Appendix H

Groundwater Assessment Addendum – Mine Development

REGIS RESOURCES LTD

McPhillamys Gold Project

Amendment Report – Groundwater Assessment Addendum

August 2020

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McPhillamys Gold Project

Amendment Report - Groundwater Assessment Addendum

Report Number

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Client

LFB Resources NL

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Prepared by	**Approved by**
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Executive Summary

ES1 Project amendment overview

LFB Resources NL, a 100% owned subsidiary of Regis Resources Limited, is seeking development consent for the construction and operation of the McPhillamys Gold Project (the project), a greenfield open cut gold mine and water supply pipeline in the Central West of New South Wales (NSW).

The project is comprised of two key components; the mine site where the ore will be extracted, processed and gold produced for distribution to the market (the mine development), and an associated water pipeline which will enable the supply of water from approximately 90 km away near Lithgow to the mine site (the pipeline development). The mine development is around 8 km north-east of Blayney, within the Blayney and Cabonne local government areas.

The mine development will consist of:

- a circular open cut gold mine with a total project life of approximately 15 years, consisting of one to two years of construction, approximately 11 years of mining and processing and a closure period (including the final rehabilitation phase), noting there may be some overlap of these phases;
- waste rock emplacement which will include encapsulation of material with the potential to produce a low pH leachate;
- an engineered tailings storage facility (TSF) to store tailings material;
- construction water supply anticipated to be primarily sourced from onsite bores to meet the short-term construction water demand (470 ML) for the first nine months of construction; and
- an external water supply during mine operation (from month 9) via the pipeline development.

Following submission of the EIS, Regis has made a number of refinements to the project. Key amendments of relevance to groundwater include:

- Mine and waste rock emplacement schedule – revision of the mine schedule and the subsequent construction sequence of the waste rock emplacement has been undertaken, in particular consideration of predicted noise levels in Kings Plains. The amended mine schedule and design has an approximate 11-year life of mine period and a slightly shallower mine depth. In comparison to the previous mine plan, the amended design of the open cut has a more gradual rate of mining, with the peak mined volume to occur in year 6 (compared to year 2 in the previous mine plan).
- TSF – amendments to the design include changes to the embankment design and construction timing, the TSF footprint, and the TSF post closure landform. While the design elevations of the TSF stages have not changed, the timing has been adjusted. The EIS base case groundwater model simulated the three TSF stage rises to occur in the first three years, in comparison to the amended project where there is more time between stage rises.

ES1.1 Multi-barrier approach to seepage management

As reported in the EIS (EMM 2019a and ATC Williams 2019), the TSF is designed to operate effectively and efficiently, and in consideration of the requirements of the NSW Government. The TSF is designed specifically to avoid adverse impacts to the surrounding environment and contain all water during large rainfall events (no spill risk).

Regis has adopted several leading practices to produce a mine design that avoids and minimises impacts to water assets, which includes a multi-barrier approach as part of the design of the TSF:

- cyanide detoxification – improving the quality tailings leachate through design of the process plant prior to tailing placement;
- floor liner, cut-off key, seepage interception trend – reducing the volume and rate of TSF seepage during operations and post closure;
- downstream seepage interception bores, if needed – reducing seepage volumes, if encountered;
- environmental management plans – defining management and monitoring criteria, responsibilities, actions; assigning trigger levels and trigger action response plans; and
- downstream monitoring – groundwater and surface water monitoring to observe trends and review predictions.

This Groundwater Assessment Addendum report assesses the potential groundwater related impacts of the amended project and outlines the differences in predicted impacts compared to the original project as presented in the EIS. Mitigation and management measures, and monitoring requirements for groundwater are also presented. In addition, the Groundwater Assessment Addendum presents an update on the baseline conditions within the mine project area and surrounding area, given the continued monitoring that has occurred since submission of the EIS.

The Groundwater Assessment Addendum has been prepared following the appropriate guidelines, policies and industry requirements, the requirements of the NSW Department of Planning, Industry and Environment, and following consultation with stakeholders including community members and relevant government agencies.

ES2 Groundwater resources

The mine development is located within the Lachlan Fold Belt Murray-Darling Basin Groundwater Source which is managed by the *Water Sharing Plan for the New South Wales Murray-Darling Basin Fractured Rock Groundwater Sources 2020*.

The mine development is underlain by metasediments and volcaniclastics of the Silurian Anson Formation and Ordovician volcanics. There are minor disconnected areas of shallow Quaternary alluvium associated with watercourses and drainage lines. The hydrogeology surrounding the project is dominated by the Palaeozoic metamorphic rocks of the eastern Lachlan Fold Belt. The watertable is typically hosted in the saprock (weathered bedrock) or alluvium (where present) and is locally a subdued reflection of topography, with depth to groundwater typically within 10 to 15 m of the ground surface. The volcanics and metasediments weather to a clay-like material and where fracturing occurs, the fractures generally become clay filled. However, recent drilling has successfully identified areas of reasonable permeability north of the open cut that have been targeted for construction water supply purposes. The saprock zone ranges from 5 to 80 m in thickness. Hydraulic conductivities of the saprock and fresh bedrock in the area is generally low. Bore yields in the metamorphic rocks and very shallow alluvium of the area are generally low (typically <5 L/s). Groundwater use in the area is limited to stock and domestic supplies.

Surface water quality is generally fresh. Groundwater quality is fresh to brackish and varies depending on the geology. Groundwater in the Anson Formation has the highest salinity (up to 4,250 mg/L total dissolved solids). Groundwater pH generally varies from slightly acidic to slightly alkaline, however some pH measurements from monitoring bores have been as low as 2.2 (Anson Formation). Laboratory reported water quality indicates that groundwater is generally suitable for livestock watering, except for salinity and pH at some locations. Dissolved metals are naturally high at some locations, including copper, aluminium, cadmium, manganese, nickel, fluoride, zinc and in some bores within the volcanics, arsenic was also reported above the livestock drinking water guideline value.

ES2.1 Groundwater receptors

Groundwater receptors identified in the mine project area were presented in the Groundwater Assessment (EMM 2019a) and include:

- bores on neighbouring properties (third-party bores); and
- groundwater dependent ecosystems including:
    - the Belubula River (aquatic ecosystem);
    - springs and seeps in the mine project area;
    - Mountain Gum - Manna Gum open forest (plant community type (PCT) 951) and Yellow Box – Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands Bioregion (PCT 1330); and
    - macroinvertebrate fauna identified at two spring/seep areas.

ES3 Impact assessment

Numerical modelling and analytical techniques have been used in this assessment to predict quantity and quality changes in groundwater resources and surface water resources. These techniques are in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al 2012). Consultation with the NSW government has occurred throughout the assessment undertaken for the project, including following submission of the EIS. Assessment of the project has been undertaken in accordance with the NSW Aquifer Interference Policy.

Overall, this assessment addendum shows that the potential impacts of the amended project are broadly the same as those presented in the EIS (EMM 2019a), with the exception of:

- Mine inflows to the open cut are predicted to be much less for the amended project (peak of 580 ML/year in mining year 2) when compared to the EIS base case modelled scenario (peak of 890 ML/year in mining year 2). The difference is due to the steadier development profile scheduled over the first years of the updated mine plan. The predicted inflow volumes are driven by the volume of material mined from the simulated saprock layer (model layer 1), which stores and transmits more groundwater than the underlying fresh rock. Regis' existing entitlement accounts for the predicted peak annual groundwater take for the life of the project.

- Conservative predictions of TSF seepage volumes are also much less for the amended project than the EIS base case scenario. This difference is due to the revised tailings schedule associated with the amended project. The EIS base case simulated the three TSF stage rises to occur in the first three years, in comparison to the amended project where there is more time between stage rises. The groundwater model predicted seepages rates are much higher than the TSF seepage rate predicted by ATC Williams (2019 and 2020) as part of the TSF design. The difference is attributed to the simulation of tailings placement, with the groundwater model adopting a highly conservative approach to inform an assessment of potential impacts on groundwater receptors (ie worst case scenario for seepage and impacts on receptors).

The potential impacts of the project and assessed significance are summarised below.

Groundwater level drawdown extending to existing third-party users and impacting supply – minor.

The extent of groundwater level drawdown of the amended project is very similar to that presented in the EIS (EMM 2019a). Drawdown at all neighbouring bores is predicted to be less than 2 m. As such, the Aquifer Interference Policy make good provisions are therefore not anticipated to be triggered. Operation of third-party bores is not predicted to affected by the project.

Groundwater level drawdown affecting flow of the Belubula River – minor.

Groundwater is currently predicted to contribute approximately 5% of overall surface flows in the Belubula River upstream of the confluence with Trib A. Below Trib A, groundwater is predicted to currently contribute approximately 5 - 10% of surface flows in the Belubula River during average climatic conditions. The groundwater model predicts baseflow to the Belubula River (upstream of Trib A) to reduce by up to 15% and up to 7% in Trib A. These results are consistent with the results presented in the EIS (EMM 2019a). There is no predicted impact to baseflows downstream of the confluence with Trib A. Given the small current contribution of groundwater to surface water flows and the ephemeral nature of the Belubula River upstream of Trib E, the predicted reduction in baseflow resulting from groundwater level drawdown upstream of the confluence with Trib A is minor.

Reduced access to the watertable for groundwater dependent vegetation as a result of groundwater level drawdown – minor.

Vegetation communities along the Belubula River, outside of the disturbance area, are not expected to experience reduced access to groundwater or water stress as a result of the project.

Changes to spring flows as a result of the project – minor.

Most springs/seeps identified in the mine development area have been altered (excavated and converted into a dam) to allow stock access for drinking water. Most identified springs are associated with the shallow, locally recharged, groundwater flow system (ie short flow path groundwater systems). Based on the assessments conducted, the main contribution to the flows in the Belubula River in the mine development area comes from rainfall and surface water runoff, with minor contribution provided by the springs and the local groundwater system. The main change to the Belubula River flows will result from a reduction in the surface water catchment area, rather than construction of the project (including the TSF) on the springs. The TSF and other project infrastructure will be constructed in areas where springs/seeps have been observed. This activity will change the ground conditions and shallow groundwater that currently discharges at surface as a seep or spring will no longer discharge at that location. Instead, the shallow groundwater will continue to move underground (ie this water will remain in the greater catchment). Some of this shallow groundwater will be intercepted by the TSF seepage interception drain or will continue to move underground discharging in the Belubula River or at new or other spring locations. Outside of the mine project area, groundwater levels are not predicted to change as a result of the project. Therefore, seeps and springs outside of the project area will not be altered as a result of the project.

Seepage from the TSF migrating outside of the mine development area and affecting the water quality of the underlying groundwater and Belubula River– minor.

The TSF modelling completed by ATC Williams (2020) shows that the proposed TSF multi-barrier seepage management system provides a robust system and is effective at reducing seepage. Following closure, seepage from the TSF will continue due to the low permeability liner, the nature of the geology and the tailings. This predicted low volume of seepage post closure (11 - 15 kL/day [1.4 - 2.1 mm/year/m^2]) is predicted to flow towards the open cut pit and some is predicted to move towards the Belubula River. This volume is very small in comparison to the Belubula River streamflow (at the gauging station downstream of the confluence with Trib A), which is estimated to have average flows that represent 10,000 times the predicted seepage rate (around 289 ML/day during average climate conditions and 2.7 ML/day during dry conditions).

The results of the highly conservative simulation of the TSF in the groundwater model predicts that the watertable underneath the TSF will become elevated. The conservative approach to the groundwater model indicates that with limited mitigation measures in place, seepage from the TSF is predicted to slowly migrate south-west and south of the TSF. Seepage from the TSF is predicted to remain within the saprock zone, flowing in a horizontal direction. Some of the seepage that migrates south from the TSF that is not intercepted by the seepage management system is predicted to seep towards the pit. Some seepage is predicted to move towards the Belubula River at a rate of approximately 50 m in 100 years.

TSF seepage is very slow and as it migrates through the saturated ground, the seepage water will mix with groundwater, become diluted and will undergo other reactions with the geology and groundwater. The results of this assessment indicate groundwater (following mixing) would have concentrations of aluminium, salinity (as electrical conductivity), sulphate, selenium, cyanide and cobalt):

- below or within the range of water quality concentrations currently measured in groundwater, the Belubula River and its tributaries;
- below ANZECC (2000) livestock drinking water guideline values; and
- below ANZECC (2000) 95% protection level for freshwater aquatic ecosystem guideline values.

Changes in water quality at third-party bores – minor.

The regional groundwater flow direction is predicted to remain unchanged from pre-mining conditions and groundwater levels at third-party bores are not predicted to be affected by the project. As such, groundwater chemistry at third-party bores is not predicted to be affected.

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1 Introduction

1.1 Background

LFB Resources NL is seeking State significant development consent under Division 4.7 of Part 4 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) to develop and operate a greenfield open cut gold mine, associated mine infrastructure and a water supply pipeline in Central West New South Wales (NSW). The project application area is illustrated at a regional scale in Figure 1.1. LFB Resources NL is a 100% owned subsidiary of Regis Resources Limited (herein referred to as Regis).

As shown in Figure 1.1, the McPhillamys Gold Project (the project) is comprised of two key components; the mine site where the ore will be extracted, processed and gold produced for distribution to the market (the mine development), and an associated water pipeline which will enable the supply of water from approximately 90 kilometres (km) away near Lithgow to the mine site (the pipeline development). The mine development is around 8 km north-east of Blayney, within the Blayney and Cabonne local government areas (LGAs).

Up to 8.5 Million tonnes per annum (Mtpa) of ore will be extracted from the McPhillamys gold deposit over a total project life of 15 years. The mine development will include a conventional carbon-in-leach processing facility, waste rock emplacement, an engineered tailings storage facility (TSF) and associated mine infrastructure including workshops, administration buildings, roads, water management infrastructure, laydown and hardstand areas, and soil stockpiles.

In accordance with the requirements of the EP&A Act, the NSW *Environmental Planning & Assessment Regulation 2000* (EP&A Regulation) and the Secretary's Environmental Assessment Requirements (SEARs) for the project, an Environmental Impact Statement (EIS) was prepared to assess the potential environmental, economic and social impacts of the project. The development application and accompanying EIS was submitted to the NSW Department of Planning, Industry and Environment (DPIE) and subsequently publicly exhibited for six weeks, from 12 September 2019 to 24 October 2019. During this exhibition period Regis received submissions from government agencies, the community, businesses and other organisations regarding varying aspects of the project.

In response to issues raised in submissions received, as well as a result of further detailed mine planning and design, Regis has made a number of refinements to the project. Accordingly, an Amendment Report has been prepared by EMM Consulting Pty Ltd (EMM 2020a) to outline the changes to the project that have been made since the public exhibition of the EIS and to assess the potential impacts of the amended project, compared to those that were presented in the EIS. This report forms part of the Amendment Report and presents an assessment of the potential groundwater impacts of the amended project.

1.2 Project amendment overview

A summary of the key amendments to the project since the exhibition of the EIS are summarised below and described in detail in Chapter 2 of the Amendment Report (EMM 2020a):

- **Site access** – a new location for the site access intersection off the Mid Western Highway is proposed, approximately 1 km east of the original location assessed in the EIS, in response to feedback from Transport for NSW (TfNSW, former Roads and Maritime Services) and the community. A new alignment is subsequently proposed for the site access road to the mine administration and infrastructure area.

- **Mine and waste rock emplacement schedule** – revision of the mine schedule and the subsequent construction sequence of the waste rock emplacement has been undertaken, in particular consideration of predicted noise levels in Kings Plains. This achieved a reduction in predicted noise levels at nearby residences while extending the construction timeframe for the southern amenity bund.

- **Pit amenity bund** – the size of the pit amenity bund has been reduced as a result of optimisation of the open cut pit design and the improved location of exit ramps for haul trucks.
- **Tailings Storage Facility (TSF)** – amendments to the design include changes to the embankment design and construction timing, the TSF footprint, and the TSF post closure landform.
- **Water management system** – the secondary water management facility (WMF) has been removed from the water management system, resulting in an avoidance of impacts to a potential item of historic heritage significance (MGP 23 - Hallwood Farm Complex (Hallwood)). The size of the WMFs has also been revised to achieve a reduced likelihood of discharge from the storages within the operational water management system as part of a revised nil discharge design.
- **Mine administration and infrastructure area** – the layout of this area has been revised and optimised.
- **Mine development project area** – a very small change has been made to the mine development project area along the eastern boundary (an additional 1 hectares (ha), or 0.04% change), to accommodate the required clean water management system. The change takes the project area from 2,513 ha to 2,514 ha.

No amendments have been made to other key aspects of the project as presented in the EIS for which approval is sought, such as the proposed mining method, operating hours, annual ore extraction rate up to 8.5 Mtpa, annual ore processing rate up to 7 Mtpa, employee numbers, and rehabilitation methods and outcomes.

The amended mine development project layout, compared to that assessed in the EIS, is shown in Figure 1.2.

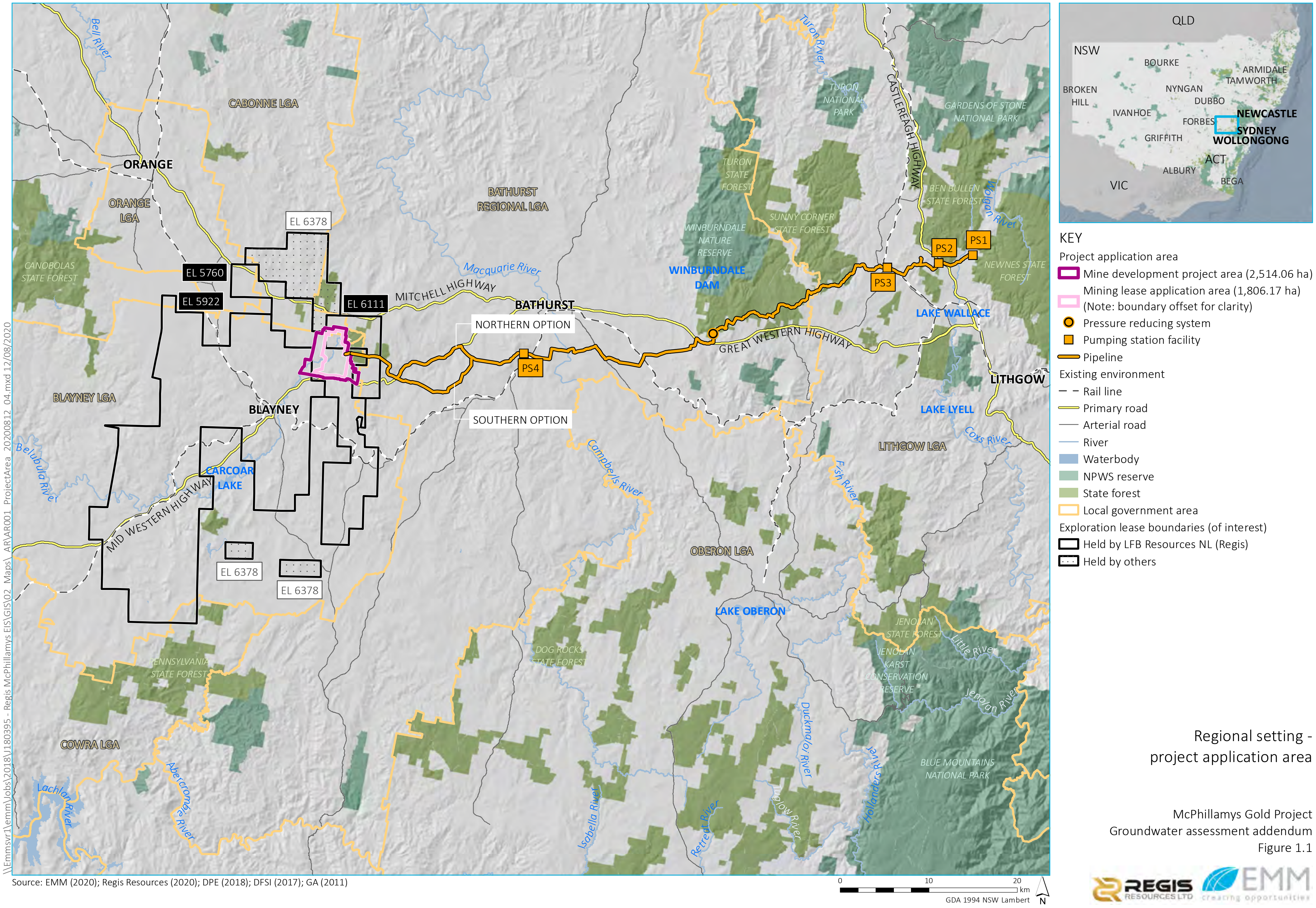
1.3 Purpose of this report

This report has been prepared to assess the potential groundwater related impacts of the amended project. The assessment considers and outlines the differences in predicted impacts compared to the original project as presented in the EIS. In this way, it serves as an update to the McPhillamys Gold Project Groundwater Assessment (EMM 2019a) (Appendix K of the McPhillamys Gold Project EIS).

Further, this report assesses the potential groundwater impacts associated with the mine development component of the McPhillamys Gold Project only. The potential groundwater impacts associated with the pipeline development component have been addressed as part of the EIS (EMM 2019b) and are not considered further in this report.

In addition, the Groundwater Assessment Addendum:

- presents an update on the baseline conditions within the mine project area and surrounding area, given the continued monitoring that has occurred since submission of the EIS; and
- defines groundwater licensing requirements in accordance with revised impact predictions and the relevant legislation.



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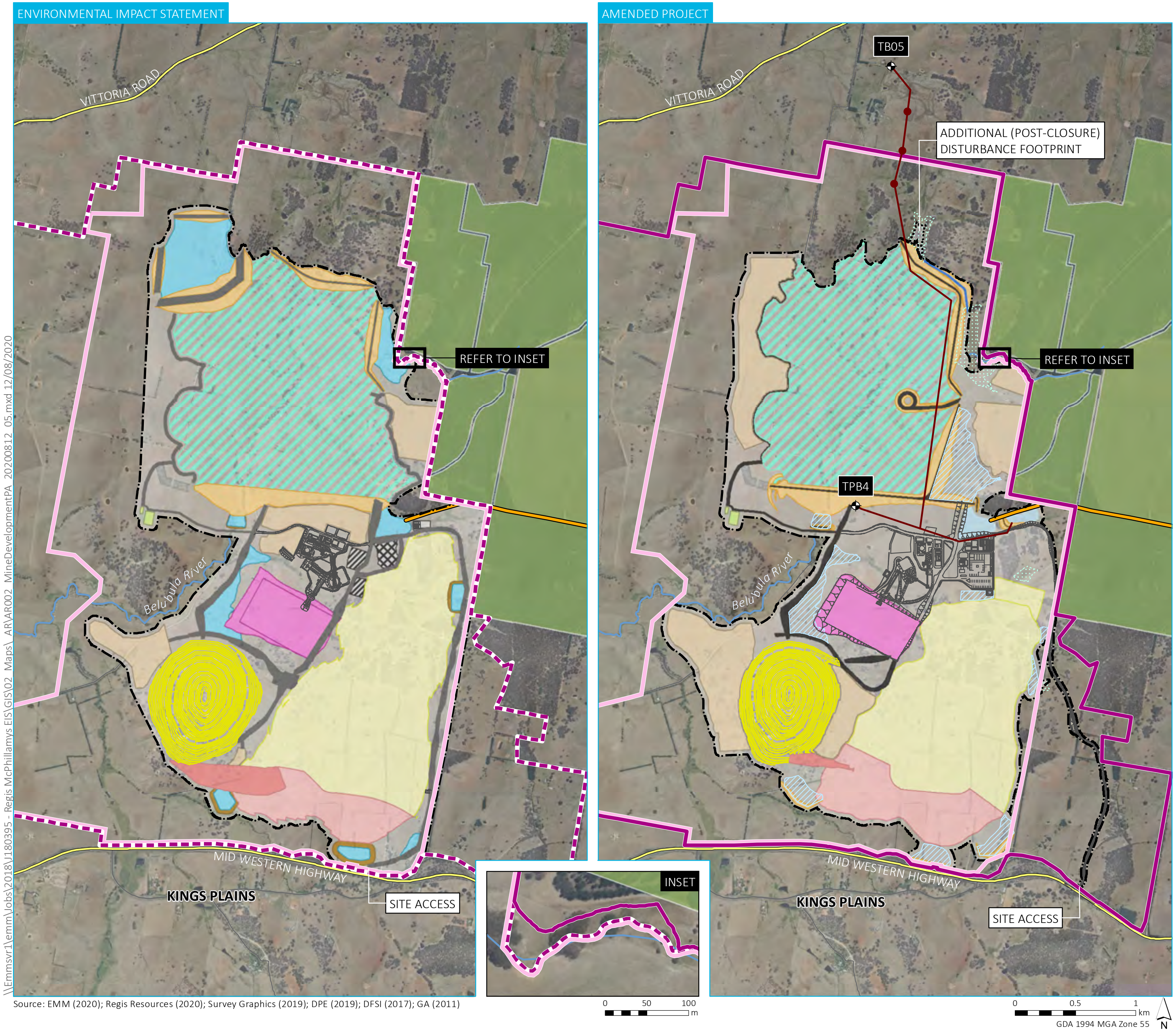
Source: EMM (2020); Regis Resources (2020); DPE (2018); DFSI (2017); GA (2011)

Regional setting - project application area

McPhillamys Gold Project
Groundwater assessment addendum
Figure 1.1



Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DPE (2019); DFSI (2017); GA (2011)

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Amended mine development area

McPhillamys Gold Project
Groundwater assessment addendum
Figure 1.2

1.4 Submissions on the EIS

A number of issues relevant to groundwater were raised in submissions received on the EIS. These issues have been considered in this revised assessment. Submissions related to springs have been addressed in a separate report: McPhillamys Gold Project Surface Water-Groundwater Interaction Assessment (EMM 2020b). Detailed responses to all the submissions received are provided in the Submissions Report prepared for the project (EMM 2020c), which has been prepared in conjunction with the Amendment Report (EMM 2020a). A summary of the key issues relevant to this assessment are provided in Table 1.1, together with how each matter has been addressed within this report.

Table 1.1 Key comments received in submissions relating to groundwater and how they have been addressed

Issue	Where addressed
Potential impact of production bores to be used for construction water supply purposes	Section 5.4 and 6.3
Provide information regarding proposed groundwater monitoring for the project	Section 7.1 and Submissions Report (EMM 2020c)
Provide information regarding Regis' proposed plan to upgrade the groundwater model	Section 5.3.2 and 7.2.1 and Submissions Report (EMM 2020c)
Use of the relevant Australian and New Zealand Guidelines for Fresh and Marine Water Quality guideline values for slightly to moderately disturbed ecosystems - 95% species protection guideline value for freshwater aquatic ecosystems	Section 6.2 and Submissions Report (EMM 2020c)
Provide more information regarding potential impacts to Groundwater Dependent Ecosystems and third-party bores	Section 6.1.2 and Submissions Report (EMM 2020c)

1.5 Terminology

The following terms in this assessment:

- **Mine project area** – refers to the mine development project area as illustrated in Figure 1.1.
- **Mine development** – construction and operation of the mine and associated mine infrastructure within the mine development project area.
- **The project -** references to 'the project' throughout this report are referring to the mine development only.
- **The amended project -** where the groundwater model predictions of the project are being compared to the original mine schedule and tailings area as presented in the EIS, 'the amended project' is used.
- **EIS scenario –** refers to the base case scenario presented in EIS groundwater assessment (EMM 2019a) to aid comparison between the updated groundwater model predictions of the project.
- **Study area** - the study area for the groundwater assessment is centred around the mine development area. Figure 1.3 presents the groundwater assessment study area (hereafter referred to as the study area).

1.6 Assessment requirements

Consistent with the groundwater assessment completed as part of the EIS (EMM 2019a), this assessment addendum has been prepared following the appropriate guidelines, policies and industry requirements, and following consultation with stakeholders including community members and relevant government agencies.

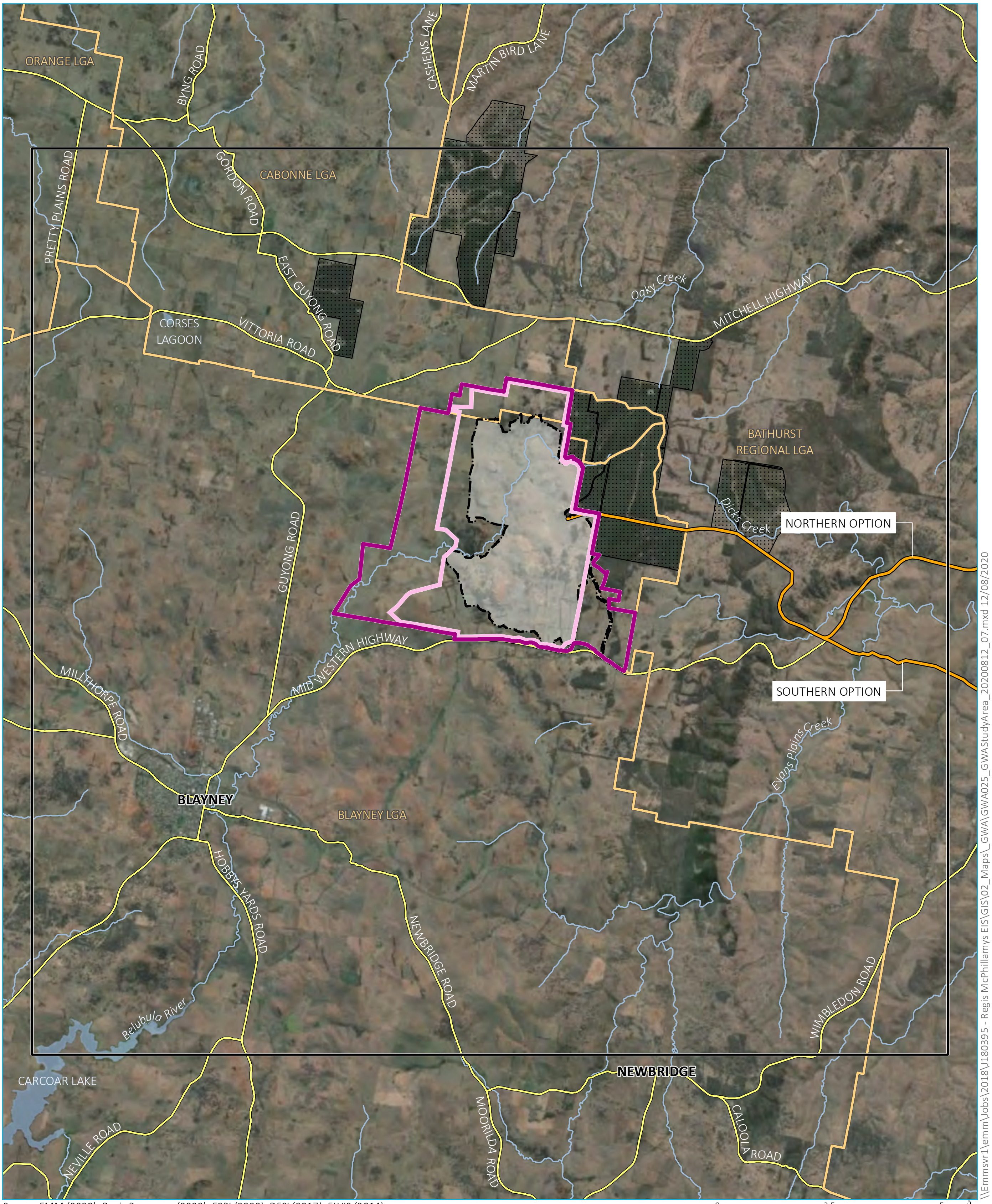
Guidelines and policies referenced are as follows:

- NSW Aquifer Interference Policy (AIP; DPI Water 2012);
    - DPI (2018) fact sheet, which documents the process and criteria applied to the assessment of application under the *Water Management Act 2000*;
- relevant Water Sharing Plans (WSP);
- NSW State Groundwater Policy Framework Document (DLWC 1997);
- Australian Groundwater Modelling Guidelines (Barnett et al 2012);
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality and Livestock Drinking Water (ANZECC & ARMCANZ 2000); and
- Australian Drinking Water Guidelines (NHMRC 2016).

Additionally, while not strictly relevant to this project, the Uncertainty Guidelines developed by the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) have been considered (consistent with that considered in the EIS):

- Middlemis and Peeters (2018): Uncertainty analysis—Guidance for groundwater modelling within a risk management framework.

The regulatory and policy context for the assessment was described in the EIS groundwater assessment (EMM 2019a), and has not been reproduced here.



Source: EMM (2020); Regis Resources (2020); ESRI (2020); DFSI (2017); ELVIS (2014)

KEY

▭ Study area

Project application area

▭ Mine development project area

▭ Mining lease application area (Note: boundary offset for clarity)

▭ Disturbance footprint

— Pipeline

Existing environment

— Major road

— Named watercourse

▭ Waterbody

▨ Vittoria State Forest

▭ Local government area

Groundwater assessment study area

McPhillamys Gold Project
Groundwater assessment addendum
Figure 1.3

2 Project setting and description

2.1 Overview

This section presents provides an update on data and information collated since the submission of the EIS.

The following information previously presented in the Groundwater Assessment (EMM 2019a) has not changed and is not presented again in this report:

- topography;
- watercourse geomorphology;
- regional and local geology;
- geochemistry; and
- regional hydrogeology.

The following information is re-presented in this addendum report to assist the reader, however the understanding and reporting of these components has not changed since the EIS (EMM 2019a):

- surface water and groundwater sources, including water management areas – an update regarding water access licences is included in Section 2.3;
- hydrostratigraphic units (HSUs);
- groundwater receptors; and
- conceptual hydrogeological model.

2.2 Climate

The Blayney-Orange district is characterised by a mild temperate climate with warm to hot summers and cool to cold winters. Rainfall is typically highest during the winter months. Rainfall data have been acquired from the site weather station since 2013 and the surrounding Bureau of Meteorology (BoM) weather stations (Blayney (station 63294); Orange airport (station 63303) and Orange Agricultural Institute (station 63254)).

More recent records from the Scientific Information for Land Owners (SILO) Data Drill (accessed May 2020) have been obtained to supplement the available rainfall data described in the EIS. SILO datasets are constructed from observational records provided by the BoM. SILO processes the raw data, which may contain missing values, to derive datasets which are both spatially and temporally complete.

The long-term average annual rainfall for the area ranges from 702 millimetres (mm) (SILO) to 916 mm (Orange Agricultural Institute, BoM station 63254). The average annual rainfall total recorded at the on-site weather station between 2013 and 2018 is 670 mm (due to technical problems with the data, a complete dataset for 2019 is not available). The SILO rainfall total for 2019 was 461 mm. The annual potential evaporation for the area exceeds the rainfall total and averages 1,339 mm (SILO). Monthly average evaporation exceeds average rainfall throughout the year except for the winter months (June-August).

The annual rainfall totals for each of the above rainfall records between 2000 to 2018 are presented in Figure 2.1. Over the past 19 years, 2010 was the wettest year and marked the end of the Millennium Drought (2002 to 2010). The next wettest year was 2016, with a rainfall total of 971 mm recorded in the mine project area, compared to the SILO rainfall total of 986.5 mm. Based on the rainfall records, the area experienced low rainfall in 2019, however rainfall in January to May 2020 has been above the SILO long-term monthly averages.

Cumulative rainfall departure from mean (CRD, also referred to as cumulative deviation from mean (CDFM)) rainfall is the accumulated difference between rainfall (in a day, month or year) and the long-term mean, providing an indication of the general climatic trend over time as well as general water availability (soil water, surface water and groundwater). Due to the hydraulically tight geology in the area, it is inferred that groundwater levels will take longer to respond to climate stresses (when compared to sandy or higher permeability lithology). As such, CRD has been calculated using the SILO record between 2010 to 2020 and is presented on Figure 2.2. The plots indicate climate (rainfall) variability is typical of the study area, with periods of:

- above average rainfall from 2010 to April 2011, November 2011 to March 2012, May 2016 to early 2017, November 2018 to January 2019 and from January 2020 to present; and

- below average rainfall from March 2012 to May 2016, January 2017 to November 2018 and from February 2019 to December 2019.

The Groundwater Assessment (EMM 2019a) presented CRD back to 1900 to illustrate that the area has experienced large variations in rainfall trends since this time, including multiple droughts and very wet periods. However, Weber & Stewart (2004) state that analyses based on the CRD method can be erroneously influenced by the use on a long time scale. Other than being used as a comparison to evaluate seasonal trends in groundwater level monitoring data, CRD was not used for further detailed analysis.

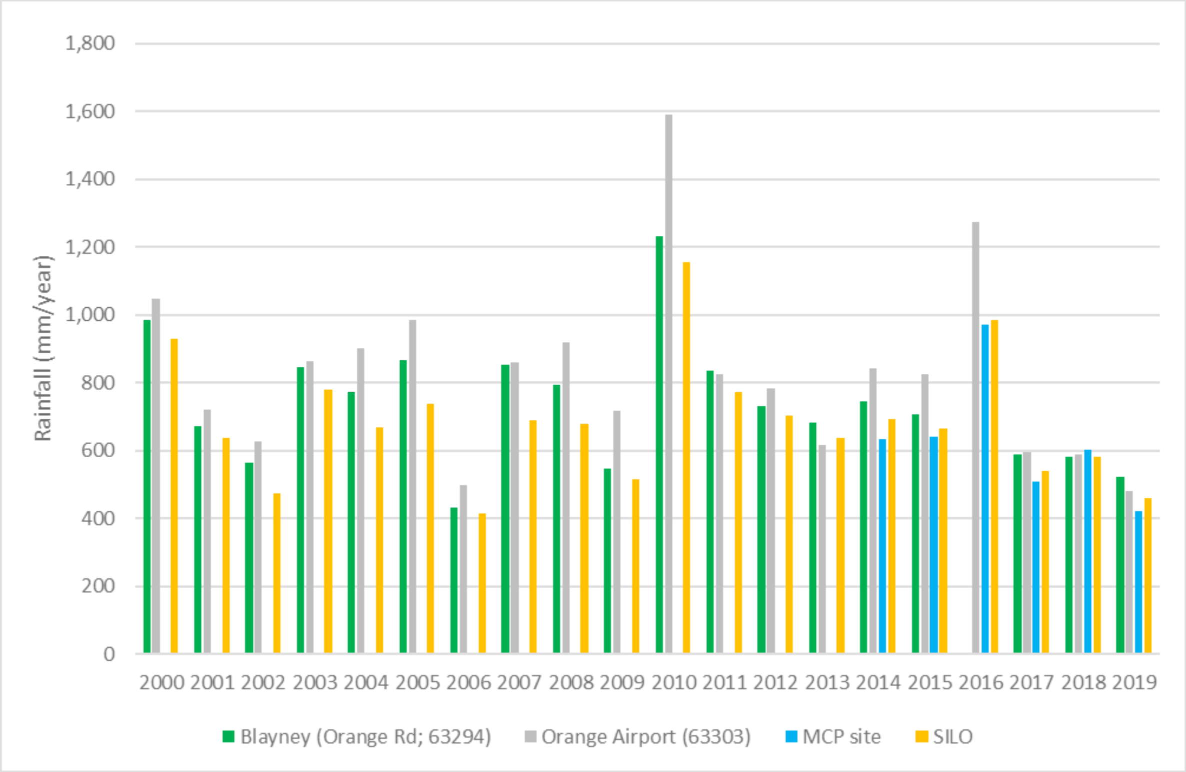


Figure 2.1 **Annual rainfall totals 2000 to 2019 (MCP site, SILO, BoM stations 63294, 63303)**

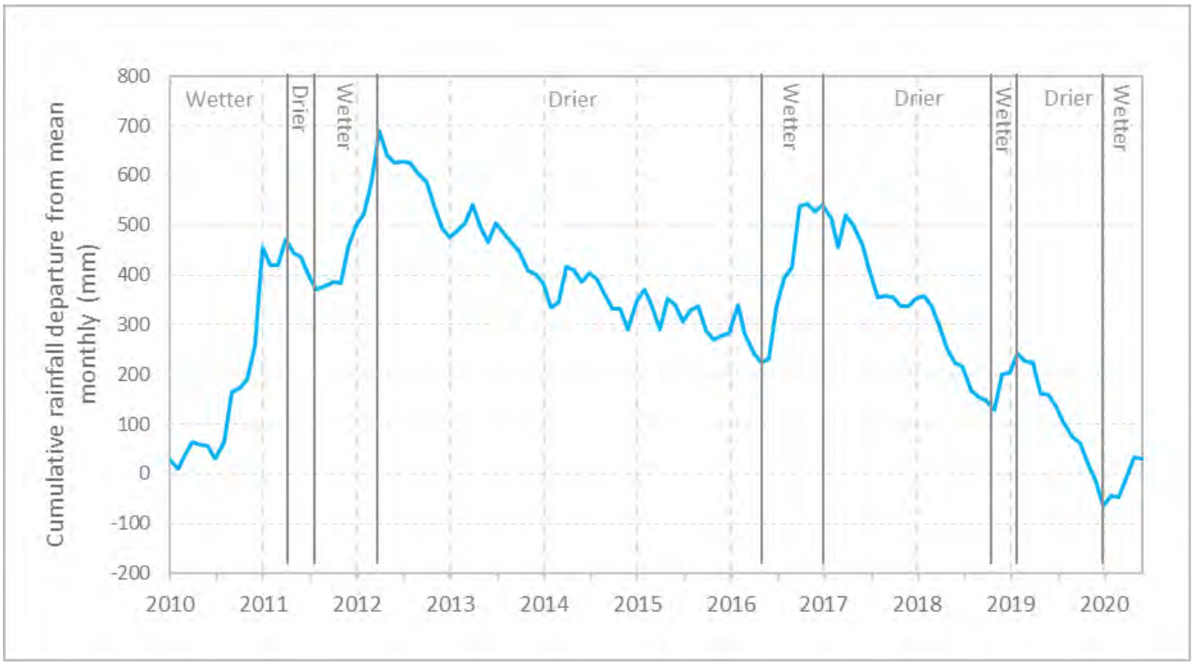


Figure 2.2 SILO cumulative rainfall departure from monthly mean (2010 to 2020)

2.3 Water resources

2.3.1 Surface water resources

The mine project area is west of the Great Dividing Range within the of the Murray Darling Basin. The majority of the mine project area is located within the Belubula River catchment which forms part of the greater Lachlan River catchment. A small area of the mine project area is within the Macquarie Catchment. The Belubula River has its headwaters immediately north-east of the project disturbance area and flows to the south-west into Carcoar Dam (26 km from the mine development). From Carcoar Dam, the Belubula River flows to the west, through Canowindra before merging with the Lachlan River between Cowra and Forbes.

A series of unnamed tributaries flow into the Belubula River in the mine project and immediately surrounding area. The upper reaches of the Belubula River are ephemeral with isolated, stagnant pools. For the purpose of this assessment, the tributaries are referred to as Trib A to Trib K. The locations and catchment areas of these tributaries are shown on Figure 2.3. The combined catchment of Trib A (note that Trib B is within the Trib A catchment) is the most substantial of these tributaries, with a catchment area of approximately 24.4 square kilometres (km^2). By comparison, the Belubula River at the confluence with Trib A has a catchment area of approximately 17.5 km^2 (ie the catchment area of Trib A is approximately 40% larger than the total sum of other tributaries flowing directly into the named Belubula River (Tribs C-J). Note that Trib K not included as it flows into the Belubula River downstream of Trib A. As a result, the Trib A catchment contributes the majority of surface water flow to the Belubula River when compared to the named Belubula River catchment itself. Many farm dams constructed along the tributaries, including Trib A, constrain flows, requiring larger or sustained periods of rainfall for streamflow to be seen at the confluence with the Belubula River. Downstream of the confluence with Trib A, the Belubula River appears to be a gaining system and is perennial (under typical climatic conditions).

A catchment water balance model was developed for the Carcoar Dam catchment as part of the EIS (HEC 2020) to estimate existing flow conditions and assess the potential effects of the project on water flows to Carcoar Dam. The work estimated:

- annual flows to Carcoar Dam average 4,485 ML/year or higher and 95% of the time flows are 1,574 ML/year or higher;

- flows at the old gauging station at the Mid Western Highway average 2,193 ML/year (or higher) and 95% of the time are at least 764 ML/year; and

- flows downstream of the confluence between Trib A and Belubula River (at the recently commissioned flow monitoring station) average 869 ML/year (or higher) and 95% of the time are at least 300 ML/year.

Surface water resources in the study area are managed under the following water sharing plans:

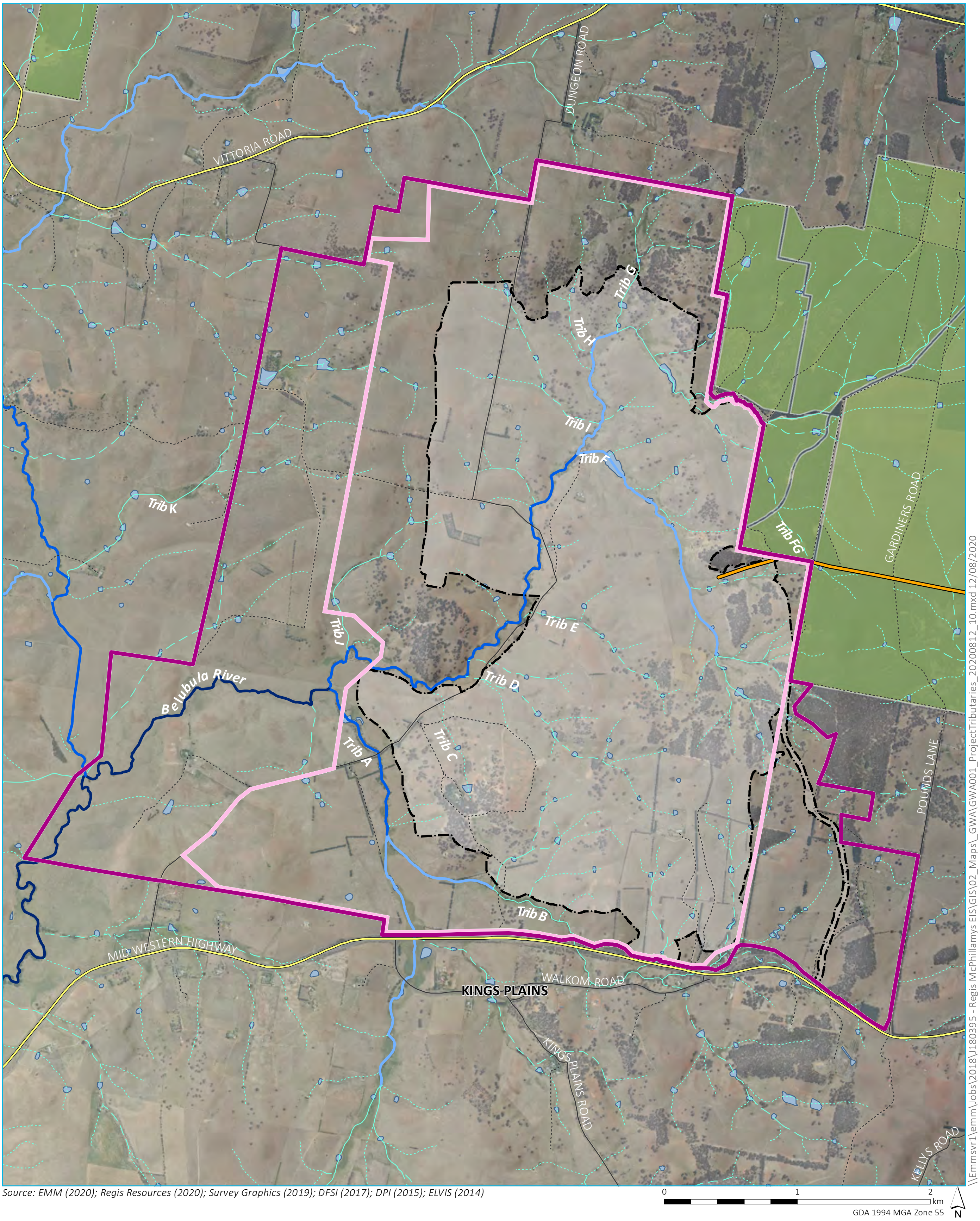
- *Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources 2012:* the mining lease application area is located within the unregulated surface water source of the Belubula River above Carcoar Dam Water Source (Figure 2.4). The water requirements for extraction under access licences differ slightly between the WSP and the NSW Water Register:

  - The WSP states that the share components for domestic and stock access licences are 5 ML/year, and that there are 0 ML/year for unregulated river access licences.

  - The NSW Water Register has no licences (hence 0 ML listed) for stock and domestic access licences, but has four active water access licences (WALs) registered for unregulated river access within this water source, with a total of 264 ML (WaterNSW 2020).

- *Water Sharing Plan for the Belubula Regulated River Water Source 2012:* the Belubula Regulated River runs from Carcoar Dam (including upstream of the dam wall) to the confluence with the Lachlan River (Figure 2.4). The system is not divided into management zones, and extraction can occur anywhere within the water source.

- The *Water Sharing Plan Macquarie Bogan Unregulated and Alluvial Water Sources 2012* sets out the surface water (and shallow groundwater) management requirements to the east of the mine project area (Figure 2.4).



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Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DFSI (2017); DPI (2015); ELVIS (2014)

KEY

Project application area

▭ Mine development project area

▭ Mining lease application area
(Note: boundary offset for clarity)

▭ Disturbance footprint

— Pipeline

Strahler stream order

┈ 1st order

╌ 2nd order

— 3rd order

— 4th order

— 5th order

— 6th order

Existing environment

— Major road

— Minor road

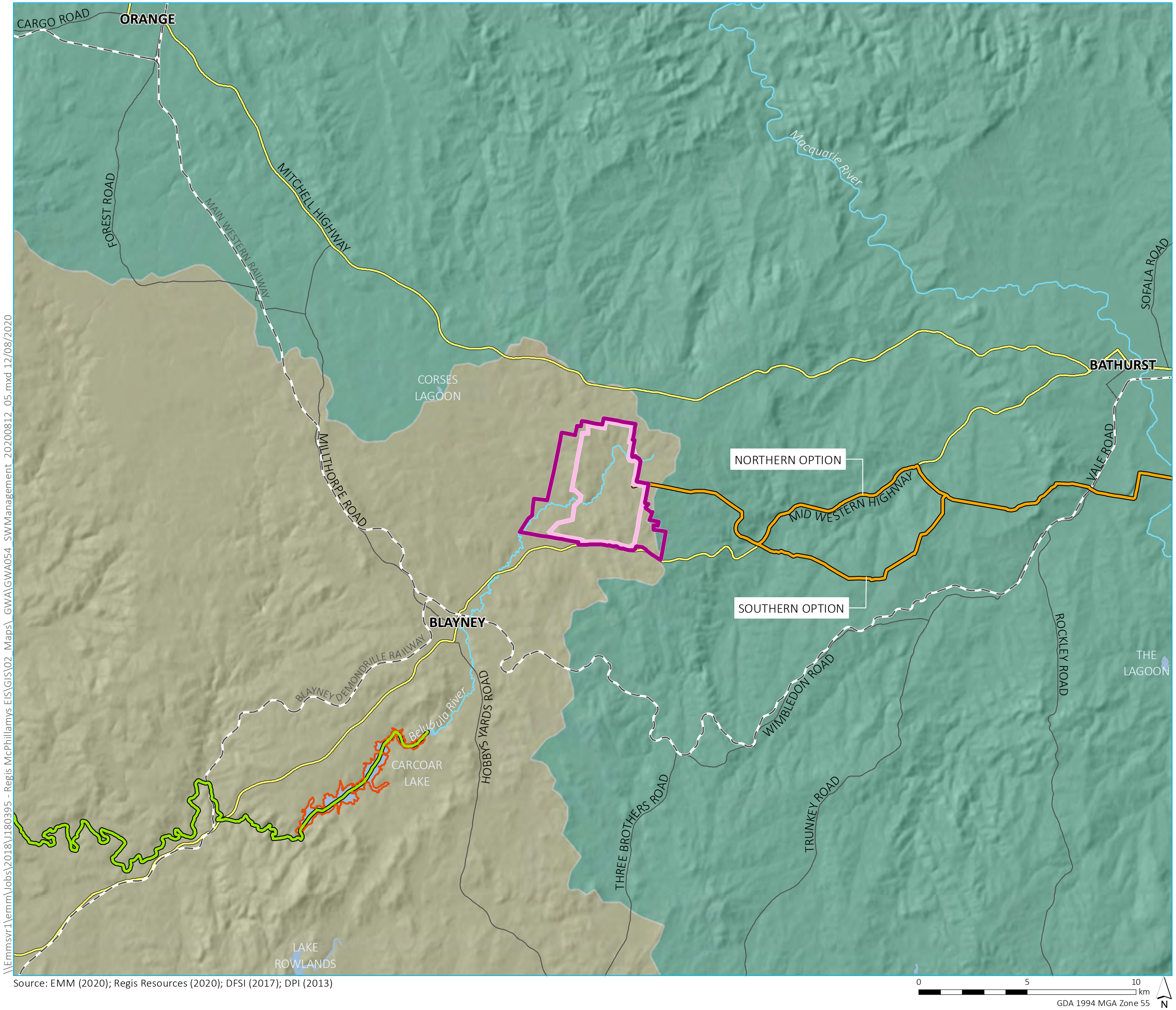
┈ Vehicular track

▭ Waterbody

🟩 Vittoria State Forest

Project area surface drainage

McPhillamys Gold Project
Groundwater assessment addendum
Figure 2.3



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Source: EMM (2020); Regis Resources (2020); DFSI (2017); DPI (2013)

KEY

Project application area

▭ Mine development project area

▭ Mining lease application area (Note: boundary offset for clarity)

— Pipeline

Water Sharing Plan for the Belubula Regulated River Water Source 2012

— Belubula River (regulated section)

— Carcoar Lake

Water Sharing Plan

▨ Lachlan Unregulated and Alluvial Water Sources 2012

▨ Macquarie Bogan Unregulated and Alluvial Water Sources 2012

Existing environment

-- Rail line

— Primary road

— Arterial road

— River

▨ Waterbody

Surface water management areas

McPhillamys Gold Project
Groundwater assessment addendum
Figure 2.4

2.3.2 Groundwater resources

The mine project area is within the Lachlan Fold Belt Murray Daring Basin (MDB) Groundwater Source. Groundwater in this source is managed by the *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2020* (Figure 2.5). This WSP has recently been revised and has come into force as of July 2020.

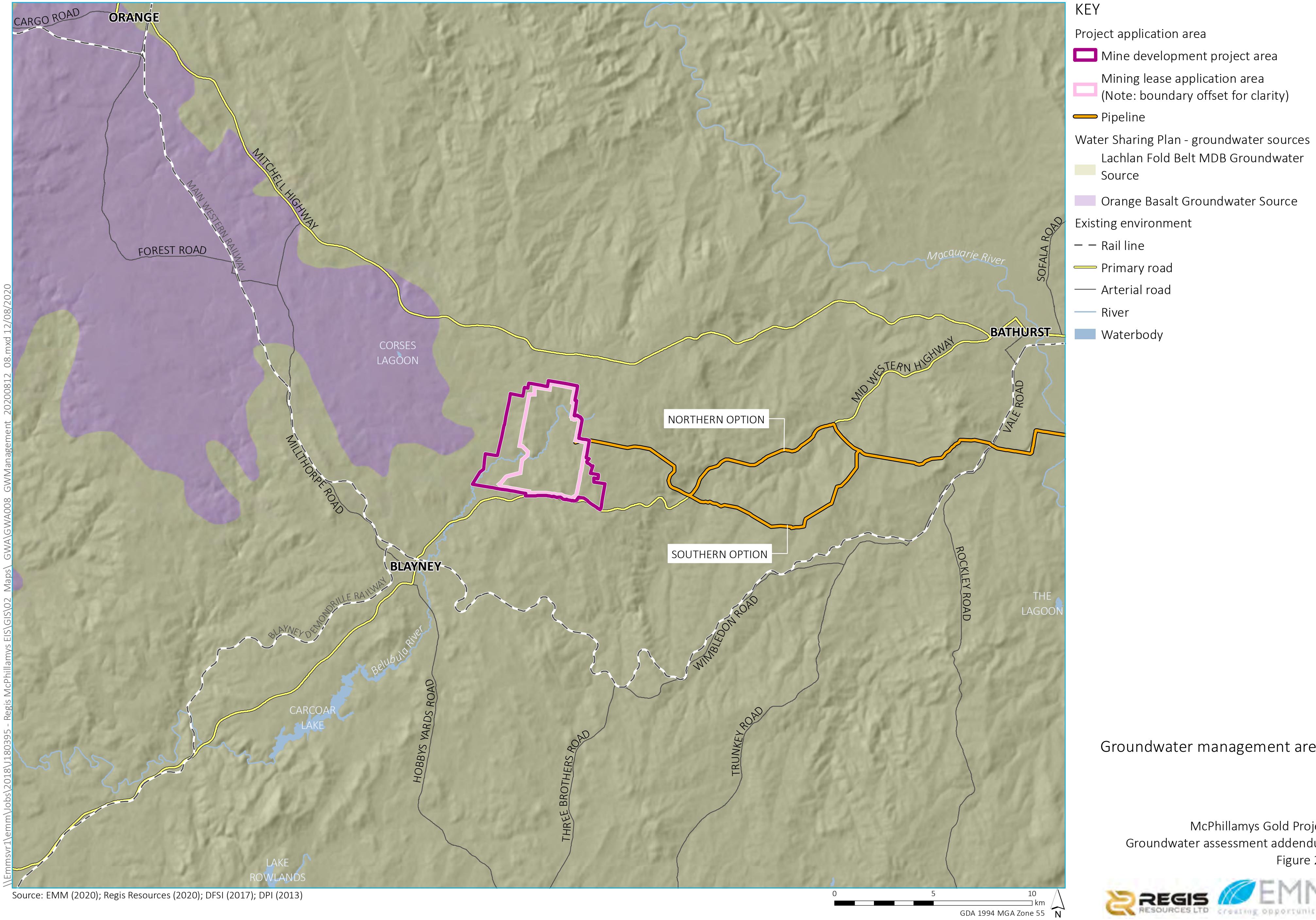
The Lachlan Fold Belt MDB Groundwater Source has a long-term average annual extraction limit (LTAAEL) of 253,788 ML/year. The NSW Water register when accessed in July 2020 reported that there are 1,086 WALs with a total entitlement of 75,521 share components in the Lachlan Fold Belt MDB Groundwater Source and these numbers differ slightly to the recently published WSP (Table 2.1).

Table 2.1 Lachlan Fold Belt MDB Groundwater Source requirements for water

Water requirements			**WSP**
Requirements for Basic Landholder Rights (BLR)			
BLR – Domestic and stock rights			74,311 ML/year
BR – native title rights			Not defined volumetrically
Requirements for water under access licences	**No. of licences [1]**	**Total share component (ML) made available in 2020/21 [2,1]**	**WSP defined access licences (ML/year)**
Domestic and stock	0	0	0
Local water utility	37	3,420.5	3,421
Aquifer	1,042	71,397	68,210
Aquifer (town water supply)	6	467.4	
Salinity and watertable management	1	236	236
TOTAL	1,086	75,521	71,867
LTAAEL		253,788	253,788
Available water (calculated LTAAEL – BLR – Access licences)		*103,956*	*107,610*

Notes: 1. Data based on a search of the NSW Water Register (accessed 31 July 2020)
2. The conversion from a unit share to a megalitre is 1:1 unless otherwise stated

WSP = water sharing plan; LTAAEL = long-term average annual extraction limit; BLR = basic landholder rights; BLR =basic right



Source: EMM (2020); Regis Resources (2020); DFSI (2017); DPI (2013)

Groundwater management areas

McPhillamys Gold Project
Groundwater assessment addendum
Figure 2.5

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i Hydrogeology overview

The hydrogeology surrounding the project area is dominated by the Palaeozoic metamorphic rocks of the eastern Lachlan Fold Belt. The Lachlan Fold Belt is a major geological fold belt occupying south-east Australia. It formed as a result of complex tectonic and intrusive processes, as well as various stages of volcanism.

The Lachlan Fold Belt is dominated by Ordovician, Silurian and Devonian period volcaniclastics and marine sediments (French et al 2013). The mine development is in the eastern sub province of the LFB. The lithological sequence reduces in age to the east, with Ordovician carbonates and mafic volcanics to the west and argillaceous Devonian sediments to the east (French et al 2013). Basalt caps, such as the basalt present around Orange to the north-west of the mine project area, occur in the regional area. There are no large deposits of basalt within the mine project area.

The regional geology is presented in Figure 2.6.

The groundwater system is recharged locally by the percolation of rainfall and leakage from surface watercourses. Groundwater discharge occurs via evapotranspiration, spring flow, and contributions to surface watercourses (baseflow). Alluvial deposits along the creek banks and drainage lines provide temporary groundwater storage following rainfall and a delayed source of baseflow.

The five key HSUs in the study area include:

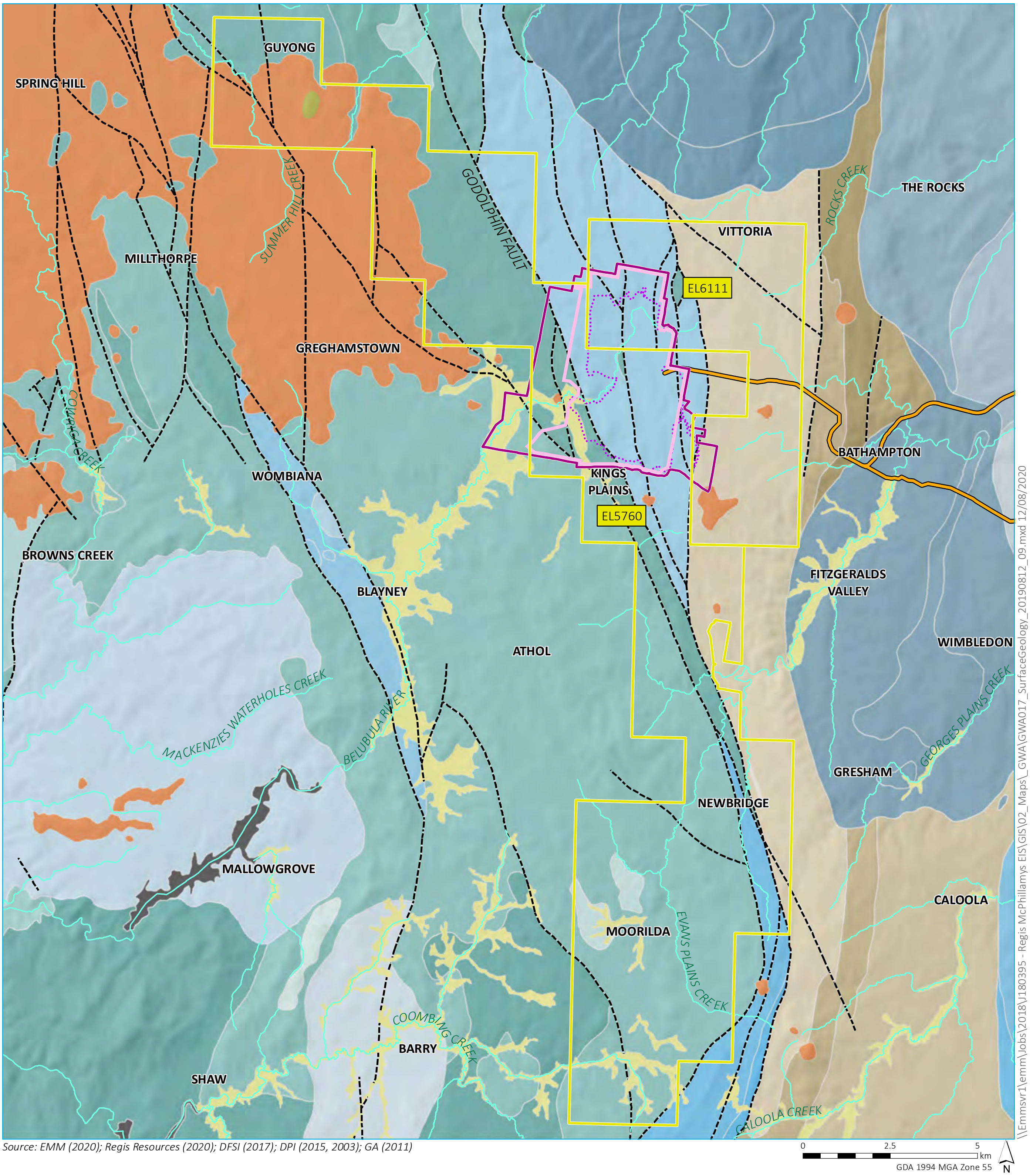
- Shallow, disconnected alluvial sequences. These unconfined, typically perched, systems are likely recharged by the infiltration of rainfall and surface flows. The alluvials provide a source of delayed flow to the Belubula River and major tributaries, however, rapidly deplete between recharge events.

- Chemically weathered metasediments and volcaniclastics sediments, collectively referred to as 'saprock'. These weathered systems are recharged via the infiltration of rainfall and surface flow. The saprock is comprised of fine-grained clay, with limited permeability and low specific yield.

- The Byng and Blayney Volcanics. These volcanics are comprised of basalt, fine volcanic siltstones and sandstones, and are dominated by andesitic composition. These volcanic units have low primary porosity and permeability. Groundwater flow is predominantly via secondary permeability (faulting and joints) and geological contacts. Bore yields are relatively low and the unit generally acts as a confining unit rather than allowing flow. Recharge to the fractured rock is via rainfall in areas of outcrop and vertical leakage from overlying saprock or alluvial sediments (where present).

- The Silurian Anson Formation and Cunningham Formation. The Anson Formation underlies the mine project area and the Cunningham Formation is located to the east of the mine project area. Both these formations have low primary porosity and permeability. Groundwater flow is primarily along fault zones or associated fracturing. Recorded bore yields are typically low (<5 litres per second (L/s)). Recharge is via rainfall in areas of outcrop and vertical leakage.

- The Orange Basalt. The Orange Basalt is a well-developed groundwater system to the north-west of the mine project area. The Orange Basalt is a relatively productive aquifer accessed for town water supply, industry and domestic purposes. Groundwater is accessed from relatively shallow (<100 m) basalt flows. The Orange Basalt is not present in the mine project area.



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Source: EMM (2020); Regis Resources (2020); DFSI (2017); DPI (2015, 2003); GA (2011)

KEY

Named watercourse
EL5760 and EL6111
Project application area
Mine development project area
Mining lease application area (Note: boundary offset for clarity)
Disturbance footprint
Pipeline
Geology (Bathurst 250k, 2nd Edition)
Fault
Quaternary / Tertiary
Alluvium
Tertiary basalt
Trachyte
Carboniferous
Bathurst Batholith
Bathurst Batholith - Bathurst Granite
Bathurst Batholith - Dunkeld Granite
Bathurst Batholith - Gresham Granite
Bathurst Batholith - Icely Granite

Devonian
Other Carboniferous Intrusions
Ungrouped Devonian Formations - Cunningham Formation
Crudine Group - Turondale and Waterbeach Formations undifferentiated
Crudine Group - Bushranger Volcanics
Crudine Group - Turondale Formation
Crudine Group - Waterbeach Formation
Silurian
Other Silurian Intrusions - Barry Granodiorite
Other Silurian Intrusions - Carcoar Granodiorite
Other Silurian Intrusions
Mumbil Group (Northwest) - Anson Formation
Mumbil Group (Northwest) - Wombiana Formation
Mumbil Group (East) - Bells Creek Volcanics

Mumbil Group (East) - Campbells Formation
Mumbil Group (East) - Box Ridge Volcanics
Ordovician
Ordovician Intrusions - Fernside Monzodiorite
Ordovician Intrusions - Moorilda Monzonite
Ordovician Intrusions - Tallwood Monzonite
Ordovician Intrusions
Ordovician Intrusions - Stokefield Metagabbro
Cabonne Group - Weemalla Formtion
Cabonne Group - Blayney Volcanics
Cabonne Group - Forest Reefs Volcanics
Cabonne Group - Oakdale Formation
Cabonne Group - Byng Volcanics
Kenilworth Group - Coombing Formation
Other
Lake

Regional surface geology

McPhillamys Gold Project
Groundwater assessment addendum
Figure 2.6

2.4 Brief project description

2.4.1 Overview

The following section provides a summary of the features of the amended project that have the greatest potential to have an effect on groundwater resources:

- the open cut mine;
- TSF; and
- construction water demand.

2.4.2 Revised mine plan

Since submission of the EIS, Regis has conducted further detailed mine planning and design, and as a result has adjusted the mining schedule and pit shell. The amended mine schedule and design has an approximate 11-year life of mine period and a slightly shallower mine depth. A comparison of the total annual mined volumes (between the previous mine plan and the amended plan) is provided in Figure 2.7. In comparison to the previous mine plan, the amended design of the open cut has a more gradual rate of mining, with the peak mined volume to occur in year 6 (compared to year 2 in the previous mine plan).

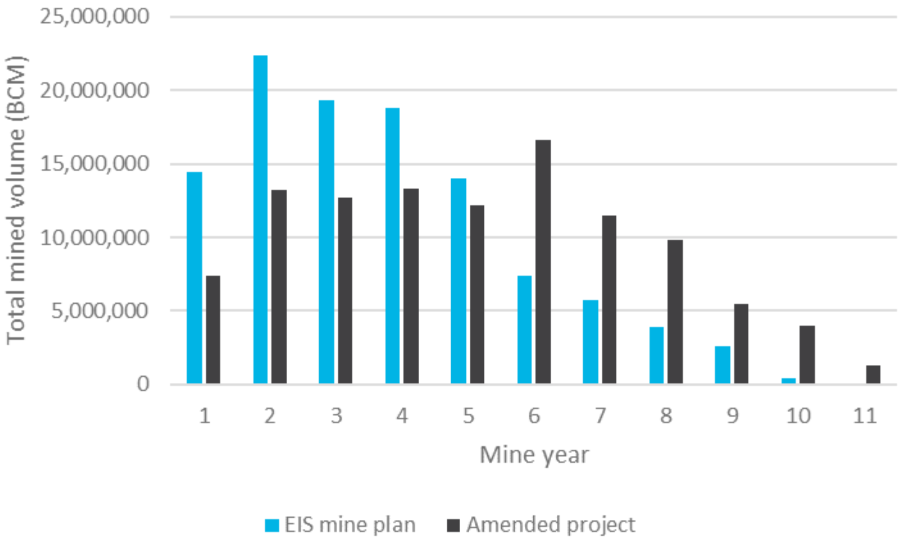


Figure 2.7 Open cut mining volumes – comparison between the previous mine plan and amended plan

A comparison of the elevation of the base of the open cut pit annually is presented in Figure 2.8. The amended design includes a constant pit depth through mine years 5 to 8, during which mining occurs as a lateral expansion of the pit. The final pit floor elevation level is 505 metres Australian Height Datum (mAHD), compared to 495 mAHD for the pit design presented in the EIS.

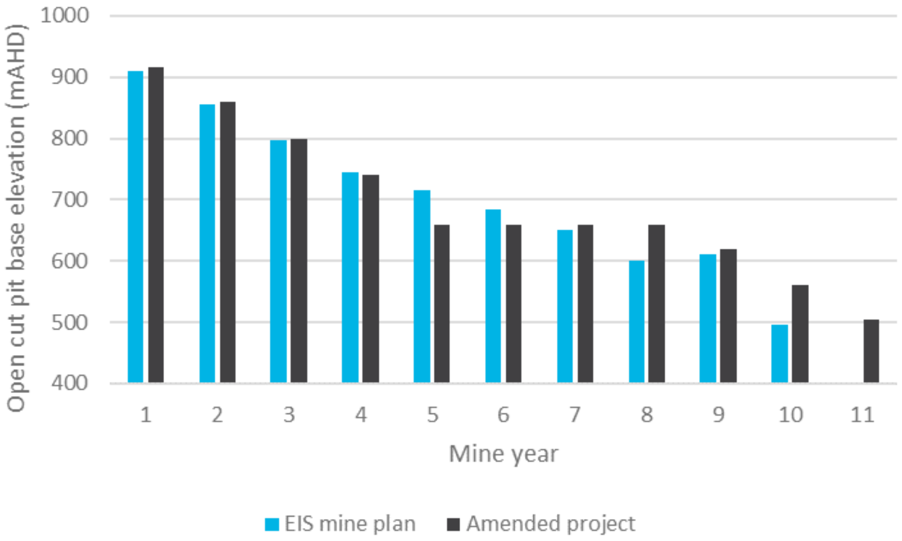


Figure 2.8 Open cut base elevation – comparison between the previous mine plan and amended plan

2.4.3 Tailings placement

In addition to the change in pit progression, the tailings placement schedule has also been refined as part of the amended project. While the design elevations of the TSF stages have not changed, the timing has been adjusted (Table 2.2).

Table 2.2 Comparison of tailings stage timing

Stage and elevation	Timing in the previous plan	Timing for the amended project
1 – 942 mAHD	Year 1	Year 1
2 – 951 mAHD	Year 2	Year 4
3 – 961 mAHD	Year 3	Year 8

i Multi-barrier seepage management

As reported in the EIS (EMM 2019a and ATC Williams 2019), the TSF is designed to operate effectively and efficiently, and in consideration of the requirements of the NSW Government. The TSF is designed specifically to avoid adverse impacts to the surrounding environment and contain all water during large rainfall events (no spill risk).

Regis has adopted several leading practices to produce a mine design that avoids and minimises impacts to water assets, which includes a multi-barrier system approach as part of the design of the TSF. The multi-barrier approach is presented graphically on Figure 2.9.

This approach begins with the design of the process plant where a cyanide detoxification process will reduce the concentration of cyanide in the tailings before it is directed to the TSF. The tailings will pass through a tailings thickener and then pumped to the cyanide detoxification circuit where oxygen and other reagents (lime, copper sulphate and sodium meta-bisulphite) are added. The reagents react with the free and weak acid dissociable (WAD) cyanide in the thickened slurry, so that the free cyanide is destroyed and the level of WAD cyanide remaining is reduced to less than 30 parts per million (ppm).

In order to reduce seepage volumes and rates, the TSF seepage management is proposed to comprise (ATC Williams 2020):

- The TSF floor will be lined using a combination of a low permeability clay liner and imported liner system. The clay liner will be constructed to a minimum 1 m thick within the existing drainage areas and a minimum 300 mm thick in areas with in-situ clay that have a permeability less than 10^{-9} metres per second (m/sec).
- A low permeability core zone will be included as part of construction of the embankment and a deepened cut-off key extending to basement.
- A seepage interception trench located downstream of the cut-off key for the recovery of seepage and dewatering of the tailings mass.
- A downstream TSF runoff dam to intercept surface contact water from incident rainfall.
- Monitoring bores downstream to monitor groundwater quality and levels and, if required, the use of pump back bores.
- Construction of the TSF decant 770 m away from the main embankment.

Environmental management plans will be prepared for the project, which will document the proposed mitigation and management measures for the approved project, and will include the surface and groundwater monitoring program, reporting requirements, spill management and response, water quality trigger levels, corrective actions, contingencies, and responsibilities for all management measures.

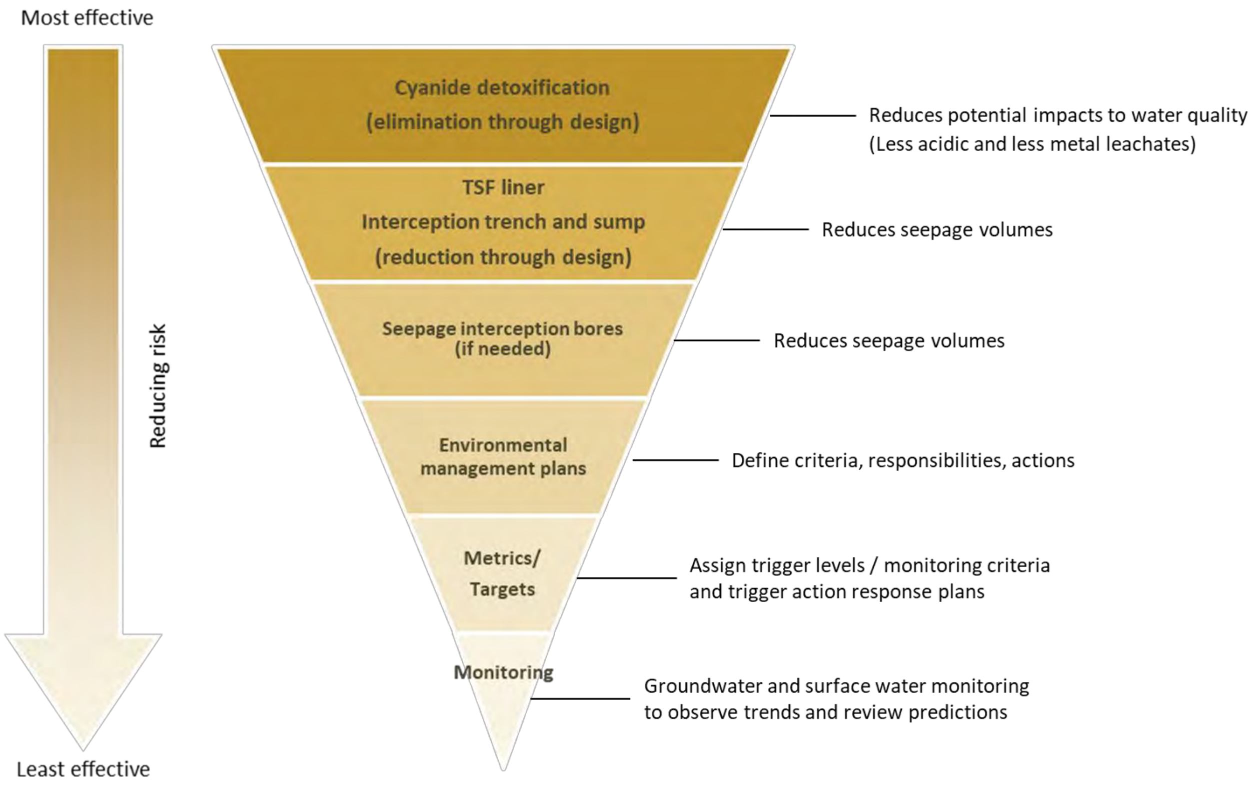


Figure 2.9 TSF multi-barrier system approach

2.4.4 Site water management and water demand

The mine project area water management system comprises the structures and associated operational procedures that will be used to manage water and its movement and use on-site. The water management system has been modelled as part of Revised Surface Water Assessment (HEC 2020) and is designed to limit the generation of waste water and segregate mine site water according to water quality and associated use constraints. The practical application of these principles involves controlling the volume of poor quality (ie higher salinity) water by maximising its re-use and by limiting the contamination of clean water (HEC 2020). Runoff from undisturbed or rehabilitated areas will be diverted around the mine project area and directed back to the Belubula River downstream of the disturbance area.

Rainfall and runoff captured within the disturbance area will be stored and used within the water management system, acting as a source to meet the construction and operational water demand. As outlined in the EIS and in Section 1.2, an external water supply pipeline will be constructed to meet the project water demand and will be operational approximately nine months after commencement of the project. The imported pipeline supply will provide up to 15.6 ML/day (HEC 2020). Prior to this time, the construction water demand is anticipated to be primarily sourced from onsite bores.

HEC (2020) developed a GoldSim water balance model for the amended project which has been used to identify the construction water demand and assess the potential risk of supply shortfalls under various climate scenarios. The simulation of the construction water demand assumes:

- construction hours from 7:00 am to 6:00 pm Monday to Friday and 8:00 am to 1:00 pm on Saturdays for the first 6 months of construction, changing to 24 hr operation from month 7;

- a construction water management facility (CWMF) will be constructed to capture and store rainfall runoff and bore water supply with a capacity of 75 ML;
- dust suppression demand of 0.8 to 2.2 ML/day;
- TSF construction water demand of 0.5 ML/day; and
- constant groundwater supply to the CWMF.

3 Baseline monitoring

3.1 Overview

Routine water monitoring commenced for the project in May 2014 across a network of landholder bores and surface water features. Up to six years of baseline water (surface water and groundwater) data has been collected across the mine project area. In December 2016, a project specific groundwater monitoring network was installed and over three years of continuous groundwater level data and water quality data have been collected.

The groundwater monitoring network and monitoring program were developed in consultation with the then Department of Industry (DoI) - Water via the project Groundwater Monitoring and Modelling Plan (GMMP) (EMM 2017). The network was designed and constructed in accordance with the NSW guideline *'Groundwater Monitoring and Modelling Plans – Information for prospective mining and petroleum exploration activities'* (DPI 2014) which is specifically designed to ensure proponents collect data and information to meet the requirements of the AIP.

3.2 Surface water

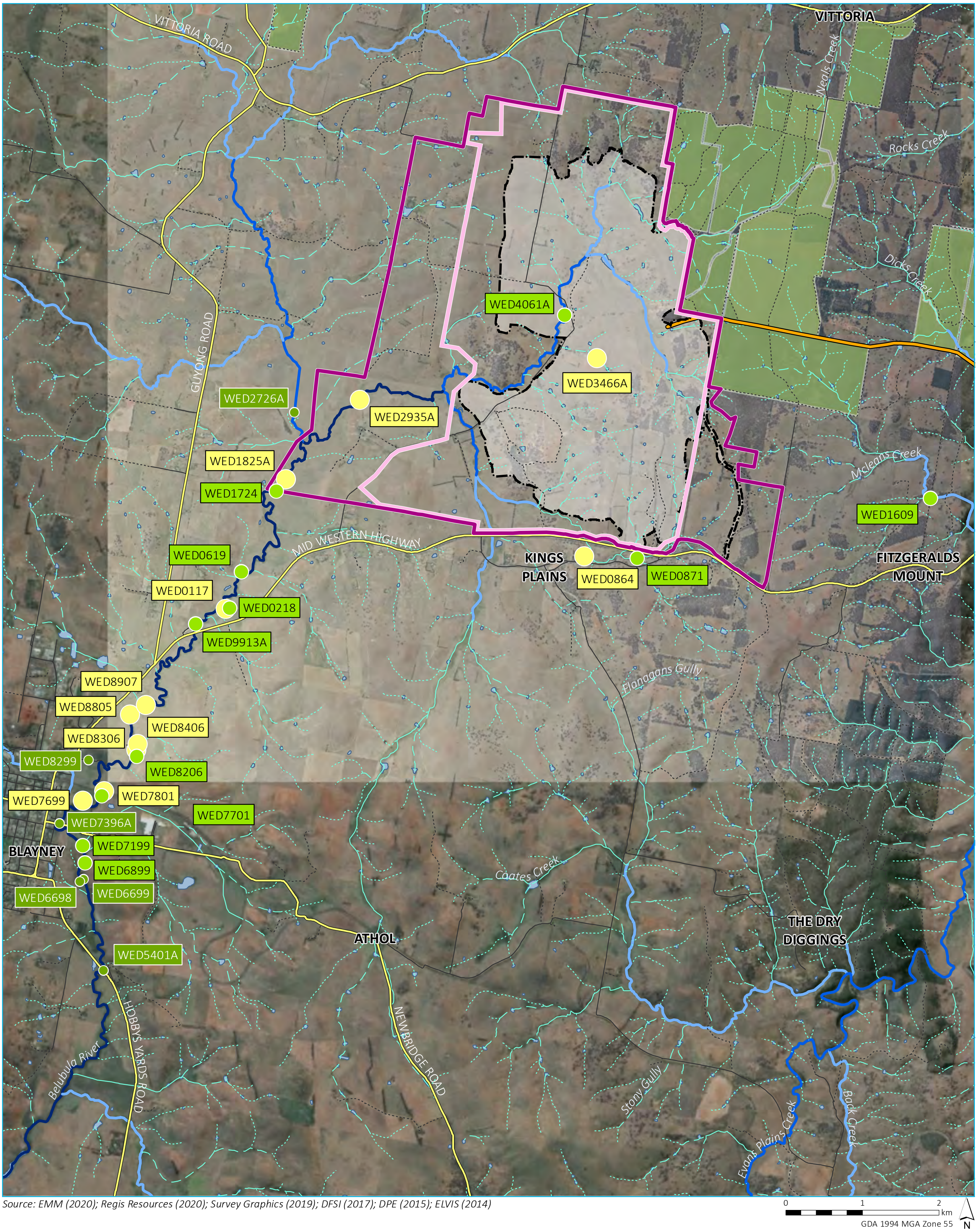
The interaction between surface water and groundwater in the mine project area has been assessed and is reported in the McPhillamys Gold Project Surface Water – Groundwater Interaction Assessment report (EMM 2020b). The report:

- provides an update and additional detail to the information presented in the EIS (EMM 2019b) on the local hydrogeological and hydrological environment, including additional water monitoring data, which further adds to the conceptual understanding of the water environment in the McPhillamys and broader Blayney area;
- describes the interaction between surface water and groundwater within the mine project and Blayney area;
- describes the categories of springs typically observed in the area and more broadly within Australia;
- categorises the springs identified in the mine project area; and
- discusses the potential changes to the interaction between surface water and groundwater, including springs, within the mine development area and Blayney area as a result of the project.

Surface water samples have been periodically collected from locations along the Belubula River watercourse, at select dams and spring/seep locations identified in and around the mine project area since May 2014. The following subsections summarise the information presented in the Surface Water – Groundwater Interaction Assessment (EMM 2020b).

3.2.1 Belubula River

Regis conducts regular water sampling at eight locations along the Belubula River, with six monitoring points located downstream of the mine project area, one located within Blayney township at Goose Park (WED7396A) and one downstream of Blayney at Brewery Bridge (WED5401A; Figure 3.1).



Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DFSI (2017); DPE (2015); ELVIS (2014)

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KEY

Project application area

- ▭ Mine development project area
- ▭ Mining lease application area (Note: boundary offset for clarity)
- ⌗ Disturbance footprint
- ━ Pipeline

Existing environment

- ━ Major road
- ━ Minor road
- ┈ Vehicular track
- 🟩 Vittoria State Forest
- 🟦 Waterbody

Strahler stream order

- ┈ 1st order
- ┈ 2nd order
- ━ 3rd order
- ━ 4th order
- ━ 5th order
- ━ 6th order

Watercourse salinity

Average TDS (mg/L)

- ● 120 - 302
- ● 303 - 490
- ● 491 - 660

Belubula River monitoring locations and average salinity

McPhillamys Gold Project
Groundwater assessment addendum
Figure 3.1

i Streamflow

The closest gauging station to the project area is the disused station GS 412104 Belubula River at Upstream Blayney, located at the Mid Western Highway. The period of record for this station was 1993 to 1997. Available flow data suggest that this gauging station was effectively perennial for the four years of recorded data (HEC 2019). A flow monitoring station located on the Belubula River downstream of the confluence with Trib A has been approved by DPIE Water and subsequently commissioned in March 2020. The v-notch weir or flume design is based on providing accurate low flow measurements. Baseline streamflow data will continue to be collected at this monitoring station.

ii Interaction with groundwater

The Surface Water-Groundwater Interaction Assessment (EMM 2020b) finds that, overall, the Belubula River (from the top of the catchment to Blayney) receives water from the following sources, in order of largest contribution to smallest:

1. Runoff of rainfall during and after rainfall events from the local catchment.
2. Direct rainfall on the watercourse.
3. Groundwater discharge (baseflow) – the contribution of groundwater increases with distance down the water catchment. That is, at the top of the catchment the watercourse is not in connection with groundwater (ie no contribution from groundwater), and along Trib A and downstream of Trib A, groundwater is inferred to contribute around 5% of flows in the Belubula River (from immediately adjacent catchment areas). Downstream of the Mid Western Highway, the contribution from groundwater is inferred to increase to around 20% and will vary with climate conditions and again is from immediately adjacent catchment contributions (ie not from upstream). During drought periods, flow of local groundwater to the Belubula River will sustain flows in the watercourse along the length of the river from the Mid Western Highway to Carcoar Dam.

iii Water quality

The salinity (as total dissolved solids, TDS) of the Belubula River is generally fresh, ranging from 84 to 1,010 milligrams per litre (mg/L) and averages 450 mg/L. Water salinity generally increases in drier periods and is lower in wetter periods.

Figure 3.1 also presents the spatial distribution of Belubula River salinity (as average TDS) and shows that there is no obvious trend in the average salinity in the Blayney and Kings Plains area.

Surface water quality results have been compared to the ANZECC (2000) 95% protection level of freshwater aquatic ecosystems, which the NSW government has adopted as the Water Quality Objectives (WQOs) for this area. The Australian and New Zealand Guidelines for Fresh and Marine Water Quality were revised in 2018 (Water Quality Australia 2018) and supersede the ANZECC (2000) guideline, however the majority of the default guideline values have not changed (ie are the same as the ANZECC (2000) guideline. Therefore, the guideline values presented in ANZECC (2000) are used for comparison in the relevant water assessments for the project. The ANZECC (2000) guideline provides recommended concentration limits for water salinity, pH, nutrients, metals and other analytes that can affect freshwater aquatic ecosystems.

Further discussion on the water quality of the Belubula River is provided in the Revised Surface Water Assessment (HEC 2020). The following is a summary of the WQO exceedances:

- the WQO for EC was exceeded in the majority of samples collected, with the exception of WED5401A (downstream of Blayney);

- there have been no exceedances of the WQO for cadmium (Cd), sulphate (SO_4) or cyanide (CN) recorded at any Belubula River surface water monitoring location;
- the WQO for arsenic (As) was exceeded in some samples collected at WED1825A, WED2935A, WED3275A and WED2726A; and
- iron (Fe), zinc (Zn), total nitrogen and total phosphorus WQOs were exceeded in samples collected from all Belubula River monitoring locations.

The baseline water chemistry suggests that the default guideline values (ANZECC 2000) are not representative of the background conditions in the mine project area and site specific WQOs should be developed prior to project commencement using all available baseline data (as part of the Water Management Plan (WMP) for the project, if approved). Exceedances of the ANZECC (2000) guideline values can be as a result of natural catchment conditions and/or land use modification.

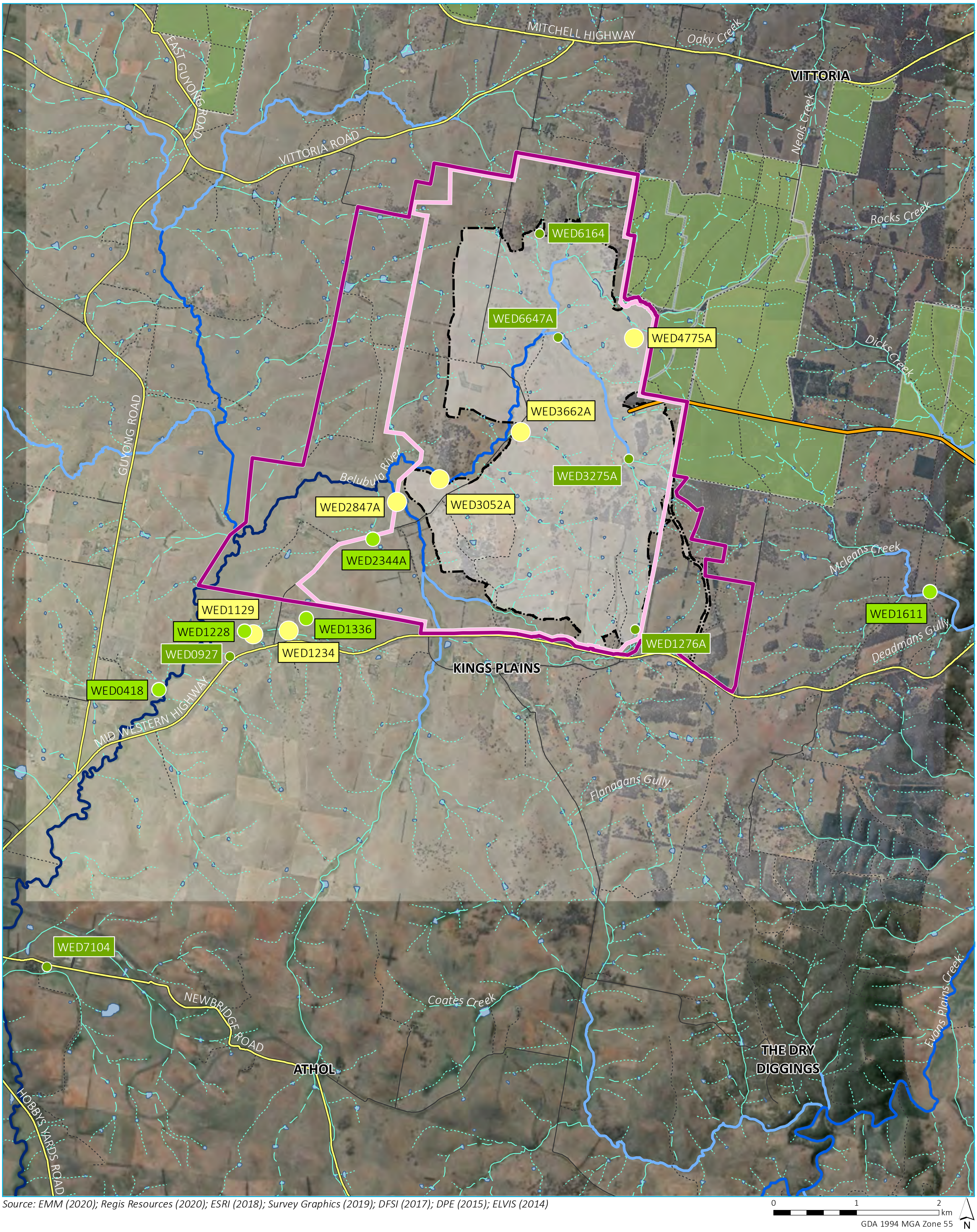
3.2.2 Dams

A number of dams have been constructed by landholders in the area to capture overland flow/or enhance groundwater seep/spring areas. A number of dams are also located within the drainage line of tributaries to the Belubula River. Regis conducts regular water quality monitoring at eight dams in the mine project area (see Figure 3.2) since May 2014.

The locations of the dams where sampling has occurred is shown on Figure 3.2, along with the average salinity (as TDS). The salinity is similar to the Belubula River water salinity and shows that the dams towards the top of the catchment are fresher (eg WED1276A and WED6164) than those further down the catchment. Dam water salinity (as TDS) ranges from 25 to 1,920 mg/L and averages 400 mg/L.

Laboratory analysis of water quality collected from dam monitoring locations have observed the following WQO exceedances (when compared to the ANZECC (2000) 95% protection level for freshwater aquatic ecosystems):

- the WQO for EC was exceeded in samples collected from six monitoring locations (WED2344A, WED2847A, WED3052A, WED3662A, WED4775A, WED6647A);
- there have been no exceedances of the WQO for SO_4 or CN recorded at the dam monitoring locations;
- the WQO for Cd was exceeded in two samples collected at WED4775A;
- the WQO for As was exceeded in a sample collected from WED3275A; and
- Fe, Zn, total nitrogen and total phosphorus WQOs were exceeded in the majority of samples from all dam monitoring sites.



Source: EMM (2020); Regis Resources (2020); ESRI (2018); Survey Graphics (2019); DFSI (2017); DPE (2015); ELVIS (2014)

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KEY

Project application area

- ▭ Mine development project area
- ▭ Mining lease application area (Note: boundary offset for clarity)
- ▭ Disturbance footprint
- ━ Pipeline

Existing environment

- ━ Major road
- ━ Minor road
- ┅ Vehicular track
- 🟩 Vittoria State Forest
- 🟦 Waterbody

Strahler stream order

- ┅ 1st order
- ━ 2nd order
- ━ 3rd order
- ━ 4th order
- ━ 5th order
- ━ 6th order

Dam salinity

Average TDS (mg/L)

- ● 99 - 302
- ● 303 - 490
- ● 491 - 610

Dam water monitoring locations and average salinity

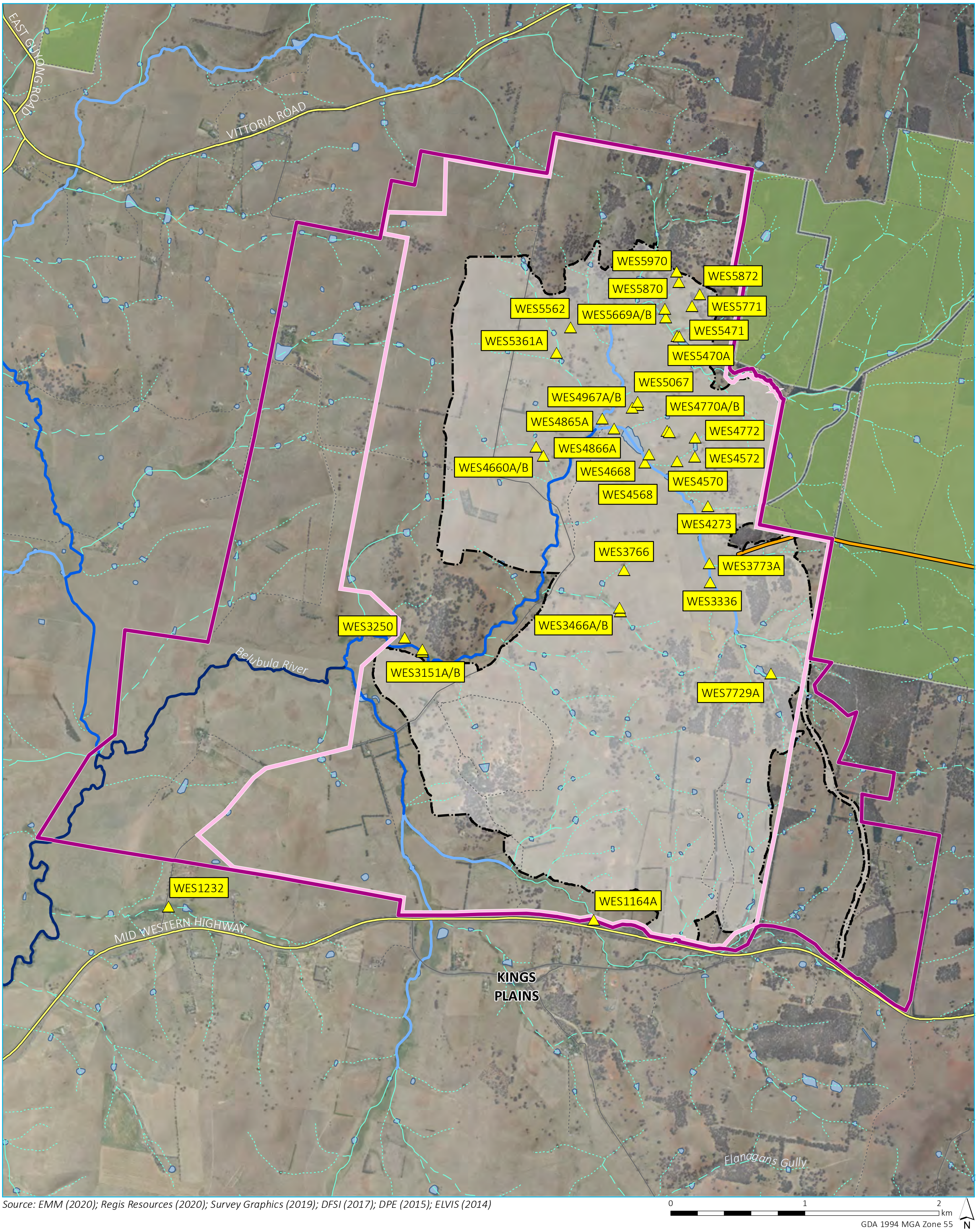
McPhillamys Gold Project
Groundwater assessment addendum
Figure 3.2

3.2.3 Seeps and springs

Landholders in the Blayney and Kings Plains area have identified and raised their reliance upon seeps and springs for water supply, including excavating the damp/wet areas to construct dams for livestock watering purposes. Seeps and springs have also been identified within the mine project area. In response to community interest and concerns about springs, Regis has conducted six field surveys in and surrounding the project area to identify seep and spring areas, and to collect information to increase the understanding of these areas. The first survey occurred in May 2013 and the most recent occurred in November 2019. Each survey aimed to identify and describe springs active at the time of the survey. It should be noted that these seep and spring areas exclude where groundwater discharges directly into the Belubula River (or associated tributaries). The identified spring/seep locations are shown on Figure 3.3.

The salinity (as TDS) of the monitored springs/seeps varies by location, ranging from 37 to 1,800 mg/L and averages 612 mg/L. As most spring/seep locations are close to or within drainage lines, the water quality is generally lower in wetter periods. Figure 3.4 presents the spatial distribution of measured salinity (as average TDS). It suggests that springs/seeps higher in the catchment are fresher (eg WES7729A and WES3773A); however, further down the catchment the salinity is variable and likely depends on the source and location of the water for the spring/seep (ie long flow path (saline) and shorter flow path (fresher groundwater)).

The conceptual understanding of springs and seeps in the area was presented in the Groundwater Assessment (EMM 2019a) and discussed further in the Surface Water-Groundwater Interaction Assessment (EMM 2020b).



Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DFSI (2017); DPE (2015); ELVIS (2014)

KEY

Project application area

▭ Mine development project area

▭ Mining lease application area
(Note: boundary offset for clarity)

⬚ Disturbance footprint

— Pipeline

△ Identified seep/spring

Existing environment

— Major road

— Minor road

······ Vehicular track

🟩 Vittoria State Forest

▨ Waterbody

Strahler stream order

······ 1st order

– – 2nd order

— 3rd order

— 4th order

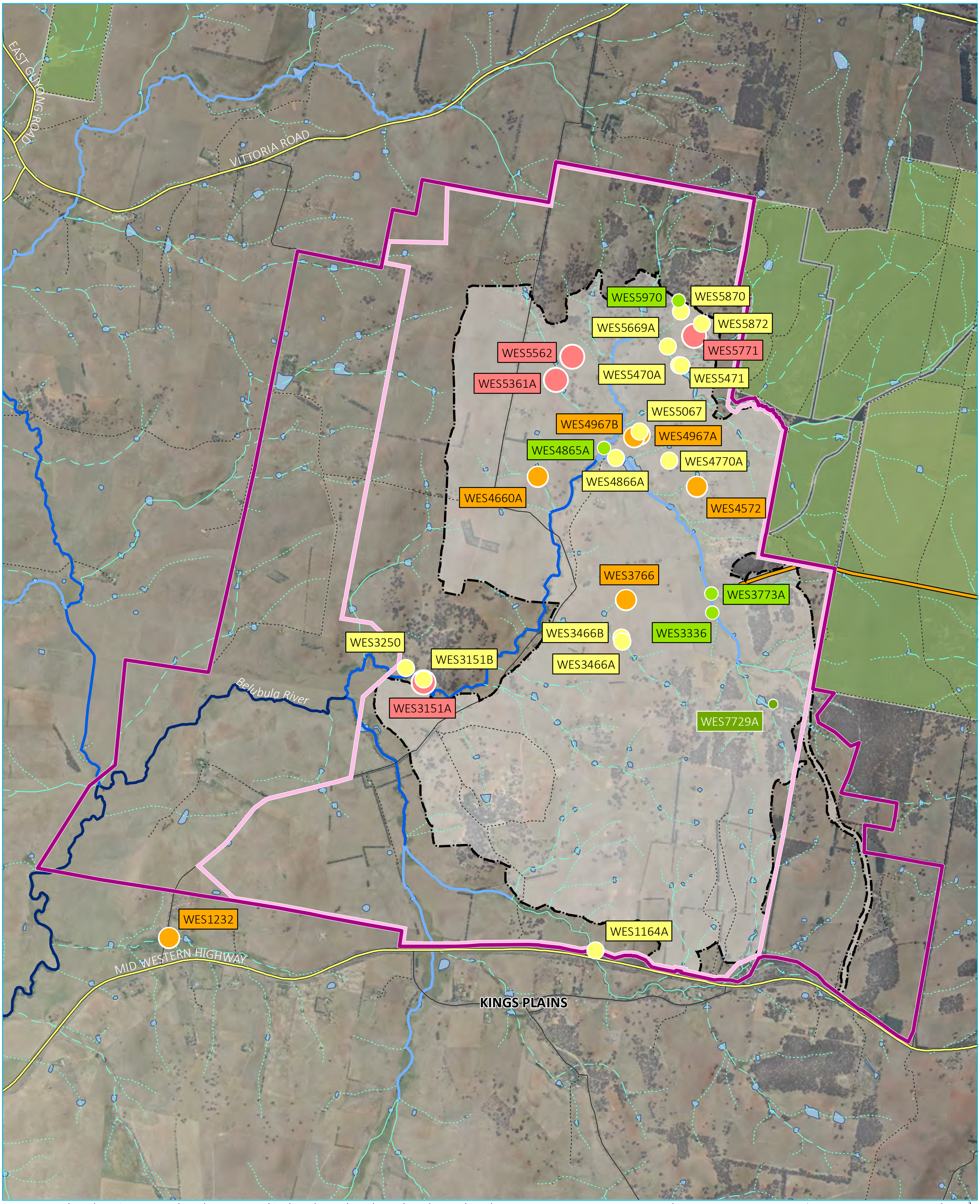
— 5th order

— 6th order

Seep and spring locations

McPhillamys Gold Project
Groundwater assessment addendum
Figure 3.3

\\Emmsvr1\emm\Jobs\2018\J180395 - Regis McPhillamys EIS\GIS\02_Maps_SWGWIA\SGIA007_SeepSpringLocations_20200812_04.mxd 12/08/2020



\\Emmsvr1\emm\Jobs\2018\J180395 - Regis McPhillamys EIS\GIS\02_Maps_SWGWIA\SGIA003_SpringMonitoring_20200812_05.mxd 12/08/2020

Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DFSI (2017); DPE (2015); ELVIS (2014)

KEY

Project application area
- Mine development project area
- Mining lease application area (Note: boundary offset for clarity)
- Disturbance footprint
- Pipeline

Existing environment
- Major road
- Minor road
- Vehicular track
- Vittoria State Forest
- Waterbody

Strahler stream order
- 1st order
- 2nd order
- 3rd order
- 4th order
- 5th order
- 6th order

Seep and spring salinity

Average TDS (mg/L)
- ● 185
- ● 186 - 437
- ● 438 - 660
- ● 661 - 990
- ● 991 - 1754

Seep and spring average salinity

McPhillamys Gold Project
Groundwater assessment addendum
Figure 3.4

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3.3 Groundwater

The project specific groundwater monitoring network has 27 monitoring points, distributed across 18 locations (Figure 3.5). Since the EIS, Regis has drilled and installed an additional test bore (TB05) and four monitoring bores. These bores were drilled and constructed as part of the groundwater drilling program conducted as part of the construction water supply assessment. Details of the bores, including bore completion logs, are provided in Appendix A.

The network comprises standpipe piezometers with nested monitoring sites (ie a shallower and a deeper bore making up a monitoring location). Monitoring coverage spans the key hydrogeological units in the mine project area, including the saprock, metasediments, volcaniclastics and alluvium. A monitoring bore has also been drilled and installed into the [1]carbonaceous alteration unit in the open cut area (visually similar to competent marble) to provide information on whether the hydraulic properties of that unit are materially different to the rest of the Anson Formation.

The locations of the monitoring bores were selected to include monitoring across the different geological and hydrogeological units and to provide a three dimensional spatial spread across the project area. The locations were also based on proximity to potentially sensitive features such as Groundwater Dependent Ecosystems (GDEs) and areas of potential interaction between surface water and groundwater. Consideration was also given to the NSW guidelines for developing monitoring and modelling plans and the information requirements needed to undertake the project assessment in accordance with the AIP.

All monitoring bores were drilled and constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia (National Uniform Drillers Licensing Committee (NUDLC) 2012) and the conditions of the relevant monitoring bore licences.

In addition to the project specific monitoring bores installed by Regis, monitoring is also conducted at bores that were previously drilled and are located on Regis-owned property. The Regis-owned monitoring bores are shown as blue points on Figure 3.5. Groundwater monitoring (as groundwater level measurements and/or groundwater quality sampling and analysis) is also routinely conducted at some neighbouring landholder bores (shown as black points on Figure 3.5).

3.3.1 Hydraulic testing

As reported in the Groundwater Assessment (EMM 2019a), a range of hydraulic tests have been conducted to provide site-specific information on the hydraulic properties of the identified HSUs, including the carbonaceous alteration (marble) that is present within the open cut mine area. Tests completed include rising and falling head tests (slug tests), laboratory core permeability tests and airlift recovery tests.

Generally, hydraulic conductivity of a geological unit reduces with depth, due to reduced weathering and fracturing and increased overburden stress with depth.

Since exhibition of the EIS, pumping tests have now also been conducted on the two test bores that were constructed as part of the groundwater drilling program in support of the construction water supply assessment.

One test bore (TPB04) is located within the mine project area within close proximity to project infrastructure. The other test bore (TB05) is located north of the mine project area (Figure 3.5). The following provides a brief summary on the two test bores:

---

[1] An indurated marble within the Anson Formation is delineated in the open cut pit area. The unit strikes north north west and dips sub vertically to the east (SRK 2017). The unit is interpreted as an in situ alteration associated with the Sherlock Fault Zone. Exploration drilling targeting the carbonaceous alteration showed it had limited extent, extremely low porosity with limited capacity to store and transmit water.

- TPB04 targeted an inferred geological structure within the Anson Formation, with moderately yielding fractures from 77 m below ground level (mbgl). The measured airlift yield at completion was 5 L/s. The estimated hydraulic conductivity and specific storage derived from the aquifer tests are 0.1 m/day and 4.3×10^{-7} m^{-1}, respectively.

- TB05 was drilled adjacent to a historical bore that had anecdotal reports of high yields. This bore intercepted an isolated limestone feature within the Anson Formation (from approximately 55 mbgl) and had a measured airlift yield of around 20 L/s. The estimated hydraulic conductivity and specific storage derived from the aquifer tests are 0.4 m/day and 5×10^{-3} m^{-1}, respectively.

i Hydraulic conductivity

Table 3.1 summarises the range in measured (slug tests, laboratory core testing and pumping tests) and literature sourced hydraulic conductivity data for the geological units in the study area.

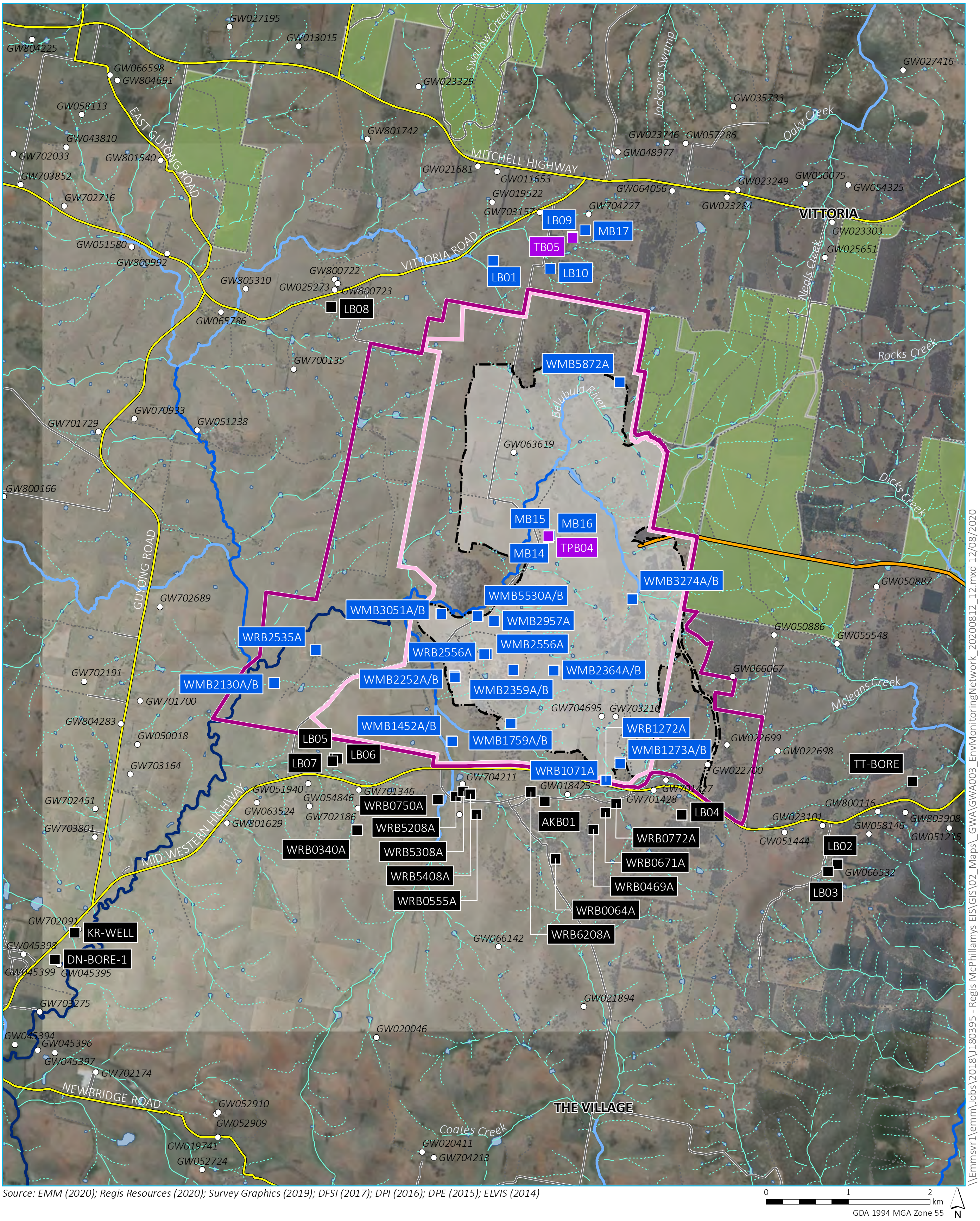
Table 3.1 Summary of hydraulic conductivity data

Geological unit	Hydraulic conductivity (m/day)	
	Measured range	**Literature range**
Alluvium	0.1	-
Carbonaceous alteration/marble (pit area)	5×10^{-3} to 0.3	-
Anson Formation (saprock)	8.6×10^{-8} to 1.3	3.8×10^{-2}
Anson Formation	9.2×10^{-8} to 0.5	
Byng Volcanics (saprock)	0.1 to 0.2	4×10^{-7} to 1.2×10^{-3}
Byng Volcanics	2×10^{-4} to 0.5	
Blayney Volcanics	0.4	
Basalt	-	2.2×10^{-1}

ii Storage parameters

As reported in the Groundwater Assessment (EMM 2019a), specific storage of the volcaniclastics and metasediments in the study area is calculated to range from 3×10^{-7} to 1×10^{-6} m^{-1} using the rock density, bulk modulus, and porosity from core testing completed for the project.

The measured data from the aquifer tests, completed as part of the recent groundwater drilling and testing program estimated specific storage values that range from 4×10^{-7} to 5×10^{-3} m^{-1}. The higher specific storage value estimated represents the localised limestone feature within the Anson Formation, which was targeted to develop a groundwater supply, and is not considered representative of the overall Anson Formation metasediments.



Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DFSI (2017); DPI (2016); DPE (2015); ELVIS (2014)

KEY

🟦 Groundwater monitoring site - Regis
■ Groundwater monitoring site - other landholder
🟪 Test bore
○ Registered bore - not monitored

Project application area
▭ Mine development project boundary
▭ Mining lease application area
(Note: boundary offset for clarity)
⬚ Disturbance footprint
— Pipeline

Existing environment
— Main road
— Local road
⋯ Vehicular track
🟩 Vittoria State Forest

▭ Waterbody
Strahler stream order
⋯ 1st order
– – 2nd order
— 3rd order
— 4th order
— 5th order
— 6th order

Groundwater monitoring and project bore locations

McPhillamys Gold Project
Groundwater assessment addendum
Figure 3.5

3.3.2 Groundwater levels and flow

i Flow directions

The inferred watertable elevation contours and groundwater flow directions in and surrounding the mine project area are presented on Figure 3.6. This figure shows the local groundwater flow direction of the watertable, which is a subdued reflection of topography. It also shows that, regionally, groundwater flows in a south-westward direction, with high groundwater elevations occurring north of the Vittoria State Forest area, consistent with the surface water catchment divide. Recharge occurs throughout the catchment, particularly on the upper and side slopes of the catchment, but also occurs in lower areas of the catchment and along creek lines. As shown on Figure 3.6, groundwater is inferred to discharge locally to the Belubula River downstream of Trib E; ie sections of the Belubula River can be classified as a gaining stream downstream of Trib E (during normal climate conditions), but it is not a gaining stream upstream of Trib E, with groundwater contribution to surface water flows inferred to reduce with distance upstream from Trib A.

Groundwater flows at a greater rate within the shallow saprock driven largely by the higher hydraulic conductivity in comparison to the underlying rock. The fresh rock has a much lower hydraulic conductivity, impeding vertical leakage, and as a result flow within the shallow weathered zone is predominantly horizontal and towards the surface watercourses.

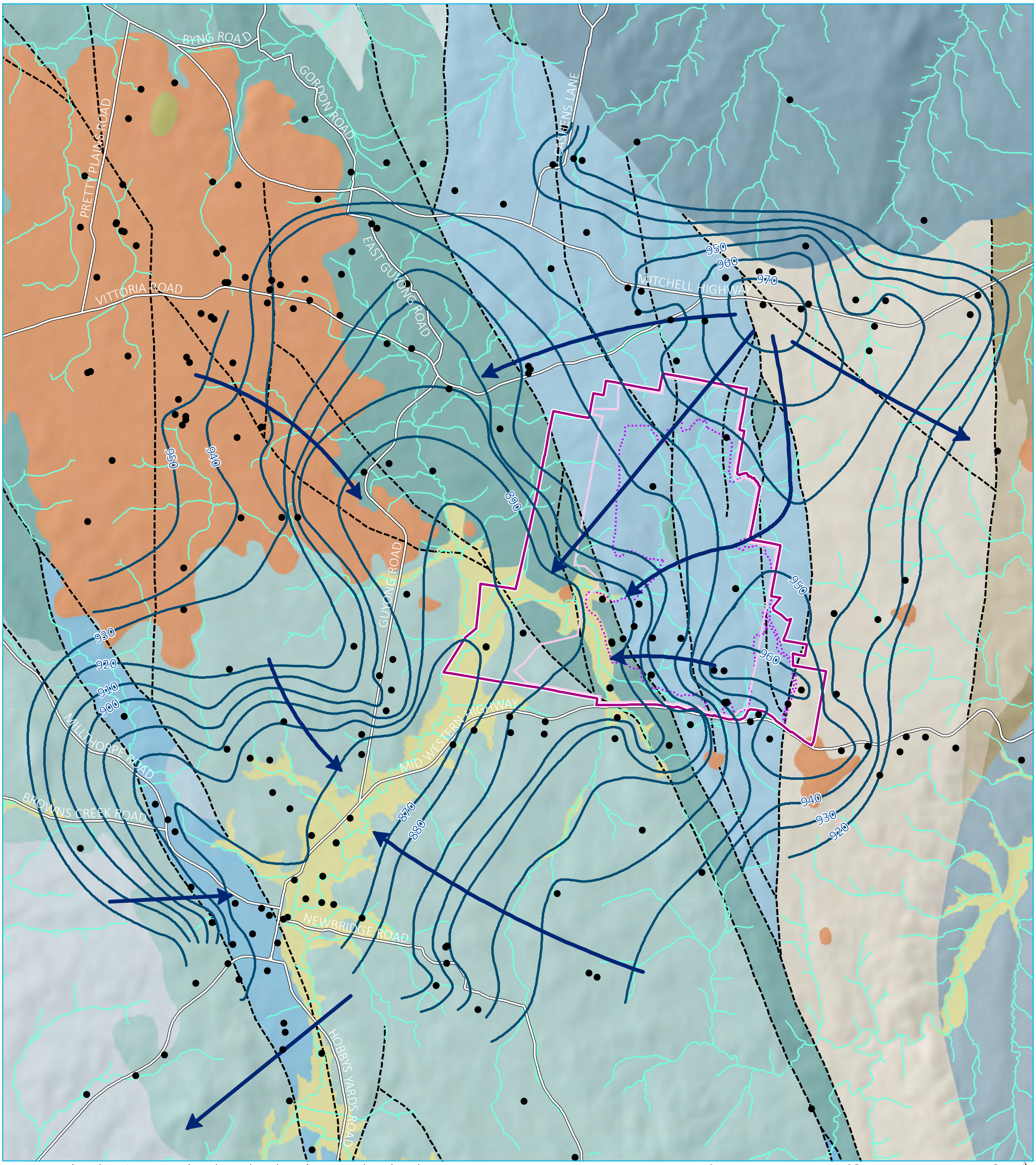
At the bore scale, fractures and faults can have a greater apparent influence on groundwater flow. However, at a regional scale, including the scale of the study area and mine project area, groundwater flow systems are sensitive to and depend on average values of hydrogeological properties.

The observations from the recent drilling program are consistent with the inferred watertable elevation contours and groundwater flow directions presented in the Groundwater Assessment (EMM 2019a; Figure 3.6).

ii Temporal trends

Hydrographs of baseline groundwater level data are plotted in Figure 3.7 to Figure 3.13. Groundwater baseline data show that groundwater levels at a number of groundwater monitoring sites across the mine project area have gradually declined since installation in late 2016/early 2017 through until early 2020, correlating with a period of below average rainfall following the wet period in 2016. Monitoring sites at higher elevations continue to show an overall declining trend, for example WMB1273A/B (Figure 3.7), WMB2359A/B (Figure 3.8) and WMB2364A/B (Figure 3.8). A few bores (WMB1452A/B, WMB2252A/B, WMB3274A/B, WMB5530A/B and WMB5872A/B) show evidence of responding to the recent increased rainfall in early 2020. Most of these monitoring bores are located within close proximity to watercourses, suggesting that during these periods of high rainfall, creek flows recharge groundwater locally.

Groundwater level data for monitoring bore WMB2556A show evidence of nearby groundwater abstraction between April 2017 and December 2018 (Figure 3.12). This low volume abstraction corresponds to local groundwater usage (anecdotal) at registered bore GW064166. This registered bore is understood to be used to fill a holding tank as a stock and domestic water supply. Groundwater level monitoring data at WMB2359A shows groundwater level decline as a result of monthly sampling events (Figure 3.8).



