Comet Ridge Mahalo North Ltd

Mahalo North CSG Development
Groundwater Impact Assessment
6 December 2024 – Final

Executive Summary

Comet Ridge Mahalo North Ltd (Comet Ridge) proposes to develop The Mahalo North Project (the Project). The Project is a greenfield coal seam gas (CSG) development located in the Denison Trough of the Bowen Basin, between Rolleston and Blackwater. The Project is planned to commence in 2025 and will include the construction of up to 68 wells, with a combination of vertical and lateral wells, a gas compression facility, a water treatment facility, a gathering network and associated supporting infrastructure.

Comet Ridge will exercise its underground water rights under the *Petroleum and Gas (Production and Safety) Act 2004* to enable the production of CSG.

The Project is located within the northern extent of Surat Cumulative Management Area (CMA).

The target formation for gas production by the Project is the Permian-aged Bandanna Formation. The Bandanna Formation comprises discrete coal seams within low permeability siltstone and mudstone interburden. It dips to the southwest in the Project area and subcrops beneath Tertiary-aged basalt and intercalated sediments to the north. Down dip, the Bandanna Formation is separated from the Tertiary Strata by the Rewan Group, a regional scale aquitard. The Bandanna Formation is underlain by a thick sequence of Permian formations, of which there are no recognised aquifers.

The Comet River is the main watercourse in the vicinity of the Project area (approximately 800 m to the west). There are Quaternary-aged alluvial sediments associated with the Comet River and its larger tributaries. The alluvial sediments may host local scale aquifers, which could support terrestrial groundwater dependent ecosystems (GDEs). Woody vegetation across the Project area is unlikely to be groundwater dependent based on field investigations.

Most groundwater use in the region is from the Tertiary Strata for stock watering purposes. The closest mapped springs are over 25 km from the closest boundary of the Project area. These springs are identified to be sourced from the Clematis Group, which is not present in the Project area.

Potential groundwater level drawdown has been predicted using the Surat CMA Underground Water Impact Report (UWIR) numerical groundwater flow model. Parameter uncertainty was assessed through Null Space Monte Carlo analysis implemented through PEST. Because of structural uncertainty in the model due to the relative paucity of data in the north of the CMA, a site-specific model was constructed for this assessment to provide an additional assessment of the groundwater level drawdown, particularly associated with the presence of a fault local to the Project area. Predictions were performed for the Project as a standalone development, and for the cumulative development of the Project as an addition to the cumulative development modelled for the 2021 Surat CMA UWIR.

Groundwater levels were predicted to decline by over 200 m in the Bandanna Formation. However, in all cases, groundwater level drawdown in the Tertiary Strata and alluvium (surficial model layers) were predicted to be less than 0.2 m.

Potential impacts to environmental values (groundwater bores and GDEs) were assessed with respect to the Queensland *Water Act 2000* trigger thresholds, and can be summarised as follows:

- One active water supply bore may be impacted by the Project as a standalone development;
- Only two registered active water supply bores were predicted to be impacted by the cumulative development;
- No springs are predicted to be impacted;
- Remote potential for impact to watercourse springs and associated aquatic GDEs;
- Remote potential for terrestrial GDEs to be impacted;
- Remote potential for stygofauna to be impacted;
- Impacts to water quality are considered unlikely;
- The predicted magnitude of surface subsidence from the Project as a standalone development is approximately 2 mm, and 10 mm for the Cumulative Case within the Project area. The potential for impacts to formation integrity and the water resource is considered negligible.

Primary monitoring and management measures to be implemented by the Project will include:

- CSG production wells will be designed, constructed, operated and decommissioned in accordance with the Code of Practice for the construction and abandonment of coal seam gas and petroleum wells, and associated bores in Queensland (DNRME 2019) (DNRME Code of Practice).
- When identified as a responsible tenure holder in a UWIR, comply with obligations under the Water Monitoring Strategy and Springs Impact Mitigation Strategy, 'make good' obligations, and any other obligations identified in an approved UWIR; and
- Comply with *Water Act 2000* requirements for bore baseline assessments. Baseline assessments for all on-tenure bores will be completed in accordance with the bore baseline assessment guideline (DES, 2022a) and the Project's Baseline Assessment Plan; and
- Should the Project be approved as a controlled action with respect to aquatic GDEs, terrestrial GDES or subterranean GDEs under the EPBC Act (not expected), management measures will be implemented in accordance with the conditions of approval and will align with the Joint Industry Framework (APPEA, 2021).

It is concluded that the Mahalo North Project will not have a significant impact on water resources.

Document Control

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14 September 2023	Final	Ryan Morris	
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RDM Hydro Pty Ltd (RDM Hydro) has prepared this report with all reasonable skill, care and diligence, and taking account of the timescale and resources allowed to it by agreement with Epic Environmental Pty Ltd and Comet Ridge Mahalo North Ltd (the Clients). Information reported herein is based on the interpretation of data collected and collated, which has been accepted in good faith as being accurate and valid.

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RDM Hydro disclaims any responsibility to the clients and any others in respect of any matters outside of the agreed scope of the work.

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1. Introduction

Comet Ridge Mahalo North Ltd (Comet Ridge) proposes to develop The Mahalo North Project (the Project). The Project is a greenfield coal seam gas (CSG) development located in the Denison Trough of the Bowen Basin, between Rolleston and Blackwater. It occupies the southern portion of Authority to Prospect (ATP) 2048 and is under application for petroleum lease 1128 (PL1128).

The objective of this assessment is to evaluate the potential impacts to groundwater resources, groundwater-dependent assets and groundwater environmental values resulting from the Project's CSG production. The assessment addresses the requirements of both State and Commonwealth regulatory regimes, to enable environmental approvals for the Project to be attained.

1.1. Project Description

The Project will involve the progressive development of gas infrastructure, planned to commence in 2025, including the following activities:

- Drilling, installation, operation and maintenance of up to 68 wells, comprising a combination of vertical and lateral wells;
- Installation, operation and maintenance of gas and water gathering flowlines;
- Installation, operation and maintenance of associated supporting infrastructure (e.g. access roads, power and communication systems, temporary accommodation camps, laydowns, stockpiles etc);
- Gas compression facilities (GCF);
- Management of CSG produced water; and
- Decommissioning and rehabilitation of infrastructure and disturbed areas.

In order to produce CSG, it is necessary to reduce the reservoir pressure to enable gas to desorb from the coal. Depressurisation is achieved by pumping groundwater via appropriately constructed wells. For the Project, pairs of horizontal and vertical wells will be installed. The horizontal well provides access to the coal seams, while the vertical provides a chamber into which the pump can be installed. Zones above the target interval are sealed with steel casing and cement to ensure that production is from the target zone only. The planned well design is shown conceptually as Figure 1.

The CSG wells will be designed, drilled, constructed, operated and decommissioned in accordance with the *Code of Practice for the construction and abandonment of petroleum wells and associated bores in Queensland* (DNRME, 2019).

Hydraulic fracturing of the wells is not proposed.

Water for drilling and construction will initially be sourced from landholders (overland flow) under commercial arrangements and in accordance with the relevant Queensland legislation and protocols. Once CSG water production commences, produced water will be used for construction and other Project purposes in accordance with EA and other regulatory requirements. It is estimated that approximately 0.2 ML of water will be required per well to drill and construct. Less than 5 ML of water sourced from landholders (under commercial arrangements) will be required prior to produced water becoming available.

Comet Ridge will exercise its underground water rights through the extraction of groundwater necessary for the production of CSG. The volumes of water that will be produced have been estimated using a dual-phase reservoir model using Comet Ridge's current understanding of the variations in depth, thickness, permeability, porosity, gas content, saturation, etc. of the target coal seams and based on pilot production of the Mahalo North 1 well. The currently estimated water production is shown on Figure 2. Figure 2 has been generated by adding the estimated water production over time for the individual wells at the time at which they are anticipated to start production.

CSG water management will be undertaken in accordance with the Mahalo North CSG Water Management Plan (RDM Hydro, 2023), which has been developed to meet the requirements of the CSG Water Management Policy (DEHP, 2012).

Produced water will be collected via a high-density polyethylene pipe water gathering systems to water storage facilities for aggregating untreated CSG water, treated water, blended water and saline effluent. Water will be stored in lined pre-engineered above ground tanks which will be designed in accordance with accepted engineering standards.

Comet Ridge may construct and operate a reverse osmosis (RO) treatment plant, which may be necessary to desalinate the produced water for some beneficial uses. The RO treatment plant produces two process water streams: a fresh permeate and saline effluent. The permeate will be stored temporarily prior to beneficial use. The saline effluent will be stored separately and evaporated to concentrate the salts into a brine and ultimately to produce salt. The salt will be disposed in a waste facility licensed to accept the material. The management of brine will be addressed through the EA requirements. Comet Ridge's approach to brine management will remain consistent with industry best practice.

Beneficial use of produced water will be maximised through the following uses:

- Project activities, such as dust suppression, drilling and construction;
- Water for revegetation during progressive rehabilitation;
- Landholder water supply arrangements for stock watering; and
- Irrigation of improved pasture or other suitable crops.

The beneficial use of water will be undertaken in accordance with the *End of Waste Code Associated Water (including coal seam gas water)* (DES, 2019a) and *End of Waste Code Irrigation of Associated Water (including coal seam gas water)* (DES, 2019b).

Figure 1 Conceptual Diagram of the Planned Well Design

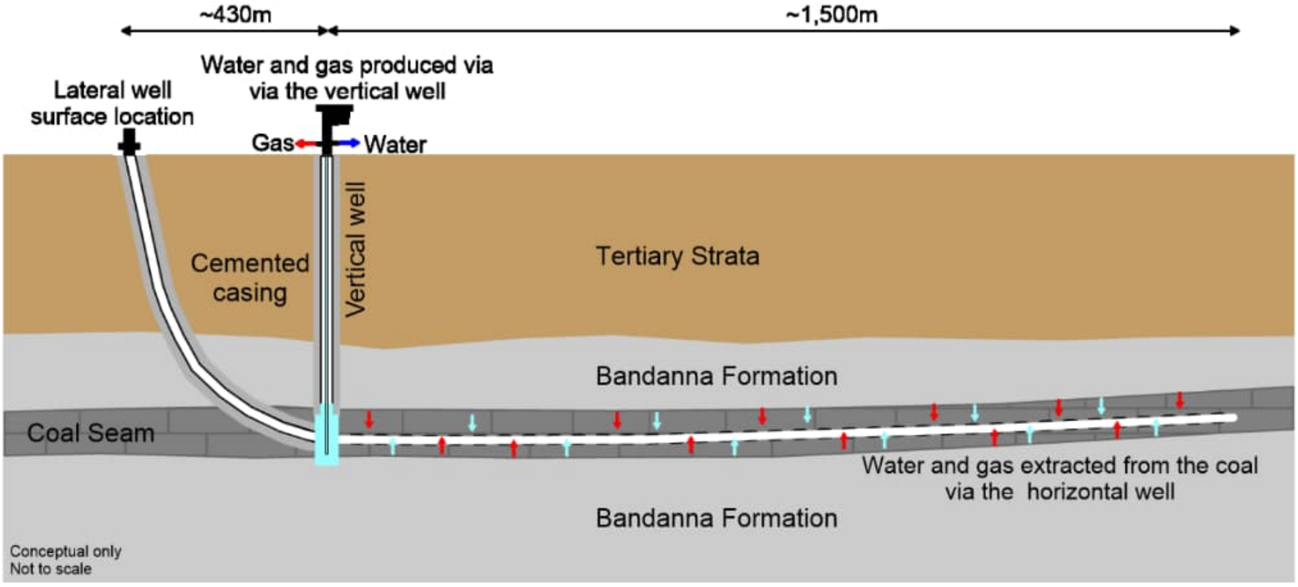
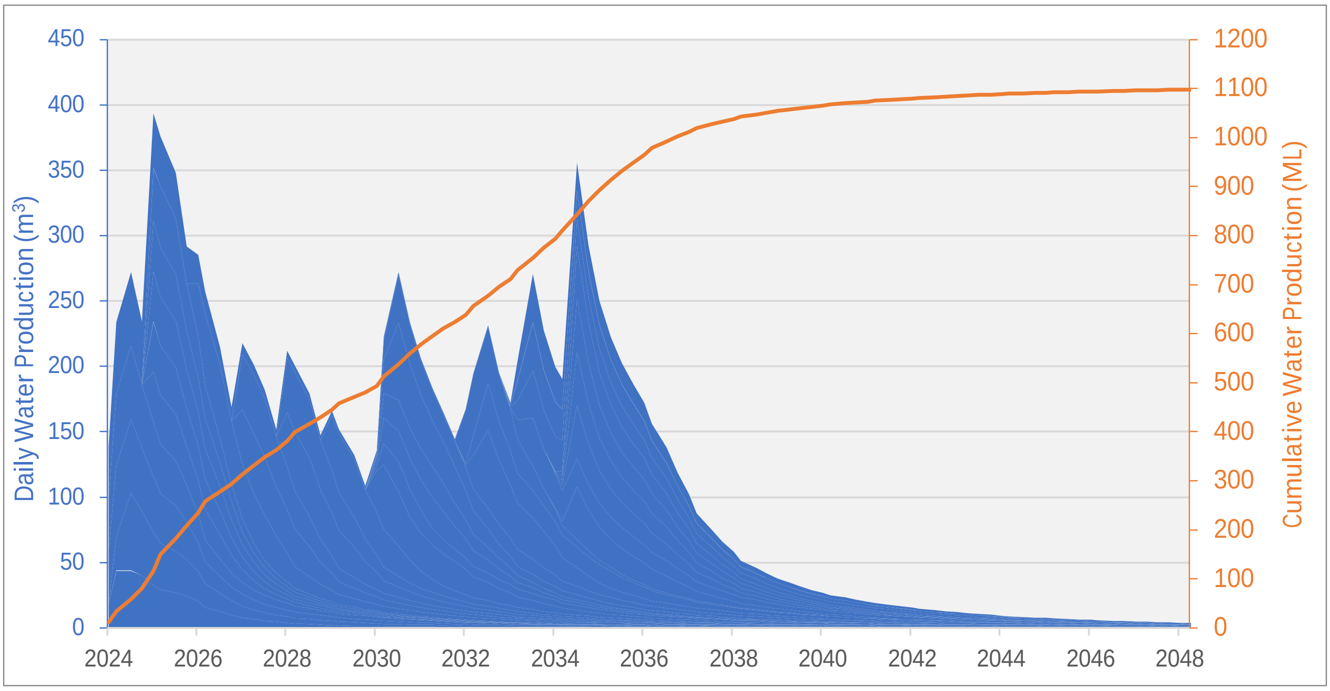


Figure 2 Forecast Monthly and Cumulative Associated Water Production (2024 to 2048)



1.2. Information and Data Sources

In addition to site-specific information acquired by the Project, this assessment has used publicly available reports and data and previous hydrogeological assessments prepared for Comet Ridge. Primary data and information utilised in this assessment includes:

Datasets:

- Comet Ridge's geological model for the Project area and surrounds, which integrates thousands of coal exploration bore logs, government stratigraphic bores, petroleum wells and seismic acquisitions. The data used was a subset of Comet Ridge's wider area geological model
- Geological information, including image log assessment, from the Mahalo North 1 CSG well

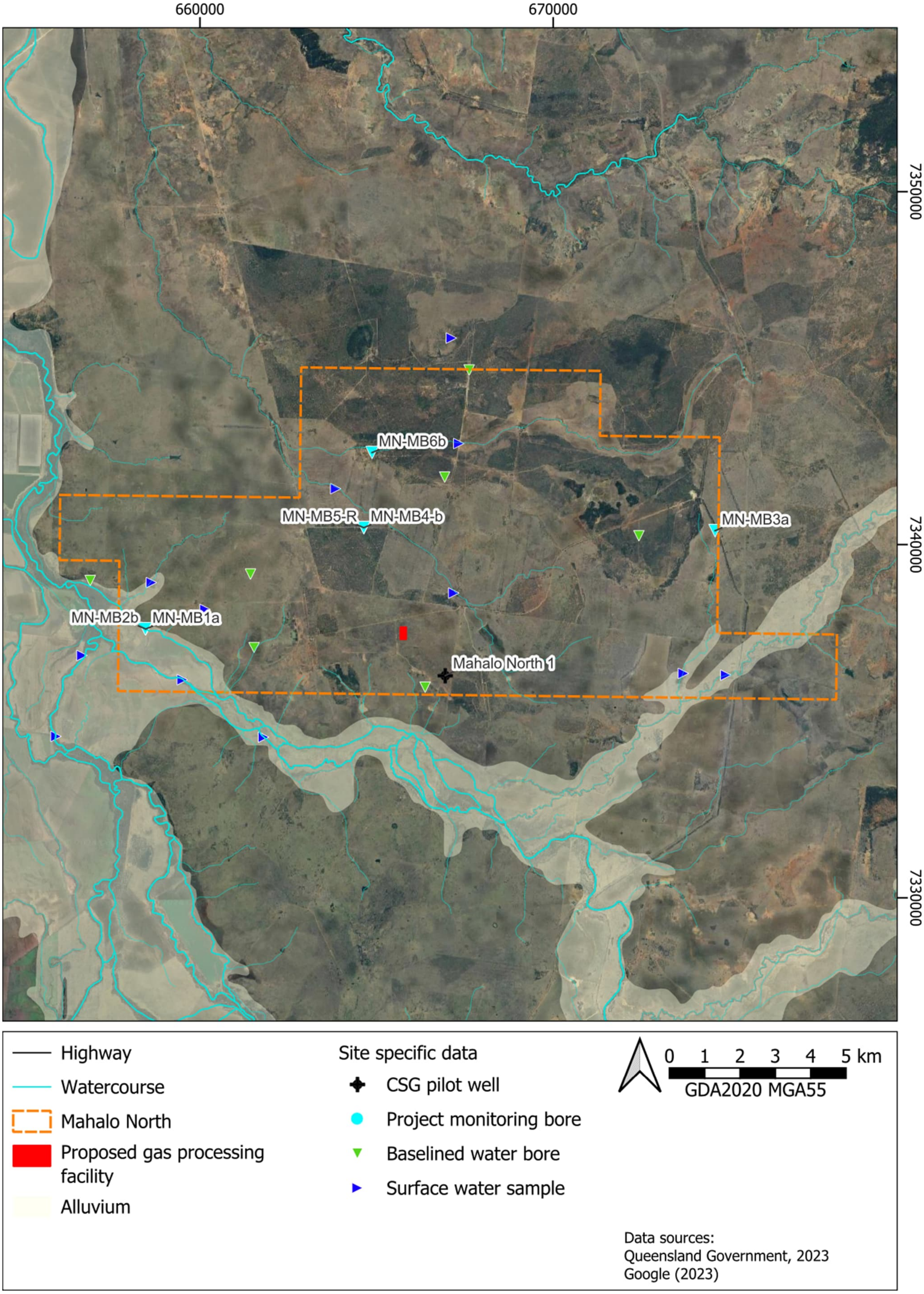
- Production data (water rates, pressure and water quality) from the Mahalo North 1 CSG production pilot
- Groundwater monitoring data from bores installed by the Project (Appendix A). Bores were primarily installed to inform groundwater dependent ecosystem (GDE) studies
- Surface water quality data collected during the dry season across the Project area (DPM EnviroSciences, 2023)
- Registered bore data from the Queensland Department of Regional Development Mines and Water Groundwater Database (GWDB)
- Geological datasets compiled by the Sliwa et al. (2017) into the “Bowen Supermodel”
- The numerical groundwater flow model for the Surat CMA UWIR (OGIA, 2023), including geological surfaces and hydraulic parameter distributions
- Surat CMA bore aquifer attribution dataset, provided by OGIA
- Potential GDE mapping published by the former Department of Environment and Science
- Surface water flow data sourced from the Queensland Government Water Monitoring Information Portal
- Petroleum well completion reports, sourced from the Geological Survey of Queensland (GSQ) Open Data Portal
- Baseline bore assessment reports and associated data, provided by Comet Ridge

Reports:

- Underground Water Impact Report for the Surat CMA
- Hydrogeological Conceptualisation Report for the Surat CMA
- Groundwater Technical Report Comet Ridge Mahalo Gas Project (Golder Associates, 2018)
- Watermark Eco (2024) Groundwater Dependent Ecosystem Assessment Mahalo North CSG Development

The locations of Project-specific data acquisition are shown on Figure 3.

Figure 3 Project-specific data acquisition



2. Legislation and Regulation

2.1. Commonwealth Legislation and Guidelines

2.1.1. Environment Protection Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the key piece of Commonwealth legislation governing environmental protection in Australia. Administered by the Commonwealth Government Department of Climate Change, Energy, the Environment and Water (DCCEEW), the EPBC Act defines and protects nine matters considered to be of National Environmental Significance (MNES) including:

- World heritage properties;
- National heritage places;
- Wetlands of international importance (listed under the Ramsar Convention);
- Listed threatened species and ecological communities;
- Migratory species protected under international agreements;
- Commonwealth marine areas;
- The Great Barrier Reef Marine Park;
- Nuclear actions (including uranium mines); and
- A water resource in relation to an unconventional gas development and large coal mining development (commonly referred to as the "water trigger").

Under Part 3 of the EPBC Act, a person must not undertake an action (e.g. a Project, a development, an undertaking, an activity or a series of activities, or an alteration of any of these things) that will have, or is likely to have, a significant impact on a protected matter, without approval from the Minister.

While several plant and animal species that are endemic to the Great Artesian Basin (GAB) springs are listed under the EPBC Act, the ecosystem associated with GAB discharge springs is a MNES as *The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin* is a listed threatened ecological community. There is negligible potential for the Project to impact on *The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin* as the Mahalo North development is outside the geological extent of the GAB.

Since the Project is an unconventional gas development, the hydrogeological system in which it is situated is considered a MNES.

IESC

The independent expert scientific committee (IESC) is a statutory committee established under the EPBC Act. The IESC's key function is to advise regulators regarding potential impacts to water resources from unconventional gas or large coal mining development proposals.

The IESC prepared an information guideline (IESC, 2024) outlining the relevant information necessary for the IESC to undertake. Appendix A includes a checklist based on the guideline and the conformance of this assessment to that checklist by identifying the relevant sections of this report against each item. It is noted that some items in the guideline and checklist are not relevant this Project (e.g. final landforms).

2.1.2. Significant Impact Guidelines 1.3: Coal Seam Gas and Large Coal Mining Developments

The stated core purpose of the *Significant Impact Guidelines 1.3: Coal Seam Gas and Large Coal Mining Developments* (Commonwealth of Australia, 2013a) (SIG1.3) is to assist with deciding whether a CSG development or large coal mining development is likely to have a significant impact on a water resource. If a significant impact is considered possible, the Project should be referred to the DEE for assessment of whether Ministerial approval is required under the EPBC Act. The guidelines provide detailed criteria for assessing a project.

The SIG1.3 define a significant impact as "*an impact which is important, notable, or of consequence, having regard to its context or intensity*". The assessment of significance is dependent on the "*sensitivity, value and quality of the water resource which is impacted, and upon the duration, magnitude and geographic extent of the impacts*." The likelihood of a significant impact occurring is assessed on the potential for real or non-remote chance of the event occurring, thus incorporating the precautionary principle in the decision.

For a water resource, the SIG1.3 identify that an action will likely have a significant impact if there is a real or non-remote possibility that the Project will affect:

- Changes in water quantity, including the timing in variations in water quantity;
- Changes in the integrity of hydrological or hydrogeological connections, including substantial structural damage (e.g. through subsidence); and
- Changes in the area or extent of a water resource.

The significance of the impact is assessed in the context of current or future use of the water resource for third party users inclusive of the environment. The SIG1.3 list the following hydrological characteristics that may need to be considered in assessing changes, through and beyond the life of the project:

- Flow regimes (volume, timing, duration and frequency of surface water flows);
- Recharge rates to groundwater;
- Aquifer pressure or pressure relationships between aquifers;
- Groundwater table and potentiometric surface levels;
- Groundwater-surface water interactions;
- River-floodplain connectivity;
- Inter-aquifer connectivity; and
- Coastal processes.

In terms of changes to water quality, the SIG1.3 identifies that a significant impact on water quality may occur when:

- There is a risk that the ability to achieve relevant local or regional water quality objectives would be compromised, resulting in:
    - Risks to human or animal health or to the condition of the natural environment;
    - Substantially reduces the amount of water available for uses which are dependent on the quality of the water, including use by the environment;
    - Causes the persistent accumulation of organic chemicals, heavy metals, salt or other harmful substances in the environment;

  - Seriously affects the habitat or lifecycle of a native species dependent on a water resource; or
  - Causes the establishment of an invasive species that is harmful to the ecosystem function of the water resource.
- There is a significant worsening of local water quality, or
- High quality water is release into an ecosystem which is adapted to a lower water quality of water.

Conformance with the requirements of SIG1.3 is summarised in Section 10.

2.1.3. Matters of National Environmental Significance - Significant impact guidelines 1.1

The Matters of National Environmental Significance - Significant impact guidelines 1.1 (Commonwealth of Australia, 2013b – SIG1.1) identify the following aspects of a critically endangered or endangered ecological communities which would be considered a likely significant impact if it were to occur:

- The extent of an ecological community was reduced;
- Fragmentation, or increased fragmentation, of an ecological community;
- The habitat critical to the survival of an ecological community was adversely affected;
- The modification or destruction of non-living factors necessary for the survival of an ecological community, including the reduction in groundwater levels;
- A substantial change in the species composition of an occurrence of the community;
- A substantial reduction in the quality or integrity of an occurrence of an ecological community, including:
  - The establishment of invasive species.
  - The mobilisation of fertiliser, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the community.
- Interfere with the recovery of an ecological community.

The test for significance is similar to SIG1.3.

2.1.4. Joint Industry Framework

The *Coal Seam Gas - Joint industry framework Managing impacts to groundwater resources in the Surat Cumulative Management Area under EPBC Act approvals* (APPEA, 2021) (JIF) was collaboratively developed between the Australian Petroleum Producing and Exploration Association (APPEA), the Commonwealth regulator, and Queensland government agencies.

The stated purpose of the JIF is t*o establish a consistent post-approval framework for the management of impacts on groundwater caused by CSG developments within the Surat CMA that are subject to approvals under the EPBC Act.*

The JIF provides a risk management framework to achieve stated outcomes for relevant MNES. It is intended to reduce duplication between regulation at the Commonwealth and State levels.

The JIF applies to approvals based on potential impacts to GAB discharge springs or to the water trigger and relates only to groundwater and all aspects of the groundwater resource (including groundwater, organisms and other components and ecosystems that contribute to the physical state and environmental value of the groundwater resource). The significance of impacts to a water resource is determined through the reduction in the current or future utility of the water resource to third party users (associated users) caused by changes to hydrology and water quality from CSG and large coal mining developments. For the purposes of the JIF, associated users are water supply bores and groundwater dependent ecosystems (GDEs).

The EPBC Act does not protect these associated users as MNES in their own right, but conditions controlling the impact of an action on these associated users are used to ensure the management of impacts on a water resource. The Commonwealth regulator identified outcomes for each associated user, and the JIF establishes the management frameworks to achieve those outcomes. The application of the outcomes and management frameworks to projects through approval conditions aims to ensure the acceptability of impacts by an action on a water resource.

2.2. State Legislation and Regulations

2.2.1. Petroleum and Gas (Production and Safety) Act 2004

The *Petroleum and Gas (Production and Safety) Act 2004* (State of Queensland, 2023a) (P&G Act) legislates for the safe and efficient exploration for, recovery of and transport of petroleum and fuel gas.

The P&G Act establishes underground water rights for petroleum tenure holders. This allows the tenure holder to take or interfere with underground water in the spatial extent of the tenure, if that interference or take occurs while undertaking another authorised activity for the tenure. There is no volumetric limit to the amount of water that may be taken, however the tenure holder is subject to the provisions of Chapter 3 of the *Water Act 2000* (State of Queensland, 2023b). The associated water can be used for any authorised purpose, within or off the tenement on which it was produced.

2.2.2. Environmental Protection Act 1994

The *Environmental Protection Act 1994* (State of Queensland, 2023c) (EP Act) is intended to regulate development in an ecologically sustainable manner. The EP Act requires an Environmental Authority (EA) to be approved for any environmentally relevant activity, which includes petroleum activities.

Sections 126A and 227AA of the EP Act identify the requirements for site-specific EAs and EA amendment applications, where a resource project involves the exercise of underground water rights or a change to the exercise of underground water. Conformance of this document with these requirements is identified in Table 1 (DES, 2021). A change to the exercise of underground water rights may include:

- The conversion of an ATP to PL;
- Adding a tenure to the EA;
- A significant change to the nature or scale of existing activities;
- Significant change to the volumes of water proposed to be taken; or
- A change to the predictions of impacts to environmental values compared with previous assessments.

The Project will incur a change to its underground water rights as it seeks to convert the ATP to a PL and will transition from an exploration to a production project. Therefore there will be a significant change to the scale of the activities and the proposed taken in water volumes.

This document is intended to address specific requirements of Section 126A (Table 1).

Table 1 Requirements Under the EP Act (DES, 2021)

Part of Guideline	EP Act	Description	Section of this Report
Part A	126A(2)(a)	A statement that the applicant proposes to exercise underground water rights	Section 1.1
Part B	126A(2)(b)	A description of the area/s in which underground water rights are proposed to be exercised	Section 1.1, Figure 4
Part C	126A(2)(c)(i)	A description of the aquifer/s affected or likely to be affected	Section 4
Part D	126A(2)(c)(ii)	An analysis of the movement of underground water to and from the aquifer	Section 4
Part E	126A(2)(c)(iii)	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 7.2
Part F	126A(2)(c)(iv)	The predicted quantities of water to be taken or interfered with because of the exercise of underground water rights - noting that the EP Act requires take for the life of the Project	Section 1.1, Figure 2
Part G	126A(2)(e)	Information on the predicted impacts to the quality of groundwater that will, or may, happen because of the exercise of underground water rights	Section 7.5
Part H	126A(2)(d)	Information on the environmental values that will, or may, be affected by the exercise of underground water rights	Section 7.3
Part I	126A(2)(f)	Information on the strategies for avoiding, mitigating or managing the predicted impacts on the environmental values or predicted impacts on the quality of groundwater	Section 8

2.2.3. Water Act 2000

The primary purpose of the *Water Act 2000* (State of Queensland, 2023b) is to provide a framework for the sustainable management of Queensland's water resources, including the management of impacts on groundwater caused by the exercise of underground water rights by the resource sector. It is intended to:

- Sustain the health of ecosystems, water quality, water-dependent ecosystems and biological diversity;
- Recognise the interests of Aboriginal people and Torres Strait Islanders;
- Enable fair access to water resources in support of economic development; and
- Promote the efficient use of water.

The *Water Act 2000* vests all rights to the control of water in Queensland to the State, and the State may authorise the use of water through a number of instruments, including legislation, allocations, licenses, and permits. The sustainable use of water is managed through the preparation and implementation of water plans and water use plans, with processes for releasing unallocated water identified in a water management protocol.

