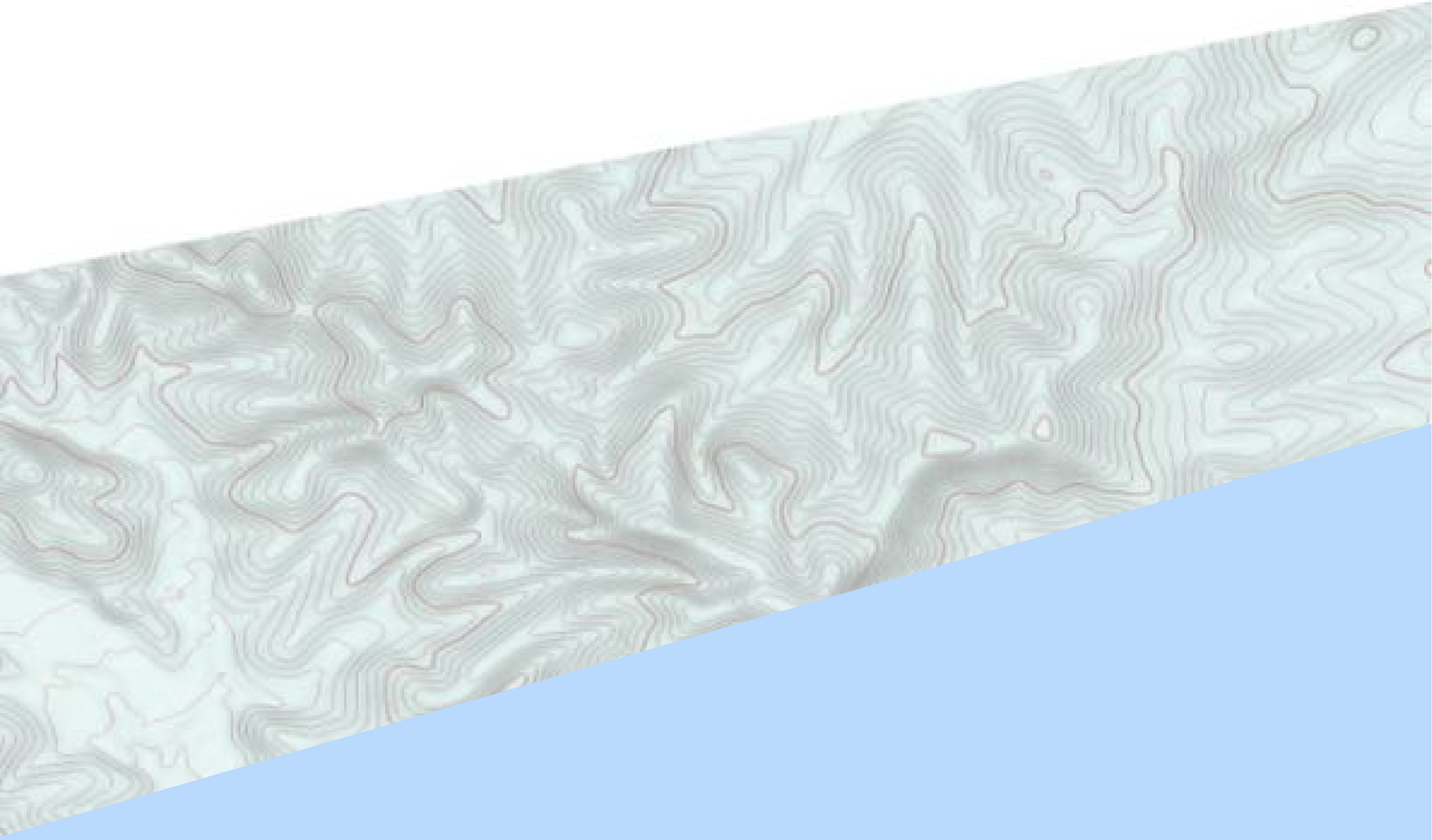

Baralaba South Pty Ltd

Baralaba South Project

Groundwater Modelling and Assessment

for the Environmental Impact Statement

Nov 2023

Document Register

Revision	Date	Comments
A	14/11/2023	Partial draft for comment
B	17/11/2023	Revision for Peer Review
C	24/11/2023	Version for EIS drafting
D	29/11/2023	Revision following Peer Review

File

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Quality Control

Process	Staff	Signature	Date
Authors	Will Minchin (Watershed HydroGeo)		29/11/2023
	Kevin Hayley (Groundwater Solutions)		

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Abbreviations

Abbreviation	Meaning
AGMG	Australian Groundwater Modelling Guidelines
AIP	Aquifer Interference Policy (NSW government)
BoM	Bureau of Meteorology
DPE	NSW Department of Planning and Environment
EPA	NSW Environment Protection Authority
Checklist	Independent Expert Scientific Committee (advising Federal and state governments)
L/s	Litres per second
mAHD	Metres above Australian Height Datum (effectively elevation as metres above sea level)
mbg	Metres below ground
ML/d	Megalitres per day
QOI	Quantity of Interest (i.e. primary or key predictions required from the numerical model)
TEC	Threatened Ecological Community (either Federally or State-listed)
THPSS	Temperate Highland Peat Swamps on Sandstone

Glossary of key construction and modelling terminology

Word	Meaning
Drained	A subsurface feature at which groundwater ingress or inflow can occur (depending on groundwater pressures and excavation geometry), and at which that water needs to be continually or regularly managed ('drained') to allow safe access.
Tanked	A subsurface feature that is constructed to effectively prevent groundwater ingress.
Model realisation	Given uncertainty in a hydrogeological system, which is the inability to know the exact value of hydraulic properties (e.g. permeability, porosity), a set of many plausible sets of parameters are modelled. Each of these is a realisation.
Model ensemble	This is the set of realisations used stochastically to simulate the project area and the project. Each realisation within the ensemble is plausible, and so the ensemble is used to estimate the approximate probability of some quantum of inflow or drawdown.
"modelled", "model representation"	How a feature/process is represented in a numerical model (i.e. model package, inputs, parameters)
"simulated" or "modelled"	Model outputs (e.g. groundwater levels, drawdown, inflow) when comparing to observations (in a historical / calibration period)
"model-predicted" or "projected"	Model outputs (e.g. groundwater levels, drawdown, inflow) in a future period or scenario
"projection"	Use of a numerical model in a subjective sense to make an estimate of future behaviour (e.g. the results of a single model realisation/scenario)
"forecast"	Use of a numerical model in a systematic sense to make an estimate of future behaviour to inform decision-making/impact assessment (i.e. the summary statistics from an ensemble) [although there is subjectivity in all modelling]

1 Introduction

The Baralaba South Project (BSP) is a proposed open cut coal mine located within Mining Lease Application (MLA) 700057, in the lower Bowen Basin region of Central Queensland (Qld). The BSP is located approximately 8 kilometres (km) south of the township of Baralaba, within the Banana (Shire) Local Government Area, and approximately 115 km south-west of Rockhampton (**Figure 1-1**).

This assessment forms the Groundwater Assessment component of the Environmental Impact Statement (EIS) for the BSP, prepared by AARC Environmental Solutions Pty Ltd, on behalf of Baralaba South Pty Ltd for the Baralaba South Project. This work has been conducted by Watershed HydroGeo with assistance, especially with the groundwater modelling, by Groundwater Solutions.

An existing mine, Baralaba North Mine (BNM, which includes both the Baralaba North and Baralaba Central mining areas) was historically mined between 1915 and1969. More recent open cut mining has been ongoing since 2005, with intermittent periods of care and maintenance. This operation is location 5 km north of the town of Baralaba (**Figure 1-1**). This operation targets the same coal measures as the proposed BSP, and significant data and experience from the BNM has informed the assessment of Baralaba South.

The relevant mine leases for the BNM and BSP are shown on **Figure 1-2**.

Relevant to BSP, Mineral Development Licence (MDL) Permit 352 has been granted for a large portion of MLA 700057 (**Figure 1-2**), and the surrounding areas are encompassed by Exploration Permit for Coal (EPC) 1047 and others further afield including EPC 783, EPC 988, EPC 1086, and EPC 1261.

ML 5656 is located immediately east of MLA 700057.

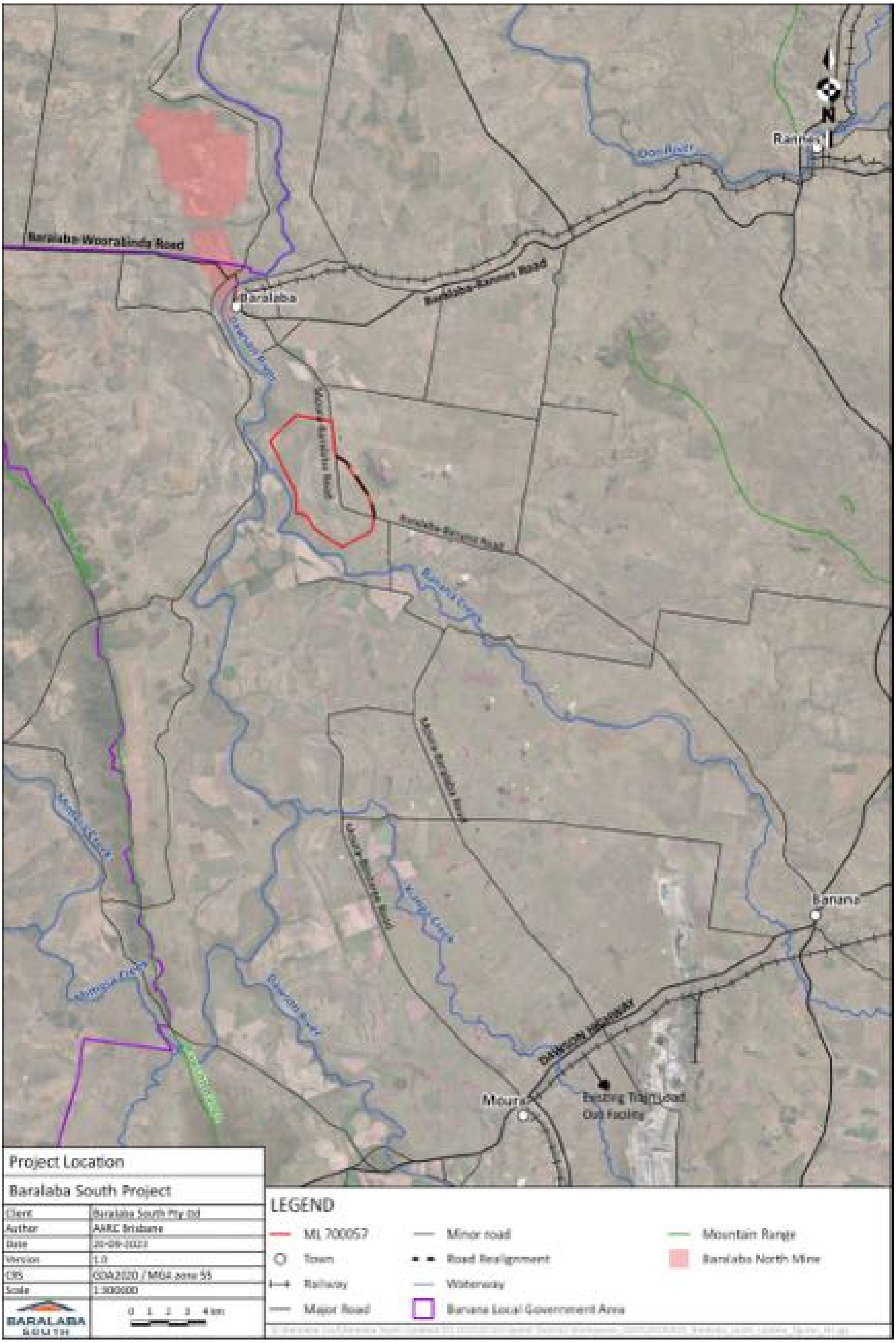


Figure 1-1 Regional Location

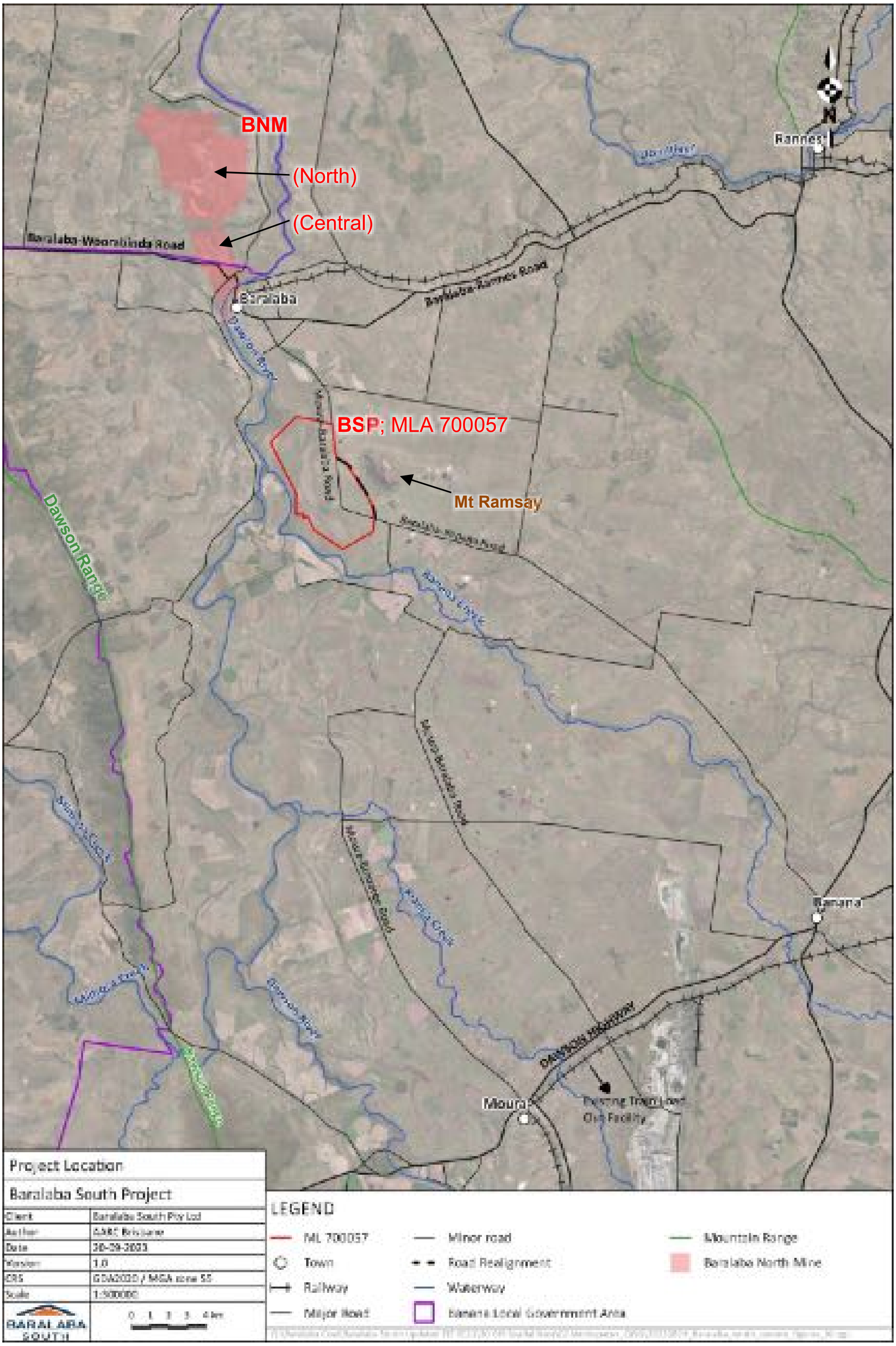


Figure 1-2 Plan showing BSP and key features near Baralaba

1.1 Project context

1.2 BSP proposed operations – ‘the Project’

Baralaba South Pty Ltd proposes to develop the BSP, a greenfield, open-cut metallurgical coal mine which would extract up to 2.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal to produce pulverised coal injection (PCI) coal for export to international markets over a life of up to 23 years (see more on timing in **Section 1.2.1**).

The main activities associated with the Project include:

- a greenfield open-cut coal mine to be developed within the MLA area, including:
  - a Coal Handling Preparation Plant (CHPP);
  - a mining infrastructure area, including workshops, administration buildings, fuel and chemical storage facilities, warehouse and hardstand areas;
  - ROM coal and product coal stockpile pads;
  - topsoil stockpiles, laydown areas and borrow pit areas;
  - haul roads and internal roads;
  - water management infrastructure;
  - backfilling of mine voids with waste rock behind the advancing open cut mining operations and the placement of waste rock in out-of-pit emplacements adjacent to the pit extents;
  - dewatering of CHPP rejects and disposal on-site within mine voids behind the advancing open cut mining operation;
  - other associated minor infrastructure, plant, equipment and activities; and
  - exploration activities.
- product coal road transport approximately 40 km to the existing train load-out facility east of Moura; and
- product coal rail transport to the Port of Gladstone for export to international markets.

The Project would employ up to 268 construction employees and up to approximately 521 employees during peak mining operations.

Approximately 49 Mt of ROM coal is estimated to be mined in the indicative mine schedule to produce approximately 36 Mt of product coal over the life of the Project. Open cut coal mining activities would target the Baralaba Coal Measures, including the basal sub-unit Kaloola Member, where the structural dip of the Permian geology brings them to or near the surface within MLA 700057.

For clarity, throughout this report, the terms “the BSP” and “the Study Area” are used as defined by:

- The BSP: generally defined by the bounds of MLA 700057 (**Figure 1-2**); and
- The Study Area: the regional area surrounding the BSP considered in detail within this assessment (and the same as the extent of the groundwater model described in **Section 6**).

1.2.1 BSP details and timing

The BSP general arrangement is shown in **Figure 1-4** to **Figure 1-8**. The BSP would be developed and operated as a multi-seam, open cut coal mine operation, ultimately producing pulverised coal injection (PCI) coal predominantly for the export market.

Conventional truck and shovel mining methods would be used at the BSP. On-site ROM coal handling and crushing facilities would be utilised at the BSP. ROM coal would be processed at a CHPP located on site.

For the purpose of cumulative impact assessment and representation in the modelling assessment, construction of the BSP is expected to commence circa 2029, with operations commencing in 2030 ("Year 1"), and the end of active mining ("Year 23") circa 2052. We emphasise that these dates are used for convenience in the groundwater modelling, and may not be the dates that eventuate.

A series of figures illustrating the progression of the pit, in terms of the floor elevation and extent of the pit, as well as the placement of waste and spoil in the out of pit dump as well as in the pit, is presented on **Figure 1-4** to Figure **1-6**. The pit progresses from north-west to south-east, while the invert of the pit floor generally descends with time. For further context, the deepest point of the pit floor, based on the mine plan GeoTiff files provided, is summarised on .

Figure 1-3 BSP pit floor elevation through time

The proposed final landform, including the final void, is shown on **Figure 1-8**, which includes a final void at the southern or south-western end of the pit limit.

Figure 1-4 Proposed BSP mine layout (Year 1)

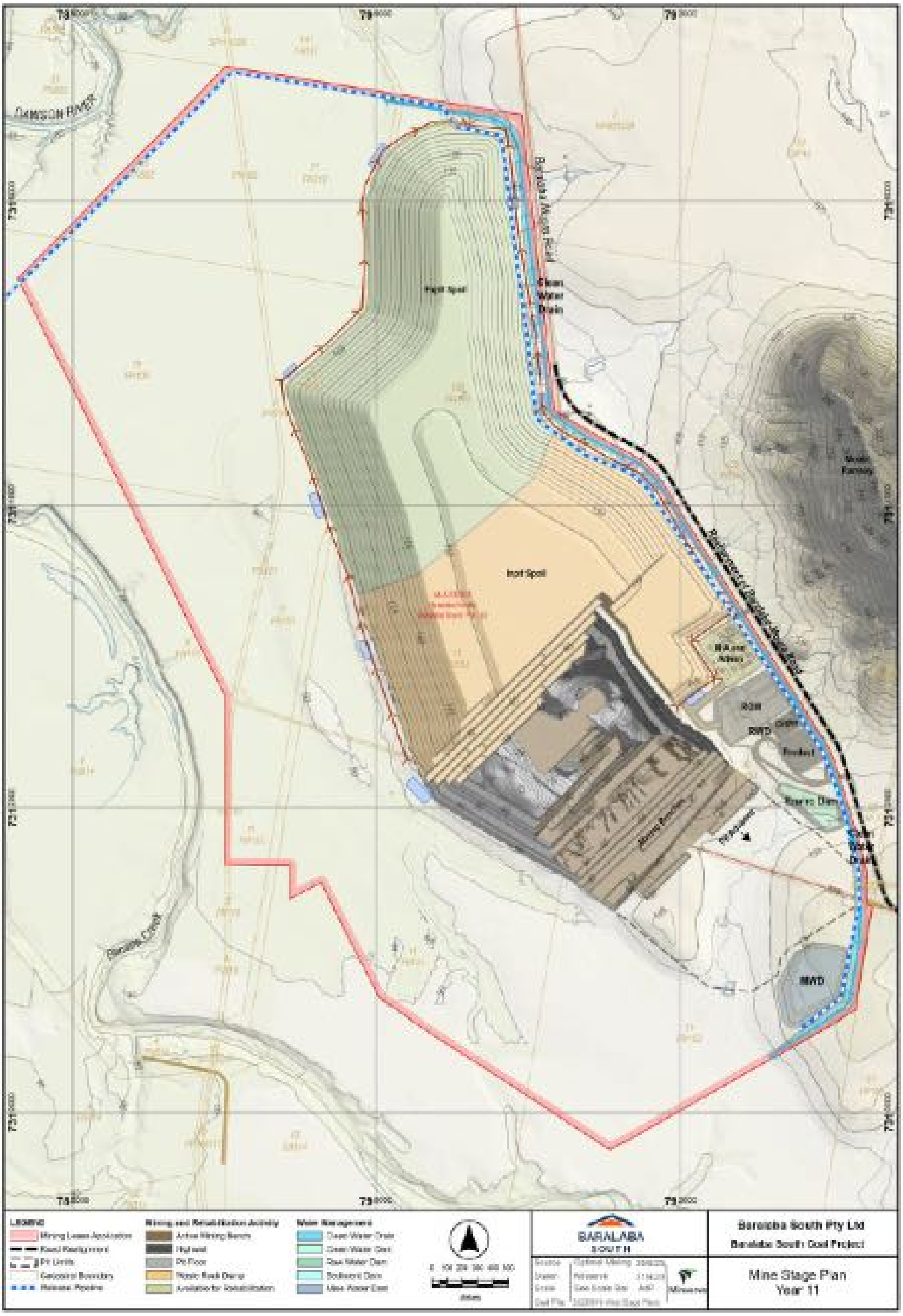


Figure 1-5 Proposed BSP mine layout (Year 11)

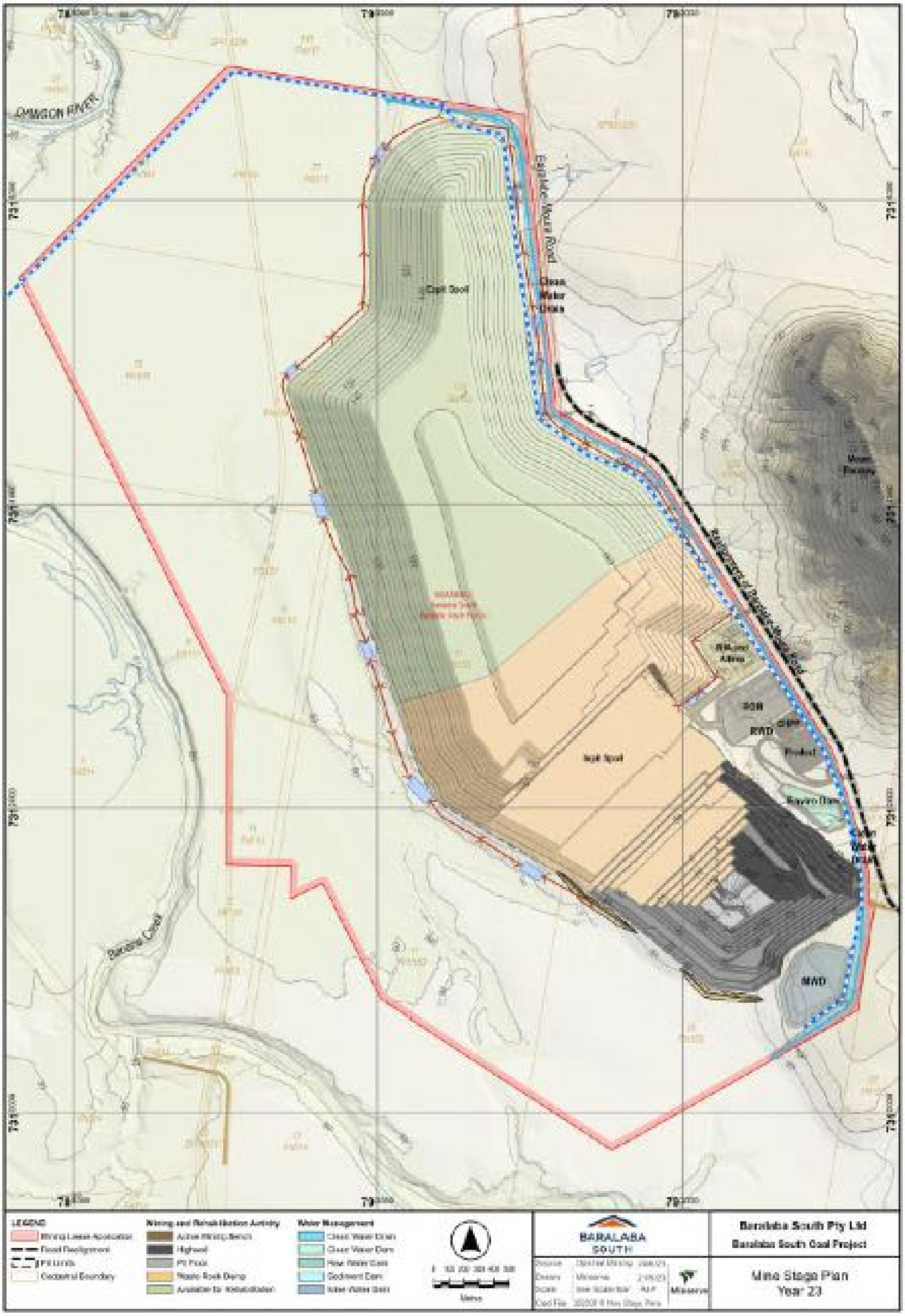
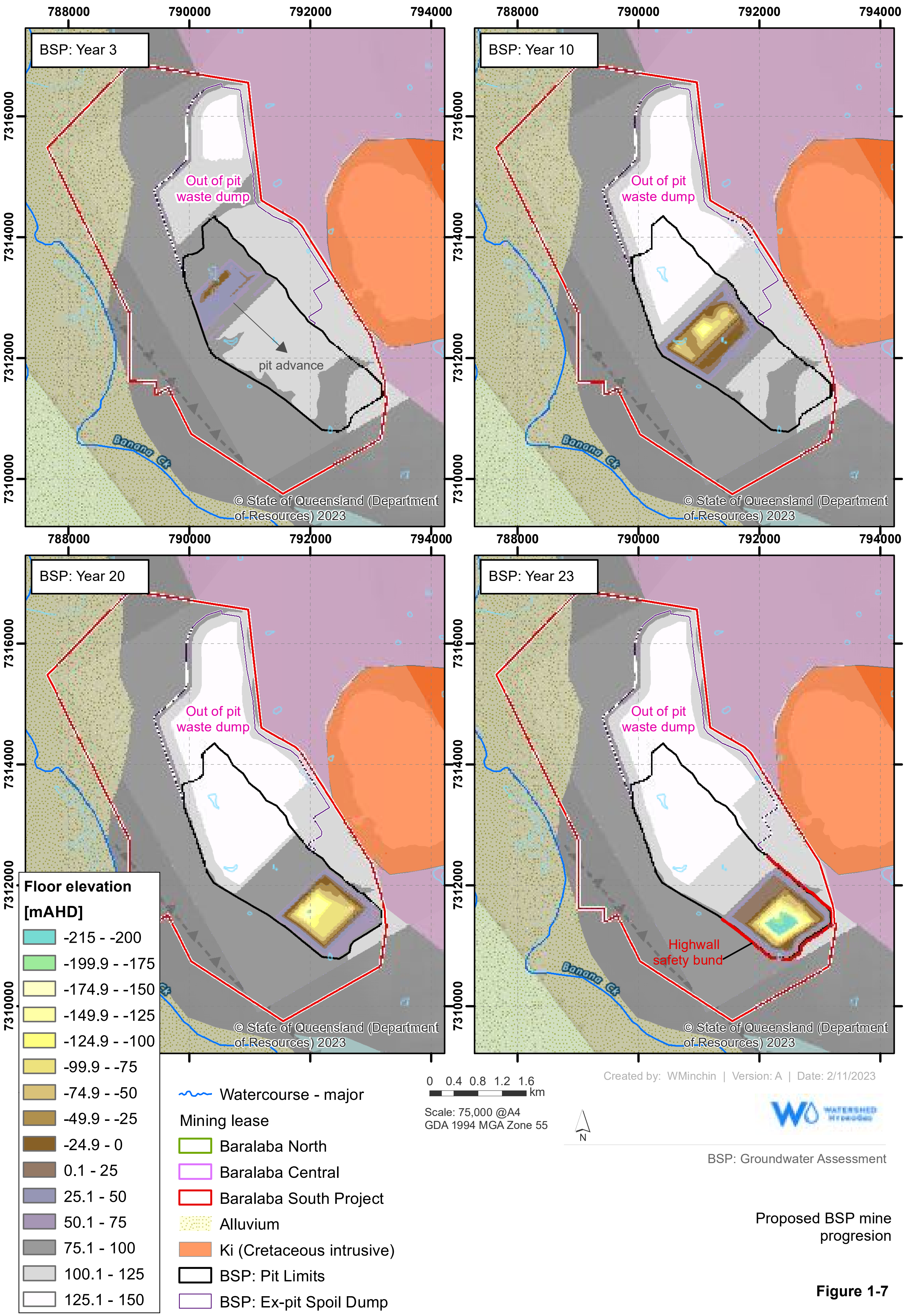


Figure 1-6 Proposed BSP mine layout (Year 23)



BSP: Groundwater Assessment

Proposed BSP mine progression

Figure 1-7

![WATERSHED HydroGeo]

Figure 1-8 Proposed BSP final landform

1.3 Purpose and Scope of this report

This groundwater modelling assessment has been prepared by Watershed HydroGeo and Groundwater Solutions. It follows on from an earlier assessment (for an earlier BSP mine plan) by SLR/HydroSimulations which was completed but not published because of the subsequent change in mine plan. This current assessment borrows heavily from that SLR/HydroSimulations document (by agreement), as well as the previously published HydroSimulations Baralaba North Continuing Operations Project (BNCOP) assessment (HydroSimulations, 2014), as listed in **Section 1.3.2**.

In terms of scope, this assessment has been prepared to:

1. meet the relevant Terms of Reference (TOR) for the BSP, dated 19 July 2017 (State of Queensland, 2017); and

2. address the relevant information requirements contained in the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC)'s *Information Guidelines for proponents preparing coal seam gas and large coal mining development proposals* (IESC Guidelines, May 2018).

At the time of preparation of the groundwater modelling and assessment, the IESC had released the following explanatory notes to the IESC Guidelines for the public consultation:

- *Information Guidelines Explanatory Note: Uncertainty analysis for groundwater modelling* (Peeters and Middlemis, 2023);
- *Information Guidelines Explanatory Note: Assessing Groundwater-Dependent Ecosystems* (Doody, Hancock and Pritchard, 2019); and
- *Information Guidelines Explanatory Note: Deriving Site-Specific Guideline Values for Physico-chemical Parameters and Toxicants* (Huynh and Hobbs, 2019).

Information Guidelines Explanatory Note: Characterisation and modelling of geological fault zones. (Murray and Power, 2021).This groundwater assessment has been prepared considering the explanatory notes, which are discussed where relevant. Further details to demonstrate how these requirements have been addressed in this assessment and elsewhere as part of the EIS are provided in **Section 2**.

To this end, the stated assessment scope is as follows:

- **Numerical Groundwater Model and Groundwater Assessment Report:** Develop a numerical groundwater model and prepare a Groundwater Assessment report for the EIS (to meet the relevant TOR for the Baralaba South Project, dated 19 July 2017), which would be subject to peer review, and address the relevant information requirements contained in the IESC's *Information guidelines for proponents preparing coal seam gas and large coal mining development proposals* (IESC Guidelines, May 2018).

Finally, this groundwater assessment has also been prepared in accordance with the *Water - EIS information guideline* (State of Queensland, 2020).

1.3.1 Report structure

The structure of this report is outlined in **Table 1-1**.

This report has been written to be relatively stand-alone, i.e. there is enough description of the project to allow the reader to understand the project and the modelling. More detail on the project, especially details that are not considered relevant to the groundwater assessment modelling, is available elsewhere in the EIS.

Table 1-1 Outline of report structure

Section		Contents
1	**Introduction**	Description of study requirements and objective (scope of work). Description of BSP (with respect to potential effects on groundwater). Includes description of regulatory and water management frameworks, and includes TOR, IESC and other checklists.
2	**Environmental context**	Describes topography, surface water drainage, climate and land use in the Study Area.
3	**Hydrogeology**	Describes the groundwater setting and "groundwater assets". Review and analysis of groundwater levels, recharge and discharge mechanisms, aquifer properties (hydraulic conductivity and porosity parameters).
4	**Groundwater quality**	Although this is technically 'hydrogeology' a separate section on groundwater quality at Baralaba has been included to include the context of the relevant Water Quality objectives.
5	**Hydrogeological Conceptual Model**	Synthesis of environmental and hydrogeological data to describe the hydrogeological system, as well as to describe the likely effects and impacts of the proposed development.
6	**Numerical model development and calibration**	Describes the approach to numerical modelling and the inputs to that process, as well as describing the 3D groundwater model and linkages to other tools. Outlines the procedure and the results of model history-matching phase of work, focussing on observations and data that are most relevant to the predictions required.
7	**Numerical model predictions and uncertainty analysis**	Presents output from the model, including predicted groundwater inflow, groundwater level and pressure hydrographs/maps/profiles, and take from surface water features and GDEs. This section is focussed on the potential effects on groundwater quantity and availability.
8	**Impacts on groundwater quality**	This summarises the potential effects on groundwater quality, based on a review of baseline data, the geochemical assessment and the beneficial uses of groundwater in this area.
9	**Conclusions**	Summary of this Groundwater Assessment, including description of the site and the Project, the conceptual model and numerical modelling. Summarises the key impacts and effects based on the conceptual and numerical model against relevant requirements. Also includes recommendations for management and monitoring.
	References	List of documents referred to in this report

Requests for data presented in this report will be considered.

1.3.2 Previous studies, plans, programs and reports

Although a complete reference list is also provided in **Section 10**, the following list of documents is highlighted as having provided important background information, data and context that have been used to complete this groundwater assessment:

- AGE, 2005. Baralaba Coal Mine: Groundwater Regime and Monitoring Program. Proj G1326. December 2005.
- AGE, 2012. Baralaba North – Mine Extension Groundwater Management Plan. Proj G1565. January 2012.
- Cockatoo Coal Limited, 2012. Baralaba South Coal Project: General Project Description – Initial Advice Statement. Prepared for Wonbindi Coal Pty Ltd. July 2012.
- SKM, 2013. Baralaba North Mine Water Management Support: Groundwater Field Installation. Draft Report QE99082.300. February 2013.
- GES, 2014. Monitoring Bore Installation and Hydraulic Testing at the Baralaba Coal Project. February 2014.

- SKM, 2014. Baralaba North Continued Operations EIS Groundwater Studies: Preliminary Conceptual Groundwater Model. Report QE06728.200, July 2013.
- HydroSimulations, 2014. Baralaba North Continued Operations (BNCOP) Groundwater Modelling and Assessment. Report HC2014/002, April 2014.
- SLR, 2019. *Baralaba South Groundwater Report 2018*. Report 620.11731-R05, January 2019 (**Appendix A**).
- 4T Consultants, 2019. *Baralaba South Landholder Bore Survey* (results provided in **Appendix B**).
- Stygoecologia, 2019. Baralaba South Project Stygofauna Assessment. Prepared by Peter Serov. November 2019. Prepared for Baralaba South Pty Ltd.
- 3d Environmental, 2023. Baralaba South Project Groundwater Dependent Ecosystems Assessment. Prepared for Baralaba South Pty Ltd.

1.4 Regulatory Framework

1.4.1 State of Queensland Terms of Reference (TOR)

TOR for the BSP application were issued by QLD Government on 19/07/2017. Items from the TOR relevant to this Groundwater Assessment are listed in **Table 1-2**.

Table 1-2 Summary of Terms of Reference (TOR), 19/07/2017 – groundwater-related issues

Ref. in TOR	Requirement	Reference in this document (or EIS)
Part B, 6.2.3 [Site Description]	Where appropriate, describe and map in plan and cross-sections the surficial and solid geology and landforms, including catchments, of the project area. Show geological structures, such as aquifers, faults and economic resources that could have an influence on, or be influenced by, the project's activities.	Discussed in Sections 2.4 and 3 of this groundwater assessment.
Part B, 8.1.6 [Information Requirements - Rehabilitation]	Notwithstanding that management techniques may improve over the life of the project, and legislative requirements may change, the EIS needs to give confidence that all potential high-impact elements of the project (e.g. spoil dumps, voids, tailings and water management dams, creek diversions/ crossings, subsidence areas, etc.) are capable of being managed and rehabilitated to achieve acceptable land use capabilities/suitability, to be stable and self-sustaining and to prevent upstream and downstream surface and groundwater contamination.	Rehabilitation design reported separately in the EIS. Relevant groundwater information is provided in this report. Surface water related details are reported separately by Engeny Water Management (2023) in the EIS.
Part B, 8.1.7 [Information Requirements - Flora and Fauna]	Describe the likely impacts on the biodiversity and natural environmental values of affected areas arising from the construction, operation and eventual decommissioning of the project (where known). Take into account any proposed avoidance and/or mitigation measures. The assessment should include, but not be limited to, the following key elements: … terrestrial and aquatic ecosystems (including groundwater-dependent ecosystems) and their interaction; …	Assessment of consequential impacts to flora and fauna, including groundwater-dependent ecosystems is undertaken by Eco Solutions & Management, Ecological Service Professionals and 3d Environmental and reported separately in the EIS.
Part B, 8.2 [Water Quality - Objectives and Performance Outcomes]	The environmental objectives to be met under the EP Act are that the activity (project) be operated in a way that: ▪ protects the environmental values of waters;	Environmental values of groundwater are presented in Section 4.1 of this groundwater assessment. Assessment of consequential impacts to wetlands, groundwater-dependent ecosystems, and associated surface ecological systems is undertaken by

Ref. in TOR	Requirement	Reference in this document (or EIS)
	▪ protects the environmental values of wetlands (including soaks and springs) and groundwater dependent ecosystems; and protects the environmental values of groundwater and any associated surface ecological systems.	Eco Solutions & Management, Ecological Service Professionals and 3d Environmental and reported separately in the EIS.
Part B, 8.2.3 [Water Quality - Information Requirements]	Detail the chemical, physical and biological characteristics of surface waters and groundwater within the area that may be affected by the project during construction, operation and following completion. The information should be based on statistically robust baseline surface water and groundwater quality data.	Available groundwater datasets provided by Baralaba South Pty Ltd are presented in Sections 3 and 4.2 of this groundwater assessment.
Part B, 8.2.4 [Water Quality - Information Requirements]	Identify the quantity, quality, location and timing of all potential and/or proposed releases of contaminants (such as controlled water releases to surface water streams) from water and waste water from the project, whether as point sources (including controlled or uncontrolled discharges, stormwater run-off from regulated structures or other dams and sediment basins) or diffuse sources (such as seepage from waste rock dumps or irrigation to land of treated sewage effluent).	Geochemical characterisation of waste rock is undertaken by Terrenus Earth Sciences and reported separately in the EIS. Surface water related details are reported separately by Engeny Water Management in the EIS. Irrigation to land of treated sewage effluent is assessed by Stantec and reported separately in the EIS.
Part B, 8.3 [Water Resources - Objectives]	The construction and operation of the project should aim to meet the following objectives: ▪ equitable, sustainable and efficient use of water resources ▪ maintenance of environmental flows, water quality, in-stream habitat diversity, and naturally occurring inputs from riparian zones (including groundwater dependent ecosystems) support the long term maintenance of the ecology of aquatic biotic communities (including stygofauna); and ▪ the condition and natural functions of water bodies (e.g. lakes, springs, watercourses and wetlands) are maintained, including the stability of beds and banks of watercourses.	Assessment of impacts on groundwater are assessed in Sections 7 and 8 of this report. Assessment of potential impacts on surface water, geomorphology, and consequential groundwater and surface water impacts to flora and fauna and their habitats (including groundwater-dependent ecosystems and stygofauna) are undertaken by Engeny Water Management, WRM Water and Environment, Eco Solutions & Management, Ecological Service Professionals, 3d Environmental and Stygoecologia and reported separately in the EIS.
Part B, 8.3.1 [Water Resources - Information Requirements]	Provide details of any proposed impoundment, extraction, discharge, injection, use or loss of surface water or groundwater.	Mine layout and extraction configurations are reported separately in the EIS, but pit geometry is described in Section 1.2 of this document. No advance dewatering or borefield extraction is proposed.
Part B, 8.3.1 [Water Resources - Information Requirements]	The environmental objectives to be met under the EP Act are that the activity (project) be operated in a way that: ▪ protects the environmental values of waters; ▪ protects the environmental values of wetlands (including soaks and springs) and groundwater dependent ecosystems; and ▪ protects the environmental values of groundwater and any associated surface ecological systems.	Environmental values of groundwater are presented in Section 4.1 of this groundwater assessment. Assessment of consequential impacts to wetlands, groundwater-dependent ecosystems, and associated surface ecological systems is undertaken by Eco Solutions & Management, Ecological Service Professionals and 3d Environmental and reported separately in the EIS.
Part B, 8.3.4 [Water Resources - Information Requirements]	Detail the chemical, physical and biological characteristics of surface waters and groundwater within the area that may be affected by the project during construction, operation and following completion. The information should be based on statistically robust baseline surface water and groundwater quality data.	Available groundwater datasets provided by Baralaba South Pty Ltd are presented in Sections 3 and 4.2of this groundwater assessment.

Ref. in TOR	Requirement	Reference in this document (or EIS)
Part B, 8.3.5 [Water Resources - Information Requirements]	Identify the quantity, quality, location and timing of all potential and/or proposed releases of contaminants (such as controlled water releases to surface water streams) from water and waste water from the project, whether as point sources (including controlled or uncontrolled discharges, stormwater run-off from regulated structures or other dams and sediment basins) or diffuse sources (such as seepage from waste rock dumps or irrigation to land of treated sewage effluent).	Geochemical characterisation of waste rock is undertaken by Terrenus Earth Sciences and reported separately in the EIS. Surface water related details are reported separately by Engeny Water Management in the EIS. Irrigation to land of treated sewage effluent is assessed by Stantec and reported separately in the EIS.
Part B, 8.3.6 [Water Resources - Information Requirements]	▪ The construction and operation of the project should aim to meet the following objectives: ▪ equitable, sustainable and efficient use of water resources ▪ maintenance of environmental flows, water quality, in-stream habitat diversity, and naturally occurring inputs from riparian zones (including groundwater dependent ecosystems) support the long term maintenance of the ecology of aquatic biotic communities (including stygofauna); and ▪ the condition and natural functions of water bodies (e.g. lakes, springs, watercourses and wetlands) are maintained—including the stability of beds and banks of watercourses.	Assessment of impacts on groundwater are assessed in Sections 8 and 9 of this report. Assessment of potential impacts on surface water, geomorphology, and consequential groundwater and surface water impacts to flora and fauna and their habitats (including groundwater-dependent ecosystems and stygofauna) are undertaken by Engeny Water Management, WRM Water and Environment, Eco Solutions & Management, Ecological Service Professionals, 3d Environmental and Stygoecologia and reported separately in the EIS.
Part B, 8.3.7 [Water Resources - Information Requirements]	Provide details of any proposed impoundment, extraction, discharge, injection, use or loss of surface water or groundwater.	Mine layout and extraction configurations are reported separately in the EIS. No advance dewatering or borefield extraction is proposed.
Part B, 8.3.8 [Water Resources - Information Requirements]	The environmental objectives to be met under the EP Act are that the activity (project) be operated in a way that: ▪ protects the environmental values of waters; ▪ protects the environmental values of wetlands (including soaks and springs) and groundwater dependent ecosystems; and ▪ protects the environmental values of groundwater and any associated surface ecological systems.	Environmental values of groundwater are presented in Section 4.1 of this groundwater assessment. Assessment of consequential impacts to wetlands, groundwater-dependent ecosystems, and associated surface ecological systems is undertaken by Eco Solutions & Management, Ecological Service Professionals and 3d Environmental and reported separately in the EIS.
Part B, 8.3.6 (*sic*) [The Independent Expert Scientific Committee (IESC)]	Detail the chemical, physical and biological characteristics of surface waters and groundwater within the area that may be affected by the project during construction, operation and following completion. The information should be based on statistically robust baseline surface water and groundwater quality data.	Available groundwater datasets provided by Baralaba South Pty Ltd are presented in Sections 3 and 4.2of this groundwater assessment.
Appendix 2 [Matters of National Environmental Significance]	Identify the quantity, quality, location and timing of all potential and/or proposed releases of contaminants (such as controlled water releases to surface water streams) from water and waste water from the project, whether as point sources (including controlled or uncontrolled discharges, stormwater run-off from regulated structures or other dams and sediment basins) or diffuse sources (such as seepage from waste rock dumps or irrigation to land of treated sewage effluent).	Geochemical characterisation of waste rock is undertaken by Terrenus Earth Sciences and reported separately in the EIS. Surface water related details are reported separately by Engeny Water Management in the EIS. Irrigation to land of treated sewage effluent is assessed by Stantec and reported separately in the EIS.

Ref. in TOR	Requirement	Reference in this document (or EIS)
Appendix 2 [Matters of National Environmental Significance]	The construction and operation of the project should aim to meet the following objectives: ■ equitable, sustainable and efficient use of water resources ■ maintenance of environmental flows, water quality, in-stream habitat diversity, and naturally occurring inputs from riparian zones (including groundwater dependent ecosystems) support the long term maintenance of the ecology of aquatic biotic communities (including stygofauna); and ■ the condition and natural functions of water bodies (e.g. lakes, springs, watercourses and wetlands) are maintained—including the stability of beds and banks of watercourses.	Assessment of impacts on groundwater are assessed in Sections 7 and 8 of this report. Assessment of potential impacts on surface water, geomorphology, and consequential groundwater and surface water impacts to flora and fauna and their habitats (including groundwater-dependent ecosystems and stygofauna) are undertaken by Engeny Water Management, WRM Water and Environment, Eco Solutions & Management, Ecological Service Professionals, 3d Environmental and Stygoecologia and reported separately in the EIS.

1.4.2 Site-specific requirements

Minimum reporting requirements for groundwater impact assessments are outlined within the *Guideline Requirements for site-specific and amendment applications – underground water rights* and relates to Section 126A of the EP Act. A summary of the guideline requirements and where they have been addressed within this report is provided in **Table 1-3**.

Table 1-3 Requirements for Site-Specific Applications – Underground Water Rights

Part	Requirement or detail	Where addressed
Part A	A statement that the applicant proposes to exercise underground water rights.	Statement made in Section 1.8 and 9of this groundwater assessment.
Part B	A description of the area/s in which underground water rights are proposed to be exercised.	MLA 700057 described in Section 1.1 of this groundwater assessment. Mine progression presented in Section 1.2.1.
Part C	A description of the aquifer/s affected or likely to be affected. ■ Aquifer type (confined, unconfined, fractured etc). ■ Geology/stratigraphy for each aquifer. ■ Depth to and thickness of the aquifers. ■ Physical integrity of the aquifer, fluvial processes and morphology. ■ Depth to water level and seasonal changes in levels. ■ Hydrogeological cross sections. ■ Maps (spatial extent).	Sections 2.4, 3 and 4 of this groundwater assessment.
Part D	An analysis of the movement of underground water to and from the aquifer. Inputs (i.e. recharge) and outputs (i.e. baseflow and abstraction). ■ Underground water elevations (i.e. mapped groundwater flow directions). ■ Connectivity between aquifers and hydraulic properties. ■ Preferential flow pathways (i.e. faults). ■ Springs.	Sections 3 and 5 of this groundwater assessment.

Part	Requirement or detail	Where addressed
Part E	A description of the area of the aquifer where the water level is predicted to decline because of the exercise of underground water rights.	Section 7.6.2 of this groundwater assessment.
	Predictions should: ▪ Be made for the life of the resource project and for post resource tenure closure. ▪ Be made about the timing, spatial extent and magnitude of maximum water level declines in affected aquifers. ▪ Be made about the timing and magnitude of groundwater level equilibrium in affected aquifers. Produce potentiometric contour maps showing maximum predicted water level decline for each affected aquifer.	Modelling predictions in Section 7 of this document. Maps in Sections 7.6.2 and 7.11.1 of this document.
	Modelling methodology, including: ▪ Model type (e.g. numerical or analytical). ▪ Modelling platform. ▪ Model inputs. ▪ Model boundary conditions. ▪ Model assumptions and limitations. ▪ Sensitivity analysis and calibration results.	Sections 6 and 7 of this groundwater assessment. Uncertainty analysis incorporating parameter sensitivities in Section 7.3.
Part F	The predicted quantities of water to be taken or interfered with because of the exercise of underground water rights. Details on the methodology used for measuring extraction volumes and developing the extraction schedule.	Associated water take in Section 7.9 of this document. Section 9.1.1 and 9.1.3 of this document.
Part G	Information on predicted impacts to the quality of groundwater that will, or may, happen because of the exercise of underground water rights. Identify the quality of the groundwater prior to the activity commencing. Explain the variation of chemical concentrations as a result of chemical reactions over the life of the project due to the exercise of underground water rights (i.e. changes in salinity and concentration of dissolved gas). Estimate extent and likelihood of groundwater quality impacts, with justification based on potential sources of contamination.	Sections 5, 7 and 8 of this groundwater assessment.
Part H	Identifying and describing environmental values: ▪ Information on the environmental values that will, or may, be affected by the exercise of underground water rights. ▪ Describe and define environmental value of aquifers, presenting available raw data used. Document groundwater use, including details on operating bores within the areas predicted to be affected by the exercise of underground water rights. Nature and extent of the impacts on the environmental values (risk assessment): ▪ The magnitude, relative size or actual extent of any impact in relation to the environmental value being affected. ▪ The vulnerability or resilience of the environmental value (severity and duration). Uncertainty of impacts and any assumptions. Surface subsidence impacts.	Sections 1.8, 3, 4.1, 7 and 8 of this groundwater assessment Uncertainty analysis in all model predictions (Section 7) No surface subsidence.

Part	Requirement or detail	Where addressed
Part I	Information on strategies for avoiding, mitigating or managing the predicted impacts on the environmental values or predicted impacts on the quality of groundwater. Strategies for avoiding, mitigating and managing the predicted impacts on both environmental values and predicted changes in groundwater quality should include: ▪ Objectives which define the outcomes that are intended to be achieved (i.e. avoiding, mitigating and managing the predicted impacts) and a description of unavoidable impacts to environmental values. ▪ Measures (specific methods/procedures/tools) to be implemented to demonstrate how the objectives will be achieved. ▪ Indicators relevant to protection of the environmental values (i.e. indicators are the values that are to be measured to gauge whether the objectives are being achieved and are used to are to be used in auditing the performance of measures). ▪ A program for monitoring the indicators (see EP Act Guideline for requirements). ▪ A reporting program which includes triggers for the review of the strategies, and identifies additional data, assessment, analysis and reporting requirements.	Section 9.1 of this groundwater assessment.

1.4.1 Commonwealth regulation

The Environment Protection and Biodiversity Conservation Act, 1999 (Commonwealth) (EPBC Act) is administered by the Department of Agriculture, Water and the Environment (DAWE). The EPBC Act is designed to protect national environmental assets, known as Matters of National Environmental Significance (MNES).

The Qld Government's EIS process has been accredited for the assessment under Part 8 of the EPBC Act in accordance with the Bilateral Agreement between the Commonwealth of Australia and the State of Queensland (dated 18 December 2014).

Thus, the controlling provisions for the BSP, with regard to potential impacts on MNES are:

- Sections 18 and 18A of the EPBC Act (listed threatened species and communities);
- Sections 20 and 20A of the EPBC Act (listed migratory species); and
- Sections 24D and 24E of the EPBC Act (water resources).

Whilst only one impact assessment is required, the documentation is reviewed separately by the Qld and Commonwealth Government departments, and in accordance with Part 2 of the TOR under the EP Act (Section 2.1.2) the assessment of the potential impacts, mitigation measures and any offsets for residual impacts must be dealt with in a stand-alone section of the EIS that fully addresses the matters relevant to the controlling provisions.

Relevantly, the IESC is a statutory body under the EPBC Act that provides scientific advice to the Commonwealth Environment Minister and relevant Qld Ministers. Guidelines have been developed to assist the IESC in reviewing coal seam gas (CSG) or large coal mining development proposals that are likely to have significant impacts on water resources. This includes completion of an independent peer review of numerical groundwater modelling in accordance with the Australian Groundwater

Modelling Guidelines (Barnett et al. 2012). The IESC information requirements checklist[1] is presented in **Table 1-4**, with details on where aspects have been addressed and documented within this groundwater assessment.

The potential impacts of the BSP on groundwater resources have been assessed in consideration of the Significant impact guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources.

Table 1-4 IESC Information Requirements Checklist (May, 2018)

Category	Specific Requirement	Where Addressed
Description of the Proposal	Provide a regional overview of the proposed project area including a description of the geological basin; coal resource; surface water catchments; groundwater systems; water-dependent assets; and past, present and reasonably foreseeable coal mining and CSG developments.	Sections 1.7, 1.8, 2, 3 and 4of this groundwater assessment.
	Describe the proposal's location, purpose, scale, duration, disturbance area, and the means by which it is likely to have a significant impact on water resources and water-dependent assets.	Section 1.1, 1.2 and 5 of this groundwater assessment.
	Describe the statutory context, including information on the proposal's status within the regulatory assessment process and any applicable water management policies or regulations.	Sections 1.4 and 1.8 of this groundwater assessment.
	Describe how impacted water resources are currently being regulated under state or Commonwealth law, including whether there are any applicable standard conditions.	Section 1.4.1 of this groundwater assessment.
Risk Assessment	Identify and assess all potential environmental risks to water resources and water-related assets, and their possible impacts. In selecting a risk assessment approach consideration should be given to the complexity of the project, and the probability and potential consequences of risks.	Sections 5, 7 and 8 of this groundwater assessment, and elsewhere in the EIS.
	Incorporate causal mechanisms and pathways identified in the risk assessment in conceptual and numerical modelling. Use the results of these models to update the risk assessment.	Sections 5, 7 and 8 of this groundwater assessment and elsewhere in the EIS (e.g. 3dE, 2023).
	Assess risks following the implementation of any proposed mitigation and management options to determine if these will reduce risks to an acceptable level based on the identified environmental objectives.	Sections 7, 8, and 9.1 of this groundwater assessment and elsewhere in the EIS.
	The risk assessment should include an assessment of: – all potential cumulative impacts which could affect water resources and water-related assets, and – mitigation and management options which the proponent could implement to reduce these impacts.	Sections 1.7 and 7 (7.1.1) of this groundwater assessment and elsewhere in the EIS.
Groundwater – Context and Conceptualisation	Describe and map geology at an appropriate level of horizontal and vertical resolution including: – definition of the geological sequence(s) in the area, with names and descriptions of the formations and accompanying surface geology, cross-sections and any relevant field data.	Sections 2.4 and 5.1.4 of this groundwater assessment.

[1] https://www.iesc.gov.au/publications/information-guidelines-independent-expert-scientific-committee-advice-coal-seam-gas (dated 2018, but retrieved in 2023),

	– geological maps appropriately annotated with symbols that denote fault type, throw and the parts of sequences the faults intersect or displace.	
	Provide data to demonstrate the varying depths to the hydrogeological units and associated standing water levels or potentiometric heads, including direction of groundwater flow, contour maps, and hydrographs. All boreholes used to provide this data should have been surveyed.	Section 3 of this groundwater assessment.
	Define and describe or characterise significant geological structures (e.g. faults, folds, intrusives) and associated fracturing in the area and their influence on groundwater – particularly groundwater flow, discharge or recharge. – Site-specific studies (e.g. geophysical, coring/ wireline logging etc.) should give consideration to characterising and detailing the local stress regime and fault structure (e.g. damage zone size, open/closed along fault plane, presence of clay/shale smear, fault jogs or splays). – Discussion on how this fits into the fault's potential influence on regional-scale groundwater conditions should also be included.	Sections 2.4 and 5.1.4 of this groundwater assessment.
	Provide hydrochemical (e.g. acidity/alkalinity, electrical conductivity, metals, and major ions) and environmental tracer (e.g. stable isotopes of water, tritium, helium, strontium isotopes, etc.) characterisation to identify sources of water, recharge rates, transit times in aquifers, connectivity between geological units and groundwater discharge locations.	Section 4 of this groundwater assessment, with recharge rate estimation in Section 3.7.
	Provide site-specific values for hydraulic parameters (e.g. vertical and horizontal hydraulic conductivity and specific yield or specific storage characteristics including the data from which these parameters were derived) for each relevant hydrogeological unit. In situ observations of these parameters should be sufficient to characterise the heterogeneity of these properties for modelling.	Section 3.6 of this groundwater assessment.
	Describe the likely recharge, discharge and flow pathways for all hydrogeological units likely to be impacted by the proposed development.	Sections 3.3, 3.7 and 5.1 of this groundwater assessment.
	Provide time series level and water quality data representative of seasonal and climatic cycles.	Section 3.1 and 4.2 of this groundwater assessment.
	Assess the frequency (and time lags if any), location, volume and direction of interactions between water resources, including surface water/groundwater connectivity, inter-aquifer connectivity and connectivity with sea water.	Section 5.1 of this groundwater assessment.
Groundwater – Analytical and Numerical Modelling	Provide a detailed description of all analytical and/or numerical models used, and any methods and evidence (e.g. expert opinion, analogue sites) employed in addition to modelling.	Numerical modelling in Sections 6 and 7 of this groundwater assessment.
	Provide an explanation of the model conceptualisation of the hydrogeological system or systems, including multiple conceptual models if appropriate. Key assumptions and model limitations and any consequences should also be described.	Sections 1.3.2 and 5 of this groundwater assessment. Model confidence and limitations Sections 6.2.1, 6.15, 7.12.

	Undertaken groundwater modelling in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al. 2012), including independent peer review.	Sections 6, and 6.15, of this groundwater assessment.
	Consider a variety of boundary conditions across the model domain, including constant head or general head boundaries, river cells and drains, to enable a comparison of groundwater model outputs to seasonal field observations.	Section 6.5 of this groundwater assessment.
	Calibrate models with adequate monitoring data, ideally with calibration targets related to model prediction (e.g. use baseflow calibration targets where predicting changes to baseflow).	Section 6.7 of this groundwater assessment.
	Undertake sensitivity analysis and uncertainty analysis of boundary conditions and hydraulic and storage parameters, and justify the conditions applied in the final groundwater model (see Peeters and Middlemis, 2023).	Sections 6.2 and 7.3, and uncertainty incorporated in all predictions in Sections 7.2 to 7.9.
Groundwater – Analytical and Numerical Modelling (continued)	Describe each hydrogeological unit as incorporated in the groundwater model, including the thickness, storage and hydraulic characteristics, and linkages between units, if any.	Sections 2.4.3, 3 and 5 of this groundwater assessment.
	Provide an assessment of the quality of, and risks and uncertainty inherent in, the data used to establish baseline conditions and in modelling, particularly with respect to predicted potential impact scenarios.	Section 7.12 describes sources of uncertainty, and Section 7.3 describes how uncertainty in predictions is addressed.
	Describe the existing recharge/discharge pathways of the units and the changes that are predicted to occur upon commencement, throughout, and after completion of the proposed project.	Section 5 of this groundwater assessment.
	Undertake an uncertainty analysis of model construction, data, conceptualisation and predictions (see Peeters and Middlemis, 2023)	Section 6.2 and 7.3 of this groundwater assessment.
	Describe the various stages of the proposed project (construction, operation and rehabilitation) and their incorporation into the groundwater model. Provide predictions of water level and/or pressure declines and recovery in each hydrogeological unit for the life of the project and beyond, including surface contour maps for all hydrogeological units.	Sections 7.1 and 7.2 of this groundwater assessment. Contour maps in Sections 7.6.1, 7.6.2 and 7.11.1.
	Provide a program for review and update of models as more data and information become available, including reporting requirements.	Sections 9.1.3 and 9.1.4 of this document.
	Identify the volumes of water predicted to be taken annually with an indication of the proportion supplied from each hydrogeological unit.	Section 7.9 of this groundwater assessment.
	Undertake model verification with past and/or existing site monitoring data.	The calibration using BNM data is somewhat of a verification (Section 6.11-6.12).

Groundwater – Impacts to Water Resources and Water-Dependent Assets	Provide an assessment of the potential impacts of the proposal, including how impacts are predicted to change over time and any residual long-term impacts. Consider and describe: – any hydrogeological units that will be directly or indirectly dewatered or depressurised, including the extent of impact on hydrological interactions between water resources, surface water/groundwater connectivity, inter-aquifer connectivity and connectivity with sea water. – the effects of dewatering and depressurisation (including lateral effects) on water resources, water-dependent assets, groundwater, flow direction and surface topography, including resultant impacts on the groundwater balance. – the potential impacts on hydraulic and storage properties of hydrogeological units, including changes in storage, potential for physical transmission of water within and between units, and estimates of likelihood of leakage of contaminants through hydrogeological units. – the possible fracturing of and other damage to confining layers. – For each relevant hydrogeological unit, the proportional increase in groundwater use and impacts as a consequence of the proposed project, including an assessment of any consequential increase in demand for groundwater from towns or other industries resulting from associated population or economic growth due to the proposal.	Sections 7, 8 and 9 of this groundwater assessment.
	Describe the water resources and water-dependent assets that will be directly impacted by mining or CSG operations, including hydrogeological units that will be exposed/partially removed by open cut mining and/or underground mining.	Sections 3, 4 and 5 of this groundwater assessment.
	For each potentially impacted water resource, provide a clear description of the impact to the resource, the resultant impact to any water-dependent assets dependent on the resource, and the consequence or significance of the impact.	Sections 5, 7 and 8of this groundwater assessment.
	Describe existing water quality guidelines, environmental flow objectives and other requirements (e.g. water planning rules) for the groundwater basin(s) within which the development proposal is based.	Sections 1.8 and 4.1 of this groundwater assessment.
Groundwater – Impacts to Water Resources and Water-Dependent Assets (continued)	Provide an assessment of the cumulative impact of the proposal on groundwater when all developments (past, present and/or reasonably foreseeable) are considered in combination.	Sections 1.7, 7.1 and 7.2 of this groundwater assessment.
	Describe proposed mitigation and management actions for each significant impact identified, including any proposed mitigation or offset measures for long-term impacts post mining.	Section 9.1 of this groundwater assessment.
	Provide a description and assessment of the adequacy of proposed measures to prevent/minimise impacts on water resources and water-dependent assets.	Section 9.1 of this groundwater assessment.
Groundwater – Data and Monitoring	Provide sufficient data on physical aquifer parameters and hydrogeochemistry to establish pre-development conditions, including fluctuations in groundwater levels at time intervals relevant to aquifer processes.	Sections 3.6 and 4 of this groundwater assessment. Hydrogeochemistry details reported separately by Terrenus Earth Sciences.

	Provide long-term groundwater monitoring data, including a comprehensive assessment of all relevant chemical parameters to inform changes in groundwater quality and detect potential contamination events.	Section 3.1 and 4.2 of this groundwater assessment.
	Develop and describe a robust groundwater monitoring program using dedicated groundwater monitoring wells – including nested arrays where there may be connectivity between hydrogeological units – and targeting specific aquifers, providing an understanding of the groundwater regime, recharge and discharge processes and identifying changes over time	Monitoring already in place at BSP (Section 3.1), with some recommendations in Sections 9.1.1 and 9.1.3.
	Ensure water quality monitoring complies with relevant National Water Quality Management Strategy (NWQMS) guidelines (ANZG 2018) and relevant legislated state protocols (e.g. QLD Government 2013).	Section 4.2 and 9.1 of this groundwater assessment.
	Develop and describe proposed targeted field programs to address key areas of uncertainty, such as the hydraulic connectivity between geological formations, the sources of groundwater sustaining GDEs, the hydraulic properties of significant faults, fracture networks and aquitards in the impacted system, etc., where appropriate.	Section 9.1.1 and 9.1.3 of this groundwater assessment.
Surface Water – Context and Conceptualisation		Undertaken by Engeny Water Management and reported separately in the EIS.
Surface Water – Analytical and Numerical Modelling		
Surface Water – Impacts to Water Resources and Water-Dependent Assets		
Surface Water – Data and Monitoring		
Surface Water – Impacts to Water Resources and Water-Dependent Assets		
Water-Dependent Assets – Context and Conceptualisation		Assessment of water-dependent flora and fauna undertaken by 3d Environmental, Ecological Survey & Management, Ecological Service Professionals, and Stygoecologia and reported separately in the EIS. Other groundwater assets discussed in Sections 3 and 4.
Water-Dependent Assets – Impacts, Risk Assessment and Management of Risks		
Water-Dependent Assets – Data and Monitoring		
Water and Salt Balance, and Water Quality		Undertaken by Engeny Water Management and reported separately in the EIS.
Cumulative Impacts – Context and Conceptualisation	Provide cumulative impact analysis with sufficient geographic and temporal boundaries to include all potentially significant water-related impacts.	Sections 1.7, 7.1 and 7.2 of this groundwater assessment.
Cumulative Impacts – Impacts	Consider all past, present and reasonably foreseeable actions, including development proposals, programs and policies that are likely to impact on the water resources of concern in the cumulative impact analysis. Where a proposed project is located	Section 1.7 in this groundwater assessment.

Cumulative Impacts – Mitigation, Monitoring and Management	within the area of a bioregional assessment consider the results of the bioregional assessment.	Section 9.1 of this groundwater assessment.
Subsidence – Underground Coal Mines and Coal Seam Gas		Not applicable.
Final Landforms and Voids – Coal Mines		Undertaken by AARC and Engeny Water Management and reported separately in the EIS.
Acid-Forming Materials and Other Contaminants of Concern		Undertaken by Terrenus Earth Sciences and reported separately in the EIS. Groundwater quality discussed in Sections 2.6, 4.2 and 8.
CSG Well Construction and Operation		Not applicable.

1.5 Objectives of this assessment

The objectives of this report are to present an assessment of groundwater-related effects on the surrounding hydrogeological system and relevant environmental features of the Project during operation and following closure. The modelling and reporting here inform the Environmental Impact Statement (EIS) for the Project.

Excavation and dewatering associated with the project would cause perturbations to groundwater pressures and levels and to fluxes, as described in the hydrogeological conceptual model presented in **Section 5**. Numerical groundwater modelling is used to quantify potential impacts that may be caused by Project-related activities and in the longer-term following closure, as well as considering cumulative impacts.

The modelling to quantify the potential effects is consistent with the conceptual model and observational data to enable forecasting of effects from the project on groundwater and connected surface water systems.

Specifically, the forecasts of groundwater and (connected) surface water effects from the Project, including estimates of uncertainty; would include:

- Estimated groundwater inflow to mine workings ('groundwater take').
- Estimates of the extent and rate of drawdown at specific locations including at private bores in the area.
- Estimates of the magnitude and timing of changes to baseflow (groundwater discharge) to nearby watercourses.
- Review the likely groundwater dependence of wetland systems, and provide estimates of the potential for effects on Groundwater Dependent Ecosystems (GDEs) [in conjunction with the GDE Assessment report (3De, 2023) and Stygofauna report (Stygoecologia, 2019)].

Following that, recommendations were provided related to:

- Areas of potential risk where groundwater impact mitigation/monitoring measures may be necessary.
- Water supply or assets that may be affected by groundwater drawdown.
- Potential losses from designated groundwater and surface water sources and management zones.

Model development addressed the following items:

i. Provision of a model projection of the time to reach steady state conditions and the predicted effects of steady state conditions.
ii. Use of the existing piezometric time series data to perform a transient calibration run.
iii. The predictive model provides sufficient detail to model geological structures with high inflow potential.
iv. Uncertainty analysis results and interpretation presented with the model results (as per Peeters and Middlemis, 2023).
v. Predictive model scenarios to evaluate potential impact(s) in relation to the rivers and creek baseflow, and to connected wetlands (GDEs).
vi. Provision and justification of all design hydrogeological parameters and assumptions used in the numerical modelling.
vii. Identification of any credible hydrogeological or groundwater related hazards.

1.6 Numerical modelling approach

The approach to groundwater modelling in this project is based on principles outlined in the *Australian Groundwater Modelling Guidelines* ['AGMG'] (Barnett et al., 2012) and the IESC guidelines for uncertainty analysis (Peeters and Middlemis, 2023). The overall scope of the model and the choice of uncertainty analysis method is considered appropriate to the environmental risks and project scope.

Groundwater modelling is typically carried out to support or inform management decisions. Models provide better support for environmental decisions if they are developed with the aim of assessing a specific question or testing a hypothesis, rather than with the aim of replicating all (or many) elements of the hydrogeological system (Doherty and Moore, 2019). Based on this view, Doherty and Moore (2019) recommend that modelling is carried out using the following approach (which is similar to the uncertainty-driven workflow of Middlemis and Peeters (2018) and Peeters and Middlemis (2023), and implicit in the Planning phase of modelling as described in the AGMG):

- Identify the decision-critical prediction(s) or Quantities of Interest (QOI) required of the numerical model.
- Conceptualise the systems and identify or include properties that contribute most to uncertainty of that prediction.
- Identify existing data (and/or collect new data) that can inform relevant parameters and reduce uncertainty through an appropriate data assimilation process (i.e. history matching).
- Use the model to calculate forecast values and uncertainty.

The above approach has implications for the design of the numerical model. In particular, the adoption of automated methods for parameter estimation and uncertainty analyses such as those in PEST/PESTPP (Watermark Numerical Computing, 2018; White et al., 2020) require that the model is numerically stable and has a relatively short runtime. The details of the modelling carried out for this study are presented in Sections 2 to 7.

PESTPP-IES (White et al., 2020) ['IES' stands for Iterative Ensemble Smoother] is used here to carry out history-matching while generating an ensemble of alternative model realisations, not just a single "calibrated" or minimum error variance model, that embed parameter sensitivity in predictions.

1.7 Potential for cumulative impacts

The proximity of the Baralaba North Mine (BNM) to the BSP means that Baralaba North effects need to be considered as part of a cumulative impact assessment. The numerical model was originally constructed to assess impacts at or from BNM (for the BNCOP EIS – 2014), and has subsequently been extended to better include BSP. As such, the modelling allows for cumulative impact assessment.

No other mining or extractive operations have been identified in this area that require cumulative impact assessment alongside the project.

1.8 Water management

The *Water Act 2000* (Qld) (the "Water Act"), supported by the subordinate Water Regulation 2016 (Qld), is the primary legislation regulating groundwater resources in Qld. The purpose of the Water Act is to advance efficient use or sustainable management of water resources by establishing a system for planning, allocation and use of water.'

The Water Act was amended in 2014 with introduction of the Water Reform and Other Legislation Amendment Act 2014 (WROLA Act). Changes to this legislation included giving new mines a limited statutory right to take groundwater they intercepted ('associated water').

The WROLA Act was later amended in 2016 with the introduction of the Water Legislation Amendment Act 2015 and the Environmental Protection (Underground Water Management) and Other Legislation Amendment Act 2016 (EPOLA Act). . There is also greater emphasis on baseline data collection for environmental assessments. In addition, mine applications can be required to verify updated groundwater impact predictions within an underground water impact report (UWIR) three years following approval, or at a frequency prescribed by the chief executive.

The Water Act is enacted under a framework of catchment specific Water Plans (WPs).

Water resources within the BSP area are captured under the Water Plan (Fitzroy Basin) 2011, which was current as of October 2023, and is shown on **Figure 1-9**. This shows that the BSP is not in a defined groundwater management area in the Fitzroy Basin.

As part of the BSP, Baralaba South Pty Ltd is proposing to exercise underground water rights during the period in which resource activities would be carried out at MLA 700057 and is discussed further in **Section 1.4.1**.

The Water Plan also covers surface waters (Lower Dawson River Sub-basin - zone WQ1309), including those relevant to the BSP, and pursuant to the Environmental Protection (Water and Wetland Biodiversity) Policy 2019, as follows:

- Lower Dawson River Catchment Fresh Waters: Eastern Tributaries; and
- Lower Dawson Main Catchment Fresh Waters: Lower Dawson Main Channel – Regulated Reaches.

Related entities of the proponent currently hold over 1,000 ML of water allocation from the Fitzroy Basin, Dawson River Zone D (discussed further in Section 2.2.1) under the Water Act, which are applied and operated in accordance with the Water Plan (Fitzroy Basin) 2011 and Fitzroy Basin Resource Operations Plan (amended September 2015).

Water quality in this area, including the management of this, is described further in **Section 4.1**.

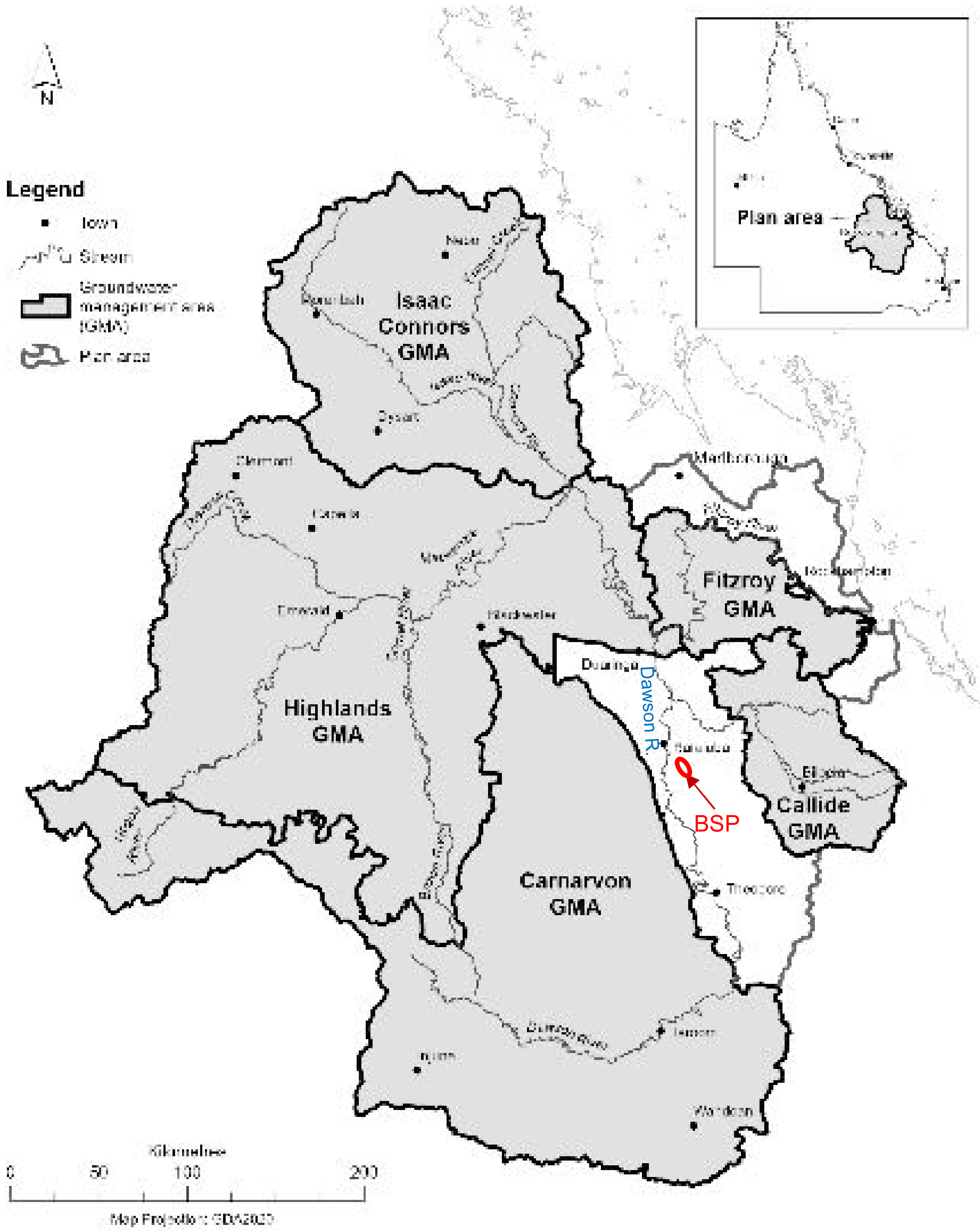


Figure 1-9 Relevant Groundwater Management Areas under Fitzroy Basin Plan (2011)

(https://www.legislation.qld.gov.au/view/html/inforce/current/sl-2011-0283#sch.3)

2 Environmental context

2.1 Climate

The climate of the Baralaba region is described as 'sub-tropical' with higher rainfall, higher evaporation and higher temperatures occurring over the summer months (SKM, 2014).

2.1.1 Rainfall and long-term trends

The nearest Bureau of Meteorology (BOM) weather station with an extensive rainfall dataset is located at the Baralaba PO (station 039004) 100 m elevation, approximately 7 km north-west of the Project. The weather station recorded rainfall from August 1926 to July 2013 (an 87-year period), with an average annual rainfall of 714 millimetres (mm) per year.

The highest annual rainfall for this period was recorded in 2010 with 1,349 mm, while the lowest annual rainfall was 350 mm recorded in 1969.

Monthly averages for the 87-year period of record at the Baralaba Post Office (station 039004) are listed in **Table 2-1**. Because this BOM station record is no longer active, for the purposes of the groundwater assessment, the SILO (Scientific Information for Land Owners) database of Australian climate data was used for the period commencing 1889 to September 2020 to generate long-term rainfall trends and as an input to the groundwater modelling. The monthly and annual averages from the SILO record for the BOM Baralaba Post Office location are also presented in **Table 2-1**.

The long-term monthly mean generated by SILO Data Drill at point grid (Latitude -24.25, Longitude 149.85) is 707 mm/yr, noting that the SILO data covers the period to 1900-2023.

Table 2-1 Average Rainfall (mm) at Baralaba PO (Station 039004) from BOM and SILO

Source	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
	Summer		Autumn			Winter			Spring			Summer	
BOM	96.2	115.6	73.5	44.8	41.7	34.9	28.6	21.8	25.6	55.1	75.3	103.1	**714**
SILO	96	104	74	38	35	36	28	20	25	51	70	97	**674**

Source: http://www.bom.gov.au/climate/averages/tables/cw_039004.shtml; https://legacy.longpaddock.qld.gov.au/silo/datadrill/

As shown in **Table 2-1**, rainfall is generally highest from December to March, and lowest in winter.

Rainfall trends over the past century are indicated by analysis of the residual mass curve (RMC) (or cumulative rainfall departure from the mean [CRD]) (**Figure 2-1**). This curve is generated by aggregating the residuals between recorded monthly rainfall[2] and long-term average rainfall for each month. The procedure is essentially a low-pass filter operation that suppresses the natural spikes in rainfall and enhances the long-term trends.

[2] Note: Records for the period from 2013-2019 presented on the RMC (Figure 3-1) are based on the SILO-generated datasets as the BOM Baralaba Post Office (station 039004) closed in 2013.

Figure 2-1 Long-term rainfall and evaporation trends (from SILO data)

The RMC displays trends in rainfall, with positive slope (rising limbs) indicating periods of rainfall greater than the mean, and negative slope (falling limbs) indicating below-mean conditions. Given the usually slow response of groundwater levels to rainfall inputs, the RMC can be expected to correlate well with groundwater hydrographs over the long term.

Figure 2-1 shows that the wetter periods on record occurred during the early 1950s, 1970s and more recently in 2010-11. The drier periods are shown as having occurred during the 1960s and early to mid-2000s (sometimes referred as the 'Millennium Drought') during which time open cut mining commenced at BNM.

The RMC also performs an additional service. If rainfall is the dominant source of recharge to the groundwater system, the temporal variability in recorded groundwater levels can be expected to mimic the pattern of this curve. That is, natural fluctuations in the groundwater table result from temporal changes in rainfall recharge to groundwater systems. Typically, changes in groundwater elevation reflect the deviation between the long-term monthly (or yearly) average rainfall, and the recorded rainfall, often illustrated by the rainfall RMC. Further analysis of corresponding trends in recorded groundwater levels is provided in Section 3.4.

2.1.2 Evaporation and evapotranspiration

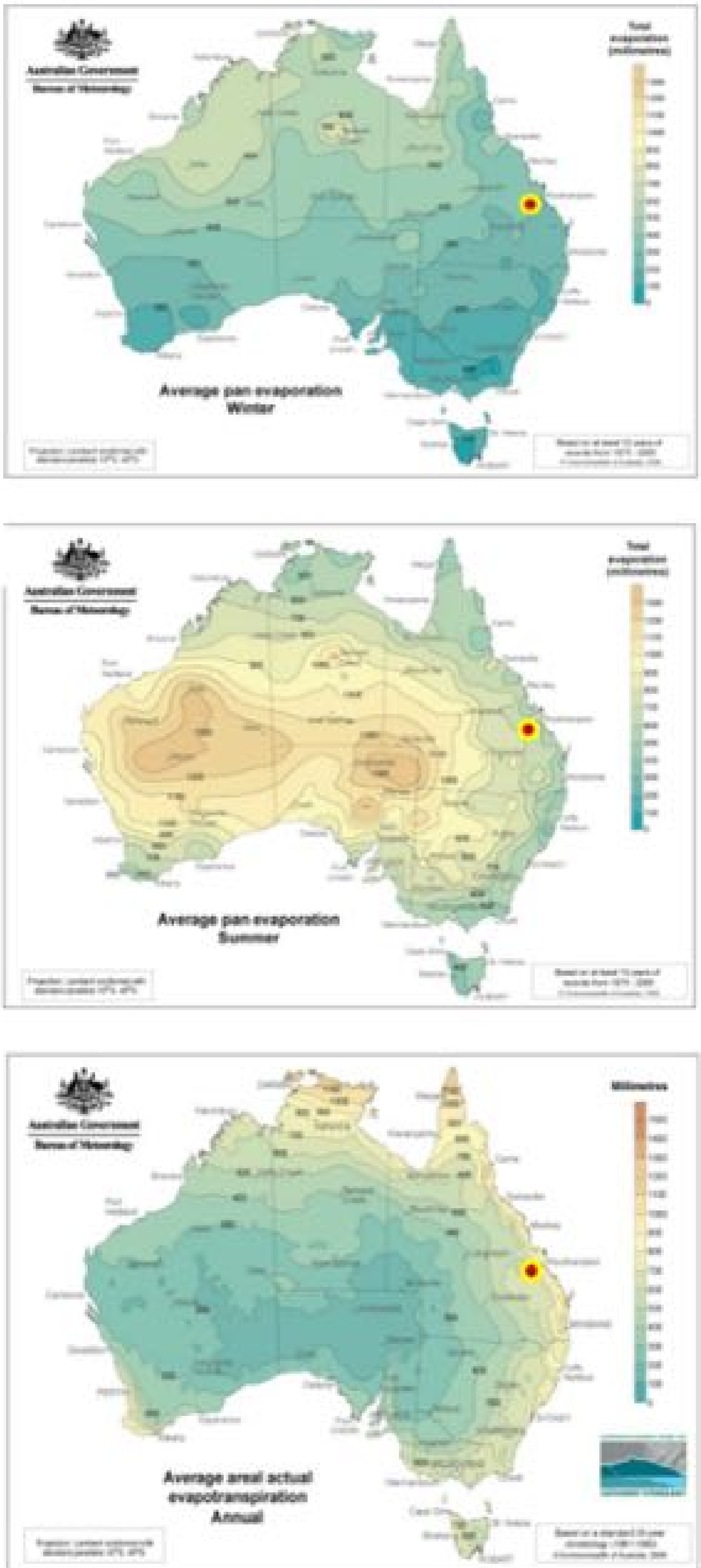
Evaporation is defined by BOM as the amount of water which evaporates from an open pan called a Class A evaporation pan. The rate of evaporation depends on factors such as cloudiness, air temperature and wind speed. The distribution of average pan evaporation across Australia in winter and summer months is shown on **Figure 2-2**.

The BOM station with class A pan evaporation data closest to the study area is the Brigalow Research Station (station 035149), approximately 80 km from Baralaba. Recorded annual evaporation is approximately 2,120 mm/year between 1966 and 2011, while the SILO data obtained for the Baralaba Post Office Location (**Section 2.1.1**) indicates that annual average potential evaporation is 2,040 mm/yr. Average rainfall at Baralaba is approximately 700 mm, which means average evaporation is three times average rainfall at Baralaba.

[a]

[b]

[c]



Source: BOM, 2005 - http://www.bom.gov.au/climate/maps/averages/evapotranspiration/?maptype=aa&period=an

Figure 2-2 Average Pan Evaporation across Australia in [a] Winter and [b] Summer Months; and [c] Annual Average Areal Actual Evapotranspiration

More relevantly, annual average areal actual evapotranspiration (ET), as estimated by the BOM (1961-1990), is between 600 and 700 mm/year for the Baralaba region (**Figure 2-2**). The definition for actual ET is:

> *"... the ET that actually takes place, under the condition of existing water supply, from an area so large that the effects of any upwind boundary transitions are negligible and local variations are integrated to an areal average. For example, this represents the evapotranspiration which would occur over a large area of land under existing (mean) rainfall conditions."*

The specific application of evapotranspiration, including extinction depths for vegetation cover for the purposes of the groundwater assessment, is discussed separately in **Section 6.5.5**.

2.2 Topography and drainage

Figure 2-3 presents the topographic context for the Project. At a regional scale, the terrain is characterised by a steep and incised mountain to the east of MLA 700057 (Mt Ramsay), which falls west towards the low-lying floodplain of the Dawson River and Banana Creek, which is the major tributary of Dawson River in this area.

The landscape setting within MLA 700057 is gently undulating, with elevation ranging between 75 m Australian Height Datum (AHD) in the west and 110 mAHD in the east. The site is drained by an un-named tributary of the Dawson River, which drains to the north-west of MLA 700057. A small proportion of the MLA 700057 catchment also drains south-west to Banana Creek.

2.2.1 Dawson River

More detailed discussion of the hydrology of the area and the Project in particular is presented in the EIS Surface Water Assessment (Engeny, 2023). However the following summary of key hydrological features aids the conceptual understanding of the system and helps put some of the later impact assessment (via the groundwater model) in context.

The Dawson River, located approximately 750 m west of MLA 700057, flows towards the north and is perennial, with river storage levels and flows regulated by the downstream Neville Hewitt Weir at Baralaba (labelled on **Figure 2-3**).

The weir is an 8.5 m high dam (to 80.3 mAHD) with 11,300 ML capacity. The Neville Hewitt Weir has likely raised the Dawson River stage above the natural levels upstream of the weir, including in the BSP area (SKM, 2014).

There are a number of existing (open) and historic (now closed) stream gauging stations along the Dawson River and up-catchment tributaries in the Baralaba region, including:

- 130374A – Dawson River at Bindaree [Open] (since 2005)
- 130322A – Dawson River at Beckers [Open] (since 1964)
- 130363A – Roundstone Creek at Dawson Highway [Open] (since 1999)
- 130304A – Dawson River at Baralaba [Closed] (1924-1961)
- 130304B – Dawson River at Neville Hewitt Weir [Closed] (1997-2002)
- 130312A – Mimosa Creek at Karamea [Closed] (1953-1958)
- 131316A – Mimosa Creek at Redcliffe [Open] (since 1957)
- 130350B – Dawson River at Moura Weir [Closed – *Storage Only*] (1997-2019)

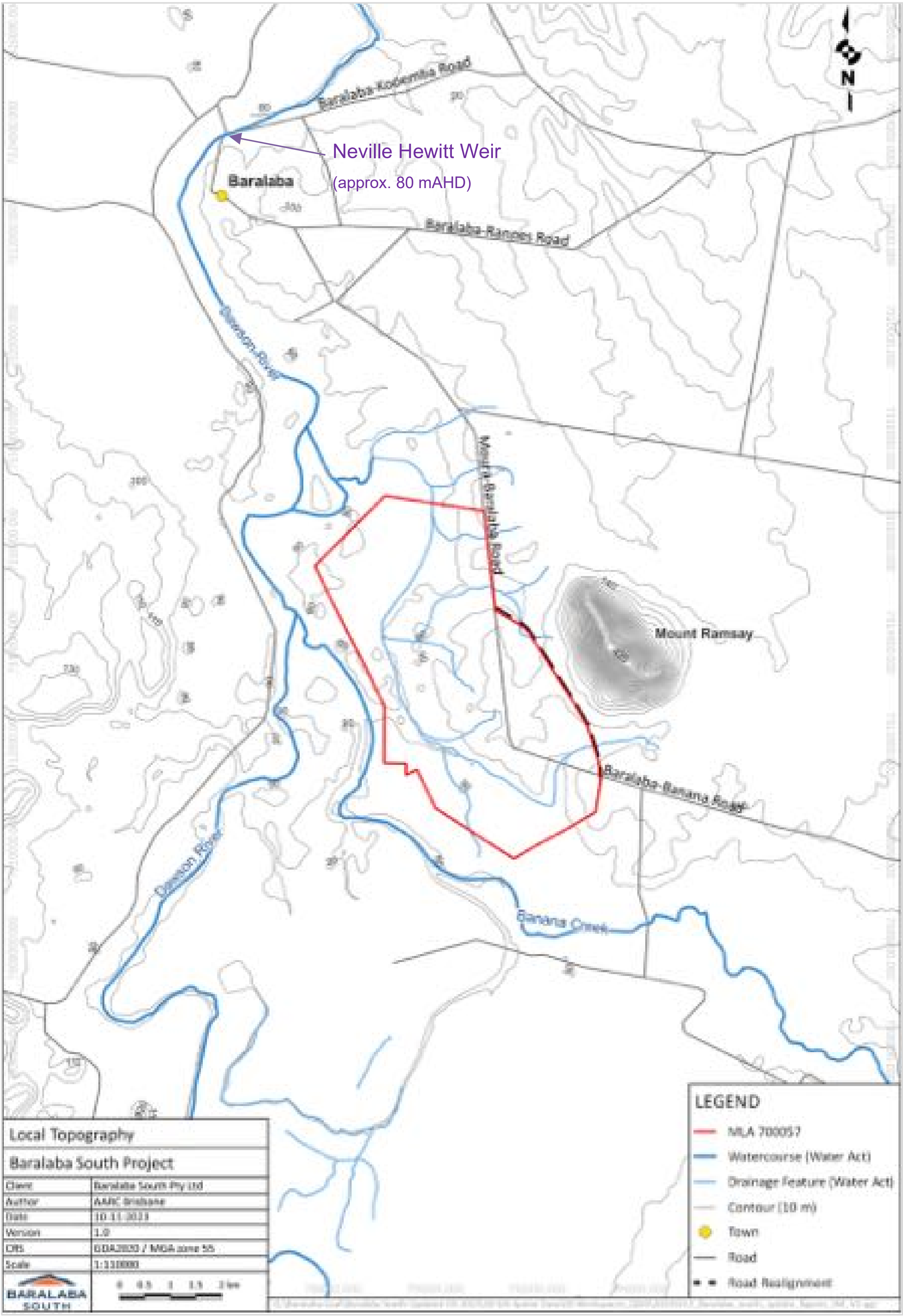


Figure 2-3 Topography of the Project Area

In March 2019 the Qld Government published the *Release of Unallocated Water for Temporary Access to Strategic Water Infrastructure Reserve (Dawson Valley Water Management Area (Water Plan [Fitzroy Basin] 2011) Terms of Sale* to make available up to 90,000 megalitres (ML) of un-supplemented water to agricultural production, but designed to meet environmental flow objectives and protect existing users' access to water. Relevantly, the environmental flow condition prescribed for all Zones (Dawson A to Dawson O) (**Figure 2-4**) along the Dawson River is approximately 2,590 ML/day.

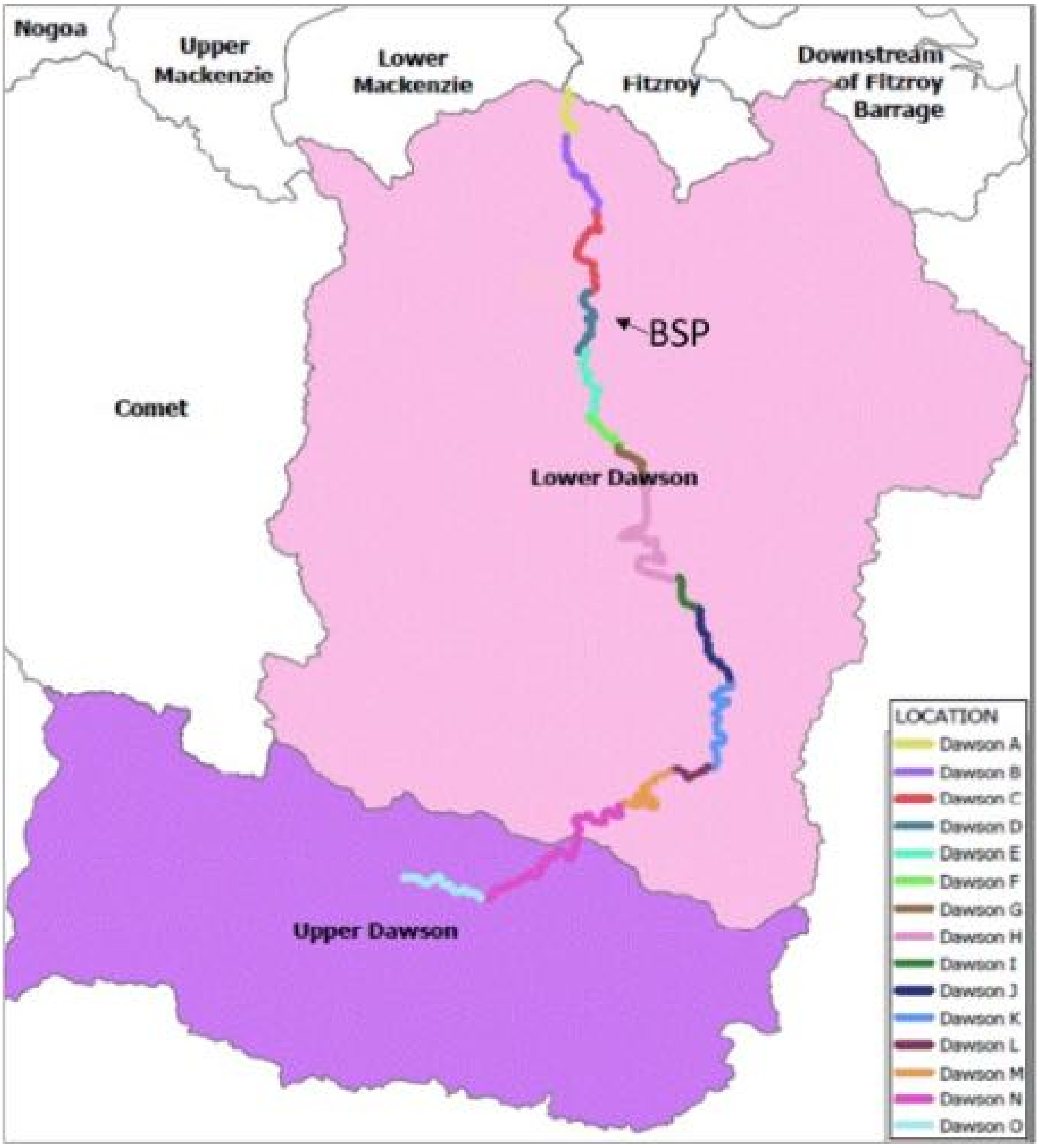


Figure 2-4 Dawson River Zones [source: DNRME, 2019]

Of the gauging stations listed above, the nearest operating (open) DNRME gauging station is at Dawson River at Bindaree (130374A), which is located approximately 10 km south-west of the MLA 700057 and is upstream of the boundary of the Dawson D and Dawson E Zones of the Dawson Valley

Water Supply Scheme. The Dawson River at Bindaree (130374A) gauging station is located downstream of the confluence with Kianga Creek, as well as the large sub-catchments of Roundstone Creek and Mimosa Creek further upstream. The gauging station has been in operation since 2005.

Further downstream on the Dawson River, the DNRME gauging station Dawson River at Beckers (130322A) located to the north-east of the Baralaba North Mine, has been in operation since 1964.

Historical data has been reviewed for Dawson River at Bindaree (2005 to 2019) and for Dawson River at Beckers (1964 to 2023). A summary of the average water level and flow statistics since 2005 for these two gauging stations is tabulated in **Table 2-2**. Average river levels at Bindaree were 2.2 m and 2.7 m for Beckers, corresponding to average flows of approximately 2,500 and 2,800 ML/d respectively.

Table 2-2 Dawson River - Mean Level [m] and Flow Statistics [ML/day]

Year	Upstream Dawson River at Bindaree (130374A)		Downstream Dawson River at Beckers (130322A)	
	Average Level [m]	Average Discharge [ML/d]	Average Level [m]	Average Discharge [ML/d]
2005	1.9	714	2.2	628
2006	1.5	276	1.6	292
2007	1.4	349	1.0	313
2008	1.9	1015	1.9	1131
2009	1.4	158	1.4	297
2010	4.6	20032	6.7	21882
2011	3.4	9018	5.4	11067
2012	2.3	1220	2.9	1179
2013	2.4	2652	4.6	3633
2014	1.8	357	2.3	661
2015	2.1	856	2.3	1107
2016	2.0	1037	2.9	1045
2017	1.6	103	2.1	224
2018	1.9	999	2.3	924
2019	1.4	19	0.8	8
2020	2.1	1703		1645
2021	2.5	3280		3142
2022	2.8	1729		1625
Average*	2.2	2,529	2.7	2,822

monitoring.information.qld.gov.au/wini/documents/copyright.pdf]
* Average based on all available recorded data for stream gauge station to end 2022

Flow duration curves for the two gauging stations most relevant to the BSP (130374A and 130322A), i.e. one upstream and one downstream, are presented in **Figure 2-5**. The curves show that there is low to no flow within the main branch of Dawson River for 25-30% of the time.

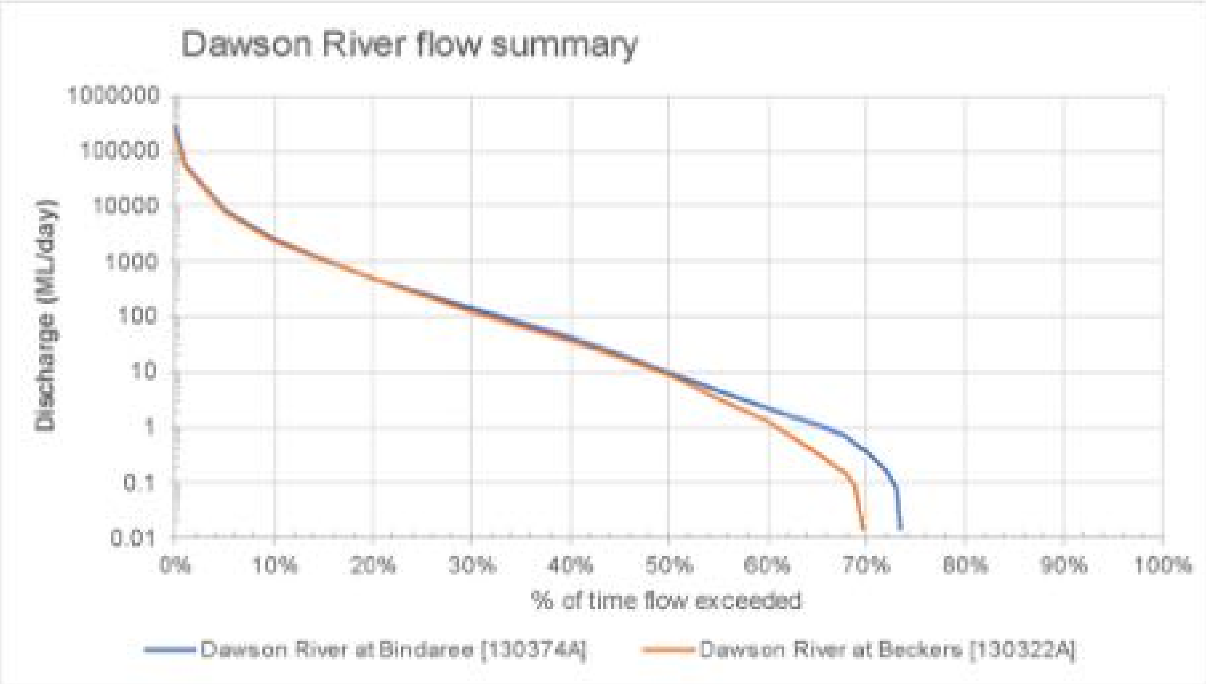


Figure 2-5 Flow Duration Curve – Dawson River near Baralaba

The most significant flow event (since 1964) occurred in December 2010. This flow was considerably greater than the gauge limit, in the order of 500,000 ML/day (Water Solutions, 2014). The Baralaba Central pits were flooded during this flood event. The December 2010 flood event is estimated to have a recurrence interval of 50 to 100 years (Water Solutions, 2014).

2.2.2 Banana Creek and other tributaries

The main channel of Banana Creek is approximately 250 m from MLA 700057 at its nearest point (**Figure 2-3**). No stream gauging data (flow, level) is available for Banana Creek. A small section of the lower reach of Banana Creek, at the confluence of the Dawson River, is mapped on Sheet 2 in Attachment 5 of the Fitzroy Basin Resource Operations Plan as being within the 'effective upstream limit of Neville Hewitt Weir'. That is, similar to the Dawson River, the Neville Hewitt Weir has likely raised the stage in the lower section of Banana Creek at the confluence with the Dawson River above the natural levels.

With the exception of the small reach at the confluence with the Dawson River, Banana Creek and other drainage features in the vicinity of the BSP are largely ephemeral in nature, with flows dependent on rainfall events, i.e. runoff.

2.2.3 Flooding

Flooding is a known occurrence in the Study Area. The *Banana Shire Flood Study Stage 2 Floodplain Management Plan* was published in January 2017 (Kellogg Brown & Root Pty Ltd, 2017). While the Baralaba township was included as one of the Study Areas, the Flood Study did not extend as far as the BSP.

Flooding and geomorphology-related assessments for the BSP are presented separately in the EIS.

2.3 Land use

The properties within and surrounding MLA 700057 are zoned by the Banana Planning Scheme 2005 as Rural and are predominantly used for cattle breeding, cattle grazing, dryland cropping or irrigated cropping. Most of the properties have been previously cleared for agricultural purposes.

2.3.1 Irrigated land

In March 2019 the Qld Government published the *Release of Unallocated Water for Temporary Access to Strategic Water Infrastructure Reserve (Dawson Valley Water Management Area (Water Plan [Fitzroy Basin] 2011) Terms of Sale* which was targeted for landholders in the Dawson Valley Water Management Area to expand or diversify irrigation activity, with the aim of strengthening economic development and creating jobs in the region.

Aerial imagery shows that two centre-pivot irrigation areas exist to the south (and west) of the confluence of the Dawson River and Banana Creek (**Figure 2-6**). More detail regarding the irrigation areas and how it relates to the private landholder bore (RN 128188) are provided in **Section 3.3**.

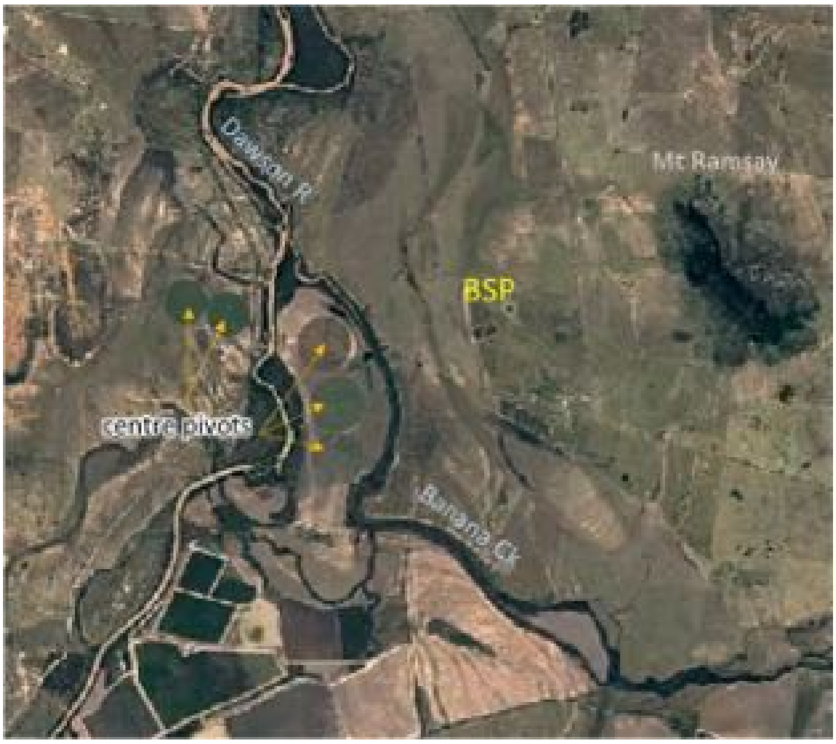
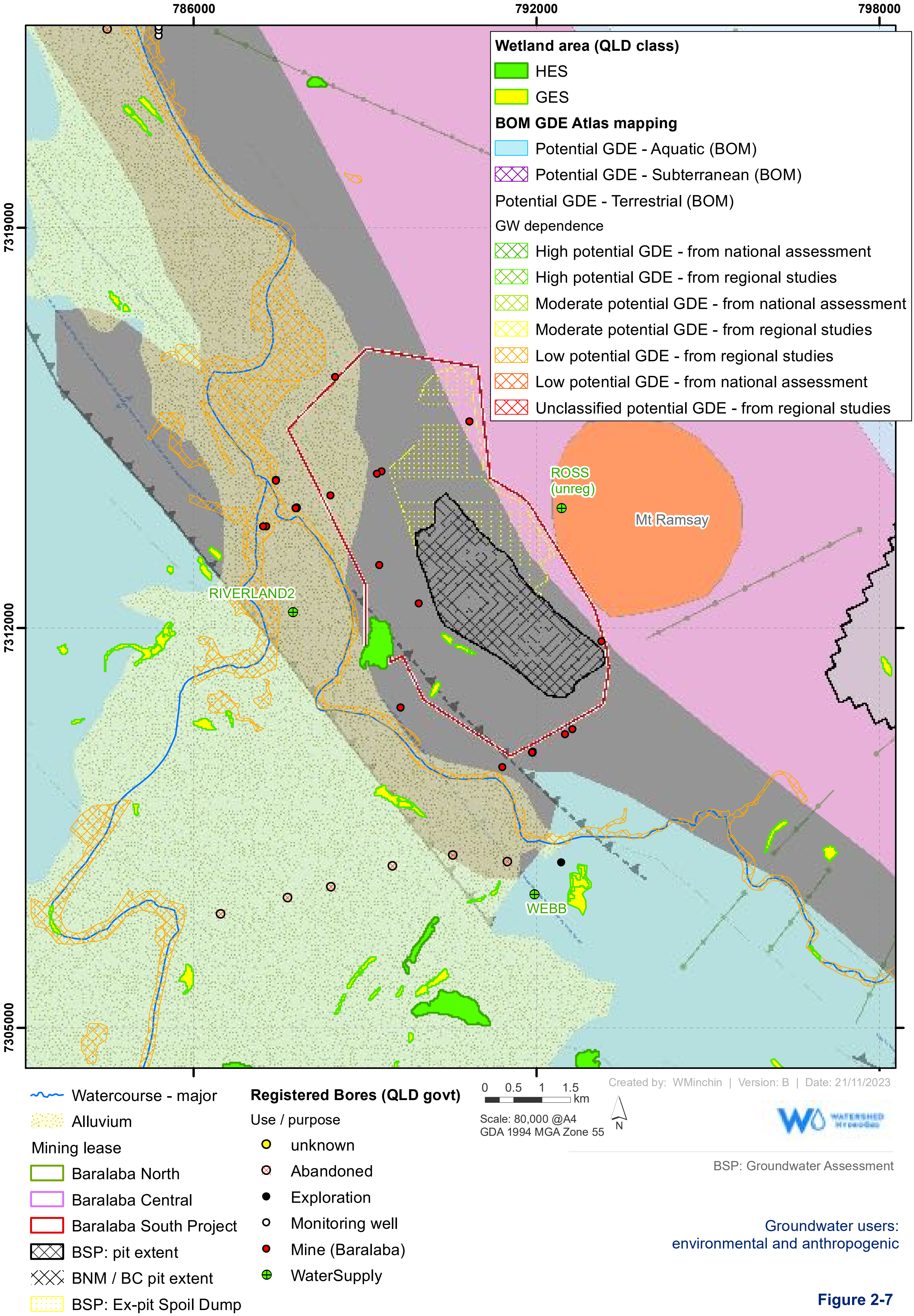


Figure 2-6 Aerial imagery from 2022 (source: GoogleMaps)

As discussed in **Sections 4.3.2 and 6.5.6.2**, given the irrigation waters are understood to have been sourced from the adjacent Dawson River surface water (and not from a groundwater bore), the numerical model has not applied any additional recharge to the two centre-pivot irrigation areas, thus in reality, groundwater levels in the immediate vicinity could be slightly higher (combined with the influence of the Neville Hewitt Weir), and/or more regularly replenished.

2.3.2 Wetlands

A wetland of high ecological significance (HES, and matter of state environmental significance [MSES]) is mapped in the west of MLA 700057 (**Figure 2-7**).



BSP: Groundwater Assessment

Groundwater users: environmental and anthropogenic

Figure 2-7

Two wetlands of general ecological significance (GES) are also located within MLA 700057), also to the west of the proposed open cut. Other wetlands of general ecological significance also occur in the wider surrounds.

Mapping of potential groundwater dependent ecosystems (GDEs) has been obtained from the BOM GDE Atlas, and is also presented on **Figure 2-7**. According to the data from BOM, there are no mapped ‘aquatic’ or ‘subterranean’ GDEs in the vicinity of BSP. There are areas of potential ‘terrestrial’ GDEs mapped along Dawson and Banana Creeks.

Further details including mapped wetland locations are provided in Eco Solutions & Management (2022) and discussed in Section 3.5.2 and 3D Environmental (2023).

2.4 Geology

The BSP is located in the southern part of the Permo-Triassic aged Bowen Basin. In this part of the Bowen Basin the Mimosa Syncline, of which Baralaba lies on the eastern flank, is the significant structural feature.

The position of Baralaba (and the BSP) relative to the Mimosa Syncline is best described by the structural cross-section presented in **Figure 2-8**. This illustrates how the Permian strata, including the coal measures, dip to the west toward the axis of the Mimosa Syncline, which is some 30-40 km west of Baralaba. The regional dip is relatively gentle, even flat, in the axis of the syncline. However, the strata steepen toward Baralaba and this structure brings the Permian Baralaba Coal Measures toward the surface there, as indicated by the red line on **Figure 2-8**.

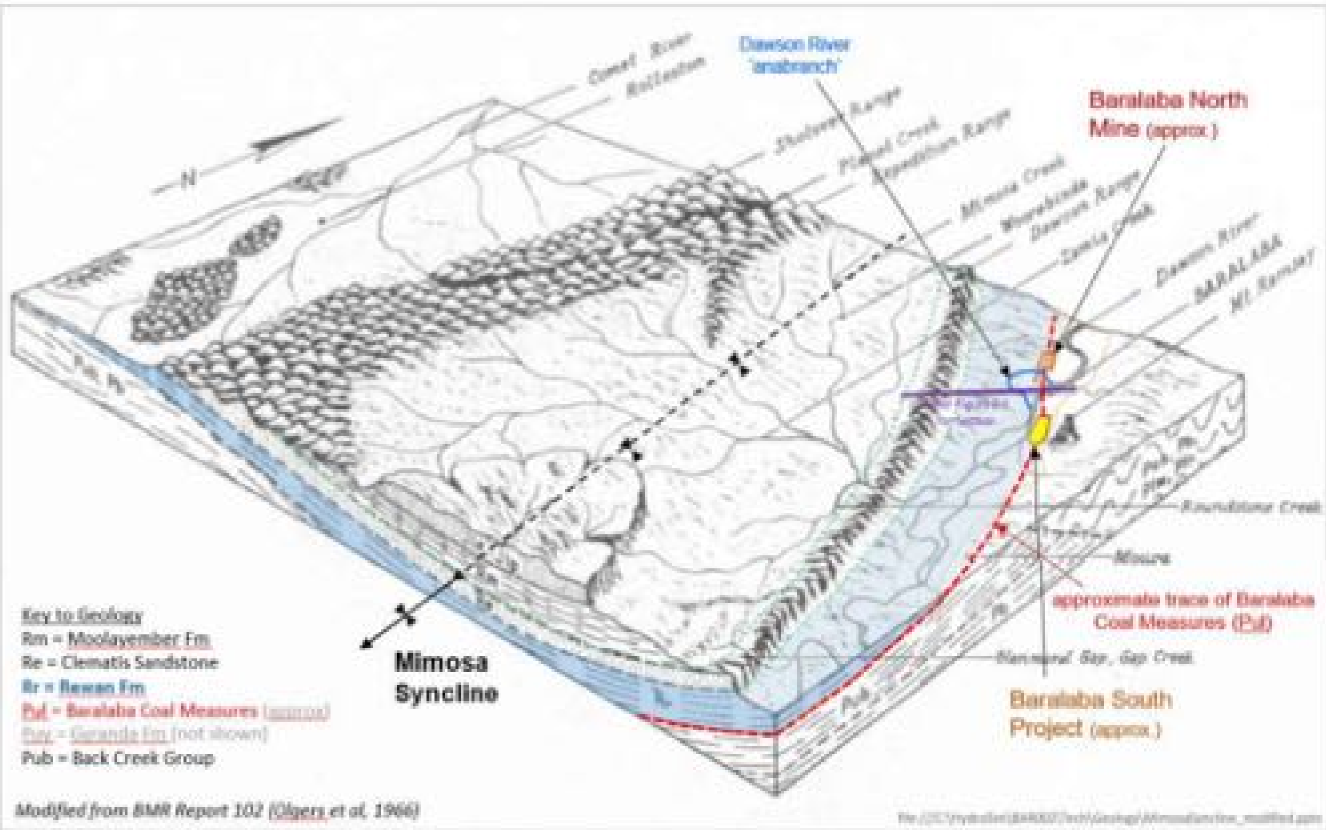


Figure 2-8 Structural Geology Setting [modified from Olgers *et al*, 1966]

The principal coal-bearing sequence targeted by the BSP is the Permian Baralaba Coal Measures, a lateral equivalent of the Rangal Coal Measures elsewhere in the Bowen Basin and the Bandanna Formation in the Galilee Basin to the west.

2.4.1 Structural features

A number of structural features are identified in the Study Area, both through regional mapping and from exploration and investigation by Baralaba mine geologists. These are described further in the following sub-sections.

2.4.1.1 Mimosa Syncline

The Mimosa Syncline is a major regional structural feature (**Figure 2-8**) within Permian and Triassic aged strata. The north-south trending axis of this syncline is approximately 40 km west of the BSP. This structurally complex zone is also referred to as the Dawson Tectonic Zone, which is characterised by a complex pattern of northerly trending folds and thrust (reverse) faults with displacements of up to 200 m. Consequently, the dip of the coal measures is relatively steep ranging from 25^{o} to 55^{o} in the Baralaba region.

2.4.1.2 Mt Ramsay

Mt Ramsay is an isolated igneous extrusive body trachyte which occurs east of MLA 700057 (**Figure 2-9**). Based on the regional mapping, the western edge of this feature runs along the eastern edge of the ML boundary, and is >500 m from the eastern edge of the proposed open cut pit.

2.4.1.3 Local Faults

Distinct local faults have been interpreted to the west of MLA 700057 as shown on **Figure 2-9**. The local faults are generally north-west striking thrust faults dipping to the south-west at 60-80 degrees.

Local faults are also evident in the geological cross-sections in the model used as the framework for the numerical groundwater model and is discussed further in **Sections 2.4.4 and 6.4.2.1**. Review of these faults, both in the government mapping and the local geological (resource) mapping, in terms of their potential to act as hydraulic barriers or conduits that might, is presented in **Section 5.1.4**.

2.4.2 Outcrop geology

The outcrop geology is presented in **Figure 2-9**. The data sources are:

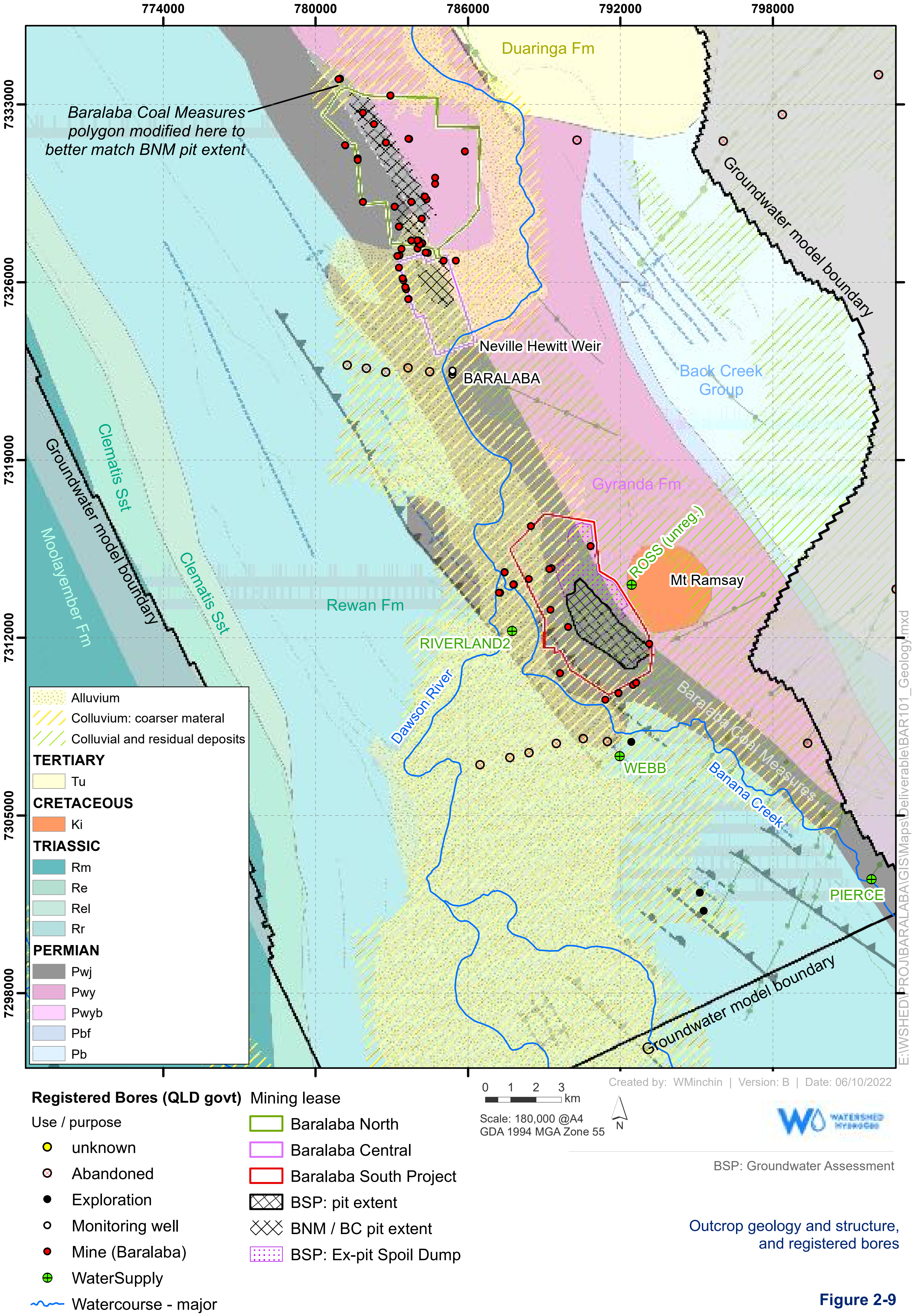
- 1:500,000 solid geology outcrop mapping of the Bowen Basin (CSIRO, 2008); and
- 1:2 million scale geological mapping of the State of QLD.

As noted on **Figure 2-9**, the solid geology mapping has been modified slightly around the Baralaba North Mine (BNM, which includes Baralaba North Mine area.

The Permian Baralaba Coal Measures subcrop along a narrow (up to 3.5 km in width) corridor that trends north-north-west, and within MLA 700057 is buried under a veneer of Quaternary alluvium (shown on **Figure 2-9**) and some Tertiary-Quaternary colluvium.

At the base of the Baralaba Coal Measures is the basal sub-unit Kaloola Member containing minor coal horizons, which in turn is underlain by the Gyranda Formation. The Kaloola Member strata are dominantly fine-sandstones and siltstones with subordinate carbonaceous shale, tuffs and banded coal with some coking and thermal properties.

Overlying the Baralaba Coal Measures is the Rewan Formation of Triassic age. It comprises mainly siltstones and mudstones, as well as unconsolidated sediments (including clays), and a lateritic weathering profile obscuring the coal measures.



Outcrop geology and structure, and registered bores

Figure 2-9

The base of the Great Artesian Basin (GAB) is defined by the Lower Triassic Dunda Beds and Rewan Formation, a thick aquitard unit that lies beneath the Clematis Sandstone, the most easterly outcropping aquifer in the GAB (and labelled on **Figure 2-9**). The Clematis Sandstone is part of the GAB recharge beds known as the Eastern Recharge Zone and lies more than 10 km to the west of MLA 700057.

2.4.3 Stratigraphy and coal measures

Regionally, the Baralaba Coal Measures, in the order of 400 m thick, includes up to 12 coal seams (in descending order, down the left-hand column, then the right-hand column):

- Moody[3];
- Boyd[2];
- Cameron;
- Reid;
- Doubtful;
- Sub-doubtful;
- Dawson;
- Dunstan;
- Wright;
- Coolum;
- Dirty; and
- Sub-Dirty.

The generalised stratigraphy of the BSP area (as reported in the *Coal Resource Report Baralaba South Coal Deposit, Queensland, Australia* [John T Boyd Company, 2017]) is presented in **Figure 2-10**.

Interburden strata typically consists of siltstones and fine-sandstones, though finer grained mudstones also exist throughout the coal measures, and typically adjacent to the roof and floor of the coal seams.

Local folding and thrust faults have caused vertical displacement in some places, which has had the effect of the one seam occurring at multiple depths at the one location (e.g. in a bore).

[3] Seams are not mapped at the BSP coal deposit as reported in the *Coal Resource Report Baralaba South Coal Deposit, Queensland, Australia* [John T Boyd Company, 2017]).

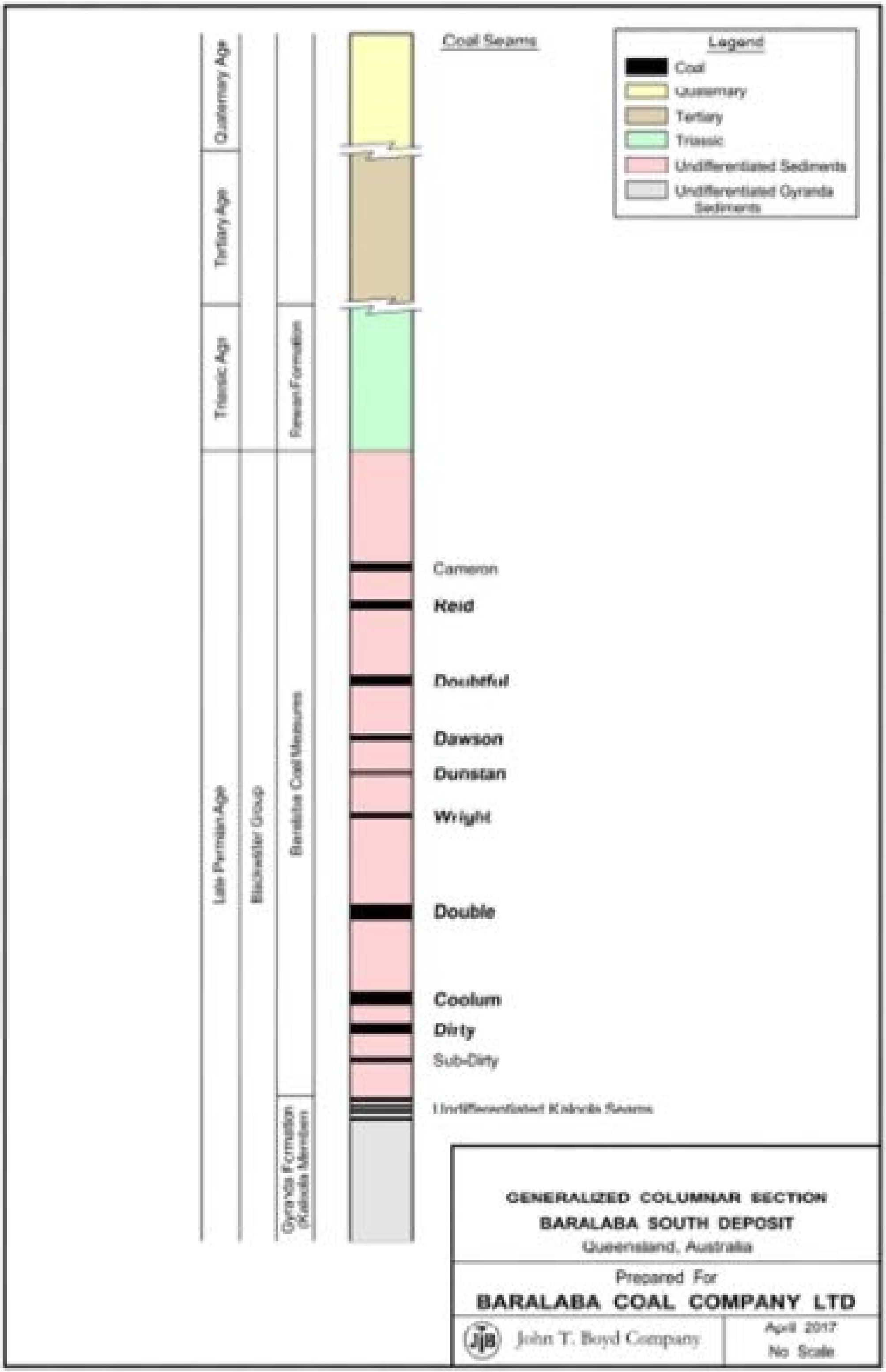


Figure 2-10 Generalised Stratigraphy for BSP area [source: John T Boyd Company, 2017]

2.4.4 Cross-sections

The coal seam subcrop and section orientation plan for MLA 700057 is shown on **Figure 2-11**.

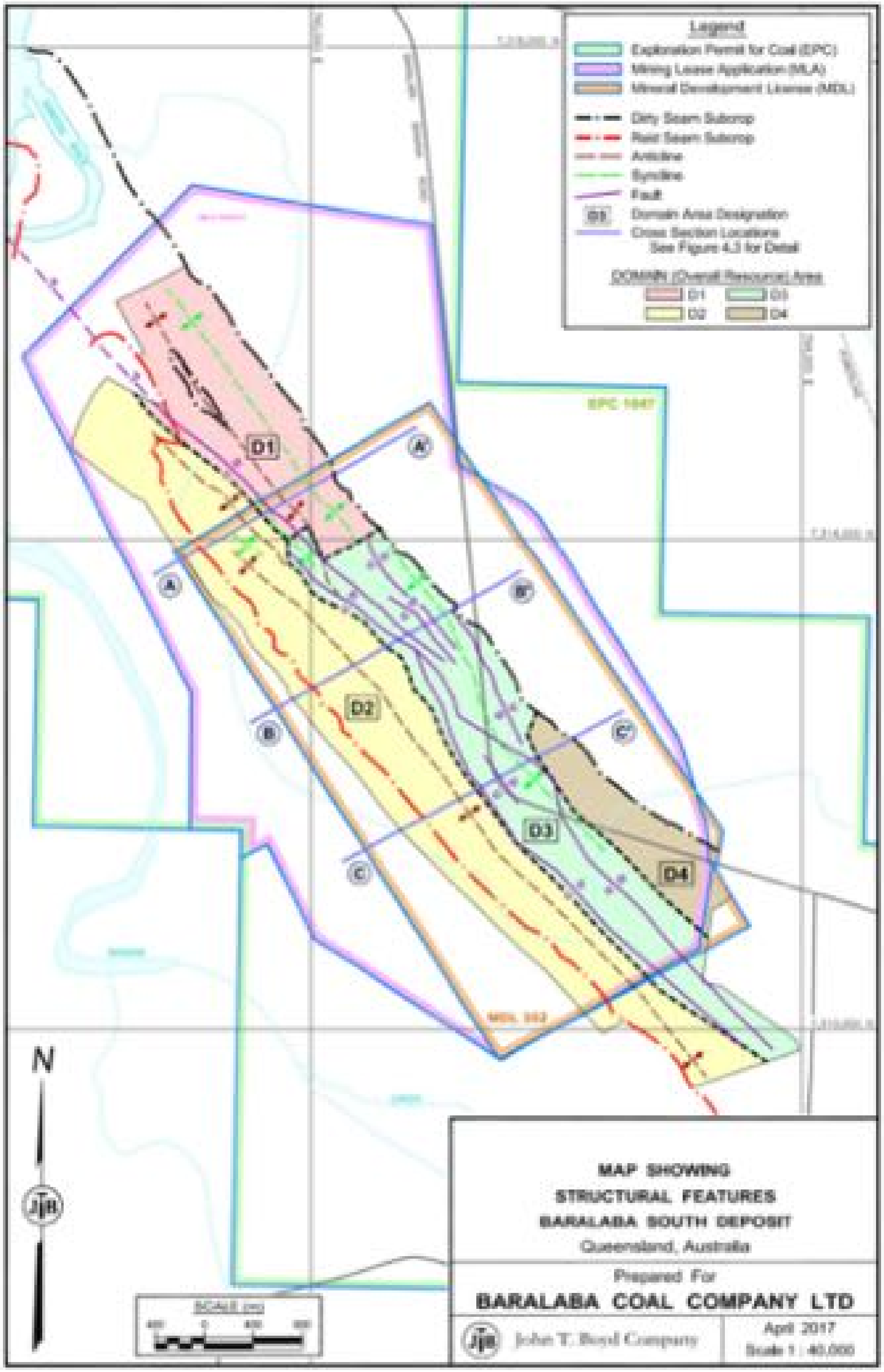


Figure 2-11 Seam Sub-crop and Section Plan at MLA 700057 [source: John T Boyd Company, 2017]

Figure 2-12 presents typical cross-sections through MLA 700057, with some local folding and faulting evident.

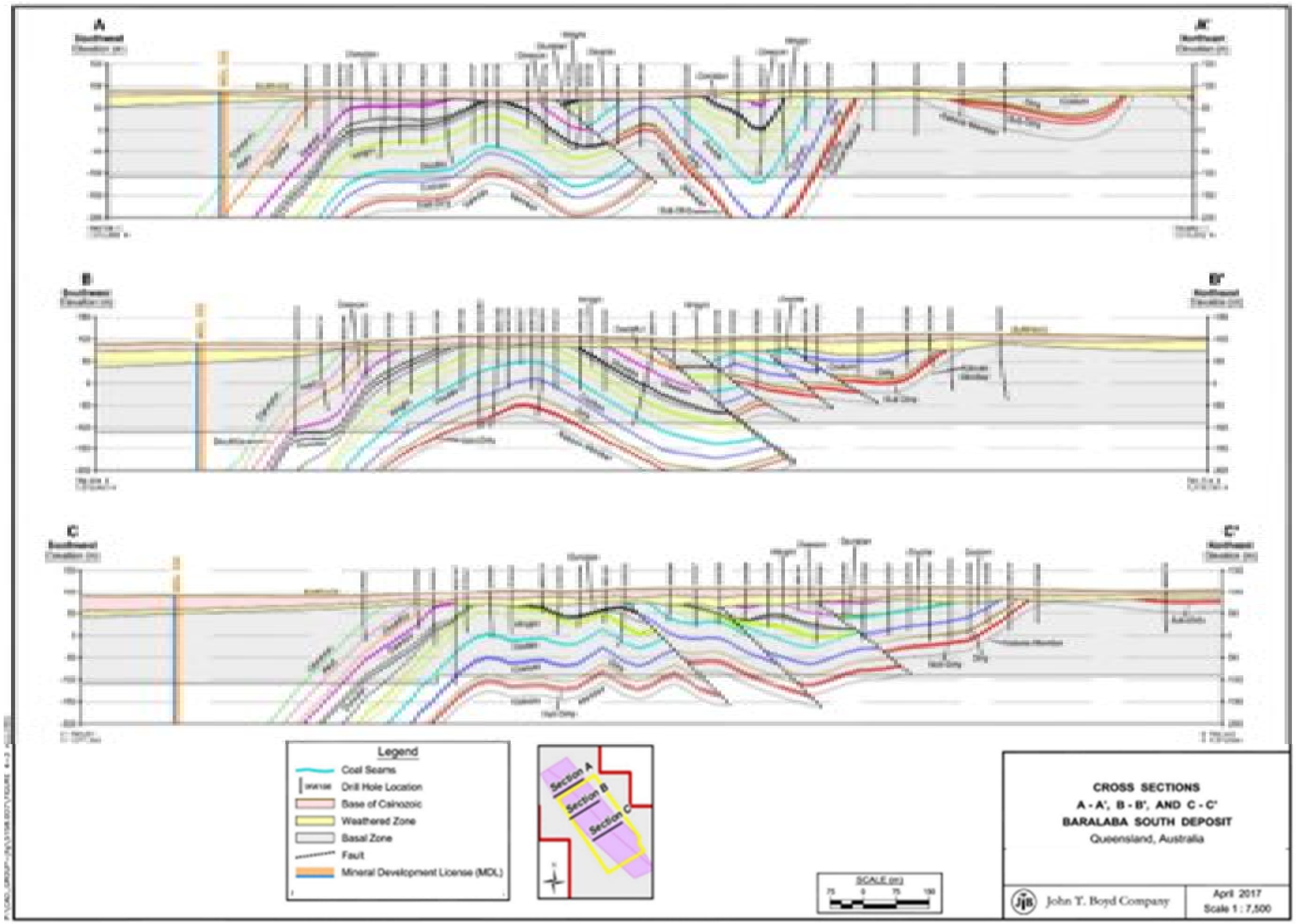


Figure 2-12 Geological cross-sections through MLA 700057 [source: John T Boyd Company, 2017]

2.4.5 Surficial geology

The Quaternary sediments consist of alluvial and colluvial sands and gravel, soil and clay. Available information indicates that the alluvium is heterogeneously distributed, but often comprises distinct layers of surficial clays, thick sands/gravels and basal sandy clays.

The sediments thicken beneath and immediately adjacent the Dawson River, and are typically about 15 m thick (HydroSimulations, 2014). The thickness of Quaternary sediments along Banana Creek are expected to be less than the Dawson River with an even lesser veneer of alluvium/colluvium across parts of MLA 700057.

The weathered rock (regolith) profile has an average depth of weathering of approximately 28 m (HydroSimulations, 2014).

2.5 Soils

Mapping of soil landscapes within MLA 700057 and surrounds is reported separately in Environmental Earth Sciences (2023).

The characteristics of the soils (including alluvial and colluvial sediments) to be handled and managed at the BSP for rehabilitation purposes are also described separately in the EIS.

2.6 Geochemistry

Geochemical characterisation of the overburden (i.e. predominantly Baralaba Coal Measures) at the BSP are reported separately in the *Geochemical Assessment of Potential Spoil and Coal Reject Materials – Baralaba South Project* (Terrenus Earth Sciences, 2023). In summary, the assessment concludes that following surface exposure, the spoil (as a bulk material) is expected to generate surface run-off and seepage which is:

- pH-neutral to alkaline; and
- low to moderate salinity.

The total sulphur concentration of the overburden sampled was very low and 110 of the 113 samples were classified as Non-Acid Forming (NAF). No samples were classified as potentially acid forming (PAF).

These results are generally consistent with the Geochemistry Assessment conducted by Terrenus Earth Sciences (2014) for the BNM (also in the Balaraba Coal Measures) which relevantly presents analysis of spoil salinity, pH and acid-generating potential as follows:

- pH was 7.3 to 10.1;
- salinity was low, between 25 and 700 µS/cm (about 16 to 440 mg/L Total Dissolved Solids [TDS]) across all samples, with a median of 287 µS/cm (200 mg/L TDS); and
- almost all samples were non-acid generating, and those considered potentially acid-generating were classified as have a 'Low Capacity' for acid generation.

Total metal and metalloid concentrations in the overburden sampled and potential leachate that spoil materials may produce (based on soluble multi-element scan results) were also assessed and reported as follows (Terrenus Earth Sciences, 2023):

- Very low total metal and metalloid concentrations (generally) in the spoil compared to average element abundance in the earth's crust.
- Spoil would not be expected to be enriched in metals and metalloids to any significant extent.

- Leachate may contain slightly elevated concentrations[4] of some soluble elements (such as aluminium, arsenic, molybdenum and selenium) compared to applied Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC & ARMCANZ) (2000) aquatic ecosystem water quality guideline concentrations.
- The geochemical characteristics of potential spoil samples for the BSP are also consistent with the geochemical characteristics of spoil materials from the Baralaba North Project (Terrenus-RGS, 2012).

Further discussion of the anticipated spoil characteristics based on the geochemistry testwork, pertaining to groundwater quality, is provided in **Section 8**.

[4] It is important to note that the results presented in Terrenus Earth Sciences (2023) represent an 'assumed worst case' scenario as the samples were pulverised prior to testing, and therefore had a very high surface area compared to materials in the field. Individual materials would also be well mixed at storage locations. The results therefore suggest that the concentration of metals/metalloids in surface run-off and seepage from spoil materials in the field would be less than the recorded laboratory water extract concentrations.

3 Hydrogeology

This section documents a review of groundwater-related data, using data from BSP groundwater monitoring network and private (third-party) bores, to review anthropogenic and environmental groundwater usage, groundwater levels, water quality, and aquifer properties. Some additional review of BNM monitoring data is presented.

3.1 Groundwater monitoring – BSP

The groundwater monitoring network installed within MLA 700057 and the immediate surrounds of the BSP in 2012 is shown on **Figure 3-1**. The network has a reasonable spatial distribution across the site and includes two main transects: (1) northern transect at the Dawson River / Banana Creek confluence; and (2) southern transect adjacent Banana Creek.

A total of fifteen (15) standpipe groundwater monitoring bores and three (3) standpipe production bores were installed in 2012. Of the monitoring bores, 10 were constructed with Class 18, 50 mm PVC and screened in alluvium (A-OB1 to A-OB4, A-OB6 to A-OB8[5], and A-OB10 to A-OB12). The remaining five monitoring bores targeted the Permian coal measures (three in coal seams of the Baralaba Coal Measures and one each in the interburden of the Baralaba Coal Measures and Gyranda Formation) and constructed with Class 18, 50 mm PVC.

Two of the production bores were set in alluvium (A-PB1 and A-PB2) and the third in the Permian Coal Measures interburden of the Baralaba Coal Measures (P-PB1). All production bores were constructed with Class 18, 100 mm PVC. Further details are provided in SKM (2014) and SLR (2019) (**Appendix A**).

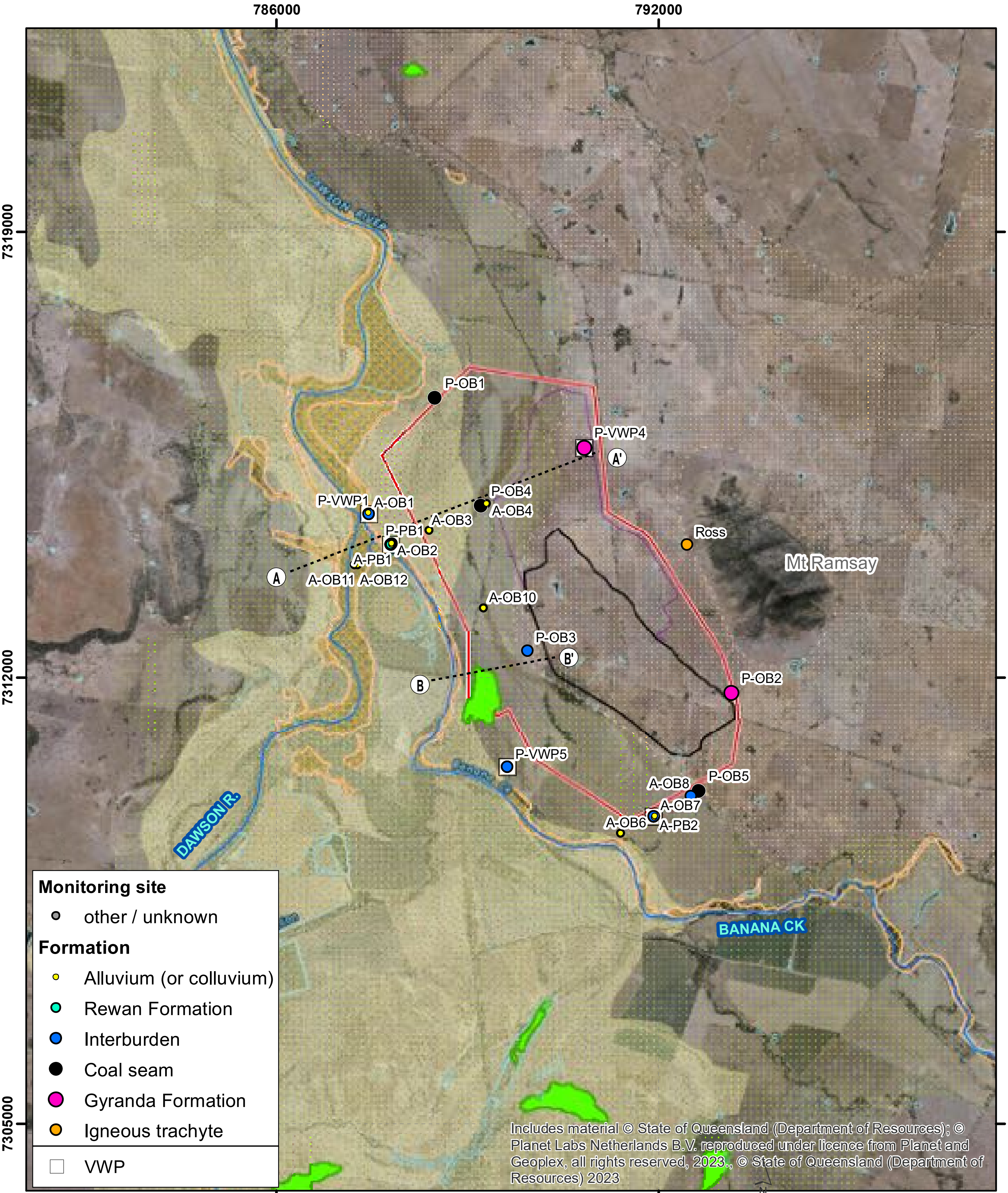
The network of standpipe groundwater monitoring bores at the BSP are augmented with an additional five (5) bores equipped with up to 4 vibrating wire piezometers (VWPs) or sensors in each bore. These sensors are at different depths (targeting the Rewan Formation, Baralaba Coal Measures and Gyranda Formation) as follows:

▪	P-VWP1	depth of 201 m with three (3) sensors at:	38 mbg;	105 mbg;	148 mbg.	
▪	P-VWP2	depth of 252 m with four (4) sensors at:	29 mbg;	76 mbg;	184 mbg;	234 mbg.
▪	P-VWP3	depth of 175 m with four (4) sensors at:	55 mbg;	121 mbg;	155 mbg;	175 mbg.
▪	P-VWP4	depth of 201 m with four (4) sensors at:	25 mbg;	80 mbg;	150 mbg;	200 mbg.
▪	P-VWP5	depth of 201 m with three (3) sensors at:	66 mbg;	138 mbg;	185 mbg.	

The following sub-sections of the report present the details of this groundwater monitoring network.

In 2017-18, a targeted (quarterly) groundwater monitoring program was conducted by SLR to augment the historic datasets presented in SKM (2014). At the same time, maintenance and repairs were carried out to re-establish the groundwater monitoring network for the ongoing collection of baseline datasets. Ongoing groundwater monitoring data has been obtained by 4T Consultants since 2018.

[5] Based on a review of recorded groundwater levels, construction and geological log details, A-OB8 appears to be dry in the sandy gravel portion of the bore and rather, the measured groundwater level indicative of the hydraulic head in the interburden (siltstone) of the Baralaba Coal Measures at the subcrop (i.e. weathered / regolith).



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Watercourse - major
Alluvium
Colluvium: sand, silt, mud and gravel
Residual deposits/ colluvium: finer-grained
Cross-section line
Wetland area (HES)
Potential GDE - Aquatic (BOM)
Potential GDE - Terrestrial (BOM)
Potential GDE - Subterranean (BOM)

Mining lease
Baralaba North
Baralaba Central
Baralaba South Project
BSP: Pit Limits
BSP: Ex-pit Spoil Dump

0 0.45 0.9 1.35 1.8 km
Scale: 80,000 @A4
GDA 1994 MGA Zone 55

BSP: Groundwater Assessment

Groundwater monitoring network at BSP

Figure 3-1

The groundwater monitoring and sampling has been conducted with guidance from the following:

- Groundwater Sampling and Analysis – A Field Guide (Geoscience Australia, 2009);
- Sampling, Part 1: Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples (AS/NZS 5667.1:1998); and
- Sampling, Part 11: Guidance on Sampling of Groundwaters (AS/NZS 5667.11:1998).

The results of the groundwater monitoring program are summarised below.

3.1.1 Standpipe bores - alluvium

In total, there are 14 standpipe groundwater bores at the BSP area screened in alluvium. Two of these bores (A-PB1 and A-PB2) have been constructed as ‘production bores’ with larger (100 mm) casing. Details of all the standpipe bores in alluvium at the BSP are provided in **Figure 3-2**.

The alluvium water level measurements provided to WatershedHG (field readings and logger downloads to early 2023) from the standpipe monitoring bores are presented in **Figure 3-3A**. The graph also presents the corresponding CRD (rainfall trend) for comparison.

The alluvium monitoring bores with the highest recorded groundwater elevations are those nearest to the Dawson River (A-OB12, A-OB11, A-OB1, A-OB2 and A-OB3) and consistent with the CRD trends all show a gradual decline from March 2018. A-OB3 was recorded as dry in February 2019 and blocked after that.

The other monitoring bores in the alluvium, at greater distance from the Dawson River, indicate the recharge mechanism is, as expected, from the Dawson River to the alluvium (i.e. losing conditions). All alluvium bores in the southern transect (furthest from the Dawson River and its confluence with Banana Creek) have been recorded as dry at some point indicating generally low groundwater level conditions (A-OB6, A-OB7, A-PB2 and A-OB8).

As shown on **Figure 3-3A**, the recovery (following drawdown by sampling) of groundwaters in A-OB8 is slow. Based on a review of recorded groundwater levels, construction and geological log details, A-OB8 appears to be effectively dry in the sandy gravel portion of the bore and the measured groundwater level is considered to be indicative of the hydraulic head in the interburden (siltstone) of the Baralaba Coal Measures at the subcrop (i.e. weathered / regolith). This dry sandy gravel observation is consistent with the adjacent dry alluvium bores (A-OB6, A-OB7 and A-PB2, which is not shown).

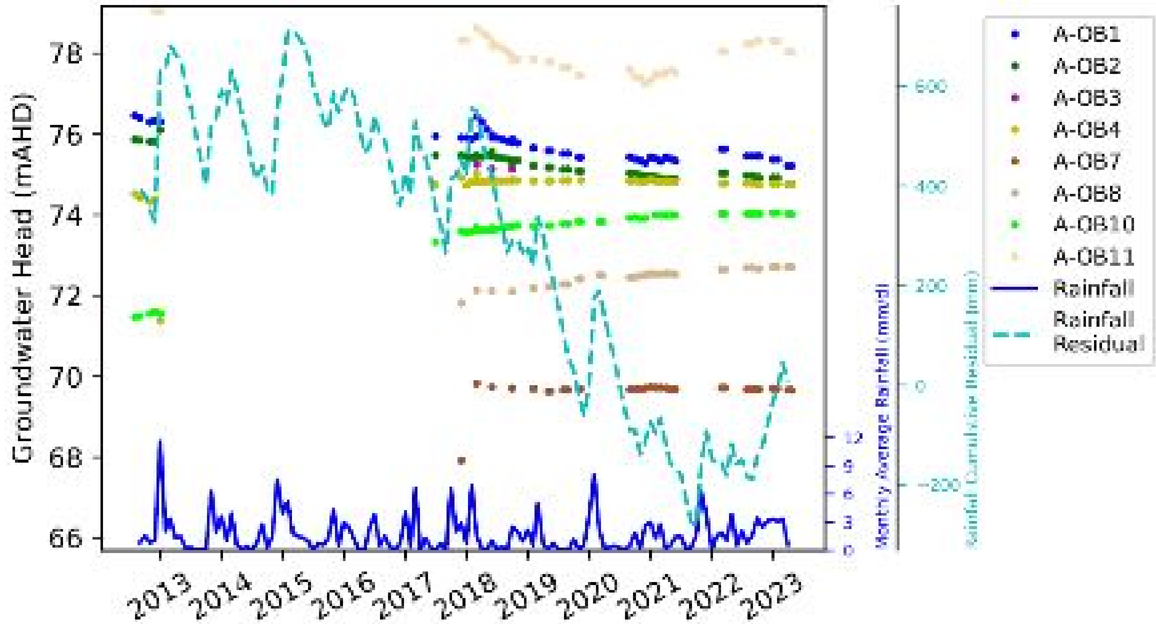
The results of sampling of the standpipe bores in the alluvium for groundwater quality are discussed separately in **Section 3.5**. The results of stygofauna sampling in the alluvium standpipe bores conducted by Stygoecologia (2019) at the BSP are described separately in **Section 3.5.3**.

Figure 3-2 BSP Groundwater Monitoring Bore Standpipe Locations - Alluvium

Bore ID	Easting	Northing	Ground Survey Elevation (mAHD) (SKM, 2014)	Drilled Bore Depth (mbg)	Alluvium Screened Interval (mbg)	Collar/ Stick-up (m)	Standing Water Levels (mbTOC)		Standing Water Levels (mbg)	Logger Depth Installed (2017-18) (mbTOC)
							SKM (2014)*	2017-2020^	2017-2020^	
A-PB1	787806	7314088	88.4	27	11.5-23.5	0.29	12.7	13.2	12.9	-
A-PB2	791931	7309808	91.5	29	11.5-23.5	0.22	Dry	Dry	Dry	-
A-OB1	787440	7314586	88.9	29	10-22	0.56	13.1	13.6	13.0	18
A-OB2	787802	7314105	88.3	20	11.5-17.5	0.3	12.7	13.3	13.0	16
A-OB3	788393	7314309	87.9	30	12-30	0.56	13.6	13.3	12.7	-
A-OB4	789290	7314733	87.5	17	8-17	0.29	14.0	13.0	12.7	-
A-OB6	791402	7309557	91.4	29	9-18	0.53	Dry	Dry	Dry	18.5
A-OB7	791935	7309829	91.7	26	11-26	0.42	Dry	22.7[+]	22.3[+]	24
A-OB8[+]	792501	7310136	91.4	23	10-22	0.35	19.4	19.6[+]	19.3[+]	22
A-OB10	789247	7313094	87.5	23	8-20	0.44	16.4	14.2	13.8	18[#]
A-OB11	787270	7313771	86.2	17	9-15	0.50	7.7	8.7	8.2	13.5
A-OB12	787220	7313767	87.2	18	9.6-15.6	0.43	8.4	9.4	9.0	13.5

Source: After SKM (2014)
mbg = metres below ground level.
mbTOC = metres below top of collar/casing.
* Average of measurements between July 2012 and December 2012.
^ Average of measurements between December 2017 and March 2020.
[#] Barometer also installed at 0.4 mbTOC.
[+] Recorded as effectively dry in the sandy gravel portion of the bore, total drill depth is logged in the interburden of Baralaba Coal Measures.

A) **A-series ("Alluvium") stand-pipe bores**



P-series (Permian strata) stand-pipe bores

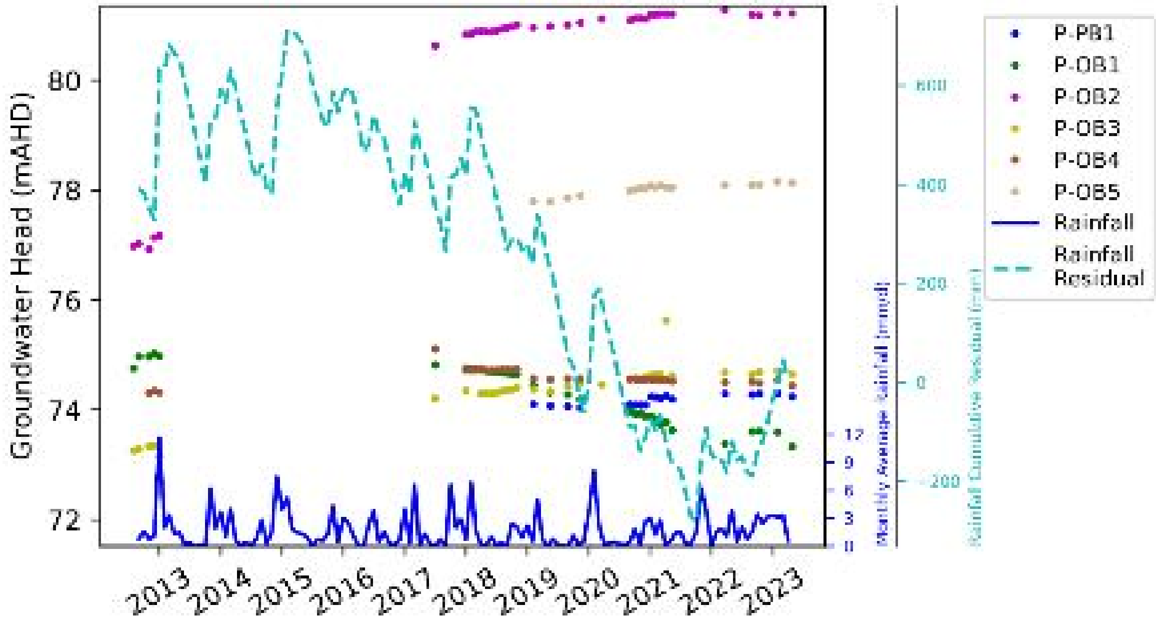


Figure 3-3 Standpipe bores groundwater levels – "Alluvium" and Permian Coal Measures

3.1.2 Standpipe bores – Baralaba coal measures (interburden)

In total, there are six (6) standpipe groundwater monitoring bores at the BSP area screened in the Permian coal measures (i.e. Blackwater Group comprising the Baralaba Coal Measures and Gyranda Formation).

Two of these bores (P-PB1 and P-OB3) have been constructed in the interburden of the Baralaba Coal Measures. Details of the standpipe bores in the interburden of the Baralaba Coal Measures at the BSP are provided in **Table 3-1**.

Table 3-1 BSP Groundwater Monitoring Standpipe locations – Baralaba Coal Measures (Interburden) and Gyranda Formation

Bore ID	Easting	Northing	Ground Survey Elevation (mAHD) (SKM, 2014)	Drilled Bore Depth (mbg)	Interburden Screened Interval (mbg)	Collar/ Stick-up (m)	Standing Water Levels (mbTOC)		Standing Water Levels (mbg)	Logger Depth Installed (2017-18) (mbTOC)
							SKM (2014)*	2017-2020^	2017-2020^	
Baralaba Coal Measures - interburden										
P-PB1	787805	7314101	88.3	185	136-178	0.4	15.5	14.6	14.3	-
P-OB3	789939	7312422	89.6	59	29-59	0.51	16.8	15.7	15.2	45
Gyranda Formation										
P-OB2	793140	7311758	105.3 mAHD	60	30-60	0.76	29.0	25.1	24.3	45

Source: After SKM (2014)

* Average of measurements between July and December 2012.

mbg = metres below ground level. mbTOC = metres below top of collar/casing.

^ Average of measurements between December2017 and March 2020.

Table 3-2 BSP Groundwater Monitoring Bore Standpipe locations – Baralaba Coal Measures (Coal Seams)

Bore ID	Easting	Northing	Ground Survey Elevation (mAHD) (SKM, 2014)	Drilled Bore Depth (mbg)	Interburden Screened Interval (mbg)	Collar/ Stick-up (m)	Standing Water Levels (mbTOC)		Standing Water Levels (mbg)	Logger Depth Installed (2017-18) (mbTOC)
							SKM (2014)*	2017-2020^	2017-2020^	
P-OB1	788477	7316388	87.4	60	30-60	0.55	13.1	13.5	12.9	45
P-OB4	789205	7314695	87.1	205	75-78	0.42	13.2	12.8	12.4	45
P-OB5	792626	7310218	91.4	204	66-69	0.44	16.5	14.0	13.6	-

Source: After SKM (2014)

* Average of measurements between July and December 2012.

mbg = metres below ground level. mbTOC = metres below top of collar/casing.

^ Average of measurements between December 2017 and March 2020.

As shown on **Figure 3-3B**, the groundwater elevations recorded in the interburden of the Baralaba Coal Measures in 2012 and 2017-2023 are at approximately 74-75 mAHD. Exceptions to this are:

- P-OB1, in which groundwater levels are declining toward 73 mAHD since 2021. The reason for this is unknown, but the pattern seems plausible.
- P-OB2, where groundwater levels have seemingly risen from 77 mAHD in 2012 to >80 mAHD in 2017. The reason for this is unknown and out of character with other sites, so may not be reliable.
- P-OB5, where groundwater levels are increasing only gradually, but at 77.5-78 mAHD.

Further to the discussion in **Section 3.1.1**, although A-OB8 appears to possibly be representative of the interburden of the Baralaba Coal Measures (rather than alluvium, which is dry), it is recognised that the recorded groundwater elevation (at approximately 72 mAHD) is several metres below the recorded groundwater elevation in the adjacent (and much deeper) coal seam bore (P-OB5).

Additional monitoring of piezometric pressures in the interburden of the Baralaba Coal Measures is undertaken at the VWP locations discussed in **Section 3.1.6** below.

The results of sampling of the standpipe bores in the Baralaba Coal Measures for groundwater quality are discussed separately in **Section 4**.

3.1.3 Standpipe bores – Baralaba coal measures (coal seams)

Three standpipe groundwater monitoring bores at the BSP (P-OB1, P-OB4 and P-OB5) are screened in coal seams of the Baralaba Coal Measures. Details of the standpipe bores in the coal seams of the Baralaba Coal Measures at the BSP are provided in **Table 3-2**.

The groundwater elevations recorded in the coal seams show that with the exception of P-OB5 (rising with topography in the south-east) at approximately 77.5-78 mAHD (**Figure 3-3B**), the groundwater elevations in the coal seams are similar to that recorded in the interburden of the Baralaba Coal Measures at approximately 74-75 mAHD in MLA 700057.

3.1.4 Standpipe bores – Gyranda formation

One standpipe groundwater monitoring bore at the BSP (P-OB2) is screened in Gyranda Formation. Details of the standpipe bore is provided in **Table 3-1**.

By comparison to the other standpipe bores in the Permian coal measures (**Figure 3-3B** the recorded groundwater elevations are highest at P-OB2 reflecting the topography rising to the east near Mt Ramsay. This supports the overall general hydraulic gradient being from east to west at the BSP area.

Additional monitoring of piezometric pressures in the Gyranda Formation is also undertaken at the BSP at the VWP groundwater monitoring location discussed in below **Section 3.1.7**.

3.1.5 VWP sensor – Rewan formation

The shallowest (at 29 mbg) of the four sensors in P-VWP2 monitors the groundwater pressure in the Rewan Formation. Details of the VWP installation at P-VWP2 is provided in **Table 3-3**.

Plots of the potentiometric groundwater pressures at P-VWP2 [Sensor 1] are presented in **Figure 3-4A**.

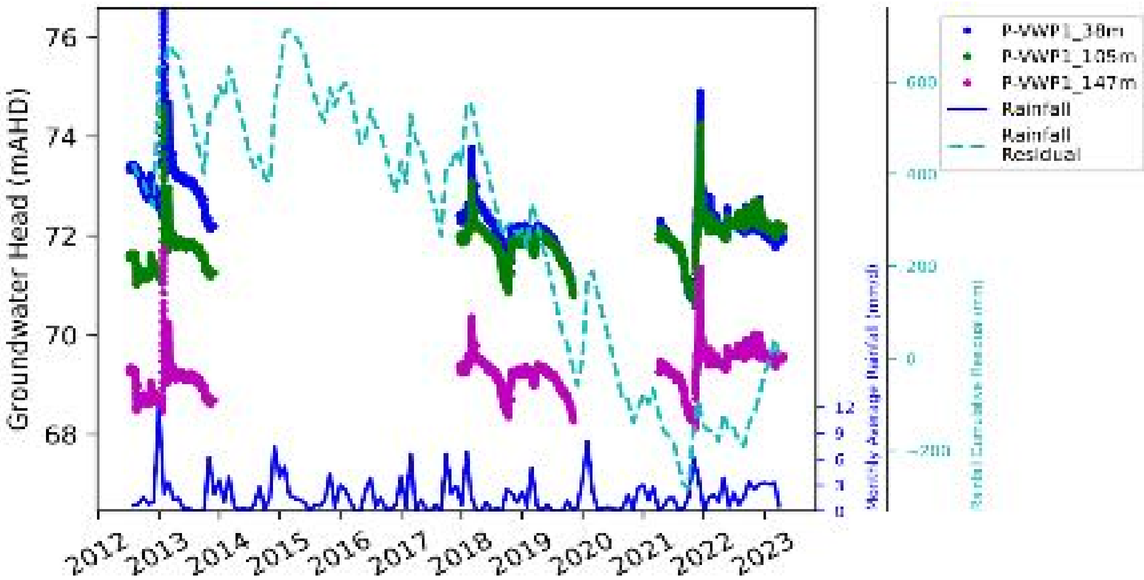
It is noted that the recorded groundwater elevation in the adjacent alluvium standpipe bore (A-OB1) has remained at and above 76 mAHD, reflecting the expected recharge mechanism from the alluvium to the underlying Rewan Formation.

Table 3-3 BSP VWP sensor details – Rewan Formation

Bore ID	Easting	Northing	Ground Survey Elevation (mAHD)	Drilled Bore Depth (mbg)	Sensor Depth (mbg)	Groundwater Elevation (mAHD) [Approximate]	
						SKM (2014) *	2014-2019^
P-VWP2 [Sensor 1]	787789	7314089	88.51 mAHD	252	29	73-74	73-74

Source: After SKM (2014). mbg = metres below ground level.
* Measurements from July and December 2012. ^ Measurements from October 2014 to February 2015 and December 2017 to May 2019.

A) P-VWP-1:



B) P-VWP-2:

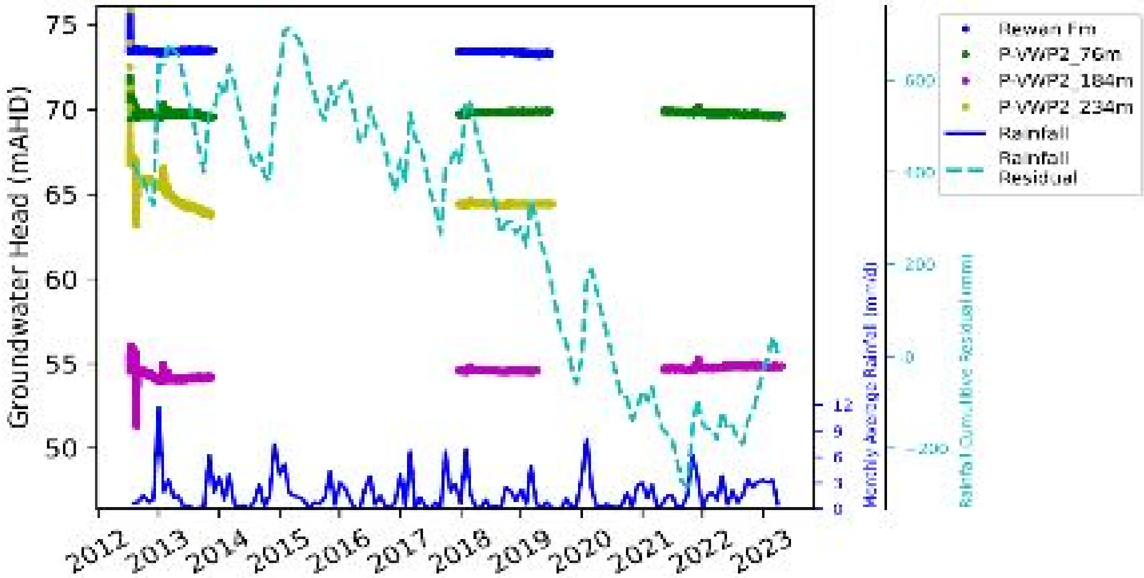


Figure 3-4 VWP-recorded groundwater elevations – Coal Measures and Rewan Formation (1&2)

3.1.6 VWP sensors – Baralaba Coal Measures (interburden)

All sensors in P-VWP1, P-VWP2 (except Sensor 1 [**Table 3-3**]), P-VWP3 and P-VWP5 monitor the groundwater pressures in the interburden of the Baralaba Coal Measures at the BSP. Details of the VWP installations are provided in **Table 3-4**.

