<1	12	0	<0.001	<0.001	<1	1.76
BGW27A	10/01/2014	ME1400079023	288	6.2	54	182	2.53	2.31	4.55	<<0.01	0	0.077	55	0.0001	8	<1	10	<0.001	0.026	0.008	<1	9.87
BGW27A	9/04/2014	ME1400540020	312	5.9	24	189	2.59	2.52		0.06	0	0.075	52	<0.0001	9	<1	10	<0.001	0.023	0.001	<1	10.8
BGW27A	21/07/2014	ME1401051023	299	5.9	39	196	2.82	2.4		0.02	0	0.063	57	<0.0001	9	<1	11	<0.001	0.022	<0.001	<1	10.1
BGW27A	14/10/2014	ME1401512023	283	6.2	54	212	3.04	2.74		<<0.01	<0.001	0.07	51	<0.0001	10	<1	20	<0.001	0.025	<0.001	<1	12.5
BGW27A	8/02/2015	ME1500221037	302	5.9	52	187	2.67	2.38		<<0.01	0	0.056	42	0.0001	9	<1	11	0	0.026	0.001	<1	9.93
BGW27A	29/04/2015	ME1500659021	307	5.8	60	197	2.73	2.71		0.02	0	0.056	39	<0.0001	10	<1	10	0	0.024	<0.001	<1	11.3
BGW27A	19/08/2015	ME1510328043	310	6	18	194	0	0	0	0.02	0	0.044	48	<0.0001	9	<1	9	0	0.02	<0.001	<1	9.78
BGW27A	22/10/2015	ME1510717029	285	6	37	111	0	0	0	0.06	0	0.06	22	<0.0001	9	<1	3	0	0.023	<0.001	<1	11.8
BGW27A	22/02/2016	ME1600265007	313	6	34	188	2.69	2.4	0	0.03	0	0.042	52	<0.0001	8	<1	12	0	0.022	<0.001	<1	9.48
BGW27A	18/05/2016	ME1600733023	295	6.1	32	175	2.34	2.38	0.74	<<0.01	0	0.064	52	<0.0001	8	<1	10	0	0.022	<0.001	<1	13
BGW27A	1/09/2016	ME1601226026	305	5.9	21	193	2.78	2.28	0	0.11	0	0.049	57	<0.0001	8	<1	11	0	0.021	<0.001	<1	11.2
BGW27A	19/12/2016	ME1601793007	283	6	17	169	2.5	2.29	0	<<0.01	0	<0.013	52	<0.0001	8	<1	12	0	<0.017	0.004	<1	2.99
BGW28	1/09/2016	ME1601226027	188	5.8	14	101	1.49	1.55	0	0.04	0	<0.001	14	0.0004	6	<1	17	0	<0.001	0.008	<1	0.07
BGW29	9/01/2014	ME1400079024	480	7.2	670	299	4.61	4.56	0.5	<<0.01	0	<0.001	110	<0.0001	29	<1	4	<0.001	<0.001	<0.001	<1	<0.05
BGW29	2/04/2014	ME1400540021	573	6.8	242	310	5.44	5.66	1.96	0.02	0	<0.001	59	<0.0001	39	<1	4	<0.001	<0.001	<0.001	<1	<0.05
BGW29	15/07/2014	ME1401051024	618	6.7	466	433	6.27	6.43	1.2	<0.01	0	<0.001	116	<0.0001	46	<1	3	<0.001	<0.001	0.001	<1	<0.05
BGW29	8/10/2014	ME1401512024	626	6.9	1162	429	6.31	6.26	0.4	<0.01	<0.001	<0.001	128	<0.0001	43	<1	4	<0.001	<0.001	<0.001	<1	<0.05
BGW29	6/02/2015	ME1500221038	593	7	47	398	5.8	5.92	1.04	0.02	0	<0.001	120	<0.0001	45	<1	4	0	<0.001	0.005	<1	<0.05
BGW29	30/04/2015	ME1500659022	472	6.7	227	328	4.59	5.2	6.18	0.03	0	<0.001	75	<0.0001	36	<1	2	0	<0.001	0.006	<1	<0.05

Sample Location	Sampling Date	Sample Num	Electrical Conductivity @ 25°C µS/cm	pH Value pH Unit	Total Suspended Solids mg/L	TDS (mg/L) Calc	Total Anions meq/L	Total Cations meq/L	Ionic Balance %	Ammonia as N mg/L	Antimony - Dissolved mg/L	Arsenic - Dissolved mg/L	Bicarbonate Alkalinity as CaCO3 mg/L	Cadmium - Dissolved mg/L	Calcium - Dissolved mg/L	Carbonate Alkalinity as CaCO3 mg/L	Chloride mg/L	Chromium - Dissolved mg/L	Cobalt - Dissolved mg/L	Copper - Dissolved mg/L	Hydroxide Alkalinity as CaCO3 mg/L	Iron - Dissolved mg/L
BGW29	11/08/2015	ME1510328044	211	6.7	3	151	0	0	0	0.05	0	<0.001	70	<0.0001	12	<1	2	0	<0.001	0.002	<1	<0.05
BGW29	27/10/2015	ME1510717030	284	6.9	229	201	0	0	0	0.03	0	<0.001	94	<0.0001	18	<1	6	0	<0.001	0.002	<1	<0.05
BGW29	23/02/2016	ME1600265020	250	7.1	7	159	2.19	2.49	0	0.02	0	<0.001	59	<0.0001	14	<1	5	0	<0.001	0.001	<1	<0.05
BGW29	25/05/2016	ME1600733024	325	6.7	57	214	3.14	3.04	1.67	<<0.01	0	<0.001	82	0.0002	20	<1	6	0	<0.001	0.001	<1	<0.05
BGW29	5/09/2016	ME1601226047	167	7.1	5	119	1.7	1.66	0	<<0.01	0	<0.001	58	<0.0001	10	<1	3	0	<0.001	0.002	<1	<0.05
BGW29	21/12/2016	ME1601793039	194	7.2	2	129	1.8	1.94	3.7	<<0.01	0	<0.001	79	<0.0001	14	<1	2	0	<0.001	0.002	<1	<0.05
BGW32	9/01/2014	ME1400079026	3080	7.2	<2	1870	30.3	32.1	2.87	<<0.01	0	<0.001	692	0.0002	194	<1	566	<0.001	<0.001	0.053	<1	0.57
BGW32	8/04/2014	ME1400540023	3110	7	5	1842	30.5	30.8	0.41	0.02	0	<0.001	665	<0.0001	202	<1	592	<0.001	<0.001	0.082	<1	<0.05
BGW33	9/01/2014	ME1400079027	1280	8.1	7	897	13.2	14.5	4.7	0.07	0	<0.001	508	<0.0001	60	28	80	0.002	<0.001	0.021	<1	<0.05
BGW33	8/07/2014	ME1401051026	633	8.4	<2	465	7.02	7.1	0.55	<<0.01	0	0.001	259	<0.0001	25	26	41	0.003	<0.001	0.004	<1	<0.05
BGW33	25/02/2016	ME1600265044	849	7.9	<1	590	8.56	10.3	9.28	<<0.01	0	<0.001	346	<0.0001	52	<1	47	0	<0.001	0.007	<1	<0.05
BGW35	8/04/2014	ME1400540024	2900	7	2	1837	30.1	31	1.38	0.12	0	<0.001	518	<0.0001	266	<1	503	<0.001	<0.001	0.005	<1	<0.05
BGW35	12/07/2014	ME1401051027	2710	7	<2	1964	33.1	30.7	3.87	<<0.01	0	<0.001	600	<0.0001	251	<1	546	<0.001	<0.001	<0.01	<1	<0.05
BGW35	13/10/2014	ME1401512026	2870	7	2	1919	31.9	30.9	1.6	<0.01	<0.001	<0.001	611	<0.0001	259	<1	506	<0.001	<0.001	0.004	<1	<0.05
BGW35	8/02/2015	ME1500221039	2820	6.8	3	1816	30.3	30.4	0.18	0.03	0	<0.001	451	<0.0001	264	<1	545	0	<0.001	0.008	<1	<0.05
BGW35	1/05/2015	ME1500659023	2910	6.8	4	1985	32	34	3.02	<<0.01	0	<0.001	539	<0.0001	311	<1	531	0	<0.001	0.002	<1	<0.05
BGW35	19/08/2015	ME1510328045	2910	6.8	4	1942	0	0	0	0.04	0	<0.001	508	<0.0001	351	<1	482	0	<0.001	0.08	<1	<0.05
BGW35	28/10/2015	ME1510717031	2890	6.8	<1	1921	0	0	0	0.03	0	<0.001	550	<0.0001	310	<1	492	0	<0.001	<0.018	<1	<0.05
BGW35	25/02/2016	ME1600265045	2620	7	15	1975	32.5	33.8	1.9	<<0.01	0	<0.001	487	<0.0001	305	<1	566	0	<0.001	0.002	<1	<0.05
BGW35	25/05/2016	ME1600733025	2590	6.8	2	1920	31.5	31.6	0.22	<<0.01	0	<0.001	615	<0.0001	274	<1	497	0	<0.001	0.003	<1	<0.05
BGW35	7/09/2016	ME1601226064	2940	6.9	2	1951	32.1	32.1	0.04	<<0.01	0	<0.001	562	<0.0001	276	<1	509	0	<0.001	0.002	<1	<0.05
BGW35	21/12/2016	ME1601793040	3660	7	<1	2398	40.5	39.3	1.46	<<0.01	0	<0.001	613	<0.0001	304	<1	738	0	<0.001	0.003	<1	<0.05
BGW36	7/01/2014	ME1400079028	1230	8	3	892	13.7	13.9	0.55	0.14	0	<0.001	509	0.0002	36	24	84	<0.001	<0.001	<0.011	<1	<0.05
BGW36	7/04/2014	ME1400540025	1170	7.8	5	784	12	12.6	2.37	0.02	0	<0.001	447	0.0002	21	<1	86	<0.001	<0.001	0.046	<1	<0.05
BGW36	23/07/2014	ME1401051028	1240	7.8	<2	958	14.9	14.3	2.24	0.09	0	<0.001	590	0.0011	39	<1	87	<0.001	0.001	0.009	<1	<0.05
BGW36	14/10/2014	ME1401512027	1200	8	2	902	14.3	12.9	5.16	<0.01	<0.001	<0.001	514	<0.0001	25	35	95	<0.001	<0.001	0.006	<1	<0.05
BGW36	4/02/2015	ME1500221040	1360	8.6	103	973	15.5	12.7	10	0.06	0	0.001	537	0.0001	6	104	73	0	<0.001	0.004	<1	<0.05
BGW36	29/04/2015	ME1500659024	1270	7.7	6	970	14	15.8	5.93	<<0.01	0	<0.001	582	<0.0001	43	<1	58	0	<0.001	0.005	<1	<0.05
BGW36	18/08/2015	ME1510328046	1160	8.3	8	823	0	0	0	0.03	0	<0.001	469	<0.0001	19	32	51	0	<0.001	0.002	<1	<0.05
BGW36	22/10/2015	ME1510717032	1120	8.4	4	878	0	0	0	<<0.01	0	0.001	429	<0.0001	6	102	60	0	<0.001	0.002	<1	<0.05
BGW36	24/02/2016	ME1600265034	1100	8.5	6	836	12.4	13.5	4.4	<<0.01	0	<0.001	451	<0.0001	9	48	63	0	<0.001	0.002	<1	<0.05
BGW36	27/05/2016	ME1600733026	1220	8	<1	976	14.3	15.4	3.65	<<0.01	0	<0.001	596	<0.0001	30	<1	65	0	<0.001	<0.001	<1	<0.05
BGW36	5/09/2016	ME1601226048	1150	8.4	1	844	12.4	13.6	4.53	0.03	0	<0.001	460	<0.0001	13	37	66	0	<0.001	0.001	<1	<0.05
BGW36	20/12/2016	ME1601793022	1100	7.6	<1	790	12	12	0.4	<<0.01	0	<0.001	532	0.0001	70	<1	36	0	<0.001	0.004	<1	<0.05
BGW37	9/01/2014	ME1400079029	2590	7.1	5	1672	26.9	28.3	2.64	<<0.01	0	<0.001	490	<0.0001	229	<1	426	<0.001	<0.001	<0.01	<1	<0.05
BGW37	8/04/2014	ME1400540026	2720	6.9	3	1736	28	29.6	2.83	0.02	0	<0.001	485	0.0001	253	<1	449	<0.001	<0.001	0.022	<1	<0.05
BGW37	8/07/2014	ME1401051029	2670	6.8	3	1996	32.8	31.1	2.75	<<0.01	0	<0.001	604	<0.0001	263	<1	466	<0.001	<0.001	0.07	<1	<0.05
BGW37	21/10/2014	ME1401512028	2830	6.9	2	1944	31.9	30.8	1.84	0.02	<0.001	<0.001	601	<0.0001	266	<1	460	<0.001	<0.001	0.065	<1	<0.05
BGW38	9/01/2014	ME1400079030	2390	7.2	105	2077	31.3	30.4	1.43	0.43	0	0.002	383	<0.0001	295	<1	12	<0.001	0.004	0.002	<1	0.27
BGW38	2/04/2014	ME1400540027	2420	7.2	123	2035	29.8	31.9	3.38	0.46	0	0.001	390	0.0001	313	<1	12	<0.001	0.004	0.001	<1	0.18
BGW38	15/07/2014	ME1401051030	2380	6.7	2	2262	34.1	32.9	1.71	0.48	0	0.002	436	0.0002	324	<1	13	<0.001	0.004	<0.001	<1	0.36
BGW38	8/10/2014	ME1401512029	2470	7.1	187	2066	30.8	31.2	0.56	0.49	<0.001	0.002	433	0.0001	308	<1	26	<0.001	0.005	<0.001	<1	0.66
BGW38	6/02/2015	ME1500221041	2380	7	231	2228	34.2	31.3	4.48	0.46	0	0.004	396	<0.0001	309	<1	26	0	0.005	0.001	<1	0.12
BGW38	30/04/2015	ME1500659025	2500	7	240	2301	33.6	36.2	3.79	0.52	0	<0.016	400	0.0001	361	<1	13	0	0.008	0.006	<1	4.76
BGW38	11/08/2015	ME1510328047	2500	7.1	34	2518	0	0	0	0.51	0	0.003	454	<0.0001	400	<1	11	0	0.003	<0.001	<1	0.71
BGW38	27/10/2015	ME1510717033	2510	7.1	164	2322	0	0	0	0.55	0	0.002	427	<0.0001	356	<1	12	0	0.003	<0.001	<1	0.37
BGW38	23/02/2016	ME1600265021	2430	7	106	2562	39.3	36.1	4.24	0.46	0	0.002	427	<0.0001	363	<1	12	0	0.004	<0.001	<1	0.46
BGW38	25/05/2016	ME1600733027	2330	6.8	40	2478	38.2	34.4	5.3	0.39	0	0.002	436	<0.0001	345	<1	13	0	0.002	<0.001	<1	0.71
BGW38	5/09/2016	ME1601226049	944	7	56	727	10.8	10.9	0.77	<<0.01	0	<0.001	126	<0.0001	111	<1	3	0	<0.001	0.001	<1	<0.05
BGW38	21/12/2016	ME1601793041	1110	7.3	60	818	12.2	12.3	0.56	<<0.01	0	<0.001	124	<0.0001	133	<1	3	0	<0.001	0.001	<1	<0.05

Sample Location	Sampling Date	Sample Num	Electrical Conductivity @ 25°C µS/cm	pH Value pH Unit	Total Suspended Solids mg/L	TDS (mg/L) Calc	Total Anions meq/L	Total Cations meq/L	Ionic Balance %	Ammonia as N mg/L	Antimony - Dissolved mg/L	Arsenic - Dissolved mg/L	Bicarbonate Alkalinity as CaCO3 mg/L	Cadmium - Dissolved mg/L	Calcium - Dissolved mg/L	Carbonate Alkalinity as CaCO3 mg/L	Chloride mg/L	Chromium - Dissolved mg/L	Cobalt - Dissolved mg/L	Copper - Dissolved mg/L	Hydroxide Alkalinity as CaCO3 mg/L	Iron - Dissolved mg/L
BGW39	9/01/2014	ME1400079031	1320	7.3	8	972	14.4	14.9	1.74	0.04	0	<0.001	582	<0.0001	102	<1	55	<0.001	<0.001	0.002	<1	<0.05
BGW39	3/04/2014	ME1400540028	1290	7.3	4	906	13.3	14.7	5.19	0.06	0	<0.001	507	<0.0001	99	<1	61	<0.001	<0.001	<0.001	<1	0.26
BGW39	13/07/2014	ME1401051031	1260	7	163	1022	15.4	15	1.47	<0.01	0	<0.001	611	<0.0001	102	<1	58	<0.001	<0.001	0.001	<1	0.23
BGW39	21/10/2014	ME1401512030	1250	7.2	6	996	15.5	13.8	5.82	<<0.01	<0.001	<0.001	609	<0.0001	90	<1	68	<0.001	<0.001	<0.001	<1	<0.05
BGW39	6/02/2015	ME1500221042	1250	7.3	12	957	14.5	14.3	0.6	0.03	0	<0.001	566	<0.0001	94	<1	61	0	<0.001	0.002	<1	<0.05
BGW39	1/05/2015	ME1500659026	1270	7.3	6	974	14.2	15.8	5.55	0.02	0	<0.001	564	<0.0001	106	<1	48	0	<0.001	0.005	<1	<0.05
BGW39	19/08/2015	ME1510328048	1220	7.2	12	883	0	0	0	0.03	0	<0.001	498	<0.0001	96	<1	45	0	<0.001	0.002	<1	<0.05
BGW39	27/10/2015	ME1510717034	1230	7.3	2	959	0	0	0	0.03	0	<0.001	581	<0.0001	99	<1	54	0	<0.001	<0.001	<1	<0.05
BGW39	24/02/2016	ME1600265035	1190	7.4	4	971	14.3	15.1	2.47	<<0.01	0	<0.001	577	<0.0001	100	<1	49	0	<0.001	<0.001	<1	<0.05
BGW39	25/05/2016	ME1600733028	1170	7.2	4	963	15	13.1	6.87	<<0.01	0	<0.001	604	<0.0001	89	<1	54	0	<0.001	<0.001	<1	<0.05
BGW39	8/09/2016	ME1601226074	1100	7.2	2	804	11.6	13.1	6.16	<<0.01	0	<0.001	480	<0.0001	101	<1	38	0	<0.001	<0.001	<1	<0.05
BGW39	21/12/2016	ME1601793042	1080	7.7	2	784	11.6	12.1	1.96	<<0.01	0	<0.001	460	<0.0001	74	10	43	0	<0.001	<0.001	<1	<0.05
BGW40	6/01/2014	ME1400079032	931	5.9	100	737	10.5	10	2.34	0.25	0	0.002	52	<0.0001	27	<1	58	<0.001	0.082	0.001	<1	126
BGW40	4/04/2014	ME1400540029	888	5.7	48	696	9.7	10.4	3.31	0.54	0	0.002	64	<0.0001	22	<1	62	<0.001	0.02	<0.001	<1	144
BGW40	18/07/2014	ME1401051032	1040	5.4	13	773	11.5	13.3	7.1	0.17	0	0.005	45	<0.0001	9	<1	68	0.001	0.135	<0.001	<1	140
BGW40	9/10/2014	ME1401512031	1030	5.4	37	750	10.9	13.8	11.8	0.2	<0.001	0.006	15	<0.0001	9	<1	76	0.003	0.187	<0.001	<1	150
BGW40	7/02/2015	ME1500221043	1030	5.4	28	809	12.4	13.8	5.29	0.15	0	0.007	25	<0.0001	8	<1	70	0	0.176	<0.001	<1	142
BGW40	30/04/2015	ME1500659027	1020	5.3	31	771	11.1	14.2	12.3	0.22	0	0.008	12	<0.0001	10	<1	55	0	0.177	0.003	<1	148
BGW40	14/08/2015	ME1510328049	1030	5.3	61	761	0	0	0	0.18	0	0.005	24	<0.0001	10	<1	49	0	0.159	<0.001	<1	146
BGW40	21/10/2015	ME1510717035	1030	5.2	59	732	0	0	0	0.19	0	0.005	10	<0.0001	13	<1	63	0	0.172	<0.001	<1	126
BGW40	22/02/2016	ME1600265008	1060	5.4	12	829	12	14.7	9.98	0.19	0	0.007	32	<0.0001	11	<1	63	0	0.185	0.002	<1	165
BGW40	19/05/2016	ME1600733029	992	5.3	34	771	11.4	13.3	7.72	0.2	0	0.005	24	<0.0001	10	<1	65	0	0.164	<0.001	<1	147
BGW40	1/09/2016	ME1601226028	1060	5.2	30	769	11.5	12.9	5.57	0.29	0	0.003	9	<0.0001	12	<1	66	0	0.168	0.008	<1	128
BGW40	20/12/2016	ME1601793023	1060	5.4	16	767	11.2	12.6	5.69	<0.10	0	0.005	24	<0.0001	9	<1	64	0	0.178	<0.001	<1	157
BGW41	4/04/2014	ME1400540030	1140	7.6	24	783	10.9	11.1	1.06	0.42	0	0.007	466	<0.0001	20	<1	44	<0.001	<0.001	<0.001	<1	0.37
BGW41	18/07/2014	ME1401051033	1240	7.2	8	991	14.1	13.3	3.13	0.16	0	0.008	625	<0.0001	24	<1	50	<0.001	<0.001	<0.001	<1	0.53
BGW41	9/10/2014	ME1401512032	1240	7.5	16	999	14.2	13.5	2.43	0.19	<0.001	0.008	629	<0.0001	20	<1	45	<0.001	<0.001	<0.001	<1	0.34
BGW41	7/02/2015	ME1500221044	1300	7.2	21	983	14.1	13.5	2.23	0.1	0	<0.011	592	<0.0001	29	<1	51	0	<0.001	0.001	<1	0.94
BGW41	30/04/2015	ME1500659028	1260	7.2	32	1010	13.8	15.2	4.93	0.1	0	<0.01	580	<0.0001	33	<1	42	0	<0.001	0.002	<1	0.92
BGW41	14/08/2015	ME1510328052	1260	7.2	32	921	0	0	0	0.2	0	0.008	536	<0.0001	32	<1	37	0	0.002	<0.001	<1	2.35
BGW41	21/10/2015	ME1510717036	1310	7.2	30	946	0	0	0	0.16	0	0.007	518	<0.0001	32	<1	53	0	<0.001	<0.001	<1	0.99
BGW41	22/02/2016	ME1600265009	1310	7.1	11	936	12.9	14.1	4.65	0.13	0	0.003	520	<0.0001	34	<1	47	0	0.001	<0.011	<1	0.66
BGW41	19/05/2016	ME1600733030	1300	6.9	8	1101	15.1	16.8	5.46	0.07	0	0.002	608	<0.0001	34	<1	54	0	<0.001	<0.001	<1	0.37
BGW41	1/09/2016	ME1601226029	1290	7.2	9	1061	15.2	14.6	1.96	0.04	0	0.002	616	<0.0001	39	<1	47	0	0.001	<0.001	<1	0.81
BGW41	20/12/2016	ME1601793024	1360	7	11	970	13.8	14	0.91	<<0.01	0	0.002	530	<0.0001	41	<1	52	0	<0.001	<0.001	<1	<0.05
BGW42	6/01/2014	ME1400079033	892	6.3	30	603	9.13	8.84	1.68	0.14	0	0.025	131	0.0001	55	<1	48	<0.001	<0.011	0.002	<1	16.5
BGW42	4/04/2014	ME1400540031	874	6.3	35	612	9.15	9.24	0.46	0.14	0	0.021	138	<0.0001	59	<1	51	<0.001	0.009	<0.001	<1	16.3
BGW42	18/07/2014	ME1401051034	877	6	10	648	9.88	9.58	1.52	0.08	0	<0.018	136	<0.0001	63	<1	62	0.001	0.008	<0.001	<1	14
BGW42	9/10/2014	ME1401512033	888	6.3	66	634	9.48	9.89	2.11	0.13	<0.001	0.02	130	<0.0001	63	<1	61	<0.001	<0.01	<0.001	<1	16.1
BGW42	7/02/2015	ME1500221045	922	6.1	48	657	10.3	11.2	4.26	0.24	0	0.02	126	<0.0001	60	<1	56	0	<0.01	0.002	<1	14.6
BGW42	30/04/2015	ME1500659029	902	6.1	23	650	9.65	10.1	2.45	0.08	0	<0.017	126	<0.0001	66	<1	44	0	0.009	<0.001	<1	15.5
BGW42	11/08/2015	ME1510328051	925	6.2	14	591	0	0	0	0.1	0	<0.016	134	<0.0001	64	<1	34	0	0.008	0.001	<1	15.9
BGW42	27/10/2015	ME1510717037	927	5.9	28	660	0	0	0	0.12	0	<0.019	132	<0.0001	65	<1	50	0	0.008	<0.001	<1	15.3
BGW42	23/02/2016	ME1600265022	917	6.2	7	686	10.4	10.1	1.76	0.13	0	<0.016	139	<0.0001	68	<1	44	0	0.009	<0.001	<1	13.9
BGW42	19/05/2016	ME1600733031	917	6.1	20	665	10.2	9.76	2.03	0.09	0	<0.012	138	<0.0001	65	<1	48	0	0.007	<0.001	<1	13.5
BGW42	6/09/2016	ME1601226065	974	6.1	9	715	10.9	10.4	2.66	0.19	0	<0.014	144	<0.0001	69	<1	48	0	0.008	<0.001	<1	15.4
BGW42	20/12/2016	ME1601793025	981	6.1	12	676	10.5	9.57	4.5	0.13	0	<0.015	120	<0.0001	67	<1	53	0	0.008	<0.001	<1	15.1
BGW43	6/01/2014	ME1400079034	1710	6.9	31	821	12.4	12	1.74	0.22	0	<0.001	194	<0.0001	122	<1	32	<0.001	0.004	<0.001	<1	4.48
BGW43	4/04/2014	ME1400540032	1380	6.8	18	1029	15	16.6	4.93	0.24	0	<0.001	220	<0.0001	171	<1	46	<0.001	0.004	<0.001	<1	4.99
BGW43	18/07/2014	ME1401051035	1330	6.4	10	1082	15.8	17.3	4.48	0.2	0	<0.001	249	<0.0001	180	<1	49	<0.001	0.006	<0.001	<1	5.65

Sample Location	Sampling Date	Sample Num	Electrical Conductivity @ 25°C µS/cm	pH Value pH Unit	Total Suspended Solids mg/L	TDS (mg/L) Calc	Total Anions meq/L	Total Cations meq/L	Ionic Balance %	Ammonia as N mg/L	Antimony - Dissolved mg/L	Arsenic - Dissolved mg/L	Bicarbonate Alkalinity as CaCO3 mg/L	Cadmium - Dissolved mg/L	Calcium - Dissolved mg/L	Carbonate Alkalinity as CaCO3 mg/L	Chloride mg/L	Chromium - Dissolved mg/L	Cobalt - Dissolved mg/L	Copper - Dissolved mg/L	Hydroxide Alkalinity as CaCO3 mg/L	Iron - Dissolved mg/L
BGW43	9/10/2014	ME1401512034	1360	6.6	25	1051	15.6	16.5	2.95	0.22	<0.001	<0.001	240	<0.0001	167	<1	54	<0.001	0.005	<0.001	<1	5.32
BGW43	8/02/2015	ME1500221046	1360	6.5	24	1048	16.2	15	3.83	0.2	0	0.001	208	<0.0001	150	<1	50	0	0.006	<0.001	<1	5.16
BGW43	30/04/2015	ME1500659030	1270	6.5	24	1037	15	17.1	6.52	0.25	0	<0.001	209	<0.0001	172	<1	38	0	0.005	<0.001	<1	4.75
BGW43	14/08/2015	ME1510328050	1340	6.4	34	1016	0	0	0	0.25	0	<0.001	198	<0.0001	182	<1	35	0	0.005	<0.001	<1	4.2
BGW43	21/10/2015	ME1510717038	1340	6.4	18	1014	0	0	0	0.24	0	<0.001	207	<0.0001	157	<1	44	0	0.005	<0.001	<1	4.15
BGW43	22/02/2016	ME1600265010	1360	6.4	9	1018	15	16	3.16	0.39	0	<0.001	194	<0.0001	176	<1	44	0	0.006	<0.001	<1	4.11
BGW43	19/05/2016	ME1600733032	1290	6.4	8	1115	17.4	15.4	6.13	0.26	0	<0.001	234	0.0002	154	<1	44	0	0.004	<0.001	<1	4.1
BGW43	1/09/2016	ME1601226030	1390	6.4	18	1176	18.2	16.4	5.1	0.34	0	<0.001	235	<0.0001	169	<1	44	0	0.005	<0.001	<1	5.08
BGW43	20/12/2016	ME1601793026	1430	6.4	20	1147	17.8	16	5.25	0.23	0	0.002	204	<0.0001	171	<1	48	0	0.005	<0.001	<1	4.24
BGW44	6/01/2014	ME1400079035	1770	7.2	6	1193	18	18.8	2.12	<<0.01	0	<0.001	474	<0.0001	64	<1	176	<0.001	<0.001	<0.001	<1	0.08
BGW44	2/04/2014	ME1400540033	1730	7.1	7	1160	18.2	17.4	2.19	0.15	0	<0.001	457	<0.0001	60	<1	194	<0.001	0.002	<0.001	<1	0.11
BGW44	18/07/2014	ME1401051036	1710	7.1	9	1296	20.2	19.4	2.09	<<0.01	0	<0.001	538	<0.0001	76	<1	204	<0.001	<0.001	<0.001	<1	<0.05
BGW44	9/10/2014	ME1401512035	1750	7.3	<2	1242	19.7	17.9	4.93	<0.01	<0.001	<0.001	540	<0.0001	72	<1	196	<0.001	<0.001	<0.001	<1	<0.05
BGW44	8/02/2015	ME1500221047	1740	7.1	19	1197	18.6	18	1.79	0.03	0	<0.001	495	<0.0001	65	<1	182	0	<0.001	0.001	<1	<0.05
BGW44	29/04/2015	ME1500659031	1660	7.4	5	1256	18.8	20.6	4.61	<<0.01	0	<0.001	484	<0.0001	72	<1	192	0	<0.001	<0.001	<1	<0.05
BGW44	14/08/2015	ME1510328053	1730	7.3	1	1184	0	0	0	0.05	0	<0.001	474	<0.0001	75	<1	160	0	<0.001	0.02	<1	<0.05
BGW44	21/10/2015	ME1510717039	1700	7.4	2	1233	0	0	0	0.02	0	<0.001	523	<0.0001	67	<1	175	0	<0.001	<0.001	<1	<0.05
BGW44	22/02/2016	ME1600265011	1630	7	3	1122	16.8	18	3.36	1.31	0	<0.001	458	<0.0001	70	<1	166	0	0.001	0.003	<1	0.07
BGW44	19/05/2016	ME1600733033	1580	7.1	3	1221	19	17.7	3.55	0.03	0	<0.001	557	<0.0001	67	<1	161	0	<0.001	<0.001	<1	<0.05
BGW44	1/09/2016	ME1601226031	1620	7.3	4	1243	19.2	18.1	2.92	<<0.01	0	<0.001	571	<0.0001	70	<1	158	0	<0.001	<0.001	<1	<0.05
BGW44	20/12/2016	ME1601793027	1590	7.7	2	1112	17.5	16.3	3.61	<<0.01	0	<0.001	438	<0.0001	43	<1	185	0	<0.001	<0.001	<1	<0.05
BGW45	6/01/2014	ME1400079036	1950	7.2	22	1522	21.6	23	2.99	0.36	0	0.002	660	<0.0001	106	<1	64	<0.001	<0.001	<0.001	<1	0.12
BGW45	2/04/2014	ME1400540034	1910	7.3	95	1430	21	20.5	1.18	0.49	0	0.002	622	<0.0001	103	<1	70	<0.001	<0.001	<0.001	<1	0.15
BGW45	18/07/2014	ME1401051037	1820	8.2		1586	23.3	22.3	2.15	0.39	0	0.002	715	<0.0001	110	<1	69	<0.001	<0.001	<0.001	<1	0.2
BGW45	9/10/2014	ME1401512036	1960	7.2	14	1580	22.9	22.7	0.53	0.39	<0.001	<0.001	721	<0.0001	98	<1	68	<0.001	<0.001	<0.001	<1	0.08
BGW45	8/02/2015	ME1500221048	1960	7.1	26	1524	22.5	21.4	2.65	0.38	0	0.001	666	<0.0001	100	<1	69	0	<0.001	0.001	<1	<0.05
BGW45	29/04/2015	ME1500659032	1880	7.1	28	1581	21.9	25.2	7.01	0.38	0	0.004	678	<0.0001	124	<1	54	0	<0.001	0.002	<1	0.42
BGW45	14/08/2015	ME1510328054	1910	7.1	10	1486	0	0	0	0.37	0	<0.001	634	<0.0001	113	<1	51	0	<0.001	<0.001	<1	0.06
BGW45	21/10/2015	ME1510717040	1910	7.2	6	1453	0	0	0	0.33	0	<0.001	618	<0.0001	103	<1	64	0	<0.001	<0.001	<1	<0.05
BGW45	22/02/2016	ME1600265012	1880	7.1	12	1494	21.2	22.6	3.07	0.45	0	<0.001	649	<0.0001	112	<1	65	0	<0.001	<0.001	<1	0.08
BGW45	19/05/2016	ME1600733034	1820	7	19	1571	23	22	2.27	0.38	0	<0.001	724	<0.0001	105	<1	63	0	<0.001	<0.001	<1	0.07
BGW45	8/09/2016	ME1601226075	1970	7.1	14	1487	20.6	23.7	6.94	0.4	0	<0.001	663	<0.0001	111	<1	58	0	<0.001	<0.001	<1	0.09
BGW45	20/12/2016	ME1601793028	1960	7.1	15	1518	22.1	21.8	0.74	0.46	0	<0.001	680	<0.0001	106	<1	66	0	<0.001	<0.001	<1	<0.05
BGW46	13/01/2014	ME1400079037	1160	7.4	44	868	12.6	12.8	0.76	0.04	0	0.107	412	<0.0001	112	<1	40	<0.001	<0.001	<0.001	<1	0.16
BGW46	3/04/2014	ME1400540035	1170	7.3	67	858	12.2	13.4	4.82	0.15	0	0.059	379	<0.0001	117	<1	42	<0.001	<0.001	<0.001	<1	0.12
BGW46	15/07/2014	ME1401051038	1140	7.2	48	956	14	13.9	0.24	0.17	0	0.114	446	<0.0001	124	<1	40	<0.001	<0.001	<0.001	<1	0.13
BGW46	8/10/2014	ME1401512037	1180	7.3	52	923	13.8	13	2.97	0.2	<0.001	0.126	452	<0.0001	114	<1	48	<0.001	<0.001	<0.001	<1	0.1
BGW46	6/02/2015	ME1500221049	1100	7.4	34	881	13.3	12.2	4.24	0.22	0	0.102	408	<0.0001	109	<1	46	0	<0.001	<0.001	<1	0.09
BGW46	30/04/2015	ME1500659033	1130	7.2	21	921	13.2	14.5	4.93	0.22	0	0.149	417	<0.0001	134	<1	35	0	<0.001	<0.001	<1	0.09
BGW46	11/08/2015	ME1510328055	1160	7.2	3	925	0	0	0	0.26	0	0.085	404	<0.0001	132	<1	33	0	<0.001	<0.001	<1	0.08
BGW46	27/10/2015	ME1510717041	1160	7.2	4	916	0	0	0	0.27	0	0.055	422	<0.0001	123	<1	32	0	<0.001	<0.001	<1	0.1
BGW46	23/02/2016	ME1600265023	1120	7.2	6	926	13.5	13.8	1.39	0.31	0	0.083	425	<0.0001	128	<1	35	0	<0.001	<0.001	<1	0.09
BGW46	25/05/2016	ME1600733035	1100	7.1	5	966	14.2	14.2	<0.01	0.72	0	0.272	452	<0.0001	114	<1	40	0	<0.001	<0.001	<1	<0.05
BGW46	6/09/2016	ME1601226066	1180	7.2	5	928	13.6	13.8	0.75	0.3	0	0.121	409	<0.0001	128	<1	39	0	<0.001	<0.001	<1	0.06
BGW46	21/12/2016	ME1601793043	1190	7.2	4	828	12.6	11.3	5.3	0.32	0	0.073	390	<0.0001	97	<1	40	0	<0.001	<0.001	<1	<0.05
BGW47	10/01/2014	ME1400079038	1020	7.6	9	742	10.9	10.9	0.33	0.16	0	0.003	328	<0.0001	70	<1	42	<0.001	<0.001	0.001	<1	0.64
BGW47	31/03/2014	ME1400540036	1010	7.6	11	726	10.6	11.1	2.3	0.18	0	0.002	314	<0.0001	69	<1	44	<0.001	<0.001	<0.001	<1	0.66
BGW47	15/07/2014	ME1401051039	999	7.5	6	788	11.8	11.3	1.83	0.02	0	0.001	352	<0.0001	76	<1	42	<0.001	<0.001	<0.001	<1	<0.05
BGW47	13/10/2014	ME1401512038	1030	7.6	7	762	11.6	10.5	5.02	<<0.01	<0.001	0.001	345	<0.0001	70	<1	52	<0.001	<0.001	<0.001	<1	<0.05
BGW47	5/02/2015	ME1500221050	949	7.4	23	756	11.3	11.3	0.1	0.08	0	0.002	315	<0.0001	76	<1	48	0	<0.001	0.002	<1	<0.05

Sample Location	Sampling Date	Sample Num	Electrical Conductivity @ 25°C µS/cm	pH Value pH Unit	Total Suspended Solids mg/L	TDS (mg/L) Calc	Total Anions meq/L	Total Cations meq/L	Ionic Balance %	Ammonia as N mg/L	Antimony - Dissolved mg/L	Arsenic - Dissolved mg/L	Bicarbonate Alkalinity as CaCO3 mg/L	Cadmium - Dissolved mg/L	Calcium - Dissolved mg/L	Carbonate Alkalinity as CaCO3 mg/L	Chloride mg/L	Chromium - Dissolved mg/L	Cobalt - Dissolved mg/L	Copper - Dissolved mg/L	Hydroxide Alkalinity as CaCO3 mg/L	Iron - Dissolved mg/L
BGW47	29/04/2015	ME1500659034	1010	7.4	7	777	11.2	12.1	3.94	0.06	0	0.002	332	<0.0001	82	<1	37	0	<0.001	0.002	<1	<0.05
BGW47	11/08/2015	ME1510328056	1010	7.6	2	819	0	0	0	0.03	0	0.002	368	<0.0001	84	<1	34	0	<0.001	0.001	<1	<0.05
BGW47	22/10/2015	ME1510717042	795	7.8	81	780	0	0	0	<<0.01	0	<0.001	338	<0.0001	80	<1	35	0	<0.001	<0.001	<1	<0.05
BGW47	23/02/2016	ME1600265024	982	7.6	2	796	11.7	11.9	1.1	0.14	0	0.001	344	<0.0001	82	<1	37	0	<0.001	<0.001	<1	<0.05
BGW47	18/05/2016	ME1600733036	901	7.4	87	592	9.06	8.43	3.65	0.02	0	<0.001	224	<0.0001	32	<1	46	0	<0.001	<0.001	<1	<0.05
BGW47	30/08/2016	ME1601226002	1050	7.6	4	798	11.8	11.8	0.32	<<0.01	0	<0.001	349	<0.0001	80	<1	40	0	<0.001	<0.001	<1	<0.05
BGW47	19/12/2016	ME1601793008	1040	7.7	2	745	11.1	10.9	0.83	<<0.01	0	<0.001	323	<0.0001	76	<1	46	0	<0.001	<0.001	<1	<0.05
BGW48	10/01/2014	ME1400079039	303	6.4	2740	179	2.66	2.8		0.4	0	0.008	30	0.0004	12	<1	36	0.001	0.005	0.028	<1	3.73
BGW48	15/07/2014	ME1401051040	320	7.5		168	2.69	2.67		<0.01	0	<0.001	12	<0.0001	13	<1	44	<0.001	<0.001	<0.001	<1	<0.05
BGW48	7/08/2015	ME1510328057	275	7.4	39	144	0	0	0	0.02	0	<0.001	17	<0.0001	12	<1	32	0	<0.001	<0.001	<1	<0.05
BGW48	22/10/2015	ME1510717043	280	7.6	24	141	0	0	0	<<0.01	0	<0.001	15	<0.0001	11	<1	32	0	<0.001	<0.001	<1	<0.05
BGW48	23/02/2016	ME1600265025	350	7	392	205	2.99	2.71	0	6.67	0	0.003	91	<0.0001	12	<1	38	0	<0.001	<0.001	<1	8.1
BGW48	30/08/2016	ME1601226003	266	6.8	26	154	2.29	2.51	0	<<0.01	0	<0.001	31	<0.0001	11	<1	26	0	<0.001	<0.001	<1	<0.05
BGW48	19/12/2016	ME1601793009	189	6.3	34	104	1.64	1.53	0	<<0.01	0	<0.001	22	<0.0001	6	<1	22	0	<0.001	<0.001	<1	<0.05
BGW48	19/12/2016	ME1600265025	350	7	392	205	2.99	2.71	0	6.67	0	0.003	91	<0.0001	12	<1	38	0	<0.001	<0.001	<1	8.1
BGW49	10/01/2014	ME1400079040	347	6.4	1010	205	3.18	3.2	0.29	0.05	0	0.002	48	0.0002	14	<1	44	<0.001	0.001	<0.018	<1	0.51
BGW49	31/03/2014	ME1400540037	332	6.7	3450	188	2.91	3.07		0.24	0	<0.001	40	<0.0001	14	<1	38	<0.001	0.004	<0.001	<1	0.51
BGW49	15/07/2014	ME1401051041	372	6.8	201	216	3.49	3.36	1.94	0.02	0	<0.001	44	<0.0001	15	<1	60	<0.001	<0.001	<0.001	<1	0.1
BGW49	13/10/2014	ME1401512041	405	6.6	262	254	4	4.14	1.74	<<0.01	<0.001	<0.001	64	<0.0001	18	<1	67	<0.001	<0.001	<0.001	<1	<0.05
BGW49	5/02/2015	ME1500221051	383	6.2	404	222	3.53	3.29	3.53	0.46	0	0.002	39	<0.0001	18	<1	48	0	0.002	0.002	<1	1.12
BGW49	29/04/2015	ME1500659035	372	6.6	216	208	3.33	2.87		2.1	0	<0.001	74	<0.0001	14	<1	37	0	0.001	0.002	<1	0.93
BGW49	7/08/2015	ME1510328058	295	6.6	32	153	0	0	0	0.03	0	<0.001	11	<0.0001	12	<1	30	0	<0.001	<0.001	<1	<0.05
BGW49	22/10/2015	ME1510717044	309	7.2	19	140	0	0	0	<<0.01	0	<0.001	11	<0.0001	12	<1	26	0	<0.001	<0.001	<1	<0.05
BGW49	23/02/2016	ME1600265026	378	6.4	20	223	3.38	3.64	3.64	0.06	0	<0.001	44	<0.0001	19	<1	40	0	<0.001	<0.001	<1	<0.05
BGW49	18/05/2016	ME1600733037	346	7.1	9840	205	3.21	3.03	2.88	0.28	0	<0.001	46	<0.0001	15	<1	43	0	0.002	<0.001	<1	0.41
BGW49	30/08/2016	ME1601226004	204	6.1	188	112	1.68	1.87	0	0.03	0	<0.001	15	<0.0001	9	<1	21	0	<0.001	<0.001	<1	<0.05
BGW49	19/12/2016	ME1601793010	173	6.1	220	90	1.4	1.43	0	0.03	0	<0.001	16	<0.0001	7	<1	19	0	<0.001	<0.001	<1	<0.05
BGW50	10/01/2014	ME1400079041	1230	8.1	11	914	14.1	13.7	1.18	0.36	0	0.003	462	<0.0001	103	<1	138	<0.001	<0.001	<0.001	<1	0.11
BGW50	31/03/2014	ME1400540038	1390	7.1	12	1012	14.7	15.8	3.58	0.14	0	0.002	306	<0.0001	134	<1	51	<0.001	<0.001	<0.001	<1	1.52
BGW50	15/07/2014	ME1401051042	1360	6.9	9	1090	16.7	15.2	4.81	0.09	0	0.001	347	<0.0001	114	<1	54	<0.001	<0.001	<0.001	<1	<0.05
BGW50	13/10/2014	ME1401512042	1400	7.3	8	1090	16.2	16.5	0.94	<<0.01	<0.001	0.002	347	<0.0001	136	<1	59	<0.001	<0.001	<0.001	<1	<0.05
BGW50	5/02/2015	ME1500221052	1260	6.7	8	1001	15.3	14.5	2.68	0.04	0	0.004	253	<0.0001	119	<1	66	0	0.002	0.002	<1	1.23
BGW50	28/04/2015	ME1500659036	1270	6.8	12	989	14.5	15.4	3.14	0.07	0	<0.01	281	<0.0001	125	<1	51	0	0.002	0.001	<1	2.86
BGW50	7/08/2015	ME1510328059	1290	7.2	9	951	0	0	0	0.08	0	<0.001	260	<0.0001	122	<1	48	0	<0.001	0.002	<1	<0.05
BGW50	22/10/2015	ME1510717045	1310	7.3	5	951	0	0	0	0.03	0	<0.001	256	<0.0001	121	<1	49	0	<0.001	<0.001	<1	<0.05
BGW50	23/02/2016	ME1600265027	1270	6.8	3	991	14.7	15.1	1.38	0.04	0	0.001	280	<0.0001	125	<1	52	0	<0.001	<0.001	<1	<0.05
BGW50	18/05/2016	ME1600733038	1210	7.5	21	857	13.5	11.6	7.63	<<0.01	0	0.001	235	<0.0001	90	<1	62	0	<0.001	<0.001	<1	<0.05
BGW50	30/08/2016	ME1601226005	420	6.8	6	274	4.04	4.19	1.74	<0.01	0	<0.001	88	<0.0001	27	<1	25	0	<0.001	<0.001	<1	<0.05
BGW50	19/12/2016	ME1601793011	294	6.9	12	175	2.62	2.62	0	0.17	0	<0.001	62	<0.0001	18	<1	18	0	<0.001	0.002	<1	<0.05
BGW51	10/01/2014	ME1400079042	1410	5.9	276	1011	15.2	15.2	<<0.01	0.07	0	0.002	259	<0.0001	113	<1	70	<0.001	0.002	0.004	<1	0.96
BGW51	31/03/2014	ME1400540039	1330	7	1370	941	13.9	14.9	3.58	0.08	0	0.002	241	<0.0001	114	<1	74	<0.001	0.002	<0.001	<1	0.84
BGW51	15/07/2014	ME1401051043	1360	6.5	179	1073	16.3	15.7	1.76	0.02	0	0.004	280	<0.0001	119	<1	74	<0.001	0.003	<0.001	<1	2.47
BGW51	13/10/2014	ME1401512043	1400	6.8	5	1065	15.5	17.1	4.92	0.02	<0.001	0.006	277	<0.0001	130	<1	80	<0.001	0.003	<0.001	<1	3.47
BGW51	5/02/2015	ME1500221053	1320	6.7	350	1029	16	14.4	5.49	0.28	0	0.004	248	<0.0001	110	<1	75	0	0.004	0.001	<1	1.53
BGW51	28/04/2015	ME1500659037	1340	6.7	528	1031	15	16.5	4.93	<<0.01	0	<0.012	254	0.0008	128	<1	59	0	0.008	0.008	<1	3.37
BGW51	7/08/2015	ME1510328060	1360	6.7	179	995	0	0	0	0.04	0	0.003	239	<0.0001	125	<1	52	0	0.005	<0.001	<1	2.46
BGW51	22/10/2015	ME1510717046	1350	6.8	82	1002	0	0	0	0.06	0	0.004	255	<0.0001	119	<1	54	0	0.004	<0.001	<1	3.04
BGW51	23/02/2016	ME1600265028	1290	6.6	60	1026	15.3	15.4	0.32	<<0.01	0	0.002	262	<0.0001	117	<1	58	0	0.003	<0.001	<1	0.77
BGW51	18/05/2016	ME1600733039	1260	6.7	63	962	15	13.2	6.51	<<0.01	0	0.002	254	<0.0001	104	<1	70	0	0.002	<0.001	<1	0.94
BGW51	30/08/2016	ME1601226006	552	6.7	54	383	5.79	5.56	2.02	<0.01	0	<0.001	131	<0.0001	37	<1	32	0	<0.001	<0.001	<1	<0.05

Sample Location	Sampling Date	Sample Num	Electrical Conductivity @ 25°C µS/cm	pH Value pH Unit	Total Suspended Solids mg/L	TDS (mg/L) Calc	Total Anions meq/L	Total Cations meq/L	Ionic Balance %	Ammonia as N mg/L	Antimony - Dissolved mg/L	Arsenic - Dissolved mg/L	Bicarbonate Alkalinity as CaCO3 mg/L	Cadmium - Dissolved mg/L	Calcium - Dissolved mg/L	Carbonate Alkalinity as CaCO3 mg/L	Chloride mg/L	Chromium - Dissolved mg/L	Cobalt - Dissolved mg/L	Copper - Dissolved mg/L	Hydroxide Alkalinity as CaCO3 mg/L	Iron - Dissolved mg/L
BGW51	19/12/2016	ME1601793012	1310	6.5	250	906	13.6	13.8	0.82	0.02	0	0.003	229	<0.0001	108	<1	73	0	0.004	<0.001	<1	2.42
BGW52	8/01/2014	ME1400079043	655	7.6	12	416	6.41	6.24	1.35	0.04	0	<0.001	180	<0.0001	46	<1	57	<0.001	<0.001	0.005	<1	<0.05
BGW52	8/04/2014	ME1400540040	665	7.4	6	439	6.96	7.13	1.23	0.02	0	<0.001	188	<0.0001	55	<1	61	<0.001	<0.001	0.002	<1	<0.05
BGW52	14/07/2014	ME1401051044	680	7.2	7	474	7.34	7.01	2.31	0.02	0	<0.001	216	<0.0001	53	<1	63	<0.001	<0.001	<0.015	<1	<0.05
BGW52	13/10/2014	ME1401512044	987	7.5	97	712	10.9	11	0.67	<0.01	<0.001	<0.001	315	<0.0001	68	<1	101	<0.001	<0.001	0.001	<1	<0.05
BGW52	4/02/2015	ME1500221054	984	7.2	15	672	10.7	9.48	5.99	<<0.01	0	0.001	288	<0.0001	60	<1	96	0	<0.001	0.002	<1	<0.05
BGW52	28/04/2015	ME1500659038	1040	7.3	11	729	11.1	11.4	1.49	0.02	0	0.001	303	<0.0001	73	<1	105	0	<0.001	0.006	<1	<0.05
BGW52	7/08/2015	ME1510328061	1020	7.6	2	679	0	0	0	0.03	0	0.001	285	<0.0001	76	6	72	0	<0.001	0.003	<1	0.17
BGW52	21/10/2015	ME1510717047	1050	7.4	1	742	0	0	0	0.02	0	<0.001	322	<0.0001	75	<1	102	0	<0.001	0.002	<1	<0.05
BGW52	22/02/2016	ME1600265013	1060	7.4	9	707	10.5	11.7	5.18	0.02	0	0.001	289	<0.0001	81	<1	104	0	<0.001	0.002	<1	<0.05
BGW52	19/05/2016	ME1600733040	1040	7.4	4	752	11.6	11.2	2.04	<<0.01	0	<0.001	336	0.0001	69	<1	105	0	<0.001	0.001	<1	<0.05
BGW52	1/09/2016	ME1601226032	878	7.2	2	599	9.09	9.41	1.72	<<0.01	0	<0.001	243	<0.0001	59	<1	89	0	<0.001	0.001	<1	<0.05
BGW52	20/12/2016	ME1601793029	775	7.3	3	487	7.35	7.62	1.84	<<0.01	0	<0.001	233	<0.0001	65	<1	60	0	<0.001	<0.001	<1	<0.05
BGW53	8/01/2014	ME1400079044	1060	7.3	200	666	10.2	10.4	0.6	0.04	0	<0.001	265	<0.0001	52	<1	115	<0.001	<0.001	0.003	<1	<0.05
BGW53	8/04/2014	ME1400540041	1190	7.2	35	766	12	12	0.17	<<0.01	0	<0.001	273	<0.0001	64	<1	156	<0.001	<0.001	0.003	<1	<0.05
BGW53	14/07/2014	ME1401051045	1280	7	56	914	14.2	14	0.97	<0.01	0	<0.001	345	<0.0001	62	<1	163	<0.001	<0.001	0.004	<1	<0.05
BGW53	13/10/2014	ME1401512045	1750	7.3	63	1213	18.8	19.2	1	<<0.01	<0.001	<0.001	437	<0.0001	84	<1	244	<0.001	<0.001	<0.001	<1	<0.05
BGW53	4/02/2015	ME1500221055	1730	7.2	167	1209	18.8	19.1	0.61	0.04	0	<0.001	443	<0.0001	86	<1	235	0	<0.001	0.001	<1	<0.05
BGW53	28/04/2015	ME1500659039	1750	7.2	122	1229	19	19.7	1.73	0.05	0	<0.001	441	<0.0001	105	<1	248	0	<0.001	0.002	<1	<0.05
BGW53	7/08/2015	ME1510328062	1700	7.2	34	1013	0	0	0	0.03	0	<0.001	408	<0.0001	94	<1	112	0	<0.001	<0.001	<1	<0.05
BGW53	21/10/2015	ME1510717048	1710	7.2	10	1223	0	0	0	0.02	0	<0.001	452	<0.0001	87	<1	229	0	<0.001	<0.001	<1	<0.05
BGW53	22/02/2016	ME1600265014	1660	7.2	61	1107	16.9	18	3.17	<0.01	0	<0.001	383	<0.0001	86	<1	218	0	<0.001	<0.001	<1	<0.05
BGW53	19/05/2016	ME1600733041	1590	7.2	126	1144	17.4	18	1.57	<0.01	0	<0.001	471	0.0002	82	<1	189	0	<0.001	<0.001	<1	<0.05
BGW53	1/09/2016	ME1601226033	866	7.3	6	608	9.29	9	1.57	<<0.01	0	<0.001	239	<0.0001	37	<1	81	0	<0.001	<0.001	<1	<0.05
BGW53	20/12/2016	ME1601793030	905	7.3	<1	608	9.24	9.15	0.47	<<0.01	0	<0.001	310	<0.0001	72	<1	60	0	<0.001	<0.001	<1	<0.05
BGW54	15/10/2013	ME1400079056	444	7	3480	264	4.27	4.27	0.03	0.19	0	0.001	79	<0.0001	17	<1	53	<0.001	0.006	0.001	<1	<0.05
BGW54	13/10/2014	ME1401512046	684	7		872	14.6	6.15	40.8	0.43	<0.001	0.002	582	<0.0001	39	<1	54	<0.001	0.003	<0.001	<1	7.55
BGW54	1/09/2016	ME1601226034	453	6.3	25	274	4.33	4.46	1.49	<<0.01	0	<0.001	70	<0.0001	21	<1	61	0	<0.001	<0.001	<1	<0.05
BGW54	20/12/2016	ME1601793031	404	6.5	425	223	3.6	3.47	1.9	<<0.01	0	<0.001	59	<0.0001	17	<1	52	0	<0.001	<0.001	<1	<0.05
BSW01	31/08/2016	ME1601226007	247	6.1	3	154	2.4	2.37	0	0.03	0	<0.001	27	<0.0001	10	<1	23	0	0.002	0.002	<1	0.16
BSW02	1/09/2016	ME1601226036	131	4.9	2	50	0.72	1.08	0	0.05	0	<0.001	4	<0.0001	<1	<1	19	0	<0.001	<0.001	<1	0.06
BSW03	17/02/2014	ME1400288001	67	5.8	45	34	0.65	0.7		<<0.01	0	0.008	6	0.0002	2	<1	8	<0.001	0.004	0.003	<1	0.52
BSW03	21/05/2014	ME1400741001	85	6.1	32	47	0.7	0.72		0.21	0	0.008	14	<0.0001	2	<1	8	<0.001	0.003	<0.001	<1	0.88
BSW03	20/08/2014	ME1401208001	70	5.9	41	50	0.67	0.77		0.03	0	0.008	5	<0.0001	2	<1	4	<0.001	0.002	0.004	<1	0.79
BSW03	30/04/2015	ME1500659047	68	5.7	19	39	0.44	0.78		<<0.01	0	0.007	6	0.0001	4	<1	4	0	0.004	0.005	<1	0.77
BSW03	4/08/2015	ME1510328001	83	6.1	32	27	0	0	0	0.05	0	0.004	5	0.0001	2	<1	3	0	0.001	0.002	<1	0.63
BSW03	3/02/2016	ME1600265048	128	8	172	90	1.23	1.29	0	0.09	0	<0.016	42	<0.0001	6	<1	14	0	0.004	0.002	<1	1.65
BSW03	12/05/2016	ME1600662001	70	7.5	16	48	0.61	0.76	0	<<0.01	0	<0.013	25	0.0001	4	<1	4	0	0.003	0.002	<1	1.12
BSW03	5/09/2016	ME1601226050	57	6.2	3	32	0.5	0.4	11.6	0.05	0	<0.001	5	<0.0001	1	<1	9	0	<0.001	<0.001	<1	0.1
BSW04	17/02/2014	ME1400288002	429	3.8	13	236	3.67	3.8	1.8	0.1	0	0.002	<1	<0.0121	10	<1	7	<0.001	0.02	0.008	<1	0.08
BSW04	21/05/2014	ME1400741002	344	3.9	5	188	2.95	2.95		0.03	0	0.001	<1	0.0067	8	<1	7	<0.001	<0.017	0.004	<1	0.12
BSW04	20/08/2014	ME1401208002	402	3.6	3	201	3.2	3.33	2.06	0.09	0	0.001	<1	0.0075	8	<1	7	<0.001	<0.012	0.005	<1	0.09
BSW04	20/11/2014	ME1401676001	429	4	324	272	4.08	4.28	2.4	0.52	<0.001	0.007	<1	<0.0129	17	<1	14	<0.001	0.03	0.007	<1	0.23
BSW04	5/02/2015	ME1500221001	338	3.8	17	167	2.58	1.62		0.88	0	0.004	<1	0.0072	8	<1	8	0	<0.018	0.004	<1	0.2
BSW04	30/04/2015	ME1500659048	203	3.9	6	90	1.36	1		0.04	0	0.001	<1	0.0049	5	<1	4	0	0.009	0.002	<1	0.12
BSW04	4/08/2015	ME1510328002	191	4.3	2	92	0	0	0	<0.01	0	<0.001	<1	0.0036	4	<1	5	0	0.007	0.003	<1	0.14
BSW04	2/02/2016	ME1600265049	165	4.3	4	78	1.16	0.85	0	0.04	0	<0.001	<1	0.004	4	<1	5	0	<0.01	0.007	<1	0.14
BSW04	11/05/2016	ME1600662002	122	4.6	34	55	0.8	0.62	0	<<0.01	0	<0.001	<1	0.0034	3	<1	4	0	0.006	0.005	<1	0.06
BSW04	30/08/2016	ME1601226008	342	4.3	1	195	3.15	2.57	0	<<0.01	0	<0.001	<1	0.0041	11	<1	26	0	0.004	0.004	<1	0.16
BSW05	30/04/2015	ME1500659049	42	5.9	135	29	0.38	0.5		<<0.01	0	0.002	<1	<0.0001	4	<1	1	0	0.002	0.004	<1	0.7

Sample Location	Sampling Date	Sample Num	Electrical Conductivity @ 25°C µS/cm	pH Value pH Unit	Total Suspended Solids mg/L	TDS (mg/L) Calc	Total Anions meq/L	Total Cations meq/L	Ionic Balance %	Ammonia as N mg/L	Antimony - Dissolved mg/L	Arsenic - Dissolved mg/L	Bicarbonate Alkalinity as CaCO3 mg/L	Cadmium - Dissolved mg/L	Calcium - Dissolved mg/L	Carbonate Alkalinity as CaCO3 mg/L	Chloride mg/L	Chromium - Dissolved mg/L	Cobalt - Dissolved mg/L	Copper - Dissolved mg/L	Hydroxide Alkalinity as CaCO3 mg/L	Iron - Dissolved mg/L
BSW05	4/08/2015	ME1510328003	110	5.4	22	55	0	0	0	0.02	0	<0.001	<1	<0.0001	2	<1	11	0	0.001	0.001	<1	0.07
BSW05	5/09/2016	ME1601226051	63	6.2	5	34	0.49	0.51	1.68	0.15	0	<0.001	4	<0.0001	2	<1	8	0	<0.001	<0.001	<1	0.2
BSW06	11/05/2016	ME1600662003	41	6.2	66	23	0.3	0.34	0	0.02	0	<0.001	12	<0.0001	2	<1	2	0	<0.001	0.003	<1	0.23
BSW06	30/08/2016	ME1601226009	143	6.8	2	79	1.22	1.2	0.88	0.02	0	<0.001	10	0.0002	7	<1	14	0	<0.001	<0.001	<1	0.05
BSW07	17/02/2014	ME1400288003	456	6.6	57	286	4.65	4.95	3.07	0.06	0	<0.001	95	<0.0001	29	<1	53	<0.001	0.001	<0.001	<1	0.22
BSW07	20/05/2014	ME1400741003	446	6.4	12	274	4.5	4.57	0.76	0.02	0	<0.001	84	<0.0001	26	<1	53	<0.001	<0.001	<0.001	<1	0.15
BSW07	19/08/2014	ME1401208003	452	6.7	10	253	3.88	4.06	2.21	<<0.01	0	<0.001	79	<0.0001	23	<1	50	<0.001	<0.001	<0.001	<1	0.56
BSW07	21/11/2014	ME1401676002	478	6.7	15	309	4.76	4.89	1.41	0.08	<0.001	<0.001	109	<0.0001	36	<1	59	<0.001	0.002	<0.001	<1	0.14
BSW07	5/02/2015	ME1500221002	507	6.5	12	294	4.54	4.78	2.54	<<0.01	0	<0.001	96	<0.0001	32	<1	59	0	<0.001	0.002	<1	0.92
BSW07	28/04/2015	ME1500659050	495	6.6	44	298	4.45	5.2	7.74	0.04	0	<0.001	80	<0.0001	33	<1	59	0	<0.001	0.001	<1	0.2
BSW07	4/08/2015	ME1510328004	526	6.6	10	260	0	0	0	0.05	0	<0.001	68	<0.0001	33	<1	42	0	<0.001	<0.001	<1	0.47
BSW07	13/10/2015	ME1510717001	525	8.1	23	324	0	0	0	0.03	0	<0.001	111	<0.0001	37	<1	64	0	<0.001	<0.001	<1	0.21
BSW07	2/02/2016	ME1600265050	523	6.5	55	334	5.17	5.65	4.46	0.03	0	<0.001	98	<0.0001	37	<1	80	0	<0.001	0.003	<1	0.12
BSW07	11/05/2016	ME1600662004	618	6.6	14	357	5.59	5.93	2.95	<<0.01	0	<0.001	113	<0.0001	41	<1	88	0	<0.001	<0.001	<1	0.27
BSW07	30/08/2016	ME1601226010	925	7.1	7	579	9.28	9.45	0.86	0.04	0	<0.001	114	<0.0001	29	<1	165	0	<0.001	0.004	<1	0.44
BSW08	20/05/2014	ME1400741004	114	6.5	19	74	1.11	1.26		0.06	0	0.003	35	<0.0001	6	<1	7	<0.001	<0.001	0.006	<1	2.53
BSW08	19/08/2014	ME1401208004	152	6.4	440	104	1.49	1.56		<<0.01	0	<0.001	17	<0.0001	5	<1	12	<0.001	<0.001	0.005	<1	0.3
BSW08	4/08/2015	ME1510328005	155	6.4	188	96	0	0	0	0.02	0	0.005	27	0.0002	11	<1	10	0	0.007	<0.019	<1	1.96
BSW08	2/02/2016	ME1600265051	137	6.7	2050	83	1.1	1.02	0	0.34	0	0.005	21	0.0002	2	<1	13	0	0.008	0.066	<1	10.1
BSW08	30/08/2016	ME1601226011	145	6.4	6	87	1.17	1.5	0	0.02	0	0.003	39	<0.0001	7	<1	14	0	<0.001	0.003	<1	0.63
BSW09	31/08/2016	ME1601226012	634	6.4	30	334	5.18	5.72	4.87	0.07	0	<0.001	68	<0.0001	22	<1	84	0	<0.001	0.002	<1	<0.05
BSW11	20/02/2014	ME1400288004	370	6.5	271	219	3.66	3.82	2.11	0.28	0	<0.001	10	<0.0001	15	<1	53	<0.001	0.002	<0.013	<1	0.12
BSW11	21/05/2014	ME1400741005	372	6.8	7	249	4.09	4	1.15	0.08	0	<0.001	108	<0.0001	17	<1	33	<0.001	<0.001	0.003	<1	1.15
BSW11	19/08/2014	ME1401208005	380	7.1	13	228	3.39	3.48	1.23	<<0.01	0	<0.001	94	<0.0001	14	<1	30	<0.001	<0.001	0.005	<1	0.2
BSW11	19/11/2014	ME1401676003	640	7.3	266	476	7.07	7.02	0.32	1.23	<0.001	0.002	253	<0.0001	38	<1	58	<0.001	0.003	0.003	<1	<0.05
BSW11	4/02/2015	ME1500221003	873	7.6	544	483	8.73	4.63	30.8	0.52	0	0.002	249	0.0002	19	<1	117	0	0.002	<0.019	<1	0.37
BSW11	28/04/2015	ME1500659051	544	6.7	139	338	4.93	5.45	5	0.29	0	<0.001	15	0.0001	30	<1	38	0	<0.001	0.005	<1	0.09
BSW11	4/08/2015	ME1510328006	105	6.4	18	61	0	0	0	0.1	0	<0.001	18	<0.0001	5	<1	8	0	0.002	0.002	<1	0.45
BSW11	2/02/2016	ME1600265052	265	7.1	54	148	2.44	1.62	0	0.03	0	<0.001	55	<0.0001	8	3	13	0	<0.001	0.001	<1	0.07
BSW11	11/05/2016	ME1600662005	267	7.1	110	171	2.48	2.36	0	1.87	0	0.002	85	<0.0001	10	<1	24	0	0.003	0.002	<1	0.44
BSW11	1/09/2016	ME1601226037	810	7.5	8	495	7.84	8.11	1.67	0.06	0	<0.001	107	<0.0001	20	<1	132	0	<0.001	0.005	<1	0.52
BSW12	18/02/2014	ME1400288005	680	7.5	13	453	6.93	7.84	6.16	0.03	0	0.002	199	<0.0001	42	<1	78	<0.001	<0.001	0.001	<1	0.12
BSW12	21/05/2014	ME1400741006	444	6.9	6	271	4.35	4.56	2.37	0.04	0	<0.001	73	<0.0001	21	<1	50	<0.001	<0.001	0.007	<1	0.1
BSW12	20/08/2014	ME1401208006	465	6.7	5	286	4.54	4.75	2.26	<0.01	0	<0.001	72	<0.0001	23	<1	51	<0.001	<0.001	<0.001	<1	0.07
BSW12	19/11/2014	ME1401676004	552	7.4	37	366	5.62	5.8	1.62	0.05	<0.001	0.001	144	<0.0001	35	<1	61	<0.001	<0.001	<0.001	<1	<0.05
BSW12	5/02/2015	ME1500221004	571	7.6	11	340	5.34	5.3	0.46	0.02	0	0.001	127	<0.0001	27	<1	67	0	<0.001	0.001	<1	<0.05
BSW12	29/04/2015	ME1500659052	537	6.9	9	322	4.87	5.44	5.48	0.02	0	<0.001	82	<0.0001	27	<1	60	0	<0.001	<0.001	<1	0.07
BSW12	7/08/2015	ME1510328007	344	6.7	2	182	0	0	0	0.02	0	<0.001	53	<0.0001	11	<1	24	0	<0.001	<0.001	<1	0.06
BSW12	14/10/2015	ME1510717002	473	8	6	266	0	0	0	<<0.01	0	<0.001	74	<0.0001	26	11	44	0	<0.001	0.001	<1	0.24
BSW12	3/02/2016	ME1600265053	286	8.7	35	196	2.91	3.54	0	0.03	0	<0.001	60	<0.0001	20	12	42	0	<0.001	<0.001	<1	0.31
BSW12	11/05/2016	ME1600662006	480	6.1	14	275	4.25	4.41	1.88	<<0.01	0	<0.001	30	<0.0001	25	<1	54	0	0.001	<0.001	<1	0.08
BSW12	31/08/2016	ME1601226013	642	7.1	4	354	5.56	5.59	0.24	0.03	0	<0.001	84	<0.0001	19	<1	80	0	<0.001	0.001	<1	0.16
BSW13	20/02/2014	ME1400288006	209	7	376	131	1.93	2.07		0.75	0	<0.001	12	<0.0001	6	<1	23	<0.001	0.002	0.005	<1	0.08
BSW13	19/05/2014	ME1400741007	572	6.8	9	329	5.34	5.49	1.39	0.04	0	<0.001	57	<0.0001	13	<1	84	0.001	<0.001	0.002	<1	<0.05
BSW13	19/08/2014	ME1401208007	1210	7	13	720	11.6	11.7	0.51	<<0.01	0	<0.001	78	<0.0001	36	<1	213	<0.001	0.002	0.001	<1	0.35
BSW13	19/11/2014	ME1401676005	1380	7.8	71	933	14.9	14.2	2.36	0.18	<0.001	0.001	178	<0.0001	47	<1	230	<0.001	0.001	0.003	<1	<0.05
BSW13	4/02/2015	ME1500221005	356	7.3	2195	360	4.33	7.35	25.9	0.66	0	0.004	75	<0.0001	24	<1	28	0	0.003	0.009	<1	0.1
BSW13	1/05/2015	ME1500659053	259	6.6	140	166	2.39	2.74		0.02	0	0.001	30	<0.0001	10	<1	23	0	0.001	0.007	<1	1.23
BSW13	7/08/2015	ME1510328008	312	6.9	190	115	0	0	0	<<0.01	0	<0.001	31	<0.0001	10	<1	7	0	0.001	0.002	<1	0.09
BSW13	3/02/2016	ME1600265054	211	9	175	144	2.29	1.8	0	0.02	0	<0.001	83	<0.0001	7	<1	12	0	<0.001	0.002	<1	0.06

Sample Location	Sampling Date	Sample Num	Electrical Conductivity @ 25°C µS/cm	pH Value pH Unit	Total Suspended Solids mg/L	TDS (mg/L) Calc	Total Anions meq/L	Total Cations meq/L	Ionic Balance %	Ammonia as N mg/L	Antimony - Dissolved mg/L	Arsenic - Dissolved mg/L	Bicarbonate Alkalinity as CaCO3 mg/L	Cadmium - Dissolved mg/L	Calcium - Dissolved mg/L	Carbonate Alkalinity as CaCO3 mg/L	Chloride mg/L	Chromium - Dissolved mg/L	Cobalt - Dissolved mg/L	Copper - Dissolved mg/L	Hydroxide Alkalinity as CaCO3 mg/L	Iron - Dissolved mg/L
BSW13	11/05/2016	ME1600662007	123	6.9	72	70	1	1.1	0	<<0.01	0	<0.001	10	<0.0001	3	<1	13	0	<0.001	0.003	<1	0.57
BSW13	31/08/2016	ME1601226014	1230	7.4	5	739	12	12	0.13	0.03	0	<0.001	126	<0.0001	34	<1	238	0	0.003	<0.001	<1	0.64
BSW14	20/02/2014	ME1400288007	1490	6.5	17	896	15	16.3	4.4	0.14	0	<0.001	35	<0.0001	63	<1	156	<0.001	<0.001	0.007	<1	<0.05
BSW14	19/08/2014	ME1401208008	155	6.8	6	81	1.17	1.37		<<0.01	0	<0.001	11	<0.0001	3	<1	16	<0.001	<0.001	0.002	<1	0.33
BSW14	31/08/2016	ME1601226015	1300	7.6	7	942	14.2	14.5	0.74	0.02	0	<0.001	247	<0.0001	76	<1	66	0	<0.001	0.002	<1	<0.05
BSW15	19/08/2014	ME1401208009	114	6	1110	74	1.02	1.2		0.03	0	<0.001	17	<0.0001	3	<1	7	<0.001	<0.001	0.001	<1	0.19
BSW15	7/08/2015	ME1510328009	192	6.7	13	64	0	0	0	0.02	0	<0.001	13	<0.0001	5	<1	6	0	0.002	0.003	<1	1.09
BSW15	5/09/2016	ME1601226052	206	6.6	5	133	1.95	2.06	2.65	0.1	0	<0.001	36	<0.0001	6	<1	20	0	<0.001	0.002	<1	0.43
BSW16	4/08/2015	ME1510328010	142	6.8	2	78	0	0	0	0.03	0	<0.001	35	<0.0001	5	<1	16	0	<0.001	0.003	<1	0.08
BSW16	4/08/2015	ME1510328010	142	6.8	2	78	0	0	0	0.03	0	<0.001	35	<0.0001	5	<1	16	0	<0.001	0.003	<1	0.08
BSW16	13/10/2015	ME1510717003	187	8.2	7	101	0	0	0	0.02	0	<0.001	58	<0.0001	4	<1	24	0	<0.001	0.002	<1	0.15
BSW16	2/02/2016	ME1600265055	180	7.9	3	94	1.72	0.83	0	0.02	0	<0.001	58	<0.0001	3	<1	20	0	<0.001	<0.001	<1	<0.05
BSW16	11/05/2016	ME1600662008	212	6.7	7	129	1.92	2.13	0	0.04	0	0.001	60	<0.0001	10	<1	24	0	0.003	0.002	<1	1.33
BSW16	1/09/2016	ME1601226038	101	6.8	<1	63	0.98	1.03	2.48	<<0.01	0	<0.001	28	<0.0001	4	<1	15	0	<0.001	0.002	<1	0.27
BSW17	21/05/2014	ME1400741008	116	6	167	54	0.86	0.97		0.2	0	<0.001	2	<0.0001	1	<1	26	<0.001	<0.001	0.009	<1	0.09
BSW17	19/08/2014	ME1401208010	185	3.9	42	64	0.99	1.12		0.11	0	<0.001	<1	<0.0001	2	<1	24	<0.001	<0.001	0.009	<1	0.08
BSW17	20/11/2014	ME1401676006	209	3.7	54	73	1.29	0.93		0.11	<0.001	<0.001	<1	<0.0001	1	<1	25	<0.001	0.004	0.006	<1	0.54
BSW17	29/04/2015	ME1500659054	170	4	4	68	1.1	1.18		<0.01	0	<0.001	<1	<0.0001	2	<1	30	0	<0.001	0.002	<1	0.1
BSW17	1/09/2016	ME1601226039	103	5.8	5	49	0.77	0.88	0	0.02	0	<0.001	6	<0.0001	2	<1	20	0	<0.001	<0.001	<1	0.12
BSW18	1/09/2016	ME1601226040	161	5.8	23	98	1.4	1.52	0	0.03	0	0.008	6	0.0022	6	<1	19	0	<0.001	0.004	<1	1.28
BSW19	20/08/2014	ME1401208011	526	6.2	26	305	4.7	4.66	0.41	0.03	0	<0.001	33	<0.0001	14	<1	59	<0.001	0.008	0.001	<1	0.2
BSW19	14/08/2015	ME1510328011	445	6.5	8	256	0	0	0	0.02	0	<0.001	23	<0.0001	21	<1	30	0	0.002	0.001	<1	0.09
BSW19	31/08/2016	ME1601226016	652	7.2	43	385	6.19	6.16	0.22	<<0.01	0	<0.001	75	<0.0001	21	<1	102	0	<0.001	<0.001	<1	0.32
BSW20	18/02/2014	ME1400288008	2050	8.5	92	1329	20.8	23	5.18	0.09	0	0.006	295	<0.0001	62	21	351	<0.001	<0.001	0.002	<1	<0.05
BSW20	22/05/2014	ME1400741017	1200	7	79	777	12.1	13	3.44	0.05	0	<0.001	136	<0.0001	61	<1	151	<0.001	<0.001	0.002	<1	<0.05
BSW20	20/08/2014	ME1401208012	1190	7.2	11	748	12.1	12.2	0.27	0.02	0	<0.001	130	<0.0001	46	<1	193	<0.001	<0.001	0.002	<1	<0.05
BSW20	20/11/2014	ME1401676007	1540	8.3	72	1053	17.6	16.4	3.55	0.04	<0.001	0.002	223	<0.0001	40	<1	298	<0.001	<0.001	<0.001	<1	0.06
BSW20	9/02/2015	ME1500221006	1930	7.6	71	1243	20.2	20.3	0.35	0.05	0	0.005	274	0.0001	60	<1	348	0	0.002	0.005	<1	0.09
BSW20	1/05/2015	ME1500659055	1900	8.4	103	1283	20.8	21.3	0.97	0.03	0	0.003	227	<0.0001	54	<1	376	0	0.002	0.004	<1	0.67
BSW20	14/08/2015	ME1510328012	1000	7	6	619	0	0	0	0.02	0	<0.001	101	<0.0001	48	<1	104	0	<0.001	0.002	<1	0.06
BSW20	14/10/2015	ME1510717004	1350	7.6	34	895	0	0	0	<0.01	0	<0.001	208	<0.0001	75	<1	167	0	<0.001	<0.001	<1	<0.05
BSW20	12/05/2016	ME1600662009	1560	8.7	14	996	16.2	16.5	1.03	<0.01	0	0.002	181	<0.0001	34	29	280	0	<0.001	0.002	<1	0.06
BSW20	31/08/2016	ME1601226017	776	7.6	10	484	7.84	7.63	1.4	<0.01	0	<0.001	104	<0.0001	30	<1	104	0	<0.001	0.001	<1	0.16
BSW21	18/02/2014	ME1400288009	1710	7.8	15	1199	18	19.7	4.65	<0.01	0	0.003	390	<0.0001	93	<1	192	<0.001	<0.001	0.002	<1	<0.05
BSW21	22/05/2014	ME1400741018	1260	7.3	48	841	13	13.8	2.71	0.04	0	<0.001	192	<0.0001	70	<1	152	<0.001	<0.001	<0.001	<1	0.06
BSW21	20/08/2014	ME1401208013	1200	7.2	14	755	12	12.4	1.4	0.03	0	<0.001	133	<0.0001	51	<1	184	<0.001	<0.001	0.001	<1	<0.05
BSW21	20/11/2014	ME1401676008	1560	7.4	14	1192	18.6	18	1.73	0.04	<0.001	0.002	446	<0.0001	95	<1	195	<0.001	<0.001	<0.001	<1	<0.05
BSW21	8/02/2015	ME1500221007	1890	7.5	190	1313	20.4	20.8	0.97	0.02	0	0.002	361	<0.0001	104	<1	236	0	<0.001	0.001	<1	<0.05
BSW21	1/05/2015	ME1500659056	1420	7.5	10	1030	15.8	16.6	2.4	0.02	0	<0.001	289	<0.0001	97	<1	173	0	<0.001	0.001	<1	<0.05
BSW21	4/08/2015	ME1510328013	1020	7.1	3	372	0	0	0	<<0.01	0	<0.001	72	<0.0001	37	<1	38	0	<0.001	0.001	<1	0.06
BSW21	14/10/2015	ME1510717005	1380	7.6	8	847	0	0	0	0.02	0	0.001	149	<0.0001	85	5	152	0	<0.001	<0.001	<1	0.1
BSW21	3/02/2016	ME1600265056	1544	7.4	88	1105	16.4	18.7	6.49	<0.01	0	<0.001	373	<0.0001	101	<1	159	0	<0.001	<0.001	<1	<0.05
BSW21	12/05/2016	ME1600662010	1410	7.7	6	987	15.1	16.1	3.16	<<0.01	0	<0.001	281	<0.0001	98	<1	170	0	<0.001	<0.001	<1	<0.05
BSW21	5/09/2016	ME1601226067	272	7.2	18	166	2.56	2.6	0	0.12	0	<0.001	46	<0.0001	11	<1	30	0	<0.001	0.002	<1	0.61
BSW22	18/02/2014	ME1400288010	961	7.9	5	659	10	11.2	5.63	0.03	0	0.004	290	0.0001	54	<1	106	<0.001	<0.001	0.002	<1	<0.05
BSW22	22/05/2014	ME1400741019	1040	7.4	21	684	10.6	11	1.73	0.04	0	<0.001	200	<0.0001	62	<1	107	<0.001	<0.001	<0.001	<1	0.05
BSW22	20/08/2014	ME1401208014	1140	7.5	2	745	11.6	12.2	2.21	<0.01	0	<0.001	171	<0.0001	63	<1	148	<0.001	<0.001	<0.001	<1	0.08
BSW22	20/11/2014	ME1401676009	1200	7.4	6	893	14.1	13.8	1.1	0.02	<0.001	<0.001	298	<0.0001	87	<1	155	<0.001	<0.001	<0.001	<1	<0.05
BSW22	8/02/2015	ME1500221008	945	7.7	6	623	9.6	9.9	1.51	0.02	0	0.002	252	<0.0001	58	18	96	0	<0.001	0.004	<1	<0.05
BSW22	1/05/2015	ME1500659057	1010	7.7	10	706	10.9	11.5	2.69	0.02	0	0.001	264	<0.0001	65	<1	127	0	<0.001	<0.001	<1	<0.05

Sample Location	Sampling Date	Sample Num	Electrical Conductivity @ 25°C µS/cm	pH Value pH Unit	Total Suspended Solids mg/L	TDS (mg/L) Calc	Total Anions meq/L	Total Cations meq/L	Ionic Balance %	Ammonia as N mg/L	Antimony - Dissolved mg/L	Arsenic - Dissolved mg/L	Bicarbonate Alkalinity as CaCO3 mg/L	Cadmium - Dissolved mg/L	Calcium - Dissolved mg/L	Carbonate Alkalinity as CaCO3 mg/L	Chloride mg/L	Chromium - Dissolved mg/L	Cobalt - Dissolved mg/L	Copper - Dissolved mg/L	Hydroxide Alkalinity as CaCO3 mg/L	Iron - Dissolved mg/L
BSW22	7/08/2015	ME1510328014	991	7.3	4	540	0	0	0	<0.01	0	<0.001	98	<0.0001	59	<1	56	0	<0.001	0.001	<1	0.11
BSW22	14/10/2015	ME1510717006	1060	7.7	44	739	0	0	0	0.04	0	0.001	241	<0.0001	70	<1	112	0	<0.001	<0.001	<1	0.06
BSW22	3/02/2016	ME1600265057	648	8.5	94	402	6.18	6.27	0.79	<0.01	0	<0.001	205	<0.0001	36	<1	56	0	<0.001	<0.001	<1	0.07
BSW22	12/05/2016	ME1600662011	992	7.8	3	667	10.3	10.7	1.56	<<0.01	0	<0.001	274	<0.0001	55	<1	119	0	<0.001	<0.001	<1	0.07
BSW23	30/04/2015	ME1500659058	119	6.7	444	114	1.71	1.48		0.03	0	0.002	29	<0.0001	8	<1	12	0	<0.011	0.006	<1	2.18
BSW23	7/09/2016	ME1601226068	94	6.4	10	50	0.72	0.93	0	<<0.01	0	<0.001	10	<0.0001	4	<1	17	0	<0.001	0.003	<1	0.28
BSW24	7/09/2016	ME1601226069	86	5.5	<1	42	0.61	0.77	0	<<0.01	0	<0.001	4	<0.0001	3	<1	15	0	<0.001	<0.001	<1	0.2
BSW25	17/02/2014	ME1400288011	241	7.6	68	161	2.35	2.57		0.04	0	0.002	89	<0.0001	4	<1	12	<0.001	0.002	0.002	<1	0.16
BSW25	21/05/2014	ME1400741009	192	6.6	24	122	1.7	1.87		0.08	0	0.001	58	<0.0001	2	<1	11	<0.001	<0.001	<0.001	<1	1.38
BSW25	20/08/2014	ME1401208015	214	7.3	28	126	1.88	1.78		0.02	0	<0.001	58	<0.0001	2	<1	13	<0.001	<0.001	0.001	<1	0.4
BSW25	20/11/2014	ME1401676010	184	7.2	30	121	1.7	1.81		<0.01	<0.001	0.002	60	<0.0001	4	<1	11	<0.001	0.002	0.002	<1	1.25
BSW25	6/02/2015	ME1500221009	157	7.8	26	98	1.38	1.47		0.05	0	0.003	48	<0.0001	3	<1	9	0	0.002	0.003	<1	1.28
BSW25	30/04/2015	ME1500659059	100	6.7	28	65	0.88	1.01		0.04	0	0.005	21	<0.0001	2	<1	6	0	0.001	0.002	<1	0.56
BSW25	4/08/2015	ME1510328015	176	7.5	9	91	0	0	0	0.05	0	<0.001	41	<0.0001	2	<1	8	0	<0.001	0.001	<1	0.14
BSW25	14/10/2015	ME1510717007	210	8	11	133	0	0	0	0.03	0	<0.001	72	<0.0001	3	<1	14	0	<0.001	<0.001	<1	0.49
BSW25	3/02/2016	ME1600265058	151	9.4	23	73	1.41	0.31	0	0.05	0	<0.001	39	<0.0001	<1	14	11	0	<0.001	<0.001	<1	0.23
BSW25	12/05/2016	ME1600662012	118	7.3	94	74	1.03	1.06	0	0.34	0	<0.001	32	<0.0001	2	<1	8	0	0.002	0.002	<1	0.43
BSW26	17/02/2014	ME1400288012	193	7.6	41	128	1.86	2.03		0.04	0	0.006	37	<0.0001	3	<1	30	<0.001	0.002	0.002	<1	2.4
BSW26	21/05/2014	ME1400741010	126	6.8	5	69	1.11	1.12		0.06	0	0.002	15	<0.0001	1	<1	17	<0.001	<0.001	<0.001	<1	0.49
BSW26	20/08/2014	ME1401208016	94	7	40	47	0.66	0.63		0.02	0	0.002	8	<0.0001	<1	<1	11	<0.001	<0.001	0.001	<1	<0.05
BSW26	20/11/2014	ME1401676011	151	7.3	4	91	1.25	1.32		0.02	<0.001	0.004	27	<0.0001	2	<1	20	<0.001	<0.001	<0.001	<1	0.73
BSW26	6/02/2015	ME1500221010	175	9.2	24	95	1.31	1.37		0.02	0	0.004	25	<0.0001	2	<1	23	0	<0.001	<0.001	<1	0.51
BSW26	30/04/2015	ME1500659060	135	6.7	13	81	1.02	1.33		0.13	0	0.004	17	<0.0001	4	<1	16	0	<0.001	0.001	<1	0.33
BSW26	5/09/2016	ME1601226053	78	5.9	6	41	0.6	0.56	0	<<0.01	0	<0.001	6	<0.0001	1	<1	12	0	<0.001	<0.001	<1	0.14
BSW27	17/02/2014	ME1400288013	252	6.9	256	150	2.8	2.58		1.01	0	0.022	10	<0.0001	3	<1	47	<0.001	0.001	0.004	<1	0.45
BSW27	21/05/2014	ME1400741011	100	6.8	37	53	0.7	0.79		0.04	0	0.004	12	<0.0001	<1	<1	12	<0.001	<0.001	<0.001	<1	0.14
BSW27	20/08/2014	ME1401208017	119	6.5	5	61	0.79	0.93		0.96	0	0.001	6	<0.0001	1	<1	15	<0.001	<0.001	0.001	<1	0.23
BSW27	20/11/2014	ME1401676012	154	7.2	48	91	1.18	1.38		0.03	<0.001	<0.01	34	<0.0001	4	<1	14	<0.001	0.001	<0.001	<1	0.67
BSW27	6/02/2015	ME1500221011	163	7.9	60	97	1.34	1.48		0.05	0	<0.012	32	<0.0001	3	<1	21	0	<0.001	0.003	<1	0.22
BSW27	30/04/2015	ME1500659061	171	6.6	8	99	1.33	1.61		0.11	0	0.002	9	<0.0001	3	<1	23	0	<0.001	<0.001	<1	0.26
BSW27	4/08/2015	ME1510328016	83	5.7	6	41	0	0	0	0.05	0	0.001	6	<0.0001	2	<1	7	0	<0.001	<0.001	<1	0.07
BSW27	14/10/2015	ME1510717008	115	7.9	12	71	0	0	0	0.03	0	0.005	24	<0.0001	2	<1	12	0	<0.001	<0.001	<1	0.8
BSW27	3/02/2016	ME1600265059	116	9.2	27	76	1.04	1.09	0	0.05	0	0.004	35	<0.0001	3	<1	12	0	<0.001	<0.001	<1	0.26
BSW27	12/05/2016	ME1600662013	130	7.2	54	80	1.07	1.2	0	0.02	0	0.005	27	<0.0001	3	<1	15	0	<0.001	<0.001	<1	0.58
BSW27	5/09/2016	ME1601226054	71	6.4	20	37	0.6	0.5	0	<<0.01	0	<0.001	4	<0.0001	1	<1	14	0	<0.001	<0.001	<1	0.1
J+J Walker Spring	8/01/2014	ME1400079048	76	5.4	24	35	0.53	0.61		0.03	0	<0.001	2	<0.0001	<1	<1	15	<0.001	0.003	0.026	<1	0.56
KURTZ	16/05/2014	ME1400741016	1590	6.9	5	1168	17.6	18.6	2.8	0.05	0	<0.001	626	<0.0001	122	<1	103	<0.001	<0.001	0.043	<1	<0.05
Lue Pub Cellar	8/04/2014	ME1400540046	384	7.3	2	228	3.94	3.79	1.95	<<0.01	0	0.002	102	<0.0001	27	<1	31	<0.001	<0.001	0.072	<1	<0.05