Source: EMM (2020); Regis Resources (2020); DFSI (2017); DPI (2015, 2003); GA (2011)

0 2.5 5 km

GDA 1994 MGA Zone 55

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KEY

- ● Regional bore
- Watertable elevation (mAHD) (inferred)
- Groundwater flow direction
- Major road
- Watercourse/drainage line

Project application area

- Mine development project area
- Mining lease application area (Note: boundary offset for clarity)
- Disturbance footprint

Geology (Bathurst 250k, 2nd Edition)

- Fault

Quaternary / Tertiary

- Alluvium
- Tertiary basalt
- Trachyte

Carboniferous

- Bathurst Batholith - Gresham Granite
- Bathurst Batholith - Icely Granite

Devonian

- Ungrouped Devonian Formations - Cunningham Formation
- Crudine Group - Bushranger Volcanics
- Crudine Group - Waterbeach Formation

Silurian

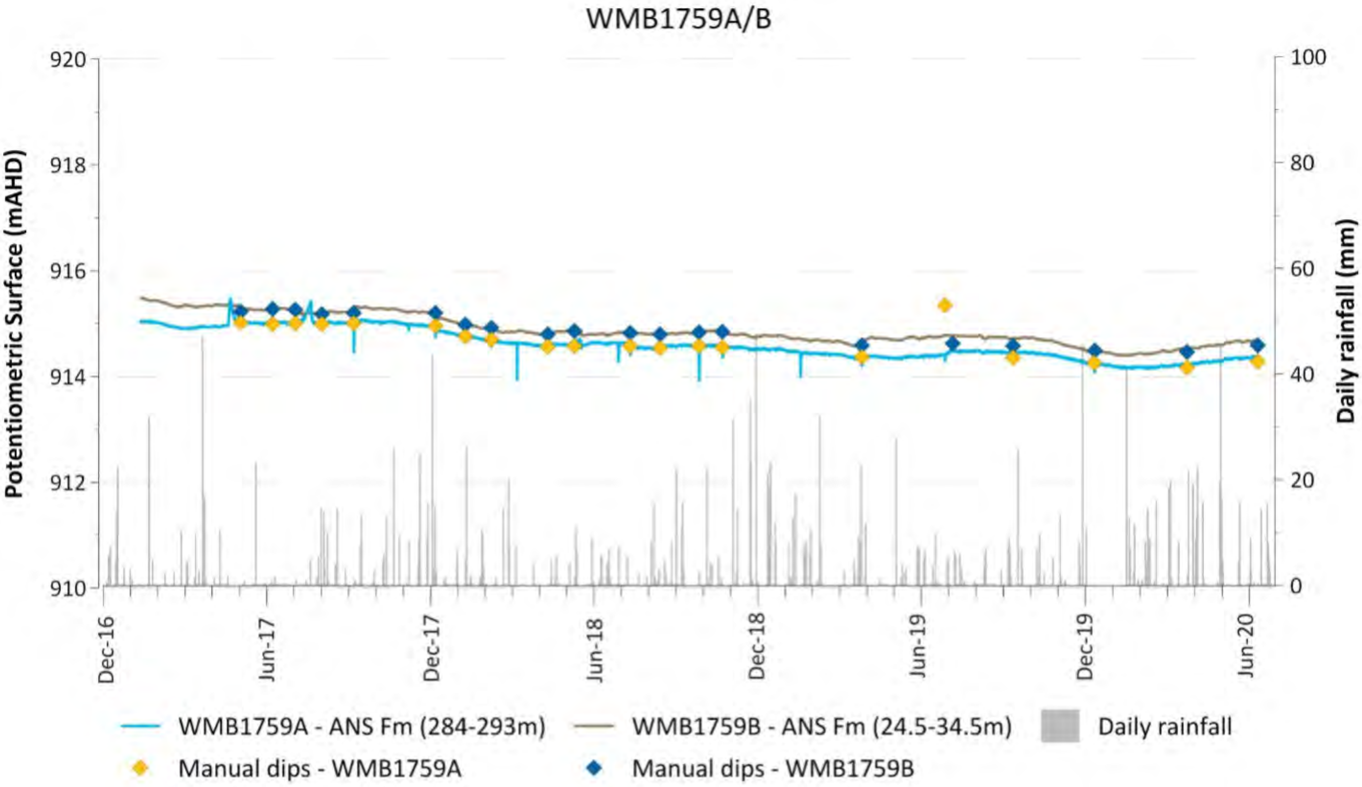
- Other Silurian Intrusions - Carcoar Granodiorite
- Other Silurian Intrusions
- Mumbil Group (Northwest) - Anson Formation
- Mumbil Group (Northwest) - Wombiana Formation
- Mumbil Group (East) - Campbells Formation

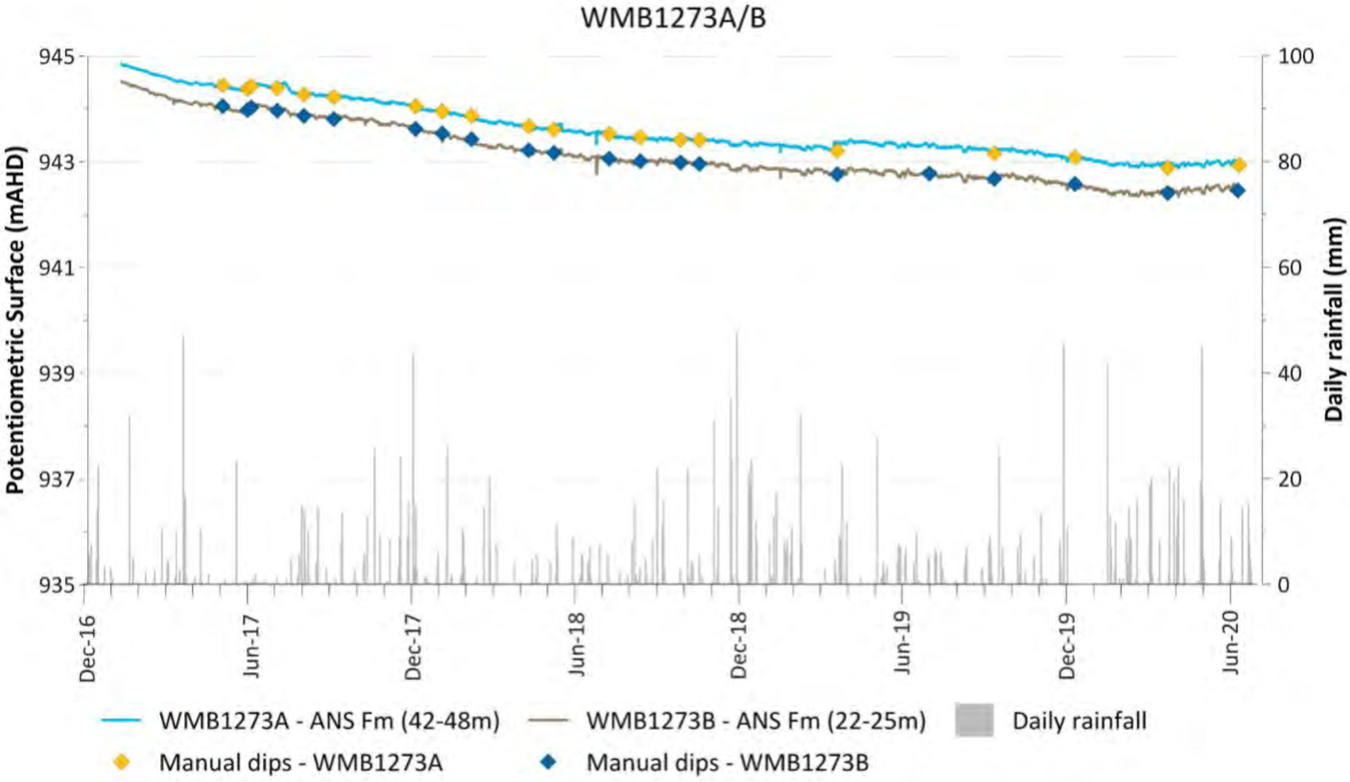
Ordovician

- Ordovician Intrusions
- Cabonne Group - Blayney Volcanics
- Cabonne Group - Oakdale Formation
- Cabonne Group - Byng Volcanics

Inferred watertable elevation and groundwater flow direction

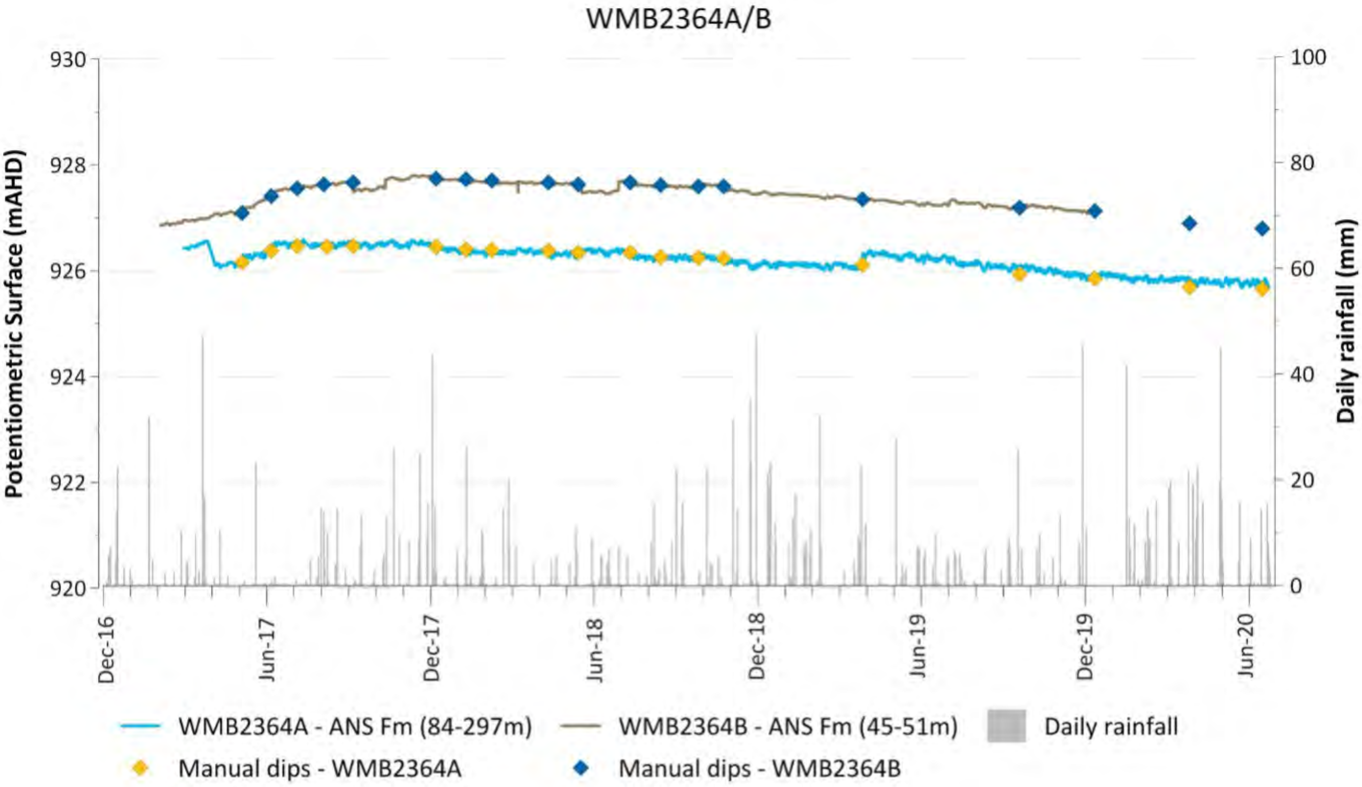
McPhillamys Gold Project
Groundwater assessment addendum
Figure 3.6

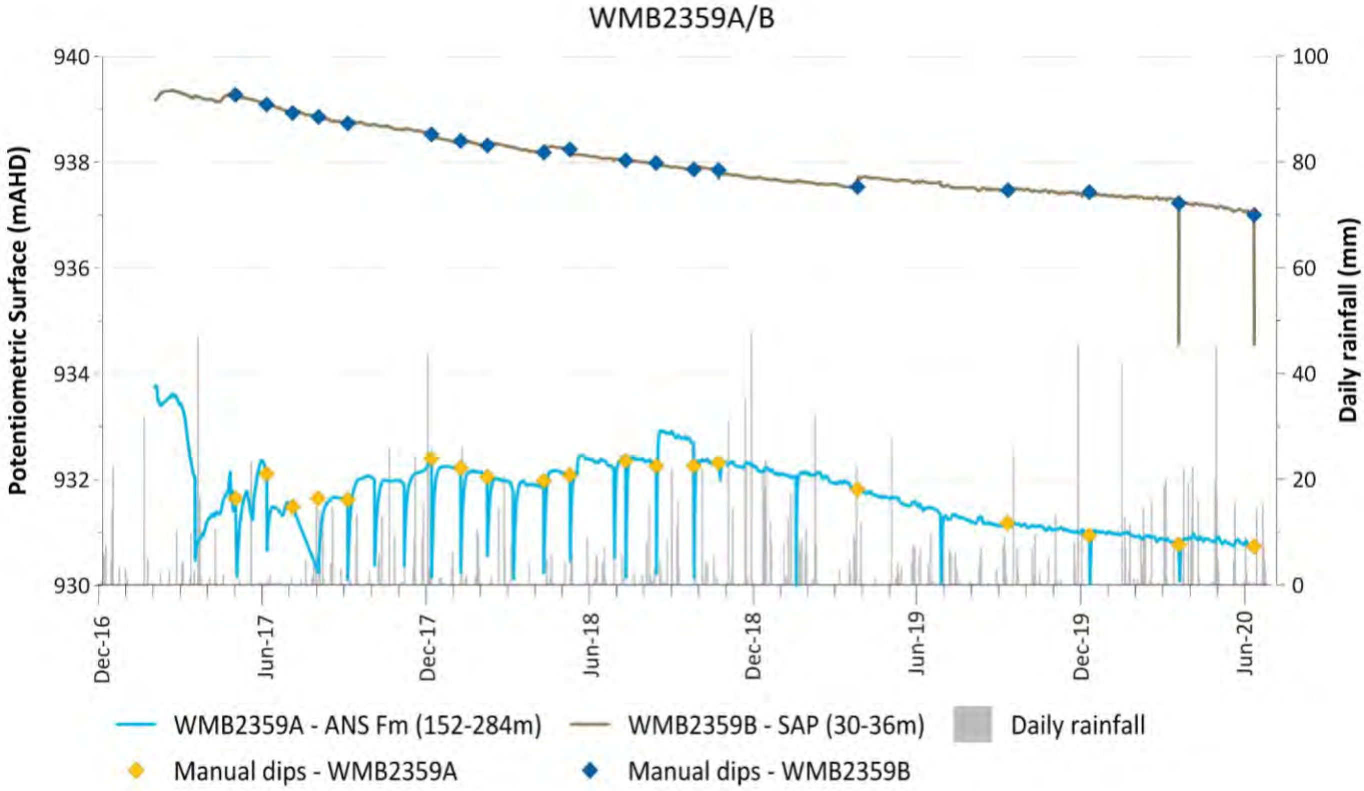




Hydrograph 1 - Anson Formation

Groundwater assessment addendum
Regis Resources Limited
Figure 3.7





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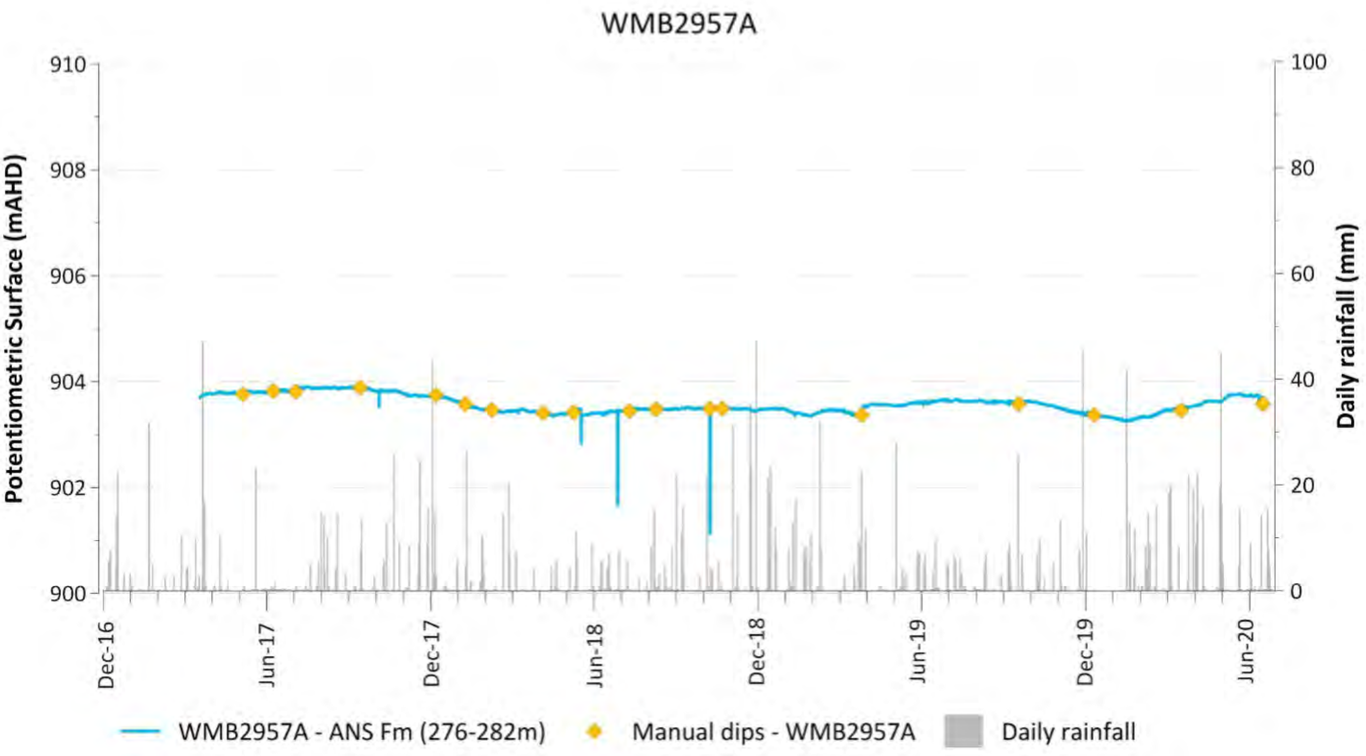
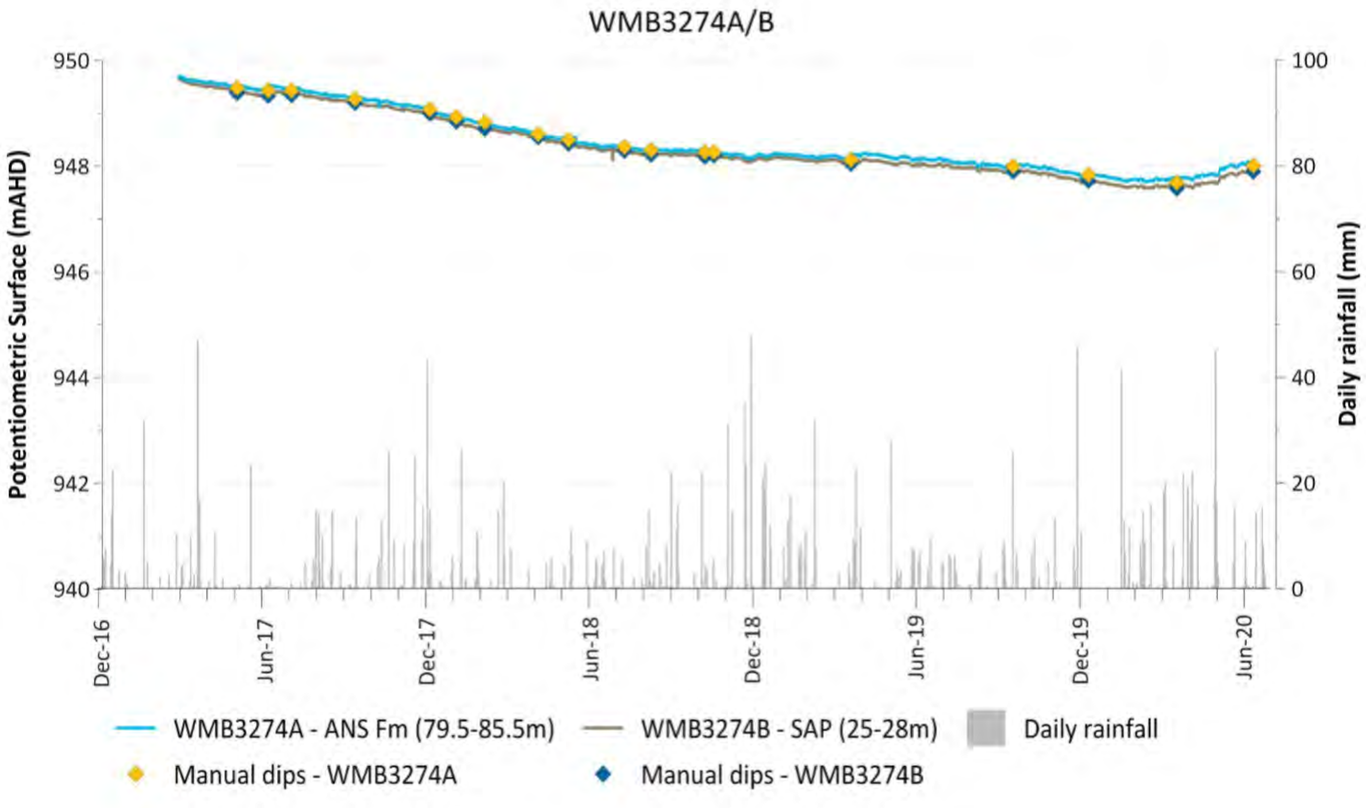
Hydrograph 2 - Anson Formation

Groundwater assessment addendum
Regis Resources Limited
Figure 3.8



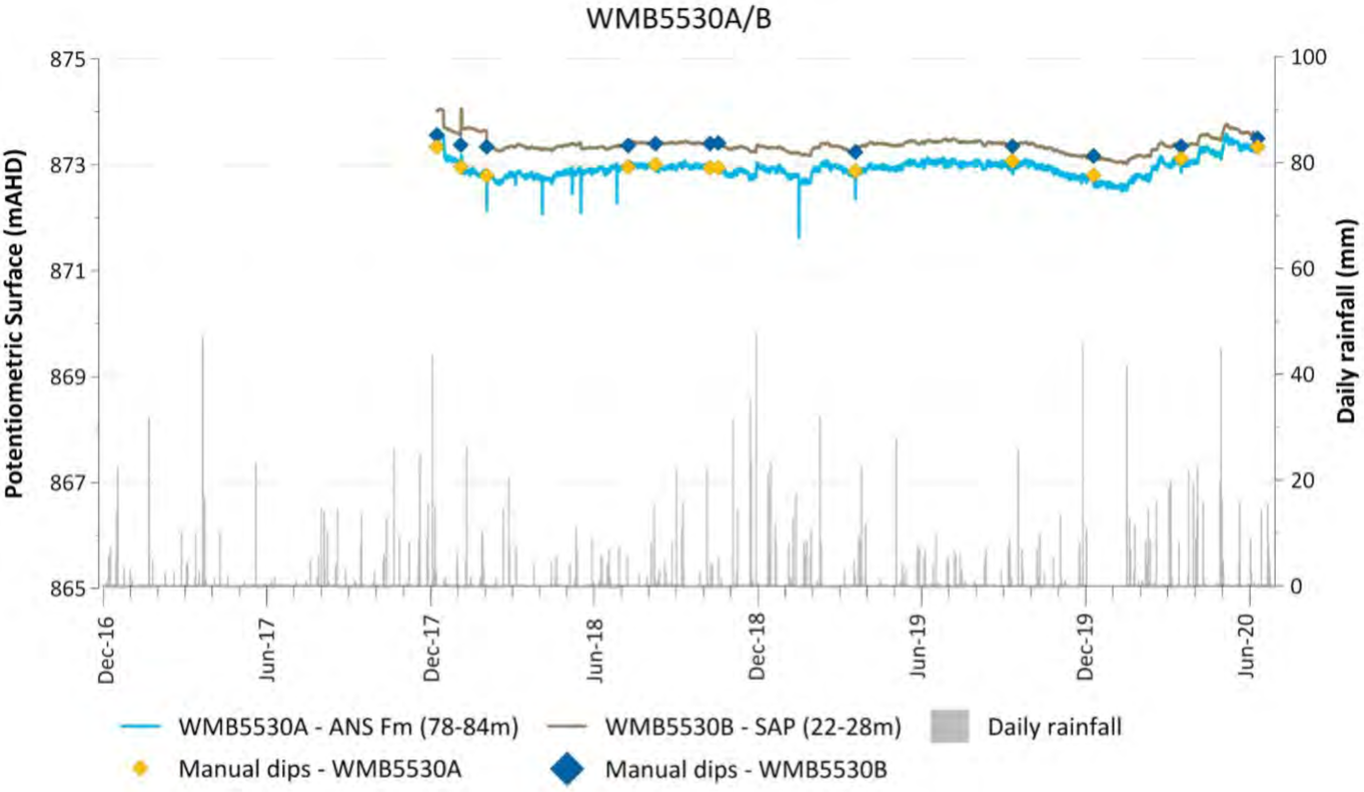


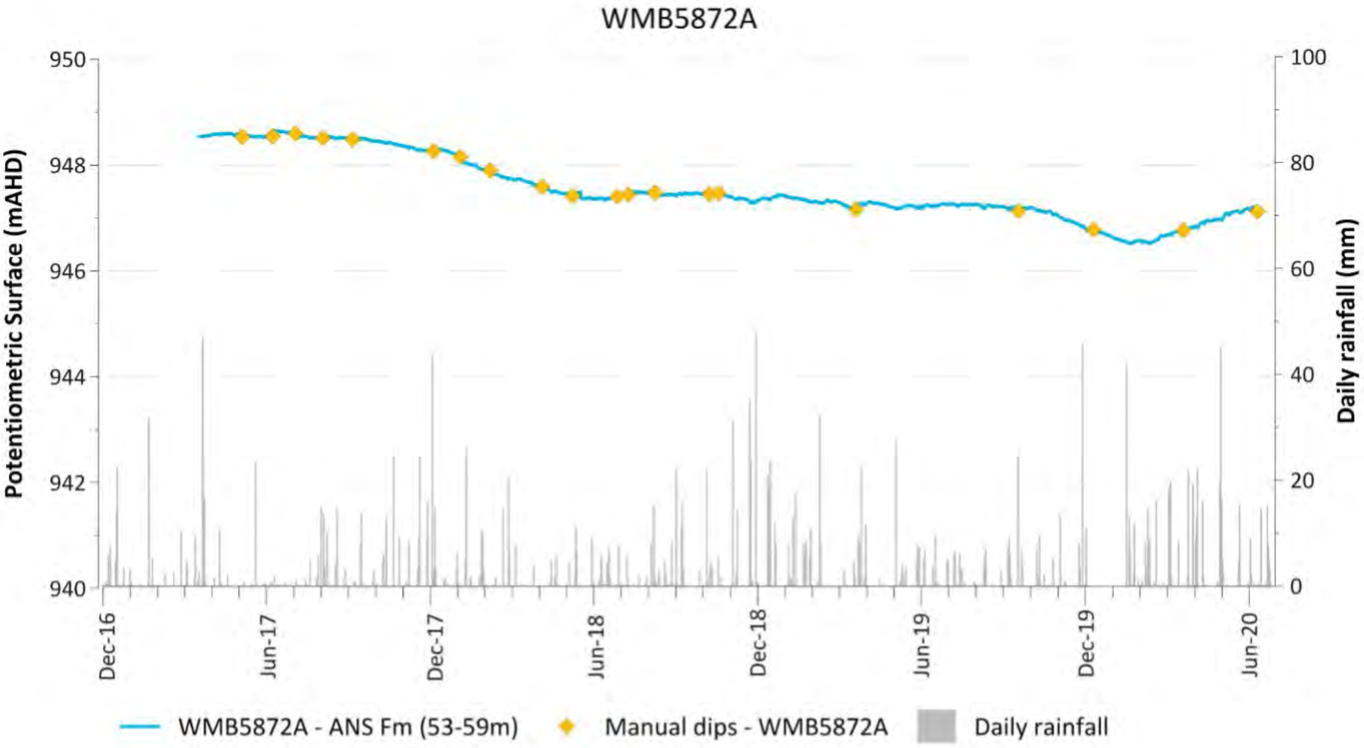
Hydrograph 3 - Anson Formation

Groundwater assessment addendum

Regis Resources Limited

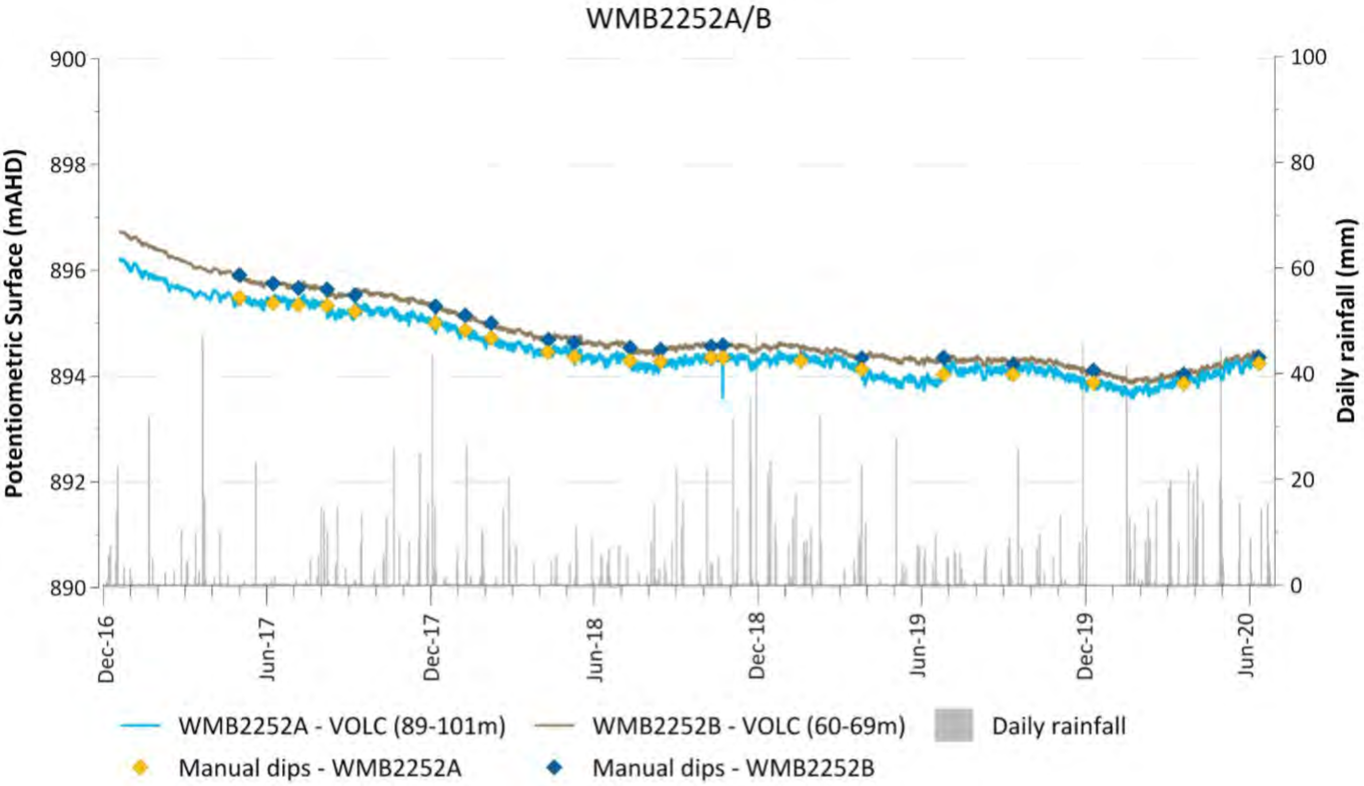
Figure 3.9

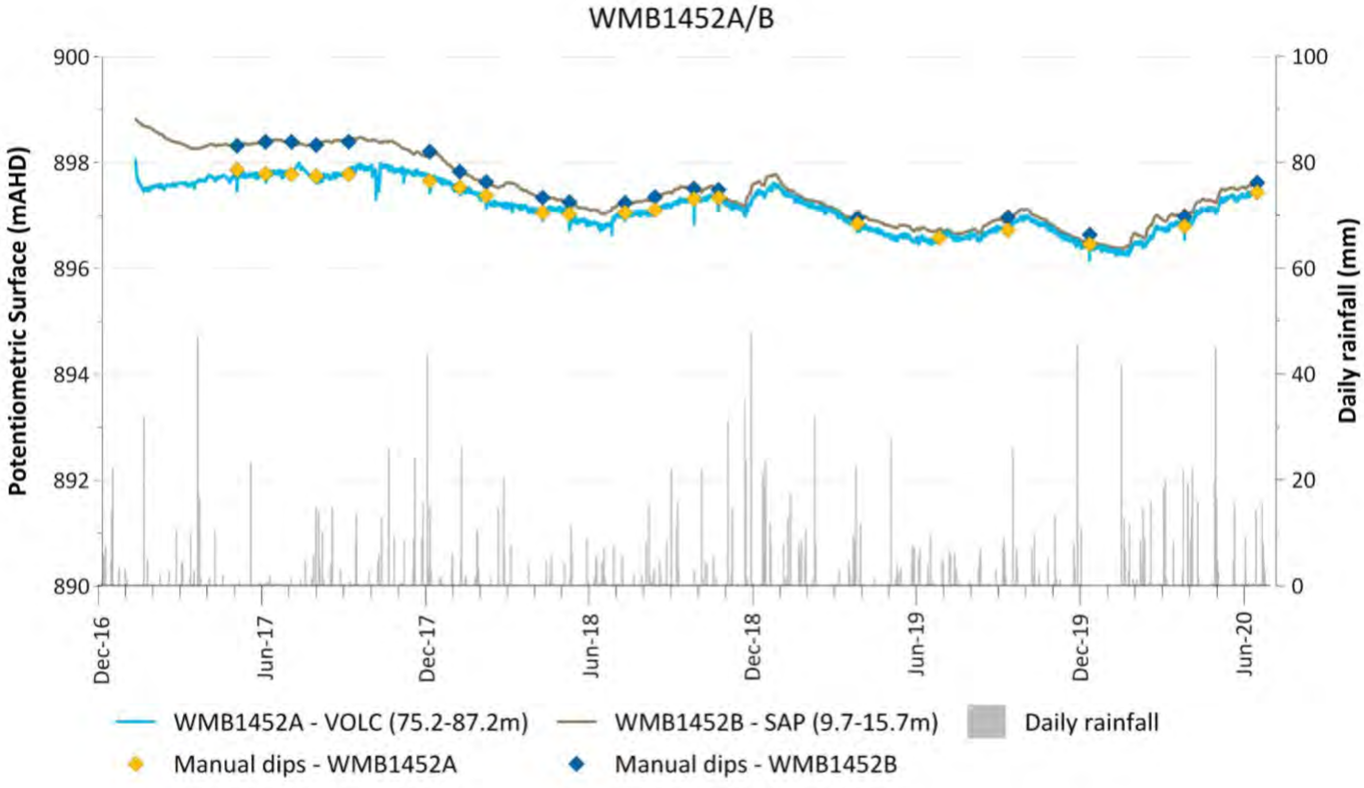




Hydrograph 4 - Anson Formation

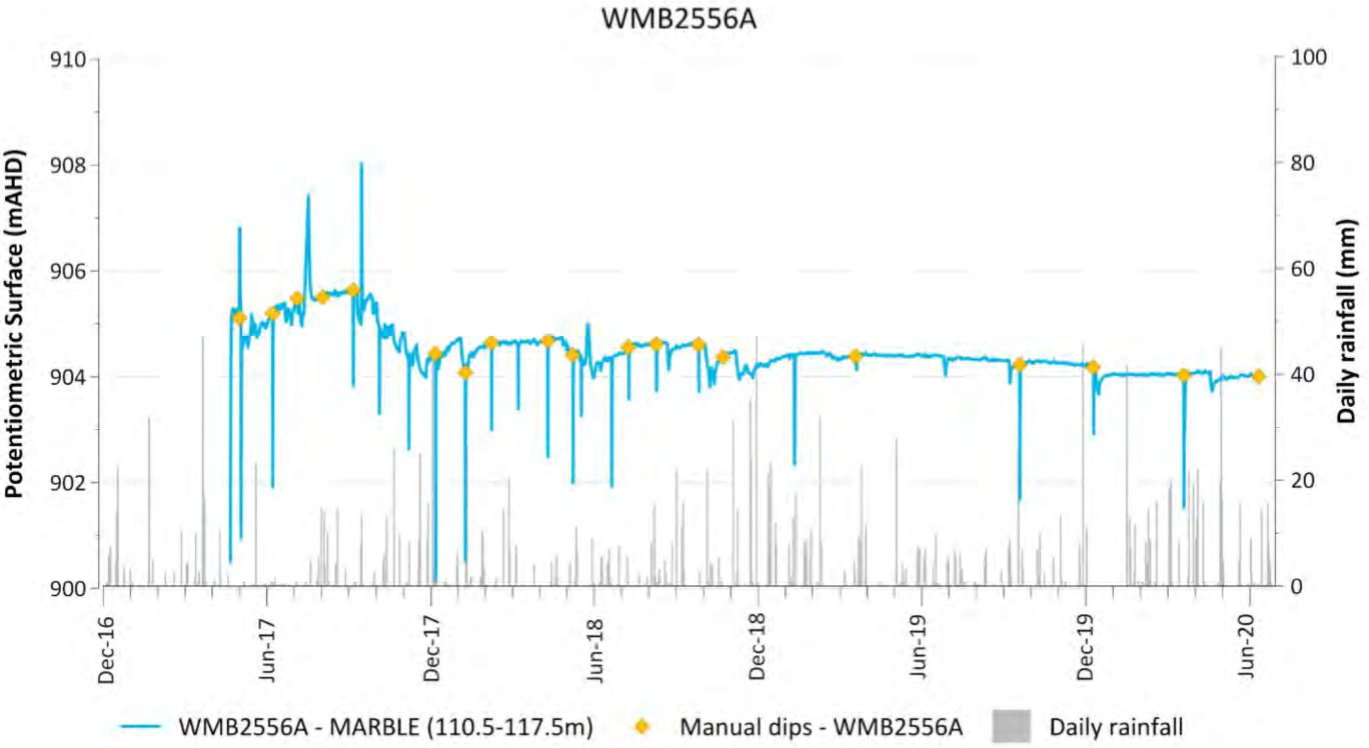
Groundwater assessment addendum
Regis Resources Limited
Figure 3.10

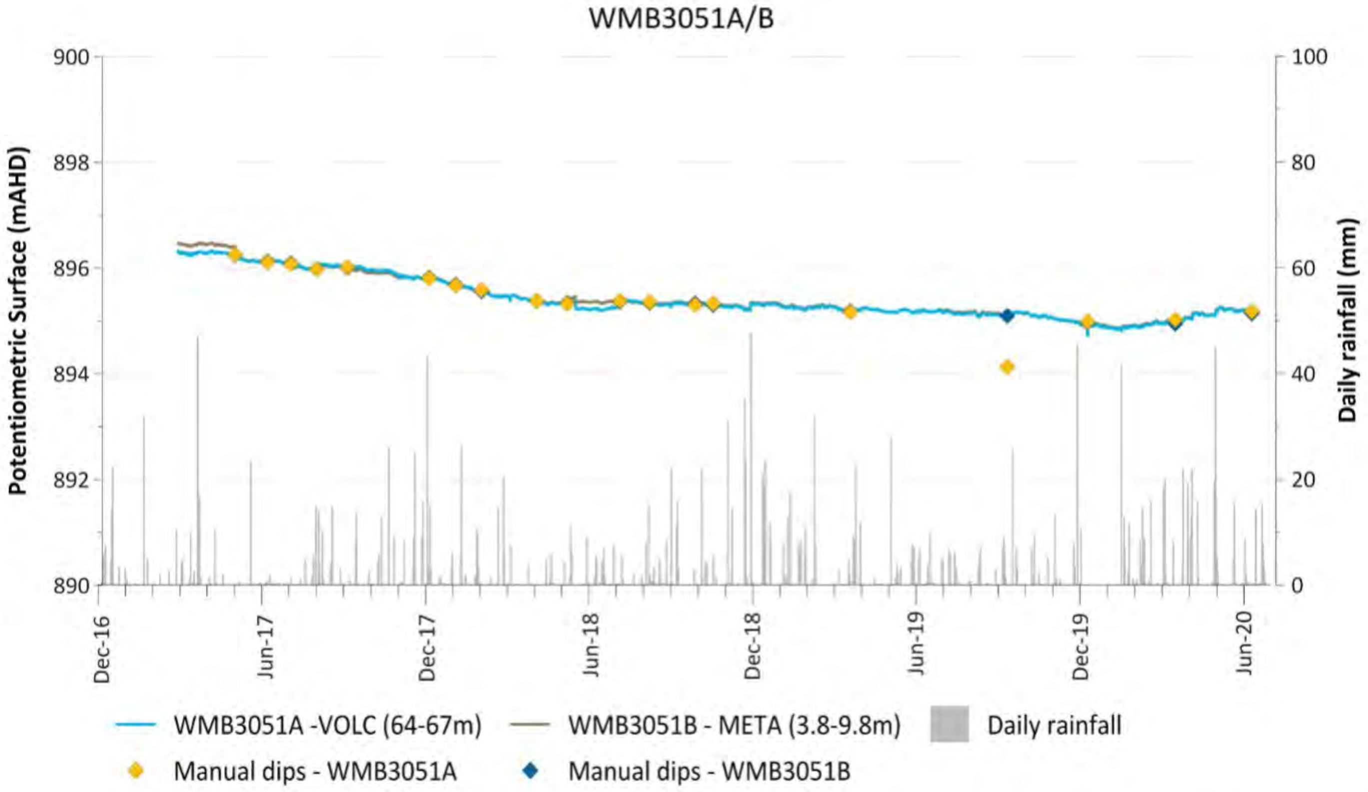




Hydrograph 5 - Byng Formation

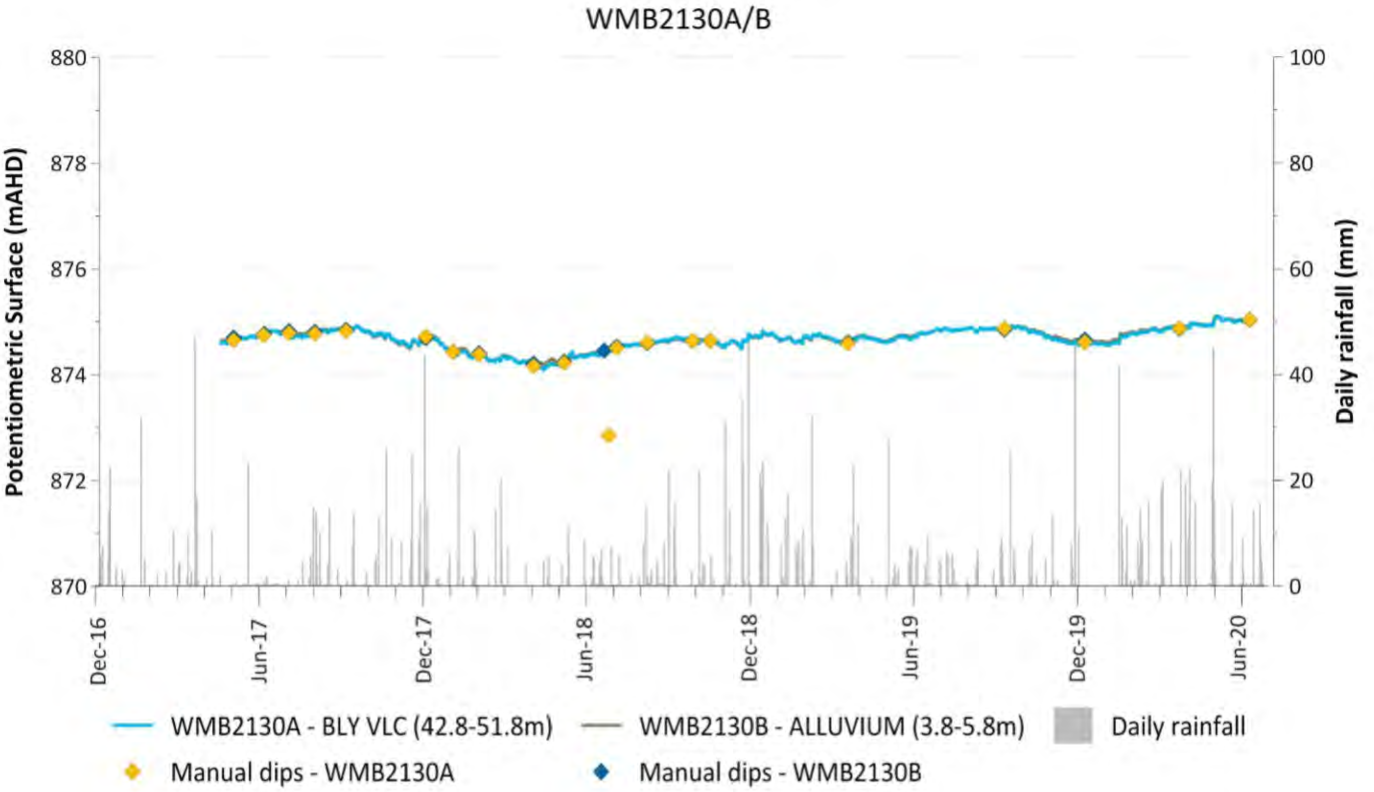
Groundwater assessment addendum
Regis Resources Limited
Figure 3.11





Hydrograph 6 - Byng Volcanics and carbonaceous alteration

Groundwater assessment addendum
Regis Resources Limited
Figure 3.12



Hydrograph 7 - Blayney Volcanics and alluvium

Groundwater assessment addendum
Regis Resources Limited
Figure 3.13

3.3.3 Groundwater quality

Groundwater chemistry data have been collected across the mine project area since May 2014 and provide the basis for understanding the pre-mine baseline groundwater resource condition. The number of baseline sampling events at third-party bores and Regis-owned bores (between May 2014 and May 2020) is presented in Figure 3.14.

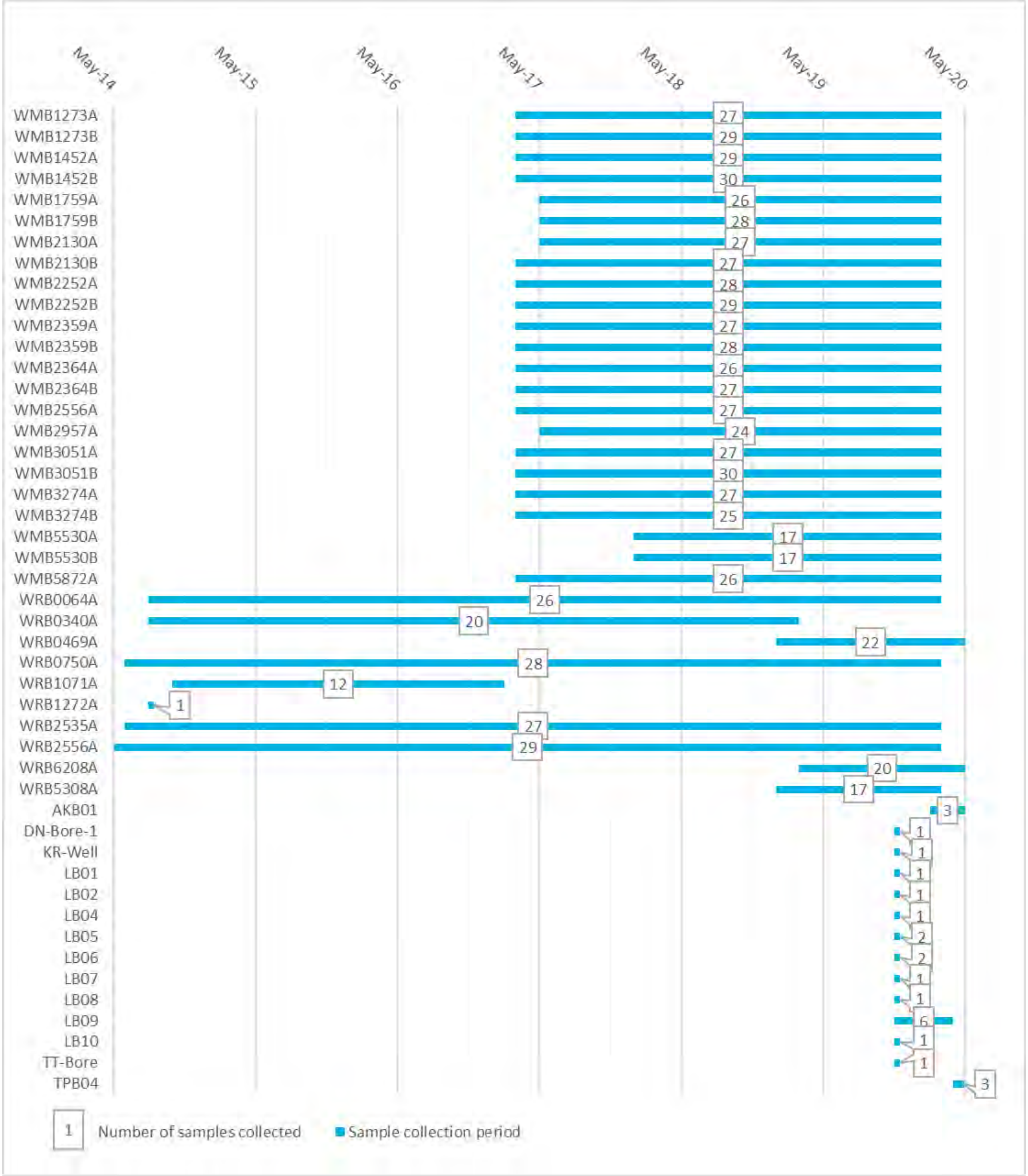


Figure 3.14 Groundwater quality baseline sampling summary

Groundwater chemistry laboratory data are compared against:

- the Australian and New Zealand (Water Quality Australia 2018 and ANZECC 2000) Guidelines that are relevant to the protection of freshwater aquatic ecosystems, irrigation and stock drinking water;
- NSW Department of Primary Industries (2014) Water requirements for sheep and cattle; and
- the ADWG (NHMRC 2016).

Site specific trigger levels and WQOs will be derived from the baseline data as part of the WMP for the project, following approval.

i Salinity and pH

Groundwater salinity and pH of samples collected from Regis and third-party monitoring bores are summarised in Table 3.2. The spatial distribution of groundwater salinity (as median TDS) is shown on Figure 3.15.

Table 3.2 Mine project area groundwater salinity and pH

Bore ID	Inferred HSU	TDS range (mg/L)	ADWG palatability	ANZECC stock suitability	pH
WMB1273A	Anson Formation	500-780	Fair	Acceptable	6.5-7.8
WMB1273B	Anson Formation (saprock)	570-907	Fair	Acceptable	6.4-7.4
WMB1452A	Byng Volcanics	290-526	Good	Acceptable	6.9-8.5
WMB1452B	Byng Volcanics (saprock)	460-928	Fair	Acceptable	5.0-7.4
WMB1759A	Anson Formation	430-690	Good-Fair	Acceptable	6.7-7.9
WMB1759B	Anson Formation	712-966	Fair	Acceptable	5.8-7.4
WMB2130A	Blayney Volcanics	270-468	Good	Acceptable	6.2-7.3
WMB2130B	Alluvium	440-926	Good-Fair	Acceptable	6.4-7.5
WMB2252A	Byng Volcanics	247-388	Good	Acceptable	5.9-7.8
WMB2252B	Byng Volcanics	367-580	Good	Acceptable	6.3-7.5
WMB2359A	Anson Formation	2,899-5,200	Unacceptable	Acceptable	4.8-6.4
WMB2359B	Anson Formation (saprock)	1,716-3,990	Unacceptable	Acceptable	2.2-5.3
WMB2364A	Anson Formation	782-1,230	Fair – Unacceptable	Acceptable – Unacceptable [4]	6.2-8.5
WMB2364B	Anson Formation (saprock)	2,240-4,250	Unacceptable	Acceptable	6.3-7.8
WMB2556A	Anson Formation (Carbonaceous alteration/marble)	294-686	Good – Fair	Acceptable	6.5-7.8
WMB2957A	Anson Formation	1,200-1,650	Unacceptable	Acceptable	6.9-7.9
WMB3051A	Byng Volcanics	640-1,010	Fair – Poor	Acceptable	5.6-7.7
WMB3051B	Byng Volcanics (saprock)	562-898	Good – Fair	Acceptable	6.5-8.0
WMB3274A	Anson Formation	474-728	Good – Fair	Acceptable	6.4-7.5
WMB3274B	Anson Formation (saprock)	630-1,480	Fair – Poor	Acceptable	6-7.7
WMB5530A	Anson Formation	360-461	Good	Acceptable	7.8-8.5
WMB5530B	Anson Formation (saprock)	610-920	Fair	Acceptable	6.5-7.2

Table 3.2 Mine project area groundwater salinity and pH

Bore ID	Inferred HSU	TDS range (mg/L)	ADWG palatability	ANZECC stock suitability	pH
WMB5872A	Anson Formation	266-478	Good	Acceptable	6.6-7.1
WRB0064A	Byng Volcanics	256-441	Good	Acceptable	6.8-7.2
WRB1272A	Anson Formation	628	Fair	Acceptable	7.7
WRB0340A	Blayney Volcanics	264-579	Good	Acceptable	7.0-7.1
WRB0469A	Anson Formation	1,700	Unacceptable	Acceptable	6.5-6.6
WRB0750A	Blayney Volcanics	440-648	Good – Fair	Acceptable	6.8-7.2
WRB1071A	Anson Formation	576-712	Good – Fair	Acceptable	7.5-7.9 [6]
WRB2535A	Blayney Volcanics	466-709	Good – Fair	Acceptable	7.0-7.3
WRB2556A	Anson Formation	236-449	Good	Acceptable	7.4
WRB5308A	Blayney Volcanics	630-680	Fair	Acceptable	7.1-7.2
AKB01	Byng Volcanics	410-533	Good	Acceptable	6.9-7.8
LB01	Anson Formation	280	Good	Acceptable	6.3
LB02	Cunningham Formation	330	Good	Acceptable	6.7
LB04	Anson Formation	410	Good	Acceptable	6.5
LB05	Blayney Volcanics	680-810	Fair	Acceptable	6.7-7.2
LB06	Blayney Volcanics	370-550	Good	Acceptable	7.2-7.3
LB07	Blayney Volcanics	840	Fair	Acceptable	7.9
LB08	Byng Volcanics	620	Fair	Acceptable	6.8
LB09	Anson Formation	360	Good	Acceptable	6.8
LB10	Anson Formation	560	Good	Acceptable	7.0
MB14	Anson Formation	398	Good	Acceptable	7.8
MB15	Anson Formation	447	Good	Acceptable	8.0
MB16	Anson Formation	357	Good	Acceptable	8.3
MB17	Anson Formation	198	Good	Acceptable	7.9
TPB04	Anson Formation	410	Good	Acceptable	8.0
TB05	Localised limestone in Anson Formation	443	Good	Acceptable	7.7
TT-Bore	Cunningham Formation	300	Good	Acceptable	6.5
DN-Bore-1	Alluvium	550	Good	Acceptable	7.3
KR-Well	Alluvium	360	Good	Acceptable	7.1

Notes:
1. TDS: total dissolved solids, analysed in laboratory.
2. ADWG palatability – Australian Drinking Water Guidelines (NHMRC 2016): Good (TDS 0-600 mg/L), Fair (TDS 600-900 mg/L), Poor (TDS 900-1,200 mg/L), Unacceptable (TDS >1,200 mg/L).
3. ANZECC (2000) stock suitability: Acceptable (TDS 2,000-5,000 mg/L) Unacceptable (TDS >5,000 mg/L).
4. DPI Water (2014) recognise that TDS concentrations up to 10,000 mg/L TDS is acceptable for beef cattle and sheep for limited periods.
5. pH measured in the field.
6. Laboratory pH used in place of field pH.

Groundwater sampled from all geological units is suitable for livestock drinking (less than 10,000 mg/L TDS) and is generally less than 2,000 mg/L TDS, except for groundwater at some Anson Formation bores that have salinities up to 5,200 mg/L TDS.

Time series plots of groundwater salinity are provided in **Error! Reference source not found.**. Figure 3.15 presents the spatial distribution of average TDS for the water sampled from bores in the mine project area. It shows that groundwater sampled from the Anson Formation is typically more saline than groundwater sampled from the other geological units.

Laboratory reported major ion concentrations in groundwater samples are presented on a trilinear (Piper) diagram on Figure 3.16. This presents the dominant ions in the water sampled and can indicate the potential source and age of the water. It shows some variation for groundwater bores in the Anson Formation and Byng Volcanics; however, groundwater in the area is generally bicarbonate dominant and shows signs of mixing between different water types and is consistent with observations reported in the Groundwater Assessment for the EIS (EMM 2019a).

As reported in the Groundwater Assessment (EMM 2019a), the laboratory reported concentrations for dissolved metals, nutrients and hydrocarbons show:

- all baseline groundwater samples had reported hydrocarbon concentrations that were below detection levels and/or below the guideline values;

- cyanide concentrations were below detection levels in all baseline groundwater samples;

- arsenic concentrations were above the ADWG (NHMRC 2016) guideline trigger value in one weathered Byng Volcanics groundwater sample and multiple fresh Byng Volcanics groundwater samples. Arsenic concentrations also exceeded the ANZECC (2000) livestock drinking water guideline value in 14 out of 154 fresh Byng Volcanics groundwater samples;

- groundwater sampled from the alluvium (HSU 1) monitoring bore exceeded the Cu and Zn trigger values for the 95% protection level of freshwater aquatic ecosystems;

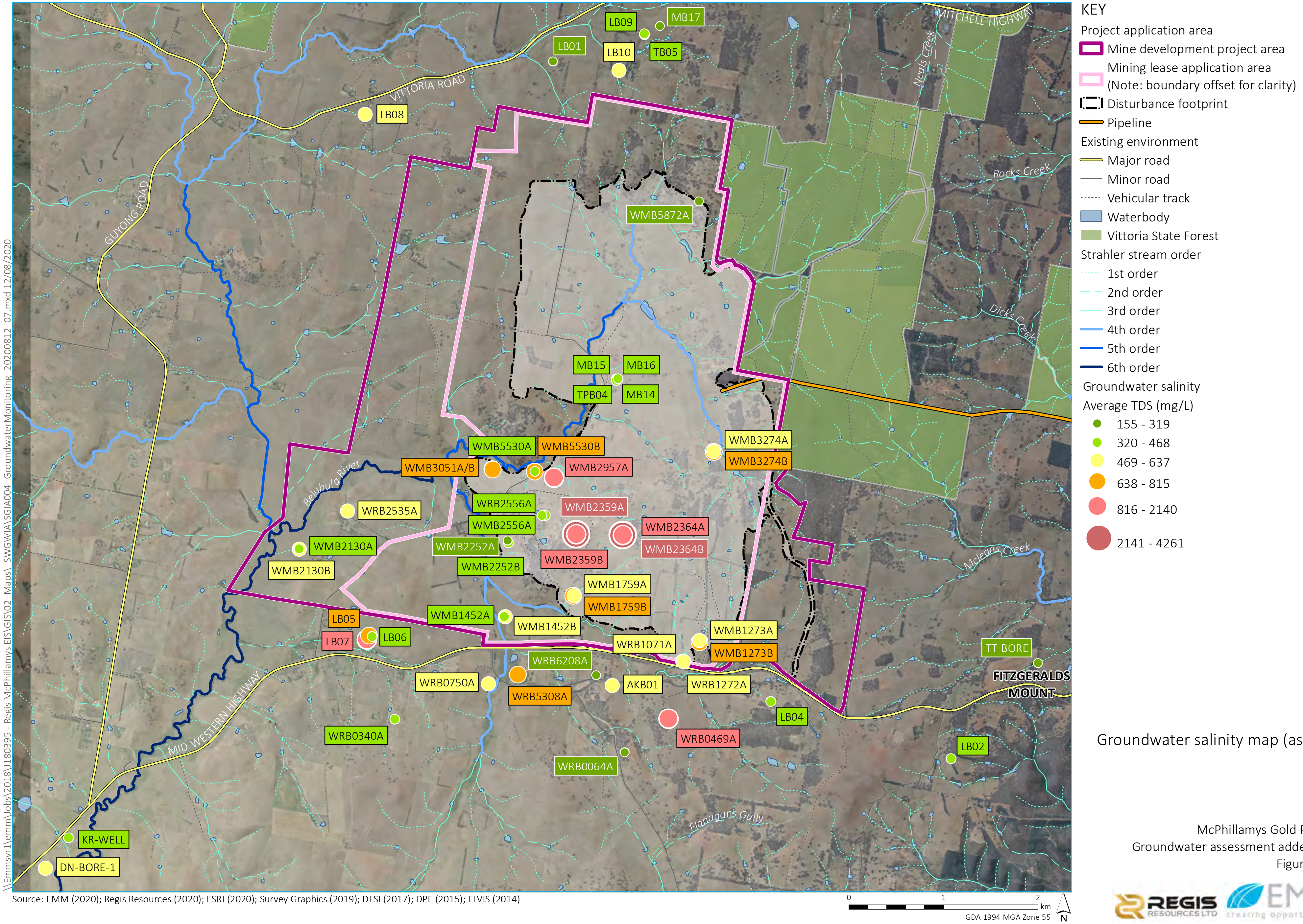
- copper and zinc concentrations in groundwater often exceed the 95% protection level of freshwater aquatic ecosystems guideline values (all sampled lithologies);

- nitrate concentrations exceeded the 95% protection level for fresh water aquatic ecosystems trigger value in groundwater sampled from all lithologies, except marble;

- groundwater sampled from the weathered Anson Formation had aluminium, cadmium, copper, lead, manganese, mercury, nickel and zinc concentrations that exceeded the relevant trigger values;

- groundwater sampled from the fresh Anson Formation had fluoride, aluminium, cadmium, copper, manganese, nickel, silver (on one occasion) and zinc concentrations that exceeded the relevant trigger values; and

- groundwater sampled from the weathered and fresh Byng and Blayney Volcanics also exceeded trigger values for manganese and nickel.



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Source: EMM (2020); Regis Resources (2020); ESRI (2020); Survey Graphics (2019); DFSI (2017); DPE (2015); ELVIS (2014)

Groundwater salinity map (as TDS)

McPhillamys Gold Project
Groundwater assessment addendum
Figure 3.15

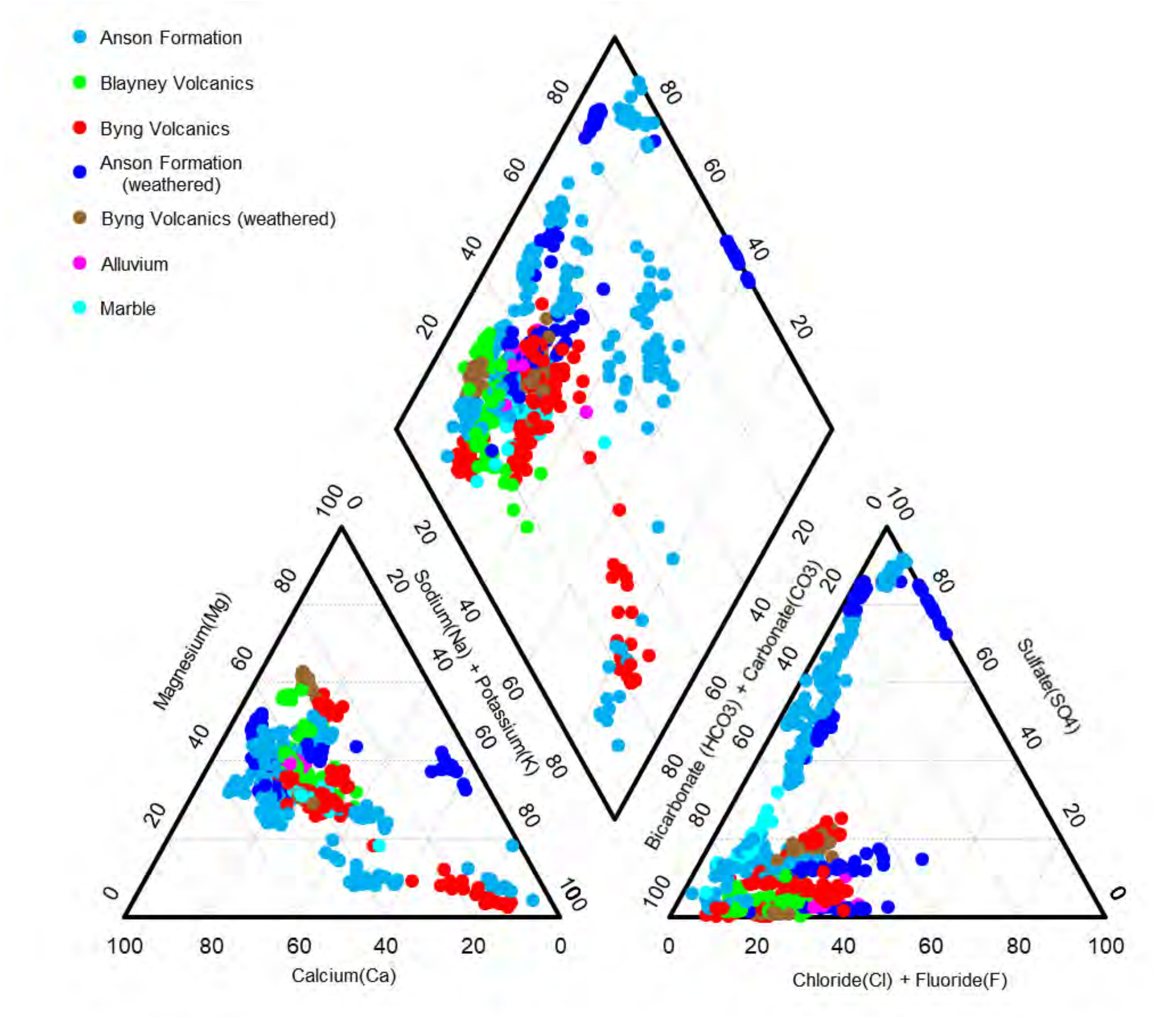


Figure 3.16 Groundwater trilinear (Piper) diagram

The available water quality monitoring data results suggest that the default guideline values (ANZECC 2000) are not representative of the baseline conditions in the mine project area and site specific WQOs and triggers should be developed prior to project commencement using all available baseline data (as part of the Water Management Plan for the project, following approval).

3.3.4 Groundwater receptors

Groundwater receptors identified in the mine project area were presented in the Groundwater Assessment (EMM 2019a) and include:

- bores owned on neighbouring properties (third-party bores);
- GDEs including:
  - the Belubula River (aquatic ecosystem), which is summarised in Section 3.2 and in further detail in the Surface Water-Groundwater Interaction Assessment (EMM 2020b);
  - springs and seeps in the mine project area, also discussed in further detail in the Surface Water-Groundwater Interaction Assessment (EMM 2020b); and

- Mountain Gum - Manna Gum open forest (plant community type (PCT) 951) and Yellow Box – Blakely's Red Gum grassy woodland on the tablelands of the South Eastern Highlands Bioregion (PCT 1330) (terrestrial ecosystems); and

- macroinvertebrate fauna identified at two spring/seep areas.

i Third-party bores

Registered bores within approximately 2 km of the mine project area are presented on Figure 3.17 and summarised in Table 3.3, with further details provided in Appendix A. Landholder bores visited as part of bore census surveys conducted by Regis are identified in Table 3.3.

Table 3.3 Summary of third-party bores within 2 km of the project

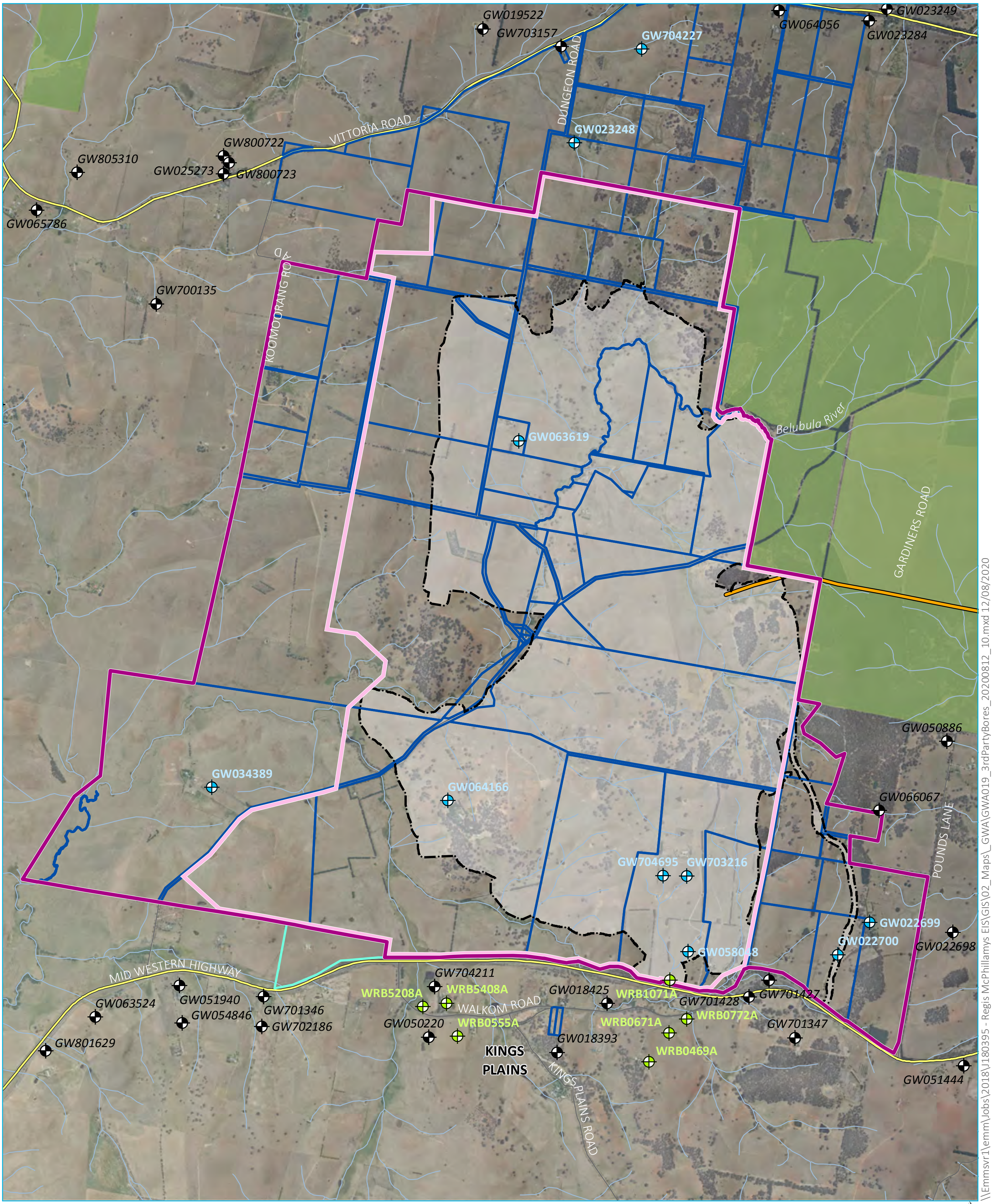
WaterNSW ID	Regis ID	Inferred lithology	Visited as part of Regis census	Landholder	GWL data available?
GW018393	WRB0064A	Byng Volcanics	Yes	Third-party	Yes
GW018425	WRB6208A	Byng Volcanics	Yes	Third-party	Yes
GW019522	-	Anson Formation	No	Third-party	Yes
GW022698	-	Anson Formation	No	Third-party	Yes
GW022699	-	Anson Formation	No	Regis land	Yes
GW022700	-	Anson Formation	No	Regis land	Yes
GW023248	-	Anson Formation	No	Regis land	Yes
GW023249	-	Anson Formation	No	Third-party	Yes
GW023284	-	Anson Formation	No	Third-party	Yes
GW025273	-	Anson Formation	No	Third-party	Yes
GW034389	WRB2535A	Blayney Volcanics	Yes	Regis land	Yes
GW050220	WRB0750A	Blayney Volcanics	Yes	Third-party	Yes
GW050886	-	Anson Formation	No	Third-party	Yes
GW051444	-	Anson Formation	No	Third-party	Yes
GW051940	-	Blayney Volcanics	No	Third-party	Yes
GW054846	-	Blayney Volcanics	No	Third-party	No
GW058048	-	Anson Formation	No	Regis land	No, but near WMB1273A/B
GW063524	-	Blayney Volcanics	No	Third-party	Yes
GW063619	-	Anson Formation	No	Regis land	No, could not locate, thought to be abandoned
GW064056	-	Anson Formation	No	Third-party	Yes
GW064166	WRB2556A	Anson Formation	Yes	Third-party	Yes
GW065786	-	Byng Volcanics	No	Third-party	Yes
GW066067	-	Anson Formation	No	Third-party	No

Table 3.3 Summary of third-party bores within 2 km of the project

WaterNSW ID	Regis ID	Inferred lithology	Visited as part of Regis census	Landholder	GWL data available?
GW700135	-	Byng Volcanics	No	Third-party	Yes
GW701346	-	Blayney Volcanics	No	Third-party	Yes
GW701347	-	Anson Formation	No	Third-party	Yes
GW701427	-	Anson Formation	No	Third-party	Yes
GW701428	-	Anson Formation	No	Third-party	No
GW702186	WRB0340A	Blayney Volcanics	Yes	Third-party	Yes
GW703157	-	Anson Formation	No	Third-party	Yes
GW703216	-	Anson Formation	No	Regis land	No
GW704211	WRB5308A	Blayney Volcanics	Yes	Third-party	Yes
GW704227	LB09	Anson Formation	Yes	Regis land	Yes
GW704695	-	Anson Formation	No	Regis land	Yes
GW800722	-	Anson Formation	No	Third-party	Yes
GW800723	-	Anson Formation	No	Third-party	Yes
GW801629	-	Blayney Volcanics	No	Third-party	Yes
GW805310	-	Byng Volcanics	No	Third-party	No
N/A	WRB0469A	Anson Formation	Yes	Third-party	Yes
N/A	WRB0555A	Blayney Volcanics	Yes	Third-party	Yes
N/A	WRB0671A	Anson Formation	Yes	Third-party	Yes
N/A	WRB0772A	Anson Formation	Yes	Third-party	Yes
N/A	WRB5208A	Blayney Volcanics	Yes	Third-party	Yes
N/A	WRB5408A	Blayney Volcanics	Yes	Third-party	Yes
N/A	WRB1071A	Anson Formation	Yes	Third-party	Yes

The volume of groundwater use in the vicinity of the mine project is estimated to be very low, due to the limited number of bores and the minimal active groundwater licences in the area. The general low yields from bores and reliability of dams is likely the main reasons for the limited reliance on groundwater.

The majority of groundwater bores in the study area are for stock and domestic purposes, with low, infrequent, and unmetered extraction. There are minimal data available regarding pumping rates, bore lithology, or screened interval, and there is limited water level data from landholder bores. Review of the registered bore database indicates the majority of stock and domestic bores drilled in the study area are drilled to the fresh rock contact, accessing groundwater infiltrating through the saprock. This is supported by anecdotal evidence provided by local drillers (per. com. Phil Brown of Competitive Drilling). Discussions with landholders and drillers in the area suggest that most bores are drilled to the top of the fresh rock and either completed as open hole or screened across the contact from weathered to fresh rock.



Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DPE (2018); DFSI (2017); GA (2011)

KEY

Project application area

- ▭ Mine development project area
- ▭ Mining lease application area (Note: boundary offset for clarity)
- ▭ Disturbance footprint
- ━ Pipeline

- ⊕ Registered groundwater monitoring bore located on Regis-owned land
- ⊕ Registered groundwater monitoring bore - other
- ⊕ Other landholder bore
- ▭ Regis-owned property
- ▭ Property under option

Existing environment

- ━ Major road
- — Minor road
- — Watercourse/drainage line
- ■ Vittoria State Forest

Registered bores within 2 km of the mine project area

McPhillamys Gold Project
Groundwater assessment addendum
Figure 3.17

ii Seeps and springs

The conceptual understanding of seeps and springs is discussed in further detail in the Surface Water-Groundwater Interaction Assessment (EMM 2020b), with a summary provided in the following section.

For the purposes of the assessments, six spring categories are introduced to assist with the categorisation of springs identified within the project area and others found in Australia:

1. break of slope seeps/springs;
2. outcrop springs;
3. fault springs;
4. bankflow/lowland pools;
5. basalt springs; and
6. springs in the Great Artesian Basin.

Based on the data collected, the identified springs/seeps have been classified into different spring types. The springs were classified based on the following information:

- water chemistry, with a comparison to groundwater, rainwater and water sampled from the Belubula River;
- observations during the field surveys, including discussions with local landholders;
- topography; and
- inferred geological structures.

The seep/spring types are shown on Figure 3.18 to Figure 3.20. The seep/spring categories of most relevance to the mine development are described below:

- Break of slope seeps/springs are present in more elevated areas, where shallow groundwater moving through the weathered rock intersects (or comes close to) a change/break of slope in the ground surface. The occurrence of the seep or spring is inferred to be due to a relatively rapid change of surface elevation (break of slope) and a reduced thickness of the weathered zone (ie more permeable shallow rock) on top of the more competent (less weathered and lower permeability) rock that results in shallow groundwater intercepting the ground surface.

- Outcrop seeps/springs are similar to break of slope seeps/springs in that they are sourced from shallow groundwater within the weathered rock that discharges to the surface. Outcrop springs are observed where the boundary between higher permeability weathered rock and the lower permeability rock beneath (fresh rock) meet at the side of a hill or cliff. Due to the lower permeability layer below the weathered zone, it is easier for some of the groundwater to flow horizontally within the weathered zone rather than to continue flowing downward into the lower permeability fresh rock. The emerging groundwater forms a damp or wet area at the ground surface, often identified by increased vegetation and grass.

- Fault seeps/springs (or geological structure springs) occur where geological faulting and/or fracturing create weaknesses within the lithology and preferential pathways for groundwater under pressure to flow to the surface (Green et al 2013).

The classification of identified springs and seeps in the area is presented on Figure 3.21 and Figure 3.22.

The following points summarise the spring types identified:

- a little over two thirds of the identified springs are inferred to be break of slope or outcrop type springs, with water sourced from shallow groundwater flow;
- around one quarter are inferred to be fault springs, with water sourced from a combination of shallower and deeper groundwater; and
- one spring area located downstream of the mine project area and in the Belubula River flood plain, is inferred to represent an area where groundwater is shallow (close to ground surface).

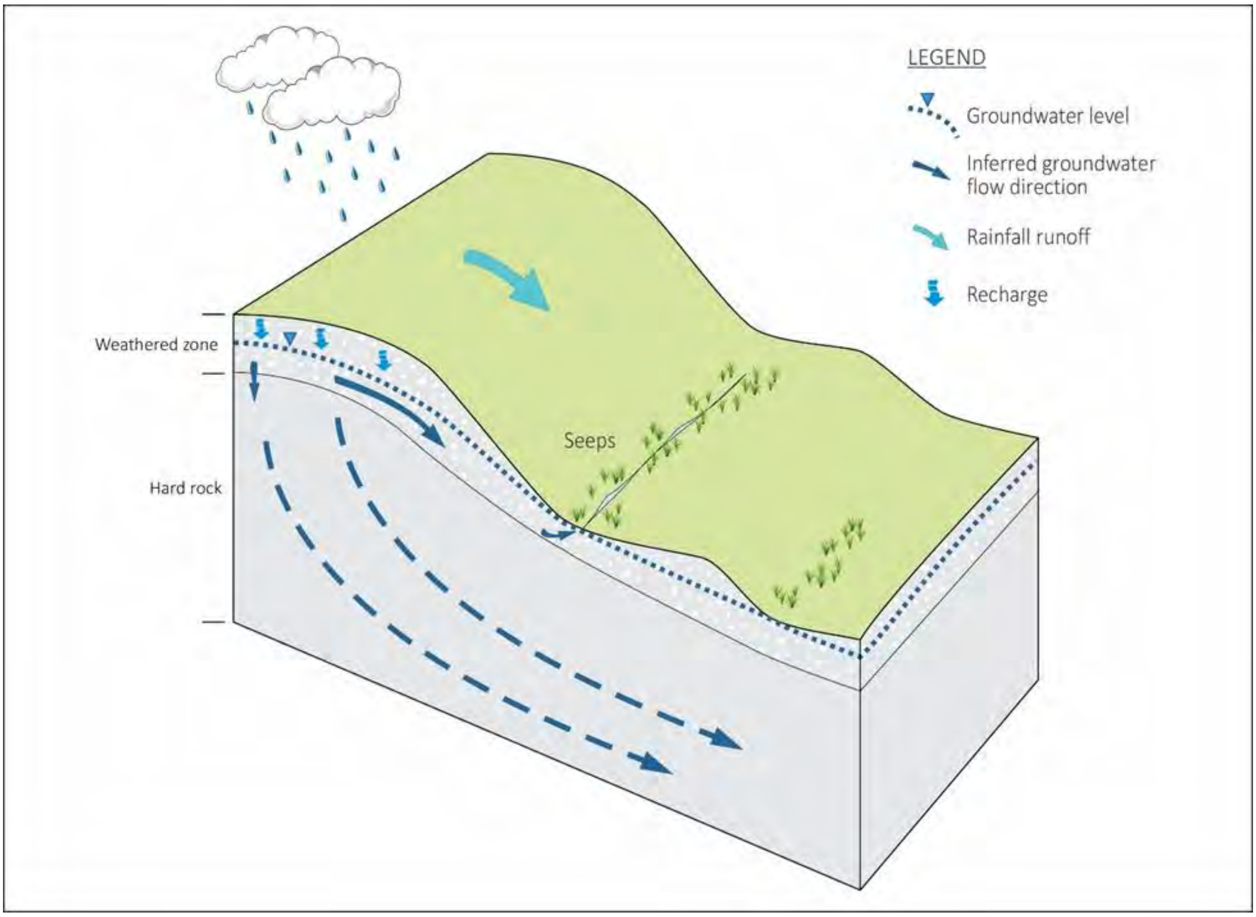


Figure 3.18 Break of slope seep/spring schematic

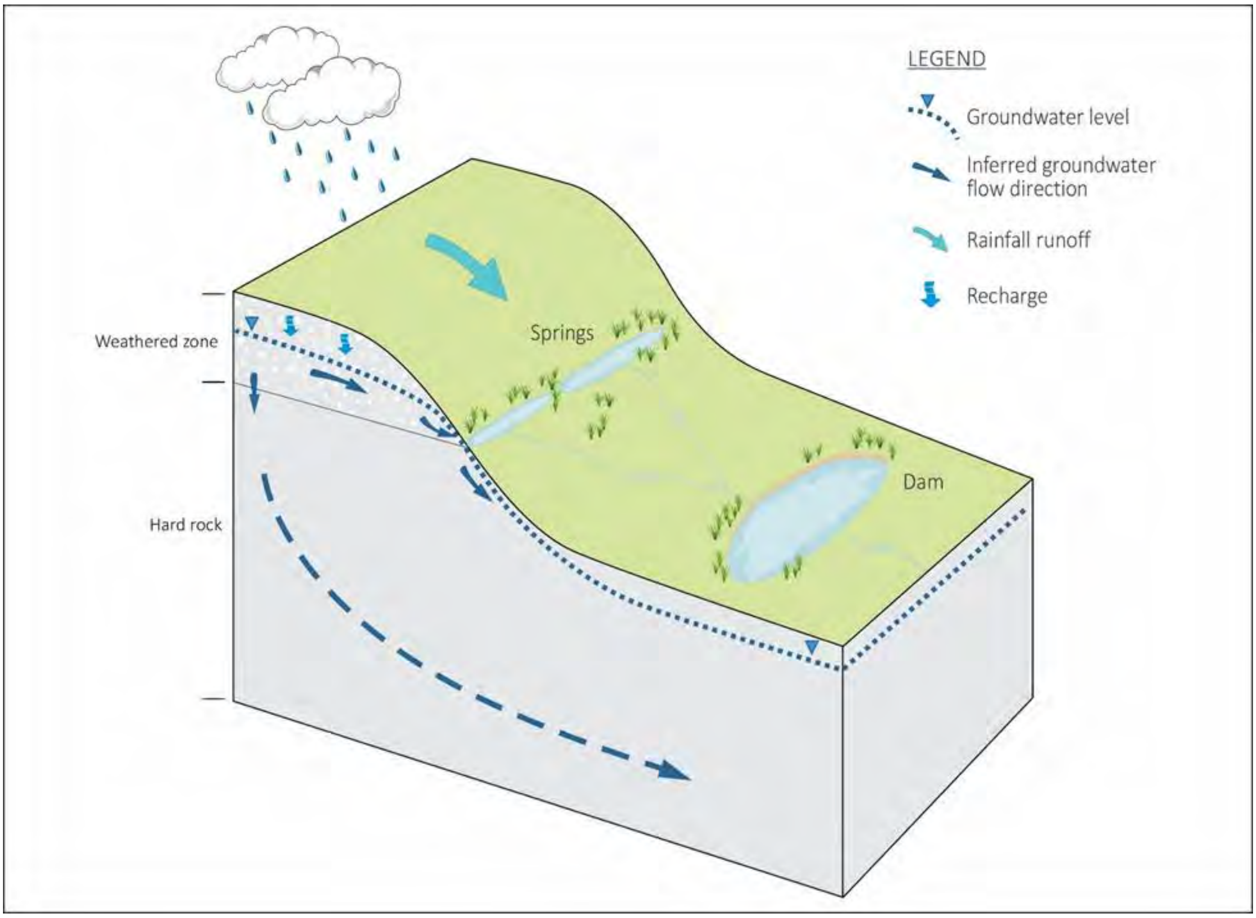


Figure 3.19 Outcrop spring/seep schematic

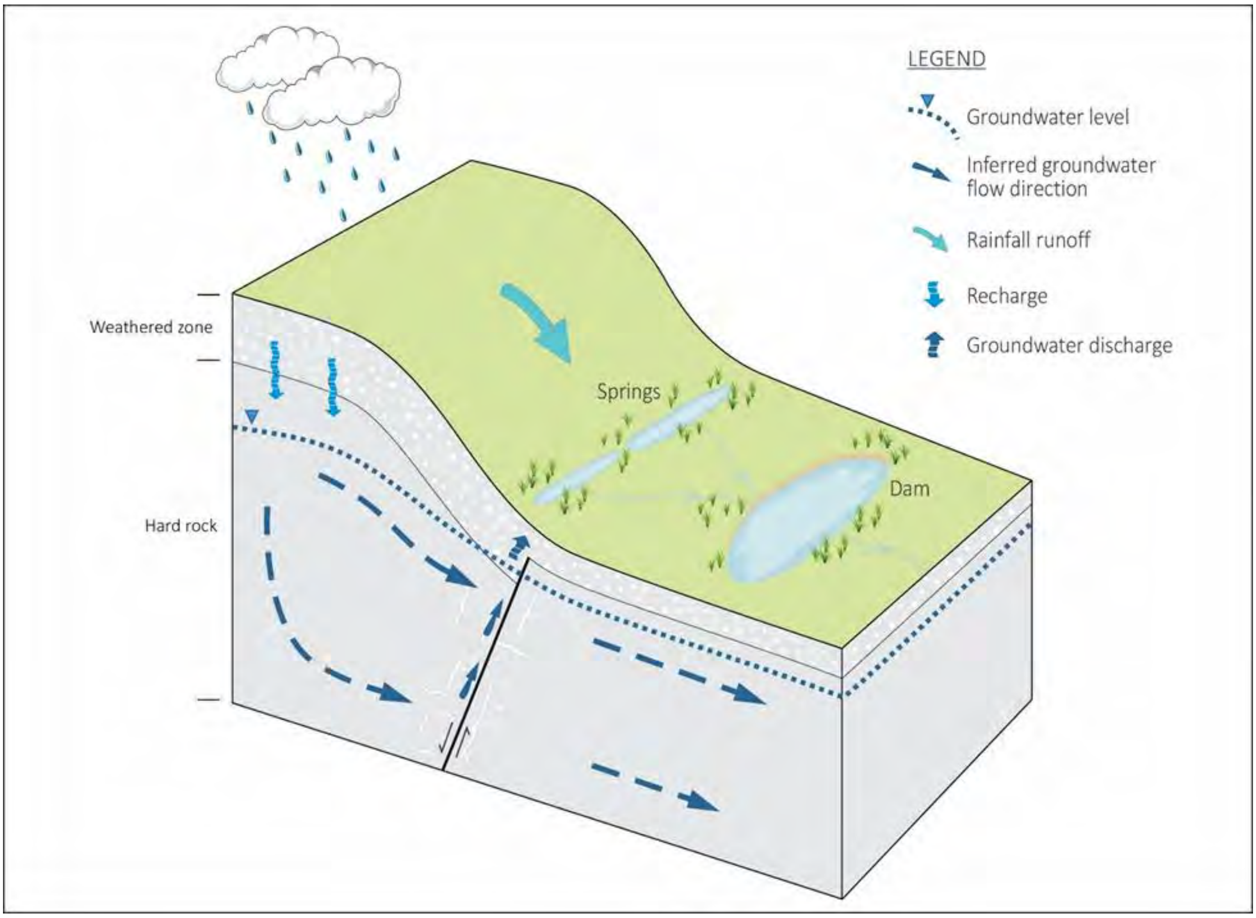
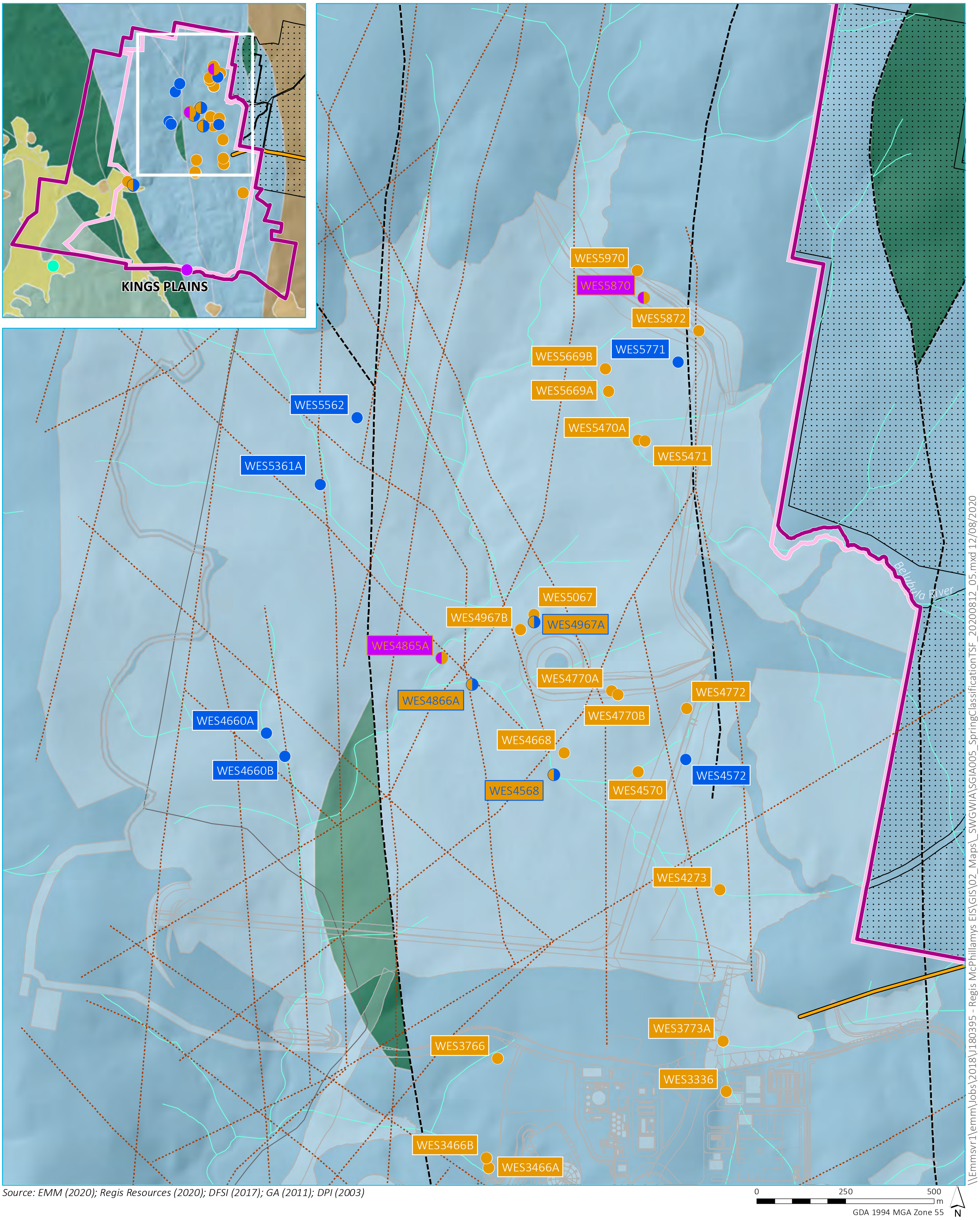


Figure 3.20 Fault spring schematic



Source: EMM (2020); Regis Resources (2020); DFSI (2017); GA (2011); DPI (2003)

KEY

Project application area

▭ Mine development project area

▭ Mining lease application area (Note: boundary offset for clarity)

▭ Project general arrangement

— Pipeline

Existing environment

— Minor road

— Watercourse/drainage line

⁞ Vittoria State Forest

⋯ Interpreted fault

Geology (Bathurst 250k, 2nd Edition)

--- Fault (250k)

Silurian

▭ Mumbil Group (Northwest) - Anson Formation

Ordovician

🟩 Cabonne Group - Byng Volcanics

Inferred spring type

● Fault spring

● Break of slope

● Outcrop spring (refer to inset)

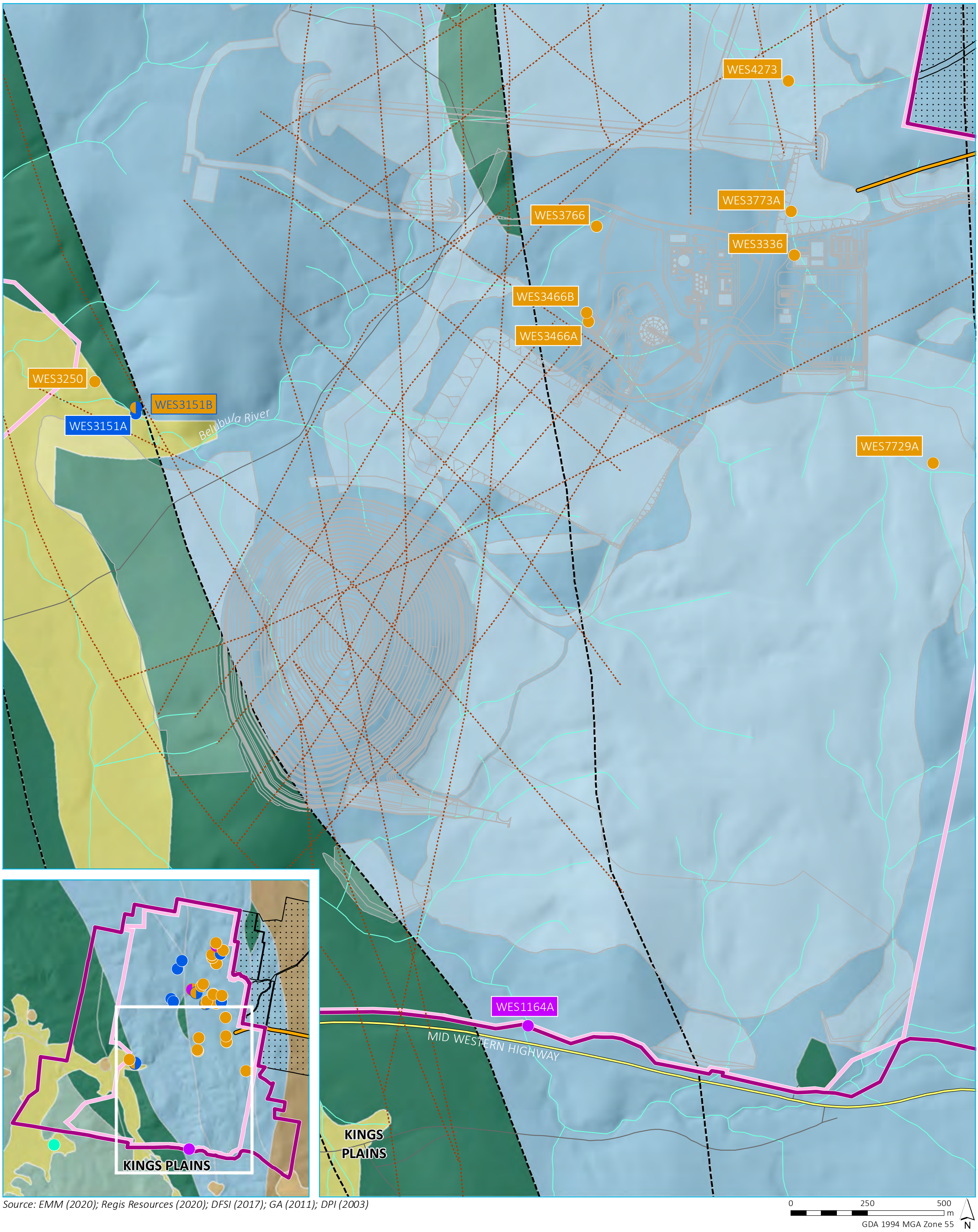
● Lowland pool/shallow groundwater (refer to inset)

● Fault spring or break of slope

● Break of slope or outcrop spring

Spring classification – TSF area

McPhillamys Gold Project
Groundwater assessment addendum
Figure 3.21



Source: EMM (2020); Regis Resources (2020); DFSI (2017); GA (2011); DPI (2003)

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KEY

Project application area

- Mine development project area
- Mining lease application area (Note: boundary offset for clarity)
- Pipeline
- Project general arrangement

Existing environment

- Major road
- Minor road
- Watercourse/drainage line
- Vittoria State Forest

- Interpreted fault

Geology (Bathurst 250k, 2nd Edition)

- Fault (250k)

Quaternary / Tertiary

- Alluvium

Silurian

- Mumbil Group (Northwest) - Anson Formation

Ordovician

- Cabonne Group - Blayney Volcanics
- Cabonne Group - Byng Volcanics

Inferred spring type

- ● Fault spring
- ● Break of slope
- ● Outcrop spring
- ● Lowland pool/shallow groundwater (refer to inset)
- ● Fault spring or break of slope
- ● Break of slope or outcrop spring (refer to inset)

Spring classification - open cut area

McPhillamys Gold Project
Groundwater assessment addendum
Figure 3.22

iii Terrestrial vegetation

Vegetation that is found in the area has attributes that allow resilience and resistance to climate variability, such as being able to cope with low soil moisture levels, reduced water loss during dry periods or being able to access groundwater when the soil water reservoir is depleted. The Biodiversity Assessment (Appendix N of the EIS) documented vegetation mapping conducted in the mine development area. Due to refinements of the project and adjusted approach to the assessment, the Biodiversity Development Assessment Report has been prepared for the project (Appendix M of the Amendment Report). Further information on the methodology for identifying groundwater dependent vegetation and results of the assessment are provided in the Biodiversity Development Assessment Report (Appendix M of the Amendment Report).

The GDE Atlas (BOM 2013) does not show any terrestrial GDEs as occurring in the project area. No high priority GDEs are identified in the *Water Sharing Plan for NSW Murray-Darling Basin Fractured Rock Groundwater Sources 2020*. Although terrestrial GDEs are not predicted to occur in the project area, the Biodiversity Development Assessment Report has identified the following PCT as an opportunistic user of groundwater during times of low rainfall:

- Mountain Gum –Manna Gum open forest of the South Eastern Highlands Bioregion (PCT 951); and
- Yellow Box – Blakely’s Red Gum grassy woodland on the tablelands, South Eastern Highlands Bioregion (PCT 1330).

These PCTs are thought to use groundwater where available but can exist without its presence. They are thought to have a greater reliance on groundwater during times of prolonged drought. The mapped occurrence of the PCTs in the mine project area is shown on Figure 3.23.

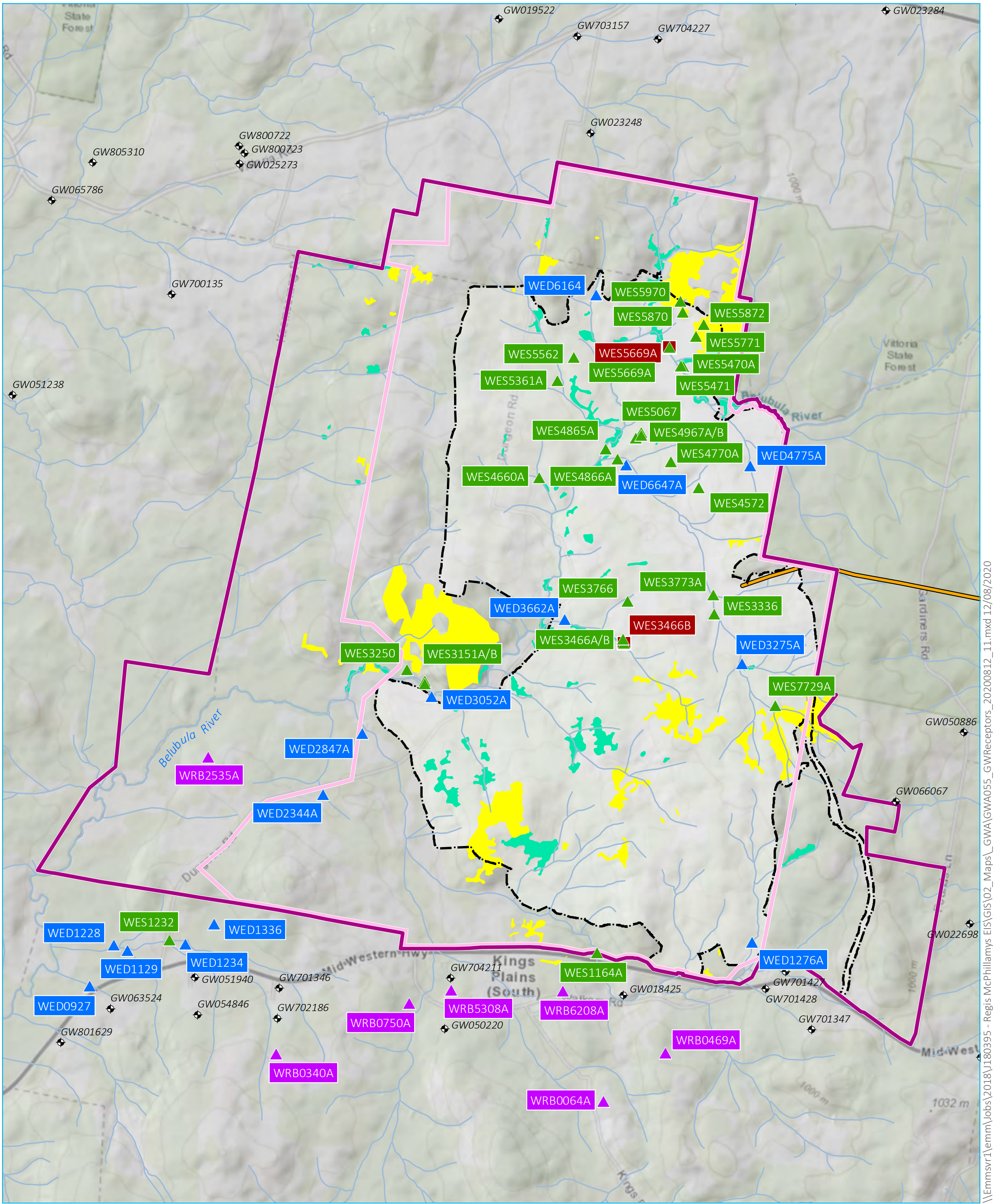
iv Subterranean fauna

As presented in the Groundwater Assessment (EMM 2019a), a subterranean fauna assessment was conducted in 2017. The survey included sampling at 13 bores, five stream sites and five spring/seep sites in and adjacent to the area of the proposed operations. The only sites that recorded fauna were the spring/seep sites. The surveyed springs contain depauperate fauna (fauna lacking species and found in similar habitats elsewhere) consisting predominately of surface macroinvertebrate taxa. A small number of macroinvertebrate fauna (Amphipoda and Copepoda crustaceans and worms) that were identified may be dependent on groundwater discharge. No listed threatened species were collected.

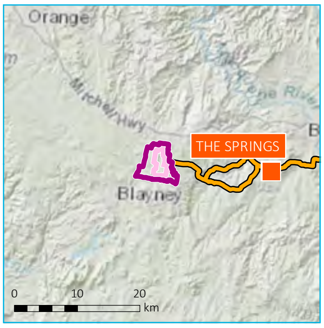
The low diversity and low abundance of the identified macroinvertebrate fauna may be influenced by the small, ephemeral, and disconnected nature of the riverine hyporheic zone habitats and the fine-grained nature of the sediments. The ecological value of springs WES5669A and WES3466B were classified as high, due to the diversity of the identified macroinvertebrate fauna. The fauna found in the springs occur within the surface waters of the springs but may be dependent on groundwater discharge, however the fauna were not identified in the bores sampled. The ecological value of springs WES7729A, WES1164A and WES3151 are considered low due to the impacted nature of the habitat and the low number of disturbance tolerant taxa identified.

As there are no stygofauna identified by the surveys in the mine project area, drawdown induced by mining will not affect stygofauna or their habitats. However, springs WES5669A and WES3466B are located under project infrastructure, including the TSF (WES5569A) and as such the habitat will be impacted. As shown on Figure 3.21 and discussed in the Surface Water – Groundwater Interaction Assessment (EMM 2020b), WES5669A is classified as an ephemeral break of slope spring, and WES3466B is classified as a break of slope spring.

The locations of WES5669A and WES3466B, as potential groundwater receptors (from an ecological perspective) are shown on Figure 3.23).



Source: EMM (2020); Regis Resources (2020); ESRI (2020); DPE (2015); ELVIS (2014)



KEY

- ⊕ Registered bore - not monitored
- 🟧 High-priority GDE (refer to inset)
- ▲ Dam
- ▲ Spring
- ▲ Groundwater
- ■ Stygofauna sample location
- — Watercourse/drainage line
- 🟩 PCT 951 | Mountain Gum - Manna Gum open forest of the South Eastern Highlands Bioregion
- 🟨 PCT 1330 | Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands Bioregion

Project application area

- ▭ Mine development project area
- ▭ Mining lease application area (Note: boundary offset for clarity)
- ▭ Disturbance footprint
- — Pipeline

Potential groundwater receptors

McPhillamys Gold Project
Groundwater assessment addendum
Figure 3.23

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4 Conceptual model

The conceptual hydrogeological model for the project has been developed based on the information presented in in the Groundwater Assessment (EMM 2019a), Surface Water-Groundwater Interaction Assessment (EMM 2020b) and Sections 2 and 3 of this report. Figure 4.1 presents a schematic of the conceptual model under existing conditions. The conceptual understanding presented in this section is consistent with the understanding presented in the Groundwater Assessment (EMM 2019a) for the EIS. Where the conceptual understanding has been refined or adjusted as a result of the work completed as part of this assessment, it has been highlighted with a border around the next.

The following describes the key elements of the model that are important in consideration of the potential effects of mining on groundwater resources and connected systems:

- Recharge to regional groundwater occurs as:
  - infiltration of rainfall, with higher rates expected where alluvium is present. Rainfall recharge is estimated to be between 2 to 8% of annual average rainfall;
  - leakage from the Belubula River and tributaries during periods of high stream flow; and
  - downward leakage from the overlying saprock and alluvium (where present) recharging the fractured rock system.
- Discharge from groundwater occurs as:
  - evapotranspiration;
  - spring flow and baseflow to streams/surface features; and
  - extraction from bores.
- Evapotranspiration occurs within the unsaturated or soil zone and can also occur where the watertable is sufficiently close to the surface for vegetation to access groundwater and from watercourse pools where the streambed intersects the watertable. Annual potential evaporation exceeds rainfall and is around 1,339 mm/year (SILO).
- The watertable is typically hosted in the saprock or alluvium (where present) and is generally a subdued reflection of topography, with depth to groundwater typically 10 to 15 m from ground surface.
- Groundwater flow is influenced by topography and surface drainage with several watersheds in the study area (refer Figure 3.6). Groundwater flows regionally from north-east to south-west along the Belubula catchment. The dominant groundwater flow direction is horizontal, with minor downward (vertical) flow between HSUs.
- The volcanics and metasediments in the mine project area weather to a clay-like material. The saprock zone ranges from 5 to 80 m in thickness.
- The Godolphin Fault defines the contact between the Byng Volcanics and the Anson Formation.
- Bore yields in the area are generally low (<5 L/s), which supports the observation that local groundwater systems have low permeability and groundwater use in the area is limited to stock and domestic supplies.

- Observations during drilling investigations completed for the project have generally found that where fracturing occurs, the fractures generally become clay filled and generally do not act as conduits for groundwater flow. However, there are areas north of the open cut where fracturing has enhanced permeability and reasonable bore yields (2 to 10 L/s) can be achieved. These areas have been targeted for the development of a construction water supply (refer Section 6.3).

- The hydraulic conductivity of the Byng Volcanics is lower than the Anson Formation and therefore will transmit water at a slower rate than the Anson Formation. While there are areas where geological structures may have enhanced permeability, the bulk hydraulic conductivity of the fresh volcanics and metasediments is very low, as seen in the hydraulic testing and observations at Newcrest's Cadia operation.

- Tributaries in the upper reaches of the Belubula River (upstream of Trib E) are dry most of the year and are not in hydraulic connection with the watertable.

- Rainfall and runoff are the main contributing sources of water to the Belubula River flows.

- Groundwater is inferred to discharge to Trib A, contributing around 5% to overall flows along that section of the watercourse.

- Downstream of the mine project area and the Mid Western Highway, groundwater is inferred to discharge to the Belubula River, contributing around 20% to overall flows in the watercourse.

- Springs and seeps are present across the study area. Most springs in the mine project area are associated with areas where the topographic gradient changes abruptly and intercepts shallow groundwater flow. Many of these springs and seeps have been excavated into dams to increase water access for stock. Whilst some springs do contribute flow to the Belubula River, a large amount of the discharging groundwater will evaporate, be used by vegetation or for stock and domestic purposes.

LEGEND

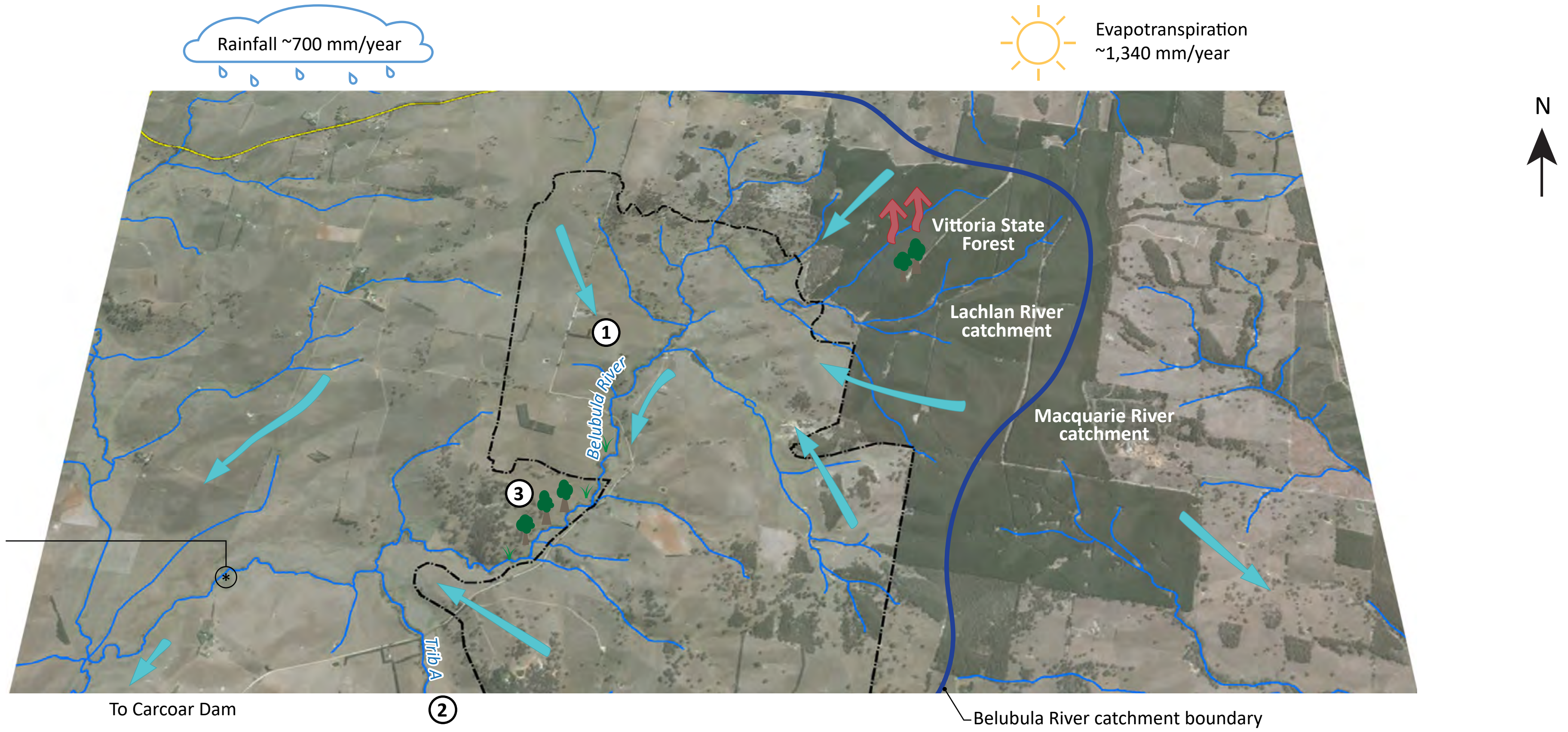
- 🟨 Alluvium
- 🟩 Byng volcanics
- 🟩 Blayney Volcanics
- 🟪 Anson Formation
- 🟪 Cunningham Formation
- ⬛ Carbonaceous alteration
- 🟫 Tertiary basalt
- ⬚ Weathered zone
- -·-·- Disturbance boundary
- ------ Geological structure
- ↙ Inferred groundwater flow direction
- ↙ Rainfall runoff/surface water flow
- ↑ Evapotranspiration
- ↓ Rainfall recharge
- ~ Watercourse
- ▼ Watertable
- = Main road
- ⇄ Fault directional movement

1. The catchment area of the upper reaches of the Belubula River (above the confluence with Trib A) is 17.5 km².
2. Trib A-B catchment area is 24.4 km².
3. PCT 951 Mountain Gum – Manna Gum, PCT 1330 Yellow Box – Blakely's Red Gum grassy woodland are opportunistic users of groundwater during periods of prolonged drought.
4. Tributaries in upper Belubula River catchment are dry most of the year and are not connected to the watertable.
5. At the lower reaches of the Belubula River and Trib A, groundwater discharges to the watercourse.
6. The bulk hydraulic conductivity of the Byng Volcanics is lower than the Anson Formation and therefore will transmit water at a slower rate than the Anson Formation. The bulk hydraulic conductivity of the fresh volcanics and metasediments is very low, as seen in the core testing and observations at Newcrest's Cadia operations.

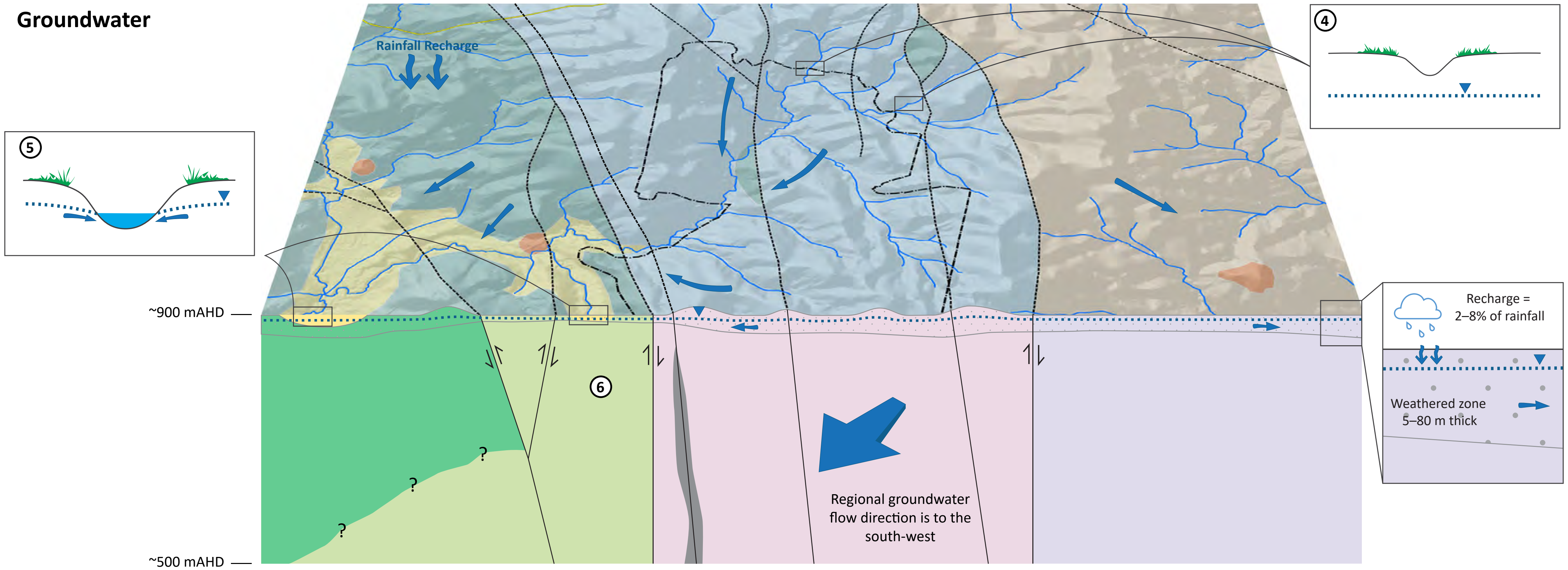
NOT TO SCALE

Surface Water

- At Carcoar dam, surface flows are usually >1,574 ML/year (95% of the time).
- At the Mid Western Highway (station 412104), surface flows are usually >764 ML/year (95% of the time).
- At the proposed downstream gauging station, surface flows are usually >300 ML/year (95% of the time).



Groundwater



Regional conceptual hydrology and hydrogeological model – existing conditions

Regis Resources
Groundwater Assessment Addendum
Figure 4.1

5 Impact assessment methods

5.1 Approach

As outlined in Section 2.4, the following features of the project have the greatest potential to have an effect on groundwater resources:

- the open cut mine;
- TSF; and
- construction water demand.

Due to the spatial scale and duration of the open cut and TSF, and the complexity inherent in the hydrogeology and geometry across multiple HSUs in the area, a numerical groundwater flow model was developed for the project. This model formed part of the Groundwater Assessment (EMM 2019a) prepared for the EIS to assess the potential impacts of the open cut and TSF.

DPIE engaged JBS&G to conduct a review of the Groundwater Assessment completed for the EIS (EMM 2019a). Consultation between DPIE, JBS&G, Regis, EMM and HydroGeoLogic personnel occurred in late 2019 and early 2020 to discuss the findings of the review and agree a path forward to respond to the queries raised. Additional work was conducted to respond to and close out the queries raised by JSB&G and included:

- conducting additional sensitivity analysis;
- providing additional information regarding selected boundary conditions, model extent and predictive uncertainty; and
- conducting additional scenarios to further assess predictive uncertainty.

EMM and Regis' response to the review conducted by JBS&G is provided in Appendix C. The additional work completed provides further confidence in the model results (including uncertainty analysis) and confirms that the Groundwater Assessment completed for the EIS (EMM 2019a) adequately assessed the potential risk of the project on landholders and other sensitive receptors.

The groundwater model development, calibration, calibration sensitivity analysis, predictions and uncertainty analysis completed as part of the Groundwater Assessment for the EIS (EMM 2019a) are fit for purpose (as confirmed by the third-party reviewer, HydroGeoLogic) and, as such, the groundwater modelling approach has not been revised for the amended project.

The groundwater model has been updated to assess the potential impacts of the amended project on groundwater resources, which specifically includes:

- the refined mine schedule, which has resulted in a more gradual rate of mining and a slightly longer mine life (approximately 11 years compared to 10 years), with the peak mined volume to occur in year 6 (compared to year 2 in the previous mine plan);
- updated design of the pit shell, which has resulted in a slightly shallower final pit elevation and smaller overall pit shell in comparison to the previous mine plan; and
- the revised TSF schedule, which has resulted in a more gradual rate of rise for the TSF.

This section provides an update on impact assessment methods, including the construction water supply.

The following information is re-presented in this addendum report to assist the reader, however for the majority of the items listed, the methodology in the groundwater model has not changed since the EIS (EMM 2019a):

- model class;
- groundwater model domain;
- model layers;
- boundary conditions (minor adjustments have been made to reflect the revised mine and TSF schedule);
- history match (also referred to as calibration); and
- summary of calibration sensitivity (additional analysis has been completed since the EIS to respond to queries raised by DPIE's technical reviewer (JBS&G)).

Note that reductions in surface water flows as a result of the project have been assessed primarily as part of the Revised Surface Water Assessment (HEC 2020). Notwithstanding, the points below summarise how changes to surface water flows have been assessed:

- changes in surface water flow as a result of a reduction in catchment area (due to project development) has been assessed in the Revised Surface Water Assessment (HEC 2020);
- predicted changes in groundwater discharge to watercourses (baseflow) and river leakage to groundwater has been assessed in this assessment;
- in the project area (area of influence), perennial and ephemeral watercourses have been simulated for this assessment (see Section 5.3.2vb); and
- outside of the mine project area, only perennial watercourses are simulated for this assessment, as when surface water flows in these watercourses, leakage from the (losing) watercourses is already occurring at the maximum rate (governed by the head of the water column in the watercourse).

5.2 Assessment criteria

5.2.1 Groundwater levels and flow

The predicted impacts of the activities affecting groundwater resources (and associated receptors) has been assessed against the minimal impact thresholds defined in the AIP. Impacts to groundwater are assessed via the consideration of high priority GDEs, high priority culturally significant sites, and third-party bores. This assessment criteria has not changed since the Groundwater Assessment (EMM 2019a) completed for the EIS.

The AIP classifies groundwater sources into 'highly productive' or 'less productive' based on the yield (>5 L/s for highly productive) and water quality (<1,500 mg/L TDS for highly productive). Thresholds are set in the AIP for the different groundwater sources for the different minimal impact considerations. Based on DPIE Water's mapped areas of groundwater productivity in NSW (DPI Water 2012), the project is within a 'less productive' porous and fractured rock source. The applicable minimal impact considerations are listed in Table 5.1.

Table 5.1 Minimal impact criteria for 'less productive' porous rock water source

Impact level	Watertable	Water pressure	Water quality
Level 1 impact (ie less than minimal)	1. Less than or equal to 10% cumulative variation in the watertable, allowing for typical climatic 'post-WSP' variations, 40 m from any: a) high priority GDE; or b) high priority culturally significant site; listed in the schedule of the relevant WSP. A maximum of a 2 m decline cumulatively at any water supply work.	1. A cumulative pressure head decline of not more than 2 m, at any water supply work.	1. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.
Level 2 impact (ie greater than minimal)	2. If more than 10% cumulative variation in the watertable, allowing for typical climatic 'post-WSP' variations, 40 m from any: a) high priority GDE; or b) high priority culturally significant site; listed in the schedule of the relevant WSP then appropriate studies[2] (including the hydrogeology, ecological condition and cultural function) will need to demonstrate to the Minister's satisfaction that the variation will not prevent the long-term viability of the dependent ecosystem or significant site. If more than a 2 m decline cumulatively at any water supply work then make good provisions should apply.	2. If the predicted pressure head decline is greater than requirement 1 above, then appropriate studies[2] are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long-term viability of the affected water supply works unless make good provisions apply.	2. If condition 1 is not met then appropriate studies[2] will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.

Source: AIP DPI Water 2012.

Notes:

1. 'post-WSP'– refers to the period after the first WSP in the water source begins, including the highest pressure head (allowing for typical climatic variations) within the first year after the first WSP begins.
2. 'Appropriate studies' on the potential impacts of watertable changes greater than 10% are to include an identification of the extent and location of the asset, the predicted range of watertable changes at the asset due to the activity, the groundwater interaction processes that affect the asset, the reliance of the asset on groundwater, the condition and resilience of the asset in relation to watertable changes and the long-term state of the asset due to these changes.
3. All cumulative impacts are to be based on the combined impacts of all 'post-WSP' activities within the water source.

5.2.2 Groundwater quality

As reported in the EIS (EMM 2019c), the project has been assessed to have the potential for groundwater quality changes as a result of:

1. spills from hazardous materials contained on site;
2. spills from the operational water management system;
3. un-intercepted runoff from areas requiring erosion and sediment control treatment prior to flowing offsite (ie topsoil stockpiles);
4. seepage from the TSF to the watertable and the Belubula River;
5. seepage from the waste rock emplacement (including AMD risk), water management facilities, or runoff from the ROM Pad to the watertable;

6. introduction of varying water quality via the water supply pipeline; and

7. production of brine from an onsite Reverse Osmosis (RO) plant.

Potential impacts to groundwater quality associated with the first four hazards (number 1 to 3) in the list above will be suitably managed through implementing a project-specific environmental management plan and through design controls.

Hazards number 5, 6 and 7 have been assessed in the Groundwater Assessment (EMM 2019a) and EIS (2019c) and as those aspects of the project have not changed, they are not re-presented in this assessment addendum. The potential impacts of seepage from the TSF was also assessed in the Groundwater Assessment (EMM 2019a), however as the TSF schedule has been adjusted for the amended project, this assessment has been revisited and is included in this report.

Criteria for assessing impacts to water quality is the deviation from baseline quality, altering the beneficial use category of the water source (consistent with the AIP and WM Act 2000) and assessment against the Australian and New Zealand Guidelines for Fresh and Marine Water Quality and Livestock Drinking Water (ANZECC & ARMCANZ 2000).

5.3 Numerical groundwater flow model

5.3.1 Model objectives

The key objectives of the McPhillamys Groundwater Assessment numerical model are to:

- implement the conceptual hydrogeological model;
- predict the likely extent and magnitude of groundwater drawdown induced by mine dewatering and closure;
- predict changes to availability of groundwater for receptors surrounding the project;
- predict potential changes to groundwater flow as a result of the TSF during operations and post-mining;
- provide information for the assessment of potential TSF impacts on groundwater quality; and
- inform the site wide water balance.

5.3.2 Groundwater model design and development

i Model class

In the Groundwater Assessment (Section 5.4.2i; EMM 2019a), EMM presented the groundwater model, overall, as being consistent with a Class 1 model as described in the Australian Groundwater Modelling Guidelines (Barnett et al, 2012). The guidelines suggest potential uses for a Class 1 model include:

- predicting long-term impacts of proposed developments in low value aquifers;
- estimating impacts of low-risk developments; and
- understanding groundwater flow processes under various hypothetical conditions.

The third-party reviewer (HydroGeoLogic) determined that the groundwater model has a confidence level of Class 1 with elements of Class 2 (and Class 3) and that it is suitable for impact assessment scenario modelling purposes (see EMM 2019a and Appendix C).

EMM is aware that there is an initiative in progress to refine the modelling guidelines, specifically in relation to the qualitative model confidence level classification. It is understood that the guideline refinements will reaffirm that the classification simply considers the data available, conceptualisation, calibration process and model performance, and that the classification was intended for cases where a predictive uncertainty analysis had not been conducted. The guideline revision is designed to correct the currently common misapplication of the 'target model confidence level' as erroneously 'the higher the better'. For this project, a predictive uncertainty was carried out and the scenarios demonstrate that there is a low risk of an unwanted outcome in terms of potentially unacceptable water-related impacts, consistent with guideline principles.

The groundwater model is deemed fit for purpose by EMM and HydroGeoLogic, given the low productive aquifer and low risk context. The uncertainty analysis (see Groundwater Assessment (EMM 2019a) and Appendix C) has been designed with a wide range of parameter values to account for the low coverage of calibration data and to assess potential impacts of the project.

ii Model domain

The model domain remains unchanged from the Groundwater Assessment (EMM 2019a) and covers a square domain of 20 km by 20 km, centred on the mine project area and with origin at GDA coordinates 705,605 mE, 6,281,922 mN (Zone 55). The domain size was selected to be large enough to:

- encompass all of the identified sensitive receptors;
- include the main hydrogeological boundary conditions influencing groundwater flow; and
- encompass changes to the groundwater system in relation to mine dewatering and tailings seepage.

Model cells are spaced at 200 m regionally and refined to 25 m in the mine project area and for all identified watercourses. The model domain is bounded by general head inflow and outflow boundaries with defined heads of 10 m below surface elevation. The model boundaries are broadly at a lower elevation than the mine project area.

The mine project area is at a local topographic high, located at the headwaters of the Belubula River. The model was calibrated in steady state mode such that it produces results representing pre-mining groundwater flow conditions. The model domain and grid are presented in Figure 5.1.

iii Model layers

A summary of the model layers and zones used to represent hydraulic properties, as presented in the Groundwater Assessment (EMM 2019a), is provided in Table 5.2 and presented in Figure 5.2 and Figure 5.3.

Table 5.2 Model layer and zone summary

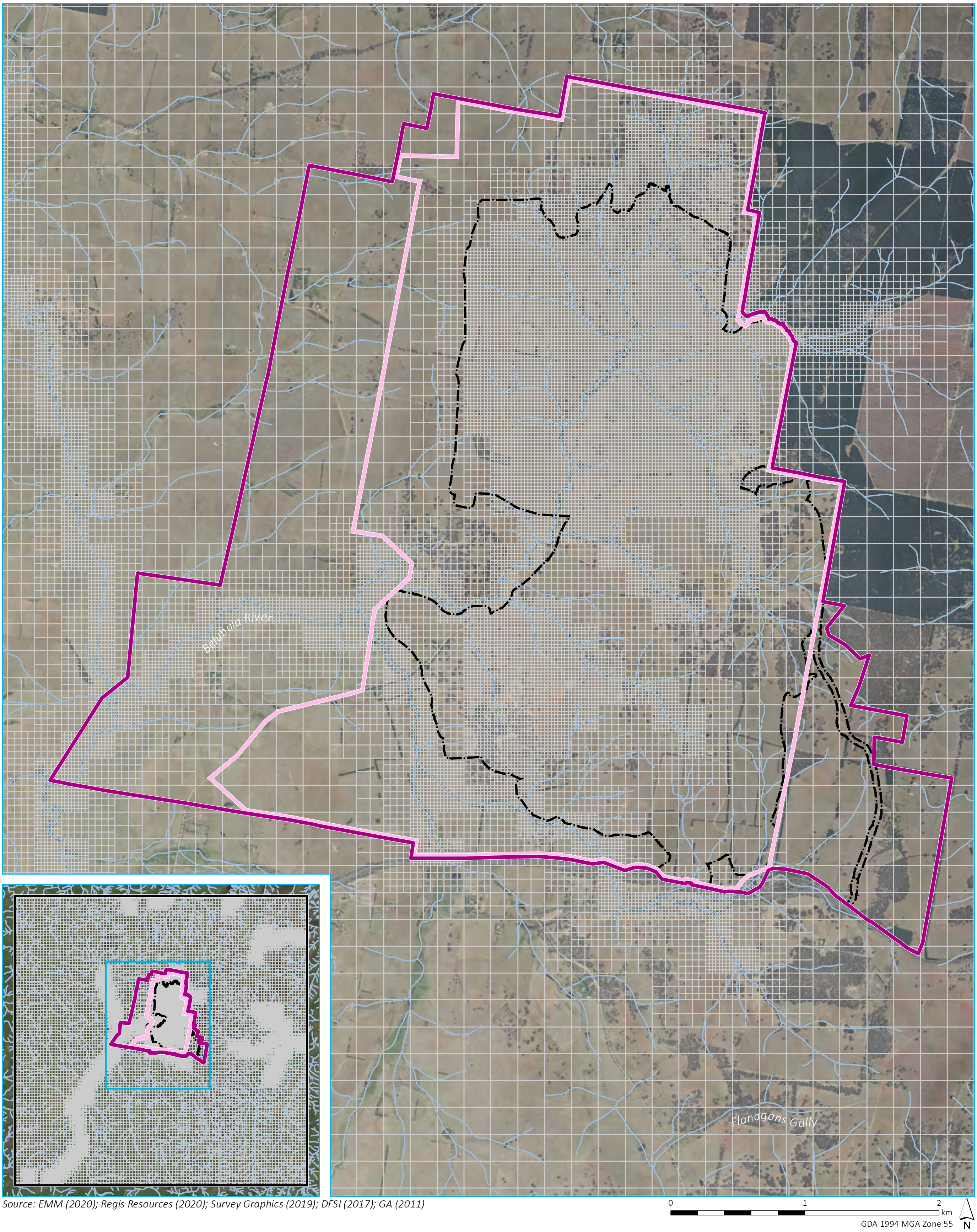
Layer	Zone [1]	Description
1	1	Alluvium
	2	Orange Basalt
	3	Carbonaceous alteration within the Anson Formation (not visible on Figure 5.2)
	4	Byng Volcanics (saprock)
	5	Anson Formation (saprock)
	6	Cunningham Formation (saprock)
	7	Blayney Volcanics (saprock)
2-9	8	Byng Volcanics (fresh)
	9	Anson Formation (fresh)
	10	Cunningham Formation (fresh)
	11	Blayney Volcanics (fresh)

Note: 1. The zoning is generally based on HSU.

The fresh rock layer elevation used in the model has been derived from the geological model, which has been informed by Regis drilling data.

EMM adopted a simple two-layer (with depth) approach to the groundwater model based on the level of detailed data available to indicate various transition zones with depth. It is again noted that regional scale groundwater flow systems are sensitive to and depend on average values of hydrogeological properties.

In terms of structural geology, the main interest and greatest significance to the project, is the Godolphin Fault, which separates the Anson Formation in the east from the Byng Volcanics in the west. In addition, there have also been a number of smaller structures inferred by Regis within the proposed mine footprint. Drilling in the mine project area has indicated these structures have resulted in highly weathered zones with high clay content and low hydraulic conductivity, and generally define the contacts between the lithological units. As discussed in Section 5.4.2iv of the Groundwater Assessment (EMM 2019a), geology is defined within each model layer as zones (or HSUs) and uniform properties are applied across each HSU.



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Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DFSI (2017); GA (2011)

KEY

▭ Model boundary

▭ Model grid

Project application area

▭ Mine development project area

▭ Mining lease application area (Note: boundary offset for clarity)

▭ Disturbance footprint

— Watercourse/drainage line

Model domain and grid

McPhillamys Gold Project
Groundwater assessment addendum
Figure 5.1

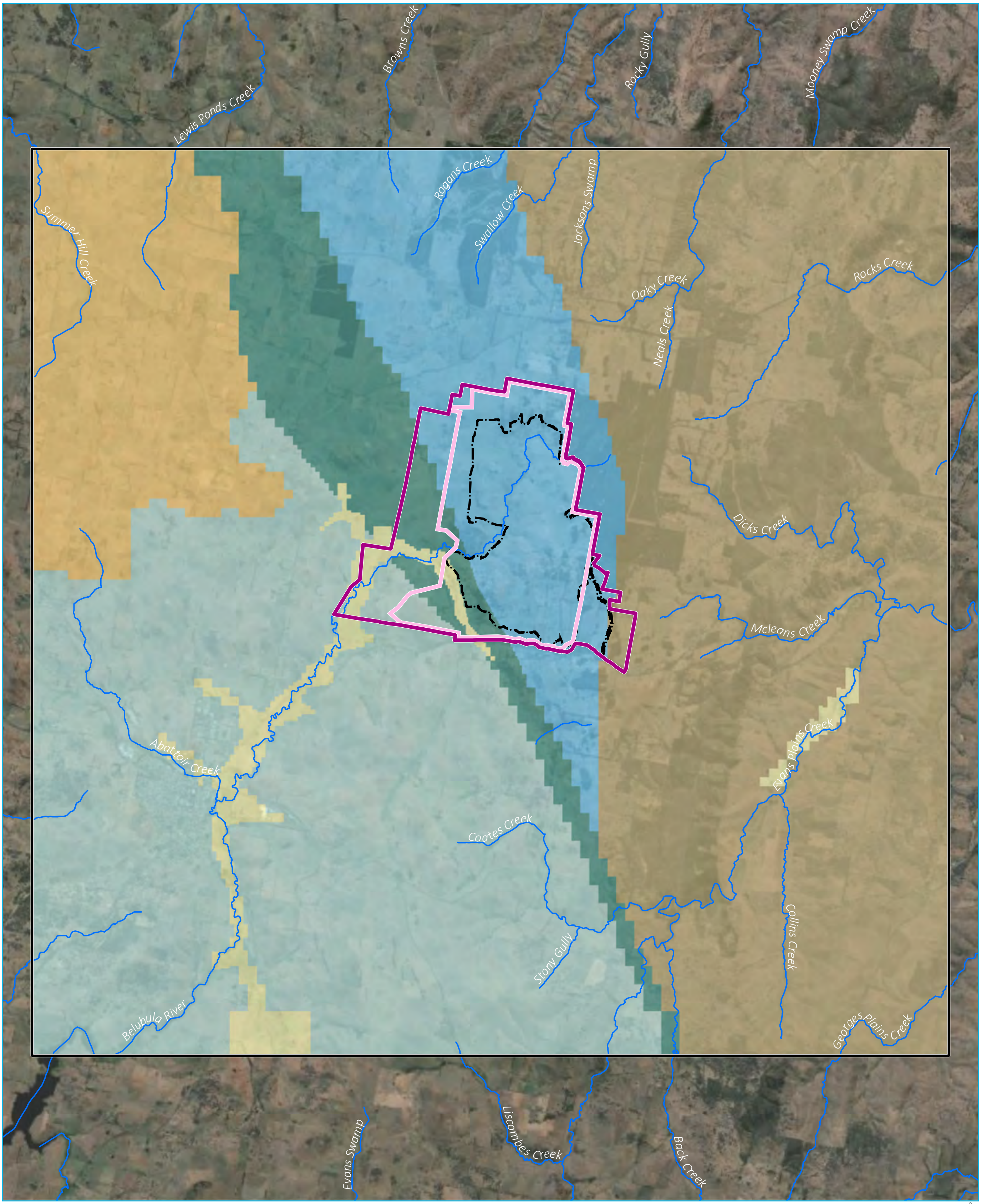
Sub-HSU-scale heterogeneity and faulting are not specifically simulated but have been considered as follows:

- the geological units are vertically dipping and lateral changes in hydrogeological properties between units is captured via the zonation employed in the model;
- the separation of the Anson Formation from the Byng Volcanics is used to represent the influence of the Godolphin Fault; and
- heterogeneity associated with weathering is represented by the upper layer in the groundwater model.

The following points provide additional justification for not explicitly simulating structures in the groundwater model:

- faults and intrusions can operate as both barriers and conduits to flow on a local scale; however, at a regional scale faults and fractures rarely influence groundwater flow in a significant way;
- regional scale groundwater flow systems are sensitive to and depend on average values of hydrogeological properties; and
- the equivalent porous medium approach has been adopted for this impact assessment model. That is, at a regional scale and the scale of this project, groundwater flow is consistent with porous media.

In addition, the uncertainty analysis conducted as part of the Groundwater Assessment (EMM 2019a) analysed a wide range of hydraulic properties for the fresh rock units, individually and grouped. Further discussion on the uncertainty analysis is provided in the Groundwater Assessment completed for the EIS (EMM 2019a) and Appendix C.



Source: EMM (2020); Regis Resources (2020); ESRI (2020); DFSI (2017); GA (2011)

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KEY

Project application area

▭ Mine development project area

▭ Mining lease application area (Note: boundary offset for clarity)

▭ Disturbance footprint

— Named watercourse

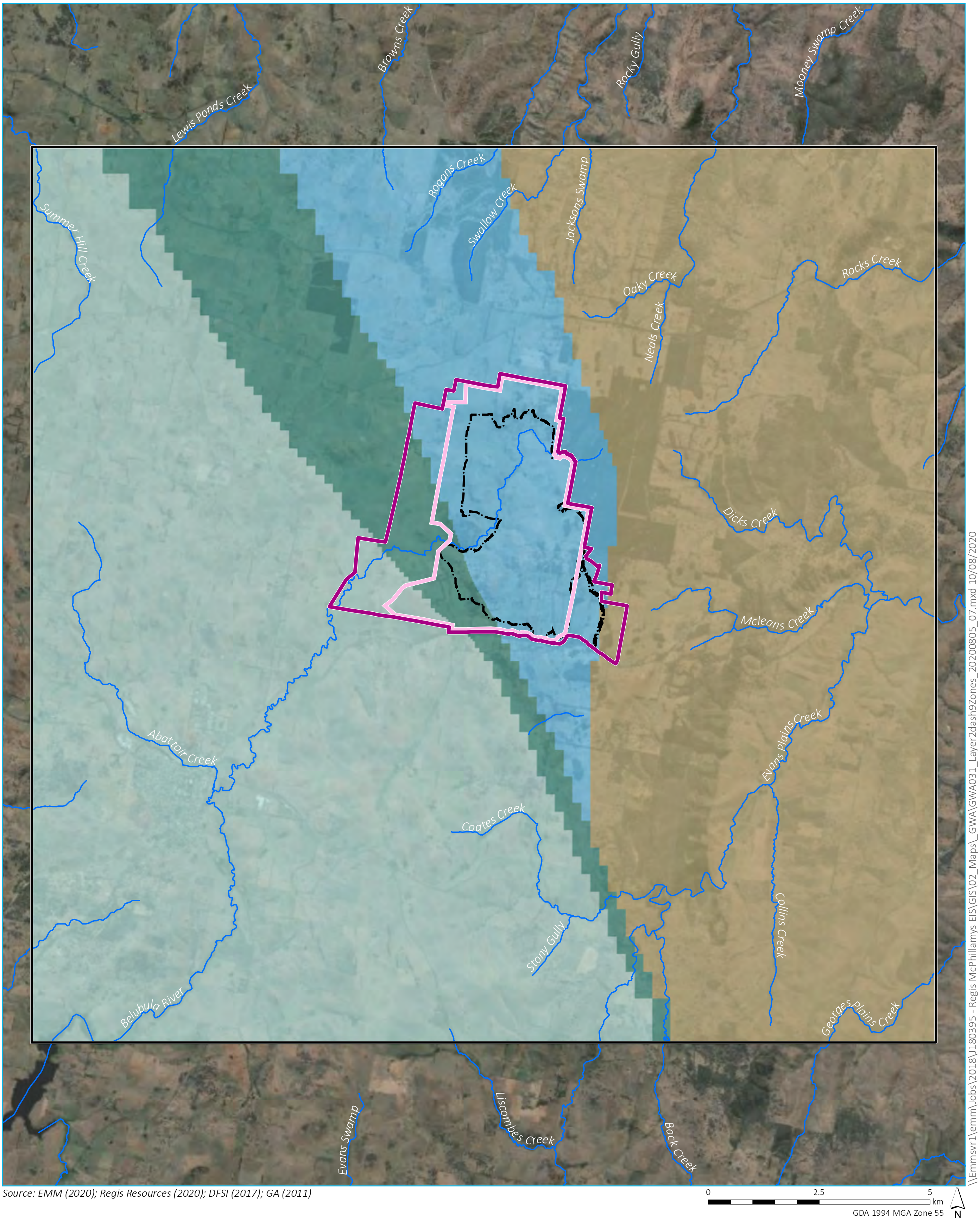
▭ Model boundary

Hydraulic property zones - Layer 1

- 🟨 1 - Alluvium
- 🟧 2 - Orange basalt
- 🟩 4 - Byng Volcanics (saprock)
- 🟦 5 - Anson Formation (saprock)
- 🟫 6 - Cunningham Formation (saprock)
- ⬜ 7 - Blayney Volcanics (saprock)

Layer 1 hydraulic property zones

McPhillamys Gold Project
Groundwater assessment addendum
Figure 5.2



Source: EMM (2020); Regis Resources (2020); DFSI (2017); GA (2011)

KEY

— Named watercourse

Project application area

▭ Mine development project area

▭ Mining lease application area (Note: boundary offset for clarity)

⬚ Disturbance footprint

▭ Model boundary

Hydraulic property zones - Layer 2-9

■ 8 - Byng Volcanics (fresh)

■ 9 - Anson Formation (fresh)

■ 10 - Cunningham Formation (fresh)

■ 11 - Blayney Volcancs (fresh)

Layer 2-9 Hydraulic property zones

McPhillamys Gold Project
Groundwater assessment addendum
Figure 5.3

iv Temporal discretisation

A summary of the stress periods used in the base case groundwater modelling is provided in Table 5.3. Generally, model simulations are transient, except for the first stress period, which is steady state. The first steady state stress period is used to initialise the model in response to simulated recharge, hydraulic conductivity and other boundary conditions (see Table 5.3). The stress periods are generally consistent with those presented in the EIS (EMM 2019a).

Table 5.3 Model stress periods

Stress period (SP)	Stress period duration	Description	TSF river cells	Drains (open cut and TSF drain)	Recharge applied
1	N/A (steady state)	Develops initial conditions in response to modelled hydraulic parameters and boundary conditions.	Inactive	Inactive	Regional recharge
2-18	1 month (transient)	History match period, from 1 January 2017 to 1 June 2018.	Inactive	Inactive	Regional recharge
19	19 months (transient)	Interim period from end of calibration to simulated start of mining, June 2018 to January 2020.	Inactive	Inactive	Regional recharge
20-29	1 year (transient)	Represents the 11-year mine plan.	Active	Active	Regional recharge, but no recharge applied to pit
30-39	1 year (transient)	Represents post-mining years 1 to 10.	Active	Inactive	Regional recharge. Negative recharge (= net evaporation) applied to base of pit
40	40 years (transient)	Represents post-mining years 11 to 50.	Active	Inactive	As above (SP 30-39)
41	50 years (transient)	Represents post-mining years 51 to 100.	Active	Inactive	As above
42	Pseudo steady state (long term transient over 1,000 years)	Used to predict long-term impacts of open pit void and TSF seepage.	Active	Inactive	Regional recharge. Negative recharge (= net evaporation) applied to open cut surface footprint based on water balance provided by HEC (2019)

v Boundary conditions

a Recharge and evapotranspiration

As presented in the Groundwater Assessment (EMM 2019a), recharge was applied to layer 1 of the model based on the conceptual understanding. Each HSU was assigned a separate recharge value as a percentage of rainfall (see points below). A monthly variable time series of recharge was assigned during the calibration period and annual average rates were assigned throughout predictions as follows:

- Alluvium: 8% (long-term average recharge of 69.4 mm/year);
- Orange Basalt: 4.1% (32.9 mm/year);

- Carbonaceous alteration /marble in the open cut area in the Anson Formation: 2.7% (21.9 mm/year);
- Byng Volcanics (saprock): 1.4% (11 mm/year);
- Anson Formation (saprock): 2.1% (17.2 mm/year);
- Cunningham Formation (saprock): 2.1% (17.2 mm/year); and
- Blayney Volcanics (saprock): 1.4% (11 mm/year).

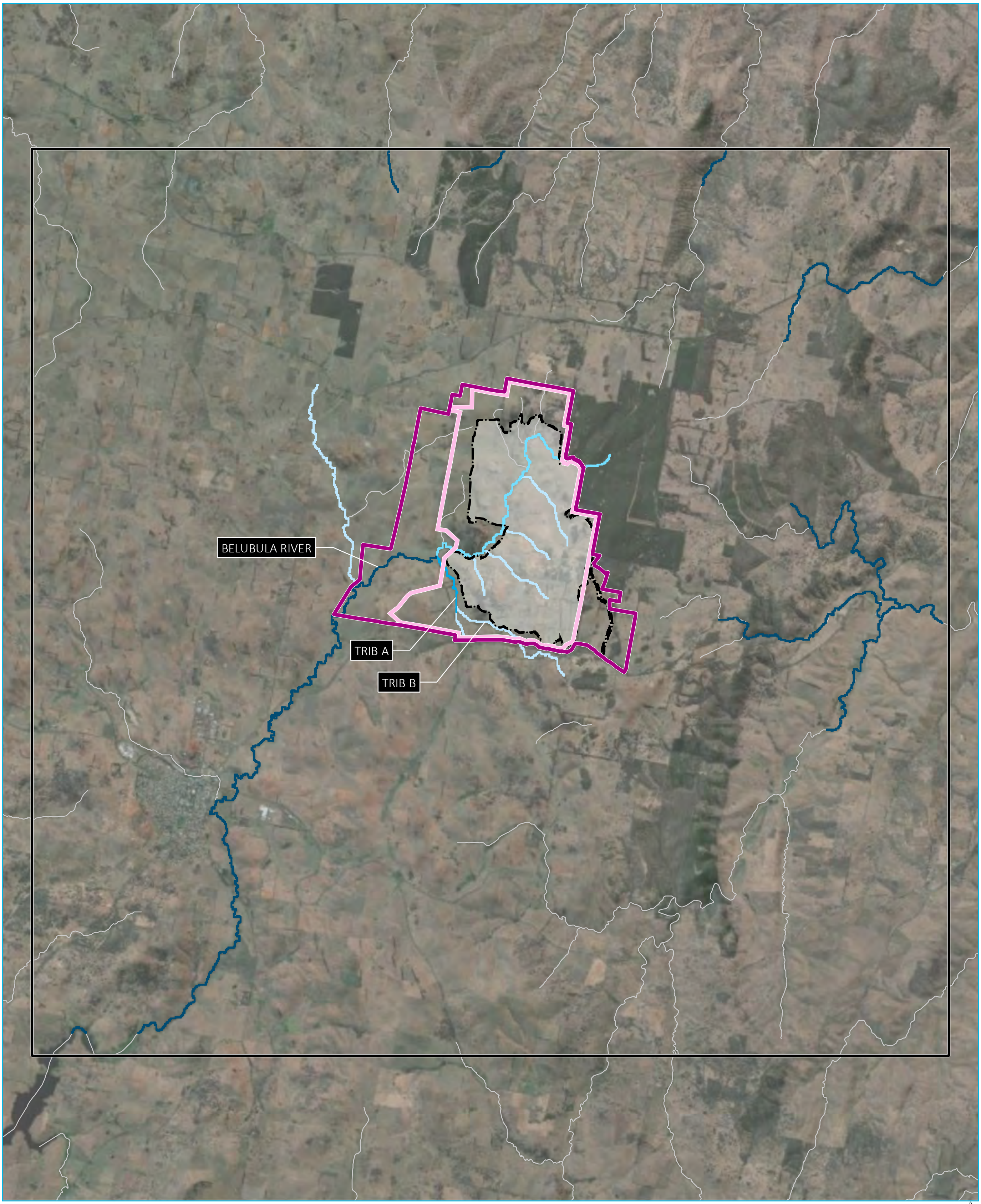
Potential evapotranspiration was applied uniformly across the model domain and, with the exception of the TSF area, was constant throughout duration of model simulation. Maximum potential evapotranspiration rate is set at the annual average of 1,641 mm/year, with an extinction depth of 2 m. Evapotranspiration was deactivated over all river cells and the TSF footprint during simulated mining.

b Simulation of watercourses

The study area is characterised by the Belubula River and associated tributaries flowing from the north-east to south-west. Several perennial watercourses have been identified within the model domain. Figure 5.4 shows the simulated river locations (unchanged since the Groundwater Assessment (EMM 2019a) completed for the EIS).

River conductance was set to 200 m^2/day. River levels (stage) were assigned based on topography using a 5 m DEM with a 1 m vertical accuracy (DFSI Spatial Services 2014). The depth of the riverbed below the water surface was defined based on conceptual understanding and field observations. The following points summarise how the watercourses are simulated in the model and Figure 5.5 provides a schematic of how the river stage and riverbed elevations are specified.

- larger and perennial watercourses have a non-zero depth from assigned river stage to riverbed elevation applied, which means that surface water-groundwater interaction can be gaining or losing, depending on whether the groundwater elevation in the model cell is higher or lower than the river stage (Figure 5.5A). Details of these are as follows:
  - perennial watercourses and the Belubula River downstream of confluence with Trib A: riverbed elevation set 0.5 m below stage/topography;
  - Trib A downstream of confluence with Trib B: riverbed elevation set 0.2 m below stage/topography; and
  - Belubula River upstream of confluence with Trib A (including Trib F): riverbed elevation set 0.1 m below stage/topography; and
- minor or headwater tributaries: river stage elevation set to riverbed elevation, so that these watercourses may receive baseflow only (ie they can only gain, not lose). They can only receive baseflow if the watertable is elevated above the height of the watercourse. These watercourses do not contribute or leak water to the modelled groundwater system (Figure 5.5B). If the watertable is below the watercourse (ie disconnected), there will be no baseflow or simulated leakage at these river locations (Figure 5.5C).