Table 3-4 BSP VWP sensor details – Baralaba Coal Measures (Interburden)

Bore ID	Easting	Northing	Ground Survey Elevation (mAHD) (SKM, 2014)	Drilled Bore Depth (mbg)	Interburden Sensor Depth (mbg)	Groundwater Elevation (mAHD) [Approximate]	
						SKM (2014) *	2013-2019 ^
P-VWP1 [Sensor 1]	787442	7314568	89	201	38+	73-74	71-77
P-VWP1 [Sensor 2]					105	71-72	71-75 (Interference)
P-VWP1 [Sensor 3]					147	68-69	68-71 (Interference)
P-VWP2 [Sensor 2]	787789	7314089	88.51	252	76	70	69-71
P-VWP2 [Sensor 3]					184	66	63-67
P-VWP2 [Sensor 4]					234	54-55	51-56
P-VWP3 [Sensor 1]	791922	7309816	91.6	175	55	67-68	67-68
P-VWP3 [Sensor 2]					121	67-68	Unstable/ Erroneous
P-VWP3 [Sensor 3]					155	64-66	64-67
P-VWP3 [Sensor 4]					175	64-66	62-66
P-VWP5 [Sensor 1]	789621	7310598	90.4	201	66	74	74
P-VWP5 [Sensor 2]					138	67-68	66-69
P-VWP5 [Sensor 3]					185	66-67	66-67

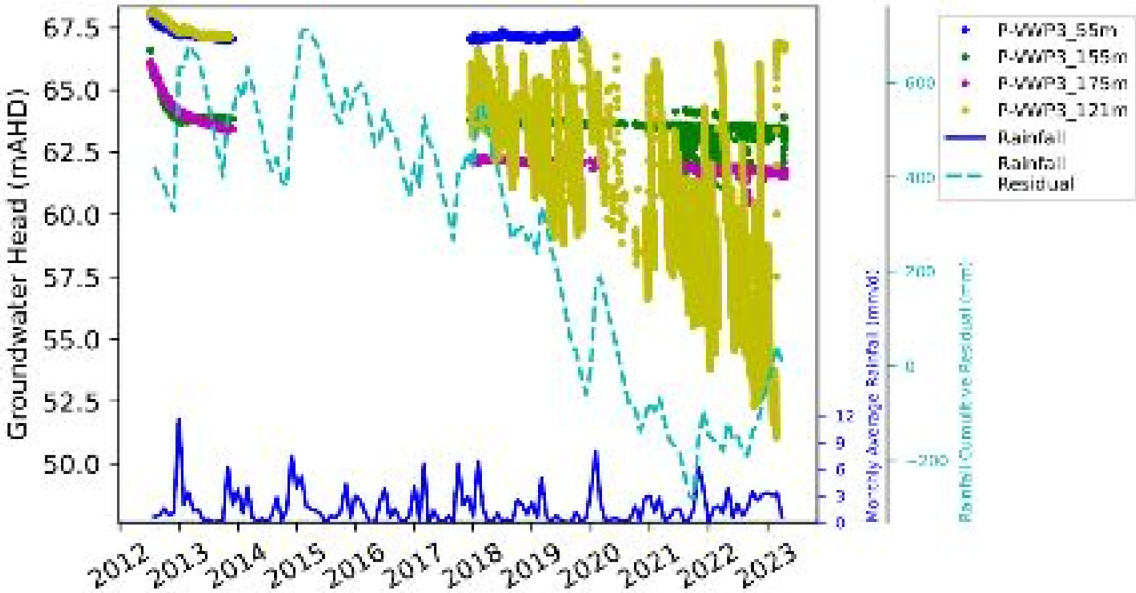
Source: After SKM (2014)
mbg = metres below ground level.
* Measurements between July 2012 and December 2012.
^ Measurements generally between January 2013 and May 2015 and December 2017 and November 2019.
+ Australian Groundwater Explorer Database record states 33.2 mbg, however it is understood alluvials were cased to 36 m when installed.

Plots of the potentiometric groundwater pressures are presented in **Figure 3-4A**, **Figure 3-5** and **Figure 3-6**.

the recorded groundwater pressures at the deep sensors in P-VWP1 (i.e. 105 m and 147 m) appear to be measuring equivalent interference in the shallowest sensor and datasets are therefore being treated as suspect.

The P-VWP3 [Sensor 2] has continued to be unstable with fluctuating measurements and thus identified as erroneous and should not be considered as accurate (SLR, 2019). Similarly, there is some more recent instability in P-VWP3 [Sensor3].

A) P-VWP-3:



(unstable data in Sensor 2 at 121 m are unreliable, while more recent instability in Sensor 3 at 155 m are also unreliable but provide some useable information).

B) P-VWP-4:

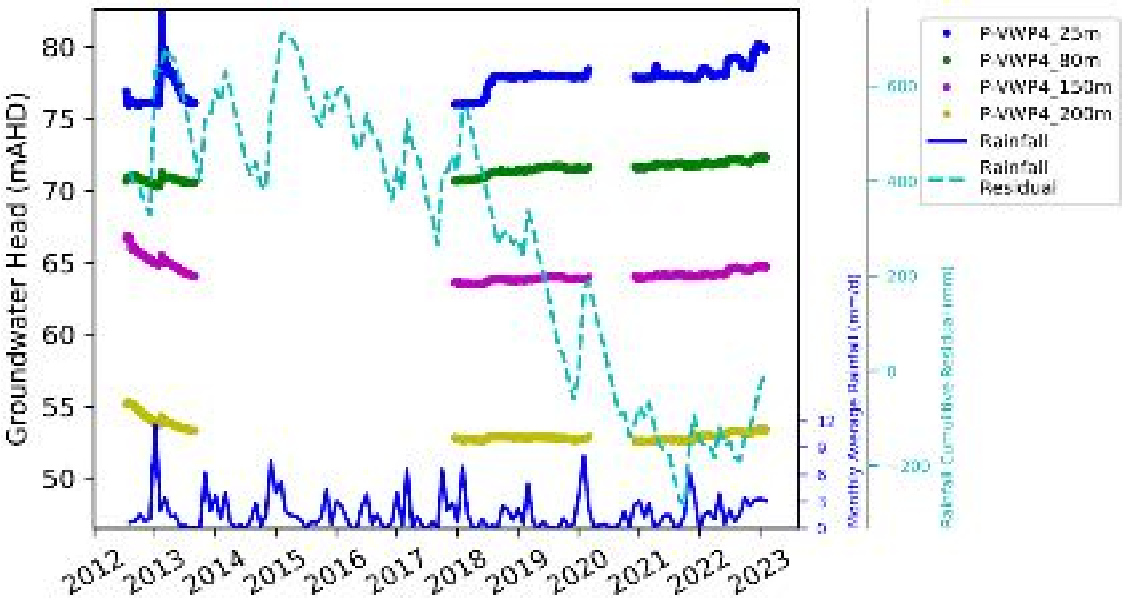


Figure 3-5 VWP-recorded groundwater elevations – Coal Measures & Gyranda Fm (3&4)

A) P-VWP-5:

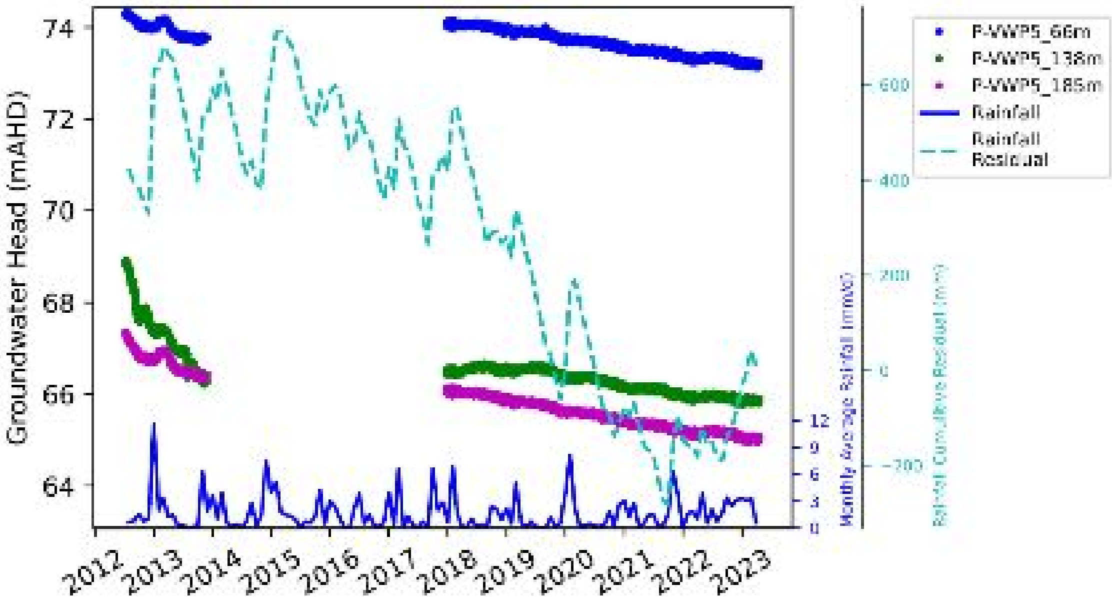


Figure 3-6 VWP-recorded groundwater elevations – Coal Measures (P-VWP5)

3.1.7 VWP sensors – Gyranda formation

The four sensors in P-VWP4 monitor groundwater pressures in the Gyranda Formation at the BSP. The shallowest (at 25 mbg) is considered to be in the weathered / regolith material where it subcrops. Details of the VWP installation at P-VWP4 is provided in **Table 3-5**.

Plots of the potentiometric groundwater pressures are presented in **Figure 3-5B**.

Table 3-5 BSP Groundwater Monitoring VWP Sensors Details – Gyranda Formation

Bore ID	Easting	Northing	Ground Survey Elevation (mAHD) (SKM, 2014)	Drilled Bore Depth (mbg)	Gyranda Formation Sensor Depth (mbg)	Groundwater Elevation (mAHD) [Approximate]	
						SKM (2014) *	2013-2019^
P-VWP4 [Sensor 1]	790829	7315606	101	201	25	76-77	76-78
P-VWP4 [Sensor 2]					80	70-71	70-72
P-VWP4 [Sensor 3]					150	65-66	63-67
P-VWP4 [Sensor 4]					200	54-55	53-55

Source: After SKM (2014)
mbg = metres below ground level.
* Measurements between July and December 2012.
^ Measurements between January 2013 and November 2019.

3.1.8 Private landholder (Ross) bore – igneous trachyte

The Ross Bore is an existing private landholder bore located at the base of Mt Ramsay, east of MLA 700057 as shown in **Figure 3-1**. The bore is located in an area mapped as Cretaceous Intrusives and associated with the igneous trachyte of Mt Ramsay.

Details of the Ross Bore is provided in **Table 3-6**.

Table 3-6 BSP private landholder bore details – Ross Bore

Bore ID	Easting	Northing	Ground Survey Elevation (mAHD) (Hand-held GPS)	Drilled Bore Depth (mbg)	Screened Interval (mbg)	Standing Water Levels (mAHD)	Logger Depth Installed (2018) (mbTOC)
						SLR (2019) ^	
Ross	792441	7314085	120	52.67	Unknown	102-103	45

Source: After SKM (2014) and SLR (2019)
mbg = metres below ground level.
^ Measurements between December 2017 and October 2018.

The available groundwater level measurements (field readings and logger downloads to the end of 2018) from the Ross Bore are presented in **Figure 3-7**.

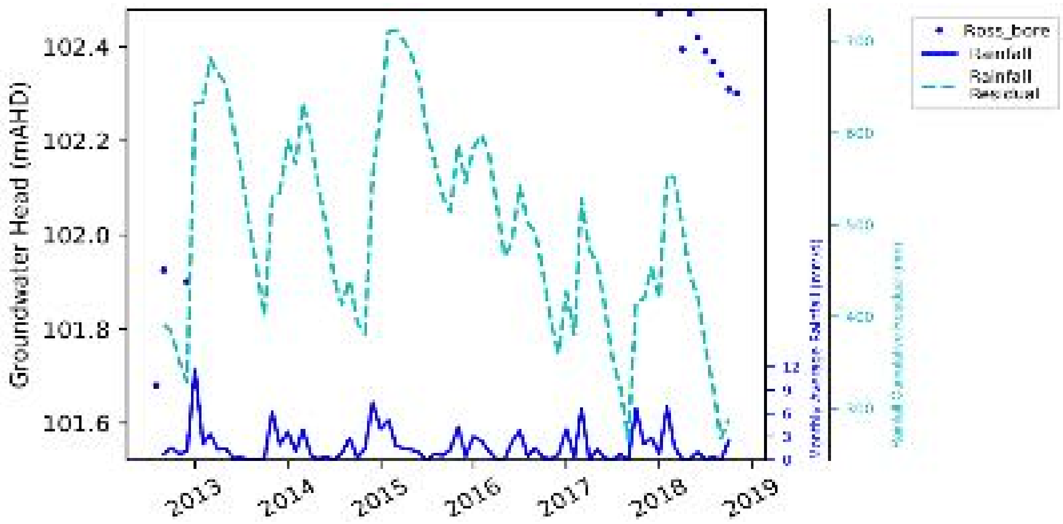


Figure 3-7 Private Landholder (Ross) Bore – Igneous Trachyte

It is noted that the recorded groundwater elevation in the igneous trachyte is much higher than the surrounding Permian Coal Measures (e.g. 77 mAHD (possibly 81 mAHD) at P-OB2 or 77-78 mAHD at P-VWP4; locations on **Figure 3-1**). It is understood that at the time of data collection the private landholder bore was not in use, however consultation with the landholder (Baralaba South Pty Ltd pers. comm) indicates this bore was recently equipped (in 2020). This bore is discussed further in **Section 5.3**.

3.2 Groundwater monitoring - BNM

The extensive groundwater monitoring network at the Baralaba North Mine also provides historic groundwater datasets upon which the groundwater model has been based for calibration and cumulative assessment. A detailed presentation and analysis of the historic datasets are provided in HydroSimulations (2014) and is summarised below.

During the mining of Baralaba North, in-pit monitoring bores BC002 to BC023 were installed to provide information on groundwater responses from November 2005 to April 2008, after which time all were destroyed by mining or surface works.

A more permanent groundwater monitoring network was established at the Baralaba Coal Mine in 2007, consisting of nine bores (PZ01 to PZ09), with an additional bore constructed south of the workshop dam (PZ07B). Since then, six of these early bores have been destroyed due to progressive mine excavation and flooding. The surviving bores are PZ07, PZ07B, PZ08 and PZ09, all screened in the alluvium.

In August 2011, the groundwater monitoring network was expanded from four to eleven bores with the addition of bores PZ10 to PZ14D. Of the new bores:

- four are screened within the alluvial aquifer (PZ10, PZ11, PZ12S, PZ14S);
- two within the Permian Coal Measures (PZ12D, PZ14D); and
- one within a fault zone (PZ13).

The hydrograph from PZ12S and PZ14D (**Figure 3-8**) showed 2-3 m groundwater level declines in 2011, either caused by Baralaba Central mining approaching or recession following the flood. Bores PZ12S (and PZ12D) were decommissioned in December 2013 because of their position at the southern (commencing) end of the Baralaba North pit. Groundwater levels in PZ14D, which are further north, remained fairly constant until late 2020 when they declined a further 3 m through 2022-23 (probably related to the pit advancing to the north).

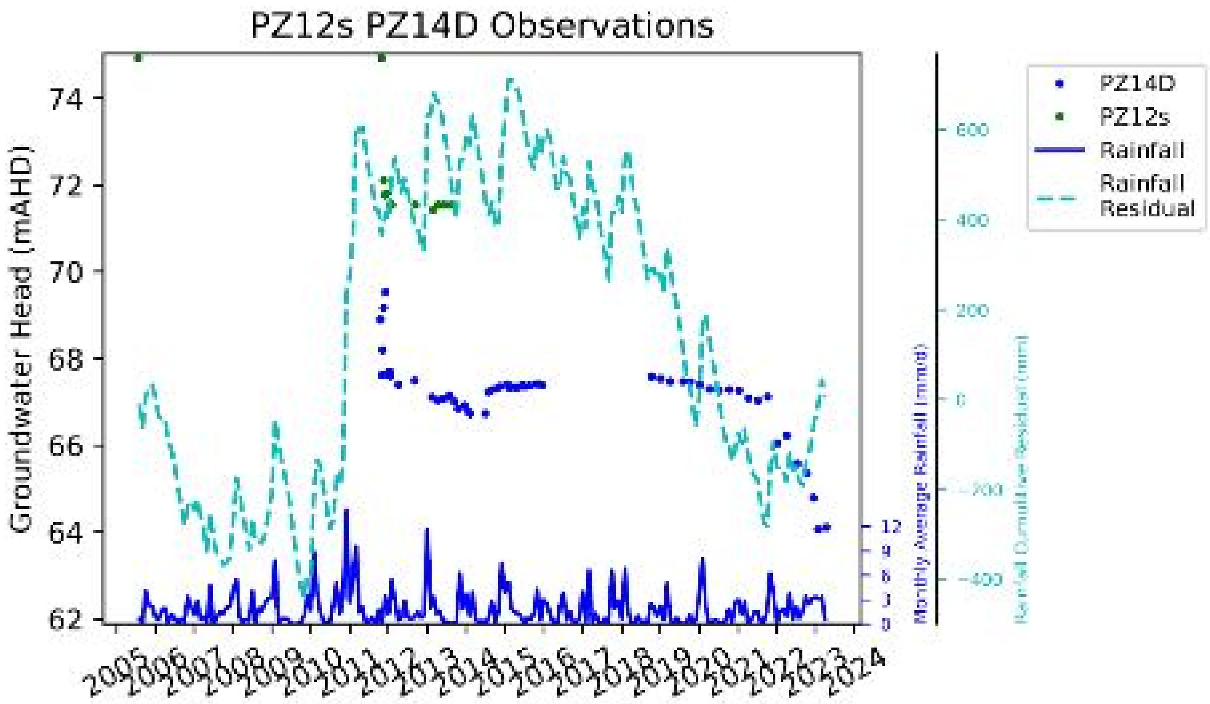


Figure 3-8 Groundwater level trends at BNM bores PZ12S and P14D

In November-December 2012, a total of 12 monitoring bores were installed and one production bore in the Baralaba North Mine area (six in alluvium, six accessing the Blackwater Group interburden and one in coal) (SKM, 2013). The bores are named CCL_AM01, CCL-AM02, and SKM_AM01-AM04 in alluvium, SKM_PM01 to PM06 in Permian sediments and CCL_PP01 in coal.

At the same time, SKM installed nine nested sites using vibrating wire piezometers (VWPs), named CCL_VWP01-VWP09. The hydrograph for CCL_VWP02 is shown on **Figure 3-9**.

This site is located just south of PZ12 and south of the southern edge of the Baralaba North pit.

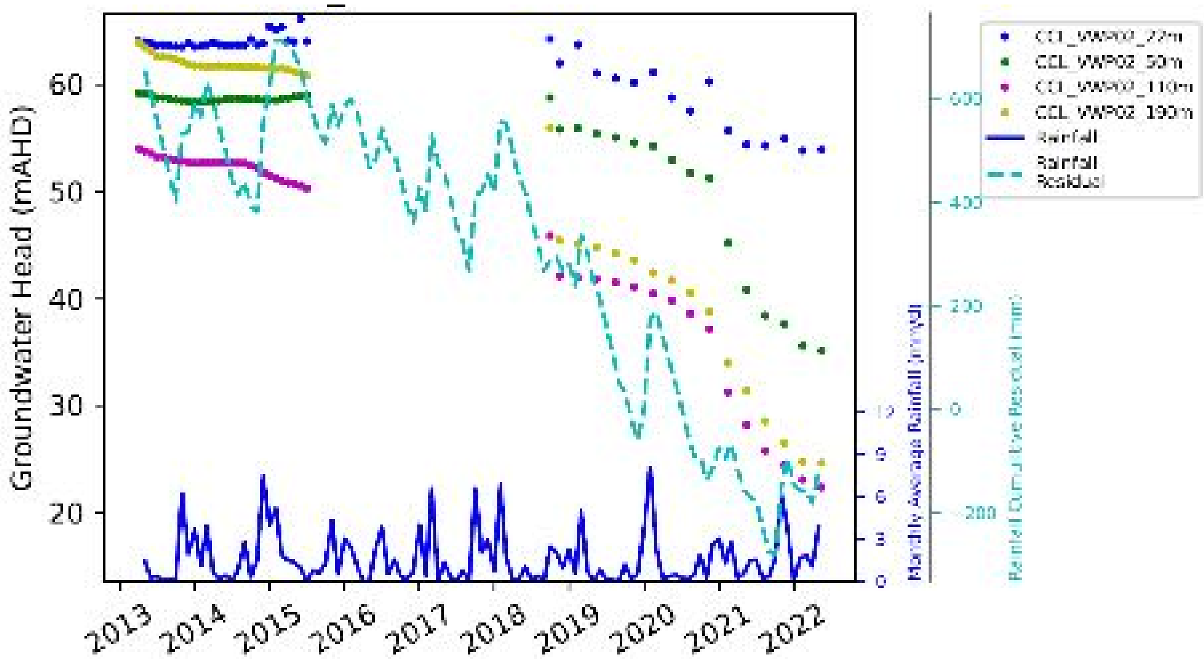


Figure 3-9 Groundwater level trends at BNM bore CCL_VWP02

Figure 3-9 shows relatively consistent groundwater pressures in 2013-15, with the start of a mining related decline in the 110m sensor in 2014-15. A stronger and persistent downward trend is evident from the 2018-2022 data, with the total drawdown from 2013 being 10 m in the shallowest (22m – blue series) piezometer up to 55 m in the deepest (190 m – yellow series) sensor.

The VWP network was augmented at two sites (CCL_VWP10-VWP11) by Groundwater Exploration Services Pty Ltd (GES) in 2013. Four standpipe piezometers at three sites were also installed by GES at this time. Their tentative names are BN0744a (alluvium), BN0744c (Reid Seam), BN0748a (alluvium) and BN0679c (Coolum Seam). The details of groundwater level monitoring bores in the Baralaba North Mine network are summarised in **Table 3-7**, **Table 3-8** and **Table 3-9** below (taken from GES, 2014).

Table 3-7 BNM Groundwater Monitoring Sites Summary – Alluvium

Monitoring Site	Depth (m)	Start Date	End Date / Note	Frequency	Collar (mAHD)
PZ07	11.5	May 2010	-	Monthly	83.9
PZ07b	11.5	Nov 2011	-	Monthly	84.0
PZ08	-	Oct 2011	-	Monthly	82.4
PZ09	-	Oct 2011	-	Monthly	82.1
PZ10	9.1	Nov 2011	Mar 2014, Dry	Monthly	86.5
PZ11	11.0	Oct 2011	Nov 2015, Dry	Monthly	79.4
PZ12s	8.7	Oct 2011	Decommissioned	Monthly	80.2
PZ14s	18.0	Oct 2011	Casing Blocked	Monthly	90.7
CCL_AM01	10.1	-	Dry	-	-
CCL_AM02	9.9	-	Dry	-	-
SKM_AM01	14	-	Dry	12-hourly	-

Monitoring Site	Depth (m)	Start Date	End Date / Note	Frequency	Collar (mAHD)
SKM AM02	10	-	Dry	12-hourly	-
SKM AM03	9.5	-	Dry	12-hourly	-
SKM_AM04	13.5	Dec 2012	Dec 2015	12-hourly	80.5
BN0744a	19	Nov 2013	Dec 2015	Monthly	98
BN0748a	17	Nov 2013	Dec 2015	Monthly	90

Source: After HydroSimulations (2014)

Table 3-8 BNM Groundwater Monitoring Sites Summary – Permian Strata

Monitoring Site	Depth (m)	Lithology	Start Date	End Date / Note	Frequency	Collar (mAHD)
PZ12D	44.8	Coolum Seam	Oct 2011	Decommissioned	Monthly	80.2
PZ13	70.2	Interburden	Oct 2011	Dec 2015	Monthly	81.1
PZ14D	39.7	Coolum Seam	Oct 2011	Dec 2015	Monthly	90.9
SKM_PM01	129	Interburden	Dec 2012	Dec 2015	Daily	95.4
SKM_PM02	55	Interburden	Dec 2012	Dec 2015	Daily	87.3
SKM_PM03	42.5	Interburden	Jan 2013	Dec 2015	Daily	79
SKM_PM04	56	Interburden	Dec 2012	Dec 2015	Monthly	80
SKM_PM05	125	Interburden	Jan 2013	Dec 2015	Daily	93.1
SKM_PM06	57.6	Interburden	Dec 2012	Mar 2014, Decommissioned	Daily	86.4
CCL_PP01	183	Coal	Jul 2013	Dec 2015	Daily	81.4
BN0744c	291.5	Reid Seam	Nov 2013	Dec 2015	24-hourly	98
BN0679c	125	Coolum Seam	Nov 2013	Dec 2015	24-hourly	91.8^

Source: After HydroSimulations (2014)

^ BN0679 surface elevation recorded as 201.0 mAHD, but log BN0679_23P_ID1 indicates 91.8 mAHD, which is used here (Mr Andrew Fulton [GES], pers comm.).

Table 3-9 BNM VWP Monitoring Sites Summary

Monitoring Site	Depths (m)	Lithologies	Start Date	End Date	Frequency	Collar (mAHD)
CCL_VWP01	123, 143, 156, 196	Ib^, Ib, Ib, Ib	Mar 2013	Sep 2018	4-hourly	78
CCL_VWP02	22, 50, 110, 190	Ib, Coal, Coal, Ib	Mar 2013	Sep 2018	4-hourly	77
CCL_VWP03	29, 65, 157, 187	Coal, Coal, Ib, Ib	Dec 2012	Sep 2018	4-hourly	79

Monitoring Site	Depths (m)	Lithologies	Start Date	End Date	Frequency	Collar (mAHD)
CCL_VWP04	34, 61, 180, 194	Ib, Ib, Ib, Coal	Dec 2012	Nov 2015	4-hourly	78
CCL_VWP05	29, 55, 88, 110, 137	Coal, Ib, Coal, Ib, Coal	Dec 2012	Jul 2015	4-hourly	80
CCL_VWP06	23, 28, 76	Ib, Ib, Ib	Jul 2013	Oct 2015, Decommissioned	4-hourly	-
CCL_VWP07	78, 105, 111, 127, 168	Ib, Ib, Ib, Ib, Coal	Mar 2013	Sep 2018	4-hourly	79
CCL_VWP08	39, 67, 91, 154	Coal, Ib, Ib, Coal	Dec 2012	Nov 2015, Decommissioned	4-hourly	80
CCL_VWP09	38	Ib	Dec 2012	Sep 2018	4-hourly	81
CCL_VWP10 (BN0744)	45, 95, 125, 155, 195	Cameron, Reid, Doubtful, Sub-Doubtful Seams, SubDoubtful Dawson, Ib	Nov 2013	Jan 2016	24-hourly	96
CCL_VWP11 (BN0748)	42, 74, 140	All Gyranda Formation	Nov 2013	Jul 2017	24-hourly	91

Source: After HydroSimulations (2014). ^Ib: Interburden.

3.3 Groundwater usage – anthropogenic

3.3.1 MLA 700057

Besides local aquifer testing conducted for the purposes of confirming hydraulic properties for this assessment (discussed further in **Section 3.6**) and routine groundwater sampling (including purging), pumping/usage of groundwater resources within MLA 700057 has been limited.

3.3.2 Database searches and private landholder bores

A review of the Qld Government Groundwater Database (Qld Globe) and Australian Groundwater Explorer (BOM) was conducted (in 2023) and correlation of registered numbers with the existing groundwater monitoring network at the BSP and surrounds is provided in **Table 3-10**.

In total, three (3) private landholder bores were initially identified within 5 km of the BSP using desktop methods, which were subsequently refined based on the results of the on-ground landholder bore survey discussed in **Section 3.3.3**, and considered further in the groundwater modelling and assessment. The bore records on the database were located on the following properties (labelled on **Figure 2-7** and **Figure 2-9**):

- 135FN143 (McLaughlin JR and V) – "Ross" Bore.
- 4FN514 (Austin DL and MJ) – RN 128188[6] - "Riverland2".
- 35FN141 (Webb LC and LA) – RN 100077[7].- "Webb".

It is also noted that approximately 500 m east of MLA 700057, a small parcel of land (156/FN504) associated with Mt Ramsay is owned by the Commissioner of Water Resources (**Figure 3-10**); the lease purpose is stated to be a quarry.

Several transects of drill holes/bores were constructed in 1991 as part of the Dawson Valley Appraisal Study (DPI, 1994) and besides the coordinates of the transect locations (**Figure 2-9**), limited hydrogeological data is available. It is understood that the transects were decommissioned and/or abandoned (labelled as such on **Figure 2-9**).

[6] As noted in **Appendix B**, the location of the desktop record RN 128188 was ground-truthed and no bore exists, however two existing bores on the Austin property were surveyed nearby (Riverland 1 & 2) (**Section 3.3.3**).

[7] As noted in **Appendix B**, the location of the desktop record RN 100077 was ground-truthed and the landholder (L Webb) indicated that it had been filled in and cleared in the past. An existing bore on the Webb property was surveyed (Webb Bore) (**Section 3.3.3**).

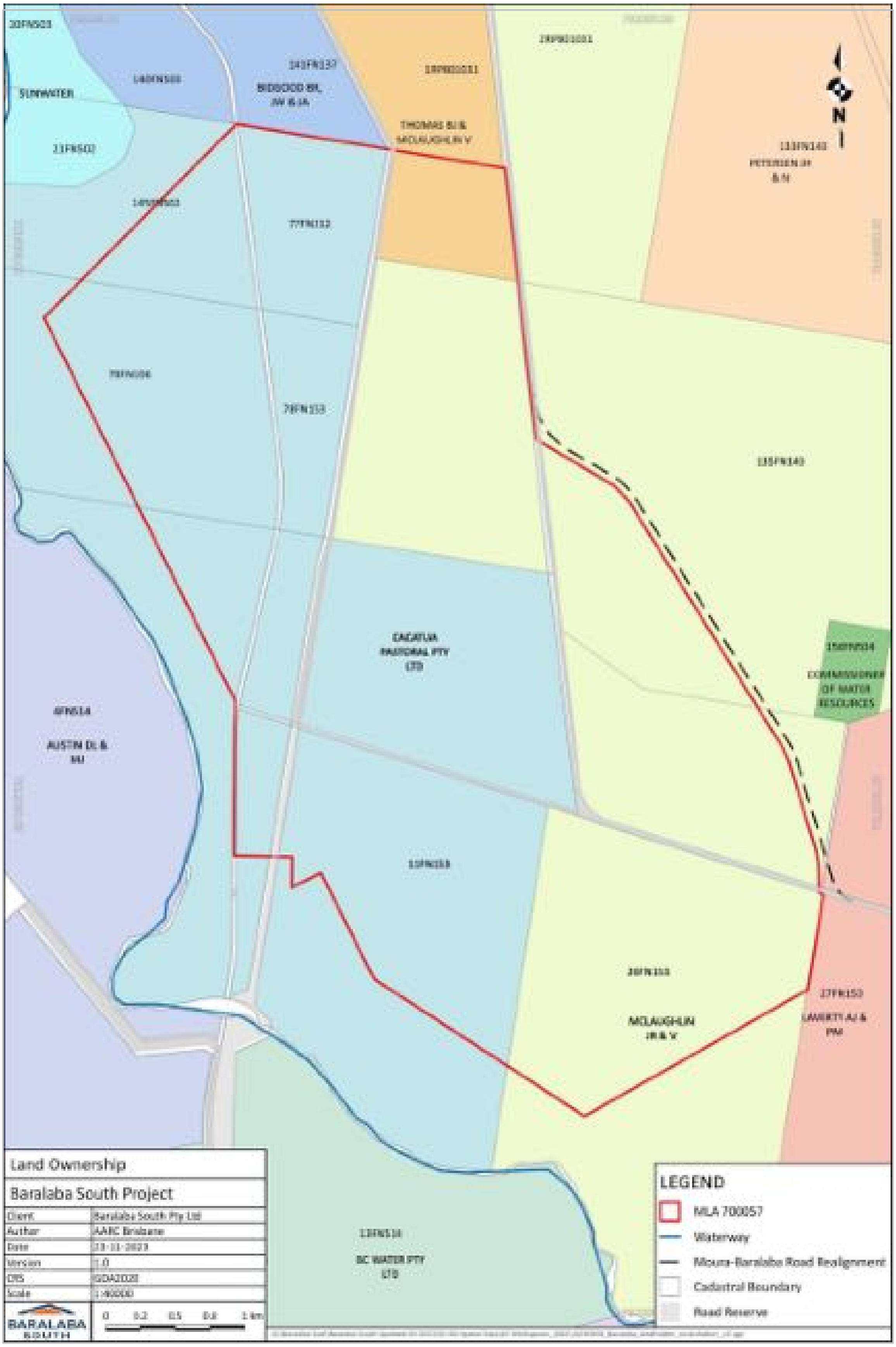


Figure 3-10 Land Ownership around BSP [source: AARC]

Table 3-10 Qld Groundwater Database / Australian Groundwater Explorer Searches and other Private Landholder Bores

Database ID	Bore ID	Type / Use	Further Details
RN 100077 / 100077	-	Private Landholder Bore[8]	2 km south of MLA 700057 (south of Banana Creek) *
RN 100078 / 100078	-	Excavation / Dam	Quarry
RN 100317 / 100317	-	Mineral Bore	MIH Banana 2/2A
RN 128188 / 128188A^	-	Private Landholder Bore[7]	1.5 km west of MLA 700057 (at the confluence of
RN 128771 / 128771A	A-OB2	Groundwater Monitoring - Standpipe	Table 3-1
RN 128772 / 128772A	A-PB1	Production Bore / Groundwater Monitoring - Standpipe	Table 3-1
RN 128773 / 128773A	P-PB1	Production Bore / Groundwater Monitoring - Standpipe	Table 3-2
RN 128774 / 128774A 128774B 128774C 128774D	P-VWP2	Groundwater Monitoring - VWP	Tables 3-5 and 3-6
RN 128775 / 128775A	P-OB3	Groundwater Monitoring - Standpipe	Table 3-2
RN 128776 / 128776A	A-PB2	Production Bore / Groundwater Monitoring - Standpipe	Table 3-1
RN 128777 / 128777A	A-OB7	Groundwater Monitoring - Standpipe	Table 3-1
RN 128778 / 128778A	A-OB8	Groundwater Monitoring - Standpipe	Table 3-1
RN 128779 / 128779A	A-OB4	Groundwater Monitoring - Standpipe	Table 3-1
RN 128881 / 128881A	A-OB1	Groundwater Monitoring - Standpipe	Table 3-1
RN 128882 / 128882A	A-OB3	Groundwater Monitoring - Standpipe	Table 3-1

Database ID	Bore ID	Type / Use	Further Details
RN 128883 / 128883A	A-OB6	Groundwater Monitoring - Standpipe	Table 3-1
RN 128884 / 128884A	A-OB10	Groundwater Monitoring - Standpipe	Table 3-1
RN 128885 / 128885A	A-OB11	Groundwater Monitoring - Standpipe	Table 3-1
RN 128886 / 128886A	A-OB12	Groundwater Monitoring - Standpipe	Table 3-1
RN 128887 / 128887A	P-OB1	Groundwater Monitoring - Standpipe	Table 3-3
RN 128888 / 128888A	P-OB2	Groundwater Monitoring - Standpipe	Table 3-4
RN 128889 / 128889A	P-OB4	Groundwater Monitoring - Standpipe	Table 3-3
RN 128890 / 128890A	P-OB5	Groundwater Monitoring - Standpipe	Table 3-3
RN 128891 / 128891A 128891B 128891C	P-VWP1	Groundwater Monitoring - VWP	Table 3-5
RN 128892 / 128892A 128892B 128892C 128892D	P-VWP3	Groundwater Monitoring - VWP	Table 3-5
RN 128893 / 128893A 128893B 128893C 128893D	P-VWP4	Groundwater Monitoring - VWP	Table 3-6
RN 128894 / 128894A 128894B 128894C	P-VWP5	Groundwater Monitoring - VWP	Table 3-5
N/A	Ross Bore	Private Landholder Bore – Not in Use (Groundwater Monitoring)	500 m east of the MLA 700057 (Table 3-7) *
RN 13030652	-	DPI Transect (1991) - Coolum Road at Baralaba	Decommissioned
RN 13030653	-	DPI Transect (1991) - Coolum Road at Baralaba	Decommissioned

Database ID	Bore ID	Type / Use	Further Details
RN 13030654	-	DPI Transect (1991) - Coolum Road at Baralaba	Decommissioned
RN 13030655	-	DPI Transect (1991) - Coolum Road at Baralaba	Decommissioned
RN 13030656	-	DPI Transect (1991) - Coolum Road at Baralaba	Decommissioned
RN 13030657	-	DPI Transect (1991) - Harcourt Road at Banana Creek / Dawson River Confluence	Decommissioned
RN 13030658	-	DPI Transect (1991) - Harcourt Road at Banana Creek / Dawson River Confluence	Decommissioned
RN 13030659	-	DPI Transect (1991) - Harcourt Road at Banana Creek / Dawson River Confluence	Decommissioned
RN 13030660	-	DPI Transect (1991) - Harcourt Road at Banana Creek / Dawson River Confluence	Decommissioned
RN 13030661	-	DPI Transect (1991) - Harcourt Road at Banana Creek / Dawson River Confluence	Decommissioned
RN 13030662	-	DPI Transect (1991) - Harcourt Road at Banana Creek / Dawson River Confluence	Decommissioned
RN 13030663	-	DPI Transect (1991) - Harcourt Road at Banana Creek / Dawson River Confluence	Decommissioned
RN 13030648	-	DPI Transect (1991) – Downstream of Roundstone Creek / Dawson River Confluence	Decommissioned
RN 13030649	-	DPI Transect (1991) – Downstream of Roundstone Creek / Dawson River Confluence	Decommissioned
RN 13030650	-	DPI Transect (1991) – Downstream of Roundstone Creek / Dawson River Confluence	Decommissioned
RN 13030651	-	DPI Transect (1991) – Downstream of Roundstone Creek / Dawson River Confluence	Decommissioned

Database ID	Bore ID	Type / Use	Further Details
RN 13030664	-	DPI Transect (1991) – Downstream of Roundstone Creek / Dawson River Confluence	Decommissioned
RN 13030665	-	DPI Transect (1991) – Downstream of Roundstone Creek / Dawson River Confluence	Decommissioned
RN 13030666	-	DPI Transect (1991) – Downstream of Roundstone Creek / Dawson River Confluence	Decommissioned
RN 13030667	-	DPI Transect (1991) – Downstream of Roundstone Creek / Dawson River Confluence	Decommissioned
RN 13030668	-	DPI Transect (1991) – Downstream of Roundstone Creek / Dawson River Confluence	Decommissioned

* Refer to Landholder Bore Survey Results (4T Consultants, 2019) (Section 3.3.3 and Appendix B).
^ Australian Groundwater Explorer (BOM; accessed 2023)

3.3.2.1 Baralaba North Mine – Previous Searches (from HydroSimulations, 2014)

A search of the Qld Groundwater Bore Database was carried out by third party consultant GES in 2014. This indicated:

- Limited irrigation within 10 km of the BNM, supported by inspection of aerial photos which only show signs of irrigation at:
  - A location immediately north of the BNM land that include three centre pivots west of the Dawson River and between Saline Creek and another un-named tributary; and
  - A location immediately west of the proposed BSP that includes a centre pivot between Dawson River and its tributary.
- Limited groundwater use, in the form of windmill pumps, for stock purposes (Mr Andrew Fulton (GES), pers. comm. – 12/2/2014).

A bore database search by AGE (2012) revealed 33 registered bores within a 20 km radius of the Baralaba North Mine, of which 13 had been abandoned. A total of seven registered bores (two private landholder bores and five DEHP groundwater investigation bores) within the 20 km radius were identified as accessing the Dawson River alluvium (SKM, 2014). The two registered landholder bores screened within the alluvium are located 15 km north-east (RN128258) and to the south (RN128188 – see Section 3.3.2).

According to AGE (2012): "The five DERM investigation bores, which were installed as part of the Dawson Valley Appraisal Study (DPI, 1994), found that there was a limited to no alluvial groundwater resource from 500m away from the Dawson River. The five DERM bores (RN13030652 to RN13030656) are all abandoned and all but one (RN13030652) destroyed[8]. The bores are located approximately 5 km southwest of the Project area and have all been recorded as dry, including bore RN13030652, which is located approximately 500 m from the Dawson River."

Based on the evidence of limited groundwater use, no additional field census of groundwater bores and wells in the vicinity of the BNM site was conducted, although additional unregistered bores could be present in the region.

3.3.3 Baralaba south landholder bore census/survey

3.3.3.1 Baralaba South - Landholder Bore Survey Results (4T Consultants, 2019)

The results of the landholder bore survey are presented in **Appendix B** and summarised below:

- **Ross Bore** – Located approximately 500 m east of MLA 700057 on property lot 135/FN143 (McLaughlin JR & V), at a total drilled depth of 52.67 m[9], intersecting mapped Cretaceous Intrusives (Igneous Trachyte) associated with Mt Ramsay. The recorded groundwater elevation is at approximately 102-103 m AHD and is much higher than the surrounding Permian coal measures. The landholder has advised Baralaba South Pty Ltd that the bore has recently (2020) been equipped and is in use. This bore does not appear as a registered bore on a search of Queensland Globe.
- **Riverland 1 & 2** – Paired bores (approximately 3 m apart) located approximately 1.5 km west of MLA 700057 on property lot 4/FN514 (Austin DI & MJ), between the Dawson River and Banana Creek, and immediately south of their confluence, adjacent the Dawson River. The

[8] In AGE (2012) this says "*and all but one (RN13031652) destroyed*". This has been corrected here to refer to bore RN130<u>3</u>0652.

[9] Whilst the landholder bore survey (4T Consultants, 2019) measured a total depth of 50.17 m, the original file note for the Ross Bore total drilled depth of 52.67 m (SKM, 2014 & SLR, 2019) was retained.

bores were recorded as being 18 m and 22 m deep (respectively), intersecting the sands and gravels of the Quaternary alluvium. The depth specifications for Riverland 2 are consistent with RN 128188. Aerial imagery shows that two centre-pivot irrigation areas exist nearby on the property, however the landholder has advised Baralaba South Pty Ltd that the supply of irrigation water is sourced from the Dawson River, not the groundwater bore(s). Neither bore is equipped.

- **Webb Bore** – Located approximately 3.5 km south of MLA 700057 on property lot 35/FN141 (Webb LC & LA) on the southern side of Banana Creek. The total hole depth recorded was approximately 78 m and the bore was not equipped. Based on the log for RN 100077, this bore is likely to be intersecting regolith sediments above or a weathered upper portion of the Rewan Formation.

3.3.4 Baralaba North Mine

There is no bore groundwater pumping carried out at the Baralaba North Mine operations, other than occasional pumping from pit floor sumps. It is noted in the literature review and from site visits that inflows are visible along sections of the exposed coal seam and usually not from the interburden. In most cases, the inflow is visible as an area of darker material, with some seepage down the wall, but often not reaching the floor due to evaporation.

No records of inflows to the mine pit are available, due in part to the low volume of groundwater inflow (i.e. this excludes flooding), and the practicality of measuring such inflows. Modelling completed for a previous study estimated inflows to the Baralaba North pit using several scenarios and sensitivity runs (JBT Consulting, 2012). The various estimates ranged from 0.4 to 12.5 ML/day with an approximate median being between 1.3 and 3.4 ML/day.

More recent estimates, based on operational dewatering and water balance studies for inflow to the BNM are 0.6 ML/d (Engeny, 2022) up to approximately 2.0 ML/d (based on advice from Engeny).

In general, groundwater in the vicinity of the Baralaba North Mine is unsuitable for use in agricultural and domestic applications due to high salinity levels.

3.4 Groundwater levels

3.4.1 Spatial analysis of groundwater levels

Using the groundwater datasets presented in **Sections 3.1** and **3.2**, contour maps of measured and inferred water levels are presented on **Figure 3-11**. This also allows for the depth to water table / interpreted unsaturated depth in the vicinity of the BSP site and surrounds to be estimated and this is presented as **Figure 3-12**.

For conservative assessment purposes, where multiple records exist at the one location, the maximum water levels (elevation) were used to assist with identifying areas of ‘potential’ interaction between vegetation and the water table.

Interpolation of the water table elevation was conducted using the ArcGIS 10 ‘Topo To Raster’ tool, which is based on a spline interpolation method, and has the advanced functionality of allowing interpolation from multiple datasets, including points (e.g. observations at bores) and polyline contours (e.g. hand-drawn contours).

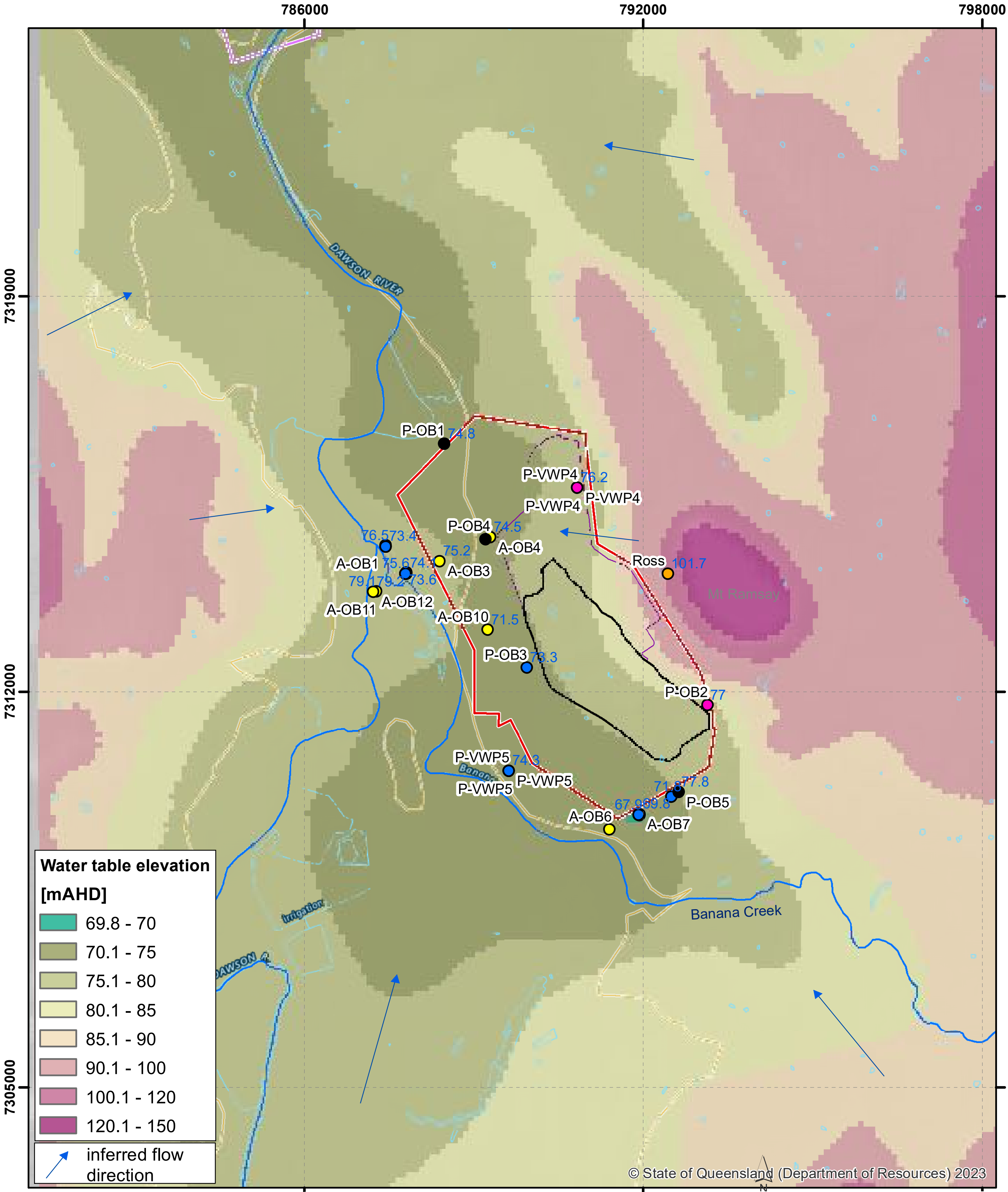
Flow directions can be inferred from a groundwater elevation contour map, as flow occurs from areas of high head to those of low head. From **Figure 3-11**, the inferred groundwater flow directions in the vicinity of the BSP are predominantly topographically controlled:

- Convergent along Banana Creek (and alluvium) toward the confluence of and then northward along the Dawson River.
- Westward from Mount Ramsay and east of the Dawson Range through the BSP site toward Dawson River.

It is likely that the regulation of the Dawson River behind the Neville Hewitt Weir, which has raised the Dawson River stage above the natural levels upstream of the weir, has led to slightly elevated groundwater levels in this area, including to the west of the BSP.

Figure 3-12 shows the depth to groundwater is typically 10-15 mbg in the north of MLA 700057, 15-20 mbg in the west of MLA 700057 and greater than 20 mbg in the east of MLA 700057.

The map also shows that near the confluence of Banana Creek with the Dawson River and along the Dawson River, the depth to groundwater is typically 10-15 mbg or 5-10 mbg, while the depth to water is inferred to be approximately 10-15 mbg along Banana Creek for the reach nearest the BSP, even in the area where the BOM GDE mapping indicates the presence of potential GDEs, as well as near the HES wetland located on the western boundary of MLA 700057.



E:\WSHED\PROJ\BARALABA\GIS\Maps\Deliverable\BAR101_WaterTableElevation.mxd

Created by: WMinchin | Version: A | Date: 1/10/2023

Watercourse - major

Mining lease
- Baralaba North
- Baralaba Central
- Baralaba South Project
- BSP: Pit Limits
- BSP: Ex-pit Spoil Dump
- Alluvium

Monitoring site
- other / unknown
- Alluvium
- Rewan Formation
- Interburden
- Coal seam
- Gyranda Formation
- Igenous trachyte

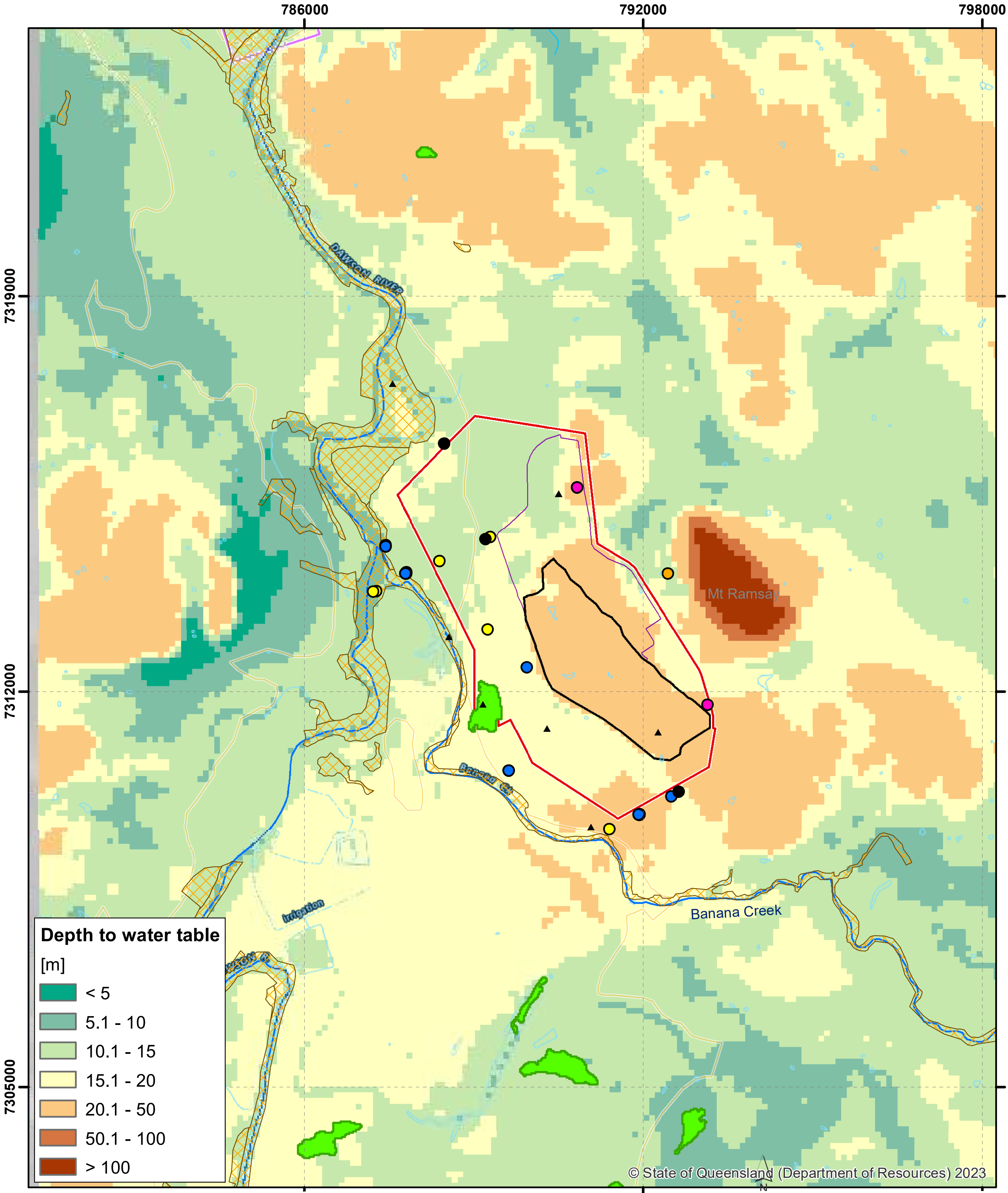
0 0.5 1 1.5 2 km

Scale: 90,000 @A4
GDA 1994 MGA Zone 55

BSP: Groundwater Assessment

Inferred water table elevation and flow directions

Figure 3-11



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Created by: WMinchin | Version: A | Date: 1/10/2023

Wetland area (HES)

Potential GDE - Terrestrial (BOM)

GW dependence

Low potential GDE - from regional studies

0 0.5 1 1.5 2 km

Scale: 90,000 @A4
GDA 1994 MGA Zone 55

BSP: Groundwater Assessment

Inferred depth to watertable

Figure 3-12

3.4.2 Temporal groundwater levels

Available groundwater levels within MLA 700057 and surrounds have been investigated to check for cause-and-effect responses in temporal water level changes which could result from rainfall recharge and are discussed where relevant in **Section 3.1** (e.g. standpipe alluvial bores).

HydroSimulations (2014) had also previously completed a similar analysis for the Baralaba North Mine, considering the effects of mining drawdown. As there has not been any previous mining activities at the BSP area, an equivalent analysis is not possible. However, responses as a result of the local aquifer testing conducted for the purposes of confirming hydraulic properties for this assessment and routine groundwater sampling (including purging) have been considered and discussed further in **Section 3.6**.

In summary, the main conclusions based on the monitoring observations are:

- mild correlation with rainfall and stage surface water levels at the alluvial bores nearest to the Dawson River;
- natural decline in potentiometric head with depth, at both BSP (e.g. **Figure 3-5**, **Figure 3-6**) and BNM (e.g. **Figure 3-9**); and
- mining-related drawdowns evident at bores installed in the coal measures at the Baralaba North Mine (**Figure 3-8** and especially on **Figure 3-9**); and
- some localised mounding occurs in shallow piezometers adjacent to waste dumps at BNM.

3.5 Environmental groundwater usage and dependency

Eco Solutions & Management (2023), Ecological Service Professionals (2023), Stygoecologia (2019) and 3d Environmental (2023) were engaged to carry out terrestrial ecology, aquatic ecology stygofauna and GDE surveys, respectively and identify the significant ecological features around the BSP area. The significant features (as identified by these reports) are summarised in the following relevant subsections and described in further detail in these reports.

3.5.1 Springs

During the landholder bore survey conducted by 4T Consultants (2019), no springs were observed or noted within MLA 700057 or surrounds.

3.5.2 Wetlands and groundwater dependent ecosystems (GDE)

As described in **Section 3.5**, a wetland of high ecological significance (and matter of state environmental significance [MSES]) is mapped in the west of MLA 700057 (**Figure 2-7** and **Figure 3-12**). Two wetlands of general ecological significance (GES) are also located within MLA 700057 (Eco Solutions & Management, 2023). Other wetlands of general ecological significance also occur in the wider surrounds (Ecological Service Professionals, 2023).

The IESC Information Guidelines Explanatory Note: Assessing Groundwater-Dependent Ecosystems (Commonwealth of Australia, 2019a) has been considered separately in the EIS by Ecological Service Professionals (2023), Eco Solutions & Management (2023), Stygoecologia (2019) and 3d Environmental (2023).

The Groundwater Dependent Ecosystems Atlas (GDE Atlas, managed by the Bureau of Meteorology) was developed as a national dataset of Australian GDEs to inform groundwater planning and management.

The GDE Atlas identifies the following GDE types:

- Aquatic ecosystems that rely to some degree on the surface expression of groundwater–this includes surface water ecosystems which may have a groundwater component, such as rivers, wetlands and springs. Marine and estuarine ecosystems can also be groundwater dependent, but these are not mapped in the Atlas.
- Terrestrial ecosystems that rely to some degree on the subsurface presence of groundwater–this includes all vegetation ecosystems.
- Subterranean ecosystems–this includes cave and aquifer ecosystems.

Figure 2-7 shows the mapping of potential GDEs in the BSP area and surrounds obtained from the GDE Atlas (BOM, 2023). This assessment shows 'Low Potential' for groundwater dependence for all the potential 'Terrestrial' GDEs associated with riparian vegetation and watercourses in this area (3d Environmental, 2023). The low potential for groundwater dependence is consistent with the unsaturated depth inferred on **Figure 3-12**.

Two hydrogeological cross-sections have been developed to illustrate the local site geology and observed and predicted groundwater conditions in the vicinity of the potential GDEs. The cross-section locations are shown in **Figure 3-1**. Cross section A-A' intersects the Dawson River and cross section B-B' is through the HES wetland.

Figure 3-13 presents cross-section A-A' and shows groundwater flow within the alluvial sediments associated with the local drainages of Banana Creek and the Dawson River is towards the west of the BSP. Groundwater levels are generally hydraulically disconnected with (i.e. deeper than) surface waters.

The depth of the water table is approximately 15 m below the HSE wetland (**Figure 3-12**) with negligible predicted groundwater level change at the end of the BSP mining (**Figure 3-14**). The HES wetland is considered to be a 'perched' system, i.e. separate from the regional groundwater system, with the presence of underlying clays.

Based on the available evidence (i.e. groundwater level monitoring, vegetation mapping and site survey and reconnaissance by Eco Solutions & Management [2023], Ecological Service Professionals [2023] and 3d Environmental [2023]), the wetlands are considered reliant on direct rainfall, runoff and floodwaters, which are held near the surface by the shallow clays.

Assessment of groundwater dependence by 3d Environmental (2023) confirmed the HES wetland is not a GDE.

Targeted GDE assessment has been undertaken by 3d Environmental (2023) to assess the groundwater dependence of the vegetation in the BSP area and surrounds and assess the potential impacts of the Project, including groundwater drawdown, on GDEs.

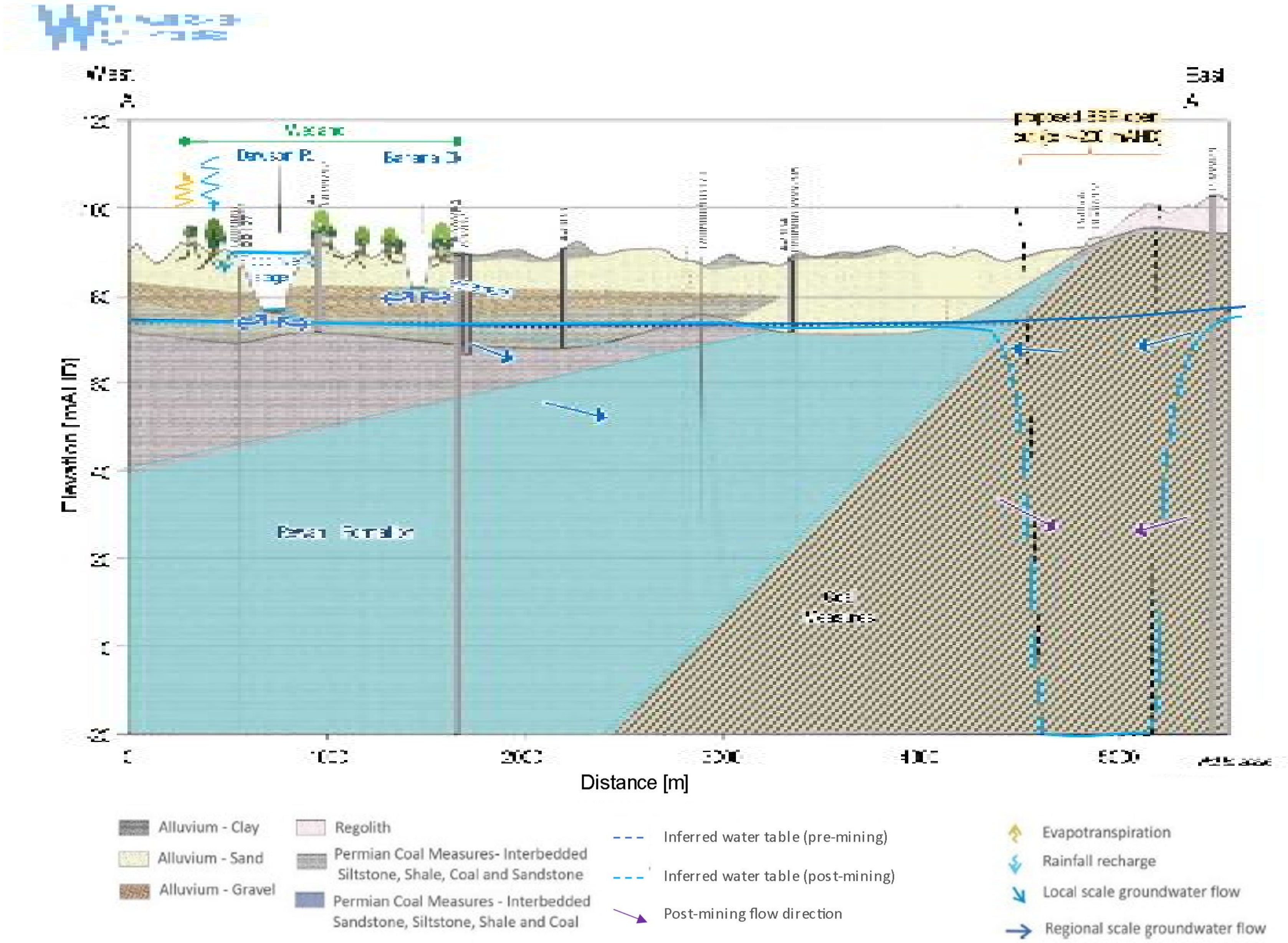


Figure 3-13 Cross-section A-A' illustrating groundwater levels and likely groundwater interaction at wetlands

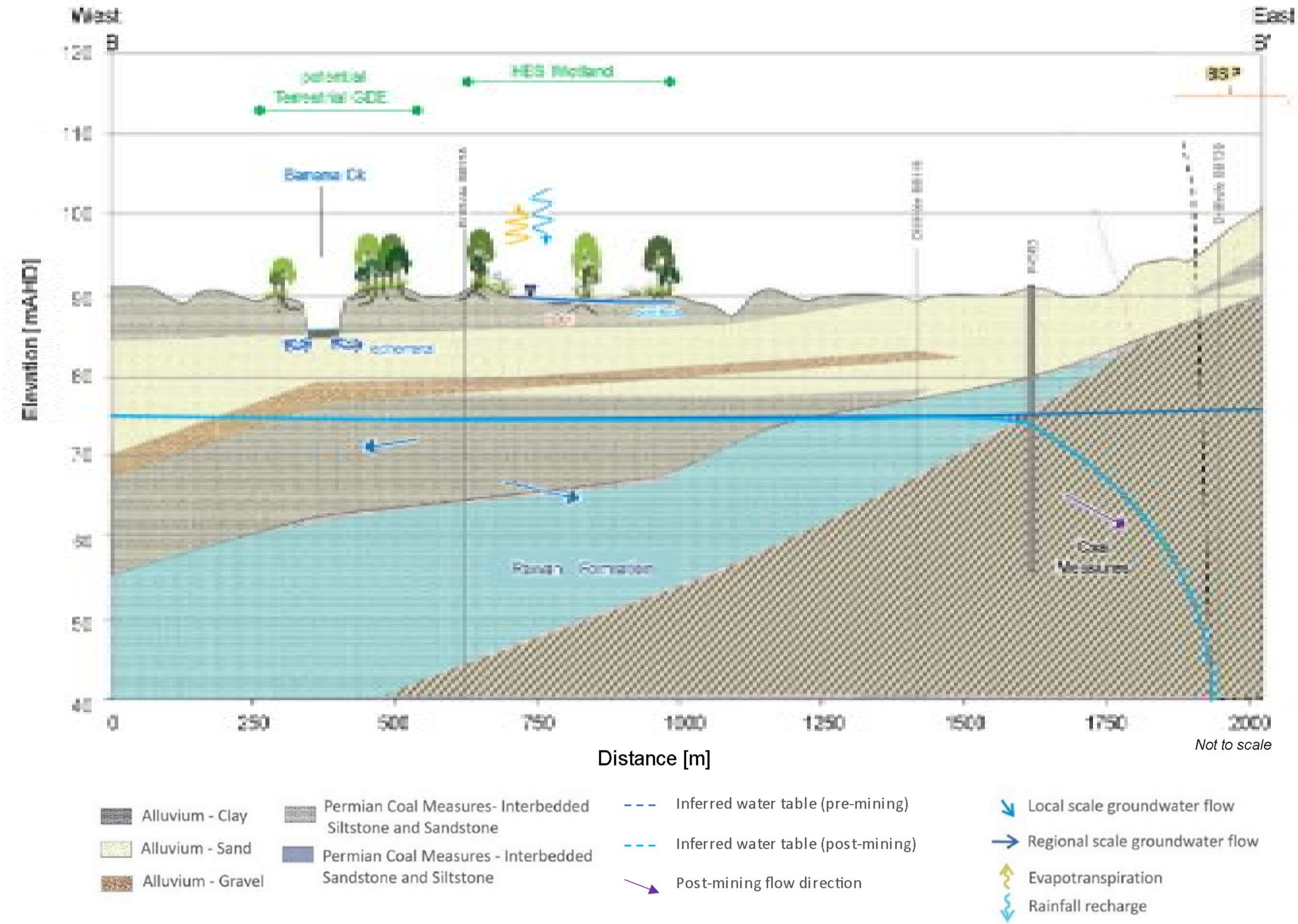


Figure 3-14 Cross-section B-B' illustrating groundwater levels and likely groundwater interaction at wetlands

3.5.3 Stygofauna

In October-December 2012, SKM conducted sampling for stygofauna from seven (7) of the alluvial groundwater monitoring bores (A-PB1, A-OB1, A-OB2, A-OB3, A-OB4, A-OB8 and A-OB10) and four (4) of the groundwater monitoring bores screened in the Permian coal measures (P-PB1, P-OB1, P-OB2 and P-OB3) at the BSP area or surrounds (**Sections 3.1.1 to 3.1.4**). Sampling was conducted in accordance with standard methods (WA EPA, 2003; 2007) and the results presented in detail in SKM (2014). A summary of the results of the stygofauna sampling program in 2012 are presented in **Table 3-11**.

Table 3-11 Stygofauna Sampling Program Results Summary (2012)

Bore ID	Geology	No. of Groundwater Fauna Recorded	
		Sample Date: October 2012	Sample Date: December 2012
A-PB1	Alluvium	1A	2B
A-OB1		Nil	1B
A-OB2		Nil	Nil
A-OB3		Nil	1B + 1C
A-OB4		1D*	Nil
A-OB8		2B	Nil
A-OB10		Nil	Nil
P-PB1	Permian coal measures	Nil	Nil
P-OB1		Nil	Nil
P-OB2		Nil	Nil
P-OB3		Nil	Nil

Source: After SKM (2014).
A – Class: Acarina; Order: Metastigmata; Family: c.f. Ixodidae; Genus/Species: Not Determined; Habitus: Edaphobite.
B – Class: Crustacea; Order: Copepoda; Family: Cyclopoidae; Genus/Species: Not Determined; Habitus: Phreatobite.
C – Class: Branchiopoda; Order: Cladocera; Family: Moinidae; Genus/Species: Moina sp.; Habitus: Stygoxene.
D – Class: Acarina; Order: Hydracarina; Family: c.f. Hygrobatidae; Genus/Species: Not Determined; Habitus: Phreatobite.*
* Stygoecologia (2017) note that this mite is likely to be a stygoxene (i.e. a surface soil species that had accidently entered the bore).

Based on the results of the 2012 stygofauna sampling program, it was concluded that stygofauna were present in the alluvium, and the absence of stygofauna detected in the Permian coal measures was consistent with other studies that have sampled similar coal seam aquifers in the Bowen Basin (ALS, 2011).

The 2012 stygofauna sampling program was augmented with four additional sampling rounds for stygofauna at the BSP area in December 2017, March 2018, June 2018 and October 2018 (Stygoecologia, 2019). Twelve bores were sampled in each survey, selected as representatives of each of the major habitats and aquifers. The sites selected were based on suitability for stygofauna: shallow monitoring piezometers of less than 100 m and they accessed groundwater situated in the unconsolidated alluvial sediments. The design of the sampling regime also considered the direction of the shallow groundwater flow (Stygoecologia, 2019).

The stygofauna community composition included one family of aquatic worms (Oligochaeta). The depauperate, sporadic and localised nature of the community across this study were assessed as having a low ecological value based on the community composition and number of taxa for the sites surveyed (Stygoecologia, 2019).

Despite several stygofauna survey campaigns, a lack of groundwater fauna was recorded at the BSP area considered to be due to a combination of factors including (Stygoecologia, 2019):

- the fine-grained nature of the substrates;
- the elevated electrical conductivity (salinity) in bores; and
- the slow hydraulic conditions of the aquifer.

3.6 Aquifer properties

Many review compilations, studies, assessments and testwork programs have been undertaken in the broader Bowen Basin (AGE, 2006; URS, 2009; BHP Billiton Mitsubishi Alliance, 2009; Parsons Brinkerhoff, 2011; Ausenco-Norwest, 2012; JBT Consulting, 2012; Matrix Plus, 2012; QWC, 2012; URS, 2012; AGE, 2013; CDM Smith, 2013; GHD, 2013a; OGIA, 2016; and DES, 2018), and specifically in the Baralaba region (SKM, 2014; HydroSimulations, 2014; SLR, 2019) to derive representative hydraulic properties of the different geological units for the purposes of numerical groundwater modelling. A summary of the previous works and relevant datasets are presented and discussed in the following sub-sections.

While the list is not necessarily exhaustive, and may not include all contemporary datasets in support, the data is presented to demonstrate the Principle of Parsimony can and should be applied for the BSP. That is, *'…the number of entities should not be increased without good reason*.'

In this section, 'permeability' is used interchangeably with 'hydraulic conductivity'. Importantly, 'permeability' refers to permeability of strata with respect to water, and not the *'intrinsic permeability'*.

3.6.1 Quaternary and Tertiary sediments

3.6.1.1 Alluvial Sediments

The hydraulic properties of alluvium are typically variable due to the heterogeneous distribution of sediments (i.e. fine clays to coarse gravels).Hydraulic testing (slug and falling head tests) of the alluvial bores at the BSP were conducted by SKM (2014), as in **Table 3-12**.

Table 3-12 Alluvium Hydraulic Conductivity Estimates (Slug and Falling Head Tests [SKM, 2014])

Bore ID	Method	Slug Test 1 (m/day)	Slug Test 2 (m/day)	Slug Test 3 (m/day)	Slug Test 4 (m/day)	Slug Test 5 (m/day)
A-PB1	Bouwer-Rice	5.7E-2	4.5E-2			
A-OB2	Bouwer-Rice	4.7E-2	1.9E-1 (early) 7.2E-2 (late)			
A-OB3	Bouwer-Rice	3.8E-2	2.4E-2			
A-OB11	Bouwer-Rice	13	7	12.5	10	12.5
A-OB12	Bouwer-Rice	7	7.5	7	7.5	8.5
Bore ID	Method	**Kh from Falling Head Test 1 (m/day)**				
A-OB3	Bouwer-Rice	1.5E-3				
A-OB4	Bouwer-Rice	1.1E-3				
A-OB8	Bouwer-Rice	3.7E-4 (early) 1.0E-4 (late)				
A-OB10	Bouwer-Rice	1.9E-3				

Source: After SKM (2014)

SKM (2014) reported an average hydraulic conductivity of 2.1 m/day, and localised readings ranging between 1E-^{4} m/day to 13 m/day, demonstrating such a natural heterogeneous distribution.

In March 2018, additional pumping tests (multi-rate step test and 24-hour constant rate test) were conducted by Australian Groundwater Services at the alluvial production bore (A-PB1) and the results reported in detail in SLR (2019) (**Appendix A**). A summary of the test results to estimate transmissivity and storativity is presented in **Table 3-13**.

Table 3-13 Alluvium Transmissivity and Storativity Estimates (24-Hour Pumping Test) [SLR, 2019]

Aquifer Type	Method	Bore ID	Aquifer Thickness (m)	Transmissivity (m^2/day)	Storativity
Unconfined	Theis (1935)	A-PB1 / A-OB2	9.3	82.2	2.2E-2
Unconfined	Theis (1935)	A-PB1 / AOB1-AOB11-A-OB12	8.4	0.26	1.06E-5

Source: After SLR (2019)

Key observations made during the 2018 constant rate pumping test included (SLR, 2019):

- possible recharge boundary effects were observed likely due to the influence of the higher Dawson River stage within 500 m of A-PB1;
- the adjacent alluvial monitoring bore (A-OB2) recorded a minor (6 cm) water level response to pumping at A-PB1, despite being only 17.5 m away; and
- other nearby bores screened in the Permian coal measures (P-PB1 and P-VWP2 [Sensor 2]) showed no visible response within the alluvium for the duration of the test, indicating limited connectivity (again, consistent with the findings in SKM [2014] discussed in **Section 3.6.3**).

Similar to the results presented in SKM (2014), the results of the 2018 pumping tests support the concept that (SLR, 2019):

> *"… the alluvium is made up of a series of sand/gravel lenses that are limited in both horizontal and vertical extent and separated from other lenses by significantly less permeable clays."*

CDM Smith (2013) presented an excellent summary of hydraulic properties used in previous studies in the Bowen Basin. A literature review of a number of other studies from the Bowen Basin and Galilee Basin was conducted by HydroSimulations (2014) to add to the CDM Smith (2013) summary and is presented in **Table 3-14**.

Table 3-14 Literature Review – Hydraulic Properties for Alluvium

Formation	Age	Conceptual Type	kH [m/d]	kV [m/d]	Sy	Ss [m-1]	Source
Alluvium	Quaternary / Tertiary	Aquifer	1 – 40	-	0.05-0.18	0.0005	Ausenco-Norwest (2012)
			100	10	0.25	0.001	AGE (2006)
			0.7-1.5	-	-	-	JBT (2012)
			10	1	0.2	0.0001	Matrix Plus (2012)
			0.088-0.38	-	-	-	URS (2009)
			10	1	0.1	1.0E-05	CDM Smith (2013)

Source: After Table 9-5 in CDM Smith (2013)

Review of estimates in literature of hydraulic conductivity for medium sand and Condamine Alluvium is also reported in the draft Regional Groundwater Chemistry Zones: Fitzroy-Capricorn-Curtis Coast and Burdekin-Haughton-Don Regions Summary and Results (DES, December 2018) as follows:

- 0.1 m/day to 45 m/day – Medium sand (Domenico & Schwartz, 1990); and
- 3 m/day to 30 m/day – Condamine Alluvium (Dafney & Silburn, 2013).

For the purposes of comparison, the model calibrated hydraulic properties for alluvium used for the BNCOP Groundwater Assessment (HydroSimulations, 2014) were as follows:

- kH = 8.61E-1 m/d;
- kV = 2.32E-2 m/d;
- Sy = 0.1;
- Ss = 1.0E-3 m^{-1}.

These parameters are in good agreement with the available field data, literature review and expectations of previous conceptual and calibrated models.

3.6.1.2 Tertiary-Quaternary Colluvium

Colluvium is material which typically accumulates at the foot of slopes (as a result of gravity), as opposed to alluvial sediments which are transported by water (i.e. fluvial processes).

As indicated on **Figure 2-9**, a broad expanse of shallow Tertiary-Quaternary colluvium exists across the Baralaba region. Most of the shallow bores drilled at the BNM area in the colluvium were dry, however closer to surface water sources, a perched water table was evident. Similarly, the mapped shallow colluvium at the BSP area is considered to be largely unsaturated, with the regional groundwater table at depths of generally 12-15 mbg (**Section 3.4.1**). The hydraulic properties of colluvium can typically be expected to be in the range of alluvial sediments and other weathered units / regolith at the surface (discussed further below for the different strata).

For the purposes of comparison, the model calibrated hydraulic properties for colluvium used for the BNCOP Groundwater Assessment (HydroSimulations, 2014) were as follows:

- k_H = 5.0 m/d;
- k_V = 1.0E-^{2} m/d;
- S_y = 0.1;
- S_s = 1.0E-^{3} m^{-1}.

3.6.1.3 Tertiary Duaringa Formation

The Tertiary Duaringa Formation is not mapped in the vicinity of the BSP. However, areas exist to the north-east of the BNM area within the broader Study Area (**Figure 2-9**). Hydraulic properties for the Tertiary Duaringa Formation based on available literature are presented in **Table 3-15**.

Table 3-15 Literature Review – Hydraulic Properties for Tertiary Duaringa Formation

Formation	Age	Conceptual Type	k_H [m/d]	k_V [m/d]	S_y	S_s [m^{-1}]	Source
Duaringa Formation	Tertiary	Aquifer	6.00E-01	1.80E-02	-	-	AGE (2013)

Source: After Table 9-5 in CDM Smith (2013)

For the purposes of comparison, the model calibrated hydraulic properties for the Tertiary Duaringa Formation used for the BNCOP Groundwater Assessment (HydroSimulations, 2014) were as follows:

- k_H = 1.7E-^{2} m/d;
- k_V = 3.0E-^{3} m/d;
- S_y = 0.02;
- S_s = 5.0E-^{6} m^{-1}.

3.6.1.4 Hydraulic Parameters – Unconsolidated Sediments Specific Storage

Rau et al. (2018) document a method to demonstrate that, despite the potential derivation of higher values using hydraulic testing, a physical upper limit of 1.3E-^{5} m^{-1} should be applied for unconsolidated material in numerical groundwater models. However, an update to that (Chowdhury *et al*, 2022) indicates that the range in specific storage applied to groundwater models could be slightly higher, at approximately 1E-05 to 1E-4.

Regardless, the unconsolidated sediments are likely to be unconfined and therefore specific yield, rather than specific storage, is relevant in a modelling context. Relevant comparisons for the BSP numerical groundwater model are discussed in **Section 6.14**.

3.6.2 Triassic age rocks

3.6.2.1 Rewan Formation

The Triassic-aged Rewan Formation is widely known for its relatively low permeability, and aquitard properties. Hydraulic properties for the Triassic Rewan Formation based on available literature are presented in **Table 3-16**.

Table 3-16 Literature Review – Hydraulic Properties for Triassic Age strata

Formation	Age	Conceptual Type	kH [m/d]	kV [m/d]	Sy	Ss [m-1]	Source
Rewan Formation	Triassic	Aquitard	1.0E-^{5} - 1.0E-^{4}	1.0E-^{6} -1.0E-^{4}	0.005	1.0E-^{6}	AGE (2006)
			7.5E-^{4}	1.0E-^{7}	0.05	5.0E-^{5}	Ausenco-Norwest (2012)
			1.0E-^{1}	-	0.05	5.0E-^{6}	BHP Billiton Mitsubishi Alliance (2009)
			1.0E-^{4}	1.0E-^{5}	0.01	1.0E-^{5}	CDM Smith (2013)
			3.6E-^{4}	7.4E-^{6}	-	-	GHD (2013a)
			9.0E-^{4}	5.4E-^{5}	-	-	AGE (2013)
			8.6E-^{6} to 1.86	-	-	-	QWC (2012)
Clematis Sandstone	Triassic	Aquifer	6.0E-^{1}	1.8E-^{2}	0.005	1.0E-^{6}	AGE (2013)
			1.6E-^{4} to 42	-	-	-	OGIA (2016)

Source: After Table 9-5 in CDM Smith (2013)

During a 72-hour constant rate pumping test at the BSP area (SKM, 2014), groundwater was extracted from a bore screened within the underlying Blackwater Group (Baralaba Coal Measures), however, negligible drawdown or leakage was induced from the Rewan Formation at that location throughout the duration of the pumping and recovery test. Thus, the local hydraulic datasets support the conclusion that the Rewan Formation can therefore be considered an aquitard.

For the purposes of comparison, the model calibrated hydraulic properties for the Rewan Formation (and weathered units / regolith at the surface) used for the BNCOP Groundwater Assessment (HydroSimulations, 2014) were as follows:

- k_H = 5.08E-^{5} m/d / 1.02E-^{1} m/d (weathered / regolith);
- k_V = 2.03E-^{6} m/d / 1.45E-^{3} m/d (weathered / regolith);
- S_y = 0.01;
- S_s = 8.0E-^{7} m^{-1}.

3.6.2.2 Clematis Sandstone

Hydraulic properties for the Triassic Clematis Sandstone based on available literature are also presented in **Table 3-16**.

For the purposes of comparison, the model calibrated hydraulic properties for the Clematis Sandstone used for the BNCOP Groundwater Assessment (HydroSimulations, 2014) were as follows:

- k_H = 1.7E-^{2} m/d;
- k_V = 3.0E-^{3} m/d;
- S_y = 0.02;
- S_s = 5.0E-^{6} m^{-1}.

3.6.3 Permian Coal Measures

3.6.3.1 Baralaba Coal Measures – Interburden

As described in **Section 3.1.2**, two standpipe **Section 3.1.2** groundwater monitoring bores at the BSP area (P-PB1 and P-OB3) have been constructed in the interburden of the Baralaba Coal Measures. Thirteen (13) of the 18 VWPs sensors installed at the BSP area are also located in the interburden sequences of the Baralaba Coal Measures (i.e. sandstones, siltstones, etc.) (**Section 3.1.6**).

In 2014, a 72-hour constant rate pumping test (followed by 72-hour recovery) was conducted at P-PB1 to estimate the local aquifer transmissivity and storativity properties and reported in SKM (2014). A summary of the test results is presented in **Table 3-17**.

Key observations made during the 2014 constant rate pumping test included (SKM, 2014):

- similar types and magnitudes of pressure response to pumping at P-PB1 in the VWP sensors located in the Baralaba Coal Measures, confirming the pumping induced vertical flow within the Permian coal measures during the test;
- negligible vertical leakage (and very low / negligible aquitard K_v values) through the aquitard units during the test;
- limited connectivity of the pumped Permian coal measures to the Dawson River (based on no recharge boundary effects being observed despite being within 500 m of the Dawson River);
- the adjacent shallow alluvial monitoring bores did not show any response to pumping in the Permian coal measures *(NB: the depth of the pumping bore screens are 118 m below the depth of the base of alluvium)*; and
- the VWP sensor in the Rewan Formation (P-VWP2 [Sensor 1]) was not influenced over the period of pumping (72-hours) and subsequent recovery (72-hours).

Table 3-17 Baralaba Coal Measures – Interburden hydraulic properties (72-Hour Pumping Test)

Aquifer Type	Method	Bore ID	Transmissivity (m^2/day)	Storativity	Aquitard Kv (m/day)	Horizontal Hydraulic Conductivity (m/day)
Confined	Cooper-Jacob	P-PB1	7.1			
Confined	Theis Recovery	P-PB1	4.9			
Confined	Theis Recovery	P- VWP2 [Sensor 3]	5.9			
Confined	Theis	P- VWP2 [Sensor 3]	3.0	4.7E-^{3}		
Confined	Papadopulous-Cooper	P- VWP2 [Sensor 3]	3.3	4.7E-^{3}		
Leaky	Hantush with Aquitard Storage	P- VWP2 [Sensor 3]	3.0	4.7E-^{3}	1E-10	
Leaky	Hantush without Aquitard Storage	P- VWP2 [Sensor 3]	3.0	4.7E-^{3}	Negligible	
Geometric Mean			4.0	4.7E-^{3}		
Horizontal Hydraulic Conductivity, K (m/day) [Calculated] *						1.2E-^{1}

Source: After SKM (2014)
* Assuming aquifer thickness of 33 m based on cuttings log and bore screened interval.

A series of slug tests were also conducted in 2014 at the two standpipe groundwater monitoring bores at the BSP area (P-PB1 and P-OB3) to provide estimates of local hydraulic conductivity in the interburden of the Baralaba Coal Measures with the results presented in **Table 3-18**.

Table 3-18 Baralaba Coal Measures – Interburden Hydraulic Conductivity estimates (Slug Tests)

Bore ID	Method	Slug Test 1 (m/day)	Slug Test 2 (m/day)	Slug Test 3 (m/day)	Slug Test 4 (m/day)
P-PB1^	Bouwer-Rice	1.8 (early) 2.6E-2 (Late)	2.2	1.9	3.2
P-OB3	Bouwer-Rice	4.2E-2	3.3E-3	3.8E-2 (early) 2.5E-4 (late)	1.6E-2

Source: After SKM (2014)
^ NB: Reported in SKM (2014) as 'Alluvium' material tested.

In 2014, GES also conducted laboratory permeability testwork on interburden core samples from the Baralaba Coal Measures at the BNM. A summary of that data is duplicated in **Table 3-19** and **Table 3-20**, with an additional line for the overall arithmetic and harmonic mean of all horizontal and vertical test results.

All core samples were taken from the interburden sequences and the results indicating that there is limited matrix permeability in the interburden of the Baralaba Coal Measures, both in the horizontal and vertical directions (HydroSimulations, 2014).

Table 3-19 Baralaba Coal Measures – Interburden Horizontal Permeability (laboratory core tests)

Horizontal Hydraulic Conductivity, Kh [m/d]					
Formation	**No. of Samples**	**Max**	**Min**	**Arithmetic Mean**	**Geometric Mean**
Cameron – Reid Interburden	6	1.5E-4	5.0E-8	3.3E-5	3.3E-6
Dawson – Dunstan Interburden	1	5.0E-8	5.0E-8	5.0E-8	5.0E-8
Dunstan – Wright Interburden	3	3.9E-5	2.0E-6	1.6E-5	8.4E-6

Wright – Coolum Interburden	12	3.6E-5	1.5E-7	6.2E-6	9.5E-7
Coolum – Sub Dirty	2	1.1E-6	5.0E-8	5.6E-7	2.3E-7
All Samples	24	1.5E-4	5.0E-8	1.3E-5	1.4E-6

C:\HydroSim\BAR002\Tech\Permeability\Baralaba Core Data_GEScoredata.xlsx

Table 3-20 Baralaba Coal Measures – Interburden Vertical Permeability (laboratory core tests)

Vertical Hydraulic Conductivity, Kv [m/d]					
Sequence within the Baralaba Coal Measures	**No. of Samples**	**Max**	**Min**	**Arithmetic Mean**	**Harmonic Mean**
Cameron – Reid Interburden	8	5.5E-5	3.0E-7	1.4E-5	1.4E-6
Reid – Doubtful Interburden	1	1.4E-6	1.4E-6	1.4E-6	1.4E-6
Doubtful – Dawson Interburden	1	2.4E-7	2.4E-7	2.4E-7	2.4E-7
Dawson – Dunstan Interburden	2	1.5E-5	1.5E-7	7.6E-6	3.0E-7
Dunstan – Wright Interburden	4	2.9E-5	5.0E-8	8.6E-6	1.6E-7
Wright – Coolum Interburden	12	4.4E-5	1.5E-7	6.0E-6	3.9E-7
Coolum – Sub Dirty	3	1.4E-6	6.8E-8	6.96E-7	1.8E-7
All Samples	31	5.5E-5	5.0E-8	7.6E-6	3.5E-7

Hydraulic properties for the interburden of the Baralaba Coal Measures based on available literature are presented in **Table 3-21**.

Table 3-21 Literature Review – Hydraulic Properties for Permian strata

Formation	Age	Conceptual Type	k_H [m/d]	k_V [m/d]	S_y	S_s [m^{-1}]	Source
Rangal Coal Measures or Equivalent (Baralaba Coal Measures)	Permian – Interburden	Aquitard	1.0E-4	7E-8	0.05	1.0E-5	Ausenco-Norwest (2012)
			1.0E-1	-	0.05	5.0E-6	BHP Billiton Mits. Alliance (2009)
			1.0E-3	1.0E-5	0.01	1.0E-5	CDM Smith (2013)
	Permian – Coal Seams	Aquifer (Minor)	2.8E-3 to 4.7E-1	-	-	-	Parsons Brinckerhoff (2011)
			1.0E-6 – 1.0	1.0E-6 to 1.0	0.01	1.0E-6	AGE (2006)
			4.1E-5 – 1.6E-1	8.3E-6 to 8.2E-2	0.01	2.0E-7	Ausenco-Norwest (2012)
			0.111-0.9	-	0.08	4.0E-4	Matrix Plus (2012)
			5.0	-	0.05	5.0E-6	BHP Billiton Mits. Alliance (2009
			5.0E-2	5.0E-3	0.01	1.0E-5	CDM Smith (2013)
			9.0E-4	1.8E-5	-	-	AGE (2013)
Back Creek Group	Permian	Aquitard	0.01-001	1.0E-3 to 1.0E-5	0.03-0.18	5.0E-4 to 5.0E-6	URS (2012)

			1.0E-3	1.0E-5	0.01	1.0E-5	CDM Smith (2013)

Source: After Table 9-5 in CDM Smith (2013)

For the purposes of comparison, the model calibrated hydraulic properties for the interburden of the Baralaba Coal Measures (and weathered units / regolith where at the subcrop) used for the BNCOP Groundwater Assessment (HydroSimulations, 2014) were as follows:

- k_H = 2.99E-^{2} m/d to 5.44 x10-^{5} m/d / 2.00 m/d (weathered units / regolith);
- k_V = 1.60E-^{3} m/d to 1.10E-^{4} m/d / 2.00 m/d (weathered units / regolith);
- S_y = 0.008 / 0.05 (weathered units / regolith);
- S_s = 3E-^{7} m^{-1} / 5E-^{4} m^{-1} (weathered units / regolith).

3.6.3.2 Baralaba Coal Measures – Coal Seams

In addition to the hydraulic testing (constant rate test and slug testing) of the bores screened in the interburden of the Baralaba Coal Measures, a series of slug and falling head tests were also completed on bores in the coal seams (P-OB1, P-OB4 and P-OB5) by SKM in 2014. The results for each test bore are presented in **Table 3-22**.

The estimates for coal seam hydraulic conductivity are within the estimates presented in coal seams elsewhere (e.g. upper Hunter Valley in NSW) by Mackie (2009) (i.e. 1.6E-^{5} to 5.3 m/day, with a mean value of 9.1E-^{2} m/day). It is noted that the hydraulic properties of the coal measures can be influenced locally by weathering (e.g. at the subcrop) and as is typically observed in coal seams, the secondary porosity (cleats), however the results demonstrated strong consistency from the repeated tests.

Table 3-22 Baralaba Coal Measures – Coal Hydraulic Conductivity estimates (Slug / Falling Head)

Bore ID	Method	Slug Test 1 (m/day)	Slug Test 2 (m/day)	Slug Test 3 (m/day)	Slug Test 4 (m/day)	Slug Test 5 (m/day)	Slug Test 6 (m/day)
P-OB1^	Bouwer-Rice	5.5E-^{3}	3.3E-^{1}	4.8E-^{1}	9.5E-^{3}	3.43E-^{1}	5E-^{1} (early) 1.2E-^{2} (Late)
Bore ID	**Method**	**Falling Head Test 1 (m/day)**		**Falling Head Test 2 (m/day)**		**Falling Head Test 3 (m/day)**	
P-OB4	Bouwer-Rice	1.7E-^{1}		1.8E-^{1}		1.8E-^{1}	
P-OB5	Bouwer-Rice	2.5E-^{3}		2.7E-^{3}		2.5E-^{3}	

Source: After SKM (2014)
^ NB: Reported in SKM (2014) as 'Interburden' material tested.

Hydraulic properties for the coal seams of the Baralaba Coal Measures based on available literature are also presented in **Table 3-21**.

For the purposes of comparison, the model calibrated hydraulic properties for the coal seams of the Baralaba Coal Measures used for the BNCOP Groundwater Assessment (HydroSimulations, 2014) were as follows:

- k_H = 1.00E-^{1} m/d to 4.66E-^{3} m/d;
- k_V = 1.48E-^{2} m/d to 9.96E-^{4} m/d;
- S_y = 0.01;
- S_s = 6.5E-^{7} m^{-1}.

3.6.3.3 Basal Sub-unit Kaloola Member and Gyranda Formation

Four sensors in P-VWP4 are located in the Gyranda Formation at the BSP area.

For the purposes of comparison, the model calibrated hydraulic properties for the Gyranda Formation – Basement (and weathered units / regolith [as well as the underlying Back Creek Group]) used for the BNCOP Groundwater Assessment (HydroSimulations, 2014) were as follows:

- k_H = 1.00E-^{4} m/d / 2.80E-^{2} m/d (weathered / regolith).
- k_V = 1.0E-^{5} m/d / 2.80E-^{4} m/d (weathered / regolith).
- S_y = 0.008.
- S_s = 1.0E-^{6} m^{-1}.

3.6.3.4 Other Regional Hydraulic Testwork – Permian Coal Measures

Coffey (2014) compiled packer testing data from many mines in the northern Bowen Basin, and found that, although there is a degree of variability in the dataset due to irregular fracturing, there is a general trend of reducing hydraulic conductivity with depth (**Figure 3-15**). This is likely due to increasing overburden pressure resulting in a reduction in fracture aperture. Hydraulic conductivity of the coal seams is typically about three times higher than the interburden.

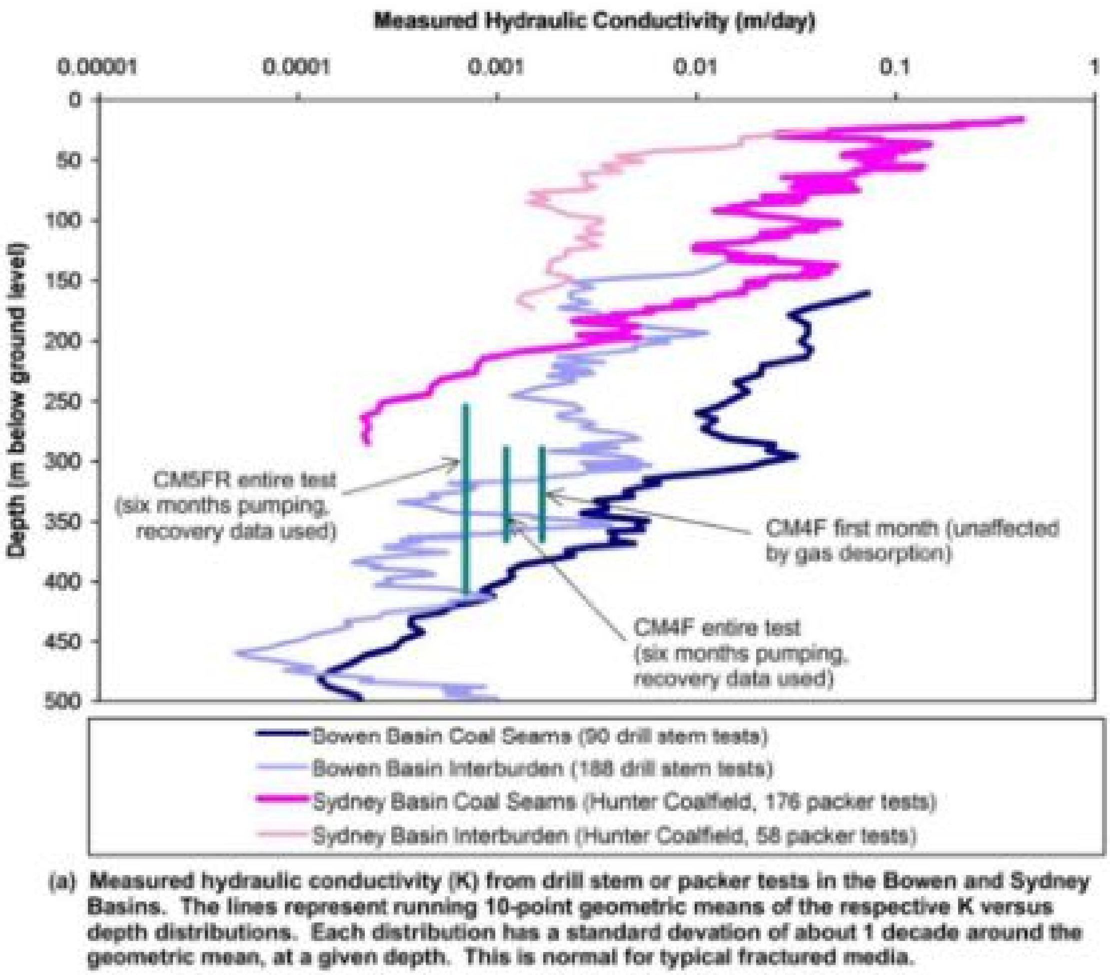
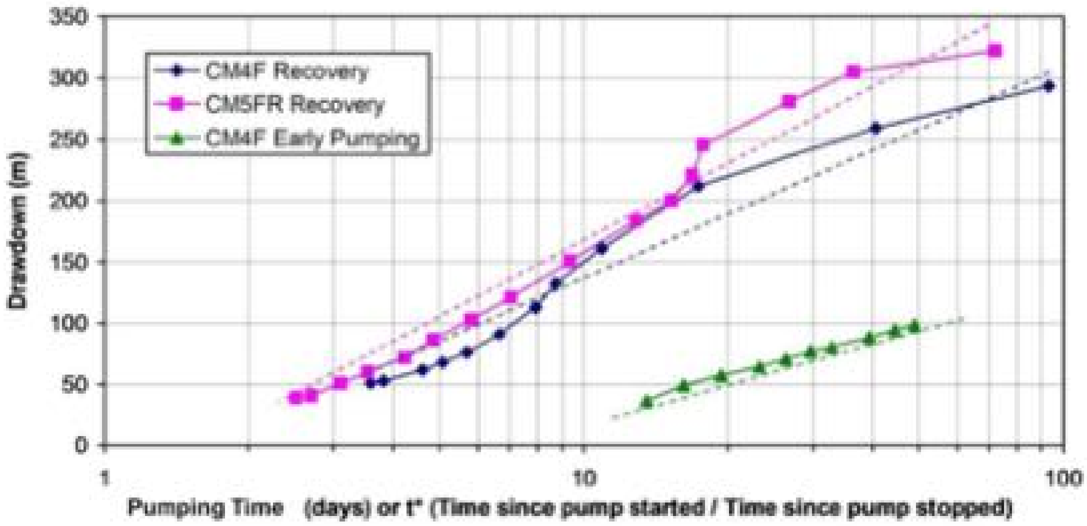


Figure 3-15 Summary of Packer Test Results for Bowen and Sydney Basins [Source: Coffey, 2014]



Well and Pumping Phase	CM004F Recovery	CM005FR Recovery	CM004F Early Pumping
Drawdown Rate (m/decade)	150	210	100
Pumping Rate (L/day)	11000	11000	11200
Transmissivity (m2/day)	0.0134	0.0096	0.0205
Hydraulic Conductivity (m/day)	1.11E-03	6.98E-04	1.69E-03

Figure 3-16 Summary of Pumping Test Results for Coal Seam Gas Wells in Baralaba Region
[Source: Coffey, 2014]

Arrow (2013) carried out long-term pumping tests on two hydraulically fractured wells (CM4F and CM5FR) followed by numerical simulation of the host media, to assess the economic potential of coal seams for gas production in the Baralaba region. Coffey (2014) analysed the drawdown measurements from these tests to interpret the transmissivity of the host media (**Figure 3-16**).

3.6.4 Faulting and groundwater behaviour

As discussed in **Sections 2.4.1.3 and 2.4.4**, local faulting has been mapped within and near MLA 700057. As identified by Jourde *et al*. (2002), faulting can result in higher permeabilities within strata parallel with the fault plane, and lower permeabilities within strata perpendicular to the fault plane. However, this can also be dependent on whether faults are currently active (Paul *et al*. 2009). Relevantly, faulting has been inactive within the Bowen Basin for over 140 million years (Clark *et al*. 2011), indicating that the fault zones are less likely to act as conduits to flow.

The behaviour of faults elsewhere in the Bowen Basin was assessed by Kinnon (2010) as part of the Bowen Gas Project. Stable isotope and water quality analysis was used to assess zones of potential recharge, water mixing and flow pathways across a series of faults. The results of the Kinnon (2010) study showed that compartmentalisation was evident and that this was due to the structural geology (faulting) in the basin.

The mapping of faults does not indicate the potential for causal pathways counter to those conceptualised based on the strike and outcrop of the coal seams. For the purposes of this assessment and conservatism, faulting is not assumed to be a barrier to groundwater flow around BSP.

3.7 Groundwater recharge

Groundwater recharge in the Baralaba area could occur as a result of three key processes (KCB, 2023):

- Recharge occurs via leakage from surface water features including rivers, and potentially from unconsolidated sediments such as alluvium.
- Infiltration along preferential pathways such as faults, joints, bedding planes, and higher permeability horizons or zones within individual formations. This mechanism is considered the dominant recharge process in the GAB.
- Diffuse infiltration of rainfall that falls directly on outcropping hydrostratigraphic units. This is expected to occur within all outcrop areas and therefore this process applies to the largest spatial extent.

KCB reported that estimates of long-term average recharge rates were made by OGIA as part of the 2016 UWIR (OGIA 2019b) using chloride mass balance (CMB) recharge estimation method. For the units outcropping within the vicinity of the BSP area, the following recharge rates were estimated by OGIA. These are tabulated below, along with recharge rates applied to the BNCOP groundwater model (HydroSimulations, 2014).

Table 3-23 Literature review of groundwater recharge rates

Unit	Source	Method	Recharge [mm/yr]	Recharge as % average rainfall
Alluvium	OGIA, 2019b	CMB	6.8	1%
	HydroSimulations, 2014	Model	2.9	0.4%
Colluvium	HydroSimulations, 2014	Model	1.1	0.2%
Moolayember Fm	OGIA, 2019b	CMB	2.5	0.4%
Clematis Group	OGIA, 2019b	CMB	26.9	3.5%
	HydroSimulations, 2014	Model	2.9	0.4%
Rewan Group	OGIA, 2019b	CMB	1.2	0.2%
Rewan (weathered)	HydroSimulations, 2014	Model	1.1	0.2%
Baralaba Coal Measures (weathered Permian)	OGIA, 2019b	CMB	5.0	1%
	HydroSimulations, 2014	Model	1.1	0.2%
Older Permian units	OGIA, 2019b	CMB	6.8	1.2%
Older Permian units (weathered Permian)	HydroSimulations, 2014	Model	1.1	0.2%

Recharge into the alluvium associated with the Dawson River is anticipated to occur during high flow periods, following significant rainfall events, although insufficient data is available to quantify the recharge. Recharge from the alluvium into the units underlying may also occur.

4 Groundwater quality

This section summarises the regulatory context for water quality and environmental values for the area that the BSP is located in, then presents baseline groundwater quality data from the BSP and surrounds, followed by an assessment of the values for the BSP site.

4.1 Environmental Values and Water Quality Objectives

Environmental values (EVs) and water quality objectives (WQOs) for Qld waters are prescribed in Schedule 1 of the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP [Water and Wetland Biodiversity]). WQOs are long-term goals for water quality management that protect environmental values. WQOs under the EPP (Water and Wetland Biodiversity) are typically based on national water quality guidelines.

The Dawson River is part of basin 130 and includes all waters of the Dawson River Sub-basin, except the Callide Creek Catchment. The environmental values for surface waters and groundwaters specific to MLA 700057 are shown on:

- **Figure 4-1**: Lower Dawson River Sub-basin – WQ1309; and
- **Figure 4-2**: Fitzroy Basin Groundwater Zones / Lower Dawson Groundwaters – WQ1310).

The BSP lies within Zone 34 of the Dawson River sub-basin (also referred to as Lower Dawson Main Channel – regulated reaches), for which Water Quality Objectives (WQOs) have been set (DEHP, 2011). This zone is described as **"Saline: [high] Na, Cl"** on the map[10] accompanying DEHP (2011) (**Figure 4-2**).

[10] https://www.ehp.qld.gov.au/water/policy/pdf/plans/fitzroy_groundwater_plan_300811.pdf

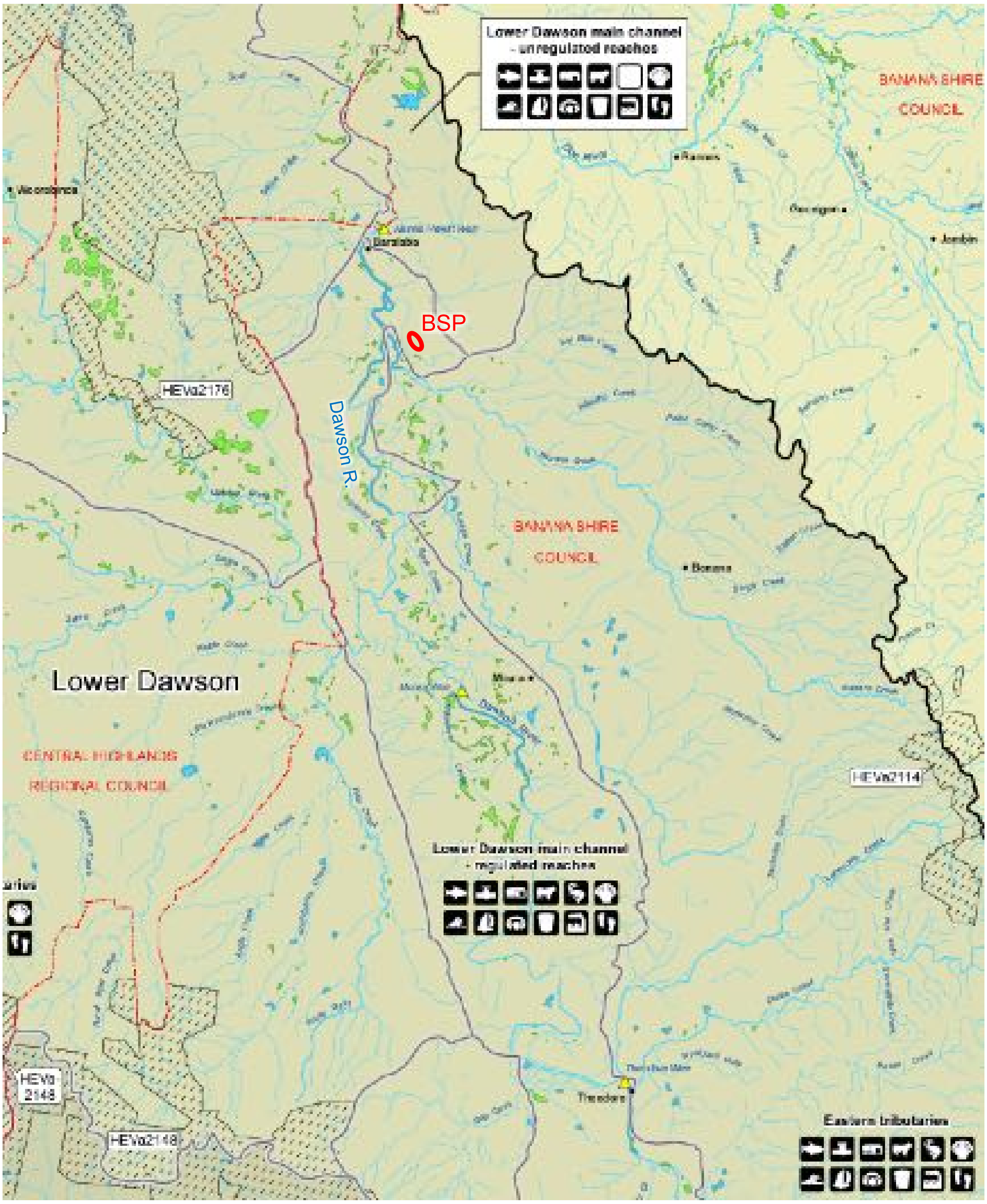


Figure 4-1 Environmental Values – Lower Dawson River Sub-basin – WQ1309

(source: https://environment.des.qld.gov.au/__data/assets/pdf_file/0022/88105/lower_dawson_plan_300811.pdf)

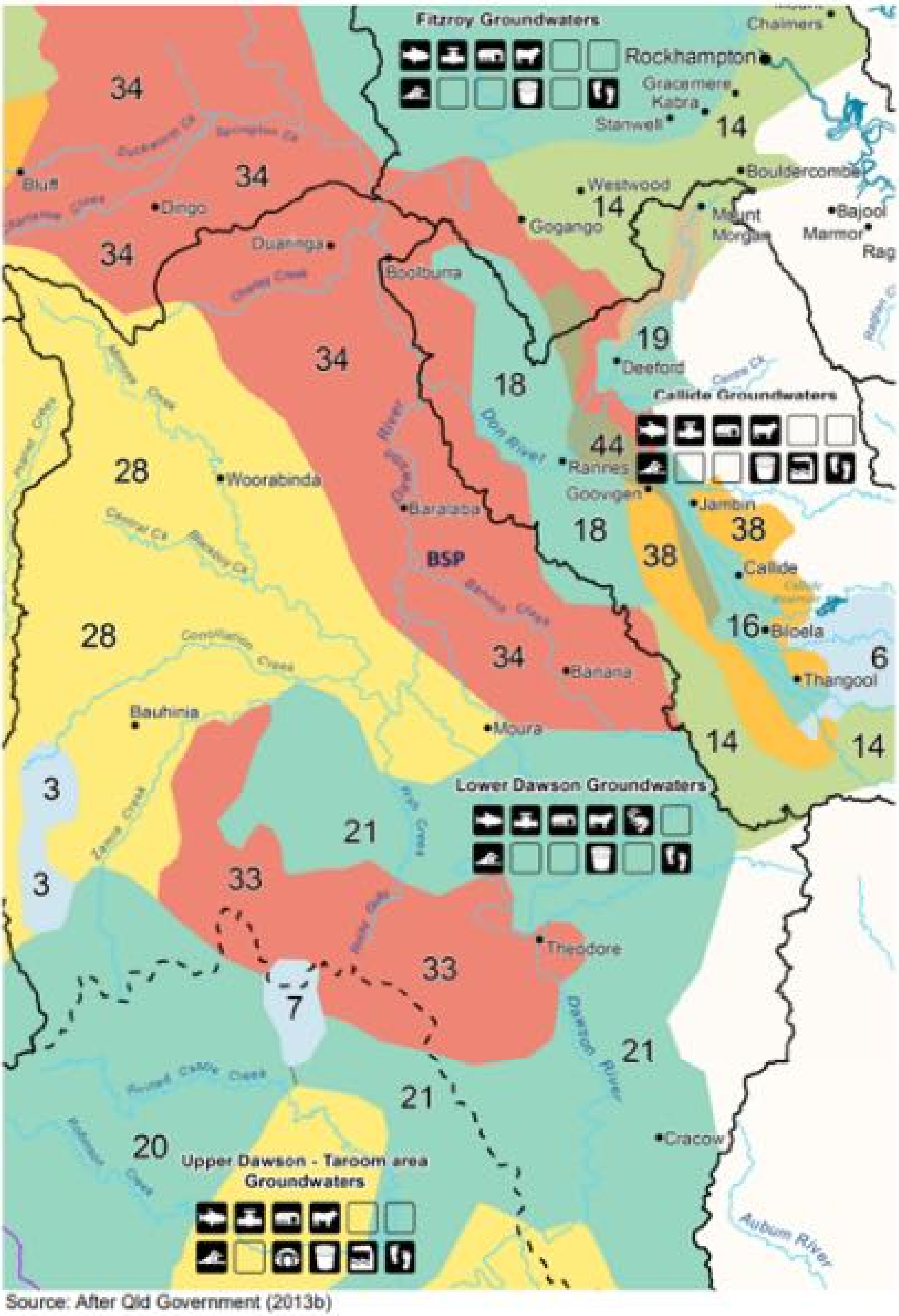


Figure 4-2 Environmental Values – Fitzroy Basin Groundwater Zones – WQ1310

4.2 Groundwater quality at Baralaba

The WQOs outlined above are specified for 'Shallow' and 'Deep' groundwater systems, which are defined for groundwaters at depths of <30 m and >30 m respectively. For the following sub-sections, it is assumed that this can be read as 'shallow' = alluvium and colluvium, 'deep' = Permo-Triassic strata.

A groundwater quality sampling program was first undertaken at the BSP area in July-August and December 2012 (SKM, 2014). A summary of the physico-chemical parameters and major ion hydrochemistry data recorded in the alluvium in 2012 is presented in **Table 4-1**.

Table 4-1 Physico-chemical Parameters and Major Ion Hydrochemistry (2012) – Alluvium

Bore ID	pH	EC (µS/cm)	TDS (mg/L)	Major Ions (mg/L)						
				Na	Mg	Ca	K	Cl	SO_4	HCO_3 [$CaCO_3$]
A-PB1	6.7	484	333	79	6	12	3	84	11.5	97.5
A-OB1	7.3	570.5	407	45	17.5	40	3.5	35	11	199
A-OB2	6.8	836	488	115	13	21	4.5	152	6.5	146
A-OB3	7.3	696	401	101	5	8.5	2	54	25	171
A-OB4	6.7	21,039	18,100	2,850	845	925	29	7,720	731	301
A-OB8+	7.3	4,400	2,310	835	42	45	11	1,000	328	-
A-OB10	6.6	28,558	1,895	2,640	1,245	1,895	29	10,035	855	294
A-OB11	7.1	664	452	64	27	42	5	4	119	242
A-OB12	7.5	421	421	54	24	43	6	89	5	212

Source: After SKM (2014)
No results are presented for A-PB2 and A-OB6 as bores were dry.
+ Results generally consistent with findings presented in **Table 5-1** (recorded as effectively dry in the sandy gravel portion of the bore, total drill depth is logged in the interburden of Baralaba Coal Measures).
~ Laboratory result not verified.

Table 4-2 summarises the sampling in Permian coal measures (i.e. Baralaba Coal Measures [interburden/coal] and Gyranda Formation).

Table 4-2 Physico-chemical Parameters and Major Ion Hydrochemistry (2012) –Coal Measures

Bore ID	pH	EC (µS/cm)	TDS (mg/L)	Major Ions (mg/L)						
				Na	Mg	Ca	K	Cl	SO_4	HCO_3 [$CaCO_3$]
Baralaba Coal Measures [Interburden]										
P-PB1	7.4	15,641	12,990	2,430	20.5	832.5	3	5,365	<1	37
P-OB3	6.5	31,765	28,350	3,910	1,115	1,475	29.5	10,550	1,205	270
Baralaba Coal Measures [Coal Seams]										
P-OB1	6.4	27,339	22,200	3,225	1,090	1,245	30	9,075	1,560	375

P-OB4	6.6	35,432	35,800	3,880	1,270	1,700	1,270	10,600	1,520	210
P-OB5	8.3	11,200	16,700	3,650	307	266	307	6,800	568	78
Gyranda Formation										
P-OB2	6.8	17,398	12,500	2,900	267.5	378	17	5,750	165	553

Source: After SKM (2014)

The results of these sampling rounds, as well as that conducted in 2017-23 are discussed in the following sub-sections, noting that tables in the main report typically include a (representative) selection of data, while a summary of the full historic dataset is presented in **Appendix C**.

Alluvial groundwater samples range from fresh (nearer Dawson River, e.g. bores A-OB3, A-OB11) to brackish at distance from the river and nearer the proposed BSP open cut (e.g. bores A-OB4, AOB-10 – see chart in **Appendix C**). The elevated salinity (EC-TDS) measurements at A-OB4 and A-OB10 (associated with the local drainage line within MLA 700057 and located at further distance from the Dawson River and Banana Creek than the other alluvium bores) are consistent with the conceptualisation of lesser rainfall/river recharge (i.e. negligible influence of the Neville Hewitt Weir within MLA 700057) and likely to be reflective of the underlying Permian coal measures and evapo-concentration effects of salts (i.e. elevated Na:Cl), and similarly for A-OB8.

The Permian coal measure groundwater samples indicate a more brackish (saline) water quality.

4.2.1 Shallow groundwater system – Quaternary sediments

To augment the 2012 groundwater quality datasets (**Section 4; Table 4-1**), a targeted baseline groundwater quality sampling program of alluvium bores at the BSP area was conducted by SLR in 2017-2018 and is presented in full in **Appendix A**. Field water quality parameters were collected quarterly and samples submitted to a NATA accredited laboratory for further analysis.

Groundwater quality samples have continued to be collected by 4T Consultants for Baralaba South Pty Ltd. For convenience in reporting, a representative selection of the field groundwater quality results for pH, EC and TDS in the alluvium bores are presented in **Table 4-3** (see full summary in **Appendix C**).

Consistent with the findings of the 2012 baseline groundwater quality sampling program (SKM, 2014), the field data shows that alluvium groundwater quality varies depending on the influence / proximity to the Dawson River, with those nearest (A-PB1, A-OB1, A-OB2, A-OB11 and A-OB12) with fresher water quality. This is also consistent with the water quality signatures based on the isotope analysis conducted at the BSP in 2012 (**Section 4.2.4**).

Table 4-3 2017-2020 Groundwater Quality Sampling Program – Alluvium [pH, EC and TDS]

Bore ID	pH									EC (µS/cm)									TDS (mg/L)							
	Dec 17	Mar 18	Jun 18	Oct 18	Feb 19	May 19	Aug 19	Nov 19	Mar 20	Dec 17	Mar 18	Jun 18	Oct 18	Feb 19	May 19	Aug 19	Nov 19	Mar 20	Dec 17	Mar 18	Jun 18	Oct 18	Feb 19	May 19	Aug 19	
A-PB1	-	6.07	6.12	6.19	6.41	6.35	6.48	6.49	I	-	646	630	610	720	711	615	648	I	-	320	340	-		390	444	
A-OB1	6.42	6.49	6.26	6.16	6.26	6.33	6.52	6.53	I	570	466	486.4	493.2	586	700	606	644	I	260	260	230	310		440	407	
A-OB2	6.41	6.48	7.00	6.27	6.48	6.6	6.75	6.75	I	657	617	686	565	583	831	843	911	I	370	300	380	350		442	475	
A-OB3	-	6.75	6.55	6.54	B	B	B	B	I	-	561	593	489.9	B	B	B	B	I	B	390	360	350		B	B	
A-OB4	6.31	6.29	6.3	6.43	7.4	6.32	6.4	6.36	I	37,011	35,920	37,557	40,022	37,150	36,385	36,423	31,759	I	30,000	34,000	23,000	38,000		28,800	23,300	3
A-OB7	6.62	6.95	6.64	6.92	6.64	6.65	6.73	6.7	I	15,681	16,809	16,637	18,390	20,122	19,487	19,657	18,058	I	13,000	13,000	16,000	16,000		13200	12,600	1
A-OB8+	6.89	6.94	6.57	6.47	6.5	6.42	6.61	6.59	6.53	26,260	25,877	26,914	27,752	28,071	28,197	27,752	25,754	28,536	14,000	18,000	19,000	27,000		19,900	17,900	2
A-OB10	6.42	6.2	6.15	6.36	7.11	6.3	6.39	6.39	6.49	31,708	36,433	38,097	38,786	37,303	35,894	34,430	29,887	32,507	32,000	37,000	33,000	38,000		27,800	19,500	2
A-OB11	6.08	6.14	6.37	6.23	6.25	6.3	6.46	6.35	I	425	405	434	376.7	440	481	452	351	I	210	210	220	240		258	298	
A-OB12	6.17	6.25	6.25	6.28	6.48	6.56	6.64	6.53	I	381	354	327.7	322.5	430	526	456	306	I	180	160	140	190		259	287	

(-) Bore Dry, not sampled. (B) Bore is blocked, not sampled. (I) Bore Inaccessible due to weather conditions, not sampled. No results are presented for A-PB2 and A-OB6 as bores were dry.
+ Results again generally consistent with findings presented in Figure 3-2 (recorded as effectively dry in the sandy gravel portion of the bore, total drill depth is logged in the interburden of Baralaba Coal Measures).

For the purposes of comparison with WQOs (**Section 4.1**), a summary of select metals in the alluvium bores are provided in **Table 4-4**. During a 24-hour pumping test conducted at A-PB1 in March 2018 (**Section 3.6.1**), additional groundwater quality samples were taken to identify trends during pumping. In summary, reducing trends were observed in the concentrations of metals including aluminium, iron and zinc during the test (SLR, 2019).

Table 4-4 2017-2020 Groundwater Quality Sampling Program – Alluvium [Metal Concentrations]

Bore ID	Maximum Recorded Metal Concentrations (mg/L) [Dissolved / Total]													
	Al	As	B	Cd	Cr	Co	Cu	Pb	Hg	Mo	Ni	Se	U	Zn
LOR	**0.05**	**0.001**	**0.05**	**0.0002**	**0.001**	**0.001**	**0.001**	**0.001**	**0.0001**	**0.005**	**0.001**	**0.001**	**0.005**	**0.005**
LRT	**5**	**5**	**5**	**0.01**	**1**	**1**	**5**	**0.1**	**0.002**	**0.15**	**1**	**0.02**	**0.2**	**20**
A-PB1	0.05 / 1.9	0.003 / 0.003	LOR / LOR	LOR / LOR	LOR / 0.009	LOR / 0.007	0.001 / 0.007	LOR / 0.003	LOR / LOR	LOR / LOR	0.002 / 0.008	LOR / LOR	LOR / LOR	0.95 / 1.2
A-OB1	LOR / 78	0.002 / 0.013	0.06 / 0.07	LOR / 0.0019	LOR / 0.053	0.003 / 0.21	0.003 / 0.15	LOR / 0.065	LOR / 0.0004	0.008 / 0.005	0.003 / 0.12	LOR / LOR	LOR / 0.008	0.013 / 0.36
A-OB2	LOR / 14.9	0.003 / 0.004	0.07 / LOR	LOR / LOR	LOR / 0.015	0.003 / 0.015	0.001 / 0.047	0.001 / 0.016	0.0002 / 0.0001	0.008 / LOR	0.003 / 0.018	0.01 / LOR	LOR / LOR	0.018 / 0.141
A-OB3	LOR / 1.8	0.005 / 0.005	0.06 / LOR	LOR / LOR	LOR / 0.003	0.002 / 0.005	0.004 / 0.004	LOR / 0.003	0.0002 / LOR	0.009 / LOR	0.002 / 0.007	0.002 / 0.001	LOR / LOR	0.018 / 0.37
A-OB4	51 / 18.1	0.017 / 0.016	0.13 / 0.13	0.0038 / 0.003	0.12 / 0.049	0.065 / 0.12	LOR / 1.1	0.99 / 0.095	LOR / 0.0042	0.02 / LOR	0.031 / 0.16	LOR / LOR	0.014 / 0.02	0.097 / 0.36
A-OB7	LOR / 920	LOR / 0.06	0.24 / 0.39	0.0006 / 0.0057	0.008 / 0.74	0.008 / 0.81	0.01 / 1.6	LOR / 0.77	LOR / 0.0016	0.011 / LOR	0.01 / 1	LOR / 0.038	0.008 / 0.055	0.18 / 4.3
A-OB8	LOR / 140	LOR / 0.068	0.37 / 0.32	0.0007 / 0.0019	0.024 / 0.3	0.004 / 0.15	0.23 / 0.46	0.002 / 0.33	LOR / 0.0006	0.034 / 0.025	0.15 / 0.37	LOR / LOR	0.081 / 0.14	0.231 / 0.66
A-OB10	0.05 / 38	0.005 / 0.011	0.12 / 0.13	0.0027 / 0.0054	0.012 / 0.04	0.018 / 0.13	0.19 / 0.33	0.001 / 0.05	0.0001 / 0.0001	0.005 / 0.006	0.02 / 0.12	LOR / LOR	0.006 / 0.007	0.089 / 0.36
A-OB11	0.07 / 49.2	0.009 / 0.015	0.05 / 0.05	LOR / 0.0004	LOR / 0.035	0.008 / 0.07	LOR / 0.029	LOR / 0.026	LOR / LOR	0.008 / LOR	0.002 / 0.062	LOR / LOR	LOR / 0.007	0.019 / 0.61
A-OB12	LOR / 28	0.011 / 0.013	LOR / 0.06	LOR / 0.0004	LOR / 0.042	0.003 / 0.016	LOR / 0.047	LOR / 0.032	LOR / LOR	0.01 / LOR	0.002 / 0.027	LOR / LOR	LOR / 0.005	0.05 / 0.2

LOR = Limit of Reporting. LRT = Low Risk Trigger – Stock Watering (refer Table 4-11).
Results obtained from December 2017 to March 2020.

4.2.2 Deep groundwater systems – Permian strata

To augment the 2012 groundwater quality datasets (**Section 4; Table 4-3**), a targeted baseline groundwater quality sampling program of the Permian coal measures bores at the BSP area was conducted by SLR in 2017-2018 and is presented in full in **Appendix A**. As for the alluvium bores (**Section 5.6.1**), field water quality parameters were collected quarterly for the Permian coal measures bores and samples submitted to a NATA accredited laboratory for further analysis.

Groundwater quality samples of the Permian coal measures have continued to be collected by 4T Consultants for Baralaba South Pty Ltd. A representative selection of the groundwater quality results for pH, EC and TDS in the Permian coal measures bores are presented in **Table 4-5**. For the purposes of comparison with WQOs (**Section 4.1**), a summary of select metals in the Permian bores are provided in **Table 4-6**.

Table 4-5 Groundwater Quality Sampling results – Permian Coal Measures [pH, EC and TDS]

Bore ID	pH									EC (µS/cm)									TDS (mg/L)								
	Dec 17	Mar 18	Jun 18	Oct 18	Feb 19	May 19	Aug 19	Nov 19	Mar 20	Dec 17	Mar 18	Jun 18	Oct 18	Feb 19	May 19	Aug 19	Nov 19	Mar 20	Dec 17	Mar 18	Jun 18	Oct 18	Feb 19	May 19	Aug 19	Nov 19	Mar 20
Baralaba Coal Measures [Interburden]																											
P-PB1	-	7.31	6.90	7.06	6.97	6.72	6.75	6.80	I	-	15,950	16,296	18,453	15,763	15,574	15,303	13,721	I	-	11,000	12,000	12,000		9,750	8,880	11,000	I
P-OB3	6.1	6.19	6.15	6.24	6.32	6.33	6.45	6.39	6.51	34,107	33,141	34,154	37,120	33042	32,548	32,169	28,835	32,386	30,000	31,000	19,000	27,000		24,600	18,200	26,700	22,900
Baralaba Coal Measures [Coal Seams]																											
P-OB1	6.1	6.32	6.23	6.19	6.27	6.06	6.35	6.29	I	29,785	30,324	31,390	33,260	34,270	34,234	33,794	30,700	I	25,000	28,000	21,000	29,000		26,100	23,600	28,500	I
P-OB4	6.5	6.11	6.22	6.29	6.40	6.31	6.48	6.46	I	37,088	36,356	37,492	40,297	36,546	36,131	35,942	31,702	I	27,000	31,000	25,000	35,000		28,700	20,200	31,100	I
P-OB5	7.3	7.21	6.76	6.54	6.50	6.44	6.63	6.54	I	24,664	27,225	23,666	34,100	29,073	28,889	28,641	25,455	I	13,000	12,000	12,000	24,000		19,200	17,200	20,800	I
Gyranda Formation																											
P-OB2	-	6.14	6.08	6.25	6.40	6.19	6.43	6.34	6.40	-	19,480	19,503	21,075	19,085	19,000	18,964	16,669	18,797	-	13,000	14,000	13,000		12,600	11,700	13,600	12,600

(-) Bore dry, not sampled. (I) Bore inaccessible due to weather conditions, not sampled.

Table 4-6 Groundwater Quality Sampling results – Permian Coal Measures [Metal Concentrations]

Bore ID	Maximum Recorded Metal Concentrations (mg/L) [Dissolved / Total]													
	Al	As	B	Cd	Cr	Co	Cu	Pb	Hg	Mo	Ni	Se	U	Zn
LOR	0.05	0.001	0.05	0.0002	0.001	0.001	0.001	0.001	0.0001	0.005	0.001	0.001	0.005	0.005
LRT	5	5	5	0.01	1	1	5	0.1	0.002	0.15	1	0.02	0.2	20
Baralaba Coal Measures [Interburden]														
P-PB1	LOR / 0.17	0.013 / 0.016	0.18 / 0.18	LOR / LOR	LOR / 0.003	0.001 / 0.001	LOR / 0.001	LOR / LOR	LOR / LOR	LOR / LOR	0.002 / 0.002	LOR / LOR	LOR / LOR	0.045 / 0.19
P-OB3	LOR / 16.2	LOR / LOR	LOR / LOR	LOR / LOR	LOR / LOR	LOR / LOR	0.063 / 0.063	LOR / LOR	LOR / LOR	LOR / LOR	LOR / LOR	LOR / LOR	LOR / LOR	0.091 / 0.112
Baralaba Coal Measures [Coal Seams]														
P-OB1	LOR / 25.6	0.007 / 0.01	0.21 / 0.21	LOR / LOR	LOR / 0.006	0.008 / 0.009	LOR / LOR	LOR / LOR	LOR / LOR	LOR / LOR	0.006 / 0.008	LOR / LOR	LOR / LOR	0.161 / 1.23
P-OB4	LOR / LOR	LOR / LOR	LOR / LOR	LOR / LOR	LOR / LOR	0.017 / 0.017	LOR / LOR	LOR / LOR	LOR / LOR	LOR / LOR	0.039 / 0.033	LOR / LOR	LOR / LOR	LOR / 0.15
P-OB5	LOR / LOR	LOR / LOR	1.4 / 1.4	LOR / LOR	LOR / 0.011	LOR / LOR	LOR / 0.02	LOR / LOR	LOR / LOR	LOR / LOR	0.011 / 0.015	LOR / LOR	LOR / LOR	LOR / 0.31
Gyranda Formation														
P-OB2	LOR / 3.26	0.002 / 0.008	1.9 / 1.9	LOR / LOR	0.002 / 0.017	0.002 / 0.002	0.1 / 0.11	LOR / LOR	LOR / LOR	LOR / LOR	0.005 / 0.013	LOR / LOR	LOR / LOR	0.38 / 0.38

LOR = Limit of Reporting
LRT = Low Risk Trigger – Stock Watering (refer Table 4-11).
NB: Where laboratory test filtered result is greater than the total metal result, the total metal result has been shown equivalent.
Results obtained from December 2017 to March 2020.

4.2.3 Igneous trachyte – Ross bore

Groundwater quality sampling was undertaken at the Ross Bore during the 2017-2018 groundwater sampling program and the results summarised in **Table 4-7** and **Table 4-8**. The full suite of laboratory testwork results are provided in **Appendix A**.

Table 4-7 Groundwater Quality Sampling (2017-18) – Igneous Trachyte [pH, EC and TDS]

Bore ID	pH				EC (uS/cm)				TDS (mg/L)			
	Dec 17	Mar 18	Jun 18	Oct 18	Dec 17	Mar 18	Jun 18	Oct 18	Dec 17	Mar 18	Jun 18	Oct 18
Ross Bore	-	8.32	6.52	6.47	-	2,020	3,038	3,690	-	1,100	1,600	2,000

Source: After SLR (2019)

Table 4-8 Groundwater Quality Sampling (2017-18) – Igneous Trachyte [Metals]

Bore ID	Maximum Recorded Metal Concentrations (mg/L) [Dissolved / Total]													
	Al	As	B	Cd	Cr	Co	Cu	Pb	Hg	Mo	Ni	Se	U	Zn
LOR	0.05	0.001	0.05	0.0002	0.001	0.001	0.001	0.001	0.0001	0.005	0.001	0.001	0.005	0.005
LRT	5	5	5	0.01	1	1	5	0.1	0.002	0.15	1	0.02	0.2	20
Ross Bore	LOR / 0.07	LOR / 0.001	0.47 / 0.51	LOR / LOR	LOR / LOR	LOR / 0.001	LOR / 0.002	LOR / 0.003	LOR / LOR	LOR / LOR	LOR / LOR	0.005 / 0.005	LOR / LOR	0.027 / 0.028

Source: After SLR (2019)
LOR = Limit of Reporting
LRT = Low Risk Trigger – Stock Watering (refer Table 4-11).

4.2.4 Isotope sampling – groundwaters

Sampling and analysis of deuterium and oxygen stable isotopes in groundwater (alluvium and Permian coal measures) was previously conducted at the BSP (and Baralaba North Mine) area and reported in SKM (2014). The results indicated the alluvium bores near Dawson River at the BSP (i.e. A-OB1, A-OB2) are more readily recharged by rainfall and streamflow, while bores away from the river (i.e. A-OB4 and A-OB8) have enriched oxygen.

4.3 Groundwater quality and environmental values at BSP

A summary of the relevant environmental values is presented in Section 4.1 and discussed further in the following sub-sections.

Based on the above, the following environmental values have been considered for the groundwater resources within MLA 700057:

- aquatic ecosystems;
- irrigation;
- farm supply;
- stock water;
- aquaculture;
- primary recreation;

Table 4-9 Environmental Values – Surface Waters and Groundwaters relevant to the BSP

Environ-mental Value	EPP Water [Schedule 1]			EPP Water Mapping (2018)					
	Surface Waters [Figure 4-1]		Groundwaters [Figure 4-2]	Surface Waters		Groundwaters			
	Lower Dawson River Sub-Basin – WQ1309		Fitzroy Basin Groundwater Zones / Lower Dawson Groundwaters – WQ1310	Lower Dawson River Sub-Basin – WQ1309		Groundwater Alluvium – GWQ1301	Fitzroy Basin Groundwater Fractured Rock – WQ1302	Fitzroy Basin Groundwater Cainozoic Deposits Overlying the GAB Zones – GWQ1303	Fitzroy Basin Groundwater Basins Partially Underlying the GAB Zones – GWQ1309
	Lower Dawson Main Channel – Regulated Reaches	Eastern Tributaries	Lower Dawson Groundwaters - Groundwater Chemistry Zone 34 [Sodic Sequence – Saline: Na, Cl]	Lower Dawson Main Channel – Regulated Reaches	Eastern Tributaries	Zone 13 – Dawson	Zone 10 - Eastern Fitzroy Trap Rocks	Zone 6 - Saline Tertiary Sediments	Zone 11 - Eastern Bowen Coal Measures
Aquatic Ecosystem	✓	✓	✓	✓	✓	✓	✓	✓	✓
Irrigation	✓	✓	✓	✓	✓	✓	✓	✓	✓
Farm Supply	✓	✓	✓	✓	✓		✓		
Stock Water	✓	✓	✓	✓	✓	✓	✓	✓	✓
Aquaculture	✓	✓	✓	✓	✓		✓		
Human Consumer	✓	✓		✓	✓				
Primary Recreation	✓	✓	✓	✓	✓				
Secondary Recreation	✓	✓		✓	✓				
Visual Recreation	✓	✓		✓	✓				
Drinking Water	✓	✓	✓	✓	✓	✓	✓	✓	✓
Industrial Use	✓	✓		✓	✓		✓	✓	✓
Cultural and Spiritual Values	✓	✓	✓	✓	✓	✓	✓	✓	✓

- drinking water;
- industrial use; and
- cultural and spiritual values.

Surface water resources and their corresponding environmental values and WQOs are considered separately in the Surface Water Assessment for the EIS (Engeny, 2023).

The *Dawson River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Dawson River Sub-basin except the Callide Creek Catchment* (DEHP, September 2011) provides general water quality objectives (WQO) for the identified groundwater environmental values. Additional commentary based on the *Burdekin, Don and Haughton River Basins* (DES, June 2022) is also provided below.

Alluvium – Zone 13 (Dawson)

The Dawson Zone includes most of the Dawson sub-basin, which occupies the south-eastern quarter of the Fitzroy basin. As the river flows northwards, the GAB gives way in the middle and lower reaches to the more undulating Bowen sediments, with sandstones exposed in the west, and the coal bearing Back Creek Group, partially blanketed by Tertiary deposits, east of the Dawson Range. Basalt remnants are scattered across the mid reaches of the Dawson. The alluvium is mainly of moderate depth extending from 15-25 m.

Annual rainfall is around 550–750 mm (**Section 2.1**), supporting a natural vegetation of mostly dry brigalow or eucalypt woodland and open forests. The rest of the zone is largely cleared for dryland cropping, with some irrigation downstream, supported by several weirs on the mid and lower reaches of the Dawson. The salinity ranges from fresh (TDS 140-620 mg/L; EC 300-1,000 µS/cm) near the major watercourses to moderate or high (TDS 12,000-38,000 mg/L; EC 15,000-40,000 µS/cm) nearer the proposed mining footprint.

Salinity may affect taste, and the water may not be ideal for other general purposes because of high EC and hardness. Precipitates may form in bores with occasional scale. The irrigation status of the water seems reasonable, although the quality is only moderate for sensitive crops because of occasionally high salinity and percentage of sodium (SAR >8). It is normally suitable for stock. Groundwater EC exceeds Queensland Water Quality Guidelines (QWQG) aquatic ecosystem surface water quality guidelines, and total nitrogen (TN) and pH (upper range values) may do also.

Fractured Rock – Zone 10 (Eastern Fitzroy Trap Rocks)

The Eastern Fitzroy Trap Rocks are a patch of Palaeozoic volcanics and sediments, including the coal bearing Back Creek Group, lying behind the coast of the in the Lower Fitzroy sub-basin and its watershed with the Dawson sub-basin. The aquifers are in fractured trap rocks and granites, with occasional basalt remnants. Bore depths are moderate at 12 m to 33 m.

The salinity ranges from moderate to high at between 760 µS/cm and 4,707 µS/cm. Salinity levels occur which would affect taste, and reduce water quality for general purposes because of high EC and hardness. Precipitates are likely to be deposited over time. The salinity may be excessive for sensitive crops but is suitable for stock. Groundwater EC exceeds QWQG aquatic ecosystem surface water quality guidelines, as TN frequently does, and pH (upper range values) may also.

Cainozoic Deposits (including Deposits overlying GAB) – Zone 6 (Saline Tertiary Sediments)

The Saline Tertiary Sediments Zone is the largest of the Cainozoic zones. It is an extensive area of flat to undulating terrain east of the Great Dividing Range. The extensive tablelands of Tertiary sediments are underlain by pre-GAB formations, some of them coal bearing. The bores mainly access colluvial deposits and Tertiary sediments, including the carbonaceous Duaringa Formation. Bore depths extend from 31 m to 149 m and are mostly deep to over 100 m.

The salinity is moderate to very high, ranging between 580 µS/cm and 16,100 µS/cm. It affects taste, and the water may not be ideal for other general purposes because of high EC and hardness. Precipitates may form in bores with occasional scale. The water quality is poor for irrigation because sodium levels are excessive for sensitive crops (SAR >8), and EC may exceed irrigation guidelines in some bores, and may occasionally be excessive for stock. It also exceeds QWQG aquatic ecosystem surface water quality guidelines, and TN and pH (upper range values) may do also.

Earlier Basins Partially Underlying GAB – Zone 11 (Eastern Bowen Coal Measures)

The Eastern Bowen Coal Measures is a belt of coal bearing sediments. The coal bearing sediments are mainly Back Creek Group, underlain by trap rocks, and overlain in the west by Tertiary sediments and weathered to recent alluvium. Bores access members of the coal bearing Back Creek and Blackwater Groups.

The salinity ranges from high to very high but variable, being between 1,190 µS/cm and 19,100 µS/cm. It affects taste, and the water may not be ideal for other general purposes because of high EC and hardness. Precipitates are likely to be deposited over time with some scaling. The water quality is poor for irrigation because sodium levels are excessive for sensitive crops (SAR >8), and EC may exceed irrigation guidelines in some bores. The water should be tested before giving to stock as there are occurrences of excessive salinity. Groundwater EC exceeds QWQG aquatic ecosystem surface water quality guidelines, and TN and pH (upper range values) may do also.

4.3.1 Aquatic Ecosystems

There are no known springs or seeps located within MLA 700057 or surrounds (**Section 3.5.1**).

Regionally, groundwater flow within the alluvial sediments associated with the local drainages of Banana Creek and the Dawson River is towards the west and north-west. Groundwater levels are generally 12-15 mbg (**Section 3.4.1**) and typically separated from surface waters.

4.3.2 Irrigation

Groundwater is not currently used for irrigation within MLA 700057. There are no known irrigation bores located in the vicinity of the BSP. As discussed in **Sections 2.3.1and 3.3.3**, it is understood that the irrigation waters for the two centre-pivot irrigation areas nearby on the private landholder property, is sourced from the Dawson River, not the groundwater bore.

4.3.3 Farm Supply

Groundwater is not currently used for farm supply within MLA 700057.

4.3.4 Stock Water

Groundwater resources may have been used (albeit limited) for stock watering within MLA 700057 in the past, with the primary agricultural use being cattle grazing. The 'Ross' bore has recently been equipped for some stock watering.

For the purposes of comparison, the tolerance of livestock to TDS in drinking water is provided in **Table 4-10**. Based on the available groundwater quality datasets (**Section 4.2**), the groundwaters within MLA 700057 associated with the Permian coal measures and alluvial sediments along the local drainage feature are generally unsuitable for stock watering.

Water quality objectives are also provided for trace metal concentrations in livestock drinking water which are summarised in **Table 4-11**. Based on the available groundwater quality datasets (**Section 4.2**; **Table 4-4**; **Table 4-6** and **Table 4-8**), most metal concentrations in groundwaters are generally suitable for stock watering.

Table 4-10 Stock Watering – Tolerance of Livestock to TDS in Drinking Water

Livestock	No Adverse Effects on Animals Expected	Some Scouring and Initial Reluctance by Animals to Drink, but Stock Should Adapt without Loss of Productivity	Loss of Production and Decline in Animal Condition and Health would be Expected. Stock May Tolerate for Short Periods if Introduced Gradually
Beef Cattle	0-4,000 mg/L	4,000-5,000 mg/L	5,000-10,000 mg/L
Dairy Cattle	0-2,500 mg/L	2,500-4,000 mg/L	4,000-7,000 mg/L
Sheep	0-5,000 mg/L	5,000-10,000 mg/L	10,000-13,000 mg/L*
Horses	0-4,000 mg/L	4,000-6,000 mg/L	6,000-7,000 mg/L
Pigs	0-4,000 mg/L	4,000-6,000 mg/L	6,000-8,000 mg/L
Poultry	0-2,000 mg/L	2,000-3,000 mg/L	3,000-4,000 mg/L

* Sheep on lush green feed may tolerate up to 13,000 mg/L TDS without loss of condition or production.

Table 4-11 Stock Watering – Metal concentration Low Risk Triggers for Livestock Drinking Water*

Metal	Concentration – Trigger Value (Low Risk)
Aluminium	5 mg/L
Arsenic	0.5 mg/L (up to 5 mg/L)
Boron	5 mg/L
Cadmium	0.01 mg/L
Chromium	1 mg/L
Cobalt	1 mg/L
Copper	0.4 mg/L (sheep) 1 mg/L (cattle) 5 mg/L (pigs / poultry)
Fluoride	2 mg/L
Lead	0.1 mg/L
Mercury	0.002 mg/L
Molybdenum	0.15 mg/L
Nickel	1 mg/L
Selenium	0.02 mg/L
Uranium	0.2 mg/L
Zinc	20 mg/L

*Higher concentrations may be tolerated in some situations (details provided in AWQG, Volume 3).

4.3.5 Aquaculture

Groundwater is not currently used for aquaculture within MLA 700057 or surrounds.

4.3.6 Primary Recreation

Groundwater is not currently used for primary recreation purposes within MLA 700057 or surrounds.

4.3.7 Drinking Water

Based on the available groundwater quality datasets (**Section 4.2**), the groundwaters are not suitable for human consumption.

4.3.8 Industrial use

The BSP would use groundwaters that drain directly to the open cut pit. The groundwaters would be pumped to holding dams, where water collected would be incorporated into the site water balance.

No WQOs are provided for industrial use as water quality requirements for industry vary within and between industries. Similarly, ANZECC & ARMCANZ (2000) does not provide guidelines for industry and indicates that industrial water quality requirements need to be considered on a case-by-case basis. Based on this approach, associated groundwaters accessed by the BSP would provide a beneficial industrial use.

4.3.9 Cultural values

There are no known environmental values in relation to cultural and spiritual values of groundwater within MLA 700057 or surrounds. Notwithstanding, no WQOs are currently provided for cultural and spiritual values.

5 Hydrogeological Conceptual Model

The conceptual model of the groundwater regime at the BSP has been developed based on the review of past conceptualisation and site-specific hydrogeological data included in SKM (2014), HydroSimulations (2014) and SLR (2019). Consideration of other more broader studies including Underground Water Impact Reports (e.g. AGE, 2013b; Arrow Energy, 2016; CDM Smith, 2016a; CDM Smith 2016b, KCB, 2023) was also made. The studies are in agreement; there are two main hydrogeological units in the BSP area:

- Quaternary alluvial and colluvial sediments associated with the Dawson River and tributaries; and
- Permian strata, specifically the Baralaba Coal Measures, as well as the overlying Rewan Formation (regional aquitard) and underlying Gyranda Formation (a poorly productive aquifer).

Based on the review of groundwater datasets and dependent assets (**Section 3**), the limited groundwater users in the vicinity, the typically dry nature of the alluvial sediments (away from the Dawson River), the brackish-saline nature of the groundwater, and the fact that the BSP is not in a defined groundwater management area in the Fitzroy Basin (**Section 1.8**) confirm that the identified groundwater systems are not significant aquifers. That is, despite being the main hydrogeological units in the BSP area, the groundwater systems at the BSP are of limited anthropogenic potential. Nevertheless, from an industrial use perspective, associated groundwaters that would be accessed by the BSP would provide a beneficial industrial use through its use in the mine site water balance / supply.

Further details of the two main hydrogeological units in the BSP area and confirmation of the corresponding environmental values and water quality objectives are provided in the following subsections. A cross-section of the groundwater system in an alignment south-west to north-east through the BSP area illustrates the conceptual groundwater model of the BSP area and surrounds before, during and after mining (see **Figure 5-1** and **Figure 5-2**).

As per IESC guidelines on fault characterisation and risk and causal pathways, later sub-sections present:

- a review the role that geological structures, being faults and dykes, mapped in the area of BSP, may play in modifying or exacerbating groundwater-related effects from the BSP, is presented in **Section 5.1.4**.
- a causal pathway diagram is presented in **Section 5.1.5**, which is an alternative way of presenting the conceptualised effects of the BSP.

This forms the basis for the numerical groundwater modelling (**Sections 6 and 7**).

5.1 Hydrogeological Conceptual Model of the BSP

The conceptualisation of the groundwater system is the foundation of the impact assessment and critical to the development and calibration of the numerical model. The conceptual hydrogeological model is an idealised and simplified representation of the natural or existing system, and is a description of how the groundwater system operates given the available data and analysis carried out to date.

This then allows for the development of a conceptual model of the Project its effects on the groundwater system, both during mining and following mine closure. These aspects are described in the following sub-sections.

5.1.1 Hydrostratigraphic units

5.1.1.1 Alluvial and colluvial sediments

Along with the Permian coal measures, the alluvium present along the Dawson River (and Banana Creek confluence) is the main groundwater bearing unit near the BSP.

Recharge of the surficial sediments is from direct rainfall and infiltration (loss) from streams, particularly where surficial clays are absent. This has been demonstrated by the isotope sampling results which indicate the alluvial bore closer to the Dawson River (i.e. A-OB2) is more readily recharged by rainfall, while bores sampled away from the river (i.e. A-OB4 and A-OB8) have more distinct signatures.

Further, as discussed in **Sections 2.2**, the Neville Hewitt Weir (which has a full storage level at approximately 79 mAHD) maintains the Dawson River stage at this higher elevation than the majority of the groundwater levels observed around Baralaba. This recharge mechanism was identified by the results (i.e. relatively swift recovery) of the pumping tests conducted on site.

A number of alluvial bores have been recorded as dry within MLA 700057 and the isotope analysis by SLR of the groundwater at P-OB1 (Permian bore) indicated it was more readily recharged by rainfall.

Because of its position away from the Dawson River, the colluvium is typically dry, being recharged only by direct rainfall.

5.1.1.2 Triassic and Permian strata

In the Permian Coal Measures, groundwater is typically stored and transmitted in the coal seams, while the sandstone/siltstone (interburden) units are of lower permeability. The Gyranda Formation underling the Baralaba Coal Measures is a poorly productive aquifer or an aquitard.

Recharge to these Permian strata is likely to be from rainfall recharge where it occurs at outcrop, noting that infiltration recharge rates in this area are quite low (typically on the order of 1% of average rainfall or less), as well as from downward leakage from the overlying alluvium, if and where saturated.

SKM (2014) conducted detailed analyses of the measured vertical head gradients at each of the VWPs in the Permian coal measures presented in **Sections 3.1.6 and 3.1.7**, and demonstrated good correlation of sensor depths (mbg) vs head on sensor (m) at the BSP area (i.e. a natural decline in potentiometric head with depth).

The Triassic-aged Rewan Formation, which directly overlies the Coal Measures, is a known aquitard, being of tens to hundreds of metres thick and having relatively low permeability.

5.1.2 Existing (pre-mining) conditions

With reference to the conceptual groundwater model cross-section (**Figure 5-1**), the following key points are made for the existing hydrogeological conditions:

- Recharge rates are low, generally <1% of rainfall (higher to the west, on the GAB aquifers – see below), where average annual rainfall is around 700 mm/year. Minimal groundwater flux or recharge occurs through the Rewan Formation (aquitard) present across much of the Study Area.
- Evaporation rates are high, with potential evaporation being over 2,000 mm/year, with actual evapotranspiration between 600 and 700 mm/year for the Baralaba region.
- Surficial units (alluvium and colluvium), are generally relatively more permeable compared to Triassic and Permian rock units present in the area. Thickness varies from absent or a few metres to around 20 metres.

- Of the Permo-Triassic strata in the Baralaba region, only the Clematis Sandstone (part of the GAB) and potentially the Duaringa Formation are thought of as significant aquifers, in the sense of producing useable quantities of groundwater. However, the Clematis Sandstone is distant (more than 10 km) from the BSP, and there is only a single registered bores (RN 128844) penetrating the Duaringa Formation. This bore is 9 km north-east of the BNM, and 22 km north of the BSP.
- The Rewan Formation (overlying the Coal Measures) and Gyranda Formation and other older units (underlying the Coal Measures) are known regional aquitards. The Rewan Formation in particular is thick (i.e. tens to hundreds of metres) and intervenes between the Baralaba Coal Measures and the Clematis Sandstone (GAB) aquifer.
- The Baralaba Coal Measures consist of coal seams with interburden consisting primarily of siltstones, sandstones and mudstones.
- The coal seams are more permeable than the surrounding interburden, although they are not highly transmissive, particularly because the coal seams are not usually more than a few metres thick.
- Local faults may act as permeable or conductive features, but more likely as barriers to flow. For the purposes of the assessment at BSP and for conservatism, faulting is not assumed to be a barrier to flow.
- There is minimal anthropogenic groundwater use in the area, due to poorer groundwater quality associated with the Permian coal measures and low-yielding formations. Irrigated paddocks near the BSP are located in areas immediately adjacent to the Dawson River and, given the lack of registered bores associated with these properties, these agricultural operations are considered to be reliant on regulated surface water extractions.
- The Dawson River is a losing watercourse (see also **Figure 3-13**), particularly upstream of Baralaba, where it is regulated by the Neville Hewitt Weir.
- Similarly, backwaters from the Dawson River to Banana Creek upstream of the confluence are also a losing system (concept illustrated on **Figure 3-13**).
- Runoff is likely to be the primary source of flow to local drainage lines across the BSP area, particularly when considering the depth to the groundwater table is typically 12-15 mbg or greater.
- Wetlands in the area are unlikely to be dependent on or connected to regional groundwater systems. The wetland systems are considered to exist due to the presence of clays in the shallow subsurface, which allow perched water tables to develop and persist after rain or flood events. This is based on the review by 3dEnvironmental, and inspection of groundwater levels in this study, as illustrated on **Figure 3-13** and **Figure 3-14**. 3dE (2023) also presents a causa pathway assessment specific to the wetlands and potential GDEs.

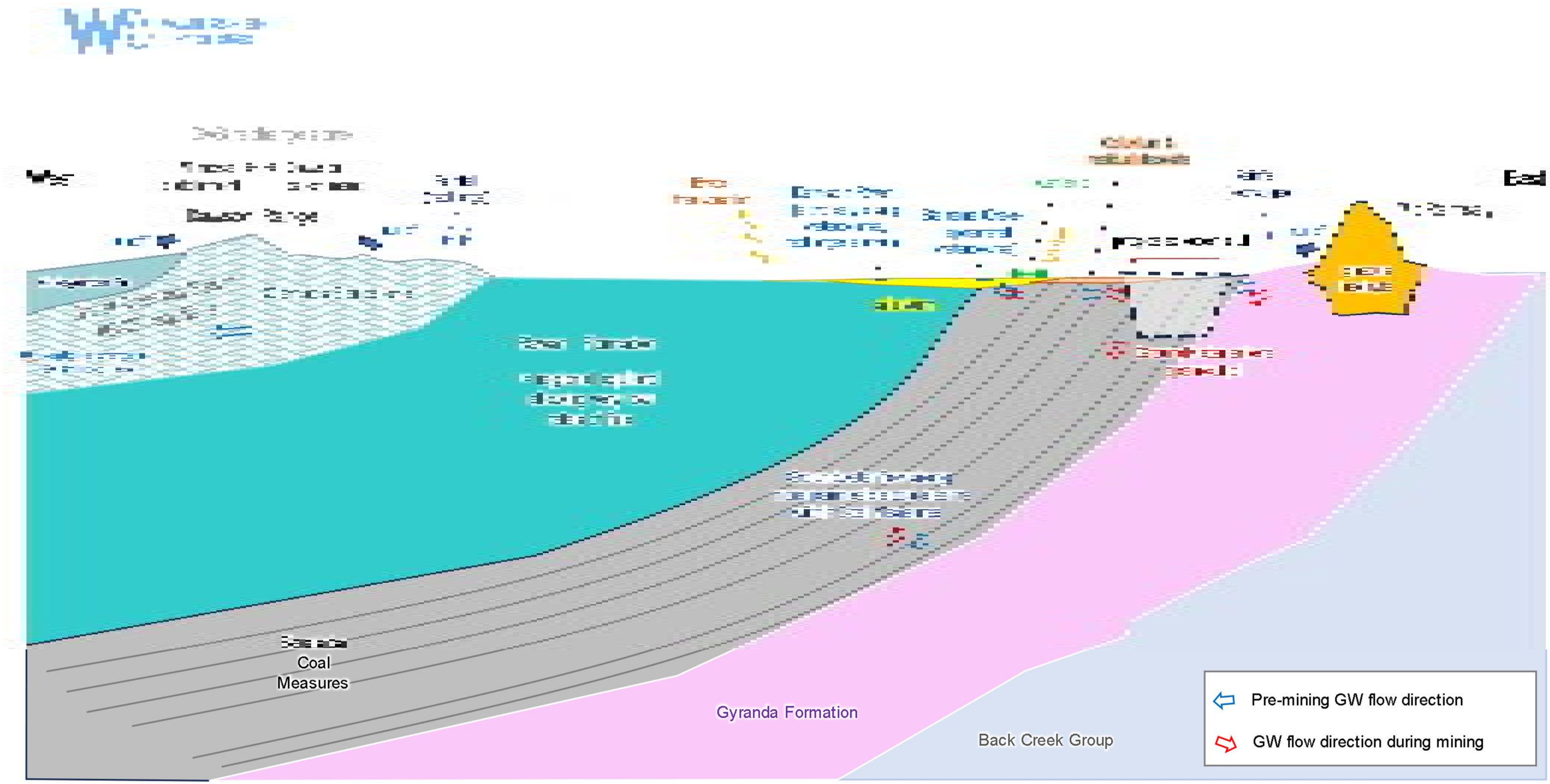


Figure 5-1 Conceptual model of conditions during mining

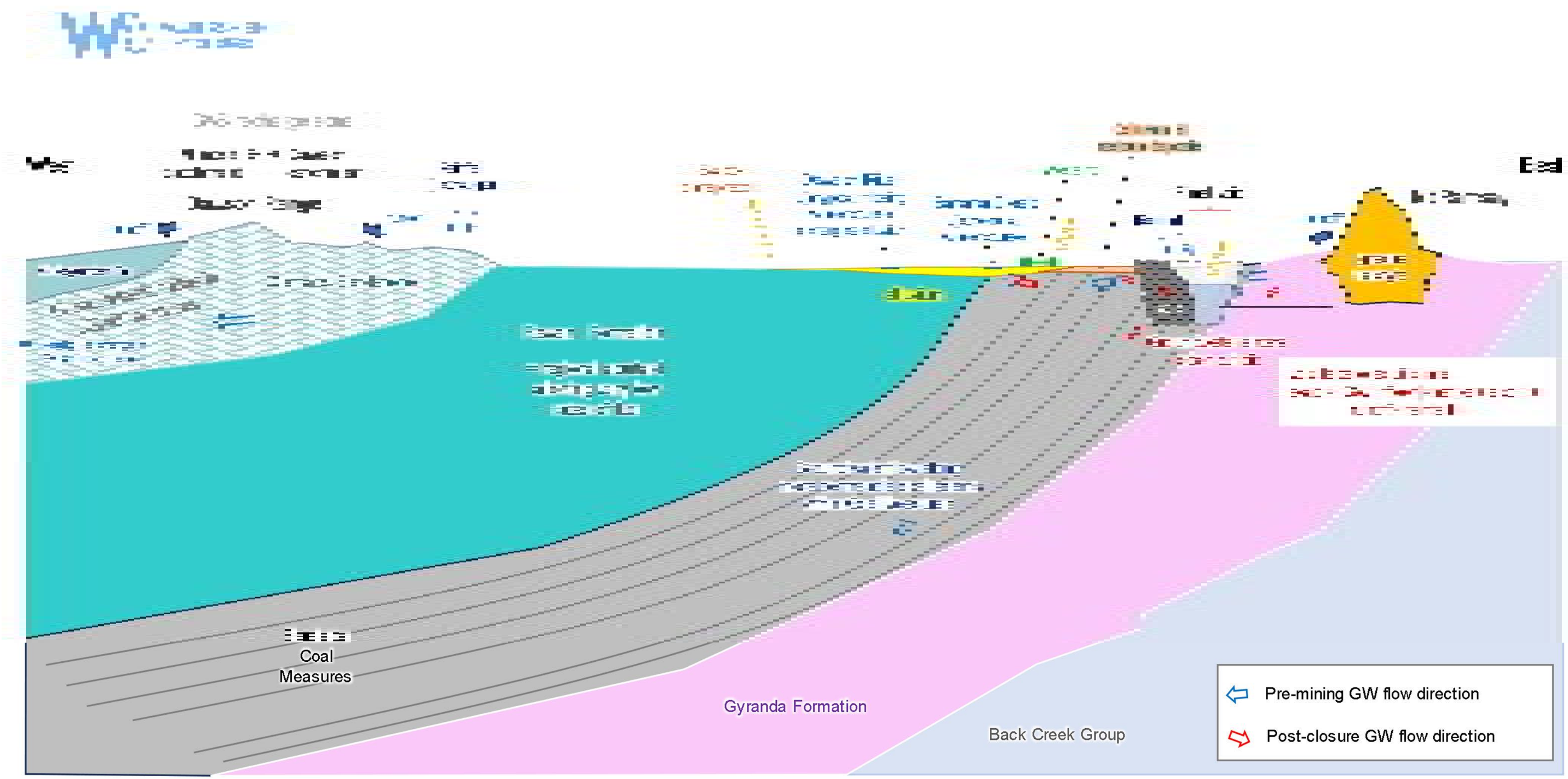


Figure 5-2 Conceptual model of post-closure groundwater conditions

5.1.3 Post-mining and post-closure conditions

As shown on the conceptual groundwater model cross-section (**Figure 5-1** and **Figure 5-2**), the targeted coal seams are toward the base of the Baralaba Coal Measures. During mining:

- The water table would be lowered in the immediate vicinity of active open cut pit. Some localised dewatering of the veneer of alluvial sediments and colluvium (albeit negligible/dry) where excavated within the pit extent could occur initially (resulting in short-term higher groundwater inflows). Gradual reduction in groundwater upflow via the permeable coal measures would also be expected over time.
- Significant drawdowns within the coal measures would occur immediately around the excavated pit, although seepage faces would be present along the walls of the pit (as has been observed at Baralaba North Mine [HydroSimulations, 2014]).
- Where the Rewan Formation is present, drawdowns (if any were to extend as far) would be impeded due to its low permeability (aquitard) properties.
- Drawdown would tend to spread along the strike of the base of the Baralaba Coal Measures (i.e. essentially north-south), rather than:
  - to the east (where the coal measures are absent and the Gyranda Formation outcrops) or
  - to the west, where the Rewan Formation becomes thicker and a more effective aquitard. Also, the increasing depth of cover to the west (with intervening siltstones, sandstones and mudstones) would be expected to result in reduced permeability (and propagation) in the deeper Baralaba Coal Measures.
- Excavated spoil is likely to exhibit more permeable characteristics than the native rock strata, hence there could be some increased recharge through areas of in-pit backfilled spoil, although the hydraulic properties of the waste are not well understood. Some localised mounding of the groundwater table may therefore also occur beneath out-of-pit spoil emplacements.
- Groundwater sourced from the coal measures and via enhanced recharge of spoil emplacements would report to the open cut pit as groundwater inflows. However, it is noted that the actual volume of groundwater inflow observed or requiring direct management may be significantly less where high evaporation rates were to occur at the pit walls and floor (as has been observed at Baralaba North Mine [HydroSimulations, 2014], and supported by observations by Engeny and operators regarding the evidence for low inflow rates).

Post-mining, it is expected that:

- Water collected within the final void would evaporate from the lake surface and continue to draw in groundwater from the surrounding geological units (predominantly the Baralaba Coal Measures).
- Evaporation from the lake surface would concentrate salts in the lake slowly over time.

5.1.4 Characterisation of faults and other structures and associated risk

Section 2.4.1.3 presents the government mapping and BSP resource geology mapping of faults and structures, while **Section 3.6.4** presents some review of the role of faults elsewhere in the Bowen Basin.

Figure 5-3 shows the key features identified at BSP from the two mapping sources, with key faults or groups of faults numbered (1-3) for review of the conceptualised effect of these:

❶ This north-east to south-west trending dyke is mapping as terminating 900 m east of the final void at BSP. In the unlikely event that this feature intersected the pit (i.e. it is not mapped in the local geological model - **Figure 2-11**) and it was a conductive feature, it could transmit drawdown to the north-east into the Gyranda Formation. However there are not receptors in this area.

If this structure is a barrier to flow, it is already hosted within the poorly productive Gyranda Formation, and the effects would be limited, and again, without receptors in this area (other than the Ross bore, which is 2.8 km north of the mapped dyke location).

❷ This swarm of north-west to south-east trending faults is located with the bounds of the open cut. Some of these features have significant displacement, up to 100 m based on the cross-section in **Figure 2-12**.

If these features were to act as conduits, then drawdown could be transmitted along strike, or down dip. The north-west and south-east direction is already conceptualised as the main direction that the cone of depression would spread (i.e. along the outcropping coal seams/coal measures), and as such the role of the faults could be to extend the cone of depression toward Banana Creek. However, to the south-east, bore P-OB5 is located where these faults would cross the MLA boundary. This bore shows relatively saline water (**Table 4-2**), which does not suggest enhanced recharge, although this by itself is not definitive. However slug testing of this bore indicates very low hydraulic conductivity (on the order of 2E-3 m/d– **Table 3-22**), consistent with the discussion in **Section 3.6.4** regarding faults in the Bowen Basin typically not being conduits.