Sample Location	Sampling Date	Sample Num	Lead - Dissolved mg/L	Lithium - Dissolved mg/L	Magnesium - Dissolved mg/L	Manganese - Dissolved mg/L	Mercury - Dissolved mg/L	Molybdenum - Dissolved mg/L	Nickel - Dissolved mg/L	Potassium - Dissolved mg/L	Silver - Dissolved mg/L	Sodium - Dissolved mg/L	Strontium - Dissolved mg/L	Sulfate as SO4 - Turbidimetric mg/L	Zinc - Dissolved mg/L	Nitrate as N mg/L	Nitrite + Nitrate as N mg/L	Nitrite as N mg/L	Total Kjeldahl Nitrogen as N mg/L	Total Nitrogen as N mg/L	Total Phosphorus as P mg/L	Total Alkalinity as CaCO3 mg/L
BGW01	7/01/2014	ME1400079002	<0.001	<0.001	1	0.008	<0.0001	<0.001	<0.001	2	<0.001	18	0.025	7	0.036	0.08	0.08	<0.01	0.9	1	0.07	22
BGW01	7/04/2014	ME1400540001	<0.001	0.002	1	<0.01	<0.0001	<0.001	0.002	3	<0.001	22	0.029	7	<0.011	0.2	0.2	<0.01	1.4	1.6	0.06	26
BGW01	7/07/2014	ME1401051001	<0.001	<0.001	1	0.004	<0.0001	<0.001	<0.001	2	<0.001	21	0.028	2	<0.018	0.38	0.38	<0.01	0.1	0.5	0.03	30
BGW01	10/10/2014	ME1401512001	<0.001	0.002	2	0.006	<0.0001	<0.001	<0.001	2		20	0.033	15	0.006	0.6	0.6	<0.01	0.4	1	0.04	16
BGW01	18/08/2015	ME1510328024	<0.001	0	2	<0.01	0	0	<0.001	3	0	22	0	2	0.006	1.66	1.66	<0.01	0.2	1.9	0.13	24
BGW03	7/01/2014	ME1400079003	<0.001	0.94	11	0.034	<0.0001	<0.001	<0.001	6	<0.001	571	0.3	6	0.028	<0.01	0.02	0.02	1.3	1.3	0.08	585
BGW03	7/04/2014	ME1400540002	<0.001	0.564	21	0.874	<0.0001	<0.001	<0.001	5	<0.001	331	0.382	11	<0.005	<0.01	0.09	0.08	1.9	2	0.02	178
BGW03	7/07/2014	ME1401051002	0.003	0.626	20	0.292	<0.0001	<0.001	<0.001	6	<0.001	400	0.464	5	0.008	<0.01	<0.01	<0.01	0.7	0.7	<0.01	303
BGW03	10/10/2014	ME1401512002	<0.001	0.686	18	0.056	<0.0001	<0.001	<0.001	6		540	0.392	7	<0.005	0.04	0.04	<0.01	0.6	0.6	<0.01	450
BGW05	7/01/2014	ME1400079004	<0.001	0.003	10	1.43	<0.0001	<0.001	0.005	2	<0.001	55	0.173	32	0.078	<0.01	<0.01	<0.01	0.7	0.7	0.04	90
BGW05	7/04/2014	ME1400540003	<0.001	0.002	10	0.022	<0.0001	<0.001	<0.001	2	<0.001	47	0.139	33	<0.016	0.42	0.42	<0.01	0.8	1.2	0.05	81
BGW05	7/07/2014	ME1401051003	<0.001	0.006	8	0.175	<0.0001	<0.001	<0.001	2	<0.001	43	0.129	22	0.021	0.07	0.07	<0.01	<0.1	<0.1	<<0.01	92
BGW05	10/10/2014	ME1401512003	<0.001	0.001	14	1.45	<0.0001	<0.001	0.004	2		44	0.202	59	<0.016	0.06	0.06	<0.01	0.2	0.3	0.02	68
BGW05	4/02/2015	ME1500221013	<0.001	0	19	1.62	0	0	0.005	4	0	54	0	72	0.048	0.03	0.03	<0.01	0.5	0.5	0.06	68
BGW05	1/05/2015	ME1500659001	<0.001	0	21	0.371			0.002	3	0	61	0	76	0.027	0.23	0.23	<0.01	0.4	0.6	0.02	62
BGW05	18/08/2015	ME1510328020	<0.001	0	23	0.469	0	0	0.002	4	0	59	0	73	<0.018	0.07	0.07	<0.01	0.1	0.2	0.1	63
BGW05	22/10/2015	ME1510717010	<0.001	0	24	0.957	0	0	0.003	2	0	58	0	70	0.041	0.07	0.07	<0.01	0.2	0.3	0.02	73
BGW05	24/02/2016	ME1600265029	<0.001	0	27	2.35	0	0	0.008	3	0	68	0	110	0.023	0.07	0.07	<0.01	0.2	0.3	<<0.01	75
BGW05	27/05/2016	ME1600733001	<0.001	0	30	0.488	0	0	0.002	4	0	60	0	143	<0.017	0.13	0.13	<0.01	<0.1	0.1	<<0.01	61
BGW05	5/09/2016	ME1601226041	<0.001	0	39	5.63	0	0	0.015	3	0	97	0	203	0.025	0.07	0.07	<0.01	0.2	0.3	<<0.01	43
BGW05	20/12/2016	ME1601793015	<0.001	0	29	4.19	0	0	0.013	3	0	90	0	184	0.02	<0.01	<0.01	<0.01	0.2	0.2	<<0.01	55
BGW06	19/05/2014	ME1400741013	<0.001	<0.001	8	0.27	<0.0001	<0.001	0.005	6	<0.001	131	0.438	128	<0.018	<0.01	<0.01	<0.01	2.4	2.4	0.24	86
BGW06	14/07/2014	ME1401051004	0.001	<0.001	9	0.081	<0.0001	<0.001	0.005	5	<0.001	137	0.434	142	0.024	0.02	0.02	<0.01	0.9	0.9	0.13	105
BGW06	10/10/2014	ME1401512004	0.002	<0.001	8	0.123	<0.0001	<0.001	0.005	5		142	0.402	116	0.065	0.03	0.03	<0.01	2.4	2.4	0.27	101
BGW06	4/02/2015	ME1500221014	0.002	0	7	0.193	0	0	0.004	4	0	108	0	92	<0.014	<0.01	<0.01	<0.01	2.6	2.6	0.33	84
BGW06	1/05/2015	ME1500659002	0.002	0	8	0.157			0.004	4	0	119	0	78	0.047	0.03	0.04	<0.01	1.9	1.9	0.37	111
BGW06	18/08/2015	ME1510328021	0.002	0	4	0.18	0	0	0.008	5	0	53	0	62	0.023	<0.01	<0.01	<0.01	3	3	0.23	41
BGW06	22/10/2015	ME1510717011	0.002	0	5	0.202	0	0	0.007	5	0	58	0	46	<0.014	<0.01	<0.01	<0.01	3.9	3.9	0.4	52
BGW06	24/02/2016	ME1600265030	0.007	0	5	0.215	0	0	0.009	5	0	84	0	63	0.031	0.02	0.02	<0.01	4.9	4.9	0.58	75
BGW06	27/05/2016	ME1600733002	0.001	0	4	0.144	0	0	0.004	5	0	70	0	48	<0.01	0.08	0.08	<0.01	2.9	3	0.42	90
BGW06	5/09/2016	ME1601226042	<0.001	0	13	0.42	0	0	0.002	5	0	163	0	175	0.007	0.05	0.05	<0.01	0.8	0.8	0.12	158
BGW06	20/12/2016	ME1601793016	<0.001	0	17	0.474	0	0	0.002	4	0	180	0	205	<0.005	0.02	0.02	<0.01	0.5	0.5	0.02	158
BGW07	7/01/2014	ME1400079005	<0.001	0.029	144	0.244	<0.0001	<0.001	<0.001	9	<0.001	428	0.957	408	0.007	<0.01	0.02	0.02	0.9	0.9	0.04	459
BGW07	7/04/2014	ME1400540004	<0.001	0.036	213	0.205	<0.0001	<0.001	<0.001	12	<0.001	479	1.18	772	<0.005	<0.01	<0.01	<0.01	0.6	0.6	0.02	390
BGW07	23/07/2014	ME1401051005	<0.001	0.049	234	0.222	<0.0001	0.002	<0.001	12	<0.001	544	1.18	814	<0.005	<0.01	<0.01	<0.01	0.3	0.3	0.02	506
BGW07	14/10/2014	ME1401512005	<0.001	0.047	222	0.232	<0.0001	0.002	<0.001	13		603	1.26	665	<0.013	0.09	0.09	<0.01	0.3	0.4	0.02	542
BGW07	4/02/2015	ME1500221015	<0.001	0	183	0.231	0	0	<0.001	11	0	485	0	638	<0.005	0.1	0.1	<0.01	0.7	0.8	0.03	466
BGW07	29/04/2015	ME1500659003	<0.001	0	183	0.245			<0.001	10	0	463	0	666	0.241	<0.01	0.06	0.06	0.8	0.8	0.04	318
BGW07	18/08/2015	ME1510328022	<0.001	0	191	0.379	0	0	<0.001	8	0	450	0	873	<0.005	0.02	0.04	0.02	0.7	0.7	0.06	115
BGW07	22/10/2015	ME1510717012	<0.001	0	189	0.355	0	0	<0.001	9	0	436	0	748	<0.005	0.05	0.05	<0.01	0.5	0.6	0.05	111
BGW07	24/02/2016	ME1600265031	<0.001	0	68	0.289	0	0	0.002	7	0	158	0	371	<0.005	0.06	0.06	<0.01	1	1.1	0.03	86
BGW07	27/05/2016	ME1600733003	<0.001	0	68	0.338	0	0	<0.001	11	0	148	0	379	<0.005	0.04	0.04	<0.01	1.2	1.2	0.04	122
BGW07	5/09/2016	ME1601226043	<0.001	0	65	0.143	0	0	<0.001	7	0	132	0	353	0.006	0.17	0.17	<0.01	0.9	1.1	0.06	52
BGW07	20/12/2016	ME1601793017	<0.001	0	82	0.683	0	0	<0.001	5	0	166	0	407	<0.005	0.02	0.02	<0.01	1.7	1.7	0.1	107
BGW08	7/01/2014	ME1400079006	0.002	0.307	12	0.008	<0.0001	0.002	0.004	10	<0.001	413	0.818	36	0.044	0.34	0.34	<0.01	1.3	1.6	0.04	766
BGW08	7/04/2014	ME1400540005	0.002	0.322	13	0.001	<0.0001	0.002	<0.001	9	<0.001	361	0.838	36	<0.01	0.3	0.3	<0.01	0.1	0.4	<<0.01	774
BGW08	23/07/2014	ME1401051006	<0.001	0.317	16	0.004	<0.0001	0.002	<0.001	9	<0.001	454	0.957	37	0.029	0.54	0.54	<0.01	0.2	0.7	0.17	964
BGW08	14/10/2014	ME1401512006	<0.001	0.201	25	0.127	<0.0001	0.002	<0.001	15		415	1.06	50	<0.014	0.12	0.12	<0.01	0.1	0.2	0.02	818
BGW08	8/02/2015	ME1500221016	<0.001	0	29	0.205	0	0	<0.001	14	0	225	0	55	<0.011	0.02	0.02	<0.01	0.4	0.4	0.02	551
BGW08	1/05/2015	ME1500659004	<0.001	0	19	0.069			0.002	9	0	433	0	49	0.029	0.08	0.1	0.02	<0.1	0.1	0.02	860

Sample Location	Sampling Date	Sample Num	Lead - Dissolved mg/L	Lithium - Dissolved mg/L	Magnesium - Dissolved mg/L	Manganese - Dissolved mg/L	Mercury - Dissolved mg/L	Molybdenum - Dissolved mg/L	Nickel - Dissolved mg/L	Potassium - Dissolved mg/L	Silver - Dissolved mg/L	Sodium - Dissolved mg/L	Strontium - Dissolved mg/L	Sulfate as SO4 - Turbidimetric mg/L	Zinc - Dissolved mg/L	Nitrate as N mg/L	Nitrite + Nitrate as N mg/L	Nitrite as N mg/L	Total Kjeldahl Nitrogen as N mg/L	Total Nitrogen as N mg/L	Total Phosphorus as P mg/L	Total Alkalinity as CaCO3 mg/L
BGW08	18/08/2015	ME1510328023	<0.001	0	22	0.142	0	0	<0.001	11	0	365	0	44	<0.01	0.05	0.05	<0.01	0.5	0.5	0.36	696
BGW08	28/10/2015	ME1510717013	<0.001	0	15	0.074	0	0	<0.001	9	0	396	0	36	<0.005	0.08	0.08	<0.01	8.6	8.7	0.81	904
BGW08	24/02/2016	ME1600265032	<0.001	0	18	0.064	0	0	<0.001	10	0	366	0	41	<0.012	0.04	0.04	<0.01	0.3	0.3	0.05	784
BGW08	27/05/2016	ME1600733004	<0.001	0	16	0.07	0	0	<0.001	10	0	362	0	42	<0.01	0.08	0.08	<0.01	<0.1	<0.1	<<0.01	830
BGW08	5/09/2016	ME1601226044	0.008	0	19	0.176	0	0	<0.001	9	0	376	0	33	0.061	0.04	0.04	<0.01	0.2	0.2	0.13	766
BGW08	20/12/2016	ME1601793018	<0.001	0	16	0.092	0	0	<0.001	9	0	375	0	37	<0.005	0.08	0.08	<0.01	0.1	0.2	0.12	762
BGW09	7/01/2014	ME1400079007	<0.001	0.117	61	0.065	<0.0001	<0.001	<0.001	8	<0.001	176	2.26	28	0.03	0.04	0.04	<0.01	1	1	0.03	654
BGW09	21/05/2014	ME1400741014	<0.001	0.112	63	0.062	<0.0001	<0.001	0.058	8	<0.001	166	2.79	40	2.75	0.17	0.17	<0.01	<0.1	0.2	0.08	597
BGW09	7/07/2014	ME1401051007	<0.001	0.115	64	0.072	<0.0001	<0.001	<0.001	8	<0.001	170	2.33	47	0.007	<0.01	<0.01	<0.01	<0.1	<0.1	<<0.01	685
BGW09	10/10/2014	ME1401512007	<0.001	0.087	59	0.084	<0.0001	<0.001	<0.001	7		140	2.51	36	<0.005	0.05	0.05	<0.01	<0.1	<0.1	<<0.01	696
BGW09	6/02/2015	ME1500221017	<0.001	0	66	0.082	0	0	0.002	7	0	166	0	28	<0.005	<0.01	<0.01	<0.01	0.2	0.2	0.02	632
BGW09	1/05/2015	ME1500659005	<0.001	0	71	0.071			0.018	8	0	195	0	22	<0.005	<0.01	<0.01	<0.01	0.2	0.2	<<0.01	661
BGW09	18/08/2015	ME1510328025	<0.001	0	71	0.085	0	0	0.003	7	0	202	0	23	<0.012	<0.01	<0.01	<0.01	0.1	0.1	0.02	640
BGW09	22/10/2015	ME1510717014	<0.001	0	70	0.063	0	0	<0.001	7	0	184	0	26	<0.005	0.07	0.07	<0.01	<0.1	<0.1	0.02	525
BGW09	24/02/2016	ME1600265033	<0.001	0	64	0.069	0	0	<0.001	8	0	186	0	29	0.007	0.05	0.05	<0.01	0.2	0.2	<0.01	671
BGW09	27/05/2016	ME1600733005	<0.001	0	61	0.063	0	0	<0.001	8	0	155	0	31	<0.005	0.02	0.02	<0.01	<0.1	<0.1	<<0.01	705
BGW09	5/09/2016	ME1601226045	<0.001	0	66	0.075	0	0	0.028	7	0	183	0	29	0.15	0.04	0.04	<0.01	<0.1	<0.1	<<0.01	651
BGW09	20/12/2016	ME1601793019	<0.001	0	59	0.061	0	0	<0.001	6	0	168	0	27	<0.005	0.06	0.06	<0.01	<0.1	<0.1	<<0.01	624
BGW10	10/01/2014	ME1400079008	<0.001	0.076	64	0.414	<0.0001	<0.001	0.002	21	<0.001	90	0.785	373	<0.012	<0.01	<0.01	<0.01	0.4	0.4	0.04	307
BGW10	31/03/2014	ME1400540006	<0.001	0.075	56	0.342	<0.0001	<0.001	<0.001	20	<0.001	84	0.638	288	0.007	1.65	1.65	<0.01	0.8	2.4	0.12	270
BGW10	15/07/2014	ME1401051008	<0.001	0.073	58	0.301	<0.0001	<0.001	<0.001	19	<0.001	87	0.657	299	<0.01	<0.01	<0.01	<0.01	0.3	0.3	0.05	316
BGW10	13/10/2014	ME1401512008	<0.001	0.066	52	0.311	<0.0001	<0.001	<0.001	16		70	0.676	300	0.009	0.04	0.04	<0.01	0.3	0.3	0.06	324
BGW10	4/12/2014	ME1401772005	<0.001	0	74	0.378	0	0	<0.001	20	0	108	0	431	<0.016	0	0	0	0	0	0	360
BGW10	5/12/2014	ME1401772006	<0.001	0	77	0.369	0	0	0.002	19	0	109	0	434	0.009	0	0	0	0	0	0	366
BGW10	6/12/2014	ME1401772007	<0.001	0	78	0.351	0	0	<0.001	20	0	110	0	451	0.007	0	0	0	0	0	0	366
BGW10	7/12/2014	ME1401772008	<0.001	0	78	0.363	0	0	0.002	20	0	109	0	451	0.008	0	0	0	0	0	0	370
BGW10	5/02/2015	ME1500221018	<0.001	0	52	0.292	0	0	<0.001	17	0	70	0	286	<0.005	<0.01	<0.01	<0.01	<0.1	<0.1	0.08	262
BGW10	29/04/2015	ME1500659006	<0.001	0	57	0.309			0.002	19	0	80	0	318	<0.014	<0.01	<0.01	<0.01	<0.1	<0.1	0.03	281
BGW10	7/08/2015	ME1510328026	<0.001	0	59	0.299	0	0	<0.001	18	0	87	0	318	<0.005	<0.01	<0.01	<0.01	<0.1	<0.1	0.03	288
BGW10	27/10/2015	ME1510717015	<0.001	0	46	0.306	0	0	<0.001	14	0	66	0	284	<0.005	0.07	0.07	<0.01	<0.1	<0.1	0.05	302
BGW10	23/02/2016	ME1600265017	<0.001	0	56	0.297	0	0	<0.001	18	0	89	0	359	0.006	0.02	0.02	<0.01	<0.1	<0.1	0.05	317
BGW10	18/05/2016	ME1600733006	<0.001	0	48	0.318	0	0	<0.001	14	0	69	0	290	0.007	0.03	0.03	<0.01	<0.1	<0.1	<<0.01	242
BGW10	30/08/2016	ME1601226001	<0.001	0	68	0.331	0	0	<0.001	19	0	103	0	377	<0.01	0.04	0.04	<0.01	<0.1	<0.1	0.03	332
BGW10	21/12/2016	ME1601793032	<0.001	0	57	0.336	0	0	<0.001	17	0	80	0	366	0.006	0.04	0.04	<0.01	<0.1	<0.1	<0.01	296
BGW102	10/01/2014	ME1400079053	0.002	0.363		3.22	<0.0001	0.013	0.003		<0.001		1.34		0.037		<0.01		0.6	0.6	0.21	
BGW102	10/01/2014	ME1400079053	0.002	0.363		3.22	<0.0001	0.013	0.003		<0.001		1.34		0.037		<0.01		0.6	0.6	0.21	
BGW102	14/10/2014	ME1401512051	<0.001	0.357	63	2.59	<0.0001	0.013	<0.001	37		75	1.26		0.103							
BGW102	14/10/2014	ME1401512051	<0.001	0.357	63	2.59	<0.0001	0.013	<0.001	37		75	1.26		0.103							
BGW102	30/04/2015	ME1500659043	0.026	0	63	2.73			0.003	32	0	70	0	393	0.239	0.04	0.04	<0.01	1.1	1.1	0.15	283
BGW102	30/04/2015	ME1500659043	0.026	0	63	2.73			0.003	32	0	70	0	393	0.239	0.04	0.04	<0.01	1.1	1.1	0.15	283
BGW106	10/01/2014	ME1400079045	0.002	0.171	39	2.41	<0.0001	<0.001	0.002	24	<0.001	81	0.94	225	0.044	<0.01	<0.01	<0.01	1.5	1.5	0.03	151
BGW106	9/04/2014	ME1400540043	<0.001	0.175	42	2.65	<0.0001	<0.001	<0.001	24	<0.001	83	1.14	218	<0.019	<0.01	<0.01	<0.01	1.1	1.1	<<0.01	144
BGW106	22/07/2014	ME1401051046	<0.001	0.156	42	2.5	<0.0001	<0.001	<0.001	25	<0.001	85	1.02	249	<0.015	0.3	0.3	<0.01	0.8	1.1	<<0.01	168
BGW106	14/10/2014	ME1401512048	<0.001	0.16	44	2.36	<0.0001	<0.001	<0.001	26		86	0.979	226	0.043	0.12	0.14	0.02	1	1.1	<0.01	163
BGW106	8/02/2015	ME1500221020	<0.001	0	43	2.55	0	0	0.002	21	0	78	0	239	0.302	0.42	0.42	<0.01	0.4	0.8	0.05	138
BGW106	30/04/2015	ME1500659044	0.003	0	46	2.29			0.003	22	0	85	0	248	0.45	0.14	0.14	<0.01	0.2	0.3	<0.01	146
BGW106	14/08/2015	ME1510328027	<0.001	0	45	0.04	0	0	<0.001	22	0	89	0	245	0.071	0.13	0.13	<0.01	0.1	0.2	<0.01	141
BGW106	22/10/2015	ME1510717051	<0.001	0	50	0.124	0	0	<0.001	24	0	86	0	229	0.12	0.08	0.08	<0.01	<0.1	<0.1	<0.01	109
BGW106	22/02/2016	ME1600265001	<0.001	0	41	0.037	0	0	<0.001	24	0	86	0	254	0.152	0.05	0.05	<0.01	0.2	0.2	<<0.01	138
BGW106	18/05/2016	ME1600733007	<0.001	0	38	0.052	0	0	<0.001	18	0	72	0	218	0.113	0.12	0.12	<0.01	<0.1	0.1	<<0.01	122

Sample Location	Sampling Date	Sample Num	Lead - Dissolved mg/L	Lithium - Dissolved mg/L	Magnesium - Dissolved mg/L	Manganese - Dissolved mg/L	Mercury - Dissolved mg/L	Molybdenum - Dissolved mg/L	Nickel - Dissolved mg/L	Potassium - Dissolved mg/L	Silver - Dissolved mg/L	Sodium - Dissolved mg/L	Strontium - Dissolved mg/L	Sulfate as SO4 - Turbidimetric mg/L	Zinc - Dissolved mg/L	Nitrate as N mg/L	Nitrite + Nitrate as N mg/L	Nitrite as N mg/L	Total Kjeldahl Nitrogen as N mg/L	Total Nitrogen as N mg/L	Total Phosphorus as P mg/L	Total Alkalinity as CaCO3 mg/L
BGW106	1/09/2016	ME1601226020	<0.001	0	45	0.021	0	0	<0.001	21	0	86	0	268	0.141	0.11	0.11	<0.01	<0.1	0.1	0.03	165
BGW106	19/12/2016	ME1601793001	<0.001	0	42	0.026	0	0	<0.001	20	0	77	0	235	0.104	0.14	0.14	<0.01	<0.1	0.1	<<0.01	146
BGW107	10/01/2014	ME1400079046	<0.001	0.279	70	3.16	<0.0001	0.003	0.006	33	<0.001	81	1.62	320	0.07	0.02	0.02	<0.01	0.6	0.6	0.31	232
BGW107	9/04/2014	ME1400540044	<0.001	0.264	78	4.43	<0.0001	0.003	0.008	34	<0.001	82	2.04	306	0.074	<0.01	<0.01	<0.01	0.2	0.2	0.05	195
BGW107	22/07/2014	ME1401051049	<0.001	0.383	63	2.04	<0.0001	0.006	0.002	31	<0.001	96	1.57	316	0.052	<0.01	<0.01	<0.01	0.2	0.2	0.05	328
BGW107	14/10/2014	ME1401512049	0.001	0.377	61	1.43	<0.0001	0.006	<0.001	30		101	1.56	284	0.049	0.1	0.1	<0.01	0.3	0.4	0.05	347
BGW107	8/02/2015	ME1500221021	<0.001	0	69	2.06	0	0	0.002	28	0	90	0	315	0.037	<0.01	<0.01	<0.01	0.2	0.2	0.07	273
BGW107	30/04/2015	ME1500659045	0.031	0	61	1.46			0.002	26	0	92	0	309	0.074	<0.01	<0.01	<0.01	0.3	0.3	0.08	315
BGW107	14/08/2015	ME1510328028	<0.001	0	59	1.23	0	0	<0.001	26	0	99	0	294	0.033	<0.01	<0.01	<0.01	0.3	0.3	0.06	316
BGW107	22/10/2015	ME1510717052	<0.001	0	64	1.11	0	0	<0.001	28	0	100	0	314	0.058	0.03	0.03	<0.01	0.2	0.2	0.06	300
BGW107	22/02/2016	ME1600265002	<0.001	0	50	1.01	0	0	<0.001	24	0	97	0	301	0.069	<0.01	<0.01	<0.01	0.4	0.4	0.04	319
BGW107	18/05/2016	ME1600733008	<0.001	0	50	1.01	0	0	<0.001	24	0	85	0	245	0.058	0.04	0.04	<0.01	<0.1	<0.1	<<0.01	285
BGW107	1/09/2016	ME1601226021	<0.001	0	54	1.04	0	0	<0.001	25	0	100	0	308	0.046	0.02	0.03	<0.01	0.2	0.2	0.05	386
BGW107	19/12/2016	ME1601793002	<0.001	0	48	1.11	0	0	<0.001	23	0	97	0	250	0.03	<0.01	0.03	0.02	0.2	0.2	0.08	356
BGW108	6/01/2014	ME1400079047	0.007	0.478	111	1.32	<0.0001	0.014	0.003	35	<0.001	207	3.1	710	0.514	<0.01	<0.01	<0.01	1.5	1.4	0.08	461
BGW108	9/04/2014	ME1400540045	0.006	0.496	102	1.4	<0.0001	0.012	0.002	33	<0.001	163	3.73	608	0.409	<0.01	<0.01	<0.01	0.4	0.4	0.15	460
BGW108	15/07/2014	ME1401051050	0.003	0.479	114	1.98	<0.0001	0.012	0.002	34	<0.001	230	3.1	754	0.418	0.06	0.06	<0.01	0.4	0.5	0.18	512
BGW108	8/10/2014	ME1401512050	0.008	0.48	122	1.45	<0.0001	0.011	<0.001	37		240	3.17	721	0.438	0.07	0.07	<0.01	0.4	0.5	0.27	489
BGW108	28/11/2014	ME1401772001	<0.001	0	120	1.51	0	0	0.002	32	0	235	0	777	0.321	0	0	0	0	0	0	493
BGW108	29/11/2014	ME1401772002	<0.001	0	116	1.48	0	0	0.002	32	0	228	0	763	0.369	0	0	0	0	0	0	490
BGW108	30/11/2014	ME1401772003	<0.001	0	114	1.34	0	0	0.002	32	0	228	0	752	0.352	0	0	0	0	0	0	488
BGW108	1/12/2014	ME1401772004	<0.001	0	108	1.28	0	0	0.002	31	0	220	0	728	0.398	0	0	0	0	0	0	486
BGW108	7/02/2015	ME1500221022	0.005	0	109	2.28	0	0	<0.001	31	0	203	0	691	0.432	<0.01	<0.01	<0.01	0.4	0.4	0.24	454
BGW108	30/04/2015	ME1500659046	0.007	0	120	1.82			0.002	32	0	222	0	710	0.422	<0.01	<0.01	<0.01	0.5	0.5	0.44	480
BGW108	11/08/2015	ME1510328029	<0.015	0	116	1.59	0	0	<0.001	31	0	228	0	728	0.45	<0.01	<0.01	<0.01	0.4	0.4	0.28	409
BGW108	27/10/2015	ME1510717053	0.022	0	112	1.3	0	0	<0.001	31	0	207	0	722	0.404	0.04	0.04	<0.01	0.4	0.4	0.14	481
BGW108	23/02/2016	ME1600265018	0.021	0	106	1.16	0	0	0.002	30	0	202	0	743	0.379	0.04	0.04	<0.01	0.4	0.4	0.1	504
BGW108	19/05/2016	ME1600733009	0.021	0	98	1.25	0	0	<0.001	28	0	206	0	712	0.345	0.02	0.02	<0.01	1	1	0.06	542
BGW108	6/09/2016	ME1601226056	0.05	0	8	0.126	0	0	0.007	9	0	23	0	60	0.288	0.73	0.73	<0.01	0.4	1.1	0.04	51
BGW108	19/12/2016	ME1601793003	0.024	0	107	2.32	0	0	0.002	29	0	198	0	710	0.725	0.02	0.02	<0.01	0.4	0.4	0.11	439
BGW11	6/01/2014	ME1400079009	<0.001	0.162	94	0.116	<0.0001	<0.001	0.003	16	<0.001	134	0.58	155	0.023	0.04	0.04	<0.01	1.1	1.1	0.02	328
BGW11	17/05/2014	ME1400741015	<0.001	0.152	94	0.103	<0.0001	<0.001	0.002	15	<0.001	121	0.551	131	0.068	0.14	0.14	<0.01	0.4	0.5	0.43	365
BGW11	18/07/2014	ME1401051009	<0.001	0.131	100	0.081	<0.0001	<0.001	0.003	14	<0.001	141	0.528	202	0.037	0.06	0.06	<0.01	0.2	0.3	0.04	352
BGW11	9/10/2014	ME1401512009	<0.001	0.1	117	0.09	<0.0001	<0.001	0.003	18		185	0.573	164	<0.015	0.1	0.1	<0.01	0.2	0.3	<0.01	355
BGW11	7/02/2015	ME1500221023	<0.001	0	92	0.12	0	0	0.002	13	0	122	0	206	0.007	0.03	0.03	<0.01	0.4	0.4	0.03	285
BGW11	29/04/2015	ME1500659007	<0.001	0	112	0.115			0.003	15	0	149	0	172	0.021	0.05	0.05	<0.01	0.3	0.4	0.03	348
BGW11	11/08/2015	ME1510328030	<0.001	0	114	0.086	0	0	0.002	14	0	162	0	187	<0.016	0.05	0.05	<0.01	<0.1	<0.1	0.14	310
BGW11	21/10/2015	ME1510717016	<0.001	0	116	0.104	0	0	0.002	15	0	165	0	170	0.02	0.11	0.11	<0.01	0.1	0.2	0.03	329
BGW11	22/02/2016	ME1600265003	<0.001	0	104	0.102	0	0	0.003	14	0	146	0	167	0.026	<0.01	<0.01	<0.01	0.2	0.2	0.03	317
BGW11	19/05/2016	ME1600733010	<0.001	0	102	0.102	0	0	0.003	14	0	139	0	201	<0.017	0.09	0.09	<0.01	0.1	0.2	<<0.01	365
BGW11	1/09/2016	ME1601226022	<0.001	0	105	0.107	0	0	0.004	14	0	152	0	191	0.021	0.03	0.03	<0.01	1.6	1.6	0.06	370
BGW11	20/12/2016	ME1601793020	<0.001	0	84	0.122	0	0	0.002	12	0	116	0	152	<0.011	<0.01	0.02	<0.01	0.1	0.1	<<0.01	348
BGW12	6/01/2014	ME1400079010	<0.001	0.152	195	0.275	<0.0001	0.004	0.044	20	<0.001	670	0.968	559	0.274	1.29	1.29	<0.01	1.3	2.6	<0.01	204
BGW12	2/04/2014	ME1400540008	<0.001	0.138	224	0.284	<0.0001	0.003	0.053	23	<0.001	695	0.957	594	0.318	1.73	1.73	<0.01	0.6	2.3	0.02	179
BGW12	18/07/2014	ME1401051010	<0.001	0.116	220	0.556	<0.0001	0.013	0.07	21	<0.001	693	1.04	596	0.521	1.02	1.04	0.02	0.5	1.5	0.03	210
BGW12	9/10/2014	ME1401512010	<0.001	0.119	199	0.353	<0.0001	0.009	0.068	17		574	1.04	595	0.35	1.5	1.5	<0.01	0.3	1.8	0.02	200
BGW12	7/02/2015	ME1500221024	<0.001	0	199	0.6	0	0	0.053	18	0	643	0	527	0.219	0.62	0.86	0.24	1.4	2.3	0.24	168
BGW12	29/04/2015	ME1500659008	<0.001	0	187	0.492			0.049	16	0	629	0	541	0.119	0.32	0.37	0.05	1.3	1.7	0.23	168
BGW12	11/08/2015	ME1510328031	<0.001	0	168	0.371	0	0	0.047	14	0	539	0	480	0.243	0.36	0.36	<0.01	0.4	0.8	0.25	158
BGW12	21/10/2015	ME1510717017	<0.001	0	190	0.278	0	0	0.042	16	0	640	0	491	0.273	0.83	0.83	<0.01	0.3	1.1	0.1	178

Sample Location	Sampling Date	Sample Num	Lead - Dissolved mg/L	Lithium - Dissolved mg/L	Magnesium - Dissolved mg/L	Manganese - Dissolved mg/L	Mercury - Dissolved mg/L	Molybdenum - Dissolved mg/L	Nickel - Dissolved mg/L	Potassium - Dissolved mg/L	Silver - Dissolved mg/L	Sodium - Dissolved mg/L	Strontium - Dissolved mg/L	Sulfate as SO4 - Turbidimetric mg/L	Zinc - Dissolved mg/L	Nitrate as N mg/L	Nitrite + Nitrate as N mg/L	Nitrite as N mg/L	Total Kjeldahl Nitrogen as N mg/L	Total Nitrogen as N mg/L	Total Phosphorus as P mg/L	Total Alkalinity as CaCO3 mg/L
BGW12	22/02/2016	ME1600265004	<0.001	0	171	0.333	0	0	0.043	14	0	554	0	456	0.105	0.19	0.21	0.02	1.4	1.6	0.27	158
BGW12	19/05/2016	ME1600733011	<0.001	0	168	0.356	0	0	0.043	15	0	628	0	545	0.195	0.32	0.34	0.02	0.5	0.8	0.07	195
BGW12	1/09/2016	ME1601226023	<0.001	0	155	0.387	0	0	0.041	13	0	516	0	394	0.057	0.18	0.18	<0.01	0.6	0.8	0.1	189
BGW12	20/12/2016	ME1601793021	<0.001	0	87	0.685	0	0	0.022	10	0	310	0	309	0.101	0.22	0.23	<0.01	0.1	0.3	0.04	134
BGW14	8/01/2014	ME1400079011	<0.001	0.251	106	0.026	<0.0001	<0.001	0.003	34	<0.001	117	0.843	195	<0.018	0.12	0.12	<0.01	0.6	0.7	0.15	513
BGW14	2/04/2014	ME1400540007	<0.001	0.257	105	<0.015	<0.0001	<0.001	0.002	33	<0.001	112	0.895	195	<0.012	0.21	0.21	<0.01	0.8	1	0.11	513
BGW14	23/07/2014	ME1401051011	<0.001	0.219	102	<0.01	<0.0001	<0.001	0.003	32	<0.001	120	0.774	147	0.024	0.14	0.14	<0.01	0.3	0.4	0.09	564
BGW14	8/10/2014	ME1401512011	<0.001	0.208	95	<0.013	<0.0001	<0.001	0.002	28		101	0.886	181	<0.018	0.22	0.22	<0.01	0.5	0.7	0.06	566
BGW14	7/02/2015	ME1500221025	<0.001	0	107	<0.013	0	0	0.005	30	0	112	0	207	<0.005	0.21	0.21	<0.01	0.4	0.6	0.08	508
BGW14	1/05/2015	ME1500659009	<0.001	0	122	<0.011			0.002	32	0	130	0	210	0.03	0.12	0.12	<0.01	0.6	0.7	0.14	544
BGW14	11/08/2015	ME1510328032	<0.001	0	107	0.006	0	0	0.002	29	0	113	0	211	0.025	0.16	0.16	<0.01	<0.1	0.2	0.06	603
BGW14	28/10/2015	ME1510717018	<0.001	0	108	<0.014	0	0	0.002	31	0	117	0	217	0.024	0.21	0.21	<0.01	0.1	0.3	0.04	580
BGW14	25/02/2016	ME1600265036	<0.001	0	115	0.009	0	0	0.003	30	0	119	0	231	0.021	0.18	0.18	<0.01	<0.1	0.2	<<0.01	503
BGW14	25/05/2016	ME1600733012	<0.001	0	109	0.033	0	0	0.006	29	0	117	0	214	<0.018	0.13	0.13	<0.01	0.2	0.3	0.08	618
BGW14	7/09/2016	ME1601226057	<0.001	0	116	0.029	0	0	0.003	31	0	127	0	242	<0.017	0.17	0.17	<0.01	<0.1	0.2	<<0.01	542
BGW14	21/12/2016	ME1601793033	<0.001	0	76	0.098	0	0	<0.001	21	0	108	0	139	0.008	0.1	0.1	<0.01	0.3	0.4	0.15	391
BGW15	13/01/2014	ME1400079012	0.003	0.691	83	0.136	<0.0001	0.01	<0.001	26	<0.001	565	2.16	593	<0.011	0.58	0.58	<0.01	0.6	1.2	0.02	860
BGW15	9/04/2014	ME1400540009	<0.001	0.673	80	0.123	<0.0001	0.01	<0.001	27	<0.001	483	2.16	560	<0.005	0.54	0.54	<0.01	0.3	0.8	<0.01	848
BGW15	22/07/2014	ME1401051012	<0.001	0.658	74	0.099	<0.0001	0.01	<0.001	26	<0.001	544	2.03	500	<0.012	0.5	0.5	<0.01	0.2	0.7	<<0.01	1030
BGW15	8/10/2014	ME1401512012	<0.001	0.601	77	0.11	<0.0001	0.01	<0.001	28		647	2.02	445	<0.011	0.43	0.43	<0.01	0.4	0.8	<0.01	1030
BGW15	7/02/2015	ME1500221026	<0.001	0	66	0.105	0	0	<0.001	23	0	509	0	458	<0.005	0.33	0.33	<0.01	0.5	0.8	0.1	931
BGW15	1/05/2015	ME1500659010	<0.001	0	70	0.099			<0.001	23	0	548	0	458	<0.017	0.3	0.3	<0.01	0.2	0.5	<<0.01	954
BGW15	11/08/2015	ME1510328033	<0.001	0	68	0.096	0	0	<0.001	21	0	514	0	457	<0.018	0.29	0.29	<0.01	0.3	0.6	0.15	907
BGW15	28/10/2015	ME1510717019	<0.001	0	67	0.098	0	0	<0.001	22	0	512	0	438	<0.01	0.53	0.53	<0.01	0.2	0.7	0.04	982
BGW15	25/02/2016	ME1600265037	<0.001	0	64	0.099	0	0	<0.001	21	0	530	0	474	<0.011	0.39	0.39	<0.01	0.1	0.5	<<0.01	862
BGW15	25/05/2016	ME1600733013	<0.001	0	58	0.106	0	0	<0.001	21	0	567	0	444	0.007	0.34	0.34	<0.01	0.2	0.5	<0.01	1030
BGW15	7/06/2016	ME1601226058	<0.001	0	72	0.138	0	0	<0.001	23	0	558	0	461	<0.014	0.26	0.26	<0.01	<0.1	0.3	<<0.01	913
BGW15	21/12/2016	ME1601793034	<0.001	0	66	0.064	0	0	<0.001	21	0	507	0	476	<0.016	0.35	0.35	<0.01	<0.1	0.4	<<0.01	840
BGW16	14/10/2013	ME1400079054	<0.001	0.067	48	0.009	<0.0001	<0.001	<0.001	15	<0.001	141	4.25	47	0.006	0.6	0.6	<0.01	0.4	1	0.06	556
BGW16	13/01/2014	ME1400079013	<0.001	0.071	48	0.007	<0.0001	<0.001	<0.001	16	<0.001	155	3.83	49	0.007	0.85	0.85	<0.01	0.8	1.6	0.14	500
BGW16	9/04/2014	ME1400540010	<0.001	0.074	47	0.003	<0.0001	<0.001	<0.001	16	<0.001	142	4	48	<0.005	0.96	0.97	<0.01	1	2	0.11	494
BGW16	22/07/2014	ME1401051013	<0.001	0.069	49	<0.01	<0.0001	<0.001	<0.001	14	<0.001	153	4.48	44	<0.011	0.47	0.47	<0.01	<0.1	0.5	<<0.01	646
BGW16	8/10/2014	ME1401512013	<0.001	0.058	54	0.005	<0.0001	<0.001	<0.001	15		175	4.7	54	0.005	0.57	0.57	<0.01	0.2	0.8	<<0.01	657
BGW16	7/02/2015	ME1500221027	<0.001	0	50	<0.016	0	0	<0.001	13	0	144	0	59	<0.005	0.73	0.73	<0.01	0.1	0.8	0.1	512
BGW16	1/05/2015	ME1500659011	<0.001	0	53	0.094			<0.001	14	0	164	0	58	<0.016	0.85	0.85	<0.01	0.4	1.2	0.03	586
BGW16	11/08/2015	ME1510328034	<0.001	0	51	0.002	0	0	<0.001	13	0	150	0	47	<0.01	0.61	0.61	<0.01	<0.1	0.6	<<0.01	564
BGW16	28/10/2015	ME1510717020	<0.001	0	59	0.006	0	0	<0.001	14	0	165	0	60	<0.01	0.49	0.49	<0.01	<0.1	0.5	0.02	642
BGW16	25/02/2016	ME1600265038	<0.001	0	58	0.036	0	0	<0.001	14	0	159	0	66	0.006	0.37	0.46	0.09	0.2	0.7	0.05	547
BGW16	25/05/2016	ME1600733014	<0.001	0	53	0.003	0	0	<0.001	14	0	155	0	68	<0.005	0.59	0.59	<0.01	<0.1	0.6	0.02	607
BGW16	7/09/2016	ME1601226059	<0.001	0	51	0.028	0	0	<0.001	13	0	159	0	33	<0.005	0.91	0.91	<0.01	<0.1	0.9	<<0.01	584
BGW16	21/12/2016	ME1601793035	<0.001	0	42	<0.018	0	0	<0.001	12	0	147	0	40	<0.005	0.75	0.75	<0.01	<0.1	0.8	0.02	549
BGW17	14/10/2013	ME1400079055	<0.001	0.213	6	<0.01	<0.0001	0.007	<0.001	11	<0.001	367	1.56	22	<0.005	0.25	0.38	0.13	0.4	0.8	0.1	814
BGW17	8/01/2014	ME1400079014	<0.001	0.233	5	0.009	<0.0001	0.008	<0.001	11	<0.001	404	1.3	18	<0.014	<0.01	<0.01	<0.01	0.7	0.7	0.09	784
BGW17	9/04/2014	ME1400540011	<0.001	0.211	4	0.157	<0.0001	0.006	<0.001	10	<0.001	306	1.12	20	<0.005	<0.01	<0.01	<0.01	0.5	0.5	0.03	679
BGW17	22/07/2014	ME1401051014	<0.001	0.206	7	0.055	<0.0001	0.008	<0.001	12	<0.001	433	1.8	20	<0.014	0.03	0.03	<0.01	0.1	0.1	<0.01	934
BGW17	8/10/2014	ME1401512014	<0.001	0.208	8	<0.016	<0.0001	0.01	<0.001	12		470	1.88	32	<0.005	0.06	0.06	<0.01	0.1	0.2	<<0.01	943
BGW17	7/02/2015	ME1500221028	<0.001	0	8	0.495	0	0	<0.001	10	0	333	0	21	<0.005	1.14	1.19	0.05	1.1	2.3	0.18	740
BGW17	1/05/2015	ME1500659012	<0.001	0	9	<0.01			<0.001	11	0	397	0	21	<0.012	0.88	0.88	<0.01	0.2	1.1	0.11	798
BGW17	11/08/2015	ME1510328035	<0.001	0	8	0.11	0	0	<0.001	9	0	376	0	14	0.008	<0.01	<0.01	<0.01	0.1	0.1	0.06	854
BGW17	28/10/2015	ME1510717021	<0.001	0	9	0.145	0	0	<0.001	10	0	378	0	15	<0.005	0.1	0.1	<0.01	0.3	0.4	0.03	889

Sample Location	Sampling Date	Sample Num	Lead - Dissolved mg/L	Lithium - Dissolved mg/L	Magnesium - Dissolved mg/L	Manganese - Dissolved mg/L	Mercury - Dissolved mg/L	Molybdenum - Dissolved mg/L	Nickel - Dissolved mg/L	Potassium - Dissolved mg/L	Silver - Dissolved mg/L	Sodium - Dissolved mg/L	Strontium - Dissolved mg/L	Sulfate as SO4 - Turbidimetric mg/L	Zinc - Dissolved mg/L	Nitrate as N mg/L	Nitrite + Nitrate as N mg/L	Nitrite as N mg/L	Total Kjeldahl Nitrogen as N mg/L	Total Nitrogen as N mg/L	Total Phosphorus as P mg/L	Total Alkalinity as CaCO3 mg/L
BGW17	25/02/2016	ME1600265039	<0.001	0	8	<0.001	0	0	<0.001	10	0	396	0	17	0.006	0.98	0.98	<0.01	0.2	1.2	0.09	736
BGW17	25/05/2016	ME1600733015	<0.001	0	8	0.003	0	0	<0.001	10	0	404	0	15	<0.005	1.94	1.94	<0.01	0.2	2.1	0.14	911
BGW17	7/09/2016	ME1601226060	<0.001	0	8	0.114	0	0	<0.001	9	0	390	0	17	<0.005	0.1	0.1	<0.01	<0.1	0.1	<<0.01	854
BGW17	21/12/2016	ME1601793036	<0.001	0	8	0.026	0	0	<0.001	9	0	375	0	18	0.006	2.79	2.79	<0.01	0.8	3.6	0.14	817
BGW18	9/01/2014	ME1400079015	<0.001	0.077	20	62.8	<0.0001	0.002	<0.001	48	<0.001	22	0.365	289	0.025	<0.01	0.02	<0.01	0.9	0.9	0.09	160
BGW18	3/04/2014	ME1400540012	<0.001	0.069	24	50.7	<0.0001	0.003	<0.001	46	<0.001	26	0.475	267	<0.017	0.02	0.02	<0.01	0.4	0.4	0.02	248
BGW18	15/07/2014	ME1401051015	<0.001	0.065	26	43.7	<0.0001	<0.001	<0.001	52	<0.001	30	0.492	309	0.022	<0.01	<0.01	<0.01	0.3	0.3	<<0.01	254
BGW18	8/10/2014	ME1401512015	<0.001	0.048	30	32	<0.0001	<0.001	<0.001	48		26	0.601	362	0.006	0.06	0.06	<0.01	0.4	0.5	0.06	213
BGW18	6/02/2015	ME1500221029	<0.001	0	27	26.6	0	0	<0.001	43	0	23	0	447	0.035	<0.01	<0.01	<0.01	0.4	0.4	0.08	182
BGW18	30/04/2015	ME1500659013	<0.001	0	29	23.9			0.003	48	0	27	0	421	0.205	0.04	0.04	<0.01	0.4	0.4	0.06	176
BGW18	11/08/2015	ME1510328036	<0.001	0	26	24.2	0	0	0.002	42	0	23	0	397	0.194	0.03	0.03	<0.01	0.2	0.2	0.05	165
BGW18	27/10/2015	ME1510717022	<0.001	0	30	22.1	0	0	<0.001	49	0	26	0	409	0.033	0.12	0.12	<0.01	0.2	0.3	0.05	185
BGW18	23/02/2016	ME1600265019	<0.001	0	28	20.6	0	0	<0.001	48	0	27	0	436	<0.015	0.06	0.06	<0.01	0.3	0.4	0.06	186
BGW18	25/05/2016	ME1600733016	<0.001	0	28	20.5	0	0	<0.001	43	0	23	0	436	0.024	0.03	0.03	<0.01	0.2	0.2	0.04	198
BGW18	5/09/2016	ME1601226046	<0.001	0	29	19.2	0	0	0.004	49	0	25	0	428	0.134	0.07	0.07	<0.01	0.1	0.2	0.02	178
BGW18	21/12/2016	ME1601793037	<0.001	0	27	17.3	0	0	<0.001	44	0	22	0	390	0.009	0.04	0.04	<0.01	0.2	0.2	0.04	162
BGW19	10/01/2014	ME1400079016	<0.001	0.077	31	2.36	<0.0001	<0.001	<0.001	44	<0.001	19	0.726	254	0.023	0.02	0.02	<0.01	1	1	0.27	226
BGW19	9/04/2014	ME1400540013	<0.001	0.073	33	2.5	<0.0001	<0.001	<0.001	42	<0.001	22	0.708	257	<0.011	0.05	0.05	<0.01	0.2	0.2	0.17	229
BGW19	21/07/2014	ME1401051016	<0.001	0.068	33	3.1	<0.0001	<0.001	<0.001	40	<0.001	18	0.677	276	0.034	<0.01	<0.01	<0.01	0.4	0.4	0.24	260
BGW19	14/10/2014	ME1401512016	<0.001	0.04	32	2.96	<0.0001	<0.001	<0.001	38		17	0.688	250	<0.014	0.06	0.06	<0.01	0.2	0.3	0.18	254
BGW19	8/02/2015	ME1500221030	<0.001	0	32	3.28	0	0	<0.001	38	0	16	0	278	<0.005	<0.01	<0.01	<0.01	0.2	0.2	0.11	219
BGW19	30/04/2015	ME1500659014	0.002	0	35	3.02			<0.001	42	0	19	0	282	0.023	0.05	0.05	<0.01	0.2	0.2	0.22	224
BGW19	19/08/2015	ME1510328037	<0.001	0	31	3.42	0	0	<0.001	37	0	17	0	267	<0.019	<0.01	<0.01	<0.01	0.2	0.2	0.24	234
BGW19	28/10/2015	ME1510717023	<0.001	0	32	3.2	0	0	<0.001	38	0	17	0	268	<0.016	0.06	0.06	<0.01	0.2	0.3	0.22	236
BGW19	25/02/2016	ME1600265040	<0.001	0	34	3.6	0	0	<0.001	38	0	17	0	290	<0.015	0.06	0.06	<0.01	0.4	0.5	0.26	203
BGW19	19/05/2016	ME1600733017	<0.001	0	31	4.26	0	0	<0.001	36	0	16	0	290	<0.011	0.03	0.03	<0.01	<0.1	<0.1	0.21	230
BGW19	8/09/2016	ME1601226073	<0.001	0	32	4.26	0	0	<0.001	40	0	17	0	251	<0.01	0.09	0.09	<0.01	0.2	0.3	0.47	212
BGW19	19/12/2016	ME1601793004	<0.001	0	29	4.39	0	0	<0.001	36	0	15	0	243	0.009	0.03	0.03	<0.01	<0.1	<0.1	0.32	222
BGW20	10/01/2014	ME1400079017	<0.001	0.046	25	31.8	<0.0001	<0.001	<0.001	49	<0.001	18	0.073	290	0.039	0.04	0.04	<0.01	1.4	1.4	0.29	41
BGW20	9/04/2014	ME1400540014	<0.001	0.049	27	30.5	<0.0001	0.002	<0.001	46	<0.001	19	0.085	294	<0.018	0.02	0.02	<0.01	0.3	0.3	0.28	45
BGW20	21/07/2014	ME1401051017	<0.001	0.046	29	28.4	<0.0001	<0.001	0.01	57	<0.001	23	0.073	342	0.187	0.1	0.1	<0.01	0.2	0.3	0.1	25
BGW20	14/10/2014	ME1401512017	<0.001	0.041	28	31.2	<0.0001	<0.001	0.002	52		19	0.063	298	0.16	0.18	0.18	<0.01	0.1	0.3	0.02	25
BGW20	8/02/2015	ME1500221031	0.002	0	27	32.2	0	0	0.008	44	0	17	0	315	0.224	0.09	0.09	<0.01	<0.1	<0.1	0.03	32
BGW20	29/04/2015	ME1500659015	<0.001	0	26	0.037			0.002	42	0	17	0	310	0.153	0.14	0.14	<0.01	0.5	0.6	0.02	25
BGW20	19/08/2015	ME1510328038	<0.001	0	25	30.7	0	0	0.002	40	0	16	0	302	0.136	0.38	0.38	<0.01	0.2	0.6	0.02	26
BGW20	22/10/2015	ME1510717024	<0.001	0	28	29.2	0	0	<0.001	44	0	18	0	297	0.094	0.3	0.3	<0.01	<0.1	0.3	0.29	27
BGW20	22/02/2016	ME1600265005	<0.001	0	26	32.8	0	0	<0.001	46	0	19	0	298	0.107	0.03	0.03	<0.01	2.4	2.4	0.16	32
BGW20	25/02/2016	ME1600265047	<0.001	0	66	0.023	0	0	<0.001	4	0	161	0	248	<0.005	0.04	0.04	<0.01	1.1	1.1	0.04	126
BGW20	18/05/2016	ME1600733018	<0.001	0	25	32.4	0	0	<0.001	18	0	16	0	265	0.028	0.09	0.09	<0.01	0.2	0.3	<0.01	30
BGW20	1/09/2016	ME1601226024	<0.001	0	26	32	0	0	<0.001	46	0	18	0	331	0.052	0.23	0.23	<0.01	<0.1	0.2	<0.01	28
BGW20	19/12/2016	ME1601793005	<0.001	0	24	35	0	0	<0.001	40	0	15	0	273	0.028	0.57	0.57	<0.01	<0.1	0.6	0.02	36
BGW21	8/01/2014	ME1400079018	0.002	0.021	163	0.028	<0.0001	<0.001	0.002	4	<0.001	183	3.28	583	0.063	0.56	0.56	<0.01	1.5	2.1	0.04	627
BGW21	8/04/2014	ME1400540015	<0.001	0.022	157	0.063	<0.0001	<0.001	0.002	2	<0.001	161	3.47	566	0.042	0.55	0.55	<0.01	<0.1	0.6	<<0.01	577
BGW21	10/07/2014	ME1401051018	<0.001	0.02	174	0.084	<0.0001	<0.001	0.002	3	<0.001	200	4.27	637	0.048	0.38	0.38	<0.01	<0.1	0.4	0.02	723
BGW21	21/10/2014	ME1401512018	<0.001	<0.012	161	0.057	<0.0001	<0.001	<0.001	3		153	3.66	589	0.186	0.64	0.64	<0.01	0.1	0.7	<0.01	722
BGW21	9/02/2015	ME1500221032	<0.001	0	163	0.086	0	0	<0.001	3	0	176	0	596	0.08	0.56	0.56	<0.01	0.1	0.7	0.02	628
BGW21	1/05/2015	ME1500659016	<0.001	0	168	31.1			0.002	2	0	183	0	600	0.195	0.5	0.5	<0.01	<0.1	0.5	<<0.01	664
BGW21	19/08/2015	ME1510328039	<0.001	0	158	0.101	0	0	0.002	2	0	179	0	610	0.028	0.46	0.46	<0.01	<0.1	0.5	0.05	632
BGW21	28/10/2015	ME1510717025	<0.001	0	160	0.056	0	0	<0.001	2	0	190	0	235	0.024	0.54	0.54	<0.01	<0.1	0.5	0.19	692
BGW21	25/02/2016	ME1600265041	<0.001	0	170	0.052	0	0	<0.001	2	0	179	0	654	0.033	0.49	0.49	<0.01	<0.1	0.5	<<0.01	607

Sample Location	Sampling Date	Sample Num	Lead - Dissolved mg/L	Lithium - Dissolved mg/L	Magnesium - Dissolved mg/L	Manganese - Dissolved mg/L	Mercury - Dissolved mg/L	Molybdenum - Dissolved mg/L	Nickel - Dissolved mg/L	Potassium - Dissolved mg/L	Silver - Dissolved mg/L	Sodium - Dissolved mg/L	Strontium - Dissolved mg/L	Sulfate as SO4 - Turbidimetric mg/L	Zinc - Dissolved mg/L	Nitrate as N mg/L	Nitrite + Nitrate as N mg/L	Nitrite as N mg/L	Total Kjeldahl Nitrogen as N mg/L	Total Nitrogen as N mg/L	Total Phosphorus as P mg/L	Total Alkalinity as CaCO3 mg/L
BGW21	25/05/2016	ME1600733019	<0.001	0	153	0.058	0	0	<0.001	3	0	203	0	642	<0.015	0.57	0.57	<0.01	<0.1	0.6	<<0.01	731
BGW21	7/09/2016	ME1601226061	<0.001	0	163	0.087	0	0	<0.001	2	0	188	0	674	<0.013	0.53	0.53	<0.01	<0.1	0.5	<<0.01	664
BGW21	21/12/2016	ME1601793038	<0.001	0	149	0.033	0	0	<0.001	2	0	180	0	569	<0.019	0.55	0.55	<0.01	<0.1	0.6	<<0.01	645
BGW24	9/01/2014	ME1400079020	<0.001	<0.018	104	0.579	<0.0001	<0.001	0.003	2	<0.001	185	2.21	43	0.093	0.76	0.76	<0.01	1.1	1.9	0.07	610
BGW24	8/04/2014	ME1400540017	<0.001	<0.013	86	0.485	<0.0001	<0.001	0.002	2	<0.001	116	1.99	43	0.091	10.3	10.5	0.19	2.7	13.2	<<0.01	545
BGW24	8/07/2014	ME1401051020	<0.001	<0.019	114	0.328	<0.0001	<0.001	0.003	2	<0.001	187	2.56	37	0.118	1.84	1.86	0.02	0.4	2.3	0.11	719
BGW24	21/10/2014	ME1401512020	<0.001	<0.016	127	0.323	<0.0001	<0.001	0.004	2		233	2.69	55	0.128	1.76	1.79	0.03	0.4	2.2	0.02	710
BGW24	9/02/2015	ME1500221034	<0.001	0	118	0.295	0	0	0.002	2	0	191	0	57	0.102	1.54	1.56	0.02	0.4	2	0.07	601
BGW24	1/05/2015	ME1500659018	<0.001	0	128	0.296			0.003	2	0	212	0	56	0.134	1.57	1.61	0.04	0.4	2	0.02	658
BGW24	19/08/2015	ME1510328040	<0.001	0	97	0.289	0	0	0.004	4	0	143	0	43	0.121	0.92	1.04	0.12	1.3	2.3	0.05	580
BGW24	28/10/2015	ME1510717026	<0.001	0	110	0.256	0	0	0.002	1	0	184	0	46	0.126	0.35	0.35	<0.01	<0.1	0.4	0.1	688
BGW24	25/02/2016	ME1600265042	<0.001	0	129	0.26	0	0	0.003	2	0	201	0	56	0.146	0.85	0.86	<0.01	0.2	1.1	0.02	594
BGW24	25/05/2016	ME1600733020	<0.001	0	125	0.275	0	0	0.002	2	0	238	0	52	0.145	0.95	1.01	0.06	0.1	1.1	0.02	745
BGW24	7/09/2016	ME1601226062	<0.001	0	58	0.065	0	0	<0.001	1	0	76	0	26	0.057	1.3	1.3	<0.01	0.6	1.9	<<0.01	368
BGW26	8/01/2014	ME1400079022	<0.001	0.053	108	<0.011	<0.0001	0.002	0.002	17	<0.001	128	0.298	156	0.04	0.27	0.27	<0.01	1.5	1.8	0.05	390
BGW26	2/04/2014	ME1400540019	<0.001	0.064	108	0.007	<0.0001	<0.001	<0.001	15	<0.001	119	0.301	160	<0.015	0.31	0.31	<0.01	0.3	0.6	<0.01	380
BGW26	23/07/2014	ME1401051022	<0.001	0.055	108	0.002	<0.0001	<0.001	<0.001	14	<0.001	126	0.31	190	0.024	0.29	0.29	<0.01	0.4	0.7	0.08	449
BGW26	8/10/2014	ME1401512022	<0.001	0.044	102	0.008	<0.0001	<0.001	<0.001	13		112	0.291	167	0.023	0.38	0.38	<0.01	0.3	0.7	<<0.01	420
BGW26	5/02/2015	ME1500221036	<0.001	0	109	0.005	0	0	<0.001	13	0	124	0	175	<0.005	0.31	0.31	<0.01	0.4	0.7	<<0.01	394
BGW26	1/05/2015	ME1500659020	<0.001	0	120	0.004			<0.001	14	0	141	0	175	0.02	0.31	0.31	<0.01	0.2	0.5	<<0.01	414
BGW26	11/08/2015	ME1510328041	<0.001	0	112	0.002	0	0	<0.001	13	0	130	0	195	0.008	0.3	0.3	<0.01	<0.1	0.3	0.08	462
BGW26	28/10/2015	ME1510717027	<0.001	0	106	0.002	0	0	<0.001	13	0	131	0	173	<0.014	0.43	0.43	<0.01	<0.1	0.4	0.05	418
BGW26	25/02/2016	ME1600265043	<0.001	0	116	<0.001	0	0	<0.001	14	0	134	0	204	<0.013	0.32	0.32	<0.01	0.3	0.6	<<0.01	358
BGW26	25/05/2016	ME1600733021	<0.001	0	111	0.002	0	0	<0.001	17	0	129	0	198	<0.017	0.34	0.34	<0.01	<0.1	0.3	<<0.01	449
BGW26	7/09/2016	ME1601226063	<0.001	0	110	<0.001	0	0	<0.001	13	0	145	0	195	<0.005	0.34	0.34	<0.01	<0.1	0.3	<<0.01	399
BGW27	19/08/2015	ME1510328042	<0.001	0	13	0.698	0	0	<0.001	12	0	37	0	87	0.024	0.47	0.47	<0.01	0.2	0.7	0.34	130
BGW27	22/10/2015	ME1510717028	<0.001	0	16	0.613	0	0	0.002	15	0	43	0	78	0.048	0.25	0.25	<0.01	0.1	0.4	0.33	144
BGW27	22/02/2016	ME1600265006	<0.001	0	16	0.939	0	0	<0.001	15	0	42	0	84	0.051	0.08	0.08	<0.01	0.2	0.3	0.4	129
BGW27	18/05/2016	ME1600733022	<0.001	0	13	1.04	0	0	<0.001	12	0	36	0	78	0.028	0.05	0.05	<0.01	<0.1	<0.1	0.05	132
BGW27	1/09/2016	ME1601226025	<0.001	0	14	0.952	0	0	<0.001	15	0	41	0	82	0.043	0.19	0.19	<0.01	0.3	0.5	0.18	146
BGW27	19/12/2016	ME1601793006	<0.001	0	13	0.809	0	0	<0.001	12	0	34	0	73	0.09	0.63	0.63	<0.01	<0.1	0.6	0.09	127
BGW27A	10/01/2014	ME1400079023	<0.001	<0.016	15	8.04	<0.0001	<0.001	0.016	11	<0.001	9	0.092	55	1.14	0.04	0.04	<0.01	0.8	0.8	0.43	55
BGW27A	9/04/2014	ME1400540020	<0.001	<0.017	17	7.69	<0.0001	0.002	0.013	11	<0.001	9	0.088	61	1.04	0.02	0.02	<0.01	0.2	0.2	0.27	52
BGW27A	21/07/2014	ME1401051023	<0.001	<0.017	16	7.06	<0.0001	<0.001	0.013	11	<0.001	8	0.088	66	1.09	<0.01	<0.01	<0.01	0.2	0.2	0.37	57
BGW27A	14/10/2014	ME1401512023	<0.001	<0.018	19	8.02	<0.0001	0.002	0.015	11		9	0.088	70	1.15	0.07	0.07	<0.01	0.4	0.5	0.33	51
BGW27A	8/02/2015	ME1500221037	<0.001	0	17	7.95	0	0	0.015	9	0	7	0	73	1.29	0.03	0.03	<0.01	<0.1	<0.1	0.14	42
BGW27A	29/04/2015	ME1500659021	<0.001	0	19	7.05			0.014	10	0	9	0	80	1.17	0.05	0.05	<0.01	0.4	0.4	0.51	39
BGW27A	19/08/2015	ME1510328043	<0.001	0	17	7.5	0	0	0.012	9	0	8	0	76	1.11	0.03	0.04	<0.01	0.3	0.3	0.88	48
BGW27A	22/10/2015	ME1510717029	<0.001	0	18	7	0	0	0.013	10	0	8	0	21	1.16	0.07	0.07	<0.01	<0.1	<0.1	0.4	22
BGW27A	22/02/2016	ME1600265007	<0.001	0	17	7.05	0	0	0.014	10	0	8	0	63	1.24	0.14	0.14	<0.01	0.2	0.3	0.74	52
BGW27A	18/05/2016	ME1600733023	<0.001	0	17	7.78	0	0	0.012	9	0	8	0	49	1.14	0.06	0.06	<0.01	<0.1	<0.1	0.34	52
BGW27A	1/09/2016	ME1601226026	<0.001	0	16	7.7	0	0	0.012	10	0	7	0	64	1.18	0.04	0.04	<0.01	<0.1	<0.1	0.47	57
BGW27A	19/12/2016	ME1601793007	<0.001	0	14	7.28	0	0	0.012	9	0	8	0	54	1.21	0.06	0.06	<0.01	<0.1	<0.1	0.33	52
BGW28	1/09/2016	ME1601226027	<0.001	0	5	0.064	0	0	<0.001	9	0	14	0	35	0.377	1.54	1.54	<0.01	0.3	1.8	<<0.01	14
BGW29	9/01/2014	ME1400079024	<0.001	0.002	17	<0.001	<0.0001	<0.001	<0.001	16	<0.001	30	0.317	93	<0.005	3.61	3.63	0.02	1.5	5.1	0.87	110
BGW29	2/04/2014	ME1400540021	<0.001	0.002	21	<0.012	<0.0001	<0.001	<0.001	18	<0.001	35	0.367	134	0.008	17.3	17.3	<0.01	2	19.3	0.19	59
BGW29	15/07/2014	ME1401051024	<0.001	0.003	24	0.027	<0.0001	<0.001	<0.001	18	<0.001	39	0.48	186	<0.013	8.46	8.46	<0.01	1	9.5	0.47	116
BGW29	8/10/2014	ME1401512024	<0.001	0.002	27	0.055	<0.0001	<0.001	<0.001	18		33	0.432	175	<0.011	2.28	2.28	<0.01	1.3	3.6	0.67	128
BGW29	6/02/2015	ME1500221038	<0.001	0	23	0.11	0	0	<0.001	17	0	31	0	158	0.078	2.38	2.38	<0.01	0.7	3.1	0.11	120
BGW29	30/04/2015	ME1500659022	<0.001	0	20	<0.017			<0.001	16	0	31	0	146	0.055	0.99	0.99	<0.01	0.8	1.8	0.32	75

Sample Location	Sampling Date	Sample Num	Lead - Dissolved mg/L	Lithium - Dissolved mg/L	Magnesium - Dissolved mg/L	Manganese - Dissolved mg/L	Mercury - Dissolved mg/L	Molybdenum - Dissolved mg/L	Nickel - Dissolved mg/L	Potassium - Dissolved mg/L	Silver - Dissolved mg/L	Sodium - Dissolved mg/L	Strontium - Dissolved mg/L	Sulfate as SO4 - Turbidimetric mg/L	Zinc - Dissolved mg/L	Nitrate as N mg/L	Nitrite + Nitrate as N mg/L	Nitrite as N mg/L	Total Kjeldahl Nitrogen as N mg/L	Total Nitrogen as N mg/L	Total Phosphorus as P mg/L	Total Alkalinity as CaCO3 mg/L
BGW29	11/08/2015	ME1510328044	<0.001	0	7	<0.01	0	0	<0.001	9	0	15	0	36	<0.005	0.84	0.84	<0.01	0.4	1.2	0.06	70
BGW29	27/10/2015	ME1510717030	<0.001	0	10	0.009	0	0	<0.001	17	0	19	0	37	<0.011	0.33	0.33	<0.01	0.6	0.9	0.3	94
BGW29	23/02/2016	ME1600265020	<0.001	0	8	0.008	0	0	<0.001	12	0	19	0	42	0.009	2.93	2.93	<0.01	0.8	3.7	0.05	59
BGW29	25/05/2016	ME1600733024	<0.001	0	11	0.002	0	0	<0.001	12	0	19	0	64	0.005	2.7	2.7	<0.01	0.3	3	0.09	82
BGW29	5/09/2016	ME1601226047	<0.001	0	5	0.004	0	0	<0.001	9	0	12	0	22	<0.005	0.83	0.83	<0.01	0.4	1.2	0.04	58
BGW29	21/12/2016	ME1601793039	<0.001	0	7	0.008	0	0	<0.001	9	0	10	0	8	<0.005	0.16	0.16	<0.01	0.3	0.5	0.03	79
BGW32	9/01/2014	ME1400079026	0.003	<0.018	139	0.021	<0.0001	<0.001	0.002	<1	<0.001	252	1.92	24	0.066	5.5	5.5	<0.01	0.4	5.9	0.15	692
BGW32	8/04/2014	ME1400540023	<0.001	<0.016	137	0.024	<0.0001	<0.001	0.002	1	<0.001	216	2.41	26	0.041	5.56	5.56	<0.01	0.5	6.1	0.03	665
BGW33	9/01/2014	ME1400079027	0.001	0.009	65	0.009	<0.0001	<0.001	0.002	2	<0.001	141	0.649	12	0.112	2.28	2.28	<0.01	1.5	3.8	0.05	536
BGW33	8/07/2014	ME1401051026	<0.001	0.004	32	0.001	<0.0001	<0.001	<0.001	<1	<0.001	74	0.3	8	0.156	1.35	1.35	<0.01	0.3	1.6	0.02	285
BGW33	25/02/2016	ME1600265044	<0.001	0	47	0.001	0	0	<0.001	1	0	88	0	9	0.127	1.84	1.84	<0.01	0.1	1.9	<<0.01	346
BGW35	8/04/2014	ME1400540024	<0.001	<0.014	145	0.006	<0.0001	<0.001	<0.001	1	<0.001	132	3.26	269	0.036	6.28	6.34	0.06	1	7.3	0.03	518
BGW35	12/07/2014	ME1401051027	<0.001	<0.012	145	0.004	<0.0001	<0.001	0.002	1	<0.001	142	2.84	276	0.152	5.95	6	0.05	0.4	6.4	0.03	600
BGW35	13/10/2014	ME1401512026	<0.001	0.006	151	0.004	<0.0001	<0.001	<0.001	1		127	2.83	261	0.024	6.07	6.09	0.02	1.2	7.3	0.07	611
BGW35	8/02/2015	ME1500221039	<0.001	0	141	0.008	0	0	<0.001	1	0	129	0	285	<0.013	4.9	4.92	0.02	5.9	10.8	0.07	451
BGW35	1/05/2015	ME1500659023	<0.001	0	151	0.004			<0.001	1	0	139	0	302	<0.018	5.45	5.45	<0.01	0.5	6	<<0.01	539
BGW35	19/08/2015	ME1510328045	0.001	0	141	0.003	0	0	0.01	1	0	133	0	325	0.898	5.73	5.74	<0.01	0.3	6	<0.01	508
BGW35	28/10/2015	ME1510717031	<0.001	0	141	0.003	0	0	0.002	1	0	136	0	291	0.212	5.66	5.66	<0.01	0.4	6.1	0.02	550
BGW35	25/02/2016	ME1600265045	<0.001	0	153	<0.018	0	0	<0.001	1	0	136	0	327	<0.011	5.17	5.17	<0.01	1.9	7.1	0.02	487
BGW35	25/05/2016	ME1600733025	<0.001	0	144	0.004	0	0	<0.001	2	0	139	0	249	0.022	4.42	4.43	<0.01	0.4	4.8	0.02	615
BGW35	7/09/2016	ME1601226064	<0.001	0	147	0.002	0	0	<0.001	1	0	143	0	313	<0.011	5.89	5.9	<0.01	0.6	6.5	<0.01	562
BGW35	21/12/2016	ME1601793040	<0.001	0	192	0.007	0	0	<0.001	1	0	192	0	358	<0.014	5.52	5.53	<0.01	0.2	5.7	<0.01	613
BGW36	7/01/2014	ME1400079028	0.034	0.072	87	0.006	<0.0001	<0.001	0.002	10	<0.001	107	0.305	34	0.376	0.16	0.16	<0.01	2.7	2.9	0.1	532
BGW36	7/04/2014	ME1400540025	0.092	0.079	81	<0.014	<0.0001	<0.001	0.002	8	<0.001	108	0.195	32	0.387	<0.01	<0.01	<0.01	0.2	0.2	0.02	447
BGW36	23/07/2014	ME1401051028	0.009	0.075	88	0.327	<0.0001	<0.001	<0.001	8	<0.001	112	0.332	32	1.08	<0.01	<0.01	<0.01	0.2	0.2	<<0.01	590
BGW36	14/10/2014	ME1401512027	0.009	0.098	83	0.005	<0.0001	<0.001	<0.001	8		107	0.223	34	0.171	0.18	0.18	<0.01	0.2	0.4	<<0.01	548
BGW36	4/02/2015	ME1500221040	0.001	0	75	0.035	0	0	<0.001	9	0	138	0	31	0.022	0.27	0.27	<0.01	0.5	0.8	0.13	641
BGW36	29/04/2015	ME1500659024	<0.001	0	73	0.006			<0.001	7	0	171	0	35	0.318	0.15	0.15	<0.01	<0.1	0.2	<<0.01	582
BGW36	18/08/2015	ME1510328046	<0.001	0	61	<0.001	0	0	<0.001	6	0	158	0	27	0.085	0.16	0.16	<0.01	<0.1	0.2	<<0.01	501
BGW36	22/10/2015	ME1510717032	<0.001	0	69	0.001	0	0	<0.001	7	0	182	0	23	0.047	0.2	0.2	<0.01	<0.1	0.2	0.02	531
BGW36	24/02/2016	ME1600265034	<0.001	0	75	0.002	0	0	<0.001	7	0	154	0	29	0.049	0.15	0.15	<0.01	<0.1	0.2	0.05	499
BGW36	27/05/2016	ME1600733026	<0.001	0	74	0.002	0	0	<0.001	7	0	176	0	28	0.062	0.16	0.16	<0.01	<0.1	0.2	0.03	596
BGW36	5/09/2016	ME1601226048	<0.001	0	67	0.002	0	0	<0.001	7	0	166	0	28	0.059	0.14	0.14	<0.01	<0.1	0.1	<<0.01	497
BGW36	20/12/2016	ME1601793022	<0.001	0	70	<0.014	0	0	<0.001	4	0	62	0	15	0.505	0.14	0.14	<0.01	<0.1	0.1	<<0.01	532
BGW37	9/01/2014	ME1400079029	<0.001	0.007	122	0.022	<0.0001	<0.001	<0.001	<1	<0.001	158	2.48	244	0.022	5.5	5.5	<0.01	1.1	6.6	0.04	490
BGW37	8/04/2014	ME1400540026	<0.001	0.008	128	0.021	<0.0001	<0.001	<0.001	<1	<0.001	148	3.34	270	0.038	8.21	8.21	<0.01	1.5	9.7	0.02	485
BGW37	8/07/2014	ME1401051029	<0.001	0.008	135	0.046	<0.0001	<0.001	0.002	1	<0.001	157	3.07	367	0.156	15.4	15.4	0.02	1	16.4	<0.01	604
BGW37	21/10/2014	ME1401512028	<0.001	0.004	138	<0.014	<0.0001	<0.001	<0.001	2		140	3.2	334	0.066	14.4	14.4	0.02	0.6	15	<0.01	601
BGW38	9/01/2014	ME1400079030	<0.001	0.07	132	3.14	<0.0001	0.002	0.005	41	<0.001	87	2.96	1120	0.045	<0.01	0.03	0.02	1.4	1.4	0.22	383
BGW38	2/04/2014	ME1400540027	<0.001	0.07	134	3.25	<0.0001	0.002	0.005	44	<0.001	94	3.85	1040	0.036	0.02	0.02	<0.01	0.7	0.7	0.13	390
BGW38	15/07/2014	ME1401051030	<0.001	0.069	137	2.72	<0.0001	0.002	0.004	47	<0.001	98	3.32	1200	0.08	0.04	0.04	<0.01	0.8	0.8	0.34	436
BGW38	8/10/2014	ME1401512029	<0.001	0.083	134	3.17	<0.0001	0.002	0.004	42		85	3.38	1030	0.054	0.07	0.08	<0.01	0.7	0.8	0.31	433
BGW38	6/02/2015	ME1500221041	<0.001	0	134	3.26	0	0	0.002	42	0	87	0	1230	0.009	<0.01	0.04	0.04	1.1	1.1	0.37	396
BGW38	30/04/2015	ME1500659025	<0.01	0	152	4.19			0.006	46	0	103	0	1210	0.072	3.32	3.34	0.02	1.4	4.7	0.41	400
BGW38	11/08/2015	ME1510328047	<0.001	0	139	3.2	0	0	0.003	41	0	89	0	1380	0.034	0.07	0.07	<0.01	0.5	0.6	0.2	454
BGW38	27/10/2015	ME1510717033	<0.001	0	140	3.13	0	0	0.002	47	0	96	0	1240	<0.014	0.08	0.08	<0.01	0.6	0.7	0.37	427
BGW38	23/02/2016	ME1600265021	<0.001	0	152	2.83	0	0	0.002	46	0	98	0	1460	0.02	0.08	0.1	0.02	0.5	0.6	0.15	427
BGW38	25/05/2016	ME1600733027	<0.001	0	147	3.09	0	0	<0.001	41	0	92	0	1400	<0.012	0.09	0.09	<0.01	0.4	0.5	0.07	436
BGW38	5/09/2016	ME1601226049	<0.001	0	46	<0.014	0	0	<0.001	26	0	22	0	393	<0.016	0.44	0.44	<0.01	0.4	0.8	0.06	126
BGW38	21/12/2016	ME1601793041	<0.001	0	52	<0.014	0	0	<0.001	25	0	18	0	463	0.009	0.35	0.35	<0.01	0.4	0.8	0.07	124

Sample Location	Sampling Date	Sample Num	Lead - Dissolved mg/L	Lithium - Dissolved mg/L	Magnesium - Dissolved mg/L	Manganese - Dissolved mg/L	Mercury - Dissolved mg/L	Molybdenum - Dissolved mg/L	Nickel - Dissolved mg/L	Potassium - Dissolved mg/L	Silver - Dissolved mg/L	Sodium - Dissolved mg/L	Strontium - Dissolved mg/L	Sulfate as SO4 - Turbidimetric mg/L	Zinc - Dissolved mg/L	Nitrate as N mg/L	Nitrite + Nitrate as N mg/L	Nitrite as N mg/L	Total Kjeldahl Nitrogen as N mg/L	Total Nitrogen as N mg/L	Total Phosphorus as P mg/L	Total Alkalinity as CaCO3 mg/L
BGW39	9/01/2014	ME1400079031	<0.001	0.072	65	0.07	<0.0001	<0.001	0.003	6	<0.001	100	1.42	60	<0.017	0.02	0.02	<0.01	0.9	0.9	0.04	582
BGW39	3/04/2014	ME1400540028	<0.001	0.069	65	0.057	<0.0001	<0.001	0.002	5	<0.001	99	1.8	68	<0.01	0.06	0.06	<0.01	0.2	0.3	<<0.01	507
BGW39	13/07/2014	ME1401051031	<0.001	0.068	65	0.052	<0.0001	<0.001	0.002	5	<0.001	102	1.42	77	0.029	0.06	0.06	<0.01	<0.1	<0.1	0.15	611
BGW39	21/10/2014	ME1401512030	<0.001	0.084	64	0.004	<0.0001	<0.001	0.002	5		90	1.53	68	<0.018	0.09	0.09	<0.01	0.2	0.3	0.03	609
BGW39	6/02/2015	ME1500221042	<0.001	0	66	0.008	0	0	<0.001	5	0	94	0	71	<0.01	0.09	0.09	<0.01	0.2	0.3	<0.01	566
BGW39	1/05/2015	ME1500659026	<0.001	0	70	0.006			<0.001	5	0	107	0	74	0.026	0.16	0.16	<0.01	<0.1	0.2	<0.01	564
BGW39	19/08/2015	ME1510328048	<0.001	0	65	0.061	0	0	<0.001	4	0	100	0	75	0.02	0.16	0.17	<0.01	<0.1	0.2	<0.01	498
BGW39	27/10/2015	ME1510717034	<0.001	0	65	0.009	0	0	<0.001	5	0	96	0	59	0.007	0.16	0.16	<0.01	<0.1	0.2	0.19	581
BGW39	24/02/2016	ME1600265035	<0.001	0	65	0.004	0	0	<0.001	5	0	106	0	69	<0.01	0.14	0.14	<0.01	<0.1	0.1	<<0.01	577
BGW39	25/05/2016	ME1600733028	<0.001	0	57	0.002	0	0	<0.001	4	0	88	0	67	0.007	0.15	0.15	<0.01	<0.1	0.2	0.02	604
BGW39	8/09/2016	ME1601226074	<0.001	0	55	0.006	0	0	<0.001	4	0	80	0	46	0.007	0.08	0.08	<0.01	<0.1	<0.1	<<0.01	480
BGW39	21/12/2016	ME1601793042	<0.001	0	54	0.001	0	0	<0.001	4	0	89	0	50	<0.005	0.46	0.46	<0.01	<0.1	0.5	<<0.01	470
BGW40	6/01/2014	ME1400079032	<0.001	0.05	39	7.01	<0.0001	<0.001	0.068	16	<0.001	34	0.182	377	0.165	0.04	0.04	<0.01	5.4	5.4	0.11	52
BGW40	4/04/2014	ME1400540029	<0.001	0.052	41	8.51	<0.0001	<0.001	0.016	11	<0.001	34	0.152	309	0.046	0.1	0.1	0.1	0.8	0.8	0.05	64
BGW40	18/07/2014	ME1401051032	<0.001	0.051	46	9.05	<0.0001	<0.001	0.248	6	<0.001	31	0.07	417	0.885	0.1	0.1	0.1	0.2	0.2	0.03	45
BGW40	9/10/2014	ME1401512031	<0.001	0.045	47	9.98	<0.0001	<0.001	0.324	5		30	0.058	406	1.04	<0.01	0.03	0.04	0.4	0.4	<0.01	15
BGW40	7/02/2015	ME1500221043	<0.001	0	40	9.9	0	0	0.308	5	0	28	0	479	1.02	<0.01	<0.01	<0.01	0.2	0.2	0.03	25
BGW40	30/04/2015	ME1500659027	0.002	0	49	9.3			0.326	6	0	35	0	445	1.18	0.05	0.05	0.05	0.3	0.3	0.02	12
BGW40	14/08/2015	ME1510328049	<0.001	0	44	9.73	0	0	0.316	4	0	30	0	442	1.24	<0.01	<0.01	<0.01	0.3	0.3	0.02	24
BGW40	21/10/2015	ME1510717035	<0.001	0	48	9.26	0	0	0.31	6	0	36	0	419	1.3	0.05	0.05	0.05	0.3	0.4	0.03	10
BGW40	22/02/2016	ME1600265008	<0.001	0	45	9.54	0	0	0.332	6	0	33	0	462	1.28	0.05	0.05	0.05	0.2	0.2	0.03	32
BGW40	19/05/2016	ME1600733029	<0.001	0	41	9.98	0	0	0.294	6	0	31	0	435	1.2	0.07	0.07	<0.01	0.2	0.3	<<0.01	24
BGW40	1/09/2016	ME1601226028	<0.001	0	45	9.87	0	0	0.313	6	0	35	0	456	1.05	<0.01	0.03	0.03	0.3	0.3	<<0.01	9
BGW40	20/12/2016	ME1601793023	<0.001	0	42	9.85	0	0	0.318	5	0	29	0	426	1.02	<0.01	0.04	0.04	0.2	0.2	<<0.01	24
BGW41	4/04/2014	ME1400540030	<0.001	0.609	6	0.292	<0.0001	<0.001	<0.001	18	<0.001	211	0.387	16	<0.01	<0.01	<0.01	<0.01	0.6	0.6	0.36	466
BGW41	18/07/2014	ME1401051033	<0.001	0.621	7	0.28	<0.0001	<0.001	<0.001	18	<0.001	254	0.408	11	<0.01	0.3	0.3	<0.01	0.2	0.5	0.36	625
BGW41	9/10/2014	ME1401512032	<0.001	0.623	7	0.276	<0.0001	<0.001	<0.001	17		264	0.392	15	0.005	0.07	0.07	<0.01	0.4	0.5	0.41	629
BGW41	7/02/2015	ME1500221044	<0.001	0	12	0.306	0	0	<0.001	16	0	244	0	38	0.03	<0.01	<0.01	<0.01	0.3	0.3	0.35	592
BGW41	30/04/2015	ME1500659028	<0.001	0	15	0.307			<0.001	18	0	273	0	48	0.024	0.03	0.03	<0.01	0.4	0.4	0.52	580
BGW41	14/08/2015	ME1510328052	<0.001	0	14	0.42	0	0	0.005	15	0	240	0	44	0.029	0.02	0.02	<0.01	0.7	0.7	0.36	536
BGW41	21/10/2015	ME1510717036	<0.001	0	18	0.346	0	0	<0.001	18	0	262	0	43	<0.015	0.04	0.04	<0.01	0.3	0.3	0.16	518
BGW41	22/02/2016	ME1600265009	<0.001	0	15	0.425	0	0	0.002	16	0	248	0	55	0.038	0.04	0.04	<0.01	0.3	0.3	0.02	520
BGW41	19/05/2016	ME1600733030	<0.001	0	19	0.163	0	0	<0.001	15	0	303	0	67	<0.019	<0.01	<0.01	<0.01	0.1	0.1	0.02	608
BGW41	1/09/2016	ME1601226029	<0.001	0	18	0.112	0	0	0.004	15	0	249	0	76	0.044	0.03	0.03	<0.01	0.1	0.1	0.02	616
BGW41	20/12/2016	ME1601793024	<0.001	0	20	0.005	0	0	<0.001	15	0	229	0	83	0.036	0.04	0.04	<0.01	<0.1	<0.1	<<0.01	530
BGW42	6/01/2014	ME1400079033	<0.001	0.05	46	1.43	<0.0001	<0.001	0.032	16	<0.001	41	0.232	248	0.069	0.06	0.06	<0.01	1.2	1.3	0.08	131
BGW42	4/04/2014	ME1400540031	<0.001	0.047	48	1.48	<0.0001	<0.001	0.028	15	<0.001	45	0.223	238	0.066	0.04	0.04	<0.01	0.4	0.4	0.04	138
BGW42	18/07/2014	ME1401051034	<0.001	0.046	48	1.2	<0.0001	<0.001	0.026	14	<0.001	49	0.233	260	0.108	<0.01	<0.01	<0.01	0.4	0.4	0.06	136
BGW42	9/10/2014	ME1401512033	<0.001	0.044	53	1.3	<0.0001	<0.001	0.029	15		46	0.237	248	0.038	0.12	0.12	<0.01	0.4	0.5	0.1	130
BGW42	7/02/2015	ME1500221045	<0.001	0	51	1.28	0	0	0.028	13	0	39	0	296	0.032	0.02	0.02	<0.01	0.4	0.4	0.04	126
BGW42	30/04/2015	ME1500659029	<0.001	0	55	1.22			0.27	14	0	45	0	283	0.041	0.03	0.03	<0.01	0.2	0.2	0.04	126
BGW42	11/08/2015	ME1510328051	<0.001	0	50	1.3	0	0	0.026	13	0	40	0	239	0.05	0.02	0.02	<0.01	0.2	0.2	0.02	134
BGW42	27/10/2015	ME1510717037	<0.001	0	61	1.26	0	0	0.026	15	0	43	0	277	0.057	0.06	0.06	<0.01	0.4	0.5	0.06	132
BGW42	23/02/2016	ME1600265022	<0.001	0	53	1.18	0	0	0.029	14	0	45	0	308	0.113	0.06	0.06	<0.01	0.2	0.3	0.03	139
BGW42	19/05/2016	ME1600733031	<0.001	0	53	1.29	0	0	0.025	13	0	42	0	291	0.081	0.05	0.05	<0.01	0.2	0.2	0.02	138
BGW42	6/09/2016	ME1601226065	<0.001	0	56	1.29	0	0	0.022	14	0	45	0	322	0.073	0.11	0.11	<0.01	0.3	0.4	0.04	144
BGW42	20/12/2016	ME1601793025	<0.001	0	51	1.23	0	0	0.029	13	0	39	0	316	0.063	0.05	0.07	0.02	0.7	0.8	0.03	120
BGW43	6/01/2014	ME1400079034	<0.001	0.141	51	2.64	<0.0001	<0.001	0.005	20	<0.001	27	1.8	366	<0.019	0.31	0.31	<0.01	0.9	1.2	0.13	194
BGW43	4/04/2014	ME1400540032	<0.001	0.14	69	2.88	<0.0001	<0.001	0.005	26	<0.001	39	2.18	448	<0.015	<0.01	<0.01	<0.01	0.3	0.3	0.06	220
BGW43	18/07/2014	ME1401051035	<0.001	0.131	70	2.4	<0.0001	<0.001	0.009	28	<0.001	42	1.74	454	0.055	<0.01	<0.01	<0.01	0.2	0.2	0.07	249

Sample Location	Sampling Date	Sample Num	Lead - Dissolved mg/L	Lithium - Dissolved mg/L	Magnesium - Dissolved mg/L	Manganese - Dissolved mg/L	Mercury - Dissolved mg/L	Molybdenum - Dissolved mg/L	Nickel - Dissolved mg/L	Potassium - Dissolved mg/L	Silver - Dissolved mg/L	Sodium - Dissolved mg/L	Strontium - Dissolved mg/L	Sulfate as SO4 - Turbidimetric mg/L	Zinc - Dissolved mg/L	Nitrate as N mg/L	Nitrite + Nitrate as N mg/L	Nitrite as N mg/L	Total Kjeldahl Nitrogen as N mg/L	Total Nitrogen as N mg/L	Total Phosphorus as P mg/L	Total Alkalinity as CaCO3 mg/L
BGW43	9/10/2014	ME1401512034	<0.001	0.141	71	2.38	<0.0001	<0.001	0.006	28		37	1.82	444	<0.014	0.91	0.91	<0.01	0.4	1.3	0.06	240
BGW43	8/02/2015	ME1500221046	<0.001	0	66	2.17	0	0	0.006	24	0	33	0	509	<0.005	0.07	0.07	<0.01	0.6	0.7	0.07	208
BGW43	30/04/2015	ME1500659030	<0.001	0	75	1.9			0.006	28	0	38	0	470	<0.019	<0.01	<0.01	<0.01	0.5	0.5	0.06	209
BGW43	14/08/2015	ME1510328050	<0.001	0	64	1.9	0	0	0.005	24	0	32	0	475	0.022	<0.01	<0.01	<0.01	0.4	0.4	0.13	198
BGW43	21/10/2015	ME1510717038	<0.001	0	81	1.62	0	0	0.005	28	0	39	0	452	0.005	0.08	0.08	<0.01	0.2	0.3	0.07	207
BGW43	22/02/2016	ME1600265010	<0.001	0	63	1.69	0	0	0.004	26	0	32	0	477	0.029	0.02	0.02	<0.01	0.5	0.5	0.06	194
BGW43	19/05/2016	ME1600733032	<0.001	0	68	1.75	0	0	0.004	24	0	34	0	551	<0.019	0.03	0.03	<0.01	0.3	0.3	0.04	234
BGW43	1/09/2016	ME1601226030	<0.001	0	70	1.69	0	0	0.005	26	0	36	0	589	0.02	0.05	0.05	<0.01	0.4	0.4	0.1	235
BGW43	20/12/2016	ME1601793026	<0.001	0	66	1.6	0	0	0.004	26	0	32	0	594	<0.016	0.03	0.03	<0.01	0.3	0.3	0.07	204
BGW44	6/01/2014	ME1400079035	<0.001	0.229	66	0.026	<0.0001	<0.001	<0.001	18	<0.001	223	0.795	171	0.022	0.43	0.43	<0.01	0.6	1	0.04	474
BGW44	2/04/2014	ME1400540033	<0.001	0.227	70	0.892	<0.0001	<0.001	<0.001	18	<0.001	188	0.839	171	<0.012	0.16	0.16	<0.01	0.3	0.5	0.02	457
BGW44	18/07/2014	ME1401051036	<0.001	0.207	73	<0.012	<0.0001	<0.001	<0.001	17	<0.001	210	0.946	177	0.021	0.26	0.26	<0.01	<0.1	0.3	<<0.01	538
BGW44	9/10/2014	ME1401512035	<0.001	0.236	73	0.002	<0.0001	<0.001	<0.001	17		180	0.851	163	<0.019	0.33	0.33	<0.01	0.2	0.5	<<0.01	540
BGW44	8/02/2015	ME1500221047	<0.001	0	71	0.006	0	0	<0.001	16	0	195	0	173	<0.005	0.37	0.37	<0.01	0.3	0.7	<<0.01	495
BGW44	29/04/2015	ME1500659031	<0.001	0	80	0.007			<0.001	18	0	230	0	179	<0.011	0.65	0.65	<0.01	0.3	1	0.02	484
BGW44	14/08/2015	ME1510328053	<0.001	0	69	<0.01	0	0	<0.001	15	0	200	0	191	0.009	0.46	0.46	<0.01	0.2	0.7	<<0.01	474
BGW44	21/10/2015	ME1510717039	<0.001	0	78	0.003	0	0	<0.001	16	0	207	0	167	0.008	0.35	0.35	<0.01	<0.1	0.4	0.02	523
BGW44	22/02/2016	ME1600265011	<0.001	0	62	0.479	0	0	0.002	16	0	206	0	142	0.025	0.08	0.61	0.53	1.7	2.3	0.39	458
BGW44	19/05/2016	ME1600733033	<0.001	0	64	<0.01	0	0	<0.001	14	0	200	0	158	0.008	0.53	0.53	<0.01	0.1	0.6	0.04	557
BGW44	1/09/2016	ME1601226031	<0.001	0	65	0.002	0	0	<0.001	14	0	205	0	160	<0.005	0.3	0.3	<0.01	<0.1	0.3	<<0.01	571
BGW44	20/12/2016	ME1601793027	<0.001	0	62	0.004	0	0	<0.001	15	0	199	0	170	<0.005	0.42	0.42	<0.01	0.1	0.5	<<0.01	438
BGW45	6/01/2014	ME1400079036	<0.001	0.412	54	0.28	<0.0001	<0.001	<0.001	28	<0.001	288	1.4	319	0.005	<0.01	<0.01	<0.01	1.1	1.1	0.09	660
BGW45	2/04/2014	ME1400540034	<0.001	0.414	52	0.391	<0.0001	<0.001	0.003	26	<0.001	239	1.71	315	0.006	0.04	0.04	<0.01	0.5	0.5	0.04	622
BGW45	18/07/2014	ME1401051037	<0.001	0.391	53	0.279	<0.0001	<0.001	0.002	25	<0.001	272	1.44	339	<0.011	<0.01	<0.01	<0.01	0.6	0.6	0.07	715
BGW45	9/10/2014	ME1401512036	<0.001	0.416	53	0.248	<0.0001	<0.001	<0.001	23		296	1.51	318	0.006	0.06	0.06	<0.01	0.5	0.6	0.03	721
BGW45	8/02/2015	ME1500221048	<0.001	0	51	0.279	0	0	<0.001	23	0	266	0	348	<0.005	0.02	0.02	<0.01	1.6	1.6	0.04	666
BGW45	29/04/2015	ME1500659032	0.005	0	58	0.314			0.002	25	0	313	0	328	0.062	0.04	0.04	<0.01	0.7	0.7	0.06	678
BGW45	14/08/2015	ME1510328054	<0.001	0	50	0.224	0	0	<0.001	21	0	271	0	345	<0.005	<0.01	0.02	0.02	0.6	0.6	0.02	634
BGW45	21/10/2015	ME1510717040	<0.001	0	57	0.237	0	0	<0.001	24	0	276	0	310	0.005	0.11	0.11	<0.01	0.5	0.6	0.03	618
BGW45	22/02/2016	ME1600265012	<0.001	0	47	0.262	0	0	<0.001	22	0	289	0	309	<0.005	<0.01	<0.01	<0.01	0.6	0.6	0.03	649
BGW45	19/05/2016	ME1600733034	<0.001	0	48	0.248	0	0	<0.001	22	0	282	0	326	<0.01	0.06	0.06	<0.01	0.4	0.5	0.04	724
BGW45	8/09/2016	ME1601226075	<0.001	0	52	0.316	0	0	<0.001	23	0	305	0	274	<0.005	0.06	0.06	<0.01	0.4	0.5	0.03	663
BGW45	20/12/2016	ME1601793028	<0.001	0	46	0.254	0	0	<0.001	20	0	280	0	319	<0.005	0.04	0.04	<0.01	0.5	0.5	0.02	680
BGW46	13/01/2014	ME1400079037	<0.001	0.626	42	1.87	<0.0001	<0.001	<0.001	32	<0.001	68	1.82	157	<0.018	<0.01	<0.01	<0.01	0.6	0.6	0.19	412
BGW46	3/04/2014	ME1400540035	<0.001	0.616	43	2.09	<0.0001	<0.001	<0.001	30	<0.001	76	2.29	166	0.006	0.02	0.02	<0.01	0.6	0.6	0.04	379
BGW46	15/07/2014	ME1401051038	<0.001	0.581	44	1.76	<0.0001	<0.001	<0.001	30	<0.001	77	1.92	190	0.034	0.02	0.02	<0.01	0.4	0.4	0.13	446
BGW46	8/10/2014	ME1401512037	<0.001	0.581	44	1.84	<0.0001	<0.001	<0.001	27		69	1.98	164	<0.011	0.68	0.68	<0.01	0.4	1.1	0.08	452
BGW46	6/02/2015	ME1500221049	0.001	0	41	1.85	0	0	<0.001	25	0	64	0	186	<0.005	<0.01	<0.01	<0.01	0.7	0.7	0.1	408
BGW46	30/04/2015	ME1500659033	<0.001	0	48	1.5			<0.001	29	0	72	0	184	<0.012	<0.01	<0.01	<0.01	0.5	0.5	0.08	417
BGW46	11/08/2015	ME1510328055	<0.001	0	44	1.67	0	0	<0.001	26	0	72	0	212	0.008	<0.01	<0.01	0.02	0.3	0.3	0.05	404
BGW46	27/10/2015	ME1510717041	<0.001	0	50	1.62	0	0	<0.001	28	0	69	0	190	0.008	0.05	0.05	<0.01	0.3	0.4	0.1	422
BGW46	23/02/2016	ME1600265023	<0.001	0	43	1.48	0	0	<0.001	26	0	75	0	192	0.006	0.05	0.05	<0.01	0.4	0.4	0.06	425
BGW46	25/05/2016	ME1600733035	<0.001	0	52	1.61	0	0	<0.001	26	0	83	0	196	<0.005	0.02	0.02	<0.01	0.9	0.9	0.05	452
BGW46	6/09/2016	ME1601226066	<0.001	0	44	1.6	0	0	<0.001	26	0	72	0	208	<0.005	0.06	0.06	<0.01	0.3	0.4	0.04	409
BGW46	21/12/2016	ME1601793043	<0.001	0	39	1.1	0	0	<0.001	24	0	61	0	176	<0.005	0.04	0.04	<0.01	0.4	0.4	0.02	390
BGW47	10/01/2014	ME1400079038	<0.001	0.083	36	1.22	<0.0001	<0.001	<0.001	18	<0.001	91	0.855	154	<0.005	0.04	0.05	<0.01	1	1	0.19	328
BGW47	31/03/2014	ME1400540036	<0.001	0.08	38	1.28	<0.0001	<0.001	<0.001	18	<0.001	93	1.06	147	<0.005	0.06	0.09	0.03	0.4	0.5	0.06	314
BGW47	15/07/2014	ME1401051039	<0.001	0.074	37	0.004	<0.0001	<0.001	<0.001	16	<0.001	94	0.881	170	0.007	0.35	0.35	<0.01	0.2	0.6	0.09	352
BGW47	13/10/2014	ME1401512038	<0.001	0.076	36	0.002	<0.0001	<0.001	<0.001	15		85	0.954	158	0.006	0.37	0.37	<0.01	0.3	0.7	0.06	345
BGW47	5/02/2015	ME1500221050	<0.001	0	40	0.032	0	0	<0.001	15	0	88	0	174	<0.005	0.68	0.7	0.02	0.2	0.9	0.07	315