Chapter 3 of the *Water Act 2000* provides for the management of impacts on underground water (groundwater) due to the exercise of underground water rights by resource tenure holders. It provides a regulatory framework that requires a resource tenure holder to:

- Monitor and assess the impacts of groundwater extraction associated with resources extraction on water bores and springs,
- Prepare underground water impact reports (UWIR) that establish obligations to monitor and manage impacts on aquifers and springs,
- Manage the cumulative impacts due to the exercise of two or more resource tenure holders' underground water rights, and
- Enter make good agreements with owners of bores impacted by the exercise of underground water rights.

In areas of concentrated development, a cumulative management area (CMA) can be declared. The Project is located within the Surat CMA, which was declared in 2011. The Office of Groundwater Impact Assessment (OGIA) was established under the *Water Act 2000* and is responsible for preparing the UWIR and for establishing obligations to monitor and manage impacts on aquifers and spring. OGIA assigns responsibility to individual petroleum tenure holders for implementing specific parts of the strategies within CMAs. These predictions, strategies and responsibilities are set out in the Surat CMA UWIR, prepared and maintained by the OGIA.

The most recent Surat CMA UWIR was published by OGIA in 2021.

The OGIA has provided Comet Ridge with data from the Surat CMA UWIR regional scale groundwater flow model to inform this assessment.

2.2.4. Environmental Protection (Water and Wetland Biodiversity) Policy 2019

The purpose of the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP (Water and Wetland Biodiversity)) (State of Queensland, 2019) is to determine the environmental values and associated WQOs for Queensland

- identifying environmental values and management goals for Queensland waters,
- stating water quality guidelines and water quality objectives to enhance or protect the environmental values,
- providing a framework for making consistent, equitable and informed decisions about Queensland waters, and
- monitoring and reporting on the condition of Queensland waters.

The Project area is located within the eastern tributaries Comet River Sub-Basin of the Fitzroy Basin. The EPP (Water and Wetland Biodiversity) provides defined EVs and water quality objectives (WQOs) for the Comet River Sub-Basin under Schedule 1 of the policy and are detailed in DEHP[1] (2011). EVs for the Comet River Sub-Basin are presented in Table 2 and includes both the values for surface water and groundwater.

[1] Note that the Queensland Department of Environment and Heritage Protection (DEHP) is now the Department of Environment and Science (DES)

For groundwaters, where they interact with surface waters, groundwater quality should not compromise identified EVs and WQOs for those waters.

Table 2 Environmental Values for the Comet River Sub-Basin Waters Within the Vicinity of the Project (DEHP, 2011)

Water	Environmental Values											
	Aquatic Ecosystem	Irrigation	Farm Supply / Use	Stock Water	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual recreation	Drinking water	Industrial use	Cultural and spiritual
Comet River Sub-Basin (WQ1307)												
Comet western tributaries – developed areas	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Comet eastern tributaries – developed areas	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Comet main channel – developed areas (including Comet weir waters)	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Fresh waters in undeveloped areas	✓		✓	✓		✓	✓	✓	✓	✓		✓
Groundwater	✓	✓	✓	✓			✓			✓	✓	✓

✓denotes the EV is selected for protection. Blank indicates that the EV is not identified for protection.

2.2.5. Water Plan (Fitzroy Basin) 2011

The Project is located in the Fitzroy River drainage basin and the volumetric surface water resources are managed under the *Water Plan (Fitzroy Basin) 2011.* The purposes of the plan is to:

- Define the availability of water in the plan area;
- Provide a framework for sustainably managing water and the taking of water;
- Identify priorities and mechanisms for dealing with future water requirements;
- Provide a framework for establishing water allocations;
- Provide a framework for reversing, where practicable, degradation in natural ecosystems;
- Regulate the taking of overland flow water; and
- Regulate the taking of groundwater.

The implementation of the *Water Plan (Fitzroy Basin) 2011* is enabled through the *Fitzroy Basin Resource Operations Plan*, which provides the operating and environmental management rules and requirements.

3. Site Setting

The Project is located in central Queensland, approximately 45km north of Rolleston, 56 km southwest of Blackwater and 73km southeast of Emerald (Figure 4).

The Project occupies PL1128 which covers an area of 140.8 km^2. For the purposes of this assessment, the area occupied by PL1128 is referred to hereafter as the “Project area”. The area within a roughly 25 km buffer of the Project area is referred to hereafter as the “Study area’.

The Project area is surrounded by a number of existing and proposed resource developments and exploration activities, as summarised in Table 3 and shown on (Figure 4).

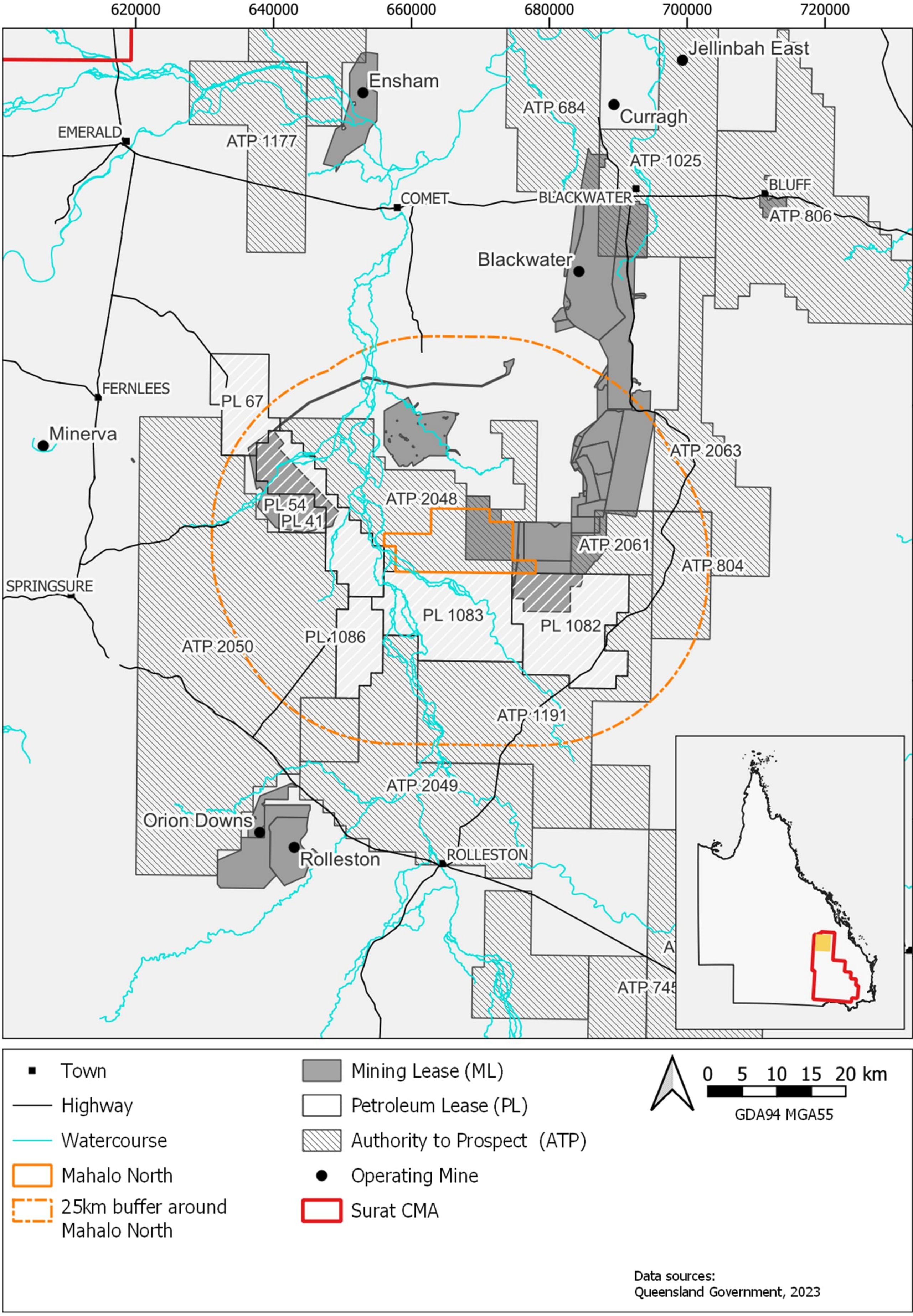
The Mahalo development, immediately adjacent to the southern boundary of the Project area was approved under the EPBC Act as “Not a Controlled Action” with respect to the water trigger.

Table 3 Surrounding Resource Projects

Tenement	Name	Description	Status	Distance and direction from nearest PL boundary
PL1082, PL1083	Mahalo	CSG development of up to 141 wells. Operated by Santos, but Comet Ridge is a major joint venture partner	Proposed (with environmental approvals in place)	Immediately adjacent to southern boundary
PL41, PL42, PL54, PL67, PL1086	Denison North	Six conventional gas fields with 37 gas wells targeting deep Bowen Basin formations	Operating	Adjacent to the western boundary
ATP2063, ATP804, ATP1191, ATP2049, ATP2050	-	CSG exploration tenements	Exploration	East, south and west in an arc of 10 - >25km
ML70167, ML70319, ML1907, ML1829*	Blackwater Mine	Large coal mine that has been in operation since the 1960s, with some historical underground workings in the south. Currently limited mining development in the southern MLs	Operating	Northeast
ML700070, ML700071	Blackwater Mine	Southern tenements of the blackwater mine	ML application	Overlaps with the northeastern corner and adjacent to the eastern boundary
ML70149	Togara North	Proposed underground coal mine	Proposed	7 km northwest
ML70486	Springsure Creek Coal Mine	Proposed coal mine	ML application	15 km northwest
ML70307, ML70415, ML70452	Rolleston/Orion Downs Coal mine	Open cut coal mine, operating since 2005	Operating	37 km southwest

* Only the southern MLs of Blackwater Mine identified.

Figure 4 Site Location and Layout



3.1. Climate

The Study area experiences a sub-tropical climate with a moderately dry winter and wet summer months. Climate data was sourced as patched point data for station 35063 Somerby extracted from SILO. The location of the Somerby Station is shown on Figure 8.

Mean maximum temperatures range between ~34°C in the summer months and ~22°C in the winter months. Mean minimum temperatures range between ~21°C in the summer months and ~6°C in the winter months.

Monthly rainfall and evaporation statistics calculated from 1930 to 2022 are presented Figure 5 and Figure 6 respectively. The annual average rainfall at Somerby is 610 mm, with the majority falling between November and March. The average monthly rainfall is higher than the median indicating that periodic large rainfall events bias the average high. Monthly evaporation rates exceed rainfall in all months of the year. The median and average monthly evaporation rates are similar.

Figure 7 presents monthly rainfall between 1960 and 2023 for the Somerby climate station, and a rainfall residual mass curve for the same period, but calculated from 1930 to the end of 2022. Rainfall residual mass curves present a cumulative deviation of long term average rainfall. This provides seasonal-scale identification of trends (wet / dry) and longer term (e.g. decadal) deviation from average conditions. These trends result in a natural tempering of peaks for rainfall events, and therefore support the correlation of rainfall events to aquifer responses. Rising trends indicate periods of above average rainfall, and declining trends are indicative of periods of below average rainfall.

The overall rainfall trend is characterised by the cycles of generally below average rainfall, with a discrete season of significantly above average rainfall (1974, 1998, 2010), followed by a few years of average or above average rainfall, and into a period of below average rainfall.

Figure 5 Monthly Rainfall Statistics - Station 35063 Somersby (1930-2022)

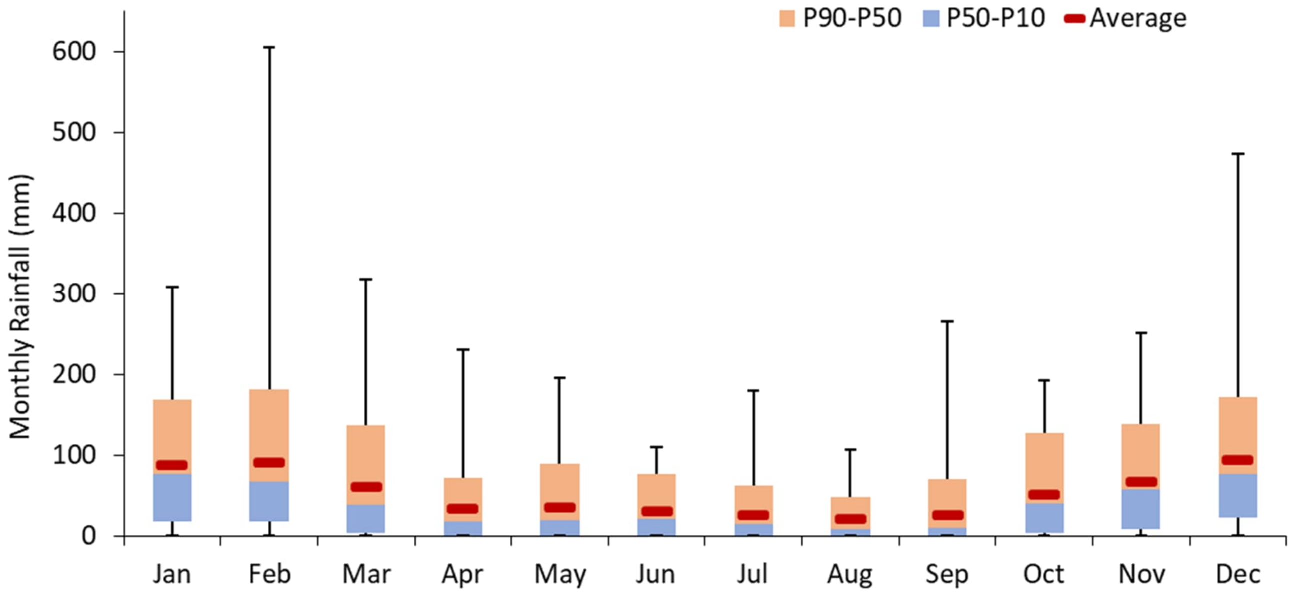


Figure 6 Monthly Evaporation Statistics - Station 35063 Somersby (1930-2022)

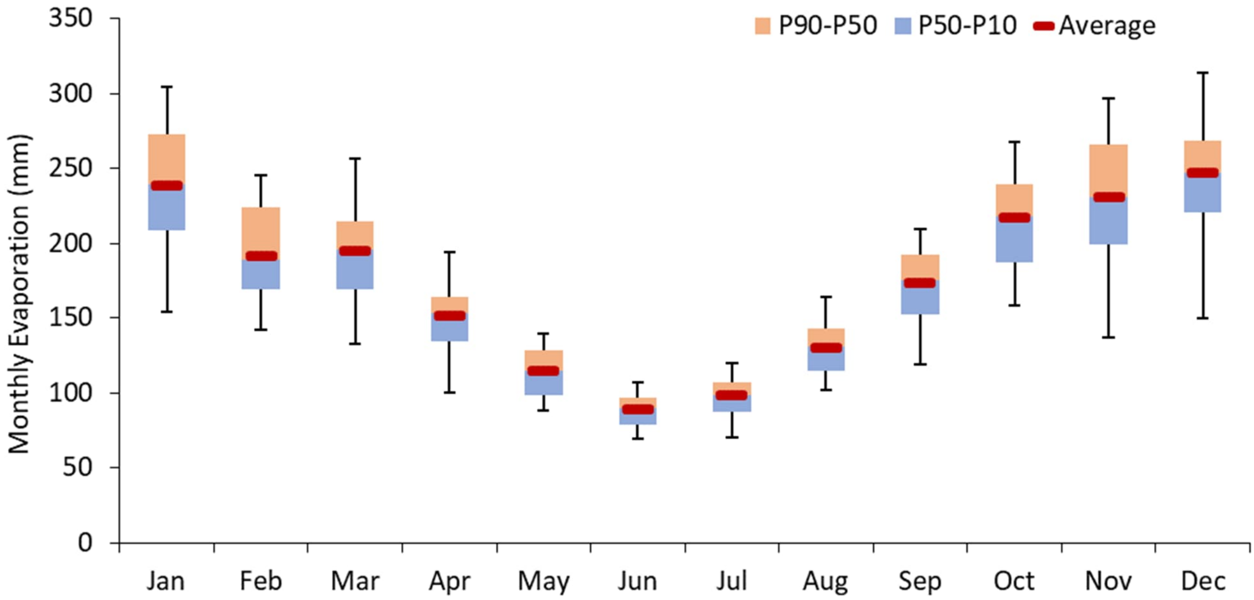
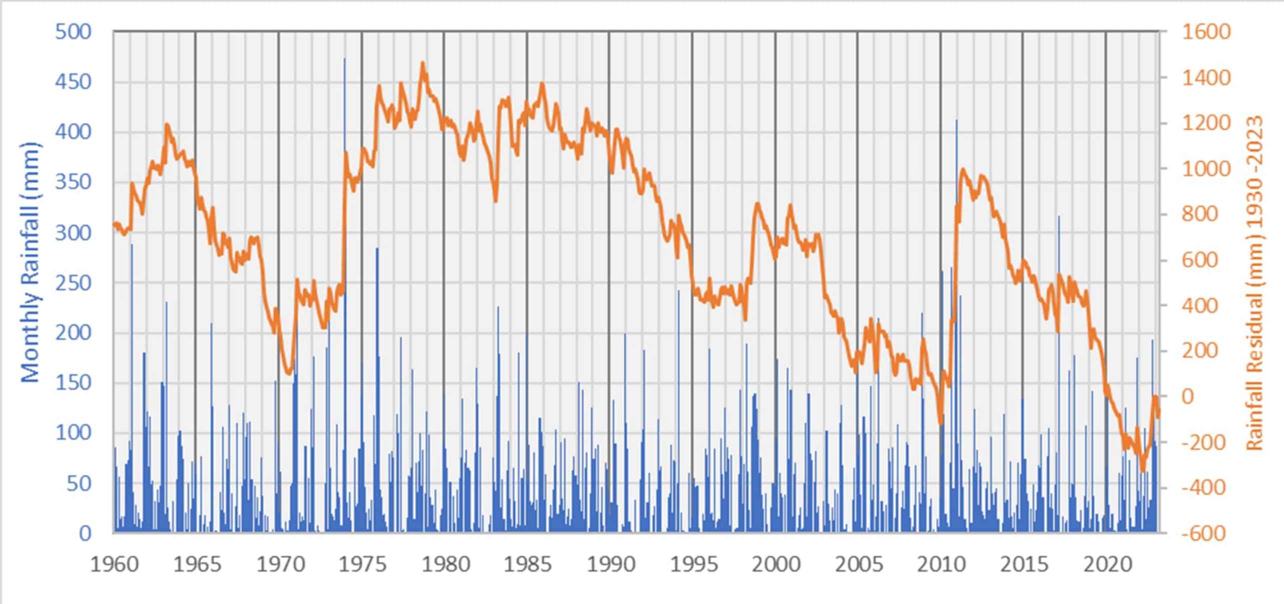


Figure 7 Monthly Rainfall and Rainfall Residual (Station 35063 Somersby)



3.2. Topography and Drainage

The Study area is wholly within the Comet River catchment of the Fitzroy Basin. The topography across the Project area generally falls from east to west, towards the Comet River, which is the main drainage feature in the region. Humboldt Creek, a tributary to the Comet River transects the southwestern corner of the Project area.

Ephemeral unnamed watercourses drain the central parts of the Project area, flowing into Sirius Creek near its confluence with the Comet River, approximately 18 km north of the Project area boundary.

Within the Project area the elevation ranges from 190 mAHD to ~250 mAHD.

The outcrop of the Clematis Group forms the high ground of the Expedition Ranges to the east of the Study area, rising to ~800 mAHD along the escarpment of the Clematis Group outcrop.

Figure 9 presents the mean daily discharge for three surface water gauging stations within the Study area. The data was sourced from the Queensland Government Water Monitoring Information Portal (State of Queensland, 2023). Stations 130506A and 130510A on the Comet River are active gauging stations (upstream and downstream of the Project area respectively), whereas 130505A on Humboldt Creek is no longer active. The locations of the gauging stations are shown on Figure 8. These streamflow data indicate:

- Flow in the Comet River and Humboldt Creek is ephemeral, with extended periods of no flow,
- The majority of flow occurs during December to March, corresponding to the wet season, and
- In wetter periods, streamflow may be sustained through the dry season, indicating the potential for significant volumes of bank storage.

The Geoscience Australia (2023) *Water Observations from Space* (WoFS) displays historical surface water observations derived from satellite imagery for the period 1987 to present. Figure 10 includes the frequency that surface water is observed based on the WoFS product. It shows:

- Areas with permanent presence of water is limited to water storages such as irrigation dams, stock watering dams, mine pit lakes and tailings dams
- There is a distinct difference between the areas underlain by Quaternary Alluvium to the west of the Comet River and those underlain by Tertiary Strata to the east of the Comet River, with the former being lower lying and more frequently inundated, albeit with surface water detected on less than 5% of observation thus related to flooding
- Water is detected in less than 1% of observations along most of the Comet River except for small, disparate areas where pools may form after surface water flows
- Water is not detected along most of the smaller water courses, including Humboldt Creek.

The streamflow gauging data and the WoFS statistics support the assertion that the watercourses in the study area are of a non-perennial nature, which is further supported by the surface water monitoring undertaken on behalf of the Project by DPM Envirosciences (2023).

Figure 8 Topography and Drainage

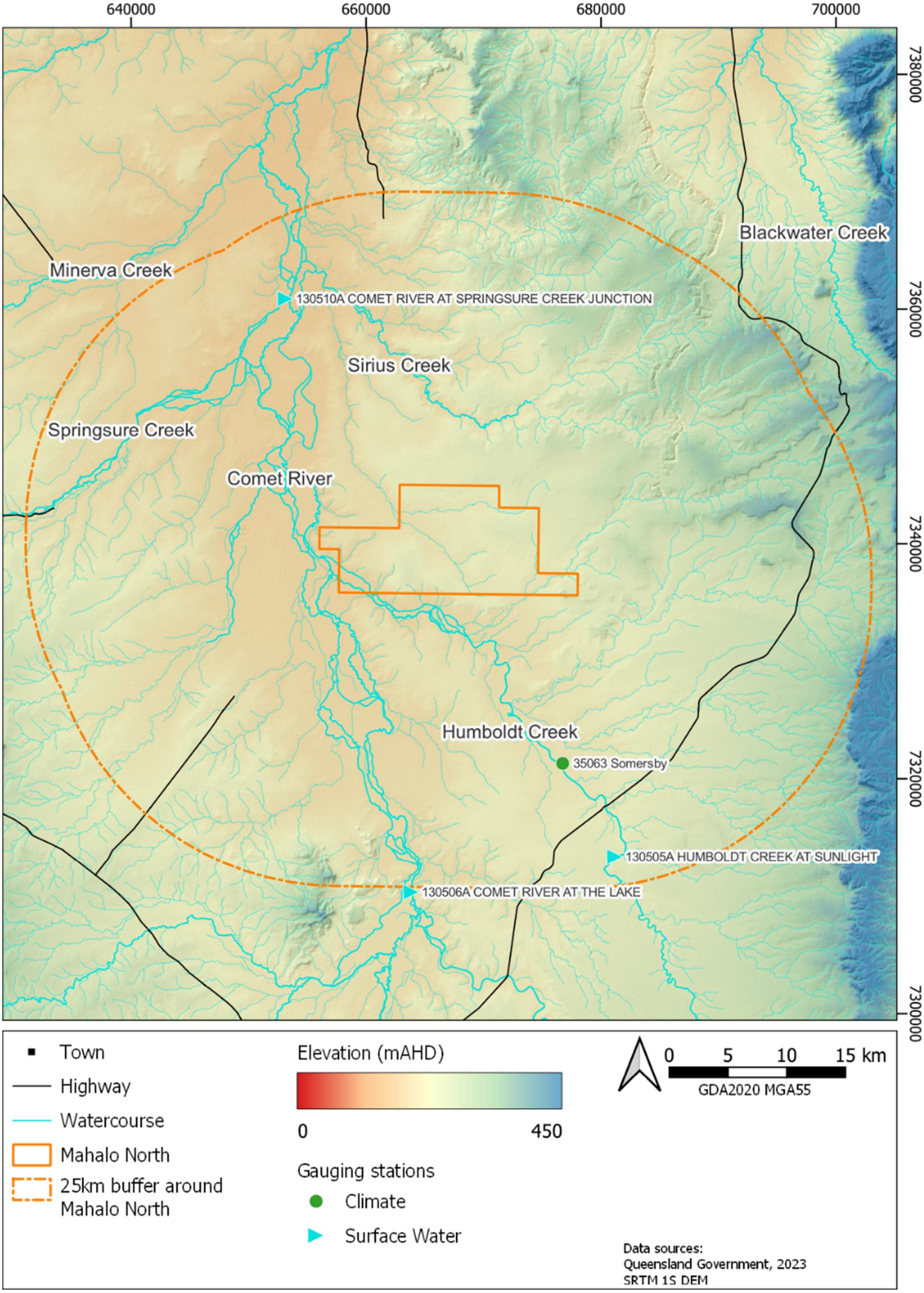


Figure 9 Mean Daily Discharge at Gauging Stations

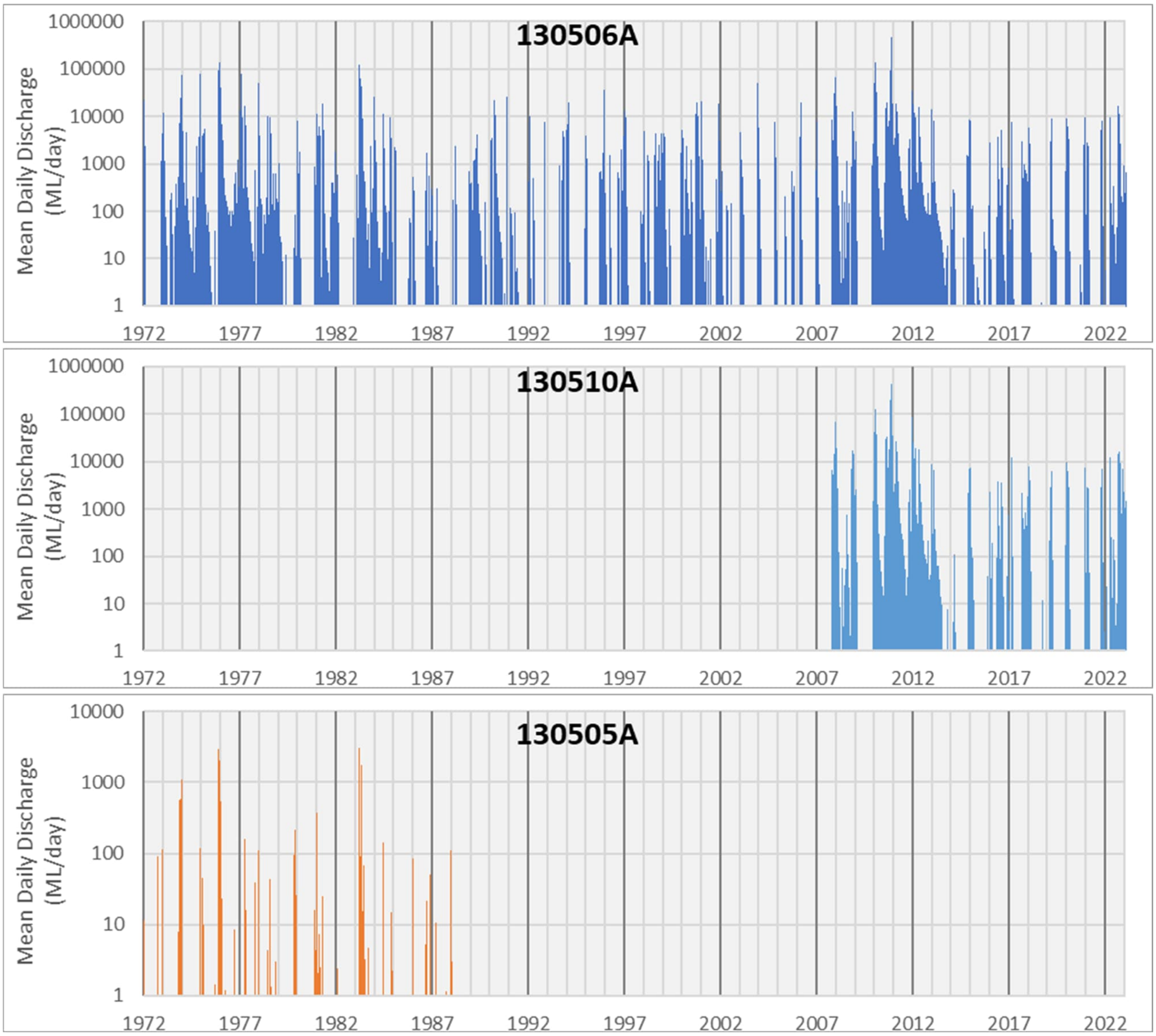
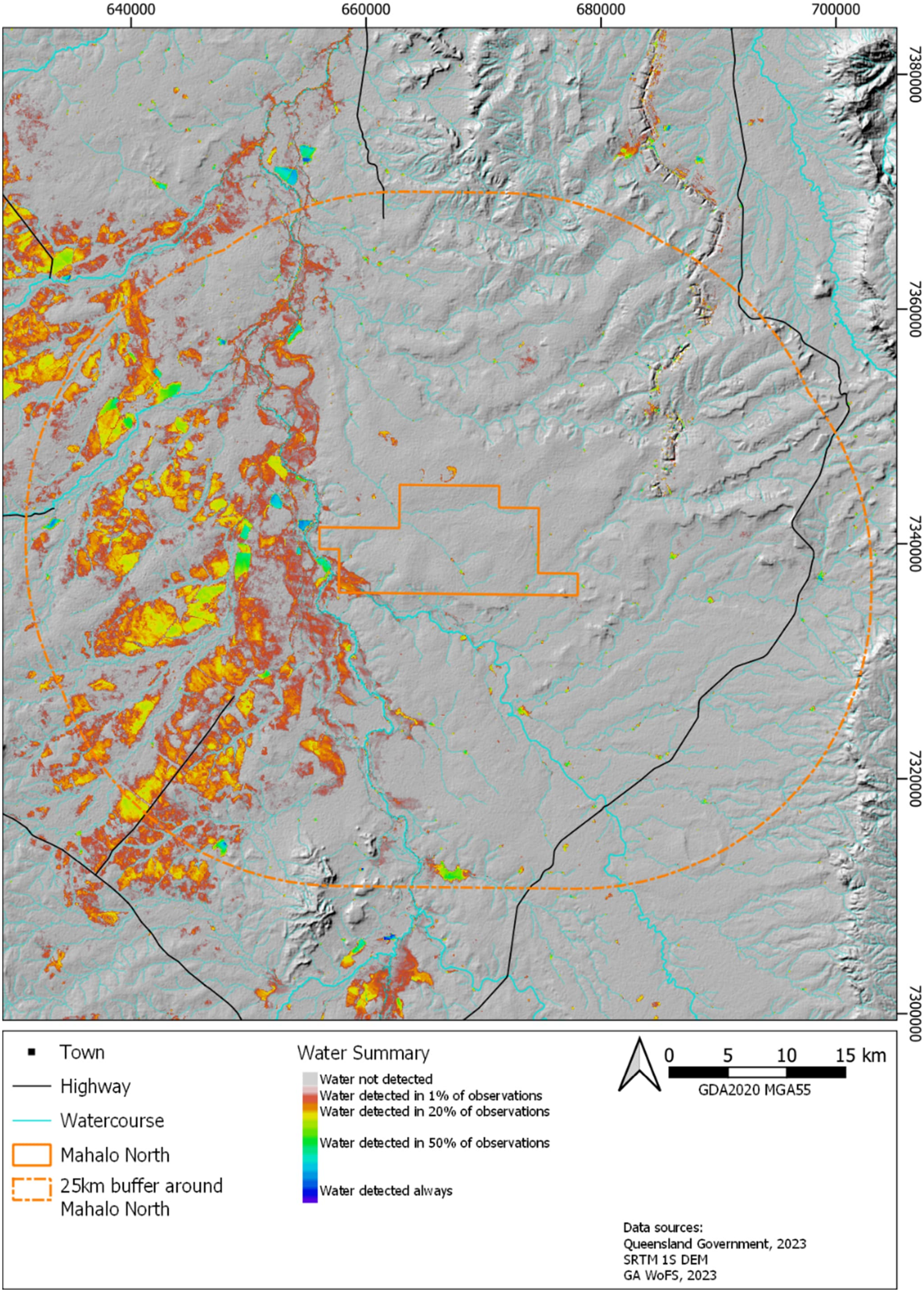


Figure 10 Presence of Surface Water



4. Hydrogeological Setting

4.1. Geological Setting

Figure 11 presents the surfaces geology in the vicinity of the Study area and the underlying solid geology is shown on Figure 12. Table 4 is a stratigraphic column with descriptions of the distribution of each formation within the Study area. Figure 15 presents two pairs of down dip and along strike cross sections through the Study area. One of the pairs of cross sections was generated from the Comet Ridge geological model use for resource estimation and reservoir modelling, while the second pair was generated from the UWIR model (OGIA, 2023). The locations of the cross sections are shown on Figure 11.