Source: *EMM (2020); Regis Resources (2020); ESRI (2020); DFSI (2017); GA (2011)*

KEY

Project application area

▭ Mine development project area

▭ Mining lease application area
(Note: boundary offset for clarity)

⌜⌟ Disturbance footprint

— Named watercourse

▭ Model boundary

Modelled stream bed depth (m)

■ 0.0 (baseflow only)

■ 0.1

■ 0.2

■ 0.5

Modelled rivers

McPhillamys Gold Project
Groundwater assessment addendum
Figure 5.4

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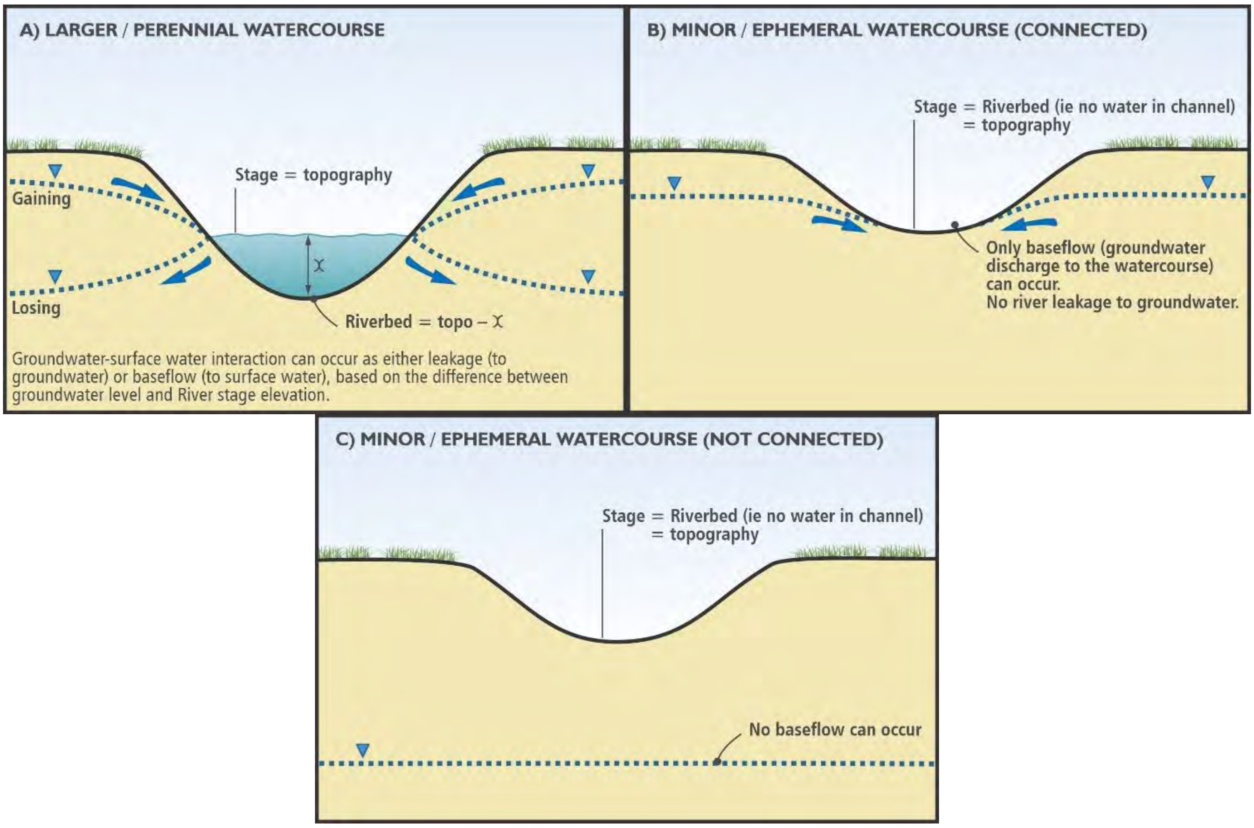


Figure 5.5 Simulation of watercourses

c Groundwater users

As mentioned above, the majority of groundwater bores in the study area are for stock and domestic purposes, with low, infrequent, and unmetered extraction. There are minimal data available regarding pumping rates, bore lithology, or screened interval, and there is limited water level data from landholder bores and there are no observation data available to inform model calibration.

The predictive groundwater model calculates drawdown with respect to a ‘null case’ scenario without mining activities, a best practice method for quantifying dewatering effects whether or not other common and minor extraction is included or excluded (Barnett et al 2012).

Due to the very low volume of groundwater extraction in the area, the inclusion of groundwater use in the model is not considered necessary.

d Boundary conditions used in predictive modelling

The following boundary conditions were updated in the predictive modelling for the amended project:

- **Open cut mine during mining:** progression of drain boundary conditions representing the open cut mine was modified to align with the current 11-year mine plan (refer Section 2.4.2).
- **Open cut mine post-mining:** time-varying material properties were applied to simulate the pit as a void for inflow purposes. Rainfall and evaporation were combined to simulate net flux to and from the open pit lake (refer Section 6.1.5).

- **TSF:** the temporal development of river boundary conditions was modified to align with the amended project schedule (refer Section 2.4.3), however the spatial area remains unchanged from the EIS base case (EMM 2019a). Additional discussion regarding the simulation of the TSF is provided below.

The above listed boundary conditions are consistent with the modelling completed for the Groundwater Assessment (EMM 2019a), and only the time period has been adjusted to reflect the amended project schedule.

Simulation of the TSF

As outlined in the Groundwater Assessment (EMM 2019a), the groundwater model does not simulate the TSF embankment, cut-off key, tailings material or tailings deposition. The simulation of the TSF in the groundwater model is more comparable to a lined water storage dam rather than a tailings dam. The key difference between a lined water dam and TSF is that a TSF will consist of solid particles (eg ground and broken rock) and fluid, at a water content of around 20-30% and will therefore contain much less water than a water dam, which has 100% water content. The water held within the pore spaces between the tailings particles will drain slowly, driven by changing hydraulic pressures, the size of the tailings particles and pore space between the particles.

The simulation of the TSF in the numerical groundwater model is therefore deliberately conservative and as outlined in the Groundwater Assessment (EMM 2019a), the simulation of the TSF in the groundwater model has been completed to assess the potential worst case TSF seepage scenario and the purpose is not to provide an accurate estimate of TSF seepage rates.

TSF design seepage modelling

TSF design and assessment of the effectiveness of the TSF seepage management measures has been conducted by ATC Williams (2019 and 2020). In comparison to the groundwater model, the ATC Williams (2019, 2020) TSF seepage model is a local scale model that specifically simulates the tailings placement, tailings material, embankment, liner, cut-off key, interception drain and sump, and is used to assess the effectiveness of the seepage management system. ATC Williams (2020) completed additional seepage modelling to demonstrate the different seepage rates (through the TSF footprint, ie not at the embankment) if no seepage management measures are applied, compared to 1 m clay liner (at 10^{-9} m/sec permeability) and the lining system proposed for the project. The predicted seepage rates are summarised in Table 5.4 (ATC Williams 2020). The TSF modelling completed by ATC Williams (2020) shows that the proposed TSF multi-barrier seepage management system (as described in Section 2.4.3i) provides a robust system and is effective at reducing seepage.

Table 5.4 Estimated seepage rates over total TSF footprint (ATC Williams 2020)

Model scenario	Median seepage rate (mm/m²/year)
No liner (in-situ conditions)	0.76-2.86
Clay liner (1 m thick at 10^{-9} m/sec permeability)	0.42-1.62
Proposed lining system	0.42-1.66

5.3.3 History match assessment

The following analyses have been undertaken on adequacy and performance of the history match (also referred to as calibration) assessment presented in the Groundwater Assessment (EMM 2019a).

i Adopted hydraulic properties

The adopted hydraulic parameter values as presented in EMM (2019a) are given in Table 5.5.

Table 5.5 Summary of model hydraulic parameters

Geology	Horizontal hydraulic conductivity, Kh (m/day)	Vertical hydraulic conductivity, Kv (m/day)	Specific storage, Ss (1/m)[1]	Specific yield, Sy (%)[2]
Alluvium	1.4	1.4	N/A	10%
Orange Basalt	0.3	0.3	6.8 x 10^{-6}	5%
Byng Volcanics (saprock)	6 x 10^{-3}	6 x 10^{-4}		
Anson Formation (saprock)	6 x 10^{-2}	6 x 10^{-3}		
Cunningham Formation (saprock)	6 x 10^{-2}	6 x 10^{-3}		
Blayney Volcanics (saprock)	6 x 10^{-2}	6 x 10^{-3}		
Byng Volcanics (fresh)	8 x 10^{-8}	8 x 10^{-8}		0.5%
Anson Formation (fresh), including the carbonaceous alteration of the Anson Formation	1 x 10^{-7}	1 x 10^{-7}		
Cunningham Formation (fresh)	1 x 10^{-7}	1 x 10^{-7}		
Blayney Volcanics (fresh)	1 x 10^{-7}	1 x 10^{-7}		

Notes: 1. Specific storage applies to confined model cells.
2. Specific yield applies to unconfined model cells.

As presented in the Groundwater Assessment (EMM 2019a), core samples have been analysed to estimate hydraulic conductivity. A Box and Whisker plot of the measured hydraulic conductivity data is presented in Figure 5.6, grouped by geological unit. The majority of tests have been performed on the Anson Formation due to the project being located in this unit. Field testing has been conducted over varying depths. The predictive uncertainty analysis covered the range of measured hydraulic conductivities and literature values, by simulating fresh rock hydraulic conductivity over a range of five orders of magnitude (up to 1 x 10^{-3} m/day).

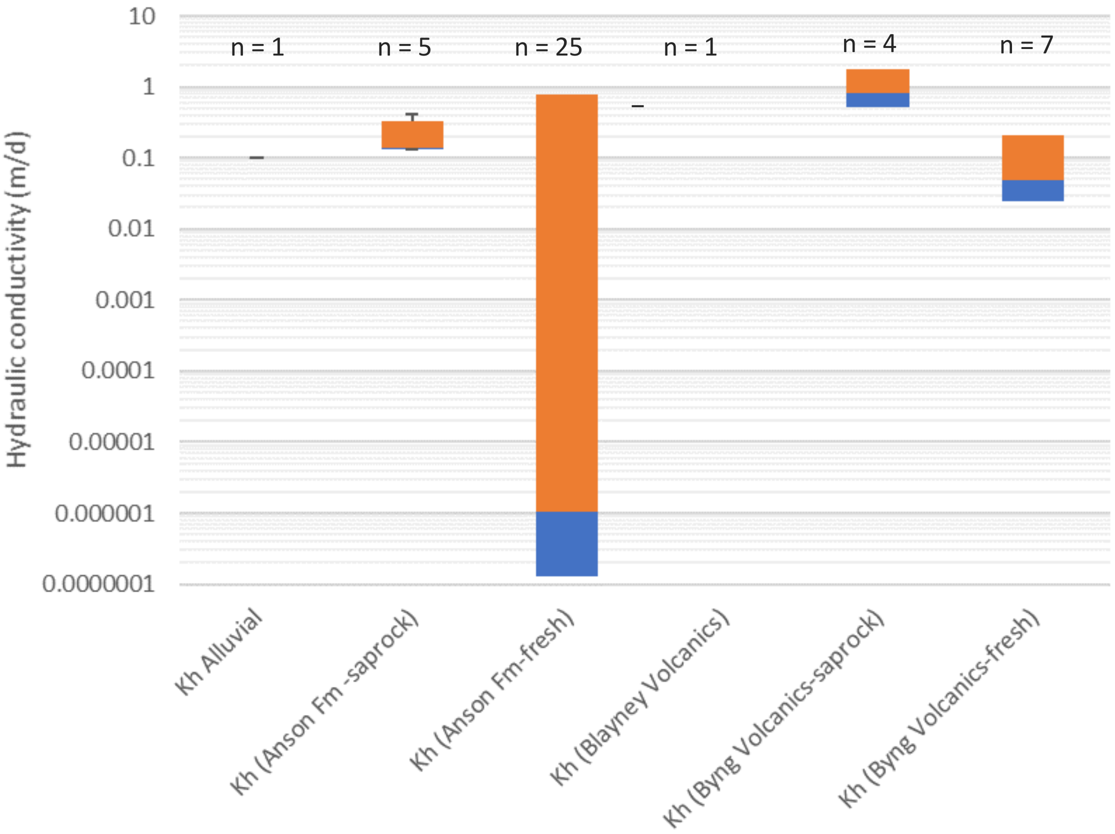


Figure 5.6 Box and whisker plot of field-measured hydraulic conductivity

Subsequent to the EIS and in consultation with the DPIE technical reviewer (JBS&G), EMM has completed an additional predictive uncertainty analysis scenario which included a more gradual vertical transition in hydraulic conductivity with depth. This involved increasing the hydraulic conductivity in layers 2 and 3 (which represent fresh rock in the base case model). Due to limited data availability to accurately support hydraulic conductivities with depth (such as detail on the thickness of the transition from the saprock to fresh rock), an approximate linear relationship between layers 1 to 4 to achieve the gradual reduction in hydraulic conductivity with depth. Further detail about this scenario is provided in Appendix C. Increasing the hydraulic conductivity between saprock and fresh rock results in minimal change to calibration statistics and model predictions (when compared to the base case and reported uncertainty analysis). The results of the additional uncertainty analysis scenario confirm that the modelling (including uncertainty analysis) completed as part of the Groundwater Assessment (EMM 2019a) has adequately assessed the potential impacts of the project.

ii Steady state history match

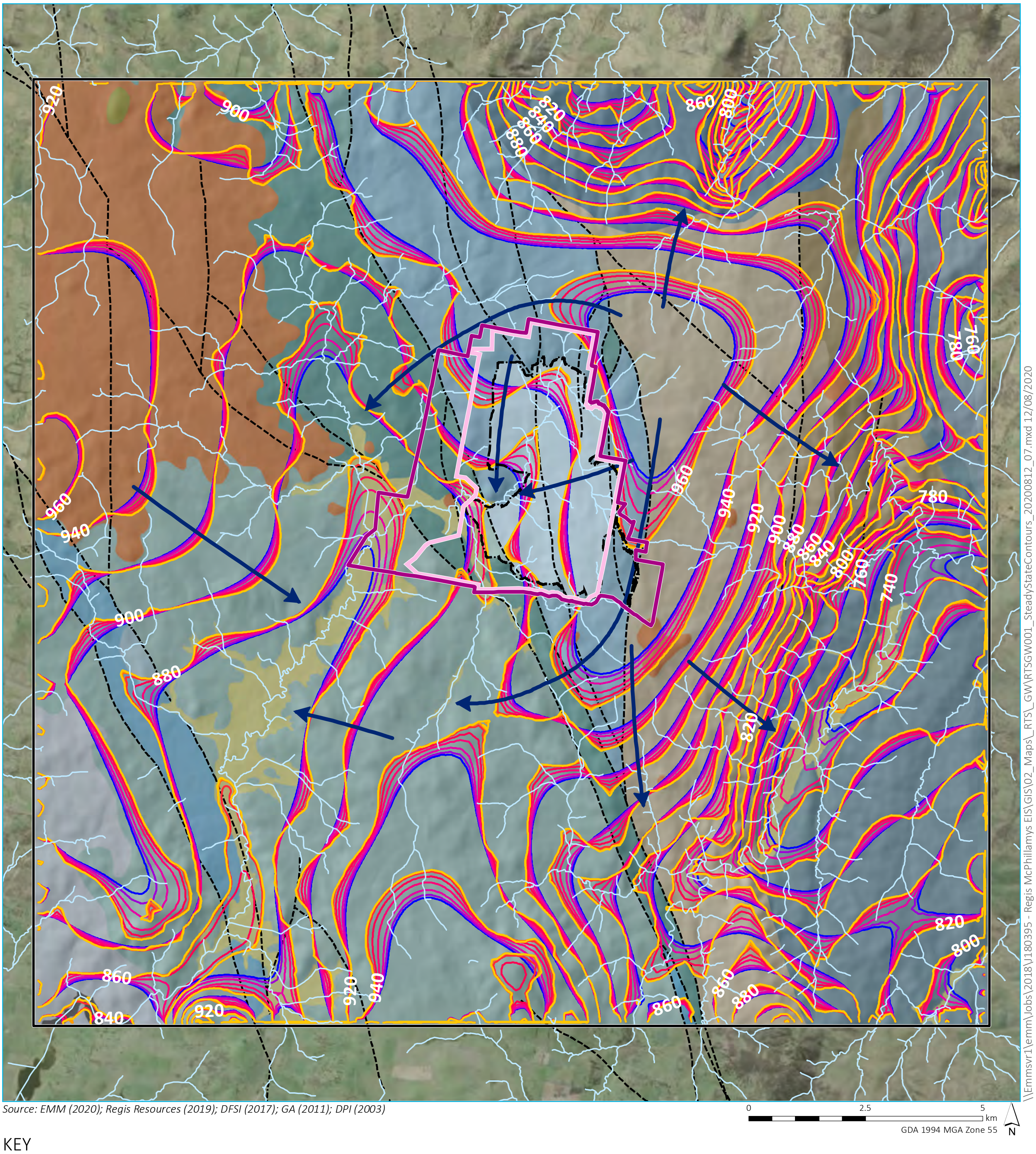
Table 5.6 below summarises the number of steady state observation points used in the model, broken down by layer and HSU. There are 15 monitoring points screened in fresh rock units, compared to 122 in the saprock.

Table 5.6 Number of history match observation points

Layer	Alluvium	Basalt	Anson Formation (saprock)	Anson Formation (fresh)	Byng Volcanics (saprock)	Byng Volcanics (fresh)	Blayney Volcanics (saprock)	Blayney Volcanics (fresh)
1	5	29	26	-	14	-	48	-
2	-	-	-	4	-	5	-	2
3	-	-	-	1	-	-	-	1
4	-	-	-	-	-	-	-	-
5	-	-	-	2	-	-	-	-
6	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-

The steady state calibrated heads for layers 1 to 9 are presented as contours on Figure 5.7. Presenting the heads in this way allows the reader to observe a slight vertical gradient across most of the model domain. Regionally there is a downward gradient which reverses in low topographic areas (ie watercourses and valleys).

As presented in the Groundwater Assessment (EMM 2019a), the scaled root mean square (SRMS) error of the steady state calibrated model is 4.3%, with mean residual of 0.09 m. A scatter plot of modelled vs measured groundwater levels for the calibration period is shown in Figure 5.8. Many of the data plot along or near the unity line, demonstrating a reasonable match and no systematic error/bias.



Source: EMM (2020); Regis Resources (2019); DFSI (2017); GA (2011); DPI (2003)

KEY

- Watercourse/drainage line
- Groundwater flow direction
- Model boundary

Project application area

- Mine development project area
- Mining lease application area (Note: boundary offset for clarity)
- Disturbance footprint

Geology (Bathurst 250k, 2nd Edition)

- Fault

Geology (Bathurst 250k, 2nd Edition)

Quaternary / Tertiary

- Alluvium
- Tertiary basalt
- Trachyte

Carboniferous

- Bathurst Batholith - Bathurst Granite
- Bathurst Batholith - Dunkeld Granite
- Bathurst Batholith - Gresham Granite
- Bathurst Batholith - Icely Granite

Devonian

- Other Carboniferous Intrusions
- Ungrouped Devonian Formations - Cunningham Formation
- Crudine Group - Bushranger Volcanics
- Crudine Group - Turondale Formation
- Crudine Group - Waterbeach Formation

Silurian

- Other Silurian Intrusions - Carcoar Granodiorite
- Other Silurian Intrusions
- Mumbil Group (Northwest) - Anson Formation
- Mumbil Group (Northwest) - Wombiana Formation
- Mumbil Group (East) - Campbells Formation

Ordovician

- Ordovician Intrusions
- Cabonne Group - Blayney Volcanics
- Cabonne Group - Oakdale Formation
- Cabonne Group - Byng Volcanics

Other

- Lake

Modelled groundwater level (by model layer)

- L01
- L02
- L03
- L04
- L05
- L06
- L07
- L08
- L09

Modelled steady state groundwater level contours (all layers)

McPhillamys Gold Project
Groundwater assessment addendum
Figure 5.7

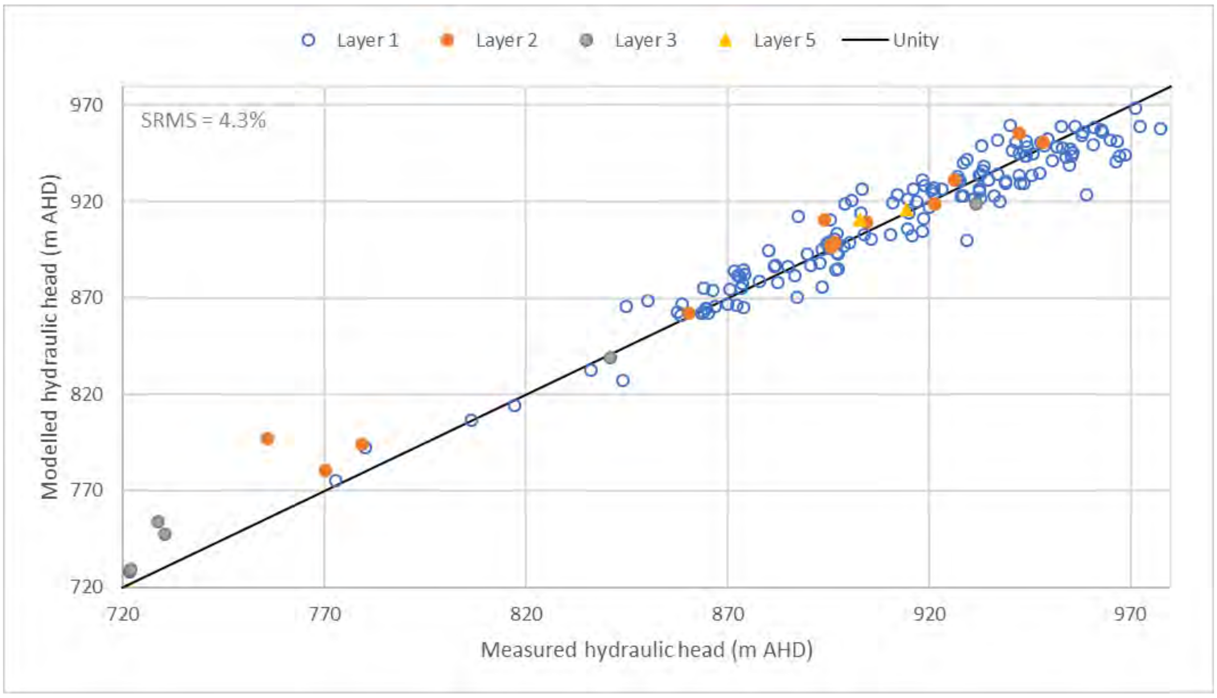


Figure 5.8 Steady state history match modelled vs measured head scatter plot

iii Extended transient verification period

Following the EIS exhibition period and in consultation with the DPIE technical reviewer (JBS&G), an additional scenario was developed in which the transient historical climate period, and associated climate inputs to the model, was extended further back in time to assess climate baseline variability (see Appendix C).

As part of this extended transient verification (also referred to as history match period) scenario, the original base case steady state stress period was divided into two segments:

- a long-term (70 years) pseudo steady state stress period with annual average recharge and evapotranspiration; and
- monthly stress periods from January 1970 using monthly recharge and evapotranspiration from 1970 to mid-2018.

The stress period setup is shown in Table 5.7. The first stress period was converted from steady state to transient, to allow for consistent formulation of the groundwater flow equation throughout the model run. Initial heads were set as the calibrated steady state heads from the base case model. Through the extended transient verification period, evapotranspiration was changed from long term average to varying monthly.

Recharge in the base case model was calculated based on rainfall from the AWRA model which only has data from 2005. For consistency through the pre-mining period, recharge and evapotranspiration were calculated from SILO Drill Data.

Table 5.7 Extended transient verification stress period setup

Detail	Stress period(s)	Stress period length	From	To	Recharge applied	Evapotranspiration applied
Quasi-steady state warmup	1	70 years	1 January 1900	1 January 1970	Annual average	Annual average
Extended transient verification period	2 - 565	1 month	1 January 1970	1 January 2017	Monthly	Monthly
History match	566 - 583	1 month	1 January 2017	1 January 2020	Monthly	Monthly

a History match performance

Results of the alternative extended transient historical period model shows a minor and insignificant change in performance against measured groundwater levels and do not influence the model predictions (refer Appendix C for further discussion).

The SRMS error of this scenario is 4.3% and is unchanged from the model presented in the Groundwater Assessment (EMM 2019a). This is consistent with the history match (calibration) sensitivity analysis presented in the Groundwater Assessment (EMM 2019a), where the SRMS is relatively insensitive to changes in model parameterisation. The mean residual is 1.1 m, larger than the previously reported 0.09 m. A scatter plot of modelled vs measured groundwater levels (for this alternative scenario) is shown in Figure 5.9. The data plot along or near the unity line, largely unchanged from the base case model.

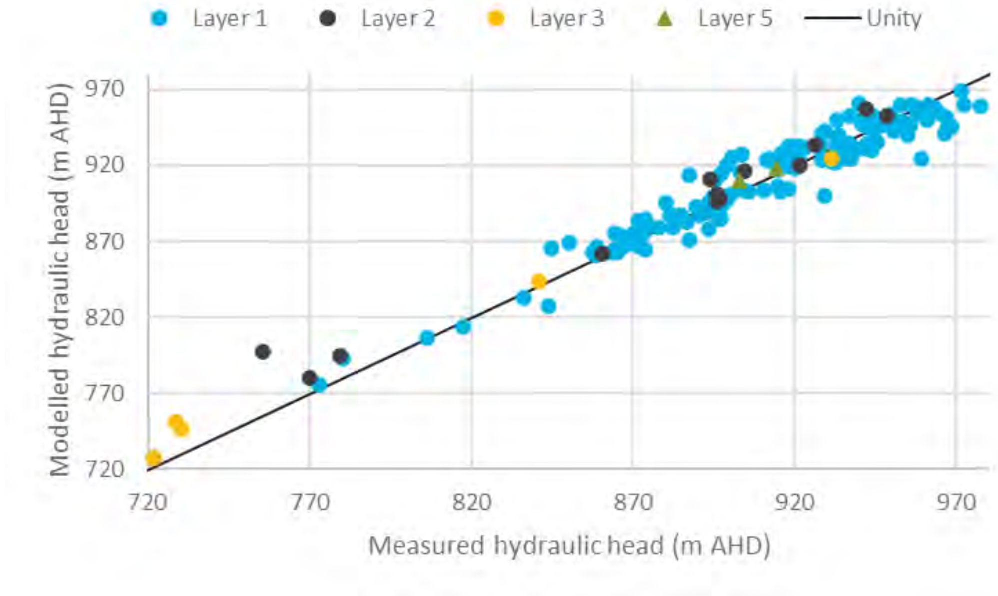


Figure 5.9 Steady state history match modelled vs measured head scatter plot (extended transient verification scenario)

b Steady state hydraulic head

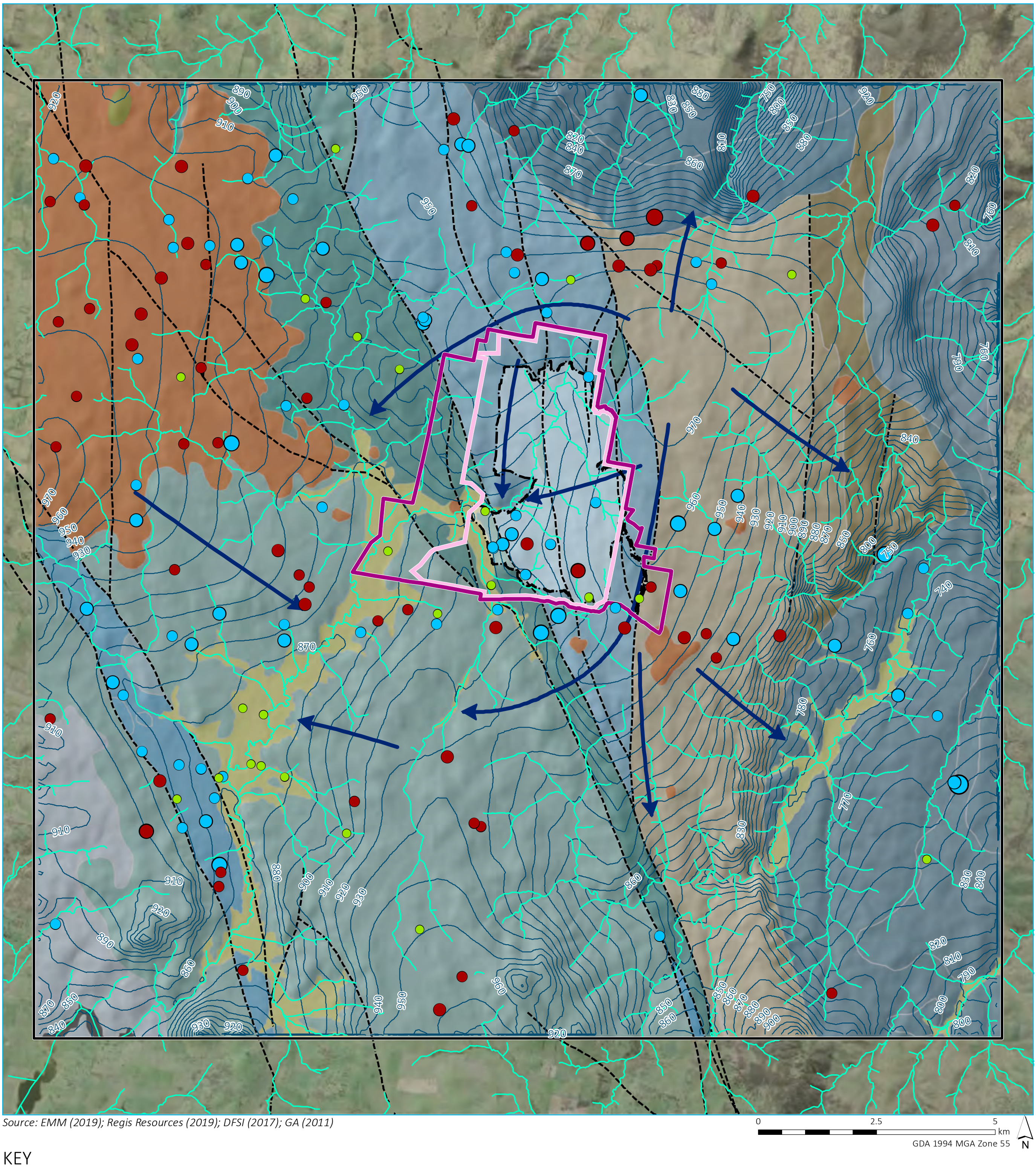
The simulated watertable elevation at 1 January 2017 is presented in Figure 5.10. The groundwater heads do not represent steady-state flow conditions due to incorporation of the extended transient verification period. Despite this, residual values of modelled minus measured heads are largely unchanged from the steady state model, where measurements taken close to the Belubula River typically show the smallest residuals, with a range of larger errors further from the study area.

c Transient hydraulic head

Hydrographs at project specific groundwater monitoring network points are presented in Figure 5.11, for both the extended transient historical climate model and the base case ("EIS") history match model.

The modelled groundwater levels in January 2017 changed slightly compared to the base case model, with some bores such as WMB1759B showing over 2 m difference. There is not a consistent trend for the differences between the base case model and the extended transient verification period, with the simulated watertable higher in some areas and lower in others. Fluctuations in modelled groundwater elevation are more pronounced in the extended transient verification period (eg sites WMB1452B and WMB2130B).

Whilst the revised temporal setup improves the model response to climate variability, the improvements are minor and do not influence the model predictions. The results also show that the heads in the groundwater model are stable when it changes from steady state to transient and there is no observable drift at observation points that materially affects model performance (see Appendix C).



Source: EMM (2019); Regis Resources (2019); DFSI (2017); GA (2011)

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KEY

- Watercourse/drainage line
- Modelled watertable elevation contour (mAHD)
- ➜ Groundwater flow direction
- ☐ Model boundary

Project application area

- ☐ Mine development project area
- ☐ Mining lease application area (Note: boundary offset for clarity)
- ☐ Disturbance footprint

Geology (Bathurst 250k, 2nd Edition)

- Fault

Geology (Bathurst 250k, 2nd Edition)

Quaternary / Tertiary

- Alluvium
- Tertiary basalt
- Trachyte

Carboniferous

- Bathurst Batholith - Bathurst Granite
- Bathurst Batholith - Dunkeld Granite
- Bathurst Batholith - Gresham Granite
- Bathurst Batholith - Icely Granite

Devonian

- Other Carboniferous Intrusions
- Ungrouped Devonian Formations - Cunningham Formation
- Crudine Group - Bushranger Volcanics
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- Crudine Group - Waterbeach Formation

Silurian

- Other Silurian Intrusions - Carcoar Granodiorite
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- Mumbil Group (Northwest) - Anson Formation
- Mumbil Group (Northwest) - Wombiana Formation
- Mumbil Group (East) - Campbells Formation

Ordovician

- Ordovician Intrusions
- Cabonne Group - Blayney Volcanics
- Cabonne Group - Oakdale Formation
- Cabonne Group - Byng Volcanics

Other

- Lake

Residual head (m) (modelled minus measured)

- ● -40 – -30
- ● -30 – -20
- ● -20 – -10
- ● -10 – -2
- ● -2 – 2
- ● 2 – 10
- ● 10 – 20
- ● 20 – 30
- ● 30 – 40
- ● 40 – 50

Modelled watertable contours and residual heads at 1 January 2017 (transient history match scenario)

McPhillamys Gold Project
Groundwater assessment addendum
Figure 5.10

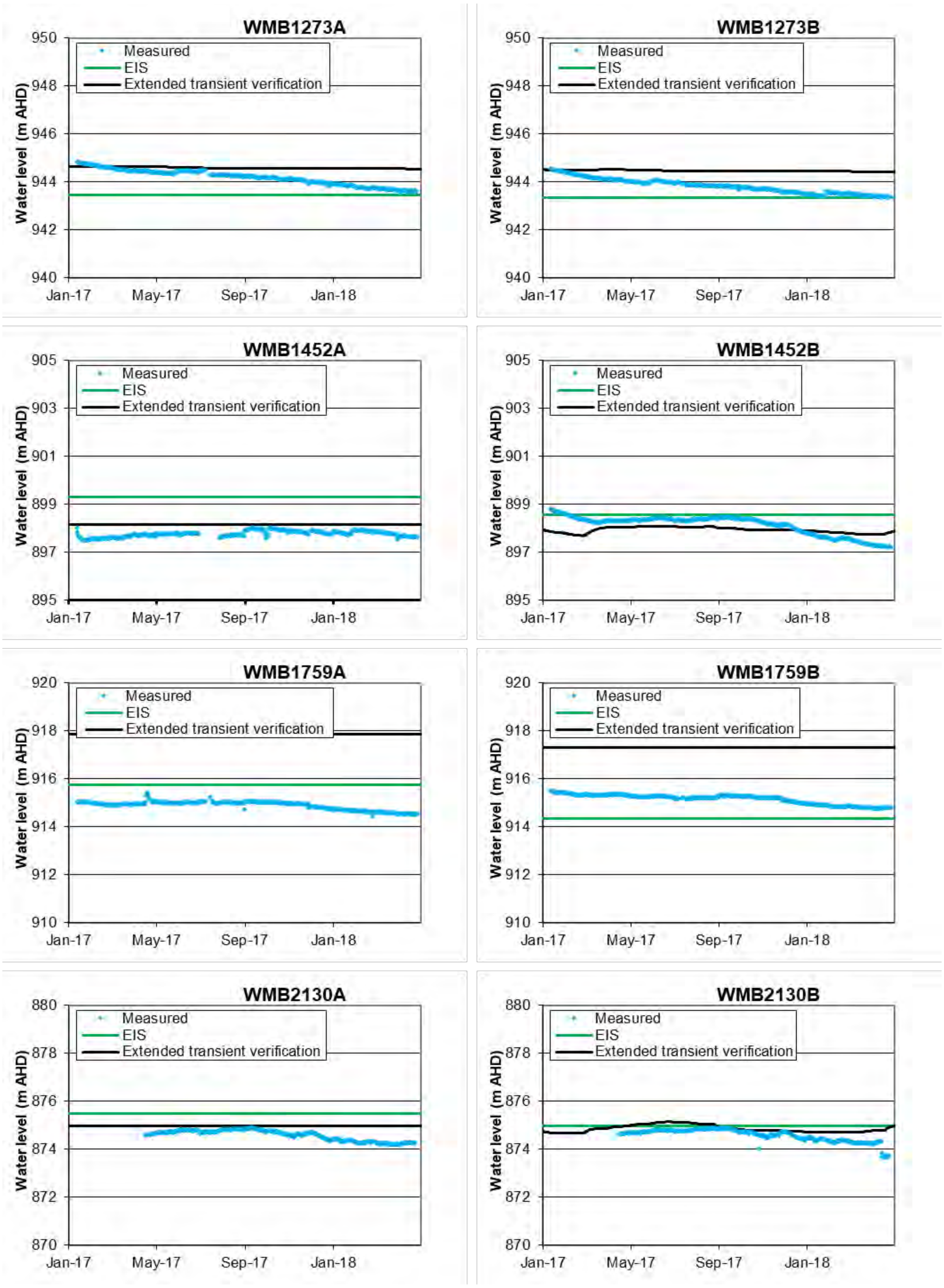


Figure 5.11 Transient hydrographs (extended transient verification period)

d Water balance

For the model period between 1 January 2017 and 1 June 2018 (from the extended transient model), the modelled mass balance error is no larger than 0.01%, which is acceptable based on the recommendations in the Australian Groundwater Modelling Guidelines (Barnett et al 2012).

The modelled water balance for the transient monitoring period is presented graphically in Figure 5.12, and tabulated for the last month (May 2018) in Table 5.8. The largest flux quantities and variations are observed in rainfall recharge and evapotranspiration. The end of the transient monitoring period corresponds to a time of low rainfall, and thus the fluxes reported in Table 5.8 show general head boundary condition fluxes to be of a similar magnitude to rainfall recharge and evapotranspiration. All of the fluxes in Table 5.8 are smaller than those reported by EMM (2019a), with the exception of storage inflow and outflow. This represents a dynamic system with a greater change of groundwater levels with time, as discussed in Section 5.3.3iii c and Appendix C.

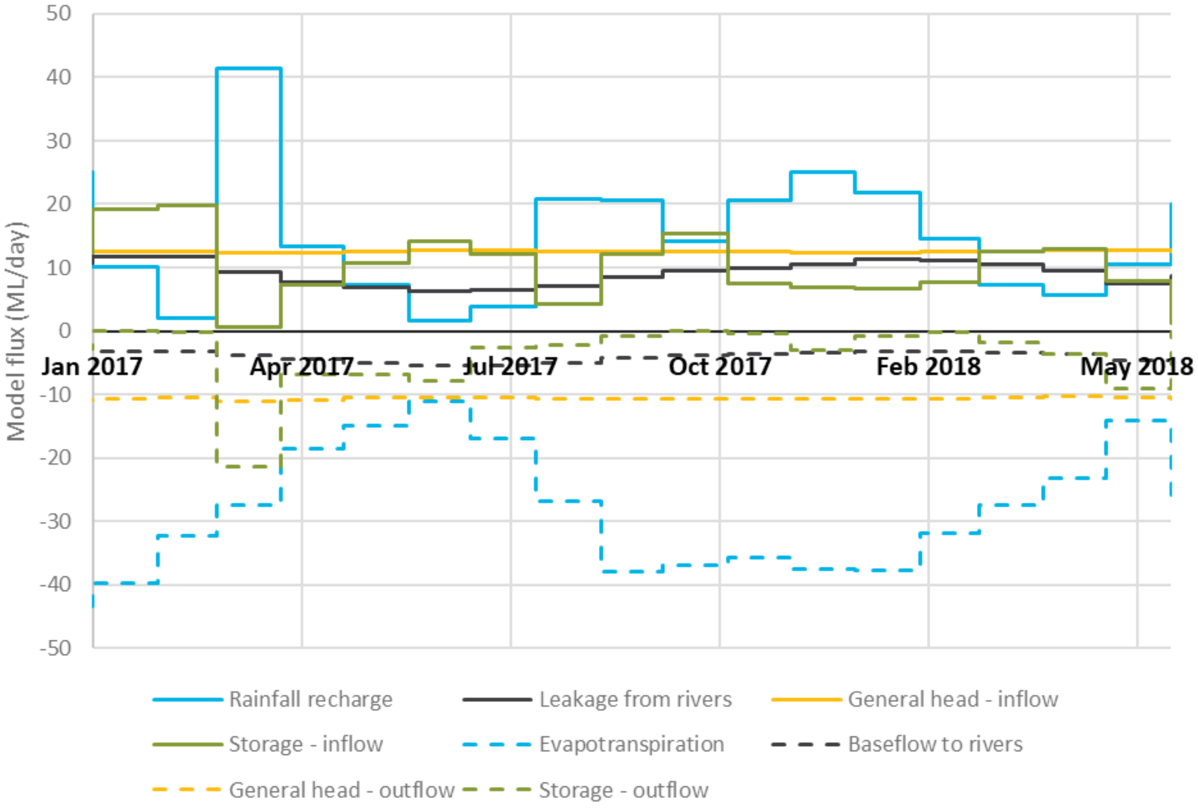


Figure 5.12 Extended transient verification period model water balance

Table 5.8 Modelled water balance at 1 June 2018 (extended transient verification model)

Component	Inflow (ML/day)	Percentage of total inflow	Outflow (ML/day)	Percentage of total outflow
Rainfall recharge	10.4	27.2%	-	-
Evapotranspiration	-	-	14.1	36.8%
Baseflow to rivers	-	-	4.7	12.3%
Leakage from rivers	7.4	19.3%	-	-
General head	12.7	33.0%	10.4	27.2%
Storage	7.9	20.6%	9.2	23.9%
TOTAL	**38.3**	**-**	**38.3**	**-**
Mass balance percentage error		**0.00%**		

Incorporation of the extended transient verification period results in a poorer statistical match to historical measurements. However, the model results display improved dynamic response to transient climatic stresses in the history match period.

5.3.4 History match sensitivity analysis

i Relative composite sensitivity analysis

Subsequent to the submission of the EIS, EMM performed a relative composite sensitivity (RCS) analysis on the base case model in order to quantify the sensitivity of the model calibration to input parameters (see Appendix C). The results are shown in Figure 5.13. The value of RCS is a unitless, scaled parameter corresponding to the sensitivity of the model calibration to changes in each parameter. Larger values mean that the model has a higher sensitivity to this parameter. The tested parameters are as follows:

- **kx**: horizontal hydraulic conductivity;
- **kz**: vertical hydraulic conductivity;
- **r**: recharge;
- **et**: maximum evapotranspiration rate;
- **ed**: evapotranspiration extinction depth;
- **ghc**: conductance of general head boundary conditions; and
- **rv**: conductance of river boundary conditions.

The number following the parameter in Figure 5.13 represents the parameter zone or boundary reach. The hydraulic conductivity zones relate to those presented in Table 5.2. The river reaches (rv), evapotranspiration and general head boundary conductances are applied uniformly across the model domain and are not divided into zones or reaches. Description of the recharge zones and river reaches used in the analysis is provided in Table 5.9.

Table 5.9 RCS parameter zones – recharge and river reach

Recharge zone number	Recharge (r)	River reach number	River (rv)
1	Alluvium	1	-
2	Orange Basalt	2	Belubula
3	-	3	Other perennial streams
4	Byng Volcanics (saprock)	4	Trib A
5	Anson Formation (saprock)	5	Trib B
6	Cunningham Formation (saprock)	6	Trib C
7	Blayney Volcanics (saprock)	7	Trib D
8	-	8	Trib E
9	-	9	Trib F
10	-	10	Trib K
11	-	11	

Storage parameters were not analysed, as storage is not relevant for steady state groundwater flow conditions. Additionally, horizontal hydraulic conductivity and recharge are considered linked, as steady state groundwater flow is dependent on the ratio of recharge to transmissivity. It is for this reason that recharge was not varied in the model calibration. However, recharge has been included in the RCS analysis.

Model layer 1 contains hydraulic conductivity parameter zones 1-7 (Table 5.2). As shown in Figure 5.13, the calibration is sensitive to horizontal hydraulic conductivity in this layer. The deeper layers representing fresh rock contain parameter zones 8-11 (Table 5.2). The calibration shows sensitivity to the parameter values in these zones, with observable sensitivity to horizontal hydraulic conductivity and, to a lesser extent, vertical hydraulic conductivity. It is clear that despite the low number of measurements from the fresh rock, the properties of these units influence the overall modelled groundwater conditions across the domain.

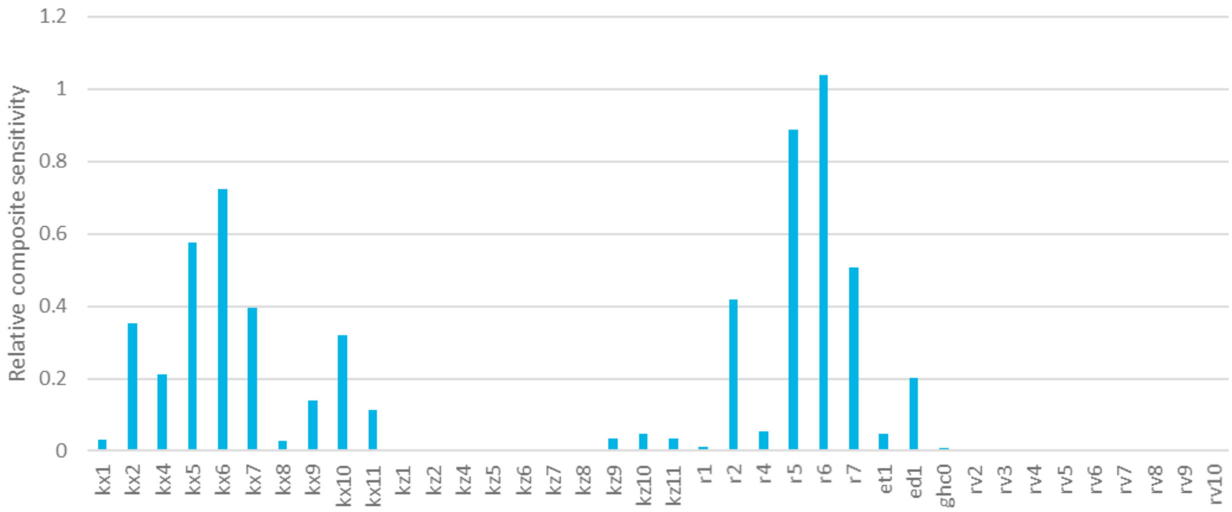


Figure 5.13 Relative composite sensitivity of model parameters

Parameters with greater RCS values indicate that the model calibration is sensitive to that parameter and, therefore, that the measurements provide information useful to constraining its value. Accordingly, the modeller can more easily determine reasonable upper and lower bounds for the more sensitive parameters. Noting the lower sensitivity of the model to fresh rock hydraulic conductivity, EMM adopted a wide range of hydraulic conductivity values in the predictive uncertainty analysis for the deeper layers. In addition to this, the lack of history match assessment to storage parameters necessitated a wide range of values applied in the uncertainty analysis.

5.3.5 Predictive uncertainty analysis

The uncertainty analysis completed as part of the Groundwater Assessment (EMM 2019a) included 63 uncertainty scenarios and considered:

- hydraulic conductivity of the weathered Byng Volcanics (saprock) in isolation (up and down);
- hydraulic conductivity of the fresh Byng Volcanics in isolation (up and down);
- hydraulic conductivity of all the weathered rock units (up and down);
- hydraulic conductivity of all fresh rock units (up and down);
- specific yield of all weathered rock units (up and down);
- specific storage of all fresh rock units (up and down); and
- river stage elevation, ‘dry watercourse’ scenario.

Uncertainty scenario S11 increased the hydraulic conductivity of the Byng Volcanics much higher than that presented in the base case model. Uncertainty scenario S11 allows assessment of the potential for greater impacts (drawdown) to be observed in the Kings Plains area.

Subsequent to submission of the EIS and following consultation with the DPIE technical expert (JBS&G), three additional scenarios were developed for the uncertainty analysis, the results of which demonstrate that the potential impacts have been adequately assessed and the groundwater model is fit for purpose. This additional work can be found in Appendix C.

5.4 Construction water supply

A groundwater drilling and testing program was undertaken in the first and second quarters of 2020 as part of the construction water supply investigations for the amended project. This recent program was a follow up to previous groundwater drilling investigations completed in early 2019. At completion of the program, two test bores and four dedicated monitoring bores were constructed and tested. The Construction Water Supply Groundwater Investigation and Impact Assessment is provided in Appendix D.

Test bore TPB4 is located in the mine development project area (on land parcel B//37372) and was first drilled in 2018, targeting an inferred north-south orientated structure in the Anson Formation:

- the test bore is screened from 96 to 138 mbgl across fractured metasediments within the Anson Formation and had an airlift yield of 5 L/s;
- monitoring bore MB14 is screened from 78 to 126 mbgl targeting the same deeper fractures as TPB4;
- monitoring bore MB15 is screened from 19 to 22 mbgl across fractures intercepted at shallower depth (at the top of the fresh rock, below the saprock); and
- monitoring bore MB16 is screened from 15 to 18 mbgl immediately below the watertable, within the saprock.

Test bore TB05 is located north of the mine development project area (on land parcel 1//801034) and was drilled targeting an area of localised enhanced permeability intercepted by an existing bore (GW704227):

- test bore TB05 intercepted a localised marine limestone feature within the Anson Formation and has been constructed with a screened and ballast infill zone from 51 to 75 mbgl;
- the airlift yield of TB05 at end of construction was 25 L/s;
- monitoring bore MB17 is located approximately 180 m to the north-east of TB05 and did not intercept the limestone feature; and
- MB17 is screened from 53 to 59 mbgl across highly weathered metasediments and saprock within the Anson Formation.

Following construction and development of the test bores and monitoring bores, aquifer tests were conducted at the test bores to allow estimation of aquifer properties which have been used to assess the suitability of the bores to meet construction demand and to assess impacts. The testing comprised step tests (4 x 100 minutes steps) and constant rate tests (3 days at TPB04 and 4.7 days at TB05), including groundwater level monitoring at the dedicated monitoring bores and existing bores in the vicinity of the pumping bore.

Analytical modelling has been conducted using the results of the aquifer test analysis to:

- estimate the potential drawdown in the vicinity of the test bores;
- estimate the area of influence (extent of drawdown as defined by the 2 m change in groundwater level) caused by pumping of the test bores; and
- assess the potential impacts of operating the bores on local receptors.

6 Impact assessment

6.1 Model results

An additional model scenario was developed to assess the amended open cut mine schedule as detailed in Section 2.4.2, with an 11-year mine life and steadier progression of both the open cut and TSF.

6.1.1 Water balance

The modelled water balance at the end of mining, 100 years post-mining and post-mining pseudo steady state is presented in Table 6.1, with a comparison to the results from the EIS base case (EMM 2019a).

At the end of the 11-year mining prediction period, the overall mass balance error reported by MODFLOW-USG is 0.01%. The modelled water balance at the end of mining prediction is given in Table 6.1, with a comparison to the EIS base case scenario, and is discussed below:

- the water balance is very similar to the base case groundwater model (EMM 2019a); and
- as with the EIS base case scenario, mine dewatering causes a net surface water take (reduction in baseflow and increase in leakage from rivers) as observed in the river boundary conditions.

As with the EIS base case scenario, the model prediction includes 100 years post-mining to simulate inflow to the pit void and aid in assessing long-term groundwater impacts post-mining. At the end of the post-mining simulation (100 years post-mining), the mass balance error reported by MODFLOW-USG is 0.02%. The modelled water balance at the end of the 100-year post-mining recovery period is presented in Table 6.1 and discussed below:

- recharge increased by 1.3 ML/day compared to the end of mining as rainfall was simulated to directly report to the final void;
- evapotranspiration increased by 0.5 ML/day in line with the EIS base case scenario due to a modelled shallow watertable in the TSF area; and
- other fluxes are largely consistent with the EIS scenario at the same model time.

At the end of the full recovery simulation (pseudo steady state), the mass balance error reported by MODFLOW-USG is 0.01%. The modelled water balance post-mining recovery pseudo steady state is broadly similar to the fluxes reported in the 100 year post-mining period (Table 6.1). The primary difference is rainfall recharge; over the final void footprint a net flux has been applied to represent rainfall, evaporation and runoff reporting to the final void. This recovery period is discussed in further detail in Section 6.1.5.

Table 6.1 Modelled water balance comparison between the EIS base case and amended project scenario at various prediction time periods

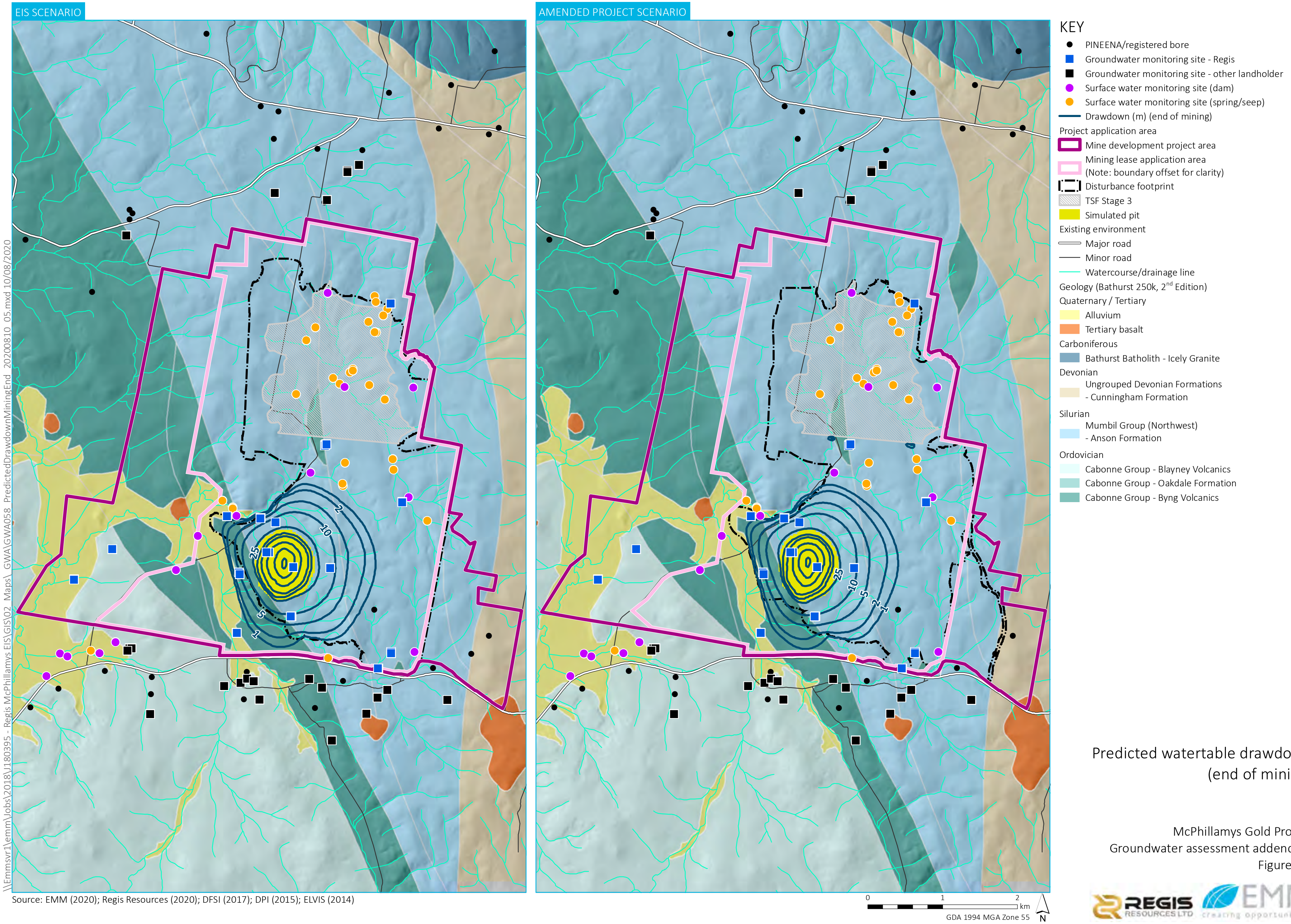
Component	End of mining				100 years post-mining				Post-mining pseudo steady state			
	EIS base case		Amended project		EIS base case		Amended project		EIS base case		Amended project	
	Inflow (ML/day)	Outflow (ML/day)	Inflow (ML/day)	Outflow (ML/day)	Inflow (ML/day)	Outflow (ML/day)	Inflow (ML/day)	Outflow (ML/day)	Inflow (ML/day)	Outflow (ML/day)	Inflow (ML/day)	Outflow (ML/day)
Rainfall recharge	20	-	20	-	20.9	-	21.3	-	20	0.1[1]	20	0.1[1]
Evapotranspiration	-	31.2	-	31.1	-	31.6	-	31.6	-	31.6	-	31.7
Baseflow to river boundary conditions	-	5.2	-	5.2	-	5.2	-	5.2	-	5.2	-	5.2
Leakage from river boundary conditions (excluding the TSF)	13.4	-	13.4	-	13.4	-	13.6	-	13.4	-	13.4	-
Leakage from the TSF river boundary condition	1.0	-	1.1	-	0.8	-	0.8	-	0.8	-	0.8	-
General head	14.3	11.3	14.3	11.3	14.3	11.3	14.3	11.3	14.3	11.3	14.3	11.3
Drain (mine dewatering and TSF drain)	-	0.9	-	0.9	-	-	-	-	-	-	-	-
Storage	0.1	0.3	0.2	0.5	0	0.9	0	1.7	0	0	0	0.2
TOTAL	**48.8**	**48.9**	**49**	**49**	**49.4**	**49**	**50.0**	**49.8**	**48.5**	**48.2**	**48.5**	**48.5**
Mass balance percentage error	**-0.10%**		**0.01%**		**0.01**		**0.02%**		**0.01%**		**0.01%**	

Notes: 1. Represents the net negative recharge applied to the pit void area

6.1.2 Drawdown related impacts

The predicted drawdown of the watertable at the end of mining (year 11) and 100 years post-mining is presented in Figure 6.1 and Figure 6.2 respectively, with comparison of equivalent model times against the EIS base case scenario. Modelled watertable elevations for the same model times are presented in Figure 6.3 and Figure 6.4. The model predicts:

- the extent of watertable drawdown at the end of mining is predicted to be very similar to that predicted in the EIS base case scenario (Figure 6.1);
- the extent of drawdown is predicted to be greatest 100 years post-mining, with the 2 m drawdown contour extending approximately 1.4 km to the east of the open cut mine for both the EIS base case scenario and the amended project scenario;
- modelled watertable contours show minor differences between the EIS and amended project scenarios;
- the watertable high north-east of the project is predicted to remain in place during mining and post-mining, confirming that project related impacts are not predicted to extend north and north-east of the project (Figure 6.3 and Figure 6.4); and
- groundwater will continue to discharge to the Belubula River downstream of the mine project area during mining and post-mining (Figure 6.3 and Figure 6.4).



Source: EMM (2020); Regis Resources (2020); DFSI (2017); DPI (2015); ELVIS (2014)

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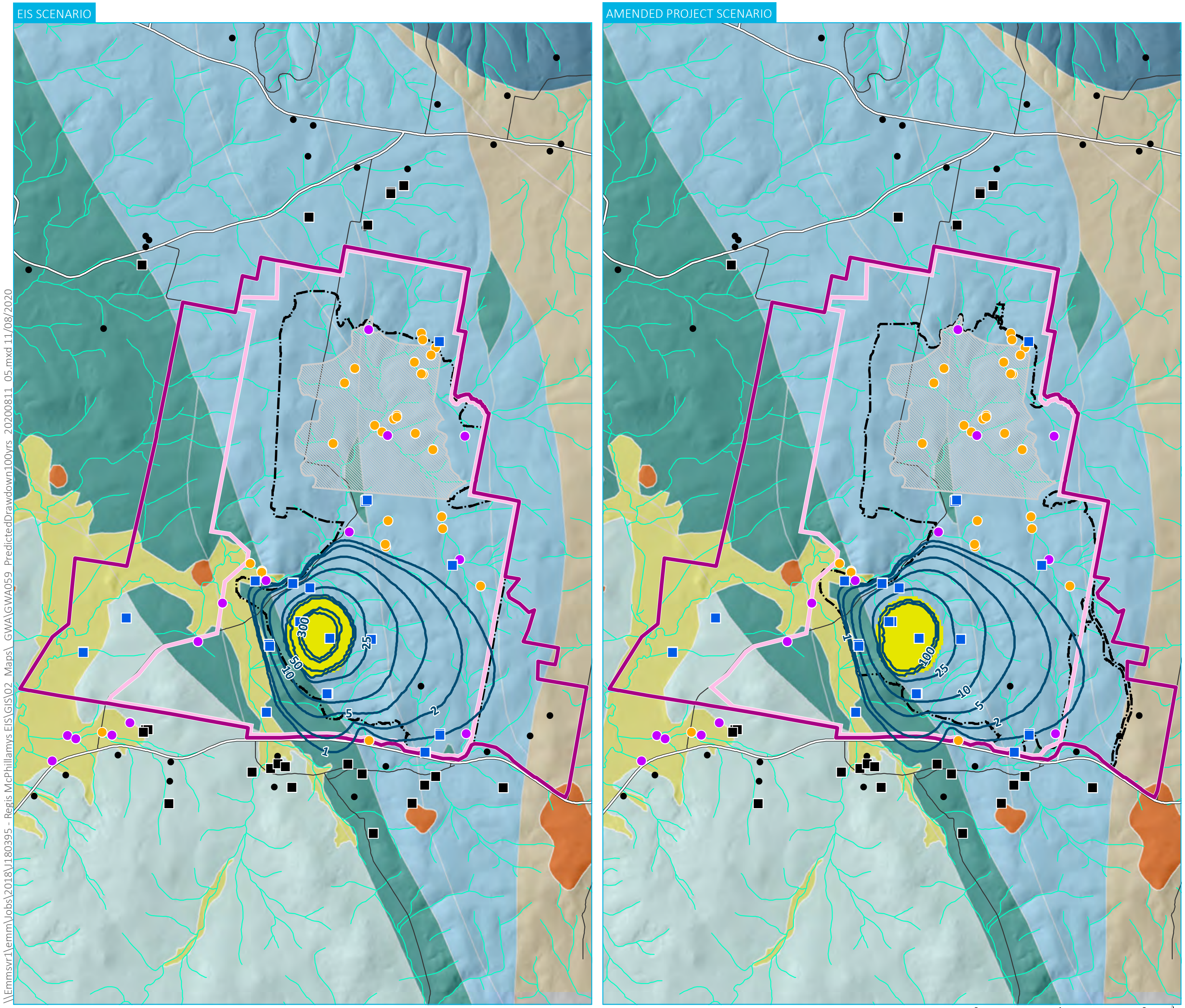
Predicted watertable drawdown
(end of mining)

McPhillamys Gold Project
Groundwater assessment addendum
Figure 6.1



\\Emmsvr1\emm\Jobs\2018\180395 - Regis McPhillamys EIS\GIS\02 Maps\ GWA\GWA059 PredictedDrawdown100yrs 20200811 05.mxd 11/08/2020

Source: EMM (2020); Regis Resources (2020); DFSI (2017); DPI (2015); ELVIS (2014)

KEY

- ● PINEENA/Registered bore
- ■ Groundwater monitoring site - Regis
- ■ Groundwater monitoring site - other landholder
- ● Surface water monitoring site (dam)
- ● Surface water monitoring site (spring/seep)
- — Drawdown (m) (100 years after mining)

Project application area

- ▭ Mine development project area
- ▭ Mining lease application area (Note: boundary offset for clarity)
- ▭ Disturbance footprint
- ▨ TSF Stage 3
- ■ Simulated pit

Existing environment

- ═ Major road
- — Minor road
- — Watercourse/drainage line

Geology (Bathurst 250k, 2nd Edition)

Quaternary / Tertiary

- ■ Alluvium
- ■ Tertiary basalt

Carboniferous

- ■ Bathurst Batholith - Icely Granite

Devonian

- ■ Ungrouped Devonian Formations - Cunningham Formation

Silurian

- ■ Mumbil Group (Northwest) - Anson Formation

Ordovician

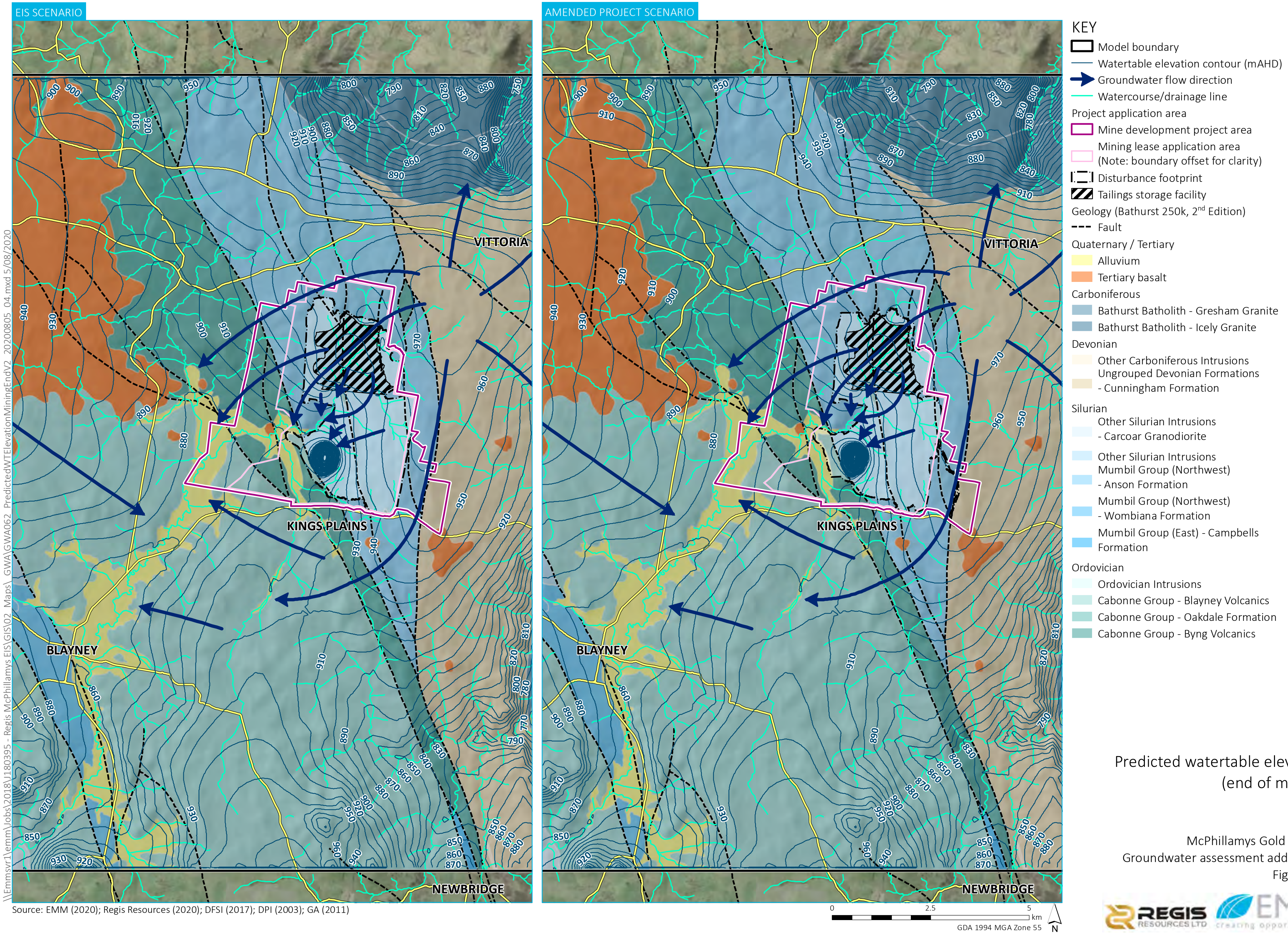
- ■ Cabonne Group - Blayney Volcanics
- ■ Cabonne Group - Oakdale Formation
- ■ Cabonne Group - Byng Volcanics

Predicted watertable drawdown
(100 years after mining)

McPhillamys Gold Project
Groundwater assessment addendum
Figure 6.2

REGIS RESOURCES LTD

EMM creating opportunities

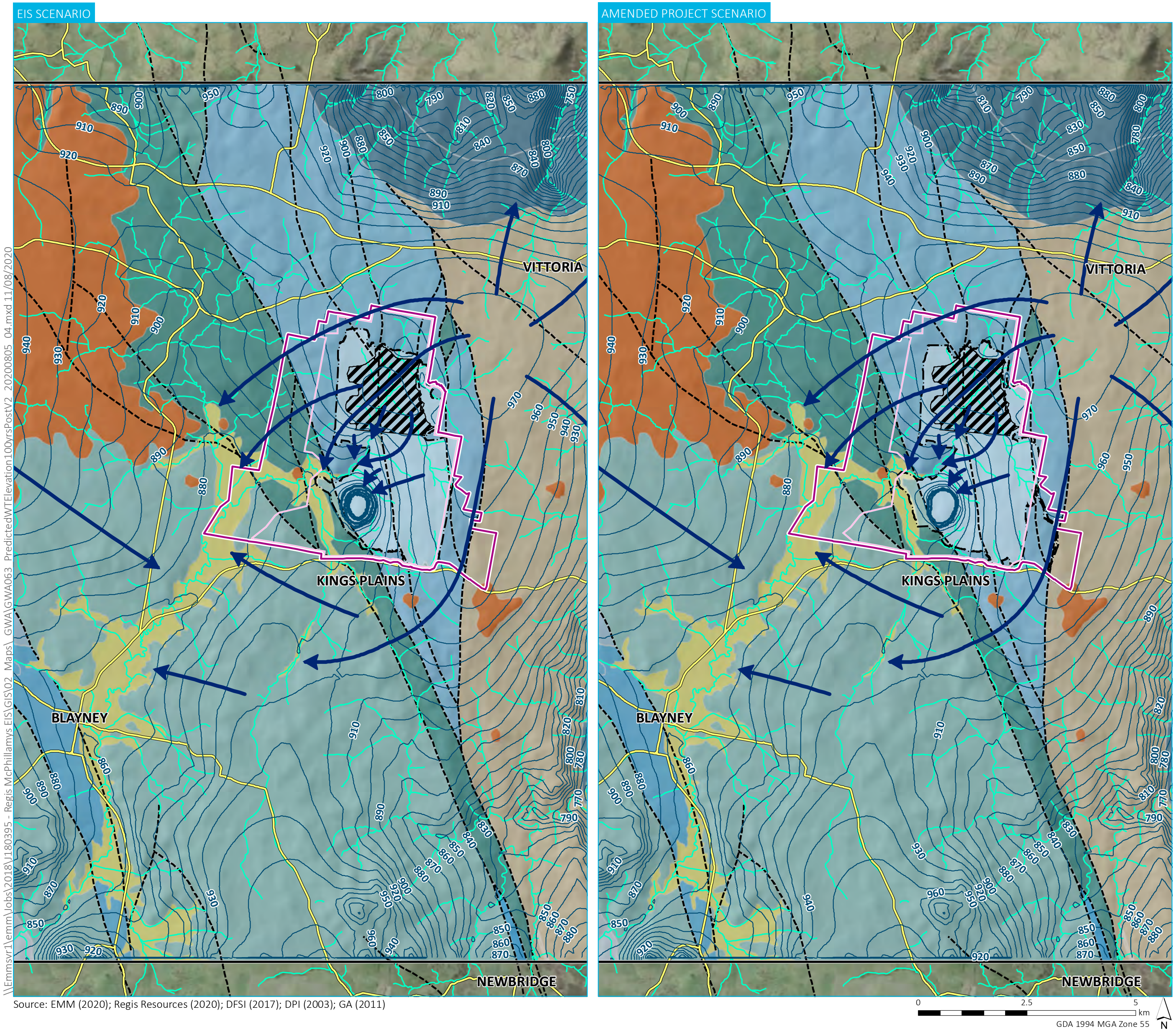


Source: EMM (2020); Regis Resources (2020); DFSI (2017); DPI (2003); GA (2011)

\\Emmsvr1\emm\Jobs\2018\J180395 - Regis McPhillamys EIS\GIS\02 Maps\ GWA\GWA062 PredictedWTElevationMiningEndV2 20200805 04.mxd 5/08/2020

Predicted watertable elevation
(end of mining)

McPhillamys Gold Project
Groundwater assessment addendum
Figure 6.3



Source: EMM (2020); Regis Resources (2020); DFSI (2017); DPI (2003); GA (2011)

KEY

- ▭ Model boundary
- — Watertable elevation contour (mAHD)
- ➔ Groundwater flow direction
- — Watercourse/drainage line

Project application area

- ▭ Mine development project area
- ▭ Mining lease application area (Note: boundary offset for clarity)
- ⬚ Disturbance footprint
- ▨ Tailings storage facility

Geology (Bathurst 250k, 2nd Edition)

- - - - Fault

Quaternary / Tertiary

- 🟨 Alluvium
- 🟧 Tertiary basalt

Carboniferous

- ■ Bathurst Batholith - Gresham Granite
- ■ Bathurst Batholith - Icely Granite

Devonian

- ■ Other Carboniferous Intrusions
- ■ Ungrouped Devonian Formations - Cunningham Formation

Silurian

- ■ Other Silurian Intrusions - Carcoar Granodiorite
- ■ Other Silurian Intrusions
- ■ Mumbil Group (Northwest) - Anson Formation
- ■ Mumbil Group (Northwest) - Wombiana Formation
- ■ Mumbil Group (East) - Campbells Formation

Ordovician

- ■ Ordovician Intrusions
- ■ Cabonne Group - Blayney Volcanics
- ■ Cabonne Group - Oakdale Formation
- ■ Cabonne Group - Byng Volcanics

Predicted watertable elevation
(100 years after mining)

McPhillamys Gold Project
Groundwater assessment addendum
Figure 6.4

\\Emmsvr1\emm\Jobs\2018\J180395 - Regis McPhillamys EIS\GIS\02_Maps_GWA\GWA063_PredictedWTElevation100yrsPostV2_20200805_04.mxd 11/08/2020

Predicted hydrographs for select existing monitoring bores located near the open cut mine are presented in Figure 6.5, out to 100 years post-mining. Equivalent hydrographs are presented for the EIS scenario, represented by dashed lines. The hydrographs show:

- consistent with the EIS base case scenario, the predicted groundwater level drawdown is greatest at the Regis-owned monitoring bore WMB2252B, showing drawdown up to 6 m; and
- insignificant change in predicted drawdown compared to the EIS scenario at the other locations.

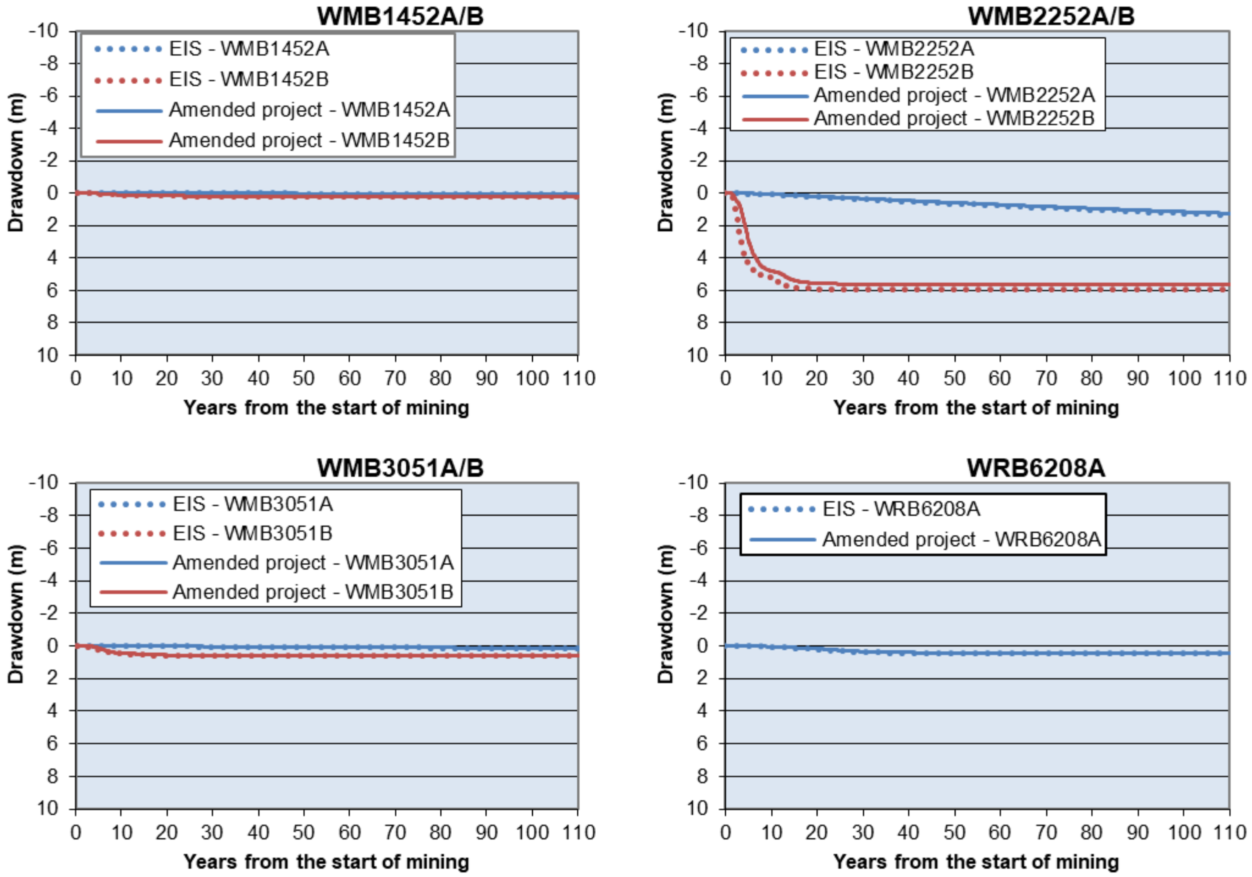


Figure 6.5 Predicted drawdown at selected pit area monitoring bores

Predicted hydrographs for selected monitoring locations near the TSF are presented in Figure 6.6, showing:

- longer time for mounding to reach maximum level at WES5970 (3 m), due to the slower TSF development (in comparison to the EIS base case); and
- similar predicted mounding between the base case and amended project scenarios at WMB5872A.

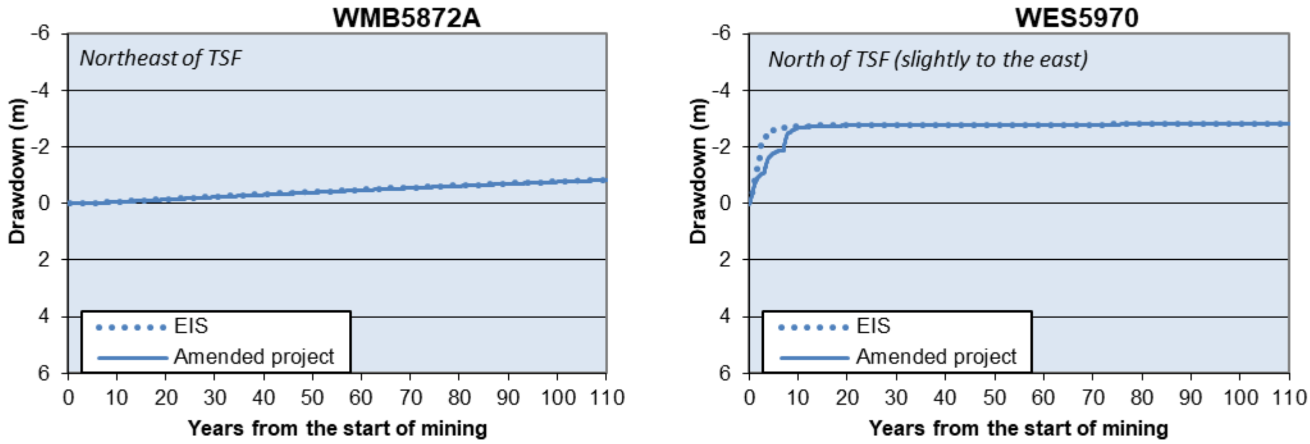


Figure 6.6 **Predicted mounding at selected TSF area monitoring sites**

i Predicted drawdown at third-party bores

As stated in EMM (2019a), the AIP identifies thresholds for impact considerations and defines a cumulative pressure head decline of <2 m (at any water supply work) as 'minimal impact'. The model predictions indicate that groundwater levels at existing third-party bores (ie bores located on land adjacent to the mine project area) will experience little to no change as a result of the project (refer Figure 6.7).

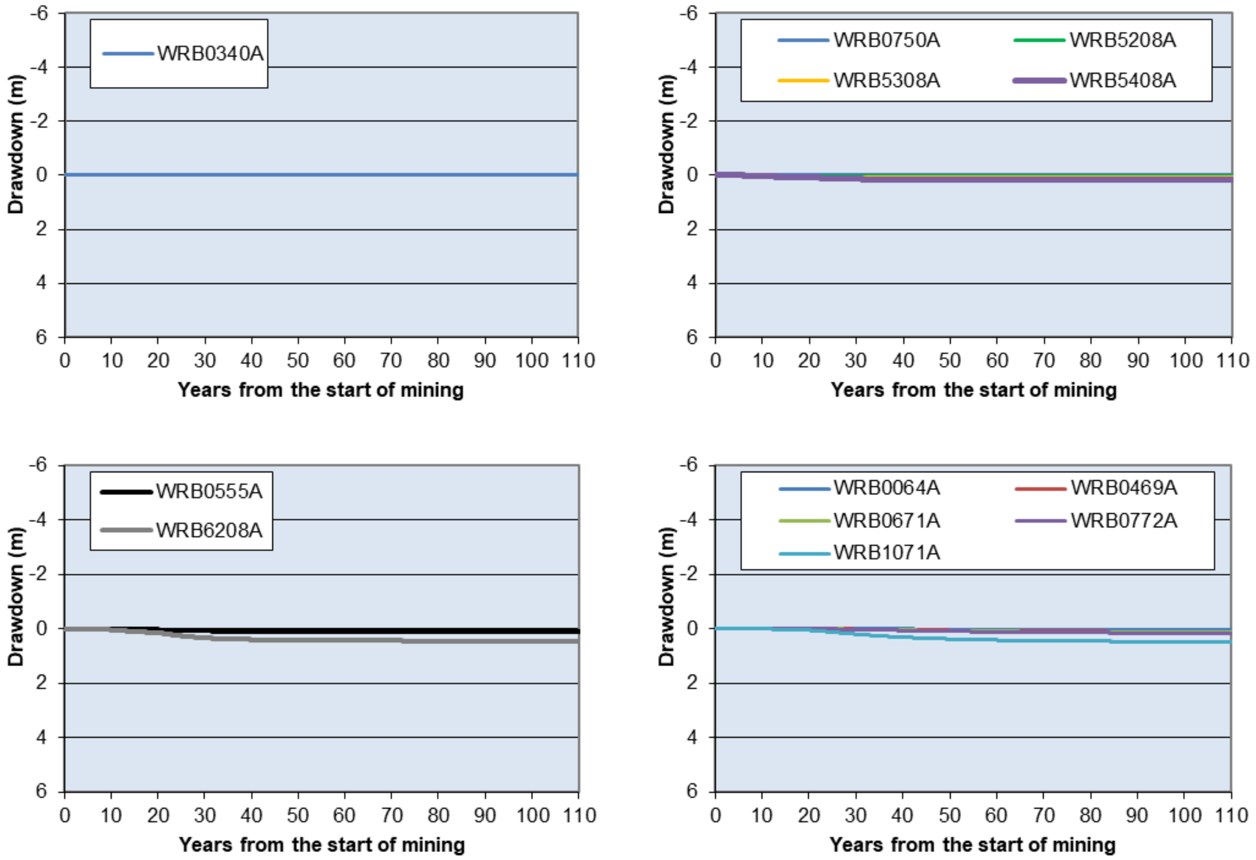


Figure 6.7 **Predicted drawdown at third-party bores (south and east of the pit area)**

ii Predicted drawdown at GDEs

The Biodiversity Development Assessment Report (EMM 2020d) documented vegetation mapping conducted in the mine project area and identified the following PCTs as opportunistic users of groundwater during times of low rainfall:

- Mountain Gum –Manna Gum open forest of the South Eastern Highlands Bioregion (PCT 951); and
- Yellow Box – Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands Bioregion (PCT 1330).

These ecosystems will use groundwater where/when available, but can exist without the input of groundwater, except in periods of prolonged drought. These PCTs are restricted to damp riparian areas where shallow groundwater up to 20 mbgl occurs and therefore is likely to have some degree of groundwater dependence.

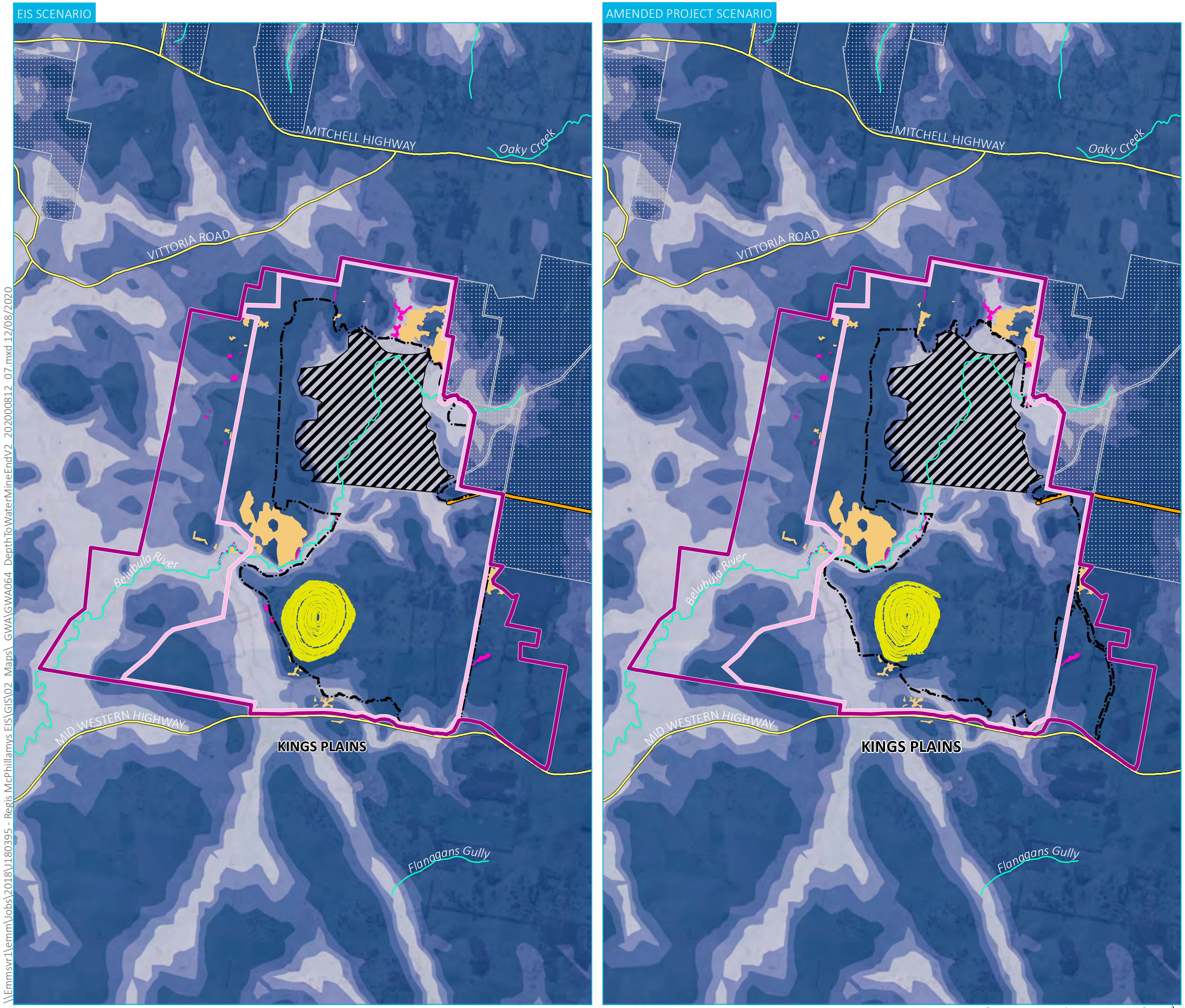
Vegetation within the disturbance footprint will be cleared for project development. As such, only vegetation outside of the disturbance footprint has the potential to be affected by changing groundwater levels.

Outside of the disturbance footprint, the project is predicted to result in no change to a minor increase in the extent of groundwater access for PCT 951 and 1330 by the end of mining and 100 years following mining.

A minor reduction in the extent of groundwater access is predicted for PCT 951 (0.15 ha). Given this minor reduction in the extent of groundwater access and the low interaction and dependence on groundwater (ie between 2–20 mbgl), water stress is not predicted to occur.

Accordingly, no negative groundwater access impacts are expected to occur for terrestrial GDEs.

Figure 6.8 and Figure 6.9 show the modelled depth to groundwater at the end of mining and 100 years post-mining respectively, each compared against the equivalent model time for the EIS base case scenario. As with the drawdown contours, there is negligible difference between the predicted impacts of the two model scenarios.



Source: EMM (2020); Regis Resources (2020); DFSI (2017); DPI (2003); GA (2011)

KEY

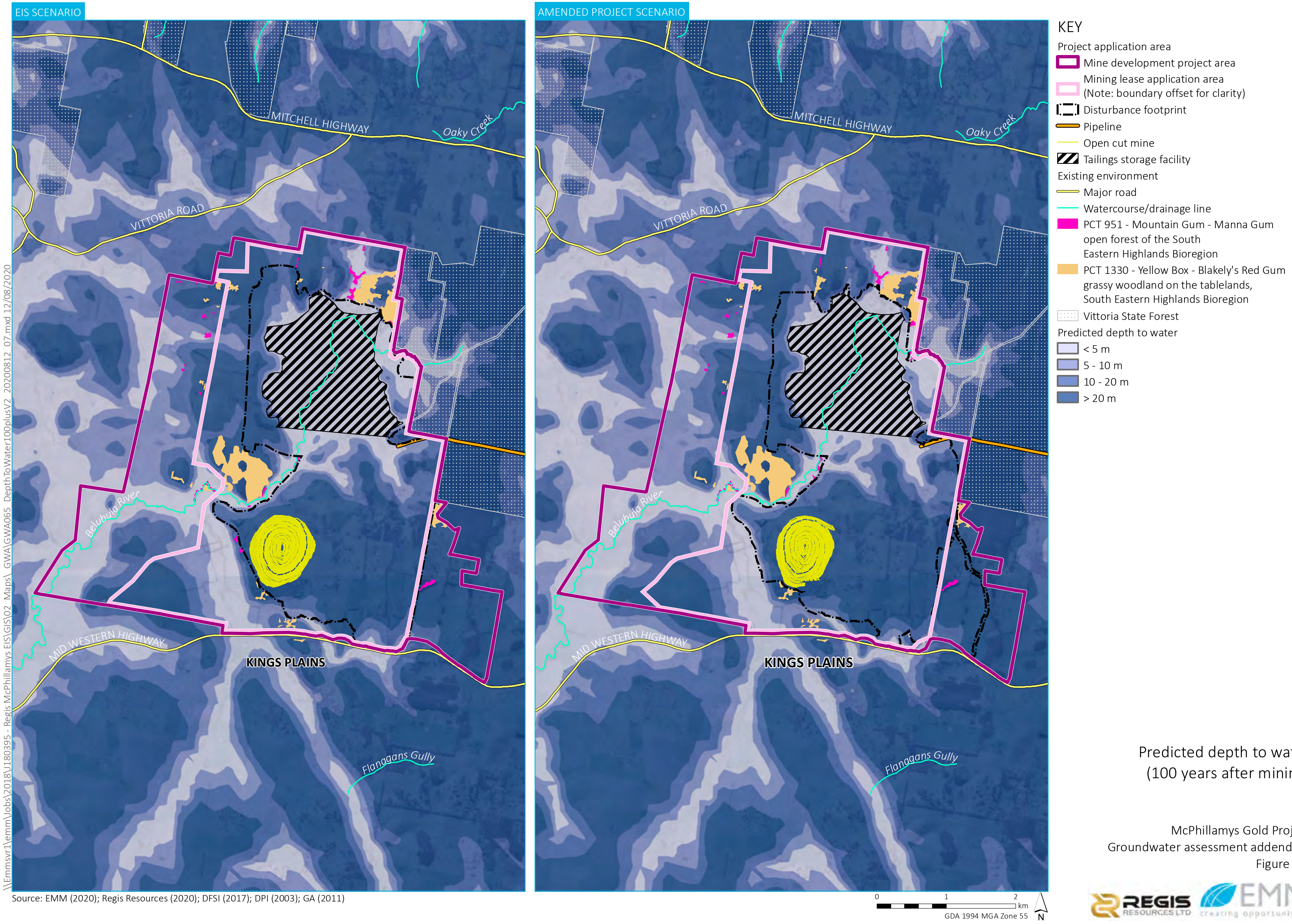
Project application area
- Mine development project area
- Mining lease application area (Note: boundary offset for clarity)
- Disturbance footprint
- Pipeline
- Open cut mine
- Tailings storage facility

Existing environment
- Major road
- Watercourse/drainage line
- PCT 951 - Mountain Gum - Manna Gum open forest of the South Eastern Highlands Bioregion
- PCT 1330 - Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands Bioregion
- Vittoria State Forest

Predicted depth to water
- < 5 m
- 5 - 10 m
- 10 - 20 m
- > 20 m

Predicted depth to groundwater (comparison to EIS) at end of mining

McPhillamys Gold Project
Groundwater assessment addendum
Figure 6.8



Source: EMM (2020); Regis Resources (2020); DFSI (2017); DPI (2003); GA (2011)

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Predicted depth to water
(100 years after mining)

McPhillamys Gold Project
Groundwater assessment addendum
Figure 6.9

iii Predicted changes to surface water-groundwater interactions

a Belubula River

Drawdown has the potential to result in ‘capture’ of surface water, due to both reduced baseflow and increased leakage from surface water bodies. This was assessed with the same method applied in the Groundwater Assessment (EMM 2019a), by running the “Null’ model scenario with no mining activities for the same duration.

The following points summarise the results:

- consistent with the predictions of the EIS base case, there is no predicted change to baseflow or river leakage along the Belubula River downstream of the confluence with Trib A;
- leakage from the Belubula River upstream of confluence with Trib A is predicted to increase by up to 10% between 5 and 10 years after mining (35 kL/day) when compared to the null scenario, which is less than the predicted leakage from EIS base case scenario (12% increase, 42 kL/day);
- leakage from Trib A is predicted to increase by 5% (42 kL/day) when compared to the null scenario, which is slightly less than the EIS base case scenario (44 kL/day);
- baseflow reduction to the Belubula River upstream of the Trib A confluence (to the TSF embankment) is predicted to peak at 28 kL/day (15% reduction) at the end of mining, compared to 29 kL/day at the end of mining in the EIS scenario;
- the predicted change in baseflow to Trib A in the amended project scenario is similar to that predicted in the EIS base case, with a maximum reduction of 13 kL/day (7% change) compared to 14 kL/day in the EIS base case; and
- overall flux changes are delayed for the amended project scenario, due to the slower progression of the open cut and TSF development.

Table 6.2 presents the predicted change in river leakage and baseflow under the amended project scenario.

Table 6.2 Predicted change in baseflow to and river leakage from Trib A and the Belubula River

Mine year	Belubula River upstream of Trib A confluence (kL/day)				Belubula River downstream of Trib A confluence (kL/day)				Trib A (kL/day)			
	Leakage [1]		Baseflow [2]		Leakage [1]		Baseflow [2]		Leakage [1]		Baseflow [2]	
	EIS base case	Amended project	EIS base case	Amended project	EIS base case	Amended project	EIS base case	Amended project	EIS base case	Amended project	EIS base case	Amended project
1	0	0	0	0	0	0	0	0	0	0	0	0
2	2	-1	-4	-1	0	0	0	0	2	1	0	0
3	10	0	-14	-2	0	0	0	0	10	2	-3	-1
4	19	5	-19	-8	0	0	0	0	19	7	-6	-2
5	24	14	-23	-16	0	0	0	0	24	15	-8	-4
6	28	23	-25	-21	0	0	0	0	29	22	-9	-7
7	29	27	-27	-24	0	0	0	0	31	26	-10	-8
8	30	30	-28	-26	0	0	0	0	33	30	-11	-10
9	30	31	-28	-27	0	0	0	0	34	32	-11	-10
10	30	31	-29	-28	0	0	0	0	35	34	-11	-11
11	-	31	-	-28	-	0	0	0	-	35	-	-11
+1	32	28	-22	-22	0	0	0	0	36	35	-12	-11
+2	36	31	-23	-21	0	0	0	0	37	36	-12	-12
+3	38	33	-24	-22	0	0	0	0	39	37	-13	-12
+4	40	34	-25	-22	0	0	0	0	40	38	-13	-12
+5	41	35	-26	-23	0	0	0	0	41	39	-13	-13
+6	42	35	-26	-23	0	0	0	0	41	39	-14	-13

Table 6.2 Predicted change in baseflow to and river leakage from Trib A and the Belubula River

Mine year	Belubula River upstream of Trib A confluence (kL/day)				Belubula River downstream of Trib A confluence (kL/day)				Trib A (kL/day)			
	Leakage [1]		Baseflow [2]		Leakage [1]		Baseflow [2]		Leakage [1]		Baseflow [2]	
	EIS base case	Amended project	EIS base case	Amended project	EIS base case	Amended project	EIS base case	Amended project	EIS base case	Amended project	EIS base case	Amended project
+7	42	35	-26	-23	0	0	0	0	42	40	-14	-13
+8	42	35	-27	-23	0	0	0	0	42	40	-14	-13
+9	42	35	-27	-23	0	0	0	0	42	41	-14	-13
+10	42	35	-27	-23	0	0	0	0	43	41	-14	-13
+50	42	24	-28	-20	0	0	0	0	44	42	-14	-13
+100	42	24	-29	-20	0	0	0	0	44	42	-14	-13

1. A positive number indicates river leakage (to groundwater) is predicted to increase as a result of the project (ie leakage is greater in the mining scenario when compared to the null scenario).
2. A negative number indicates baseflow (groundwater discharge to the watercourse) is predicted to reduce as a result of the project, when compared to the null (no mining) scenario.

The predicted surface water capture (net change in baseflow to and leakage from each watercourse) as a result of the project is summarised in Table 6.3, with a comparison to equivalent predicted flux changes as predicted in the EIS base case. Net surface water capture from both the Belubula River and Trib A is consistent between each scenario by the end of mining, with an initially slower progression for the amended project scenario. Post-mining flux changes are lower for the amended project.

As mentioned in the Groundwater Assessment (EMM 2019a), groundwater is currently predicted to contribute approximately 5% of overall surface flows in the Belubula River upstream of the confluence with Trib A. Therefore, the predicted reduction in baseflow is expected to have a minor influence on overall surface flows in Trib A and the Belubula River upstream of the confluence with Trib A.

Table 6.3 Predicted net surface water capture

Mine year	Amended project scenario		EIS base case scenario	
	Belubula River upstream of Trib A confluence (kL/day)	Trib A (kL/day)	Belubula River upstream of Trib A confluence (kL/day)	Trib A (kL/day)
1	0	0	0	0
2	0	1	6	2
3	1	3	23	13
4	12	9	38	24
5	31	19	47	32
6	44	28	52	38
7	52	34	56	42
8	57	40	57	44
9	58	43	58	45
10	59	45	59	46
11	59	46	-	-
+1	50	46	54	48
+2	52	48	59	50
+3	55	49	63	51
+4	56	50	65	53
+5	58	51	67	54
+6	58	52	68	55
+7	59	53	68	56
+8	59	53	69	56
+9	59	54	69	56
+10	58	54	69	57
+50	45	56	67	58
+100	44	56	71	59

b Seeps/springs

Figure 6.10 presents predicted watertable drawdown/mounding at selected spring locations that are outside of the project disturbance footprint:

- north of the TSF (WES5970);
- between the TSF and the open cut mine, near the Belubula River (WES3250, WES3151A and WES3151B); and
- south-east of the open cut mine (WES1164A).

The model predicts:

- mounding of the watertable at spring WES5970 north of the TSF (>2 m draw up), consistent with the predictions of the base case scenario but with a slower development due to the changed placement schedule;
- minor changes to the watertable in the area between the TSF and the open cut mine, consistent with the predictions from the EIS base case scenario; and
- minor drawdown of the watertable at spring WES1164A south-east of the open cut mine (<1 m drawdown predicted), unchanged from the EIS base case.

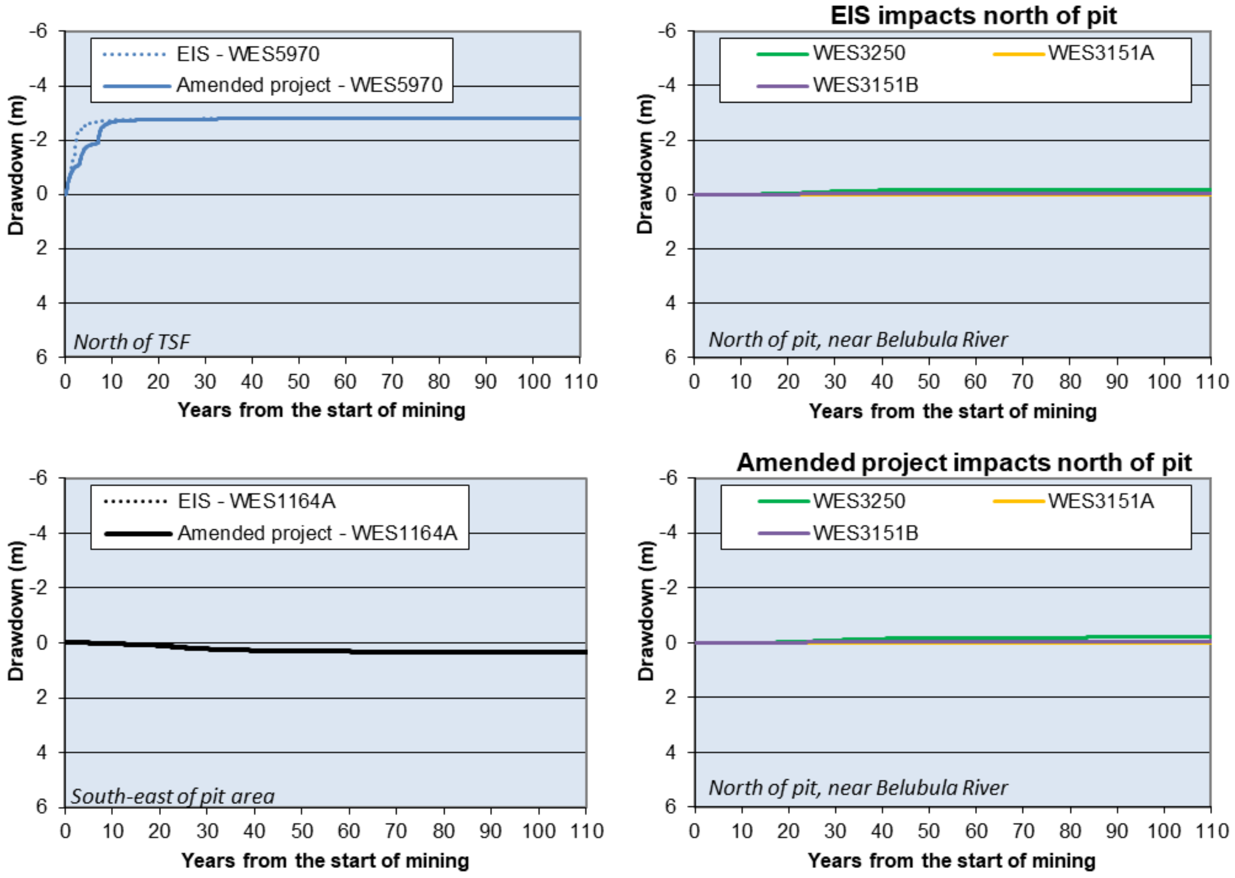


Figure 6.10 Predicted watertable drawdown at selected spring locations outside of disturbance area

c Summary

Based on the assessments conducted, the main contribution to the Belubula River surface flows in the mine project area comes from rainfall and surface water runoff, with minor contribution provided by the springs and the local groundwater system. The main change to the surface water flows will result from a reduction in the surface water catchment area, rather than construction of the project (including the TSF) on the springs.

The TSF and other project infrastructure will be constructed in areas where springs/seeps have been observed. This activity will change the ground conditions and shallow groundwater that currently discharges at surface as a seep or spring will no longer discharge at that location. Instead, the shallow groundwater will continue to move underground (ie this water will remain in the greater catchment). Some of this shallow groundwater will be intercepted by the TSF seepage interception drain or will continue to move underground discharging in the Belubula River or at new or other spring locations. Outside of the mine project area, groundwater levels are not predicted to change as a result of the project. Therefore, seeps and springs outside of the project area will not be altered as a result of the project.

6.1.3 Mine inflow predictions

The predicted inflows to the open cut mine during operation are presented in Figure 6.11 with a comparison to the predicted dewatering from the EIS base case scenario. Consistent with the EIS base case, mine advancement over the 11-year mine life is simulated annually. The predicted inflow rate peaks in mining year 2 at 580 ML/year, with a second slightly smaller peak in year 5 at 557 ML/year and declines to 160 ML/year in mining year 11. The predicted inflow volumes are driven by the volume of material mined from the simulated saprock layer (model layer 1), which stores and transmits more groundwater than the underlying fresh rock. Figure 6.12 displays the total mined volume per year against the mined volume within the weathered zone below the pre-mining watertable. This figure shows that the higher mine inflow rates in years 2, 4 and 5 correlate with volumes mined from the simulated weathered zone.

The predicted peak inflows for the amended project are lower than the previous simulated mine schedule (EIS base case) due to the steadier development profile scheduled over the first years of the amended project (Figure 6.13). The peak mine inflow in the EIS scenario was predicted to occur in mining year 2, which represented the peak mined volume under the earlier mine plan (Figure 6.13) and also simulated removal of more material from model layer 1, which as explained above, is the main driver the predicted inflow volumes. As discussed in Section 2.4.2, and shown on Figure 6.12 and Figure 6.13, the refined mine design and schedule has resulted in less volume mined from shallower depths (model layer 1, with relatively higher permeability and storage properties) in mine year 2 and 3. This can also be seen on Figure 6.14 which presents the mine development general arrangement in mining year 2 and shows the difference in the pit shell between the EIS and the amended project in year 2.

Figure 6.15 presents a cross section through the proposed open cut, showing the simulated annual mine advancement and predicted watertable elevation.

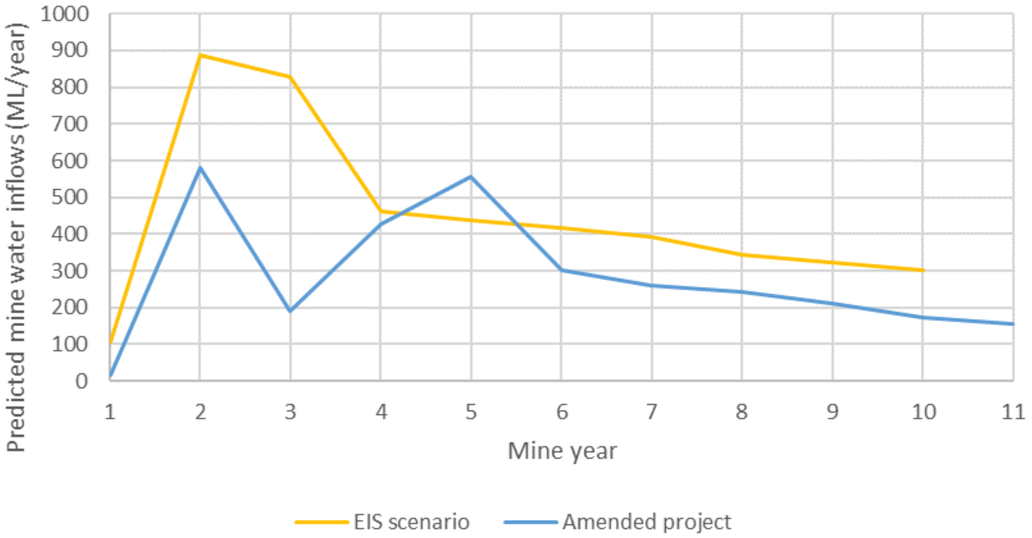


Figure 6.11 Predicted mine inflows

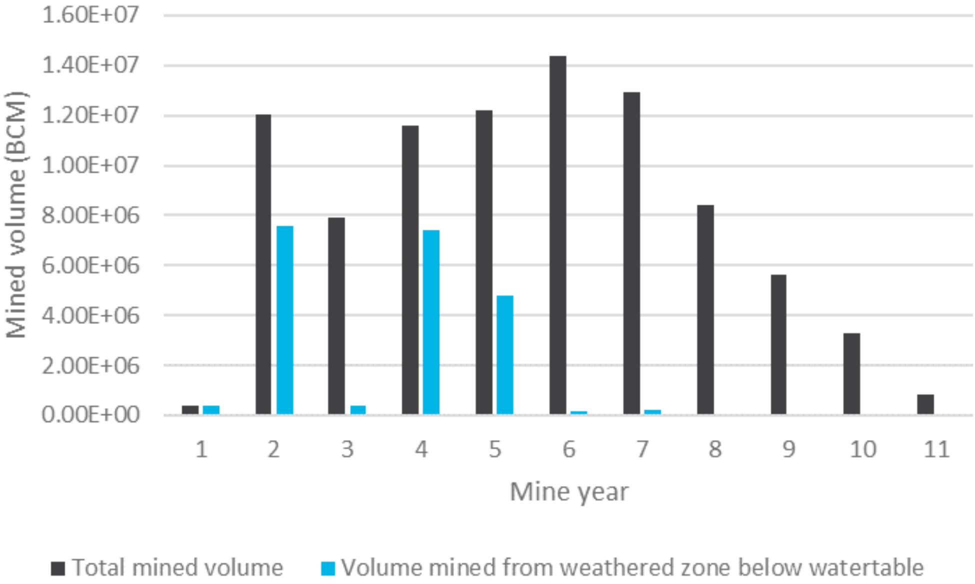


Figure 6.12 Annual volume mined from weathered zone (model layer 1) below pre-mine watertable (amended project)

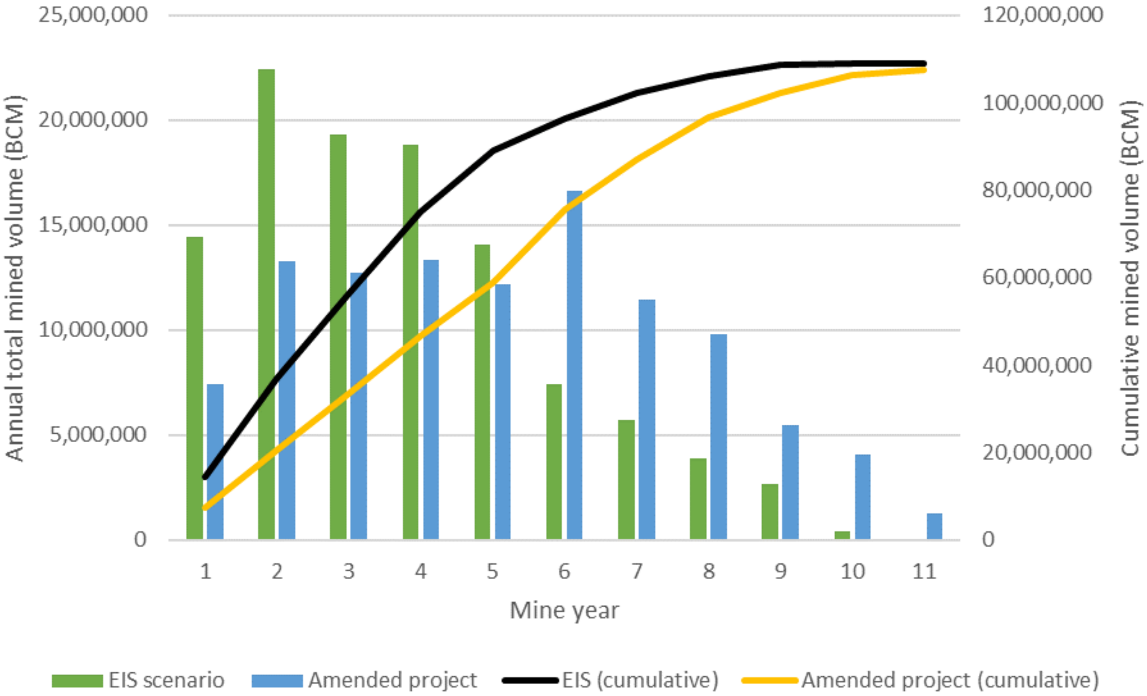
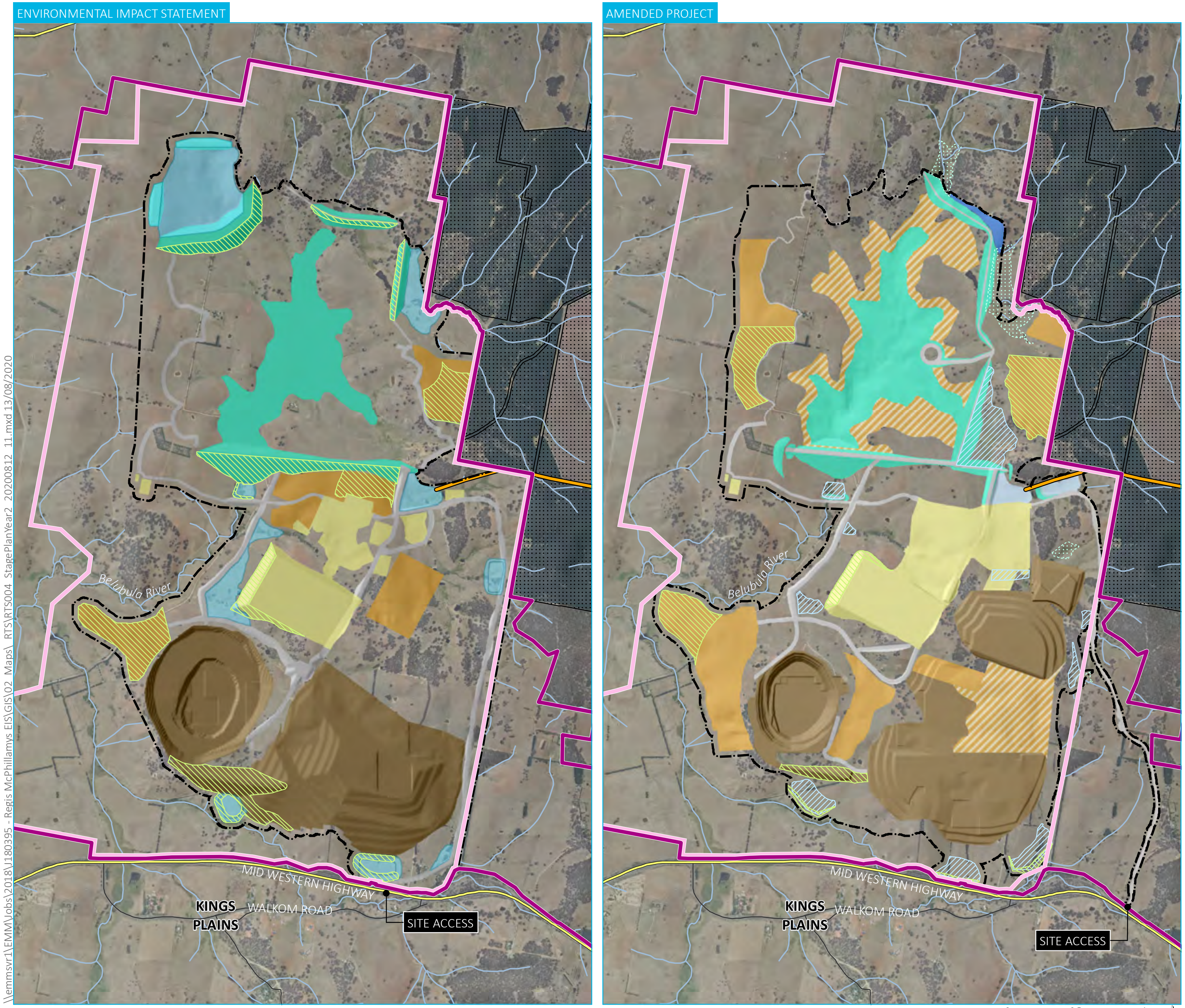


Figure 6.13 Open cut mining volumes (annual and cumulative)



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Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DFSI (2017)

KEY

Project application area
- ▭ Mine development project area
- ▭ Mining lease application area (Note: boundary offset for clarity)
- ▭ Disturbance footprint
- ━ Pipeline

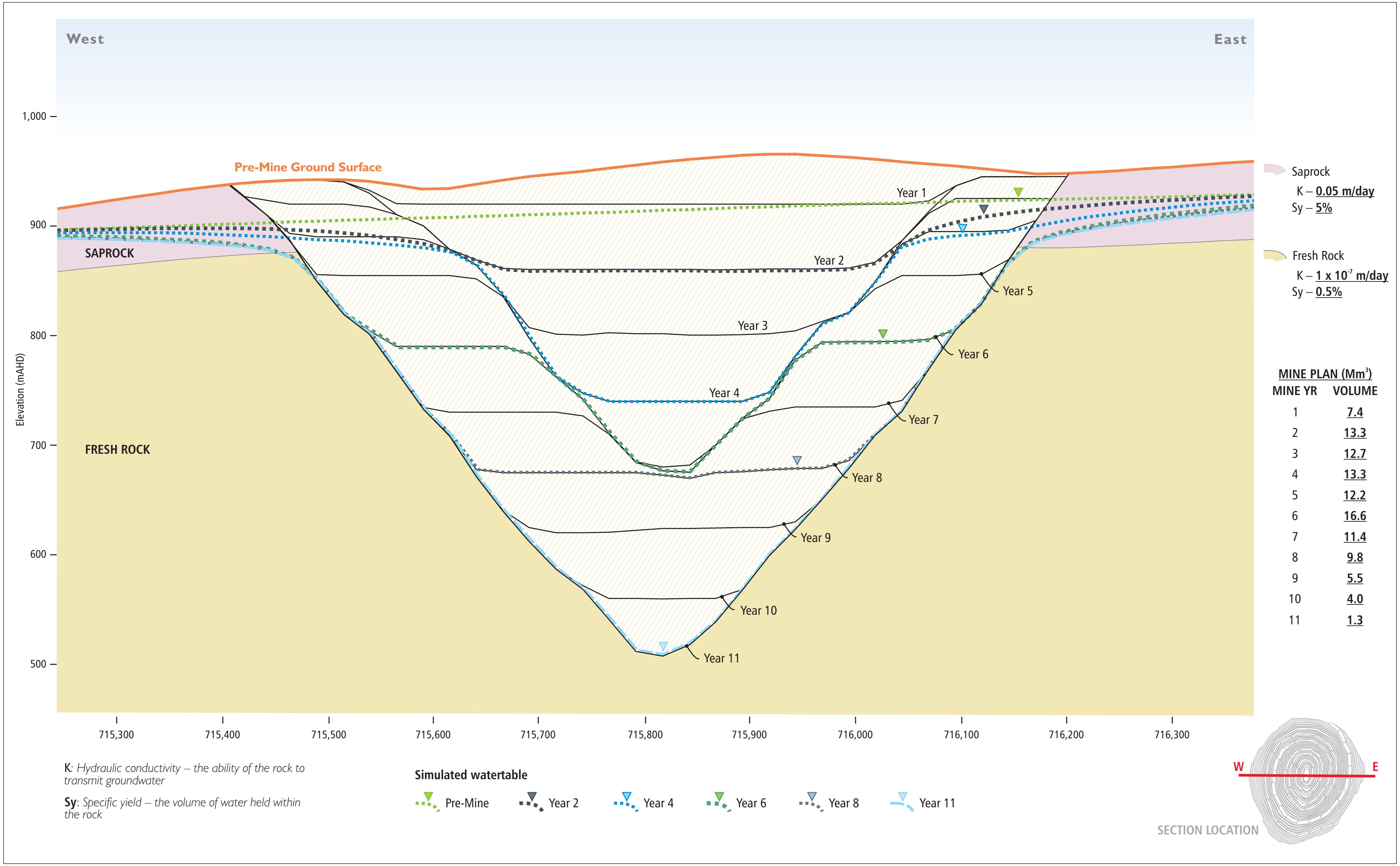
Existing environment
- ━ Major road
- — Minor road
- — Watercourse/drainage line
- ▨ Vittoria State Forest

Completed works
- 🟨 Mine infrastructure area
- 🟫 Mining operations (open cut & waste rock emplacement)
- ⬜ Road
- 🟩 Tailings storage facility
- 🟧 Soil zone
- ▨ Soil stripping
- 🟦 Water management area (EIS)
- 🟦 Clean water diversion (amended project)
- 🟦 Water management facility (WMF) - continuous storage (amended project)
- ▨ Water management facility (WMF) - infrequent storage (amended project)
- ▨ Clean water facility (CWF) (amended project)

Mine rehabilitation
- ▨ Hydromulched/grass

Mine development general arrangement – year 2

McPhillamys Gold Project
Groundwater assessment addendum
Figure 6.14



MINE PLAN (Mm^3)

MINE YR	VOLUME
1	7.4
2	13.3
3	12.7
4	13.3
5	12.2
6	16.6
7	11.4
8	9.8
9	5.5
10	4.0
11	1.3

K: *Hydraulic conductivity – the ability of the rock to transmit groundwater*

Sy: *Specific yield – the volume of water held within the rock*

Cross section showing open cut pit progression

McPhillamys Gold Project
Groundwater Assessment Addendum

Figure 6.15

6.1.4 TSF seepage predictions

As outlined in the Groundwater Assessment (EMM 2019a) and Section 5.3.2, the simulation of the TSF in the groundwater model has been completed to assess the potential worst case TSF seepage scenario and the purpose is not to provide an accurate estimate of TSF seepage rates.

The predicted seepage results from the TSF assessment (ATC Williams 2019 and 2020) is provided in Section 5.3.2.

i Groundwater model results

The model predicted TSF seepage is presented in Figure 6.16. The groundwater model predicts the TSF seepage rate to peak at approximately 460 ML/year (in mine year 8) for the amended project, which is much lower than the 700 ML/year previously predicted in the EIS base case scenario. This difference is due to the revised tailings schedule associated with the amended project. As presented in Table 2.2, the EIS base case simulated the three TSF stage rises to occur in the first three years, in comparison to the amended project where there is more time between stage rises. The predicted seepage rate of the amended project increases in years 4 and 8, following the planned TSF stage rises and then reduces over time to approximately align with the long-term seepage predicted in the EIS base case.

The predicted seepage rate is still much higher than the TSF seepage rate predicted by ATC Williams (2019 and 2020) as part of the TSF design. The difference is attributed to the simulation of tailings placement, with the groundwater model adopting a highly conservative approach to inform an assessment of potential impacts on groundwater receptors (ie worst case scenario for seepage and impacts on receptors).

Note that the EIS base case predicted seepage trend presented in Figure 6.16 shows a gap between mining year 10 and 1 year after mining (shown as +1). This reflects the schedule simulated in EIS base case scenario, which had a mining operating period for 10 years.

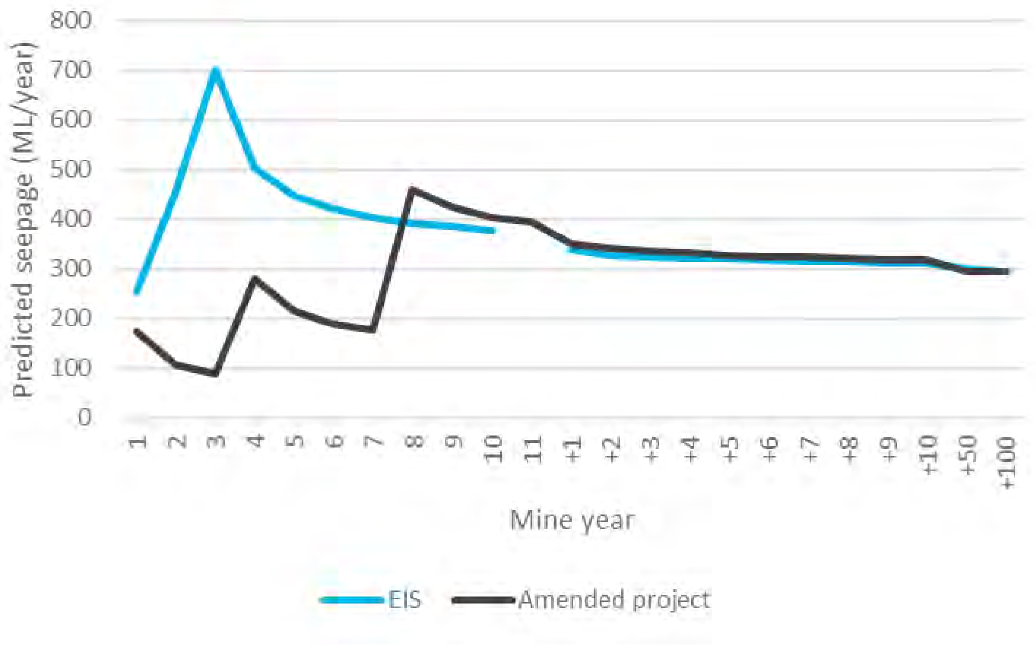


Figure 6.16 Predicted TSF seepage

6.1.5 Pit lake recovery

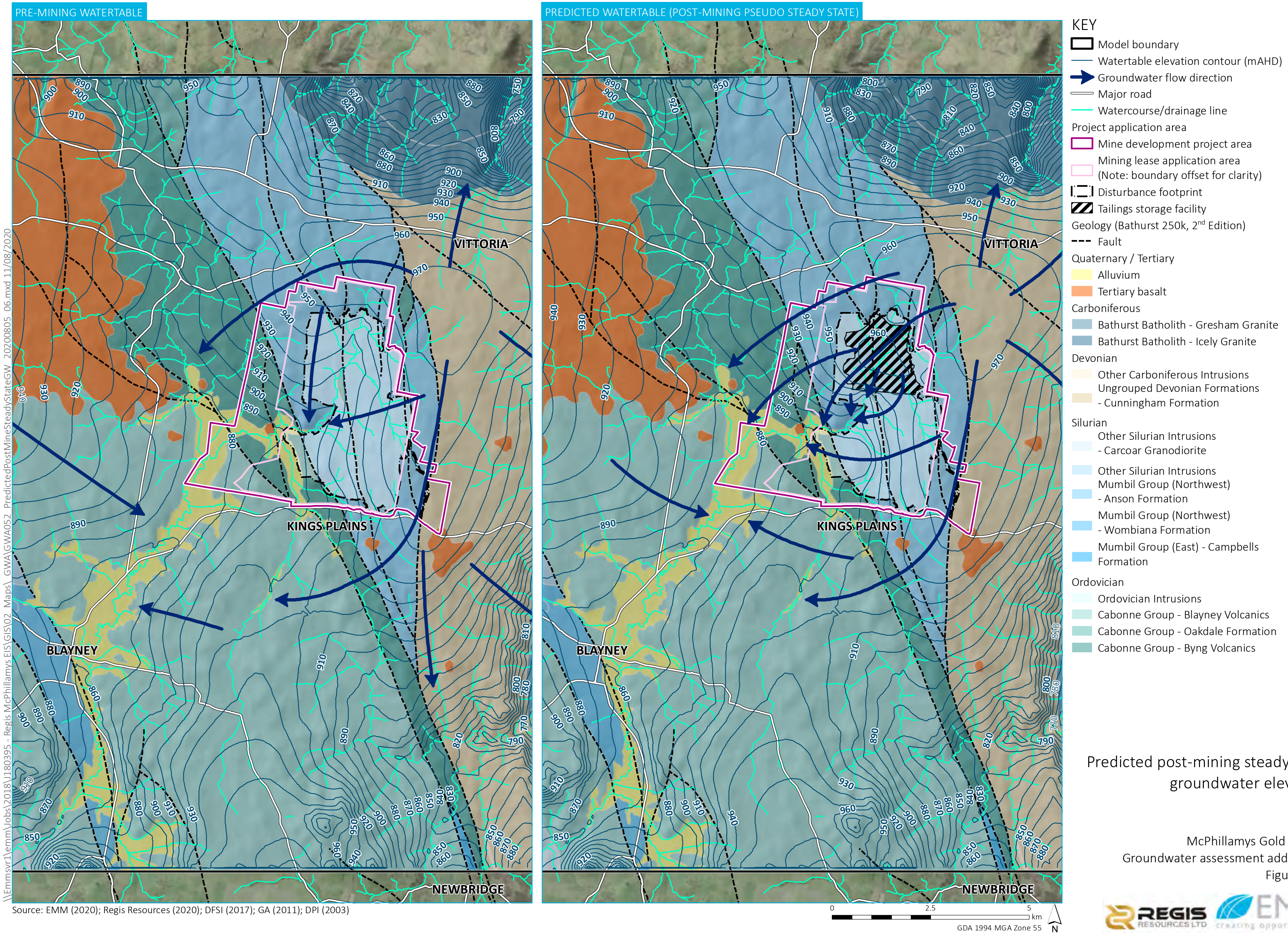
Predicted groundwater flux and groundwater elevation post-mining has been provided to HEC for use in the post-mine water balance to assess pit lake recovery in the Revised Surface Water Assessment. The HEC (2020) assessment predicts the pit lake will recover to an elevation of around 902 mAHD, however the rate of pit lake level rise is slow, and it is predicted to take over 500 years to reach this elevation.

Water balance information from the HEC (2020) pit lake assessment has been used in the groundwater model to assess the long-term impacts of the project on the regional groundwater system and to provide comparison to the HEC (2020) assessment. The long-term average inputs and outputs of the pit lake water balance model (excluding groundwater inflow; HEC 2019) are:

- rainfall and runoff: 472 ML/year; and
- evaporation: 519 ML/year.

The predicted post-mining pseudo steady state groundwater elevation is presented on Figure 6.17. The predicted groundwater elevation is consistent with the results of the HEC (2020) assessment, with groundwater elevation predicted to return to around 900 mAHD in the open cut mine area in the long term post closure. Based on the predicted watertable elevations and the work completed by HEC (2020), the open cut mine is predicted to act as a groundwater sink for around 500 years and may then change to a throughflow pit under pseudo steady state conditions. However, the model predicts predominantly sink conditions, with only minor groundwater flow through, and the final void under steady state conditions is:

- predicted groundwater inflow to void: 66 ML/year (181 kL/day); and
- predicted groundwater outflow from the void: 11 ML/year (31 kL/day) after 500 years.



Source: EMM (2020); Regis Resources (2020); DFSI (2017); GA (2011); DPI (2003)

Predicted post-mining steady state groundwater elevation

McPhillamys Gold Project
Groundwater assessment addendum
Figure 6.17

6.2 Groundwater quality

As reported in the Groundwater Assessment (EMM 2019a), the water affecting activities of the project have the potential to cause groundwater quality changes as a result of:

1. seepage from the TSF to the watertable and the Belubula River;
2. seepage from the waste rock emplacement to the watertable (including AMD risk);
3. seepage from water management facilities to the watertable;
4. evaporative concentration of solutes in the final pit void; and
5. introduction of varying water quality via the pipeline.

Points number 2, 3 and 5 were assessed as part of the Groundwater Assessment (EMM 2019a) and are not represented in this addendum report. The potential changes to groundwater quality as a result of the predicted TSF seepage has been updated based on the amended TSF schedule and the final pit lake salinity has also been reassessed by HEC (2020) and is summarised in this section.

6.2.1 TSF seepage

As discussed in the Groundwater Assessment (EMM 2019a) and in Section 6.1.4, the groundwater flow model included simulation of the TSF using a deliberately conservative approach to assess the potential changes to groundwater movement under a "worst-case" seepage scenario. The design and assessment of the TSF seepage management measures have been completed by ATC Williams (2019) and demonstrate that seepage from the TSF will be effectively managed using design controls (as described in Section 2.4.3i), including a lined embankment and cut-off key, floor liners, seepage interception drain and downstream interception bores (if needed). Following completion of mining and tailings placement, the TSF will be capped to facilitate surface water drainage, prevent any ponding of water and limit potential rainfall infiltration into the tailings (ATC Williams 2019).

The results of groundwater modelling (EIS base case and amended project) demonstrate that under a highly conservative scenario, with limited mitigation measures in place, seepage from the TSF is predicted to slowly migrate south-west and south of the TSF. Seepage from the TSF is predicted to remain within the saprock zone, flowing in a horizontal direction. Some of the seepage that migrates south from the TSF that is not intercepted by the seepage management system is predicted to seep towards the pit. Some seepage is predicted to move towards the Belubula River at a rate of approximately 50 m in 100 years.

The work completed by ATC Williams (2020) shows that during operations, seepage from the TSF is predicted to be much lower at around 22 kL/day (peak; 3 mm/year/m^2), with approximately 90% captured by the interception drain. Following closure, seepage from the TSF will continue due to the low permeability liner, the nature of the geology and the tailings. This predicted low volume of seepage post closure (11 - 15 kL/day [1.4 - 2.1 mm/year/m^2]) is predicted to flow towards the pit and some is predicted to move towards the Belubula River. This volume is very small in comparison to the Belubula River streamflow (at the gauging station downstream of the confluence with Trib A), which is estimated to have flows of around 289 ML/day during average climate conditions and 2.7 ML/day during dry conditions. That is, average flows down the Belubula River represent 10,000 times the predicted seepage rate.

TSF seepage is very slow and by the time it migrates through the ground and moves towards the Belubula River, the seepage water will mix with groundwater, become diluted and will undergo other reactions with the geology and groundwater. Changes are unlikely to be measurable.

i Tailings water quality

As presented in the Groundwater Assessment (EMM 2019a) and the Geochemistry characterisation report (SRK 2019; Appendix G to the EIS) the tailings will undergo cyanide destruction as part of the ore processing to minimise potential impacts to the environment from elevated concentrations of cyanide and other metals (see Section 2.4.3).

Geochemical metallurgical testing of tailings samples occurred as part of the geochemical characterisation for the project (SRK 2019). This included testing tailings samples pre-cyanide detoxification and samples following the cyanide detoxification. The results of the testing provide an indication of leachate concentrations in TSF seepage (SRK 2019). The results of five samples representing the tailings leachate following cyanide detoxification are summarised in Table 6.4, along with a comparison to laboratory reported concentrations for surface water and groundwater in the area.

When compared to the ANZECC (2000) livestock drinking water guideline values, the results show the tailings leachate is expected to have elevated concentrations of electrical conductivity, sulphate, fluoride (marginal) and selenium (see Table 6.4).

When compared to the ANZECC (2000) 95% species protection of freshwater aquatic ecosystems, the results show the tailings leachate is expected to have elevated concentrations of pH (marginally above), electrical conductivity, aluminium, arsenic, cobalt and selenium (see Table 6.4).

However, the following parameters are within the baseline surface water quality and/ or groundwater concentration ranges (see Table 6.4):

- pH
- electrical conductivity;
- aluminium;
- arsenic;
- cobalt; and
- fluoride.

Table 6.4 also shows that the surface water and groundwater quality local to the area has elevated concentrations of cadmium, copper, mercury, manganese, nickel, lead and zinc.

Table 6.4 Summary of tailings geochemical testing (liquid fraction) results following cyanide detoxification (SRK 2019)

Analyte	ANZECC (2000) Livestock drinking water guideline value	ANZECC (2000) 95% protection level for freshwater aquatic ecosystems	Concentration range	Average concentration	Concentration in baseline groundwater	Concentration in baseline surface water
pH		6.5-8	7.9-8.4	8.2	2.1-8.5	5.4-9.5
Electrical Conductivity (µS/cm)	3,350 [1]	30-350	4,050-9,490	5,264	281-4,817	42.6-1,650
Alkalinity - CO_3 ($mgCaCO_3/L$)			<1-13	8.5	<5	<1-110
Alkalinity - HCO_3 ($mgCaCO_3/L$)			149-399	215	<1-490	<1-620
Alkalinity – OH ($mgCaCO_3/L$)			<5	<5	<1-5	<1-5
Alkalinity – Total ($mgCaCO_3/L$)			149-412	218	<1-490	<1-620
Acidity ($mgCaCO_3/L$)			4-9.6	6.9	-	-
Sulphate, SO_4 (mg/L)	1,000		2,201-5,267	2,942	1-3,000	<1-450
Silver, Ag (µg/L)		0.05	<0.1-0.2	0.2	<1-2	<1-3
Aluminium, Al (mg/L)	5	0.055	0.3-0.5	0.36	0.01-200	0.01-47
Arsenic, As (µg/L)	500	24	2-76	21	<1-1,450	<1-40
Boron, B (mg/L)	5	0.37	<0.1-0.1	<0.1	0.02-0.3	0.02-0.05
Barium, Ba (µg/L)			77-132	93.6	<1-740	25-910
Beryllium, Be (µg/L)			<1	<1	<0.5-4	<0.5-4
Bismuth, Bi (µg/L)			0.06-0.13	0.095	-	-

Table 6.4 Summary of tailings geochemical testing (liquid fraction) results following cyanide detoxification (SRK 2019)

Analyte	ANZECC (2000) Livestock drinking water guideline value	ANZECC (2000) 95% protection level for freshwater aquatic ecosystems	Concentration range	Average concentration	Concentration in baseline groundwater	Concentration in baseline surface water
Calcium, Ca (mg/L)			466-631	519	3.5-680	<1-230
Cadmium, Cd (µg/L)	10	0.2	<0.2	<0.2	<0.1-210	<0.1-0.6
Chloride, Cl (mg/L)			305-1,321	525.2	5-251	<1-285
Cobalt, Co (µg/L)	1,000	1	41-163	72	<1-310	<1-45
Chromium, Cr (mg/L)	1		<0.1	<0.1	<0.001-0.016	<0.001-0.2
Copper, Cu (mg/L)	0.4	0.0014	<0.1-0.1	<0.1	<0.001-16	<0.001-0.154
Fluoride, F (mg/L)	2		1-3.9	1.9	0.1-2.2	0.1-0.6
Iron, Fe (mg/L)			<0.1-0.7	0.22	<0.01-37	<0.01-84
Mercury, Hg (µg/L)	2	0.6	<1	<1	<0.05-42	<0.05-3.8
Potassium, K (mg/L)			74-304	133	0.5-27	<1-84
Magnesium, Mg (mg/L)			26-142	54.2	2-376	<1-150
Manganese, Mn (mg/L)		1.9	0.3-0.5	0.4	<0.001-60	0.005-7.8
Molybdenum, Mo (µg/L)	150		9.1-39	16	<1-30	<1-9
Sodium, Na (mg/L)			698-2,465	1,059	13-291	0.9-126
Nickel, Ni (mg/L)	1	0.011	<0.1	<0.1	<0.001-0.42	<0.001-0.19
Lead, Pb (µg/L)	100	3.4	<5	<5	<1-18	<1-234
Antimony, Sb (µg/L)			4.5-19	8.9	<1-8	<1-2
Selenium, Se (µg/L)	20	11	16-252	81	<1-10	<1-10

Table 6.4 Summary of tailings geochemical testing (liquid fraction) results following cyanide detoxification (SRK 2019)

Analyte	ANZECC (2000) Livestock drinking water guideline value	ANZECC (2000) 95% protection level for freshwater aquatic ecosystems	Concentration range	Average concentration	Concentration in baseline groundwater	Concentration in baseline surface water
Tin, Sn (µg/L)			<1	<1	-	-
Strontium, Sr (µg/L)			3,563-8,590	5,014	-	-
Thorium, Th (µg/L)			<0.05	<0.05	-	-
Titanium, Ti (mg/L)			<0.1	<0.1	-	-
Thallium, Tl (µg/L)			0.1	0.1	-	-
Uranium, U (µg/L)	200	[2]	0.4-2.4	1.2	-	-
Vanadium, V (mg/L)			<0.1	<0.1	<0.001-0.41	<0.001-0.14
Zinc, Zn (mg/L)	20	0.008	<0.1	<0.1	<0.001-28	<0.001-0.693
Cyanide, CN-Total (mg/L)			0.6-1.6	0.9	<0.0004	<0.0004-0.006
Weak Acid Dissociable Cyanide, CN-WAD (mg/L)			<0.5-0.8	0.7	<0.0004	<0.004

▨	Note: Shaded cells represent concentrations that exceed the 95% protection level for freshwater aquatic ecosystems (ANZECC 2000) guideline value
☐	Note: Cells with green borders represent concentrations that exceed the ANZECC (2000) livestock drinking water guideline values

Note:

1 – Beef cattle TDS range 4,000-5,000 mg/L converted to EC using 0.67 converting factor.