Sample Location	Sampling Date	Sample Num	Lead - Dissolved mg/L	Lithium - Dissolved mg/L	Magnesium - Dissolved mg/L	Manganese - Dissolved mg/L	Mercury - Dissolved mg/L	Molybdenum - Dissolved mg/L	Nickel - Dissolved mg/L	Potassium - Dissolved mg/L	Silver - Dissolved mg/L	Sodium - Dissolved mg/L	Strontium - Dissolved mg/L	Sulfate as SO4 - Turbidimetric mg/L	Zinc - Dissolved mg/L	Nitrate as N mg/L	Nitrite + Nitrate as N mg/L	Nitrite as N mg/L	Total Kjeldahl Nitrogen as N mg/L	Total Nitrogen as N mg/L	Total Phosphorus as P mg/L	Total Alkalinity as CaCO3 mg/L
BGW47	29/04/2015	ME1500659034	<0.001	0	41	0.338			<0.001	16	0	98	0	170	0.027	0.46	0.46	0.02	0.2	0.7	0.07	332
BGW47	11/08/2015	ME1510328056	<0.001	0	38	0.041	0	0	<0.001	14	0	87	0	194	0.008	0.27	0.27	<0.01	<0.1	0.3	0.04	368
BGW47	22/10/2015	ME1510717042	<0.001	0	45	0.002	0	0	<0.001	16	0	92	0	174	<0.005	0.17	0.17	<0.01	<0.1	0.2	0.02	338
BGW47	23/02/2016	ME1600265024	<0.001	0	39	0.009	0	0	<0.001	15	0	98	0	181	0.005	0.55	0.59	0.04	0.2	0.8	0.09	344
BGW47	18/05/2016	ME1600733036	<0.001	0	35	0.088	0	0	<0.001	15	0	82	0	158	0.006	0.32	0.32	<0.01	0.2	0.5	0.08	224
BGW47	30/08/2016	ME1601226002	<0.001	0	40	0.003	0	0	<0.001	14	0	95	0	180	0.006	0.2	0.2	<0.01	<0.1	0.2	0.05	349
BGW47	19/12/2016	ME1601793008	<0.001	0	36	0.001	0	0	<0.001	14	0	88	0	162	<0.005	0.42	0.42	<0.01	<0.1	0.4	0.04	323
BGW48	10/01/2014	ME1400079039	0.004	0.005	9	1.31	<0.0001	<0.001	0.01	6	<0.001	30	0.195	50	0.09	0.7	0.71	<0.01	4.9	5.6	1.53	30
BGW48	15/07/2014	ME1401051040	<0.001	0.002	9	0.007	<0.0001	<0.001	<0.001	6	<0.001	26	0.167	58	<0.011	0.53	0.53	<0.01	0.6	1.1	0.27	12
BGW48	7/08/2015	ME1510328057	<0.001	0	8	<0.016	0	0	0.002	3	0	30	0	42	<0.013	0.92	0.92	<0.01	0.2	1.1	0.04	17
BGW48	22/10/2015	ME1510717043	<0.001	0	9	0.031	0	0	0.002	4	0	29	0	41	0.021	0.58	0.58	<0.01	0.1	0.7	0.03	15
BGW48	23/02/2016	ME1600265025	<0.001	0	9	0.726	0	0	<0.001	6	0	28	0	5	0.005	0.1	0.1	<0.01	9.7	9.8	1.14	91
BGW48	30/08/2016	ME1601226003	<0.001	0	6	0.007	0	0	<0.001	3	0	32	0	45	0.02	2.12	2.12	<0.01	0.5	2.6	0.04	31
BGW48	19/12/2016	ME1601793009	<0.001	0	4	<0.015	0	0	<0.001	3	0	19	0	28	<0.017	0.81	0.81	<0.01	1.6	2.4	0.13	22
BGW48	19/12/2016	ME1600265025	<0.001	0	9	0.726	0	0	<0.001	6	0	28	0	5	0.005	0.1	0.1	<0.01	9.7	9.8	1.14	91
BGW49	10/01/2014	ME1400079040	0.002	0.006	10	0.215	<0.0001	<0.001	0.004	6	<0.001	35	0.23	47	0.043	0.14	0.14	<0.01	1.3	1.4	1.18	48
BGW49	31/03/2014	ME1400540037	<0.001	0.007	9	0.503	<0.0001	<0.001	0.002	6	<0.001	34	0.209	46	0.006	0.09	0.11	0.02	1	1.1	2.5	40
BGW49	15/07/2014	ME1401051041	<0.001	0.002	11	0.04	<0.0001	<0.001	0.002	7	<0.001	35	0.232	44	<0.018	0.18	0.18	<0.01	<0.2	<0.2	0.2	44
BGW49	13/10/2014	ME1401512041	<0.001	0.002	14	<0.014	<0.0001	<0.001	<0.001	7		44	0.275	40	<0.015	0.15	0.15	<0.01	0.4	0.6	0.22	64
BGW49	5/02/2015	ME1500221051	<0.001	0	11	0.295	0	0	0.005	7	0	30	0	67	<0.01	0.09	0.09	<0.01	0.9	1	0.23	39
BGW49	29/04/2015	ME1500659035	<0.001	0	9	0.305			0.002	6	0	26	0	39	<0.018	0.07	0.07	<0.01	2.8	2.9	0.48	74
BGW49	7/08/2015	ME1510328058	<0.001	0	9	0.004	0	0	0.002	4	0	25	0	62	0.029	1.34	1.34	<0.01	0.3	1.6	0.04	11
BGW49	22/10/2015	ME1510717044	<0.001	0	12	0.004	0	0	0.002	5	0	29	0	45	0.03	1.05	1.05	<0.01	<0.1	1	0.03	11
BGW49	23/02/2016	ME1600265026	<0.001	0	12	<0.017	0	0	<0.001	7	0	35	0	66	<0.019	0.56	0.56	<0.01	0.2	0.8	0.03	44
BGW49	18/05/2016	ME1600733037	<0.001	0	9	0.871	0	0	<0.001	6	0	32	0	52	<0.005	0.16	0.16	<0.01	6.1	6.3	3.68	46
BGW49	30/08/2016	ME1601226004	<0.001	0	6	0.004	0	0	0.002	4	0	19	0	38	0.031	1.82	1.82	<0.01	0.6	2.4	0.07	15
BGW49	19/12/2016	ME1601793010	<0.001	0	5	0.003	0	0	<0.001	4	0	13	0	26	0.026	1.65	1.65	<0.01	0.5	2.2	0.07	16
BGW50	10/01/2014	ME1400079041	<0.001	0.084	45	0.318	<0.0001	<0.001	<0.001	16	<0.001	103	0.706	45	<0.013	<0.01	<0.01	<0.01	1	1	0.25	462
BGW50	31/03/2014	ME1400540038	<0.001	0.086	50	0.32	<0.0001	<0.001	<0.001	18	<0.001	105	0.804	345	<0.005	<0.01	<0.01	<0.01	0.7	0.7	0.05	306
BGW50	15/07/2014	ME1401051042	<0.001	0.084	51	0.317	<0.0001	<0.001	<0.001	17	<0.001	111	0.77	395	0.038	0.03	0.03	<0.01	<0.1	<0.1	0.02	347
BGW50	13/10/2014	ME1401512042	<0.001	0.084	53	0.009	<0.0001	<0.001	0.002	18		112	0.784	364	0.061	0.16	0.16	<0.01	0.1	0.3	<0.01	347
BGW50	5/02/2015	ME1500221052	<0.001	0	49	0.501	0	0	0.004	15	0	95	0	402	<0.012	0.05	0.05	<0.01	0.3	0.4	0.04	253
BGW50	28/04/2015	ME1500659036	<0.001	0	52	0.499			0.004	15	0	104	0	357	0.02	0.02	0.02	<0.01	0.1	0.1	0.04	281
BGW50	7/08/2015	ME1510328059	<0.001	0	46	0.008	0	0	0.002	14	0	93	0	368	0.024	0.07	0.07	<0.01	<0.1	<0.1	0.03	260
BGW50	22/10/2015	ME1510717045	<0.001	0	55	0.025	0	0	<0.001	16	0	100	0	354	0.062	0.14	0.14	<0.01	<0.1	0.1	0.02	256
BGW50	23/02/2016	ME1600265027	<0.001	0	48	0.004	0	0	<0.001	14	0	105	0	367	0.042	0.31	0.31	<0.01	<0.1	0.3	0.04	280
BGW50	18/05/2016	ME1600733038	<0.001	0	40	0.005	0	0	<0.001	12	0	80	0	338	0.034	0.28	0.28	<0.01	0.1	0.4	0.02	235
BGW50	30/08/2016	ME1601226005	<0.001	0	11	0.004	0	0	<0.001	6	0	41	0	76	<0.011	1.84	1.84	<0.01	0.4	2.2	0.03	88
BGW50	19/12/2016	ME1601793011	<0.001	0	7	0.003	0	0	<0.001	4	0	24	0	42	<0.01	0.49	0.49	<0.01	1.3	1.8	0.02	62
BGW51	10/01/2014	ME1400079042	<0.001	0.092	53	0.667	<0.0001	<0.001	0.005	19	<0.001	108	0.694	386	<0.014	0.02	0.02	<0.01	0.5	0.5	0.8	259
BGW51	31/03/2014	ME1400540039	<0.001	0.078	48	0.384	<0.0001	<0.001	0.004	18	<0.001	110	0.699	334	<0.012	0.06	0.06	<0.01	0.9	1	0.36	241
BGW51	15/07/2014	ME1401051043	<0.001	0.085	54	0.82	<0.0001	<0.001	0.004	19	<0.001	111	0.684	412	<0.018	<0.01	<0.01	<0.01	<0.1	<0.1	0.47	280
BGW51	13/10/2014	ME1401512043	<0.001	0.087	59	0.674	<0.0001	<0.001	0.004	21		121	0.712	372	<0.016	0.04	0.04	<0.01	0.2	0.2	0.97	277
BGW51	5/02/2015	ME1500221053	<0.001	0	52	0.612	0	0	0.003	16	0	96	0	430	<0.005	0.02	0.02	<0.01	0.3	0.3	1.09	248
BGW51	28/04/2015	ME1500659037	0.007	0	58	0.963			0.006	18	0	113	0	396	0.388	0.03	0.03	<0.01	0.3	0.3	1.38	254
BGW51	7/08/2015	ME1510328060	<0.001	0	54	0.765	0	0	0.004	16	0	102	0	404	<0.016	<0.01	<0.01	<0.01	0.1	0.1	0.7	239
BGW51	22/10/2015	ME1510717046	<0.001	0	62	0.739	0	0	0.003	17	0	108	0	383	<0.014	<0.01	<0.01	<0.01	<0.1	<0.1	0.74	255
BGW51	23/02/2016	ME1600265028	<0.001	0	52	0.455	0	0	0.004	16	0	113	0	407	<0.01	0.04	0.04	<0.01	<0.1	<0.1	0.34	262
BGW51	18/05/2016	ME1600733039	<0.001	0	46	0.433	0	0	<0.001	14	0	89	0	384	0.008	0.03	0.03	<0.01	<0.1	<0.1	0.35	254
BGW51	30/08/2016	ME1601226006	<0.001	0	16	<0.014	0	0	<0.001	7	0	51	0	109	<0.005	0.47	0.47	<0.01	0.5	1	0.06	131

Sample Location	Sampling Date	Sample Num	Lead - Dissolved mg/L	Lithium - Dissolved mg/L	Magnesium - Dissolved mg/L	Manganese - Dissolved mg/L	Mercury - Dissolved mg/L	Molybdenum - Dissolved mg/L	Nickel - Dissolved mg/L	Potassium - Dissolved mg/L	Silver - Dissolved mg/L	Sodium - Dissolved mg/L	Strontium - Dissolved mg/L	Sulfate as SO4 - Turbidimetric mg/L	Zinc - Dissolved mg/L	Nitrate as N mg/L	Nitrite + Nitrate as N mg/L	Nitrite as N mg/L	Total Kjeldahl Nitrogen as N mg/L	Total Nitrogen as N mg/L	Total Phosphorus as P mg/L	Total Alkalinity as CaCO3 mg/L
BGW51	19/12/2016	ME1601793012	<0.001	0	47	0.945	0	0	0.004	14	0	97	0	335	<0.014	0.03	0.03	<0.01	0.9	0.9	0.34	229
BGW52	8/01/2014	ME1400079043	<0.001	0.006	19	0.008	<0.0001	<0.001	0.003	3	<0.001	53	0.356	58	0.021	0.46	0.46	<0.01	1.3	1.8	0.04	180
BGW52	8/04/2014	ME1400540040	<0.001	0.006	22	0.003	<0.0001	<0.001	0.002	2	<0.001	58	0.377	53	<0.01	0.66	0.66	<0.01	0.3	1	<0.01	188
BGW52	14/07/2014	ME1401051044	<0.001	0.008	22	0.005	<0.0001	<0.001	<0.001	3	<0.001	57	0.394	60	<0.015	0.68	0.68	<0.01	0.1	0.8	<<0.01	216
BGW52	13/10/2014	ME1401512044	<0.001	0.034	37	0.003	<0.0001	<0.001	<0.001	4		103	0.986	83	<0.013	0.82	0.82	<0.01	0.2	1	0.02	315
BGW52	4/02/2015	ME1500221054	<0.001	0	33	<0.01	0	0	<0.001	3	0	85	0	107	<0.005	0.8	0.8	<0.01	0.3	1.1	0.02	288
BGW52	28/04/2015	ME1500659038	<0.001	0	39	<0.012			0.002	4	0	103	0	100	0.062	0.87	0.87	<0.01	0.3	1.2	0.02	303
BGW52	7/08/2015	ME1510328061	<0.001	0	38	0.001	0	0	<0.001	3	0	97	0	102	<0.019	0.82	0.82	<0.01	0.1	0.9	<<0.01	291
BGW52	21/10/2015	ME1510717047	<0.001	0	44	0.006	0	0	<0.001	4	0	102	0	93	<0.016	1.55	1.55	<0.01	0.3	1.8	0.02	322
BGW52	22/02/2016	ME1600265013	<0.001	0	36	0.009	0	0	<0.001	3	0	106	0	88	<0.013	1.85	1.85	<0.01	0.4	2.2	<0.01	289
BGW52	19/05/2016	ME1600733040	<0.001	0	36	0.009	0	0	<0.001	6	0	106	0	94	<0.012	1.78	1.78	<0.01	0.2	2	<0.01	336
BGW52	1/09/2016	ME1601226032	<0.001	0	28	0.003	0	0	<0.001	3	0	94	0	83	0.008	1.58	1.58	<0.01	0.3	1.9	<<0.01	243
BGW52	20/12/2016	ME1601793029	<0.001	0	23	0.003	0	0	<0.001	2	0	56	0	48	<0.005	1.58	1.58	<0.01	0.2	1.8	<<0.01	233
BGW53	8/01/2014	ME1400079044	<0.001	0.005	33	0.004	<0.0001	<0.001	<0.001	4	<0.001	114	0.616	82	<0.016	2.62	2.62	<0.01	1.4	4	0.28	265
BGW53	8/04/2014	ME1400540041	<0.001	0.004	40	0.001	<0.0001	<0.001	<0.001	4	<0.001	124	0.691	104	<0.005	3.01	3.01	<0.01	0.6	3.6	0.07	273
BGW53	14/07/2014	ME1401051045	<0.001	0.003	44	0.002	<0.0001	<0.001	<0.001	4	<0.001	164	0.695	131	<0.011	2.85	2.85	<0.01	0.3	3.2	0.13	345
BGW53	13/10/2014	ME1401512045	<0.001	0.003	62	0.002	<0.0001	<0.001	<0.001	4		226	0.935	155	0.023	5.58	5.58	<0.01	0.8	6.4	0.1	437
BGW53	4/02/2015	ME1500221055	<0.001	0	66	0.005	0	0	<0.001	4	0	213	0	162	<0.005	7.07	7.07	<0.01	1.2	8.3	0.21	443
BGW53	28/04/2015	ME1500659039	<0.001	0	67	0.007			<0.001	4	0	203	0	154	<0.015	3.48	3.48	<0.01	1.2	4.7	0.23	441
BGW53	7/08/2015	ME1510328062	<0.001	0	59	<0.001	0	0	<0.001	3	0	199	0	138	0.006	5.22	5.23	<0.01	0.6	5.8	0.08	408
BGW53	21/10/2015	ME1510717048	<0.001	0	70	0.003	0	0	<0.001	5	0	215	0	165	0.008	5.34	5.34	<0.01	0.5	5.8	0.06	452
BGW53	22/02/2016	ME1600265014	<0.001	0	53	0.006	0	0	<0.001	3	0	214	0	150	0.007	4.74	4.74	<0.01	0.5	5.2	0.09	383
BGW53	19/05/2016	ME1600733041	<0.001	0	54	0.003	0	0	<0.001	4	0	215	0	129	0.006	4.53	4.53	<0.01	0.5	5	0.16	471
BGW53	1/09/2016	ME1601226033	<0.001	0	24	0.002	0	0	<0.001	2	0	118	0	107	<0.005	1.08	1.08	<0.01	0.2	1.3	0.04	239
BGW53	20/12/2016	ME1601793030	<0.001	0	31	0.008	0	0	<0.001	2	0	68	0	65	<0.005	2.28	2.29	<0.01	0.4	2.7	<<0.01	310
BGW54	15/10/2013	ME1400079056	<0.001	0.001	15	1.46	<0.0001	<0.001	0.006	2	<0.001	49	0.273	47	<0.005	0.23	0.23	<0.01	2.8	3	2.41	79
BGW54	13/10/2014	ME1401512046	<0.001	<0.001	30	3.37	<0.0001	<0.001	0.003	5		37	0.676	71	0.006	0.51	0.56	0.05	26	26.6	24	582
BGW54	1/09/2016	ME1601226034	<0.001	0	18	0.002	0	0	<0.001	4	0	42	0	58	0.006	0.68	0.68	<0.01	0.1	0.8	0.02	70
BGW54	20/12/2016	ME1601793031	<0.001	0	14	0.005	0	0	<0.001	3	0	32	0	46	0.006	1.71	1.72	<0.01	0.5	2.2	0.18	59
BSW01	31/08/2016	ME1601226007	<0.001	0	10	0.3	0	0	0.008	2	0	23	0	58	<0.016	0.04	0.04	<0.01	0.4	0.4	0.02	27
BSW02	1/09/2016	ME1601226036	<0.001	0	4	0.049	0	0	<0.001	2	0	16	0	5	0.008	4.41	4.41	<0.01	0.7	5.1	<<0.01	4
BSW03	17/02/2014	ME1400288001	0.006	0.001	2	0.488	<0.0001	<0.001	<0.001	12	<0.001	3	0.023	<10	0.043	<0.01	<0.01	<0.01	1.6	1.6	0.44	6
BSW03	21/05/2014	ME1400741001	0.002	<0.001	2	0.41	<0.0001	<0.001	<0.001	11	<0.001	4	0.032	4	0.063	0.09	0.09	<0.01	1.5	1.6	0.52	14
BSW03	20/08/2014	ME1401208001	0.002	<0.001	2	0.261	<0.0001	<0.001	<0.001	6	<0.001	8	0.026	22	0.028	<0.01	<0.01	<0.01	2.4	2.4	0.29	5
BSW03	30/04/2015	ME1500659047	0.006	0	3	0.307			0.002	8	0	3	0	10	0.102	0.04	0.04	<0.01	1.3	1.3	0.1	6
BSW03	4/08/2015	ME1510328001	0.003	0	2	0.166	0	0	<0.001	6	0	7	0	1	0.022	0.02	0.02	<0.01	1.2	1.2	0.13	5
BSW03	3/02/2016	ME1600265048	0.002	0	5	0.963	0	0	<0.001	16	0	4	0	<10	<0.014	1.38	1.38	<0.01	3.3	4.7	0.41	42
BSW03	12/05/2016	ME1600662001	0.003	0	3	0.291	0	0	<0.001	9	0	2	0	<1	0.026	<0.01	<0.01	<0.01	1.1	1.1	0.16	25
BSW03	5/09/2016	ME1601226050	<0.001	0	<1	0.008	0	0	<0.001	5	0	5	0	7	<0.011	0.06	0.06	<0.01	0.5	0.6	<<0.01	5
BSW04	17/02/2014	ME1400288002	0.059	<0.016	9	5.15	<0.0001	<0.001	0.019	24	<0.001	15	0.129	164	1.39	0.23	0.23	<0.01	0.6	0.8	0.02	<1
BSW04	21/05/2014	ME1400741002	0.041	0.009	8	4.72	<0.0001	<0.001	0.015	16	<0.001	11	0.095	132	1.06	<0.01	<0.01	<0.01	0.3	0.3	0.06	<1
BSW04	20/08/2014	ME1401208002	0.039	0.008	9	3.16	<0.0001	<0.001	0.013	14	<0.001	14	0.105	144	1.06	<0.01	<0.01	<0.01	0.4	0.4	0.02	<1
BSW04	20/11/2014	ME1401676001	0.046	<0.015	10	10.2	<0.0001	<0.001	0.03	24	0	17	0.187	177	2.12	0.04	0.04	<0.01	1.4	1.4	0.05	<1
BSW04	5/02/2015	ME1500221001	0.037	0	6	6.86	0	0	0.019	15	0	8	0	113	1.32	0.03	0.03	<0.01	1.6	1.6	0.09	<1
BSW04	30/04/2015	ME1500659048	<0.014	0	4	2.96			0.01	8	0	5	0	60	0.805	0.04	0.04	<0.01	0.3	0.3	<0.01	<1
BSW04	4/08/2015	ME1510328002	<0.014	0	4	2.46	0	0	0.008	6	0	8	0	62	0.656	<0.01	<0.01	<0.01	<0.1	<0.1	<<0.01	<1
BSW04	2/02/2016	ME1600265049	<0.013	0	3	3.34	0	0	0.011	9	0	4	0	49	0.85	0.09	0.09	<0.01	0.3	0.4	<0.01	<1
BSW04	11/05/2016	ME1600662002	0.007	0	2	2.18	0	0	0.008	7	0	3	0	33	0.564	<0.01	<0.01	<0.01	0.2	0.2	0.03	<1
BSW04	30/08/2016	ME1601226008	<0.012	0	11	1.2	0	0	0.012	8	0	21	0	116	1.06	0.03	0.03	<0.01	<0.1	<0.1	0.02	<1
BSW05	30/04/2015	ME1500659049	0.006	0	2	0.152			0.002	2	0	2	0	17	0.037	<0.01	<0.01	<0.01	0.7	0.7	0.25	<1

Sample Location	Sampling Date	Sample Num	Lead - Dissolved mg/L	Lithium - Dissolved mg/L	Magnesium - Dissolved mg/L	Manganese - Dissolved mg/L	Mercury - Dissolved mg/L	Molybdenum - Dissolved mg/L	Nickel - Dissolved mg/L	Potassium - Dissolved mg/L	Silver - Dissolved mg/L	Sodium - Dissolved mg/L	Strontium - Dissolved mg/L	Sulfate as SO4 - Turbidimetric mg/L	Zinc - Dissolved mg/L	Nitrate as N mg/L	Nitrite + Nitrate as N mg/L	Nitrite as N mg/L	Total Kjeldahl Nitrogen as N mg/L	Total Nitrogen as N mg/L	Total Phosphorus as P mg/L	Total Alkalinity as CaCO3 mg/L
BSW05	4/08/2015	ME1510328003	<0.001	0	3	0.062	0	0	<0.001	7	0	9	0	23	0.055	<0.01	<0.01	<0.01	0.4	0.4	<0.01	<1
BSW05	5/09/2016	ME1601226051	<0.001	0	1	<0.018	0	0	<0.001	6	0	4	0	9	<0.013	0.03	0.03	<0.01	0.8	0.8	<0.01	4
BSW06	11/05/2016	ME1600662003	<0.001	0	1	0.039	0	0	<0.001	6	0	<1	0	<1	0.025	0.02	0.02	<0.01	1	1	0.14	12
BSW06	30/08/2016	ME1601226009	<0.001	0	4	0.126	0	0	0.002	5	0	9	0	30	0.096	<0.01	<0.01	<0.01	0.2	0.2	0.12	10
BSW07	17/02/2014	ME1400288003	<0.001	0.003	15	0.87	<0.0001	<0.001	<0.001	7	<0.001	48	0.25	38	0.033	<0.01	<0.01	<0.01	2	2	1.85	95
BSW07	20/05/2014	ME1400741003	<0.001	0.003	15	0.201	<0.0001	<0.001	<0.001	5	<0.001	44	0.229	46	<0.018	<0.01	<0.01	<0.01	0.4	0.4	0.04	84
BSW07	19/08/2014	ME1401208003	<0.001	0.003	13	0.24	<0.0001	<0.001	<0.001	4	<0.001	40	0.242	43	0.009	<0.01	<0.01	<0.01	0.2	0.2	0.04	79
BSW07	21/11/2014	ME1401676002	<0.001	0.004	16	1.08	<0.0001	<0.001	<0.001	5	0	38	0.262	44	<0.01	0.03	0.03	<0.01	1.5	1.5	0.05	109
BSW07	5/02/2015	ME1500221002	<0.001	0	17	0.457	0	0	<0.001	5	0	38	0	46	0.009	0.02	0.02	<0.01	0.1	0.1	0.06	96
BSW07	28/04/2015	ME1500659050	<0.001	0	18	0.081			<0.001	6	0	44	0	57	<0.014	0.13	0.13	<0.01	3.7	3.8	0.38	80
BSW07	4/08/2015	ME1510328004	<0.001	0	17	0.234	0	0	<0.001	4	0	45	0	50	0.005	0.19	0.19	<0.01	0.1	0.3	<0.01	68
BSW07	13/10/2015	ME1510717001	<0.001	0	20	0.332	0	0	<0.001	5	0	48	0	38	0.008	0.05	0.05	<0.01	0.9	1	0.1	111
BSW07	2/02/2016	ME1600265050	<0.001	0	20	0.235	0	0	<0.001	8	0	45	0	46	0.029	0.2	0.2	<0.01	0.8	1	0.2	98
BSW07	11/05/2016	ME1600662004	<0.001	0	20	0.173	0	0	<0.001	6	0	48	0	41	<0.011	<0.01	<0.01	<0.01	<0.1	<0.1	0.45	113
BSW07	30/08/2016	ME1601226010	<0.001	0	33	0.143	0	0	0.004	6	0	118	0	113	0.009	0.06	0.06	<0.01	1	1.1	0.05	114
BSW08	20/05/2014	ME1400741004	0.002	0.002	4	0.17	<0.0001	<0.001	0.01	11	<0.001	8	0.077	<10	0.021	<0.01	<0.01	<0.01	3	3	0.38	35
BSW08	19/08/2014	ME1401208004	0.001	0.003	3	0.163	<0.0001	<0.001	0.005	6	<0.001	21	0.071	39	0.033	<0.01	<0.01	<0.01	6.5	6.5	1.01	17
BSW08	4/08/2015	ME1510328005	0.008	0	6	0.665	0	0	0.019	18	0	21	0	<10	0.682	<0.01	<0.01	<0.01	1.6	1.6	0.2	27
BSW08	2/02/2016	ME1600265051	0.027	0	3	0.457	0	0	0.047	6	0	12	0	15	0.206	0.28	0.35	0.07	1.3	1.6	0.51	21
BSW08	30/08/2016	ME1601226011	<0.001	0	5	0.028	0	0	0.005	10	0	11	0	<10	0.038	<0.01	<0.01	<0.01	2.7	2.7	0.18	39
BSW09	31/08/2016	ME1601226012	<0.001	0	26	<0.017	0	0	0.002	17	0	47	0	70	0.032	3.51	3.51	<0.01	1	4.5	0.05	68
BSW11	20/02/2014	ME1400288004	<0.001	0.002	10	0.629	<0.0001	<0.001	0.006	8	<0.001	47	0.145	75	<0.005	0.93	0.96	0.03	2.1	3.1	0.36	10
BSW11	21/05/2014	ME1400741005	<0.001	<0.001	12	0.354	<0.0001	<0.001	0.005	8	<0.001	45	0.187	24	0.025	0.08	0.08	<0.01	2	2.1	0.16	108
BSW11	19/08/2014	ME1401208005	<0.001	<0.001	10	0.216	<0.0001	<0.001	0.004	5	<0.001	42	0.183	32	0.032	0.08	0.08	<0.01	1.3	1.4	0.08	94
BSW11	19/11/2014	ME1401676003	<0.001	0.001	22	2.91	<0.0001	0.004	0.007	14	0	68	0.348	18	0.008	0.02	0.08	0.06	5.6	5.7	0.3	253
BSW11	4/02/2015	ME1500221003	0.007	0	16	0.419	0	0	0.011	9	0	49	0	22	0.206	0.02	0.02	<0.01	11.6	11.6	0.87	249
BSW11	28/04/2015	ME1500659051	<0.001	0	20	0.69			0.004	12	0	46	0	171	0.032	2.26	2.32	0.06	2	4.3	0.22	15
BSW11	4/08/2015	ME1510328006	<0.001	0	3	0.257	0	0	0.004	5	0	9	0	12	0.007	0.02	0.02	<0.01	0.5	0.5	0.05	18
BSW11	2/02/2016	ME1600265052	<0.001	0	6	0.119	0	0	<0.001	8	0	12	0	43	<0.012	0.05	0.05	<0.01	0.8	0.8	0.09	59
BSW11	11/05/2016	ME1600662005	<0.001	0	8	1.1	0	0	0.007	20	0	16	0	5	0.006	0.02	0.02	<0.01	4.6	4.6	0.53	85
BSW11	1/09/2016	ME1601226037	<0.001	0	30	0.089	0	0	0.004	8	0	102	0	95	0.009	<0.01	<0.01	<0.01	0.2	0.2	<0.01	107
BSW12	18/02/2014	ME1400288005	<0.001	0.003	29	0.134	<0.0001	<0.001	<0.001	14	<0.001	69	0.441	21	<0.012	<0.01	<0.01	<0.01	0.7	0.7	0.09	199
BSW12	21/05/2014	ME1400741006	<0.001	0.002	16	0.078	<0.0001	<0.001	<0.001	6	<0.001	47	0.225	58	<0.01	<0.01	<0.01	<0.01	0.5	0.5	0.02	73
BSW12	20/08/2014	ME1401208006	<0.001	0.003	17	0.094	<0.0001	<0.001	<0.001	8	<0.001	46	0.269	69	<0.018	0.15	0.15	<0.01	0.3	0.4	0.02	72
BSW12	19/11/2014	ME1401676004	<0.001	0.003	21	<0.013	<0.0001	<0.001	<0.001	6	0	50	0.313	49	0.005	<0.01	<0.01	<0.01	1.4	1.4	0.04	144
BSW12	5/02/2015	ME1500221004	<0.001	0	20	0.008	0	0	<0.001	5	0	50	0	44	<0.005	<0.01	<0.01	<0.01	0.8	0.8	0.07	127
BSW12	29/04/2015	ME1500659052	<0.001	0	21	0.111			0.002	9	0	49	0	74	0.037	<0.01	<0.01	<0.01	0.4	0.4	0.02	82
BSW12	7/08/2015	ME1510328007	<0.001	0	8	0.022	0	0	<0.001	4	0	22	0	60	0.007	0.06	0.06	<0.01	<0.1	<0.1	<<0.01	53
BSW12	14/10/2015	ME1510717002	<0.001	0	19	0.217	0	0	<0.001	8	0	40	0	44	0.008	0.02	0.02	<0.01	0.3	0.3	0.02	85
BSW12	3/02/2016	ME1600265053	<0.001	0	14	0.181	0	0	<0.001	5	0	29	0	13	0.008	0.07	0.07	<0.01	0.4	0.5	<0.01	73
BSW12	11/05/2016	ME1600662006	<0.001	0	15	0.361	0	0	0.004	9	0	39	0	102	0.126	<0.01	<0.01	<0.01	0.3	0.3	0.04	30
BSW12	31/08/2016	ME1601226013	<0.001	0	19	0.058	0	0	0.002	8	0	66	0	78	0.023	0.02	0.02	<0.01	0.6	0.6	0.02	84
BSW13	20/02/2014	ME1400288006	<0.001	0.002	5	0.59	<0.0001	<0.001	0.005	4	<0.001	29	0.066	50	0.008	0.42	0.46	0.04	3.3	3.8	1.01	12
BSW13	19/05/2014	ME1400741007	<0.001	0.002	13	0.042	<0.0001	<0.001	0.002	2	<0.001	86	0.153	74	<0.013	<0.01	<0.01	<0.01	0.6	0.6	0.05	57
BSW13	19/08/2014	ME1401208007	<0.001	0.006	35	0.903	<0.0001	<0.001	0.004	7	<0.001	157	0.413	192	0.006	<0.01	<0.01	<0.01	1.1	1.1	0.08	78
BSW13	19/11/2014	ME1401676005	<0.001	0.002	39	0.581	<0.0001	0.003	0.006	11	0	193	0.491	234	<0.017	0.05	0.05	<0.01	1.9	2	0.07	178
BSW13	4/02/2015	ME1500221005	0.001	0	20	0.286	0	0	0.01	25	0	89	0	98	<0.018	0.36	0.39	0.03	10.3	10.7	2.62	75
BSW13	1/05/2015	ME1500659053	0.002	0	9	0.291			0.008	6	0	31	0	55	0.029	<0.01	<0.01	<0.01	1.4	1.4	0.29	30
BSW13	7/08/2015	ME1510328008	<0.001	0	10	0.546	0	0	0.004	4	0	38	0	14	<0.005	0.02	0.02	<0.01	0.2	0.2	0.03	31
BSW13	3/02/2016	ME1600265054	<0.001	0	7	0.113	0	0	0.003	2	0	19	0	14	<0.005	0.18	0.18	<0.01	0.8	1	0.1	83

Sample Location	Sampling Date	Sample Num	Lead - Dissolved mg/L	Lithium - Dissolved mg/L	Magnesium - Dissolved mg/L	Manganese - Dissolved mg/L	Mercury - Dissolved mg/L	Molybdenum - Dissolved mg/L	Nickel - Dissolved mg/L	Potassium - Dissolved mg/L	Silver - Dissolved mg/L	Sodium - Dissolved mg/L	Strontium - Dissolved mg/L	Sulfate as SO4 - Turbidimetric mg/L	Zinc - Dissolved mg/L	Nitrate as N mg/L	Nitrite + Nitrate as N mg/L	Nitrite as N mg/L	Total Kjeldahl Nitrogen as N mg/L	Total Nitrogen as N mg/L	Total Phosphorus as P mg/L	Total Alkalinity as CaCO3 mg/L
BSW13	11/05/2016	ME1600662007	<0.001	0	3	0.061	0	0	0.004	7	0	12	0	21	0.009	<0.01	<0.01	<0.01	0.7	0.7	0.2	10
BSW13	31/08/2016	ME1601226014	<0.001	0	40	1.01	0	0	0.003	6	0	158	0	135	<0.005	0.03	0.03	<0.01	1.1	1.1	0.05	126
BSW14	20/02/2014	ME1400288007	<0.001	0.022	56	0.084	<0.0001	<0.001	0.003	9	<0.001	192	0.512	384	0.049	17.8	17.9	0.08	4	21.9	0.18	35
BSW14	19/08/2014	ME1401208008	<0.001	0.003	3	0.008	<0.0001	<0.001	0.002	4	<0.001	20	0.04	24	<0.013	<0.01	<0.01	<0.01	1.5	1.5	0.1	11
BSW14	31/08/2016	ME1601226015	<0.001	0	62	0.038	0	0	0.007	12	0	121	0	358	0.006	0.03	0.03	<0.01	1.5	1.5	0.04	247
BSW15	19/08/2014	ME1401208009	<0.001	<0.001	2	0.081	<0.0001	<0.001	<0.001	4	<0.001	18	0.078	23	0.006	<0.01	<0.01	<0.01	2.7	2.7	0.37	17
BSW15	7/08/2015	ME1510328009	<0.001	0	3	0.304	0	0	0.004	4	0	20	0	12	0.007	0.03	0.03	<0.01	0.7	0.7	0.05	13
BSW15	5/09/2016	ME1601226052	<0.001	0	5	0.022	0	0	<0.001	5	0	28	0	32	<0.005	0.03	0.03	<0.01	0.8	0.8	0.04	36
BSW16	4/08/2015	ME1510328010	<0.001	0	6	0.006	0	0	0.002	2	0	14	0	<1	0.027	0.02	0.02	<0.01	0.2	0.2	<<0.01	35
BSW16	4/08/2015	ME1510328010	<0.001	0	6	0.006	0	0	0.002	2	0	14	0	<1	0.027	0.02	0.02	<0.01	0.2	0.2	<<0.01	35
BSW16	13/10/2015	ME1510717003	<0.001	0	5	0.024	0	0	0.004	1	0	9	0	<1	0.007	0.25	0.25	<0.01	0.2	0.4	0.02	58
BSW16	2/02/2016	ME1600265055	<0.001	0	4	0.008	0	0	<0.001	2	0	7	0	<1	0.029	0.32	0.32	<0.01	0.2	0.5	<0.01	58
BSW16	11/05/2016	ME1600662008	<0.001	0	10	0.211	0	0	0.006	6	0	15	0	2	<0.01	<0.01	<0.01	<0.01	0.6	0.6	0.15	60
BSW16	1/09/2016	ME1601226038	<0.001	0	4	0.003	0	0	0.003	1	0	11	0	<10	<0.005	0.02	0.02	<0.01	0.3	0.3	0.02	28
BSW17	21/05/2014	ME1400741008	<0.001	<0.001	2	<0.016	<0.0001	<0.001	0.003	4	<0.001	15	<0.014	4	0.13	0.48	0.48	<0.01	3.2	3.7	0.08	2
BSW17	19/08/2014	ME1401208010	<0.001	0.001	2	<0.013	<0.0001	<0.001	0.003	3	<0.001	18	0.025	15	0.071	1.3	1.3	<0.01	2.2	3.5	0.08	<1
BSW17	20/11/2014	ME1401676006	<0.001	0.001	2	0.106	<0.0001	<0.001	0.004	2	0	14	<0.014	28	0.04	0.06	0.06	<0.01	1.5	1.6	0.03	<1
BSW17	29/04/2015	ME1500659054	<0.001	0	4	<0.019			0.002	2	0	16	0	12	<0.015	0.99	0.99	<0.01	0.4	1.4	<<0.01	<1
BSW17	1/09/2016	ME1601226039	<0.001	0	2	0.006	0	0	0.003	2	0	13	0	4	<0.013	0.77	0.77	<0.01	0.4	1.2	<0.01	6
BSW18	1/09/2016	ME1601226040	0.005	0	4	0.158	0	0	0.006	11	0	14	0	36	0.84	<0.01	<0.01	<0.01	2.4	2.4	0.12	6
BSW19	20/08/2014	ME1401208011	<0.001	0.002	13	0.858	<0.0001	<0.001	0.004	11	<0.001	60	0.182	114	0.041	0.13	0.13	<0.01	1.3	1.4	0.1	33
BSW19	14/08/2015	ME1510328011	<0.001	0	16	0.177	0	0	0.004	6	0	42	0	118	0.061	0.03	0.03	<0.01	0.3	0.3	<<0.01	23
BSW19	31/08/2016	ME1601226016	<0.001	0	22	0.063	0	0	0.003	5	0	73	0	87	<0.014	0.02	0.02	<0.01	1.5	1.5	0.1	75
BSW20	18/02/2014	ME1400288008	<0.001	0.002	93	0.082	<0.0001	0.003	0.002	10	<0.001	277	0.799	219	<0.005	<0.01	0.02	<0.01	2	2	0.12	316
BSW20	22/05/2014	ME1400741017	<0.001	0.004	57	0.545	<0.0001	<0.001	0.003	8	<0.001	116	0.484	247	0.008	<0.01	<0.01	<0.01	1	1	0.06	136
BSW20	20/08/2014	ME1401208012	<0.001	0.007	50	0.348	<0.0001	<0.001	0.002	5	<0.001	129	0.419	194	<0.016	0.05	0.05	<0.01	0.6	0.6	0.04	130
BSW20	20/11/2014	ME1401676007	<0.001	0.003	74	0.349	<0.0001	<0.001	0.002	5	0	187	0.29	225	<0.005	<0.01	<0.01	<0.01	1.3	1.3	0.06	223
BSW20	9/02/2015	ME1500221006	0.005	0	85	0.994	0	0	0.005	9	0	232	0	234	0.109	<0.01	<0.01	<0.01	2.1	2.1	0.11	274
BSW20	1/05/2015	ME1500659055	0.001	0	92	0.607			0.005	15	0	244	0	274	<0.014	0.02	0.02	<0.01	2.4	2.4	0.16	227
BSW20	14/08/2015	ME1510328012	<0.001	0	45	0.244	0	0	0.002	5	0	106	0	210	<0.005	<0.01	<0.01	<0.01	0.4	0.4	<0.01	101
BSW20	14/10/2015	ME1510717004	<0.001	0	63	1.38	0	0	0.002	6	0	129	0	246	<0.005	0.03	0.03	<0.01	0.7	0.7	0.06	208
BSW20	12/05/2016	ME1600662009	<0.001	0	76	<0.016	0	0	0.003	11	0	190	0	195	<0.005	<0.01	<0.01	<0.01	1.1	1.1	0.06	210
BSW20	31/08/2016	ME1601226017	<0.001	0	37	0.167	0	0	0.003	5	0	68	0	136	<0.005	0.02	0.02	<0.01	0.7	0.7	0.03	104
BSW21	18/02/2014	ME1400288009	<0.001	0.002	62	0.653	<0.0001	<0.001	<0.001	3	<0.001	228	1.16	229	0.006	<0.01	<0.01	<0.01	0.6	0.6	0.08	390
BSW21	22/05/2014	ME1400741018	<0.001	0.004	55	0.203	<0.0001	<0.001	<0.001	7	<0.001	128	0.61	236	<0.01	0.15	0.15	<0.01	0.7	0.8	0.04	192
BSW21	20/08/2014	ME1401208013	<0.001	0.006	50	0.098	<0.0001	<0.001	<0.001	5	<0.001	129	0.479	202	<0.013	0.14	0.14	<0.01	0.8	0.9	0.04	133
BSW21	20/11/2014	ME1401676008	<0.001	0.003	58	0.154	<0.0001	<0.001	<0.001	4	0	192	0.953	201	<0.005	0.05	0.05	<0.01	1	1	0.04	446
BSW21	8/02/2015	ME1500221007	<0.001	0	70	0.279	0	0	<0.001	3	0	225	0	314	<0.005	<0.01	<0.01	<0.01	0.5	0.5	0.1	361
BSW21	1/05/2015	ME1500659056	<0.001	0	54	0.053			<0.001	2	0	167	0	248	0.007	<0.01	<0.01	<0.01	0.4	0.4	0.02	289
BSW21	4/08/2015	ME1510328013	<0.001	0	33	0.06	0	0	0.002	4	0	74	0	114	<0.005	0.08	0.08	<0.01	0.6	0.7	<<0.01	72
BSW21	14/10/2015	ME1510717005	<0.001	0	62	1.38	0	0	0.002	6	0	154	0	232	0.006	0.04	0.04	<0.01	0.4	0.4	0.03	154
BSW21	3/02/2016	ME1600265056	<0.001	0	64	0.02	0	0	<0.001	4	0	190	0	214	0.008	1.24	1.24	<0.01	0.3	1.5	0.02	373
BSW21	12/05/2016	ME1600662010	<0.001	0	51	0.249	0	0	<0.001	3	0	159	0	225	<0.005	<0.01	<0.01	<0.01	0.1	0.1	<0.01	281
BSW21	5/09/2016	ME1601226067	<0.001	0	10	0.075	0	0	0.003	4	0	26	0	38	<0.014	0.09	0.09	<0.01	1	1.1	0.07	46
BSW22	18/02/2014	ME1400288010	<0.001	0.001	46	0.068	<0.0001	<0.001	<0.001	6	<0.001	105	0.529	51	0.009	<0.01	<0.01	<0.01	0.7	0.7	0.12	290
BSW22	22/05/2014	ME1400741019	<0.001	0.001	44	0.103	<0.0001	<0.001	<0.001	4	<0.001	95	0.523	171	0.005	0.06	0.06	<0.01	0.4	0.5	0.04	200
BSW22	20/08/2014	ME1401208014	<0.001	0.002	48	0.093	<0.0001	<0.001	<0.001	5	<0.001	114	0.515	195	<0.005	0.03	0.03	<0.01	0.4	0.4	0.03	171
BSW22	20/11/2014	ME1401676009	<0.001	0.002	52	0.077	<0.0001	<0.001	<0.001	4	0	116	0.688	180	<0.005	<0.01	<0.01	<0.01	0.6	0.6	0.02	298
BSW22	8/02/2015	ME1500221008	<0.001	0	40	0.041	0	0	<0.001	4	0	83	0	72	<0.005	0.03	0.03	<0.01	0.5	0.5	0.03	270
BSW22	1/05/2015	ME1500659057	<0.001	0	46	0.047			<0.001	4	0	101	0	99	0.005	<0.01	<0.01	<0.01	0.4	0.4	0.02	264

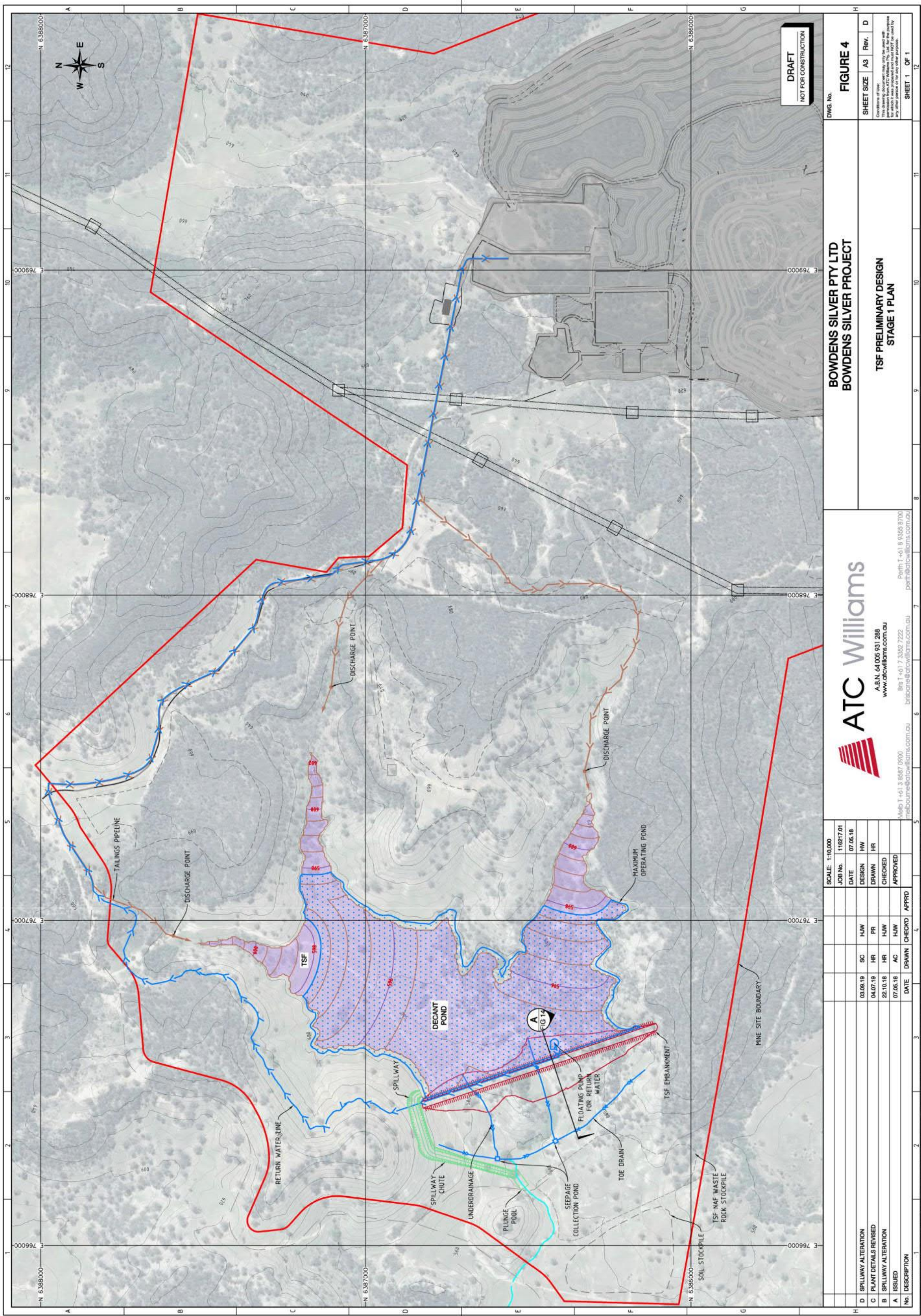
Sample Location	Sampling Date	Sample Num	Lead - Dissolved mg/L	Lithium - Dissolved mg/L	Magnesium - Dissolved mg/L	Manganese - Dissolved mg/L	Mercury - Dissolved mg/L	Molybdenum - Dissolved mg/L	Nickel - Dissolved mg/L	Potassium - Dissolved mg/L	Silver - Dissolved mg/L	Sodium - Dissolved mg/L	Strontium - Dissolved mg/L	Sulfate as SO4 - Turbidimetric mg/L	Zinc - Dissolved mg/L	Nitrate as N mg/L	Nitrite + Nitrate as N mg/L	Nitrite as N mg/L	Total Kjeldahl Nitrogen as N mg/L	Total Nitrogen as N mg/L	Total Phosphorus as P mg/L	Total Alkalinity as CaCO3 mg/L
BSW22	7/08/2015	ME1510328014	<0.001	0	44	0.078	0	0	<0.001	5	0	98	0	180	<0.005	<0.01	<0.01	<0.01	0.2	0.2	<<0.01	98
BSW22	14/10/2015	ME1510717006	<0.001	0	48	0.422	0	0	<0.001	4	0	97	0	166	<0.005	0.03	0.03	<0.01	0.3	0.3	0.03	241
BSW22	3/02/2016	ME1600265057	<0.001	0	26	0.176	0	0	<0.001	3	0	52	0	24	0.005	0.45	0.45	<0.01	0.4	0.8	0.04	205
BSW22	12/05/2016	ME1600662011	<0.001	0	42	0.066	0	0	<0.001	6	0	99	0	72	0.007	<0.01	<0.01	<0.01	0.2	0.2	<0.01	274
BSW23	30/04/2015	ME1500659058	0.008	0	5	0.829			0.018	9	0	10	0	38	0.039	0.02	0.02	<0.01	3.9	3.9	0.54	29
BSW23	7/09/2016	ME1601226068	<0.001	0	2	<0.017	0	0	0.002	5	0	10	0	2	0.006	0.02	0.02	<0.01	0.5	0.5	0.03	10
BSW24	7/09/2016	ME1601226069	<0.001	0	2	0.005	0	0	<0.001	6	0	7	0	5	0.006	0.04	0.04	<0.01	0.5	0.5	<<0.01	4
BSW25	17/02/2014	ME1400288011	<0.001	<0.001	14	0.242	<0.0001	<0.001	<0.001	24	<0.001	14	0.079	3	0.008	<0.01	<0.01	<0.01	1.3	1.3	0.12	89
BSW25	21/05/2014	ME1400741009	<0.001	<0.001	10	0.046	<0.0001	<0.001	<0.001	15	<0.001	13	0.062	11	<0.018	0.02	0.02	<0.01	1.1	1.1	0.07	58
BSW25	20/08/2014	ME1401208015	<0.001	<0.001	10	0.03	<0.0001	<0.001	<0.001	13	<0.001	12	0.078	17	0.006	<0.01	<0.01	<0.01	0.6	0.6	0.03	58
BSW25	20/11/2014	ME1401676010	<0.001	<0.001	10	0.068	<0.0001	<0.001	<0.001	19	0	7	0.057	9	0.009	<0.01	<0.01	<0.01	1.9	1.9	0.11	60
BSW25	6/02/2015	ME1500221009	0.001	0	9	0.172	0	0	<0.001	14	0	5	0	8	<0.005	<0.01	<0.01	<0.01	0.6	0.6	0.06	48
BSW25	30/04/2015	ME1500659059	0.002	0	5	0.075			<0.001	11	0	5	0	14	0.034	0.04	0.04	<0.01	0.9	0.9	0.04	21
BSW25	4/08/2015	ME1510328015	<0.001	0	8	0.022	0	0	<0.001	8	0	9	0	15	<0.005	0.09	0.09	<0.01	0.1	0.2	<<0.01	41
BSW25	14/10/2015	ME1510717007	<0.001	0	13	<0.018	0	0	<0.001	12	0	11	0	7	<0.005	0.04	0.04	<0.01	0.7	0.7	0.04	72
BSW25	3/02/2016	ME1600265058	<0.001	0	2	<0.018	0	0	<0.001	4	0	1	0	2	0.006	0.25	0.25	<0.01	0.8	1	0.05	53
BSW25	12/05/2016	ME1600662012	<0.001	0	5	0.077	0	0	<0.001	13	0	5	0	8	<0.013	0.19	0.2	<0.01	1.2	1.4	0.18	32
BSW26	17/02/2014	ME1400288012	<0.001	<0.001	3	0.36	<0.0001	<0.001	<0.001	35	<0.001	17	0.054	<1	0.021	<0.01	<0.01	<0.01	3.5	3.5	0.11	37
BSW26	21/05/2014	ME1400741010	<0.001	<0.001	2	<0.012	<0.0001	<0.001	<0.001	20	<0.001	9	0.031	4	0.02	0.32	0.32	<0.01	2	2.3	0.03	15
BSW26	20/08/2014	ME1401208016	<0.001	<0.001	<1	0.008	<0.0001	<0.001	<0.001	11	<0.001	8	0.025	9	0.006	<0.01	<0.01	<0.01	3.4	3.4	0.19	8
BSW26	20/11/2014	ME1401676011	<0.001	<0.001	3	<0.014	<0.0001	<0.001	<0.001	21	0	10	0.033	7	0.005	<0.01	<0.01	<0.01	2.4	2.4	0.06	27
BSW26	6/02/2015	ME1500221010	<0.001	0	3	0.031	0	0	<0.001	23	0	10	0	8	<0.005	<0.01	<0.01	<0.01	1.1	1.1	0.05	25
BSW26	30/04/2015	ME1500659060	0.001	0	3	0.083			<0.001	21	0	8	0	11	0.023	0.08	0.08	<0.01	2.6	2.7	0.12	17
BSW26	5/09/2016	ME1601226053	<0.001	0	1	0.008	0	0	<0.001	10	0	4	0	7	<0.018	0.24	0.24	<0.01	0.7	0.9	0.02	6
BSW27	17/02/2014	ME1400288013	0.008	<0.001	2	0.264	<0.0001	<0.001	<0.001	35	<0.001	31	0.054	20	0.075	0.39	0.39	<0.01	11.8	12.2	0.73	10
BSW27	21/05/2014	ME1400741011	<0.001	<0.001	1	0.023	<0.0001	<0.001	<0.001	14	<0.001	8	0.025	6	<0.012	0.1	0.1	<0.01	3.3	3.4	0.12	12
BSW27	20/08/2014	ME1401208017	<0.001	<0.001	1	<0.015	<0.0001	<0.001	<0.001	16	<0.001	9	0.025	12	<0.014	0.5	0.5	<0.01	1.8	2.3	0.06	6
BSW27	20/11/2014	ME1401676012	0.001	<0.001	3	0.1	<0.0001	<0.001	<0.001	21	0	9	0.054	5	0.009	<0.01	<0.01	<0.01	4.5	4.5	0.25	34
BSW27	6/02/2015	ME1500221011	<0.001	0	4	0.047	0	0	<0.001	22	0	10	0	5	0.006	0.02	0.02	<0.01	5.7	5.7	0.34	32
BSW27	30/04/2015	ME1500659061	<0.001	0	4	<0.012			<0.001	24	0	12	0	24	0.038	0.02	0.02	<0.01	2.3	2.3	0.06	9
BSW27	4/08/2015	ME1510328016	<0.001	0	2	0.024	0	0	<0.001	8	0	8	0	8	<0.01	0.43	0.43	<0.01	0.6	1	0.02	6
BSW27	14/10/2015	ME1510717008	0.001	0	3	0.166	0	0	<0.001	13	0	10	0	6	0.007	0.03	0.03	<0.01	2	2	0.14	24
BSW27	3/02/2016	ME1600265059	<0.001	0	3	0.082	0	0	<0.001	17	0	6	0	<1	<0.014	1.88	1.88	<0.01	1.5	3.4	0.11	35
BSW27	12/05/2016	ME1600662013	0.001	0	3	0.061	0	0	<0.001	18	0	8	0	5	0.006	<0.01	<0.01	<0.01	3.3	3.3	0.31	27
BSW27	5/09/2016	ME1601226054	<0.001	0	1	0.008	0	0	<0.001	6	0	5	0	6	<0.014	0.04	0.04	<0.01	1	1	0.06	4
J+J Walker Spring	8/01/2014	ME1400079048	<0.001	0.001	<1	0.043	<0.0001	<0.001	0.002	<1	<0.001	14	0.004	3	<0.012	<0.01	<0.01	<0.01	0.4	0.4	0.1	2
KURTZ	16/05/2014	ME1400741016	<0.001	<0.015	86	0.021	<0.0001	<0.001	<0.001	4	<0.001	122	1.89	103	0.088	0.95	0.95	<0.01	0.6	1.6	0.08	626
Lue Pub Cellar	8/04/2014	ME1400540046	<0.001	0.002	12	0.003	<0.0001	<0.001	0.003	6	<0.001	30	0.289	20	0.048	5.04	5.04	<0.01	1	6	0.29	102

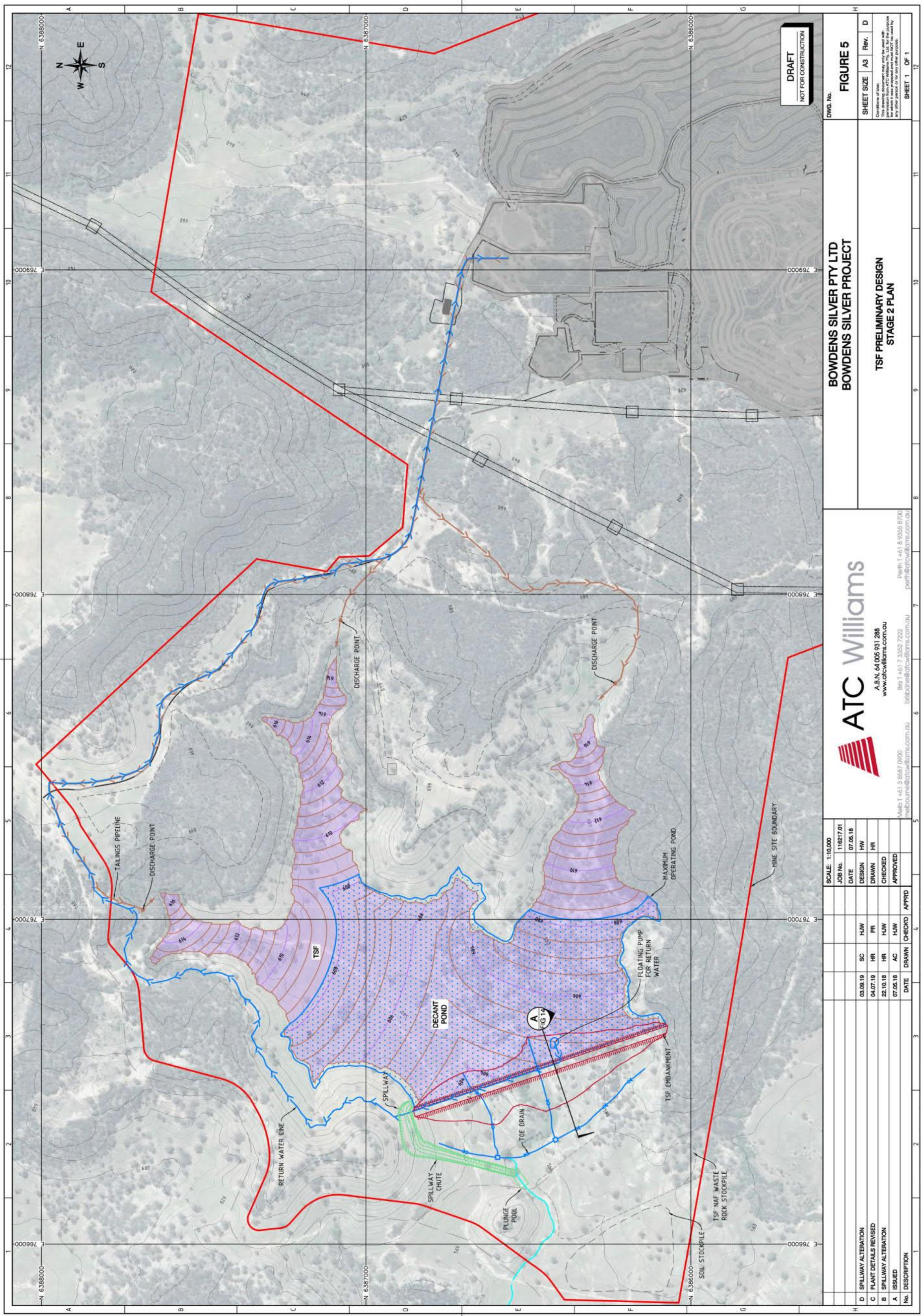
Annexure 8

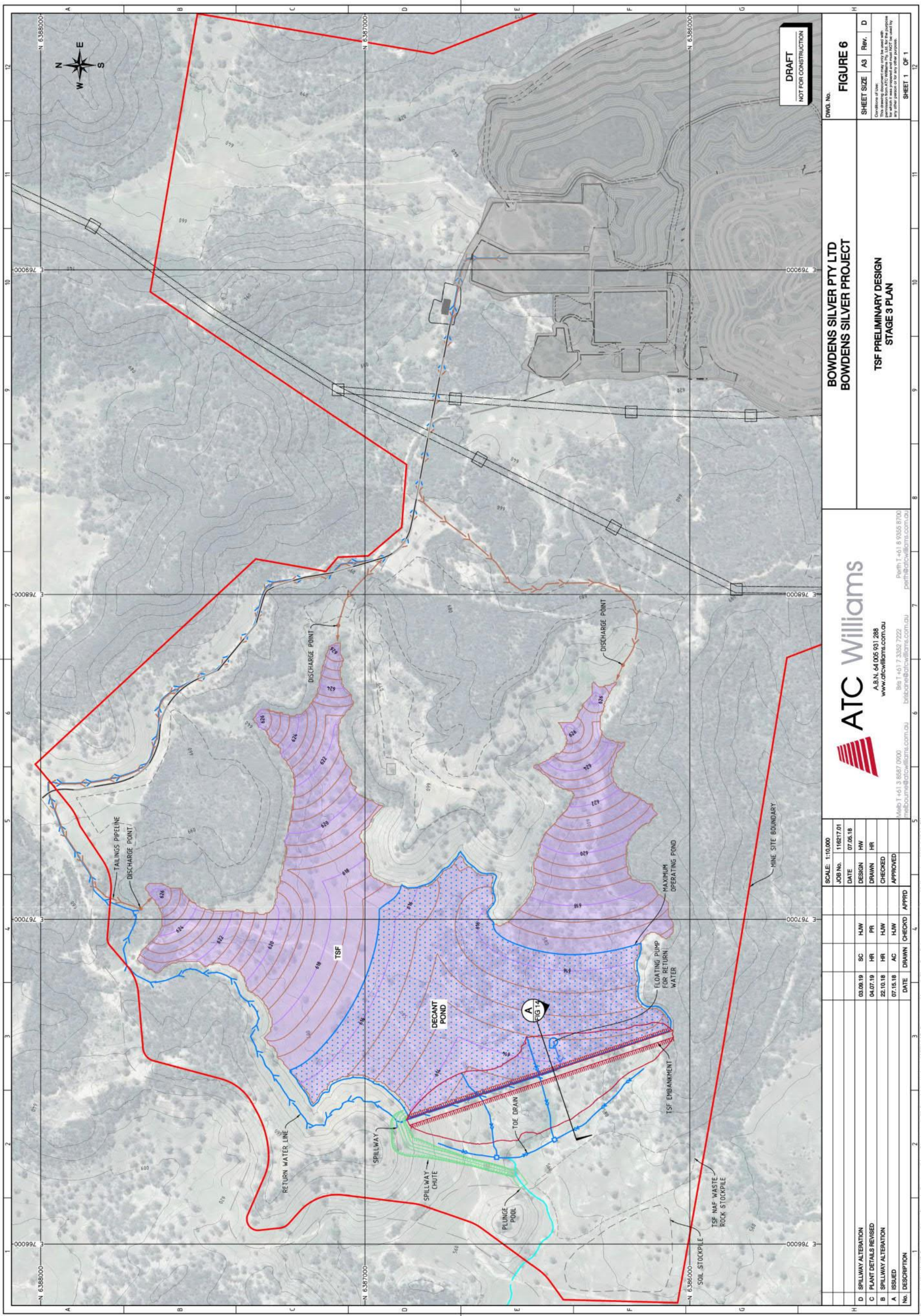
Tailings Storage Facility

(Total No. of pages including blank pages = 6)

This page has intentionally been left blank


DRAFT
NOT FOR CONSTRUCTION
FIGURE 4
BOWDENS SILVER PTY LTD
BOWDENS SILVER PROJECT
TSF PRELIMINARY DESIGN
STAGE 1 PLAN
ATC Williams
TAILINGS PIPELINE
DISCHARGE POINT
MAXIMUM OPERATING POND
TSF
DECANT POND
SPILLWAY
TSF EMBANKMENT
FLOATING POND FOR RETURN WATER
RETURN WATER LINE
SPILLWAY CHUTE
UNDERDRAINAGE
PLUNGE POOL
SEEPAGE COLLECTION POND
TOE DRAIN
TSF NAF WASTE ROCK STOCKPILE
SOIL STOCKPILE
MINE SITE BOUNDARY


DRAFT
NOT FOR CONSTRUCTION
FIGURE 5
BOWDENS SILVER PTY LTD
BOWDENS SILVER PROJECT
TSF PRELIMINARY DESIGN
STAGE 2 PLAN
ATC Williams
TSF
DECANT POND
SPILLWAY
SPILLWAY CHUTE
PLUNGE POOL
TOE DRAIN
TSF EMBANKMENT
RETURN WATER LINE
TAILINGS PIPELINE
DISCHARGE POINT
MAXIMUM OPERATING POND
FLOATING PUMP FOR RETURN WATER
MINE SITE BOUNDARY
TSF NAF WASTE ROCK STOCKPILE
SOIL STOCKPILE
D SPILLWAY ALTERATION
C PLANT DETAILS REVISED
B SPILLWAY ALTERATION
A ISSUED


DRAFT
NOT FOR CONSTRUCTION
FIGURE 6
BOWDENS SILVER PTY LTD
BOWDENS SILVER PROJECT
TSF PRELIMINARY DESIGN
STAGE 3 PLAN
ATC Williams
DISCHARGE POINT
DISCHARGE POINT
TAILINGS PIPELINE
DISCHARGE POINT
TSF
DECANT POND
MAXIMUM OPERATING POND
FLOATING PUMP FOR RETURN WATER
MINE SITE BOUNDARY
RETURN WATER LINE
SPILLWAY
SPILLWAY CHUTE
TOE DRAIN
TSF EMBANKMENT
PLUNGE POOL
TSF NAF WASTE ROCK STOCKPILE
SOIL STOCKPILE

This page has intentionally been left blank

Annexure 9

Groundwater Model Report

(Total No. of pages including blank pages = 118)

This page has intentionally been left blank

BOWDENS SILVER

ABN: 37 009 250 051

Annexure 9
Technical Modelling Report

Prepared for: R.W. Corkery & Co. Pty Limited
1st Floor, 12 Dangar Road
PO Box 239
BROOKLYN NSW 2083

Tel: (02) 9985 8511
Email: brooklyn@rwcorkery.com

On behalf of: Bowdens Silver Pty Limited
ABN: 37 009 250 051

Sydney Office
Level 11, 52 Phillip Street
SYDNEY NSW 2000

Tel: (02) 8316 3997
Fax: (02) 8316 3999

Operations Office
68 Maloneys Road
LUE NSW 2850
P.O. Box 1115
MUDGEE NSW 2850

Tel: (02) 6373 6420

Email: information@bowdenssilver.com.au

A Silver Mines Limited company

Prepared by: Jacobs Group (Australia) Pty Limited
177 Pacific Highway
NORTH SYDNEY NSW 2060

Tel: (02) 9032 1284
Email: greg.sheppard@jacobs.com

Ref No: IA132500

June 2021

CONTENTS

Page

CONTENTS

Page

ATTACHMENTS

FIGURES

CONTENTS

Page

CONTENTS

Page

TABLES

COMMONLY USED ACRONYMS / ABBREVIATIONS

AHD	Australian Height Datum
bgl	below ground level
BoM	Bureau of Meteorology
CRD	cumulative rainfall deviation
DRN	Drain Cell (MODFLOW)
EC	electrical conductivity
EPA	Environment Protection Authority
EVT	Evapotranspiration Cell (MODFLOW)
GDE	groundwater dependent ecosystems
GUI	Graphical User Interface
HFB	horizontal flow boundary
Kh	Horizontal hydraulic conductivity
Kv	Vertical hydraulic conductivity
LiDAR	Light detection and ranging
ML	Mining Lease
PAF	potentially acid forming
RCH	Recharge (MODFLOW)
RIV	River Cell (MODFLOW)
RMS	root mean square
SCSC	Specialist Consultant Studies Compendium
SILO	Scientific Information for Landowners
SSD	State Significant Development
SWL	Standing Water Level
TDS	total dissolved solids
TSF	tailings storage facility
USGS	United States Geological Survey
WAL	water access licence
WEL	Well Cell (MODFLOW)
WRE	waste rock emplacement

This page has intentionally been left blank

FOREWORD

This Groundwater Assessment Model Report has been created in response to comments received from the Department of Planning, Industry and Environment-Water's review following public exhibition of the Environmental Impact Statement and Specialist Consultant Studies Compendium for the Project. These comments were supplied on 1 September 2020 and are provided in **Annexure 11** of the Updated Groundwater Impact Assessment (Jacobs 2021). The principal objective of this report is to document the technical modelling information previously included in the Groundwater Impact Assessment that accompanied the Environmental Impact Statement. The results of this groundwater modelling was used to undertake the impact assessment presented in Section 5 of Jacobs (2021).

In addition, the regional groundwater flow model described in this report was refined in the vicinity of the tailings storage facility to assess the implications of the TSF preliminary and additional design elements. The results of this additional modelling and technical information associated with its development are presented in **Annexure 10** of Jacobs (2021).

However, it is noted that the data sources, data ranges, potential groundwater impacts of the Project and the regulatory paradigm by which these impacts are assessed remains unchanged from the original assessment.

This page has intentionally been left blank

1. INTRODUCTION

1.1 BACKGROUND

Bowdens Silver Pty Ltd (Bowdens Silver) proposes to develop and operate the Bowdens Silver Project (the Project), located approximately 2.5km northeast of Lue and approximately 26km southeast of Mudgee, in New South Wales.

This report has been prepared as a technical appendix to the Updated Groundwater Assessment (Jacobs 2021) in response to comments provided by the NSW Department of Planning, Infrastructure and Environment – Water. This report documents the conceptual and numerical groundwater model that was used to assess potential groundwater impacts due to the Project.

It is noted that whilst numerical groundwater model results are presented in this report, the assessment of groundwater impacts in accordance with relevant legislation, policies and guidelines is outside the scope of this report. Full coverage of the assessment of groundwater impacts is provided in Section 6 of the Updated Groundwater Assessment (Jacobs 2021).

1.2 PROJECT DESCRIPTION

1.2.1 Overview

The Project would mine epithermal silver deposits hosted in the Rylstone Volcanics and would incorporate a conventional open cut pit where overburden/waste rock is removed from above and around the silver-zinc-lead ore and either used for on-site construction activities or placed in the out-of-pit waste rock emplacement or the southern barrier. The mined ore would be transported by haul trucks to the on-site processing plant where it would be crushed, milled and processed to liberate the silver, zinc and lead minerals. These minerals would be collected by conventional froth flotation to produce two concentrates that would be dewatered and transported off site by truck. The residual materials from processing (tailings) would be pumped in the form of a slurry to a tailings storage facility (TSF) located to the west of the open cut pit.

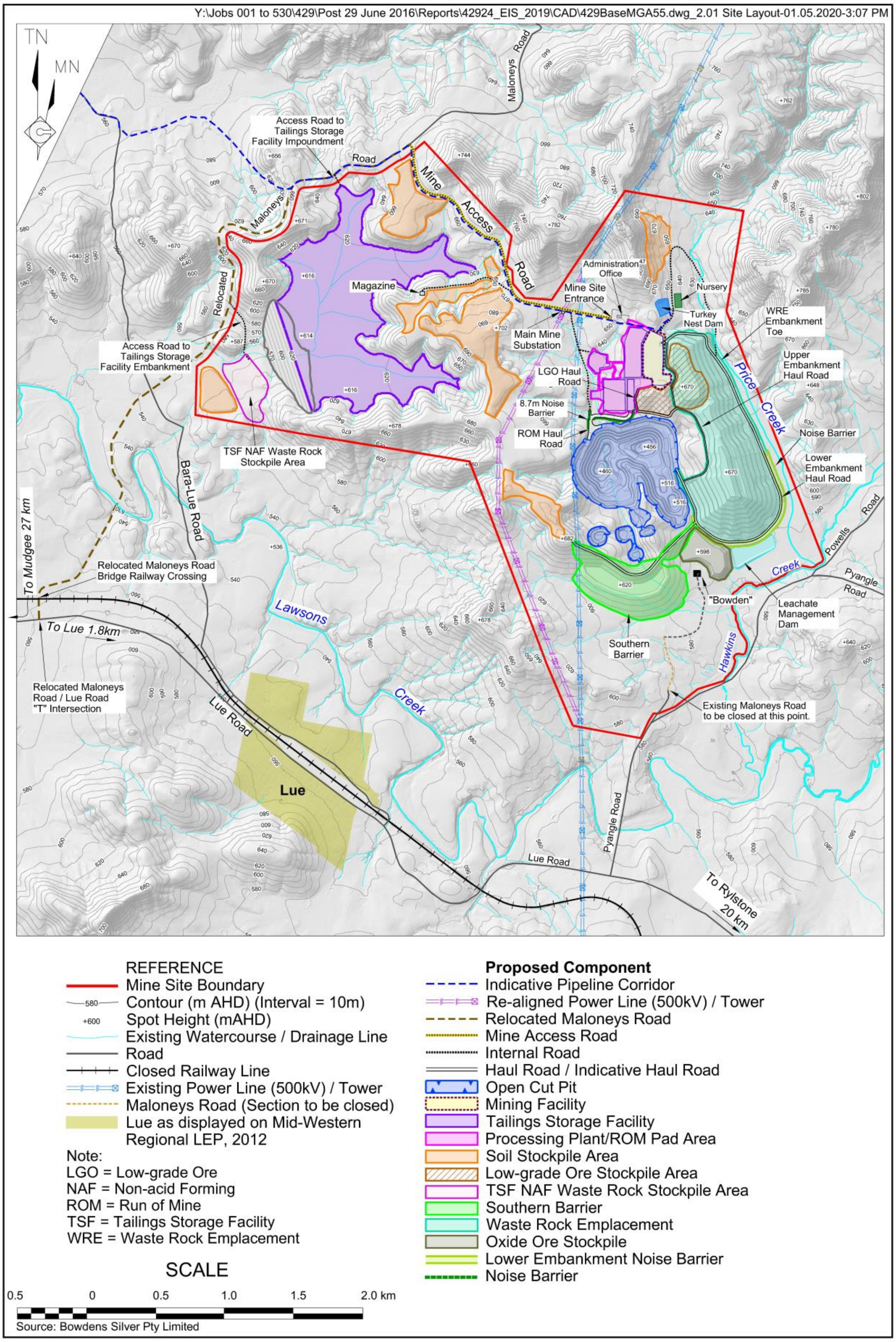
The principal infrastructure supporting the Project would be located within a proposed Mine Site that would cover an area of approximately 1 000 hectares (ha) with the open cut pit, processing area, tailings storage facility, waste rock emplacement (WRE) and ancillary components resulting in the disturbance of approximately 420ha. The mine life is expected to be 15.5 years with an annual processing throughput of up to 2 million tonnes.

The proposed Mine Site layout is provided on **Figure 1**. Key components of the Project that would potentially impact on groundwater include:

- open cut mining;
- TSF; and
- WRE.

A maximum open cut pit depth at an elevation of 456m AHD (approximately 150 to 200m below natural ground level) would be reached in Year 9 of operations. Other sections of the main open cut pit would be developed to a depth of 460m AHD and two satellite open cut pits would be developed to elevations of 565m AHD and 580m AHD.

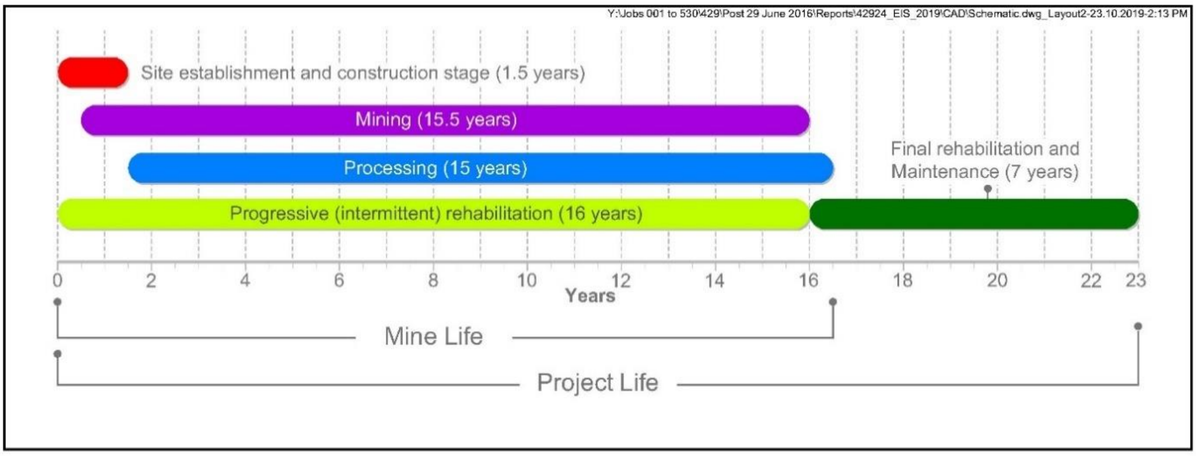
Figure 1 Indicative Mine Site Layout



For the purposes of this report, reference is made to the "Mine Site", as displayed in **Figure 1** and the "study area" comprising the Mine Site and the surrounding area, typically up to 10km from the Mine Site.

The Project would require a site establishment and construction period of approximately 18 months during which the processing plant and all related infrastructure and the initial embankment of the TSF would be constructed. Once operational, Bowdens Silver anticipates the mine would produce concentrates for approximately 15 years. In total, it is proposed the mine life would be approximately 16.5 years, i.e. from the commencement of the site establishment and construction stage to the completion of concentrate production. It is envisaged rehabilitation activities would be completed over a period of approximately 7 years, i.e. from Year 16 to Year 23. **Figure 2** displays the duration of each of the main components throughout the mine life and Project life.

Figure 2 Mine Life and Project Life



Water supply of approximately 0.5ML/d to 1.0ML/d would be required for site establishment and construction, principally for dust suppression and achieving the optimum moisture content in those components or areas where compaction is required. Water during this period would be drawn from on-site groundwater bores and water storages (e.g. harvestable rights dams). During operation, water demand will be required primarily for ore processing and dust suppression, with an average annual daily water demand of approximately 5ML. During operations water would be sourced preferentially from on-site sources such as site dams (e.g. containment zone), return water from the TSF and mine dewatering. Additional make up water would also be sourced from harvestable rights dams and a third party via a purpose-built pipeline.

1.2.2 Mine Development

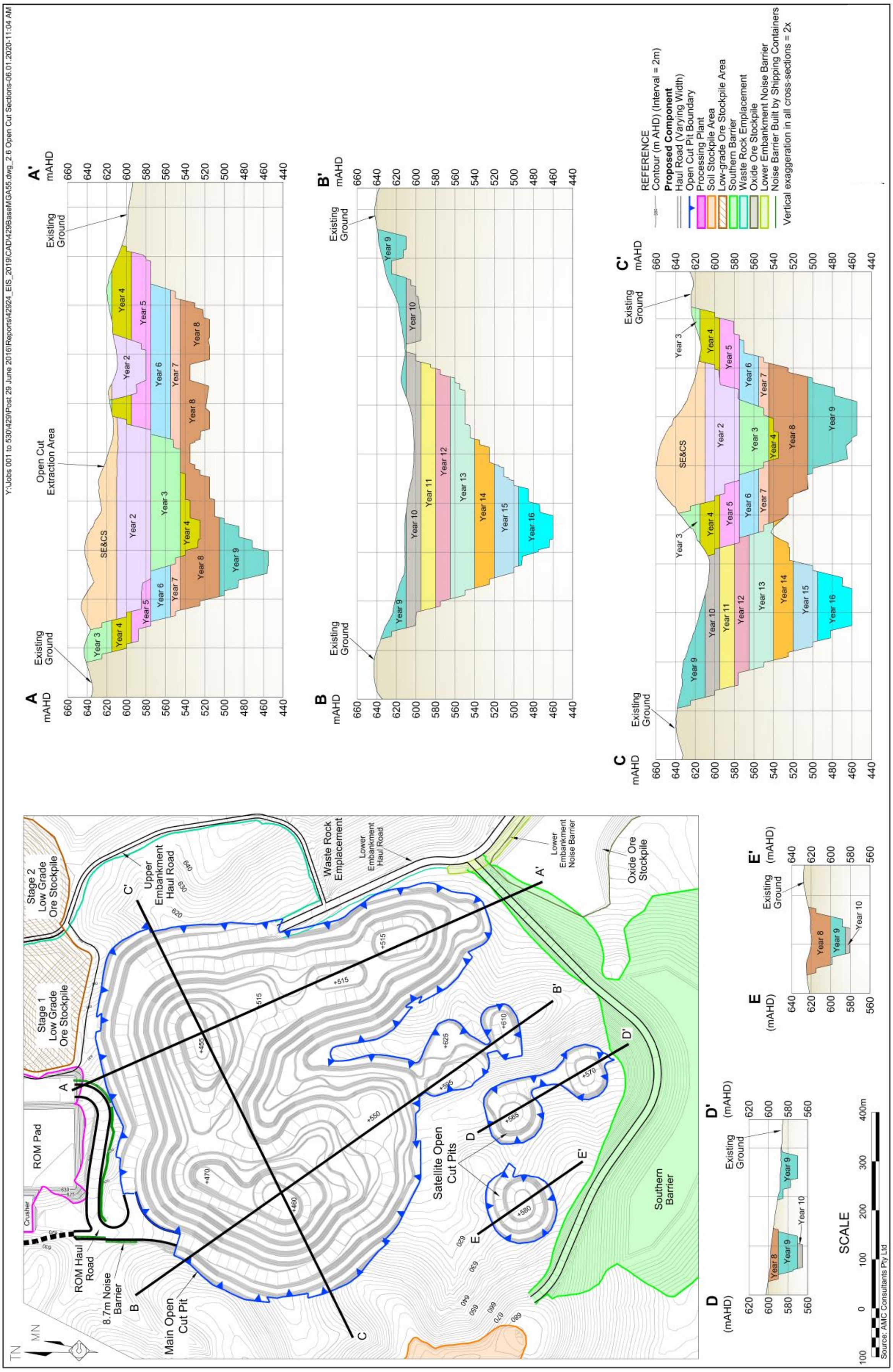
1.2.2.1 Mine Schedule

Mining operations are planned to be undertaken over a 15.5 year mine life, with the incremental annual development of the open cut pit and satellite pits shown on **Figure 3**.

Each open cut pit would be progressed in 5m bench intervals to generate annual average processing throughput of 2 million tonnes (Mt) and total annual mining material movement of typically between 5 Mtpa and 6 Mtpa.

A maximum open cut pit depth at 456m AHD would be reached in Year 9. After Year 9, the western section of the open cut pit would be developed to a depth of 460m AHD.

Figure 3 Proposed Open Cut Pit Development



1.2.2.2 Waste Rock Emplacement

The WRE would be progressively developed in stages (cells) to encapsulate potentially acid forming (PAF) waste rock material. Each cell of the WRE would be lined with a 1.5mm HDPE liner that would be protected by geofabric and a cushion layer of crushed rock (Advisian, 2020a).

Cell development would include the construction of intercell embankments that would, in conjunction with the lower perimeter embankment, enable the collection, storage and management of the leachate generated by the PAF waste rock material. Leachate intercepted by the 1.5mm HDPE liner would flow via gravity to the point where the intercell embankment joins the lower embankment and directed via underdrainage infrastructure to the Leachate Management Dam from where it would be returned to the processing plant for use.

The WRE would be progressively rehabilitated over the course of mining operations. As each WRE cell is completed it would be covered with a low permeability Geosynthetic clay liner. This clay liner would then be overlain by a store and release cover (Advisian, 2020b) and vegetation established.

As the lined and covered WRE would not have any interaction with groundwater, it is not considered further in this assessment.

1.2.2.3 Tailings Storage Facility

The proposed TSF for the Project would be constructed in three stages, with an initial embankment developed for Stage 1, and successive embankment lifts for Stages 2 and 3. The TSF design is for a down-valley discharge style of tailings deposition with deposited tailings impounded against a down-stream embankment. The location of the TSF is shown in **Figure 1**.

The tailings slurry would be pumped from the processing plant via a pipeline to one of three discharge points and would comprise approximately 56% solids, with an average daily discharge of decant water to the TSF of 4,302m^3/day. Decant water would be reclaimed from a decant pond located at the upstream face of the TSF embankment and returned to the processing plant.

Seepage control measures would include grouting of the rock foundations beneath the TSF embankment, compacted clay lining of the tailings impoundment area and either full or partial lining of the decant pond area with a low permeability bituminous geomembrane liner (BGM). The TSF embankment would be constructed using a zoned rockfill embankment with a low permeability BGM on the upstream face. The grout curtain beneath the TSF embankment would be installed to depth of approximately 40m with primary, secondary and possibly tertiary grouting to achieve a permeability of around 10^{-7}m/sec ($8.64x10^{-3}$m/d).

A toe drain and a seepage collection drain would be installed to collect any seepage from the TSF and runoff from the downstream face of the TSF embankment. This would then be pumped back to the TSF.

Details of the TSF design and investigations are provided in the TSF Preliminary Design Report (ATC Williams, 2020).

Tailings slurry and decant water quality is expected to be of neutral pH (pH 7-8). Electrical conductivity would be commensurate with process water supply. Minor manganese concentrations in the order of 10mg/L to 30mg/L above the process water quality are anticipated (GCA, 2019).

The results of laboratory testing of tailings solids samples (GCA, 2019) indicate that the tailings are classified as PAF due to the presence of trace and accessory sulphide minerals and the absence of reactive carbonate materials.

2. CONCEPTUALISATION

The Australian Groundwater Modelling Guidelines (Barnett *et al.* 2012) outline guidelines for developing a conceptual hydrogeological model. A conceptual hydrogeological model is a descriptive representation of a groundwater system that incorporates an interpretation of the geological and hydrological conditions and consolidates the current understanding of the key processes of the groundwater system, including the influence of stresses, and assists in the understanding of possible future changes.

Barnett *et al.* (2012) provide the following guiding principles for the conceptualisation of a groundwater system:

Guiding Principle 1

- The level of detail within the conceptual model should be chosen, based on the modelling objectives, the availability of quality data, knowledge of the groundwater system of interest, and its complexity.

Guiding Principle 2

- Alternative conceptual models should be considered to explore the significance of the uncertainty associated with different views of how the system operates.

Guiding Principle 3

- The conceptual model should be developed based on observation, measurement and interpretation wherever possible. Quality-assured data should be used to improve confidence in the conceptual model.

Guiding Principle 4

- The hydrogeological domain should be conceptualised to be large enough to cover the location of the key stresses on the groundwater system (both the current locations and those in the foreseeable future) and the area influenced or impacted by those stresses. It should also be large enough to adequately capture the processes controlling groundwater behaviour in the study area.

Guiding Principle 5

- There should be an ongoing process of refinement and feedback between conceptualisation, model design and model calibration to allow revisions and refinements to the conceptual model over time.

The conceptual hydrogeological model for the Project and broader study area is described in Sections 2.1 to 2.6. Key elements of the conceptual hydrogeological model in the vicinity of the Mine Site are presented on **Figure 4** for the pre-mining condition and **Figure 5** for the operational and post-mining conditions.