The regional geology of the Study area comprises sediments from the Early Permian to Middle Triassic age Bowen Basin. The Bowen Basin is an elongated, north to south trending basin extending over 160,000 km^2 from central Queensland, south beneath the Surat Basin, and into New South Wales, where it connects with the Gunnedah and Sydney basins (OGIA 2016).

The Bowen Basin contains up to 10 km of terrestrial and shallow-marine sediments (Green, 1997; Korsch and Totterdell, 2009). The southern Queensland and northernmost New South Wales portion of the basin is overlaid by up to 2.5 km of Early Jurassic to Early Cretaceous Surat Basin sedimentary sequences (Fielding et al, 2000; Korsch and Totterdell, 2009). In the vicinity of the Study area, the Bowen Basin units reside under Cainozoic cover.

The Project is located on the mid-western extent of the Bowen Basin, on the southern end of the Comet Ridge crest, and is flanked by the Taroom Trough to the east and the Denison Trough to the west (Green 1997; Fielding et al. 2000; Korsch and Totterdell, 2009). Having developed inbound of an active convergence margin during the New England Orogeny, the Bowen Basin formed within a back arc tectonic setting (R. Korsch and Totterdell 2009).

Regionally, Quaternary and Tertiary (Cainozoic) sedimentary deposits overlay the Bowen Basin units. The Cainozoic deposits were formed through subsidence-related faulting and erosion, in conjunction with fluvial sedimentary depositional processes (Laronne and Shlomi 2007; Nichols and Fisher 2007; Korsch et al. 2009). Crustal thinning due to extensional tectonic events resulted in magma upwelling and intermittent volcanism; expressed as basaltic lava flows in the vicinity of the Project area as well as interbedded tuff and volcanolithic fragments within the Tertiary sedimentary sequences (Korsch and Totterdell 2009).

4.2. Structural Geology

The Project is situated in the eastern extent of the north-northwest to south-southeast trending Denison Trough, which is bounded by the Anakie Inlier and the Colinsville, Springsure and Roma shelves in the west, and the Comet Platform to the east (Olgers et al., 1963; Totterdell ,1990)

The following description of the tectonic history of the Bowen Basin is based on McLoughlin (1986), Korsch et al. (2009) and Korsch and Totterdell (2009).

Early Permian east-west or northeast-southwest extension formed a series of half-grabens across the Denison Trough. Volcanism, mechanical extension, thermal cooling, thrust related flexing of the lithosphere and dynamic platform tilting resulted in block subsidence during the Late Carboniferous to

Early Permian, resulting in rapid sedimentary infill forming a thin veneer across the Denison Trough. Extension was followed by mid-Permian mild compression, then more intense northeast-southwest oriented compression in the Late Triassic. The tectonic history has resulted in northwest to southeast trending extensional bounding-faults of half-grabens occurring across the Denison Trough.

Sliwa et al. (2017) map several larger scale faults in the west and southwest of the Study area, including the Inderi and Arcturus faults (Figure 12). An unnamed fault is mapped on the western boundary of the Project area, which Korsch et al. (2009) identify to underly the Bowen Basin. Sliwa et al. (2017) indicate fault throws of between 400 m and 800 m on the Inderi Fault. Since these faults are Triassic in age, the do not penetrate the overlying Tertiary strata. The commercial accumulation of conventional gas in adjacent petroleum tenements (Figure 4) provides a line of evidence that the faults are of low permeability.

In addition to faulting, a series of regional scale, meridional en échelon synclines and anticlines occur adjacent to the faulting in a north-northwest to south-southeast orientation. Folds include the Springsure Anticline, Inglis Serocold Anticline, Rewan Syncline and Consuelo Anticline are located to the southwest of the Project, and the Mimosa Syncline to the southeast.

The cross sections presented in Figure 15 clearly show the presence of the Inderi/Arcturus fault system in the southwest of the Comet Ridge geological model. This faulting is not clearly observed in the OGIA (2023) geological model. The Comet Ridge anticline can be clearly observed in both models. It is noted that while OGIA does not model individual coal seams, the relative thickness of the Rewan Formation/overburden in OGIA geological model is less than the Comet Ridge model.

4.3. Hydrostratigraphy

Table 4 presents a hydrostratigraphic column for the geological units present in the Study area and their hydrostratigraphic designation based on OGIA (2021a). Table 4 also describes the distribution of the units within the Study area. A brief description of each of the relevant units follows.

Quaternary Sediments

Unconsolidated Quaternary-age alluvial deposits occur adjacent to the Comet River and Humboldt Creek. The alluvium was deposited by its associated watercourses, with the sediment source from the surrounding outcropping formations. Due to the fine-grained and clay rich nature of the geology, discontinuous aquifers may form within the alluvium where there is a greater volume of connected coarser material with lesser amounts of clay. The aquifers are often ephemeral and perched above the regional water table. The extent, thickness and composition of the alluvium is locally variable. Pearce and Hansen (2006) report the Comet Rive alluvium to be typically 20 m thick, reaching thicknesses of up to 50 m near Comet and south of Rolleston where is it much wider than in the vicinity of the Study area. The Quaternary Alluvium reaches a maximum width of approximately 6.5 km t the southwest of the Project area. The Project's monitoring bore MN-MB1-a encountered 12.4 m of unconsolidated alluvial material in the southwest of the Project area.

Twenty one estimates of bore yields for the alluvium were identified within the Study area, with a range of 0.2 L/s to 3.9 L/s, and median of 0.9 L/s.

Quaternary Colluvium is present to the west of the Comet River, where it covers the lower slopes associated with Tertiary Basalt outcrop. The basaltic source rock of the colluvium will result in a clay-rich deposit of low permeability, and therefore this material is considered an aquitard.

Tertiary Strata

The majority of the Project area and eastern half of the Study area is underlain by Tertiary aged sediments, predominantly of the Emerald Formation, which is described as fluviatile and lacustrine claystone and siltstone, sandstone and gravel with interbedded basalt. It is often deeply weathered. Pearce and Hansen (2006) reports that this unit has poorly developed porosity due to the predominantly fine-grained nature of the sediments and poorly developed fracture networks due to the semi- to unconsolidated nature of the material.

Extensive outcrop of Tertiary basalts are mapped in the west of the Study area. Small outcrops within the Project area extent, and to the north of the Study area where it is exposed in the drainage lines and descriptions of basalt in water bore strata logs from the Queensland Groundwater Bore Database (GWBD) attest to its presence beneath the Tertiary Sediments in the east of the Study area. The Tertiary Basalts forms a discontinuous fractured rock aquifer with varying degrees of hydraulic connectivity both laterally and vertically.

The Tertiary Strata are used extensively for water supply for agricultural purposes, particularly to the west of the Comet River, with the majority of the supply coming from the basalts. Bore yields from the GWBD within the Study area range from 0.1 L/s to 50 L/s, but with a median of only 1.1 L/s from 164 values, indicating that high yielding bores are an exception.

The combined thickness of the Tertiary-aged strata was identified from the interpretation of GWBD records at a maximum thickness of 80 m within the Project area (Figure 13) and increasing to greater than 100 m in the wider Study area. The thickness in the UWIR model is roughly consistent with those identified from the GWBD data (Figure 13).

Clematis Group

The Clematis Group comprises sandstone, siltstone and mudstone which are relatively resistant to weather compared with the other Permo-Triassic sediments, and it forms the elevated topography of the Expedition Ranges to the east of the Study area, and an isolated outcrop on the southern boundary of the Study area.

While the Clematis Group was formerly included in the Great Artesian Basin (GAB) (Habermehl and Lau, 1997), Ransley and Smerdon (2012) identify the base of the Precipice Sandstone (Jurassic-aged) of the Surat Basin as the margin of the GAB.

Rewan Group

The Rewan Group is partially present in the sub-surface beneath the Project area (Figure 12). It dips to the southwest, reaching a thickness in excess of 200m at the Project area boundary and outcrops to the northeast of the Project area within the Blackwater Creek catchment of the wider Study area, where OGIA (2023) indicates its reaches in excess of 500 m thickness (Figure 14).

The Rewan Group comprises interbedded mudstone, siltstone and sandstone with a minor conglomeratic zone at the base of the formation. OGIA (2021a) designates the Rewan Formation as a tight aquitard.

Ten bores with yield data were identified from the GWBD within the Study area for upper Permian formation, which is predominantly the Rewan Formation across the Study area. The range in reported yields was 0.2 L/s to 5.6 L/s with a median of 0.7 L/s.

Bandanna Formation/Rangal Coal Measures

The Bandanna Formation is the lateral equivalent of the Rangal Coal Measures (e.g. Sliwa et al., 2015) and is the target of CSG production at Mahalo North and Mahalo, and coal mining at Blackwater and Rolleston. The Bandanna Formation/Rangal Coal Measures comprises interbedded mudstone and siltstone with relatively thin coal seams that are regionally distinguishable but not regionally continuous. This unit outcrops within the Blackwater Mine leases (Figure 4) and subcrops beneath the Tertiary strata within the Project area, and dips centrifugally around the Comet Anticline. The Project will target CSG development at depth of roughly 120 mbgl to 220 mbgl. OGIA (2023) indicates a total formation thickness generally less than 200 m (Figure 14). The zero-thickness margin is roughly coincident with the northern boundary of the Project area.

Hair (1987) undertook extensive field testing of the Rangal Coal Measures at Curragh (approximately 62 km north of the Project area boundary). The Rangal Coal Measures are the lateral equivalent of the Bandanna Formation. Hair (1987) concluded that aquifers were restricted to the coal seams. From field permeability testing, they found that the interseam sediments had a permeability about two orders of magnitude less than that of the coal seams, individual coal seam aquifers are hydrologically isolated within the Rangal Coal Measure sequence and are internally significantly anisotropic. The major thrust fault at Curragh behaved as a barrier boundary during a pumping test.

Sliwa et al. (2017) identify extensive small-scale faulting within the Rangal Coal Measures at the Blackwater mine (Figure 12). There is no preferential orientation to the faults, thus it is likely that some will be hydraulically conductive, while others may seal. While not mapped, it is likely that similar faulting is present within the Study area, and therefore is likely to provide hydraulic connection between the individual coal seams to some degree.

Fourteen bores with yield data were identified from the GWBD within the Study area, with a reported of between 0.1 L/s and 2.5 L/s. The median yield was 1.1 L/s.

Back Creek Group

The Back Creek Group underlies the Bandanna Formation/Rangal Coal Measures throughout the Study area and since there are no recognised aquifer within it, forms the hydrogeological basement to the area. The Back Creek Group outcrops within the core of the Comet Anticline in the north of the Study area and in the southwest of the mapped area (Figure 11).

Yield estimates from 25 bores were identified from the GWBD for the Back Creek Group within the Study area, with a range of 0.01 L/s to 3.0 L/s, and a median of 0.6 L/s.

4.3.1. Site specific hydrostratigraphy

Figure 16 presents selected geophysical traces from the wireline logging performed on the Mahalo North 1 well (Figure 3). The figure includes:

- The depth of the surface casing shoe as this affects the data at depths shallower than the shoe
- Formation and coal seam top depths
- Indications of permeability. These are based on the separation of the different depths of investigation of the resistivity tool., i.e. where the traces become separate (especially the shallow and deep investigation) is indicative of permeability as the drilling mud is able to penetrate deeper into the formation
- Semi-quantitative interpretation of the acoustic image logs to identify the presence of natural fractures and drilling induced tensile fractures (DITF). DITF can be used to identify the orientation of the maximum horizontal stress.

From Figure 16, the following becomes evident:

- The Tertiary strata were not present at Mahalo North 1 and the Rewan Formation was the formation in outcrop
- At the location of the Mahalo North 1 well the Aries Seam (the shallowest of the coal seams) has bifurcated into three very thin separate seams. The Orion Seam is also thin (~0.5 m)
- The Castor and Pollux Seams have effectively joined into a single coal seam approximately 7 m thick. This seam will be the primary target of the lateral wells
- The coal seams are separated by siltstone and fine-grained sandstone interburden. The resistivity separation indicate that there may be some thin beds with permeability, however the gamma log indicates that these beds are not clean sandstones (greater than 80 API). This is consistent with general understanding of the hydrostratigraphy of the Bandanna Formation
- The most permeable zone appears to be the Castor/Pollux seam due to the greatest separation of the resistivity responses. The modular dynamic formation tester (MDT) resolved a permeability of the seam of 250 millidarcies (approximately 0.2 m/day as an hydraulic conductivity)
- Natural fracturing was only observed at depths of less than 160 m. This also corresponded to where the majority of DITF were observed
- The DITF were predominantly oriented at 30 to 40 degrees. This is consistent with literature sources (e.g. Nemcik et al., 2005 ; Rajabi et al., 2024).

Table 4 Stratigraphy and hydrostratigraphy of the Study area

Age		Formation		Hydrostratigraphic Description (after OGIA, 2021)	Location in Study area
Quaternary		Alluvium		Partial aquifer	Associated with the Comet River and Humboldt Creek. Distribution within the Project area limited to the southeastern and southwestern corners
		Colluvium		Aquitard*	Extensively present to the west of the Comet River, associated with the lower slopes of Tertiary Basalt outcrop.
Tertiary		Tertiary Sediments		Aquitard*	Surficial deposits across the majority of the Project area and to the north and east of the Study area
		Tertiary Basalt		Partial aquifer*	Small areas of outcrop throughout the Project area and Study area, predominantly in the west.
Triassic	Middle	Moolayember Formation		Tight aquitard	Does not outcrop or subcrop within the Study area
	Early	Showground Sandstone	Clematis Group	Regional aquifer	Outcrops as the Expedition Ranges to the east of the Study area, with a small inlier of outcrop to the south of the Study area adjacent to the Inderi Fault.
		Rewan Group		Tight aquitard	Outcrops to the northeast of the Study area and subcrops beneath the Tertiary strata within the Project area, forming the primary aquitard.
Permian	Late	Bandanna Formation/Rangal Coal Measures		Interbedded aquitard	Target formation. Subcrops beneath the Tertiary Strata within the Project area and outcrops to the northeast of the Study area within the Blackwater mine tenements.
		Back Creek Group	Black Alley Shale	Tight Aquitard*	Outcrop and subcrop within the Comet Anticline to the north of the Study area. Also subcrops with a small amount of outcrop to the southwest of the Study area
			Peawaddy Formation		
			Burngrove Formation		
			Fair Hill Formation		
			MacMillan Formation		
			Crocker Formation		
			Maria Formation		
			Catherine Sandstone Ingelara Formation Freitag Formation		
	Early		Upper Aldebaran Sandstone		Does not outcrop or subcrop within the Study area
			Lower Aldebaran Sandstone	Interbedded aquitard*	
			Cattle Creek Formation	Tight Aquitard*	
			Reids Dome Beds	Tight Aquitard*	

* No hydrostratigraphic designation by OGIA (2021)

Figure 11 Surface Geology (after Queensland Government, 2022)

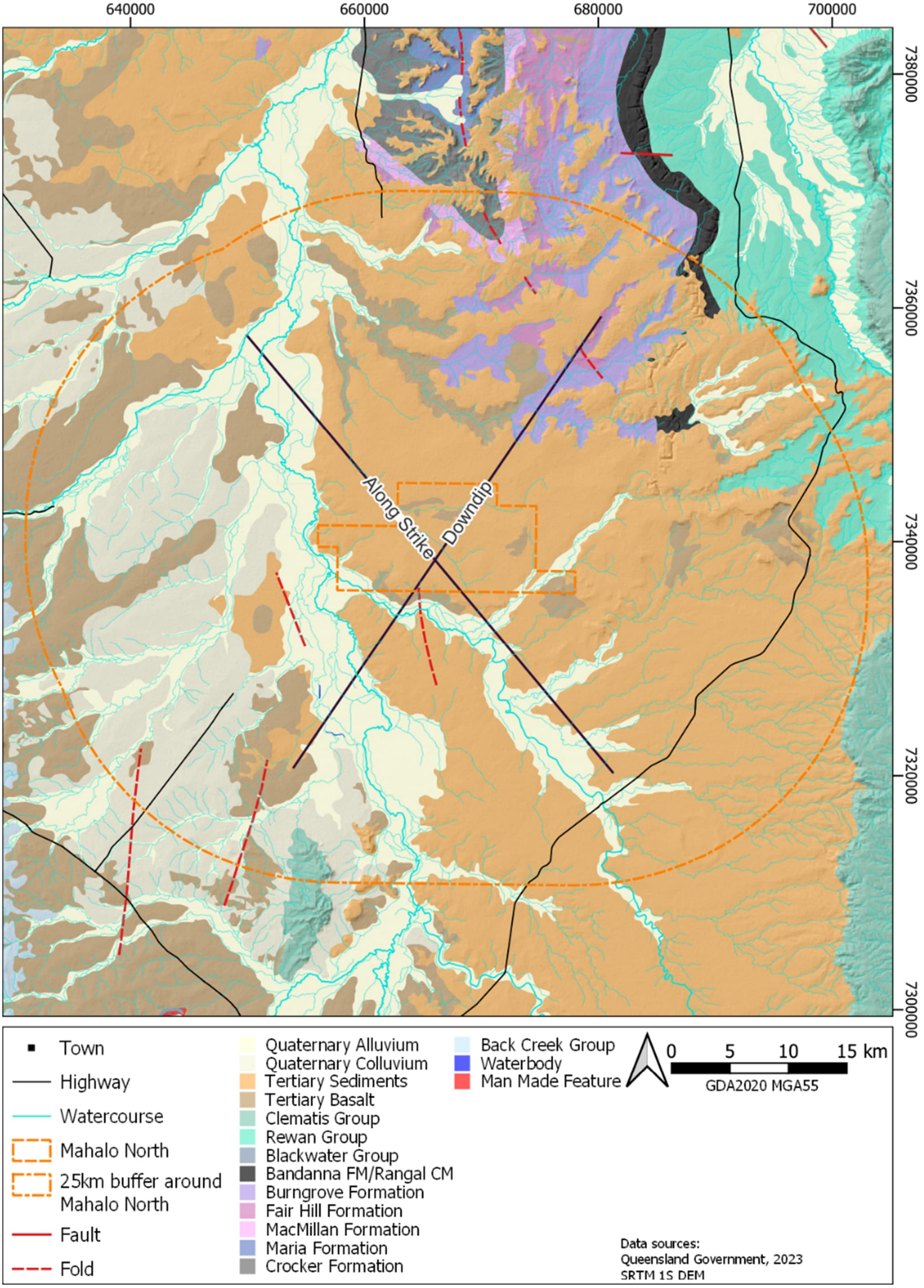


Figure 12 Solid Geology (after Sliwa et al, 2017)

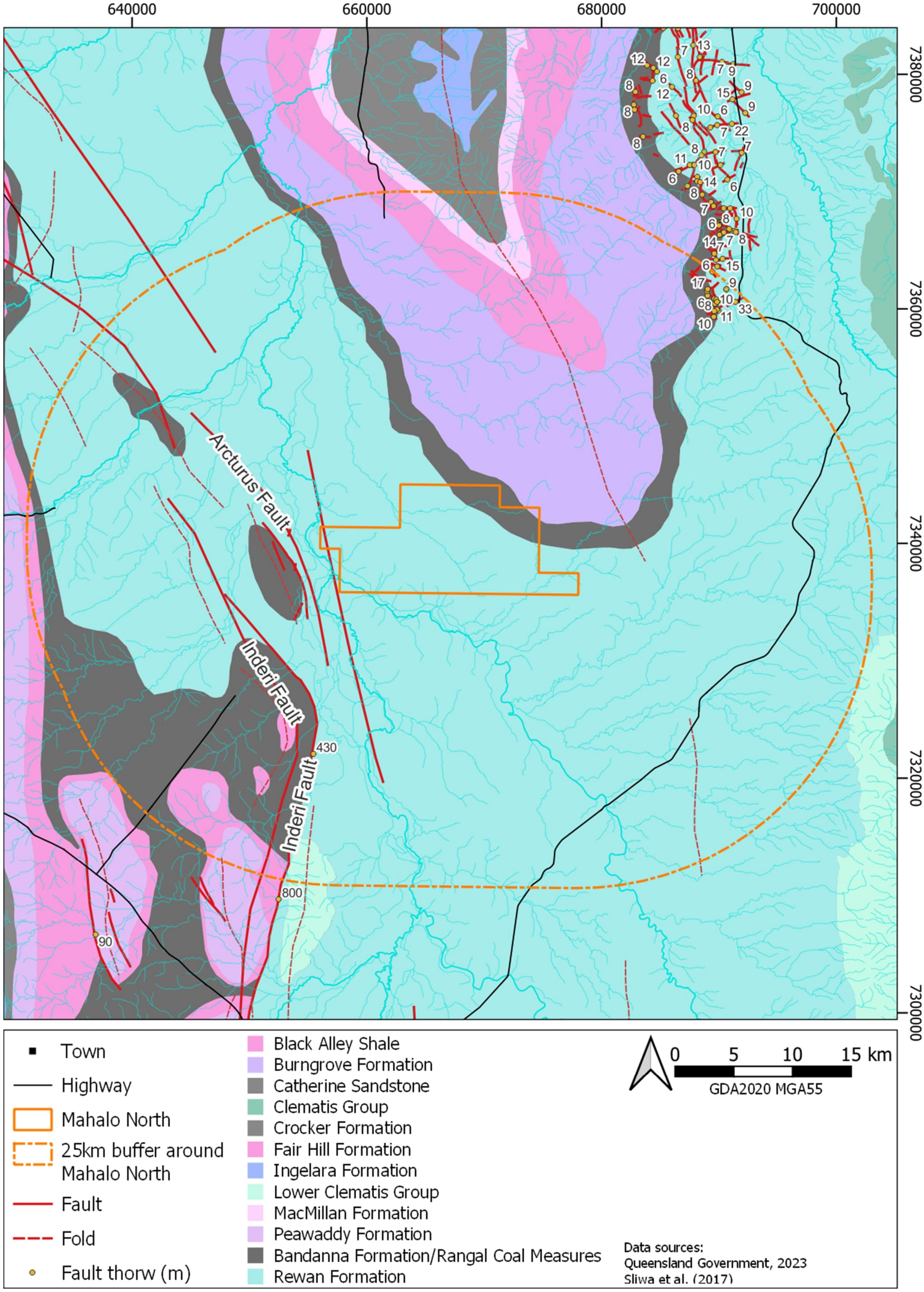


Figure 13 Thickness of the Tertiary Strata

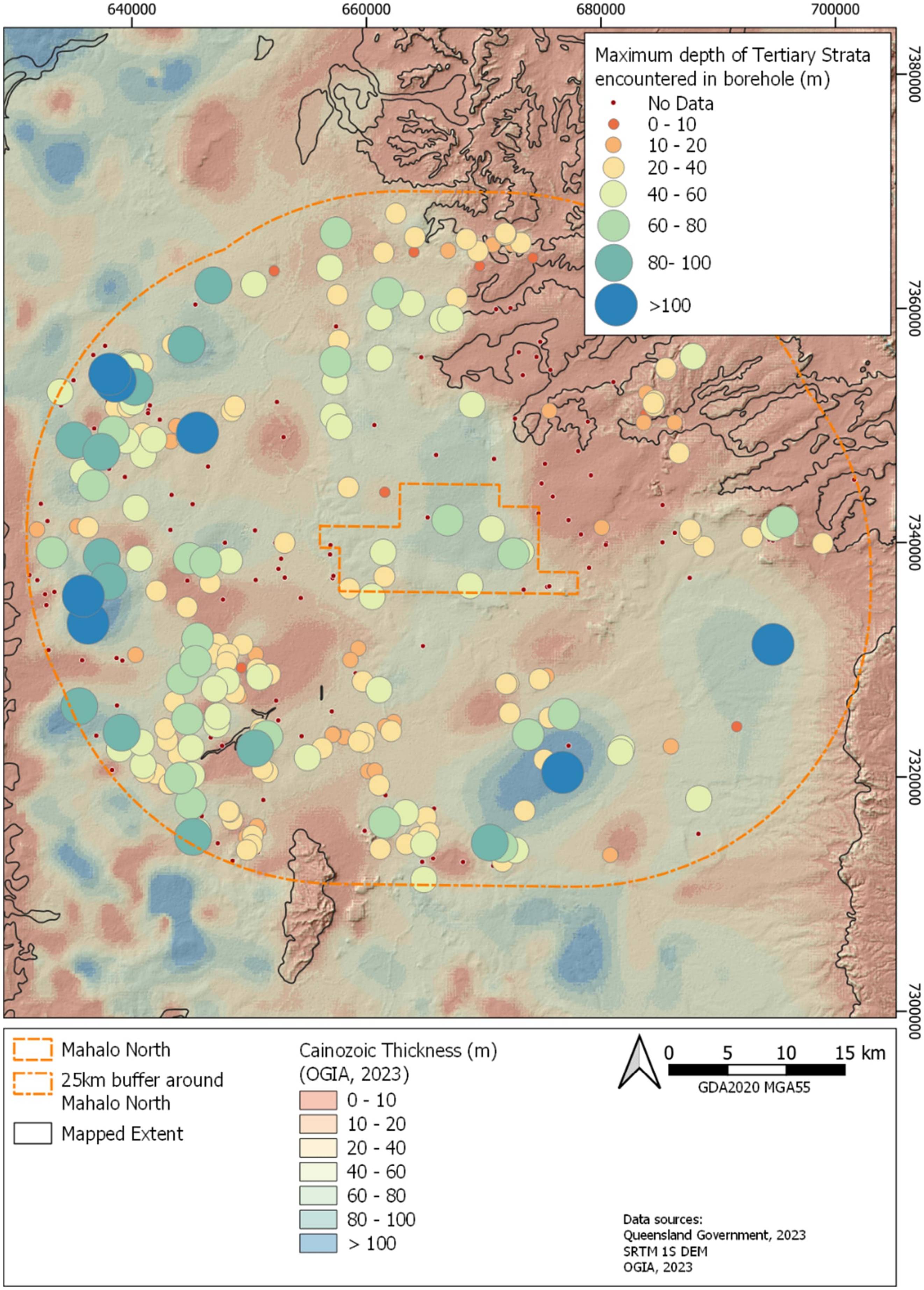


Figure 14 Thickness of the Rewan Group and Bandanna Formation (OGIA, 2023)