❸ This north-west to south-east trending thrust fault is mapped as being approximately 700 m southwest of the open cut at its closest point, and almost congruent with the MLA boundary. This feature is parallel to the strike of the coal seams. The displacement is not recorded in the Qld government dataset. It is parallel to the locally mapped faults (#2, above).

Pumping bore P-PB1 is located 1.7 km north-west of the mapped end of this, and the 72-hr pumping test at this site indicated only moderate hydraulic conductivity, in the order of 0.1 m/d (**Section 3.6.3**). This suggests limited potential for further northward transmission of groundwater or drawdown along this feature.

To the south-east, if this fault were to be a conduit, it might cause a slightly change in drawdown spread to the south, but because it is not connected to the open cut, this drawdown would be minimal.

Because of the orientation, if this fault were to act as a barrier to flow, it might reduce the south-east expansion of drawdown from the open cut, which is already expected to be limited in this direction because of the geometry of the coal measures and presence of the overlying Rewan Formation.

In summary, the orientation of the mapped dyke is such that were it to be a conduit for groundwater flow, it might transmit drawdown but without a receptor near the feature, it would not result in environmental risk.

The mapped faults are oriented along the coal measures, which are already outcropping in a north-west to south-easterly direction. There is a possibility that these could behave as conduits, however the drawdown is conceptualised as being likely to be transmitted in this direction with or without the faults. Despite the inferred (minimal) effect, some recommendations are made (**Section 9.1.3**) regarding the potentially enhanced hydraulic conductivity of these. If these features were to act as barriers, they would not cause a change in the cone of depression because of their location within the extent of the pit and their orientation.

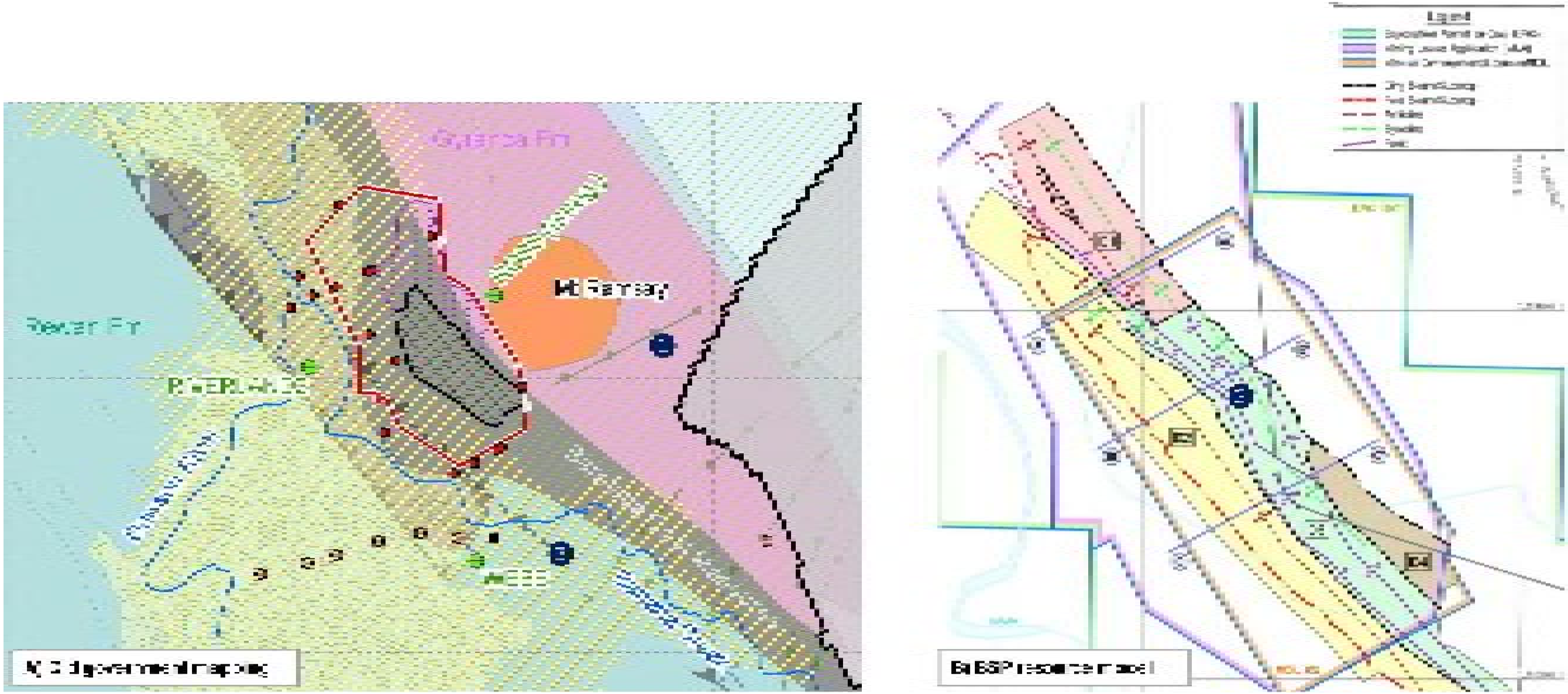


Figure 5-3 Review of geological structures mapped around BSP

5.1.5 Causal pathways

A conceptual model of the relevant "causal pathways" or risk pathways has been developed (**Figure 5-4**). This is similar to suggested by the IESC. This framework is based on the linkages or processes that result from:

- a driver, which in this case is the Project;
- activities and processes associated with that driver;
- end points (including receptors); and
- a description of the stress and consequence on the landscape / receptors.

This outlines the potential water resource (quantity) and water quality impact pathways for the BSP, and is an alternative view to the conceptual diagrams presented in **Figure 5-1** and **Figure 5-2**. A further causal pathway diagram focussed on wetlands and potential GDEs is presented in 3dEnvironmental (2023).

In general, drawdown-related risks may occur because of, or be amplified due to geological structures, including faults and other structures. However, mapping and characterisation (previous section) suggests that interaction with structures is unlikely to change the direction in which the cone of depression is anticipated to extend and/or change it in a direction where no receptors exist, or to have minimal effect because the structures are oriented in the direction of coal seam outcrop.

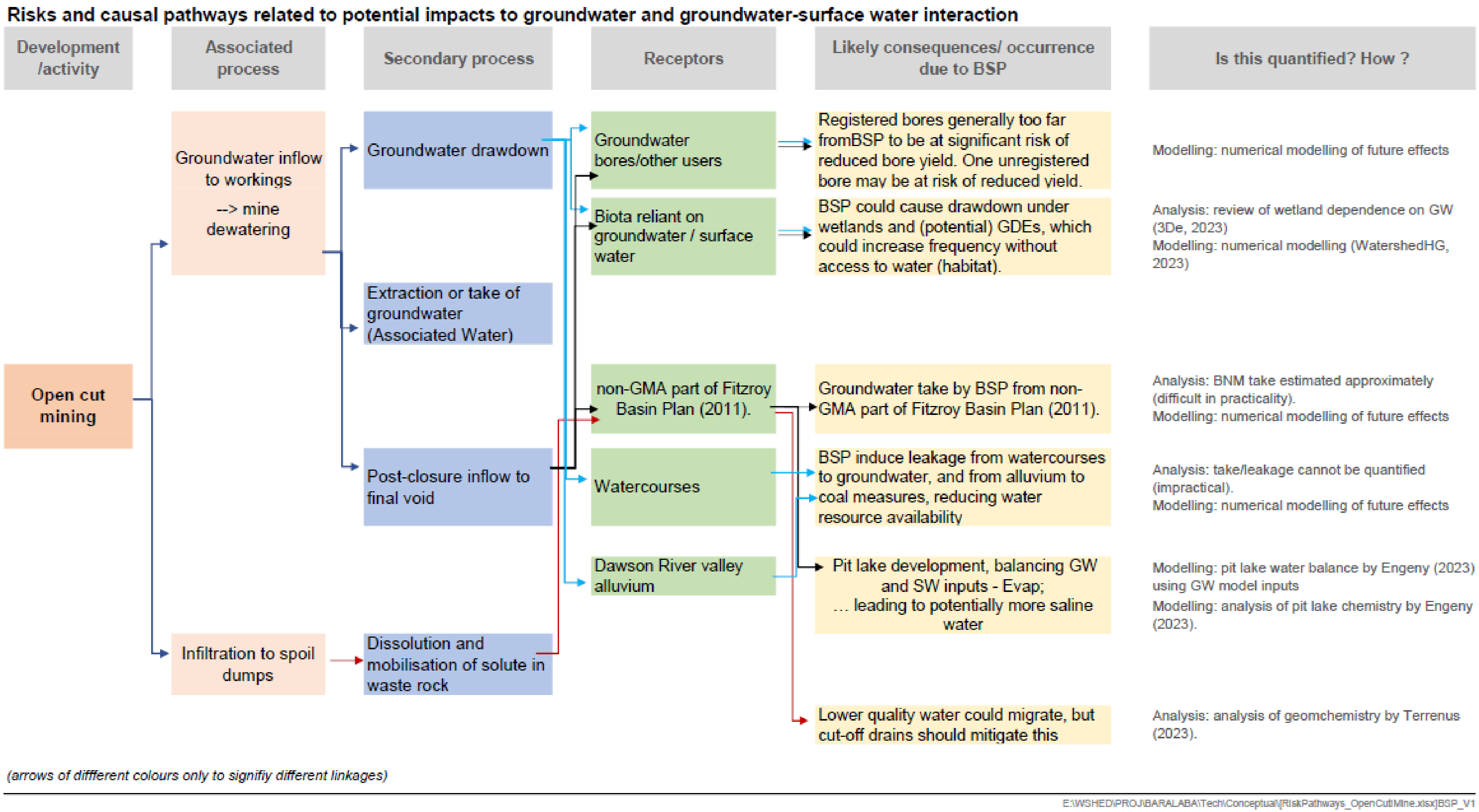


Figure 5-4 Causal pathways for potential impacts to water assets related to BSP

6 Numerical model – design and calibration

The purpose of **Sections 6 and 7** of this report are is to describe the numerical model setup, calibration or history-matching, and subsequent predictive scenarios undertaken considering uncertainty.

6.1 Modelling objectives

The numerical model must be able to represent the groundwater system, and the mining within in it, to a reasonable degree in order to provide quantified estimates of groundwater-related effects from the Project. Based on the recommended approach of Peeters and Middlemis (2023), the Quantities of Interest (QOI) are:

- Inflow to mine pit – this to inform licensing requirements and to inform the site water balance conducted as part of the Surface Water Assessment;
- Surface water flow losses (via changes in groundwater-surface water interaction)- aggregated for four (4) reaches or zones of the Dawson River and Banana Creek:
  - Dawson River (Upstream) [Zone E] - (groundwater model reach 7);
  - Dawson River (Upstream of Neville Hewitt Weir) [Zone D] - (groundwater model reach 21);
  - Dawson River (Downstream of Neville Hewitt Weir) [Zone C] - (groundwater model reach 2);
  - Banana Creek - (groundwater model reach 31);
- Groundwater drawdown at private bores - primarily Ross, Webb and Riverland;
- Groundwater drawdown at potential GDEs – although wetlands in this area are predominantly surface water fed and/or perched (**Section 3.5.2 and 5.1.2**);
- Spatial distribution of groundwater drawdown – drawdown contour maps;
- Change in flux to/from GAB - simulated as GHB reach 21, on western edge of model);
- Long-term inflow to pit related to groundwater level recovery and potential pit lake development.

The outputs above are produced for a specific (assumed) mining schedule (**Sections 1.2.1 and 7.2**).

To provide more confidence in the model's ability to inform the impact assessment and decision-making process, 'calibration' to field measurements of groundwater levels, transient change in groundwater levels ("drawdown") and to estimated inflow estimates for BNM has been carried out via history-matching. Model development and history matching are described in Section 6.2 to 6.8.

It is noted that no underground mining operations are proposed as part of the BSP. Therefore, surface subsidence caused by underground goafing would not occur. Any residual subsidence associated with strata relaxation at the edge of the open cut, or related to dewatering and depressurisation of groundwater from the surrounding formations at the BSP (i.e. Permian coal measures) and to a far lesser extent in the overlying Quaternary sediments would be negligible and immeasurable for off-site open cut effects, and therefore is not considered any further.

6.2 Modelling approach

Figure 6-1 summarises the modelling workflow, which has been designed to facilitate history-matching or calibration of the groundwater model leading to predictive modelling that incorporates quantitative uncertainty analysis

The workflow adopts the industry-standard parameter estimation and uncertainty analysis software, PEST and PESTPP (Watermark Numerical Computing, 2018; White et al., 2020) as a central element, coupled with a MODFLOW groundwater model. Much of the pre-processing was done in Groundwater Vistas 8, as well as other custom python scripts.

The design of the groundwater model is described in **Section 6.3**-onward, including model calibration or history-matching. The subsequent application of the model to make forecasts of behaviour and effects associated with the project under uncertainty, and which relies on the ensemble approach of PESTPP-IES, is described in **Section 7**.

Model history-matching is considered in the Model Confidence Classification (**Section 6.2.1** and **Appendix F**). Model history-matching is also commonly referred to as model "calibration" and the terms may be used interchangeably.

6.2.1 Sensitivity analysis

As noted above, PESTPP-IES has been used, and done so in combination with pilot points for hydraulic conductivity and storage parameters to develop a large number of alternative model realisations. This highly parameterised method is focussed on simulating the key predictions or "Quantities of Interest" multiple times with a range of parameter values to provide a quantified estimate of uncertainty. The parameter sensitivities developed in **Sections 6.9 and 6.10** are embedded in this quantification of uncertainty presented for the predictions in **Section 7.3**.

This therefore precludes the need for a formal sensitivity analysis which is typically done to assess the scale of changes to model outputs as a result of changing input parameters, Doherty (2022) states: *With the availability of regularised, highly parameterised inversion, sensitivity analysis, undertaken for this reason, is no longer required*".

6.2.1 Model confidence classification

The Australian Groundwater Modelling Guidelines [AGMG] (Barnett et al., 2012a) recommend adoption of "confidence level" classification terminology with further guidance on the application of the classification provided by Middlemis and Peeters (2018), although we note that Peeters and Middlemis (2023) appear to be moving away from the confidence classification. That said, there remains value in the classification.

The confidence level classification comprises Class 1, Class 2 and Class 3, in order of increasing confidence. Confidence typically depends on the available knowledge and data, consistency between the calibration conditions and predictive analysis scenario, and the level or severity of stresses being simulated (relative to baseline conditions). The AGMG includes a table of quantifiable indicators with which to assess a models confidence level based on those attributes. Middlemis and Peeters (2018) recommend that the confidence level should be determined by indicating which attributes in the table are satisfied for a given model and considering the score counts in each class.

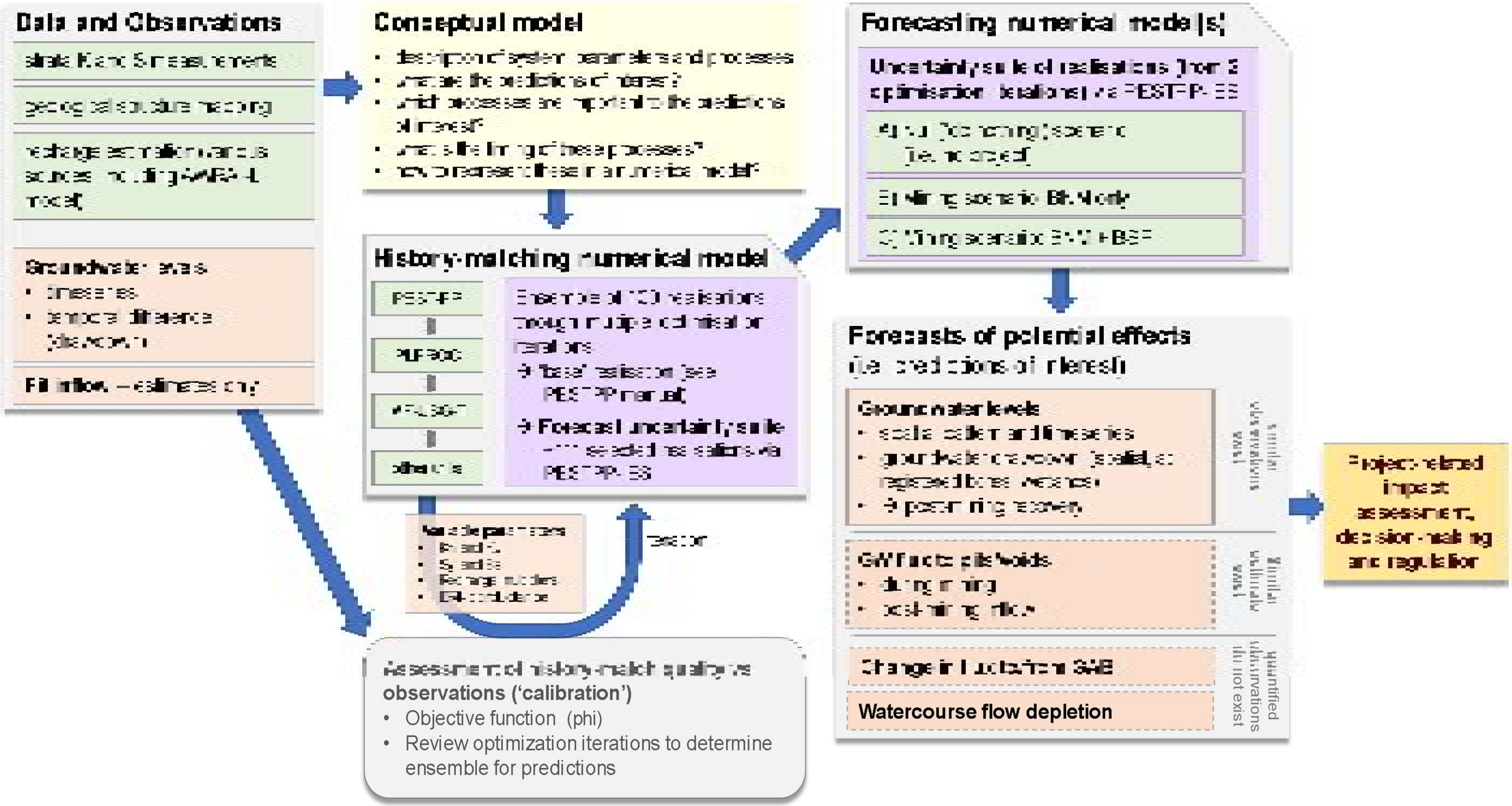


Figure 6-1 Workflow to integrate data and to achieve modelling objectives

Using this approach, the current project groundwater model is considered to satisfy some attributes of the different confidence classes. Overall, it is considered to be a 'Class 2' (medium confidence) model but is currently limited by temporally and spatially sparse datasets (e.g., groundwater levels, permeability testing, geological characterisation), and especially so by a lack of flux data or targets (e.g., baseflow) and mine inflow (although inflow rates are estimated by engineers/field staff, they are not measured *per se*). In addition, the currently simulated BNM mine plan is not up-to-date. The annotated classification table, updated after model development, is included in **Appendix G**.

It is considered that the ensemble approach to model predictions is most suitable for the current level of knowledge. In the future, other approaches may become more appropriate.

6.3 Modelling software

The numerical groundwater model for Baralaba Coal operations has evolved over the past decade, but remains in the MODFLOW family of model software. MODFLOW (McDonald and Harbaugh, 1988), originally developed by the United States Geological Survey (USGS) is the most widely used code for groundwater modelling and has long been considered an industry standard.

This software uses the "equivalent porous medium" approach. Although this is a simplification of the real-world situation, the AGMG state "Fractured rock aquifers are commonly modelled as equivalent porous media and this assumption is usually valid for large-scale groundwater flow models".

6.3.1 Previous BNCOP Numerical Model (MODFLOW- SURFACT)

The groundwater impact assessment for the BNCOP EIS was based on a regional MODFLOW-SURFACT groundwater model developed and reported in HydroSimulations (2014). MODFLOW-SURFACT was an advanced version of the original USGS code, developed and sold by HGL.

Model predictions were made on the basis of a calibrated numerical groundwater model using available datasets (including mining activities at the Baralaba North Mine at that time), and was capable of simulating observed groundwater levels with reasonable accuracy.

The approximate BSP extent was included within the MODFLOW-SURFACT groundwater model for assessment of cumulative impacts for the BNCOP, but as specifically noted at the time, was a secondary feature of the model and recognised that a refined numerical groundwater model would be developed separately for the BSP (including detailed mine progression/scheduling information, final void design and additional baseline datasets).

That is, vice versa, the inclusion of the Baralaba North Mine in the BSP numerical groundwater model is a secondary feature of this study (for the purposes of cumulative assessment), and does not supersede nor re-assess the previously approved groundwater assessments presented for the BNCOP (HydroSimulations, 2014). Nevertheless, the previous BNCOP numerical groundwater model has been used to demonstrate that the results presented for the BSP numerical groundwater model remain generally consistent, in particular the total volumes and rate of groundwater inflows predicted to the open cut pits (**Section 7.7**).

6.3.2 BSP Numerical Model (MODFLOW-USG)

The current BSP numerical groundwater model was developed by HydroSimulations/SLR in 2020-21 and is based on the earlier BNCOP model. The main changes to the model were:

- an extension to the south to cover the BSP area; and

- a change to use the MODFLOW-USG-Transport software (sometimes referred to as "MODFLOW-USG-T").

MODFLOW-USG (Panday et al., 2013) represents a major revision of the MODFLOW code, in that it uses a different underlying numerical scheme: control volume finite difference (CVFD), rather than traditional MODFLOW's finite difference (FD) scheme. MODFLOW-USG-T is another advanced and more recent version of the MODFLOW software family, written by Panday (2022), where v.1.10 was used for much of this project.

Like MODFLOW-SURFACT, MODFLOW-USG is able to simulate variably saturated flow and can handle desaturation and re-saturation of multiple hydrogeological layers without the "dry cell" problems of traditional MODFLOW. This is pertinent to models which simulate layers, such as surficial regolith, which frequently alternate between unsaturated and saturated, as well as the depressurisation and desaturation that occur due to mine excavation. This model uses the 'upstream weighting' function of MODFLOW-USG-T is used to simulate unsaturated conditions in the current MODFLOW-USG model. The parameter values that were selected for the upstream weighting function in the MODFLOW-USG model were aimed at producing model predictions that are consistent with the BNCOP (2014) model.

A number of individual 'packages' are used within MODFLOW for different purposes including those discussed in the following sections:

- LPF – MODFLOW 'Layer-Property Flow' package;
- GHB – MODFLOW 'General Head Boundary' package;
- RIV – MODFLOW 'River' package;
- RCH – MODFLOW 'Recharge' package;
- EVT – MODFLOW 'Evapotranspiration' package;
- HFB – MODFLOW 'Horizontal Flow Barrier' package;
- DRN – MODFLOW 'Drain' package;
- TVM – MODFLOW 'Time-Varying Material Properties' package;

Further details of the MODFLOW-USG model design and construction (including geometry, mesh, boundary conditions, etc.) used for the BSP numerical groundwater model is provided in the following sections.

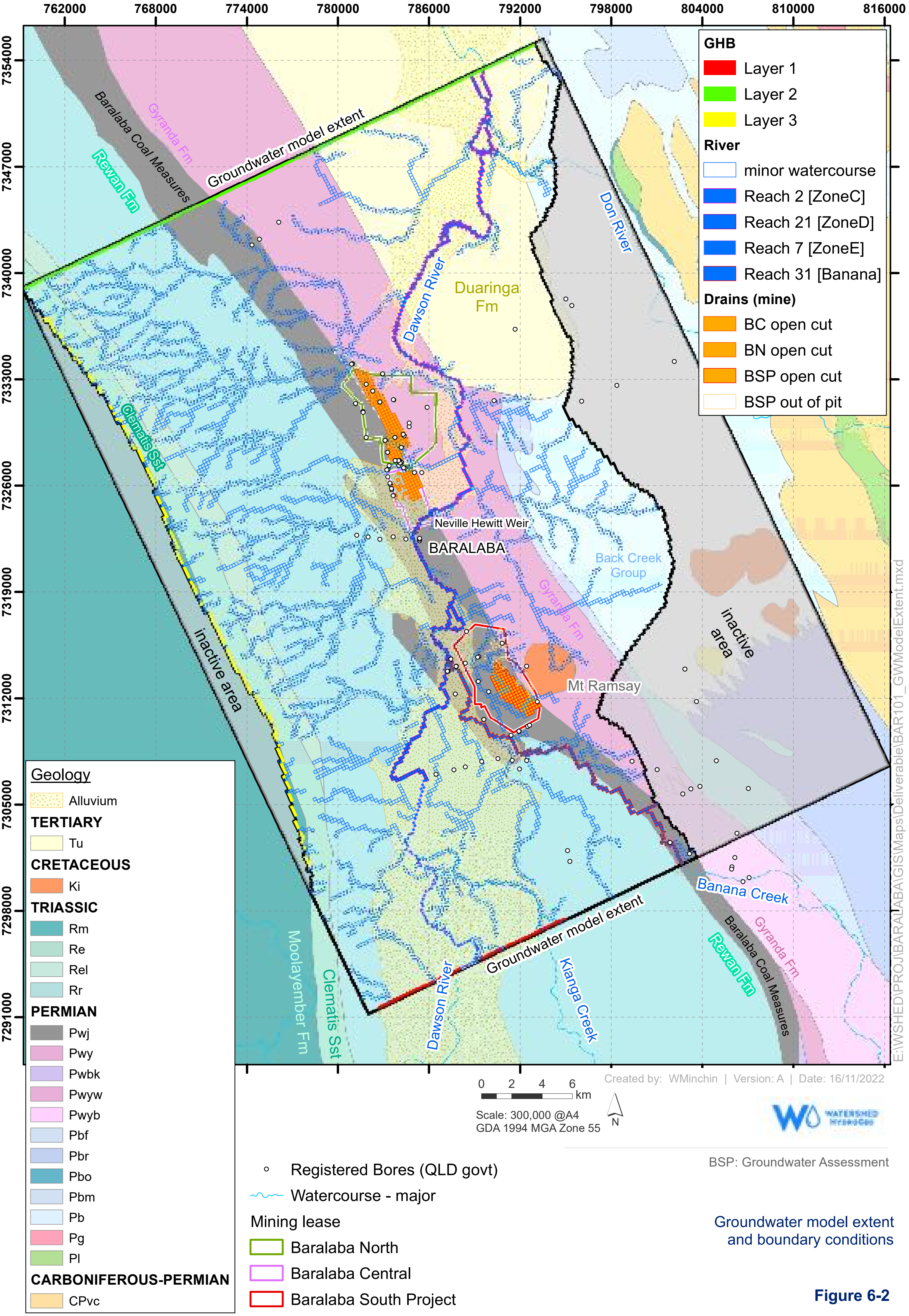
6.4 Model structure

6.4.1 Spatial discretisation: model mesh

The BSP numerical groundwater model covers an area of approximately 2,000 km^2 and extending roughly 38 km from west to east (actually WSW to ENE) and 53 km from south to north (actually SSE to NNW).

Although MODFLOW-USG is used, the rectangular model grid has been retained for the BSP numerical model. The model grid is shown on **Figure 6-2**, with each cell being a regular 200 m by 200 m. Over the 17 model layers the BSP numerical groundwater model has a total of 855,950 cells, with 640,428 of these being active.

The model is centred on the Dawson River valley, but by comparison to the BNCOP model, has been extended approximately 10 km to the south to better cover the BSP area.



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BSP: Groundwater Assessment

Groundwater model extent and boundary conditions

Figure 6-2

The western edge is located just west of the Dawson Range. The Dawson River enters the model domain on the southern boundary, immediately downstream of the confluence of Roundstone Creek, and exits via the northern boundary. Consistent with the previous BNCOP groundwater model, the eastern edge is partially congruent with a catchment divide, although in some areas it is incongruent with a divide, and is a somewhat arbitrary boundary drawn for practicality, however would not affect the model's ability as an impact assessment model given its distance, and considering the strike and sub-cropping of the coal measures.

6.4.2 Hydrostratigraphy and model layering

The 3D regional geological model developed to provide layers for the previous BNCOP numerical groundwater model was again used for the BSP. The regional geological model was built covering 120 km x 120 km, which was deliberately a much larger area than the numerical groundwater model domain (**Section 6.4.1**). The reason for this was to take advantage of substantial geological datasets and information from a variety of local and regional sources, including:

- two local-scale geological models, that covered:
  - the BNM mine area; and
  - the BSP area.
- 1:500,000 scale solid geology outcrop mapping of the Bowen Basin (CSIRO, 2008) – modified slightly as per Figure 4-2 based on the local-scale geological models;
- 1:2 million scale geological mapping of Qld (available from Qld Government); and
- stratigraphic details from bore completion reports available for the following CSG exploration programs/studies that included the Rewan Formation and the Baralaba Coal Measures:
- Arrow – Baralaba-2C (Arrow Energy, 2010);
- Arrow – Coomooboolaroo-1 (Arrow Energy, 2008);
- OCA (Oil Company of Australia) – Friendly Hill-1 (OCA, 2004);
- Bronco – Kullanda-1 (GeoConsult, 2010); and
- MIM – Kinma-A1 (MIM, 1994).

The geological and stratigraphic framework devised for the BSP numerical groundwater model is presented in **Figure 6-3** (and the outcropping extent of most of these units is evident from **Figure 6-2**). This stratigraphic framework is the same as that used for the BNCOP numerical groundwater model, with the exception of an additional layer included by dividing the basement layer (BNCOP Model Layer 16) into two to specifically model the basal sub-unit Kaloola Member as new Layer 16, separate from the basement layer (Gyranda Formation).

The geological and stratigraphic framework for the BSP numerical groundwater model was built in ArcGIS 10, using the Spatial Analyst 'Topo To Raster' and 'Raster Calculator' tools, to interpolate and ensure consistency between layers (i.e. no overlaps or negative thicknesses).

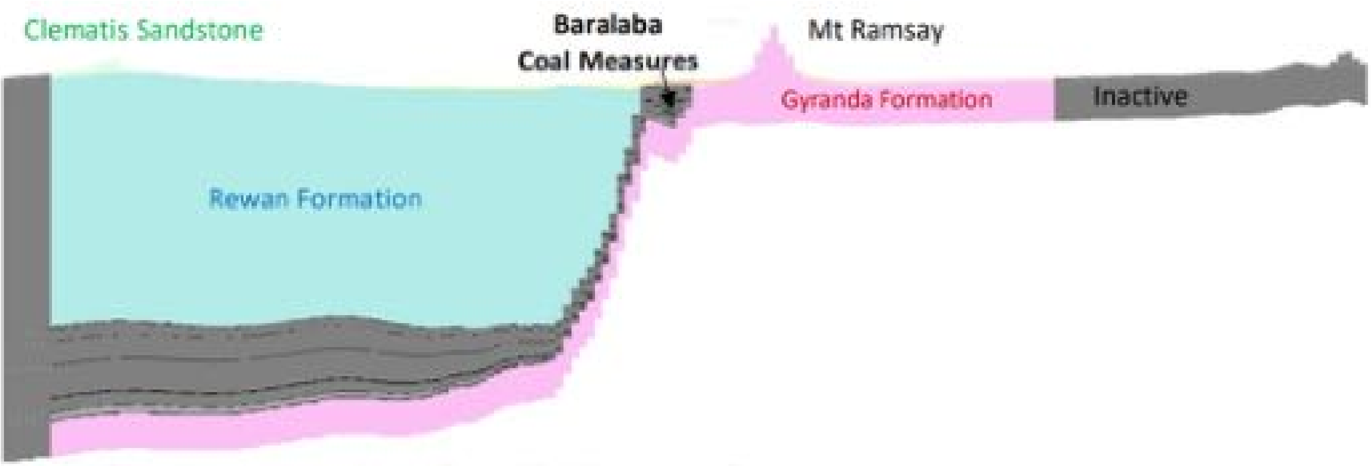
INDICATIVE THICKNESS (m)	MODEL LAYER	COLOUR	LITHOLOGY FAR WEST	LITHOLOGY WEST	LITHOLOGY CENTRE	LITHOLOGY EAST	FORMATIONS
20	1		Clematis Sandstone	Alluvium or Regolith	Alluvium or Regolith	Alluvium or Regolith	Quaternary & Tertiary Sands; Clematis Ss
20	2		Rewan Gp	Colluvium or Regolith	Colluvium or Regolith	Colluvium or Regolith	Quaternary & Tertiary Sands; Rewan Gp
25	3		Overburden	Overburden	Overburden	Overburden	<u>Baralaba Coal Measures</u>
3	4		A Coal Seams	A Coal Seams	A Coal Seams	A Coal Seams	Moody & Boyd Seams
45	5		Interburden	Interburden	Interburden	Interburden	Baralaba Coal Measures
3	6		B Coal Seams	B Coal Seams	B Coal Seams	B Coal Seams	Cameron & Reid Seams
50	7		Interburden	Interburden	Interburden	Interburden	Baralaba Coal Measures
3	8		C Coal Seams	C Coal Seams	C Coal Seams	C Coal Seams	Doubtful & Sub-Doubtful Seams
50	9		Interburden	Interburden	Interburden	Interburden	Baralaba Coal Measures
5	10		D Coal Seams	D Coal Seams	D Coal Seams	D Coal Seams	Dawson & Dunstan Seams
85	11		Interburden	Interburden	Interburden	Interburden	Baralaba Coal Measures
8	12		E Coal Seams	E Coal Seams	E Coal Seams	E Coal Seams	Wright, Double & Coolum Seams
40	13		Interburden	Interburden	Interburden	Interburden	Baralaba Coal Measures
3	14		F Coal Seams	F Coal Seams	F Coal Seams	F Coal Seams	Dirty & Sub-Dirty Seams
120	15		Interburden	Interburden	Interburden	Interburden	Baralaba Coal Measures BASE
10	16		G Coal Seams	G Coal Seams	G Coal Seams	G Coal Seams	Kaloola Member Seams
170	17		Basement	Basement	Basement	Basement	Gyranda Formation

Figure 6-3 Geological and Stratigraphic framework and groundwater model layers –

The key points for the geological and stratigraphic framework for the BSP numerical groundwater model are:

- Consistent with the BNCOP model, coal seams were 'lumped' together, as per **Figure 6-3**, in order to minimise the number of model layers required. This is typically done in pairs, and the model layer representing coals, e.g. Layer 4, has been constructed using the combined coal seam thickness of the relevant coal seams:
    - (e.g. Moody and Boyd seams), based on picking the floor of the lower coal seam (i.e. Boyd), and adding the combined seam thickness to this. This then honours the total transmissivity of the coals as much as possible, even though they were 'lumped' rather than modelled as individual layers.
- As for the BNCOP model, the CSG bores provided useful data for extrapolating the stratigraphic layers away from the local-scale geological models. However, they usually only provided the top and sometimes the base of the Baralaba Coal Measures, and rarely provide information on the thickness or elevation of the component overburden or coal seams.
- In the area between the two local-scale geological models, (i.e. between the BSP and BNM), the coal seam (combined per 2-seam layer, as in **Figure 6-3**) and interburden elevations were interpolated consistent with the BNCOP model.
- Away from the local-scale geological models, and toward the northern, southern and western edges of the model coal seam thickness was preserved as best as possible (i.e. extrapolated using the nearest edge of the local-scale geological models), and the interburden layers thickened or thinned according to the Baralaba Coal Measures top and bottom elevations at the nearest exploration bore. Again, this was done to honour coal seam transmissivity, although it is acknowledged that coal seams may be variable, discontinuous and or absent in areas.

Layer geometry and corresponding aquifer parameters are attributed using the MODFLOW BAS and LPF packages. A cross-section through the BSP numerical model is presented in **Figure 6-4**. This section is east-west through the BSP area.



Source: Groundwater Vistas. Model Row 190. With Vertical Exaggeration.

Figure 6-4 Cross-section through numerical model

The top surface of Layer 1 in the model relies on topographical data (DEM – Digital Elevation Model) which is the 3 second resolution data from the SRTM dataset, provided by Baralaba South Pty Ltd . In translating the underlying geological model layers into groundwater model layers, the following points are relevant:

- Groundwater model layers typically each represent one of the stratigraphic layers listed in **Figure 6-3**.
- Model Layer 1 is present across the full model domain, representing alluvium and colluvium where these are mapped as being present, and representing the upper 1 metre of weathered rock/soil in areas where alluvium and colluvium are not present.
- Other model layers represent the primary stratigraphic layering as shown in **Figure 6-3**, but where that stratigraphic unit is absent, they are 'passed through' the base or top of overlying/underlying layers, assigned a 1 metre thickness, and also assigned the hydraulic properties of the overlying/underlying layer. This is especially pertinent for the areas within and to the east of the BSP area, where the Baralaba Coal Measures are absent – in these areas the layers that represented the coal and interburden in the west of the model domain are passed through the base of the weathered strata (within the mine areas) or through the top of the Gyranda Formation to the east.

Indicative thicknesses for each of the groundwater model layers are listed in **Figure 6-3**. It is noted that the basement layer (BNCOP Model Layer 16) was split into two (10 m and 190 m) to specifically model the basal sub-unit Kaloola Member as new Layer 16, separate from the basement layer (Gyranda Formation).

6.4.2.1 Structure and faulting

Faulting within the Study Area has been identified by a number of sources:

- Regional mapping (CSIRO, 2008);
- Local-scale geological models (**Sections 2.4.1.3 and 2.4.4**); and
- Transient electromagnetic (TEM) survey by Groundwater Imaging (2013)
  [NB: while not specifically relevant to the BSP area, the TEM survey results provided greater insight for the BNCOP area and is reported in full in HydroSimulations, 2014].

Geological faults have been incorporated into the numerical groundwater model in two ways:

- Those from regional and local scale geological have been incorporated into the geological model surfaces. That is, flow barrier boundary conditions and/or zones of enhanced permeability have not been used to simulate these structures. As coal continuity is assumed across these structures, estimates for distant environmental effects would be conservative.
- The faults identified in the TEM survey data at the BNM have been simulated using flow barriers (MODFLOW HFB package). They have been specified in model Layers 2-16 (i.e. not in Layer 1, which is the alluvium and colluvium). In Layers 3-16 the HFBs have been set with a horizontal hydraulic conductivity equal to that of the least permeable Permian stratum in the groundwater model, while in Layer 2 the hydraulic conductivity is specified as an order of magnitude lower than the surrounding weathered material.

Besides the elevated topography associated the igneous trachyte at Mt Ramsay, the structure has been conservatively represented as a continuation of the Gyranda Formation in the model, and not a barrier to groundwater flow.

Figure 6-5 presents an oblique view of the model domain, looking north-west, which shows the dip of thickening of the Permian coal measures to the west (toward the Mimosa Syncline – **Section 2.4.1.1**), with the overlying Triassic Rewan Formation also thickening to the west. The unconsolidated deposits form a thin veneer of these Permian and Triassic units within the Dawson River valley. Mount Ramsay and Dawson Range are the obvious topographic and structural features at surface.

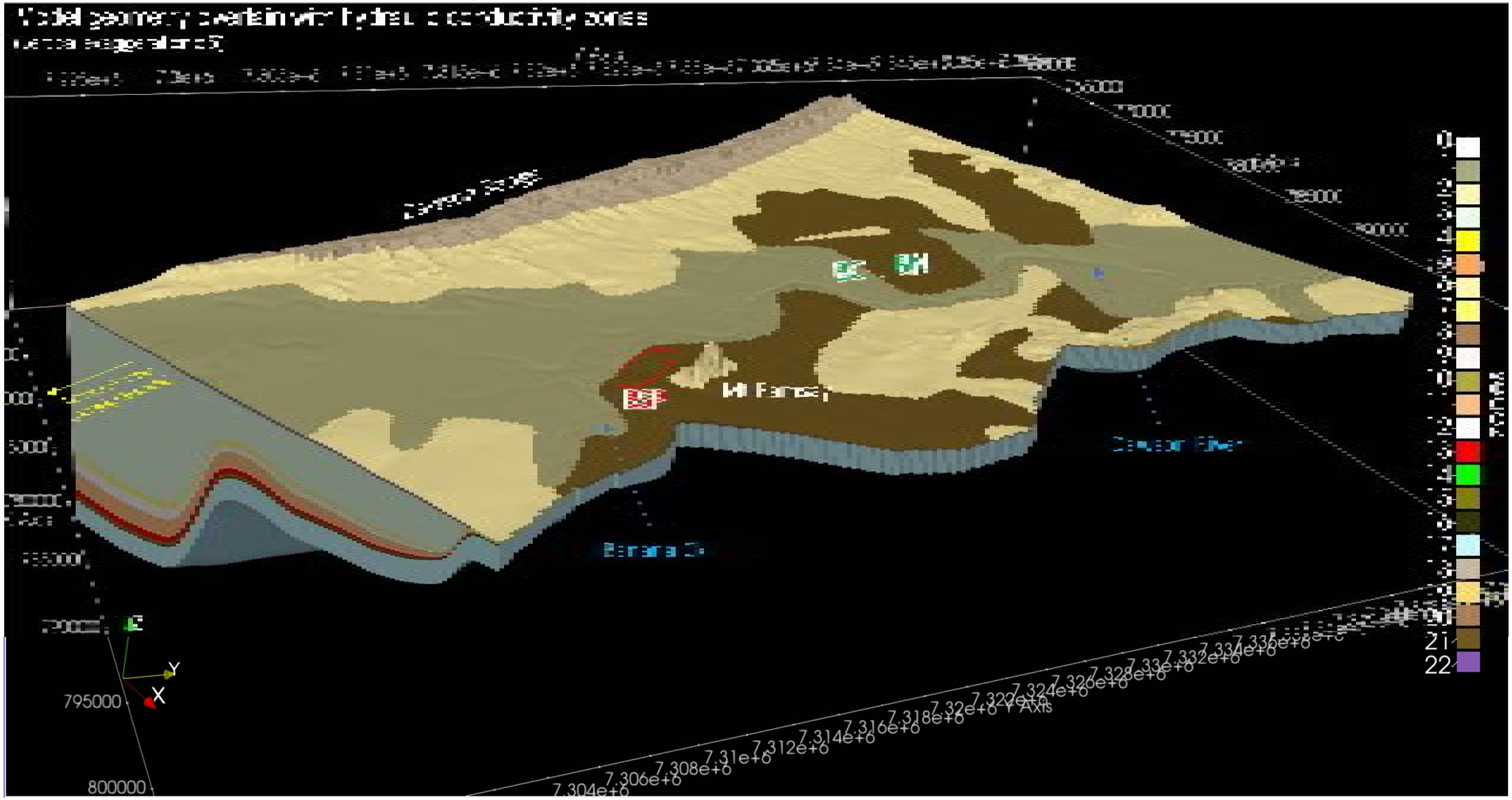


Figure 6-5 3D view of model structure

6.4.3 Temporal discretisation: model stress periods

The model stress period schedule is included as **Appendix C** to this report, along with annotations of mining schedule (for predictive simulations).

The transient historic groundwater model was run for the period 1970 to present day. The 1970 start data is consistent with the previous work of HydroSimulations/SLR. This historical period is discretised into a total of 45 stress periods:

- A steady state stress period (Stress Period 1) representing the pre-development, and particularly pre-regulation, of the Dawson River at Baralaba (i.e. this period excludes the ponded storage behind Neville Hewitt Weir, and is simulated before the weir was constructed in 1976) (i.e. 1970).
- A transient stress period (Stress Period 2) to June 2005, in this stress period the Neville Hewitt Weir was constructed and during this period river levels on the Dawson River upstream of the Baralaba township rose in response to impoundment behind the weir.
- Transient stress periods (Stress Periods 3-45) of variable duration after that to simulate the development of the Baralaba North Mine.
  - from 2005-2008, the stress periods are 4 months long to align with the provided Baralaba Central mine schedule
  - from November 2008 to 2017, there are 11 stress periods that are typically 1 year long, with some shorter periods to accommodate the period of flooding around January 2011 and subsequent recession after that flooding.
  - then there is a series of 22 quarterly stress period to mid-2023, and a 6-monthly period to the end of 2023, which is the end of the historical period.

The subsequent predictive period is set as 2024 to 2500, represented as a further 45 stress periods (a total of 90 for the historical and predictive period). Stress periods are set at an annual resolution for the duration of BSP mining, extending to decades and then centuries to represent very long-term post-closure conditions (**Appendix C**, and Section 7.1 for further detail). This allows simulation of the progressive changes to the groundwater system in response to mining and dewatering.

6.5 Boundary conditions

A summary of the boundary conditions is presented in the following sub-sections, documenting inactive areas, general head boundaries, watercourses, recharge, evaporation and mine dewatering. **Figure 6-6** shows an overall view of boundary conditions in the numerical model.

6.5.1 Inactive areas

Inactive areas are shown in grey on **Figure 6-2** (and are not shown, i.e. blanked out, in **Figure 6-6**). These lie to the west of the Dawson Range, and to the east of the Dawson River valley. Consistent with the BNCOP numerical groundwater model, the eastern boundary was drawn (and extended in the south near BSP) to follow the topographic divide.

6.5.2 Regional groundwater flow

MODFLOW's General Head Boundaries (GHB) package was used to apply general head conditions at the edge of the model to simulate groundwater entering and leaving the model domain. This includes parts of the model associated with the alluvium and weathered Permian units in Layer 1.

6.5.3 Watercourses (creeks and rivers)

Watercourses including Dawson River, Banana Creek and other drainage features were represented using the MODFLOW River (RIV) package (**Figure 6-2** and **Figure 6-6**).

- Dawson River – Upstream: The river cell set up is based on Upstream Dawson River stream station data, with two metres stage (depth) of water and the river bottom elevation based on the zero gauge data about 12-15 mbg.
- Dawson River – Upstream of Neville Hewitt Weir: stage height of 79 mAHD based on weir crest stage close to the surface, which then lowers back down to around 12 mbg (as topography increases) south of the weir with two to six metres stage (depth) of water.
- Dawson River – Downstream of Neville Hewitt Weir: stage height based on the DEM, with a one metre stage (depth) of water, and river bottom elevation is approximately 4 m below the general natural surface.
- Banana Creek: stage height based on the DEM, with approximately two metre stage (depth) of water, and river bottom elevation is approximately 3 m below the general natural surface. The simulated head of water means that consistently represents wet conditions for conservatism related to predicted leakage.
- Other watercourses / drainage features – stage height based on the DEM, with a zero stage (depth) of water. This means that these boundaries act in the same way as MODFLOW Drains, and allow baseflow (groundwater discharge) but do not allow leakage from the watercourse to the aquifer.
- All River cells were assigned to layers based on the elevation of the riverbed, most River cells are within layers 1 and 2, but some in layers 3 and 4.

Riverbed conductance remained constant in the calibration process (and for subsequent predictions). Most Dawson River cells have a conductance of 100 m^2/d, which is representative of a 10 m wide channel, a bed thickness of 1 m and a vertical K of 0.05 m/d. Higher conductances (125 m^2/d) are used on the minor tributaries.

The following details were also added during the modelling process:

- A pre-Neville Hewitt Weir stage based on topography for all watercourses in the first model stress period, which was then altered for all River cells upstream of Baralaba to be 78 mAHD (or above, if topographic data indicated this), based on the storage level of the weir.
- A user-specified head was applied to all River cells of 6 metres above the River bed for a single model stress period in early 2011 to represent the occurrence of significant flooding along the Dawson River. After that period River stages returned to the previously specified level.

General head conditions were also applied in Layers 2 and 3 at the western extent of the model, consistent with the approach adopted for the BNCOP numerical groundwater model, to represent the groundwater resources within the Great Artesian Basin (GAB) aquifers in that area.

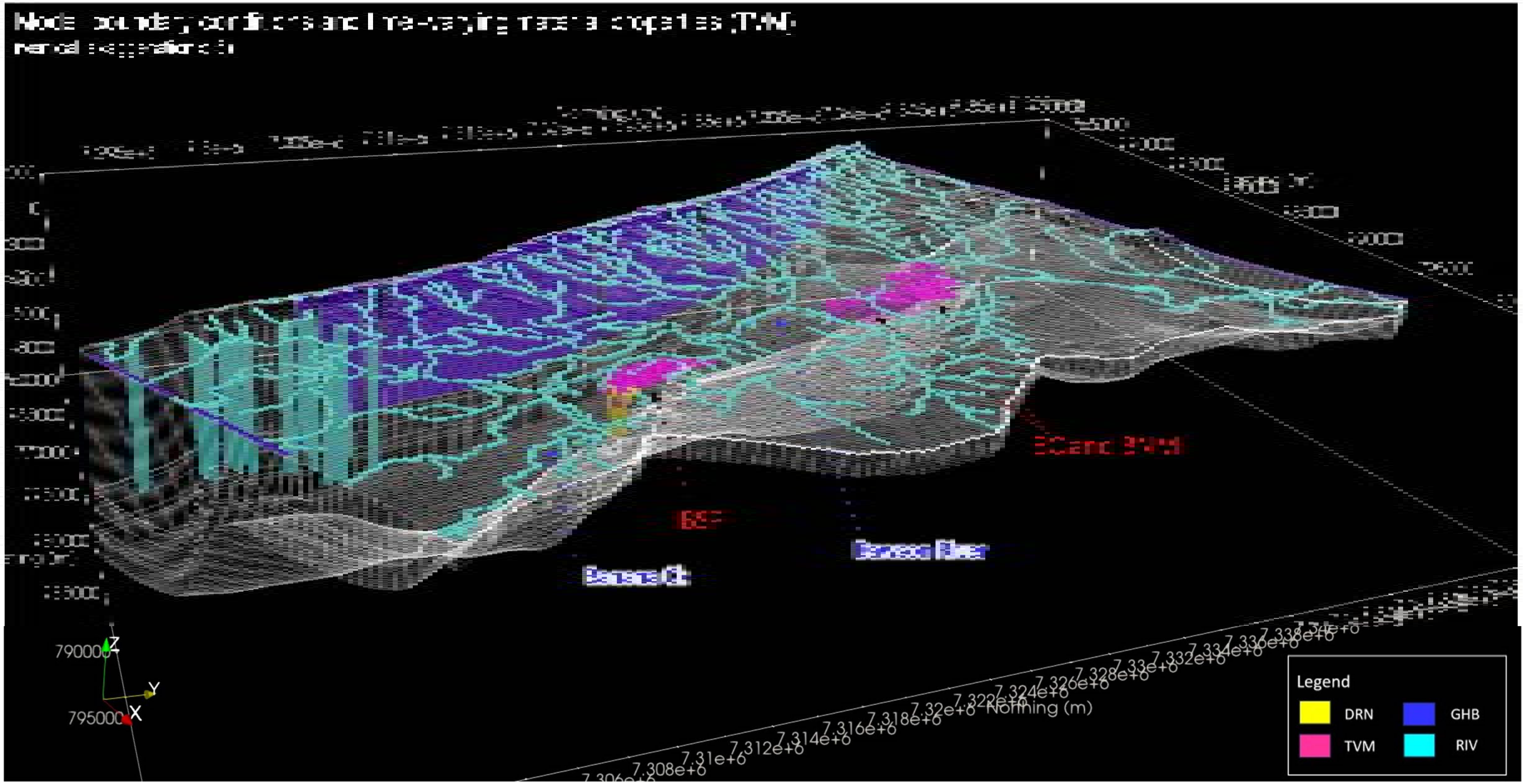


Figure 6-6 3D view of model boundary conditions and altered material property cells

6.5.4 Rainfall recharge

Rainfall recharge is applied to each active model cell as a percentage of actual rainfall using the MODFLOW RCH package. Four zones of differing recharge rates (**Figure 6-7**) were set-up in the model based on the natural outcrop geology (**Figure 2-9**), as follows:

- 1) alluvium;
- 2) Permian regolith;
- 3) Clematis Sandstone and Duaringa Formation; and
- 4) colluvium.

Additional zones were set for the spoil dumps (“in-pit” and “ex-pit spoil areas on **Figure 1-4** to **Figure 1-6**) to represent the likely enhanced infiltration occurring to these areas following emplacement.

Initial recharge rates were set based on the BNCOP model and then allowed to vary with consideration of “deep drainage” estimates from BOM’s AWRA-L landscape model, analysis provided by KCB and others for the Bowen Basin (**Section 3.7**).

The initial recharge estimate applied to the model (which was then adjusted by the parameter estimation and uncertainty analysis software, PEST) is essentially the BNCOP rate (as % of average rainfall) as per **Table 6-1**.

Table 6-1 Recharge zonation and estimates

Zone		Initial estimate (% rainfall)	Estimated annual average recharge	Comment	PEST multiplier range
1	**Triassic outcrop**	0.4 %	2.6 mm/yr	Transient sequence based on transient variation in the historical AWRA-L modelled deep drainage obtained from BOM.	0.1. to 5 (x initial estimate)
3	**Permian outcrop**	0.2 %	1.3 mm/yr		
3	**Clematis / Duaringa**	0.4 %	2.6 mm/yr		
4	**Colluvium**	0.2 %	1.3 mm/yr		
5	**Waste / spoil**	5 %	32 mm/yr		

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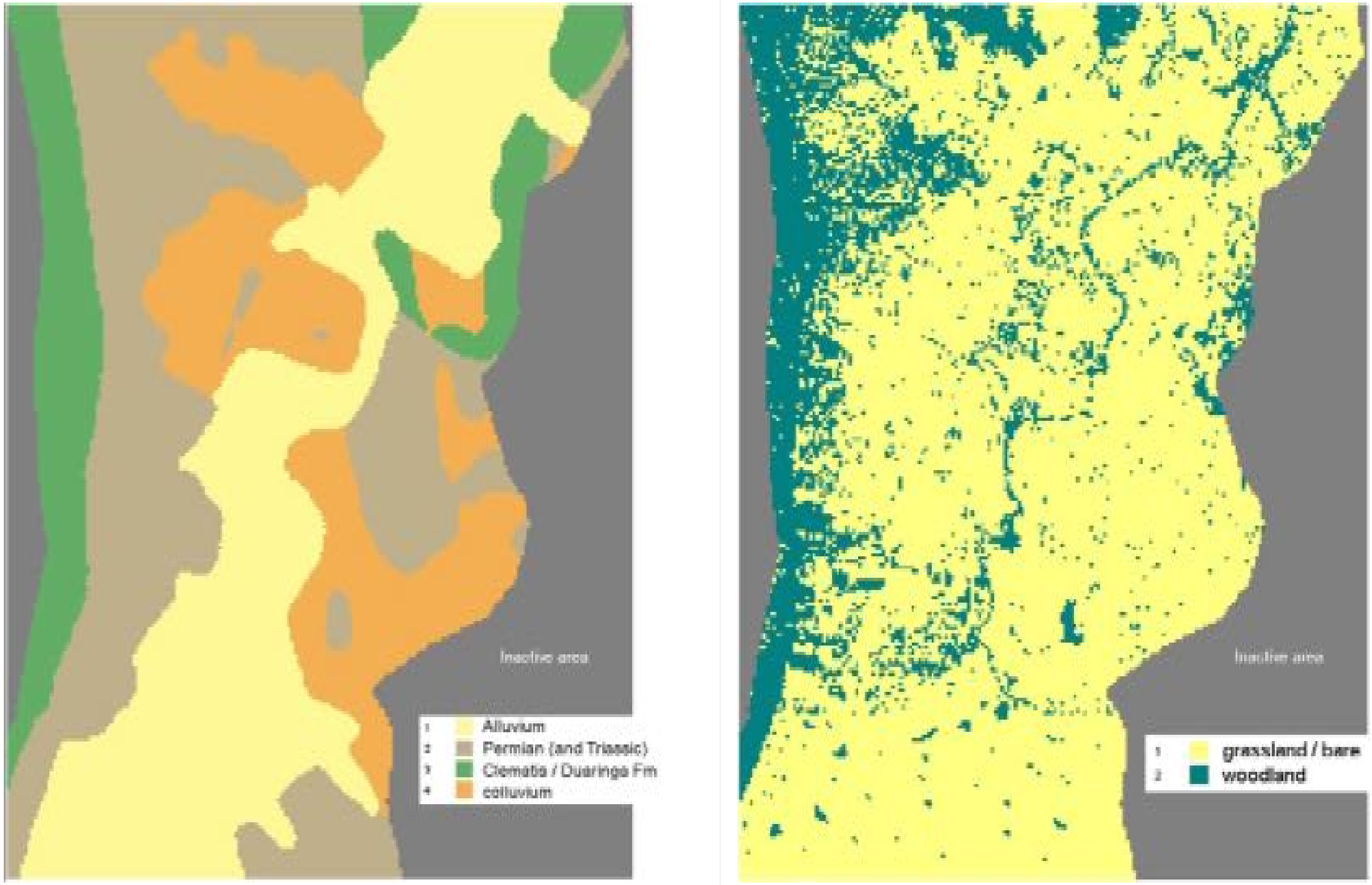
PEST -IES was supplied with a range of 0.1 to 5 as a multiplier on the initial estimate for each zone, which means that there was a significant amount of freedom to move those recharge estimates up and down within the PESTPP-IES realisations.



A) Recharge zones **B) Evapotranspiration zones**

Figure 6-7 Model recharge and evapotranspiration zones

Figure 6-8 shows that groundwater model simulates variable recharge rates until model stress period 45 (equivalent of late 2023). From then on, repeated average values were utilised to simulate recharge for stress periods 46-90 (to the end of the simulation period).

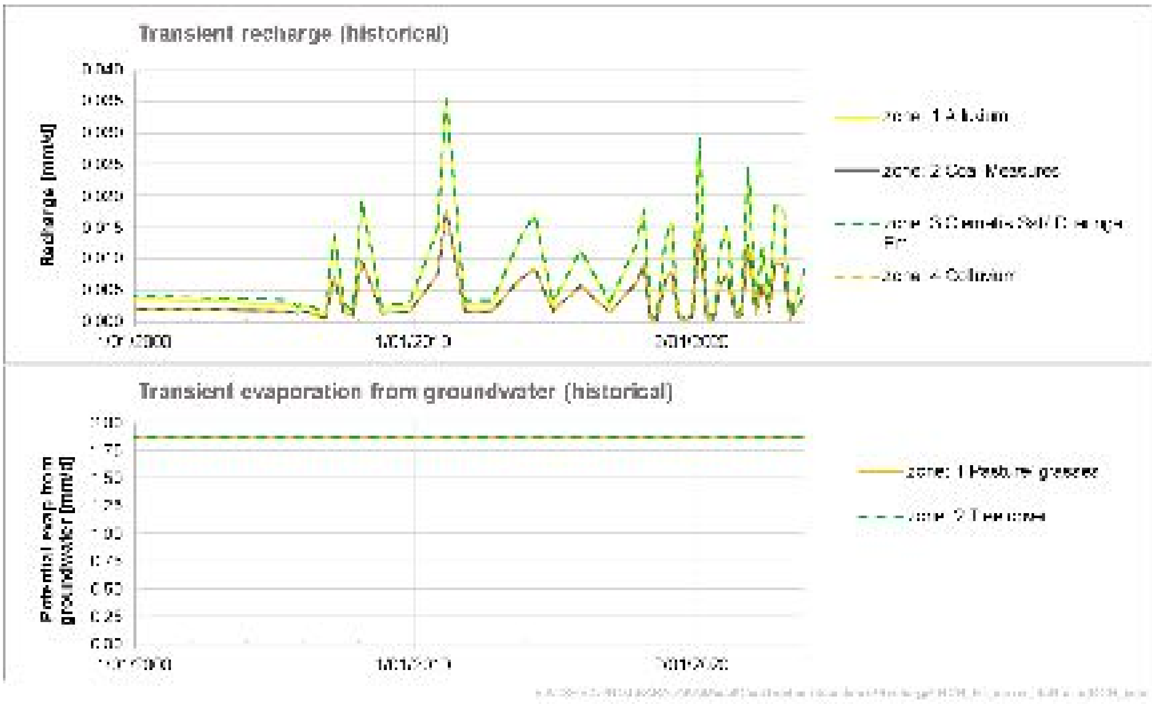


Figure 6-8 Model recharge and evapotranspiration sequences

Of note on **Figure 6-8** are the high rainfall/recharge periods in late 2010/early 2011, and during 2020-22, and generally lower recharge from 2013 through 2019.

The use of the multipliers by PEST mean that these sequences are shifted up and down according to the multipliers supplied (that is, the multipliers act consistently on the full transient sequence).

Flood recharge has only been represented by increasing the stage on River cells (using the MODFLOW RIV package) for a selected stress period (in 2011). The coverage of River cells was not increased, beyond that shown in **Figure 6-2** or **Figure 6-6**, to represent inundation of low-lying areas. This is also in consideration of the conceptualisation, with the presence of low permeability surficial clays that inhibit flood inundation outside of the riverbed. Due to the flooding period in 2011 that was a result of high rainfall, the rainfall recharge has been increased at this time and the river stage has been increased above the surface to create high recharge to groundwater. **Figure 3-13** shows the conceptual model of how during a flooding period, river stage is elevated and causes high recharge (leakage) to the groundwater.

6.5.5 Evapotranspiration

Evapotranspiration has been simulated using the MODFLOW EVT package. Two conceptual zones have been set based on vegetation cover. A simple analysis of trees versus grassland/ bare areas was completed in GIS based on aerial photography provided by Baralaba South Pty Ltd . The GIS calculation yielded reasonable results in terms of contrasting areas of trees versus grasses (assumed to be shallower-rooted). This was then used to assign zones for the MODFLOW EVT package as shown on **Figure 6-7**.

Evapotranspiration rates have been set using 'Actual ET' data from the BOM as described in **Section 2.1.2**. The annual average Area Actual Evapotranspiration shown by BOM's mapping is approximately 680 mm/year at Baralaba.

This rate of evapotranspiration from the groundwater table was applied to the MODFLOW EVT package for both grasses and trees. Maximum rooting depths (i.e. the depths to which the model attempts to take ET from the water table) have been assumed to be 3 m for the grasses and 8 m for trees for the BSP numerical model (**Figure 7-4**), consistent with the approach adopted for the previous BNCOP numerical groundwater model.

None of the EVT parameters have been adjusted by PEST.

6.5.6 Historical mine dewatering and other groundwater extraction

6.5.6.1 Mine dewatering

Drain cells (MODFLOW DRN package) were used to simulate previous mining at Baralaba North Mine (BNM), consistent with that for the BNCOP numerical groundwater model, with the drain invert based on the 'Cut' elevation data provided previously to HydroSimulations (2014). The drain conductance was unchanged and set at 400 m^2/d.

No prior mining or associated dewatering activities have occurred within MLA 700057, and therefore is not simulated at the BSP area in the historical model. However the set-up and parameterisation of BSP Drain cells for the predictive model uses the same methods as for the BNM (**Section 7.1.2**).

Initial estimates of drain conductance are shown in **Table 6-2**.

Table 6-2 Model Drain boundary conditions

Feature	Model Layer(s)	Cell geometry [m]	Conductance	Range for PEST
BNM (BC and BN pits)	1-16	200 x 200	20	0.05 to 500

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6.5.6.2 Groundwater extraction

As discussed in **Section 2.3.1 and 4.3.2**, it is understood that the supply of irrigation water for the nearby property 'Riverland' is sourced from the Dawson River, not the groundwater bores that occur on the property, and therefore no prior dewatering by neighbouring properties has been simulated in the BSP area. Thus, the MODFLOW WEL package was not used for the BSP numerical groundwater model.

6.6 Parameterisation – hydraulic properties

This section outlines the modelled hydraulic properties based on the compilation of data and review of literature presented **Section 3.6**.

Aquifer hydraulic properties, hydraulic conductivity (horizontal: Kh; and vertical: Kv), specific yield (Sy) and specific storage (Ss), were assigned to the groundwater model using a combination of pilot points and parameter zones. Note that in this report, Kx is used interchangeably with Kh, as is Kz with Kv.

6.6.1 Pilot point distribution

To allow PEST to adjust hydraulic conductivity and storage parameters in the groundwater model, the pre-processing software PLPROC (Watermark Numerical Computing) is used with pilot points. The combined K and S pilot point distribution is shown on **Figure 6-9**, and is based on:

- regularly spaced points on a 2x2 km grid pattern; and
- additional points placed at selected locations to ensure that zones (defined by geological mapping) are covered by pilot points to allow an appropriate interpolation;
- and some areas where zones are used, instead of pilot points (the weathered and older strata to the northeast of BSP).

This has resulted in a maximum possible 242 points per model layer. The number of pilot points to parameterise each stratigraphic unit or zone are summarised in Table E1 (**Appendix E**). Where this value is 1, it means that a single (but adjustable) value is used for that zone.

6.6.2 Hydraulic conductivity - horizontal (Kh or Kx)

The available dataset of hydraulic conductivity data is presented in **Section 3.6**.

Figure 6-10 summarises the initial values of Kx and the allowable range of these for pilot points in each model layer/zone. Note that there is broad trend of decreasing Kx with depth down to zone 17 (zones 18-21 are not in depth order).

Also of note:

- Coal seam permeability is typically one or two orders of magnitude greater than that of the interburden.
- Colluvium and weathered Permian coal measures horizontal permeabilities are relatively high.
- Rewan Formation vertical permeability is low, in line with literature, specifically GHD (2013b).

A summary of posterior values, i.e. those developed as a result of the PESTPP-IES history-matching process, are described in **Section 6.14**.

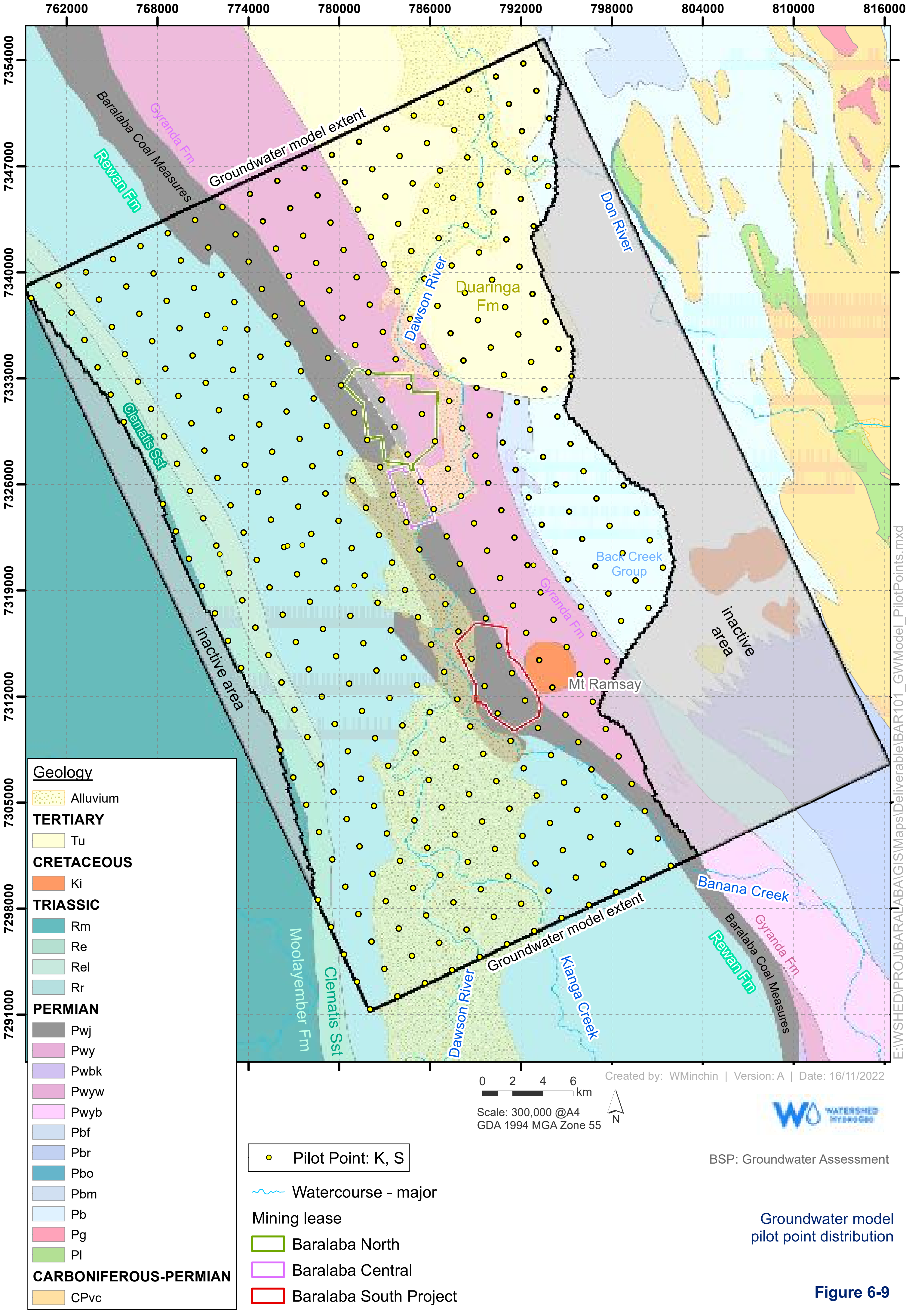
6.6.3 Hydraulic conductivity - vertical (Kv or Kz)

The available dataset of site-specific hydraulic conductivity data provides a useful basis for characterisation, using a statistical analysis of harmonic mean and its relationship to arithmetic averages.

For convenience (and is typically done), pilot points are used to assign a value of vertical anisotropy (VKA) for interpolation across each layer, which is subsequently converted to Kv or Kz (= 1/vka x Kh).

Figure 6-10 provides a summary of the vertical anisotropy range and initial values used by PEST, prior to them being transposed to Kz for input to the groundwater model.

Of note are that the VKA values are broadly centered around 10. The Rewan Formation vertical permeability is low, in line with literature, specifically GHD (2013b).



BSP: Groundwater Assessment

Groundwater model pilot point distribution

Figure 6-9

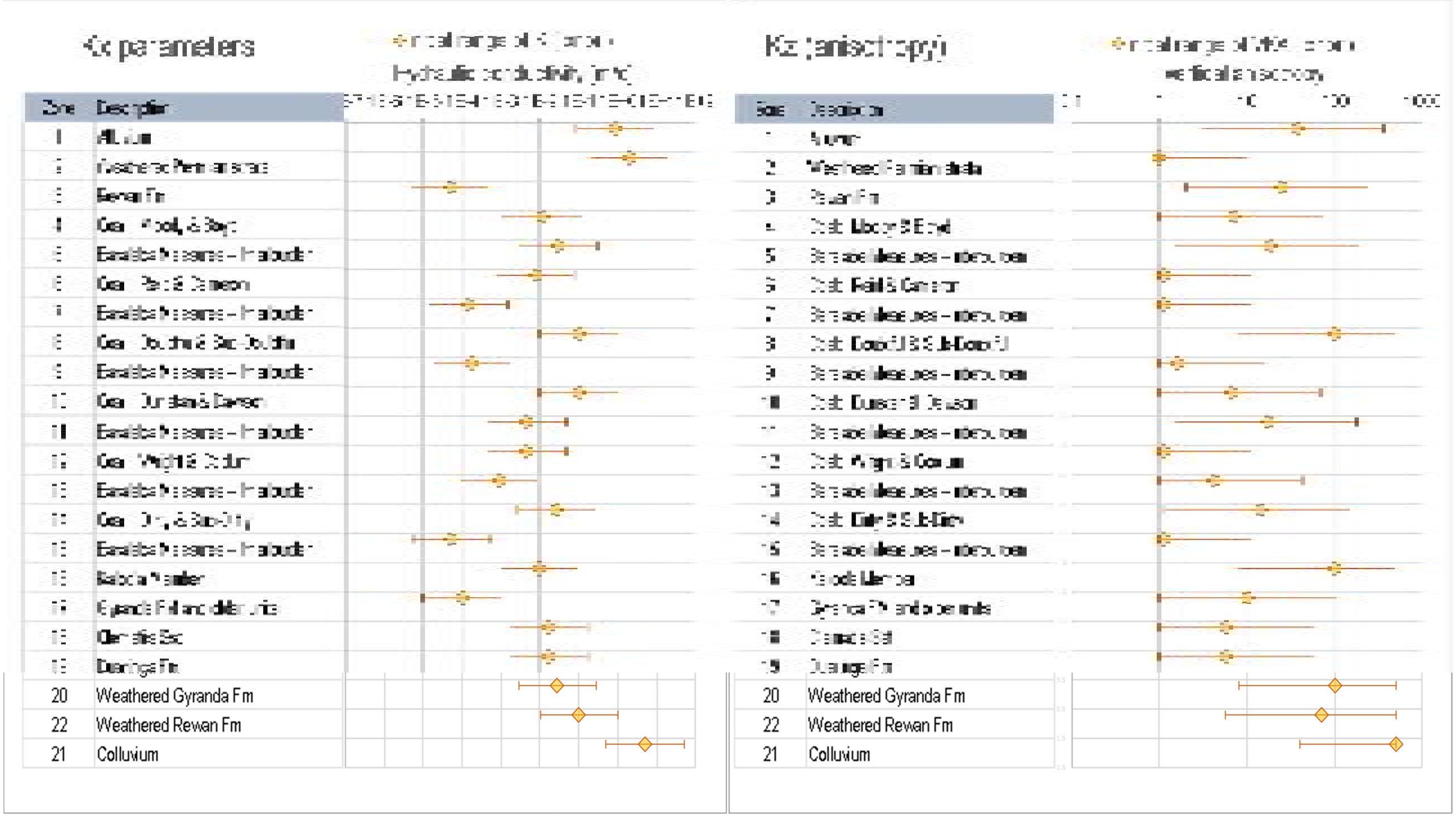


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Figure 6-10 Summary of modelled Kx and vertical anisotropy by unit/layer (initial values)

6.6.4 Aquifer storage

The initial value and ranges supplied to PEST for specific yield (Sy) and specific storage (Ss) on **Figure 6-11** are based on the literature and data review and previous modelling (Section 3.6). These estimates of Ss are consistent with literature (Mackie, 2009; David et al., 2017, Rau *et al.* (2018) and Chowdhury *et al*. (2022).

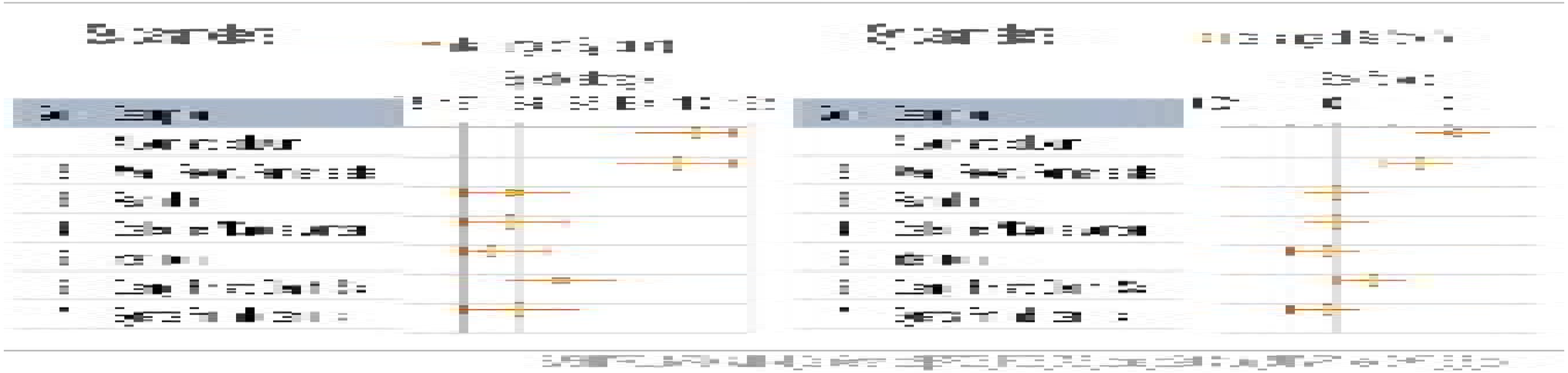


Figure 6-11 Summary of modelled Sy and Ss by unit/layer (initial values)

Sy and Ss parameters are supplied to PLPROC and PEST using the general set of pilot points shown on **Figure 6-9**. This means that although a general conceptual trend of decreasing Ss with depth is likely in reality, the adjustment by PEST at each pilot point means that this may not eventuate. A summary of posterior values after PESTPP-IES history-matching are described in **Section 6.14.2**.

6.7 Observation data

History-matching or calibration has considered three types of observation:

- Groundwater levels or heads (as absolute elevation);
- Transient change in groundwater levels (from the groundwater levels); and
- Estimated groundwater inflow to the BNM pits.

This is consistent with the suggested history-matching datasets in Tomlin *et al* (2023), noting that baseflow or leakage observations are not available at this site. The limited availability of inflow (flux) targets for use in the modelling, and the reliability of these, affects the confidence classification regarding the objectives and forecasts (**Appendix G**).

The total number of observations (7958) are summarised by observation type in **Table 6-3**.

Table 6-3 Observations used in model history-matching (calibration)

Observation type (group)	Count	Comment / source
Groundwater levels	4053	Transient groundwater levels from monitoring bores at BNM and BSP
Groundwater level change	3903	Groundwater level differences calculated as difference from first record
Inflow (constraint)	2	Estimated groundwater inflow (applied as an approximate minimum and maximum value at known seepage locations

Each of these are described further in the following sub-sections.

6.7.1 Groundwater levels

A dataset of groundwater level measurements has been collated across a total of 104 target instruments (stand pipe bores, vibrating wire piezometers [VWP]) from which groundwater level observations have been used to derive transient "calibration targets". The count of monitoring sites with data is summarised on **Table 6-4**.

The locations of monitoring points used for groundwater level calibration are mapped later on **Figure 6-19** (see also monitoring network at BSP, **Figure 3-1**).

From the periodic dips and logger data recorded at those sites, the data have been converted into 4053 targets using, where possible, the groundwater level on the last day of a model stress period. Of these, 3671 are considered "good" quality (weighting =1), and 382 are assigned a weighting of 0.1.

Further recommendations for data gathering are made in **Section 9.1.1**.

Zone	Description	Count
1	Surficial	13
2	Weathered	15
3	Rewan Fm	18
4	Coal: Moody & Boyd	0
5	Baralaba Measures – Interburden	3
6	Coal: Reid & Cameron	0
7	Baralaba Measures – Interburden	8
8	Coal: Doubtful & Sub-Doubtful	1
9	Baralaba Measures – Interburden	7
10	Coal: Dunstan & Dawson	2
11	Baralaba Measures – Interburden	10
12	Coal: Wright & Coolum	1
13	Baralaba Measures – Interburden	12
14	Coal: Dirty & Sub-Dirty	0
15	Baralaba Measures – Interburden	3
16	Kaloola Member	2
17	Gyranda FM and older units	9
18	Clematis Sst	0
19	Duaringa Fm	0

E:\WSHED\PROJ\BARALABA\Model_CalibReview\pp2\[BAR003_TR006_CAL6_update_pp2a.0 & 1.par_SUMMARY.xlsx]Observations

Table 6-4 Summary of data availability: sites by model layer / stratigraphic unit

6.7.2 Change in groundwater level (drawdown targets)

At each of the groundwater level monitoring sites listed above, the change in groundwater level from the first observation at each site and all subsequent observations is calculated as “drawdown” or recovery in metres.

This is more useful than absolute groundwater level magnitude in trying to calibrate storage and recharge parameters.

6.7.3 Flux targets

At this time, there are no quantified flux targets available, however advice from consultant engineers and site operators at BNM is that the previous versions of the Baralaba groundwater model over-estimated inflow to the BNM open cuts. Engeny (2022) have made estimates of the groundwater flux to the pit (**Section 3.3.4**), and based on this, constraints have been supplied to PEST-IES for history matching:

- A “greater than” inequality constraint of 0.6 ML/d, which means that PEST-IES penalises realisations where the average inflow to the BNM (for the period 2019-20) is less than 0.6 ML/d; and
- A “less than” inequality constraint of 2.0 ML/d (based on advice from Engeny), which means that PEST-IES penalises realisations where the average inflow to the BNM (for the period 2019-20) is greater than 2.0 ML/d.

In future, it is possible that these estimates might be improved (as per the Recommendations in **Sections 9.1.3 and 9.1.4**).

6.8 Model execution

The historical model has a moderate model run time. Most of the model runs have been carried out, in parallel on an Threadripper-5995 with 256 GB of RAM.

The historical model of 45 stress periods runs in 35 minutes when one instance is run, but slows down to 1-2 hours, including pre- and post-processing, when run in parallel.

The 'Full Development' predictive model (90 stress periods, including the historical period again) takes approximately 5-6 hours to run (including pre- and post-processing) when run in parallel). As such it took about a week to carry out the predictive runs (3 x scenarios for each parameter realisation, as in **Section 7.2**).

Heads and budget outputs are saved on multiple timesteps, usually 4, during each stress period (**Appendix D**), producing approximately 13 gigabytes (Gb) of output for each historical model run, and 57 Gb across three predictive scenarios when including both historical and predictive periods. The run-time and disk space requirements are amenable to automated calibration and forecasting under uncertainty via many realisations, although as noted above the run time of the predictive ensemble was long.

The numerical solver used is the MODFLOW-USG 'SMS' solver (Panday et al., 2013; Panday, 2021) with a head close criterion of 0.06 m (outer iterations) and 0.006 m (inner iterations). Other solver settings are available on request. Adaptive time-stepping was used. The resultant model mass balance error is reported in **Section 6.13**.

6.9 Approach to calibration

Model history-matching is the process of replicating hydrogeological targets (**Section 6.7**) by varying key model parameters such as hydraulic conductivity and storage within the range of reasonable values described in **Section 6.6** and some of the boundary condition parameters in **Section 6.5**.

The modelling relies on many available values of hydraulic conductivities and storage parameters Some trial-and-error calibration and testing of the model was carried out to adjust boundary conditions and hydraulic conductivity (horizontal and vertical), and storage parameters of model layers or zones to test model stability and plausible representation to groundwater levels.

Along with trial and error methods, PESTPP-IES (White et al., 2020) has been used to carry out automated calibration. PESTPP-IES does not focus solely on 'calibration' per se. White *et al* (2020) state: that the exploration and regularisation of parameters "implemented by PESTPP-IES thus attempts to ensure that parameters comprising each realisation are changed from their initial values by the smallest amount required for model outputs to reproduce field observations "acceptably" well". So while performing 'calibration', PESTPP-IES also generates a set of plausible alternative model realisations that fit the observations or targets to this "acceptable" degree.

The following documents provide a full description of the methods applied to the modelling in this report:

- The PESTPP-IES manual (White et al., 2020) and associated literature for detailed information on practical application of the PEST and PESTPP-IES software, in addition to description of concepts and processes.
- PEST – The Book (Doherty, 2015) for the theory behind the approach to inversion and uncertainty analysis and application to environmental modelling.

6.10 History-matching (calibration) and ensemble development

In this section, the reporting focusses on the final history-matching process attempted with PESTPP-IES. At the outset, we note that after a review of results through the process it was decided to adopt the calibrated results at earlier iterations of the process (in discussion with the peer reviewer), rather than the results from where the process ended.

At the end of this final PESTPP-IES history-matching process presented in the following sections, PESTPP-IES had run the model 243 times to the end of the PESTPP-IES iteration 4 (**Figure 6-12A**), having set an initial ensemble size of 100.

To achieve an acceptable calibration or fit to the targets, PESTPP-IES adjusts the specified parameters (**Section 6.6**) within their user-specified allowable ranges (based on site-specific and literature values and "expert knowledge"), and compares the modelled results against the targets. The overall measure of 'fit' to the targets (or overall model error) is the objective function ("phi"). During the iterations PESTPP-IES reduces phi as shown in the **Figure 6-12B**, although the phi reduction is minimal after iteration 2.

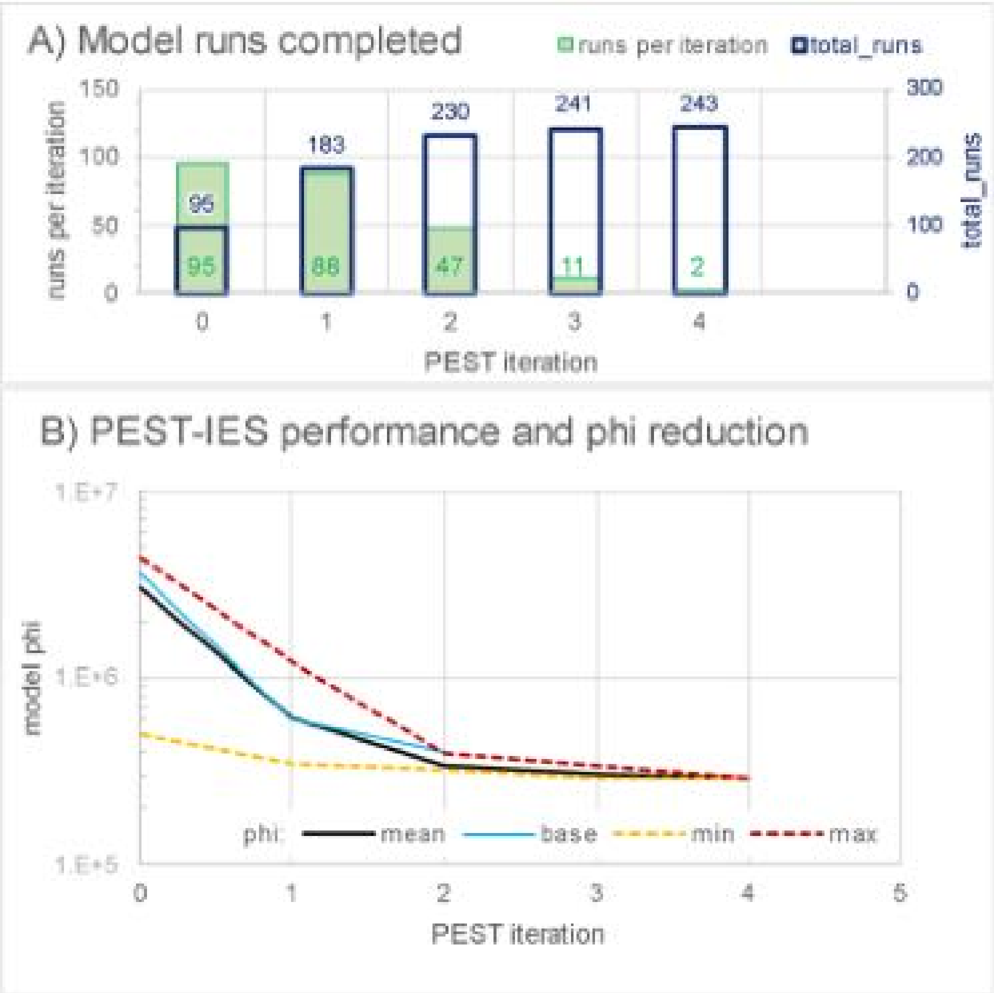


Figure 6-12 Summary of PESTPP-IES reduction in objective function (phi)

However, over those iterations, the initial model ensemble of 100 alternative realisations reduced in size due to model failures (numerical non-convergence, which is a frequent problem in groundwater modelling, especially when using transient material properties and also with PEST attempting to use a wide range of parameters.

By iteration 2, the ensemble is 47 realisations (see green series on **Figure 6-12A**), and just 11 in iteration 3. 11 was considered too few for predictive uncertainty analysis, and even more than 47 was preferred.

As a result, and in discussion with the Peer Reviewer, it was decided that for predictive purposes, the calibration ensemble should use iteration 1 and iteration 2, and then use this combined ensemble of more than 100 realisations for predictive modelling (**Section 7.3**).

This ensemble includes the 'Base' realisation which represents the optimised version of the initial (prior) base parameter realisation provided to PESTPP-IES. The results and outputs presented in the following sub-sections (**Sections 6.11 and 6.13**) to illustrate the capability of the model to replicate observations and conform to expected behaviours are primarily for the PESTPP-IES "Base" realisation, and some outputs show the range across all realisations.

A phenomenon that sometimes occurs using an ensemble smoother like PESTPP_IES (and was encountered in earlier PEST runs for this project) "is a collapse in diversity of parameter realizations as the iterative adjustment process progresses. Sometimes this collapse can invalidate the integrity of posterior parameter and predictive probability distributions that the ensemble attempts to characterize" (White et al., 2020). This desire to minimise the potential for this ensemble collapse to occur was one of the reasons why the combined ensemble, derived from iteration 1 and 2, was selected for predictive modelling.

6.11 Groundwater levels

This section describes the calibration process that referenced groundwater level measurements from the project's monitoring network, followed by comparison with drawdown (change in groundwater levels) targets. Contour maps of simulated (pre-BSP) groundwater levels are then presented at the end of this section.

6.11.1 Project monitoring sites

A summary of model performance with respect to the overall simulation of groundwater levels is provided below, with simulated heads plotted against the observed head targets (described in **Section 6.7.1**) on **Figure 6-16**. This shows the progression of the overall fit to groundwater levels across the model domain through iteration 0, 1 and 2.

The coloured symbols are the 'base' realisation, and the grey symbols behind those (labelled as "ies result") are the values from the other realisations in the ensemble.

This shows results that tend to cluster around the 1:1 line across the range of stratigraphic units (at least those for which targets or observations are available), especially in iteration 1. Iteration 0 tended underestimate groundwater levels (as a result of over-estimating drawdown), and in iteration 2 the reverse is more typical.

While there is some spread (variance) from that line, generally the simulated groundwater levels lie within +/- 10 m (especially for iteration 1). Iteration 1 shows the least bias to over- or under-estimation.

The key possible reasons for variation between observed and simulated heads, other than the model trying to simulate a complex heterogeneous and anisotropic groundwater system, on the X:Y plot are:

- potentially incorrect layer assignment.
- incorrect or uncertain data which has not been identified or cannot be confirmed as incorrect, and so is used 'as-is';

- model layers may be markedly thicker than the strata that is actually monitored by a piezometer (especially a VWP or standpipes with short screens); and
- incorrect or imperfect boundary condition elevations and parameterisation of the model re: K, S, recharge parameters, either on a local or larger-scale. This includes imperfect representation of the major stress in the groundwater level dataset, which is the BNM (particularly Baralaba North, rather than Baralaba Central) pit and spoil development.

A number of statistical measures of calibration quality are suggested in the AGMG (Barnett et al., 2012a). A few of these are reported for the base realisation (which has a 'phi' slightly above that of the median 'phi' in the ensemble) as follows:

Statistic	Prior	Iteration 1	Iteration 2
Average Residual (m)	-3.3	-4.11	-4.6
Average Abs Residual (m)	10.1	6.6	6.3
RMS (m)	15.3	8.7	8.1
SRMS (%)	26.7	15.2	14.1

The scaled Root-Mean-Square (SRMS) error for the correlation between observed data and the transient model groundwater levels is outside the often-quoted example of 10 % (MDBC (Murray Darling Basin Commission), 2000; Barnett *et al*., 2012), however, the improvement in this statistic from the prior (iteration 0) is obvious. The other statistics are appropriate for a model such as this.

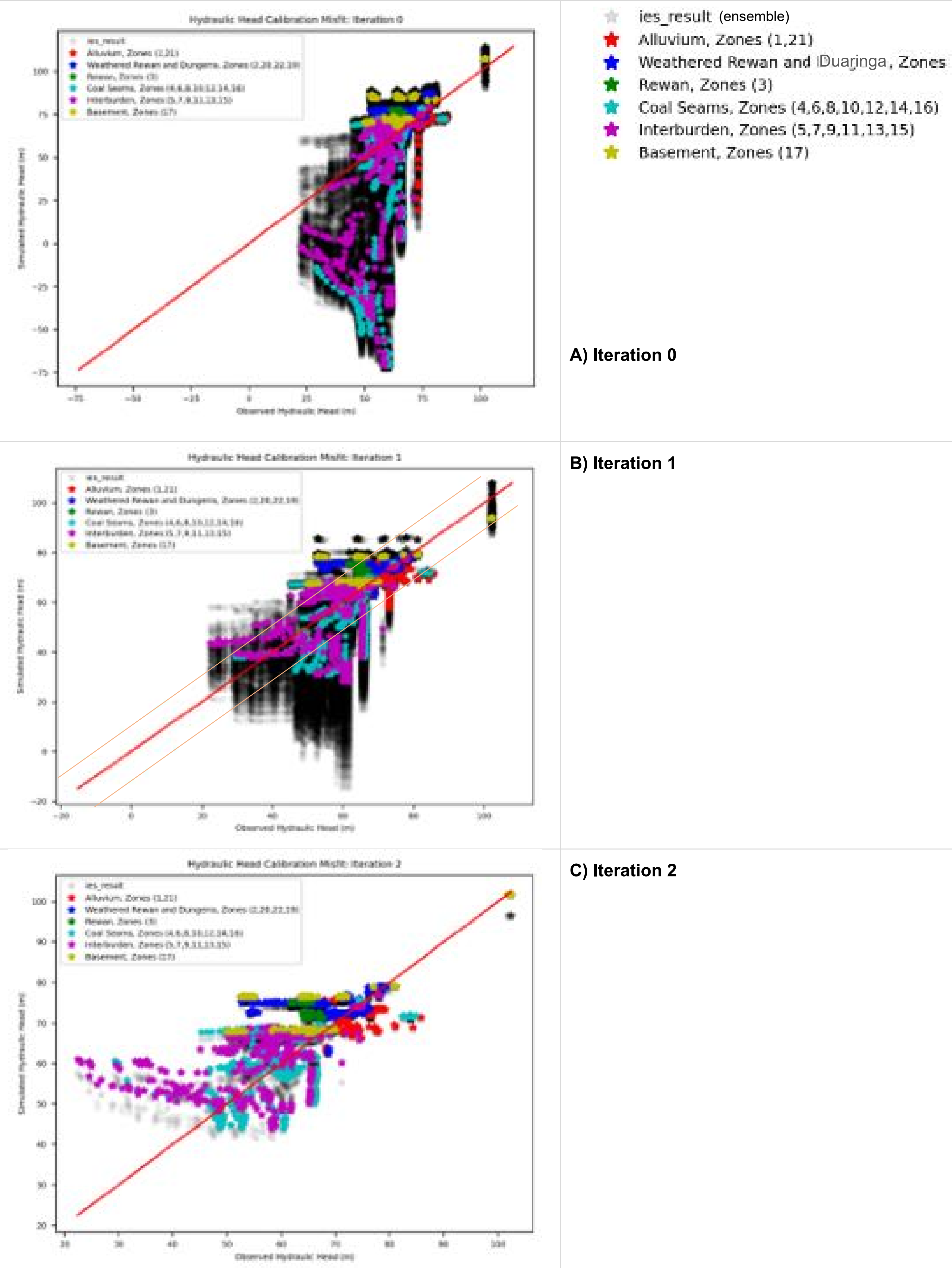
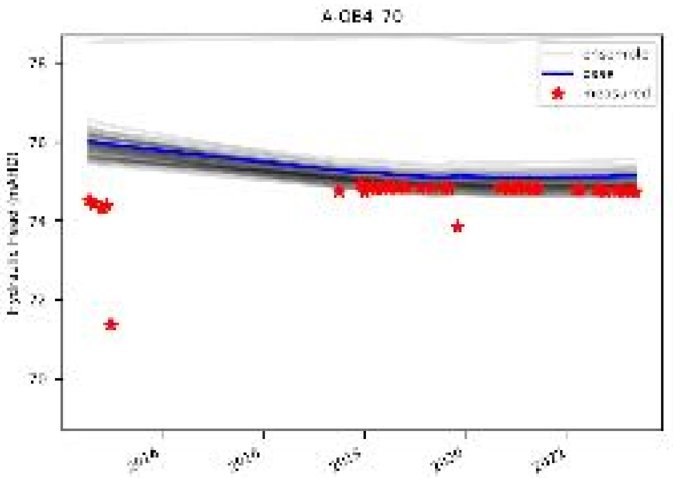


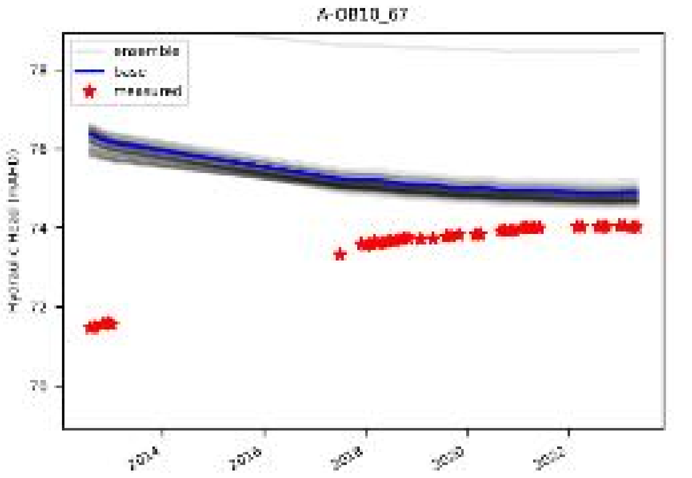
Figure 6-13 Summary of groundwater level calibration through iteration 0,1 and 2

The full set of monitoring sites for which a useful hydrograph can be produced is presented in **Appendix F**; first for the sites at BSP, and then for the sites at BNM.

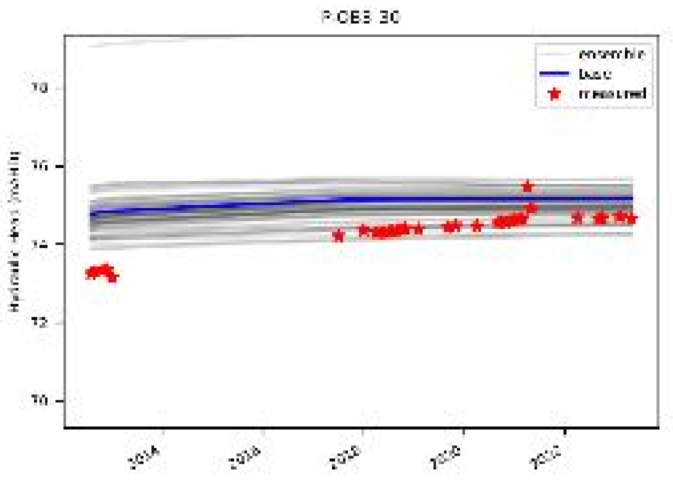
A selection of groundwater level hydrographs are presented in the following pages. The sites in **Figure 6-14** and **Figure 6-15** show sites at BSP, and then some sites at BNM are presented in **Figure 6-16** and **Figure 6-17**. The sites are selected to illustrate the capability of the model, i.e. sites with good matches to observations and some with poorer fits. These are all from iteration 1.



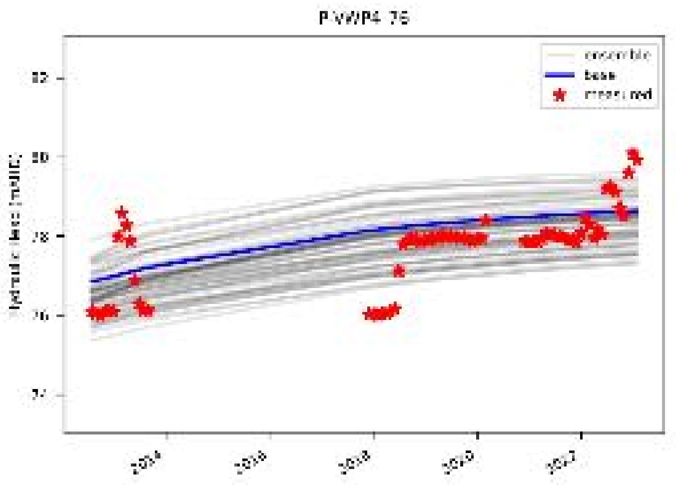
Alluvial bore A-OB4. Good fit overall.



Alluvial bore A-OB10. Poorer fit, especially in the early record.



Permian bore P-OB3. Good fit overall.



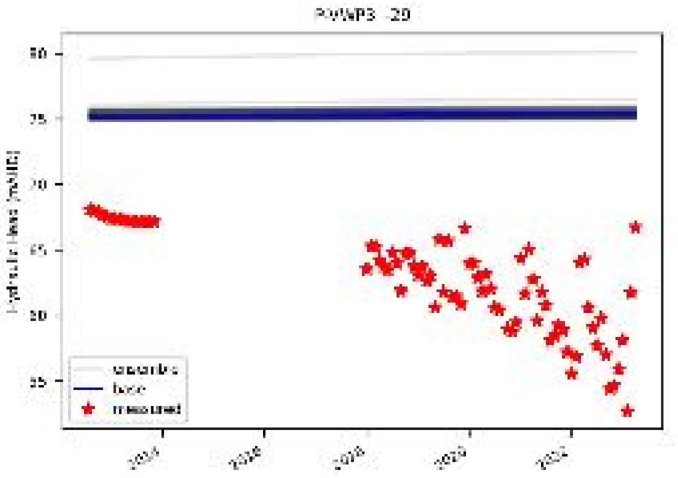
Permian VWP, P-VWP4. Reasonable fit, ensemble covers the range.

Figure 6-14 Modelled and observed groundwater level hydrographs from sites at BSP

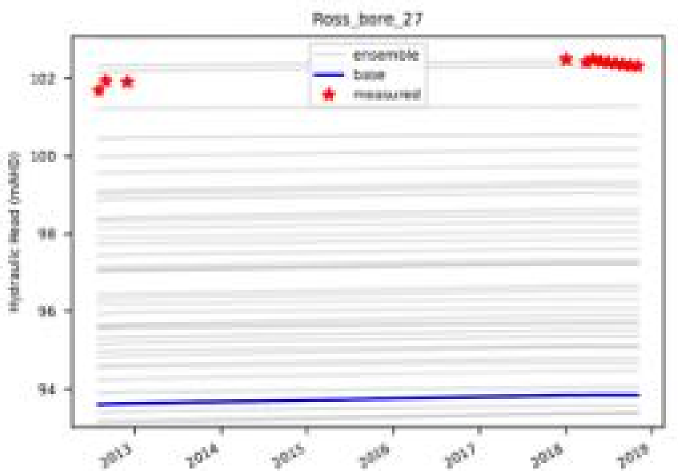
These hydrographs show a reasonable match to the recorded levels in the alluvium and Permian strata around the BSP. The base realisation is typically a good fit to the data, and the ensemble is typically capable of covering the range.

Additional sites from the BSP are shown on **Figure 6-15**.

These show an example (P-VWP-3 at -29 mAHD) where the ensemble does not capture the groundwater pressures, possibly because of bad quality data, but that is not certain, as well as the private landholder bore ("Ross" bore), where the ensemble just captures the range in groundwater levels. The simulation here suggests that in the model the igneous trachyte might be too hydraulically connected to the strata to the west where the groundwater levels are lower (see **Section 3.1.8**).



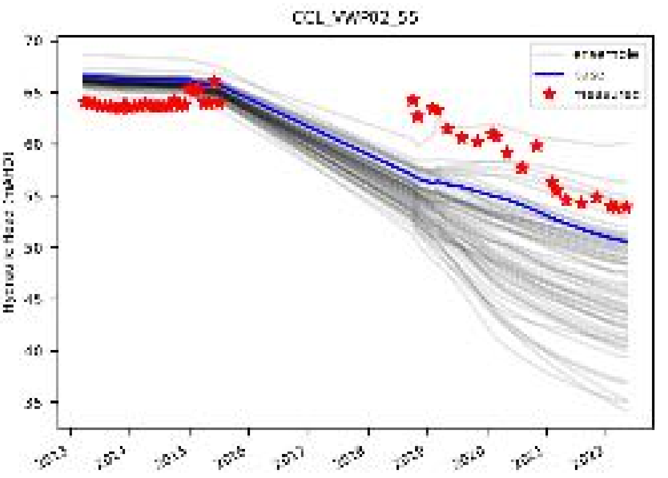
Permian VWP, P-VWP-3: the match for the base is poor, either because of bad quality data from the VWP, or some other process that is not captured near this site.



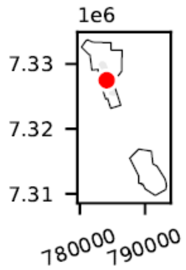
Ross bore: the match for the base is poor (Iteration 2 is better at this site), but the ensemble almost covers this.

Figure 6-15 Modelled and observed groundwater level hydrographs from sites at BSP

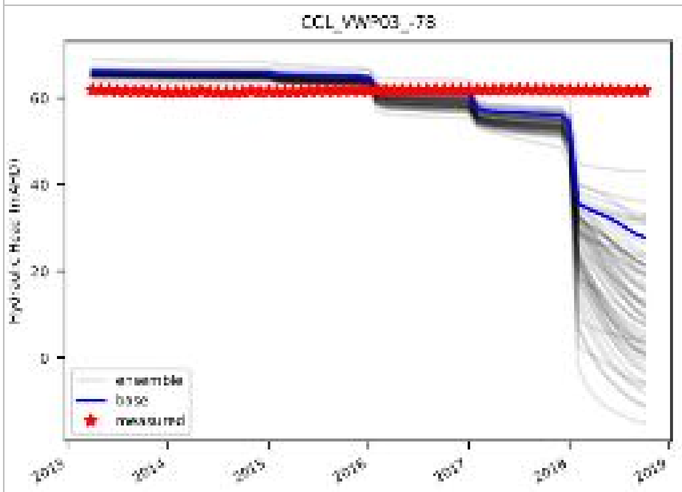
The following hydrographs are for sites at the BNM (**Figure 6-16** and **Figure 6-17**).



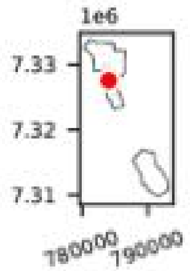
Permian VWP at CCL_VWP02.



This shows that the groundwater levels and the overall drawdown related to BNM mining are well represented by the base realisation and the ensemble. At this site, the ensemble actually tends to over-estimate the drawdown.

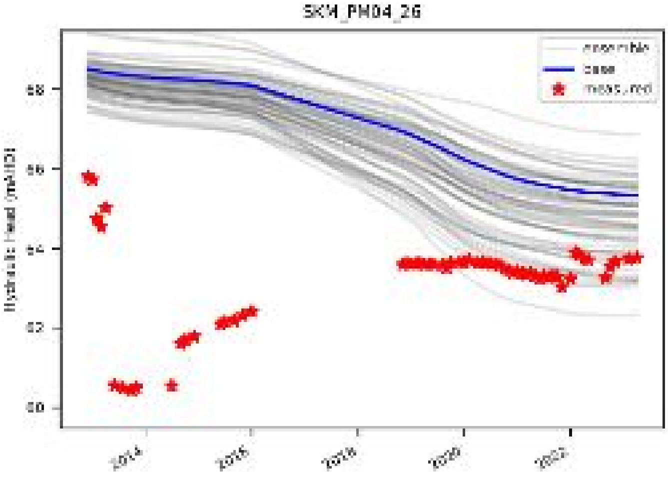


Permian VWP at CCL_VWP03.

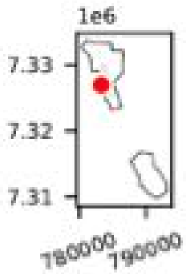


This shows an example where the groundwater levels and the overall drawdown related to BNM mining are poorly represented by the base realisation and the ensemble. The model suggests significant drawdown, but the observed pressure is steady.

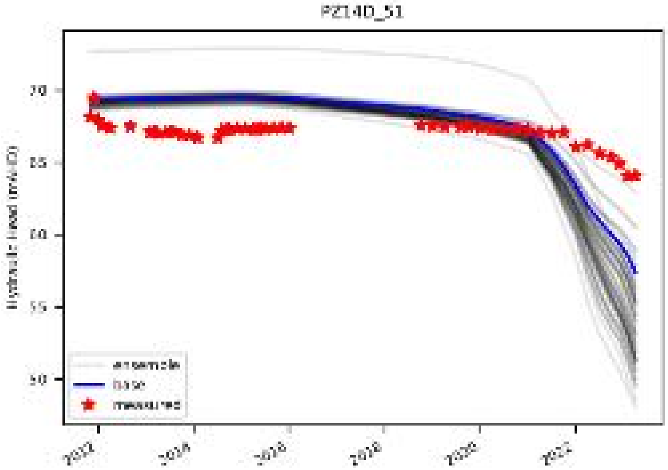
Figure 6-16 Modelled and observed groundwater level hydrographs from sites at BNM



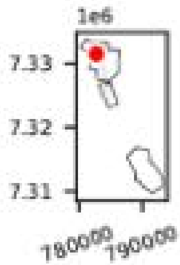
Standpipe PM04.



This shows that the groundwater levels and the overall drawdown related to BNM mining are poorly represented by the base realisation and the ensemble. It is likely that the model does not accurately represent dewatering and spoil emplacement at this site, rather than being problem caused by hydraulic properties.



Standpipe PZ14D.



This shows that the groundwater levels and the overall drawdown related to BNM mining are well represented, albeit conservatively, by the base realisation and the ensemble. It is likely that the model does not accurately represent pit progression toward this site, rather than being problem caused by hydraulic properties.

Figure 6-17 Modelled and observed groundwater level hydrographs from sites at BNM

6.11.2 Spatial distribution of groundwater levels

Two figures are provided here to summarise the modelled regional behaviour of the groundwater system. The first (**Figure 6-18**) is a contour map of modelled water table in 2023. This shows the highest groundwater levels present along the flanks of the Dawson River valley, especially at the Dawson Range (far west) and the isolated high at Mt Ramsay.

The water table mapping shows that groundwater levels are relatively flat (i.e. low gradient) in the Dawson River alluvium.

The levels around the BSP including in the alluvium to the west compare well to those presented based on observations presented in **Figure 3-11**.

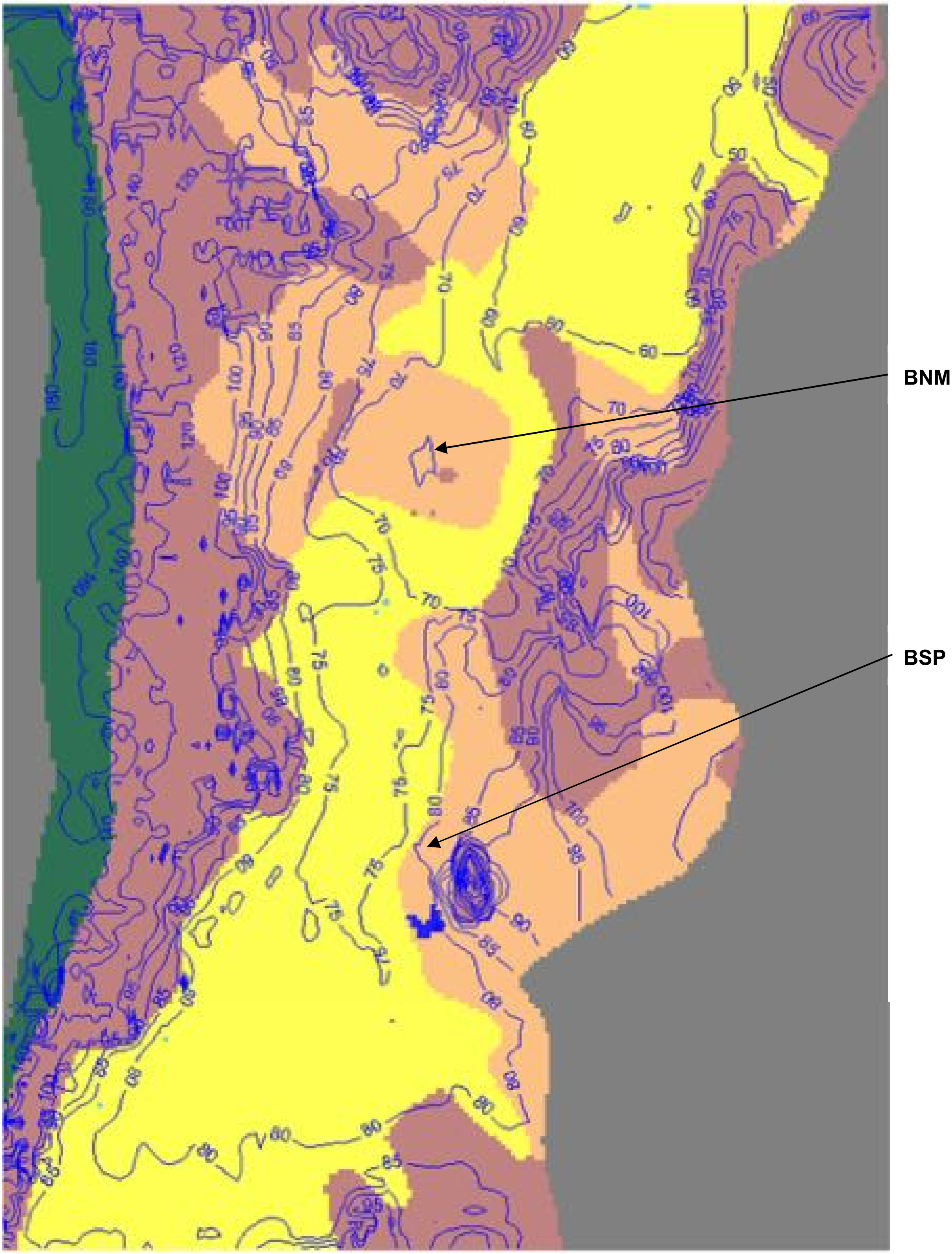


Figure 6-18 Contoured modelled water table elevation in 2023

Second, a map of residuals or errors calculated as the difference between the modelled value and the observed value has been prepared to summarise the overall performance of the model (**Figure 6-19**).

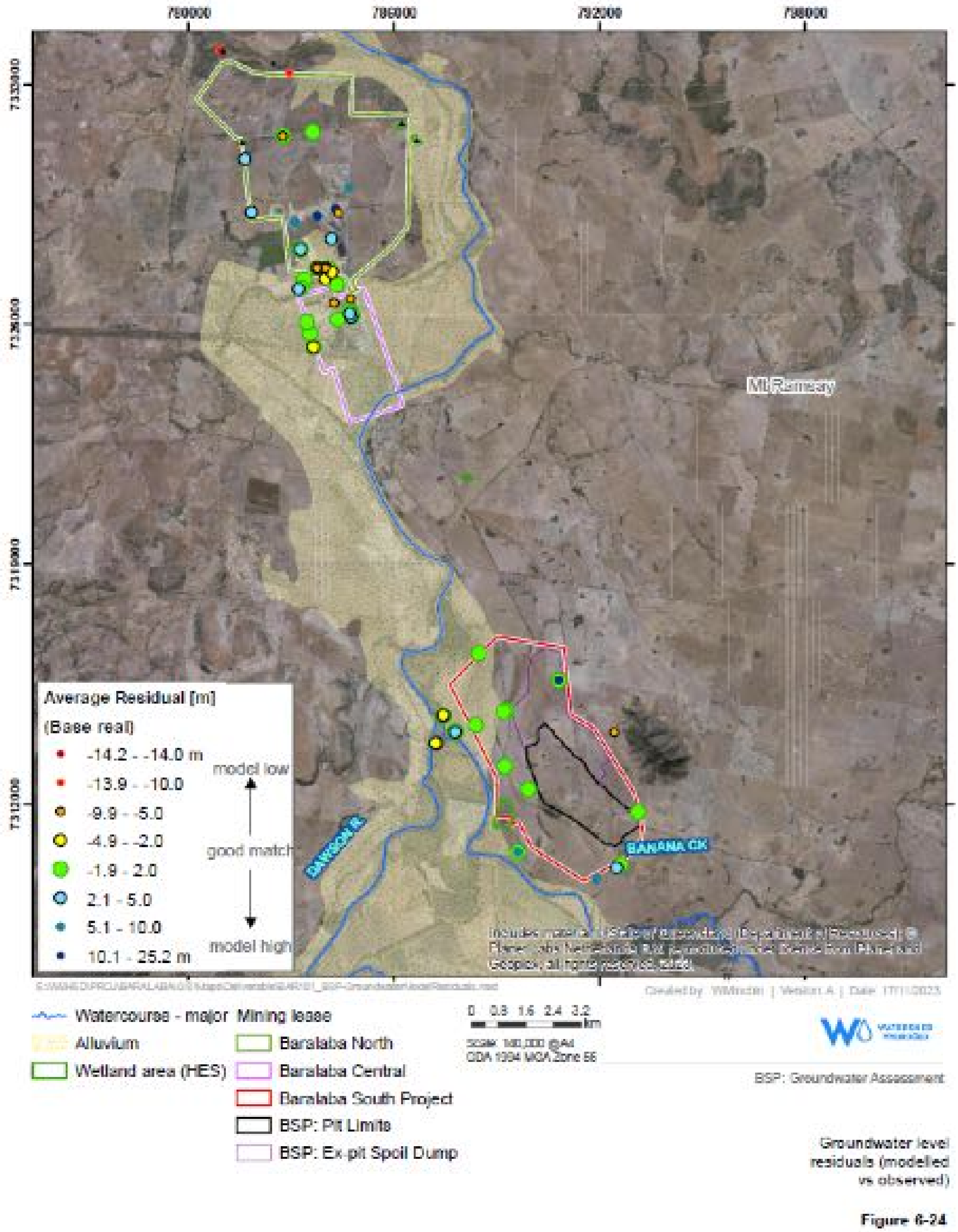


Figure 6-19   Groundwater level residuals (average modelled vs observed)

This figure shows the difference between the average observed value at a site and the average of all modelled values for the corresponding times at that site.

The key conclusions from this are that most of the mis-match in average groundwater levels is around the BNM pit, especially the southern and middle sections of the northern open cut, while the match around the BSP is good. The main weaknesses at the BSP are sites at the very confluence between Banana Creek and Dawson River, and at P-VWP3 on the southern boundary of the MLA, where the groundwater levels are recorded at 62-67 mAHD, which is approximately 30m below ground level.

6.11.3 Change in groundwater level (drawdown)

Modelled changes in head at each site through time have been summarised on **Figure 6-20**, again showing the progression of the modelling from iteration 0 through to iteration 2.

It is clear that iteration 0 over-estimates the change in groundwater levels, iteration 1 improves on this, and then iteration 2 begins to bias the simulation in the wrong manner.

It is likely that in an attempt to try to reduce inflow to the BNM mine (**Section 6.12**), which PESTPP-IES succeeds in doing in Iteration 2, it starts to underestimate drawdown around the BNM pit.

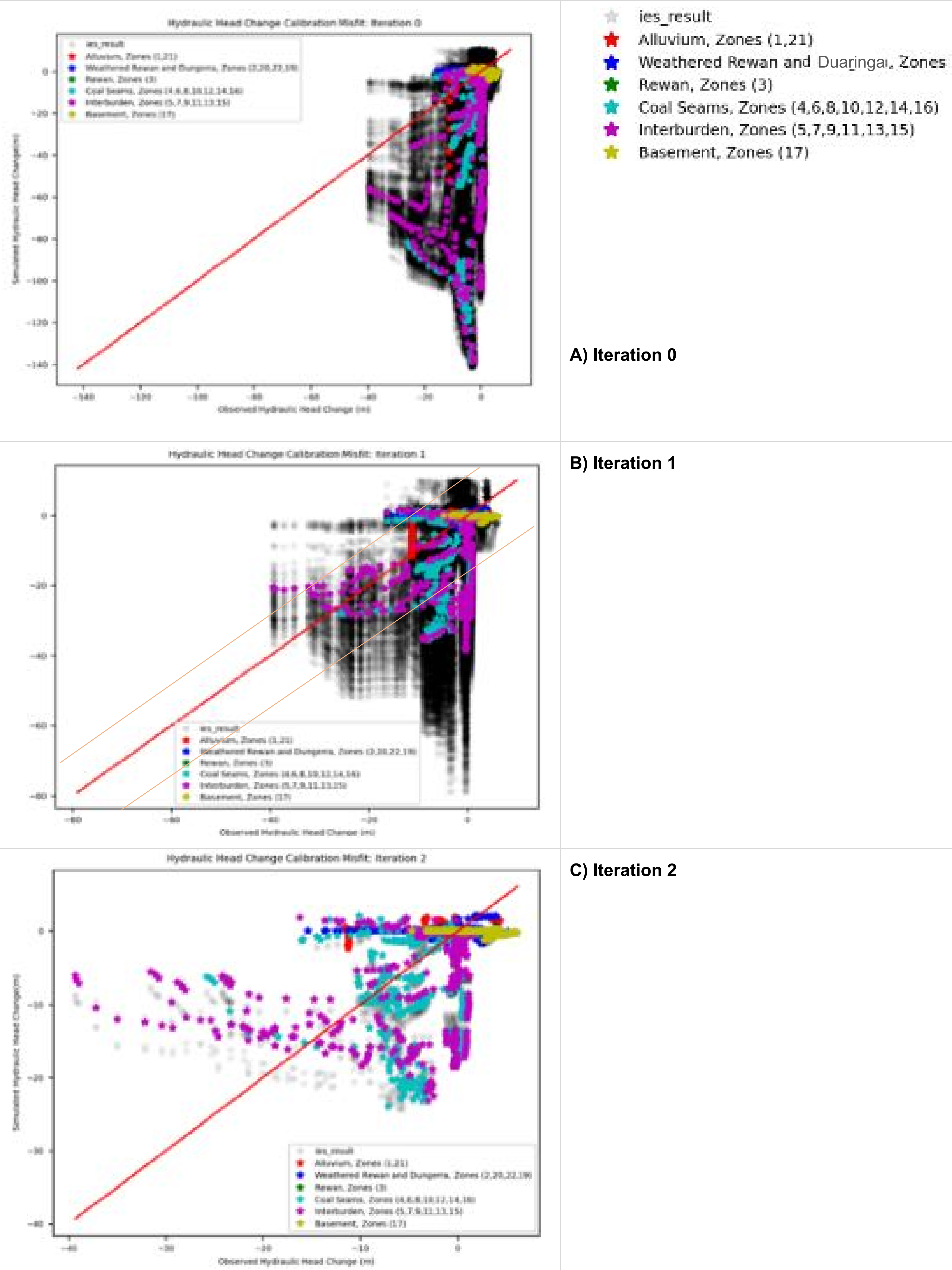


Figure 6-20 Summary of groundwater level drawdown calibration through iteration 0,1 and 2

6.12 Modelled mine inflow

The target mine inflow for BNM is discussed in **Section 6.7.3**. The targets applied mean that PEST was trying to adjust parameters to achieve mine inflow between 0.6 and 2.0 ML/d.

As seen on **Figure 6-21**, PESTPP-IES generally improved the representation of inflow to the BNM, with iteration 1 having a slightly narrower range in inflow, and iteration 2 reducing the inflow to more appropriate volumes, albeit still slightly higher than the upper estimate (2 ML/d).

It is considered that rather than trying to improve the match further than this (while preserving calibration to other observations), there is more value in improving the reliability of the flux estimates from site and improving the representation of the BNM mine plan (**Section 9.1**).

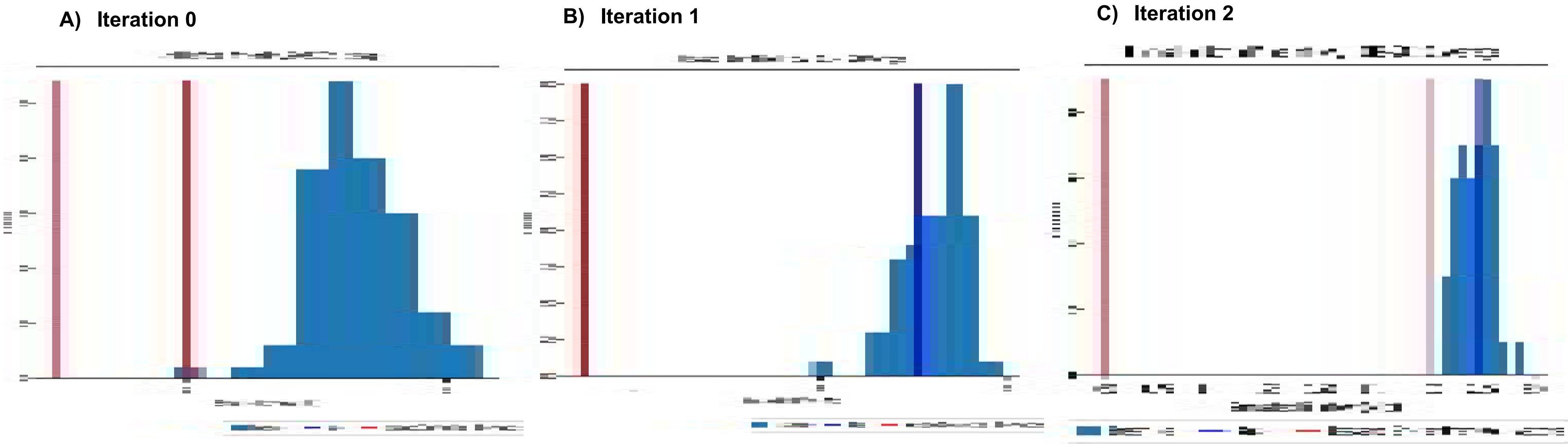


Figure 6-21 History-matching of inflow targets by PEST-IES iteration

A check on the ability of the MODFLOW Drain cells was to dewater strata within the BNM pits was requested by the peer reviewer, and the presence of 'dry' model cells in relevant layers (down to Layer 15) was confirmed. This suggests an appropriate representation of mine dewatering.

6.13 Model water balance

A tabulated water balance for the whole model domain is summarised in **Table 6-5**. This presents the average water balance for the (transient) historical period, 2005-2023.

In general, the largest simulated influx and outflux components being river leakage (35.1 ML/d) is expected, as well as this being primarily balanced by evapotranspiration (32.8 ML/d). Recharge is low, as is baseflow to watercourses, and this is consistent with the conceptual model. Net groundwater storage change is relatively small for this period, representing a slight increase in modelled groundwater levels across the model for the selected period.

Table 6-5 Simulated water balance: model-wide water balance – average 2005-2023

Modelled component	Catchment process	Simulated flux [ML/d]	
		In	Out
Recharge	Infiltration recharge	7.6	0
River Leakage	Groundwater interaction w/ watercourses and springs (leakage/baseflow)	35.1	13.6
Evapotranspiration	Evapo-transpiration from water table	0	32.8
Head Dep Bounds	Regional groundwater flow	26.4	16.2
Drains	Inflow to BNM	0	0.6
Storage	Groundwater storage	6.9	12.8
Total (ML/d)		76	76
			Realisation:i1,base

At the end of the calibration period (late 2023, stress period 45), the modelled mass balance error was less than 0.04%, which is within the 1-2% error recommended by the AGMG (Barnett et al., 2012).

6.13.1 Transient mass balance error

As noted above, at the end of the calibration period (stress period 45), the modelled cumulative mass balance error was approximately 0.04%, which is well within the thresholds recommended by the AGMG. The timeseries of the mass balance error for each timestep in the model simulation has been reviewed for the base realisation, and was up to 0.05% (iteration 1) and up to 0.18% (Iteration 2).

As such, the mass balance error is low and acceptable and provides a sound basis for using the model for forecasting.

For the forecast period, errors are generally low and acceptable (e.g. 0.08% overall), with occasional spikes to 2-5% (in the base realisation there were 8 timesteps out of >1400 with a mass balance error >2%, maximum 4.9%). These errors usually occur as newly-activated TVM and Drains simulating mine progression interact at the beginning of stress periods (**Section 7.2**), and lower at the end of stress periods. Smaller errors might have been achieved with smaller HCLOSE (solver criteria), but at the expense of model run time which was already lengthy. Some model realisations are likely to have higher mass balance errors, however the mass balance above gives confidence that the numerical model is not artificially introducing significant errors to the simulation and predictions.

6.14 Simulated (posterior) parameters

The method of adjusting and applying hydraulic properties (K and S) to the groundwater model is described in **Section 6.6**. This section presents a summary of resultant modelled parameters at the end of the PESTPP-IES history matching process, i.e. the 'posterior' parameters.

6.14.1 Hydraulic conductivity

Hydraulic conductivity (Kx) and the vertical anisotropy (vka) applied to the combined ensemble (iteration 1 and 2) of realisations following the history-matching process is charted on **Figure 6-22**, compared to the initial (prior) estimate and the range supplied to PEST.

The charts in **Figure 6-22** show that the median for the ensemble is generally slightly higher than the initial Kx estimate, but not significantly so. The posterior min-max range (which is the range for all pilot points in each conceptual zone) is essentially the same as the initial or allowable range (with the exception being mainly in the weathered strata, where PEST has pushed the parameters up to the maximum or near the maximum, where parameters more often lie at the top of the allowable range). This is likely to be because of the lack of observations within the weathered Rewan, and possible generally unsaturated nature of these sediments, which then allows PEST some freedom to do this.

Figure 6-22 shows ranges typically remain at 2 orders of magnitude or more for Kx and 2-3 orders of magnitude for Kz) across the model realisations. This indicates that the hydraulic conductivity parameters are relatively unconstrained through history matching (calibration). This suggests that the hydraulic conductivity parameters are insensitive to the history-matching process, or at least non-unique, across the model domain as a whole.

This means that the forecasting (**Section 7**) explores the sensitivity of the predictions of interest to a large range of Kx and vka/Kz parameters.

This observation, and the conceptual model of effects and impacts (and subsequent model predictions of impacts that consider and account for parameter sensitivities), guides some recommendations (Section 9.1.4).

6.14.2 Storage properties

The storage parameter ranges shown on **Figure 6-23** indicate the ensemble is using almost the full range of parameters initially specified. PEST has tended to increase all the storage parameters slightly but without reducing the range of these parameters that is applied to pilot points.

As with hydraulic conductivity, this means that on the scale of the model domain, the history-matching process is not able to constrain these parameters to a significant extent. Therefore, the forecasts for the predictions of interest (**Section 7**) account for the sensitivity to a large range in storage properties.

6.14.3 Recharge and Drain conductance

The model has adjusted the recharge and drain conductance parameters (**Figure 6-24**) more than the hydraulic properties. In the case of drain conductance, this is likely to try to improve drawdown and inflow at BNM.

The posterior range in Drain conductance for representing mine dewatering (Sections 6.5.6.1) is 0.1 to 1.5 (iteration 1) and 0.17 to 0.21 (iteration 2). This compares to the initial value of 20 (range 0.05 to 500). For iteration 2, despite the improvement in mine inflow simulated (**Section 6.12**), this represents a degree of ensemble collapse. The simulated conductances still allow the simulation of pit dewatering which were checked following query by the Peer Reviewer.

The posterior range in the recharge multipliers has been adjusted from the initial values. Broadly, these are consistent with the conceptual model. The recharge multiplier for the Clematis Sandstone zone is quite high (and there is evidence for it being elevated, e.g. KCB, 2023), but given the distance from that zone to the BSP (or BNM) this should not have a significant bearing on predictions.

The other recharge parameters appear reasonable across the ensemble.

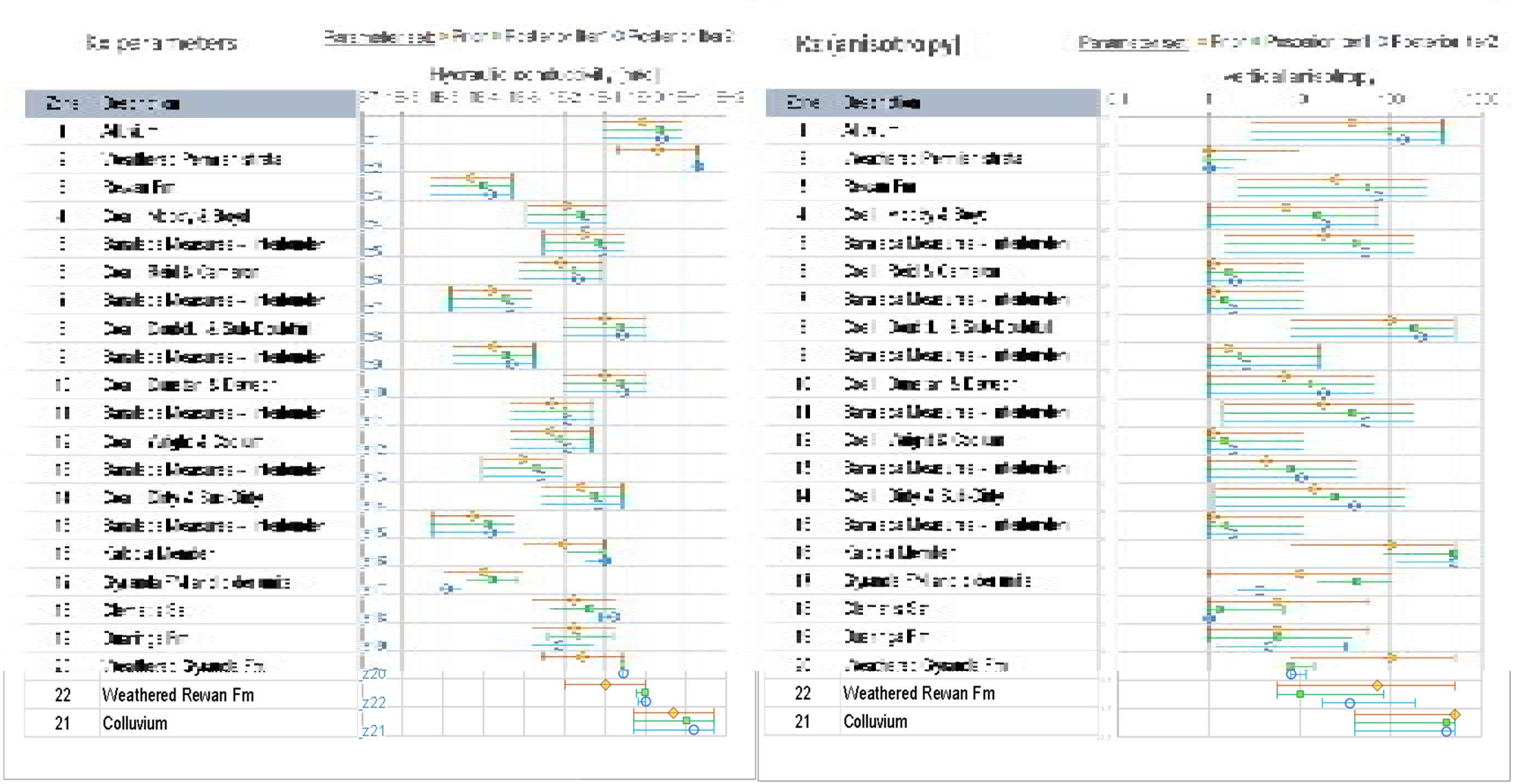


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Figure 6-22 Modelled (posterior) hydraulic conductivity parameters

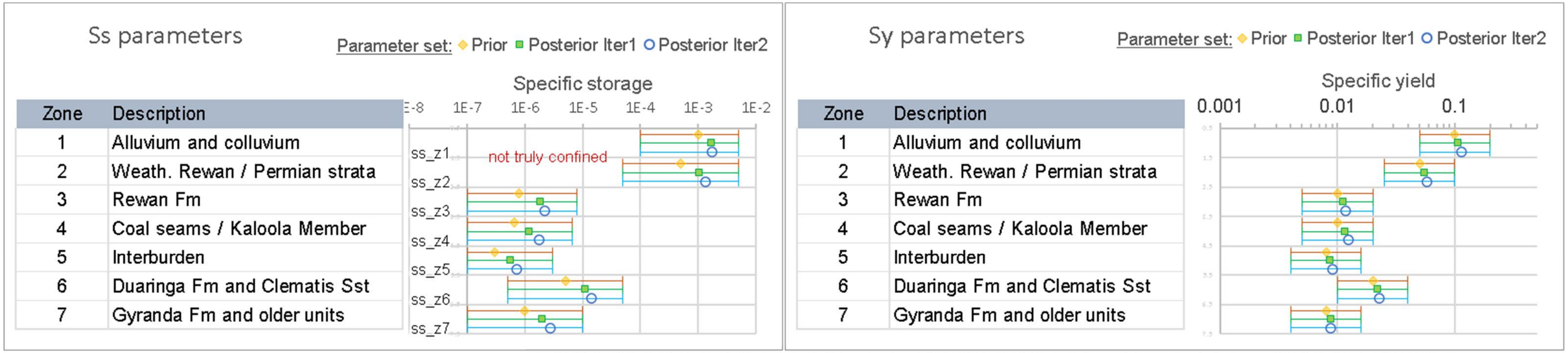

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Figure 6-23 Modelled (posterior) storage parameters

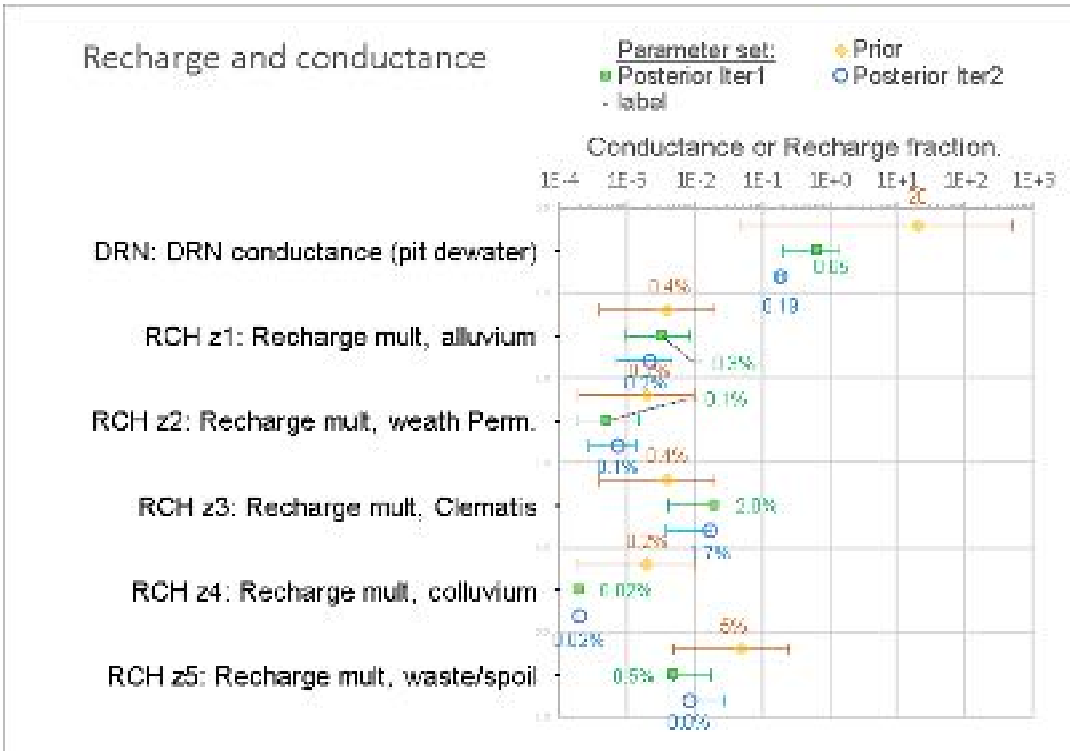


Figure 6-24 Modelled (posterior) recharge and drain conductance

6.15 Summary of model performance and suitability

The comparison of model results with the observations (groundwater levels and gradients and the constraints) in the preceding section provides some confidence that the model is suitable for use in predictive analysis for estimating project-related effects.

The use of multiple realisations in the predictive modelling phase (**Section 7**) then addresses the issue of parameter variability, limited constraint by observations and uncertainty.

As noted in **Appendix G**, while the model is capable of simulating groundwater levels at the current BSP monitoring sites and to a reasonable degree at the BNM sites, groundwater levels in some locations and key fluxes (baseflow, spring flow to hanging swamps and, with respect to the future project, mine inflow) that are required to assess the impacts of the project are not ‘calibrated’ to quantified data.

Recommendations have been made regarding data gathering and further modelling (**Section 9.1**).

We re-iterate that we consider the modelling approach and the numerical groundwater model developed this point to be fit-for-purpose considering the requirements of the model for impact assessment and the data/knowledge obtained to this time.

As per the AGMG, this modelling assessment has been peer-reviewed. This independent review is by Andrew Durick (of AGE Consultants), who is an experienced groundwater modeller and reviewer.

7 Predictive modelling and potential impacts on groundwater

This section presents results from the model ensemble which is described in **Section 7.3**. The objectives of the predictive or forecast modelling are to provide estimates of the following (see **Section 6.1**):

- Groundwater inflow to the BSP pit;
- Groundwater drawdown around the pit, including specific consideration of:
  - water table drawdown, and its relation to environmental features;
  - drawdown at registered bores;
- Change in groundwater flux to/from watercourses;
- Change in groundwater resource in the GAB.

7.1 Mining schedule / progression

The predictive modelling incorporates the remaining BNM mine life and the full (proposed) BSP mine life .The development of the BSP open cut pit and its associated dewatering activities, is summarised in **Section 1.2** and **Figure 1-3** to **Figure 1-7**. Modelling of these is discussed further below.

7.1.1 Baralaba North Mine (BNM)

For the purposes of cumulative assessment, the Baralaba North Mine development has been modelled with the same mining progression in the BNCOP numerical groundwater model consistent with (and unchanged from) that approved for the interim period, extending until stress period 55 (**Appendix D**).

This is for cumulative simulation purposes only. The assessment presented in the BNCOP EIS for BNM should continue to be used for the purposes of groundwater take accounting at the BNM, unless an update to the modelled BNM mine plan is completed (see Recommendations in **Section 9.1.4**).

7.1.2 Baralaba South Project (BSP)

The mine plan progression for the BSP commences in the north-west, progressing toward the south-east (**Section 1.2.1**). The predictive period for the BSP is from stress period 52 (start of BSP Mine Year 1) to stress period 75 (end of BSP Mine Year 23) in annual time steps (**Appendix D**).

As discussed in **Section 8.3.2** progressive in-pit spoil emplacement is simulated in all mining years. The exception to this is at the final void at the end of BSP mining. It is noted that partial backfilling of the final void may occur to integrate with the final landform design that will be developed as part of future mine closure studies. Nevertheless, post-mining recovery was conservatively simulated with the drains for the last year mining operation turned off (i.e. without partial backfilling) to year 2500. Further details are provided in **Sections 8.11** and **8.12**.

7.2 Forecasting scenarios and simulation methods

To assess the effects of the project, predictive scenarios are used to represent the development, and these are summarised in **Table 7-1**. Comparison of the outputs of these runs allows quantification of the effect or impact of the development(s), and assessment of project-specific effects.

Table 7-1 Summary of development scenarios for forecasting

Scenario	Run	Name	Comment
A	TR006A	Null (as existing conditions)	'Null run' as per Barnett et al, 2012.
B	TR006B	Mining baseline	Simulates historic mining and the remaining life of BNM (nominally to 2030)
C	TR006C	Cumulative mining including the BSP – proposed development schedule	Simulates both BNM and BSP and post-closure conditions. Comparison against Scenario A gives effects of the cumulative mining. Comparison against Scenario B gives incremental effects of the Project.

Each predictive run simulates the period to the year 2500 (**Appendix D**), with a sequence of climatic inputs (recharge, evapotranspiration) based on historical average conditions (Sections 6.5.4 and 6.5.5).

The focus of the development scenarios is on simulating the pit progression and dewatering for the purpose of understanding the associated water management requirements and environmental effects. For conservatism, these predictions do not include the imposition of a pit lake or void lake, as the formation and equilibrium of this level is uncertain, and requires iterative inputs with the surface water modelling (Engeny, 2023). However, a single model run incorporating the estimated equilibrium lake level has been carried out using the 'base realisation' parameter set, and is reported in **Section 7.11**.

7.2.1 Open cut pit and dewatering

The BSP will be a 'terrace' mining operation in that once the open cut pit reaches full depth in a strip (i.e. base of the economic coal seams), it progresses on the south side with backfilling in the north and the excess (swelled) spoil is dumped out-of-pit. The initial open cut excavation commences at the northern end of the total pit limit boundary, and then steadily moves south-east along the coal seams outcrop with the advancing mining sequence.

Active open cut pits are simulated in the numerical groundwater model using Drain cells (MODFLOW DRN package) with the invert elevation guided by the mine progression plans provided by Baralaba South Pty Ltd (summarised in to **Figure 1-3**).

Specifically, each drain cell elevation was set based on GIS analysis of the minimum elevation of the rasterised pit floor elevations lying within each model cell (at the point in time based on the annual mine progression), or in some cases the base of the modelled layer was used as the drain invert level. As noted in the model calibration (**Sections 6.5.6.1 and 6.14.3**), the conductance for each drain cell was an adjustable parameter, based on the model ensemble.

Given the groundwater monitoring data demonstrates that a number of the shallow alluvium and weathered Permian bores remained dry or largely unsaturated within MLA 700057, pre-stripping of the weathered / regolith material was not simulated in advance of the mine progression plans.

7.2.2 Spoil emplacement

The mine progression plans provided by Baralaba South Pty Ltd specified both the annual progress of open cut pit excavation followed by the annual progress of the out-of-pit and in-pit (backfilling) spoil emplacement process. This backfilling process was simulated in the numerical groundwater model.

Changes to hydraulic properties were applied to both backfill spoil emplacement areas as well as to out-of-pit spoil emplacement beyond the open cut pits (see **Figure 1-3**).

The generally higher permeability of this (broken) spoil was altered from the host value using MODFLOW's Time-varying Material Properties (TVM) package. The hydraulic properties applied to simulate the spoil are presented in **Table 7-2** (for both BNM and BSP).

Table 7-2 Hydraulic Properties Applied to Spoil in the BSP Groundwater Model

kH [m/d]	kV [m/d]	Sy	Ss [m-1]	ET	Recharge
1	0.1	0.2*	No change	No change	varied in the ensemble

kH value based on Hawkins (1998)

The changes of the storage values (Sy) were applied to backfill spoil emplacement areas after completion of the open cut pit progression at BSP.

The generally higher infiltration characteristics of the spoil were also accommodated by allocating enhanced rainfall recharge (as per **Section 6.5.4**, this was an adjustable parameter based on the model ensemble). The initial range in simulated infiltration rates was 0.5 to 25% of average rainfall, although this was reduced in the history-matching process to approximately 0.5 to 3% - **Section 6.14.3**).

Vegetation rooting depths (in the MODFLOW EVT package) were not modified to simulate changed vegetation characteristics.

It is also noted that the topography of the backfilled spoil emplacements within the pit extent was not altered despite differences in the final rehabilitated landform, (primarily as the groundwater table is generally in excess of 12-15 mbg and hydraulically disconnected from the surface waters, with the exception of the final void discussed separately).

7.3 Uncertainty analysis

Given the available dataset of hydraulic properties, and the currently 'unstressed' or green-field nature of the BSP site (although the historical mining at BNM is considered within this model), there is uncertainty about the behaviour of the groundwater system (e.g. magnitude of drawdown) in response to a feature such as the Project. As such, and in accordance with the AGMG and IESC uncertainty guidelines, there is a need to explore the model and system uncertainty related to the potential effects and impacts of the project.

PESTPP-IES has been selected for this purpose. As described in Section 6.9, as a result of the iterative history-matching process, PESTPP-IES generates a set of plausible alternative model realisations that fit the observations or targets to an "acceptable" degree. This ensemble of posterior realisations is used in combination with the development scenarios (Section 7.2) to quantify the potential effects of the project and the uncertainty in these effects.

The mechanics of this are:

- Over 100 realisations (the 'ensemble') were run by PESTPP-IES for forecasting. The assumption here is that this number of realisations represents the full range parameter uncertainty (at the scale of the model cells) in this groundwater system. This original ensemble size is similar to the 100 recommended in literature as the minimum size (Peeters and Middlemis, 2022), however as Peeters and Middlemis note, there is a trade-off with practicality, and this was the case here given the week of total computer run time for the forecasting scenarios.

- 88 of these realisations were completed successfully by PESTPP-IES. The unsuccessful realisations failed due to non-convergence of one (or more) of the development scenarios. This number of failures will likely have the small effect on the ensemble's use in characterising the range in uncertainty associated with the various predictions (**Sections 7.4 to 7.9**).
- For the inflow forecasts, the results of the 'C' development scenario (**Table 7-1**) were analysed for each of the 88 successful realisations..
- For head (groundwater level) forecasts, such as those presenting contours of heads, the results of the 'A', 'B' and 'C' scenarios are analysed independently for each of the 88 successful realisations. A particular statistic, such as the median groundwater level for any model cell across all realisations, is used for mapping (**Section 7.6.1**).
- For the drawdown forecasts (e.g. **Section 7.6.2, 7.6.3 and 7.6.4**) the difference between the groundwater level results of the C' scenario (all mining) and either of the 'A' (Null) or 'B' (mining baseline) development scenarios were analysed for each of the successful realisations, yielding 88 estimates of drawdown for every model cell and model timestep. For each realisation, the maximum drawdown was assessed for each model cell in selected layers. The maximum drawdown is then summarised as 5^{th}, 50^{th} and 95^{th} percentile, where the 50^{th} percentile (median) estimate is the central (or "likely") value from the ensemble, while the 5^{th} percentile represents a "likely best case" and the 95^{th} percentile represents a "likely worst case". The impact assessment is focussed on the 50^{th} and 95^{th} percentile forecasts ("likely" and "likely worst case").

This approach is consistent with the recommendations in the AGMG (Barnett et al., 2012) and the latest revision of the IESC uncertainty guidelines, although we have opted to present $5^{th}/50^{th}/95^{th}$ percentile estimates of drawdown or some flux of interest, rather then the $10/33/67/90^{th}$ percentile probability of exceeding specific drawdown (or flux) thresholds (e.g. 2 m).

7.4 Simulated regional water balance

Simulated water balances are useful for understanding how a change in one or more water balance components (a stress or stresses) can affect others.

The model water balance for development scenarios A, B and C, along with the calculated difference in the model water balance to show the incremental change due to the project, is summarised in **Table 7-3** (BSP mining period) and **Table 7-4** (approximately 150 years post-mining). This is reported for a single realisation (the base realisation) that is near the median BSP inflow estimate (**Section 7.5**).

Table 7-3 Model-predicted water balance: whole model domain during BSP mining– 2030-2054

Modelled component	Catchment process	Null / Natural		Baseline mining (BNM only)		With BSP		Change in water balance: BSP incremental effect		
		Scenario A		Scenario B		Scenario C		=Scenario B - Scenario C		
		In	Out	In	Out	In	Out	delta IN	delta OUT	Net
Storage	Groundwater storage	1.4 (GWL decline)	0.7 (GWL rise)	1.7	1.7	4.2	4.0	-2.5	-2.3	-0.2
Recharge	Infiltration recharge	7.9	0.0	8.1	0	8.2	0	-0.1	0.0	-0.1
River-aquifer interaction	GW-SW interaction w/ watercourses, springs	26.8	11.6	26.8	11.5	27.0	11.3	-0.2	0.2	-0.3
ET	Evapo-transpiration from water table	0	34.7	0	34.2	0	34.4	0.0	-0.2	0.2
Head Dep Bounds	Regional groundwater flow	26.9	16.0	26.9	16.0	26.9	16.0	0.0	0.0	0.0
Drains	Groundwater inflow / dewatering	0	0	0	0	0	0.5	0.0	-0.5	0.5
	Total	**62.9**	**62.9**	**63.5**	**63.5**	**66.3**	**66.3**	**-2.8**	**-2.7**	**-0.1**

Units are ML/d.

Results for run.id (#7): E:\WSHED\PROJ\BARALABA\Model\Processing\Model Water balance_simple_BSP.xlsx

There may be some rounding errors.

For all scenarios, the total inflow (recharge) to the groundwater system within the model extent is approximately 62-66 ML/d, of which rainfall recharge is approximately 13% and leakage from the river (RIV) cells is up to approximately 40%. Groundwater discharge is dominated by evapotranspiration (ET) (approximately 55%) with some residual baseflow to the river (RIV) cells. BSP mine inflow is approximately 1%.

The water balance is consistent with the model conceptualisation.

The Project-related effects occur primarily due to the mine dewatering. On a regional scale (i.e. the scale of the model domain), the project's dewatering flux is minor (in the regional context), but is the main stress during the mining period, along with the enhanced infiltration recharge to the spoil areas. The dewatering is turned off at the end of mining, so is zero in the post-mining period.

The dewatering (and enhanced recharge) results in small changes to some of parts of the model water balance, causing changes to groundwater storage (i.e. a reduction in groundwater levels during mining), increased leakage and reduced baseflow to watercourses representing an overall reduction in stream flow, and some minor changes to evapotranspiration from groundwater.

Table 7-4 Model-predicted water balance: whole model domain post-mining – 2054-2200

Modelled component	Catchment process	Null / Natural		Baseline mining (BNM only)		With BSP		Change in water balance: BSP incremental effect		
		Scenario A		Scenario B		Scenario C		=Scenario B - Scenario C		
		In	Out	In	Out	In	Out	delta IN	delta OUT	Net
Storage	Groundwater storage	0.4	0.1	0.3	0.3	0.5	1.3	-0.2	-1.0	0.8
Recharge	Infiltration recharge	7.9	0.0	8.1	0.0	8.3	0.0	-0.1	0.0	-0.1
River-aquifer interaction	GW-SW interaction w/ watercourses, springs	26.8	11.5	26.8	11.5	27.2	11.1	-0.4	0.5	-0.8
ET	Evapo-transpiration from water table	0.0	34.3	0.0	34.3	0.0	34.5	0.0	-0.2	0.2
Head Dep Bounds	Regional groundwater flow	26.9	16.0	26.9	16.0	26.9	16.0	0.0	0.0	0.0
Drains	Groundwater inflow / dewatering	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	**61.9**	**61.9**	**62.1**	**62.1**	**62.8**	**62.8**	**-0.7**	**-0.7**	**0.00**

Units are ML/d.

Results for run.id (#7): E:\WSHED\PROJ\BARALABA\Model\Processing\Model Water balance_simple_BSP.xlsx

There may be some rounding errors.

7.5 Inflow forecasting for the project

Groundwater take/inflows to the BSP open cut mining operations have been extracted from the predictive model. The model predicted groundwater take/inflows estimates, presented as a daily average for an average annual period, for the BSP are presented in **Figure 7-1**. The total inflow is is summarised as the 5th, 50th and 95th percentile estimates from the model ensemble.

It is noted that the predicted groundwater inflow estimates include any moisture in ROM coal, and are before evaporative losses from pit floor or walls and does not account for direct rainfall or surface water ingress.

The model ensemble predicts groundwater inflows to range up to 1.5 ML/day (peaking in Year 23), with an average of 0.3 (5th percentile) to 0.75 ML/day (95th percentile) for the operational life of the mine. The predicted total volume of the BSP open cut inflow is 2250 to 6900 ML for the proposed life of the mine (median estimate 3700 ML).

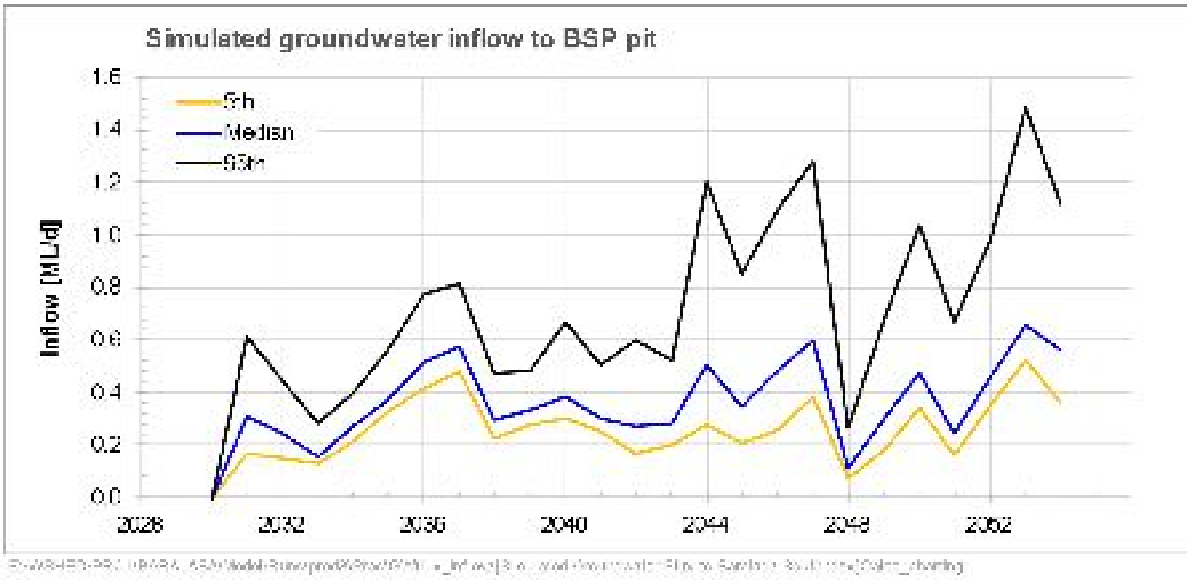


Figure 7-1 Estimated total groundwater inflow to the project

All of the estimates tend to show a small peak in inflow in 2036 (Year 7) followed by more consistent peaks in the latter years of the proposed mine life (Years 15-23) as the mine progresses deeper, and potentially as the groundwater levels within the in-pit waste begin to rise.

7.5.1 Potential effects of climate change

The effect of climate change are uncertain, as briefly described in **Section 7.10**. Based on the two climate change groundwater model scenarios for the BSP, groundwater take/inflow estimates could vary as follows (from the base realisation):

- -20% rainfall recharge: average take/inflows reduced to a range of 0.25 ML/d to 0.7 ML/d (median estimate of 0.4 ML/d), being -5% to essentially no change.
- +20% rainfall recharge: average take/inflows increased to a range of 0.35 ML/d to 0.8 ML/d (median estimate of 0.4 ML/d), again representing a relatively small change.

The small changes are likely related to the low rainfall recharge in this area. Literature indicates that shallow aquifers and surface water system are more sensitive to climate change, rather than ‘deep’ aquifer systems.

7.6 Groundwater level forecasts

A variety of methods of presenting modelled groundwater levels are provided in the following sections, including groundwater drawdown hydrographs at receptor sites, contours of the model-predicted maximum drawdown (at various times) in a selection of model layers or stratigraphic units, and contour maps of groundwater levels .

7.6.1 Groundwater level contour maps

Groundwater level contour maps for the predictive period have been produced for the purpose of understanding the post-closure equilibrium groundwater levels (**Section 7.11**), while contouring of drawdown is considered more useful for understanding the potential effects of the BSP (**Section 7.6.2**).

7.6.2 Maximum groundwater drawdown contour maps

Groundwater level contour maps are useful for illustrating the simulated pattern of groundwater levels, and the inferred direction of flow, as a result of the excavations that form the project and other processes. For environmental impact assessment, the simulated location, extent and magnitude of drawdown is more important than actual groundwater level. The maximum drawdown predicted in every model cell in a number of selected ‘stratigraphic’ layers, as well as the drawdown in the simulated water table has been calculated during construction (2024-2030), and in the long-term for the following stratigraphic units or layers:

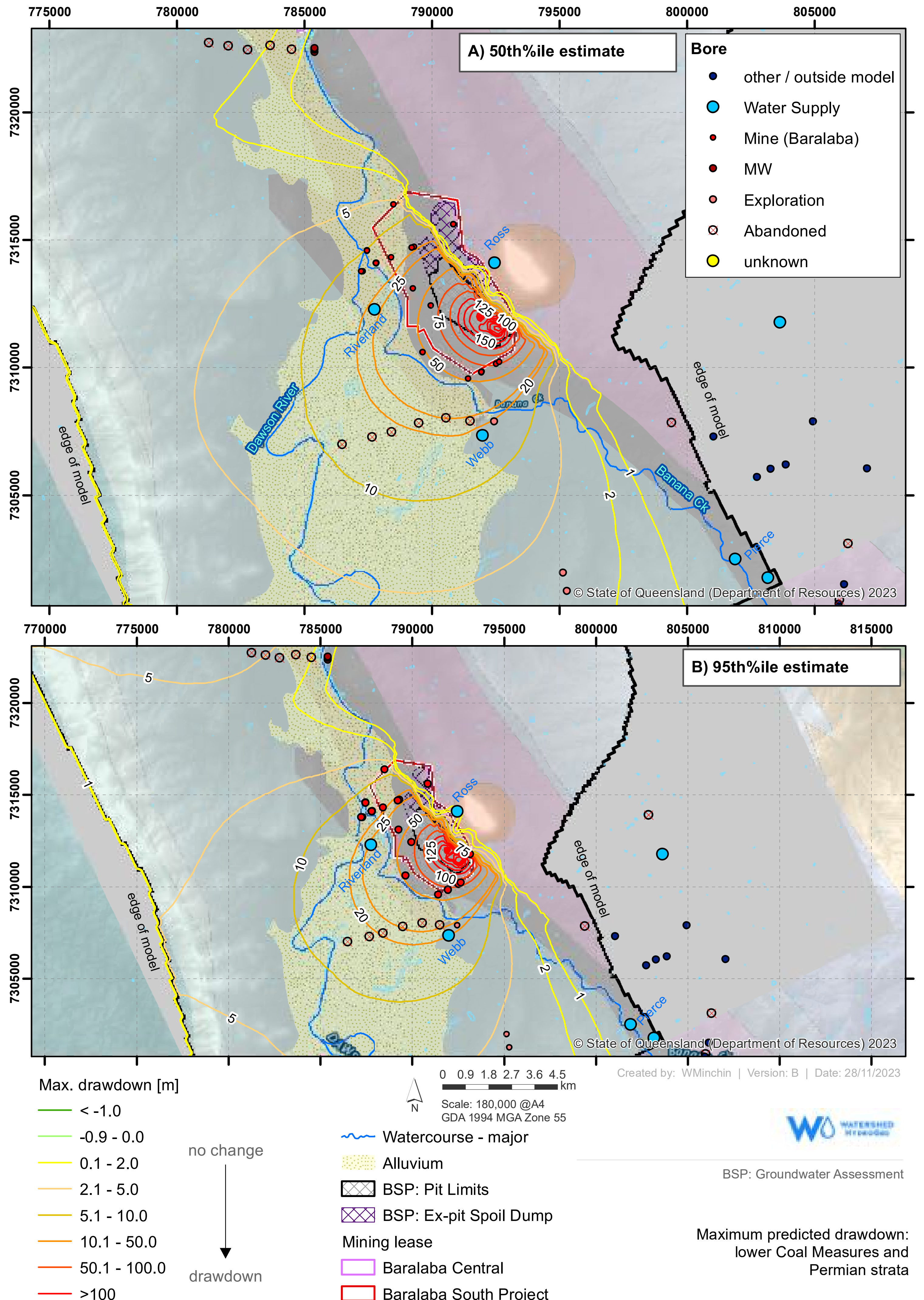
- the lower Coal Measures and Permian strata (model layer 16); and.
- water table (calculated here as the modelled water level in the uppermost saturated model layer, i.e. uppermost saturated or partially saturated stratigraphic unit).

These maps are presented on the following pages, with **Figure 7-2** (Permian strata) and **Figure 7-3** (water table) to showing the maximum modelled drawdown predicted to occur between 2030 and 2054. These are calculated from Scenario A groundwater levels minus those from Scenario C.

The median or 50th percentile estimate of the maximum drawdown from the ensemble is the main focus on these maps, but the key drawdown contours from the 95th percentile (‘realistic worst case’) are also shown to illustrate uncertainty in the predictions. For the water table drawdown, the 5th percentile estimate (‘realistic best case’) is also shown. The following discussion and observations are made from inspection of these drawdown maps.