Figure 4 Conceptual Hydrogeological Model – Pre-Mining

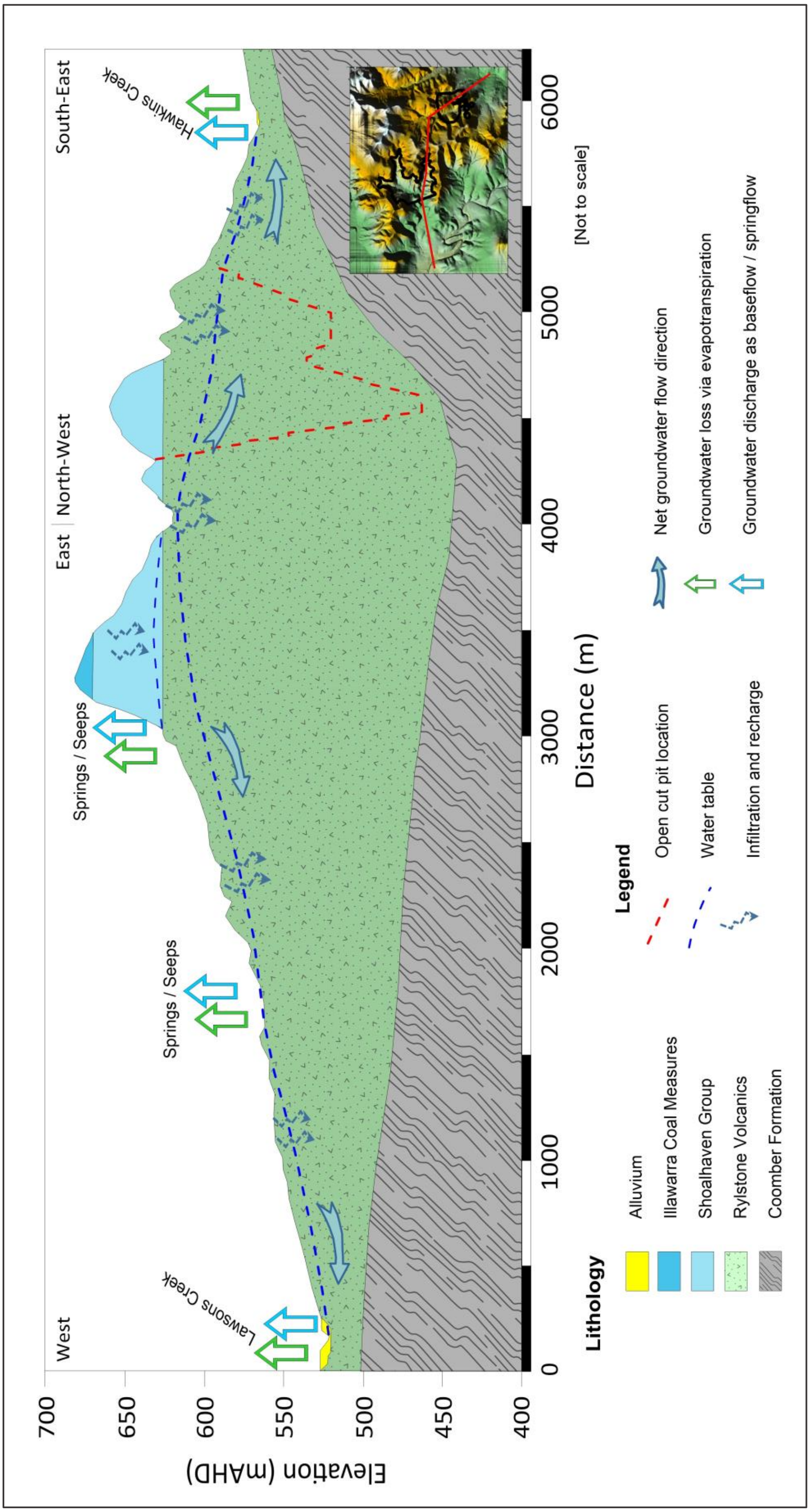
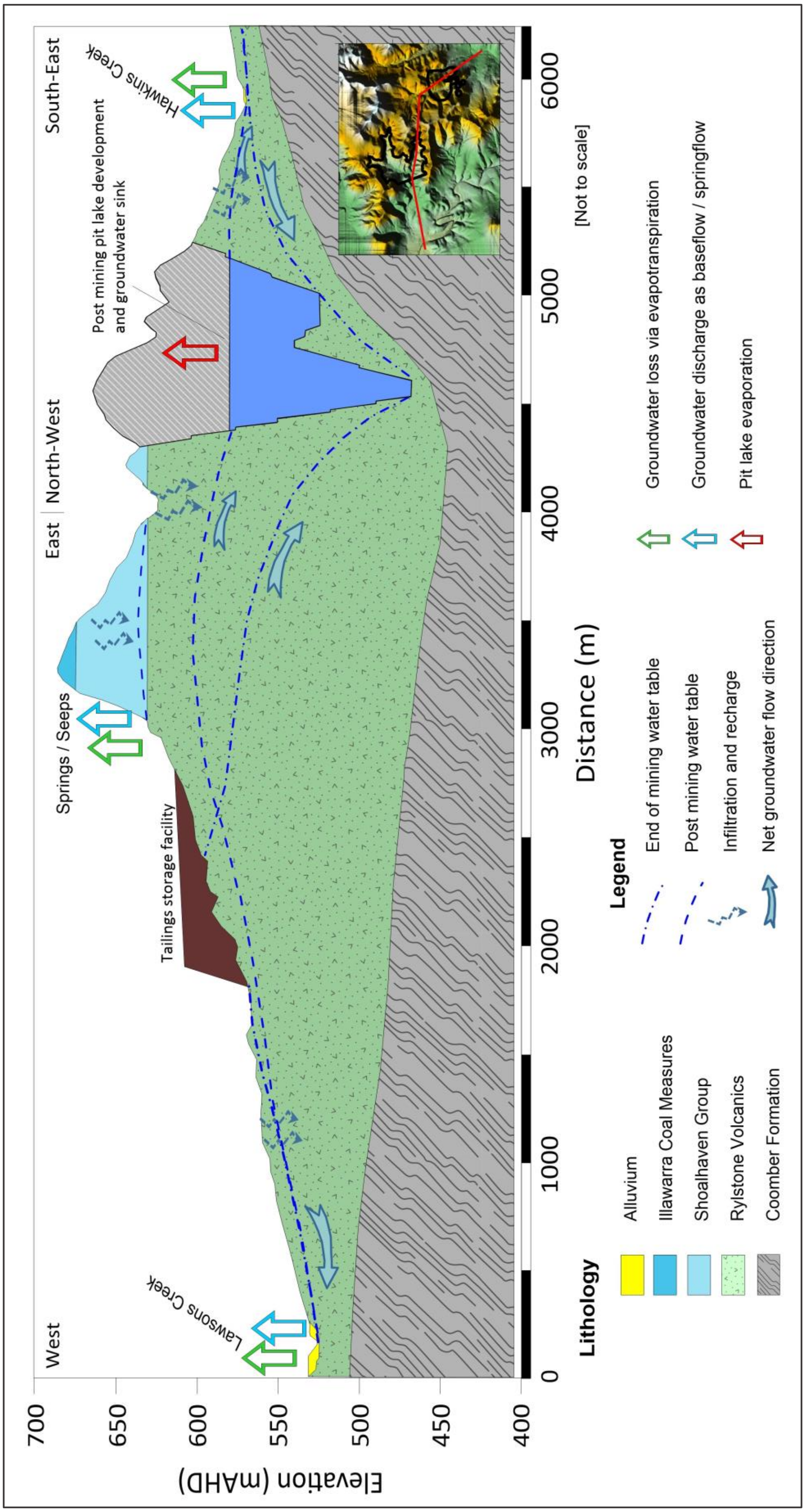


Figure 5 Conceptual Hydrogeological Model – During and Post Mining



2.1 GEOLOGICAL PROVINCES

The primary geological provinces within the study area are the Lachlan Fold Belt (Lachlan Orogen) and the Sydney Basin. Each of these provinces contain limited areas of Quaternary alluvium that are associated with major surface water drainage features. These geological provinces also host two distinct regional groundwater systems, the Lachlan Fold Belt system with regional groundwater flow and discharge occurring typically to the northwest and the Sydney Basin system which regionally flows and discharges to the northeast.

2.2 MAIN HYDROSTRATIGRAPHIC UNITS

The regional lithologies and stratigraphic units encountered at, or in the vicinity of the Mine Site each have various aquifer potential and may include one or a number of the potential aquifer types identified in Section 4.5.1 of Jacobs (2021). For the purposes of groundwater investigations, it is useful to re-assign the conventional geological lithological or stratigraphic units into hydrostratigraphic units based on similar or grouped hydraulic properties.

Four main hydrostratigraphic units exist in the Mine Site in a regional context. For the purposes of a more detailed assessment of groundwater inflows during mining operations and the potential response in regional groundwater systems, the main hydrostratigraphic units can be further divided in sub-units as outlined below.

The key hydrostratigraphic units and sub-units (including water source of the relevant water sharing plan) adopted for this groundwater assessment are shown on **Figure 4** and **Figure 5** and include:

1. Alluvium (Lawsons Creek Water Source)
2. Sydney Basin sediments (Sydney Basin Groundwater Source)
   a) Narrabeen Group
   b) Illawarra Coal Measures
   c) Shoalhaven Group
3. Rylstone Volcanics (Lachlan Fold Belt Groundwater Source)
   a) Rhyolite Breccia
   b) Welded Tuff / Ignimbrite
   c) Crystal Tuff
4. Lachlan Fold Belt (Ordovician Basement) / Coomber Formation (Lachlan Fold Belt Groundwater Source)

2.2.1 Alluvium

Alluvial deposits are mostly developed in association with Hawkins and Lawsons Creeks. Monitoring bore drilling along Hawkins Creek recorded alluvial thickness ranging up to 4m to 6m. The alluvial material encountered during this drilling was dominated by silty sandy gravel and clay sediments. Mapped alluvium in the vicinity of the Mine Site on **Figure 11** of the main report is limited to Hawkins and Lawsons Creeks upstream from the Mine Site boundary, however, a veneer of alluvium exists within the Mine Site boundary associated with the Hawkins Creek floodplain (Jacobs, 2021).

This hydrostratigraphic unit has moderate potential for local water supply and is utilised for domestic and stock watering purposes.

2.2.2 Sydney Basin Sediments

The Sydney Basin sediments contain a number of significant sandstone units. Within the Illawarra Coal Measures, the coal seams themselves are typically the main aquifer unit due to the development of cleats within the coal seams. Only limited primary porosity and permeability is likely to remain within the Sydney Basin sediments with original interstitial pore spaces being largely infilled by carbonate and silicate crystallisation during diagenesis. Groundwater flow is typically dominated by fracture flow and bedding, with some minor flow through relict primary porosity. On a regional scale groundwater flow is largely sub-horizontal, controlled by bedding planes and cleats with coal seams and is expected to be in a general north-easterly direction. Locally however, in the vicinity of outcrop on hills and valley flanks, and in the vicinity of the Mine Site, groundwater flow is likely to be consistent with prevailing topography.

The stratified nature and low permeability layers within the Sydney Basin sediments act to impede vertical groundwater flow. The Shoalhaven Group, which is present at site, is typically regarded as being of low permeability and may act as an aquitard separating groundwater flow in the Sydney Basin sediments from those in underlying formations.

No permeability testing has been undertaken locally for the Sydney Basin sediments, however, Bish (1999) suggested that the bulk permeability of the Bankswall Sandstone of the Narrabeen Group could be as high as 0.9m/day. Other literature values suggest representative permeabilities ranging from $1x10^{-4}$ to $1x10^{-1}$m/day for the Narrabeen Group and $1x10^{-3}$ to $1x10^{-2}$m/day for the Illawarra Coal Measures.

2.2.3 Rylstone Volcanics

Groundwater flow within the Rylstone Volcanics is dominated by fracture flow, however high fracture density and sub-orthogonal fracturing within the orebody means that on a meso-scale, groundwater flow behaves in an equivalent porous media manner. Given the dominance of fracture flow, the horizontal to vertical flow anisotropy is not as great as that assumed for the Sydney Basin sediments. Groundwater flow within the Rylstone Volcanics are expected to largely mimic topography with flow generally toward topographic lows.

Within the Rylstone Volcanics, the individual sub-units display differing hydraulic properties. The welded tuff / ignimbrite unit typically displays lower primary porosity and permeability. From investigations undertaken on site (Jacobs, 2021), there does not appear to be a significant distinction in porosity between the volcanic units. Given that groundwater flow within the volcanic units is predominantly fracture-controlled, the minor differences in primary porosity between the volcanic units are unlikely to cause significant differences in dewatering and drawdown impacts within the volcanic units.

Permeability testing suggests representative hydraulic conductivity values can range from 0.1m/day to $1x10^{-4}$m/day.

2.2.4 Coomber Formation / Lachlan Fold Belt (Ordovician Basement)

The Coomber Formation and other undifferentiated members of the Lachlan Fold Belt (Ordovician Basement) are considered to be the hydrogeological basement for the groundwater systems in which the Mine Site is situated. However, these units still have potential to host enhanced permeability in the vicinity of major structures.

Regionally, the formations of the Lachlan Foldbelt are highly structurally deformed and comprise meta-sedimentary and meta-volcaniclastic lithologies with minor primary porosity. The bedding orientation of these units is variable, with bedding typically varying from moderately dipping to steeply dipping. Where these units outcrop, to the west and south of the Mine Site, there is a prevailing cleavage orientation trending northwest-southeast, to north-south, consistent with the prevailing structural orientation. Cleavage planes dip variably to the east and west. As groundwater flow in this unit will be controlled by fracture flow there is likely to be a preferred flow direction consistent with cleavage and fracturing. Shallower groundwater flow within the weathered zones of this unit (typically in the upper 20m to 30m) will be more topographically controlled.

Permeability testing suggests that representative hydraulic conductivity values for the Coomber Formation ranges from $2x10^{-4}$ up to 6.5m/day, with the higher values being obtained from shallow weathered material in the vicinity of one of the major structures (BGW27A). Hydraulic conductivity determined from the pump testing at BGW10 was of the order of 0.08m/day.

2.3 LOCAL INFLUENCE OF MAJOR STRUCTURES

Pumping test data from BGW10 and BGW108 is discussed in Jacobs (2021). The data suggests that the two major sub north-south trending structures in the vicinity of the orebody act to inhibit but not completely prevent groundwater flow, while drilling results suggest that relatively high groundwater yields can be obtained in the vicinity of the structures.

These major structures have, therefore, been conceptualised as compartmentalising groundwater movement across the structure while locally enhancing permeability locally in the vicinity of the structure.

2.4 GROUNDWATER RECHARGE

Groundwater recharge is dominated by infiltration of rainfall runoff and ephemeral streamflow on outcropping and sub-cropping hard rock lithologies and regolith, and directly onto the alluvium. A small component of vertical leakage is also possible from the Sydney Basin sediments to underlying formations.

The major drainage features, such as Hawkins and Lawsons Creeks, are likely to alternate between being zones of groundwater recharge and groundwater discharge, depending on streamflow conditions and topography.

2.5 GROUNDWATER DISCHARGE

Groundwater discharge will occur locally in lower lying areas to the alluvium aquifers, drainage features (periodically), and via evapotranspiration from riparian vegetation and deep-rooted terrestrial vegetation. Regionally, groundwater discharge (throughflow) will be to the northwest in the Coomber Formation and wider Lachlan Fold Belt. Within the Sydney Basin sediments, regional groundwater discharge will be to the northeast, to the drainage features within the Totnes and Barigan Valleys, as well as the Bylong Valley, with minor vertical leakage to underlying formations.

Groundwater abstraction by other groundwater users is also considered a mechanism of groundwater discharge (refer Section 2.6).

2.6 GROUNDWATER USERS

A search of the WaterNSW database has been undertaken within a notional 10km radius of the proposed open cut pit to identify registered groundwater works. Bore construction, geology and drilling information obtained from this database in conjunction with surface geology mapping was then used to identify potential aquifers, bore depths and approximate aquifer yields. The locations of identified groundwater works are presented on **Figure 6**.

Approximately 106 groundwater works are registered within the 10km search radius, with 24 of those being monitoring bores currently utilised by Bowdens Silver. The majority of the remaining registered groundwater works are bores used for stock, domestic and irrigation purposes.

Lue village situated approximately 2.6km southwest of the Project, has approximately 23 private bores (within a 2km radius from the centre of town) that are used for stock, domestic and irrigation purposes. These bores extract groundwater from the Coomber Formation, Tannabutta Group, Adaminaby Group, Dungeree Volcanics, and alluvium at depths ranging from 3.65 to 60m and yields ranging from 0.05 to 7.00L/s.

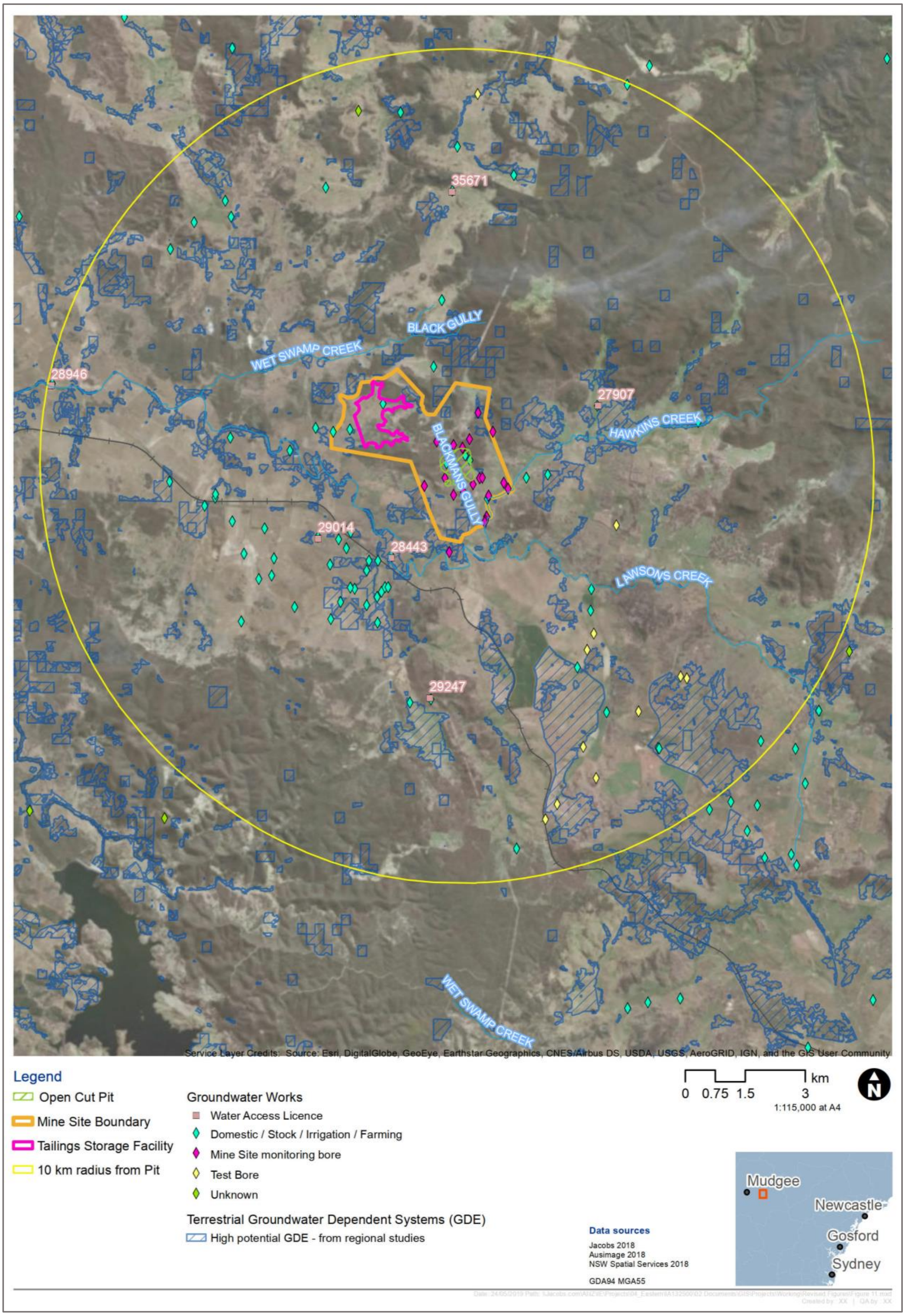
A summary of existing groundwater works is provided in Jacobs (2021).

2.7 GROUNDWATER DEPENDENT ECOSYSTEMS

No high priority GDEs have been identified in the vicinity of the Mine Site.

The assessment of potential impacts on other GDEs as a result of predicted groundwater drawdown and reduced baseflow contributions to stream discharge is provided in Jacobs (2021).

Figure 6 Registered Groundwater Bores and Groundwater Dependent Ecosystems



3. MODEL DESIGN

3.1 MODEL CLASS

In accordance with the Australian Groundwater Modelling Guidelines (Barnett *et al.* 2012), the intended model confidence level classification is Class 2 – Impact Assessment.

Table 1 presents a comparison between the characteristics of the model and quantitative indicators for that of a confidence Class 2 model, following the recommendation of Middlemis and Peters (2018). From **Table 1**, it can be seen that the model prepared for the Project is fit for purpose as it either meets or exceeds most Class 2 criteria whilst also meeting many Class 3 criteria.

Table 1
Model Comparison with Australian Groundwater Modelling Guidelines: Model Confidence Level Classification Characteristics and Indicators

Page 1 of 2

Class	Data	Calibration	Prediction	Quantitative Indicators
1 Simple	Not much / Sparse coverage	Not possible.	Timeframe >> Calibration	Model predictive timeframe >10x transient calibration period
	No metered usage.	Large error statistic.	Long stress periods.	Stresses in predictions >5x higher than calibration
	Low resolution topography.	Inadequate data spread.	Poor / no validation.	Mass balance error > 1% (or one-off >5%)
	Poor aquifer geometry.	Targets incompatible with model purpose.	Targets incompatible with model purpose.	Properties <> range from expected field values
	Basic / Initial conceptualisation.			No review by Hydrogeologist / Modeller.
2 Impact assessment	Some data / adequate coverage.	Weak seasonal match.	Timeframe > Calibration	Predictive timeframe = 3 to 10x calibration (exceeded for life of mine predictions)
	Some usage data/low volumes.	Long-term trends not replicated in entire model domain.	Long stress periods.	Stresses = 2 to 5 greater than calibration
	Baseflow estimates. Some hydraulic conductivity and storage measurements	Partial performance (e.g. some statistics / part record / model-measure offsets).	Validation. (no validation undertaken at this stage)	Mass balance error< 1%

Table 1 (Cont'd)

Model Comparison with Australian Groundwater Modelling Guidelines: Model Confidence Level Classification Characteristics and Indicators

Page 2 of 2

Class	Data	Calibration	Prediction	Quantitative Indicators
2 **Impact assessment (Cont'd)**	Some high resolution. topography &/or some aquifer geometry.	Head & Flux targets used to constrain calibration.	Calibration & prediction consistent (transient or steady-state)	Some properties <> range from expected field values.
				Review by Hydrogeologist
	Sound conceptualisation, reviewed & stress-tested.	Non-uniqueness and qualitative uncertainty partially addressed.	Significant new stresses not in calibration.	Some coarse discretisation in key areas (grid or time).
3 **Complex simulator**	Significant data, good coverage.	Good performance statistics.	Timeframe ~ Calibration	Predictive timeframe = < 3x calibration period (with exception of post mining period)
	Good metered usage information.	Most long term trends matched.	Similar stress periods.	Stresses < 2x
	Local climate data.	Most seasonal matches OK.	Good validation.	Mass balance error < 0.5%
	Aquifer testing data (Kh, Kv & Sy) measurements from range of tests.	Present day head / flux targets, with good model validation.	Transient calibration and prediction.	Properties ~ field measurements.
	High resolution topography in all areas with good aquifer geometry.	Non-uniqueness minimised, qualitative uncertainty justified.	Similar stresses to those in calibration.	No coarse discretisation in key areas (grid or time).
	Detailed conceptualisation.			Review by experienced Modeller.
Legend	Criterion exceeded	Criterion met	Criterion partially met	Criterion not met

3.2 MODEL CODE

The model was prepared using the United States Geological Survey (USGS) modelling code, MODFLOW which is an industry standard groundwater modelling code. The MODFLOW-USG variant of MODFLOW was used for the model which was executed in the saturated flow mode. The input and output MODFLOW files were processed using the Groundwater Vistas Graphical User Interface Version 7.24 Build 254.

3.3 MODEL DOMAIN

Figure 7 presents the extent of the model domain. The model domain is approximately 43.5km east to west by 44km north to south, as shown on **Figure 7**. The model boundary locations are typically associated with natural drainage features and are located at a distance from the Mine Site such that the assessment of mine inflows and resulting drawdown will have negligible influence from any boundary conditions. The areal extent of the model domain is as follows:

- the northern and north-eastern boundaries are the upper catchments of the Bylong Valley, including Peters Creek, Barigan Creek and Burrumbelong Creek;
- the eastern boundary is the Growee River;
- the south-eastern boundary is Coxs Creek and the Cudgegong River/Rylstone Dam;
- the southern and southwestern boundary is the Cudgegong River/Lake Windamere;
- the western boundary transects a series of east to west flowing creeks, including Lawsons Creek, Buckaroo Creek and Pipeclay Creek; and,
- the northern and north-west boundaries of the model are Cooyal Creek.

3.4 MODEL GRID

The model grid comprises cell sizes ranging from 31.2m to 250m, with the finer resolution grid cells (31.25m) being used in the vicinity of the open cut pit. The origin point (0, 0) for the model grid was easting 749 000m and northing 6 364 000m (Map Grid of Australia 1994, Zone 55).

The total number of cells, across 8 model layers (vertical) is 460 512, of which 364 072 cells are active. Cells outside of the area of interest, defined by the model boundary conditions, (Inactive Cells on **Figure 7**) were made inactive to reduce unnecessary computational power.

It is noted that the Quadtree and Nested Grid options available within MODFLOW-USG were not utilised in the numerical groundwater model for this assessment. Accordingly, the adopted modelling approach is akin to the ‘traditional’ approach to modelling with MODFLOW (i.e. with continuous columns [layers] and rows of grid cells). By adopting the traditional grid cells approach, MODFLOW-USG has the benefit of a ‘more robust’ computational engine, based on control volume finite difference, therefore delivering a more robust numerical solution.

Similarly, the opportunity to ‘pinch-out’ discontinuous layers in the model grid was not utilised as a geological model, prepared in AlgoMesh, was already available from an earlier version of the groundwater model (not reported here and not completed). **Figure 8** presents the model grid at the regional scale **Figure 9** presents the model grid at the local (Mine Site) scale.

Figure 7 Numerical Hydrogeological Model Domain

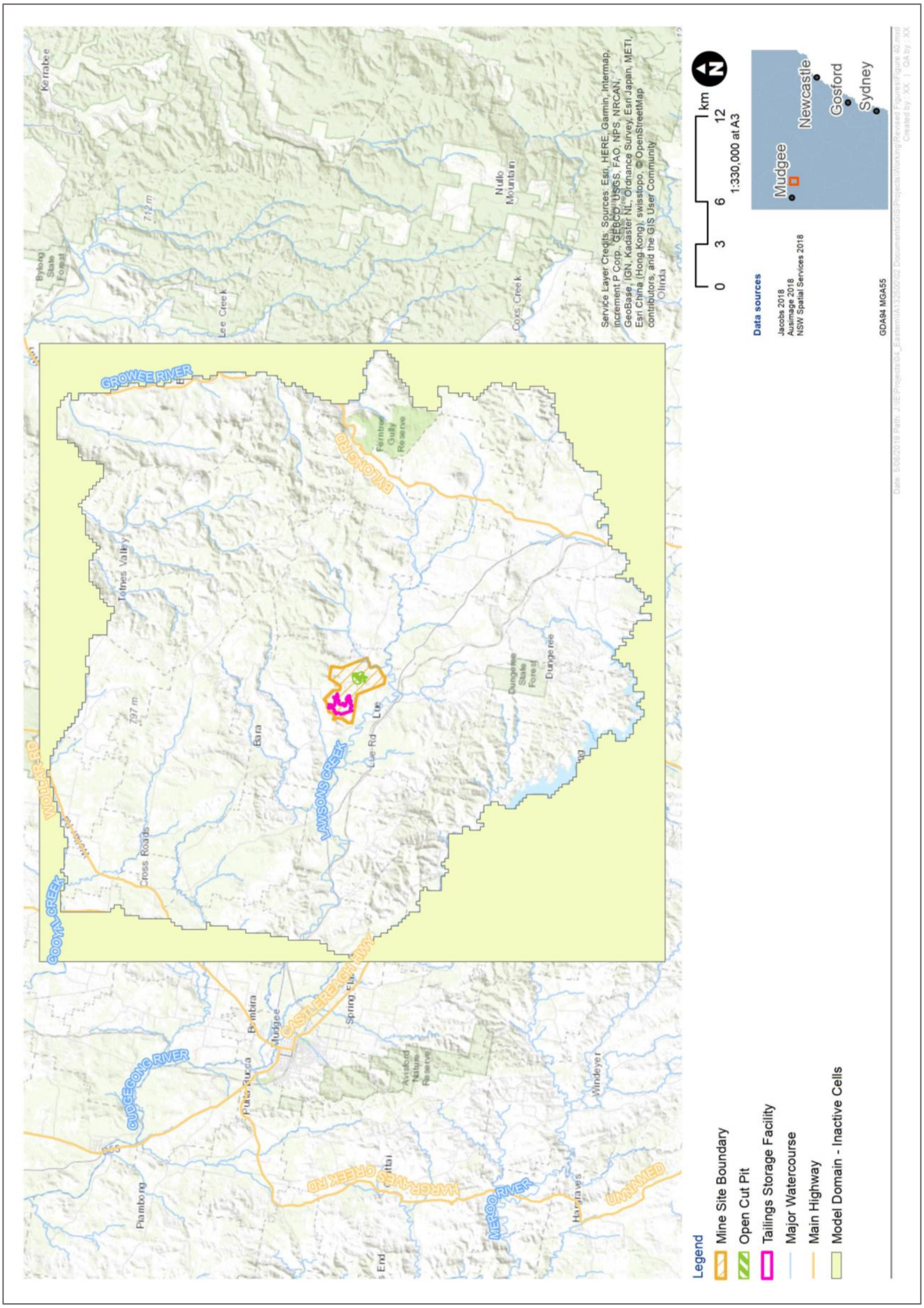


Figure 8 Groundwater Model Grid – Regional View

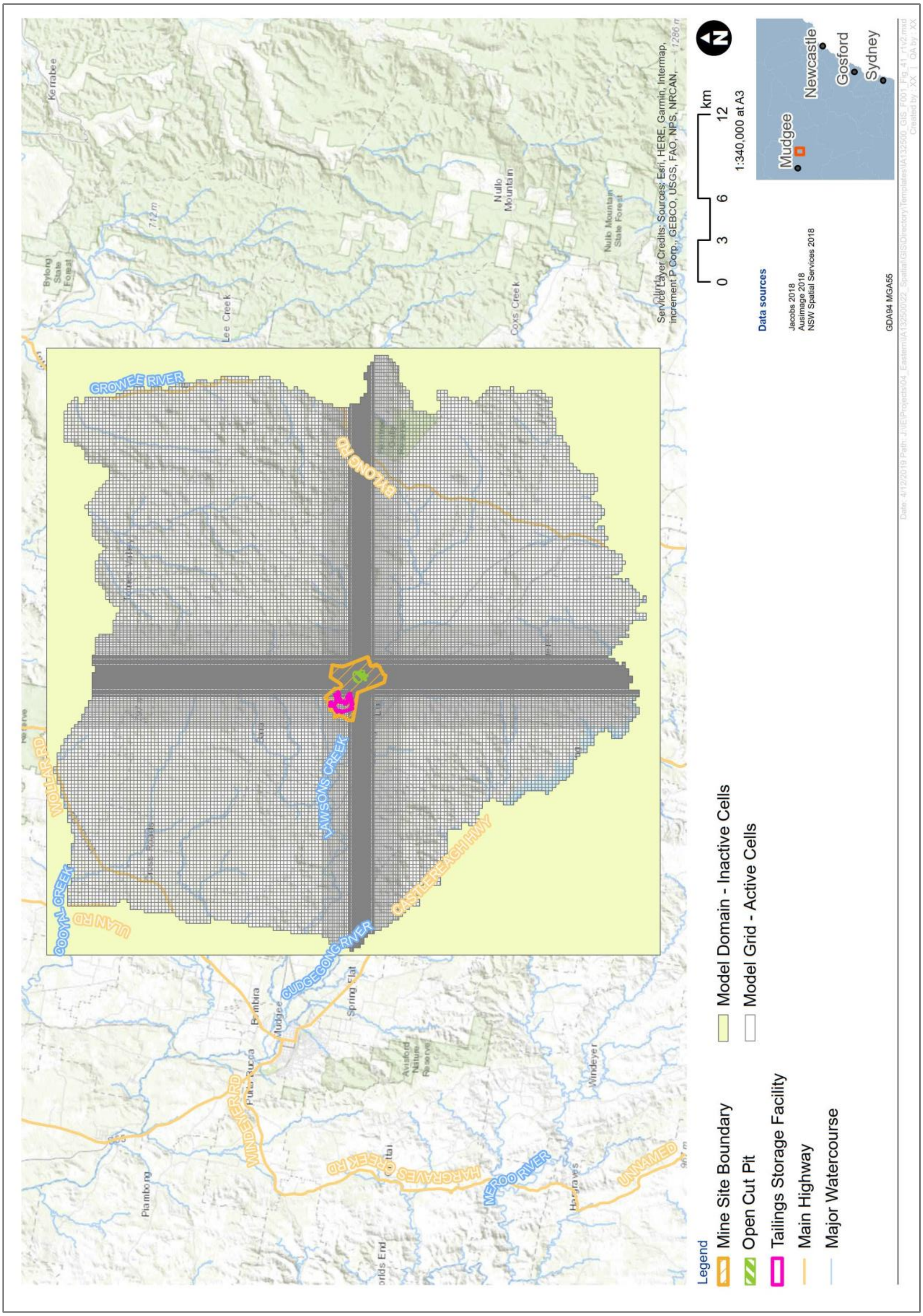
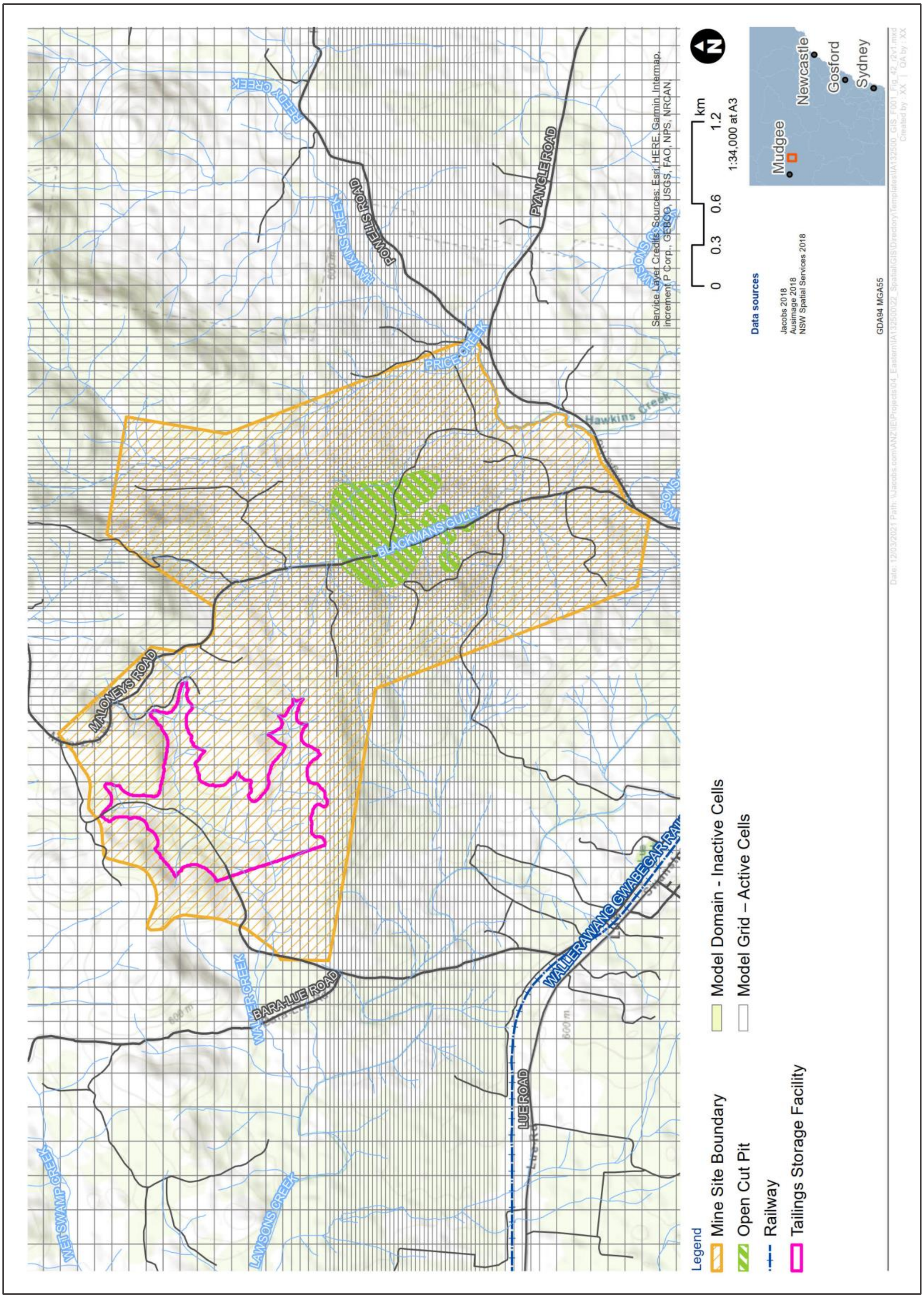


Figure 9 Groundwater Model Grid – Mine Site View



3.5 MODEL BOUNDARY CONDITIONS

The adopted MODFLOW boundary conditions and cell packages utilised within the model grid are described below.

3.5.1 Rivers (RIV)

The River (RIV) boundary condition is a head dependant flux boundary suitable for simulating permanent drainages. In the RIV package if the head in the cell falls below a certain threshold, the flux from the river to the model cell is set to a specified lower bound.

The RIV boundary condition was used for major watercourses, including Lawsons Creek in the centre of the model, Pipeclay Creek on the western boundary, Cooyal Creek on the northwestern boundary, Barigan Creek on the northeastern boundary. On the southern boundary, the Cudgegong River, including Rylstone Dam and Lake Windamere were also included as RIV boundary conditions. The location of the major watercourses was guided by the 1:25 000 scale hydrology layer obtained from NSW Lands and Property Information.

In MODFLOW, conductance is the factor that relates the difference in head (between the surface water body and groundwater) to the rate of flow. Conductance is computed in MODFLOW using the following equation:

$$c = \frac{k * l * w}{m}$$

Where

c = conductance ($\frac{L^2}{T}$),

k= hydraulic conductivity of the sediment in the river boundary condition (L/T),

l= the length of the boundary condition (L),

w= the width of the boundary condition (L), and

m= the thickness of the sediment in the boundary condition perpendicular to flow between the boundary and the cell. Usually this is the vertical thickness of the sediment (L)

The assumed hydraulic conductivity of the streambed in the surface watercourses modelled using RIV was 0.1m/day whilst the width of these watercourses ranged between 5m and 125m. The modelled streambed thickness ranged between 0.5m and 1.0m. Accordingly, the modelled conductance, which is grid cell size dependent, ranged between 156.25m^2/day and 6 250m^2/day.

The stage of the RIV cells was set at 2m below the top elevation of the RIV cell whilst the bottom was set at 4m below the top elevation.

Figure 10 presents the location of the RIV boundary conditions within the model grid.

Figure 10 Groundwater Model Boundary Conditions – River (RIV) Cells

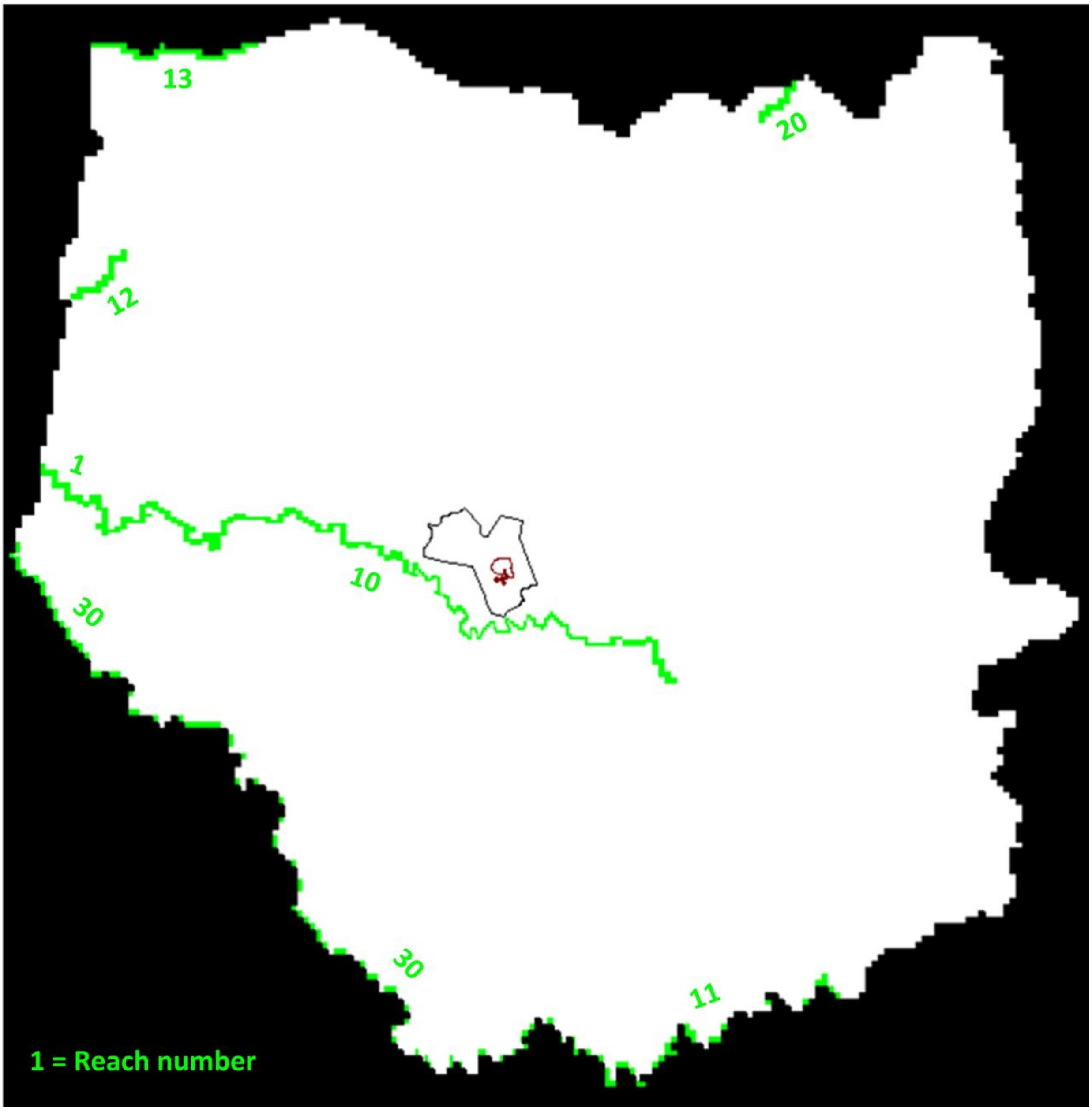


Table 2 presents the reach numbers used in setting the RIV boundary conditions and the applicable water source under the relevant water sharing plan.

Table 2
Groundwater Model Boundary Conditions – RIV Boundaries

Reach	Watercourse	Groundwater Water Source	Groundwater Water Sharing Plan	Surface Water Water Source	Surface Water Water Sharing Plan
1	Lawsons Creek	Lachlan Fold Belt MDB Groundwater Source	NSW Murray Darling Basin Fractured Rock Groundwater Sources Order 2020	Lawsons Creek Water Source	Macquarie Bogan Unregulated and Alluvial Water Sources 2012
10	Lawsons Creek	Lachlan Fold Belt MDB Groundwater Source	NSW Murray Darling Basin Fractured Rock Groundwater Sources Order 2020	Lawsons Creek Water Source	Macquarie Bogan Unregulated and Alluvial Water Sources 2012
10	Lawsons Creek	Sydney Basin MDB Groundwater Source	NSW Murray Darling Basin Porous Rock Groundwater Sources Order 2020	Lawsons Creek Water Source	Macquarie Bogan Unregulated and Alluvial Water Sources 2012
11	Cudgegong River (above Lake Windamere)	Lachlan Fold Belt MDB Groundwater Source	NSW Murray Darling Basin Fractured Rock Groundwater Sources Order 2020	Upper Cudgegong River Water Source	Macquarie Bogan Unregulated and Alluvial Water Sources 2012
11	Cudgegong River (above Lake Windamere)	Sydney Basin MDB Groundwater Source	NSW Murray Darling Basin Porous Rock Groundwater Sources Order 2020	Upper Cudgegong River Water Source	Macquarie Bogan Unregulated and Alluvial Water Sources 2012
12	Stoney Creek	Lachlan Fold Belt MDB Groundwater Source	NSW Murray Darling Basin Fractured Rock Groundwater Sources Order 2020	Pipeclay Creek Water Source	Macquarie Bogan Unregulated and Alluvial Water Sources 2012
13	Cooyal Creek	Lachlan Fold Belt MDB Groundwater Source	NSW Murray Darling Basin Fractured Rock Groundwater Sources Order 2020	Cooyal Wialdra Creek Water Source	Macquarie Bogan Unregulated and Alluvial Water Sources 2012
20	Barrigan Creek	Sydney Basin - North Coast Groundwater Source	North Coast Fractured and Porous Rock Groundwater Sources 2016	Wollar Creek Water Source	Hunter Unregulated and Alluvial Water Sources 2009
30	Cudgegong River (including Lake Windamere)	Lachlan Fold Belt MDB Groundwater Source	NSW Murray Darling Basin Fractured Rock Groundwater Sources Order 2020	Lawsons Creek Water Source (Lake Windamere)	Macquarie Bogan Unregulated and Alluvial Water Sources 2012

3.5.2 Drains (DRN)

The Drain (DRN) boundary condition is a head dependant flux boundary that is suitable for simulating seasonal or ephemeral drainages. In the DRN package, if the head in the cell falls below a certain threshold, the flux from the drain to the model cell drops to zero. The DRN boundary condition was used for minor watercourses within the model domain and guided by the 1:25 000 scale hydrology layer obtained from NSW Lands and Property Information.

This approach was adopted so that 'major' or more significant watercourses at distance from the Mine Site could be included as well those watercourses in the 1:25 000 scale hydrology layer that are close to, or within the Mine Site.

The stage of the DRN cells was set at 2m below top elevation of those cells. In the vicinity of the Mine Site, streambed hydraulic conductivity is informed by that of the underlying model layer, the calculated conductance was grid cell size dependent and ranged between 16.2m^2/day and 129.6m^2/day.

Figure 11 presents the location of the DRN boundary conditions within the model grid.

Figure 11 Groundwater Model Boundary Conditions – Drain (DRN) Cells

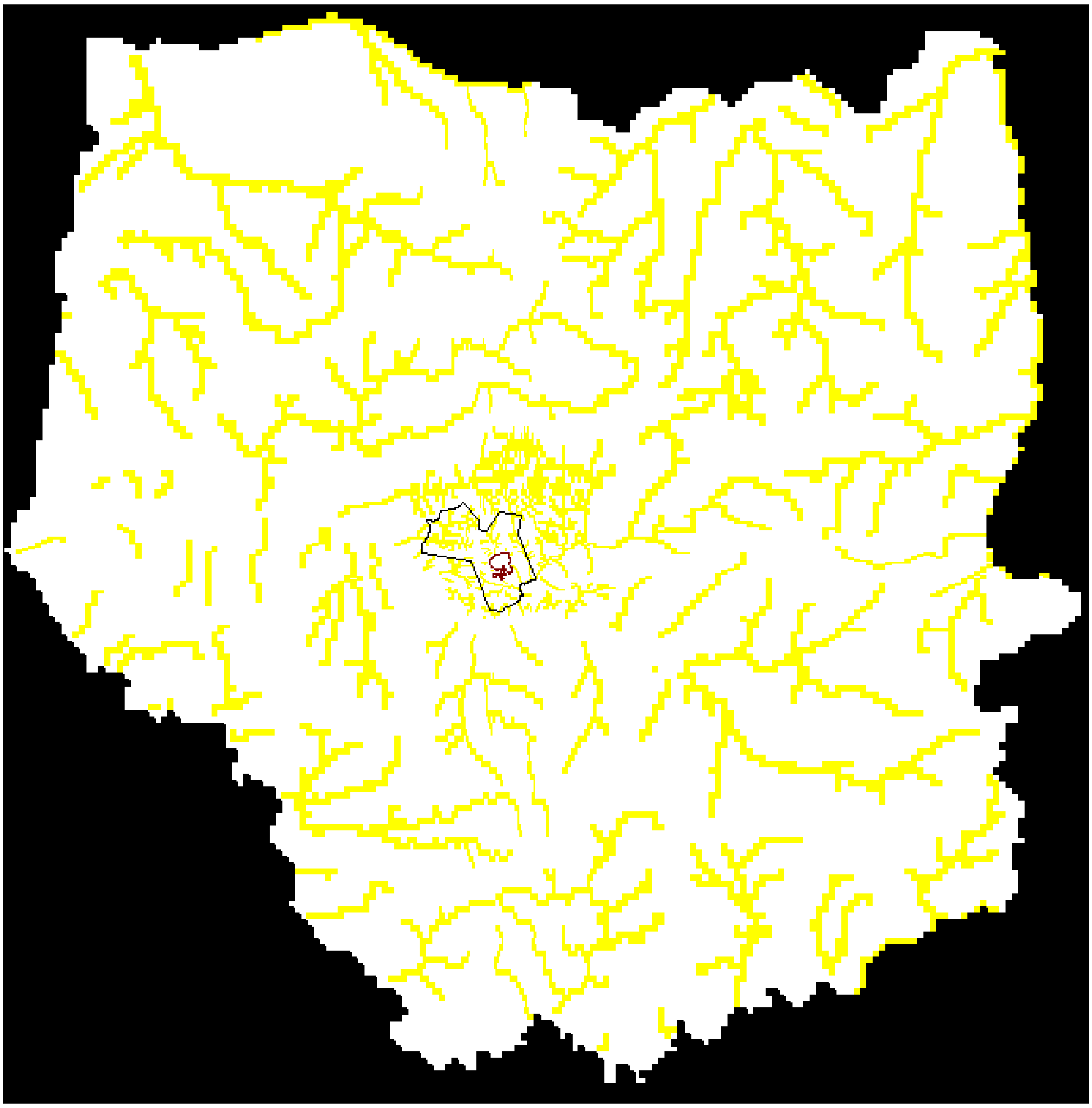


Table 3 presents the reach numbers used in the DRN boundary conditions and the applicable water source under the relevant water sharing plan.

Table 3
Groundwater Model Boundary Conditions – DRN Boundaries

Reach	Groundwater Water Source	Groundwater Water Sharing Plan	Surface Water Water Source	Surface Water Sharing Plan
1	Lachlan Fold Belt MDB Groundwater Source	NSW Murray Darling Basin Fractured Rock Groundwater Sources Order 2020	Lawsons Creek Water Source	Macquarie Bogan Unregulated and Alluvial Water Sources 2012
10	Lachlan Fold Belt MDB Groundwater Source	NSW Murray Darling Basin Fractured Rock Groundwater Sources Order 2020	Lawsons Creek Water Source	Macquarie Bogan Unregulated and Alluvial Water Sources 2012
10	Sydney Basin MDB Groundwater Source	NSW Murray Darling Basin Porous Rock Groundwater Sources Order 2020	Lawsons Creek Water Source	Macquarie Bogan Unregulated and Alluvial Water Sources 2012
11	Lachlan Fold Belt MDB Groundwater Source	NSW Murray Darling Basin Fractured Rock Groundwater Sources Order 2020	Upper Cudgegong River Water Source	Macquarie Bogan Unregulated and Alluvial Water Sources 2012
11	Sydney Basin MDB Groundwater Source	NSW Murray Darling Basin Porous Rock Groundwater Sources Order 2020	Upper Cudgegong River Water Source	Macquarie Bogan Unregulated and Alluvial Water Sources 2012
12	Lachlan Fold Belt MDB Groundwater Source	NSW Murray Darling Basin Fractured Rock Groundwater Sources Order 2020	Pipeclay Creek Water Source	Macquarie Bogan Unregulated and Alluvial Water Sources 2012
13	Lachlan Fold Belt MDB Groundwater Source	NSW Murray Darling Basin Fractured Rock Groundwater Sources Order 2020	Cooyal Wialdra Creek Water Source	Macquarie Bogan Unregulated and Alluvial Water Sources 2012
13	Sydney Basin MDB Groundwater Source	NSW Murray Darling Basin Porous Rock Groundwater Sources Order 2020	Cooyal Wialdra Creek Water Source	Macquarie Bogan Unregulated and Alluvial Water Sources 2012
20	Sydney Basin - North Coast Groundwater Source	North Coast Fractured and Porous Rock Groundwater Sources 2016	Wollar Creek Water Source	Hunter Unregulated and Alluvial Water Sources 2009
21	Sydney Basin - North Coast Groundwater Source	North Coast Fractured and Porous Rock Groundwater Sources 2016	Bylong River Water Source	Hunter Unregulated and Alluvial Water Sources 2009
21	Unnamed Upriver Alluvium in WSP in the Bylong River	Hunter Unregulated and Alluvial Water Sources 2009	Bylong River Water Source	Hunter Unregulated and Alluvial Water Sources 2009

3.5.3 Wells (WEL)

The WEL package in MODFLOW is used to simulate bore pumping as a specified flux to individual cells and is specified in units of volume/time (m^3/day). Pumping wells are specified as a negative flux.

The PINNEENA database from the (then) NSW Department of Industry - Crown Lands & Water (CL&W), together with the NSW Water Registry, was used to identify the location of active groundwater works within the model grid.

These works were then designated as pumping wells using WEL cells. The assigned pumping rate was based on the water access licence (WAL) entitlement obtained from the NSW Water Registry with the distribution of pumping adjusted for seasonal variation. Details of the utilised WALs are provided in Jacobs (2021). The pumping distribution for those groundwater works utilised under basic landholder rights was also seasonal, however, these works were assumed to be active throughout the year. The pumping distribution for all other works were based on an assumed dry season irrigation as outlined on **Table 4**. It is noted that the basic landholder rights works were assumed to abstract 2ML per year.

Table 4
Groundwater Model Boundary Condition – Distribution of Pumping Rate (WEL)

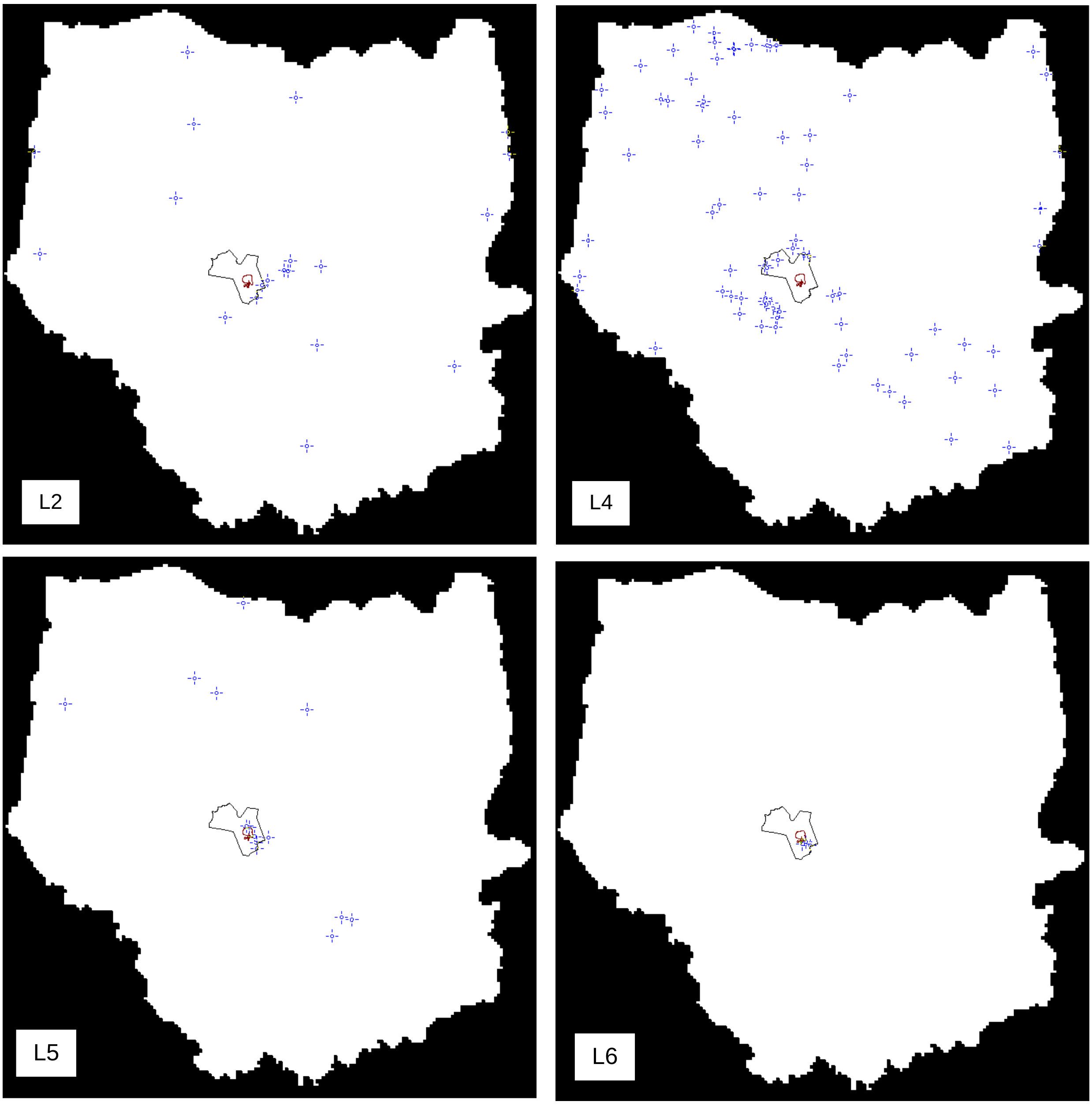
Month	Basic Landholder Rights	Other Works
Jan	12.0%	15.0%
Feb	10.0%	11.5%
Mar	8.0%	0.0%
Apr	7.0%	0.0%
May	6.0%	0.0%
Jun	5.0%	0.0%
Jul	5.0%	0.0%
Aug	7.0%	9.0%
Sep	8.0%	11.5%
Oct	9.0%	15.0%
Nov	11.0%	19.0%
Dec	12.0%	15.0%

Figure 12 presents the distribution of the WELs in each layer of the model (refer Section 3.6 for a description of these layers). It is noted that no WELs are represented in Layer 1, Layer 3, Layer 7 or Layer 8 of the model.

3.5.4 Recharge (RCH)

Rainfall recharge to the model was represented using the Recharge (RCH) boundary condition. This recharge was informed by rainfall data obtained from the SILO climatic database that is maintained by the Queensland Department of Environment and Science (DES).

Figure 12 Groundwater Model Boundary Conditions – Well (WEL) Cells



SILO patched rainfall data was obtained for Bureau of Meteorology (BoM) rainfall stations 62012, 62021, 62026 and 62032. As the model was established with monthly stress periods, daily rainfall data was summed to monthly totals and a recharge factor was then applied. This recharge factor was included as a calibration parameter, except for Lake Windamere which was assigned a factor of 1.0 (equivalent to 100%). The recharge factor zones applied to RCH cells in the model grid were derived based on land-use (as identified using aerial and satellite imagery) and topography. These recharge factor zones included:

- Hilltops
- Foothills
- Floodplain
- Lake

The distribution of rainfall data, from the respective rainfall station, was based on the Thiessen polygon approach, where a Thiessen polygon is a polygon whose boundaries are all closer to the rainfall station within the area than any other rainfall station outside of the area (Thiessen, 1911).

Figure 13 presents the distribution of recharge zones and **Table 5** presents the calibrated recharge factors, including the relevant zone colour from **Figure 13**.

Figure 13 Groundwater Model Boundary Conditions – Recharge (RCH) Zones

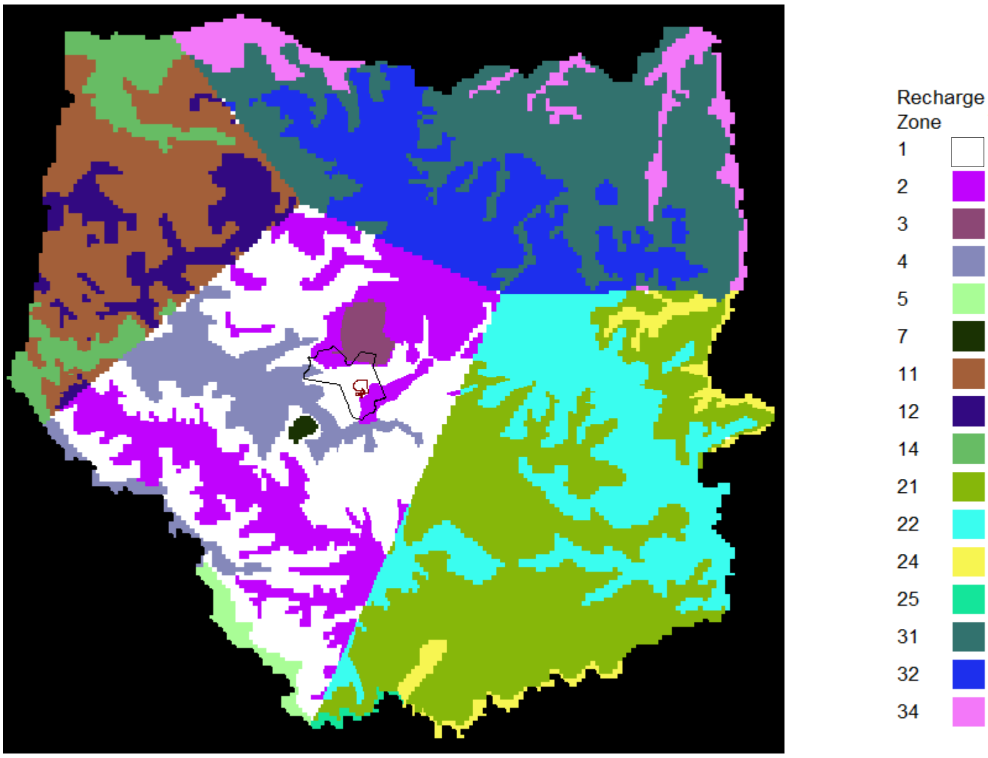


Table 5
Groundwater Model Boundary Condition – Recharge (RCH) Zones

Zone Number	BoM Rainfall Station	Description	Recharge Factor
1	62012	Foothills	0.12
2	62012	Hilltops	0.02
3	62012	Hilltops	0.04
4	62012	Floodplain	0.025
5	62012	Lake	1.00
7	62012	Foothills	0.12
11	62021	Foothills	0.06
12	62021	Hilltops	0.12
14	62021	Floodplain	0.25
21	62026	Foothills	0.04
22	62026	Hilltops	0.02
24	62026	Floodplain	0.39
25	62026	Lake	1.00
31	62032	Foothills	0.04
32	62032	Hilltops	0.04
34	62032	Floodplain	0.40

3.5.5 Evapotranspiration (EVT)

Losses from the model via evapotranspiration was represented using the Evapotranspiration (EVT) boundary condition. The adopted approach utilised SILO evapotranspiration data rather than Pan A evaporation to calculate losses.

The SILO evapotranspiration data used was that provided using the Food and Agricultural Organisation of the United Nations (FAO) short crop version of the Penman-Monteith equation. Daily SILO evapotranspiration data was then totalised with respect to months and an evapotranspiration factor applied for each of the identified weather station RCH zones.

An evapotranspiration factor was included as a model calibration factor. However, this was found to be insensitive in earlier versions of the groundwater model. Accordingly, a fixed value of 0.4 (equivalent to 40%) was applied to most land-use types whilst a fixed value of 1.0 (equivalent to 100%) was applied to Lake Windamere.

Similar to recharge, evapotranspiration factor zones were derived based on land-use and topography, and included:

- Foothill/Floodplain
- Hilltop
- Lake

It is noted that the EVT extinction depth was set at a uniform value of 3.0m. The EVT extinction depth is the depth at which EVT approaches zero, and beyond which EVT cannot remove water from the model.

The 3m extinction depth was adopted, in part, to represent the soil moisture deficit process. Representing soil moisture deficits in this manner accounts for the process whereby percolating rainfall (with an allowance for rainfall/runoff loss) overcomes any cumulative moisture deficit before model recharge can occur. An advantage of this approach is that it resolves the potential for “flooded cells” in the model simulation. These “flooded cells” occur when the modelled hydraulic head in some cells is above ground surface. Flooded cells should not be present in a groundwater model as they are non-physical and invariably result in the model’s numerical solver being unable to converge.

Whilst the combined RCH and EVT approach is a simplification of the soil moisture deficit process, any disadvantage associated with this approach is partly overcome by the inclusion of the recharge factor in model calibration. However, as noted above, earlier versions of the model identified that calibration was insensitive to evapotranspiration factors. Subsequently, evapotranspiration factors were ‘locked’ at assumed values. Accordingly, the combined RCH and EVT approach, whilst having some limitations due to simplification, was adopted for the model as it is considered superior to the externally calculated ‘effective’ recharge via the RCH package due to its advantage in resolving areas of flooded cells.

The distribution of evapotranspiration data, from the respective rainfall stations, was again based on the Thiessen polygon approach. **Figure 14** presents the distribution of evapotranspiration zones in the model grid whilst **Table 6** presents the adopted evapotranspiration factors, including the relevant zone colour from **Figure 14**.

Figure 14 Groundwater Model Boundaries – Evapotranspiration (EVT) Zones

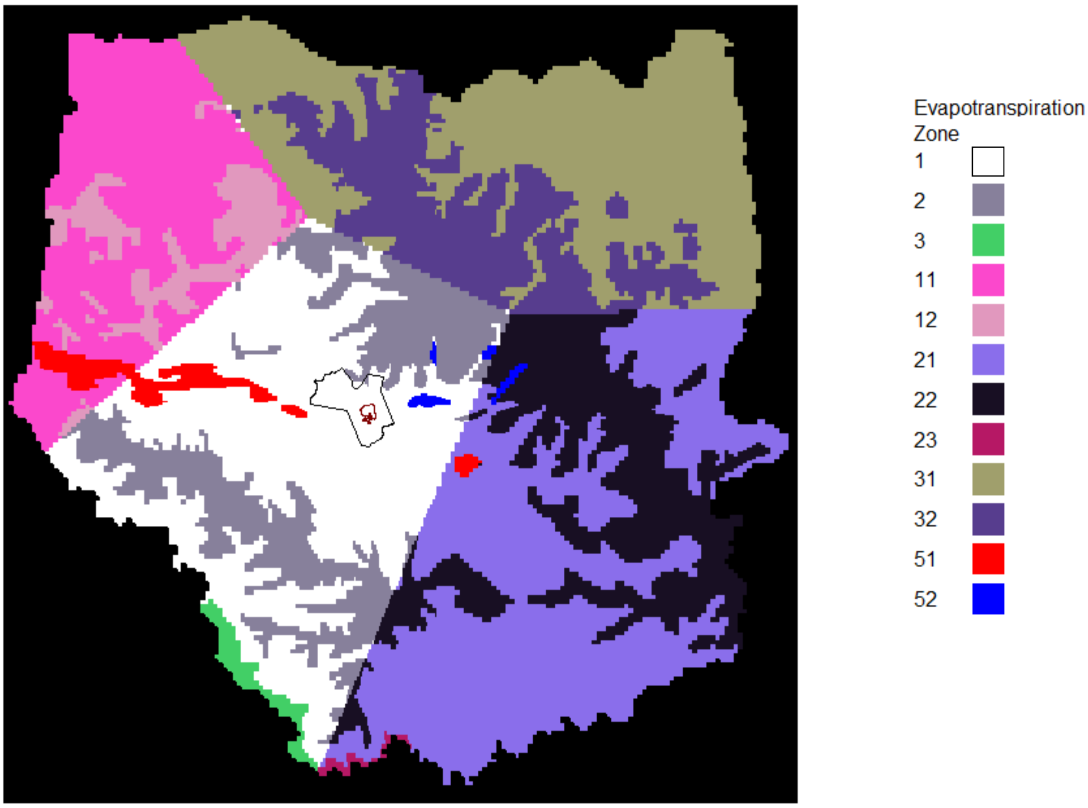


Table 6
Groundwater Model Boundary Condition – Evapotranspiration (EVT) Zones

Zone Number	Rainfall Station	Description	Evapotranspiration Factor	Extinction Depth (m)
1	62012	Foothills/Floodplain	0.40	3.0
2	62012	Hilltops	0.40	3.0
3	62012	Lake	1.00	3.0
11	62021	Foothills/Floodplain	0.40	3.0
12	62021	Hilltops	0.40	3.0
21	62026	Foothills/Floodplain	0.40	3.0
22	62026	Hilltops	0.40	3.0
23	62026	Lake	1.00	3.0
31	62032	Foothills/Floodplain	0.40	3.0
32	62032	Hilltops	0.40	3.0
51	62012	Lawsons Creek / Farm dam	0.40	3.0
52	62012	Hawkins Creek and tributaries, Horse Gully Creek swamp	0.40	3.0

3.6 MODEL LAYERS

The model layer geometry was based on geological data supplied by Bowdens Silver and supplemented with data from regional data from the Western Coalfield Geological Modelling Project undertaken by the (then) NSW Department of Resources and Energy (DRE).

The surface of Layer 1 was derived using light detection and ranging (LiDAR) data supplied by Bowdens Silver and supplemented, regionally, by the 1:25 000 topographic dataset of NSW Lands and Property Information.

Figure 15 and **Figure 16** present west-east and north-south geological cross-sections through the model, respectively. The location of the cross-section lines is shown on the 3D surface of the model presented in **Figure 17**. The layering of the model with respect to the hydrostratigraphic units represented in Section 2.2 is summarised in **Table 7**.

Figure 15 West-East Geological Cross-section through the Model

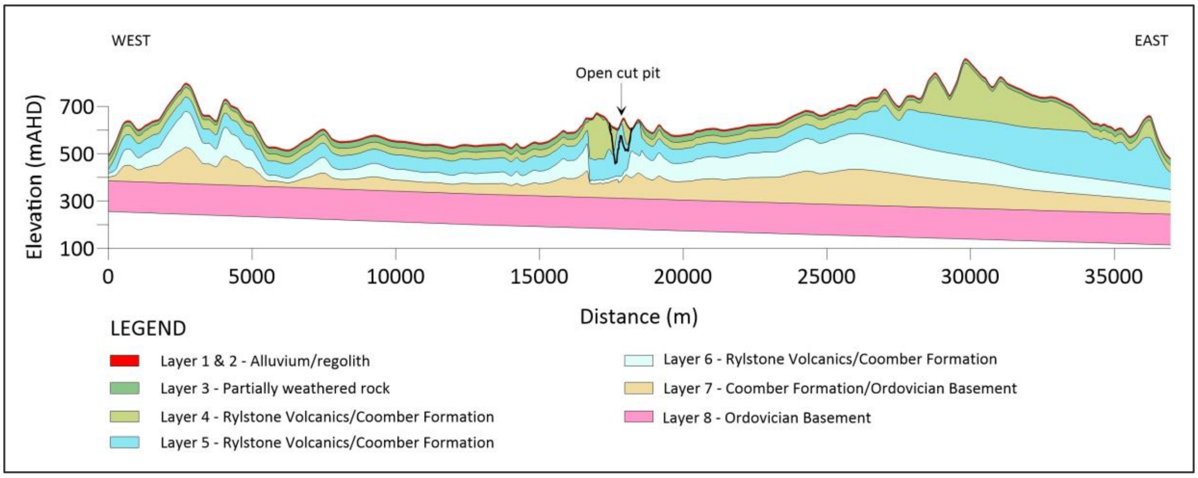


Figure 16 North-South Geological Cross-section through the Model

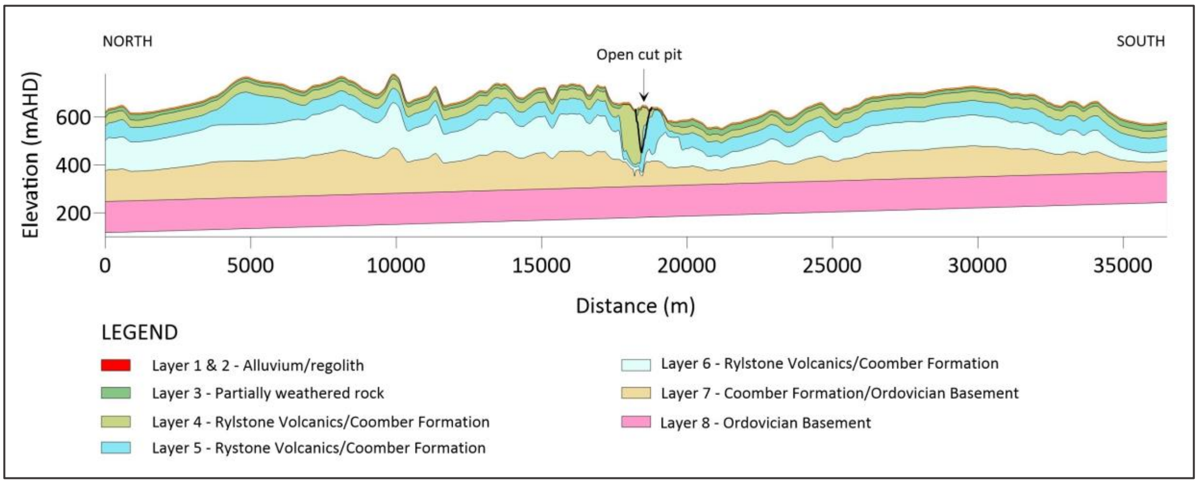


Figure 17 Groundwater Model Shaded Relief

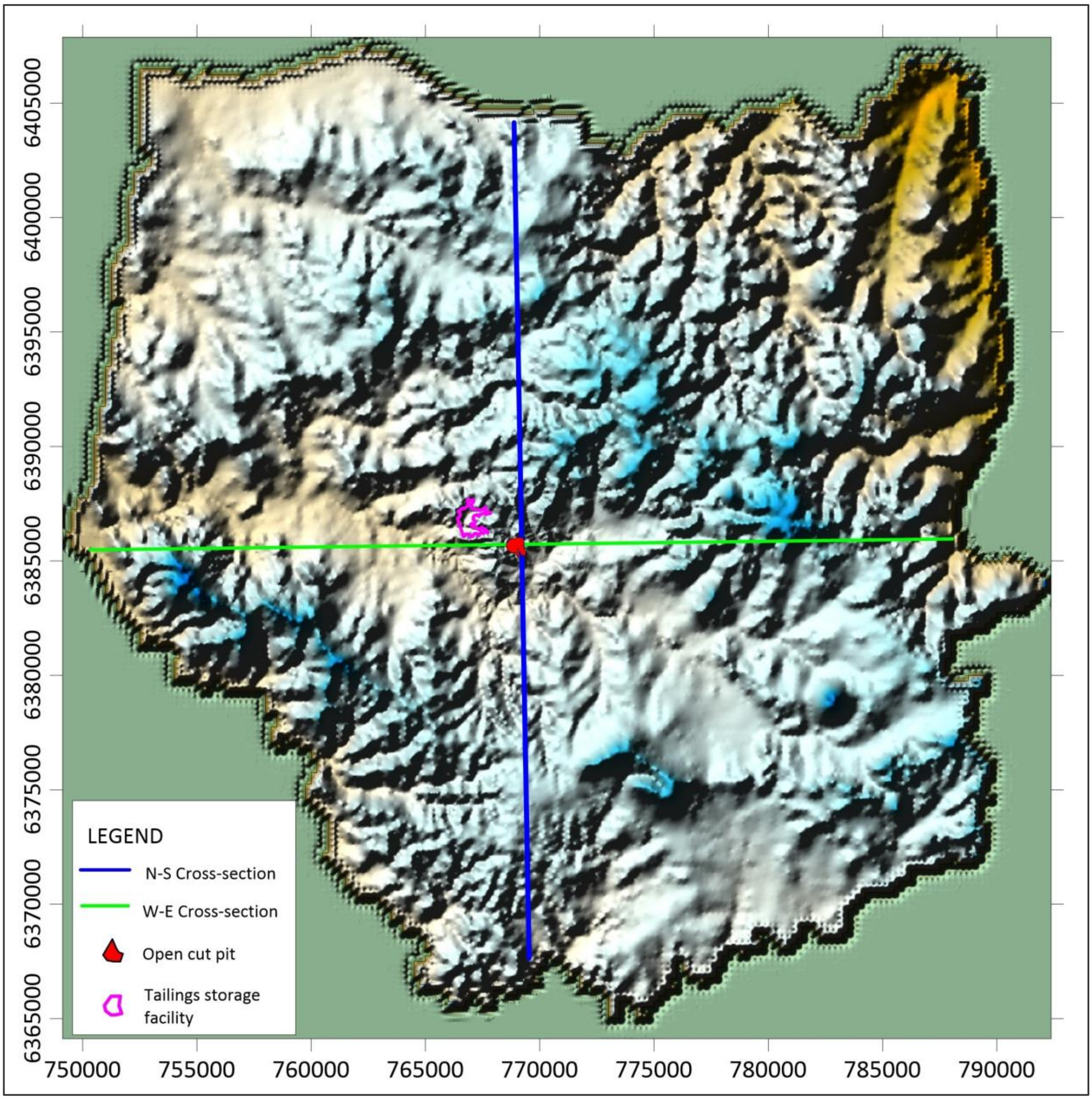


Table 7
Model Layers

Page 1 of 2

Near Surface				
Layer	**Locality**			**Thickness (m)**
	Valleys	**Hills**	**Outcrop Rock (Local)**	
1	Alluvium (Sandy Silt)	Regolith (clayey silt with vegetation)	Rock	3.0
2	Alluvium (Silty Sand)	Extremely Weathered Rock (silty clay)	Rock	3.0
3	Partially Weathered Rock (weathered rock with stiff clay)	Partially Weathered Rock	Rock	3.0 to 104 (median 17.8)

Table 7 (Cont'd)
Model Layers

Page 2 of 2

Underlying Rock				
Layer	**Locality**			**Thickness (m)**
	South West	**Mine Site**	**North East**	
4	Rylstone Volcanics / Coomber Formation / Ordovician Basement	Rylstone Volcanics	Sydney Basin	3.0 to 287 (median 37.7)
5	Rylstone Volcanics / Coomber Formation / Ordovician Basement	Rylstone Volcanics	Rylstone Volcanics / Sydney Basin	3.0 to 249 (median 60)
Basement				
Layer	**Locality**			**Thickness (m)**
	South West	**Mine Site**	**North East**	
6	Rylstone Volcanics / Ordovician Basement	Rylstone Volcanics / Coomber Formation	Ordovician Basement	4.3 to 235 (median 83.8)
7	Ordovician Basement	Coomber Formation	Ordovician Basement	4.3 to 235 (median 83.9)
8	Ordovician Basement	Ordovician Basement	Ordovician Basement	130

3.7 INITIAL HYDRAULIC PARAMETERS

Figure 18 and **Figure 19** presents the distribution of the initial hydraulic parameters in each model layer. To assist correlation with model geometry, zones of differing hydraulic parameters were also to respective layers. These zones are identified numerically whereby the first numeral of the two-digit zone number represents the model layer (e.g. Layer 1) whilst the second presents the zone (e.g. Layer 2 contains zones 21, 22 and 23, etc.). **Table 8** presents the zone descriptions and the assigned initial hydraulic parameters used to represent the various hydrostratigraphic units.

Results of hydraulic testing indicated that the Bowdens deposit and surrounding units of the Rylstone Volcanics exhibit relatively elevated hydraulic conductivity due to the high fracture concentration. Pilot points were initially used during early model calibration of hydraulic conductivity values. These were used to assess if finer resolution hydraulic conductivity zones within Layer 4, 5 and 6, representing the influence of the major geological structures in the near vicinity of the Mine Site, would improve calibration. Regional values were then adopted outside of the Mine Site area for this model iteration. However, this approach was not beneficial to calibration and a zone of moderately elevated hydraulic conductivity (refer **Table 8**) was subsequently introduced to Layers 4, 5 and 6 in the Mine Site area to account for the increased concentration of structural deformation.

Despite this small scale dominance of fracture flow, the groundwater system has been implemented in the model as an equivalent porous medium due to the field scale observations from pump testing (Jacobs, 2021). This approach is supported by the calibration results, as discussed in Section 4.

Figure 18 Distribution of Model Hydraulic Properties Zones (Layer 1 to 6)

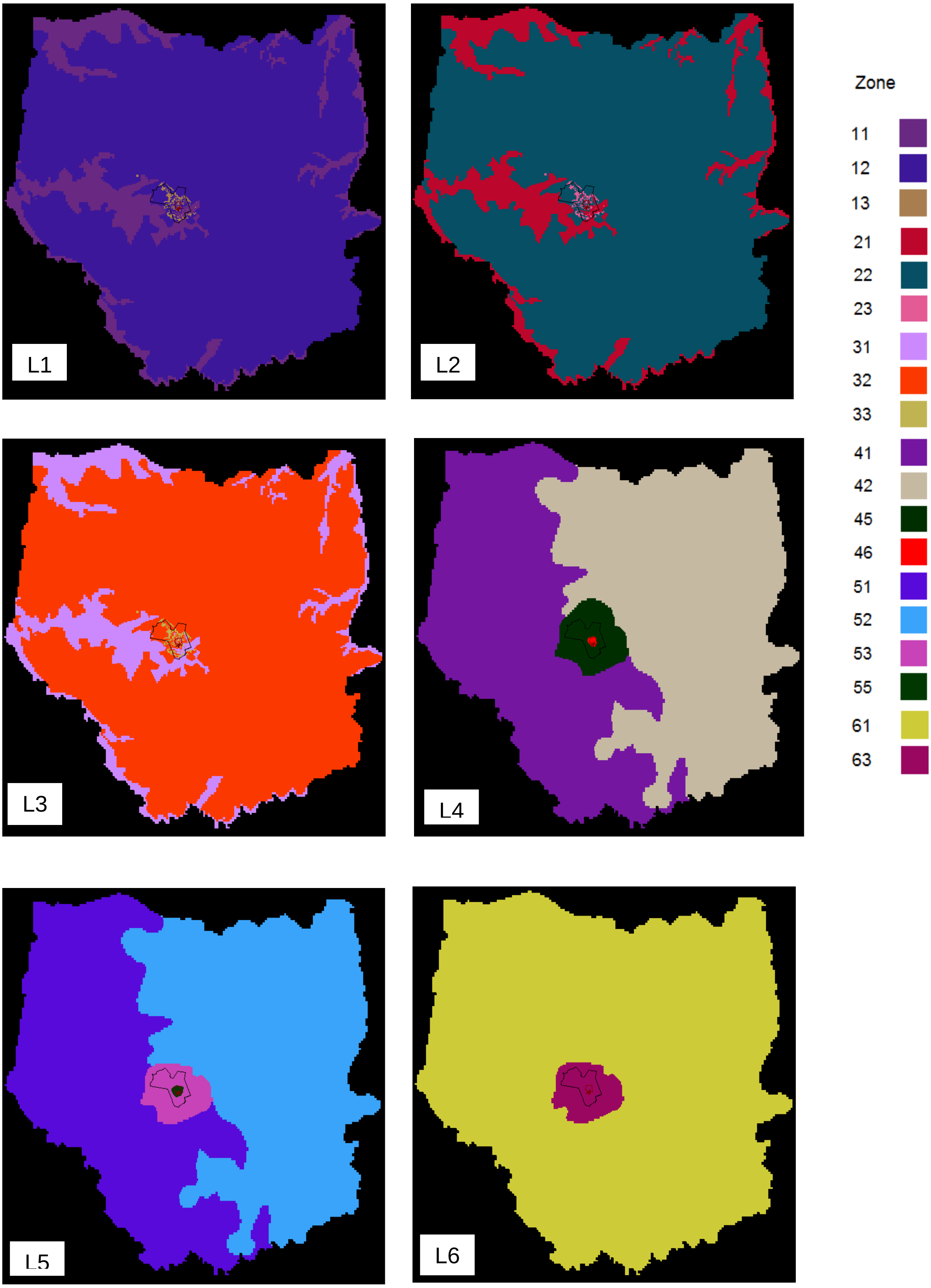


Figure 19 Distribution of Model Hydraulic Properties Zones (Layer 7 and 8)

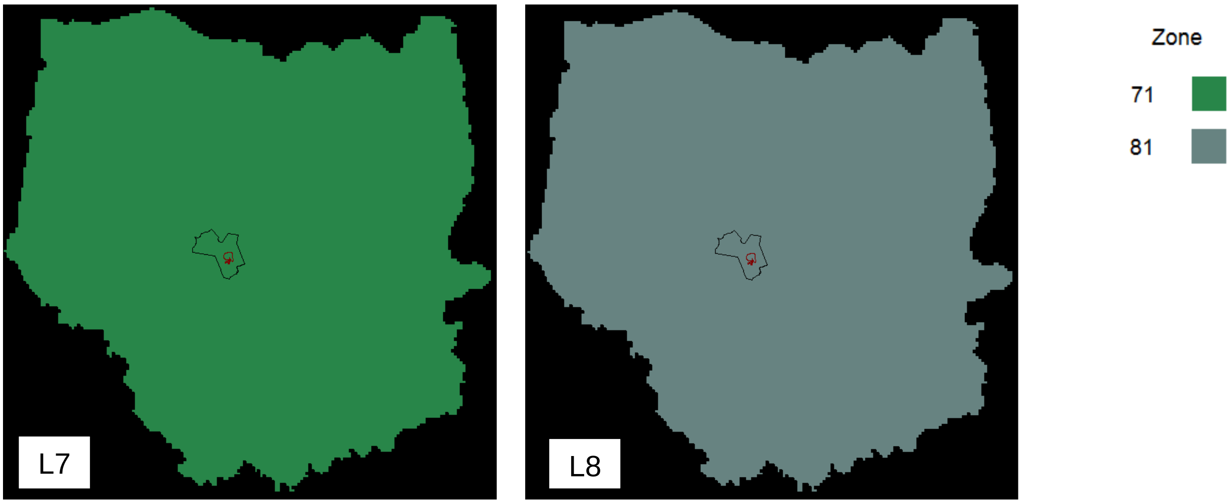


Table 8
Groundwater Model – Initial Values of Hydraulic Parameters

Page 1 of 2

Zone	Kh (m/day)	Kv (m/day)	Ss (m^{-1})	Sy	Locality	Hydrostratigraphic Unit / Description
Layer 1						
11	2.5	0.5	9.0x10-4	0.11	Valley	Alluvium (Sandy Silt)
12	0.5	0.1	9.0x10-4	0.09	Hills	Regolith (clayey silt with vegetation)
13	0.02	0.01	5.0x10-5	0.02	Outcrop Rock (Local)	Weathered Rock
Layer 2						
21	5	0.5	$7.0x10^{-4}$	0.2	Valley	Alluvium (Silty Sand)
22	0.025	0.005	$7.0x10^{-4}$	0.04	Hills	Extremely Weathered Rock (silty clay)
23	0.02	0.01	$5.0x10^{-5}$	0.02	Outcrop Rock (Local)	Weathered Rock
Layer 3						
31	1	0.15	$5.0x10^{-4}$	0.09	Valley	Partially Weathered Rock (weathered rock with stiff clay)
32	0.25	0.0375	$5.0x10^{-4}$	0.09	Hills	Partially Weathered Rock
33	0.02	0.01	$5.0x10^{-5}$	0.02	Outcrop Rock (Local)	Weathered Rock
Layer 4						
41	0.05	0.025	$2.0x10^{-5}$	0.01	South West	Ordovician Basement
42	0.075	0.0075	$5.0x10^{-5}$	0.02	North East	Sydney Basin
45	0.2	0.01	$5.0x10^{-5}$	0.01	Outer Mine Area	Rylstone Volcanics / Coomber Formation
46	0.2	0.02	$2.0x10^{-5}$	0.01	Mine Area	Rylstone Volcanics
Layer 5						
51	0.04	0.02	$3.0x10^{-5}$	0.01	West	Rylstone Volcanics / Ordovician Basement
52	0.025	0.0025	$3.0x10^{-5}$	0.01	North East	Sydney Basin

Table 8 (Cont'd)
Groundwater Model – Initial Values of Hydraulic Parameters

Page 2 of 2

Zone	Kh (m/day)	Kv (m/day)	Ss (m^{-1})	Sy	Locality	Hydrostratigraphic Unit / Description
Layer 5 (Cont'd)						
53	0.005	0.0025	$3.0x10^{-5}$	0.01	Outer Mine Area	Rylstone Volcanics / Coomber Formation
55	0.2	0.02	$2.0x10^{-5}$	0.01	Mine Area	Rylstone Volcanics / Coomber Formation
Layer 6						
61	0.025	0.0125	$2.0x10^{-5}$	0.01	Whole Model	Ordovician Basement
63	0.001	0.001	$2.0x10^{-5}$	as 61	Mine Area	Rylstone Volcanics / Coomber Formation
Layer 7						
71	0.01	0.005	$1.0x10^{-5}$	0.01	Whole Model	Ordovician Basement
Layer 8						
81	0.005	0.0025	$8.0x10^{-6}$	0.01	Whole Model	Ordovician Basement

4. MODEL CALIBRATION

To test the model's ability in representing the behaviour of the groundwater system, the model was calibrated to actual, measured (observed) groundwater conditions using groundwater levels (heads) and baseflow. This calibration was performed for both steady state and transient groundwater conditions.

4.1 CALIBRATION FOR GROUNDWATER LEVELS – STEADY STATE CONDITIONS

The steady state model was calibrated using the following groundwater level (head) targets:

- average (mean) of measured groundwater levels for the period from 1 January 2011 through to 30 April 2017, as derived from Bowdens Silver's groundwater monitoring programme.
- one-off water levels extracted from the CL&W PINNEENA database as available (refer Annexure 2 of Jacobs, 2021). It is noted that water levels obtained from the PINNEENA database do not necessarily have associated measurement dates. Recorded dates for individual groundwater works range from 1914 through to 2010, as such the water level record covers a considerable time span and will be representative of highly variable climatic conditions.

Average (mean) pumping rates, based on pumping data from 2011 to 2017, were applied to the steady state model to represent average pumping conditions.

Calibration of the steady state model assigned equal weighting to observed heads (groundwater levels) from the CL&W PINNEENA database and those derived from Bowdens Silver's groundwater monitoring data.

Figure 20a presents the distribution of the steady state calibration model targets used for Layer 2 and Layer 4 whilst **Figure 20b** presents the distribution of model targets for Layer 5 and Layer 6. There were no steady state calibration targets for Layers 1, 3, 7 and 8.

The model was initially calibrated using the automated parameter estimation tool "PEST-HP" (Watermark Numerical Computing, 2018). Initial attempts to use pilot points within PEST-HP to assess if finer resolution hydraulic conductivity zones would improve calibration in the vicinity of the Mine Site, provided little benefit. Further calibration was then undertaken via an iterative step-wise process using manual adjustment of input parameters (hydraulic conductivity and recharge, within realistic ranges) to achieve an acceptable match between simulated and observed heads (groundwater levels). Calibration success was gauged by qualitatively assessing the match between modelled and observed heads as well as assessing statistical calibration measures. This approach to calibration resulted in the adoption of the Mine Area and Outer Mine Area hydraulic parameter zones presented in **Table 8**. Manual calibration then proceeded using this zonation with calibration considered complete when a reasonably good match between observed and simulated heads was obtained.