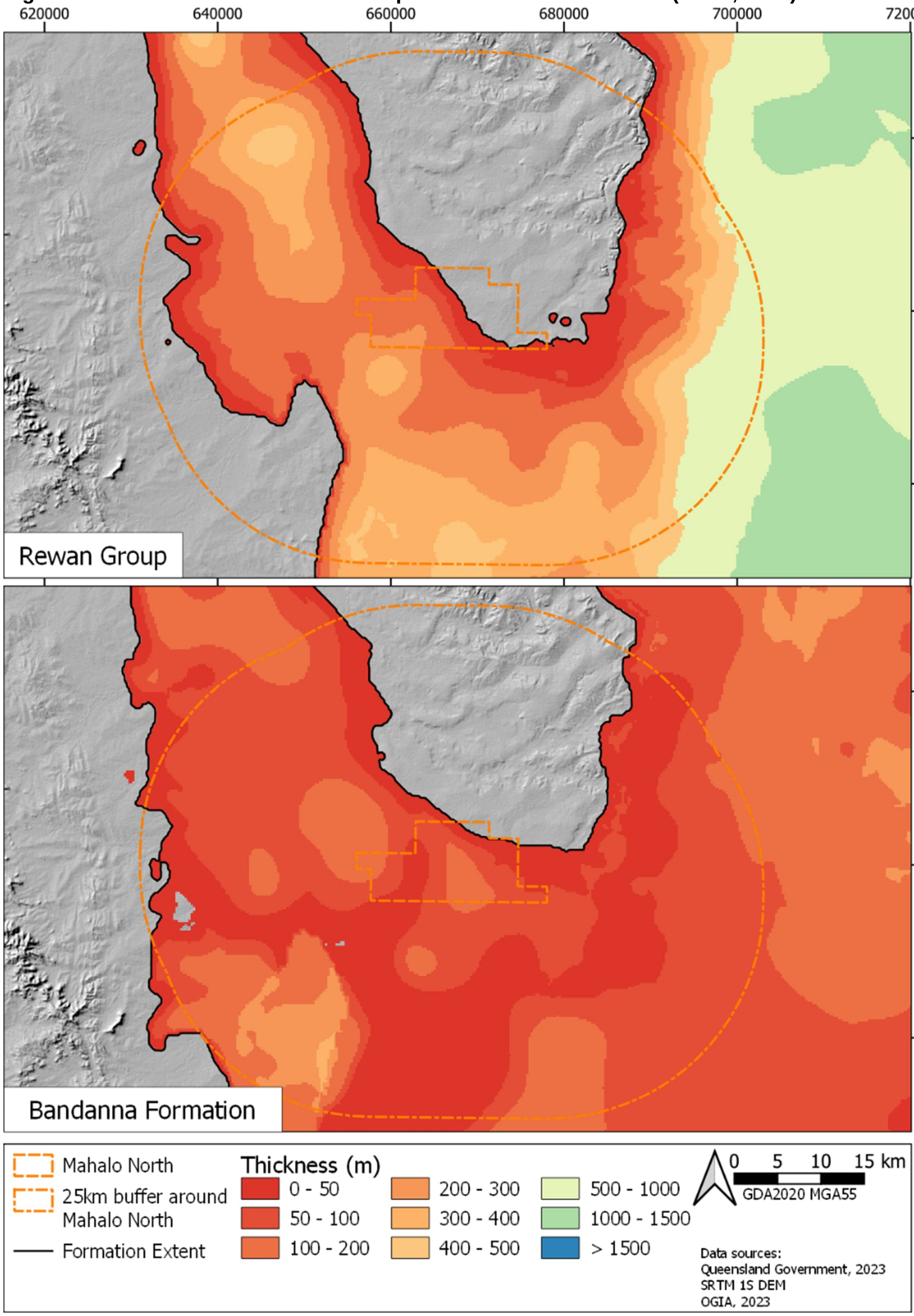


Figure 15 Hydrostratigraphic Cross-sections Through the Study Area

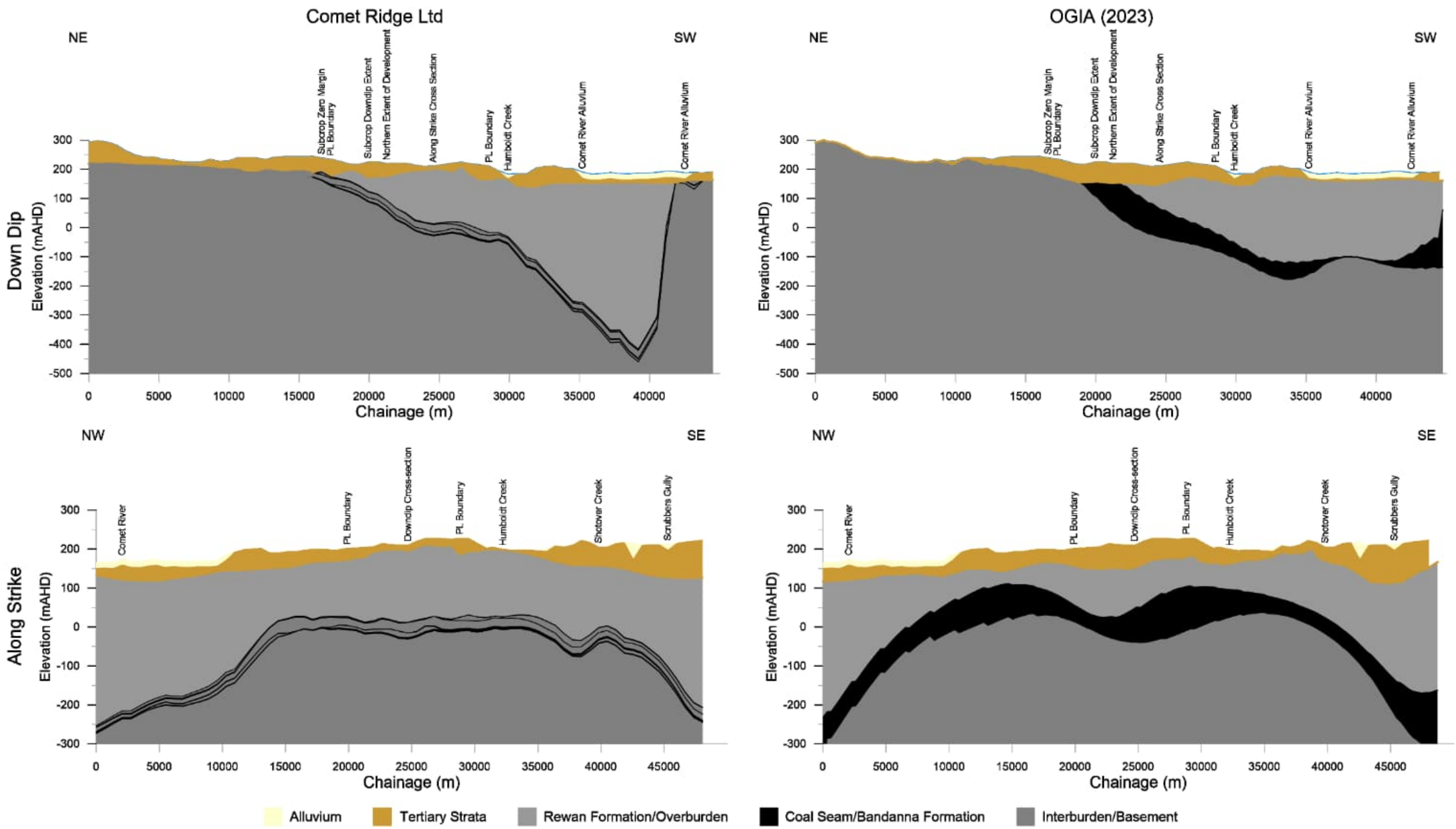
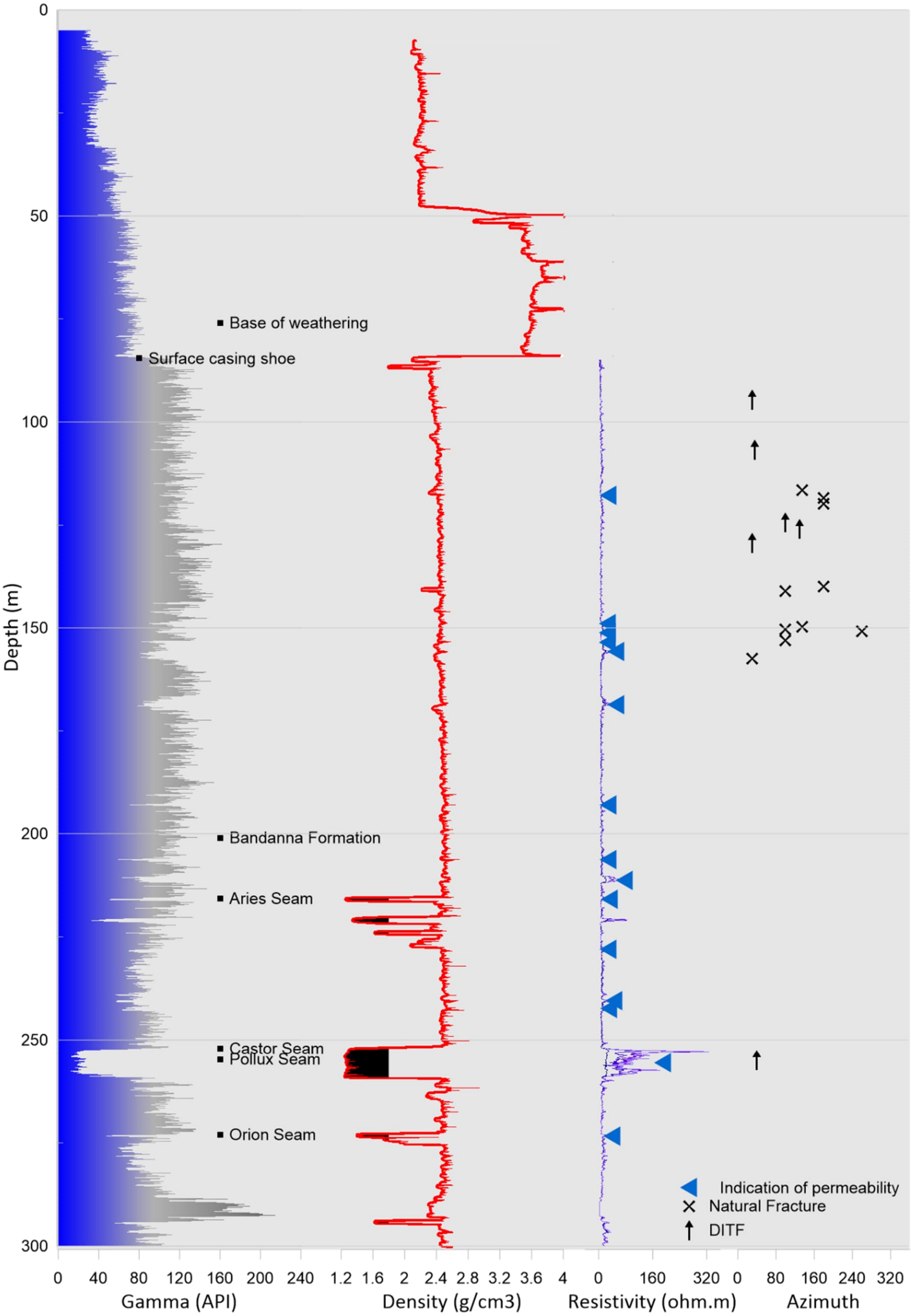


Figure 16 Mahalo North 1 wireline log data



4.4. Hydraulic Parameters

Horizontal hydraulic conductivity data for the Study area has been compiled from the following sources:

- From recovery or slug tests performed on Project monitoring bores,
- Using data from the GWBD and the method described by Bradbury and Rothschild (1985),
- Interpreted drill stem test (DST) and modular dynamic formation tester (MDT) data from Golder (2019), and converted from intrinsic permeability to hydraulic conductivity using the following equation:

$$K = k\frac{\rho g}{\mu}$$

  Where:
  K = hydraulic conductivity
  k = intrinsic permeability
  ρ = fluid density
  g = acceleration due to gravity
  μ = dynamic viscosity
  ρ and μ were determined from fluid temperatures estimated from the test depth and a geothermal gradient of 25°C + 3.3°C/100 m.
- Interpreted MDT data from Mahalo North 1 appraisal well (Schlumberger, 2021), converted from intrinsic permeability to hydraulic conductivity per the equation above.

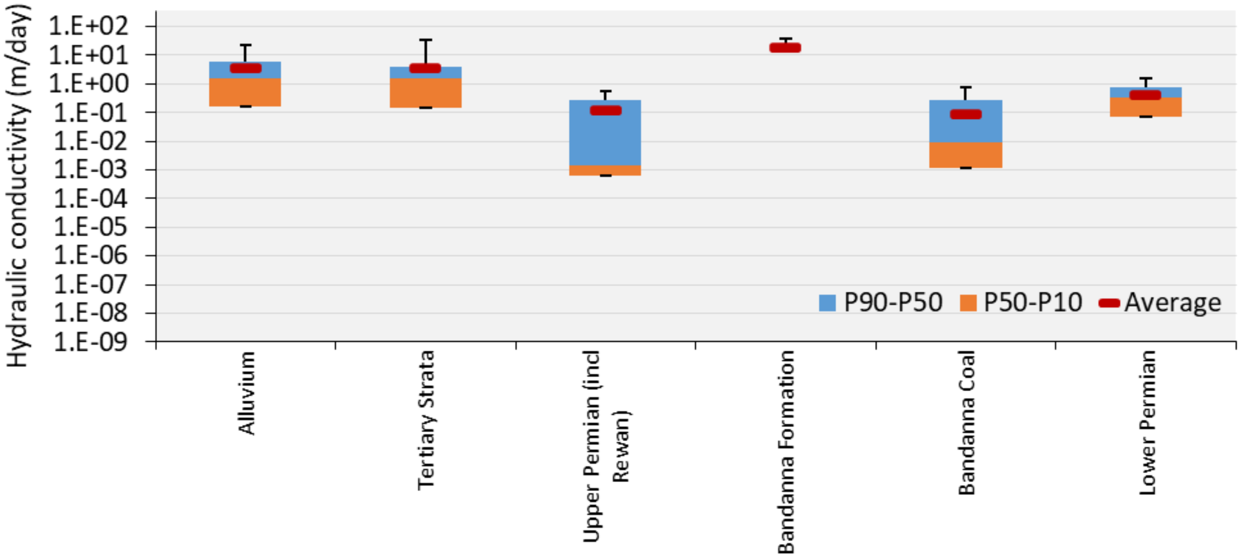
These data are summarised in Figure 17 with the locations of the measurements shown on Figure 19. These can be compared with the equivalent statistics from the UWIR groundwater flow model layer (OGIA, 2023) for the Study area, presented in Figure 18. Spatial distributions of horizontal hydraulic conductivity from the UWIR model are included in Appendix D. These figures indicate:

- **Alluvium and Tertiary Strata** - The OGIA (2023) values show a wider range, however the Study area specific values lie within this range. In both cases the average value is greater than the median, indicating that that higher values are the exception rather than the rule. The site-specific measurement in the Project's alluvium monitoring bore is approximately equal to the OGIA (2023) median
- **Upper Permian/Rewan Formation** – Testing of the Project's monitoring bores installed in the Rewan Formation resolved hydraulic conductivities of 10^{-3} and 10^{-4} m/day, which are less than or at the lower end of the OGIA (2023) range. Only one other value was available within the Study area for the Rewan Formation, and it was more than one order of magnitude greater than the maximum of the OGIA (2023) data. This bore was less than 10 m deep and was screened within the weathered profile
- **Bandanna Formation** – the two different datasets are difficult to compare because of the different intraformational divisions. However, the Bandanna coal hydraulic conductivities from the Project-specific data are generally greater than the bulked hydraulic conductivities that were incorporated in the OGIA (2023) model. This is expected as the latter values would be calculated over a much thicker interval. Similarly, the field measurement of permeability in the Mahalo North 1 exploration was greater than the OGIA (2023) range for the Bandanna Formation production zone, however the value obtained from transient calibration of a site-specific groundwater model to the pilot production data (Appendix G) resolved a much larger scale value approximately half an order of magnitude less than OGIA (2023).

- **Lower Permian/Lower Bowen 1** – Study area specific values were several orders of magnitude greater than the OGIA (2023) model values. This is again related to the relatively shallow depths of measurement of the Project specific values
- Median values are always lower than average values thus higher values are not the norm.

No measured values for vertical hydraulic conductivity were identified within the Study area. Figure 20 presents a statistical summary extracted from OGIA (2023). With the exception of Layer 1 (Alluvium and Tertiary Strata), the vertical hydraulic conductivity in the OGIA model is generally three orders of magnitude lower than the hydraulic conductivity. For Layer 1, the vertical hydraulic conductivity approximately ranges from one to three orders of magnitude lower than the horizontal hydraulic conductivity.

Figure 17 Horizontal Hydraulic Conductivity Statistics – Project-specific Values*



*Locations and formations shown on Figure 19

Figure 18 Horizontal Hydraulic Conductivity Statistics - UWIR Model within 25 km Buffer of the Project Area – with comparison to site-specific measurements

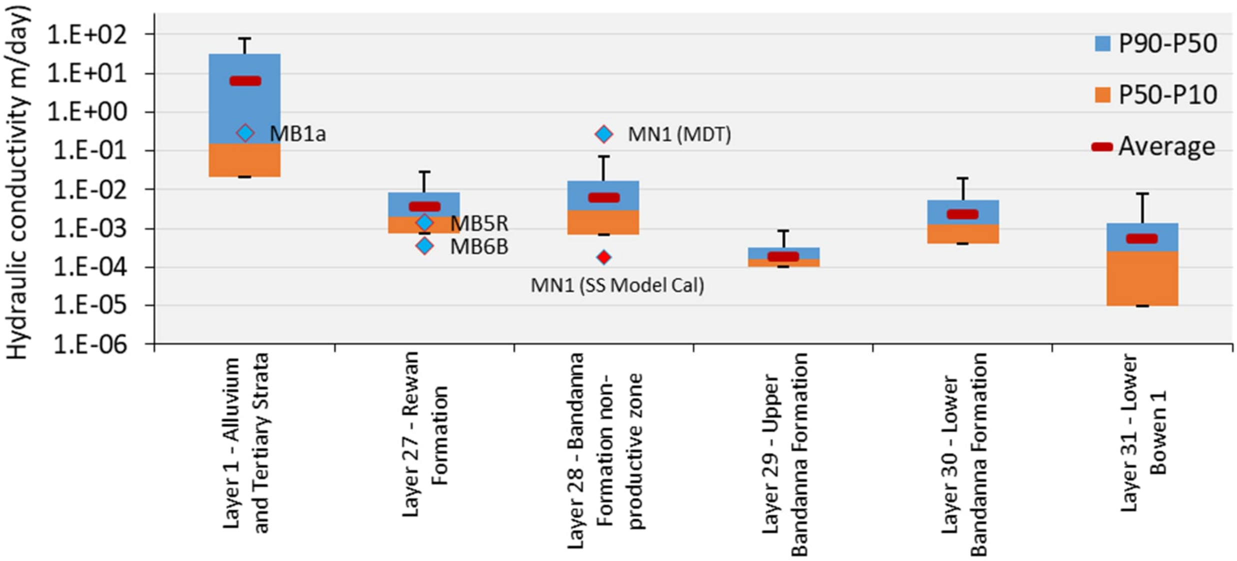


Figure 19 Spatial Distribution of Project-specific Hydraulic Conductivity Measurements

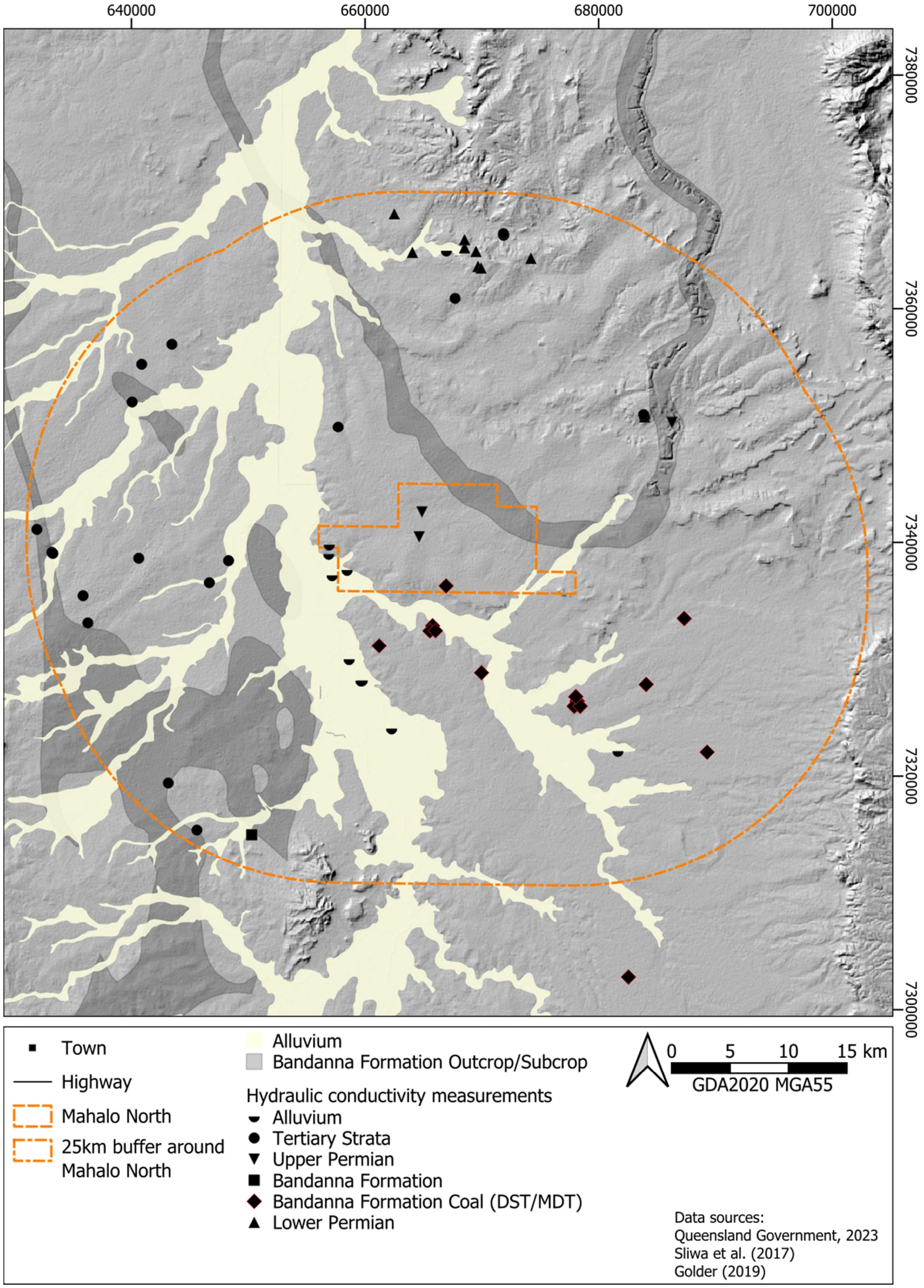
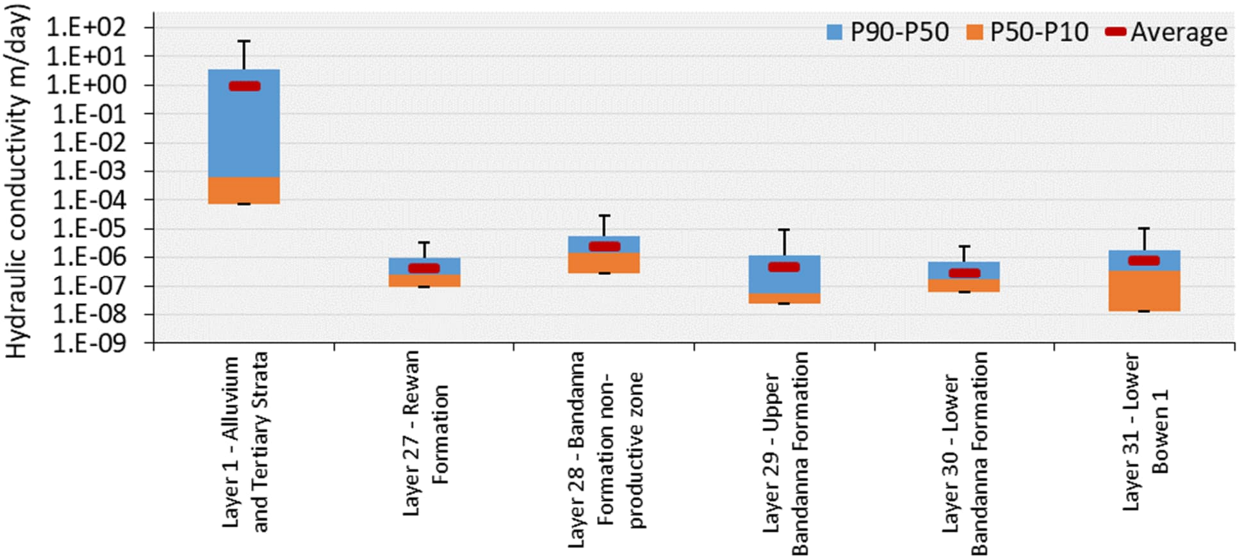

640000
660000
680000
700000
7380000
7360000
7340000
7320000
7300000
Town
Highway
Mahalo North
25km buffer around Mahalo North
Alluvium
Bandanna Formation Outcrop/Subcrop
Hydraulic conductivity measurements
Alluvium
Tertiary Strata
Upper Permian
Bandanna Formation
Bandanna Formation Coal (DST/MDT)
Lower Permian
0
5
10
15 km
GDA2020 MGA55
Data sources:
Queensland Government, 2023
Sliwa et al. (2017)
Golder (2019)

Figure 20 Vertical Hydraulic Conductivity Statistics - UWIR Model Within 25 km buffer of the Project Area



4.5. Recharge

Recharge processes within the Surat CMA are summarised in (OGIA 2016b) and based on (Kellett et al. 2003a). Key processes of recharge include localised recharge, preferential pathway flow and diffuse recharge:

- Localised recharge occurs beneath drainage features including rivers, creeks and alluvium, and Tertiary groundwater systems where there is sufficient saturation and hydraulic head to allow water to infiltrate into aquifers. Areas of localised recharge are considered limited in extent in the GAB (Kellett et al. 2003b)
- Preferential pathway flow arises from changes in permeability within aquifers and in overlying regolith, providing conduits for water to infiltrate. Zones of higher permeability may include fissures, faults, joints, tree roots and high-permeability beds within individual formations and along bedding planes (Kellett et al. 2003b; Suckow et al. 2016). This mechanism is considered the dominant recharge process in the GAB (Kellett et al. 2003b)
- Diffuse recharge is the process by which rainfall infiltrates directly into outcropping hydrostratigraphic units. This is expected to occur within all outcrop areas and therefore this process applies to the largest spatial extent across the Surat CMA (Kellett et al. 2003b).

Initial estimates of long-term average recharge rates were made by OGIA (2019) using the chloride mass balance recharge estimation method and applied to those bores attributed to one formation only. The estimates were made on a significantly expanded bore dataset compared with Kellet et al (2003b) and the 2016 UWIR model. The initial recharge estimates based on chloride mass balance were modified during model calibration, with the calibrated steady-state model recharge distribution presented as Figure 21.

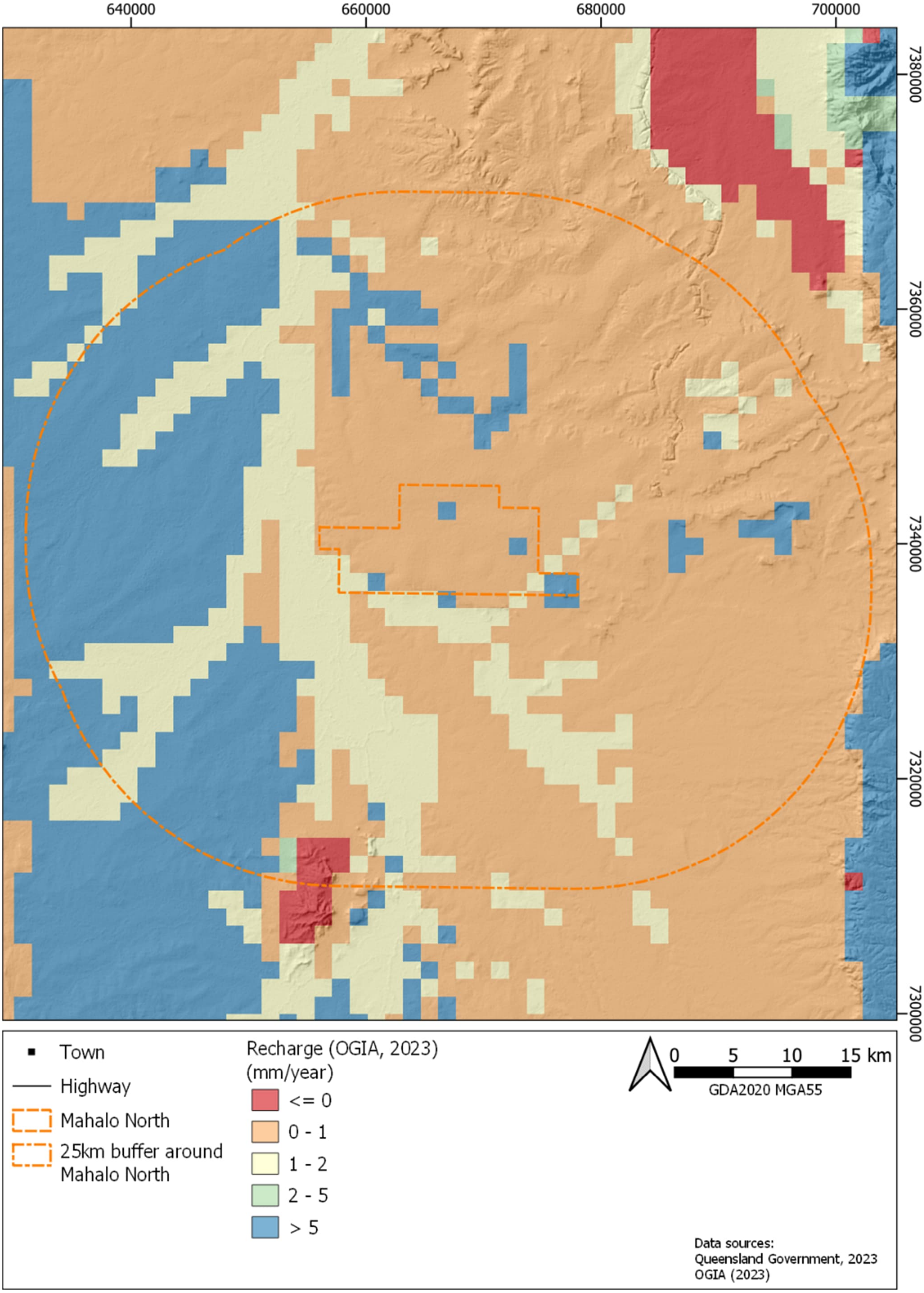
Figure 21 indicates average long-term recharge rates in the vicinity of the Study area as follows:

- **Alluvium** - 1 mm to 2mm per year
- **Tertiary Strata** – 0.1 mm to 1 mm per year in the eastern part of the Study area overlying the Taroom Trough, with recharges rates to the Tertiary Strata in the western part of the Study area

overlying the Denison Trough are generally in the order of 10 mm per year. The reason for this difference cannot be ascertained. Timeseries water level measurements from Tertiary Strata bores across the region exhibit rainfall recharge responses when rainfall is above average (Section 4.6.1)

- **Permian strata** – highly variable ranging from less than 0.1 mm per year to greater than 35 mm per year. The highest recharge rates from the calibrated model are associated with the outcrop of the Clematis Sandstone in the Expedition Ranges to the east of the Study area.

Figure 21 Calibrated Steady-state Recharge Distribution for 1995 (OGIA, 2023)



4.6. Groundwater Levels

4.6.1. Temporal Trends

The GWBD was interrogated to identify bores with temporal water level data within the Study area and surrounds. The locations and attributed formations of those bores with five or more water level measurements are shown on Figure 25. Individual water level hydrographs have been prepared for all these bores and are included in Appendix A. Also included in Appendix A is a map that shows the bore numbering in the vicinity of the Rolleston mine, to the southwest of the Study area, where most of these bores are located.