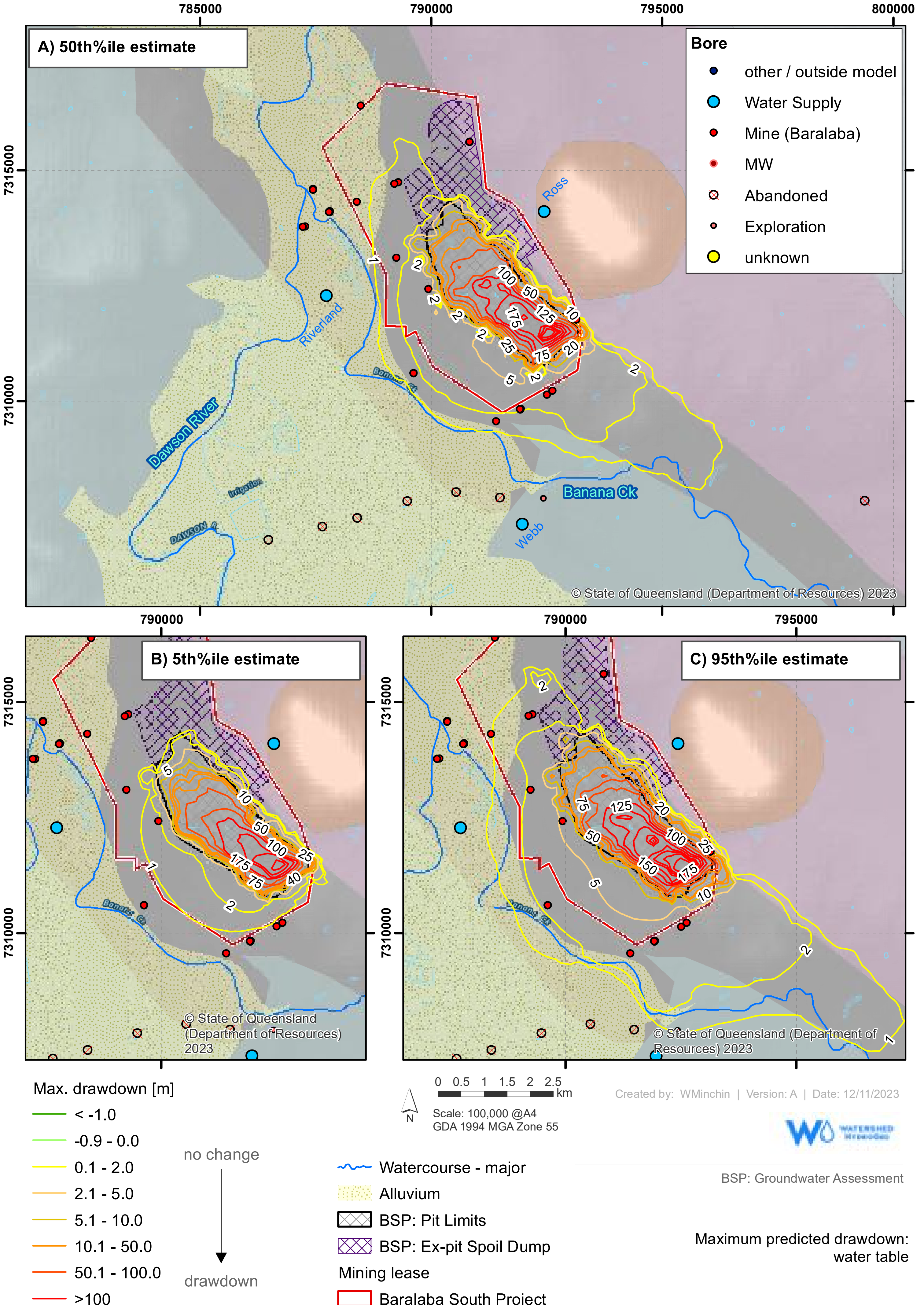
The content of **Figure 7-2** is shown at a relatively small scale to show the relatively extensive cone of depression in the Permian strata. The cone of depression is large because of the high hydraulic conductivity, the lack of direct rainfall or river recharge, and the confined nature of the coal measures. It can be seen that the cone of depression reaches the edge of the model to the west and south, and overlaps the cone of depression extending south from the BNM in these deeper units.

This superposition is not considered a problem because it does not manifest as measurable drawdown in the water table (where the environmental features are), as discussed below, and because there are so few anthropogenic bore users in the Coal Measures. However it is shown on **Figure 7-2** that the contours do intersect the location of the Ross bore to the east of the BSP (see **Section 7.6.3**).



Maximum predicted drawdown: lower Coal Measures and Permian strata

Figure 7-2



Maximum predicted drawdown: water table

Figure 7-3

The water table drawdown (**Figure 7-3**) is focussed on BSP open cut, and it can be seen that the 1 m contour of the cone of depression is essentially contained within the northern and eastern boundaries of the MLA, and extends beyond the MLA boundary to the west (by up to 800 m [50th percentile] to 1200 m [95th percentile]), and extends further to the south (by 3.5-4.5 km) along the strike of the coal seams. The 5th percentile estimate of drawdown (**Figure 7-3B**) is almost completely contained within the MLA boundary.

The fact that the cone of depression, even the 50th and 95th percentile estimates, does not extend further north or north-west indicates that there are no cumulative drawdown effects on the water table related to BNM (unlike the drawdown in the confined coal measures at depth).

To the west, the cone of depression in the water table is mitigated by the presence of the higher permeability and porosity alluvium and the presence of the watercourses.

In order to understand the potential drawdown within the alluvial and colluvial deposits around the BSP, **Figure 7-4** shows the maximum predicted saturated groundwater drawdown in alluvium and colluvium deposits due to the BSP, i.e. the 50th percentile maximum drawdown is limited to the inferred saturated thickness of these deposits (model layer 1), based on the groundwater levels presented in **Figure 3-11**.

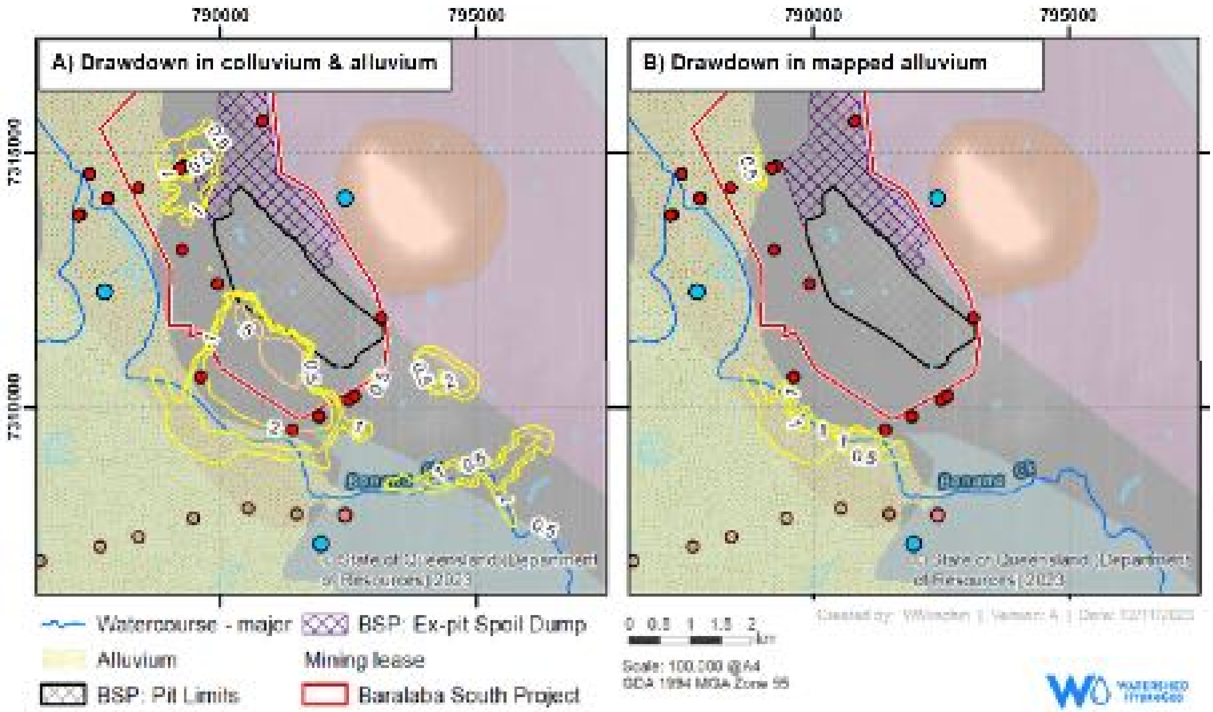


Figure 7-4 Modelled drawdown in surficial deposits

The figure includes the drawdown across A) all surficial deposits, and B) restricted to the mapped alluvium only, showing contours down to 0.5 m. **Figure 7-4A** indicates that there is up to 8 m predicted drawdown within the colluvium just to the west or south-west of the open cut pit, and this cone of depression extends to the west toward Banana Creek. Other small cones of depression are evident to the south-east (near Banana Creek) and north-west of the pit.

Figure 7-4B shows this drawdown restricted further to the alluvium shown by the Queensland government mapping. This means that the maximum drawdown is approximately 1 m within this mapped alluvium, mainly around the reach of Banana Creek where it flows on the Dawson River alluvium (and outside of the MLA boundary), as well as a small cone of depression (also approximately 1 m drawdown) to the north-west of the open cut (within the MLA boundary).

These model results are consistent with the conceptualised cross-sections on **Figure 3-13** and **Figure 3-14**.

As noted previously, post-closure groundwater levels are presented in **Section 7.11**.

7.6.3 Drawdown at landholder bores

A small number of private landholder bores were identified in the vicinity of the BSP during the landholder bore survey (**Section 3.3.3** and **Appendix B**) and a more recent search of Queensland Globe and BOM Groundwater Explorer databases. These bores are listed in **Table 7-5**.

The numerical model was used to make estimates of groundwater drawdown as a result of mining at the BSP. The predictions, including the model uncertainty in these predictions is illustrated for Riverland (**Figure 7-5**) and Ross (**Figure 7-6**). In these figures, the upper pane shows the predicted cumulative mining effect (calculated as the difference between Scenarios A and C), and the lower pane shows the BSP incremental effect (calculated as the difference between Scenarios B and C).

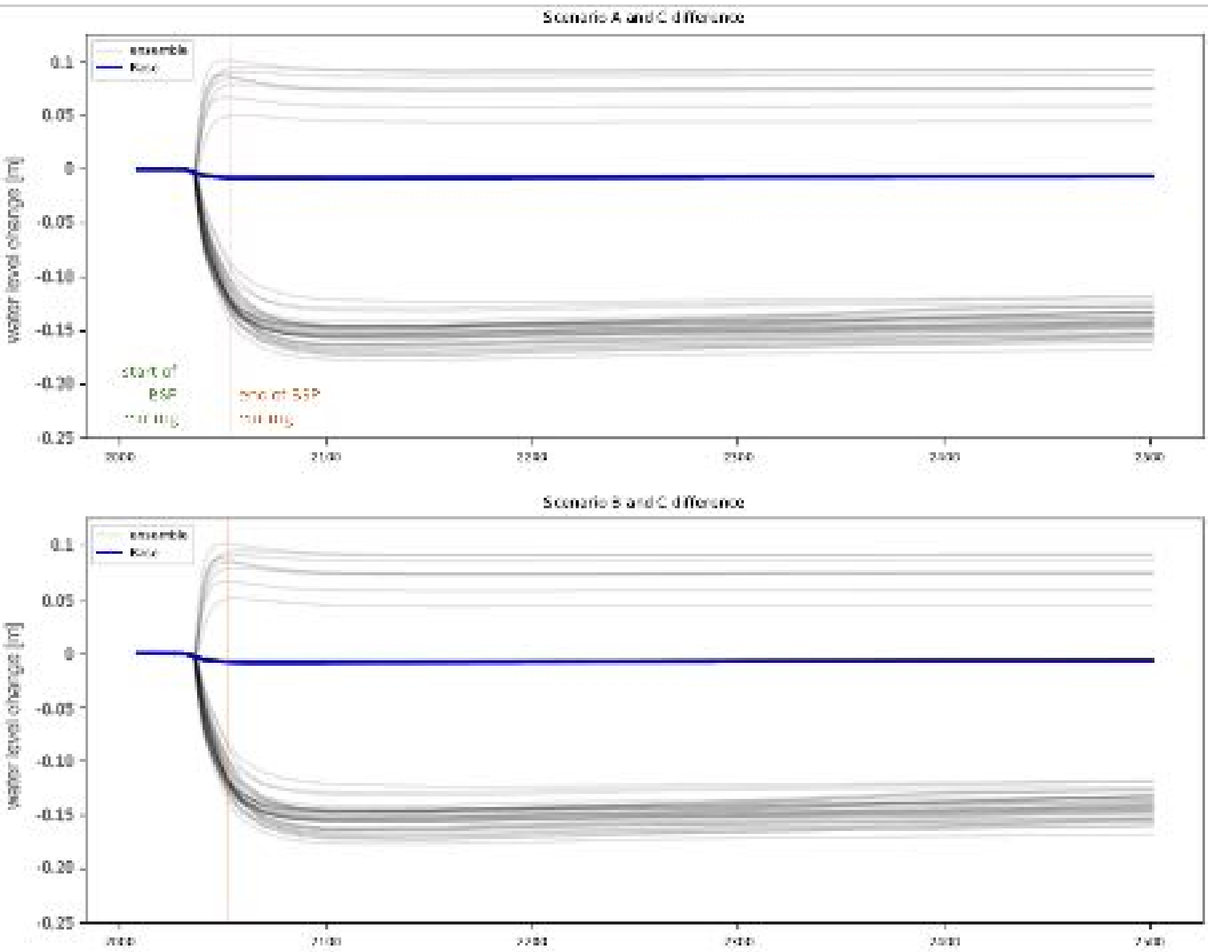


Figure 7-5 Modelled change in groundwater level (drawdown) at bore Riverland2

In the case of Riverland2 (**Figure 7-5**), there is no difference between the cumulative mining effect and the BSP effect, indicating that at this location, there is no contribution to drawdown from the BNM, i.e. no overlapping drawdown cone in this aquifer. This is expected given the distance (>13 km) to the Baralaba Central open cut.

A simulation situation occurs at the (unregistered) Ross bore (**Figure 7-6**).

From the predictive ensemble of results presented on these figures, a range of estimated of maximum drawdown has been derived, and this is reported in **Table 7-5**. For the maximum predicted post-closure drawdown, the approximate date of peak drawdown is included.

Table 7-5 Predicted Drawdown at private landholder bores – BSP

Bore	Hydrogeological Unit	Relative Location from MLA 700057	Other comments	Predicted Maximum Drawdown (m) related to BSP:						
				During BSP mining			Maximum (during and after)			
				5th%ile	**50th%ile**	95th%ile	5th%ile	**50th%ile**	95th%ile	Date of peak
Riverland 1 & 2	Quaternary Alluvium*	1.5 km west	Bore(s) not in use	0.01	**0.11**	0.13	0.02	**0.15**	0.17	2070
Ross	Cretaceous Intrusive	500 m east	Bore in use (Stock watering)	0.15	**0.4**	0.7	1.5	**2.25**	4.2	2500; **Figure 7-6** shows drawdown approaches maximum at this time.
Webb	Triassic / Permian strata (likely in weathered regolith*)	3.5 km south	Bore not in use	0	**0**	0	0	**0**	0	--

* Estimated based on bore depth.

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The results indicate the Project would have a negligible impact on groundwater levels or groundwater yield at the Riverland and Webb landholder bores. The maximum predicted drawdown of 0.15-0.7 m at the Ross Bore during mining would be similar to natural variation in the recorded groundwater table (**Figure 3-7**), as well as other bores within MLA 700057 and the surrounds considering the results of the baseline groundwater monitoring network in the Quaternary alluvium and Permian coal measures (**Section 3.1**). The drawdown at Ross (like at Riverland) is predicted to increase through time, with the long time to peak drawdown at the Ross bore a function of the low permeability of the strata in this area. The maximum drawdown at this site is predicted to be in the order of 1.5-4.2 m (where recent groundwater levels are approximately 102 mAHD and the bottom of the bore is at approximately 68 mAHD).

In regard to this predicted maximum drawdown at the Ross bore, the model developed is likely conservative with respect to the geometry or layering of the intrusive feature (see comment at the end of Section 6.4.2.1), and the peak post-closure drawdown might be mitigated to some degree by the formation of a void lake in the final void at BSP, but it was preferred to report the conservative drawdown estimate, given the uncertainty related to the lake level and time to equilibrium.

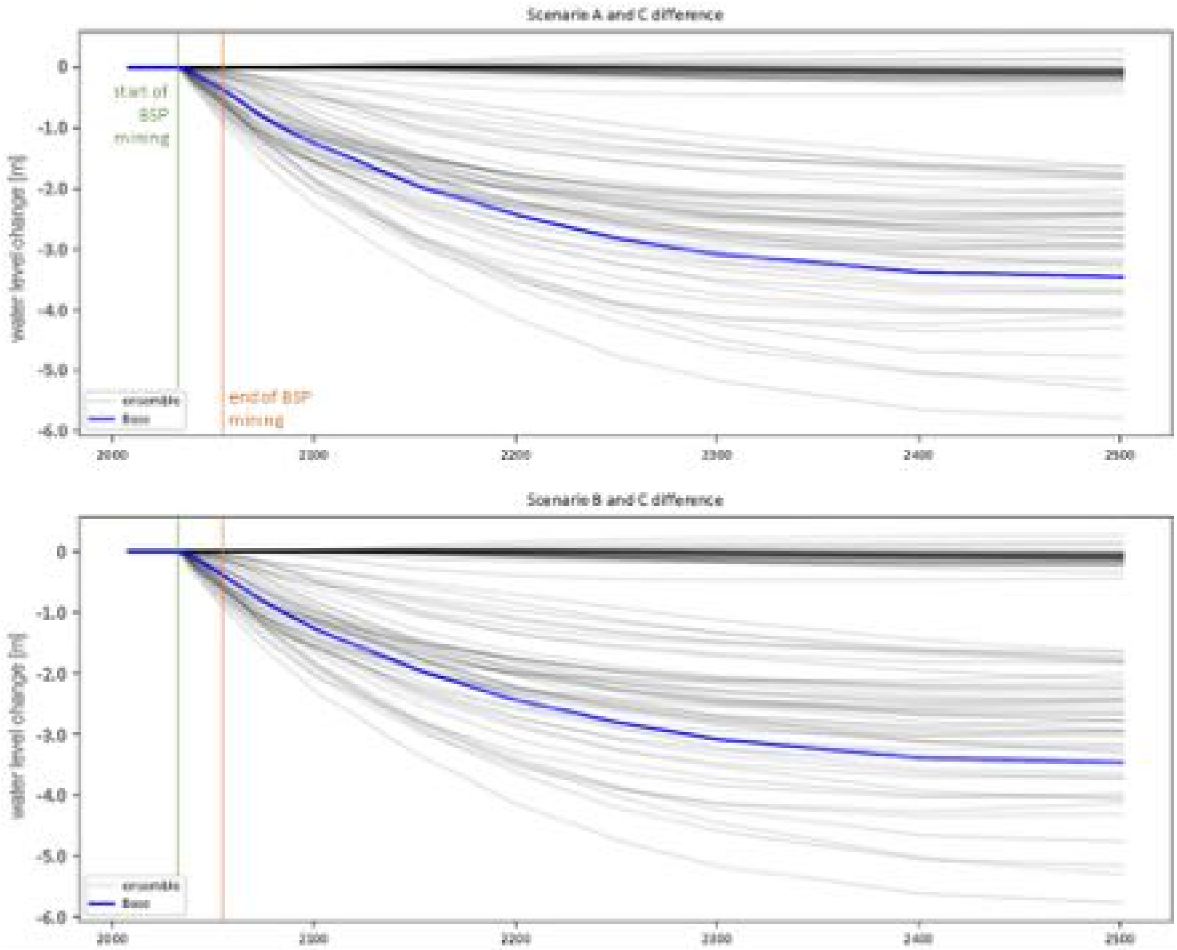

Figure 7-6 Modelled change in groundwater level (drawdown) at bore Ross

For the purposes of comparison, private bores much further afield in the Clematis Sandstone and reported in the BNCOP numerical groundwater model (HydroSimulations, 2014) were investigated to numerically predict drawdowns (where it asymptotes) in the order of millimetres, which therefore supports the conclusion that there would be effectively no decline in groundwater levels in the hydrogeological units that constitute the Great Artesian Basin (GAB) as a result of the BSP.

7.6.4 Drawdown at springs, wetlands, and GDEs

Springs

As described in **Section 3.5.1**, during the landholder bore survey conducted by 4T Consultants (2019), no springs were observed or noted within MLA 700057 or surrounds.

Wetlands and potential GDEs

As described in **Section 3.5.2**, the HES wetland is considered to be a 'perched' system, i.e. separate from the regional groundwater system, with the presence of underlying clays. Based on the available evidence (i.e. groundwater level monitoring, vegetation mapping, and site survey and reconnaissance by Ecological Survey & Management [2021], Ecological Service Professionals [2021] and 3d Environmental [2023], the wetlands are considered reliant on direct rainfall, runoff and floodwaters, which are held near the surface by the shallow clays. Assessment of groundwater dependence by 3d Environmental (2023) confirmed the HES wetland is not a GDE.

The depth of the groundwater level is approximately 15 m below the HSE wetland with negligible predicted groundwater level change at the end of the BSP mining (**Figure 3-14** - cross-section B-B'). No significant drawdown effects that would cause a reduction in water availability are predicted at the wetland.

An example of how drawdown would develop around the mine is presented on **Figure 7-7**. This is for a wetland site identified by 3d Environmental (2023) as "GDE Area 1", located to the southwest of the BSP open cut (see inset).

This shows drawdown of approximately 1-2.5 m being predicted by the groundwater model beneath this feature.

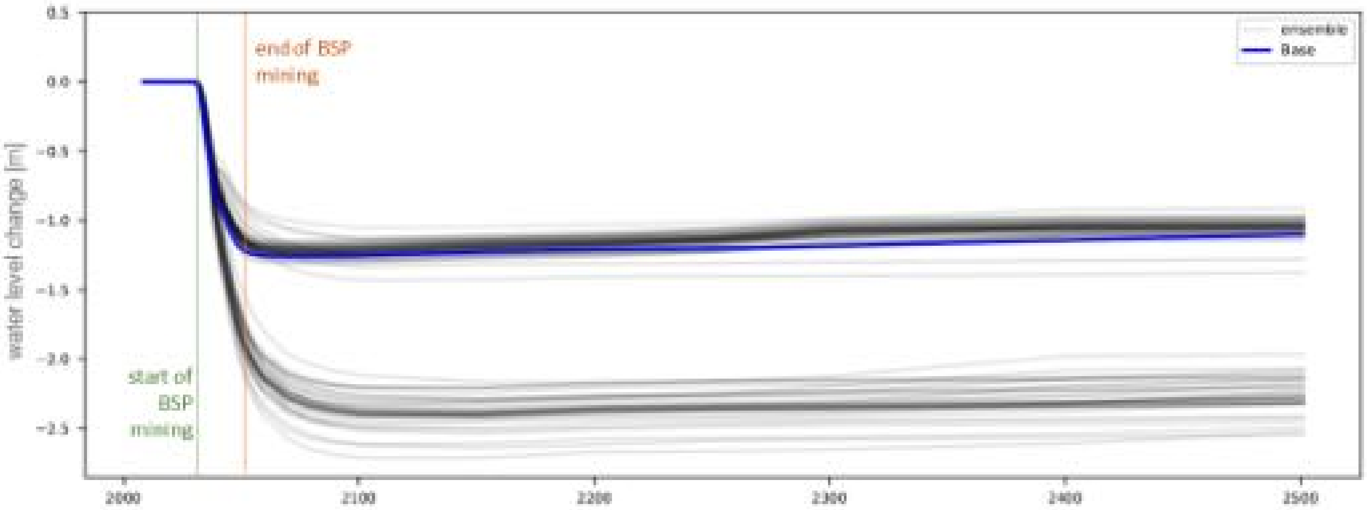

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Figure 7-7 Modelled groundwater drawdown at site "GDE Area1"

As part of their assessment, 3d Environmental (2023) has assessed the dependence of vegetation in the BSP area on groundwater for the Project through the measurement of leaf water potential, soil moisture potential, stable isotopes and physical observation. 3d Environmental (2023) concluded that groundwater dependence within MLA 700075 and adjacent areas associated with the Dawson River flood plain is controlled by small discontinuous lenses of sand that are distributed sporadically throughout the heavy clay soils that otherwise characterise the flood plain sediments. The sandy lenses support fresh groundwater resources on a seasonal basis that are perched above and disconnected from the regional groundwater table. Recharge of the sandy lenses occurs during surface water infiltration associated with overbank flow and intense rainfall events.

Although groundwater drawdown may reach strata beneath some of the wetland features (as in **Figure 7-7**). The groundwater drawdown associated with mining void development (**Figure 7-3**) is not predicted to impact the ecological function of any GDEs which utilise and rely upon the perched seasonal groundwater resources as:

- there is no hydraulic connectivity between the sandy lenses and the regional groundwater table (including potentiometric surfaces of the alluvial aquifer and the Permian coal measures) which will be directly impacted by mining; and
- there is low hydraulic connectivity between the sandy lenses;
- there is no causal pathway identified which will affect the recharge of perched aquifer systems, which is controlled by surface flows and surface water infiltration (3d Environmental, 2023).

Where development of mining infrastructure is predicted to result in some direct clearing of (potentially groundwater dependent) vegetation, this will be addressed elsewhere in the EIS.

7.7 Effects on groundwater-surface water interaction (river flow)

Dewatering of mine voids, as well as potential enhanced recharge to spoil/waste dumps, could cause changes to groundwater-surface water interaction to nearby watercourses. Specifically, a reduction in stream baseflow via two mechanisms:

- groundwater depressurisation or drawdown in the groundwater system that is connected to the watercourse (i.e. outcropping beneath the watercourse) can cause a reduction in baseflow or an increase in leakage from the watercourse to the underlying groundwater system; and
- enhanced recharge leading to mounding around waste dumps may result in reduced leakage and/or increase baseflow to the watercourse.

The numerical model has been used to estimate change in flux to/from watercourses on the scale of reaches, as requested by the hydrologists for use in the EIS Surface Water Assessment. With respect to this forecast, the model is not (cannot be) calibrated to groundwater-surface water fluxes nor to measured changes in flux (**Appendix G**).

The results of the analysis are presented in **Table 7-6**, and includes comparison of the predicted groundwater-surface water interactions with the BSP (and BNM) and without (i.e. null).

Table 7-6 Predicted change in groundwater-surface water interaction at river reaches

Watercourse reach	**Modelled groundwater-surface water flux (average 2030-2054)** [ML/d]		Predicted Change due to the BSP (Predictive Model Run Minus 'Null' Run)	
	Model without mining (Null)	Model with BNM and BSP	**Effect During Mining at BSP [ML/d]**	
Dawson River (d/s Neville Hewitt Weir) [**Zone C**]	Mean +3.79 Range +2.48 to +5.22 [consistent Leakage]	Mean +3.80 Range +2.49 to +5.23	0.01 ML/d	Negligible
Dawson River (u/s Neville Hewitt Weir) [**Zone D**]	Mean +1.94 Range +1.20 to +2.63 [consistent Leakage]	Mean +2.04 Range +1.26 to +2.73	0.06 to 0.1 (average 0.09)	Peak effect of <0.01% of average flow^
Dawson River (Upstream) [**Zone E**]	Mean +1.41 Range +1.18 to +1.56 [consistent Leakage]	Mean +1.40 Range +1.17 to +1.55	0.01 ML/d	Negligible
Banana Creek *	Mean +0.06 Range +0.01 - +0.11 [consistent Leakage#]	Mean +0.16 Range +0.11 to- +0.22	0.1 additional loss#	Negligible as Banana Creek only flows on occasions following rainfall events
			# this is filtered to include only model realisations where Banana Creek is predominantly losing, as per the conceptual model. Modelled loss up to 0.15 ML/d if including realisations where baseflow dominates, but this is not considered likely.	

^ Based on average gauged flow in the Dawson River of 2,371 ML/d (@ Beckers 130322A) [Beckers average for 2018-22 = 1469 ML/d).

* Note that a small section of the lower reach of Banana Creek, at the confluence of the Dawson River, is mapped as being within the 'effective upstream limit of Neville Hewitt Weir' which has likely raised the stage in part above the natural levels.

While the predicted groundwater drawdown due to the BSP in the Permian strata would be limited in the shallow groundwater systems, it would incidentally transfer indirectly to some, albeit immeasurable, leakage from the Dawson River (upstream of Neville Hewitt Weir) to the surficial geology by peak of up to approximately 0.1 + 0.1 (0.2 ML/day, although more likely 0.16 ML/d), which when compared to the average surface water flows in the Dawson River for the past 5 years (approximately 1469 ML/d for Beckers - 2018-22) is a 0.01% reduction in flow. Similarly, the modelled leakage predicted from Banana Creek is considered negligible as it only flows on occasions following rainfall events (while in the model it is simulated as a fixed head or consistent source of water, which is conservative with respect to river-aquifer interaction, but perhaps not with respect to the potential extent of drawdown).

These small to negligible changes are primarily due to a combination of the relatively low permeability of the Triassic (e.g. the Rewan Formation) and steeply dipping Permian stratigraphy that largely prevents drawdown in the Coal Measures from propagating up into the shallow groundwater system.

The BSP numerical groundwater model verifies the conceptual model that there is poor connection between the groundwater system and ephemeral drainage features. This is largely due to the 12-15 m depth to groundwater which in turn limits the ability of drawdown to capture any localised baseflows that may occur at or near the invert of the watercourses and drainage features

Further implications of the modelled reductions in river flow are presented in the Surface Water Assessment (Engeny, 2023).

7.8 Estimated change in flux with the GAB

The BSP numerical groundwater model demonstrates that the BSP would not cause a change in flow direction of groundwater in the hydrogeological units that constitute the GAB.

Capture of groundwater from the GAB units was assessed using ZoneBudget mass balance functionality, and comparing the results from the models run both with and without the BSP. The modelled incidental reduction in GAB groundwater resources caused by the BSP operation were up to:

- Incremental BSP effect: median estimate <0.1 m^3/d (<0.008 ML/yr) and 95th percentile estimate of 0.4 m^3/d or 0.026 ML/yr.
- Cumulative BNM and BSP effects (2030-onward): median estimate 0.2 m^3/d (<0.07 ML/yr) and 95th percentile estimate of 2 m^3/d or 0.76 ML/yr. (noting that the peak mining effect of approximately 6 m^3/d is simulated as occurring prior to the commencement of BSP).

Over such a broad model domain, these modelled rates of groundwater capture are minor, and immeasurable, and the model supports the conclusion that there would be effectively no decline in groundwater levels in the hydrogeological units that constitute the Great Artesian Basin (GAB) as a result of the BSP. The difference between simulated BNM and BSP effects is likely due to their relative position compared to the other major hydraulic source/sink in this area, which is the Dawson River, with the BNM being to the west of the river.

This is consistent with the previous BNCOP numerical groundwater model results indicating negligible change in GAB groundwater resources.

7.9 Associated Water take

This section summaries the estimates of ‘take’ or groundwater captured or lost from the hydrogeological system. Surface water effects are documented in Engeny (2023).

Table 7-7 presents indicative ranges for Associated groundwater take derived from model-predicted groundwater inflow (Section 7.5).

This table presents estimates of the annualised 'take' from the relevant area of the over-arching *Fitzroy Basin Water Plan 2011*, noting that **Figure 1-9** (**Section 1.8**) indicates that BSP is in an area that is not part of a declared Groundwater Management Area.

Table 7-7 Associated Water Take (ML/year)

Water Source / Management Zone	Estimated Take^ (ML/yr)	
	Median	Upper
Groundwater: un-declared area within the Water Plan (Fitzroy Basin) 2011.		
Year 1	115	224
Year 2	97	164
Year 3	59	103
Year 4	99	146
Year 5	143	204
Year 6	192	283
Year 7	215	296
Year 8	108	171
Year 9	124	176
Year 10	150	244
Year 11	114	183
Year 12	103	220
Year 13	109	191
Year 14	180	438
Year 15	140	311
Year 16	180	402
Year 17	244	468
Year 18	47	96
Year 19	114	249
Year 20	195	379
Year 21	95	245
Year 22	175	359
Year 23	273	541

^ Ranges are the 50th%ile and 95th%ile take predicted for each yea

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The maximum take from any period in the mine life, based on the predictive model ensemble, is 541 ML/yr, occurring near toward the end of the BSP mine life (when the pit is deepest -).

The groundwater model ensemble results have been used, in conjunction with Zonebudget software, to estimate source of the groundwater taken by the BSP. Based on an average of the model ensemble, the breakdown is summarised in **Table 7-8**.

Table 7-8 Proportion of water from different hydrogeological units

Formation	Estimated proportion of Associated Water take from:	
	Native strata	assumed, including from Spoil
Alluvium /	8%	8%
Weathered strata	12%	12%
Permian – Coal	37%	28%
Permian -	44%	33%
Spoil		20%

7.10 The portion of water sourced from advancing in-pit spoil dump is not well understood, and difficult to process given the transient development of the open cut within in-pit emplacement following it, so an assumption is made as to the fraction of water that would be sourced from spoil rather than from the coal and interburden horizons of the Baralaba Coal Measures.Climate change

Climate change is predicted to affect rainfall and other climatic variables, of which rainfall has the most significant effect on recharge to groundwater. One source of projected changes in rainfall has been reviewed:

Future climate projections are available at the Commonwealth Government website (*Climate Change in Australia – Projections for Australia's NRM Regions*)[11]. The future climate projections are based on the latest set of climate models, as used in the Intergovernmental Panel on Climate Change (IPCC)'s Fifth Assessment Report (referred as the CMIP5 set of models).

The climate models consider a range of potential emission scenarios to allow comparison, of which most used the following three (as presented in the Special Report of Emissions Scenarios [SRES]):

- **B1 (Low Emission) Scenario** – Assuming a convergent world with low population growth, but with rapid changes in economic structures toward a service and information economy, with reductions in material intensity, and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social, and environmental sustainability, including improved equity, but without additional climate initiatives.
- **A1B (Medium Emission) Scenario** – Assuming a future world of very rapid economic growth, low population growth, and the rapid introduction of new and more efficient technologies, with a balanced emphasis on all energy sources. Major underlying themes are convergence among regions, capacity building, and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income.
- **A2 (High Emission) Scenario** - Assumes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in high population growth. Economic development is primarily

[11] https://www.climatechangeinaustralia.gov.au/en

regionally oriented and per capita economic growth and technological change are more fragmented and slower than other scenarios.

Representative Concentration Pathways (RCPs) are also used (where data is available) and comparisons with the three scenarios from the SRES. In summary, RCP4.5 is effectively equivalent to the SRES B1 (Low Emission) Scenario and RCP8.5 is at an equivalent trajectory as SRES A2 (High Emission) Scenario, albeit at a lesser level.

The BSP is located within the East Coast Cluster[12] and in a region where the following rainfall and temperature future climate projections are relevantly noted:

- Rainfall changes are possible, but unclear.
- Increased intensity of extreme rainfall events is projected, with *high confidence*.
- Average temperatures will continue to increase in all seasons (*very high confidence*).
- More hot days and warm spells are projected with *very high confidence*.

Despite the lack of clarity for potential rainfall changes, the effects of climate change on annual rainfall and evaporation in the BSP area have been taken from the Climate Change in Australia (CCiA) Model East Coast Climate Futures Projections and are presented in **Table 7-9**. For ease of comparison, the consensus of models for the A1B (medium emissions) SRES scenario in 2030 and the high emissions (A2) scenario in 2090 are presented. These results were selected to correspond with likely first year of the BSP mine life (i.e. 2030) and longer-term projections post-mining (i.e. 2090). Equivalent data was not available for the RCP scenarios.

Table 7-9 East Coast Climate Futures Projections – Change in Rainfall and Evaporation

Climate Futures Predicted Change		Annual Evaporation (% Change)					Horizon
		Large Decrease (< -4.6%)	Small Decrease (-4.6% to -1%)	No Change (-1% to +1%)	Small Increase (+1% to +4.6%)	Large Increase (> +4.6%)	
Annual Rainfall (% Change)	Much Wetter (> +15%)	0	0	0	0	0	2030
					1 of 9	1 of 9	2090
	Wetter (+5% to +15%)	0	0	0	3 of 11	2 of 11	2030
					0	1 of 9	2090
	Little Change (-5% to +5%)	0	0	1 of 11	2 of 11	2 of 11	2030
		1 of 9		0	1 of 9	2 of 9	2090
	Drier (-15% to -5%)	0	0	1 of 11	0	0	2030
			1 of 9	0		2 of 9	2090
	Much Drier (< -15%)	0	0	0	0	0	2030
							2090

Source: https://www.climatechangeinaustralia.gov.au/en/projections-tools/climate-futures-tool/projections/.

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In general this shows that there is not a great consensus between the models (the highest consensus for a specific change in evaporation and rainfall is 3 of 11 models in 2030 from the A1B scenario (**Table 7-9**). Our interpretation of these results is that there is more likely to be:

- A slight increase in annual rainfall, probably in the range 5-15%, but closer to 5%.
- A slight increase in potential evaporation, probably in the range of 1-5%, but closer to 5%.

[12] https://www.climatechangeinaustralia.gov.au/en/projections-tools/climate-futures-tool/projections/

Based on experience in rainfall-runoff-recharge modelling (including for consideration of climate change projections for water resource assessments in other settings) and literature, a general rule is that broad changes in rainfall (e.g. rainfall increased by 3%) are typically magnified 2-4 times when converted to rainfall recharge (e.g. recharge then increased by 6-12%) ('rainfall elasticity in recharge'), as has been described as occurring for historical climate variability (Barron et al., 2012). Using this concept, the more likely changes in rainfall (approximately 7%) are predicted to result in changes in rainfall recharge in the order of +20% in the future. However, some rainfall projections indicate that higher rainfall would be derived from larger, more frequent high rainfall events, which could lead to more runoff and lower recharge.

As such, the approach taken for this assessment has been to conduct a transient simulation for the prediction period perturbing rainfall recharge by -20% and +20% to represent postulated climate change scenarios, noting that in the short-term, climate variability, rather than climate change, will govern whether rainfall is similar to the long-term average or not. Potential evaporation from groundwater was not modified.

The effect of the postulated climate change scenarios has been assessed for the BSP groundwater take/inflow estimates (**Section 7.5.1**).

7.11 Post-mining inflow and groundwater levels

The transient predictive model run described in the earlier sections simulated a period to 2500 without representation of potential rainfall and runoff inputs to the final void. This is a simplification and is considered somewhat conservative with regard to the magnitude of groundwater drawdown around the open cut.

This section of the report documents the modelling used to first inform the final void water balance, which is carried out by Engeny Water Management, and then incorporate the results of that water balance in the groundwater modelling.

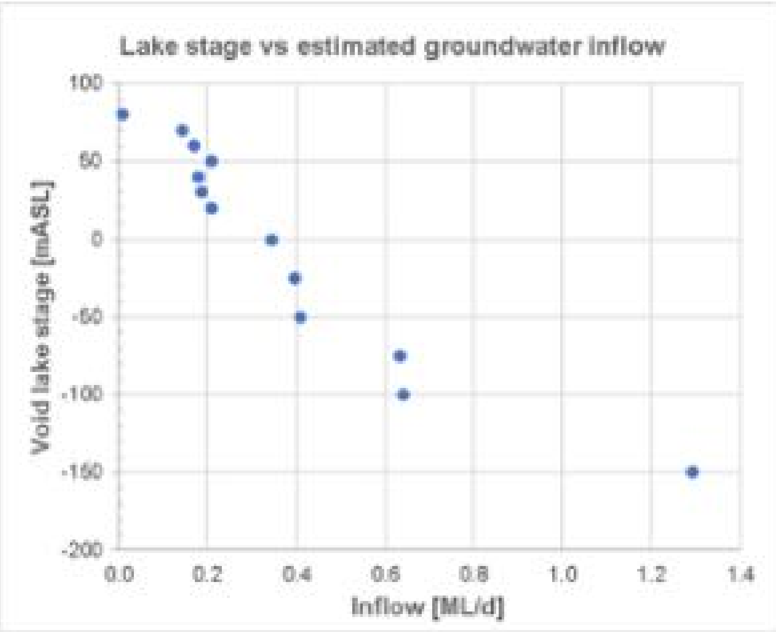
7.11.1 Initial or interim simulation of void inflows

Recognising that there are several factors which effect the final void equilibrium lake levels (including void surface catchment area, varying evaporation rates, rainfall scenarios and potential for inundation due to flooding [i.e. final landforms]), the post-mining equilibrium levels were determined in an integrated manner with AARC and Engeny with WatershedHG initially providing modelled stage groundwater inflow estimates to the void (at the end of mining within BSP, and then a further post-mining period). This was done by setting constant head boundary conditions to a range of stage levels to get the modelled long-term inflow in response to these.

The resulting stage groundwater inflows provided to AARC and Engeny Water Management are presented in **Table 7-10**.

Table 7-10 Initial model-predicted stage-groundwater inflows to the Interim final void

Lake stage (mAHD)	Estimated inflow (ML/d)
-150	1.29
-100	0.64
-75	0.64
-50	0.41
-25	0.40
0	0.35
20	0.21
30	0.19
40	0.18
50	0.21
60	0.17
70	0.14
80	0.01



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7.11.1 Post-closure equilibrium groundwater levels

Subsequent simulation of the recovery of void lake water levels were based on transient lake recovery levels provided by Engeny (2023). Engeny have indicated that:

- The final equilibrium lake level would be approximately 32 mAHD, likely ranging between 28 and 37.5 mAHD according to variability in rainfall and evaporation; and
- It would take approximately 325 years for this to be achieved (i.e. approximately year 2375).

To establish the post-mining equilibrium target groundwater levels in the BSP numerical groundwater model the time-variant constant head package (CHD) was used, with the final void lake stage level target set at 32 mAHD.

The post-mining recovery model was then run and groundwater levels for year 2500 are presented on **Figure 7-8**. The results of this are summarised as follows:

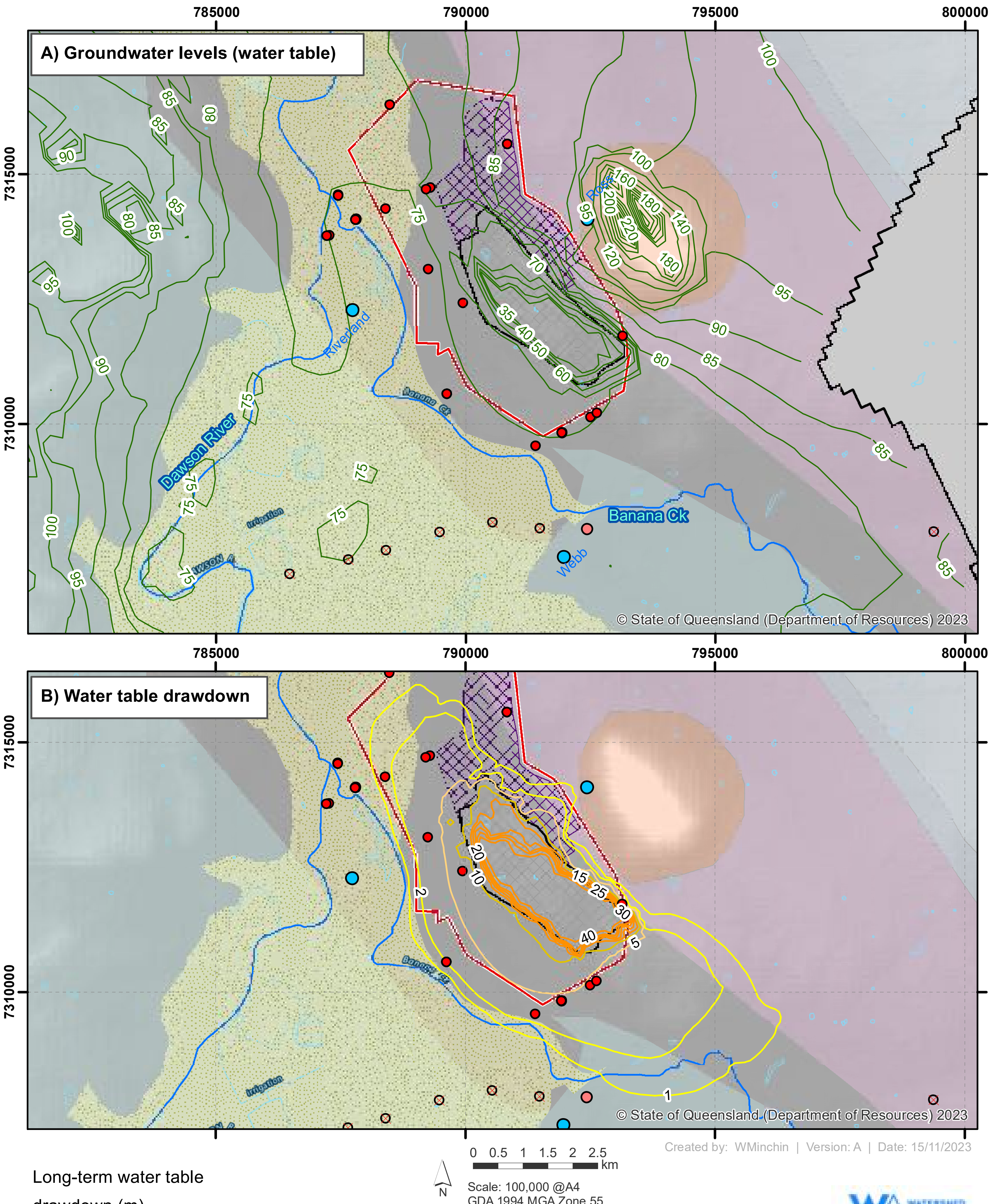
- In the BSP final void, lake water levels are predicted to recover to approximately 40 m below pre-mining standing water levels (based on observed data, this is typically 68-80 mAHD – and the modelling is consistent with this; **Figure 7-8A**) and therefore remain as a sink.
- The continued residual capture of water from the Permian strata means that there remains a residual long-term drawdown. At this equilibrium level the 1 m water table drawdown contours extended 2 km to the north of the pit limit (but effectively within the MLA boundary) and 3 km to the south (south-east) of BSP mine footprint (**Figure 7-8B**).
- There is predicted to be some recovery of groundwater levels at the backfilled (northern end) of the BSP, nearest the Dawson River / Banana Creek confluence, yet the relative permeability of

those sediments and uncertainty about the infiltration into those means that some drawdown will persist within them.

- Groundwater levels are predicted to rise to approximately 10 m residual drawdown within the limits of the BSP pit, and up to 5 m residual drawdown at the northernmost extent of the backfilled pit, when compared to the pre-mine standing groundwater level (**Figure 7-8b**). Recovery is relatively quick (in the order of a decade) due to the likely enhanced recharge rates through the backfill spoil at the northern end of the BSP.

It is noted that the final void lake recovery analysis (i.e. timeframes and final levels) undertaken by Engeny Water Management (2023) incorporates the stage versus groundwater inflow from the (interim) modelling (**Table 7-10**), and also includes a number of other processes which are either not simulated (i.e. rainfall runoff from the direct surface water catchment) or are better simulated in a surface water model than in a groundwater model (e.g. the void lake volume-surface area-level relationships which governs evaporation and direct rainfall).

Based on the final void configuration, the predicted additional leakage due to BSP from the Dawson River (Zone D - upstream of Neville Hewitt Weir) would be approximately 0.07 L/d post-mining, which is slightly lower than the rate during mining (**Section 7.7**), and so is also noted to be approximately equivalent to 0.01% of flow in the Dawson. Similarly the model predicts the long-term reduction in flow in Banana Creek (by way of increased leakage) would be 0.06 ML/d; this is slightly reduced from the rate in **Section 7.7**.



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Long-term water table drawdown (m)

- 1.0 - 2.0
- 2.1 - 5.0
- 5.1 - 10.0
- 10.1 - 50.0
- 50.1 - 100.0
- > 100

minimal change → drawdown

- Watercourse - major
- Alluvium
- BSP: Pit Limits
- BSP: Ex-pit Spoil Dump

Mining lease

- Baralaba South Project

BSP: Groundwater Assessment

Long-term equilibrium groundwater levels and drawdown

Figure 7-10

7.12 Model limitations

As stated in the IESC's *Information Guidelines Explanatory Note: Uncertainty Analysis – Guidance for Groundwater Modelling* (Peeters and Middlemis, 2023), there are four sources of scientific uncertainty affecting groundwater model simulations:

- Structural/Conceptual - geological structure and hydrogeological conceptualisation assumptions applied to derive a simplified view of a complex hydrogeological reality (any system aspect that cannot be changed in an automated way in a model).
- Parameterisation - hydrogeological property values and assumptions applied to represent complex reality in space and time (any system aspect that can be changed in an automated way in a model via parameterisation).
- Measurement Error - combination of uncertainties associated with the measurement of complex system states (heads, discharges), parameters and variability (3D spatial and temporal) with those induced by upscaling or downscaling (site-specific data, climate data).
- Scenario Uncertainties - guessing future stresses, dynamics and boundary condition changes (e.g. mining, climate variability, land and water use change).

Each of the above has been considered during the development of the BSP numerical model and the qualitative uncertainties are discussed in the following sections.

It is also noted that the overall target model confidence level classification for the BSP numerical groundwater model is Class 2, and as demonstrated in **Appendix G**, has been largely achieved and exceeded for several key criteria (based on the criteria in Barnett *et al*., 2012), most notably (**Sections 6.2.1 and 6.15**):

- Groundwater head observations and bore logs are available and with a reasonable spatial coverage around the BSP area and regionally.
- Aquifer-testing data is available to define key parameters.
- Calibration statistics (average residual, mass balance closure error) are acceptable and is calibrated to heads. SRMS is higher than desired, due to the representation of the BNM, but the calibration process has reduced this significantly.
- The length of the forward predictive model is not excessive compared to length of the mining simulated within the transient calibration period (from 2005 to 2023).

While there is a reasonable amount of groundwater level and pressure data for the BSP area, being a 'new' mining area where groundwater systems are of limited potential, the area is naturally limited by a lack of flow/flux (i.e. mine inflow and stream baseflow) data, to calibrate against, primarily as: (1) no mining has occurred to date within MLA 700057; and (2) with the exception of the Dawson River, other drainage features are ephemeral..

7.12.1 Structural and conceptual uncertainties

Structural and conceptual uncertainties are minimised in the BSP numerical groundwater model by using the 3D regional geological model (including the local-scale geological model which is supported by exploration data collected from drillholes) for the BSP area.

Potential future opportunities for the Baralaba numerical groundwater model include the use of the unstructured grids (either quadtree or Voronoi meshes) to allow for cell refinement in the vicinity of the open cut pit excavations, watercourses, drainage features and wetlands to offer more precision for specific impact predictions on key features and reduce conservatism. Similarly, increased definition of the Quaternary sediments along the western boundary of MLA 700057 may also allow for increased model precision, however it is recognised that backwaters from the Dawson River to Banana Creek upstream of the confluence are a losing system, and all alluvium bores in the southern monitoring transect (furthest from the Dawson River and its confluence with Banana Creek) have been recorded as dry (A-OB6, A-OB7, A-PB2 and A-OB8).

7.12.2 Parameterisation uncertainties and opportunities

Parameterisation uncertainties are minimised in the BSP numerical groundwater model by:

- Review of many review compilations, studies, assessments and testwork programs have been undertaken in the broader Bowen Basin (AGE, 2006; URS, 2009; BHP Billiton Mitsubishi Alliance, 2009; Parsons Brinkerhoff, 2011; Ausenco-Norwest, 2012; JBT, 2012; Matrix Plus, 2012; QWC, 2012; URS, 2012; AGE, 2013a; CDM Smith, 2013; GHD, 2013a; OGIA, 2016; and DES, 2018, KBR, 2023), and specifically in the Baralaba region (SKM, 2014; HydroSimulations, 2014; SLR, 2019) to derive representative hydraulic properties of the different geological units for the purposes of numerical groundwater modelling (**Section 5.7**).
- Systematic consideration of the literature values and where available local aquifer testwork results, and previous calibrated BNM parameters for each hydrogeological unit including:
    - Quaternary and Tertiary sediments;
    - Triassic age rock; and
    - Permian coal measures.
- Consideration of the behaviour of faults elsewhere in the Bowen Basin (and a recommendation for permeability testing to investigate this further at the southern end of the BSP – **Section 9.1.3**).
- Initial and calibrated specific storage values are consistent with Rau *et al* (2018) and Chowdhury *et al* (2022).
- Conducted a transient simulation for the prediction period perturbing rainfall recharge by -20% and +20% to represent postulated climate change scenarios.
- Undertook a quantitative uncertainty analysis (PESTPP-IES to develop an ensemble of parameter sets) for alternative permeabilities, storage properties and recharge rates, incorporating the sensitivities determined by PESTPP-IES during its history-matching/calibration process.

7.12.3 Measurement error uncertainties and opportunities

Measurement error uncertainties are minimised in the BSP numerical groundwater model by:

- Review of raw datasets which identified anomalies and past corrections which are noted where relevant. Recommendations regarding further improvement are in **Section 9.1.3**.
- Completing groundwater monitoring and sampling program with guidance from relevant standards and installation of additional data loggers.
- Utilising the nearest Bureau of Meteorology (BOM) weather station with an extensive rainfall dataset at the Baralaba Post Office (station 039004). and a number of existing (open) and historic (now closed) stream gauging stations along the Dawson River and up-catchment tributaries in the Baralaba region.
- Conducting a landholder bore survey (see **Appendix B**).
- Application of weighting at the beginning of the calibration process based on the perceived or known reliability of each observation.

- Preparation of contour maps of measured and interpolated groundwater standing water levels, based on the available datasets with a reasonable spatial distrubtion.
- Use of available groundwater levels within MLA 700057 and surrounds (from 2012 and 2017-2023) to investigate for cause-and-effect responses in temporal water level changes which could result from rainfall recharge (e.g. standpipe alluvial bores).

Recommendations for the proposed groundwater monitoring program are provided separately in **Section 9.1.1**.

7.12.4 Scenario uncertainties and opportunities

Scenario uncertainties are minimised in the BSP numerical groundwater model by:

- Modelling the proposed mine progression plans for the BSP, based on the planned mine schedule provided by Mount Ramsay Coal Company.
- Conducting a landholder bore survey to confirm groundwater usage (**Appendix B**).
- Recognising that future climate projections are unclear and therefore conservatively perturbing rainfall recharge, but noting that the situation regarding future final void lake development is more complex.
- Conducting quantitative uncertainty analysis using an ensemble method, consistent with the latst IESC uncertainty Guidelines (Peeters and Middlemis, 2023) testing the variability in predictions with changes in hydraulic conductivity, storage and recharge parameters.

Utilising the approved mine progression at the BNM consistent with that completed previously by HydroSimulations (2014) for the calibration and cumulative predictive model leads to consistency with previous predictions, but may lead to an increase in model mis-fit (hence why the use of an ensemble method for predictions is suitable). Recommendations for verification of the numerical groundwater model predictions, and updates to the numerical groundwater model (e.g. re-calibration, additional sensitivity analysis or revised forward predictions) are provided in **Section 9.1.4**.

8 Potential impacts on groundwater quality

Based on the baseline groundwater quality data (**Section 4**), alluvial groundwater samples are generally fresh to the west of the BSP (associated with the Dawson River leakage) but relatively saline near the proposed mine footprint, while the Permian coal measure groundwater samples indicate a more brackish (saline) water quality (**Section 4.2.2**). As noted in **Section 4.3.4**, the groundwaters within MLA 700057 associated with the Permian coal measures and alluvial sediments along the local drainage feature are generally unsuitable for stock watering.

The BSP would use waters that drain directly to the open cut pit. The groundwaters would be pumped to holding dams, where water collected would be incorporated into the site water balance. Associated groundwaters accessed by the BSP would provide a beneficial industrial use, despite the brackish (saline) water quality.

There is not expected to be any measurable change in the quality of groundwater, either in Permo-Triassic strata (within which groundwater level drawdown would be largely contained) or in younger units such as alluvium or colluvium, as a consequence of mining (albeit limited). The localised hydraulic sink that would form as mining develops would minimise the potential migration of saline or poorer quality groundwater from within the open cut pit to other areas as the groundwater level will remain in the Permian (e.g. from the coal seams to surrounding alluvium or colluvium). Consequently, there would be negligible impacts on surface water quality in downstream waters due to interaction with groundwater.

Based on the geochemical characterisation of overburden (**Section 2.6**), runoff and potentially enhanced infiltration / recharge across or within the backfill spoil and out-of-pit emplacements are likely to be less saline than the naturally occurring groundwaters associated with the Permo-Triassic sediments in the area, and therefore not considered a risk to local groundwater exceeding the WQOs (DEHP, 2011) discussed in **Section 4.1**. Terrenus Earth Sciences (2014; 2023) indicates a low risk of environmental harm from spoil emplacement.

Terrenus Earth Sciences (2023) also concludes that slightly elevated concentrations for some metals/metalloids for spoil materials are common at coal mines in the Bowen Basin and generally do not result in any significant water quality issues.

Workshop and fuel/chemical storage areas for the BSP will be established in accordance with Australian Standards and include appropriate bunding and equipment for spill clean-up. There is considered limited potential for groundwater contamination to occur with relation to workshops and fuel/chemical storage.

Based on the above, the BSP is not considered to have a significant impact on groundwater quality.

9 Conclusions

This assessment documents the groundwater-related effects of the proposed Baralaba South Project (BSP). Proposed open cut coal mining activities would target the Baralaba Coal Measures, including the basal sub-unit Kaloola Member, where the structural dip of the Permian geology brings them to or near the surface within MLA 700057.

The proposed open cut pit would be approximately 3.8 km long in a north-west to south-east to north-west direction (along coal seam strike), approximately 1.5 km wide, and extend down to approximately -210 mAHD at its deepest point.

This groundwater assessment has included the compilation and analysis of comprehensive baseline groundwater datasets collected at the BSP in 2012 and from 2017-2023 (as well as review of previous datasets collected at the BNM), review and refinement of prior conceptualisation of the groundwater systems at the BSP area and surrounds, and importantly the extension and contemporising of the numerical groundwater model (previously used for the approved BNM) to assess potential groundwater impacts at the BSP, including cumulative impacts.

The model is demonstrated to be capable of simulating groundwater conditions around the BSP, and to simulating the magnitude of historical drawdown (and probable mine inflow) at the BNM.

The key findings of this groundwater assessment are as follows:

- The predicted quantities of groundwater ("Associated Water") to be taken or interfered with because of the exercise of underground water rights at the BSP for the proposed 23-year mine life, is likely to range up to 1.5 ML/d (peaking toward the end of mining as the pit reaches its deepest extent), with the average ranging 0.4-0.75 ML/d for the operational life of the mine. The inflow rate that would require active management at the pit floor would however be expected to be less due to the high evaporation rates that would remove the bulk of the inflow volume, as has been experienced at Baralaba North Mine.
- Given the Permian strata steepens where the Baralaba Coal Measures are brought to the surface within MLA 700057, groundwater level drawdown would be largely contained within the Permian Coal Measures. Modelling, including uncertainty analysis, suggests that drawdown could elongate further along strike than the boundaries of the MLA, especially to the south toward Banana Creek. Drawdown is not predicted to encroach to any appreciable extent into the saturated alluvium of the Dawson River.
- Groundwater level drawdown in the shallow groundwater systems associated with the surficial geology (i.e. alluvium, colluvium and regolith), where saturated beyond the open cut pit extent, would be limited, primarily as the saturated extent of the alluvium is variable, with the presence of water largely localised along Dawson River becoming unsaturated with distance from the river.
- While the predicted groundwater drawdown due to the BSP in the Permian strata would be limited in the shallow groundwater systems, it would incidentally enhance or transmit some leakage from the Dawson River (upstream of Neville Hewitt Weir) to the surficial geology by a peak of up to approximately 0.1 ML/day for a mine life of 23 years. When compared to the average surface water flows in the Dawson River, this is less than 0.01% reduction in flow. Similarly, the modelled leakage (also up to 0.1 ML/d) predicted from Banana Creek is considered negligible as it only flows on occasions following rainfall events.
- Only one private landholder bore (Ross Bore – which is unregistered) identified in the vicinity of the BSP, and confirmed by the landholder bore survey (4T Consultants, 2019), is predicted

to have any potentially measurable drawdown as a result of the Project. The estimated drawdown is noted to be likely conservative. Make-good measures may be required.

- All other private landholder bores identified are located at further distances, or different geology, beyond that predicted to be measurably impacted by drawdown resulting from the open cut mine pit extent.
- Drawdown associated with mining void development is not predicted to impact the ecological function of any GDEs which utilise and rely upon perched seasonal groundwater resources (3d Environmental, 2023).
- The BSP is not predicted to significantly impact stygofauna considering the limited groundwater level drawdown predicted in the shallow groundwater systems, and groundwater level drawdown would be largely contained within the Permian coal measures wherein no stygofauna had been recorded during either the 2012 or 2017-19 sampling programs by Stygoecologia (2019).
- Backfilled spoil seepage is likely to be low salinity (Terrenus Earth Sciences, 2023), and considered a low risk of environmental harm (e.g. in terms of acid generating potential), and would be of no consequence to the surrounding groundwater.
- Post mining, the final void at the BSP would act as a localised hydraulic sink, drawing in groundwater from the more saline Permian strata. Surface and groundwaters captured within the final void would evaporate from the lake surface, concentrating salts in the void water body slowly over time. This gradually increasing salinity would not pose a risk to the surrounding groundwater regime as the final void would remain in the long-term as a permanent, localised hydraulic sink (of which the predicted equilibrium elevation is some 40 m below natural groundwater levels).
- The groundwater inflows predicted to the final void are predicted to reduce to approximately 0.2 ML/d following the pit lake reaching equilibrium. The corresponding leakage from the Dawson River at post closure equilibrium is predicted to steadily reduce to be less than 0.13 ML/d, which when compared to recent flows in Dawson River of 1,469 ML/day, is less than 0.01%.

Assessment of cumulative impacts of approved mining within the Baralaba region, including the BNM, has also been conducted and confirms that predicted impacts at the BSP (related to drawdown in the near-surface and water table) would not overlap with any existing / approved mining activities.

The BSP (and cumulatively with the approved Baralaba North Mine) is not predicted to cause a change in flow direction in the hydrogeological units that constitute the Great Artesian Basin (GAB) (i.e. Clematis Sandstone), and capture of groundwater from the GAB units and the decline in GAB water levels are predicted to be negligible.

The potential impacts of the BSP on groundwater resources have been assessed in accordance with the *Significant impact guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources* (DoE, 2013) and the BSP is not considered to have a significant impact on groundwater resources.

9.1 Recommendations

It is recommended Baralaba South Pty Ltd continue to maintain the existing groundwater monitoring network at the BSP. It is also recommended the groundwater monitoring program be complemented with a groundwater pit inflow monitoring program during the open cut mining operations. Further details on the proposed monitoring program is provided below.

9.1.1 Monitoring program

The monitoring network at BSP is relatively mature, with an appropriate mix of standpipe bores and some multi-level VWP-equipped bores (**Table 9-1**). The standpipes allow monitoring of water quality and are useful in the verification of any VWPs at similar depths. This is a practical approach to a monitoring network, and only a few sites are proposed to augment the existing network (**Section 3.1**).

A Water Management Plan should be developed for the BSP (if approved), and include details of the groundwater monitoring program. It is recommended the management plan include:

- maintaining the existing groundwater monitoring network at the BSP with regular reviews to detect changes in groundwater levels and quality as a result of mining and improve knowledge of aquifer definition and interactions;
- installation of three proposed shallow alluvial holes to improve coverage of monitoring for the Project design, with:
  - an alluvium site near P-OB1 (Proposed-A1 in **Table 9-1**).
  - one near the HES wetland (despite its likely 'perched' nature) (Proposed-A2);
  - one to the south or south-east the BSP site (Proposed-A3), near to Banana Creek (i.e. along the strike of the coal measures).
- water level and flow monitoring be conducted at the private landholder bore (i.e. Ross bore) if access is permissible by the landholder. Potential drawdown effects are predicted at this bore, this will provide early indication of any changes to predictions as well as identification of influence of local bore usage on groundwater trends.
- derivation and progressive development of groundwater level and quality triggers for the BSP, and inclusion in the Environmental Authority.
- It is recommended that future groundwater quality monitoring continue to be undertaken on a quarterly basis as outlined. Each quarterly event will include manual measurement of water levels and download of logger level data, as well as representative sampling and field analysis of EC and pH. In addition to this, on an annual basis water samples will be submitted to a NATA accredited laboratory (ALS) for analysis of:
  - Physio-chemical indicators (pH, EC and total dissolved solids);
  - Major ions (calcium, fluoride, magnesium, potassium, sodium, chloride, sulphate);
  - Total alkalinity as $CaCO_3$, HCO_3, CO_3; and
  - Total and dissolved metals (aluminium, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt copper, iron, lead, manganese, molybdenum, nickel, selenium, uranium, vanadium, zinc and mercury).

- It is recommended that during the operation of the BSP, groundwater pit inflows be estimated through annual review of pit dewatering/pumping records and site water balance model, catchment (rainfall runoff), coal moisture and evaporation considerations to partition groundwater inflow/seepage rates. It is recommended that periodic (e.g. quarterly) water quality sampling from representative in-pit sumps also be conducted to allow for comparisons with groundwater quality sampling conducted in the surrounding groundwater monitoring network. Any observations of unexpected or significantly increased groundwater inflows directly to the open cut pit should also be recorded during the operation of the BSP.

Table 9-1 Existing and proposed BSP Groundwater Monitoring Network

Bore ID	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	Stratigraphy	Water Level Monitoring	Water Quality	Purpose
A-PB1	787806	7314088	88.4	11.5-23.5	Alluvium	Q†	-	Monitor change in water levels and quality in alluvium for early detection of potential impacts from site activities beyond those predicted, and monitor interaction between alluvium and coal measures
A-PB2	791931	7309808	91.5	11.5-23.5	Alluvium	Q†	-	
A-OB1	787440	7314586	88.9	10-22	Alluvium	D	Q/A	
A-OB2	787802	7314105	88.3	11.5-17.5	Alluvium	D	Q/A	
A-OB3	788393	7314309	87.9	12-30	Alluvium	Q	Q/A	
A-OB4*	789290	7314733	87.5	8-17	Alluvium	Q*	-	
A-OB6	791402	7309557	91.4	9-18	Alluvium	D	Q/A	
A-OB7	791935	7309829	91.7	11-26	Alluvium	D	Q/A	
A-OB8	792501	7310136	91.4	10-22	Alluvium	D	Q/A	
A-OB10*	789247	7313094	87.5	8-20	Alluvium	D*	-	
A-OB11	787270	7313771	86.2	9-15	Alluvium	D	Q/A	Background information on groundwater trends in alluvium at Dawson River
A-OB12	787220	7313767	87.2	9.6-15.6	Alluvium	D	Q/A	
P-PB1	787805	7314101	88.3	38	BG (interburden)	Q	Q/A	Monitor change in water levels and quality in coal measures for early detection of potential impacts from site activities beyond those predicted
P-OB1	788477	7316388	87.4	105	BG (coal seam)	Q	Q/A	
P-OB2	793140	7311758	105.3	147	BG (interburden)	Q	Q/A	
P-OB3*	789939	7312422	89.6	29	BG (interburden)	Q*	-	
P-OB4*	789205	7314695	87.1	76	BG (coal seam)	Q*	-	
P-OB5	792626	7310218	91.4	184	BG (coal seam)	Q	Q/A	
P-VWP1	787442	7314568	89.0	38	Interburden	D	-	Monitor depressurisation of Permian coal measures and Rewan Formation in response to mining to verify against predicted changes.
				105	Interburden	D	-	
				147	Interburden	D	-	
P-VWP2	787789	7314089	88.51	29	Overburden	D	-	
				76	Rewan Formation	D	-	
				184	Interburden	D	-	
				234	Interburden	D	-	

Bore ID	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	Stratigraphy	Water Level Monitoring	Water Quality	Purpose
P-VWP3	791922	7309816	91.6	55	Interburden	D	-	
				121	Interburden	D	-	
				155	Interburden	D	-	
				175	Interburden	D	-	
P-VWP4	790829	7315606	101.0	25	Interburden	D	-	
				80	Interburden	D	-	
				150	Interburden	D	-	
				200	Interburden	D	-	
P-VWP5	789621	7310598	90.4	66	Interburden	D	-	
				138	Interburden	D	-	
				185	Interburden	D	-	
Proposed-A1	788475	7316390	87.4	~15	Alluvium	Q	Q/A	Paired bore with P-OB1 and between Dawson River and BSP. Monitor change in water levels and quality for early detection of potential impacts from site activities beyond those predicted.
Proposed-A2	789320	7312065	90 (approx.)	~15	Alluvium	Q	Q/A	Baseline data on alluvium near HES wetland and west of the open cut. Monitor change in water levels (and quality) for early detection of potential impacts from site activities beyond those predicted.
Proposed-A3	794800	7309250	94 (approx.)	~5-20	Alluvium	D	-	Alluvium bore to monitor baseline and change in water levels for detection of effects from BSP activities.
Proposed-P4	793100	310622	100 (approx.)	TBC	Permian Coal Measures	D	-	Drilled to 200 m depth to understand geology (faulting) and permeability (via packer testing). Monitoring bore to be installed to depth based on this testing/analysis.

Note: Coordinates in MGA94 Zone 55
* within disturbance footprint, to monitor for baseline data only, no triggers to be applied
D – Daily – bore equipped with level logger/VWP
Q/A – Quarterly field water quality and annual full suite of water quality
BG – Blackwater Group
† - Near other existing bores therefore water level monitoring proposed only
Q – Quarterly

9.1.2 Groundwater trigger criteria

Groundwater monitoring criteria will be established to monitor predicted impacts on both environmental values and predicted changes in groundwater quality. Impact assessment criteria for the site will be documented within the Water Management Plan (WMP).

Groundwater quality trigger levels should be developed in accordance with the Department of Science, Information Technology and Innovation (DSITIA) guideline on "Using monitoring data to assess groundwater quality and potential environmental impacts" (DSITI, 2017). Consistent with the DSITI (2017) guidelines, the triggers will be established in consideration of the Water Plan (Fitzroy Basin) 2011 WQOs, ANZECC (2000) criteria and site-specific conditions. Trigger criteria will be established for each groundwater unit potentially impacted by the Project, being alluvium and the Permian coal measures.

Due to the structural geology of the area, most site monitoring bores are located within the zone of predicted groundwater level change due to the Project. Therefore, changes in groundwater levels at the site bores will be compared to predicted groundwater trends to evaluate any deviations from the predicted trends.

The actual trigger levels should be developed prior to mine commencement.

9.1.3 Data gathering and review

Permeability testing: given the mapped presence of faults and anomalous groundwater levels, additional drilling and permeability testing (e.g. packer testing) is recommended in the coal measures in the vicinity of bores P-VWP3 and P-OB5 (or east of P-OB5 – see **Table 9-1**) in discussion with project geologists to understand geological conditions, permeability in this area, and the potential role of faults. Once packer testing is completed, this may indicate the need to carry out further testing to characterise transmissivity in a more representative manner. This site can also be used for groundwater monitoring (**Table 9-1**).

Database: It is recommended that groundwater (and other hydrological or related) data be stored within a consolidated groundwater database and that quality assurance and quality control procedures be put in place to help ensure the accuracy of data entered within the database. This should ensure environmental data, not just groundwater data, be managed with a single point of truth and to allow readier reporting.

Review and quality assurance: It is recommended the groundwater monitoring program be reviewed annually by an appropriately qualified person. The review would assess the change in groundwater level and quality over the year, compared to historical trends and impact assessment predictions. This would provide a routine check on the data in the database (above). The annual review would also discuss any groundwater trigger exceedances or where trends show potential for environmental harm.

Groundwater inflow monitoring: If possible and practical, develop quantified estimates of groundwater inflow to the BNM and/or Baralaba Central mine pits (as per the recommendation of inflow monitoring at the BSP, above) to improve the understanding of water take. This may also lead to inputs for future modelling should it be required (i.e. for verifying and calibration the numerical model).

9.1.4 Modelling

If the BSP is approved, and once commenced, The model should be verified periodically to allow the validity of the model predictions be assessed. If the data indicate significant divergence from the model predictions, it is recommended the groundwater model be updated for simulation of mining.

A series of suggestions for the numerical groundwater model relevant to both the BNM and BSP coal operations are:

- Updated mine plan (dewatering and pit progression, as well as waste dump/spoil emplacement) at BNM to improve the representation of the major stress in the model.
- If the BNM and/or BSP mine plan is updated, also consider a refined model mesh (e.g. quadtree refinement) around the workings.
- Obtain an improved DEM, possibly from Engeny (surface water consultants), for the study area.

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Appendix A: Baralaba South Groundwater Report 2018 (SLR, 2019)

BARALABA SOUTH

Groundwater Report 2018

Prepared for:

Wonbindi Coal Pty Ltd
Baralaba

SLR Ref: 620.11731-R05
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1 Introduction

Wonbindi Coal Pty Ltd (Wonbindi Coal) propose to develop the Baralaba South Project (Project), an open cut coal mine on MLA 80193 (Figure 1)). The Project is a greenfield site 8 km south of Baralaba township and approximately 115 km south-west of Rockhampton, Queensland.

A groundwater monitoring network was established at the site in 2012, with monitoring conducted from July 2012 until December 2012. No further monitoring was conducted at the site from December 2012 until June 2017, when SLR Consulting (SLR) conducted a field assessment of the Baralaba South groundwater monitoring network. The assessment identified a range of repairs required to re-establish the groundwater monitoring network.

SLR were commissioned by Wonbindi Coal to re-establish the pre-existing monitoring network and complete four quarterly groundwater monitoring rounds. The main objective of this monitoring was to collect baseline groundwater level and quality data for a future groundwater impact assessment. Background on the site and historical data is provided within the SLR (2017) gap analysis.

This report presents the results from the quarterly monitoring events conducted in December 2017, March 2018, June 2018 and October 2018.

2 Groundwater Monitoring Network

The Baralaba South groundwater monitoring network was established in 2012. The network comprises:

- 10 alluvial monitoring bores constructed with Class 18, 50mm PVC.
- 2 alluvial pumping bores constructed with Class 18, 100mm PVC.
- 5 monitoring bores targeting the Permian coal measures (3 in coal and 2 in interburden), constructed with Class 18, 50mm PVC.
- 1 pumping bore targeting the Permian coal measures (interburden), constructed with Class 18, 100mm PVC.

The network also includes five vibrating wire piezometers (VWPs) that intersect various units. The location and general construction details for the Baralaba South groundwater monitoring network is listed in **Table 1** below, and shown spatially in Figure 1. The bore construction details and target geology were derived from SKM (2014) conceptualisation report.

Table 1 Baralaba South Monitoring Network

Bore ID	Easting	Northing	Elevation[1] (mAHD)	TD (mBGL)	Top Screen (mBGL)	Base Screen (mBGL)	Type	Geology[2]
A-PB1	787806	7314088	88.4	27	11.5	23.5	PB	Quaternary alluvium
A-PB2	791931	7309808	91.5	29	11.5	23.5	PB	Quaternary alluvium
A-OB1	787440	7314586	88.9	29	10	22	MB	Quaternary alluvium
A-OB2	787802	7314105	88.3	20	11.5	17.5	MB	Quaternary alluvium
A-OB3	788393	7314309	87.9	30	12	30	MB	Quaternary alluvium
A-OB4	789290	7314733	87.5	17	8	17	MB	Quaternary alluvium
A-OB6	791402	7309557	91.4	29	9	18	MB	Quaternary alluvium
A-OB7	791935	7309829	91.7	26	11	26	MB	Quaternary alluvium
A-OB8	792501	7310136	91.4	23	10	22	MB	Quaternary alluvium
A-OB10	789247	7313094	87.5	23	8	20	MB	Quaternary alluvium
A-OB11	787270	7313771	86.2	17	9	15	MB	Quaternary alluvium
A-OB12	787220	7313767	87.2	18	9.6	15.6	MB	Quaternary alluvium
P-PB1	787805	7314101	88.3	185	136	178	PB	BG (interburden)
P-OB1	788477	7316388	87.4	60	30	60	MB	BG (coal seam)
P-OB2	793140	7311758	105.3	60	30	60	MB	BG (interburden)
P-OB3	789939	7312422	89.6	59	29	60	MB	BG (interburden)
P-OB4	789205	7314695	87.1	205	75	78	MB	BG (coal seam)
P-OB5	792626	7310218	91.4	204	66	69	MB	BG (coal seam)
Ross Bore	792441[3]	7314085[3]	120[3]	52.67	unknown		PB	Igneous Trachyte
P-VWP1	787442	7314568	89.0	201	38		VWP	BG (interburden)
					105		VWP	BG (interburden)
					147		VWP	BG (interburden)
P-VWP2	787789	7314089	88.51	252	29		VWP	BG (interburden)
					76		VWP	Rewan Formation
					184		VWP	BG (interburden)
					234		VWP	BG (interburden)
P-VWP3	791922	7309816	91.6	175	55		VWP	BG (interburden)
					121		VWP	BG (interburden)
					155		VWP	BG (interburden)
					175		VWP	BG (interburden)
P-VWP4	790829	7315606	101.0	201	25		VWP	BG (interburden)
					80		VWP	BG (interburden)
					150		VWP	BG (interburden)
					200		VWP	BG (interburden)
P-VWP5	789621	7310598	90.4	201	66		VWP	BG (interburden)
					138		VWP	BG (interburden)
					185		VWP	BG (interburden)

Note: Coordinates in MGA94 Zone 55

VWP Vibrating wire piezometer
MB Monitoring bore
[1] Surveys levels from SKM 2012
[3] From Hand held GPS
PB Production bore
mBGL Metres below ground level
[2] BG Blackwater Group

Sheet Size : A4

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Bore Locations

FIGURE 1

3 Groundwater Network Repairs

The Project site was visited on June 2017 to assess the current state of the groundwater monitoring network. During this visit it was identified that:

- Groundwater level transducer dataloggers (dataloggers) within open standpipe monitoring bores were non-operational due to battery failure and deterioration;
- The VWP's loggers could not be interfaced with in the field, and were removed to be sent back to the supplier, GEL Instrumentation (GEL), for servicing;
- Bore condition:
    - Gates around several of the bores were either missing required repairs;
    - Missing PVC bore caps;
    - Roots and debris within some bores;
- Poor bore access, with tracks disused and overgrown.

Repairs to the network were progressively conducted from December 2017 to June 2018. Further details on the installation of data loggers, VWP repairs and bore development are included in **Section 3.1** to **Section 3.3**.

3.1 Installation of Dataloggers

During the December 2017 field program, 11 Solinst dataloggers and one barometric logger were installed within open standpipe monitoring bores, as listed in **Table 2**. The loggers were installed with 1.6 mm stainless steel wire rope and attached to the bore cap, with the loggers set to record results on a 4-hourly basis, on the hour. During the March 2018 site visit, 4 additional bores (Ross Bore, P-OB3, A-OB11 and A-OB12) were installed with data loggers. The installation details for the data loggers are summarised in **Table 2**.

The dataloggers record water pressure that can be converted to groundwater levels when compared to the installation depth. For ongoing monitoring, pressure readings can be compensated to account for the variable atmospheric pressure with the barometric logger and verified against physical water level dips taken in the field.

Table 2 Summary of Loggers Installed in December 2017 and March 2018

Bore	Install date	Serial Number	Install Depth mbTOC	Specifications
A-OB1	20-Dec-17	52082843	18	Model 3001 LT F100/M30
A-OB2	20-Dec-17	52078374	16	Model 3001 LT F100/M30
A-OB4	19-Dec-17	52082845	16.5	Model 3001 LT F100/M30
A-OB6	16-Dec-17	52082849	18.5	Model 3001 LT F100/M30
A-OB7	16-Dec-17	52082853	24	Model 3001 LT F100/M30
A-OB8	17-Dec-17	52082847	22	Model 3001 LT F100/M30
A-OB10	18-Dec-17	52082858	18	Model 3001 LT F100/M30
A-OB10	18-Dec-17	12078918	0.4	Model 3001 LT F15/M5 (Baro)

Bore	Install date	Serial Number	Install Depth mbTOC	Specifications
P-OB1	19-Dec-17	62077595	45	Model 3001 LT F300/M100
P-OB2	18-Dec-17	52078282	45	Model 3001 LT F100/M30
P-OB4	19-Dec-17	62077596	45	Model 3001 LT F300/M100
A-OB11	21-Mar-18	52081770	13.5	Model 3001 LT F100/M30
A-OB12	21-Mar-18	52080230	13.5	Model 3001 LT F100/M30
P-OB3	24-Mar-18	62078500	45	Model 3001 LT F300/M100
Ross Bore	25-Mar-18	62078491	45	Model 3001 LT F300/M100

***Note:** mbTOC – metres below top of casing*

3.2 Installation of Vibrating Wire Piezometer Logger Boxes

As part of the June 2017 visit to site, VWP logger boxes were removed to be serviced. The boxes were sent to GEL for servicing. This revealed three of the five AVW200 interfaces needed replacement. All five enclosures needed to be replaced because the seals were no longer weather proof. As part of the service, new batteries were also supplied. GEL recommends the batteries be replaced every 2 years or sooner if voltages outside of 11 and 15 are observed.

The logger boxes were installed at the five locations onsite. During installation the solar panel, voltage was checked as well as the cable and plug conditions. All five VWP sites were found to be in good condition, with only minor additional repairs required to seal off the plugs. **Table 3** contains a summary of the sensor serials and VWP sensor depths.

Table 3 Summary of Vibrating Wire Piezometer Sensors

Site	Date	Sensor1		Sensor2		Sensor3		Sensor4	
		Serial#	**Depth m**	**Serial#**	**Depth m**	**Serial#**	**Depth m**	**Serial#**	**Depth m**
P-VWP1	20-Dec-17	16624	33	16984	105	16997	147	NA	
P-VWP2	20-Dec-17	16701	29	16985	76	16998	184	17095	234
P-VWP3	16-Dec-17	16702	55	16986	121	16999	150	17030	175
P-VWP4	15-Dec-17	16625	25	16703	80	17031	150	17032	200
P-VWP5	22-Dec-17	16704	66	17033	138	17034	185	NA	

3.3 Bore Development

During the initial bore inspections, several were found to have sediment and debris within the base of the open standpipe monitoring bore. Most bores were cleared using a stainless-steel bailer; however further bore development was required for private landholder bore, Ross Bore. Ross Bore was found to contain organic matter, flakes of rusted old steel casing and be in a deteriorated state (i.e. no bore cap and casing rusted). To conduct ongoing groundwater quality monitoring, it was required that the bore undergo development with compressed air to remove all the suspended matter in the water column.

This work was completed on the 25th March 2018 round using a 250 CFM air compressor. A T-piece was constructed onsite that fed in 40 m of 2” pressure hose and collected the purge water in a bucket (**Figure 2**). The bore was developed for approximately 1 hour until the purge water was clear and free of fines.

Figure 2 Ross Bore

3.4 Bore Network Conditions

During the most recent field trip conducted in October 2018, observations of the condition of the monitoring bore network were made. These observations included:

- Loose bore monument at bore P-OB1;
- Damaged fences around bores P-OB1, P-OB5 and A-OB3 that require repair to prevent damage of the bores from cattle;
- Ants nest at bore P-OB2; and
- Poor track access to the bores.

4 Routine Groundwater Monitoring

SLR Consulting (SLR) completed four quarterly field surveys of the groundwater monitoring network at the Project site from December 2017 to October 2018. The groundwater monitoring was conducted to collect baseline data on groundwater level and quality fluctuations and stygofauna sampling. The tasks included the following:

- Measure standing water levels:
  - Manual water level measurement with an electronic dip tape;
  - Automatic logging using dataloggers and VWPs;
- Groundwater quality monitoring:
  - Field parameters of pH, electrical conductivity (EC);
  - Laboratory analysis; and
- Sample for stygofauna in alluvial bores.

Details on the methodology followed for the routine groundwater monitoring is discussed in **Section 4.1**, groundwater level results discussed in **Section 4.2** and groundwater quality results in **Section 4.3**.

4.1 Methodology

The routine groundwater sampling was conducted in accordance with:

- Geoscience Australia (2009) “Groundwater Sampling and Analysis – A Field Guide” (record 2009/27);
- The Australian/New Zealand Standard Water quality – “Sampling, Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples” (AS/NZS 5667.1:1998); and
- The Australian/New Zealand Standard Water quality – “Sampling, Part 11: Guidance on sampling of groundwaters” (AS/NZS 5667.11:1998).

The standing water level (SWL) and total depth was measured using an electronic water level meter for monitoring bores (MB). The bores were purged using a range of methods depending on the bore construction and condition. Low-flow sampling was performed using a Solinst bladder pump or a 12-volt submersible pump. Shallow bores were purged and sampled using a hand bailer. High-flow sampling was performed using a 12-volt Monsoon submersible pump. When using high flow, three well volumes were purged before to sampling. During low-flow sampling, groundwater levels were monitored for significant change during sampling.

While purging, field water quality was measured using a YSI 556 Multi Probe System. Measured parameters included: temperature, pH, electrical conductivity (EC), oxidation/reduction potential (ORP) and dissolved oxygen (DO). The YSI 556 MPS was calibrated (pH 4, pH 7, pH 10 and EC 1,413 µS/cm) daily, with results documented on field sheets.

During sampling, the following field observations were recorded on a field data sheet:

- Date and time of sampling for each monitoring location;
- Depth to groundwater from the top of casing;

- Field measurements of pH, EC, temperature, ORP and DO
- Purge volumes; and
- Observations of sample water, where relevant.

Once the purge volume was met and field parameters had stabilised, groundwater samples were collected. Nitrile gloves were worn during sampling to reduce chance of contamination. The groundwater was sampled using laboratory supplied bottles. For dissolved metals, sample water was filtered using a vacuum driven Stericup (0.45 µm). Groundwater samples were stored in cool boxes with ice during the day and then stored in a fridge before sending. Samples were packaged in iced cool boxes ice and sent to a NATA accredited laboratory (Eurofins - Brisbane) with a chain of custody (COC) form. The samples were tested for the full suite of analytes, being:

- Physio-chemical indicators (pH, EC and total dissolved solids);
- Major ions (calcium, fluoride, magnesium, potassium, sodium, chloride, sulphate);
- Total alkalinity as $CaCO_3$, HCO_3, CO_3;
- Total and dissolved metals (aluminium, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt copper, iron, lead, manganese, molybdenum, nickel, selenium, uranium, vanadium, zinc and mercury); and
- Total recoverable hydro-carbons (TRH)

For QA/QC purposes, one blind duplicate sample was taken for every ten samples.

Stygofauna surveys were also conducted for the alluvial monitoring bores. Sampling was performed using the sieve method. Before sampling, the sediment at the base of the non-purged bore was agitated using a steel bailer. Five to six bails of water were emptied into a 150 µm stainless steel sieve to capture the samples. A squirt bottle with methylated spirits (>90 % ethanol) was used to transfer the samples on the sieve into a 500 mL HDPE unpreserved sample bottle. The sample bottles were topped up with methylated spirits, leaving approximately 2 cm head space.

The samples were stored on ice in an ice box during the day of sampling and were stored in a fridge for the rest of the field program. Samples were chilled and couriered to Stygo-Ecologia with a chain of custody form for identification.

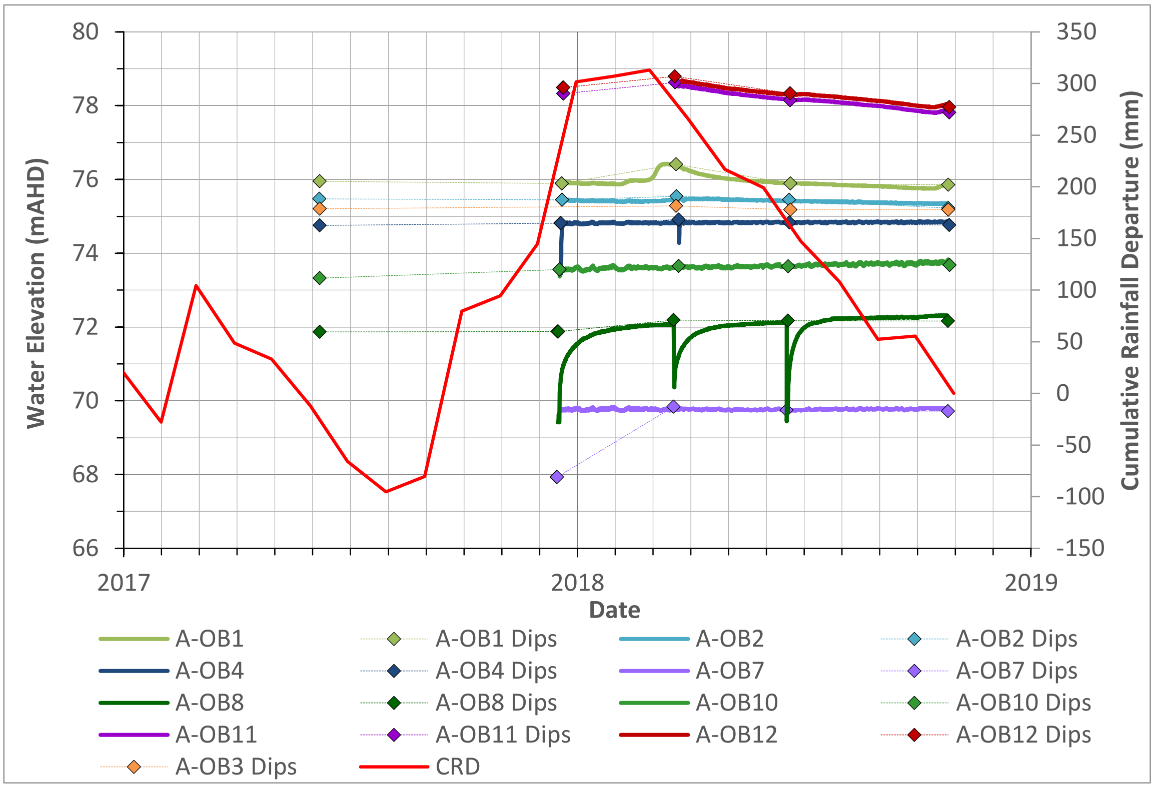
4.2 Water Levels

The collected water levels over the monitoring period were collated and displayed in hydrographs for the alluvium and Permian coal measures. Datalogger data was corrected to barometric pressure from the barometric logger data. The water levels were then corrected to the dipped water level measurements. Groundwater level trends are compared to the Cumulative Rainfall Departure (CRD), which was developed based on rainfall data from Station 039004 at Baralaba Post Office.

4.2.1 Alluvium

The water levels collected for the alluvial bores are presented in **Figure 3** with CRD. The hydrographs present available data from June 2017 field readings and up to the water levels collected in the October 2018 monitoring round.

Figure 3 Alluvial Groundwater Levels



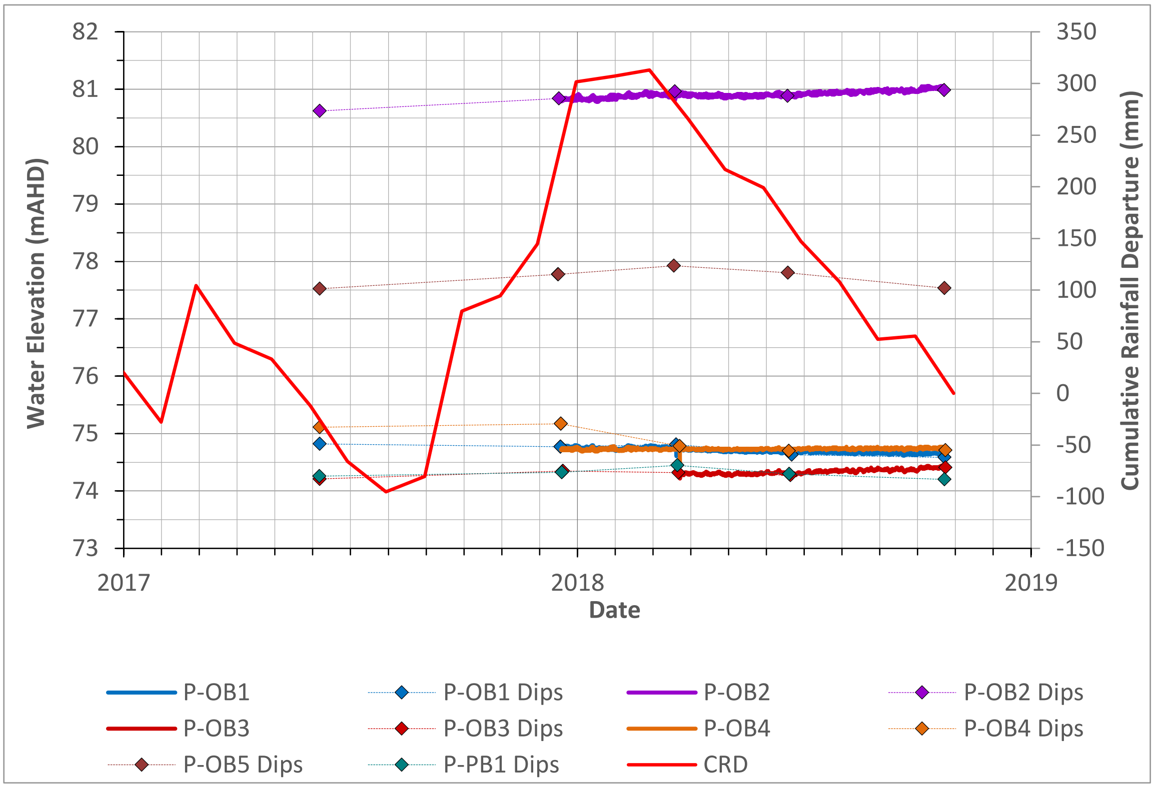
The bores with the highest groundwater elevations are those in proximity to the Dawson River (i.e. A-OB12, A-OB11, A-OB1, A-OB2 and A-OB3). Groundwater elevations within the alluvium reduce with distance from Dawson River, indicating potential recharge to the alluvium from the river (losing conditions). Bores A-OB11 and A-OB12 recorded a decline in groundwater levels from March 2018, which appears to correlate to declining rainfall (CRD) and streamflow.

Results for bore A-OB8 exhibit slow recovery after sampling. The construction of the A-OB8 shows that the alluvial gravels portion of the bore is dry. The slow recovery may be indicative of a hydraulic head from the underlying siltstone. The first dip on A-OB7 was taken following development and has recovered before the first data log interval.

4.2.2 Permian Coal Measures

Groundwater levels collected for the bores intersecting the Permian coal measures are presented in **Figure 4** with CRD. The hydrographs present available data from June 2017 field readings and up to the water levels collected in the October 2018 monitoring round.

Figure 4 Coal Measures Groundwater Levels



Groundwater elevations ranged between 74.3 mAHD and 81.0 mAHD. Groundwater elevations are highest at bores P-OB2, which is located furthest east of the Project site and near Mount Ramsay. The lowest groundwater elevation is recorded for bore P-OB3 located to the west of site, near the Dawson River. This indicates a general hydraulic gradient from east to west.

The VWP data collected over the last 12-months is present in **Figure 5** through to **Figure 9**. The data presented in these figures has been corrected for barometric pressure. The P-VWP3-Sensor 2, still appears to be recording erroneous data and should not be considered as accurate.

Figure 5 Groundwater Potentiometric Pressures – P-VWP1

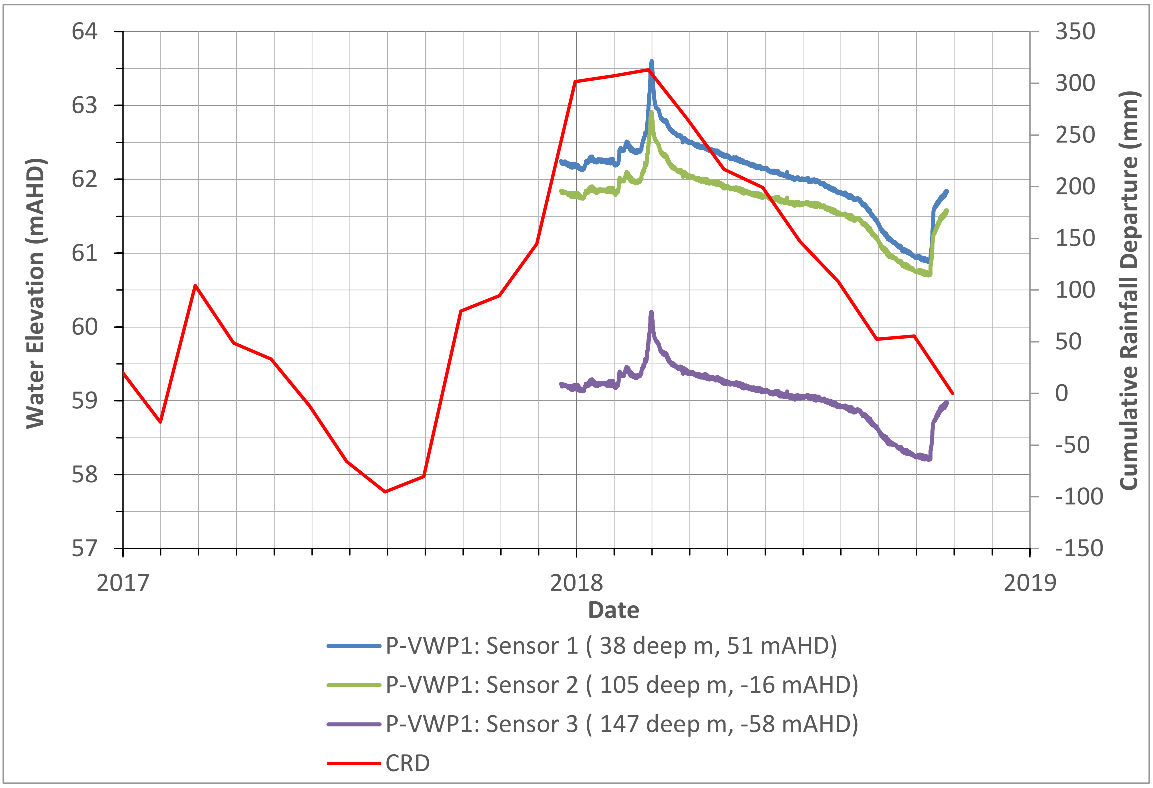


Figure 6 Groundwater Potentiometric Pressures – P-VWP2

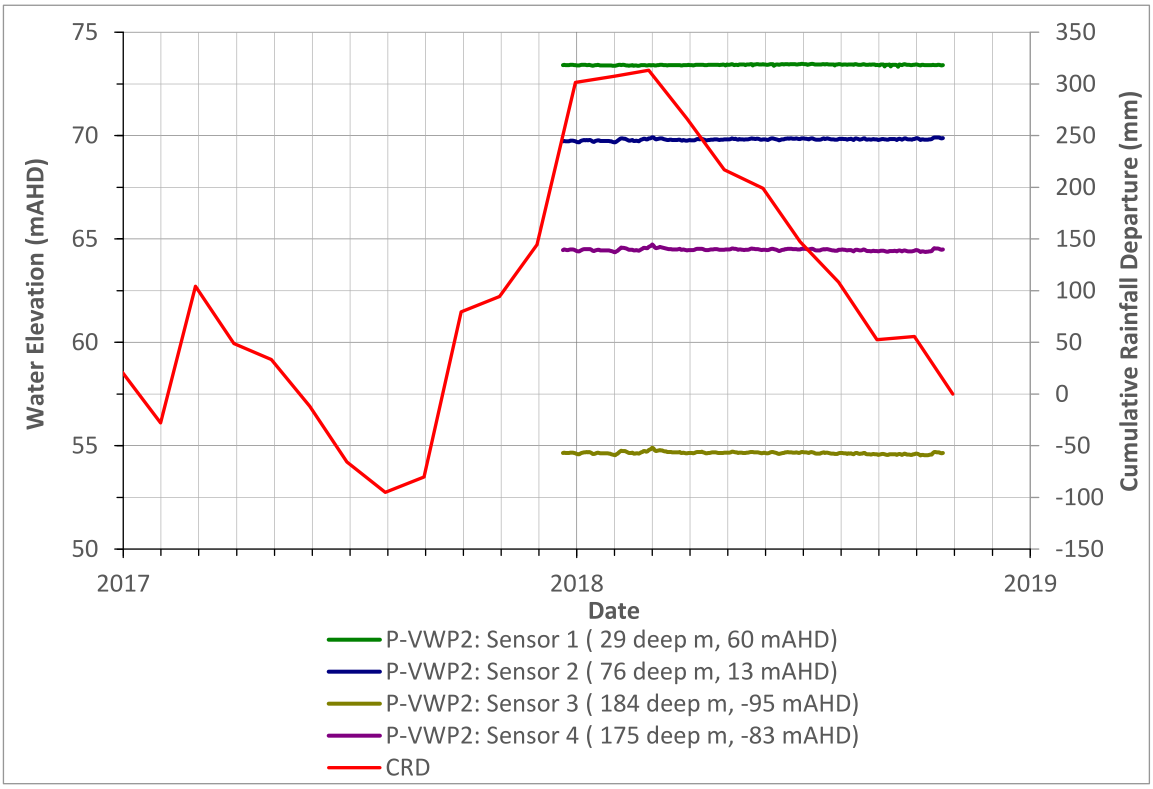


Figure 7 Groundwater Potentiometric Pressures – P-VWP3

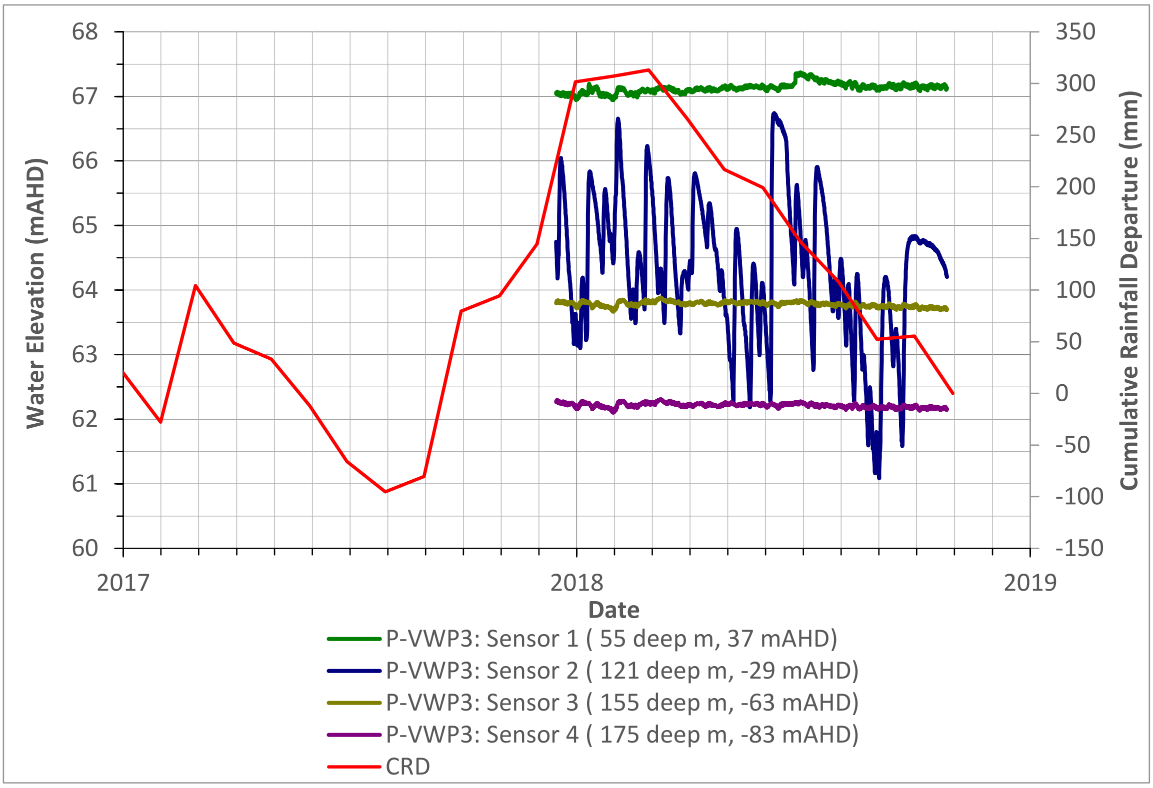


Figure 8 Groundwater Potentiometric Pressures – P-VWP4

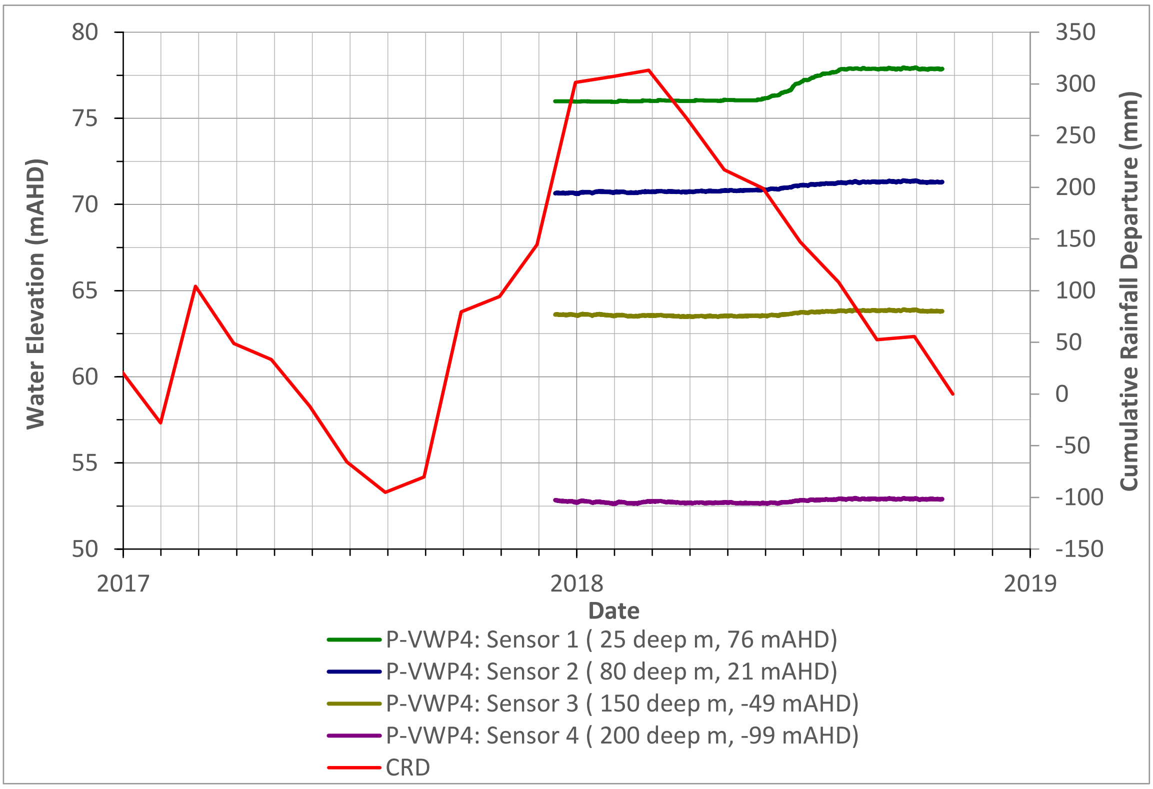
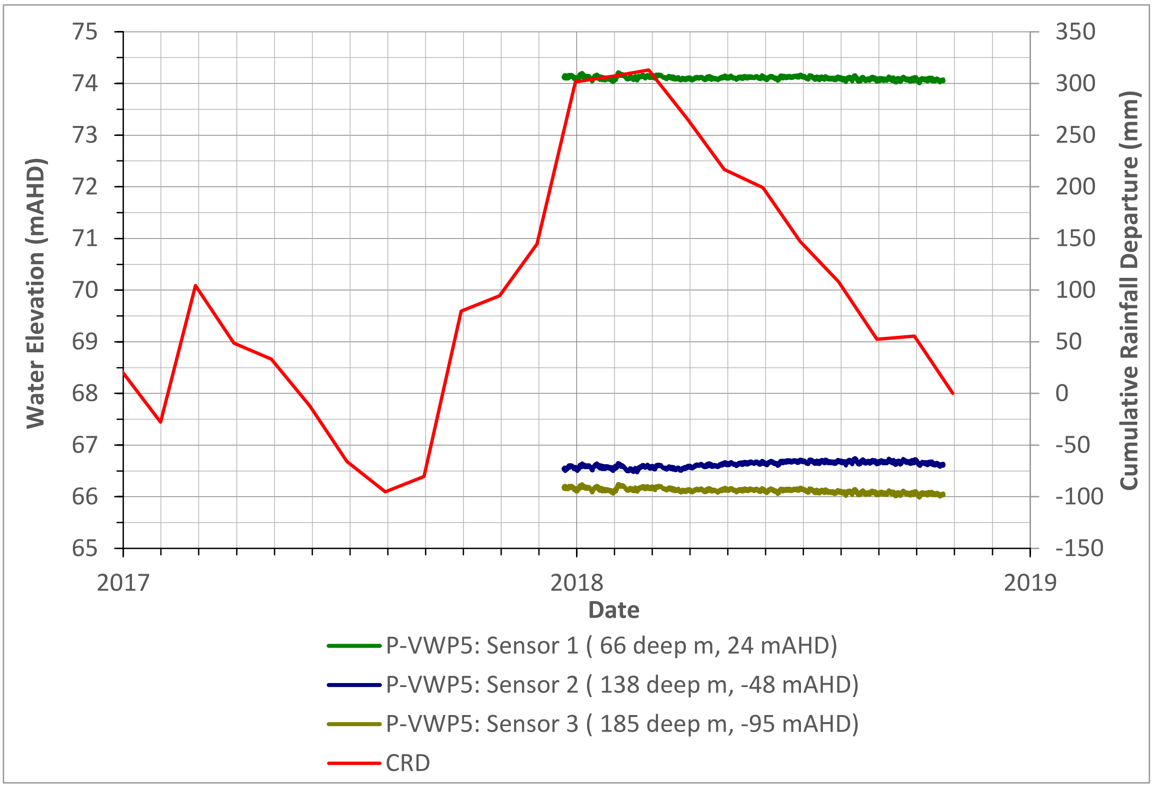


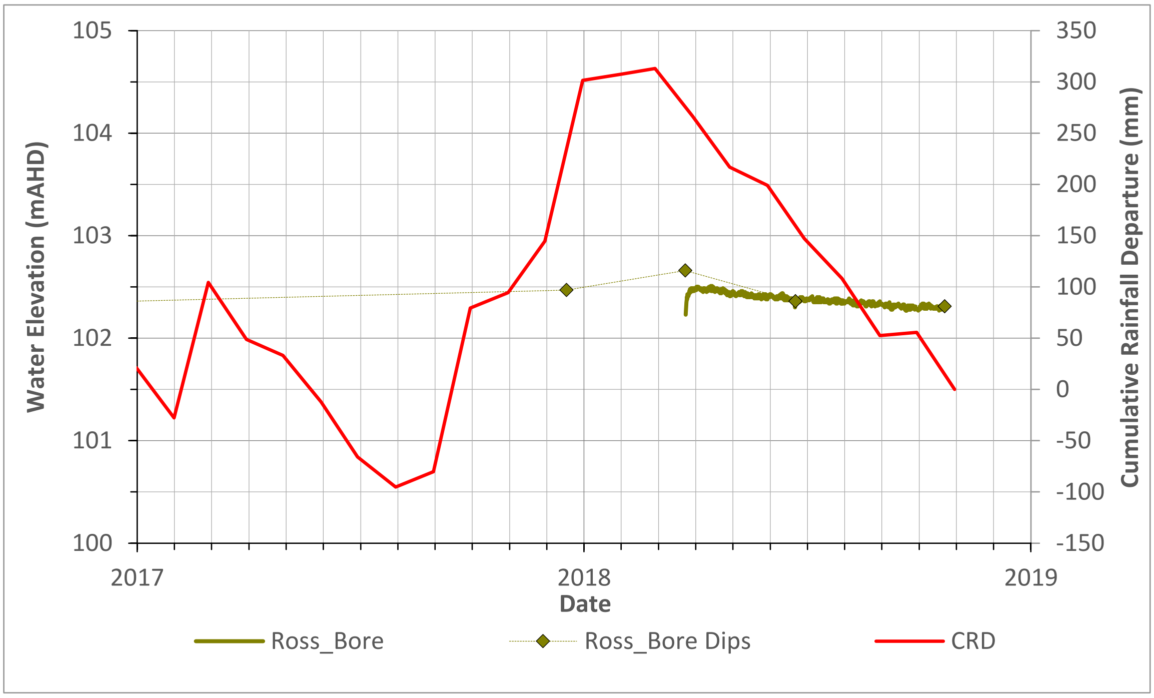
Figure 9 Groundwater Potentiometric Pressures – P-VWP5



4.2.3 Cretaceous Trachyte

Ross Bore is an existing landholder bore located at the base of Mount Ramsay and constructed within the Upper Cretaceous aged trachyte intrusion. Manual dipped water levels were collected from December 2017 and a datalogger installed in March 2018, following bore development. The water level data for Ross Bore is presented in **Figure 10** compared to CRD.

Figure 10 Mount Ramsay Trachyte Groundwater Levels



The water levels in this bore are higher than the surrounding Permian bores. The groundwater levels declined slightly from April 2018 to October 2018. The bore is currently not used for water supply so unlikely to be due to bore usage. Trend of declining groundwater levels appears to correlate with a period of below average rainfall.

4.3 Groundwater Quality

Field water quality parameters were collected, and samples submitted to a NATA accredited laboratory for further analysis of water quality. The field data refers to the data collected onsite for each bore during the four monitoring events. A summary of field data collected over the monitoring period have been presented in **Table 4**, with full results included in **Appendix A**. Laboratory groundwater quality reports are presented in **Appendix B** and a summary table of the results are included in **Appendix C**. A summary of the December 2017 – October 2018 water quality results for the alluvium and Permian coal measures is presented in **Section 4.3.1** and **Section 4.3.2**, and QA/QC included in **Section 4.5**.

Table 4 Field Water Quality Parameter Results December 2017 – October 2018

Bore	December 2017			March 2018			June 2018			October 2018		
	SWL mbgl	EC	pH	SWL mbgl	EC	pH	SWL mbgl	EC	pH	SWL mbgl	EC	pH
A-OB1	13.55	570	6.42	13.03	466	6.49	13.55	486.4	6.26	13.59	493.2	6.16
A-OB2	13.13	657	6.41	13.03	617	6.48	13.13	686	7	13.351	565	6.27
A-OB3	Not Visited	Not Visited	Not Visited	13.22	561	6.75	13.323	593	6.55	13.33	489.9	6.54
A-OB4	12.87	37011	6.31	12.78	35920	6.29	12.85	37557	6.3	12.92	40022	6.43
A-OB6	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
A-OB7	24.2	15681	6.62	22.29	16809	6.95	22.385	16637	6.64	22.416	18390	6.92
A-OB8	19.93	26260	6.89	19.62	25877	6.94	19.638	26914	6.57	19.65	27752	6.47
A-OB10	14.35	31708	6.42	14.25	36433	6.2	14.264	38097	6.15	14.225	38786	6.36
A-OB11	8.37	425	6.08	8.07	405	6.14	8.55	434	6.37	8.88	376.7	6.23
A-OB12	9.14	381	6.17	8.84	354	6.25	9.3	327.7	6.25	9.671	322.5	6.28
P-OB2	25.19	Not Sampled	Not Sampled	25.07	19480	6.14	25.15	19503	6.08	25.05	21075	6.25
P-OB3	15.71	34107	6.1	15.74	33141	6.19	15.786	34154	6.15	15.651	37120	6.24
P-OB4	12.35	37088	6.5	12.74	36356	6.11	12.82	37492	6.22	12.81	40297	6.29
P-OB5	14.1	24664	7.25	13.95	27225	7.21	14.07	23666	6.76	14.34	34100	6.54
P-OB1	13.19	29785	6.16	13.15	30324	6.32	13.33	31390	6.23	13.375	33260	6.19
A-PB1	13.1	Not Sampled	Not Sampled	13.03	646	6.07	13.13	630	6.12	13.205	610	6.19
A-PB2	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
P-PB1	14.4	Not Sampled	Not Sampled	14.28	15950	7.31	14.43	16296	6.9	14.525	18453	7.06
Ross Bore	18.2	2478	6.67	18.01	2020	8.32	18.311	3038	6.52	18.36	3690	6.47

Note: *SWL mbgl – Standing water level, metres below ground level*

4.3.1 Alluvium

The field data indicates two separate water qualities within the alluvium. The water qualities appear to vary due to the proximity to the Dawson River. Those less than 750 m from the Dawson River (A-OB1, A-OB2, A-OB11 and A-OB12) show fresher water with EC of 300 µS/cm to 700 µS/cm. The alluvial bores further from the river (A-OB4, A-OB7, A-OB8 and A-OB10) show higher EC of 15,000 µS/cm to 38,000 µS/cm. The pH values for the alluvial bores were all slightly acidic ranging from 6.0 to 6.9.

Figure 11 Electrical Conductivity River Alluvium Bores

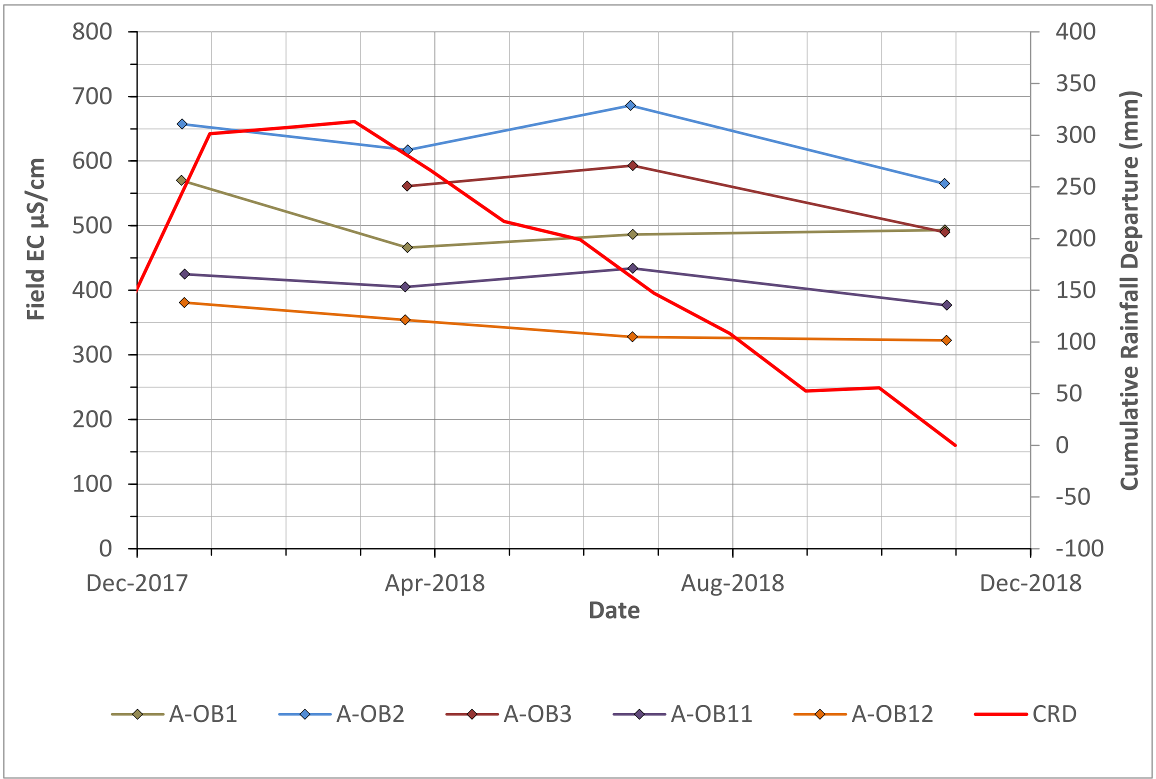


Figure 12 Electrical Conductivity Distant Alluvial Bores

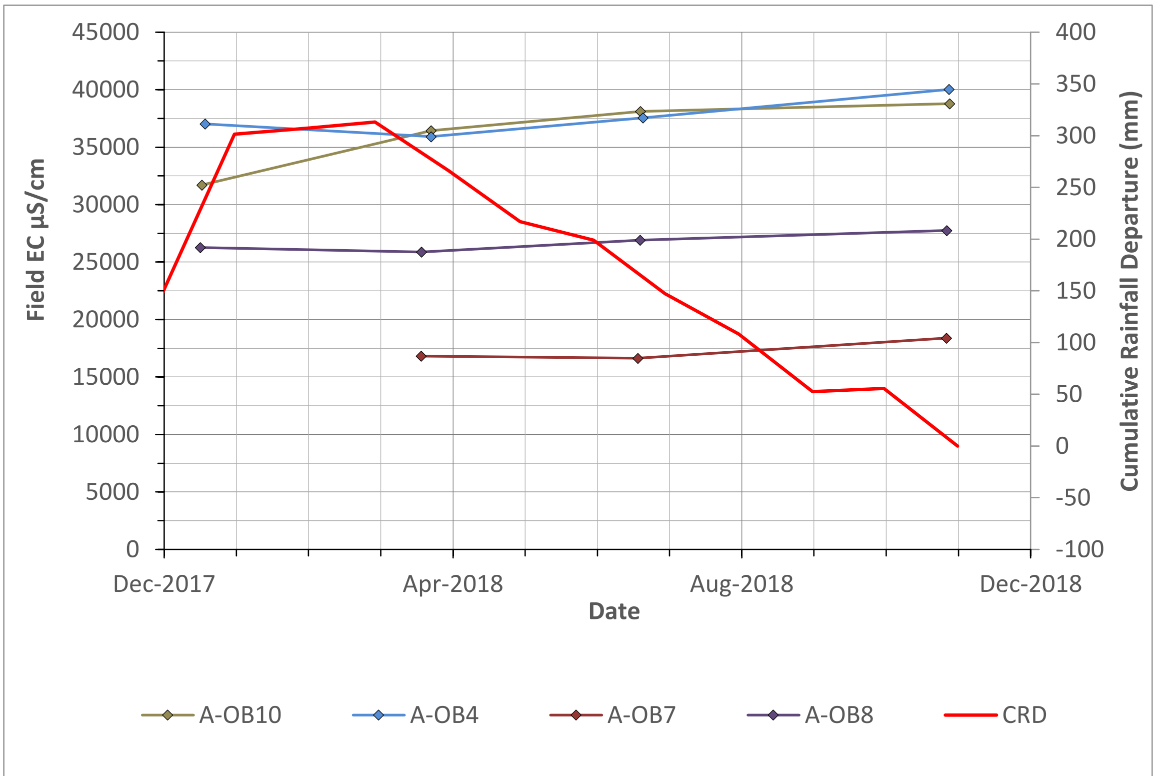
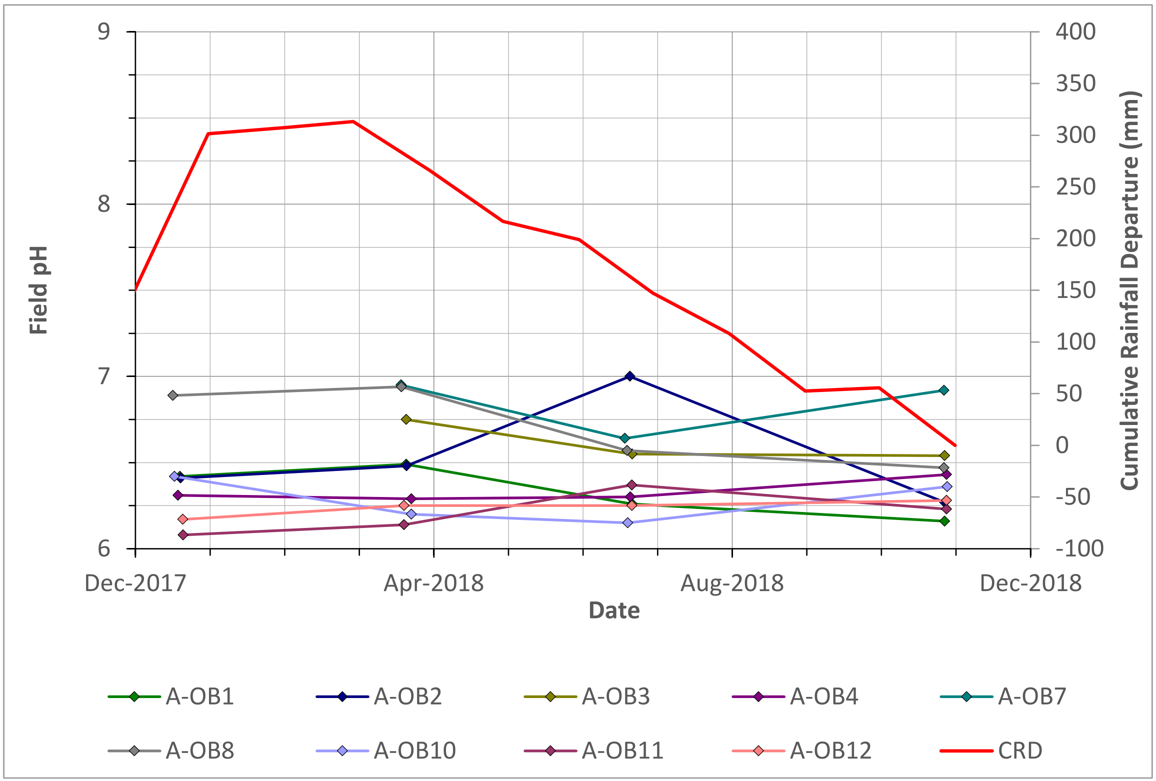


Figure 13 pH Alluvium Bores



The samples were also tested for hydrocarbons (with silica gel clean-up). Most samples recorded total recoverable hydrocarbons (TRH) below the laboratory limit of reporting. Bore A-OB4 recorded a TRH (C_{10}-C_{14}) concentration of 0.41 mg/L on average over three samples. The consistent readings are isolated to bore A-OB4 and may relate to the bore development works.

4.3.2 Permian Coal Measures

Field data indicates water quality in the Permian coal measures is brackish, with an EC ranging from 17,000 µS/cm to 38,000 µS/cm. The timeseries plot shows a rise in EC over the year. As there is no land use activitiy over this time, this may relate to period of below average rainfall (recharge). The pH was less variable and typically slightly acidic with pH ranging from 6.1 and 7.2. The laboratory groundwater quality results indicate sulphate concentrations ranged from 310 mg/L to 1800 mg/L except for P-PB1 which had sulphate concentrations below detection limits.

Figure 14 Electrical Conductivity Permian Bores

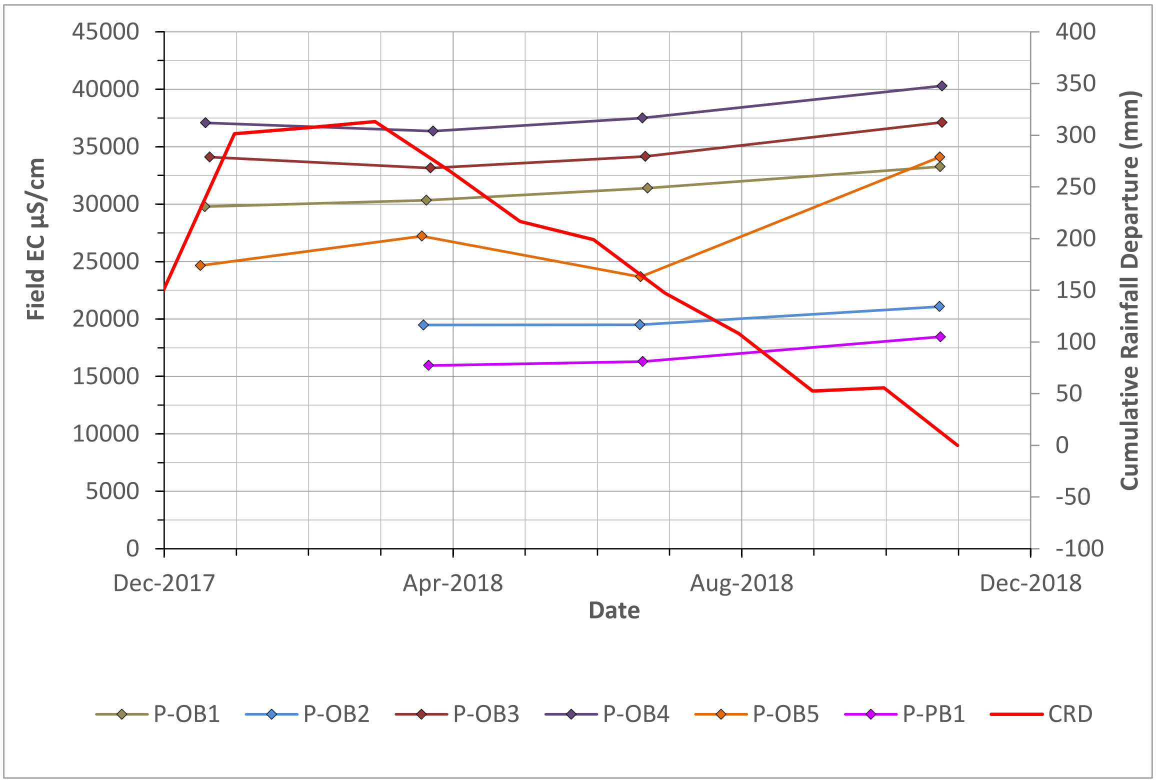
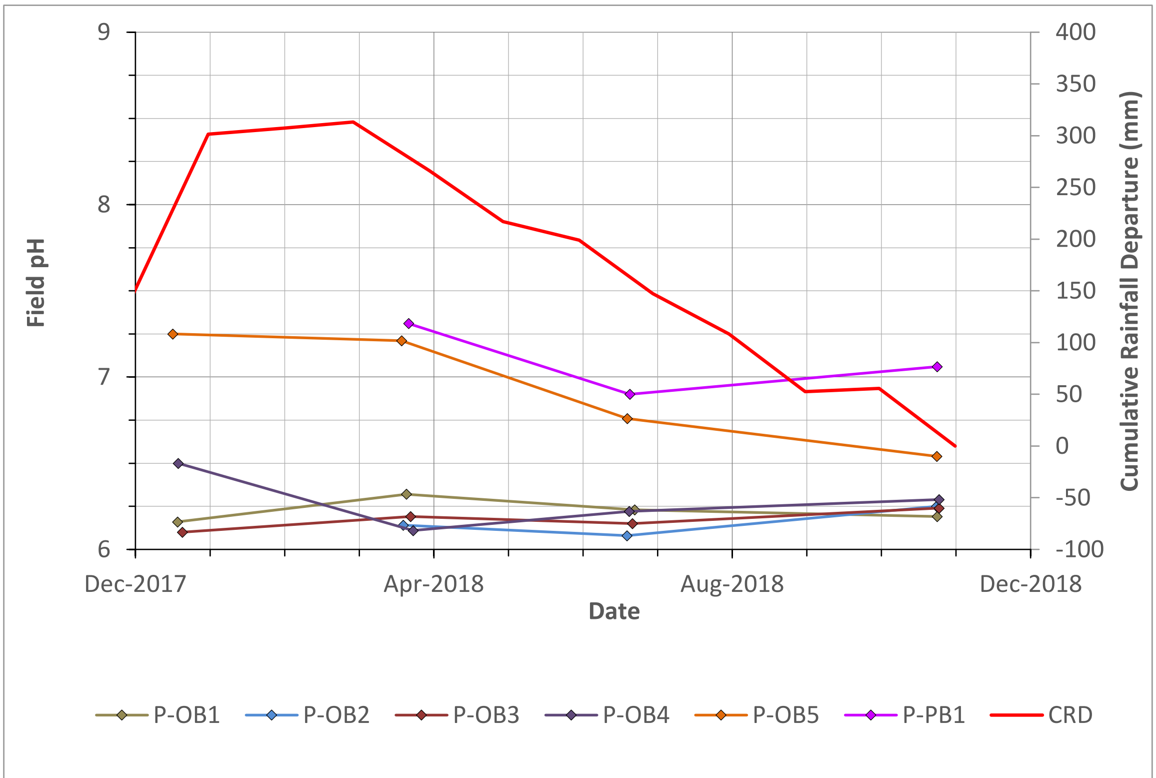


Figure 15 pH Permian Bores



The samples were also tested for hydrocarbons (with a silica gel clean-up) and two isolated hits at P-OB2 and P-OB3 were measured from the March 2018 sampling round. As these measurements were just above the LOR measured at 0.2 mg/L and the LOR at 0.1 mg/L. Results outside of the March 2018 were all below the laboratory LOR, indicating an isolated event that may relate to sampling or testing error.

4.3.3 Cretaceous Trachyte

For Ross Bore the EC values ranged between 2020 to 3690 µS/cm. An increasing trend of EC values occurs with the below average rainfall periods. The pH was generally slightly acidic over the year but basic in March 2018. It should be noted that the purge method for the March 2018 sampling was with compressed air during development which may have altered the readings with the introduced compressed air.

Figure 16 Electrical Conductivity Trachyte Bore

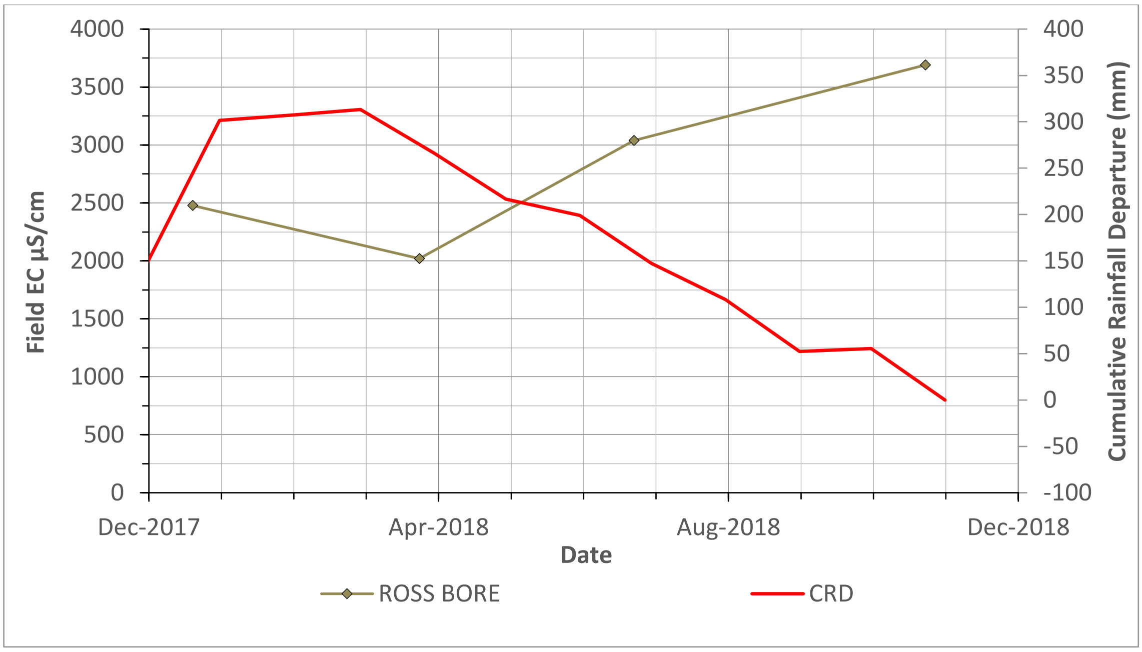
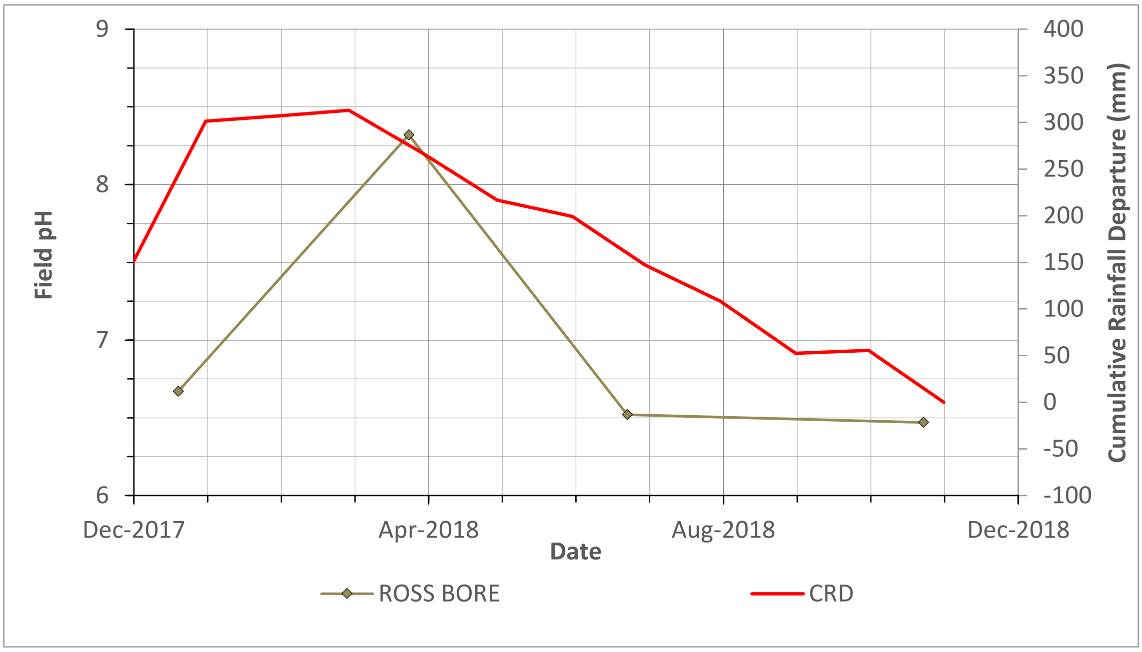


Figure 17 pH Trachyte Bore



The samples were also tested for hydrocarbons (with silica gel clean-up) and all results for Ross Bore were below the limit of reporting.

4.4 Stygofauna

Sampling for stygofauna was completed on all sampled alluvial observation bores. The samples were couriered to Stygo-Ecologia in NSW following each sample round for analysis by Dr Peter Serov. A summary of the sampling is presented in **Table 5**. Two reports for the first 2 rounds were generated from Stygo-Ecologia and are included in **Appendix D.**

Table 5 Summary of Stygofauna Results

Bore	2017 Dec	2018 Mar	2018 Jun	2018 Oct
A-OB1	Not Detected	Not Detected	1	4
A-OB2	Not Detected	Not Detected	Not Detected	Not Detected
A-OB3	*Not sampled*	1	12	1
A-OB4	Not Detected	Not Detected	Not Detected	Not Detected
A-OB7	Not Detected	Not Detected	Not Detected	Not Detected
A-OB8	Not Detected	Not Detected	1	Not Detected
A-OB10	Not Detected	Not Detected	Not Detected	Not Detected
A-OB11	Not Detected	Not Detected	Not Detected	Not Detected
A-OB12	Not Detected	Not Detected	Not Detected	Not Detected

The detected stygofauna were categorized by species, the counts and details are presented in **Table 6**

Table 6 Summary of Stygofauna Details

Quarter	Locality	Phylum	Class	Order	Family	*Habitus*	No. of animals
Mar-18	A-0B3	Annelida	Clitellata	Oligochaeta	Naididae	Phreatobite	1
Jun-18	A-0B1	Annelida	Clitellata	Oligochaeta	Naididae	Phreatobite	1
Jun-18	A-0B3	Annelida	Clitellata	Oligochaeta	Naididae	Phreatobite	12
Jun-18	A-0B8	Arthropoda	Diplopoda	Polydesmida	Haplodesmidae	Stygophile	1
Oct-18	A-0B1	Arthropoda	Diplopoda	Polydesmida	Haplodesmidae	Stygophile	2
Oct-18	A-0B1	Annelida	Clitellata	Oligochaeta	Naididae	Phreatobite	2
Oct-18	A-0B3	Annelida	Clitellata	Oligochaeta	Naididae	Phreatobite	1

4.5 Water Quality QA/QC

This section presents a discussion on quality assurance and quality control. It includes relative percentage difference (RPD) for duplicate samples, holding times and laboratory quality control. The laboratory report and chain of custody (COC) are provided in **Appendix B**.

4.5.1 Duplicate Results – Relative Percentage Difference

Two duplicates were sampled per round in the field for the purpose of providing blind duplicates to the laboratory. The duplicates sample names and corresponding bores are summarised in Error! Reference source n ot found..

Table 7 Duplicate samples taken during monitoring period

Date	Sample ID	Bore
19-Dec-17	DUP1	P-OB1
21-Dec-17	DUP2	P-OB3
21-Mar-18	DUP1	P-OB2
24-Mar-18	DUP2	A-OB4
20-Jun-18	DUP1	P-OB2
22-Jun-18	DUP2	A-OB3
23-Oct-18	DUP1	ROSS BORE
27-Oct-18	DUP2	A-OB7

RPD calculations are used to assess how the primary sample and duplicate sample match. It measures the precision of the laboratory analysis. Details of this can be found in Geoscience Australia (2009) Groundwater Sampling and Analysis – A Field Guide (record 2009/27). The acceptable limit for RPD is set at 50%.

The results and RPD calculations are shown in **Appendix E**. Most results were within the acceptable limit for RPD of 50%. A small number of analytes report an RPD of over 50%. In many of these occurrences the values are close to the LOR which increases the uncertainty of the values. The laboratory analysis performed on the duplicates for the March sampling, had higher LOR values by an order of magnitude than the corresponding named samples. This resulted in a RPD values of 164% even though both assessments read below the LOR.

4.5.2 Holding Times

Most samples were extracted and analysed within the prescribed holding times, except for pH. Field pH was recorded for each sample using calibrated equipment. This ensures a representative reading is recorded.

4.5.3 Laboratory Quality Control

Laboratory quality control includes assessment of laboratory duplicates, method blanks and matrix spikes, detailing the relative percentage difference (RPD) and acceptance limits. Laboratory duplicates provide information on method precision and sample heterogeneity. The RPD for laboratory duplicate samples analysed over the sampling round were mostly less than 30%. Method blanks are tested to monitor potential laboratory contamination, and matrix spikes are used to monitor potential matrix effects on analyte recoveries. Laboratory QC results for method blanks, matrix spikes, and laboratory control samples included in the Eurofins laboratory QC report were within the acceptable limits.

5 Pumping Test

To collect additional data on the properties and behaviour of the unconsolidated alluvium along the Dawson River, a pumping test was conducted on existing alluvial bore A-PB1 in March 2018. Bore A-PB1 is an open standpipe bore 100 mm in diameter and intersects alluvial sands, gravels and clays.

Pumping test contractor Australian Groundwater Services (AGS) was engaged to conduct a multi-rate step test, and a 24-hour constant rate test including recovery monitoring.

The step test was attempted on Monday the 26th of March 2018, with the primary aim of determining an acceptable flow rate at which the bore could be pumped for the 24-hour constant rate test. The test commenced at a rate of 2 L/s however it became immediately apparent that the bore could not support that pumping rate, due to poor bore yield and interference with the pump from sediment (sand) being drawn into the bore column. The pumping rates for the step test are summarised in **Table 8** and the selected pumping rate for the 24-hour test was 0.18 L/s.

Table 8 Step test pumping rates

From (min)	To (min)	Duration (m)	Rate (l/s)
1	3	3	1.3
3	4	1	1.6*
4	41	37	0
41	48	7	0.6
48	53	5	0.3
53	73	20	0.13
73	88	15	0.15
88	100	12	0.18
100	155	55	0.26

* Target flow rate of 2 l/s could not be achieved

The 24-hour constant rate test commenced from 11:00 am on the 27th March 2018 and was completed at 11:00 am on 28th March 2018. The pump was installed with the water intake at 21.4 mbgl and the extracted water was directed away from the immediate site using a 25 m flat lay hose. During the test, the discharge rate varied between 0.16 L/s and 0.22 L/s due to difficulties maintaining the relatively low pumping rate with the size of the contractor's pump, and to prevent the water column being lowered below the pump inlet depth. Following the 24-hour pumping test, the recovery of groundwater levels was then monitored.

During the constant rate test, field chemical parameters from the pumped bore were measured hourly using a flow cell setup by AGS. Four water quality samples were taken over the duration of the pumping test for laboratory analysis.

Water levels were recorded during the testing program from an automated logger installed on the pump rods within A-PB1. Groundwater level monitoring was also conducted using automated dataloggers within surrounding monitoring bores, with readings collected every 10 minutes to observe connectivity within the alluvial unit. **Table 9** presents details on the observations bores, including the maximum change in groundwater level observed within the bore during the pumping test.

Table 9 Observation bore distances from A-PB1

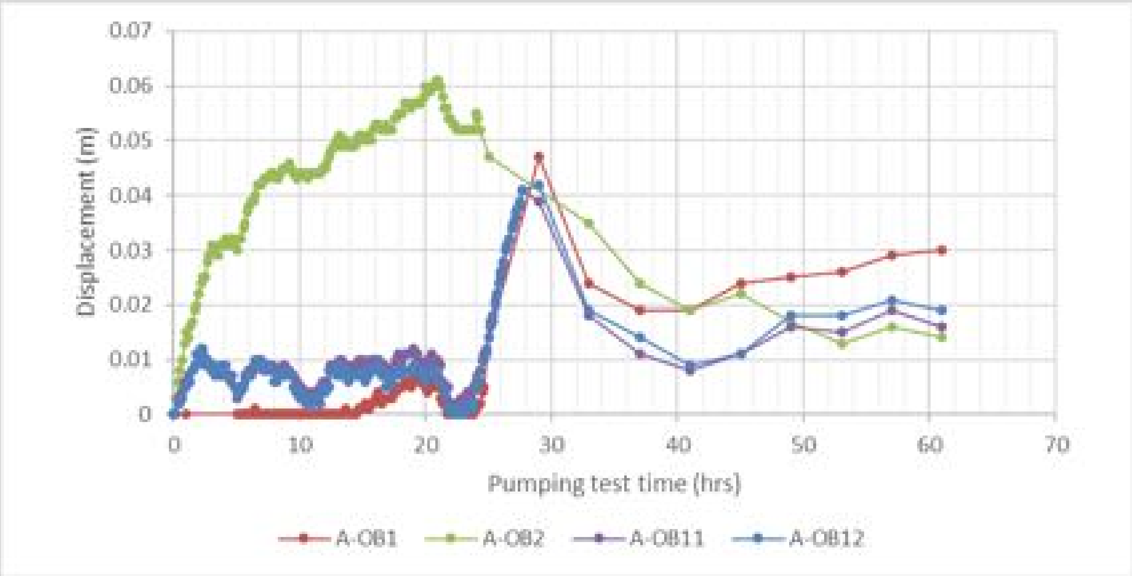
Bore	Ground Elevation (mAHD)	Screen (mbgl)	Screened Lithology	Distance from A-PB1 (m)	Starting Groundwater Level (mAHD)	Maximum Change in Level (m)
A-PB1	88.392	11.5-23.5	Alluvium	0	75.362	4.497
A-OB2	88.273	11.5-17.5	Alluvium	17.5	75.243	0.061
A-OB11	86.2*	9-15	Alluvium	623	78.11	0.041
A-OB12	87.2*	9.6-15.6	Alluvium	668	78.33	0.042
A-OB1	88.886	10-22	Alluvium	618	75.786	0.047
P-VWP2	88.510	76	Permian	17.0	69.77	0.001

***Note:** mbgl – metres below ground level*

Hydrographs for the monitoring bores near A-PB1 during the pumping test are shown in **Figure 18**. Key groundwater level observations during the testing of A-PB1 include:

- Possible recharge boundary effects were observed in the water level data in A-PB1 likely due to the presence of the Dawson River within 500 m of the bore, suggesting possible connectivity of the alluvium to the River;
- The nearby shallow alluvial monitoring bore (A-OB2) showed a minor (6 cm) water level response to pumping from A-PB1 despite being only 17.5 m away;
- The distant shallow alluvial bores (A-OB1, A-OB11 and A-OB12) located between 600m and 700m away from A-PB1 showed a delayed response to the pumping from A-PB1, with significant drawdown only occurring from around the 23-hour mark, and;
- The nearby bores P-PB1 and VWP2 within the Permian coal measures showed no visible response to pumping within the alluvium, indicating limited vertical hydraulic connection at least over the duration of the test.

Figure 18 Pumping Test Groundwater Level Observations – Alluvium



SLR compiled the groundwater level data collected during the pumping test conducted by AGS. The data was processed using industry-standard aquifer test software (AQTESOLV) to estimate aquifer transmissivity and storativity. Analysis was conducted using the Theis (1935) solution for unconfined aquifers using the water level data from the closest monitoring bore (A-OB2).

A separate analysis was also performed on the bores A-OB1, A-OB11 and A-OB12 located between 600 and 700 m away. However, a clean match to the test data in AQTESOLV proved difficult due to the minimal response at these bores and other possible interference effects. Furthermore, although a model fit to the drawdown data was possible, the model could not also match the recovery data. This is potentially indicative of leakage to the aquifer from another source. These observation bores are in proximity to the Dawson River and Banana Creek, and therefore it is considered likely that the relatively swift recovery observed in these bores was at least in part due to leakage/recharge from these water sources.

The Theis solution reports for the A-PB1 pumping test analysis are presented in **Appendix F** and a summary of the results are shown in **Table 10**. The discrepancy in the results between the parameter estimates for the nearby observation bore A-OB2 and the more distant observation bores (A-OB1, A-PB11 and A-OB12) potentially indicates that on a local scale (tens of metres) the alluvium behaves as a more significant aquifer than at the bulk scale (hundreds of metres). In this regard, the data supports that concept that the alluvium is made up of a series of sand/gravel lenses that are limited in both horizontal and vertical extent and separated from other lenses by significantly less permeable clays.

Table 10 Estimated Hydraulic Properties for 2018 A-PB1 Pumping Test

Method	Pumping Bore	Observation Bores	Aquifer Thickness (m)	Transmissivity (m2/day)	Storativity
Theis (1935)	A-PB1	A-OB2	9.3	82.2	2.2×10^{-2}
		A-OB1 A-OB11 A-OB12	8.4	0.26	1.06×10^{-5}

Laboratory analysis of the pumped water from A-PB1 is presented in **Appendix G**. The analytes generally showed minimal variation over the collected water samples. Reducing trends were observed in the heavy metals aluminium, iron and zinc. A result above the laboratory limit of reporting for low chain TRH was observed at the start of the test but it is considered that this is likely due the pump setup where tape and grease were used on the rods.

Field parameters were recorded during the day of the pumped water. Slight trends were observed indication that another water source may have been present. The time series data for pH and EC are presented in **Figure 19** and **Figure 20** respectively.

Figure 19 Time series pH measurements of A-PB1 during pumping test

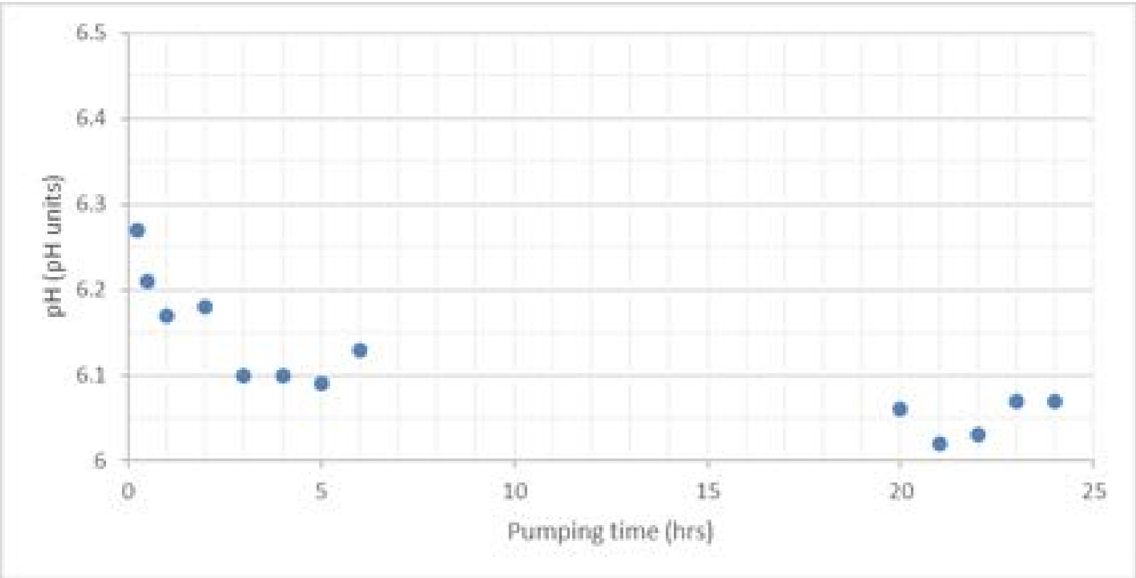
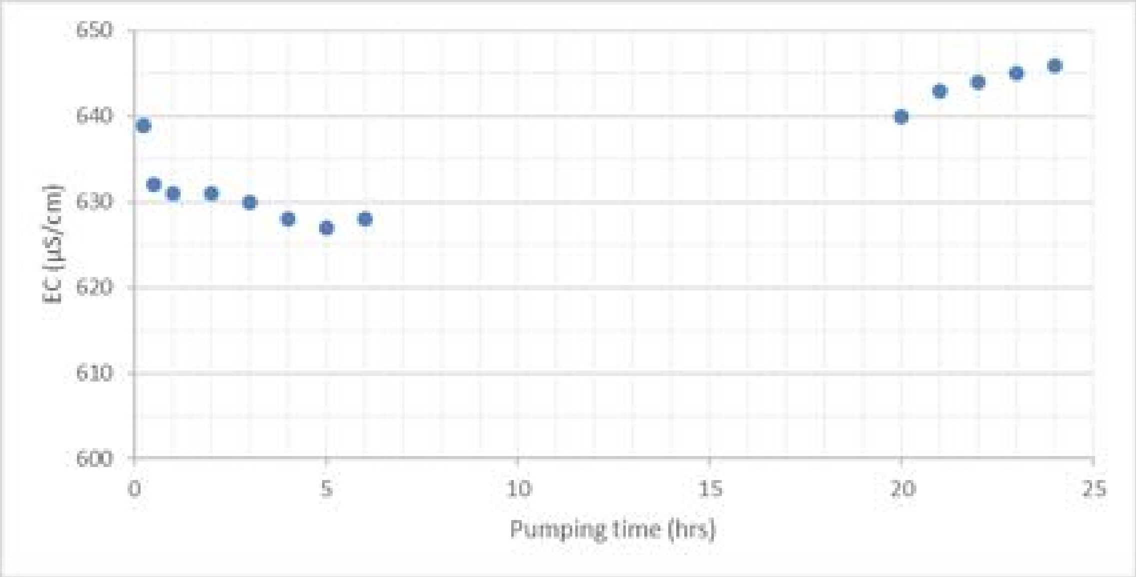


Figure 20 Time series EC measurements of A-PB1 during pumping test



6 Conclusions and Recommendations

This report presents groundwater level and quality data for the four quarterly baseline sampling rounds. The following conclusions are made from the field program and after consideration of the data:

- The 14 Solinst Leveloggers and 1 Solinst Barologger were installed and presumed collecting data;
- 5 VWP data loggers were installed and collecting data;
- Groundwater quality samples from the first monitoring event were not collected for four bores due to access restrictions(A-OB3), bore conditions (Ross Bore) and pump failure (P-OB2 and P-PB1);
- Stygofauna were identified in three of the sampled bores; and
- The pumping test to determine hydraulic properties of the alluvium at A-PB1 was completed.

Recommendations identified as part of this monitoring program are as follows:

- Repair the monument on P-OB1 as it is currently loose;
- Install an additional data logger at bore A-OB3;
- Repair fences around bores (P-OB1, P-OB5 and A-OB3);
- Remove ants nest at bore P-OB2; and
- Conduct further review of the extent of alluvium, particularly relating to 'alluvial' bores distant from the Dawson River.

7 References

SKM 2014, Bar*alaba North Continued Operations EIS Groundwater Studies: Preliminary Conceptual Groundwater Mode*l, Report QE06728.200, prepared for Cockatoo Coal Ltd, February 2014.

SLR 2017, *Baralaba South Project Groundwater Gap Analysis*, Report Number 620.11731 R01 June 2017

Theis, C.V., 1935, *The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage*, Am. Geophys. Union Trans., vol. 16, pp. 519-524.