2 – ANZECC (2000) and Water Quality Australia (2018) report a low reliability/confidence trigger for uranium of 0.5 µg/L and the level of species protection is not specified. This value is reported by Water Quality Australia (2018) and AZECC (2000) as indicative only, is based on limited data with inherent uncertainty and should not be used as default guidelines.

ii Estimated change to water quality

By the time TSF seepage migrates through the ground and moves towards the Belubula River, the seepage water chemistry will mix with groundwater along the flow path and will undergo other hydrogeochemical reactions (eg as water moves through the ground, analytes can adsorb to clays or other minerals in the unsaturated or saturated zone, changing the concentration along the flow path). Consistent with the approach used for the Groundwater Assessment (EMM 2019a), a simple dilution calculation was conducted to provide an estimate of the concentration of selected analytes within the saturated saprock, based on the predicted peak seepage rate (refer Section 6.1.4), using the average leachate concentration (Table 6.4) and groundwater chemistry reported from monitoring bore WMB5530A. The selected parameters are aluminium, electrical conductivity, total cyanide, weak acid dissociable cyanide, cobalt, selenium and sulphate. These parameters were selected as they are expected to be elevated in comparison to the baseline concentrations measured in surface water and groundwater and in comparison to the ANZECC (2000) 95% protection level for freshwater aquatic ecosystem guideline values.

Following mixing between groundwater and TSF seepage water, groundwater quality parameters (in particular: aluminium, electrical conductivity, sulphate, selenium, cyanide, cobalt) are estimated have concentrations that are:

- below or within the range of water quality concentrations currently measured in groundwater, and the Belubula River and its tributaries;
- below ANZECC (2000) livestock drinking water guideline values (with the exception of cobalt); and
- below ANZECC (2000) 95% protection level for freshwater aquatic ecosystem guideline values.

Table 6.5 summarises the results of the water quality concentration assessment, providing a comparison to concentrations measured in groundwater and surface water over the historical monitoring period.

Table 6.5 Concentrations in groundwater following mixing with TSF seepage

Parameter	Calculated concentration following mixing		Current groundwater concentration range [1]	Current surface water concentration range [2]
	EIS base case	Amended project scenario		
Aluminium (mg/L)	0.03	0.02	<0.01-140	0.01-1.2
Electrical conductivity, EC (µS/cm)	931	843	499-4,817	377-1,040
Total Cyanide (mg/L)	0.057	0.039	<0.004	<0.004
Weak Acid Dissociable Cyanide (mg/L)	0.04	0.024	<0.004	<0.004
Cobalt (mg/L)	9.4	6.3	<0.001-0.31	<0.004
Selenium (mg/L)	0.006	0.004	<0.001-0.01	0.001-0.01
Sulphate (mg/L)	213	157	7-3,000	1-190

Notes:

1. Water quality measured from samples collected from bores monitoring groundwater in the Anson Formation.
2. Water quality measured from samples collected from WED4061A (27 samples), which is a Belubula River monitoring location in the TSF area.

The above demonstrates that even under the conservative simulation of the TSF, groundwater and surface water quality will not be adversely affected by the TSF.

6.2.2 Final pit lake water quality

While the mine void acts as a groundwater sink (for around 500 years), the dissolved salts and metals are expected to become concentrated with time due to evaporation and exposed potentially acid forming material within the void. Under predicted long-term steady state conditions, the pit lake is predicted to act as a minor throughflow pit. As such, there is the potential for water with elevated salts and metals within the pit lake to migrate from the final void in the very long-term (greater than 500 years after mining). However, the rate that the water is predicted to flow from the pit is very low (11 ML/year).

The final pit lake salinity assessment has been conducted by HEC (2020) as part of the pit lake recovery modelling using inputs from the Geochemical Characterisation (SRK 2019), groundwater and surface water quality monitoring data. HEC estimates that the salinity of the pit lake is predicted to increase due to evapo-concentration, reaching around 1,600 µS/cm (electrical conductivity) after 1,000 years, which is within the current groundwater salinity range.

As discussed in Section 7, the groundwater model will continue to be reviewed and updated as additional data become available, and closure planning for the project will continue to be refined as the project develops.

6.3 Construction water supply

As outlined in Section 5.4 and Appendix D, the results of the aquifer tests were analysed to determine a sustainable long-term pumping rate from each test bore (Table 6.6).

Under the assumptions of the water balance (HEC 2020), a groundwater supply of 20 L/s is required in order to avoid a water supply shortfall under all climate scenarios assessed. Additional investigation of the water balance identified that a groundwater supply of 15 L/s will have a 25% risk of a supply shortfall (ie during periods of hot and dry climate; pers. comm. HEC 2020). As such, an additional water supply of 5 L/s is required to meet short-term peaks during periods of hot and dry weather (in the first nine months of construction).

Table 6.6 Recommended test bore pumping rates

Bore ID	Recommended pumping rate (L/s)
TB05	10
TPB4	5
Secured groundwater supply	**15**
Groundwater supply demand	20
Groundwater supply shortfall	**5**

Note: L/s = litres per second

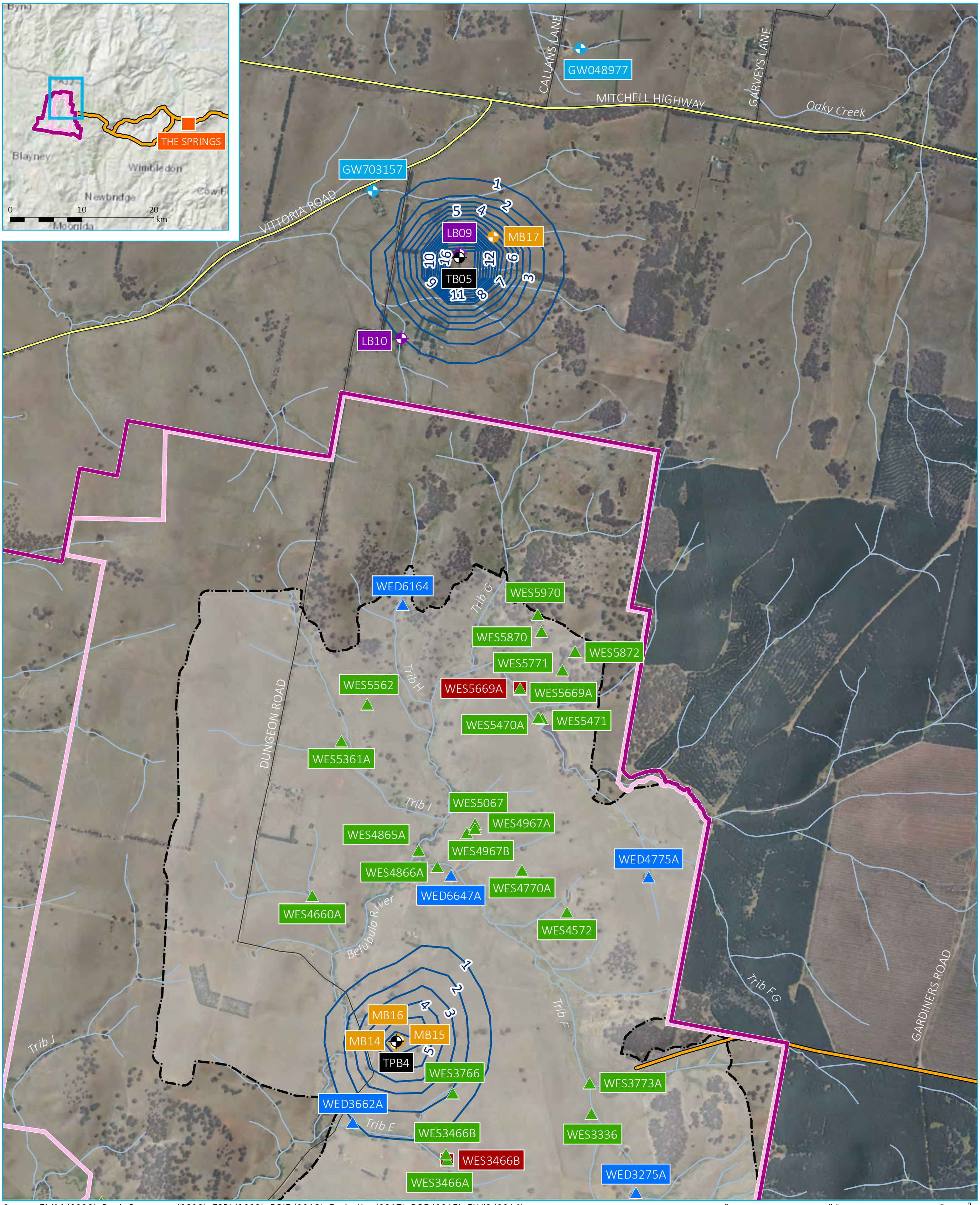
The construction water supply groundwater investigation has demonstrated that production bores can be used to meet the demand. Regis will drill and install additional bores to meet peak demands at drilling targets identified within the mine development and on Regis-owned land.

Potential impacts have been assessed in accordance with the DPI (2018) water resources plans fact sheet (refer Appendix D) and include:

- Localised groundwater level drawdown around the production bores extending no more than 500 m. There are no third-party bores or identified high priority GDEs within the modelled drawdown.

- A temporary reduction in baseflow contribution of 0.7 ML (2.5 kL/day) to the Belubula River is estimated in the vicinity of TPB4. Based on the existing understanding of the Belubula River (HEC 2020, EMM 2020b), this is a minor change and will not result in a noticeable change in flow downstream of the project. This short-term reduction in baseflow to the Belubula River will be licensed by entitlements held by Regis in the Lachlan Fold Belt MDB Groundwater Source.

The groundwater drawdown predicted after nine months of pumping (from the analytical modelling) is presented in Figure 6.18.



Source: EMM (2020); Regis Resources (2020); ESRI (2020); DPIE (2018); EnviroKey (2017); DPE (2015); ELVIS (2014)

0 0.5 1 km
GDA 1994 MGA Zone 55
N

KEY

- ⊕ Test bore
- ⊕ Monitoring bore
- ⊕ Existing bore (Regis land)
- ⊕ Landholder bore
- 🟧 High-priority GDE (refer to inset)
- ▲ Dam
- ▲ Spring
- 🟥 Stygofauna sample location
- — Predicted drawdown (m)

Project application area

- ▭ Mine development project area
- ▭ Mining lease application area (Note: boundary offset for clarity)
- ▭ Disturbance footprint
- — Pipeline

Existing environment

- — Major road
- — Minor road
- — Watercourse/drainage line

Modelled drawdown in response to construction water supply

McPhillamys Gold Project
Groundwater assessment addendum
Figure 6.18

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7 Monitoring, management and mitigation

Section 7 of the Groundwater Assessment (EMM 2019a) presented the proposed monitoring, mitigation and management measures to reduce the potential impact of the project on sensitive receptors. It also presented a discussion on the planned water management strategies and plans for the project and specific measures to mitigate or manage identified potential impacts to sensitive receptors or potential risks to the project.

Further discussion on groundwater monitoring and verification and review of the groundwater model is provided in the following sub-sections.

7.1 Groundwater monitoring

Section 7.3 of the Groundwater Assessment (EMM 2019a) outlined Regis' planned approach regarding groundwater monitoring and is documented in the Groundwater Monitoring and Modelling Plan (GMMP; EMM 2017). As described in Section 3.3, the groundwater monitoring network coverage spans the key hydrogeological units in the mine project area, including the saprock, metasediments, volcaniclastics and alluvium.

Groundwater monitoring (levels and quality) has been conducted since May 2014, with more frequent monitoring occurring from December 2016. The Regis environmental monitoring network also includes surface water flow monitoring sites, surface water quality monitoring, dust monitoring, and weather station.

Groundwater monitoring data will continue to be collected from Regis' project specific monitoring locations throughout the life of the mine. Data loggers that currently monitor groundwater levels will continue to operate.

The monitoring program will provide an early indication of potential impacts to sensitive receptors, including the Belubula River, GDEs, and existing users.

As part of the approved WMP for the mine development, the existing environmental monitoring network will be reviewed and adjusted (as needed) to ensure adequate spatial coverage and collection of data to validate and update groundwater modelling predictions and to ensure that predicted impacts (in most cases no impact) can be measured at sensitive receptors. The ongoing development and expansion of the monitoring network will occur in consultation with EPA, NRAR and DPIE Water, and as per the guidelines for the GMMP, which will evolve as the project progresses. The monitoring program during the operations phase of the project will include monitoring and recording of groundwater abstraction (including mine water inflows), water use, pumping and handling (including water volumes pumped from and to water storages, the plant and the TSF), and the maintenance of associated flow meters.

The WMP will document the proposed mitigation and management measures for the approved project, and will include the surface and groundwater monitoring program, reporting requirements, spill management and response, water quality and level trigger levels, corrective actions, contingencies, and responsibilities for all management measures.

Groundwater quality performance triggers will be based on statistical analysis of the reported ranges in baseline concentrations of identified analytes of concern (eg pH, salinity and concentrations of other analytes such as arsenic, cadmium, cyanide (free, WAD and Total), copper, sulphide, sulphate, selenium, fluoride and aluminium). Groundwater 'quantity' (head) performance triggers will be based on a combination of baseline head data for selected monitoring bores as well as comparison of observed and model predicted heads for different stages of mine development (operational and closure).

Two types of triggers will be defined for groundwater quality and quantity (levels), the first will be a performance trigger and the second an early warning trigger (assigned, for example, as 75% of the performance trigger). Response (review, further investigations and evaluation) will be required when the early warning trigger is exceeded and, depending on the results, action may be required to implement mitigation measures to ensure the performance trigger is not exceeded. In terms of groundwater heads, review will also be required if there is divergence observed from model predicted heads. Triggers will also be assigned based on distance from the water affecting activity (ie TSF, open cut etc) and will be based on a typical Source-Pathway-Receptor assessment approach as illustrated in Table 7.1.

Table 7.1 Source-Pathway-Receptor trigger level assessment approach

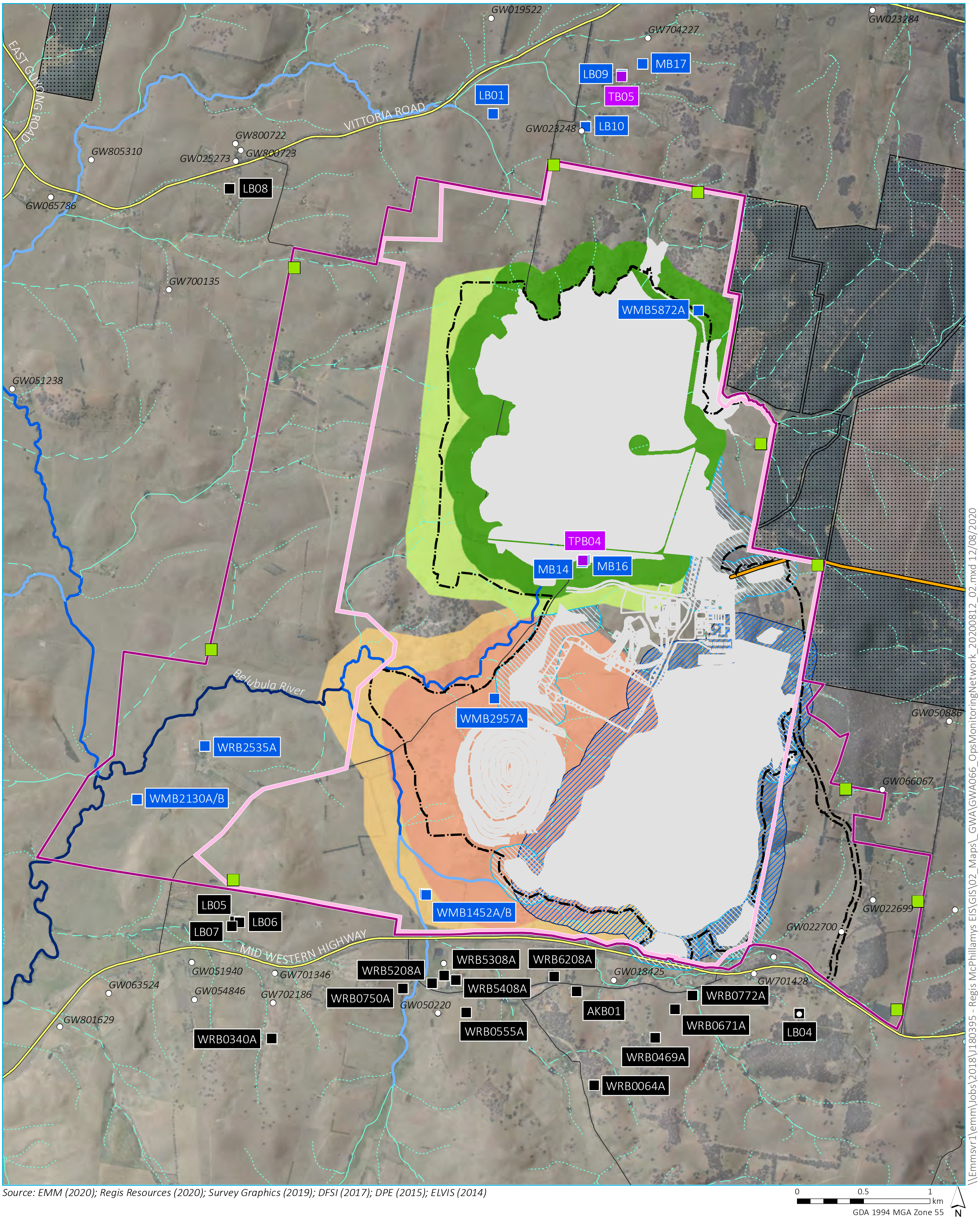
Category	Purpose	Definition and example
Source	Mine affected / performance monitoring	Bores associated with potential sources of impact. Used for diagnostic/ information purposes to understand source water quality and levels (heads and flows) and potential for downgradient changes. Changes to groundwater quality and/or quantity (levels) will be observed at these locations in advance of other monitoring locations. Typically, trigger levels are not developed for monitoring bores that are in this category, but data collected from these bores is used to improve understanding.
Pathway	Early warning	Monitoring bores located downgradient of potential source and within the pathway between the source and receptor. That is, for a water affecting activity to result in a change in quality or quantity at a receptor, there must be a pathway between the source and the receptor (eg hydraulic gradient driving the movement of water). Monitoring will involve assessment of trends within the groundwater flow path and as the bore is located downgradient from the potential source, it acts as an early warning to identify unexpected changes that have the potential to affect receptors. Typically, trigger levels are developed for monitoring bores that are in this category using values that are based on site specific baseline data.
Receptor	Compliance	These monitoring bores are typically located within close proximity to identified receptors (eg landholder bores, watercourses) and are outside of the predicted area of influence of mining activities. Groundwater monitoring data provides information on groundwater conditions at receptor locations and is used for compliance monitoring. Trigger levels are developed for monitoring bores that are in this category using values that are based on site specific baseline data.

Groundwater monitoring bores will be installed as part of the project development, with locations to be finalised based on access, health, safety and environmental considerations. Zones where monitoring bores will be installed are presented in Figure 7.1. The monitoring zones are categorised based on the typical Source-Pathway-Receptor approach, with the areas based on the main water affecting activities: open cut pit, TSF, waste rock emplacement and water management facilities. Further details regarding the preliminary groundwater monitoring zones and the number of monitoring bores is provided in Table 7.2. Existing monitoring bores will be utilised for monitoring where possible, including existing third-party bores that are currently included in Regis' monitoring program. Final locations of the monitoring network will occur in consultation with EPA, NRAR and DPIE Water.

Table 7.2 Preliminary LOM groundwater monitoring zones

Water affecting activity	S-P-R	Preliminary number of monitoring bores	Purpose	Bore monitoring zone
TSF	Source	6	Monitor the performance of the seepage monitoring system (groundwater quality and levels). Monitoring locations will be based on predicted groundwater flow direction.	Combination of saprock (shallow) and metasediments (deep)
	Pathway	4	Monitor for potential TSF seepage (groundwater quality and levels). Locations will be based on predicted groundwater flow direction.	Combination of saprock (shallow) and metasediments (deep)
Open cut pit	Source	6	Monitor groundwater level drawdown (groundwater levels). Some locations may have dual purpose to monitor potential for effects of the WRE and WMF (groundwater quality and levels), as well as effects of the pit.	Combination of saprock (shallow) and metasediments (deep)
	Pathway	4	Monitor groundwater level drawdown and surface water-groundwater interaction. Some locations may have dual purpose to monitor potential for effects of the WRE and WMFs (groundwater quality and levels), as well as effects of the pit.	Combination of saprock (shallow) and metasediments (deep)
WRE and WMF	Source and Pathway	4	Monitor potential for effects of the WRE and WMFs (groundwater quality and levels). Some locations may have dual purpose to monitor potential for effects of the WRE and WMFs.	Shallow saprock
-	Receptor	10	Monitoring at the project boundary to assess the potential for impacts (groundwater levels and groundwater quality) on receptors.	Combination of saprock (shallow) and metasediments (deep)

Notes: LOM = life of mine
WRE = waste rock emplacement
WMF = water management facility



Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DFSI (2017); DPE (2015); ELVIS (2014)

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KEY

- ○ Registered bore – not monitored
- 🟦 Groundwater monitoring site - Regis
- ■ Groundwater monitoring site - other landholder
- 🟪 Test bore

Project application area

- Mine development project boundary
- Mining lease application area (Note: boundary offset for clarity)
- Disturbance footprint
- Mine development general arrangement
- Pipeline

- 🟩 Receptor monitoring site (preliminary)

Monitoring zones

- WMF (source) monitoring zone
- WRE (source & pathway) monitoring zone
- Pit (source) monitoring zone
- Pit (pathway) monitoring zone
- TSF (source) monitoring zone
- TSF (pathway) monitoring zone

Existing environment

- Major road
- Minor road
- Vittoria State Forest

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order
- 5th order
- 6th order

Preliminary groundwater monitoring network during operations

McPhillamys Gold Project
Groundwater assessment addendum
Figure 7.1

7.2 Groundwater model verification and review

As described in the EIS, future improvements to the numerical groundwater flow model will be undertaken as and when new data become available, particularly where there is a divergence of observed groundwater system response from that predicted by the model. Groundwater monitoring data will be used to validate and verify the groundwater model predictions. New data may require a revision and update of the conceptual hydrogeological model prior to updating and recalibrating the numerical model and re-running of predictive scenarios. Where this is deemed necessary, the WMP may also require updating depending on any changes to the conceptualisation and model predictions.

As mining progresses, a need for further model updates will be assessed every two years based on evaluation of groundwater monitoring data and findings of impact verification. It is expected the confidence level of model predictions will increase over time as the model is updated to reflect the observed effects on groundwater from the monitoring program.

Where additional management strategies are required in response to environmental performance, the existing numerical model will be used to test the effectiveness of mitigation measures prior to implementation to improve the outcomes of the proposed measures.

The process for adaptive management related to groundwater modelling is illustrated in Figure 7.2.

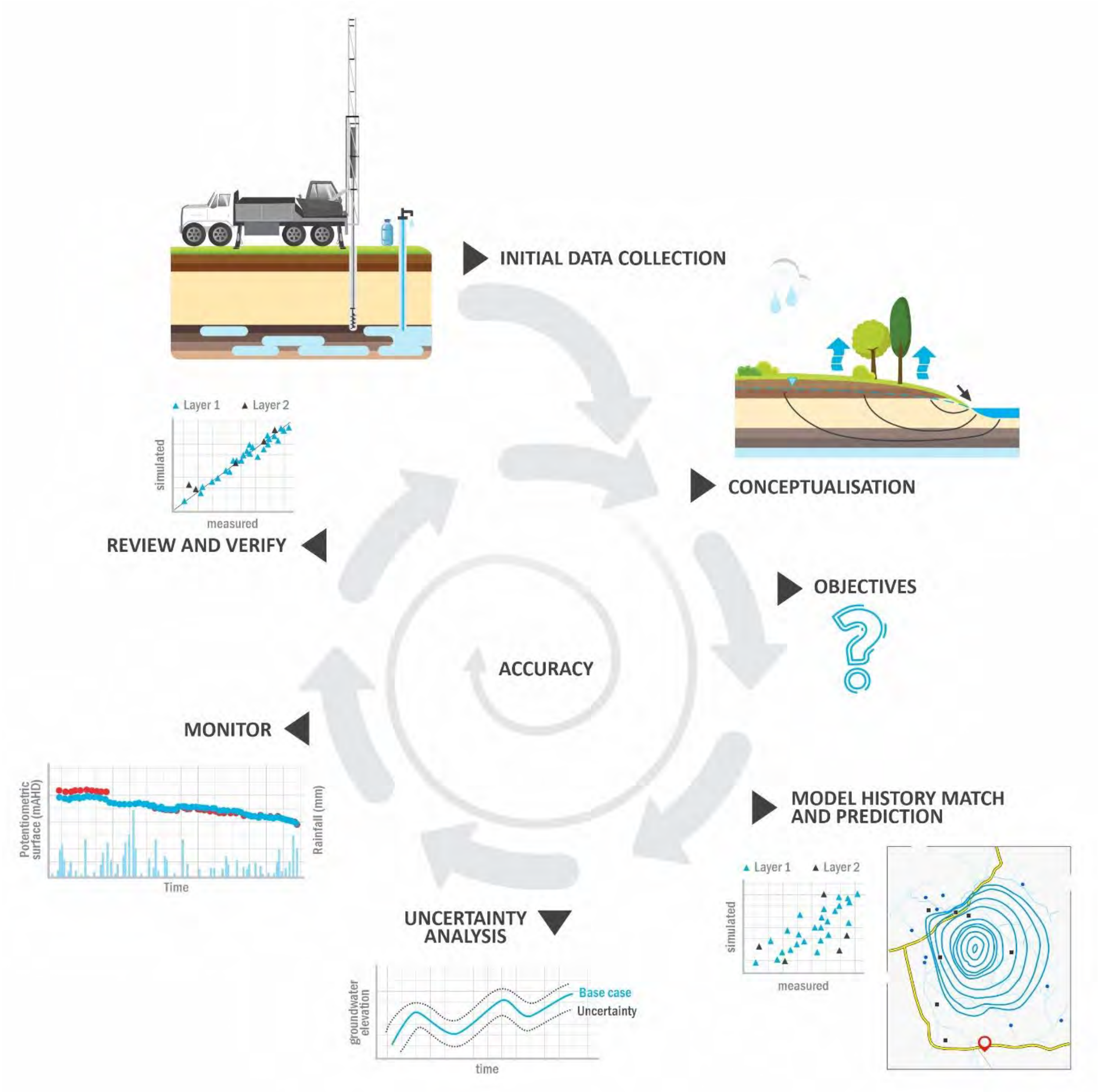

Figure 7.2 Groundwater modelling adaptive management

7.2.1 Groundwater model upgrade plan

The groundwater model will be upgraded over time and with additional baseline data and data from active mining. Upgrades to the model using additional data and actual data responses to stresses will result in the model predictions becoming more accurate over time and the model classification will also increase as per the current version of the Australian Groundwater Modelling Guidelines (Barnett et al 2012).

Model upgrades include incorporating groundwater system observations in response to a transient stress at a similar scale to that of a 500 m deep open cut mine. In most (if not all) greenfield mining situations, there has been no significant (ie deep) excavation, causing an equivalent stress, within the model domain. Aquifer tests which may have been carried out for periods of days or weeks, at the constructed bore maximum pumping rate, induce stresses far less than predicted rates of inflow to a mine.

Construction of a mine puts stress on a groundwater system by causing groundwater to flow into the mine. Prior to mining (or significant extraction), most systems are under a very low stress.

As mining commences and progresses, the following information will be collected, collated and reviewed by Regis and their specialist consultants prior to and during mine construction and development. The data will be used to review, verify and refine the groundwater model as needed. The additional data include:

- groundwater level and quality monitoring that continue to be collected from Regis' dedicated groundwater monitoring network, including landholder bores and from future monitoring bores installed as part of the project;
- surface water quality monitoring data that continue to be collected from Regis' environmental monitoring network within the mine project area and at downstream sites to contribute to the existing baseline dataset;
- surface water flow monitoring data collected will be used in the review the existing conceptual understanding regarding surface water-groundwater interaction;
- annual monitoring via established photo and assessment points on the Belubula River downstream of the proposed TSF (to be established immediately prior to construction) at approximately 50 m intervals;
- monitoring of volumes of water pumped from the open cut pit, all production bores used by the project, and between selected storages in the water management system; and
- monitoring of seepage collected by the TSF seepage interception drain.

Mine construction is expected to occur over one to two years and, during this time, groundwater observations and abstraction records will be collated and reviewed. However, the greatest effect on groundwater flows (including levels) is expected to occur during mining year 2 when the open cut is predicted to intercept the regional watertable. Groundwater level observations and groundwater abstraction records (from bores and the pit) during the first two years of mining will be collated and used to review, and potentially update, the groundwater model.

Regis commits to conducting a review of the groundwater model in mining year 2, unless significant changes are made to the mine plan and schedule. As part of future improvements, the groundwater model will include assessment of:

- climate sensitivity analysis;
- river conductance sensitivity analysis;
- simulation of Regis production bores; and
- additional uncertainty analysis as appropriate.

In order to further assess potential impacts of the TSF from a hydrogeochemical perspective as part of future improvements, Regis will consider revision of how the tailings placement is simulated to refine seepage estimates and include a geochemical assessment to refine estimates of leachate concentrations.

8 Groundwater licensing

8.1 NSW Water legislation and policies for licensing water

Mining projects are required to licence water that is either taken or intercepted in accordance with the *WM Act 2000* and the AIP. Regis is required to hold water access licences in each affected water source to account for all water extracted and intercepted.

In accordance with the AIP, the project is required to licence both the direct and indirect take from adjacent and overlying water sources. The volume of water to be licensed for the project is defined as:

- groundwater inflow to the open cut mine that is physically handled by the mine water management system (predicted by the groundwater model);
- groundwater inflow to the open cut mine that is evaporated and thereby lost from the system;
- groundwater abstracted from production bores to meet construction water requirements (driven by the construction water demand);
- reduced baseflow to overlying water sources (predicted by the groundwater model); and
- increases in the induced leakage from overlying water sources (predicted by the groundwater model) – defined as a surface water take.

With the exception of induced leakage from the watercourse(s) to the watertable, all water is sourced from the Lachlan Fold Belt MDB Groundwater Source. The source of induced leakage is classified as surface water.

Surface water take as a result of reduced catchment is considered in the Amendment Report (EMM 2020a).

8.2 Predicted take from the Lachlan Fold Belt MDB Groundwater Source

The project will have a direct take of water from the Lachlan Fold Belt MDB Groundwater Source as a result of groundwater inflow to the open cut and groundwater pumping to meet construction water demands.

The predicted mine inflow rates are detailed in Section 6.1.3. The predicted take from the Lachlan Fold Belt MDB groundwater source includes the following components:

- Direct take:
    - 580 ML/year peak mine dewatering in year 2;
    - 155 ML/year at the end of mining (year 11);
    - 150 ML/year for 100 years after mining ceases; and
    - 470 ML in the first year of mining for construction purposes.
- Indirect take:
    - 14 ML/year peak baseflow reduction at the end of mining (year 11); and
    - 12 ML/year total baseflow reduction 100 years after mining ceases.

A chart of the total predicted groundwater take over time is shown in Figure 8.1.

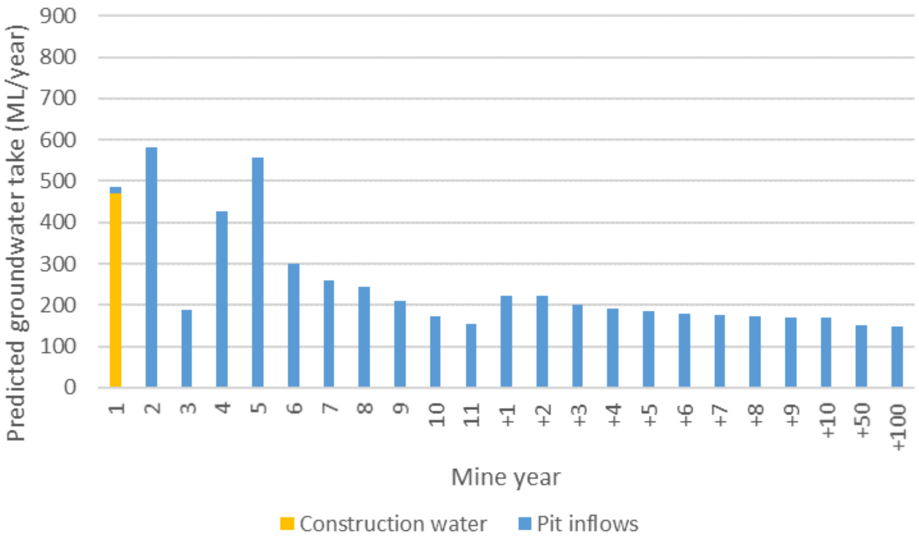

Figure 8.1 Predicted groundwater take (direct and indirect) over time

8.2.1 Required groundwater licence entitlements

Based on the results of the groundwater model, the maximum volume required for licensing in the Lachlan Fold Belt MDB Groundwater Source is 580 ML/year in mine year 2, which (as per Figure 8.1) can reduce in year 7 to approximately 300 ML/year and then reduce further to approximately 200 ML/yr following 5 years of recovery post mining. The pit void is predicted to act as a groundwater sink following completion of mining. As such, groundwater inflows to the pit will continue after mining and it is conservatively predicted to eventually become a throughflow pit after 500 years (with minor groundwater flow out of the pit).

There are sufficient licence entitlements available in the Lachlan Fold Belt MDB Groundwater Source for this take and the take required to meet construction water demand. Regis has secured 400 shares in the Lachlan Fold Belt MDB Groundwater Source to licence groundwater abstraction for the project (WAL 41835) and has also applied to purchase an additional 200 unit-shares in the Controlled Allocation Order 2020. Regis has been informed that the application has been received and successfully lodged, and the application payment has been made. Once finalised, Regis' total licence entitlement will be 600 unit-shares per annum. This entitlement covers the project construction water demand and modelled groundwater take for the life of the project.

The mechanisms available for Regis to purchase these licence entitlements are:

- purchase of unassigned water during a controlled allocation order, which occur approximately every 18 months; or
- trading of existing water allocations (water allocation assignment or share assignment).

As discussed in Section 7.2.1, the groundwater model will be reviewed and recalibrated (if necessary) in the second year of mining (following the interception of the watertable). Any revision to the model predictions will be used to confirm the licensing requirements in subsequent years. This approach aligns with the approved groundwater monitoring and modelling plan for the project commitment to periodically review and update the groundwater model.

8.3 Predicted take from the Belubula River above Carcoar Dam water source

An indirect take of water occurs via an increase in leakage from the Belubula River and Trib A (Section 6.1.2iii). The model predicts leakage from the Belubula River (including Trib A) would increase by up to 24 ML/year (65 kL/day) at the end of mining (year 11) and up to 28 ML/year (76 kL/day) post-mining. These results are slightly less than the predictions of the EIS base case.

There is no predicted surface water capture (change in baseflow or leakage) from the Belubula River downstream of Trib A confluence as a result of the project.

These volumes will require licensing in accordance with the relevant WSP. Surface water licensing requirements as a result of the project are discussed further in the Amendment Report (EMM 2020a).

9 Conclusions

Regis has continued to collect baseline environmental monitoring data, including groundwater and surface water data, since submission of the EIS. These additional data have been used to continue the conceptual hydrogeological understanding of the study area, which remains unchanged from the Groundwater Assessment (EMM 2019a).

The predicted changes to the groundwater system as a result of the amended project are comparable with the impacts assessed as part of the EIS (EMM 2019a). Potential impacts have been assessed in accordance with the AIP and include:

- Take of groundwater in the form of inflow to the open cut mine which will occur during mining and post closure (peak dewatering rate in year 2 of mining of 580 ML/year, which will reduce to less than 300 ML/year by year 7. The predicted peak mine water inflow to the open cut (for the amended project) is less than the peak predicted in the EIS base case (890 ML/year).

- Following completion of mining, a pit lake will form however, the pit lake is predicted to act as a groundwater sink until around 500 years post-mining when the lake level is predicted to reach equilibrium at an elevation of approximately 902 mAHD. At steady state in the very long term, the pit void is predicted to act as a throughflow pit, however the ongoing inflow is 66 ML/year while the outflow from the void is predicted to be much lower at around 11 ML/year.

- Take of groundwater from production bores to meet construction water requirements is calculated to be 470 ML in the first nine months of construction. Regis' entitlements account for the groundwater take.

- Minor reduction in surface water flows (ie the Belubula River) as a result of mining induced drawdown in the local area: the predicted increase in river leakage (up to 24 ML/year at the end of mining and up to 28 ML/year post-mining) will require licensing under the Belubula River above Carcoar Dam Water Source.

- Predicted extent of groundwater drawdown (defined by the 1 m drawdown contour on Figure 6.2) 100 years after mining ceases that is similar to the drawdown extent predicted for the EIS base case scenario (EMM 2019a).

- Groundwater level drawdown around the open cut mine: the AIP requires landholder bores affected by greater than 2 m drawdown as a result of the project are subject to 'make good' provisions. However, there are no third-party bores with a predicted drawdown in excess of 2 m. As such, there is no requirement for 'make good' provisions.

- Groundwater level drawdown associated with construction water supply production bores: There are no third-party bores or identified high priority GDEs within the modelled drawdown (as defined by the 1 m drawdown contour).

- With regard to the AIP's groundwater quality requirements, the project is not anticipated to result in a lowering of the beneficial use category of the local water sources.

- PCTs identified as opportunistic users of groundwater outside of the disturbance footprint are not predicted to have reduced access to groundwater as a result of the project.

Monitoring of the groundwater network will continue, and the network will be expanded to target the identification of potential impacts from mining activities. Monitoring each component of the water management system underpins if, how, and when management responses are required. Triggers and thresholds will be developed to provide context on if, how, and when management measures are required as part of the WMP for the project.

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Appendix A

McPhillamys bore details and completion logs

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(02) 9493 9589

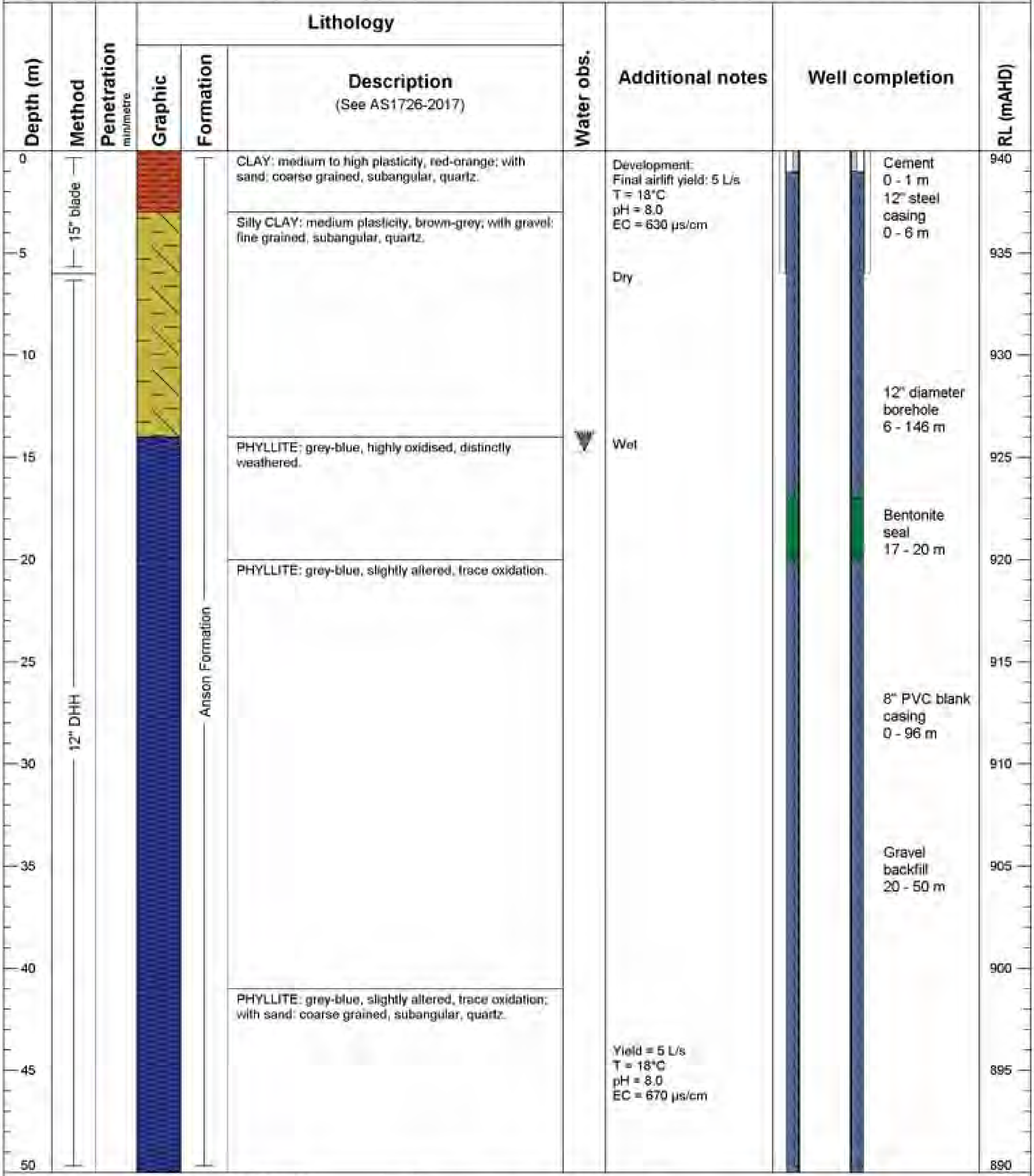
Test Bore

ID: TPB4

Project: McPhillamys CWS
Project number: J17065
Client: Regis Resources Ltd
Site: Arbour Hills - Dungeon Rd
Logged by: Claire Corthier
Date completed: 25/04/2020

Easting: 716,425 m
Northing: 6,293,990 m
Spatial reference: MGA Zone 55
Elevation (collar):
Elevation (ground): 940 mAHD
Nominal diameter: 203 mm (casing ND)

Screened lithology: Fractured phyllite
Screen interval: 96 - 138 mbgl
Drilling method: DHH reaming
Total depth: 144 mbgl
Standing water level: 14.2 mbgl
Date of water level: 26/05/2020



Description
(See AS1726-2017)

CLAY: medium to high plasticity, red-orange; with sand: coarse grained, subangular, quartz.

Silty CLAY: medium plasticity, brown-grey; with gravel: fine grained, subangular, quartz.

PHYLLITE: grey-blue, highly oxidised, distinctly weathered.

PHYLLITE: grey-blue, slightly altered, trace oxidation.

PHYLLITE: grey-blue, slightly altered, trace oxidation; with sand: coarse grained, subangular, quartz.

Additional notes

Development:
Final airlift yield: 5 L/s
T = 18°C
pH = 8.0
EC = 630 μs/cm

Dry

Wet

Yield = 5 L/s
T = 18°C
pH = 8.0
EC = 670 μs/cm

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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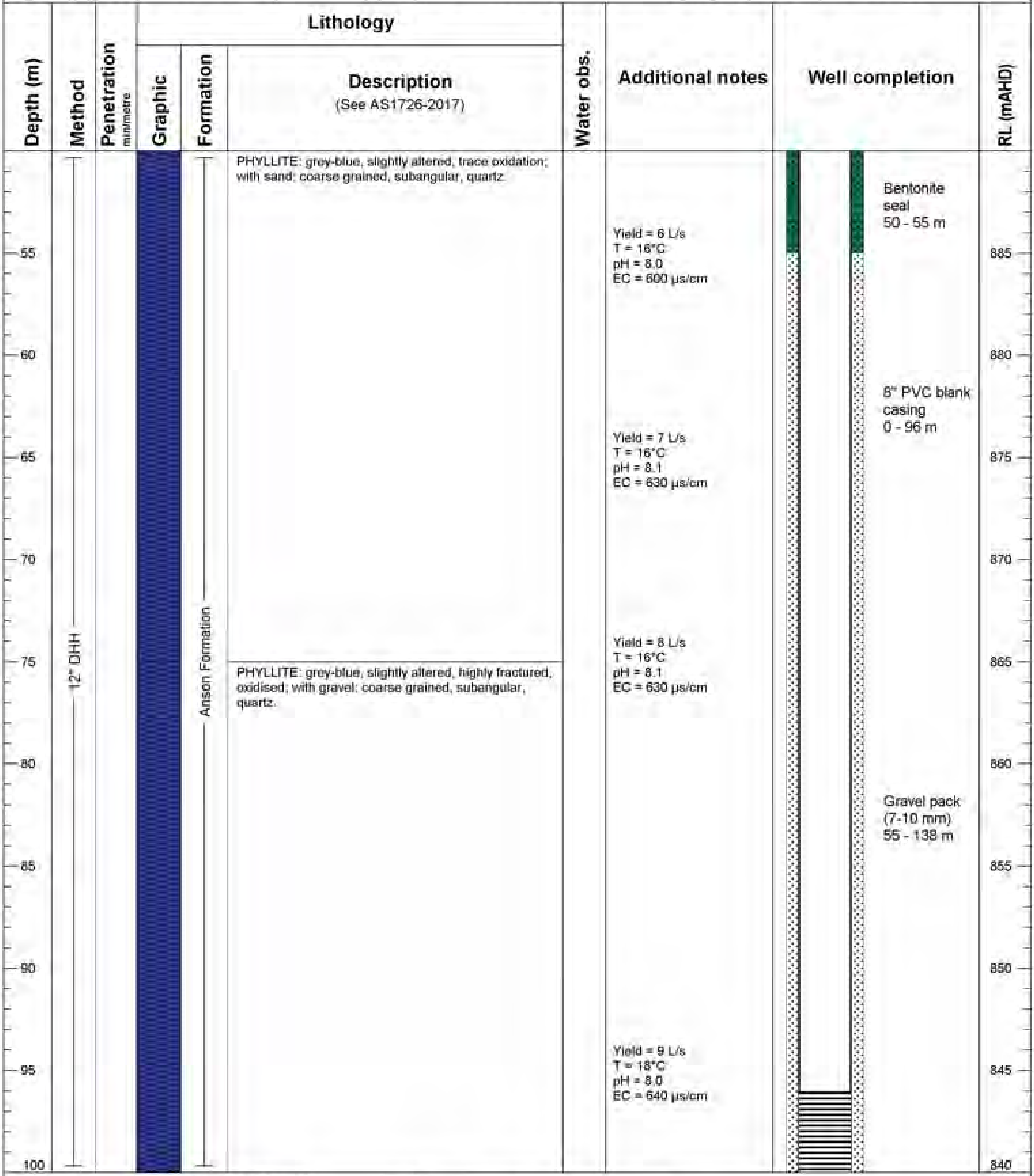
Test Bore

ID: TPB4

Project: McPhillamys CWS
Project number: J17065
Client: Regis Resources Ltd
Site: Arbour Hills - Dungeon Rd
Logged by: Claire Corthier
Date completed: 25/04/2020

Easting: 716,425 m
Northing: 6,293,990 m
Spatial reference: MGA Zone 55
Elevation (collar):
Elevation (ground): 940 mAHD
Nominal diameter: 203 mm (casing ND)

Screened lithology: Fractured phyllite
Screen interval: 96 - 138 mbgl
Drilling method: DHH reaming
Total depth: 144 mbgl
Standing water level: 14.2 mbgl
Date of water level: 26/05/2020



PHYLLITE: grey-blue, slightly altered, trace oxidation; with sand: coarse grained, subangular, quartz.

PHYLLITE: grey-blue, slightly altered, highly fractured, oxidised; with gravel: coarse grained, subangular, quartz.

Yield = 6 L/s
T = 16°C
pH = 8.0
EC = 600 μs/cm

Yield = 7 L/s
T = 16°C
pH = 8.1
EC = 630 μs/cm

Yield = 8 L/s
T = 16°C
pH = 8.1
EC = 630 μs/cm

Yield = 9 L/s
T = 18°C
pH = 8.0
EC = 640 μs/cm

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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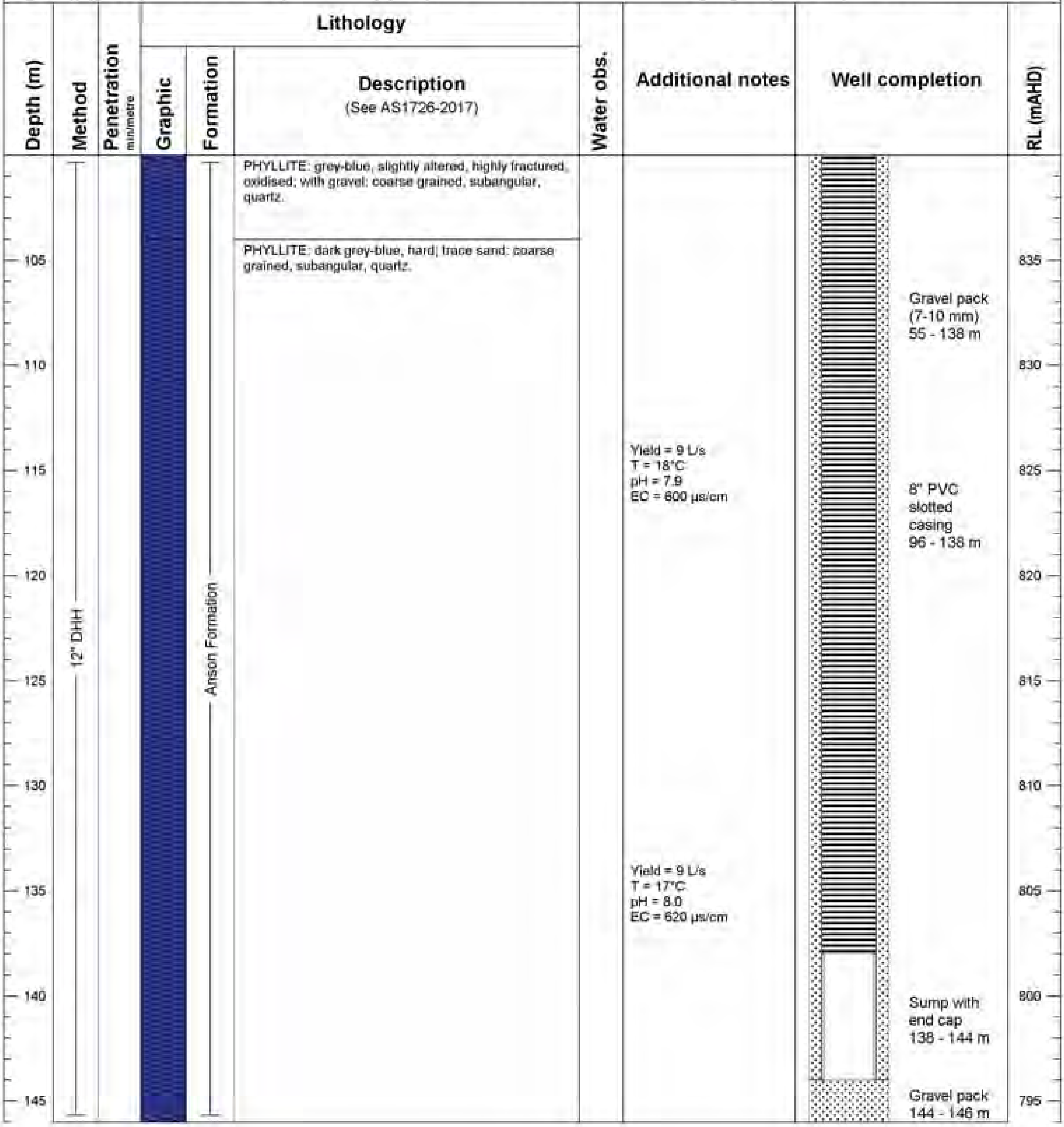
Test Bore

ID: TPB4

Project: McPhillamys CWS
Project number: J17065
Client: Regis Resources Ltd
Site: Arbour Hills - Dungeon Rd
Logged by: Claire Corthier
Date completed: 25/04/2020

Easting: 716,425 m
Northing: 6,293,990 m
Spatial reference: MGA Zone 55
Elevation (collar):
Elevation (ground): 940 mAHD
Nominal diameter: 203 mm (casing ND)

Screened lithology: Fractured phyllite
Screen interval: 96 - 138 mbgl
Drilling method: DHH reaming
Total depth: 144 mbgl
Standing water level: 14.2 mbgl
Date of water level: 26/05/2020



PHYLLITE: grey-blue, slightly altered, highly fractured, oxidised; with gravel: coarse grained, subangular, quartz.

PHYLLITE: dark grey-blue, hard; trace sand: coarse grained, subangular, quartz.

Yield = 9 L/s
T = 18°C
pH = 7.9
EC = 600 μs/cm

Yield = 9 L/s
T = 17°C
pH = 8.0
EC = 620 μs/cm

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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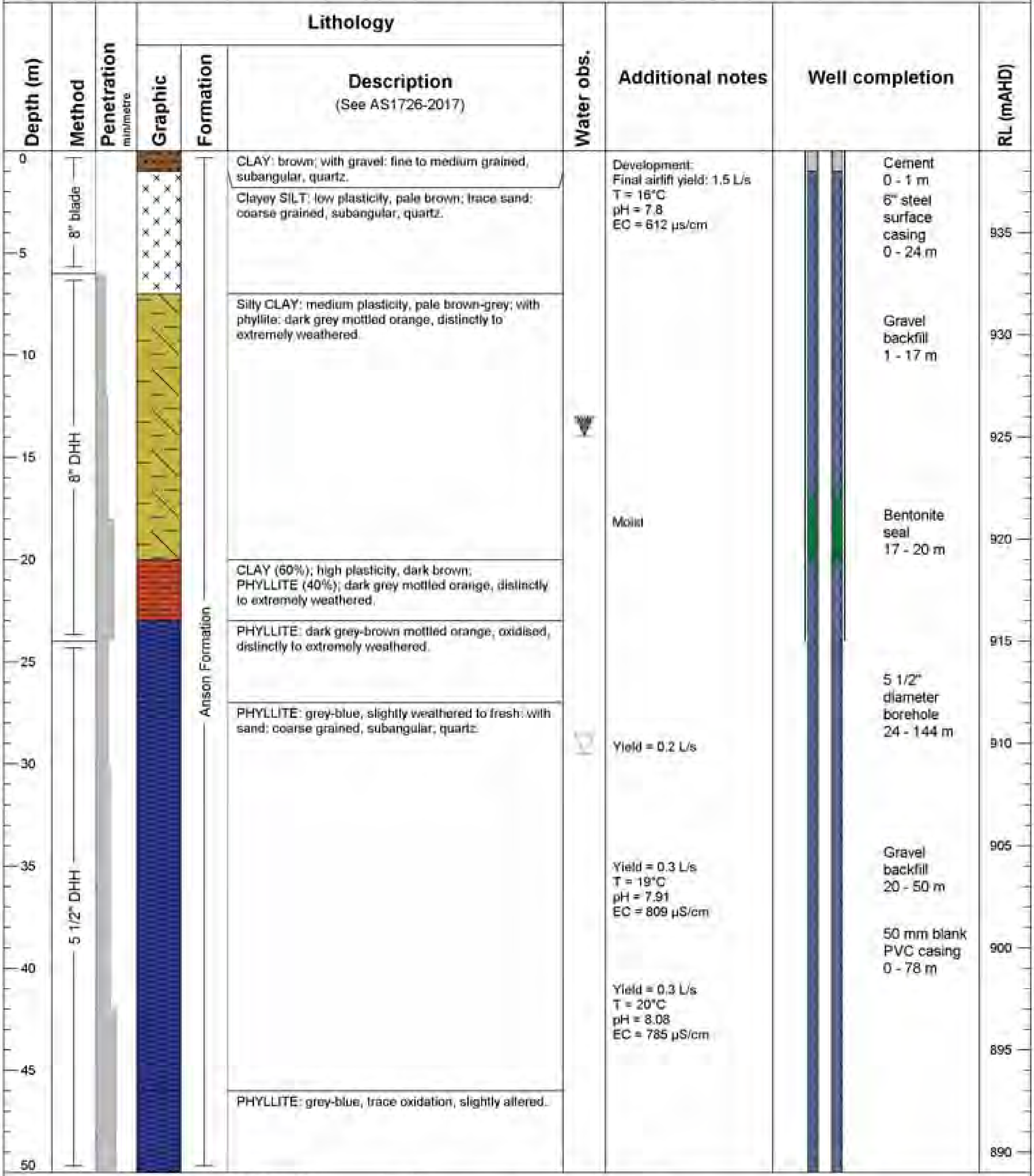
Monitoring Bore

ID: MB14

Project: McPhillamys CWS
Project number: J17065
Client: Regis Resources Ltd
Site: Arbour Hills - Dungeon Rd
Logged by: Claire Corthier
Date completed: 30/04/2020

Easting: 716,421 m
Northing: 6,293,978 m
Spatial reference: MGA Zone 55
Elevation (collar):
Elevation (ground): 939 mAHD
Nominal diameter: 50 mm (casing ID)

Screened lithology: Fractured phyllite
Screen interval: 78-90; 108-126 mbgl
Drilling method: DHH
Total depth: 144 mbgl
Standing water level: 13.5 mbgl
Date of water level: 6/05/2020



Description
(See AS1726-2017)

CLAY: brown; with gravel: fine to medium grained, subangular, quartz.

Clayey SILT: low plasticity, pale brown; trace sand: coarse grained, subangular, quartz.

Silty CLAY: medium plasticity, pale brown-grey; with phyllite: dark grey mottled orange, distinctly to extremely weathered.

CLAY (60%); high plasticity, dark brown; PHYLLITE (40%); dark grey mottled orange, distinctly to extremely weathered.

PHYLLITE: dark grey-brown mottled orange, oxidised, distinctly to extremely weathered.

PHYLLITE: grey-blue, slightly weathered to fresh: with sand: coarse grained, subangular, quartz.

PHYLLITE: grey-blue, trace oxidation, slightly altered.

Additional notes

Development:
Final airlift yield: 1.5 L/s
T = 16°C
pH = 7.8
EC = 612 µs/cm

Moist

Yield = 0.2 L/s

Yield = 0.3 L/s
T = 19°C
pH = 7.91
EC = 809 µS/cm

Yield = 0.3 L/s
T = 20°C
pH = 8.08
EC = 785 µS/cm

Well completion

Cement
0 - 1 m

6" steel
surface
casing
0 - 24 m

Gravel
backfill
1 - 17 m

Bentonite
seal
17 - 20 m

5 1/2"
diameter
borehole
24 - 144 m

Gravel
backfill
20 - 50 m

50 mm blank
PVC casing
0 - 78 m

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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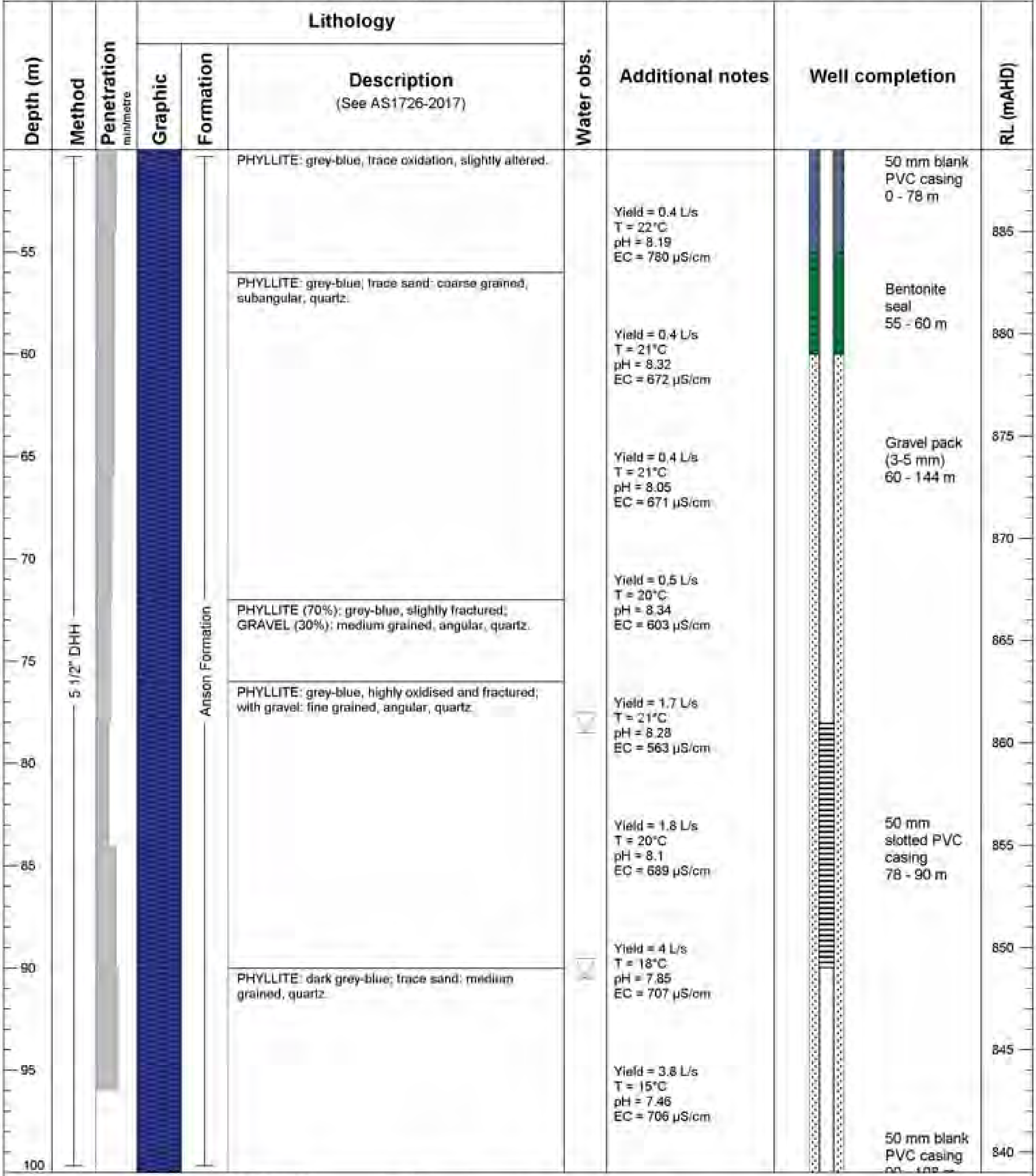
Monitoring Bore

ID: MB14

Project: McPhillamys CWS
Project number: J17065
Client: Regis Resources Ltd
Site: Arbour Hills - Dungeon Rd
Logged by: Claire Corthier
Date completed: 30/04/2020

Easting: 716,421 m
Northing: 6,293,978 m
Spatial reference: MGA Zone 55
Elevation (collar):
Elevation (ground): 939 mAHD
Nominal diameter: 50 mm (casing ID)

Screened lithology: Fractured phyllite
Screen interval: 78-90; 108-126 mbgl
Drilling method: DHH
Total depth: 144 mbgl
Standing water level: 13.5 mbgl
Date of water level: 6/05/2020



Description
(See AS1726-2017)

PHYLLITE: grey-blue, trace oxidation, slightly altered.

PHYLLITE: grey-blue; trace sand: coarse grained, subangular, quartz.

PHYLLITE (70%): grey-blue, slightly fractured; GRAVEL (30%): medium grained, angular, quartz.

PHYLLITE: grey-blue, highly oxidised and fractured; with gravel: fine grained, angular, quartz.

PHYLLITE: dark grey-blue; trace sand: medium grained, quartz.

Additional notes

Yield = 0.4 L/s
T = 22°C
pH = 8.19
EC = 780 µS/cm

Yield = 0.4 L/s
T = 21°C
pH = 8.32
EC = 672 µS/cm

Yield = 0.4 L/s
T = 21°C
pH = 8.05
EC = 671 µS/cm

Yield = 0.5 L/s
T = 20°C
pH = 8.34
EC = 603 µS/cm

Yield = 1.7 L/s
T = 21°C
pH = 8.28
EC = 563 µS/cm

Yield = 1.8 L/s
T = 20°C
pH = 8.1
EC = 689 µS/cm

Yield = 4 L/s
T = 18°C
pH = 7.85
EC = 707 µS/cm

Yield = 3.8 L/s
T = 15°C
pH = 7.46
EC = 706 µS/cm

Well completion

50 mm blank PVC casing 0 - 78 m

Bentonite seal 55 - 60 m

Gravel pack (3-5 mm) 60 - 144 m

50 mm slotted PVC casing 78 - 90 m

50 mm blank PVC casing

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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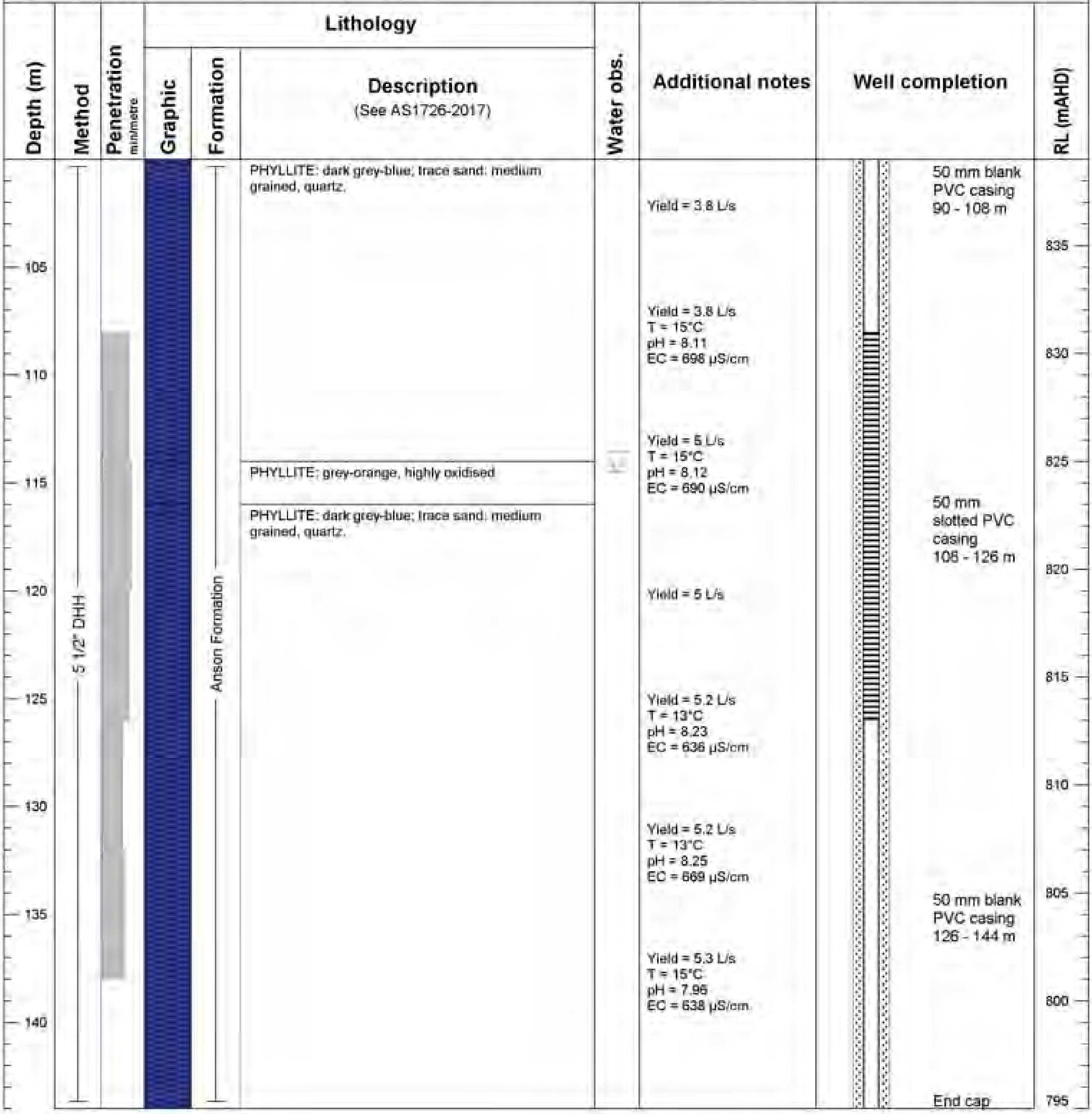
Monitoring Bore

ID: MB14

Project: McPhillamys CWS
Project number: J17065
Client: Regis Resources Ltd
Site: Arbour Hills - Dungeon Rd
Logged by: Claire Corthier
Date completed: 30/04/2020

Easting: 716,421 m
Northing: 6,293,978 m
Spatial reference: MGA Zone 55
Elevation (collar):
Elevation (ground): 939 mAHD
Nominal diameter: 50 mm (casing ID)

Screened lithology: Fractured phyllite
Screen interval: 78-90; 108-126 mbgl
Drilling method: DHH
Total depth: 144 mbgl
Standing water level: 13.5 mbgl
Date of water level: 6/05/2020



PHYLLITE: dark grey-blue; trace sand: medium grained, quartz.

PHYLLITE: grey-orange, highly oxidised

PHYLLITE: dark grey-blue; trace sand: medium grained, quartz.

Yield = 3.8 L/s

Yield = 3.8 L/s
T = 15°C
pH = 8.11
EC = 698 µS/cm

Yield = 5 L/s
T = 15°C
pH = 8.12
EC = 690 µS/cm

Yield = 5 L/s

Yield = 5.2 L/s
T = 13°C
pH = 8.23
EC = 636 µS/cm

Yield = 5.2 L/s
T = 13°C
pH = 8.25
EC = 669 µS/cm

Yield = 5.3 L/s
T = 15°C
pH = 7.96
EC = 638 µS/cm

50 mm blank PVC casing 90 - 108 m

50 mm slotted PVC casing 108 - 126 m

50 mm blank PVC casing 126 - 144 m

End cap

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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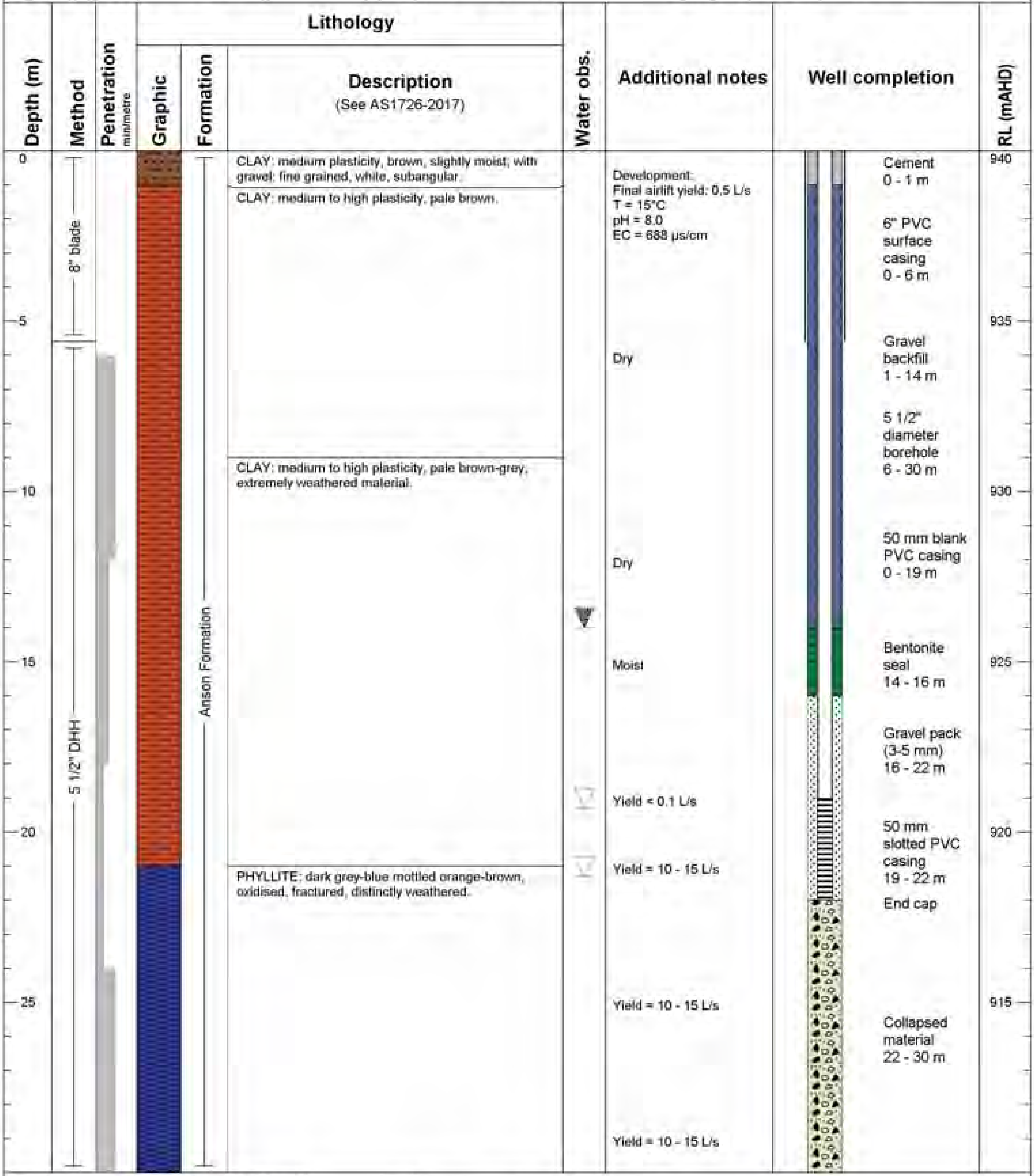
Monitoring Bore

ID: MB15

Project: McPhillamys CWS
Project number: J17065
Client: Regis Resources Ltd
Site: Arbour Hills - Dungeon Rd
Logged by: Emily Barber
Date completed: 5/05/2020

Easting: 716,434 m
Northing: 6,293,994 m
Spatial reference: MGA Zone 55
Elevation (collar):
Elevation (ground): 940 mAHD
Nominal diameter: 50 mm (casing ID)

Screened lithology: Fractured phyllite
Screen interval: 19 - 22 mbgl
Drilling method: DHH
Total depth: 30 mbgl
Standing water level: 13.7 mbgl
Date of water level: 6/05/2020



Description (See AS1726-2017)

CLAY: medium plasticity, brown, slightly moist; with gravel: fine grained, white, subangular.

CLAY: medium to high plasticity, pale brown.

CLAY: medium to high plasticity, pale brown-grey, extremely weathered material.

PHYLLITE: dark grey-blue mottled orange-brown, oxidised, fractured, distinctly weathered.

Additional notes

Development:
Final airlift yield: 0.5 L/s
T = 15°C
pH = 8.0
EC = 688 µs/cm

Dry

Dry

Moist

Yield < 0.1 L/s

Yield = 10 - 15 L/s

Yield = 10 - 15 L/s

Yield = 10 - 15 L/s

Well completion

Cement
0 - 1 m

6" PVC surface casing
0 - 6 m

Gravel backfill
1 - 14 m

5 1/2" diameter borehole
6 - 30 m

50 mm blank PVC casing
0 - 19 m

Bentonite seal
14 - 16 m

Gravel pack (3-5 mm)
16 - 22 m

50 mm slotted PVC casing
19 - 22 m

End cap

Collapsed material
22 - 30 m

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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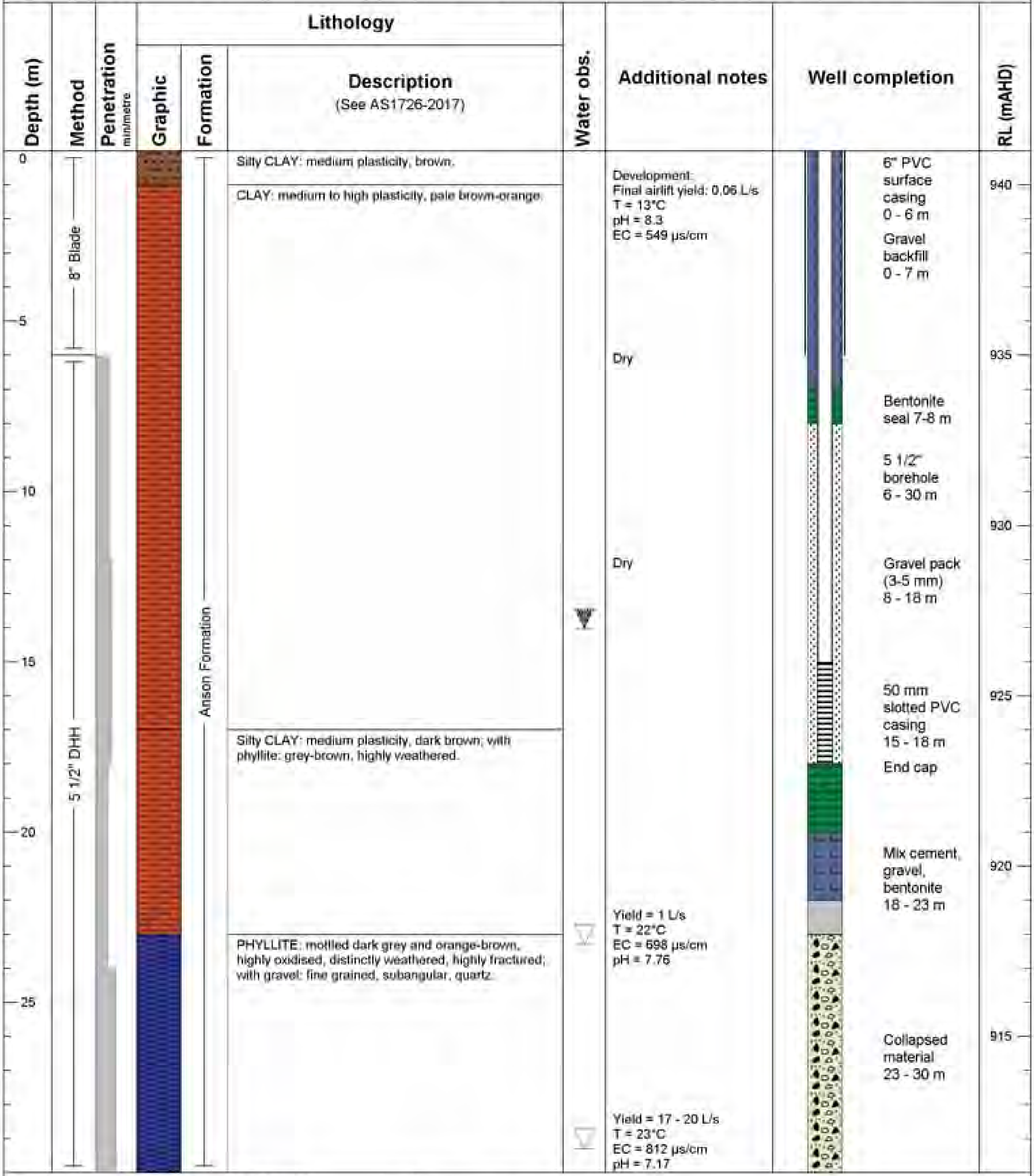
Monitoring Bore

ID: MB16

Project: McPhillamys CWS
Project number: J17065
Client: Regis Resources Ltd
Site: Arbour Hills - Dungeon Rd
Logged by: Emily Barber
Date completed: 28/04/2020

Easting: 716,439 m
Northing: 6,293,996 m
Spatial reference: MGA Zone 55
Elevation (collar):
Elevation (ground): 941 mAHD
Nominal diameter: 50 mm (casing ID)

Screened lithology: Saprock
Screen interval: 15 - 18 mbgl
Drilling method: DHH
Total depth: 23 mbgl
Standing water level: 13.7 mbgl
Date of water level: 6/05/2020



Description (See AS1726-2017)

Silty CLAY: medium plasticity, brown.

CLAY: medium to high plasticity, pale brown-orange.

Silty CLAY: medium plasticity, dark brown; with phyllite: grey-brown, highly weathered.

PHYLLITE: mottled dark grey and orange-brown, highly oxidised, distinctly weathered, highly fractured; with gravel: fine grained, subangular, quartz.

Additional notes

Development:
Final airlift yield: 0.06 L/s
T = 13°C
pH = 8.3
EC = 549 µs/cm

Dry

Dry

Yield = 1 L/s
T = 22°C
EC = 698 µs/cm
pH = 7.76

Yield = 17 - 20 L/s
T = 23°C
EC = 812 µs/cm
pH = 7.17

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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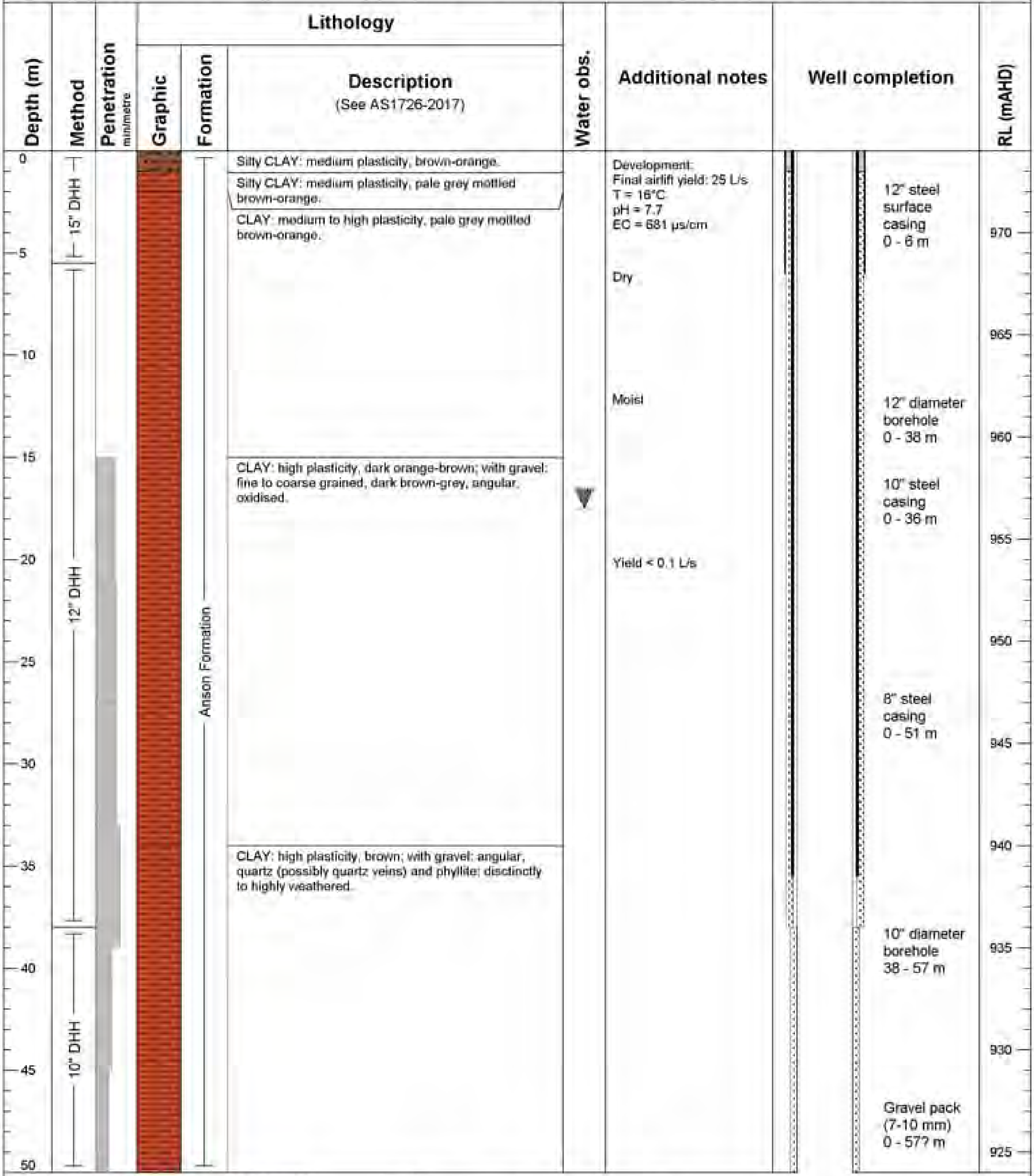
Test Bore

ID: TB05

Project: McPhillamys CWS
Project number: J17065
Client: Regis Resources Ltd
Site: Vaughan Property - Dungeon Rd
Logged by: Emily Barber/ Claire Corthier
Date completed: 18/05/2020

Easting: 716,718 m
Northing: 6,297,629 m
Spatial reference: MGA Zone 55
Elevation (collar):
Elevation (ground): 974 mAHD
Nominal diameter: 203 mm (casing ND)

Screened lithology: Limestone/sand
Screen interval: 51 - 57 mbgl
Drilling method: DHH
Total depth: 75 mbgl
Standing water level: 17.2 mbgl
Date of water level: 26/05/2020



Silty CLAY: medium plasticity, brown-orange.

Silty CLAY: medium plasticity, pale grey mottled brown-orange.

CLAY: medium to high plasticity, pale grey mottled brown-orange.

CLAY: high plasticity, dark orange-brown; with gravel: fine to coarse grained, dark brown-grey, angular, oxidised.

CLAY: high plasticity, brown; with gravel: angular, quartz (possibly quartz veins) and phyllite; distinctly to highly weathered.

Development:
Final airlift yield: 25 L/s
T = 16°C
pH = 7.7
EC = 681 µs/cm

Dry

Moist

Yield < 0.1 L/s

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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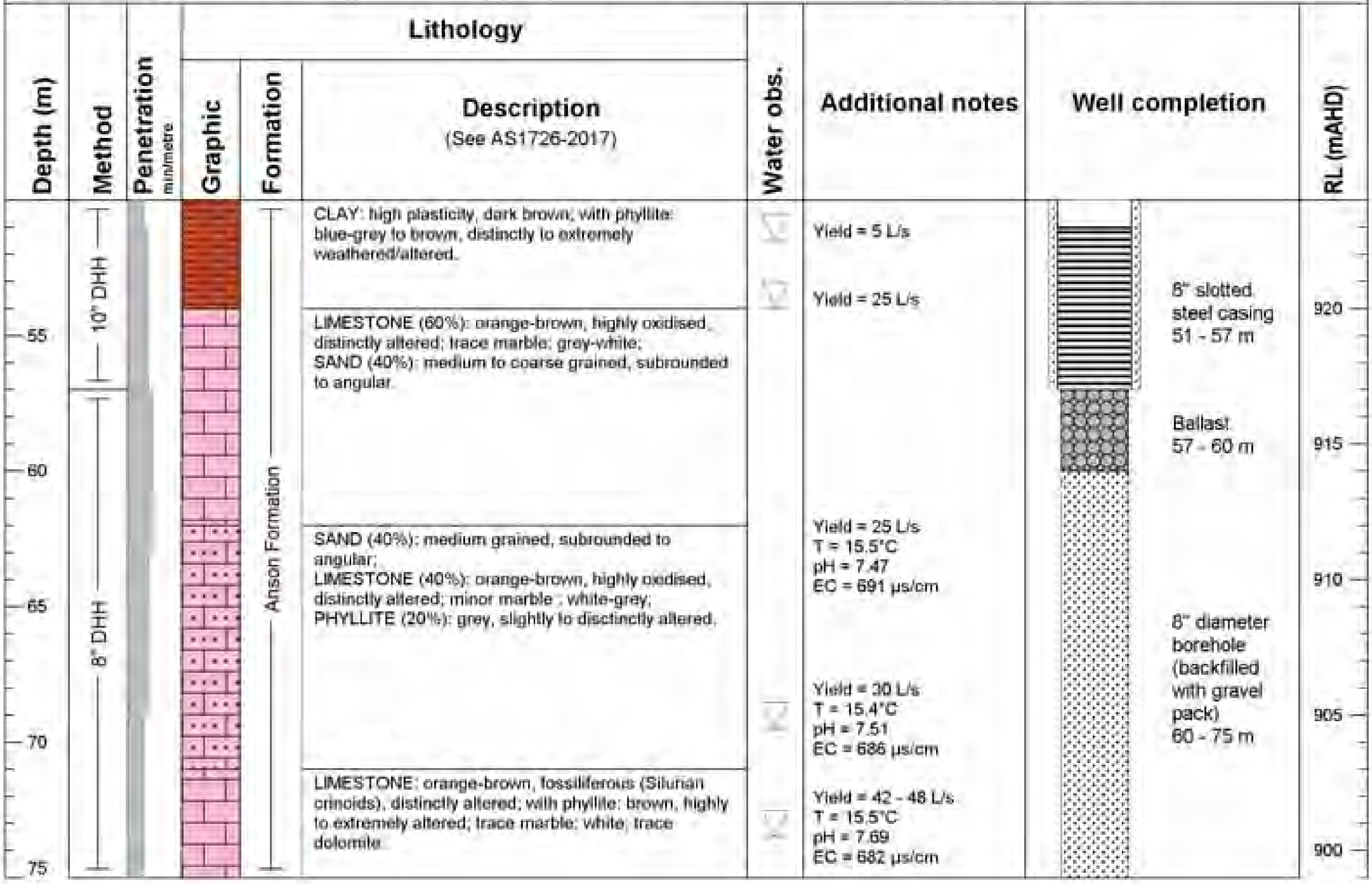
Test Bore

ID: TB05

Project: McPhillamys CWS
Project number: J17065
Client: Regis Resources Ltd
Site: Vaughan Property - Dungeon Rd
Logged by: Emily Barber/ Claire Corthier
Date completed: 18/05/2020

Easting: 716,718 m
Northing: 6,297,629 m
Spatial reference: MGA Zone 55
Elevation (collar):
Elevation (ground): 974 mAHD
Nominal diameter: 203 mm (casing ND)

Screened lithology: Limestone/sand
Screen interval: 51 - 57 mbgl
Drilling method: DHH
Total depth: 75 mbgl
Standing water level: 17.2 mbgl
Date of water level: 26/05/2020



Description (See AS1726-2017)	Additional notes
CLAY: high plasticity, dark brown; with phyllite: blue-grey to brown, distinctly to extremely weathered/altered.	Yield = 5 L/s Yield = 25 L/s
LIMESTONE (60%): orange-brown, highly oxidised, distinctly altered; trace marble: grey-white; SAND (40%): medium to coarse grained, subrounded to angular.	
SAND (40%): medium grained, subrounded to angular; LIMESTONE (40%): orange-brown, highly oxidised, distinctly altered; minor marble : white-grey; PHYLLITE (20%): grey, slightly to disctinctly altered.	Yield = 25 L/s T = 15.5°C pH = 7.47 EC = 691 µs/cm Yield = 30 L/s T = 15.4°C pH = 7.51 EC = 686 µs/cm
LIMESTONE: orange-brown, fossiliferous (Silurian crinoids), distinctly altered; with phyllite: brown, highly to extremely altered; trace marble: white; trace dolomite.	Yield = 42 - 48 L/s T = 15.5°C pH = 7.69 EC = 682 µs/cm

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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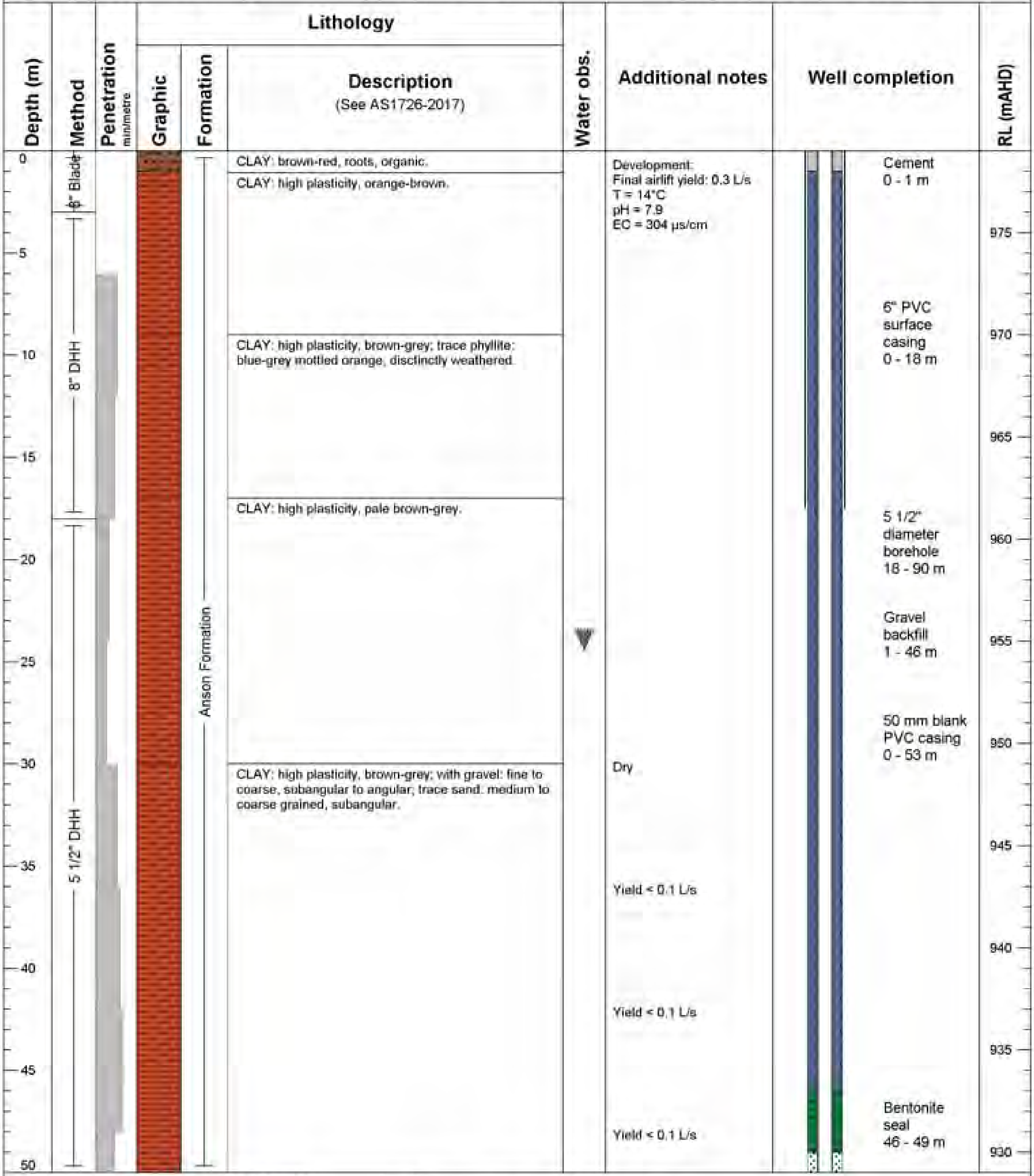
Monitoring Bore

ID: MB17

Project: McPhillamys CWS
Project number: J17065
Client: Regis Resources Ltd
Site: Vaughan Property - Dungeon Rd
Logged by: Emily Barber
Date completed: 21/05/2020

Easting: 716,875 m
Northing: 6,297,724 m
Spatial reference: MGA Zone 55
Elevation (collar):
Elevation (ground): 979 mAHD
Nominal diameter: 50 mm (casing ID)

Screened lithology: Clay/phyllite
Screen interval: 53-59 mbgl
Drilling method: DHH
Total depth: 90 mbgl
Standing water level: 23.9 mbgl
Date of water level: 26/05/2020



Description
(See AS1726-2017)

CLAY: brown-red, roots, organic.

CLAY: high plasticity, orange-brown.

CLAY: high plasticity, brown-grey; trace phyllite: blue-grey mottled orange, disctinctly weathered.

CLAY: high plasticity, pale brown-grey.

CLAY: high plasticity, brown-grey; with gravel: fine to coarse, subangular to angular; trace sand: medium to coarse grained, subangular.

Additional notes

Development:
Final airlift yield: 0.3 L/s
T = 14°C
pH = 7.9
EC = 304 µs/cm

Dry

Yield < 0.1 L/s

Yield < 0.1 L/s

Yield < 0.1 L/s

Well completion

Cement
0 - 1 m

6" PVC
surface
casing
0 - 18 m

5 1/2"
diameter
borehole
18 - 90 m

Gravel
backfill
1 - 46 m

50 mm blank
PVC casing
0 - 53 m

Bentonite
seal
46 - 49 m

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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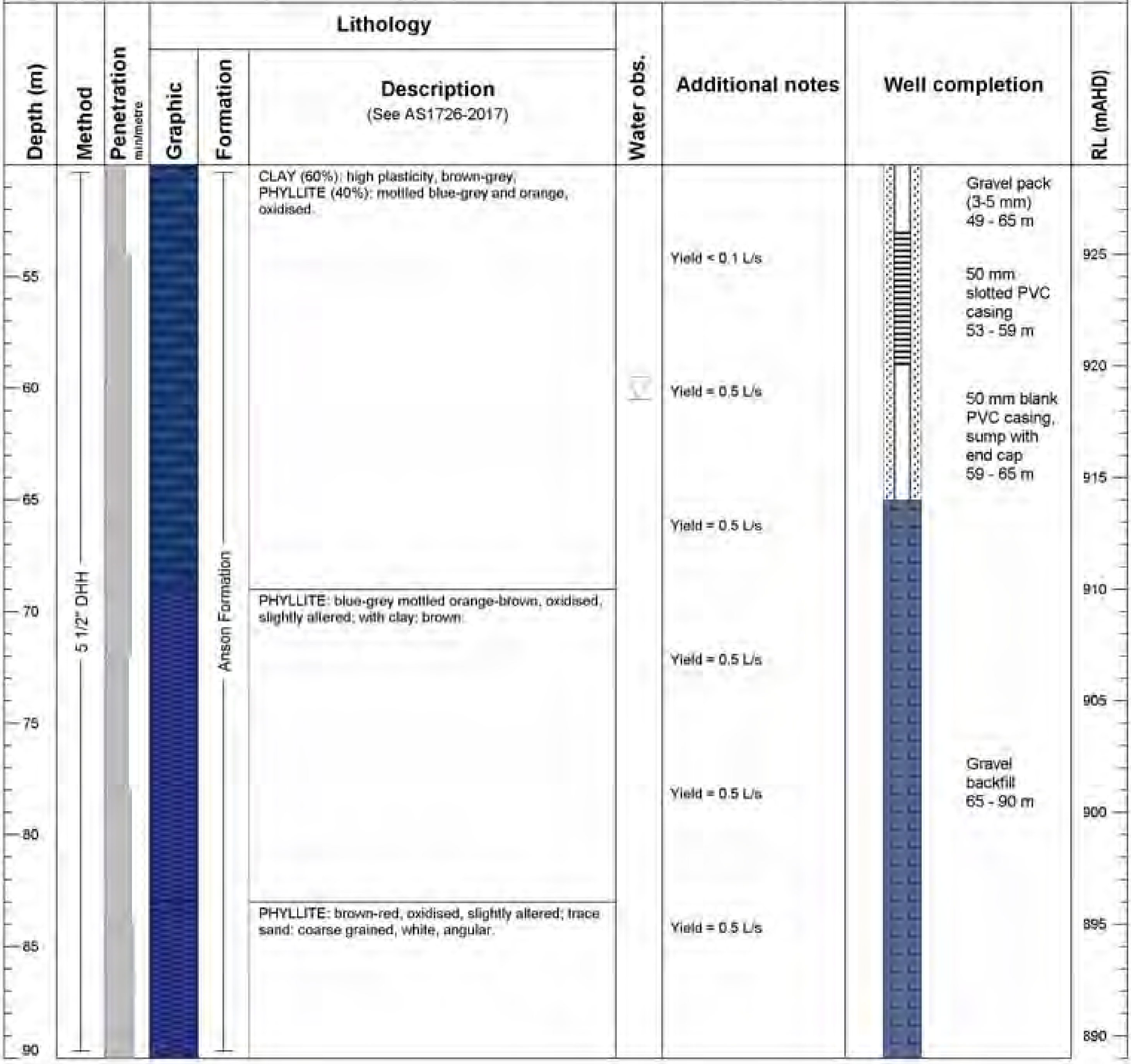
Monitoring Bore

ID: MB17

Project:	McPhillamys CWS	**Easting:**	716,875 m
Project number:	J17065	**Northing:**	6,297,724 m
Client:	Regis Resources Ltd	**Spatial reference:**	MGA Zone 55
Site:	Vaughan Property - Dungeon Rd	**Elevation (collar):**	
Logged by:	Emily Barber	**Elevation (ground):**	979 mAHD
Date completed:	21/05/2020	**Nominal diameter:**	50 mm (casing ID)

Screened lithology:	Clay/phyllite	**Drilling method:**	DHH	**Standing water level:**	23.9 mbgl
Screen interval:	53-59 mbgl	**Total depth:**	90 mbgl	**Date of water level:**	26/05/2020



Description
(See AS1726-2017)

CLAY (60%): high plasticity, brown-grey; PHYLLITE (40%): mottled blue-grey and orange, oxidised.

PHYLLITE: blue-grey mottled orange-brown, oxidised, slightly altered; with clay: brown.

PHYLLITE: brown-red, oxidised, slightly altered; trace sand: coarse grained, white, angular.

Additional notes

Yield < 0.1 L/s

Yield = 0.5 L/s

Yield = 0.5 L/s

Yield = 0.5 L/s

Yield = 0.5 L/s

Yield = 0.5 L/s

Well completion

Gravel pack (3-5 mm) 49 - 65 m

50 mm slotted PVC casing 53 - 59 m

50 mm blank PVC casing, sump with end cap 59 - 65 m

Gravel backfill 65 - 90 m

Company:	Highland Drilling Pty Ltd	▽	Water strike/s intercepted during drilling
Driller:	Ian Palk	▼	Standing water level after drilling

BORE COMPLETION REPORT: WMB1273A

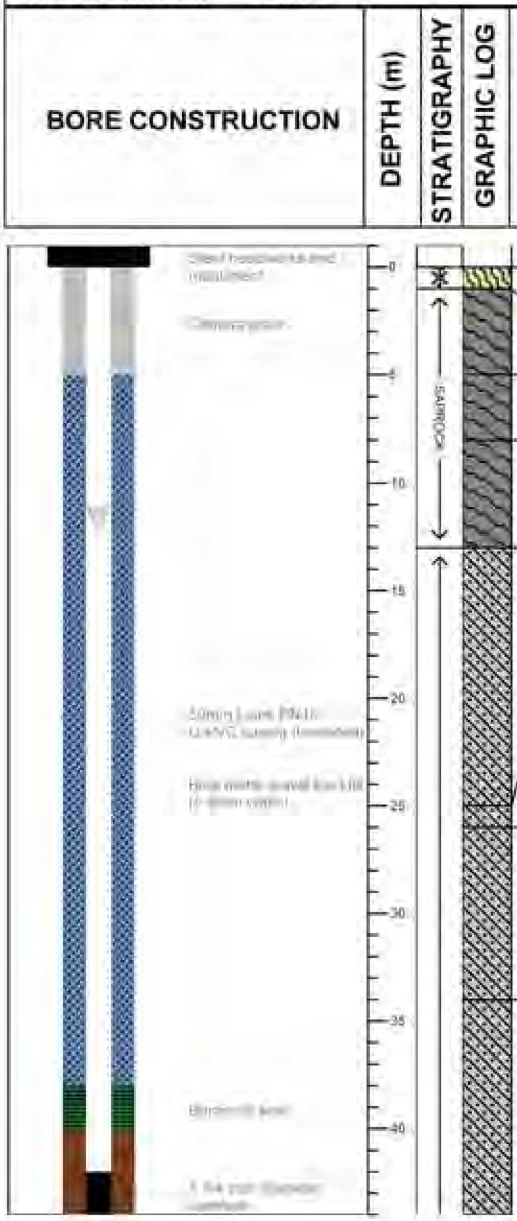
Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 717300.2 **Northing:** 6291226.9
Top of casing elevation: 956.6 mAHD (monument)
Grid system: MGA Zone 55 **Stick-up height:** 0.91 m

Drilling contractor: Britts Drilling Services
Driller: D Britt **Rig:** BDS1
Drilling method: Air rotary **Total drilled depth:** 86 m
Borehole diameter: 200 mm 0 - 1 m **Bit:** Blade
Borehole diameter: 130 mm 1 - 86 m **Bit:** DHH

Purpose of bore: Groundwater monitoring bore
Screened Formation: Metasediments
Logged by: S Moran
Start date: 13/12/17
Completion date: 18/12/17

Static WL: 944.94 mAHD
11.66 mbtoc
Water level date: 12/01/17

Plain casing: 0-42m: Class 18 50mm PVC
Screen: 42-48: 50mm PVC Class 18 (0.5mm slot)
Sump: NA - Well cap fixed to base of screen
Cement grout: 0-5m: 0.05m3
Gravel backfill: 5-38m: 5-8mm gravel
Bentonite seal: 38-40m
Gravel pack: 40-48m: 3mm washed gravel
Bentonite plug: 48-49m



LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS
Mottled brown, residual soil	
Light brown, extremely altered	
Light brown still with a tinge of dark green	
Light grey, extremely altered, dark surfaces have smooth sheen, quartz veining.	
Mottled grey, brecciated, medium grained	
Mottled grey, brecciated, medium grained , light green, Large crystal grain Veining	
Dark grey, brecciated, medium grained	**Water Cut @ 25m** Yield: 0.02 L/s Temp. 21.7 °C EC: 908 µS/cm pH: 7.24 ORP: 86 mV
Mottled grey, brecciated, medium grained, light green with coarse quartz veining	**Airlift at 35m** Yield: 1.2 L/s

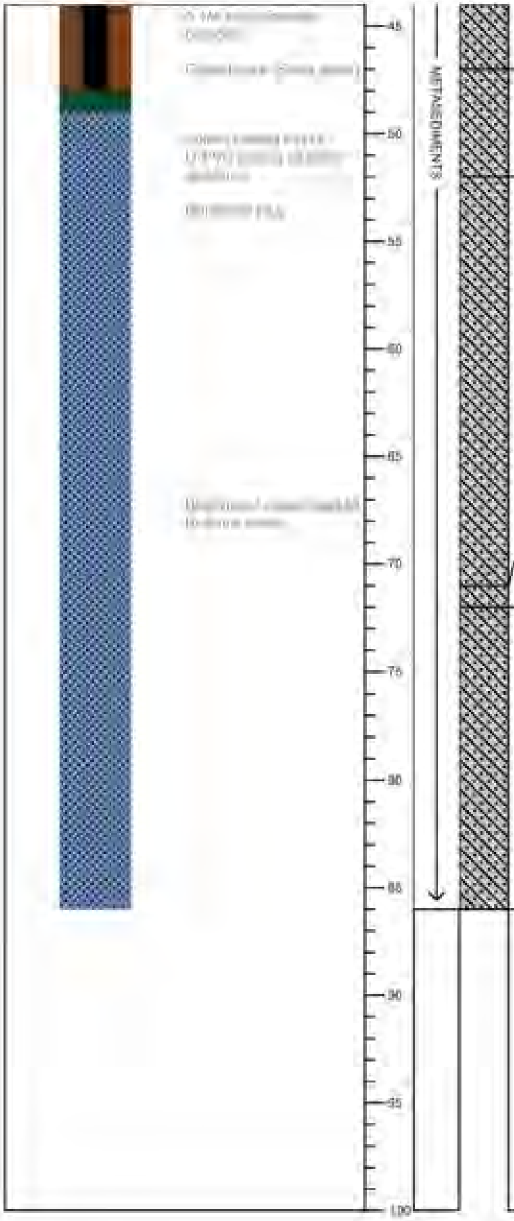
EMM

Drawing No:
Revision: A
Date drawn: 13/2/17
Drawn by: K Maher
Checked by:
Project No: J17084

WMB1273A
Groundwater Investigations

BORE COMPLETION REPORT - WMB1273A

BORE CONSTRUCTION | **DEPTH (m)** | **STRATIGRAPHY** | **GRAPHIC LOG** | **LITHOLOGY** | **HYDROGEOLOGICAL OBSERVATIONS**



LITHOLOGY

Mottled grey, brecciated, medium grained

Mottled grey, brecciated, medium grained, change in colour minor green in parts. Fracture @ 79m. Looks brecciated in vein. Plagioclase present (pale pink)

Mottled grey, brecciated, medium grained; black grains in green altered matrix, becciated

Mottled grey, brecciated, medium grained

HYDROGEOLOGICAL OBSERVATIONS

Airlift at 47m
Yield: 0.06 L/s
Temp: 25 °C
EC: 984 µS/cm
pH: 7.7
ORP: 125 mV

Airlift at 54m
Yield: 0.06 L/s
Temp: 26 °C
EC: 825 µS/cm
pH: 7.91
ORP: 116 mV

Airlift at 60m
Yield: 0.06 L/s
Temp: 26.5 °C
EC: 1012 µS/cm
pH: 7.82

Airlift at 66m
Yield: 0.06 L/s
Temp: 26 °C
EC: 551 µS/cm
pH: 7.76
ORP: 104 mV

Airlift at 74m
Yield: 0.06 L/s
Temp: 26.5 °C
EC: 612 µS/cm
pH: 7.3

Airlift at 86m
Yield: 0.06 L/s
Temp: 24.4 °C
EC: 624 µS/cm
pH: 7.24
ORP: 124 mV

Drawing No:
Revision: A
Date drawn: 13/2/17
Drawn by: K Maher
Checked by:
Project No: J17084

WMB1273A

Groundwater Investigations

BORE COMPLETION REPORT: WMB1273B

Page1/1

Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 717301.3 **Northing:** 6291211.1
Top of casing elevation: 956.0 m AHD (monument)
Grid system: MGA Zone 55 **Stick-up height:** 0.87 m

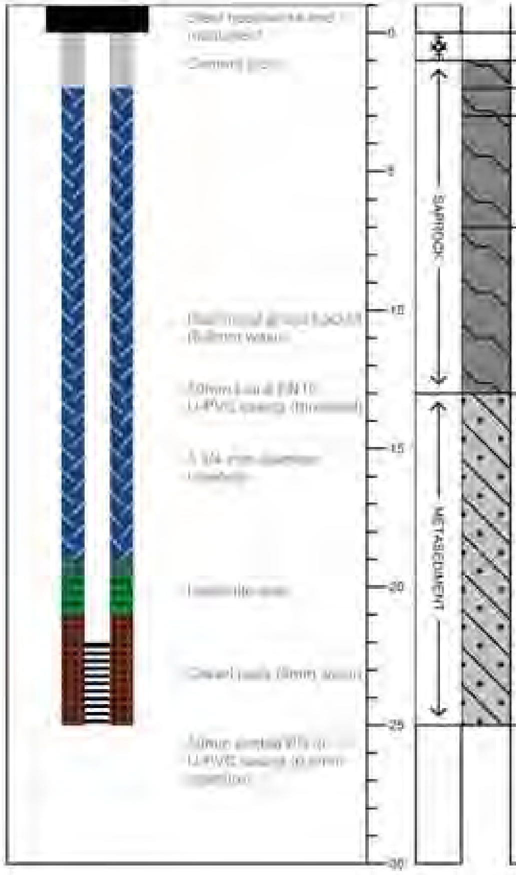
Drilling contractor: Britts Drilling Services
Driller: D Britt **Rig:** BDS1
Drilling method: Air rotary **Total drilled depth:** 25 m
Borehole diameter: 200 0 - 1 m **Bit:** Blade
Borehole diameter: 133 m 1 - 25 m **Bit:** DHH

Purpose of bore: Groundwater monitoring bore
Screened Formation: Metasediments
Logged by: T Wilkinson
Start date: 19/12/16
Completion date: 20/12/16

Static WL: 944.63 mAHD
11.37 mbtoc
Water level date: 12/01/16

Plain casing: 0-22m: Class 18 50mm PVC
Screen: 22-25m: 50mm PVC Class 18 (0.5mm slot)
Sump: NA - well cap fixed to base of screen
Cement grout: 0-2m: 0.02m3
Gravel backfill: 12-19m: 5-8mm gravel
Bentonite seal: 19-21m
Gravel pack: 21-25m: 3mm washed gravel
Bentonite plug: NA

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Mottled red, well sorted, rounded

Pale yellow, poorly sorted, subrounded

Pale yellow, extremely altered

Pale yellow, residual soil

Pale grey, massive, aphanitic

Mottled grey, massive, aphanitic

Brown, insufficient volume to measure

Drawing No:
Revision: A
Date drawn: 13/3/17
Drawn by: K Maher
Checked by
Project No: J17084

WMB1273B

Groundwater Investigations

BORE COMPLETION REPORT: WMB1452A

Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 715238.0 **Northing:** 6291483.5
Top of casing elevation: 900.7 m AHD (monument)
Grid system: MGA Zone 55 **Stick-up height:** 0.91 m

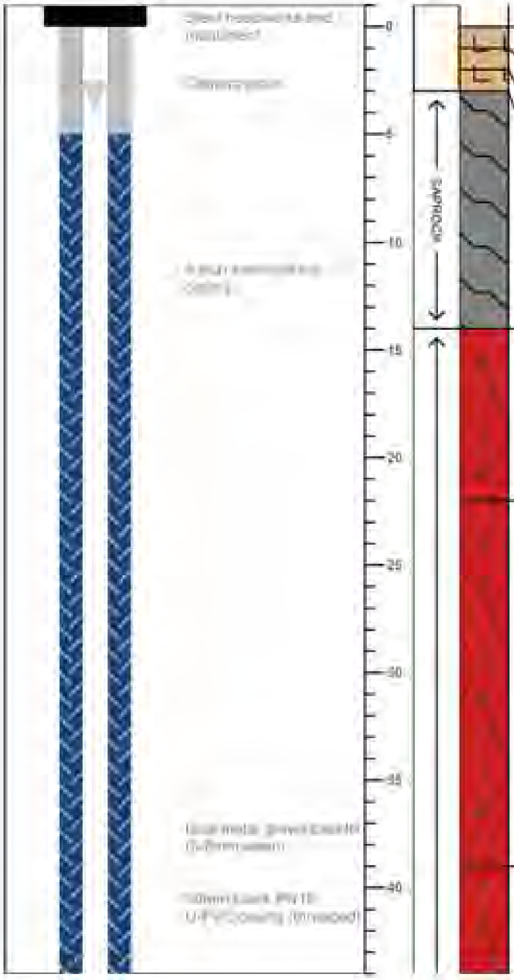
Drilling contractor: New Competitive Drilling
Driller: S Smith **Rig:** NCD1
Drilling method: Air rotary **Total drilled depth:** 98 m
Borehole diameter: 196 mm 0 - 15 m **Bit:** Blade
Borehole diameter: 132 mm 15 - 98 m **Bit:** DHH

Purpose of bore: Groundwater monitoring bore
Screened Formation: Volcanaclastics
Logged by: T Wilkinson
Start date: 19/12/16
Completion date: 20/12/16

Static WL: 897.53 mAHD
3.17 mbtoc
Water level date: 17/03/17

Plain casing: 0-75.2m: Class 18 50mm PVC
Screen: 75.2-87.2: 50mm PVC Class 18 (0.5mm slot)
Sump: 87.2-87.7m: 50mm PVC Class 19
Cement grout: 0-5m: 0.05m3
Gravel backfill: 5-70m: 5-8mm gravel
Bentonite seal: 70-73m
Gravel pack: 73-87.7m: 3mm washed gravel
Bentonite plug: 87.7-89m

BORE CONSTRUCTION | **DEPTH (m)** | **STRATIGRAPHY** | **GRAPHIC LOG** | **LITHOLOGY** | **HYDROGEOLOGY**



Pale brown, mud sized, rounded
Mottled grey, poorly sorted, subangular
Mottled brown, moderately sorted
Dark green, massive, vuggy
Dark grey, massive, medium grained
Dark grey, massive, vuggy
Dark grey, massive, medium grained

Water cut at 20m
Temp: 20 °C
EC: 891 µS/cm
pH: 6.5
ORP: 149 mV

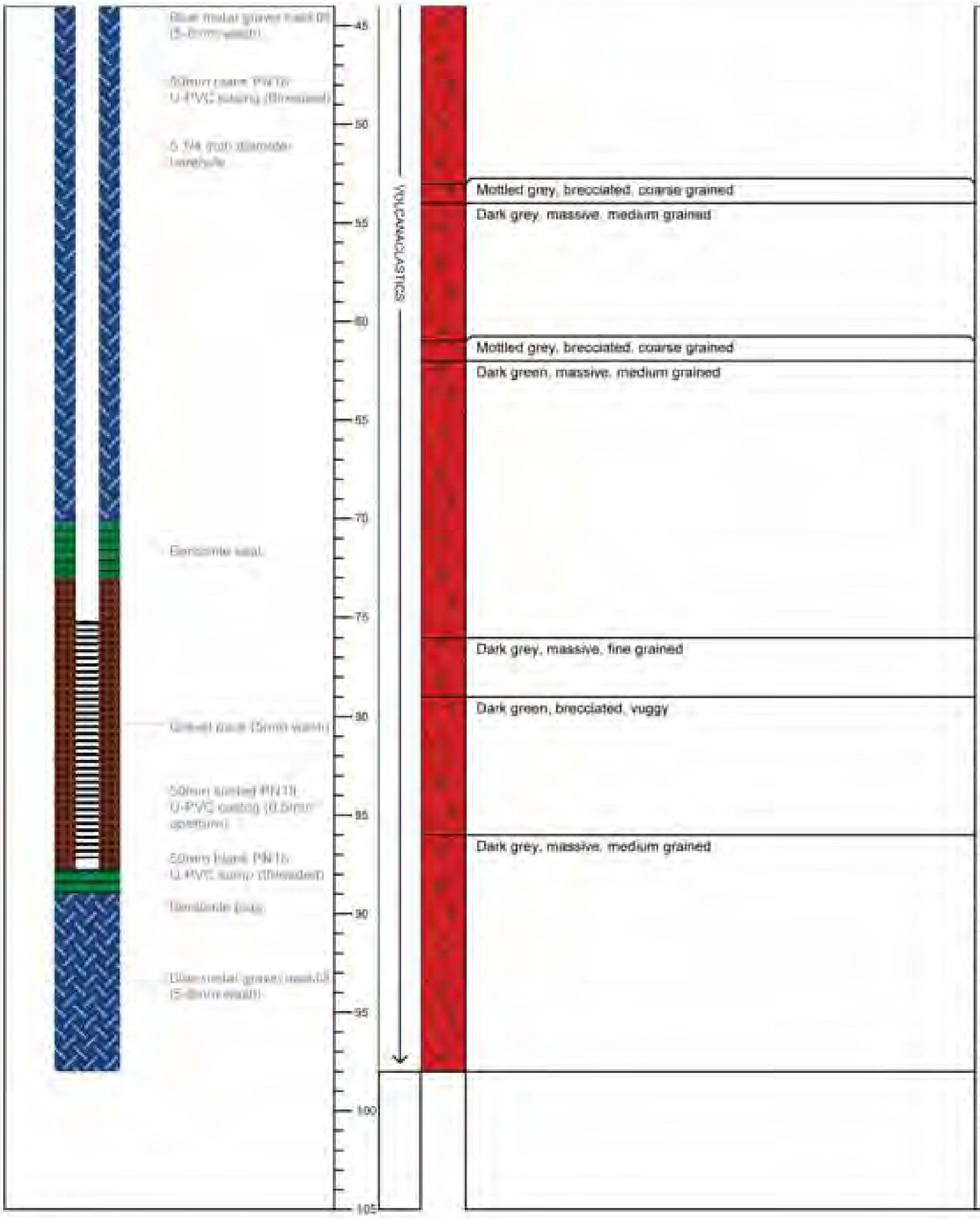
Airlift at 38m
Yield: 1.2 L/s
Temp: 16.5 °C
EC: 450 µS/cm
pH: 7.95
ORP: 134 mV

Drawing No:
Revision: A
Date drawn: 20/03/17
Drawn by: K Maher
Checked by:
Project No: J17084

WMB1452A
Groundwater Investigations

BORE COMPLETION REPORT - WMB1452A

BORE CONSTRUCTION | **DEPTH (m)** | **STRATIGRAPHY** | **GRAPHIC LOG** | **LITHOLOGY** | **HYDROGEOLOGICAL OBSERVATIONS**



Mottled grey, brecciated, coarse grained

Dark grey, massive, medium grained

Mottled grey, brecciated, coarse grained

Dark green, massive, medium grained

Dark grey, massive, fine grained

Dark green, brecciated, vuggy

Dark grey, massive, medium grained

Airlift at 50m
Yield: 1.8 L/s
Temp: 15.2 °C
EC: 480 µS/cm
pH: 7.33
ORP: 173 mV

Airlift at 56m
Yield: 1.8 L/s
Temp: 14.6 °C
EC: 464 µS/cm
pH: 7.7
ORP: 143 mV

Airlift at 62m
Yield: 1.5 L/s
Temp: 14.2 °C
EC: 458 µS/cm
pH: 7.49
ORP: 143 mV

Airlift at 80m
Yield: 0.1 L/s
Temp: 19 °C
EC: 495 µS/cm, pH: 8, ORP: 57 mV

Airlift at 86m
Yield: 0.1 L/s
Temp: 18.5 °C
EC: 491 µS/cm
pH: 8
ORP: 81 mV

Airlift at 92m
Yield: 0.5 L/s

Airlift at 96m
Yield: 0.4 L/s
Temp: 15.7 °C
EC: 477 µS/cm
pH: 7.9
ORP: 102 mV

EMM

Drawing No:
Revision: A
Date drawn: 30/03/17
Drawn by: K Maher
Checked by:
Project No: J17064

WMB1452A

Groundwater Investigations

BORE COMPLETION REPORT: WMB1452B

Page1/1

Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 715247.1 **Northing:** 6291477.7
Top of casing elevation: 900.7 m AHD (monument)
Grid system: MGA Zone 55 **Stick-up height:** 0.93 m

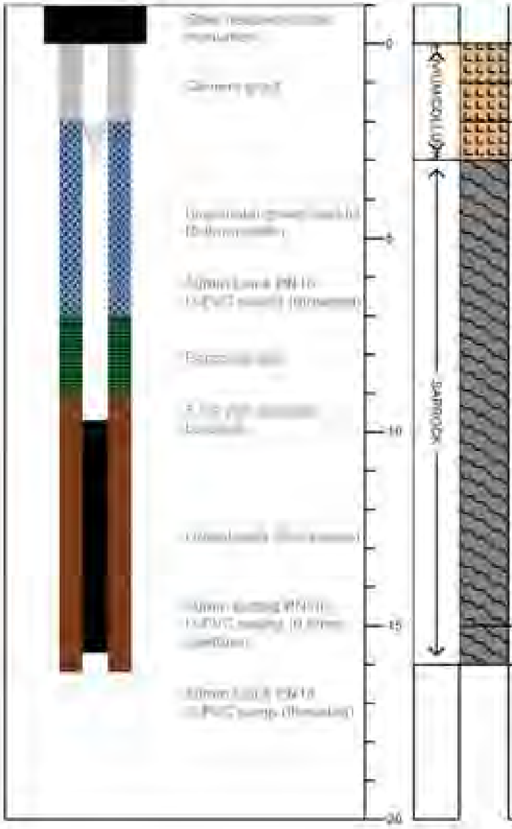
Drilling contractor: New Competitive Drilling
Driller: S Smith **Rig:** NCD1
Drilling method: Air rotary **Total drilled depth:** 16.2 m
Borehole diameter: 132 mm 0 - 16.2 m **Bit:** Blade
Borehole diameter: **Bit:**

Purpose of bore: Groundwater monitoring bore
Screened Formation: Saprock
Logged by: T Wilkinson
Start date: 19/12/16
Completion date: 19/12/16

Static WL: 898.23 mAHD
2.47 mbtoc
Water level date: 17/03/17

Plain casing: 0-9.7m: Class 18 50mm PVC
Screen: 9.7-15.7: 50mm PVC Class 18 (0.5mm slot)
Sump: 15.7-16.2m: 50mm PVC Class 18
Cement grout: 0-2m: 0.02m3
Gravel backfill: 2-7m: 5-8mm gravel
Bentonite seal: 7-9m
Gravel pack: 9-16.2m: 3mm washed gravel
Bentonite plug: NA

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGY



Pale brown, moderately sorted, rounded

Mottled grey, poorly sorted, subangular

Mottled brown, moderately sorted, subrounded

Dark green, massive, vuggy

Dark grey, massive, medium grained

Water Cut: at 16m
Yield: 5 L/s
Temp: 21 °C
EC: 709 µS/cm
pH: 7.02
ORP: 87.1 mV

EMM

Drawing No:
Revision: A
Date drawn: 13/3/17
Drawn by: K Maree
Checked by
Project No: J17084

WMB1452B

Groundwater Investigations

BORE COMPLETION REPORT: WMB1759A

Page1/4

Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 715975.4 **Northing:** 6291702.0
Top of casing elevation: 919.8 m AHD (monument)
Grid system: MGA Zone 55 **Stick-up height:** 0.56 m

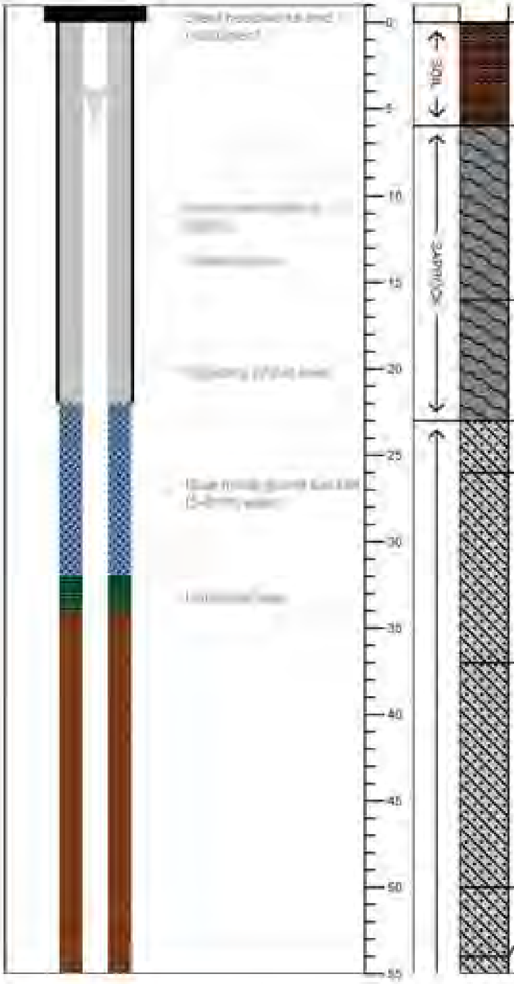
Drilling contractor: New Competitive Drilling
Driller: Shane Smith **Rig:** NCD1
Drilling method: Air rotary **Total drilled depth:** 296m
Borehole diameter: 205 0 - 26 m **Bit:** Blade
Borehole diameter: 149 mm 26 - 296 m **Bit:** DHH

Purpose of bore: Groundwater monitoring bore
Screened Formation: Metasediments
Logged by: S Moran & T Wilkinson
Start date: 1/12/16
Completion date: 8/12/16

Plain casing: 0-284m: Class 18 50mm PVC
Screen: 284-293m: 50mm PVC Class 18 (0.5mm slot)
Sump: 293-296m: 50mm PVC Class 18
Cement grout: 0-22m: 0.24m3
Gravel backfill: 22-32m: 5-8mm gravel
Bentonite seal: 32-34m
Gravel pack: 34-296m: 3mm washed gravel
Bentonite plug: NA

Static WL: 915.12 mAHD
4.68 mbtoc
Water level date: 11/01/17

BORE CONSTRUCTION | **DEPTH (m)** | **STRATIGRAPHY** | **GRAPHIC LOG**



LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS
Mottled brown	
Light brown	
Mottled grey, consolidated, fractured	
Dark green, consolidated, fractured	**Water Cut at 23m** Yield: 2 L/s Temp: 18 °C EC: 1287 µS/cm pH: 7.37 ORP: 146 mV
Dark green, consolidated, massive	
Dark green, consolidated, fractured	**Airlift at 38m** Yield: 5 L/s Temp: 16 °C EC: 1,114 µS/cm pH: 7.78 ORP: 157 mV
Dark green, consolidated, massive	**Airlift at 50m** Yield: 5 L/s Temp: 18 °C EC: 1,108 µS/cm pH: 7.93
Dark green, consolidated, fractured	

EMM

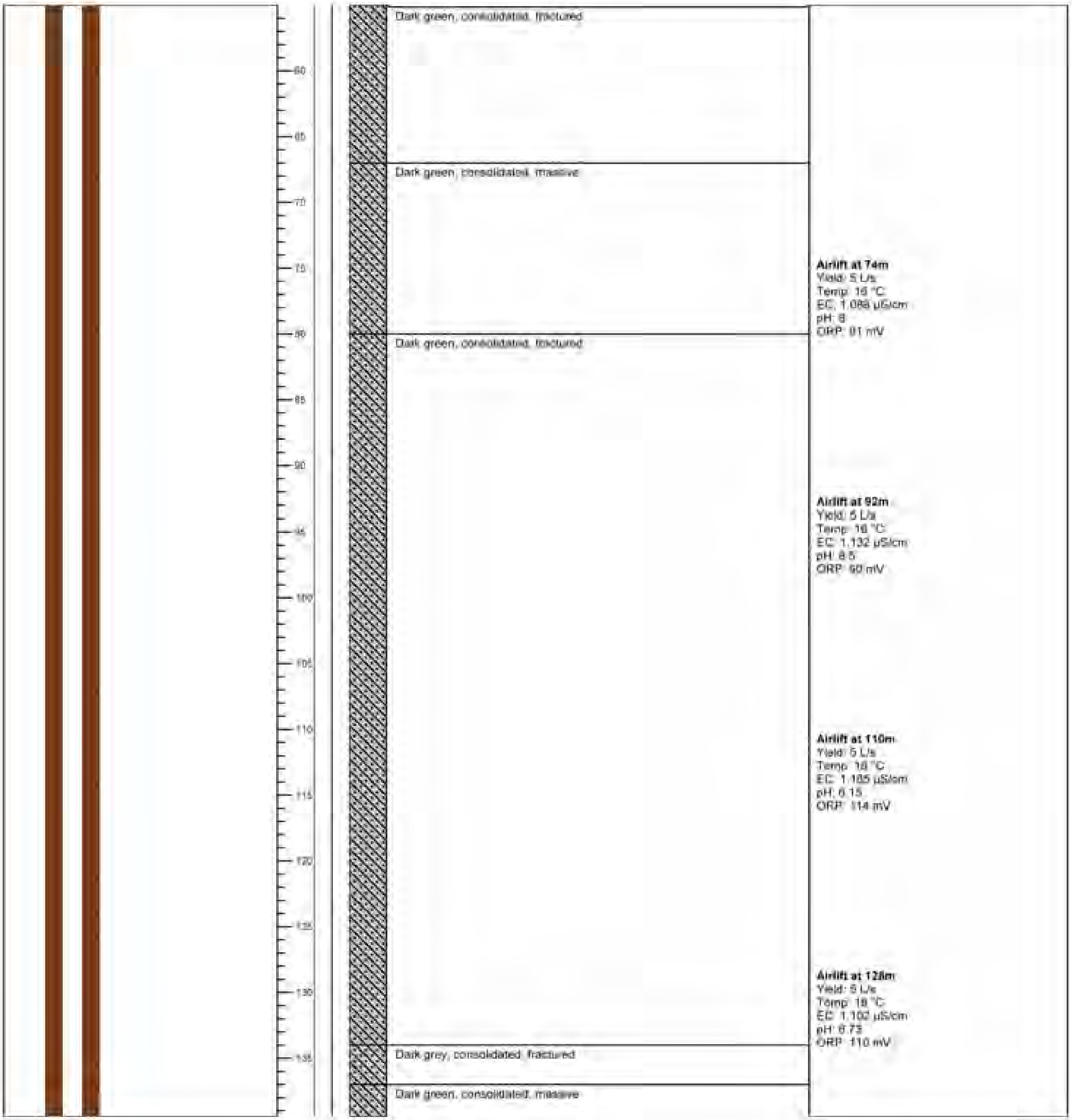
Drawing No:
Revision: A
Date drawn: 13/1/17
Drawn by: K Mann
Checked by:
Project No: J16053

WMB1759A
Groundwater Investigations

BORE COMPLETION REPORT - WMB1759A

Page 2 /4

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Dark green, consolidated, fractured

Dark green, consolidated, massive

Dark green, consolidated, fractured

Dark grey, consolidated, fractured

Dark green, consolidated, massive

Airlift at 74m
Yield: 5 L/s
Temp: 16 °C
EC: 1,088 µS/cm
pH: 8
ORP: 91 mV

Airlift at 92m
Yield: 5 L/s
Temp: 16 °C
EC: 1,132 µS/cm
pH: 8.5
ORP: 60 mV

Airlift at 110m
Yield: 5 L/s
Temp: 16 °C
EC: 1,185 µS/cm
pH: 8.15
ORP: 114 mV

Airlift at 128m
Yield: 5 L/s
Temp: 18 °C
EC: 1,102 µS/cm
pH: 8.73
ORP: 110 mV

EMM

Drawing No:
Revision: A
Date drawn: 13/1/17
Drawn by: K Maher
Checked by:
Project No: J16052

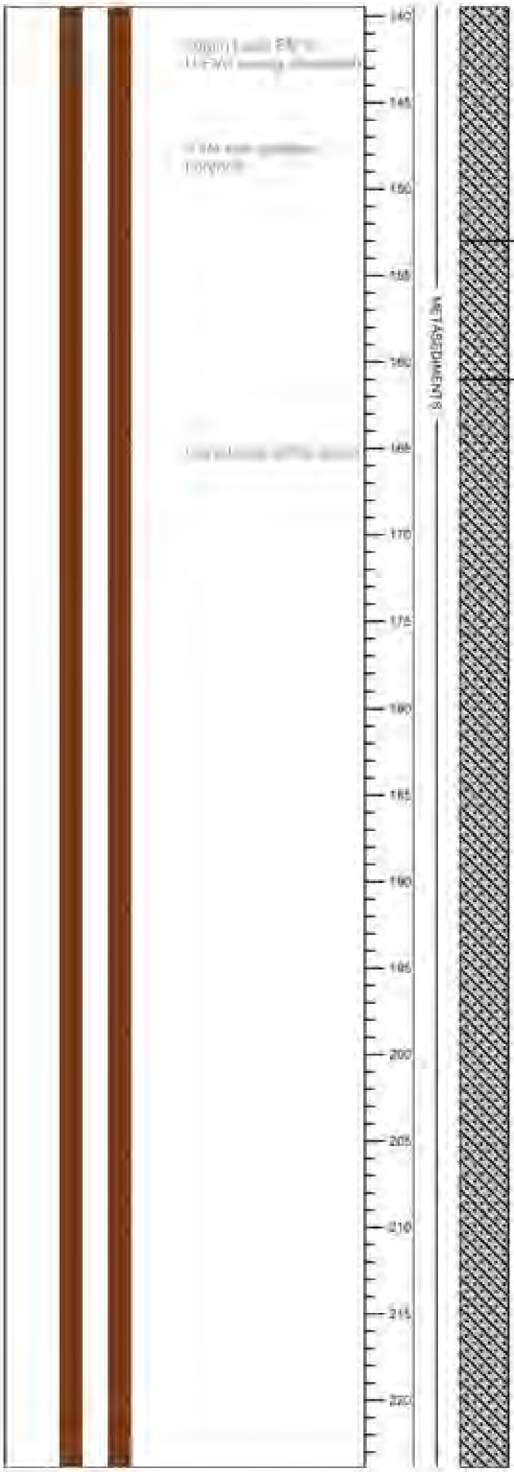
WMB1759A

Groundwater Investigations

BORE COMPLETION REPORT - WMB1759A

Page 3 /4

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Depth (m)	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS
153	Dark green, consolidated, fractured	
161	Dark green, consolidated, massive	
164		**Airlift at 164m** Yield: 5 L/s Temp: 15.4 °C EC: 1,051 µS/cm pH: 7.1 ORP: 146 mV
200		**Airlift at 200m** Yield: 5 L/ Temp: 15.2 °C EC: 1,072 µS/cm pH: 6.8 ORP: 153 mV

EMM

Drawing No:

Revision: A

Date drawn: 12/11/17

Drawn by: K Maier

Checked by:

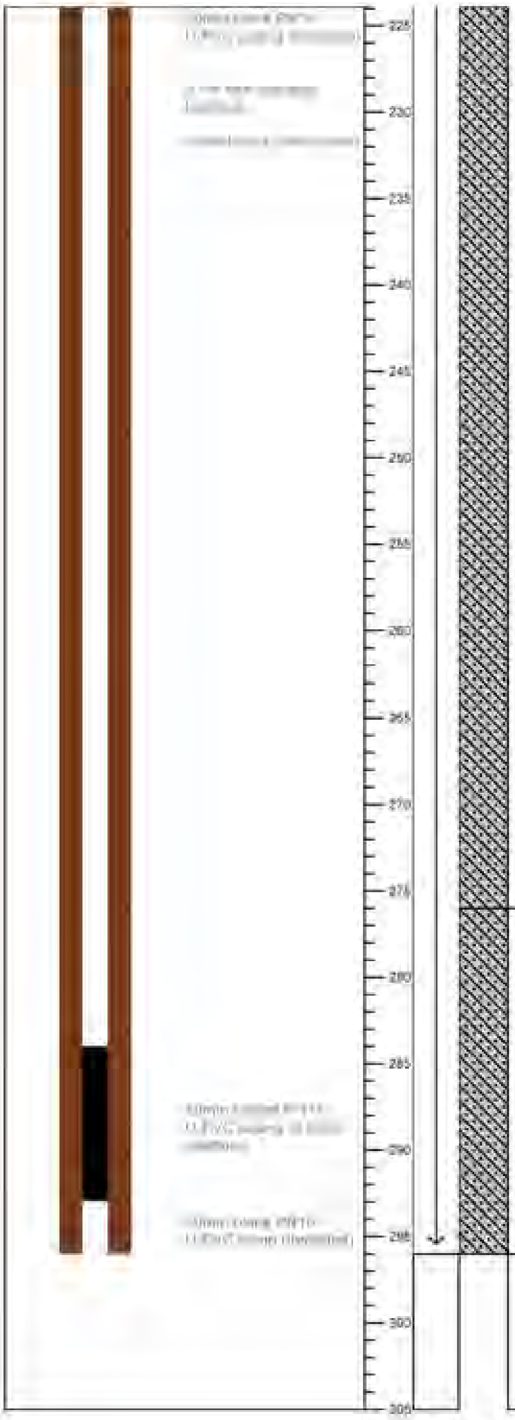
Project No: J16052

WMB1759A

Groundwater Investigations

BORE COMPLETION REPORT - WMB1759A

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Dark grey, consolidated, massive

Airlift at 244m
Yield: 5 L/s
Temp: 14.5 °C
EC: 1,010 µS/cm
pH: 7.53
ORP: 115 mV

Airlift at 260
Yield: 5 L/s
Temp: 15 °C
EC: 1,040 µS/cm
pH: 7.55
ORP: 116 mV

Airlift at 284m
Yield: 5 L/s
Temp: 14.6 °C
EC: 996 µS/cm
pH: 7.62
ORP: 79 mV

Airlift at 298m
Yield: 5 L/s
Temp: 15 °C
EC: 1,053 µS/cm
pH: 6.7
ORP: 129 mV

EMM

Drawing No:
Revision: A
Date drawn: 13/11/17
Drawn by: K Maree
Checked by:
Project No: J16052

WMB1759A

Groundwater Investigations

BORE COMPLETION REPORT: WMB1759B

Page1/1

Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 715965.2 **Northing:** 6291700.5
Top of casing elevation: 919.6 m AHD (monument)
Grid system: MGA Zone 55 **Stick-up height:** 0.60 m

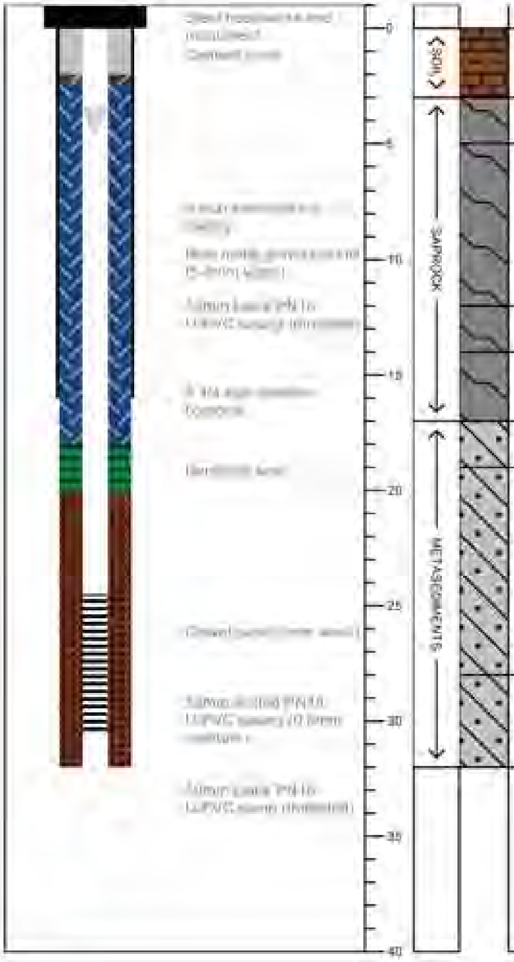
Drilling contractor: New Competitive Drilling
Driller: S Smith **Rig:** NCD1
Drilling method: Air rotary **Total drilled depth:** 32 m
Borehole diameter: 203 mm 0 - 16 m **Bit:** Blade
Borehole diameter: 149 mm 16 - 32 m **Bit:** DHH

Purpose of bore: Groundwater monitoring bore
Screened Formation: Metasediments
Logged by: S Moran
Start date: 11/12/16
Completion date: 12/12/17

Static WL: 915.55 mAHD
4.05 mbtoc
Water level date: 13/12/16

Plain casing: 0-24.5m: Class 18 50mm PVC
Screen: 24.5-30.5: 50mm PVC Class 18 (0.5mm slot)
Sump: 30.5-32m: 50mm PVC Class 18
Cement grout: 0-2m: 0.02m3
Gravel backfill: 2-18m: 5-8mm gravel
Bentonite seal: 18-20m
Gravel pack: 20-32m: 3mm washed gravel
Bentonite plug: NA

BORE CONSTRUCTION | **DEPTH (m)** | **STRATIGRAPHY** | **GRAPHIC LOG**



LITHOLOGY	HYDROGEOLOGY
Red brown, unconsolidated, well sorted	
Red, consolidated, layered	
Red brown, consolidated, layered, moderately sorted, dry, some small stones.	
Dark brown, consolidated, layered, consolidated.	
Red brown, consolidated, layered, distinctly altered, weathered/altered zone	
Dark green brown, consolidated, layered, minor oxidisation	Water cut at 18m Yield: <0.1 L/sec
Dark green, consolidated, layered, soft clay like clumps in sample	
Dark green white, consolidated, layered, looks like fracture zone	**Airlift at 30m** Yield: 1.7 L/s

EMM

Drawing No:
Revision: A Date drawn: 13/3/17
Drawn by: K Maier Checked by: R Holden
Project No: J16053

WMB1759B

Groundwater Investigations

BORE COMPLETION REPORT: WMB2130A

Page1/2

Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 713071.9 **Northing:** 6292196.6
Top of casing elevation: 880 mAHD
Grid system: MGA Zone 55 **Stick-up height:** ~0.90 m

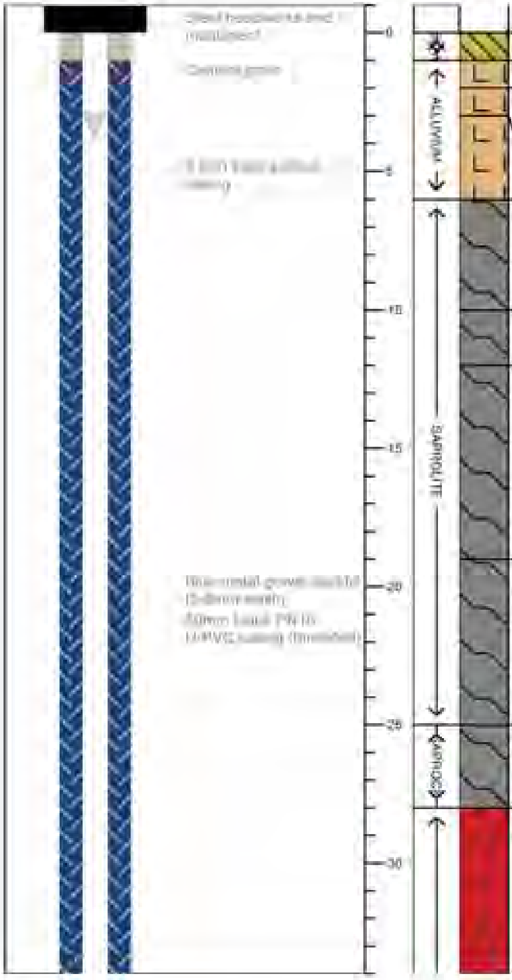
Drilling contractor: Britts Drilling Services
Driller: S Smith **Rig:**
Drilling method: Air rotary **Total drilled depth:** 71 m
Borehole diameter: 195 mm 0 - 13 m **Bit:** Blade
Borehole diameter: 132 mm 13 - 71 m **Bit:** DHH

Purpose of bore: Groundwater monitoring bore
Screened Formation: Volcaniclastics
Logged by: K Maher & T Wilkinson
Start date: 14/03/2017
Completion date: 17/3/17

Static WL: 876.67 mAHD
3.33 mbtoc
Water level date: 18/03/17

Plain casing: 0-42.8m: Class 18 50mm PVC
Screen: 42.8-51.8: 50mm PVC Class 18 (0.5mm slot)
Sump: 51.8-52.5m: 50mm PVC Class 18
Cement grout: 0-1m: 0.01m3
Gravel backfill: 1-39m: 3mm washed gravel
Bentonite seal: 39-41mm
Gravel pack: 41-52.5m: 3mm washed gravel
Bentonite plug: 52.5-53.5m

BORE CONSTRUCTION | **DEPTH (m)** | **STRATIGRAPHY** | **GRAPHIC LOG**



LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS
Pale, pinkish-grey, dry	
Dark, grey with gravel	
Orange-brown with minor gravel moderately weathered/oxidised. Moisture @ ~2.5m	
Dark, brown, gravel, residual soil with clay	
Light, yellowish-orange,dry, residual soil	
Orange-brown,wet, residual soil, gravel and clay, fallback from above gravel moisture from gravel above	
Mottled, orange-brown dry, residual soil, highly weathered	**Water Cut at 16m** Yield: 0.5 L/s pH: 7.15
Mottled, orange-brown,wet, distinctly altered. Moderately weathered clay and quartz fragments	Fractured: 19-25 m
Mottled, brown, layered, vuggy, medium-grained, crystalline, distinctly altered	**Airlift at 25m** Yield: 1 L/s pH: 7.65
Dark, black, layered,aphanitic, fresh rock, not scratched with score, clayey around vein	Fractured 29-30m **Airlift at 31m** Yield: 1.7 L/s pH: 7.77

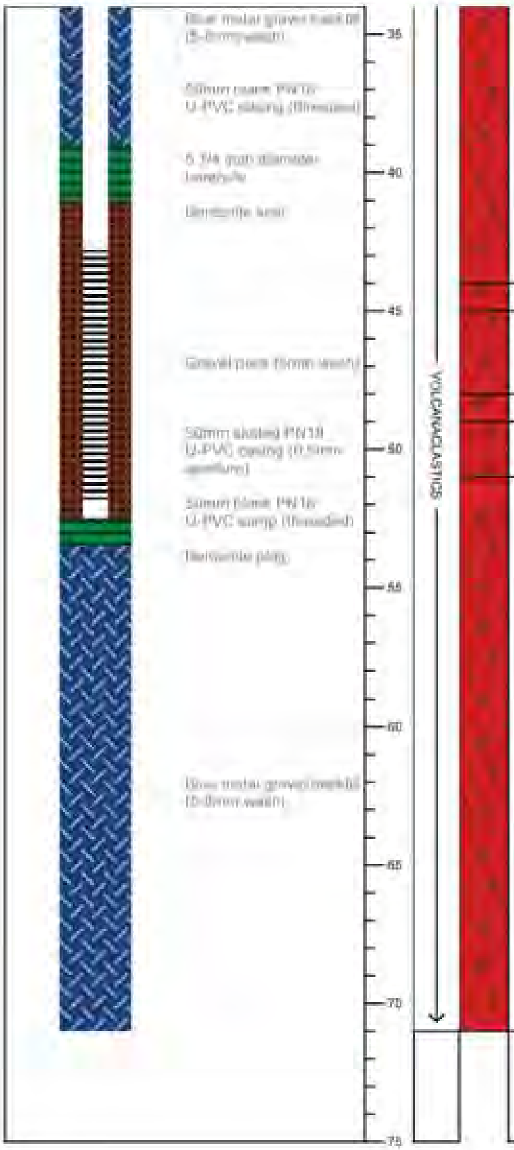
EMM

Drawing No:
Revision: A
Date drawn: 4/04/17
Drawn by: K Maher
Checked by: R Hobbs
Project No: J17054

WMB2130A
Groundwater Investigations

BORE COMPLETION REPORT - WMB2130A

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



LITHOLOGY

Dark, grey, massive,aphanitic, fresh rock, colour change to grey

Dark, brown, massive, vuggy, fine grained, finely crystalline, colour change to brown with evidsence of oxidation.