The horizontal (Kh) and vertical (Kv) hydraulic conductivity values assigned to the calibrated steady state model are presented in **Table 9**. The recharge factors assigned to the calibrated steady state model were presented in **Table 5.**

Figure 20a Distribution of Model Calibration Targets in Layer 2 and 4

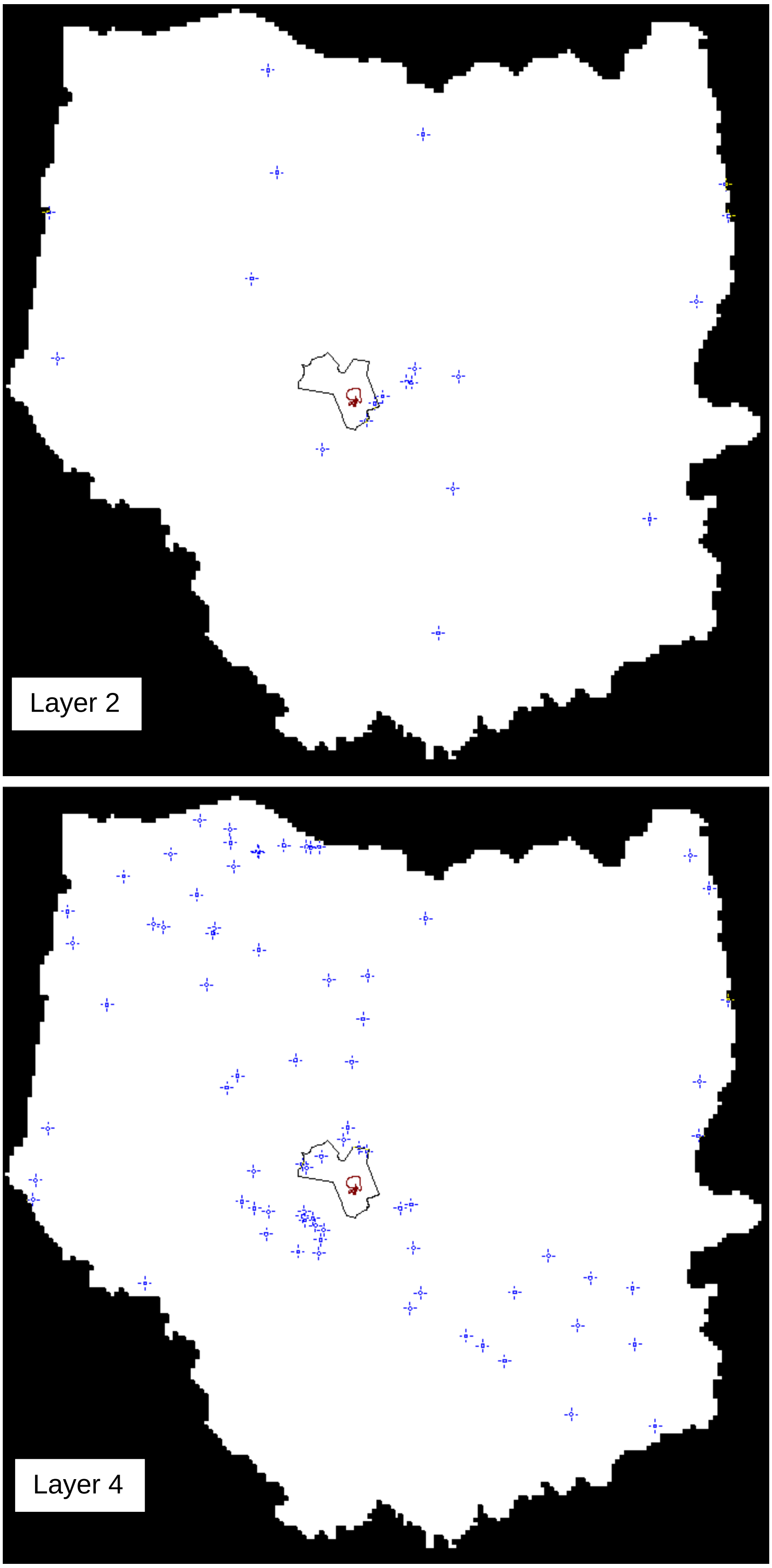


Figure 20b Distribution of Model Calibration Targets in Layer 5 and 6

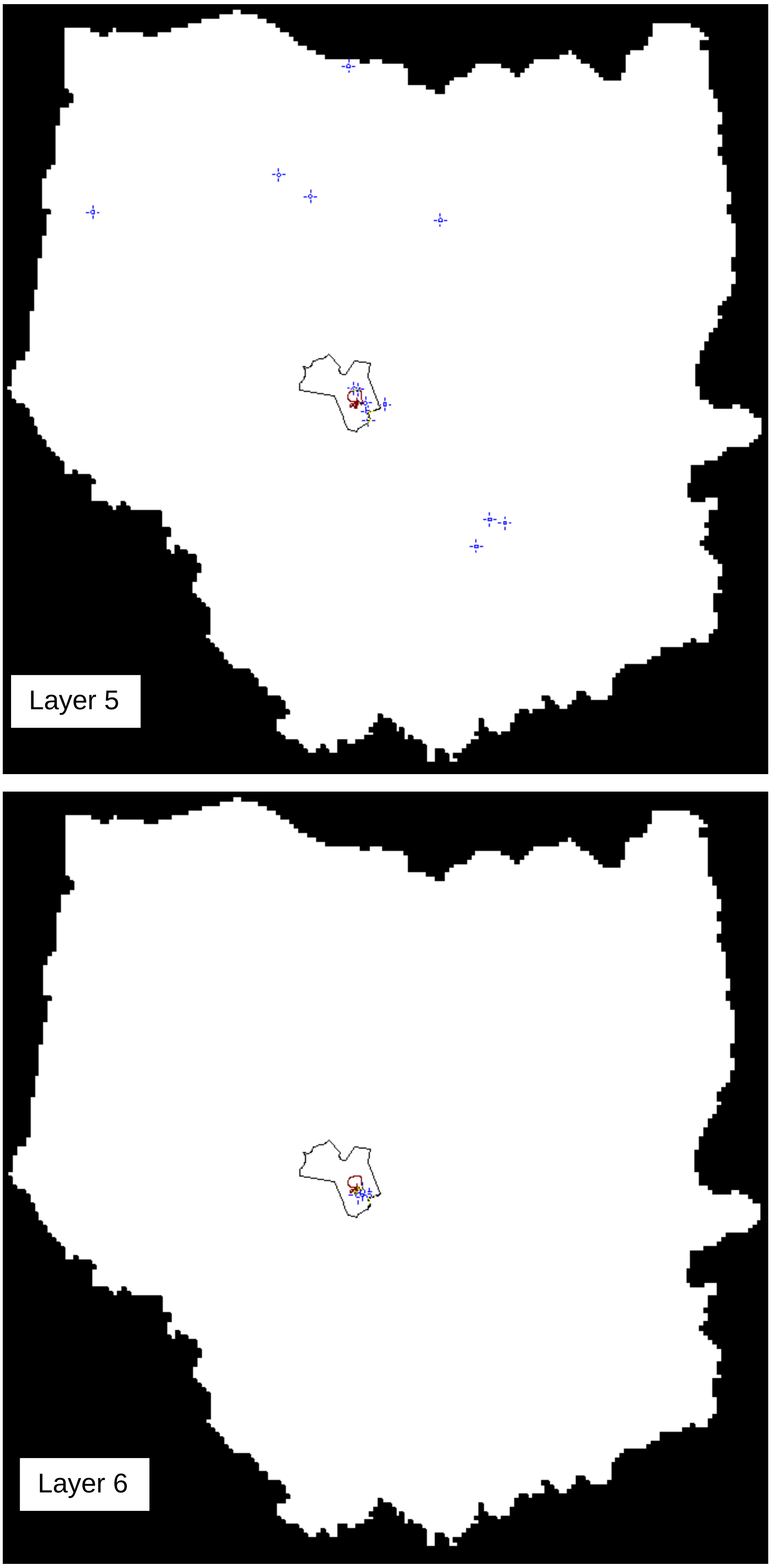


Table 9
Groundwater Model – Calibrated Values of Hydraulic Parameters

Zone	Kh (m/day)	Kv (m/day)	Locality	Description
Layer 1				
11	2.05	1.06	Valley	Alluvium (Sandy Silt)
12	0.098	0.08	Hills	Regolith (clayey silt with vegetation)
13	0.1	0.02	Outcrop Rock (Local)	Weathered Rock
Layer 2				
21	3	0.6	Valley	Alluvium (Silty Sand)
22	0.05	0.01	Hills	Extremely Weathered Rock (silty clay)
23	0.25	0.05	Outcrop Rock (Local)	Weathered Rock
Layer 3				
31	0.89	0.09	Valley	Partially Weathered Rock (weathered work with stiff clay)
32	0.57	0.057	Hills	Partially Weathered Rock
33	0.87	0.09	Outcrop Rock (Local)	Weathered Rock
Layer 4				
41	0.003	0.0003	South West	Ordovician Basement
42	0.003	0.0003	North East	Sydney Basin
45	0.06	0.012	Outer Mine Area	Volcanics / Coomber Formation
46	0.1	0.02	Mine Area	Volcanics
Layer 5				
51	0.0021	0.0004	West	Volcanics / Ordovician
52	0.0021	0.0004	North East	Sydney Basin
53	0.02	0.002	Outer Mine Area	Volcanics / Coomber Formation
55	0.2	0.02	Mine Area	Volcanics / Coomber Formation
Layer 6				
61	0.00023	0.00004	Whole Model	Ordovician Basement
63	0.01	0.002	Outer Mine Area	Volcanics / Coomber Formation
Layer 7				
71	0.0006	0.0001	Whole Model	Ordovician Basement
Layer 8				
81	0.0005	0.0001	Whole Model	Ordovician Basement

Figure 21 shows the match between simulated heads (groundwater levels) in the calibrated steady state model and observed heads for all model targets. **Figure 22** shows the match between simulated heads (groundwater levels) in the calibrated steady state model and the model targets for the Bowdens Silver monitoring bored. Qualitative assessment of the degree of calibration can be determined by the match between modelled and observed heads that are shown on **Figure 21 and Figure 22**. This is determined according to how close the plotted points are to the diagonal line from the origin (i.e. along the line y=x that represents perfect calibration). As shown on **Figure 21 and Figure 22** there is a good correlation between simulated and observed heads (groundwater levels) in the calibrated steady state model.

Figure 21 Steady State Model Calibration – Modelled vs Observed Heads (m AHD) (all model targets)

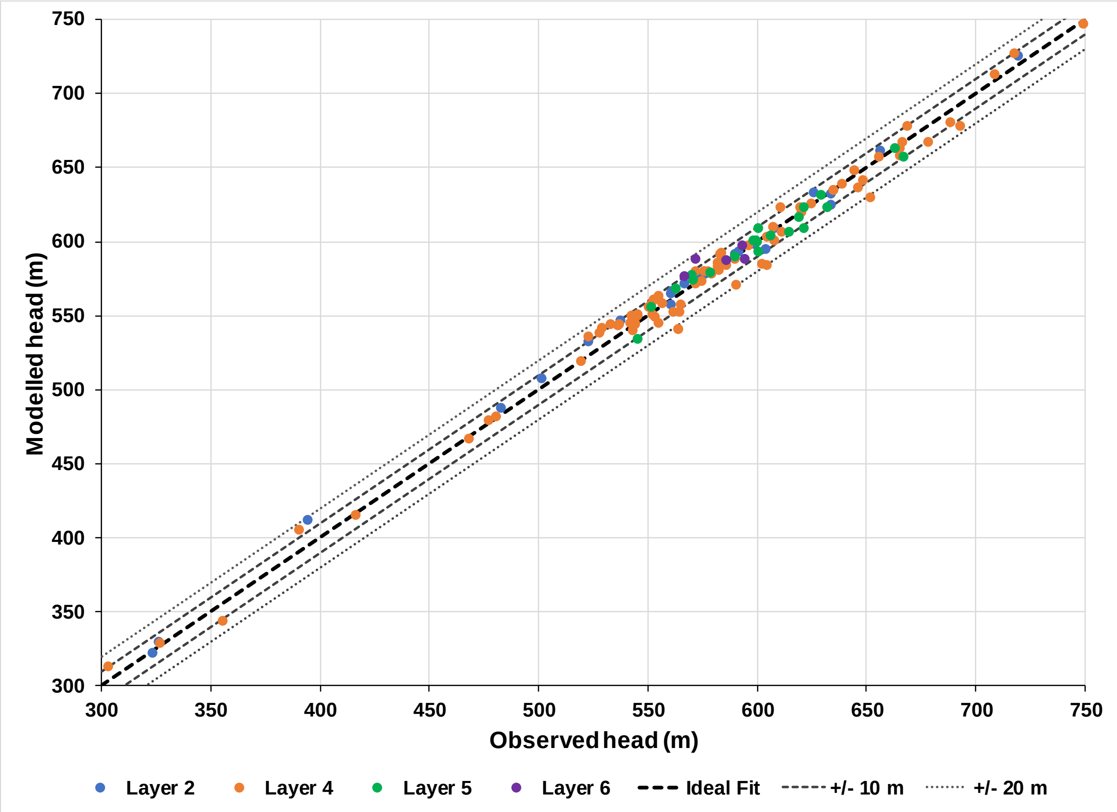


Figure 22 Steady State Model Calibration – Modelled vs Observed Heads (m AHD) (Bowdens Silver model targets)

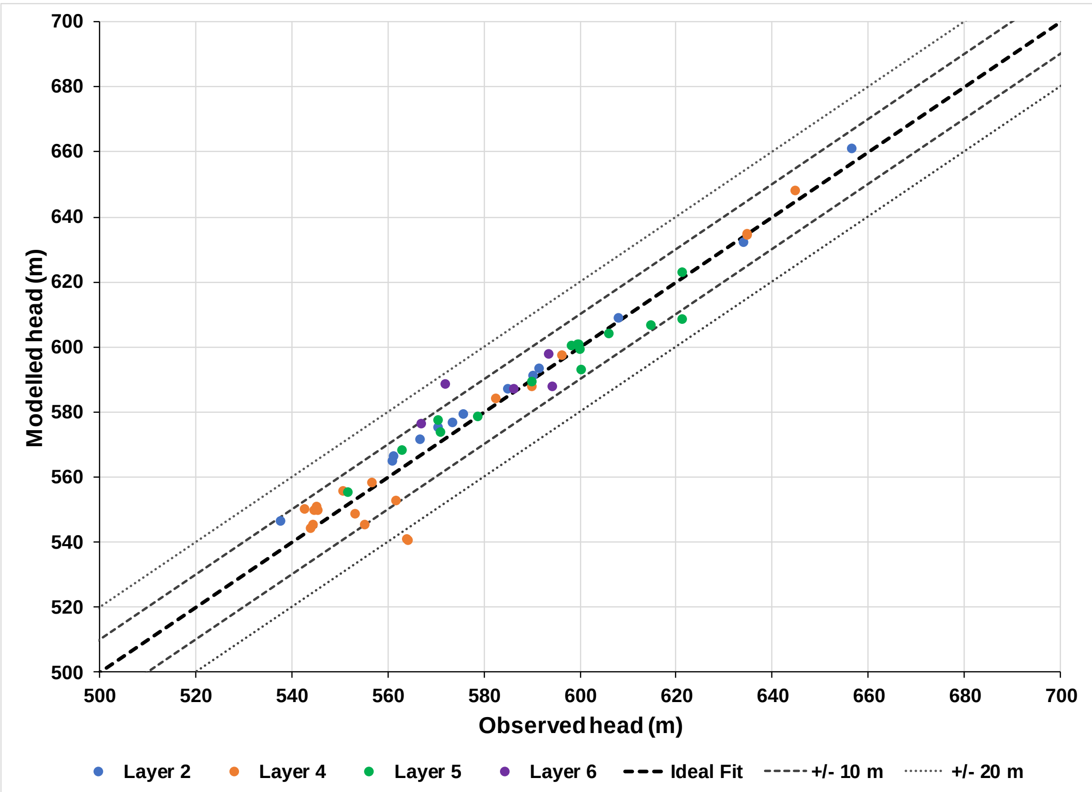


Table 10 presents a summary of the calibration statistics for the calibrated steady state model. For calibration of groundwater models, one of the key performance measures is the correlation between observed and simulated heads (groundwater levels) in terms of absolute levels, with the difference in observed and simulated heads termed the residual. The residual is the difference between the simulated and observed head (groundwater level). The scaled root mean square (scaled RMS) of the residual is a statistic often used to quantitatively assess the goodness-of-fit (i.e. calibration) between simulated and observed heads (groundwater levels). A scaled RMS error that is less than ten per cent usually indicates a reasonably high degree of model calibration. The scaled RMS error of 1.7% obtained for the calibrated steady state model (**Table 10**) identifies that the model is well calibrated to measured heads. **Figure 23** shows the residual for calibration targets in each model layer.

Table 10
Calibration Statistics for Steady State Model

Statistical Parameters	**Value**
Residual Mean	0.02 m
Residual Standard Deviation	7.74 m
Absolute Residual Mean	5.73 m
Residual Sum of Squares	8 090
RMS Error	7.74 m
Minimum Residual	-17.22 m
Maximum Residual	23.93 m
Range of Observation	446.08 m
Scaled Residual Standard Deviation	0.017 m
Scaled Absolute Mean	0.013 m
Scaled RMS	1.7%
Number of Observations	135

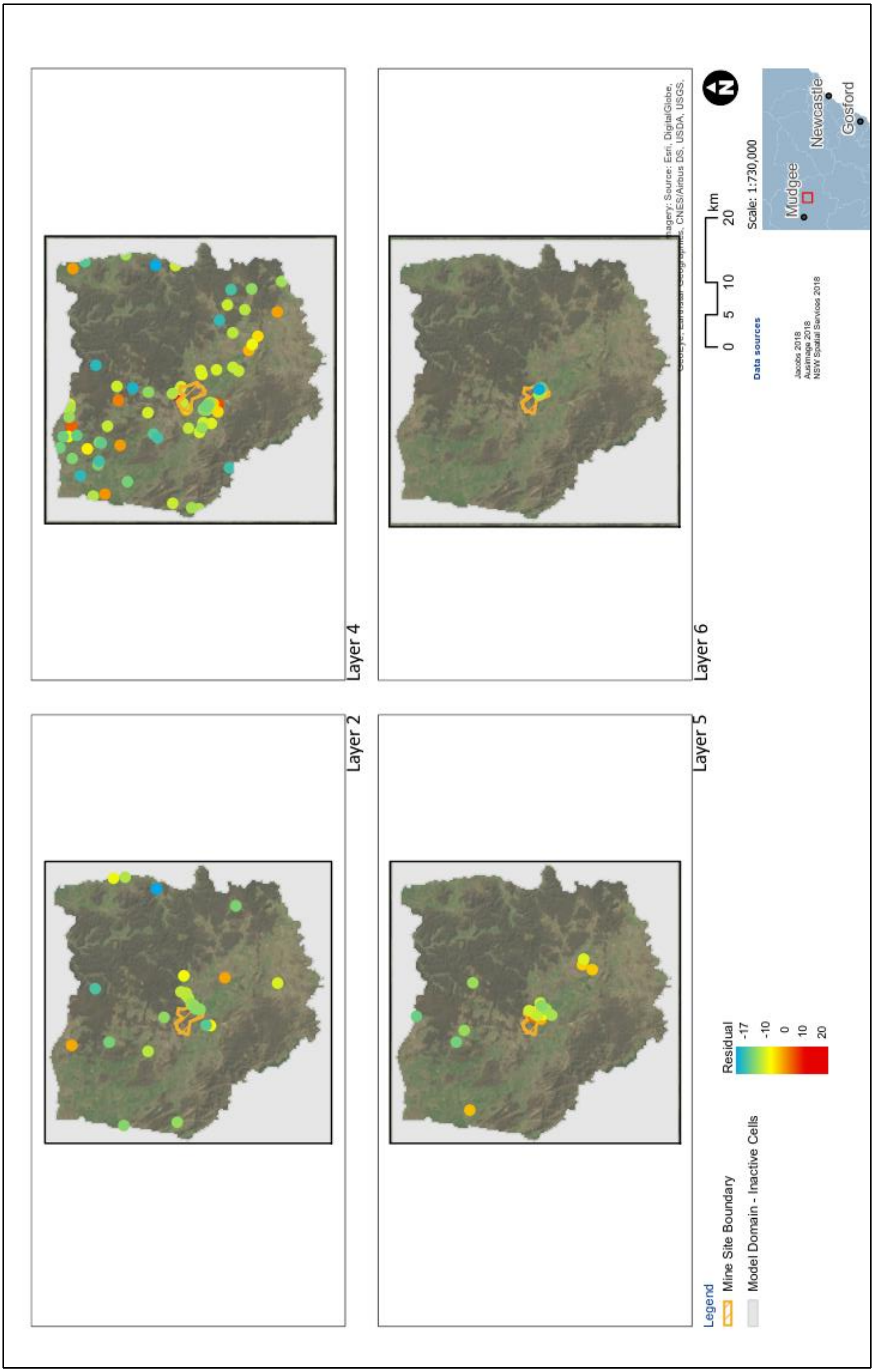
Given the good match between simulated and observed heads (groundwater levels) in **Figure 21** and the acceptable calibration statistics (**Table 10**) it was concluded that the calibrated steady state model simulates observed heads (groundwater levels) with reasonably high degree of accuracy.

4.2 SENSITIVITY ANALYSIS – STEADY STATE MODEL

Following calibration of the steady state model, automated sensitivity analysis was undertaken using PEST-HP (Watermark Numerical Computing, 2018) to identify those parameters with the greatest and/or least influence on calibration. The sensitivity analysis undertaken for the steady state calibration model assessed the effect of changing hydraulic conductivity and recharge values on the objective function. The objective function is a measure of the level of agreement between observed water levels and model-simulated values.

Parameter sensitivities were calculated using the PEST-HP automated parameter estimation process. This process systematically varies each of the adjustable parameters (e.g. hydraulic conductivity and recharge), one at a time and then re-runs the model to establish the change in the objective function. PEST-HP then calculates a “composite sensitivity” for each parameter at the end of each model run.

Figure 23 Calibration Residual Maps



To calculate the composite sensitivity, the groundwater model is run a minimum number of times where the number of runs is generally equal to or greater than the number of adjustable parameters during each PEST-HP optimisation iteration. PEST-HP then calculates a Jacobian matrix for each optimisation iteration. Based on the contents of this Jacobian matrix, PEST-HP calculates the composite sensitivity for each parameter (Watermark Numerical Computing, 2018).

The horizontal hydraulic conductivity (Kh) and recharge parameters assessed during the sensitivity analysis for the various model layer zones (refer **Table 8**) are provided in **Table 11** and **Table 12** respectively. Estimates of vertical hydraulic conductivity were not undertaken as this parameter was set as a factor of the horizontal hydraulic conductivity. This meant that whilst only horizontal hydraulic conductivity values were estimated using PEST-HP, it was accompanied by the subsequent scaling of vertical hydraulic conductivity values.

Table 11
Horizontal Hydraulic Conductivity Parameter Zones Assessed during Sensitivity Analysis

Hydraulic conductivity zone	Calibrated hydraulic conductivity (m/day)	Range (m/day)		Composite sensitivity
		Minimum	Maximum	
11	2.05	$2.05x10^{-1}$	20.5	0
12	$9.8x10^{-2}$	$9.\ 8x10^{-3}$	$9.\ 8x10^{-1}$	$1.2x10^{-2}$
13	$1.0x10^{-1}$	$1.0x10^{-2}$	1.00	$4.0x10^{-11}$
21	3.00	$3.0x10^{-1}$	30.0	0
22	$5.0x10^{-2}$	$5.0x10^{-3}$	$5.x10^{-1}$	$4.0x10^{-11}$
23	$2.5x10^{-1}$	$2.5x10^{-1}$	2.50	0
31	$8.9x10^{-1}$	$8.9x10^{-2}$	8.90	$3.6x10^{-11}$
32	$5.7x10^{-1}$	$5.7x10^{-2}$	5.70	0
33	$8.7x10^{-1}$	$8.7x10^{-2}$	8.70	$3.7x10^{-11}$
41	$3.0x10^{-3}$	$3.0x10^{-4}$	$3.0x10^{-2}$	$4.2x10^{-11}$
42	$3.0x10^{-3}$	$3.0x10^{-4}$	$3.0x10^{-2}$	$4.2x10^{-11}$
45	$6.0x10^{-2}$	$6.0x10^{-3}$	$6.0x10^{-1}$	0
46	$1.0x10^{-1}$	$1.0x10^{-2}$	1.00	$4.0x10^{-11}$
51	$2.1x10^{-3}$	$2.1x10^{-4}$	$2.1x10^{-2}$	2885
52	$2.1x10^{-3}$	$2.1x10^{-4}$	$2.1x10^{-2}$	$5.8x10^{-11}$
53	$2.0x10^{-2}$	$2.0x10^{-4}$	$2.0x10^{-2}$	0
55	$2.0x10^{-1}$	$2.0x10^{-1}$	2.00	$4.0x10^{-11}$
61	$2.3x10^{-4}$	$2.3x10^{-5}$	$2.3x10^{-3}$	$3.4x10^{-11}$
63	$1.0x10^{-2}$	$1.0x10^{-3}$	$1.0x10^{-1}$	0
71	$6.0x10^{-4}$	$6.0x10^{-5}$	$6.0x10^{-3}$	$5.2x10^{-11}$
81	$5.0x10^{-4}$	$5.0x10^{-5}$	$5.0x10^{-3}$	0

Table 11 presents the composite sensitivity values for horizontal hydraulic conductivity according to the model layer zone. The most sensitive model layer zone for horizontal hydraulic conductivity was zone 51 (Layer 5), which is the zone representing the Rylstone Volcanics and Ordovician Basement hydrostratigraphic units located to the west of the Mine Site. This zone's composite sensitivity of 2 885 is several orders of magnitude higher than the next most sensitive

model layer zone (12, Layer 1) that represents the clayey silt regolith material in hilly areas. The composite sensitivity values for all the other hydraulic conductivity zones were either zero or near zero. A composite sensitivity of zero indicates that changing the parameter value neither degrades nor improves calibration (i.e. the objective function is unaffected).

Based on the sensitivity analysis undertaken on the steady state model it was concluded that, with the exception of zones 12 and 51, further refinement of hydraulic conductivity via an extended calibration would not provide any meaningful improvement in model reliability. This was due to the parameters being relatively insensitive to variation. Moreover, doing so could lead to assigning physically unrealistic values to the parameters to match simulated heads (groundwater levels) with observed heads.

Table 12 presents composite sensitivity values for the recharge zones presented in **Table 5** and shown on **Figure 13**. The most sensitive recharge zones were 32 and 34. The composite sensitivities for these two zones (approximately 2,885) were several orders of magnitude higher than those of the remaining recharge zones. Recharge zones 1, 2, 3, 7, 14, 21, 31, with composite sensitivities of zero, represent insensitivity recharge value variation from that of the calibrated model. It is noted that zones 32 and 34 are located a significant distance to the north of the Mine Site and are associated with Sydney Basin sediments. While calibration is shown to be sensitive to these recharge parameters, they will have little influence on the outcomes of modelling at the Mine Site.

Table 12
Recharge Zones Assessed during Sensitivity Analysis

Recharge Zone	Calibrated Recharge Factor	Range Assessed		Composite sensitivity
		Minimum	Maximum	
1	0.12	0.06	0.24	0
2	0.02	0.01	0.04	0
3	0.04	0.02	0.08	0
4	0.03	0.01	0.05	4.2×10^{-11}
7	0.12	0.06	0.24	0
11	1.00	0.50	2.00	3.5×10^{-11}
12	0.12	0.06	0.24	3.4×10^{-11}
14	0.06	0.03	0.12	0
21	0.12	0.06	0.24	0
22	0.25	0.13	0.50	4.4×10^{-11}
24	0.04	0.02	0.08	4.5×10^{-11}
31	0.02	0.01	0.04	0
32	0.39	0.20	0.78	2885
34	1.00	0.50	2.00	2885

4.3 WATER BALANCE – STEADY STATE MODEL

Table 13 presents the water balance for the calibrated steady state model. As shown in **Table 13**, groundwater discharge (outflow) along water courses that are represented in the model by DRN and RIV boundary cells account for approximately 52% of total outflows from the steady state model. A further 46% (approximately) of the losses from the groundwater system occur via evapotranspiration with groundwater pumping from wells accounting for the balance (2%) of groundwater losses. **Table 13** also identifies that groundwater recharge contributes approximately 99% of inflows to the groundwater system. The steady state water balance indicates that, on average, the modelled groundwater system predominantly loses water to water courses.

Table 13
Water Balance for Calibrated Steady State Model

Component (Cell Package)	Inflow (m^3/day)	Outflow (m^3/day)
Well (WEL)	0	3,910
River (RIV)	2,746	26,270
Drain (DRN)	0	77,302
Recharge (RCH)	196,648	0
Evapotranspiration (EVT)	0	91,911
Total	199,394	199,394
	Error	0
	Percentage Error	0%

In addition, it is noted that the water balance error of approximately 0% is lower than the suggested 1% upper threshold for a Class 2 groundwater model that is presented in the Australian Groundwater Modelling Guidelines.

4.4 CALIBRATION FOR GROUNDWATER LEVELS – TRANSIENT CONDITIONS

The model was calibrated for the period from 1 January 2011 through to 30 April 2017. The calibration simulation used transient stress periods (monthly), with the exception of the initial stress period that was assumed to be 1 day in duration with the model in steady-state condition. Initial water levels were approximated from the same dataset used for the steady state calibration.

The groundwater level targets for transient model calibration included one-off water levels extracted from the CL&W PINNEENA database, as well as monthly time series water level data collected from the Bowdens Silver groundwater monitoring network. The period of monitoring data used in the calibration ranged from 1 January 2011 through to 30 April 2017.

Hydraulic conductivity values assigned to the calibrated steady state model (**Table 9**) were assigned as initial values in the transient model. Storage parameters (specific yield and specific storage) and, if necessary, hydraulic conductivity values were adjusted manually to obtain a suitable match between observed and simulated heads (groundwater levels).

Similar to steady state calibration, transient model calibration was conducted by iterative manual step-wise adjustment of model input parameters as required to achieve an acceptable match between simulated and observed heads (groundwater levels). Calibration was achieved by visually comparing simulated and observed hydrographs, as well as by assessing the statistical calibration measures.

A reasonable level of calibration for the transient model was achieved using the same hydraulic conductivity values assigned to the calibrated steady state model (**Table 9**) (i.e. transient calibration was attained with no modification to the hydraulic conductivity values utilised for the calibrated steady state model).

During the transient model calibration, storage parameters were adjusted within the range of typical values for the formations occurring within the region. Storage parameters assigned to the respective layer zones in the calibrated transient model are presented in **Table 14**.

Transient model calibration hydrographs showing observed and simulated heads (groundwater levels) for bores located in the vicinity of the open cut pit and TSF area are presented in **Figure 24** and **Figure 25**. Calibration hydrographs for bores to the north and south of the open cut pit area are presented in **Figure 26** and **Figure 27** respectively. Calibration hydrographs for bores in the vicinity of Hawkins Creek and Lue village are presented in **Figure 28** and **Figure 30**, respectively.

Table 14
Calibrated Model Storage Parameter Values

Page 1 of 2

Zone	Ss (m^{-1})	Sy	Locality	Description
Layer 1				
11	$9.0x10^{-4}$	0.11	Valley	Alluvium (Sandy Silt)
12	$9.0x10^{-4}$	0.09	Hills	Regolith (clayey silt with vegetation)
13	$5.0x10^{-5}$	0.02	Outcrop Rock (Local)	Weathered Rock
Layer 2				
21	$7.0x10^{-4}$	0.3	Valley	Alluvium (Silty Sand)
22	$7.0x10^{-4}$	0.04	Hills	Extremely Weathered Rock (silty clay)
23	$5.0x10^{-5}$	0.02	Outcrop Rock (Local)	Weathered Rock
Layer 3				
31	$5.0x10^{-4}$	0.09	Valley	Partially Weathered Rock (weathered rock with stiff clay)
32	$5.0x10^{-4}$	0.09	Hills	Partially Weathered Rock
33	$5.0x10^{-5}$	0.02	Outcrop Rock (Local)	Weathered Rock
Layer 4				
41	$2.0x10^{-5}$	0.01	South West	Ordovician Basement
42	$4.0x10^{-5}$	0.02	North East	Sydney Basin
43	$5.0x10^{-5}$	0.01	Mine Area	Volcanics
45	$5.0x10^{-5}$	0.01	Outer Mine Area	Volcanics / Coomber Formation
Layer 5				
51	$2.0x10^{-5}$	0.01	South West	Volcanics / Ordovician
52	$2.0x10^{-5}$	0.01	North East	Sydney Basin
53	$2.0x10^{-5}$	0.01	Outer Mine Area	Volcanics / Coomber Formation
55	$2.0x10^{-5}$	0.01	Mine Area	Volcanics / Coomber Formation

Table 14 (Cont'd)
Calibrated Model Storage Parameter Values

Page 2 of 2

Zone	Ss (m^{-1})	Sy	Locality	Description
Layer 6				
61	$2.0x10^{-5}$	0.01	Whole Model	Ordovician Basement
63	$2.0x10^{-5}$	0.01	Outer Mine Area	Volcanics / Coomber Formation
Layer 7				
71	$1.0x10^{-5}$	0.01	Whole Model	Ordovician Basement
Layer 8				
81	$8.0x10^{-6}$	0.01	Whole Model	Ordovician Basement

A qualitative assessment of the hydrographs shows a reasonably good match between simulated and observed heads. The simulated peak head elevations were slightly lower than observed peaks as the transient model is formulated with monthly stress periods. High intensity short duration rainfall events therefore cannot be represented explicitly in the model and as a result the simulated peaks are under-predicted. In addition, as an average pumping rate was assigned to extraction wells, the impact of daily and variable pumping cycles cannot be simulated accurately.

Figure 24 Transient Model Calibration Hydrographs (m AHD): Vicinity of Open Cut Pit

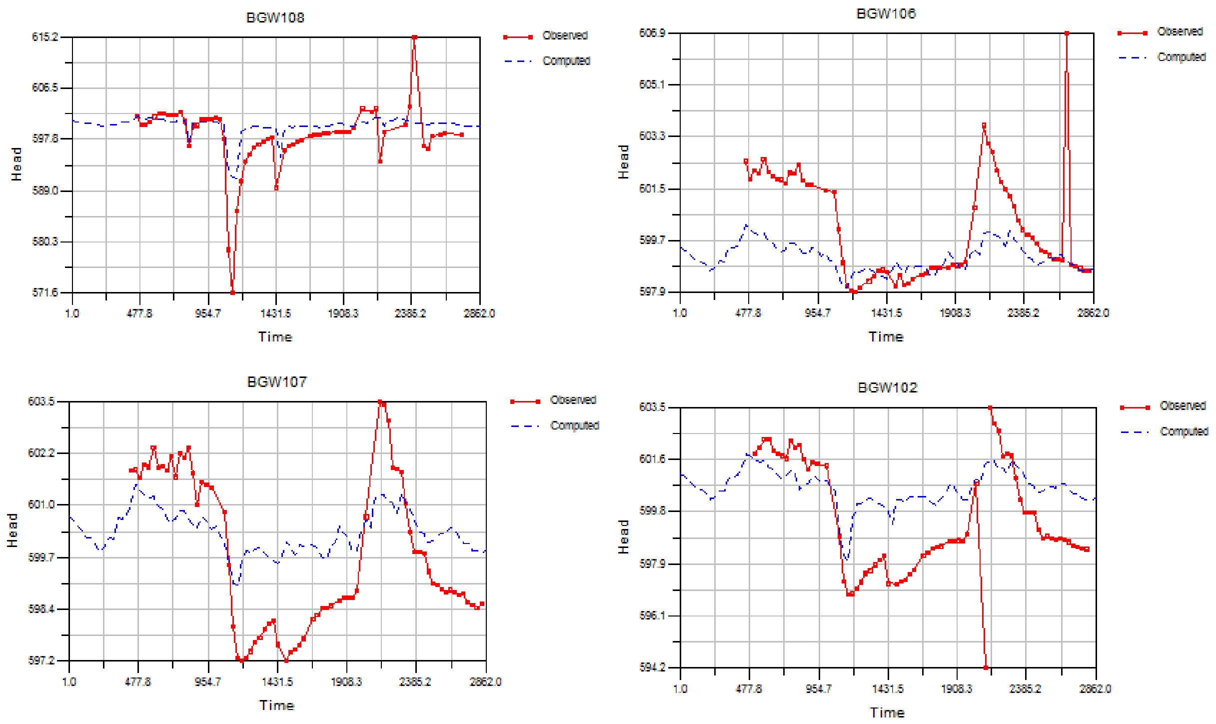


Figure 25 Transient Model Calibration Hydrographs (m AHD): TSF Area

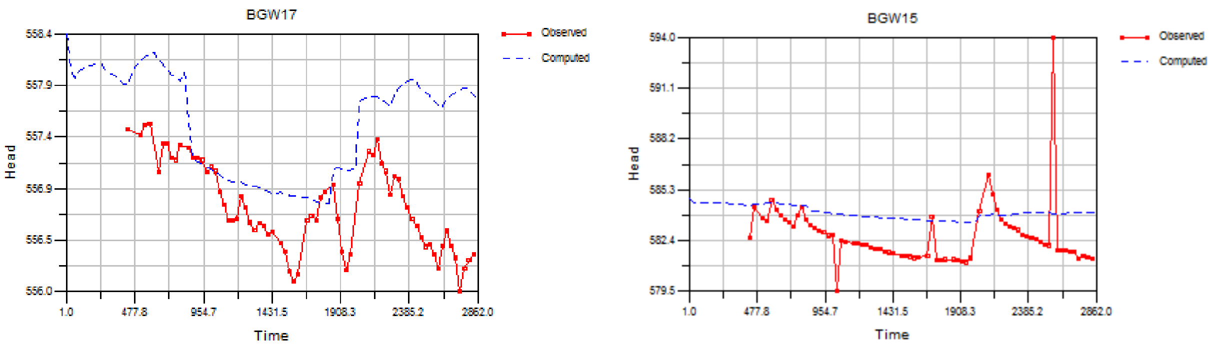


Figure 26 Transient Model Calibration Hydrographs (m AHD): north of the Open Cut Pit

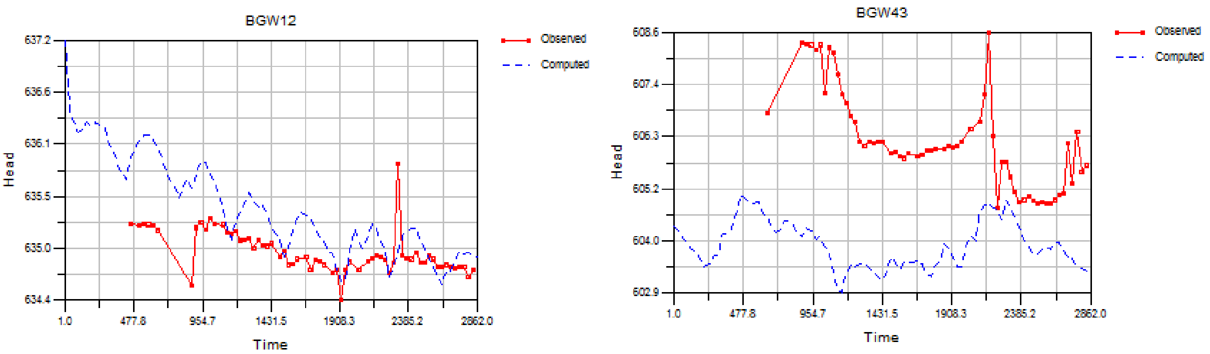


Figure 27 Transient Model Calibration Hydrographs (m AHD): south of the Open Cut Pit

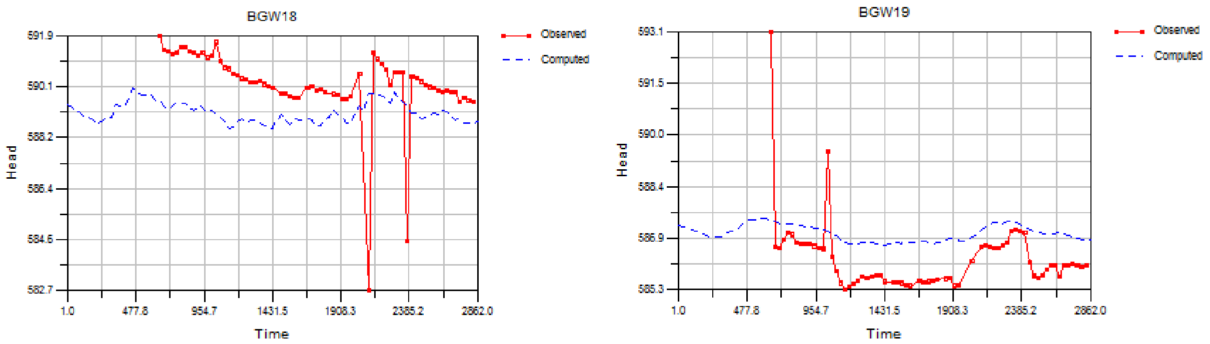


Figure 28 Transient Model Calibration Hydrographs (m AHD): in the vicinity of Hawkins Creek

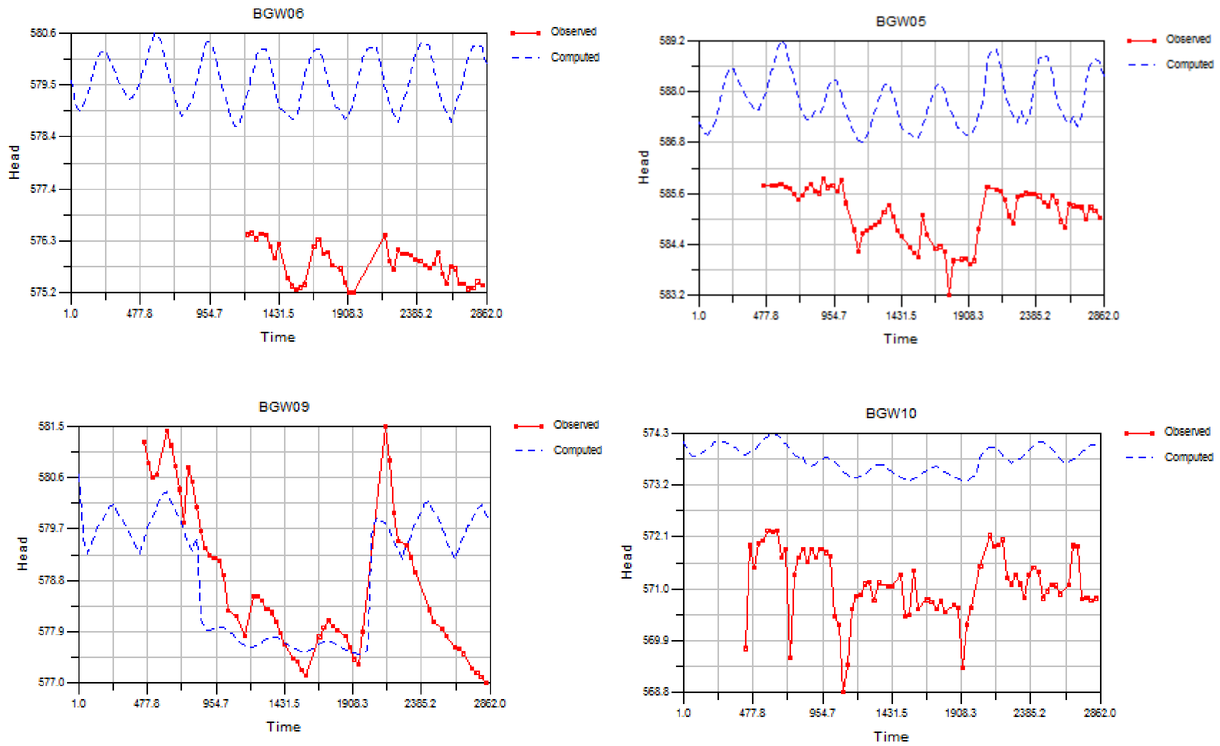
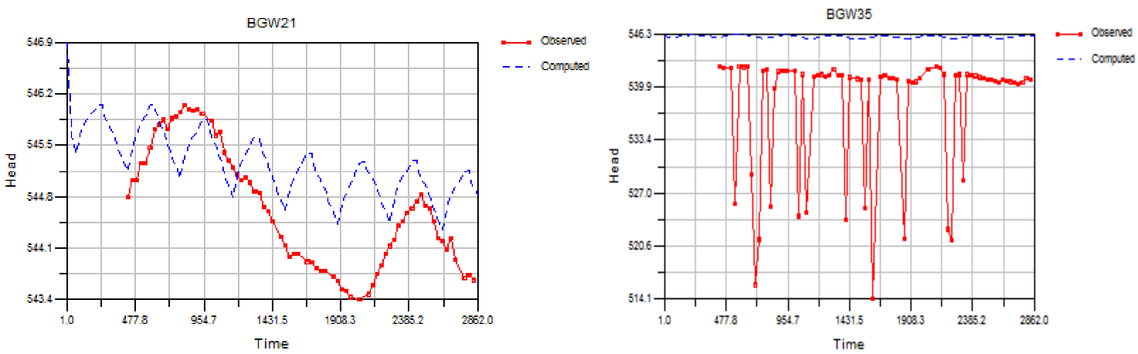


Figure 29 Transient Model Calibration Hydrographs (m AHD): Lue village



The transient model calibration statistics for quantitatively assessing the goodness-of-fit between simulated and observed heads are presented in **Table 15**. The maximum residuals shown are accentuated due to the pumping effect on the extraction wells. As noted above, an average pumping rate was assigned to extraction wells and subsequently the impact of daily and variable pumping cycles could not be simulated accurately.

The calculated residuals for the transient model calibration targets are then treated statistically as described in Section 4.1, in accordance with methods described in the Australian Groundwater Modelling Guidelines (Barnett *et al*. 2012) with the results presented on **Table 15**. Overall, transient model calibration achieved a very good scaled root mean square (RMS) error of 1.4%.

Table 15
Calibration Statistics for Transient Simulation

Statistical Parameters	Value
Residual Mean	-1.68 m
Residual Standard Deviation	4.03 m
Absolute Residual Mean	7.07e+6 m
RMS Error	6.26 m
Minimum Residual	-41.71 m
Maximum Residual	28.74 m
Range of Observation	446.08 m
Scaled Residual Standard Deviation	0.014 m
Scaled Absolute Mean	0.010 m
Scaled RMS	1.4%
Number of Observations	180 361

4.5 WATER BALANCE – TRANSIENT MODEL

The transient model calibration water balance is provided on **Table 16**. Groundwater outflows along water courses, represented in the model by DRN and RIV boundary cells, account for approximately 42% of the outflows from the model. Evapotranspiration also accounts for approximately 42% of the losses from the groundwater system. On average, groundwater pumping from wells accounted for approximately 2% of modelled losses. Groundwater recharge and leakage from rivers respectively contributed approximately 91% and 1% of inflows to the model. The net negative change in groundwater storage indicates a net gain in groundwater storage over the modelled period.

Table 16
Water Balance for Transient Calibrated Model

Component (Cell Package)	Inflow (m^3/day)	Outflow (m^3/day)
Storage	18,389	32,111
Well (WEL)	0	4,975
River (RIV)	2,881	24,693
Drain (DRN)	0	74,363
Recharge (RCH)	212,132	0
Evapotranspiration (EVT)	0	97,260
Total	233,402	233,402
	Error	0
	Percentage Error	0%

The water balance error of approximately 0% is lower than the suggested upper threshold of 1% presented in the Australian Groundwater Modelling Guidelines for a Class 2 groundwater model.

4.6 BASE FLOW CALIBRATION

The transient model was also calibrated for surface water interaction by comparing predicted baseflow in Hawkins Creek to baseflow calculated from measured streamflow data. Streamflow in Hawkins Creek (downstream of the Mine Site) is monitored by a gauge with the results for the calibration period presented in **Figure 30**. The baseflow contribution was calculated from the gauged streamflow data using the method described by Chapman (1999). Chapman's approach utilises the recession constant of the hydrograph, which represents the ratio of the flow to the proceeding flow during a period of no direct runoff. This filter assumes that the baseflow is a weighted average of the quick flow (immediate runoff) and the baseflow at the previous time interval and only requires a single pass through the data. The estimated baseflow component generally remains less than 0.2ML/day with the exception being during periods of peak rainfall runoff.

The estimated and simulated baseflow are presented in **Figure 31**. Similar to the estimated baseflow, the simulated baseflow contributions show a rise and fall with rainfall recharge to the aquifer, in response to rising and falling groundwater levels. The model baseflow value matches well with the calculated value based on measured flows (**Figure 31**).

Figure 30 Measured Discharge at Hawkins Creek (June 2013 to April 2018)

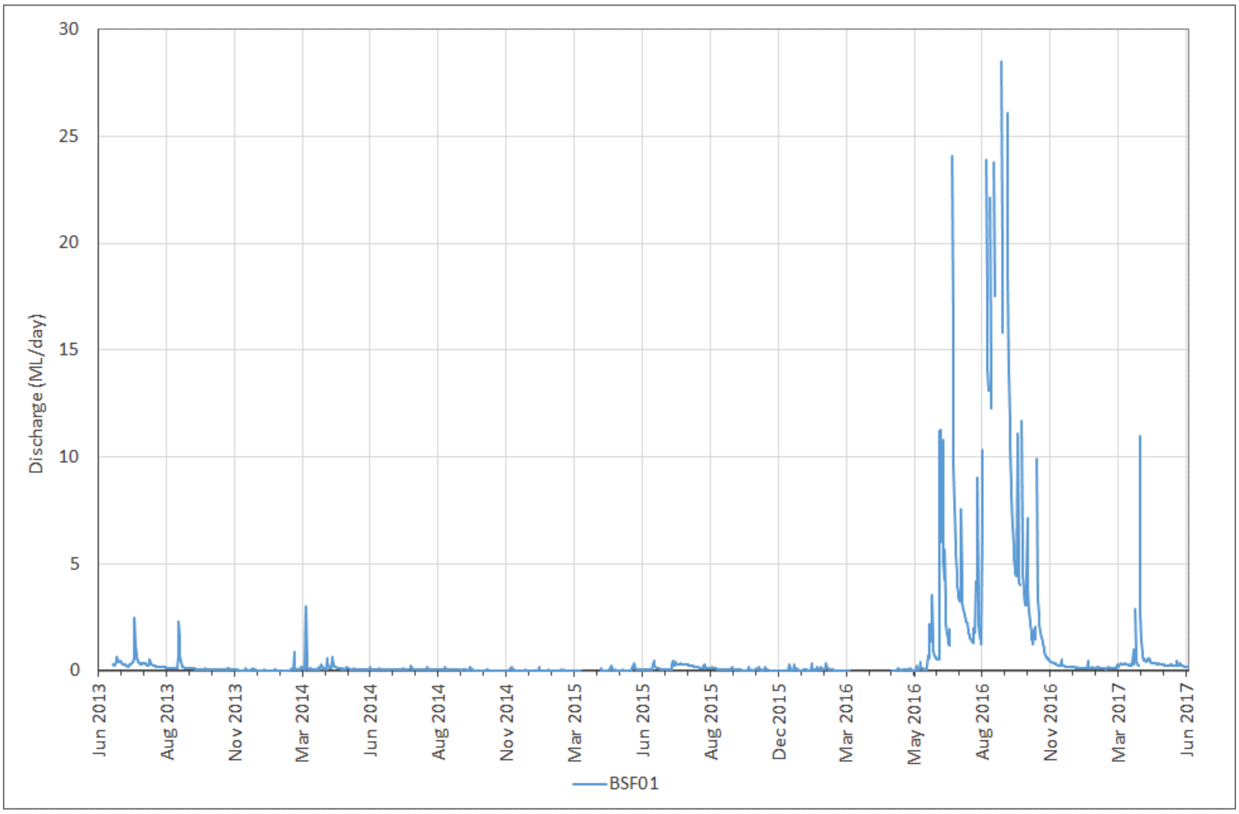
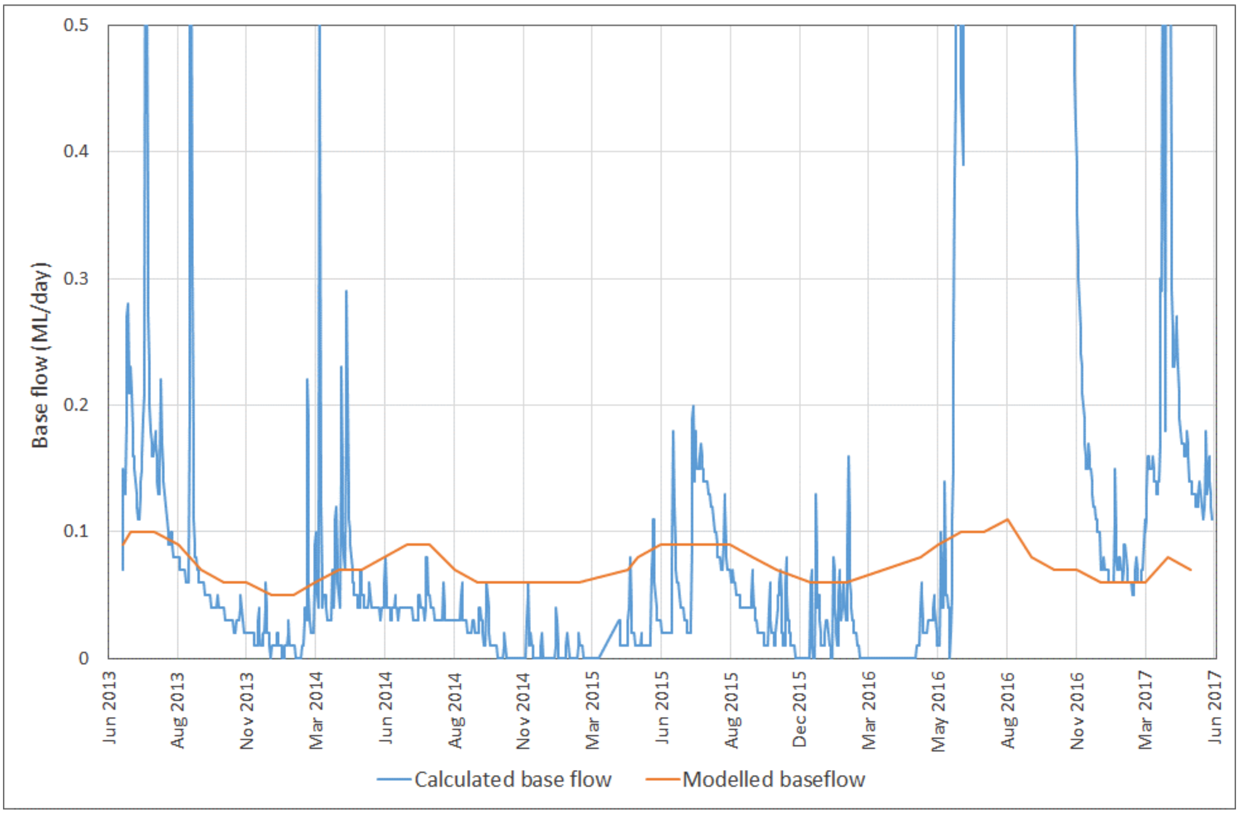


Figure 31 Modelled vs Calculated Baseflow in Hawkins Creek (Calibration Period)



5. PREDICTIVE MODELLING

Following successful calibration of the transient model, two predictive model scenarios were run. One scenario represented the "Null Case" in which no mining takes place, whilst the other represented the "Mining Case", in which the proposed open cut pit development and other associated mine infrastructure is simulated.

The Mining Case scenario included:

- a period of one year (pre-mining);
- a 15.5 year period of proposed mine development; and
- a 100 year period following the cessation of mining (closure).

Groundwater inflows due to open cut pit dewatering are obtained as a direct output from the Mining Case scenario, whereas groundwater impacts due to mining, such as groundwater drawdown or baseflow reduction, are calculated by comparing the Mining Case scenario to the Null Case scenario (for the same period).

5.1 MINING

The Mining Case scenario assumes that mining operations and open cut pit development would occur as summarised in Section 1.2.2.1. This scenario also assumes no future temporal variation in climatic stresses. In this regard, the model assumes average rainfall and evaporation in the future, as estimated from historic climate observations. It is noted that potential future climatic variability was assessed by applying high and low recharge scenarios during the uncertainty analysis that is described in Section 6.

Mine dewatering has been simulated using the MODFLOW DRN cell package. A series of DRN cells were assigned to simulate the removal of groundwater (via sump dewatering) that would flow into the open cut pits as the mine operation advances throughout the life of the Project. These cells are activated in a manner that replicates the mining schedule based on an incremental 6-monthly open cut pit progression. The elevations of these DRN cells were set according to the mining schedule.

For the post mining period, the final void was represented as a region of high hydraulic conductivity with specific yield set to 1.0. These are considered as appropriate settings for the simulation of a void in which water may accumulate.

Rainfall recharge and evaporation were assumed to be active in the final void and these climatic stresses help to predict post-mining final void water levels.

5.2 TAILINGS STORAGE FACILITY

The TSF has been replicated in the regional groundwater model in accordance with the TSF Preliminary Design Report (ATC Williams, 2020) including the staged development of the TSF decant pond.

During mining, the TSF has been simulated by applying higher recharge rates to the area of inundation of the decant pond. Post-mining, per the Project's closure and rehabilitation strategy, it was assumed that the TSF would be capped to reduce recharge and minimise seepage, and subsequently a reduced rate of recharge was applied over the TSF area for this period. Nominal rainfall recharge is applied to the TSF areas outside of the decant pond area.

Adopted recharge rates for the TSF decant pond during mining are provided in **Table 17**. A seepage rate of $1.56x10^{-8}m^3/s/m^2$ ($1.3x10^{-3}$m/day) considering a 20m thick tailings profile (ATC Williams, 2020) was applied over the entire ponded area for each stage.

Table 17
Recharge Rate within TSF Decant Pond

Predictive modelling (Mine schedule)	Recharge applied (m/day)	Comments
Pre-mining (Year 0-1)	$9.55x10^{-5}$	Average climatic condition
Mining (Years 1-2)	$9.55x10^{-5}$	Average climatic condition
Mining (Years 2 -15.5)	$1.3x10^{-3}$	Elevated recharge due to TSF ponding

A low permeability grout curtain is proposed beneath the TSF embankment to mitigate against potential seepage. The grout curtain was simulated using the Wall horizontal flow boundary (HFB) package in layers 1, 2 and 3 of the model beneath the TSF embankment in accordance with ATC Williams (2020) TSF design. The HFB was assigned a wall thickness of 25m and a hydraulic conductivity of 0.00864m/day ($1 x 10^{-7}$m/s).

It is noted that more detailed modelling of the TSF and potential seepage has been undertaken and is presented in Jacobs (2021).

5.3 POST-MINING

Post mining, when active dewatering is discontinued, groundwater levels in the vicinity of the open cut pit would rebound, resulting in the net inflow of groundwater to the open cut pit.

Two post-mining model variants (Recovery Model A and Recovery Model B) were used to assess groundwater recovery in the final void and the surrounding groundwater system.

Recovery Model A was used to assess the water level recovery rate in the Mine Void Model and the time taken to reach equilibrium between the total groundwater inflows towards, and the final losses (outflows) from, the final void. Recovery Model A was also used to predict the maximum extent of the post-mining cone of depression (groundwater drawdown). The assumptions applied to Recovery Model A were as follows:

- Hydraulic conductivity of 1 000m/day, which represents very high conductivity consistent with a void filled with water. The assumption ensures there are no substantial head gradients within the void.
- Specific storage in the final void area was set to equal $5x10^{-6}$m to match the compressibility of water where the pit lake climbs through a number of model layers. The specific yield in the final void area was set to 1.
- Rainfall was assumed to accumulate in the void at a rate equivalent to 100% of the mean annual rainfall.

- In the final void area, a maximum evaporation rate of 4.15mm/day was applied when the water table/void water level was above the EVT surface. This maximum evaporation rate is equivalent to the mean daily evaporation from the SILO data. The EVT surface was assigned as the top elevation of the highest active model cell in a given column. An extinction depth of 55m was applied based on an iterative process of matching simulated evaporation volumes to analytically calculated evaporation volumes.

Recovery Model B was used to assess the impact of final void water level on long-term groundwater levels in areas surrounding the final void. MODFLOW Constant Head Boundary conditions of 574.5m AHD were applied to model cells within the final void area for the entire duration of the post mining model. The water level assigned to the constant head boundary cells was based on the final void post-mining recovery water level that was predicted from the post mining water balance model (WRM, 2020).

The aim of simulating the final void water level using constant head conditions was to assess the impact of final void water level on long-term groundwater levels in areas surrounding the final void.

For both models, groundwater conditions at the TSF were represented by gradually reducing the recharge rate over the TSF to simulate the recharge rate reduction that would occur over time due to capping of the TSF. A very low recharge rate was therefore applied to the TSF following six years post closure. The recharge rates adopted for the TSF are provided on **Table 18**.

A lower recharge rate ($1.15x10^{-7}$m/day) was also applied in the post mining period to the WRE that would be located at the eastern side of the open cut pit. This was undertaken on the basis of the preliminary WRE design whereby it would be lined during its development and capped during progressive rehabilitation and closure (Advisian, 2020a).

Table 18
Recharge rate within TSF Area (post mining)

Predictive Modelling (Mine schedule)	Recharge Applied (m/day) in the Decant Pond Area of the Model	Comments
Post-mining (1-2 years)	$1.3x10^{-3}$	Higher recharge due to TSF ponding
Post-mining (2 to 6 years)	$1.3x10^{-4}$	Capped and draining
Post-mining (6-200 years)	$1.3x10^{-6}$	Fully drained

5.4 MODEL RESULTS

5.4.1 Mine Dewatering

Predicted mine inflows to the open cut pit are provided on **Figure 32** with predicted annual dewatering volumes provided on **Figure 33**.

Figure 32 provides both the raw DRN cell output (Modelled Inflows) and a smoothed inflow which is considered more representative of likely inflow rates. This is because the direct DRN cell output displays large spiked inflow events that are an artefact of the incremental six-monthly open cut pit shells (blocks) being implemented in the model. As each 6-month block is extracted (via DRN cells replicating the base elevation of the block), inflows spike as the surrounding groundwater system equilibrates with the newly imposed DRN cell elevation. However, in reality mining would advance at a relatively steady rate that would result in a more gradual (smooth) increase in inflows, as represented by the smoothed inflow curve.

Figure 32 Predicted Raw and Smoothed Inflows to the Open Cut Pit

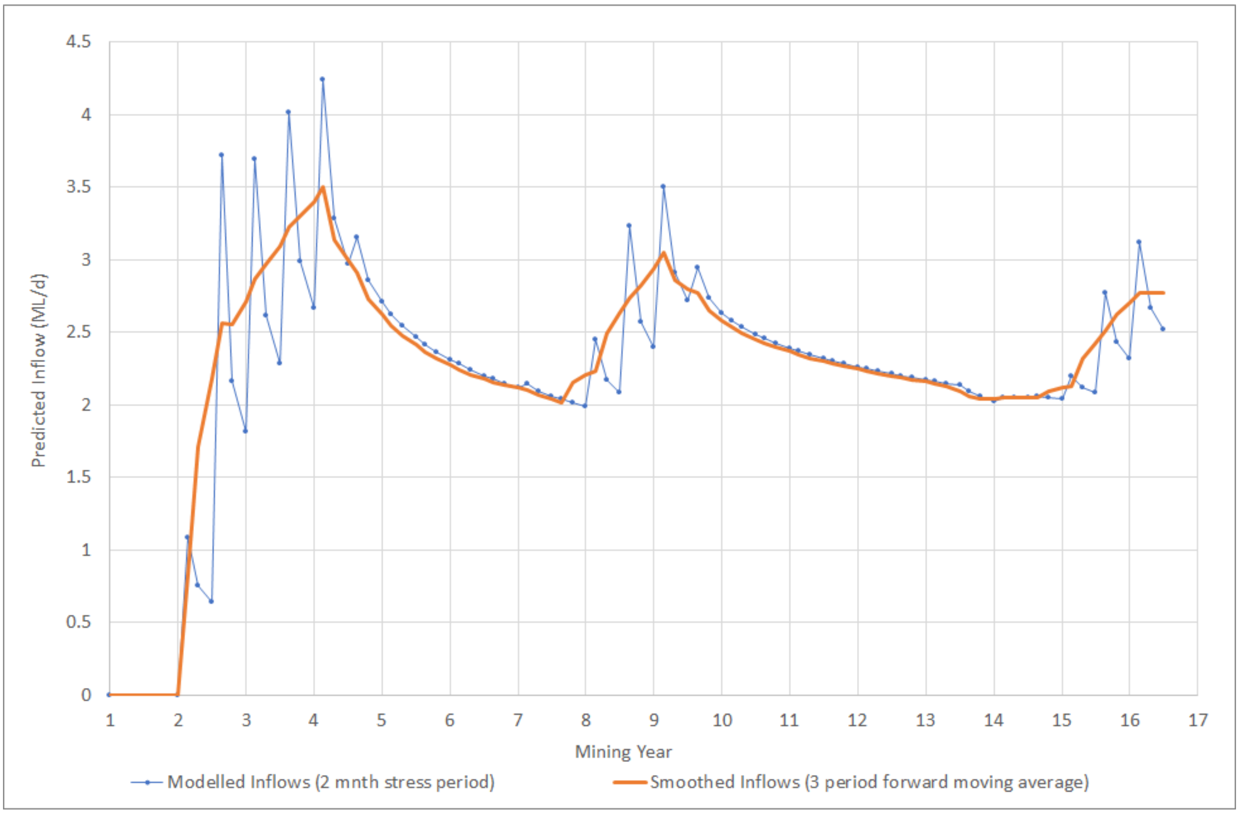
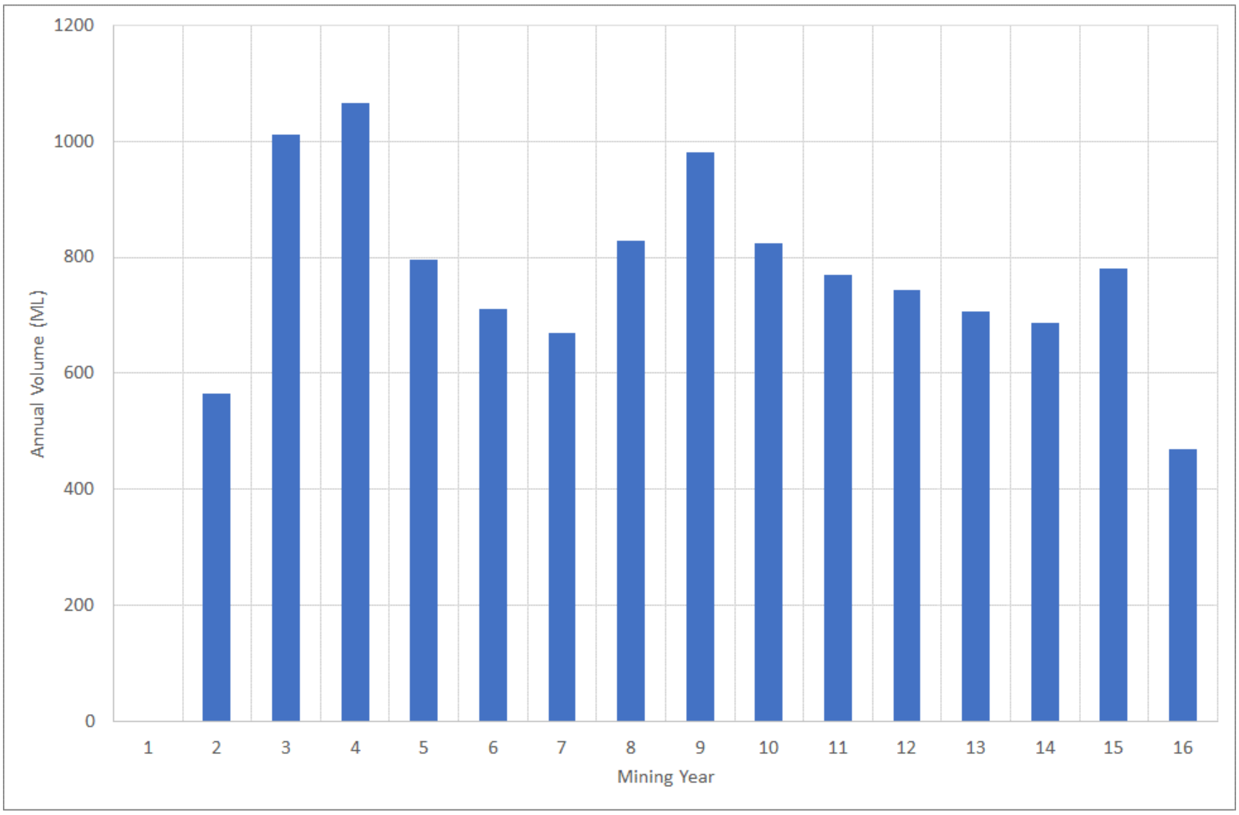


Figure 33 Predicted Annual Dewatering Volumes



Once mining advances below the water table during the second year of mining, dewatering requirements steadily increase until the open cut pit reaches a depth of 525m AHD at the end of Year 4, with average inflows of the order of 3.5ML/day.

Dewatering rates then drop off as cut backs expand the open cut pit at higher elevations. Inflows start to increase again as mining advances below 525m AHD during Year 7, peaking at approximately 3ML/day as the open cut pit reaches its maximum depth of 456m AHD at the end of Year 9.

Subsequent open cut pit development is initially a westward expansion at shallower depths, resulting in diminishing dewatering requirements until Year 15. In the last year and a half of mining, dewatering requirements are predicted to increase again as the eastern pit advances towards its final depth of 460m AHD.

Average inflows over the life of mining are of the order of 2.4ML/day. The satellite open cut pit stages do not significantly influence overall mine dewatering requirements as these are either typically above the water table of have been already dewatered by the main pit development prior to being mined.

Annualised dewatering volumes (January to December) are provided on **Figure 33**. Rapid vertical advancement of the open cut pit means that the dewatering requirements increase rapidly once mining proceeds below the water table. The peak annual dewatering requirement is during Year 4 with a predicted annual volume of approximately 1 066ML. The average annual dewatering requirement, once dewatering commences, is approximately 774ML.

It is noted that as dewatering will be achieved via pumping from sumps within the open cut pit, there is potential for significant evaporative losses as groundwater seeps from exposed faces or is directed around active work areas towards the dewatering sumps. While these evaporative losses cannot be readily quantified, there is potential that the volume of active dewatering required, may be somewhat less than the predicted dewatering requirement.

5.4.2 Groundwater Drawdown

The inflow of groundwater to the open cut pit over the duration of mining would result in the drawdown of groundwater levels in the formations surrounding the open cut pit area. Predicted drawdown at the end of Year 9 and at the completion of mining in Stage 6 (15.5 years) are shown in **Figure 34** and **Figure 35** respectively.

The extent of this drawdown is noted to extend to Hawkins Creek, with predicted drawdown of the order of 1 to 2m over a 1.9km section of the creek at the end of Year 9 (**Figure 34**). At the end of mining this drawdown, typically of the order of 2m would extend over a 2.8km section of the creek (**Figure 35**).

Figure 36 shows a section though the open cut pit, TSF and groundwater level after Year 9 (black line) and Year 15.5 (blue line). As mining has reached its maximum depth by the end of Year 9, there is only a minor difference in groundwater levels between this year and Year 15.5.

At the end of mining, the propagation of predicted groundwater drawdown as represented by the 1m drawdown contour is typically in the order of 1.5km to the east and south, 2km to the west and 2.2km to the north (refer **Figure 35**). Drawdown to the northwest is attenuated due to mounding beneath the TSF, with maximum mounding of the order of 8m.

Figure 34 Predicted Drawdown at End of Stage 3 (Year 9)

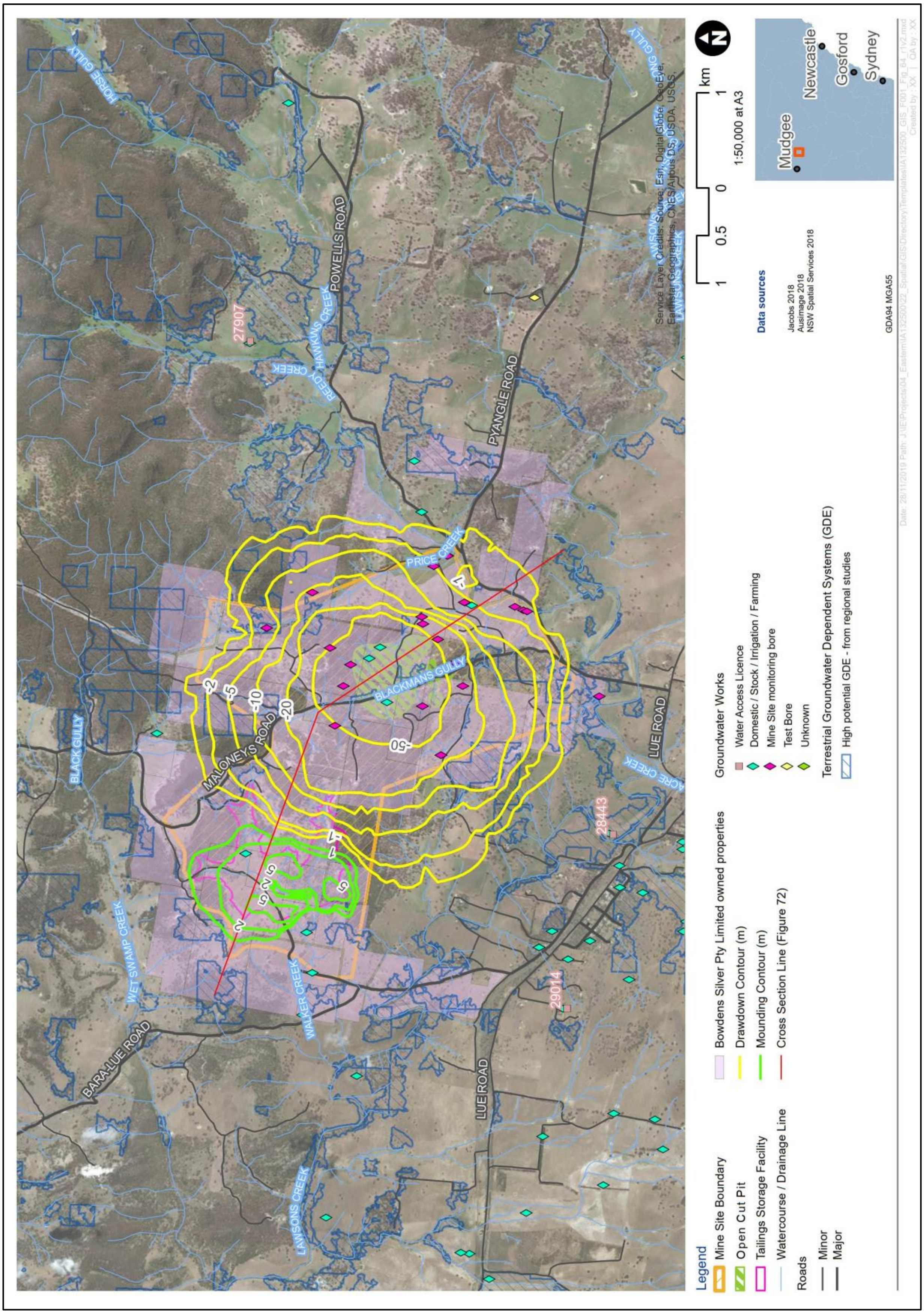


Figure 35 Predicted Drawdown at End of Mining (Year 15.5)

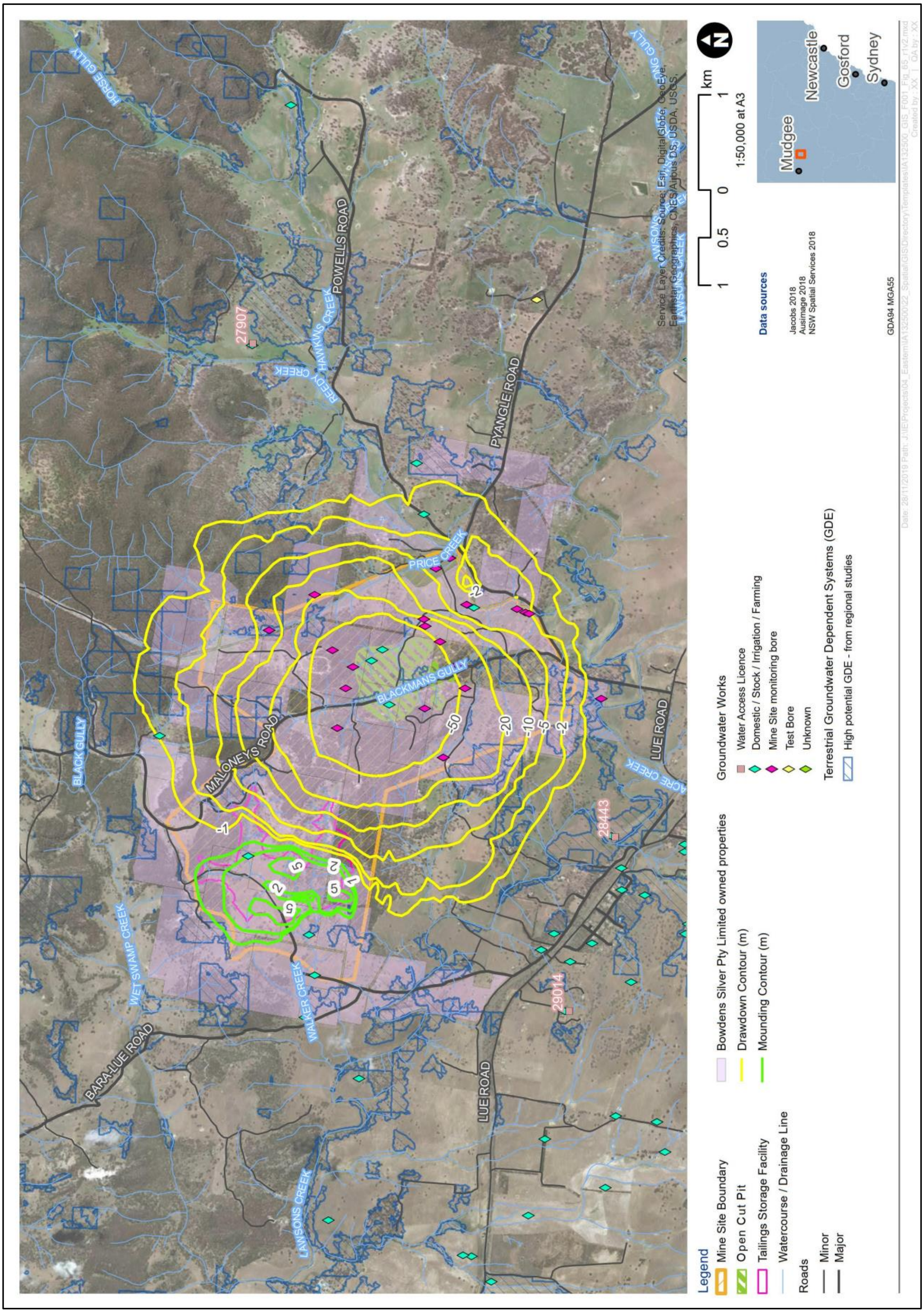
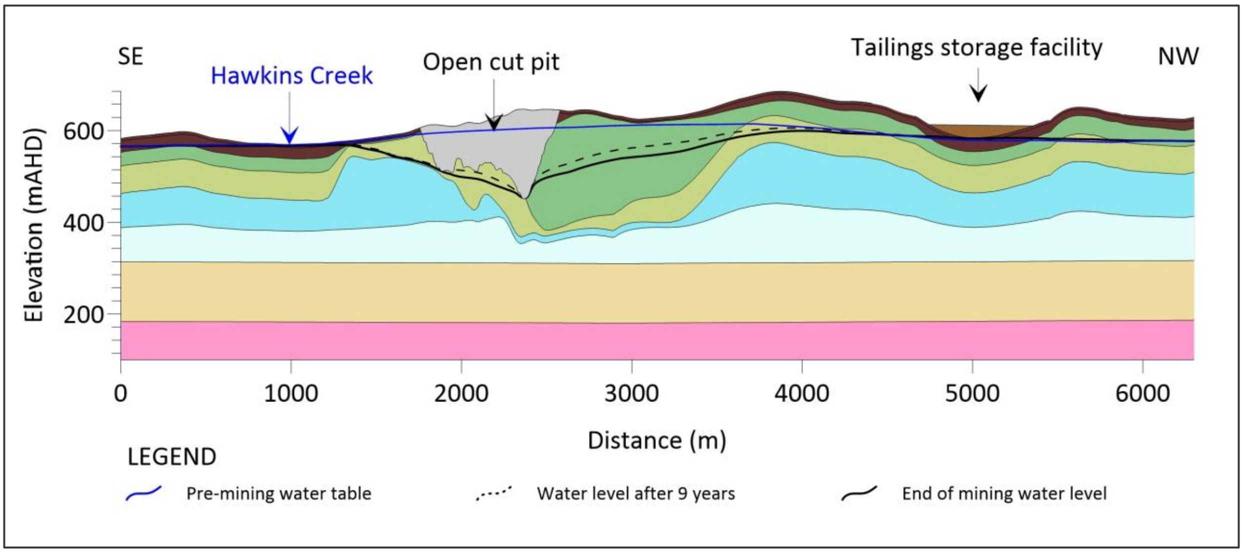


Figure 36 Mine Section and Predicted Groundwater Levels



It is noted that the predictive model is conservative with respect to drawdown within the Sydney Basin sediments that overly the Rylstone Volcanics. In reality, the hydraulic connection between mining related drawdown within the Rylstone Volcanics and Coomber Formation and the Sydney Basin sediments is likely to be limited. This is due to the highly stratified nature of the Sydney Basin sediments and the presence of low permeability siltstone and shale horizons within this unit. Whilst these low permeability layers are not specifically represented in the predictive model, they would inhibit the vertical (downward) migration of groundwater. This would act to isolate the Sydney Basin sediments from any mining induced depressurisation and subsequent drawdown in the underlying Rylstone Volcanics and/or Coomber Formation. Therefore, the drawdown within the Sydney Basin sediments is unlikely to be realised to the full extent predicted.

5.4.3 Tailings Storage Facility

As discussed in Section 5.2 a higher recharge rate was applied in the model to account for the seepage flux from the TSF decant pond. In the vicinity of the TSF, groundwater levels are predicted to rise and form a mound beneath the TSF impoundment area. This groundwater mounding, at the end of Year 9 and Year 15.5 is presented in **Figure 34** and **Figure 35** respectively. A maximum 8m rise was predicted beneath the TSF due to higher recharge from the decant pond. The mounding is not readily apparent in section view on **Figure 36** due to the vertical scale of the section.

A more detailed modelling of the TSF and associated impacts is presented in Annexure 10 of Jacobs (2021).

Groundwater flow in the vicinity of the TSF post-mining is discussed in Section 5.4.5.

5.4.4 Waste Rock Emplacement

As the WRE is to be fully lined and encapsulated, it has not been simulated during mining. In the post mining period, the WRE has been modelled as an area of reduced recharge consistent with preliminary design of the structure (that is, design to maximise runoff and minimise infiltration, refer Advisian [2019a]).

5.4.5 Post Mining Recovery

Results from Recovery Model A indicate that the drawdown cone from the end of mining is initially predicted to expand until equilibrium is reached between the total groundwater inflows towards the open cut pit and the final losses from the open cut pit. The cone of drawdown is predicted to approach its maximum extent 16 years post mining with further minor increases occurring until approximately 50 years after mine closure. Predicted residual drawdown at this time is shown in **Figure 37**.

In the post mining period, mounding beneath the TSF diminishes and the TSF area is encompassed by the cone of drawdown.

Results from Recovery Model A also indicate that drawdown propagation at 50 years post mining, as represented by the predicted 1m drawdown contour, is typically less than 2km to the east and south, up to 3km to the west and 2.5km to the north. Drawdown to the south is largely attenuated by Lawsons Creek. Predicted drawdown at Lawsons Creek is typically less than 1m, with approximately 2m maximum drawdown predicted at Hawkins Creek.

The residual drawdown, as predicted from Recovery Model A at 50 years post mining, is indicative of the long-term residual drawdown representing the predicted post-mining equilibrium with the final void acting as a groundwater sink. Some minor continued recovery is likely before complete dynamic equilibrium is achieved. However, any variations in residual drawdown at greater than 50 years post mining are insignificant with respect to the inherent uncertainty of the model and time span of predictions.

5.4.6 Final Void

Recovery Model A was run for an extended period of up to 200 years post mining to inform the final void water and salt balance undertaken by WRM Water + Environment (WRM, 2020). As the Project's mining activities result in excavations below the regional groundwater level, the model predicts the formation of a pit lake in the final void once mining and active dewatering ceases. A final void recovery scenario was undertaken without fluxes of rainfall or evaporation over the pit area to develop a groundwater inflow vs pit lake elevation relationship. These residual inflows to the mine void were then supplied to WRM Water + Environment for inclusion in the final void water balance (WRM, 2020). **Figure 38** shows the predicted long-term equilibrium water level in the pit lake fluctuating between approximately 571 and 577m AHD after approximately 100 years post mining, with an average elevation of approximately 574.5m AHD. This is approximately 16 to 26m below the pre-mining groundwater level, and 23m below the pit crest spill height of 597m AHD.

The salt balance undertaken for the final void (WRM, 2020) indicates that salts would gradually accumulate within the pit lake due to evaporative concentration. Based on an indicative electrical conductivity of groundwater inflow of 1 420µS/cm, the following pit lake salinities are predicted to develop over time:

- 100 years – 2 000 µS/cm
- 200 years – 2 880 µS/cm
- 300 years – 3 725 µS/cm
- 400 years – 4 375 µS/cm
- 500 years – 5 375 µS/cm

Figure 37 Predicted 50 Year Post Mining Residual Drawdown

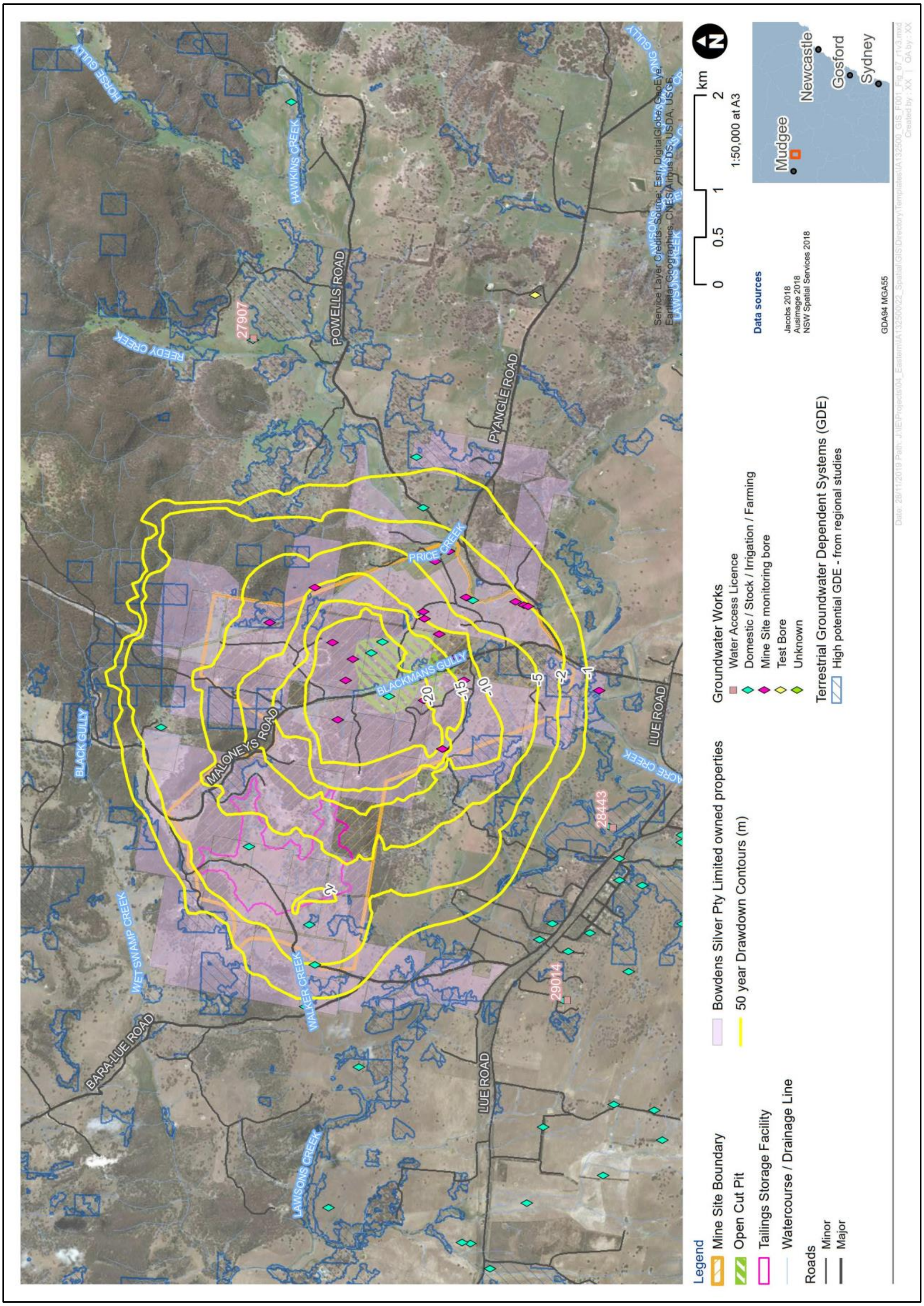
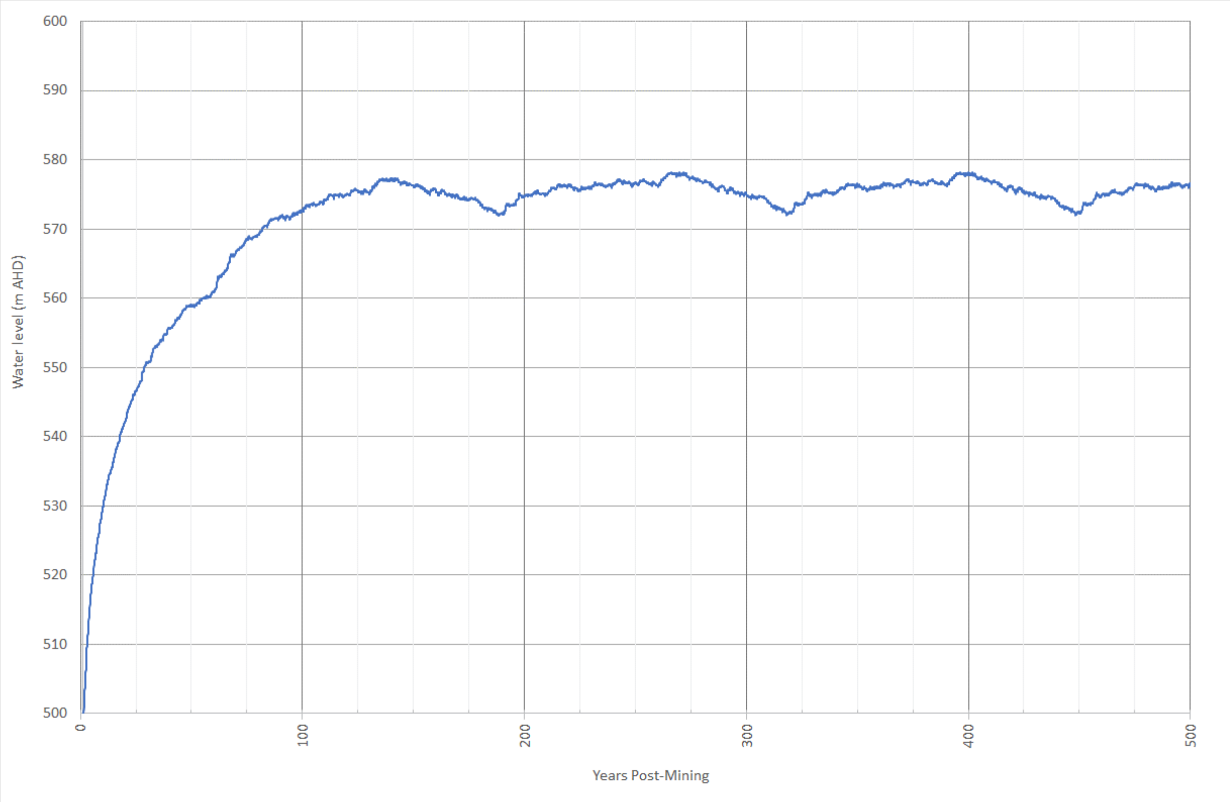


Figure 38 Pit Lake Equilibrium Level



Further detail on the final void water balance, including pit lake water quality is provided in Section 7 of the Surface Water Assessment (WRM, 2020).

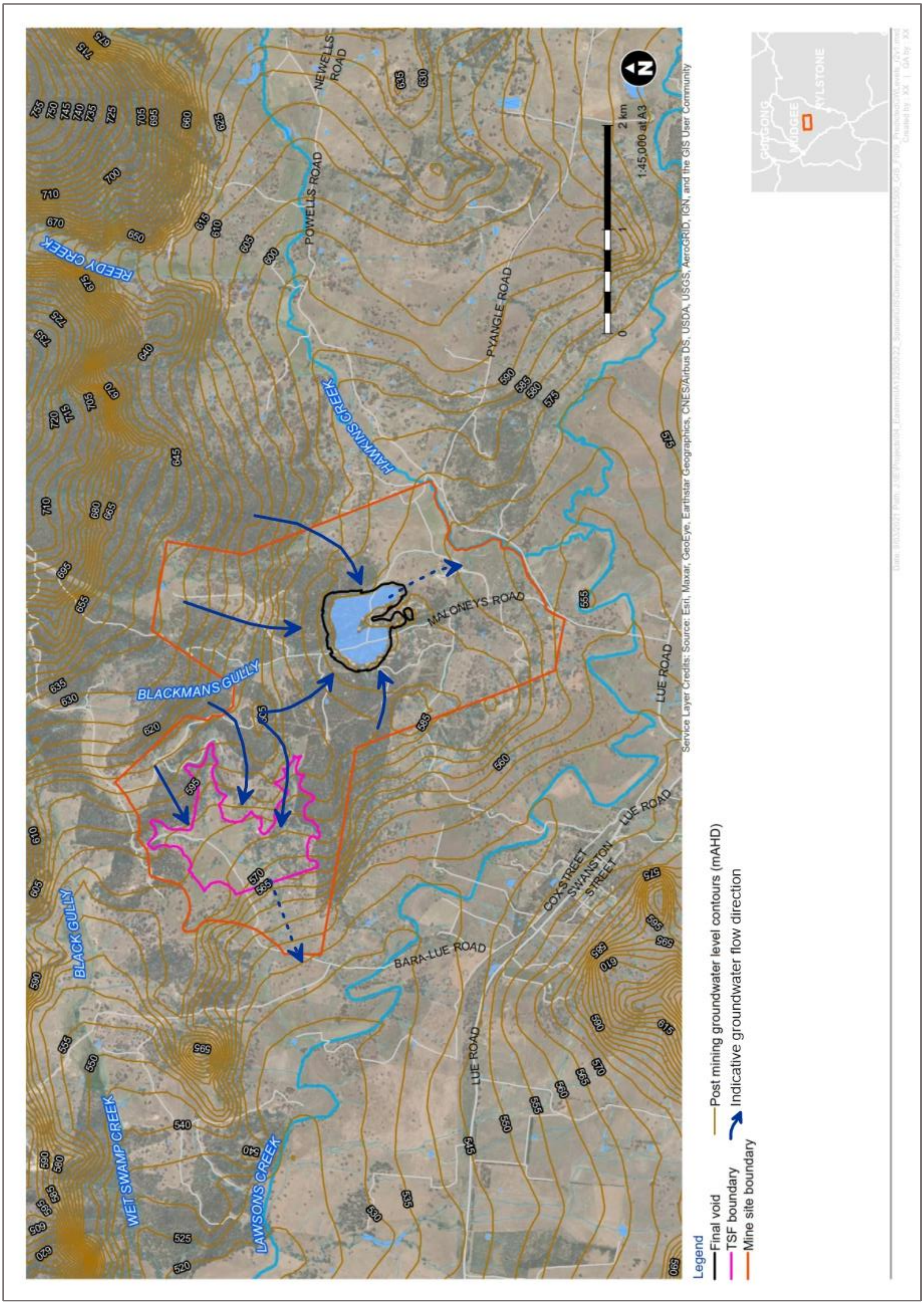
5.4.7 Post Mining Water Levels and Flow Directions

Recovery Model B was used to assess the potential long term impacts of the post mining pit lake water level on groundwater flow. This model simulated the pit lake water level as a constant head boundary with a water level of 574.5m AHD with the results presented on **Figure 39**.

From **Figure 39** it can be seen that from the final void, groundwater flow direction is generally to the southeast toward Hawkins Creek with a hydraulic gradient that is less than 1% (1m elevation for every 100m distance). Based on this gradient over an approximate distance of 800m, and applying conservative indicative hydraulic parameters (Kh = 0.1m/day and effective porosity = 5%) a potential groundwater travel time in excess of 100 years is indicated.

Given the distance to Hawkins Creek coupled with the indicative travel times, and including allowance for dilution and attenuation of any seepage along the flow path, the degradation of water quality in Hawkins Creek or surrounding groundwater due to seepage from the final void is considered unlikely. In addition, as shown on **Figure 39**, there is no direct flow towards Lawsons Creek or Lue village from the final void.

Figure 39 Long-term groundwater levels and flow directions



5.4.8 Baseflow Reduction

Groundwater drawdown has the potential to reduce streamflow through either direct stream depletion or through intercepting groundwater that would otherwise discharge to surface water. Baseflow reductions to Hawkins and Lawsons Creeks have been calculated from the change in flux between the Mining Case and Null Case scenarios for the RIV boundaries (Lawsons Creek) or DRN boundaries (Hawkins Creek). The flux calculations included reaches of Hawkins and Lawsons Creeks that extend beyond the predicted cone of drawdown. For Hawkins Creek, the included reach extended upstream from the confluence with Lawsons Creek to approximately 6 northeast of the Mine Site, in the upper catchments of the Reedy Creek and Horse Gully tributaries (Jacobs, 2021). The Lawsons Creek reach extended from approximately 3.5km southeast of the Mine Site to 4km west of the Mine Site.