There are no bores within the Project area with timeseries water level data available. Composite hydrographs for the bores outside of the Rolleston area are presented as Figure 22 to Figure 24, with descriptions of the water level trends provided in Table 5, and key findings summarised as follows:

- **Figure 22** – Almost all of the hydrographs from the Tertiary Strata show connection between the aquifer and the ground surface through a recharge response to rainfall. The magnitude and lag of this response differs between bores indicting that the Tertiary Strata is not a single, homogeneous isotropic aquifer with consistent hydraulic connection to the ground surface
- **Figure 23** - There is a nest of three collocated bores 21 km northwest of the Project area with a bore screened in each of the Tertiary basalt, the Rewan Group and Bandanna Formation. The water level monitoring record for these bores is short (less than one year) and shows the Bandanna Formation and Rewan Group water levels rising rapidly by roughly 7 m and 23 m respectively over a fortnight at the very beginning of the monitoring record. This type of response is typical of the water level recovery in a bore recently constructed in a low permeability formation. The water levels stabilised over the period of available data, with the relative water levels indicating a downward gradient from the Tertiary basalt to the Rewan Group and an upward hydraulic gradient from the Bandanna Formation to the Rewan Group
- **Figure 24** - 1305023 and 1305024 are co-located bores both screened in the Tertiary Basalt and are 71.6 m and 25.6 m deep respectively. Both bores showed a lag in their response to rainfall, however the shallower bore, RN1305024, responded much more rapidly to significant rainfall with a much quicker recession compared with the deeper bore which also declined much more slowly. This may be due to hydrostatic loading or may indicate that the deeper bore is connected to a greater volume of storage in the aquifer. When plotted on the same scale axes, it become evident that the vertical hydraulic gradients within the aquifer change, indicating that the aquifer is not isotropic and homogeneous and that the location of the recharge sources to each bore may be spatially different.

Hydrographs for bores in the Rolleston area have not been individually described. Key observations from these hydrographs indicate:

- There is a strong correlation between rainfall and water level response in bore constructed in the alluvium (e.g. RN15866)
- The Tertiary Strata show similar behaviour to those bores closer to the Project area, with variable connection to surface recharge processes and differing storage capacities (e.g. RN15871 vs RN13050020). In addition, some of the hydrographs show strong seasonal responses (e.g. RN62599) which may be related to nearby groundwater extraction. Ranges in water level fluctuation between the minimum and maximum water level can be in excess of 20 m (e.g. RN158572)

- The Bandanna Formation monitoring bores are heavily influenced by mining operations (e.g. RN24255, RN158160, RN165001) showing rapid and significant declines in water levels over a sustained period of time
- The low permeability of the Bandanna Formation is clearly evident in the recovery response of RN158158, which require ~6 months to recover from a 20 m drawdown.

Figure 22 Combined Timeseries Water Level Responses - Tertiary Strata

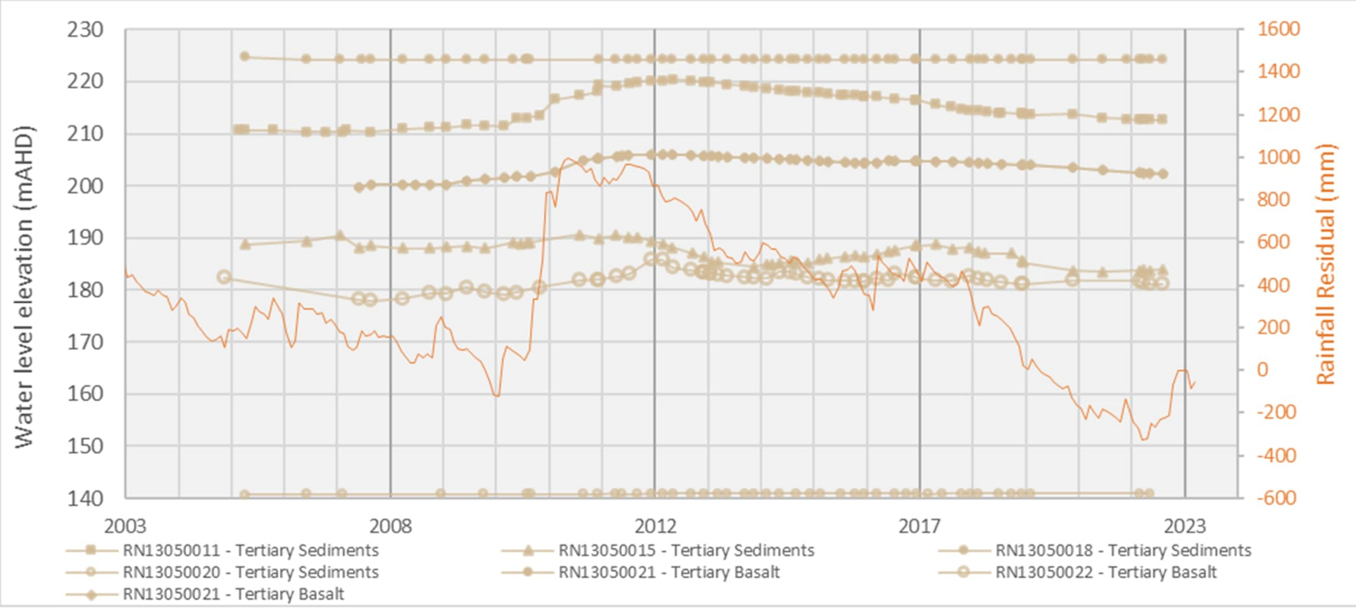


Figure 23 Combined Timeseries Water Level Responses – Multi-formation Nested Site

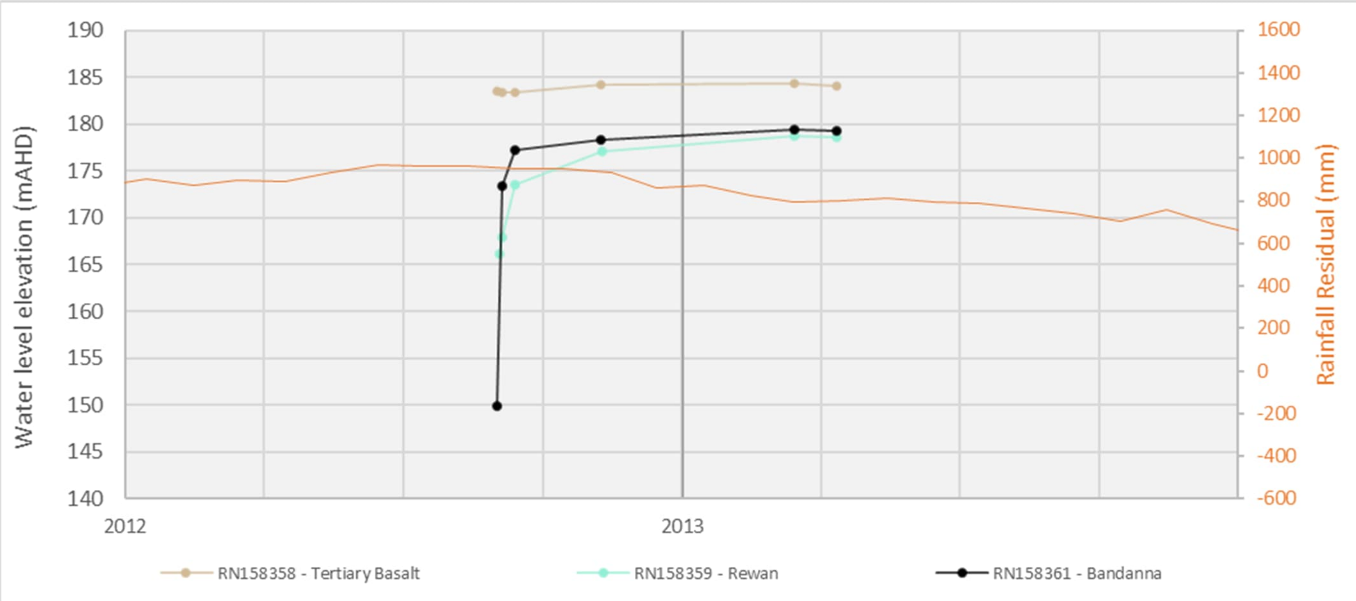


Figure 24 Combined Timeseries Water Level Responses – Tertiary Basalt Nested Site

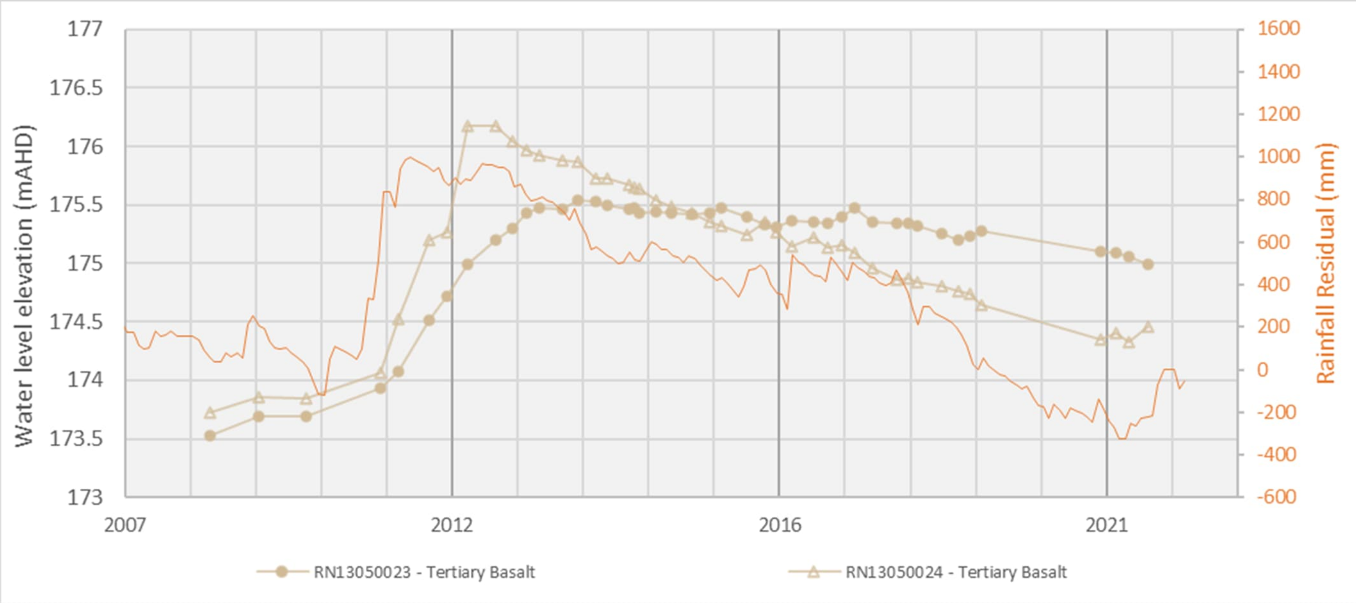


Figure 25 Bores with More than Five Water Level Measurements

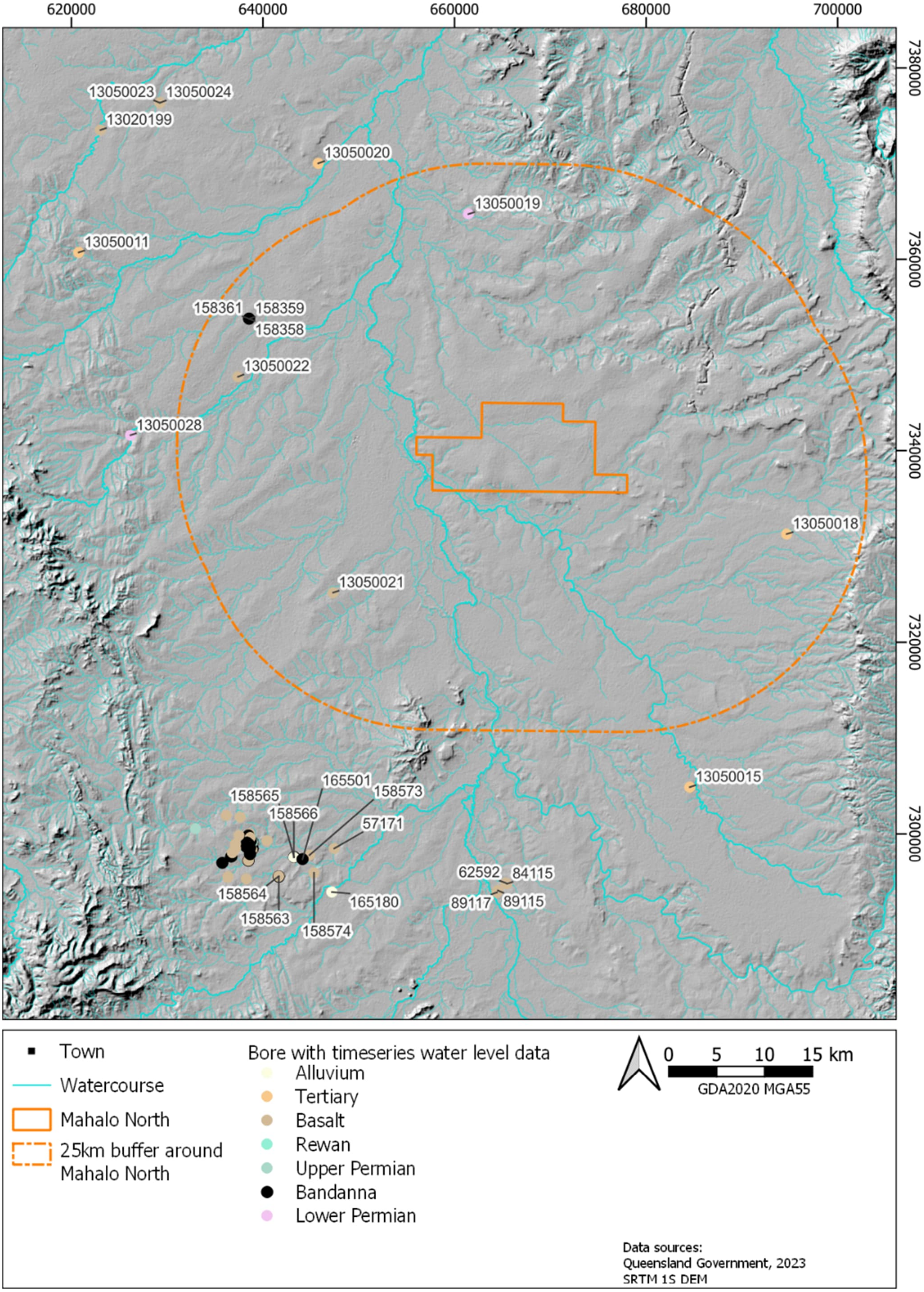


Table 5 Descriptions of Water Level Trends

RN	Hydrograph Figure	Distance and Direction from Project Area*	Formation	Bore Depth (m)	Water Level Depth Range (mbgl)	Seasonally Dynamic Water Level	Correlation to Rainfall	General Description
13050021	Figure 22	15 km SE	Tertiary Basalt	62.4	10 - 16	No	Strong	Significant water level rise associated with above average rainfall in 2010, with gradual decline thereafter
13050018		17.2 km ESE	Tertiary Sediments	112	60.8	No	None	Water level has not changed over the period 2006-2022 and 58 measurements. Bore may be blocked
13050022		19.6 km WNW	Tertiary Basalt	90	10 - 19	Yes	Strong	Rapid and pronounced response to rainfall, with quick recession indicative of aquifer of low storage volume
13050019		19.7 km N	Lower Permian	52.3	18.1 – 19.7	Slight	Strong	Water level rise associated with above average rainfall in 2011, with very gradual decline thereafter.
13050028		29.8 km W	Lower Permian	242.6	2.2 – 3.6	Unknown	Strong	Sparse data, however clear rise in water level following 2010, followed by slow decline.
13050020		30.4 km NW	Tertiary Sediments	53	24 – 24.3	Slight	Mild	Slow rise in water level following above average rain in 2010, with some seasonality. Water level started to decline from 2020, correlating with below average rainfall.
13050015		31.3 km SSE	Tertiary Sediments	75.2	65.3 – 72.5	No	Mild	Cyclicity in water level however no strong correlation to preceding rainfall as same magnitude of water level rise observed from significantly different rainfall events.
1305011		40.3 NW	Tertiary Sediments	28.2	10.6 – 20.8	No	Strong	Significant water level rise associated with above average rainfall in 2010, with gradual decline thereafter. Rate of rise and falls change with magnitude of rainfall
13020199		50 km NW	Tertiary Basalt	29.0	5.1 – 14.1	No	Strong	Pronounced water level rise following above average rain in 2010, followed by very gradual decline in water level since

RN	Hydrograph Figure	Distance and Direction from Project Area*	Formation	Bore Depth (m)	Water Level Depth Range (mbgl)	Seasonally Dynamic Water Level	Correlation to Rainfall	General Description
								with overprint of small water level rises associated with high rainfall events
158358	Figure 23	21.2 km NW	Tertiary Basalt	63	16 - 18	Unknown	Yes	Less than 1 year of data. Rapid rise in water level followed by quick recession indicative of aquifer of low storage volume
158359			Rewan Group	183	22 - 35	Unknown	Unknown	Less than 1 year of data. Rapid rise in water level indicative of recovery in low permeability formation after drilling
158361			Bandanna Formation	312	20 - 51	Unknown	Unknown	Less than 1 year of data. Rapid rise in water level indicative of recovery in low permeability formation after drilling
1305023	Figure 24	43.9 km NW	Tertiary Basalt	71.6	12.4 – 14.5	No	Strong	Water level rise associated with above average rainfall in 2011, with very gradual decline thereafter.
1305024			Tertiary Basalt	25.6	11.8 – 14.3	No	Strong	Water level rise associated with above average rainfall in 2011, with gradual decline thereafter.

* measured from closest point of Project area boundary

4.6.2. Spatial Trends

Figure 26, Figure 27 and Figure 28 present potentiometric surfaces for the alluvium, Tertiary strata (combined basalt and sediments) and the Bandanna Formation/Rangal Coal Measures. These surfaces were primarily prepared using water level data sourced from the GWBD. Where timeseries data was available, the shallowest water level was used.

Ground surface elevations we obtained from the Shuttle Radar Topography Mission 1 second digital elevation model (SRTM DEM). For the Bandanna Formation potentiometric surface, the GWBD data was augmented with reservoir pressures calculated from DST or MDT data. The water level elevation was calculated by subtracting the water level measurement from the ground surface elevation. The discrete data was then interpolated using the Kriging algorithm in Surfer©. For the Tertiary and Bandanna surfaces, twenty meter contours were extracted, whereas for the alluvium surface, ten meter contours were extracted. The contours were then clipped to the mapped extent of the formation and/or available data distribution. The surfaces are acknowledged to represent composites of different times and climatic conditions however they are considered to be hydrogeological sensible and to reasonably the general flow directions and elevations at a regional scale. Greatest uncertainties will be in the local vicinity of active groundwater extraction, such as the Rolleston mine.

The potentiometric surfaces indicate the following:

- A northerly groundwater flow direction along the Denison Trough in all three of the potentiometric surfaces, consistent with the ground surface elevation and indicating a gravity-controlled groundwater flow system with discharge to the north of the Project area
- In the vicinity of the Project area, upward hydraulic gradients from the Bandanna Formation to the Tertiary Strata and similar hydraulic heads between the Alluvium and the Tertiary Strata. It is recognised that due to the dynamic water levels in the alluvium and Tertiary Strata that hydraulic gradients and directions of groundwater movement may change temporally.

There was insufficient data available to prepare potentiometric surfaces for the Upper and Lower Permian strata.

Figure 26 Water Level Elevation – Alluvium

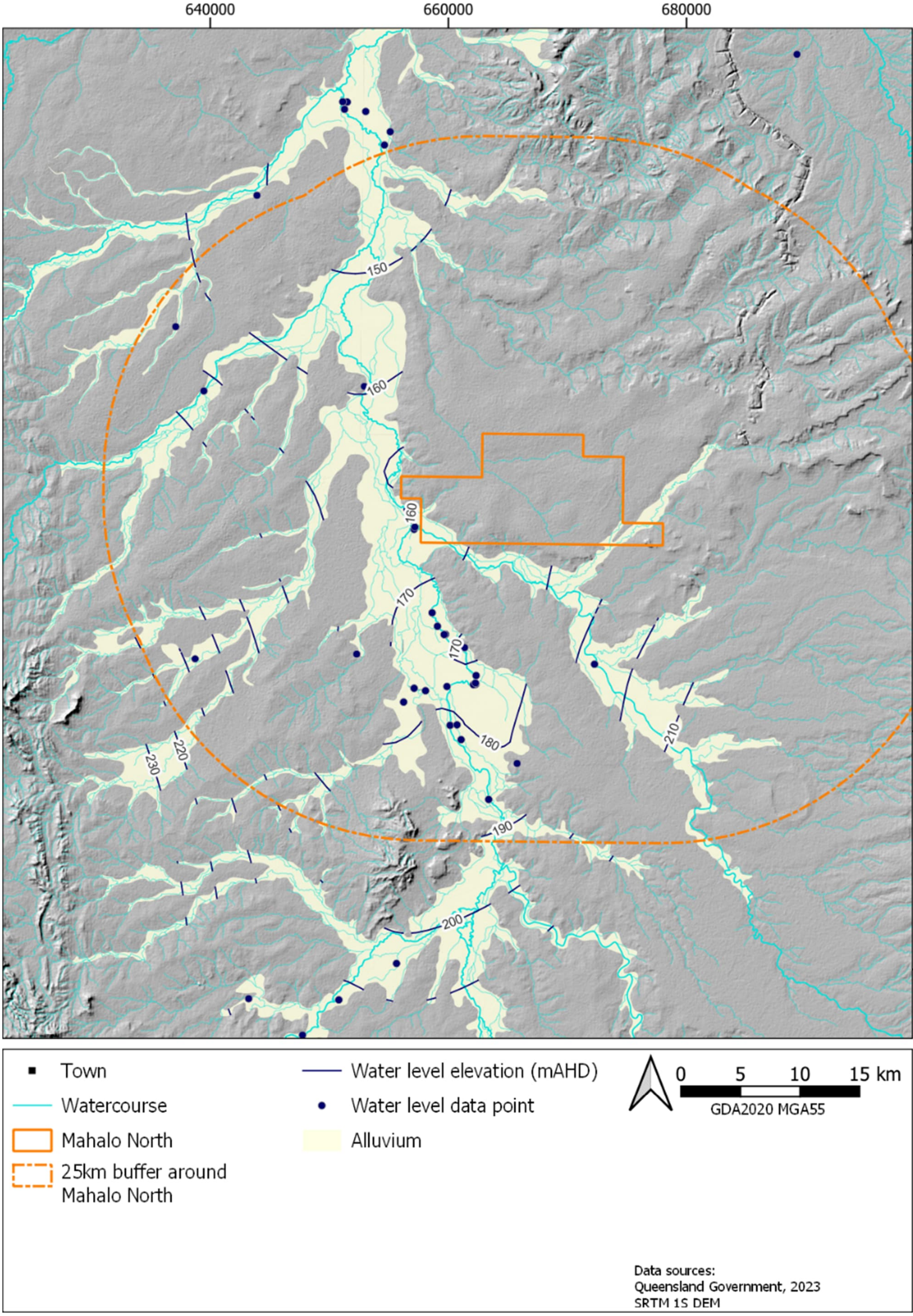


Figure 27 Water Level Elevation - Tertiary Strata

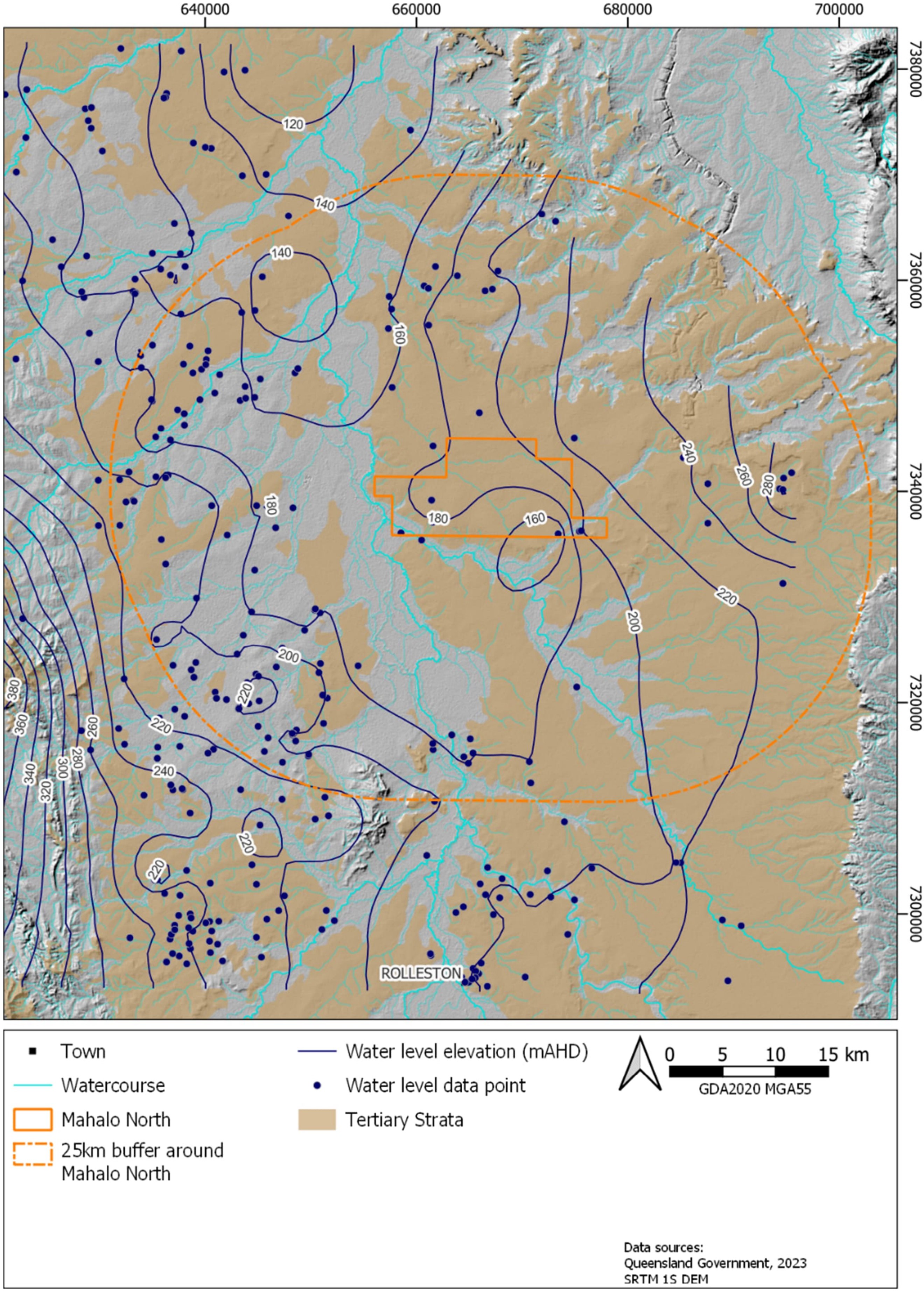
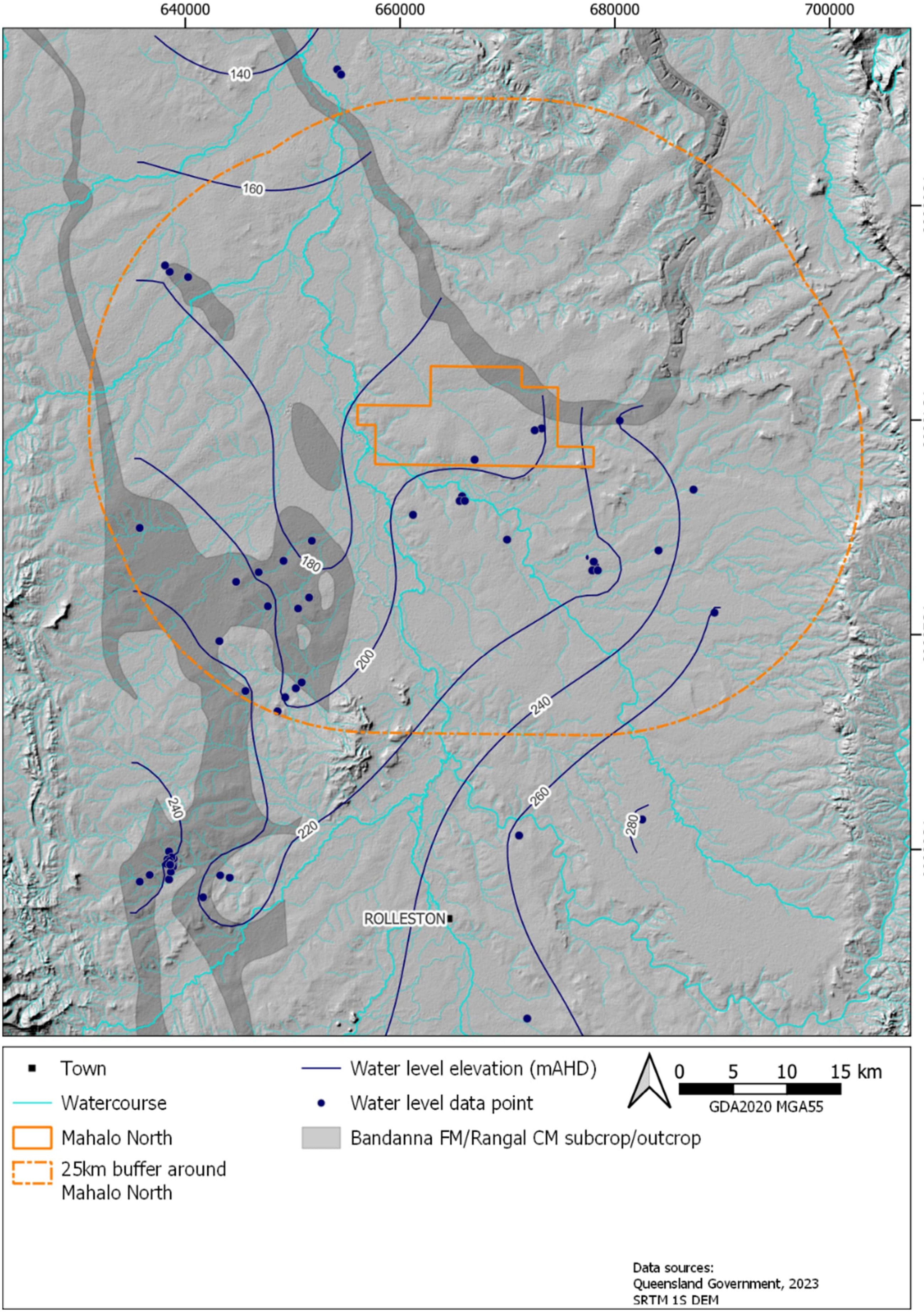


Figure 28 Water Level Elevation - Bandanna Formation/Rangal Coal Measures



4.6.3. Water table depth

The water table represents the shallowest depth at which the subsurface is saturated. It is independent of geological formation and hydraulic nature (aquifer/aquitard). Understanding the water table depth is as vegetation that is groundwater dependent (terrestrial GDEs) will utilise the shallowest groundwater that is within its root zone. It also informs the risk of groundwater contamination from surface spills and leaks.