Dark, grey, massive, fine grained, crystalline, fresh rock.

Dark, brown, massive,aphanitic, slightly altered, staining on chip surfaces.

Dark, grey, massive,fine grained, finely crystalline, fresh rock,solid rock.

HYDROGEOLOGICAL OBSERVATIONS

Fractured 34-38 m

Airlift at 37m
Yield: 0.5 L/s
Temp: 22.5 °C
EC: 644 µS/cm
pH: 7.96
ORP: 117 mV

Airlift at 49m
Yield: 0.5 L/s
Temp: 22.3 °C
EC: 621 µS/cm
pH: 8.1
ORP: 124 mV

Drill penetration rate slowed from 50 to 71 mbgl

Airlift at 55m
Yield: 0.5 L/s
Temp: 22 °C
EC: 628 µS/cm
pH: 8.34
ORP: 118 mV

Airlift at 61m
Yield: 0.5 L/s
Temp: 22 °C
EC: 613 µS/cm
pH: 7.95
ORP: 144 mV

Airlift at 67m
Yield: 0.5 L/s
Temp: 21 °C
EC: 553 µS/cm
pH: 7.97
ORP: 142 mV

EMM

Drawing No:	
Revision: A	Date drawn: 4/04/17
Drawn by: K Maher	Checked by: R Hobbs
Project No: J17064	

WMB2130A

Groundwater Investigations

BORE COMPLETION REPORT: WMB2130B

Page1/1

Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 713071.8 **Northing:** 6292192.2
Top of casing elevation: 877.92 m AHD
Grid system: MGA Zone 55 **Stick-up height:** 0.90 m

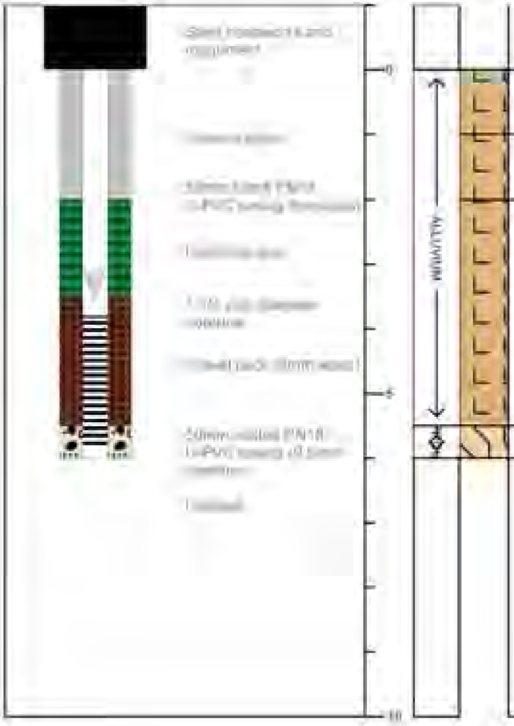
Drilling contractor: Britts Drilling Services
Driller: D Britt **Rig:** BDS1
Drilling method: Air rotary **Total drilled depth:** 6 m
Borehole diameter: 195 mm 0- 6 m **Bit:** Blade
Borehole diameter: **Bit:**

Purpose of bore: Groundwater monitoring bore
Screened Formation: Alluvium
Logged by: T Wilkinson
Start date: 16/03/17
Completion date: 16/03/17

Static WL: 874.78 mAHD
3.31 mbtoc
Water level date: 18/03/17

Plain casing: 0-3.8m: Class 18 50mm PVC
Screen: 3.8-5.8: 50mm PVC Class 18 (0.5mm slot)
Sump: NA - Well capped at base of screen
Cement grout: 0-2m: 0.02m3
Gravel backfill: 5.5-5.8m: Fallback
Bentonite seal: 2-3.5m
Gravel pack: 3.5-5.5m: 5mm washed gravel
Bentonite plug: NA

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGY



Pale, pinkish grey, dry, clay

Dark grey, dry clay with some gravel

Dark grey with minor gravel, moderately weatered/oxidised

Sticky clay

Water Cut at 4m
Yield: 1.0 L/s
Temp: 18.5 °C
EC 735 µS/cm
pH: 10.4
ORP: 40 mV

EMM

Drawing No:
Revision: A
Date drawn: 20/03/17
Drawn by: K Maree
Checked by:
Project No: J17084

WMB2130B
Groundwater Investigations

BORE COMPLETION REPORT: WMB2252A

Page1/2

Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 715274.5 **Northing:** 6292284.2
Top of casing elevation: 915.5 m AHD
Grid system: MGA Zone 55 **Stick-up height:** 0.73 m

Drilling contractor: New Competitive Drilling
Driller: S Smith **Rig:** NCD1
Drilling method: Air rotary **Total drilled depth:** 104 m

Borehole diameter:	203.2 mm	0 - 44 m	**Bit:** Blade
Borehole diameter:	133.3 mm	44 - 104 m	**Bit:** DHH

Purpose of bore: Groundwater monitoring bore
Screened Formation: Volcanics
Logged by: S Moran
Start date: 28/11/16
Completion date: 30/11/16

Static WL: 896.45 mAHD
19.05 mbtoc
Water level date: 11/12/16

Plain casing: 0-89m: Class 18 50mm PVC
Screen: 89-101m: 50mm PVC Class 18 (0.5mm slot)
Sump: 101-104m: 50mm PVC Class 18
Cement grout: 0-5m: 0.05m3
Gravel backfill: 5-84m: 5-8mm gravel
Bentonite seal: 84-86m
Gravel pack: 86-104m: 3mm washed gravel
Bentonite plug: NA

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS

Red brown, well sorted

Red brown, layered

Red Brown, layered with a high clay content

Dark brown, layered, weathered, high in biotites and red brown clay

White and dark brown, weathered quartz and metasediments high in biotite and red brown clay

Dark brown, weathered metasediments and red brown clay

Yellow brown, very high clay content and minor quartz

Olive green, very high clay content

Dark green, massive, fresh rock, mica present

EMM

Drawing No:
Revision: A
Date drawn: 13/3/17
Drawn by: K Maier
Checked by:
Project No: J17084

WMB2252A

McPhillamys Groundwater Investigations

BORE COMPLETION REPORT - WMB2252A

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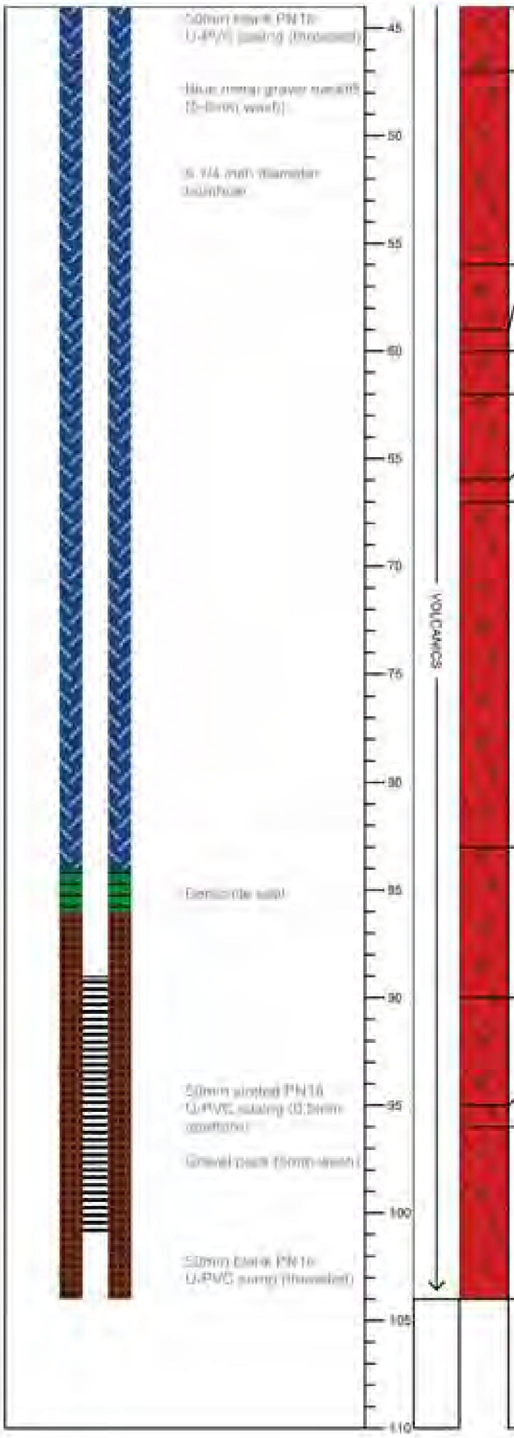
BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



LITHOLOGY

Dark green, massive, slightly altered rock, dolerite with chloritic alteration

Dark Green, massive, fresh rock, mica present

Dark green, massive, fresh rock, mica and minor quartz present

White and dark green, massive, fresh rock, quartz and dark green metasedimnets

Dark green, massive with quartz

Dark green, massive, slightly altered, dolerite with chloritic alteration

Dark green, massive, dolerite and metasediments

Dark and pale green, massive, less chloridation and some quartz present 73-77

Dark and pale green, oxidation 83-85

Pale green, fractured

Pale and dark green, fractured

Pale and dark green

HYDROGEOLOGICAL OBSERVATIONS

Water cut at 52m
Insufficeient yield for sample

76-78 m - small water cut noted by driller

Airlift at 92m
Ieild: 0.5 L/s
EC: 526 µS/c
pH: 6.58

Airlift at 98m
Yield: 0.5 L/s
EC: 502 µS/cm
pH: 8.18

Airlift at 104m
yield: 0.5 L/s
EC: 503 µS/cm
pH: 8.19

EMM

Drawing No:	
Revision: A	Date drawn: 13/3/17
Drawn by: K Maher	Checked by:
Project No: J17084	

WMB2252A

McPhillamys Groundwater Investigations

BORE COMPLETION REPORT: WMB2252B

Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 715284.9 **Northing:** 6292264.2
Top of casing elevation: 915.8 m AHD (monument)
Grid system: MGA Zone 55 **Stick-up height:** 0.85 m

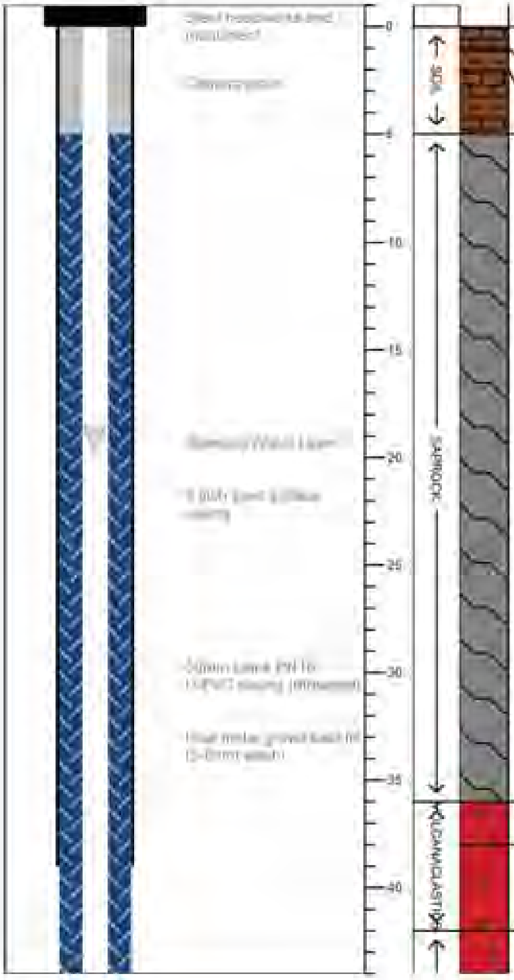
Drilling contractor: New Competitive Drilling
Driller: S Smith **Rig:** NCD1
Drilling method: Air rotary **Total drilled depth:** 100 m
Borehole diameter: 203 mm 0 - 39 m **Bit:** DHH
Borehole diameter: 146 mm 39 - 100 m **Bit:** DHH

Purpose of bore: Groundwater monitoring bore
Screened Formation: Volcanics
Logged by: S Moran
Start date: 24/11/16
Completion date: 29/11/16

Static WL: 896.65 mAHD
19.15 mbtoc
Water level date: 11/12/16

Plain casing: 0-60m: Class 18 50mm PVC
Screen: 60-69: 50mm PVC Class 18 (0.5mm slot)
Sump: 69-71m: 50mm PVC Class 18
Cement grout: 0-5m: 0.05m3
Gravel backfill: 74-100m: 5-8mm gravel
Bentonite seal: 55-57m
Gravel pack: 57-71 m: 3mm washed gravel
Bentonite plug: 71-73m

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Red brown, poorly sorted,, dry, clay, topsoil

Yellow brown, poorly sorted, sub-angular, dry, gravel, topsoil

Brown, poorly sorted, dry, clay, topsoil

Red brown, layered very soft, high clay content

Olive green highly weathered dolerite with magnetite and chloride alteration

Dark green dolerite with magnetite and chloride alteration

Dark green, massive oxidation present at 65-66 m, large fragments >10mm at 67 m

EMM

Drawing No:
Revision: A
Date drawn: 13/3/18
Drawn by: K Maher
Checked by:
Project No: J17054

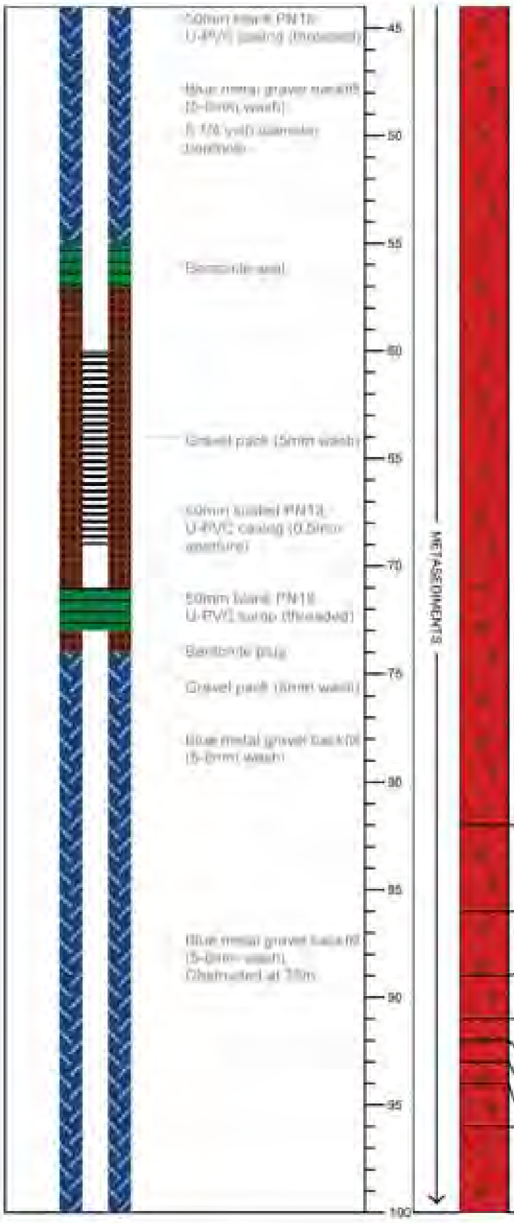
WMB2252B

Groundwater Investigations

BORE COMPLETION REPORT - WMB2252B

Page 2 /2

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



LITHOLOGY

Dark green and white, massive metadsediments with chloride alteration and minor quartz

White and dark green, fractured quartz and metasediments with significant oxidation

Dark green and white, fractured metadsediments with minor quartz and some oxidation

Dark green and white, massive metadsediments with minor quartz

Dark green and white, massive metasediments and quartz

Dark green, massive

Dark green and white, massive metasediments and quartz

Dark green and white, massive metadsediments with minor quartz

HYDROGEOLOGICAL OBSERVATIONS

Water cut at 68m
Yield: 0.3 L/s
Temp: 16.2 °C
EC: 659 µS/cm
pH: 8.35

Airlift at 80m
Yield: 0.23 L/s
Temp: 16.1 °C
EC: 660 µS/cm
pH: 8.38

Airlift at 94m
Yield: 0.34 L/s
EC: 659 µS/cm
pH: 8.35

EMM

Drawing No.:
Revision: A
Date drawn: 13/3/15
Drawn by: K Maher
Checked by:
Project No.: J17084

WMB2252B

Groundwater Investigations

BORE COMPLETION REPORT: WMB2359A & WMB2359B

Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 715996.3 **Northing:** 6292353.7
Top of casing elevation: 967.5 mAHD
Grid system: MGA Zone 55 **Stick-up height:** 0.93 m

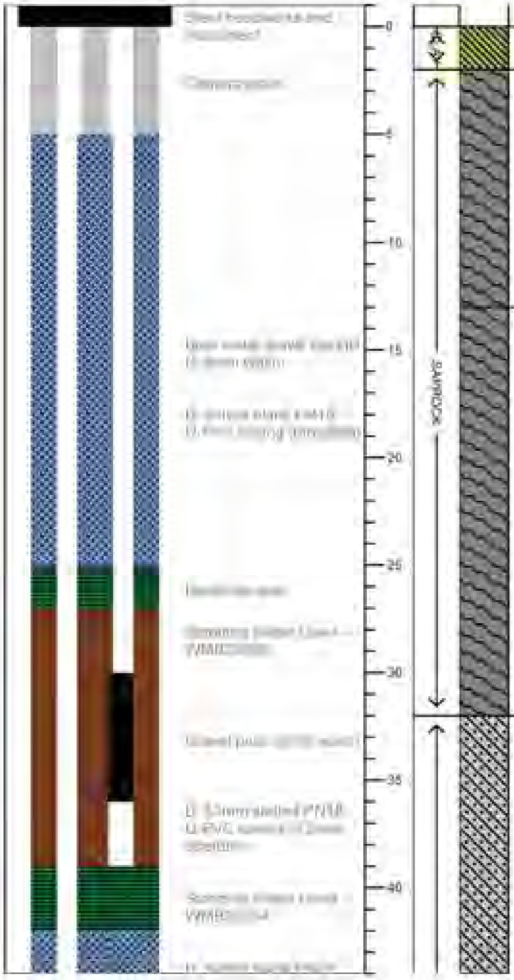
Drilling contractor: Britts Drilling Services
Driller: D Britt **Rig:** BDS1
Drilling method: Air rotary **Total drilled depth:** 287 m
Borehole diameter: 155 mm 0 - 287 m **Bit:** DHH
Borehole diameter: **Bit:**

Purpose of bore: Groundwater monitoring bore
Screened Formation: A: Metasediments / B: Saprock
Logged by: S Moran
Start date: 10/1/17
Completion date: 14/1/17

Static WL: A: 931.94 B: 939.14 mAHD
Water level date: 18/03/17

Plain casing: A: 152-284m / B: 30-36m: Class 18 50mm PVC
Screen: A:152-284m / B: 30-36m: 50mm PVC Class 18
Sump: A 284-287m / B: 36-39m: 50mm PVC Class 18
Cement grout: 0-5m: 0-05m3
Gravel backfill: A: 42-142m / B: 5-25: 5-8mm washed gravel
Bentonite seal: A: 142-145m / B: 25-27m
Gravel pack: A; 145-287m / B: 27-39m: 3mm washed gravel
Bentonite plug: A: NA / B: 39-42m

BORE CONSTRUCTION | **DEPTH (m)** | **STRATIGRAPHY** | **GRAPHIC LOG**



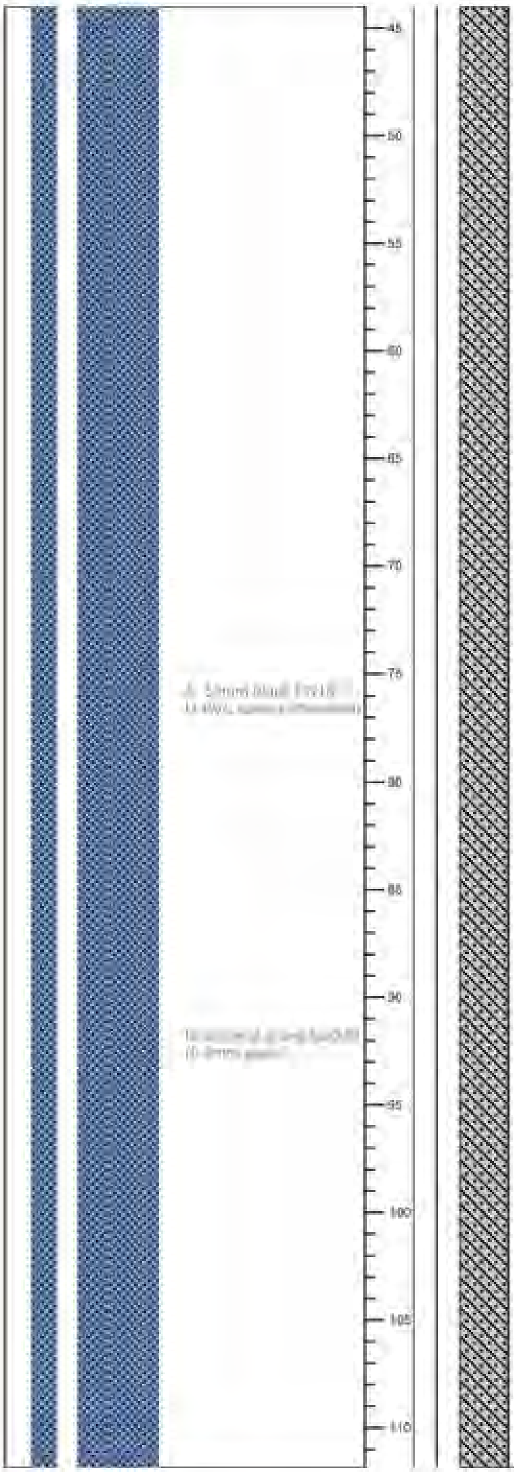
LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS
Pale, brown dry	
Pale, yellow, residual soil, powdered by nail.	
Mottled, brown, distinctly altered, scratched with score.	
Dark, grey, not scratched with score, intensely altered unit ~160m sericite altered with later silicification	Water Cut: <0.1 L/s

Drawing No:
Revision: A
Date drawn:
Drawn by: K Maher
Checked by: R Hobbs
Project No: J17064

WMB2359A & WMB2359B
Groundwater Investigations

BORE COMPLETION REPORT - WMB2359A & WMB2359B

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Airlift at 97m
Yield: <0.1 L/s
EC: 4,724 µS/cm
pH: 3.77
ORP: 231.7 mV

Airlift at 109m
Yield: <0.1 L/s
EC: 2,118 µS/cm

EMM

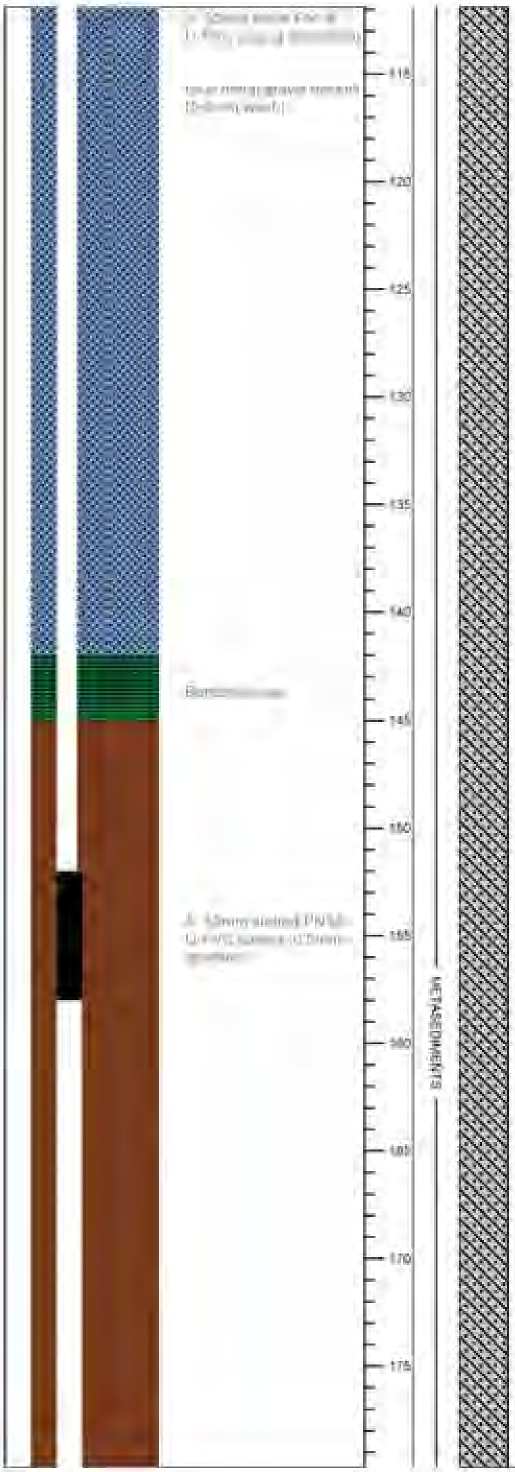
Drawing No:
Revision: A
Date drawn:
Drawn by: K Maier
Checked by: [illegible]
Project No: J17084

WMB2359A & WMB2359B

Groundwater Investigations

BORE COMPLETION REPORT - WMB2359A & WMB2359B

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Airlift at 133m
Yield: <0.1 L/s
EC: 2,994 µS/cm
pH: 3.66
ORP: 242.7 mV

Airlift at 155m
Yield: 0.1 L/s
EC: 1,613 µS/cm
pH: 3.98
ORP: 178 mV

Airlift at163m
Yield: 0.1 L/s
EC: 4,098 µS/cm
pH: 3.84
ORP: 209.2 mV

EMM

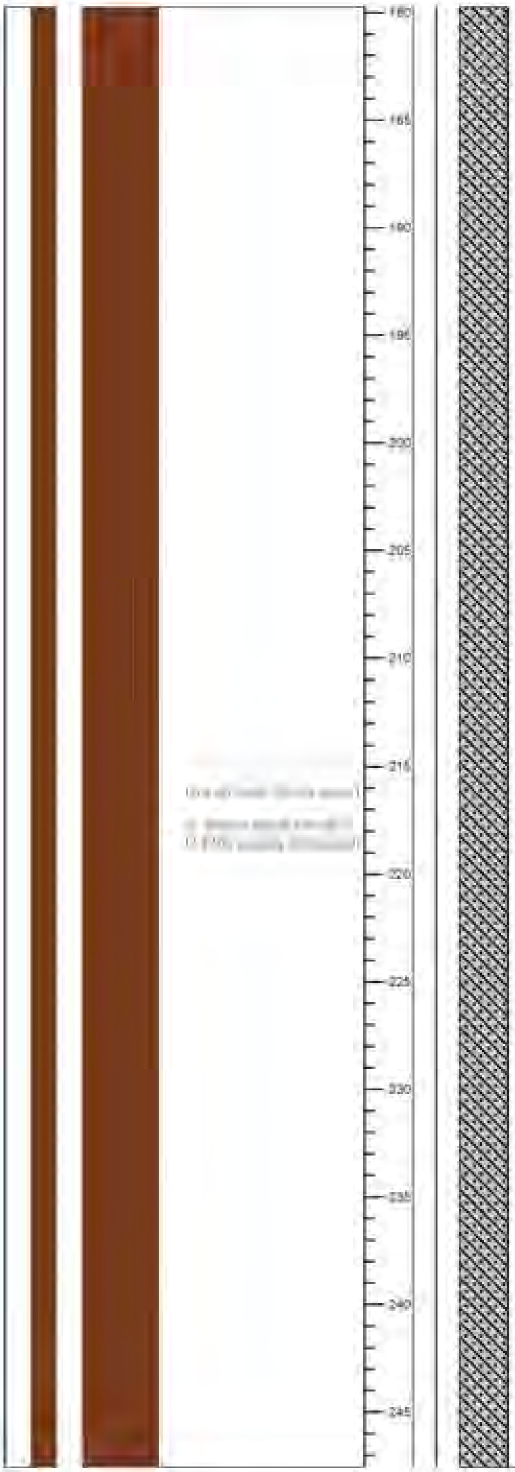
Drawing No:
Revision: A
Date drawn:
Drawn by: K Maher
Checked by: R Hobbs
Project No: J17084

WMB2359A & WMB2359B

Groundwater Investigations

BORE COMPLETION REPORT - WMB2359A & WMB2359B

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Airlift at 211m
Yield: 0.1 L/s
EC: 1,870 µS/cm
pH: 4.11
ORP: 166.2 mV

Airlift at 241m
Yield: 0.1 L/s
EC: 4,991 µS/cm
pH: 4.11
ORP: 184.5 mV

EMM

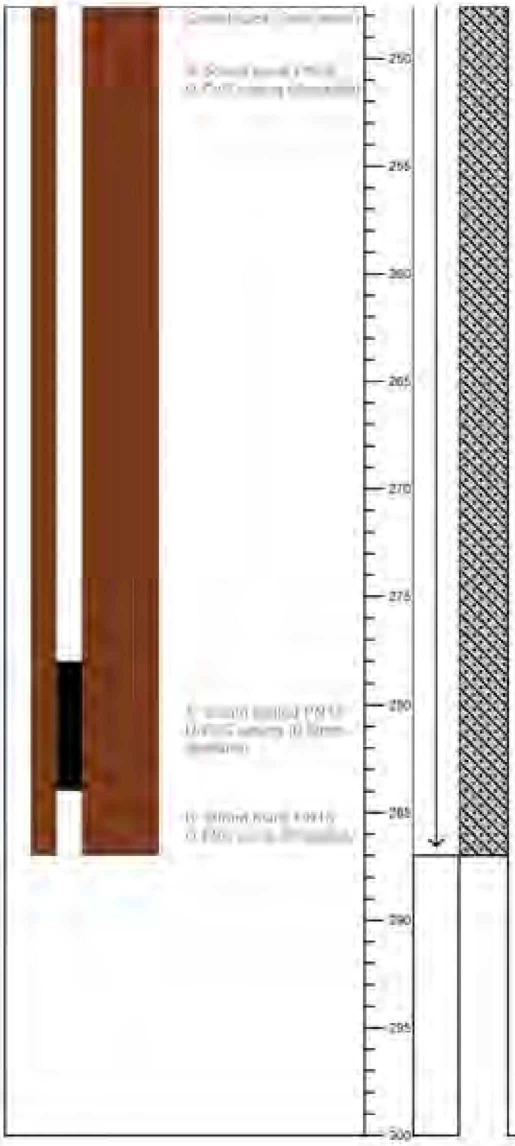
Drawing No:
Revision: A
Date drawn:
Drawn by: K Maher
Checked by: R nobler
Project No: J17084

WMB2359A & WMB2359B

Groundwater Investigations

BORE COMPLETION REPORT - WMB2359A & WMB2359B

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Airlift at 261m
Yield: 0.15 L/s
EC: 2,197 µS/cm
pH: 4.11
ORP: 190.7 mV

Airlift at 287m
Yield: 0.1 L/s
Temp: 24.5 °
EC: 4,364 µS/cm
pH: 4.0
ORP: 216.9 mV

Drawing No:
Revision: A
Date drawn:
Drawn by: K Maher
Checked by: [illegible]
Project No: J17084

WMB2359A & WMB2359B

Groundwater Investigations

BORE COMPLETION REPORT: WMB2364A & WMB2364B

Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 716490.038 **Northing:** 6292345.231
Top of casing elevation: 963.2 m AHD (steel casing)
Grid system: MGA Zone 55 **Stick-up height:** 0.33 m

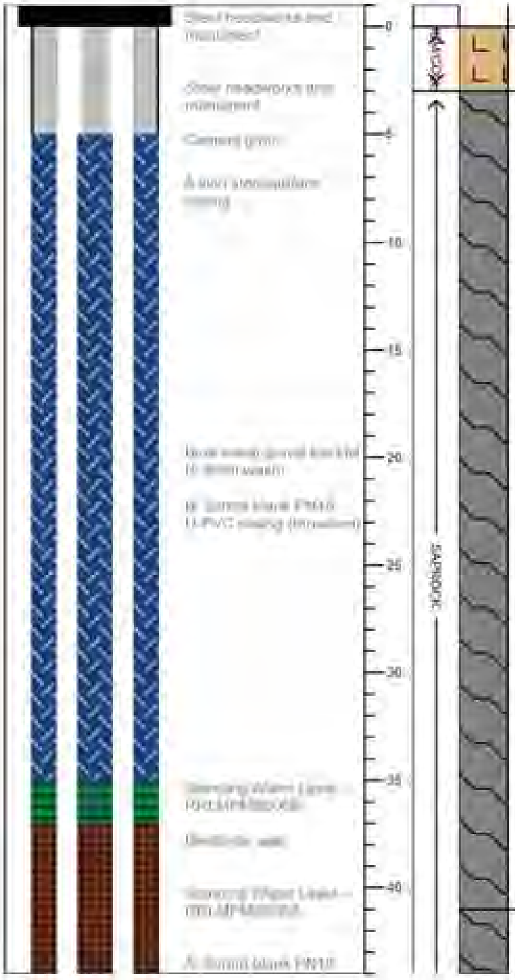
Drilling contractor: Britts Drilling Services
Driller: D Britt **Rig:**
Drilling method: Air rotary **Total drilled depth:** 300 m
Borehole diameter: 250 mm 0-3 m **Bit:** Blade
Borehole diameter: 160 mm 3-300 m **Bit:** DHH

Purpose of bore: Groundwater monitoring bore
Screened Formation: Metasediments
Logged by: T Wilkinson
Start date: 21/12/16
Completion date: 7/1/17

Static WL: A: 926.61 B: 927.59 mAHD
A: 36.59 B: 35.61 mbtoc
Water level date: 18/03/17

Plain casing: A: 0-84m / B: 0-45m: Class 18 50mm PVC
Screen: A: 84-297 / B: 45-51m: 50mm PVC Class 18
Sump: A: 297-300m / B: 51-52.5m: 50mm PVC Class 18
Cement grout: 0-5m: 0.05m3
Gravel backfill: 5-35m: 5-8mm washed blue metal gravel
Bentonite seal: A: 78-80m / B: 35-37m
Gravel pack: A: 80-300m / B: 37-52m: 3mm washed gravel
Bentonite plug: A: NA / B: 52.5-54.5m

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Red brown, unconsolidated

Mottled brown, semi-consolidated with fracture

Mottled brown, consolidated, fractured, specks of chalcopyrite or pyrrhotite

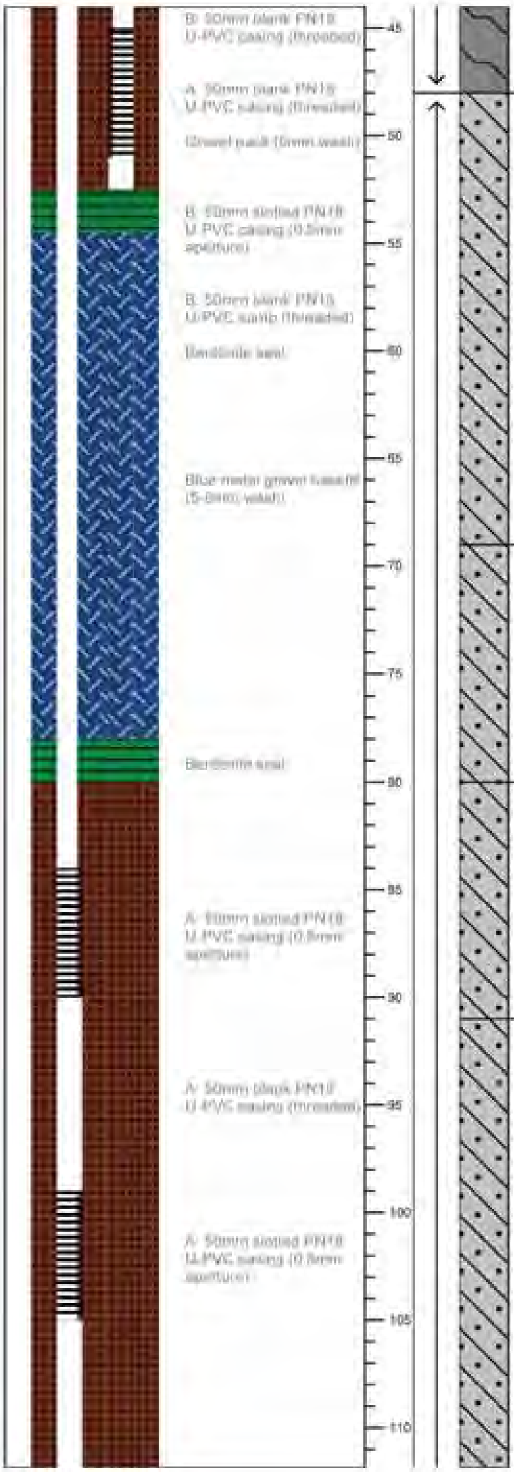
Drawing No:	
Revision: A	Date drawn: 13/2/17
Drawn by: K Maher	Checked by:
Project No: J17064	

WMB2364A & WMB2364B

Groundwater Investigations

BORE COMPLETION REPORT - WMB2364A & WMB2364B

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Mottled green, consolidated, massive, soft section cavity.

Water cut at 48m
Temp: 21 °C
EC: 4,119 µS/cm
pH: 7.2
ORP: 87 mV

Dark green, consolidated, massive, pyrite present.

Airlift at 79m
Yield: 0.1 L/s

Dark green, consolidated, massive

Fractured 85-91m

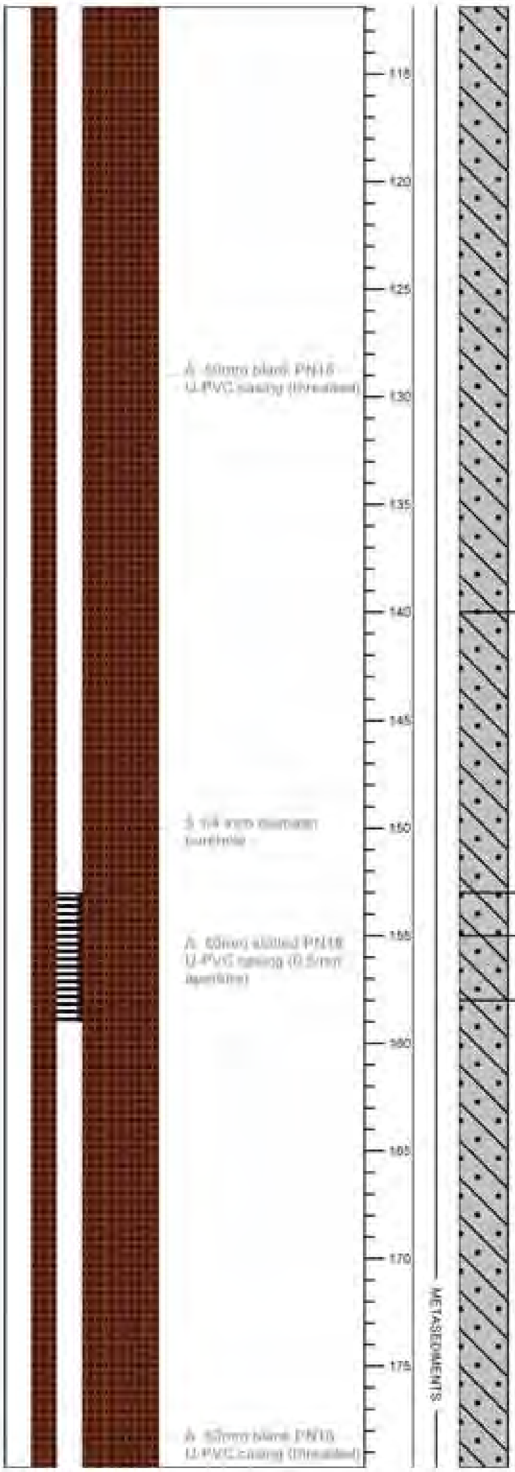
Dark green, consolidated, massive, pyrite present.

Airlift at 91m
Yield: 0.1 L/s
Temp: °C
EC: 3,292 µS/cm
pH: 7.61

Drawing No:		WMB2364A & WMB2364B
Revision: A	Date drawn: 13/2/17	Groundwater Investigations
Drawn by: K Maher	Checked by:	
Project No: J17064		

BORE COMPLETION REPORT - WMB2364A & WMB2364B

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Dark green, consolidated, massive, sulphides scattered throughout

Dark green, consolidated, massive, no sulphides with quartz veining

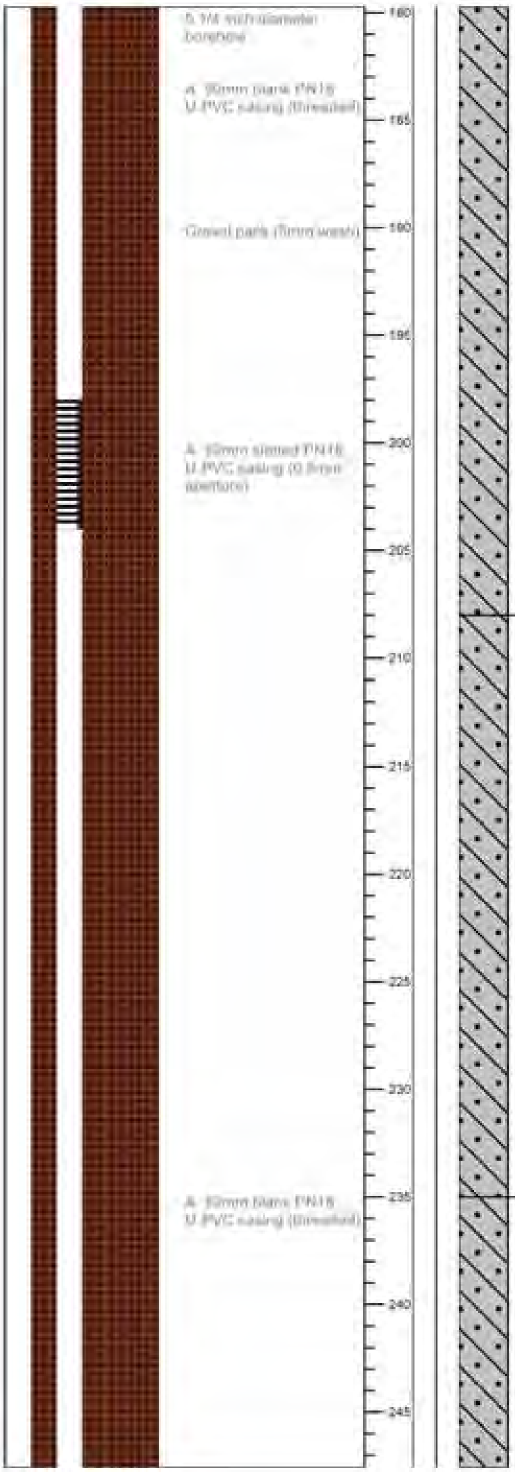
Dark green, consolidated, massive

Mottled black, consolidated, massive with a high clay content

Drawing No.:		**WMB2364A & WMB2364B** Groundwater Investigations
Revision: A	Date drawn: 13/2/17	
Drawn by: K Maher	Checked by:	
Project No.: J17064		

BORE COMPLETION REPORT - WMB2364A & WMB2364B

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Mottled green, consolidated, massive with a high clay content

Mottled black, consolidated, massive with a high clay content

Airlift at 205m
Yield: 0.5 L/s
Temp: 20.6 °
EC: 2429 µS/cm
pH: 7.9
ORP: 38.9 mV

Airlift at 229m
Yield: 0.5 L/s
Temp: 22.9 °C
EC: 2,639 µS/cm
pH: 8.01
ORP: 81.1 mV

EMM

Drawing No.:
Revision: A
Date drawn: 13/2/17
Drawn by: K Maher
Checked by:
Project No.: J17064

WMB2364A & WMB2364B

Groundwater Investigations

BORE COMPLETION REPORT - WMB2364A & WMB2364B

BORE CONSTRUCTION

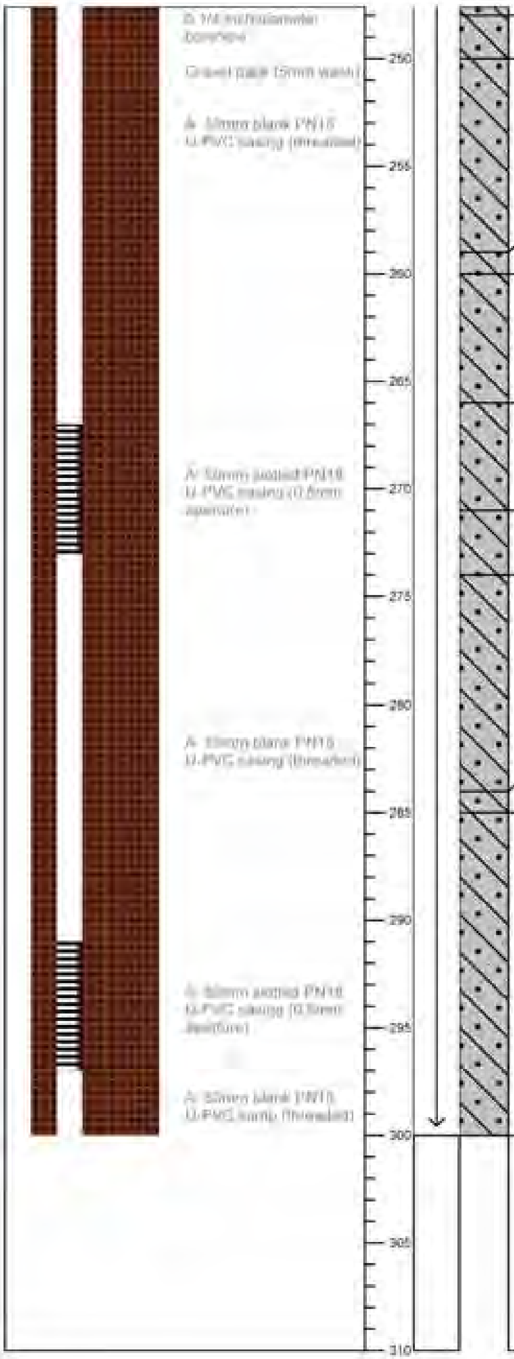
DEPTH (m)

STRATIGRAPHY

GRAPHIC LOG

LITHOLOGY

HYDROGEOLOGICAL OBSERVATIONS



Mottled green, consolidated, massive, weathered

Mottled black, consolidated, massive, weathered - chips <2mm

Pale green, consolidated, massive, chip size up to 10mm, minor quartz

Mottled black, consolidated, massive

Dark black, consolidated, massive with silty-clay

Pale green and fractured

Dark green, consolidated, massive

Mottled green, consolidated, massive with quartz

Dark green and fractured

Airlift at 271m
Yield: 0.5 L/s
Temp: 19.9 °C
EC: 1,694 µS/cm
pH: 8.01
ORP: 112.2 mV

Airlift at 289m
Yield: 0.5 L/s
Temp: 25.2 °C
EC: 1,590 µS/cm
pH: 7.97
ORP: 93.4 mV

Airlift at 295m
Yield: 0.5 L/s'
Temp: 25.4 °C
EC: 1,559 µS/cm
pH: 7.87
ORP: 94.6 mV

EMM

Drawing No:
Revision: A
Date drawn: 13/2/17
Drawn by: K Maher
Checked by:
Project No: J17084

WMB2364A & WMB2364B

Groundwater Investigations

BORE COMPLETION REPORT: WMB2556A

Page1/3

Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 715674.0 **Northing:** 6292552.6
Top of casing elevation: 927.8 m AHD (monument)
Grid system: MGA Zone 55 **Stick-up height:** 0.55 m

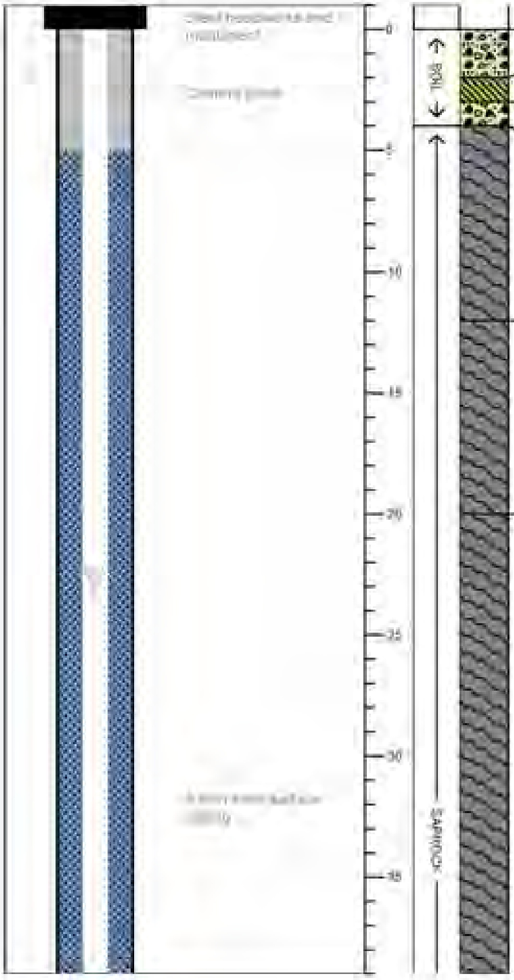
Drilling contractor: Britts Drilling Services
Driller: D Britt **Rig:** BDS1
Drilling method: Air rotary **Total drilled depth:** 133 m
Borehole diameter: 150 mm 0 - 73 m **Bit:** DHH
Borehole diameter: 133 mm 73 - 133 m **Bit:** DHH

Purpose of bore: Groundwater monitoring bore
Screened Formation: Carbonaceous alteration
Logged by: T Wilkinson & K Maher
Start date: 17/1/17
Completion date: 25/1/17

Static WL: 905.1 mAHD
22.7 mbtoc
Water level date: 18/03/2017

Plain casing: 0-107.5m: Class 18 50mm PVC
Screen: 107.5-110.5: 50mm PVC Class 18 (0.5mm slot)
Sump: 110.5-111m: 50mm PVC Class 18
Cement grout: 0-5m: 0.05m3
Gravel backfill: 5-103.5m: 5-8mm gravel
Bentonite seal: 103.5-105.5m
Gravel pack: 105.5-111m: 3mm washed gravel
Bentonite plug: 111-113m

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Silty, dark brown, poorly sorted, angular

Pale pink, subangular, unconsolidated

Silty, mottled brown, subangular, unconsolidated, pyryte fragment at 210m

Dark yellow, consolidated

Dark brown, consolidated

Pale yellow, consolidated, vuggy

Fractured 26-31m

Water Cut at 31m
Temp: 28 °C
EC: 195 µS/cm
pH: 5.8
ORP: 107 mV

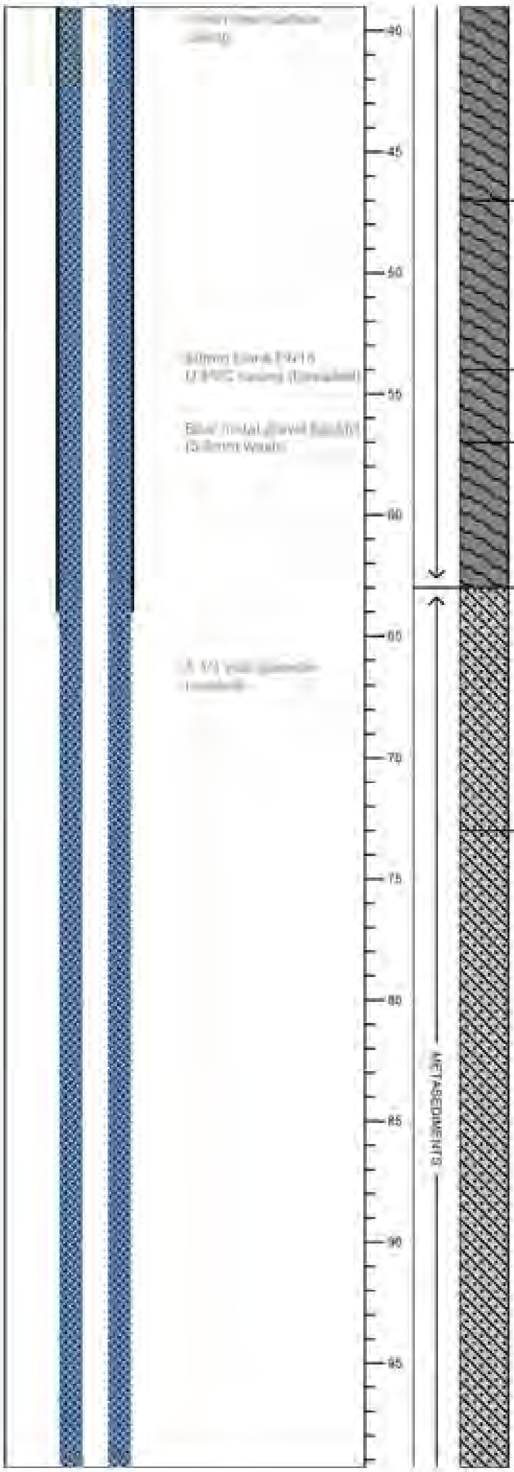
Drawing No:	
Revision: A	Date drawn: 13/3/17
Drawn by: K Maher	Checked by:
Project No: J17084	

WMB2556A

Groundwater Investigations

BORE COMPLETION REPORT - WMB2556A

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Pale brown, vuggy, aphanitic, pyrite fragment

Pale brown, vuggy, fine grained

Pale brown, vuggy, fine grained

Dark brown, vuggy, fine grained

Dark grey, layered, fine grained, quartz carbonate fragmetns @ 253m, 255m, 258m, 259m

Airlift at 81m
Yield: 0.1 L/s
Temp: 29 °C
EC: 495 µS/cm
pH: 7.4
ORP: 140 mV

EMM

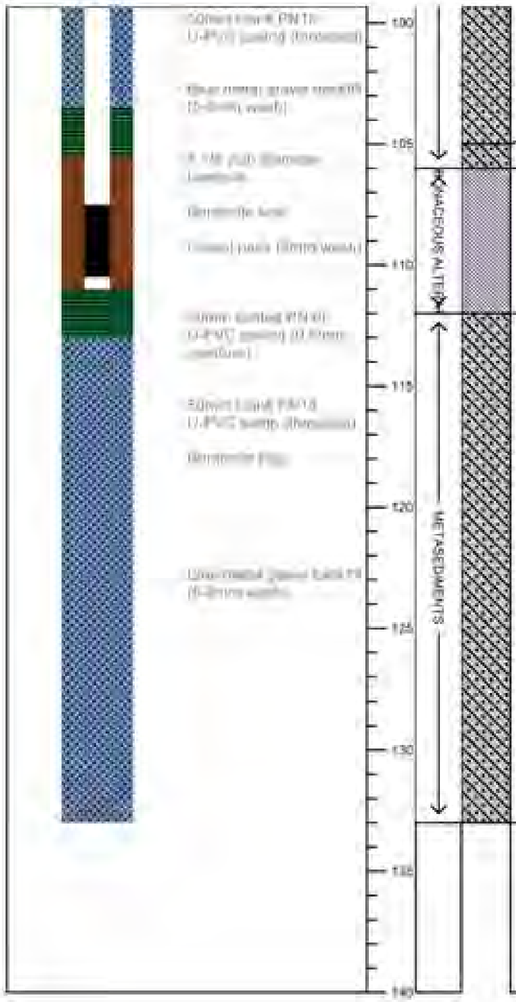
Drawing No:
Revision: A
Date drawn: 13/3/17
Drawn by: K Maher
Checked by:
Project No: J17064

WMB2556A

Groundwater Investigations

BORE COMPLETION REPORT - WMB2556A

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Mottled grey, massive, fresh rock. Very sulphide rich

Light grey, carbonaceous alteration (chemically weathered)

Dark grey, layered, fine grained

Airlift at 115m
Yield: 0.2 L/s
Temp: 29.9 °C
EC: 495 µS/cm
pH: 8.11
ORP: 109.4 mV

Airlift at 121m
Yield: 0.21 L/s
Temp: 28.6 °C
EC: 532 µS/cm
pH: 8.24
ORP: 102.1 mV

Airlift at 133m
Yield not sustained
Temp: 27.1 °C
EC: 419 µS/cm
pH: 7.96
ORP: 108.7 mV

EMM

Drawing No.:	
Revision: A	Date drawn: 13/3/17
Drawn by: K Maher	Checked by:
Project No.: J17054	

WMB2556A

Groundwater Investigations

BORE COMPLETION REPORT: WMB2957A

Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 715760.9 **Northing:** 6292952.2
Top of casing elevation: 918.7 m AHD (monument)
Grid system: MGA Zone 55 **Stick-up height:** 0.96 m

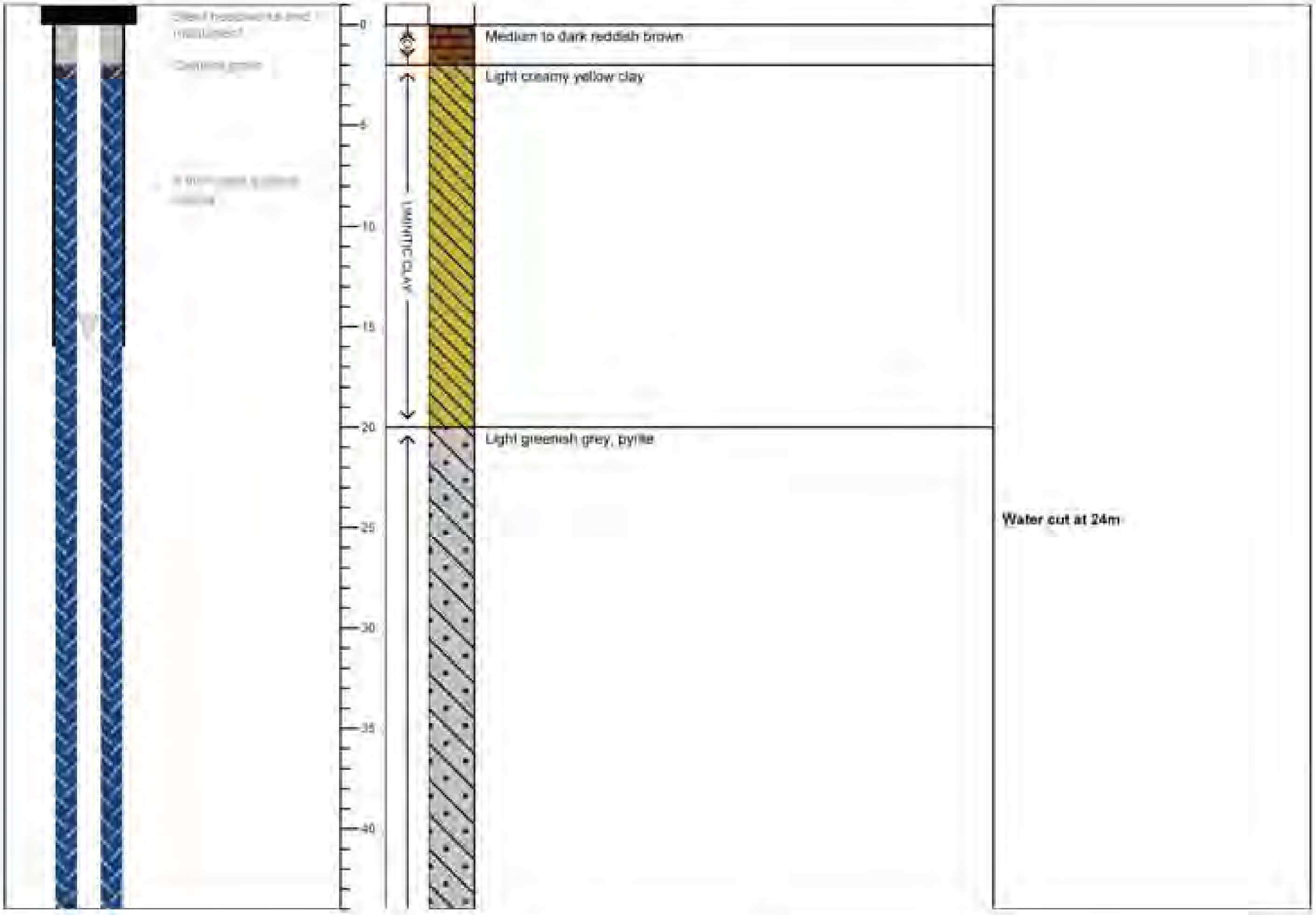
Drilling contractor: Britts Drilling services
Driller: D Britt **Rig:** BDS1
Drilling method: Air rotary **Total drilled depth:** 300 m
Borehole diameter: 203 mm 0 - 32 m **Bit:** Blade
Borehole diameter: 133 mm 32 - 300 m **Bit:** DHH

Purpose of bore: Groundwater monitoring bore
Screened Formation: Metasediments
Logged by: S Moran & K Maher
Start date: 6/2/17
Completion date: 16/2/17

Static WL: 903.72 mAHD
14.98 mbtoc
Water level date: 18/03/17

Plain casing: 0-276m: Class 18 50mm PVC
Screen: 276-282: 50mm PVC Class 18 (0.5mm slot)
Sump: 282-283m: 50mm PVC Class 18
Cement grout: 0-2m: 0.02m3
Gravel backfill: 2-272m: 5-8mm gravel
Bentonite seal: 272-274m
Gravel pack: 274-284m: 3mm washed gravel
Bentonite plug: NA

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Medium to dark reddish brown

Light creamy yellow clay

Light greenish grey, pyrite

Water cut at 24m

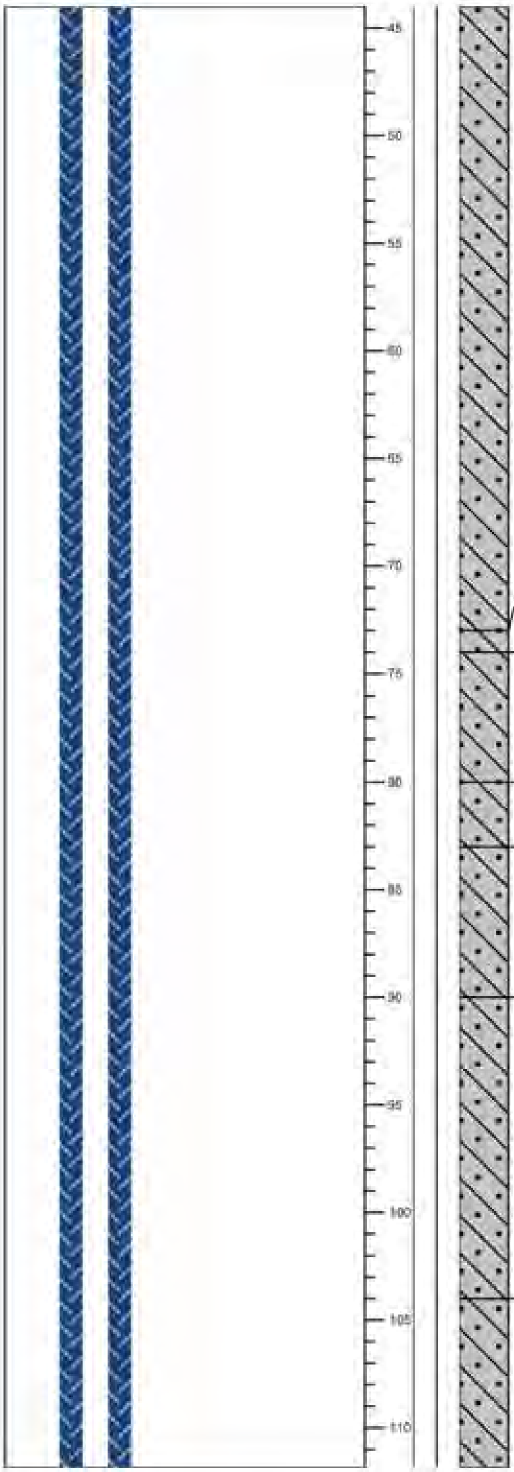
Drawing No:
Revision: A
Date drawn: 13/3/17
Drawn by: K Maher
Checked by:
Project No: J17084

WMB2957A
Groundwater Investigations

BORE COMPLETION REPORT - WMB2957A

Page 2 /5

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Light to medium grey, pyrite, k-feldspar coarsely crystalline, fresh rock with quartz veining

Light to medium grey, pyrite, coarsely crystalline

Airlift at 73m
Yield: ~0.1 L/s
Temp: 21.4 °C
EC: 2,032 µS/cm
pH: 7.85
ORP: 167.8 mV

Light to medium grey, pyrite, k-feldspar coarsely crystalline, fresh rock

Light to medium grey, pyrite, coarsely crystalline

Light to medium grey, pyrite, quartz

Medium grey, coarsely crystalline

EMM

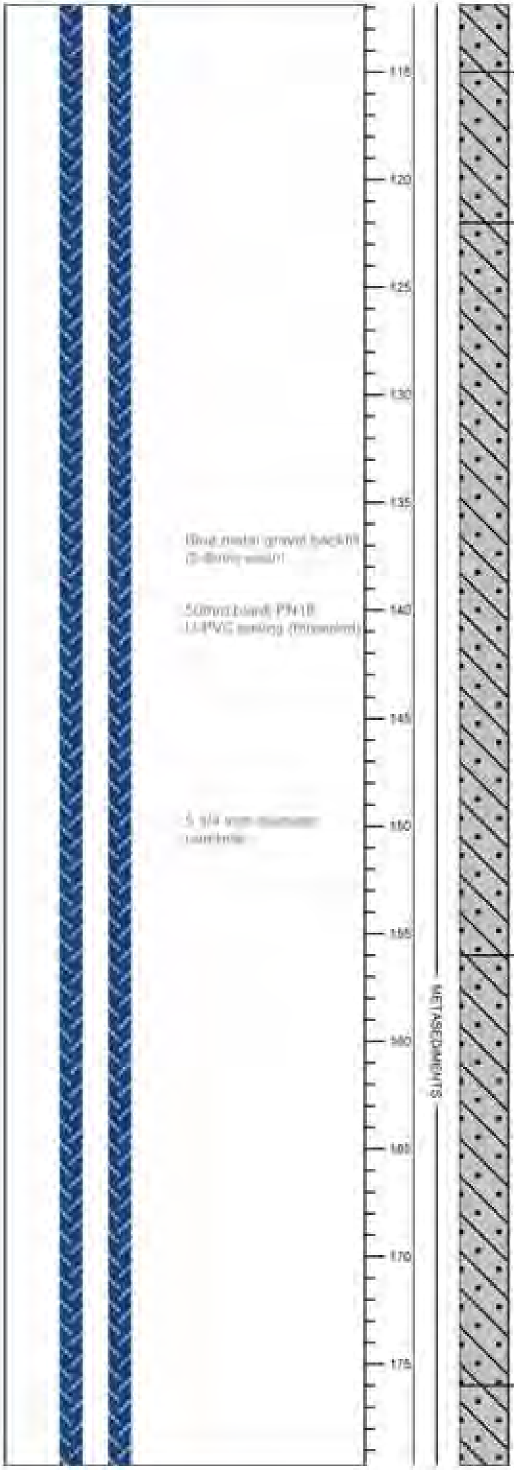
Drawing No:
Revision: A
Date drawn: 13/3/17
Drawn by: K Maher
Checked by:
Project No: J17064

WMB2957A

Groundwater Investigations

BORE COMPLETION REPORT - WMB2957A

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



LITHOLOGY

Light to medium grey

Light grey, pyrite, coarsely crystalline, fresh rock

Light grey, coarsely crystalline, fresh rock.

Light grey, abundant, pyrite

HYDROGEOLOGICAL OBSERVATIONS

Airlift at 115m
Yield: 0.2 L/s
Temp: 18.8 °C
EC: 1,788 µS/cm
pH: 7.69
ORP: 31.9 mV

EMM

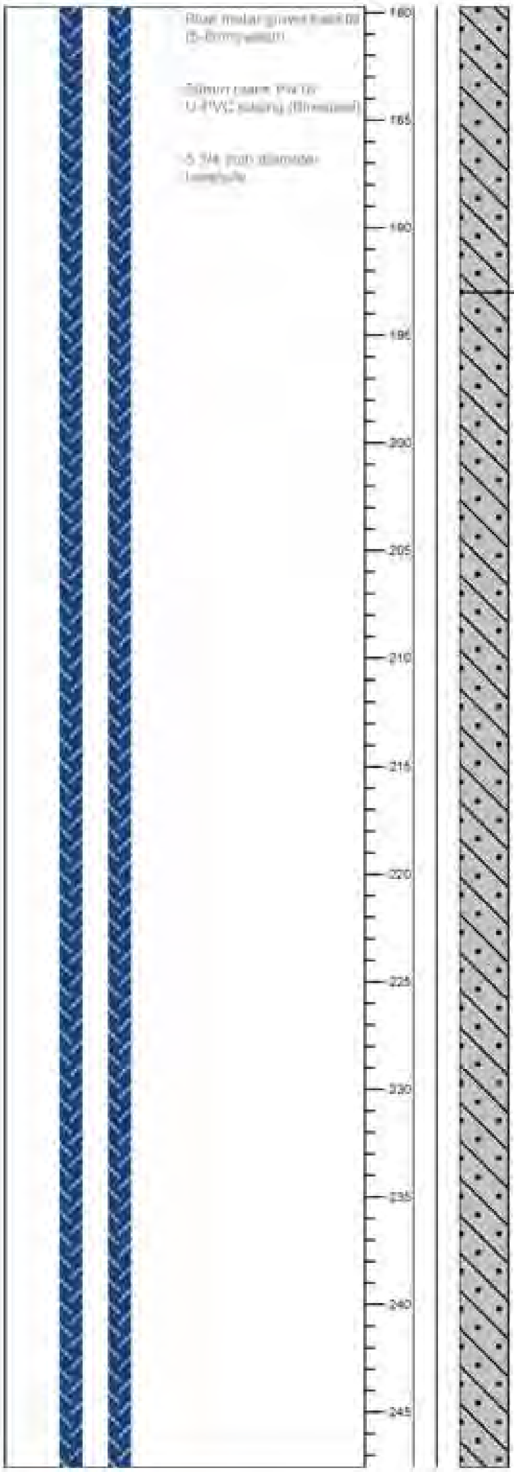
Drawing No:	
Revision: A	Date drawn: 13/3/17
Drawn by: K Maher	Checked by:
Project No: J17064	

WMB2957A

Groundwater Investigations

BORE COMPLETION REPORT - WMB2957A

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Light grey with abundant pyrite, phyllite sericite and quartz veining

EMM

Drawing No:

Revision: A

Date drawn: 13/3/17

Drawn by: K Maher

Checked by:

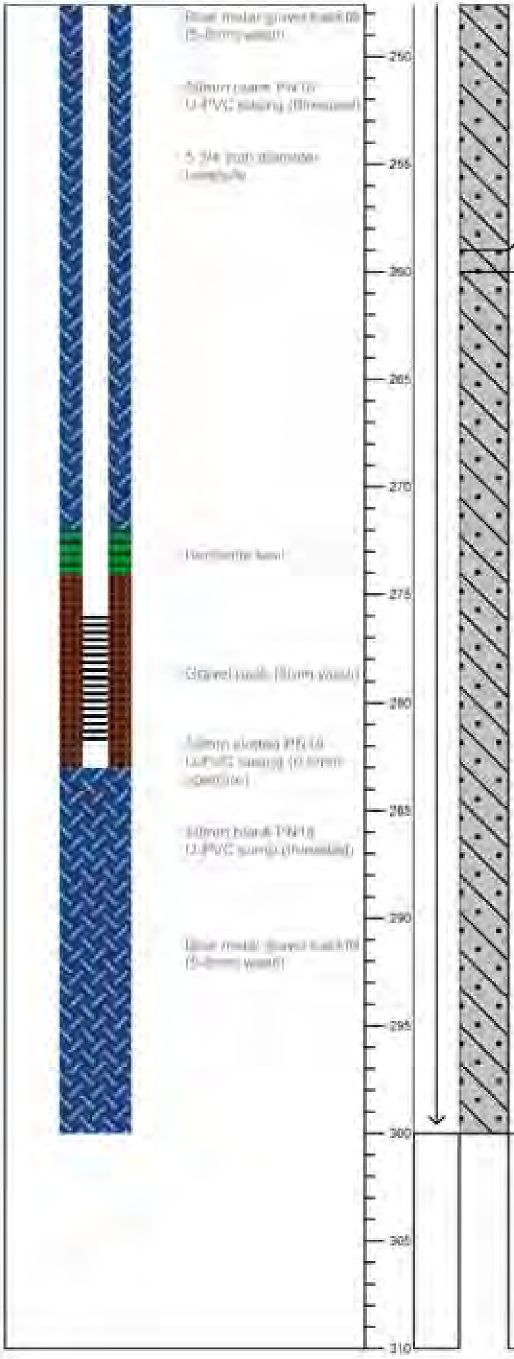
Project No: J17084

WMB2957A

Groundwater Investigations

BORE COMPLETION REPORT - WMB2957A

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Light brownish grey, abundant, pyrite

Light grey, abundant, pyrite

Airlift at 259m
Yield: 0.2 L/s
Temp: 26.6 °C
EC: 1,478 µS/cm
pH: 8.22
ORP: 88.3 mV

Airlift at 300m
yield: 2.5 L/s
Temp: 28.1 °C
EC: 1,559 µS/cm
pH: 8.13
ORP: 14.1 m

Drawing No:		WMB2957A
Revision: A	Date drawn: 13/3/17	Groundwater Investigations
Drawn by: K Maher	Checked by:	
Project No: J17064		

BORE COMPLETION REPORT: WMB3051A

Page1/2

Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 715111.7 **Northing:** 6293038.0
Top of casing elevation: 900.1 m AHD (monument)
Grid system: MGA Zone 55 **Stick-up height:** 0.91 m

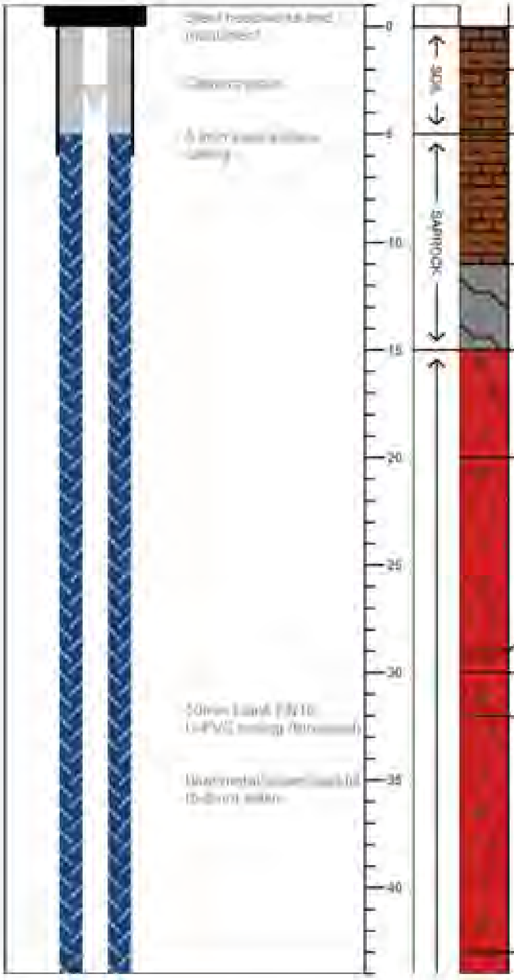
Drilling contractor: Britts Drilling Services
Driller: D Britt **Rig:** BDS1
Drilling method: Air rotary **Total drilled depth:** 100 m
Borehole diameter: 150 mm 0-6 m **Bit:** Blade
Borehole diameter: 133 mm 6 - 100 m **Bit:** DHH

Purpose of bore: Groundwater monitoring bore
Screened Formation: Volcanics
Logged by: S Moran
Start date: 1/2/17
Completion date: 4/2/17

Static WL: 896.71 mAHD
3.39 mbtoc
Water level date: 16/03/17

Plain casing: 0-64m: Class 18 50mm PVC
Screen: 64-67m: 50mm PVC Class 18 (0.5mm slot)
Sump: 67-70m: 50mm PVC Class 18
Cement grout: 0-5m: 0.05m3
Gravel backfill: 5-59.5m: 5-8mm gravel
Bentonite seal: 59.5-61.5m
Gravel pack: 61.5-70m: 3mm washed gravel
Bentonite plug: 70-72m

BORE CONSTRUCTION | **DEPTH (m)** | **STRATIGRAPHY** | **GRAPHIC LOG** | **LITHOLOGY** | **HYDROGEOLOGICAL OBSERVATIONS**



LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS
Mottled brown, poorly sorted, subangular	
Dark brown, clayey	
Light brown, consolidted, brecciated, porous, fine grained, finely crystalline, extremely altered	
Light brown, brecciated, porous	
Light grey, fractured, fine grained	**Water Cut at 16m** Yield: 0.6 L/s EC: 1075 µS/cm pH: 7.15 ORP: 128.8 mV
Grey, massive, fine grained, pale pink colour. Leached soapy feel	**Airlift at 25m** Yield: 1 L/s EC: 1,044 µS/cm pH: 7.65 ORP: 66.8 mV
Grey, fractured, fine grained, possibly saprock	Fractured 29-30m
Grey, massive, fine grained, exremely weathered rpck. Coming out like stiff clay. Quartzite frags amongst softer/finer matrix. Oxidised clay in fault zone	**Airlift at 31m** Yield: 1.66 L/s Temp: 17.4 °C EC: 1037 µS/cm pH: 7.77 ORP: 79.8 mV
Grey, fractured, fine grained, exremely weathered rpck. Coming out like stiff clay. Quartzite frags amongst softer/finer matrix. Oxidised clay in fault zone	**Airlift at 37m** Yield: 1.8 L/s Temp: 17.4 °C EC: 1,031 µS/cm pH: 7.96 ORP: 87.4 mV
Grey, fractured, fine grained, mainly large quartzite rock chips present	

EMM

Drawing No:
Revision: A
Date drawn: 13/3/17
Drawn by: K Maner
Checked by:
Project No: J17054

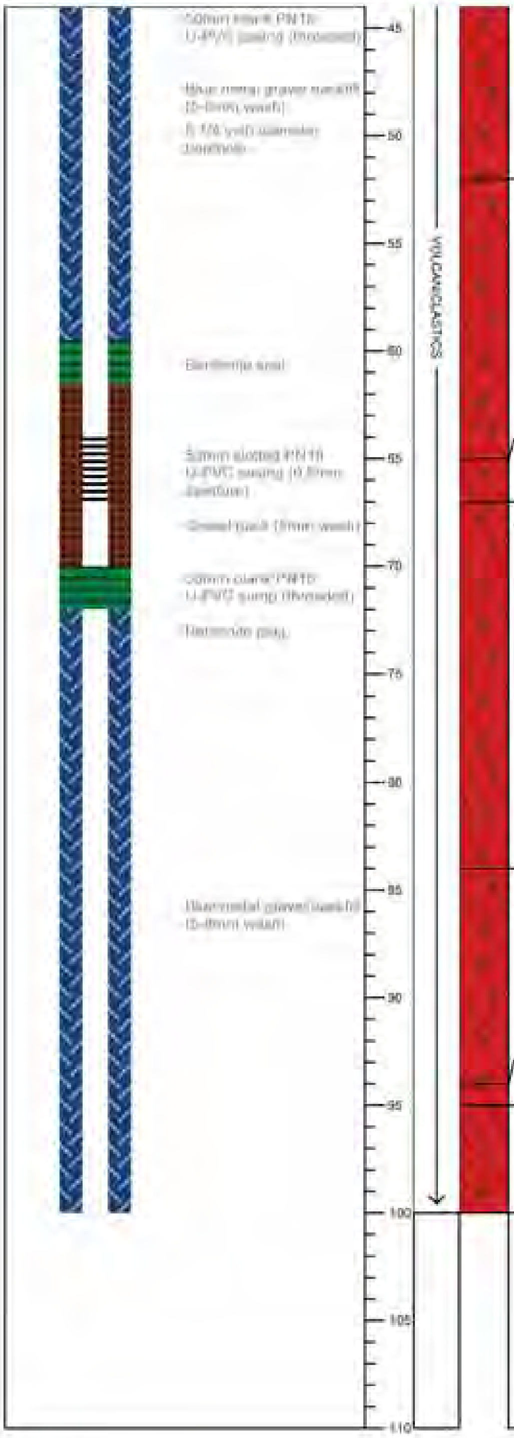
WMB3051A

Groundwater Investigations

BORE COMPLETION REPORT - WMB3051A

Page 2 /2

BORE CONSTRUCTION | **DEPTH (m)** | **STRATIGRAPHY** | **GRAPHIC LOG** | **LITHOLOGY** | **HYDROGEOLOGICAL OBSERVATIONS**



LITHOLOGY

Grey, fractured, fine grained, mainly large quartzite rock chips present. Minor micas. Very vuggy. fractured at 26-31m.. First wster strike @ 26m Hammer hardly firing. Very soft ground. Oxidised clay in fault zone

Dark grey, massive, fine grained, change in colour from mustard to bown. Smaller returns. Getting less quartzite. Mainly brittle micas. edge of oxidised clay zone. getting into host rock

Dark grey, fractured, fine grained, similar to above, but with small chips of dark black chips. Still very soft and sloppy returns. Getting less quartzite. Oxidised clay in fault zone

Dark grey, massive, fine grained, getting hard at 64m. 50/50 micas/quartzite

Dark green, massive, fine grained, mainly micas (serisite) green sheen (metasedimenTs). Very little to no quartzite. Minor black mafic volcanics. Very little sample returns

Mottled green, massive, fine grained, mainly sersite. Green shn. Minor weathered fragments. Rare quartz fragments

Mottled green, massive, fine grained

HYDROGEOLOGICAL OBSERVATIONS

Airlift at 43m
Yield: ~2 L/s
Temp: 17.6 °C
EC: 1,044 µS/cm
pH: 7.89
ORP: 71.9 mV

Fractured 66-67m

Airlift at 67m
Yield: ~2 L/s
Temp: 17.8 °C
EC: 1,015 µS/cm
pH: 7.89
ORP: 80.1 mV m

Airlift at 85m
Yield: ~2 L/s
Temp: 17.5 °C
EC: 1,052 µS/cm
pH: 7.91
ORP: 67.5 mV

Airlift at 100m
Yield: ~2 L/s
Temp: 17.6 °C
EC: 1,090 µS/cm
pH: 8.01
ORP: 43.5 mV

EMM

Drawing No:
Revision: A
Date drawn: 13/3/17
Drawn by: K Maher
Checked by:
Project No: J17064

WMB3051A

Groundwater Investigations

BORE COMPLETION REPORT: WMB3051B

Page1/1

Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 715115.4 **Northing:** 6293036.2
Top of casing elevation: 900.2 m AHD (monument)
Grid system: MGA Zone 55 **Stick-up height:** 0.91 m

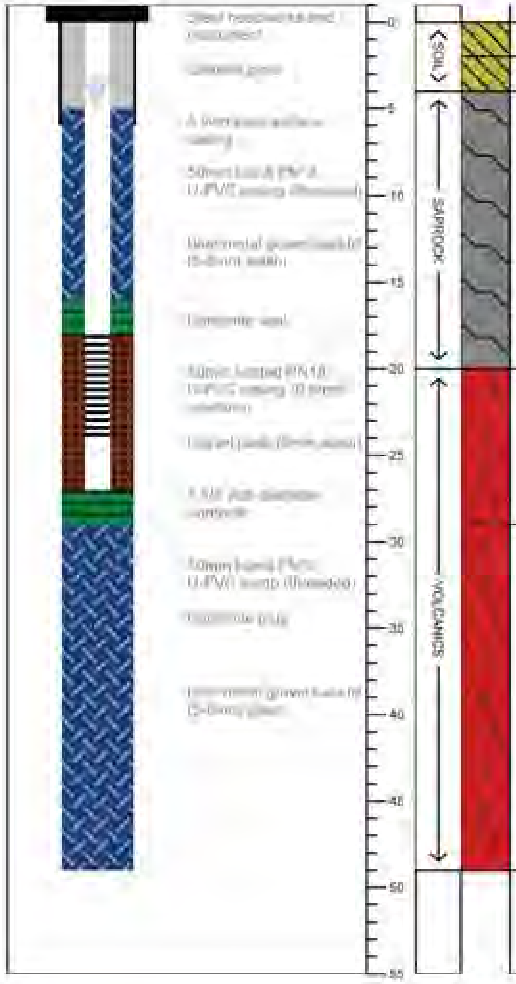
Drilling contractor: Britts Drilling Services
Driller: D Britt **Rig:** BDS1
Drilling method: Air rotary **Total drilled depth:** 49 m
Borehole diameter: 150 mm 0 - 16 m **Bit:** Blade
Borehole diameter: 133 mm 16 - 49 m **Bit:** DHH

Purpose of bore: Groundwater monitoring bore
Screened Formation: Volcanics
Logged by: S Moran
Start date: 4/2/17
Completion date: 5/2/17

Static WL: 896.17 mAHD
4.03 mbtoc
Water level date: 16/03/17

Plain casing: 0-18m: Class 18 50mm PVC
Screen: 18-24m: 50mm PVC Class 18 (0.5mm slot)
Sump: 24-27m: 50mm PVC Class 18
Cement grout: 0-5m: 0.05m3
Gravel backfill: 5-16m: 3mm washed gravel
Bentonite seal: 16-18m
Gravel pack: 18-27m: 3mm washed gravel
Bentonite plug: 27-29m

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Pale yellow clay

Dark brown clay with minor, poorly sorted gravel

Mottled grey, brecciated, fine grained

Dark grey, layered

Dark black, layered; fine grained

Water cut at 19m
Yield: 0.5 L/s
Temp: 19.5 °C
EC: 1,022 µS/cm
pH: 8.2
ORP: 59.2 mV

Airlift at 25m
Yield: 1.2 L/s
Temp: 18.4 °C
EC: 1075 µS/cm
pH: 6.79
ORP: 168.1 mV

Airlift at 37m
Yield: 1.5 L/s
Temp: 18.1 °C
EC: 1,048 µS/cm
pH: 7.76
ORP: 114.6 mV

Airlift at 49m
Yield:1.5 L/s
Temp: 19.4 °C
EC: 1,050 µS/cm
pH: 8.06
ORP: 66.2 mV turbidity

EMM

Drawing No:
Revision: A
Date drawn: 13/7/17
Drawn by: K Maher
Checked by
Project No: J17054

WMB3051B

Groundwater Investigations

BORE COMPLETION REPORT: WMB3274A

Page1/2

Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 717451.3 **Northing:** 6293226.3
Top of casing elevation: 965.5 m AHD (monument)
Grid system: MGA Zone 55 **Stick-up height:** 1.21 m

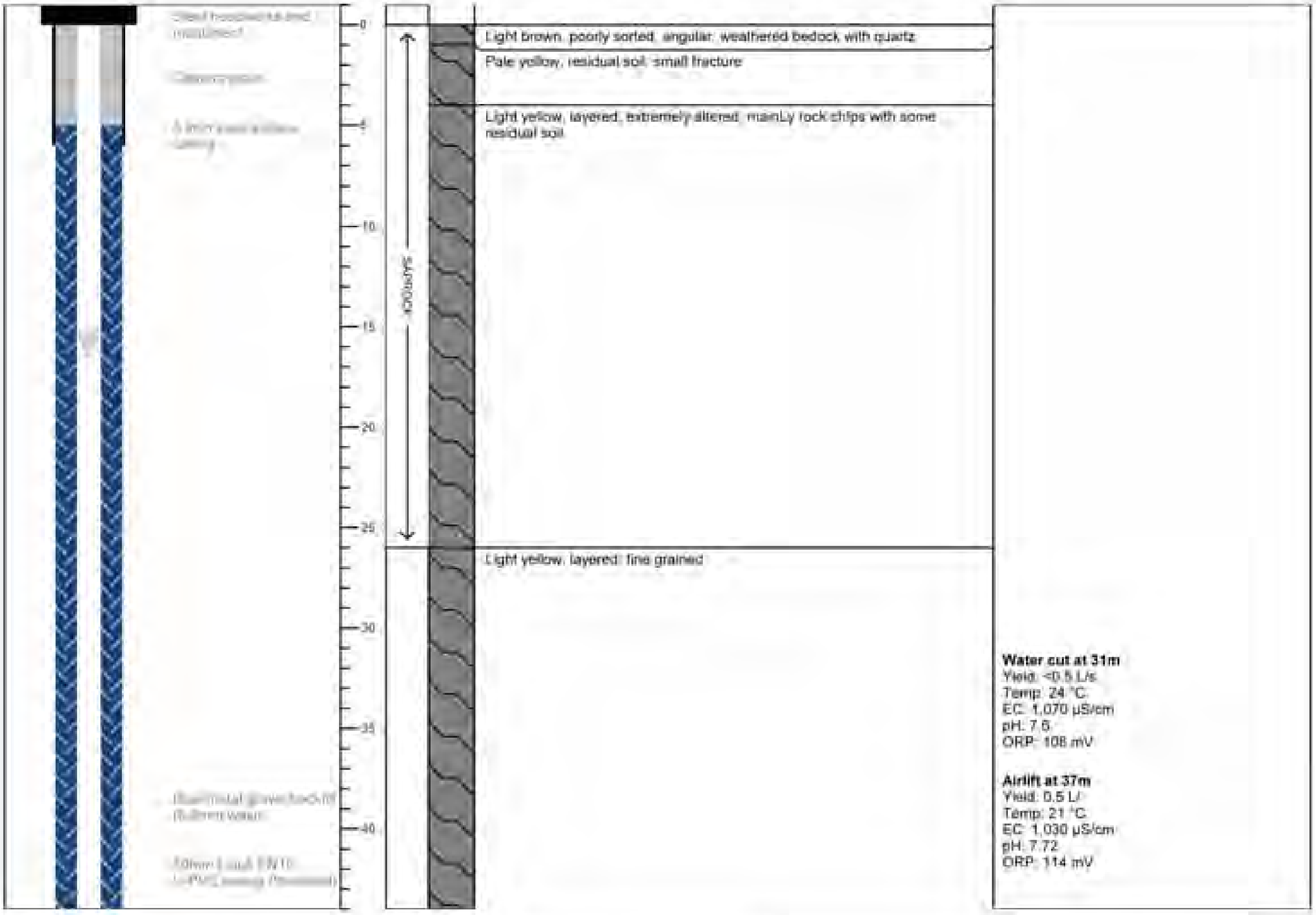
Drilling contractor: Britts Drilling Services
Driller: S Smith **Rig:** BDS1
Drilling method: Air rotary **Total drilled depth:** 91 m
Borehole diameter: 196 mm 0 - 30 m **Bit:** Blade
Borehole diameter: 132 mm 30 - 91 **Bit:** DHH

Purpose of bore: Groundwater monitoring bore
Screened Formation: Metasediments
Logged by: T Wilkinson
Start date: 1/3/17
Completion date: 11/3/17

Static WL: 949.69 mAHD
15.81 mbtoc
Water level date: 13/03/2017

Plain casing: 0-79.5m: Class 18 50mm PVC
Screen: 79.5-85.5: 50mm PVC Class 18 (0.5mm slot)
Sump: 85.5-86.5m: 50mm PVC Class 18
Cement grout: 0-5m: 0.05m3
Gravel backfill: 5-72.5m: 3mm washed gravel
Bentonite seal: 72.5-74.5m
Gravel pack: 74.5-86.5m: 3mm washed gravel
Bentonite plug: NA

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Light brown, poorly sorted, angular, weathered bedrock with quartz

Pale yellow, residual soil, small fracture

Light yellow, layered, extremely altered, mainLy rock chips with some residual soil

Light yellow, layered, fine grained

Water cut at 31m
Yield: <0.5 L/s
Temp: 24 °C
EC: 1,070 µS/cm
pH: 7.6
ORP: 108 mV

Airlift at 37m
Yield: 0.5 L/
Temp: 21 °C
EC: 1,030 µS/cm
pH: 7.72
ORP: 114 mV

Drawing No:	
Revision: A	Date drawn: 30/03/17
Drawn by: K Maree	Checked by:
Project No: J17084	

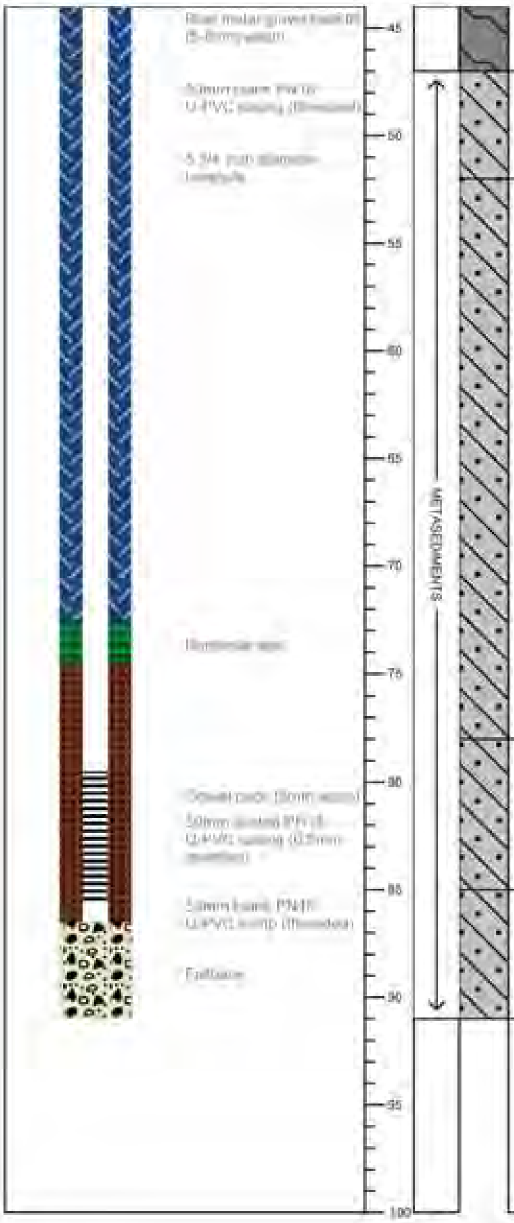
WMB3274A

Groundwater Investigations

BORE COMPLETION REPORT - WMB3274A

Page 2 /2

BORE CONSTRUCTION | **DEPTH (m)** | **STRATIGRAPHY** | **GRAPHIC LOG**



LITHOLOGY

Light yellow, layered, medium grained , fractured, staining on chip surfaces

Mottled brown, layered, medium grained , consolidated

Mottled brown, layered, medium grained , stained quartzite chips throughout

Mottled brown, layered, medium grained, large quartzite chips. Small fracture @ 47-48m

HYDROGEOLOGICAL OBSERVATIONS

Airlift at 49m
Yield: 0.5 L/s
Temp: 22 °C
EC: 860 µS/cm
Fractured 52-55m
pH: 7.41
ORP: 113 mV

Airlift at 55m
Yield: 1.2 L/s
Temp: 17 °C
EC: 940 µS/cm
pH: 7.52
ORP: 154 mV

Airlift at 67m
Yield: 1.2 L/s
Temp: 17 °C
EC: 929 µS/cm
pH: 7.74
ORP: 148 mV

Airlift at 73m
Yield: 1.5 L/s
Temp: 16.6 °C
EC: 930 µS/cm
pH: 7.91
ORP: [illegible]
Fractured 61-63m

Airlift at 79m
Yield: 1.65 L/s
Temp: 16.4 °C
EC: 926 µS/cm
pH: 7.98
ORP: 142 mV

Airlift at 85m
Yield: 1.65 L/s
Temp: 16.6 °C
EC: 939 µS/cm
pH: 8.01
ORP: 112 mV

EMM

Drawing No:
Revision: A | Date drawn: 20/03/17
Drawn by: K Maher | Checked by:
Project No: J17054

WMB3274A

Groundwater Investigations

BORE COMPLETION REPORT: WMB3274B

Page1/1

Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 717450.4 **Northing:** 6293221.5
Top of casing elevation: 965.4 m AHD (monument)
Grid system: MGA Zone 55 **Stick-up height:** 0.98 m

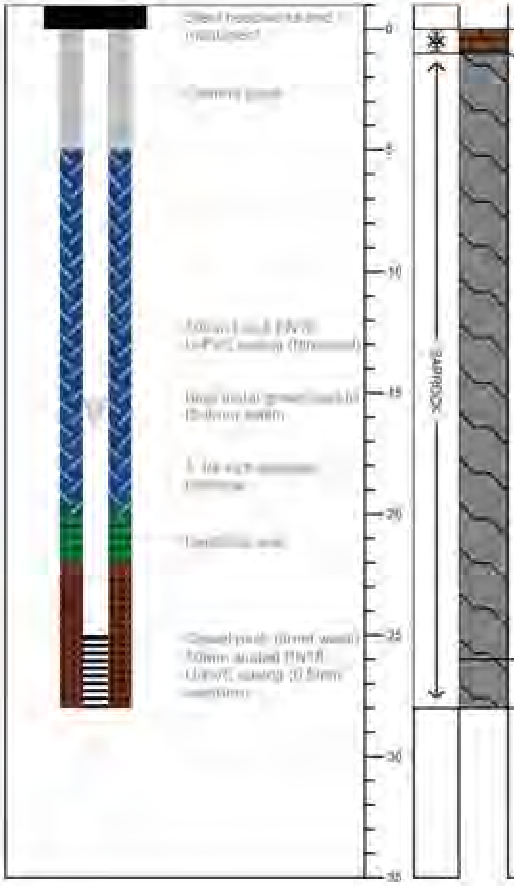
Drilling contractor: Britts Drilling Services
Driller: S Smith **Rig:** DBS1
Drilling method: Air rotary **Total drilled depth:** 28 m
Borehole diameter: 150 mm 0 - 28 m **Bit:** Blade
Borehole diameter: **Bit:**

Purpose of bore: Groundwater monitoring bore
Screened Formation: Saprock
Logged by: T Wilkinson
Start date: 26/2/17
Completion date: 26/2/17

Plain casing: 0-25m: Class 18 50mm PVC
Screen: 25-28m: 50mm PVC Class 18 (0.5mm slot)
Sump: NA - capped at base of screen
Cement grout: 0-5m: 0.05m3
Gravel backfill: 5-20m: 3mm washed gravel
Bentonite seal: 20-22m
Gravel pack: 22-28m: 3mm washed gravel
Bentonite plug: NA

Static WL: 949.58 mAHD
15.82 mbtoc
Water level date: 17/03/17

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Depth	Lithology
0 - 1	Pale brown, well sorted, soil
1 - 26	Pale yellow, well sorted, clay, large quartzie chips
26 - 28	Brecciated, vuggy

Water cut at 28m
Yield: <0.5 L/s
Temp: 20 °C
EC: 992 µS/cm
pH: 7.62
ORP: 50 mV

EMM

Drawing No:	
Revision: A	Date drawn: 13/3/17
Drawn by: K Maner	Checked by:
Project No: J17084	

WMB3274B
Groundwater Investigations

BORE COMPLETION REPORT: WMB5872A

Page1/2

Project: Regis McPhillamys Gold Project
Location: McPhillamys
Easting: 712997 **Northing:** 6295881
Top of casing elevation: 964.16 m AHD (monument)
Grid system: MGA Zone 55 **Stick-up height:** ~0.90 m

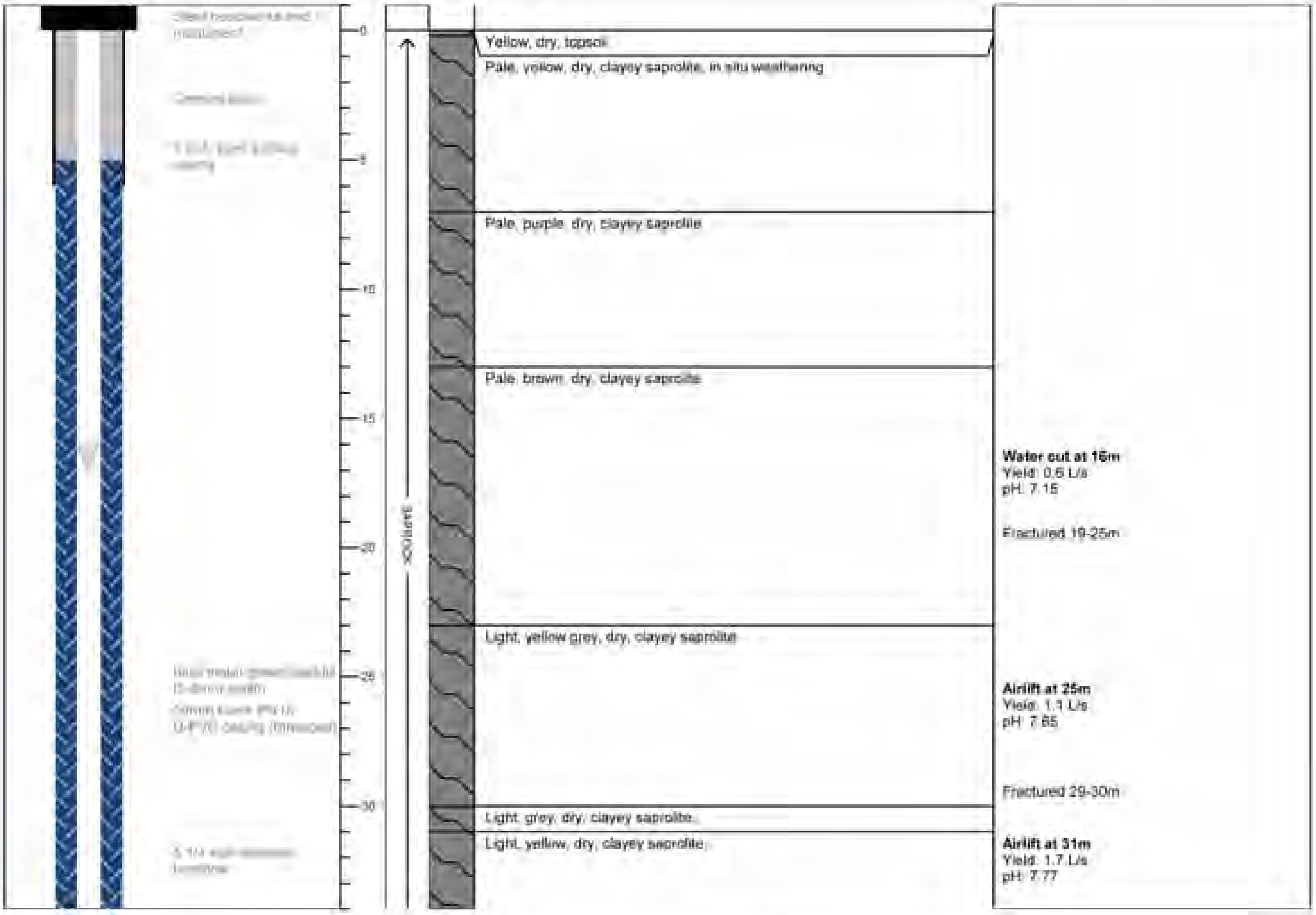
Drilling contractor: Britts Drilling Services
Driller: S Smith **Rig:** BDS1
Drilling method: Air rotary **Total drilled depth:** 64 m
Borehole diameter: 150 mm 0 - 7 m **Bit:** Blade
Borehole diameter: 132 mm 7 - 64 m **Bit:** DHH

Purpose of bore: Groundwater monitoring bore
Screened Formation: Metasediments
Logged by: T Wilkinson & K Maher
Start date: 28/2/17
Completion date: 12/3/17

Static WL: 947.64 mAHD
16.52 mbtoc
Water level date: 17/03/17

Plain casing: 0-53m: Class 18 50mm PVC
Screen: 53-59: 50mm PVC Class 18 (0.5mm slot)
Sump: 59-60m: 50mm PVC Class 18
Cement grout: 0-5m: 0.05m3
Gravel backfill: 60-64m: 5-8mm washed blue metal gravel
Bentonite seal: 49-51m
Gravel pack: 47-60m: 3mm washed gravel
Bentonite plug: NA

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



EMM

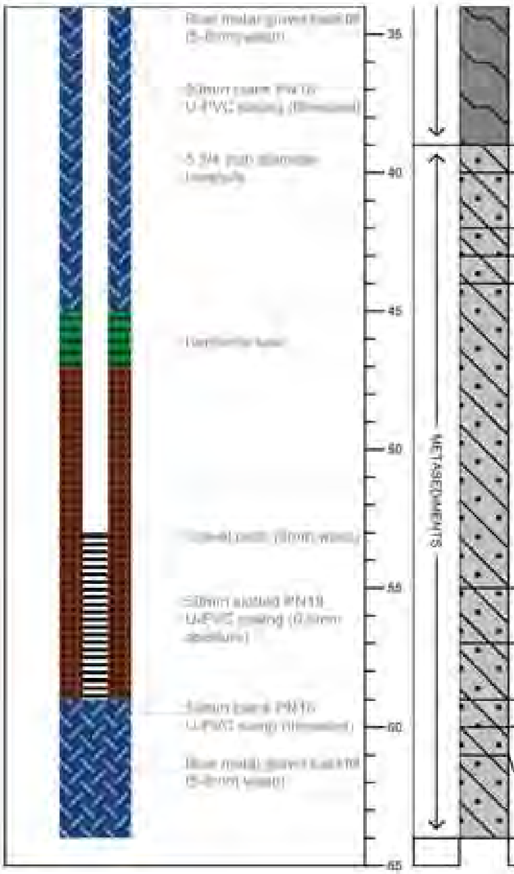
Drawing No:
Revision: A
Date drawn: 31/03/17
Drawn by: K Maher
Checked by:
Project No: J17054

WMB5872A

Groundwater Investigations

BORE COMPLETION REPORT - WMB5872A

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	HYDROGEOLOGICAL OBSERVATIONS



Dark, grey, dry, clayey saprolite, moisture @ 42m

Grey, moist, saprolite, rod handler computer issues

Grey, layered, started injecting water to drill

Grey, layered, fine grained, finely crystalline, fracture @ 53m

Dark, grey, layered, fine grained, finely crystalline, oxidised frgaments most likely from fall back/contamination

Dark, grey, layered, fine grained, finely crystalline, large quartz fragments ~2cm @ 56m, ~0.5cm, harder to drill, very fractured

Dark, grey-black, layered, fine grained, finely crystalline, carbonaceous oil slick evident, fractured

Dark, grey-black, layered, fine grained, finely crystalline, possible clay band

Dark, grey, layered, fine grained, finely crystalline, fractured, oxidised fragmens from fallback/contamination

Dark grey, layered, fine grained, finely crystalline, oxidised fragments increasing in abundance, hole collapsing

EMM

Drawing No:

Revision: A

Date drawn: 31/03/17

Drawn by: K Maher

Checked by:

Project No: J17064

WMB5872A

Groundwater Investigations

Table A.1 McPhillamys project test bore and groundwater monitoring network

Bore ID	Easting	Northing	Drilled depth (mbgl)[1]	Screen (mbgl) [1]	Monitored formation	Lithology	Installed	Monitored parameters
WMB1273A	717300	6291226	86	42-48	Anson Formation	metasediments	Dec-16	Piezometric surface & water quality
WMB1273B	717301	6291211	25	22-25	Anson Formation	metasediments	Dec-16	Piezometric surface & water quality
WMB1452A	715238	6291483	98	75.2-87.2	Byng Volcanics	volcaniclastics	Dec-16	Piezometric surface & water quality
WMB1452B	715247	6291477	16.2	9.7-15.7	Byng Volcanics	saprock	Dec-16	Piezometric surface & water quality
WMB1759A	715975	6291702	296	284-293	Anson Formation	metasediments	Dec-16	Piezometric surface & water quality
WMB1759B	715965	6291700	32	24.5-30.5	Anson Formation	metasediments	Dec-16	Piezometric surface & water quality
WMB2130A	713073	6292197	71	42.8-51.8	Blayney Volcanics	volcaniclastics	Mar-17	Piezometric surface & water quality
WMB2130B	713073	6292189	6	3.8-5.8	Alluvium	alluvium	Mar-17	Piezometric surface & water quality
WMB2252A	715274	6292284	104	89-101	Byng Volcanics	volcaniclastics	Dec-16	Piezometric surface & water quality
WMB2252B	715284	6292264	100	60-69	Byng Volcanics	volcaniclastics	Dec-16	Piezometric surface & water quality
WMB2359A	715996	6292353	287	152-284	Anson Formation	metasediments	Jan-17	Piezometric surface & water quality
WMB2359B	715996	6292353	287	30-36	Anson Formation	saprock	Jan-17	Piezometric surface & water quality
WMB2364A	716490	6292345	300	84-297	Anson Formation	metasediments	Jan-17	Piezometric surface & water quality
WMB2364B	716490	6292345	53	45-51	Anson Formation	saprock	Jan-17	Piezometric surface & water quality
WMB2556A	715674	6292552	133	107.5-110.5	Carbonaceous alteration	marble	Feb-17	Piezometric surface & water quality
WMB2957A	715760	6292952	300	276-282	Anson Formation	metasediments	Feb-17	Piezometric surface & water quality
WMB3051A	715111	6293038	100	64-67	Byng Volcanics	volcaniclastics	Feb-17	Piezometric surface & water quality
WMB3051B	715115	6293036	49	18-24	Byng Volcanics	saprock	Feb-17	Piezometric surface & water quality
WMB3274A	717451	6293226	91	79.5-85.5	Anson Formation	metasediments	Mar-17	Piezometric surface & water quality

Table A.1 McPhillamys project test bore and groundwater monitoring network

Bore ID	Easting	Northing	Drilled depth (mbgl)[1]	Screen (mbgl) [1]	Monitored formation	Lithology	Installed	Monitored parameters
WMB3274B	717450	6293221	28	24-28	Anson Formation	saprock	Mar-17	Piezometric surface & water quality
WMB5530A	715564	6293015	84	78-84	Anson Formation	metasediments	Oct-17	Piezometric surface & water quality
WMB5530B	715559	6293011	28	22-28	Anson Formation	saprock	Oct-17	Piezometric surface & water quality
WMB5872A	717297	6295881	64	53-59	Anson Formation	metasediments	Mar-17	Piezometric surface & water quality
TPB04	716425	6293990	144	96-138	Anson Formation	Metasediments (fractured phyllite)	Apr-20	Piezometric surface & water quality
MB14	716421	6293978	144	78-90; 108-126	Anson Formation	Metasediments (fractured phyllite)	Apr-20	Piezometric surface
MB15	716434	6293994	30	19-22	Anson Formation	Metasediments (fractured phyllite)	May-20	Piezometric surface
MB16	716439	6293996	23	15-18	Anson Formation	saprock	Apr-20	Piezometric surface
TB05	716718	6297629	75	51-57	Anson Formation	limestone	May-20	Piezometric surface & water quality
MB17	716875	6297724	90	53-59	Anson Formation	saprock	May-20	Piezometric surface

1. mbgl = metres below ground level

A.2 Third-party bores within 2 km of project

Table A.2 Summary of third-party bores within 2 km of project

WaterNSW ID	Regis ID	Inferred lithology	Confirmed bore depth (m)	Easting	Northing	Visited as part of Regis census	Landholder	GWL data available? *
GW018393	WRB0064A	Byng Volcanics	48.8	716510	6290047	Yes	Third-party	Yes
GW018425	WRB6208A	Byng Volcanics	31.7	716209	6290864	Yes	Third-party	Yes
GW019522	-	Anson Formation	N/A	715736	6298067	No	Third-party	Yes
GW022698	-	Anson Formation	N/A	719227	6291362	No	Third-party	Yes
GW022699	-	Anson Formation	N/A	718609	6291438	No	Regis land	Yes
GW022700	-	Anson Formation	N/A	718371	6291196	No	Regis land	Yes
GW023248	-	Anson Formation	N/A	716415	6297220	No	Regis land	Yes
GW023249	-	Anson Formation	N/A	718737	6298216	No	Third-party	Yes
GW023284	-	Anson Formation	N/A	718606	6298126	No	Third-party	Yes
GW025273	-	Anson Formation	N/A	713814	6296993	No	Third-party	Yes
GW034389	WRB2535A	Blayney Volcanics	39.6	713582	6292597	Yes	Regis land	Yes
GW050220	WRB0750A	Blayney Volcanics	22.7	715073	6290772	Yes	Third-party	Yes
GW050886	-	Anson Formation	N/A	719182	6292781	No	Third-party	Yes
GW051444	-	Anson Formation	N/A	719308	6290374	No	Third-party	Yes
GW051940	-	Blayney Volcanics	N/A	713486	6290967	No	Third-party	Yes
GW054846	-	Blayney Volcanics	N/A	713505	6290689	No	Third-party	No
GW058048	-	Anson Formation	N/A	717262	6291221	No	Regis land	No, but near WMB1273A /B
GW063524	-	Blayney Volcanics	N/A	712861	6290734	No	Third-party	Yes
GW063619	-	Anson Formation	N/A	716004	6295010	No	Regis land	No, could not locate, thought to be abandoned
GW064056	-	Anson Formation	N/A	717936	6298203	No	Third-party	Yes
GW064166	WRB2556A	Anson Formation	91.4	715640	6292552	Yes	Third-party	Yes
GW065786	-	Byng Volcanics	N/A	712425	6296723	No	Third-party	Yes
GW066067	-	Anson Formation	N/A	718680	6292268	No	Third-party	No
GW700135	-	Byng Volcanics	N/A	713313	6296025	No	Third-party	Yes
GW701346	-	Blayney Volcanics	N/A	714109	6290887	No	Third-party	Yes
GW701347	-	Anson Formation	N/A	718053	6290580	No	Third-party	Yes
GW701427	-	Anson Formation	N/A	717863	6291008	No	Third-party	Yes
GW701428	-	Anson Formation	N/A	717713	6290883	No	Third-party	No

Table A.2 Summary of third-party bores within 2 km of project

WaterNSW ID	Regis ID	Inferred lithology	Confirmed bore depth (m)	Easting	Northing	Visited as part of Regis census	Landholder	GWL data available? *
GW702186	WRB0340A	Blayney Volcanics	42	714085	6290398	Yes	Third-party	Yes
GW703157	-	Anson Formation	N/A	716317	6297937	No	Third-party	Yes
GW703216	-	Anson Formation	N/A	717249	6291782	No	Regis land	No
GW704211	WRB5308A	Blayney Volcanics	41	715382	6290869	Yes	Third-party	Yes
GW704227	LB09	Anson Formation	N/A	716916	6297918	Yes	Regis land	Yes
GW704695	-	Anson Formation	N/A	717075	6291785	No	Regis land	Yes
GW800722	-	Anson Formation	N/A	713813	6297123	No	Third-party	Yes
GW800723	-	Anson Formation	N/A	713853	6297073	No	Third-party	Yes
GW801629	-	Blayney Volcanics	N/A	712493	6290483	No	Third-party	Yes
GW805310	-	Byng Volcanics	N/A	712727	6297003	No	Third-party	No
N/A	WRB0469A	Anson Formation	N/A	716971	6290404	Yes	Third-party	Yes
N/A	WRB0555A	Blayney Volcanics	N/A	715548	6290592	Yes	Third-party	Yes
N/A	WRB0671A	Anson Formation	N/A	717120	6290615	Yes	Third-party	Yes
N/A	WRB0772A	Anson Formation	N/A	717251	6290720	Yes	Third-party	Yes
N/A	WRB5208A	Blayney Volcanics	N/A	715293	6290812	Yes	Third-party	Yes
N/A	WRB5408A	Blayney Volcanics	N/A	715469	6290837	Yes	Third-party	Yes
N/A	WRB1071A	Anson Formation	N/A	717124	6291009	Yes	Third-party	Yes

Appendix B

TDS charts

B.1 Groundwater salinity trends

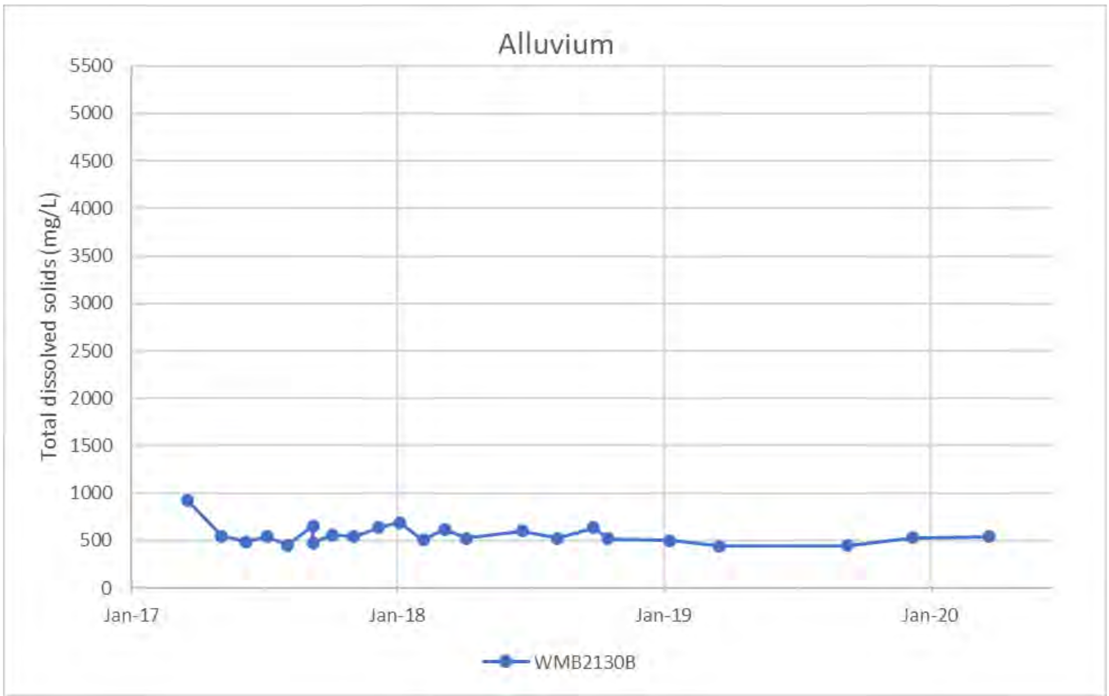


Figure B.1 Alluvium groundwater salinity trend (as TDS)

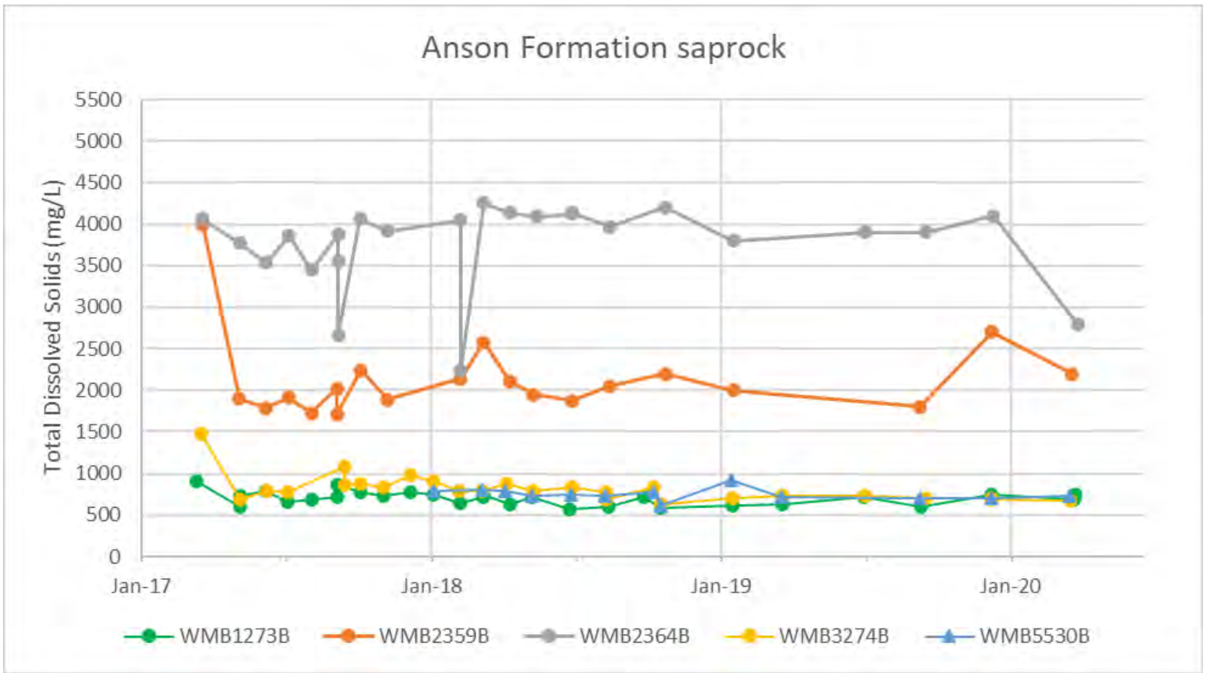


Figure B.2 Anson Formation saprock groundwater salinity trend (as TDS)

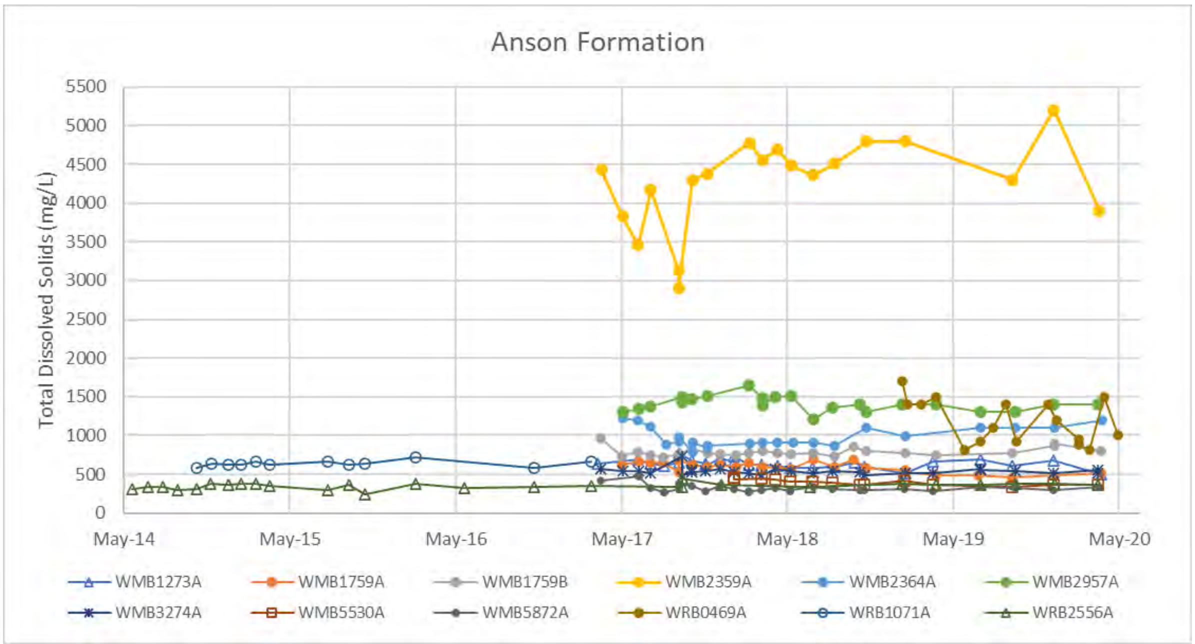


Figure B.3 Anson Formation groundwater salinity trend (as TDS; erroneous data point not shown)

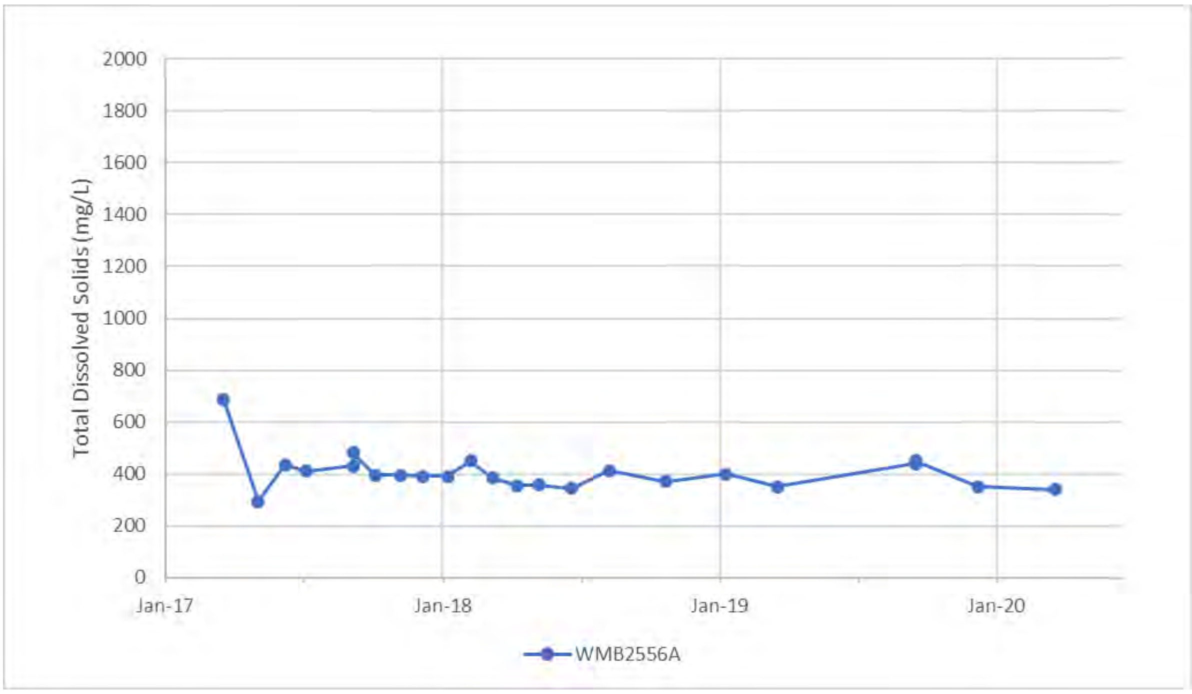


Figure B.4 Marble (carbonaceous alteration in Anson Formation) groundwater salinity trend (as TDS)

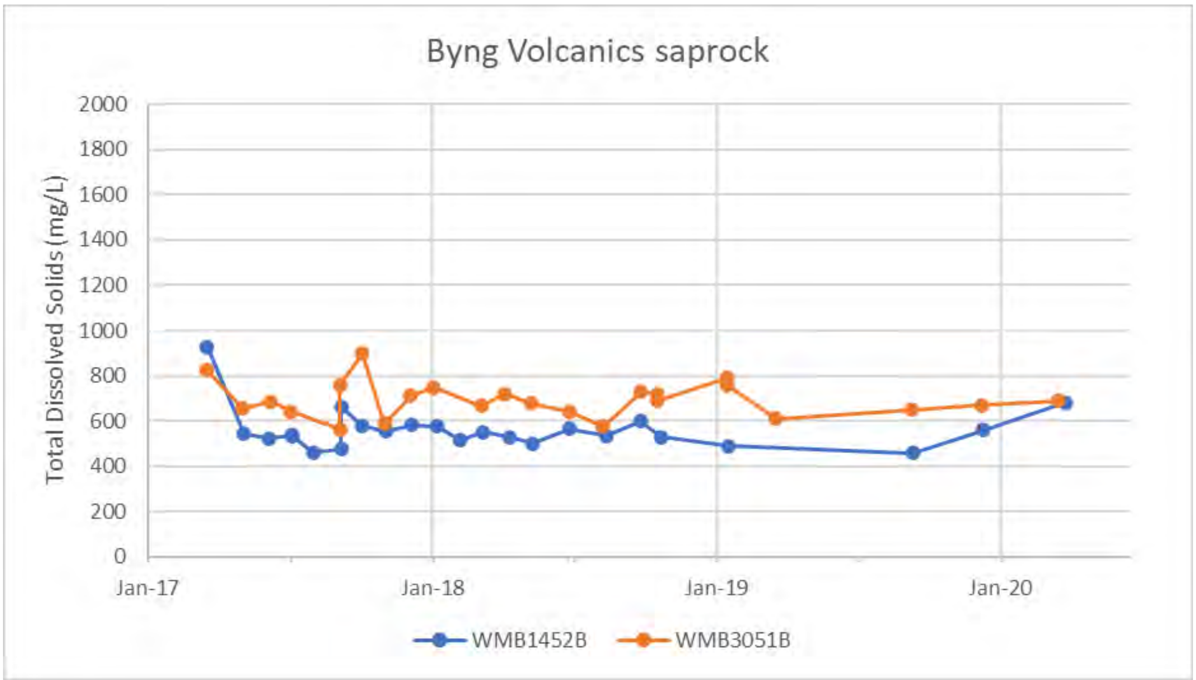


Figure B.5 Byng Volcanics saprock groundwater salinity trend (as TDS)

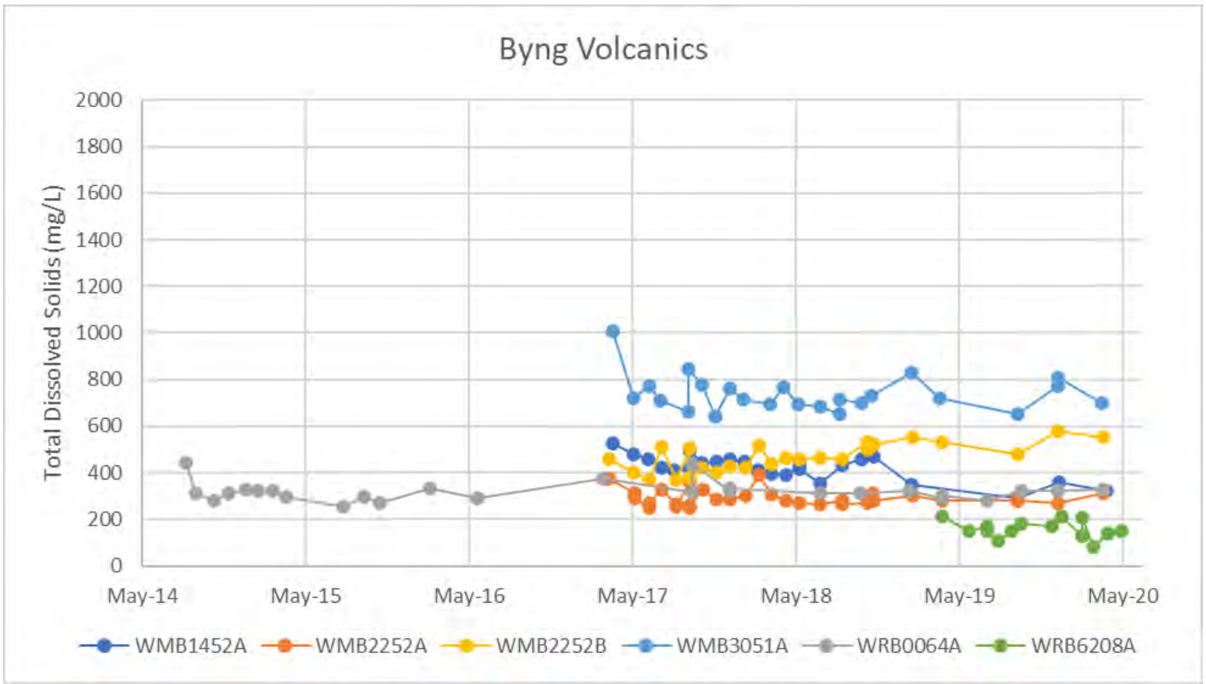


Figure B.6 Byng Volcanics groundwater salinity trend (as TDS)

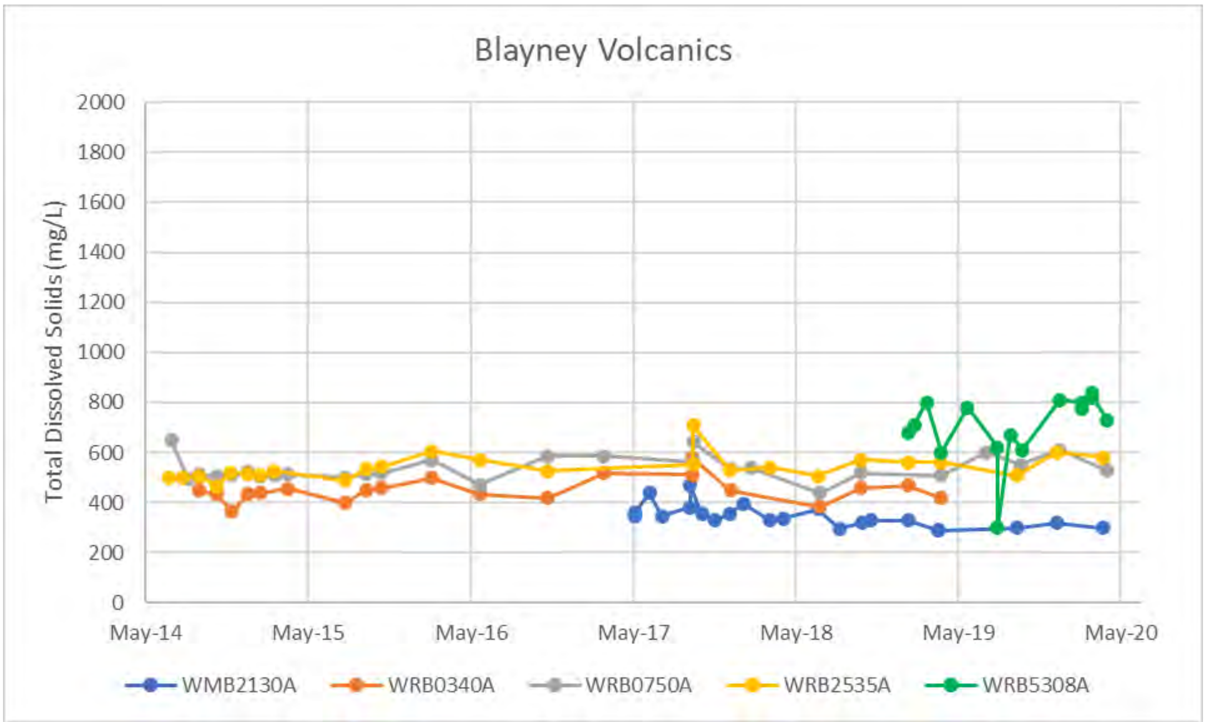


Figure B.7 Blayney Volcanics groundwater salinity trend (as TDS)

Appendix C

Response to DPIE technical review of the EIS groundwater assessment

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17 August 2020

Mandana Mazaheri
Department of Planning, Industry and Environment
12 Darcy Street
Parramatta NSW 2124

Re: McPhillamys Gold Project - response to expert review of the EIS groundwater assessment

Dear Mandana,

1 Introduction

The following letter provides a summary of EMM Consulting Pty Limited (EMM) and Regis Resources Ltd (Regis) response to the JBS&G review of the Groundwater Assessment of the McPhillamys Project submitted as part of the Environmental Impact Study (EIS) (JBS&G 2019).