The modelled Null Case baseflow contribution to Hawkins and Lawsons Creeks was relatively low. The groundwater contribution to streamflow at Hawkins Creek (72m^3/day [0.072ML/day]), was less than half that of Lawsons Creek (184m^3/day [0.184ML/day]). As noted in Section 4.6, the predicted baseflow to Hawkins Creek matches well with the overall baseflow calculated for the downstream gauging station. However, the model over-predicts baseflow contribution during times of low or no flow. The Null Case baseflow contribution for Hawkins and Lawsons Creeks are shown on **Figure 40** and **Figure 41** respectively.

During mining, the baseflow to both Hawkins and Lawsons Creeks reduces with the expansion of the cone of drawdown. This baseflow reduction was estimated by subtracting the modelled baseflow for the Mining Case from that of the Null Case. From **Figure 40** and **Figure 41** it can be seen that baseflow reductions attributed to the Project continue to increase beyond the end of mining, peaking at approximately 28 to 34 years from the commencement of mining (12 to 18 years post mining). The long term baseflow reduction due to the Project is likely to reach equilibrium at approximately 0.024ML/day for Hawkins Creek and 0.018ML/day for Lawsons Creek. This equilibrium condition is predicted to occur approximately 34 years post mining, as indicated on **Figure 40** and **Figure 41**.

A maximum baseflow reduction of approximately 30m^3/day (0.030ML/day) is predicted for Hawkins Creek and 24m^3/day (0.024ML/day) for Lawsons Creek within 100 years of commencement of mining. However, as noted above, actual baseflow reduction attributable to the Project is likely to be less due to the over prediction of baseflow during sustained dry periods.

Figure 40 Predicted Baseflow Reduction at Hawkins Creek

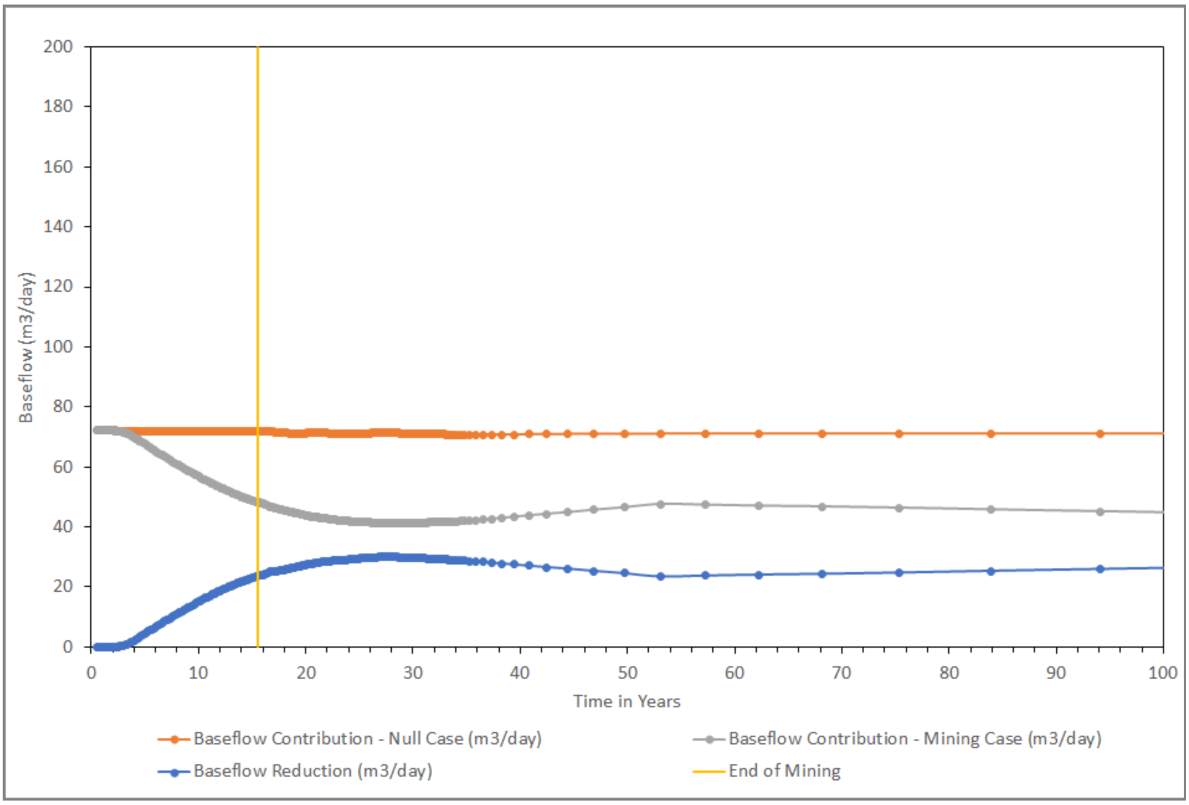
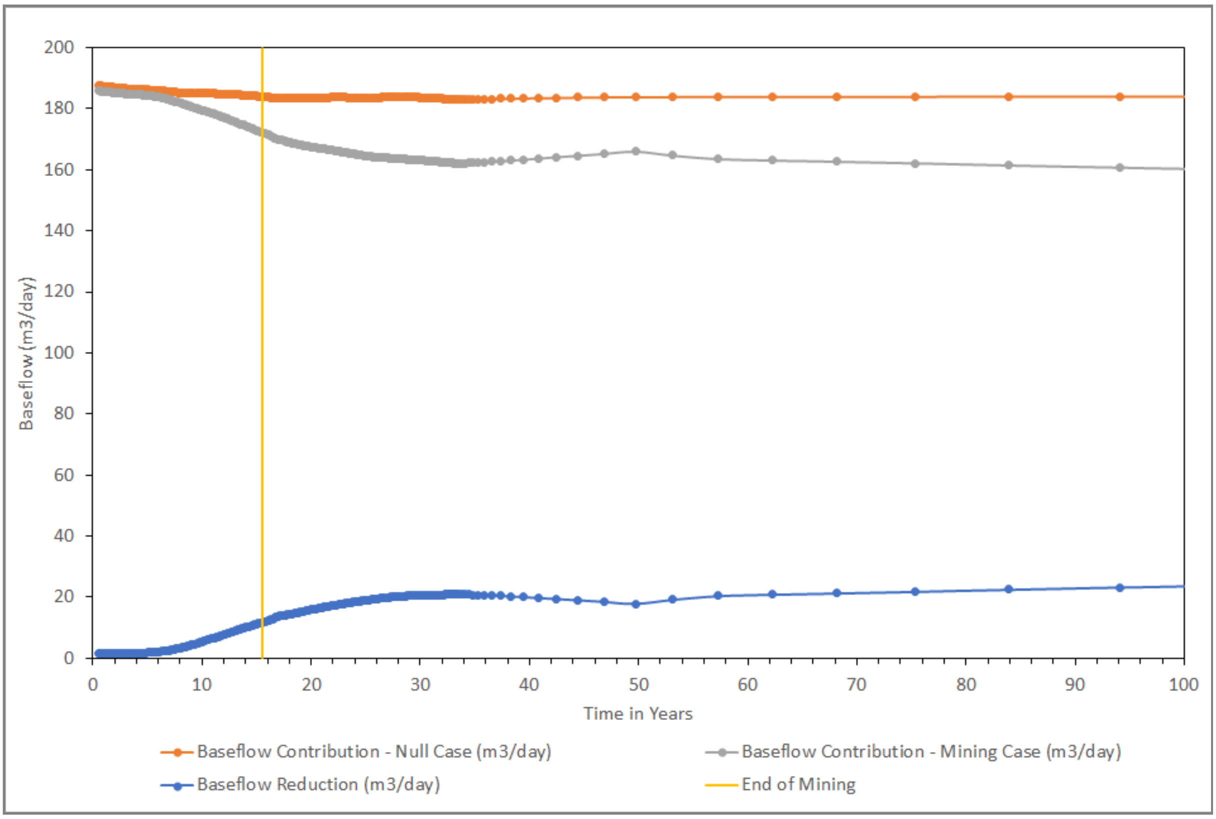


Figure 41 Predicted Baseflow Reduction at Lawsons Creek



6. MODEL UNCERTAINTY ANALYSIS

An uncertainty analysis was undertaken to assess the effect of individually varying model input parameter values such as hydraulic conductivity, recharge and storage on model predictions. The uncertainty analysis technique follows the "*Deterministic scenario analysis with subjective probability assessment"* technique as described in the IESC uncertainty analysis guidelines (Middlemis and Peeters. 2018). Middlemis and Peeters (2018) note that this approach is often referred to as a sensitivity analysis.

The following model scenarios were therefore developed using the Mining Case model as the "base case":

- **High and low hydraulic conductivity scenario**: Bulk hydraulic conductivity (K, including Kh and Kv) values assigned to the uncertainty analysis models were one order of magnitude higher and lower than K values assigned to the base case model (refer **Table 9**) for high and low K scenario respectively.

- **High and low storage parameter scenario**: All storage parameter values were varied by 200% higher and 50% lower than values in the base case model (refer **Table 8** and **Table 14**) for the high and low storage parameter scenarios respectively.

- **High and low recharge scenario**: Recharge factor values were varied by 200% higher and 50% lower than in the base case model (refer **Table 5**) for the high and low recharge scenarios respectively.

- **High and low evapotranspiration scenario**: Evapotranspiration factors were varied by 200% higher and 50% lower than in the base case model (refer **Table 6**) for the high and low evapotranspiration scenarios respectively.

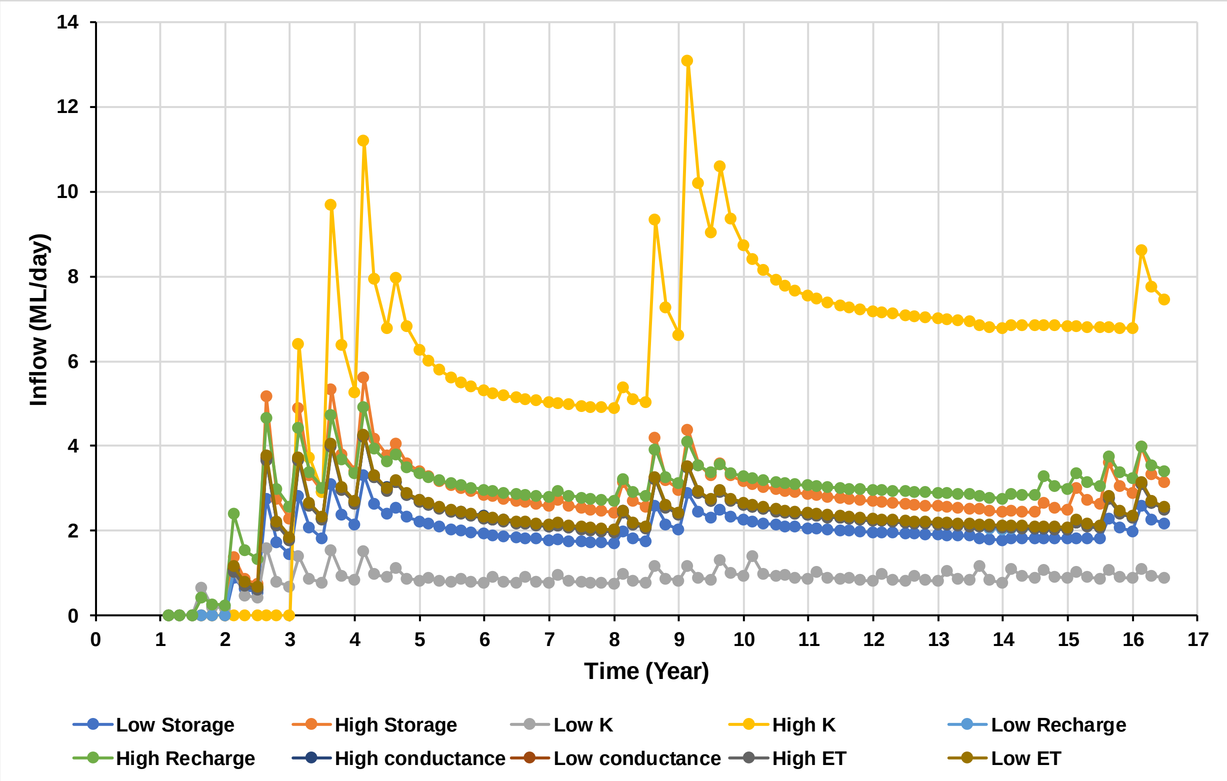
- **High and low DRN and RIV conductance scenario**: DRN and RIV conductance values for watercourses and open cut pit wall simulations were varied by one order of magnitude higher and lower than values assigned to the base case model for the high and low conductance scenarios respectively.

The predicted open cut pit inflows from the models scenarios described above were then compared to the Mining Case predictions from the base case model. The analysis results for predicted groundwater inflow are presented in **Figure 42** below. The predicted drawdown at the end of mining for each scenario is provided in **Attachment 1**.

The results of the uncertainty analysis indicate that predicted inflows are most sensitive to changes in hydraulic conductivity. Where the hydraulic conductivity value is one order magnitude higher, inflows could be up to 1.5 to 3.5 times higher than the base case scenario (**Figure 42**). However, this scenario is considered extremely unlikely as the range of hydraulic conductivity in the vicinity of the open cut pit is well understood. Whilst high permeability zones have been identified during field testing, longer-term testing has shown these zones to be discrete and rapidly dewatered.

The low hydraulic conductivity scenario produced the lowest predicted inflows. Reduced mine inflows, while not considered likely, would be of little consequence to the Project as any required make-up water would be sourced from the Ulan Coal Mine and/or Moolarben Coal Mine.

Figure 42 Uncertainty Analysis Results of Mine Inflow Rates



The elevated formation storage and recharge scenarios also result in marginally higher inflows than the base case, with approximately up to 1.4 and 1.2 times the base case scenario, respectively.

The model appears to be relatively insensitive to changes in the DRN conductance values used to simulate open cut pit inflows. The uncertainty analysis results show that varying the DRN conductance by over two orders of magnitude between the high and low conductance values had an insignificant effect on the predicted inflows.

A comparison of predicted open cut pit inflows from the high and low evapotranspiration scenarios (**Figure 42)** indicates that inflows are relatively insensitive to evapotranspiration values applied to the model.

Predicted drawdown at end of mining for the uncertainty analyses are provided in **Attachment 1**. The only significant increase to drawdown extents was due to the high hydraulic conductivity scenario. All other scenarios (high conductance, low conductance, high EVT, low EVT, low recharge and low storage) predicted a similar drawdown extent to that of the base case, or one that was significantly reduced (low hydraulic conductivity, high recharge, and high storage).

Of note is that the difference between the high and low recharge scenarios was not significant. This would indicate that the bulk of open cut pit inflows are derived from formation storage.

The main difference in drawdown for the high hydraulic conductivity scenario was the increased drawdown propagation to the north and east. Similar to the base case, drawdown propagation to the south and southwest is likely attenuated by Lawsons Creek. However, as noted previously the high hydraulic conductivity scenario is considered to be extremely unlikely and unsupported by field testing.

The sole purpose of the uncertainty analyses was to assess the effect of applying parameter values at the high end and low ends of the probable range of values for the parameters. The high and low parameter values assigned to the uncertainty analysis models do not necessarily result in well calibrated models. It was noted in the hydraulic conductivity (K) sensitivity analysis discussion (Section 4.2) that for the range of K values assessed spanning two orders of magnitude (i.e. one order of magnitude higher to one order of magnitude lower than the calibrated model K values), the objective function was not significantly affected by changes in all zones with the exception of zones 51 and 12. The recharge rate sensitivity analysis (Section 4.2) indicated that for the range of recharge values assessed, the objective function was not significantly affected by changes in all recharge zone values, except zones 32 and 34.

7. MODEL REVIEW

Independent peer review of the groundwater model and modelling process has been undertaken by Dr Noel Merrick of HydroSimulations. The review comprised progressive reviews throughout model development including:

- Inception review and groundwater model study plan
- Calibration review
- Final review

Review comments have been acknowledged and used to refine the groundwater model and modelling process where relevant. The final review finds the groundwater model fit for the purpose of estimation of water take and the prediction of the reduction in regional groundwater levels (and associated impacts). A copy of the model review is provided as **Attachment 2**.

8. MODEL LIMITATIONS

Groundwater flow models are inherently subject to uncertainties arising from the fact that models are generally unable to incorporate the full complexity of the natural environment. In particular, groundwater models are unable to capture all of the salient features of the natural environment that influence groundwater behaviour.

Predictive uncertainty also arises from the fact that groundwater models are generally founded on relatively sparse data resulting in the need to apply bulk parameters and simplifying assumptions. While it is generally not possible to map and include all of the spatial complexity of the system being modelled, it is necessary to acknowledge predictive uncertainty and to try to quantify and deal with such uncertainties.

For this assessment, a balance has been struck between an overly conservative approach and getting entangled in overly complex small-scale detail. As previously noted, initial attempts at high resolution pilot point calibration in the near open cut pit area, to replicate short term pumping observations and structural influences, were found to be of little overall benefit with limited influence on predicted inflows or drawdown. A more simplified approach, with relatively uniform and elevated permeability in the open cut mining area, surrounded by an outer zone of intermediate permeability was ultimately adopted and provided for a better calibration.

9. CONCLUSION

A Class 2 – Impact Assessment (Barnett *et al*. 2012) numerical groundwater model has been developed to inform assessment of potential groundwater impacts due to development and operation of the Bowdens Silver Project.

The objectives of the numerical groundwater model were:

- Calculate drawdown in the vicinity of the Mine Site due to the Project, including at any existing groundwater works or groundwater dependent ecosystems in the area of potential impact.
- Calculate the volumetric take of groundwater from the open cut pit for dewatering purposes due to the Project.
- Calculate the incidental volumetric take from surface watercourses due to baseflow reduction, in particular Hawkins and Lawsons Creeks, due to the Project.

The model was developed and calibrated based on hydrogeological investigations documented in Jacobs (2021) and has been peer reviewed.

Predictive modelling results are summarised as follows:

- Average groundwater inflows over the life of mining are predicted to be of the order of 2.4ML/day. The peak annual dewatering requirement is during Year 4 with a predicted annual volume of approximately 1 066ML. The average annual dewatering requirement, once dewatering commences, is approximately 774ML.
- At the end of mining, propagation of drawdown, as represented by the predicted 1m drawdown contour, is typically of the order of 1.5km to the east and south, 2km to the west and 2.2km to the north of the open cut pit. During mining, drawdown to the northwest is attenuated due to mounding beneath the TSF, with maximum mounding of the order of 8m.
- Following the completion of mining, a pit lake would form in the final void. Equilibration of net inflows and evaporative losses from the pit is predicted after approximately 100 years at an elevation of approximately 574.5m AHD, 16 to 26m below the pre-mining groundwater level. This indicates that the mine void would remain a partial groundwater sink. A small component of outflow from the pit lake is expected down gradient.
- Mine closure management measures include allowance for diversion of surface water around the pit lake to ensure that it remains a groundwater sink. The salinity of the pit lake would increase due to evaporative concentration. Electrical conductivity is predicted to increase to approximately 2 000µS/cm at 100 years post mining to 5 375µS/cm by 500 years post mining. Being a groundwater sink, the resulting saline water would remain captured within the final void.

10. REFERENCES

Advisian – Worley Parsons Group (2020a), *Preliminary Design of PAF Waste Rock Emplacement, Oxide Ore Stockpile and the Southern Barrier*, August 2019, Part 16b of the Specialist Consultant Studies Compendium. Prepared on behalf of Bowdens Silver Pty Limited.

Advisian – Worley Parsons Group (2020b), *TSF and WRE Closure Cover Design*, December 2019, Part 16c of the Specialist Consultant Studies Compendium. Prepared on behalf of Bowdens Silver Pty Limited.

AMC, (2012), *Bowdens Open Pit Geotechnical Study*. Consultants report prepared for Kingsgate Consolidated Limited by AMC Consultants.

ATC Williams, (2020), *Tailings Storage Facility Preliminary Design*, Bowdens Silver Pty Ltd, Lue N.S.W. Reference 116217.01 R02 Rev5 May 2020

ATC Williams, (2019), Email communications detailing predicted TSF seepage rates. Wardlaw-Sheppard, 12 February 2019.

ANZG, (2018), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. The 2018 revision of the Water Quality Guidelines is presented as an online platform, to improve usability and facilitate updates as new information becomes available (http://www.waterquality.gov.au/anz-guidelines).

Barnett, B., Townley, L.R., Post, V., Evans, R.E., Hunt, R.J., Peeters, I., Richardson, S., Werner, A.D., Knapton, A., and Boronkay, A. (2012), *Australian groundwater modelling guidelines*. Sinclair Knight Merz and National Centre for Groundwater Research and Training. Waterlines Report Series No. 82, June 2012.

Bish, S., (1999), *Hydrogeological Assessment for Coxs River Catchment, Sydney* – South Coast Region, NSW. Department of Land and Water Conservation. October 1999.

Cardno, (2013), *Bowdens Silver Mine Aquatic Ecology Assessment*. Consultant report prepared for R.W. Corkery and Co. Pty Ltd by Cardno Pty Ltd. Job No. EL1112038. May 2013.

Chapman, T., (1999), *A comparison of algorithms for stream flow recession and baseflow separation*. Hydrol. Processes 13, 701–714.

Coffey, (1998), *Bowdens Silver Project Pre-Feasibility Water Supply Study*. Consultant report prepared by Coffey Partners International Pty Ltd for Silver Standard Australia Pty Ltd.

Colqhoun G.P., Hughes K.S., Deyssing L., Ballard J.C., Phillips G., Troedson A.L., Folkes C.B. & Fitzherbert J.A. (2019), *New South Wales Seamless Geology dataset, version 1.1 [Digital Dataset]*. Geological Survey of New South Wales, NSW Department of Planning and Environment, Maitland.

Colqhoun G.P., Meakin N.S., Henderson G.A.M., Krynen J.P., Jagodzinski E.A., Watkins J.J. and Yoo E.K., (2000), *Mudgee 1:100 000 Geological Sheet 8832, 1st edition. Geological Survey of New South Wales*, Sydney & Geoscience Australia, Canberra.

Watermark Numerical Computing, (2018), *PEST, Model-Independent Parameter Estimation – User Manual. 7th Edition* published in 2018.

DoIR&E, (2016), *Western Coalfield Geological Modelling Project*. Department of Industry, Resources and Energy. 16 December 2016.

DPI Water, (2016), *Methods for the identification of high probability groundwater dependent vegetation ecosystems*. Department of Primary Industries. ISBN 978-1-74256-967-3. September 2016.

Dresel, P. E., Clark, R. Cheng, X., Reid, M., Fawcett, J., and Cochraine, D. (2010), *Mapping Terrestrial Groundwater Dependent Ecosystems: Method Development and Example Output.* Victoria Department of Primary Industries, Melbourne VIC. 66 pp

DRET, (2008), *Cyanide Management - Leading Practise Sustainable Development Program for the Mining Industry*. Australian Government, Department of Resources, Energy and Trade. May 2008.

EnviroKey, (2019), *Terrestrial Ecology Assessment, Part 9a of the Specialist Consultant Studies Compendium*. Prepared on behalf of Bowdens Silver Pty Limited.

GCA, (2019), Materials Characterisation, Part 3 of the Specialist Consultant Studies Compendium. Prepared on behalf of Bowdens Silver Pty Limited.

Gibbs, R.J., (1970), *Mechanisms controlling world water chemistry*. Science 170 (3962), 1088-1090.

Hydroilex, (2003), *Hydrogeological Investigation, Groundwater Supply for Bowdens Silver Project*. Consultant report prepared Hydroilex (Geological Services Division of Panorama Drilling Company Pty Ltd) for Silver Standard Australia Pty Ltd. Report No. HG03.5.3. 5th May 2003.

Jacobs, (2014), *Bowdens Project: Aquifer Testing*. Consultant memo report prepared by Jacobs (Australia) Pty Ltd for Kingsgate Consolidated Limited. Project No. IA035500.03. 12 January 2015.

Jacobs, (2021), *Part 5 Updated Groundwater Assessment*. Consultant report prepared by Jacobs (Australia) Pty Ltd for Bowdens Silver Pty Limited. Project No: IA132500. March 2021.

Jewell, (2003), *Hydrogeological Assessment, Bowdens Silver-lead-Zinc Deposit*. Consultant report prepared by C. M. Jewell and Associates Pty Ltd for Silver Standard Australia Pty Ltd. Report No. J0824.3. September 2003.

Merrick, (2011), *An Assessment of Existing Groundwater Conditions at the Bowdens Silver Mine Project Site near Lue, NSW*. Consultant report prepared by Heritage Computing Pty Ltd for Kingsgate Consolidated Limited. Report HC2011/14. November 2011.

Middlemis, H. and Peeters L.J.M., (2018), *Uncertainty analysis—Guidance for groundwater modelling within a risk management framework*. A report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Commonwealth of Australia 2018.

NSW Office of Water, (2012), *NSW Aquifer Interference Policy. NSW Government policy for the licensing and assessment of aquifer Interference activities*. NSW Department of Primary Industries, Publication number: 11445. First published: September 2012.

NHMRC, (2011), *Australian Drinking Water Guidelines, Paper 6. National Water Quality Management Strategy*. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.

Piper A.M., (1944), *A graphic procedure in the geochemical interpretation of water analysis [M]*. Trans. AM Geophys. Union. 25, 914–923.

SKM, (2013), *Bowdens Groundwater Monitoring Network, Bore Construction and Aquifer Testing*. Consultant report prepared by Sinclair Knight Merz Pty Ltd for Kingsgate Consolidated Limited. 11 February 2013.

Thiessen, A.H. (1911), *Precipitation averages for large areas*. Monthly Weather Review, 39(7): 1082-1084.

WaterNSW, (2019), *NSW Water Register - https://waterregister.waternsw.com.au/water-register-frame#*

WRM, (2020), *Surface Water Assessment, Part 6 of the Specialist Consultant Studies Compendium*. Prepared on behalf of Bowdens Silver Pty Limited.

This page has intentionally been left blank

Attachments

(Total No. of pages including blank pages = 32)

Attachment 1* Uncertainty Analysis Predicted Drawdown (12 pages)

Attachment 2* Groundwater Model Review (18 pages)

* This Attachment is only available on the digital version of this document

This page has intentionally been left blank

Attachment 1

Uncertainty Analysis Predicted Drawdown

(Total No. of pages including blank pages = 12)

Note: This Attachment is only available on the digital version of this document

This page has been intentionally left blank

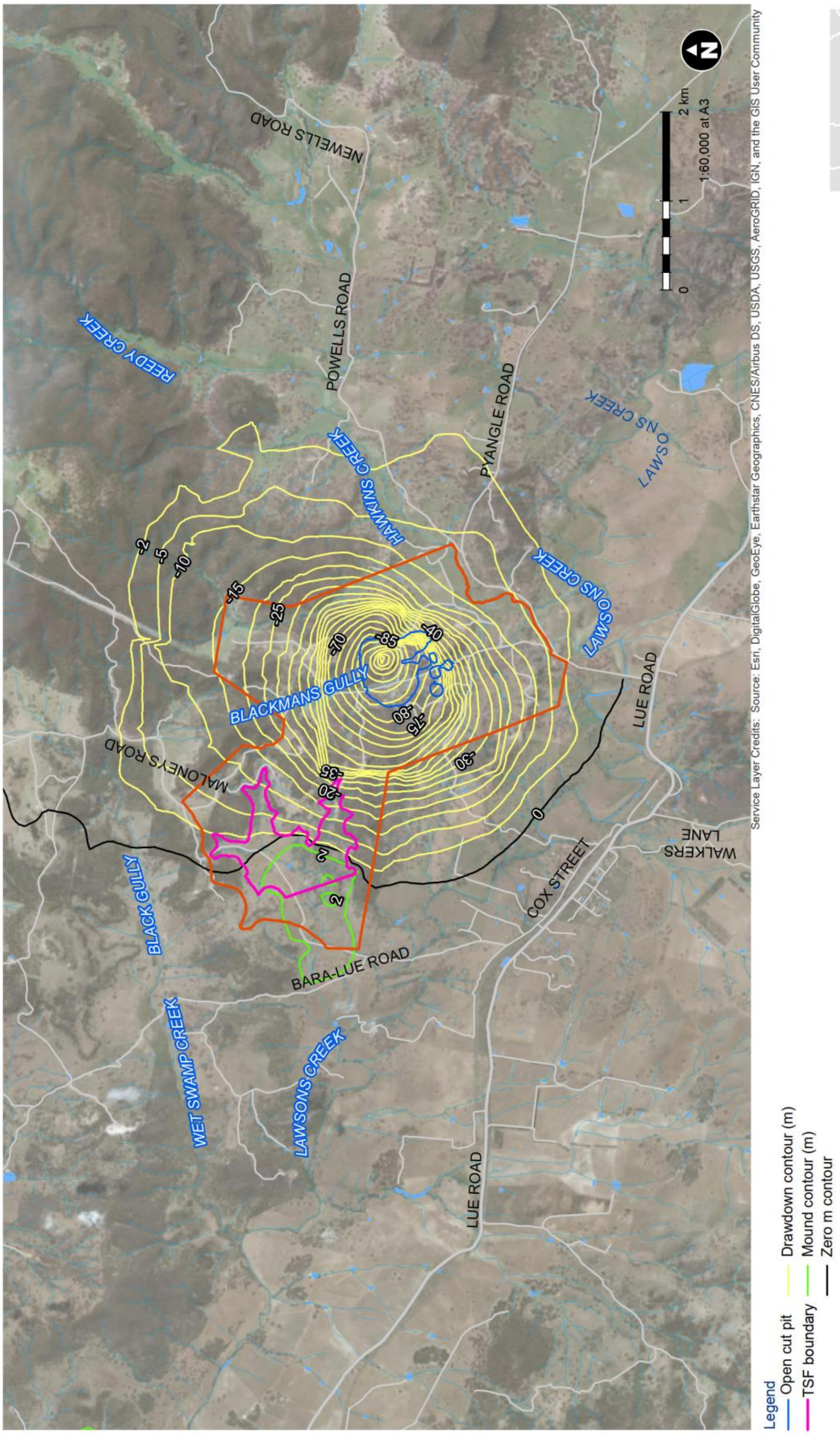


Figure A1-1 - High Hydraulic Conductivity Scenario

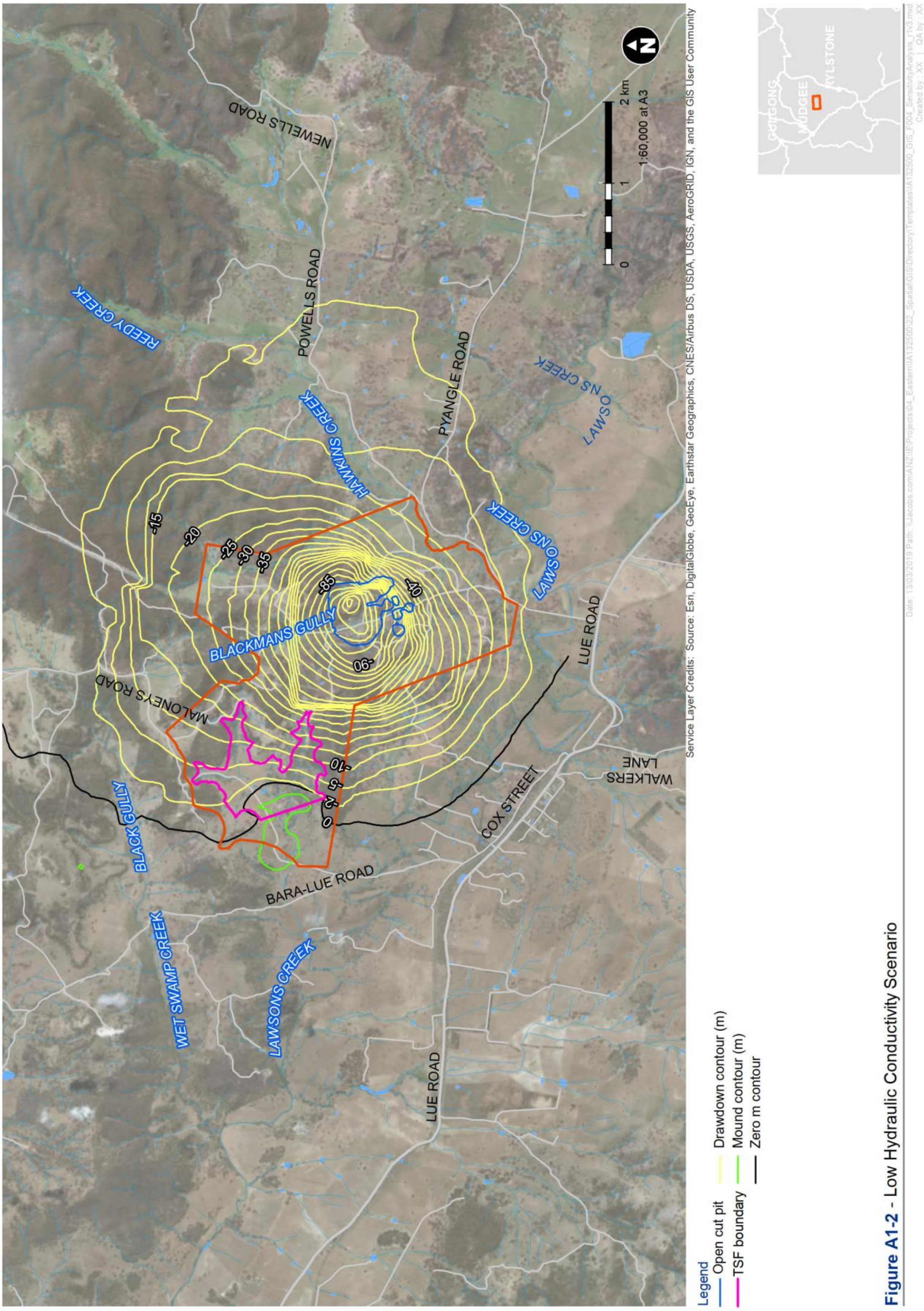


Figure A1-2 - Low Hydraulic Conductivity Scenario

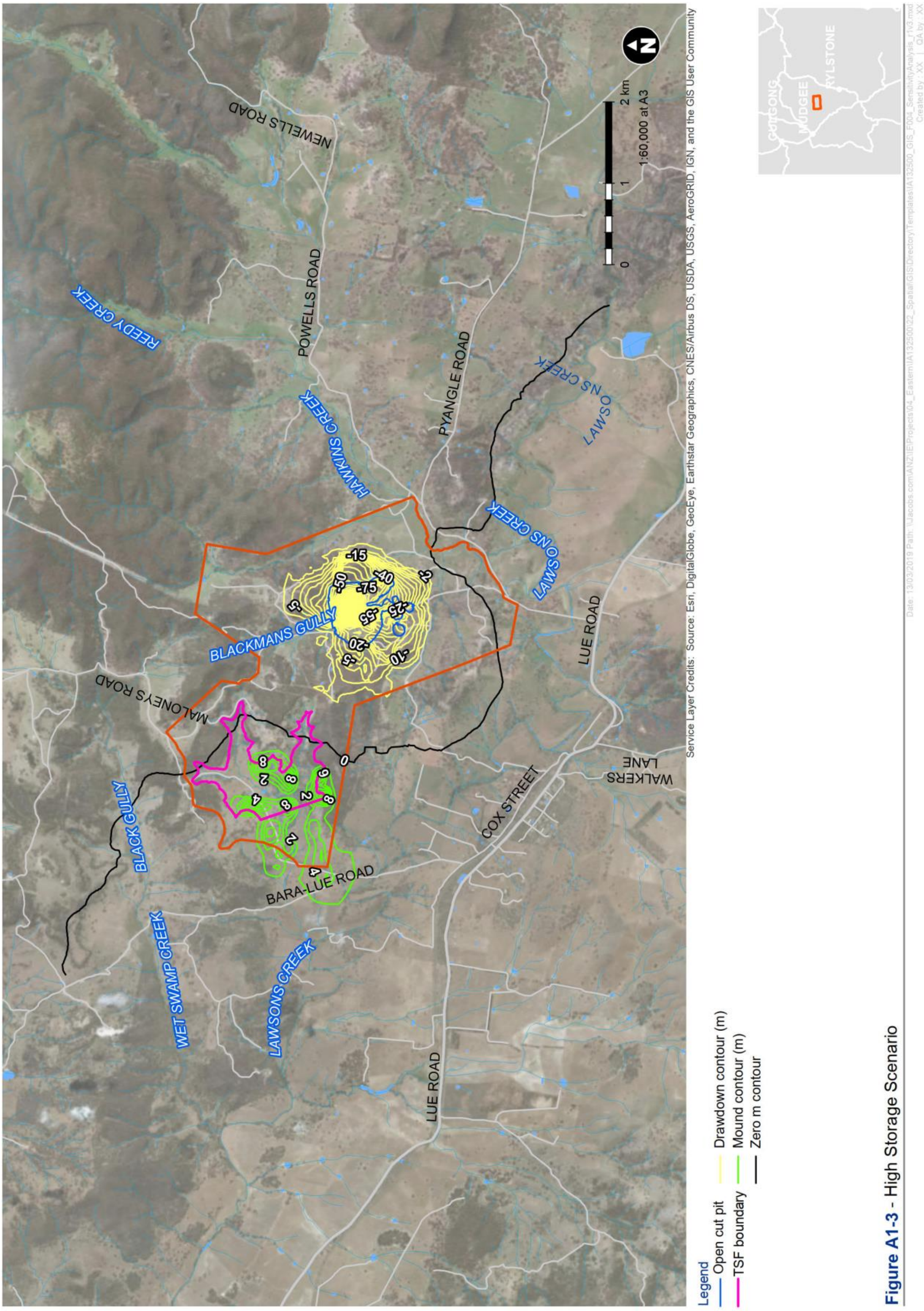


Figure A1-3 - High Storage Scenario

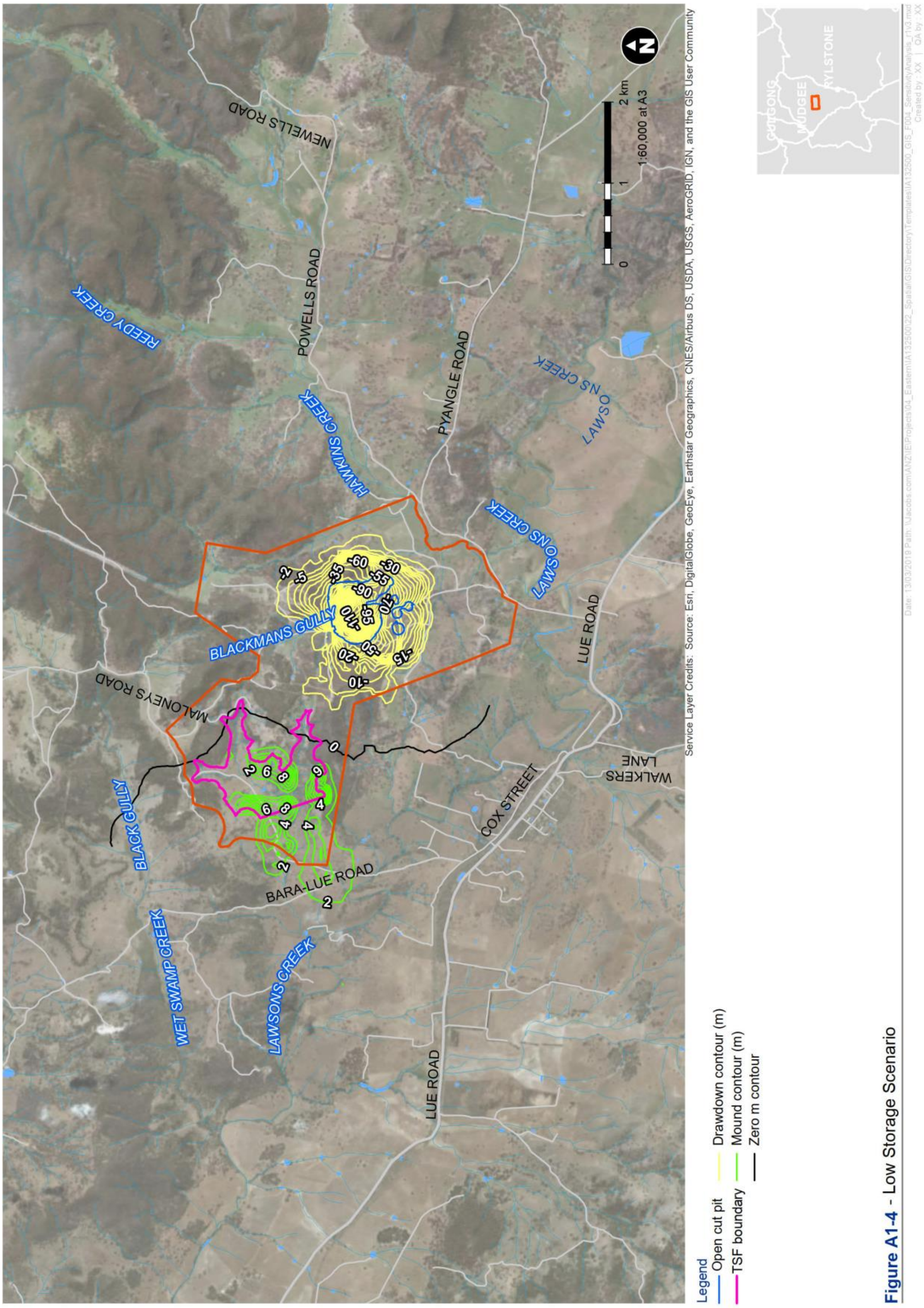


Figure A1-4 - Low Storage Scenario

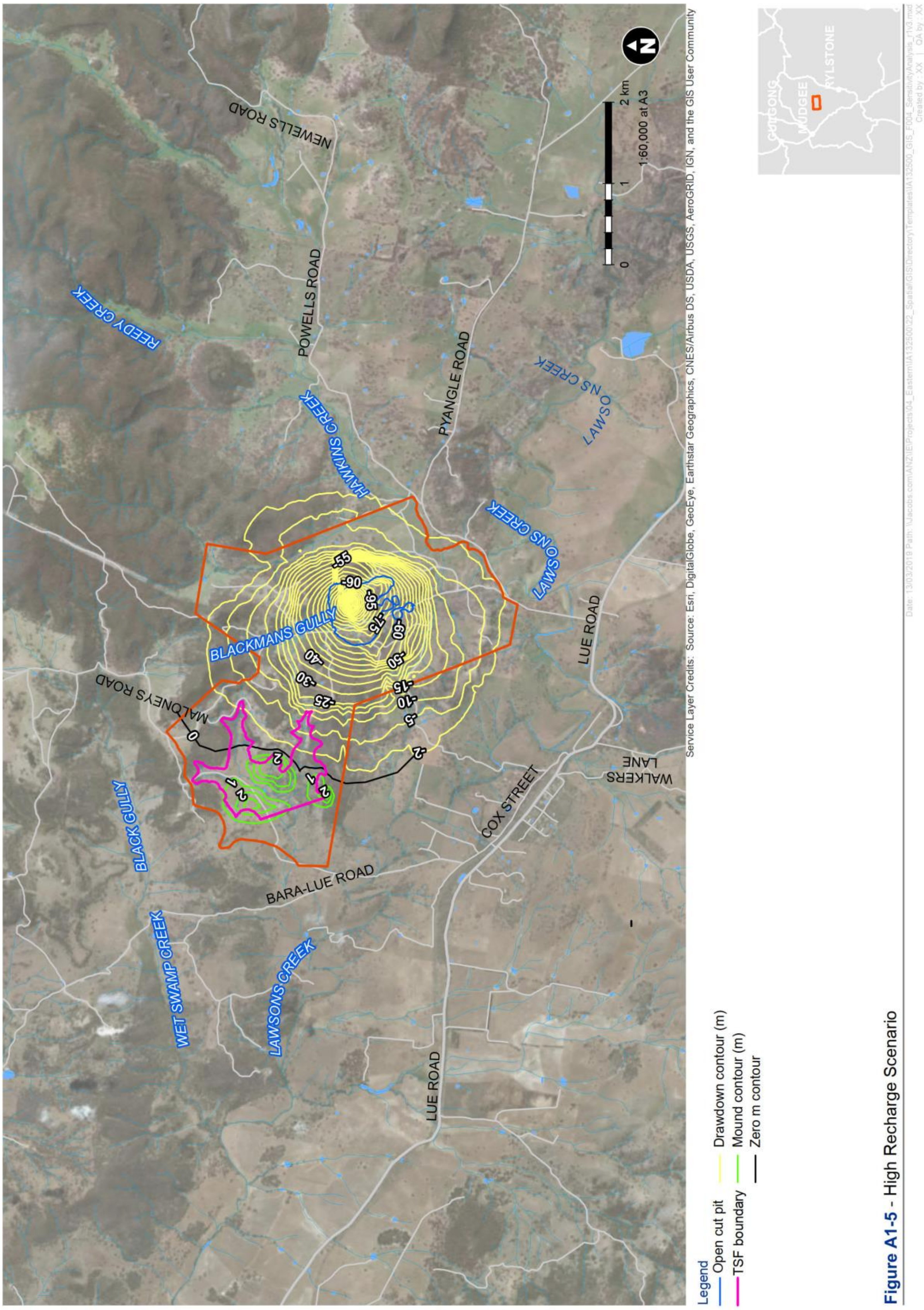


Figure A1-5 - High Recharge Scenario

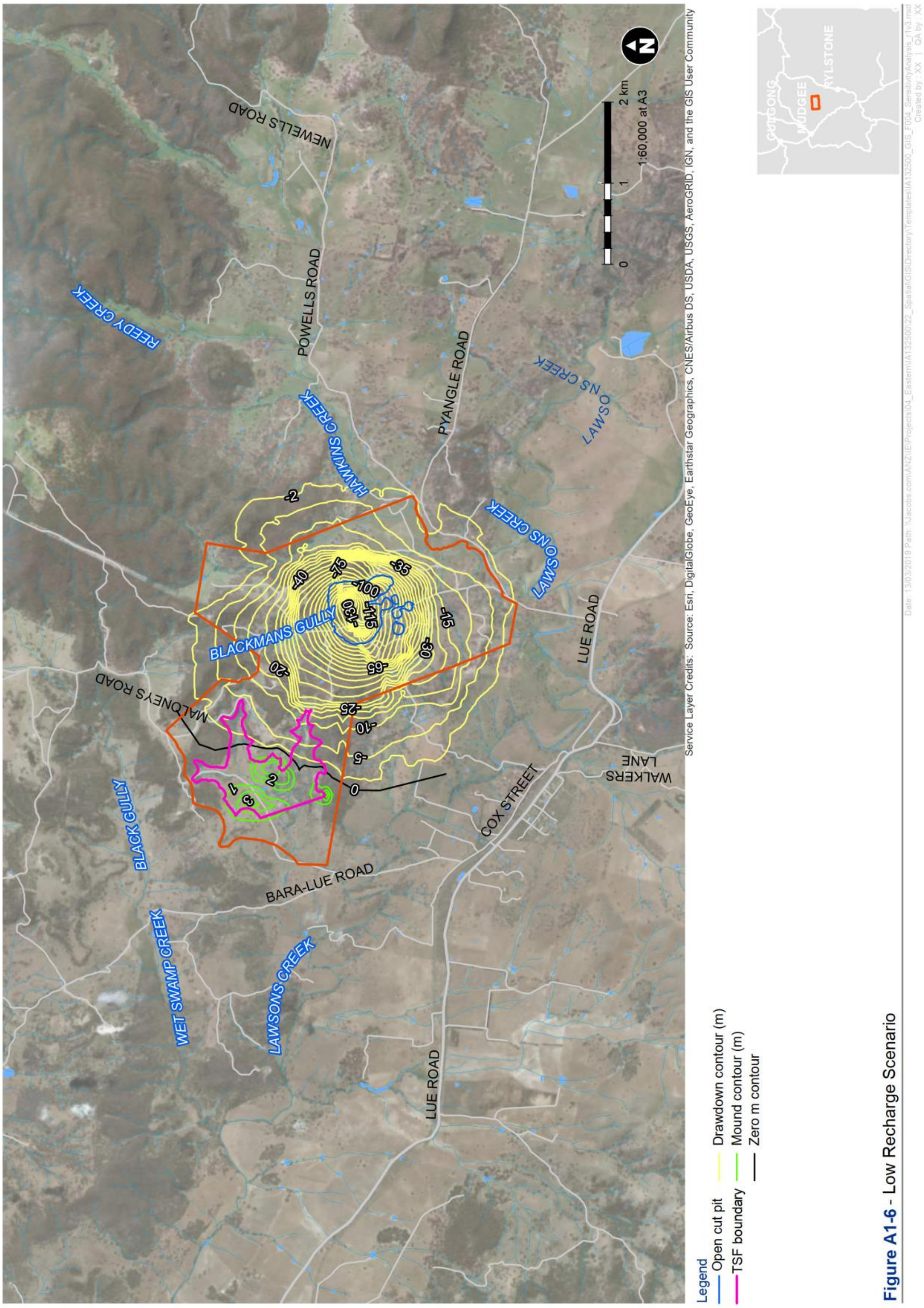


Figure A1-6 - Low Recharge Scenario

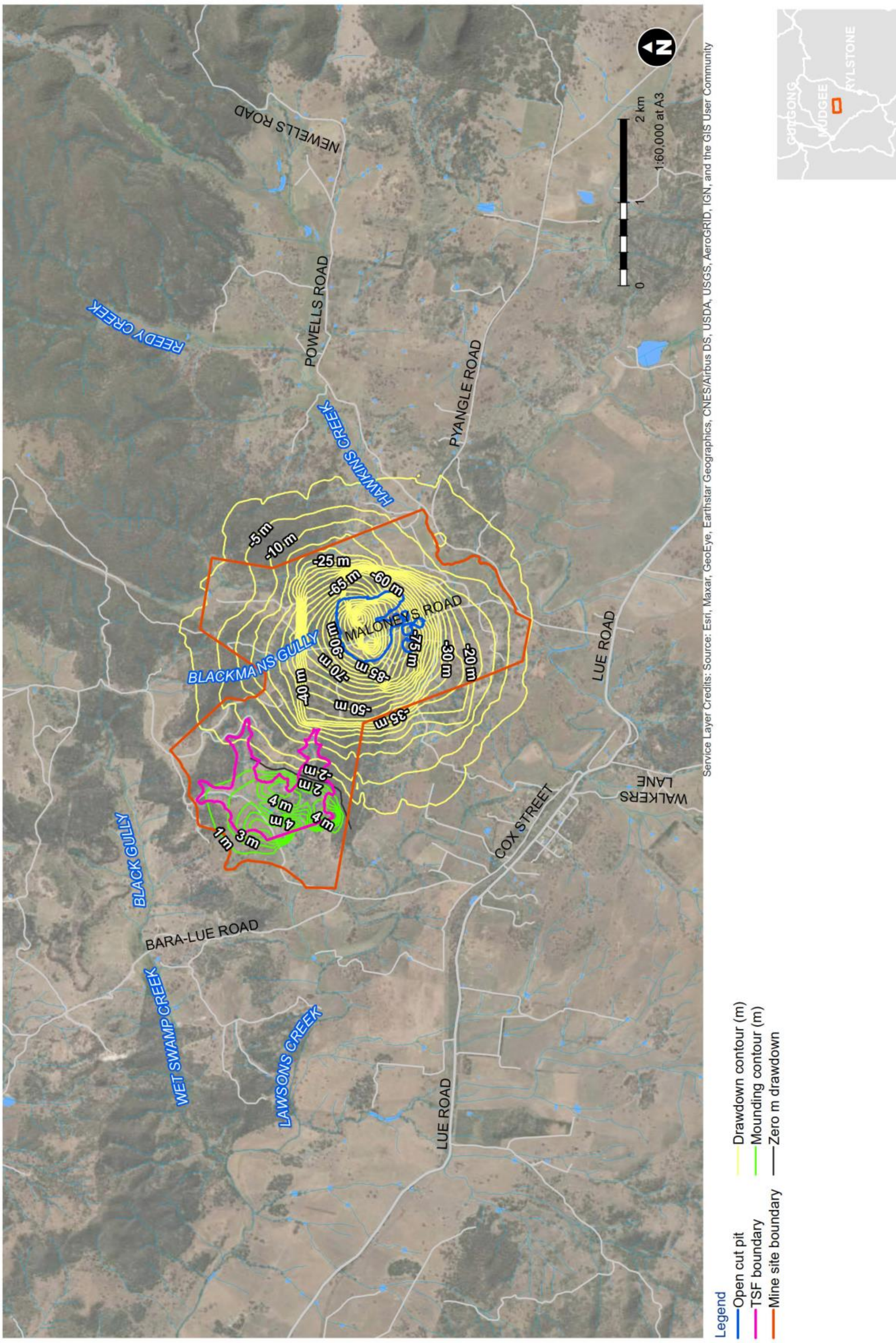


Figure A1-7 High Evapotranspiration Scenario

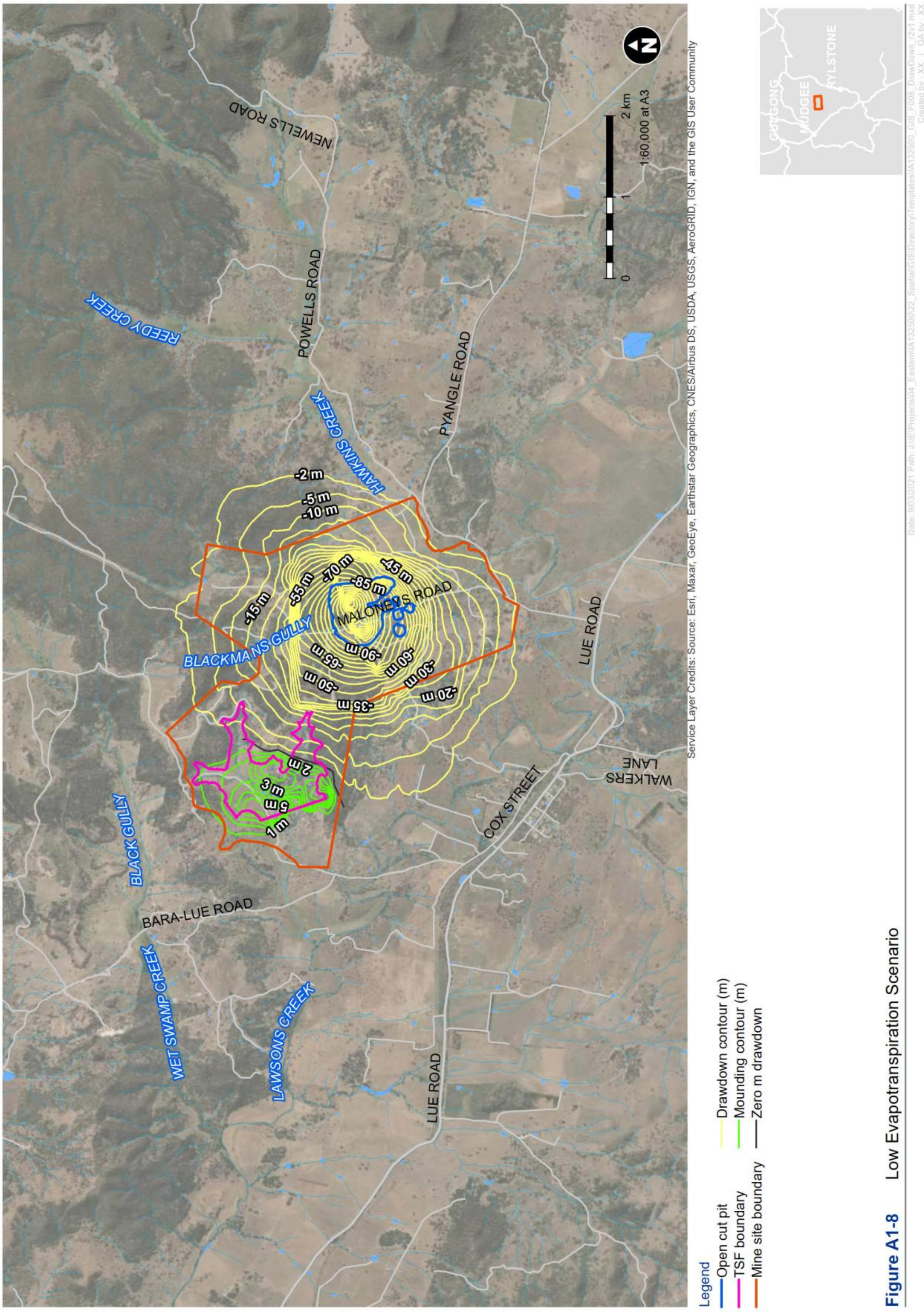


Figure A1-8 Low Evapotranspiration Scenario

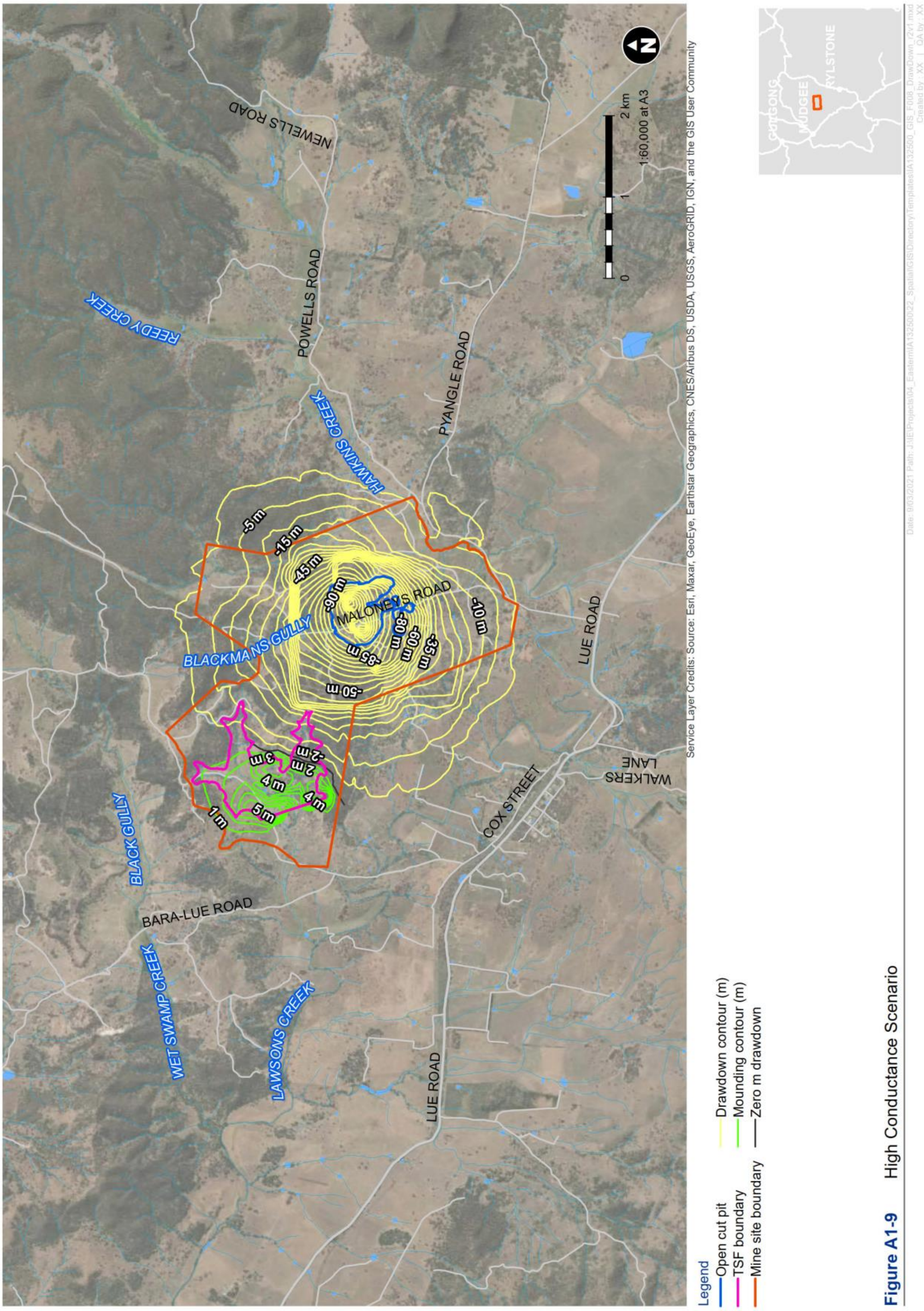


Figure A1-9 High Conductance Scenario

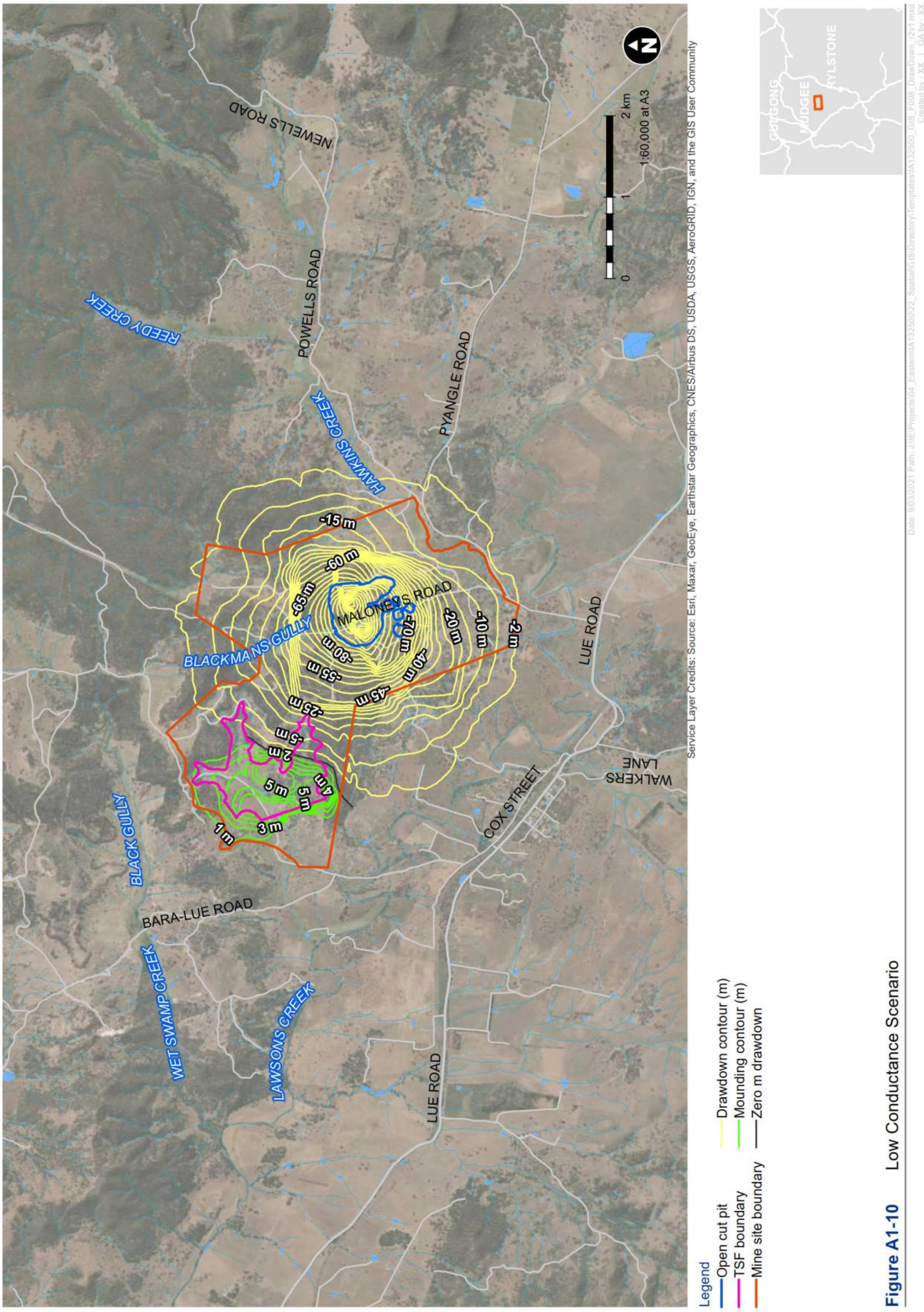


Figure A1-10 Low Conductance Scenario

Attachment 2

Groundwater Model Review

prepared by

HydroSimulations

(Total No. of pages including blank pages = 18)

Note: This Attachment is only available on the digital version of this document

Erratum to Attachment 2

The following erratum provides updated references to address changes to the report structure and layout following the third-party review by HydroSimulations.

The report revision reviewed by HydroSimulations was:

> Jacobs, 2019. Bowdens Silver Project Groundwater Impact Assessment. Specialist Consultant Studies Compendium Volume 2, Part 5. Report prepared for Bowdens Silver Pty Ltd, version 3, 27 September 2019.

Subsequent to the third party review the report structure has undergone a number of changes, including the migration of the modelling information to a standalone report and included as an Annexure to the main report.

The current report for which this Erratum is prepared is:

> Jacobs, 2021. Bowdens Silver Groundwater Assessment. Part 5. Updated Groundwater Assessment, State Significant Development No. 5765. Prepared by Jacobs Group (Australia) Pty Limited. March 2021.

In the following table the Updated Groundwater Assessment is referred to as the UGA and the Groundwater Modelling Report is referenced as GMR.

Third party review item	Jacobs 2019 reference	Jacobs 2021 reference
Documentation – Report sections - Page 1	Executive Summary 1. Introduction 2. Legislation and policy 3. Previous Investigations 4. Existing Environment 5. Groundwater Modelling 6. Impact Assessment 7. Licensing requirements 8. Monitoring and management 9. References	UGA: Foreword Executive summary 1. Introduction 2. Legislation and policy 3. Previous Investigations 4. Existing Environment 5. Conceptual hydrogeological model 6. Impact assessment 7. Licensing requirements 8. Monitoring and management 9. References GMR: 1. Introduction 2. Model objectives 3. Conceptualisation 4. Model Design 5. Model calibration 6. Predictive Modelling 7. Model uncertainty analysis 8. Model Review 9. Model limitations 10. Conclusions 11. References

Third party review item	Jacobs 2019 reference	Jacobs 2021 reference
Documentation – Annexures - Page 1/2	1. Aquifer interference policy checklist 2. Groundwater works summary 3. BGW10, BGW108 pumping tests 4. Airlift recovery tests 5. Packer injection tests 6. Comprehensive water quality analysis 7. Tailings storage facility 8. WAL summary 9. Uncertainty analysis- predicted groundwater drawdown 10. Groundwater model review	UGA: 1. Aquifer interference policy checklist 2. Groundwater works summary 3. WAL summary 4. BGW10, BGW108 pumping tests 5. Airlift recovery tests 6. Packer injection tests 7. Comprehensive water quality analysis 8. Tailings storage facility 9. Groundwater model report 10. TSF model report 11. DPIE-Water's review comments GMR: 1. Uncertainty analysis predicted drawdown 2. Groundwater model review
Report matters – page 3	Section 5.3.3.3 Figure 64 and 65	GMR Section 5.6 GMR Figure 30 and 31
Data matters – page 4	Section 5.3.2.6 Figures 37 and 38	GWR Section 4.8 AGR Figures 40 and 41
Model matters – page 4	Figures 58 to 63	GMR Figures 24 to 29
Model matters – page 5	Section 5.3.4.2	GMR Section 6.2
Model matters – page 5	Figure 72	AGR Figure 48
Table 3 Q 1.1	Table 1 Section 1.2 Section 1.3 Section 5.3.1	AGR Table 1 AGR Section 1.2 AGR Section 1.3 GMR Section 2
Table 3 Q 2.1	Section 4.5 Section 4.5.7 to 4.5.10 Figure 16 Figure 18 Table 17 Section 4.3 and 4.4	AGR Section 4.5 AGR Section 4.5.7 to 4.5.10 AGR Figure 19 AGR Figure 21 AGR Table 17 AGR Section 4.3 and 4.4
Table 3 Q 2.2	Figure 25	AGR Figure 28
Table 3 Q 2.3	Figure 64 Section 5.3.3.3	AGR Figure 43 GMR Section 5.6
Table 3 Q 2.4	Figure 65 Section 5.3.3.3 Section 4.5.2	AGR Figure 44 GMR Section 5.6 GMR Section 3.6
Table 3 Q 2.5	Table 18	AGR Table 19
Table 3 Q 2.5	Figures 20 to 23	Figures 24 to 26
Table 3 Q 3.2	Section 5.1	AGR Section 5

Third party review item	Jacobs 2019 reference	Jacobs 2021 reference
Table 3 Q 3.2	Figure 37	AGR Figure 40
Table 3 Q 4.2	Section 5.3.2.4	GMR Section 4.6
Table 4 Q 5.1	Figures 58 to 63	GMR Figure 24 to 29
Table 4 Q 5.3	Figures 58 to 63	GMR Figure 24 to 29
Table 4 Q 5.4	Table 39 (error Table 34) Table 34 Figure 17	GMR Table 9 GMR Table 9 AMR Figure 20

NPM TECHNICAL PTY LTD
ABN 52 613 099 540
Trading as ***HydroSimulations***

PO Box 241 Gerringong N.S.W. 2534
Phone (+61 2) 42343802

noel.merrick@hydrosimulations.com

Date: 23 November 2019

To: Nick Warren
Senior Environmental Consultant
R.W.Corkery & Co. Pty Ltd
1st Floor, 12 Dangar Road
BROOKLYN NSW 2083

From: Dr Noel Merrick

Re: **Bowdens Silver Project - Peer Review of Groundwater Impact Assessment**

Your Ref: 429
Our Ref: HS2019/36b

Introduction

This report provides a peer review of the groundwater impact assessment (GIA) and associated modelling for the Bowdens Silver Project to the south-east of Mudgee, NSW. The GIA has been prepared by Jacobs Group (Australia) Pty Limited [Jacobs] under the project management of R.W.Corkery & Co. Pty Ltd, for the client Bowdens Silver Pty Ltd.

Documentation

The review is based on the following report:

1. Jacobs, 2019, Bowdens Silver Project Groundwater Impact Assessment. Specialist Consultant Studies Compendium Volume 2, Part 5, report prepared for Bowdens Silver Pty Ltd, version 3, 27 September 2019. 198p + 10 Annexures.

Document #1 has the following sections:

- Executive Summary
1. Introduction
2. Legislation and policy
3. Previous investigations
4. Existing environment
5. Groundwater modelling
6. Impact assessment
7. Licensing requirements
8. Monitoring Management
9. References

The Annexures are:

1. Aquifer Interference Policy Checklist
2. Groundwater Works Summary
3. BGW10, BGW108 Pumping Tests
4. Airlift Recovery Tests
5. Packer Injection Tests
6. Comprehensive Water Quality Analyses
7. Tailings Storage Facility

8. WAL Summary
9. Uncertainty Analysis – Predicted Groundwater Drawdown
10. Groundwater Model Review

Apart from the current peer review report, progressive reviews were conducted by HydroSimulations as documented in these reports:

2. Merrick, N., 2016, Review of Bowdens Silver Mine Groundwater Proposal. HydroSimulations Report HS2016/59. 22 November 2016. 2p.

3. Merrick, N., 2017, Bowdens Silver Project – Peer Review of Hydrogeological Assessment. HydroSimulations Report HS2017/18. 7 May 2017. 5p.

4. Merrick, N., 2019, Bowdens Silver Project – Peer Review of Groundwater Impact Assessment. HydroSimulations Report HS2019/36. 4 August 2017. 14p.

Document #2 reviewed the groundwater model study plan. Document #3 reviewed model calibration. Document #4 is a draft version of the current review, based on:

5. Jacobs, 2019, Bowdens Silver Project Groundwater Impact Assessment. Specialist Consultant Studies Compendium Volume 2, Part 5, report prepared for Bowdens Silver Pty Ltd, version 2, 4 June 2019. 185p + 9 Annexures.

Comments on the review in Document #4 have been received from Jacobs (file "Review comments register_GS.xlsx").

The peer review was conducted progressively and included face-to-face meetings on two occasions at the Jacobs office in North Sydney:

1. Inception meeting (held on 3 November 2016).

2. Calibration milestone meeting (held on 20 April 2017).

Review Methodology

While there are no standard procedures for peer reviews of entire groundwater assessments, there are guidelines for the numerical modelling that underpins the assessment.

There are two accepted guides to the review of groundwater models: (A) the Murray-Darling Basin Commission (**MDBC**) Groundwater Flow Modelling Guideline[1], issued in 2001, and (B) guidelines issued by the National Water Commission (**NWC**) in June 2012 (Barnett *et al.*, 2012[2]). The NWC national guidelines were built upon the original MDBC guide, with substantial consistency in the model conceptualisation, design, construction and calibration principles, and the performance and review criteria, although there are differences in details.

The NWC guide promotes the concept of "model confidence level", which is defined using a number of criteria that relate to data availability, calibration, and prediction scenarios. The NWC guide is almost silent on modelling of mines and offers no direction on best practice methodology for such applications. There is, however, an expectation of more effort in uncertainty analysis, although the guide is not prescriptive as to which methodology should be adopted.

Guidelines on uncertainty analysis for groundwater models were issued by the Independent Expert Scientific Committee (**IESC**) on Coal Seam Gas and Large Coal Mining Development in February 2018

[1] MDBC (2001). Groundwater flow modelling guideline. Murray-Darling Basin Commission. URL: www.mdbc.gov.au/nrm/water_management/groundwater/groundwater_guides

[2] Barnett, B, Townley, L.R., Post, V., Evans, R.E., Hunt, R.J., Peeters, L., Richardson, S., Werner, A.D., Knapton, A. and Boronkay, A. (2012). *Australian Groundwater Modelling Guidelines*. Waterlines report 82, National Water Commission, Canberra.

in draft form and finalised in December 2018[3]. Although it could be argued that this guide has no applicability to metalliferous mining, the document contains useful generic advice relevant to the broader mining industry.

The groundwater guides include useful checklists for peer review. This groundwater impact assessment has been reviewed according to the 2-page Model Appraisal checklist[4] in MDBC (2001). This checklist has questions on (1) The Report; (2) Data Analysis; (3) Conceptualisation; (4) Model Design; (5) Calibration; (6) Verification; (7) Prediction; (8) Sensitivity Analysis; and (9) Uncertainty Analysis. Non-modelling components of the groundwater impact assessment are addressed by the first three sections of the checklist.

The review has also considered whether compliance with the minimal impact considerations of the *NSW Aquifer Interference Policy* (AIP) (NSW Government, 2012[5]) has been addressed adequately.

It should be recognised that the effort put into the modelling component of a groundwater impact assessment is very dependent on possible timing and budgetary constraints that are generally not known to a reviewer. However, this is less of an issue with a progressive review. This review has been conducted progressively since November 2016. The meeting on 20 April 2017 was an interrogative review based on screen displays of model construction and model performance, with consensus completion of detailed checklists for *Model Design* and *Model Calibration*, as presented at **Table 1** and **Table 2** for model development at that time.

The assessment of all aspects of finalised groundwater modelling is recorded in the checklist at **Table 3** and **Table 4**. This includes updated commentary on aspects of **Table 1** and **Table 2** which required attention at April 2017, but have now been addressed satisfactorily. Supplementary comment is offered in the following sections of this review.

Report Matters

The GIA report is a standalone report of about 200 pages in total, to which are appended 10 Annexures of another almost 100 pages, providing an adequate groundwater impact assessment in support of the Project. The report commences with a succinct 2-page Executive Summary that addresses each potential impact and water licensing requirement in turn.

The report is well structured, written very clearly, and offers substantial explanations of concepts and background material. The illustrations are well chosen and informative. Consequently, there is a very thorough basis for conceptualisation of the groundwater system.

The objectives are outlined at the start and those objectives are addressed at the end of the report. In particular, Annexure 1 includes an *Aquifer Interference Policy* checklist.

The discussion on stream flow does not appear until late in the report at Section 5.3.3.3 and Figures 64 and 65. A flow-duration curve for Hawkins Creek would assist or confirm the Chapman baseflow separation analysis, which is explained at Section 5.3.3.3. It is understood that more detail is provided in the Surface Water Assessment.

A global water balance is provided for both steady-state and transient calibration, but not for prediction. That for transient calibration is presumably averaged over the 6.3 years of the calibration period (2011-2017). Included is an interpretation of the components in the form of the main recharge and discharge drivers, as relative

[3] Middlemis H and Peeters LJM (2018) *Uncertainty analysis—Guidance for groundwater modelling within a risk management framework*. A report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Commonwealth of Australia 2018.

[4] The NWC guidelines include a more detailed checklist with yes/no answers but without the graded assessments of the 2001 checklist, which this reviewer regards as more informative for readers.

[5] NSW Government, 2012, NSW Aquifer Interference Policy – NSW Government policy for the licensing and assessment of aquifer interference activities. Office of Water, NSW Department of Primary Industries, September 2012.

percentages, whether the streams are mostly gaining or losing, and whether the net storage means a net gain or a net loss.

Data Matters

The geology and hydrogeology of the area are explained very clearly and in detail. The case for dominant fracture flow is advanced convincingly, and justification for implementation in the model as an equivalent porous medium (EPM) is presented at Section 5.3.2.6. The reviewer agrees that an EPM is appropriate, and attempts to model discrete fracture paths in a regional model would be counter-productive.

Given a lengthy history of geological and hydrogeological investigations in the area, extant data sources and information are investigated to sufficient detail. There is a very expansive coverage of background data and baseline data analysis of all types: rainfall, stream flow, hydraulic conductivity, porosity, EC, pH, major ions.

A thorough cause-and-effect analysis has been conducted on groundwater hydrographs, EC charts, and Piper / Gibbs Diagrams, to infer the importance of driver mechanisms. Vertical hydraulic gradients have also been investigated. The key processes are shown schematically on pre-mining and post-mining cross-section conceptual models (Figures 37 and 38). However, a notional Tailings Storage Facility (TSF) could have been included on the latter figure.

Model Matters

The model is said to have a Class 2 confidence level, but this has not been substantiated. Nevertheless, Class 2 is the appropriate target confidence level for a mining impact assessment. Justification could have been provided for this ranking by completion of a table modified from Table 2-1 in the NWC guide as recommended in the IESC guide on Uncertainty Analysis (see attached **Table 5** template). By examining counts for each relevant attribute in each Class, a model can be characterised as having stated percentages of each Class.

There are no issues with model design in terms of areal extent, vertical subdivision into model layers, spatial resolution scales, choice of boundary conditions, or software. There are many options at the disposal of the modeller with MODFLOW-USG, but they have not been listed (see item 4.3 in **Table 3**).

Although the modelling appears to have been undertaken competently and successfully, there are deficiencies in reporting, namely:

- No scattergram is reported for transient calibration.
- A global water balance table for prediction is not presented for comparison with that shown for the calibration period.
- Figures 58-63 are poor quality. The y-axis should have integer intervals (e.g. 1m, 5m or 10m), not fractional, and the x-axis should show the date, not number of days.

Nevertheless, calibration statistics are very good: 1.4 %RMS and about 6.3 mRMS[6]. Qualitative comparison of hydrographs (Figures 58-63) suggests a mixture from "good" to "bad" agreement, but it is not easy for the reader to judge whether there is any spatial pattern to the degree of performance. The lack of replication of many measured amplitudes could be due to overestimation of specific storage (Ss). The calibrated values happen to be always higher (except for one case) than the purported maximum in a recent publication by Rau *et al.* (2018)[7]. However, this reviewer is of the opinion that considerably higher values are legitimate, especially for unconsolidated sediments.

[6] There is a presumed "typo" for absolute residual mean = 7.07E+06 m.
[7] Rau, G.C., Acworth, R.I., Halloran, L.J.S., Timms, W.A. and Cuthbert, M.O., 2018. Quantifying compressible groundwater storage by combining cross-hoe seismic surveys and head response to atmospheric tides. Journal of Geophysical Research: Earth Surface, **123**, 1910-1930.

Rainfall recharge is accomplished by a simple fraction of actual rainfall, partitioned into separate spatial zones for ridgetops, foothills, floodplain and Lake Windamere. Similarly, maximum evapotranspiration (ET) rate is taken to be a fraction of Actual ET for the same divisions, with extinction depth uniformly 3 m. This approach is satisfactory.

It is not clear to a reader how the TSF has been modelled (Section 5.3.4.2). Is it regarded as a thicker Layer 1? Has it been given material properties? Is it handled only as a time-varying recharge rate? If the latter, how can a water level rise be predicted?

The drawdown predictions and regional extents appear plausible, as does the predicted expansion post-mining. Baseflow reduction impacts are quantified by a proper process.

The predicted pit lake water level is in good agreement with more thorough final void modelling by WRM (2019), and modelling of final voids by surface water specialists should always take priority. It is likely that the pit lake water level in Figure 72 is from the WRM model but a reader could interpret otherwise. As the final salinities are not high, and the freeboard is about 27 m, there is little risk of density-dependent flow against the apparent hydraulic gradient. The final void is likely to remain a perennial sink.

The sensitivity of hydraulic properties and rainfall recharge factors was investigated using the steady-state model with PEST software and the Jacobian matrix.

An IESC-Type1 uncertainty analysis has been conducted through perturbations of key properties for their effects on predicted outputs of interest. During the sensitivity analysis with the same ranges for hydraulic properties and rainfall recharge factors, no significant effect on calibration performance was noted. This suggests the uncertainty outputs are consistent with model realisations that remain calibrated. While a factor of 2 is appropriate for Sy, it is not for Ss, where an order-of-magnitude perturbation should have been applied in order to see any appreciable effects.

Conclusion

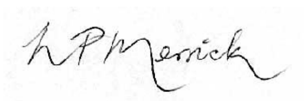
The degree of model complexity and modelling effort for this groundwater assessment are considered to be appropriate.

Modelling of a dominant fracture-flow groundwater system by an equivalent porous medium is also appropriate.

There is very low risk that **the owners of private bores near Lue township would be affected by drawdown caused by mining of the deposit.**

The reviewer regards this model as being *fit for purpose*, where the purpose is jointly estimation of water take and prediction of the reduction in regional groundwater levels.

Yours sincerely



Dr Noel Merrick

Table 1. Peer Review of Model Design [at 20 April 2017]^

Q.	QUESTION	Not Applicable or Unknown	Score 0	Score 1	Score 3	Score 5	Score	Max. Score (0, 3, 5)	COMMENT
4.1	Is the choice of mathematical model appropriate (analytical / numerical)?			No	Maybe	Yes			Numerical
4.2	Is the spatial extent of the model appropriate?			No	Maybe	Yes			Yet to specify km
4.3	Is the spatial discretisation scale appropriate?		Missing	No	Maybe	Yes			20-31m minimum at pit
4.4	Is the number of model layers justified?		Missing	No	Maybe	Yes			8
4.5	Is steady state simulated?		Missing	Deficient	Adequate	Very Good			
4.6	Is transient behaviour simulated?		Missing	Deficient	Adequate	Very Good			183 months = 15.25 yrs (calib) + 15 yrs prediction
4.7	Is the stress period reasonable?		Missing	No	Maybe	Yes			6 months
4.8	Is the number of time steps per stress period justified?	Yet to check	Missing	Deficient	Adequate	Very Good			
4.9	Are the applied boundary conditions plausible and unrestrictive?		Missing	Deficient	Adequate	Very Good			
4.10	Are boundary condition locations consistent with the model grid configuration?		Missing	No	Maybe	Yes			
4.11	Are the initial conditions defensible?		Missing	Deficient	Adequate	Very Good			Steady state base
4.12	Is it clear what software has been selected?		Missing	No	Maybe	Yes			MF-USG
4.13	Is the software appropriate for the objectives of the study?			No	Maybe	Yes			
4.14	Is the software reputable?			No	Maybe	Yes			AlgoMesh & Groundwater Vistas
4.15	Is the software in common use and accessible to reviewers?			No	Maybe	Yes			
4.16	How detailed is the rainfall recharge algorithm?		Missing	Deficient	Adequate	Very Good			Rain fraction
4.	TOTAL SCORE								

^ Items marked in **green** have been addressed satisfactorily since April 2017

HS2019_36b Bowdens Silver Project - Peer review of Groundwater Assessment.docx   Page 6

Table 2. Peer Review of Model Calibration [at 20 April 2017]^

Q.	QUESTION	Not Applicable or Unknown	Score 0	Score 1	Score 3	Score 5	Score	Max. Score (0, 3, 5)	COMMENT
5.1	Is sufficient data available for spatial calibration?			No	Maybe	Yes			PINNEENA + monitoring network
5.2	Is sufficient data available for temporal calibration?			No	Maybe	Yes			40 hydrographs measured monthly from 2012
5.3	Does the model claim to be adequately calibrated for the purpose of the study?		Missing	No	Maybe	Yes			Not yet finalised
5.4	Are calibration difficulties acknowledged?		Missing	Deficient	Adequate	Very Good			Difficulty with bores upgradient from mine site
5.5	Is it clear whether calibration is automated or trial-and-error?		Missing	No		Yes			Trial & error
5.6	Is there sufficient evidence provided for model calibration?		Missing	Deficient	Adequate	Very Good			Scattergram. Statistics. Hydrographs. Spatial water level contours. Yet to see a check of baseflow magnitudes.
5.7	Is the model sufficiently calibrated against spatial observations?		Missing	Deficient	Adequate	Very Good			Can infer from scattergram. Yet to see a comparison with observed/interpolated water table contour pattern
5.8	Is the model sufficiently calibrated against temporal observations?		Missing	Deficient	Adequate	Very Good			Good trends.
5.9	Are parts of the model well calibrated?		Unknown	No	Maybe	Yes			Most of the area.
5.10	Are parts of the model poorly calibrated?		Unknown	Yes	Maybe	No			At present – north of mine site.
5.11	Is the model calibrated to data from different hydrological regimes?		Unknown	No	Maybe	Yes			The 2002-2017 period covers wet and dry episodes. Data are limited to about 5 years.
5.12	Are calibrated parameter distributions and ranges plausible?		Missing	No	Maybe	Yes			Examined for each layer – plausible.
5.13	Is a calibration statistic reported?		Missing	No		Yes			1.9 %RMS; 10 mRMS (should reduce)
5.14	Does the calibration statistic satisfy agreed performance criteria?		Missing	Deficient	Adequate	Very Good			<<5 %RMS target
5.15	Are there good reasons for not meeting agreed performance criteria?		Missing	Deficient	Adequate	Very Good			Awaiting finalised calibration.
5.	TOTAL SCORE								

^ Items marked in **green** have been addressed satisfactorily since April 2017

HS2019_36b Bowdens Silver Project - Peer review of Groundwater Assessment.docx Page 7

Table 3. Peer Review of Bowdens Silver Project Model [Part A]

Q.	QUESTION	Not Applicable or Unknown	Score 0	Score 1	Score 3	Score 5	Score	Max. Score (0, 3, 5)	COMMENT
1.0	**THE REPORT**								
1.1	Is there a clear statement of project objectives in the modelling report?		Missing	Deficient	Adequate	Very Good			Agency requirements: Table 1. Sections 1.2, 1.3. Modelling objectives S5.3.1.
1.2	Is the level of model complexity clear or acknowledged?		Missing	No	Yes				Stated as Class 2 – agreed. But evidence not provided *(see Table 5 template following here)*.
1.3	Is a water or mass balance reported?		Missing	Deficient	Adequate	Very Good			Calibration (Tables 38, 41). Interpretation of relativities. Not prediction.
1.4	Has the modelling study satisfied project objectives?		Missing	Deficient	Adequate	Very Good			
1.5	Are the model results of any practical use?			No	Maybe	Yes			
2.0	**DATA ANALYSIS**								
2.1	Has hydrogeology data been collected and analysed?		Missing	Deficient	Adequate	Very Good			Section 4.5. Hydraulic tests in S4.5.7 to S4.5.10 (airlift tests, pumping tests, 4 packer tests). Figure 16 summary of K(z). Figure 18 summary of porosity(z). Table 17: calculation of Ss. Geology: S4.3, S4.4. Fracture stereonet.
2.2	Are groundwater contours or flow directions presented??		Missing	Deficient	Adequate	Very Good			Figure 25.
2.3	Have all potential recharge data been collected and analysed? (rainfall, streamflow, irrigation, floods, etc.)		Missing	Deficient	Adequate	Very Good			SILO rainfall compared to site. Used 4 stations in model (Thiessen polygons). Streamflow Figure 64 S5.3.3.3 – could include flow-duration curve.
2.4	Have all potential discharge data been collected and analysed? (abstraction, evapotranspiration, drainage, springflow, etc.)		Missing	Deficient	Adequate	Very Good			Baseflow analysis Figure 65 S5.3.3.3. Chapman method explained. Users: S4.5.2 & Annexure 2: 82 private bores within 10km.

2.5	Have the recharge and discharge datasets been analysed for their groundwater response?		Missing	Deficient	Adequate	Very Good			CRD comparison. Evident rain and pumping effects. Good analysis of vertical gradients at paired sites (Table 18). Analysis of EC(t) plots and Piper / Gibbs Diagrams.
2.6	Are groundwater hydrographs used for calibration?			No	Maybe	Yes			Many hydrograph sites on Figures 20-23: unstated number. Hydrograph plots in 3 groups.
2.7	Have consistent data units and standard geometrical datums been used?			No	Yes				
3.0	**CONCEPTUALISATION**								
3.1	Is the conceptual model consistent with project objectives and the required model complexity?		Unknown	No	Maybe	Yes			
3.2	Is there a clear description of the conceptual model?		Missing	Deficient	Adequate	Very Good			S5.1: extensive detail. Inferences from dh/dz and water quality.
3.3	Is there a graphical representation of the modeller's conceptualisation?		Missing	Deficient	Adequate	Very Good			X-Sections Fig.37, 38 with mine cutout and flow indicators. Should add TSF.
3.4	Is the conceptual model unnecessarily simple or unnecessarily complex?			Yes	No				Conceptualised as a fracture flow system but implemented appropriately as an equivalent porous medium. Pumping test: "*…groundwater flow can be expected to behave in a pseudo-radial and porous media flow fashion.*" Rylstone Volcanics: "*…on a meso-scale, groundwater flow behaves in a pseudo-radial manner, similar to a porous aquifer.*"
4.0	**MODEL DESIGN**								**Some abandoned prior models**
4.1	Is the spatial extent of the model appropriate?			No	Maybe	Yes			Very large: 43.5km x 44km. 8 layers. Max 32k cells/layer (less pinchouts). Total 0.36 million active cells. Cell sizes 31.25-250m. No neighbouring mines.
4.2	Are the applied boundary conditions plausible and unrestrictive?		Missing	Deficient	Adequate	Very Good			Justified in S5.3.2.4.

4.3	Is the software appropriate for the objectives of the study?			No	Maybe	Yes			Gw-Vistas GUI. MF-USG variable structured grid. Unstated USG options: e.g. upstream weighting? CONSTANTCV? Lateral connections?

Table 4. Peer Review of Bowdens Silver Project Model [Part B]

Q.	QUESTION	Not Applicable or Unknown	Score 0	Score 1	Score 3	Score 5	Score	Max. Score (0, 3, 5)	COMMENT
5.0	**CALIBRATION**								**Steady-state. Transient Jan.2011-April 2017 (6.3 years).**
5.1	Is there sufficient evidence provided for model calibration?		Missing	Deficient	Adequate	Very Good			Steady-state: scattergram and statistics; ; residuals map; no head contours. Transient: 16 hydrographs shown (Figs.58-63); statistics; good spread of sites (x,z). No scattergram Baseflow agreement.
5.2	Is the model sufficiently calibrated against spatial observations?		Missing	Deficient	Adequate	Very Good			Steady-state residuals map and scattergram suggests OK but no heads map.
5.3	Is the model sufficiently calibrated against temporal observations?		Missing	Deficient	Adequate	Very Good			Figs.58-63 hydrograph comparisons: 7 good, 5 fair, 4 bad. Trends reasonable. Amplitudes mostly underpredicted – could require lower Ss. Figs.58-63 poor quality: need standard y-axis intervals, and date as x-axis.
5.4	Are calibrated parameter distributions and ranges plausible?		Missing	No	Maybe	Yes			Table 39: Ss values seem high. K values agree reasonably with field range (Table 34 vs Figure 17).
5.5	Does the calibration statistic satisfy agreed performance criteria?		Missing	Deficient	Adequate	Very Good			1.4%RMS, 6.3 mRMS. Need to correct Absolute Residual Mean = 7.07e+6m
5.6	Are there good reasons for not meeting agreed performance criteria?		Missing	Deficient	Adequate	Very Good			Mining complexity; homogeneous K per zone; fracture flow represented as equivalent porous medium.
6.0	**VERIFICATION**								**Optional for heads subset**
6.1	Is there sufficient evidence provided for model verification?	N/A	Missing	Deficient	Adequate	Very Good			

HS2019_36b Bowdens Silver Project - Peer review of Groundwater Assessment.docx

Page 11

6.2	Does the reserved dataset include stresses consistent with the prediction scenarios?	N/A	Unknown	No	Maybe	Yes			
6.3	Are there good reasons for an unsatisfactory verification?	N/A	Missing	Deficient	Adequate	Very Good			
7.0	**PREDICTION**								**2020?-2035 (15.5 years) + 200 years**
7.1	Have multiple scenarios been run for climate variability?		Missing	Deficient	Adequate	Very Good			Long-term average during prediction and recovery.
7.2	Have multiple scenarios been run for operational /management alternatives?		Missing	Deficient	Adequate	Very Good			One mine plan.
7.3	Is the time horizon for prediction comparable with the length of the calibration / verification period?		Missing	No	Maybe	Yes			6.3 versus 15.5 years. Ratio Pred/Calib = 2.4 (implies high "confidence")
7.4	Are the model predictions plausible?			No	Maybe	Yes			Mostly radial pattern. Recovery pit hydrograph Fig.72 suggests 90% recovery in 75years. Regional drawdown increases post-mining (as expected).
8.0	**SENSITIVITY ANALYSIS**								**K, Rain recharge**
8.1	Is the sensitivity analysis sufficiently intensive for key parameters?		Missing	Deficient	Adequate	Very Good			Composite sensitivities for K and %RCH by PEST and Jacobian matrix. Only 4 significant zones (2 K, 2 RCH). Sensible explored ranges.
8.2	Are sensitivity results used to qualify the reliability of model calibration?		Missing	Deficient	Adequate	Very Good			
8.3	Are sensitivity results used to qualify the accuracy of model prediction?		Missing	Deficient	Adequate	Very Good			Output of interest: mine inflow. Not baseflow.
9.0	**UNCERTAINTY ANALYSIS**								

9.1	If required by the project brief, is uncertainty quantified in any way?		Missing	No	Maybe	Yes			Based on sensitivity analysis by perturbation [IESC Type 1]. Factors on K (x10, /10) are sufficient. Factors on Ss are inadequate (x2, /2); OK for Sy. Factors on recharge are OK (x2, /2). During the sensitivity analysis with the same ranges for K and %RCH, no significant effect on calibration performance was noted. This suggests the uncertainty outputs are consistent with model realisations that remain calibrated.
9.2	Are uncertainty results used to qualify the reliability of model calibration?		Missing	Deficient	Adequate	Very Good			No significant effect on calibration performance was noted with the PEST objective function value.
9.3	Are uncertainty results used to qualify the accuracy of model prediction?		Missing	Deficient	Adequate	Very Good			Outputs of interest: mine inflow; drawdown extents. Not baseflow.
	TOTAL SCORE								PERFORMANCE: %

Table 5. Model Confidence Level Classification

CLASS	DATA	CALIBRATION	PREDICTION	INDICATORS
1	Not much. Sparse. No metered usage. Remote climate data.	Not possible. Large error statistic. Inadequate data spread. Targets incompatible with model purpose.	Timeframe >> calibration Long stress periods. Transient prediction but steady-state calibration. Bad verification.	Timeframe > 10x Stresses > 5x Mass balance > 1% (or single 5%) Properties <> field. Bad discretisation. No review.
2	Some. Poor coverage. Some usage info. Baseflow estimates.	Partial performance. Long-term trends wrong. Short time record. Weak seasonal replication. No use of targets compatible with model purpose.	Timeframe > calibration. Long stress periods. New stresses not in calibration. Poor verification.	Timeframe = 3-10x Stresses = 2-5x Mass balance < 1% Some properties <> field measurements. Some key coarse discretisation. Review by hydrogeo.
3	Lots. Good aquifer geometry. Good usage info. Local climate info. K measurements. Hi-res DEM.	Good performance stats. Long-term trends replicated. Seasonal fluctuations OK. Present day data targets. Head and flux targets.	Timeframe ~ calibration. Similar stress periods. Similar stresses to those in calibration. Steady-state prediction consistent with steady-state calibration. Good verification.	Timeframe < 3x Stresses < 2x Mass balance < 0.5% Properties ~ field measurements. No key coarse discretisation. Review by modeller.