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APPENDIX A

Field Parameters

Bore	Date	WL mbTOC	WL mAHD	Field		Lab		Comments
				pH	EC µS/cm	pH	EC µS/cm	
A-OB1	20-Dec-17	13.55	75.891	6.42	570	7.1	530	Developed with steel bailer (2m clay at base and roots in piezometer)
A-OB1	22-Mar-18	13.03	76.411	6.49	466	7.8	410	Corrosion on copper swages
A-OB1	22-Jun-18	13.55	75.891	6.26	486.4	6.8	540	Pale brown, mild turbidity
A-OB1	27-Oct-18	13.59	75.851	6.16	493.2	6.9	440	Clear
A-OB2	20-Dec-17	13.13	75.443	6.41	657	7.2	660	-
A-OB2	22-Mar-18	13.03	75.543	6.48	617	7.2	550	Ants in stygofauna sample, corrosion on copper swage
A-OB2	21-Jun-18	13.13	75.443	7	686	7	680	Pale brown, mild turbidity
A-OB2	27-Oct-18	13.351	75.222	6.27	565	6.9	520	Clear, odourless
A-OB3	Not Sampled	NA	NA	NA	NA	NA	NA	No Access
A-OB3	22-Mar-18	13.22	75.285	6.75	561	7.7	480	Four frogs removed from hole, new cap, casing needs repairing.
A-OB3	22-Jun-18	13.323	75.182	6.55	593	7.1	660	Opaque, anoxic odour, low turbidity
A-OB3	27-Oct-18	13.33	75.175	6.54	489.9	7.3	460	Clear
A-OB4	19-Dec-17	12.87	74.815	6.31	37011	7.4	35000	Very murky water, hard to filter
A-OB4	24-Mar-18	12.78	74.905	6.29	35920	7.4	35000	Clayey sample
A-OB4	21-Jun-18	12.85	74.835	6.3	37557	6.9	39000	Pale brown, mild turbidity
A-OB4	28-Oct-18	12.92	74.765	6.43	40022	7.1	35000	Purged dry, sampled from recovery
A-OB6	16-Dec-17	Dry	Dry	Dry	Dry	-	-	Dry, Fence Fixed, New Bore Cap
A-OB6	20-Mar-18	Dry	Dry	Dry	Dry	-	-	Dry
A-OB6	19-Jun-18	Dry	Dry	Dry	Dry	-	-	Dry
A-OB6	27-Oct-18	Dry	Dry	Dry	Dry	-	-	Dry
A-OB7	16-Dec-17	24.2	67.932	6.62	15681	7.6	17000	Developed with steel bailer (4m clay at base), clayey sample. Ants
A-OB7	20-Mar-18	22.29	69.842	6.95	16809	7.7	15000	Very dirty, clayey, settles
A-OB7	19-Jun-18	22.385	69.747	6.64	16637	7.4	18000	Pale brown, very turbid. Logger out overnight.
A-OB7	27-Oct-18	22.416	69.716	6.92	18390	7.3	18000	Muddy, odourless
A-OB8	17-Dec-17	19.93	71.878	6.89	26260	7.9	22000	Purged dry and sampled 6 hrs later, Temp probe out
A-OB8	20-Mar-18	19.62	72.188	6.94	25877	7.8	23000	Very dirty, clayey
A-OB8	20-Jun-18	19.638	72.17	6.57	26914	7.2	28000	Purged dry, sampled following morning

Bore	Date	WL mbTOC	WL mAHD	Field		Lab		Comments
				pH	EC µS/cm	pH	EC µS/cm	
A-OB8	27-Oct-18	19.65	72.158	6.47	27752	7.3	27000	Purged dry, sampled next day
A-OB10	18-Dec-17	14.35	73.556	6.42	31708	7.3	31000	Clayey water, hard to filter
A-OB10	24-Mar-18	14.25	73.656	6.2	36433	7.2	35000	Clayey sample, does settle
A-OB10	20-Jun-18	14.264	73.642	6.15	38097	6.8	39000	Pale brown, mild turbidity
A-OB10	28-Oct-18	14.225	73.681	6.36	38786	6.9	37000	Silty
A-OB11	21-Dec-17	8.37	78.325	6.08	425	7	410	Overgrown tracks
A-OB11	21-Mar-18	8.07	78.625	6.14	405	7.4	350	Grey tinge, organic odour
A-OB11	22-Jun-18	8.55	78.145	6.37	434	6.7	470	Brown
A-OB11	28-Oct-18	8.88	77.815	6.23	376.7	7	320	Clear
A-OB12	21-Dec-17	9.14	78.49	6.17	381	7.1	370	Overgrown tracks
A-OB12	21-Mar-18	8.84	78.79	6.25	354	7.7	290	Sandy water, organic odour.
A-OB12	22-Jun-18	9.3	78.33	6.25	327.7	6.8	310	Dark brown, mild turbidity, sandy
A-OB12	28-Oct-18	9.671	77.959	6.28	322.5	6.8	280	Clear
P-OB2	18-Dec-17	25.19	80.842	NA	NA	NA	NA	Pump malfunction, site on ants nest.
P-OB2	21-Mar-18	25.07	80.962	6.14	19480	7.5	17000	-
P-OB2	20-Jun-18	25.15	80.882	6.08	19503	6.9	20000	Clear, low flowed
P-OB2	24-Oct-18	25.05	80.982	6.25	21075	7	21000	Clear, low flowed
P-OB3	21-Dec-17	15.71	74.35	6.1	34107	7.1	32000	Low recovery, low flow rate required (0.01 L/s)
P-OB3	24-Mar-18	15.74	74.32	6.19	33141	7.2	31000	-
P-OB3	22-Jun-18	15.786	74.274	6.15	34154	6.8	28000	Clear, low flowed
P-OB3	25-Oct-18	15.651	74.409	6.24	37120	7	31000	Clear, low flowed
P-OB4	19-Dec-17	12.35	75.17	6.5	37088	7.5	35000	Very low recovery, low flow rate required (0.005 L/s)
P-OB4	25-Mar-18	12.74	74.78	6.11	36356	7.3	34000	Stable flow rate at 0.03 L/s, Pump at 40m
P-OB4	21-Jun-18	12.82	74.7	6.22	37492	7.1	38000	Clear, low flowed
P-OB4	25-Oct-18	12.81	74.71	6.29	40297	6.9	35000	Clear, low flowed
P-OB5	17-Dec-17	14.1	77.774	7.25	24664	7.8	22000	Bladder pump playing up, Temp probe not working
P-OB5	20-Mar-18	13.95	77.924	7.21	27225	8	17000	Very poor recovery, use low flow rate

Bore	Date	WL mbTOC	WL mAHD	Field		Lab		Comments
				pH	EC µS/cm	pH	EC µS/cm	
P-OB5	20-Jun-18	14.07	77.804	6.76	23666	7.7	21000	Very poor recovery, use low flow rate (0.008 L/s), Sulphur odour
P-OB5	24-Oct-18	14.34	77.534	6.54	34100	7.3	32000	Clear, sulphurous, low flowed
P-OB1	19-Dec-17	13.19	74.77	6.16	29785	7.4	28000	Cement monument loose, needs repairing, 2 gates missing
P-OB1	22-Mar-18	13.15	74.81	6.32	30324	7.7	28000	Sulphur odour
P-OB1	23-Jun-18	13.33	74.63	6.23	31390	7.5	29000	Clear, slight sulphur odour, low flowed
P-OB1	24-Oct-18	13.375	74.585	6.19	33260	7.1	32000	Strong sulphur odour, low flowed
A-PB1	20-Dec-17	13.1	75.577	-	-	NA	NA	Not Sampled (AOB-2 on same site)
A-PB1	27-Mar-18	13.03	75.647	6.07	646	7.3	470	24 hr Pump test, 4 samples taken
A-PB1	21-Jun-18	13.13	75.547	6.12	630	6.8	670	Clear, odourless
A-PB1	27-Oct-18	13.205	75.472	6.19	610	7.1	540	Clear
A-PB2	16-Dec-17	Dry	Dry	Dry	Dry	-	-	Dry, Fixed Fences
A-PB2	20-Mar-18	Dry	Dry	Dry	Dry	-	-	Dry (mud at base)
A-PB2	19-Jun-18	Dry	Dry	Dry	Dry	-	-	Dry
A-PB2	27-Oct-18	Dry	Dry	Dry	Dry	-	-	Dry
P-PB1	20-Dec-17	14.4	74.326	-	-	NA	NA	Not Sampled - Pump malfunction
P-PB1	23-Mar-18	14.28	74.446	7.31	15950	7.8	15000	Gassy, clear
P-PB1	21-Jun-18	14.43	74.296	6.9	16296	6.9	16000	Gassy, clear, low flowed
P-PB1	24-Oct-18	14.525	74.201	7.06	18453	6.8	18000	Clear, odourless
Ross_Bore	Not sampled	18.2	102.47	6.67	2478	NA	NA	Too much foreign matter in hole to sample (Organic matter and rusted flakes), pH/EC from grab sample only.
Ross_Bore	25-Mar-18	18.01	102.66	8.32	2020	8.2	1100	Developed with compressed air and sampled with bailer
Ross_Bore	23-Jun-18	18.311	102.359	6.52	3038	6.8	3200	Low flowed, clear, odourless
Ross_Bore	23-Oct-18	18.36	102.31	6.47	3690	7.3	3500	Low flowed, clear, odourless

APPENDIX B

Eurofins Laboratory Reports

Certificate of Analysis

NATA Accredited
Accreditation Number 1261
Site Number 20794

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

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QLD 4000

Attention: **Claire Stephenson**

Report **578984-W**
Project name BARALABA
Project ID 620.11731.20000
Received Date Dec 27, 2017

Client Sample ID			**P-OB3**	**A-OB12**	**A-OB11**	**DUP02**
Sample Matrix			**Water**	**Water**	**Water**	**Water**
Eurofins | mgt Sample No.			**B17-De32266**	**B17-De32267**	**B17-De32268**	**B17-De32269**
Date Sampled			**Dec 21, 2017**	**Dec 21, 2017**	**Dec 21, 2017**	**Dec 21, 2017**
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
Naphthalene[N02]	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
BTEX						
Benzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Toluene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Ethylbenzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
m&p-Xylenes	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
o-Xylene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Xylenes - Total	0.003	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
4-Bromofluorobenzene (surr.)	1	%	88	103	114	115
TRH - 2013 NEPM Fractions (after silica gel clean-up)						
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH - 1999 NEPM Fractions (after silica gel clean-up)						
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Chloride	1	mg/L	13000	69	95	13000
Conductivity (at 25°C)	1	uS/cm	32000	370	410	33000
Fluoride	0.5	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
pH	0.1	pH Units	7.1	7.1	7.0	7.1
Sulphate (as SO4)	5	mg/L	1200	9.2	7.4	1200
Total Dissolved Solids	10	mg/L	30000	180	210	27000
Alkalinity (speciated)						
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	310	120	150	300
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Total Alkalinity (as CaCO3)	20	mg/L	310	120	150	300
Heavy Metals						
Aluminium	0.05	mg/L	< 0.05	4.8	3.4	< 0.05
Aluminium (filtered)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic	0.001	mg/L	0.002	0.011	0.004	0.001
Arsenic (filtered)	0.001	mg/L	0.001	0.010	0.004	0.001

Client Sample ID			P-OB3	A-OB12	A-OB11	DUP02
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			B17-De32266	B17-De32267	B17-De32268	B17-De32269
Date Sampled			Dec 21, 2017	Dec 21, 2017	Dec 21, 2017	Dec 21, 2017
Test/Reference	LOR	Unit				
Heavy Metals						
Barium	0.02	mg/L	0.07	0.14	0.06	0.07
Barium (filtered)	0.02	mg/L	0.07	0.10	0.06	0.07
Beryllium	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Beryllium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Boron	0.05	mg/L	0.22	< 0.05	< 0.05	0.22
Boron (filtered)	0.05	mg/L	0.22	< 0.05	< 0.05	0.22
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium (filtered)	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	0.002	0.007	0.005	0.002
Chromium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Cobalt	0.001	mg/L	0.002	0.005	0.005	0.002
Cobalt (filtered)	0.001	mg/L	0.002	0.003	0.006	0.002
Copper	0.001	mg/L	< 0.001	0.007	0.005	< 0.001
Copper (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Iron	0.05	mg/L	9.1	13	5.6	8.7
Iron (filtered)	0.05	mg/L	8.9	8.3	5.0	8.7
Lead	0.001	mg/L	< 0.001	0.003	0.002	< 0.001
Lead (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	3.1	0.61	0.46	2.9
Manganese (filtered)	0.005	mg/L	3.0	0.61	0.46	2.9
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Molybdenum (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Nickel	0.001	mg/L	0.002	0.006	0.004	0.002
Nickel (filtered)	0.001	mg/L	0.002	0.001	0.002	0.002
Selenium	0.001	mg/L	< 0.001	< 0.001	0.001	< 0.001
Selenium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Silver	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Silver (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Tin	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Tin (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Uranium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Vanadium	0.005	mg/L	< 0.005	0.011	0.007	< 0.005
Vanadium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Zinc	0.005	mg/L	0.006	0.025	0.020	< 0.005
Zinc (filtered)	0.005	mg/L	< 0.005	< 0.005	0.009	< 0.005
Eurofins | mgt Suite B11C: Na, K, Ca, Mg						
Calcium	0.5	mg/L	1800	23	24	1700
Magnesium	0.5	mg/L	1300	11	13	1300
Potassium	0.5	mg/L	29	5.5	5.4	27
Sodium	0.5	mg/L	4800	40	48	4500

Client Sample ID			A-OB7	A-OB8	P-OB5	A-OB10
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			B17-De32270	B17-De32271	B17-De32272	B17-De32273
Date Sampled			Dec 16, 2017	Dec 17, 2017	Dec 17, 2017	Dec 18, 2017
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
Naphthalene[N02]	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
TRH C6-C10	0.02	mg/L	-	-	-	< 0.02
TRH C6-C10 less BTEX (F1)[N04]	0.02	mg/L	-	-	-	< 0.02
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	0.02	mg/L	-	-	-	< 0.02
BTEX						
Benzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Toluene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Ethylbenzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
m&p-Xylenes	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
o-Xylene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Xylenes - Total	0.003	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
4-Bromofluorobenzene (surr.)	1	%	128	107	113	112
TRH - 2013 NEPM Fractions (after silica gel clean-up)						
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	-
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	-
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	-
TRH - 1999 NEPM Fractions (after silica gel clean-up)						
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	-
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	-
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	-
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	-
Chloride	1	mg/L	5500	6900	6800	14000
Conductivity (at 25°C)	1	uS/cm	17000	22000	22000	31000
Fluoride	0.5	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
pH	0.1	pH Units	7.6	7.9	7.8	7.3
Sulphate (as SO4)	5	mg/L	490	1600	360	1100
Total Dissolved Solids	10	mg/L	13000	14000	13000	32000
Alkalinity (speciated)						
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	420	760	590	260
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Total Alkalinity (as CaCO3)	20	mg/L	420	760	590	260
Heavy Metals						
Aluminium	0.05	mg/L	55	4.1	0.25	28
Aluminium (filtered)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic	0.001	mg/L	0.009	0.004	0.002	0.011
Arsenic (filtered)	0.001	mg/L	< 0.001	0.002	0.001	0.002
Barium	0.02	mg/L	0.84	0.16	0.55	0.73
Barium (filtered)	0.02	mg/L	0.33	0.13	0.55	0.43
Beryllium	0.001	mg/L	0.003	0.002	< 0.001	0.006
Beryllium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Boron	0.05	mg/L	0.21	0.32	0.78	0.12
Boron (filtered)	0.05	mg/L	0.21	0.32	0.78	0.12
Cadmium	0.0002	mg/L	0.0025	0.0008	< 0.0002	0.0054
Cadmium (filtered)	0.0002	mg/L	0.0005	0.0007	< 0.0002	< 0.0002
Chromium	0.001	mg/L	0.037	0.017	0.002	0.026
Chromium (filtered)	0.001	mg/L	< 0.001	0.002	< 0.001	< 0.001

Client Sample ID Sample Matrix Eurofins | mgt Sample No. Date Sampled Test/Reference	LOR	Unit	A-OB7 Water B17-De32270 Dec 16, 2017	A-OB8 Water B17-De32271 Dec 17, 2017	P-OB5 Water B17-De32272 Dec 17, 2017	A-OB10 Water B17-De32273 Dec 18, 2017
Heavy Metals						
Cobalt	0.001	mg/L	0.094	0.009	< 0.001	0.13
Cobalt (filtered)	0.001	mg/L	0.006	0.003	< 0.001	0.017
Copper	0.001	mg/L	0.081	0.052	0.005	0.046
Copper (filtered)	0.001	mg/L	0.001	0.039	< 0.001	< 0.001
Iron	0.05	mg/L	85	5.3	0.82	43
Iron (filtered)	0.05	mg/L	< 0.05	< 0.05	0.08	< 0.05
Lead	0.001	mg/L	0.034	0.023	< 0.001	0.050
Lead (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	8.2	0.68	0.65	8.6
Manganese (filtered)	0.005	mg/L	2.0	0.34	0.65	2.5
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.005	mg/L	< 0.005	0.011	0.021	< 0.005
Molybdenum (filtered)	0.005	mg/L	< 0.005	0.011	0.020	< 0.005
Nickel	0.001	mg/L	0.11	0.16	0.014	0.12
Nickel (filtered)	0.001	mg/L	0.008	0.15	0.011	0.020
Selenium	0.001	mg/L	0.003	0.002	< 0.001	0.003
Selenium (filtered)	0.001	mg/L	< 0.001	0.002	< 0.001	< 0.001
Silver	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Silver (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Tin	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Tin (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	0.005	mg/L	< 0.005	0.070	< 0.005	< 0.005
Uranium (filtered)	0.005	mg/L	< 0.005	0.070	< 0.005	< 0.005
Vanadium	0.005	mg/L	0.10	0.013	< 0.005	0.080
Vanadium (filtered)	0.005	mg/L	< 0.005	0.005	< 0.005	< 0.005
Zinc	0.005	mg/L	0.43	0.12	0.081	0.36
Zinc (filtered)	0.005	mg/L	0.051	0.029	0.007	0.021
Eurofins | mgt Suite B11C: Na, K, Ca, Mg						
Calcium	0.5	mg/L	1000	640	520	2600
Magnesium	0.5	mg/L	670	840	320	1700
Potassium	0.5	mg/L	15	27	100	29
Sodium	0.5	mg/L	2200	3900	3900	3500

Client Sample ID Sample Matrix Eurofins | mgt Sample No. Date Sampled Test/Reference	LOR	Unit	P-OB1 Water B17-De32274 Dec 19, 2017	A-OB4 Water B17-De32275 Dec 19, 2017	P-OB4 Water B17-De32276 Dec 19, 2017	A-OB1 Water B17-De32277 Dec 20, 2017
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
Naphthalene[N02]	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
BTEX						
Benzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Toluene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Ethylbenzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
m&p-Xylenes	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
o-Xylene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Xylenes - Total	0.003	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
4-Bromofluorobenzene (surr.)	1	%	108	117	109	104

Client Sample ID			P-OB1	A-OB4	P-OB4	A-OB1
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			B17-De32274	B17-De32275	B17-De32276	B17-De32277
Date Sampled			Dec 19, 2017	Dec 19, 2017	Dec 19, 2017	Dec 20, 2017
Test/Reference	LOR	Unit				
TRH - 2013 NEPM Fractions (after silica gel clean-up)						
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	< 0.05	0.31	< 0.05	< 0.05
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH - 1999 NEPM Fractions (after silica gel clean-up)						
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	< 0.1	0.49	< 0.1	< 0.1
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	< 0.05	0.39	< 0.05	< 0.05
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	< 0.1	0.1	< 0.1	< 0.1
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Chloride	1	mg/L	11000	17000	16000	70
Conductivity (at 25°C)	1	uS/cm	28000	35000	35000	530
Fluoride	0.5	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
pH	0.1	pH Units	7.4	7.4	7.5	7.1
Sulphate (as SO4)	5	mg/L	1600	1500	1700	20
Total Dissolved Solids	10	mg/L	25000	30000	27000	260
Alkalinity (speciated)						
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	440	410	370	240
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Total Alkalinity (as CaCO3)	20	mg/L	440	410	370	240
Heavy Metals						
Aluminium	0.05	mg/L	< 0.05	4.8	< 0.05	33
Aluminium (filtered)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic	0.001	mg/L	0.005	0.007	0.002	0.011
Arsenic (filtered)	0.001	mg/L	0.004	0.004	0.002	0.002
Barium	0.02	mg/L	0.04	0.29	0.17	1.6
Barium (filtered)	0.02	mg/L	0.04	0.16	0.17	0.17
Beryllium	0.001	mg/L	< 0.001	< 0.001	< 0.001	0.007
Beryllium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Boron	0.05	mg/L	0.21	0.12	0.23	< 0.05
Boron (filtered)	0.05	mg/L	0.21	0.12	0.25	< 0.05
Cadmium	0.0002	mg/L	< 0.0002	0.0009	< 0.0002	0.0019
Cadmium (filtered)	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	< 0.001	0.009	0.005	0.024
Chromium (filtered)	0.001	mg/L	< 0.001	< 0.001	0.002	< 0.001
Cobalt	0.001	mg/L	0.003	0.036	0.017	0.21
Cobalt (filtered)	0.001	mg/L	0.003	0.028	0.016	0.003
Copper	0.001	mg/L	< 0.001	0.026	< 0.001	0.064
Copper (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Iron	0.05	mg/L	5.2	9.9	0.44	60
Iron (filtered)	0.05	mg/L	5.1	2.0	0.41	< 0.05
Lead	0.001	mg/L	< 0.001	0.012	< 0.001	0.031
Lead (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	1.5	3.9	3.9	5.2
Manganese (filtered)	0.005	mg/L	1.5	3.9	3.9	0.18
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.005	mg/L	< 0.005	< 0.005	0.007	< 0.005
Molybdenum (filtered)	0.005	mg/L	< 0.005	< 0.005	0.007	< 0.005

Client Sample ID Sample Matrix Eurofins | mgt Sample No. Date Sampled Test/Reference	LOR	Unit	P-OB1 Water B17-De32274 Dec 19, 2017	A-OB4 Water B17-De32275 Dec 19, 2017	P-OB4 Water B17-De32276 Dec 19, 2017	A-OB1 Water B17-De32277 Dec 20, 2017
Heavy Metals						
Nickel	0.001	mg/L	0.003	0.032	0.017	0.12
Nickel (filtered)	0.001	mg/L	0.003	0.019	0.016	0.003
Selenium	0.001	mg/L	0.011	0.002	< 0.001	0.002
Selenium (filtered)	0.001	mg/L	0.011	< 0.001	< 0.001	< 0.001
Silver	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Silver (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Tin	0.005	mg/L	< 0.005	0.006	< 0.005	< 0.005
Tin (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Uranium	0.005	mg/L	< 0.005	0.008	< 0.005	< 0.005
Uranium (filtered)	0.005	mg/L	< 0.005	0.008	< 0.005	< 0.005
Vanadium	0.005	mg/L	< 0.005	0.020	< 0.005	0.13
Vanadium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Zinc	0.005	mg/L	0.032	0.084	0.038	0.36
Zinc (filtered)	0.005	mg/L	0.005	0.029	0.019	0.010
Eurofins | mgt Suite B11C: Na, K, Ca, Mg						
Calcium	0.5	mg/L	1500	1800	2000	32
Magnesium	0.5	mg/L	1300	1600	1600	16
Potassium	0.5	mg/L	29	33	44	7.3
Sodium	0.5	mg/L	3900	5700	4800	61

Client Sample ID Sample Matrix Eurofins | mgt Sample No. Date Sampled Test/Reference	LOR	Unit	A-OB2 Water B17-De32278 Dec 20, 2017	DUP01 Water B17-De32279 Dec 19, 2017
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				
Naphthalene[N02]	0.01	mg/L	< 0.01	< 0.01
BTEX				
Benzene	0.001	mg/L	< 0.001	< 0.001
Toluene	0.001	mg/L	< 0.001	< 0.001
Ethylbenzene	0.001	mg/L	< 0.001	< 0.001
m&p-Xylenes	0.002	mg/L	< 0.002	< 0.002
o-Xylene	0.001	mg/L	< 0.001	< 0.001
Xylenes - Total	0.003	mg/L	< 0.003	< 0.003
4-Bromofluorobenzene (surr.)	1	%	109	112
TRH - 2013 NEPM Fractions (after silica gel clean-up)				
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1
TRH - 1999 NEPM Fractions (after silica gel clean-up)				
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1

Client Sample ID Sample Matrix Eurofins | mgt Sample No. Date Sampled Test/Reference	LOR	Unit	A-OB2 Water B17-De32278 Dec 20, 2017	DUP01 Water B17-De32279 Dec 19, 2017
Chloride	1	mg/L	98	15000
Conductivity (at 25°C)	1	uS/cm	660	28000
Fluoride	0.5	mg/L	< 0.5	< 0.5
pH	0.1	pH Units	7.2	7.2
Sulphate (as SO4)	5	mg/L	6.7	1600
Total Dissolved Solids	10	mg/L	370	23000
Alkalinity (speciated)				
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	210	440
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	10	mg/L	< 10	< 10
Total Alkalinity (as CaCO3)	20	mg/L	210	440
Heavy Metals				
Aluminium	0.05	mg/L	7.1	< 0.05
Aluminium (filtered)	0.05	mg/L	< 0.05	< 0.05
Arsenic	0.001	mg/L	0.003	0.002
Arsenic (filtered)	0.001	mg/L	0.001	0.004
Barium	0.02	mg/L	0.22	0.04
Barium (filtered)	0.02	mg/L	0.13	0.04
Beryllium	0.001	mg/L	< 0.001	< 0.001
Beryllium (filtered)	0.001	mg/L	< 0.001	< 0.001
Boron	0.05	mg/L	< 0.05	0.21
Boron (filtered)	0.05	mg/L	< 0.05	0.22
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002
Cadmium (filtered)	0.0002	mg/L	< 0.0002	< 0.0002
Chromium	0.001	mg/L	0.008	< 0.001
Chromium (filtered)	0.001	mg/L	< 0.001	< 0.001
Cobalt	0.001	mg/L	0.011	0.003
Cobalt (filtered)	0.001	mg/L	0.003	0.003
Copper	0.001	mg/L	0.012	< 0.001
Copper (filtered)	0.001	mg/L	< 0.001	< 0.001
Iron	0.05	mg/L	8.3	2.4
Iron (filtered)	0.05	mg/L	0.13	5.1
Lead	0.001	mg/L	0.007	< 0.001
Lead (filtered)	0.001	mg/L	< 0.001	< 0.001
Manganese	0.005	mg/L	0.32	1.4
Manganese (filtered)	0.005	mg/L	0.19	1.5
Mercury	0.0001	mg/L	< 0.0001	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001
Molybdenum	0.005	mg/L	< 0.005	< 0.005
Molybdenum (filtered)	0.005	mg/L	< 0.005	< 0.005
Nickel	0.001	mg/L	0.010	0.003
Nickel (filtered)	0.001	mg/L	0.002	0.003
Selenium	0.001	mg/L	0.001	< 0.001
Selenium (filtered)	0.001	mg/L	< 0.001	0.010
Silver	0.005	mg/L	< 0.005	< 0.005
Silver (filtered)	0.005	mg/L	< 0.005	< 0.005
Tin	0.005	mg/L	< 0.005	< 0.005
Tin (filtered)	0.005	mg/L	< 0.005	< 0.005
Uranium	0.005	mg/L	< 0.005	< 0.005

Client Sample ID			A-OB2	DUP01
Sample Matrix			**Water**	**Water**
Eurofins | mgt Sample No.			**B17-De32278**	**B17-De32279**
Date Sampled			**Dec 20, 2017**	**Dec 19, 2017**
Test/Reference	LOR	Unit		
Heavy Metals				
Uranium (filtered)	0.005	mg/L	< 0.005	< 0.005
Vanadium	0.005	mg/L	0.021	< 0.005
Vanadium (filtered)	0.005	mg/L	< 0.005	< 0.005
Zinc	0.005	mg/L	0.11	0.006
Zinc (filtered)	0.005	mg/L	0.018	0.005
Eurofins | mgt Suite B11C: Na, K, Ca, Mg				
Calcium	0.5	mg/L	20	1500
Magnesium	0.5	mg/L	13	1300
Potassium	0.5	mg/L	7.0	27
Sodium	0.5	mg/L	110	3800

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Eurofins | mgt Suite B1SG: TRH (With Silica Gel Clean up), BTEXN			
BTEX	Melbourne	Dec 28, 2017	14 Day
- Method: TRH C6-C40 - LTM-ORG-2010			
TRH - 2013 NEPM Fractions (after silica gel clean-up)	Melbourne	Jan 04, 2018	7 Day
- Method: LM-LTM-ORG2010			
TRH - 1999 NEPM Fractions (after silica gel clean-up)	Melbourne	Jan 04, 2018	7 Day
- Method: TRH C6-C36 (Silica Gel Cleanup) - MGT 100A			
Total Recoverable Hydrocarbons	Melbourne	Dec 28, 2017	7 Day
- Method: TRH C6-C40 - LTM-ORG-2010			
Total Recoverable Hydrocarbons - 1999 NEPM Fractions	Melbourne	Dec 28, 2017	7 Day
- Method: LTM-ORG-2010 TRH C6-C36			
Eurofins | mgt Suite B11F: Cl, SO4, Alkalinity (CO3, HCO3, OH-, Total Alkalinity), Total F			
Chloride	Melbourne	Dec 28, 2017	28 Day
- Method: LTM-INO-4090 Chloride by Discrete Analyser			
Fluoride	Melbourne	Dec 28, 2017	28 Day
- Method: APHA-F-C			
Sulphate (as SO4)	Melbourne	Dec 28, 2017	28 Day
- Method: LTM-INO-4110 Sulfate by Discrete Analyser			
Alkalinity (speciated)	Melbourne	Dec 28, 2017	14 Day
- Method: APHA 2320 Alkalinity by Titration			
Conductivity (at 25°C)	Melbourne	Dec 28, 2017	28 Day
- Method: LTM-INO-4030			
pH	Melbourne	Dec 28, 2017	0 Hours
- Method: LTM-GEN-7090 pH in water by ISE			
Total Dissolved Solids	Melbourne	Dec 28, 2017	7 Day
- Method: LTM-INO-4170 Total Dissolved Solids in Water			
Heavy Metals	Melbourne	Dec 28, 2017	180 Day
- Method: LTM-MET-3040 Metals in Waters by ICP-MS			
Heavy Metals (filtered)	Melbourne	Dec 28, 2017	180 Day
- Method: LTM-MET-3040 Metals in Waters by ICP-MS			
VIC EPA Metals : Metals M17	Melbourne	Dec 28, 2017	28 Day
- Method: LTM-MET-3040 Metals in Waters by ICP-MS			
Vic EPA Metals : Metals M17 filtered	Melbourne	Dec 28, 2017	28 Day
- Method: LTM-MET-3040 Metals in Waters by ICP-MS			
Eurofins | mgt Suite B11C: Na, K, Ca, Mg	Melbourne	Dec 28, 2017	0 Day

Company Name:	SLR Consulting (Qld)	**Order No.:**		**Received:**	Dec 27, 2017 10:00 AM
Address:	Level 2 15 Astor Terrace Spring Hill QLD 4000	**Report #:**	578984	**Due:**	Jan 4, 2018
		Phone:	07 3858 4800	**Priority:**	5 Day
		Fax:		**Contact Name:**	Claire Stephenson
Project Name:	BARALABA				
Project ID:	620.11731.20000				

Eurofins | mgt Analytical Services Manager : Ryan Gilbert

Sample Detail						Aluminium	Aluminium (filtered)	Conductivity (at 25°C)	Iron	Iron (filtered)	pH	Total Dissolved Solids	Uranium	Uranium (filtered)	Vanadium	Vanadium (filtered)	VIC EPA Metals : Metals M17	Vic EPA Metals : Metals M17 filtered	BTEXN and Volatile TRH	Eurofins | mgt Suite B1SG: TRH (With Silica Gel Clean up), BTEXN	Eurofins | mgt Suite B11F: Cl, SO4, Alkalinity (CO3, HCO3, OH-, Total Alkalinity), Total F	Eurofins | mgt Suite B11C: Na, K, Ca, Mg
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																						
Brisbane Laboratory - NATA Site # 20794																						
Perth Laboratory - NATA Site # 23736																						
External Laboratory																						
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**																	
1	P-OB3	Dec 21, 2017		Water	B17-De32266	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
2	A-OB12	Dec 21, 2017		Water	B17-De32267	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
3	A-OB11	Dec 21, 2017		Water	B17-De32268	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
4	DUP02	Dec 21, 2017		Water	B17-De32269	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
5	A-OB7	Dec 16, 2017		Water	B17-De32270	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
6	A-OB8	Dec 17, 2017		Water	B17-De32271	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
7	P-OB5	Dec 17, 2017		Water	B17-De32272	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
8	A-OB10	Dec 18, 2017		Water	B17-De32273	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
9	P-OB1	Dec 19, 2017		Water	B17-De32274	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X

Company Name:	SLR Consulting (Qld)	**Order No.:**		**Received:**	Dec 27, 2017 10:00 AM
Address:	Level 2 15 Astor Terrace Spring Hill QLD 4000	**Report #:**	578984	**Due:**	Jan 4, 2018
		Phone:	07 3858 4800	**Priority:**	5 Day
		Fax:		**Contact Name:**	Claire Stephenson
Project Name:	BARALABA				
Project ID:	620.11731.20000				

Eurofins | mgt Analytical Services Manager : Ryan Gilbert

Sample Detail						Aluminium	Aluminium (filtered)	Conductivity (at 25°C)	Iron	Iron (filtered)	pH	Total Dissolved Solids	Uranium	Uranium (filtered)	Vanadium	Vanadium (filtered)	VIC EPA Metals : Metals M17	Vic EPA Metals : Metals M17 filtered	BTEXN and Volatile TRH	Eurofins | mgt Suite B1SG: TRH (With Silica Gel Clean up), BTEXN	Eurofins | mgt Suite B11F: Cl, SO4, Alkalinity (CO3, HCO3, OH-, Total Alkalinity), Total F	Eurofins | mgt Suite B11C: Na, K, Ca, Mg
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																						
Brisbane Laboratory - NATA Site # 20794																						
Perth Laboratory - NATA Site # 23736																						
10	A-OB4	Dec 19, 2017		Water	B17-De32275	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
11	P-OB4	Dec 19, 2017		Water	B17-De32276	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
12	A-OB1	Dec 20, 2017		Water	B17-De32277	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
13	A-OB2	Dec 20, 2017		Water	B17-De32278	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
14	DUP01	Dec 19, 2017		Water	B17-De32279	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
Test Counts						14	14	14	14	14	14	14	14	14	14	14	14	14	1	13	14	14

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. All biota results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the Sample Receipt Advice.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram

ug/L: micrograms per litre

ppb: Parts per billion

org/100mL: Organisms per 100 millilitres

MPN/100mL: Most Probable Number of organisms per 100 millilitres

mg/L: milligrams per litre

ppm: Parts per million

%: Percentage

NTU: Nephelometric Turbidity Units

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	Quality Systems Manual ver 5.1 US Department of Defense
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 50-150%-Phenols & PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.1 where no positive PFAS results have been reported have been reviewed and no data was affected.

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
Naphthalene	mg/L	< 0.01			0.01	Pass	
TRH C6-C10	mg/L	< 0.02			0.02	Pass	
Method Blank							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	mg/L	< 0.02			0.02	Pass	
Method Blank							
BTEX							
Benzene	mg/L	< 0.001			0.001	Pass	
Toluene	mg/L	< 0.001			0.001	Pass	
Ethylbenzene	mg/L	< 0.001			0.001	Pass	
m&p-Xylenes	mg/L	< 0.002			0.002	Pass	
o-Xylene	mg/L	< 0.001			0.001	Pass	
Xylenes - Total	mg/L	< 0.003			0.003	Pass	
Method Blank							
TRH - 2013 NEPM Fractions (after silica gel clean-up)							
TRH >C10-C16 (after silica gel clean-up)	mg/L	< 0.05			0.05	Pass	
TRH >C16-C34 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
TRH >C34-C40 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
Method Blank							
TRH - 1999 NEPM Fractions (after silica gel clean-up)							
TRH C10-C14 (after silica gel clean-up)	mg/L	< 0.05			0.05	Pass	
TRH C15-C28 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
TRH C29-C36 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
Method Blank							
Chloride	mg/L	< 1			1	Pass	
Fluoride	mg/L	< 0.5			0.5	Pass	
Sulphate (as SO4)	mg/L	< 5			5	Pass	
Total Dissolved Solids	mg/L	< 10			10	Pass	
Method Blank							
Heavy Metals							
Aluminium	mg/L	< 0.05			0.05	Pass	
Aluminium (filtered)	mg/L	< 0.05			0.05	Pass	
Arsenic	mg/L	< 0.001			0.001	Pass	
Arsenic (filtered)	mg/L	< 0.001			0.001	Pass	
Barium	mg/L	< 0.02			0.02	Pass	
Barium (filtered)	mg/L	< 0.02			0.02	Pass	
Beryllium	mg/L	< 0.001			0.001	Pass	
Beryllium (filtered)	mg/L	< 0.001			0.001	Pass	
Boron	mg/L	< 0.05			0.05	Pass	
Boron (filtered)	mg/L	< 0.05			0.05	Pass	
Cadmium	mg/L	< 0.0002			0.0002	Pass	
Cadmium (filtered)	mg/L	< 0.0002			0.0002	Pass	
Chromium	mg/L	< 0.001			0.001	Pass	
Chromium (filtered)	mg/L	< 0.001			0.001	Pass	
Cobalt	mg/L	< 0.001			0.001	Pass	
Cobalt (filtered)	mg/L	< 0.001			0.001	Pass	
Copper	mg/L	< 0.001			0.001	Pass	
Copper (filtered)	mg/L	< 0.001			0.001	Pass	
Iron	mg/L	< 0.05			0.05	Pass	
Iron (filtered)	mg/L	< 0.05			0.05	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Lead	mg/L	< 0.001			0.001	Pass	
Lead (filtered)	mg/L	< 0.001			0.001	Pass	
Manganese	mg/L	< 0.005			0.005	Pass	
Manganese (filtered)	mg/L	< 0.005			0.005	Pass	
Mercury	mg/L	< 0.0001			0.0001	Pass	
Mercury (filtered)	mg/L	< 0.0001			0.0001	Pass	
Molybdenum	mg/L	< 0.005			0.005	Pass	
Molybdenum (filtered)	mg/L	< 0.005			0.005	Pass	
Nickel	mg/L	< 0.001			0.001	Pass	
Nickel (filtered)	mg/L	< 0.001			0.001	Pass	
Selenium	mg/L	< 0.001			0.001	Pass	
Selenium (filtered)	mg/L	< 0.001			0.001	Pass	
Silver	mg/L	< 0.005			0.005	Pass	
Silver (filtered)	mg/L	< 0.005			0.005	Pass	
Tin	mg/L	< 0.005			0.005	Pass	
Tin (filtered)	mg/L	< 0.005			0.005	Pass	
Uranium	mg/L	< 0.005			0.005	Pass	
Uranium (filtered)	mg/L	< 0.005			0.005	Pass	
Vanadium	mg/L	< 0.005			0.005	Pass	
Vanadium (filtered)	mg/L	< 0.005			0.005	Pass	
Zinc	mg/L	< 0.005			0.005	Pass	
Zinc (filtered)	mg/L	< 0.005			0.005	Pass	
Method Blank							
Eurofins | mgt Suite B11C: Na, K, Ca, Mg							
Calcium	mg/L	< 0.5			0.5	Pass	
Magnesium	mg/L	< 0.5			0.5	Pass	
Potassium	mg/L	< 0.5			0.5	Pass	
Sodium	mg/L	< 0.5			0.5	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
Naphthalene	%	91			70-130	Pass	
TRH C6-C10	%	109			70-130	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	%	109			70-130	Pass	
LCS - % Recovery							
BTEX							
Benzene	%	108			70-130	Pass	
Toluene	%	110			70-130	Pass	
Ethylbenzene	%	99			70-130	Pass	
m&p-Xylenes	%	102			70-130	Pass	
Xylenes - Total	%	101			70-130	Pass	
LCS - % Recovery							
TRH - 2013 NEPM Fractions (after silica gel clean-up)							
TRH >C10-C16 (after silica gel clean-up)	%	85			70-130	Pass	
LCS - % Recovery							
TRH - 1999 NEPM Fractions (after silica gel clean-up)							
TRH C10-C14 (after silica gel clean-up)	%	78			70-130	Pass	
LCS - % Recovery							
Chloride	%	107			70-130	Pass	
Fluoride	%	89			70-130	Pass	
Sulphate (as SO4)	%	100			70-130	Pass	
Total Dissolved Solids	%	96			70-130	Pass	
LCS - % Recovery							

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Alkalinity (speciated)							
Carbonate Alkalinity (as CaCO3)	%	99			70-130	Pass	
Total Alkalinity (as CaCO3)	%	104			70-130	Pass	
LCS - % Recovery							
Heavy Metals							
Aluminium	%	86			80-120	Pass	
Aluminium (filtered)	%	102			80-120	Pass	
Arsenic	%	86			80-120	Pass	
Arsenic (filtered)	%	100			80-120	Pass	
Barium	%	84			80-120	Pass	
Beryllium	%	90			80-120	Pass	
Boron	%	98			80-120	Pass	
Boron (filtered)	%	97			80-120	Pass	
Cadmium	%	87			80-120	Pass	
Cadmium (filtered)	%	89			80-120	Pass	
Chromium	%	84			80-120	Pass	
Chromium (filtered)	%	91			80-120	Pass	
Cobalt	%	84			80-120	Pass	
Cobalt (filtered)	%	96			80-120	Pass	
Copper	%	87			80-120	Pass	
Copper (filtered)	%	95			80-120	Pass	
Iron	%	85			80-120	Pass	
Iron (filtered)	%	105			80-120	Pass	
Lead	%	87			80-120	Pass	
Lead (filtered)	%	89			80-120	Pass	
Manganese	%	86			80-120	Pass	
Manganese (filtered)	%	109			80-120	Pass	
Mercury	%	88			75-125	Pass	
Mercury (filtered)	%	95			70-130	Pass	
Molybdenum	%	84			80-120	Pass	
Molybdenum (filtered)	%	90			80-120	Pass	
Nickel	%	86			80-120	Pass	
Nickel (filtered)	%	97			80-120	Pass	
Selenium	%	86			80-120	Pass	
Selenium (filtered)	%	101			80-120	Pass	
Silver	%	90			80-120	Pass	
Silver (filtered)	%	90			80-120	Pass	
Tin	%	85			80-120	Pass	
Tin (filtered)	%	114			80-120	Pass	
Uranium	%	86			80-120	Pass	
Uranium (filtered)	%	84			70-130	Pass	
Vanadium	%	85			80-120	Pass	
Zinc	%	88			80-120	Pass	
Zinc (filtered)	%	98			80-120	Pass	
LCS - % Recovery							
Eurofins | mgt Suite B11C: Na, K, Ca, Mg							
Calcium	%	120			70-130	Pass	
Magnesium	%	116			70-130	Pass	
Potassium	%	106			70-130	Pass	
Sodium	%	114			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Spike - % Recovery									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1					
Naphthalene	M17-De31513	NCP	%	105			70-130	Pass	
Spike - % Recovery									
BTEX				Result 1					
Benzene	M17-De31513	NCP	%	118			70-130	Pass	
Toluene	M17-De31513	NCP	%	116			70-130	Pass	
Ethylbenzene	M17-De31513	NCP	%	110			70-130	Pass	
m&p-Xylenes	M17-De31513	NCP	%	111			70-130	Pass	
o-Xylene	M17-De31513	NCP	%	114			70-130	Pass	
Xylenes - Total	M17-De31513	NCP	%	112			70-130	Pass	
Spike - % Recovery									
				Result 1					
Chloride	M17-De31391	NCP	%	87			70-130	Pass	
Spike - % Recovery									
Alkalinity (speciated)				Result 1					
Carbonate Alkalinity (as CaCO3)	M17-De31390	NCP	%	84			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Aluminium	M17-De31433	NCP	%	102			75-125	Pass	
Aluminium (filtered)	M17-De32723	NCP	%	91			75-125	Pass	
Arsenic (filtered)	M17-De32723	NCP	%	94			70-130	Pass	
Barium (filtered)	M17-De32723	NCP	%	92			75-125	Pass	
Beryllium (filtered)	M17-De32723	NCP	%	94			75-125	Pass	
Cadmium	M17-De31433	NCP	%	88			75-125	Pass	
Cadmium (filtered)	M17-De32723	NCP	%	96			70-130	Pass	
Chromium	M17-De31433	NCP	%	88			75-125	Pass	
Chromium (filtered)	M17-De32723	NCP	%	89			70-130	Pass	
Copper	M17-De31390	NCP	%	93			75-125	Pass	
Iron	M17-De31390	NCP	%	94			75-125	Pass	
Iron (filtered)	M17-De30293	NCP	%	87			70-130	Pass	
Lead	M17-De31433	NCP	%	90			75-125	Pass	
Lead (filtered)	M17-De32723	NCP	%	92			70-130	Pass	
Manganese	M17-De31433	NCP	%	113			75-125	Pass	
Manganese (filtered)	M17-De30293	NCP	%	84			70-130	Pass	
Mercury (filtered)	M17-De32723	NCP	%	96			70-130	Pass	
Nickel	M17-De31433	NCP	%	87			75-125	Pass	
Selenium (filtered)	M17-De32723	NCP	%	93			70-130	Pass	
Silver	M17-De31433	NCP	%	88			75-125	Pass	
Uranium	M17-De31433	NCP	%	89			75-125	Pass	
Uranium (filtered)	M17-De32723	NCP	%	92			70-130	Pass	
Zinc (filtered)	M17-De32723	NCP	%	97			70-130	Pass	
Spike - % Recovery									
Alkalinity (speciated)				Result 1					
Total Alkalinity (as CaCO3)	B17-De32267	CP	%	86			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Cobalt (filtered)	B17-De32268	CP	%	114			75-125	Pass	
Copper (filtered)	B17-De32268	CP	%	118			70-130	Pass	
Molybdenum (filtered)	B17-De32268	CP	%	114			75-125	Pass	
Nickel (filtered)	B17-De32268	CP	%	119			70-130	Pass	
Silver (filtered)	B17-De32268	CP	%	88			75-125	Pass	
Tin (filtered)	B17-De32268	CP	%	117			75-125	Pass	
Vanadium (filtered)	B17-De32268	CP	%	117			75-125	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Spike - % Recovery									
Eurofins | mgt Suite B11C: Na, K, Ca, Mg				Result 1					
Calcium	B17-De32268	CP	%	124			70-130	Pass	
Magnesium	B17-De32268	CP	%	119			70-130	Pass	
Potassium	B17-De32268	CP	%	111			70-130	Pass	
Sodium	B17-De32268	CP	%	113			70-130	Pass	
Spike - % Recovery									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1					
TRH C6-C10	M17-De31513	NCP	%	108			70-130	Pass	
Spike - % Recovery									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1					
TRH C6-C9	M17-De31513	NCP	%	110			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Arsenic	B17-De32275	CP	%	92			75-125	Pass	
Barium	B17-De32275	CP	%	117			75-125	Pass	
Beryllium	B17-De32275	CP	%	82			75-125	Pass	
Boron	B17-De32275	CP	%	101			75-125	Pass	
Cobalt	B17-De32275	CP	%	80			75-125	Pass	
Mercury	B17-De32275	CP	%	83			70-130	Pass	
Molybdenum	B17-De32275	CP	%	81			75-125	Pass	
Selenium	B17-De32275	CP	%	85			75-125	Pass	
Tin	B17-De32275	CP	%	115			75-125	Pass	
Vanadium	B17-De32275	CP	%	83			75-125	Pass	
Zinc	B17-De32275	CP	%	83			75-125	Pass	
Spike - % Recovery									
TRH - 2013 NEPM Fractions (after silica gel clean-up)				Result 1					
TRH >C10-C16 (after silica gel clean-up)	B17-De32276	CP	%	90			70-130	Pass	
Spike - % Recovery									
TRH - 1999 NEPM Fractions (after silica gel clean-up)				Result 1					
TRH C10-C14 (after silica gel clean-up)	B17-De32276	CP	%	97			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1	Result 2	RPD			
Naphthalene	M17-De31512	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Duplicate									
BTEX				Result 1	Result 2	RPD			
Benzene	M17-De31512	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Toluene	M17-De31512	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Ethylbenzene	M17-De31512	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
m&p-Xylenes	M17-De31512	NCP	mg/L	< 0.002	< 0.002	<1	30%	Pass	
o-Xylene	M17-De31512	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Xylenes - Total	M17-De31512	NCP	mg/L	< 0.003	< 0.003	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Conductivity (at 25°C)	B17-De32266	CP	uS/cm	32000	31000	5.0	30%	Pass	
pH	B17-De32266	CP	pH Units	7.1	7.2	pass	30%	Pass	
Duplicate									
Alkalinity (speciated)				Result 1	Result 2	RPD			
Bicarbonate Alkalinity (as CaCO3)	B17-De32266	CP	mg/L	310	310	1.0	30%	Pass	
Carbonate Alkalinity (as CaCO3)	B17-De32266	CP	mg/L	< 10	< 10	<1	30%	Pass	
Hydroxide Alkalinity (as CaCO3)	B17-De32266	CP	mg/L	< 10	< 10	<1	30%	Pass	
Total Alkalinity (as CaCO3)	B17-De32266	CP	mg/L	310	310	1.0	30%	Pass	

Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Aluminium (filtered)	B17-De32268	CP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Arsenic (filtered)	B17-De32268	CP	mg/L	0.004	0.004	<1	30%	Pass	
Barium (filtered)	B17-De32268	CP	mg/L	0.06	0.06	<1	30%	Pass	
Beryllium (filtered)	B17-De32268	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Boron (filtered)	B17-De32268	CP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Cadmium (filtered)	B17-De32268	CP	mg/L	< 0.0002	< 0.0002	<1	30%	Pass	
Chromium (filtered)	B17-De32268	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Cobalt (filtered)	B17-De32268	CP	mg/L	0.006	0.007	5.0	30%	Pass	
Copper (filtered)	B17-De32268	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Iron (filtered)	B17-De32268	CP	mg/L	5.0	5.3	6.0	30%	Pass	
Lead (filtered)	B17-De32268	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Manganese (filtered)	B17-De32268	CP	mg/L	0.46	0.46	<1	30%	Pass	
Mercury (filtered)	B17-De32268	CP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Molybdenum (filtered)	B17-De32268	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Nickel (filtered)	B17-De32268	CP	mg/L	0.002	0.002	7.0	30%	Pass	
Selenium (filtered)	B17-De32268	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Silver (filtered)	B17-De32268	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Tin (filtered)	B17-De32268	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Uranium (filtered)	B17-De32268	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Vanadium (filtered)	B17-De32268	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Zinc (filtered)	B17-De32268	CP	mg/L	0.009	0.009	3.0	30%	Pass	
Duplicate									
Eurofins | mgt Suite B11C: Na, K, Ca, Mg				Result 1	Result 2	RPD			
Calcium	B17-De32268	CP	mg/L	24	23	2.0	30%	Pass	
Magnesium	B17-De32268	CP	mg/L	13	13	2.0	30%	Pass	
Potassium	B17-De32268	CP	mg/L	5.4	5.4	<1	30%	Pass	
Sodium	B17-De32268	CP	mg/L	48	46	2.0	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Fluoride	B17-De32269	CP	mg/L	< 0.5	< 0.5	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1	Result 2	RPD			
TRH C6-C10	M17-De31512	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1	Result 2	RPD			
TRH C6-C9	M17-De31512	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Total Dissolved Solids	B17-De32274	CP	mg/L	25000	24000	4.0	30%	Pass	
Duplicate									
TRH - 2013 NEPM Fractions (after silica gel clean-up)				Result 1	Result 2	RPD			
TRH >C10-C16 (after silica gel clean-up)	B17-De32275	CP	mg/L	0.31	0.71	79	30%	Fail	Q15
TRH >C16-C34 (after silica gel clean-up)	B17-De32275	CP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
TRH >C34-C40 (after silica gel clean-up)	B17-De32275	CP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
Duplicate									
TRH - 1999 NEPM Fractions (after silica gel clean-up)				Result 1	Result 2	RPD			
TRH C10-C36 (Total) (after silica gel clean-up)	B17-De32275	CP	mg/L	0.49	0.98	64	30%	Fail	Q15
TRH C10-C14 (after silica gel clean-up)	B17-De32275	CP	mg/L	0.39	0.63	49	30%	Fail	Q15
TRH C15-C28 (after silica gel clean-up)	B17-De32275	CP	mg/L	0.1	0.4	96	30%	Fail	Q15
TRH C29-C36 (after silica gel clean-up)	B17-De32275	CP	mg/L	< 0.1	< 0.1	<1	30%	Pass	

Duplicate									
				Result 1	Result 2	RPD			
Fluoride	B17-De32275	CP	mg/L	< 0.5	< 0.5	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Aluminium	B17-De32275	CP	mg/L	4.8	4.7	2.0	30%	Pass	
Arsenic	B17-De32275	CP	mg/L	0.007	0.007	4.0	30%	Pass	
Barium	B17-De32275	CP	mg/L	0.29	0.28	3.0	30%	Pass	
Beryllium	B17-De32275	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Boron	B17-De32275	CP	mg/L	0.12	0.12	2.0	30%	Pass	
Cadmium	B17-De32275	CP	mg/L	0.0009	0.0008	6.0	30%	Pass	
Chromium	B17-De32275	CP	mg/L	0.009	0.008	5.0	30%	Pass	
Cobalt	B17-De32275	CP	mg/L	0.036	0.035	2.0	30%	Pass	
Copper	B17-De32275	CP	mg/L	0.026	0.026	3.0	30%	Pass	
Iron	B17-De32275	CP	mg/L	9.9	9.6	2.0	30%	Pass	
Lead	B17-De32275	CP	mg/L	0.012	0.012	1.0	30%	Pass	
Manganese	B17-De32275	CP	mg/L	3.9	3.8	2.0	30%	Pass	
Mercury	B17-De32275	CP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Molybdenum	B17-De32275	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Nickel	B17-De32275	CP	mg/L	0.032	0.031	2.0	30%	Pass	
Selenium	B17-De32275	CP	mg/L	0.002	0.002	9.0	30%	Pass	
Silver	B17-De32275	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Tin	B17-De32275	CP	mg/L	0.006	0.038	140	30%	Fail	Q15
Uranium	B17-De32275	CP	mg/L	0.008	0.008	5.0	30%	Pass	
Vanadium	B17-De32275	CP	mg/L	0.020	0.019	3.0	30%	Pass	
Zinc	B17-De32275	CP	mg/L	0.084	0.091	7.0	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Chloride	B17-De32276	CP	mg/L	16000	17000	<1	30%	Pass	
Conductivity (at 25°C)	B17-De32276	CP	uS/cm	35000	35000	<1	30%	Pass	
pH	B17-De32276	CP	pH Units	7.5	7.4	pass	30%	Pass	
Sulphate (as SO4)	B17-De32276	CP	mg/L	1700	1700	7.0	30%	Pass	
Duplicate									
Alkalinity (speciated)				Result 1	Result 2	RPD			
Bicarbonate Alkalinity (as CaCO3)	B17-De32276	CP	mg/L	370	380	1.0	30%	Pass	
Carbonate Alkalinity (as CaCO3)	B17-De32276	CP	mg/L	< 10	< 10	<1	30%	Pass	
Hydroxide Alkalinity (as CaCO3)	B17-De32276	CP	mg/L	< 10	< 10	<1	30%	Pass	
Total Alkalinity (as CaCO3)	B17-De32276	CP	mg/L	370	380	1.0	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Comments

Qualifier Codes/Comments

Code	Description
N02	Where we have reported both volatile (P&T GCMS) and semivolatile (GCMS) naphthalene data, results may not be identical. Provided correct sample handling protocols have been followed, any observed differences in results are likely to be due to procedural differences within each methodology. Results determined by both techniques have passed all QAQC acceptance criteria, and are entirely technically valid.
N04	F1 is determined by arithmetically subtracting the "Total BTEX" value from the "C6-C10" value. The "Total BTEX" value is obtained by summing the concentrations of BTEX analytes. The "C6-C10" value is obtained by quantitating against a standard of mixed aromatic/aliphatic analytes.
Q15	The RPD reported passes Eurofins | mgt's QC - Acceptance Criteria as defined in the Internal Quality Control Review and Glossary page of this report.

Authorised By

Ryan Gilbert	Analytical Services Manager
Alex Petridis	Senior Analyst-Metal (VIC)
Alex Petridis	Senior Analyst-Organic (VIC)
Harry Bacalis	Senior Analyst-Volatile (VIC)
Huong Le	Senior Analyst-Inorganic (VIC)
Joseph Edouard	Senior Analyst-Organic (VIC)

Glenn Jackson
National Operations Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

Certificate of Analysis

NATA Accredited
Accreditation Number 1261
Site Number 20794

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

SLR CONSULTING
Level 2 15 Astor Terrace
Spring Hill
QLD 4000

Attention: **Claire Stephenson**

Report **591504-W**
Project name BARALABA
Project ID 620.11737.20000
Received Date Mar 28, 2018

Client Sample ID			**A-OB1**	**A-OB2**	**A-OB3**	**A-OB4**
Sample Matrix			**Water**	**Water**	**Water**	**Water**
Eurofins | mgt Sample No.			**B18-Ma32960**	**B18-Ma32961**	**B18-Ma32962**	**B18-Ma32963**
Date Sampled			**Mar 22, 2018**	**Mar 22, 2018**	**Mar 22, 2018**	**Mar 24, 2018**
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
TRH C6-C10	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TRH - 2013 NEPM Fractions (after silica gel clean-up)						
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	0.27
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH - 1999 NEPM Fractions (after silica gel clean-up)						
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	0.23
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	0.13
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	0.1
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Chloride	1	mg/L	31	83	72	11000
Conductivity (at 25°C)	1	uS/cm	410	550	480	35000
Fluoride	0.5	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
pH (at 25°C)	0.1	pH Units	7.8	7.2	7.7	7.4
Sulphate (as SO4)	5	mg/L	< 5	< 5	23	1500
Total Dissolved Solids	10	mg/L	260	300	390	34000
Alkalinity (speciated)						
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	190	220	170	460
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	20	mg/L	< 20	< 20	< 20	< 20
Total Alkalinity (as CaCO3)	20	mg/L	190	220	170	460
Heavy Metals						
Aluminium	0.05	mg/L	0.51	< 0.05	0.13	18
Aluminium (filtered)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic	0.001	mg/L	0.002	0.002	0.005	0.016
Arsenic (filtered)	0.001	mg/L	0.002	< 0.001	0.004	0.006
Barium	0.02	mg/L	0.18	0.12	0.12	1.2
Barium (filtered)	0.02	mg/L	0.17	0.12	0.10	0.15
Beryllium	0.001	mg/L	< 0.001	< 0.001	< 0.001	0.001
Beryllium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Boron	0.05	mg/L	0.07	< 0.05	< 0.05	0.11
Boron (filtered)	0.05	mg/L	0.06	< 0.05	< 0.05	0.11

Client Sample ID			A-OB1	A-OB2	A-OB3	A-OB4
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			B18-Ma32960	B18-Ma32961	B18-Ma32962	B18-Ma32963
Date Sampled			Mar 22, 2018	Mar 22, 2018	Mar 22, 2018	Mar 24, 2018
Test/Reference	LOR	Unit				
Heavy Metals						
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	0.0017
Cadmium (filtered)	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	0.0008
Chromium	0.001	mg/L	0.006	< 0.001	< 0.001	0.049
Chromium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	0.010
Cobalt	0.001	mg/L	< 0.001	< 0.001	0.001	0.065
Cobalt (filtered)	0.001	mg/L	< 0.001	< 0.001	0.001	0.039
Copper	0.001	mg/L	0.003	< 0.001	< 0.001	0.075
Copper (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Iron	0.05	mg/L	0.65	0.07	0.24	40
Iron (filtered)	0.05	mg/L	< 0.05	< 0.05	0.09	1.1
Lead	0.001	mg/L	< 0.001	< 0.001	< 0.001	0.026
Lead (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	0.027	0.027	0.17	3.6
Manganese (filtered)	0.005	mg/L	0.010	0.027	0.17	3.5
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	0.0002
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Molybdenum (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Nickel	0.001	mg/L	0.003	0.003	0.001	0.083
Nickel (filtered)	0.001	mg/L	< 0.001	0.003	0.001	0.031
Selenium	0.001	mg/L	< 0.001	< 0.001	0.001	0.003
Selenium (filtered)	0.001	mg/L	< 0.001	< 0.001	0.001	< 0.001
Uranium	0.005	mg/L	< 0.005	< 0.005	< 0.005	0.013
Uranium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	0.011
Vanadium	0.005	mg/L	< 0.005	0.005	0.009	0.057
Vanadium (filtered)	0.005	mg/L	< 0.005	0.005	0.009	< 0.005
Zinc	0.005	mg/L	0.069	0.025	0.37	0.19
Zinc (filtered)	0.005	mg/L	0.008	0.009	0.018	0.097
Eurofins | mgt Suite B11C: Na/K/Ca/Mg						
Calcium	0.5	mg/L	43	17	7.1	2200
Magnesium	0.5	mg/L	16	12	4.3	1900
Potassium	0.5	mg/L	2.8	3.6	1.3	36
Sodium	0.5	mg/L	33	95	110	5700

Client Sample ID			A-OB7	A-OB8	A-OB10	A-OB11
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			B18-Ma32964	B18-Ma32965	B18-Ma32966	B18-Ma32967
Date Sampled			Mar 20, 2018	Mar 20, 2018	Mar 24, 2018	Mar 21, 2018
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
TRH C6-C10	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TRH - 2013 NEPM Fractions (after silica gel clean-up)						
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1

Client Sample ID			A-OB7	A-OB8	A-OB10	A-OB11
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			B18-Ma32964	B18-Ma32965	B18-Ma32966	B18-Ma32967
Date Sampled			Mar 20, 2018	Mar 20, 2018	Mar 24, 2018	Mar 21, 2018
Test/Reference	LOR	Unit				
TRH - 1999 NEPM Fractions (after silica gel clean-up)						
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Chloride	1	mg/L	3800	5700	8800	55
Conductivity (at 25°C)	1	uS/cm	15000	23000	35000	350
Fluoride	0.5	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
pH (at 25°C)	0.1	pH Units	7.7	7.8	7.2	7.4
Sulphate (as SO4)	5	mg/L	430	1500	1100	< 5
Total Dissolved Solids	10	mg/L	13000	18000	37000	210
Alkalinity (speciated)						
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	430	1000	330	170
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	20	mg/L	< 20	< 20	< 20	< 20
Total Alkalinity (as CaCO3)	20	mg/L	430	1000	330	170
Heavy Metals						
Aluminium	0.05	mg/L	920	140	9.4	1.9
Aluminium (filtered)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic	0.001	mg/L	0.060	0.068	0.007	0.009
Arsenic (filtered)	0.001	mg/L	< 0.001	0.005	0.004	0.009
Barium	0.02	mg/L	8.9	2.8	0.43	0.13
Barium (filtered)	0.02	mg/L	0.35	0.16	0.37	0.12
Beryllium	0.001	mg/L	0.043	0.015	< 0.001	< 0.001
Beryllium (filtered)	0.001	mg/L	< 0.01	< 0.001	< 0.001	< 0.001
Boron	0.05	mg/L	0.39	0.13	0.11	< 0.05
Boron (filtered)	0.05	mg/L	0.24	< 0.05	0.11	< 0.05
Cadmium	0.0002	mg/L	0.0057	0.0011	0.0029	< 0.0002
Cadmium (filtered)	0.0002	mg/L	0.0006	0.0004	0.0027	< 0.0002
Chromium	0.001	mg/L	0.74	0.30	0.026	0.005
Chromium (filtered)	0.001	mg/L	0.008	0.024	0.012	< 0.001
Cobalt	0.001	mg/L	0.81	0.15	0.025	0.009
Cobalt (filtered)	0.001	mg/L	0.007	0.004	0.018	0.008
Copper	0.001	mg/L	1.6	0.46	0.074	0.003
Copper (filtered)	0.001	mg/L	0.003	0.024	0.044	< 0.001
Iron	0.05	mg/L	1500	220	13	6.3
Iron (filtered)	0.05	mg/L	< 0.25	< 0.05	0.06	5.2
Lead	0.001	mg/L	0.77	0.33	0.006	0.002
Lead (filtered)	0.001	mg/L	< 0.01	< 0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	43	6.7	2.0	0.92
Manganese (filtered)	0.005	mg/L	2.3	0.57	1.8	0.92
Mercury	0.0001	mg/L	0.0016	0.0006	< 0.0001	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.005	mg/L	< 0.05	0.018	< 0.005	< 0.005
Molybdenum (filtered)	0.005	mg/L	< 0.005	0.018	< 0.005	< 0.005
Nickel	0.001	mg/L	1.0	0.37	0.034	0.004
Nickel (filtered)	0.001	mg/L	0.010	0.027	0.020	0.002
Selenium	0.001	mg/L	0.038	0.011	0.004	< 0.001
Selenium (filtered)	0.001	mg/L	< 0.001	0.003	0.003	< 0.001

Client Sample ID			A-OB7	A-OB8	A-OB10	A-OB11
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			B18-Ma32964	B18-Ma32965	B18-Ma32966	B18-Ma32967
Date Sampled			Mar 20, 2018	Mar 20, 2018	Mar 24, 2018	Mar 21, 2018
Test/Reference	LOR	Unit				
Heavy Metals						
Uranium	0.005	mg/L	0.055	0.14	0.006	< 0.005
Uranium (filtered)	0.005	mg/L	0.008	0.077	0.005	< 0.005
Vanadium	0.005	mg/L	1.2	0.28	0.022	0.006
Vanadium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Zinc	0.005	mg/L	4.3	0.66	0.075	0.043
Zinc (filtered)	0.005	mg/L	0.012	0.058	0.047	0.018
Eurofins | mgt Suite B11C: Na/K/Ca/Mg						
Calcium	0.5	mg/L	1200	900	3600	25
Magnesium	0.5	mg/L	810	1200	2300	12
Potassium	0.5	mg/L	18	33	34	3.4
Sodium	0.5	mg/L	2900	4100	4700	35

Client Sample ID			A-OB12	P-PB1	P-OB1	P-OB2
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			B18-Ma32968	B18-Ma32969	B18-Ma32970	B18-Ma32971
Date Sampled			Mar 21, 2018	Mar 23, 2018	Mar 22, 2018	Mar 24, 2018
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
TRH C6-C10	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TRH - 2013 NEPM Fractions (after silica gel clean-up)						
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	0.2
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	0.3
TRH - 1999 NEPM Fractions (after silica gel clean-up)						
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	0.2
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	0.2
Chloride	1	mg/L	49	3500	6900	3700
Conductivity (at 25°C)	1	uS/cm	290	15000	28000	17000
Fluoride	0.5	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
pH (at 25°C)	0.1	pH Units	7.7	7.8	7.7	7.5
Sulphate (as SO4)	5	mg/L	< 5	< 5	1600	440
Total Dissolved Solids	10	mg/L	160	11000	28000	13000
Alkalinity (speciated)						
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	110	72	390	750
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	20	mg/L	< 20	< 20	< 20	< 20
Total Alkalinity (as CaCO3)	20	mg/L	110	72	390	750
Heavy Metals						
Aluminium	0.05	mg/L	2.4	< 0.05	< 0.05	< 0.05
Aluminium (filtered)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic	0.001	mg/L	0.012	0.016	0.009	0.002
Arsenic (filtered)	0.001	mg/L	0.010	0.013	0.007	0.001

Client Sample ID			A-OB12	P-PB1	P-OB1	P-OB2
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			B18-Ma32968	B18-Ma32969	B18-Ma32970	B18-Ma32971
Date Sampled			Mar 21, 2018	Mar 23, 2018	Mar 22, 2018	Mar 24, 2018
Test/Reference	LOR	Unit				
Heavy Metals						
Barium	0.02	mg/L	0.11	19	0.05	0.15
Barium (filtered)	0.02	mg/L	0.10	19	0.05	0.14
Beryllium	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Beryllium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Boron	0.05	mg/L	< 0.05	0.12	0.18	1.6
Boron (filtered)	0.05	mg/L	< 0.05	0.11	0.17	1.6
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium (filtered)	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	0.004	0.003	< 0.001	0.017
Chromium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	0.002
Cobalt	0.001	mg/L	0.004	0.001	0.004	0.002
Cobalt (filtered)	0.001	mg/L	0.003	0.001	0.004	0.002
Copper	0.001	mg/L	0.004	0.001	< 0.001	0.036
Copper (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	0.009
Iron	0.05	mg/L	9.5	1.6	4.8	0.40
Iron (filtered)	0.05	mg/L	6.9	1.5	4.8	0.18
Lead	0.001	mg/L	0.002	< 0.001	< 0.001	< 0.001
Lead (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	0.49	1.7	1.5	0.67
Manganese (filtered)	0.005	mg/L	0.49	1.7	1.5	0.65
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Molybdenum (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Nickel	0.001	mg/L	0.004	0.002	0.004	0.013
Nickel (filtered)	0.001	mg/L	0.002	0.002	0.004	0.005
Selenium	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Selenium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Uranium	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Uranium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Vanadium	0.005	mg/L	0.008	< 0.005	< 0.005	< 0.005
Vanadium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Zinc	0.005	mg/L	0.050	0.19	0.097	0.38
Zinc (filtered)	0.005	mg/L	0.050	0.045	0.014	0.38
Eurofins | mgt Suite B11C: Na/K/Ca/Mg						
Calcium	0.5	mg/L	21	1100	1700	750
Magnesium	0.5	mg/L	9.7	23	1400	590
Potassium	0.5	mg/L	2.9	10	31	37
Sodium	0.5	mg/L	30	3000	4300	3700

Client Sample ID			P-OB3	P-OB4	P-OB5	DUP1
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			B18-Ma32972	B18-Ma32973	B18-Ma32974	B18-Ma32975
Date Sampled			Mar 24, 2018	Mar 25, 2018	Mar 20, 2018	Mar 21, 2018
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
TRH C6-C10	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TRH - 2013 NEPM Fractions (after silica gel clean-up)						
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	0.1	< 0.1	< 0.1	< 0.1
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	0.2	< 0.1	< 0.1	< 0.1
TRH - 1999 NEPM Fractions (after silica gel clean-up)						
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	0.2	< 0.1	< 0.1	< 0.1
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	0.06
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	0.2	< 0.1	< 0.1	< 0.1
Chloride	1	mg/L	7800	8400	3900	3800
Conductivity (at 25°C)	1	uS/cm	31000	34000	17000	17000
Fluoride	0.5	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
pH (at 25°C)	0.1	pH Units	7.2	7.3	8.0	7.5
Sulphate (as SO4)	5	mg/L	1200	1600	300	450
Total Dissolved Solids	10	mg/L	31000	31000	12000	12000
Alkalinity (speciated)						
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	360	520	620	640
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	20	mg/L	< 20	< 20	< 20	< 20
Total Alkalinity (as CaCO3)	20	mg/L	360	520	620	640
Heavy Metals						
Aluminium	0.05	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Aluminium (filtered)	0.05	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Arsenic	0.001	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic (filtered)	0.001	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Barium	0.02	mg/L	0.07	0.06	0.44	0.13
Barium (filtered)	0.02	mg/L	0.07	0.06	0.41	0.12
Beryllium	0.001	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Beryllium (filtered)	0.001	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Boron	0.05	mg/L	< 0.5	< 0.5	0.78	2.0
Boron (filtered)	0.05	mg/L	< 0.5	< 0.5	0.78	1.9
Cadmium	0.0002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Cadmium (filtered)	0.0002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Chromium	0.001	mg/L	< 0.01	< 0.01	0.011	0.011
Chromium (filtered)	0.001	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Cobalt	0.001	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Cobalt (filtered)	0.001	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Copper	0.001	mg/L	0.063	< 0.01	< 0.01	0.043
Copper (filtered)	0.001	mg/L	0.063	< 0.01	< 0.01	0.011
Iron	0.05	mg/L	8.9	4.4	0.76	0.50
Iron (filtered)	0.05	mg/L	8.8	4.4	< 0.5	< 0.5
Lead	0.001	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Lead (filtered)	0.001	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Manganese	0.005	mg/L	3.1	3.3	0.64	0.67
Manganese (filtered)	0.005	mg/L	3.0	3.2	0.59	0.66

Client Sample ID Sample Matrix Eurofins | mgt Sample No. Date Sampled Test/Reference	LOR	Unit	P-OB3 Water B18-Ma32972 Mar 24, 2018	P-OB4 Water B18-Ma32973 Mar 25, 2018	P-OB5 Water B18-Ma32974 Mar 20, 2018	DUP1 Water B18-Ma32975 Mar 21, 2018
Heavy Metals						
Mercury	0.0001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Mercury (filtered)	0.0001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Molybdenum	0.005	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Molybdenum (filtered)	0.005	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Nickel	0.001	mg/L	< 0.01	< 0.01	0.015	0.011
Nickel (filtered)	0.001	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Selenium	0.001	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Selenium (filtered)	0.001	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Uranium	0.005	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Uranium (filtered)	0.005	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Vanadium	0.005	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Vanadium (filtered)	0.005	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Zinc	0.005	mg/L	0.10	0.15	0.31	0.12
Zinc (filtered)	0.005	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Eurofins | mgt Suite B11C: Na/K/Ca/Mg						
Calcium	0.5	mg/L	2000	2200	370	660
Magnesium	0.5	mg/L	1400	1700	290	480
Potassium	0.5	mg/L	32	36	120	32
Sodium	0.5	mg/L	4600	5300	3700	3300

Client Sample ID Sample Matrix Eurofins | mgt Sample No. Date Sampled Test/Reference	LOR	Unit	DUP2 Water B18-Ma32976 Mar 24, 2018	ROSS BORE Water B18-Ma33024 Mar 24, 2018
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				
TRH C6-C9	0.02	mg/L	< 0.02	< 0.02
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				
TRH C6-C10	0.02	mg/L	< 0.02	< 0.02
TRH - 2013 NEPM Fractions (after silica gel clean-up)				
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	0.64	< 0.1
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1
TRH - 1999 NEPM Fractions (after silica gel clean-up)				
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	0.74	< 0.1
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	0.34	< 0.05
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	0.4	< 0.1
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1
Chloride	1	mg/L	8400	240
Conductivity (at 25°C)	1	uS/cm	35000	1100
Fluoride	0.5	mg/L	< 0.5	< 0.5
pH (at 25°C)	0.1	pH Units	7.5	8.2
Sulphate (as SO4)	5	mg/L	1500	88
Total Dissolved Solids	10	mg/L	14000	1100

Client Sample ID			DUP2	ROSS BORE
Sample Matrix			Water	Water
Eurofins | mgt Sample No.			B18-Ma32976	B18-Ma33024
Date Sampled			Mar 24, 2018	Mar 24, 2018
Test/Reference	LOR	Unit		
Alkalinity (speciated)				
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	650	470
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	20	mg/L	< 20	< 20
Total Alkalinity (as CaCO3)	20	mg/L	650	470
Heavy Metals				
Aluminium	0.05	mg/L	120	0.07
Aluminium (filtered)	0.05	mg/L	< 0.5	< 0.05
Arsenic	0.001	mg/L	0.042	0.001
Arsenic (filtered)	0.001	mg/L	< 0.01	< 0.001
Barium	0.02	mg/L	4.8	0.04
Barium (filtered)	0.02	mg/L	0.13	0.04
Beryllium	0.001	mg/L	0.011	< 0.001
Beryllium (filtered)	0.001	mg/L	< 0.01	< 0.001
Boron	0.05	mg/L	0.20	0.48
Boron (filtered)	0.05	mg/L	< 0.5	0.47
Cadmium	0.0002	mg/L	0.0087	< 0.0002
Cadmium (filtered)	0.0002	mg/L	< 0.002	< 0.0002
Chromium	0.001	mg/L	0.28	< 0.001
Chromium (filtered)	0.001	mg/L	< 0.01	< 0.001
Cobalt	0.001	mg/L	0.23	0.001
Cobalt (filtered)	0.001	mg/L	0.039	< 0.001
Copper	0.001	mg/L	0.53	0.002
Copper (filtered)	0.001	mg/L	< 0.01	< 0.001
Iron	0.05	mg/L	240	1.0
Iron (filtered)	0.05	mg/L	0.67	< 0.05
Lead	0.001	mg/L	0.17	0.003
Lead (filtered)	0.001	mg/L	< 0.01	< 0.001
Manganese	0.005	mg/L	4.9	0.10
Manganese (filtered)	0.005	mg/L	3.4	0.010
Mercury	0.0001	mg/L	0.0020	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.001	< 0.0001
Molybdenum	0.005	mg/L	< 0.05	< 0.005
Molybdenum (filtered)	0.005	mg/L	< 0.05	< 0.005
Nickel	0.001	mg/L	0.41	< 0.001
Nickel (filtered)	0.001	mg/L	0.034	< 0.001
Selenium	0.001	mg/L	0.017	0.003
Selenium (filtered)	0.001	mg/L	< 0.01	0.003
Uranium	0.005	mg/L	< 0.05	< 0.005
Uranium (filtered)	0.005	mg/L	< 0.05	< 0.005
Vanadium	0.005	mg/L	0.34	< 0.005
Vanadium (filtered)	0.005	mg/L	< 0.01	< 0.005
Zinc	0.005	mg/L	1.2	0.017
Zinc (filtered)	0.005	mg/L	0.058	0.010
Eurofins | mgt Suite B11C: Na/K/Ca/Mg				
Calcium	0.5	mg/L	1800	70
Magnesium	0.5	mg/L	1600	63
Potassium	0.5	mg/L	29	3.5
Sodium	0.5	mg/L	5400	330

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Total Recoverable Hydrocarbons - 1999 NEPM Fractions	Melbourne	Apr 04, 2018	7 Day
- Method: LTM-ORG-2010 TRH C6-C36			
Total Recoverable Hydrocarbons - 2013 NEPM Fractions	Melbourne	Apr 04, 2018	7 Day
- Method: TRH C6-C40 - LTM-ORG-2010			
Conductivity (at 25°C)	Melbourne	Apr 04, 2018	28 Day
- Method: LTM-INO-4030 Conductivity			
pH (at 25°C)	Melbourne	Apr 04, 2018	0 Hours
- Method: LTM-GEN-7090 pH in water by ISE			
Total Dissolved Solids	Melbourne	Apr 04, 2018	7 Day
- Method: LTM-INO-4170 Total Dissolved Solids in Water			
Heavy Metals	Melbourne	Apr 04, 2018	180 Day
- Method: LTM-MET-3040 Metals in Waters by ICP-MS			
Heavy Metals (filtered)	Melbourne	Apr 04, 2018	180 Day
- Method: LTM-MET-3040 Metals in Waters by ICP-MS			
Mobil Metals : Metals M15	Melbourne	Apr 04, 2018	28 Day
- Method: LTM-MET-3040 Metals in Waters by ICP-MS			
Eurofins | mgt Suite B11C: Na/K/Ca/Mg	Melbourne	Apr 04, 2018	180 Day
- Method: LTM-MET-3010 Alkali Metals by ICP-AES			
TRH - 2013 NEPM Fractions (after silica gel clean-up)	Melbourne	Apr 04, 2018	7 Day
- Method: LM-LTM-ORG2010			
TRH - 1999 NEPM Fractions (after silica gel clean-up)	Melbourne	Apr 04, 2018	7 Day
- Method: TRH C6-C36 (Silica Gel Cleanup) - MGT 100A			
Eurofins | mgt Suite B11F: Cl/SO4/Alkalinity/Total F			
Chloride	Melbourne	Apr 04, 2018	28 Day
- Method: LTM-INO-4090 Chloride by Discrete Analyser			
Fluoride	Melbourne	Apr 04, 2018	28 Day
- Method: APHA-F-C			
Sulphate (as SO4)	Melbourne	Apr 04, 2018	28 Day
- Method: LTM-INO-4110 Sulfate by Discrete Analyser			
Alkalinity (speciated)	Melbourne	Apr 04, 2018	14 Day
- Method: APHA 2320 Alkalinity by Titration			

Company Name:	SLR Consulting (Qld)	**Order No.:**	
Address:	Level 2 15 Astor Terrace Spring Hill QLD 4000	**Report #:**	591504
		Phone:	07 3858 4800
		Fax:	
Project Name:	BARALABA	**Received:**	Mar 28, 2018 9:00 AM
Project ID:	620.11737.20000	**Due:**	Apr 11, 2018
		Priority:	5 Day
		Contact Name:	Claire Stephenson

Eurofins | mgt Analytical Services Manager : Ryan Gilbert

Sample Detail						Aluminium	Aluminium (filtered)	Arsenic	Arsenic (filtered)	Barium	Barium (filtered)	Beryllium	Beryllium (filtered)	Boron	Boron (filtered)	Cadmium	Cadmium (filtered)	Chromium	Chromium (filtered)	Cobalt	Cobalt (filtered)	Conductivity (at 25°C)	Copper	Copper (filtered)	Iron	Iron (filtered)	Lead	Lead (filtered)	Manganese	Manganese (filtered)	Mercury	Mercury (filtered)	Molybdenum	Molybdenum (filtered)	Nickel	Nickel (filtered)	pH (at 25°C)	Selenium	Selenium (filtered)	Total Dissolved Solids	TRH C6-C10	TRH C6-C9	Uranium	Uranium (filtered)	Vanadium	Vanadium (filtered)	Zinc	Zinc (filtered)	TRH (after Silica Gel cleanup)	Eurofins | mgt Suite B11F:	Eurofins | mgt Suite B11C: Na/K/Ca/Mg
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																																																			
Brisbane Laboratory - NATA Site # 20794																																																			
Perth Laboratory - NATA Site # 23736																																																			
External Laboratory																																																			
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**																																														
1	A-OB1	Mar 22, 2018		Water	B18-Ma32960	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2	A-OB2	Mar 22, 2018		Water	B18-Ma32961	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3	A-OB3	Mar 22, 2018		Water	B18-Ma32962	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4	A-OB4	Mar 24, 2018		Water	B18-Ma32963	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5	A-OB7	Mar 20, 2018		Water	B18-Ma32964	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6	A-OB8	Mar 20, 2018		Water	B18-Ma32965	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7	A-OB10	Mar 24, 2018		Water	B18-Ma32966	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8	A-OB11	Mar 21, 2018		Water	B18-Ma32967	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
9	A-OB12	Mar 21, 2018		Water	B18-Ma32968	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

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Order No.:
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Received: Mar 28, 2018 9:00 AM
Due: Apr 11, 2018
Priority: 5 Day
Contact Name: Claire Stephenson

Eurofins | mgt Analytical Services Manager : Ryan Gilbert

Sample Detail						Aluminium	Aluminium (filtered)	Arsenic	Arsenic (filtered)	Barium	Barium (filtered)	Beryllium	Beryllium (filtered)	Boron	Boron (filtered)	Cadmium	Cadmium (filtered)	Chromium	Chromium (filtered)	Cobalt	Cobalt (filtered)	Conductivity (at 25°C)	Copper	Copper (filtered)	Iron	Iron (filtered)	Lead	Lead (filtered)	Manganese	Manganese (filtered)	Mercury	Mercury (filtered)	Molybdenum	Molybdenum (filtered)	Nickel	Nickel (filtered)	pH (at 25°C)	Selenium	Selenium (filtered)	Total Dissolved Solids	TRH C6-C10	TRH C6-C9	Uranium	Uranium (filtered)	Vanadium	Vanadium (filtered)	Zinc	Zinc (filtered)	TRH (after Silica Gel cleanup)	Eurofins | mgt Suite B11F:	Eurofins | mgt Suite B11C: Na/K/Ca/Mg
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																																																			
Brisbane Laboratory - NATA Site # 20794																																																			
Perth Laboratory - NATA Site # 23736																																																			
10	P-PB1	Mar 23, 2018		Water	B18-Ma32969	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
11	P-OB1	Mar 22, 2018		Water	B18-Ma32970	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
12	P-OB2	Mar 24, 2018		Water	B18-Ma32971	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
13	P-OB3	Mar 24, 2018		Water	B18-Ma32972	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
14	P-OB4	Mar 25, 2018		Water	B18-Ma32973	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
15	P-OB5	Mar 20, 2018		Water	B18-Ma32974	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
16	DUP1	Mar 21, 2018		Water	B18-Ma32975	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
17	DUP2	Mar 24, 2018		Water	B18-Ma32976	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
18	ROSS BORE	Mar 24, 2018		Water	B18-Ma33024	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Test Counts						18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram
ppm: Parts per million
org/100mL: Organisms per 100 millilitres
mg/L: milligrams per litre
ppb: Parts per billion
NTU: Nephelometric Turbidity Units
ug/L: micrograms per litre
%: Percentage
MPN/100mL: Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	Quality Systems Manual ver 5.1 US Department of Defense
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 50-150%-Phenols & PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.1 where no positive PFAS results have been reported have been reviewed and no data was affected.

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	mg/L	< 0.02			0.02	Pass	
Method Blank							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
TRH C6-C10	mg/L	< 0.02			0.02	Pass	
Method Blank							
TRH - 2013 NEPM Fractions (after silica gel clean-up)							
TRH >C10-C16 (after silica gel clean-up)	mg/L	< 0.05			0.05	Pass	
TRH >C16-C34 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
TRH >C34-C40 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
Method Blank							
TRH - 1999 NEPM Fractions (after silica gel clean-up)							
TRH C10-C14 (after silica gel clean-up)	mg/L	< 0.05			0.05	Pass	
TRH C15-C28 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
TRH C29-C36 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
Method Blank							
Chloride	mg/L	< 1			1	Pass	
Fluoride	mg/L	< 0.5			0.5	Pass	
Sulphate (as SO4)	mg/L	< 5			5	Pass	
Total Dissolved Solids	mg/L	< 10			10	Pass	
Method Blank							
Alkalinity (speciated)							
Bicarbonate Alkalinity (as CaCO3)	mg/L	< 20			20	Pass	
Carbonate Alkalinity (as CaCO3)	mg/L	< 10			10	Pass	
Hydroxide Alkalinity (as CaCO3)	mg/L	< 20			20	Pass	
Total Alkalinity (as CaCO3)	mg/L	< 20			20	Pass	
Method Blank							
Heavy Metals							
Aluminium	mg/L	< 0.05			0.05	Pass	
Aluminium (filtered)	mg/L	< 0.05			0.05	Pass	
Arsenic	mg/L	< 0.001			0.001	Pass	
Arsenic (filtered)	mg/L	< 0.001			0.001	Pass	
Barium	mg/L	< 0.02			0.02	Pass	
Barium (filtered)	mg/L	< 0.02			0.02	Pass	
Beryllium	mg/L	< 0.001			0.001	Pass	
Beryllium (filtered)	mg/L	< 0.001			0.001	Pass	
Boron	mg/L	< 0.05			0.05	Pass	
Boron (filtered)	mg/L	< 0.05			0.05	Pass	
Cadmium	mg/L	< 0.0002			0.0002	Pass	
Cadmium (filtered)	mg/L	< 0.0002			0.0002	Pass	
Chromium	mg/L	< 0.001			0.001	Pass	
Chromium (filtered)	mg/L	< 0.001			0.001	Pass	
Cobalt	mg/L	< 0.001			0.001	Pass	
Cobalt (filtered)	mg/L	< 0.001			0.001	Pass	
Copper	mg/L	< 0.001			0.001	Pass	
Copper (filtered)	mg/L	< 0.001			0.001	Pass	
Iron	mg/L	< 0.05			0.05	Pass	
Iron (filtered)	mg/L	< 0.05			0.05	Pass	
Lead	mg/L	< 0.001			0.001	Pass	
Lead (filtered)	mg/L	< 0.001			0.001	Pass	
Manganese	mg/L	< 0.005			0.005	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Manganese (filtered)	mg/L	< 0.005			0.005	Pass	
Mercury	mg/L	< 0.0001			0.0001	Pass	
Mercury (filtered)	mg/L	< 0.0001			0.0001	Pass	
Molybdenum	mg/L	< 0.005			0.005	Pass	
Molybdenum (filtered)	mg/L	< 0.005			0.005	Pass	
Nickel	mg/L	< 0.001			0.001	Pass	
Nickel (filtered)	mg/L	< 0.001			0.001	Pass	
Selenium	mg/L	< 0.001			0.001	Pass	
Selenium (filtered)	mg/L	< 0.001			0.001	Pass	
Uranium	mg/L	< 0.005			0.005	Pass	
Uranium (filtered)	mg/L	< 0.005			0.005	Pass	
Vanadium	mg/L	< 0.005			0.005	Pass	
Vanadium (filtered)	mg/L	< 0.005			0.005	Pass	
Zinc	mg/L	< 0.005			0.005	Pass	
Zinc (filtered)	mg/L	< 0.005			0.005	Pass	
Method Blank							
Eurofins | mgt Suite B11C: Na/K/Ca/Mg							
Calcium	mg/L	< 0.5			0.5	Pass	
Magnesium	mg/L	< 0.5			0.5	Pass	
Potassium	mg/L	< 0.5			0.5	Pass	
Sodium	mg/L	< 0.5			0.5	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	%	113			70-130	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
TRH C6-C10	%	117			70-130	Pass	
LCS - % Recovery							
TRH - 2013 NEPM Fractions (after silica gel clean-up)							
TRH >C10-C16 (after silica gel clean-up)	%	101			70-130	Pass	
LCS - % Recovery							
TRH - 1999 NEPM Fractions (after silica gel clean-up)							
TRH C10-C14 (after silica gel clean-up)	%	96			70-130	Pass	
LCS - % Recovery							
Chloride	%	104			70-130	Pass	
Fluoride	%	100			70-130	Pass	
Sulphate (as SO4)	%	107			70-130	Pass	
Total Dissolved Solids	%	101			70-130	Pass	
LCS - % Recovery							
Alkalinity (speciated)							
Carbonate Alkalinity (as CaCO3)	%	81			70-130	Pass	
Total Alkalinity (as CaCO3)	%	89			70-130	Pass	
LCS - % Recovery							
Heavy Metals							
Aluminium	%	94			80-120	Pass	
Aluminium (filtered)	%	94			80-120	Pass	
Arsenic	%	110			80-120	Pass	
Arsenic (filtered)	%	89			80-120	Pass	
Barium	%	114			80-120	Pass	
Beryllium	%	80			80-120	Pass	
Boron	%	95			80-120	Pass	
Boron (filtered)	%	103			80-120	Pass	
Cadmium	%	102			80-120	Pass	
Cadmium (filtered)	%	87			80-120	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Chromium			%	101			80-120	Pass	
Chromium (filtered)			%	88			80-120	Pass	
Cobalt			%	108			80-120	Pass	
Cobalt (filtered)			%	89			80-120	Pass	
Copper			%	103			80-120	Pass	
Copper (filtered)			%	88			80-120	Pass	
Iron			%	101			80-120	Pass	
Iron (filtered)			%	91			80-120	Pass	
Lead			%	114			80-120	Pass	
Lead (filtered)			%	90			80-120	Pass	
Manganese			%	102			80-120	Pass	
Manganese (filtered)			%	91			80-120	Pass	
Mercury			%	99			75-125	Pass	
Mercury (filtered)			%	85			70-130	Pass	
Molybdenum			%	106			80-120	Pass	
Molybdenum (filtered)			%	86			80-120	Pass	
Nickel			%	104			80-120	Pass	
Nickel (filtered)			%	89			80-120	Pass	
Selenium			%	99			80-120	Pass	
Selenium (filtered)			%	88			80-120	Pass	
Uranium			%	111			80-120	Pass	
Uranium (filtered)			%	111			70-130	Pass	
Vanadium			%	105			80-120	Pass	
Zinc			%	106			80-120	Pass	
Zinc (filtered)			%	90			80-120	Pass	
LCS - % Recovery									
Eurofins | mgt Suite B11C: Na/K/Ca/Mg									
Calcium			%	114			70-130	Pass	
Magnesium			%	110			70-130	Pass	
Potassium			%	97			70-130	Pass	
Sodium			%	106			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
				Result 1					
Chloride	S18-Ma34608	NCP	%	81			70-130	Pass	
Sulphate (as SO4)	M18-Ma34635	NCP	%	101			70-130	Pass	
Spike - % Recovery									
Alkalinity (speciated)				Result 1					
Total Alkalinity (as CaCO3)	M18-Ma34928	NCP	%	93			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Aluminium	B18-Ma32960	CP	%	93			75-125	Pass	
Aluminium (filtered)	B18-Ma32960	CP	%	120			75-125	Pass	
Arsenic	B18-Ma32960	CP	%	103			75-125	Pass	
Arsenic (filtered)	B18-Ma32960	CP	%	129			70-130	Pass	
Barium	B18-Ma32960	CP	%	113			75-125	Pass	
Beryllium	B18-Ma32960	CP	%	76			75-125	Pass	
Beryllium (filtered)	B18-Ma32960	CP	%	104			75-125	Pass	
Boron	B18-Ma32960	CP	%	82			75-125	Pass	
Boron (filtered)	B18-Ma32960	CP	%	103			75-125	Pass	
Cadmium	B18-Ma32960	CP	%	95			75-125	Pass	
Cadmium (filtered)	B18-Ma32960	CP	%	124			70-130	Pass	
Chromium	B18-Ma32960	CP	%	107			75-125	Pass	
Chromium (filtered)	B18-Ma32960	CP	%	126			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Cobalt	B18-Ma32960	CP	%	100			75-125	Pass	
Cobalt (filtered)	B18-Ma32960	CP	%	130			75-125	Fail	Q08
Copper	B18-Ma32960	CP	%	94			75-125	Pass	
Copper (filtered)	B18-Ma32960	CP	%	123			70-130	Pass	
Iron	B18-Ma32960	CP	%	100			75-125	Pass	
Iron (filtered)	B18-Ma32960	CP	%	122			70-130	Pass	
Lead	B18-Ma32960	CP	%	106			75-125	Pass	
Manganese	B18-Ma32960	CP	%	97			75-125	Pass	
Manganese (filtered)	B18-Ma32960	CP	%	126			70-130	Pass	
Mercury	B18-Ma32960	CP	%	95			70-130	Pass	
Mercury (filtered)	B18-Ma32960	CP	%	113			70-130	Pass	
Molybdenum	B18-Ma32960	CP	%	100			75-125	Pass	
Molybdenum (filtered)	B18-Ma32960	CP	%	117			75-125	Pass	
Nickel	B18-Ma32960	CP	%	99			75-125	Pass	
Nickel (filtered)	B18-Ma32960	CP	%	124			70-130	Pass	
Selenium	B18-Ma32960	CP	%	93			75-125	Pass	
Selenium (filtered)	B18-Ma32960	CP	%	124			70-130	Pass	
Uranium	B18-Ma32960	CP	%	104			75-125	Pass	
Vanadium	B18-Ma32960	CP	%	101			75-125	Pass	
Zinc (filtered)	B18-Ma32960	CP	%	138			70-130	Fail	Q08
Spike - % Recovery									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1					
TRH C6-C9	B18-Ma32964	CP	%	102			70-130	Pass	
Spike - % Recovery									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1					
TRH C6-C10	B18-Ma32964	CP	%	99			70-130	Pass	
Spike - % Recovery									
TRH - 2013 NEPM Fractions (after silica gel clean-up)				Result 1					
TRH >C10-C16 (after silica gel clean-up)	B18-Ma32964	CP	%	121			70-130	Pass	
Spike - % Recovery									
TRH - 1999 NEPM Fractions (after silica gel clean-up)				Result 1					
TRH C10-C14 (after silica gel clean-up)	B18-Ma32964	CP	%	130			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Aluminium	B18-Ma32969	CP	%	90			75-125	Pass	
Aluminium (filtered)	B18-Ma32969	CP	%	91			75-125	Pass	
Arsenic	B18-Ma32969	CP	%	99			75-125	Pass	
Arsenic (filtered)	B18-Ma32969	CP	%	104			70-130	Pass	
Beryllium	B18-Ma32969	CP	%	72			75-125	Fail	Q08
Beryllium (filtered)	B18-Ma32969	CP	%	73			75-125	Fail	Q08
Boron	B18-Ma32969	CP	%	85			75-125	Pass	
Boron (filtered)	B18-Ma32969	CP	%	96			75-125	Pass	
Cadmium	B18-Ma32969	CP	%	78			75-125	Pass	
Cadmium (filtered)	B18-Ma32969	CP	%	81			70-130	Pass	
Chromium	B18-Ma32969	CP	%	86			75-125	Pass	
Chromium (filtered)	B18-Ma32969	CP	%	87			70-130	Pass	
Cobalt	B18-Ma32969	CP	%	91			75-125	Pass	
Cobalt (filtered)	B18-Ma32969	CP	%	97			75-125	Pass	
Copper	B18-Ma32969	CP	%	82			75-125	Pass	
Copper (filtered)	B18-Ma32969	CP	%	87			70-130	Pass	
Iron	B18-Ma32969	CP	%	99			75-125	Pass	
Iron (filtered)	B18-Ma32969	CP	%	112			70-130	Pass	
Lead	B18-Ma32969	CP	%	94			75-125	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Lead (filtered)	B18-Ma32969	CP	%	92			70-130	Pass	
Mercury	B18-Ma32969	CP	%	89			70-130	Pass	
Mercury (filtered)	B18-Ma32969	CP	%	106			70-130	Pass	
Molybdenum	B18-Ma32969	CP	%	91			75-125	Pass	
Molybdenum (filtered)	B18-Ma32969	CP	%	89			75-125	Pass	
Nickel	B18-Ma32969	CP	%	86			75-125	Pass	
Nickel (filtered)	B18-Ma32969	CP	%	89			70-130	Pass	
Selenium	B18-Ma32969	CP	%	86			75-125	Pass	
Selenium (filtered)	B18-Ma32969	CP	%	85			70-130	Pass	
Uranium	B18-Ma32969	CP	%	94			75-125	Pass	
Uranium (filtered)	B18-Ma32969	CP	%	93			70-130	Pass	
Vanadium	B18-Ma32969	CP	%	95			75-125	Pass	
Vanadium (filtered)	B18-Ma32969	CP	%	95			75-125	Pass	
Zinc	B18-Ma32969	CP	%	88			75-125	Pass	
Zinc (filtered)	B18-Ma32969	CP	%	108			70-130	Pass	
Spike - % Recovery									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1					
TRH C6-C9	B18-Ma32974	CP	%	116			70-130	Pass	
Spike - % Recovery									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1					
TRH C6-C10	B18-Ma32974	CP	%	115			70-130	Pass	
Spike - % Recovery									
Alkalinity (speciated)				Result 1					
Bicarbonate Alkalinity (as CaCO3)	M18-Ap08148	NCP	%	80			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
				Result 1	Result 2	RPD			
Conductivity (at 25°C)	B18-Ma32960	CP	uS/cm	410	410	<1	30%	Pass	
pH (at 25°C)	B18-Ma32960	CP	pH Units	7.8	7.9	pass	30%	Pass	
Duplicate									
Alkalinity (speciated)				Result 1	Result 2	RPD			
Bicarbonate Alkalinity (as CaCO3)	B18-Ma32960	CP	mg/L	190	190	1.0	30%	Pass	
Carbonate Alkalinity (as CaCO3)	B18-Ma32960	CP	mg/L	< 10	< 10	<1	30%	Pass	
Hydroxide Alkalinity (as CaCO3)	B18-Ma32960	CP	mg/L	< 20	< 20	<1	30%	Pass	
Total Alkalinity (as CaCO3)	B18-Ma32960	CP	mg/L	190	190	1.0	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Aluminium	B18-Ma32960	CP	mg/L	0.51	0.53	4.0	30%	Pass	
Aluminium (filtered)	B18-Ma32960	CP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Arsenic	B18-Ma32960	CP	mg/L	0.002	0.003	26	30%	Pass	
Arsenic (filtered)	B18-Ma32960	CP	mg/L	0.002	0.002	18	30%	Pass	
Barium	B18-Ma32960	CP	mg/L	0.18	0.18	<1	30%	Pass	
Barium (filtered)	B18-Ma32960	CP	mg/L	0.17	0.18	6.0	30%	Pass	
Beryllium	B18-Ma32960	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Beryllium (filtered)	B18-Ma32960	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Boron	B18-Ma32960	CP	mg/L	0.07	0.07	3.0	30%	Pass	
Boron (filtered)	B18-Ma32960	CP	mg/L	0.06	0.06	1.0	30%	Pass	
Cadmium	B18-Ma32960	CP	mg/L	< 0.0002	< 0.0002	<1	30%	Pass	
Cadmium (filtered)	B18-Ma32960	CP	mg/L	< 0.0002	< 0.0002	<1	30%	Pass	
Chromium	B18-Ma32960	CP	mg/L	0.006	0.006	<1	30%	Pass	
Chromium (filtered)	B18-Ma32960	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Cobalt	B18-Ma32960	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Cobalt (filtered)	B18-Ma32960	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Copper	B18-Ma32960	CP	mg/L	0.003	0.003	3.0	30%	Pass	

Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Copper (filtered)	B18-Ma32960	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Iron	B18-Ma32960	CP	mg/L	0.65	0.72	10	30%	Pass	
Iron (filtered)	B18-Ma32960	CP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Lead	B18-Ma32960	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Lead (filtered)	B18-Ma32960	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Manganese	B18-Ma32960	CP	mg/L	0.027	0.028	4.0	30%	Pass	
Manganese (filtered)	B18-Ma32960	CP	mg/L	0.010	0.010	2.0	30%	Pass	
Mercury	B18-Ma32960	CP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Mercury (filtered)	B18-Ma32960	CP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Molybdenum	B18-Ma32960	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Molybdenum (filtered)	B18-Ma32960	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Nickel	B18-Ma32960	CP	mg/L	0.003	0.003	<1	30%	Pass	
Nickel (filtered)	B18-Ma32960	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Selenium	B18-Ma32960	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Selenium (filtered)	B18-Ma32960	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Uranium	B18-Ma32960	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Uranium (filtered)	B18-Ma32960	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Vanadium	B18-Ma32960	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Vanadium (filtered)	B18-Ma32960	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Zinc	B18-Ma32960	CP	mg/L	0.069	0.069	<1	30%	Pass	
Zinc (filtered)	B18-Ma32960	CP	mg/L	0.008	0.012	42	30%	Fail	
Duplicate									
Eurofins | mgt Suite B11C: Na/K/Ca/Mg				Result 1	Result 2	RPD			
Calcium	B18-Ma32960	CP	mg/L	43	42	1.0	30%	Pass	
Magnesium	B18-Ma32960	CP	mg/L	16	16	1.0	30%	Pass	
Potassium	B18-Ma32960	CP	mg/L	2.8	2.9	3.0	30%	Pass	
Sodium	B18-Ma32960	CP	mg/L	33	33	1.0	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1	Result 2	RPD			
TRH C6-C9	B18-Ma32963	CP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1	Result 2	RPD			
TRH C6-C10	B18-Ma32963	CP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Chloride	B18-Ma32963	CP	mg/L	11000	11000	4.0	30%	Pass	
Sulphate (as SO4)	B18-Ma32963	CP	mg/L	1500	1600	1.0	30%	Pass	
Total Dissolved Solids	B18-Ma32963	CP	mg/L	34000	36000	6.0	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Conductivity (at 25°C)	B18-Ma32967	CP	uS/cm	350	350	1.0	30%	Pass	
pH (at 25°C)	B18-Ma32967	CP	pH Units	7.4	7.4	pass	30%	Pass	
Duplicate									
Alkalinity (speciated)				Result 1	Result 2	RPD			
Bicarbonate Alkalinity (as CaCO3)	B18-Ma32967	CP	mg/L	170	160	7.0	30%	Pass	
Carbonate Alkalinity (as CaCO3)	B18-Ma32967	CP	mg/L	< 10	< 10	<1	30%	Pass	
Hydroxide Alkalinity (as CaCO3)	B18-Ma32967	CP	mg/L	< 20	< 20	<1	30%	Pass	
Total Alkalinity (as CaCO3)	B18-Ma32967	CP	mg/L	170	160	7.0	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Conductivity (at 25°C)	B18-Ma32968	CP	uS/cm	290	290	<1	30%	Pass	
pH (at 25°C)	B18-Ma32968	CP	pH Units	7.7	7.7	pass	30%	Pass	

Duplicate									
Alkalinity (speciated)				Result 1	Result 2	RPD			
Bicarbonate Alkalinity (as CaCO3)	B18-Ma32968	CP	mg/L	110	110	<1	30%	Pass	
Carbonate Alkalinity (as CaCO3)	B18-Ma32968	CP	mg/L	< 10	< 10	<1	30%	Pass	
Hydroxide Alkalinity (as CaCO3)	B18-Ma32968	CP	mg/L	< 20	< 20	<1	30%	Pass	
Total Alkalinity (as CaCO3)	B18-Ma32968	CP	mg/L	110	110	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Aluminium	B18-Ma32969	CP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Aluminium (filtered)	B18-Ma32969	CP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Arsenic	B18-Ma32969	CP	mg/L	0.016	0.016	1.0	30%	Pass	
Arsenic (filtered)	B18-Ma32969	CP	mg/L	0.013	0.014	6.0	30%	Pass	
Barium	B18-Ma32969	CP	mg/L	19	20	2.0	30%	Pass	
Barium (filtered)	B18-Ma32969	CP	mg/L	19	19	1.0	30%	Pass	
Beryllium	B18-Ma32969	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Beryllium (filtered)	B18-Ma32969	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Boron	B18-Ma32969	CP	mg/L	0.12	0.11	4.0	30%	Pass	
Boron (filtered)	B18-Ma32969	CP	mg/L	0.11	0.11	3.0	30%	Pass	
Cadmium	B18-Ma32969	CP	mg/L	< 0.0002	< 0.0002	<1	30%	Pass	
Cadmium (filtered)	B18-Ma32969	CP	mg/L	< 0.0002	< 0.0002	<1	30%	Pass	
Chromium	B18-Ma32969	CP	mg/L	0.003	0.002	42	30%	Fail	Q15
Chromium (filtered)	B18-Ma32969	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Cobalt	B18-Ma32969	CP	mg/L	0.001	0.001	<1	30%	Pass	
Cobalt (filtered)	B18-Ma32969	CP	mg/L	0.001	0.001	6.0	30%	Pass	
Copper	B18-Ma32969	CP	mg/L	0.001	0.001	11	30%	Pass	
Copper (filtered)	B18-Ma32969	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Iron	B18-Ma32969	CP	mg/L	1.6	1.6	1.0	30%	Pass	
Iron (filtered)	B18-Ma32969	CP	mg/L	1.5	1.6	7.0	30%	Pass	
Lead	B18-Ma32969	CP	mg/L	< 0.001	0.001	10	30%	Pass	
Lead (filtered)	B18-Ma32969	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Manganese	B18-Ma32969	CP	mg/L	1.7	1.7	3.0	30%	Pass	
Manganese (filtered)	B18-Ma32969	CP	mg/L	1.7	1.9	9.0	30%	Pass	
Mercury	B18-Ma32969	CP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Mercury (filtered)	B18-Ma32969	CP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Molybdenum	B18-Ma32969	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Molybdenum (filtered)	B18-Ma32969	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Nickel	B18-Ma32969	CP	mg/L	0.002	0.002	10	30%	Pass	
Nickel (filtered)	B18-Ma32969	CP	mg/L	0.002	0.002	25	30%	Pass	
Selenium	B18-Ma32969	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Selenium (filtered)	B18-Ma32969	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Uranium	B18-Ma32969	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Uranium (filtered)	B18-Ma32969	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Vanadium	B18-Ma32969	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Vanadium (filtered)	B18-Ma32969	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Zinc	B18-Ma32969	CP	mg/L	0.19	0.19	<1	30%	Pass	
Zinc (filtered)	B18-Ma32969	CP	mg/L	0.045	0.045	<1	30%	Pass	
Duplicate									
Eurofins | mgt Suite B11C: Na/K/Ca/Mg				Result 1	Result 2	RPD			
Calcium	B18-Ma32970	CP	mg/L	1700	1600	4.0	30%	Pass	
Magnesium	B18-Ma32970	CP	mg/L	1400	1400	4.0	30%	Pass	
Potassium	B18-Ma32970	CP	mg/L	31	30	4.0	30%	Pass	
Sodium	B18-Ma32970	CP	mg/L	4300	4100	3.0	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Chloride	B18-Ma32973	CP	mg/L	8400	8500	1.0	30%	Pass	
Sulphate (as SO4)	B18-Ma32973	CP	mg/L	1600	1700	3.0	30%	Pass	

Duplicate									
TRH - 2013 NEPM Fractions (after silica gel clean-up)				Result 1	Result 2	RPD			
TRH >C10-C16 (after silica gel clean-up)	M18-Ma35830	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
TRH >C16-C34 (after silica gel clean-up)	M18-Ma35830	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
TRH >C34-C40 (after silica gel clean-up)	M18-Ma35830	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
Duplicate									
TRH - 1999 NEPM Fractions (after silica gel clean-up)				Result 1	Result 2	RPD			
TRH C10-C36 (Total) (after silica gel clean-up)	M18-Ma35830	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
TRH C10-C14 (after silica gel clean-up)	M18-Ma35830	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
TRH C15-C28 (after silica gel clean-up)	M18-Ma35830	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
TRH C29-C36 (after silica gel clean-up)	M18-Ma35830	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Fluoride	B18-Ma32975	CP	mg/L	< 0.5	< 0.5	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Total Dissolved Solids	B18-Ma32976	CP	mg/L	14000	11000	25	30%	Pass	

Comments

Sample Integrity

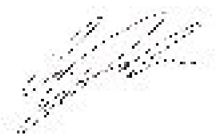
Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	No
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
Q08	The matrix spike recovery is outside of the recommended acceptance criteria. An acceptable recovery was obtained for the laboratory control sample indicating a sample matrix interference
Q15	The RPD reported passes Eurofins | mgt's QC - Acceptance Criteria as defined in the Internal Quality Control Review and Glossary page of this report.

Authorised By

Ryan Gilbert	Analytical Services Manager
Alex Petridis	Senior Analyst-Metal (VIC)
Harry Bacallis	Senior Analyst-Volatile (VIC)
Joseph Edouard	Senior Analyst-Organic (VIC)
Michael Brancati	Senior Analyst-Inorganic (VIC)



Glenn Jackson
National Operations Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

Certificate of Analysis

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

SLR CONSULTING
Level 2 15 Astor Terrace
Spring Hill
QLD 4000

Attention: **Tony Johnson**

Report **592785-W**
Project name BARALABA
Project ID 620.11731.40000
Received Date Apr 06, 2018

Client Sample ID			**A-PB1_0**	**A-PB1_6**	**A-PB1_20**	**A-PB1_24**
Sample Matrix			**Water**	**Water**	**Water**	**Water**
Eurofins | mgt Sample No.			**M18-Ap06012**	**M18-Ap06013**	**M18-Ap06014**	**M18-Ap06015**
Date Sampled			**Mar 27, 2018**	**Mar 27, 2018**	**Mar 28, 2018**	**Mar 28, 2018**
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
Naphthalene[N02]	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
TRH C6-C10	0.02	mg/L	0.10	0.02	< 0.02	< 0.02
Total Recoverable Hydrocarbons						
TRH C6-C9	0.02	mg/L	0.09	< 0.02	< 0.02	< 0.02
TRH - 2013 NEPM Fractions (after silica gel clean-up)						
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH - 1999 NEPM Fractions (after silica gel clean-up)						
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Chloride	1	mg/L	94	94	90	90
Conductivity (at 25°C)	1	uS/cm	490	470	470	480
Fluoride	0.5	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
pH (at 25°C)	0.1	pH Units	7.3	7.3	7.4	7.4
Sulphate (as SO4)	5	mg/L	< 5	6.2	5.2	5.3
Total Dissolved Solids	10	mg/L	300	350	340	290
Alkalinity (speciated)						
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	180	170	170	170
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	20	mg/L	< 20	< 20	< 20	< 20
Total Alkalinity (as CaCO3)	20	mg/L	180	170	170	170
Heavy Metals						
Aluminium	0.05	mg/L	2.0	1.9	0.37	< 0.05
Aluminium (filtered)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic	0.001	mg/L	0.002	0.002	< 0.001	< 0.001
Arsenic (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Barium	0.02	mg/L	0.13	0.14	0.12	0.12
Barium (filtered)	0.02	mg/L	0.12	0.12	0.12	0.10
Beryllium	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Beryllium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Boron	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05

Client Sample ID			A-PB1_0	A-PB1_6	A-PB1_20	A-PB1_24
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			M18-Ap06012	M18-Ap06013	M18-Ap06014	M18-Ap06015
Date Sampled			Mar 27, 2018	Mar 27, 2018	Mar 28, 2018	Mar 28, 2018
Test/Reference	LOR	Unit				
Heavy Metals						
Boron (filtered)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium (filtered)	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	0.011	0.009	0.002	< 0.001
Chromium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Cobalt	0.001	mg/L	0.007	0.007	0.002	< 0.001
Cobalt (filtered)	0.001	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	0.001	mg/L	0.015	0.007	0.004	< 0.001
Copper (filtered)	0.001	mg/L	0.002	0.001	0.001	< 0.001
Iron	0.05	mg/L	5.3	4.6	1.3	0.43
Iron (filtered)	0.05	mg/L	1.2	0.53	0.55	< 0.05
Lead	0.001	mg/L	0.006	0.003	0.001	< 0.001
Lead (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	0.093	0.074	0.019	0.009
Manganese (filtered)	0.005	mg/L	0.034	0.011	0.007	0.008
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Molybdenum (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Nickel	0.001	mg/L	0.010	0.008	0.003	0.001
Nickel (filtered)	0.001	mg/L	0.003	0.002	0.001	< 0.001
Selenium	0.001	mg/L	< 0.001	0.002	< 0.001	< 0.001
Selenium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Uranium	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Uranium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Vanadium	0.005	mg/L	0.008	0.009	< 0.005	< 0.005
Vanadium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Zinc	0.005	mg/L	2.9	1.2	1.1	0.95
Zinc (filtered)	0.005	mg/L	2.5	0.95	1.1	0.092
Alkali Metals						
Calcium	0.5	mg/L	19	21	20	19
Magnesium	0.5	mg/L	9.6	9.6	9.8	9.7
Potassium	0.5	mg/L	3.7	3.7	3.7	3.8
Sodium	0.5	mg/L	85	93	90	91

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Total Recoverable Hydrocarbons - 2013 NEPM Fractions	Melbourne	Apr 09, 2018	7 Day
- Method: TRH C6-C40 - LTM-ORG-2010			
Total Recoverable Hydrocarbons	Melbourne	Apr 09, 2018	7 Day
- Method: TRH C6-C40 - LTM-ORG-2010			
TRH - 2013 NEPM Fractions (after silica gel clean-up)	Melbourne	Apr 11, 2018	7 Day
- Method: LM-LTM-ORG2010			
TRH - 1999 NEPM Fractions (after silica gel clean-up)	Melbourne	Apr 11, 2018	7 Day
- Method: TRH C6-C36 (Silica Gel Cleanup) - MGT 100A			
Eurofins | mgt Suite B11F: Cl/SO4/Alkalinity/Total F			
Chloride	Melbourne	Apr 09, 2018	28 Day
- Method: LTM-INO-4090 Chloride by Discrete Analyser			
Fluoride	Melbourne	Apr 09, 2018	28 Day
- Method: APHA-F-C			
Sulphate (as SO4)	Melbourne	Apr 09, 2018	28 Day
- Method: LTM-INO-4110 Sulfate by Discrete Analyser			
Alkalinity (speciated)	Melbourne	Apr 09, 2018	14 Day
- Method: APHA 2320 Alkalinity by Titration			
Conductivity (at 25°C)	Melbourne	Apr 09, 2018	28 Day
- Method: LTM-INO-4030 Conductivity			
pH (at 25°C)	Melbourne	Apr 09, 2018	0 Hours
- Method: LTM-GEN-7090 pH in water by ISE			
Total Dissolved Solids	Melbourne	Apr 09, 2018	7 Day
- Method: LTM-INO-4170 Total Dissolved Solids in Water			
Heavy Metals	Melbourne	Apr 09, 2018	180 Day
- Method: LTM-MET-3040 Metals in Waters by ICP-MS			
Heavy Metals (filtered)	Melbourne	Apr 09, 2018	180 Day
- Method: LTM-MET-3040 Metals in Waters by ICP-MS			
Mercury	Melbourne	Apr 09, 2018	28 Day
- Method: USEPA 7470/1 Mercury			
Mercury (filtered)	Melbourne	Apr 09, 2018	28 Day
- Method: USEPA 7470/1 Mercury			
Eurofins | mgt Suite B11C: Na/K/Ca/Mg	Melbourne	Apr 09, 2018	180 Day
- Method: LTM-MET-3010 Alkali Metals by ICP-AES			

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NATA # 1261
Site # 23736

Company Name: SLR Consulting (Qld)
Address: Level 2 15 Astor Terrace
Spring Hill
QLD 4000

Project Name: BARALABA
Project ID: 620.11731.40000

Order No.:
Report #: 592785
Phone: 07 3858 4800
Fax:

Received: Apr 6, 2018 10:47 AM
Due: Apr 13, 2018
Priority: 5 Day
Contact Name: Tony Johnson

Eurofins | mgt Analytical Services Manager : Ryan Gilbert

Sample Detail						Aluminium	Aluminium (filtered)	Arsenic	Arsenic (filtered)	Barium	Barium (filtered)	Beryllium	Beryllium (filtered)	Boron	Boron (filtered)	Cadmium	Cadmium (filtered)	Chromium	Chromium (filtered)	Cobalt	Cobalt (filtered)	Conductivity (at 25°C)	Copper	Copper (filtered)	Iron	Iron (filtered)	Lead	Lead (filtered)	Manganese	Manganese (filtered)	Mercury	Mercury (filtered)	Molybdenum	Molybdenum (filtered)	Nickel	Nickel (filtered)	pH (at 25°C)	Selenium	Selenium (filtered)	Total Dissolved Solids	Uranium	Uranium (filtered)	Vanadium	Vanadium (filtered)	Zinc	Zinc (filtered)	TRH (after Silica Gel cleanup)	Total Recoverable Hydrocarbons	Eurofins | mgt Suite B11F:	Eurofins | mgt Suite B11C: Na/K/Ca/Mg
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																																																		
Brisbane Laboratory - NATA Site # 20794																																																		
Perth Laboratory - NATA Site # 23736																																																		
External Laboratory																																																		
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**																																													
1	A-PB1_0	Mar 27, 2018		Water	M18-Ap06012	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2	A-PB1_6	Mar 27, 2018		Water	M18-Ap06013	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3	A-PB1_20	Mar 28, 2018		Water	M18-Ap06014	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4	A-PB1_24	Mar 28, 2018		Water	M18-Ap06015	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Test Counts						4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram	**mg/L:** milligrams per litre	**ug/L:** micrograms per litre
ppm: Parts per million	**ppb:** Parts per billion	**%:** Percentage
org/100mL: Organisms per 100 millilitres	**NTU:** Nephelometric Turbidity Units	**MPN/100mL:** Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	Quality Systems Manual ver 5.1 US Department of Defense
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 50-150%-Phenols & PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.1 where no positive PFAS results have been reported have been reviewed and no data was affected.

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
Naphthalene	mg/L	< 0.01			0.01	Pass	
TRH C6-C10	mg/L	< 0.02			0.02	Pass	
Method Blank							
Total Recoverable Hydrocarbons							
TRH C6-C9	mg/L	< 0.02			0.02	Pass	
Method Blank							
TRH - 2013 NEPM Fractions (after silica gel clean-up)							
TRH >C10-C16 (after silica gel clean-up)	mg/L	< 0.05			0.05	Pass	
TRH >C16-C34 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
TRH >C34-C40 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
Method Blank							
TRH - 1999 NEPM Fractions (after silica gel clean-up)							
TRH C10-C14 (after silica gel clean-up)	mg/L	< 0.05			0.05	Pass	
TRH C15-C28 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
TRH C29-C36 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
Method Blank							
Chloride	mg/L	< 1			1	Pass	
Fluoride	mg/L	< 0.5			0.5	Pass	
Sulphate (as SO4)	mg/L	< 5			5	Pass	
Total Dissolved Solids	mg/L	< 10			10	Pass	
Method Blank							
Alkalinity (speciated)							
Bicarbonate Alkalinity (as CaCO3)	mg/L	< 20			20	Pass	
Carbonate Alkalinity (as CaCO3)	mg/L	< 10			10	Pass	
Hydroxide Alkalinity (as CaCO3)	mg/L	< 20			20	Pass	
Total Alkalinity (as CaCO3)	mg/L	< 20			20	Pass	
Method Blank							
Heavy Metals							
Aluminium	mg/L	< 0.05			0.05	Pass	
Aluminium (filtered)	mg/L	< 0.05			0.05	Pass	
Arsenic	mg/L	< 0.001			0.001	Pass	
Arsenic (filtered)	mg/L	< 0.001			0.001	Pass	
Barium	mg/L	< 0.02			0.02	Pass	
Barium (filtered)	mg/L	< 0.02			0.02	Pass	
Beryllium	mg/L	< 0.001			0.001	Pass	
Beryllium (filtered)	mg/L	< 0.001			0.001	Pass	
Boron	mg/L	< 0.05			0.05	Pass	
Boron (filtered)	mg/L	< 0.05			0.05	Pass	
Cadmium	mg/L	< 0.0002			0.0002	Pass	
Cadmium (filtered)	mg/L	< 0.0002			0.0002	Pass	
Chromium	mg/L	< 0.001			0.001	Pass	
Chromium (filtered)	mg/L	< 0.001			0.001	Pass	
Cobalt	mg/L	< 0.001			0.001	Pass	
Cobalt (filtered)	mg/L	< 0.001			0.001	Pass	
Copper	mg/L	< 0.001			0.001	Pass	
Copper (filtered)	mg/L	< 0.001			0.001	Pass	
Iron	mg/L	< 0.05			0.05	Pass	
Iron (filtered)	mg/L	< 0.05			0.05	Pass	
Lead	mg/L	< 0.001			0.001	Pass	
Lead (filtered)	mg/L	< 0.001			0.001	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Manganese	mg/L	< 0.005			0.005	Pass	
Manganese (filtered)	mg/L	< 0.005			0.005	Pass	
Mercury	mg/L	< 0.0001			0.0001	Pass	
Mercury (filtered)	mg/L	< 0.0001			0.0001	Pass	
Molybdenum	mg/L	< 0.005			0.005	Pass	
Molybdenum (filtered)	mg/L	< 0.005			0.005	Pass	
Nickel	mg/L	< 0.001			0.001	Pass	
Nickel (filtered)	mg/L	< 0.001			0.001	Pass	
Selenium	mg/L	< 0.001			0.001	Pass	
Selenium (filtered)	mg/L	< 0.001			0.001	Pass	
Uranium	mg/L	< 0.005			0.005	Pass	
Uranium (filtered)	mg/L	< 0.005			0.005	Pass	
Vanadium	mg/L	< 0.005			0.005	Pass	
Vanadium (filtered)	mg/L	< 0.005			0.005	Pass	
Zinc	mg/L	< 0.005			0.005	Pass	
Zinc (filtered)	mg/L	< 0.005			0.005	Pass	
Method Blank							
Alkali Metals							
Calcium	mg/L	< 0.5			0.5	Pass	
Magnesium	mg/L	< 0.5			0.5	Pass	
Potassium	mg/L	< 0.5			0.5	Pass	
Sodium	mg/L	< 0.5			0.5	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
Naphthalene	%	101			70-130	Pass	
TRH C6-C10	%	118			70-130	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons							
TRH C6-C9	%	122			70-130	Pass	
LCS - % Recovery							
TRH - 2013 NEPM Fractions (after silica gel clean-up)							
TRH >C10-C16 (after silica gel clean-up)	%	118			70-130	Pass	
LCS - % Recovery							
TRH - 1999 NEPM Fractions (after silica gel clean-up)							
TRH C10-C14 (after silica gel clean-up)	%	117			70-130	Pass	
LCS - % Recovery							
Chloride	%	106			70-130	Pass	
Fluoride	%	100			70-130	Pass	
Sulphate (as SO4)	%	105			70-130	Pass	
Total Dissolved Solids	%	99			70-130	Pass	
LCS - % Recovery							
Alkalinity (speciated)							
Bicarbonate Alkalinity (as CaCO3)	%	87			70-130	Pass	
Carbonate Alkalinity (as CaCO3)	%	88			70-130	Pass	
Total Alkalinity (as CaCO3)	%	93			70-130	Pass	
LCS - % Recovery							
Heavy Metals							
Aluminium	%	97			80-120	Pass	
Aluminium (filtered)	%	97			80-120	Pass	
Arsenic	%	98			80-120	Pass	
Arsenic (filtered)	%	98			80-120	Pass	
Barium	%	96			80-120	Pass	
Beryllium	%	97			80-120	Pass	
Boron	%	94			80-120	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Boron (filtered)	%	94			80-120	Pass	
Cadmium	%	96			80-120	Pass	
Cadmium (filtered)	%	96			80-120	Pass	
Chromium	%	94			80-120	Pass	
Chromium (filtered)	%	94			80-120	Pass	
Cobalt	%	94			80-120	Pass	
Cobalt (filtered)	%	94			80-120	Pass	
Copper	%	95			80-120	Pass	
Copper (filtered)	%	95			80-120	Pass	
Iron	%	95			80-120	Pass	
Iron (filtered)	%	95			80-120	Pass	
Lead	%	99			80-120	Pass	
Lead (filtered)	%	99			80-120	Pass	
Manganese	%	96			80-120	Pass	
Manganese (filtered)	%	96			80-120	Pass	
Mercury	%	91			75-125	Pass	
Mercury (filtered)	%	91			70-130	Pass	
Molybdenum	%	92			80-120	Pass	
Molybdenum (filtered)	%	92			80-120	Pass	
Nickel	%	95			80-120	Pass	
Nickel (filtered)	%	95			80-120	Pass	
Selenium	%	103			80-120	Pass	
Selenium (filtered)	%	103			80-120	Pass	
Uranium	%	99			80-120	Pass	
Uranium (filtered)	%	99			70-130	Pass	
Vanadium	%	96			80-120	Pass	
Zinc	%	99			80-120	Pass	
Zinc (filtered)	%	99			80-120	Pass	
LCS - % Recovery							
Alkali Metals							
Calcium	%	111			70-130	Pass	
Magnesium	%	112			70-130	Pass	
Potassium	%	103			70-130	Pass	
Sodium	%	111			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Spike - % Recovery									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1					
Naphthalene	M18-Ap06438	NCP	%	104			70-130	Pass	
TRH C6-C10	M18-Ap06438	NCP	%	109			70-130	Pass	
Spike - % Recovery									
Total Recoverable Hydrocarbons				Result 1					
TRH C6-C9	M18-Ap06438	NCP	%	115			70-130	Pass	
Spike - % Recovery									
				Result 1					
Chloride	M18-Ap04764	NCP	%	93			70-130	Pass	
Sulphate (as SO4)	P18-Ap03710	NCP	%	88			70-130	Pass	
Spike - % Recovery									
Alkalinity (speciated)				Result 1					
Total Alkalinity (as CaCO3)	M18-Ap04622	NCP	%	71			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Aluminium	M18-Ap06159	NCP	%	97			75-125	Pass	
Aluminium (filtered)	M18-Ap06012	CP	%	91			75-125	Pass	
Arsenic	P18-Ap03926	NCP	%	94			75-125	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Arsenic (filtered)	M18-Ap06012	CP	%	93			70-130	Pass	
Barium	M18-Ap06159	NCP	%	99			75-125	Pass	
Barium (filtered)	M18-Ap06012	CP	%	94			75-125	Pass	
Beryllium	M18-Ap06159	NCP	%	94			75-125	Pass	
Beryllium (filtered)	M18-Ap06012	CP	%	94			75-125	Pass	
Boron	M18-Ap06159	NCP	%	104			75-125	Pass	
Boron (filtered)	M18-Ap06012	CP	%	97			75-125	Pass	
Cadmium	P18-Ap03926	NCP	%	90			75-125	Pass	
Cadmium (filtered)	M18-Ap06012	CP	%	89			70-130	Pass	
Chromium	P18-Ap03926	NCP	%	118			75-125	Pass	
Chromium (filtered)	M18-Ap06012	CP	%	87			70-130	Pass	
Cobalt	M18-Ap06159	NCP	%	95			75-125	Pass	
Cobalt (filtered)	M18-Ap06012	CP	%	88			75-125	Pass	
Copper	P18-Ap03926	NCP	%	90			75-125	Pass	
Copper (filtered)	M18-Ap06012	CP	%	88			70-130	Pass	
Iron	M18-Ap06159	NCP	%	100			75-125	Pass	
Iron (filtered)	M18-Ap06012	CP	%	91			70-130	Pass	
Lead	P18-Ap03926	NCP	%	95			75-125	Pass	
Lead (filtered)	M18-Ap06012	CP	%	91			70-130	Pass	
Manganese	M18-Ap06159	NCP	%	95			75-125	Pass	
Manganese (filtered)	M18-Ap06012	CP	%	91			70-130	Pass	
Mercury	P18-Ap03926	NCP	%	86			70-130	Pass	
Mercury (filtered)	M18-Ap06012	CP	%	81			70-130	Pass	
Molybdenum	M18-Ap06159	NCP	%	96			75-125	Pass	
Molybdenum (filtered)	M18-Ap06012	CP	%	82			75-125	Pass	
Nickel	P18-Ap03926	NCP	%	98			75-125	Pass	
Nickel (filtered)	M18-Ap06012	CP	%	89			70-130	Pass	
Selenium	M18-Ap06159	NCP	%	105			75-125	Pass	
Selenium (filtered)	M18-Ap06012	CP	%	96			70-130	Pass	
Uranium	M18-Ap06159	NCP	%	100			75-125	Pass	
Uranium (filtered)	M18-Ap06012	CP	%	92			70-130	Pass	
Vanadium	M18-Ap06159	NCP	%	99			75-125	Pass	
Vanadium (filtered)	M18-Ap06012	CP	%	89			75-125	Pass	
Zinc (filtered)	M18-Ap05827	NCP	%	122			70-130	Pass	
Spike - % Recovery									
Alkali Metals				Result 1					
Calcium	M18-Ap08151	NCP	%	114			70-130	Pass	
Magnesium	M18-Ap08151	NCP	%	105			70-130	Pass	
Potassium	M18-Ap08151	NCP	%	103			70-130	Pass	
Sodium	M18-Ap08151	NCP	%	103			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
				Result 1	Result 2	RPD			
Chloride	M18-Ap06495	NCP	mg/L	1800	1900	2.0	30%	Pass	
Conductivity (at 25°C)	M18-Ap06419	NCP	uS/cm	1400	1300	3.0	30%	Pass	
Fluoride	M18-Ap04024	NCP	mg/L	< 0.5	< 0.5	<1	30%	Pass	
pH (at 25°C)	M18-Ap06419	NCP	pH Units	7.9	8.0	pass	30%	Pass	
Sulphate (as SO4)	M18-Ap06495	NCP	mg/L	500	520	5.0	30%	Pass	
Total Dissolved Solids	M18-Ap06422	NCP	mg/L	1100	1100	1.0	30%	Pass	
Duplicate									
Alkalinity (speciated)				Result 1	Result 2	RPD			
Bicarbonate Alkalinity (as CaCO3)	M18-Ap06419	NCP	mg/L	660	570	14	30%	Pass	
Carbonate Alkalinity (as CaCO3)	M18-Ap06419	NCP	mg/L	< 10	< 10	<1	30%	Pass	
Hydroxide Alkalinity (as CaCO3)	M18-Ap06419	NCP	mg/L	< 20	< 20	<1	30%	Pass	
Total Alkalinity (as CaCO3)	M18-Ap06419	NCP	mg/L	660	570	14	30%	Pass	

Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Aluminium	M18-Ap06159	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Aluminium (filtered)	M18-Ap06012	CP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Arsenic	P18-Ap03926	NCP	mg/L	0.005	0.005	4.0	30%	Pass	
Arsenic (filtered)	M18-Ap06012	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Barium	M18-Ap06159	NCP	mg/L	0.03	0.03	<1	30%	Pass	
Barium (filtered)	M18-Ap06012	CP	mg/L	0.12	0.12	3.0	30%	Pass	
Beryllium	M18-Ap06159	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Beryllium (filtered)	M18-Ap06012	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Boron	M18-Ap06159	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Boron (filtered)	M18-Ap06012	CP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Cadmium	P18-Ap03926	NCP	mg/L	< 0.0002	< 0.0002	<1	30%	Pass	
Cadmium (filtered)	M18-Ap06012	CP	mg/L	< 0.0002	< 0.0002	<1	30%	Pass	
Chromium	P18-Ap03926	NCP	mg/L	0.011	0.011	<1	30%	Pass	
Chromium (filtered)	M18-Ap06012	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Cobalt	M18-Ap06159	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Cobalt (filtered)	M18-Ap06012	CP	mg/L	0.001	< 0.001	8.0	30%	Pass	
Copper	P18-Ap03926	NCP	mg/L	0.010	0.010	3.0	30%	Pass	
Copper (filtered)	M18-Ap06012	CP	mg/L	0.002	0.002	1.0	30%	Pass	
Iron	M18-Ap06159	NCP	mg/L	0.08	0.07	8.0	30%	Pass	
Iron (filtered)	M18-Ap06012	CP	mg/L	1.2	1.2	2.0	30%	Pass	
Lead	P18-Ap03926	NCP	mg/L	0.003	0.003	3.0	30%	Pass	
Lead (filtered)	M18-Ap06012	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Manganese	M18-Ap06159	NCP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Manganese (filtered)	M18-Ap06012	CP	mg/L	0.034	0.034	1.0	30%	Pass	
Mercury	P18-Ap03926	NCP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Mercury (filtered)	M18-Ap06012	CP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Molybdenum	M18-Ap06159	NCP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Molybdenum (filtered)	M18-Ap06012	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Nickel	P18-Ap03926	NCP	mg/L	0.003	0.003	<1	30%	Pass	
Nickel (filtered)	M18-Ap06012	CP	mg/L	0.003	0.003	19	30%	Pass	
Selenium	M18-Ap06159	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Selenium (filtered)	M18-Ap06012	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Uranium	M18-Ap06159	NCP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Uranium (filtered)	M18-Ap06012	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Vanadium	M18-Ap06159	NCP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Vanadium (filtered)	M18-Ap06012	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Zinc	P18-Ap03926	NCP	mg/L	0.047	0.047	<1	30%	Pass	
Zinc (filtered)	M18-Ap06012	CP	mg/L	2.5	2.5	1.0	30%	Pass	
Duplicate									
Alkali Metals				Result 1	Result 2	RPD			
Calcium	M18-Ap08151	NCP	mg/L	6.3	6.4	1.0	30%	Pass	
Magnesium	M18-Ap08151	NCP	mg/L	3.0	3.0	1.0	30%	Pass	
Potassium	M18-Ap08151	NCP	mg/L	7.5	7.6	2.0	30%	Pass	
Sodium	M18-Ap08151	NCP	mg/L	7.4	7.5	1.0	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	No
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
N02	Where we have reported both volatile (P&T GCMS) and semivolatile (GCMS) naphthalene data, results may not be identical. Provided correct sample handling protocols have been followed, any observed differences in results are likely to be due to procedural differences within each methodology. Results determined by both techniques have passed all QAQC acceptance criteria, and are entirely technically valid.

Authorised By

Ryan Gilbert	Analytical Services Manager
Alex Petridis	Senior Analyst-Metal (VIC)
Harry Bacallis	Senior Analyst-Volatile (VIC)
Joseph Edouard	Senior Analyst-Organic (VIC)
Michael Brancati	Senior Analyst-Inorganic (VIC)

Glenn Jackson

National Operations Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

Certificate of Analysis

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

SLR CONSULTING
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Attention: **Tony Johnson**

Report **604676-W**
Project name BARALABA
Project ID 620.11731.20000.0032
Received Date Jun 25, 2018

Client Sample ID **Sample Matrix** **Eurofins | mgt Sample No.** **Date Sampled** Test/Reference	LOR	Unit	**A-0B7** **Water** **M18-Jn29471** **Jun 19, 2018**	**A-0B8** **Water** **M18-Jn29472** **Jun 19, 2018**	**A-0B10** **Water** **M18-Jn29473** **Jun 20, 2018**	**P-0B2** **Water** **M18-Jn29474** **Jun 20, 2018**
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	0.02	mg/L	R18< 0.04	< 0.02	< 0.02	< 0.02
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
TRH C6-C10	0.02	mg/L	R18< 0.04	< 0.02	< 0.02	< 0.02
TRH - 2013 NEPM Fractions (after silica gel clean-up)						
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH - 1999 NEPM Fractions (after silica gel clean-up)						
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Chloride	1	mg/L	5300	7500	14000	5400
Conductivity (at 25°C)	1	uS/cm	18000	28000	39000	20000
Fluoride	0.5	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
pH (at 25°C)	0.1	pH Units	7.4	7.2	6.8	6.9
Sulphate (as SO4)	5	mg/L	500	1500	1100	440
Total Dissolved Solids	10	mg/L	16000	19000	33000	14000
Alkalinity (speciated)						
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	390	750	280	650
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	20	mg/L	< 20	< 20	< 20	< 20
Total Alkalinity (as CaCO3)	20	mg/L	390	750	280	650
Heavy Metals						
Aluminium	0.05	mg/L	120	0.70	27	< 0.05
Aluminium (filtered)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic	0.001	mg/L	0.017	0.003	0.007	< 0.001
Arsenic (filtered)	0.001	mg/L	< 0.001	0.002	< 0.001	< 0.001
Barium	0.02	mg/L	1.3	0.09	0.60	0.11
Barium (filtered)	0.02	mg/L	0.33	0.08	0.32	0.11
Beryllium	0.001	mg/L	0.006	< 0.001	0.002	< 0.001
Beryllium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Boron	0.05	mg/L	0.22	0.20	0.12	1.8
Boron (filtered)	0.05	mg/L	0.21	0.19	0.12	1.8

Client Sample ID			A-0B7	A-0B8	A-0B10	P-0B2
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			M18-Jn29471	M18-Jn29472	M18-Jn29473	M18-Jn29474
Date Sampled			Jun 19, 2018	Jun 19, 2018	Jun 20, 2018	Jun 20, 2018
Test/Reference	LOR	Unit				
Heavy Metals						
Cadmium	0.0002	mg/L	0.0018	0.0003	0.0014	< 0.0002
Cadmium (filtered)	0.0002	mg/L	0.0005	0.0003	0.0014	< 0.0002
Chromium	0.001	mg/L	0.091	0.020	0.033	< 0.001
Chromium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Cobalt	0.001	mg/L	0.12	0.003	0.035	0.002
Cobalt (filtered)	0.001	mg/L	0.008	0.003	0.016	0.002
Copper	0.001	mg/L	0.24	0.26	0.28	0.11
Copper (filtered)	0.001	mg/L	0.005	0.23	0.19	0.10
Iron	0.05	mg/L	220	0.77	39	0.19
Iron (filtered)	0.05	mg/L	< 0.05	< 0.05	0.06	0.11
Lead	0.001	mg/L	0.091	0.005	0.020	< 0.001
Lead (filtered)	0.001	mg/L	< 0.001	0.002	< 0.001	< 0.001
Manganese	0.005	mg/L	12	1.8	2.6	0.64
Manganese (filtered)	0.005	mg/L	2.8	1.8	1.7	0.64
Mercury	0.0001	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.005	mg/L	< 0.005	0.024	< 0.005	< 0.005
Molybdenum (filtered)	0.005	mg/L	< 0.005	0.023	< 0.005	< 0.005
Nickel	0.001	mg/L	0.14	0.032	0.051	0.003
Nickel (filtered)	0.001	mg/L	0.010	0.030	0.020	0.003
Selenium	0.001	mg/L	0.005	0.001	0.004	< 0.001
Selenium (filtered)	0.001	mg/L	< 0.001	< 0.001	0.002	< 0.001
Uranium	0.005	mg/L	0.007	0.065	0.006	< 0.005
Uranium (filtered)	0.005	mg/L	0.007	0.065	< 0.005	< 0.005
Vanadium	0.005	mg/L	0.23	< 0.005	0.052	< 0.005
Vanadium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Zinc	0.005	mg/L	0.45	0.025	0.11	0.008
Zinc (filtered)	0.005	mg/L	0.022	0.024	0.021	0.008
Alkali Metals						
Calcium	0.5	mg/L	800	740	2700	600
Magnesium	0.5	mg/L	590	990	1900	520
Potassium	0.5	mg/L	21	28	28	29
Sodium	0.5	mg/L	1900	4000	3700	3100

Client Sample ID			P-0B5	A-PB1	A-0B2	A-0B4
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			M18-Jn29475	M18-Jn29476	M18-Jn29477	M18-Jn29478
Date Sampled			Jun 20, 2018	Jun 21, 2018	Jun 21, 2018	Jun 21, 2018
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	0.02	mg/L	R18< 0.08	< 0.02	< 0.02	< 0.02
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
TRH C6-C10	0.02	mg/L	R18< 0.08	< 0.02	< 0.02	< 0.02
TRH - 2013 NEPM Fractions (after silica gel clean-up)						
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1

Client Sample ID Sample Matrix Eurofins | mgt Sample No. Date Sampled Test/Reference	LOR	Unit	P-0B5 Water M18-Jn29475 Jun 20, 2018	A-PB1 Water M18-Jn29476 Jun 21, 2018	A-0B2 Water M18-Jn29477 Jun 21, 2018	A-0B4 Water M18-Jn29478 Jun 21, 2018
TRH - 1999 NEPM Fractions (after silica gel clean-up)						
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Chloride	1	mg/L	5400	96	92	14000
Conductivity (at 25°C)	1	uS/cm	21000	670	680	39000
Fluoride	0.5	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
pH (at 25°C)	0.1	pH Units	7.7	6.8	7.0	6.9
Sulphate (as SO4)	5	mg/L	310	< 5	6.8	1600
Total Dissolved Solids	10	mg/L	12000	340	380	23000
Alkalinity (speciated)						
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	890	180	200	390
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	20	mg/L	< 20	< 20	< 20	< 20
Total Alkalinity (as CaCO3)	20	mg/L	890	180	200	390
Heavy Metals						
Aluminium	0.05	mg/L	0.08	< 0.05	12	4.6
Aluminium (filtered)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic	0.001	mg/L	0.002	< 0.001	0.004	0.006
Arsenic (filtered)	0.001	mg/L	0.002	< 0.001	0.001	0.004
Barium	0.02	mg/L	0.29	0.11	0.24	0.29
Barium (filtered)	0.02	mg/L	0.28	0.11	0.10	0.13
Beryllium	0.001	mg/L	< 0.001	< 0.001	0.001	< 0.001
Beryllium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Boron	0.05	mg/L	0.89	< 0.05	< 0.05	0.13
Boron (filtered)	0.05	mg/L	0.86	< 0.05	< 0.05	0.13
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	0.0014
Cadmium (filtered)	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	0.0014
Chromium	0.001	mg/L	0.003	< 0.001	0.015	0.009
Chromium (filtered)	0.001	mg/L	0.003	< 0.001	< 0.001	< 0.001
Cobalt	0.001	mg/L	0.001	< 0.001	0.015	0.048
Cobalt (filtered)	0.001	mg/L	< 0.001	< 0.001	0.002	0.044
Copper	0.001	mg/L	0.005	< 0.001	0.047	0.030
Copper (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	0.003
Iron	0.05	mg/L	1.6	< 0.05	14	11
Iron (filtered)	0.05	mg/L	0.71	< 0.05	< 0.05	1.6
Lead	0.001	mg/L	< 0.001	< 0.001	0.016	0.005
Lead (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	0.69	< 0.005	0.29	3.2
Manganese (filtered)	0.005	mg/L	0.68	< 0.005	0.11	3.2
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.005	mg/L	0.013	< 0.005	< 0.005	< 0.005
Molybdenum (filtered)	0.005	mg/L	0.007	< 0.005	< 0.005	< 0.005
Nickel	0.001	mg/L	0.010	0.001	0.018	0.036
Nickel (filtered)	0.001	mg/L	0.007	0.001	0.002	0.026
Selenium	0.001	mg/L	0.001	< 0.001	0.001	< 0.001
Selenium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001

Client Sample ID			P-0B5	A-PB1	A-0B2	A-0B4
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			M18-Jn29475	M18-Jn29476	M18-Jn29477	M18-Jn29478
Date Sampled			Jun 20, 2018	Jun 21, 2018	Jun 21, 2018	Jun 21, 2018
Test/Reference	LOR	Unit				
Heavy Metals						
Uranium	0.005	mg/L	< 0.005	< 0.005	< 0.005	0.010
Uranium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	0.010
Vanadium	0.005	mg/L	< 0.005	< 0.005	0.037	0.014
Vanadium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Zinc	0.005	mg/L	0.027	0.005	0.089	0.045
Zinc (filtered)	0.005	mg/L	< 0.005	0.008	0.011	0.020
Alkali Metals						
Calcium	0.5	mg/L	450	14	17	1500
Magnesium	0.5	mg/L	370	7.9	13	1500
Potassium	0.5	mg/L	89	3.6	3.9	23
Sodium	0.5	mg/L	3400	93	100	4900

Client Sample ID			P-PB1	P-0B4	A-0B1	A-0B12
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			M18-Jn29479	M18-Jn29480	M18-Jn29481	M18-Jn29482
Date Sampled			Jun 21, 2018	Jun 21, 2018	Jun 22, 2018	Jun 22, 2018
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	0.02	mg/L	< 0.02	< 0.02	0.02	< 0.02
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
TRH C6-C10	0.02	mg/L	< 0.02	< 0.02	0.02	< 0.02
TRH - 2013 NEPM Fractions (after silica gel clean-up)						
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH - 1999 NEPM Fractions (after silica gel clean-up)						
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Chloride	1	mg/L	4800	13000	35	32
Conductivity (at 25°C)	1	uS/cm	16000	38000	540	310
Fluoride	0.5	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
pH (at 25°C)	0.1	pH Units	6.9	7.1	6.8	6.8
Sulphate (as SO4)	5	mg/L	< 5	1600	16	< 5
Total Dissolved Solids	10	mg/L	12000	25000	230	140
Alkalinity (speciated)						
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	42	450	200	110
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	20	mg/L	< 20	< 20	< 20	< 20
Total Alkalinity (as CaCO3)	20	mg/L	42	450	200	110
Heavy Metals						
Aluminium	0.05	mg/L	< 0.05	< 0.05	78	28
Aluminium (filtered)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic	0.001	mg/L	0.013	0.002	0.013	0.013
Arsenic (filtered)	0.001	mg/L	0.011	0.002	< 0.001	0.008

Client Sample ID			P-PB1	P-0B4	A-0B1	A-0B12
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			M18-Jn29479	M18-Jn29480	M18-Jn29481	M18-Jn29482
Date Sampled			Jun 21, 2018	Jun 21, 2018	Jun 22, 2018	Jun 22, 2018
Test/Reference	LOR	Unit				
Heavy Metals						
Barium	0.02	mg/L	22	0.09	1.4	0.45
Barium (filtered)	0.02	mg/L	22	0.09	0.08	0.11
Beryllium	0.001	mg/L	< 0.001	< 0.001	0.005	0.003
Beryllium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Boron	0.05	mg/L	0.14	0.23	0.07	0.06
Boron (filtered)	0.05	mg/L	0.13	0.23	< 0.05	< 0.05
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	0.0010	0.0004
Cadmium (filtered)	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	< 0.001	0.002	0.053	0.042
Chromium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Cobalt	0.001	mg/L	0.001	0.017	0.10	0.016
Cobalt (filtered)	0.001	mg/L	0.001	0.017	< 0.001	0.003
Copper	0.001	mg/L	< 0.001	0.004	0.15	0.047
Copper (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Iron	0.05	mg/L	1.8	2.3	110	34
Iron (filtered)	0.05	mg/L	1.6	2.3	< 0.05	4.2
Lead	0.001	mg/L	< 0.001	< 0.001	0.065	0.032
Lead (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	1.7	3.7	2.2	0.76
Manganese (filtered)	0.005	mg/L	1.7	3.7	0.025	0.46
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	0.0004	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Molybdenum (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Nickel	0.001	mg/L	0.001	0.031	0.078	0.027
Nickel (filtered)	0.001	mg/L	0.001	0.030	< 0.001	0.002
Selenium	0.001	mg/L	< 0.001	< 0.001	0.004	0.002
Selenium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Uranium	0.005	mg/L	< 0.005	< 0.005	0.008	0.005
Uranium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Vanadium	0.005	mg/L	< 0.005	< 0.005	0.16	0.092
Vanadium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Zinc	0.005	mg/L	0.009	0.006	0.26	0.20
Zinc (filtered)	0.005	mg/L	0.009	0.006	< 0.005	0.014
Alkali Metals						
Calcium	0.5	mg/L	860	1900	11	19
Magnesium	0.5	mg/L	23	1600	5.1	11
Potassium	0.5	mg/L	< 5	30	1.3	3.4
Sodium	0.5	mg/L	2600	4800	25	46

Client Sample ID			P-0B3	A-0B3	ROSS-BORE	P-0B1
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			M18-Jn29483	M18-Jn29484	M18-Jn29485	M18-Jn29486
Date Sampled			Jun 22, 2018	Jun 22, 2018	Jun 23, 2018	Jun 23, 2018
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
TRH C6-C10	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TRH - 2013 NEPM Fractions (after silica gel clean-up)						
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	-	< 0.05	< 0.05	< 0.05
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	-	< 0.1	< 0.1	< 0.1
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	-	< 0.1	< 0.1	< 0.1
TRH - 1999 NEPM Fractions (after silica gel clean-up)						
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	-	< 0.1	< 0.1	< 0.1
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	-	< 0.05	< 0.05	< 0.05
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	-	< 0.1	< 0.1	< 0.1
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	-	< 0.1	< 0.1	< 0.1
Chloride	1	mg/L	8400	70	590	9000
Conductivity (at 25°C)	1	uS/cm	28000	660	32000	29000
Fluoride	0.5	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
pH (at 25°C)	0.1	pH Units	6.8	7.1	6.8	7.5
Sulphate (as SO4)	5	mg/L	920	28	78	1600
Total Dissolved Solids	10	mg/L	19000	360	1600	21000
Alkalinity (speciated)						
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	250	190	390	290
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	20	mg/L	< 20	< 20	< 20	< 20
Total Alkalinity (as CaCO3)	20	mg/L	250	190	390	290
Heavy Metals						
Aluminium	0.05	mg/L	< 0.05	1.8	< 0.05	< 0.05
Aluminium (filtered)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic	0.001	mg/L	0.002	0.005	< 0.001	0.004
Arsenic (filtered)	0.001	mg/L	0.001	0.005	< 0.001	0.004
Barium	0.02	mg/L	0.08	0.37	0.10	0.04
Barium (filtered)	0.02	mg/L	0.08	0.11	0.10	0.04
Beryllium	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Beryllium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Boron	0.05	mg/L	0.22	< 0.05	0.51	0.19
Boron (filtered)	0.05	mg/L	0.22	< 0.05	0.47	0.18
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium (filtered)	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	0.001	0.003	< 0.001	0.006
Chromium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Cobalt	0.001	mg/L	0.002	0.005	< 0.001	0.006
Cobalt (filtered)	0.001	mg/L	0.002	0.002	< 0.001	0.006
Copper	0.001	mg/L	0.001	0.004	0.002	< 0.001
Copper (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Iron	0.05	mg/L	8.6	3.6	0.24	4.7
Iron (filtered)	0.05	mg/L	8.6	0.56	< 0.05	4.9
Lead	0.001	mg/L	< 0.001	0.003	0.001	< 0.001
Lead (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	3.1	0.28	0.094	1.3
Manganese (filtered)	0.005	mg/L	3.1	0.28	0.022	1.3

Client Sample ID Sample Matrix Eurofins | mgt Sample No. Date Sampled Test/Reference	LOR	Unit	P-0B3 Water M18-Jn29483 Jun 22, 2018	A-0B3 Water M18-Jn29484 Jun 22, 2018	ROSS-BORE Water M18-Jn29485 Jun 23, 2018	P-0B1 Water M18-Jn29486 Jun 23, 2018
Heavy Metals						
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Molybdenum (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Nickel	0.001	mg/L	0.003	0.007	< 0.001	0.008
Nickel (filtered)	0.001	mg/L	0.002	0.002	< 0.001	0.005
Selenium	0.001	mg/L	< 0.001	< 0.001	0.005	< 0.001
Selenium (filtered)	0.001	mg/L	< 0.001	< 0.001	0.005	< 0.001
Uranium	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Uranium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Vanadium	0.005	mg/L	< 0.005	0.011	< 0.005	< 0.005
Vanadium (filtered)	0.005	mg/L	< 0.005	0.006	< 0.005	< 0.005
Zinc	0.005	mg/L	< 0.005	0.022	0.028	0.021
Zinc (filtered)	0.005	mg/L	< 0.005	< 0.005	0.027	0.013
Alkali Metals						
Calcium	0.5	mg/L	1400	18	160	1400
Magnesium	0.5	mg/L	1100	13	77	1300
Potassium	0.5	mg/L	16	1.6	2.9	23
Sodium	0.5	mg/L	3900	170	330	3700

Client Sample ID Sample Matrix Eurofins | mgt Sample No. Date Sampled Test/Reference	LOR	Unit	DUP01 Water M18-Jn29487 Jun 20, 2018	DUP02 Water M18-Jn29488 Jun 22, 2018	A-0B11 Water M18-Jn29867 Jun 22, 2018
Total Recoverable Hydrocarbons - 1999 NEPM Fractions					
TRH C6-C9	0.02	mg/L	< 0.02	< 0.02	< 0.02
Total Recoverable Hydrocarbons - 2013 NEPM Fractions					
TRH C6-C10	0.02	mg/L	< 0.02	< 0.02	< 0.02
TRH - 2013 NEPM Fractions (after silica gel clean-up)					
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	< 0.05	-	< 0.05
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	< 0.1	-	< 0.1
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	< 0.1	-	< 0.1
TRH - 1999 NEPM Fractions (after silica gel clean-up)					
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	< 0.1	-	< 0.1
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	< 0.05	-	< 0.05
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	< 0.1	-	< 0.1
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	< 0.1	-	< 0.1
Chloride	1	mg/L	5500	75	44
Conductivity (at 25°C)	1	uS/cm	19000	700	470
Fluoride	0.5	mg/L	< 0.5	< 0.5	< 0.5
pH (at 25°C)	0.1	pH Units	6.9	7.3	6.7
Sulphate (as SO4)	5	mg/L	440	34	12
Total Dissolved Solids	10	mg/L	12000	390	220

Client Sample ID			DUP01	DUP02	A-0B11
Sample Matrix			Water	Water	Water
Eurofins | mgt Sample No.			M18-Jn29487	M18-Jn29488	M18-Jn29867
Date Sampled			Jun 20, 2018	Jun 22, 2018	Jun 22, 2018
Test/Reference	LOR	Unit			
Alkalinity (speciated)					
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	660	200	150
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	20	mg/L	< 20	< 20	< 20
Total Alkalinity (as CaCO3)	20	mg/L	660	200	150
Heavy Metals					
Aluminium	0.05	mg/L	< 0.05	1.3	25
Aluminium (filtered)	0.05	mg/L	< 0.05	< 0.05	0.07
Arsenic	0.001	mg/L	< 0.001	0.006	0.011
Arsenic (filtered)	0.001	mg/L	< 0.001	0.006	0.006
Barium	0.02	mg/L	0.11	0.26	1.1
Barium (filtered)	0.02	mg/L	0.11	0.11	0.17
Beryllium	0.001	mg/L	< 0.001	< 0.001	0.009
Beryllium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001
Boron	0.05	mg/L	2.0	< 0.05	< 0.05
Boron (filtered)	0.05	mg/L	1.7	< 0.05	< 0.05
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	0.0004
Cadmium (filtered)	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	< 0.001	0.003	0.035
Chromium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001
Cobalt	0.001	mg/L	0.002	0.005	0.070
Cobalt (filtered)	0.001	mg/L	0.002	0.002	0.006
Copper	0.001	mg/L	0.11	0.003	0.029
Copper (filtered)	0.001	mg/L	0.10	< 0.001	< 0.001
Iron	0.05	mg/L	0.20	3.0	70
Iron (filtered)	0.05	mg/L	0.09	0.60	4.4
Lead	0.001	mg/L	< 0.001	0.002	0.026
Lead (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	0.66	0.31	3.2
Manganese (filtered)	0.005	mg/L	0.64	0.29	1.3
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.005	mg/L	< 0.005	< 0.005	< 0.005
Molybdenum (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005
Nickel	0.001	mg/L	0.003	0.007	0.062
Nickel (filtered)	0.001	mg/L	0.003	0.001	0.002
Selenium	0.001	mg/L	< 0.001	0.001	0.002
Selenium (filtered)	0.001	mg/L	< 0.001	0.001	< 0.001
Uranium	0.005	mg/L	< 0.005	< 0.005	< 0.005
Uranium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005
Vanadium	0.005	mg/L	< 0.005	0.011	0.22
Vanadium (filtered)	0.005	mg/L	< 0.005	0.006	< 0.005
Zinc	0.005	mg/L	0.008	0.020	0.61
Zinc (filtered)	0.005	mg/L	0.008	< 0.005	0.016
Alkali Metals					
Calcium	0.5	mg/L	520	13	22
Magnesium	0.5	mg/L	420	9.0	12
Potassium	0.5	mg/L	21	1.7	4.2
Sodium	0.5	mg/L	2700	160	39

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Total Recoverable Hydrocarbons - 1999 NEPM Fractions	Melbourne	Jun 28, 2018	7 Day
- Method: LTM-ORG-2010 TRH C6-C36			
Total Recoverable Hydrocarbons	Melbourne	Jun 28, 2018	7 Day
- Method: TRH C6-C40 - LTM-ORG-2010			
Conductivity (at 25°C)	Melbourne	Jun 29, 2018	28 Day
- Method: LTM-INO-4030 Conductivity			
pH (at 25°C)	Melbourne	Jun 29, 2018	0 Hours
- Method: LTM-GEN-7090 pH in water by ISE			
Total Dissolved Solids	Melbourne	Jun 28, 2018	7 Day
- Method: LTM-INO-4170 Total Dissolved Solids in Water			
Heavy Metals	Melbourne	Jun 29, 2018	180 Day
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Heavy Metals (filtered)	Melbourne	Jun 29, 2018	180 Day
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Mobil Metals : Metals M15	Melbourne	Jun 29, 2018	28 Day
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Eurofins | mgt Suite B11C: Na/K/Ca/Mg	Melbourne	Jun 28, 2018	180 Day
- Method: LTM-MET-3010 Alkali Metals by ICP-AES			
TRH - 2013 NEPM Fractions (after silica gel clean-up)	Melbourne	Jun 29, 2018	7 Day
- Method: LM-LTM-ORG2010			
TRH - 1999 NEPM Fractions (after silica gel clean-up)	Melbourne	Jun 29, 2018	7 Day
- Method: TRH C6-C36 (Silica Gel Cleanup) - MGT 100A			
Eurofins | mgt Suite B11F: Cl/SO4/Alkalinity/Total F			
Chloride	Melbourne	Jun 28, 2018	28 Day
- Method: LTM-INO-4090 Chloride by Discrete Analyser			
Fluoride	Melbourne	Jun 28, 2018	28 Day
- Method: APHA 4500 F-C Fluoride by Ion Selective Electrode			
Sulphate (as SO4)	Melbourne	Jun 28, 2018	28 Day
- Method: LTM-INO-4110 Sulfate by Discrete Analyser			
Alkalinity (speciated)	Melbourne	Jun 29, 2018	14 Day
- Method: APHA 2320 Alkalinity by Titration			

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Project Name: BARALABA
Project ID: 620.11731.20000.0032

Order No.:
Report #: 604676
Phone: 07 3858 4800
Fax:

Received: Jun 25, 2018 3:18 PM
Due: Jul 2, 2018
Priority: 5 Day
Contact Name: Tony Johnson

Eurofins | mgt Analytical Services Manager : Ryan Gilbert

Sample Detail						Aluminium	Aluminium (filtered)	Arsenic	Arsenic (filtered)	Barium	Barium (filtered)	Beryllium	Beryllium (filtered)	Boron	Boron (filtered)	Cadmium	Cadmium (filtered)	Chromium	Chromium (filtered)	Cobalt	Cobalt (filtered)	Conductivity (at 25°C)	Copper	Copper (filtered)	Iron	Iron (filtered)	Lead	Lead (filtered)	Manganese	Manganese (filtered)	Mercury	Mercury (filtered)	Molybdenum	Molybdenum (filtered)	Nickel	Nickel (filtered)	pH (at 25°C)	Selenium	Selenium (filtered)	Total Dissolved Solids	TRH C6-C10	TRH C6-C9	Uranium	Uranium (filtered)	Vanadium	Vanadium (filtered)	Zinc	Zinc (filtered)	TRH (after Silica Gel cleanup)	Eurofins | mgt Suite B11F:	Eurofins | mgt Suite B11C: Na/K/Ca/Mg
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																																																			
Brisbane Laboratory - NATA Site # 20794																																																			
Perth Laboratory - NATA Site # 23736																																																			
External Laboratory																																																			
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**																																														
1	A-0B7	Jun 19, 2018		Water	M18-Jn29471	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2	A-0B8	Jun 19, 2018		Water	M18-Jn29472	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3	A-0B10	Jun 20, 2018		Water	M18-Jn29473	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4	P-0B2	Jun 20, 2018		Water	M18-Jn29474	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5	P-0B5	Jun 20, 2018		Water	M18-Jn29475	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6	A-PB1	Jun 21, 2018		Water	M18-Jn29476	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7	A-0B2	Jun 21, 2018		Water	M18-Jn29477	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8	A-0B4	Jun 21, 2018		Water	M18-Jn29478	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
9	P-PB1	Jun 21, 2018		Water	M18-Jn29479	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Company Name:	SLR Consulting (Qld)	**Order No.:**		**Received:**	Jun 25, 2018 3:18 PM
Address:	Level 2 15 Astor Terrace	**Report #:**	604676	**Due:**	Jul 2, 2018
	Spring Hill	**Phone:**	07 3858 4800	**Priority:**	5 Day
	QLD 4000	**Fax:**		**Contact Name:**	Tony Johnson
Project Name:	BARALABA				
Project ID:	620.11731.20000.0032				

Eurofins | mgt Analytical Services Manager : Ryan Gilbert

Sample Detail						Aluminium	Aluminium (filtered)	Arsenic	Arsenic (filtered)	Barium	Barium (filtered)	Beryllium	Beryllium (filtered)	Boron	Boron (filtered)	Cadmium	Cadmium (filtered)	Chromium	Chromium (filtered)	Cobalt	Cobalt (filtered)	Conductivity (at 25°C)	Copper	Copper (filtered)	Iron	Iron (filtered)	Lead	Lead (filtered)	Manganese	Manganese (filtered)	Mercury	Mercury (filtered)	Molybdenum	Molybdenum (filtered)	Nickel	Nickel (filtered)	pH (at 25°C)	Selenium	Selenium (filtered)	Total Dissolved Solids	TRH C6-C10	TRH C6-C9	Uranium	Uranium (filtered)	Vanadium	Vanadium (filtered)	Zinc	Zinc (filtered)	TRH (after Silica Gel cleanup)	Eurofins | mgt Suite B11F:	Eurofins | mgt Suite B11C: Na/K/Ca/Mg
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																																																			
Brisbane Laboratory - NATA Site # 20794																																																			
Perth Laboratory - NATA Site # 23736																																																			
10	P-0B4	Jun 21, 2018		Water	M18-Jn29480	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
11	A-0B1	Jun 22, 2018		Water	M18-Jn29481	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
12	A-0B12	Jun 22, 2018		Water	M18-Jn29482	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
13	P-0B3	Jun 22, 2018		Water	M18-Jn29483	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
14	A-0B3	Jun 22, 2018		Water	M18-Jn29484	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
15	ROSS-BORE	Jun 23, 2018		Water	M18-Jn29485	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
16	P-0B1	Jun 23, 2018		Water	M18-Jn29486	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
17	DUP01	Jun 20, 2018		Water	M18-Jn29487	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
18	DUP02	Jun 22, 2018		Water	M18-Jn29488	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
19	A-0B11	Jun 22, 2018		Water	M18-Jn29867	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Test Counts						19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	17	19	19

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram	**mg/L:** milligrams per litre	**ug/L:** micrograms per litre
ppm: Parts per million	**ppb:** Parts per billion	**%:** Percentage
org/100mL: Organisms per 100 millilitres	**NTU:** Nephelometric Turbidity Units	**MPN/100mL:** Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	Quality Systems Manual ver 5.1 US Department of Defense
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 50-150%-Phenols & PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.1 where no positive PFAS results have been reported have been reviewed and no data was affected.