The Groundwater Assessment (EMM 2019) prepared in support of the EIS included a numerical groundwater flow model, which has been independently reviewed by Hugh Middlemis of HydroGeoLogic Pty Ltd. The Department of Planning, Industry and Environment (DPIE) engaged Justin Bell of JBS&G to conduct a review of the Groundwater Assessment on behalf of DPIE. A meeting was held on 2 December 2019 between Dr Justin Bell, EMM, Regis and DPIE personnel where JBS&G presented a summary of the review. Following receipt of the JBS&G review letter, a follow up meeting was held on 29 January 2020 with Dr Justin Bell, Hugh Middlemis, DPIE, EMM and Regis personnel to provide preliminary response to the review.

1.1 Response approach

As discussed during the 29 January 2020 meeting, responses to most of the review comments simply required additional information or documentation to better explain the Groundwater Assessment work (EMM 2019).

The letter includes information presented and discussed during the 29 January meeting and also provides a breakdown of the review comments, followed by the response. To assist with the response to key review comments, three additional model scenarios have also been undertaken to comprehensively address certain issues raised by Dr Bell. These scenarios also complement the uncertainty analysis already completed and to provide additional confidence in the predictions presented in the Groundwater Assessment (EMM 2019). These scenarios are intended to be considered in the context of the full uncertainty analysis, confirming that the range of parameter values and conceptualisations are sufficiently conservative for robust assessment of the potential impacts of the project on water resources.

2 Extracts from the Groundwater Assessment

The following subsections provide information previously presented in the Groundwater Assessment (EMM 2019) of the EIS to assist the reader.

2.1 Model objectives

The key objectives for the McPhillamys Groundwater Assessment numerical model are to:

- implement the conceptual hydrogeological model;
- assess the likely extent and magnitude of groundwater drawdown induced by mine dewatering and closure;
- predict changes to availability of groundwater for sensitive receptors surrounding the project;
- assess the potential changes to groundwater flow as a result of the tailings storage facility (TSF) during operations and post-mining;
- provide information for the assessment of potential TSF impacts on groundwater quality; and
- inform the site wide water balance.

2.2 Water affecting activities

The main water affecting activities of the project are:

- mine dewatering;
- open cut mining;
- tailings storage;
- waste stockpiling;
- water storage facilities; and
- surface water diversions.

Each of the above activities has the potential to result in changes in groundwater quantity, groundwater quality and surface water-groundwater interaction. The groundwater model has been used to predict the potential changes to groundwater flow (heads) from the open cut pit (mining and dewatering) and a conservative representation of the TSF.

2.3 Model layers

A summary of the model layers and zones is provided in Table 2.1.

Table 2.1 Model layer and zone summary

Layer	Zone [1]	Description
1	1	Alluvium
	2	Orange Basalt
	3	Carbonaceous alteration within the Anson Formation
	4	Byng Volcanics (saprock)
	5	Anson Formation (saprock)
	6	Cunningham Formation (saprock)
	7	Blayney Volcanics (saprock)
2-9	8	Byng Volcanics (fresh)
	9	Anson Formation (fresh)
	10	Cunningham Formation (fresh)
	11	Blayney Volcanics (fresh)

Note: 1. The zoning is generally based on hydrostratigraphic unit (HSU).

3 Comments and queries regarding adequacy of groundwater model

3.1 Model classification

JBS&G provide the following comment:

> "A Class 2 Groundwater Model, with an amended representation of the vertical discretisation of hydraulic conductivity with depth, is considered necessary to appropriately assess the impacts due to the project."

In the Groundwater Assessment (Section 5.4.2i), EMM presented the groundwater model as Class 1 in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al 2012). The guidelines suggest potential uses for a Class 1 model to include:

- predicting long-term impacts of proposed developments in low value aquifers;
- estimating impacts of low-risk developments; and
- understanding groundwater flow processes under various hypothetical conditions.

The third-party reviewer (HydroGeoLogic) determined that the groundwater model has a confidence level of Class 1 with elements of Class 2 (and Class 3) and that it is suitable for impact assessment scenario modelling purposes (see Appendix H of EMM (2019)).

We note that there is an initiative in progress that will result in a refinement of the modelling guidelines specifically in relation to the qualitative model confidence level classification. The guideline refinements reaffirm that the classification simply considers the level of data available to support model development, the conceptualisation and calibration process and model performance, and that it was intended for application to cases where a predictive uncertainty analysis has not been conducted. The guideline principles hold that the classification should not be used as an indicator of the confidence in the model results, because that should be based on predictive uncertainty assessments, as has been conducted in this case. The guideline revision is designed to correct its currently common misapplication of the 'target model confidence level' as erroneously 'the higher the better'. The revision reduces the importance of the qualitative confidence classification and raises the importance of a predictive uncertainty analysis in an assessment of the fitness for purpose of a model, commensurate with the risk context for the project. In this case, the predictive uncertainty scenarios demonstrate that there is a low risk of an unwanted outcome in terms of potentially unacceptable water-related impacts, consistent with guideline principles.

JBS&G also suggest that simulating a gradually reducing hydraulic conductivity with depth and adding more detail to simulated watercourses should be sufficient to achieve Class 2. Firstly, as discussed in Section 3, EMM have conducted additional uncertainty analysis where the hydraulic conductivity has been adjusted in the upper two fresh rock layers (layer 2 and 3) to assess the implications of a more gradual transition. Secondly, EMM consider the simulation of watercourses in the groundwater model appropriate, as the surface water assessment (see Chapter 9 of the EIS and Appendix J of the EIS) considered the reduction in catchment area as a result of the project and the changes in surface water flow. This is discussed further in Section 3.2.

The groundwater model is deemed fit for purpose by EMM and HydroGeoLogic, given the low productive aquifer and low risk context. As stated by JBS&G (2019) there are few groundwater users in the area, with locations of bores corresponding to landholdings and proximity to road access rather than clustered within a particular geological unit. This is consistent with the observations that the geology has low hydraulic conductivity and low potential for development as a groundwater resource. The uncertainty analysis (see Section 3.7) has been designed with a wide range of parameter values to account for the low coverage of calibration data and to assess potential impacts of the project.

With the overall Groundwater Assessment that included predictive uncertainty and with the additional scenarios completed following discussions with DPIE and JBS&G (see Section 4), EMM suggest that the model is demonstrably fit for purpose, consistent with the modelling guidelines and the findings of independent reviews.

3.2 Simulation of watercourses

JBS&G provided the following comment:

> "At present, only selected segments of surface watercourses in the vicinity of the Project are included in the groundwater model. Whilst it is accepted that most of the upper reaches of the Belubula River catchment may be ephemeral, in particular when considering a saturated flow simulation, take from all of the watercourses is required to be calculated, else the total 'take' will be underestimated."

Surface water 'take' has been assessed primarily as part of the Surface Water Assessment (Appendix J of the EIS) and summarised in Chapter 9 of the EIS. The points below summarise how it has been assessed:

- changes in surface water flow as a result of a reduction in catchment area (due to project development) has been assessed in the Surface Water Assessment;
- predicted changes in groundwater discharge to watercourses (baseflow) and river leakage to groundwater has been assessed in the Groundwater Assessment (EMM 2019);
- in the project area (area of influence), perennial and ephemeral watercourses have been simulated (see Section 5.4.2v of the Groundwater Assessment (EMM 2019)); and
- outside of the project area, only perennial watercourses are simulated, as when surface water flows in these watercourses, leakage from the (losing) watercourses is already occurring at the maximum rate (governed by the head of the water column in the watercourse).

Figure 3.1 provides a graphical representation of the components that were considered for surface water take.

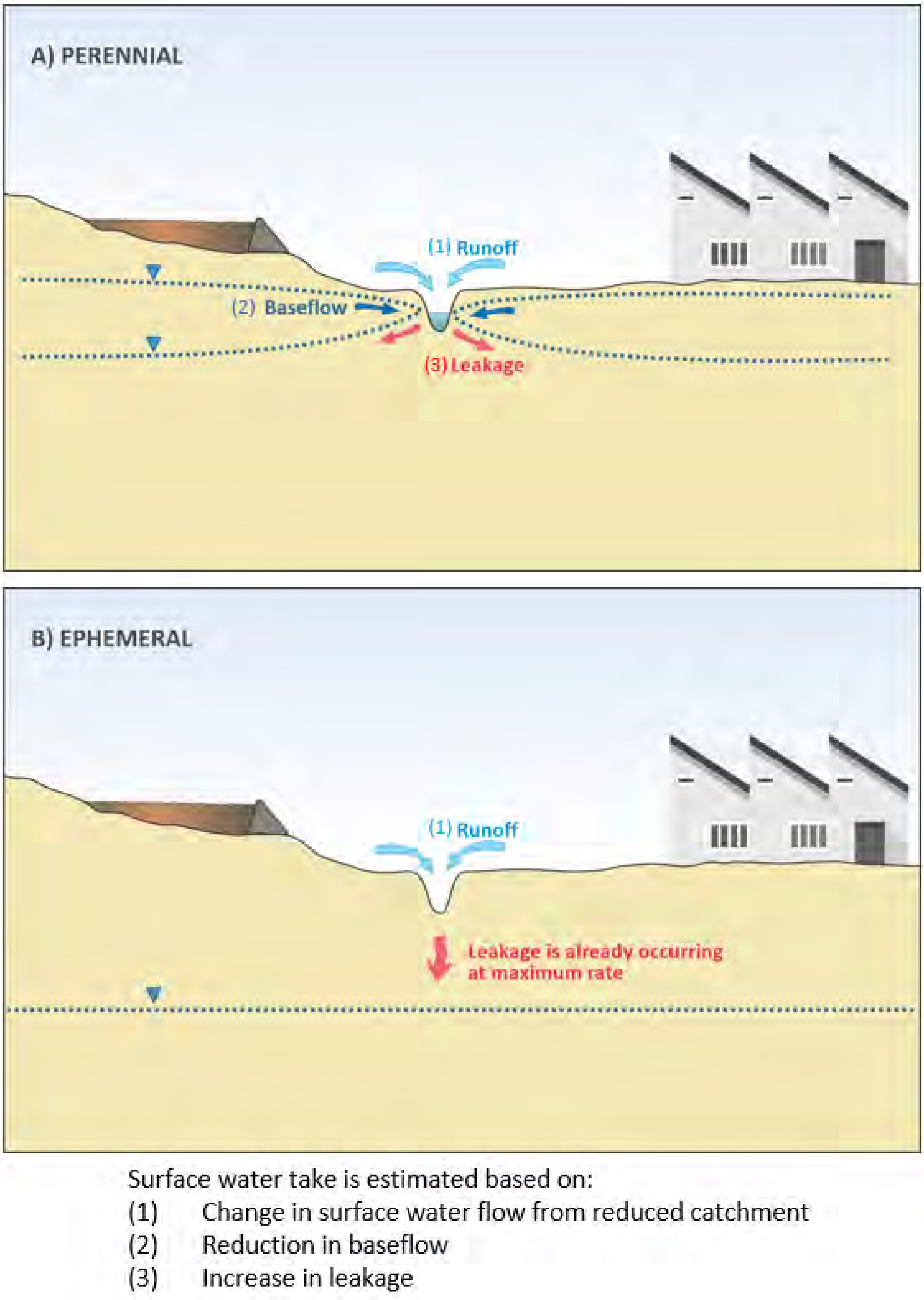


Figure 3.1 Components considered for assessing surface water take

3.3 Simulation of springs

JBS&G provide the following comment:

> "Whilst it is accepted that the majority of the identified springs and seeps are located within the 'Disturbance Footprint' and hence may be 'built over', JBS&G does not understand why springs and seeps were not included in the groundwater model, as the mechanism through which they occur was obviously considered important enough to warrant the substantial and thorough investigation as presented by EMM (2019)."

The surface water-groundwater interaction assessment and hydrological characterisation of springs in the study area was undertaken as part of the EIS in order to address community concerns regarding the springs. There are many springs in the area.

As described in the Groundwater Assessment (EMM 2019) and the Surface Water-Groundwater Interaction Assessment (EMM 2020a), most springs identified in the mine development area have been altered (excavated and converted into a dam) to allow cattle access for drinking water. Most identified springs are associated with the shallow, locally recharged, groundwater flow system (ie perched and short flow path groundwater systems) and are associated with changes in topography. The results of the Surface Water-Groundwater Interaction Assessment indicate that these springs do not contribute significant flows to the Belubula River. Construction of project infrastructure (including clearing, grubbing and preparing for construction) will change the local flow system in these areas, removing the groundwater discharge at the spring and seep locations. This groundwater resource will not be removed from the flow system. As flow gradients readjust, the groundwater will discharge at another location, which may be to a waterway or at another spring location. There is the potential for the predicted decline in groundwater levels to alter spring flows on the mine development boundary, however as these springs contribute minor flows to the Belubula River and do not provide habitat for sensitive fauna, the impact at a project scale is expected to be minor. An example conceptual diagram is provided in Figure 3.2.

The groundwater model is a regional scale impact assessment model and is not designed to simulate small-scale local flow. The springs were not simulated in the groundwater model based on the conceptualisation and objective and scale of the groundwater model. EMM and Regis believe that revisions to the groundwater model on this aspect are not required.

Due to community focus and other submissions received on the EIS, EMM and Regis have provided further detail on the conceptual understanding and additional data collected since the EIS in the Surface Water – Groundwater Interaction Assessment report (EMM 2020a), which is included in the Submissions Report (EMM 2020b).

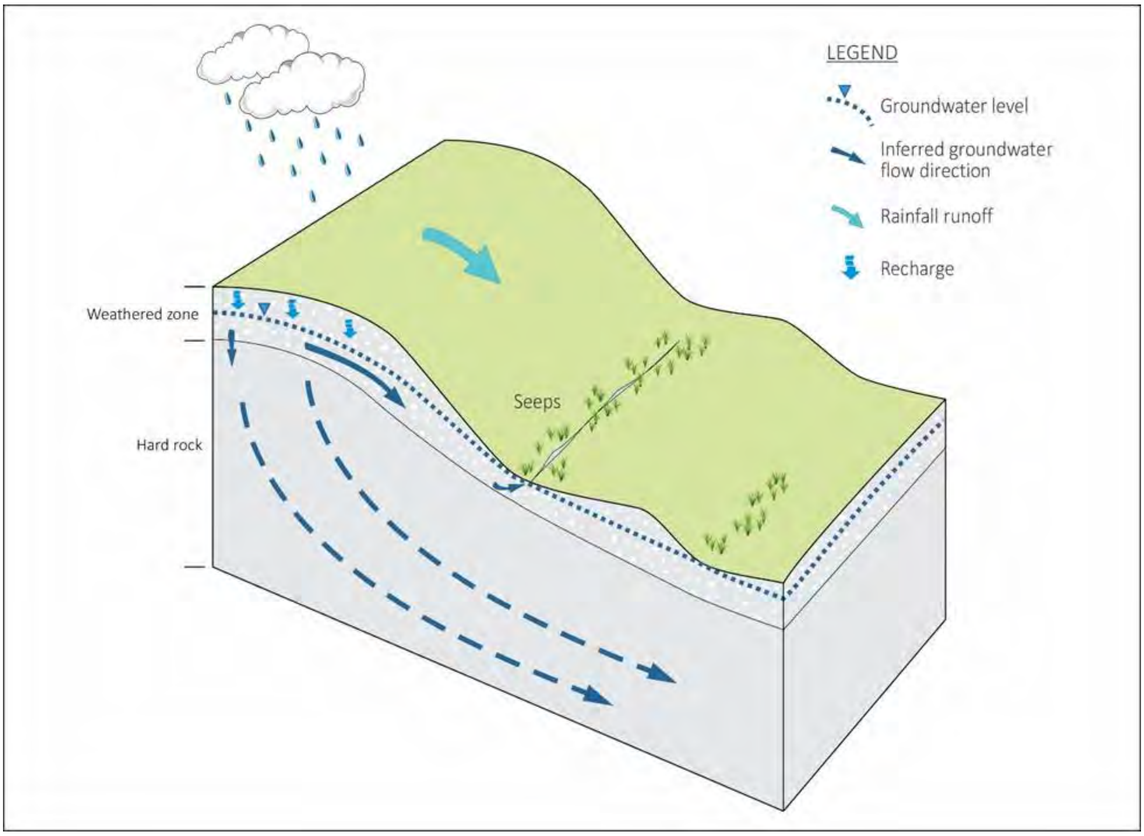


Figure 3.2 Conceptual diagram of perched highland springs

3.4 Geological structures and heterogeneity

JBS&G provide the following comment:

> "Consideration of the influence of geological structures on bulk hydraulic conductivity is considered by JBS&G to be important."

Of greatest significance to the project is the Godolphin Fault, which separates the Anson Formation in the east from the Byng Volcanics in the west. There have also been a number of smaller structures inferred by Regis within the proposed mine footprint. Extensive drilling has indicated faulted areas in the open cut area are highly weathered zones with high clay content and low hydraulic conductivity, and generally define the contacts between the lithological units. As discussed in Section 5.4.2iv of the Groundwater Assessment, geology is defined within each model layer as zones (or hydrostratigraphic unit (HSU)) and uniform properties are applied across each HSU. Heterogeneity and faulting are not specifically simulated but have been considered as follows:

- the geological units are vertically dipping and lateral changes in hydrogeological properties between units is captured via the zonation in the model;
- the separation of the Anson Formation from the Byng Volcanics is used to represent the influence of the Godolphin Fault;
- information available regarding faulting and associated fracturing indicates that fractures generally do not act as conduits for groundwater flow and are clay-filled; and
- heterogeneity associated with weathering is represented by the upper layer in the groundwater model.

The following points provide additional justification for not explicitly simulating structures in the groundwater model:

- regional scale groundwater flow systems are sensitive to and depend on average values of hydrogeological properties; and
- the equivalent porous medium approach has been adopted for this impact assessment model.

In addition, the uncertainty analysis conducted as part of the Groundwater Assessment analysed a wide range of hydraulic properties for the fresh rock units, individually and grouped. Further discussion on the uncertainty analysis is provided in Section 3.7.

EMM and Regis believe that no further modelling is necessary for this aspect of the current model. Future model improvements, as more data becomes available, may incorporate additional uncertainty analysis on the influence of structures. This is documented in the Groundwater Assessment Addendum (EMM 2020c).

3.5 Adopted hydraulic conductivity of fresh rock

JBS&G provide the following comments:

> "The values of hydraulic conductivity presented in Table 4.3 [of the Groundwater Assessment] are such that the hydrogeologic unit, if the test values were representative of the whole unit, would be considered an aquiclude (impermeable rock). JBS&G notes that this may not be representative of the formation."
>
> "JBS&G also considers that the current approach in the groundwater model, whereby there is an instantaneous transition (vertically) from Layer 1 (saprock) to Layer 2 through 9 (fresh rock), is inconsistent with the conceptual model presented in EMM (2019), namely that there is a gradually decreasing hydraulic conductivity with depth."

Core samples have been analysed to estimate hydraulic conductivity. A Box and Whisker plot of the measured hydraulic conductivity data is presented in Figure 3.3, grouped by geological unit. The majority of tests have been performed on the Anson Formation due to the project being located in this unit. Field testing has been conducted over varying depths. The uncertainty analysis covered the range of measured hydraulic conductivities and literature values, by simulating fresh rock hydraulic conductivity over a range of five orders of magnitude (up to 1 x 10^{-3} m/day).

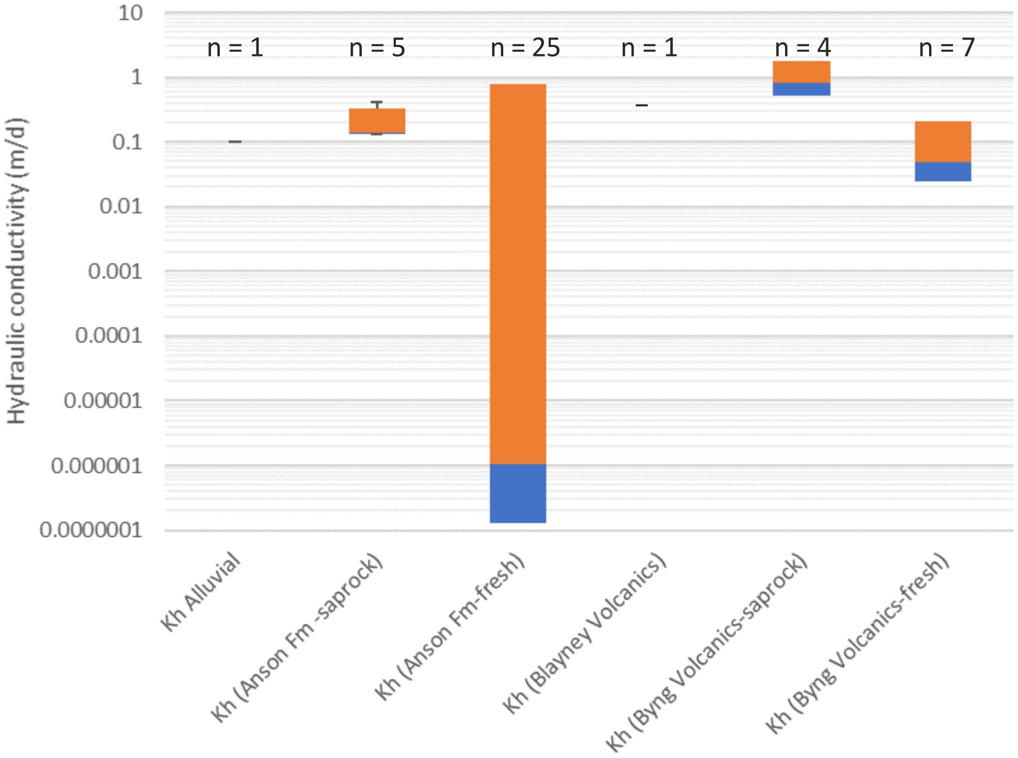


Figure 3.3 **Box and whisker plot of field-measured hydraulic conductivity**

The fresh rock layer elevation used in the model has been derived from the geological model which has been informed by Regis drilling data.

With a lack of detailed data to indicate various transition zones with depth, EMM adopted a simple two-layer (with depth) approach to the groundwater model. As mentioned above, regional scale groundwater flow systems are sensitive to and depend on average values of hydrogeological properties.

In order to respond to JBS&G's comment regarding the two-layer system, EMM have completed an additional uncertainty analysis scenario which included a more gradual vertical transition in hydraulic conductivity with depth. Information about this scenario is provided in Section 4. Increasing the hydraulic conductivity between saprock and fresh rock results in minimal change to calibration statistics and model predictions (when compared to the base case and reported uncertainty analysis). The results of the additional uncertainty analysis confirms that the modelling (including uncertainty analysis) completed as part of the Groundwater Assessment have adequately assessed the potential impacts of the project.

3.6 Sensitivity analysis and impact of metasediments on calibration

JBS&G provide the following comment:

> "The majority of the monitoring piezometers and wells in the vicinity of the Project are located in the 'saprock'. Accordingly, it is to be expected with changing the values of hydraulic conductivity for fresh rock units has, essentially, no impact on the Scaled Root Mean Square (SRMS) error."

EMM agree that most landholder bores are likely screened in the saprock, however Regis' groundwater monitoring network target locations in the fresh rock as well as the saprock (to obtain groundwater elevation, hydraulic properties and water quality information at different depths).

Table 3.1 below summarises the number of steady state observation points used in the model, broken down by layer and hydrostratigraphic unit. There are 15 monitoring points screened in fresh rock units, compared to 122 in the saprock.

The information presented here supports the discussion provided in the Groundwater Assessment that the model is not sensitive to hydraulic properties of fresh rock.

Table 3.1 Number of calibration observation points

Layer	Alluvium	Basalt	Anson Formation (saprock)	Anson Formation (fresh)	Byng Volcanics (saprock)	Byng Volcanics (fresh)	Blayney Volcanics (saprock)	Blayney Volcanics (fresh)
1	5	29	26	-	14	-	48	-
2	-	-	-	4	-	5	-	2
3	-	-	-	1	-	-	-	1
4	-	-	-	-	-	-	-	-
5	-	-	-	2	-	-	-	-
6	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-

3.6.1 Relative composite sensitivity analysis

Following the meeting on 2 December 2019, EMM performed a relative composite sensitivity (RCS) analysis on the EIS base case model in order to quantify the sensitivity of the model calibration. The results are shown in Figure 3.4. The value of RCS is a unitless, scaled parameter corresponding to the sensitivity of the model calibration to changes in each parameter. Larger values mean that the model has a higher sensitivity to this parameter. The tested parameters are as follows:

- **kx**: horizontal hydraulic conductivity;
- **kz**: vertical hydraulic conductivity;
- **r**: recharge rate;
- **et**: evapotranspiration rate;
- **ed**: evapotranspiration extinction depth;
- **ghc**: conductance of general head boundary cells; and
- **rv**: conductance of river boundary cells.

The number following the parameter in Figure 3.4 represents the parameter zone or boundary reach. The zones and river reaches (rv) are detailed in the Groundwater Assessment (EMM 2019). Storage parameters were not analysed, as storage is neglected in steady state groundwater flow conditions. Additionally, horizontal hydraulic conductivity and recharge are considered linked, as steady state groundwater flow is dependent on the ratio of recharge to transmissivity. It is for this reason that recharge was not varied in the model calibration; allowing recharge and hydraulic conductivity to both vary would allow for non-unique parameter values. However, recharge has been included in the RCS analysis.

Model layer 1 contains hydraulic conductivity parameter zones 1-7 (Table 2.1). As shown in Figure 3.4, the calibration is sensitive to horizontal hydraulic conductivity in this layer. The deeper layers representing fresh rock contain parameter zones 8-11 (Table 2.1). The calibration shows sensitivity to the parameter values in these zones, with observable sensitivity to horizontal hydraulic conductivity and, to a lesser extent, vertical hydraulic conductivity. It is clear that despite the lower number of measurements from the fresh rock, the properties of these units influence the overall groundwater conditions across the domain.

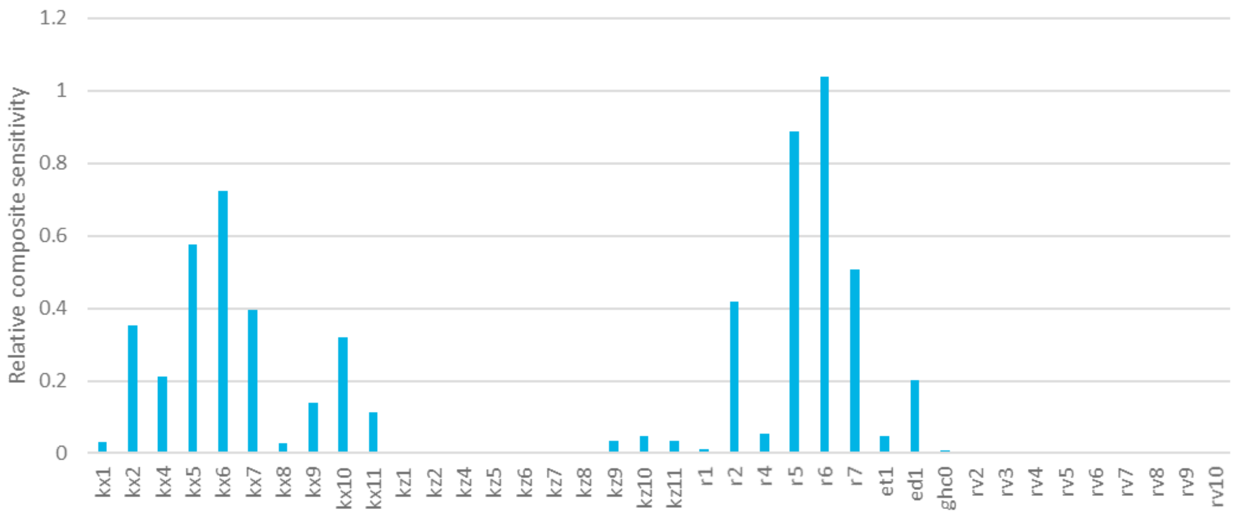


Figure 3.4 Relative composite sensitivity of model parameters against steady state SRMS

Parameters with greater RCS values indicate that the model calibration is sensitive to that parameter and, therefore, that the measurements provide information useful to constraining its value. Accordingly, the modeller can more easily determine reasonable upper and lower bounds for the more sensitive parameters. Noting the lower sensitivity of the model to fresh rock hydraulic conductivity, EMM adopted a wide range of hydraulic conductivity values in the predictive uncertainty analyses for the deeper layers. In addition to this, the lack of calibration to storage parameters necessitated a wide range of values applied in the uncertainty analysis.

3.7 Uncertainty analysis

JBS&G provide the following comment:

> "A limitation to the approach by EMM (2019) of changing a single parameter value at a time is that, because of the location of the Open Pit in the Anson Formation, and that surrounding groundwater users are in the Blayney Volcanics, because of the very very low value of hydraulic conductivity adopted in Layers 2 to 9, changes to the Anson Formation will not be 'seen' by those groundwater users. Conversely, changes to the Blayney Volcanics, because of the very very low value of hydraulic conductivity in the Anson Formation will not be 'seen' by the Open Pit."

It is apparent that the Groundwater Assessment (EMM 2019) did not clearly communicate the work completed as part of the uncertainty analysis. As discussed on 29 January 2020, the uncertainty analysis completed as part of the Groundwater Assessment (EMM 2019) considered:

- hydraulic conductivity of the weathered Byng Volcanics (saprock) in isolation of other units (up and down);
- hydraulic conductivity of the fresh Byng Volcanics in isolation of other units (up and down);
- hydraulic conductivity of all the weathered rock units (up and down);
- hydraulic conductivity of all fresh rock units (up and down);
- specific yield of all weathered rock units (up and down);
- specific storage of all fresh rock units (up and down); and
- river stage elevation, 'dry watercourse' scenario and recent additional scenarios detailed in Section 4.

At the time of the expert review, JBS&G commented that there is residual risk of potential impacts to landholders to the south of the project (in Kings Plains). However, as presented on 29 January 2020 and in this document, the uncertainty analysis included changes in parameter values that have been applied to all fresh and all weathered units.

Uncertainty scenario S11 included increasing the hydraulic conductivity of the Byng Volcanics much higher than that presented in the EIS base case model. This scenario allows assessment of the potential for greater impacts (drawdown) to be observed in the Kings Plains area. The results of the uncertainty analysis (presented in Section 4) demonstrate that the potential impacts have been adequately assessed and the groundwater model is fit for purpose.

Additional uncertainty analysis and proposed model review is documented in the Groundwater Assessment Addendum (EMM 2020a).

3.8 Transition from steady state to transient calibration

JBS&G provide the following comment:

> "Currently, the calibration period is too close to the steady state period (refer Table 5.5 of EMM 2019 [Model stress periods]).
>
> Due to a different form of the groundwater flow equation being solved in steady-state compared to transient conditions, JBS&G expects that the groundwater model was 'drifting'."

As described in the Groundwater Assessment (Section 4.4.2), seasonal trends in groundwater elevations have not been evident at most groundwater monitoring sites during the baseline monitoring period. There has been an observable gradual groundwater level decline at most sites since installation in late 2016/early 2017 through until early 2020, correlating with below average rainfall following the wet year in 2016.

Calibration of the model was performed against single data points and assumed steady state flow conditions. Following calibration, validation was performed by comparing modelled groundwater elevations against measured time series data taken in the project area. Following the meeting on 29 January 2020, EMM adopted the advice of Dr Justin Bell and Hugh Middlemis and developed an additional long-term transient model scenario, incorporating additional commentary from JBS&G regarding the modelled evaporation/ evapotranspiration in the transient verification period.

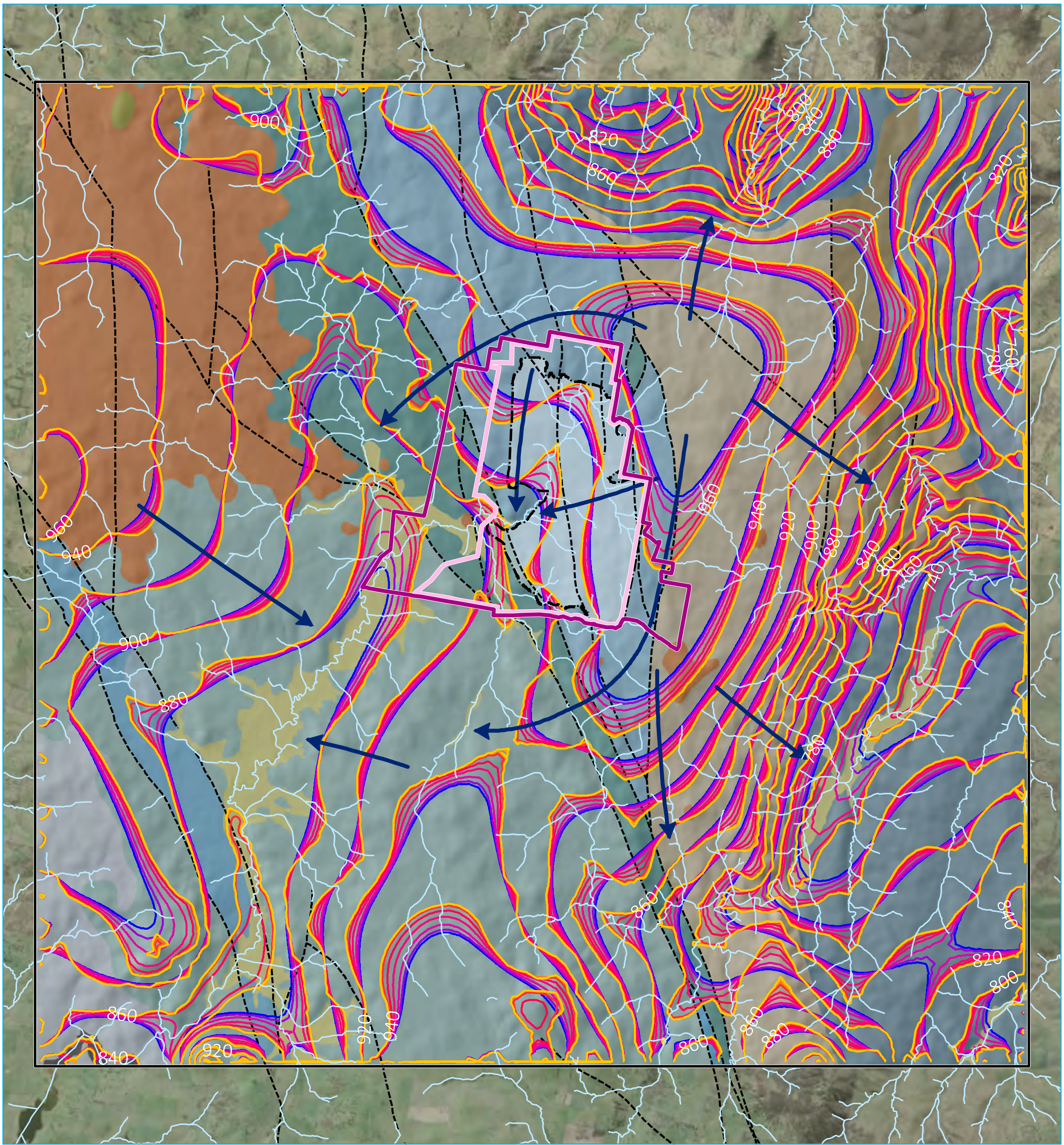
EMM conducted a model run with an extended transient calibration period to assess climate baseline variability. The model setup and results are described in detail in Section 4. In summary, the extended transient verification period, using monthly recharge and evapotranspiration from 1970 to mid-2018, result in a slightly greater response to climate stresses in the history match period. Transient calibration statistics from 2017 to 2018 improve slightly from 6.1% to 5.9%. Whilst the revised temporal setup improves the model response to climate variability, the improvements are minor and do not influence the model predictions. The results also show that the heads in the groundwater model are stable when it changes from steady state to transient and there is no observable drift at observation points.

3.9 Groundwater elevation in fresh rock

JBS&G provide the following comment:

> "At present, the groundwater elevation in the lower layers of the model is not presented in EMM (2019). This is potentially of interest with respect to the approach to regional throughflow […] as well as the influence of the Godolphin Fault in the model."

The model-derived watertable elevation and predicted change in the watertable as a result of proposed mine activities are presented in the Groundwater Assessment (EMM 2019) and Groundwater Assessment Addendum (EMM 2020a). Calibrated hydraulic head contours for model layers 1 to 9 are presented in Figure 3.5 and in the Groundwater Assessment Addendum (EMM 2020a). Presenting the heads in this way allows the reader to observe a slight vertical gradient across most of the model domain. Regionally there is a downward gradient which reverses in low topographic areas (ie watercourses and valleys).



\\Emmsvr1\emm\Jobs\2018\J180395 - Regis McPhillamys EIS\GIS\02_Maps_RTS_GW\RTSGW005_SteadyStateContoursFeb_20200217_02.mxd 18/08/2020

Source: EMM (2020); Regis Resources (2019); DFSI (2017); GA (2011)

0 2.5 5 km
GDA 1994 MGA Zone 55
N

KEY

— Watercourse/drainage line
➔ Groundwater flow direction
▭ Model boundary
Project application area
▭ Mine development project area
▭ Mining lease application area (Note: boundary offset for clarity)
▭ Disturbance footprint
Geology (Bathurst 250k, 2nd Edition)
--- Fault
Geology (Bathurst 250k, 2nd Edition)
Quaternary / Tertiary
▨ Alluvium
▨ Tertiary basalt
▨ Trachyte
Carboniferous
▨ Bathurst Batholith - Bathurst Granite
▨ Bathurst Batholith - Dunkeld Granite
▨ Bathurst Batholith - Gresham Granite
▨ Bathurst Batholith - Icely Granite
Devonian
▨ Other Carboniferous Intrusions
▨ Ungrouped Devonian Formations - Cunningham Formation
▨ Crudine Group - Bushranger Volcanics
▨ Crudine Group - Turondale Formation
▨ Crudine Group - Waterbeach Formation
Silurian
▨ Other Silurian Intrusions - Carcoar Granodiorite
▨ Other Silurian Intrusions
▨ Mumbil Group (Northwest) - Anson Formation
▨ Mumbil Group (Northwest) - Wombiana Formation
▨ Mumbil Group (East) - Campbells Formation
Ordovician
▨ Ordovician Intrusions
▨ Cabonne Group - Blayney Volcanics
▨ Cabonne Group - Oakdale Formation
▨ Cabonne Group - Byng Volcanics
Other
▨ Lake

Modelled groundwater level (by model layer)
— L01
— L02
— L03
— L04
— L05
— L06
— L07
— L08
— L09

Steady state modelled groundwater level contours (all layers)

McPhillamys Gold Project
Groundwater assessment
response to DPIE expert review
Figure 3.5

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EMM creating opportunities

3.10 Regional throughflow and use of general head boundary conditions

JBS&G provide the following comment:

> "JBS&G suggests that consideration is given to far field hydraulic head as a potential alternative to the current approach by EMM."

The mine development area is at a local topographic high, located at the headwaters of the Belubula River. The model domain is approximately 20 km in each direction, centred on the mine development, and the model boundaries are broadly at a lower elevation than the mine development area. Steady state calibration and the spatial distribution of observed groundwater elevations suggest that the model sufficiently represents pre-mining groundwater flow conditions. The comment raised by JBS&G refers to low lying areas outside of the model domain that appear to be major groundwater discharge locations. In order to capture these, either the model domain would need to be significantly expanded or the general head boundaries would need to be modified using stage elevation of the discharge features and calculated conductance based on distance to these features, hydraulic conductivity and model cell size. EMM agree that this could assist in refining the steady state calibration, but the additional modelling effort required would not be beneficial with respect to the model objectives. Increasing the model domain would also introduce additional uncertainty due to data gaps in the extended areas, which are well beyond the predicted extent of drawdown.

EMM believe that the groundwater model provides an adequate representation of the conceptual hydrogeological understanding and regional groundwater flow system. As such, alterations to the model domain or boundary conditions at the model extent are not proposed.

3.11 Waste rock emplacement

JBS&G provide the following comment:

> "Given the location of the Project at the 'top' of one of several catchments, JBS&G suggests that incorporating the Waste Rock Dump into the prediction simulation is worth consideration, as the Waste Rock Dump may lead to local waterlogging/enhanced discharge to surface watercourses to the east of the project."

The waste rock emplacement (WRE) has been considered as part of the Groundwater Assessment (EMM 2019) and Surface Water Assessment (Appendix J of the EIS). As described in the Groundwater Assessment (Section 5.2.4), the water storages capturing surface runoff from the WRE will be positioned downstream and will be engineered to capture any seepage reporting to the toe of the emplacement for recirculation in the operational water management system. In addition, the WRE will be undergoing compaction from heavy vehicle traffic, further reducing the risk of vertical migration of seepage.

As the main water affecting activities of the project are dewatering of the open cut and tailings storage, simulation of the WRE was not included in the model objectives (see Section 2.1). EMM and Regis maintain this view and do not consider that further modelling is required for this aspect.

3.12 Groundwater users

JBS&G provide the following comment:

> "It does not appear that 'take' from groundwater users in the vicinity of the Project, and in general, is included in the groundwater model. JBS&G considers this to be an important aspect to include."

Groundwater use in the vicinity of the Project is expected to be very low, due to the low productivity of the geology in the area, as evident in the minimal active groundwater licenses in the area. The majority of groundwater use in the study area is for stock and domestic purposes, with low, infrequent, and unmonitored extraction. There is minimal data available regarding pumping rates, bore lithology, screened interval for pumping bores and there is no observation data available to enhance model calibration. The predictive groundwater model calculates drawdown with respect to a 'null case' scenario without mining activities, a best practice method for quantifying dewatering effects whether or not other common and minor extraction is included or excluded (Barnett et al 2012).

Inclusion of groundwater use in the model is not considered necessary due to these factors and the increased data uncertainty that would be included due to there being no records of extraction volumes.

3.13 Cumulative departure from mean rainfall

JBS&G provide the following comment:

> "CRD analysis is helpful in groundwater studies due to the slow response of groundwater systems to changes in average climate. JBS&G advises, however, that starting analysis in 1900 is difficult to justify and it is recommended that the original paper on the CRD technique and critique of the CRD technique in the literature is reviewed and Figure 3.3 is updated to a closer starting date."

JBS&G refer to Weber & Stewart (2004), who state that analyses based on the CRD method can be erroneously influenced by use on a long time scale. The Groundwater Assessment (EMM 2019) presented CRD back to 1900 to illustrate that the area has experienced large variations in rainfall trends since this time, including multiple droughts and very wet periods (see Section 3.2 of the Groundwater Assessment). Other than being used as a comparison to evaluate seasonal trends in groundwater level monitoring data, CRD was not used for further detailed analysis.

EMM present an additional CRD plot in the Groundwater Assessment Addendum (EMM 2020a) calculated over a shorter time period. However, EMM consider that it has no influence on the groundwater modelling work completed.

4 Overview of additional model scenarios

As advised above, the three additional model scenarios have been performed to:

- complement the uncertainty analysis completed as part of the EIS;
- provide additional confidence in the groundwater model; and
- contribute towards responses in Section 3.

The scenarios do not present as new upper or lower bounds for the uncertainty analysis, thereby providing further justification that the results presented in the EIS appropriately assess the potential impacts of the project.

The additional scenarios are as follows:

- **S64**: Increased hydraulic conductivity in model fresh rock layers 2 and 3, providing a more gradual reduction in hydraulic conductivity with depth. The adopted hydraulic conductivity values are presented in Table 4.1. Note that the anisotropy of horizontal to vertical hydraulic conductivity has been maintained as 10:1 for saprock (model layer 1) and 1:1 for fresh rock (model layers 2-9).
- **S65**: Extended transient verification period to assess climate baseline variability. JBS&G suggested that the direct change from steady state to transient formulations in MODFLOW may result in numerical drift and potentially contribute to difficulty in matching observed groundwater level trends. To test this, an additional scenario was run with a quasi-steady state stress period from 1900 to 1970, followed by a period of monthly transient stress periods applying recharge (using SILO Data Drill (2019) rainfall

records) and evapotranspiration from 1970 to mid-2018. As monthly evapotranspiration was applied through the history match period (2017-2018), this scenario differs from the base case model which had annual average evapotranspiration applied across the model.

- **S66**: A combination of S64 and S65, with a gradual decrease of hydraulic conductivity with depth and an extended transient verification period.

Table 4.1 Modelled horizontal hydraulic conductivity (Kh) for base case and S64 (m/day)

Model layer/s	Base case		S64	
	Byng Volcanics	Other units[1]	Byng Volcanics	Other units [1]
1 (saprock)	6 x 10^{-3}	6 x 10^{-2}	6 x 10^{-3}	6 x 10^{-2}
2	8 x 10^{-8}	1 x 10^{-7}	8 x 10^{-4}	1 x 10^{-3}
3			8 x 10^{-6}	1 x 10^{-5}
4-9			8 x 10^{-8}	1 x 10^{-7}

1. Note: excludes areas of alluvium and basalt

4.1 Model design

4.1.1 S64 – change in hydraulic conductivity in layer 2 and 3

As stated above, scenario S64 simulated a more gradual reduction in hydraulic conductivity with depth. Figure 4.1 presents a chart of measured hydraulic conductivity with depth. As discussed in the Groundwater Assessment (EMM 2019), slug test results tend to be biased to higher hydraulic conductivity areas and core tests can only be done on intact core and therefore tend to result in lower hydraulic conductivity values.

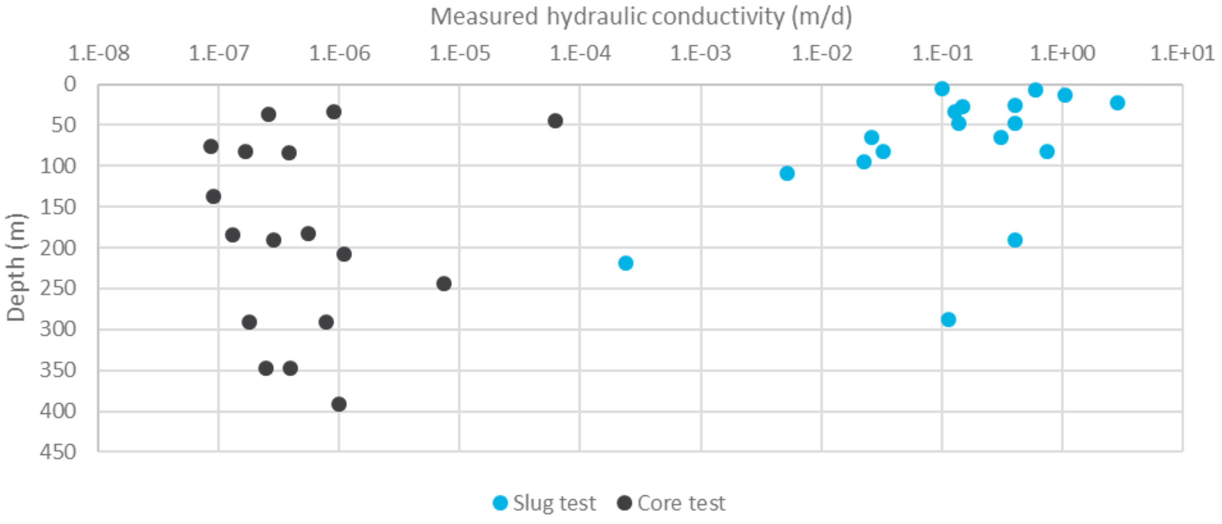


Figure 4.1 Measured hydraulic conductivity with depth

There is insufficient data available to provide estimates of the thickness of a transition layer (from saprock to fresh). Due to limited data availability to accurately support hydraulic conductivities with depth, an approximately linear relationship was used between layers 1 and 4 to derive the hydraulic conductivities for layer 2 and 3 for S64.

Aside from hydraulic conductivity, all other properties, stresses, and temporal setup were maintained from the base case model.

4.1.2 S65 – Base case model with extended transient verification period

Model scenario S65 incorporated an extended transient verification period to assess climate baseline variability. The base case history match model was run with a single steady state stress period at the start of the simulation, followed by monthly transient stress periods starting January 2017. The time series of measured groundwater level data have been used for validation of the calibration. The base case model showed little change in groundwater elevation in the transient verification period.

Review comments have suggested that this may be due to the temporal setup, and increasing the duration of the transient verification period may allow for better representation of temporal trends leading into the history match period.

In scenario S65, the steady state stress period was divided into two segments:

- a long-term (70 years) pseudo steady state stress period with annual average recharge and evapotranspiration; and
- monthly stress periods from January 1970 using monthly recharge and evapotranspiration from 1970 to mid-2018.

The stress period setup is shown in Table 4.2. The first stress period was converted from steady state to transient, to allow for consistent formulation of the groundwater flow equation throughout the model run. Initial heads were set as the calibrated steady state heads from the base case model. Through the history match period, evapotranspiration was converted from annual average to monthly in order to better represent conditions.

Recharge in the base case model was calculated based on rainfall from the AWRA model which only has data from 2005. For consistency through the pre-mining period, recharge and evapotranspiration were calculated from SILO (2019) data.

Table 4.2 S65 stress period setup

Detail	Stress period/s	Stress period length	From	To	Recharge applied	Evapotranspiration applied
Quasi-steady state warmup	1	70 years	1/01/1900	1/01/1970	Annual average	Annual average
Extended transient verification period	2 - 565	1 month	1/01/1970	1/01/2017	Monthly	Monthly
History match	566 - 583	1 month	1/01/2017	1/01/2020	Monthly	Monthly

4.1.3 S66 – combination of S64 and S65

Scenario S66 was run as a combination of S64 and S65. Hydraulic conductivities were applied consistent with Table 4.1, and the stress period setup, recharge and evapotranspiration outlined in Table 4.2 was used.

4.2 Assessment against calibration

Assessment of results from the three additional scenarios included:

- review of steady state SRMS and comparison to base case (4.3%);
- for S65, the measured data hydrographs were compared to model derived hydraulic heads from S65 and the base case model;
- review of pre-mining watertable elevation and groundwater flow directions; and
- review of mass balance results at the end of calibration, with a comparison to the base case.

4.2.1 SRMS and heads

Calibration statistics are presented in Table 4.3. The transient SRMS has been calculated against hydraulic heads.

Table 4.3 Model calibration performance summary

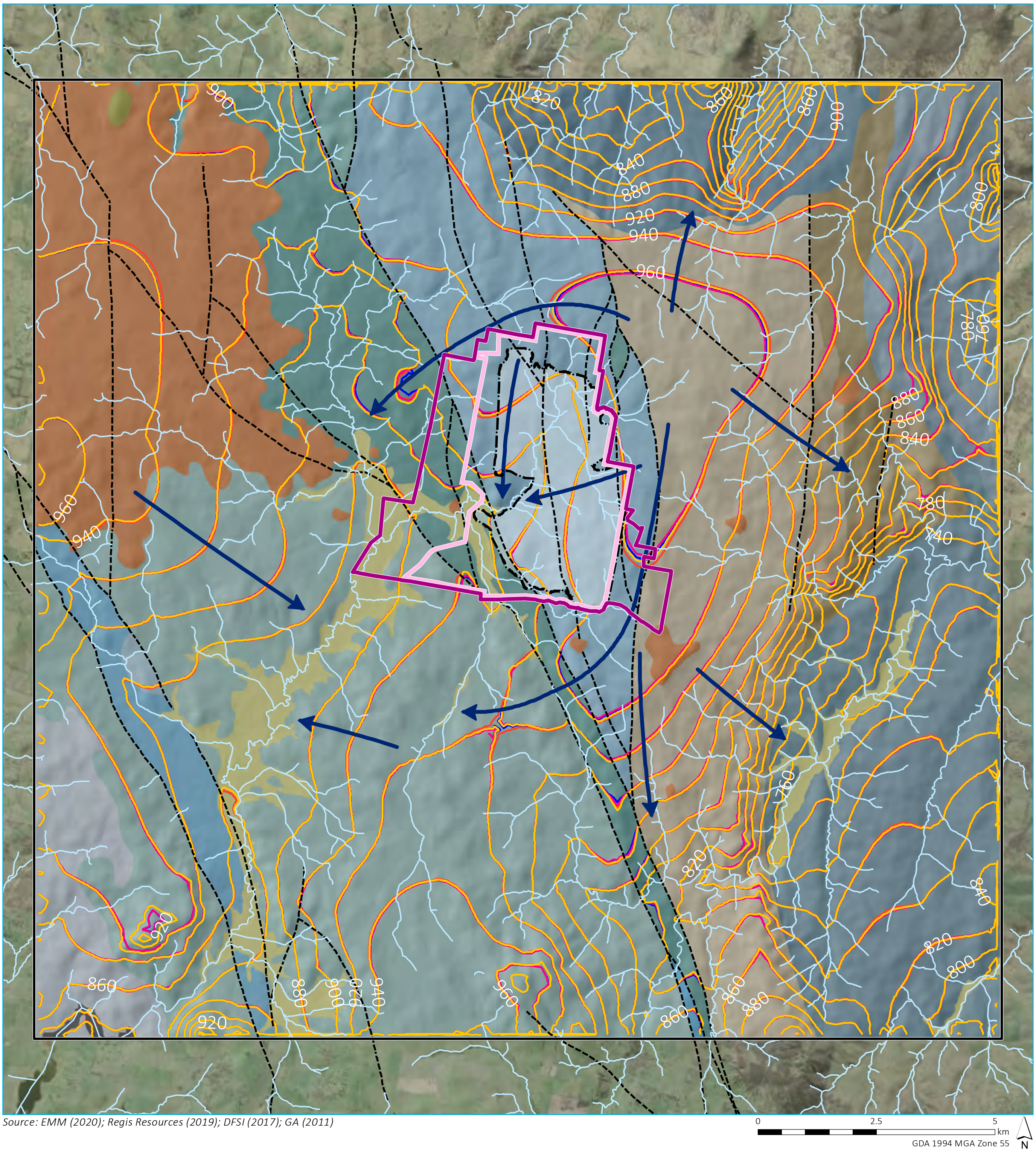
Run name	Detail	Steady state SRMS	Transient SRMS
Base case	Base case	4.3%	6.1%
S64	Increased K in L2-3	4.3%	5.9%
S65	Transient RCH and ET from Jan 1970 to mid-2018	4.3%	5.9%
S66	Increased K in L2-3, transient RCH and ET from Jan 1970 to mid-2018	4.3%	5.9%

Note: SRMS = scaled root mean squared

Each of the additional model scenarios show no change to steady state SRMS. These would all be accepted as part of the uncertainty analysis following the criteria of <5% SRMS. Modelled steady state watertable contours are shown in Figure 4.2. There are minimal changes across the model scenarios, consistent with the unchanged SRMS. The absolute average variance between the base case and the three additional scenarios is 0.5 m. Regional flow conditions are unchanged.

Transient SRMS has improved for each of the additional scenarios over the base case. Hydrographs showing the base case against S65 for the history match period are presented in Attachment A. S65 shows slightly changed starting conditions and a slightly greater response to climate stresses. This may be due to the addition of the extended verification period and/or the inclusion of monthly evapotranspiration rates. There is not a consistent trend for the differences between the base case model and the extended transient verification period, with the simulated watertable higher in some areas and lower in others.

Whilst the revised temporal setup improves the model response to climate variability, the improvements are minor and do not influence the model predictions. The results also show that the heads in the groundwater model are stable when it changes from steady state to transient and there is no observable drift at observation points that materially affects model performance.



Source: *EMM (2020); Regis Resources (2019); DFSI (2017); GA (2011)*

KEY

Watercourse/drainage line
Groundwater flow direction
Model boundary
Project application area
Mine development project area
Mining lease application area
(Note: boundary offset for clarity)
Disturbance footprint
Geology (Bathurst 250k, 2nd Edition)
Fault
Geology (Bathurst 250k, 2nd Edition)
Quaternary / Tertiary
Alluvium
Tertiary basalt
Trachyte
Carboniferous
Bathurst Batholith - Bathurst Granite
Bathurst Batholith - Dunkeld Granite
Bathurst Batholith - Gresham Granite
Bathurst Batholith - Icely Granite
Devonian
Other Carboniferous Intrusions

Ungrouped Devonian Formations
- Cunningham Formation
Crudine Group - Bushranger Volcanics
Crudine Group - Turondale Formation
Crudine Group - Waterbeach Formation
Silurian
Other Silurian Intrusions
- Carcoar Granodiorite
Other Silurian Intrusions
Mumbil Group (Northwest)
- Anson Formation
Mumbil Group (Northwest)
- Wombiana Formation
Mumbil Group (East) - Campbells Formation
Ordovician
Ordovician Intrusions
Cabonne Group - Blayney Volcanics
Cabonne Group - Oakdale Formation
Cabonne Group - Byng Volcanics
Other
Lake

Modelled pre-mining watertable contours
Base case
S64
S65
S66

Modelled pre-mining watertable contours for base case and additional scenarios

McPhillamys Gold Project
Groundwater assessment
response to DPIE expert review
Figure 4.2

\\Emmsvr1\emm\Jobs\2018\J180395 - Regis McPhillamys EIS\GIS\02_Maps_RTS_GW\RTSGW004_PreMiningWTScenariosFeb_20200217_02.mxd 18/08/2020

4.2.2 Mass balance

Mass balance results at the end of calibration for the base case and additional scenarios are presented in Table 4.4 to Table 4.7. The following provides a discussion of the mass balance results:

- Smoothing the transition between saprock and fresh rock (S64) results in less river leakage and baseflow, and reduced evapotranspiration when compared to the base case model (see Table 4.5). This is thought to be due to lower groundwater elevations in areas that do not have monitoring bores and therefore are not captured by the SRMS.
- Extending the transient verification period, and altering the modelled evapotranspiration results in the following (see Table 4.6):
  - greater flux via storage;
  - decrease in modelled baseflow, recharge, and evapotranspiration; and
  - changes in recharge and evapotranspiration are a result of the changed calculation methodology (see Section 4.1).
- The calculated mass balance error is very low for all scenarios.

Table 4.4 Base case modelled water balance at the end of calibration (1 June 2018)

	Input (kL/day)	Output (kL/day)	Net (kL/day)
Storage	1,886	51	1,835
General head boundaries	14,353	11,247	3,106
Rivers	13,746	5,379	8,367
Recharge	17,852	-	17,852
Evapotranspiration	-	31,163	-31,163
Drains	-	0.0	0.0
TOTAL IN		47,836	
TOTAL OUT		47,839	
Error		-0.01%	

Table 4.5 S64 modelled water balance at the end of calibration (1 June 2018)

	Input (kL/day)	Output (kL/day)	Net (kL/day)
Storage	1,769	73	1,696
General head boundaries	12,824	10,728	2,096
Rivers	9,716	3,666	6,050
Recharge	17,852	-	17,852
Evapotranspiration	-	27,699	-27,699
Drains	-	0.0	0.0
TOTAL IN		42,161	
TOTAL OUT		42,165	
Error		-0.01%	

Table 4.6 S65 modelled water balance at the end of calibration (1 June 2018)

	Input (kL/day)	Output (kL/day)	Net (kL/day)
Storage	7,918	9,157	-1,239
General head boundaries	12,652	10,419	2,233
Rivers	7,384	4,674	2,710
Recharge	10,409	-	10,409
Evapotranspiration	-	14,113	-14,113
Drains	-	0.0	0.0
TOTAL IN		38,362	
TOTAL OUT		38,363	
Error		0.0%	

Table 4.7 S66 modelled water balance at the end of calibration (1 June 2018)

	Input (kL/day)	Output (kL/day)	Net (kL/day)
Storage	7,4301	9,165	-1,735
General head boundaries	12,948	10,535	2,413
Rivers	7,448	4,678	2,770
Recharge	10,409	-	10,409
Evapotranspiration	-	13,858	-13,858
Drains	-	0.0	0.0
TOTAL IN		38,235	
TOTAL OUT		38,236	
Error		0.0%	

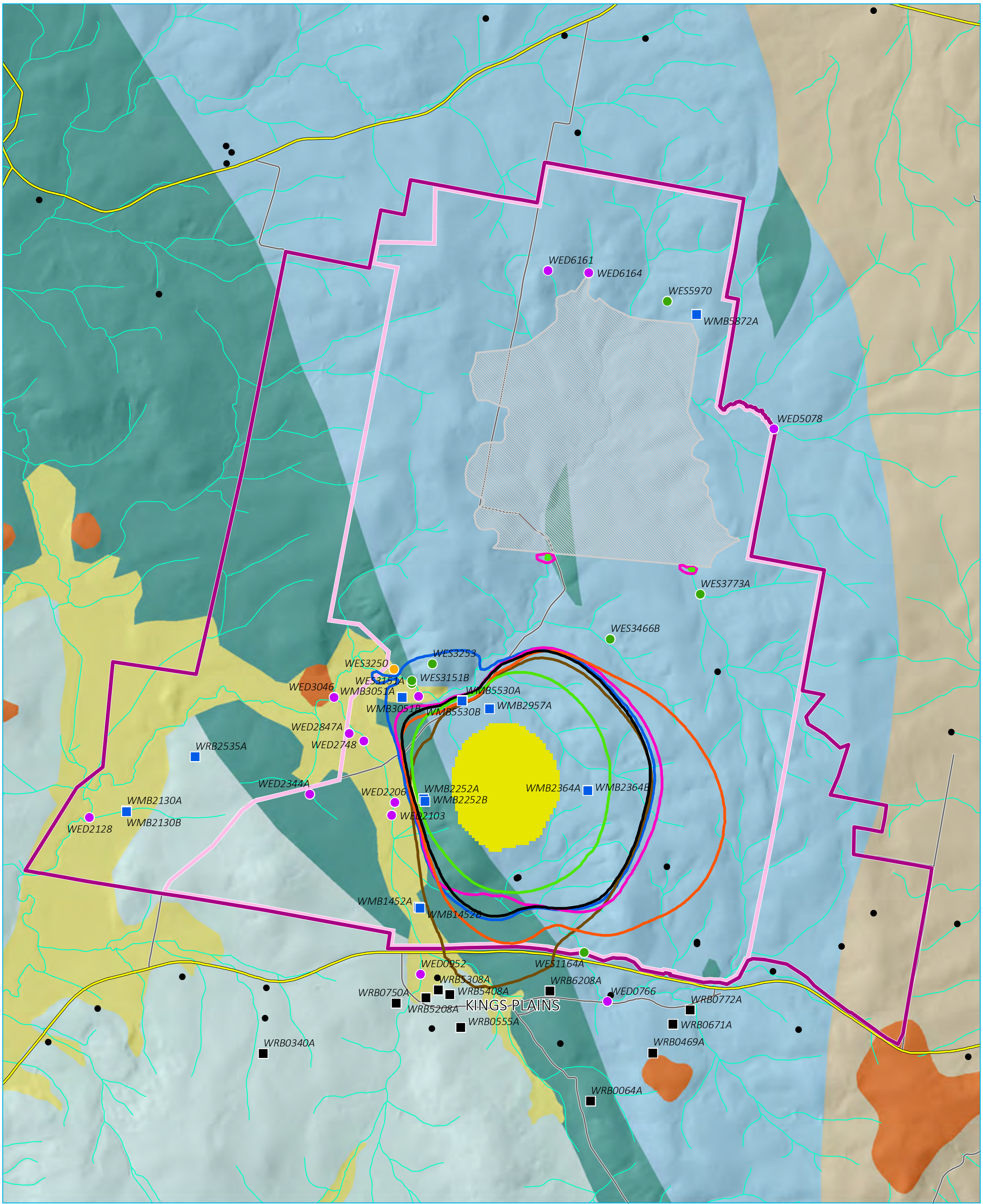
4.3 Model prediction results (S64)

Model scenario S64 (altered hydraulic conductivity in layers 2 and 3) is the primary focus of predictive modelling results (for comparison with the base case), as the objective for scenario S65 and S66 was to assess model verification and climate baseline variability.

4.3.1 Watertable drawdown

The predicted 2 m drawdown contour at the end of mining in scenario S64 has been compared to the base case results and the results of the predictive uncertainty analysis completed as part of the Groundwater Assessment (see Figure 4.3). The figure shows that the S64 predicted 2 m drawdown contour is located within the extent of the best and worst case scenarios presented in the uncertainty analysis.

The results presented here and above demonstrate that the groundwater model calibration and predictions are not sensitive to increasing the hydraulic conductivity in layer 2 and 3, providing a smoother transition between saprock and fresh rock.



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Source: EMM (2020); Regis Resources (2019); DFSI (2017); DPI (2015); ELVIS (2014)

0 1 2 km

GDA 1994 MGA Zone 55

N

KEY

- Best case 2 m drawdown
- Base case 2 m drawdown
- Worst case 2 m drawdown
- Dry watercourse scenario 2 m drawdown
- S64 2 m drawdown
- Byng Volcanics (saprock) high K
- ● PINEENA/Registered bore
- ■ Groundwater monitoring site - Regis
- ■ Groundwater monitoring site - other landholder
- ● Surface water monitoring site (dam)
- ● Surface water monitoring site (seepage area)
- ● Surface water monitoringsite (spring)

Project application area

- ▭ Mine development project area
- ▭ Mining lease application area (Note: boundary offset for clarity)
- ▨ TSF Stage 3 (961 mAHD)
- ■ Simulated pit (year 10)

Existing environment

- Main road
- Local road
- Watercourse/drainage line

Geology (Bathurst 250k, 2nd Edition)

Quaternary / Tertiary

- ■ Alluvium
- ■ Tertiary basalt

Devonian

- ■ Ungrouped Devonian Formations - Cunningham Formation

Silurian

- ■ Mumbil Group (Northwest) - Anson Formation

Ordovician

- ■ Cabonne Group - Blayney Volcanics
- ■ Cabonne Group - Byng Volcanics

Uncertainty analysis modelled drawdown at end of mining

McPhillamys Gold Project
Groundwater assessment
response to DPIE expert review
Figure 4.3

4.3.2 Mass balance

Mass balance results at the end of mining for the base case and scenario S64 are presented in Table 4.8 and Table 4.9. As observed at the end of calibration (Table 4.5 to Table 4.7), river leakage and baseflow and evapotranspiration are lower in S64 than in the base case prediction model. This is thought to be due to lower groundwater elevations in low lying areas around watercourses and in areas that do not have monitoring bores, ie away from the mine development area, and therefore are not captured by the SRMS.

Each of the models report a very low mass balance error.

Table 4.8 Base case modelled water balance at the end of mine year 10

	Input (kL/day)	Output (kL/day)	Net (kL/day)
Storage	150	343	-193
General head boundaries	14,307	11,308	2,999
Rivers	14,440	5,203	9,237
Recharge	20,037	-	20,037
Evapotranspiration	-	31,172	-31,172
Drains	-	913	-913
TOTAL IN		48,934	
TOTAL OUT		48,938	
Error		-0.01%	

Table 4.9 S64 modelled water balance at the end of mine year 10

	Input (kL/day)	Output (kL/day)	Net (kL/day)
Storage	136	313	-177
General head boundaries	12,779	10,795	1,984
Rivers	10,366	3,470	6,895
Recharge	20,037	-	20,037
Evapotranspiration	-	27,849	-27,849
Drains	-	896	-895
TOTAL IN		43,318	
TOTAL OUT		43,322	
Error		-0.01%	

5 Summary

The Groundwater Assessment (EMM 2019) considered the potential risk of the project on the local environment, including assessing the potential range in hydrogeological properties (uncertainty analysis). The following provides a summary of the key points of the McPhillamys Groundwater Assessment (EMM 2019), including the groundwater model:

- the model is fit for purpose;
- the Groundwater Assessment (EMM 2019) and Groundwater Assessment Addendum (EMM 2020) is appropriate for the low risk context and low productive aquifer;
- uncertainty analysis has been completed to assess the potential risk of the project from a hydrogeological perspective;
- the additional modelling has been performed to extend the reported uncertainty analysis, and all results are within previously identified upper and lower bounds reported in the Groundwater Assessment (EMM 2019); and
- the additional uncertainty assessments confirm that the Groundwater Assessment (EMM 2019) has adequately assessed the potential risk of the project on landholders and other sensitive receptors.

6 Closing

EMM trust that the responses and additional information provided in this letter are satisfactory for the queries raised by DPIE's expert reviewer JBS&G.

Yours sincerely	Yours sincerely
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7 References

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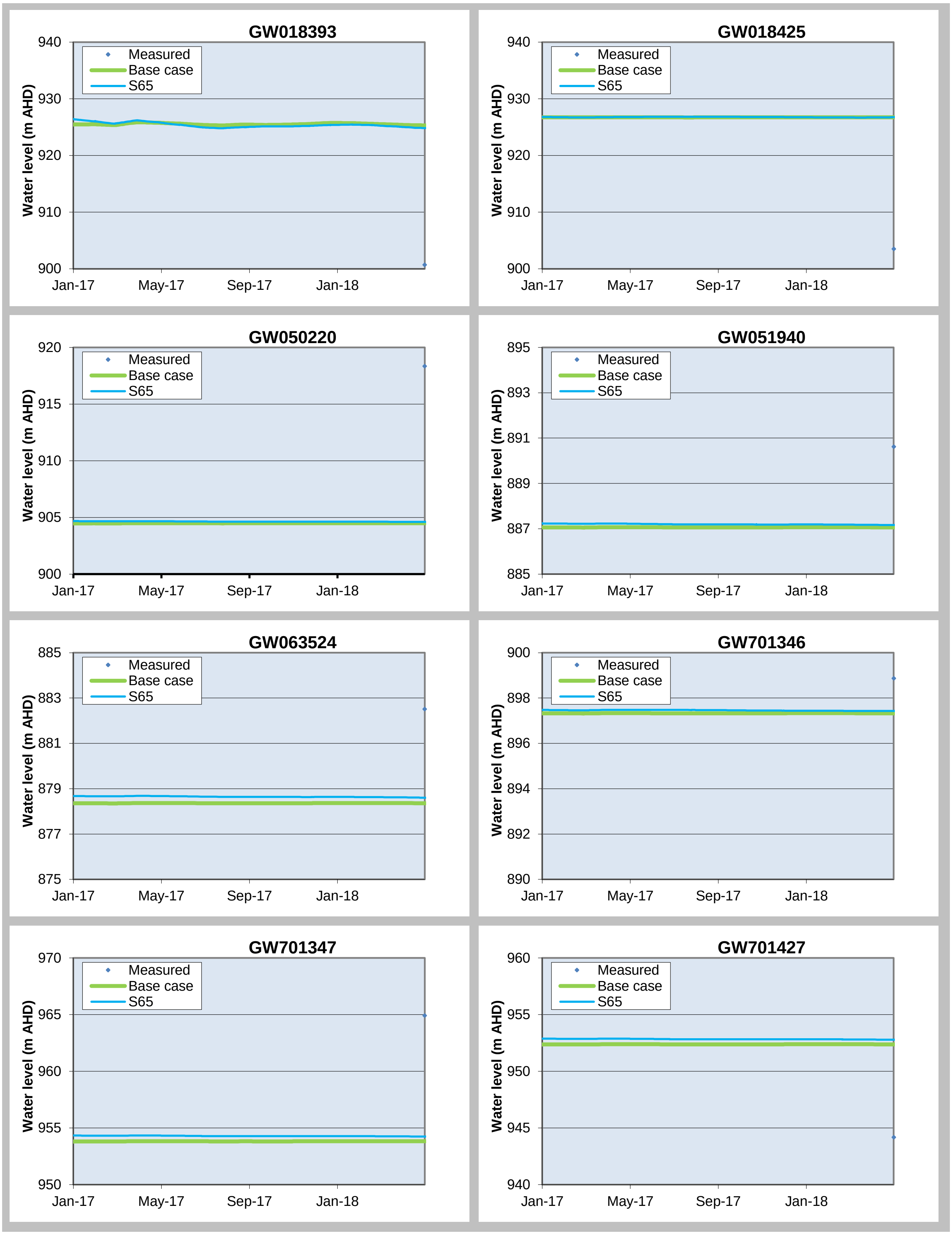
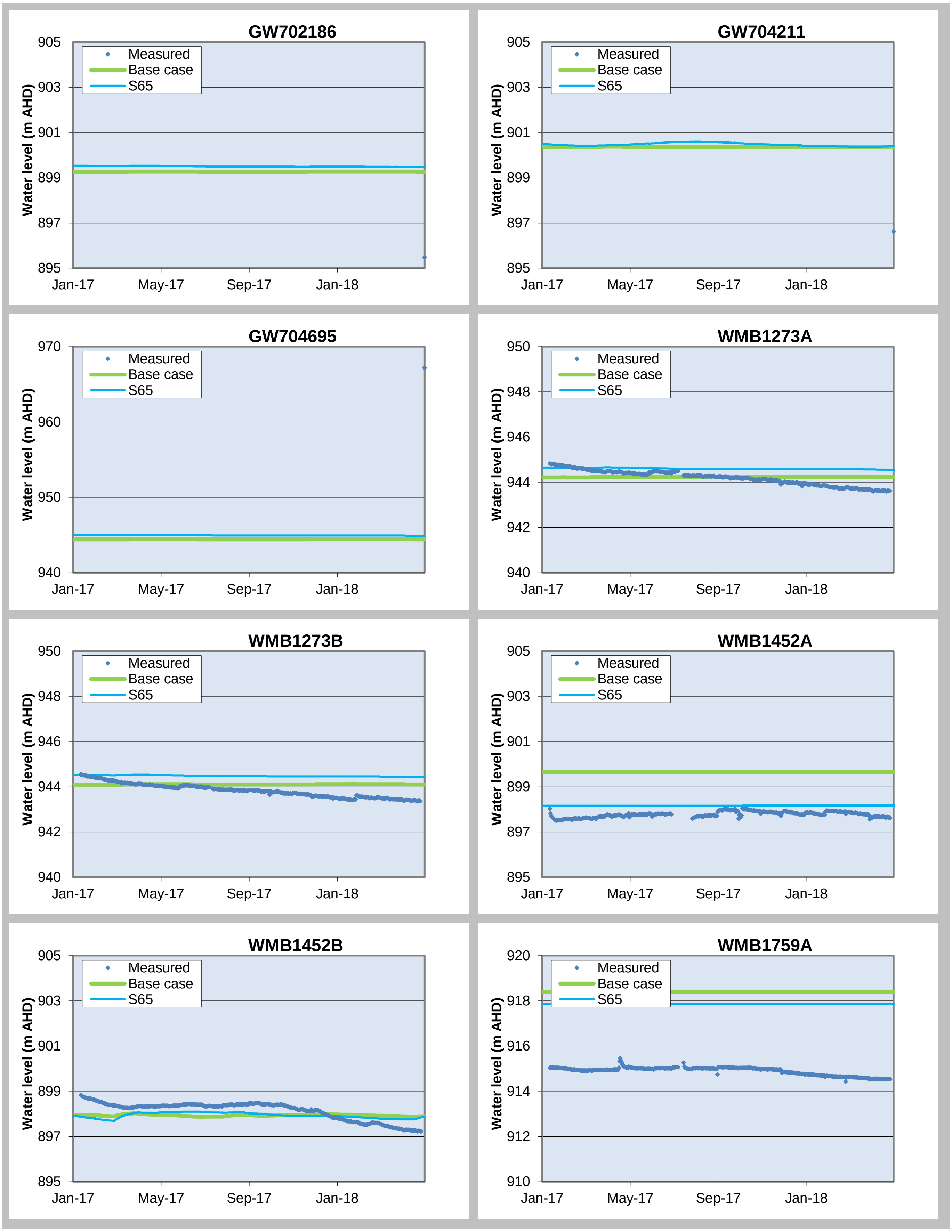
Attachment A

Base case and S65 modelled against measured hydrographs



Appendix A - Base case and S65 modelled against measured hydrographs



Appendix A - Base case and S65 modelled against measured hydrographs

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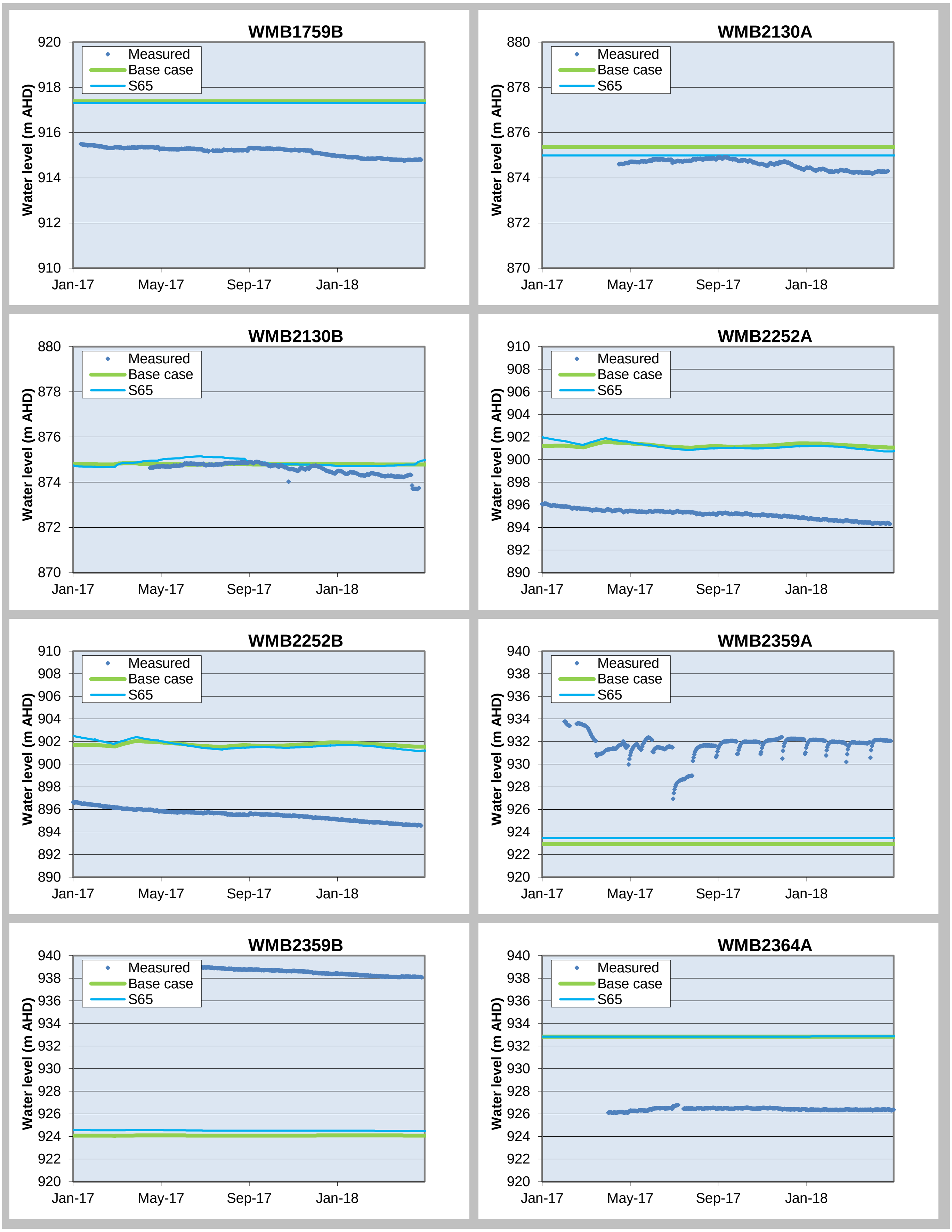
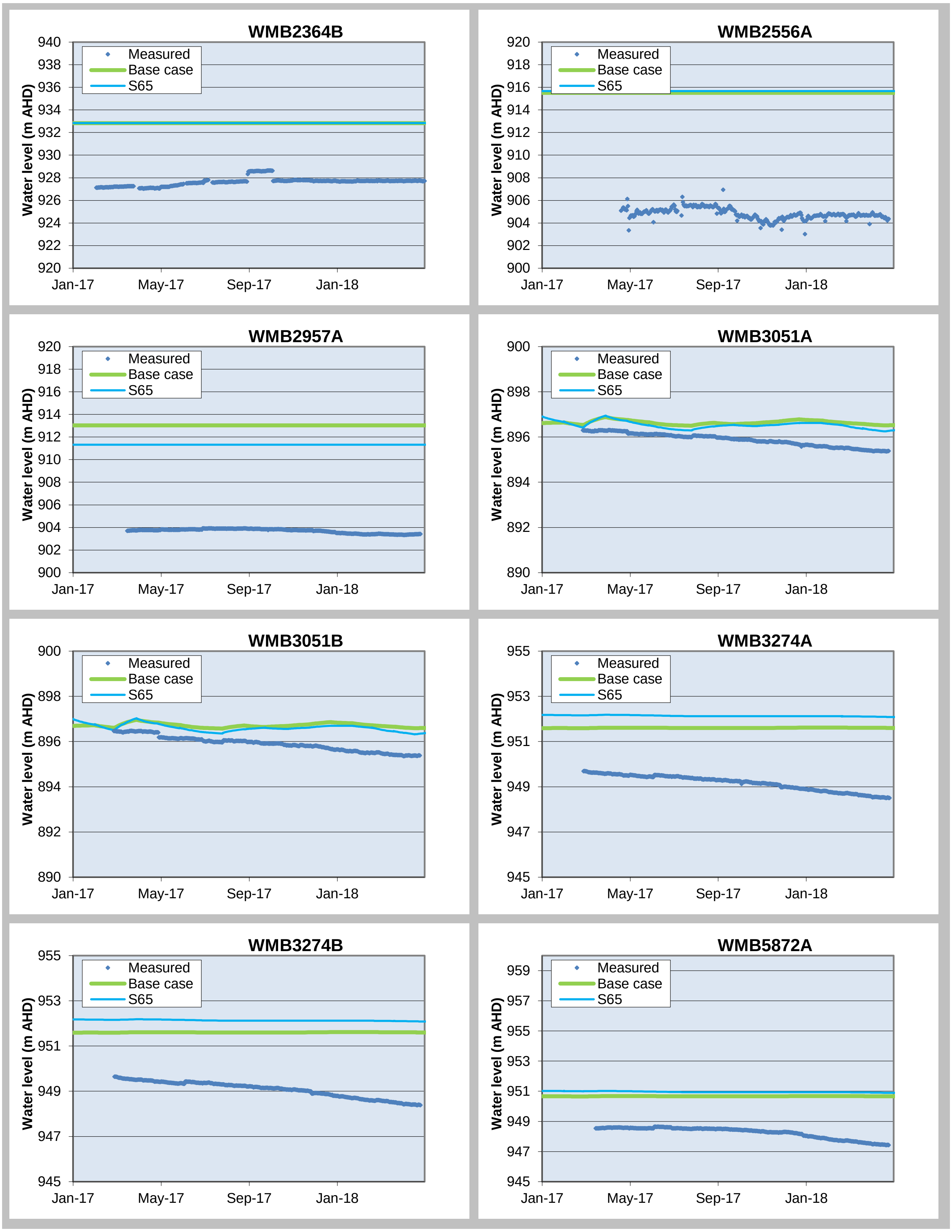


Appendix A - Base case and S65 modelled against measured hydrographs



Appendix A - Base case and S65 modelled against measured hydrographs

Appendix D

Construction Water Supply Groundwater Investigation and Impact Assessment

Construction Water Supply Groundwater Investigation and Impact Assessment

McPhillamys Gold Project

August 2020

PREPARED FOR LFB RESOURCES NL

EMM

creating opportunities

Construction Water Supply Groundwater Investigation and Impact Assessment

McPhillamys Gold Project

Report Number

J17065 RP6

Client

LFB Resources NL

Date

17 August 2020

Version

v4 Final

Prepared by

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17 August 2020

Sam Cook
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17 August 2020

Approved by

Kate Holder
Associate Hydrogeologist
17 August 2020

Executive Summary

ES1 Overview

LFB Resources NL, a 100% owned subsidiary of Regis Resources Limited, is seeking development consent for the construction and operation of the McPhillamys Gold Project (the project), a greenfield open cut gold mine and water supply pipeline in the Central West of New South Wales.

The project is comprised of the mine site and an associated water pipeline which will supply water from approximately 90 km away near Lithgow to the mine site.

The pipeline will be operational approximately nine months after commencement of the project. A water supply for the first nine months of the construction stage of the project is therefore required prior to the commissioning of the pipeline. The construction water demand is estimated to be 15 to 20 litres per second (L/s) depending on climatic conditions, with a maximum total of 470 megalitres (ML) for the initial nine months.

The construction water supply will be primarily sourced from groundwater via production bores within or close to the mine development area. Groundwater investigations have been completed to consider the potential for groundwater to provide the initial project water supply and to assess the potential impacts on groundwater users and the environment.

ES2 Environmental setting

ES2.1 Local geology and hydrogeology

The geology of the upper Lachlan River catchment forms part of the Palaeozoic metamorphic rocks of the eastern Lachlan Fold Belt. The mine development area is underlain by metasediments and volcaniclastics of the Silurian Anson Formation and Ordovician volcanics. Both the Anson Formation and the Ordovician volcanics have low primary porosity and permeability, and groundwater flow is likely to be primarily via secondary porosity (local fissures and fractures).

The construction water supply groundwater investigation targeted areas within the Anson Formation where reasonable groundwater yields have been anecdotally reported or intercepted. Specifically, the drilling targeted a localised area of enhanced permeability in the mine development area and a localised limestone feature to the north of the mine development area.

ES2.2 Groundwater receptors

Groundwater receptors identified in the project area comprise:

- stock and domestic bores on neighbouring properties (third-party bores);
- groundwater dependent ecosystems including:
    - the Belubula River;
    - terrestrial vegetation (three plant community types);
    - springs/seeps; and
    - macroinvertebrate fauna at two spring locations.

ES3 Legislation, regulation and licensing

The primary water-related statutes that apply to the project are the *Water Act 1912*, *Water Management Act 2000*, *Protection of the Environment Operations Act 1997* and relevant water sharing plans.

Two test bore licences (70BL234003 and 70BL234083) issued under Section 115 of the *Water Act 1912* licensed the drilling activities undertaken for the groundwater investigations.

The mine development is located within the Lachlan Fold Belt Murray-Darling Basin Groundwater Source which is managed by the *Water Sharing Plan for the New South Wales Murray-Darling Basin Fractured Rock Groundwater Sources 2020*. Regis has secured 400 unit-shares (equivalent to 400 ML per annum) in the groundwater source and has submitted an expression of interest for an additional 200 unit-shares in the Controlled Allocation Order in July 2020. Regis has been informed that the application has been received and successfully lodged, and the application payment has been made. Once finalised, Regis' total entitlement of 600 unit-shares per annum will licence the project construction water demand.

Regis has secured 70 unit-shares (equivalent to 70 ML per annum) in the Belubula River above Carcoar Dam water source, managed under the *Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources 2012*.

ES4 Groundwater investigations

Two test bores and four dedicated monitoring bores at two sites were installed as part of the groundwater investigations:

- test bore TPB4 and three monitoring bores in the mine development area, screened across fractured metasediments; and
- test bore TB05 and a monitoring bore on land 1 km north of the mine development area, targeting a localised limestone feature.

The areas of higher permeability targeted at TB05 and TPB4 are not regionally extensive. The identified shear zone and limestone are localised and not found in other areas within the mine development.

Aquifer testing was conducted on the test bores and comprised step tests to assess bore efficiencies, and constant rate tests to estimate the hydraulic parameters of the aquifer.

The results of the aquifer tests were analysed to select appropriate pumping rates for operating the bores during the construction period (nine months):

- TPB4: 5 L/s; and
- TB05: 10 L/s.

Regis will drill and install additional bores to meet peak demands at drilling targets identified within the mine development and on Regis-owned land.

ES5 Impact assessment

Analytical modelling has been conducted using the results of the aquifer test analyses to:

- estimate the potential drawdown from the proposed groundwater abstraction for the initial nine months of the construction period at the pumping bores;

- estimate the area of influence (extent of drawdown as defined by the 1 m change in groundwater level) caused by pumping of the bores; and

- assess the potential impacts of operating the bores on local receptors.

Results predict:

- localised groundwater level drawdown around the production bores extending no more than 500 m;

- there are no third-party bores or springs within the extent of modelled drawdown;

- the extent of drawdown will be significantly less than the predicted drawdown from the open cut pit; and

- a temporary reduction in baseflow contribution of 0.7 ML (2.5 kL/day) to the Belubula River in the vicinity of TPB4 during the nine-month period[1]. Users downstream of the project who rely on and access water from the Belubula River will not experience a reduced access to water. This reduction in baseflow contribution will be covered by the entitlements held by Regis for the Lachlan Fold Belt Murray-Darling Basin Groundwater Source.

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[1] Based on the existing understanding of the Belubula River (HEC 2020, EMM 2020), this is a minor change and not expected to be measurable.

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Appendices

Tables

Figures

Photographs

1 Introduction

1.1 Background

LFB Resources NL is seeking State significant development consent under Division 4.7 of Part 4 of the New South Wales (NSW) *Environmental Planning and Assessment Act 1979* for the construction and operation of the McPhillamys Gold Project (the project), a greenfield open cut gold mine and associated water supply pipeline in the Central West of NSW. LFB Resources NL is a 100% owned subsidiary of Regis Resources Limited (herein referred to as Regis).

As shown in Figure 1.1, the project comprises two key components; the mine site where the ore will be extracted, processed and gold produced for distribution to the market (the mine development), and an associated water pipeline that will enable the supply of water from approximately 90 kilometres (km) away near Lithgow to the mine site (the pipeline development). The mine development is around 8 km north-east of Blayney within the Blayney and Cabonne local government areas (LGAs). It is also in the upper reaches of the Belubula River catchment, within the greater Lachlan River catchment.

Up to 8.5 million tonnes per annum (Mtpa) of ore will be extracted from the McPhillamys gold deposit over a total project life of around 15 years. The mine development will include a conventional carbon-in-leach processing facility, waste rock emplacement, an engineered tailings storage facility (TSF) and associated mine infrastructure including workshops, administration buildings, roads, water management infrastructure, laydown and hardstand areas, and soil stockpiles.

A water supply for the construction stage is required for the first nine months of the project prior to the commissioning of the pipeline development. The construction water supply will be primarily sourced from groundwater via production bores within and close to the mine development area.

In accordance with the requirements of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act), the *NSW Environmental Planning & Assessment Regulation 2000* (EP&A Regulation) and the Secretary's Environmental Assessment Requirements (SEARs) for the project, an Environmental Impact Statement (EIS) was prepared to assess the potential environmental, economic and social impacts of the project. The development application and accompanying EIS were submitted to the NSW Department of Planning, Industry and Environment (DPIE) in August 2019. The EIS identified the local fractured rock groundwater system (Lachlan Fold Belt Murray-Darling Basin [MDB] Groundwater source) as a potential water supply for the construction stage.

Additional groundwater investigations have been completed to assess the viability and potential impact of the proposed construction water supply. Specifically, the investigations were completed to assess the development of various groundwater options (yields, bore numbers, suitability of existing bores on Regis-owned land) and the potential impacts associated with groundwater abstraction on groundwater users and the environment.

The groundwater investigations comprised the installation and testing of two test bores and four monitoring bores. The location of the test bores in relation to the mine development is shown on Figure 1.2. The drilling and construction of the bores and subsequent aquifer testing are detailed in this report.

1.2 Purpose of this report

In response to the EIS submission, the DPIE – Water requested an assessment of potential impacts associated with construction water supply:

> Arrange an impact assessment of the construction and operation of proposed production bores to supply water for the project as soon as possible. This is to meet the requirements of the relevant water sharing plan and demonstrate the ability to trade the necessary entitlement to the bores.

Accordingly, this Construction Water Supply Groundwater Investigation and Impact Assessment report demonstrates Regis can secure a construction water supply for the project, meet the requirements of the *Water Sharing Plan for Murray-Darling Basin Fractured Rock Groundwater Sources 2020* and secure the necessary entitlements for the groundwater take (refer to Section 3).

In addition, the assessment considers potential impacts to other groundwater receptors notably, the Belubula River. Potential impacts have been quantified via analytical groundwater modelling with a discussion of associated licensing requirements.

Further, references to 'the project area' throughout this report are therefore referring to the area investigated as part of this Construction Water Supply Groundwater Investigation and Impact Assessment (refer to Figure 1.2).

1.3 Construction water demand

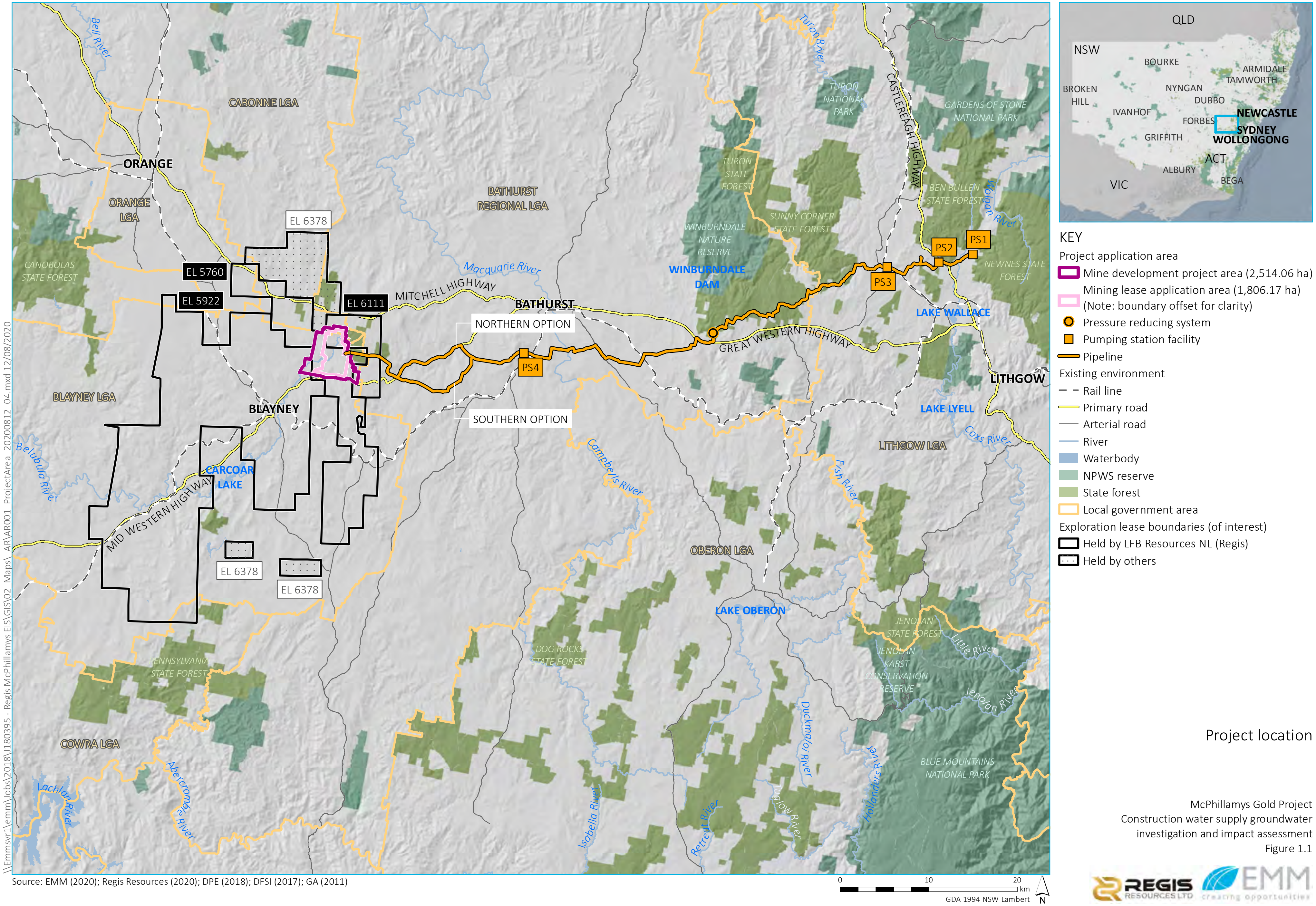
The project water management system comprises the structures and associated operational procedures that will be used to manage water, its movement and use on-site. The water management system has been modelled as part of Revised Surface Water Assessment (HEC 2020) and is designed to optimise the management and reuse of wastewater and segregate mine site water according to water quality and associated use constraints. The practical application of these principles involves controlling the volume of poor quality (ie higher salinity) water by maximising its re-use and by limiting the contamination of clean water (HEC 2020). Runoff from undisturbed or rehabilitated areas will be diverted around the mine development and directed back to the Belubula River downstream of the disturbance area.

Rainfall and runoff captured within the disturbance area will be stored and used within the water management system, acting as a source to meet the construction and operational water demand. As outlined in the EIS and in the Amendment Report (EMM 2020a), an external water supply pipeline will be constructed to meet the project water demand and will be operational approximately nine months after commencement of the project. The imported pipeline supply will provide up to 15.6 megalitres per day (ML/day) (HEC 2020). Prior to this time, the construction water demand can be sourced from onsite bores located within or near the mine development area (refer to Figure 1.2).

HEC (2020) developed a GoldSim water balance model for the project which has been used to identify the construction water demand and assess the potential risk of supply shortfalls under various climate scenarios. The construction water demand assumes:

- construction hours from 7:00 am to 6:00 pm Monday to Friday and 8:00 am to 1:00 pm on Saturdays for the first six months of construction, changing to 24-hour operation from month 7;
- a construction water management facility (CWMF) will be constructed to capture and store rainfall runoff and bore water supply with a capacity of 75 ML;
- dust suppression demand of 0.8 to 2.2 ML/day;
- TSF construction water demand of 0.5 ML/day; and
- constant groundwater supply to the CWMF.

Based on the model results, the construction water demand is estimated at 470 ML for the initial nine months construction period. With a constant groundwater supply of 20 litres per second (L/s), directing water into the CWMF, there is no risk of water deficits identified in any of the modelled climate scenarios (HEC 2020). In the initial months of operation, as part of commissioning, abstracted water will be stored in surface tanks adjacent to the bores prior to being directed to the CWMF via a dedicated pipeline.



Source: EMM (2020); Regis Resources (2020); DPE (2018); DFSI (2017); GA (2011)

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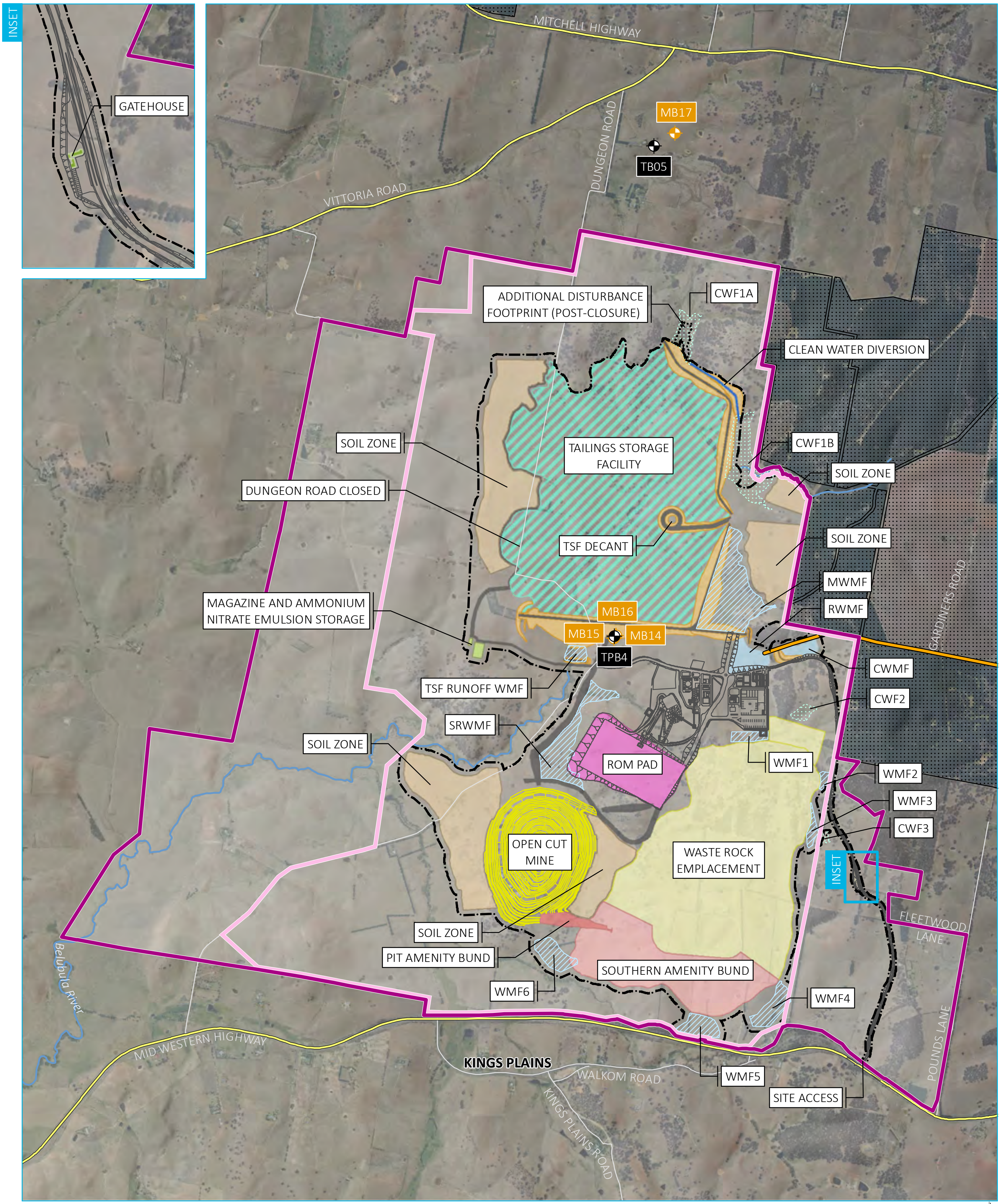
Project location

McPhillamys Gold Project
Construction water supply groundwater
investigation and impact assessment
Figure 1.1



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Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DFSI (2017)

KEY

⊕ Test bore location

⊕ Monitoring bore location

Existing environment

— Major road

— Minor road

— Belubula River

▨ Vittoria State Forest

Project application area

▭ Mine development project area (2,514.06 ha)

▭ Mining lease application area (1,806.17 ha) (Note: boundary offset for clarity)

▭ Disturbance footprint (1,115.54 ha)

▭ Additional (post-closure) disturbance footprint (1.64 ha)

— Pipeline

Project general arrangement

— Open cut mine

— Site infrastructure

■ Site access roads

🟩 Gatehouse

■ Magazine and ammonium nitrate emulsion storage

■ Soil zone

■ Embankments

■ ROM pad

■ Southern amenity bund

■ Pit amenity bund

■ Waste rock emplacement

▨ Tailings storage facility (TSF)

■ Clean water diversion

■ Water management facility (WMF) – continuous storage

▨ Water management facility (WMF) – infrequent storage

▨ Clean water facility (CWF)

Mine development and test bore locations

McPhillamys Gold Project
Construction water supply groundwater investigation and impact assessment
Figure 1.2

2 Local setting

2.1 Climate

The Blayney-Orange district is characterised by a mild temperate climate with warm to hot summers and cool to cold winters. Rainfall is typically highest during the winter months.

The average annual rainfall total recorded at the site weather station between 2013 and 2018 is 670 millimetres (mm) (due to technical problems with the data, a complete dataset for 2019 is not available). The SILO Data Drill (2020) rainfall total for 2019 was 461 mm. The long-term average annual rainfall for the area is 702 mm and the annual potential evaporation for the area exceeds the rainfall total and averages 1,339 mm (SILO Data Drill 2020).

2.2 Geology

2.2.1 Regional geology

The geology within the mine development area is characterised by the Palaeozoic metamorphic rocks of the eastern Lachlan Fold Belt (Geoscience Australia 1997). The Lachlan Fold Belt is a major geological fold belt occupying south-east Australia. It formed following complex tectonic and intrusive processes and various stages of volcanism.

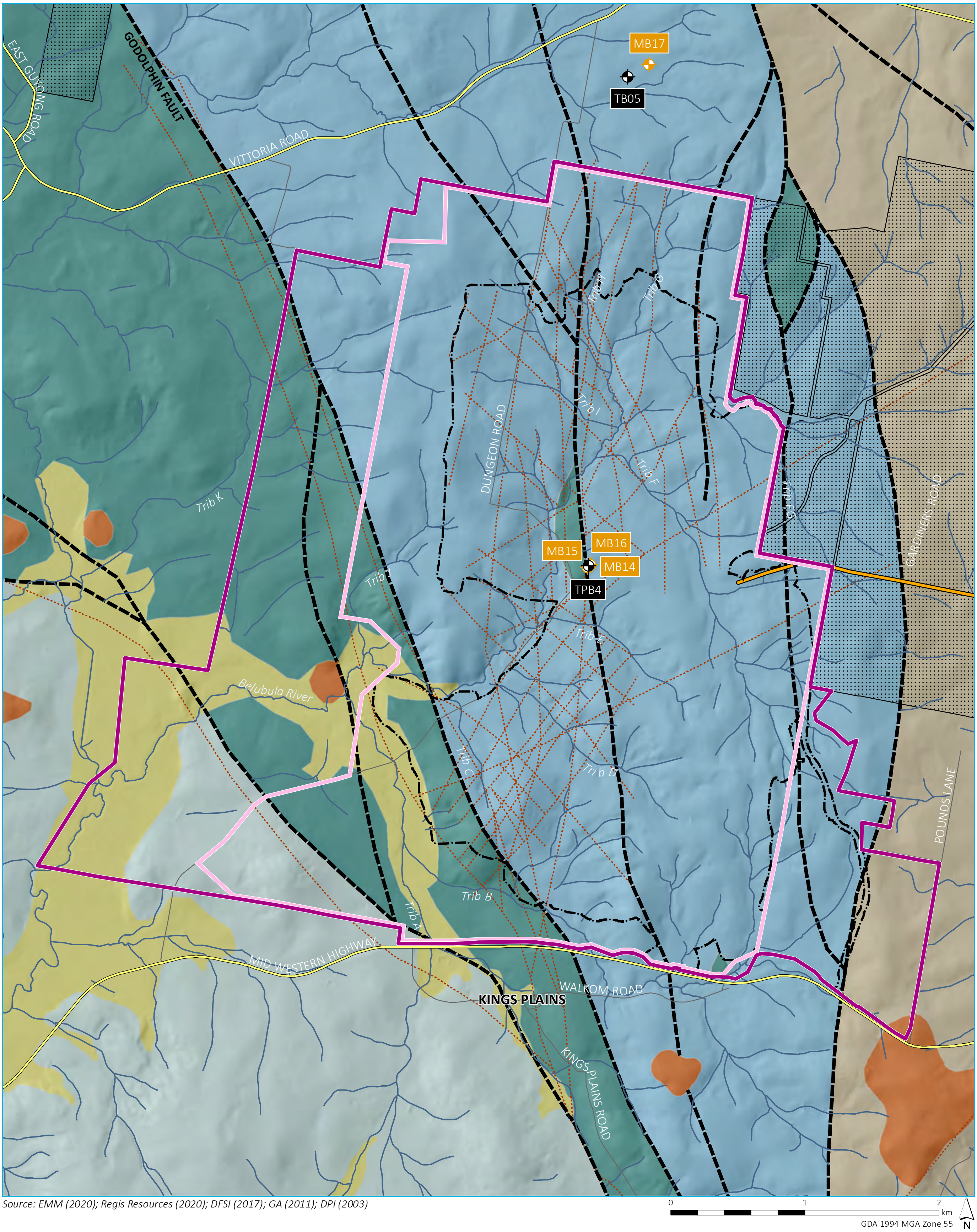
The Lachlan Fold Belt is dominated by Ordovician, Silurian and Devonian period volcaniclastics and marine sediments (French et al 2013). The mine development is in the eastern sub province of the Lachlan Fold Belt. The lithological sequence regionally reduces in age to the east, with Ordovician carbonates and mafic volcanics to the west and argillaceous Devonian sediments to the east (French et al 2013).

2.2.2 Structural geology

The intrusive belts of the Lachlan Fold Belt in the mine development area and surrounds are relatively undeformed and bounded by north-south trending fault systems. The dominant structure in the mine development area is the Godolphin-Copperhania Fault Zone. The Godolphin Fault separates Ordovician rocks to the west from Silurian and Devonian period rocks to the east.

The McPhillamys gold deposit is located within the Silurian-aged Anson Formation of the eastern Lachlan Fold Belt. The deposit occurs on the eastern side of the Sherlock Fault, part of the Godolphin-Copperhania thrust fault zone. The deposit lies along one of a series of north-south trending splays/horsetail structures that occur at the inflection of the Godolphin-Copperhania Fault Zone where the orientation changes from north north-west/south south-east to south south-west/north north-east. The splays are defined by strong shearing and faulting and continue to the south for over 6 km. Low grade metamorphism has affected all the geological units.

The local and structural geology in the mine development area is presented in Figure 2.1.



Source: EMM (2020); Regis Resources (2020); DFSI (2017); GA (2011); DPI (2003)

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KEY

- ⊕ Test bore location
- ⊕ Monitoring bore location

Project application area

- ▭ Mine development project area
- ▭ Mining lease application area (Note: boundary offset for clarity)
- ▭ Disturbance footprint
- ━ Pipeline

Existing environment

- ━ Major road
- ━ Minor road
- ━ Watercourse/drainage line
- ▨ Vittoria State Forest
- ┅ Interpreted structure

Geology (Bathurst 250k, 2nd Edition)

- ━ ━ Fault

Quaternary/Tertiary

- ▭ Alluvium
- ▭ Tertiary basalt

Devonian

- ▭ Ungrouped Devonian Formations – Cunningham Formation

Silurian

- ▭ Mumbil Group (Northwest) – Anson Formation

Ordovician

- ▭ Cabonne Group – Blayney Volcanics
- ▭ Cabonne Group – Byng Volcanics

Local geology

McPhillamys Gold Project
Construction water supply groundwater investigation and impact assessment
Figure 2.1

2.2.3 Local geology

The mine development is predominantly underlain by metasediments and volcaniclastics of the Silurian Anson Formation. The north-south trending Godolphin Fault marks the western boundary of the Anson Formation abutted by the older Blayney and Byng Volcanics.

There are minor disconnected areas of shallow Quaternary alluvium associated with watercourses and drainage lines. Granite intrusions and discontinuous basalt capping are present, with the main body of basalt outcropping 4 km to the north-west of the proposed mine development (Geological Survey of NSW, Bathurst Geology 1:250,000, 1998).

The local stratigraphy is presented in Table 2.1.

Table 2.1 Stratigraphy

Period	Group	Formation	Description
Quaternary	-	Alluvium	Disconnected alluvial sediments deposited by surface watercourses.
Tertiary	Canobolas Volcanic Complex	Basalt	Pyroxene olivine basalt, plagioclase basalt, alkali basalt, trachybasalt, trachyandesite. Succession of basalts flows generally 2-60 m thick (up to 150 m).
Devonian	-	Cunningham	Phyllite, slate, shale, siltstone, quartz-feldspar-lithic- calcareous sandstone, tuff.
Silurian	Mumbil Group	Anson Formation	Metasediments and volcaniclastics separated by north-south trending faults. Carbonaceous pyritic siltstone, felsic volcanics, volcanic sandstone, limestone.
Ordovician	Cabonne Group	Blayney Volcanics	Clinopyroxene basalt, agglomeratic in places; volcanic sandstone. Dominated by volcaniclastic rocks of andesitic composition.
Ordovician	Cabonne Group	Byng Volcanics	Basalt, volcaniclastic sandstone. Dominated by volcaniclastic rocks of andesitic composition.
Ordovician	Cabonne Group	Oakdale Formation	Mafic volcanic sandstone. Basalt, basaltic andesite, latite lavas and intrusions Volcaniclastic breccia and conglomerate, siltstone, shale, chert. Minor allochthonous limestone and calcareous sediments.

Notes: Australian Stratigraphic Units Database (GeoScience Australia).

i The Anson Formation

The Anson Formation is present in a series of fault slices extending from the Clifton Grove area (north-east of Orange) to Kings Plains (south of the mine development and east of Blayney). The Anson Formation unconformably overlies the Byng Volcanics and Oakdale Formation (Pogson & Watkins 1998). The formation has an estimated thickness of 1,500 m to 2,000 m, trends north-south and dips steeply to the east (French 2013).

The Anson Formation is well folded and comprises a basal conglomerate overlain by a thin unit comprising calcareous sediments and limestone. The remainder of the sequence consists of pyritic, carbonaceous siltstone with felsic volcanics, volcaniclastics and a few small limestones. The siltstones are grey-black to buff with bedding delineated by black carbonaceous flecks, and occur with interbedded sandstone and minor black shale (Pogson & Watkins 1998).

Weathering associated with exposure of the Anson Formation at surface has resulted in fine grained saprock (Scott 2003) overlain by a thin kaolinite soil layer. The weathering interface is typically 20 to 50 m below ground surface but is known to extend to 50 to 100 m in areas where faulting has enhanced the weathering process (French et al 2013). In the construction water supply drill target areas, the saprock is mostly comprised of clay and is at least 20 m thick (refer to Section 4.6.1i).

An indurated marble within the Anson Formation is delineated in the open cut pit area. The unit strikes north-north west and dips sub vertically to the east (SRK 2017). The unit is interpreted as an in-situ alteration associated with the Sherlock Fault Zone. Exploration drilling targeting the carbonaceous alteration showed it had limited extent, extremely low porosity with limited capacity to store and transmit water (refer Photograph 2.1).

Photograph 2.1 Carbonaceous alteration (marble) in the Anson Formation

A shallow marine deposited limestone within the Anson Formation, located 1 km to the north of the mine infrastructure, has been targeted for the construction water supply (refer to Section 4.6.1iii). The limestone is richly fossiliferous, containing corals, crinoids, conodonts, brachiopods, calcareous algae and stromatoporoids (Pogson & Watkins 1998).

Similar occurrences of fossiliferous limestone are reported in the Anson Formation at Emu Swamp Creek, approximately 10 km to the north-west of the project (estimated to be 80 to 90 m thick) and Licking Hole Creek a further 10 km north.

The construction water supply investigations targeted a quartz zone where previous drilling intercepted reasonable groundwater yields within the mine development area, and the limestone occurrence to the north of the project, each overlain by at least 20 m of saprock. Detailed descriptions of the intercepted geological units and the conceptual understanding are provided in Section 4.6.1.

2.3 Hydrogeology

The regional hydrogeology is dominated by the Palaeozoic metamorphic rocks of the eastern Lachlan Fold Belt. The dominant regional structure influencing groundwater flow is the Godolphin-Copperhania Fault Zone.

Local groundwater flow is influenced by the steep relief in the project area. Groundwater generally flows from areas of higher elevation to incised areas around the Belubula River and major tributaries.

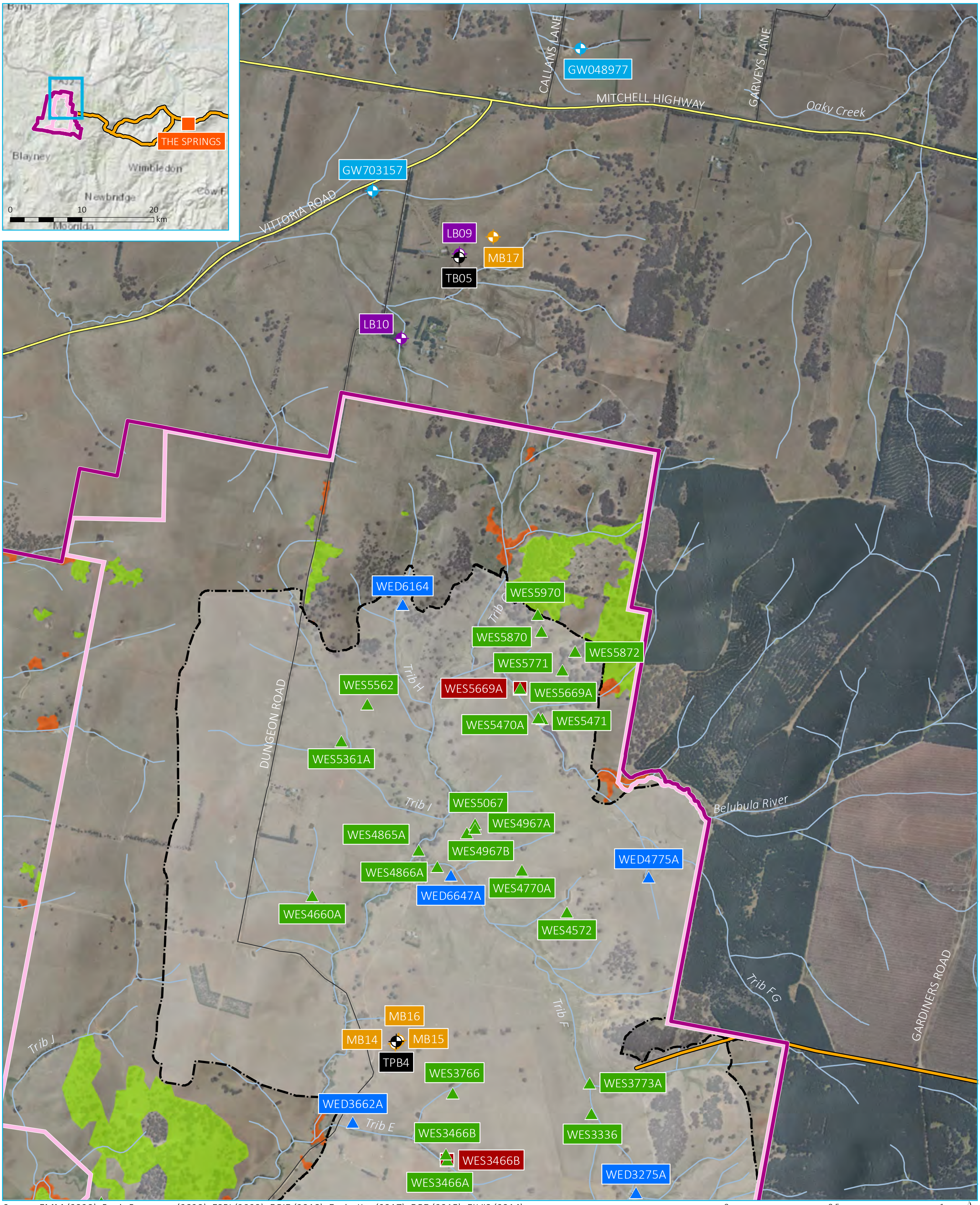
The groundwater system is recharged locally by the percolation of rainfall and leakage from surface watercourses into the underlying groundwater systems. Groundwater discharge occurs via evapotranspiration, spring flow, and contributions to surface watercourses (baseflow). Alluvial deposits along the creek banks and drainage lines are inferred to temporarily store groundwater following rainfall events and provide a delayed source of baseflow to watercourses.

The Anson Formation has low primary porosity and permeability. Groundwater flow is primarily along local fissures and fractures. Recorded bore yields are typically low (<5 L/s), relatively higher yields are possible where shear zones have enhanced secondary porosity. However, drilling across the mine development has shown that regional fault zones are infilled with weathered clay limiting the potential for groundwater development.

2.4 Groundwater receptors

Groundwater receptors identified in the mine development area have been described and assessed as part of the Groundwater Assessment completed for the EIS (EMM 2019), Surface Water-Groundwater Interaction Assessment (EMM 2020b) and the Groundwater Assessment Addendum (EMM 2020c) completed in support of the project. Nearby receptors are shown on Figure 2.2 and comprise:

- stock and domestic bores on neighbouring properties (third-party bores);
- groundwater dependent ecosystems (GDEs) including:
  - the Belubula River;
  - springs/seeps;
  - terrestrial vegetation (Mountain Gum - Manna Gum open forest (plant community type (PCT) 951) and Yellow Box – Blakely’s Red Gum grassy woodland on the tablelands, South Eastern Highlands Bioregion (PCT 1330)); and
  - macroinvertebrate fauna identified at two springs.



Source: EMM (2020); Regis Resources (2020); ESRI (2020); DPIE (2018); EnviroKey (2017); DPE (2015); ELVIS (2014)

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KEY

- ⊕ Test bore
- ⊕ Monitoring bore
- ⊕ Existing bore (Regis land)
- ⊕ Landholder bore
- 🟧 High-priority GDE (refer to inset)
- ▲ Dam
- ▲ Spring
- 🟥 Stygofauna sample location

Project application area

- ▭ Mine development project area
- ▭ Mining lease application area (Note: boundary offset for clarity)
- ▭ Disturbance footprint
- ― Pipeline

Existing environment

- ― Major road
- ― Minor road
- ― Watercourse/drainage line

Plant community types

- 🟧 PCT 951 | Mountain Gum - Manna Gum open forest of the South Eastern Highlands Bioregion
- 🟩 PCT 1330 | Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands Bioregion

Local groundwater receptors

McPhillamys Gold Project
Construction water supply groundwater investigation and impact assessment
Figure 2.2

i Registered bores

Registered bores which could be impacted by pumping of the production bores (used for construction water supply purposes) are presented on Figure 2.2 and summarised in Table 2.2.

The groundwater bores in the Blayney and Kings Plains area are for stock and domestic purposes and not metered. Groundwater abstraction by stock and domestic bores is typically around 2 L/s, a review of stock and domestic bores and consultation with landowners in the area support this observation (EMM 2019).

Table 2.2 Summary of registered bores in the vicinity of the test bores

WaterNSW ID	Other ID	Distance from closest test bore (m)	Easting (m)	Northing (m)	Bore depth (m)	Inferred lithology*	Landholder
GW704227	LB09	15	716719	6297644	50	Limestone feature	Regis
GW023248	LB10	463	716448	6297253	33.5	Metasediments	Regis
GW703157	-	506	716317	6297937	67	Basalt	Third-party
GW048977	-	1,119	717280	6298597	43	Shale with quartz veins	Third-party

Notes: * Lithology descriptions interpreted from WaterNSW groundwater work summary

ii Terrestrial ecosystems

Vegetation that is found in the area has attributes that allow resilience and resistance to climate variability, such as being able to cope with low soil moisture levels, reduced water loss during dry periods or being able to access groundwater when the soil water reservoir is depleted. The Biodiversity Assessment (Appendix N of the EIS) documented vegetation mapping conducted in the mine development area. Due to refinements of the project and adjusted approach to the assessment, the Biodiversity Development Assessment Report has been prepared for the project (Appendix M of the Amendment Report).

Further information on the methodology for identifying groundwater dependent vegetation and results of the assessment are provided in the Biodiversity Development Assessment Report (Appendix M of the Amendment Report).

The GDE Atlas does not show any terrestrial GDEs as occurring in the project area. No high priority GDEs are identified in the *Water Sharing Plan for NSW Murray-Darling Basin Fractured Rock Groundwater Sources 2020*. Although terrestrial GDEs are not mapped in the project area, the Biodiversity Development Assessment Report has identified the following PCTs as opportunistic users of groundwater during times of low rainfall:

- Mountain Gum –Manna Gum open forest of the South Eastern Highlands Bioregion (PCT 951); and
- Yellow Box – Blakely’s Red Gum grassy woodland on the tablelands, South Eastern Highlands Bioregion (PCT 1330).

iii Aquatic ecosystems

a Belubula River

The mine development area is located within the unregulated surface water source of the Belubula River above Carcoar Dam, which is managed under the *Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources 2012.* The water sharing plan (WSP) does not list any high priority GDEs in the mine development area or surrounds.

The Belubula River flows through the mine development, approximately 220 m to the west of test bore TPB4 (Figure 2.2). Trib E is located approximately 400 m south of TPB4 (Figure 2.2). Groundwater springs discharging from the fractured rock aquifers contribute to the Belubula River baseflow.

Test bore TB05 is located within the upper reaches of a tributary to the Belubula River, which joins the Belubula River at the south-western corner of the mine development area. The mapped watercourses in the vicinity of TB05 are mapped as first order streams, but observed in the field as depressions in the topography without incised channels, flow confinement or other attributes common to surface watercourses (Figure 2.2).

b Springs/seeps

Springs and seeps have been surveyed and assessed within the mine development area as part of the Groundwater Assessment of the EIS (EMM 2019) and the Surface Water-Groundwater Impact Assessment (EMM 2020b).

There is a total of 16 springs/seeps mapped within 1 km of TPB4 (Figure 2.2).

No springs have been identified in the vicinity of TB05.

c Subterranean and aquatic fauna

As reported in the Groundwater Assessment for the EIS (EMM 2019), a subterranean fauna assessment was conducted in 2017. The survey included sampling at 13 bores, 5 stream sites and 5 spring/seep sites in and adjacent to the area of the proposed operations. The only sites that recorded fauna were associated with spring/seep sites. The surveyed springs contain depauperate fauna consisting predominately of surface macroinvertebrate taxa. A small number of macroinvertebrate fauna (Amphipoda and Copepoda crustaceans and worms) that were identified may be dependent on groundwater discharge. No listed threatened species were collected and no stygofauna were identified by the surveys in the mine development area.

The low diversity and low abundance of the identified macroinvertebrate fauna may be influenced by the small, ephemeral, and disconnected nature of the riverine hyporheic zone habitats and the fine grained nature of the sediments.

One spring located approximately 600 m south of TPB4 (WES3466B) was listed as having a high ecological value, due to the diversity of the identified macroinvertebrate fauna. The fauna found in the springs occur within the surface waters of the springs but may be dependent on groundwater discharge, however the fauna were not identified in the bores sampled.

3 Legislation and policy

3.1 Overview

The primary water related statutes that apply to the project are the *Water Act 1912* (Water Act), *Water Management Act 2000* (WM Act) and *Protection of the Environment Operations Act 1997* (POEO Act). The provisions of each Act are applied in accordance with their attendant regulation.

The requirements of the applicable legislation and policies and the assessments of the project against these key policy requirements are given in the following sections. The relevant WSPs and the Aquifer Interference Policy (AIP) (DPI Water 2012) are key documents dictating the assessment of the potential impacts of the project on groundwater resources.

3.2 Water Act 1912

The Water Act has been largely superseded by the WM Act, with WSPs developed for all water sources across NSW. However, some aspects of the Water Act are still operational such as licences for monitoring and test bores.

3.3 Water Management Act 2000

The WM Act is the primary legislation governing water management and licensing within the mine development area. It provides for water sharing between different water users including environmental, basic rights and industry. In addition, the WM Act provides security to holders of water access licences (WALs).

The licensing provisions of the WM Act apply to those areas where a WSP has commenced; it has progressively been enacted across NSW since July 2004. The licensing provisions of the WM Act become effective for any water source once a WSP for that water source commences.

One of the key components of the WM Act is the separation of the water licence from the land; this facilitates opportunities for licence holders to trade water. The WM Act outlines the requirements for taking and trading water through WALs, water supply works, and water use approvals.

The licensing requirements for mining are similar to other licensing requirements with additional policies and clauses related to mining that need consideration, in particular the AIP, and Section 60 I of the WM Act (which specifically establishes the access licence requirements for water used in mining activities).

3.4 Water sharing plans

3.4.1 Overview

WSPs are statutory documents dictating the management and sharing of water sources. The WSPs set the water management vision and objectives, management rules for WALs, what water is available within the various water sources, and procedures for dealing in licences and water allocations, water supply works approvals and the extraction of water. WSPs are designed to establish sustainable use and management of water resources and are periodically reviewed (every 10 years).

Each WSP documents the water available and how it is shared between environmental, extractive, and other uses. The WSPs outline the water availability for extractive uses within different categories, such as: local water utilities, domestic and stock, basic rights, and access licences.

3.4.2 Lachlan Fold Belt Murray-Darling Basin Groundwater Source

The groundwater proposed to be accessed for the construction water supply is within the Lachlan Fold Belt MDB Groundwater Source, managed under the *Water Sharing Plan for the New South Wales Murray-Darling Basin Fractured Rock Groundwater Sources 2020*.

The reported long-term average annual extraction limit (LTAAEL) for the Lachlan Fold Belt MDB Groundwater Source is 253,788 ML/year. There are currently 1,086 WALs in the source with a total entitlement of 75,521 unit-shares plus an estimated domestic and stock usage of 74,311 unit-shares (Table 3.1).