The GWBD water level data from within the Study area and beyond. Bores with the following criteria were excluded from the data used to generate a depth to water table surface:

- Artesian water levels
- A construction depth/screen interval greater than 50 m (and therefore considered unlikely to represent the water table)
- Construction/stratigraphy data that indicates the bore is not monitoring the water table formation.

Where bores had multiple water level measurements the data set was filtered to select the shallowest water level reading in the record. The final water level data set comprised water level measurements from 482 bores.

Standing water levels were converted to reduced water levels (RWL), relative to Australian Height Datum (mAHD), by assigning each bore with a surface elevation from the SRTM DEM.

The RWL point data set was interpolated into a continuous grid using the Kriging algorithm in Surfer©. Universal (block) kriging was used with a custom variogram that was developed based on the input RWL data. The resulting potentiometric surface was produced with a grid spacing of 100 m.

As a by-product of the kriging algorithms a variance is calculated at every grid cell allowing the generation of an estimate standard deviation grid. The resulting variance map (see inset Figure 29) can be used to provide an evaluation of the confidence in the interpolated potentiometric surface/depth to water table surface. Intuitively, it shows that confidence in the kriged surface is greatest in proximity to areas where water level data is available. Since there was no water level data available in the east of the study area, confidence in the RWL is lowest in that area.

The SRTM DTM was resampled to a consistent 100 m grid size and the potentiometric surface was then subtracted to produce a continuous depth to water table depth map (Figure 30).

The water table depth map shows:

- The water table depth as mapped is a subdued reflected of topography
- Shallowest water levels are associated with watercourses, where they are generally mapped to be within 10 m of ground surface. Water depths associated with Humboldt Creek to the south of the Project area are mapped to be within 5 m of the ground surface over a relatively wide area. There was limited data to constrain the interpolation in this area
- Water levels across the Comet River alluvium may be up to 15 m deep, and water levels beneath the unnamed water course that transects the Project area tend to be greater than 20 m deep.
- The water table depth across most of the Project area exceeds 25 mbgl.

Figure 29 Water table reduced water level/elevation (mAHD)

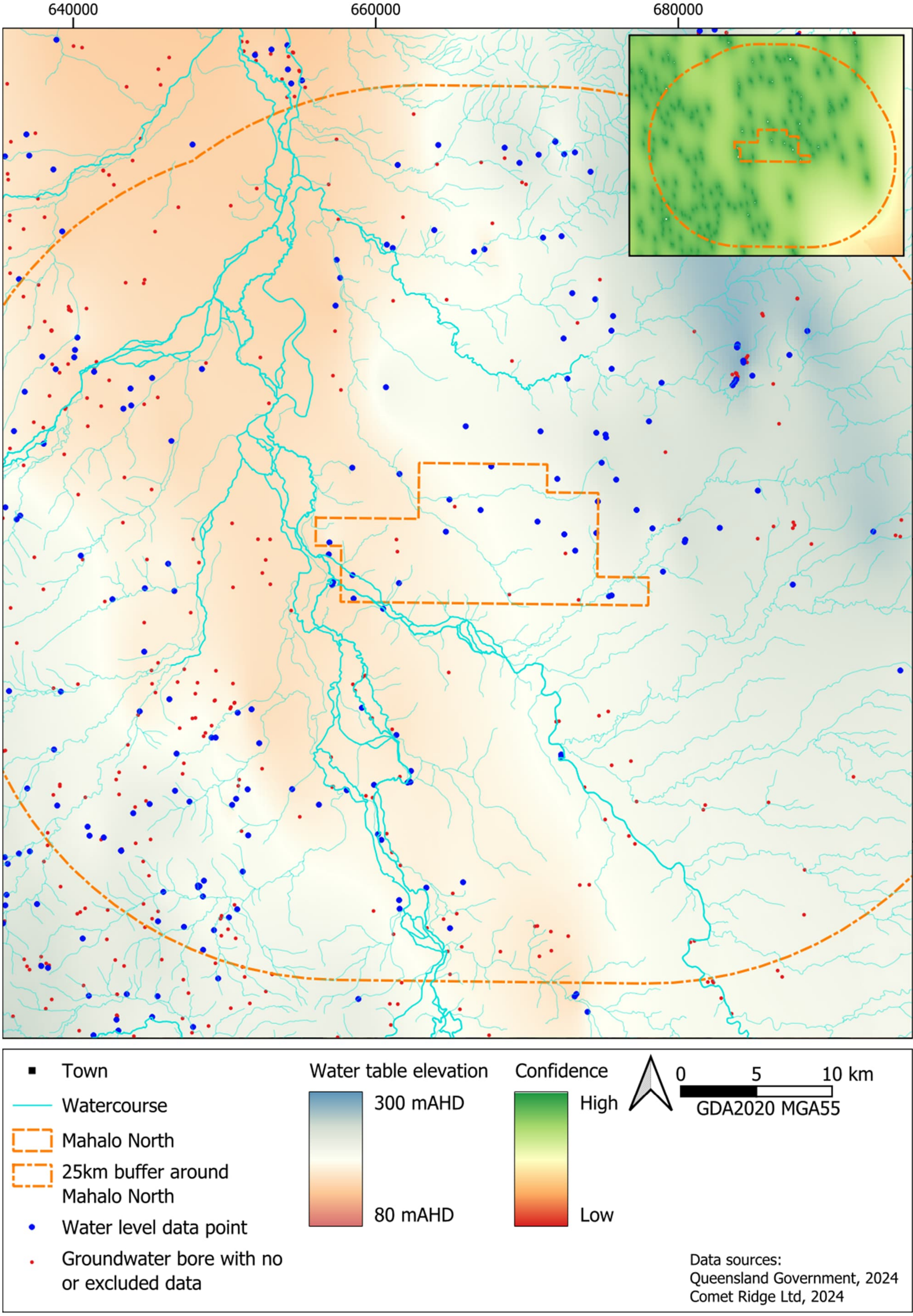
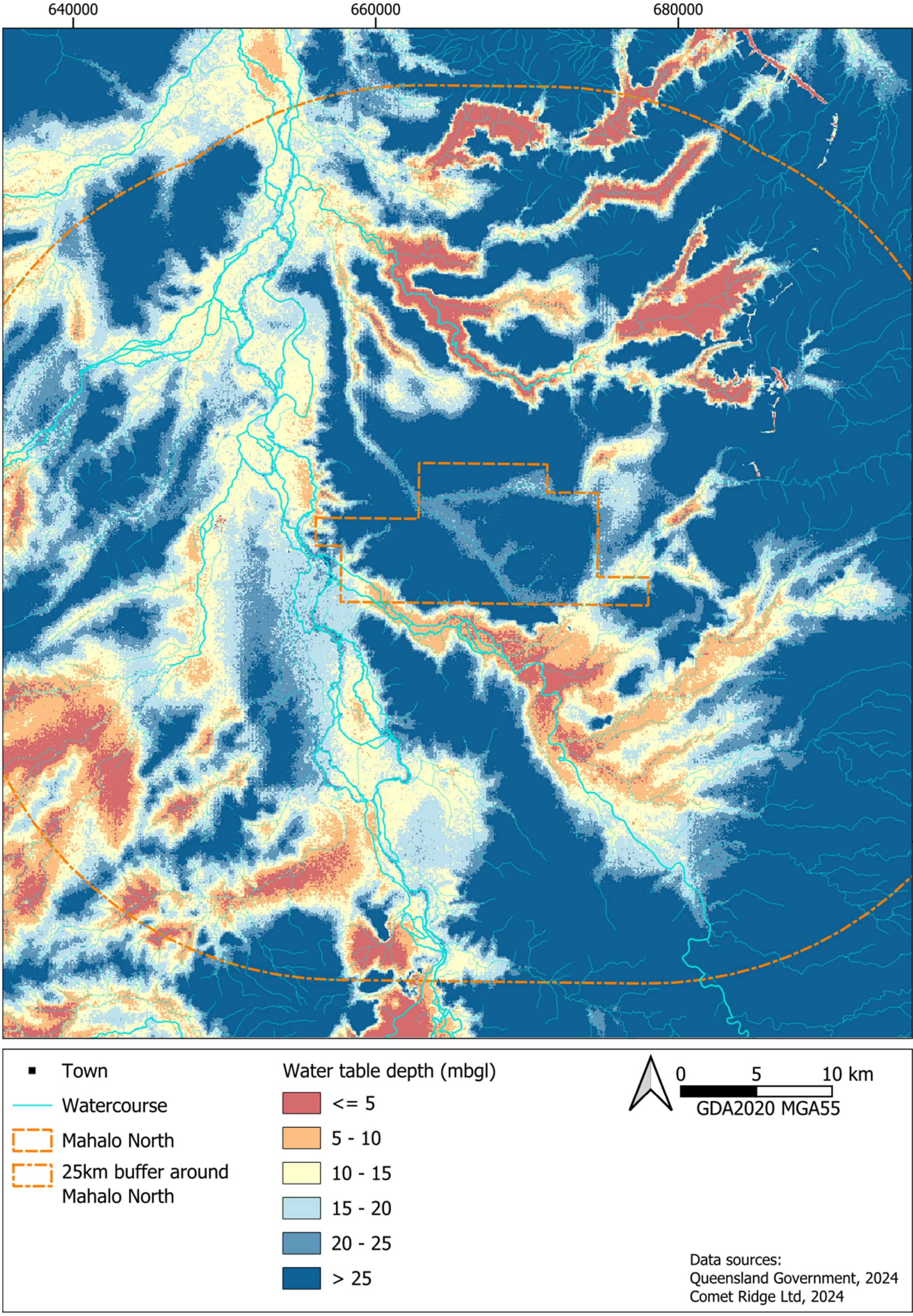


Figure 30 Water table depth (mbgl)



4.7. Groundwater Quality

Groundwater quality data has been sourced from the GWBD, Comet Ridge monitoring bores and baseline assessment samples and from Comet Ridge samples of produced water from gas production pilots, including Mahalo North 1. Where multiple samples were available for a particular bore, the most recent sample with a suitable balance of major ions (+/- 10%) was used. Surface water samples collected by the Project were also incorporated.

4.7.1. Study area water quality

The major anion and cation data have been plotted on a Piper trilinear diagram for each formation using the method described by Peeters (2014), and are presented as Figure 31. The position of the data point on the diamond of the ternary diagram determines its colour, which has then been plotted spatially (for all formations) as Figure 32. The size and shape of the symbols used on Figure 32 represent the total dissolved solids (TDS) and associated formation respectively. Statistics of the TDS concentrations are plotted in Figure 33.

Observations of the water quality characteristics pertinent to this study include:

- The surface water samples and the samples from the alluvium generally show similar major ion composition, with a predominance of the bicarbonate anion (some chloride) and a more variable and mixed cation composition. Overall, the surface water and alluvium samples have the lowest salinities, except for the Project's monitoring bore (MN-MB1-a) installed in the alluvium which was highly saline. The otherwise general similarity between the alluvium and surface water samples suggests limited geochemical evolution of the rainfall recharge as it enters the alluvial aquifer. The dissimilarity of MN-MB1-a indicates that the permeable material within the alluvium may not be hydraulically connected spatially, with localised aquifers within the wider mapped alluvium.
- The Tertiary Strata exhibit a wide range in water types, generally showing an evolution from mixed cations to a sodium dominance and an associated increase in chloride. There is no clear spatial pattern to this trend, with most of the samples from the southwestern portion of the study area. The variability in major ion composition and no clear spatial pattern suggest that the Tertiary Strata are internally heterogeneous with limited lateral connectivity between water-bearing zones. The Tertiary Strata generally have a brackish salinity, higher than the alluvium and surface water, but much fresher than the underlying Permian Strata. The relatively low salinity suggests relatively short residence time and a reasonably active hydrodynamic regime.
- Only five samples were available for bores attributed to the Rewan Group, two of which were the Project's shallow monitoring bores. These showed water chemistry tending towards sodium-bicarbonate-chloride, but with some variability and no discernible spatial trend. The salinity statistics for the Rewan Group are heavily skewed by the high salinity of the monitoring bores. Of the other three samples, the range in salinity was similar to the alluvium (and fresher than the Tertiary Strata), it is likely that this was affected by the small number of samples and the relatively shallow bore depths (21 - 100 m).
- Groundwater quality in the Bandanna Formation can be separated into two distinct groups: higher salinity (~4,000 – 10,000 mg/L TDS) sodium-chloride waters present in the central part of the study area, where the Bandanna is separated by the Rewan Group and/or Upper Permian Formations and lower salinity (<1,000 mg/L) sodium-bicarbonate waters in the southwestern portion of the study area where the Bandanna Formation subcrops directly beneath Quaternary

or Tertiary Strata. It is likely that there is direct hydraulic connection between the cover and the Bandanna Formation in the southwest of the Study area that allows recharge of fresher water to the Bandanna Formation. The higher salinity samples are mostly from CSG pilot wells that are also deeper than surrounding water bores. This indicates long residence times and limited hydraulic connection with fresher, surficial waters.

- There are only seven samples from the Upper and Lower Permian Formations combined. Their major ion chemistry is relatively similar with sodium-bicarbonate-chloride water, however the Upper Permian formations appear to be fresher than the Lower Permian formations.

Figure 31 Piper Diagrams - by Stratigraphic Interval

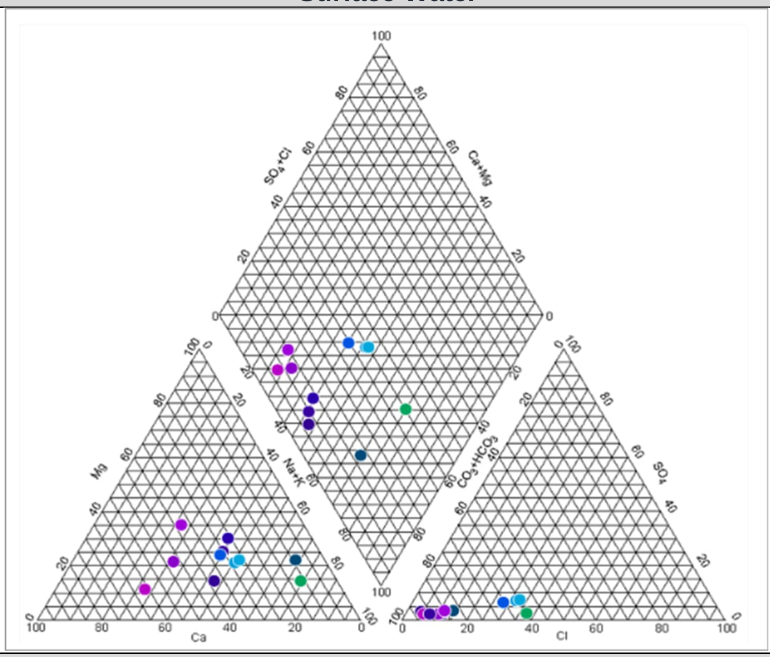
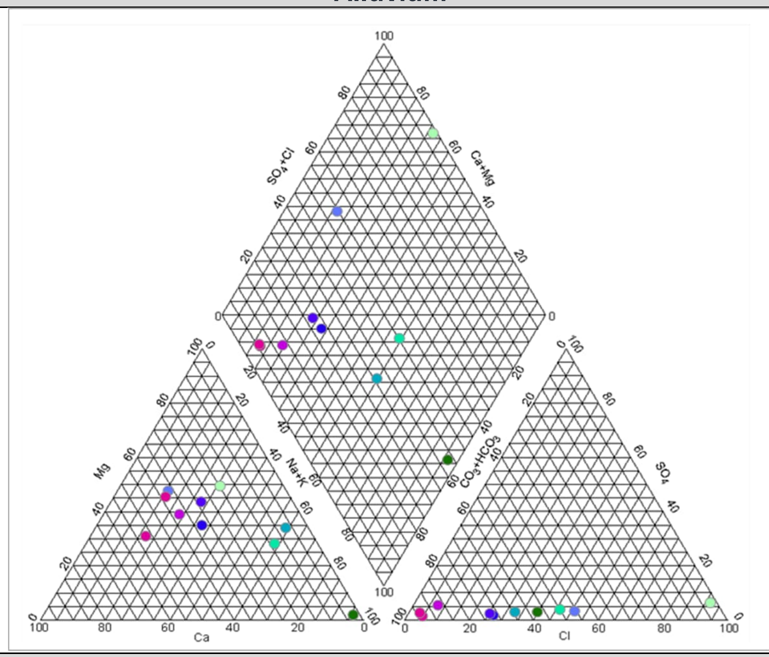
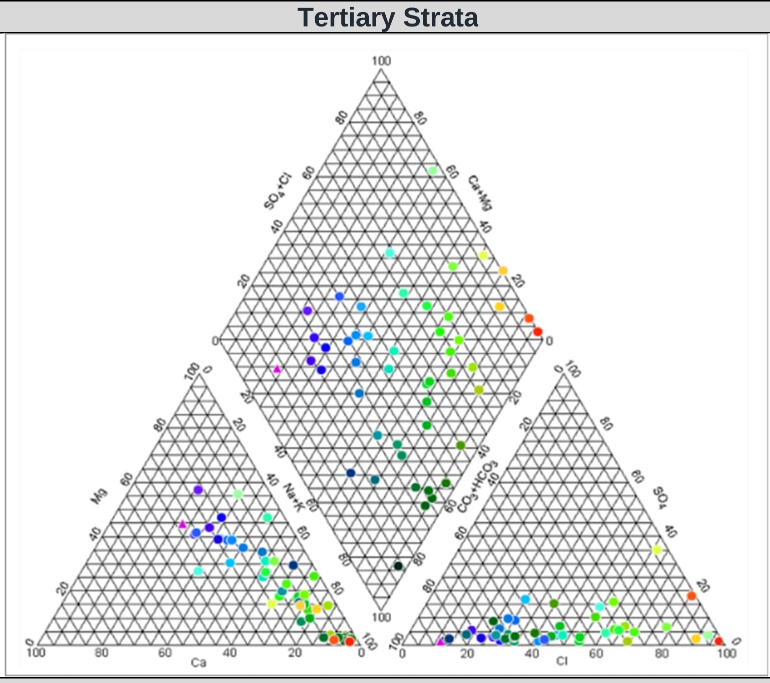
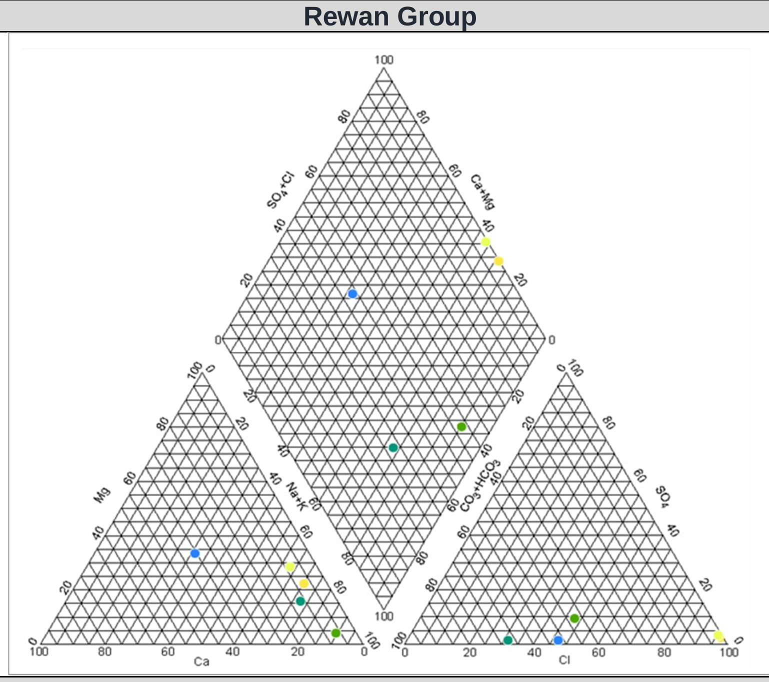
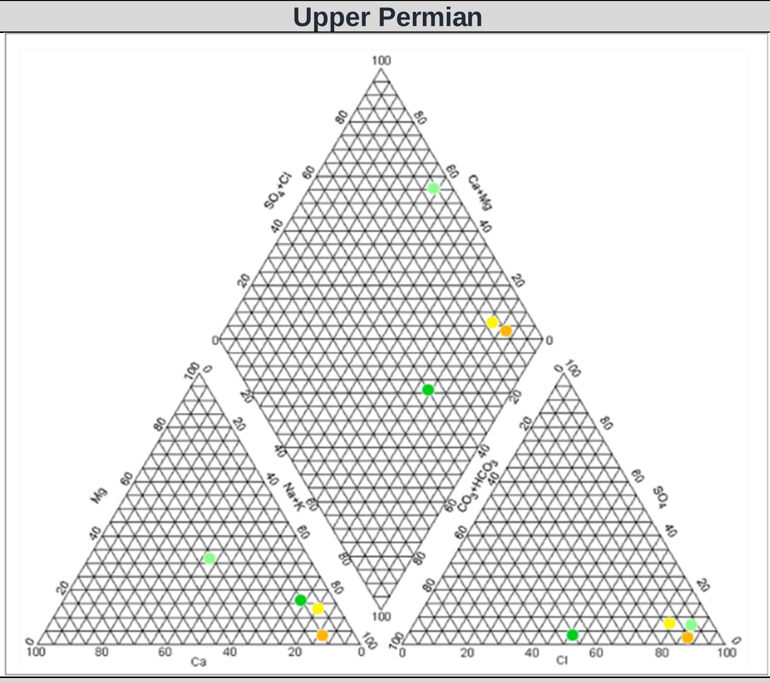
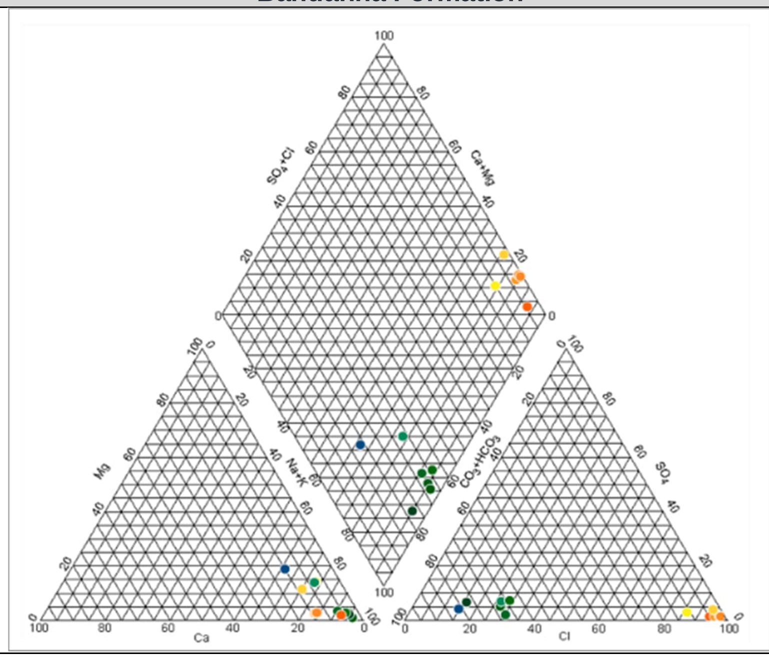
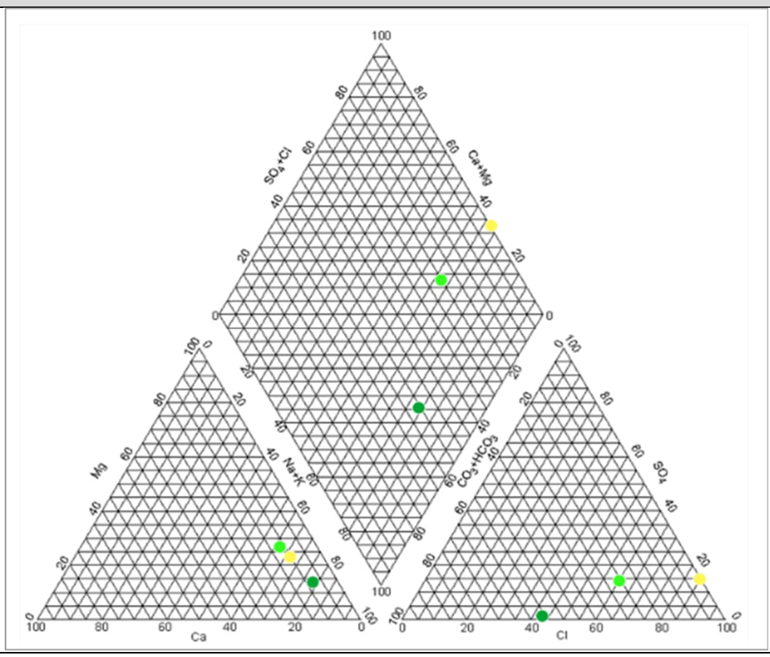
Surface Water	Alluvium
	
Tertiary Strata	**Rewan Group**
	
Upper Permian	**Bandanna Formation**
	
Lower Permian	
	

Figure 32 Water Quality Samples Plotted by Water Type and Electrical Conductivity

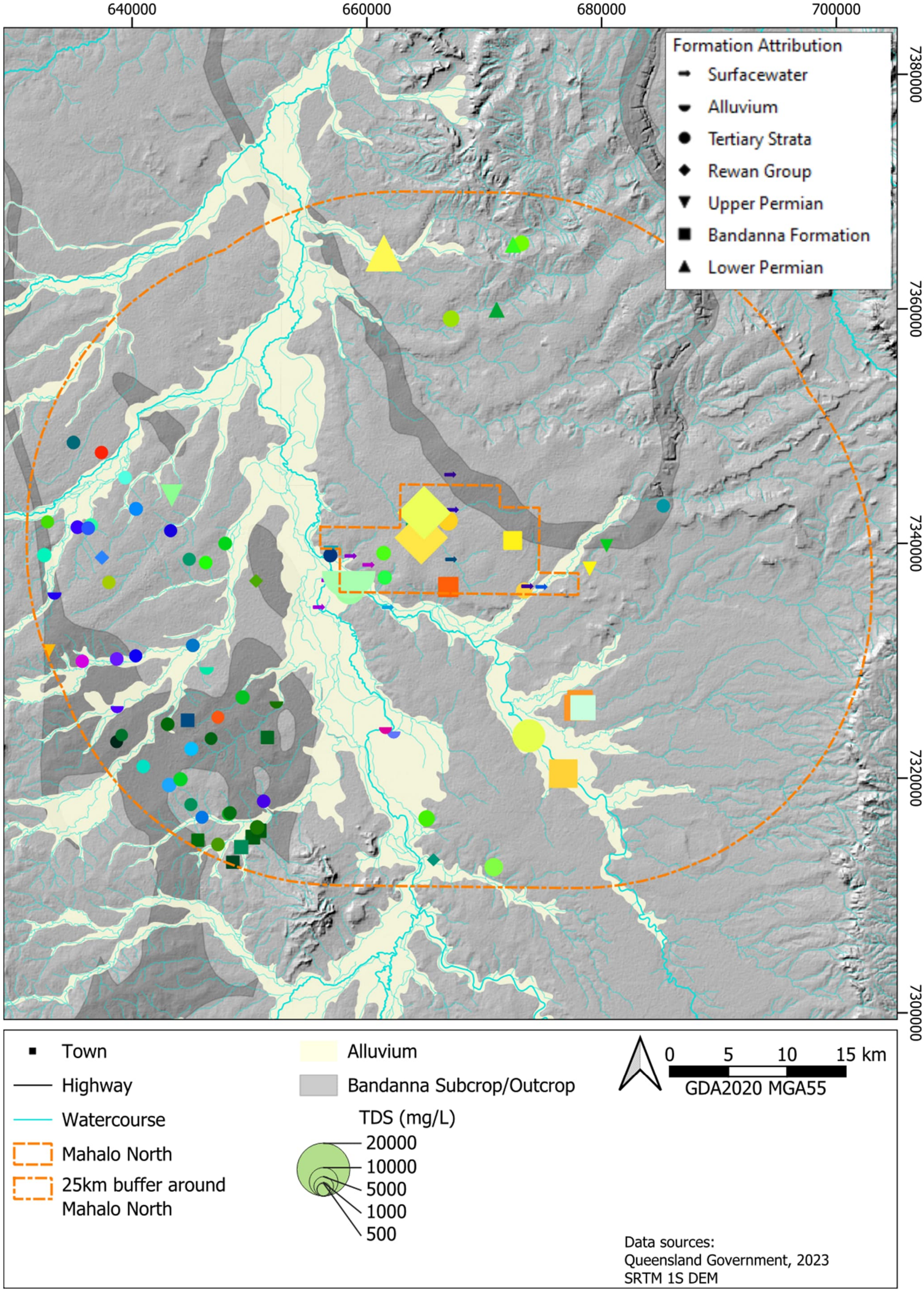
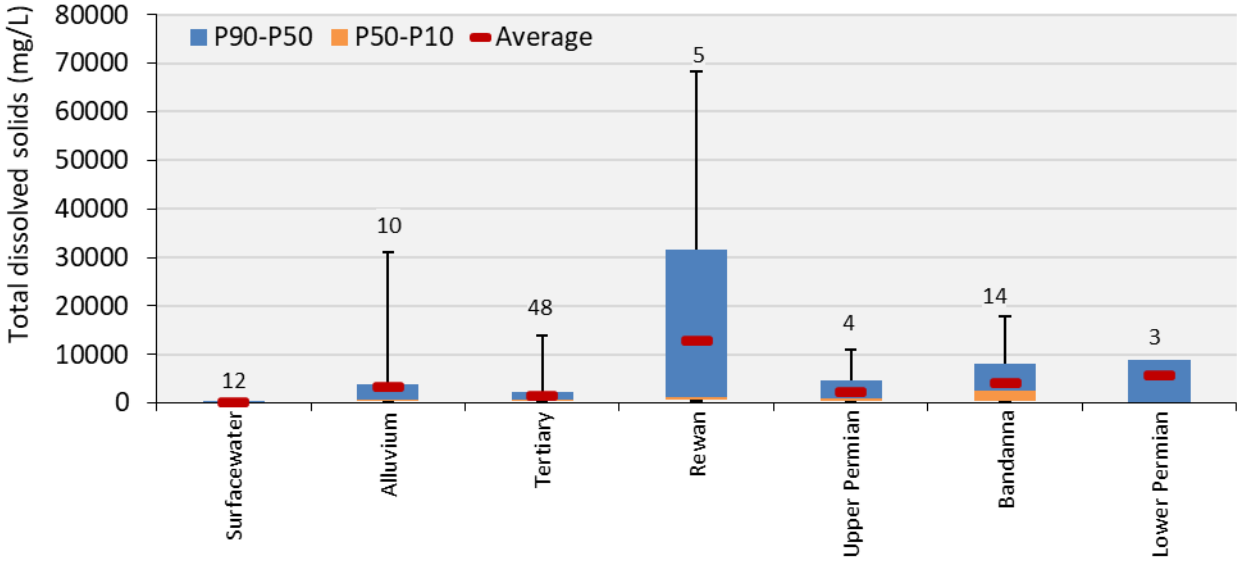


Figure 33 TDS Statistics by Unit



4.7.2. Project area water quality

Major ion chemistry, TDS and pH have been plotted on a Durov diagram for water quality samples collected by the Project and within the Project area (Figure 35). This includes:

- Dry season surface water monitoring data,
- Samples collected from existing landholder bores,
- A sample collected during the Mahalo North 1 pilot production, and
- Samples collected from the Project's groundwater monitoring bores

The groundwater samples have been plotted by attributed source formation on Figure 35. A general grouping of the samples by source is evident with a distinct difference between the surface water (low TDS, low chloride, and highly variable cations) and groundwater quality. Furthermore, while there is some overlap between the basalt water quality and the Bandanna Formation, the different source formation generally plot separately, suggesting limited interaction. Other observations include:

- A basalt bore which appears to have similar chemical properties to a surface water sample. This bore is immediately adjacent to the Comet River, which may provide a localised recharge source. The surface water sample adjacent to which in plots on the Durov diagram was not collected from close proximity to the bore
- A basalt bore which has similar chemical properties to the Bandanna Formation. The lithological log for this bore is poor, therefore it is possible that some of its supply is sourced from the Bandanna Formation and the bore is incorrectly attributed
- The sample collected from the Comet River alluvium is significantly more saline (20,000 mg/L) than the surface water samples, basalt and Bandanna Formation samples, and is only exceeded by one of the Rewan Formation bore samples. The distinct stratigraphic differences in the groundwater salinity, with the most saline samples coming from shallowest in the profile are indicative of poor hydraulic connectivity.