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	mg/L	< 0.02			0.02	Pass	
Method Blank							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
TRH C6-C10	mg/L	< 0.02			0.02	Pass	
Method Blank							
TRH - 2013 NEPM Fractions (after silica gel clean-up)							
TRH >C10-C16 (after silica gel clean-up)	mg/L	< 0.05			0.05	Pass	
TRH >C16-C34 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
TRH >C34-C40 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
Method Blank							
TRH - 1999 NEPM Fractions (after silica gel clean-up)							
TRH C10-C14 (after silica gel clean-up)	mg/L	< 0.05			0.05	Pass	
TRH C15-C28 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
TRH C29-C36 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
Method Blank							
Chloride	mg/L	< 1			1	Pass	
Fluoride	mg/L	< 0.5			0.5	Pass	
Sulphate (as SO4)	mg/L	< 5			5	Pass	
Total Dissolved Solids	mg/L	< 10			10	Pass	
Method Blank							
Alkalinity (speciated)							
Bicarbonate Alkalinity (as CaCO3)	mg/L	< 20			20	Pass	
Carbonate Alkalinity (as CaCO3)	mg/L	< 10			10	Pass	
Hydroxide Alkalinity (as CaCO3)	mg/L	< 20			20	Pass	
Total Alkalinity (as CaCO3)	mg/L	< 20			20	Pass	
Method Blank							
Heavy Metals							
Aluminium	mg/L	< 0.05			0.05	Pass	
Aluminium (filtered)	mg/L	< 0.05			0.05	Pass	
Arsenic	mg/L	< 0.001			0.001	Pass	
Arsenic (filtered)	mg/L	< 0.001			0.001	Pass	
Barium	mg/L	< 0.02			0.02	Pass	
Barium (filtered)	mg/L	< 0.02			0.02	Pass	
Beryllium	mg/L	< 0.001			0.001	Pass	
Beryllium (filtered)	mg/L	< 0.001			0.001	Pass	
Boron	mg/L	< 0.05			0.05	Pass	
Boron (filtered)	mg/L	< 0.05			0.05	Pass	
Cadmium	mg/L	< 0.0002			0.0002	Pass	
Cadmium (filtered)	mg/L	< 0.0002			0.0002	Pass	
Chromium	mg/L	< 0.001			0.001	Pass	
Chromium (filtered)	mg/L	< 0.001			0.001	Pass	
Cobalt	mg/L	< 0.001			0.001	Pass	
Cobalt (filtered)	mg/L	< 0.001			0.001	Pass	
Copper	mg/L	< 0.001			0.001	Pass	
Copper (filtered)	mg/L	< 0.001			0.001	Pass	
Iron	mg/L	< 0.05			0.05	Pass	
Iron (filtered)	mg/L	< 0.05			0.05	Pass	
Lead	mg/L	< 0.001			0.001	Pass	
Lead (filtered)	mg/L	< 0.001			0.001	Pass	
Manganese	mg/L	< 0.005			0.005	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Manganese (filtered)	mg/L	< 0.005			0.005	Pass	
Mercury	mg/L	< 0.0001			0.0001	Pass	
Mercury (filtered)	mg/L	< 0.0001			0.0001	Pass	
Molybdenum	mg/L	< 0.005			0.005	Pass	
Molybdenum (filtered)	mg/L	< 0.005			0.005	Pass	
Nickel	mg/L	< 0.001			0.001	Pass	
Nickel (filtered)	mg/L	< 0.001			0.001	Pass	
Selenium	mg/L	< 0.001			0.001	Pass	
Selenium (filtered)	mg/L	< 0.001			0.001	Pass	
Uranium	mg/L	< 0.005			0.005	Pass	
Uranium (filtered)	mg/L	< 0.005			0.005	Pass	
Vanadium	mg/L	< 0.005			0.005	Pass	
Vanadium (filtered)	mg/L	< 0.005			0.005	Pass	
Zinc	mg/L	< 0.005			0.005	Pass	
Zinc (filtered)	mg/L	< 0.005			0.005	Pass	
Method Blank							
Alkali Metals							
Calcium	mg/L	< 0.5			0.5	Pass	
Magnesium	mg/L	< 0.5			0.5	Pass	
Potassium	mg/L	< 0.5			0.5	Pass	
Sodium	mg/L	< 0.5			0.5	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	%	92			70-130	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
TRH C6-C10	%	95			70-130	Pass	
LCS - % Recovery							
TRH - 2013 NEPM Fractions (after silica gel clean-up)							
TRH >C10-C16 (after silica gel clean-up)	%	94			70-130	Pass	
LCS - % Recovery							
TRH - 1999 NEPM Fractions (after silica gel clean-up)							
TRH C10-C14 (after silica gel clean-up)	%	98			70-130	Pass	
LCS - % Recovery							
Chloride	%	108			70-130	Pass	
Fluoride	%	95			70-130	Pass	
Sulphate (as SO4)	%	103			70-130	Pass	
Total Dissolved Solids	%	111			70-130	Pass	
LCS - % Recovery							
Alkalinity (speciated)							
Bicarbonate Alkalinity (as CaCO3)	%	98			70-130	Pass	
Carbonate Alkalinity (as CaCO3)	%	98			70-130	Pass	
Total Alkalinity (as CaCO3)	%	106			70-130	Pass	
LCS - % Recovery							
Heavy Metals							
Aluminium	%	99			80-120	Pass	
Aluminium (filtered)	%	99			80-120	Pass	
Arsenic	%	96			80-120	Pass	
Arsenic (filtered)	%	96			80-120	Pass	
Barium	%	97			80-120	Pass	
Beryllium	%	99			80-120	Pass	
Boron	%	109			80-120	Pass	
Boron (filtered)	%	109			80-120	Pass	
Cadmium	%	98			80-120	Pass	

Test			Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Cadmium (filtered)			%	98			80-120	Pass	
Chromium			%	99			80-120	Pass	
Chromium (filtered)			%	99			80-120	Pass	
Cobalt			%	98			80-120	Pass	
Cobalt (filtered)			%	98			80-120	Pass	
Copper			%	90			80-120	Pass	
Copper (filtered)			%	90			80-120	Pass	
Iron			%	94			80-120	Pass	
Iron (filtered)			%	94			80-120	Pass	
Lead			%	99			80-120	Pass	
Lead (filtered)			%	99			80-120	Pass	
Manganese			%	98			80-120	Pass	
Manganese (filtered)			%	98			80-120	Pass	
Mercury			%	95			75-125	Pass	
Mercury (filtered)			%	95			70-130	Pass	
Molybdenum			%	97			80-120	Pass	
Molybdenum (filtered)			%	97			80-120	Pass	
Nickel			%	96			80-120	Pass	
Nickel (filtered)			%	96			80-120	Pass	
Selenium			%	97			80-120	Pass	
Selenium (filtered)			%	97			80-120	Pass	
Uranium			%	98			80-120	Pass	
Uranium (filtered)			%	98			70-130	Pass	
Vanadium			%	99			80-120	Pass	
Zinc			%	96			80-120	Pass	
Zinc (filtered)			%	96			80-120	Pass	
LCS - % Recovery									
Alkali Metals									
Calcium			%	111			70-130	Pass	
Magnesium			%	120			70-130	Pass	
Potassium			%	99			70-130	Pass	
Sodium			%	119			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1					
TRH C6-C9	B18-Jn29519	NCP	%	104			70-130	Pass	
Spike - % Recovery									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1					
TRH C6-C10	B18-Jn29519	NCP	%	105			70-130	Pass	
Spike - % Recovery									
				Result 1					
Chloride	M18-Jn32261	NCP	%	101			70-130	Pass	
Spike - % Recovery									
Alkalinity (speciated)				Result 1					
Carbonate Alkalinity (as CaCO3)	M18-Jn30662	NCP	%	101			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Aluminium	M18-Jn32134	NCP	%	99			75-125	Pass	
Arsenic	M18-Jn29471	CP	%	78			75-125	Pass	
Barium	M18-Jn29471	CP	%	101			75-125	Pass	
Beryllium	M18-Jn29471	CP	%	78			75-125	Pass	
Boron	M18-Jn29471	CP	%	83			75-125	Pass	
Cadmium	M18-Jn29471	CP	%	70			75-125	Fail	Q08
Chromium	M18-Jn29471	CP	%	86			75-125	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Cobalt	M18-Jn29471	CP	%	77			75-125	Pass	
Copper	M18-Jn29471	CP	%	83			75-125	Pass	
Iron	M18-Jn32134	NCP	%	92			75-125	Pass	
Lead	M18-Jn29471	CP	%	87			75-125	Pass	
Manganese	M18-Jn32134	NCP	%	97			75-125	Pass	
Mercury	M18-Jn29471	CP	%	92			70-130	Pass	
Molybdenum	M18-Jn29471	CP	%	78			75-125	Pass	
Nickel	M18-Jn29471	CP	%	81			75-125	Pass	
Selenium	M18-Jn29471	CP	%	73			75-125	Fail	Q08
Uranium	M18-Jn29471	CP	%	88			75-125	Pass	
Vanadium	M18-Jn29471	CP	%	98			75-125	Pass	
Zinc	M18-Jn29471	CP	%	90			75-125	Pass	
Spike - % Recovery									
Alkalinity (speciated)				Result 1					
Bicarbonate Alkalinity (as CaCO3)	M18-Jn29472	CP	%	110			70-130	Pass	
Total Alkalinity (as CaCO3)	M18-Jn29472	CP	%	110			70-130	Pass	
Spike - % Recovery									
Alkali Metals				Result 1					
Calcium	M18-Jn29473	CP	%	124			70-130	Pass	
Magnesium	M18-Jn29473	CP	%	122			70-130	Pass	
Potassium	M18-Jn29473	CP	%	112			70-130	Pass	
Sodium	M18-Jn29473	CP	%	121			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Aluminium (filtered)	M18-Jn29475	CP	%	97			75-125	Pass	
Arsenic (filtered)	M18-Jn29475	CP	%	93			70-130	Pass	
Barium (filtered)	M18-Jn29475	CP	%	113			75-125	Pass	
Beryllium (filtered)	M18-Jn29475	CP	%	93			75-125	Pass	
Cadmium (filtered)	M18-Jn29475	CP	%	74			70-130	Pass	
Chromium (filtered)	M18-Jn29475	CP	%	84			70-130	Pass	
Cobalt (filtered)	M18-Jn29475	CP	%	85			75-125	Pass	
Copper (filtered)	M18-Jn29475	CP	%	82			70-130	Pass	
Iron (filtered)	M18-Jn29475	CP	%	96			70-130	Pass	
Lead (filtered)	M18-Jn29475	CP	%	78			70-130	Pass	
Manganese (filtered)	M18-Jn29475	CP	%	127			70-130	Pass	
Mercury (filtered)	M18-Jn29475	CP	%	92			70-130	Pass	
Molybdenum (filtered)	M18-Jn29475	CP	%	82			75-125	Pass	
Nickel (filtered)	M18-Jn29475	CP	%	84			70-130	Pass	
Selenium (filtered)	M18-Jn29475	CP	%	88			70-130	Pass	
Uranium (filtered)	M18-Jn29475	CP	%	79			70-130	Pass	
Vanadium (filtered)	M18-Jn29475	CP	%	89			75-125	Pass	
Zinc (filtered)	M18-Jn29475	CP	%	83			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Boron (filtered)	M18-Jn32139	NCP	%	86			75-125	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Arsenic	M18-Jn29481	CP	%	76			75-125	Pass	
Barium	M18-Jn29481	CP	%	115			75-125	Pass	
Beryllium	M18-Jn29481	CP	%	87			75-125	Pass	
Boron	M18-Jn29481	CP	%	98			75-125	Pass	
Cadmium	M18-Jn29481	CP	%	77			75-125	Pass	
Chromium	M18-Jn29481	CP	%	93			75-125	Pass	
Cobalt	M18-Jn29481	CP	%	80			75-125	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Copper	M18-Jn29481	CP	%	87			75-125	Pass	
Lead	M18-Jn29481	CP	%	94			75-125	Pass	
Mercury	M18-Jn29481	CP	%	94			70-130	Pass	
Molybdenum	M18-Jn29481	CP	%	78			75-125	Pass	
Nickel	M18-Jn29481	CP	%	81			75-125	Pass	
Selenium	M18-Jn29481	CP	%	77			75-125	Pass	
Uranium	M18-Jn29481	CP	%	92			75-125	Pass	
Vanadium	M18-Jn29481	CP	%	105			75-125	Pass	
Zinc	M18-Jn29481	CP	%	92			75-125	Pass	
Spike - % Recovery									
				Result 1					
Sulphate (as SO4)	M18-Jn29482	CP	%	100			70-130	Pass	
Spike - % Recovery									
Alkali Metals				Result 1					
Calcium	M18-Jn29483	CP	%	112			70-130	Pass	
Magnesium	M18-Jn29483	CP	%	111			70-130	Pass	
Potassium	M18-Jn29483	CP	%	91			70-130	Pass	
Sodium	M18-Jn29483	CP	%	111			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Aluminium (filtered)	M18-Jn29485	CP	%	93			75-125	Pass	
Arsenic (filtered)	M18-Jn29485	CP	%	91			70-130	Pass	
Barium (filtered)	M18-Jn29485	CP	%	89			75-125	Pass	
Beryllium (filtered)	M18-Jn29485	CP	%	96			75-125	Pass	
Cadmium (filtered)	M18-Jn29485	CP	%	88			70-130	Pass	
Chromium (filtered)	M18-Jn29485	CP	%	89			70-130	Pass	
Cobalt (filtered)	M18-Jn29485	CP	%	85			75-125	Pass	
Copper (filtered)	M18-Jn29485	CP	%	85			70-130	Pass	
Iron (filtered)	M18-Jn29485	CP	%	84			70-130	Pass	
Lead (filtered)	M18-Jn29485	CP	%	88			70-130	Pass	
Manganese (filtered)	M18-Jn29485	CP	%	89			70-130	Pass	
Mercury (filtered)	M18-Jn29485	CP	%	89			70-130	Pass	
Molybdenum (filtered)	M18-Jn29485	CP	%	85			75-125	Pass	
Nickel (filtered)	M18-Jn29485	CP	%	84			70-130	Pass	
Selenium (filtered)	M18-Jn29485	CP	%	91			70-130	Pass	
Uranium (filtered)	M18-Jn29485	CP	%	91			70-130	Pass	
Vanadium (filtered)	M18-Jn29485	CP	%	92			75-125	Pass	
Zinc (filtered)	M18-Jn29485	CP	%	87			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1	Result 2	RPD			
TRH C6-C9	B18-Jn29518	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1	Result 2	RPD			
TRH C6-C10	B18-Jn29518	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Conductivity (at 25°C)	M18-Jn29471	CP	uS/cm	18000	18000	1.0	30%	Pass	
Fluoride	M18-Jn29471	CP	mg/L	< 0.5	< 0.5	<1	30%	Pass	
pH (at 25°C)	M18-Jn29471	CP	pH Units	7.4	7.3	pass	30%	Pass	

Duplicate									
Alkalinity (speciated)				Result 1	Result 2	RPD			
Bicarbonate Alkalinity (as CaCO3)	M18-Jn29471	CP	mg/L	390	440	11	30%	Pass	
Carbonate Alkalinity (as CaCO3)	M18-Jn29471	CP	mg/L	< 10	< 10	<1	30%	Pass	
Hydroxide Alkalinity (as CaCO3)	M18-Jn29471	CP	mg/L	< 20	< 20	<1	30%	Pass	
Total Alkalinity (as CaCO3)	M18-Jn29471	CP	mg/L	390	440	11	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Arsenic	M18-Jn29471	CP	mg/L	0.017	0.017	3.0	30%	Pass	
Barium	M18-Jn29471	CP	mg/L	1.3	1.3	<1	30%	Pass	
Beryllium	M18-Jn29471	CP	mg/L	0.006	0.006	<1	30%	Pass	
Boron	M18-Jn29471	CP	mg/L	0.22	0.22	3.0	30%	Pass	
Cadmium	M18-Jn29471	CP	mg/L	0.0018	0.0018	1.0	30%	Pass	
Chromium	M18-Jn29471	CP	mg/L	0.091	0.095	5.0	30%	Pass	
Cobalt	M18-Jn29471	CP	mg/L	0.12	0.12	2.0	30%	Pass	
Copper	M18-Jn29471	CP	mg/L	0.24	0.24	2.0	30%	Pass	
Lead	M18-Jn29471	CP	mg/L	0.091	0.094	3.0	30%	Pass	
Mercury	M18-Jn29471	CP	mg/L	0.0002	0.0002	5.0	30%	Pass	
Molybdenum	M18-Jn29471	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Nickel	M18-Jn29471	CP	mg/L	0.14	0.15	3.0	30%	Pass	
Selenium	M18-Jn29471	CP	mg/L	0.005	0.005	4.0	30%	Pass	
Uranium	M18-Jn29471	CP	mg/L	0.007	0.007	<1	30%	Pass	
Vanadium	M18-Jn29471	CP	mg/L	0.23	0.24	4.0	30%	Pass	
Zinc	M18-Jn29471	CP	mg/L	0.45	0.46	1.0	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Chloride	M18-Jn29472	CP	mg/L	7500	8000	6.0	30%	Pass	
Sulphate (as SO4)	M18-Jn29472	CP	mg/L	1500	1500	1.0	30%	Pass	
Duplicate									
Alkali Metals				Result 1	Result 2	RPD			
Calcium	M18-Jn29473	CP	mg/L	2700	2500	6.0	30%	Pass	
Magnesium	M18-Jn29473	CP	mg/L	1900	1800	6.0	30%	Pass	
Potassium	M18-Jn29473	CP	mg/L	28	25	11	30%	Pass	
Sodium	M18-Jn29473	CP	mg/L	3700	3500	7.0	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Total Dissolved Solids	M18-Jn29475	CP	mg/L	12000	11000	9.0	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Aluminium (filtered)	M18-Jn29475	CP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Arsenic (filtered)	M18-Jn29475	CP	mg/L	0.002	0.002	3.0	30%	Pass	
Barium (filtered)	M18-Jn29475	CP	mg/L	0.28	0.29	6.0	30%	Pass	
Beryllium (filtered)	M18-Jn29475	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Boron (filtered)	M18-Jn29475	CP	mg/L	0.86	0.86	<1	30%	Pass	
Cadmium (filtered)	M18-Jn29475	CP	mg/L	< 0.0002	< 0.0002	<1	30%	Pass	
Chromium (filtered)	M18-Jn29475	CP	mg/L	0.003	0.003	1.0	30%	Pass	
Cobalt (filtered)	M18-Jn29475	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Copper (filtered)	M18-Jn29475	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Iron (filtered)	M18-Jn29475	CP	mg/L	0.71	0.70	1.0	30%	Pass	
Lead (filtered)	M18-Jn29475	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Manganese (filtered)	M18-Jn29475	CP	mg/L	0.68	0.69	1.0	30%	Pass	
Mercury (filtered)	M18-Jn29475	CP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Molybdenum (filtered)	M18-Jn29475	CP	mg/L	0.007	0.006	2.0	30%	Pass	
Nickel (filtered)	M18-Jn29475	CP	mg/L	0.007	0.007	1.0	30%	Pass	
Selenium (filtered)	M18-Jn29475	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Uranium (filtered)	M18-Jn29475	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	

Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Vanadium (filtered)	M18-Jn29475	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Zinc (filtered)	M18-Jn29475	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Duplicate									
TRH - 2013 NEPM Fractions (after silica gel clean-up)				Result 1	Result 2	RPD			
TRH >C10-C16 (after silica gel clean-up)	M18-Jn28074	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
TRH >C16-C34 (after silica gel clean-up)	M18-Jn28074	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
TRH >C34-C40 (after silica gel clean-up)	M18-Jn28074	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
Duplicate									
TRH - 1999 NEPM Fractions (after silica gel clean-up)				Result 1	Result 2	RPD			
TRH C10-C36 (Total) (after silica gel clean-up)	M18-Jn28074	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
TRH C10-C14 (after silica gel clean-up)	M18-Jn28074	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
TRH C15-C28 (after silica gel clean-up)	M18-Jn28074	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
TRH C29-C36 (after silica gel clean-up)	M18-Jn28074	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Conductivity (at 25°C)	M18-Jn29481	CP	uS/cm	540	510	7.0	30%	Pass	
Fluoride	M18-Jn29481	CP	mg/L	< 0.5	< 0.5	<1	30%	Pass	
pH (at 25°C)	M18-Jn29481	CP	pH Units	6.8	6.8	pass	30%	Pass	
Duplicate									
Alkalinity (speciated)				Result 1	Result 2	RPD			
Bicarbonate Alkalinity (as CaCO3)	M18-Jn29481	CP	mg/L	200	200	<1	30%	Pass	
Carbonate Alkalinity (as CaCO3)	M18-Jn29481	CP	mg/L	< 10	< 10	<1	30%	Pass	
Hydroxide Alkalinity (as CaCO3)	M18-Jn29481	CP	mg/L	< 20	< 20	<1	30%	Pass	
Total Alkalinity (as CaCO3)	M18-Jn29481	CP	mg/L	200	200	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Aluminium	M18-Jn29481	CP	mg/L	78	78	<1	30%	Pass	
Arsenic	M18-Jn29481	CP	mg/L	0.013	0.014	6.0	30%	Pass	
Barium	M18-Jn29481	CP	mg/L	1.4	1.4	<1	30%	Pass	
Beryllium	M18-Jn29481	CP	mg/L	0.005	0.005	8.0	30%	Pass	
Boron	M18-Jn29481	CP	mg/L	0.07	0.07	1.0	30%	Pass	
Cadmium	M18-Jn29481	CP	mg/L	0.0010	0.0010	<1	30%	Pass	
Chromium	M18-Jn29481	CP	mg/L	0.053	0.058	9.0	30%	Pass	
Cobalt	M18-Jn29481	CP	mg/L	0.10	0.10	1.0	30%	Pass	
Copper	M18-Jn29481	CP	mg/L	0.15	0.16	3.0	30%	Pass	
Iron	M18-Jn29481	CP	mg/L	110	110	<1	30%	Pass	
Lead	M18-Jn29481	CP	mg/L	0.065	0.069	6.0	30%	Pass	
Manganese	M18-Jn29481	CP	mg/L	2.2	2.2	1.0	30%	Pass	
Mercury	M18-Jn29481	CP	mg/L	0.0004	0.0004	5.0	30%	Pass	
Molybdenum	M18-Jn29481	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Nickel	M18-Jn29481	CP	mg/L	0.078	0.081	4.0	30%	Pass	
Selenium	M18-Jn29481	CP	mg/L	0.004	0.004	7.0	30%	Pass	
Uranium	M18-Jn29481	CP	mg/L	0.008	0.009	7.0	30%	Pass	
Vanadium	M18-Jn29481	CP	mg/L	0.16	0.17	7.0	30%	Pass	
Zinc	M18-Jn29481	CP	mg/L	0.26	0.26	1.0	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Chloride	M18-Jn29482	CP	mg/L	32	33	2.0	30%	Pass	
Sulphate (as SO4)	M18-Jn29482	CP	mg/L	< 5	< 5	<1	30%	Pass	

Duplicate									
Alkali Metals				Result 1	Result 2	RPD			
Calcium	M18-Jn29483	CP	mg/L	1400	1500	4.0	30%	Pass	
Magnesium	M18-Jn29483	CP	mg/L	1100	1100	2.0	30%	Pass	
Potassium	M18-Jn29483	CP	mg/L	16	17	9.0	30%	Pass	
Sodium	M18-Jn29483	CP	mg/L	3900	4000	3.0	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Aluminium (filtered)	M18-Jn29485	CP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Arsenic (filtered)	M18-Jn29485	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Barium (filtered)	M18-Jn29485	CP	mg/L	0.10	0.10	<1	30%	Pass	
Beryllium (filtered)	M18-Jn29485	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Boron (filtered)	M18-Jn29485	CP	mg/L	0.47	0.48	2.0	30%	Pass	
Cadmium (filtered)	M18-Jn29485	CP	mg/L	< 0.0002	< 0.0002	<1	30%	Pass	
Chromium (filtered)	M18-Jn29485	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Cobalt (filtered)	M18-Jn29485	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Copper (filtered)	M18-Jn29485	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Iron (filtered)	M18-Jn29485	CP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Lead (filtered)	M18-Jn29485	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Manganese (filtered)	M18-Jn29485	CP	mg/L	0.022	0.022	<1	30%	Pass	
Mercury (filtered)	M18-Jn29485	CP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Molybdenum (filtered)	M18-Jn29485	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Nickel (filtered)	M18-Jn29485	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Selenium (filtered)	M18-Jn29485	CP	mg/L	0.005	0.005	2.0	30%	Pass	
Uranium (filtered)	M18-Jn29485	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Vanadium (filtered)	M18-Jn29485	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Zinc (filtered)	M18-Jn29485	CP	mg/L	0.027	0.027	1.0	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Conductivity (at 25°C)	M18-Jn29487	CP	uS/cm	19000	20000	1.0	30%	Pass	
pH (at 25°C)	M18-Jn29487	CP	pH Units	6.9	6.9	pass	30%	Pass	
Duplicate									
Alkalinity (speciated)				Result 1	Result 2	RPD			
Bicarbonate Alkalinity (as CaCO3)	M18-Jn29487	CP	mg/L	660	660	<1	30%	Pass	
Carbonate Alkalinity (as CaCO3)	M18-Jn29487	CP	mg/L	< 10	< 10	<1	30%	Pass	
Hydroxide Alkalinity (as CaCO3)	M18-Jn29487	CP	mg/L	< 20	< 20	<1	30%	Pass	
Total Alkalinity (as CaCO3)	M18-Jn29487	CP	mg/L	660	660	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Total Dissolved Solids	M18-Jn29867	CP	mg/L	220	210	6.0	30%	Pass	

Comments

Sample Integrity

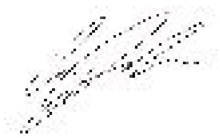
Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
Q08	The matrix spike recovery is outside of the recommended acceptance criteria. An acceptable recovery was obtained for the laboratory control sample indicating a sample matrix interference
R18	The LORs have been raised due to the matrix interference.

Authorised By

Ryan Gilbert	Analytical Services Manager
Alex Petridis	Senior Analyst-Metal (VIC)
Harry Bacalis	Senior Analyst-Volatile (VIC)
Joseph Edouard	Senior Analyst-Organic (VIC)
Michael Brancati	Senior Analyst-Inorganic (VIC)



Glenn Jackson

National Operations Manager

Final report: this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

Certificate of Analysis

NATA Accredited
Accreditation Number 1261
Site Number 20794

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

SLR CONSULTING
Level 2 15 Astor Terrace
Spring Hill
QLD 4000

Attention: **Tony Johnson**

Report **625206-W**
Project name BARALABA SOUTH
Project ID 620.11731.20000.0042
Received Date Oct 30, 2018

Client Sample ID			**AOB8**	**AOB7-DUP**	**POB3**	**POB4**
Sample Matrix			**Water**	**Water**	**Water**	**Water**
Eurofins | mgt Sample No.			**B18-Oc37609**	**B18-Oc37610**	**B18-Oc37611**	**B18-Oc37612**
Date Sampled			**Oct 27, 2018**	**Oct 27, 2018**	**Oct 25, 2018**	**Oct 25, 2018**
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
TRH C6-C10	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TRH - 2013 NEPM Fractions (after silica gel clean-up)						
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH - 1999 NEPM Fractions (after silica gel clean-up)						
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Chloride	1	mg/L	13000	8800	16000	17000
Conductivity (at 25°C)	1	uS/cm	27000	18000	31000	35000
Fluoride	0.5	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
pH (at 25°C)	0.1	pH Units	7.3	7.3	7.0	6.9
Sulphate (as SO4)	5	mg/L	1500	530	1200	1800
Total Dissolved Solids	10	mg/L	27000	19000	27000	35000
Alkalinity (speciated)						
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	800	430	330	550
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	20	mg/L	< 20	< 20	< 20	< 20
Total Alkalinity (as CaCO3)	20	mg/L	800	430	330	550
Heavy Metals						
Aluminium	0.05	mg/L	47	200	< 0.05	< 0.05
Aluminium (filtered)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic	0.001	mg/L	0.040	0.024	0.002	0.001
Arsenic (filtered)	0.001	mg/L	0.002	< 0.001	0.002	0.001
Barium	0.005	mg/L	1.5	2.2	0.076	0.10
Barium (filtered)	0.005	mg/L	0.095	0.35	0.077	0.11
Beryllium	0.001	mg/L	0.019	0.010	< 0.001	< 0.001
Beryllium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Boron	0.05	mg/L	0.18	0.17	0.20	0.22
Boron (filtered)	0.05	mg/L	0.37	0.26	0.16	0.28

Client Sample ID			AOB8	AOB7-DUP	POB3	POB4
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			B18-Oc37609	B18-Oc37610	B18-Oc37611	B18-Oc37612
Date Sampled			Oct 27, 2018	Oct 27, 2018	Oct 25, 2018	Oct 25, 2018
Test/Reference	LOR	Unit				
Heavy Metals						
Cadmium	0.0002	mg/L	0.0019	0.0020	< 0.0002	< 0.0002
Cadmium (filtered)	0.0002	mg/L	0.0003	0.0006	< 0.0002	< 0.0002
Chromium	0.001	mg/L	0.092	0.12	0.002	0.003
Chromium (filtered)	0.001	mg/L	0.002	< 0.001	0.001	0.003
Cobalt	0.001	mg/L	0.042	0.16	0.001	0.015
Cobalt (filtered)	0.001	mg/L	0.004	0.008	0.001	0.017
Copper	0.001	mg/L	0.38	0.41	< 0.001	0.009
Copper (filtered)	0.001	mg/L	0.021	0.008	< 0.001	< 0.001
Iron	0.05	mg/L	70	320	7.8	2.0
Iron (filtered)	0.05	mg/L	< 0.05	< 0.05	7.4	2.1
Lead	0.001	mg/L	0.24	0.14	< 0.001	< 0.001
Lead (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	4.8	9.0	2.8	3.5
Manganese (filtered)	0.005	mg/L	1.7	2.4	2.9	3.6
Mercury	0.0001	mg/L	0.0003	0.0004	< 0.0001	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.005	mg/L	0.019	< 0.005	< 0.005	< 0.005
Molybdenum (filtered)	0.005	mg/L	0.034	0.012	0.008	0.013
Nickel	0.001	mg/L	0.14	0.19	0.002	0.033
Nickel (filtered)	0.001	mg/L	0.044	0.010	0.001	0.039
Selenium	0.001	mg/L	0.002	< 0.001	< 0.001	< 0.001
Selenium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Uranium	0.005	mg/L	0.12	0.014	< 0.005	< 0.005
Uranium (filtered)	0.005	mg/L	0.058	< 0.005	< 0.005	< 0.005
Vanadium	0.005	mg/L	0.076	0.28	< 0.005	< 0.005
Vanadium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Zinc	0.001	mg/L	0.57	0.70	0.005	0.007
Zinc (filtered)	0.005	mg/L	0.020	0.010	0.008	< 0.005
Eurofins | mgt Suite B11C: Na/K/Ca/Mg						
Calcium	0.5	mg/L	900	1200	1700	2300
Magnesium	0.5	mg/L	1100	770	1100	1600
Potassium	0.5	mg/L	34	20	34	45
Sodium	0.5	mg/L	4400	2700	4700	5000

Client Sample ID			AOB2	AOB7	AOB11	AOB3
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			B18-Oc37613	B18-Oc37614	B18-Oc37615	B18-Oc37616
Date Sampled			Oct 27, 2018	Oct 27, 2018	Oct 28, 2018	Oct 27, 2018
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
TRH C6-C10	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TRH - 2013 NEPM Fractions (after silica gel clean-up)						
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1

Client Sample ID			AOB2	AOB7	AOB11	AOB3
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			B18-Oc37613	B18-Oc37614	B18-Oc37615	B18-Oc37616
Date Sampled			Oct 27, 2018	Oct 27, 2018	Oct 28, 2018	Oct 27, 2018
Test/Reference	LOR	Unit				
TRH - 1999 NEPM Fractions (after silica gel clean-up)						
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Chloride	1	mg/L	80	8100	40	63
Conductivity (at 25°C)	1	uS/cm	520	18000	320	460
Fluoride	0.5	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
pH (at 25°C)	0.1	pH Units	6.9	7.3	7.0	7.3
Sulphate (as SO4)	5	mg/L	6.1	500	< 5	16
Total Dissolved Solids	10	mg/L	350	16000	240	350
Alkalinity (speciated)						
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	180	390	140	160
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	20	mg/L	< 20	< 20	< 20	< 20
Total Alkalinity (as CaCO3)	20	mg/L	180	390	140	160
Heavy Metals						
Aluminium	0.05	mg/L	< 0.05	210	0.38	< 0.05
Aluminium (filtered)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic	0.001	mg/L	< 0.001	0.024	0.007	0.003
Arsenic (filtered)	0.001	mg/L	< 0.001	< 0.001	0.008	0.003
Barium	0.005	mg/L	0.090	2.5	0.10	0.10
Barium (filtered)	0.005	mg/L	0.087	0.35	0.098	0.10
Beryllium	0.001	mg/L	< 0.001	0.011	< 0.001	< 0.001
Beryllium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Boron	0.05	mg/L	< 0.05	0.18	< 0.05	< 0.05
Boron (filtered)	0.05	mg/L	0.07	0.23	< 0.05	0.06
Cadmium	0.0002	mg/L	< 0.0002	0.0021	< 0.0002	< 0.0002
Cadmium (filtered)	0.0002	mg/L	< 0.0002	0.0006	< 0.0002	< 0.0002
Chromium	0.001	mg/L	< 0.001	0.14	< 0.001	< 0.001
Chromium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Cobalt	0.001	mg/L	< 0.001	0.17	0.007	0.001
Cobalt (filtered)	0.001	mg/L	< 0.001	0.008	0.006	0.001
Copper	0.001	mg/L	< 0.001	0.44	< 0.001	0.002
Copper (filtered)	0.001	mg/L	< 0.001	0.010	< 0.001	0.004
Iron	0.05	mg/L	< 0.05	360	4.1	0.19
Iron (filtered)	0.05	mg/L	< 0.05	< 0.05	3.7	0.16
Lead	0.001	mg/L	< 0.001	0.16	< 0.001	< 0.001
Lead (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	0.014	10	0.84	0.15
Manganese (filtered)	0.005	mg/L	0.013	2.3	0.84	0.15
Mercury	0.0001	mg/L	< 0.0001	0.0005	< 0.0001	< 0.0001
Mercury (filtered)	0.0001	mg/L	0.0002	< 0.0001	0.0001	0.0002
Molybdenum	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Molybdenum (filtered)	0.005	mg/L	0.008	0.011	0.008	0.009
Nickel	0.001	mg/L	0.001	0.21	0.002	0.002
Nickel (filtered)	0.001	mg/L	0.001	0.010	0.002	0.002
Selenium	0.001	mg/L	< 0.001	< 0.001	< 0.001	0.001
Selenium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	0.002

Client Sample ID			AOB2	AOB7	AOB11	AOB3
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			B18-Oc37613	B18-Oc37614	B18-Oc37615	B18-Oc37616
Date Sampled			Oct 27, 2018	Oct 27, 2018	Oct 28, 2018	Oct 27, 2018
Test/Reference	LOR	Unit				
Heavy Metals						
Uranium	0.005	mg/L	< 0.005	0.015	< 0.005	< 0.005
Uranium (filtered)	0.005	mg/L	< 0.005	0.005	< 0.005	< 0.005
Vanadium	0.005	mg/L	0.005	0.29	< 0.005	0.008
Vanadium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	0.007
Zinc	0.001	mg/L	0.006	0.76	0.007	0.006
Zinc (filtered)	0.005	mg/L	< 0.005	0.18	< 0.005	< 0.005
Eurofins | mgt Suite B11C: Na/K/Ca/Mg						
Calcium	0.5	mg/L	14	1300	21	4.7
Magnesium	0.5	mg/L	10	800	11	3.4
Potassium	0.5	mg/L	3.8	22	3.6	1.4
Sodium	0.5	mg/L	82	2900	32	94

Client Sample ID			APB1	AOB12	AOB1	AOB10
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			B18-Oc37617	B18-Oc37618	B18-Oc37619	B18-Oc37620
Date Sampled			Oct 27, 2018	Oct 27, 2018	Oct 27, 2018	Oct 28, 2018
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
TRH C6-C10	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TRH - 2013 NEPM Fractions (after silica gel clean-up)						
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH - 1999 NEPM Fractions (after silica gel clean-up)						
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Chloride	1	mg/L	95	33	36	19000
Conductivity (at 25°C)	1	uS/cm	540	280	440	37000
Fluoride	0.5	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
pH (at 25°C)	0.1	pH Units	7.1	6.8	6.9	6.9
Sulphate (as SO4)	5	mg/L	< 5	< 5	15	1200
Total Dissolved Solids	10	mg/L	370	190	310	38000
Alkalinity (speciated)						
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	180	140	230	280
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	20	mg/L	< 20	< 20	< 20	< 20
Total Alkalinity (as CaCO3)	20	mg/L	180	140	230	280
Heavy Metals						
Aluminium	0.05	mg/L	< 0.05	0.41	0.46	38
Aluminium (filtered)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic	0.001	mg/L	< 0.001	0.010	0.001	0.010
Arsenic (filtered)	0.001	mg/L	< 0.001	0.011	0.001	< 0.001

Client Sample ID			APB1	AOB12	AOB1	AOB10
Sample Matrix			Water	Water	Water	Water
Eurofins | mgt Sample No.			B18-Oc37617	B18-Oc37618	B18-Oc37619	B18-Oc37620
Date Sampled			Oct 27, 2018	Oct 27, 2018	Oct 27, 2018	Oct 28, 2018
Test/Reference	LOR	Unit				
Heavy Metals						
Barium	0.005	mg/L	0.10	0.080	0.15	0.61
Barium (filtered)	0.005	mg/L	0.10	0.081	0.15	0.21
Beryllium	0.001	mg/L	< 0.001	< 0.001	< 0.001	0.003
Beryllium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Boron	0.05	mg/L	< 0.05	< 0.05	0.06	0.13
Boron (filtered)	0.05	mg/L	< 0.05	< 0.05	0.06	0.11
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	0.0020
Cadmium (filtered)	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	0.0016
Chromium	0.001	mg/L	< 0.001	< 0.001	< 0.001	0.040
Chromium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Cobalt	0.001	mg/L	< 0.001	0.002	< 0.001	0.032
Cobalt (filtered)	0.001	mg/L	< 0.001	0.002	< 0.001	0.005
Copper	0.001	mg/L	0.002	< 0.001	0.005	0.33
Copper (filtered)	0.001	mg/L	< 0.001	< 0.001	0.003	0.087
Iron	0.05	mg/L	< 0.05	6.6	0.27	53
Iron (filtered)	0.05	mg/L	< 0.05	6.3	< 0.05	< 0.05
Lead	0.001	mg/L	< 0.001	< 0.001	< 0.001	0.043
Lead (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	< 0.005	0.41	0.034	1.5
Manganese (filtered)	0.005	mg/L	< 0.005	0.42	0.031	0.44
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	0.0001
Mercury (filtered)	0.0001	mg/L	0.0001	< 0.0001	0.0001	< 0.0001
Molybdenum	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Molybdenum (filtered)	0.005	mg/L	0.009	0.010	0.008	0.005
Nickel	0.001	mg/L	0.001	0.001	0.002	0.053
Nickel (filtered)	0.001	mg/L	0.002	0.001	0.002	0.007
Selenium	0.001	mg/L	< 0.001	< 0.001	< 0.001	0.008
Selenium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	0.005
Uranium	0.005	mg/L	< 0.005	< 0.005	< 0.005	0.006
Uranium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Vanadium	0.005	mg/L	< 0.005	< 0.005	< 0.005	0.086
Vanadium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Zinc	0.001	mg/L	0.006	0.007	0.009	0.17
Zinc (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	0.051
Eurofins | mgt Suite B11C: Na/K/Ca/Mg						
Calcium	0.5	mg/L	16	17	-	-
Magnesium	0.5	mg/L	8.1	8.3	-	-
Potassium	0.5	mg/L	3.8	3.3	-	-
Sodium	0.5	mg/L	91	28	-	-

Client Sample ID			AOB4
Sample Matrix			**Water**
Eurofins | mgt Sample No.			**B18-Oc37621**
Date Sampled			**Oct 28, 2018**
Test/Reference	LOR	Unit	
Chloride	1	mg/L	17000
Conductivity (at 25°C)	1	uS/cm	35000
Fluoride	0.5	mg/L	< 0.5
pH (at 25°C)	0.1	pH Units	7.1
Sulphate (as SO4)	5	mg/L	1700
Total Dissolved Solids	10	mg/L	38000
Alkalinity (speciated)			
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	510
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10
Hydroxide Alkalinity (as CaCO3)	20	mg/L	< 20
Total Alkalinity (as CaCO3)	20	mg/L	510

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Total Recoverable Hydrocarbons - 1999 NEPM Fractions	Melbourne	Nov 01, 2018	7 Day
- Method: LTM-ORG-2010 TRH C6-C40			
Total Recoverable Hydrocarbons	Melbourne	Nov 01, 2018	7 Day
- Method: LTM-ORG-2010 TRH C6-C40			
Conductivity (at 25°C)	Melbourne	Nov 01, 2018	28 Day
- Method: LTM-INO-4030 Conductivity			
pH (at 25°C)	Melbourne	Nov 01, 2018	0 Hours
- Method: LTM-GEN-7090 pH in water by ISE			
Total Dissolved Solids	Melbourne	Nov 01, 2018	7 Day
- Method: LTM-INO-4170 Total Dissolved Solids in Water			
Heavy Metals	Brisbane	Oct 31, 2018	180 Day
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Heavy Metals (filtered)	Brisbane	Oct 31, 2018	180 Day
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Mobil Metals : Metals M15	Brisbane	Oct 31, 2018	28 Day
- Method: USEPA 6010/6020 Heavy Metals & USEPA 7470/71 Mercury			
Eurofins | mgt Suite B11C: Na/K/Ca/Mg	Melbourne	Nov 01, 2018	180 Day
- Method: LTM-MET-3010 Alkali Metals by ICP-AES			
TRH - 2013 NEPM Fractions (after silica gel clean-up)	Melbourne	Nov 02, 2018	7 Day
- Method: LTM-ORG-2010 TRH C6-C40			
TRH - 1999 NEPM Fractions (after silica gel clean-up)	Melbourne	Nov 02, 2018	7 Day
- Method: TRH C6-C36 (Silica Gel Cleanup) - MGT 100A			
Eurofins | mgt Suite B11F: Cl/SO4/Alkalinity/Total F			
Chloride	Melbourne	Nov 01, 2018	28 Day
- Method: LTM-INO-4090 Chloride by Discrete Analyser			
Fluoride	Melbourne	Nov 01, 2018	28 Day
- Method: APHA 4500 F-C Fluoride by Ion Selective Electrode			
Sulphate (as SO4)	Melbourne	Nov 01, 2018	28 Day
- Method: LTM-INO-4110 Sulfate by Discrete Analyser			
Alkalinity (speciated)	Melbourne	Nov 01, 2018	14 Day
- Method: APHA 2320 Alkalinity by Titration			

Company Name:	SLR Consulting (Qld)	**Order No.:**		**Received:**	Oct 30, 2018 2:30 PM
Address:	Level 2 15 Astor Terrace	**Report #:**	625206	**Due:**	Nov 6, 2018
	Spring Hill	**Phone:**	07 3858 4800	**Priority:**	5 Day
	QLD 4000	**Fax:**		**Contact Name:**	Tony Johnson
Project Name:	BARALABA SOUTH				
Project ID:	620.11731.20000.0042				

Eurofins | mgt Analytical Services Manager : Ryan Gilbert

Sample Detail						Aluminium	Aluminium (filtered)	Arsenic	Arsenic (filtered)	Barium	Barium (filtered)	Beryllium	Beryllium (filtered)	Boron	Boron (filtered)	Cadmium	Cadmium (filtered)	Chromium	Chromium (filtered)	Cobalt	Cobalt (filtered)	Conductivity (at 25°C)	Copper	Copper (filtered)	Iron	Iron (filtered)	Lead	Lead (filtered)	Manganese	Manganese (filtered)	Mercury	Mercury (filtered)	Molybdenum	Molybdenum (filtered)	Nickel	Nickel (filtered)	pH (at 25°C)	Selenium	Selenium (filtered)	Total Dissolved Solids	TRH C6-C10	TRH C6-C9	Uranium	Uranium (filtered)	Vanadium	Vanadium (filtered)	Zinc	Zinc (filtered)	TRH (after Silica Gel cleanup)	Eurofins | mgt Suite B11F:	Eurofins | mgt Suite B11C: Na/K/Ca/Mg
Melbourne Laboratory - NATA Site # 1254 & 14271																						X															X			X	X	X							X	X	X
Sydney Laboratory - NATA Site # 18217																																																			
Brisbane Laboratory - NATA Site # 20794						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X				X	X	X	X	X	X			
Perth Laboratory - NATA Site # 23736																																																			
External Laboratory																																																			
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**																																														
1	AOB8	Oct 27, 2018		Water	B18-Oc37609	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2	AOB7-DUP	Oct 27, 2018		Water	B18-Oc37610	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3	POB3	Oct 25, 2018		Water	B18-Oc37611	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4	POB4	Oct 25, 2018		Water	B18-Oc37612	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5	AOB2	Oct 27, 2018		Water	B18-Oc37613	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6	AOB7	Oct 27, 2018		Water	B18-Oc37614	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7	AOB11	Oct 28, 2018		Water	B18-Oc37615	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8	AOB3	Oct 27, 2018		Water	B18-Oc37616	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
9	APB1	Oct 27, 2018		Water	B18-Oc37617	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

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Project ID: 620.11731.20000.0042

Order No.:
Report #: 625206
Phone: 07 3858 4800
Fax:

Received: Oct 30, 2018 2:30 PM
Due: Nov 6, 2018
Priority: 5 Day
Contact Name: Tony Johnson

Eurofins | mgt Analytical Services Manager : Ryan Gilbert

Sample Detail						Aluminium	Aluminium (filtered)	Arsenic	Arsenic (filtered)	Barium	Barium (filtered)	Beryllium	Beryllium (filtered)	Boron	Boron (filtered)	Cadmium	Cadmium (filtered)	Chromium	Chromium (filtered)	Cobalt	Cobalt (filtered)	Conductivity (at 25°C)	Copper	Copper (filtered)	Iron	Iron (filtered)	Lead	Lead (filtered)	Manganese	Manganese (filtered)	Mercury	Mercury (filtered)	Molybdenum	Molybdenum (filtered)	Nickel	Nickel (filtered)	pH (at 25°C)	Selenium	Selenium (filtered)	Total Dissolved Solids	TRH C6-C10	TRH C6-C9	Uranium	Uranium (filtered)	Vanadium	Vanadium (filtered)	Zinc	Zinc (filtered)	TRH (after Silica Gel cleanup)	Eurofins | mgt Suite B11F:	Eurofins | mgt Suite B11C: Na/K/Ca/Mg
Melbourne Laboratory - NATA Site # 1254 & 14271																						X															X			X	X	X							X	X	X
Sydney Laboratory - NATA Site # 18217																																																			
Brisbane Laboratory - NATA Site # 20794						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X				X	X	X	X	X	X			
Perth Laboratory - NATA Site # 23736																																																			
10	AOB12	Oct 27, 2018		Water	B18-Oc37618	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
11	AOB1	Oct 27, 2018		Water	B18-Oc37619	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
12	AOB10	Oct 28, 2018		Water	B18-Oc37620	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
13	AOB4	Oct 28, 2018		Water	B18-Oc37621																	X															X			X										X	
Test Counts						12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	13	12	12	12	12	12	12	12	12	12	12	12	12	12	12	13	12	12	13	12	12	12	12	12	12	12	12	12	13	10

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram	**mg/L:** milligrams per litre	**ug/L:** micrograms per litre
ppm: Parts per million	**ppb:** Parts per billion	**%:** Percentage
org/100mL: Organisms per 100 millilitres	**NTU:** Nephelometric Turbidity Units	**MPN/100mL:** Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	Quality Systems Manual ver 5.1 US Department of Defense
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 50-150%-Phenols & PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.1 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	mg/L	< 0.02			0.02	Pass	
Method Blank							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
TRH C6-C10	mg/L	< 0.02			0.02	Pass	
Method Blank							
TRH - 2013 NEPM Fractions (after silica gel clean-up)							
TRH >C10-C16 (after silica gel clean-up)	mg/L	< 0.05			0.05	Pass	
TRH >C16-C34 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
TRH >C34-C40 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
Method Blank							
TRH - 1999 NEPM Fractions (after silica gel clean-up)							
TRH C10-C14 (after silica gel clean-up)	mg/L	< 0.05			0.05	Pass	
TRH C15-C28 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
TRH C29-C36 (after silica gel clean-up)	mg/L	< 0.1			0.1	Pass	
Method Blank							
Chloride	mg/L	< 1			1	Pass	
Fluoride	mg/L	< 0.5			0.5	Pass	
Sulphate (as SO4)	mg/L	< 5			5	Pass	
Total Dissolved Solids	mg/L	< 10			10	Pass	
Method Blank							
Alkalinity (speciated)							
Bicarbonate Alkalinity (as CaCO3)	mg/L	< 20			20	Pass	
Carbonate Alkalinity (as CaCO3)	mg/L	< 10			10	Pass	
Hydroxide Alkalinity (as CaCO3)	mg/L	< 20			20	Pass	
Total Alkalinity (as CaCO3)	mg/L	< 20			20	Pass	
Method Blank							
Heavy Metals							
Aluminium	mg/L	< 0.05			0.05	Pass	
Aluminium (filtered)	mg/L	< 0.05			0.05	Pass	
Arsenic	mg/L	< 0.001			0.001	Pass	
Arsenic (filtered)	mg/L	< 0.001			0.001	Pass	
Barium	mg/L	< 0.005			0.005	Pass	
Barium (filtered)	mg/L	< 0.005			0.005	Pass	
Beryllium	mg/L	< 0.001			0.001	Pass	
Beryllium (filtered)	mg/L	< 0.001			0.001	Pass	
Boron	mg/L	< 0.05			0.05	Pass	
Boron (filtered)	mg/L	< 0.05			0.05	Pass	
Cadmium	mg/L	< 0.0002			0.0002	Pass	
Cadmium (filtered)	mg/L	< 0.0002			0.0002	Pass	
Chromium	mg/L	< 0.001			0.001	Pass	
Chromium (filtered)	mg/L	< 0.001			0.001	Pass	
Cobalt	mg/L	< 0.001			0.001	Pass	
Cobalt (filtered)	mg/L	< 0.001			0.001	Pass	
Copper	mg/L	< 0.001			0.001	Pass	
Copper (filtered)	mg/L	< 0.001			0.001	Pass	
Iron	mg/L	< 0.05			0.05	Pass	
Iron (filtered)	mg/L	< 0.05			0.05	Pass	
Lead	mg/L	< 0.001			0.001	Pass	
Lead (filtered)	mg/L	< 0.001			0.001	Pass	
Manganese	mg/L	< 0.005			0.005	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Manganese (filtered)	mg/L	< 0.005			0.005	Pass	
Mercury	mg/L	< 0.0001			0.0001	Pass	
Mercury (filtered)	mg/L	< 0.0001			0.0001	Pass	
Molybdenum	mg/L	< 0.005			0.005	Pass	
Molybdenum (filtered)	mg/L	< 0.005			0.005	Pass	
Nickel	mg/L	< 0.001			0.001	Pass	
Nickel (filtered)	mg/L	< 0.001			0.001	Pass	
Selenium	mg/L	< 0.001			0.001	Pass	
Selenium (filtered)	mg/L	< 0.001			0.001	Pass	
Uranium	mg/L	< 0.005			0.005	Pass	
Uranium (filtered)	mg/L	< 0.005			0.005	Pass	
Vanadium	mg/L	< 0.005			0.005	Pass	
Vanadium (filtered)	mg/L	< 0.005			0.005	Pass	
Zinc (filtered)	mg/L	< 0.005			0.005	Pass	
Method Blank							
Eurofins | mgt Suite B11C: Na/K/Ca/Mg							
Calcium	mg/L	< 0.5			0.5	Pass	
Magnesium	mg/L	< 0.5			0.5	Pass	
Potassium	mg/L	< 0.5			0.5	Pass	
Sodium	mg/L	< 0.5			0.5	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	%	116			70-130	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
TRH C6-C10	%	125			70-130	Pass	
LCS - % Recovery							
TRH - 2013 NEPM Fractions (after silica gel clean-up)							
TRH >C10-C16 (after silica gel clean-up)	%	96			70-130	Pass	
LCS - % Recovery							
TRH - 1999 NEPM Fractions (after silica gel clean-up)							
TRH C10-C14 (after silica gel clean-up)	%	88			70-130	Pass	
LCS - % Recovery							
Chloride	%	107			70-130	Pass	
Fluoride	%	103			70-130	Pass	
Sulphate (as SO4)	%	110			70-130	Pass	
Total Dissolved Solids	%	114			70-130	Pass	
LCS - % Recovery							
Alkalinity (speciated)							
Carbonate Alkalinity (as CaCO3)	%	93			70-130	Pass	
Total Alkalinity (as CaCO3)	%	94			70-130	Pass	
LCS - % Recovery							
Heavy Metals							
Aluminium	%	103			80-120	Pass	
Aluminium (filtered)	%	99			80-120	Pass	
Arsenic	%	91			80-120	Pass	
Arsenic (filtered)	%	94			80-120	Pass	
Barium	%	95			80-120	Pass	
Beryllium	%	100			80-120	Pass	
Beryllium (filtered)	%	98			80-120	Pass	
Boron	%	107			80-120	Pass	
Boron (filtered)	%	104			80-120	Pass	
Cadmium	%	95			80-120	Pass	
Cadmium (filtered)	%	95			80-120	Pass	

Test			Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Chromium			%	95			80-120	Pass	
Chromium (filtered)			%	96			80-120	Pass	
Cobalt			%	97			80-120	Pass	
Cobalt (filtered)			%	94			80-120	Pass	
Copper			%	96			80-120	Pass	
Copper (filtered)			%	96			80-120	Pass	
Iron			%	94			80-120	Pass	
Iron (filtered)			%	97			80-120	Pass	
Lead			%	97			80-120	Pass	
Lead (filtered)			%	93			80-120	Pass	
Manganese			%	96			80-120	Pass	
Manganese (filtered)			%	96			80-120	Pass	
Mercury			%	95			70-130	Pass	
Mercury (filtered)			%	98			70-130	Pass	
Molybdenum			%	97			80-120	Pass	
Molybdenum (filtered)			%	94			80-120	Pass	
Nickel			%	96			80-120	Pass	
Nickel (filtered)			%	96			80-120	Pass	
Selenium			%	89			80-120	Pass	
Selenium (filtered)			%	98			80-120	Pass	
Uranium			%	97			80-120	Pass	
Uranium (filtered)			%	96			80-120	Pass	
Vanadium			%	98			80-120	Pass	
Zinc			%	89			80-120	Pass	
Zinc (filtered)			%	95			80-120	Pass	
LCS - % Recovery									
Eurofins | mgt Suite B11C: Na/K/Ca/Mg									
Calcium			%	108			70-130	Pass	
Magnesium			%	110			70-130	Pass	
Potassium			%	96			70-130	Pass	
Sodium			%	106			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
				Result 1					
Chloride	B18-Oc37465	NCP	%	112			70-130	Pass	
Spike - % Recovery									
Alkalinity (speciated)				Result 1					
Carbonate Alkalinity (as CaCO3)	M18-No00450	NCP	%	71			70-130	Pass	
Total Alkalinity (as CaCO3)	M18-No00450	NCP	%	78			70-130	Pass	
Spike - % Recovery									
Eurofins | mgt Suite B11C: Na/K/Ca/Mg				Result 1					
Calcium	B18-Oc37609	CP	%	116			70-130	Pass	
Magnesium	B18-Oc37609	CP	%	118			70-130	Pass	
Potassium	B18-Oc37609	CP	%	111			70-130	Pass	
Sodium	B18-Oc37609	CP	%	115			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Aluminium (filtered)	B18-Oc37610	CP	%	88			75-125	Pass	
Arsenic	B18-Oc37610	CP	%	77			75-125	Pass	
Arsenic (filtered)	B18-Oc37610	CP	%	89			70-130	Pass	
Barium	B18-Oc37610	CP	%	107			75-125	Pass	
Barium (filtered)	B18-Oc37610	CP	%	112			75-125	Pass	
Beryllium (filtered)	B18-Oc37610	CP	%	86			75-125	Pass	
Boron	B18-Oc37610	CP	%	78			75-125	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Boron (filtered)	B18-Oc37610	CP	%	100			75-125	Pass	
Cadmium	B18-Oc37610	CP	%	91			75-125	Pass	
Cadmium (filtered)	B18-Oc37610	CP	%	99			70-130	Pass	
Chromium (filtered)	B18-Oc37610	CP	%	80			70-130	Pass	
Cobalt (filtered)	B18-Oc37610	CP	%	74			75-125	Fail	Q08
Copper (filtered)	B18-Oc37610	CP	%	74			70-130	Pass	
Iron (filtered)	B18-Oc37610	CP	%	76			70-130	Pass	
Lead	B18-Oc37610	CP	%	81			75-125	Pass	
Lead (filtered)	B18-Oc37610	CP	%	81			70-130	Pass	
Manganese	B18-Oc37610	CP	%	96			75-125	Pass	
Mercury	B18-Oc37610	CP	%	83			70-130	Pass	
Mercury (filtered)	B18-Oc37610	CP	%	89			70-130	Pass	
Molybdenum (filtered)	B18-Oc37610	CP	%	90			75-125	Pass	
Nickel (filtered)	B18-Oc37610	CP	%	75			70-130	Pass	
Selenium (filtered)	B18-Oc37610	CP	%	90			70-130	Pass	
Uranium	B18-Oc37610	CP	%	87			75-125	Pass	
Uranium (filtered)	B18-Oc37610	CP	%	86			70-130	Pass	
Vanadium	B18-Oc37610	CP	%	75			75-125	Pass	
Vanadium (filtered)	B18-Oc37610	CP	%	83			75-125	Pass	
Zinc (filtered)	B18-Oc37610	CP	%	72			70-130	Pass	
Spike - % Recovery									
				Result 1					
Sulphate (as SO4)	B18-Oc37619	CP	%	108			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Aluminium (filtered)	B18-Oc37620	CP	%	99			75-125	Pass	
Arsenic	B18-Oc37620	CP	%	99			75-125	Pass	
Arsenic (filtered)	B18-Oc37620	CP	%	116			70-130	Pass	
Barium	B18-Oc37620	CP	%	97			75-125	Pass	
Barium (filtered)	B18-Oc37620	CP	%	110			75-125	Pass	
Beryllium	B18-Oc37620	CP	%	92			75-125	Pass	
Beryllium (filtered)	B18-Oc37620	CP	%	77			75-125	Pass	
Boron	B18-Oc37620	CP	%	81			75-125	Pass	
Cadmium	B18-Oc37620	CP	%	95			75-125	Pass	
Cadmium (filtered)	B18-Oc37620	CP	%	90			70-130	Pass	
Chromium	B18-Oc37620	CP	%	80			75-125	Pass	
Chromium (filtered)	B18-Oc37620	CP	%	79			70-130	Pass	
Cobalt	B18-Oc37620	CP	%	72			75-125	Fail	Q08
Cobalt (filtered)	B18-Oc37620	CP	%	68			75-125	Fail	Q08
Copper (filtered)	B18-Oc37620	CP	%	61			70-130	Fail	Q08
Iron (filtered)	B18-Oc37620	CP	%	76			70-130	Pass	
Lead	B18-Oc37620	CP	%	80			75-125	Pass	
Lead (filtered)	B18-Oc37620	CP	%	74			70-130	Pass	
Manganese	B18-Oc37620	CP	%	83			75-125	Pass	
Manganese (filtered)	B18-Oc37620	CP	%	80			70-130	Pass	
Mercury	B18-Oc37620	CP	%	85			70-130	Pass	
Mercury (filtered)	B18-Oc37620	CP	%	80			70-130	Pass	
Molybdenum	B18-Oc37620	CP	%	92			75-125	Pass	
Molybdenum (filtered)	B18-Oc37620	CP	%	104			75-125	Pass	
Nickel (filtered)	B18-Oc37620	CP	%	65			70-130	Fail	Q08
Selenium	B18-Oc37620	CP	%	84			75-125	Pass	
Selenium (filtered)	B18-Oc37620	CP	%	74			70-130	Pass	
Uranium	B18-Oc37620	CP	%	88			75-125	Pass	
Uranium (filtered)	B18-Oc37620	CP	%	81			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Vanadium	B18-Oc37620	CP	%	85			75-125	Pass	
Vanadium (filtered)	B18-Oc37620	CP	%	85			75-125	Pass	
Zinc (filtered)	B18-Oc37620	CP	%	60			70-130	Fail	Q08
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
				Result 1	Result 2	RPD			
Sulphate (as SO4)	M18-Oc37832	NCP	mg/L	540	550	1.2	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Aluminium (filtered)	B18-Oc37609	CP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Arsenic	B18-Oc37609	CP	mg/L	0.040	0.040	1.0	30%	Pass	
Arsenic (filtered)	B18-Oc37609	CP	mg/L	0.002	0.002	2.0	30%	Pass	
Barium	B18-Oc37609	CP	mg/L	1.5	1.5	1.0	30%	Pass	
Barium (filtered)	B18-Oc37609	CP	mg/L	0.095	0.10	5.0	30%	Pass	
Beryllium	B18-Oc37609	CP	mg/L	0.019	0.018	6.0	30%	Pass	
Beryllium (filtered)	B18-Oc37609	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Boron	B18-Oc37609	CP	mg/L	0.18	0.18	<1	30%	Pass	
Cadmium	B18-Oc37609	CP	mg/L	0.0019	0.0018	3.0	30%	Pass	
Cadmium (filtered)	B18-Oc37609	CP	mg/L	0.0003	0.0004	29	30%	Pass	
Chromium	B18-Oc37609	CP	mg/L	0.092	0.089	3.0	30%	Pass	
Chromium (filtered)	B18-Oc37609	CP	mg/L	0.002	0.002	5.0	30%	Pass	
Cobalt	B18-Oc37609	CP	mg/L	0.042	0.040	7.0	30%	Pass	
Cobalt (filtered)	B18-Oc37609	CP	mg/L	0.004	0.004	2.0	30%	Pass	
Copper	B18-Oc37609	CP	mg/L	0.38	0.35	6.0	30%	Pass	
Copper (filtered)	B18-Oc37609	CP	mg/L	0.021	0.022	5.0	30%	Pass	
Iron	B18-Oc37609	CP	mg/L	70	70	<1	30%	Pass	
Iron (filtered)	B18-Oc37609	CP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Lead	B18-Oc37609	CP	mg/L	0.24	0.23	8.0	30%	Pass	
Lead (filtered)	B18-Oc37609	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Manganese	B18-Oc37609	CP	mg/L	4.8	4.6	3.0	30%	Pass	
Manganese (filtered)	B18-Oc37609	CP	mg/L	1.7	1.7	2.0	30%	Pass	
Mercury	B18-Oc37609	CP	mg/L	0.0003	0.0002	15	30%	Pass	
Mercury (filtered)	B18-Oc37609	CP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Molybdenum	B18-Oc37609	CP	mg/L	0.019	0.020	6.0	30%	Pass	
Molybdenum (filtered)	B18-Oc37609	CP	mg/L	0.034	0.030	12	30%	Pass	
Nickel	B18-Oc37609	CP	mg/L	0.14	0.13	5.0	30%	Pass	
Nickel (filtered)	B18-Oc37609	CP	mg/L	0.044	0.044	1.0	30%	Pass	
Selenium	B18-Oc37609	CP	mg/L	0.002	0.002	4.0	30%	Pass	
Selenium (filtered)	B18-Oc37609	CP	mg/L	< 0.001	0.001	10	30%	Pass	
Uranium	B18-Oc37609	CP	mg/L	0.12	0.11	6.0	30%	Pass	
Uranium (filtered)	B18-Oc37609	CP	mg/L	0.058	0.059	2.0	30%	Pass	
Vanadium	B18-Oc37609	CP	mg/L	0.076	0.071	7.0	30%	Pass	
Vanadium (filtered)	B18-Oc37609	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Zinc	B18-Oc37609	CP	mg/L	0.57	0.52	8.0	30%	Pass	
Zinc (filtered)	B18-Oc37609	CP	mg/L	0.020	0.019	10	30%	Pass	
Duplicate									
Eurofins | mgt Suite B11C: Na/K/Ca/Mg				Result 1	Result 2	RPD			
Calcium	B18-Oc37609	CP	mg/L	900	860	4.0	30%	Pass	
Magnesium	B18-Oc37609	CP	mg/L	1100	1100	4.0	30%	Pass	
Potassium	B18-Oc37609	CP	mg/L	34	35	3.0	30%	Pass	
Sodium	B18-Oc37609	CP	mg/L	4400	4300	2.0	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Total Dissolved Solids	B18-Oc37610	CP	mg/L	19000	19000	1.0	30%	Pass	

Duplicate									
				Result 1	Result 2	RPD			
Conductivity (at 25°C)	B18-Oc37611	CP	uS/cm	31000	32000	3.0	30%	Pass	
pH (at 25°C)	B18-Oc37611	CP	pH Units	7.0	6.9	pass	30%	Pass	
Duplicate									
Alkalinity (speciated)				Result 1	Result 2	RPD			
Bicarbonate Alkalinity (as CaCO3)	B18-Oc37611	CP	mg/L	330	350	7.0	30%	Pass	
Carbonate Alkalinity (as CaCO3)	B18-Oc37611	CP	mg/L	< 10	< 10	<1	30%	Pass	
Hydroxide Alkalinity (as CaCO3)	B18-Oc37611	CP	mg/L	< 20	< 20	<1	30%	Pass	
Total Alkalinity (as CaCO3)	B18-Oc37611	CP	mg/L	330	350	7.0	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Fluoride	B18-Oc37613	CP	mg/L	< 0.5	< 0.5	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Conductivity (at 25°C)	B18-Oc37614	CP	uS/cm	18000	18000	<1	30%	Pass	
pH (at 25°C)	B18-Oc37614	CP	pH Units	7.3	7.3	pass	30%	Pass	
Duplicate									
Alkalinity (speciated)				Result 1	Result 2	RPD			
Bicarbonate Alkalinity (as CaCO3)	B18-Oc37614	CP	mg/L	390	380	3.0	30%	Pass	
Carbonate Alkalinity (as CaCO3)	B18-Oc37614	CP	mg/L	< 10	< 10	<1	30%	Pass	
Hydroxide Alkalinity (as CaCO3)	B18-Oc37614	CP	mg/L	< 20	< 20	<1	30%	Pass	
Total Alkalinity (as CaCO3)	B18-Oc37614	CP	mg/L	390	380	3.0	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Chloride	B18-Oc37618	CP	mg/L	33	33	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Aluminium	B18-Oc37619	CP	mg/L	0.46	0.50	7.0	30%	Pass	
Aluminium (filtered)	B18-Oc37619	CP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Arsenic	B18-Oc37619	CP	mg/L	0.001	0.001	1.0	30%	Pass	
Arsenic (filtered)	B18-Oc37619	CP	mg/L	0.001	0.001	4.0	30%	Pass	
Barium	B18-Oc37619	CP	mg/L	0.15	0.14	6.0	30%	Pass	
Barium (filtered)	B18-Oc37619	CP	mg/L	0.15	0.15	<1	30%	Pass	
Beryllium	B18-Oc37619	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Beryllium (filtered)	B18-Oc37619	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Boron	B18-Oc37619	CP	mg/L	0.06	0.06	4.0	30%	Pass	
Boron (filtered)	B18-Oc37619	CP	mg/L	0.06	0.07	9.0	30%	Pass	
Cadmium	B18-Oc37619	CP	mg/L	< 0.0002	< 0.0002	<1	30%	Pass	
Cadmium (filtered)	B18-Oc37619	CP	mg/L	< 0.0002	< 0.0002	<1	30%	Pass	
Chromium	B18-Oc37619	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Chromium (filtered)	B18-Oc37619	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Cobalt	B18-Oc37619	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Cobalt (filtered)	B18-Oc37619	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Copper	B18-Oc37619	CP	mg/L	0.005	0.005	7.0	30%	Pass	
Copper (filtered)	B18-Oc37619	CP	mg/L	0.003	0.003	6.0	30%	Pass	
Iron	B18-Oc37619	CP	mg/L	0.27	0.26	4.0	30%	Pass	
Iron (filtered)	B18-Oc37619	CP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Lead	B18-Oc37619	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Lead (filtered)	B18-Oc37619	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Manganese	B18-Oc37619	CP	mg/L	0.034	0.033	5.0	30%	Pass	
Manganese (filtered)	B18-Oc37619	CP	mg/L	0.031	0.030	2.0	30%	Pass	
Mercury	B18-Oc37619	CP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Mercury (filtered)	B18-Oc37619	CP	mg/L	0.0001	0.0002	14	30%	Pass	
Molybdenum	B18-Oc37619	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Molybdenum (filtered)	B18-Oc37619	CP	mg/L	0.008	0.008	4.0	30%	Pass	

Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Nickel	B18-Oc37619	CP	mg/L	0.002	0.002	1.0	30%	Pass	
Nickel (filtered)	B18-Oc37619	CP	mg/L	0.002	0.002	26	30%	Pass	
Selenium	B18-Oc37619	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Selenium (filtered)	B18-Oc37619	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Uranium	B18-Oc37619	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Uranium (filtered)	B18-Oc37619	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Vanadium	B18-Oc37619	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Vanadium (filtered)	B18-Oc37619	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Zinc	B18-Oc37619	CP	mg/L	0.009	0.004	71	30%	Fail	Q15
Zinc (filtered)	B18-Oc37619	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Total Dissolved Solids	B18-Oc37620	CP	mg/L	38000	35000	7.0	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
Q08	The matrix spike recovery is outside of the recommended acceptance criteria. An acceptable recovery was obtained for the laboratory control sample indicating a sample matrix interference
Q15	The RPD reported passes Eurofins | mgt's QC - Acceptance Criteria as defined in the Internal Quality Control Review and Glossary page of this report.

Authorised By

Ryan Gilbert	Analytical Services Manager
Chris Bennett	Senior Analyst-Metal (VIC)
Harry Bacalis	Senior Analyst-Volatile (VIC)
Joseph Edouard	Senior Analyst-Organic (VIC)
Julie Kay	Senior Analyst-Inorganic (VIC)
Steven Trout	Senior Analyst-Metal (QLD)

Glenn Jackson
National Operations Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

Certificate of Analysis

NATA Accredited
Accreditation Number 1261
Site Number 20794

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

SLR CONSULTING
Level 2 15 Astor Terrace
Spring Hill
QLD 4000

Attention: **Tony Johnson**

Report **626708-W**
Project name BARALABA SOUTH
Project ID 620.11731.20000.0042
Received Date Nov 07, 2018

Client Sample ID			AOB1	AOB10	AOB4
Sample Matrix			Water	Water	Water
Eurofins | mgt Sample No.			B18-No10179	B18-No10180	B18-No10181
Date Sampled			Not Provided	Not Provided	Not Provided
Test/Reference	LOR	Unit			
Total Recoverable Hydrocarbons - 1999 NEPM Fractions					
TRH C6-C9	0.02	mg/L	-	-	< 0.02
Total Recoverable Hydrocarbons - 2013 NEPM Fractions					
TRH C6-C10	0.02	mg/L	-	-	< 0.02
TRH - 2013 NEPM Fractions (after silica gel clean-up)					
TRH >C10-C16 (after silica gel clean-up)	0.05	mg/L	-	-	< 0.05
TRH >C16-C34 (after silica gel clean-up)	0.1	mg/L	-	-	< 0.1
TRH >C34-C40 (after silica gel clean-up)	0.1	mg/L	-	-	< 0.1
TRH - 1999 NEPM Fractions (after silica gel clean-up)					
TRH C10-C36 (Total) (after silica gel clean-up)	0.1	mg/L	-	-	< 0.1
TRH C10-C14 (after silica gel clean-up)	0.05	mg/L	-	-	< 0.05
TRH C15-C28 (after silica gel clean-up)	0.1	mg/L	-	-	< 0.1
TRH C29-C36 (after silica gel clean-up)	0.1	mg/L	-	-	< 0.1
Heavy Metals					
Aluminium	0.05	mg/L	-	-	< 0.05
Aluminium (filtered)	0.05	mg/L	-	-	51
Arsenic	0.001	mg/L	-	-	0.002
Arsenic (filtered)	0.001	mg/L	-	-	0.017
Barium	0.005	mg/L	-	-	0.095
Barium (filtered)	0.005	mg/L	-	-	2.4
Beryllium	0.001	mg/L	-	-	< 0.001
Beryllium (filtered)	0.001	mg/L	-	-	0.005
Boron	0.05	mg/L	-	-	0.10
Boron (filtered)	0.05	mg/L	-	-	0.12
Cadmium	0.0002	mg/L	-	-	0.0030
Cadmium (filtered)	0.0002	mg/L	-	-	0.0038
Chromium	0.001	mg/L	-	-	< 0.001
Chromium (filtered)	0.001	mg/L	-	-	0.12
Cobalt (filtered)	0.001	mg/L	-	-	0.12
Copper	0.001	mg/L	-	-	0.065
Copper (filtered)	0.001	mg/L	-	-	1.1
Iron	0.05	mg/L	-	-	< 0.05
Iron (filtered)	0.05	mg/L	-	-	62
Lead	0.001	mg/L	-	-	< 0.001
Lead (filtered)	0.001	mg/L	-	-	0.095
Manganese	0.005	mg/L	-	-	0.99

Client Sample ID			AOB1	AOB10	AOB4
Sample Matrix			Water	Water	Water
Eurofins | mgt Sample No.			B18-No10179	B18-No10180	B18-No10181
Date Sampled			Not Provided	Not Provided	Not Provided
Test/Reference	LOR	Unit			
Heavy Metals					
Manganese (filtered)	0.005	mg/L	-	-	1.4
Mercury	0.0001	mg/L	-	-	< 0.0001
Mercury (filtered)	0.0001	mg/L	-	-	0.0042
Molybdenum	0.005	mg/L	-	-	< 0.005
Molybdenum (filtered)	0.005	mg/L	-	-	< 0.005
Nickel	0.001	mg/L	-	-	0.020
Nickel (filtered)	0.001	mg/L	-	-	0.16
Selenium	0.001	mg/L	-	-	0.010
Selenium (filtered)	0.001	mg/L	-	-	0.009
Uranium	0.005	mg/L	-	-	0.011
Uranium (filtered)	0.005	mg/L	-	-	0.020
Vanadium	0.005	mg/L	-	-	0.010
Vanadium (filtered)	0.005	mg/L	-	-	0.16
Zinc	0.001	mg/L	-	-	0.032
Zinc (filtered)	0.005	mg/L	-	-	0.36
Eurofins | mgt Suite B11C: Na/K/Ca/Mg					
Calcium	0.5	mg/L	32	3300	1800
Magnesium	0.5	mg/L	14	2200	1600
Potassium	0.5	mg/L	3.5	45	43
Sodium	0.5	mg/L	46	4300	5200

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Total Recoverable Hydrocarbons - 1999 NEPM Fractions	Melbourne	Nov 12, 2018	7 Day
- Method: LTM-ORG-2010 TRH C6-C40			
Total Recoverable Hydrocarbons	Melbourne	Nov 12, 2018	7 Day
- Method: LTM-ORG-2010 TRH C6-C40			
Heavy Metals	Brisbane	Nov 08, 2018	180 Day
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Heavy Metals (filtered)	Brisbane	Nov 08, 2018	180 Day
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Mobil Metals : Metals M15	Brisbane	Nov 08, 2018	28 Day
- Method: USEPA 6010/6020 Heavy Metals & USEPA 7470/71 Mercury			
Eurofins | mgt Suite B11C: Na/K/Ca/Mg	Melbourne	Nov 12, 2018	180 Day
- Method: LTM-MET-3010 Alkali Metals by ICP-AES			
TRH - 2013 NEPM Fractions (after silica gel clean-up)	Melbourne	Nov 15, 2018	7 Day
- Method: LTM-ORG-2010 TRH C6-C40			
TRH - 1999 NEPM Fractions (after silica gel clean-up)	Melbourne	Nov 15, 2018	7 Day
- Method: TRH C6-C36 (Silica Gel Cleanup) - MGT 100A			

Company Name:	SLR Consulting (Qld)	**Order No.:**		**Received:**	Nov 7, 2018 12:42 PM
Address:	Level 2 15 Astor Terrace	**Report #:**	626708	**Due:**	Nov 16, 2018
	Spring Hill	**Phone:**	07 3858 4800	**Priority:**	7 Day
	QLD 4000	**Fax:**		**Contact Name:**	Tony Johnson
Project Name:	BARALABA SOUTH				
Project ID:	620.11731.20000.0042				

Eurofins | mgt Analytical Services Manager : Ryan Gilbert

Sample Detail						Aluminium	Aluminium (filtered)	Arsenic	Arsenic (filtered)	Barium	Barium (filtered)	Beryllium	Beryllium (filtered)	Boron	Boron (filtered)	Cadmium	Cadmium (filtered)	Chromium	Chromium (filtered)	Cobalt (filtered)	Copper	Copper (filtered)	Iron	Iron (filtered)	Lead	Lead (filtered)	Manganese	Manganese (filtered)	Mercury	Mercury (filtered)	Molybdenum	Molybdenum (filtered)	Nickel	Nickel (filtered)	Selenium	Selenium (filtered)	TRH C6-C10	TRH C6-C9	Uranium	Uranium (filtered)	Vanadium	Vanadium (filtered)	Zinc	Zinc (filtered)	TRH (after Silica Gel cleanup)	Eurofins | mgt Suite B11C: Na/K/Ca/Mg
Melbourne Laboratory - NATA Site # 1254 & 14271																																					X	X							X	X
Sydney Laboratory - NATA Site # 18217																																														
Brisbane Laboratory - NATA Site # 20794						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X		
Perth Laboratory - NATA Site # 23736																																														
External Laboratory																																														
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**																																									
1	AOB1	Not Provided		Water	B18-No10179																																									X
2	AOB10	Not Provided		Water	B18-No10180																																									X
3	AOB4	Not Provided		Water	B18-No10181	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Test Counts						1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram	**mg/L:** milligrams per litre	**ug/L:** micrograms per litre
ppm: Parts per million	**ppb:** Parts per billion	**%:** Percentage
org/100mL: Organisms per 100 millilitres	**NTU:** Nephelometric Turbidity Units	**MPN/100mL:** Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	Quality Systems Manual ver 5.1 US Department of Defense
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 50-150%-Phenols & PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.1 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	mg/L	< 0.02			0.02	Pass	
Method Blank							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
TRH C6-C10	mg/L	< 0.02			0.02	Pass	
Method Blank							
Heavy Metals							
Aluminium	mg/L	< 0.05			0.05	Pass	
Aluminium (filtered)	mg/L	< 0.05			0.05	Pass	
Arsenic	mg/L	< 0.001			0.001	Pass	
Arsenic (filtered)	mg/L	< 0.001			0.001	Pass	
Barium	mg/L	< 0.005			0.005	Pass	
Barium (filtered)	mg/L	< 0.005			0.005	Pass	
Beryllium	mg/L	< 0.001			0.001	Pass	
Beryllium (filtered)	mg/L	< 0.001			0.001	Pass	
Boron	mg/L	< 0.05			0.05	Pass	
Boron (filtered)	mg/L	< 0.05			0.05	Pass	
Cadmium	mg/L	< 0.0002			0.0002	Pass	
Cadmium (filtered)	mg/L	< 0.0002			0.0002	Pass	
Chromium	mg/L	< 0.001			0.001	Pass	
Chromium (filtered)	mg/L	< 0.001			0.001	Pass	
Cobalt (filtered)	mg/L	< 0.001			0.001	Pass	
Copper	mg/L	< 0.001			0.001	Pass	
Copper (filtered)	mg/L	< 0.001			0.001	Pass	
Iron	mg/L	< 0.05			0.05	Pass	
Iron (filtered)	mg/L	< 0.05			0.05	Pass	
Lead	mg/L	< 0.001			0.001	Pass	
Lead (filtered)	mg/L	< 0.001			0.001	Pass	
Manganese	mg/L	< 0.005			0.005	Pass	
Manganese (filtered)	mg/L	< 0.005			0.005	Pass	
Mercury	mg/L	< 0.0001			0.0001	Pass	
Mercury (filtered)	mg/L	< 0.0001			0.0001	Pass	
Molybdenum	mg/L	< 0.005			0.005	Pass	
Molybdenum (filtered)	mg/L	< 0.005			0.005	Pass	
Nickel	mg/L	< 0.001			0.001	Pass	
Nickel (filtered)	mg/L	< 0.001			0.001	Pass	
Selenium	mg/L	< 0.001			0.001	Pass	
Selenium (filtered)	mg/L	< 0.001			0.001	Pass	
Uranium	mg/L	< 0.005			0.005	Pass	
Uranium (filtered)	mg/L	< 0.005			0.005	Pass	
Vanadium	mg/L	< 0.005			0.005	Pass	
Vanadium (filtered)	mg/L	< 0.005			0.005	Pass	
Zinc	mg/L	< 0.001			0.001	Pass	
Zinc (filtered)	mg/L	< 0.005			0.005	Pass	
Method Blank							
Eurofins | mgt Suite B11C: Na/K/Ca/Mg							
Calcium	mg/L	< 0.5			0.5	Pass	
Magnesium	mg/L	< 0.5			0.5	Pass	
Potassium	mg/L	< 0.5			0.5	Pass	
Sodium	mg/L	< 0.5			0.5	Pass	
LCS - % Recovery							

Test			Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Total Recoverable Hydrocarbons - 1999 NEPM Fractions									
TRH C6-C9			%	105			70-130	Pass	
LCS - % Recovery									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions									
TRH C6-C10			%	109			70-130	Pass	
LCS - % Recovery									
Heavy Metals									
Aluminium			%	92			80-120	Pass	
Aluminium (filtered)			%	91			80-120	Pass	
Arsenic			%	96			80-120	Pass	
Arsenic (filtered)			%	88			80-120	Pass	
Barium			%	96			80-120	Pass	
Beryllium			%	87			80-120	Pass	
Beryllium (filtered)			%	92			80-120	Pass	
Boron			%	89			80-120	Pass	
Boron (filtered)			%	106			80-120	Pass	
Cadmium			%	93			80-120	Pass	
Cadmium (filtered)			%	87			80-120	Pass	
Chromium			%	94			80-120	Pass	
Chromium (filtered)			%	93			80-120	Pass	
Cobalt (filtered)			%	89			80-120	Pass	
Copper			%	89			80-120	Pass	
Copper (filtered)			%	88			80-120	Pass	
Iron			%	93			80-120	Pass	
Iron (filtered)			%	88			80-120	Pass	
Lead			%	93			80-120	Pass	
Lead (filtered)			%	99			80-120	Pass	
Manganese			%	94			80-120	Pass	
Manganese (filtered)			%	89			80-120	Pass	
Mercury			%	106			70-130	Pass	
Mercury (filtered)			%	110			70-130	Pass	
Molybdenum			%	95			80-120	Pass	
Molybdenum (filtered)			%	92			80-120	Pass	
Nickel			%	94			80-120	Pass	
Nickel (filtered)			%	93			80-120	Pass	
Selenium			%	96			80-120	Pass	
Selenium (filtered)			%	89			80-120	Pass	
Uranium			%	100			80-120	Pass	
Uranium (filtered)			%	100			80-120	Pass	
Vanadium			%	94			80-120	Pass	
Zinc			%	90			80-120	Pass	
Zinc (filtered)			%	86			80-120	Pass	
LCS - % Recovery									
Eurofins | mgt Suite B11C: Na/K/Ca/Mg									
Calcium			%	115			70-130	Pass	
Magnesium			%	112			70-130	Pass	
Potassium			%	98			70-130	Pass	
Sodium			%	114			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
Eurofins | mgt Suite B11C: Na/K/Ca/Mg				Result 1					
Calcium	B18-No10179	CP	%	112			70-130	Pass	
Magnesium	M18-No12748	NCP	%	98			70-130	Pass	
Potassium	M18-No12748	NCP	%	92			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Sodium	B18-No10179	CP	%	116			70-130	Pass	
Spike - % Recovery									
TRH - 2013 NEPM Fractions (after silica gel clean-up)				Result 1					
TRH >C10-C16 (after silica gel clean-up)	B18-No12241	NCP	%	102			70-130	Pass	
Spike - % Recovery									
TRH - 1999 NEPM Fractions (after silica gel clean-up)				Result 1					
TRH C10-C14 (after silica gel clean-up)	B18-No12241	NCP	%	107			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Aluminium	B18-No09696	NCP	%	99			75-125	Pass	
Aluminium (filtered)	B18-No09696	NCP	%	92			75-125	Pass	
Arsenic	B18-No09696	NCP	%	121			75-125	Pass	
Arsenic (filtered)	B18-No09696	NCP	%	93			70-130	Pass	
Barium	B18-No09696	NCP	%	107			75-125	Pass	
Barium (filtered)	B18-No09696	NCP	%	86			75-125	Pass	
Beryllium	B18-No09696	NCP	%	80			75-125	Pass	
Beryllium (filtered)	B18-No09696	NCP	%	81			75-125	Pass	
Boron (filtered)	B18-No09696	NCP	%	116			75-125	Pass	
Cadmium	B18-No09696	NCP	%	93			75-125	Pass	
Cadmium (filtered)	B18-No09696	NCP	%	86			70-130	Pass	
Chromium	B18-No09696	NCP	%	83			75-125	Pass	
Chromium (filtered)	B18-No09696	NCP	%	78			70-130	Pass	
Cobalt (filtered)	B18-No09696	NCP	%	71			75-125	Fail	Q08
Iron	B18-No09696	NCP	%	77			75-125	Pass	
Iron (filtered)	B18-No09696	NCP	%	73			70-130	Pass	
Lead	B18-No09696	NCP	%	80			75-125	Pass	
Lead (filtered)	B18-No09696	NCP	%	87			70-130	Pass	
Manganese	B18-No09696	NCP	%	85			75-125	Pass	
Manganese (filtered)	B18-No09696	NCP	%	78			70-130	Pass	
Mercury	B18-No09696	NCP	%	96			70-130	Pass	
Mercury (filtered)	B18-No09696	NCP	%	101			70-130	Pass	
Molybdenum	B18-No09696	NCP	%	105			75-125	Pass	
Molybdenum (filtered)	B18-No09696	NCP	%	95			75-125	Pass	
Nickel	B18-No09696	NCP	%	71			75-125	Fail	Q08
Selenium	B18-No09696	NCP	%	84			75-125	Pass	
Selenium (filtered)	B18-No09696	NCP	%	71			70-130	Pass	
Uranium	B18-No09696	NCP	%	83			75-125	Pass	
Uranium (filtered)	B18-No09696	NCP	%	90			70-130	Pass	
Vanadium	B18-No09696	NCP	%	89			75-125	Pass	
Vanadium (filtered)	B18-No09696	NCP	%	83			75-125	Pass	
Zinc	B18-No09696	NCP	%	71			75-125	Fail	Q08
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
Eurofins | mgt Suite B11C: Na/K/Ca/Mg				Result 1	Result 2	RPD			
Calcium	B18-No10179	CP	mg/L	32	32	<1	30%	Pass	
Magnesium	B18-No10179	CP	mg/L	14	13	<1	30%	Pass	
Potassium	B18-No10179	CP	mg/L	3.5	3.6	1.0	30%	Pass	
Sodium	B18-No10179	CP	mg/L	46	46	<1	30%	Pass	

Duplicate									
TRH - 2013 NEPM Fractions (after silica gel clean-up)				Result 1	Result 2	RPD			
TRH >C10-C16 (after silica gel clean-up)	B18-No12242	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
TRH >C16-C34 (after silica gel clean-up)	B18-No12242	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
TRH >C34-C40 (after silica gel clean-up)	B18-No12242	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
Duplicate									
TRH - 1999 NEPM Fractions (after silica gel clean-up)				Result 1	Result 2	RPD			
TRH C10-C36 (Total) (after silica gel clean-up)	B18-No12242	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
TRH C10-C14 (after silica gel clean-up)	B18-No12242	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
TRH C15-C28 (after silica gel clean-up)	B18-No12242	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
TRH C29-C36 (after silica gel clean-up)	B18-No12242	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Aluminium	B18-No09695	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Aluminium (filtered)	B18-No09695	NCP	mg/L	0.16	0.15	5.0	30%	Pass	
Arsenic	B18-No09695	NCP	mg/L	0.001	0.001	8.0	30%	Pass	
Arsenic (filtered)	B18-No09695	NCP	mg/L	0.002	0.002	40	30%	Fail	Q15
Barium	B18-No09695	NCP	mg/L	0.031	0.034	8.0	30%	Pass	
Barium (filtered)	B18-No09695	NCP	mg/L	0.039	0.031	23	30%	Pass	
Beryllium	B18-No09695	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Beryllium (filtered)	B18-No09695	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Boron	B18-No09695	NCP	mg/L	1.9	1.9	2.0	30%	Pass	
Boron (filtered)	B18-No09695	NCP	mg/L	3.1	2.4	25	30%	Pass	
Cadmium	B18-No09695	NCP	mg/L	< 0.0002	< 0.0002	<1	30%	Pass	
Cadmium (filtered)	B18-No09695	NCP	mg/L	< 0.0002	< 0.0002	<1	30%	Pass	
Chromium	B18-No09695	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Chromium (filtered)	B18-No09695	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Cobalt (filtered)	B18-No09695	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Copper	B18-No09695	NCP	mg/L	0.001	< 0.001	70	30%	Fail	Q15
Copper (filtered)	B18-No09695	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Iron	B18-No09695	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Iron (filtered)	B18-No09695	NCP	mg/L	0.31	0.29	6.0	30%	Pass	
Lead	B18-No09695	NCP	mg/L	0.001	< 0.001	53	30%	Fail	Q15
Lead (filtered)	B18-No09695	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Manganese	B18-No09695	NCP	mg/L	0.20	0.20	<1	30%	Pass	
Manganese (filtered)	B18-No09695	NCP	mg/L	0.20	0.20	5.0	30%	Pass	
Mercury	B18-No09695	NCP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Mercury (filtered)	B18-No09695	NCP	mg/L	0.0001	< 0.0001	130	30%	Fail	Q15
Molybdenum	B18-No09695	NCP	mg/L	0.007	0.008	9.0	30%	Pass	
Molybdenum (filtered)	B18-No09695	NCP	mg/L	0.011	0.007	53	30%	Fail	Q15
Nickel	B18-No09695	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Nickel (filtered)	B18-No09695	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Selenium	B18-No09695	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Selenium (filtered)	B18-No09695	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Uranium	B18-No09695	NCP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Uranium (filtered)	B18-No09695	NCP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Vanadium	B18-No09695	NCP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Vanadium (filtered)	B18-No09695	NCP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Zinc	B18-No09695	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Zinc (filtered)	B18-No09695	NCP	mg/L	< 0.005	< 0.005	<1	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
Q08	The matrix spike recovery is outside of the recommended acceptance criteria. An acceptable recovery was obtained for the laboratory control sample indicating a sample matrix interference
Q15	The RPD reported passes Eurofins | mgt's QC - Acceptance Criteria as defined in the Internal Quality Control Review and Glossary page of this report.

Authorised By

Ryan Gilbert	Analytical Services Manager
Chris Bennett	Senior Analyst-Metal (VIC)
Harry Bacalis	Senior Analyst-Volatile (VIC)
Joseph Edouard	Senior Analyst-Organic (VIC)
Steven Trout	Senior Analyst-Metal (QLD)

Glenn Jackson
General Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

APPENDIX C

Laboratory Water Quality Summary

Bore	Date	Field pH (pH units)	Field EC µS/cm	pH (at 25°C) (pH units)	Conductivity (at 25°C) µS/cm	Total Dissolved Solids
A-OB7	06-12-2017 12:31	6.62	15681	7.6	17000	13000
A-OB8	17-12-2017 12:40	6.89	26260	7.9	22000	14000
P-OB5	17-12-2017 14:13	7.25	24664	7.8	22000	13000
A-OB10	18-12-2017 5:10	6.42	31708	7.3	31000	32000
P-OB1	19-12-2017 11:35	6.16	29785	7.4	28000	25000
DUP1_[POB1]	19-12-2017 11:35			7.2	28000	23000
A-OB4	19-12-2017 14:18	6.31	37011	7.4	35000	30000
P-OB4	19-12-2017 17:30	6.5	37088	7.5	35000	27000
A-OB1	20-12-2017 11:40	6.42	570	7.1	530	260
A-OB2	20-12-2017 15:37	6.41	657	7.2	660	370
P-OB3	21-12-2017 11:00	6.1	34107	7.1	32000	30000
DUP2_[POB3]	21-12-2017 11:00			7.1	33000	27000
A-OB12	21-12-2017 15:18	6.17	381	7.1	370	180
A-OB11	21-12-2017 17:11	6.08	425	7	410	210
A-OB7	20-03-2018 11:15	6.95	16809	7.7	15000	13000
A-OB8	20-03-2018 12:30	6.94	25877	7.8	23000	18000
P-OB5	20-03-2018 16:10	7.21	27225	8	17000	12000
P-OB2	21-03-2018 10:00	6.14	19480	7.5	17000	13000
DUP1_[POB2]	21-03-2018 10:00			7.5	17000	12000
A-OB12	21-03-2018 14:30	6.25	354	7.7	290	160
A-OB11	21-03-2018 16:00	6.14	405	7.4	350	210
A-OB3	22-03-2018 11:35	6.75	561	7.7	480	390
A-OB1	22-03-2018 13:30	6.49	466	7.8	410	260
P-OB1	22-03-2018 15:14	6.32	30324	7.7	28000	28000
A-OB2	22-03-2018 16:35	6.48	617	7.2	550	300
P-PB1	23-03-2018 13:30	7.31	15950	7.8	15000	11000
P-OB3	24-03-2018 9:05	6.19	33141	7.2	31000	31000
A-OB10	24-03-2018 14:00	6.2	36433	7.2	35000	37000
A-OB4	24-03-2018 15:45	6.29	35920	7.4	35000	34000
DUP2_[AOB4]	24-03-2018 15:45			7.5	35000	14000
P-OB4	25-03-2018 10:50	6.11	36356	7.3	34000	31000
ROSS BORE	25-03-2018 16:45	8.32	2020	8.2	1100	1100
A-OB7	19-06-2018 12:16	6.64	16637	7.4	18000	16000
P-OB2	20-06-2018 8:55	6.08	19503	6.9	20000	14000
DUP1_[POB2]	20-06-2018 8:55			6.9	19000	12000
A-OB8	20-06-2018 10:30	6.57	26914	7.2	28000	19000
P-OB5	20-06-2018 13:10	6.76	23666	7.7	21000	12000
A-OB10	20-06-2018 16:00	6.15	38097	6.8	39000	33000
P-OB4	21-06-2018 9:21	6.22	37492	7.1	38000	25000
P-PB1	21-06-2018 13:50	6.9	16296	6.9	16000	12000
A-OB2	21-06-2018 14:00	7	686	7	680	380
A-OB4	21-06-2018 16:50	6.3	37557	6.9	39000	23000
A-OB12	22-06-2018 8:30	6.25	327.7	6.8	310	140
A-OB11	22-06-2018 9:35	6.37	434	6.7	470	220
A-OB1	22-06-2018 11:30	6.26	486.4	6.8	540	230
A-OB3	22-06-2018 11:30	6.55	593	7.1	660	360
DUP2_[AOB3]	22-06-2018 11:30			7.3	700	390
P-OB3	22-06-2018 15:50	6.15	34154	6.8	28000	19000
P-OB1	23-06-2018 12:15	6.23	31390	7.5	29000	21000
ROSS BORE	23-06-2018 15:50	6.52	3038	6.8	3200	1600
ROSS BORE	23-10-2018 16:20	6.47	3690	7.3	3500	2000
DUP1_[Rossbore]	23-10-2018 16:20			7.2	3500	2100
P-OB2	24-10-2018 8:37	6.25	21075	7	21000	13000
P-OB5	24-10-2018 11:10	6.54	34100	7.3	32000	24000
P-OB1	24-10-2018 14:10	6.19	33260	7.1	32000	29000
P-PB1	24-10-2018 15:50	7.06	18453	6.8	18000	12000
P-OB3	25-10-2018 8:50	6.24	37120	7	31000	27000
P-OB4	25-10-2018 8:50	6.29	40297	6.9	35000	35000
A-OB7	27-10-2018 8:15	6.92	18390	7.3	18000	16000
DUP2_[AOB7]	27-10-2018 8:15			7.3	18000	19000
A-OB8	27-10-2018 9:00	6.47	27752	7.3	27000	27000
A-OB2	27-10-2018 14:20	6.27	565	6.9	520	350
A-OB1	27-10-2018 16:00	6.16	493.2	6.9	440	310
A-OB3	27-10-2018 16:00	6.54	489.9	7.3	460	350
A-OB12	28-10-2018 8:53	6.28	322.5	6.8	280	190
A-OB4	28-10-2018 8:53	6.43	40022	7.1	35000	38000
A-OB11	28-10-2018 10:21	6.23	376.7	7	320	240
A-OB10	28-10-2018 16:20	6.36	38786	6.9	37000	38000

All units in mg/L unless stated otherwise

Bore	Chloride	Fluoride	Sulphate (as SO4)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)
A-OB7	5500	< 0.5	490	420	< 10	< 10
A-OB8	6900	< 0.5	1600	760	< 10	< 10
P-OB5	6800	< 0.5	360	590	< 10	< 10
A-OB10	14000	< 0.5	1100	260	< 10	< 10
P-OB1	11000	< 0.5	1600	440	< 10	< 10
DUP1_[POB1]	15000	< 0.5	1600	440	< 10	< 10
A-OB4	17000	< 0.5	1500	410	< 10	< 10
P-OB4	16000	< 0.5	1700	370	< 10	< 10
A-OB1	70	< 0.5	20	240	< 10	< 10
A-OB2	98	< 0.5	6.7	210	< 10	< 10
P-OB3	13000	< 0.5	1200	310	< 10	< 10
DUP2_[POB3]	13000	< 0.5	1200	300	< 10	< 10
A-OB12	69	< 0.5	9.2	120	< 10	< 10
A-OB11	95	< 0.5	7.4	150	< 10	< 10
A-OB7	3800	< 0.5	430	430	< 10	< 20
A-OB8	5700	< 0.5	1500	1000	< 10	< 20
P-OB5	3900	< 0.5	300	620	< 10	< 20
P-OB2	3700	< 0.5	440	750	< 10	< 20
DUP1_[POB2]	3800	< 0.5	450	640	< 10	< 20
A-OB12	49	< 0.5	< 5	110	< 10	< 20
A-OB11	55	< 0.5	< 5	170	< 10	< 20
A-OB3	72	< 0.5	23	170	< 10	< 20
A-OB1	31	< 0.5	< 5	190	< 10	< 20
P-OB1	6900	< 0.5	1600	390	< 10	< 20
A-OB2	83	< 0.5	< 5	220	< 10	< 20
P-PB1	3500	< 0.5	< 5	72	< 10	< 20
P-OB3	7800	< 0.5	1200	360	< 10	< 20
A-OB10	8800	< 0.5	1100	330	< 10	< 20
A-OB4	11000	< 0.5	1500	460	< 10	< 20
DUP2_[AOB4]	8400	< 0.5	1500	650	< 10	< 20
P-OB4	8400	< 0.5	1600	520	< 10	< 20
ROSS BORE	240	< 0.5	88	470	< 10	< 20
A-OB7	5300	< 0.5	500	390	< 10	< 20
P-OB2	5400	< 0.5	440	650	< 10	< 20
DUP1_[POB2]	5500	< 0.5	440	660	< 10	< 20
A-OB8	7500	< 0.5	1500	750	< 10	< 20
P-OB5	5400	< 0.5	310	890	< 10	< 20
A-OB10	14000	< 0.5	1100	280	< 10	< 20
P-OB4	13000	< 0.5	1600	450	< 10	< 20
P-PB1	4800	< 0.5	< 5	42	< 10	< 20
A-OB2	92	< 0.5	6.8	200	< 10	< 20
A-OB4	14000	< 0.5	1600	390	< 10	< 20
A-OB12	32	< 0.5	< 5	110	< 10	< 20
A-OB11	44	< 0.5	12	150	< 10	< 20
A-OB1	35	< 0.5	16	200	< 10	< 20
A-OB3	70	< 0.5	28	190	< 10	< 20
DUP2_[AOB3]	75	< 0.5	34	200	< 10	< 20
P-OB3	8400	< 0.5	920	250	< 10	< 20
P-OB1	9000	< 0.5	1600	290	< 10	< 20
ROSS BORE	590	< 0.5	78	390	< 10	< 20
ROSS BORE	690	< 0.5	72	860	< 10	< 20
DUP1_[Rossbore]	610	< 0.5	74	920	< 10	< 20
P-OB2	6700	< 0.5	530	780	< 10	< 20
P-OB5	11000	< 0.5	480	630	< 10	< 20
P-OB1	11000	< 0.5	1600	430	< 10	< 20
P-PB1	5700	< 0.5	< 5	53	< 10	< 20
P-OB3	16000	< 0.5	1200	330	< 10	< 20
P-OB4	17000	< 0.5	1800	550	< 10	< 20
A-OB7	8100	< 0.5	500	390	< 10	< 20
DUP2_[AOB7]	8800	< 0.5	530	430	< 10	< 20
A-OB8	13000	< 0.5	1500	800	< 10	< 20
A-OB2	80	< 0.5	6.1	180	< 10	< 20
A-OB1	36	< 0.5	15	230	< 10	< 20
A-OB3	63	< 0.5	16	160	< 10	< 20
A-OB12	33	< 0.5	< 5	140	< 10	< 20
A-OB4	17000	< 0.5	1700	510	< 10	< 20
A-OB11	40	< 0.5	< 5	140	< 10	< 20
A-OB10	19000	< 0.5	1200	280	< 10	< 20

All units in mg/L unless stated otherwise

Bore	Total Alkalinity (as CaCO3)	Calcium	Magnesium	Potassium	Sodium	Aluminium
A-OB7	420	1000	670	15	2200	55
A-OB8	760	640	840	27	3900	4.1
P-OB5	590	520	320	100	3900	0.25
A-OB10	260	2600	1700	29	3500	28
P-OB1	440	1500	1300	29	3900	< 0.05
DUP1_[POB1]	440	1500	1300	27	3800	< 0.05
A-OB4	410	1800	1600	33	5700	4.8
P-OB4	370	2000	1600	44	4800	< 0.05
A-OB1	240	32	16	7.3	61	33
A-OB2	210	20	13	7	110	7.1
P-OB3	310	1800	1300	29	4800	< 0.05
DUP2_[POB3]	300	1700	1300	27	4500	< 0.05
A-OB12	120	23	11	5.5	40	4.8
A-OB11	150	24	13	5.4	48	3.4
A-OB7	430	1200	810	18	2900	920
A-OB8	1000	900	1200	33	4100	140
P-OB5	620	370	290	120	3700	< 0.5
P-OB2	750	750	590	37	3700	< 0.05
DUP1_[POB2]	640	660	480	32	3300	< 0.5
A-OB12	110	21	9.7	2.9	30	2.4
A-OB11	170	25	12	3.4	35	1.9
A-OB3	170	7.1	4.3	1.3	110	0.13
A-OB1	190	43	16	2.8	33	0.51
P-OB1	390	1700	1400	31	4300	< 0.05
A-OB2	220	17	12	3.6	95	< 0.05
P-PB1	72	1100	23	10	3000	< 0.05
P-OB3	360	2000	1400	32	4600	< 0.5
A-OB10	330	3600	2300	34	4700	9.4
A-OB4	460	2200	1900	36	5700	18
DUP2_[AOB4]	650	1800	1600	29	5400	120
P-OB4	520	2200	1700	36	5300	< 0.5
ROSS BORE	470	70	63	3.5	330	0.07
A-OB7	390	800	590	21	1900	120
P-OB2	650	600	520	29	3100	< 0.05
DUP1_[POB2]	660	520	420	21	2700	< 0.05
A-OB8	750	740	990	28	4000	0.7
P-OB5	890	450	370	89	3400	0.08
A-OB10	280	2700	1900	28	3700	27
P-OB4	450	1900	1600	30	4800	< 0.05
P-PB1	42	860	23	< 5	2600	< 0.05
A-OB2	200	17	13	3.9	100	12
A-OB4	390	1500	1500	23	4900	4.6
A-OB12	110	19	11	3.4	46	28
A-OB11	150	22	12	4.2	39	25
A-OB1	200	11	5.1	1.3	25	78
A-OB3	190	18	13	1.6	170	1.8
DUP2_[AOB3]	200	13	9	1.7	160	1.3
P-OB3	250	1400	1100	16	3900	< 0.05
P-OB1	290	1400	1300	23	3700	< 0.05
ROSS BORE	390	160	77	2.9	330	< 0.05
ROSS BORE	860	220	110	3.2	380	< 0.05
DUP1_[Rossbore]	920	210	110	3.4	380	< 0.05
P-OB2	780	630	470	37	3000	< 0.05
P-OB5	630	1000	820	65	6100	< 0.05
P-OB1	430	1500	1300	35	3900	< 0.05
P-PB1	53	1000	22	11	2800	< 0.05
P-OB3	330	1700	1100	34	4700	< 0.05
P-OB4	550	2300	1600	45	5000	< 0.05
A-OB7	390	1300	800	22	2900	210
DUP2_[AOB7]	430	1200	770	20	2700	200
A-OB8	800	900	1100	34	4400	47
A-OB2	180	14	10	3.8	82	< 0.05
A-OB1	230	32	14	3.5	46	0.46
A-OB3	160	4.7	3.4	1.4	94	< 0.05
A-OB12	140	17	8.3	3.3	28	0.41
A-OB4	510	1800	1600	43	5200	< 0.05
A-OB11	140	21	11	3.6	32	0.38
A-OB10	280	3300	2200	45	4300	38

All units in mg/L unless stated otherwise

Bore	Aluminium (filtered)	Arsenic	Arsenic (filtered)	Barium	Barium (filtered)	Beryllium
A-OB7	< 0.05	0.009	< 0.001	0.84	0.33	0.003
A-OB8	< 0.05	0.004	0.002	0.16	0.13	0.002
P-OB5	< 0.05	0.002	0.001	0.55	0.55	< 0.001
A-OB10	< 0.05	0.011	0.002	0.73	0.43	0.006
P-OB1	< 0.05	0.005	0.004	0.04	0.04	< 0.001
DUP1_[POB1]	< 0.05	0.002	0.004	0.04	0.04	< 0.001
A-OB4	< 0.05	0.007	0.004	0.29	0.16	< 0.001
P-OB4	< 0.05	0.002	0.002	0.17	0.17	< 0.001
A-OB1	< 0.05	0.011	0.002	1.6	0.17	0.007
A-OB2	< 0.05	0.003	0.001	0.22	0.13	< 0.001
P-OB3	< 0.05	0.002	0.001	0.07	0.07	< 0.001
DUP2_[POB3]	< 0.05	0.001	0.001	0.07	0.07	< 0.001
A-OB12	< 0.05	0.011	0.01	0.14	0.1	< 0.001
A-OB11	< 0.05	0.004	0.004	0.06	0.06	< 0.001
A-OB7	< 0.05	0.06	< 0.001	8.9	0.35	0.043
A-OB8	< 0.05	0.068	0.005	2.8	0.16	0.015
P-OB5	< 0.5	< 0.01	< 0.01	0.44	0.41	< 0.01
P-OB2	< 0.05	0.002	0.001	0.15	0.14	< 0.001
DUP1_[POB2]	< 0.5	< 0.01	< 0.01	0.13	0.12	< 0.01
A-OB12	< 0.05	0.012	0.01	0.11	0.1	< 0.001
A-OB11	< 0.05	0.009	0.009	0.13	0.12	< 0.001
A-OB3	< 0.05	0.005	0.004	0.12	0.1	< 0.001
A-OB1	< 0.05	0.002	0.002	0.18	0.17	< 0.001
P-OB1	< 0.05	0.009	0.007	0.05	0.05	< 0.001
A-OB2	< 0.05	0.002	< 0.001	0.12	0.12	< 0.001
P-PB1	< 0.05	0.016	0.013	19	19	< 0.001
P-OB3	< 0.5	< 0.01	< 0.01	0.07	0.07	< 0.01
A-OB10	< 0.05	0.007	0.004	0.43	0.37	< 0.001
A-OB4	< 0.05	0.016	0.006	1.2	0.15	0.001
DUP2_[AOB4]	< 0.5	0.042	< 0.01	4.8	0.13	0.011
P-OB4	< 0.5	< 0.01	< 0.01	0.06	0.06	< 0.01
ROSS BORE	< 0.05	0.001	< 0.001	0.04	0.04	< 0.001
A-OB7	< 0.05	0.017	< 0.001	1.3	0.33	0.006
P-OB2	< 0.05	< 0.001	< 0.001	0.11	0.11	< 0.001
DUP1_[POB2]	< 0.05	< 0.001	< 0.001	0.11	0.11	< 0.001
A-OB8	< 0.05	0.003	0.002	0.09	0.08	< 0.001
P-OB5	< 0.05	0.002	0.002	0.29	0.28	< 0.001
A-OB10	< 0.05	0.007	< 0.001	0.6	0.32	0.002
P-OB4	< 0.05	0.002	0.002	0.09	0.09	< 0.001
P-PB1	< 0.05	0.013	0.011	22	22	< 0.001
A-OB2	< 0.05	0.004	0.001	0.24	0.1	0.001
A-OB4	< 0.05	0.006	0.004	0.29	0.13	< 0.001
A-OB12	< 0.05	0.013	0.008	0.45	0.11	0.003
A-OB11	0.07	0.011	0.006	1.1	0.17	0.009
A-OB1	< 0.05	0.013	< 0.001	1.4	0.08	0.005
A-OB3	< 0.05	0.005	0.005	0.37	0.11	< 0.001
DUP2_[AOB3]	< 0.05	0.006	0.006	0.26	0.11	< 0.001
P-OB3	< 0.05	0.002	0.001	0.08	0.08	< 0.001
P-OB1	< 0.05	0.004	0.004	0.04	0.04	< 0.001
ROSS BORE	< 0.05	< 0.001	< 0.001	0.1	0.1	< 0.001
ROSS BORE	< 0.05	< 0.001	< 0.001	0.12	0.12	< 0.001
DUP1_[Rossbore]	< 0.05	< 0.001	< 0.001	0.11	0.11	< 0.001
P-OB2	< 0.05	< 0.001	< 0.001	0.07	0.07	< 0.001
P-OB5	< 0.05	0.002	0.003	0.22	0.22	< 0.001
P-OB1	< 0.05	0.007	0.006	0.05	0.05	< 0.001
P-PB1	< 0.05	0.014	0.012	27	27	< 0.001
P-OB3	< 0.05	0.002	0.002	0.076	0.077	< 0.001
P-OB4	< 0.05	0.001	0.001	0.1	0.11	< 0.001
A-OB7	< 0.05	0.024	< 0.001	2.5	0.35	0.011
DUP2_[AOB7]	< 0.05	0.024	< 0.001	2.2	0.35	0.01
A-OB8	< 0.05	0.04	0.002	1.5	0.095	0.019
A-OB2	< 0.05	< 0.001	< 0.001	0.09	0.087	< 0.001
A-OB1	< 0.05	0.001	0.001	0.15	0.15	< 0.001
A-OB3	< 0.05	0.003	0.003	0.1	0.1	< 0.001
A-OB12	< 0.05	0.01	0.011	0.08	0.081	< 0.001
A-OB4	51	0.002	0.017	0.095	2.4	< 0.001
A-OB11	< 0.05	0.007	0.008	0.1	0.098	< 0.001
A-OB10	< 0.05	0.01	< 0.001	0.61	0.21	0.003

All units in mg/L unless stated otherwise

Bore	Beryllium (filtered)	Boron	Boron (filtered)	Cadmium	Cadmium (filtered)	Chromium
A-OB7	< 0.001	0.21	0.21	0.0025	0.0005	0.037
A-OB8	< 0.001	0.32	0.32	0.0008	0.0007	0.017
P-OB5	< 0.001	0.78	0.78	< 0.0002	< 0.0002	0.002
A-OB10	< 0.001	0.12	0.12	0.0054	< 0.0002	0.026
P-OB1	< 0.001	0.21	0.21	< 0.0002	< 0.0002	< 0.001
DUP1_[POB1]	< 0.001	0.21	0.22	< 0.0002	< 0.0002	< 0.001
A-OB4	< 0.001	0.12	0.12	0.0009	< 0.0002	0.009
P-OB4	< 0.001	0.23	0.25	< 0.0002	< 0.0002	0.005
A-OB1	< 0.001	< 0.05	< 0.05	0.0019	< 0.0002	0.024
A-OB2	< 0.001	< 0.05	< 0.05	< 0.0002	< 0.0002	0.008
P-OB3	< 0.001	0.22	0.22	< 0.0002	< 0.0002	0.002
DUP2_[POB3]	< 0.001	0.22	0.22	< 0.0002	< 0.0002	0.002
A-OB12	< 0.001	< 0.05	< 0.05	< 0.0002	< 0.0002	0.007
A-OB11	< 0.001	< 0.05	< 0.05	< 0.0002	< 0.0002	0.005
A-OB7	< 0.01	0.39	0.24	0.0057	0.0006	0.74
A-OB8	< 0.001	0.13	< 0.05	0.0011	0.0004	0.3
P-OB5	< 0.01	0.78	0.78	< 0.002	< 0.002	0.011
P-OB2	< 0.001	1.6	1.6	< 0.0002	< 0.0002	0.017
DUP1_[POB2]	< 0.01	2	1.9	< 0.002	< 0.002	0.011
A-OB12	< 0.001	< 0.05	< 0.05	< 0.0002	< 0.0002	0.004
A-OB11	< 0.001	< 0.05	< 0.05	< 0.0002	< 0.0002	0.005
A-OB3	< 0.001	< 0.05	< 0.05	< 0.0002	< 0.0002	< 0.001
A-OB1	< 0.001	0.07	0.06	< 0.0002	< 0.0002	0.006
P-OB1	< 0.001	0.18	0.17	< 0.0002	< 0.0002	< 0.001
A-OB2	< 0.001	< 0.05	< 0.05	< 0.0002	< 0.0002	< 0.001
P-PB1	< 0.001	0.12	0.11	< 0.0002	< 0.0002	0.003
P-OB3	< 0.01	< 0.5	< 0.5	< 0.002	< 0.002	< 0.01
A-OB10	< 0.001	0.11	0.11	0.0029	0.0027	0.026
A-OB4	< 0.001	0.11	0.11	0.0017	0.0008	0.049
DUP2_[AOB4]	< 0.01	0.2	< 0.5	0.0087	< 0.002	0.28
P-OB4	< 0.01	< 0.5	< 0.5	< 0.002	< 0.002	< 0.01
ROSS BORE	< 0.001	0.48	0.47	< 0.0002	< 0.0002	< 0.001
A-OB7	< 0.001	0.22	0.21	0.0018	0.0005	0.091
P-OB2	< 0.001	1.8	1.8	< 0.0002	< 0.0002	< 0.001
DUP1_[POB2]	< 0.001	2	1.7	< 0.0002	< 0.0002	< 0.001
A-OB8	< 0.001	0.2	0.19	0.0003	0.0003	0.02
P-OB5	< 0.001	0.89	0.86	< 0.0002	< 0.0002	0.003
A-OB10	< 0.001	0.12	0.12	0.0014	0.0014	0.033
P-OB4	< 0.001	0.23	0.23	< 0.0002	< 0.0002	0.002
P-PB1	< 0.001	0.14	0.13	< 0.0002	< 0.0002	< 0.001
A-OB2	< 0.001	< 0.05	< 0.05	< 0.0002	< 0.0002	0.015
A-OB4	< 0.001	0.13	0.13	0.0014	0.0014	0.009
A-OB12	< 0.001	0.06	< 0.05	0.0004	< 0.0002	0.042
A-OB11	< 0.001	< 0.05	< 0.05	0.0004	< 0.0002	0.035
A-OB1	< 0.001	0.07	< 0.05	0.001	< 0.0002	0.053
A-OB3	< 0.001	< 0.05	< 0.05	< 0.0002	< 0.0002	0.003
DUP2_[AOB3]	< 0.001	< 0.05	< 0.05	< 0.0002	< 0.0002	0.003
P-OB3	< 0.001	0.22	0.22	< 0.0002	< 0.0002	0.001
P-OB1	< 0.001	0.19	0.18	< 0.0002	< 0.0002	0.006
ROSS BORE	< 0.001	0.51	0.47	< 0.0002	< 0.0002	< 0.001
ROSS BORE	< 0.001	0.52	0.52	< 0.0002	< 0.0002	< 0.001
DUP1_[Rossbore]	< 0.001	0.5	0.5	< 0.0002	< 0.0002	< 0.001
P-OB2	< 0.001	1.9	1.9	< 0.0002	< 0.0002	0.002
P-OB5	< 0.001	1.4	1.4	< 0.0002	< 0.0002	0.003
P-OB1	< 0.001	0.21	0.21	< 0.0002	< 0.0002	< 0.001
P-PB1	< 0.001	0.18	0.18	< 0.0002	< 0.0002	< 0.001
P-OB3	< 0.001	0.2	0.16	< 0.0002	< 0.0002	0.002
P-OB4	< 0.001	0.22	0.28	< 0.0002	< 0.0002	0.003
A-OB7	< 0.001	0.18	0.23	0.0021	0.0006	0.14
DUP2_[AOB7]	< 0.001	0.17	0.26	0.002	0.0006	0.12
A-OB8	< 0.001	0.18	0.37	0.0019	0.0003	0.092
A-OB2	< 0.001	< 0.05	0.07	< 0.0002	< 0.0002	< 0.001
A-OB1	< 0.001	0.06	0.06	< 0.0002	< 0.0002	< 0.001
A-OB3	< 0.001	< 0.05	0.06	< 0.0002	< 0.0002	< 0.001
A-OB12	< 0.001	< 0.05	< 0.05	< 0.0002	< 0.0002	< 0.001
A-OB4	0.005	0.1	0.12	0.003	0.0038	< 0.001
A-OB11	< 0.001	< 0.05	< 0.05	< 0.0002	< 0.0002	< 0.001
A-OB10	< 0.001	0.13	0.11	0.002	0.0016	0.04

All units in mg/L unless stated otherwise

Bore	Chromium (filtered)	Cobalt	Cobalt (filtered)	Copper	Copper (filtered)	Iron
A-OB7	< 0.001	0.094	0.006	0.081	0.001	85
A-OB8	0.002	0.009	0.003	0.052	0.039	5.3
P-OB5	< 0.001	< 0.001	< 0.001	0.005	< 0.001	0.82
A-OB10	< 0.001	0.13	0.017	0.046	< 0.001	43
P-OB1	< 0.001	0.003	0.003	< 0.001	< 0.001	5.2
DUP1_[POB1]	< 0.001	0.003	0.003	< 0.001	< 0.001	2.4
A-OB4	< 0.001	0.036	0.028	0.026	< 0.001	9.9
P-OB4	0.002	0.017	0.016	< 0.001	< 0.001	0.44
A-OB1	< 0.001	0.21	0.003	0.064	< 0.001	60
A-OB2	< 0.001	0.011	0.003	0.012	< 0.001	8.3
P-OB3	< 0.001	0.002	0.002	< 0.001	< 0.001	9.1
DUP2_[POB3]	< 0.001	0.002	0.002	< 0.001	< 0.001	8.7
A-OB12	< 0.001	0.005	0.003	0.007	< 0.001	13
A-OB11	< 0.001	0.005	0.006	0.005	< 0.001	5.6
A-OB7	0.008	0.81	0.007	1.6	0.003	1500
A-OB8	0.024	0.15	0.004	0.46	0.024	220
P-OB5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.76
P-OB2	0.002	0.002	0.002	0.036	0.009	0.4
DUP1_[POB2]	< 0.01	< 0.01	< 0.01	0.043	0.011	0.5
A-OB12	< 0.001	0.004	0.003	0.004	< 0.001	9.5
A-OB11	< 0.001	0.009	0.008	0.003	< 0.001	6.3
A-OB3	< 0.001	0.001	0.001	< 0.001	< 0.001	0.24
A-OB1	< 0.001	< 0.001	< 0.001	0.003	< 0.001	0.65
P-OB1	< 0.001	0.004	0.004	< 0.001	< 0.001	4.8
A-OB2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.07
P-PB1	< 0.001	0.001	0.001	0.001	< 0.001	1.6
P-OB3	< 0.01	< 0.01	< 0.01	0.063	0.063	8.9
A-OB10	0.012	0.025	0.018	0.074	0.044	13
A-OB4	0.01	0.065	0.039	0.075	< 0.001	40
DUP2_[AOB4]	< 0.01	0.23	0.039	0.53	< 0.01	240
P-OB4	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	4.4
ROSS BORE	< 0.001	0.001	< 0.001	0.002	< 0.001	1
A-OB7	< 0.001	0.12	0.008	0.24	0.005	220
P-OB2	< 0.001	0.002	0.002	0.11	0.1	0.19
DUP1_[POB2]	< 0.001	0.002	0.002	0.11	0.1	0.2
A-OB8	< 0.001	0.003	0.003	0.26	0.23	0.77
P-OB5	0.003	0.001	< 0.001	0.005	< 0.001	1.6
A-OB10	< 0.001	0.035	0.016	0.28	0.19	39
P-OB4	< 0.001	0.017	0.017	0.004	< 0.001	2.3
P-PB1	< 0.001	0.001	0.001	< 0.001	< 0.001	1.8
A-OB2	< 0.001	0.015	0.002	0.047	< 0.001	14
A-OB4	< 0.001	0.048	0.044	0.03	0.003	11
A-OB12	< 0.001	0.016	0.003	0.047	< 0.001	34
A-OB11	< 0.001	0.07	0.006	0.029	< 0.001	70
A-OB1	< 0.001	0.1	< 0.001	0.15	< 0.001	110
A-OB3	< 0.001	0.005	0.002	0.004	< 0.001	3.6
DUP2_[AOB3]	< 0.001	0.005	0.002	0.003	< 0.001	3
P-OB3	< 0.001	0.002	0.002	0.001	< 0.001	8.6
P-OB1	< 0.001	0.006	0.006	< 0.001	< 0.001	4.7
ROSS BORE	< 0.001	< 0.001	< 0.001	0.002	< 0.001	0.24
ROSS BORE	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.05
DUP1_[Rossbore]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.05
P-OB2	0.001	0.001	0.001	0.019	0.018	0.13
P-OB5	0.002	< 0.001	< 0.001	0.02	< 0.001	4.3
P-OB1	< 0.001	0.009	0.008	< 0.001	< 0.001	4.7
P-PB1	< 0.001	0.001	0.001	< 0.001	< 0.001	1.7
P-OB3	0.001	0.001	0.001	< 0.001	< 0.001	7.8
P-OB4	0.003	0.015	0.017	0.009	< 0.001	2
A-OB7	< 0.001	0.17	0.008	0.44	0.01	360
DUP2_[AOB7]	< 0.001	0.16	0.008	0.41	0.008	320
A-OB8	0.002	0.042	0.004	0.38	0.021	70
A-OB2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.05
A-OB1	< 0.001	< 0.001	< 0.001	0.005	0.003	0.27
A-OB3	< 0.001	0.001	0.001	0.002	0.004	0.19
A-OB12	< 0.001	0.002	0.002	< 0.001	< 0.001	6.6
A-OB4	0.12	0.12	0.065	1.1	< 0.05	62
A-OB11	< 0.001	0.007	0.006	< 0.001	< 0.001	4.1
A-OB10	< 0.001	0.032	0.005	0.33	0.087	53

All units in mg/L unless stated otherwise

Bore	Iron (filtered)	Lead	Lead (filtered)	Manganese	Manganese (filtered)	Mercury
A-OB7	< 0.05	0.034	< 0.001	8.2	2	< 0.0001
A-OB8	< 0.05	0.023	< 0.001	0.68	0.34	< 0.0001
P-OB5	0.08	< 0.001	< 0.001	0.65	0.65	< 0.0001
A-OB10	< 0.05	0.05	< 0.001	8.6	2.5	< 0.0001
P-OB1	5.1	< 0.001	< 0.001	1.5	1.5	< 0.0001
DUP1_[POB1]	5.1	< 0.001	< 0.001	1.4	1.5	< 0.0001
A-OB4	2	0.012	< 0.001	3.9	3.9	< 0.0001
P-OB4	0.41	< 0.001	< 0.001	3.9	3.9	< 0.0001
A-OB1	< 0.05	0.031	< 0.001	5.2	0.18	< 0.0001
A-OB2	0.13	0.007	< 0.001	0.32	0.19	< 0.0001
P-OB3	8.9	< 0.001	< 0.001	3.1	3	< 0.0001
DUP2_[POB3]	8.7	< 0.001	< 0.001	2.9	2.9	< 0.0001
A-OB12	8.3	0.003	< 0.001	0.61	0.61	< 0.0001
A-OB11	5	0.002	< 0.001	0.46	0.46	< 0.0001
A-OB7	< 0.25	0.77	< 0.01	43	2.3	0.0016
A-OB8	< 0.05	0.33	< 0.001	6.7	0.57	0.0006
P-OB5	< 0.5	< 0.01	< 0.01	0.64	0.59	< 0.001
P-OB2	0.18	< 0.001	< 0.001	0.67	0.65	< 0.0001
DUP1_[POB2]	< 0.5	< 0.01	< 0.01	0.67	0.66	< 0.001
A-OB12	6.9	0.002	< 0.001	0.49	0.49	< 0.0001
A-OB11	5.2	0.002	< 0.001	0.92	0.92	< 0.0001
A-OB3	0.09	< 0.001	< 0.001	0.17	0.17	< 0.0001
A-OB1	< 0.05	< 0.001	< 0.001	0.027	0.01	< 0.0001
P-OB1	4.8	< 0.001	< 0.001	1.5	1.5	< 0.0001
A-OB2	< 0.05	< 0.001	< 0.001	0.027	0.027	< 0.0001
P-PB1	1.5	< 0.001	< 0.001	1.7	1.7	< 0.0001
P-OB3	8.8	< 0.01	< 0.01	3.1	3	< 0.001
A-OB10	0.06	0.006	< 0.001	2	1.8	< 0.0001
A-OB4	1.1	0.026	< 0.001	3.6	3.5	0.0002
DUP2_[AOB4]	0.67	0.17	< 0.01	4.9	3.4	0.002
P-OB4	4.4	< 0.01	< 0.01	3.3	3.2	< 0.001
ROSS BORE	< 0.05	0.003	< 0.001	0.1	0.01	< 0.0001
A-OB7	< 0.05	0.091	< 0.001	12	2.8	0.0002
P-OB2	0.11	< 0.001	< 0.001	0.64	0.64	< 0.0001
DUP1_[POB2]	0.09	< 0.001	< 0.001	0.66	0.64	< 0.0001
A-OB8	< 0.05	0.005	0.002	1.8	1.8	< 0.0001
P-OB5	0.71	< 0.001	< 0.001	0.69	0.68	< 0.0001
A-OB10	0.06	0.02	< 0.001	2.6	1.7	< 0.0001
P-OB4	2.3	< 0.001	< 0.001	3.7	3.7	< 0.0001
P-PB1	1.6	< 0.001	< 0.001	1.7	1.7	< 0.0001
A-OB2	< 0.05	0.016	< 0.001	0.29	0.11	< 0.0001
A-OB4	1.6	0.005	< 0.001	3.2	3.2	< 0.0001
A-OB12	4.2	0.032	< 0.001	0.76	0.46	< 0.0001
A-OB11	4.4	0.026	< 0.001	3.2	1.3	< 0.0001
A-OB1	< 0.05	0.065	< 0.001	2.2	0.025	0.0004
A-OB3	0.56	0.003	< 0.001	0.28	0.28	< 0.0001
DUP2_[AOB3]	0.6	0.002	< 0.001	0.31	0.29	< 0.0001
P-OB3	8.6	< 0.001	< 0.001	3.1	3.1	< 0.0001
P-OB1	4.9	< 0.001	< 0.001	1.3	1.3	< 0.0001
ROSS BORE	< 0.05	0.001	< 0.001	0.094	0.022	< 0.0001
ROSS BORE	< 0.05	< 0.001	< 0.001	0.065	0.061	< 0.0001
DUP1_[Rossbore]	< 0.05	< 0.001	< 0.001	0.061	0.061	< 0.0001
P-OB2	0.05	< 0.001	< 0.001	0.58	0.58	< 0.0001
P-OB5	5	< 0.001	< 0.001	0.41	0.41	< 0.0001
P-OB1	4.7	< 0.001	< 0.001	1.6	1.6	< 0.0001
P-PB1	1.6	< 0.001	< 0.001	1.7	1.7	< 0.0001
P-OB3	7.4	< 0.001	< 0.001	2.8	2.9	< 0.0001
P-OB4	2.1	< 0.001	< 0.001	3.5	3.6	< 0.0001
A-OB7	< 0.05	0.16	< 0.001	10	2.3	0.0005
DUP2_[AOB7]	< 0.05	0.14	< 0.001	9	2.4	0.0004
A-OB8	< 0.05	0.24	< 0.001	4.8	1.7	0.0003
A-OB2	< 0.05	< 0.001	< 0.001	0.014	0.013	< 0.0001
A-OB1	< 0.05	< 0.001	< 0.001	0.034	0.031	< 0.0001
A-OB3	0.16	< 0.001	< 0.001	0.15	0.15	< 0.0001
A-OB12	6.3	< 0.001	< 0.001	0.41	0.42	< 0.0001
A-OB4	< 0.001	0.095	0.99	1.4	< 0.0001	0.0042
A-OB11	3.7	< 0.001	< 0.001	0.84	0.84	< 0.0001
A-OB10	< 0.05	0.043	< 0.001	1.5	0.44	0.0001

All units in mg/L unless stated otherwise

Bore	Mercury (filtered)	Molybdenum	Molybdenum (filtered)	Nickel	Nickel (filtered)	Selenium
A-OB7	< 0.0001	< 0.005	< 0.005	0.11	0.008	0.003
A-OB8	< 0.0001	0.011	0.011	0.16	0.15	0.002
P-OB5	< 0.0001	0.021	0.02	0.014	0.011	< 0.001
A-OB10	< 0.0001	< 0.005	< 0.005	0.12	0.02	0.003
P-OB1	< 0.0001	< 0.005	< 0.005	0.003	0.003	0.011
DUP1_[POB1]	< 0.0001	< 0.005	< 0.005	0.003	0.003	< 0.001
A-OB4	< 0.0001	< 0.005	< 0.005	0.032	0.019	0.002
P-OB4	< 0.0001	0.007	0.007	0.017	0.016	< 0.001
A-OB1	< 0.0001	< 0.005	< 0.005	0.12	0.003	0.002
A-OB2	< 0.0001	< 0.005	< 0.005	0.01	0.002	0.001
P-OB3	< 0.0001	< 0.005	< 0.005	0.002	0.002	< 0.001
DUP2_[POB3]	< 0.0001	< 0.005	< 0.005	0.002	0.002	< 0.001
A-OB12	< 0.0001	< 0.005	< 0.005	0.006	0.001	< 0.001
A-OB11	< 0.0001	< 0.005	< 0.005	0.004	0.002	0.001
A-OB7	< 0.0001	< 0.05	< 0.005	1	0.01	0.038
A-OB8	< 0.0001	0.018	0.018	0.37	0.027	0.011
P-OB5	< 0.001	< 0.05	< 0.05	0.015	< 0.01	< 0.01
P-OB2	< 0.0001	< 0.005	< 0.005	0.013	0.005	< 0.001
DUP1_[POB2]	< 0.001	< 0.05	< 0.05	0.011	< 0.01	< 0.01
A-OB12	< 0.0001	< 0.005	< 0.005	0.004	0.002	< 0.001
A-OB11	< 0.0001	< 0.005	< 0.005	0.004	0.002	< 0.001
A-OB3	< 0.0001	< 0.005	< 0.005	0.001	0.001	0.001
A-OB1	< 0.0001	< 0.005	< 0.005	0.003	< 0.001	< 0.001
P-OB1	< 0.0001	< 0.005	< 0.005	0.004	0.004	< 0.001
A-OB2	< 0.0001	< 0.005	< 0.005	0.003	0.003	< 0.001
P-PB1	< 0.0001	< 0.005	< 0.005	0.002	0.002	< 0.001
P-OB3	< 0.001	< 0.05	< 0.05	< 0.01	< 0.01	< 0.01
A-OB10	< 0.0001	< 0.005	< 0.005	0.034	0.02	0.004
A-OB4	< 0.0001	< 0.005	< 0.005	0.083	0.031	0.003
DUP2_[AOB4]	< 0.001	< 0.05	< 0.05	0.41	0.034	0.017
P-OB4	< 0.001	< 0.05	< 0.05	< 0.01	< 0.01	< 0.01
ROSS BORE	< 0.0001	< 0.005	< 0.005	< 0.001	< 0.001	0.003
A-OB7	< 0.0001	< 0.005	< 0.005	0.14	0.01	0.005
P-OB2	< 0.0001	< 0.005	< 0.005	0.003	0.003	< 0.001
DUP1_[POB2]	< 0.0001	< 0.005	< 0.005	0.003	0.003	< 0.001
A-OB8	< 0.0001	0.024	0.023	0.032	0.03	0.001
P-OB5	< 0.0001	0.013	0.007	0.01	0.007	0.001
A-OB10	< 0.0001	< 0.005	< 0.005	0.051	0.02	0.004
P-OB4	< 0.0001	< 0.005	< 0.005	0.031	0.03	< 0.001
P-PB1	< 0.0001	< 0.005	< 0.005	0.001	0.001	< 0.001
A-OB2	< 0.0001	< 0.005	< 0.005	0.018	0.002	0.001
A-OB4	< 0.0001	< 0.005	< 0.005	0.036	0.026	< 0.001
A-OB12	< 0.0001	< 0.005	< 0.005	0.027	0.002	0.002
A-OB11	< 0.0001	< 0.005	< 0.005	0.062	0.002	0.002
A-OB1	< 0.0001	< 0.005	< 0.005	0.078	< 0.001	0.004
A-OB3	< 0.0001	< 0.005	< 0.005	0.007	0.002	< 0.001
DUP2_[AOB3]	< 0.0001	< 0.005	< 0.005	0.007	0.001	0.001
P-OB3	< 0.0001	< 0.005	< 0.005	0.003	0.002	< 0.001
P-OB1	< 0.0001	< 0.005	< 0.005	0.008	0.005	< 0.001
ROSS BORE	< 0.0001	< 0.005	< 0.005	< 0.001	< 0.001	0.005
ROSS BORE	< 0.0001	< 0.005	< 0.005	< 0.001	< 0.001	0.005
DUP1_[Rossbore]	< 0.0001	< 0.005	< 0.005	< 0.001	< 0.001	0.004
P-OB2	< 0.0001	< 0.005	< 0.005	0.003	0.003	< 0.001
P-OB5	< 0.0001	< 0.005	< 0.005	0.003	0.002	< 0.001
P-OB1	< 0.0001	< 0.005	< 0.005	0.007	0.006	< 0.001
P-PB1	< 0.0001	< 0.005	< 0.005	0.001	0.001	< 0.001
P-OB3	< 0.0001	< 0.005	0.008	0.002	0.001	< 0.001
P-OB4	< 0.0001	< 0.005	0.013	0.033	0.039	< 0.001
A-OB7	< 0.0001	< 0.005	0.011	0.21	0.01	< 0.001
DUP2_[AOB7]	< 0.0001	< 0.005	0.012	0.19	0.01	< 0.001
A-OB8	< 0.0001	0.019	0.034	0.14	0.044	0.002
A-OB2	0.0002	< 0.005	0.008	0.001	0.001	< 0.001
A-OB1	0.0001	< 0.005	0.008	0.002	0.002	< 0.001
A-OB3	0.0002	< 0.005	0.009	0.002	0.002	0.001
A-OB12	< 0.0001	< 0.005	0.01	0.001	0.001	< 0.001
A-OB4	< 0.005	< 0.005	0.02	0.16	0.01	0.009
A-OB11	0.0001	< 0.005	0.008	0.002	0.002	< 0.001
A-OB10	< 0.0001	< 0.005	0.005	0.053	0.007	0.008

All units in mg/L unless stated otherwise

Bore	Selenium (filtered)	Uranium	Uranium (filtered)	Vanadium	Vanadium (filtered)	Zinc
A-OB7	< 0.001	< 0.005	< 0.005	0.1	< 0.005	0.43
A-OB8	0.002	0.07	0.07	0.013	0.005	0.12
P-OB5	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.081
A-OB10	< 0.001	< 0.005	< 0.005	0.08	< 0.005	0.36
P-OB1	0.011	< 0.005	< 0.005	< 0.005	< 0.005	0.032
DUP1_[POB1]	0.01	< 0.005	< 0.005	< 0.005	< 0.005	0.006
A-OB4	< 0.001	0.008	0.008	0.02	< 0.005	0.084
P-OB4	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.038
A-OB1	< 0.001	< 0.005	< 0.005	0.13	< 0.005	0.36
A-OB2	< 0.001	< 0.005	< 0.005	0.021	< 0.005	0.11
P-OB3	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.006
DUP2_[POB3]	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
A-OB12	< 0.001	< 0.005	< 0.005	0.011	< 0.005	0.025
A-OB11	< 0.001	< 0.005	< 0.005	0.007	< 0.005	0.02
A-OB7	< 0.001	0.055	0.008	1.2	< 0.005	4.3
A-OB8	0.003	0.14	0.077	0.28	< 0.005	0.66
P-OB5	< 0.01	< 0.05	< 0.05	< 0.01	< 0.01	0.31
P-OB2	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.38
DUP1_[POB2]	< 0.01	< 0.05	< 0.05	< 0.01	< 0.01	0.12
A-OB12	< 0.001	< 0.005	< 0.005	0.008	< 0.005	0.05
A-OB11	< 0.001	< 0.005	< 0.005	0.006	< 0.005	0.043
A-OB3	0.001	< 0.005	< 0.005	0.009	0.009	0.37
A-OB1	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.069
P-OB1	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.097
A-OB2	< 0.001	< 0.005	< 0.005	0.005	0.005	0.025
P-PB1	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.19
P-OB3	< 0.01	< 0.05	< 0.05	< 0.01	< 0.01	0.1
A-OB10	0.003	0.006	0.005	0.022	< 0.005	0.075
A-OB4	< 0.001	0.013	0.011	0.057	< 0.005	0.19
DUP2_[AOB4]	< 0.01	< 0.05	< 0.05	0.34	< 0.01	1.2
P-OB4	< 0.01	< 0.05	< 0.05	< 0.01	< 0.01	0.15
ROSS BORE	0.003	< 0.005	< 0.005	< 0.005	< 0.005	0.017
A-OB7	< 0.001	0.007	0.007	0.23	< 0.005	0.45
P-OB2	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.008
DUP1_[POB2]	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.008
A-OB8	< 0.001	0.065	0.065	< 0.005	< 0.005	0.025
P-OB5	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.027
A-OB10	0.002	0.006	< 0.005	0.052	< 0.005	0.11
P-OB4	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.006
P-PB1	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.009
A-OB2	< 0.001	< 0.005	< 0.005	0.037	< 0.005	0.089
A-OB4	< 0.001	0.01	0.01	0.014	< 0.005	0.045
A-OB12	< 0.001	0.005	< 0.005	0.092	< 0.005	0.2
A-OB11	< 0.001	< 0.005	< 0.005	0.22	< 0.005	0.61
A-OB1	< 0.001	0.008	< 0.005	0.16	< 0.005	0.26
A-OB3	< 0.001	< 0.005	< 0.005	0.011	0.006	0.022
DUP2_[AOB3]	0.001	< 0.005	< 0.005	0.011	0.006	0.02
P-OB3	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
P-OB1	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.021
ROSS BORE	0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.028
ROSS BORE	0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.027
DUP1_[Rossbore]	0.004	< 0.005	< 0.005	< 0.005	< 0.005	0.021
P-OB2	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.016
P-OB5	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.013
P-OB1	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.046
P-PB1	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.01
P-OB3	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.005
P-OB4	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.007
A-OB7	< 0.001	0.015	0.005	0.29	< 0.005	0.76
DUP2_[AOB7]	< 0.001	0.014	< 0.005	0.28	< 0.005	0.7
A-OB8	< 0.001	0.12	0.058	0.076	< 0.005	0.57
A-OB2	< 0.001	< 0.005	< 0.005	0.005	< 0.005	0.006
A-OB1	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.009
A-OB3	0.002	< 0.005	< 0.005	0.008	0.007	0.006
A-OB12	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.007
A-OB4	0.011	0.02	0.01	0.16	0.032	0.36
A-OB11	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	0.007
A-OB10	0.005	0.006	< 0.005	0.086	< 0.005	0.17

All units in mg/L unless stated otherwise

Bore	Zinc (filtered)	TRH C6-C9	TRH C6-C10	TRH C10-C14 (after silica gel clean-up)	TRH C10-C36 (Total) (after silica gel clean-up)	TRH C15-C28 (after silica gel clean-up)
A-OB7	0.051	NA	NA	< 0.05	< 0.1	< 0.1
A-OB8	0.029	NA	NA	< 0.05	< 0.1	< 0.1
P-OB5	0.007	NA	NA	< 0.05	< 0.1	< 0.1
A-OB10	0.021	< 0.02	< 0.02	NA	NA	NA
P-OB1	0.005	NA	NA	< 0.05	< 0.1	< 0.1
DUP1_[POB1]	0.005	NA	NA	< 0.05	< 0.1	< 0.1
A-OB4	0.029	NA	NA	0.39	0.49	0.1
P-OB4	0.019	NA	NA	< 0.05	< 0.1	< 0.1
A-OB1	0.01	NA	NA	< 0.05	< 0.1	< 0.1
A-OB2	0.018	NA	NA	< 0.05	< 0.1	< 0.1
P-OB3	< 0.005	NA	NA	< 0.05	< 0.1	< 0.1
DUP2_[POB3]	< 0.005	NA	NA	< 0.05	< 0.1	< 0.1
A-OB12	< 0.005	NA	NA	< 0.05	< 0.1	< 0.1
A-OB11	0.009	NA	NA	< 0.05	< 0.1	< 0.1
A-OB7	0.012	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB8	0.058	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
P-OB5	< 0.05	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
P-OB2	0.38	< 0.02	< 0.02	< 0.05	0.2	< 0.1
DUP1_[POB2]	< 0.05	< 0.02	< 0.02	0.06	< 0.1	< 0.1
A-OB12	0.05	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB11	0.018	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB3	0.018	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB1	0.008	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
P-OB1	0.014	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB2	0.009	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
P-PB1	0.045	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
P-OB3	< 0.05	< 0.02	< 0.02	< 0.05	0.2	< 0.1
A-OB10	0.047	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB4	0.097	< 0.02	< 0.02	0.13	0.23	0.1
DUP2_[AOB4]	0.058	< 0.02	< 0.02	0.34	0.74	0.4
P-OB4	< 0.05	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
ROSS BORE	0.01	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB7	0.022	< 0.04	< 0.04	< 0.05	< 0.1	< 0.1
P-OB2	0.008	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
DUP1_[POB2]	0.008	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB8	0.024	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
P-OB5	< 0.005	< 0.08	< 0.08	< 0.05	< 0.1	< 0.1
A-OB10	0.021	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
P-OB4	0.006	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
P-PB1	0.009	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB2	0.011	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB4	0.02	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB12	0.014	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB11	0.016	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB1	< 0.005	0.02	0.02	< 0.05	< 0.1	< 0.1
A-OB3	< 0.005	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
DUP2_[AOB3]	< 0.005	< 0.02	< 0.02	NA	NA	NA
P-OB3	< 0.005	< 0.02	< 0.02	NA	NA	NA
P-OB1	0.013	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
ROSS BORE	0.027	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
ROSS BORE	0.024	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
DUP1_[Rossbore]	0.021	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
P-OB2	0.01	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
P-OB5	0.008	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
P-OB1	0.011	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
P-PB1	0.01	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
P-OB3	0.008	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
P-OB4	< 0.005	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB7	0.18	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
DUP2_[AOB7]	0.01	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB8	0.02	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB2	< 0.005	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB1	< 0.005	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB3	< 0.005	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB12	< 0.005	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB4	NA	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB11	< 0.005	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1
A-OB10	0.051	< 0.02	< 0.02	< 0.05	< 0.1	< 0.1

All units in mg/L unless stated otherwise

Bore	TRH C29-C36 (after silica gel clean-up)	TRH >C10-C16 (after silica gel clean-up)	TRH >C16-C34 (after silica gel clean-up)	TRH >C34-C40 (after silica gel clean-up)	TRH >C34-C40 (after silica gel clean-up)
A-OB7	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB8	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
P-OB5	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB10	NA	NA	NA	NA	NA
P-OB1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
DUP1_[POB1]	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB4	< 0.1	0.31	< 0.1	< 0.1	< 0.1
P-OB4	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB2	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
P-OB3	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
DUP2_[POB3]	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB12	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB11	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB7	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB8	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
P-OB5	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
P-OB2	0.2	< 0.05	0.2	0.3	0.3
DUP1_[POB2]	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB12	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB11	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB3	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
P-OB1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB2	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
P-PB1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
P-OB3	0.2	< 0.05	0.1	0.2	0.2
A-OB10	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB4	< 0.1	0.27	< 0.1	< 0.1	< 0.1
DUP2_[AOB4]	< 0.1	0.64	< 0.1	< 0.1	< 0.1
P-OB4	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
ROSS BORE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
A-OB7	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
P-OB2	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
DUP1_[POB2]	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB8	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
P-OB5	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB10	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
P-OB4	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
P-PB1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB2	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB4	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB12	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB11	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB3	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
DUP2_[AOB3]	NA	NA	NA	NA	NA
P-OB3	NA	NA	NA	NA	< 0.1
P-OB1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
ROSS BORE	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
ROSS BORE	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
DUP1_[Rossbore]	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
P-OB2	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
P-OB5	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
P-OB1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
P-PB1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
P-OB3	< 0.1	< 0.05	< 0.1	< 0.1	NA
P-OB4	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB7	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
DUP2_[AOB7]	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB8	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB2	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB3	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB12	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB4	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB11	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1
A-OB10	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1

All units in mg/L unless stated otherwise

APPENDIX D

Stygofauna Reports

Report for the First Round of Monitoring of Stygofauna for Baralaba South December 2017
By Peter Serov

Sampling Methodology
In order to sample a habitat effectively it is often necessary to use a combination of techniques to comprehensively collect all possible biota as the stygofaunal community occupies a range of habitat niches. The habitat surveyed for this project is the Phreatic (Groundwater) Zone accessed via bores and wells. For routine surveying or monitoring of bores and wells a bailer and or plankton nets (Mathieu et al. 1991) are the preferred devices.

The Phreatic/Hypogean Zone
The phreatic zone is the subsurface area within an aquifer where voids in the rock are completely filled with water. This is occupied by phreatobites. The stygofauna community was sampled using two standardised methods and one non-standard method.

The first technique is the Phreatobiology Net. This is the standard technique that has been used successfully overseas and in Australia (Bou, 1974). The method used conforms to WA guideline [2003 & 2007] requirements. This method involves using a weighted long haul or plankton net with a fine mesh. Sampling consisted of dropping the net down to the bottom of the bore and taking at least three consecutive hauls from the entire water column at each bore. Upon removal from the bore the net is washed of sediment and animals and the contents of the sampling jar (the weighted container at the bottom of the net) are decanted through a fine mesh sieve. The contents of the sieve are then transferred to a labelled sample jar and preserved with 100% ethanol.

The second method is the use of a groundwater bailer. A bailer is typically used by hydrogeologists to take water samples from bores for water quality/water chemistry analysis. The advantage of using a bailer is twofold. The main reason for using a bailer is that it can sample the bottom sediment of a bore that cannot be sampled by a haul net and therefore enables the collection of cryptic invertebrates that do not inhabit the water column or sides of the bore. The second advantage is that in shallow bores down to 5 meters in sediments with low transitivity porosity) a bailer is able to empty the entire contents of a bore and thereby confidently collect all animals within the bore. Following sampling and preservation of the sample and prior to the next sampling all equipment including the bailer, net and sieves must be rinsed clean with clean water via a spray bottle to remove any sediment and animals that may have remained attached to the sampling devices. This is to reduce the possibility of cross contamination of organisms (stygofauna or bacteria) or pollutants from one aquifer or bore to another.

Laboratory Methods

Identification
All samples are preserved in the field with 100% ethanol and returned to the laboratory where each sample is sorted under a stereomicroscope and stored in 100% alcohol. All specimens found are identified to the lowest possible taxonomic level, generally to family, where possible. Specimens are identified under a compound microscope using a combination of current taxonomic works and keys such as Williams (1981) and the taxonomic identification series (Serov 2002) produced by the Murray Darling Freshwater Research Centre as well as the authors taxonomic expertise and experience.

Physico-Chemical Data
Water quality parameters including temperature, electrical conductivity, ph were collected in the field using a water quality multimeter. Bore depth and water level (SWL) data was collected at each site during each survey using a depth probe in the field during the survey.

Background
Stygofauna has previously been recorded at both Baralaba South in 2012 (SKM 2013) and Baralaba North in 2014 (EcoLogical 2014) approximately 8 km north in the alluvial aquifer of the Dawson River Anabranch. The previously collected fauna at Baralaba South has consisted entirely of Cyclopoida Copepoda, in bores (AOB1, AOB3, AOB8, APB01), and a damaged mite in AOB04. The stygofauna were collected only from the alluvial aquifer. Water from the four bores that contained cyclopoids had temperature between 20.1 and 24.9 °C, electrical conductivity between 570.5 and 4,400 µS/cm, dissolved oxygen between 2.7 and 3.9 mg/L, and the pH for all bores was 7.3. Contrasting with these variables, AOB04 (where the mite was recorded) had an EC of 21,039 □S/cm and a pH of 6.7 (SKM 2013). The mite recorded on this occasion is likely to be a stygoxene i.e. a surface soil species that had accidentally entered the bore.

At Baralaba North the fauna consisted of both Cyclopoida Copepoda and Bathynellacea Syncarida which were collected exclusively from Dawson River Alluvial Aquifer. In the broader regional context of the Bowen Basin, stygofauna are known from the alluvial aquifer Devlin Creek (ALS 2011), the Bowen River (GHD 2012), and MacKenzie River (ELA unpublished), and are likely to occur in many alluvial aquifers present in the Basin (4T Consultants 2012). The fauna generally, consists of cyclopoid and harpacticoid copepods, as well as Bathynellacea (GHD 2012). Amphipoda have been collected from northern aquifers with coarse sediments and high hydraulic conductivity (GHD 2012). Stygofauna have also been recorded in a shallow sandstone seam in the Gallilee Basin (4T Consultants 2012).

Results
The first round of stygofauna survey was conducted between 16-21st of December 2017. During this round 8 bores were surveyed. These recorded a negative result for stygofauna. All samples contained significant quantities of decomposed terrestrial insect parts indicating open standpipes. The samples also contained very fine sand and clay sediments of between approximately 50-300µm.

Discussion
The lack of fauna collected in the sites sampled during this round is suggested to be because of either singly or a combination of factors.
These factors include:
- the fine-grained nature of the substrates
- the elevated electrical conductivity of bores
- the hydraulic conditions of the aquifer.

The fine-grained nature of the sediments within the aquifer is likely to be the limiting factor for the bores that recorded low levels of salinity.

The previous records of stygofauna (Cyclopoida, Copepoda) from bores with high EC values is something of an oddity. Although the Western Australian Guidelines suggest that stygofauna have been recorded in hyposaline waters, the general situation for freshwater/non-coastal aquifers is that salinities in excess of 2000µS/cm will significantly reduce or preclude the presence of stygofauna. This is particular the case for the Copepoda. Copepoda

The Copepoda are a subclass of Crustacea comprising over 10,000 known species (Williamson and Read 2001). Copepoda are predominantly marine, although 3 of the 10 orders are widespread and abundant in freshwater habitats. The Cyclopoida and Harpacticoida are common in benthic habitats of surface waters and are important components of many groundwater communities.

The Copepoda Cyclopidae is normally associated with fine to course sandy substrates of still water environments of rivers, wetlands, the hyporheic zone and shallow groundwaters. Although they are a ubiquitous component of these habitats, their small size means that they are often overlooked and undercounted. In terms of management, therefore, they are potentially very useful bioindicators, particularly of base flow fed streams or alluvial aquifers or flow through wetlands, as they are sensitive to changes in the environment (Tomlinson & Boulton, 2008). The Cyclopidae were previously collected at two sites in the alluvial aquifer. The conductivity levels however vary considerably from low to high suggesting that the fauna is either very tolerant of salinity changes or composed of different taxa. It is suggested that fauna is composed of different species with differing salinity tolerance ranges.

The last point refers to alluvial aquifers that have a hydraulic connection with a river. All rivers that possess an alluvial floodplain will contain an alluvial aquifer. These habitats are formed by the uneven porosity present within fissures, fractures, solutional conduits and pore spaces between unconsolidated sediments. Therefore, one of the primary drivers of subterranean ecosystems is the presence of hydraulic conductivity and preferential flow paths within the geological matrix that forms the aquifer (Serov & Kuginis 2017). Alluvial aquifer subterranean habitats rely on and are directly influenced by the direction of flow and water chemistry of the groundwater through the aquifer.

The direction of flow through an alluvial aquifer and its water chemistry are dictated by the water level of the river i.e. whether the river is either loosing or gaining. A losing stream is one where the river water is higher than the groundwater and is lost to the surrounding and underlying groundwater system and therefore the flow is away from the river and into the alluvial. This occurs when there is a flood or the regional groundwater levels are below the bed of the river. In this case the water chemistry of the aquifer reflects the river water chemistry and the fauna within the aquifer can contain riverine hyporheic or stygoxene fauna. A gaining stream on the other hand is one where the stream water level is below the surrounding groundwater level and flow is from the alluvial aquifer into the river. This baseflow, or groundwater discharge, serves to maintain and even increase stream flow as one goes downstream. In this scenario the what chemistry in the river reflects the chemistry of the groundwater and the fauna composition of the aquifer has a high proportion of phreatobytes or stygofauna (Serov, et al, 2012). Therefore, although stygofaunal community composition in aquifers can be quite consistent over time, the stygofauna composition within alluvial aquifers can be variable depending on conditions of water flow, level and water chemistry of both the aquifer and associated river at the time of sampling. It is for this reason that PASCALIS (2003) stipulated that multiple temporal and spatial surveys are required to accurately determine the species composition, distribution and ecosystem dynamics of aquifer ecosystems.

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Report for the Second Round of Monitoring of Stygofauna for Baralaba South March 2018
By Dr Peter Serov, Stygoecologia

Sampling Methodology
As per previous report.

Background
Stygofauna has previously been recorded at both Baralaba South in 2012 (SKM 2013) and Baralaba North in 2014 (EcoLogical 2014) approximately 8 km north in the alluvial aquifer of the Dawson River Anabranch. The previously collected fauna at Baralaba South has consisted entirely of Cyclopoida Copepoda, in bores (AOB1, AOB3, AOB8, APB01), and a damaged mite in AOB04.

At Baralaba North the fauna consisted of both Cyclopoida Copepoda and Bathynellacea Syncarida which were collected exclusively from Dawson River Alluvial Aquifer. In the broader regional context of the Bowen Basin, stygofauna are known from the alluvial aquifer Devlin Creek (ALS 2011), the Bowen River (GHD 2012), and MacKenzie River (ELA unpublished), and are likely to occur in many alluvial aquifers present in the Basin (4T Consultants 2012). The fauna generally, consists of cyclopoid and harpacticoid copepods, as well as Bathynellacea (GHD 2012). Amphipoda have been collected from northern aquifers with coarse sediments and high hydraulic conductivity (GHD 2012). Stygofauna have also been recorded in a shallow sandstone seam in the Gallilee Basin (4T Consultants 2012).

The second round of the current survey program yielded a negative result for all bores sampled except for one site. Bore AOB3 recorded the first record of an aquatic worm within the groundwater. The worm belongs to the Oligochaete family Naididae.

Results
The second round of stygofauna survey was conducted between 20-24th of March 2018. During this round 9 bores were surveyed. These recorded a negative result for stygofauna except for one bore, Bore No. A-0B3. The obligate groundwater fauna within this bore is characterised by a single specimen of Oligochaeta (aquatic worm) belonging to the Family Naididae. All samples still contained significant quantities of decomposed terrestrial insect parts indicating open standpipes. The samples also contained very fine sand and clay sediments of between approximately 50-300µm.

The taxon collected belongs to the hypogean (true groundwater) ecosystem, which typically has relatively low DO, permanent darkness, highly stable water quality, and low energy levels from allochthonous input and bacteria. The presence of Oligochaeta within the groundwater suggests that the stratum was unconsolidated and is probably a paleochannel of an ancient river bed consisting of inter-bedded medium to course grained sands and gravels. Oligochaeta are usually associated with finer unconsolidated substrates that act as slow to trickling filters and play an important role in increases the efficiency of bacterial growth and maintain open interstitial spaces through their feeding activities (Danielopol, et al, 2000). The family Naididae is a common aquatic family of freshwater worms, which currently contains approximately 23 genera and 59 species. In terms of their use within current environmental sensitivity indices such as the SIGNAL Index ranking, they can only be assessed at the Order level of Oligochaeta which has a ranking of 2. This equates to a family which is quite tolerant of environmental disturbance. This, however, is misleading as the family is usually associated with high water quality environments.

The Naididae typically inhabit and swim in the water column just above the substratum, whereas other aquatic oligochaetes that do not burrow, crawl along the substratum. The feeding habit of most aquatic oligochaetes is to ingest detritus and sediments although some species of Naididae may be carnivorous, while others are parasitic. Naididae species reproduce by a process of budding from a special segment (Pinder & Brinkhurst, 1994).

The Australian naidid fauna consists mostly of cosmopolitan species, although there are indications of greater endemicity than currently recognised. Increasingly, new Naidid species are being collected from seasonal habitats on granite outcrops in the south-west and from refugial habitats (caves, groundwater and permanent river pools) in drier regions. A complete picture of oligochaete distributions will require much more work and patterns suggested by current data are presented here as hypotheses. (Pinder, 2001).

The presence of worms and a general paucity of large crustaceans at these sites indicates that the water quality is characterised by elevated organic carbon, and possibly high levels of dissolved iron, lower (acidic) pH levels ranging from approximately 6-4 pH units and relatively low DO. The relatively small size (1-2mm) of the Oligochaete (worm) species present indicates a low to moderate connectivity within the river/aquifer environment. The shallow water table levels within the riverine hyporheic zone suggests a direct association/connectivity with a slow base flow river system with a shallow alluvial water table.

Subterranean Oligochaetes are an increasingly important component of Australia's groundwater fauna that contain a large number of short range endemic species with large faunas along the continental marginal areas, particular in the southwest and eastern seaboards. They are a poorly known group that requires further taxonomic work (Pinder & Brinkhurst, 1994).

Although primarily phreatobites i.e. belonging to the shallow groundwater ecotone, this family can also be found within the riverine, hyporheic zones in areas of groundwater discharge where the discharge can be either point source springs or diffuse discharge through a moderate to course grained substrate such as sand or gravels (Gilbert 1994).

Discussion

The lack of fauna collected in most sites sampled during this round is suggested to be because of either singly or a combination of factors.

These factors include:

- the fine-grained nature of the substrates
- the elevated electrical conductivity of bores
- the slow hydraulic conditions of the aquifer.

The fine-grained nature of the sediments within the aquifer is likely to be the limiting factor for the bores that recorded low levels of salinity. This is particularly the case for the bores with a high clay content. The lower porosity within the sediment will limit both water movement and fauna dispersal capabilities within the aquifer.

The continued depauperate nature of the bores is suggested to be as a result of the long dry period that has preceded this sampling round and resulted in a lowering of the watertable and possible disconnection to the river. The direction of flow through an alluvial aquifer and its water chemistry are dictated by the water level of the river i.e. whether the river is either loosing or gaining. A losing stream is one where the river water is higher than the groundwater and is lost to the surrounding and underlying groundwater system and therefore the flow is away from the river and into the alluvial. This occurs when there is a flood or the regional groundwater levels are below the bed of the river. A gaining stream on the other hand is one where the stream water level is below the surrounding groundwater level and flow is from the alluvial aquifer into the river. This baseflow, or groundwater discharge, serves to maintain and even increase stream flow as one goes downstream. In this scenario the water chemistry in the river reflects the chemistry of the groundwater and the fauna composition of the aquifer has a high proportion of phreatobytes or stygofauna (Serov, et al, 2012). Therefore, although stygofaunal community composition in aquifers can be quite consistent over time, the stygofauna composition within alluvial aquifers can be variable depending on conditions of water flow, level and water chemistry of both the aquifer and associated river at the time of sampling. It is for this reason that PASCALIS (2003) stipulated that multiple temporal and spatial surveys are required to accurately determine the species composition, distribution and ecosystem dynamics of aquifer ecosystems.