The groundwater source is therefore under allocated with 103,956 available unit-shares.

Table 3.1 Lachlan Fold Belt Murray-Darling Basin Groundwater Source 2020/21

Water access licence (category)	No. of WALs [1]	Total share components (ML)[2]
Domestic and stock rights (basic landholder rights)	NA	74,311
Aquifer	1,042	71,397
Aquifer [town water supply]	6	467
Local water utility	36	3,371
Local water utility [domestic and commercial]	1	50
Salinity and water table management	1	236
Total	**1,086**	**149,832**
Long-term average annual extraction limit		**253,788**
Available water (calculated)		**103,956**

Notes: 1. WAL = Water access licences; data sourced from NSW Water Register (accessed 31 July 2020).
2. The conversion from a unit share to a megalitre is 1:1 unless otherwise stated.
3. Data sourced from the WSP for the New South Wales MDB Fractured Rock Groundwater Sources 2020 (NSW Government 2020).

Regis has secured 400 unit-shares (equivalent to 400 ML/annum) in the Lachlan Fold Belt MDB Groundwater Source. This entitlement is linked to their WAL (# 41835) and will be linked to works approvals for the production bores prior to abstraction for the construction water supply.

Regis has submitted an expression of interest for an additional 200 unit-shares in the Controlled Allocation Order in July 2020. If successful, the total licence entitlement will be 600 unit-shares per annum. This entitlement covers the anticipated project construction water demand and modelled groundwater take for the life of the project (EMM 2020c).

3.4.3 Belubula River above Carcoar Dam Water Source

The project area is located within the unregulated surface water source of the Belubula River above Carcoar Dam, managed under the *Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012*. As stated in the WSP, unregulated streams (like the Belubula River above Carcoar Dam) in western NSW experience long periods of no flow, interspersed with flow periods of varying magnitude.

Regis has secured 70 unit-shares (equivalent to 70 ML/annum) in this water source.

The water requirements in the Belubula River above Carcoar Dam are listed in Table 3.2.

Table 3.2 Belubula River above Carcoar Dam Water Source 2020/21

Water access licence (category)	No. of WALs[1]	Total share components (ML)[2]
Domestic and stock rights (basic landholder rights)	0	68
Domestic and stock access licences	Not available	5
Unregulated River	4	264
Local water utility	0	0

Notes: 1. WAL = Water access licences; data sourced from NSW Water Register (accessed 31 July 2020)
2. Data sourced from - the WSP for the Lachlan Unregulated River Water Sources 2012.
3. The long-term average annual extraction limit is equal to the annual extraction of water averaged over the period from 1 July 1993 to 30 June 1999 under entitlements issued under Part 2 of the Water Act 1912

4 Drilling program

4.1 Overview

A groundwater drilling program, aimed at assessing the water supply options specifically, was undertaken by Highland Drilling from 20 April to 26 May 2020. Two test bores and four monitoring bores were installed (Table 4.1). Bore completion logs are provided in Appendix A.

Table 4.1 Groundwater bore completion

Area	Target ID	Purpose	MGA coordinates		Ground elevation	Drilled depth	Screened interval	Screened lithology
			mE	mN	mAHD	mbgl	mbgl	
Arbour Hills	TPB4	Testing	716439	6293996	939.7	144	96 - 138	Fractured metasediments
	MB14	Monitoring	716425	6293990	939.9	146	78 - 90, 108 - 126	Fractured metasediments
	MB15	Monitoring	716421	6293978	939.2	30	19 - 22	Weathered metasediments
	MB16	Monitoring	716434	6293994	939.8	30	15 - 18	Weathered metasediments
Mungarra site	TB05	Testing	716718	6297629	970.4	75	51 - 57	Limestone
	MB17	Monitoring	716875	6297724	979.0	90	53 - 59	Weathered metasediments

Notes: 1. Coordinate system Zone 55 GDA 94
2. AHD = Australian Height Datum (no precise surveying - elevations taken from satellite imagery)
3. mbgl = metres below ground level

4.2 Investigated groundwater targets

4.2.1 TPB4 – Arbour Hills

The "Arbour Hills" site is accessed off Dungeon Road, 8 km north-east of Blayney on the side of a rocky outcrop and in the mine development area, south of the proposed TSF embankment (Figure 4.1).

Preliminary drilling investigations were undertaken in February 2019 to assess the potential to develop a construction water supply for the project. Four test bores (named TPB1, TPB2, TPB3 and TPB4) were drilled across the mine development area by Highland Drilling targeting a fracturing and weathered zones.

Of these bores, TPB4 (Regis ID RRLMPMB018A) was the only successful bore. Drilling in the other areas observed weathered clay-filled fractures with no significant groundwater yields. The drilling target at TPB4 was a shear zone near an inferred north-south trending geological structure with a local surface expression of quartz-filled veins. The pilot hole at TPB4 intercepted fractured rock from 77 to 120 metres below ground level (mbgl). TPB4 was left open while the remaining test bores were backfilled.

An airlift yield of 5 L/s was sustained at TPB4 at the completion of the drilling. TPB4 was left uncased below 30 mbgl for future testing and monitoring; however, the hole later partially collapsed below 81 mbgl. A subsequent constant rate test (CRT) at TPB4 in early 2020 sustained a pumping rate of 4.5 L/s over a 72-hour period.

In April 2020, Regis resumed the construction water supply drilling investigations at TPB4 which comprised:

- the reaming of TPB4 to clean out the collapsed material and widen the borehole diameter;
- the installation of casing and screens and completion of the borehole annulus;
- the drilling and construction of three monitoring bores (MB14, MB15 and MB16) installed at various depths surrounding TPB4;
- airlift development of TPB4, MB14, MB15 and MB16; and
- aquifer testing at TPB4 to estimate aquifer properties.

4.2.2 TB05 – Mungarra site

Regis identified the land parcel Lot B DP37372 for further investigation following anecdotal reports of an existing bore (GW704227, also known as LB09) intercepting a high yielding zone associated with 'rounded gravels'. The Mungarra site and area of further investigation is located off Dungeon Road, 12 km north-east of Blayney and approximately 1 km north of the proposed mine development (Figure 4.2).

LB09 is an existing bore that was initially tested (in April 2020) at 5 L/s to confirm anecdotal reports of the prospective groundwater exploration area. A drawdown of 2 m was recorded over a 72-hour period of constant pumping. The bore casing diameter (nominal 127 mm) limited the pumping rate at 5 L/s, as a larger pump (capable of achieving higher flow rates) cannot fit down the borehole.

Subsequent investigation at the Mungarra site comprised:

- the drilling and construction of the new test bore (TB05);
- the drilling and construction of a monitoring bore (MB17) 180 m north-east of TB05m, which did not intercept the limestone feature;
- airlift development of TB05 and MB17; and
- aquifer testing at TB05 to estimate aquifer properties.

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Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DFSI (2017)

KEY

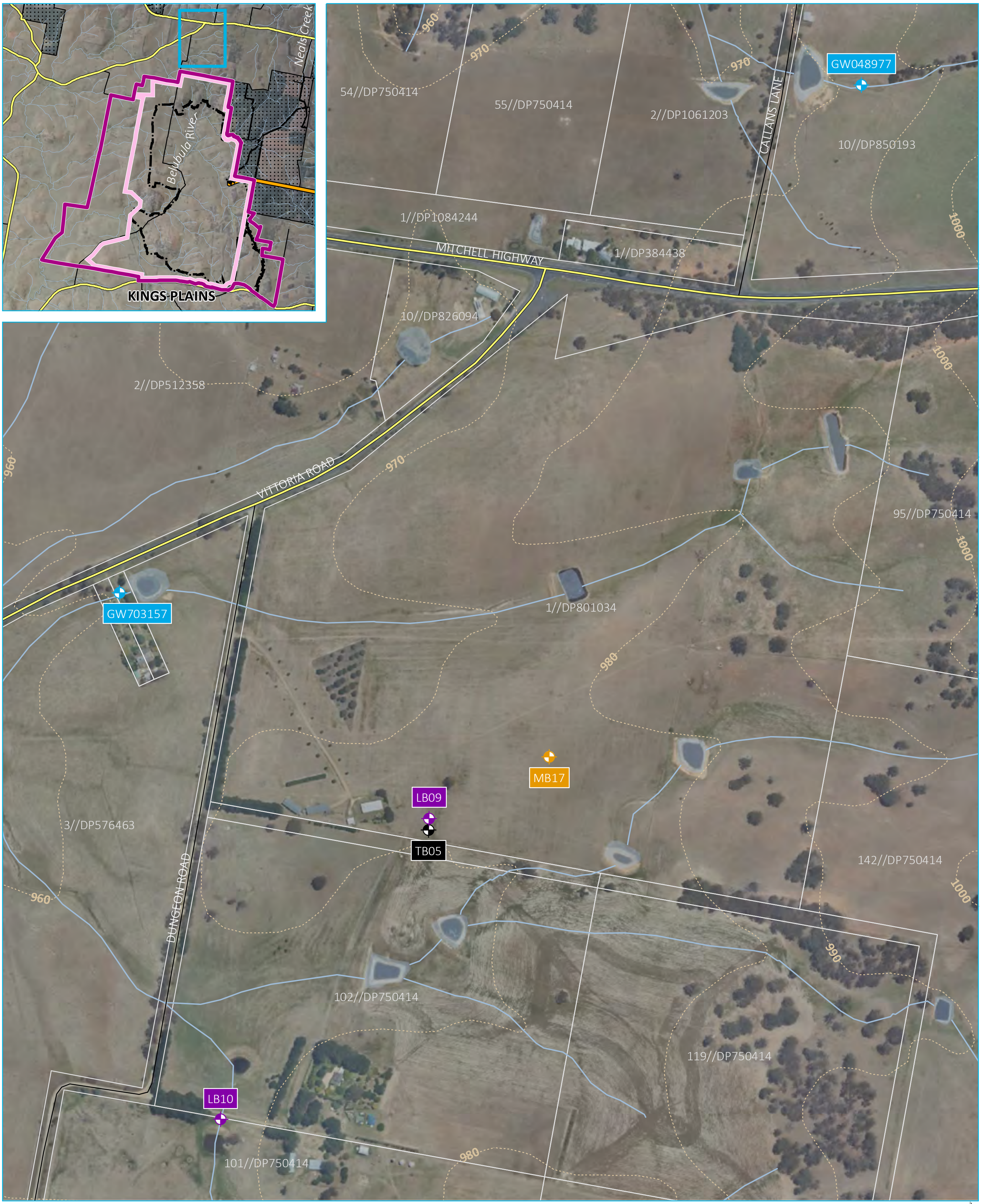
- ⊕ Test bore
- ⊕ Monitoring bore
- — Watercourse/drainage line
- ┄ Surface elevation (10 m)
- ☐ Cadastral boundary
- ▨ Tailings storage facility

INSET KEY

- ☐ Mine development project area
- ☐ Mining lease application area
- ☐ Disturbance footprint
- — Pipeline
- — Major road
- — Minor road
- ▦ Vittoria State Forest

TPB4 – Arbour Hills Test

McPhillamys Gold Project
Construction water supply groundwater investigation and impact assessment
Figure 4.1



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Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DFSI (2017)

KEY

- ⊕ Test bore
- ⊕ Monitoring bore
- ⊕ Existing bore (Regis land)
- ⊕ Landholder bore
- ― Major road
- ― Minor road
- ― Watercourse/drainage line
- ┈ Surface elevation (10 m)
- ☐ Cadastral boundary

INSET KEY

- ☐ Mine development project area
- ☐ Mining lease application area
- ⬚ Disturbance footprint
- ― Pipeline
- ▨ Vittoria State Forest

TB05 – Mungarra Test

McPhillamys Gold Project
Construction water supply groundwater
investigation and impact assessment
Figure 4.2

4.3 Licensing

The drilling program was licensed with test bore licences issued under Section 115 of the Water Act.

- 70BL234003 licensed drilling activities on Lot B DP37372:
  - the drilling, completion and testing of test bore TPB4; and
  - the drilling and completion of monitoring bores MB14, MB15 and MB16.
- 70BL234083 licensed drilling activities on Lot 1 DP801034 with:
  - the drilling, completion and testing of test bore TP05; and
  - the drilling and completion of monitoring bore MB17.

On completion of the drilling, the driller completed the necessary “Particulars of Completed Works” (known as *Form As*) which have been submitted to WaterNSW. Scanned copies of the licences and associated conditions[2] are provided in Appendix B.

4.4 Drilling and construction specifications

All test and monitoring bores were drilled and constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia (NUDLC 2020). Table 4.2 summarises the drilling and construction details.

Table 4.2 Drilling and construction summary details

	Surface section			Production section				
Bore ID	**Depth (mbgl)**	**Drilled diameter (mm)**	**Casing type**	**Depth (mbgl)**	**Drilled diameter (mm)**	**Casing type**	**Screened interval (mbgl)**	**Screen type**
TPB4	6	381	12” steel	144	305	226 mm ID PVC-U, bell-end	96 - 138	203 mm PVC-U, machine slotted
MB14	24	203	6” PVC	144	140	50 mm ID PVC-U, screwed	78 - 90 108 - 126	50 mm PVC-U, machine slotted
MB15	6	203	6” PVC	22	140	50 mm ID PVC-U, screwed	19 - 22	50 mm PVC-U, machine slotted
MB16	6	203	6” PVC	18	140	50 mm ID PVC-U, screwed	15 - 18	50 mm PVC-U, machine slotted
TB05	36	245	12” steel (6 m) 10" steel (36 m)	75	215	203 mm ID steel	51–57 57–75: backfilled with gravel pack and ballast	203 mm steel, plasma slotted
MB17	18	203	6” PVC	65	140	50 mm ID PVC-U, screwed	53 - 59	50 mm PVC-U, machine slotted

Notes: mm = millimetres
mbgl = metres below ground level
ID = internal diameter

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[2] Condition 11(2) of 70BL234003 and condition 12(2) of 70BL234083 allow for bores to be completed as permanent monitoring bores.

Schematics presenting the bores construction and interpreted geological cross-section at each site are provided in Figure 4.3 and Figure 4.4, and bore completion logs are provided in Appendix A.

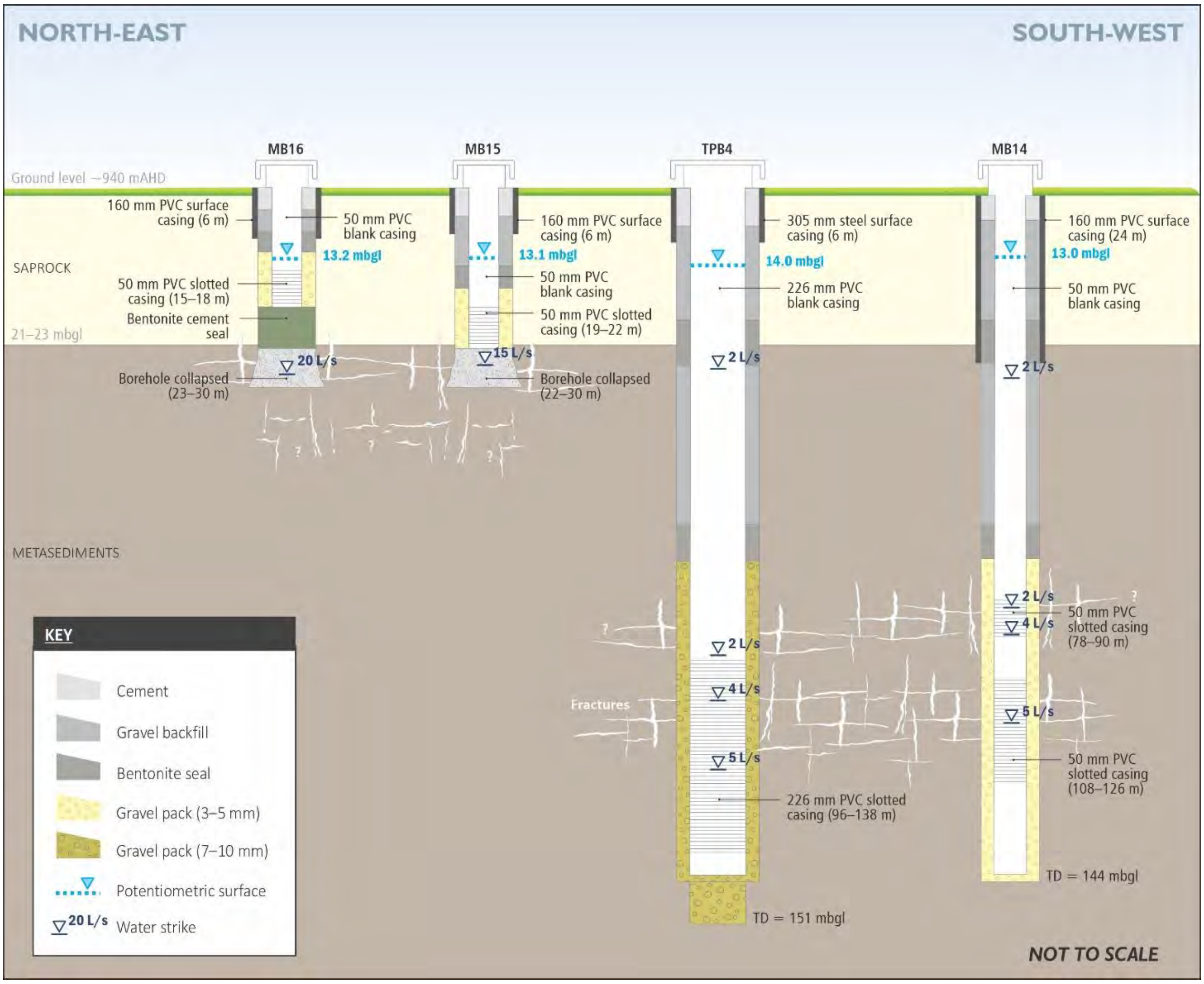


Figure 4.3 TPB4 schematic cross-section

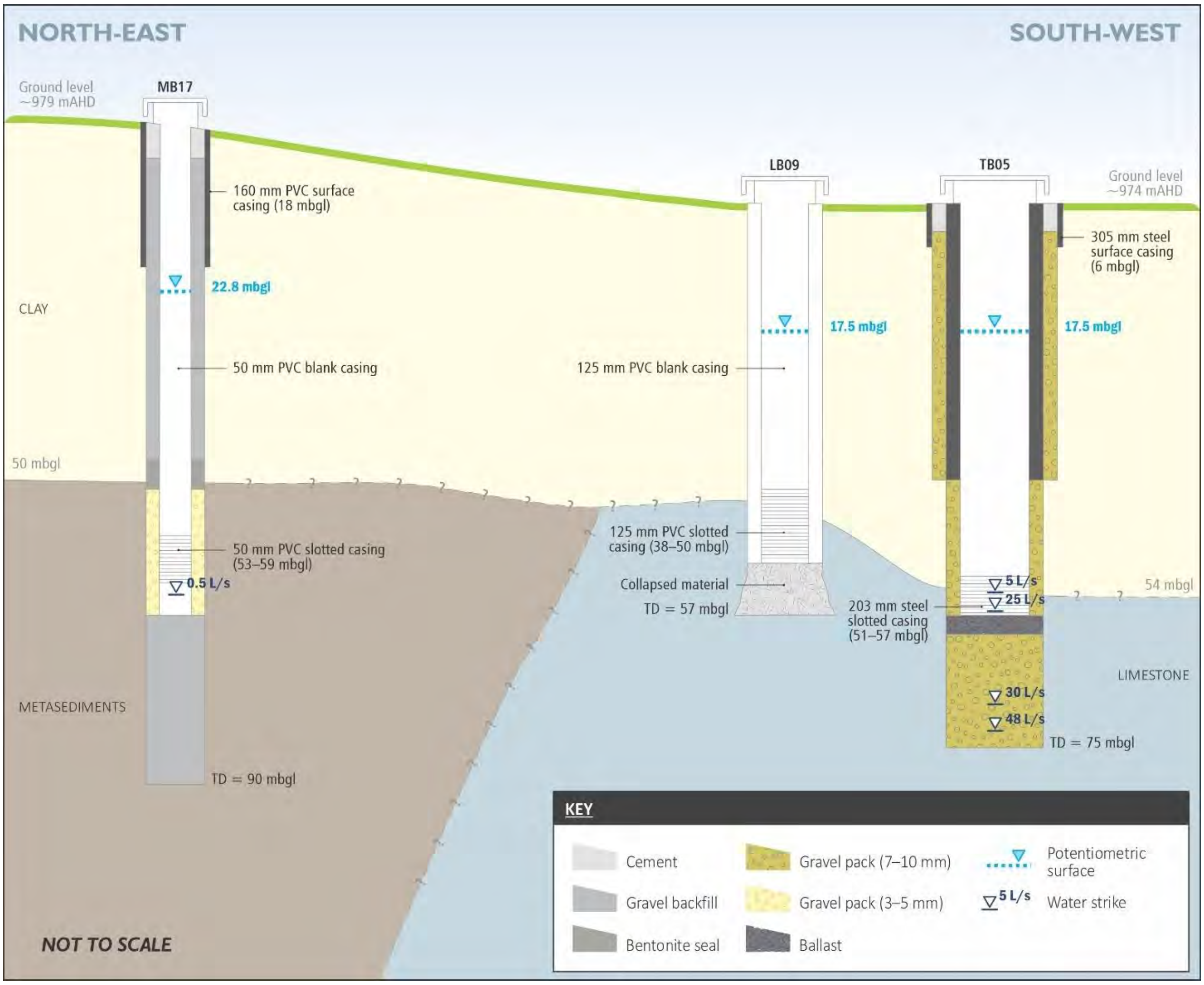


Figure 4.4 TB05 schematic cross-section

4.5 Bore development

Following installation, the bores were developed by airlifting until the purged water was visually free of sediment or as directed by the site supervisor. Airlifting focused on the screened intervals to remove any drilling fines on the bore wall, thereby maximising the hydraulic connection between the bore and the aquifer.

The airlifted water was captured at the surface in sumps. No tailwater/drainage was discharged to surface water features, native vegetation, or outside of Regis-owned land.

The volumes removed during airlifting are summarised in Table 4.3, including comparison to bore volumes.

Table 4.3 Airlifted volumes

Bore ID	Final airlift yield (L/s)	One bore volume (L)*	Estimated airlifted volume (kL)	Airlift duration (hr)
TPB4	5	4,266	18	1
MB14	1.5	256	5	1
MB15	0.5	16	4	2
MB16	0.06	8	0.5	2.25
TB05	25	1,869	720	8
MB17	0.3	81	3	2.5

Notes: L /s= litres per second; kL = kilolitres
* calculated from bottom of bore to static water level

4.6 Drilling observations

4.6.1 Geological Logging

Geological logs were prepared by the onsite hydrogeologist describing and recording the soil and rock cuttings (drill returns) brought to the surface at 1 m intervals, as well as records of water strikes and field water quality. A summary of the lithology encountered during the drilling of each drill location is presented in Table 4.4.

Table 4.4 Geological sequence

Age	Geological Formation	Lithology	Elevation of base of lithology (mAHD)					
			TPB4	MB14	MB15	MB16	TB05	MB17
Ground elevation			939.7	939.9	939.2	939.8	970.4	979
Silurian	Anson Formation	Saprolite/saprock	926	916	919	918	920	929
		Metasediments	<796	<795	<910	<911		<889
		Limestone	Absent	Absent	Absent	Absent	< 901	Absent

Notes: mAHD = metres above Australian Height Datum

i Saprock

Within the project area, the saprolite and saprock are chemically weathered metasediments and volcaniclastic sediments collectively referred to as 'saprock.'

The encountered saprock is comprised of brown-grey clay to silty clay of high to medium plasticity with traces of medium grained subangular quartz sand and highly weathered metasediments.

ii Metasediments

The metasediments of the Anson Formation encountered at both sites are mostly comprised of dark blue-grey phyllite (a fine grained metamorphosed rock), locally oxidised and fractured, fresh to slightly altered, with quartz veins.

iii Limestone

A localised limestone feature within the Anson Formation was intercepted at TB05 and comprises:

- marine limestone: orange-brown, locally white, oxidised, fossiliferous (Silurian crinoids); and
- sand: medium grained, moderately sorted, subrounded to angular.

The limestone encountered at TB05 is overlain by 54 m of brown-orange puggy clay of high plasticity with quartz veins. The clay profile is interpreted to be extremely weathered metasediments (saprock).

The deposit is interpreted to be from the late Silurian period and deposited in shallow marine environments as evidenced by the crinoid fossils (Photograph 4.1 and Photograph 4.2). The encountered limestone unit may be an allochthonous block (a block that has been moved from its original site of formation, usually by thrust faulting) or a small karstic reef limestone within the metasediments of the Anson Formation. The origin of the sand within the voids of the limestone deposit is unknown. Drilling has confirmed that this high permeability limestone feature is localised and does not extend south towards the proposed open cut area.

The occurrences of carbonates are identified in the region and comprise conglomerates, limestones, volcaniclastics and felsic-intermediate volcanics (refer to Section 2.2.3i). However, Regis has conducted extensive drilling as part of mineral exploration in the mine development area and the occurrence of limestone and the carbonaceous alteration in the open cut area (formed by different processes to the limestone encountered at TB05) are the only known local occurrences.

Photograph 4.1 Fossiliferous formation at the base of TB05

Photograph 4.2 Columnal crinoid fossils (from the Silurian period)

4.6.2 Groundwater levels

Static water levels (SWL) were measured in all bores post-development and recovery, and are presented in Table 4.5.

Table 4.5 Groundwater levels

Bore ID	Screened lithology	SWL (mbgl)	SWL (mAHD)	Date of reading
TPB4	Fractured metasediments	14.0	925.6	7 July 2020
MB14	Fractured metasediments	13.0	926.2	7 July 2020
MB15	Weathered metasediments	13.1	926.7	7 July 2020
MB16	Weathered metasediments	13.2	926.5	7 July 2020
TB05	Limestone	17.5	952.9	24 June 2020
LB09	Limestone	17.5	953.2	24 June 2020
MB17	Weathered metasediments	22.8	956.2	25 June 2020

Notes: mbgl = metres below ground level
mAHD = metres above Australian Height Datum
SWL = static water level

4.6.3 Groundwater yields

Groundwater yields (where inflow was encountered) were recorded while drilling and are summarised in Table 4.6 and presented on the bore completion logs in Appendix A.

Table 4.6 Airlift yield summary

Bore ID	First water cut (mbgl)	Lithology at first water cut	Screened interval (mbgl)	Screened lithology	Airlift yield at screened interval (L/s)	Final airlift yield (L/s)
TPB4	29	Fractured metasediments	78–90, 108 - 126	Fractured metasediments	5	5
MB14	19	Fractured metasediments	19 - 22	Fractured metasediments	10 - 15	1.5
MB15	23	Weathered metasediments	15 - 18	Saprock	<0.1	0.5
MB16	15	Weathered metasediments	96 - 138	Saprock	9	0.1
TB05	20	Saprock	51 - 57	Limestone	25	25
MB17	36	Saprock	53 - 59	Saprock	<0.5	0.3

Notes: L/s = litres per second
mbgl = metres below ground level

4.6.4 Groundwater quality

Field water quality (electrical conductivity (EC), pH and temperature) were recorded during drilling at regular intervals and at the end of airlift development. The field parameters taken at the end of development are listed in Table 4.7.

Groundwater encountered at both test bore sites is slightly alkaline and relatively fresh. Groundwater samples for laboratory analysis were collected during the aquifer testing, which is described in Sections 5 and 6.

Table 4.7 Field parameters at the end of development

Bore ID	Screened lithology	Temperature (°C)	pH	EC (µS/cm)
TPB4	Fractured metasediments	13	8.3	549
MB14	Fractured metasediments	18	8.0	630
MB15	Saprock	16	7.8	612
MB16	Saprock	15	8.0	688
TB05	Limestone	16	7.7	681
MB17	Saprock	14	7.9	304

Notes: EC = Electrical Conductivity
°C = degrees Celsius
µS/cm = microSiemens per centimetre

5 Aquifer testing

5.1 Methodology

Aquifer testing was designed to assess the bore performance and estimate hydraulic properties of the screened aquifer. All aquifer tests complied with the Minimum requirements for pumping tests on water bores in New South Wales (DPIE 2019).

The aquifer tests were undertaken at both test bores (TPB4 and TB05) to estimate the hydraulic properties of the intercepted aquifers and the supply potential of the production bores.

The aquifer testing involved both step tests and CRTs:

- Step tests were undertaken to estimate bore efficiencies (aquifer and well losses) and inform the selection of an appropriate pumping rate for the CRT. The step test comprised four nominal 100-minute steps of incrementally increasing flow rates.

- CRTs are designed to estimate aquifer properties at a pumped bore. A constant pumping rate was maintained for the duration of the tests. The groundwater level was monitored at the test bore and surrounding monitoring bores (and available landholder bores) during the tests.

Aquifer testing services were provided by TWS Evolution, which were completed in two stages.

1. Testing LB09 and TPB4 pilot hole to investigate the potential for test bore drilling at LB09 and construction of a larger bore at TPB4. This testing took place between 31 March and 8 April 2020 using a Grundfos SP13A-14 submersible pump. The results of the preliminary aquifer tests are provided in Appendix C.

2. Testing the larger diameter test bores (TPB4 and TB05) following construction and development. This testing took place between 26 June and 10 July 2020 using a Grundfos SP77-7 submersible pump.

A variable flow control box fitted with a pressure gauge was used to control the pumping rates.

Groundwater level changes in test bores and adjacent monitoring bores were recorded with a down hole pressure transducer; manual measurements were also recorded using a water level meter. For test bores, recordings were taken from a dedicated dip-tube to avoid interaction with the submersible pump, rising main and electrical cables.

Groundwater pumped from the bores was discharged to and contained in surrounding dams.

5.2 Results from post-drilling aquifer testing

5.2.1 Overview

Aquifer tests were conducted post-drilling on the larger diameter bores TB05 and TPB4. This section presents a summary of test results (pumping rates, observed drawdown), conceptual hydrogeological understanding of each test site and analysis of the test data. The results of the aquifer test analysis have been used to assess supply potential of the production bores and estimate pumping rates for operating the bores during the initial nine months of the construction period.

The aquifer test hydrographs and detailed results are provided in Appendix D and Appendix E.

5.2.2 TB05

i Step test

Table 5.1 details the pumping rates, step durations and incremental drawdowns of the step test conducted at TB05. Pumping ceased prior to completion of the fourth step (after 72 min of pumping) due to the groundwater level decline causing turbulent flows and disturbance of the ballast and gravel below the screened interval. Pumping ceased to avoid damage to the pump.

Table 5.1 TB05 step test

Step #	Duration (min)	Flow rate (L/s)	Drawdown (m)
1	100	5.1	0.7
2	100	9.8	2.0
3	100	19.6	7.4
4	72	27.8	16.4
Recovery	95	0	1.5*

Note: * residual drawdown
L/s = litres per second

The results of the step test analysis are provided in Table 5.2 and discussed below.

Table 5.2 TB05 step test analysis

Step #	Flow rate (L/s)	Incremental drawdown (m)	Linear aquifer-loss coefficient (B) (min/m²)	Non-linear well-loss coefficient (C) (min²/m⁵)	Apparent efficiency (Ew) (%)
1	5.1	0.7	1.9	4.0	62
2	9.8	1.3			46
3	19.6	5.4			30
4	27.8	9.0			23

Note: L/s = litres per second

The calculated bore efficiencies range from 62% at 5 L/s to 23% at 28 L/s. The low bore efficiency is attributed to challenging drilling conditions and completion methods, increasing non-linear well-losses. The calculated non-linear well-loss coefficient (4.0 min^2/m^5) and requirement to push in slotted steel casing demonstrates that groundwater inflow is impeded by the slotted casing/bottom entry and suggests reduced connection with the surrounding aquifer/inflow zones.

Due to difficulties drilling and maintaining an open hole through the main inflow zone, Highland Drilling were unable to install casing within the borehole to its total drilled depth (ie 75 mbgl). As presented in Section 4.4, the bore was cased and screened to a total depth of 57 mbgl. Below this depth, the borehole was backfilled with a permeable gravel pack. This construction allows groundwater inflows from the backfilled (gravel packed) interval (57 to 75 mbgl) into the cased section of the bore; however, it is noted that this is not an ideal construction specification, reducing the available drawdown and increasing the friction losses.

ii Constant rate test

Based on the results of the step test data analysis, and considering the available capacity of the dams to contain discharge water, the CRT at TB05 was conducted at a rate of 15 L/s.

The planned duration of the CRT was five days, in order to maximise the potential to observe boundary conditions (which could indicate the extent of the aquifer or a source of enhanced recharge). However, the CRT ceased after 4.7 days (113 hours) because the dams were full. On completion of the CRT, the drawdown at the test bore was 10.5 m, which translates to a groundwater level in the bore of 28.1 mbgl (23 m above the slotted interval).

During the CRT, groundwater levels were monitored in surrounding monitoring bores, including an accessible landholder bore (GW048977) located approximately 1.1 km from TB05 (Table 5.3).

Table 5.3 Bores monitored during the TB05 CRT

Bore ID	Distance from test bore (m)	Total depth (mbgl)	Screened lithology
TB05	NA	75	Limestone feature
LB09	15	50	Limestone feature
MB17	183	65	Saprock/metasediments
LB10	463	33.5	Metasediments
GW048977	1,119	43	Shale with quartz veins

Note: mbgl = metres below ground level

Table 5.4 summarises the pumping rate, duration and final drawdown of the CRT conducted at TB05.

Table 5.4 TB05 CRT pumping and recovery summary

	Duration (hr)	Flow rate (L/s)	Final drawdown (m)
Pumping	113	14.9	10.5
Recovery	250	0	1.6*

Note: * residual drawdown
L/s = litres per second

It is not clear whether the drilling extended to the base of the high permeability zone (ie the bore may not be fully penetrating the aquifer). The actual aquifer thickness is therefore unknown. For the analysis, the aquifer thickness was conservatively assumed to be the intercepted high inflow zone (ie 51 to 75 mbgl).

The analysis of TB05 CRT data assumed the:

- aquifer is leaky confined or confined (analysed under both assumptions). The saprock overlying the limestone aquifer is considered to be leaky, providing a slow source of recharge to the limestone; however, the duration of the pumping test was not sufficient to induce a leakage response;
- bore is fully penetrating; and
- aquifer thickness is 24 m.

Based on the above assumptions, the Dougherty-Babu (1984) solution for a confined aquifer has been selected as the most suitable model for the analysis. It is applicable to partial and full penetration with wellbore storage and well bore skin.

The Moench (1985) solution for a leaky confined aquifer has also been used to compare to the results of the Dougherty-Babu (1984) confined solution. It assumes unsteady flow to a fully penetrating, finite-diameter well with wellbore storage and wellbore skin in a homogeneous, isotropic leaky confined aquifer.

Table 5.5 presents the key results of the TB05 CRT analysis.

The estimated horizontal hydraulic conductivity for the limestone feature is 0.4 m/day. This value is consistent with the textbook ranges for similar lithologies:

- EMM (2019) derived hydraulic conductivities (from core and slug testing) for the Anson Formation in the project area of 2 x 10^{-2} m/day to 5.0 x 10^{-1} m/day;
- Domenico and Schwartz (1990) provide representative hydraulic conductivity ranges of:
  - 8.6 x 10^{-5} m/day to 5.2 x 10^{-1} m/day for limestone; and
  - 8.6 x 10^{-2} m/day to 1.7 x 10^{3} m/day for karst and reef limestone.

The storativity of 0.1 (ie specific storage of 5 x 10^{-3} m^{-1}) is greater than the typical storativity of a confined aquifer which normally ranges from 5 x 10^{-5} to 5 x 10^{-3} (Todd 1980). This is attributed to the duration of the pumping test being sufficient to observe a response from the primary porosity of the rock matrix (noting the potentially cavernous nature of the feature) but not sufficient to assess the secondary porosity of fractures or porosity of the surrounding rock, which will have a lower storativity, or leakage from the overlying saprock.

The skin effect accounts for the head losses in the vicinity of a well. The negative skin factor indicates an area of enhanced permeability in the formation near the bore, typically as a result of drilling activities.

The groundwater level recovery that followed the cessation of the CRT was slow. After 12 hours, the groundwater level rose to 5.2 m below the pre-pumping water level (ie 50% of the maximum drawdown). This suggests the extent of the aquifer (limestone feature) is limited, most water is sourced from localised karstic storage and partial dewatering of the primary porosity of the rock matrix may have occurred over the five-day test.

Table 5.5 TB05 - Summary of CRT results

Bore	**Initial SWL (mbrp)**	**Distance from test bore (m)**	**Pumping rate (L/s)**	**Maximum drawdown (inc. well losses) (m)**	**Non-linear well losses (m)**	**Aquifer drawdown (m)**	**% recovery after 15 days**
TB05: pumping bore	18.1	NA	14.9	10.5	3.2	7.3	85
LB09: observation bore	17.7	15	NA	6.8	NA	6.8	77
MB17: observation bore	23.6	183	NA	0*	NA	0	NA
LB10: observation bore		463	NA	0*	NA	0	NA
GW048977: observation bore	20.7	1,119	NA	0	NA	0	NA

Table 5.5 TB05 - Summary of CRT results

Estimated hydraulic parameters (limestone feature)						
Solution	**Transmissivity (m^2/day)**	**Hydraulic conductivity (K) (m/day)**	**Aquifer thickness (m)**	**Storativity (S) (-)**	**Well loss factor (min^2/m^5)**	**Skin factor (Sw) (-)**
Dougherty-Babu (1984) - confined	8.6	$3.6 \times 10^{--1}$	24	$1.2 \times 10^{--1}$	4.0	-6.4
Moench (1985) – semi-confined	9.3	$3.9 \times 10^{--1}$	24	$1.2 \times 10^{--1}$	NA	-6.4

Note: SWL = static water level prior to start of CRT
mbrp = metres below reference point (pumping bore = below dip tube | observation bore = below top of casing)
L/s = litres per second
NA = not applicable
* Due to high rainfall prior to the pumping tests, a minor water level decline was observed in the observation bores MB17 and LB10 at the beginning of the CRT but is not attributed to the groundwater abstraction from TB05.

5.2.3 TPB4

i Step test

Table 5.6 details the pumping rates, step durations and incremental drawdowns of the step test conducted at TPB4. The duration of the third step was extended from 100 min to 120 min to allow more time for the drawdown to stabilise, which is useful for analysis. Pumping ceased 12 min into the fourth step due to large groundwater level decline. Pumping ceased to avoid damage to the pump.

Table 5.6 TPB4 step test

Step #	Duration (min)	Flow rate (L/s)	Drawdown (m)
1	100	2.0	14.4
2	100	3.0	26.6
3	120	5.0	58.8
4	12	6.6	79.0
Recovery	90	0	4.6*

Note: * residual drawdown
L/s = litres per second

The results of the step test analysis are provided in Table 5.7. The results suggest low bore efficiencies (ranging from 58% at 2 L/s to 30% at 6.5 L/s) and are attributed to a high calculated well-loss coefficient.

Table 5.7 TPB4 step test analysis

Step #	Flow rate (L/s)	Incremental drawdown (m)	Linear aquifer-loss coefficient (B) (min/m^2)	Non-linear well-loss coefficient (C) (min^2/m^5)	Apparent efficiency (Ew) (%)
1	2.0	14.4	7.1	high (unrealistic)	58
2	3.0	12.3			48
3	5.0	32.2			36
4	6.5	20.2			30

Note: L/s = litres per second

ii Constant rate test

Based on the results of the step test data analysis, the CRT was conducted at 5 L/s.

On completion of the 72-hour CRT, the drawdown at the test bore reached 70.2 m, which translates to a groundwater level in the bore of 84.2 mbgl (11.8 m above the slotted interval).

During the CRT, the groundwater level was measured in monitoring bores in the vicinity of TPB4 (Table 5.3).

Table 5.8 Bores monitored during the CRT at TPB4

Bore ID	Distance from test bore (m)	Total depth (mbgl)	Screened lithology
TPB4	NA	144	Fractured metasediments
MB14	12	144	Fractured metasediments
MB15	10	65	Saprock/metasediments
MB16	13	33.5	Saprock

Note: mbgl = metres below ground level
NA = not applicable

Table 5.9 summarises the pumping rate, duration and final drawdown of the CRT conducted at TPB4.

Table 5.9 TPB4 CRT pumping and recovery summary

	Duration (hr)	Flow rate (L/s)	Final drawdown (m)
Pumping	72	5	70.2
Recovery	6	0	6.9*

Note: * residual drawdown
L/s = litres per second
NA = not applicable

The analysis of TPB4 CRT data assumes the:

- aquifer is leaky confined, with the overlying saprock acting a confining aquitard;
- bore is fully penetrating; and

- aquifer thickness is 60 m.

The hydraulic parameters of the aquifer have been calculated using the following leaky confined aquifer solutions:

- Neuman and Witherspoon (1969): a solution for unsteady flow to a fully penetrating well in a confined two-aquifer system assuming a line source for the pumped well and therefore neglecting wellbore storage; and
- Moench (1985): a solution for unsteady flow to a fully penetrating, finite-diameter well with wellbore storage and wellbore skin in a homogeneous, isotropic leaky confined aquifer.

Table 5.10 presents the key results of the CRT analysis.

Table 5.10 TPB4 - Summary of CRT results

CRT

Bore	Initial SWL (mbrp)	Distance from test bore (m)	Pumping rate (L/s)	Maximum drawdown (inc. well losses) (m)	Non-linear well losses (m)*	Aquifer drawdown (m)	% recovery after 24 hours
TPB4: pumping bore	14.5	NA	5.0	70.2	0.1	70.1	96
MB14: observation bore	13.8	13	NA	40.8	NA	40.8	92
MB15: observation bore	13.9	10	NA	6.3	NA	6.3	32
MB16: observation bore	13.9	15	NA	Dry (TD = 18 mbgl)	NA	-	-

Estimated hydraulic parameters (fractured metasediments)

Solution	Transmissivity (m^2/day)	Hydraulic conductivity (K) (m/day)	Aquifer thickness (m)	Storativity (S) (-)	Well-loss coefficient (min^2/m^5)	Skin factor (Sw)
Neuman-Witherspoon (1969)	8.6	1.4 x 10^{-1}	60	3.7 x 10^{-5}	NA	NA
Moench (1985)	8.3	1.4 x 10^{-1}		1.5 x 10^{-5}	NA	-1.0
Adopted parameters	**8.5**	**1.4 x 10^{-1}**	**60**	**2.6 x 10^{-5}**	**0.5***	**-1.0**

Note: SWL = static water level prior to start of CRT
mbrp = metres below reference point (pumping bore = below dip tube | observation bore = below top of casing)
mbgl = metres below ground level
L/s = litres per second
TD = total depth
NA = not applicable
min = minute(s)
* The well-loss coefficient was assumed for the analyses = C = 0.5 min^2/m^5 (ie the well-loss coefficient of an averagely developed and designed new bore).

The estimated horizontal hydraulic conductivity for the fractured metasediments in the vicinity of TPB4 is 0.14 m/day. This value is consistent with the project groundwater assessment (EMM 2019) and textbook ranges for similar lithologies:

- EMM (2019) derived hydraulic conductivities (from core and slug testing) for the Anson Formation saprock in the mine development area of 8.6 x 10^{-8} to 1.3 m/day and fresh Anson Formation from 9 x 10^{-8} to 0.5 m/day;

- Domenico and Schwartz (1990) provide representative hydraulic conductivity ranges of:

    - 6.9 x 10^{-4} to 2.6 x 10^{1} m/day for fractured igneous and metamorphic rock; and

    - 2.6 x 10^{-9} to 1.7 x 10^{-5} m/day for unfractured igneous and metamorphic rock.

The storativity of 2.6 x 10^{-5} (specific storage of 4 x $10^{.7}$ m^{-1}) is similar to the typical storativity range of a confined aquifer (5 x 10^{-5} to 5 x 10^{-3}) as reported by Todd (1980).

The slightly negative skin factor suggests the permeability of the formation in the vicinity of the borehole has been slightly enhanced by the drilling and development.

6 Groundwater quality

6.1 Methodology

Field groundwater quality was monitored and recorded regularly during drilling. The monitoring data are used to evaluate groundwater quality changes observed with changing depth, water level and attributed to the various changes in geology. Physicochemical results measured during drilling are included in the bore logs in Appendix A.

Groundwater samples were collected for laboratory analysis from each of the monitoring bores following bore development using bailing techniques. Groundwater samples were collected at 12-hourly intervals during the CRTs from the test bores.

The samples were sent under appropriate chain of custody to a NATA-certified laboratory for analysis of the suite of parameters detailed in Table 6.1.

Table 6.1 Groundwater sampling analytical suite

Group	Analyte
Physicochemical parameters (field measurements)	EC, Total Dissolved Solids (TDS), pH, temperature
Laboratory analytes	
Physicochemical parameters	EC, TDS
Major ions	Calcium, magnesium, sodium, potassium, chloride, sulphate and alkalinity (total, carbonate and bicarbonate)
Metals (dissolved) NEPM Suite	Arsenic, aluminium, boron, barium, beryllium, cadmium, chromium, cobalt, copper, fluoride, iron, manganese, nickel, lead, selenium, vanadium, zinc and mercury
Nutrients	Total nitrogen, total Kjeldahl nitrogen, nitrite, nitrate, ammonia, total phosphorus and reactive phosphorus

Water quality sampling was conducted in accordance with Geoscience Australia's Groundwater Sampling and Analysis – A Field Guide (Geoscience Australia 2009).

Field and laboratory quality assurance/quality control (QA/QC) procedures were used to establish accurate, reliable and precise results. QA/QC procedures included: calibration of equipment, submitting laboratory samples within holding times, keeping samples chilled and wearing gloves during sampling.

6.2 Groundwater quality results

An overview of groundwater quality results is provided in Table 6.2. As the groundwater quality did not change during the CRTs at both TB4 and TB05, the presented data are the medians of the laboratory results. The laboratory reports are included in Appendix F.

The groundwater chemistry laboratory results have been compared to:

- the Australian and New Zealand guidelines for fresh and marine water quality (ANZECC and ARMCANZ 2000) for the protection of freshwater aquatic ecosystems and stock drinking water; and
- the Australian drinking water guidelines (NHMRC 2018).

These are very conservative criteria given the water is to be used as a construction water supply.

Table 6.2 Overview of laboratory derived groundwater quality

Parameter	Units	Guideline value										
		Fresh water ecosystems[1]	Livestock[2]	Drinking water[3]	TPB4 (median value)	MB14	MB15	MB16	MB17	TB05 (median value)	LB09 (median value)	LB10
pH (Field)	-	-	7.0-8.5	-	7.26	7.2	7.5	7.6	7.9	6.95	6.76	7
Temperature	˚C	-	-	-	15	18	16	15	14	15.2	8.8	9
Conductivity	µS/cm	-	-	-	666	706	612	688	304	674	686	920
Total Dissolved Solids (Lab)	mg/L	-	2000/4000/5000	-	395	450	460	340	200	380	360	560
Alkalinity as $CaCO_3$	mg/L	-	-	-	310	320	310	120	140	355	355	380
Carbonate Alkalinity	mg/L	-	-	-	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR
Bicarbonate Alkalinity	mg/L	-	-	-	310	320	310	120	140	355	355	380
Hydroxide Alkalinity	mg/L	-	-	-	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR
Sulphate as SO_4	mg/L	-	-	500	16	21	51	170	8	7	7	46
Chloride	mg/L	-	-	-	33	39	45	19	22	16	14	42
Calcium (Filtered)	mg/L	-	1000	-	70	75	95	65	20	120	120	68
Magnesium (Filtered)	mg/L	-	-	-	27	28	34	10	9	12	12	47
Sodium (Filtered)	mg/L	-	-	-	28	26	23	37	22	13	15	25
Potassium (Filtered)	mg/L	-	-	-	4	5	4	8	3	2	2	10
Fluoride	mg/L	-	2	1.5	< LOR	< LOR	< LOR	< LOR	0.2	< LOR	< LOR	< LOR
Aluminium (Filtered)	mg/L	0.055	5	-	< LOR	< LOR	<0.01	0.04	0.05	< LOR	0.03	< LOR
Antimony (Filtered)	mg/L	-	-	0.003	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR
Arsenic (Filtered)	mg/L	0.013	0.5	0.01	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	0.003
Barium (Filtered)	mg/L	-	-	2	0.5	0.3	0.2	0.1	0.013	0.032	0.036	0.084
Boron (Filtered)	mg/L	0.37	5	4	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR
Beryllium (Filtered)	mg/L	-	-	0.06	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR

Table 6.2 Overview of laboratory derived groundwater quality

Parameter	Units	Guideline value										
		Fresh water ecosystems[1]	Livestock[2]	Drinking water[3]	TPB4 (median value)	MB14	MB15	MB16	MB17	TB05 (median value)	LB09 (median value)	LB10
Cadmium (Filtered)	mg/L	0.0002	0.01	0.002	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR
Chromium (Filtered)	mg/L	0.001	1	-	< LOR	< LOR	< LOR	0.085	< LOR	< LOR	0.002	0.01
Cobalt (Filtered)	mg/L	-	1	-	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR
Copper (Filtered)	mg/L	0.0014	0.4/1/5	2	< LOR	< LOR	< LOR	< LOR	< LOR	0.002	0.002	< LOR
Iron (Filtered)	mg/L	-	-	-	0.02	< LOR	< LOR	0.04	0.028	0.01	0.04	0.01
Lead (Filtered)	mg/L	0.0034	0.1	0.01	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR
Manganese (Filtered)	mg/L	1.9	-	0.5	< LOR	< LOR	< LOR	0.006	0.055	0.01	< LOR	< LOR
Mercury (Filtered)	mg/L	0.0006	0.002	0.001	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR
Molybdenum (Filtered)	mg/L	-	0.15	-	< LOR	< LOR	< LOR	0.017	< LOR	< LOR	< LOR	< LOR
Nickel (Filtered)	mg/L	0.011	1	0.02	< LOR	0.005	< LOR	< LOR	0.003	< LOR	< LOR	0.018
Selenium (Filtered)	mg/L	0.011	0.02	-	< LOR	< LOR	< LOR	< LOR	0.001	< LOR	< LOR	< LOR
Zinc (Filtered)	mg/L	0.008	20	-	0.005	0.031	0.023	0.01	0.11	0.005	0.004	0.014
Silver (Filtered)	mg/L	0.00005	-	-	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR
Vanadium (Filtered)	mg/L	-	-	-	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	0.002	0.002
Ammonia (as N)	mg/L	0.9	-	-	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR
Nitrite (as N)	mg/L	-	10	0.6	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	0.018
Nitrate (as N)	mg/L	0.7	30	11.3	1.8	1.9	2.8	2	1.8	0.3	1.1	1.8
Total phosphorus	mg/L	-	-	-	< LOR	< LOR	0.1	8.2	2.2	< LOR	< LOR	< LOR
Nitrogen (Total)	mg/L	-	-	-	1.9	3.5	3.6	3.1	2.1	0.4	1.2	2.3
Ionic Balance	%	-	-	-	5	4	1	5	12	2	5	6

Notes: 1. Guidelines for the protection of aquatic ecosystems (ANZECC and ARMCANZ 2000): 95% species protection level

2. Livestock drinking water quality (ANZECC and ARMCANZ 2000)

3. Australian drinking water guidelines (NHMRC 2018)

ADWG palatability – Good (TDS 0-600 mg/L), Fair (TDS 600-900 mg/L), Poor (TDS 900-1,200 mg/L), Unacceptable (TDS >1,200 mg/L).

ANZECC (2000) stock suitability = Acceptable (TDS 2,000-5,000 mg/L) Unacceptable (TDS >5,000 mg/L).

DPI Water (2014) recognise that TDS concentrations up to 10,000 mg/L TDS is acceptable for beef cattle and sheep for limited periods

TDS = total dissolved solids, analysed in laboratory.

pH measured in the field.

< LOR = below limit of reporting

Exceedances

Key findings from a groundwater chemistry perspective include:

- groundwater sampled from at these locations and lithologies is suitable for livestock watering;
- groundwater sampled from the Anson Formation bores has comparatively low salinity when compared to other baseline monitoring data (EMM 2019):
  - groundwater within the Anson Formation saprock (in MB16) is fresh (340 mg/L TDS) and is neutral (pH of 7.5);
  - groundwater within the fresh metasediments of the Anson Formation (ie TPB4, MB14, MB15, MB17 and LB10) ranges from 200‑560 mg/L TDS and is neutral to slightly alkaline (pH ranging from 7‑7.9); and
  - groundwater within the limestone unit at the base of the Anson Formation (ie TB05 and LB09) ranges from 360‑380 mg/L TDS and is neutral (pH of 6.8‑7).
- the natural groundwater regime in this area exceeds the generic guideline values for the protection of aquatic ecosystems (ANZECC and ARMCANZ 2000; 95% protection level) for a few metal concentrations (chromium at MB16, LB09 and LB10; copper at TB05 and LB09; nickel at LB10; and zinc at MB14, MB15, MB16 and LB10) and nitrite concentration at all bores except TB05.

Laboratory reported major ion concentrations in groundwater samples are presented on a Piper diagram in Figure 6.1 and Figure 6.2. The groundwater chemistry data presented on the plots are grouped by test bore sites (ie TB05 and TPB4).

The spread of data points on the Piper diagrams (Figure 6.1 and Figure 6.2) indicate:

- groundwater within the limestone feature (TB05 and LB09) is notably different to MB17 and LB10, with:
  - a calcium (Ca)-bicarbonate (HCO_3) dominance;
  - low concentrations of cations sodium (Na), magnesium (Mg) and potassium (K);
  - low concentrations of anions chloride (Cl) and sulphate (SO_4);
- within the metasediments (MB17 and LB10):
  - groundwater is HCO_3 dominant and cation indiscriminate, indicating partial ion exchange;
- groundwater quality within the fresh metasediments (TPB4, MB14 and MB15) is similar to water quality in the Belubula River:
  - the water is HCO_3 dominant;
  - major cations are high in Ca and Mg, and low in Na and K;
  - major anions are low in Cl and SO_4 concentrations;
- groundwater within the saprock at site TPB4 (MB16) is of mixed type:
  - major cations are high in Ca and Mg, and low in Na and K;

  - no anion dominant type; and

- there are no changes in water quality at TB05, LB09 and TPB4 during the pumping tests.

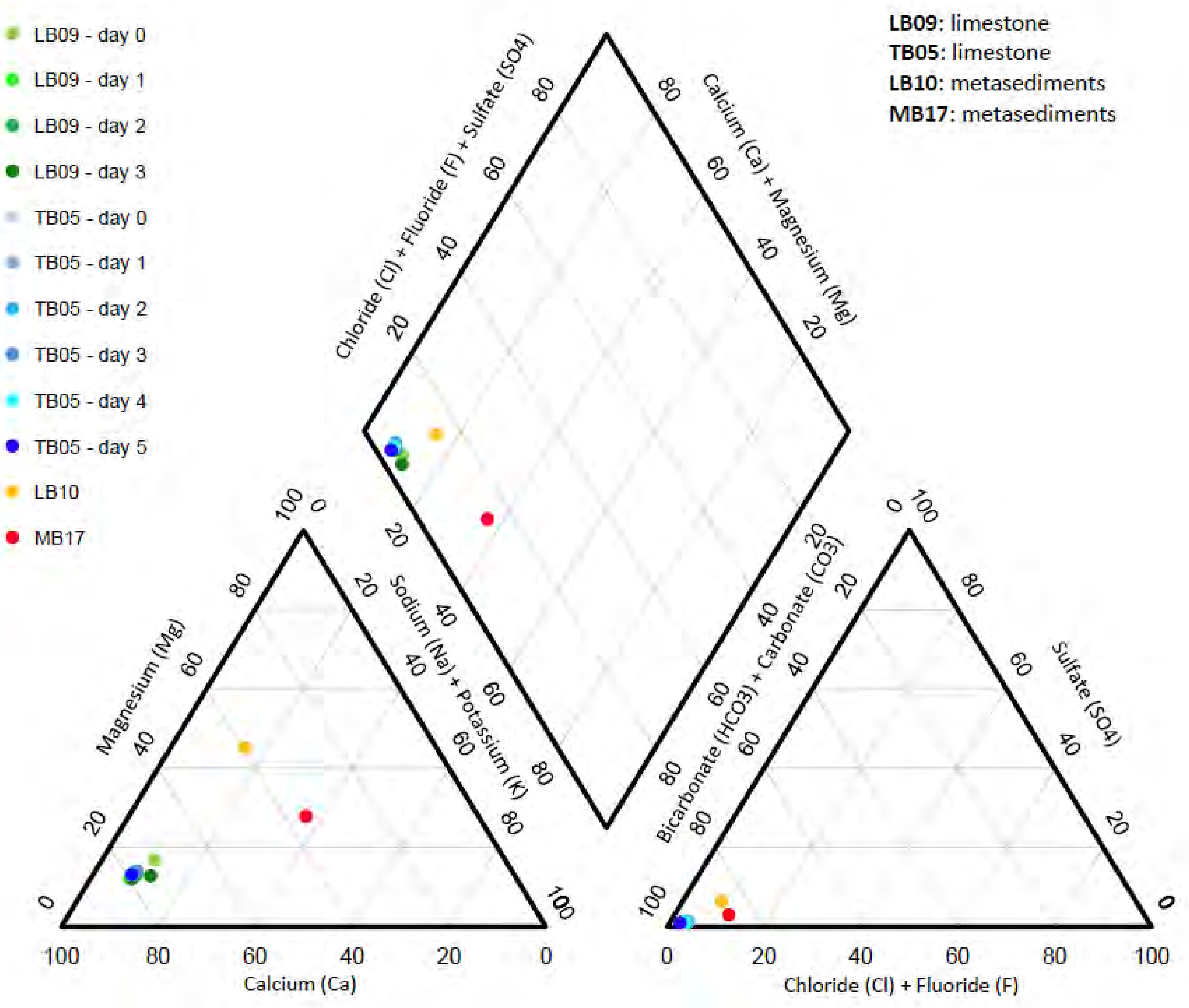


Figure 6.1 TB05 - Piper diagram

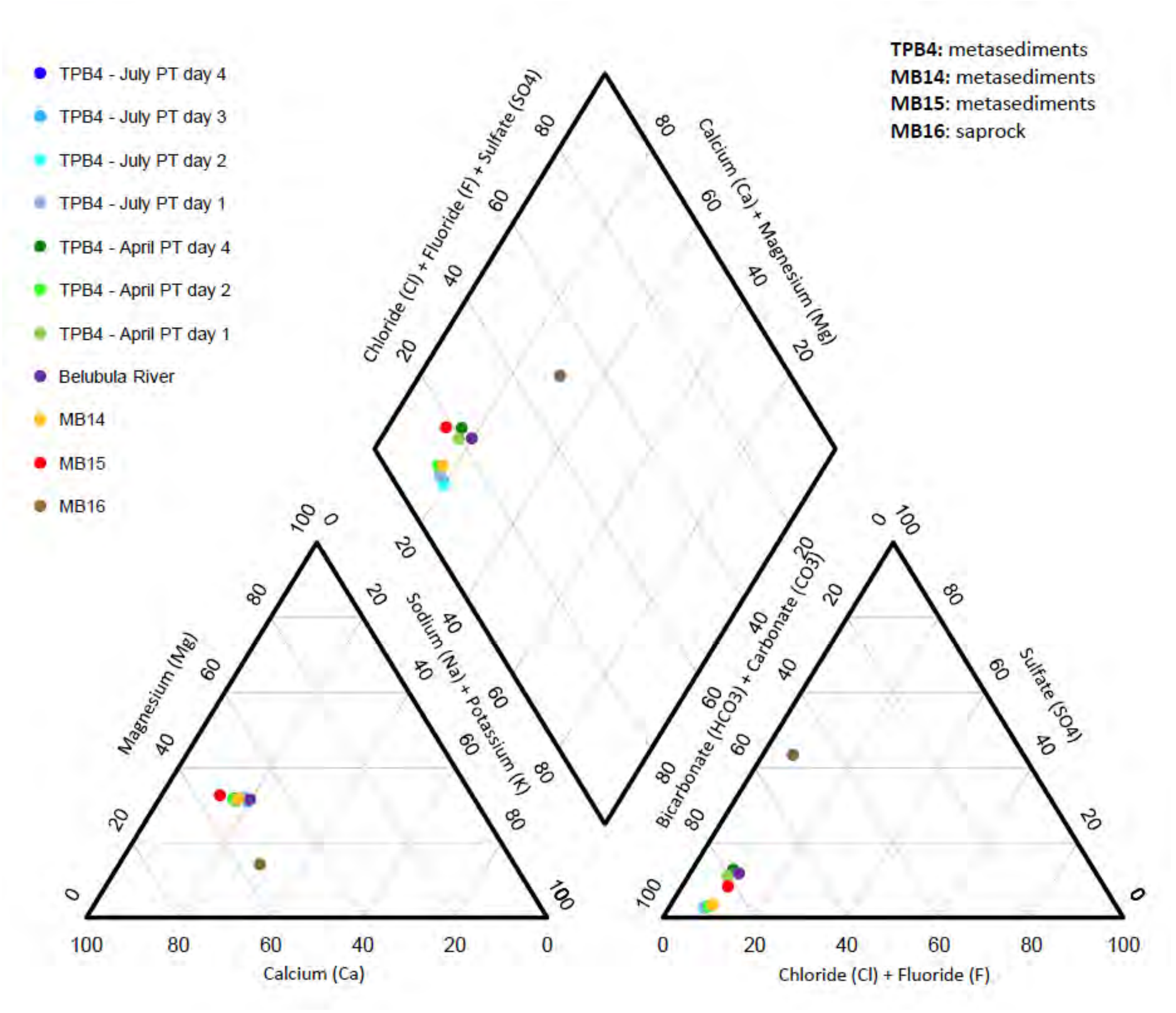


Figure 6.2 TPB4 - Piper diagram

7 Long-term pumping rates

7.1 Overview

The estimated aquifer parameters from the aquifer tests have been used to predict the long-term drawdown at the two test bores at different pumping rates. These predicted drawdowns have been compared to the maximum available heads at both test bores.

The estimated hydraulic properties (Section 5.2) and conceptual understanding at each test bore location have been used to conduct forward modelling (a function in AQTESOLV [Duffield 2007]) to assist in assessing aquifer response to pumping from the individual test bores at various rates over the initial nine-month construction period.

7.2 TB05

The assessment to identify a pumping rate for operation of a production bore at TB05 assumes the:

- limestone feature has a finite extent, modelled by four no-flow boundaries forming a 300 m length square;
- maximum allowable groundwater level (within the test bore) to the top of the screened interval (ie 51 mbgl);
- maximum available head is 33.5 m; and
- pumping is continuous for nine months (with no recovery periods).

Table 7.1 shows the calculated predicted drawdown after nine months of continuous pumping at different flow rates. Based on the criteria and assumptions listed above, the recommended pumping rate at TB05 is 10 L/s.

Table 7.1 Predicted drawdown –continuous pumping over a 9-month period

Pumping rate (L/s)	Drawdown from Well Loss (m)	Long-term aquifer drawdown (m)	Total drawdown (m)	Comparison with available head (H)
5	0.4	15.8	16.2	< H
8	0.9	25.4	26.3	< H
10	1.4	31.1	32.5	~H
15	3.2	46.6	49.8	> H
20	5.8	62.3	68.1	> H

Note: L/s = litres per second

7.3 TPB4

The assessment to identify a pumping rate for operation of a production bore at TPB4 assumes the:

- aquifer is leaky with the overlying saprock acting as a leaky confining aquitard;
- maximum allowable groundwater level (within the test bore) to the top of the screened interval (ie 96 mbgl);
- maximum available head is 82.0 m; and

- pumping is continuous for nine months (with no recovery periods).

Table 7.2 shows the calculated predicted drawdown after nine months of pumping at different flow rates. Based on the criteria and assumptions listed above, the recommended pumping rate at TPB4 is 5 L/s.

Table 7.2 Predicted drawdown –continuous pumping over a 9-month period

Pumping rate (L/s)	Drawdown from Well Loss (m)	Long-term aquifer drawdown (m)	Total drawdown (m)	Comparison with available head (H)
4	0.0	66.6	66.6	< H
4.5	0.0	74.2	74.2	< H
5	0.1	82.4	82.5	~H
6	0.1	98.5	98.6	> H

Note: L/s = litres per second

7.4 Recommended pumping rates

Based on the above, Table 7.3 presents the recommended operational pumping rates at TB05 and TPB4. Drawdown predictions are provided in Appendix G.

Table 7.3 Recommended pumping regime

Bore ID	Recommended pump inlet depth (mbgl)	Recommended maximum pumping water level (mbgl)	Recommended maximum pumping rate (L/s)
TB05	52	50	10
TPB4	100	98	5
Total			**15**

Note: L/s = litres per second
mbgl = metres below ground level

8 Impact assessment

8.1 Assessment framework

The predicted impacts of the construction water supply on groundwater receptors have been assessed with reference to the AIP (DPI Water 2012) and DPI water resources plans fact sheet (DPI 2018).

The DPI water resources plans fact sheet documents the process and criteria applied to the assessment of application under the WM Act. The relevant assessment criteria are presented in Table 8.1.

Table 8.1 Groundwater criteria for acceptable level of impacts (DPI)

Groundwater source	Impact on water table (unconfined aquifers)	Impact on groundwater pressure (confined/semi-confined aquifers)	Proponent assessment
Porous and fractured rock groundwater sources	1. Less than 0.1 m cumulative drawdown in the water table 40 m from any: – high-priority GDE; or – high-priority culturally significant site. 2. An additional drawdown of not more than 10% of the pre-development TAD to a maximum of 2 m at any: – third or higher order surface water source measured at 40 m from the high bank; and – water supply works (excluding those on the same property), subject to negotiation with impacted parties. 3. A cumulative drawdown of no more than 10% of the pre-development TAD of the unconfined aquifer at a distance of 200 m from any water supply works including the pumping bores.	4. A cumulative drawdown of not more than 40% of the pre-development TAD at a distance of 200 m from any water supply works including the pumping bores. 5. An additional drawdown of not more than 3 m at any water supply works (excluding those on the same property) subject to negotiation with impacted parties.	1. No identified high-priority GDE or high-priority culturally significant site within or nearby the mine development area. 2. Predicted drawdown: – less than 2 m of drawdown predicted 40 m from the high bank at the Belubula River. – No drawdown predicted at third-party water supply works. 3. No drawdown predicted at any water supply works. 4. As per response 3. 5. As per response 3.

Note: TAD = total available drawdown GDE = Groundwater dependant ecosystem
Assessment criteria extracted from Water resources plans fact sheet (DPI 2018)

8.2 Objective and approach

Groundwater flow modelling has been conducted using the results of the aquifer test analysis and parameters from the calibrated numerical model (EMM 2019 and 2020c) to:

- estimate the potential drawdown from proposed groundwater abstraction for the initial nine months of the construction period;
- estimate the area of influence (extent of drawdown as defined by the 1 m change in groundwater level) caused by pumping of the test bores; and
- assess the potential impacts of operating the bores on local receptors (see Section 2.4).

The model was developed in AnAqSim (Fitts Geosolutions 2019), which allows multiple analytical calculations (flow calculations) to derived solutions as a function of location and time. The analytical model writes equations in two-dimensions and represents three-dimensional flow using multiple, planar layers. The modelling has been completed in accordance with the Australian groundwater modelling guidelines and satisfies the requirements for a class 1 flow model (Barnett et al 2012).

The assessment is focused on potential changes to the groundwater level. Use of groundwater to meet the short-term construction water demand will not result in impacts to groundwater quality. Water quality is fresh and neutral (refer Section 6) and similar to groundwater quality recorded in the surrounding bores. In addition, there is no existing contamination or contamination sources identified in area.

8.3 Model construction

The boundary conditions for the model are based on geology and groundwater contours from the Groundwater Assessment (EMM 2019). Where boundaries are assigned perpendicular to groundwater flow, they have been set as no flow boundaries. Where model boundaries are parallel to groundwater flow the boundaries have been set as constant head. The model elements (boundaries, river, faults and nodes) are shown in Figure 8.1.

The southern and western specified head boundary is consistent with the interpreted 865 mAHD groundwater contour. The northern and eastern boundary are consistent with EMM (2019) modelled 930 mAHD groundwater contour.

The baseline groundwater contours from the numerical groundwater model (EMM 2020) have been used to develop the boundaries and validate aquifer parameters in the steady state analytical model.

Recharge has been distributed across the analytical model at 17.2 mm/year using spatially variable sinks. No evapotranspiration losses have been simulated in the model.

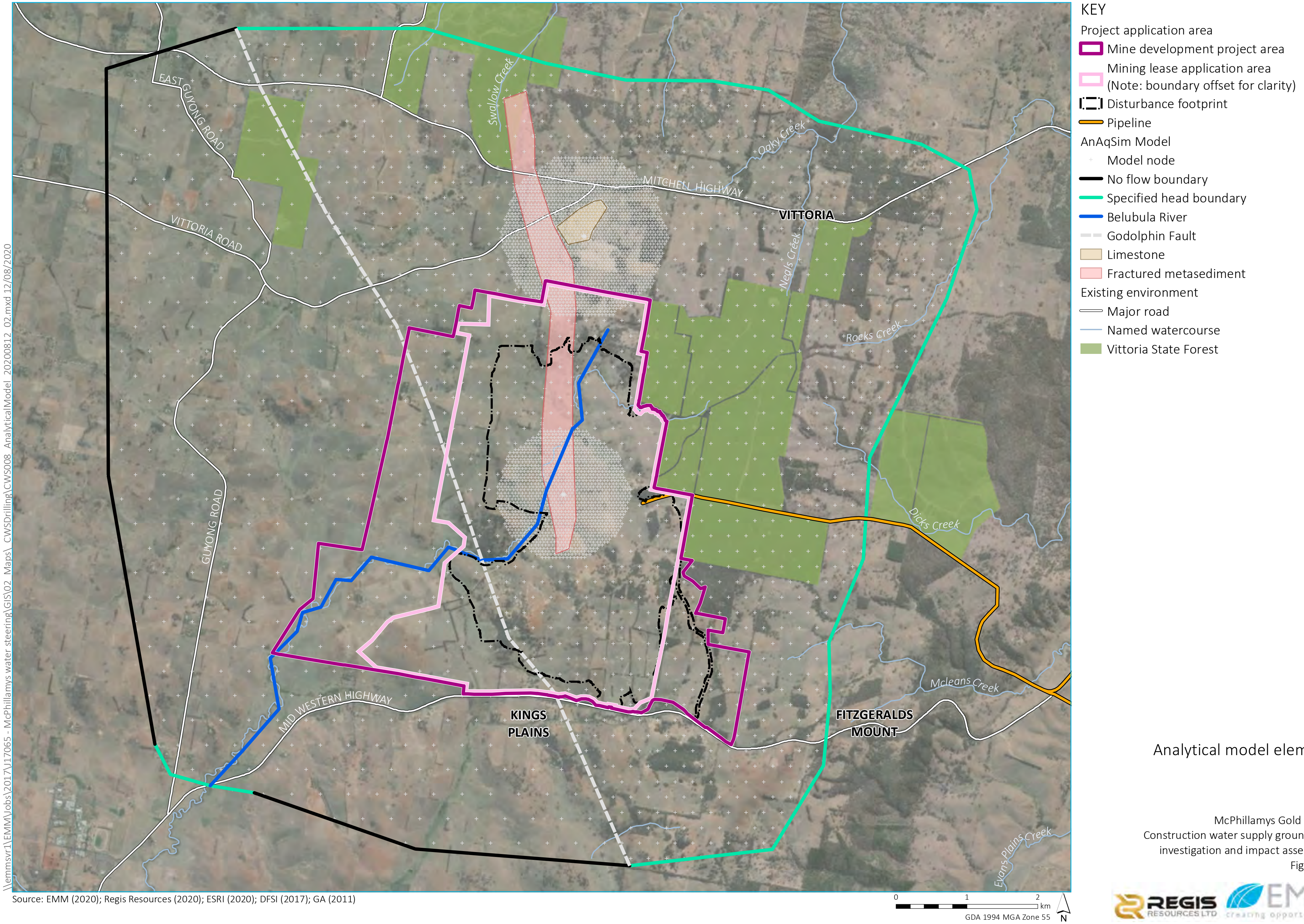
A simplified representation of hydrostratigraphic units (adapted from the Groundwater Assessment (EMM 2019) and aquifer test results summarised in Section 5) has been applied as model domains within the analytical model.

The four model domains comprise the:

- metasediments (saprock);
- metasediments (fractured);
- limestone (shallow marine deposited); and
- volcanics.

The weathered metasediments have been represented as two layers (saprock and fractured) to allow the simulation of vertical flow into the limestone and fractured metasediments layers (where present). This is important to represent groundwater abstraction from the simulated limestone unit and fractured zone. The vertical hydraulic conductivity for the saprock has been applied an order of magnitude lower than horizontal hydraulic conductivity to represent in-situ weathering. This representation aligns with the calibrated groundwater model for the project (EMM 2019).

The limestone unit has been represented as a small discontinuous layer (0.23 km^2 and 25 m thick).



Source: EMM (2020); Regis Resources (2020); ESRI (2020); DFSI (2017); GA (2011)

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Analytical model elements

McPhillamys Gold Project
Construction water supply groundwater
investigation and impact assessment
Figure 8.1

Table 8.2 Model parameters

Domain	Layer	Aquifer type	Maximum thickness (m)	Storativity (-)	Specific yield (%)	Horizontal hydraulic conductivity (m/day)	Vertical hydraulic conductivity (m/day)
Metasediments (saprock)	1	Unconfined	150	NA	5	0.06	0.006
Metasediments (fractured)	2	Confined	50	0.001	NA	0.14	NA*
Limestone	2		25	0.1	NA	0.36	NA*
Volcanics	1		200	0.001	NA	0.06	NA*

Notes: Storativity is not used within the steady state model (independent of change in storage).
NA = not applicable (dependent on aquifer type)
* The model does not simulate vertical flow in layer 2 or single layer zones.

8.4 Prediction modelling

The steady state model was used to generate initial head conditions for transient simulations representing groundwater abstraction for construction water supply purposes, with the following details:

- simulation period of nine months (270 days);
- two transient simulations (scenarios 1 and 2) were run with groundwater abstraction at continuous combined rate of 20 L/s (ie 24 hours, 7 days a week; see below for further information);
- a transient model was also run without any groundwater abstraction and used to compare baseflows to the Belubula River in isolation (ie acting as a null model);
- pumping at neighbouring landholder bores was not simulated as the predicted drawdown from construction water supply bores will not be affected by landholder pumping; and
- the Belubula River was represented in the analytical model as a river line boundary with specified stage heads consistent with the numerical model (EMM 2019). River line boundaries allow water into and out of the model, the upper stages of the river were allowed to go dry if/when the groundwater head falls below the specified river stage.

8.4.1 Scenarios

The analytical modelling included assessment of two pumping bore configurations:

- Scenario 1:
  - TB05 at a rate of 15 L/s, which is above the recommended pumping rate presented in Section 7.2. The simulated pumping at TB05 in the analytical model represents a replacement test bore drilled in the limestone feature, with higher efficiencies, greater depth, and therefore higher pumping rates; and
  - TPB4 at 5 L/s, which is the recommended pumping rate presented in Section 7.2.
- Scenario 2:
  - TB05 at rate of 10 L/s, which is the recommended pumping rate presented in Section 7.2;

- TPB4 at 5 L/s, which is the recommended pumping rate presented in Section 7.2; and

- TB06 at 5 L/s, which represents an additional bore located at an identified drill target (fractured metasediments).

8.4.2 Results

Modelled groundwater drawdown contours at the end of the nine-month period of constant groundwater abstraction are presented in Figure 8.2 and Figure 8.3.

The key findings of scenario 1 (two bores: TB05 and TPB4 operating) are:

- the modelled drawdown from an abstraction of 15 L/s at TB05 extends 390 m to the north-east and 500 m to the south;

- the modelled drawdown from an abstraction of 5 L/s at TPB4 extends 490 m to the north and 460 m to the south;

- no predicted change in groundwater levels at nearby third-party bores;

- insignificant impacts to watercourses or other identified environmental receptors; and

- a minor net reduction in baseflow to the Belubula River of 0.7 ML at the end of the nine-month construction period (2.5 kL/day), in response to groundwater abstraction at TPB4.

The key findings of scenario 2 (three bores: TB05, TPB4 and TB06 operating) are:

- the modelled drawdown from an abstraction of 10 L/s at TB05 extends 350 m to the north, east and west;

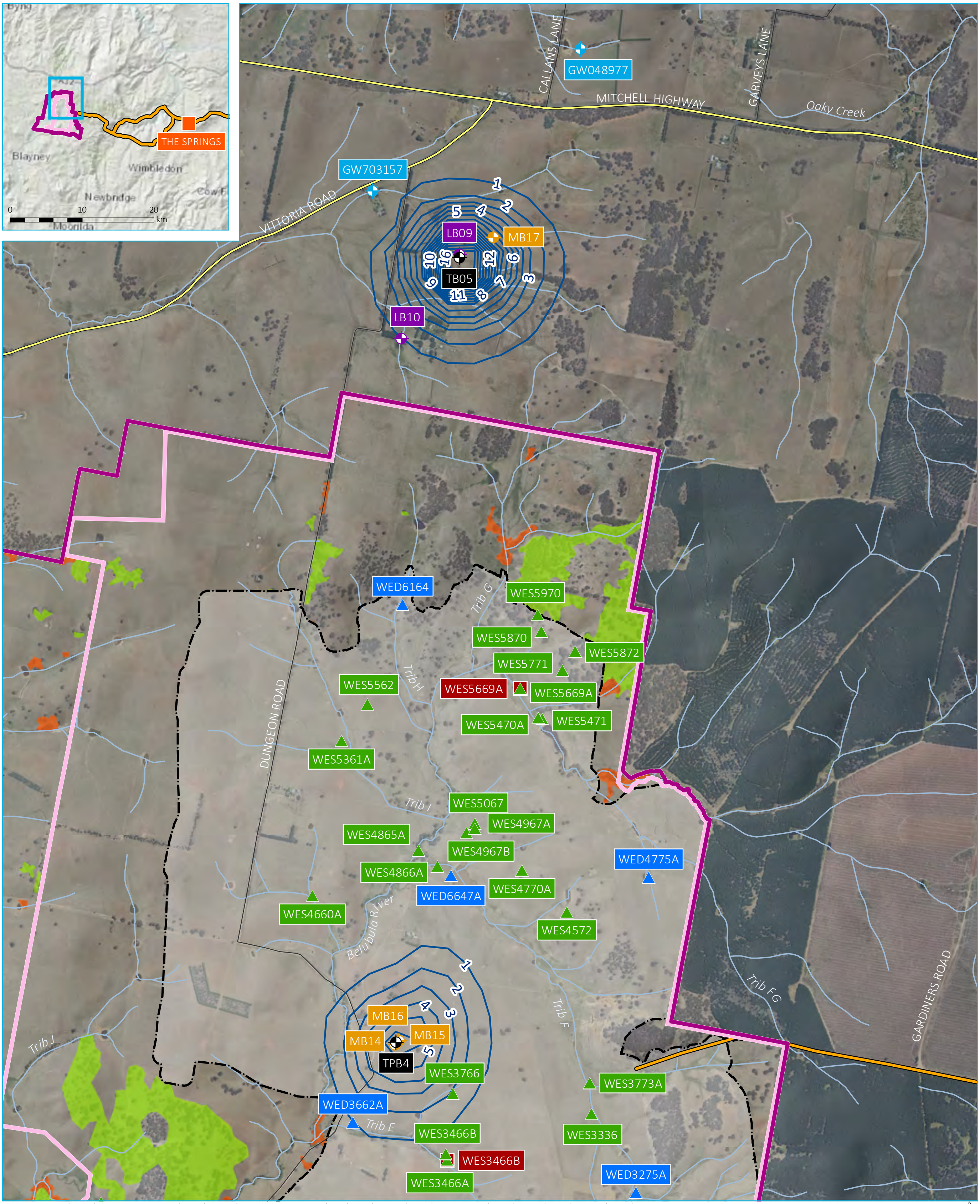
- the modelled drawdown from an abstraction of 5L/s at TB06 extends 430 m to the south;

- the modelled drawdown from an abstraction of 5 L/s at TPB4 extends 490 m to the north and 460 m to the south (similar to scenario 1 predictions);

- no predicted change in groundwater level at third-party bores;

- insignificant impacts to watercourses or other identified environmental receptors; and

- a minor net reduction in baseflow to the Belubula River of 0.7 ML at the end of the nine-month construction period (2.5 kL/day), in response to groundwater abstraction at TPB4.



\\emmsvr1\EMM\Jobs\2017\J17065 - McPhillamys water steering\GIS\02_Maps_CWSDrilling\CWS009_DrawdownScenario1_20200812_03.mxd 12/08/2020

Source: EMM (2020); Regis Resources (2020); ESRI (2020); Survey Graphics (2019); DPIE (2018); EnviroKey (2017); DPE (2015); ELVIS (2014)

0 0.5 1 km

GDA 1994 MGA Zone 55

N

KEY

- Test bore
- Monitoring bore
- Existing bore (Regis land)
- Landholder bore
- 🟧 High-priority GDE (refer to inset)
- ▲ Dam
- ▲ Spring
- 🟥 Stygofauna sample location
- Predicted drawdown (m) (Scenario 1)

Project application area

- Mine development project area
- Mining lease application area (Note: boundary offset for clarity)
- Disturbance footprint
- Pipeline

Existing environment

- Major road
- Minor road
- Watercourse/drainage line

Plant community types

- 🟧 PCT 951 - Mountain Gum - Manna Gum open forest of the South Eastern Highlands Bioregion
- 🟩 PCT 1330 - Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands Bioregion

Modelled drawdown in response to construction water supply (scenario 1)

McPhillamys Gold Project
Construction water supply groundwater investigation and impact assessment
Figure 8.2

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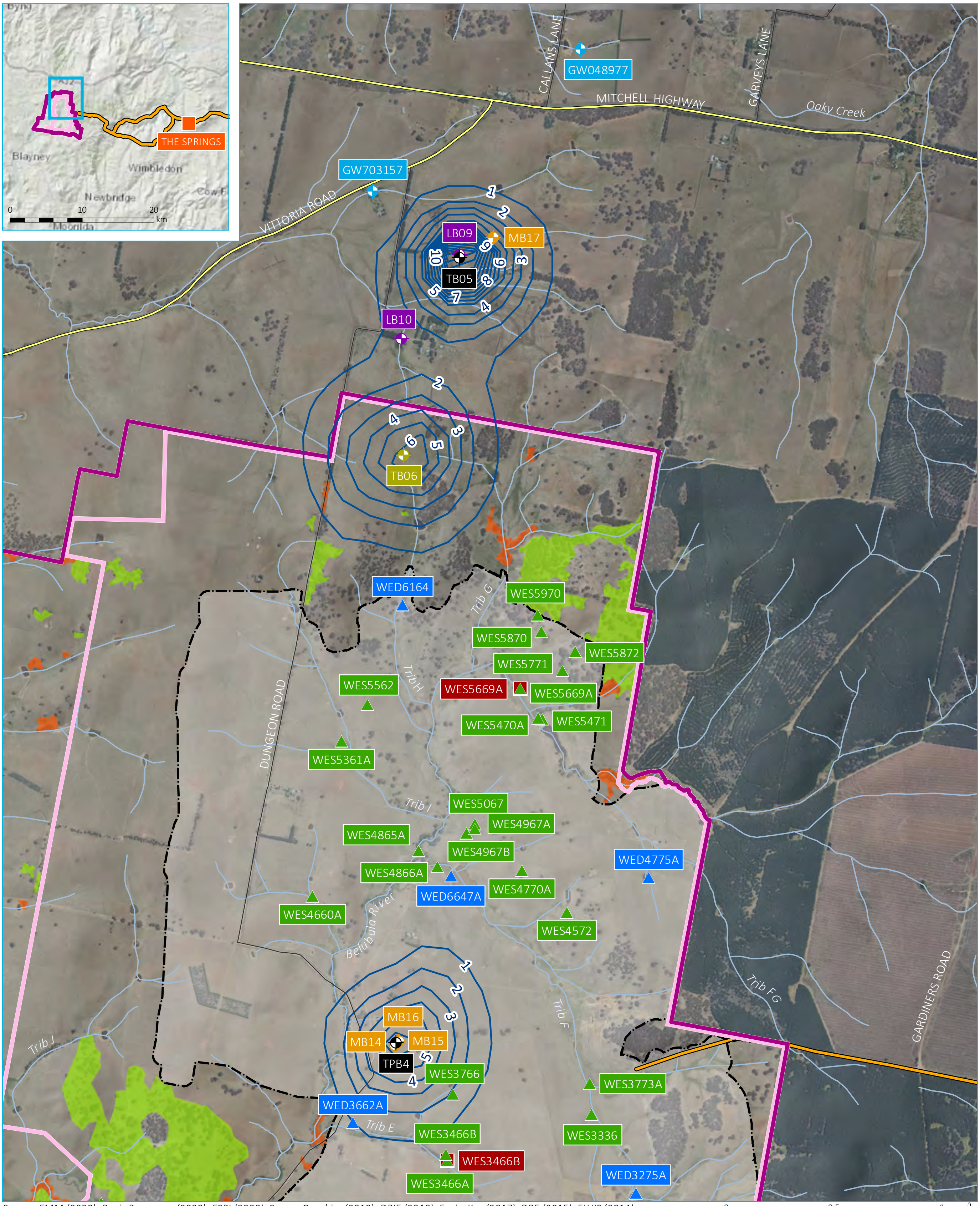

Source: EMM (2020); Regis Resources (2020); ESRI (2020); Survey Graphics (2019); DPIE (2018); EnviroKey (2017); DPE (2015); ELVIS (2014)

0 0.5 1 km

GDA 1994 MGA Zone 55

N

KEY

- ⊕ Test bore
- ⊕ Indicative test bore
- ⊕ Monitoring bore
- ⊕ Existing bore (Regis land)
- ⊕ Landholder bore
- 🟧 High-priority GDE (refer to inset)
- ▲ Dam
- ▲ Spring
- 🟥 Stygofauna sample location
- — Predicted drawdown (m) (Scenario 2)

Project application area

- ▭ Mine development project area
- ▭ Mining lease application area (Note: boundary offset for clarity)
- ▭ Disturbance footprint
- — Pipeline

Existing environment

- — Major road
- — Minor road
- — Watercourse/drainage line

Plant community types

- 🟧 PCT 951 - Mountain Gum - Manna Gum open forest of the South Eastern Highlands Bioregion
- 🟩 PCT 1330 - Yellow Box - Blakely's Red Gum grassy woodland on the tablelands, South Eastern Highlands Bioregion

Modelled drawdown in response to construction water supply (scenario 2)

McPhillamys Gold Project
Construction water supply groundwater investigation and impact assessment
Figure 8.3

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9 Summary

9.1 Overview

The project requires an initial construction water supply for the first nine months of construction prior to the commissioning of the pipeline water supply. This initial supply is required for a period of nine months with a maximum total over this period of 470 ML. Assuming the construction water supply is primarily sourced from groundwater via production bores, the required range is between 15 and 20 L/s, depending on climatic conditions.

This volume will be licensed under the existing Regis groundwater licence for the Lachlan Fold Belt MDB groundwater source. Regis has secured entitlement of 400 unit-shares plus the proposed purchase of an additional 200 unit-shares under the July 2020 Controlled Allocation Order. Regis has been informed that the application for 200 unit-shares has been received and successfully lodged, and the application payment has been made. Alternatively, additional shares can be purchased via the trading market.

The Construction Water Supply Groundwater Investigation and Impact Assessment demonstrates:

- production bores installed within and close to the mine development can be used to meet the short-term construction water demand;
- there are no predicted impacts from the abstraction of 470 ML over a period of nine months on local receptors; and
- the proposed groundwater abstraction will be covered under Regis' existing secured entitlement plus additional unit-shares that are in the process of being acquired and will be held prior to extraction from these bores.

9.2 Field investigations

Drilling and testing investigations were undertaken between March and July 2020 to establish the potential for groundwater supply and assess associated impacts. The investigations included the installation and testing of two test bores and four dedicated monitoring bores:

- test bore TPB4 on land comprising Lot B DP37372, in the mine development area:
  - TPB4 is screened from 96 to 138 mbgl across fractured metasediments within the Anson Formation;
  - monitoring bore MB14 is screened from 78 to 126 mbgl targeting the same deep fractures within the metasediments of the Anson Formation as TPB4;
  - monitoring bore MB15 is screened from 19 to 22 mbgl across a shallower fractured interval, located at the interface between the saprock and the metasediments; and
  - monitoring bore MB16 is screened from 15 to 18 mbgl immediately below the watertable, within the saprock;
- test bore TB05 on land comprising Lot 1 DP801034, north of the mine development area:
  - TB05 intercepted a localised limestone feature within the Anson Formation and has been constructed with a screened and ballast infill zone from 51 to 75 mbgl; and

    - monitoring bore MB17 is located approximately 180 m to the north-east of TB05 (and did not intercept the limestone feature) with a screened interval from 53 to 59 mbgl across Anson Formation saprock);

- drilling at both locations validates the existing conceptual hydrogeological understanding across the mine development area (and surrounds):
    - a saprock layer is present across the area, overlying the fresh metasediments and volcanics and areas of enhanced permeability (targeted for the construction water supply investigations);
    - at the scale of the project, the underlying Anson Formation and Byng Volcanics has low permeability;
    - high permeability is associated with local shear zones and not associated with regional structures;
    - there is limited connection between the Belubula River and regional groundwater system in the upper reaches of the catchment (upstream of Trib E); and
    - the underlying conceptual understanding used as part of the design of the TSF and the seepage management system remains unchanged.

9.3 Results and assessment

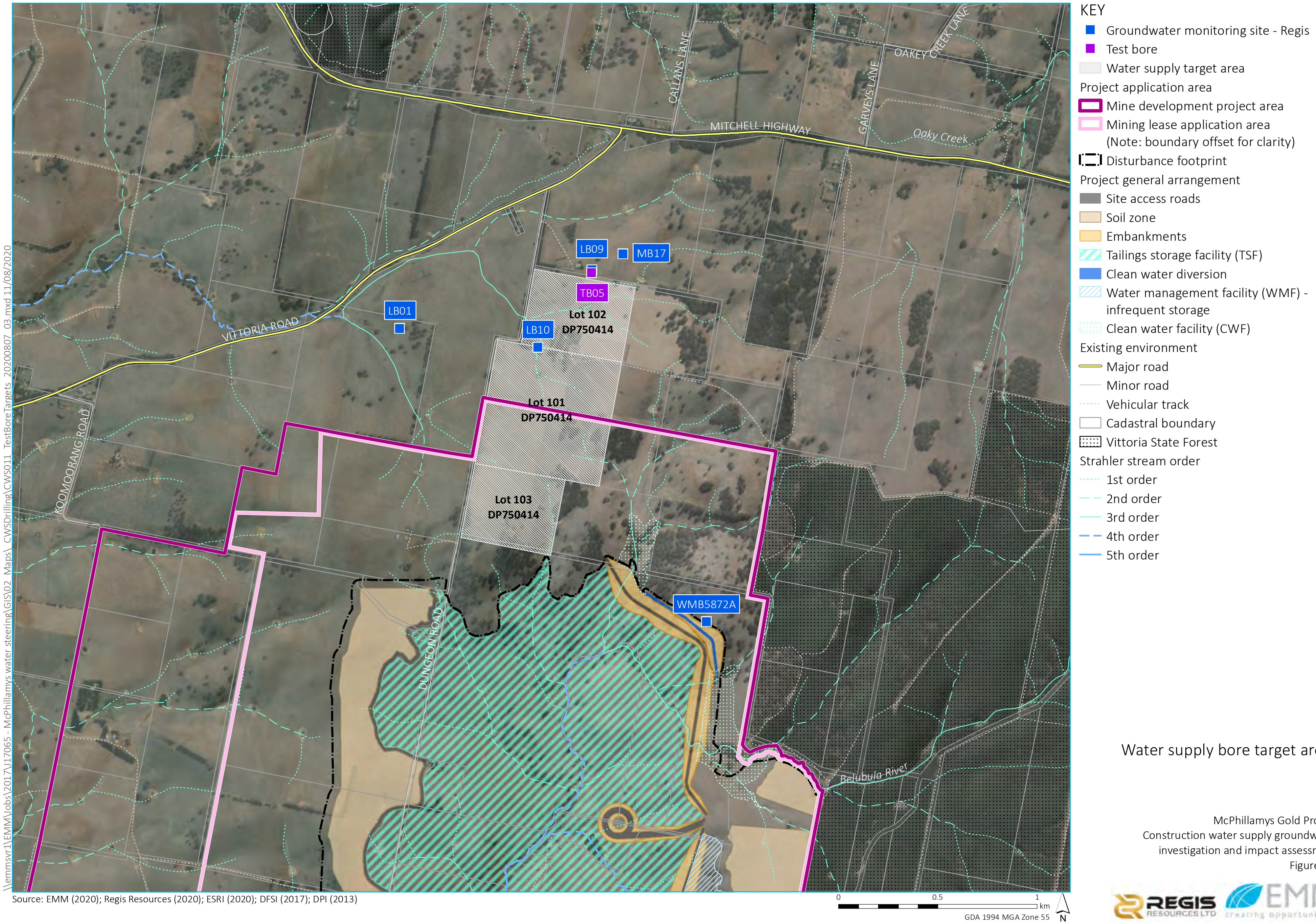
The results of the aquifer test analyses have been used to identify a pumping rate for operation of each test bore during the first nine months of the construction period (Table 9.1).

Table 9.1 Recommended pumping rates over nine months

Bore ID	Recommended pumping rate (L/s)
TB05	10
TPB4	5
Secured groundwater supply	**15**
Groundwater supply demand (to meet the demand under all assessed climate scenarios)	20
Groundwater supply shortfall	**5**

Notes: L/s = litres per second

Regis will drill and install additional bores to meet peak demands at drilling targets identified within the mine development and on Regis-owned land (Figure 9.1).



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Source: EMM (2020); Regis Resources (2020); ESRI (2020); DFSI (2017); DPI (2013)

Water supply bore target areas

McPhillamys Gold Project
Construction water supply groundwater
investigation and impact assessment
Figure 9.1

Analytical modelling was completed to predict the area of influence from operating the production bores and to assess the potential impact on nearby receptors:

- The groundwater level drawdown around the production bores is localised, extending no more than 500 m. There are no third-party bores or identified springs within the modelled drawdown (except for WES3766 located on the outer edge of the predicted extent of drawdown for TPB4 which will be disturbed by project infrastructure).
- The predicted extent of drawdown will be significantly less than the predicted drawdown from the open cut pit due to the limited and one-off time that abstraction will occur over, and the shallower depth of pumping.
- A temporary reduction in baseflow contribution of 0.7 ML (2.5 kL/day) to the Belubula River is estimated in the vicinity of TPB4. Based on the existing understanding of the Belubula River (HEC 2020, EMM 2020), this is a minor change. The estimated short-term reduction in baseflow to the Belubula River will be licensed by entitlements held by Regis in the Lachlan Fold Belt MDB Groundwater Source.

The areas of higher permeability (at TB05 and TPB4) targeted for short-term water supply are not regionally extensive. Enhanced permeability is rare and difficult to identify within and surrounding the mine development area. The lithology within and surrounding the proposed pit shell has been extensively drilled with no water bearing structures or areas of enhanced permeability encountered.

The localised shear zone and limestone identified by this study are not considered to introduce risk to the project as:

- the shear zone is approximately 1 km from the proposed pit shell;
- the limestone is over 5 km from the proposed pit shell; and
- the TSF design includes a multi barrier approach to seepage management (ATC Williams 2020).

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Glossary

Term	Definition
Abstraction	The removal of water from a water store.
Allocation	The specific volume of water allocated to water access entitlements in a given water year or allocated as specified within a water resource plan.
Aquiclude	A geological formation through which zero flow occurs. May function as a confining layer.
Aquifer	A geological structure, formation or group of formations; able to receive, store and transmit significant quantities of water. A geological structure or formation, or an artificial landfill, that is permeated with water or is capable of being permeated with water (NSW Water Management Act 2000 definition).
Aquifer, confined	An aquifer overlain by a confining bed. The confining bed has a significantly lower hydraulic conductivity than the aquifer. Typically, groundwater in a confined aquifer is under pressure significantly greater than atmospheric pressure.
Aquifer, leaky	A leaky aquifer, also known as a semi-confined aquifer, is an aquifer whose upper and lower boundaries are aquitards, or one boundary is an aquitard and the other is an aquiclude.
Aquifer, fractured rock	An aquifer that occurs in sedimentary, igneous and metamorphosed rocks which have been subjected to disturbance, deformation, or weathering, and which allow water to move through joints, bedding planes, fractures and faults.
Aquifer interference activity (AIP)	Means an activity involving any of the following: (a) the penetration of an aquifer, (b) the interference with water in an aquifer, (c) the obstruction of the flow of water in an aquifer, (d) the taking of water from an aquifer in the course of carrying out mining, or any other activity prescribed by the regulations, (e) the disposal of water taken from an aquifer as referred to in paragraph (d). (NSW Water Management Act 2000 definition).
Aquifer, unconfined	An aquifer in which there is no confining bed between the zone of saturation and the surface. The water table is the upper boundary of an unconfined aquifer and is at atmospheric pressure.
Aquitard	A geological formation that may contain groundwater but is not capable of transmitting significant quantities of it under normal hydraulic gradients. May function as a confining layer.
Baseflow	The component of streamflow supplied by groundwater discharge.
Beneficial use	Referenced in the NSW Aquifer Interference Policy relating to assessment of water quality impacts. The term “beneficial use” is interchangeable with the term “environmental value” (NWQMS 2013) (see below for definition).
Bore	A hole drilled in the ground, a well or any other excavation used to access groundwater. May be used for observation of groundwater (including water level, pressure or quality).
Calibration	Process of adjusting the values of model parameters within physically defensible ranges until the model performance adequately matches observed historical data from one or more locations represented by the model (ie a match is obtained that is robust and fit for purpose).
Confining unit	Low permeability strata that may be saturated but will not allow water to move through it under natural hydraulic gradients.
Drawdown	The decline in groundwater level (hydraulic head) compared to the original (or static) groundwater level. It is a change in groundwater level and is reported in metres.

Term	Definition
Electrical conductivity (EC)	Electrical conductivity (EC) measures dissolved salt in water. The standard EC unit is microSiemens per centimetre (µS/cm) at 25 °C.
Evapotranspiration	The combined loss of water from a given area during a specified period of time by evaporation from the soil or water surface and by transpiration from plants.
Groundwater	The water contained in interconnected pores within rocks and sediments below the ground surface in the saturated zone, including perched systems above the regional water table.
Groundwater access entitlement	Water access entitlement granted on the groundwater resource. In NSW, equivalent to an aquifer access licence.
Groundwater Dependent Ecosystem (GDE)	Natural ecosystems that require access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis, so as to maintain their communities of plants and animals, ecosystem processes and ecosystem services.
Groundwater discharge	The process by which groundwater is released into the environment usually either via baseflow or evapotranspiration.
Groundwater flow	Water that flows in aquifers and aquitards.
Groundwater level	The level of groundwater in an aquifer, typically measured in a groundwater bore. In the case of an unconfined aquifer, the groundwater level is equal to the water table level.
Groundwater recharge	The process which replenishes groundwater, usually by rainfall infiltrating from the ground surface to the water table and/or by surface water infiltrating to the water table from a stream. Other forms of recharge include flooding and irrigation, and artificial recharge can also occur through various means, including bore injection.
Hydraulic conductivity	A property of soil or rock, which describes the ease with which water can move through pore spaces or fractures. It depends on the intrinsic permeability of the material and on the degree of saturation. Saturated hydraulic conductivity describes water movement through saturated media.
Hydrogeology	The study of the interrelationships of geologic materials and processes with water, especially groundwater.
Hydrograph	A graph showing the surface level, discharge, velocity, or some other feature of water, with respect to time.
Hydrostratigraphic unit	The subsurface is divided into hydrostratigraphic units that have similar properties from the point of view of storage and transmission of groundwater. Units that store significant amounts of water and transmit this water relatively easily are called aquifers. Units that offer a high resistance to flow are called aquitards, or confining units.
Permeability	The measure of the ability of a rock, soil or sediment to transmit a fluid. The magnitude of the permeability depends largely on the porosity and the connectedness of pores spaces. Synonymous with hydraulic conductivity when water is the fluid involved.
pH	Value that represents the acidity or alkalinity of an aqueous solution. It is defined as the negative logarithm of the hydrogen ion concentration of the solution.
Potentiometric surface	A surface representing the hydraulic head of groundwater; represented by the water table altitude in an unconfined aquifer or by the altitude to which water will rise in a properly constructed bore in a confined aquifer.
Seep	A moist or wet location where groundwater reaches the land surface.
Specific storage	The storage property for a confined aquifer that defines the quantity of water released from storage from a unit volume of the aquifer per unit decline in hydraulic head.
Spring	A location at the land surface where groundwater discharges creating a visible flow.
Static water level	Depth to groundwater below a datum point or reference point, usually from the top of casing or natural surface.

Term	Definition
Storativity	The volume of water a confined aquifer will release when the water-level is lowered due to pumping or natural discharge. Upon the lowering of potentiometric water levels in such aquifers, they remain fully saturated so that no dewatering occurs (ie the potentiometric surface remains above the top of the confined aquifer formation). The water released is volumetrically equivalent to the volumetric expansion of the water and contraction of the pore space.
Stream	A watercourse and its tributaries. A stream can be permanent or ephemeral.
Surface water	Water that flows over or is stored on the surface of the earth that includes: water in a watercourse, lake or wetland and any water flowing over or lying on land: after having precipitated naturally or after having risen to the surface naturally from underground.
Total dissolved solids (TDS)	The sum of all particulate material dissolved in water. Usually expressed in terms of milligrams per litre (mg/L).
Transmissivity	The product of hydraulic conductivity and saturated thickness.
Water balance	The flow of water into and out of, and changes in the storage volume of, a surface water system, groundwater system, catchment or specified area over a defined period of time.
Water quality	The physical, chemical and biological characteristics of water. Water-quality compliance is usually assessed by comparing these characteristics with a set of reference standards. Common standards used are those for drinking water, safety of human contact and the health of ecosystems.
Water resource	All natural water (surface water or groundwater) and alternative water sources, such as recycled or desalinated water, that has not yet been abstracted or used.
Water sharing plan	A legislated plan that establishes rules for managing and sharing water between ecological processes and environmental needs of the respective water source (river/aquifer). It manages water access licences, water allocation and trading, water extraction, operation of dams, management of water flows, and use and rights of different water users.
Water source	In NSW, water source means the whole or any part of: (a) one or more rivers, lakes or estuaries, or (b) one or more places where water occurs on or below the surface of the ground (including overland flow water flowing over or lying there for the time being), and includes the coastal waters of the State. (NSW Water Management Act 2000 definition).
Watertable	The top of an unconfined aquifer which can be either perched or regional. It is at atmospheric pressure and, in a regional context, indicates the level below which soil and rock are saturated with water.

APPENDIX A –
BORE COMPLETION LOGS

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St Leonards NSW 2065
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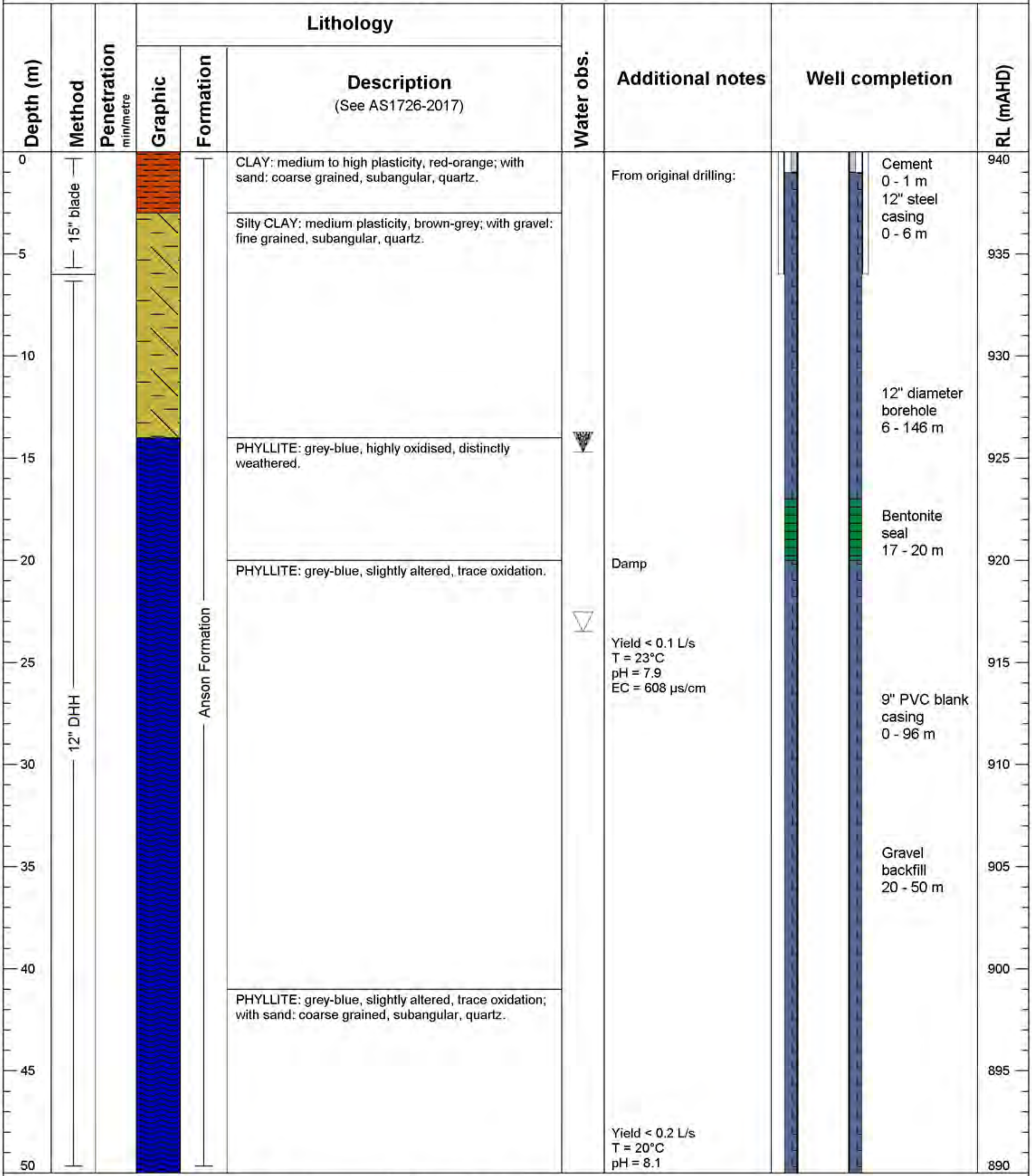
Test Bore

ID: TPB4

Project: McPhillamys CWS
Project number: J17065
Client: Regis Resources Ltd
Site: Arbour Hills - Dungeon Rd
Logged by: Claire Corthier
Date completed: 25/04/2020

Easting: 716,425 m
Northing: 6,293,990 m
Spatial reference: MGA Zone 55
Elevation (collar):
Elevation (ground): 940 mAHD
Nominal diameter: 226 mm (casing ID)

Screened lithology: Fractured phyllite
Screen interval: 96 - 138 mbgl
Drilling method: DHH reaming
Total depth: 144 mbgl
Standing water level: 14.2 mbgl
Date of water level: 26/05/2020



Description
(See AS1726-2017)

CLAY: medium to high plasticity, red-orange; with sand: coarse grained, subangular, quartz.

Silty CLAY: medium plasticity, brown-grey; with gravel: fine grained, subangular, quartz.

PHYLLITE: grey-blue, highly oxidised, distinctly weathered.

PHYLLITE: grey-blue, slightly altered, trace oxidation.

PHYLLITE: grey-blue, slightly altered, trace oxidation; with sand: coarse grained, subangular, quartz.

Additional notes

From original drilling:

Damp

Yield < 0.1 L/s
T = 23°C
pH = 7.9
EC = 608 µs/cm

Yield < 0.2 L/s
T = 20°C
pH = 8.1

Well completion

Cement
0 - 1 m

12" steel casing
0 - 6 m

12" diameter borehole
6 - 146 m

Bentonite seal
17 - 20 m

9" PVC blank casing
0 - 96 m

Gravel backfill
20 - 50 m

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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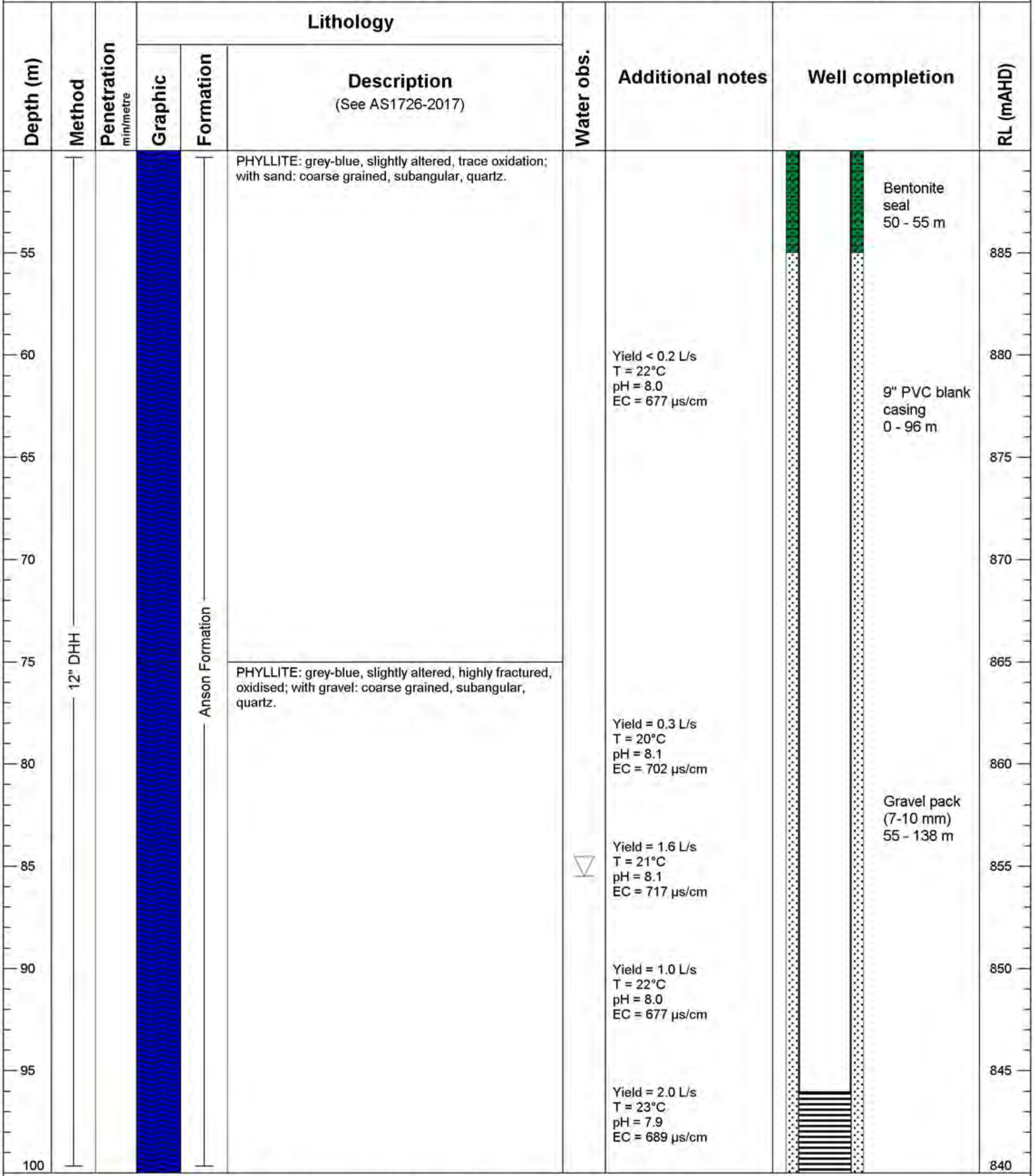

PHYLLITE: grey-blue, slightly altered, trace oxidation; with sand: coarse grained, subangular, quartz.

PHYLLITE: grey-blue, slightly altered, highly fractured, oxidised; with gravel: coarse grained, subangular, quartz.

Yield < 0.2 L/s
T = 22°C
pH = 8.0
EC = 677 µs/cm

Yield = 0.3 L/s
T = 20°C
pH = 8.1
EC = 702 µs/cm

Yield = 1.6 L/s
T = 21°C
pH = 8.1
EC = 717 µs/cm

Yield = 1.0 L/s
T = 22°C
pH = 8.0
EC = 677 µs/cm

Yield = 2.0 L/s
T = 23°C
pH = 7.9
EC = 689 µs/cm

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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Test Bore

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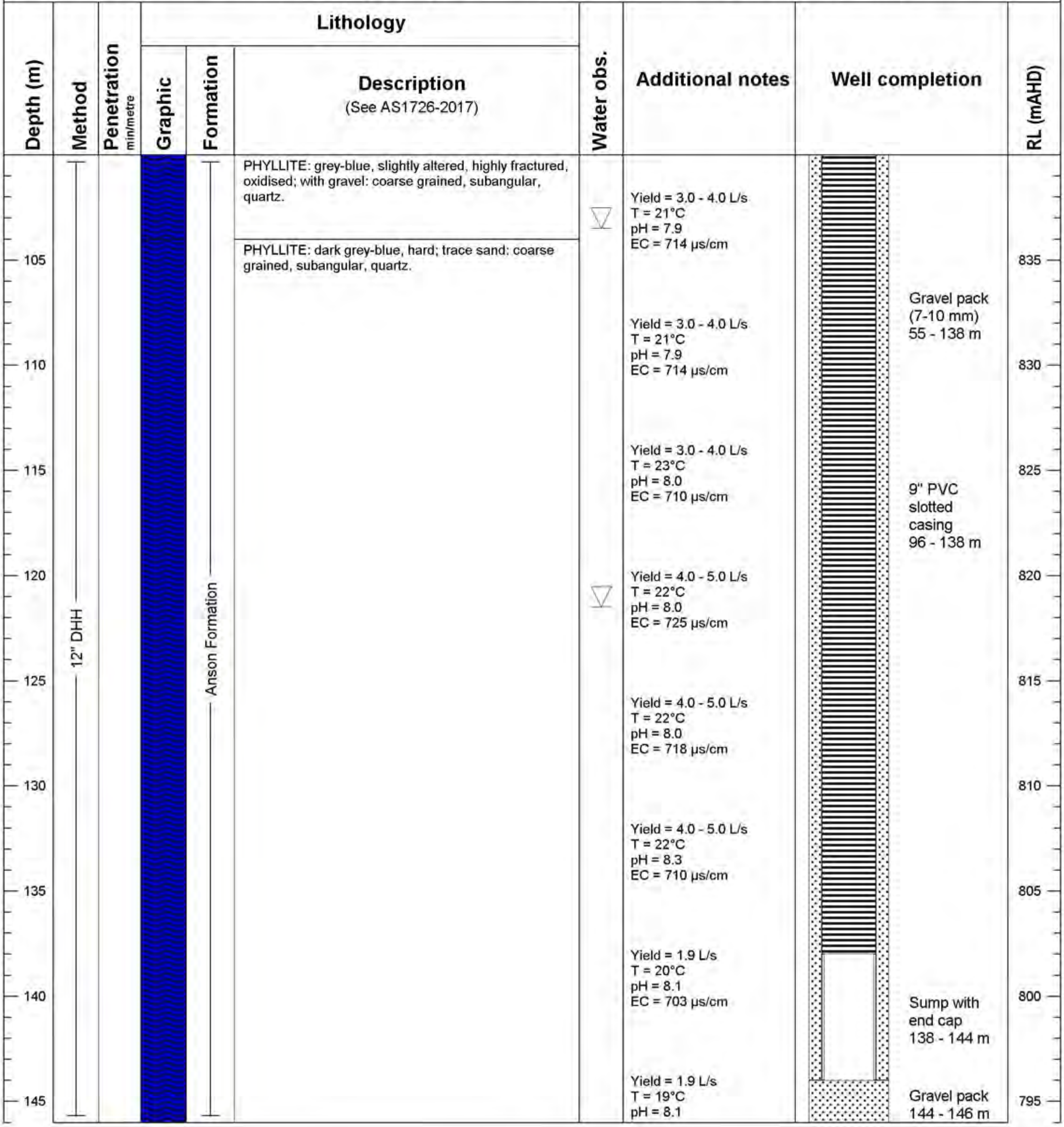

PHYLLITE: grey-blue, slightly altered, highly fractured, oxidised; with gravel: coarse grained, subangular, quartz.

PHYLLITE: dark grey-blue, hard; trace sand: coarse grained, subangular, quartz.

Yield = 3.0 - 4.0 L/s
T = 21°C
pH = 7.9
EC = 714 µs/cm

Yield = 3.0 - 4.0 L/s
T = 21°C
pH = 7.9
EC = 714 µs/cm

Yield = 3.0 - 4.0 L/s
T = 23°C
pH = 8.0
EC = 710 µs/cm

Yield = 4.0 - 5.0 L/s
T = 22°C
pH = 8.0
EC = 725 µs/cm

Yield = 4.0 - 5.0 L/s
T = 22°C
pH = 8.0
EC = 718 µs/cm

Yield = 4.0 - 5.0 L/s
T = 22°C
pH = 8.3
EC = 710 µs/cm

Yield = 1.9 L/s
T = 20°C
pH = 8.1
EC = 703 µs/cm

Yield = 1.9 L/s
T = 19°C
pH = 8.1

Gravel pack
(7-10 mm)
55 - 138 m

9" PVC
slotted
casing
96 - 138 m

Sump with
end cap
138 - 144 m

Gravel pack
144 - 146 m

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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(02) 9493 9589

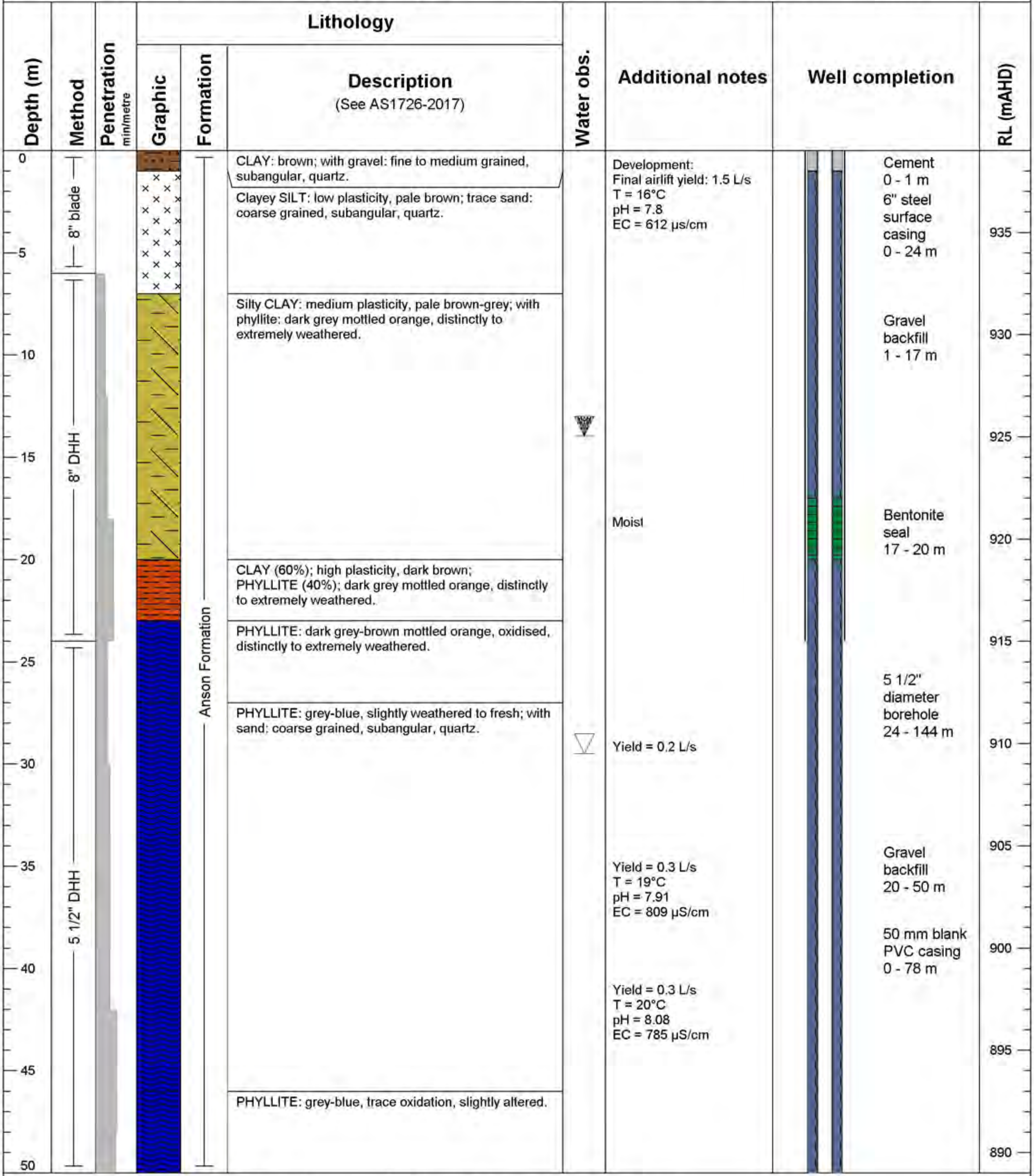
Monitoring Bore

ID: MB14

Project: McPhillamys CWS
Project number: J17065
Client: Regis Resources Ltd
Site: Arbour Hills - Dungeon Rd
Logged by: Claire Corthier
Date completed: 30/04/2020

Easting: 716,421 m
Northing: 6,293,978 m
Spatial reference: MGA Zone 55
Elevation (collar):
Elevation (ground): 939 mAHD
Nominal diameter: 50 mm (casing ID)

Screened lithology: Fractured phyllite
Screen interval: 78-90; 108-126 mbgl
Drilling method: DHH
Total depth: 144 mbgl
Standing water level: 13.5 mbgl
Date of water level: 6/05/2020



Description (See AS1726-2017)

CLAY: brown; with gravel: fine to medium grained, subangular, quartz.

Clayey SILT: low plasticity, pale brown; trace sand: coarse grained, subangular, quartz.

Silty CLAY: medium plasticity, pale brown-grey; with phyllite: dark grey mottled orange, distinctly to extremely weathered.

CLAY (60%); high plasticity, dark brown; PHYLLITE (40%); dark grey mottled orange, distinctly to extremely weathered.

PHYLLITE: dark grey-brown mottled orange, oxidised, distinctly to extremely weathered.

PHYLLITE: grey-blue, slightly weathered to fresh; with sand: coarse grained, subangular, quartz.

PHYLLITE: grey-blue, trace oxidation, slightly altered.

Additional notes

Development:
Final airlift yield: 1.5 L/s
T = 16°C
pH = 7.8
EC = 612 µs/cm

Moist

Yield = 0.2 L/s

Yield = 0.3 L/s
T = 19°C
pH = 7.91
EC = 809 µS/cm

Yield = 0.3 L/s
T = 20°C
pH = 8.08
EC = 785 µS/cm

Well completion

Cement
0 - 1 m
6" steel surface casing
0 - 24 m

Gravel backfill
1 - 17 m

Bentonite seal
17 - 20 m

5 1/2" diameter borehole
24 - 144 m

Gravel backfill
20 - 50 m

50 mm blank PVC casing
0 - 78 m

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

File path: T:\Jobs\2017\J17065 - McPhillamys water steering\Technical studies\Construction supply\Drilling program\LogPlot\LogPLot files\MB14.ldal8

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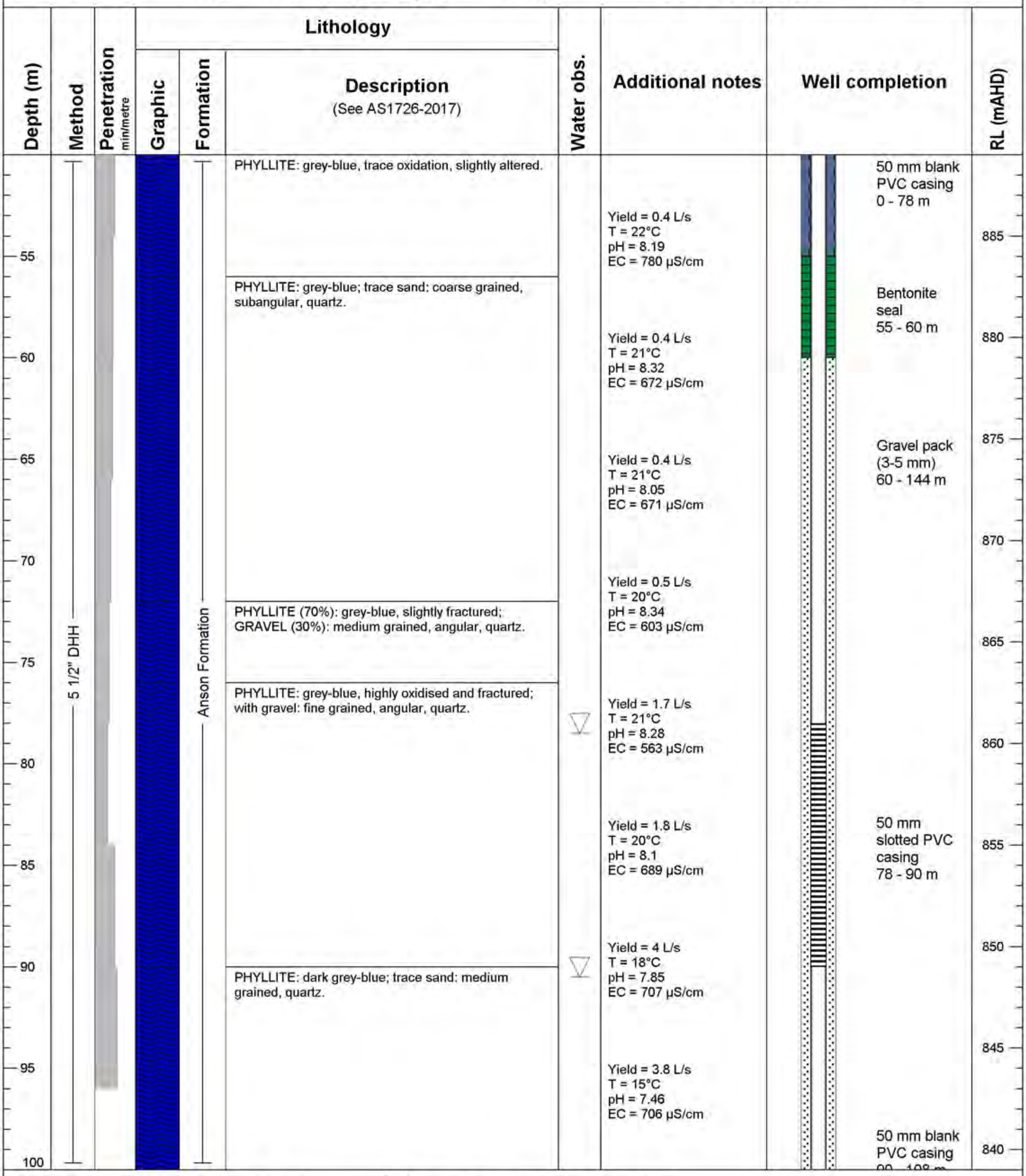
Monitoring Bore

ID: MB14

Project:	McPhillamys CWS	**Easting:**	716,421 m
Project number:	J17065	**Northing:**	6,293,978 m
Client:	Regis Resources Ltd	**Spatial reference:**	MGA Zone 55
Site:	Arbour Hills - Dungeon Rd	**Elevation (collar):**	
Logged by:	Claire Corthier	**Elevation (ground):**	939 mAHD
Date completed:	30/04/2020	**Nominal diameter:**	50 mm (casing ID)

Screened lithology:	Fractured phyllite	**Drilling method:**	DHH	**Standing water level:**	13.5 mbgl
Screen interval:	78-90; 108-126 mbgl	**Total depth:**	144 mbgl	**Date of water level:**	6/05/2020



PHYLLITE: grey-blue, trace oxidation, slightly altered.

PHYLLITE: grey-blue; trace sand: coarse grained, subangular, quartz.

PHYLLITE (70%): grey-blue, slightly fractured; GRAVEL (30%): medium grained, angular, quartz.

PHYLLITE: grey-blue, highly oxidised and fractured; with gravel: fine grained, angular, quartz.

PHYLLITE: dark grey-blue; trace sand: medium grained, quartz.

Yield = 0.4 L/s
T = 22°C
pH = 8.19
EC = 780 µS/cm

Yield = 0.4 L/s
T = 21°C
pH = 8.32
EC = 672 µS/cm

Yield = 0.4 L/s
T = 21°C
pH = 8.05
EC = 671 µS/cm

Yield = 0.5 L/s
T = 20°C
pH = 8.34
EC = 603 µS/cm

Yield = 1.7 L/s
T = 21°C
pH = 8.28
EC = 563 µS/cm

Yield = 1.8 L/s
T = 20°C
pH = 8.1
EC = 689 µS/cm

Yield = 4 L/s
T = 18°C
pH = 7.85
EC = 707 µS/cm

Yield = 3.8 L/s
T = 15°C
pH = 7.46
EC = 706 µS/cm

50 mm blank PVC casing 0 - 78 m

Bentonite seal 55 - 60 m

Gravel pack (3-5 mm) 60 - 144 m

50 mm slotted PVC casing 78 - 90 m

50 mm blank PVC casing

Company: Highland Drilling Pty Ltd

Driller: Ian Palk

▽ Water strike/s intercepted during drilling

▼ Standing water level after drilling

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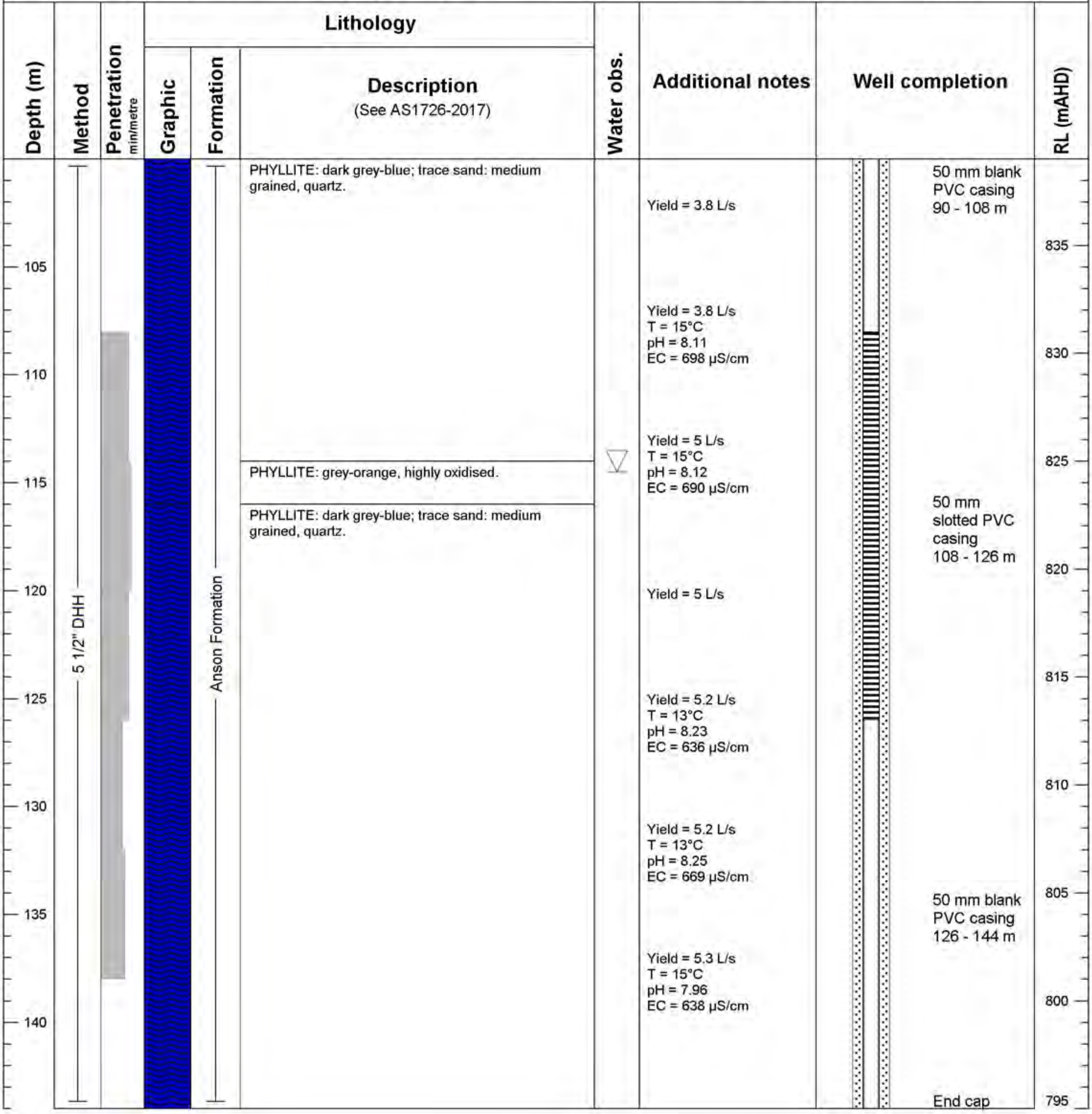
Monitoring Bore

ID: MB14

Project: McPhillamys CWS
Project number: J17065
Client: Regis Resources Ltd
Site: Arbour Hills - Dungeon Rd
Logged by: Claire Corthier
Date completed: 30/04/2020

Easting: 716,421 m
Northing: 6,293,978 m
Spatial reference: MGA Zone 55
Elevation (collar):
Elevation (ground): 939 mAHD
Nominal diameter: 50 mm (casing ID)

Screened lithology: Fractured phyllite
Screen interval: 78-90; 108-126 mbgl
Drilling method: DHH
Total depth: 144 mbgl
Standing water level: 13.5 mbgl
Date of water level: 6/05/2020



PHYLLITE: dark grey-blue; trace sand: medium grained, quartz.

PHYLLITE: grey-orange, highly oxidised.

PHYLLITE: dark grey-blue; trace sand: medium grained, quartz.

Yield = 3.8 L/s

Yield = 3.8 L/s
T = 15°C
pH = 8.11
EC = 698 µS/cm

Yield = 5 L/s
T = 15°C
pH = 8.12
EC = 690 µS/cm

Yield = 5 L/s

Yield = 5.2 L/s
T = 13°C
pH = 8.23
EC = 636 µS/cm

Yield = 5.2 L/s
T = 13°C
pH = 8.25
EC = 669 µS/cm

Yield = 5.3 L/s
T = 15°C
pH = 7.96
EC = 638 µS/cm

50 mm blank PVC casing 90 - 108 m

50 mm slotted PVC casing 108 - 126 m

50 mm blank PVC casing 126 - 144 m

End cap

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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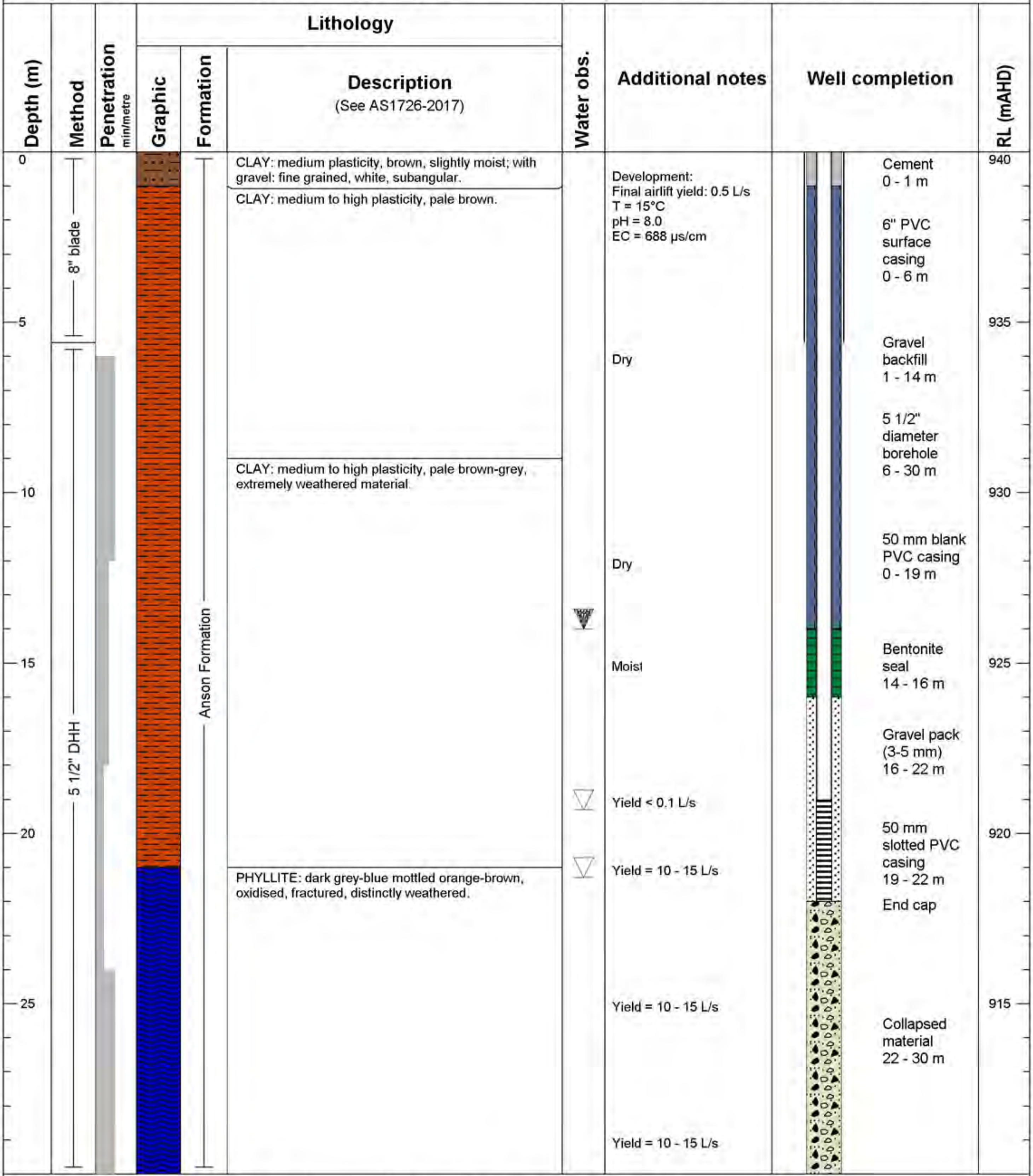
Monitoring Bore

ID: MB15

Project: McPhillamys CWS
Project number: J17065
Client: Regis Resources Ltd
Site: Arbour Hills - Dungeon Rd
Logged by: Emily Barber
Date completed: 5/05/2020

Easting: 716,434 m
Northing: 6,293,994 m
Spatial reference: MGA Zone 55
Elevation (collar):
Elevation (ground): 940 mAHD
Nominal diameter: 50 mm (casing ID)

Screened lithology: Fractured phyllite
Screen interval: 19 - 22 mbgl
Drilling method: DHH
Total depth: 30 mbgl
Standing water level: 13.7 mbgl
Date of water level: 6/05/2020



Description
(See AS1726-2017)

CLAY: medium plasticity, brown, slightly moist; with gravel: fine grained, white, subangular.