Stable isotopes were analysed from samples collected from the Project's monitoring bores (Figure 34) for the primary purpose of assessing the source of the water used by potential terrestrial GDEs and secondary objective of improving understanding of the recharge regime.

Two rounds of stable isotope analysis had been performed at the time of preparation of this report. These data have been compared with local meteoric water lines (LMWL) for Brisbane and Charleville sourced from Hollins et al., 2018) and spot rainfall data for Injune and Clermont sourced from Crosbie et al., (2012).

Figure 35 indicates:

- The similarity between the Charleville LMWL, Brisbane LMWL and the spot samples (albeit limited in number) suggest the LMWL likely provides a reasonable representation of the local isotopic conditions of rainwater at the site
- The three groundwater samples plot on a line that is offset from the LMWL but with a relatively similar gradient. The samples do not have an evaporative signature, which would be shown by samples plotting on a line with a flatter gradient relative to the LMWL. This suggests that the groundwater samples are unlikely to be recharged under the current climatic conditions. This is consistent with the low permeability of the formation (particularly MN-MB5-R and MN-MB6-b) and high TDS, both of which suggest low recharge rates and longer groundwater residence times
- The shift in isotopic composition of the groundwater samples is likely due to the influence of the introduction of compressed air into the formation during drilling (particularly MN-MB1-a) and the groundwater's subsequent re-equilibration.

Figure 34 Durov diagram of site-specific water quality data

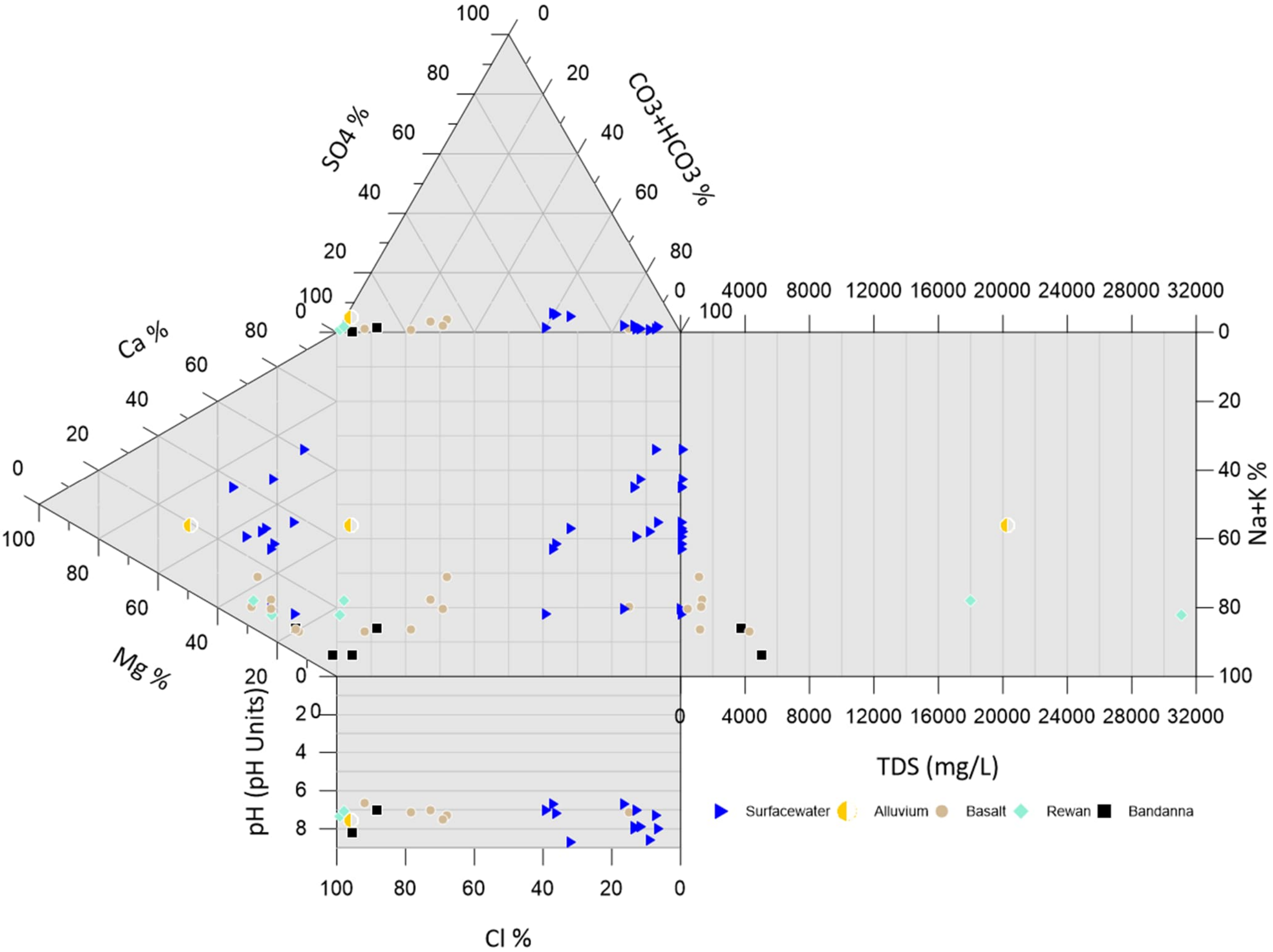
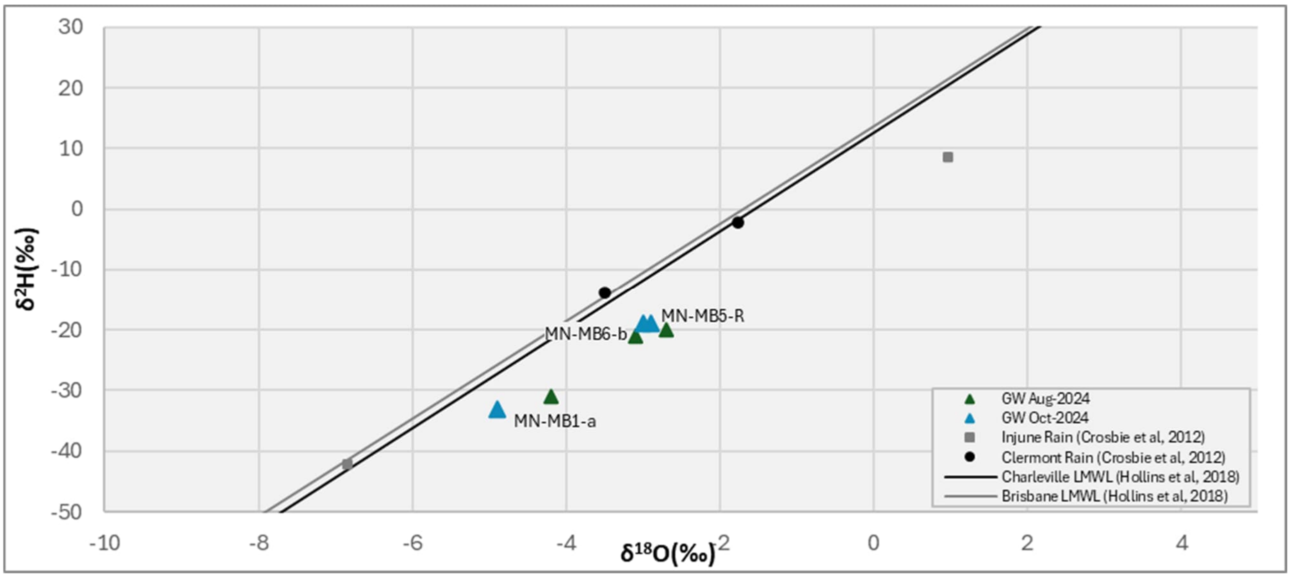


Figure 35 Stable isotope results relative to LMWL



5. Environmental Values

The environmental values (EVs) of water are the qualities that make it capable of supporting aquatic ecosystems and human uses. The Queensland Government's *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP Water and Wetland Biodiversity) is the primary regulation through which the EVs of waterways in Queensland are protected. As identified in Section 2.2.4, the following environmental values are applicable to the Comet Groundwater zone:

Aquatic ecosystems associated with high ecological value, slightly disturbed moderately disturbed and highly disturbed waters;

- Irrigation;
- Farm Supply/Use
- Stock watering;
- Primary recreation;
- Drinking water;
- Industrial use;
- Cultural and spiritual values;

The exercise of underground water rights has the potential to impact on these EVs through the degradation of water quality or the reduction in water availability through depressurisation. The EVs are supported by either groundwater supply bores (e.g.. aquaculture, agriculture, drinking water and industrial use) or through the surface expression of groundwater via springs and baseflow to surface water bodies and their associated wetlands (e.g. aquatic ecosystems, recreation and cultural and spiritual values). Aquatic ecosystems also include terrestrial GDEs, for which there may not be a surface expression of the groundwater.

The EVs within the vicinity of the Project area are described in the following sections.

5.1. Groundwater Bores

The GWBD was used to identify potentially active water supply bores within the Study area. Potentially active includes all those registered bores that are not identified as "Abandoned and Destroyed" or that cannot be readily identified as petroleum, monitoring or investigation bores via their original names or construction details (e.g. less than 125 mm diameter casing). Where the purpose of the bore could not be confidently ascertained, it was assumed that the bore was used for water supply. Based on the GWBD "facility roles", all of the water supply bores are used for stock and/or domestic purposes.

Bores were initially attributed by using the aquifer attribution provided by OGIA. However, when quality assurance of this data was performed, it was found that many of the bores were incorrectly attributed due to the use of a regional scale model and automated processes. In lieu of the OGIA attribution, the construction details, strata logs and surface and solid geology mapping was used to attribute the bores. Whenever coal was identified in the strata log, it was assumed that the bore accessed the Bandanna Formation.

Of the 426 registered bores identified within the Study area:

- 21 were petroleum or CSG wells;
- 53 were monitoring or investigation bores; and
- 352 were presumed to be used for water supply purposes, of which 277 are still active and 75 are inactive.

The status and purpose of registered bores are shown on Figure 36 and the attributed formations of active water supply bores are shown on Figure 37. The number of active water supply bores per attributed formation is listed in Table 6.

The vast majority of active water supply bores in the Study area access the Tertiary strata, predominantly the basalt, and are located to the west and southwest of the Project area. Within the Project area, one active water supply bore was identified that accesses the Bandanna Formation, and one that accesses the Rewan Formation. There are several bores that access the Bandanna Formation Rewan Formation to the southwest and west of the Project area.

In 2021, and in accordance with its Baseline Assessment Plan, Comet Ridge completed bore baseline assessments across two of the properties within the Project area (TerraSana, 2021a and 2021b). A total of nine active groundwater bores were identified, of which four were considered unregistered. All bores were indicated to source their water from the Tertiary Basalt and were all used for stock watering. The locations of the baselined bores are shown on Figure 36.

Figure 38 shows the locations of water licenses. For groundwater-related licences, the most intensive authorised purpose has been shown. The "other" category includes purposes identified as agriculture, aquaculture or other. From Figure 38, there are no groundwater licences within the Project area but there are surface water licences immediately surrounding and within the Project area. There are irrigation, stock intensive and other purpose groundwater licences in the southwest of the Study area, with one licence at the northern extent of the Study area. The majority of the groundwater licences authorise extraction from the Tertiary Strata (basalt) or alluvium.

Table 6 Aquifer Attribution of Active Water Supply Bores within the Study Area

Unit	Number of bores
Alluvium	35
Tertiary Sediments	5
Basalt	168
Rewan Group	17
Upper Permian	7
Bandanna Formation	23
Lower Permian	22
Total	**277**

Figure 36 Registered Water Bore Purpose

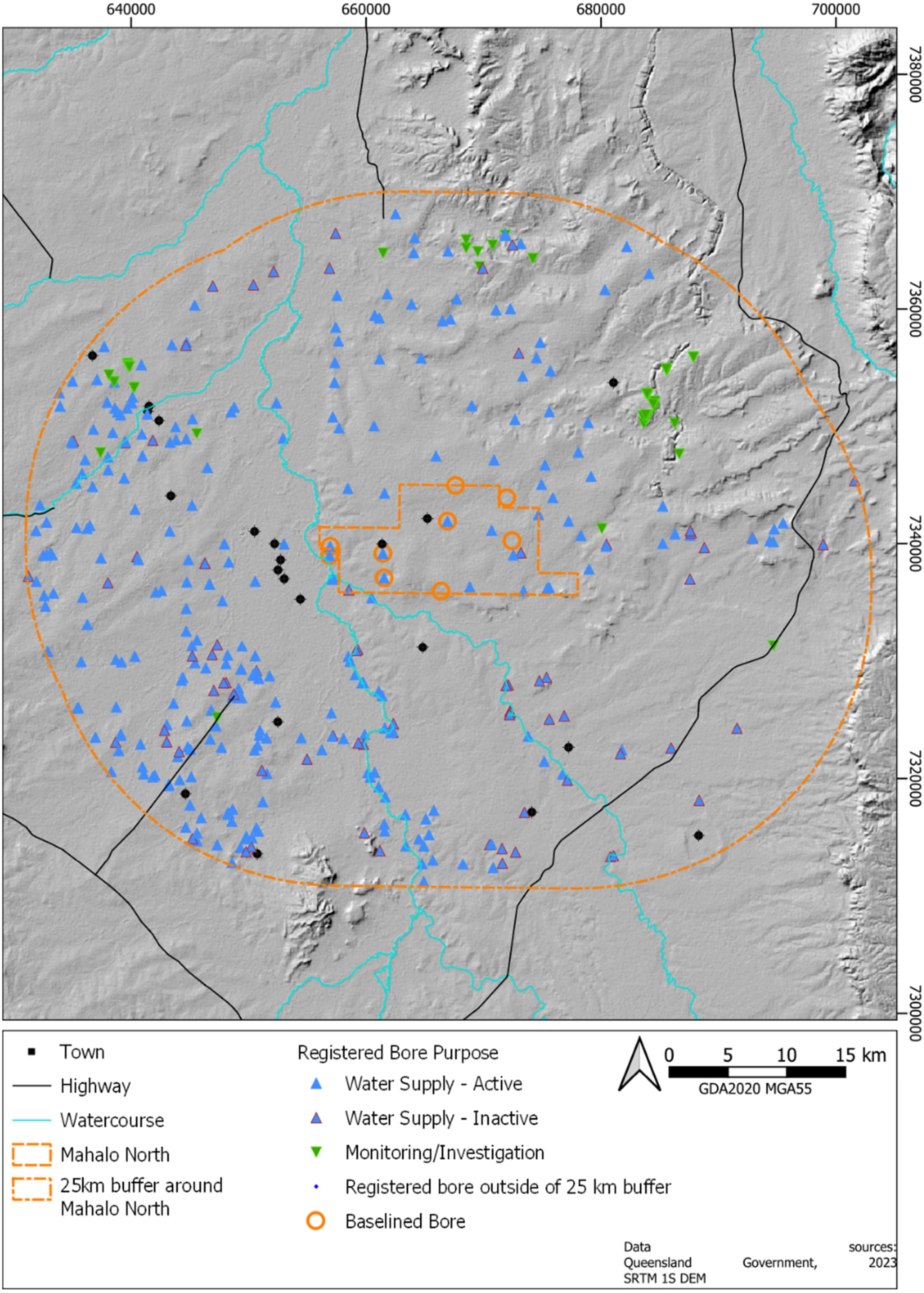


Figure 37 Attributed Formation of Water Supply Bores

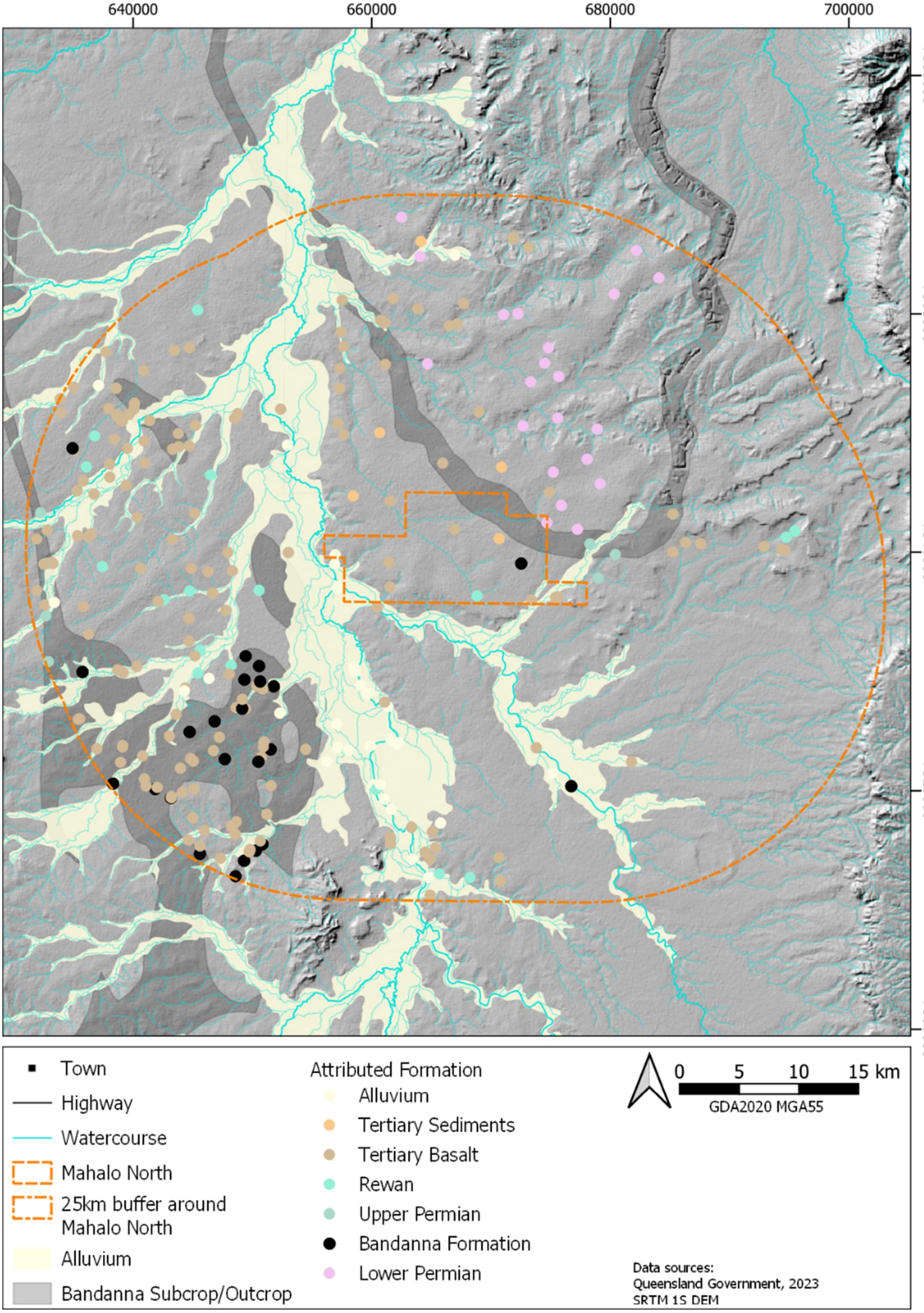
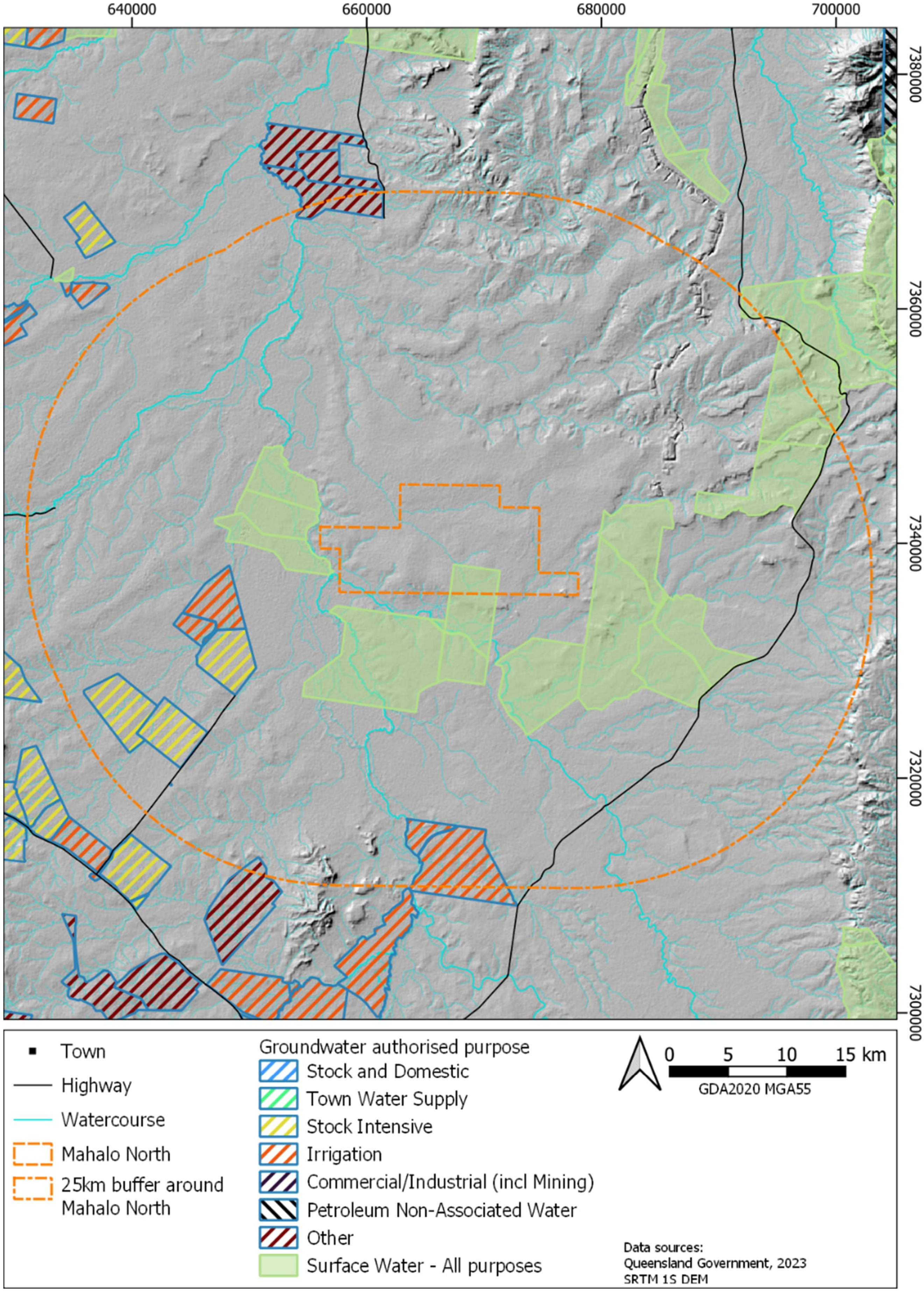


Figure 38 Water Licence Locations and Authorised Purpose



5.2. Groundwater Dependent Ecosystems

Doody et al. (2019) define GDEs as natural ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services (Richardson et al., 2011). The broad types of GDEs are (Eamus et al., 2006):

- **Aquatic GDEs** - Ecosystems dependent of surface expression of groundwater including springs, groundwater fed wetlands or baseflow fed streams or rivers;
- **Terrestrial GDEs** - Ecosystems dependent on sub-surface use of groundwater; and
- **Subterranean ecosystems** - stygofauna

Queensland GDE mapping (State of Queensland, 2023d) was interrogated to identify the locations of potential GDEs in the vicinity of the Study area. This mapping is based on regional scale mapping and is intended to provide a first pass assessment of the likely presence of GDEs. The mapped confidence of the presence of aquatic and terrestrial GDEs are presented as Figure 39 and Figure 40 respectively. The were no identified stygofauna in the vicinity of the Study area, however this may be related to the absence of site-specific studies, rather than the absence of the GDE.

5.2.1. Aquatic GDEs

Figure 39 shows the locations of the nearest springs to the Project area and the mapped confidence in the presence of springs and watercourse springs and wetlands in the vicinity of the Project. From Figure 39:

- The closest mapped springs are approximately 28 km east of the closest boundary of the Project area. These springs have been field verified and are named the Kullanda complex. They have been identified to be sourced from the Clematis Group. They are identified as riverine springs in the upper catchments of active watercourses
- The Arduarad complex is located approximately 32.5 km to the northeast of the Project area and comprises two springs vents – Arduarad and Rockland. The mapping identifies these springs to be sourced from the Clematis Group, however the Clematis Group is not present in their mapped locations. They are identified as riverine springs in the upper catchments of active watercourses
- Additional springs are present within the Expedition Ranges and Blackdown Tablelands at greater distances from the Study area. These are all underlain by the Clematis Group
- The closest spring complexes identified to host a listed species under the EPBC Act or host a *community of native species dependent on natural discharge of groundwater from the Great Artesian Basin,* and hence be classified as a MNES in their own right are the:
  - Cleanskins complex, approximately 46 km to the east of the closest boundary of the Project area; and
  - Elgin complex, over 55 km southeast of the closest boundary of the Project area.

  Both complexes are underlain and sourced from the Clematis Group, which is not present within the Project area.
- Several short reaches of moderate confidence aquatic GDEs are mapped along and within approximately 3 km of the southern boundary of the Project area. The mapping identifies these to have intermittent groundwater connectivity which may be either gaining or losing. They are identified to be locally recharged, unconfined and associated with the Tertiary Strata (basalt) which underlies them (mapping rule Surat_RS02A).

- There is a roughly 250 m length of high confidence mapped aquatic GDE to the south of the southern boundary, with the same characteristics as the surrounding moderate confidence mapped aquatic GDEs
- There is a moderate confidence aquatic GDEs mapped within the northern portion of the Project area, with the same characteristics as the surrounding moderate confidence mapped aquatic GDEs
- Across the Project area, the water table depth (within the Tertiary Strata) is estimated to be 20 m to 40 m below ground level (refer Figure 27). These mapped aquatic GDEs are unlikely to be supported by the regional groundwater system but may be supported by shallow short flow path groundwater flow systems
- Within the wider Study area, particularly to the west of the Project area, there are extensive reaches of watercourses mapped as high to moderate potential aquatic GDEs. The mapping dataset identifies all of these to be associated with the following four mapping rules (DES, 2017):
  - **Surat_RS_01A** – Quaternary alluvial aquifers overlying sandstone ranges with fresh,
  - intermittent groundwater connectivity regime
  - **Surat_RS_02A** – Permeable rock aquifers (basalts) greater than or equal to 100 ha
  - in size with fresh, intermittent groundwater connectivity regime
  - **Surat_RS_02B** – Permeable rock aquifers (basalts) less than 100 ha in size with
  - fresh, episodic groundwater connectivity regime
  - **Surat_RS_03A** – Permeable consolidated sedimentary rock aquifers with fresh, intermittent groundwater connectivity regime. These are location outside of Study area and are identified to be associated with local scale groundwater flow systems.

5.2.2. Terrestrial GDEs

Figure 40 shows the locations of mapped terrestrial GDEs and their assigned confidence intervals (State of Queensland, 2023d). From Figure 40:

- There are large swathes of low confidence terrestrial GDEs mapped throughout and immediately to the north of the Project area boundary
- Extensive areas of low confidence terrestrial GDEs are mapped as riparian vegetation in association with the mapped alluvium of many reaches of the Comet River and its tributaries, particularly the tributaries that rise on the Tertiary Strata to in the west of the Study area. These areas are in part fringed by thin strips of high confidence areas. The confidence generally transitions to medium confidence closer to the headwaters of the watercourse
- A large swathe of low confidence terrestrial GDE in the southeastern corner of the Study area. This is identified as being associated with shallow, alluvial local scale aquifers of intermittent connectivity.

Canopy trees will have the most developed and deepest root architecture and will therefore be more likely to utilise groundwater compared with underlying grass and shrub species (Barbeta et al, 2017). The regional ecosystems identified in the terrestrial GDE mapping were cross referenced with the Regional Ecosystem Description Database (Queensland Herbarium, 2023) to identify the dominant canopy species composition of the mapped potential GDEs (Appendix E).