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APPENDIX E

Pumping Test Results

Bore	P-OB1	DUP1_[POB1]	RPD	P-OB3	DUP2_[POB3]	RPD
Date	19-Dec-17	19-Dec-17		21-Dec-17	21-Dec-17	
Chloride	11000	15000	31%	13000	13000	0%
Conductivity (µS/cm)	28000	28000	0%	32000	33000	3%
Fluoride	< 0.5	< 0.5	0%	< 0.5	< 0.5	0%
pH (pH Units)	7.4	7.2	3%	7.1	7.1	0%
Sulphate (as SO4)	1600	1600	0%	1200	1200	0%
Total Dissolved Solids	25000	23000	8%	30000	27000	11%
Bicarbonate Alkalinity (as CaCO3)	440	440	0%	310	300	3%
Carbonate Alkalinity (as CaCO3)	< 10	< 10	0%	< 10	< 10	0%
Hydroxide Alkalinity (as CaCO3)	< 10	< 10	0%	< 10	< 10	0%
Total Alkalinity (as CaCO3)	440	440	0%	310	300	3%
Calcium	1500	1500	0%	1800	1700	6%
Magnesium	1300	1300	0%	1300	1300	0%
Potassium	29	27	7%	29	27	7%
Sodium	3900	3800	3%	4800	4500	6%
Aluminium	< 0.05	< 0.05	0%	< 0.05	< 0.05	0%
Aluminium (filtered)	< 0.05	< 0.05	0%	< 0.05	< 0.05	0%
Arsenic	0.005	0.002	**86%**	0.002	0.001	**67%**
Arsenic (filtered)	0.004	0.004	0%	0.001	0.001	0%
Barium	0.04	0.04	0%	0.07	0.07	0%
Barium (filtered)	0.04	0.04	0%	0.07	0.07	0%
Beryllium	< 0.001	< 0.001	0%	< 0.001	< 0.001	0%
Beryllium (filtered)	< 0.001	< 0.001	0%	< 0.001	< 0.001	0%
Boron	0.21	0.21	0%	0.22	0.22	0%
Boron (filtered)	0.21	0.22	5%	0.22	0.22	0%
Cadmium	< 0.0002	< 0.0002	0%	< 0.0002	< 0.0002	0%
Cadmium (filtered)	< 0.0002	< 0.0002	0%	< 0.0002	< 0.0002	0%
Chromium	< 0.001	< 0.001	0%	0.002	0.002	0%
Chromium (filtered)	< 0.001	< 0.001	0%	< 0.001	< 0.001	0%
Cobalt	0.003	0.003	0%	0.002	0.002	0%
Cobalt (filtered)	0.003	0.003	0%	0.002	0.002	0%
Copper	< 0.001	< 0.001	0%	< 0.001	< 0.001	0%
Copper (filtered)	< 0.001	< 0.001	0%	< 0.001	< 0.001	0%
Iron	5.2	2.4	**74%**	9.1	8.7	4%
Iron (filtered)	5.1	5.1	0%	8.9	8.7	2%
Lead	< 0.001	< 0.001	0%	< 0.001	< 0.001	0%
Lead (filtered)	< 0.001	< 0.001	0%	< 0.001	< 0.001	0%
Manganese	1.5	1.4	7%	3.1	2.9	7%
Manganese (filtered)	1.5	1.5	0%	3	2.9	3%
Mercury	< 0.0001	< 0.0001	0%	< 0.0001	< 0.0001	0%
Mercury (filtered)	< 0.0001	< 0.0001	0%	< 0.0001	< 0.0001	0%
Molybdenum	< 0.005	< 0.005	0%	< 0.005	< 0.005	0%
Molybdenum (filtered)	< 0.005	< 0.005	0%	< 0.005	< 0.005	0%
Nickel	0.003	0.003	0%	0.002	0.002	0%
Nickel (filtered)	0.003	0.003	0%	0.002	0.002	0%
Selenium	0.011	< 0.001	**167%**	< 0.001	< 0.001	0%
Selenium (filtered)	0.011	0.01	10%	< 0.001	< 0.001	0%
Uranium	< 0.005	< 0.005	0%	< 0.005	< 0.005	0%
Uranium (filtered)	< 0.005	< 0.005	0%	< 0.005	< 0.005	0%
Vanadium	< 0.005	< 0.005	0%	< 0.005	< 0.005	0%
Vanadium (filtered)	< 0.005	< 0.005	0%	< 0.005	< 0.005	0%
Zinc	0.032	0.006	**137%**	0.006	< 0.005	18%
Zinc (filtered)	0.005	0.005	0%	< 0.005	< 0.005	0%
TRH C6-C9	Not Analysed	Not Analysed		Not Analysed	Not Analysed	
TRH C6-C10	Not Analysed	Not Analysed		Not Analysed	Not Analysed	
TRH C10-C14 (after silica gel clean-up)	< 0.05	< 0.05	0%	< 0.05	< 0.05	0%
TRH C10-C36 (Total) (after silica gel clean-up)	< 0.1	< 0.1	0%	< 0.1	< 0.1	0%
TRH C15-C28 (after silica gel clean-up)	< 0.1	< 0.1	0%	< 0.1	< 0.1	0%
TRH C29-C36 (after silica gel clean-up)	< 0.1	< 0.1	0%	< 0.1	< 0.1	0%
TRH >C10-C16 (after silica gel clean-up)	< 0.05	< 0.05	0%	< 0.05	< 0.05	0%
TRH >C16-C34 (after silica gel clean-up)	< 0.1	< 0.1	0%	< 0.1	< 0.1	0%
TRH >C34-C40 (after silica gel clean-up)	< 0.1	< 0.1	0%	< 0.1	< 0.1	0%
TRH >C34-C40 (after silica gel clean-up)	< 0.1	< 0.1	0%	< 0.1	< 0.1	0%

All units are mg/L unless stated otherwise

67%	Above 50% RPD
164%	Laboratory QC discrepancy
	Not Analysed

Bore	P-OB2	DUP1_[POB2]	RPD	A-OB4	DUP2_[AOB4]	RPD
Date	21-Mar-18	21-Mar-18		24-Mar-18	24-Mar-18	
Chloride	3700	3800	3%	11000	8400	27%
Conductivity (µS/cm)	17000	17000	0%	35000	35000	0%
Fluoride	< 0.5	< 0.5	0%	< 0.5	< 0.5	0%
pH (pH Units)	7.5	7.5	0%	7.4	7.5	1%
Sulphate (as SO4)	440	450	2%	1500	1500	0%
Total Dissolved Solids	13000	12000	8%	34000	14000	83%
Bicarbonate Alkalinity (as CaCO3)	750	640	16%	460	650	34%
Carbonate Alkalinity (as CaCO3)	< 10	< 10	0%	< 10	< 10	0%
Hydroxide Alkalinity (as CaCO3)	< 20	< 20	0%	< 20	< 20	0%
Total Alkalinity (as CaCO3)	750	640	16%	460	650	34%
Calcium	750	660	13%	2200	1800	20%
Magnesium	590	480	21%	1900	1600	17%
Potassium	37	32	14%	36	29	22%
Sodium	3700	3300	11%	5700	5400	5%
Aluminium	< 0.05	< 0.5	164%	18	120	148%
Aluminium (filtered)	< 0.05	< 0.5	164%	< 0.05	< 0.5	164%
Arsenic	0.002	< 0.01	133%	0.016	0.042	90%
Arsenic (filtered)	0.001	< 0.01	164%	0.006	< 0.01	50%
Barium	0.15	0.13	14%	1.2	4.8	120%
Barium (filtered)	0.14	0.12	15%	0.15	0.13	14%
Beryllium	< 0.001	< 0.01	164%	0.001	0.011	167%
Beryllium (filtered)	< 0.001	< 0.01	164%	< 0.001	< 0.01	164%
Boron	1.6	2	22%	0.11	0.2	58%
Boron (filtered)	1.6	1.9	17%	0.11	< 0.5	128%
Cadmium	< 0.0002	< 0.002	164%	0.0017	0.0087	135%
Cadmium (filtered)	< 0.0002	< 0.002	164%	0.0008	< 0.002	86%
Chromium	0.017	0.011	43%	0.049	0.28	140%
Chromium (filtered)	0.002	< 0.01	133%	0.01	< 0.01	0%
Cobalt	0.002	< 0.01	133%	0.065	0.23	112%
Cobalt (filtered)	0.002	< 0.01	133%	0.039	0.039	0%
Copper	0.036	0.043	18%	0.075	0.53	150%
Copper (filtered)	0.009	0.011	20%	< 0.001	< 0.01	164%
Iron	0.4	0.5	22%	40	240	143%
Iron (filtered)	0.18	< 0.5	94%	1.1	0.67	49%
Lead	< 0.001	< 0.01	164%	0.026	0.17	147%
Lead (filtered)	< 0.001	< 0.01	164%	< 0.001	< 0.01	164%
Manganese	0.67	0.67	0%	3.6	4.9	31%
Manganese (filtered)	0.65	0.66	2%	3.5	3.4	3%
Mercury	< 0.0001	< 0.001	164%	0.0002	0.002	164%
Mercury (filtered)	< 0.0001	< 0.001	164%	< 0.0001	< 0.001	164%
Molybdenum	< 0.005	< 0.05	164%	< 0.005	< 0.05	164%
Molybdenum (filtered)	< 0.005	< 0.05	164%	< 0.005	< 0.05	164%
Nickel	0.013	0.011	17%	0.083	0.41	133%
Nickel (filtered)	0.005	< 0.01	67%	0.031	0.034	9%
Selenium	< 0.001	< 0.01	164%	0.003	0.017	140%
Selenium (filtered)	< 0.001	< 0.01	164%	< 0.001	< 0.01	164%
Uranium	< 0.005	< 0.05	164%	0.013	< 0.05	117%
Uranium (filtered)	< 0.005	< 0.05	164%	0.011	< 0.05	128%
Vanadium	< 0.005	< 0.01	67%	0.057	0.34	143%
Vanadium (filtered)	< 0.005	< 0.01	67%	< 0.005	< 0.01	67%
Zinc	0.38	0.12	104%	0.19	1.2	145%
Zinc (filtered)	0.38	< 0.05	153%	0.097	0.058	50%
TRH C6-C9	< 0.02	< 0.02	0%	< 0.02	< 0.02	0%
TRH C6-C10	< 0.02	< 0.02	0%	< 0.02	< 0.02	0%
TRH C10-C14 (after silica gel clean-up)	< 0.05	0.06	18%	0.13	0.34	89%
TRH C10-C36 (Total) (after silica gel clean-up)	0.2	< 0.1	67%	0.23	0.74	105%
TRH C15-C28 (after silica gel clean-up)	< 0.1	< 0.1	0%	0.1	0.4	120%
TRH C29-C36 (after silica gel clean-up)	0.2	< 0.1	67%	< 0.1	< 0.1	0%
TRH >C10-C16 (after silica gel clean-up)	< 0.05	< 0.05	0%	0.27	0.64	81%
TRH >C16-C34 (after silica gel clean-up)	0.2	< 0.1	67%	< 0.1	< 0.1	0%
TRH >C34-C40 (after silica gel clean-up)	0.3	< 0.1	100%	< 0.1	< 0.1	0%
TRH >C34-C40 (after silica gel clean-up)	0.3	< 0.1	100%	< 0.1	< 0.1	0%

All units are mg/L unless stated otherwise

67%	Above 50% RPD
164%	Laboratory QC discrepancy
	Not Analysed

Bore	P-OB2	DUP1_[POB2]	RPD	A-OB3	DUP2_[AOB3]	RPD
Date	20-Jun-18	20-Jun-18		22-Jun-18	22-Jun-18	
Chloride	5400	5500	2%	70	75	7%
Conductivity (µS/cm)	20000	19000	5%	660	700	6%
Fluoride	< 0.5	< 0.5	0%	< 0.5	< 0.5	0%
pH (pH Units)	6.9	6.9	0%	7.1	7.3	3%
Sulphate (as SO4)	440	440	0%	28	34	19%
Total Dissolved Solids	14000	12000	15%	360	390	8%
Bicarbonate Alkalinity (as CaCO3)	650	660	2%	190	200	5%
Carbonate Alkalinity (as CaCO3)	< 10	< 10	0%	< 10	< 10	0%
Hydroxide Alkalinity (as CaCO3)	< 20	< 20	0%	< 20	< 20	0%
Total Alkalinity (as CaCO3)	650	660	2%	190	200	5%
Calcium	600	520	14%	18	13	32%
Magnesium	520	420	21%	13	9	36%
Potassium	29	21	32%	1.6	1.7	6%
Sodium	3100	2700	14%	170	160	6%
Aluminium	< 0.05	< 0.05	0%	1.8	1.3	32%
Aluminium (filtered)	< 0.05	< 0.05	0%	< 0.05	< 0.05	0%
Arsenic	< 0.001	< 0.001	0%	0.005	0.006	18%
Arsenic (filtered)	< 0.001	< 0.001	0%	0.005	0.006	18%
Barium	0.11	0.11	0%	0.37	0.26	35%
Barium (filtered)	0.11	0.11	0%	0.11	0.11	0%
Beryllium	< 0.001	< 0.001	0%	< 0.001	< 0.001	0%
Beryllium (filtered)	< 0.001	< 0.001	0%	< 0.001	< 0.001	0%
Boron	1.8	2	11%	< 0.05	< 0.05	0%
Boron (filtered)	1.8	1.7	6%	< 0.05	< 0.05	0%
Cadmium	< 0.0002	< 0.0002	0%	< 0.0002	< 0.0002	0%
Cadmium (filtered)	< 0.0002	< 0.0002	0%	< 0.0002	< 0.0002	0%
Chromium	< 0.001	< 0.001	0%	0.003	0.003	0%
Chromium (filtered)	< 0.001	< 0.001	0%	< 0.001	< 0.001	0%
Cobalt	0.002	0.002	0%	0.005	0.005	0%
Cobalt (filtered)	0.002	0.002	0%	0.002	0.002	0%
Copper	0.11	0.11	0%	0.004	0.003	29%
Copper (filtered)	0.1	0.1	0%	< 0.001	< 0.001	0%
Iron	0.19	0.2	5%	3.6	3	18%
Iron (filtered)	0.11	0.09	20%	0.56	0.6	7%
Lead	< 0.001	< 0.001	0%	0.003	0.002	40%
Lead (filtered)	< 0.001	< 0.001	0%	< 0.001	< 0.001	0%
Manganese	0.64	0.66	3%	0.28	0.31	10%
Manganese (filtered)	0.64	0.64	0%	0.28	0.29	4%
Mercury	< 0.0001	< 0.0001	0%	< 0.0001	< 0.0001	0%
Mercury (filtered)	< 0.0001	< 0.0001	0%	< 0.0001	< 0.0001	0%
Molybdenum	< 0.005	< 0.005	0%	< 0.005	< 0.005	0%
Molybdenum (filtered)	< 0.005	< 0.005	0%	< 0.005	< 0.005	0%
Nickel	0.003	0.003	0%	0.007	0.007	0%
Nickel (filtered)	0.003	0.003	0%	0.002	0.001	67%
Selenium	< 0.001	< 0.001	0%	< 0.001	0.001	0%
Selenium (filtered)	< 0.001	< 0.001	0%	< 0.001	0.001	0%
Uranium	< 0.005	< 0.005	0%	< 0.005	< 0.005	0%
Uranium (filtered)	< 0.005	< 0.005	0%	< 0.005	< 0.005	0%
Vanadium	< 0.005	< 0.005	0%	0.011	0.011	0%
Vanadium (filtered)	< 0.005	< 0.005	0%	0.006	0.006	0%
Zinc	0.008	0.008	0%	0.022	0.02	10%
Zinc (filtered)	0.008	0.008	0%	< 0.005	< 0.005	0%
TRH C6-C9	< 0.02	< 0.02	0%	< 0.02	< 0.02	0%
TRH C6-C10	< 0.02	< 0.02	0%	< 0.02	< 0.02	0%
TRH C10-C14 (after silica gel clean-up)	< 0.05	< 0.05	0%	< 0.05	Broken Vial	
TRH C10-C36 (Total) (after silica gel clean-up)	< 0.1	< 0.1	0%	< 0.1	Broken Vial	
TRH C15-C28 (after silica gel clean-up)	< 0.1	< 0.1	0%	< 0.1	Broken Vial	
TRH C29-C36 (after silica gel clean-up)	< 0.1	< 0.1	0%	< 0.1	Broken Vial	
TRH >C10-C16 (after silica gel clean-up)	< 0.05	< 0.05	0%	< 0.05	Broken Vial	
TRH >C16-C34 (after silica gel clean-up)	< 0.1	< 0.1	0%	< 0.1	Broken Vial	
TRH >C34-C40 (after silica gel clean-up)	< 0.1	< 0.1	0%	< 0.1	Broken Vial	
TRH >C34-C40 (after silica gel clean-up)	< 0.1	< 0.1	0%	< 0.1	Broken Vial	

All units are mg/L unless stated otherwise

67%	Above 50% RPD
164%	Laboratory QC discrepancy
	Not Analysed

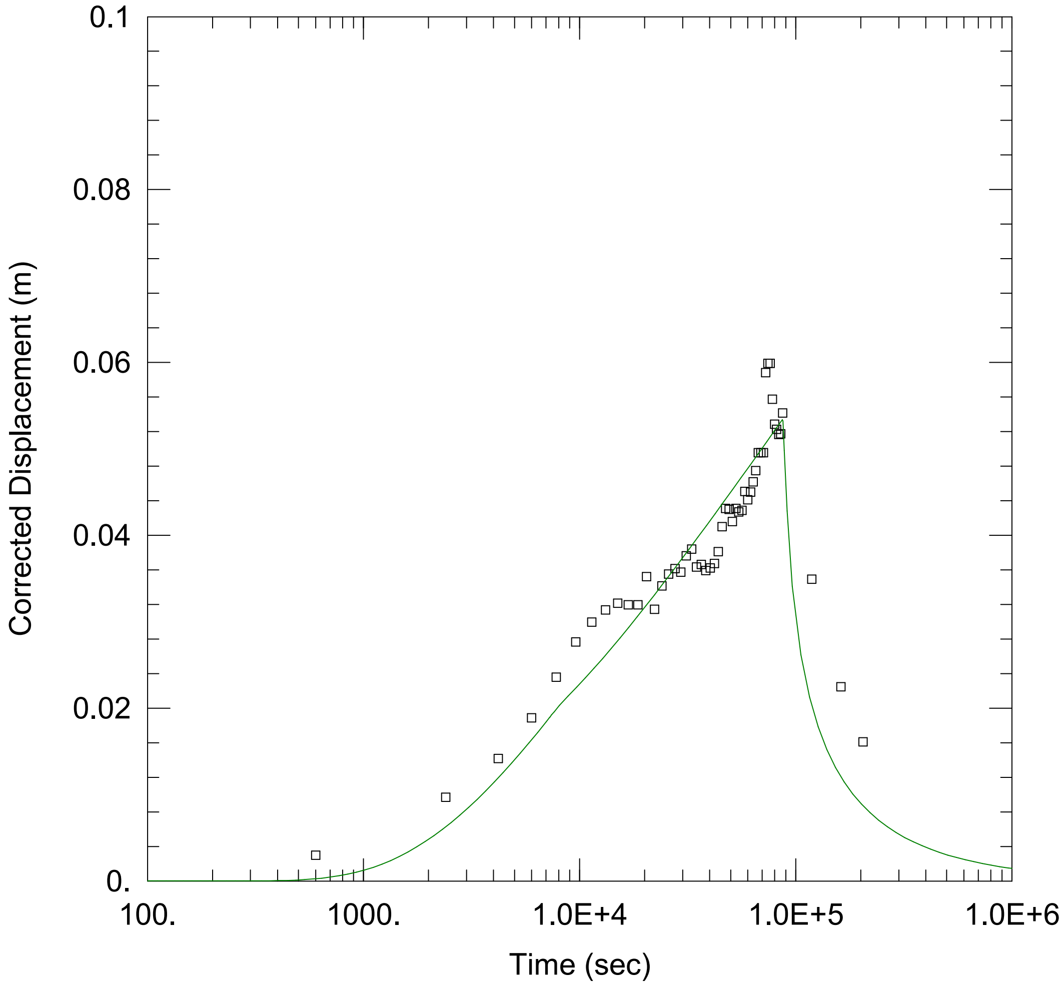
Bore	ROSS BORE	DUP1_[Rossbore]	RPD	A-OB7	DUP2_[AOB7]	RPD
Date	23-Oct-18	23-Oct-18		27-Oct-18	27-Oct-18	
Chloride	690	610	12%	8100	8800	8%
Conductivity (µS/cm)	3500	3500	0%	18000	18000	0%
Fluoride	< 0.5	< 0.5	0%	< 0.5	< 0.5	0%
pH (pH Units)	7.3	7.2	1%	7.3	7.3	0%
Sulphate (as SO4)	72	74	3%	500	530	6%
Total Dissolved Solids	2000	2100	5%	16000	19000	17%
Bicarbonate Alkalinity (as CaCO3)	860	920	7%	390	430	10%
Carbonate Alkalinity (as CaCO3)	< 10	< 10	0%	< 10	< 10	0%
Hydroxide Alkalinity (as CaCO3)	< 20	< 20	0%	< 20	< 20	0%
Total Alkalinity (as CaCO3)	860	920	7%	390	430	10%
Calcium	220	210	5%	1300	1200	8%
Magnesium	110	110	0%	800	770	4%
Potassium	3.2	3.4	6%	22	20	10%
Sodium	380	380	0%	2900	2700	7%
Aluminium	< 0.05	< 0.05	0%	210	200	5%
Aluminium (filtered)	< 0.05	< 0.05	0%	< 0.05	< 0.05	0%
Arsenic	< 0.001	< 0.001	0%	0.024	0.024	0%
Arsenic (filtered)	< 0.001	< 0.001	0%	< 0.001	< 0.001	0%
Barium	0.12	0.11	9%	2.5	2.2	13%
Barium (filtered)	0.12	0.11	9%	0.35	0.35	0%
Beryllium	< 0.001	< 0.001	0%	0.011	0.01	10%
Beryllium (filtered)	< 0.001	< 0.001	0%	< 0.001	< 0.001	0%
Boron	0.52	0.5	4%	0.18	0.17	6%
Boron (filtered)	0.52	0.5	4%	0.23	0.26	12%
Cadmium	< 0.0002	< 0.0002	0%	0.0021	0.002	5%
Cadmium (filtered)	< 0.0002	< 0.0002	0%	0.0006	0.0006	0%
Chromium	< 0.001	< 0.001	0%	0.14	0.12	15%
Chromium (filtered)	< 0.001	< 0.001	0%	< 0.001	< 0.001	0%
Cobalt	< 0.001	< 0.001	0%	0.17	0.16	6%
Cobalt (filtered)	< 0.001	< 0.001	0%	0.008	0.008	0%
Copper	< 0.001	< 0.001	0%	0.44	0.41	7%
Copper (filtered)	< 0.001	< 0.001	0%	0.01	0.008	22%
Iron	< 0.05	< 0.05	0%	360	320	12%
Iron (filtered)	< 0.05	< 0.05	0%	< 0.05	< 0.05	0%
Lead	< 0.001	< 0.001	0%	0.16	0.14	13%
Lead (filtered)	< 0.001	< 0.001	0%	< 0.001	< 0.001	0%
Manganese	0.065	0.061	6%	10	9	11%
Manganese (filtered)	0.061	0.061	0%	2.3	2.4	4%
Mercury	< 0.0001	< 0.0001	0%	0.0005	0.0004	22%
Mercury (filtered)	< 0.0001	< 0.0001	0%	< 0.0001	< 0.0001	0%
Molybdenum	< 0.005	< 0.005	0%	< 0.005	< 0.005	0%
Molybdenum (filtered)	< 0.005	< 0.005	0%	0.011	0.012	9%
Nickel	< 0.001	< 0.001	0%	0.21	0.19	10%
Nickel (filtered)	< 0.001	< 0.001	0%	0.01	0.01	0%
Selenium	0.005	0.004	22%	< 0.001	< 0.001	0%
Selenium (filtered)	0.005	0.004	22%	< 0.001	< 0.001	0%
Uranium	< 0.005	< 0.005	0%	0.015	0.014	7%
Uranium (filtered)	< 0.005	< 0.005	0%	0.005	< 0.005	0%
Vanadium	< 0.005	< 0.005	0%	0.29	0.28	4%
Vanadium (filtered)	< 0.005	< 0.005	0%	< 0.005	< 0.005	0%
Zinc	0.027	0.021	25%	0.76	0.7	8%
Zinc (filtered)	0.024	0.021	13%	0.18	0.01	179%
TRH C6-C9	< 0.02	< 0.02	0%	< 0.02	< 0.02	0%
TRH C6-C10	< 0.02	< 0.02	0%	< 0.02	< 0.02	0%
TRH C10-C14 (after silica gel clean-up)	< 0.05	< 0.05	0%	< 0.05	< 0.05	0%
TRH C10-C36 (Total) (after silica gel clean-up)	< 0.1	< 0.1	0%	< 0.1	< 0.1	0%
TRH C15-C28 (after silica gel clean-up)	< 0.1	< 0.1	0%	< 0.1	< 0.1	0%
TRH C29-C36 (after silica gel clean-up)	< 0.1	< 0.1	0%	< 0.1	< 0.1	0%
TRH >C10-C16 (after silica gel clean-up)	< 0.05	< 0.05	0%	< 0.05	< 0.05	0%
TRH >C16-C34 (after silica gel clean-up)	< 0.1	< 0.1	0%	< 0.1	< 0.1	0%
TRH >C34-C40 (after silica gel clean-up)	< 0.1	< 0.1	0%	< 0.1	< 0.1	0%
TRH >C34-C40 (after silica gel clean-up)	< 0.1	< 0.1	0%	< 0.1	< 0.1	0%

All units are mg/L unless stated otherwise

67%	Above 50% RPD
164%	Laboratory QC discrepancy
	Not Analysed

APPENDIX F

Pumping Test Laboratory Analysis



A-PB1 PUMPTEST

Data Set: C:\Users\BNESolver\Desktop\Tony_Johnson\APB1_Pumptest_AOB2_Analysis_Theis.aqt
Date: 01/08/19 Time: 15:55:28

PROJECT INFORMATION

Company: SLR
Client: Wonbindi Coal
Project: 620.11731.40000
Location: Baralaba_South
Test Well: A-PB1
Test Date: 27/3/2018

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
A-PB1	787806	7314088

Observation Wells

Well Name	X (m)	Y (m)
□ A-OB2	787802	7314105

SOLUTION

Aquifer Model: Unconfined

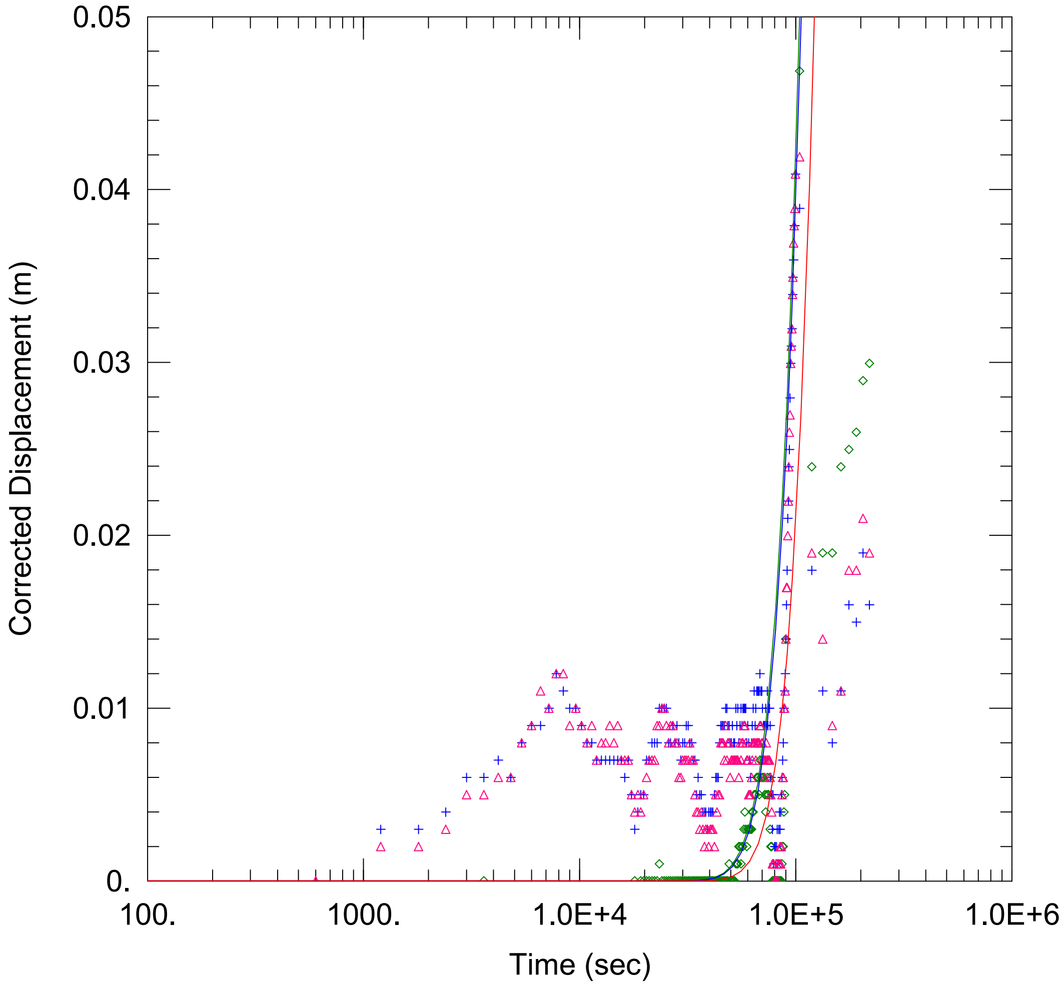
Solution Method: Theis

T = 82.21 m^2/day

Kz/Kr = 0.1024

S = 0.02174

b = 9.27 m



A-PB1 PUMPTEST

Data Set: C:\Users\BNESolver\Desktop\Tony_Johnson\APB1_Pumptest_AOB12_Analysis_Theis.aqt
Date: 01/16/19 Time: 12:45:14

PROJECT INFORMATION

Company: SLR
Client: Wonbindi Coal
Project: 620.11731.40000
Location: Baralaba_South
Test Well: A-PB1
Test Date: 27/3/2018

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
A-PB1	787806	7314088

Observation Wells

Well Name	X (m)	Y (m)
◇ AOB1	787440	7314586
+ AOB11	787270	7313771
△ AOB12	787220	7313767

SOLUTION

Aquifer Model: Unconfined

Solution Method: Theis

T = 0.2569 m^2/day

S = 1.057E-5

Kz/Kr = 0.1

b = 8.4 m

APPENDIX G

Relative Percentage Difference Results

Sample Name	A-PB1_0	A-PB1_6	A-PB1_20	A-PB1_24
Sample time (relative to pumping test)	**0.5 Hours**	**6 Hours**	**20 Hours**	**24 Hours**
Chloride	94	94	90	90
Conductivity (at 25°C) (µS/cm)	490	470	470	480
Fluoride	< 0.5	< 0.5	< 0.5	< 0.5
pH (at 25°C) (pH uits)	7.3	7.3	7.4	7.4
Sulphate (as SO4)	< 5	6.2	5.2	5.3
Total Dissolved Solids	300	350	340	290
Calcium	19	21	20	19
Magnesium	9.6	9.6	9.8	9.7
Potassium	3.7	3.7	3.7	3.8
Sodium	85	93	90	91
Bicarbonate Alkalinity (as CaCO3)	180	170	170	170
Carbonate Alkalinity (as CaCO3)	< 10	< 10	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	< 20	< 20	< 20	< 20
Total Alkalinity (as CaCO3)	180	170	170	170
Aluminium	2	1.9	0.37	< 0.05
Aluminium (filtered)	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic	0.002	0.002	< 0.001	< 0.001
Arsenic (filtered)	< 0.001	< 0.001	< 0.001	< 0.001
Barium	0.13	0.14	0.12	0.12
Barium (filtered)	0.12	0.12	0.12	0.1
Beryllium	< 0.001	< 0.001	< 0.001	< 0.001
Beryllium (filtered)	< 0.001	< 0.001	< 0.001	< 0.001
Boron	< 0.05	< 0.05	< 0.05	< 0.05
Boron (filtered)	< 0.05	< 0.05	< 0.05	< 0.05
Cadmium	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium (filtered)	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.011	0.009	0.002	< 0.001
Chromium (filtered)	< 0.001	< 0.001	< 0.001	< 0.001
Cobalt	0.007	0.007	0.002	< 0.001
Cobalt (filtered)	0.001	< 0.001	< 0.001	< 0.001
Copper	0.015	0.007	0.004	< 0.001
Copper (filtered)	0.002	0.001	0.001	< 0.001
Iron	5.3	4.6	1.3	0.43
Iron (filtered)	1.2	0.53	0.55	< 0.05
Lead	0.006	0.003	0.001	< 0.001
Lead (filtered)	< 0.001	< 0.001	< 0.001	< 0.001
Manganese	0.093	0.074	0.019	0.009
Manganese (filtered)	0.034	0.011	0.007	0.008
Mercury	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Mercury (filtered)	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	< 0.005	< 0.005	< 0.005	< 0.005
Molybdenum (filtered)	< 0.005	< 0.005	< 0.005	< 0.005
Nickel	0.01	0.008	0.003	0.001
Nickel (filtered)	0.003	0.002	0.001	< 0.001
Selenium	< 0.001	0.002	< 0.001	< 0.001
Selenium (filtered)	< 0.001	< 0.001	< 0.001	< 0.001
Uranium	< 0.005	< 0.005	< 0.005	< 0.005
Uranium (filtered)	< 0.005	< 0.005	< 0.005	< 0.005
Vanadium	0.008	0.009	< 0.005	< 0.005
Vanadium (filtered)	< 0.005	< 0.005	< 0.005	< 0.005
Zinc	2.9	1.2	1.1	0.95
Zinc (filtered)	2.5	0.95	1.1	0.092
TRH C6-C9	0.09	< 0.02	< 0.02	< 0.02
Naphthalene	< 0.01	< 0.01	< 0.01	< 0.01
TRH C6-C10	0.1	0.02	< 0.02	< 0.02
TRH C10-C14 (after silica gel clean-up)	< 0.05	< 0.05	< 0.05	< 0.05
TRH C10-C36 (Total) (after silica gel clean-up)	< 0.1	< 0.1	< 0.1	< 0.1

Sample Name	A-PB1_0	A-PB1_6	A-PB1_20	A-PB1_24
Sample time (relative to pumping test)	**0.5 Hours**	**6 Hours**	**20 Hours**	**24 Hours**
TRH C15-C28 (after silica gel clean-up)	< 0.1	< 0.1	< 0.1	< 0.1
TRH C29-C36 (after silica gel clean-up)	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C10-C16 (after silica gel clean-up)	< 0.05	< 0.05	< 0.05	< 0.05
TRH >C16-C34 (after silica gel clean-up)	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C34-C40 (after silica gel clean-up)	< 0.1	< 0.1	< 0.1	< 0.1

All unit in mg/L unless specified

Appendix B: Baralaba South – Landholder Bore Survey (4T, 2019)

Historical Groundwater Bore Assessment

Bore ID: Ross's Bore

18/6/19 10:20

SWL (m)	TOC to GL (m)	Total Depth (m)
18.63	0.70	50.17

Item	Comments
General site information: • Location • Nearby infrastructure that may impact on bore	Location: GDA94 55J E 0792442 N 7314087 Infrastructure: No nearby infrastructure. At base of Mt Ramsay. No bores nearby.
Bore casing: • ID • OD • Wall thickness • Condition	Bore casing: 115mm inside, 130mm outside, 7.5mm. Good condition. Steel casing.
Monument • Condition • Protection (fenced?) • Plinth condition • Photos of surrounding area (NSEW)	Monument: No monument. Steel casing into ground. No plinth. No protection.
Existing monitoring equipment • Condition of equipment • Photos • Loggers downloaded if working • If not working details of depth/serial # etc	Existing monitoring equipment: Solinst logger - S/N 0062078491 – installed at 45m BTC.
VWP Download • Screenshot PC when connecting	VWP download: N/A

	
Casing	Casing
	
Towards North	Towards East
	
Towards South	Towards West

Historical Groundwater Bore Assessment

Bore ID: Webb Bore

18/6/19 12:35

SWL (m)	TOC to GL (m)	Total Depth (m)
14.11		77.83

Item	Comments
General site information: • Location • Nearby infrastructure that may impact on bore	Location: GDA94 55J E 0789694 N 7306672. Infrastructure: No other bores in vicinity.
Bore casing: • ID • OD • Wall thickness • Condition	Bore casing: 125mm outside, 115mm inside.
Monument • Condition • Protection (fenced?) • Plinth condition • Photos of surrounding area (NSEW)	Monument: N/A
Existing monitoring equipment • Condition of equipment • Photos • Loggers downloaded if working • If not working details of depth/serial # etc	Existing monitoring equipment: N/A
VWP Download • Screenshot PC when connecting	VWP download: N/A

Historical Groundwater Bore Assessment

Bore ID: Riverland 1

18/6/19 13:30

SWL (m)	TOC to GL (m)	Total Depth (m)
12.135	0.41	18.04

Item	Comments
General site information: • Location • Nearby infrastructure that may impact on bore	Location: GDA94 55J E 0787188 N 7313004. Infrastructure: N/A
Bore casing: • ID • OD • Wall thickness • Condition	Bore casing: 225mm outside, 205mm inside. Bucket used as bore cap.
Monument • Condition • Protection (fenced?) • Plinth condition • Photos of surrounding area (NSEW)	Monument: N/A
Existing monitoring equipment • Condition of equipment • Photos • Loggers downloaded if working • If not working details of depth/serial # etc	Existing monitoring equipment: N/A
VWP Download • Screenshot PC when connecting	VWP download: N/A

	
Casing	
	
Towards North	Towards East
	
Towards South	Towards West

Historical Groundwater Bore Assessment

Bore ID: Riverland 2

18/6/19 13:45

SWL (m)	TOC to GL (m)	Total Depth (m)
12.30	0.71	22.60

Item	Comments
General site information: • Location • Nearby infrastructure that may impact on bore	Location: GDA94 55J E 0787185 N 7313005. Infrastructure: N/A
Bore casing: • ID • OD • Wall thickness • Condition	Bore casing: 90mm outside, 85mm inside. No cap on bore casing. Top of bore casing cracked.
Monument • Condition • Protection (fenced?) • Plinth condition • Photos of surrounding area (NSEW)	Monument: N/A
Existing monitoring equipment • Condition of equipment • Photos • Loggers downloaded if working • If not working details of depth/serial # etc	Existing monitoring equipment: N/A
VWP Download • Screenshot PC when connecting	VWP download: N/A

	
Casing	Casing
	
Towards North	Towards East
	
Towards South	Towards West

Historical Groundwater Bore Assessment

Bore ID: RN 128188

18/6/19 14:15

SWL (m)	TOC to GL (m)	Total Depth (m)
N/A	N/A	N/A

Item	Comments
General site information: • Location • Nearby infrastructure that may impact on bore	Location: GDA94 55J E 787733 N 7312273. No bore was found at location coordinates for RN 128188. Riverland 1 and Riverland 2 bores were located close to the coordinates for RN 128188.
Bore casing: • ID • OD • Wall thickness • Condition	N/A
Monument • Condition • Protection (fenced?) • Plinth condition • Photos of surrounding area (NSEW)	N/A
Existing monitoring equipment • Condition of equipment • Photos • Loggers downloaded if working • If not working details of depth/serial # etc	N/A
VWP Download • Screenshot PC when connecting	N/A

Historical Groundwater Bore Assessment

Bore ID: RN 100077

18/6/19 11:40

SWL (m)	TOC to GL (m)	Total Depth (m)
N/A	N/A	N/A

Item	Comments
General site information: • Location • Nearby infrastructure that may impact on bore	Location: GDA94 55J E 792431 N 7307891. Searched area and could not find bore. Landholder Lester Webb informed us that it had been filled in and cleared in the past. Lester pointed out the machinery tracks that could be seen leading into paddock on the outside of the fence.
Bore casing: • ID • OD • Wall thickness • Condition	N/A
Monument • Condition • Protection (fenced?) • Plinth condition • Photos of surrounding area (NSEW)	N/A
Existing monitoring equipment • Condition of equipment • Photos • Loggers downloaded if working • If not working details of depth/serial # etc	N/A
VWP Download • Screenshot PC when connecting	N/A

Appendix C: Groundwater quality monitoring summary

The following summary tables from 4T's database:

- Alluvium pH, EC and TDS (timeseries data 2017-23);
- Permian strata pH,EC and TDS (timeseries data 2017-23);
- Alluvium metals concentrations (statistical summary 2017-23);
- Permian strata metals concentrations (statistical summary 2017-23).

Baralaba South Groundwater Monitoring

Alluvium (and colluvium) field parameters

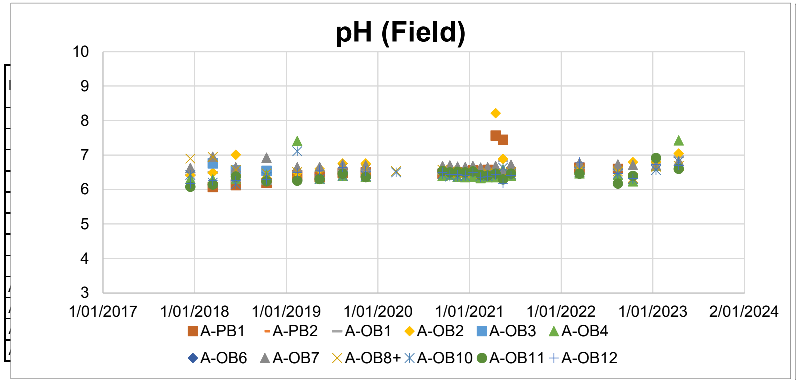
Bore ID	Dec 17	Mar 18	Jun 18	Oct 18	Feb 19	May 19	Aug 19	Nov 19	Mar 20	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb 21	Mar 21	Apr 21	May 21	Jun 21	Mar 22	Aug 22	Oct 22	Jan 23	Apr 23
											pH (Field)													
A-PB1	-	6.07	6.12	6.19	6.41	6.35	6.48	6.49	-	6.46	6.5	6.49	6.48	6.56	6.54	6.57	7.56	7.44	6.5	6.63	6.6	D	D	D
A-PB2										D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
A-OB1	6.42	6.49	6.26	6.16	6.26	6.33	6.52	6.53	-	6.46	6.45	6.45	6.38	6.39	6.37	6.44	6.44	6.83	6.41	6.62	6.58	6.4	6.72	6.95
A-OB2	6.41	6.48	7	6.27	6.48	6.6	6.75	6.75	-	6.55	6.52	6.51	6.48	6.55	6.5	6.52	8.21	6.88	6.52	6.62	6.63	6.79	6.81	7.04
A-OB3	-	6.75	6.55	6.54	B	B	B	B	-	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
A-OB4	6.31	6.29	6.3	6.43	7.4	6.32	6.4	6.36	-	6.39	6.43	6.36	6.35	6.37	6.33	6.35	6.35	6.58	6.4	6.47	6.42	6.23	6.69	7.42
A-OB6										D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
A-OB7	6.62	6.95	6.64	6.92	6.64	6.65	6.73	6.7	-	6.68	6.7	6.66	6.65	6.68	6.63	6.64	6.68	6.53	6.72	6.77	6.73	6.71	6.7	6.83
A-OB8+	6.89	6.94	6.57	6.47	6.5	6.42	6.61	6.59	6.53	6.57	6.52	6.48	6.5	6.48	6.44	6.48	6.47	6.36	6.49	6.57	6.52	6.34	6.66	6.68
A-OB10	6.42	6.2	6.15	6.36	7.11	6.3	6.39	6.39	6.49	6.44	6.37	6.37	6.38	-	6.39	6.38	6.42	6.63	6.44	6.5	6.46	6.3	6.56	6.81
A-OB11	6.08	6.14	6.37	6.23	6.25	6.3	6.46	6.35	-	6.53	6.49	6.51	6.49	6.52	6.42	6.4	6.46	6.29	6.46	6.46	6.17	6.39	6.91	6.6
A-OB12	6.17	6.25	6.25	6.28	6.48	6.56	6.64	6.53	-	6.49	6.43	6.43	6.41	6.48	6.35	6.38	6.44	6.18	6.4	6.79	6.46	6.32	6.72	6.7
											EC (mS/cm) (Field)													
A-PB1	-	646	630	610	720	711	615	648	-	630	685	766	830	877	861	868	906	857	1011	710	588	D	D	D
A-PB2										D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
A-OB1	570	466	486	493	586	700	606	644	-	675	598	622	645	524	654	645	563	559	564	695	714	629	897	693
A-OB2	657	617	686	565	583	831	843	911	-	612	621	649	658	686	665	679	960	649	628	509	524	824	831	508
A-OB3	-	561	593	489	B	B	B	B	-	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
A-OB4	37,011	35,920	37,557	40,022	37,150	36,385	36,423	31,759	-	37,592	37,445	37,703	37,581	37,415	37,197	37,461	37,120	36,990	37,258	37,936	37,027	19,314	37,328	32,341
A-OB6										D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
A-OB7	15,681	16,809	16,637	18,390	20,122	19,487	19,657	18,058	-	20,717	20,547	20,584	20,597	20508	20436	20578	20358	20611	20548	20,807	20402	19,314	20,417	19,539
A-OB8+	26,260	25,877	26,914	27,752	28,071	28,197	27,752	25,754	28,536	29,366	29,951	29,668	29,744	29553	29457	29469	29439	29496	29648	30,580	29951	28,287	27,533	27,945
A-OB10	31,708	36,433	38,097	38,786	37,303	35,894	34,430	29,887	32,507	33,117	33,025	33,242	32,847	-	32584	32833	32450	32673	32850	33,746	31792	30,885	32,405	32,668
A-OB11	425	405	434	377	440	481	452	351	-	360	335	362.7	397	346	336	452	370	427	438	515	399	370	449	489
A-OB12	381	354	328	323	430	526	456	306	-	392	392	417	343	393	388	378	477	393	395	375	360	308	399	325
											TDS (mg/L) (Lab)													
A-PB1	-	320	340	-		390	444	393	-	372	404	451	462	496	472	484	516	485	554	383	299	D	D	D
A-PB2										D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
A-OB1	260	260	230	310		440	407	432	-	432	409	432	407	368	313	408	384	381	370	405	381	412	545	472
A-OB2	370	300	380	350		442	475	588	-	363	357	382	375	391	372	378	527	622	356	308	319	402	447	338
A-OB3	-	390	360	350		B	B	B	-	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
A-OB4	30,000	34,000	23,000	38,000		28,800	23,300	30,200	-	B	31,000	31,600	31,700	28,100	29,800	31,000	30,400	26,600	31,400	33,400	25,800	29,200	33,800	28,200
A-OB6										D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
A-OB7	13,000	13,000	16,000	16,000		13200	12,600	15,600	-	14,900	15100	14,500	15,400	15,000	15,900	16,200	15400	13,600	16,100	17,300	13,700	14,500	16,700	14,500
A-OB8+	14,000	18,000	19,000	27,000		19,900	17,900	21,200	19,200	21,000	21600	22,700	22,100	21,800	22,500	22,000	22,100	19,700	23,700	24,200	18,400	21,400	20,400	20,800
A-OB10	32,000	37,000	33,000	38,000		27800	19,500	28,200	23,400	27,800	26,900	28,400	26,900	-	26,000	28,800	26,800	23,400	28,800	30,400	24,400	25,500	31,300	26,000
A-OB11	210	210	220	240		258	298	262	-	228	213	252	213	243	300	279	308	248	320	314	276	254	254	339
A-OB12	180	160	140	190		259	287	219	-	251	243	258	211	243	230	239	289	230	228	230	204	197	231	208

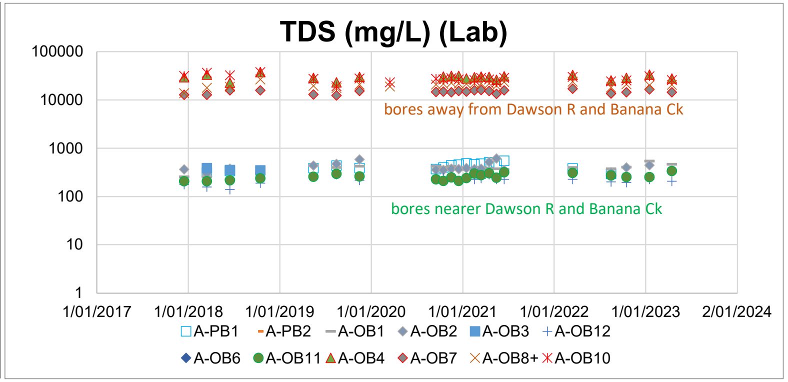
Parameter	Near Dawson River Min	Near Dawson River Max	Near Dawson River Average	Further Dawson River Min	Further Dawson River Max	Further Dawson River Average
pH (Field)	6.07	8	6.51	6.15	7.42	6.55
EC (mS/cm) (Field)	306	1,011	561.3	15,681	40,022	29,408
TDS (mg/L) (Lab)	140	622	336.4	12,600	38,000	23,285

March 2020 - symbol, bores were inaccessable due to wet weather / boggy conditions

D Dry

B Blocked

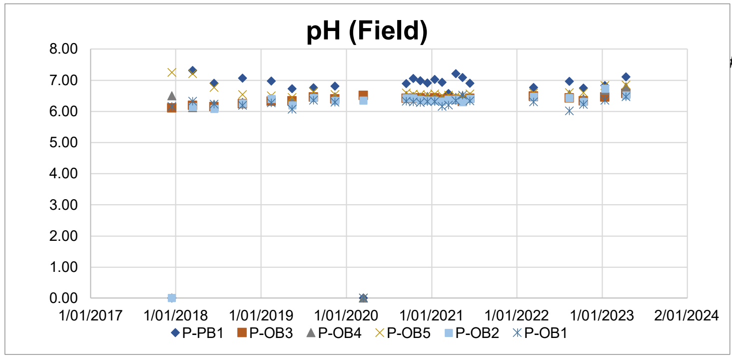


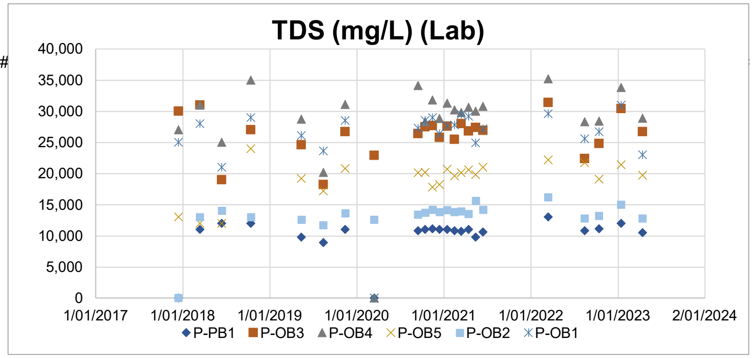


Baralaba South Groundwater Monitoring

Permian strata field parameters

Bore ID	Dec 17	Mar 18	Jun 18	Oct 18	Feb 19	May 19	Aug 19	Nov 19	Mar 20	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb 21	Mar 21	Apr 21	May 21	Jun 21	Mar 22	Aug 22	Oct 22	Jan 23	Apr 23		Min	Max	Average
pH (Field)																												
Baralaba Coal Measures [Interburden]																												
P-PB1	-	7.31	6.90	7.06	6.97	6.72	6.75	6.80	-	6.89	7.05	6.98	6.91	7.02	6.93	6.57	7.21	7.08	6.90	6.76	6.96	6.74	6.82	7.10				
P-OB3	6.10	6.19	6.15	6.24	6.32	6.33	6.45	6.39	6.51	6.41	6.41	6.42	6.37	6.42	6.38	6.39	6.37	6.31	6.41	6.49	6.42	6.33	6.45	6.57	**Coal measures**			
Baralaba Coal Measures [Coal Seams]																										**6.01**	**7.31**	**6.52**
P-OB1	6.16	6.32	6.23	6.19	6.27	6.06	6.35	6.29	-	6.32	6.30	6.28	6.31	6.31	6.16	6.20	6.34	6.52	6.33	6.30	6.01	6.22	6.35	6.46				
P-OB4	6.50	6.11	6.22	6.29	6.40	6.31	6.48	6.46	-	6.51	6.48	6.45	6.47	6.45	6.40	6.41	6.44	6.50	6.46	6.46	6.55	6.40	6.67	6.78				
P-OB5	7.25	7.21	6.76	6.54	6.50	6.44	6.63	6.54	-	6.59	6.55	6.54	6.53	6.56	6.51	6.52	6.49	6.41	6.56	6.59	6.60	6.60	6.83	6.85	**Gyranda formation**			
Gyranda Formation																										**6.08**	**6.73**	**6.36**
P-OB2	-	6.14	6.08	6.25	6.40	6.19	6.43	6.34	6.35	6.42	6.42	6.37	6.35	6.35	6.32	6.38	6.38	6.29	6.40	6.47	6.43	6.30	6.73	6.51				
EC (mS/cm) (Field)																												
Baralaba Coal Measures [Interburden]																												
P-PB1	-	15,950	16,296	18,453	15,763	15,574	15,303	13,721	-	15,839	16,031	15,955	15,902	15,813	15,861	15,906	16,115	15,776	15,884	16,156	15,697	15,260	15,763	15,177				
P-OB3	34,107	33,141	34,154	37,120	33,042	32,548	32,169	28,835	32,386	32,661	33,460	33,292	33,074	33,012	32,906	33,050	32,502	32,427	32,605	33,534	32,405	31,220	32,811	30,890	**Coal measures**			
Baralaba Coal Measures [Coal Seams]																										**13,721.00**	**40,297.00**	**29,480.80**
P-OB1	29,785	30,324	31,390	33,260	34,270	34,234	33,794	30,700	-	34,370	34,711	34,510	34,547	34,400	34,437	34,360	34,392	34,214	34,488	34,801	34,257	32,274	31,888	32,999				
P-OB4	37,088	36,356	37,492	40,297	36,546	36,131	35,942	31,702	-	36,644	37,035	37,051	36,818	36,415	36,511	36,698	36,164	36,311	36,677	37,223	35,792	33,348	36,299	32,669				
P-OB5	24,664	27,225	23,666	34,100	29,073	28,889	28,641	25,455	-	29,147	29,529	29,324	29,143	29,062	28,955	29,035	28,866	29,044	29,100	29,602	28,682	26,602	28,127	27,201	**Gyranda formation**			
Gyranda Formation																										**16,669.00**	**21,075.00**	**19,103.91**
P-OB2	-	19,480	19,503	21,075	19,085	19,000	18,964	16,669	18,797	19,560	19,435	19,371	19,242	19,196	19,126	19,351	18,750	19,252	19,316	19,970	19,514	18,182	19,372	17,180				
TDS (mg/L) (Lab)																												
Baralaba Coal Measures [Interburden]																												
P-PB1	-	11,000	12,000	12,000		9,750	8,880	11,000	-	10,800	11,000	11,100	11,000	11,000	10,800	10,700	11,000	9,780	10,600	13,000	10,800	11,100	12,000	10,500				
P-OB3	30,000	31,000	19,000	27,000		24,600	18,200	26,700	22,900	26,400	27,500	27,700	25,800	27,600	25,500	28,000	26,800	27,400	26,900	31,400	22,400	24,800	30,400	26,700	**Coal measures**			
Baralaba Coal Measures [Coal Seams]																										**8,880.00**	**35,200.00**	**22,798.27**
P-OB1	25,000	28,000	21,000	29,000		26,100	23,600	28,500	-	27,300	28,500	29,000	26,400	27,700	27,800	29,500	29,200	24,900	27,200	29,600	25,600	26,700	31,000	23,000				
P-OB4	27,000	31,000	25,000	35,000		28,700	20,200	31,100	-	34,100	28,300	31,800	28,800	31,300	30,200	29,800	30,600	30,000	30,800	35,200	28,300	28,400	33,800	28,900				
P-OB5	13,000	12,000	12,000	24,000		19,200	17,200	20,800	-	20,100	20,200	17,800	18,200	20,700	19,600	20,100	20,600	19,800	21,000	22,200	21,700	19,100	21,400	19,700	**Gyranda formation**			
Gyranda Formation																										**11,700.00**	**16,200.00**	**13,668.18**
P-OB2	-	13,000	14,000	13,000		12,600	11,700	13,600	12,600	13,400	13,700	14,200	13,800	14,100	13,800	13,900	13,500	15,600	14,200	16,200	12,800	13,200	15,000	12,800				





Baralaba South Groundwater Monitoring

Alluvium Metal Concentrations

		Alluvium Metals Concentrations (Mg/L) - Total & Filtered													
Bore ID		**Al**	**Al (f)**	**As**	**As (f)**	**B**	**B (f)**	**Cd**	**Cd(f)**	**Cr**	**Cr(f)**	**Co**	**Co (f)**	**Cu**	**Cu (f)**
A-PB1	Sample Count	12	12	12	12	3	3	3	3	3	3	3	3	3	3
	Min	<0.05	<0.1	<0.001	<0.001	<0.05	<0.05	< 0.0002	< 0.0002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	20th Percentile	0.076	0.01	0.001	0.001	0.05	0.05	0.0002	0.0002	0.001	0.001	0.001	0.001	0.0014	0.001
	Median	0.26	0.01	0.0015	0.001	0.05	0.05	0.0002	0.0002	0.001	0.001	0.001	0.001	0.002	0.001
	95th Percentile	1.8615	0.05	0.003	0.003	0.05	0.05	0.0002	0.0002	0.0082	0.001	0.0064	0.001	0.0065	0.001
	Max	1.9	<0.05	0.003	0.003	< 0.05	< 0.05	< 0.0002	< 0.0002	0.009	< 0.001	0.007	< 0.001	0.007	0.001
A-OB1	Sample Count	24	24	24	24	4	4	4	4	4	4	4	4	4	4
	Min	0.46	<0.01	<0.001	<0.001	< 0.05	< 0.05	<0.0002	<0.0002	< 0.001	< 0.001	< 0.001	< 0.001	0.003	< 0.001
	20th Percentile	6.298	0.01	0.002	0.001	0.056	0.05	0.0002	0.0002	0.004	0.001	0.001	0.001	0.0042	0.001
	Median	10.27	0.01	0.002	0.001	0.065	0.055	0.0006	0.0002	0.015	0.001	0.0505	0.001	0.0345	0.001
	95th Percentile	31.2000	0.0500	0.0099	0.0020	0.0700	0.0600	0.0018	0.0002	0.0487	0.0010	0.1935	0.0027	0.1371	0.0027
	Max	78	0.05	0.013	0.002	0.07	0.06	0.0019	<0.0002	0.053	< 0.001	0.21	0.003	0.15	0.003
A-OB2	Sample Count	22	22	22	22	3	3	3	3	3	3	3	3	3	3
	Min	<0.05	<0.01	<0.001	<0.001	< 0.05	< 0.05	< 0.0002	< 0.0002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	20th Percentile	0.672	0.01	0.001	0.001	0.05	0.05	0.0002	0.0002	0.001	0.001	0.001	0.001	0.001	0.001
	Median	1.71	0.01	0.0015	0.001	0.05	0.05	0.0002	0.0002	0.001	0.001	0.001	0.001	0.001	0.001
	95th Percentile	12.1900	0.0500	0.0040	0.0030	0.0500	0.0680	0.0002	0.0002	0.0136	0.0010	0.0136	0.0019	0.0424	0.0010
	Max	14.9	<0.05	0.004	0.004	<0.05	0.07	< 0.0002	< 0.0002	0.015	< 0.001	0.015	0.002	0.047	<0.001
A-OB3	Sample Count	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Min	< 0.05	< 0.05	0.003	0.003	< 0.05	< 0.05	< 0.0002	< 0.0002	< 0.001	< 0.001	0.001	0.001	< 0.001	< 0.001
	20th Percentile	0.082	0.05	0.0038	0.0034	0.05	0.05	0.0002	0.0002	0.001	0.001	0.001	0.001	0.0014	0.001
	Median	0.13	0.05	0.005	0.004	0.05	0.05	0.0002	0.0002	0.001	0.001	0.001	0.001	0.002	0.001
	95th Percentile	1.6330	0.0500	0.0050	0.0049	0.0500	0.0590	0.0002	0.0002	0.0028	0.0010	0.0046	0.0019	0.0038	0.0037
	Max	1.8	< 0.05	0.005	0.005	< 0.05	0.06	< 0.0002	< 0.0002	0.003	< 0.001	0.005	0.002	0.004	0.004
A-OB4	Sample Count	13	13	13	13	4	4	4	4	4	4	4	4	4	4
	Min	<0.05	<0.01	0.002	0.002	0.1	0.11	0.0009	< 0.0002	< 0.001	< 0.001	0.036	0.028	0.026	< 0.001
	20th Percentile	2.864	0.05	0.005	0.004	0.106	0.116	0.0012	0.00056	0.0058	0.001	0.0432	0.0346	0.0284	0.001
	Median	3.49	0.05	0.005	0.005	0.115	0.12	0.00155	0.0011	0.009	0.0055	0.0565	0.0415	0.0525	0.002
	95th Percentile	18.0400	20.4600	0.0124	0.0128	0.1285	0.1285	0.0028	0.0034	0.0430	0.1035	0.1118	0.0619	0.9463	0.0430
	Max	18.1	51	0.016	0.017	0.13	0.13	0.003	0.0038	0.049	0.12	0.12	0.065	1.1	<0.05
A-OB7	Sample Count	13	13	13	13	4	4	4	4	4	4	4	4	4	4
	Min	10.3	<0.01	0.003	<0.001	0.18	0.21	0.0018	0.0005	0.037	0.001	0.094	0.006	0.081	0.001
	20th Percentile	14.56	0.01	0.003	0.001	0.198	0.21	0.00198	0.0005	0.0694	0.001	0.1096	0.0066	0.1764	0.0022
	Median	20	0.01	0.004	0.001	0.215	0.22	0.0023	0.00055	0.1155	0.001	0.145	0.0075	0.34	0.004
	95th Percentile	494.0000	0.0700	0.0384	0.0046	0.3645	0.2385	0.0052	0.0006	0.6500	0.0070	0.7140	0.0080	1.4260	0.0093
	Max	920	0.1	0.06	<0.01	0.39	0.24	0.0057	0.0006	0.74	0.008	0.81	0.008	1.6	0.01
A-OB8	Sample Count	14	14	14	14	4	4	4	4	4	4	4	4	4	4
	Min	0.7	<0.01	0.003	0.001	0.13	0.05	0.0003	0.0003	0.017	0.001	0.003	0.003	0.052	0.021
	20th Percentile	6.262	0.05	0.0056	0.002	0.16	0.134	0.0006	0.0003	0.0188	0.0016	0.0066	0.003	0.1768	0.0228
	Median	8.79	0.05	0.006	0.005	0.19	0.255	0.00095	0.00035	0.056	0.002	0.0255	0.0035	0.32	0.0315
	Median	18.8	0.01	0.009	0.006	0.05	0.05	0.0002	0.0002	0.005	0.001	0.008	0.006	0.004	0.001
	95th Percentile	39.9600	0.0580	0.0126	0.0084	0.0500	0.0500	0.0004	0.0002	0.0305	0.0010	0.0609	0.0077	0.0254	0.0010
	Max	49.2	0.07	0.015	0.009	0.05	0.05	0.0004	< 0.0002	0.035	< 0.001	0.07	0.008	0.029	< 0.001
A-OB12	Sample Count	13	13	13	13	4	4	4	4	4	4	4	4	4	4
	Min	0.41	<0.01	0.008	0.007	< 0.05	< 0.05	< 0.0002	< 0.0002	< 0.001	< 0.001	0.002	0.002	< 0.001	< 0.001
	20th Percentile	4.47	0.01	0.01	0.008	0.05	0.05	0.0002	0.0002	0.0028	0.001	0.0032	0.0026	0.0028	0.001
	Median	6.64	0.01	0.011	0.009	0.05	0.05	0.0002	0.0002	0.0055	0.001	0.0045	0.003	0.0055	0.001
	95th Percentile	18.5800	0.0500	0.0124	0.0104	0.0585	0.0500	0.0004	0.0002	0.0368	0.0010	0.0144	0.0030	0.0410	0.0010
	Max	28	<0.05	0.013	0.011	0.06	< 0.05	0.0004	< 0.0002	0.042	< 0.001	0.016	0.003	0.047	< 0.001
Bore ID		**Pb**	**Pb (f)**	**Hg**	**Hg (f)**	**Mo**	**Mo (F)**	**Ni**	**Ni (f)**	**Se**	**Se (f)**	**U**	**U (f)**	**Zn**	**Zn (f)**
A-PB1	Sample Count	3	3	12	12	12	12	3	3	12	12	12	12	12	11
	Min	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.001	< 0.001	0.001	0.001	< 0.001	< 0.001	< 0.005	< 0.005	<0.005	<0.005
	20th Percentile	0.001	0.001	0.0001	0.0001	0.001	0.001	0.001	0.0014	0.0036	0.0028	0.001	0.001	0.0096	0.008
	Median	0.001	0.001	0.0001	0.0001	0.001	0.001	0.001	0.002	0.01	0.01	0.001	0.001	0.0235	0.015
	95th Percentile	0.0028	0.001	0.0001	0.0001	0.005	0.0068	0.0073	0.002	0.01	0.01	0.005	0.005	0.57685	0.517
	Max	0.003	<0.001	< 0.0001	< 0.0001	<0.005	0.009	0.008	0.002	<0.01	<0.01	< 0.005	< 0.005	1.2	0.95
A-OB1	Sample Count	4	4	24	24	24	24	4	4	24	24	24	24	24	23
	Min	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.009	0.005
	20th Percentile	0.001	0.001	0.0001	0.0001	0.001	0.001	0.0026	0.001	0.01	0.01	0.001	0.001	0.046	0.009
	Median	0.016	0.001	0.0001	0.0001	0.001	0.001	0.0405	0.0015	0.01	0.01	0.001	0.001	0.07	0.015
	95th Percentile	0.0599	0.0010	0.0002	0.0001	0.0050	0.0050	0.1137	0.0029	0.0100	0.0100	0.0050	0.0050	0.2561	0.0976
	Max	0.065	< 0.001	0.0004	< 0.0001	<0.005	0.008	0.12	0.003	<0.01	<0.01	0.008	<0.005	0.36	0.101
A-OB2	Sample Count	3	3	22	22	22	22	3	3	22	22	22	22	22	21
	Min	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.001	< 0.001	0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.006	<0.005
	20th Percentile	0.001	0.001	0.0001	0.0001	0.001	0.001	0.0018	0.0014	0.01	0.01	0.001	0.001	0.0252	0.007
	Median	0.001	0.001	0.0001	0.0001	0.001	0.001	0.003	0.002	0.01	0.01	0.001	0.001	0.0375	0.019
	95th Percentile	0.0145	0.0010	0.0001	0.0001	0.0050	0.0050	0.0165	0.0029	0.0100	0.0100	0.0050	0.0050	0.1270	0.0900
	Max	0.016	<0.001	<0.0001	0.0002	<0.005	0.008	0.018	0.003	0.01	0.01	<0.005	<0.005	0.141	0.124
A-OB3	Sample Count	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Min	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.005	< 0.005	0.001	0.001	< 0.001	< 0.001	< 0.005	< 0.005	0.006	< 0.005
	20th Percentile	0.001	0.001	0.0001	0.0001	0.005	0.005	0.0014	0.0014	0.001	0.001	0.005	0.005	0.0124	0.005
	Median	0.001	0.001	0.0001	0.0001	0.005	0.005	0.002	0.002	0.001	0.001	0.005	0.005	0.022	0.005
	95th Percentile	0.0028	0.0010	0.0001	0.0002	0.0050	0.0086	0.0065	0.0020	0.0010	0.0019	0.0050	0.0050	0.3352	0.0167
	Max	0.003	< 0.001	< 0.0001	0.0002	< 0.005	0.009	0.007	0.002	0.001	0.002	< 0.005	< 0.005	0.37	0.018
A-OB4	Sample Count	4	4	13	13	13	13	4	4	13	13	13	13	13	11
	Min	0.005	< 0.001	< 0.0001	< 0.0001	< 0.005	0.002	0.032	0.01	< 0.001	< 0.001	0.008	0.008	0.045	0.02
	20th Percentile	0.0092	0.001	0.0001	0.0001	0.005	0.005	0.0344	0.0154	0.0054	0.0046	0.01	0.01	0.0564	0.029
	Median	0.019	0.001	0.0001	0.0001	0.005	0.005	0.0595	0.0225	0.05	0.05	0.011	0.01	0.084	0.051
	95th Percentile	0.0847	0.8417	0.0018	0.0021	0.0078	0.0140	0.1485	0.0303	0.0700	0.0700	0.0170	0.0122	0.2580	0.1135
	Max	0.095	0.99	<0.005	<0.005	0.012	0.02	0.16	0.031	0.1	0.1	0.02	0.014	0.36	0.116
A-OB7	Sample Count	4	4	13	13	13	13	4	4	13	13	13	13	13	12
	Min	0.034	< 0.001	<0.0001	<0.0001	0.002	0.002	0.11	0.008	< 0.001	< 0.001	< 0.005	< 0.005	0.059	0.012
	20th Percentile	0.0682	0.001	0.0001	0.0001	0.002	0.002	0.128	0.0092	0.007	0.001	0.008	0.007	0.086	0.0222
	Median	0.1255	0.001	0.0001	0.0001	0.002	0.002	0.175	0.01	0.01	0.01	0.01	0.008	0.121	0.033
	95th Percentile	0.6785	0.0087	0.0009	0.0001	0.0260	0.0104	0.8815	0.0100	0.0628	0.0460	0.0310	0.0094	2.1760	0.1465
	Max	0.77	<0.01	0.0016	<0.0001	<0.05	0.011	1	0.01	0.1	0.1	0.055	0.01	4.3	0.18
A-OB8	Sample Count	4	4	14	14	14	14	4	4	14	14	14	14	14	13
	Min	0.005	< 0.001	< 0.0001	< 0.0001	0.011	0.01	0.032	0.027	< 0.001	< 0.001	0.054	0.047	0.025	0.02
	20th Percentile	0.0158	0.001	0.0001	0.0001	0.0126	0.0106	0.0968	0.0288	0.0068	0.0026	0.063	0.049	0.112	0.0338
	Median	0.1315	0.001	0.0001	0.0001	0.0165	0.015	0.15	0.037	0.05	0.05	0.0715	0.0645	0.135	0.069
	95th Percentile	0.095	0.99	0.0042	0.005	0.012	0.02	0.16	0.031	0.1	0.1	0.02	0.014	0.36	0.116
	Max	4	4	13	13	13	13	4	4	13	13	13	13	13	12
A-OB10	Sample Count	0.034	0.001	0.0001	0.0001	0.002	0.002	0.11	0.008	0.001	0.001	0.005	0.005	0.059	0.012
	Min	0.0682	0.001	0.0001	0.0001	0.002	0.002	0.128	0.0092	0.007	0.001	0.008	0.007	0.086	0.0222
	20th Percentile	0.1255	0.001	0.0001	0.0001	0.002	0.002	0.175	0.01	0.01	0.01	0.01	0.008	0.121	0.033
	Median	0.6785	0.00865	0.00094	0.0001	0.026	0.0104	0.8815	0.01	0.0628	0.046	0.031	0.0094	2.176	0.14645
	95th Percentile	0.77	0.01	0.0016	0.0001	0.05	0.011	1	0.01	0.1	0.1	0.055	0.01	4.3	0.18
	Max	4	4	14	14	14	14	4	4	14	14	14	14	14	13
A-OB11	Sample Count	0.005	0.001	0.0001	0.0001	0.011	0.01	0.032	0.027	0.001	0.001	0.054	0.047	0.025	0.02
	Min	0.0158	0.001	0.0001	0.0001	0.0126	0.0106	0.0968	0.0288	0.0068	0.0026	0.063	0.049	0.112	0.0338
	20th Percentile	0.1315	0.001	0.0001	0.0001	0.0165	0.015	0.15	0.037	0.05	0.05	0.0715	0.0645	0.135	0.069
	Median	0.002	0.001	0.0001	0.0001	0.001	0.001	0.004	0.002	0.01	0.01	0.004	0.001	0.142	0.017
	95th Percentile	0.0224	0.0010	0.0001	0.0001	0.0050	0.0062	0.0533	0.0020	0.0100	0.0100	0.0058	0.0050	0.3838	0.0264
	Max	0.026	< 0.001	< 0.0001	0.0001	<0.005	0.008	0.062	0.002	<0.01	<0.01	0.007	<0.005	0.61	0.028
A-OB12	Sample Count	4	4	13	13	13	13	4	4	13	13	13	13	13	12
	Min	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.001	< 0.001	0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.007	< 0.005
	20th Percentile	0.0016	0.001	0.0001	0.0001	0.001	0.001	0.0028	0.001	0.0014	0.001	0.001	0.001	0.0504	0.0144
	Median	0.0025	0.001	0.0001	0.0001	0.001	0.001	0.005	0.0015	0.01	0.01	0.001	0.001	0.072	0.0275
	95th Percentile	0.0277	0.0010	0.0001	0.0001	0.0050	0.0070	0.0239	0.0020	0.0100	0.0100	0.0050	0.0050	0.1772	0.0939
	Max	0.032	< 0.001	< 0.0001	< 0.0001	<0.005	0.01	0.027	0.002	<0.01	<0.01	0.005	0.005	0.2	0.128

Baralaba South Groundwater Monitoring

Permian strata Metal Concentrations

Bore ID		Al	Al (f)	As	As (f)	B	B (f)	Cd	Cd(f)	Cr	Cr(f)	Co	Co (f)	Cu	Cu (f)
		Alluvium Metals Concentrations (Mg/L) - Total & Filtered													
		Baralaba Coal Measures (Interburden)													
P-PB1	Sample Count	12	12	12	12	3	3	3	3	3	3	3	3	3	3
	Min	< 0.01	< 0.01	0.002	0.001	0.12	0.11	< 0.0002	< 0.0002	< 0.001	< 0.001	0.001	0.001	< 0.001	< 0.001
	20th Percentile	0.03	0.01	0.0092	0.0084	0.128	0.118	0.0002	0.0002	0.001	0.001	0.001	0.001	0.001	0.001
	Median	0.05	0.01	0.012	0.0115	0.14	0.13	0.0002	0.0002	0.001	0.001	0.001	0.001	0.001	0.001
	95th Percentile	0.2060	0.0500	0.0155	0.0149	0.1760	0.1750	0.0002	0.0002	0.0028	0.0010	0.0010	0.0010	0.0010	0.0010
	Max	0.25	<0.05	0.016	0.016	0.18	0.18	< 0.0002	< 0.0002	0.003	< 0.001	0.001	0.001	0.001	< 0.001
P-OB3	Sample Count	14	14	14	14	4	4	4	4	4	4	4	4	4	4
	Min	< 0.05	< 0.01	0.002	0.001	0.2	0.16	< 0.0002	< 0.0002	0.001	< 0.001	0.001	0.001	< 0.001	< 0.001
	20th Percentile	0.32	0.05	0.0038	0.002	0.212	0.196	0.0002	0.0002	0.0016	0.001	0.0016	0.0016	0.001	0.001
	Median	3.495	0.05	0.005	0.005	0.22	0.22	0.0002	0.0002	0.002	0.001	0.002	0.002	0.001	0.001
	95th Percentile	16.8300	0.2400	0.0100	0.0100	0.4580	0.4580	0.0017	0.0017	0.0088	0.0087	0.0088	0.0088	0.0537	0.0537
	Max	18	<0.05	<0.01	<0.01	< 0.5	< 0.5	< 0.002	< 0.002	< 0.01	< 0.01	< 0.01	< 0.01	0.063	0.063
		Baralaba Coal Measures (Coal Seams)													
P-OB1	Sample Count	13	13	13	13	4	4	4	4	4	4	4	4	4	4
	Min	<0.05	<0.01	0.004	0.003	0.18	0.17	<0.0002	<0.0002	<0.001	<0.001	0.003	0.003	<0.001	<0.001
	20th Percentile	0.05	0.05	0.0054	0.004	0.186	0.176	0.0002	0.0002	0.001	0.001	0.0036	0.0036	0.001	0.001
	Median	4.32	0.05	0.006	0.005	0.2	0.195	0.0002	0.0002	0.001	0.001	0.005	0.005	0.001	0.001
	95th Percentile	14.0980	0.0700	0.0100	0.0082	0.2100	0.2100	0.0002	0.0002	0.0053	0.0010	0.0086	0.0077	0.0010	0.0010
	Max	25.6	<0.10	0.01	<0.01	0.21	0.21	<0.0002	<0.0002	0.006	<0.001	0.009	0.008	<0.001	<0.001
P-OB4	Sample Count	13	13	13	13	4	4	4	4	4	4	4	4	4	4
	Min	< 0.05	< 0.01	< 0.001	< 0.001	0.22	0.23	< 0.0002	< 0.0002	0.002	< 0.001	< 0.01	< 0.01	< 0.001	< 0.001
	20th Percentile	0.05	0.05	0.0032	0.002	0.226	0.242	0.0002	0.0002	0.0026	0.0016	0.013	0.0136	0.0028	0.001
	Median	0.05	0.05	0.005	0.005	0.23	0.265	0.0002	0.0002	0.004	0.0025	0.016	0.0165	0.0065	0.001
	95th Percentile	0.5000	0.2600	0.0100	0.0100	0.4595	0.4670	0.0017	0.0017	0.0093	0.0090	0.0170	0.0170	0.0099	0.0087
	Max	0.5	<0.5	<0.01	0.01	< 0.05	< 0.05	< 0.002	< 0.002	< 0.01	< 0.01	0.0170	0.0170	< 0.01	< 0.01
P-OB5	Sample Count	13	13	13	13	4	4	4	4	4	4	4	4	4	4
	Min	< 0.05	< 0.01	0.002	0.001	0.78	0.78	< 0.0002	< 0.0002	0.002	< 0.001	< 0.001	< 0.001	0.005	< 0.001
	20th Percentile	0.08	0.05	0.0032	0.0034	0.78	0.78	0.0002	0.0002	0.0026	0.0016	0.001	0.001	0.005	0.001
	Median	0.12	0.05	0.006	0.005	0.835	0.82	0.0002	0.0002	0.003	0.0025	0.001	0.001	0.0075	0.001
	95th Percentile	0.3500	0.2600	0.0100	0.0100	1.3235	1.3190	0.0017	0.0017	0.0098	0.0090	0.0087	0.0087	0.0185	0.0087
	Max	<0.5	<0.5	<0.01	<0.01	1.4	1.4	< 0.002	< 0.002	0.011	< 0.01	< 0.01	< 0.01	0.02	< 0.01
		Gyranda Formation													
P-OB2	Sample Count	13	13	13	13	3	3	3	3	3	3	3	3	3	3
	Min	<0.05	<0.01	<0.001	<0.001	1.6	1.6	< 0.0002	< 0.0002	< 0.001	< 0.001	0.001	0.001	0.019	0.009
	20th Percentile	0.098	0.01	0.001	0.001	1.68	1.68	0.0002	0.0002	0.0014	0.001	0.0014	0.0014	0.0258	0.0126
	Median	2.18	0.01	0.003	0.001	1.8	1.8	0.0002	0.0002	0.002	0.001	0.002	0.002	0.036	0.018
	95th Percentile	3.734	0.07	0.0088	0.0052	1.89	1.89	0.0002	0.0002	0.0155	0.0019	0.002	0.002	0.1026	0.0918
	Max	4.43	<0.1	<0.01	<0.01	1.9	1.9	< 0.0002	< 0.0002	0.017	0.002	0.002	0.002	0.11	0.1

	Median	0.001	0.001	0.0001	0.0001	0.005	0.005	0.0025	0.002	0.05	0.05	0.005	0.005	0.078	0.05
	95th Percentile	0.0087	0.0087	0.0004	0.0004	0.0240	0.0240	0.0090	0.0088	0.0675	0.0675	0.0240	0.0240	0.1670	0.1002
	Max	<0.01	<0.01	<0.001	<0.001	<0.05	<0.05	<0.01	<0.01	<0.1	<0.1	<0.05	<0.05	0.206	0.114
		Baralaba Coal Measures (Coal Seams)													
P-OB1	Sample Count	4	4	13	13	13	13	4	4	13	13	13	13	13	12
	Min	< 0.001	< 0.001	< 0.0001	< 0.0001	<0.005	< 0.001	0.003	0.003	< 0.001	< 0.001	< 0.005	< 0.001	0.021	0.005
	20th Percentile	0.001	0.001	0.0001	0.0001	0.005	0.005	0.0036	0.0036	0.005	0.0046	0.005	0.005	0.0664	0.0132
	Median	0.001	0.001	0.0001	0.0001	0.005	0.005	0.0055	0.0045	0.05	0.05	0.005	0.005	0.33	0.0735
	95th Percentile	0.0010	0.0010	0.0001	0.0001	0.0070	0.0070	0.0079	0.0059	0.0700	0.0700	0.0070	0.0070	0.8100	0.2450
	Max	< 0.01	< 0.01	0.0002	<0.0001	<0.01	<0.01	0.008	0.006	<0.1	<0.1	<0.01	<0.01	1.23	0.256
P-OB4	Sample Count	4	4	13	13	13	13	4	4	13	13	13	13	13	12
	Min	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.005	0.003	< 0.01	< 0.01	< 0.001	< 0.001	< 0.005	0.002	0.006	<0.005
	20th Percentile	0.001	0.001	0.0001	0.0001	0.005	0.005	0.0142	0.0136	0.0046	0.0046	0.005	0.005	0.0428	0.0202
	Median	0.001	0.001	0.0001	0.0001	0.005	0.005	0.024	0.023	0.05	0.05	0.005	0.005	0.053	0.04
	95th Percentile	0.0087	0.0087	0.0005	0.0005	0.0260	0.0278	0.0327	0.0377	0.0700	0.0700	0.0260	0.0260	0.1500	0.1233
	Max	< 0.01	< 0.01	<0.001	<0.001	<0.05	<0.05	0.033	0.039	<0.1	<0.1	<0.05	<0.05	0.15	0.153
P-OB5	Sample Count	4	4	13	13	13	13	4	4	13	13	13	13	13	12
	Min	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.005	< 0.005	0.003	0.002	< 0.001	< 0.001	0.002	<0.001	0.013	<0.005
	20th Percentile	0.001	0.001	0.0001	0.0001	0.006	0.005	0.0072	0.005	0.0046	0.0046	0.005	0.005	0.0418	0.0114
	Median	0.001	0.001	0.0001	0.0001	0.008	0.006	0.012	0.0085	0.05	0.05	0.005	0.005	0.062	0.0365
	95th Percentile	0.0087	0.0087	0.0005	0.0005	0.0326	0.0320	0.0149	0.0109	0.0700	0.0700	0.0260	0.0260	0.2446	0.1551
	Max	< 0.01	< 0.01	<0.001	<0.001	<0.05	<0.05	0.015	0.011	<0.1	<0.1	<0.05	<0.05	0.31	0.193
		Gyranda Formation													
P-OB2	Sample Count	3	3	13	13	13	13	3	3	13	13	13	13	13	12
	Min	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.001	< 0.001	0.003	0.003	< 0.001	< 0.001	0.002	0.001	0.008	0.008
	20th Percentile	0.001	0.001	0.0001	0.0001	0.001	0.001	0.003	0.003	0.0046	0.0046	0.002	0.002	0.0424	0.0266
	Median	0.001	0.001	0.0001	0.0001	0.001	0.001	0.003	0.003	0.01	0.01	0.002	0.002	0.078	0.0475
	95th Percentile	0.0010	0.0010	0.0001	0.0001	0.0070	0.0070	0.0120	0.0048	0.0460	0.0460	0.0070	0.0070	0.3020	0.3129
	Max	< 0.001	< 0.001	<0.0002	<0.0001	<0.01	<0.01	0.013	0.005	<0.1	<0.1	<0.01	<0.01	0.38	0.38

Appendix D: Numerical Model stress period schedule

Model stress period schedule

SP	DateStart	DateEnd	Length	Steady State or Transient	No. of timesteps	Elapsed time (d)	Comment
1	1/01/1970	1/01/1970	1	SS	1	1	Initialising in steady state
2	2/01/1970	30/06/2005	12964	TR	10	12965	Commence transient historical period
3	1/07/2005	31/10/2005	123	TR	4	13088	**Commence mining Baralaba Central**
4	1/11/2005	28/02/2006	120	TR	4	13208	
5	1/03/2006	30/06/2006	122	TR	4	13330	
6	1/07/2006	31/10/2006	123	TR	4	13453	
7	1/11/2006	28/02/2007	120	TR	4	13573	
8	1/03/2007	30/06/2007	122	TR	4	13695	
9	1/07/2007	31/10/2007	123	TR	4	13818	
10	1/11/2007	29/02/2008	121	TR	4	13939	
11	1/03/2008	31/10/2008	245	TR	4	14184	
12	1/11/2008	31/10/2009	365	TR	4	14549	
13	1/11/2009	31/10/2010	365	TR	4	14914	
14	1/11/2010	28/02/2011	120	TR	4	15034	
15	1/03/2011	31/10/2011	245	TR	4	15279	
16	1/11/2011	31/10/2012	366	TR	4	15645	
17	1/11/2012	31/10/2013	365	TR	4	16010	
18	1/11/2013	30/04/2014	181	TR	4	16191	
19	1/05/2014	31/12/2014	245	TR	4	16436	
20	1/01/2015	31/12/2015	365	TR	4	16801	**Commence mining at Baralaba North**
21	1/01/2016	31/12/2016	366	TR	4	17167	
22	1/01/2017	31/12/2017	365	TR	4	17532	
23	1/01/2018	31/03/2018	90	TR	2	17622	
24	1/04/2018	30/06/2018	91	TR	2	17713	
25	1/07/2018	30/09/2018	92	TR	2	17805	
26	1/10/2018	31/12/2018	92	TR	2	17897	
27	1/01/2019	31/03/2019	90	TR	2	17987	
28	1/04/2019	30/06/2019	91	TR	2	18078	
29	1/07/2019	30/09/2019	92	TR	2	18170	
30	1/10/2019	31/12/2019	92	TR	2	18262	
31	1/01/2020	31/03/2020	91	TR	2	18353	
32	1/04/2020	30/06/2020	91	TR	2	18444	
33	1/07/2020	30/09/2020	92	TR	2	18536	
34	1/10/2020	31/12/2020	92	TR	2	18628	
35	1/01/2021	31/03/2021	90	TR	2	18718	
36	1/04/2021	30/06/2021	91	TR	2	18809	
37	1/07/2021	30/09/2021	92	TR	2	18901	
38	1/10/2021	31/12/2021	92	TR	2	18993	
39	1/01/2022	31/03/2022	90	TR	2	19083	
40	1/04/2022	30/06/2022	91	TR	2	19174	
41	1/07/2022	30/09/2022	92	TR	2	19266	
42	1/10/2022	31/12/2022	92	TR	2	19358	
43	1/01/2023	31/03/2023	90	TR	2	19448	
44	1/04/2023	30/06/2023	91	TR	2	19539	
45	1/07/2023	31/12/2023	184	TR	2	19723	end of historical period for EIS model
46	1/01/2024	31/12/2024	366	TR	3	20089	commence forecast period
47	1/01/2025	31/12/2025	365	TR	3	20454	
48	1/01/2026	31/12/2026	365	TR	3	20819	
49	1/01/2027	31/12/2027	365	TR	3	21184	
50	1/01/2028	31/12/2028	366	TR	3	21550	
51	1/01/2029	31/12/2029	365	TR	3	21915	
52	1/01/2030	31/12/2030	365	TR	3	22280	**Commence mining at BSP**
53	1/01/2031	31/12/2031	365	TR	3	22645	
54	1/01/2032	31/12/2032	366	TR	3	23011	
55	1/01/2033	31/12/2033	365	TR	3	23376	(simulated) End of mining at BNM
56	1/01/2034	31/12/2034	365	TR	3	23741	
57	1/01/2035	31/12/2035	365	TR	3	24106	
58	1/01/2036	31/12/2036	366	TR	3	24472	
59	1/01/2037	31/12/2037	365	TR	3	24837	
60	1/01/2038	31/12/2038	365	TR	3	25202	
61	1/01/2039	31/12/2039	365	TR	3	25567	
62	1/01/2040	31/12/2040	366	TR	3	25933	
63	1/01/2041	31/12/2041	365	TR	3	26298	
64	1/01/2042	31/12/2042	365	TR	3	26663	
65	1/01/2043	31/12/2043	365	TR	3	27028	

Model stress period schedule

SP	DateStart	DateEnd	Length	Steady State or Transient	No. of timesteps	Elapsed time (d)	Comment
66	1/01/2044	31/12/2044	366	TR	3	27394	
67	1/01/2045	31/12/2045	365	TR	3	27759	
68	1/01/2046	31/12/2046	365	TR	3	28124	
69	1/01/2047	31/12/2047	365	TR	3	28489	
70	1/01/2048	31/12/2048	366	TR	3	28855	
71	1/01/2049	31/12/2049	365	TR	3	29220	
72	1/01/2050	31/12/2050	365	TR	3	29585	
73	1/01/2051	31/12/2051	365	TR	3	29950	
74	1/01/2052	31/12/2052	366	TR	3	30316	
75	1/01/2053	31/12/2053	365	TR	4	30681	**end BSP mining**
76	1/01/2054	31/12/2054	365	TR	5	31046	
77	1/01/2055	31/12/2055	365	TR	6	31411	separate post-closure "recovery" period
78	1/01/2056	31/12/2056	366	TR	4	31777	
79	1/01/2057	31/12/2057	365	TR	4	32142	
80	1/01/2058	31/12/2058	365	TR	4	32507	
81	1/01/2059	31/12/2068	3653	TR	4	36160	
82	1/01/2069	31/12/2078	3652	TR	4	39812	
83	1/01/2079	31/12/2088	3653	TR	4	43465	
84	1/01/2089	31/12/2100	4382	TR	4	47847	
85	1/01/2101	31/12/2150	18262	TR	4	66109	
86	1/01/2151	31/12/2200	18262	TR	4	84371	
87	1/01/2201	31/12/2250	18262	TR	4	102633	
88	1/01/2251	31/12/2300	18262	TR	4	120895	
89	1/01/2301	31/12/2400	36525	TR	4	157420	
90	1/01/2401	31/12/2500	36524	TR	4	193944	simulating to ~450yrs post-mining

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Appendix E: Numerical Model Parameterisation and Boundary Conditions

Maps on the following pages show the modelled hydraulic property zones and pilot point distributions, and boundary conditions:

Figure E1: Model Layer 1and 2.

Figure E2: Model Layer 3 and 4.

- Other coal seam layers (6,8,10,12,14) are very similar to Layer 4.

Figure E3: Model Layer 16 and 17.

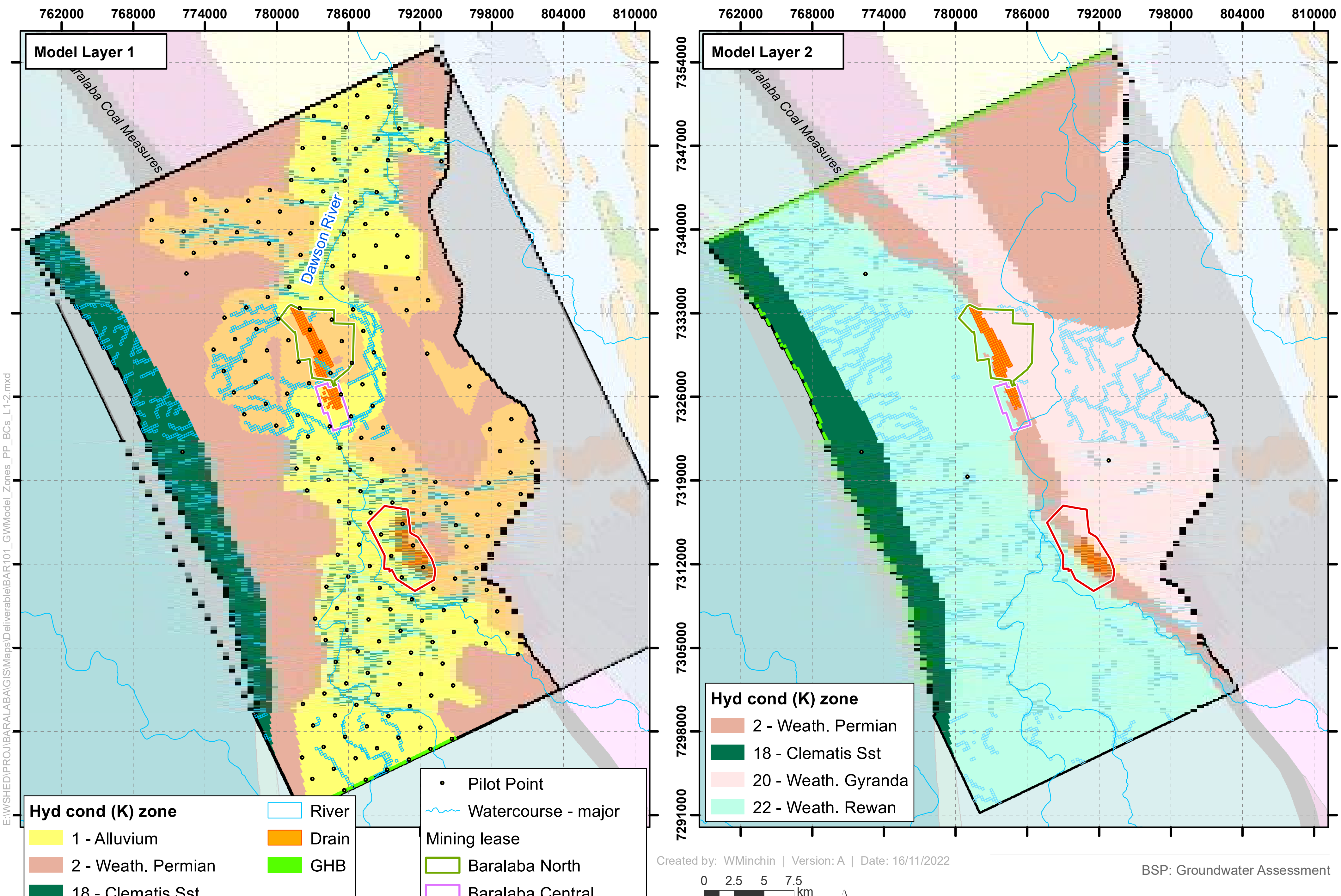
- Interburden layers (5,7,9,11,13,15) are very similar to Layer 16.

Table E1 Parameters used in PESTPP-IES history-matching

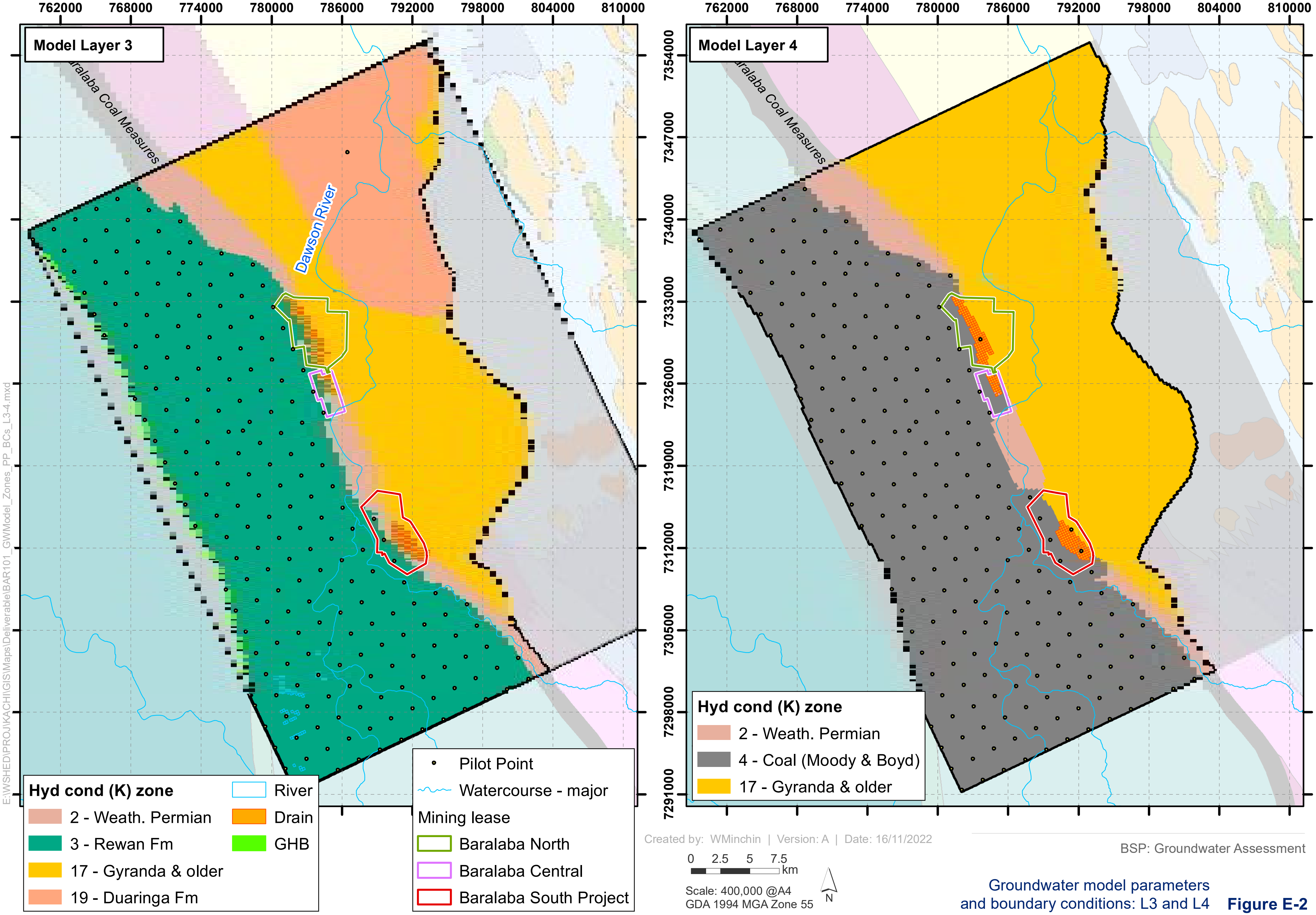
Parameter type	Group	Lithology / zone	No. of parameters
Recharge (5 parameters in total)	Zone-based multiplier	Alluvium	1
		Permo-Triassic	1
		Clematis	1
		Colluvium	1
		Spoil	1
Drain conductance	BNM and BSP drains	Global	1
			No. of pilot points
Hydraulic conductivity – horizontal (Kx) and Hydraulic conductivity – vertical anisotropy (vka → Kz) *(no. of pilots for each of Kx and Kz)*	Alluvium	1	127
	Weathered Rewan Formation and Weathered Permian	2	1
	Rewan Formation	3	216
	Coal – Moody & Boyd Seams	4	222
	Baralaba Coal Measures – Interburden	5	223
	Coal – Reid & Cameron Seams	6	223
	Baralaba Coal Measures – Interburden	7	222
	Coal – Doubtful & Sub-Doubtful Seams	8	224
	Baralaba Coal Measures – Interburden	9	230
	Coal – Dunstan & Dawson Seams	10	232
	Baralaba Coal Measures – Interburden	11	231
	Coal – Wright & Coolum Seams	12	234
	Baralaba Coal Measures – Interburden	13	237
	Coal – Dirty & Sub-Dirty Seams	14	238
	Baralaba Coal Measures – Interburden	15	242
	Kaloola Member	16	1
	Gyranda Formation and Older Units	17	1
	Clematis Sandstone	18	1
	Duaringa Formation	19	1
	Weathered Gyranda Formation (including Kaloola Member)	20	1
	Colluvium	21	81
Specific yield (Sy) and Specific Storage (Ss) *(no. of pilots for each of Sy and Ss)*	Alluvium and Colluvium	1	208
	Weathered Permian Coal Measures	2	349
	Rewan Formation (and Overburden)	3	216
	Coal Seams and Kaloola Member	4	224
	Interburden	5	225
	Duaringa Formation and Clematis Sandstone	6	94

Parameter type	Group	Lithology / zone	No. of parameters
	Gyranda Formation and Older Units	7	386
Total parameters used by PESTPP-IES			**9788**

P:\PROJ\BARALABA\Model\Runs\Cal_model_vistas\Cal_pp2\BAR003_TR006_CAL6_update_pp2a.pst

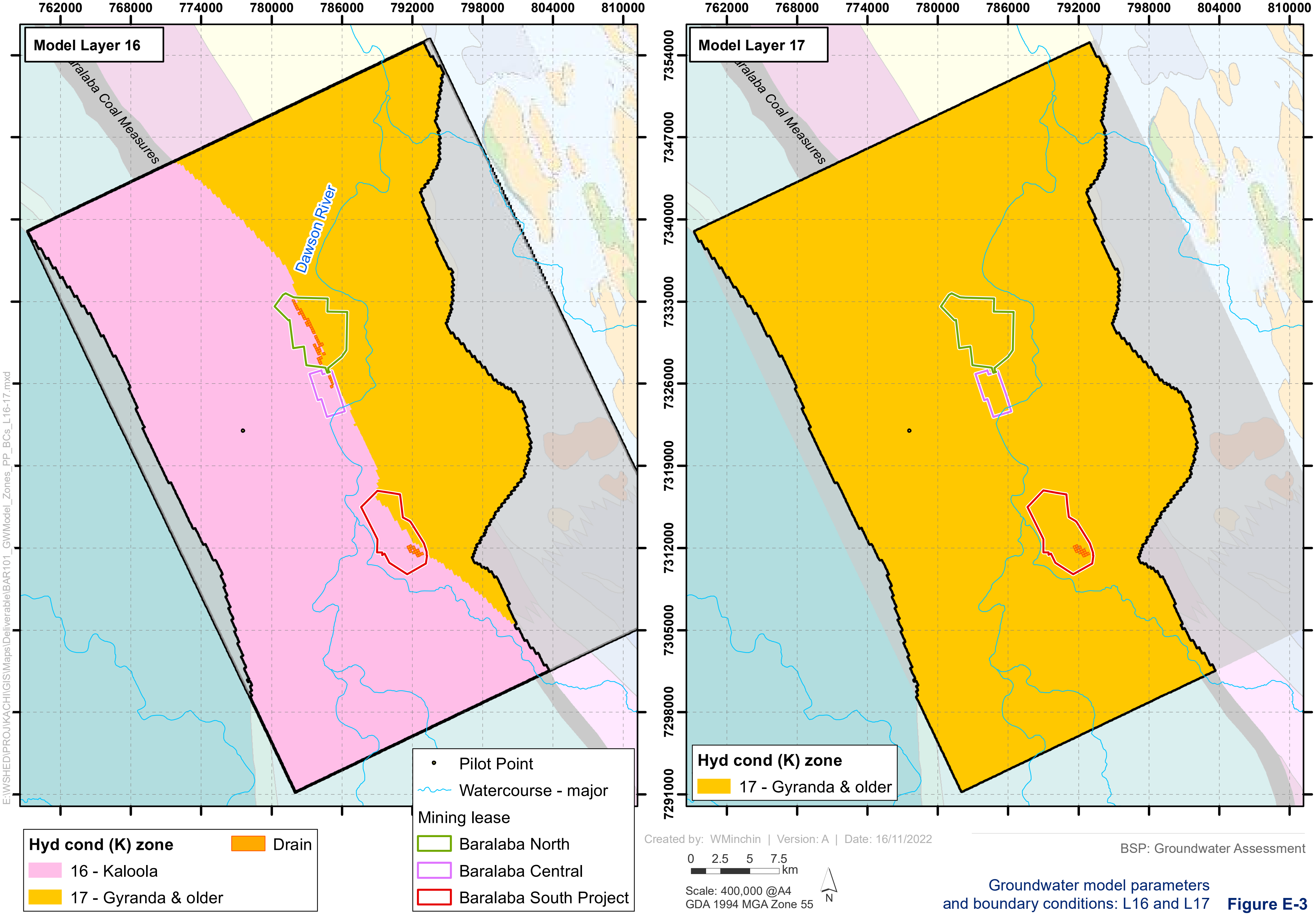


Groundwater model parameters and boundary conditions: L1 and L2 **Figure E-1**



BSP: Groundwater Assessment

Groundwater model parameters and boundary conditions: L3 and L4 **Figure E-2**



BSP: Groundwater Assessment

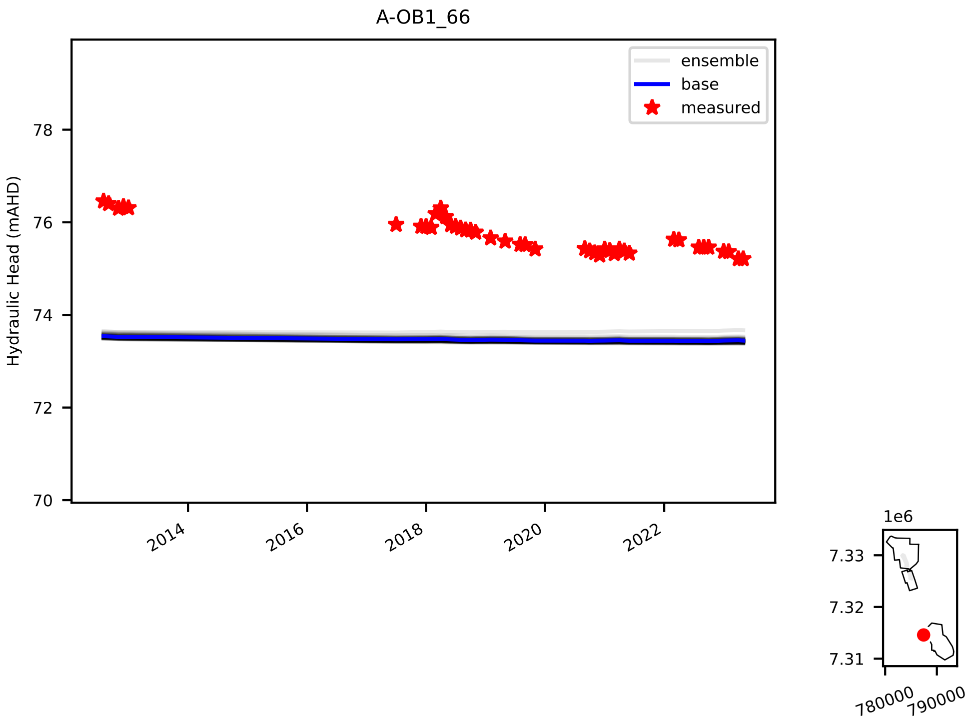
Groundwater model parameters and boundary conditions: L16 and L17 **Figure E-3**

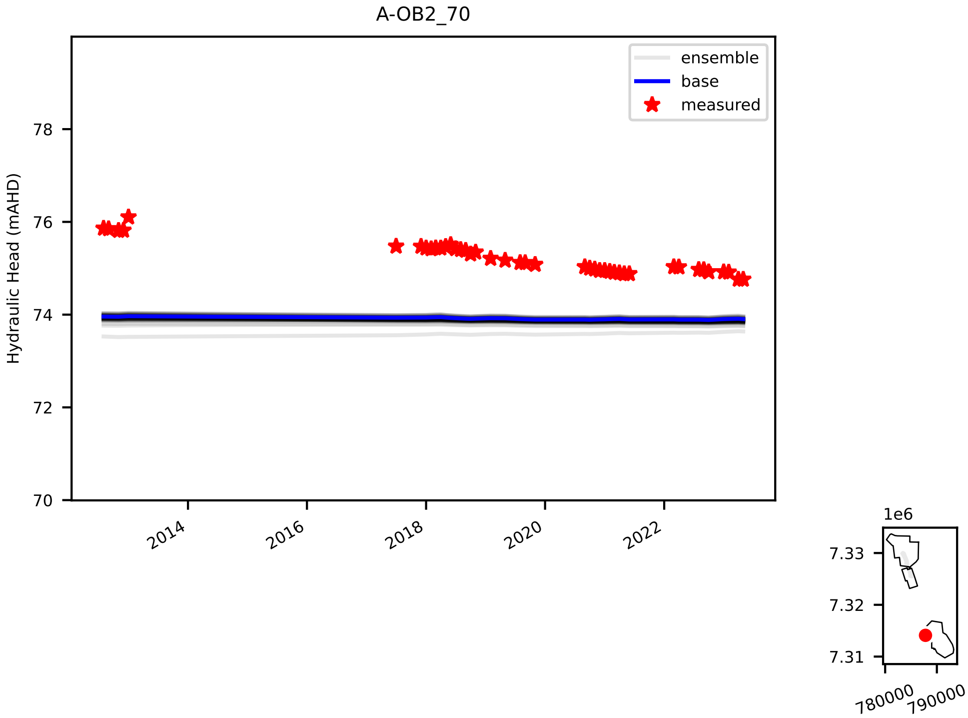
Appendix F: Numerical model calibration hydrographs

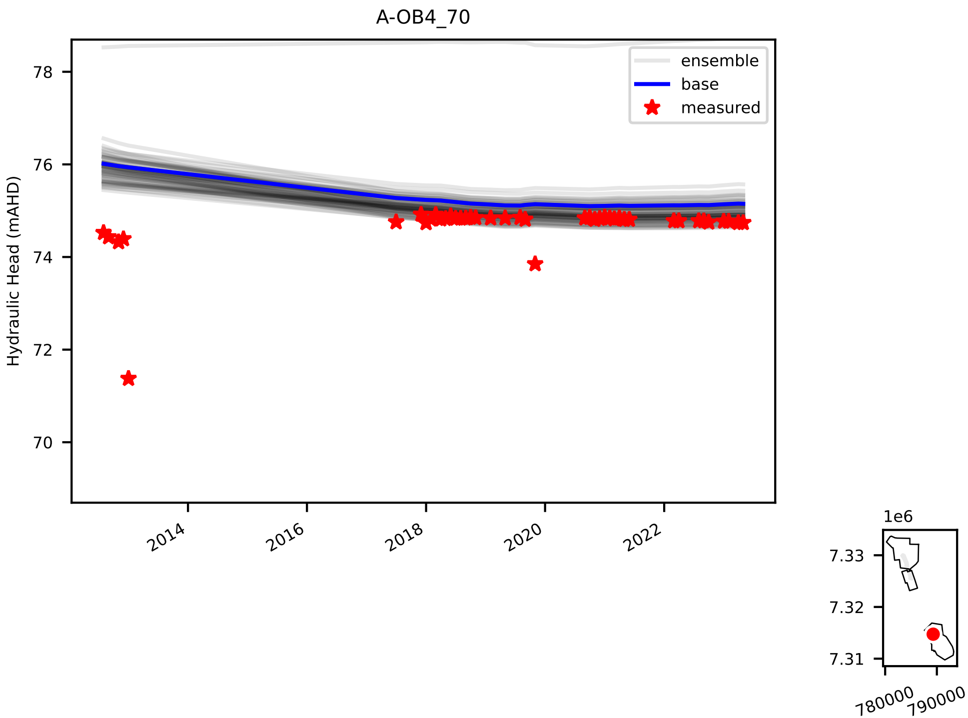
The hydrographs on the following pages show the calibration hydrographs for:

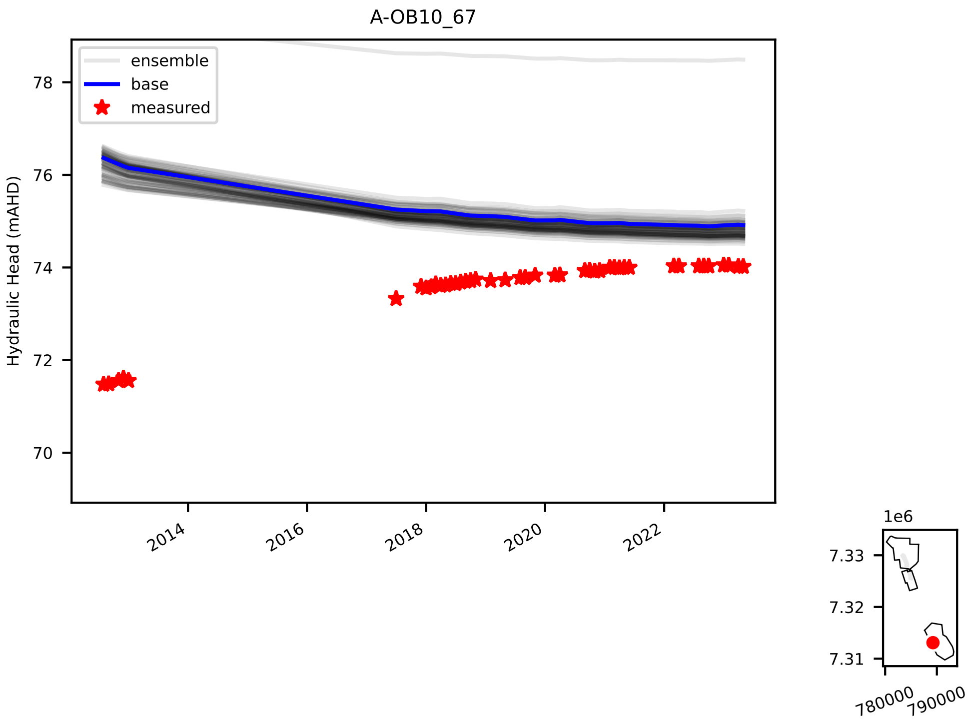
- Bores at BNM.
- Bores at BSP.

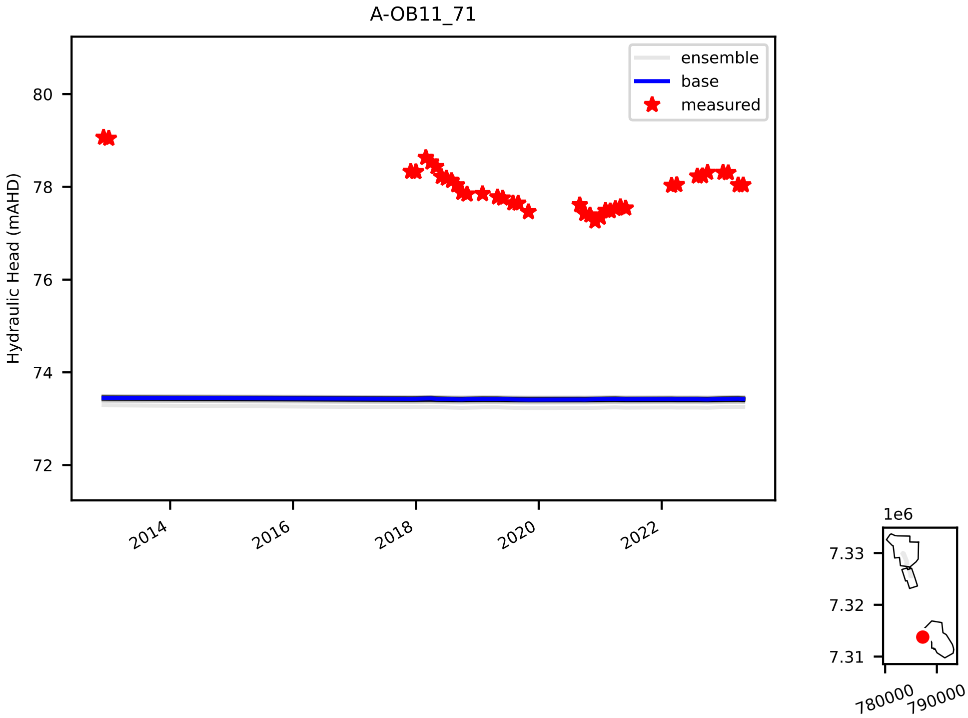
F1: Calibration hydrographs for bores at BSP


A-OB1_66
ensemble
base
measured
Hydraulic Head (mAHD)
78
76
74
72
70
2014
2016
2018
2020
2022
1e6
7.33
7.32
7.31
780000
790000

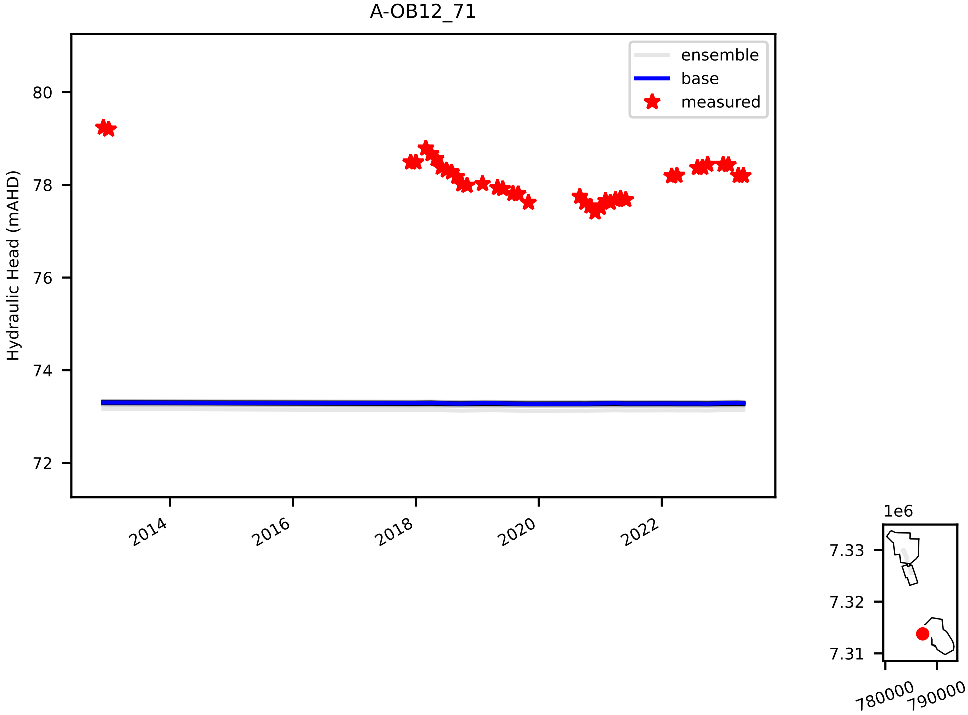

A-OB2_70
ensemble
base
measured
Hydraulic Head (mAHD)
78
76
74
72
70
2014
2016
2018
2020
2022
1e6
7.33
7.32
7.31
780000
790000


A-OB4_70
Hydraulic Head (mAHD)
78
76
74
72
70
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

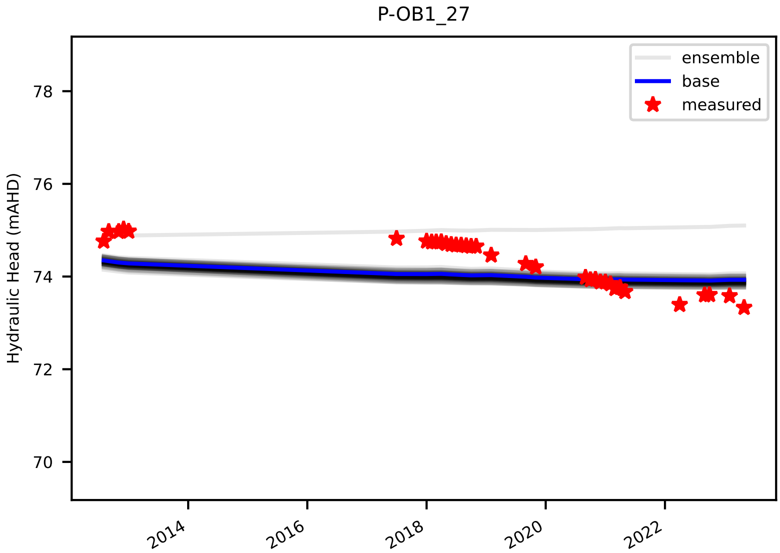

A-OB10_67
ensemble
base
measured
Hydraulic Head (mAHD)
78
76
74
72
70
2014
2016
2018
2020
2022
1e6
7.33
7.32
7.31
780000
790000



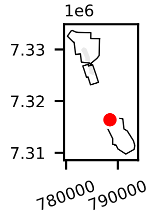
A-OB11_71
ensemble
base
measured
Hydraulic Head (mAHD)
80
78
76
74
72
2014
2016
2018
2020
2022
1e6
7.33
7.32
7.31
780000
790000



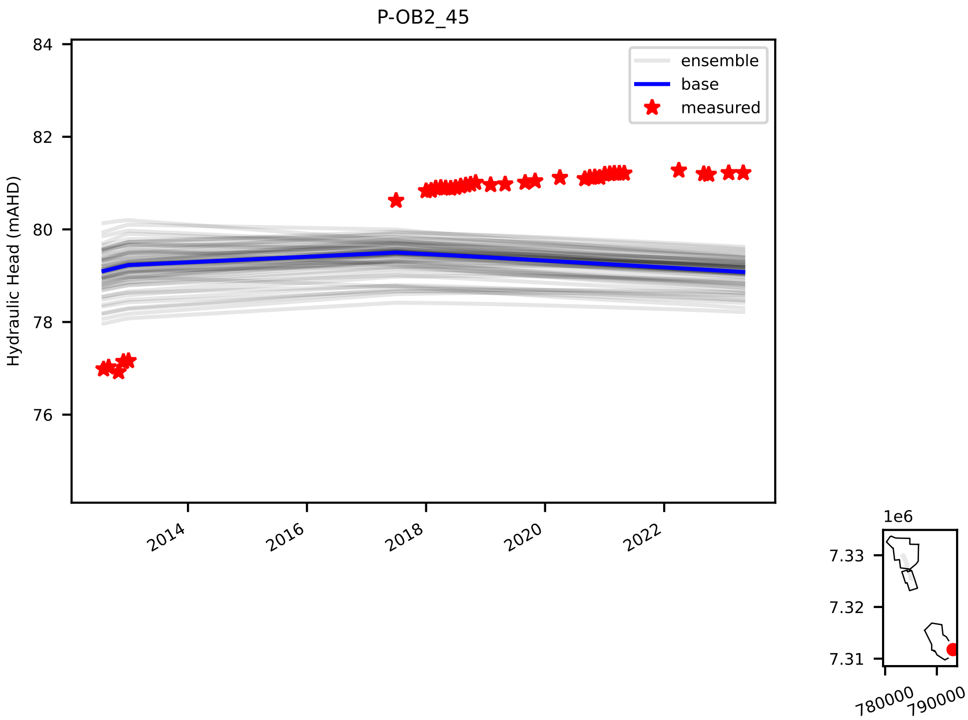
A-OB12_71
ensemble
base
measured
Hydraulic Head (mAHD)
80
78
76
74
72
2014
2016
2018
2020
2022
1e6
7.33
7.32
7.31
780000
790000



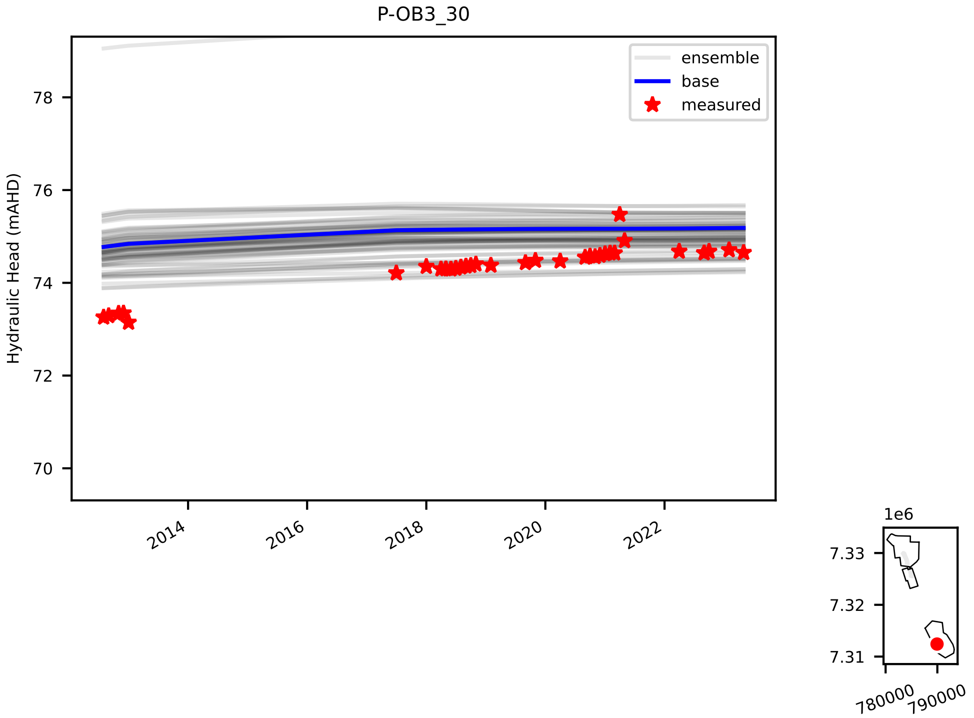
P-OB1_27
ensemble
base
measured
Hydraulic Head (mAHD)
78
76
74
72
70
2014
2016
2018
2020
2022



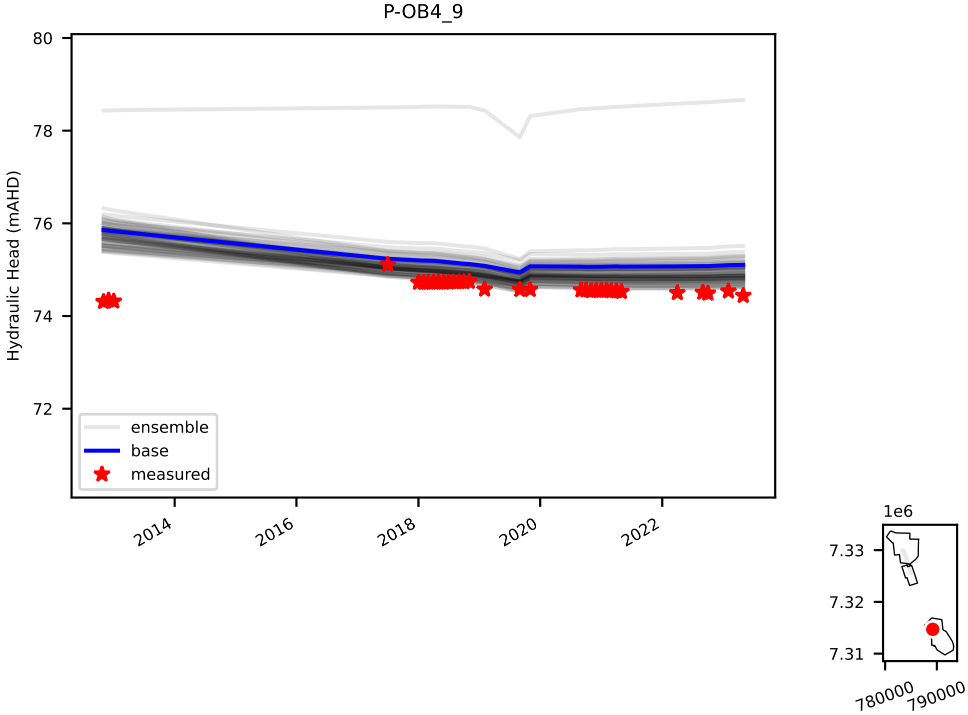
1e6
7.33
7.32
7.31
780000
790000



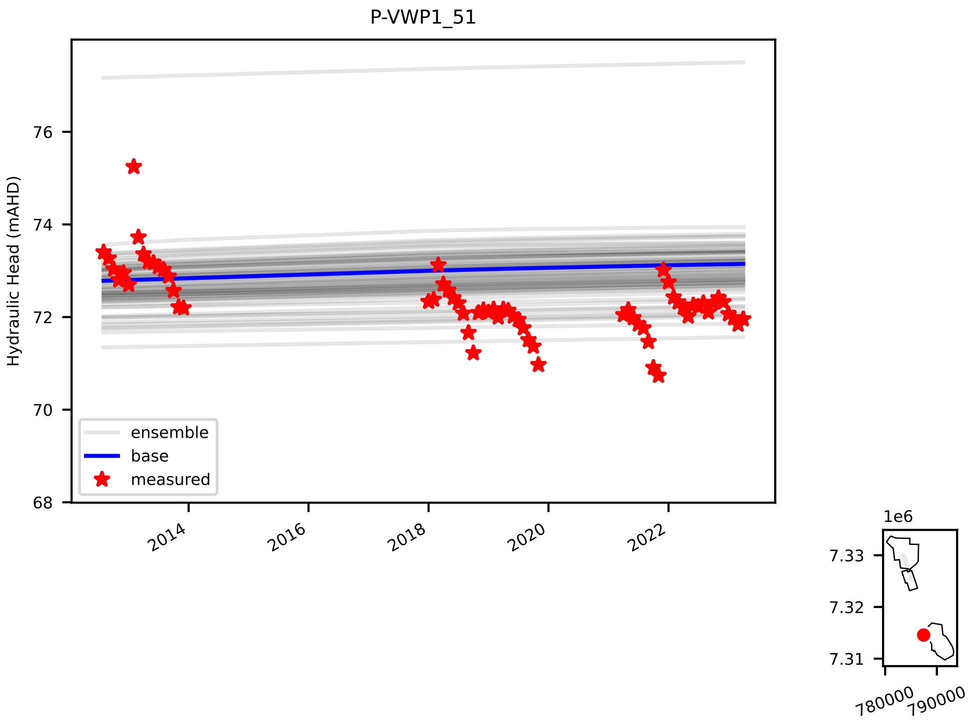
P-OB2_45
Hydraulic Head (mAHD)
84
82
80
78
76
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000



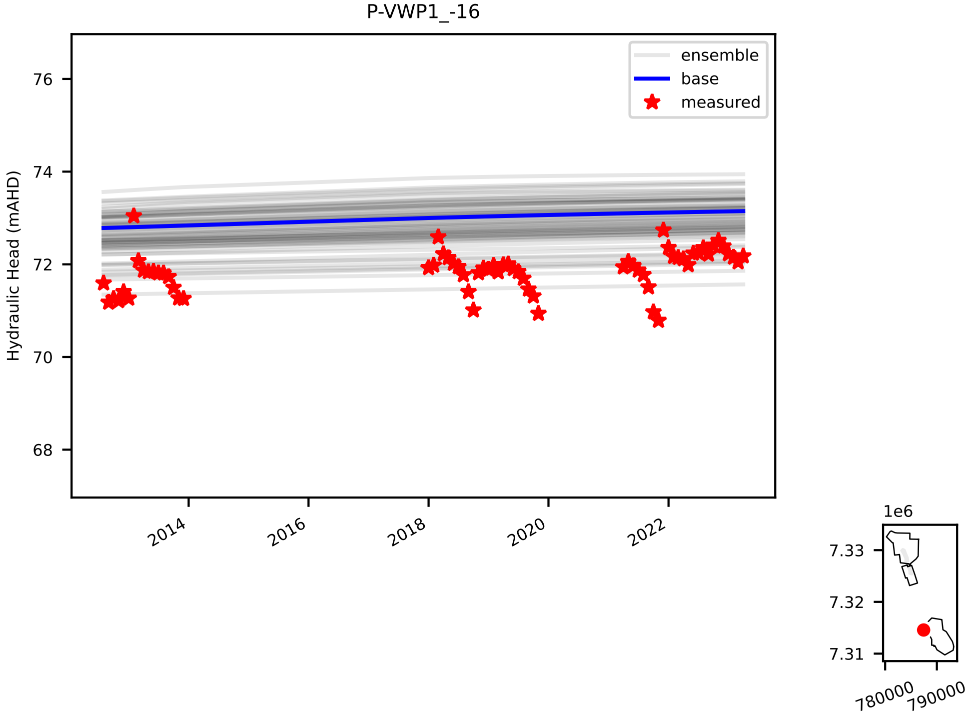
P-OB3_30
ensemble
base
measured
Hydraulic Head (mAHD)
78
76
74
72
70
2014
2016
2018
2020
2022
1e6
7.33
7.32
7.31
780000
790000

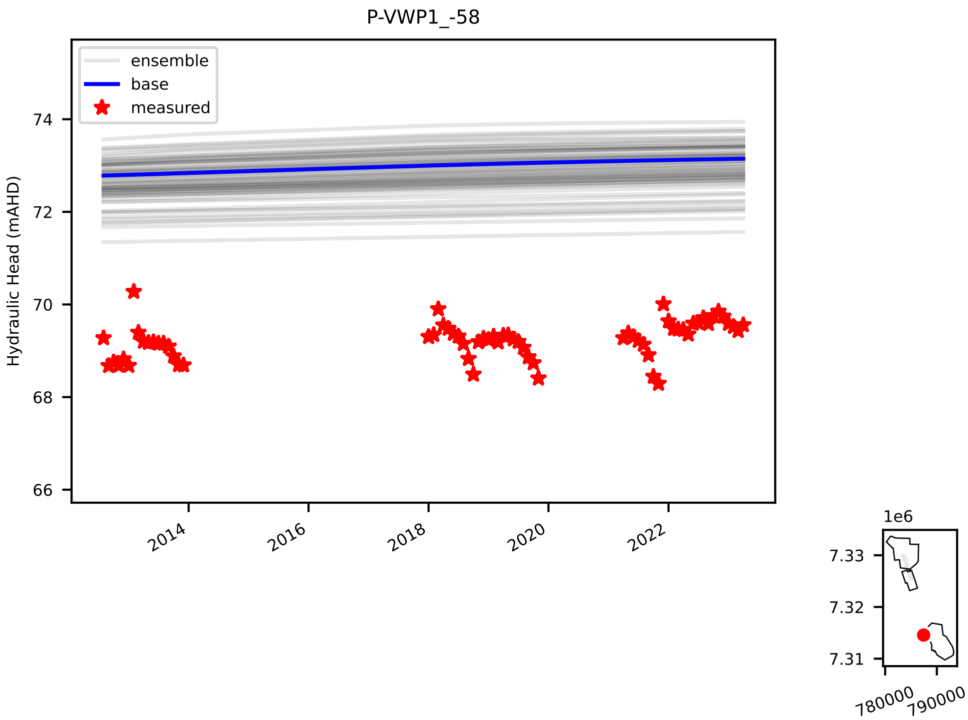


P-OB4_9
Hydraulic Head (mAHD)
80
78
76
74
72
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

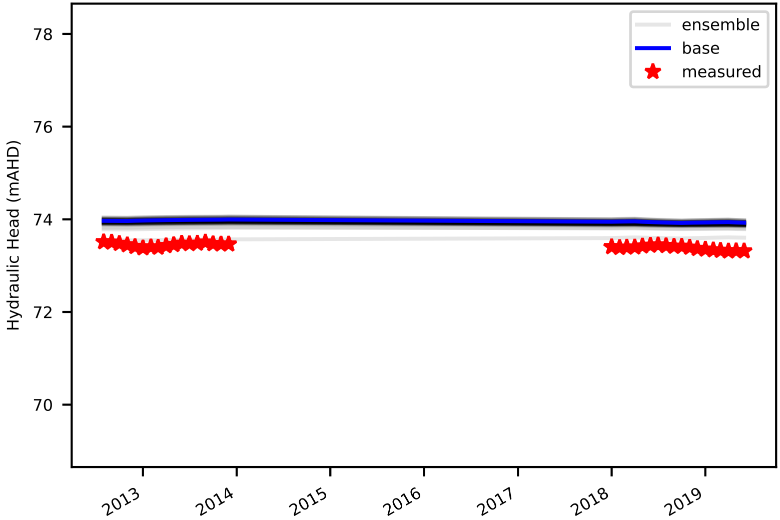


P-VWP1_51
Hydraulic Head (mAHD)
76
74
72
70
68
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

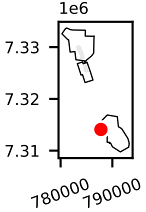

P-VWP1_-16
Hydraulic Head (mAHD)
76
74
72
70
68
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000


P-VWP1_-58
ensemble
base
measured
Hydraulic Head (mAHD)
74
72
70
68
66
2014
2016
2018
2020
2022
1e6
7.33
7.32
7.31
780000
790000

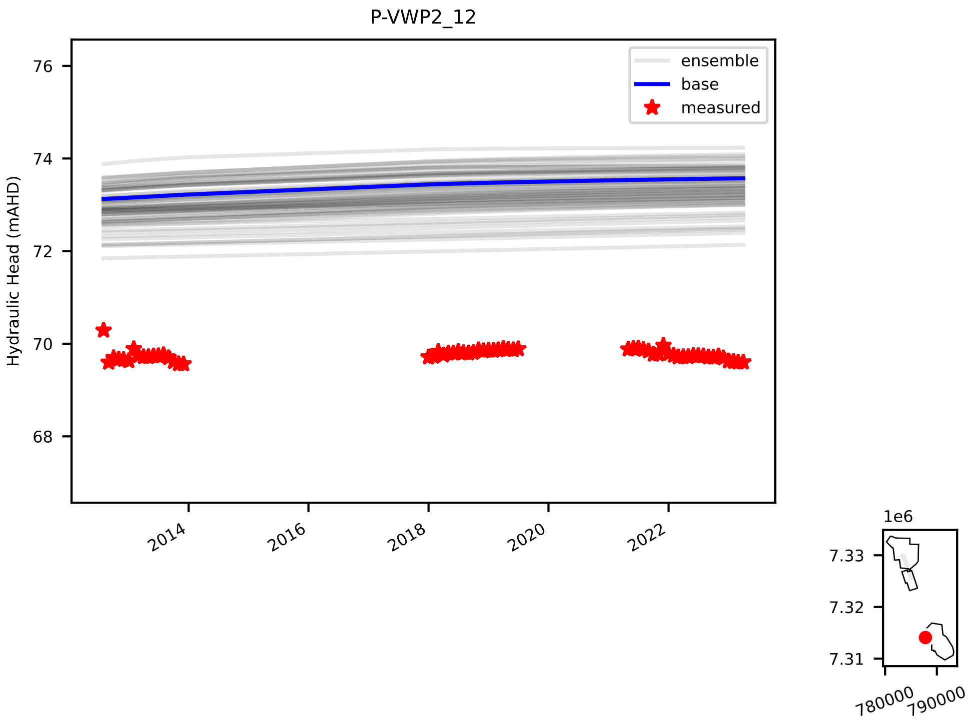
P-VWP2_59

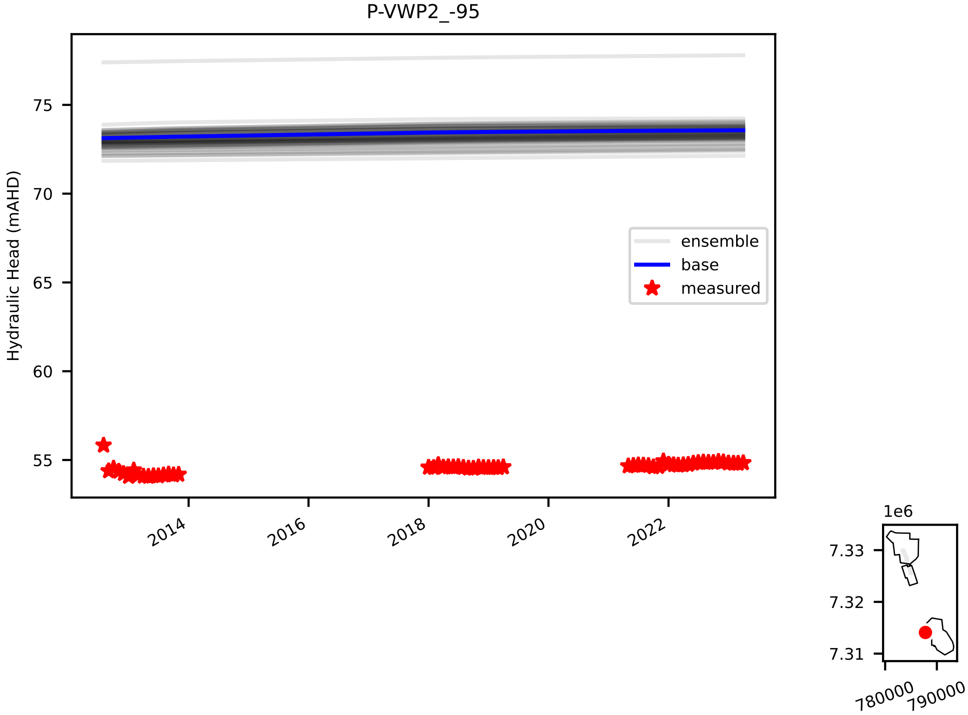


ensemble
base
measured
Hydraulic Head (mAHD)
78
76
74
72
70
2013
2014
2015
2016
2017
2018
2019

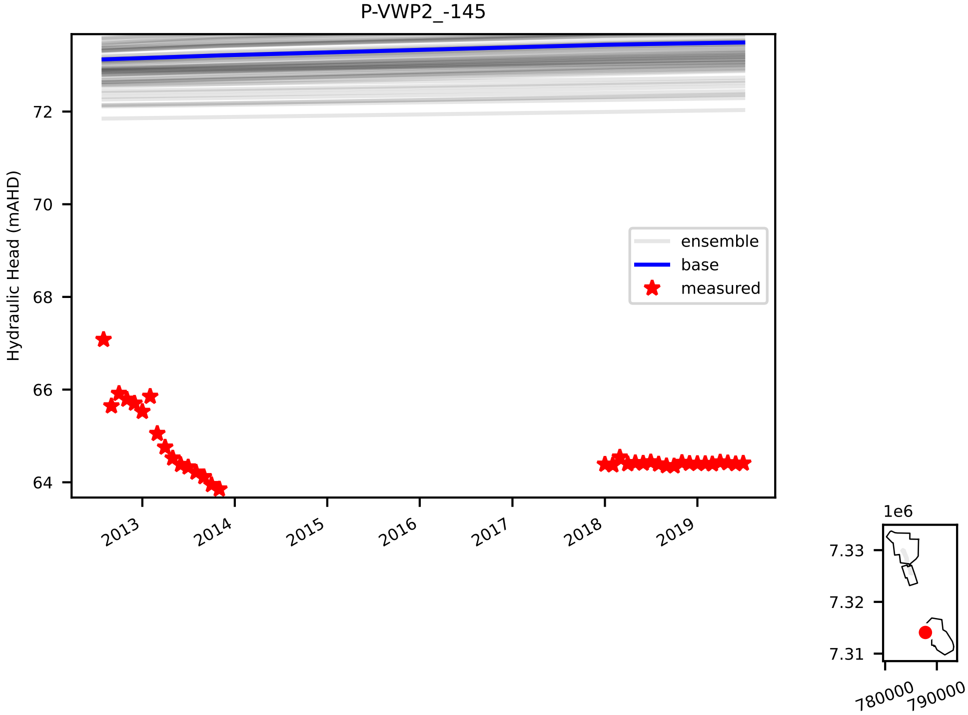


1e6
7.33
7.32
7.31
780000
790000

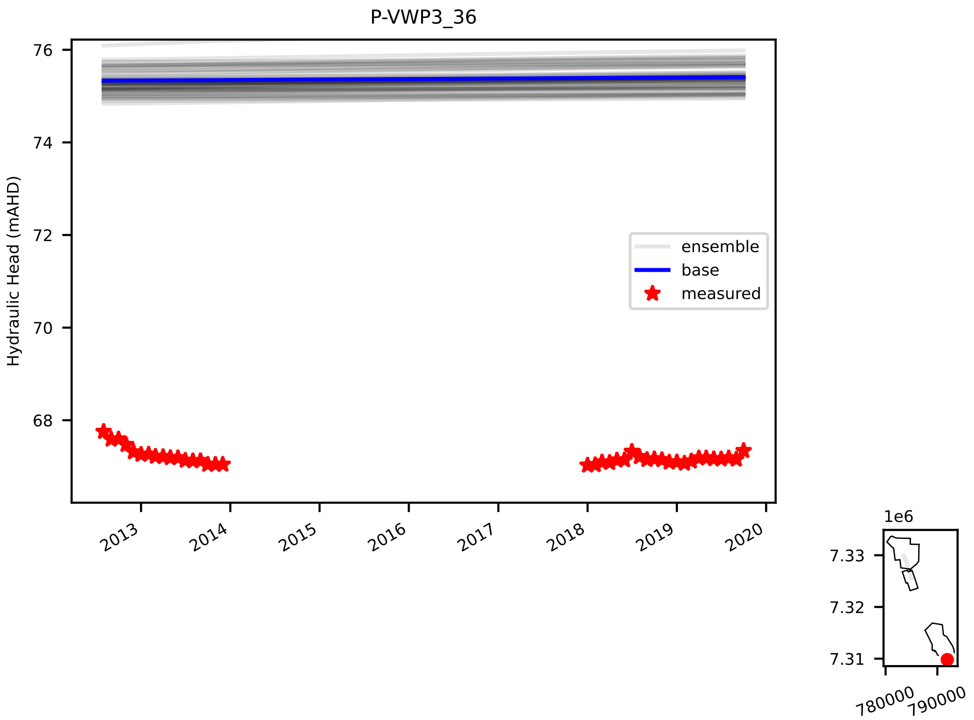

P-VWP2_12
ensemble
base
measured
Hydraulic Head (mAHD)
76
74
72
70
68
2014
2016
2018
2020
2022
1e6
7.33
7.32
7.31
780000
790000



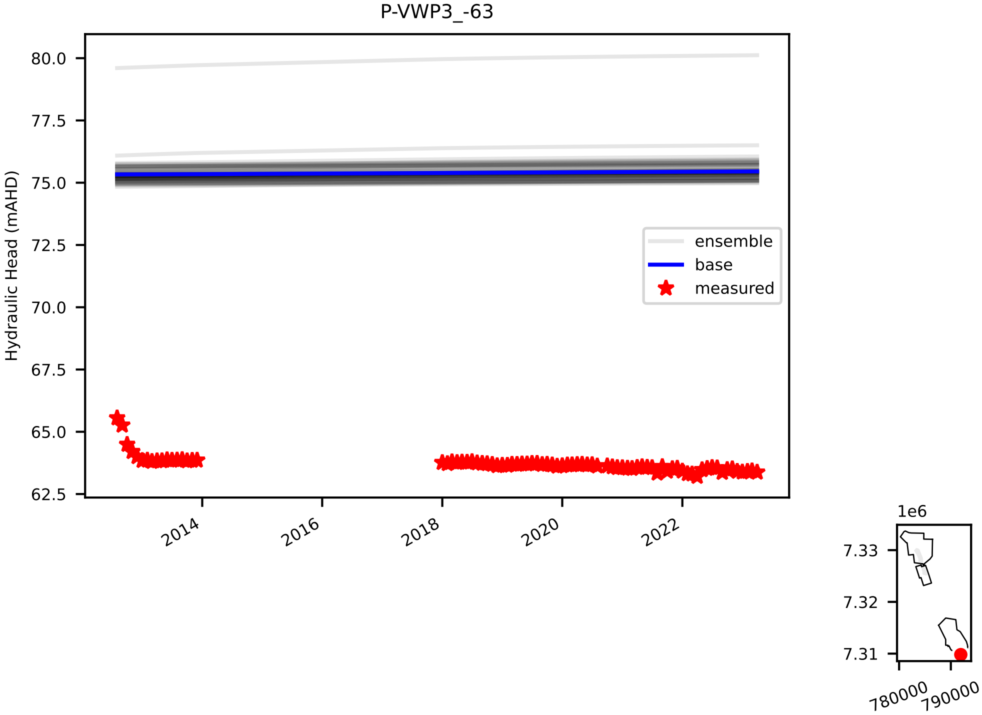
P-VWP2_-95
Hydraulic Head (mAHD)
75
70
65
60
55
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

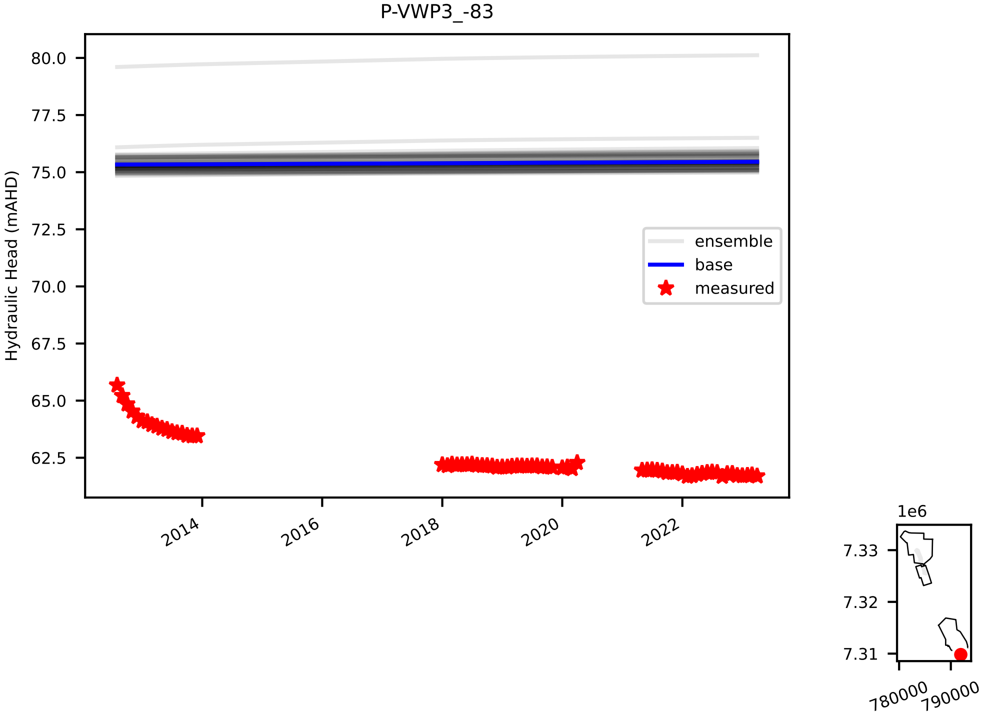


P-VWP2_-145
Hydraulic Head (mAHD)
72
70
68
66
64
2013
2014
2015
2016
2017
2018
2019
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

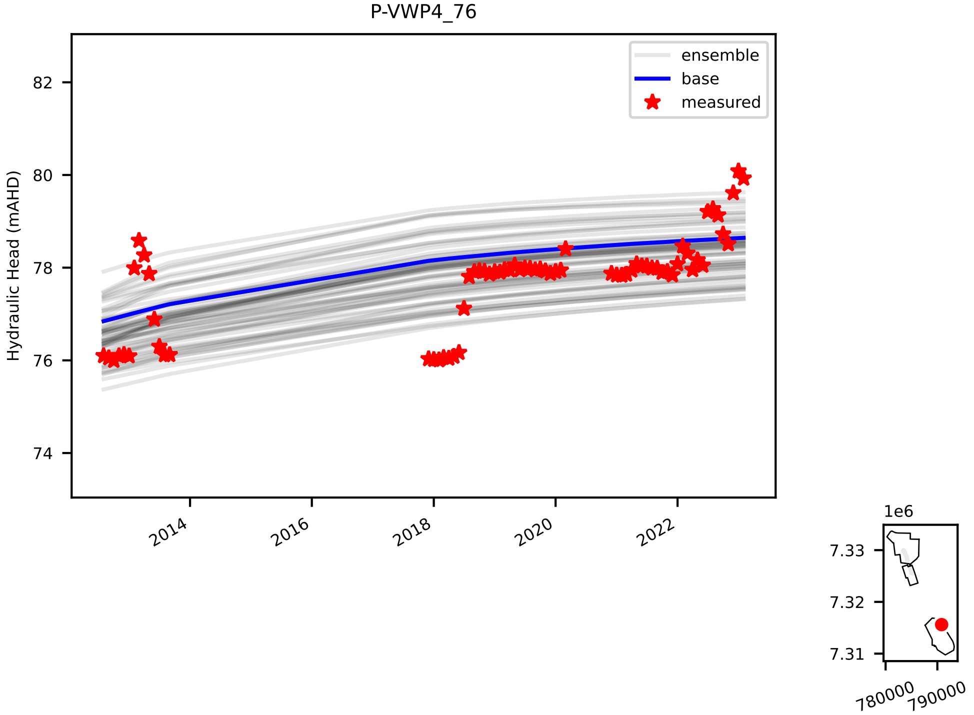


P-VWP3_36
Hydraulic Head (mAHD)
76
74
72
70
68
2013
2014
2015
2016
2017
2018
2019
2020
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

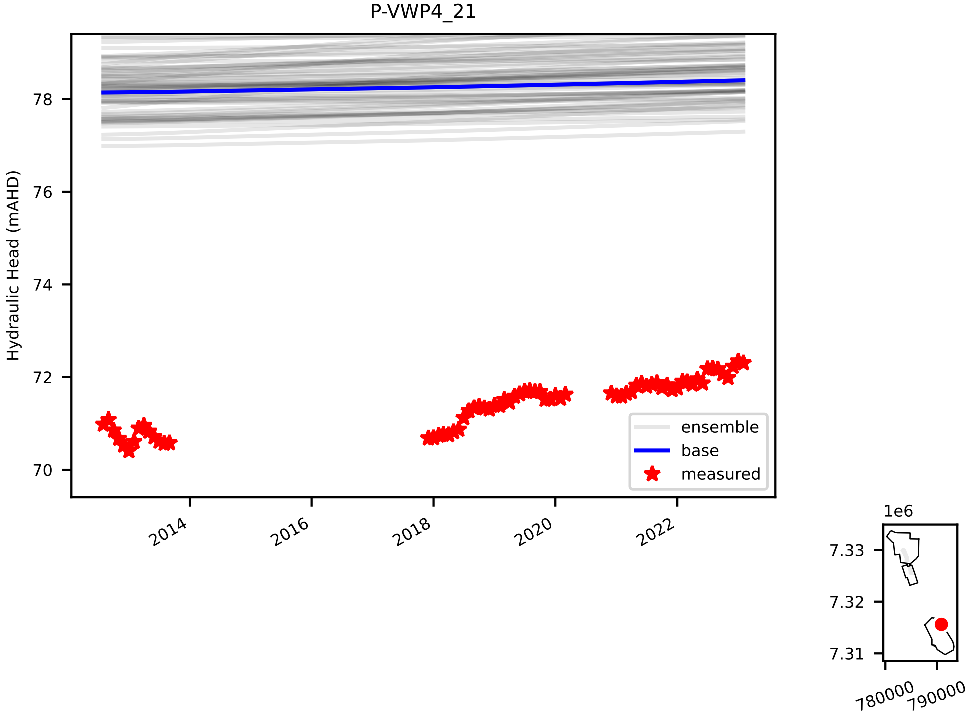

P-VWP3_-63
Hydraulic Head (mAHD)
80.0
77.5
75.0
72.5
70.0
67.5
65.0
62.5
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000



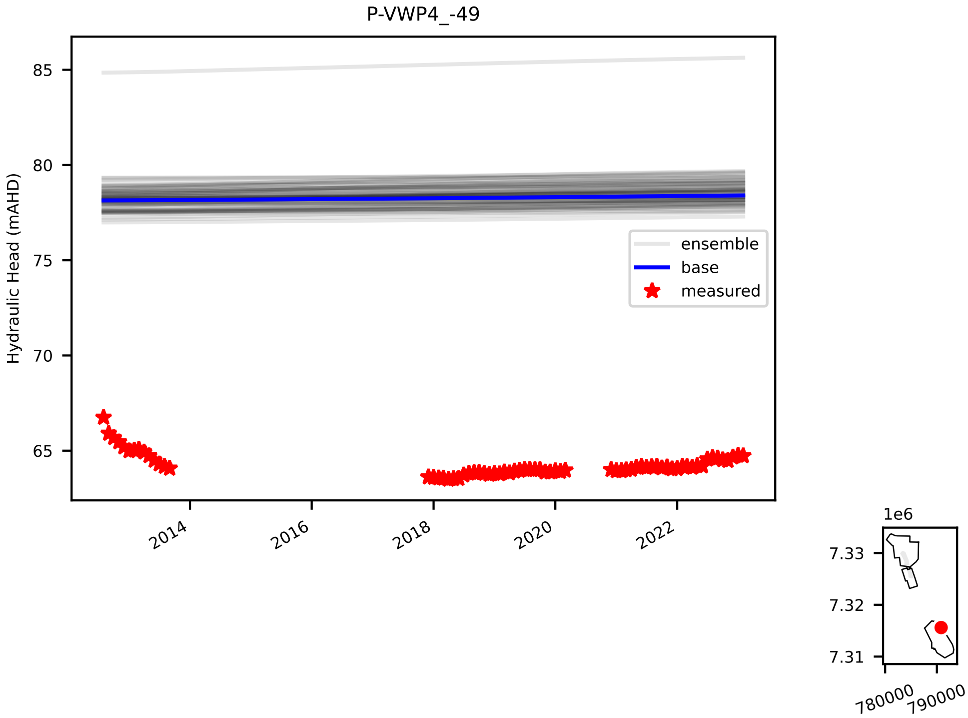
P-VWP3_-83
Hydraulic Head (mAHD)
80.0
77.5
75.0
72.5
70.0
67.5
65.0
62.5
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000



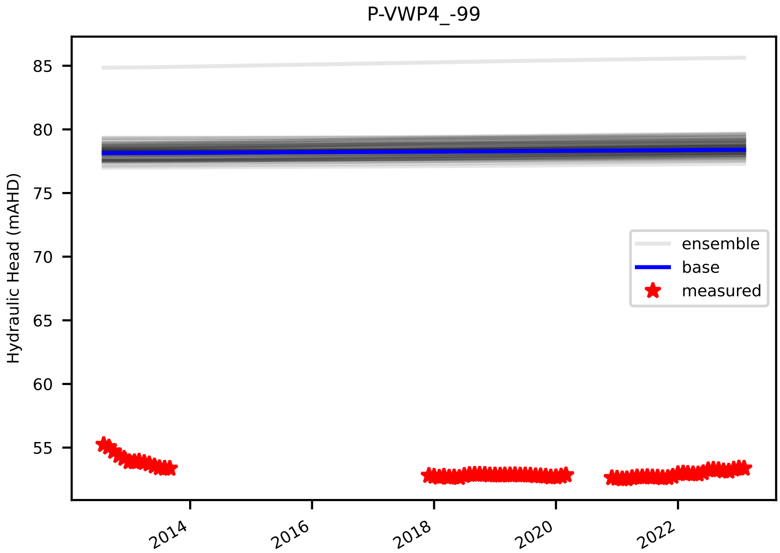
P-VWP4_76
Hydraulic Head (mAHD)
82
80
78
76
74
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000



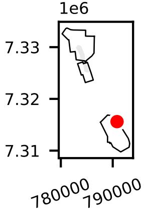
P-VWP4_21
Hydraulic Head (mAHD)
78
76
74
72
70
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000



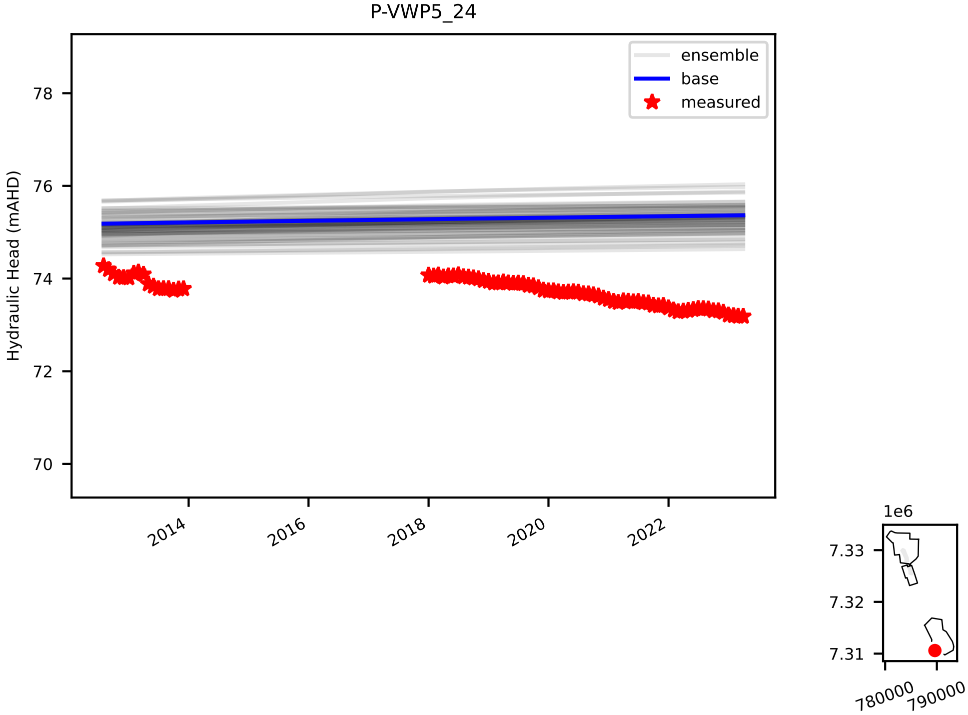
P-VWP4_-49
Hydraulic Head (mAHD)
85
80
75
70
65
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000



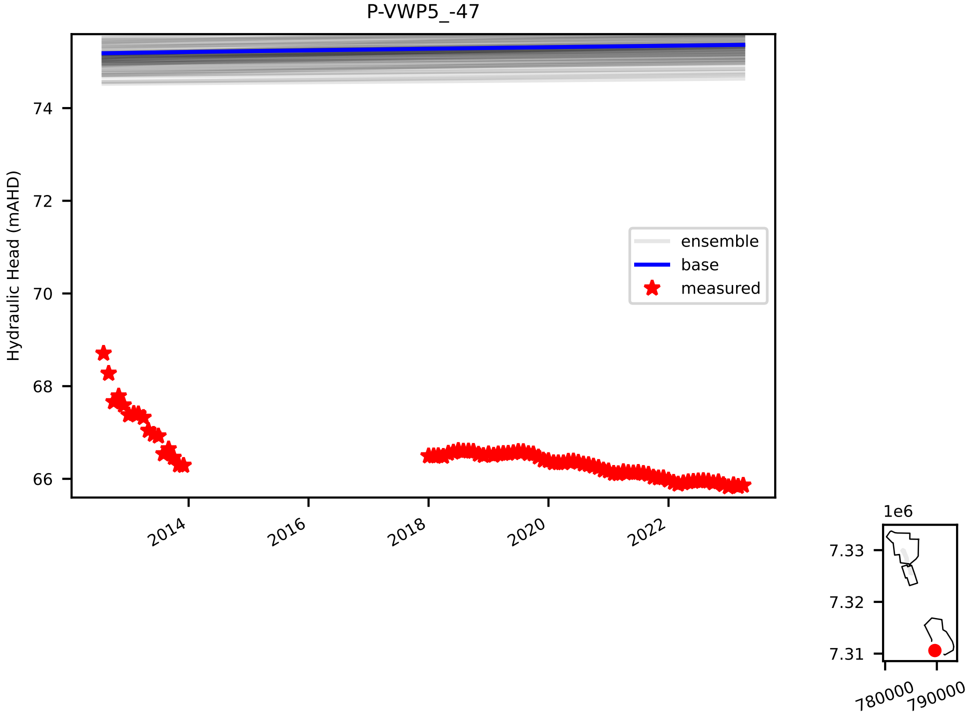
P-VWP4_-99
Hydraulic Head (mAHD)
85
80
75
70
65
60
55
2014
2016
2018
2020
2022
ensemble
base
measured

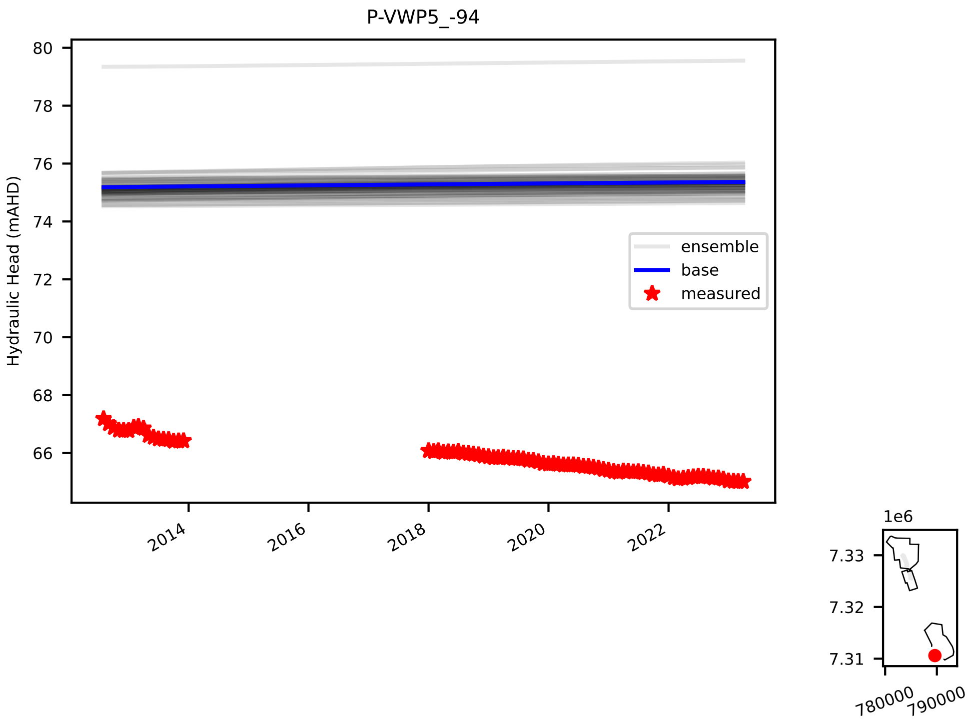


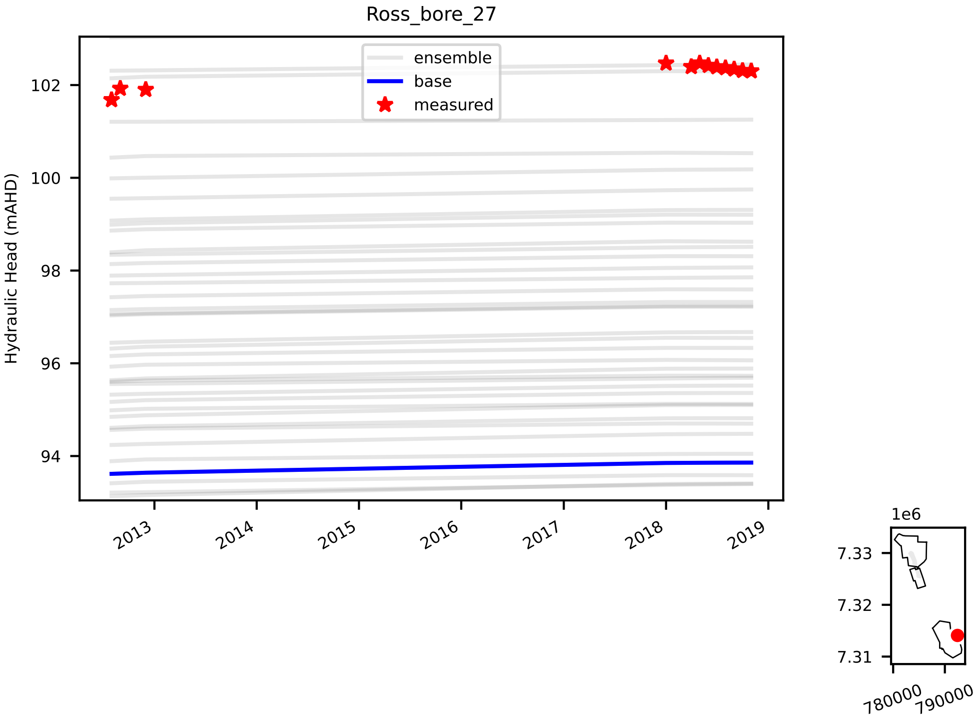
1e6
7.33
7.32
7.31
780000
790000



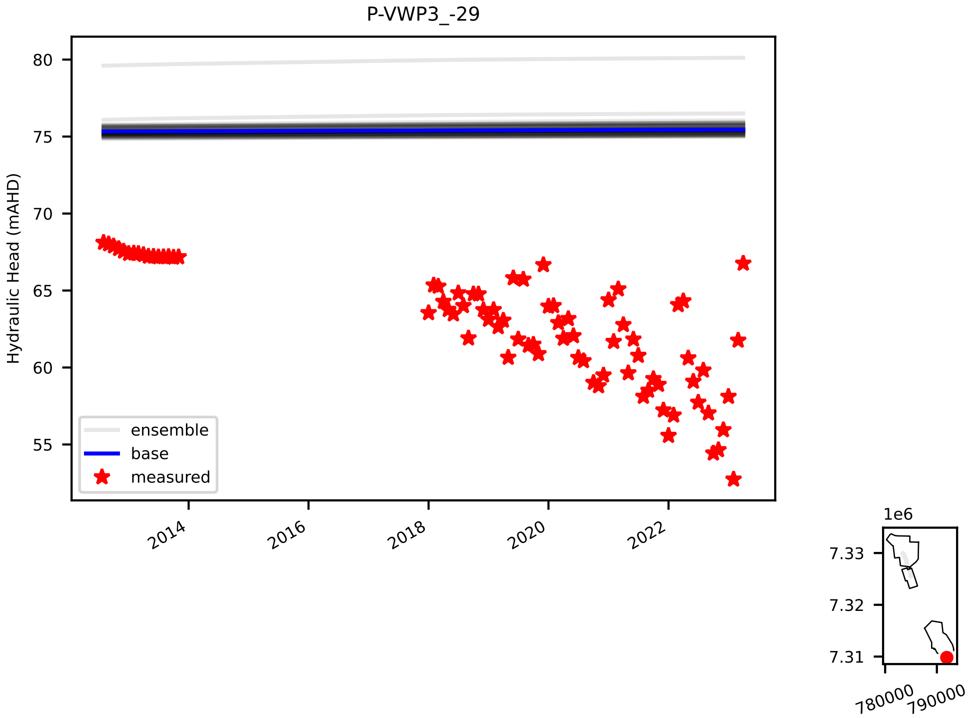
P-VWP5_24
ensemble
base
measured
Hydraulic Head (mAHD)
78
76
74
72
70
2014
2016
2018
2020
2022
1e6
7.33
7.32
7.31
780000
790000


P-VWP5_-47
Hydraulic Head (mAHD)
74
72
70
68
66
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

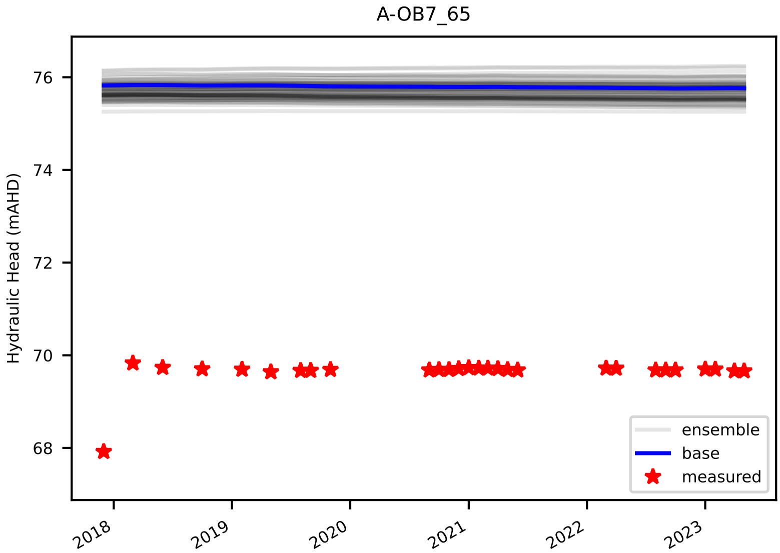

P-VWP5_-94
Hydraulic Head (mAHD)
80
78
76
74
72
70
68
66
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

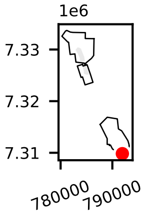


Ross_bore_27
ensemble
base
measured
Hydraulic Head (mAHD)
102
100
98
96
94
2013
2014
2015
2016
2017
2018
2019
1e6
7.33
7.32
7.31
780000
790000

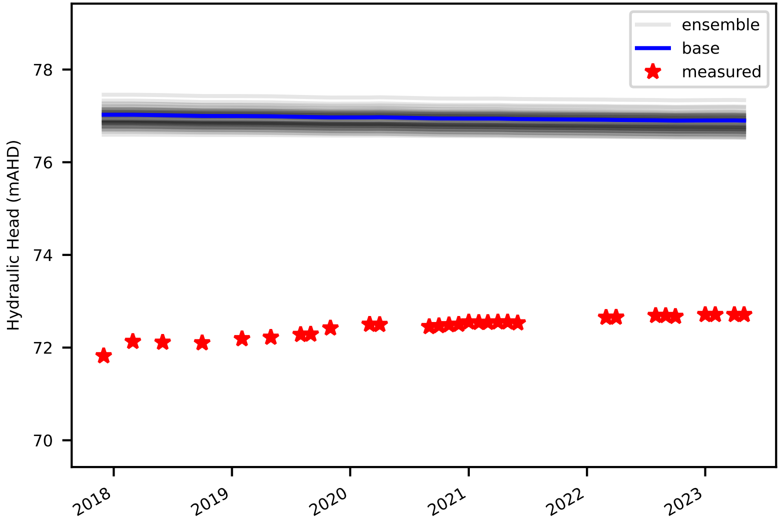


P-VWP3_-29
Hydraulic Head (mAHD)
80
75
70
65
60
55
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

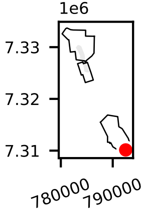

A-OB7_65
Hydraulic Head (mAHD)
76
74
72
70
68
2018
2019
2020
2021
2022
2023
ensemble
base
measured


1e6
7.33
7.32
7.31
780000
790000

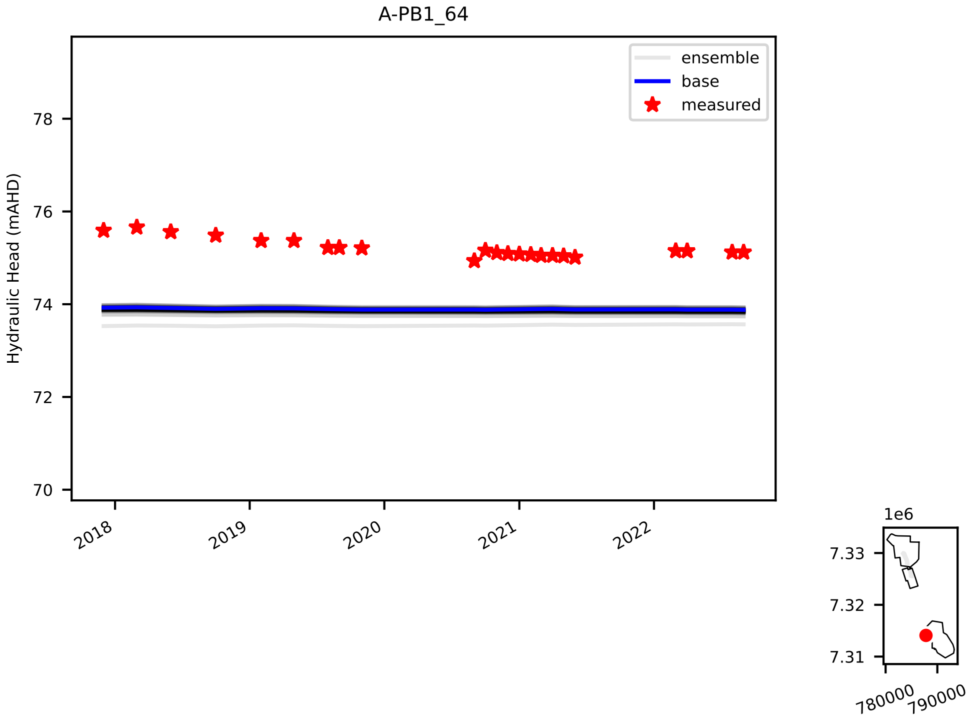
A-OB8_69

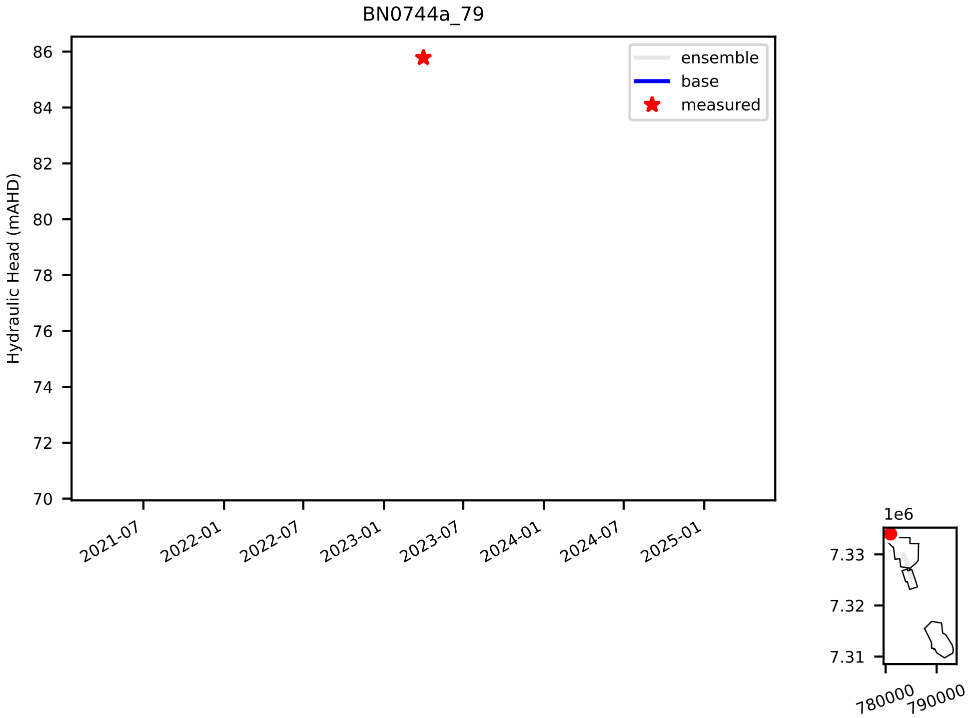


ensemble
base
measured
Hydraulic Head (mAHD)
78
76
74
72
70
2018
2019
2020
2021
2022
2023