Annexure 10

TSF Model Report

(Total No. of pages including blank pages = 44)

This page has intentionally been left blank

BOWDENS SILVER

ABN: 37 009 250 051

Annexure 10
TSF Model Report

Prepared for: R.W. Corkery & Co. Pty Limited
1st Floor, 12 Dangar Road
PO Box 239
BROOKLYN NSW 2083

Tel: (02) 9985 8511
Email: brooklyn@rwcorkery.com

On behalf of: Bowdens Silver Pty Limited
ABN: 37 009 250 051

Sydney Office
Level 11, 52 Phillip Street
SYDNEY NSW 2000

Tel: (02) 8316 3997
Fax: (02) 8316 3999

Operations Office
68 Maloneys Road
LUE NSW 2850
P.O. Box 1115
MUDGEE NSW 2850

Tel: (02) 6373 6420

Email: information@bowdenssilver.com.au

A Silver Mines Limited company

Prepared by: Jacobs Group (Australia) Pty Limited
177 Pacific Highway
NORTH SYDNEY NSW 2060

Tel: (02) 9032 1284
Email: greg.sheppard@jacobs.com

Ref No: IA132500

June 2021

CONTENTS

FIGURES

CONTENTS

Page

TABLES

1. INTRODUCTION

1.1 BACKGROUND

Bowdens Silver Pty Ltd (Bowdens Silver) proposes to develop and operate the Bowdens Silver Project (the Project), located approximately 2.5km northeast of Lue and approximately 26km southeast of Mudgee, in New South Wales (**Figure 1**). The Project would mine epithermal silver deposits hosted in the Rylstone Volcanics and would incorporate a conventional open cut pit where overburden/waste rock is removed from above and around the silver-zinc-lead ore and either used for on-site construction activities or placed in the out-of-pit waste rock emplacement or the southern barrier. The mined ore would be transported by haul trucks to the on-site processing plant where it would be crushed, milled and processed to liberate the silver, zinc and lead minerals. These minerals would be collected by conventional froth flotation to produce two concentrates that would be dewatered and transported off site by truck. The residual materials from processing (tailings) would be pumped in the form of a slurry to a tailings storage facility (TSF) located to the west of the open cut pit (**Figures 1** and **2**).

The proposed TSF for the Project would be constructed in three stages, with an initial embankment developed for Stage 1, and successive embankment lifts for Stages 2 and 3. Details of the preliminary TSF design and investigations are provided in the TSF Preliminary Design Report (ATC Williams, 2020).

The TSF preliminary design is for a down-valley discharge style of tailings deposition with deposited tailings impounded against a down-stream embankment. The tailings slurry would be pumped from the processing plant via a pipeline to one of three discharge points and would comprise approximately 56% solids, with an average daily discharge of decant water to the TSF of 4 302m^3/day. Decant water would be reclaimed from a decant pond located at the upstream face of the TSF embankment and returned to the processing plant.

Seepage control measures presented in the TSF preliminary design included grouting of the rock foundations beneath the TSF embankment and compacted clay lining of the tailings impoundment area. The TSF embankment would be constructed using a zoned rockfill embankment with a low permeability bituminous geomembrane liner on the upstream face. A toe drain and a seepage collection drain would be installed to collect any seepage from the TSF and runoff from the downstream face of the TSF embankment. This would then be pumped back to the TSF.

Tailings slurry and decant water quality is expected to be of neutral pH (pH 7-8). Electrical conductivity would be commensurate with process water supply. Minor manganese concentrations in the order of 10mg/L to 30mg/L above the process water quality are anticipated (GCA, 2019).

The results of laboratory testing of tailings solids samples (GCA, 2019) indicate that the tailings are classified as PAF due to the presence of trace and accessory sulphide minerals and the absence of reactive carbonate materials.

An Environmental Impact Statement (EIS) was submitted for the Project in May 2020. A regional groundwater flow model (Bowdens RGFM) was developed to inform the Groundwater Impact Assessment (Jacobs, 2020) that was undertaken in support of the EIS. Jacobs (2020) predicted seepage rates for each stage of the TSF development using a nominal tailings thickness of 20m and a 0.45m compacted clay liner at 1.56x10^{-8}m^3/s/m^2 (1.35x10^{-3}m^3/d/m^2) (ATC Williams, 2020).

Figure 1 Mine Site Layout

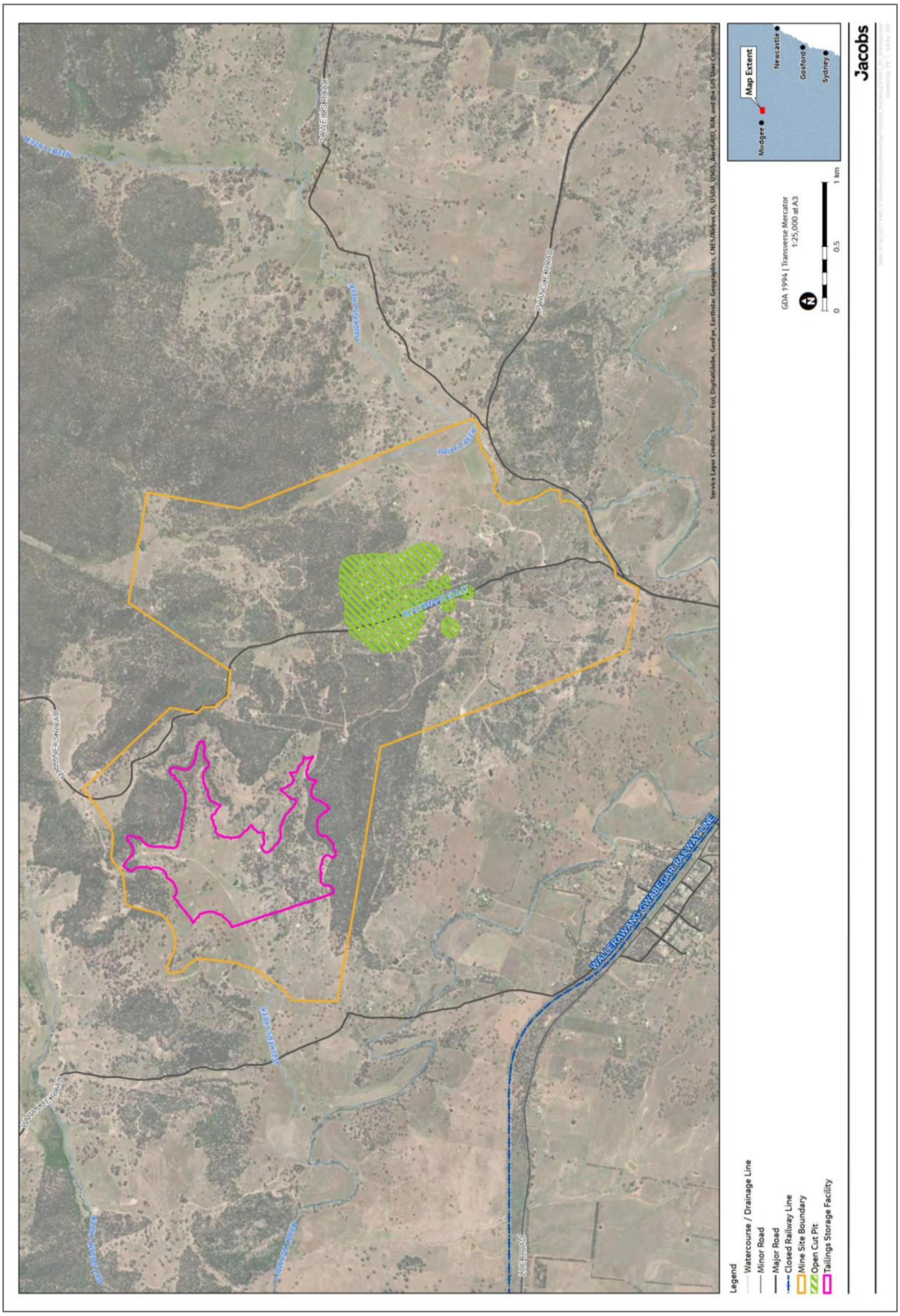
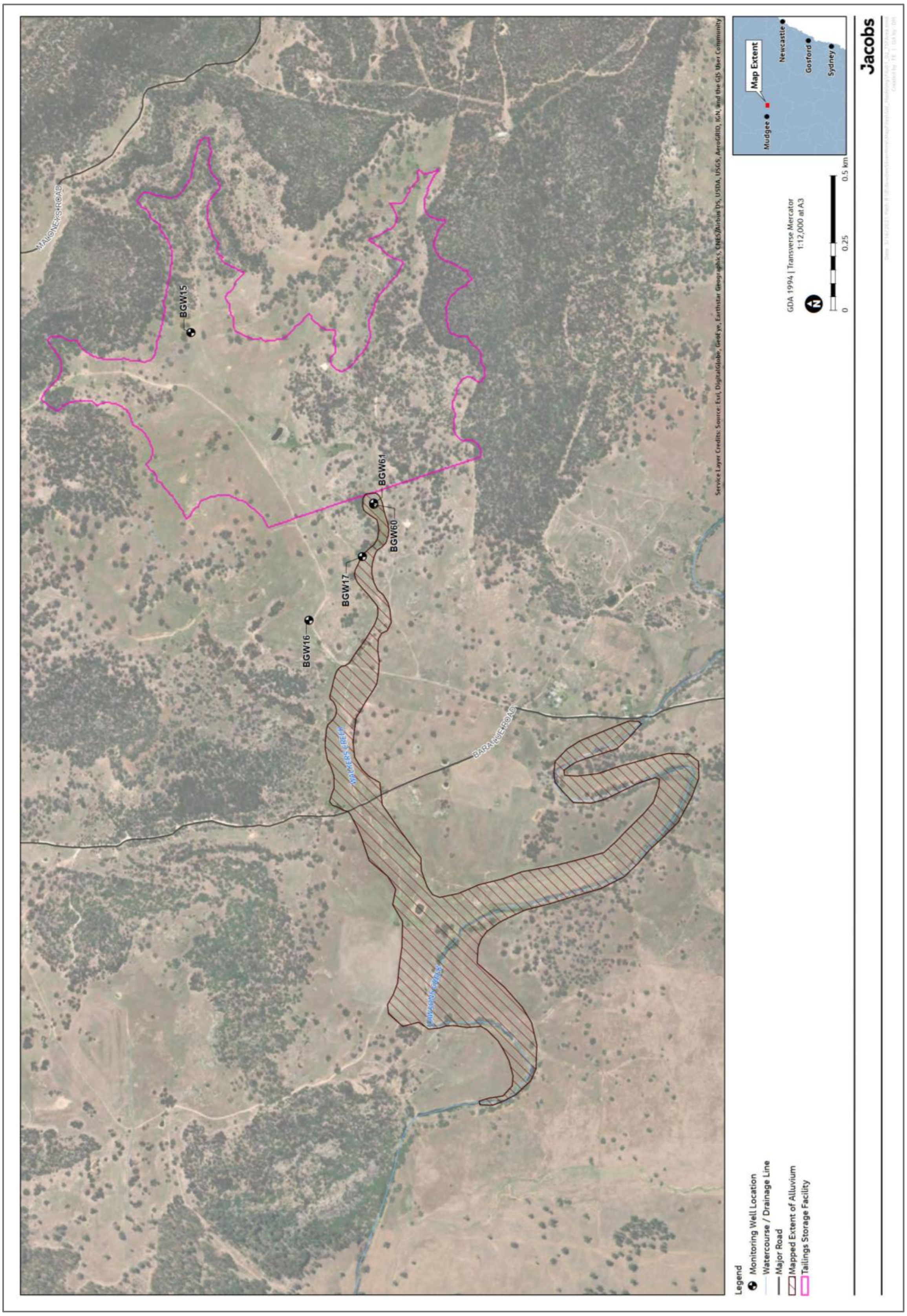


Figure 2 Tailings Storage Facility Area



It is noted that the anticipated seepage rate meets the NSW Environment Protection Authority (EPA) guideline seepage rate whereby seepage rates must be equivalent to or less than that transmitted by a 1m thick clay liner with a permeability of $1x10^{-9}$m/s.

In response to submissions received from government agencies and community members regarding information presented in the EIS and Jacobs (2021), additional modelling of the TSF has been undertaken using the Bowdens RGFM that was refined in the vicinity of the TSF to assess the TSF preliminary and additional design elements. Whilst the predicted seepage rates presented in Jacobs (2020) were within NSW EPA guidance, these additional TSF design elements were included at the request of Bowdens Silver to further reduce potential groundwater impacts. The model iterations, their development, implementation and results of groundwater flow and advective transport modelling are also described in this report.

1.2 MODELLING OBJECTIVES

The Bowdens RGFM (Jacobs 2021) was refined to achieve the following objectives:

- Refine the conceptual model with respect to aquifer and subsurface flow characteristics in the vicinity of the TSF.
- Assess two alternative TSF design options and operational strategies to limit potential groundwater impacts.
- Develop and run solute transport simulations to estimate the proportion of groundwater originating at the TSF that could potentially reach Lawsons Creek.
- Conduct sensitivity analysis on select model parameters.

1.3 MODEL FUNCTION

The development, calibration, and application of the Bowdens RGFM that was used to assess the broader Project-related impacts in accordance with the NSW Aquifer Interference Policy, is documented in **Annexure 9** of Jacobs (2021). Refinements to the Bowdens RGFM were made only within, and downgradient of, the TSF area, along Walkers Creek and near the confluence of Walkers Creek and Lawsons Creek. Thus, the refined model is predominantly the Bowdens RGFM with small scale modifications restricted to small sections of the Bowdens RGFM domain. These modifications are described in subsequent sections of this report. The modelling objectives have been achieved through a series of transient groundwater flow and solute transport simulations.

1.4 MODEL ASSUMPTIONS AND LIMITATIONS

Updates to the Bowdens RGFM included the following assumptions and limitations:

- Modelling the subsurface in the model domain as an equivalent porous medium is valid.
- Modelling groundwater in the study area as a single-density fluid is valid.
- Conceptual errors associated with no-flow assumptions across no-flow boundaries along the exterior and bottom of the Bowdens RGFM are negligible.
- The Bowdens RGFM does not simulate surface water processes, and as such, it does not address issues of surface-water routing and conveyance.

- There exists the possibility that specific subsurface features that act as barriers or conduits to groundwater flow have not been explicitly represented in the Bowdens RGFM.
- All model elevations related to model layering and boundary conditions were referenced to the Australian Height Datum (AHD).

1.5 MODEL CLASS

In accordance with the Australian Groundwater Modelling Guidelines (Barnett *et al.* 2012), the intended model confidence level classification for the Bowdens RGFM is Class 2 – Impact Assessment. Table 1 of **Annexure 9** (Jacobs 2021) presents a comparison between the characteristics of the Bowdens RGFM and quantitative indicators for that of a confidence Class 2 model, following the recommendation of Middlemis and Peters (2018). From this table, it can be seen that the Bowdens RGFM is fit for purpose as it either meets or exceeds most Class 2 criteria whilst also meeting many Class 3 criteria.

2. MODIFICATIONS TO BOWDENS RGFM

Modifications to the Bowdens RGFM were made in the vicinity of the proposed TSF to refine model geometry and incorporate geomorphological and alluvial mapping data collected in the intervening period. This data helped refine the conceptual model in this specific area with the goal of increasing the resolution of model predictions relating to the TSF. These modifications to the Bowdens RGFM included refinement of the model grid, hydraulic property distribution, and the boundary conditions representing Walkers Creek.

2.1 MODIFICATIONS TO THE MODEL GRID

Modifications to the model grid in the TSF area included the following:

- Refinement of grid cell spacing – Grid cell spacing was reduced in the TSF area to increase the spatial resolution near and downgradient from the TSF. **Figure 3** shows the refined model grid in the TSF area. Refined cell lengths and widths are 62.5m and 31.25m, respectively.
- Refined land surface elevation – Due to the refining of the model grid, the top of Model Layer 1 was also refined in the TSF area to reflect the smaller cell size over which the elevation data is averaged. The updated data set was based on light-detection and ranging (LiDAR) survey elevation data that was processed to create a 2 metre digital elevation model[1]. The new dataset was intersected with the refined MODFLOW-USG model grid, whereby elevations were assigned on a cell-by-cell basis in the RGFM. **Figure 4** illustrates the updated land-surface elevations incorporated into the top of the RGFM grid. Addition of a new model layer – A thin model layer was added at the surface so that the clay liner underneath the TSF could be explicitly simulated in the predictive models. Whilst this new layer was assigned a thickness of 0.1m over most of the model domain, the layer thickness was increased to 0.45m within the TSF impoundment area.
- Revised regolith/alluvium thickness – Model Layers 1 and 2 represent regolith and alluvium in the TSF area. In the northern portion of the TSF, the regolith was extended into Model Layer 3 as the regolith depth exceeds 4m (**Figure 5**). The base of Model Layer 2 was also revised using additional regolith and alluvium thickness data in the TSF area (test pits excavated within the TSF and geomorphic survey along Walkers Creek). **Figure 5** shows the combined thickness of Model Layers 1 and 2, which represent the thickness of material above competent weathered rock (except for the small zone in the northern TSF where regolith extends into Model Layer 3). **Figure 5** also shows that outside of the TSF and Walkers Creek areas, modelled regolith thickness is 3m, which is consistent with the Bowdens RGFM.

[1] https://elevation.fsdf.org.au/

Figure 3 Model Grid

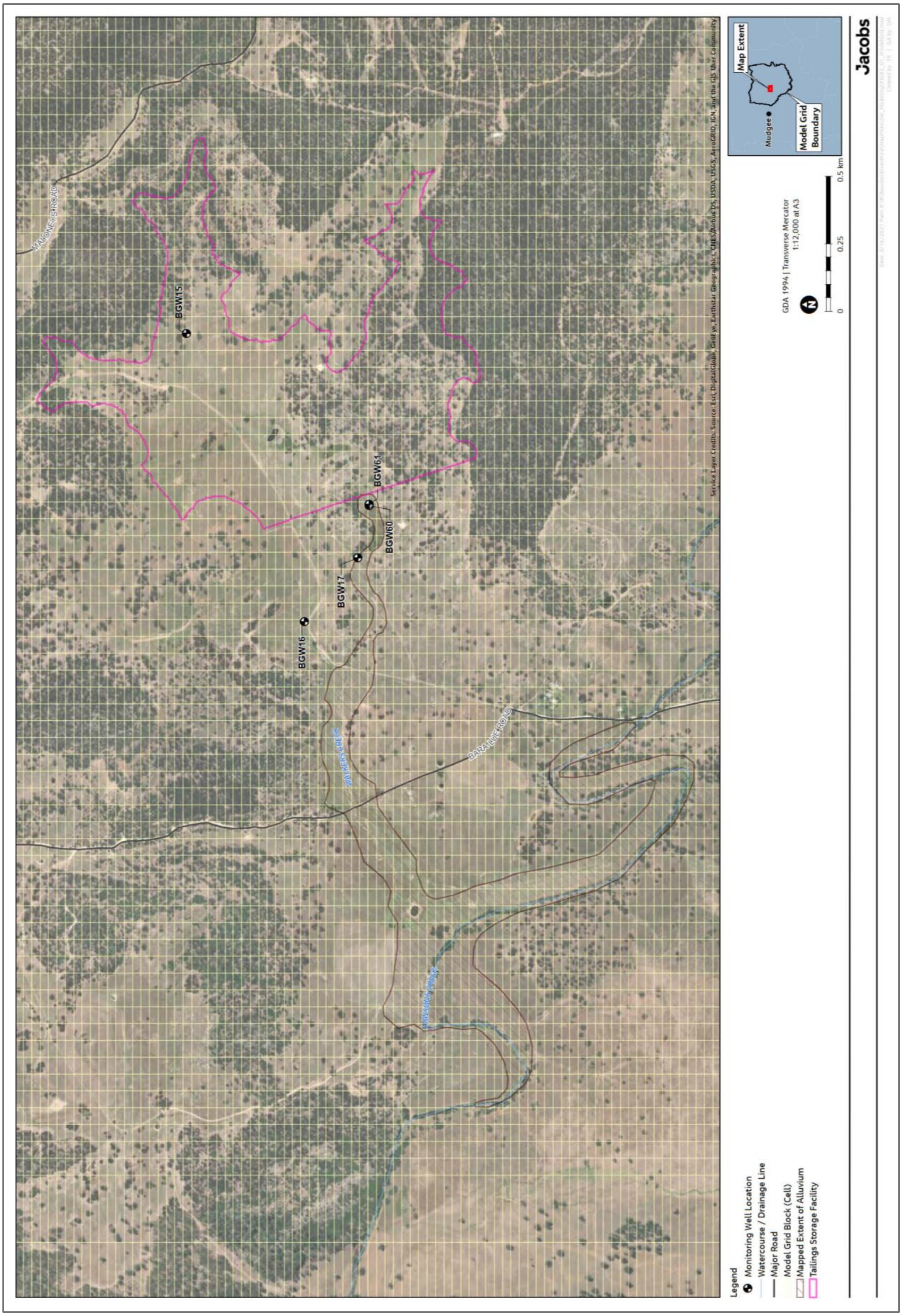


Figure 4 Modelled Land Surface Elevation

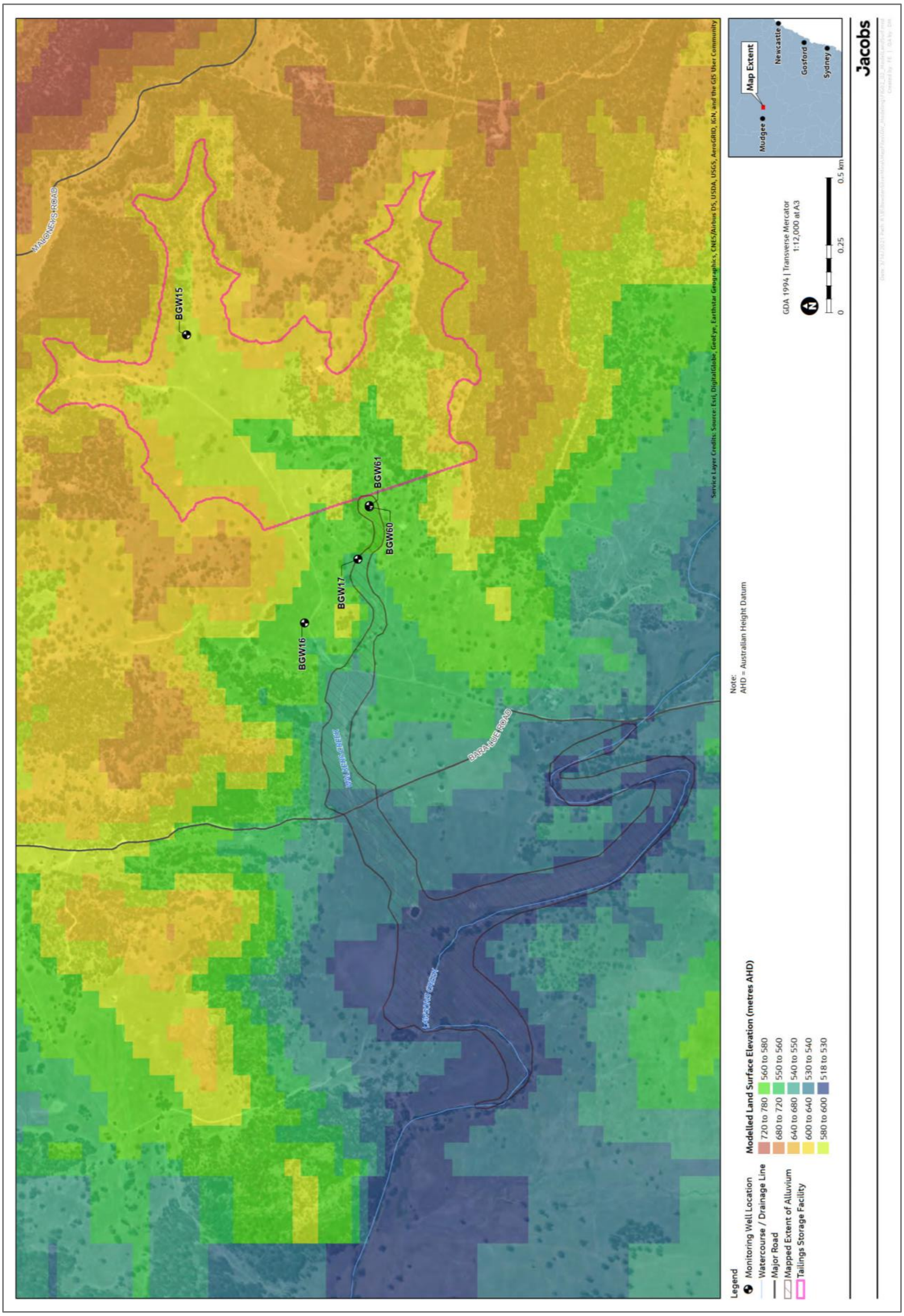
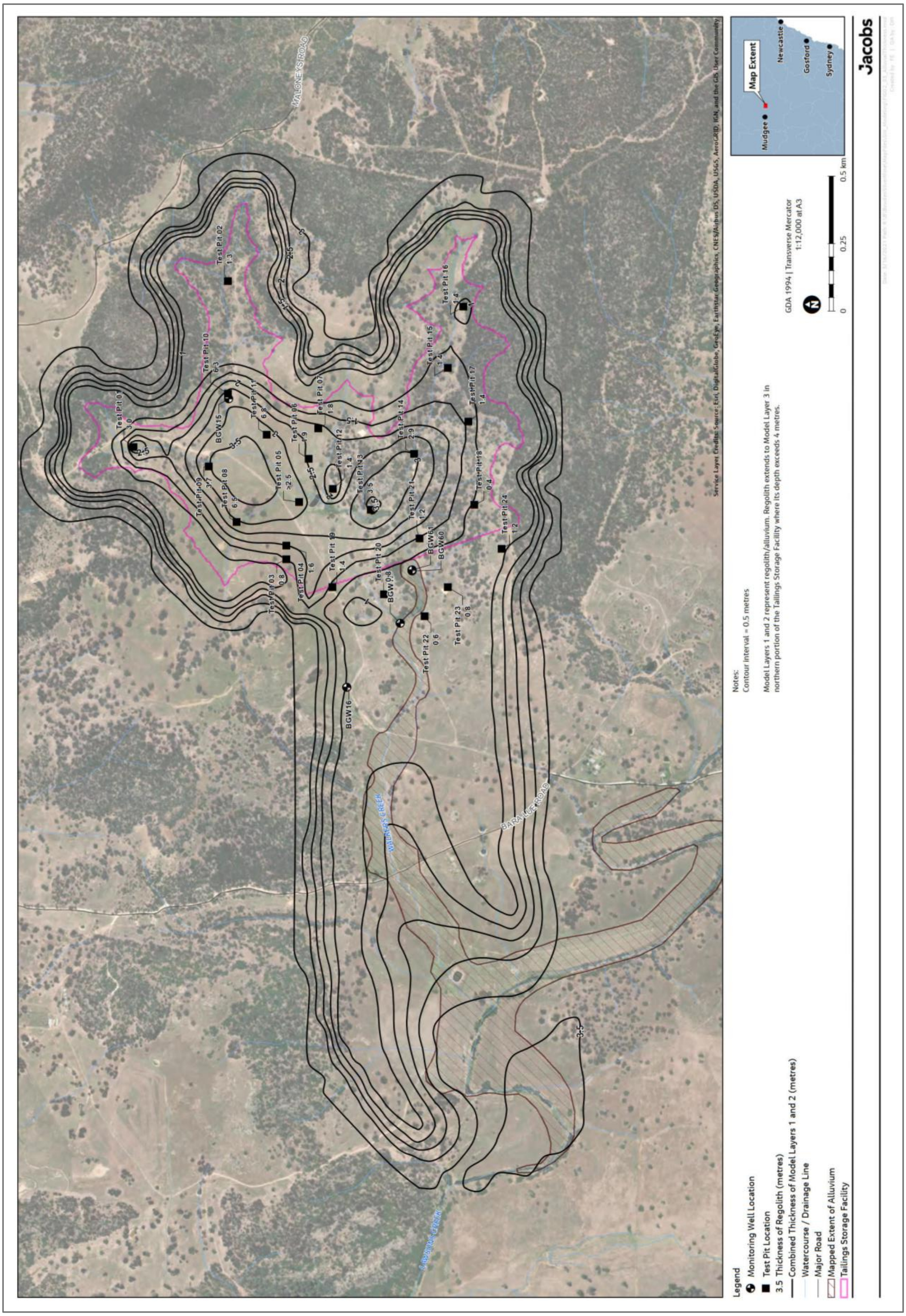


Figure 5 Combined Thickness of Model Layers 1 and 2



2.2 MODIFICATIONS TO HYDRAULIC CONDUCTIVITY

The distribution of hydraulic conductivity zones (K) was modified in the TSF area to better reflect the updated alluvial and regolith distribution and thicknesses in the model. **Figure 6** shows the modified K zonation maps in the TSF area that were limited to Model Layers 1 through 4 only. A new K zone (K Zone 2) was added in Model Layers 1 and 2 to represent alluvium near Walkers Creek (**Figure 6**). This additional zone was refined based on the alluvial extent mapped during the geomorphic survey with K values being 0.2m/d (Kh) and 0.02m/d (Kv). These values are considered reasonable given the dominant lithology of the alluvium was observed to be silty loam. Furthermore, as the thickness of Model Layers 1 and 2 were revised to incorporate the alluvium along Walkers Creek, zones that represented alluvium in deeper model layers were removed. **Table 1** presents the Kh and Kv values for the modelled K zones shown on **Figure 6**. The Bowdens RGFM K zonation for deeper layers and the values of horizontal and vertical hydraulic conductivity (Kh and Kv, respectively) were left unchanged.

Table 1
Modelled Hydraulic Conductivity Zone

Modelled Hydraulic Conductivity Zone[d]	Kh[b] (m/d)	Kv[c] (m/d)	Description
2	0.2	0.02	Alluvium (Silty Loam)
11	2.05	1.06	Alluvium (Sandy Silt)
12	0.098	0.08	Regolith
13	0.1	0.02	Weathered Rock
21	3	0.6	Alluvium (Silty Sand)
22	0.05	0.01	Weathered Rock (Silty Clay)
23	0.25	0.05	Weathered Rock
31	1.3[a]	0.009[a]	Partially Weathered Rock
32	0.57	0.057	Partially Weathered Rock
33	0.87	0.09	Weathered Rock
41	0.003	0.0003	Ordovician Basement
45	0.06	0.012	Volcanics / Coomber Formation
46	0.1	0.02	Volcanics

Notes:
[a] – Value modified from Bowdens RGFM
[b] – Kh = Horizontal hydraulic conductivity
[c] – Kv = Vertical hydraulic conductivity
[d] – Modelled hydraulic conductivity zones shown on **Figure 6**

2.3 MODIFICATIONS TO BOUNDARY CONDITIONS

Drain and river boundary conditions were altered from the Bowdens RGFM as ephemeral drainages were previously modelled using the head-dependent MODFLOW-USG Drain Package. Input parameters for this package include the drain dimensions, drain thickness, drain hydraulic conductivity, and drain elevation. Except for drain elevation and drain dimensions, all drain parameters were equivalent to those in the Bowdens RGFM. Drain elevations were assigned values of 2m below the modelled land surface in the Bowdens RGFM. However, because the top of Model Layer 1 was revised due to the higher grid resolution, the drain stage was also revised where the top of Model Layer 1 was updated. Furthermore, because the thickness of the upper two layers varies in the TSF area (**Figure 5**), some drain cells were moved into deeper layers so that the drain elevations were consistent with the layer in which the drain cells reside. In addition, the locations of the drain boundaries representing Walkers Creek were refined based on the geomorphic survey (**Figure 7**). Drain cell dimensions were also updated for consistency with refined grid cell dimensions. As with the drain boundaries, head-dependent river boundaries representing Lawsons Creek were modified based on the updated top of Model Layer 1, and river cell dimensions were updated based on the refined grid cell dimensions.

Figure 6 Modelled Hydraulic Conductivity Zones

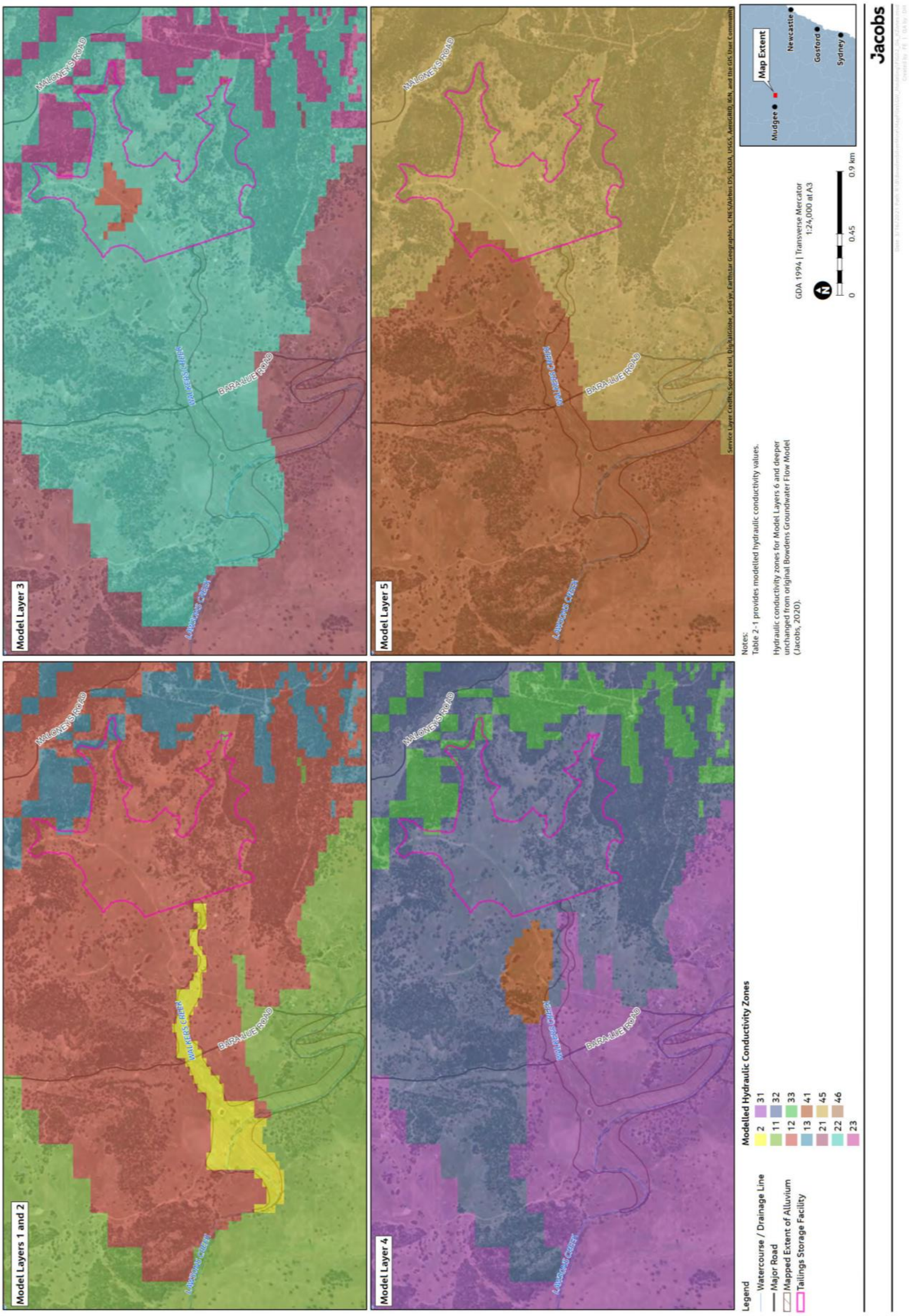
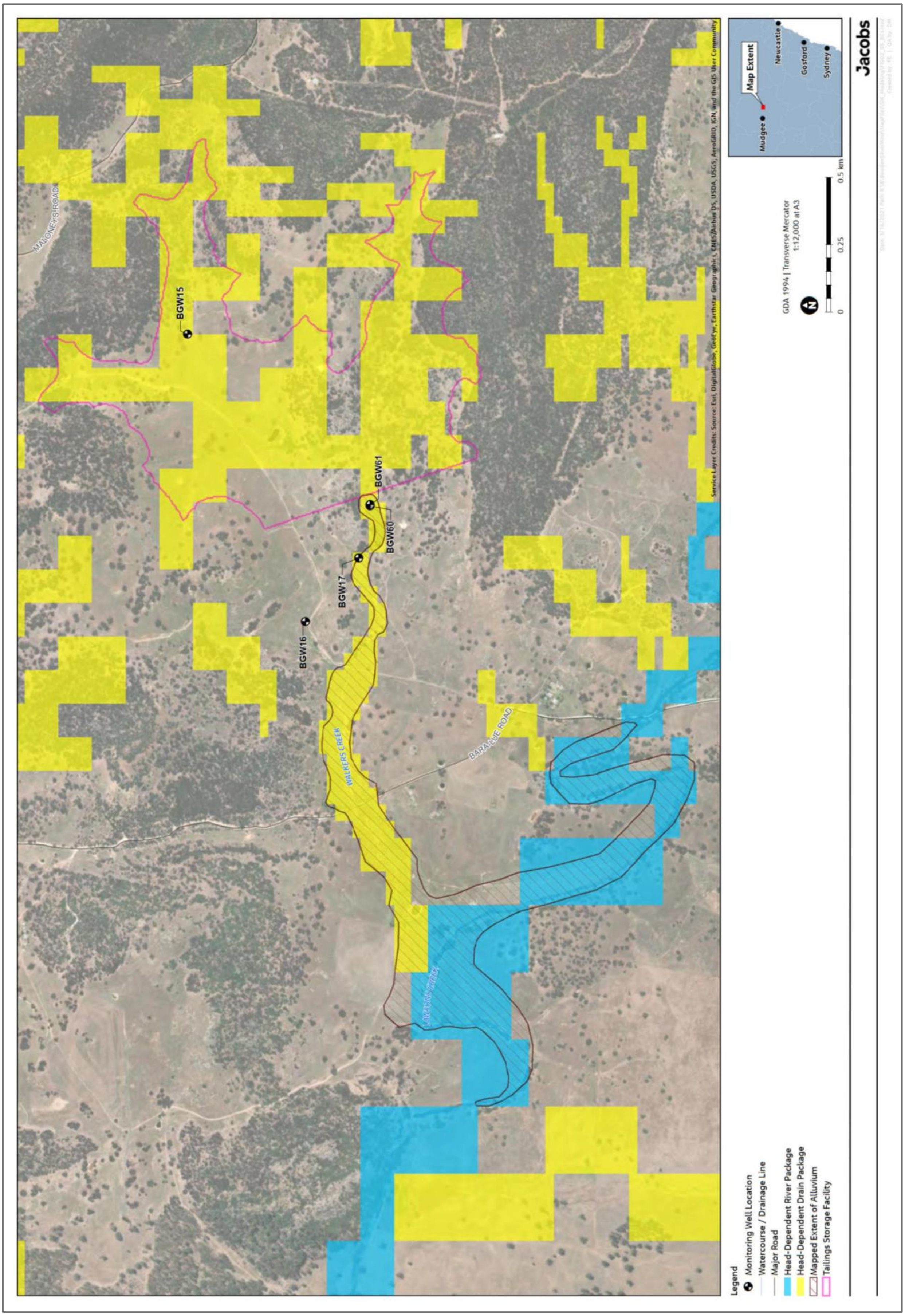


Figure 7 Model Boundary Conditions



3. MODEL CALIBRATION

Model calibration is the process of tuning numerical model parameters to adequately replicate selected observed values of interest (calibration targets). The Bowdens RGFM was calibrated in accordance with the Standard Guide for Calibrating a Ground-Water Flow Model Application (ASTM 1996) and consistent with Australian Groundwater Modelling Guidelines (Barnett *et al.*, 2012). This section discusses the modifications to the Bowdens RGFM, to achieve updated calibration targets, and calibration results for the TSF modelling.

3.1 CALIBRATION PROCESS

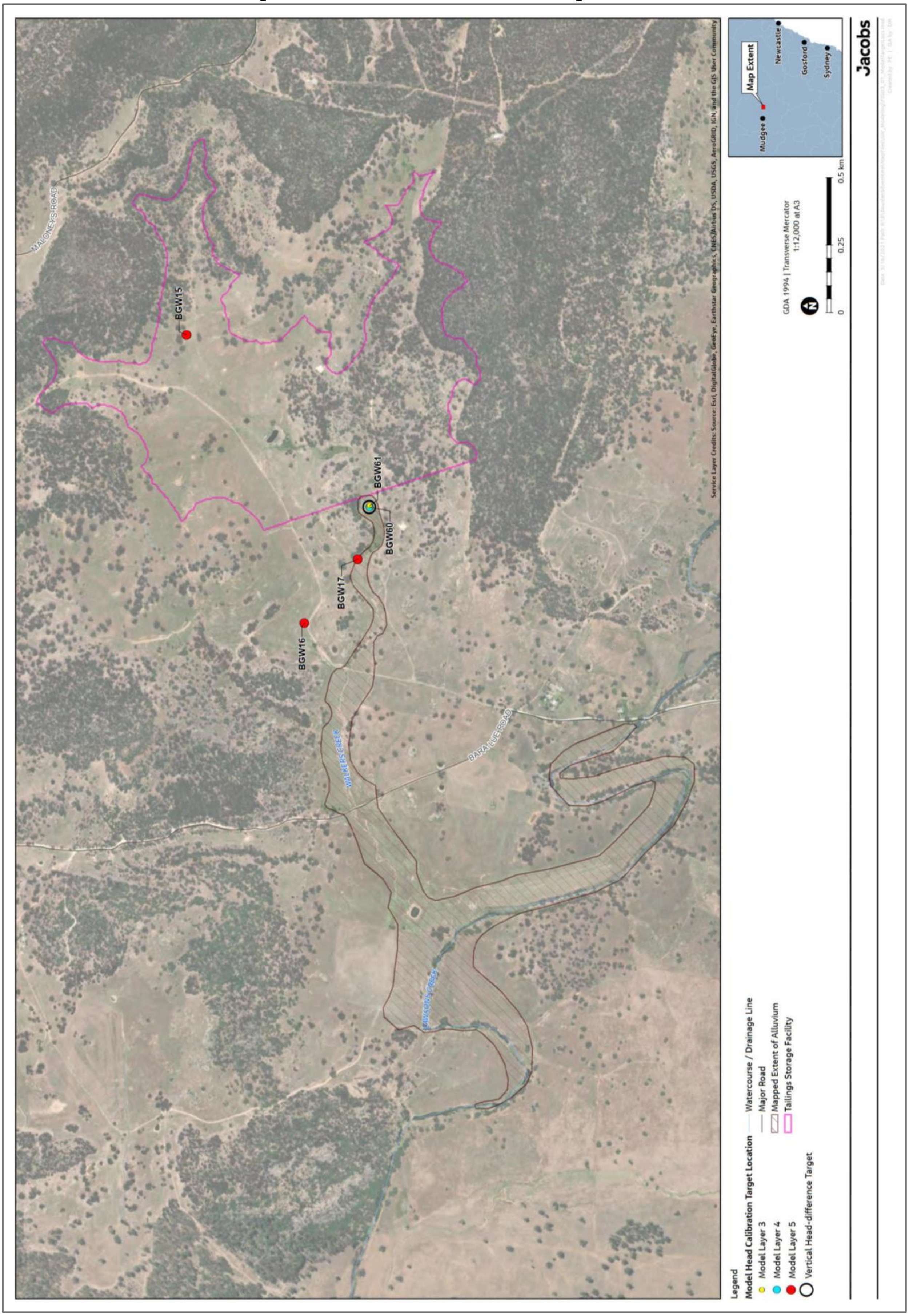
Hydraulic conductivity property zones were revised as described in Section 2.1.2. Minor adjustments to the locations and associated Kh and Kv values of some zones were made during the calibration process. Adjustments were made using a manual interactive technique. This involved manually running the simulations, comparing model results with qualitative and quantitative calibration targets to assess the progress of calibration, and making manual changes to parameter values in areas where important calibration mismatches were noted. In some cases, zone locations were also modified during the calibration process. This procedure was repeated until only minor improvements in calibration were achieved. Updates to the model calibration focused on calibration targets located within the TSF area. However, it was also important to verify that changes made to hydraulic properties within the TSF area did not negatively impact the overall model calibration. Thus, two sets of target data were reviewed during the calibration process: local (TSF area) scale targets and model wide targets.

3.2 CALIBRATION TARGETS

Quantitative and qualitative calibration targets were selected to refine calibration of the Bowdens RGFM to achieve the modelling objectives. Therefore, model calibration focused on targets within the TSF area. Average groundwater elevations (heads) served as quantitative calibration targets for the steady-state Bowdens RGFM. Calibration targets in the TSF area were refined to include the nested shallow/deep well pair (BGW61/BGW60). As BGW61/BGW60 were installed in July 2017, they were not utilised for calibration of the Bowdens RGFM that was based on the period from January 2011 to April 2017. Subsequently, the steady-state averaging period for the TSF area targets was revised to include the period for which BGW61/BGW60 data was available (July 2017 to September 2020). **Figure 8** depicts the head-target locations in the TSF area. Calibration summary statistics were then computed for head targets to provide a quantitative measure of the Bowdens RGFM's ability to replicate head-target values. Head calibration was evaluated using the following summary statistics:

- Residual, computed as the modelled head value minus the target head value
- Mean residual (MR), computed as the sum of all residuals divided by the number of observations
- Root mean squared residual (RMSR), computed as the square root of the mean of all squared residuals
- Scaled RMSR (SRMSR), RMSR divided by the range of head-target values
- Coefficient of determination (R^2), computed as the square of the correlation coefficient

Figure 8 Model Head Calibration Target Locations



The following general goals were applied to the quantitative calibration:

- Minimise spatial bias of residuals in key areas of the model domain
- Minimise residuals, MR, RMSR, and SRMSR
- Maintain R^2 values as close to unity as possible

In addition to calibrating to average heads, qualitative targets were also used to aid in the calibration process. Calibration summary statistics were not computed for qualitative calibration targets. The qualitative targets used for the modelling effort were as follows:

- Average steady-state vertical head difference at BGW61/BGW60. Vertical head difference is computed as the head from the shallower layer minus the head in the lower layer, thus, a negative value indicates an upward hydraulic gradient, whereas a positive value indicates a downward hydraulic gradient.
- General groundwater flow patterns throughout the TSF area.

3.3 CALIBRATION RESULTS AND DISCUSSION

Figure 9 compares the steady-state modelled and head-target values for all targets in the model and separately for only those targets in the TSF area. The figure shows that the modelled and head target values are in reasonable agreement, considering the modelling objectives. The head calibration summary statistics are listed in **Table 2** and shown on **Figure 9**. **Table 2** also provides head calibration summary statistics from the original Bowdens RGFM for comparison.

Table 2
Model Head Calibration Summary Statistics

Summary Statistic	*Original RGFM*	Model Wide Targets	TSF Area Only Targets
Mean Residual (m)	*0.02*	-0.92	-0.19
RMSR (m)	*7.74*	8.10	0.37
Range (m)	*446.08*	446.08	25.86
SRMSR	*0.017 (1.7%)*	0.018 (1.8%)	0.014 (1.4%)
R^2	*0.99*	0.99	1.00
Notes: RMSR = Root mean squared residual R^2 = Coefficient of determination			

These summary statistics are well within industry standards for model calibration and exceed Australian Groundwater Modelling Guideline characteristics for good model calibration (Barnett *et al*., 2012). Furthermore, **Figure 9** does not indicate global bias in modelled head values. Global bias would be evident if the residual values were either all large positive or large negative values. In this case, the residual values plot on both sides of and close to the 1:1 correlation line on **Figure 9**. **Figure 10** shows the spatial distribution of head residuals in the TSF area. For the TSF area targets, all steady-state head residuals were within plus or minus 0.75 metres, and all but one residual were within plus or minus 0.5 metres.

The match between modelled and target vertical head difference was also evaluated during the calibration process for the well pair located in the TSF area (**Figure 8**). The target and modelled steady-state vertical head-difference values, along with the residual is listed in **Table 3**. The table shows a negative target vertical head difference, which indicates an upward component of groundwater flow. The Bowdens RGFM matches the general direction of vertical groundwater flow implied by the vertical head difference at this location.

Figure 9 Calibration Target Groundwater Elevation (metres AHD)

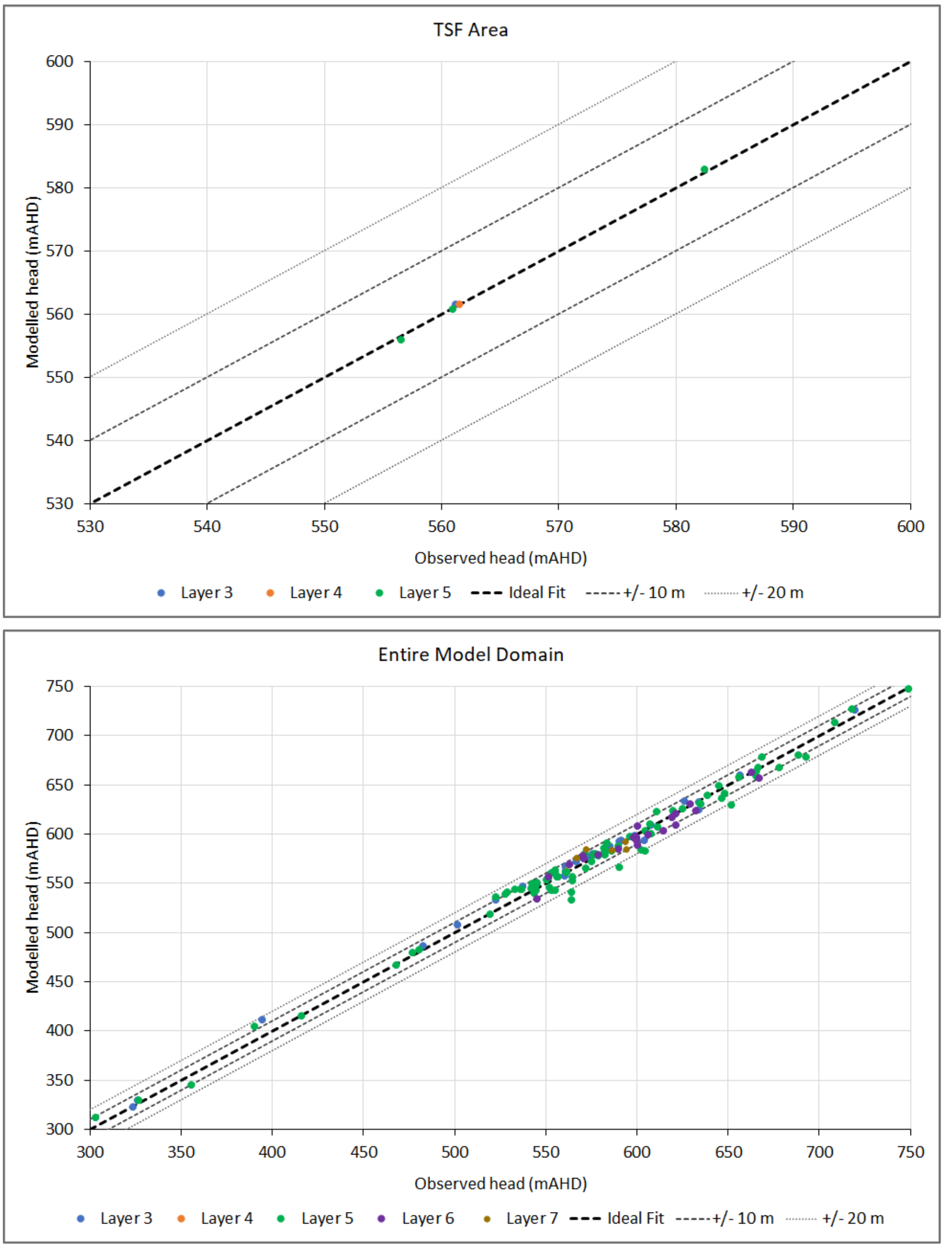


Table 3
Modelled and Target Steady-state Vertical Head-difference Comparison

Upper/Lower Monitoring Well	Upper/Lower Model Layer	Target Steady-state Vertical Head Difference (m)	Modelled Steady-state Vertical Head Difference (m)	Residual (m)
BGW61/BGW60	3/4	-0.35	-0.15	0.20

Notes: Negative vertical head difference indicates upward flow
a Residual computed as the modelled vertical head difference minus the target vertical head difference

Figure 11 shows the modelled steady-state water table contours. The figure shows that groundwater in the vicinity of the TSF generally flows to the west-southwest toward Lawsons Creek. The groundwater flow directions inferred from these contours are consistent with the conceptual model and are reasonable for this setting.

Figure 10 Distribution of Residuals in Modelled Steady-state Heads

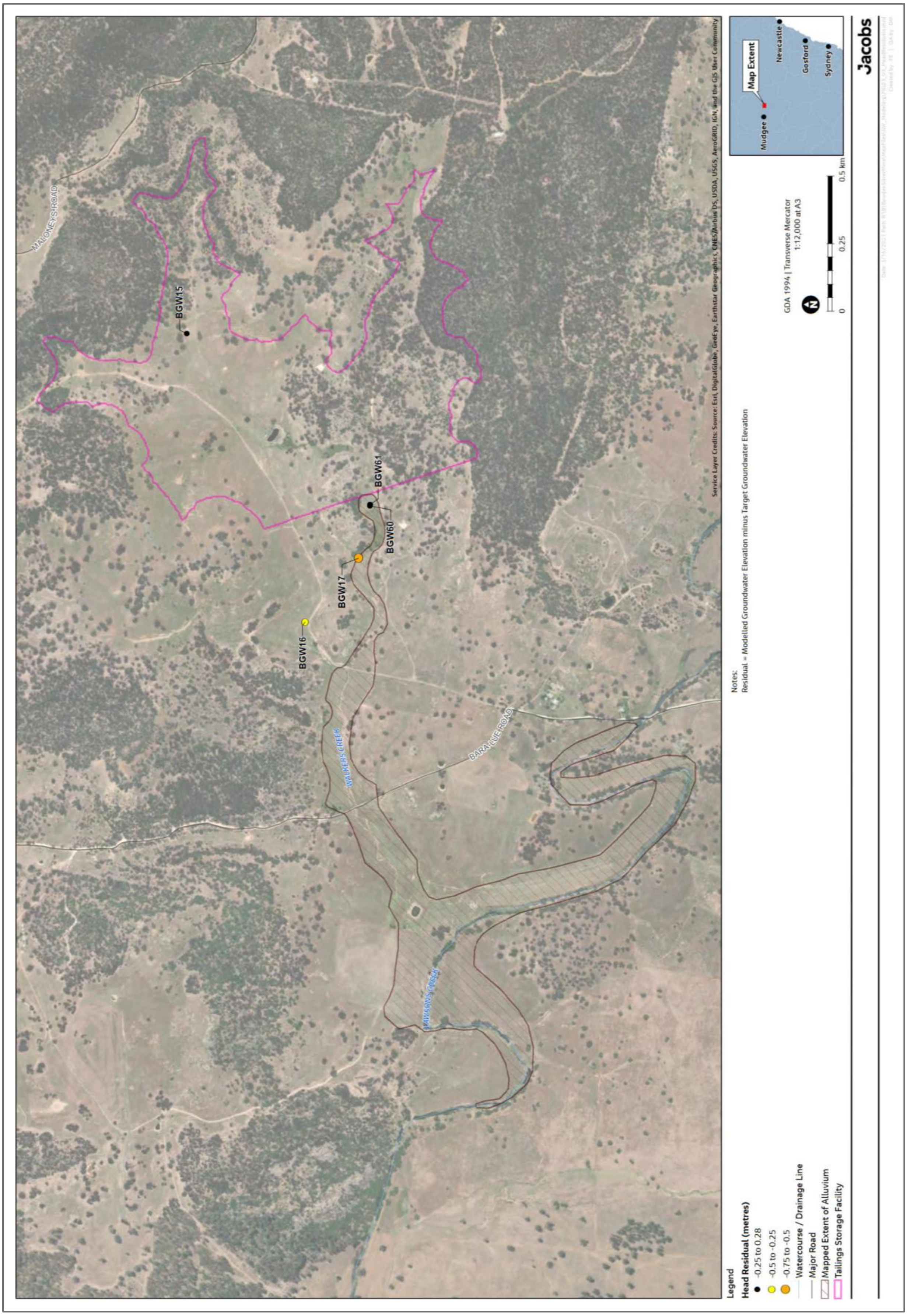
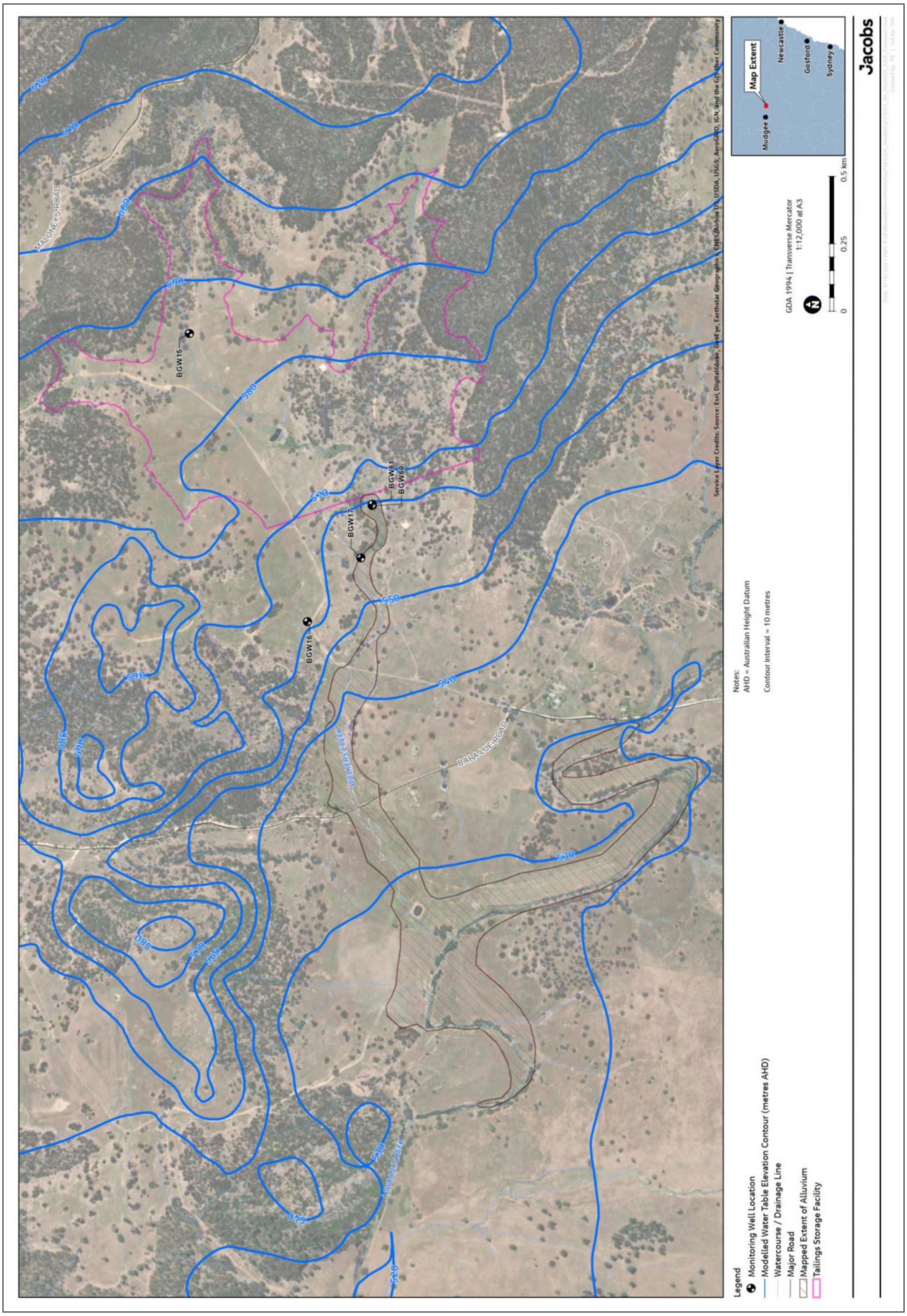


Figure 11 Modelled Steady-state Water Table Elevation Contours



4. MODEL APPLICATION

The Bowdens RGFM, and associated refinements in the vicinity of the TSF, was used to assess two TSF design options. These design options were developed to supplement the seepage mitigation measures described in the "Tailings Storage Facility Preliminary Design Report" (ATC Williams, 2020). The following subsections present the modifications made to the calibrated Bowdens RGFM for modelling the design options.

4.1 MODEL SETUP FOR DESIGN OPTION SIMULATIONS

Based on the refinements to the Bowdens RGFM, two model iterations were developed to predict and assess the potential groundwater impacts from operation of the TSF under each of the design options. The following section details the changes made to the Bowdens RGFM to represent and assess each design option that are shown on **Figure 12**. These changes included updated time discretisation and horizontal flow barriers (HFBs) to simulate the various elements of the design options.

Both design options model iterations were converted to transient simulations with a 200 year simulation period. In these models, Stress Period 1 was a steady-state stress period representing conditions prior to TSF operation. Following this initial stress period was a 15.5 year transient simulation period representing the period of TSF operation. The stress period duration for this phase of the transient simulation was 182.5 days. The final phase of the transient simulation represented a 184.5 year post mining period. Stress period durations for the final phase were 365 days until a simulation time of 100 years was reached; stress period durations were then increased to 1 825 days for the final 100 years of the simulation.

Specific storage and specific yield values used in the transient simulations were adopted directly from the original Bowdens RGFM (Jacobs, 2021).

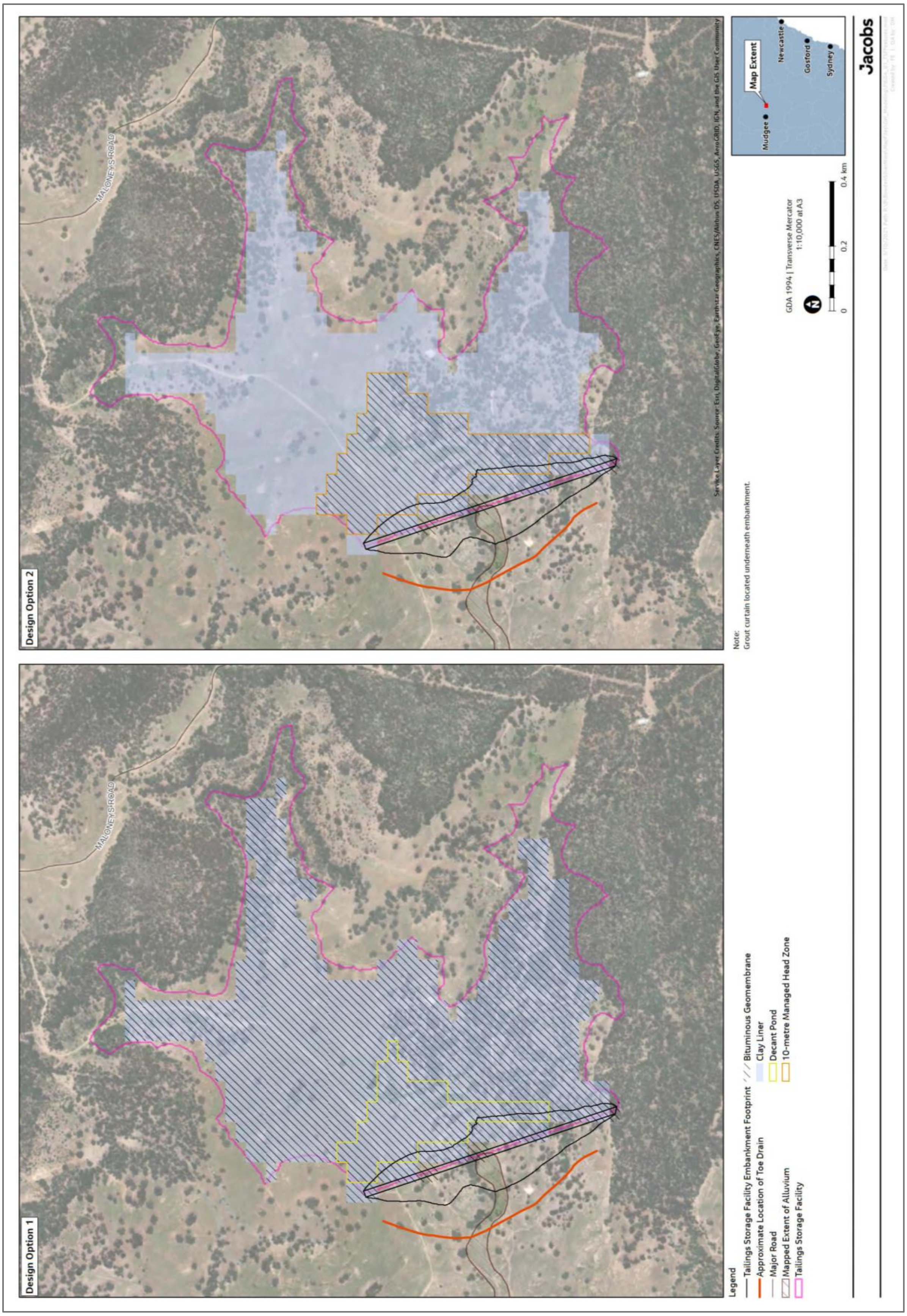
The two design option models are described below:

TSF Design Option 1 – The features associated with this TSF design option included the seepage mitigation elements presented in the preliminary TSF design (ATC Williams, 2020), such as a 0.45m-thick clay liner under the TSF impoundment area, toe drain downgradient from the embankment and a 40m-deep grout curtain underneath the embankment. In addition, a low permeability bituminous geomembrane (BGM) underneath the entire TSF impoundment area was also incorporated into the model. To simulate the staged development of the TSF an active decant pond with increasing head was modelled at the embankment throughout the 15.5 year period of TSF operation. The decant pond was subsequently allowed to drain following cessation of the TSF operational period.

TSF Design Option 2 – In this design option, water levels (heads) within the TSF are managed via underdrains. These underdrains are not explicitly represented in the model, instead representative constant head conditions, as provided by ATC Williams (*pers.comm.* ATC Williams, 2021) were applied. The TSF was modelled using two separate constant head conditions over most of the TSF, as follows:

1. A constant head of 10m above the modelled land surface (and TSF liner) was maintained in the central and downgradient portions of the TSF near the embankment for the duration of the period of TSF operation (**Figure 12**); and
2. Areas beyond the 10m managed head zone were modelled using a constant head of 2m above the modelled land surface (**Figure 12**).

Figure 12 Components Associated with Modelled Tailings Storage Facility Design Options



In this model iteration, the seepage mitigation elements presented in the preliminary TSF design (ATC Williams, 2020) were included along with a low permeability BGM underneath the 10m managed head zone. The managed head conditions were simulated as active throughout the TSF operational period and maintained for a further 6.5 years post mining. After which time, the tailings were allowed to drain.

4.1.1 Changes to the Groundwater Flow Model

The design option model iterations included the following modifications to the Bowdens RGFM:

4.1.1.1 Additional Model Layers

Two model layers were added on top of the existing land surface represented in the Bowdens RGFM as Model Layer 1. These layers were added to explicitly simulate the tailings within the TSF. Outside of the TSF impoundment area, the combined thickness of these two added layers was 0.05m. Within the TSF impoundment area, the top of the uppermost additional layer (new Model Layer 1) was assigned an elevation equal to the final tailings elevation at the embankment (613.1m AHD). Most of the tailings thickness was assigned to the new Model Layer 1. Within the TSF boundary, the new Model Layer 2 was assigned a thickness of 0.3m to allow modelling of the low permeability BGM. Whilst the BGM would be 5mm thick, the modelled thickness was increased to 0.3m within the footprint of the TSF to maintain model stability. For model cells representing the BGM, an effective K value was assigned based on the respective K and thicknesses of BGM and tailings within each cell.

4.1.1.2 Modifications to Hydraulic Conductivity

Modifications to Kh and Kv were made in the model iterations to simulate the different tailings thickness and the presence of the BGM and clay liner. These modifications were made only to Model Layers 1 through 3. For both model iterations, tailings were simulated in the new Model Layers 1 and 2 over the entire TSF impoundment area. To account for tailings consolidation, hydraulic conductivity was forecast to decrease with increasing tailings depth as per the following hydraulic conductivity estimates for different depths (ATC Williams 2020):

- Tailings depth 0m to 3m = 8×10^{-8}m/s (6.9×10^{-3}m/day)
- Tailings depth 3m to 10m = 4×10^{-8}m/s (3.5×10^{-3}m/day)
- Tailings depth 10m to 20m = 2×10^{-8}m/s (1.7×10^{-3}m/day)
- Tailings depth 20m to 45m = 8×10^{-9}m/s (6.9×10^{-4}m/day)

For TSF Design Option 1, Kh and Kv values for new Model Layer 1 were assumed to be isotropic (i.e. Kh = Kv) and based on the harmonic mean of the tailings thickness weighted K values for each cell in the TSF impoundment area. The tailings thickness was calculated using the nominal Stage 3 tailings elevation at the decant pond (613.1m AHD) less the top of the new Model Layer 2. The tailings weighted K value was then derived from the depth dependent K values provided by ATC Williams (2020) and using the calculated tailings thickness.

For instance, if the tailings were calculated to be 23m thick, the Kh and Kv would be calculated as:

$$Kh = Kv = 23m / [(3m / 8\times10^{-8}m/s) + (7m / 4\times10^{-8}m/s) + (10m / 2\times10^{-8}m/s) + (3m / 8\times10^{-9}m/s)] = 2.11\times10^{-8}m/s.$$

For Model Layer 2, the effective K was calculated assuming a low permeability BGM K value of 8.6×10^{9}m/day and BGM thickness of 5mm (1.0×10^{-13}m/s), and a tailings K consistent with the depth of tailings in Model Layer 1 and a layer thickness of 0.295m. Thus, Kh and Kv varied for those model cells representing tailings in Model Layers 1 and 2, depending on the modelled thickness of tailings in the cell. Model Layer 3 explicitly simulated the 0.45m-thick clay liner across the TSF impoundment area. The clay liner was assigned a Kh and Kv of 4.32×10^{-5}m/day (5.0×10^{-10}m/s) (ATC Williams 2020). **Figure 13** shows the distribution of Kh and Kv for Model Layers 1 through 3 for Design Option 1.

For TSF Design Option 2, Kh and Kv for the new Model Layer 1 were calculated in a similar manner as described above for TSF Design Option 1. However, as TSF Design Option 2 simulates heads that are managed at either 10m or 2m above the land surface, the effective K calculation did not account for the entire tailings thickness. Rather, the effective K calculation accounts only for the bottom 10m or 2m of tailings in the model cell, depending on the managed head condition. Subsequently, if new Model Layer 1 had a calculated tailings thickness of 23m, under a 10m managed head scenario, the Kh and Kv would be:

$Kh = Kv = 10m / [(3m / 8\times10^{-9}m/s) + (7m / 2\times10^{-8}m/s)] = 1.38\times10^{-8}m/s$.

The Kh and Kv of Model Layers 2 and 3 for TSF Design Option 2 were calculated as described for TSF Design Option 1. **Figure 14** shows the distribution of Kh and Kv for Model Layers 1 through 3 for TSF Design Option 2.

Comparing **Figures 13** and **14**, the K distribution in Model Layer 1 is generally lower for TSF Design Option 2 because the managed head condition maintains water levels in the deepest (lower K) portions of the tailings. In addition, **Figure 14** shows the reduced extent of the low permeability BGM in new Model Layer 2 for TSF Design Option 2.

4.1.1.3 Horizontal Flow Barrier

TSF Design Options 1 and 2 both included a grout curtain beneath the embankment that would be completed into competent rock. The grout curtain, as included in the original Bowdens RGFM, was refined as necessary to match the refined model grid. The HFB (horizontal flow barrier) package (Hsieh and Freckleton, 1993) was used to simulate the grout curtain in the model iterations. The HFB package requires input of a hydraulic characteristic, defined as the hydraulic conductivity divided by the width of the barrier. Whilst the HFB does not affect groundwater flow parallel to the HFB, the hydraulic characteristic will determine the effectiveness of the HFB as a barrier to groundwater flow. The simulated thickness and hydraulic conductivity of the grout curtain was 25m and 8.64×10^{-3}m/d (1.0×10^{-5}cm/s), consistent with Jacobs (2021). The grout curtain was modelled in Model Layers 3 through 6 (i.e., current land surface to bedrock) and represents a total depth of approximately 40m, in accordance with the preliminary TSF design (ATC Williams, 2020). The grout curtain was simulated as shown on **Figure 15**.

4.1.1.4 Removal of Drain Boundary Conditions

All drain boundaries were removed from within the TSF footprint for the design option model iterations.

Figure 13 Modelled Hydraulic Conductivity – Design Option 1

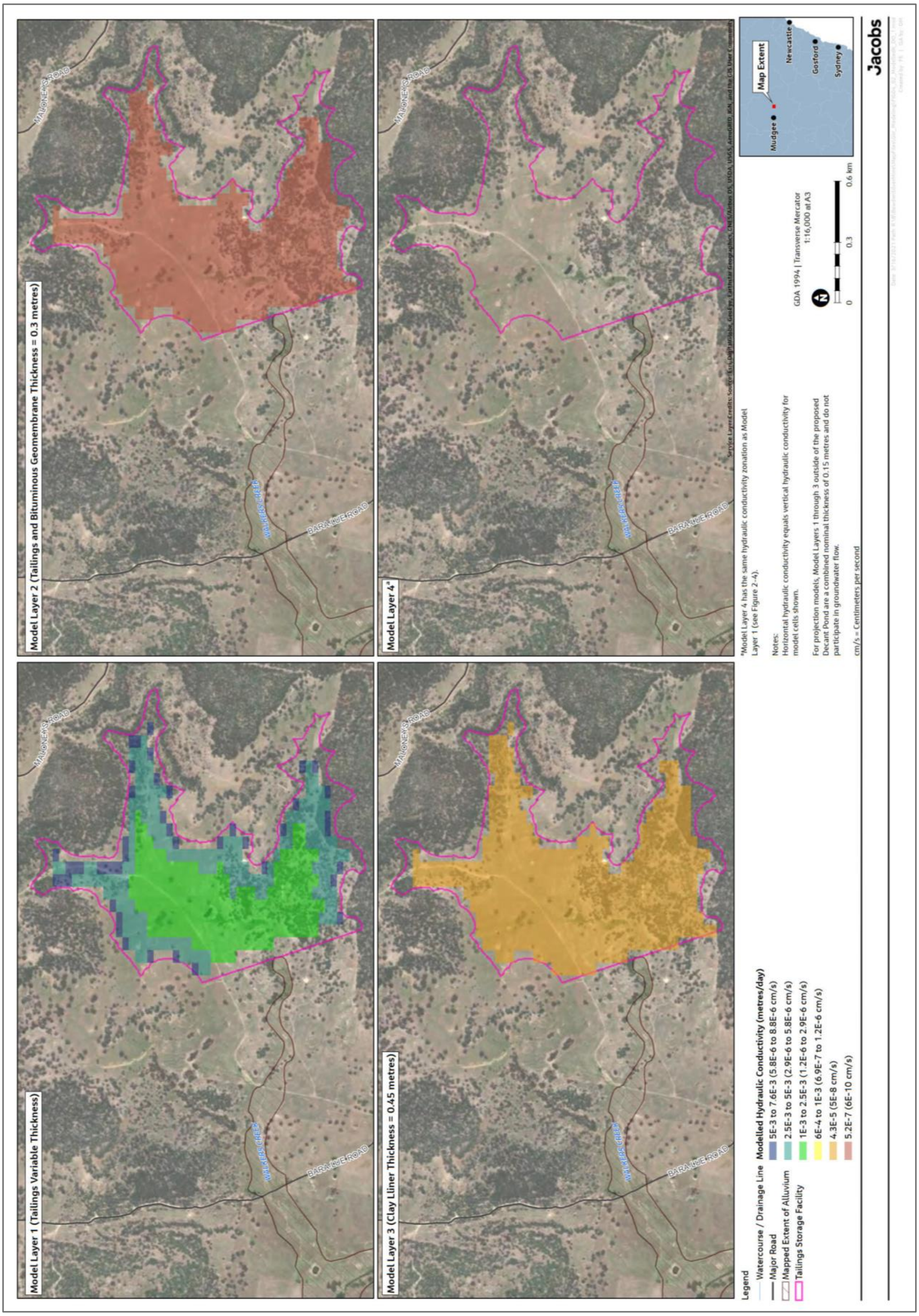


Figure 14 Modelled Hydraulic Conductivity – Design Option 2

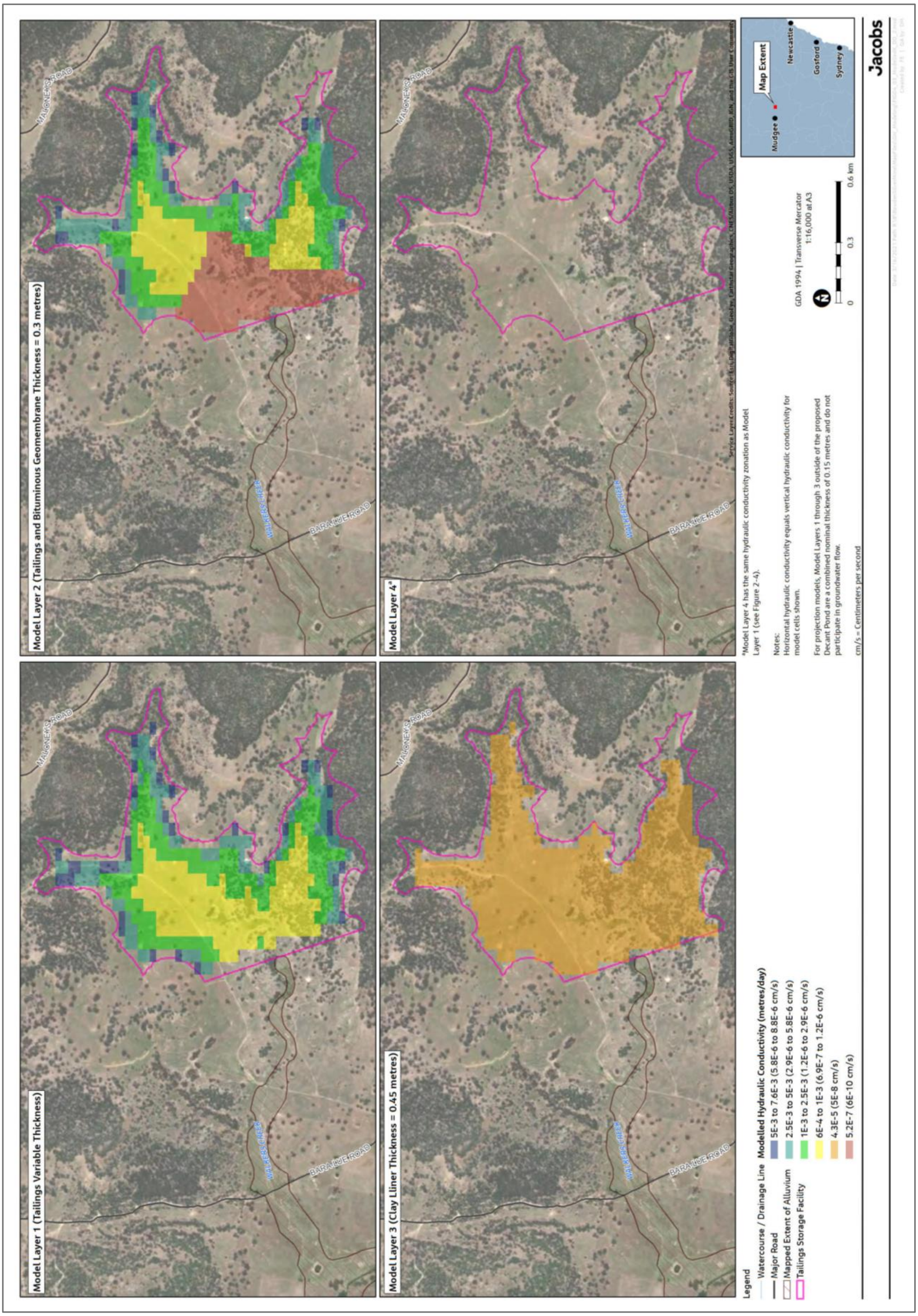
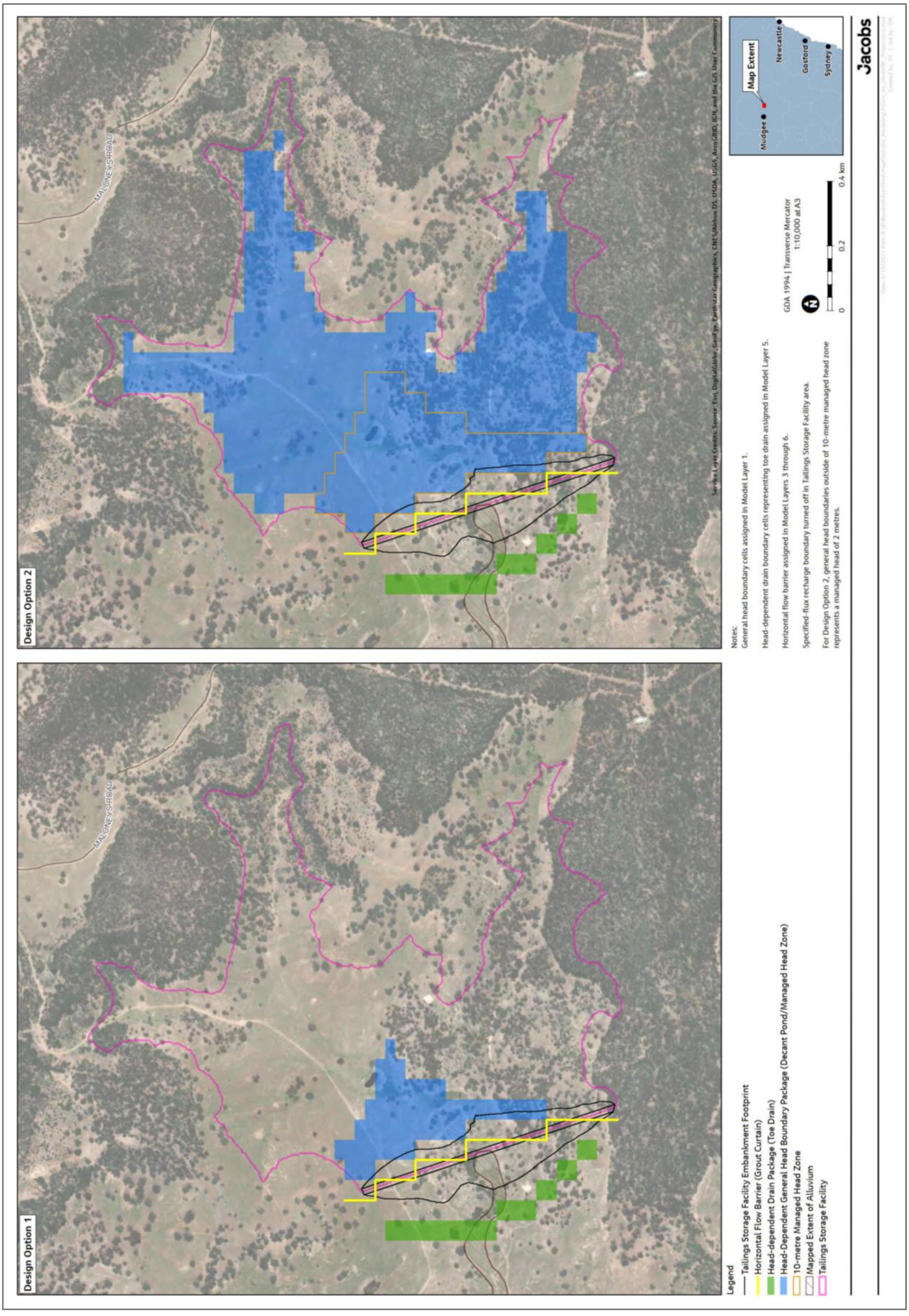


Figure 15 Additional Boundary Conditions for Projection Models



4.1.1.5 Addition of Drain Boundary Conditions

Drain boundaries, as included in the original Bowdens RGFM, were refined as necessary to match the refined model grid, and were added to the design option model iterations to simulate the toe drain downgradient from the embankment in accordance with the preliminary TSF design (ATC Williams, 2020) (**Figure 15**). The drain package requires input of the following parameters that govern the resistance to flow between the groundwater system and the drain:

- drain head;
- drain cell dimensions;
- drain thickness; and
- drain hydraulic conductivity.

The modelled drain parameters were set as follows: thickness - 0.3m; width – 2m, length was that of the model cell (31.25m). The drain hydraulic conductivity was set at 300m/day, representing a gravel-filled drain trench whilst the head was assigned a value of 2m below land surface.

4.1.1.6 Addition of General Head Boundaries

The MODFLOW-USG CHD package is typically used to simulate a constant head boundary condition, such as the decant pond. However, as this boundary condition is rendered inactive once tailings deposition ceases and the decant pond has been capped, the CHD package is unsuitable as it cannot be turned off. Subsequently, for TSF Design Option 1, the decant pond was modelled using the head-dependent MODFLOW-USG General Head boundary (GHB) condition that were assigned to Model Layer 1 (**Figure 15**).

Whilst the GHB is typically used to simulate a head condition located at some distance outside of the model domain, in this case, the input parameters were assigned such that it functioned as a constant head boundary. The head assigned at the GHB was equal to 2m above the maximum tailings elevation for each decant pond stage (**Table 4**). In addition, the GHB requires the input of a conductance value. To achieve GHB condition function as a constant head boundary, an extremely high conductance value ($1\times10^6 m^2$/day) was therefore assigned. **Table 4** provides the transient head values assigned to the GHB and their respective active periods. The GHB was turned off after 15.5 years to represent the end of processing operations and tailings deposition and the subsequent capping of the TSF.

Table 4
Modelled Decant Pond Characteristics

Decant Pond Stage	Duration (years)	Tailings Elevation (m AHD)[a]	Assigned Head at GHB (m AHD)
Stage 1	3	595	597
Stage 2	5	603.7	605.7
Stage 3	7.5	613.1	615.1

m AHD – metres Australian Height Datum
[a] from **Table 17** (Jacobs 2021)
GHB – General head boundary

For TSF Design Option 2 the TSF was simulated assuming a managed head condition and GHBs were used to simulate the managed heads within the TSF. The central and downgradient portions of the TSF, near the embankment were simulated using a 10m managed head condition to represent elevated heads beneath the decant pond. Those areas of the TSF beyond the decant pond were modelled using a 2m managed head condition (**Figure 15**). The two GHB conditions were maintained for a total period of 22.5 years to represent the 15.5 year TSF operational period and a 6.5 year post-mining period to represent drainage and capping.

4.1.1.7 Modifications to Recharge

Groundwater recharge from precipitation was set to zero in the TSF impoundment area. This change was made for all stress periods of each model iteration.

4.1.1.8 Modifications to Well Boundaries

Simulated pumping (assumed basic landholder rights) from all TSF-area wells [BGW15, BGW16, and BGW17 (**Figure 2**)] was turned off.

4.1.2 Addition of Solute Transport

Solute transport was added to the design options model iterations using the capabilities within MODFLOW-USG. This was added to the model in a simplified manner to forecast the blending ratio of water originating at the TSF with native groundwater. Prescribed concentration boundaries (PCBs) were assigned to all model cells representing the decant pond or managed head zones and thus were coincident with the GHB boundaries (**Figure 15**) in new Model Layer 1. The PCBs were activated at the commencement of TSF deposition in Stress Period 2 and remained active for the duration of the simulation period at a concentration of 100. This approach does not simulate a specific solute. Instead, the model simulates the percentage of groundwater originating at the TSF that mixes with native groundwater (i.e. blending ratio). Results from this analysis should not be confused with projected plume concentrations. To forecast concentrations of a specific solute, estimates of the starting concentrations within the TSF would be required, in addition to the solute-specific transport parameters.

Transport modelling was used to fingerprint the blending of native groundwater with the modelled "solute" initially simulated as a conservative tracer with no sorption or degradation. Dispersivity was then included in the transport simulations and calculated based on the approximate distance between the TSF embankment and Lawsons Creek (roughly 1 700m) using the approach of Xu and Eckstein (1995), as modified by al Suwaiyan (1996). The longitudinal dispersivity was calculated to be 14.4m, whilst transverse and vertical dispersivity were assumed to be 1.4m and 0.14m, respectively.

Solute mass balance errors that were initially observed were addressed by adding linear sorption to the transport formulation and assigning only a miniscule value corrected the solute mass balance errors. The soil partitioning coefficient (Kd) assigned in the transport models was equal to 0.001 cubic centimetres per gram.

4.2 MODEL RESULTS

The refined Bowdens RGFM was used to predict and compare potential impacts from TSF Design Options 1 and 2. These predictions allow insight into the flow of groundwater originating within the TSF impoundment area and the effectiveness of different design elements for seepage mitigation strategies. The following subsections describe the results of each model iteration.

4.2.1 Projection Simulations

To evaluate the effectiveness of each design option, virtual monitoring well pairs were placed in the model domain at locations within Lawsons Creek and Walkers Creek (**Figure 16**). The shallow virtual wells were placed in the uppermost saturated model layer to represent a well screened near the water table whilst deep virtual wells were placed in Model Layer 6, to represent the deepest layer of weathered rock. Projected blending ratios were then output at each virtual well for the entire simulation period to evaluate model output.

Figure 16 shows forecast blending ratios through time at the virtual well pairs for both design options. The figure shows that for all virtual wells, the percentage of groundwater originating at the TSF is considerably lower for TSF Design Option 1. Only the MW-1 well pair show blending ratios greater than five percent for TSF Design Option 1. In contrast, all virtual wells for TSF Design Option 2 are predicted to have blending ratios exceeding ten percent.

Figure 17 shows contour maps of the percentage of groundwater originating at the TSF for both design options at different simulation times. As shown in **Figure 16**, the percentages of groundwater originating at the TSF do not exceed ten percent for TSF Design Option 1. For TSF Design Option 2, the twenty-five percent contour extends beyond the TSF at simulation times of 50 and 100 years. The reduced blending ratios predicted under TSF Design Option 1 are the result of two main factors:

1. The reduced area of active GHB and PCB (**Figure 15**); and
2. The increased area of TSF underlain by the low permeability BGM. For the 10m managed head zone, the BGM was not simulated under most of the TSF area.

Thus, even though greater heads were assigned at the GHB in TSF Design Option 1, the presence of the low permeability BGM underneath the TSF impoundment area was more effective at limiting vertical seepage from the TSF when compared to that which resulted from TSF Design Option 2.