CLAY: medium to high plasticity, pale brown.

CLAY: medium to high plasticity, pale brown-grey, extremely weathered material.

PHYLLITE: dark grey-blue mottled orange-brown, oxidised, fractured, distinctly weathered.

Additional notes

Development:
Final airlift yield: 0.5 L/s
T = 15°C
pH = 8.0
EC = 688 μs/cm

Dry

Dry

Moist

Yield < 0.1 L/s

Yield = 10 - 15 L/s

Yield = 10 - 15 L/s

Yield = 10 - 15 L/s

Well completion

Cement
0 - 1 m

6" PVC surface casing
0 - 6 m

Gravel backfill
1 - 14 m

5 1/2" diameter borehole
6 - 30 m

50 mm blank PVC casing
0 - 19 m

Bentonite seal
14 - 16 m

Gravel pack (3-5 mm)
16 - 22 m

50 mm slotted PVC casing
19 - 22 m

End cap

Collapsed material
22 - 30 m

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

File path: T:\Jobs\2017\J17065 - McPhillamys water steering\Technical studies\Construction supply\Drilling program\LogPlot\LogPLot files\MB15.ldat8

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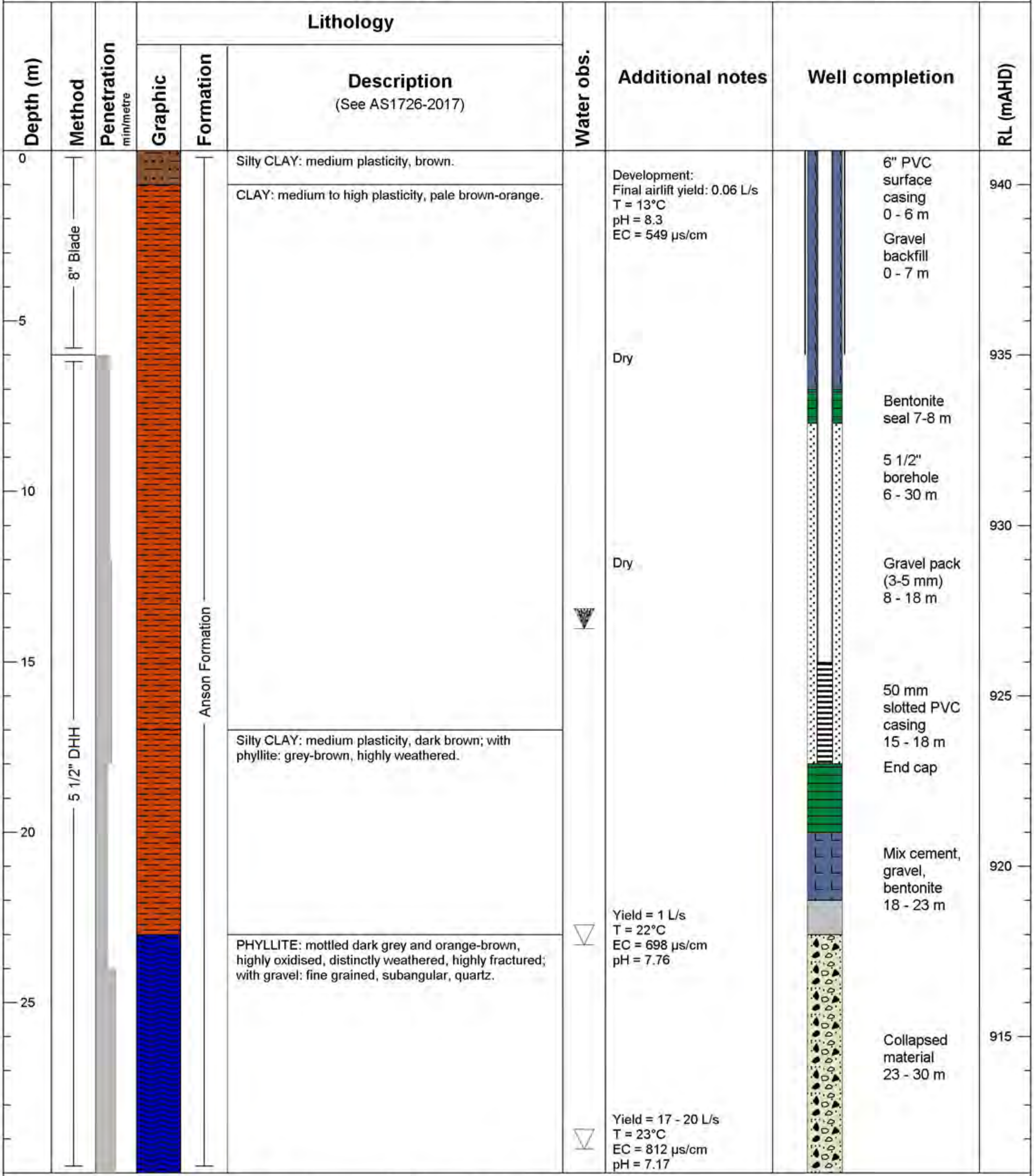
Monitoring Bore

ID: MB16

Project: McPhillamys CWS
Project number: J17065
Client: Regis Resources Ltd
Site: Arbour Hills - Dungeon Rd
Logged by: Emily Barber
Date completed: 28/04/2020

Easting: 716,439 m
Northing: 6,293,996 m
Spatial reference: MGA Zone 55
Elevation (collar):
Elevation (ground): 941 mAHD
Nominal diameter: 50 mm (casing ID)

Screened lithology: Saprock
Screen interval: 15 - 18 mbgl
Drilling method: DHH
Total depth: 23 mbgl
Standing water level: 13.7 mbgl
Date of water level: 6/05/2020



Description
(See AS1726-2017)

Silty CLAY: medium plasticity, brown.

CLAY: medium to high plasticity, pale brown-orange.

Silty CLAY: medium plasticity, dark brown; with phyllite: grey-brown, highly weathered.

PHYLLITE: mottled dark grey and orange-brown, highly oxidised, distinctly weathered, highly fractured; with gravel: fine grained, subangular, quartz.

Additional notes

Development:
Final airlift yield: 0.06 L/s
T = 13°C
pH = 8.3
EC = 549 µs/cm

Dry

Dry

Yield = 1 L/s
T = 22°C
EC = 698 µs/cm
pH = 7.76

Yield = 17 - 20 L/s
T = 23°C
EC = 812 µs/cm
pH = 7.17

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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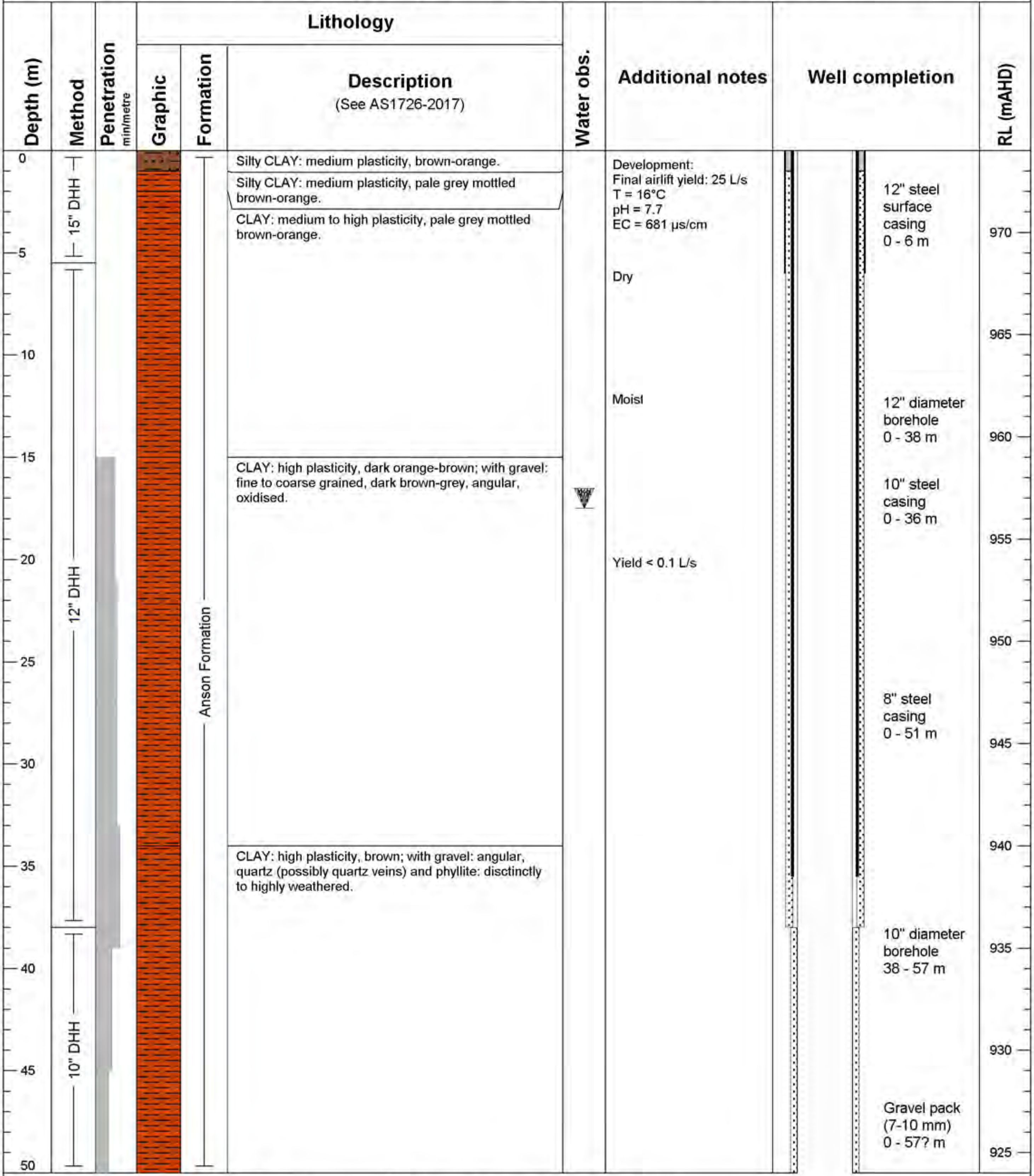
Test Bore

ID: TB05

Project: McPhillamys CWS
Project number: J17065
Client: Regis Resources Ltd
Site: Vaughan Property - Dungeon Rd
Logged by: Emily Barber/ Claire Corthier
Date completed: 18/05/2020

Easting: 716,718 m
Northing: 6,297,629 m
Spatial reference: MGA Zone 55
Elevation (collar):
Elevation (ground): 974 mAHD
Nominal diameter: 203 mm (casing ND)

Screened lithology: Limestone/sand
Screen interval: 51 - 57 mbgl
Drilling method: DHH
Total depth: 75 mbgl
Standing water level: 17.2 mbgl
Date of water level: 26/05/2020



Depth (m)	Description (See AS1726-2017)
0 - 1	Silty CLAY: medium plasticity, brown-orange.
1 - 2.8	Silty CLAY: medium plasticity, pale grey mottled brown-orange.
2.8 - 15	CLAY: medium to high plasticity, pale grey mottled brown-orange.
15 - 34	CLAY: high plasticity, dark orange-brown; with gravel: fine to coarse grained, dark brown-grey, angular, oxidised.
34 -	CLAY: high plasticity, brown; with gravel: angular, quartz (possibly quartz veins) and phyllite: disctinctly to highly weathered.

Additional notes

Development:
Final airlift yield: 25 L/s
T = 16°C
pH = 7.7
EC = 681 μs/cm

Dry

Moist

Yield < 0.1 L/s

Well completion

12" steel surface casing 0 - 6 m

12" diameter borehole 0 - 38 m

10" steel casing 0 - 36 m

8" steel casing 0 - 51 m

10" diameter borehole 38 - 57 m

Gravel pack (7-10 mm) 0 - 57? m

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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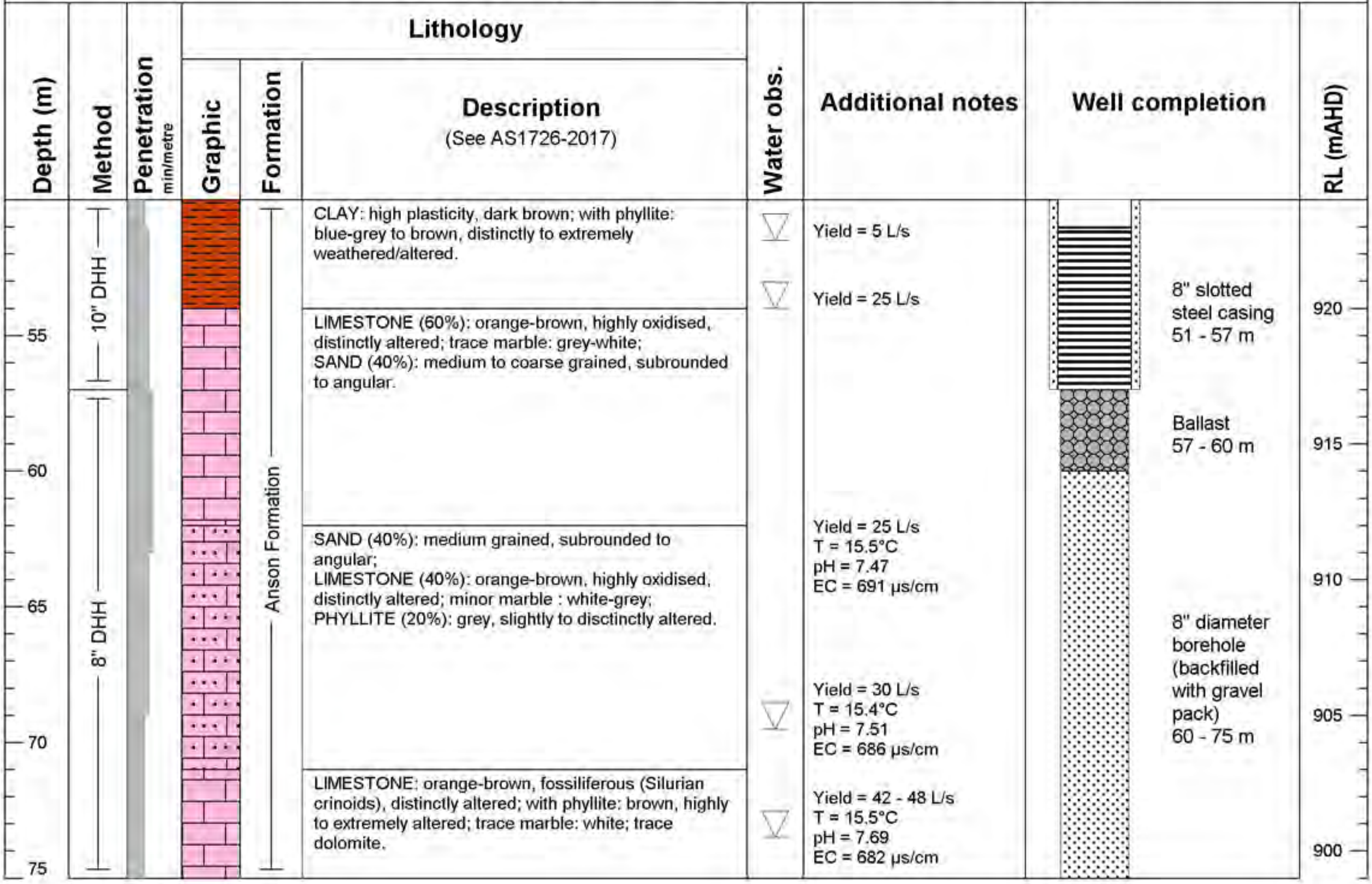
Test Bore

ID: TB05

Project: McPhillamys CWS
Project number: J17065
Client: Regis Resources Ltd
Site: Vaughan Property - Dungeon Rd
Logged by: Emily Barber/ Claire Corthier
Date completed: 18/05/2020

Easting: 716,718 m
Northing: 6,297,629 m
Spatial reference: MGA Zone 55
Elevation (collar):
Elevation (ground): 974 mAHD
Nominal diameter: 203 mm (casing ND)

Screened lithology: Limestone/sand
Screen interval: 51 - 57 mbgl
Drilling method: DHH
Total depth: 75 mbgl
Standing water level: 17.2 mbgl
Date of water level: 26/05/2020



Description (See AS1726-2017)

CLAY: high plasticity, dark brown; with phyllite: blue-grey to brown, distinctly to extremely weathered/altered.

LIMESTONE (60%): orange-brown, highly oxidised, distinctly altered; trace marble: grey-white; SAND (40%): medium to coarse grained, subrounded to angular.

SAND (40%): medium grained, subrounded to angular; LIMESTONE (40%): orange-brown, highly oxidised, distinctly altered; minor marble : white-grey; PHYLLITE (20%): grey, slightly to disctinctly altered.

LIMESTONE: orange-brown, fossiliferous (Silurian crinoids), distinctly altered; with phyllite: brown, highly to extremely altered; trace marble: white; trace dolomite.

Additional notes

Yield = 5 L/s

Yield = 25 L/s

Yield = 25 L/s
T = 15.5°C
pH = 7.47
EC = 691 µs/cm

Yield = 30 L/s
T = 15.4°C
pH = 7.51
EC = 686 µs/cm

Yield = 42 - 48 L/s
T = 15.5°C
pH = 7.69
EC = 682 µs/cm

Well completion

8" slotted steel casing
51 - 57 m

Ballast
57 - 60 m

8" diameter borehole (backfilled with gravel pack)
60 - 75 m

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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Monitoring Bore

ID: MB17

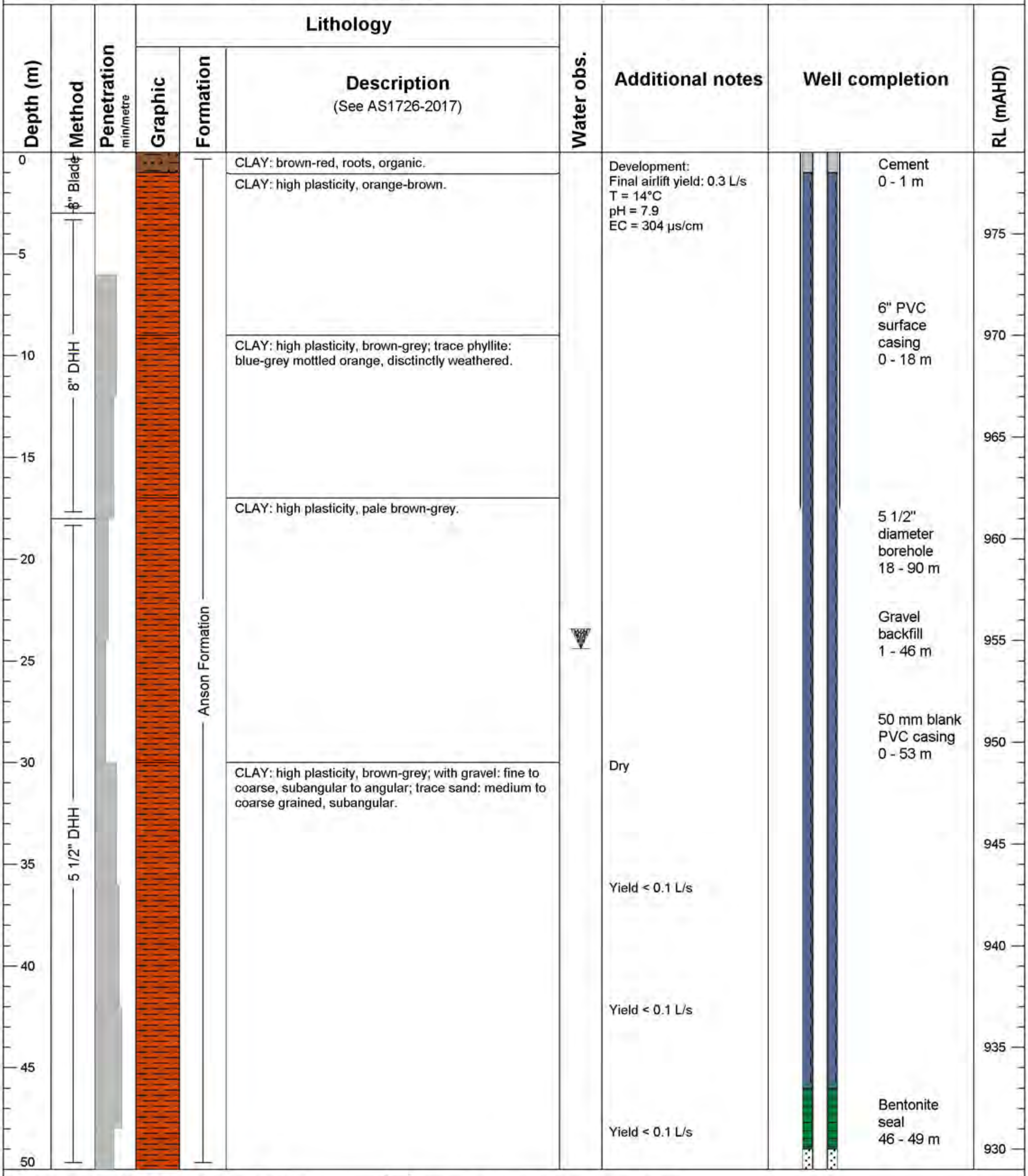
Project:	McPhillamys CWS
Project number:	J17065
Client:	Regis Resources Ltd
Site:	Vaughan Property - Dungeon Rd
Logged by:	Emily Barber
Date completed:	21/05/2020

Easting:	716,875 m
Northing:	6,297,724 m
Spatial reference:	MGA Zone 55
Elevation (collar):	
Elevation (ground):	979 mAHD
Nominal diameter:	50 mm (casing ID)

Screened lithology: Clay/phyllite
Screen interval: 53-59 mbgl

Drilling method: DHH
Total depth: 90 mbgl

Standing water level: 23.9 mbgl
Date of water level: 26/05/2020



CLAY: brown-red, roots, organic.

CLAY: high plasticity, orange-brown.

CLAY: high plasticity, brown-grey; trace phyllite: blue-grey mottled orange, disctinctly weathered.

CLAY: high plasticity, pale brown-grey.

CLAY: high plasticity, brown-grey; with gravel: fine to coarse, subangular to angular; trace sand: medium to coarse grained, subangular.

Development:
Final airlift yield: 0.3 L/s
T = 14°C
pH = 7.9
EC = 304 μs/cm

Dry

Yield < 0.1 L/s

Yield < 0.1 L/s

Yield < 0.1 L/s

Company: Highland Drilling Pty Ltd
Driller: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

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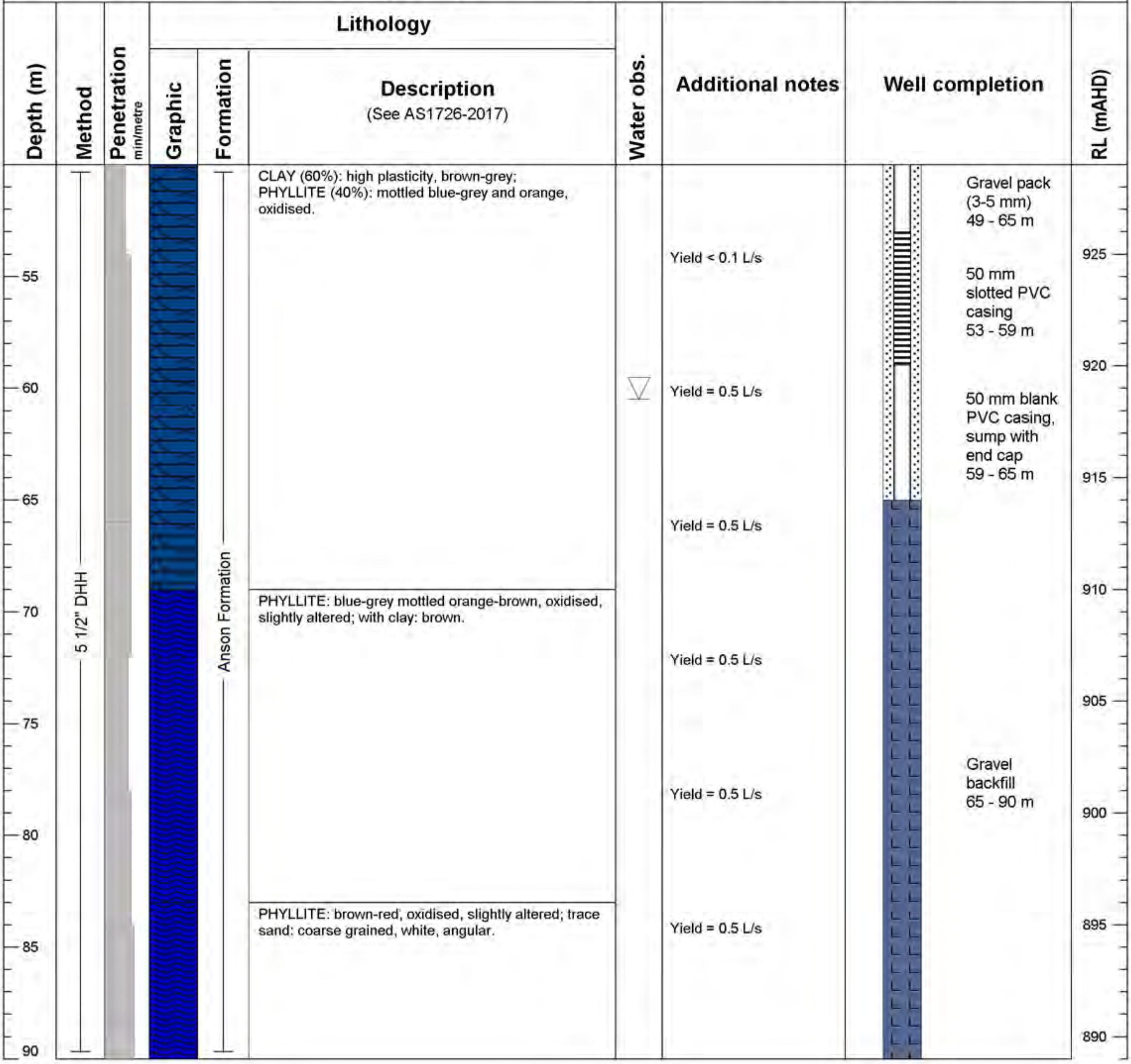
Monitoring Bore

ID: MB17

Project:	McPhillamys CWS
Project number:	J17065
Client:	Regis Resources Ltd
Site:	Vaughan Property - Dungeon Rd
Logged by:	Emily Barber
Date completed:	21/05/2020
Easting:	716,875 m
Northing:	6,297,724 m
Spatial reference:	MGA Zone 55
Elevation (collar):	
Elevation (ground):	979 mAHD
Nominal diameter:	50 mm (casing ID)
Screened lithology:	Clay/phyllite
Screen interval:	53-59 mbgl
Drilling method:	DHH
Total depth:	90 mbgl
Standing water level:	23.9 mbgl
Date of water level:	26/05/2020



CLAY (60%): high plasticity, brown-grey; PHYLLITE (40%): mottled blue-grey and orange, oxidised.

PHYLLITE: blue-grey mottled orange-brown, oxidised, slightly altered; with clay: brown.

PHYLLITE: brown-red, oxidised, slightly altered; trace sand: coarse grained, white, angular.

Yield < 0.1 L/s

Yield = 0.5 L/s

Yield = 0.5 L/s

Yield = 0.5 L/s

Yield = 0.5 L/s

Yield = 0.5 L/s

Gravel pack (3-5 mm) 49 - 65 m

50 mm slotted PVC casing 53 - 59 m

50 mm blank PVC casing, sump with end cap 59 - 65 m

Gravel backfill 65 - 90 m

Company: Highland Drilling Pty Ltd
Driver: Ian Palk

▽ Water strike/s intercepted during drilling
▼ Standing water level after drilling

APPENDIX B –
TEST BORE LICENCES

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NSW Office of Water

Licensing Branch
Po Box 291
9 Spring Street
Forbes NSW 2871
Phone: (02) 68502800

BORE LICENSE CERTIFICATE
UNDER SECTION 115 OF THE WATER ACT, 1912

70BL234003

Department of Primary Industries
NSW Office of Water

Lfb Resources Nl
Level 2, 516 Hay St
Subiaco WA 6008

LICENSE NUMBER
70BL234003
DATE LICENSE VALID FROM
19-Feb-2019
DATE LICENSE VALID TO
PERPETUITY
FEE
$151.00 PAID

ABN 72189919072 GST NIL

LOCATION OF WORKS

Portion(s) or Lot/Section/DP	PARISH	COUNTY
B//37372	Torrens	Bathurst

TYPE OF WORKS	PURPOSE(S) FOR WHICH WATER MAY BE USED
Test Bore	Test Bore

CONDITIONS APPLYING TO THIS LICENSE ARE

As shown on the attached Condition Statement

ORIGINAL

Mr R Smith
P O Box 862
SUBIACO WA 6904

Contact: Abbie Howell
Phone: 02 6850 1305
Fax: 02 6852 3419
Email: abbie.howell@waternsw.com.au

22nd April 2020

Test Bore Licenses: 70BL234083

Please find enclosed your Test bore license, together with x2 blank Form A for recording details of the bores and a map showing location of the approved test bore sites. Your attention is drawn to the nature and description of the work, terms, limitations and conditions under which the licence is issued.

Please show the licence to the driller so that the driller is aware of any conditions affecting the construction of the bore. The driller must have a current driller's licence issued by the Department.

Condition (2) of the licence applies whether the bore is successful or not. The attached Form A has been provided for the recording of details of the proposed bore. The driller is required to record the details of the bore and provide you with the completed form. The driller is also required to mark the location of the bore site on the attached plan. This sketch is required even though you may have already indicated the site to the Department.

You are required to return the completed Form A and plan to the contact officer and address shown in this letter. Failure to do so could restrict future actions relating to the licensed work, such as the future conversion from a Water Act licence to a Water Management Act approval.

If you wish to make a photocopy of the completed Form A, you should do so before forwarding the form to the Department.

If during the construction poor quality water is encountered above the main supply, it is essential that the bore be completed in accordance with condition (4). This will prevent contamination and pollution of the supply and ensure maximum useful life of the bore by protecting the casing and equipment against corrosion.

If you decide to convert the test bores to a production bore (ie: irrigation), you will be required to submit an application for water supply work and/or use approval, and pay the required fee. This application will be assessed in accordance with the requirements of the Upper Lachlan Alluvial Groundwater Source Water Sharing Plan rules.

Yours sincerely

Abbie Howell
Water Regulation Officer- Forbes

NSW Office of Water

Licensing Branch
Po Box 291
9 Spring Street
Forbes NSW 2871
Phone: (02) 68501300

BORE LICENSE CERTIFICATE
UNDER SECTION 115 OF THE WATER ACT, 1912

70BL234083

Department of Primary Industries
Office of Water

Smith, Rodney
P O Box 862
Subiaco WA 6904

LICENSE NUMBER
70BL234083
DATE LICENSE VALID FROM
22-Apr-2020
DATE LICENSE VALID TO
PERPETUITY
FEE
$0.00

ABN 72189919072 GST NIL

LOCATION OF WORKS

Portion(s) or Lot/Section/DP	PARISH	COUNTY
1//801034	Vittoria	Bathurst
1//801034	Vittoria	Bathurst

TYPE OF WORKS	PURPOSE(S) FOR WHICH WATER MAY BE USED
Test Bore	Test Bore

CONDITIONS APPLYING TO THIS LICENSE ARE

As shown on the attached Condition Statement

COPY

70BL234083

NSW Office of Water

CONDITIONS STATEMENT REFERRED TO ON
70BL234083
ISSUED UNDER PART V OF THE WATER ACT, 1912
ON 22-Apr-2020

(1) THE LICENCE SHALL LAPSE IF THE WORK IS NOT COMMENCED AND COMPLETED WITHIN THREE YEARS OF THE DATE OF THE ISSUE OF THE LICENCE.

(2) THE LICENSEE SHALL WITHIN TWO MONTHS OF COMPLETION OR AFTER THE ISSUE OF THE LICENSE IF THE WORK IS EXISTING, FURNISH TO NSW OFFICE OF WATER:-

(A) DETAILS OF THE WORK SET OUT IN THE ATTACHED FORM "A" (MUST BE COMPLETED BY A DRILLER).

(B) A PLAN SHOWING ACCURATELY THE LOCATION OF THE WORK, IN RELATION TO PORTION AND PROPERTY BOUNDARIES.

(C) A ONE LITRE WATER SAMPLE FOR ALL LICENCES OTHER THAN THOSE FOR STOCK, DOMESTIC, TEST BORES AND FARMING PURPOSES.

(D) DETAILS OF ANY WATER ANALYSIS AND/OR PUMPING TESTS.

(3) THE LICENSEE SHALL ALLOW NSW OFFICE OF WATER OR ANY PERSON AUTHORISED BY IT, FULL AND FREE ACCESS TO THE WORKS, EITHER DURING OR AFTER CONSTRUCTION, FOR THE PURPOSE OF CARRYING OUT INSPECTION OR TEST OF THE WORKS AND ITS FITTINGS AND SHALL CARRY OUT ANY WORK OR ALTERATIONS DEEMED NECESSARY BY THE DEPARTMENT FOR THE PROTECTION AND PROPER MAINTENANCE OF THE WORKS, OR THE CONTROL OF THE WATER EXTRACTED AND FOR THE PROTECTION OF THE QUALITY AND THE PREVENTION FROM POLLUTION OR CONTAMINATION OF SUB-SURFACE WATER.

(4) IF DURING THE CONSTRUCTION OF THE WORK, SALINE OR POLLUTED WATER IS ENCOUNTERED ABOVE THE PRODUCING AQUIFER, SUCH WATER SHALL BE SEALED OFF BY:-

(A) INSERTING THE APPROPRIATE LENGTH(S) OF CASING TO A DEPTH SUFFICIENT TO EXCLUDE THE SALINE OR POLLUTED WATER FROM THE WORK.

(B) CEMENTING BETWEEN THE CASING(S) AND THE WALLS OF THE BORE HOLE FROM THE BOTTOM OF THE CASING TO GROUND LEVEL.

ANY DEPARTURE FROM THESE PROCEDURES MUST BE APPROVED BY THE DEPARTMENT BEFORE UNDERTAKING THE WORK.

(5) (A) THE LICENSEE SHALL NOTIFY NSW OFFICE OF WATER IF A FLOWING SUPPLY OF WATER IS OBTAINED. THE BORE SHALL THEN BE LINED WITH CASING AND CEMENTED AND A SUITABLE CLOSING GEAR SHALL BE ATTACHED TO THE BOREHEAD AS SPECIFIED BY NSW OFFICE OF WATER.

(B) IF A FLOWING SUPPLY OF WATER IS OBTAINED FROM THE WORK, THE LICENSEE SHALL ONLY DISTRIBUTE WATER FROM THE BORE HEAD BY A SYSTEM OF PIPE LINES AND SHALL NOT DISTRIBUTE IT IN DRAINS, NATURAL OR ARTIFICIAL CHANNELS OR DEPRESSIONS.

(6) IF A WORK IS ABANDONED AT ANY TIME THE LICENSEE SHALL NOTIFY NSW OFFICE OF WATER THAT THE WORK HAS BEEN ABANDONED AND SEAL OFF THE AQUIFER BY:-

(A) BACKFILLING THE WORK TO GROUND LEVEL WITH CLAY OR CEMENT AFTER WITHDRAWING THE CASING (LINING); OR

(B) SUCH METHODS AS AGREED TO OR DIRECTED BY NSW OFFICE OF WATER.

(7) THE LICENSEE SHALL NOT ALLOW ANY TAILWATER/DRAINAGE TO DISCHARGE INTO OR ONTO:-

- ANY ADJOINING PUBLIC OR CROWN ROAD;
- ANY OTHER PERSONS LAND;
- ANY CROWN LAND;
- ANY RIVER, CREEK OR WATERCOURSE;
- ANY NATIVE VEGETATION AS DESCRIBED UNDER THE NATIVE VEGETATION CONSERVATION ACT 1997;
- ANY WETLANDS OF ENVIRONMENTAL SIGNIFICANCE.

(8) WORKS USED FOR THE PURPOSE OF CONVEYING, DISTRIBUTING OR STORING WATER TAKEN BY MEANS OF THE LICENSED WORK SHALL NOT BE CONSTRUCTED OR INSTALLED SO AS TO OBSTRUCT THE REASONABLE PASSAGE OF FLOOD WATERS FLOWING INTO OR FROM A RIVER.

(9) IF THE BORE AUTHORISED BY THIS LICENSE IS LINED WITH STEEL OR PLASTIC CASING THE INSIDE DIAMETER OF THAT CASING SHALL NOT EXCEED 220 MM.

(10) WATER SHALL NOT BE PUMPED FROM THE BORE AUTHORISED BY THIS LICENSE FOR ANY PURPOSE OTHER THAN GROUNDWATER INVESTIGATION.

(11) SUBJECT TO CONDITION (12) THE LICENSEE SHALL WITHIN TWO MONTHS OF THE DATE OF COMPLETION OF THE BORE AUTHORISED BY THE LICENSE,

(1) BACKFILL IT WITH CLAY OR CEMENT TO GROUND LEVEL, AFTER WITHDRAWING ANY CASING(LINING), OR:-
(2) RENDER IT INEFFECTIVE BY ANY OTHER MEANS ACCEPTABLE TO THE DEPARTMENT.

(12) CONDITION (11) SHALL HAVE NO FORCE OR EFFECT IF:-

(1) AT THE RELEVANT TIME THERE IS WITH NSW OFFICE OF WATER, AN APPLICATION IN RESPECT OF WHICH THE DEPARTMENT HAS NOT MADE A DECISION TO CONVERT THE GROUNDWATER INVESTIGATION BORE INTO A PRODUCTION BORE; OR
(2) THE LICENSEE HAS COMPLETED THE BORE FOR THE PURPOSE OF MEASURING WATER LEVELS OR WATER QUALITY BY THE ADDITION OF CASING WITH A DIAMETER NOT EXCEEDING 220MM.

(13) THE WORKS MUST BE:-

(1) 200 METRES FROM ANY BOUNDARY OF THE PROPERTY.

(2) 600 METRES FROM ANY IRRIGATION BORE ON ANY ADJOINING PROPERTY.

(3) 600 METRES FROM ANY TOWN WATER SUPPLY BORE.

(4) 500 METRES FROM ANY DEPARTMENT OBSERVATION BORE.

(5) 40 METRES FROM THE NEAREST HIGH BANK OF ANY RIVER, CREEK OR WATERCOURSE,

(6) 500 METRES FROM ANY ARTESIAN BORE ON AN ADJOINING PROPERTY,

(7) 200 METRES FROM ANY WETLAND OR OTHER NATURE - CONSERVATION AREA.

End Of Conditions

Department of Industry

Division:
Branch:

Unit:
Ref:

22-Apr-2020
Approved Test Bore Sites
- 70BL234083

Legend
Folio Label
☐ Boundary

Notes
Lot 1 DP 801034

0.5 0 0.23 0.5 Kilometers

WGS_1984_Web_Mercator_Auxiliary_Sphere
© NSW Trade and Investment

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.
THIS MAP IS NOT TO BE USED FOR NAVIGATION

APPENDIX C – PRELIMINARY TESTING ANALYSIS

EMM

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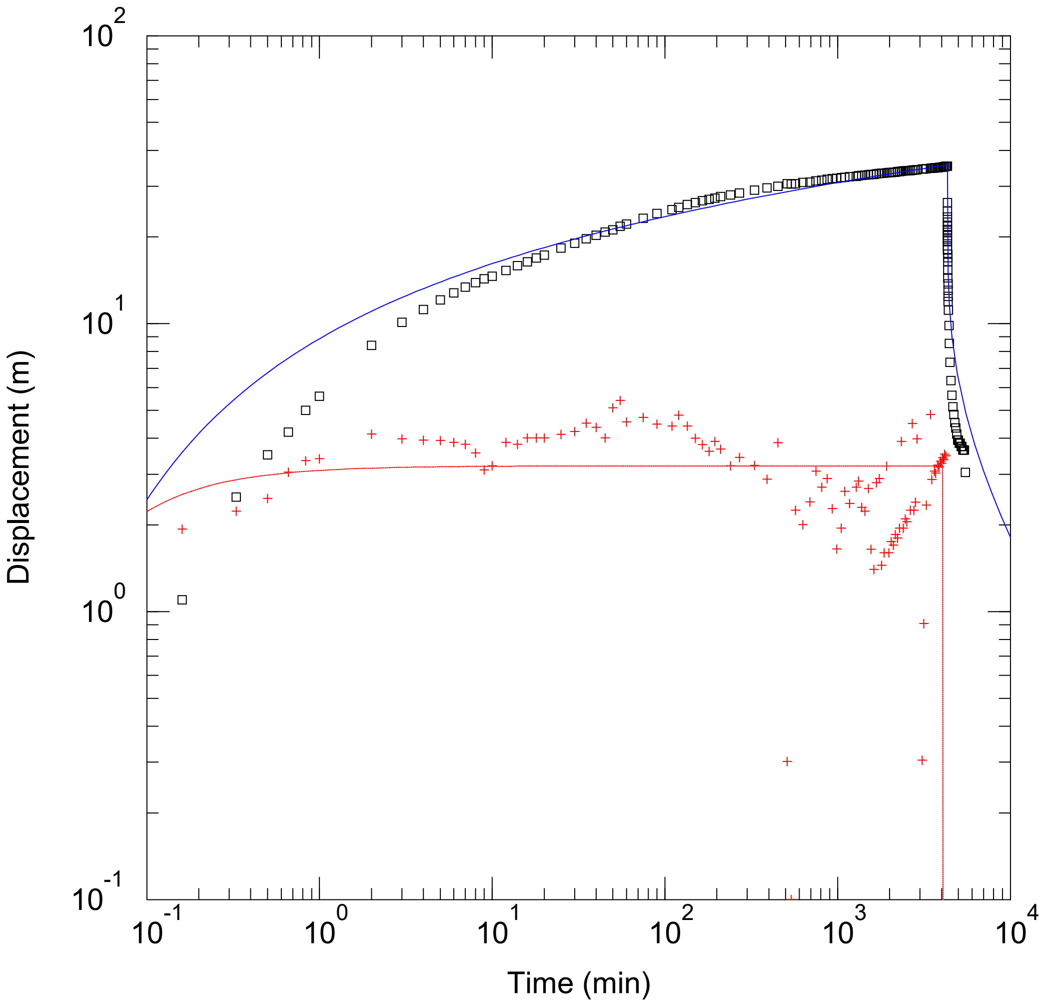


WELL TEST ANALYSIS

Data Set: T:\...\TPB4-CRT 72 hr-confined.aqt
Date: 04/30/20 Time: 14:46:57

PROJECT INFORMATION

Company: EMM Consulting
Client: Regis Resources
Project: H200112
Location: MacPhillamys
Test Well: TPB4
Test Date: 04/04/20

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TPB4	716429	6293990

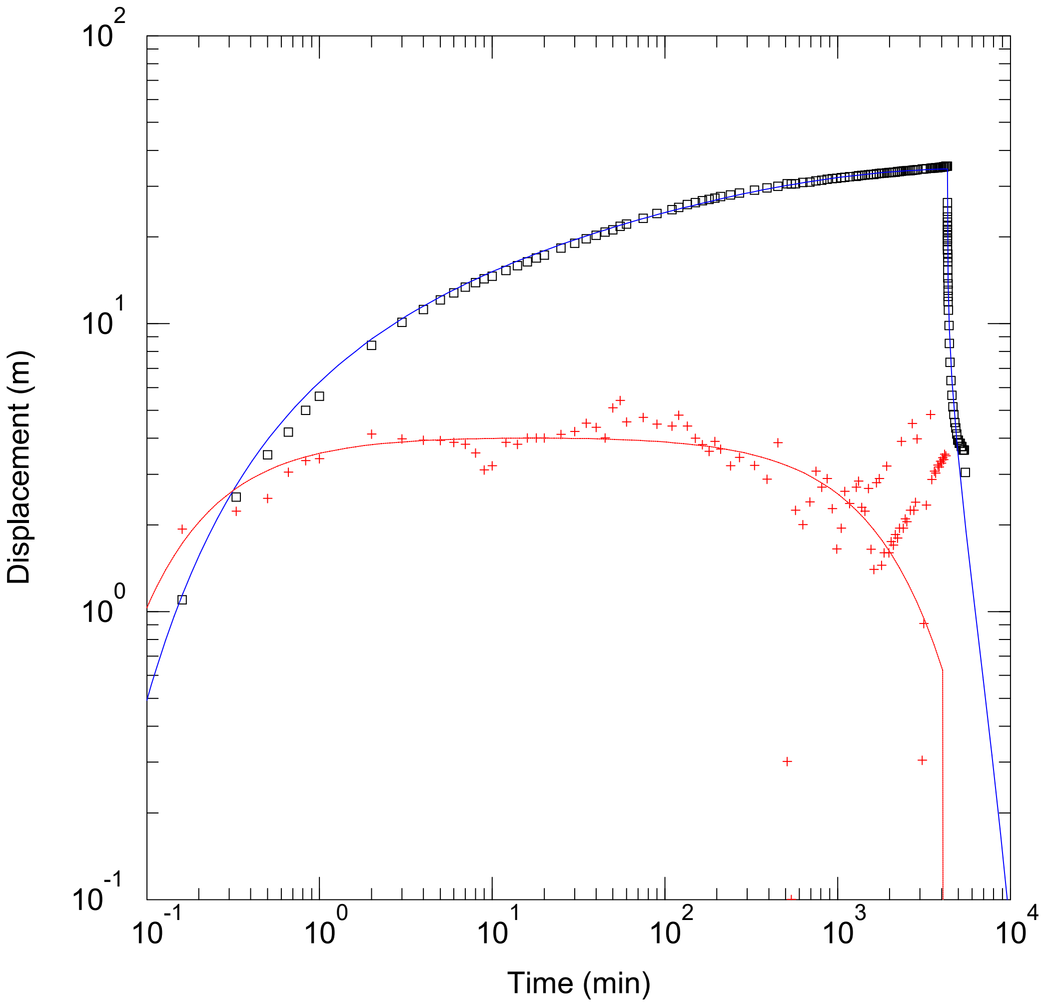
Observation Wells

Well Name	X (m)	Y (m)
□ TPB4	716429	6293990

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 9.647 m^2/day
Kz/Kr = 1.
S = 0.1745
b = 137. m



WELL TEST ANALYSIS

Data Set: T:\...\TPB4-CRT 72 hr-leaky.aqt
Date: 04/30/20 Time: 14:46:18

PROJECT INFORMATION

Company: EMM Consulting
Client: Regis Resources
Project: H200112
Location: MacPhillamys
Test Well: TPB4
Test Date: 04/04/20

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TPB4	716429	6293990

Observation Wells

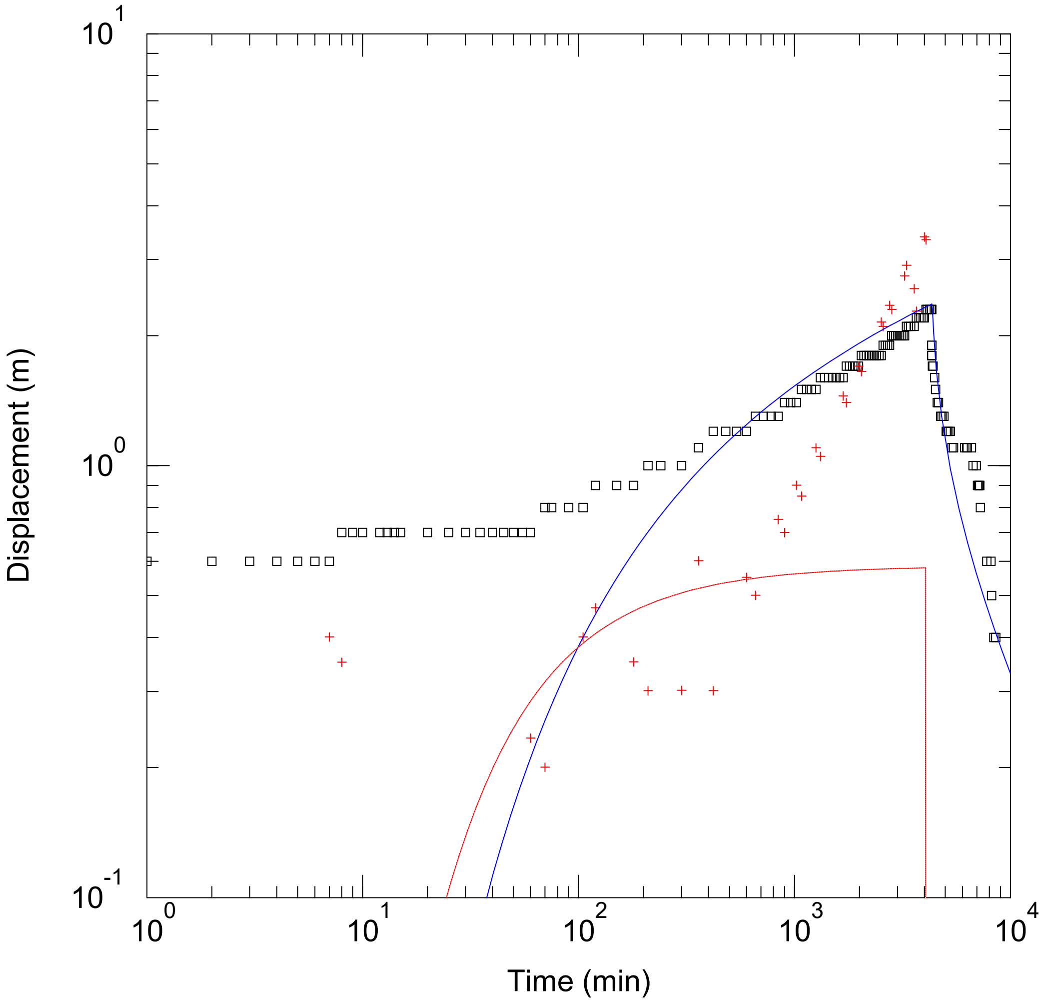
Well Name	X (m)	Y (m)
□ TPB4	716429	6293990

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 7.603 m^2/day
r/B = 0.01593
b = 137. m

S = 0.5156
Kz/Kr = 1.



WELL TEST ANALYSIS

Data Set: T:\...\Mungarra_CRT 72 hr-confined.aqt
Date: 04/30/20 Time: 14:48:05

PROJECT INFORMATION

Company: EMM Consulting
Client: Regis Resources
Project: H200112
Location: MacPhillamys
Test Well: Mungarra
Test Date: 02/04/20

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
Mungarra	716719.48	6297641.12

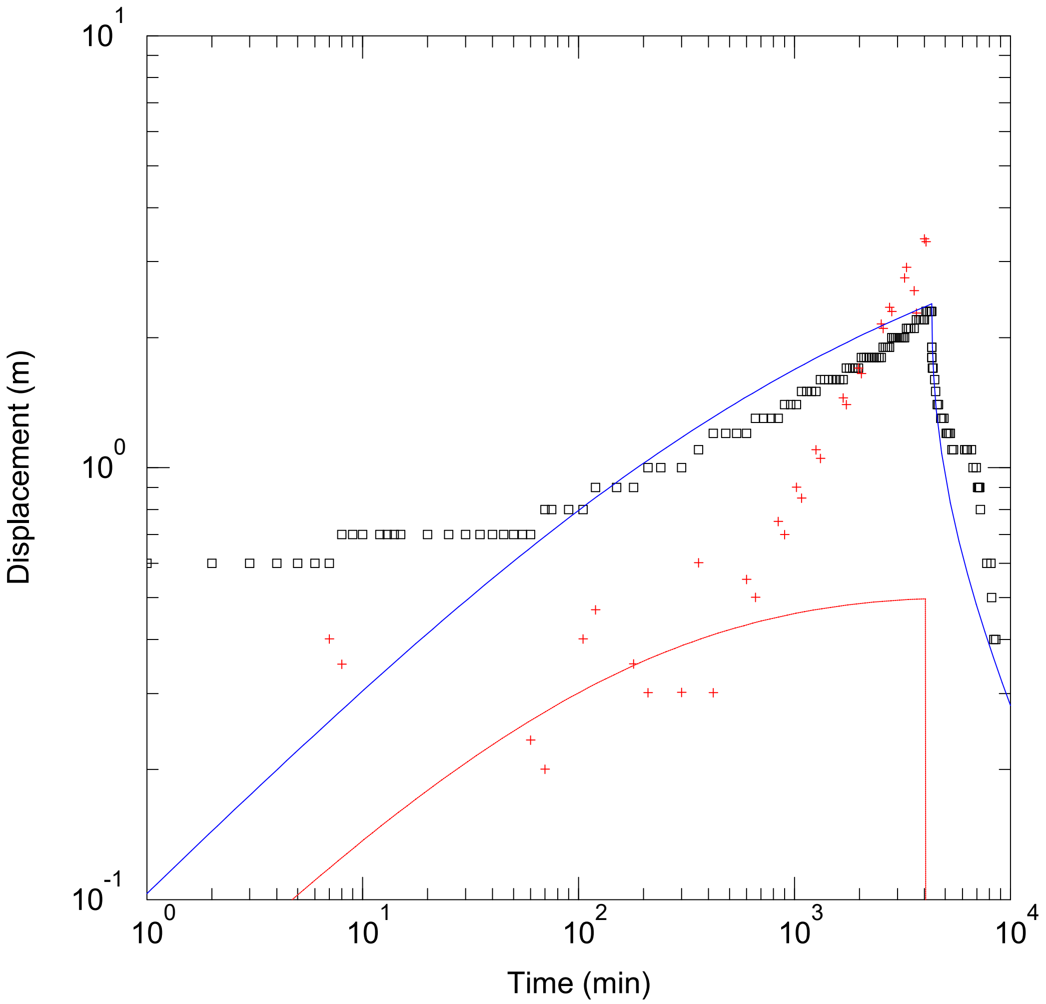
Observation Wells

Well Name	X (m)	Y (m)
□ Mungarra	716719.48	6297641.12

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 58.65 m^2/day
S = 1747.
Kz/Kr = 1.
b = 33. m



WELL TEST ANALYSIS

Data Set: T:\...\Mungarra_CRT 72 hr-confined pp.aqt
Date: 04/30/20 Time: 14:49:26

PROJECT INFORMATION

Company: EMM Consulting
Client: Regis Resources
Project: H200112
Location: MacPhillamys
Test Well: Mungarra
Test Date: 02/04/20

AQUIFER DATA

Saturated Thickness: 33. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
Mungarra	716719.48	6297641.12

Observation Wells

Well Name	X (m)	Y (m)
□ Mungarra	716719.48	6297641.12

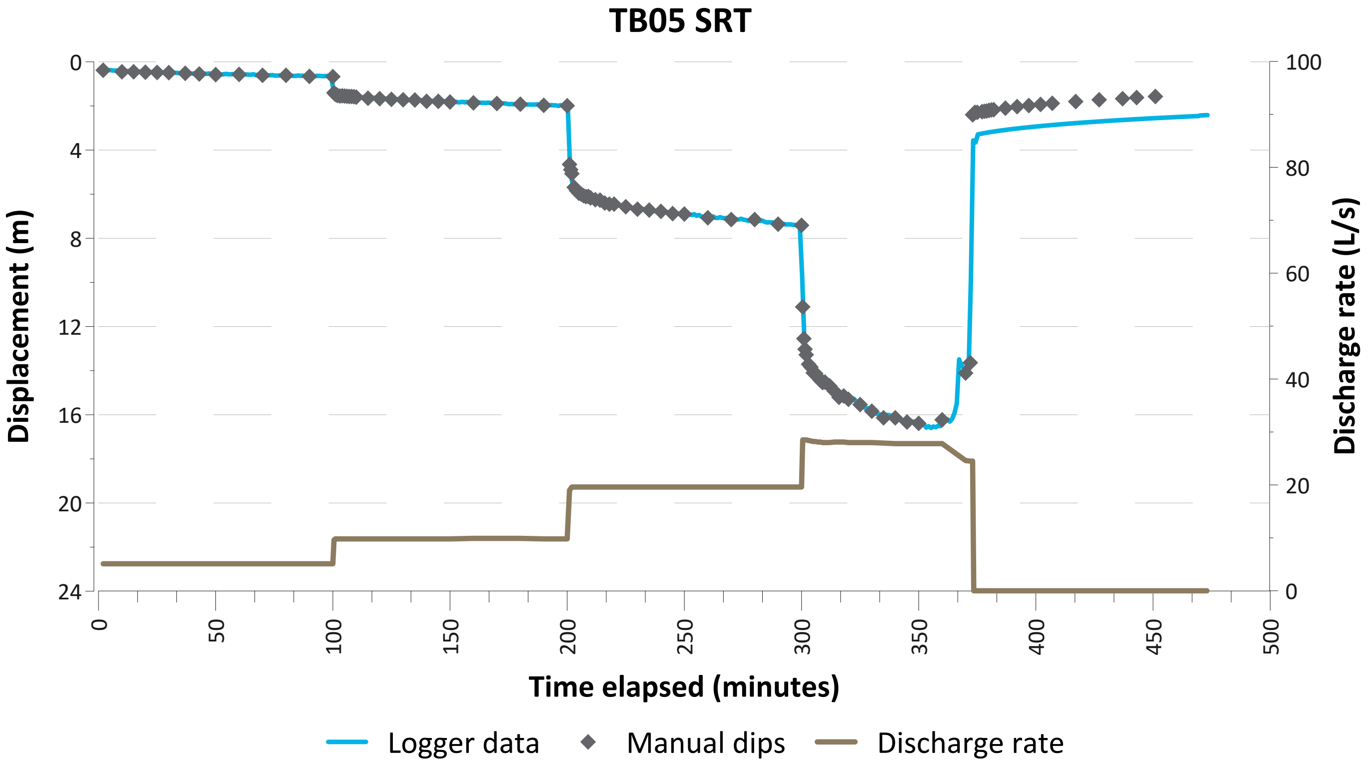
SOLUTION

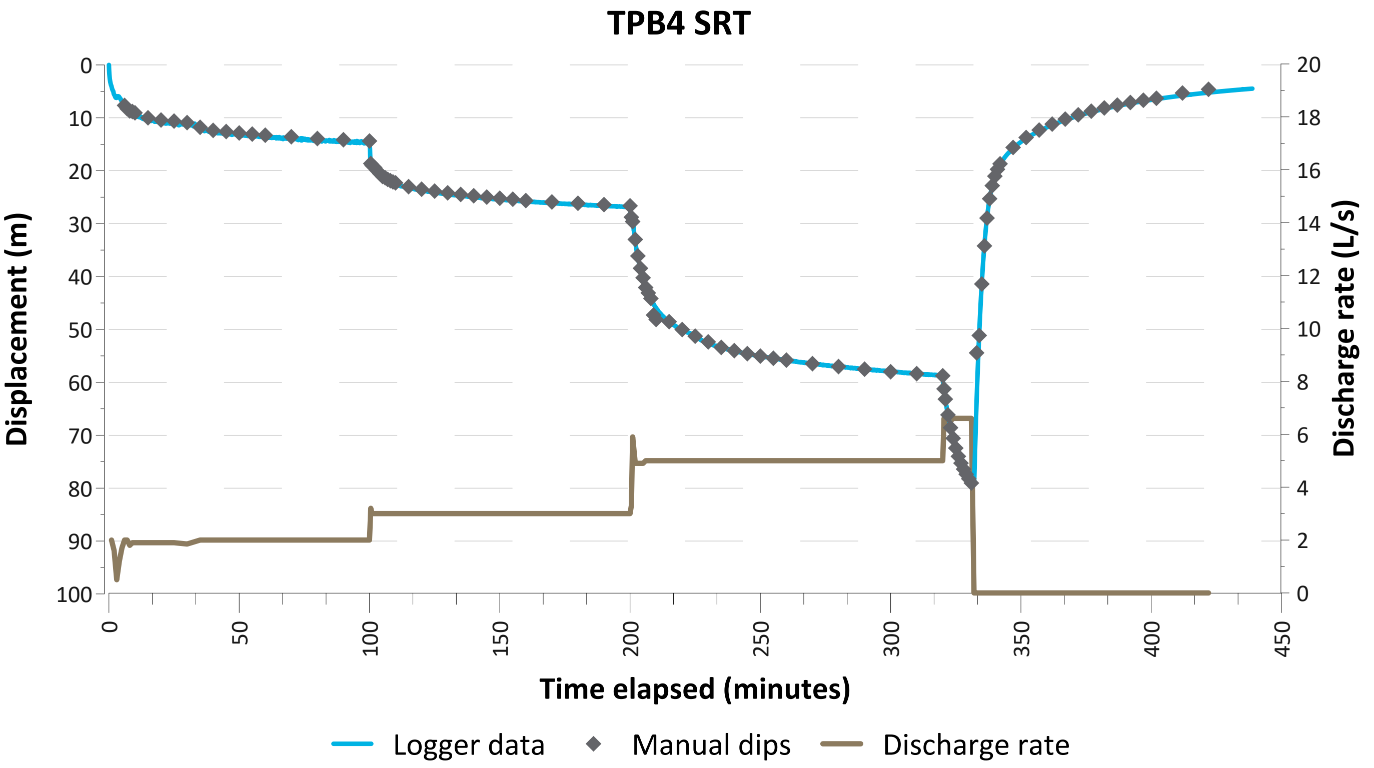
Aquifer Model: Confined
Solution Method: Dougherty-Babu

T = 332.1 m^2/day
S = 8108.9
Kz/Kr = 1.
Sw = 0.
r(w) = 0.0635 m
r(c) = 0.0635 m

APPENDIX D – PUMPING TEST HYDROGRAPHS

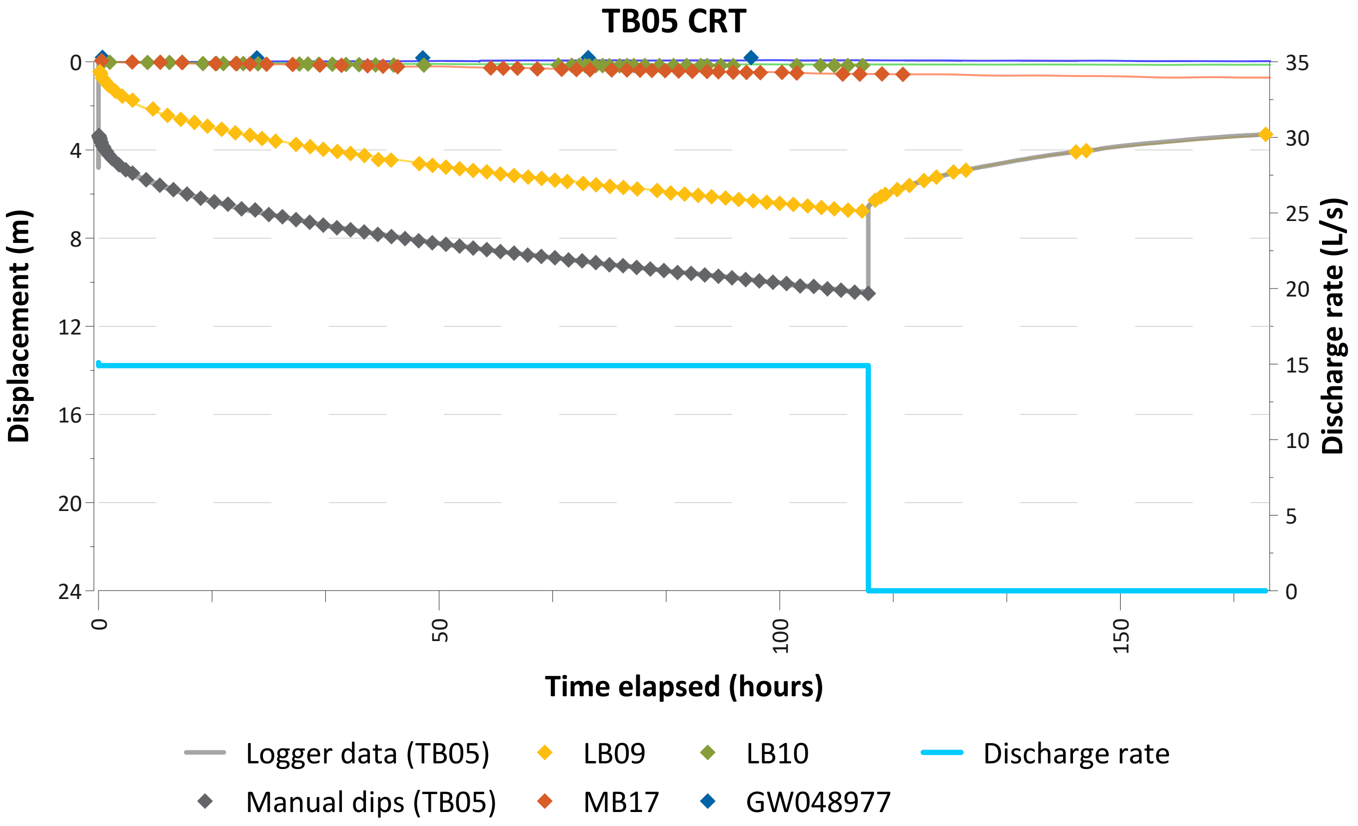
EMM
creating opportunities

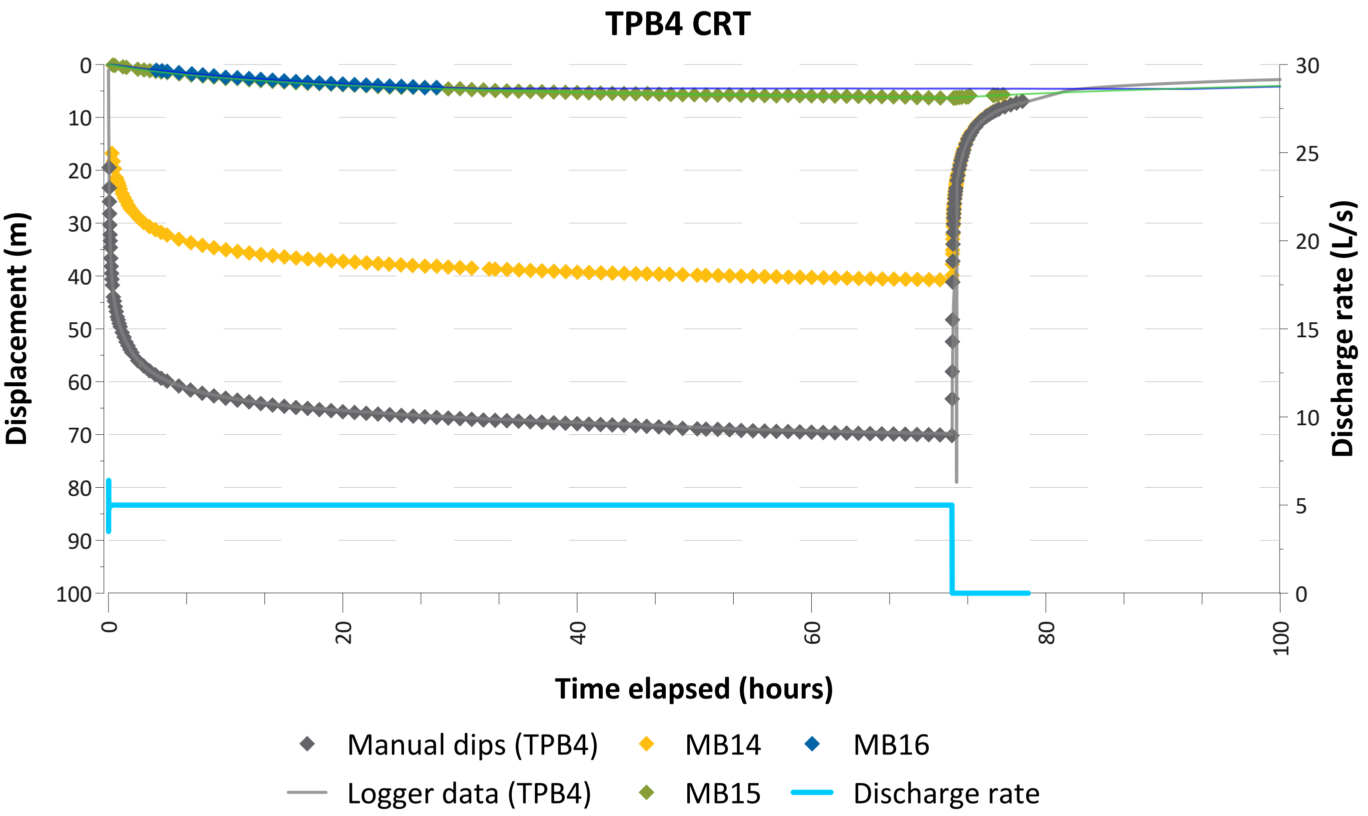




TB05 and TPB04 step rate tests

Construction water supply
Regis Resources Limited
Figure D.1





TB05 and TPB4 constant rate tests

Construction water supply

Regis Resources Limited

Figure D.2

APPENDIX E – PUMPING TEST AQTESOLV RESULTS

EMM
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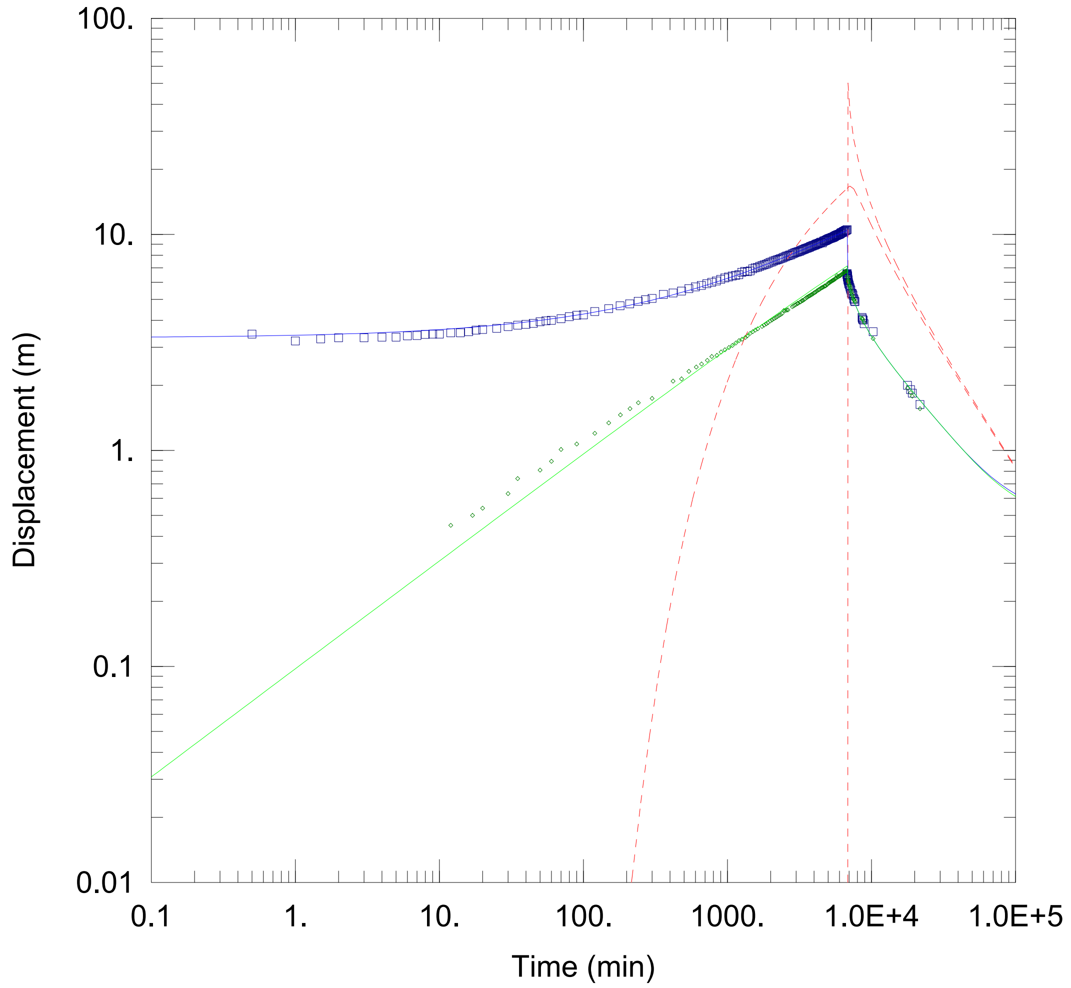


TB05 CONSTANT-RATE TEST

Data Set: T:\...\TB05_Dougherty-Babu.aqt
Date: 07/23/20 Time: 20:48:30

PROJECT INFORMATION

Company: EMM Consulting
Client: Regis Resources
Project: J17065
Location: Dungeon Road, Vittoria
Test Well: TB05
Test Date: 25/6/2020

AQUIFER DATA

Saturated Thickness: 24. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB05	716718	6297629

Observation Wells

Well Name	X (m)	Y (m)
□ TB05	716718	6297629
◦ LB09	716719	6297644

SOLUTION

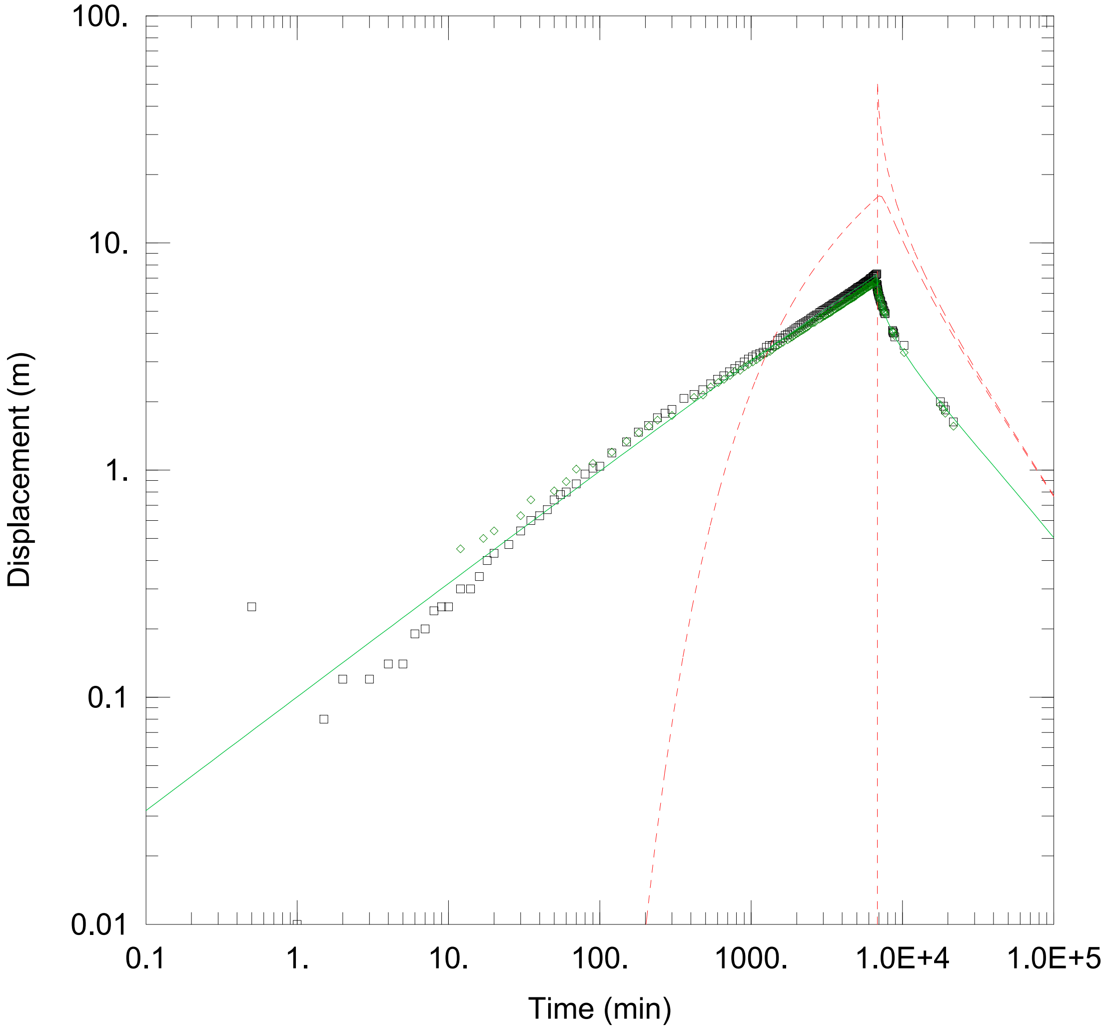
Aquifer Model: Confined Solution Method: Dougherty-Babu

T = 8.585 m^2/day
Kz/Kr = 1.
r(w) = 0.1 m
C = 4.01 min^2/m^5

S = 0.12
Sw = -6.42
r(c) = 0.1 m
P = 1.7

Step Test Model: Jacob-Rorabaugh
Time (t) = 1. min Rate (Q) in cu. m/min

$s(t) = 0.109Q + 4.01Q^{1.7}$
W.E. = 4493.7% (Q from last step)



TB05 CONSTANT-RATE TEST

Data Set: \...\TB05_Moench_leaky.aqt
Date: 08/06/20 Time: 13:28:20

PROJECT INFORMATION

Company: EMM Consulting
Client: Regis Resources
Project: J17065
Location: Dungeon Road, Vittoria
Test Well: TB05
Test Date: 25/6/2020

AQUIFER DATA

Saturated Thickness: 24. m
Aquitard Thickness (b'): 51. m
Anisotropy Ratio (Kz/Kr): 1.
Aquitard Thickness (b"): 1. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB05	716718	6297629

Observation Wells

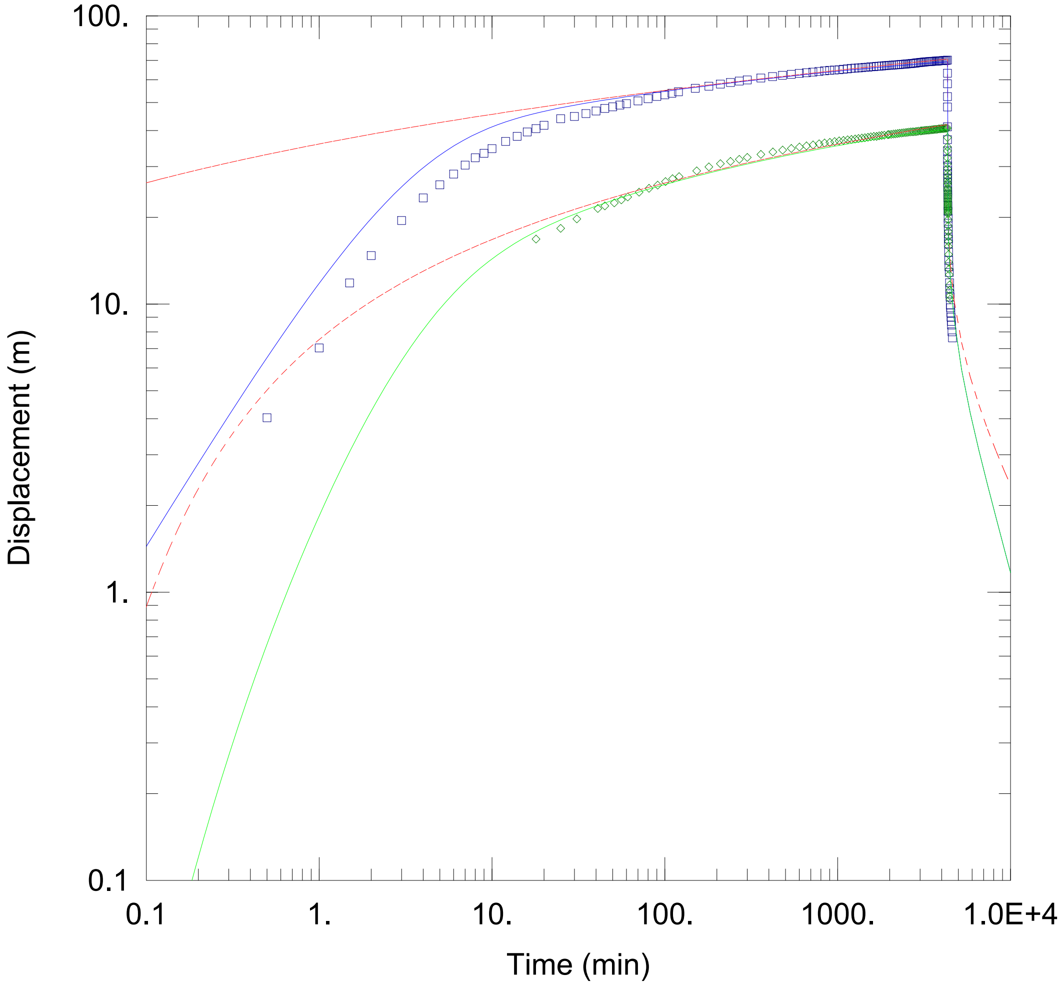
Well Name	X (m)	Y (m)
□ TB05	716718	6297629
◇ Mungarra	716719	6297644

SOLUTION

Aquifer Model: Leaky
Solution Method: Moench (Case 3)

T = 9.3 m^2/day
1/B' = 0.0001 m^{-1}
1/B" = 0. m^{-1}
Sw = -6.35
r(c) = 0.1 m

S = 0.12
ß'/r = 0.0001 m^{-1}
ß"/r = 0. m^{-1}
r(w) = 0.1 m



TPB4 CONSTANT-RATE TEST

Data Set: T:\...\TPB4_Moench.aqt
Date: 07/23/20 Time: 20:50:50

PROJECT INFORMATION

Company: EMM Consulting
Client: Regis Resources
Project: J17065
Location: Arbour Hill
Test Well: TPB4
Test Date: 7/7/2020

AQUIFER DATA

Saturated Thickness: 60. m
Anisotropy Ratio (Kz/Kr): 1.
Aquitard Thickness (b'): 20. m
Aquitard Thickness (b"): 1. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TPB4	716425	6293990

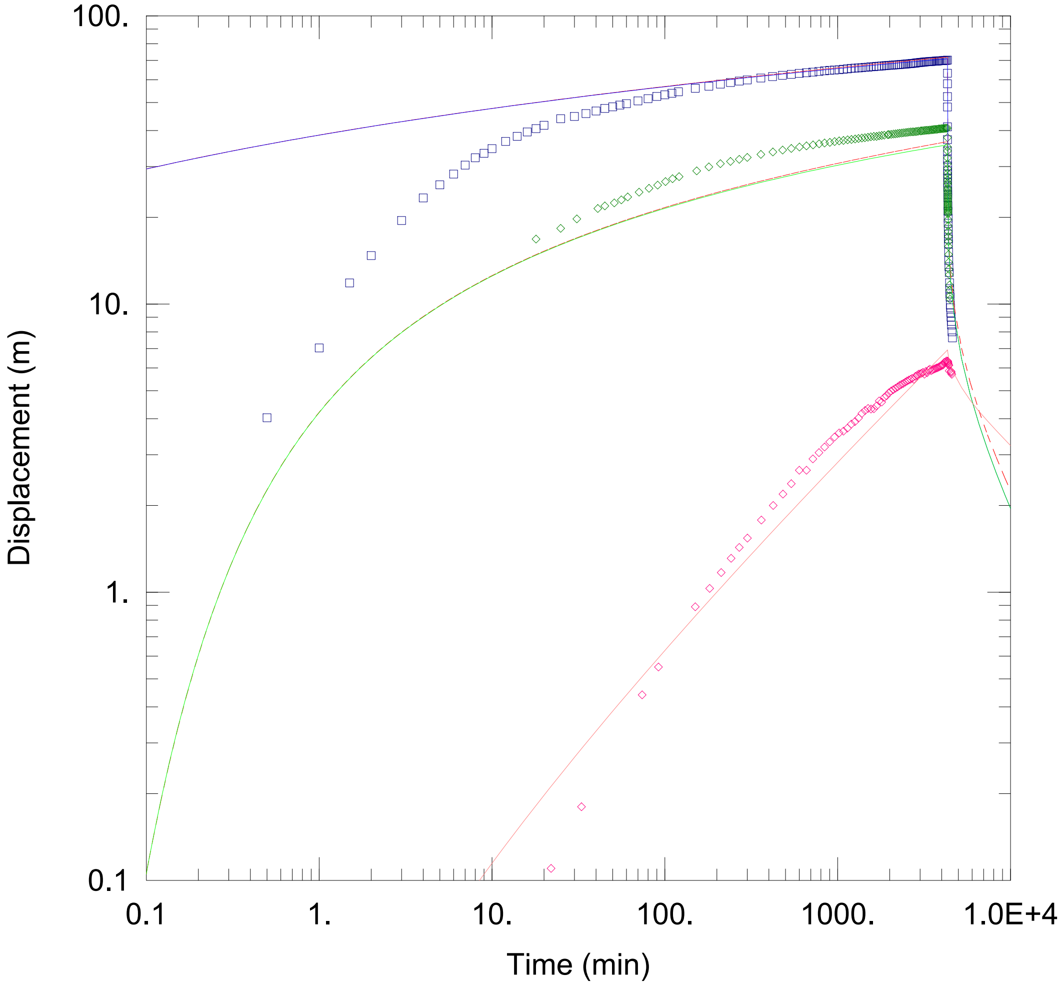
Observation Wells

Well Name	X (m)	Y (m)
□ TPB4	716425	6293990
◇ MB14	716421	6293978
◇ MB15	716434	6293994

SOLUTION

Aquifer Model: Leaky
Solution Method: Moench (Case 3)

T = 8.255 m^2/day
S = 1.458E-5
1/B' = 0.001296 m^{-1}
ß'/r = 6.667E-5 m^{-1}
1/B" = 0. m^{-1}
ß"/r = 0. m^{-1}
Sw = -0.975
r(w) = 0.15 m
r(c) = 0.1 m



TPB4 CONSTANT-RATE TEST

Data Set: T:\...\TPB4_Neuman-Witherspoon.aqt
Date: 07/23/20 Time: 20:51:40

PROJECT INFORMATION

Company: EMM Consulting
Client: Regis Resources
Project: J17065
Location: Arbour Hill
Test Well: TPB4
Test Date: 7/7/2020

AQUIFER DATA

Saturated Thickness: 60. m
Anisotropy Ratio (Kz/Kr): 1.
Aquitard Thickness (b'): 20. m
Aquitard Thickness (b"): 1. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TPB4	716425	6293990

Observation Wells

Well Name	X (m)	Y (m)
□ TPB4	716425	6293990
◇ MB14	716421	6293978
◇ MB15	716434	6293994

SOLUTION

Aquifer Model: Leaky
Solution Method: Neuman-Witherspoon

T = 8.643 m^2/day
1/B = 0.0002348 m^{-1}
T2 = 1.44E+8 m^2/day

S = 3.682E-5
ß/r = 6.667E-5 m^{-1}
S2 = 1.0E-10

APPENDIX F –
WATER QUALITY LABORATORY RESULTS

EMM

creating opportunities

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 246102

Client Details

Client	Regis Resources Limited
Attention	Luke Bowman, S Cook, Claire Corthier
Address	183 Marshalls Lane, BLAYNEY, NSW, 2799

Sample Details

Your Reference	**McPhillamy's Pump Test TB05**
Number of Samples	6 Water
Date samples received	02/07/2020
Date completed instructions received	02/07/2020

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	09/07/2020
Date of Issue	09/07/2020

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Jaimie Loa-Kum-Cheung, Metals Supervisor
Loren Bardwell, Senior Chemist
Priya Samarawickrama, Senior Chemist

Authorised By

Nancy Zhang, Laboratory Manager

All metals in water-dissolved						
Our Reference		246102-1	246102-2	246102-3	246102-4	246102-5
Your Reference	UNITS	TB05	TB05	TB05	TB05	TB05
Date Sampled		25/06/2020	26/06/2020	27/06/2020	28/06/2020	29/06/2020
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	03/07/2020	03/07/2020	03/07/2020	03/07/2020	03/07/2020
Date analysed	-	03/07/2020	03/07/2020	03/07/2020	03/07/2020	03/07/2020
Arsenic-Dissolved	µg/L	<1	<1	<1	<1	<1
Cadmium-Dissolved	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium-Dissolved	µg/L	<1	<1	<1	1	1
Copper-Dissolved	µg/L	4	7	1	3	<1
Lead-Dissolved	µg/L	<1	<1	<1	<1	<1
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel-Dissolved	µg/L	<1	1	<1	<1	<1
Zinc-Dissolved	µg/L	5	17	5	3	4
Aluminium-Dissolved	µg/L	<10	<10	<10	<10	<10
Antimony-Dissolved	µg/L	<1	<1	<1	<1	<1
Barium-Dissolved	µg/L	32	33	33	32	32
Beryllium-Dissolved	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Boron-Dissolved	µg/L	<20	<20	<20	<20	<20
Cobalt-Dissolved	µg/L	<1	<1	<1	<1	<1
Manganese-Dissolved	µg/L	<5	<5	<5	<5	<5
Molybdenum-Dissolved	µg/L	<1	<1	<1	<1	<1
Selenium-Dissolved	µg/L	<1	<1	<1	<1	<1
Silver-Dissolved	µg/L	<1	<1	<1	<1	<1
Vanadium-Dissolved	µg/L	<1	<1	<1	<1	<1
Iron-Dissolved	µg/L	12	<10	<10	<10	<10

All metals in water-dissolved		
Our Reference		246102-6
Your Reference	UNITS	TB05
Date Sampled		30/06/2020
Type of sample		Water
Date prepared	-	03/07/2020
Date analysed	-	03/07/2020
Arsenic-Dissolved	µg/L	<1
Cadmium-Dissolved	µg/L	<0.1
Chromium-Dissolved	µg/L	1
Copper-Dissolved	µg/L	<1
Lead-Dissolved	µg/L	<1
Mercury-Dissolved	µg/L	<0.05
Nickel-Dissolved	µg/L	<1
Zinc-Dissolved	µg/L	5
Aluminium-Dissolved	µg/L	<10
Antimony-Dissolved	µg/L	<1
Barium-Dissolved	µg/L	32
Beryllium-Dissolved	µg/L	<0.5
Boron-Dissolved	µg/L	<20
Cobalt-Dissolved	µg/L	<1
Manganese-Dissolved	µg/L	<5
Molybdenum-Dissolved	µg/L	<1
Selenium-Dissolved	µg/L	<1
Silver-Dissolved	µg/L	<1
Vanadium-Dissolved	µg/L	<1
Iron-Dissolved	µg/L	<10

Metals in Waters - Total						
Our Reference		246102-1	246102-2	246102-3	246102-4	246102-5
Your Reference	UNITS	TB05	TB05	TB05	TB05	TB05
Date Sampled		25/06/2020	26/06/2020	27/06/2020	28/06/2020	29/06/2020
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	03/07/2020	03/07/2020	03/07/2020	03/07/2020	03/07/2020
Date analysed	-	03/07/2020	03/07/2020	03/07/2020	03/07/2020	03/07/2020
Phosphorus - Total	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05

Metals in Waters - Total		
Our Reference		246102-6
Your Reference	UNITS	TB05
Date Sampled		30/06/2020
Type of sample		Water
Date prepared	-	03/07/2020
Date analysed	-	03/07/2020
Phosphorus - Total	mg/L	<0.05

Client Reference: McPhillamy's Pump Test TB05

Miscellaneous Inorganics						
Our Reference		246102-1	246102-2	246102-3	246102-4	246102-5
Your Reference	UNITS	TB05	TB05	TB05	TB05	TB05
Date Sampled		25/06/2020	26/06/2020	27/06/2020	28/06/2020	29/06/2020
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	02/07/2020	02/07/2020	02/07/2020	02/07/2020	02/07/2020
Date analysed	-	02/07/2020	02/07/2020	02/07/2020	02/07/2020	02/07/2020
Total Nitrogen in water	mg/L	0.2	0.7	0.3	0.4	0.4
TKN in water	mg/L	<0.1	0.4	<0.1	<0.1	<0.1
Nitrite as N in water	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Nitrate as N in water	mg/L	0.19	0.24	0.28	0.31	0.33
Ammonia as N in water	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Phosphate as P in water	mg/L	0.008	0.009	0.009	0.008	0.008
Fluoride, F	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Electrical Conductivity	µS/cm	710	700	710	710	710
Total Dissolved Solids (grav)	mg/L	390	380	380	390	360

Miscellaneous Inorganics		
Our Reference		246102-6
Your Reference	UNITS	TB05
Date Sampled		30/06/2020
Type of sample		Water
Date prepared	-	02/07/2020
Date analysed	-	02/07/2020
Total Nitrogen in water	mg/L	0.4
TKN in water	mg/L	<0.1
Nitrite as N in water	mg/L	<0.005
Nitrate as N in water	mg/L	0.34
Ammonia as N in water	mg/L	<0.005
Phosphate as P in water	mg/L	0.008
Fluoride, F	mg/L	<0.1
Electrical Conductivity	µS/cm	710
Total Dissolved Solids (grav)	mg/L	350

Client Reference: McPhillamy's Pump Test TB05

Ion Balance						
Our Reference		246102-1	246102-2	246102-3	246102-4	246102-5
Your Reference	UNITS	TB05	TB05	TB05	TB05	TB05
Date Sampled		25/06/2020	26/06/2020	27/06/2020	28/06/2020	29/06/2020
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	02/07/2020	02/07/2020	02/07/2020	02/07/2020	02/07/2020
Date analysed	-	02/07/2020	02/07/2020	02/07/2020	02/07/2020	02/07/2020
Calcium - Dissolved	mg/L	120	120	110	120	120
Potassium - Dissolved	mg/L	1.9	2.1	1.9	2.0	1.9
Sodium - Dissolved	mg/L	13	13	13	13	13
Magnesium - Dissolved	mg/L	12	12	12	12	12
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	370	360	360	350	350
Carbonate Alkalinity as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	370	360	360	350	350
Sulphate, SO4	mg/L	6	7	7	7	8
Chloride, Cl	mg/L	10	14	15	16	16
Ionic Balance	%	-1.0	-1.0	-4.0	-2.0	-2.0

Ion Balance		
Our Reference		246102-6
Your Reference	UNITS	TB05
Date Sampled		30/06/2020
Type of sample		Water
Date prepared	-	02/07/2020
Date analysed	-	02/07/2020
Calcium - Dissolved	mg/L	120
Potassium - Dissolved	mg/L	1.9
Sodium - Dissolved	mg/L	13
Magnesium - Dissolved	mg/L	12
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	350
Carbonate Alkalinity as $CaCO_3$	mg/L	<5
Total Alkalinity as $CaCO_3$	mg/L	350
Sulphate, SO4	mg/L	7
Chloride, Cl	mg/L	16
Ionic Balance	%	-2.0

Method ID	Methodology Summary
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-006	Alkalinity - determined titrimetrically in accordance with APHA latest edition, 2320-B.
Inorg-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180+/-10°C.
Inorg-026	Fluoride determined by ion selective electrode (ISE) in accordance with APHA latest edition, 4500-F-C.
Inorg-040	The concentrations of the major ions (mg/L) are converted to milliequivalents and summed. The ionic balance should be within +/- 10% ie total anions = total cations +/-10%.
Inorg-055	Nitrate - determined colourimetrically. Waters samples are filtered on receipt prior to analysis. Soils are analysed following a water extraction.
Inorg-055	Nitrite - determined colourimetrically based on APHA latest edition NO2- B. Waters samples are filtered on receipt prior to analysis. Soils are analysed following a water extraction.
Inorg-055/062/127	Total Nitrogen - Calculation sum of TKN and oxidised Nitrogen. Alternatively analysed by combustion and chemiluminescence.
Inorg-057	Ammonia - determined colourimetrically, based on APHA latest edition 4500-NH3 F. Waters samples are filtered on receipt prior to analysis. Soils are analysed following a KCl extraction.
Inorg-060	Phosphate determined colourimetrically based on EPA365.1 and APHA latest edition 4500 P E. Waters samples are filtered on receipt prior to analysis. Soils are analysed following a water extraction.
Inorg-062	TKN - determined colourimetrically based on APHA latest edition 4500 Norg. Alternatively, TKN can be derived from calculation (Total N - NOx).
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: All metals in water-dissolved						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W4	246102-2
Date prepared	-			03/07/2020	1	03/07/2020	03/07/2020		03/07/2020	03/07/2020
Date analysed	-			03/07/2020	1	03/07/2020	03/07/2020		03/07/2020	03/07/2020
Arsenic-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	91	95
Cadmium-Dissolved	µg/L	0.1	Metals-022	<0.1	1	<0.1	<0.1	0	99	101
Chromium-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	108	105
Copper-Dissolved	µg/L	1	Metals-022	<1	1	4	4	0	104	98
Lead-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	103	96
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	1	<0.05	<0.05	0	101	101
Nickel-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	98	91
Zinc-Dissolved	µg/L	1	Metals-022	<1	1	5	5	0	95	89
Aluminium-Dissolved	µg/L	10	Metals-022	<10	1	<10	<10	0	116	117
Antimony-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	103	102
Barium-Dissolved	µg/L	1	Metals-022	<1	1	32	32	0	109	101
Beryllium-Dissolved	µg/L	0.5	Metals-022	<0.5	1	<0.5	<0.5	0	104	108
Boron-Dissolved	µg/L	20	Metals-022	<20	1	<20	<20	0	107	112
Cobalt-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	106	100
Manganese-Dissolved	µg/L	5	Metals-022	<5	1	<5	<5	0	98	95
Molybdenum-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	98	102
Selenium-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	106	118
Silver-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	101	97
Vanadium-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	106	100
Iron-Dissolved	µg/L	10	Metals-022	<10	1	12	12	0	106	100

Client Reference: McPhillamy's Pump Test TB05

QUALITY CONTROL: Metals in Waters - Total						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	246102-2
Date prepared	-			03/07/2020	1	03/07/2020	03/07/2020		03/07/2020	03/07/2020
Date analysed	-			03/07/2020	1	03/07/2020	03/07/2020		03/07/2020	03/07/2020
Phosphorus - Total	mg/L	0.05	Metals-020	<0.05	1	<0.05	<0.05	0	97	98

QUALITY CONTROL: Miscellaneous Inorganics					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	246102-2
Date prepared	-			02/07/2020	1	02/07/2020	02/07/2020		02/07/2020	02/07/2020
Date analysed	-			02/07/2020	1	02/07/2020	02/07/2020		02/07/2020	02/07/2020
Total Nitrogen in water	mg/L	0.1	Inorg-055/062/127	<0.1	1	0.2	0.2	0	82	92
TKN in water	mg/L	0.1	Inorg-062	<0.1	1	<0.1	<0.1	0	82	92
Nitrite as N in water	mg/L	0.005	Inorg-055	<0.005	1	<0.005	<0.005	0	100	101
Nitrate as N in water	mg/L	0.005	Inorg-055	<0.005	1	0.19	0.19	0	104	101
Ammonia as N in water	mg/L	0.005	Inorg-057	<0.005	1	<0.005	<0.005	0	106	91
Phosphate as P in water	mg/L	0.005	Inorg-060	<0.005	1	0.008	0.008	0	105	108
Fluoride, F	mg/L	0.1	Inorg-026	<0.1	1	<0.1	<0.1	0	94	92
Electrical Conductivity	µS/cm	1	Inorg-002	<1	1	710	[NT]		106	[NT]
Total Dissolved Solids (grav)	mg/L	5	Inorg-018	<5	1	390	[NT]		94	[NT]

Client Reference: McPhillamy's Pump Test TB05

QUALITY CONTROL: Ion Balance						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	246102-2
Date prepared	-			02/07/2020	1	02/07/2020	02/07/2020		02/07/2020	02/07/2020
Date analysed	-			02/07/2020	1	02/07/2020	02/07/2020		02/07/2020	02/07/2020
Calcium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	120	120	0	97	#
Potassium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	1.9	2.0	5	97	100
Sodium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	13	13	0	80	80
Magnesium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	12	12	0	102	99
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	5	Inorg-006	<5	1	<5	[NT]		[NT]	[NT]
Bicarbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	370	[NT]		[NT]	[NT]
Carbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	<5	[NT]		[NT]	[NT]
Total Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	370	[NT]		103	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	1	6	6	0	117	108
Chloride, Cl	mg/L	1	Inorg-081	<1	1	10	10	0	84	86
Ionic Balance	%		Inorg-040	[NT]	1	-1.0	[NT]		[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

Ion Balance - # Percent recovery is not possible to report due to the high concentration of the element/s in the sample/s. However an acceptable recovery was obtained for the LCS.

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CERTIFICATE OF ANALYSIS 246404

Client Details

Client	Regis Resources Limited
Attention	Luke Bowman
Address	183 Marshalls Lane, BLAYNEY, NSW, 2799

Sample Details

Your Reference	**McPhillamy's**
Number of Samples	3 Water
Date samples received	07/07/2020
Date completed instructions received	07/07/2020

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	10/07/2020
Date of Issue	10/07/2020

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Results Approved By
Loren Bardwell, Senior Chemist
Priya Samarawickrama, Senior Chemist

Authorised By

Nancy Zhang, Laboratory Manager

All metals in water-dissolved				
Our Reference	UNITS	246404-1	246404-2	246404-3
Your Reference		MB15	MB16	MB17
Date Sampled		2/07/2020	2/07/2020	3/07/2020
Type of sample		Water	Water	Water
Date prepared	-	08/07/2020	08/07/2020	08/07/2020
Date analysed	-	08/07/2020	08/07/2020	08/07/2020
Arsenic-Dissolved	μg/L	<1	<1	<1
Cadmium-Dissolved	μg/L	<0.1	<0.1	<0.1
Chromium-Dissolved	μg/L	<1	85	<1
Copper-Dissolved	μg/L	1	<1	<1
Lead-Dissolved	μg/L	<1	<1	<1
Mercury-Dissolved	μg/L	<0.05	<0.05	<0.05
Nickel-Dissolved	μg/L	<1	1	3
Zinc-Dissolved	μg/L	23	10	110
Aluminium-Dissolved	μg/L	<10	40	50
Antimony-Dissolved	μg/L	<1	<1	<1
Barium-Dissolved	μg/L	210	57	13
Beryllium-Dissolved	μg/L	<0.5	<0.5	<0.5
Boron-Dissolved	μg/L	<20	<20	<20
Cobalt-Dissolved	μg/L	<1	<1	<1
Manganese-Dissolved	μg/L	5	6	55
Molybdenum-Dissolved	μg/L	<1	17	<1
Selenium-Dissolved	μg/L	<1	<1	<1
Silver-Dissolved	μg/L	<1	<1	<1
Vanadium-Dissolved	μg/L	2	2	<1
Iron-Dissolved	μg/L	<10	40	28

Metals in Waters - Total				
Our Reference		246404-1	246404-2	246404-3
Your Reference	UNITS	MB15	MB16	MB17
Date Sampled		2/07/2020	2/07/2020	3/07/2020
Type of sample		Water	Water	Water
Date prepared	-	08/07/2020	08/07/2020	08/07/2020
Date analysed	-	08/07/2020	08/07/2020	08/07/2020
Phosphorus - Total	mg/L	0.1	8.2	2.2

Miscellaneous Inorganics				
Our Reference		246404-1	246404-2	246404-3
Your Reference	UNITS	MB15	MB16	MB17
Date Sampled		2/07/2020	2/07/2020	3/07/2020
Type of sample		Water	Water	Water
Date prepared	-	7/07/2020	7/07/2020	7/07/2020
Date analysed	-	7/07/2020	7/07/2020	7/07/2020
Total Nitrogen in water	mg/L	3.6	3.1	2.1
TKN in water	mg/L	0.8	1.1	0.3
Nitrite as N in water	mg/L	<0.005	<0.005	<0.005
Nitrate as N in water	mg/L	2.8	2.0	1.8
Ammonia as N in water	mg/L	0.007	<0.005	<0.005
Phosphate as P in water	mg/L	0.03	0.11	0.15
Fluoride, F	mg/L	<0.1	0.1	0.2
Electrical Conductivity	µS/cm	770	560	330
Total Dissolved Solids (by calc)	mg/L	460	340	200

Ion Balance				
Our Reference		246404-1	246404-2	246404-3
Your Reference	UNITS	MB15	MB16	MB17
Date Sampled		2/07/2020	2/07/2020	3/07/2020
Type of sample		Water	Water	Water
Date prepared	-	07/07/2020	07/07/2020	07/07/2020
Date analysed	-	07/07/2020	07/07/2020	07/07/2020
Calcium - Dissolved	mg/L	95	65	20
Potassium - Dissolved	mg/L	4.0	7.5	2.9
Sodium - Dissolved	mg/L	23	37	22
Magnesium - Dissolved	mg/L	34	10	9.4
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5	<5	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	310	120	140
Carbonate Alkalinity as $CaCO_3$	mg/L	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	310	120	140
Sulphate, SO4	mg/L	51	170	8
Chloride, Cl	mg/L	45	19	22
Ionic Balance	%	1.0	-5.0	-12

Method ID	Methodology Summary
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-006	Alkalinity - determined titrimetrically in accordance with APHA latest edition, 2320-B.
Inorg-026	Fluoride determined by ion selective electrode (ISE) in accordance with APHA latest edition, 4500-F-C.
Inorg-040	The concentrations of the major ions (mg/L) are converted to milliequivalents and summed. The ionic balance should be within +/- 10% ie total anions = total cations +/-10%.
Inorg-055	Nitrate - determined colourimetrically. Waters samples are filtered on receipt prior to analysis. Soils are analysed following a water extraction.
Inorg-055	Nitrite - determined colourimetrically based on APHA latest edition NO2- B. Waters samples are filtered on receipt prior to analysis. Soils are analysed following a water extraction.
Inorg-055/062/127	Total Nitrogen - Calculation sum of TKN and oxidised Nitrogen. Alternatively analysed by combustion and chemiluminescence.
Inorg-057	Ammonia - determined colourimetrically, based on APHA latest edition 4500-NH3 F. Waters samples are filtered on receipt prior to analysis. Soils are analysed following a KCl extraction.
Inorg-060	Phosphate determined colourimetrically based on EPA365.1 and APHA latest edition 4500 P E. Waters samples are filtered on receipt prior to analysis. Soils are analysed following a water extraction.
Inorg-062	TKN - determined colourimetrically based on APHA latest edition 4500 Norg. Alternatively, TKN can be derived from calculation (Total N - NOx).
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: All metals in water-dissolved					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	246404-2
Date prepared	-			08/07/2020	1	08/07/2020	08/07/2020		08/07/2020	08/07/2020
Date analysed	-			08/07/2020	1	08/07/2020	08/07/2020		08/07/2020	08/07/2020
Arsenic-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	99	97
Cadmium-Dissolved	µg/L	0.1	Metals-022	<0.1	1	<0.1	<0.1	0	99	103
Chromium-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	105	88
Copper-Dissolved	µg/L	1	Metals-022	<1	1	1	1	0	113	103
Lead-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	108	104
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	1	<0.05	<0.05	0	98	99
Nickel-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	101	93
Zinc-Dissolved	µg/L	1	Metals-022	<1	1	23	23	0	102	96
Aluminium-Dissolved	µg/L	10	Metals-022	<10	1	<10	<10	0	114	100
Antimony-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	100	100
Barium-Dissolved	µg/L	1	Metals-022	<1	1	210	200	5	112	97
Beryllium-Dissolved	µg/L	0.5	Metals-022	<0.5	1	<0.5	<0.5	0	103	108
Boron-Dissolved	µg/L	20	Metals-022	<20	1	<20	<20	0	108	111
Cobalt-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	112	105
Manganese-Dissolved	µg/L	5	Metals-022	<5	1	5	<5	0	102	96
Molybdenum-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	97	117
Selenium-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	103	105
Silver-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	106	92
Vanadium-Dissolved	µg/L	1	Metals-022	<1	1	2	2	0	113	111
Iron-Dissolved	µg/L	10	Metals-022	<10	1	<10	<10	0	112	103

QUALITY CONTROL: Metals in Waters - Total						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	246404-2
Date prepared	-			08/07/2020	1	08/07/2020	08/07/2020		08/07/2020	08/07/2020
Date analysed	-			08/07/2020	1	08/07/2020	08/07/2020		08/07/2020	08/07/2020
Phosphorus - Total	mg/L	0.05	Metals-020	<0.05	1	0.1	0.1	0	99	75

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			07/07/2020	[NT]	[NT]	[NT]	[NT]	07/07/2020	[NT]
Date analysed	-			07/07/2020	[NT]	[NT]	[NT]	[NT]	07/07/2020	[NT]
Total Nitrogen in water	mg/L	0.1	Inorg-055/062/127	<0.1	[NT]	[NT]	[NT]	[NT]	86	[NT]
TKN in water	mg/L	0.1	Inorg-062	<0.1	[NT]	[NT]	[NT]	[NT]	86	[NT]
Nitrite as N in water	mg/L	0.005	Inorg-055	<0.005	[NT]	[NT]	[NT]	[NT]	100	[NT]
Nitrate as N in water	mg/L	0.005	Inorg-055	<0.005	[NT]	[NT]	[NT]	[NT]	103	[NT]
Ammonia as N in water	mg/L	0.005	Inorg-057	<0.005	[NT]	[NT]	[NT]	[NT]	100	[NT]
Phosphate as P in water	mg/L	0.005	Inorg-060	<0.005	[NT]	[NT]	[NT]	[NT]	85	[NT]
Fluoride, F	mg/L	0.1	Inorg-026	<0.1	[NT]	[NT]	[NT]	[NT]	93	[NT]
Electrical Conductivity	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	94	[NT]
Total Dissolved Solids (by calc)	mg/L	5	Inorg-002	<5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

Client Reference: McPhillamy's

QUALITY CONTROL: Ion Balance						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	246404-2
Date prepared	-			07/07/2020	3	07/07/2020	07/07/2020		07/07/2020	07/07/2020
Date analysed	-			07/07/2020	3	07/07/2020	07/07/2020		07/07/2020	07/07/2020
Calcium - Dissolved	mg/L	0.5	Metals-020	<0.5	3	20	19	5	116	#
Potassium - Dissolved	mg/L	0.5	Metals-020	<0.5	3	2.9	2.9	0	113	86
Sodium - Dissolved	mg/L	0.5	Metals-020	<0.5	3	22	21	5	116	73
Magnesium - Dissolved	mg/L	0.5	Metals-020	<0.5	3	9.4	9.1	3	116	90
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	5	Inorg-006	<5	3	<5	[NT]		<5	[NT]
Bicarbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	3	140	[NT]		<5	[NT]
Carbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	3	<5	[NT]		<5	[NT]
Total Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	3	140	[NT]		104	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	3	8	[NT]		109	[NT]
Chloride, Cl	mg/L	1	Inorg-081	<1	3	22	[NT]		88	[NT]
Ionic Balance	%		Inorg-040	[NT]	3	-12	[NT]		[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

NO2/NO3/PO4 - out of recommended holding time

Total metals: no preserved sample was received, therefore analysis was conducted from the unpreserved sample bottle.
Note: there is a possibility some elements may be underestimated.

Ion Balance - # Percent recovery is not possible to report due to the high concentration of the element/s in the sample/s. However an acceptable recovery was obtained for the LCS.

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CERTIFICATE OF ANALYSIS 246895

Client Details

Client	Regis Resources Limited
Attention	Luke Bowman, S Cook, Claire Corthier
Address	183 Marshalls Lane, BLAYNEY, NSW, 2799

Sample Details

Your Reference	**McPhillamys**
Number of Samples	6 Water
Date samples received	14/07/2020
Date completed instructions received	14/07/2020

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	15/07/2020
Date of Issue	15/07/2020

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Results Approved By
Diego Bigolin, Team Leader, Inorganics
Hannah Nguyen, Senior Chemist
Jaimie Loa-Kum-Cheung, Metals Supervisor

Authorised By

Nancy Zhang, Laboratory Manager

All metals in water-dissolved						
Our Reference		246895-1	246895-2	246895-3	246895-4	246895-5
Your Reference	UNITS	TPB4_1	TPB4_2	TPB4_3	TPB4_4	BELU
Date Sampled		07/07/2020	08/07/2020	09/07/2020	10/07/2020	09/07/2020
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	15/07/2020	15/07/2020	15/07/2020	15/07/2020	15/07/2020
Date analysed	-	15/07/2020	15/07/2020	15/07/2020	15/07/2020	15/07/2020
Arsenic-Dissolved	µg/L	<1	<1	2	<1	<1
Cadmium-Dissolved	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium-Dissolved	µg/L	<1	<1	<1	<1	<1
Copper-Dissolved	µg/L	3	1	2	1	4
Lead-Dissolved	µg/L	1	<1	<1	<1	2
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel-Dissolved	µg/L	<1	<1	2	<1	<1
Zinc-Dissolved	µg/L	19	7	7	5	15
Aluminium-Dissolved	µg/L	<10	<10	260	<10	<10
Antimony-Dissolved	µg/L	4	1	<1	1	1
Barium-Dissolved	µg/L	400	930	77	1,000	1,000
Beryllium-Dissolved	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Boron-Dissolved	µg/L	<20	<20	<20	<20	<20
Cobalt-Dissolved	µg/L	<1	<1	1	<1	<1
Manganese-Dissolved	µg/L	<5	<5	660	<5	<5
Molybdenum-Dissolved	µg/L	<1	<1	<1	<1	<1
Selenium-Dissolved	µg/L	<1	<1	<1	<1	<1
Silver-Dissolved	µg/L	<1	<1	<1	<1	<1
Vanadium-Dissolved	µg/L	2	2	1	2	2
Iron-Dissolved	µg/L	<10	<10	2,200	<10	<10

All metals in water-dissolved		
Our Reference		246895-6
Your Reference	UNITS	MB14
Date Sampled		10/07/2020
Type of sample		Water
Date prepared	-	15/07/2020
Date analysed	-	15/07/2020
Arsenic-Dissolved	µg/L	<1
Cadmium-Dissolved	µg/L	<0.1
Chromium-Dissolved	µg/L	1
Copper-Dissolved	µg/L	1
Lead-Dissolved	µg/L	<1
Mercury-Dissolved	µg/L	<0.05
Nickel-Dissolved	µg/L	5
Zinc-Dissolved	µg/L	31
Aluminium-Dissolved	µg/L	10
Antimony-Dissolved	µg/L	<1
Barium-Dissolved	µg/L	280
Beryllium-Dissolved	µg/L	<0.5
Boron-Dissolved	µg/L	<20
Cobalt-Dissolved	µg/L	<1
Manganese-Dissolved	µg/L	10
Molybdenum-Dissolved	µg/L	<1
Selenium-Dissolved	µg/L	<1
Silver-Dissolved	µg/L	<1
Vanadium-Dissolved	µg/L	2
Iron-Dissolved	µg/L	<10

Metals in Waters - Total						
Our Reference		246895-1	246895-2	246895-3	246895-4	246895-5
Your Reference	UNITS	TPB4_1	TPB4_2	TPB4_3	TPB4_4	BELU
Date Sampled		07/07/2020	08/07/2020	09/07/2020	10/07/2020	09/07/2020
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	15/07/2020	15/07/2020	15/07/2020	15/07/2020	15/07/2020
Date analysed	-	15/07/2020	15/07/2020	15/07/2020	15/07/2020	15/07/2020
Phosphorus - Total	mg/L	<0.05	<0.05	<0.05	<0.05	0.2

Metals in Waters - Total		
Our Reference		246895-6
Your Reference	UNITS	MB14
Date Sampled		10/07/2020
Type of sample		Water
Date prepared	-	15/07/2020
Date analysed	-	15/07/2020
Phosphorus - Total	mg/L	<0.05

Miscellaneous Inorganics						
Our Reference		246895-1	246895-2	246895-3	246895-4	246895-5
Your Reference	UNITS	TPB4_1	TPB4_2	TPB4_3	TPB4_4	BELU
Date Sampled		07/07/2020	08/07/2020	09/07/2020	10/07/2020	09/07/2020
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	14/07/2020	14/07/2020	14/07/2020	14/07/2020	14/07/2020
Date analysed	-	14/07/2020	14/07/2020	14/07/2020	14/07/2020	14/07/2020
Total Nitrogen in water	mg/L	2.1	1.9	1.9	1.9	1.3
TKN in water	mg/L	0.5	0.3	0.3	0.3	1.2
Nitrite as N in water	mg/L	0.025	<0.005	<0.005	0.006	0.013
Nitrate as N in water	mg/L	1.6	1.5	1.6	1.6	0.094
Ammonia as N in water	mg/L	0.006	<0.005	<0.005	<0.005	0.22
Phosphate as P in water	mg/L	0.02	0.02	0.02	0.02	0.11
Fluoride, F	mg/L	0.1	0.2	0.2	0.2	0.2
Electrical Conductivity	µS/cm	670	660	660	700	520
Total Dissolved Solids (by calc)	mg/L	400	390	390	420	310

Miscellaneous Inorganics		
Our Reference		246895-6
Your Reference	UNITS	MB14
Date Sampled		10/07/2020
Type of sample		Water
Date prepared	-	14/07/2020
Date analysed	-	14/07/2020
Total Nitrogen in water	mg/L	3.5
TKN in water	mg/L	1.6
Nitrite as N in water	mg/L	0.006
Nitrate as N in water	mg/L	1.9
Ammonia as N in water	mg/L	<0.005
Phosphate as P in water	mg/L	0.01
Fluoride, F	mg/L	<0.1
Electrical Conductivity	µS/cm	750
Total Dissolved Solids (by calc)	mg/L	450

Ion Balance						
Our Reference		246895-1	246895-2	246895-3	246895-4	246895-5
Your Reference	UNITS	TPB4_1	TPB4_2	TPB4_3	TPB4_4	BELU
Date Sampled		07/07/2020	08/07/2020	09/07/2020	10/07/2020	09/07/2020
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	14/07/2020	14/07/2020	14/07/2020	14/07/2020	14/07/2020
Date analysed	-	14/07/2020	14/07/2020	14/07/2020	14/07/2020	14/07/2020
Calcium - Dissolved	mg/L	70	67	66	68	67
Potassium - Dissolved	mg/L	4.7	4.0	3.8	3.9	3.9
Sodium - Dissolved	mg/L	26	29	28	28	29
Magnesium - Dissolved	mg/L	27	26	25	26	26
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	320	320	310	320	190
Carbonate Alkalinity as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	320	320	310	320	190
Sulphate, SO4	mg/L	16	15	15	16	47
Chloride, Cl	mg/L	33	32	32	33	31
Ionic Balance	%	-5.0	-5.0	-5.0	-6.0	10

Ion Balance		
Our Reference		246895-6
Your Reference	UNITS	MB14
Date Sampled		10/07/2020
Type of sample		Water
Date prepared	-	14/07/2020
Date analysed	-	14/07/2020
Calcium - Dissolved	mg/L	75
Potassium - Dissolved	mg/L	5.0
Sodium - Dissolved	mg/L	26
Magnesium - Dissolved	mg/L	28
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	320
Carbonate Alkalinity as $CaCO_3$	mg/L	<5
Total Alkalinity as $CaCO_3$	mg/L	320
Sulphate, SO4	mg/L	21
Chloride, Cl	mg/L	39
Ionic Balance	%	-4.0

Method ID	Methodology Summary
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-006	Alkalinity - determined titrimetrically in accordance with APHA latest edition, 2320-B.
Inorg-026	Fluoride determined by ion selective electrode (ISE) in accordance with APHA latest edition, 4500-F-C.
Inorg-040	The concentrations of the major ions (mg/L) are converted to milliequivalents and summed. The ionic balance should be within +/- 10% ie total anions = total cations +/-10%.
Inorg-055	Nitrate - determined colourimetrically. Waters samples are filtered on receipt prior to analysis. Soils are analysed following a water extraction.
Inorg-055	Nitrite - determined colourimetrically based on APHA latest edition NO2- B. Waters samples are filtered on receipt prior to analysis. Soils are analysed following a water extraction.
Inorg-055/062/127	Total Nitrogen - Calculation sum of TKN and oxidised Nitrogen. Alternatively analysed by combustion and chemiluminescence.
Inorg-057	Ammonia - determined colourimetrically, based on APHA latest edition 4500-NH3 F. Waters samples are filtered on receipt prior to analysis. Soils are analysed following a KCl extraction.
Inorg-060	Phosphate determined colourimetrically based on EPA365.1 and APHA latest edition 4500 P E. Waters samples are filtered on receipt prior to analysis. Soils are analysed following a water extraction.
Inorg-062	TKN - determined colourimetrically based on APHA latest edition 4500 Norg. Alternatively, TKN can be derived from calculation (Total N - NOx).
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: All metals in water-dissolved						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	246895-2
Date prepared	-			15/07/2020	1	15/07/2020	15/07/2020		15/07/2020	15/07/2020
Date analysed	-			15/07/2020	1	15/07/2020	15/07/2020		15/07/2020	15/07/2020
Arsenic-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	91	93
Cadmium-Dissolved	µg/L	0.1	Metals-022	<0.1	1	<0.1	<0.1	0	95	98
Chromium-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	103	98
Copper-Dissolved	µg/L	1	Metals-022	<1	1	3	3	0	104	91
Lead-Dissolved	µg/L	1	Metals-022	<1	1	1	1	0	101	95
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	1	<0.05	<0.05	0	105	105
Nickel-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	93	83
Zinc-Dissolved	µg/L	1	Metals-022	<1	1	19	19	0	95	87
Aluminium-Dissolved	µg/L	10	Metals-022	<10	1	<10	<10	0	106	111
Antimony-Dissolved	µg/L	1	Metals-022	<1	1	4	4	0	101	102
Barium-Dissolved	µg/L	1	Metals-022	<1	1	400	390	3	102	#
Beryllium-Dissolved	µg/L	0.5	Metals-022	<0.5	1	<0.5	<0.5	0	96	106
Boron-Dissolved	µg/L	20	Metals-022	<20	1	<20	<20	0	102	112
Cobalt-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	102	91
Manganese-Dissolved	µg/L	5	Metals-022	<5	1	<5	<5	0	96	92
Molybdenum-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	99	105
Selenium-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	101	108
Silver-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	108	102
Vanadium-Dissolved	µg/L	1	Metals-022	<1	1	2	2	0	94	103
Iron-Dissolved	µg/L	10	Metals-022	<10	1	<10	<10	0	102	94

QUALITY CONTROL: Metals in Waters - Total					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	246895-2
Date prepared	-			15/07/2020	1	15/07/2020	15/07/2020		15/07/2020	15/07/2020
Date analysed	-			15/07/2020	1	15/07/2020	15/07/2020		15/07/2020	15/07/2020
Phosphorus - Total	mg/L	0.05	Metals-020	<0.05	1	<0.05	<0.05	0	93	91

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	246895-5
Date prepared	-			14/07/2020	1	14/07/2020	14/07/2020		14/07/2020	14/07/2020
Date analysed	-			14/07/2020	1	14/07/2020	14/07/2020		14/07/2020	14/07/2020
Total Nitrogen in water	mg/L	0.1	Inorg-055/062/127	<0.1	1	2.1	2.1	0	111	[NT]
TKN in water	mg/L	0.1	Inorg-062	<0.1	1	0.5	0.5	0	111	[NT]
Nitrite as N in water	mg/L	0.005	Inorg-055	<0.005	1	0.025	[NT]		103	117
Nitrate as N in water	mg/L	0.005	Inorg-055	<0.005	1	1.6	[NT]		103	88
Ammonia as N in water	mg/L	0.005	Inorg-057	<0.005	1	0.006	[NT]		102	83
Phosphate as P in water	mg/L	0.005	Inorg-060	<0.005	1	0.02	[NT]		102	101
Fluoride, F	mg/L	0.1	Inorg-026	<0.1	1	0.1	[NT]		100	[NT]
Electrical Conductivity	µS/cm	1	Inorg-002	<1	1	670	[NT]		100	[NT]
Total Dissolved Solids (by calc)	mg/L	5	Inorg-002	<5	1	400	[NT]		[NT]	[NT]

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	3	14/07/2020	14/07/2020		[NT]	[NT]
Date analysed	-			[NT]	3	14/07/2020	14/07/2020		[NT]	[NT]
Total Nitrogen in water	mg/L	0.1	Inorg-055/062/127	[NT]	3	1.9	[NT]		[NT]	[NT]
TKN in water	mg/L	0.1	Inorg-062	[NT]	3	0.3	0.4	29	[NT]	[NT]
Nitrite as N in water	mg/L	0.005	Inorg-055	[NT]	3	<0.005	<0.005	0	[NT]	[NT]
Nitrate as N in water	mg/L	0.005	Inorg-055	[NT]	3	1.6	1.5	6	[NT]	[NT]
Ammonia as N in water	mg/L	0.005	Inorg-057	[NT]	3	<0.005	<0.005	0	[NT]	[NT]
Phosphate as P in water	mg/L	0.005	Inorg-060	[NT]	3	0.02	0.02	0	[NT]	[NT]
Fluoride, F	mg/L	0.1	Inorg-026	[NT]	3	0.2	[NT]		[NT]	[NT]
Electrical Conductivity	µS/cm	1	Inorg-002	[NT]	3	660	660	0	[NT]	[NT]
Total Dissolved Solids (by calc)	mg/L	5	Inorg-002	[NT]	3	390	400	3	[NT]	[NT]

QUALITY CONTROL: Ion Balance					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	246895-2
Date prepared	-			14/07/2020	1	14/07/2020	14/07/2020		14/07/2020	14/07/2020
Date analysed	-			14/07/2020	1	14/07/2020	14/07/2020		14/07/2020	14/07/2020
Calcium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	70	71	1	89	#
Potassium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	4.7	4.7	0	86	83
Sodium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	26	25	4	87	80
Magnesium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	27	27	0	93	93
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	5	Inorg-006	<5	1	<5	[NT]		[NT]	[NT]
Bicarbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	320	[NT]		[NT]	[NT]
Carbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	<5	[NT]		[NT]	[NT]
Total Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	320	[NT]		106	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	1	16	[NT]		107	[NT]
Chloride, Cl	mg/L	1	Inorg-081	<1	1	33	[NT]		86	[NT]
Ionic Balance	%		Inorg-040	[NT]	1	-5.0	[NT]		[NT]	[NT]

QUALITY CONTROL: Ion Balance					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	3	14/07/2020	14/07/2020		[NT]	[NT]
Date analysed	-			[NT]	3	14/07/2020	14/07/2020		[NT]	[NT]
Calcium - Dissolved	mg/L	0.5	Metals-020	[NT]	3	66	[NT]		[NT]	[NT]
Potassium - Dissolved	mg/L	0.5	Metals-020	[NT]	3	3.8	[NT]		[NT]	[NT]
Sodium - Dissolved	mg/L	0.5	Metals-020	[NT]	3	28	[NT]		[NT]	[NT]
Magnesium - Dissolved	mg/L	0.5	Metals-020	[NT]	3	25	[NT]		[NT]	[NT]
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	5	Inorg-006	[NT]	3	<5	<5	0	[NT]	[NT]
Bicarbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	[NT]	3	310	320	3	[NT]	[NT]
Carbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	[NT]	3	<5	<5	0	[NT]	[NT]
Total Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	[NT]	3	310	320	3	[NT]	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	[NT]	3	15	[NT]		[NT]	[NT]
Chloride, Cl	mg/L	1	Inorg-081	[NT]	3	32	[NT]		[NT]	[NT]
Ionic Balance	%		Inorg-040	[NT]	3	-5.0	[NT]		[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

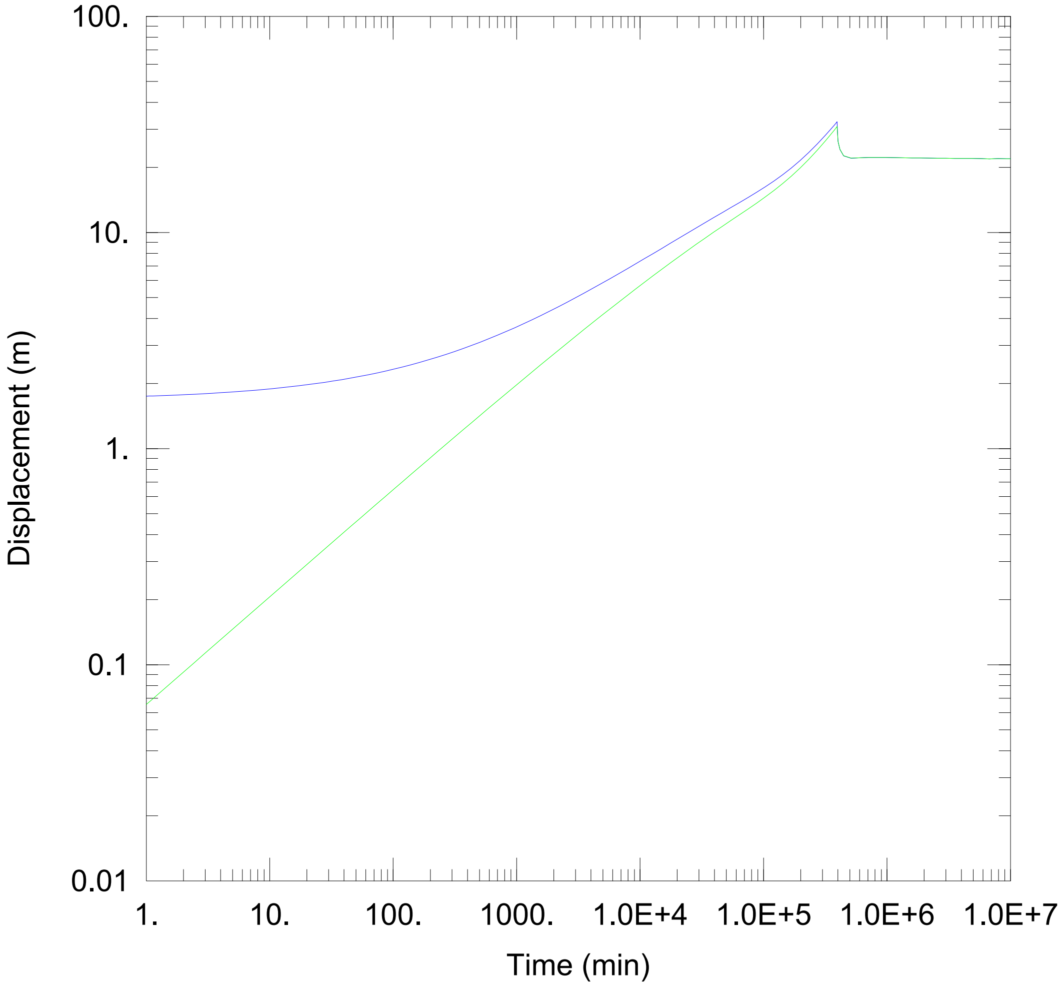
NO2/NO3/PO4 - out of recommended holding time

Ion Balance - # Percent recovery is not possible to report due to the high concentration of the element/s in the sample/s. However an acceptable recovery was obtained for the LCS.

Total metals: no preserved sample was received, therefore analysis was conducted from the unpreserved sample bottle.
Note: there is a possibility some elements may be underestimated.

All metals in water-dissolved - # Percent recovery is not possible to report due to the high concentration of the element/s in the sample/s. However an acceptable recovery was obtained for the LCS.

APPENDIX G –
AQTESOLV PREDICTIONS



TB05 FORWARD SOLUTION

Data Set: \...\TB05_9 months continuous_10 L.s-1_finite square aquifer.aqt
Date: 07/23/20 Time: 20:41:53

PROJECT INFORMATION

Company: EMM Consulting
Client: Regis Resources
Project: J17065
Location: Dungeon Road, Vittoria
Test Well: TB05

AQUIFER DATA

Saturated Thickness: 24. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB05	716718	6297629

Observation Wells

Well Name	X (m)	Y (m)
□ TB05	716718	6297629
◦ LB09	716719	6297644

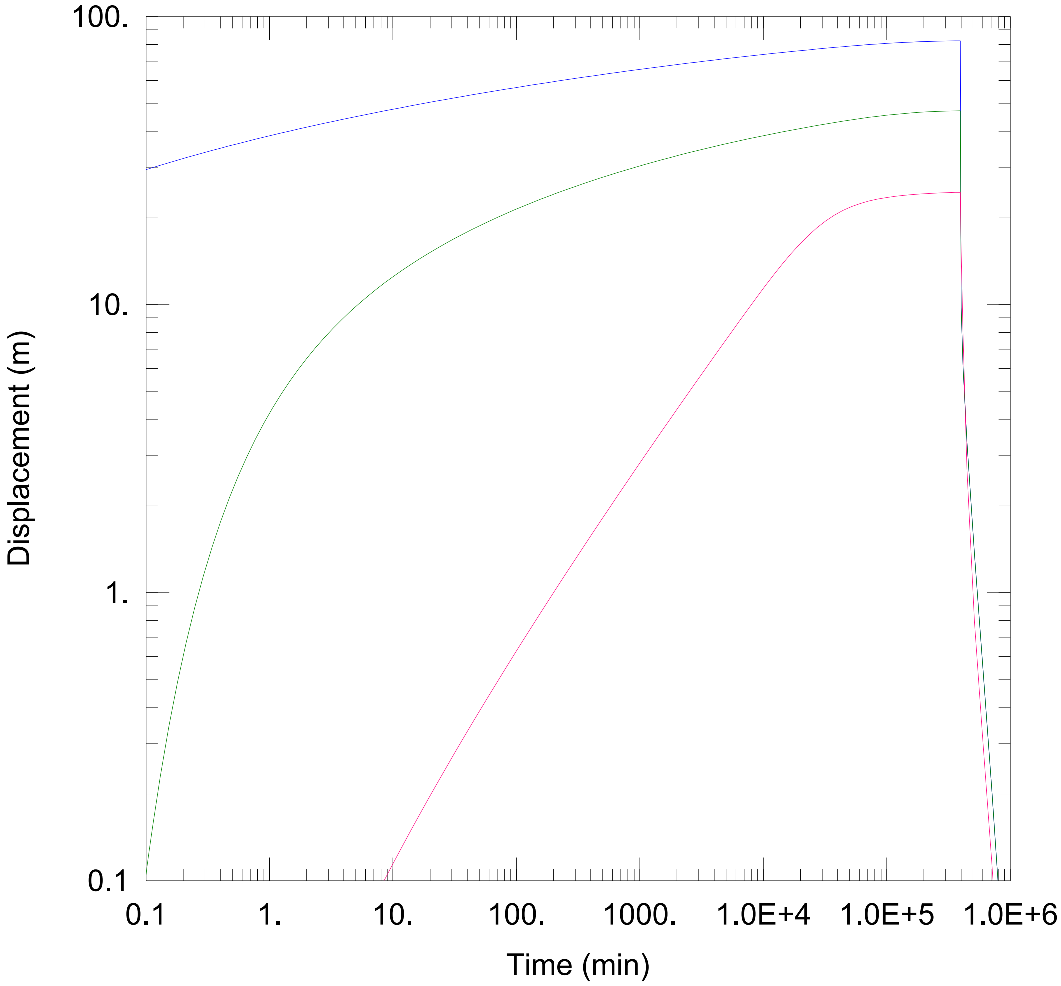
SOLUTION

Aquifer Model: Confined
Solution Method: Dougherty-Babu

T = 8.585 m^2/day
Kz/Kr = 1.
r(w) = 0.1 m
C = 4.01 min^2/m^5

S = 0.12
Sw = -6.42
r(c) = 0.1 m
P = 1.7

Step Test Model: Jacob-Rorabaugh
$s(t) = 0.109Q + 4.01Q^{1.7}$



TPB4 FORWARD SOLUTION

Data Set: \...\TPB4 forward solution leaky_N-Wither_V2.aqt
Date: 07/23/20
Time: 20:45:15

PROJECT INFORMATION

Company: EMM Consulting
Client: Regis Resources
Project: J17065
Location: Dungeon Road, Vittoria
Test Well: TPB4

AQUIFER DATA

Saturated Thickness: 60. m
Aquitard Thickness (b'): 20. m

Anisotropy Ratio (Kz/Kr): 1.
Aquitard Thickness (b"): 1. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TPB4	716425	6293990

Observation Wells

Well Name	X (m)	Y (m)
□ TPB4	716425	6293990
◇ MB14	716421	6293978
◇ MB15	716434	6293994

SOLUTION

Aquifer Model: Leaky

$T = 8.643$ m^2/day
$1/B = 0.0002348$ m^{-1}
$T2 = 1.44E+8$ m^2/day

Solution Method: Neuman-Witherspoon

$S = 3.682E-5$
$ß/r = 6.667E-5$ m^{-1}
$S2 = 1.0E-10$

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