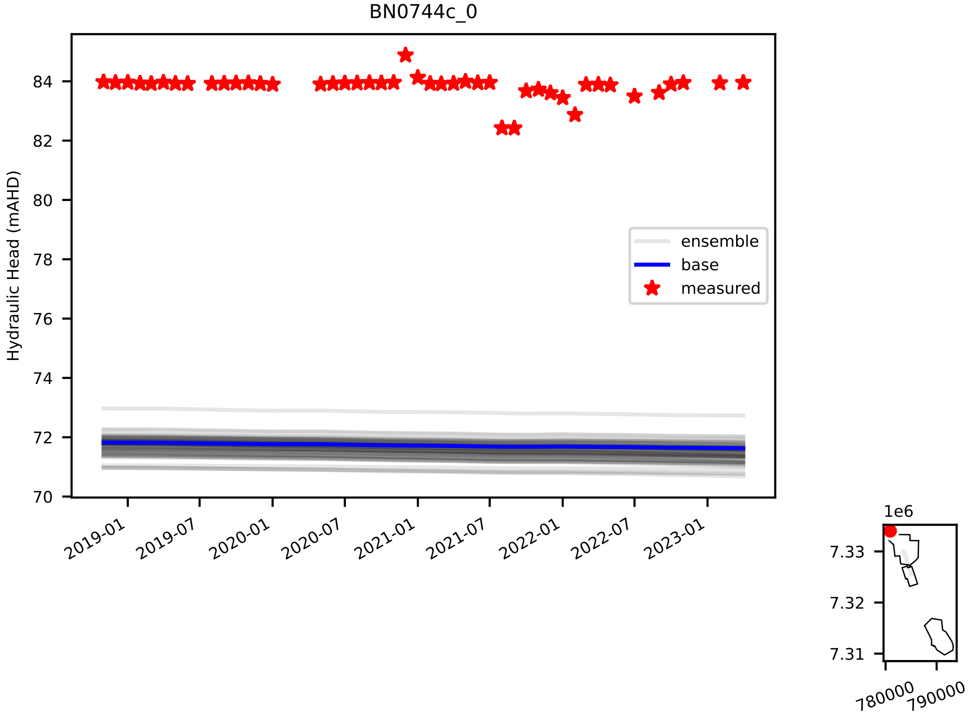


1e6
7.33
7.32
7.31
780000
790000

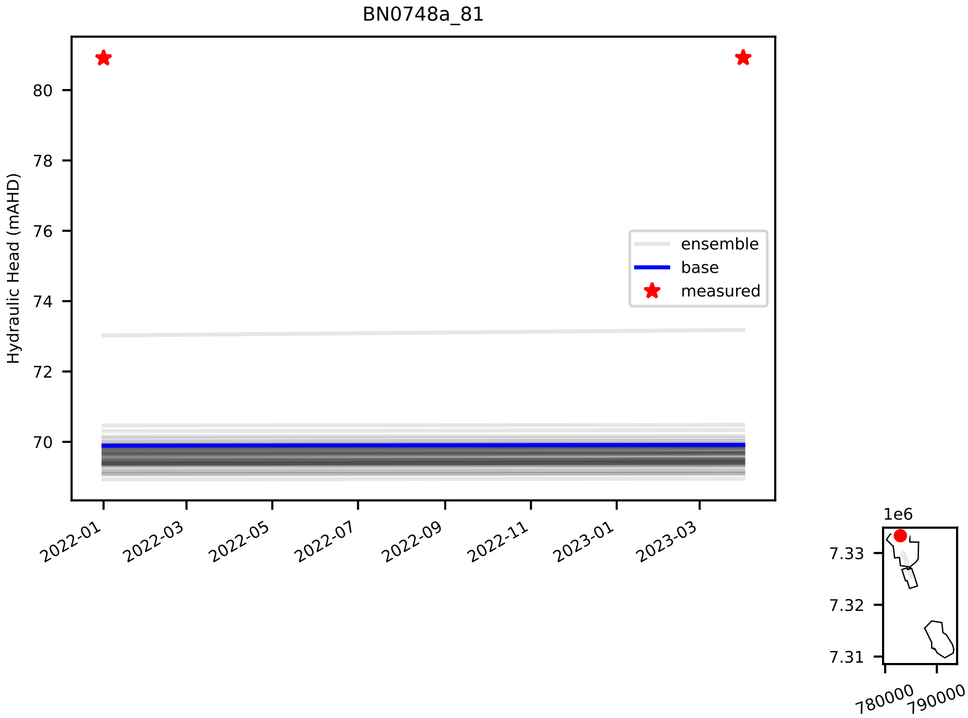

A-PB1_64
ensemble
base
measured
Hydraulic Head (mAHD)
78
76
74
72
70
2018
2019
2020
2021
2022
1e6
7.33
7.32
7.31
780000
790000



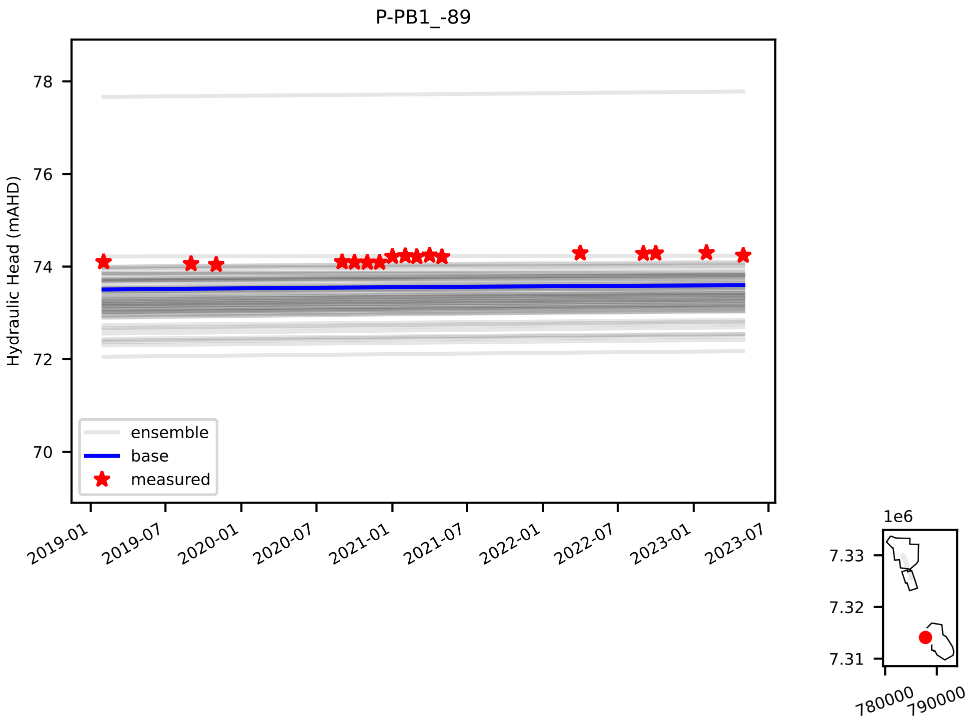
BN0744a_79
Hydraulic Head (mAHD)
86
84
82
80
78
76
74
72
70
2021-07
2022-01
2022-07
2023-01
2023-07
2024-01
2024-07
2025-01
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000



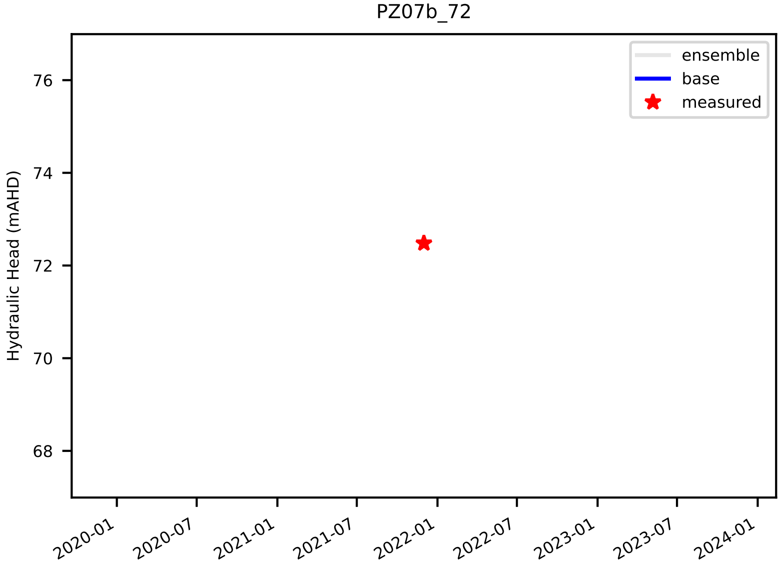
BN0744c_0
Hydraulic Head (mAHD)
84
82
80
78
76
74
72
70
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
2022-01
2022-07
2023-01
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

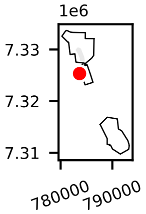


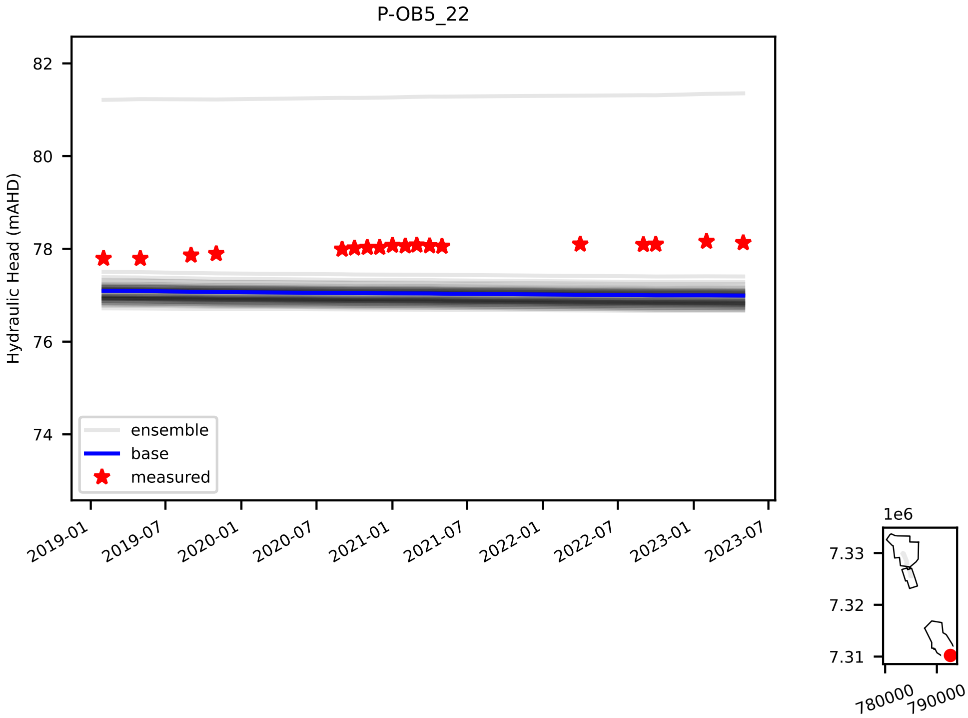
BN0748a_81
Hydraulic Head (mAHD)
80
78
76
74
72
70
ensemble
base
measured
2022-01
2022-03
2022-05
2022-07
2022-09
2022-11
2023-01
2023-03
1e6
7.33
7.32
7.31
780000
790000



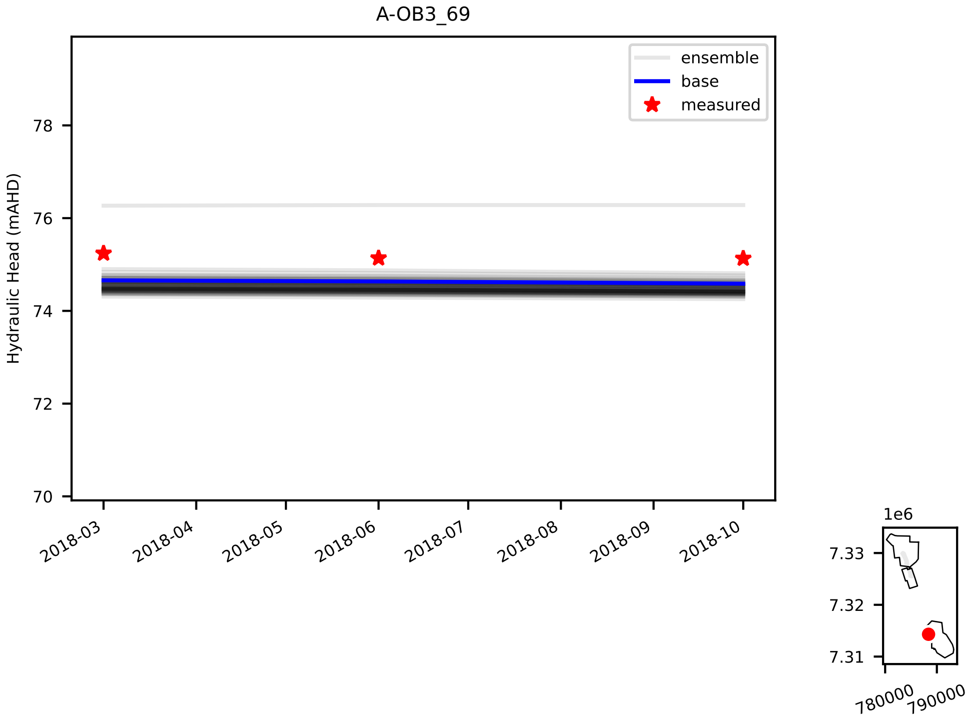
P-PB1_-89
Hydraulic Head (mAHD)
78
76
74
72
70
ensemble
base
measured
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
2022-01
2022-07
2023-01
2023-07
1e6
7.33
7.32
7.31
780000
790000


PZ07b_72
Hydraulic Head (mAHD)
76
74
72
70
68
2020-01
2020-07
2021-01
2021-07
2022-01
2022-07
2023-01
2023-07
2024-01
ensemble
base
measured

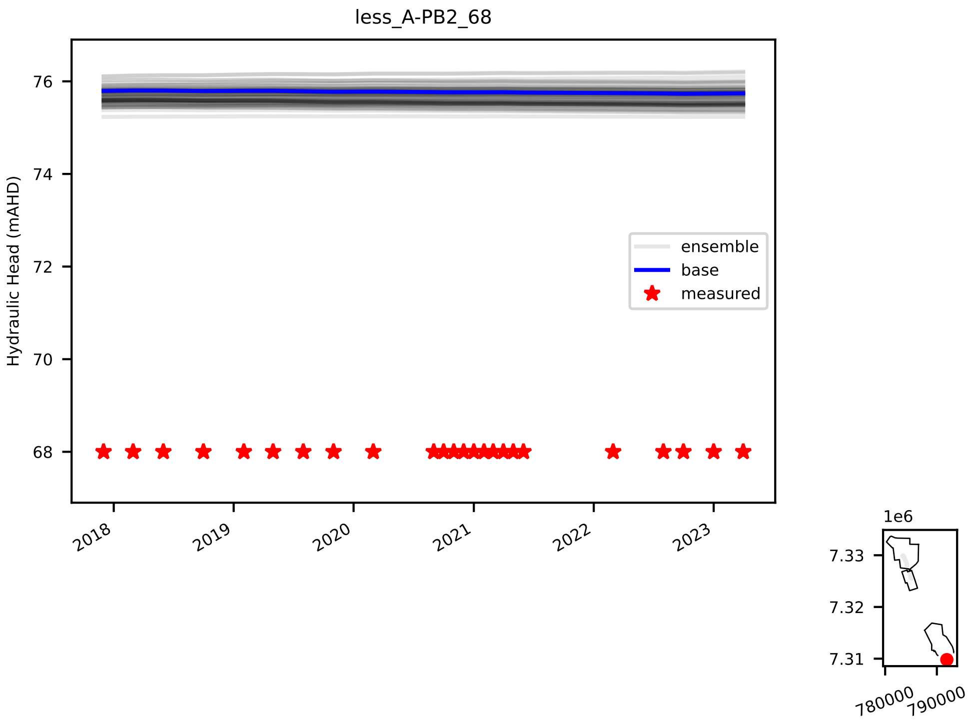

1e6
7.33
7.32
7.31
780000
790000



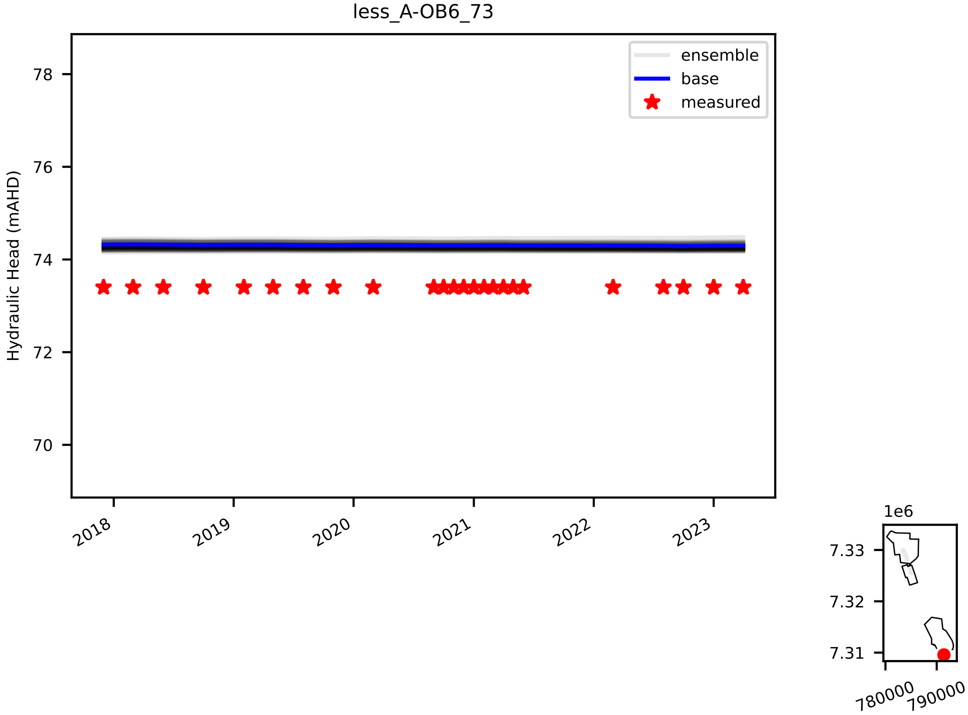
P-OB5_22
Hydraulic Head (mAHD)
82
80
78
76
74
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
2022-01
2022-07
2023-01
2023-07
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000



A-OB3_69
ensemble
base
measured
Hydraulic Head (mAHD)
78
76
74
72
70
2018-03
2018-04
2018-05
2018-06
2018-07
2018-08
2018-09
2018-10
1e6
7.33
7.32
7.31
780000
790000

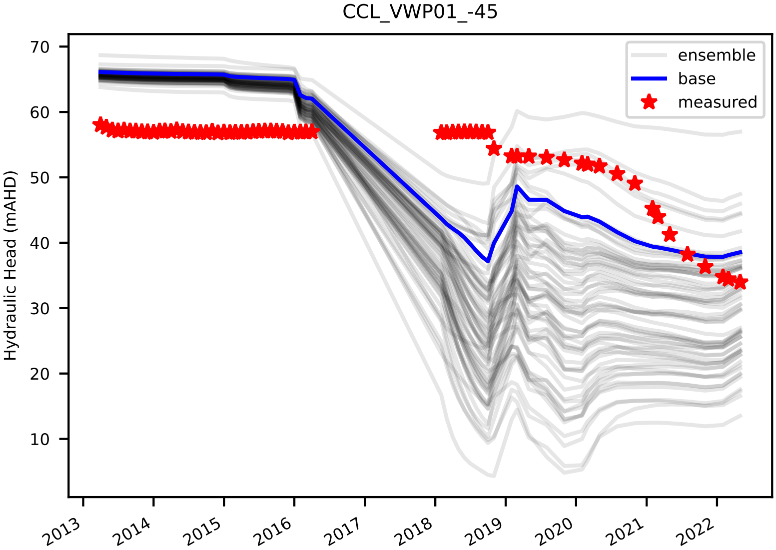


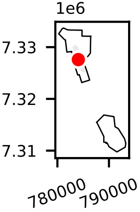
less_A-PB2_68
Hydraulic Head (mAHD)
76
74
72
70
68
2018
2019
2020
2021
2022
2023
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

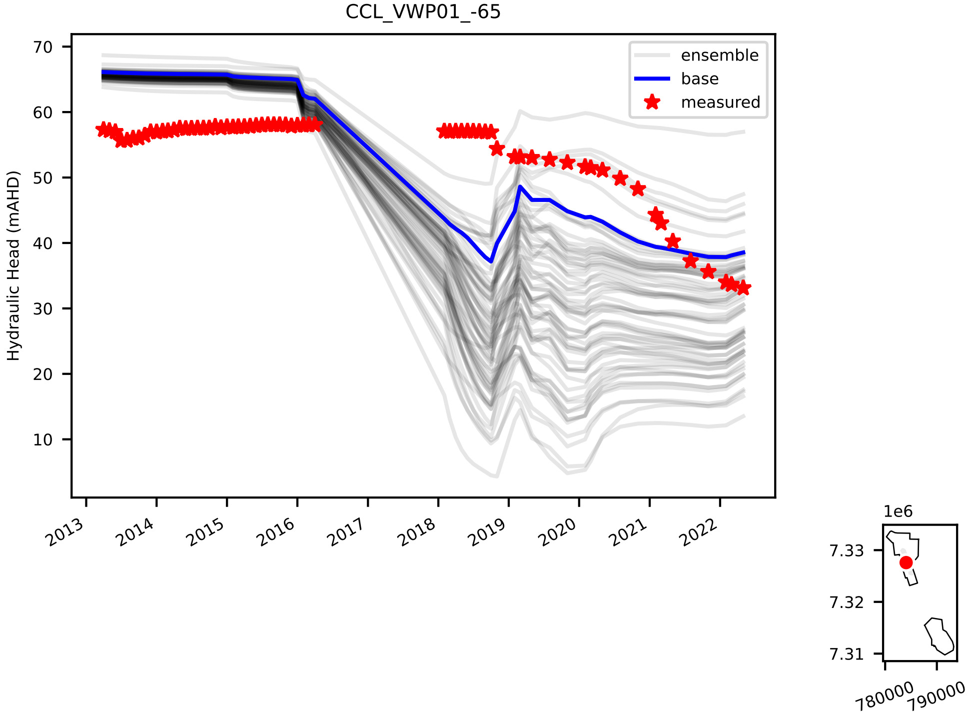


less_A-OB6_73
ensemble
base
measured
Hydraulic Head (mAHD)
78
76
74
72
70
2018
2019
2020
2021
2022
2023
1e6
7.33
7.32
7.31
780000
790000

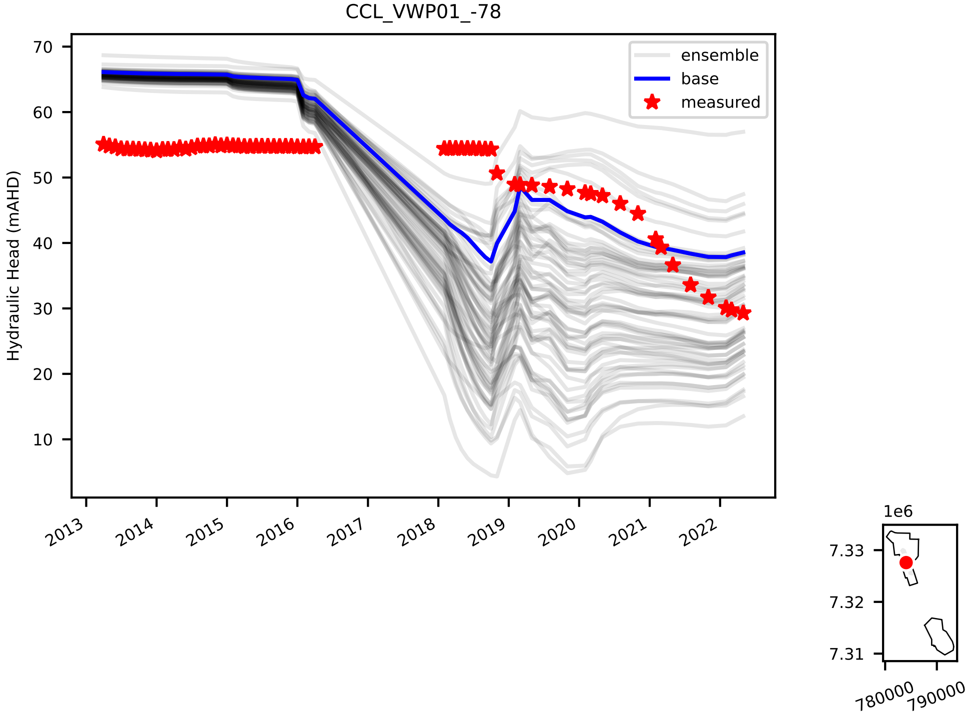
F2: Calibration hydrographs for bores at BNM


CCL_VWP01_-45
Hydraulic Head (mAHD)
70
60
50
40
30
20
10
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
ensemble
base
measured

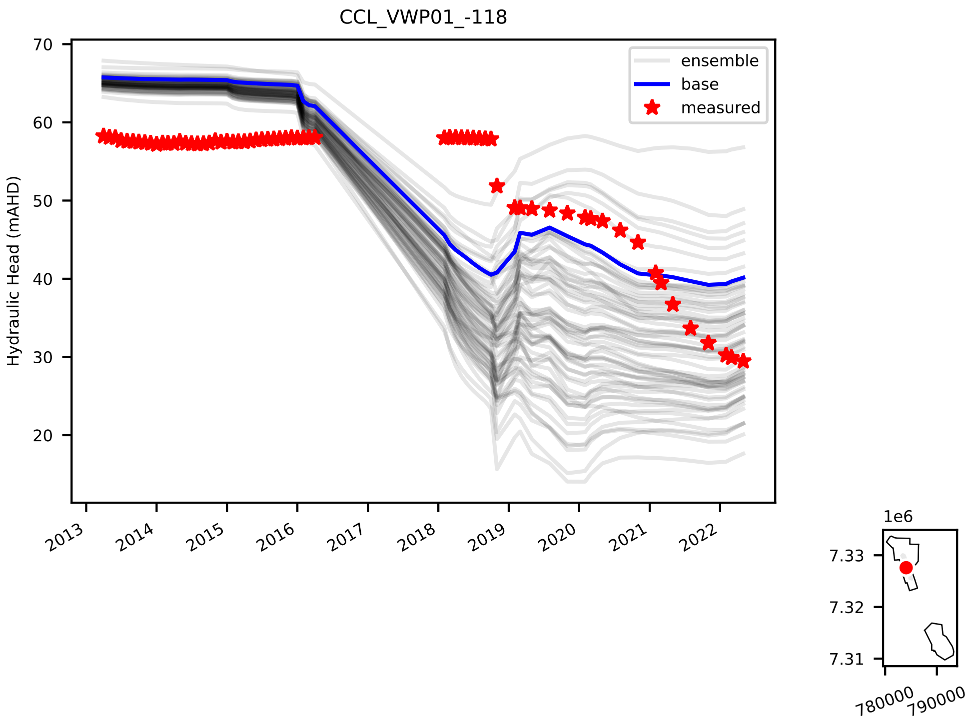

1e6
7.33
7.32
7.31
780000
790000

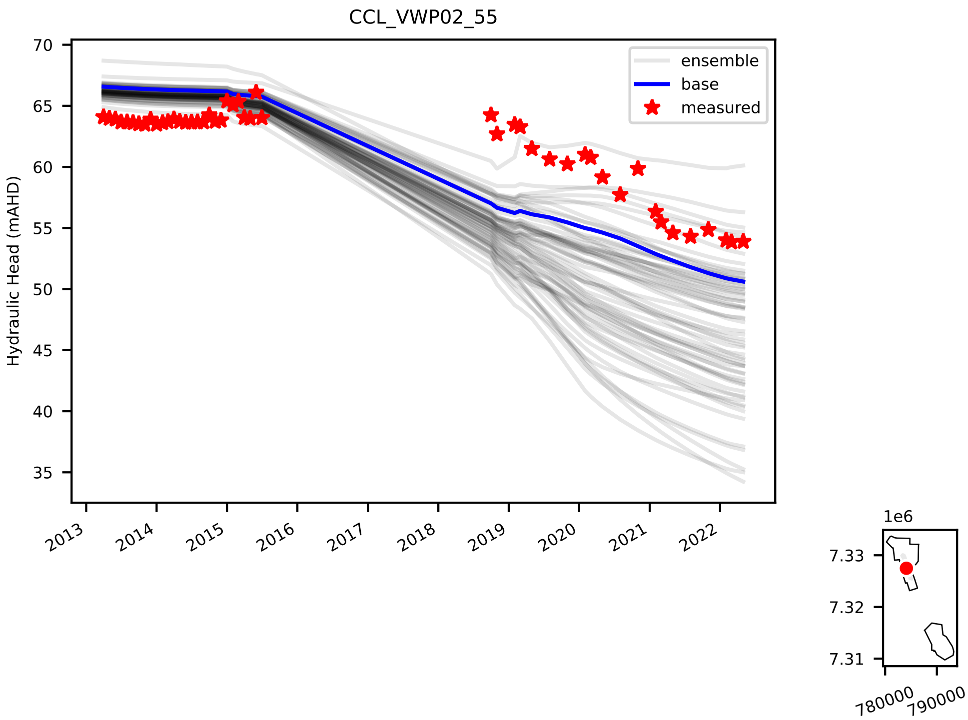


CCL_VWP01_-65
Hydraulic Head (mAHD)
70
60
50
40
30
20
10
ensemble
base
measured
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
1e6
7.33
7.32
7.31
780000
790000

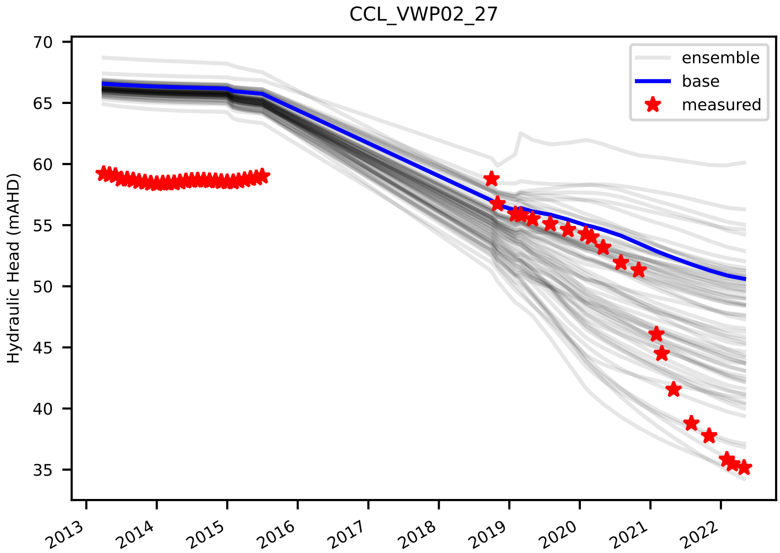


CCL_VWP01_-78
Hydraulic Head (mAHD)
70
60
50
40
30
20
10
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

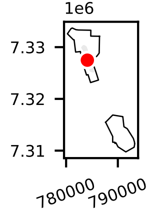

CCL_VWP01_-118
Hydraulic Head (mAHD)
70
60
50
40
30
20
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000



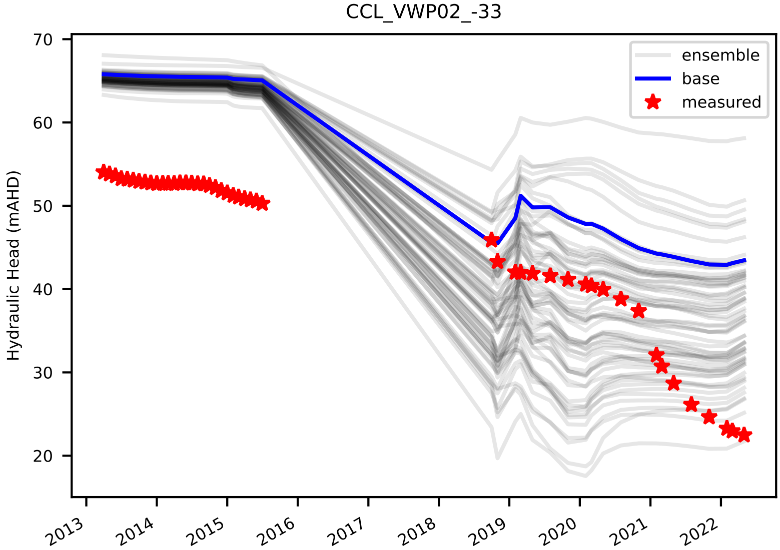
CCL_VWP02_55
Hydraulic Head (mAHD)
70
65
60
55
50
45
40
35
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

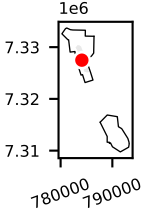


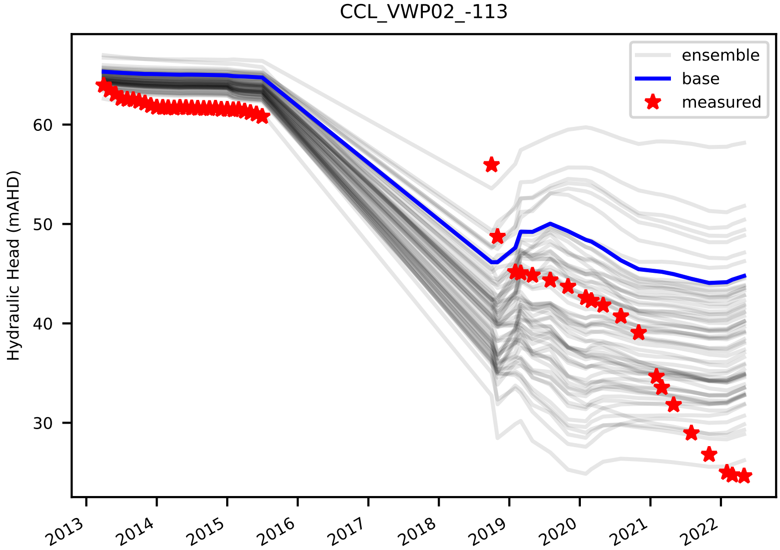
CCL_VWP02_27
Hydraulic Head (mAHD)
70
65
60
55
50
45
40
35
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
ensemble
base
measured

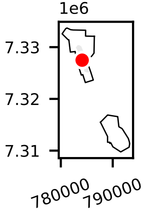


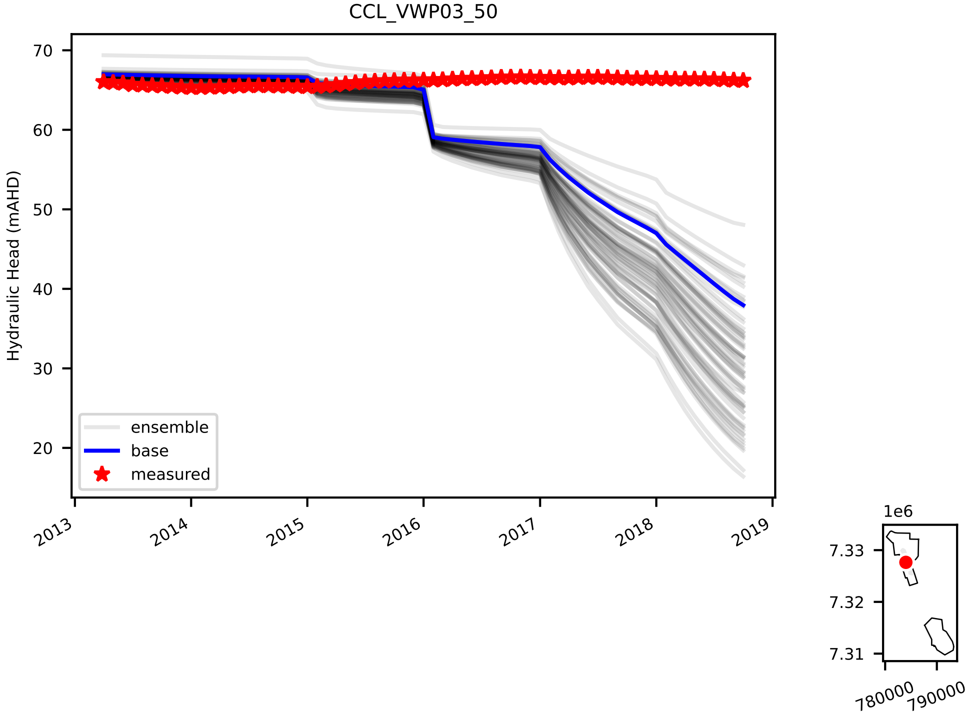
1e6
7.33
7.32
7.31
780000
790000


CCL_VWP02_-33
Hydraulic Head (mAHD)
70
60
50
40
30
20
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
ensemble
base
measured

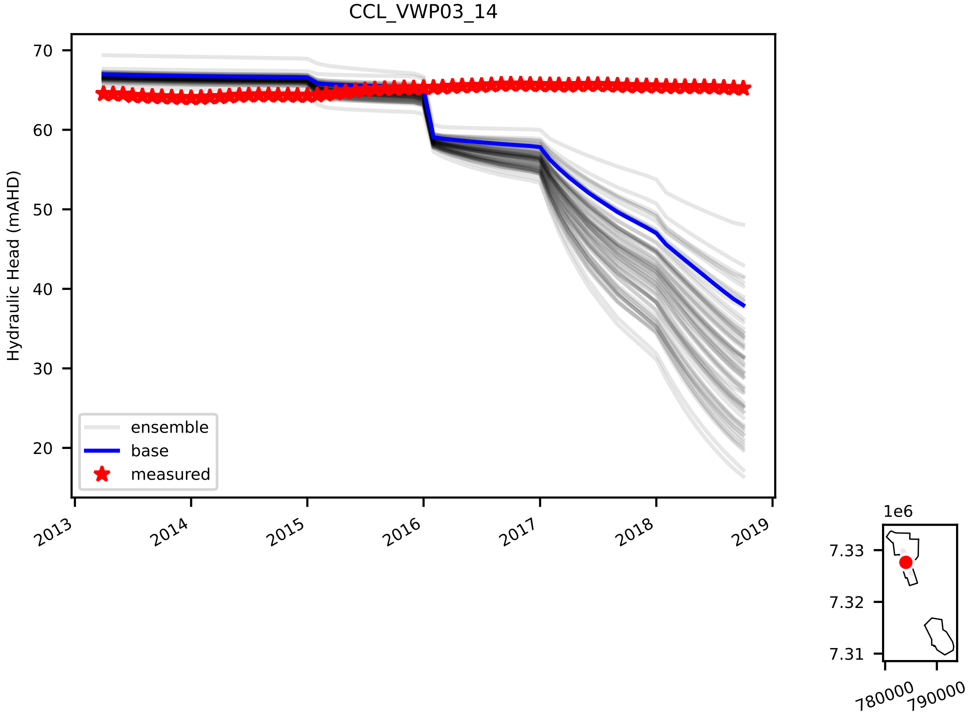

1e6
7.33
7.32
7.31
780000
790000

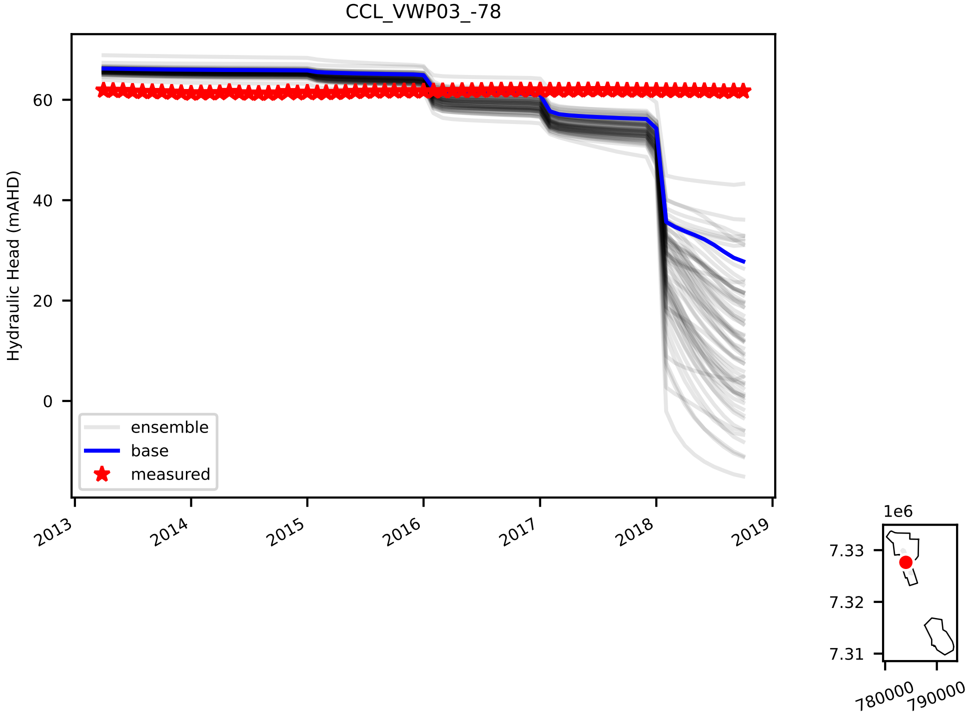

CCL_VWP02_-113
Hydraulic Head (mAHD)
60
50
40
30
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
ensemble
base
measured

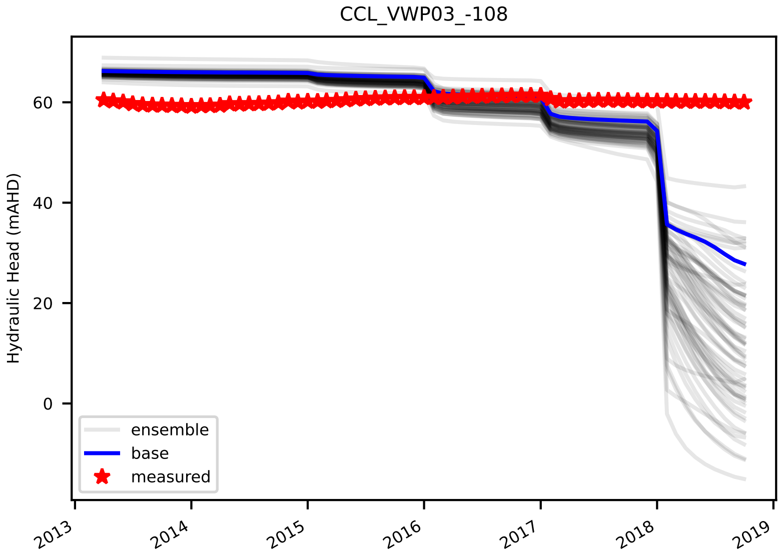

1e6
7.33
7.32
7.31
780000
790000



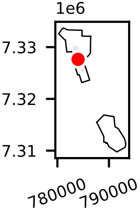
CCL_VWP03_50
Hydraulic Head (mAHD)
70
60
50
40
30
20
ensemble
base
measured
2013
2014
2015
2016
2017
2018
2019
1e6
7.33
7.32
7.31
780000
790000


CCL_VWP03_14
Hydraulic Head (mAHD)
70
60
50
40
30
20
2013
2014
2015
2016
2017
2018
2019
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

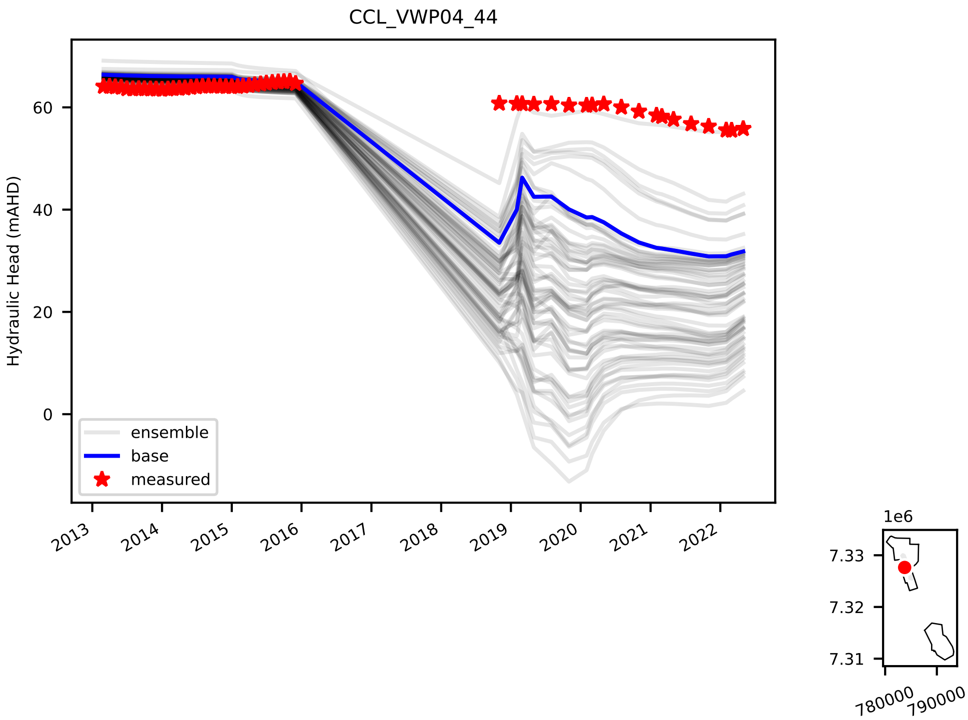

CCL_VWP03_-78
Hydraulic Head (mAHD)
60
40
20
0
ensemble
base
measured
2013
2014
2015
2016
2017
2018
2019
1e6
7.33
7.32
7.31
780000
790000

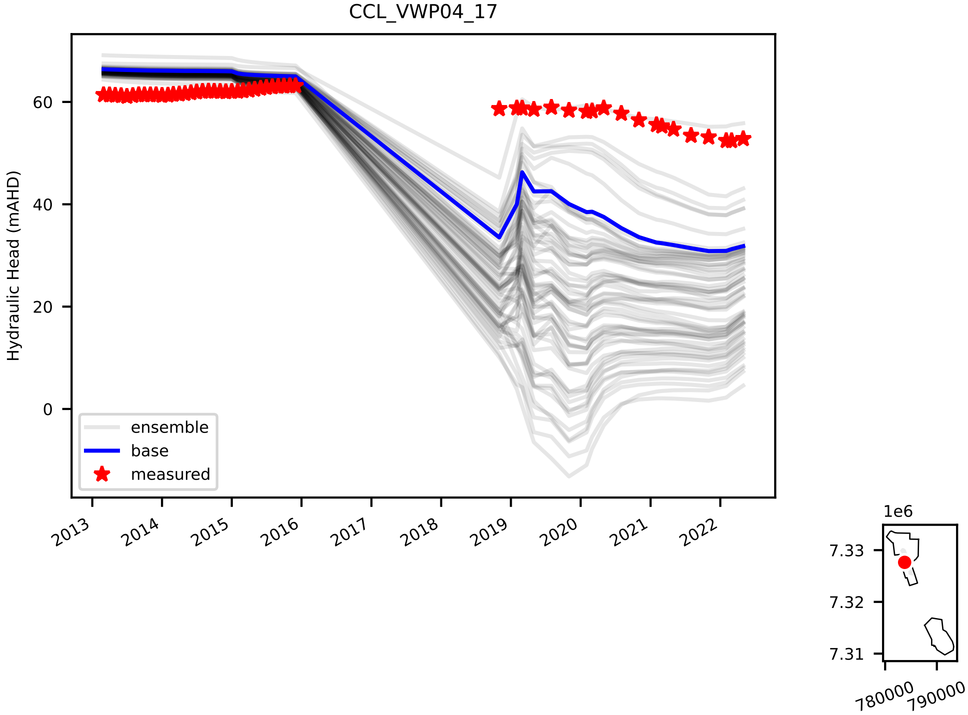


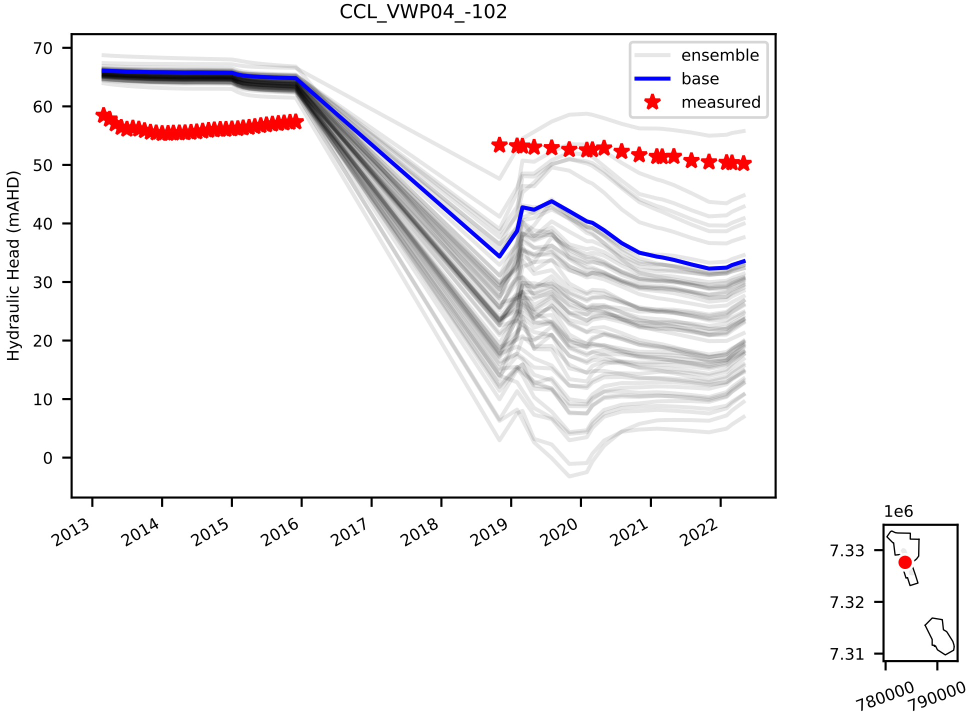
CCL_VWP03_-108
Hydraulic Head (mAHD)
60
40
20
0
ensemble
base
measured
2013
2014
2015
2016
2017
2018
2019



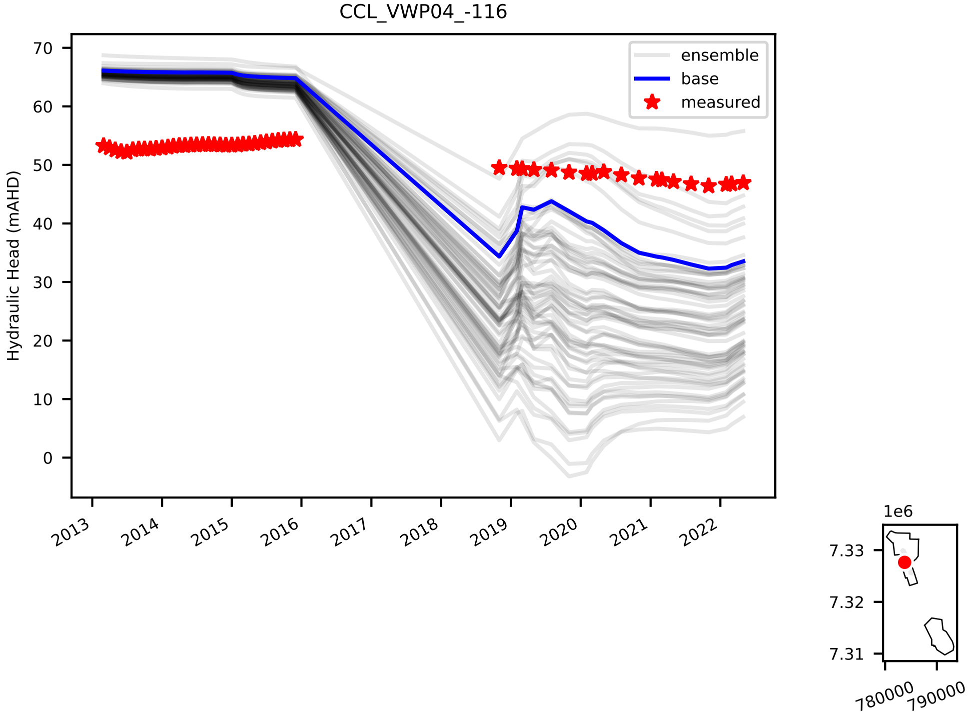
1e6
7.33
7.32
7.31
780000
790000


CCL_VWP04_44
Hydraulic Head (mAHD)
60
40
20
0
ensemble
base
measured
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
1e6
7.33
7.32
7.31
780000
790000

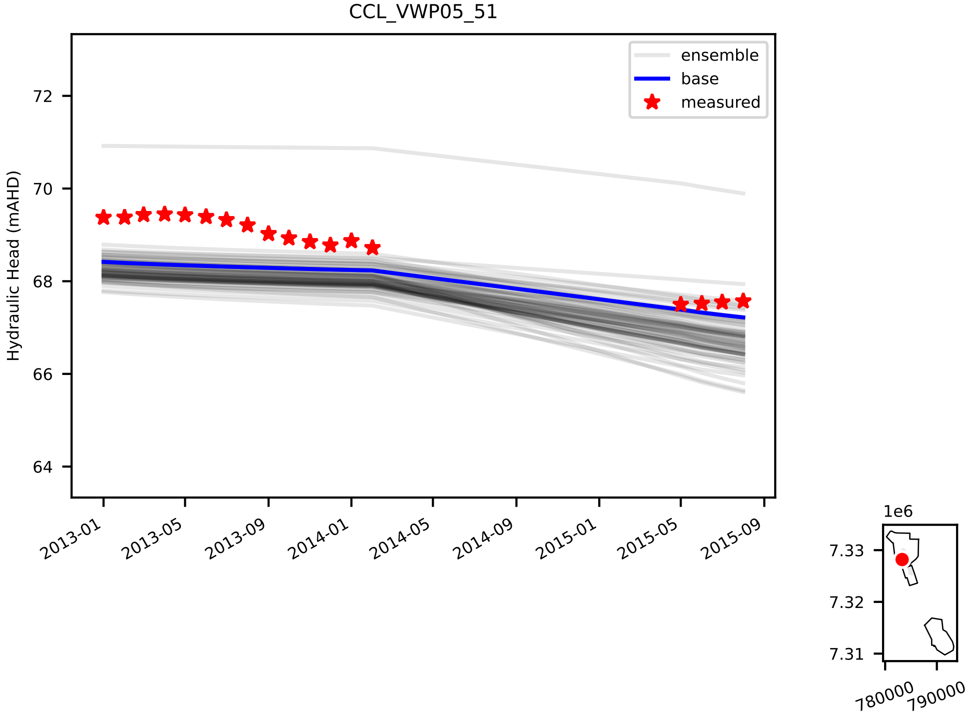

CCL_VWP04_17
Hydraulic Head (mAHD)
60
40
20
0
ensemble
base
measured
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
1e6
7.33
7.32
7.31
780000
790000



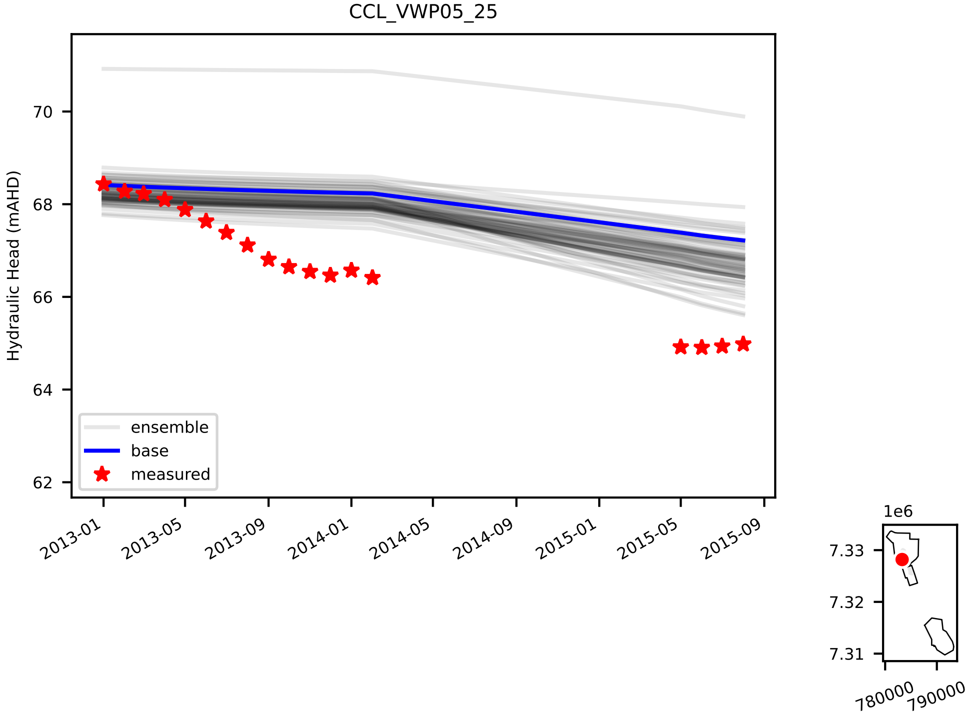
CCL_VWP04_-102
Hydraulic Head (mAHD)
70
60
50
40
30
20
10
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

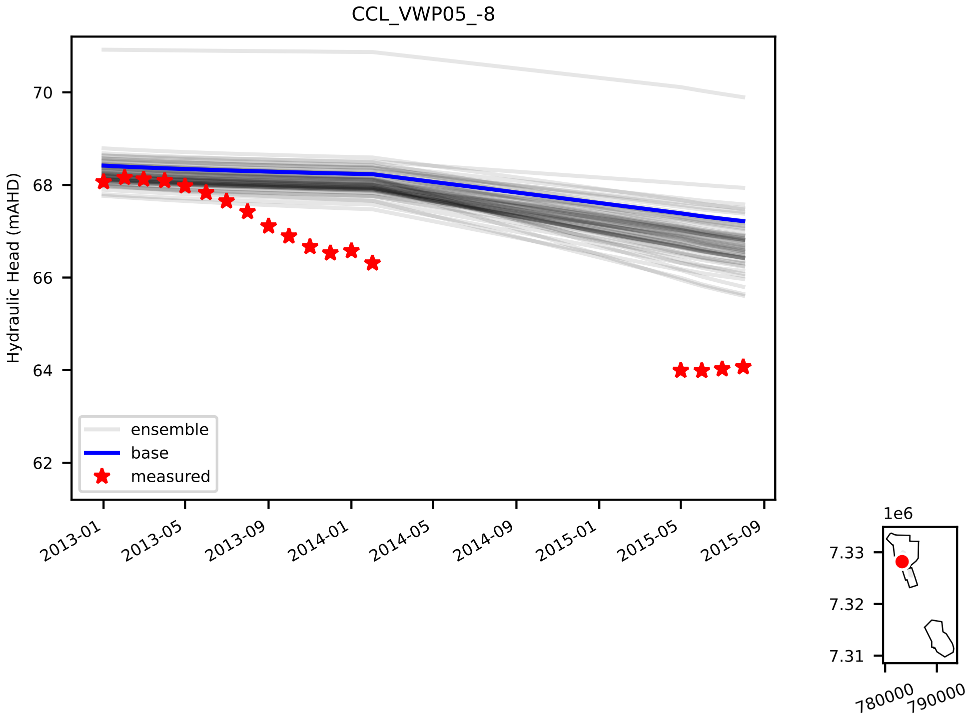


CCL_VWP04_-116
ensemble
base
measured
Hydraulic Head (mAHD)
70
60
50
40
30
20
10
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
1e6
7.33
7.32
7.31
780000
790000

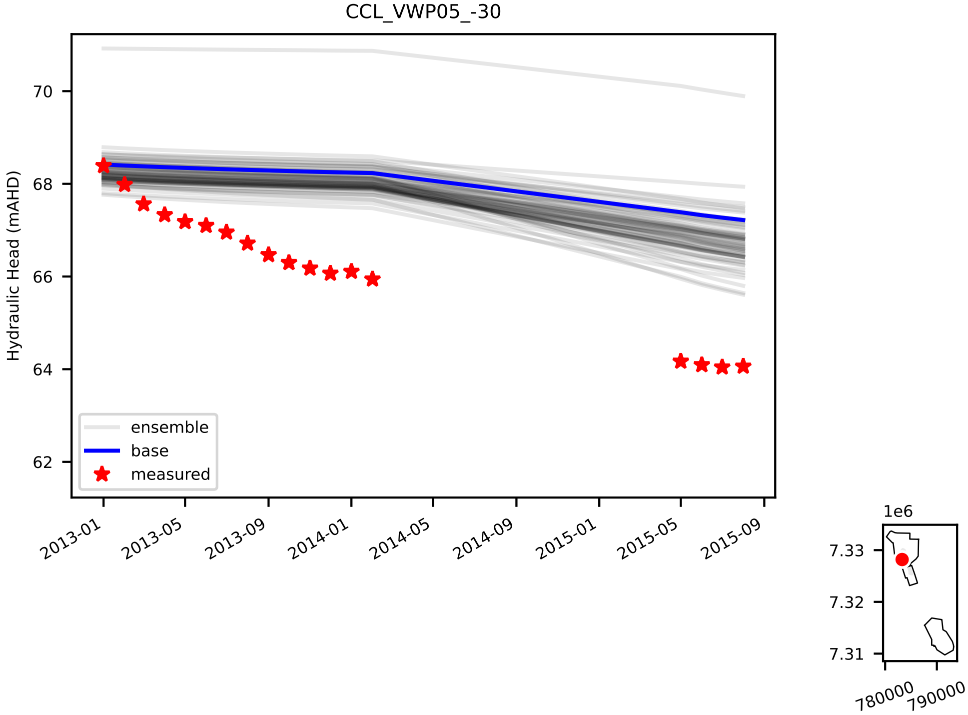


CCL_VWP05_51
ensemble
base
measured
Hydraulic Head (mAHD)
72
70
68
66
64
2013-01
2013-05
2013-09
2014-01
2014-05
2014-09
2015-01
2015-05
2015-09
1e6
7.33
7.32
7.31
780000
790000

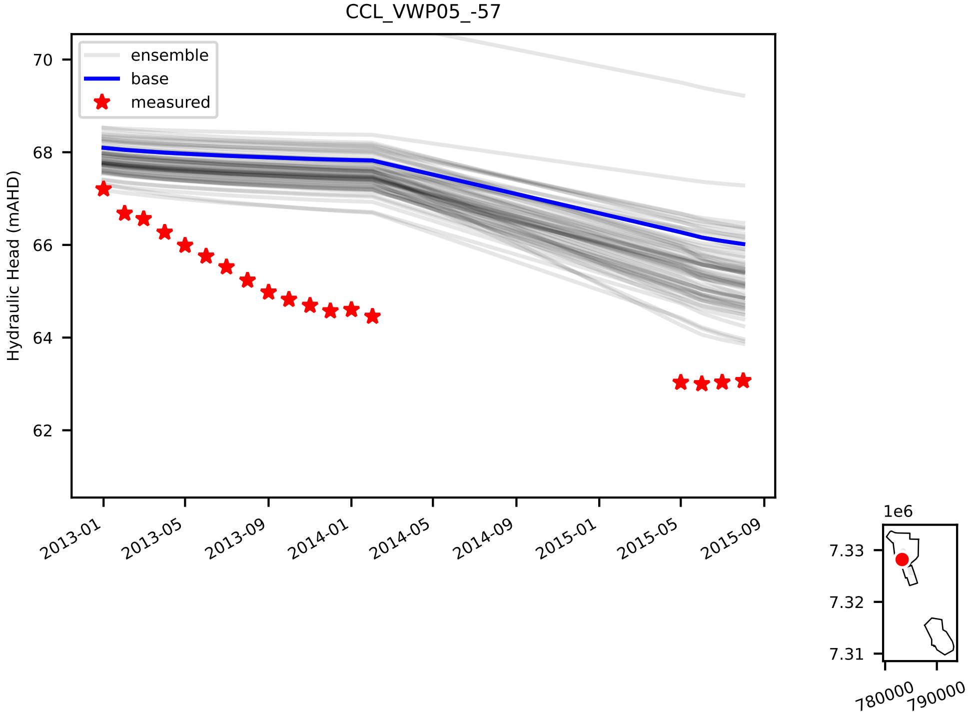

CCL_VWP05_25
Hydraulic Head (mAHD)
70
68
66
64
62
ensemble
base
measured
2013-01
2013-05
2013-09
2014-01
2014-05
2014-09
2015-01
2015-05
2015-09
1e6
7.33
7.32
7.31
780000
790000



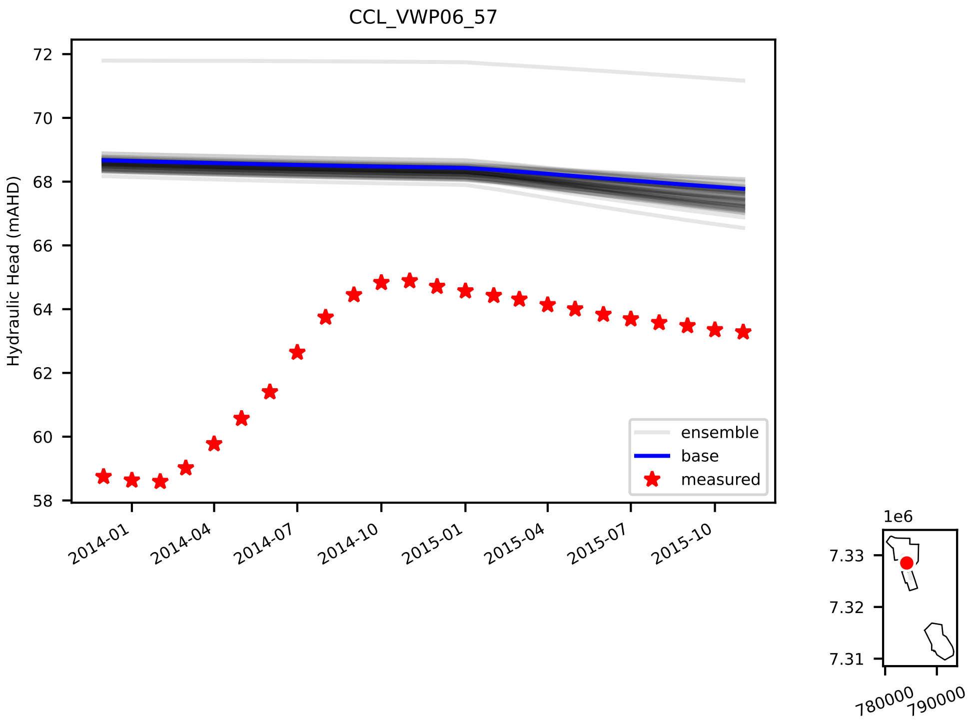
CCL_VWP05_-8
Hydraulic Head (mAHD)
70
68
66
64
62
ensemble
base
measured
2013-01
2013-05
2013-09
2014-01
2014-05
2014-09
2015-01
2015-05
2015-09
1e6
7.33
7.32
7.31
780000
790000

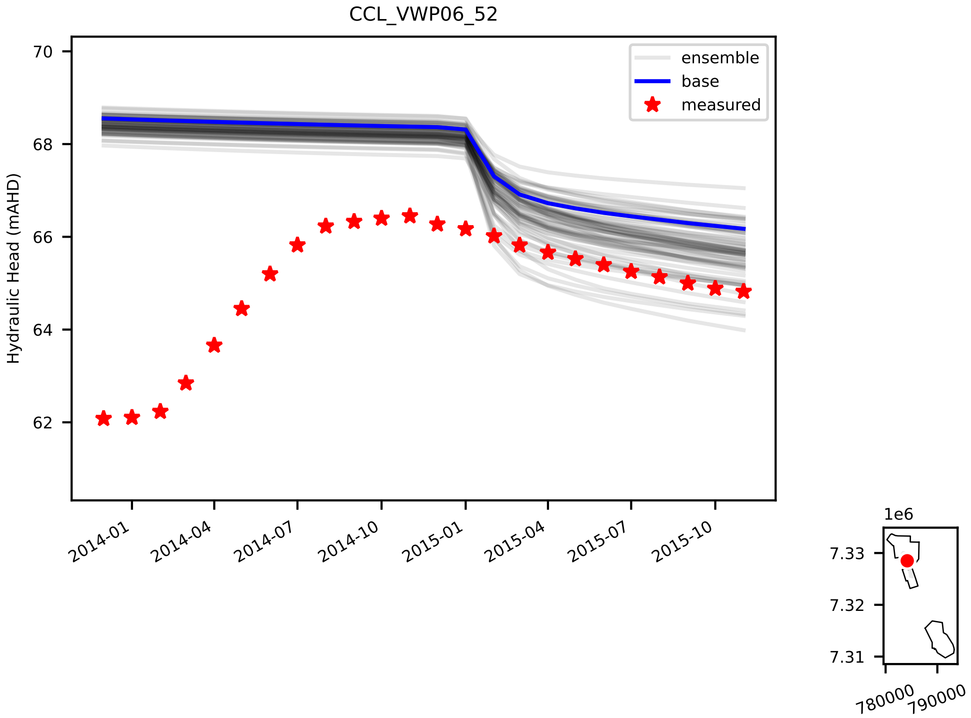


CCL_VWP05_-30
Hydraulic Head (mAHD)
70
68
66
64
62
2013-01
2013-05
2013-09
2014-01
2014-05
2014-09
2015-01
2015-05
2015-09
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

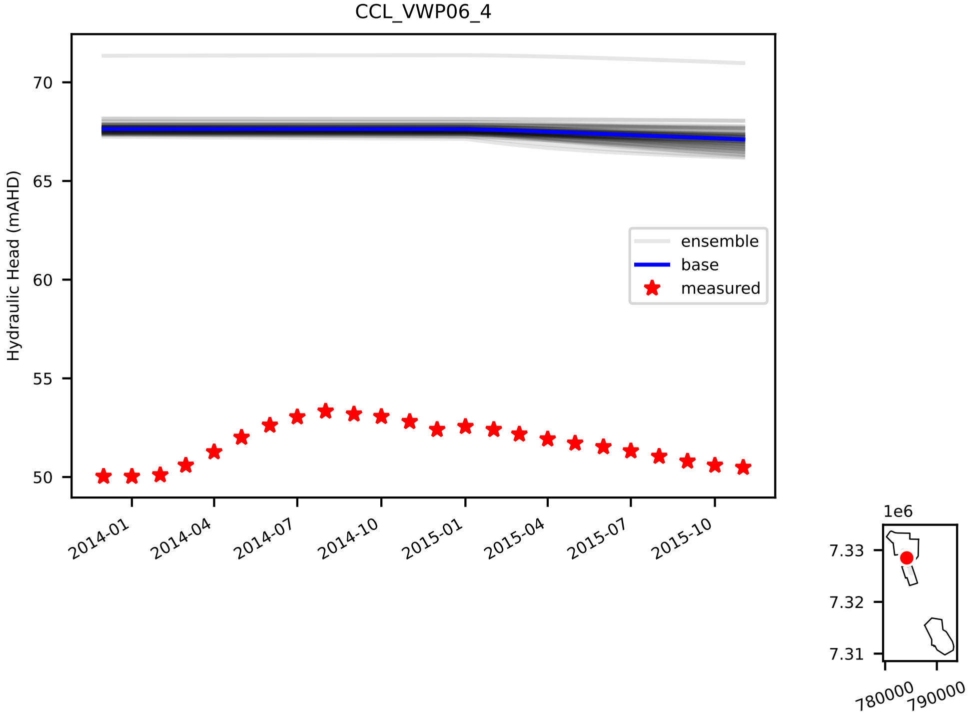


CCL_VWP05_-57
ensemble
base
measured
Hydraulic Head (mAHD)
70
68
66
64
62
2013-01
2013-05
2013-09
2014-01
2014-05
2014-09
2015-01
2015-05
2015-09
1e6
7.33
7.32
7.31
780000
790000

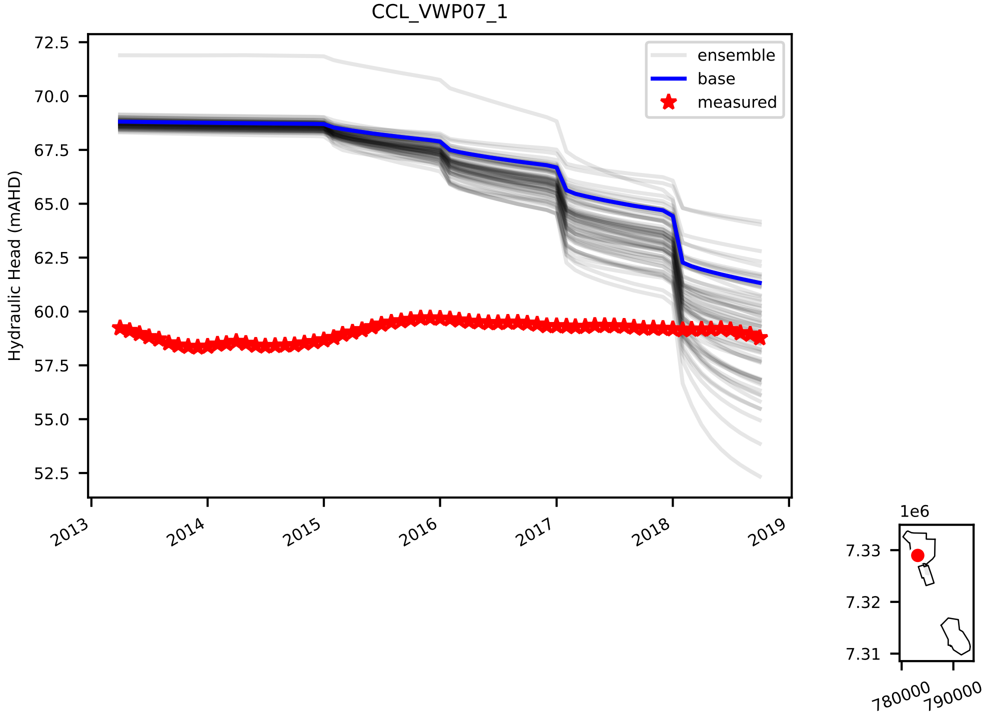

CCL_VWP06_57
Hydraulic Head (mAHD)
72
70
68
66
64
62
60
58
2014-01
2014-04
2014-07
2014-10
2015-01
2015-04
2015-07
2015-10
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000



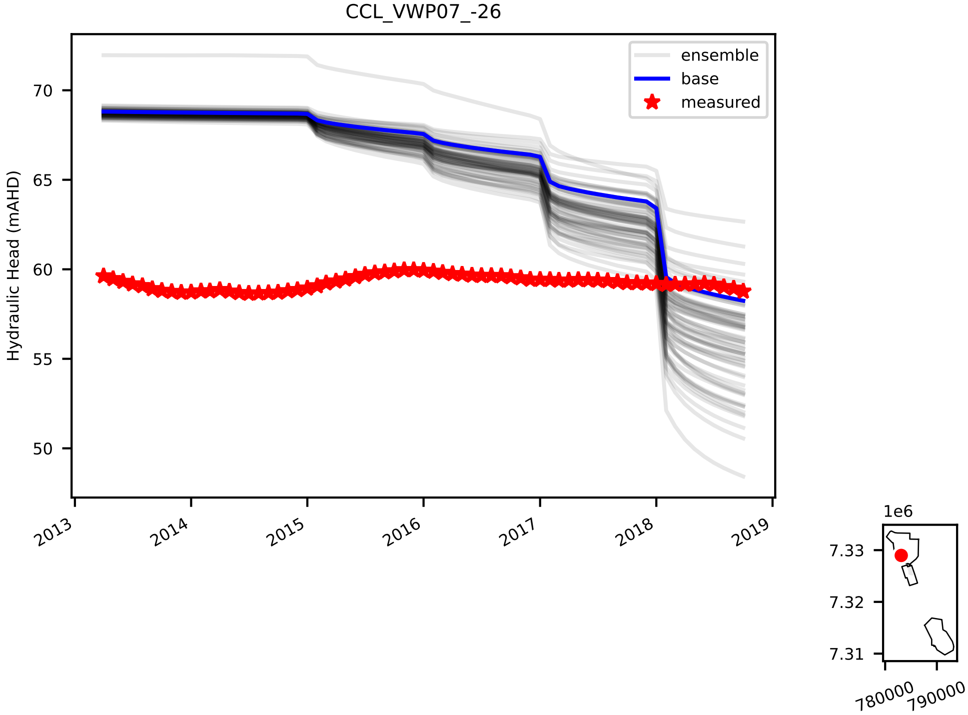
CCL_VWP06_52
Hydraulic Head (mAHD)
70
68
66
64
62
2014-01
2014-04
2014-07
2014-10
2015-01
2015-04
2015-07
2015-10
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000



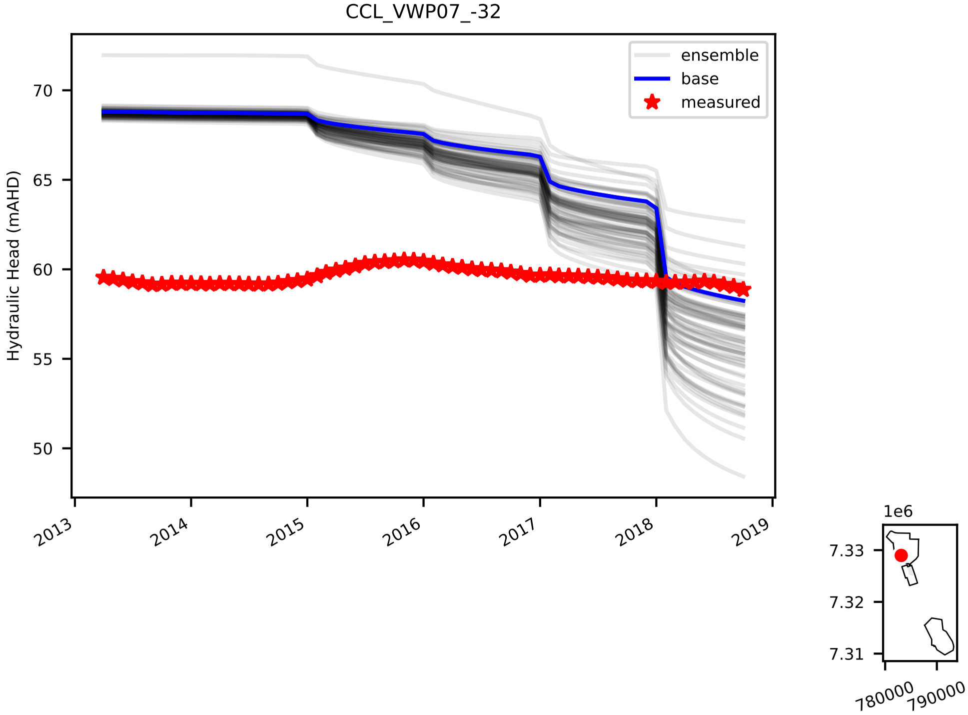
CCL_VWP06_4
Hydraulic Head (mAHD)
70
65
60
55
50
2014-01
2014-04
2014-07
2014-10
2015-01
2015-04
2015-07
2015-10
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000



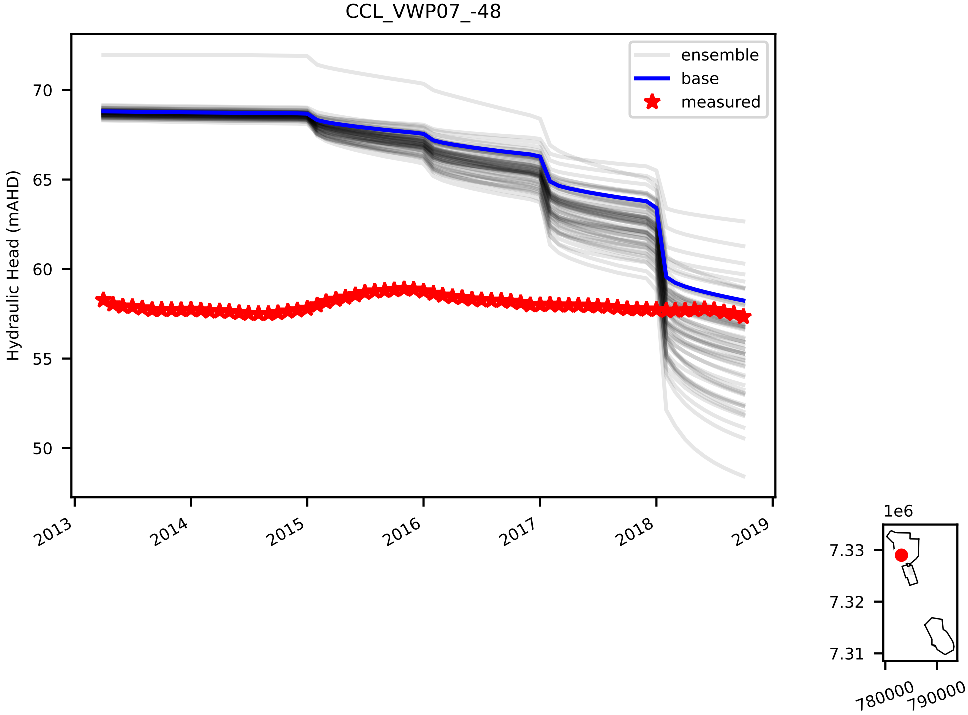
CCL_VWP07_1
Hydraulic Head (mAHD)
72.5
70.0
67.5
65.0
62.5
60.0
57.5
55.0
52.5
2013
2014
2015
2016
2017
2018
2019
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

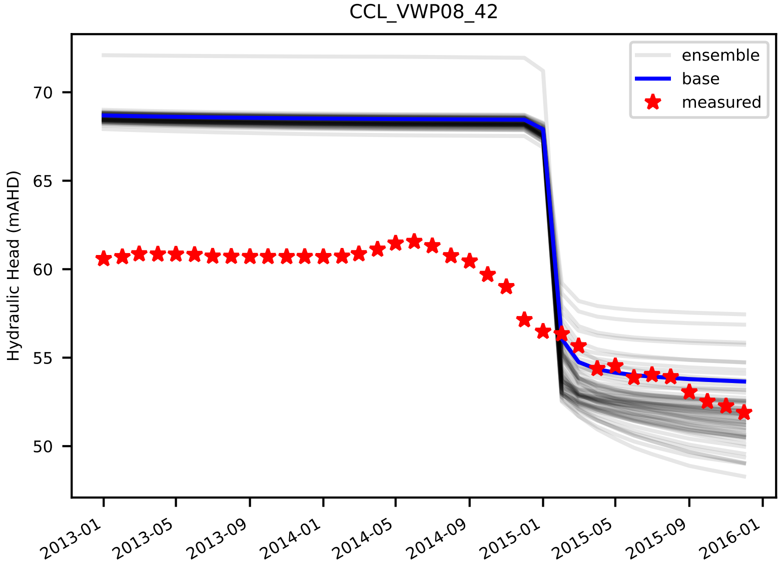


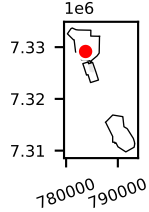
CCL_VWP07_-26
Hydraulic Head (mAHD)
70
65
60
55
50
2013
2014
2015
2016
2017
2018
2019
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

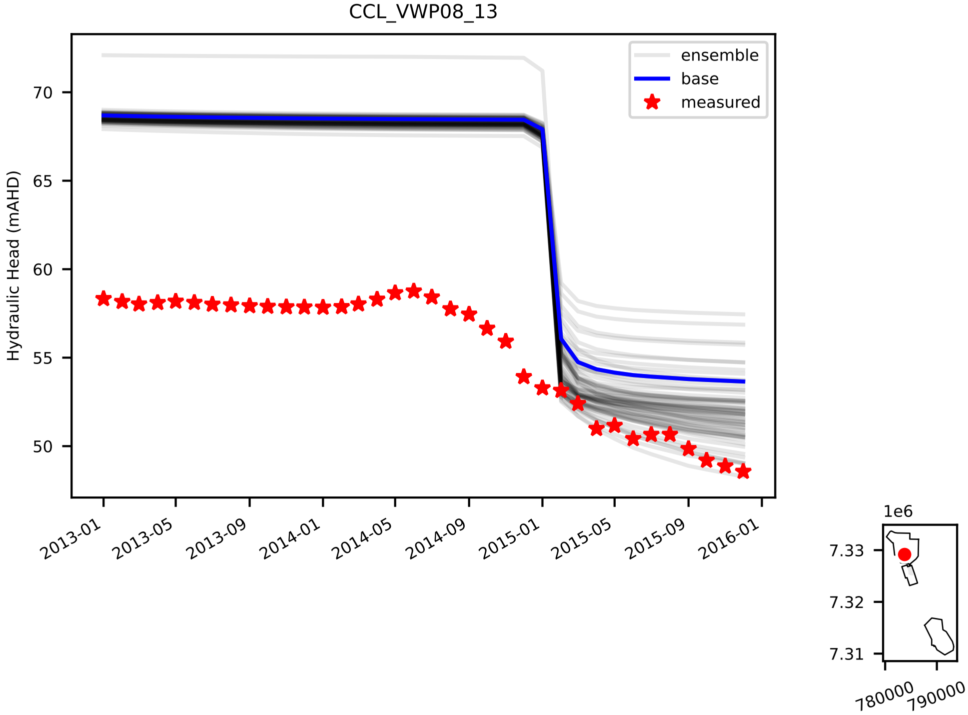


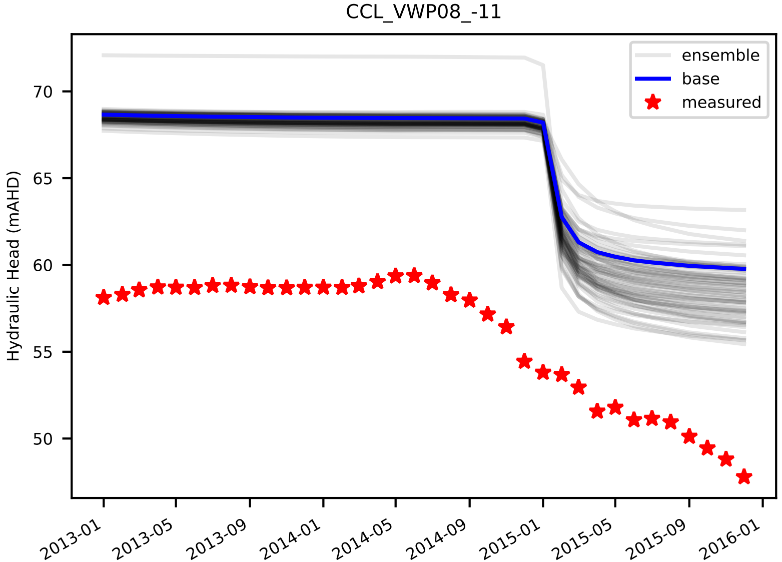
CCL_VWP07_-32
ensemble
base
measured
Hydraulic Head (mAHD)
70
65
60
55
50
2013
2014
2015
2016
2017
2018
2019
1e6
7.33
7.32
7.31
780000
790000


CCL_VWP07_-48
Hydraulic Head (mAHD)
70
65
60
55
50
2013
2014
2015
2016
2017
2018
2019
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

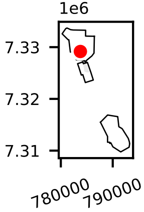

CCL_VWP08_42
Hydraulic Head (mAHD)
70
65
60
55
50
ensemble
base
measured
2013-01
2013-05
2013-09
2014-01
2014-05
2014-09
2015-01
2015-05
2015-09
2016-01


1e6
7.33
7.32
7.31
780000
790000

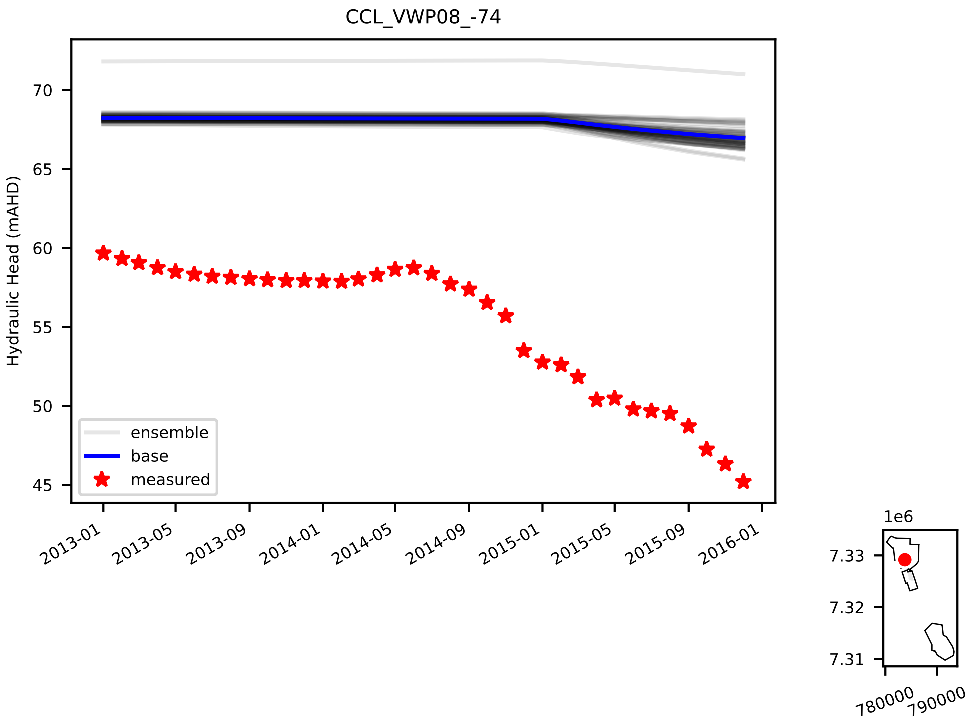

CCL_VWP08_13
ensemble
base
measured
Hydraulic Head (mAHD)
70
65
60
55
50
2013-01
2013-05
2013-09
2014-01
2014-05
2014-09
2015-01
2015-05
2015-09
2016-01
1e6
7.33
7.32
7.31
780000
790000

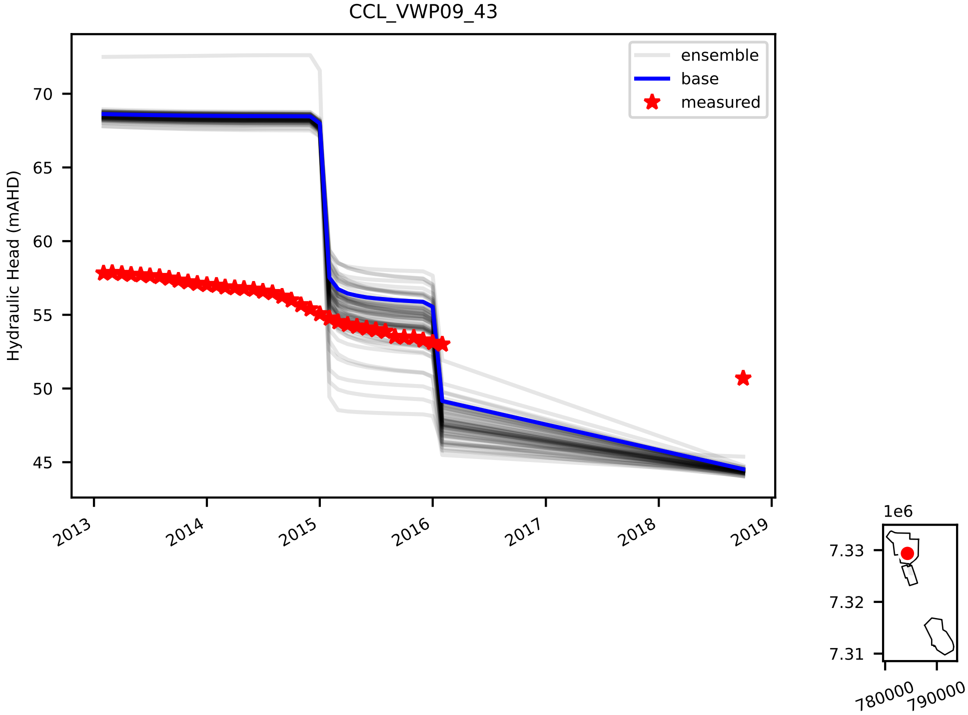


CCL_VWP08_-11
Hydraulic Head (mAHD)
70
65
60
55
50
ensemble
base
measured
2013-01
2013-05
2013-09
2014-01
2014-05
2014-09
2015-01
2015-05
2015-09
2016-01

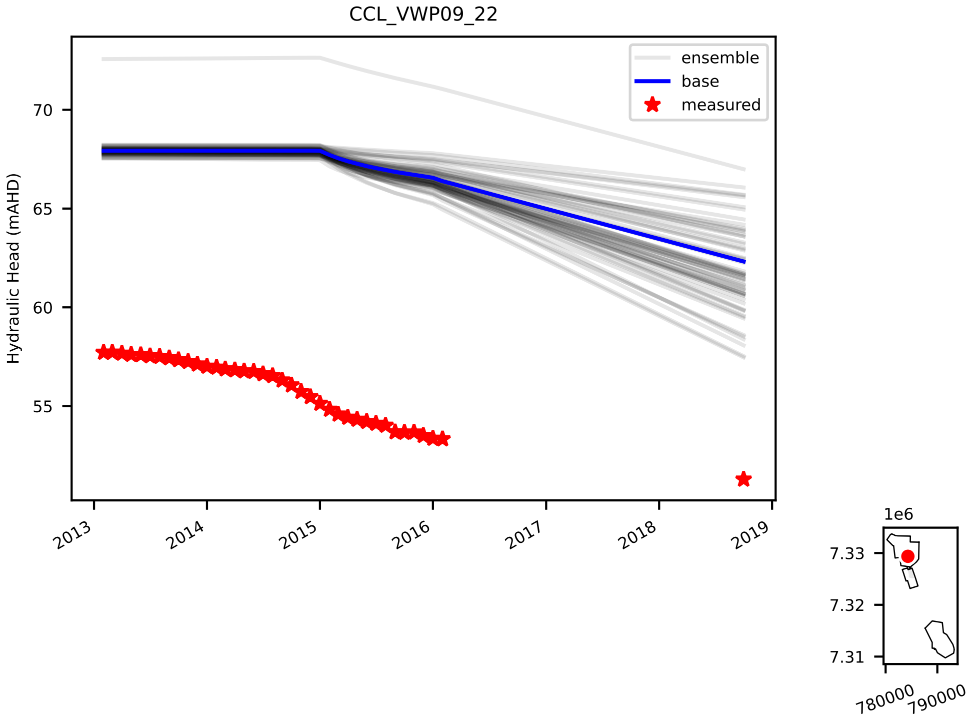


1e6
7.33
7.32
7.31
780000
790000

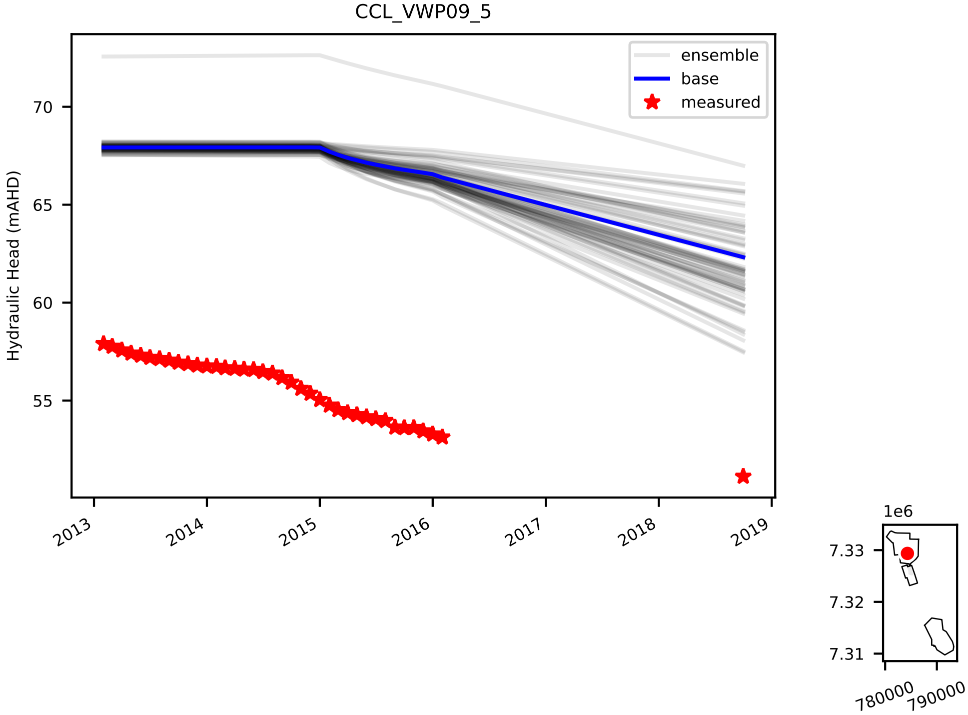

CCL_VWP08_-74
Hydraulic Head (mAHD)
70
65
60
55
50
45
ensemble
base
measured
2013-01
2013-05
2013-09
2014-01
2014-05
2014-09
2015-01
2015-05
2015-09
2016-01
1e6
7.33
7.32
7.31
780000
790000



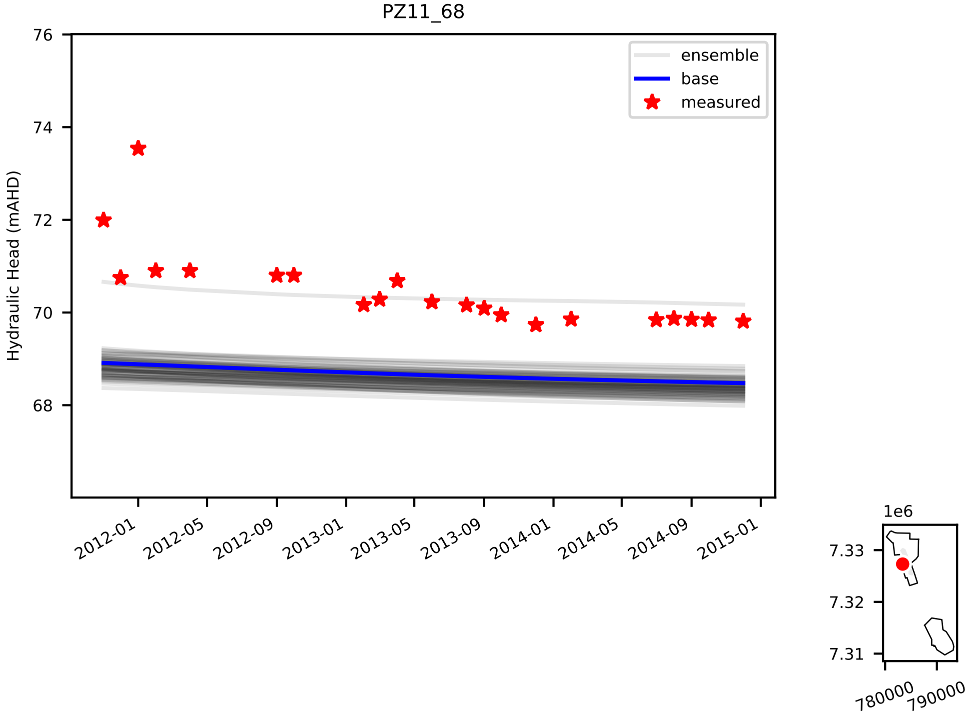
CCL_VWP09_43
Hydraulic Head (mAHD)
70
65
60
55
50
45
2013
2014
2015
2016
2017
2018
2019
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000



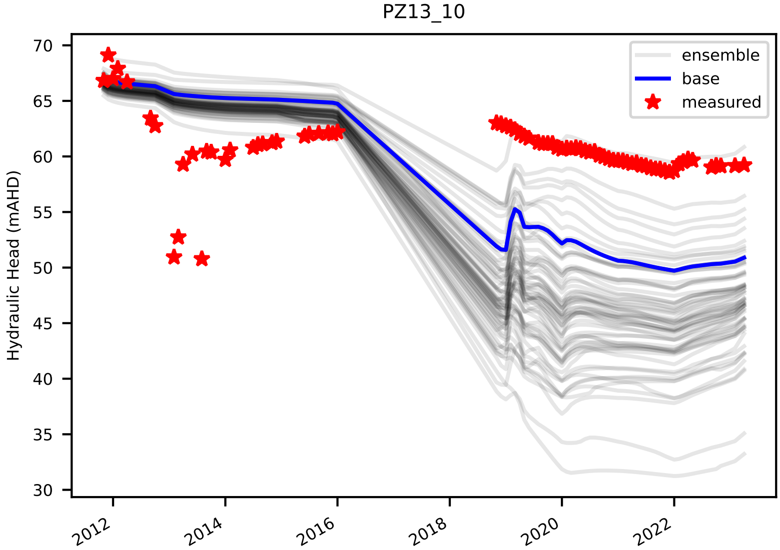
CCL_VWP09_22
Hydraulic Head (mAHD)
70
65
60
55
2013
2014
2015
2016
2017
2018
2019
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

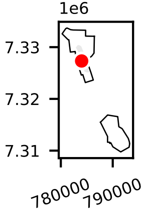


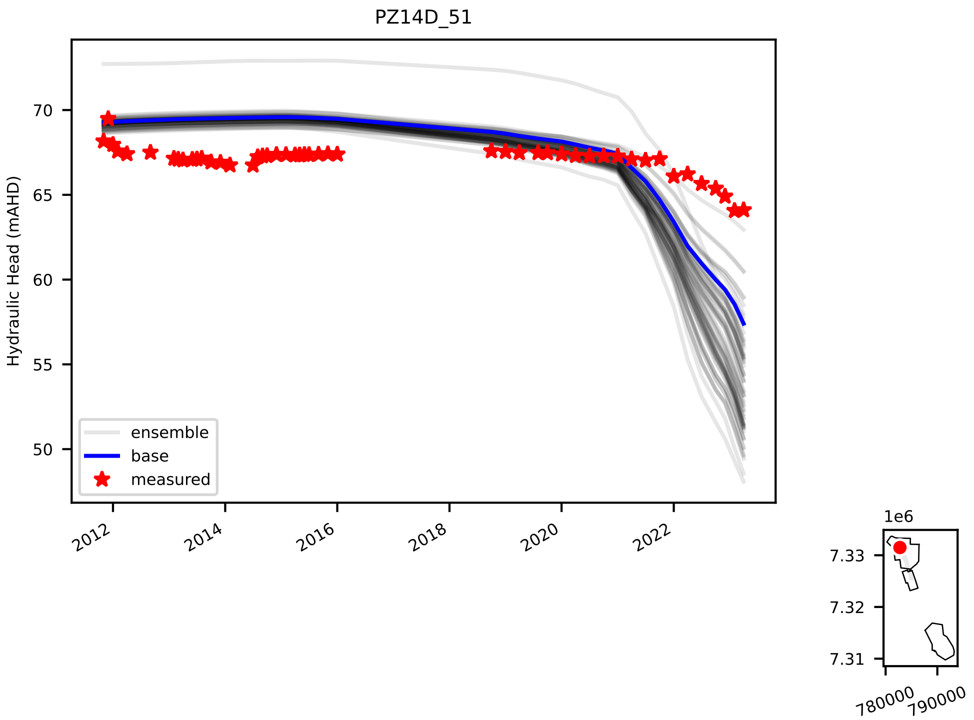
CCL_VWP09_5
ensemble
base
measured
Hydraulic Head (mAHD)
70
65
60
55
2013
2014
2015
2016
2017
2018
2019
1e6
7.33
7.32
7.31
780000
790000

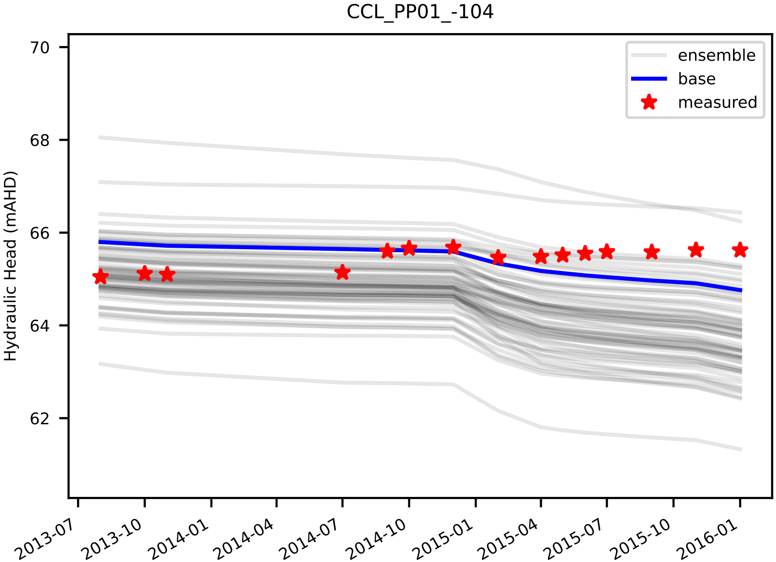


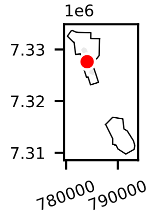
PZ11_68
Hydraulic Head (mAHD)
76
74
72
70
68
ensemble
base
measured
2012-01
2012-05
2012-09
2013-01
2013-05
2013-09
2014-01
2014-05
2014-09
2015-01
1e6
7.33
7.32
7.31
780000
790000

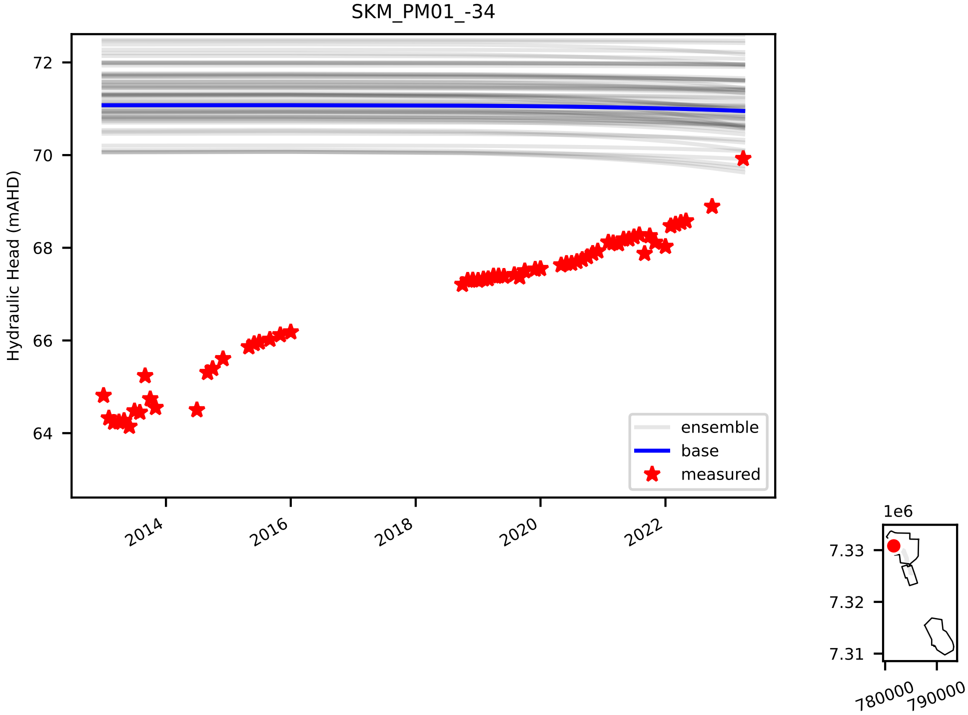

PZ13_10
Hydraulic Head (mAHD)
70
65
60
55
50
45
40
35
30
2012
2014
2016
2018
2020
2022
ensemble
base
measured


1e6
7.33
7.32
7.31
780000
790000

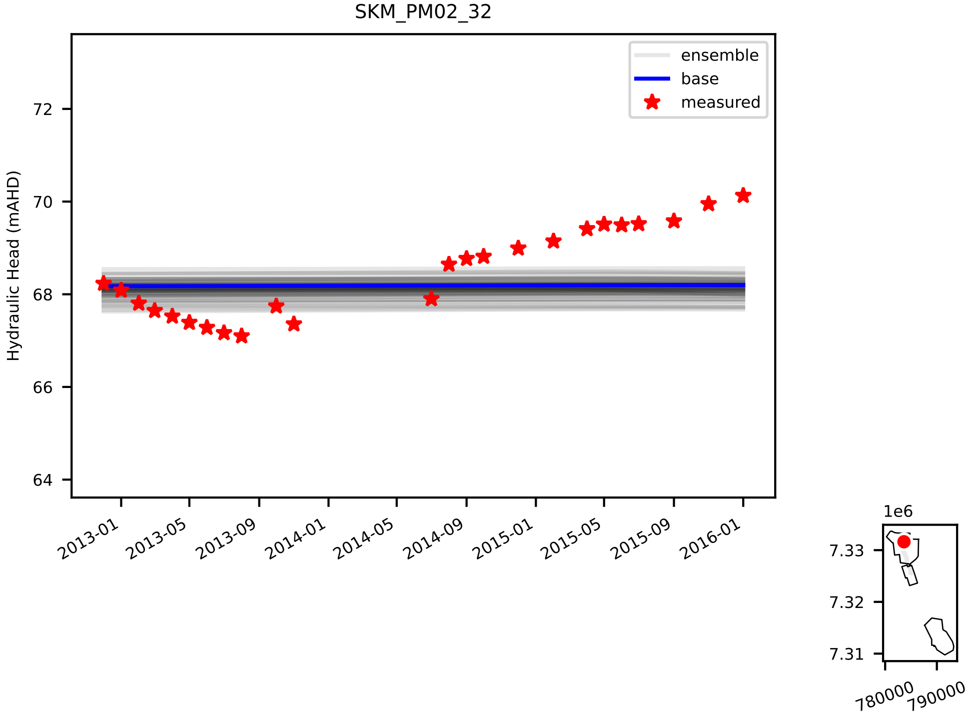

PZ14D_51
Hydraulic Head (mAHD)
70
65
60
55
50
2012
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000


CCL_PP01_-104
ensemble
base
measured
Hydraulic Head (mAHD)
70
68
66
64
62
2013-07
2013-10
2014-01
2014-04
2014-07
2014-10
2015-01
2015-04
2015-07
2015-10
2016-01

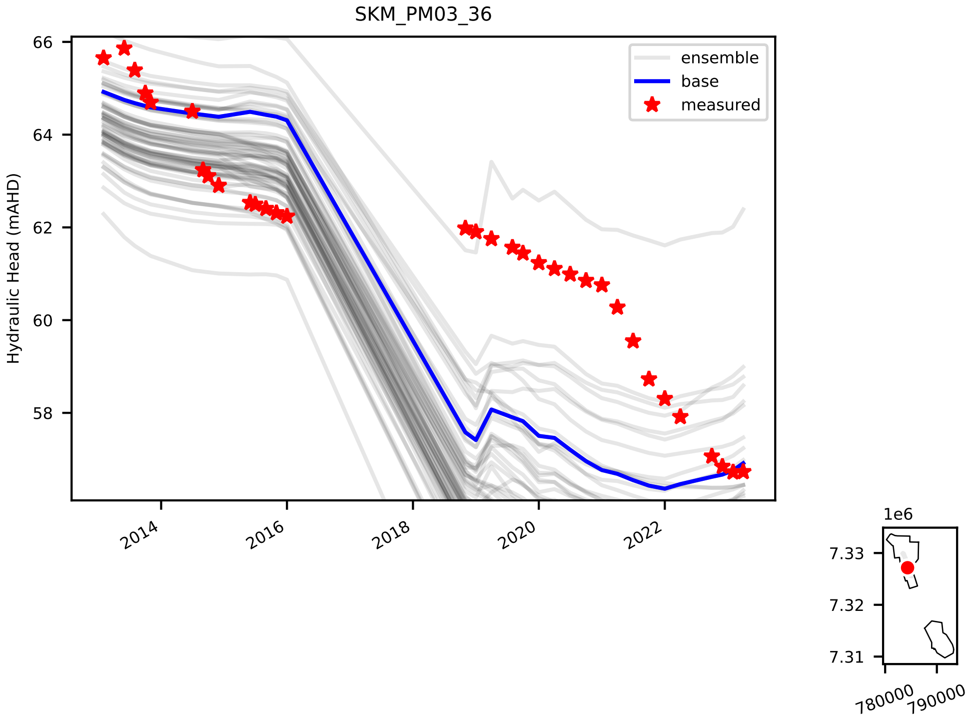

1e6
7.33
7.32
7.31
780000
790000



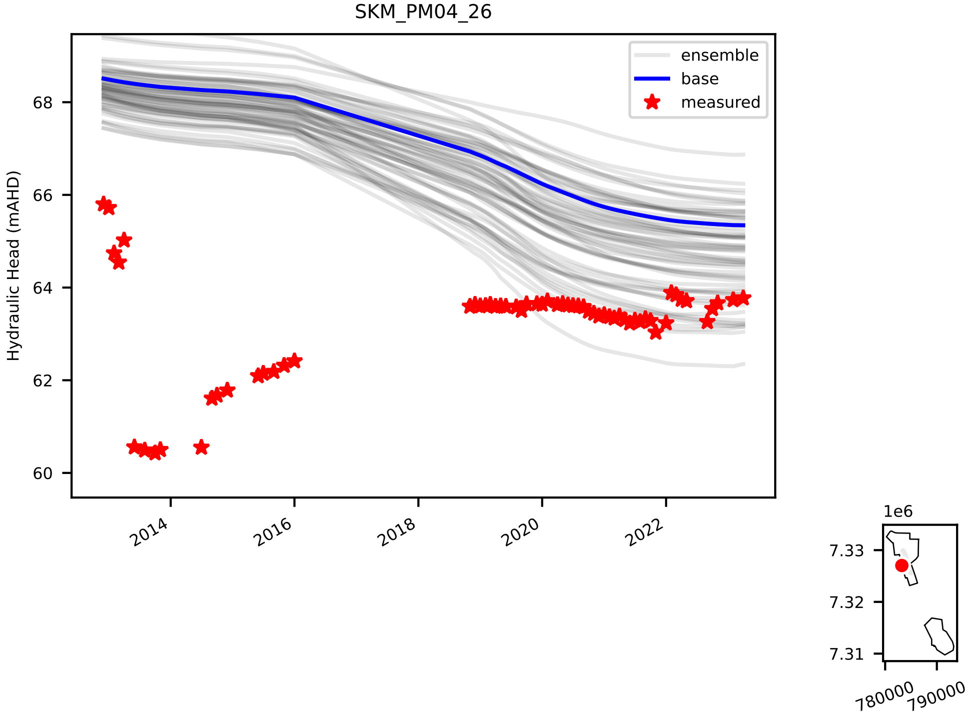
SKM_PM01_-34
Hydraulic Head (mAHD)
72
70
68
66
64
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000



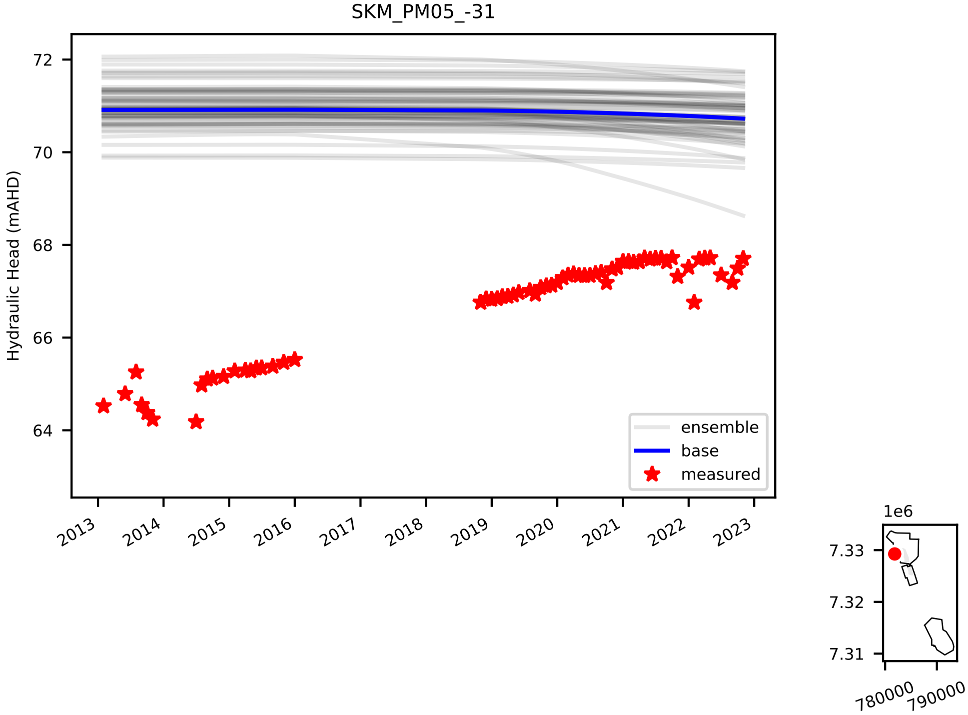
SKM_PM02_32
Hydraulic Head (mAHD)
64
66
68
70
72
2013-01
2013-05
2013-09
2014-01
2014-05
2014-09
2015-01
2015-05
2015-09
2016-01
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000



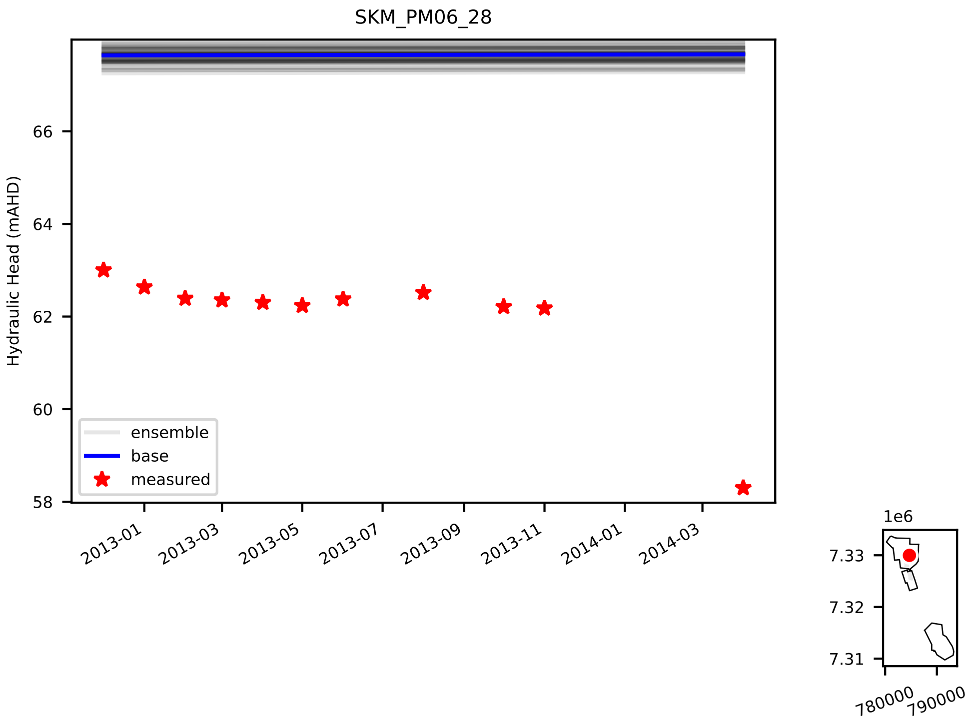
SKM_PM03_36
Hydraulic Head (mAHD)
66
64
62
60
58
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

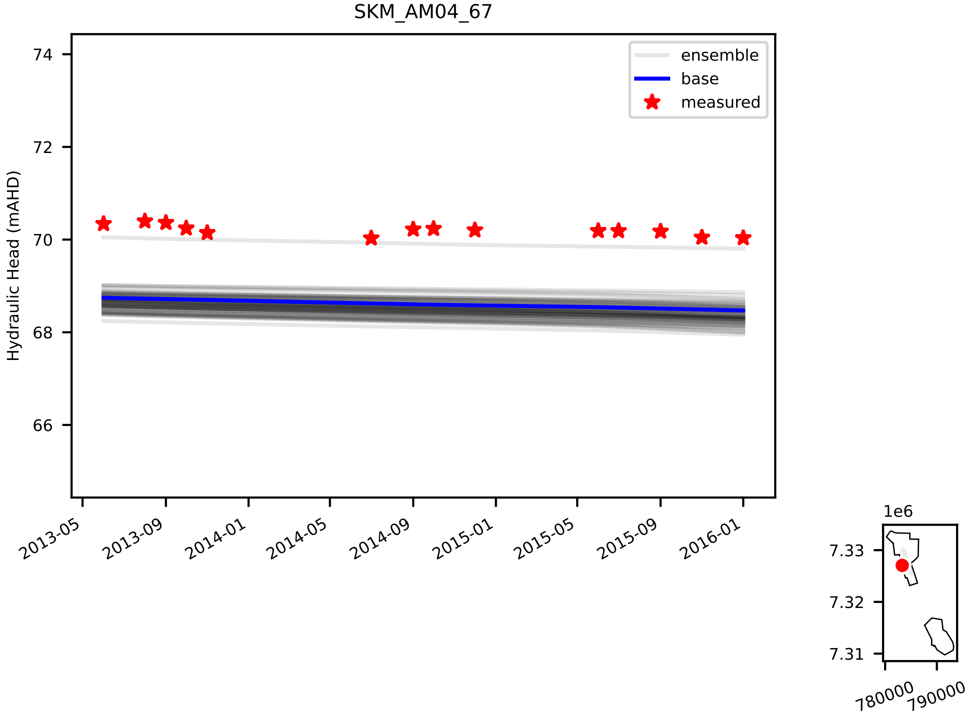


SKM_PM04_26
Hydraulic Head (mAHD)
60
62
64
66
68
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

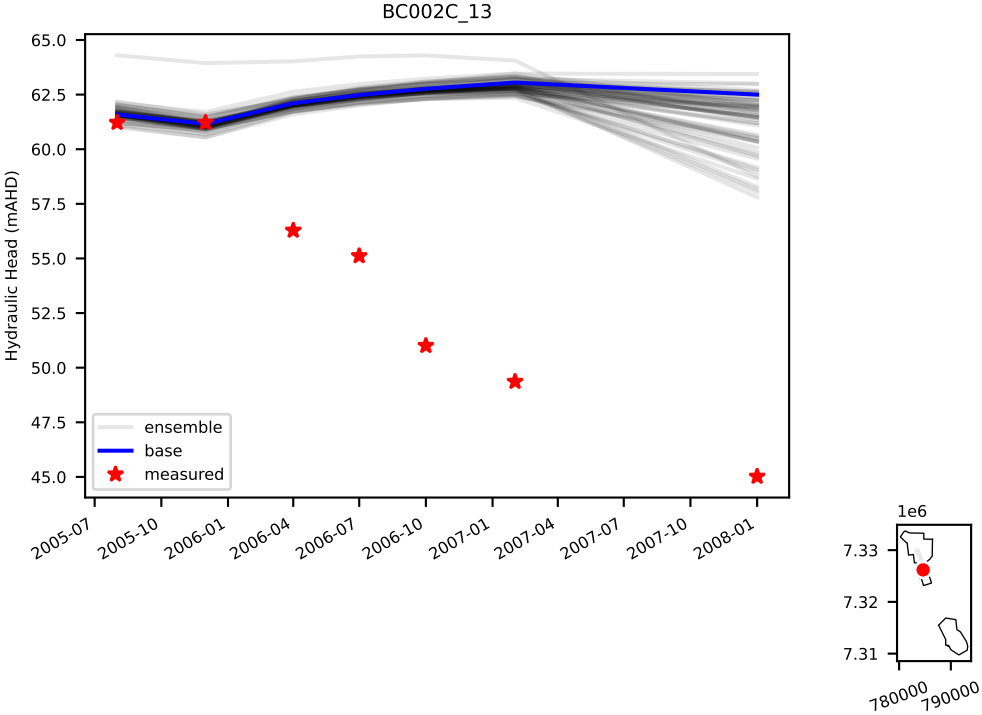


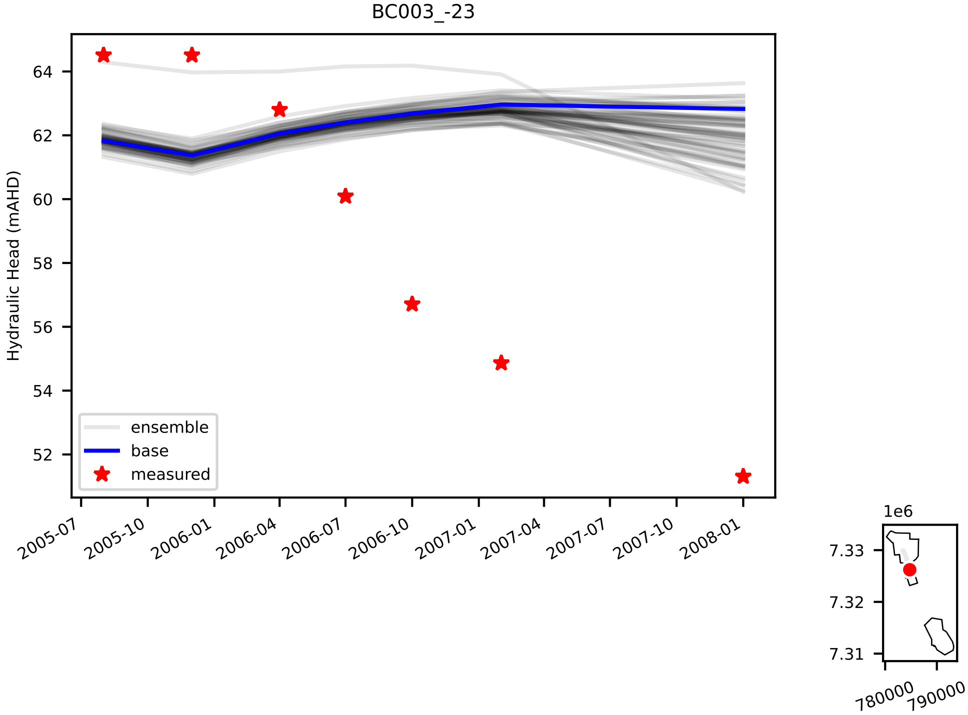
SKM_PM05_-31
Hydraulic Head (mAHD)
72
70
68
66
64
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000


SKM_PM06_28
Hydraulic Head (mAHD)
66
64
62
60
58
ensemble
base
measured
2013-01
2013-03
2013-05
2013-07
2013-09
2013-11
2014-01
2014-03
1e6
7.33
7.32
7.31
780000
790000



SKM_AM04_67
Hydraulic Head (mAHD)
74
72
70
68
66
2013-05
2013-09
2014-01
2014-05
2014-09
2015-01
2015-05
2015-09
2016-01
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000


BC002C_13
Hydraulic Head (mAHD)
65.0
62.5
60.0
57.5
55.0
52.5
50.0
47.5
45.0
2005-07
2005-10
2006-01
2006-04
2006-07
2006-10
2007-01
2007-04
2007-07
2007-10
2008-01
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000


BC003_-23
Hydraulic Head (mAHD)
64
62
60
58
56
54
52
ensemble
base
measured
2005-07
2005-10
2006-01
2006-04
2006-07
2006-10
2007-01
2007-04
2007-07
2007-10
2008-01
1e6
7.33
7.32
7.31
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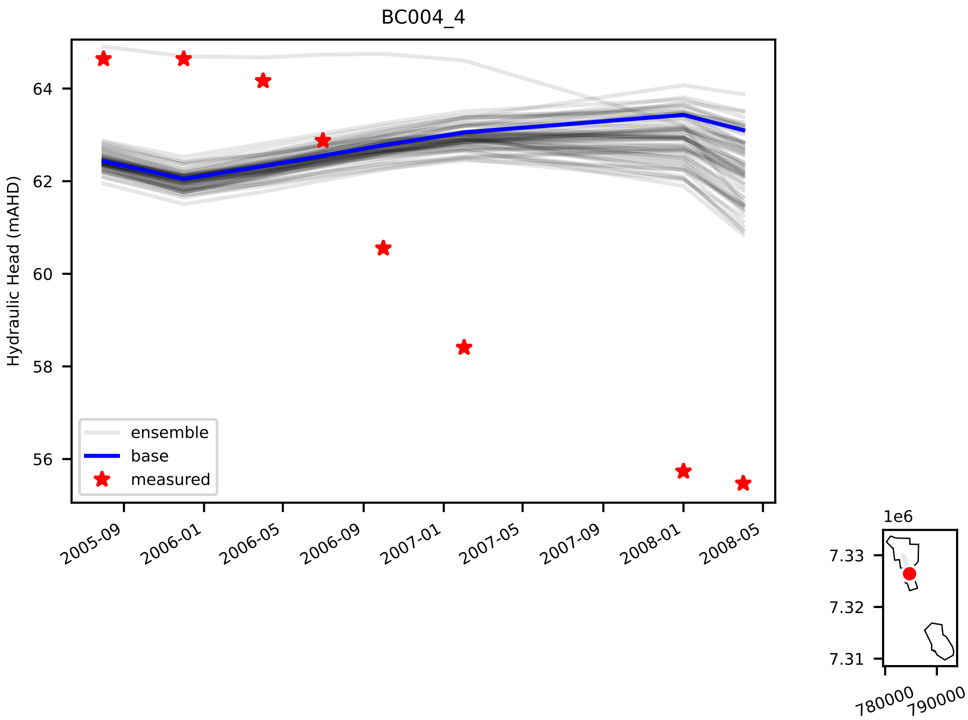
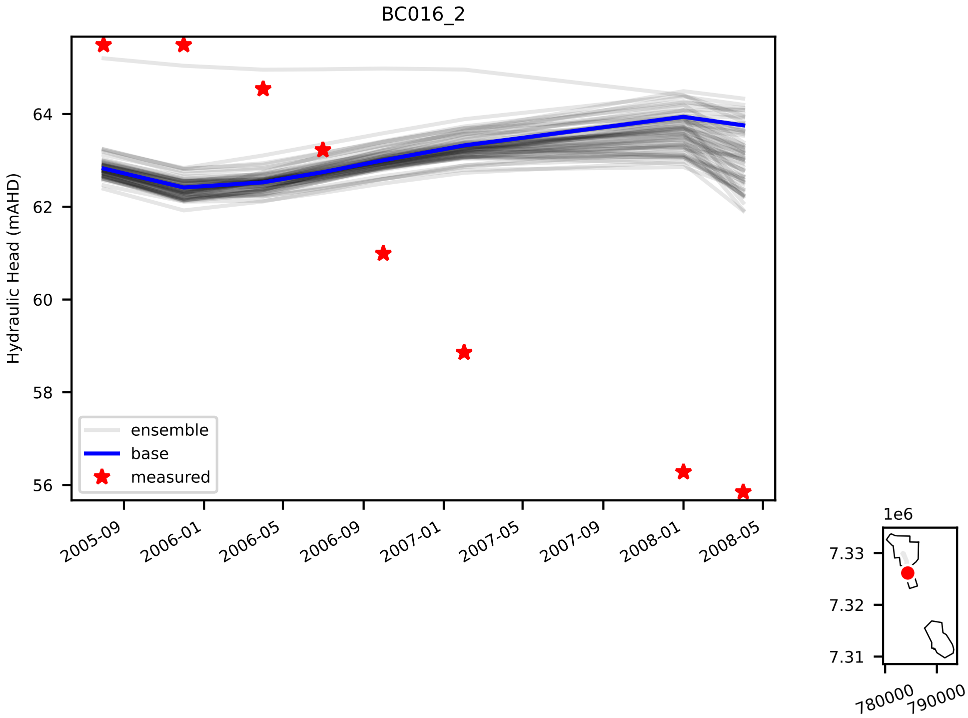
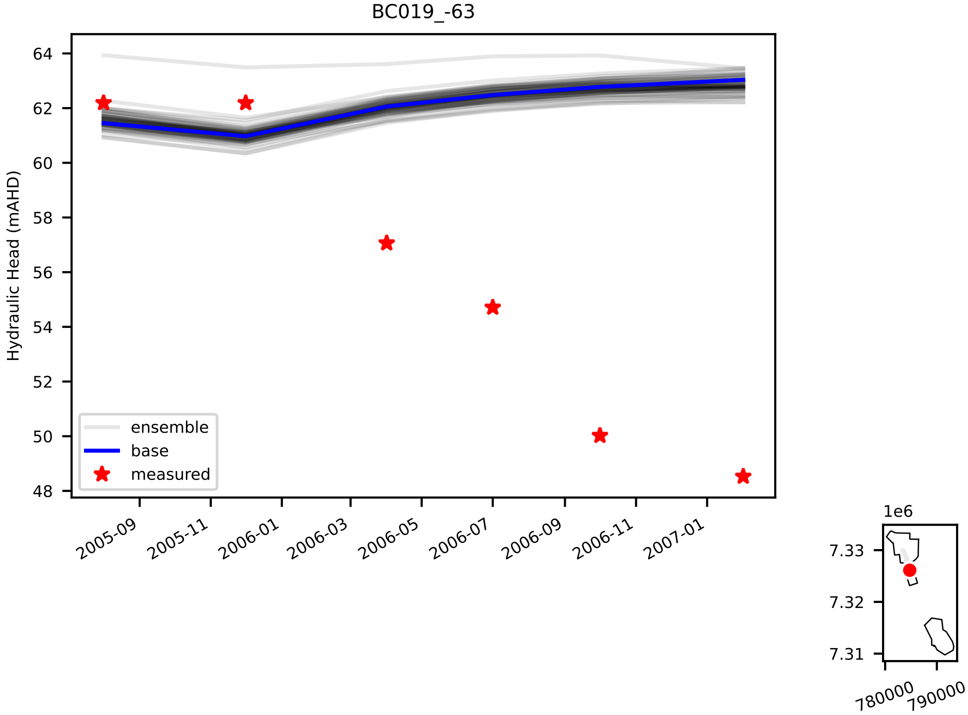
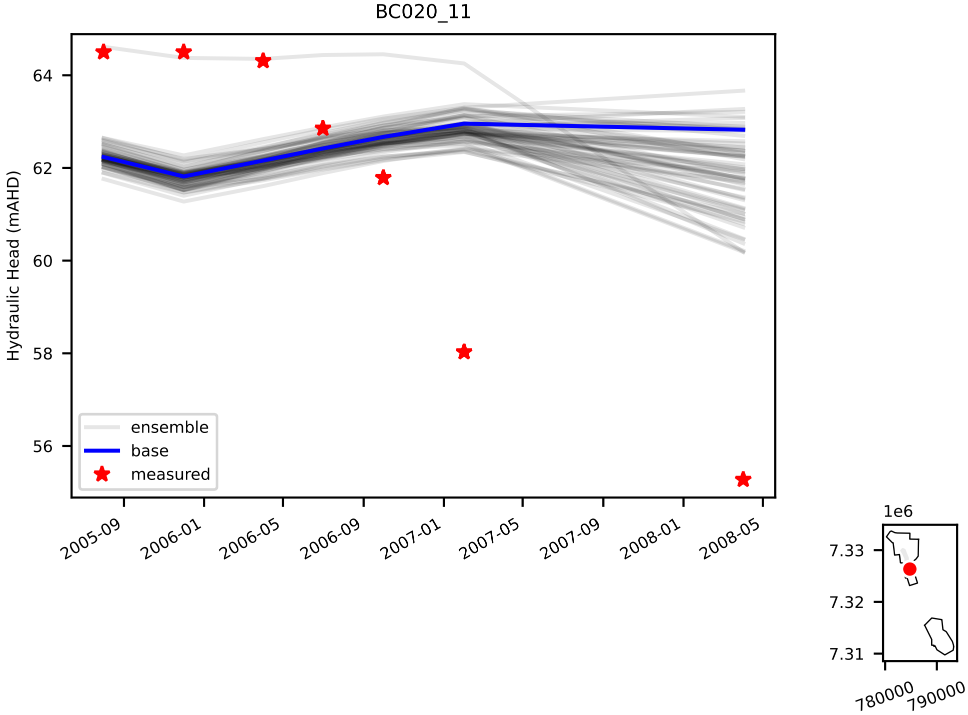
790000

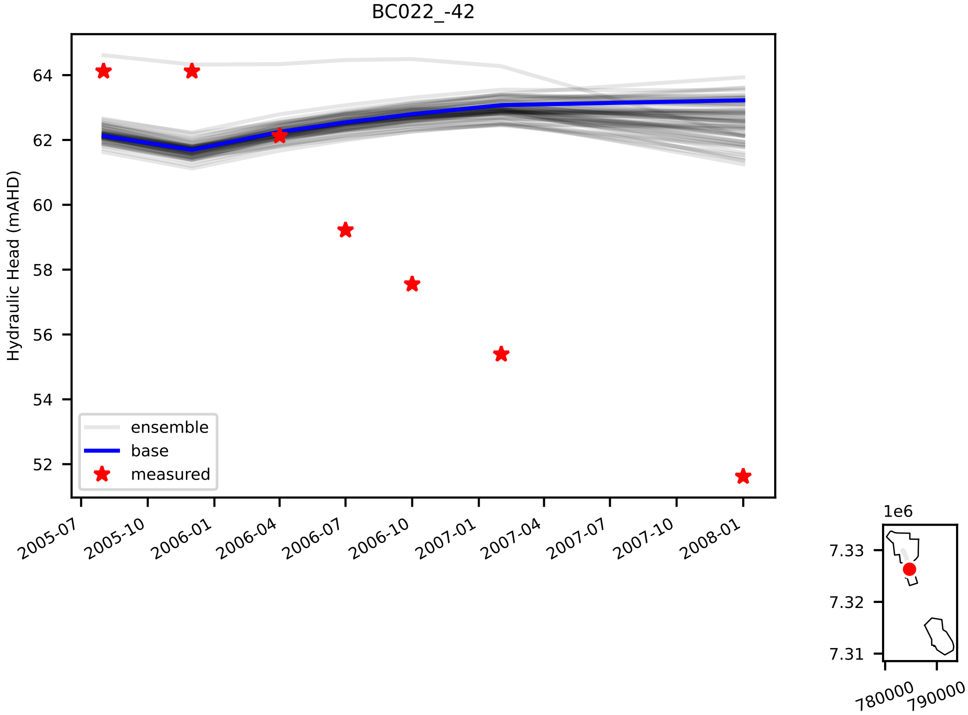

BC004_4
Hydraulic Head (mAHD)
64
62
60
58
56
ensemble
base
measured
2005-09
2006-01
2006-05
2006-09
2007-01
2007-05
2007-09
2008-01
2008-05
1e6
7.33
7.32
7.31
780000
790000



BC016_2
Hydraulic Head (mAHD)
64
62
60
58
56
ensemble
base
measured
2005-09
2006-01
2006-05
2006-09
2007-01
2007-05
2007-09
2008-01
2008-05
1e6
7.33
7.32
7.31
780000
790000


BC019_-63
Hydraulic Head (mAHD)
64
62
60
58
56
54
52
50
48
2005-09
2005-11
2006-01
2006-03
2006-05
2006-07
2006-09
2006-11
2007-01
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000


BC020_11
Hydraulic Head (mAHD)
64
62
60
58
56
ensemble
base
measured
2005-09
2006-01
2006-05
2006-09
2007-01
2007-05
2007-09
2008-01
2008-05
1e6
7.33
7.32
7.31
780000
790000



BC022_-42
Hydraulic Head (mAHD)
64
62
60
58
56
54
52
ensemble
base
measured
2005-07
2005-10
2006-01
2006-04
2006-07
2006-10
2007-01
2007-04
2007-07
2007-10
2008-01
1e6
7.33
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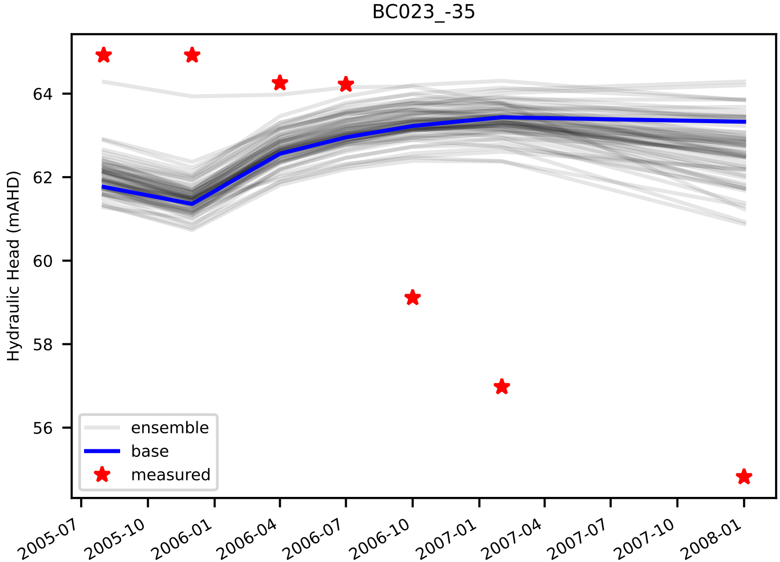
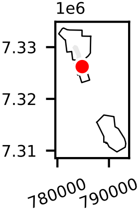
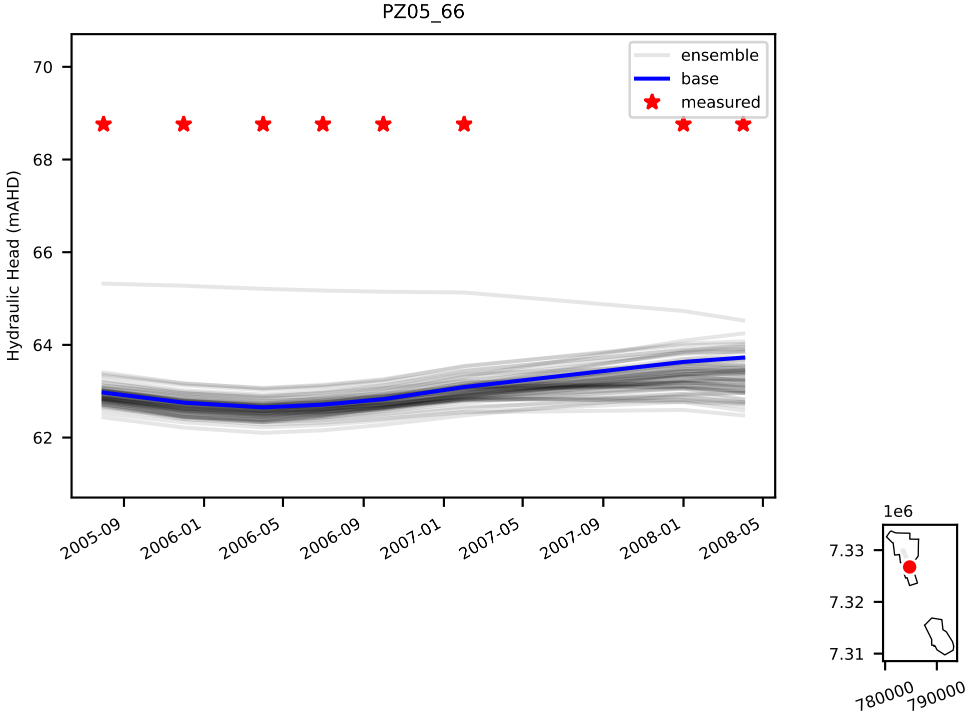
7.31
780000
790000



BC023_-35
Hydraulic Head (mAHD)
64
62
60
58
56
ensemble
base
measured
2005-07
2005-10
2006-01
2006-04
2006-07
2006-10
2007-01
2007-04
2007-07
2007-10
2008-01



1e6
7.33
7.32
7.31
780000
790000



PZ05_66
ensemble
base
measured
Hydraulic Head (mAHD)
70
68
66
64
62
2005-09
2006-01
2006-05
2006-09
2007-01
2007-05
2007-09
2008-01
2008-05
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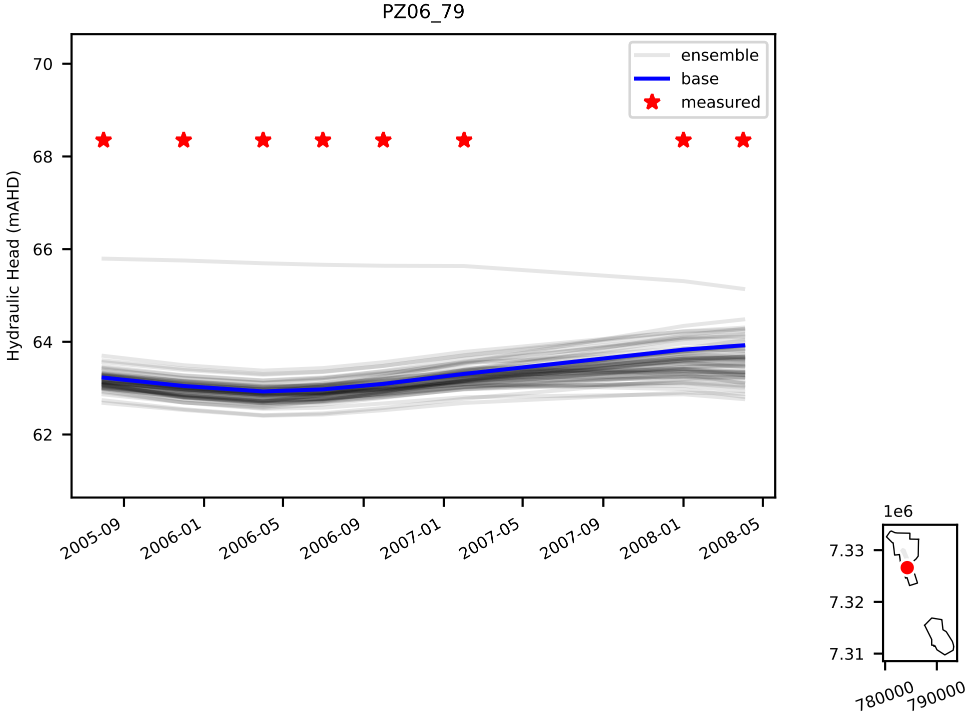
7.31
780000
790000



PZ06_79
ensemble
base
measured
Hydraulic Head (mAHD)
70
68
66
64
62
2005-09
2006-01
2006-05
2006-09
2007-01
2007-05
2007-09
2008-01
2008-05
1e6
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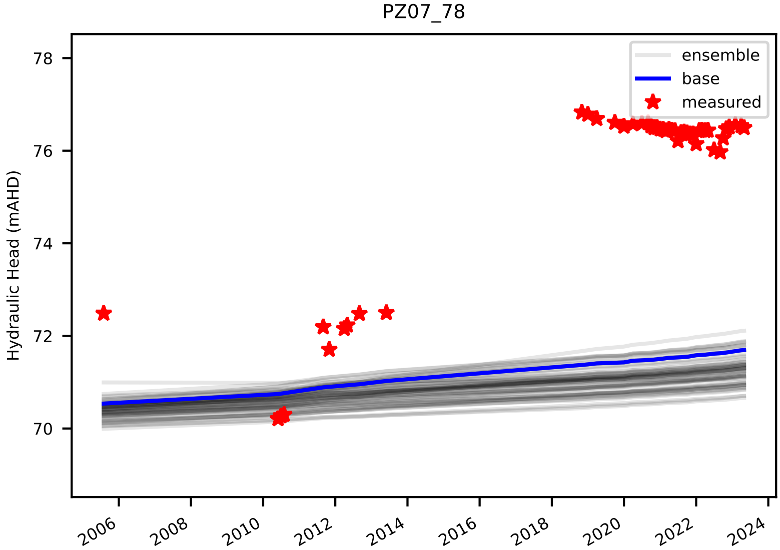
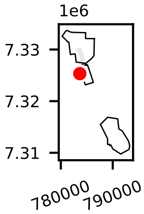
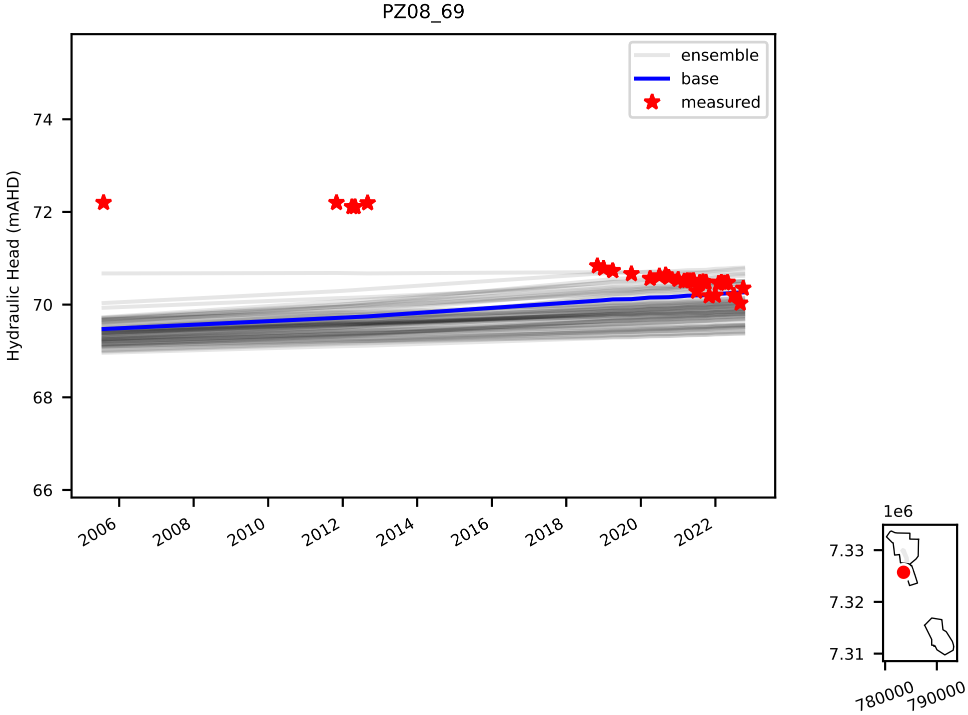
7.32
7.31
780000
790000



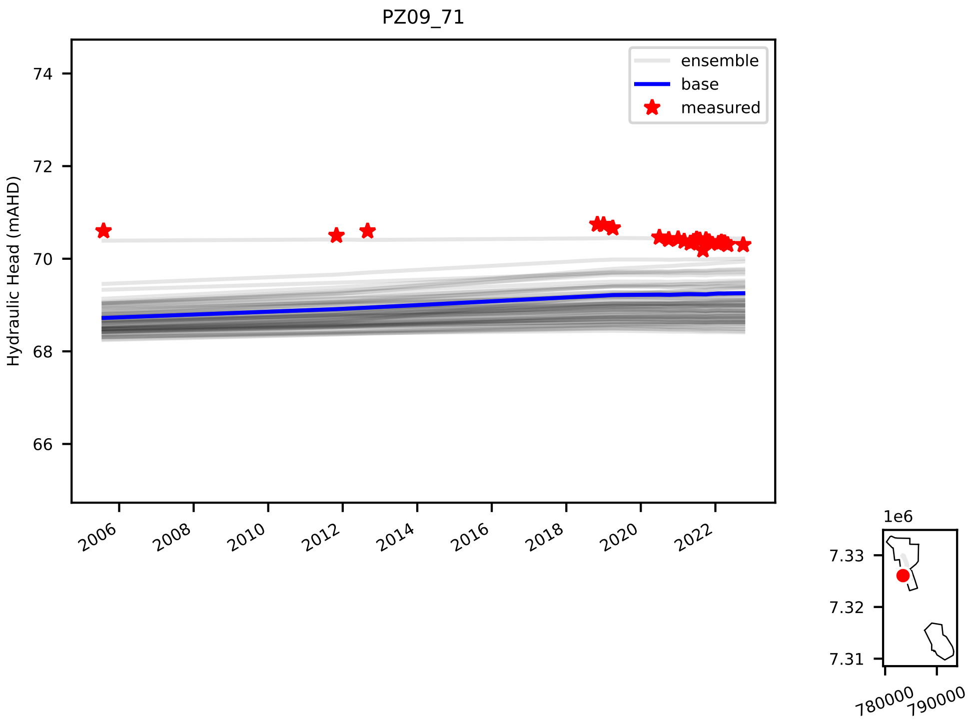
PZ07_78
Hydraulic Head (mAHD)
78
76
74
72
70
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
ensemble
base
measured

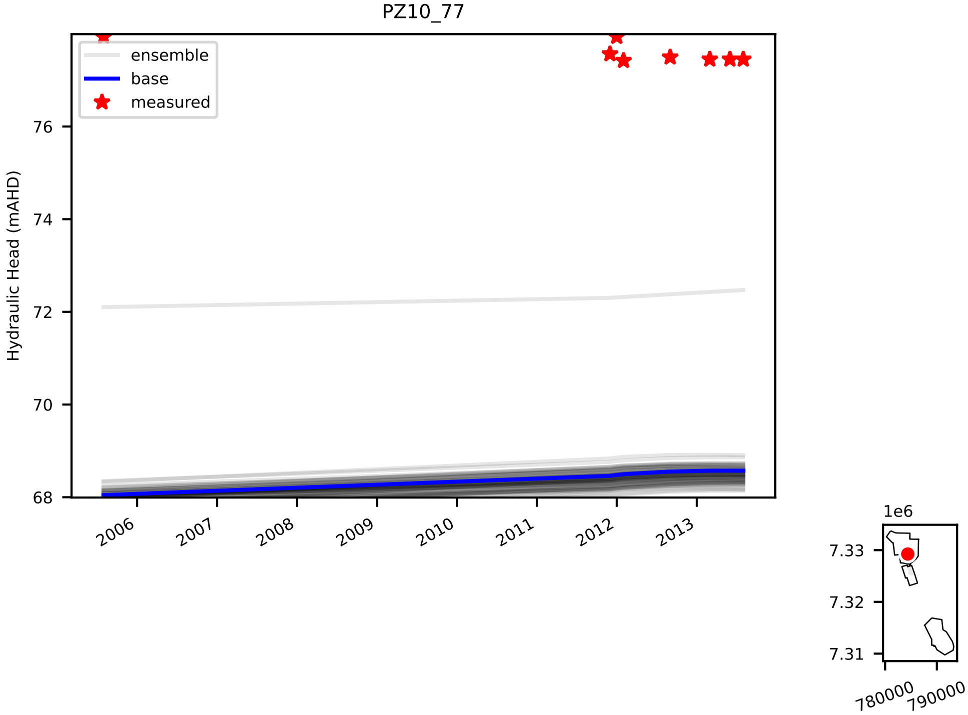


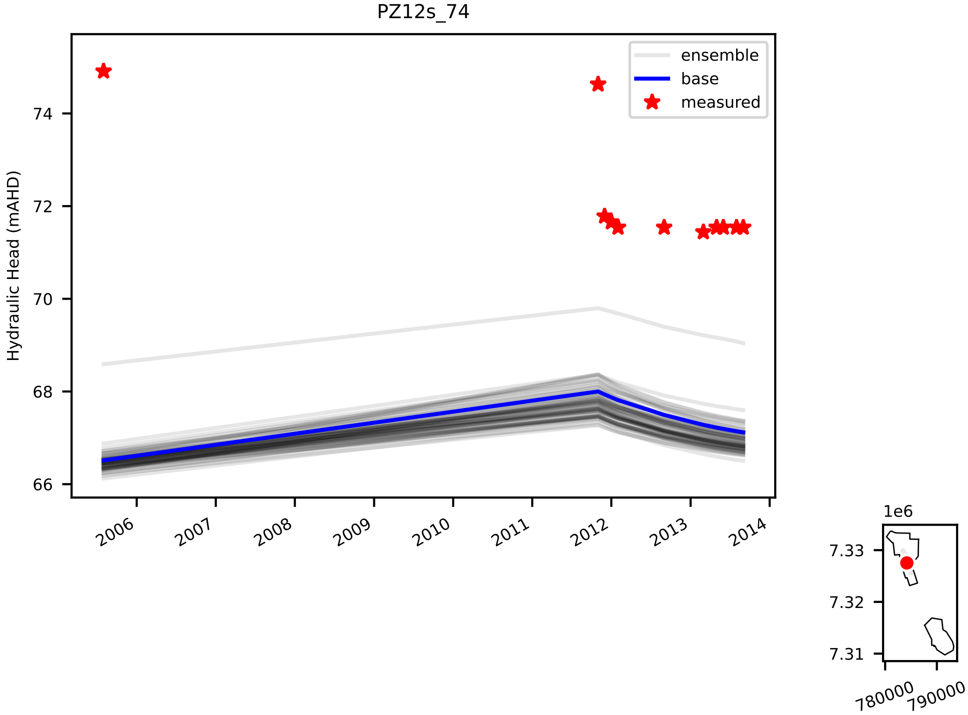
1e6
7.33
7.32
7.31
780000
790000

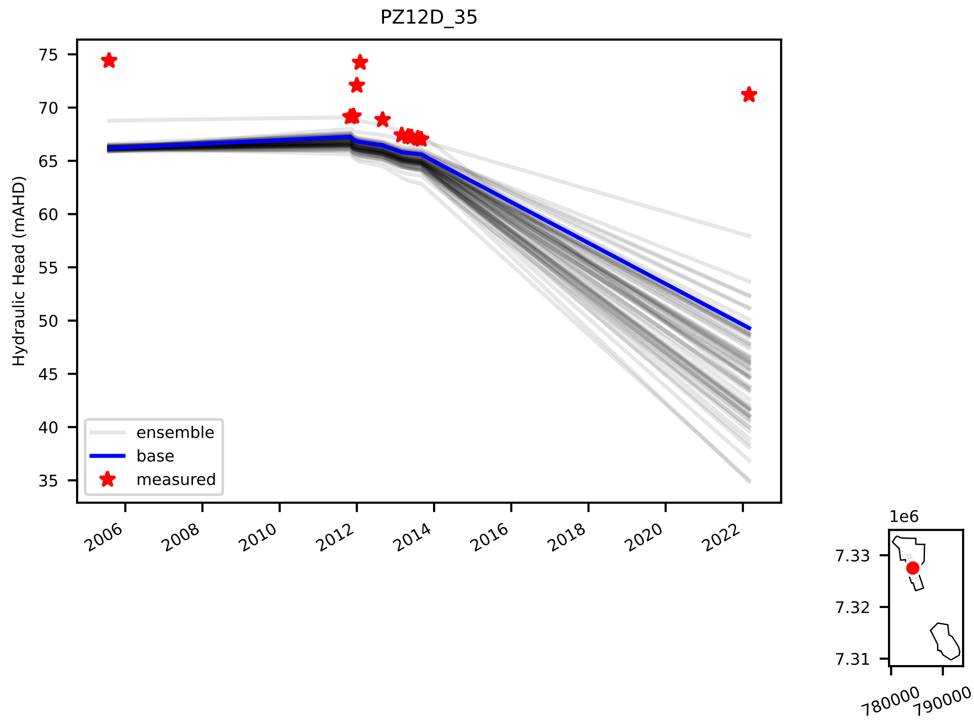


PZ08_69
ensemble
base
measured
Hydraulic Head (mAHD)
74
72
70
68
66
2006
2008
2010
2012
2014
2016
2018
2020
2022
1e6
7.33
7.32
7.31
780000
790000

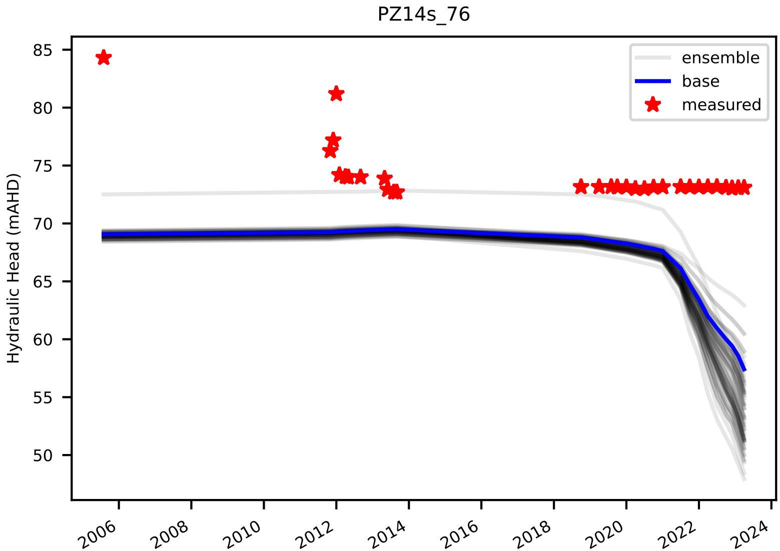

PZ09_71
Hydraulic Head (mAHD)
74
72
70
68
66
2006
2008
2010
2012
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000

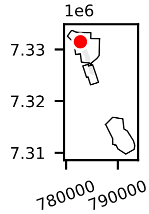

PZ10_77
ensemble
base
measured
Hydraulic Head (mAHD)
76
74
72
70
68
2006
2007
2008
2009
2010
2011
2012
2013
1e6
7.33
7.32
7.31
780000
790000


PZ12s_74
Hydraulic Head (mAHD)
ensemble
base
measured
74
72
70
68
66
2006
2007
2008
2009
2010
2011
2012
2013
2014
1e6
7.33
7.32
7.31
780000
790000



PZ12D_35
Hydraulic Head (mAHD)
75
70
65
60
55
50
45
40
35
2006
2008
2010
2012
2014
2016
2018
2020
2022
ensemble
base
measured
1e6
7.33
7.32
7.31
780000
790000


PZ14s_76
Hydraulic Head (mAHD)
85
80
75
70
65
60
55
50
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
ensemble
base
measured


1e6
7.33
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7.31
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790000

Appendix G: Model Confidence Classification

Table G1: Groundwater model confidence level classification table

Australian Groundwater Modelling Guidelines (Barnett *et al*., 2012)

	Data		Calibration		Prediction		Key indicator	
Class 3	Spatial and temporal distribution of groundwater head observations adequately define groundwater behaviour, especially in areas of greatest interest and where outcomes are to be reported.		Adequate validation is demonstrated. **Noting that it is not widely agreed that setting aside data for verification is the best use of that information.*		Length of predictive model is not excessive compared to length of calibration period.		Key calibration statistics are acceptable and meet agreed targets.	
	Spatial distribution of bore logs and associated stratigraphic interpretations clearly define aquifer geometry.	✓	Scaled RMS error (refer Chapter 5) or other calibration statistics(e.g. mean residual) are acceptable.	✓	Temporal discretisation used in the predictive model is consistent with the transient calibration.	✓	Model predictive time frame is less than 3 times the duration of transient calibration. *(for mining period)*	✓
	Reliable metered groundwater extraction and injection data is available.		Long-term trends are adequately replicated where these are important.		Level and type of stresses included in the predictive model are within the range of those used in the transient calibration.		Stresses are not more than 2 times greater than those included in calibration.	
	Rainfall and evaporation data is available.	✓	Seasonal fluctuations are adequately replicated where these are important.		Model validation* suggests calibration is appropriate for locations and/or times outside the calibration model.		Temporal discretisation in predictive model is the same as that used in calibration.	
	Aquifer-testing data to define key parameters		Transient calibration is current, i.e. uses recent data.	✓	Steady-state predictions used when the model is calibrated in steady- state only.		Mass balance closure error is less than 0.5% of total.	✓
	Streamflow and stage measurements are available with reliable baseflow estimates at a number of points.		Model is calibrated to heads and fluxes.				Model parameters consistent with conceptualisation.	✓
	Reliable land-use and soil- mapping data available.		Observations of the key modelling outcomes dataset is used in calibration:				Appropriate computational methods used with appropriate spatial discretisation to model the problem.	✓
			* Groundwater levels	✓				
			* Groundwater drawdown	✓				
	Good quality and adequate spatial coverage of digital elevation model to define ground surface elevation.	✓					The model has been reviewed and deemed fit for purpose by an experienced, independent hydrogeologist with modelling experience.	✓
Class 2	Groundwater head observations and bore logs are available but may not provide adequate coverage throughout the model domain.	✓	Validation* is either not undertaken or is not demonstrated for the full model domain.	✓	Transient calibration over a short time frame compared to that of prediction.	✓	Key calibration statistics suggest poor calibration in parts of the model domain.	
	Metered groundwater- extraction data may be available but spatial and temporal coverage may not be extensive.		Calibration statistics are generally reasonable but may suggest significant errors in parts of the model domains).	✓	Temporal discretisation used in the predictive model is different from that used in transient calibration.		Model predictive time frame is between 3 and 10 times the duration of transient calibration.	
	Streamflow data and baseflow estimates available at a few points.		Long-term trends not replicated in all parts of the model domain.		Level and type of stresses included in the predictive model are outside the range of those used in the transient calibration.		Stresses are between 2 and 5 times greater than those included in calibration.	
	Reliable irrigation-application data available in part of the area or for part of the model duration.		Transient calibration to historic data but not extending to the present day.		Validation* suggests relatively poor match to observations when calibration data is extended in time and/or space.		Temporal discretisation in predictive model is not the same as that used in calibration.	
	Aquifer-testing data to define key parameters is available, but limited	✓	Seasonal fluctuations not adequately replicated in all parts of the model domain.	✓			Mass balance closure error is less than 1% of total.	
			Observations of the key modelling outcome data set are not used in calibration (i.e. not available) (see above for those that are used) > no observations of groundwater drawdown, baseflow/leakage. > inferred changes in water balance are lower reliability (but countered by uncertainty analysis).	X			Not all model parameters consistent with conceptualisation.	
							Spatial refinement too coarse in key parts of the model domain.	✓
							The model has been reviewed and deemed fit for purpose by an independent hydrogeologist.	
Class 1	Few or poorly distributed existing wells from which to obtain reliable groundwater and geological information.		No calibration is possible.		Predictive model time frame far exceeds that of calibration.		Model is uncalibrated or key calibration statistics do not meet agreed targets.	
	Observations and measurements unavailable or sparsely distributed in areas of greatest interest.		Calibration illustrates unacceptable levels of error especially in key areas.		Temporal discretisation is different to that of calibration.		Model predictive time frame is more than 10 times longer than the duration of transient calibration. (for long-term post-closure estimates)	✓
	No available records of metered groundwater extraction or injection.	✓	Calibration is based on an inadequate distribution of data.		Transient predictions are made when calibration is in steady state only.		Stresses in predictions are more than 5 times higher than those in calibration.	
	Climate data only available from relatively remote locations.		Calibration only to datasets other than that required for prediction.	✓	Model validation* suggests unacceptable errors when calibration dataset is extended in time and/or space.		Stress period or calculation interval is different from that used in calibration.	
	Little or no useful data on land-use, soils or river flows and stage elevations.						Transient predictions made but calibration in steady state only.	
	No streamflow data available	✓					Cumulative mass-balance closure error exceeds 1% or exceeds 5% at any given calculation time.	
							Model parameters outside the range expected by the conceptualisation with no further justification.	
							Unsuitable spatial or temporal discretisation.	
							The model has not been reviewed.	