Figure 18 shows the modelled vertical seepage from the TSF for both design options for the first 50 years of the simulation period. As shown on **Figure 18**, TSF Design Option 2 is predicted to generate a higher seepage rate than TSF Design Option 1 for the first 23 years of the simulation period. The dashed lines on **Figure 18** show the seepage from the sections of the TSF with and without the BGM for TSF Design Option 2. The dashed lines illustrate that, even though the TSF section with no BGM has a managed head of only 2metres, this section represents most of the predicted seepage. This notwithstanding, **Figure 18** shows the benefit of a low permeability BGM in limiting seepage from the TSF for both design options.

Groundwater baseflow discharging to Lawsons Creek and the percent component of baseflow originating at the TSF were estimated for both design options. These data were summarised for an approximately 2 kilometre section of Lawsons Creek downgradient from the TSF. **Figure 19** (top graph) shows the modelled net groundwater inflow (discharge) to Lawsons Creek for each model iteration. As shown on **Figure 19**, TSF Design Option 2 identifies inflows of groundwater to Lawsons Creek for the first 60 years of TSF operation slightly larger than those of TSF Design Option 1. Similarly, the predicted component of groundwater originating at the TSF that discharges to Lawsons Creek as baseflow is projected to be greater for TSF Design Option 2.

Figure 16 Project Percent of Groundwater Originating at Virtual Monitoring Wells

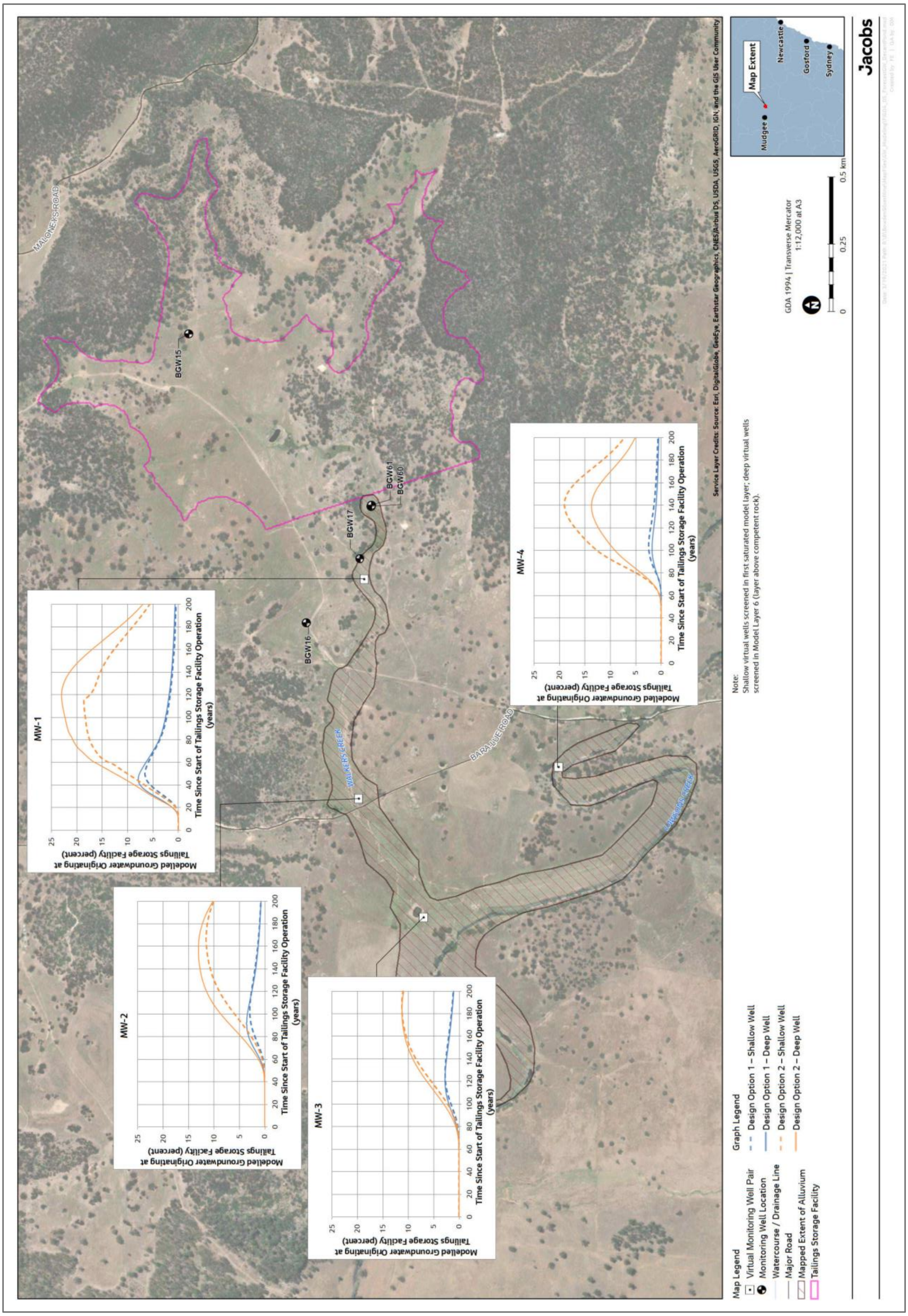


Figure 17 Project Percent of Groundwater Originating at the Tailings Storage Facility

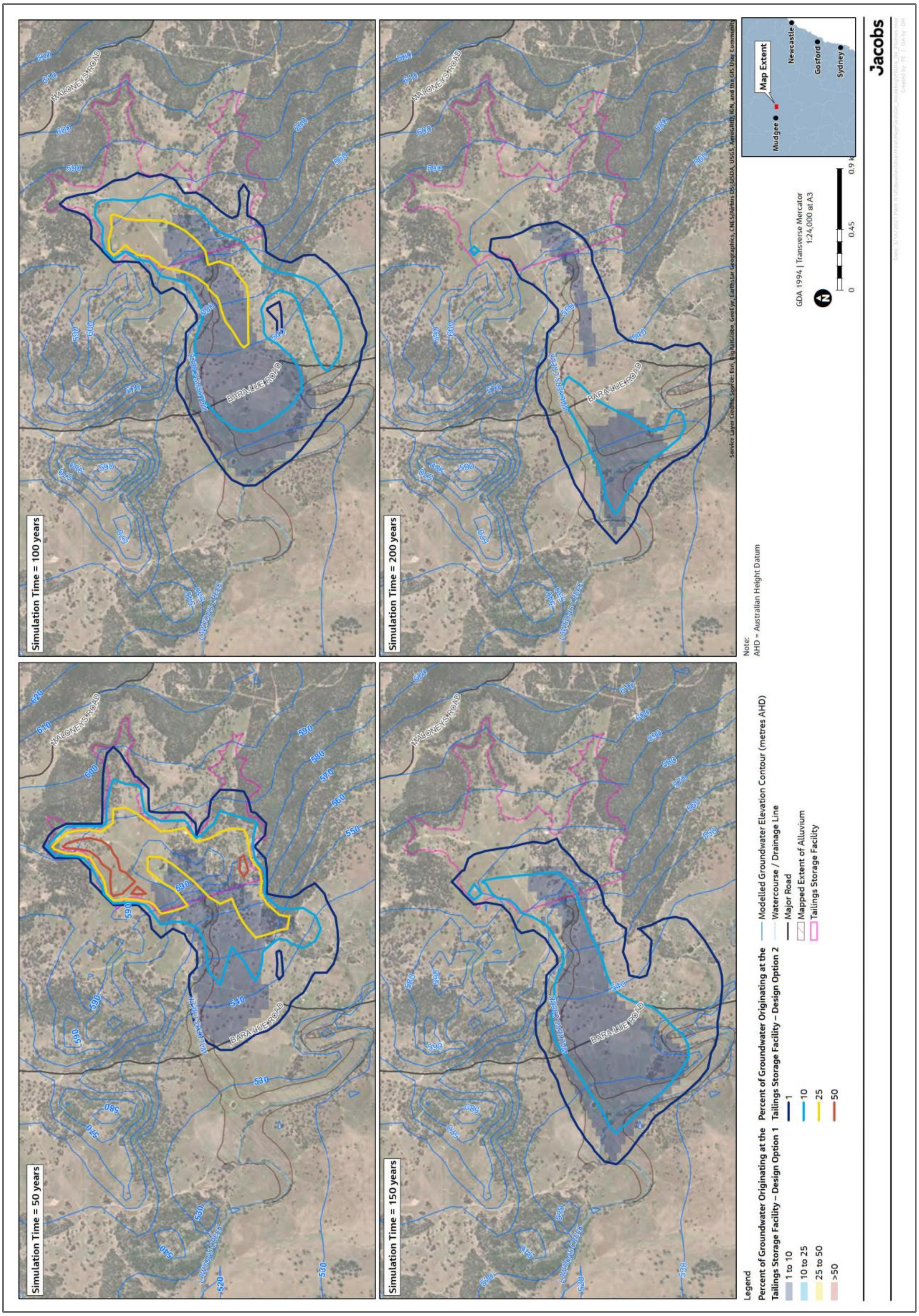
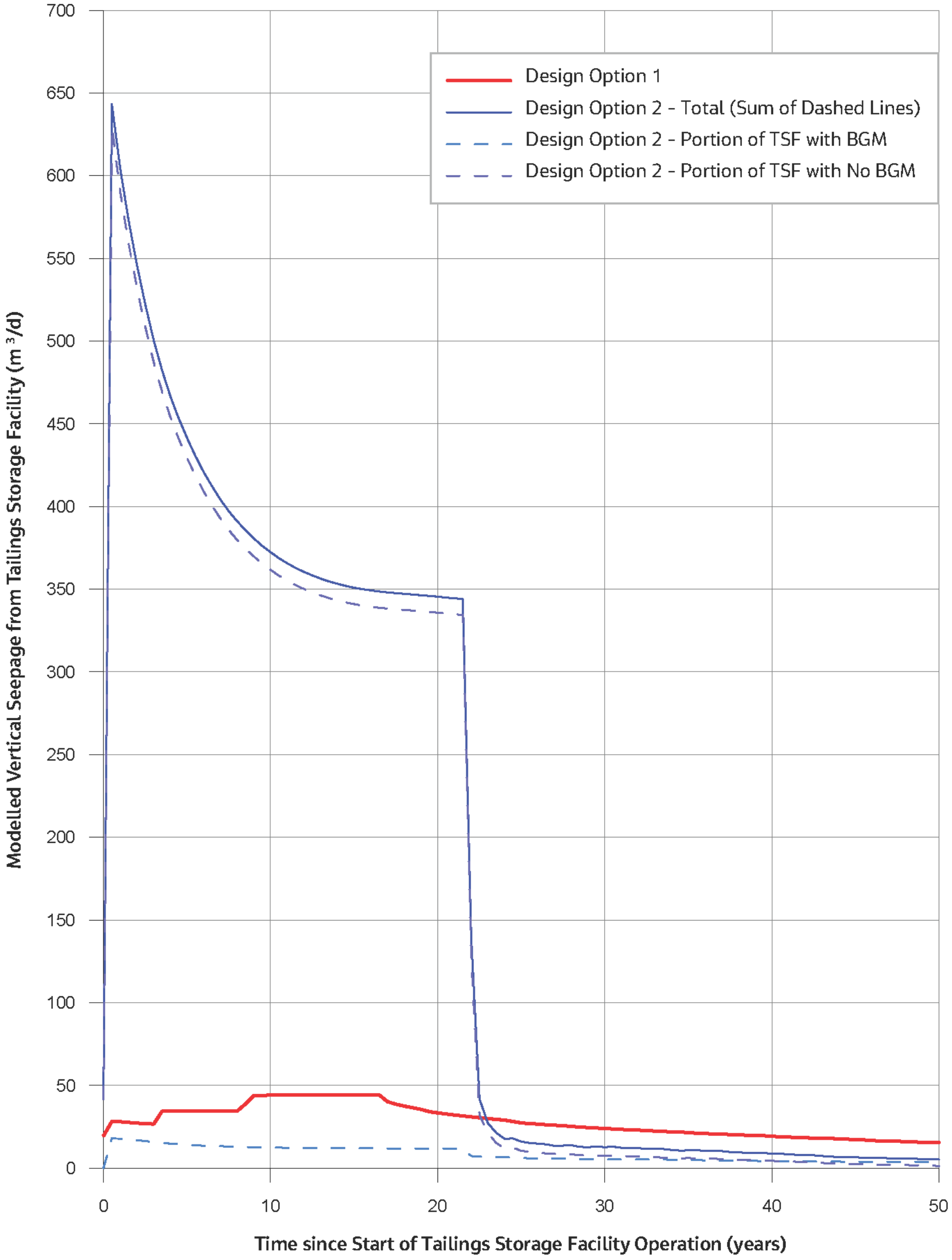


Figure 18 Projected Seepage from Tailings Storage Facility



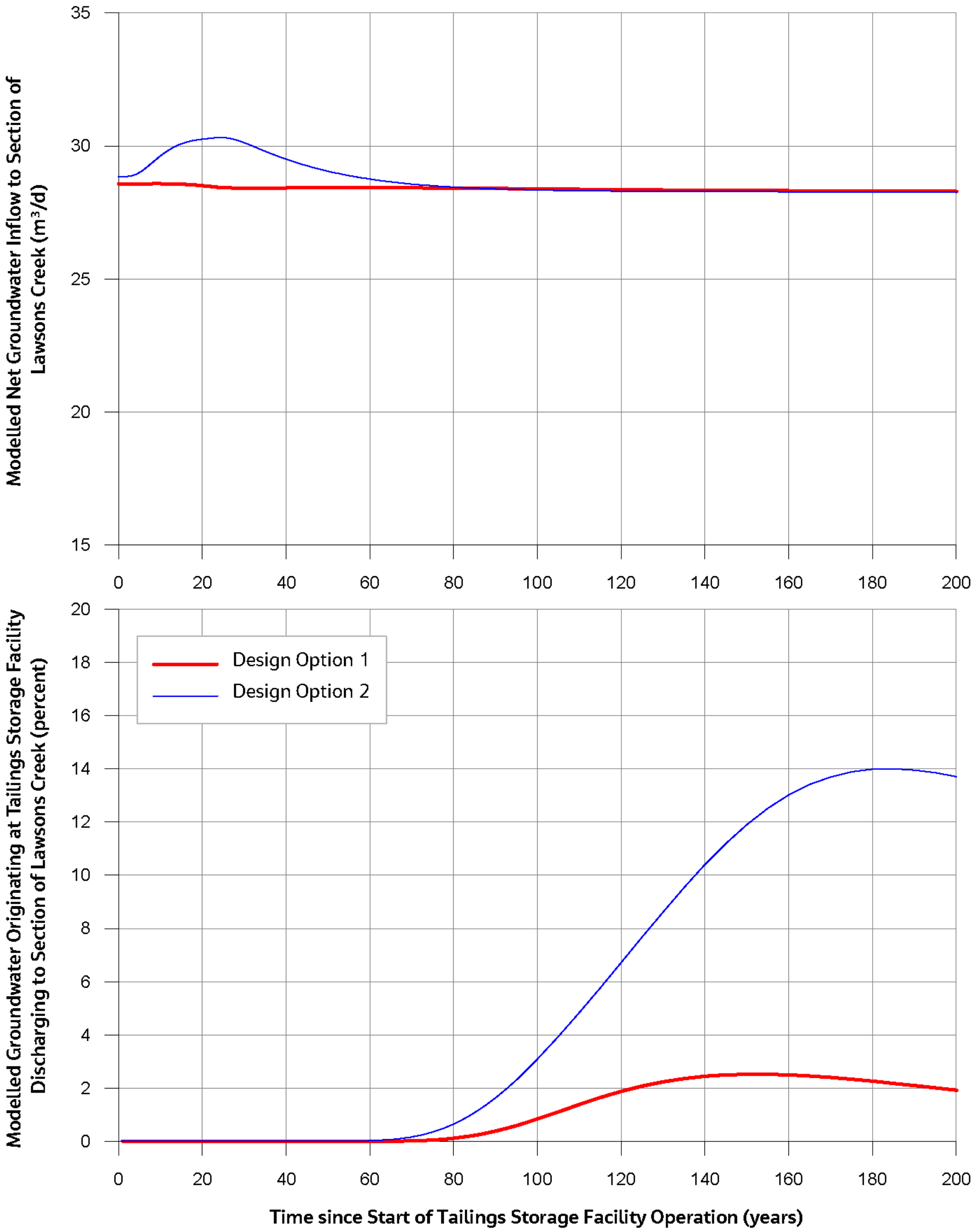
Notes:

m³/d = cubic metres per day

TSF = Tailings Storage Facility

BGM = Bituminous Geomembrane

Figure 19 Projected Groundwater Inflow Rate and Percent of Groundwater at the Tailings Storage Facility



Notes:

m^3/d = cubic metres per day

Data summarized for section of Lawsons Creek downgradient from Tailings Storage Facility.

4.2.2 Sensitivity Analysis

A sensitivity analysis was performed on both model iterations to evaluate the influence of K and recharge values on predicted blending ratios at the virtual monitoring well locations. For each design option, a high and low K and recharge scenario was run. For the K sensitivity runs, Kh and Kv values were multiplied or divided by 10 for Model Layers 4 and deeper (i.e. natural formations). Thus, these model runs focused on the sensitivity of predictions to changes in K for the host groundwater system only and not those of tailings, low permeability BGM of the clay liner. For the recharge sensitivity runs, modelled recharge rates, as presented in **Annexure 9** of Jacobs (2021), were globally multiplied or divided by 2.

Figure 20 shows the projected percentage of groundwater originating at the TSF for all Design Option 1 sensitivity simulations. The black dashed and solid lines represent the base parameter set for the shallow and deep virtual wells, respectively. **Figure 20** shows that the High-K sensitivity run results in greater blending ratios and earlier arrivals at the virtual monitoring wells as compared to the base parameter set. The only exception is at MW-4. The High-K scenario results in a more westerly flow direction, so that groundwater originating at the TSF does not arrive at MW-4. In the Low-K scenario, MW-1 is the only virtual well pair at which groundwater originating at the TSF arrives within the simulation period. The High-recharge scenario generally results in higher blending ratios and delayed arrivals at the virtual wells in comparison to the base parameter set. This is likely a result of reduced hydraulic gradients between the TSF and the virtual wells. Whilst hydraulic head at the TSF remained unchanged for all sensitivity runs as it is controlled by the GHB, heads downgradient from the TSF increase due to the higher recharge rate. This results in reduced hydraulic gradients and thus lower groundwater velocities downgradient from the TSF.

Figure 21 shows the projected percentage of groundwater originating at the TSF for all Design Option 2 sensitivity simulations. Similar to TSF Design Option 1 sensitivity runs, the High-K sensitivity run results for TSF Design Option 2 result in greater blending ratios and earlier arrivals at the virtual monitoring wells. In addition, **Figure 21** also shows similar blending ratio patterns for the recharge sensitivity runs as observed on **Figure 20**.

Figure 20 Projected Percent of Groundwater Originating at the Tailings Storage Facility at Virtual Monitoring Wells – Design Option 1 Sensitivity Analysis

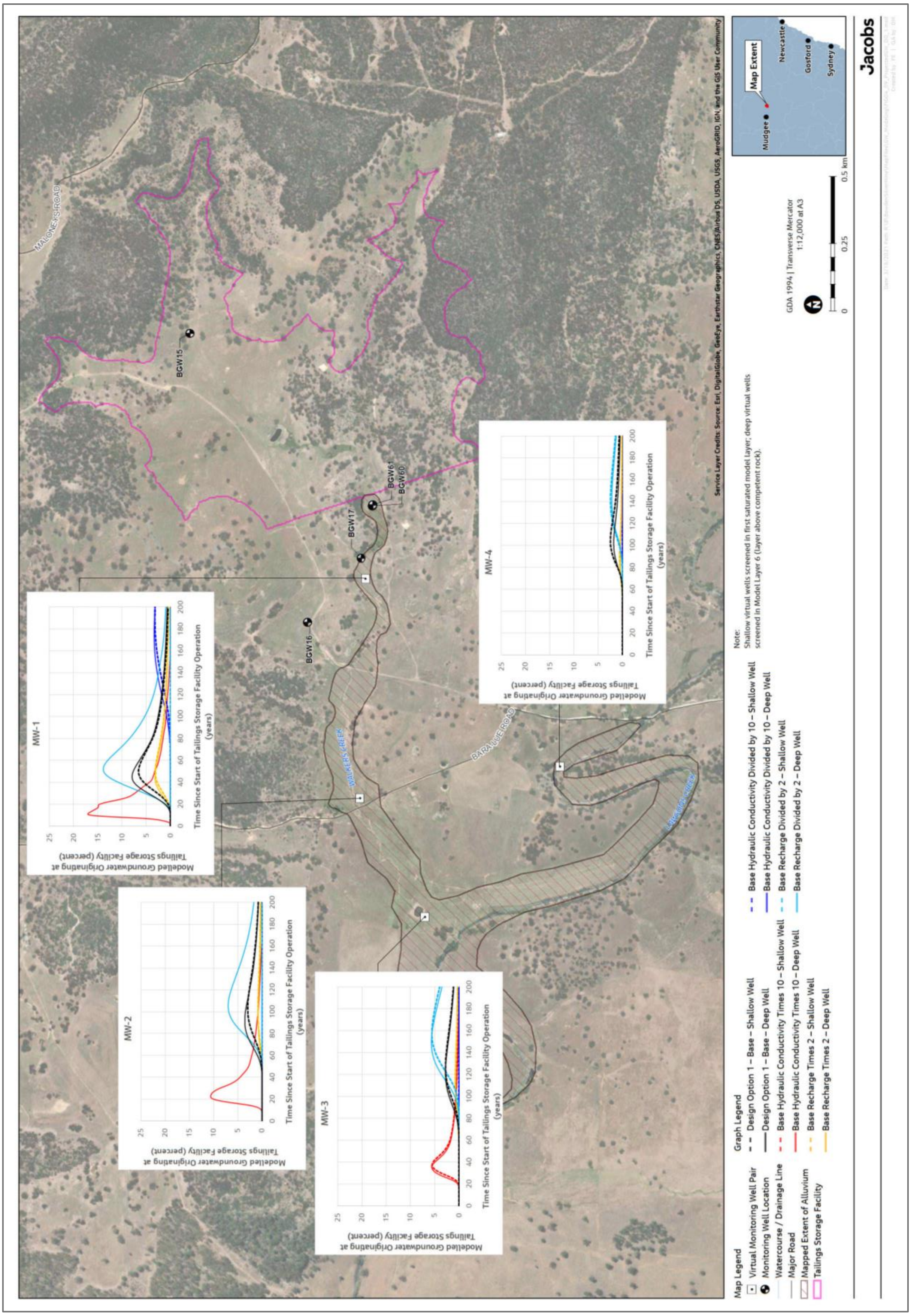
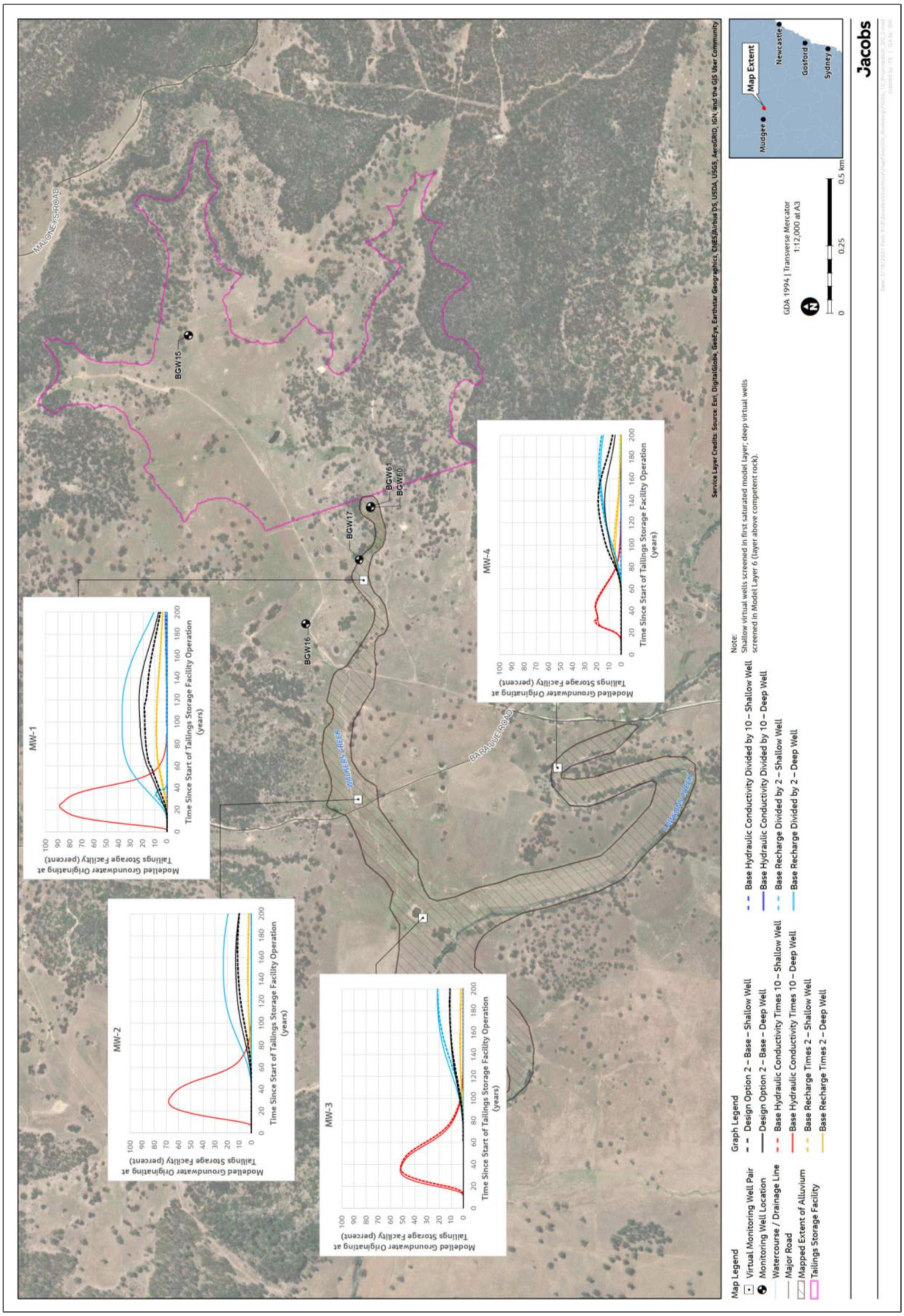


Figure 21 Projected Percent of Groundwater Originating at the Tailings Storage Facility at Virtual Monitoring Wells – Design Option 2 Sensitivity Analysis



5. SUMMARY

The Bowdens RGFM was updated to incorporate new data and refine the model in the TSF area to evaluate supplementary TSF design elements and operational strategies to augment the preliminary TSF design (ATC Williams, 2020) and their implications for managing groundwater impacts in the vicinity of the TSF. The model results identify TSF Design Option 1 as the most effective for reducing potential groundwater impacts from TSF operation. In addition, the modelled percentage component of baseflow entering Lawsons Creek that originated at the TSF was much lower for TSF Design Option 1. This is due to all TSF Design Option 1 model cells within the TSF being underlain by a low permeability BGM liner. In contrast and despite the reduced TSF head condition, TSF Design Option 2 resulted in more seepage and a greater percentage of groundwater originating at the TSF. These results underscore the effectiveness of the low-permeability liner reducing TSF seepage and minimising the percentage of groundwater originating at the TSF.

6. REFERENCES

Al-Suwaiyan, M. 1996. Discussion of “Use of Weighted Least-Squares Method in Evaluation of the Relationship between Dispersivity and Field Scale” by M. Xu and Y. Eckstein. Groundwater, v. 34. 578.

ASTM International. 1996. Standard Guide for Calibrating a Ground-Water Flow Model Application. D5981-96. Reapproved 2002.

ATC Williams. 2020. *Tailings Storage Facility Preliminary Design*. Report prepared for Bowdens Silver Pty Ltd. Reference 116217.01 R02 Rev5. May 2020.

ATC Williams. 2021. Personal communication Heather Wardlaw “RE: 429_TSF Seepage Modelling_liner and under drainage”, email to Paul Ryall, cc Greg Sheppard. 2 February 2021.

Barnett, B., Townley, L.R., Post, V., Evans, R.E., Hunt, R.J., Peeters, I., Richardson, S., Werner, A.D., Knapton, A., and Boronkay, A. 2012. Australian groundwater modelling guidelines. Sinclair Knight Merz and National Centre for Groundwater Research and Training. Waterlines Report Series No. 82, June 2012.

GCA, 2019. Materials Characterisation, Part 3 of the Specialist Consultant Studies Compendium. Prepared on behalf of Bowdens Silver Pty Limited.

Hsieh, P. and J.R. Freckleton. 1993. Documentation of a Computer Program to Simulate Horizontal-Flow Barriers Using the U.S. Geological Survey’s Modular Three-Dimensional Finite-Difference Ground-Water Flow Model. U.S. Geological Survey Open-File Report 92-477. Prepared in cooperation with the City of Santa Barbara, California. Available at https://pubs.er.usgs.gov/publication/ofr92477.

Jacobs. 2021. *Updated Groundwater Impact Assessment*. Prepared for R.W. Corkery & Co. Pty Limited. May 2020.

Middlemis, H. and Peeters L.J.M., 2018. Uncertainty analysis—Guidance for groundwater modelling within a risk management framework. A report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Commonwealth of Australia 2018.

Xu, M. and Y. Eckstein. 1995. *Use of Weighted Least-Squares Method in Evaluation of the Relationship between Dispersivity and Field Scale.* Groundwater, v. 33. 905-908.

Annexure 11

DPIE-Water's Review Comments

(Total No. of pages including blank pages = 32)

This page has intentionally been left blank

DPIE – Water and NRAR

Responses to Minor Errors, Inconsistencies and Formatting Issues – Groundwater

Issue / Matter Raised by DPIE – Water and NRAR		**RWC / Jacobs Response**
Electronic File Provided – Entire Document	The Groundwater Assessment report is provided in protected pdf format, which makes it difficult for the reviewer to use, e.g. adding annotated comments and highlighting text.	All documents provided to DPIE are in editable format. Considered and internal matter for DPIE and reviewer.
	The third-party model review presented in Annexure 10 (pp 305–38) is provided in scanned image format, which makes it difficult for the reviewer to mark up and highlight text for review purposes.	
	It is recommended to provide future versions of the report in a more user friendly (unprotected) format.	
Report Structure and Table of Contents – pp 118-190	There are five levels of sections. Levels sections 1-4 are numbered, but level 5 sections are not, making them difficult to reference.	These comments have been addressed and the report re-structured as an Updated Groundwater Assessment including a standalone Groundwater Modelling Report (Annexure 9). General editorial comments have been addressed in the Updated Groundwater Assessment and Annexures 9 (Groundwater Modelling) and 10 (TSF Modelling). Where specific items are identified below, a cross reference to location of updates is provided.
	The table of contents (pp 3–5) lists only the highest three section levels. Levels 4 and 5 are not listed in the table of contents, making it difficult to navigate the document. For example, there is cross-reference to Section 5.3.3.1 in page 174. However, this section is not shown in the table of contents.	
	Addition of all section levels in the table of contents will enable the report authors, the reviewers, and the readers to understand its structure and flow of thoughts. It will also help the authors deciding on the best way to present information about the groundwater system and the model.	
	The numbering of level 4 section headers in the provided pdf is not provided in text format. So, it cannot be copied or searched for using standard methods (e.g. Section 5.3.3.1 in page 148, which is cross-referenced in page 174.).	
	The discussion of potential impacts (Section 5.1.6) is presented before the description of the project (Section 5.2). It is recommended to revise this order of information presentation.	

Issue / Matter Raised by DPIE – Water and NRAR		RWC / Jacobs Response
	The discussion of potential impacts (Section 5.1.6) does not fit well as a subsection in the conceptual model section (Section 5.1). Revision of the report structure in this part of the report is recommended.	
	It is recommended to reconsider the report section structuring, the format of section headers and the levels of sections included in the report's table of contents.	
	The level of subdivision of some sections is inappropriate. For example, the various types of boundary conditions are presented within a level four section (Section 5.3.2.4), which is very long (12 pages; pp 131–142, inclusive). As a result, boundary conditions are presented as fifth level subsections, which are not numbered, making them difficult to reference and find in both electronic and printed format of the report especially that level four and level five section headers are not included in the table of contents. It is recommended to promote the boundary conditions subsections from fifth level to at least level four, which will require re-consideration of the report structure. The report should be structured in a manner that enables easy navigation to information and helps the reader to understand the content and relationships between sections.	
	In Section 5.3.2.7, Table 32 is mentioned before Table 31. The order of cross-referencing these two tables in the text or their order of presentation should be changed	
Follow up on review by Dr Noel Merrick – pp 303-318	There are some recommendations in the review by Dr Merrick that have not been implemented. For example, the Tailing Storage Facility (TSF) has not been shown on the conceptual groundwater model diagrams (Figures 40 and 41).	Figure 41 of the Updated Groundwater Assessment and Figure 5 of Annexure 9 present the conceptual model with TSF.
	The model confidence level classification according to the Australian groundwater modelling guidelines (AGMG 2012) has not been provided in the report despite being noted as missing in the review (p 308).	Additional discussion on model confidence level classification response to the third-party reviewer is provided in Section 3.1 of Annexure 9.
	A table like Table 1 (pp 5–27) is required to show how the proponent responded to the feedback from the third-party reviewer.	

Issue / Matter Raised by DPIE – Water and NRAR		**RWC / Jacobs Response**
Identified Errors and Inconsistencies – Entire Report	There are nomenclature inconsistencies between the report text and figures. For example, the hydrostratigraphic units at the bottom of page 119 and the lithologic units in Figures 40 and 41 are not readily related. In addition, the order of units in the text at the bottom of page 119 is different than that in Figures 40 and 41, and there is apparent inconsistency between the information presented at these two locations and the text at the top of page 59.	General editorial comments have been addressed in the Updated Groundwater Assessment and Annexures 9 (Groundwater Modelling) and 10 (TSF Modelling). Where specific items are identified below, a cross reference to location of updates is provided. Figures 40 and 41 of the Updated Groundwater Assessment and Figures 4 and 5 of Annexure 9 have been updated.
	There is inadequate cross-referencing to information in various parts of the report, e.g. cross-referencing to Section 3.6 and Annexure 3 is needed in Section 5.1.3.	
	The design of some tables require modification. For example, Tables 32 and 33 present Kx and Ky data separately in two different columns, but the system is conceptualised and modelled as being horizontally isotropic (i.e. Kx/Ky=1). Hence, a horizontal hydraulic conductivity (KH) column would have sufficed and the saved space could have been used to present vertical anisotropy (i.e. KH/KZ), which would be useful to the report readers and reviewers.	Updated refer Tables 8 and 9 of Annexure 9.
	The last paragraph in Section 5.1.2.4 and Table 24 do not fit in their location. They are not related only to the Lachlan Fold Belt / Coomber Formation.	Revised text in Section 2.2.4 of Annexure 9.
	There are maps that are difficult to relate to features in the area and to information presented in the report. For example, Figures 46 and 47 are difficult to relate to surface waterways in the area and those listed in Tables 26 and 27.	Reach numbering for RIV cells identified in Table 2 and presented on Figure 10 of Annexure 9. For clarity, no individual reach identification is provided on Figure 11 due to number of reaches presented.
	Table 32 is unnecessarily split across two pages.	Formatting issue with no bearing on technical reporting.
	Some figures need to be corrected. For example, the 'Ideal Fit' line in Figure 57 is drawn incorrectly, suggesting that the model consistently overestimated head, whereas this is not the case (see Figure 4 below).	Updated, refer Figures 21 and 22 of Annexure 9.
	The scale (minimum, maximum and division of axes) in many figures is not user-friendly. For example, a more user-friendly scale will help the reader to understand the model performance more readily from the data presented in Figure 57. Also, the addition of overestimation and under estimation lines (e.g. ±10 m and ±20 m lines) will help the reader understand the level of fit between observed heads and model estimates.	

Issue / Matter Raised by DPIE – Water and NRAR		**RWC / Jacobs Response**
	There is inconstancy in the use of space between values and units throughout the report. For example, there values and units presented with and without space in the same line in the first paragraph on page (2 km… and 2.2km…). Values and units must be presented in consistent format, preferable with separating space but not before the percentage sign where it is used.	General editorial comments have been addressed in the Updated Groundwater Assessment and Annexures 9 (Groundwater Modelling) and 10 (TSF Modelling).
	Numbers are presented with and without thousands separators (e.g. 1,000 m/d in page 165 and 1420 µS/cm in page 172). In addition, numbers are presented using space and comma as thousands separator (e.g. 2 746 in Table 37 on page 157 and 1,000 m/d in page 165). Consistency in number formatting is recommended, preferably using comma as thousands separator.	
	There are cross-referencing errors. For example, in the beginning of Section 5.3.2.2 (page 129) the reference to Figure 41 is incorrect. It should be changed to Figure 43.	
	There are grammatical errors and verb mismatches, e.g. 'Figure 54 and Figure 55 presents…' at the bottom of page 143.	
	There are spelling errors, e.g. losses must be corrected to loses at the end of the first paragraph in Section 5.3.3.3 (p 157).	
	There is unhelpful/unspecific cross-referencing, e.g. 'Detail of the resultant hydraulic conductivity fields are presented further below' on page 144, without citing the section, page, table, or figure.	
	There is inconsistency in the use of punctuation marks, e.g. comma/semi comma mix in the same bullet points set on page 164.	
	There are illegible figures. For example, Figures 43 and 44 are low resolution (fuzzy/pixelated) and some of the colours used in them are indistinguishable (highway lines and mine site boundary). The inset map in the middle is difficult to relate to the larger map, especially that the solid greenish/yellowish colour is obscuring the map background. The same applies to Figure 44. It may be useful to make the colour denoting inactive cells in Figures 43 and 44 transparent to enable relating the inset map to the underlying larger map. In addition, Figures 43 and 44 are too small. It is recommended to reproduce them in A3 format.	Updated, refer Figures 7 and 8 of Annexure 9.

Issue / Matter Raised by DPIE – Water and NRAR		**RWC / Jacobs Response**
	There are data that are presented in the report text whereas they would be better presented in table format. For example, the data on different tests at the end of Section 4.5.10.1 would have been better presented in table format. Alternatively, they could be included in Tables 12 and 13. This also applies to other chapters in the Groundwater Assessment, e.g. the airlift tests summary on page 80.	Updated text, refer Section 4.5.11.1 of Updated Groundwater Assessment.
	There are formatting errors in the report. For example, m2/d in the paragraph before the last on page 135. The power should be superscript (i.e. m^2/d). Preferably, the power can be typed in using a symbol (e.g. ^{2}) to prevent accidental formatting changes.	General editorial comments have been addressed in the Updated Groundwater Assessment and Annexures 9 (Groundwater Modelling) and 10 (TSF Modelling).
	Some section headers must be made clearer. For example, Section 5.3 header is ‘Groundwater Modelling’, whereas the parent Chapter 5 is also titled ‘Groundwater Modelling’. It is recommended to change Section 5.3 header into ‘Numerical groundwater modelling’.	Updated text, refer Section 6 of Updated Groundwater Assessment and Annexure 9.
	The report is required to undergo rigorous proofreading and review to resolve shortcomings and inconsistencies, which if left uncorrected would degrade confidence in the model and groundwater assessment. The above examples are not exhaustive by any means.	General editorial comments have been addressed in the Updated Groundwater Assessment and Annexures 9 (Groundwater Modelling) and 10 (TSF Modelling).
Conceptual Model pp118-125	The report lists guiding principles for the conceptualisation of groundwater systems from the AGMG (2012) but does not discuss whether they have been met, how, and if not, why. This self-assessment is required.	Additional discussion on guiding principles for the conceptualisation, are provided in Section 2 of Annexure 9.
	There is no evidence that the modelling exercise has complied with the listed principles for the groundwater system conceptualisation. For example, it seems that alternative conceptual models have not been considered (e.g. the use of drain (DRN) cells to represent most surface water features rather than river (RIV) cells without considering using RIV cells for all surface water features, and not considering alternative model domain extents). Similarly, there is no indication in the report that the conceptual and numerical models have been progressed through a process of iterative refinement.	Alternate conceptualisation and iterative refinements to the groundwater model were undertaken during calibration and these are discussed in Annexure 9 (e.g. Section 4). For example, calibration scenarios were conducted that incorporated the main north-south trending structures within the Mine Site and applied to extended pumping observation (BG108). Pilot points were also introduced to help inform the near-mine water level calibration. It is noted that incorporation of structures did not benefit calibration (head matching) efforts. A justification for the use of RIV vs DRN cells is provided on Page 13 below.

Issue / Matter Raised by DPIE – Water and NRAR		**RWC / Jacobs Response**
	The domain does not extend to incorporate the nearest mining operations. Although this seems reasonable in this specific case, the report must include a section that discusses the extent of effects from the other operations listed in Section 5.1.6.3 to demonstrate that their effects do not interfere with the effects expected from the proposed Bowdens Silver Mine. This information can be sourced from literature.	Additional discussion on cumulative impacts, are provided in Section 6.6 of the Updated Groundwater Assessment.
	The sources of hydraulic property estimates in Section 5.1.2 are required to be provided (referencing of external sources and cross-referencing of sections in the report, as applicable).	Representative hydraulic properties are provided in Table 18 with Section 4.5.12 of the Updated Groundwater Assessment noting they are based in formation in Sections 4.5.6 to 4.5.11.
	In Figures 40 and 41, different line symbols (markers and/or colours) are recommended to differentiate water tables in different hydrostratigraphic units, and pre- and post-mining periods.	Figures 40 and 41 of the Updated Groundwater Assessment and Figures 4 and 5 of Annexure 9 have been updated. It is noted that the scale of the sections does not allow differentiation of any minor drawdowns such as might be expected in the alluvium.
	In Figure 41, the post mining shallow water table is the same as that presented in the pre mining conceptual diagram (Figure 40). Expected changes should be shown in Figure 41. If no change is conceptualised, this should be clearly stated and discussed.	
	TSF and Waste Rock Emplacement (WRE) must be shown on the conceptual drawings (Figures 40 and 41). The conceptual diagrams should also show potential groundwater mounding underneath such features.	Figures 40 and 41 of the Updated Groundwater Assessment and Figures 4 and 5 of Annexure 9 have been updated. It is noted the cross section line of the figures does not intersect the WRE.
	The conceptual model should include third-party and mine dewatering bores.	It is noted that the scale and location of the sections on Figures 40 and 41 of the Updated Groundwater Assessment and Figures 4 and 5 of Annexure 9 does not facilitate depiction of other mining operations and groundwater users. Additional discussion on groundwater discharge is provided in Section 5.3 of the Updated Groundwater Assessment.
	The Shoalhaven Group is suggested to be acting as an aquitard (Section 5.1.2.2). However, the drawings in Figures 40 and 41 show vertical infiltration and seepage from this unit in a manner that does not suggest that it is an aquitard as compared to the other units. Explanation or modification of figures is required.	Figures 40 and 41 of the Updated Groundwater Assessment and Figures 4 and 5 of Annexure 9 have been updated to reflect conceptualisation of the Shoalhaven Group.

Issue / Matter Raised by DPIE – Water and NRAR		**RWC / Jacobs Response**
	Section 5.1.2.3 refers to lithologic units 4–6 from the top down as 'Rylstone Volcanics', but this may not be readily clear to the reader from Figures 40 and 41 as the lithologic units are not grouped there, but only in the text at the bottom of page 119. The unit grouping in the text and figures should be consistent.	Figures 40 and 41 of the Updated Groundwater Assessment and Figures 4 and 5 of Annexure 9 have been updated to conceptually present Rylstone Volcanics as single unit.
	Alluvium deposits are limited in areal extent and thickness. Nevertheless, they are important in terms of their influence on the flow in rivers and streams like the Hawkins and Lawsons creeks. Special diagram/s are required to show the pre-mining, mining and post-mining hydrological situations in alluvium.	Updated text, refer Section 6.2.1 and Figure 46 of Updated Groundwater Assessment.
	Figures 40 and 41 should show water users (other mines, Basic Landowner Right (BLR) bores, and bores associated with water access licences (WAL's). Section 5.1.6.3 states that bores have been identified in Sections 4.5.2 and 4.5.3 and incorporated into the numerical hydrogeological model for cumulative effects consideration. Figure 14 shows that most bores are located upgradient of the proposed mining operation. Therefore, they are at greater risk to be impacted by the proposed mining operation.	It is noted that the scale and location of the sections on Figures 40 and 41 of the Updated Groundwater Assessment and Figures 4 and 5 of Annexure 9 does not facilitate depiction of other groundwater users. The impact assessment clearly identifies impacted groundwater users.
	There seems to be conflicting information and lack of clarity with regards to horizontal groundwater flow direction and no discussion of vertical groundwater flow and inter-aquifer relationships: • Water level survey [by Jewell, 2003] indicated a general southerly groundwater flow direction (p 47). • Sydney Basins sediments dip gently to the northeast by approximately 0.5 degrees (p 59). • The geology of the Mine Site is heavily fractured, with six major fracture sets, two of which (a north-northwesterly trending set and an easterly trending set) primarily control the distribution of mineralisation (p 60).	Discussion and clarification of groundwater flow is provided in Section 5.2 of the Updated Groundwater Assessment.

Issue / Matter Raised by DPIE – Water and NRAR		**RWC / Jacobs Response**
	• The most dominant faulting in the area is associated with the north-northwesterly structures (p 60). • Throughout the Macquarie-Bogan catchment, the dominant surface drainage direction is to the northwest toward the Darling River, and this will also be the case for shallow groundwater within the regolith profile. More locally shallow groundwater flow will mimic topography, initially to the south toward Hawkins and Lawsons Creeks and then in a northwesterly direction immediately north of Lue (p 63). • Deeper groundwater flow within the Ordovician basement is likely to be more structurally controlled with the dominant structures trending in a north-northwesterly direction, locally inducing groundwater flow to the south (p-63). • Regional groundwater flow will therefore be dominated by down-dip flow to the northeast, consistent with regional bedding dip on the western flank of the Sydney Basin. (p 63) • Localised flow towards the southwest and seepage faces at outcrop from the Sydney Basin sediments is also likely (p 63) • While the water strike map suggests a concentration of water strikes in the southeastern open cut pit area, anecdotal evidence suggests that the wettest part of the ore body is in the northern open cut pit area and to the west of the structure that runs along Maloneys Road (p 70). • The flow characteristics presented in page 96 based on Figure 28 (p 97) are not considered in the conceptual and numerical models. • On page 96, it is noted that Figure 28 show 'a general southeasterly flow direction', which contradicts with other information presented in various sections of the report. • These geological provinces [Lachlan Fold Belt or Orogen and the Sydney Basin] also host two distinct regional groundwater systems with groundwater flow and discharge in the Lachlan Fold Belt system occurring to the northwest, whilst regional groundwater flow and discharge in the Sydney Basin system occurring to the northeast (p 119).	

Issue / Matter Raised by DPIE – Water and NRAR		RWC / Jacobs Response
	• The flow directions shown in Figures 40 and 41 are to the north and south (pp 120–121). This indicates a groundwater divide to the north, which is not shown in the figures or discussed in the text. • Cleavage planes [in the Lachlan Fold Belt / Coomber Formation] dip variably to the east and west. As groundwater flow in this unit will be controlled by fracture flow there is likely to be a preferred flow direction consistent with cleavage and fracturing. Shallower groundwater flow within the weathered zones of this unit (typically in the upper 20-30 m) will be more topographically controlled (p 123). Shallower groundwater flow direction/s must be discussed further and presented more clearly. • Regionally, groundwater discharge (throughflow) will be to the northwest in the Coomber Formation and wider Lachlan Fold Belt. Within the Sydney Basin sediments, regional groundwater discharge will be to the northeast, to the drainage features, the Totnes and Barigan Valleys, as well as the Bylong Valley, with minor vertical leakage to underlying formations (p 124). • Structure influences on the groundwater system are noted in different sections. However, they are not shown on Figure 28 and associated discussion, the conceptual model (Figures 40 and 41), and the numerical model. Some of these structures will act as groundwater flow conduits whereas some will act as barriers. • There is a possibility for enhanced hydraulic conductivity due to structure (e.g. Section 4.5.10.4). This aspect of the groundwater system has not been incorporated in the conceptual and numerical models. • The effects of mineralisation and veins (pp 60 and 62) on the groundwater heads and flow have not been included in the conceptual or numerical models. Flow direction arrows should be added to all existing and additional maps and cross-sections representing observations, conceptualisation, and numerical modelling results (e.g. Figure 28). A special section on groundwater flow direction is recommended to resolve apparent inconsistencies between various relevant parts in the report.	

Issue / Matter Raised by DPIE – Water and NRAR		**RWC / Jacobs Response**
	It is clear that the proposed mine is situated within a complex groundwater flow system. Although it is understood and accepted that modelling entails simplification, there is a worry that the system has been oversimplified. For example, the report notes in page 67 that 'Within the Mine Site, a number of potential GDEs have been identified including springs and seeps, terrestrial vegetation, and river baseflow systems.' However, the conceptual and numerical models fail to represent these features. The proponent should justify the exclusion of such features or include them in the conceptual and numerical models.	The model was not constructed to resolve small scale features such as very localised occurrences of springs within the proposed Mine Site. The groundwater report assesses the majority of springs as being the surface expression of local catchment interflow through the soil profile, forced to surface either via change in slope or shallowing bedrock. These seepage areas are not expected to be impacted by open cut pit dewatering.
	The model must demonstrate the ability to reproduce the modelled groundwater system nature and behaviour. As such, groundwater level contour maps are recommended for all model layer. These maps must also show contours derived from observations. If data availability is limiting, then observation points in each layer with the corresponding observed groundwater level must be shown on these maps. Horizontal flow direction vectors must be shown on all such maps. The agreement between the modelled groundwater level contour maps and observations must be discussed within the context of the assessment of the model goodness of calibration. These figures can replace, supplement or be supplemented by Figure 58.	Whole of model water level contour maps for each model layer are not feasible due to the general sparsity of data. Figure 28 of the Updated Groundwater Assessment presents composite water table contours in the vicinity of the Project. These contours display a distinct correlation of groundwater flow with general topographic trends, that is, from high topographic relief to lower topographic relief. There is no reason to believe that this general trend would not be the same throughout the model domain. Whilst the recommended water level contours are not provided, Figure 23 of Annexure 9 provides maps of calibration residuals for targets in their respective model layers. In addition, the scaled root mean square (RMS) of the residuals is provided in Tables 10 and 15. A scaled RMS error that is less than ten per cent usually indicates a reasonably high degree of model calibration. The scaled RMS error of 1.7% obtained for the calibrated steady state model and 1.4% for the calibrated transient model identifies that the model is well calibrated to measured heads.
	Cross-sections along strategically selected transects are recommended to show modelled and observed groundwater levels at suitable horizontal scale and vertical exaggeration. Figure 73 shows only the modelled water table. Vertical flow direction vectors should be shown on all such cross sections. Inter-aquifer and groundwater-surface water relationships should be shown on the figures and discussed in the text.	Refer Figure 46 of the Updated Groundwater Assessment that includes pre-mining and end of mining water table. As potential impacts to licensed groundwater users are predicted to the north and east of the Mine Site, this cross section (SE to NW) is considered sufficiently representative.

Issue / Matter Raised by DPIE – Water and NRAR		**RWC / Jacobs Response**
	The report indicates the possibility that some shallow groundwater and surface water features are perched above the regional groundwater table, i.e. possibility of unsaturated flow (e.g. first bullet point on p 95). The report should show this in the conceptual diagrams (e.g. Figures 40 and 41), discuss this matter in the modelling text (Chapter 5) and explain how they have been incorporated in the numerical model. If this characteristic of the groundwater system is not included in the model, justification for its exclusion is recommended alongside a discussion on how it has been compensated for and how it affects the model representativeness of the groundwater system, performance and predictions.	It is noted that the scale and location of the sections on Figures 40 and 41 of the Updated Groundwater Assessment and Figures 4 and 5 of Annexure 9 does not allow resolution of these small scale features. These features are considered to be maintained by rainfall fed sub-flow within the soil profile are not anticipated to be impacted by mine dewatering as they are not inferred to be groundwater dependant. Springs associated with discharge from bedding planes within the Sydney Basin sediments are also unlikely to be impacted by drawdown.
	In Section 5.1.2.3, clarification is requested on what 'pseudo-radial flow' mean and how this enables modelling the system as porous media.	Refer Section 2.2.3 of Annexure 9 for updated text and removal of term.
	Section 5.1.2.3 argues that although groundwater flow in the Rylstone Volcanics unit is dominated by fracture flow, on a meso-scale groundwater flow behaves in a pseudo-radial manner, similar to a porous aquifer. Clarification is requested on whether modelling of all other units using an equivalent porous medium approach (Section 5.3.2.7) is appropriate.	As noted in Section 3.7 of Annexure 9, Despite small scale dominance of fracture flow, the groundwater system was implemented in the model as an equivalent porous medium due to the field scale observations from pump testing (refer Section 4.5.9 of Updated Groundwater Assessment). This approach is supported by the calibration results, as discussed in Section 4 of Annexure 9.
	The source of information for the data presented in Table 24 should be provided.	Refer Section 4.5.12 of Updated Groundwater Assessment that includes text on sources of data for Table 18 (formerly Table 24).
	The data in Tables 24 (representative hydraulic parameters) and Table 32 (initial values for hydraulic parameters) are different, particularly in terms of vertical isotropy ratios (KH/KV) and specific storage (Ss). Explanation is requested. In addition, the two tables present the data in inconsistent format (KV/KH in Table 24 vs Kx, Ky and Kz in Table 32), which may unnecessarily confuse the reader.	Table 18 of the Updated Groundwater Assessment presents representation hydraulic parameters that have been derived from various hydraulic testing methodologies at the mine site. The values are also noted as indicative, not absolute. The initial values of hydraulic parameters presented in Table 8 of Annexure 9 are whole of model parameter and need to be indicative of a much broader area.

Issue / Matter Raised by DPIE – Water and NRAR		RWC / Jacobs Response
		Notwithstanding it is noted that the values are not dissimilar: • From Table 18 indicative values for alluvium are Kh of 0.1 to 10 m/day, Kv/Kh of 0.1, and Sy of 0.2. From Table 8 the values are Kh of 2.5 to 5 m/day, Kv/Kh of 0.2 to 0.1, and Sy of 0.11 to 0.2. • From Table 18 indicative values for Sydney Basin (Narrabeen Group, Illawarra Coal Measures, Shoalhaven Group) are Kh of 0.05 to 0.15 m/day, Kv/Kh of 0.1, and Sy of 0.05. From Table 8 the values are Kh of 0.025 to 0.25 (partly weathered rock) m/day, Kv/Kh of 0.1 to 0.15, and Sy of 0.01 to 0.09. • From Table 18 indicative values for Rylstone Volcanics (Rhyolite Breccia, Welded Tuff/Ignimbrite, Crystal Tuff) are Kh of 0.01 to 0.1 m/day, Kv/Kh of 0.5, and Sy of 0.02 to 0.05. It is noted that the elevated Kv/Kh noted as being representative for the mine site is due to the highly fractured nature of the orebody and surrounds and the significant volume of drilling that has been undertaken. From Table 8 the values are Kh of 0.025 to 0.25 (partly weathered rock) m/day, Kv/Kh of 0.1 to 0.5, and Sy of 0.01 to 0.09 (partly weathered rock). • From Table 18 indicative values for Ordovician Basement are Kh of 0.001 to 1 m/day (10 m/day shallow subcrop), Kv/Kh of 0.5, and Sy of 0.01 (0.05 for shallow subcrop). From Table 8 the values are Kh of 0.001 to 0.2 m/day, Kv/Kh of 0.5, and Sy of 0.01. Formats in both tables are revised to Kv / Kh.

Issue / Matter Raised by DPIE – Water and NRAR		RWC / Jacobs Response
	Section 5.1.3 discusses the influence of geological structure on groundwater flow. However, it does not specify which structures shown on Figure 11 are relevant and how the discussed structures impact on the groundwater flow pattern shown on Figure 28). Clarification is requested.	Refer Section 5.2.1 of Updated Groundwater Assessment that discusses influence of local structures on groundwater flow as inferred by pump testing described in Section 4.5.9, with test location and inferred structure shown in Figure 17.
Modelling Objectives – pp128-129	The modelling objectives should include:	The purpose of model was to assess regional impacts of the Project.
	Assessment of seepage into and mounding of groundwater due to seepage from the WRE and TSF.	Potentially acid forming materials placed within the WRE would be encapsulated using a low permeability HDPE liner and (progressively) capped with an impermeable GCL liner and a vegetated store and release cover system. All seepage intercepted by the HDPE liner would be directed (via gravity drainage) to a leachate collection and storage system. As such no seepage is anticipated. Lining materials and design will be refined during detailed design of the WRE. Refer Section 6.5 of Updated Groundwater Assessment and Annexure 10 for assessment of TSF seepage.
	• Assessment of post-mining groundwater and surface water licencing requirements and environmental effects (not just dewatering during active mining).	Refer Table 28 of Updated Groundwater Assessment for post mining groundwater licencing requirements that includes baseflow losses from surface water systems. Refer Section 8.4.2 of WRM (2020) (Surface Water Assessment) for assessment of post mining baseflow loss on streamflow in Hawkins and Lawsons Creeks.
	• Include springs in the first objective (the report notes that some springs occur in the proposed mine site).	The groundwater model is built at a regional scale to assess regional scale responses and impacts due to mining. The model was not constructed to resolve small scale features such as very localised occurrences of springs within the proposed Mine Site. Section 4.5.5.3 of the Updated Groundwater Assessment (Section 4.5.4.3 of Jacobs [2020]) identify the majority of springs as being the surface expression of local catchment interflow through the soil profile, forced to surface either via change in slope or shallowing bedrock. These seepage areas are not expected to be impacted by mine dewatering.

Issue / Matter Raised by DPIE – Water and NRAR		**RWC / Jacobs Response**
		Where springs are identified as being potentially sourced from groundwater via positive vertical gradients or lateral seepage from fractures/bedding planes at outcrop (Shoalhaven Group), the springs are typically highly modified by agricultural activity. For the former it is expected that springflow would cease due to dewatering, for the later no significant impacts are anticipated.
	Section 5.3.1 should list the criteria for the target model confidence level class (Class 2).	Refer Section 3.1 and Table 1 of Annexure 9.
Model Domain – Areal (horizontal) extent – pp129	The description in Section 5.3.2.2 and Figure 43 are not clear. For example, it is not clear whether the catchments mentioned in the description are included in the model domain or border it. Specifically, it is not clear whether the Rylstone Dam is within or outside the model domain.	Figures 7, 8 and 9 of Annexure 9 provide greater resolution for interpreting the model domain. As stated in Section 5.3.2.2 of Jacobs (2020) and Section 3.3 of the Updated Groundwater Assessment, Rylstone Dam and the Cudgegong River form the southeastern boundary of the model domain. The model boundary locations are typically associated with natural drainage features that are distant from the Mine Site and having negligible influence on the assessment of mine inflows.
Vertical Discretisation – pp129-131	The basis for vertical discretisation of the model domain into eight numerical layers corresponding to the eight hydrostratigraphic layers noted in Section 5.1.2 and Figures 40 and 41 is not provided. For example, the AGMG (2012) suggests that aquitard layers like the Shoalhaven Group can be subdivided into multiple numerical model layers to provide information about vertical flows. Also, hydrostratigraphic units can be lumped together in numerical model layers or split into supplementary numerical model layers. Model revision and/or appropriate discussion are recommended.	Vertical discretisation (Sydney Basin Sediments). Conservative approach was adopted for regional modelling, increased layering and model complexity will likely reduce flows (and impacts) and potentially increase uncertainty. The AGMG provides the following guidance… ***"Box 4C: CAUTION regarding vertical discretisation (layers).*** *In cases where it is important to model hydraulic gradients in the vertical direction within specific units (i.e. estimating the curvature of the hydraulic gradient with depth), it is necessary to subdivide individual hydrogeological units into a number of sub-layers. This issue is particularly relevant when considering how to model aquitards. If an aquitard is explicitly modelled as a single layer, groundwater*

Issue / Matter Raised by DPIE – Water and NRAR		RWC / Jacobs Response
		responses are (sometimes erroneously) simulated to propagate instantaneously through the unit. In reality, groundwater responses travelling vertically will be retarded or delayed by an aquitard. *It is recommended that where a model is required to predict time lags of the propagation of responses in the vertical direction, thick aquitards should be subdivided into a number (at least three) of thinner layers."* In this instance there is no specific need to assess the rate of propagation through the Shoalhaven Group, and the representation of the Shoalhaven Group as a single layer as opposed to a composite of three or more layers is conservative with respect to mine dewatering, predicted groundwater take from the Sydney Basin sediments, and impacts due to drawdown or depressurisation within the Sydney Basin Sediments. The representation of ephemeral watercourses as either RIV or DRN cells is acceptable, with the adoption of either approach informed by model scale and data availability. For representation of an ephemeral watercourse in a local catchment scale model, with good temporal resolution of flows and stage heights available, the use of RIV cells would be preferable. However, for a regional scale model that includes hundreds of ephemeral drainages with no available flow data or stage heights, applying RIV cells that require specified river stage information would introduce an unacceptable level of uncertainty. Therefore, the use of DRN cells in this case is a necessary simplification and a widely adopted approach. Water table fluctuations that might be replicated in a catchment scale model due to seasonal flow with RIV cells, are captured in a regional scale model through detailed zonation of rainfall recharge. It must be noted that a good

Issue / Matter Raised by DPIE – Water and NRAR		**RWC / Jacobs Response**
		match to recorded alluvial groundwater levels and fluctuations in the vicinity of Hawkins Creek is achieved in model results. Hawkins Creek is considered an ephemeral system and is represented by DRN cells in the groundwater model.
Boundary Conditions – pp131-142	RIV & DRN boundary conditions (pp 131–136) • The conceptual differentiation between the RIV and DRN is incorrect (paragraph 1, p 135). It is made based on major versus minor watercourses. The main difference between the two MODFLOW packages is that RIV cells can exchange water with the groundwater system (add and remove) whereas DRN cells can only remove water from it. DRN cells cannot be used to represent surface water if some of that water may seep into the modelled groundwater system. So, representing seasonal or ephemeral runoff using DRN cells is inappropriate as these surface water features do not drain groundwater, but surface water and have the potential to recharge groundwater. This means they should be represented using RIV not DRN cells.	Use of RIV cells requires river stage information that is unavailable for ephemeral systems in model. Use of RIV cells increases model uncertainty. Use of DRN cells reduces potential errors in model and is recommended by USGS. The representation of ephemeral watercourses as either RIV or DRN cells is acceptable, with the adoption of either approach informed by model scale and data availability. For representation of an ephemeral watercourse in a local catchment scale model, with good temporal resolution of flows and stage heights available, the use of RIV cells would be preferable. However, for a regional scale model that includes hundreds of ephemeral drainages with no available flow data or stage heights, applying RIV cells that require specified river stage information would introduce an unacceptable level of uncertainty. Therefore, the use of DRN cells in this case is a necessary simplification and a widely adopted approach. Water table fluctuations that might be replicated in a catchment scale model due to seasonal flow with RIV cells, are captured in a regional scale model through detailed zonation of rainfall recharge. It must be noted that a good match to recorded alluvial groundwater levels and fluctuations in the vicinity of Hawkins Creek is achieved in model results. Hawkins Creek is considered an ephemeral system and is represented by DRN cells in the groundwater model.

Issue / Matter Raised by DPIE – Water and NRAR		RWC / Jacobs Response
	• Surface water features modelled using MODFLOW RIV and DRN packages are not clear in Figures 46 and 47, especially at the periphery of the model domain. It is very difficult to relate them to the data presented in Tables 26 and 27. These figures would better be reproduced using an appropriate mapping or GIS software. They must show the features, their types, names and reach numbers as referenced in Tables 26 and 27 on a useful basemap.	Reach numbering for RIV cells identified in Table 2 and presented on Figure 10 of Annexure 9. For clarity, no individual reach identification is provided on Figure 11 due to number of reaches with DRN cells being presented.
	• The basis for universally setting DRN and RIV cells bottom and water level (as applicable) relative to topographic elevation should be explained. The universal approach may particularly be inappropriate/unrealistic for features like Lake Windamere and the Rylstone Dam.	The approach is considered reasonable for a regional scale model where actual data is generally unavailable. It is noted that, with the exception of Lawsons Creek, all other RIV cells are generally located away from the Mine Site and will have little influence on model outcomes.
	• Enhanced conceptual and numerical modelling of surface water is recommended, especially as Section 5.3.3.3 notes that 'The water balance indicates that, on average, the modelled groundwater system predominantly losses1 water to water courses.' Hence, surface water is considered an essential and integral constituent in the modelled hydrogeological system.	Enhanced surface water modelling will increase complexity of modelling and introduce further uncertainty. RIV cell conductance in model was controlled by formation permeability. RIV cell conductance was analysed for baseflow assessment and returned a good match. The current model matches water levels in alluvium well. Jacobs will produce hydrographs for points near watercourses as part of response. Enhanced modelling of surface water is beyond the requirements of the current assessment. It is noted that baseflow contribution to Hawkins Creek has been calibrated to baseflow estimates derived from flow gauging data. Hydrographs associated with shallow alluvial bores along Hawkins Creek are also well represented in the model.
	• Varying depths of surface water stage and bottom below the surrounding land level should be considered. Sensitivity analysis of these parameters are also required to be undertaken followed by uncertainty analysis if found necessary.	
	• The source of topographic elevation data is assumed to be Figure 8 or Figure 53. However, Section 5.3.2.6 (top of p 143) notes that the top of the model was based on LiDAR and 1:25,000 topographic dataset of NSW Lands and Property Information. Clarification of the used data source is recommended. In addition, a discussion of the similarity between Figures 8 and 53.	As discussed, the topographic data set over the mining lease is publicly available LiDAR data. The LiDAR data is a 2 m gridded DEM. The high resolution data set was merged with regional 1:25,000 topographic dataset. Updates to 2m gridded DEM for regional model areas will be considered for future model updates. Figures 8 and 53 utilise the same 1:25,000 topographic dataset.

Issue / Matter Raised by DPIE – Water and NRAR	RWC / Jacobs Response
• Seepage faces, springs, seeps, and wetlands Section 6.1.2 argues that Sydney Basin sediments bedding planes springs are unlikely to be impacted by drawdown from the proposed project. Explanation is requested of the apparent discrepancy between the above points. – Seepage faces (e.g. p 63), springs, seeps and wetlands (e.g. p 67) are not shown on a map or the conceptual cross-section diagrams. They are also not represented in the numerical model and the project effects on these features are not assessed despite that these features have been incorporated in water quality analysis (Section 4.5.12). – Some springs are deemed not to be connected to the groundwater system (i.e. perched) based on groundwater quality evidence, e.g. p 98. – Section 6.1.2 (p 180) suggests that there are springs that drain Sydney Basin sediments (model layers 2-4) through bedding planes. • It is recommended to provide an improved discussion of seepage faces, springs, seeps, and wetlands. They should be included in the conceptual model and where appropriate in the numerical model and reported water budgets. The discussion can be presented in a special 'groundwater-surface water interaction' section.	Additional discussion of seepage faces, springs, seeps, and wetlands will be included in the revised report. The groundwater model is built at a regional scale to assess regional scale responses and impacts due to mining. The model was not constructed to resolve small scale features such as very localised occurrences of springs within the proposed mine site. The groundwater report assesses the majority of springs as being the surface expression of local catchment interflow through the soil profile, forced to surface either via change in slope or shallowing bedrock. These seepage areas are not expected to be impacted by mine dewatering. Where springs are identified as being potentially sourced from groundwater via positive vertical gradients or lateral seepage from fractures/bedding planes at outcrop (Shoalhaven Group), the springs are typically highly modified by agricultural activity. For the former it is expected that springflow would cease due to dewatering, for the later no significant impacts are anticipated. It is not intended to try and replicate these features in the groundwater model, however additional discussion will be included as suggested.
• Effects on seepage faces, springs, seeps, and wetlands should be assessed.	These features are considered to be maintained by rainfall fed sub-flow within the soil profile are not anticipated to be impacted by mine dewatering as they are not inferred to be groundwater dependant. Springs associated with discharge from bedding planes within the Sydney Basin sediments are also unlikely to be impacted by drawdown.
Wells (pp 136–138) • Mine pit dewatering wells are not represented in the conceptual and numerical groundwater models. Clarification is requested.	Mine dewatering is simulated utilising drain cells to simulate sump pumping within the active mine area. To date, sufficient permeability or yields have not been identified to warrant the installation of ex-pit dewatering bores for advance dewatering. Whilst dewatering bores were included in the Design Feasibility Study, they were

Issue / Matter Raised by DPIE – Water and NRAR	RWC / Jacobs Response
	used as an element of conservatism (representing increased cost) with respect to sump dewatering. The groundwater assessment for the EIS was undertaken using sump dewatering only. Notwithstanding this, the method of dewatering is of little consequence in terms of regional impacts. The use of bores over sumps is only relevant from an operational perspective (mine planning and pit wall depressurisation for example). Any additional volume of dewatering required through use of dewatering bores from a licencing perspective would be well within the predictive uncertainty of the model.
• In Table 28, either the headers or the data in the second and third columns should be swapped as they are inconsistent with the discussion under the header 'Wells (WEL)' (pp 136–138). The text articulates that BLR bores were assumed to be active throughout the year. However, the data in the table suggest they are assumed to be inactive from March to July. On the other hand, the data in Table 28 suggests that licenced bores (bores associated with WALs) are assumed to be active year-round whereas the text suggests these works are only active during the dry season (August–February) (See Figure 5 below).	Amended text, refer Section 3.5.3 and Table 4 of Annexure 9
• The data in Table 28 suggest that the dry season extends from August to February. This assumption must be substantiated using data from Section 4.1 Climate (pp 50–52). • There is a risk that the error noticed in Table 28 has transpired into the numerical model. The proponent should check the model and clarify the situation.	From Table 5 of the Updated Groundwater Assessment it is apparent that on average there is a rainfall deficit, where monthly evaporation exceeds monthly rainfall, for ten months of the year. The deficit commences in August and extends through to May. It is also noted that the summer crop growing season typically ends in February or March when crops are harvested, so the assumption of dry season irrigation from August to February is not unreasonable. It is also noted that water use by basic landholder rights and other works is assumed, not known.

Issue / Matter Raised by DPIE – Water and NRAR		RWC / Jacobs Response
		Section 5.3.3.5 of Jacobs (2020) and Section 4.5 of Annexure 9 identify modelled outflow from groundwater users represent only 2% of the total water balance for the calibrated transient model. As the numerical model was developed using a six-monthly timestep, minor changes to the rate or temporal distribution of groundwater losses from abstraction would have limited implications for model predictions.
	• Bore labels (at least for bores associated with WAL) must be shown on the maps in Figure 48. A useful basemap is required for the maps in the figure. Also, it would be useful to use different symbols for BLR and production bores.	Refer Figure 14 and Table 7 of Updated Groundwater Assessment that identifies water supply works associated with WALs. Figure 14 also provides separate symbology for various bore types.
	Climate (pp 50–52) • Add mean annual rainfall and potential/open water evaporation into Table 5.	Section 4.1 of Jacobs (2020) and the Updated Groundwater Assessment identify average annual rainfall (606mm/year) and evaporation (1,514mm/year) with monthly totals for these parameters tabulated in Table 5.
	• Add rainfall–potential/open water evaporation balance into Table 5 as an indicator of wet/dry months and preliminary overall annual water balance. Alternatively, represent data monthly rainfall and potential evapotranspiration data in a single [bar] graph.	
	Atmosphere-aquifer water exchange, i.e. recharge and evapotranspiration from the water table (pp 138–142) • The reported basis for recharge and evapotranspiration zonation is the same. However, the report defines different zone systems for these two parameters (Figures 49 and 50 and Tables 29 and 30). It is noted that the there is an additional land-use/topography class (‘Hilltops’) in the recharge zonation. However, it is not clear why this land-use/topography class was not also included in evapotranspiration zonation. Explanation of these apparent areas of discrepancy is requested.	Both recharge zones and ET zones were initially assigned based on land-use and topography. However, during preliminary calibration of earlier versions of the groundwater model some of the original recharge zones were further refined (sub-divided) to improve model calibration (which is a common approach when parameters are estimated during calibration in a series of piece-wise homogenous zones). Using this approach, the original Recharge Zone 2 (Hilltops) was split into Zone 2 and Zone 3, which both represent recharge for “Hilltops”. However, during preliminary calibration of earlier versions of the groundwater model, it was observed that the model was relatively insensitive to changes in ET and, as a result, a fixed value of 0.4 was applied to most land-use types. It

Issue / Matter Raised by DPIE – Water and NRAR		**RWC / Jacobs Response**
		was, therefore, considered unnecessary to refine the ET zonation further during the almost uniform representation of ET in the preliminary calibrated model. This explains why the two recharge zones Zone 2 and Zone 3 correspond to only one ET Zone (Zone 2). Given the insensitivity of ET during preliminary calibration, and that a fixed ET value was assigned over most of the model domain, a further step was taken to combine the following adjacent ET zones to reduce the number of variable parameters in the model: • Recharge zone 1 (Foothills) and Recharge Zone 4 (Floodplain) correspond to ET Zone 1 (Foothills/floodplain). • Recharge zone 31 (Foothills) and recharge zone 34 (Floodplain) corresponds to ET Zone 31 (Foothills/Floodplain).
	• The effects of TSF and WRE on recharge and evapotranspiration are not discussed or represented in the numerical model. Explanation is requested.	The TSF is simulated as a higher rate of recharge equivalent to seepage during mining, with post mining recharge reduced to represent the capping of the TSF. During mining the WRE isn't specifically modelled with the WRE area receiving background recharge. Post mining, recharge is reduced consistent with the final landform design to minimise infiltration.
	Groundwater recharge (pp 138–140) • The modelled groundwater recharge is reported as a 'recharge factor', which is a proportion of rainfall. A map showing initial recharge estimates for the steady-state model is recommended to be presented as a recharge depth rate (e.g. mm/year or m/year) to enable understanding the areal distribution of this parameter. Similar maps are required for the calibrated steady-state recharge and annual average recharge in the transient calibrated model.	Section 3.5.4 of Annexure 9 describes the approach to deriving and applying recharge across the model domain. The information supplied in Table 5 and shown on Figure 13 are considered sufficient to represent recharge zones of the model domain.

Issue / Matter Raised by DPIE – Water and NRAR		RWC / Jacobs Response
	• In page 138, the report states that recharge was included as a calibration parameter, except for Lake Windamere, which was assigned a factor of 1.0 (equivalent to 100%). Conceptually, the area under Lake Windamere does not receive direct rainfall recharge, unless it is dry. – If Lake Windamere was also modelled as RIV cells, correction or explanation is recommended as this constitutes double counting of water inputs.	Lake Windamere was also modelled as RIV cells. The reviewer is correct that applying recharge as 100% of rainfall constitutes double accounting. However, the lake surface area constitutes a very small portion of the model domain such that the additional recharge applied to the model over the lake surface constitutes a very small percentage of the total recharge to the groundwater model. Therefore, there is a very small error in the total model water balance due to applying recharge over the modelled lake surface. Furthermore, the lake is located at a considerable distance from the mine site such that the additional recharge flux applied to the lake in the model is likely to have negligible effects on the predicted groundwater-related impacts associated with the project.
	– If Lake Windamere was not modelled as RIV cells, then there may be underestimation of the groundwater influx from the lake into the aquifer as it would be incorrectly limited in the model to the amount of rainfall whereas there is theoretically an infinite source of water that can seep into the aquifer.	
	• The colours used in Figure 49 are not easy to differentiate. Also, it is difficult to relate the zones in the figure to features in the area due to the lack of a useful basemap.	Refer Figure 13 of Annexure 9 for updated figure.
	• The logic behind specifying recharge factors for different zones should be clarified. For example, it is noticed that the recharge factor for the foothills is 0.12, 0.06, 0.04, and 0.04 in Thiessen polygons for rain stations 62012, 62021, 62026 and 62032, respectively. The report does not explain why the recharge factor changed in these zones despite having the same 'land-use'. It is understandable that the topography in these different zones may be different, but the repot does not provide data that can be used to replicate the recharge zonation.	While the recharge zones are classified broadly based on geomorphological environment (floodplain, foothills, hill tops etc) the final recharge factor applied has been optimised during calibration and is independent of the zone classification.
	• The report should clarify the topographic basis (classification system) that is used with land use for recharge zonation purposes.	
	• The legend in Figure 49 shows 16 recharge zones, whereas there are only 15 recharge zones in Table 29. Zone 7 is missing in Table 29. Explanation or correction is requested.	Refer Table 5 of Annexure 9.

Issue / Matter Raised by DPIE – Water and NRAR		**RWC / Jacobs Response**
	Evapotranspiration (pp 141–142) • SILO potential evapotranspiration data is inappropriately referred to as 'FAO56 data'. This must be corrected to 'Modified Penman-Monte evapotranspiration' or simply 'potential evapotranspiration'.	It is not clear why the reviewer believes the reference to FAO56 is inappropriate. FAO56 short crop is a derived variable available from the SILO database.
	• Explanation is requested with regards to why and how an 'evapotranspiration factor [has been] applied' to calculate monthly totals from SILO daily potential evapotranspiration' data.	For each model ET zone, a constant daily maximum ET rate was applied to each day of the month with the daily maximum ET rates varied from month to month. For each month simulated, the daily maximum ET rate was based on the average SILO daily ET rate for the corresponding month. The daily maximum ET rate applied to the model was the product of the average SILO daily ET rate and an ET factor. The ET factor was adjusted during the calibration for earlier versions of the model. During the calibration process, it was observed that the model was insensitive to changes in the ET factor. A decision was then made to fix this insensitive parameter (ET factor) at a value of 0.4 during further calibration.
	• The report argues that unreported earlier versions of the groundwater model showed that the numerical groundwater model is insensitive to evapotranspiration. The proponent is requested to explain the reasoning behind including evapotranspiration in the model where it is not affecting the model. To simplify the model and reduce uncertainty, could evapotranspiration have been left out and compensated for implicitly in the recharge values?	ET was retained in the model so as not to have to further modify rainfall recharge and introduce additional calibration runs. ET is also utilised in the recovery model and mine void equilibration.
	• If there is evidence that evapotranspiration is not an important process in the Bowdens Silver Mine hydrogeological system, it should be clarified on the conceptual diagrams (Figures 40 and 41).	

Issue / Matter Raised by DPIE – Water and NRAR		**RWC / Jacobs Response**
	• Hydrometeorological data analysis (e.g. Section 4.1 Climate) does not provide useful information on the relationship between evapotranspiration (combined evaporation and evapotranspiration). However, Section 4.5.12.4 Major Hydrogeochemical Processes articulates that ‘a number of monitoring locations suggest an evaporative influence’. This indicates that the groundwater system conceptual model (Section 5.1, including Figures 40 and 41) and numerical modelling (Section 5.3.2.4, specifically page 141) are incongruous to the hydrochemical evidence. Correction and/or explanation are recommended.	Stating the model calibration is relatively insensitive to ET factor on a regional scale is not the same as saying that ET is not an important hydrological process. Evaporative enrichment is an expected hydrochemical process in shallow alluvial systems.
	• An evapotranspiration factor of 1 means that ‘actual’ evapotranspiration will occur at maximum possible level (i.e. at the potential evapotranspiration rate). Assignment of evapotranspiration factor of 1 to lake-covered areas may not be appropriate as MODFLOW EVT package removes water from the aquifer, not the overlying surface water like lakes. Hence, direct evapotranspiration from the water table underlying unvegetated lakes (plants not showing above the lake water level) is conceptually flawed. Clarification/correction is recommended.	The reviewer is technically correct that applying an evapotranspiration factor of 1 over the lake surface means that ‘actual’ evapotranspiration will occur at maximum possible level from the aquifer underlying the lake. Given the small area covered by Lake Windamere, this may result in a slight over-estimation of the groundwater removed as ET from the model. However, the effects of the ET over-estimation on the overall model water balance and on the predicted groundwater related impacts due to the proposed project are considered to be minor. In future updates to the model, the area over Lake Windamere will be assigned a maximum ET of 0 m/day.
	• The legend in Figure 50 shows 12 recharge zones, whereas there are only 10 recharge zones in Table 30. Zones 51 and 52 are missing in Table 30. Explanation is recommended.	Refer Table 6 of Annexure 9.
Model Geometry – pp142-143	Section 5.3.2.6 discusses only the model layers configuration. Hence, the section header ‘model geometry’ is a misnomer.	Refer Section 3.6 of Annexure 9.
	The source of the geological data should be clarified.	Refer Sections 2.2 and 3.6 and Table 7 of Annexure 9.
	There is a cross reference error to Table 32 at the end of the section. It must be corrected to Table 31.	Editorial comment noted and reflected in updated reporting.

Issue / Matter Raised by DPIE – Water and NRAR		RWC / Jacobs Response
	All layers are continuous throughout the model domain. Commentary is required on how realistic this representation of the geology is.	While all layers are continuous throughout the model, they are not necessarily active or representative of the same hydrostratigraphic unit. As is apparent from Figure 18 of Annexure 9, hydraulic property zones are used to distinguish between differing units within the same layer (e.g. alluvium and regolith in layer 1).
	The numerical model layers presented in Figures 51 and 52 cannot be readily related to the conceptualised hydrostratigraphic units listed in Section 5.1.2 and presented in Figures 40 and 41. This section is required to explain how the numerical layers overlap with the stratigraphic units to form hydraulic property zones as presented in the Section 5.3.27, particularly Table 32 and Figure 54.	Refer Sections 2.2 and Table 7 of Annexure 9 for correlation with hydrostratigraphic units shown on Figures 15 and 16.
	It is recommended to reproduce Figures 51 and 52 in larger format with a suitable vertical exaggeration and show the different hydraulic property zones on them.	
Initial Hydraulic Parameters – pp143-147	Although the basis for delineating hydraulic property zones (Figures 54 and 55, and Table 31) can be understood from the information provided in Section 5.3.2.7, it is not well described or explained. Clarification is requested.	Refer Section 3.7 and Table 8 of Annexure 9.
	The basis for assigning the initial hydraulic parameter values in Table 32 is not clear. It is difficult to relate them to the data in Section 4.5.7 Previous Hydraulic Testing, Section 4.5.8 Pumping Tests, Section 4.5.9 Extended Pumping, Section 4.5.10 Recent Investigations, and Section 4.5.10.1 Airlift Testing. It is recommended to combine and simplify Tables 12 and 13 to help understanding the hydraulic properties of various units.	
	Section 5.3.2.7 does not clarify the source of the initial estimates of hydraulic parameter values. However, apparently hydraulic conductivity estimates are obtained from Sections 4.5.7-4.5.10.4 and porosity and storage parameters values from Sections 4.5.10.5–4.5.10.6. The names of the geological units used in Chapter 4 are not readily translatable into the names of the hydrostratigraphic units or model layers used in Chapter 5, making it difficult for the reader to understand the model set up and parameterisation. The report should be adjusted to overcome this difficulty.	Refer Section 3.7 and Table 8 of Annexure 9.

Issue / Matter Raised by DPIE – Water and NRAR		RWC / Jacobs Response
	Section 5.1.3: drilling results suggest that relatively high groundwater yields can be obtained in the vicinity of the structures. However, these structures are apparently not represented in the numerical model. Explanation or correction is recommended.	It is noted in Section 3.7 of Annexure 9 that explicit representation of the major structures was attempted during calibration, however, was found to be detrimental to calibration and not pursued.
	There is a note that two structures 'inhibit groundwater flow across them while enhancing groundwater flow parallel to their strike, both laterally and vertically.' It is not clear whether these structures have been incorporated in the model. Clarification or correction is recommended.	
	Section 5.3.2.7 indicates that 'a zone of moderately elevated hydraulic conductivity has been introduced surrounding the orebody in Layers 4, 5 and 6 to account for the increased concentration of structural deformation.' However, no information is presented about this zone in Tables 31 and 32 and Figures 54 and 55. This zone could be hydraulic conductivity zone 45, 46, 55 or 63. Clarification is recommended.	Refer Section 3.7 and Table 8 of Annexure 9.
Steady-State Groundwater Level Calibration – pp148-154	There are very few or no calibration targets in some model layers (e.g. layers 6–8). The report should make recommendations to enhance the monitoring network to enable better calibration of future model versions.	Installing additional monitoring bores to create calibration targets in specific model layers is not considered a priority. The groundwater model as it stands has been subjected to two peer reviews that identify it as fit for purpose. The model is considered to be sufficiently calibrated. Future recalibration will be to existing monitoring bores and observed mine inflows. Where additional monitoring bores are installed as part of ongoing exploration and groundwater investigation, these bores will also be utilised as appropriate.
	There are no multi-level monitoring wells or well pairs/clusters to enable conceptualisation and numerical model representation of vertical groundwater gradients. The report should utilise available data to address vertical groundwater gradients and, if necessary, recommend collecting additional data to do so.	
	The discussion of the use of Pilot Points to parameterise hydraulic conductivity in Layers 4, 5 and 6 is not useful. The Pilot Points are not shown on a map and the discussion does not provide the reader with adequate information about this part of the modelling process.	Pilot points were utilised in the vicinity of the mine site in order to try and achieve calibration with the explicit representation of the major geological structures. The results were not favourable to the calibration and the explicit representation of the faults was not pursued further. Significantly better calibration was achieved through the adoption of the zone of moderately elevated hydraulic conductivity.
	It is not understood why it has been attempted to use Pilot Points only in the vicinity of the mine site and how that was attempted (pages 144, 51 and 178). Pilot Point calibration could have been used with or without zones across the entire model domain. It seems that there has been an error applying this technique. This aspect should be explained further.	

Issue / Matter Raised by DPIE – Water and NRAR		RWC / Jacobs Response
	Some parameter values vary greatly between the initial estimates (Table 32) and the steady-state calibrated values (Table 33). Since the data in Table 32 are thought to be sourced from hydraulic testing (Chapter 4), an explanation is requested for the apparent occasional large discrepancy between field and model parameter values, (e.g. KH values for zones 51, 61 and 71).	Refer Section 4.1 of Annexure 9.
	In Figure 58, the map legend colour ramp is not user-friendly. It does not enable instant understanding of close fit, over- and under-estimations of the head. It is recommended to use distinct intervals rather than a gradual colour scheme to represent agreement between observed and modelled heads.	Refer Figure 23 of Annexure 9.
	Figure 58 is fuzzy, and the maps are too small to clearly show the data. It is recommended to provide the figures in larger and higher resolution format.	
	Commentary is recommended with regards to initial and calibrated hydraulic conductivity vertical anisotropy values and their agreement.	Refer Section 4.1 of Annexure 9.
	Conductance values for RIV cells (156.25–6,250 m^2/d) and DRN cells (16.2– 129.6 m^2/d) have not been varied during calibration despite that these parameters are related to hydraulic conductivity, which has been adjusted during calibration. A discussion is recommended. These parameters should be included in the sensitivity and uncertainty analysis.	The initial RIV and DRN conductance values assigned to the model boundaries were based on the products of streambed material hydraulic conductivity and boundary cross-section areas divided by streambed thickness. An assumed streambed material hydraulic conductivity of 0.2 m/day was used to calculate these initial conductance values. This assumed hydraulic conductivity was between the initial vertical hydraulic conductivity values assigned to the regolith (0.1 m/day) and alluvium (0.5 m/day). The conductance terms assigned to the RIV and DRN were subsequently adjusted during the calibration to measured groundwater levels. Conductance terms assigned to the DRN cells representing Hawkins Creek were further adjusted during calibration for baseflow estimated from continuous streamflow data. Conductance terms for other creeks were also adjusted during calibration based on spot streamflow measurements. Uncertainty analyses for DRN and RIV conductance are provided in Section 6 of Annexure 9.

Issue / Matter Raised by DPIE – Water and NRAR		RWC / Jacobs Response
Steady-State Model Sensitivity Analysis – pp154-157	Table 32 is presented in slightly different formats than Tables 33 and 38, which makes it difficult to compare initial and calibrated hydraulic property values. It is recommended to make these tables more similar.	Refer Section 4.4 of Annexure 9 which notes a reasonable level of calibration for the transient model was achieved using the same hydraulic conductivity values assigned to the calibrated steady state model (see Table 9 of Annexure 9). Section 4.4 also notes that during the transient model calibration, storage parameters were adjusted and assigned to the respective layer zones in the calibrated transient model and are presented in Table 14 of Annexure 9.
	It is not clear from the caption of Table 29 and the text on pages 139 and 151 whether the recharge factors presented in the table are for steady-state calibration only or also the transient model. Clarification is required.	Refer Section 4 of Annexure 9 that provides updated text and tables on steady-state and transient model calibration, including sensitivity testing.
	Table 35 is redundant. It presents the same information presented in Tables 31, 32 and 33 and only adds info on the minimum and maximum used Kx value in the sensitivity analysis (order of magnitude either way of the calibrated model value). This information would have been ideally presented in the text. In addition, there is no mention of the Ky values noted in Table 32, which suggest that the report should not be discussing Kx and Ky separately, but combining them as KH. Confirmation/clarification is requested.	
	Like the previous point, Table 36 is redundant, virtually providing the same information as Table 29 and limited new information (range allowed for recharge variation in sensitivity runs, being 0.5–2 times the calibrated model values). This information is better included in the text rather than in a separate table. In addition, the report does not clarify whether the variation in the recharge parameter were made for the recharge factors or values.	
Transient Model Groundwater Calibration – pp158-162	A map is recommended to show the locations of the bores included in Figures 61–66.	Refer Figure 23 of Updated Groundwater Assessment
	The vertical scale (axis min, max and interval) in Figures 61–66 is not user-friendly.	While sensitivity analysis was not undertaken during transient model calibration to assess the effect of varying storage parameter values on the magnitude of the error between simulated and observed heads, it was undertaken as part of the predictive modelling uncertainty analysis to assess the effect of changing storage parameter values on predicted groundwater drawdown and flows due to the proposed project.
	The history matching and calibration statistics are very good.	
	No transient model sensitivity analysis is reported. This is important as it means that the model sensitivity to storage parameters (Sy and Ss) and the model uncertainty in relation to these parameters have not been investigated. Clarification and/or additional work is required.	

Issue / Matter Raised by DPIE – Water and NRAR		**RWC / Jacobs Response**
Min (sic) Pit Representation – pp164-166 Sections 5.3.4.1 and 5.3.4.3	Mine pit development is represented using DRN cells. Information on the DRN cells conductance is requested to be provided, including whether it varied in area and/or with depth.	A uniform conductance of approximately 970,000 m^2/day was assigned to all DRN cells representing the pit walls. The conservative approach involves assigning artificially high conductance at drain cells to ensure negligible flow resistance at the boundary (i.e. allowing unrestricted inflows). Using this approach, groundwater inflows to the pit are controlled by the hydraulic conductivity of the geological formations along the pit wall. Using the recommended approach by Zaidel et. al. (2010)[1], the drain conductance values assigned to the drain DRN cells are specified to be approximately 2 orders of magnitude higher than the MODFLOW hydraulic conductance term (i.e., the product of hydraulic conductivity and cell cross-section areas divided by average distance between the nodes).
	The representation of the mine pit during the mining and the post-mining periods is appropriate. However, it is recommended to consider the use of the LAK package for post-mining pit modelling. As clarified by Ünsal (2013)2, the 'LAK33 package is superior to other lake simulation techniques. Its ability to simulate lake stage is an improvement over lake simulations using constant heads or head dependent flux boundaries because changes in lake stage can have appreciable effects on the groundwater system. Although High-K simulations and LAK3 results reported to compare well both at steady-state and transient stages, it is known that LAK3 simulations are more stable and require less computational time.'. This recommendation is in line with the AGMG (2012) which encourages the consideration of alternative conceptual models.	Representation of the mine pit void recovery was undertaken in the groundwater model as a check of the GoldSim water balance model and to inform post mining water level recovery. A groundwater inflow to pit lake level relationship was derived by running a separate recovery scenario without external fluxes to the pit (rainfall or ET). The relationship was then used in the GoldSim water balance model, coupled with surface water runoff, rainfall and evaporation at a daily stress period. As the MODFLOW time step is coarser than that of the GoldSim model prepared by WRM it was considered unnecessary to adopt the LAK package approach. It is not intended to re-run the pit lake recovery scenarios, however the LAK package will be considered for future model updates.

[1] Zaidel, J., Markham B., and Bleiker D. (2010), Simulating Seepage into Mine Shafts and Tunnels with MODFLOW, GROUND WATER, Volume 48.

Issue / Matter Raised by DPIE – Water and NRAR		**RWC / Jacobs Response**
	The mine pits development is staged in six-monthly steps (stress-periods), whereas the model is built using monthly stress-periods. It is recommended to adopt monthly stress-periods for all model components to avoid abrupt changes as noted in Section 5.3.5.1.	Pit development stages supplied by client, based on financial and geological model and incremental monthly pit development discretised from this information. Approach adopted is commonly applied in groundwater modelling for mining. Noted – however the mine pit shell was available in six monthly increments. While it would have been possible to implement a progressive transition between pit shells this was not deemed necessary.
Model Predictions and Uncertainty – pp164-178	The approach and results are plausible. In Figures 71 and 72, the drawdown contour lines labels have incorrect signs. Negative drawdown is an expression of groundwater mounding. Either signs must be reversed, or the figure captions changes to state ‘groundwater level change’ rather than ‘drawdown’.	Refer Figures 44 and 45 of Update Groundwater Assessment noting legend clearly identifies line symbology with drawdown inferring a decrease in level with the opposite for mounding.
Conclusion	The modelling chapter requires a conclusion, which effectively summarises the modelling outcomes, including recommendations for model validation and updating.	Refer Section 9 of Annexure 9.
Model Review Referencing Errors – pp178 and pp303-318	Some referenced content in the report reviewed by Dr Noel Merrick has changed. For example, the Dr Merrick’s review references Tables 38 and 41 in point 1.3 (p 312), which are numbered 37 and 40 in the version provided to DPIE Water. Similarly, Figures referenced as 37 and 38 in Dr Merrick’s review are numbered 40 and 41 in the report reviewed by DPIE Water.	Noted
	An erratum is required to be added in the report at the beginning of Annexure 10.	Refer Attachment 2 of Annexure 9