A literature review has been undertaken to assess the potential for groundwater use by most of these species, which is summarised as follows:

- **Brigalow *(Acacia harpophylla*)** - habitats and individual trees regularly occur adjacent to the floodplain of the major and ephemeral drainage systems and generally occupy heavy clay soils (vertosols) with well-developed gilgai. Johnson et. al. (2016) described Brigalow's root mass as concentrated in the upper soil profile, and the plant suckers profusely from horizontal roots. The shallow rooting of Brigalow is evidenced by its propensity for mature trees to topple. The fallen trees universally expose a well-developed lateral root system with little evidence for deep sinker roots. Because of its shallow roots, Brigalow is not considered groundwater dependent
- **Poplar Box (*Eucalyptus populnea*)** - Fensham and Fairfax (2007) identify poplar box to have a shallow rooting system with limited investment in deep root architecture. Based on field observation, tree roots would not be expected to penetrate beyond 4 mbgl. While GDE mapping datasets (BOM 2017) frequently represent poplar box woodlands on alluvium (RE11.3.2), their likelihood this situation would likely only occur when fresh groundwater is relatively close to the surface (<4 mbgl), and there would be almost no potential for groundwater dependence when the species occurs higher in the landscape (RE11.5.3, 11.9.7 and 11.10.12)
- **Blackbutt (*Eucalyptus cambageana)*** – There is limited information in literature on moisture sources and requirements for *E. cambageana*. However, the species occurrence mixed with brigalow ecosystems suggests an association with heavy clay substrates which limits deeper taproot penetration and capacity to utilise deeper moisture / groundwater sources
- **River Red Gum *(Eucalyptus camaldulensis)* -** *Eucalyptus camaldulensis* is a riparian specialist that is known to have deep sinker roots, hypothesised to grow down towards zones of higher water supply (Bren and Gibbs, 1986). The maximum potential rooting depth of river red gum uncertain, however it is widely accepted that the species has capacity to access deep groundwater sources (Eamus et al., 2006). Horner et al. (2009) found rooting depths at 12–15 metres below ground level and Jones et al. (2020) found maximum rooting depths of 8.1 mbgl in river red gum in a broad study area in the Surat Basin. Given its position in the landscape (riparian) and its potential to access deep groundwater, any RE that includes river red gums is considered likely to be groundwater dependent
- **Forest Red Gum** (***Eucalyptus tereticornis)* –** Forest red gum can occupy similar ecological environments as the river red gum, but is more adaptable as it is can also occupy dry hill slopes. It is expected to be more tolerant to changes in water availability than river red gum. Kallarackal and Somen (1998) observed *E. tereticornis* roots to a depth of 9.5 m in a 20 year old plantation which was within the seasonally variable water table depth. Forest red gum is considered likely to be groundwater dependen
- **Ironbark species (*Eucalyptus crebra, Eucalyptus melanophloia)*** - Fensham and Fairfax (2007) and Fensham et al. (2009) indicate that ironbark have shallow root systems, unlikely to penetrate beyond 5 m below ground. The ironbark species are most likely to be found higher in the landscape, where the water table is likely to be deeper. Ironbarks are considered unlikely to be groundwater dependent
- **Lancewood (*Acacia shirleyi)*** – Lancewood occupies positions higher in the landscape, such as jump-ups which are well above the regional water table. These species are not considered to be potentially groundwater dependent
- ***Coolibah* (*Eucalyptus coolabah*)** - Coolibah favours sites with heavier clay soils, typically close to drainage lines and requires flooding for regeneration (Roberts, 1993). The heavy clay associated with of RE11.3.3 will limit the potential for root penetration. Clay substrates are an unsuitable medium for development of a deep tap root system that would be necessary to

penetrate to the water table (Dupuy et al., 2005) and soils with low hydraulic conductivities, such as clays, greatly limit the ability of trees to utilise groundwater (Feikema, 2010). Coolibah is considered likely to only utilise groundwater only when groundwater is shallow (<5 mbgl) and moisture availability in the vadose zone is extremely limited

- **Stringybark** (***Eucalyptus sphaerocarpa***) **and Gympie Messmate** (***Eucalyptus cloeziana***) - no literature was identified that specifically discussed the water requirements of these species. However the landcapes of distribution of the REs with which they area associated (11.10.5 and 11.10.13), being sandstone hills, plateaux and escarpments suggest they will not be groundwater dependent

Field validation surveys were conducted by terrestrial ecologists from Epic Environmental at five locations associated with mapped terrestrial GDEs. These locations are shown on the inset map of Figure 40, and photographs[2] and included as Figure 41 to Figure 43. The validation surveys identified the following:

- **Survey Points 1 and 2** – vegetation corridor along Comet River and associated minor anabranch channel. This is mostly a Brigalow (*Acacia harpophylla*) community (considered to be in good condition) with some large Blackbutt (*Eucalyptus cambageana*) on or close to the two channels that were surveyed. There was water present in the channels at the time of the survey. The tree species present are generally consistent with those associated with the mapped regional ecosystems (REs 11.3.1, 11.3.3, 11.3.25). While *Eucalyptus camaldulensis* was not observed, this may be because it is most likely present immediately adjacent to the main channel of the Comet River, which could not be reached due to the density of the riparian vegetation
- **Survey Point 3** – a mixture of Poplar Box (*Eucalyptus populnea*) and Silver-leaved Ironbark (*Eucalyptus melanophloia*) woodland with various other species in the lower storey such as Wilga (*Geijera parviflora*). It was identified to be quite disturbed with historical clearing or at least thinning. There was Brigalow (*Acacia harpophylla*) along the edges including a patch on the north-east corner. The tree species present are consistent with species identified in the mapped regional ecosystem (RE 11.5.3)
- **Survey Points 4 and 5** - Woodland with Poplar Box (*Eucalyptus populnea*) canopy with *Brachychiton rupestris* and *Terminalia oblongata* in the lower storey. The grass layer was identified to be a combination of weeds and native species and was cattle disturbed. Species present are consistent with those identified in the mapped regional ecosystem (RE 11.5.3).

Groundwater dependence will also vary from complete dependence (obligate phreatophyte) to occasional usage when groundwater is available within the tree root zone (facultative phreatophytes), to no usage of groundwater across any season.

Based on the above discussion and field evidence, the following conclusions are made:

- The large areas of RE11.5.3, dominated by Brigalow and Poplar Box mapped and validated within and adjacent the Project area boundary are unlikely to represent groundwater dependent vegetation. This is supported by the potentiometric surface for the Tertiary Strata which indicates that the water table exceeds 20 m depth, far beyond the maximum rooting depth of the dominant canopy species, which have shallow root systems
- REs associated with floodplain alluvium (RE11.3.2, 11.3.4, 11.3.6, 11.3.11 and 11.3.25) are likely to represent GDEs

[2] Photographs courtesy of Epic Environmental.

- The vegetation associated alluvial REs with heavy clay substrates (11.3.1, 11.3.3, 11.4.1, 11.4.2) are only likely utilise groundwater when water levels are shallow (<5 mbgl)
- Vegetation associated with REs higher in the landscape are unlikely to be groundwater dependent.

Site-specific terrestrial GDE assessment

An information request issued by the Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW) on the preliminary documentation provided required the following prior to assessment of the EOBC referral:

- **Item 2.1.7** - Conduct an investigation to determine whether any linkage between Brigalow (Acacia harpophylla) TEC and groundwater exists. This investigation must be done using validated, ground-truthed methods such as Doody et al. (2019). Discuss the findings of these investigations within the PD and provide supporting evidence to inform whether these linkages exist and, if so,to what extent.
- **Item 2.3.8** - An assessment of the impacts of the proposed action on Brigalow TEC with respect to changes to surface hydrology and potential decline in groundwater availability and quality and whether this may reduce the condition of the community to the extent in which it would not meet the threshold to be classed as Brigalow TEC.
- **Item 3.3.4** - Provide a discussion with supporting evidence of the occurrence of terrestrial, aquatic and subterranean GDEs within, adjacent to and downstream of the proposed action area. Groundwater dependency should be ground-truthed using a validated method, such as Doody et al. (2019) (3.3.4).

In response, Comet Ridge engaged Watermark Eco to undertake a detailed field-based investigation to address these items (Watermark Eco, 2024). The investigation was undertaken in August 2024 and accordance with the protocols detailed by Doody et al. (2019 and Richardson et al. (2019), targeting fifteen locations across the Project area (generally corresponding to high potential GDE locations identified in the remote sensing multicriteria analysis) and included:

- Measurement of leaf water potential (LWP);
- Measurement of soil water potential (SWP);
- Stable isotope sampling and analysis of plant xylem;
- Stable isotope sampling and analysis of soil moisture;
- Utilisation of the stable isotope data collected from the Project's groundwater monitoring bores.

Watermark Eco (2024) identified the following lines of evidence that woody vegetation within the Project area does not rely on groundwater to support transpiration:

- LWP values for all trees sampled from a range of habitats, including both brigalow and eucalypt woodlands, were consistently strongly negative, suggesting that woody vegetation is either reliant on soil moisture from unsaturated portions of the soil profile that is held tightly in a clay matrix or trees were using a highly saline groundwater source
- SMP values for the four deeper augers sampled during the field assessment overlap with LWP values reported for trees sampled at the individual assessment sites, implying that moisture in the soil profile's unsaturated regions supported transpiration at the time of sampling
- Analysis of stable isotopes confirm that the unsaturated zone is the dominant moisture source supporting transpiration across the Project area. There was no overlap between the isotopic composition of sampled xylem moisture and groundwater samples, while strong isotopic overlap

exists between twigs and soils. $\delta^{18}O$ of the soils also support a source of moisture from shallow in the soil profile (less than 2.4 m)

- Groundwater within the tenement, confirmed by dedicated GDE monitoring bores, is both too deep (>19m) (refer Figure 30 Water table depth (mbgl)Figure 30) and too saline (>30 000µS/cm) to provide a functional source of moisture for deep-rooted woody vegetation
- There was substantial evidence across the Project area that Brigalow is subject to episodic droughting with abundant dead stags throughout many observed Brigalow habitats providing further evidence that groundwater does not sustain Brigalow through drought periods. It is therefore likely that the source of moisture for transpiration is from unsaturated soil profile.

Watermark Eco (2024) concluded the following:

- Brigalow predominantly draws moisture from the shallow soil profile to maximum depths of 2.4 m. Extremely dry and hard clays arrest deeper penetration. This is consistent with previous studies on Brigalow, which suggest a shallow rooting system
- There is no evidence from LWP measurement recorded in brigalow that trees rely on permanent or seasonal groundwater sources, supported by the observed susceptibility of the species to drought dieback
- Stable isotope also support Brigalow deriving moisture from the unsaturated soil profile, with strong isotopic overlap between twig xylem and soils and limited overlap between twig xylem and groundwater sources
- Eucalypts across the Project area are mostly shallow-rooted box species that rely on moisture from the shallow soil profile. Some species, such as Dawson gum, have a strong affinity with Brigalow, suggesting that they derive moisture from similar shallow regions of the soil profile. Based on LWP values, there is also no indication of any substantial groundwater utilisations for any eucalypt species on the Project site

Figure 39 Mapped Locations of Aquatic GDEs

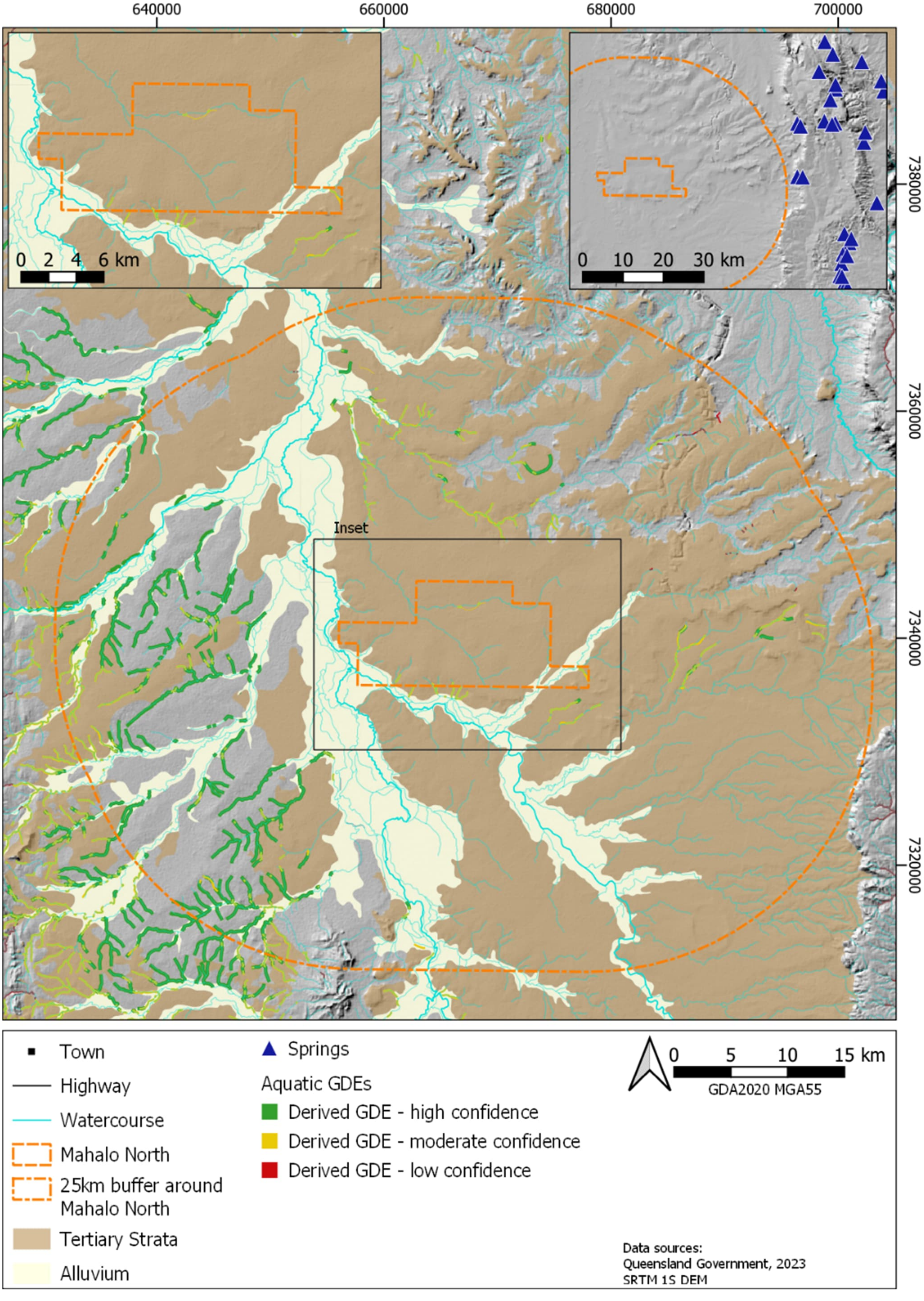


Figure 40 Mapped locations of terrestrial GDEs

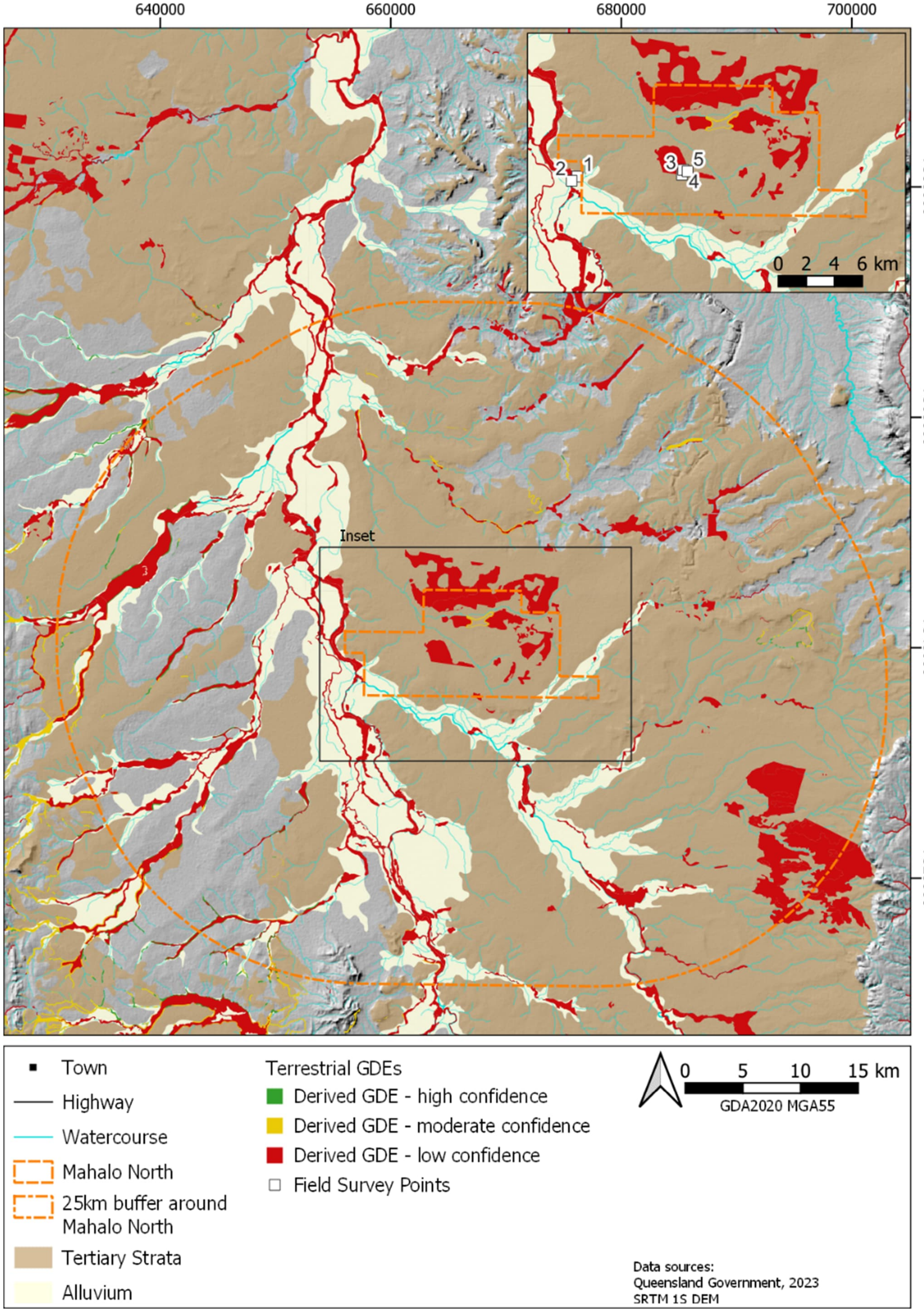


Figure 41 Vegetation validation survey photographs – Point 1

Figure 42 Vegetation validation survey photographs – Point 2

Figure 43 Vegetation validation survey photographs– Point 3

5.2.3. Subterranean Fauna

Stygofauna are predominantly crustaceans that are between 0.3 mm and 15 mm in length (Humphreys 2006). They are predominantly found in aquifers with large (mm or greater) pore spaces, especially alluvial, karstic and some fractured rock aquifers (Hose et al. 2015). The size of the pore spaces is a key determinant of the suitability of an aquifer as stygofauna habitat. Stygofauna have been recorded occasionally in coal seam aquifers, particularly where those aquifers are hydrologically connected to a shallow alluvial aquifers (Hose et al. 2015). Hose et al. (2015) indicates the following related to the presence of stygofauna:

- The abundance and diversity of stygofauna typically decreases with depth below ground. Stygofauna are rarely found more than 100 m below ground level.
- Stygofauna are found across a range of water quality conditions (from fresh to saline), but most common in fresh and brackish water (electrical conductivity less than 5,000 µS/cm).
- Stygofauna are rarely found in hypoxic groundwater (< 0.3 mg O2/L).
- Stygofauna are more abundant in areas of surface water-groundwater exchange, compared to deeper areas or those further along the groundwater flow path remote from areas of exchange or recharge.

In the context of the Project, it is unlikely that stygofauna will be present within the target coal seams due to the depth below ground level. However, there is the potential for stygofauna to be present within the alluvial and basalt aquifers, which are shallower in depth, and likely be a more favorable habitat for stygofauna (e.g. more suitable water quality and nutrients available and larger pore spaces).

6. Summary Conceptual Hydrogeological Model

This section provides a summary of the key information discussed in the previous sections. It provides the basis of the assessment of potential impacts associated with the Project on the groundwater environment and its associated users (both human and environmental).

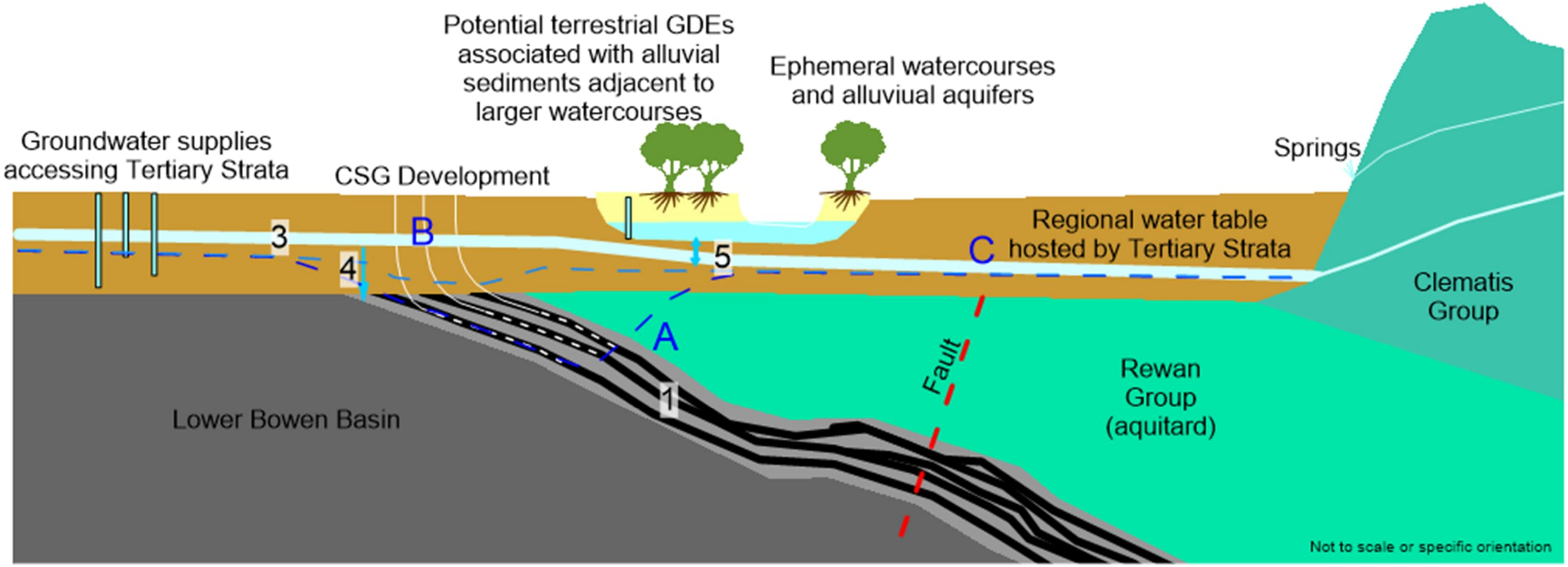
- The target for the CSG production is the Bandanna Formation of the Bowen Basin. The Bandanna Formation dips to southwest through the Project area, and subcrops beneath Tertiary-aged strata in the north of the Project area. The Bandanna Formation comprises interbedded mudstone and siltstone with relatively thin coal seams that are regionally distinguishable but not regionally continuous. The coal seams are water (and gas) bearing, whereas the interburden forms aquitards. Small scale faulting may connect the individual coal seams.
- The Project will target CSG development at depth of roughly 120 mbgl to 220 mbgl. CSG will be produced via pairs of lateral and vertical wells. The laterals will be approximately 1,500 m long.
- The Tertiary-aged strata comprises basalt and sediments, which cover the majority of the Project area. The Tertiary Strata forms the main productive aquifer in the region. The aquifer is heterogeneous with limited lateral and vertical connectivity between individual water beds as evidenced by the variability in groundwater chemistry and water level responses to rainfall recharge.
- The area where the Bandanna Formation subcrops beneath the Tertiary-aged strata is a potential hotspot for water level drawdown due to the greater potential for hydraulic connectivity. This area is located in the northeast corner and to the north of the Project area.
- Quaternary-aged alluvium is associated with the Comet River and its larger tributaries. The alluvium can hydrogeologically dynamic, with fluctuations in water level (observed up to 1 m) directly related to rainfall events, and water quality similar to surface water. However, while the alluvium may host aquifers, site-specific data (specifically the groundwater chemistry and high TDS) indicates that these aquifers may also be hydraulically disconnected from each other and the river.
- The Rewan Formation, a regional scale aquitard, separates the Bandanna Formation from the overlying Tertiary Strata downdip of the sub-crop. Water quality stratification, with the Rewan Formation being significantly more saline than both the overlying Tertiary Strata and the underlying Bandanna Formation provides evidence of the low permeability of the Rewan Formation on sub-regional scale.
- Faults are mapped to the southwest of the Project area. These faults are of Permian or earlier age and therefore do not penetrate the Tertiary Strata. However, the subcropping of the faults may provide a conduit between the production zone and the Tertiary Strata. The hydraulic nature (sealing or conductive) of the fault is uncertain, however the argillaceous nature of the lithologies of the Bowen Basin formations suggests that it is more likely to be sealing.
- The regional water table is predominantly hosted by the Tertiary Strata, and is estimated to be at depths of between 20 mbgl and 40 mbgl across the Project area.
- There appears to be a downward hydraulic gradient between the Tertiary Strata and the underlying Bowen Basin geology. The hydraulic gradient between the Tertiary Strata and the alluvium varies depending on preceding rainfall and location.
- The watercourses within the Project area are ephemeral and typically flow only during significant rainfall events. Pooled water may remain for many months after significant rainfall events.

- Potential terrestrial GDEs associated with the watercourses, if groundwater dependent at least in part, would likely source the groundwater from the alluvial sediments. However, the observed salinity of the groundwater alluvial sediments may preclude its use by vegetation.
- The closest Spring complexes are present over 25 km to the west of the Project area and are associated with the Clematis Group. There is no mapped Clematis Group within the Project area.
- Groundwater is primarily used for stock purposes, with some irrigation use, and predominantly from the Tertiary Strata. There are no licensed groundwater allocations within the Project area.

Based on this conceptual understanding, the following potential impact pathways may be realised from the Project:

- CSG production will necessarily reduce the pressure in the Bandanna Formation to enable gas desorption and production. The pressure reduction may result in water level drawdown in overlying hydrostratigraphic units.
- Where the Bandanna Formation subcrops beneath the Tertiary Strata creates an area where the intervening aquitard(s) (primarily the Rewan Formation) are thin and/or absent, providing a more direct pathway to induce drawdown in surficial aquifers that may host potential GDEs and water courses.
- Faults may provide potential preferential pathways to propagate drawdown between the Bandanna Formation and the Tertiary Strata (potential hotspot).

Figure 44 Schematic Conceptual Hydrogeological Model and Potential Impact Pathways



1. Bandanna Formation comprised of fine grained interburden with discrete coal seams
2. Coal seams subcrop beneath Tertiary Strata
3. Dynamic water level in Tertiary Strata
4. Downward hydraulic gradient from Tertiary Strata to Permian Sediments
5. Variable hydraulic gradient between alluvium and Tertiary Strata

A CSG production will result in pressure drawdown in the target coal seams (Bandanna Formation)

B The pressure drawdown may propagate to overlying hydrostratigraphic units. The area where the Bandanna Formation subcrops beneath the Tertiary strata is a potential "hotspot"

C Faults may provide a by-pass conduit to preferentially transmit pressure up the hydrostratigraphic sequence. The location of the fault trace beneath the Tertiary strata is a potential "hotspot".

7. Predictions of Groundwater Impacts

Groundwater extraction is necessary to depressurise the coal seams to enable the gas to be liberated and produced. The water and gas will be produced via 34 pairs of horizontal and vertical wells (refer Section 1.1 and Figure 1). The right to extract water in association with gas production is conferred to the tenure holder under the P&G Act, however the tenure holder is then subject to obligations under the *Water Act 2000* (refer Section 2.2), which identify triggers and management measures required to mitigate potential impacts due to the exercise of underground water rights by the tenure holder.

Potential impacts due to CSG water production include:

- Decline in groundwater level / pressure at water bores, reducing water availability for its authorised use,
- Reduction in groundwater head resulting in a reduction of groundwater discharge at springs, potentially causing degradation of GDEs,
- Increase in water table depth resulting in a reduction of the availability of groundwater to terrestrial GDEs, and
- Reduction of baseflow to watercourses, potentially resulting in degradation of GDEs and reduced water availability to potential users downstream.
- These potential impacts, where receptors exist within the vicinity of the Project, have been assessed against the *Water Act 2000* trigger thresholds.

Other potential impacts to groundwater associated with the proposed development are provided below.

- Potential to introduce a connection between hydrostratigraphic units, which were previously isolated units, through drilling and construction of CSG production wells, resulting in the potential for alteration of groundwater flow regimes and quality,
- Degradation of groundwater quality from:
  - drilling fluids and additives used during the drilling process,
  - seepage or unplanned releases from CSG water surface storages,
  - fuel or chemicals leaks and spills resulting in localised potential impacts to soil and groundwater, and
- Salinisation or waterlogging is CSG water is used to irrigate in an inappropriate manner.

7.1. Method

Potential groundwater level drawdown associated with the Project has been assessed using multilayered transient numerical groundwater flow models.

The Project area is in the northern extent of the Surat CMA (refer to the inset on Figure 4) where there is lower confidence in the Surat CMA UWIR model due to the sparsity of data with which to construct it. To address the lower confidence, a multi-model approach has been employed to assess predicted drawdowns:

1. The 2021 Surat CMA UWIR model was used as a base case to assess the potential Project case and Cumulative case drawdown predictions. OGIA ran the model based on the development scenario provided by Comet Ridge;

2. OGIA used the Surat CMA UWIR model to perform uncertainty analysis of drawdown predictions utilising 550 stochastic parameter sets and model files from the 2021 UWIR numerical groundwater model. Model output was provided as 5th (best case), 50th (most likely case) and 95th percentile (worst case) probability predictions and was only provided for the Cumulative Case
3. A site-specific numerical groundwater flow model constructed using the Comet Ridge geological model through the heart of the development and calibration to the Mahalo North 1 pilot data. This model was primarily used to assess the potential drawdown associated with the potential effects of the local faulting and the hydraulic properties of the Tertiary Strata on the surficial aquifers.

7.1.1. Surat CMA UWIR model

For the Surat CMA, OGIA has developed a regional scale numerical groundwater flow model to predict groundwater level drawdown resulting from the cumulative development of multiple CSG, conventional petroleum and coal mining within the Surat and southern Bowen Basins. OGIA was engaged by Comet Ridge to assess the water level drawdown associated with the Project in isolation and through its incremental increase in water level drawdown associated with the cumulative regional development.

OGIA provided two sets of model output:

- The 2021 UWIR predictions, which accounts for the cumulative drawdown *excluding* Mahalo North;
- Predictions of the cumulative drawdown from the 2021 UWIR model development scenario *including* Mahalo North.

The predicted drawdown associated with the Mahalo North development as a standalone project was calculated by subtracting the former from the latter output.

In addition, uncertainty analysis predictions from 550 model runs using stochastic parameter sets were provided for the cumulative development scenario, i.e. inclusive of the 2021 UWIR development and Mahalo North for key layers only.

Detailed descriptions of the hydrogeological conceptualisation that underpins the numerical groundwater flow model and the construction of the numerical groundwater flow model can be found in the following reports, with a brief summary provided in Table 7:

- OGIA (2016) Hydrogeological conceptualisation report for the Surat Cumulative Management Area.
- OGIA (2021b) Geology and 3D geological models for Queensland’s Surat and southern Bowen basins
- OGIA (2019) Groundwater Modelling Report Surat Cumulative Management Area
- OGIA (2021c) Modelling of cumulative groundwater impacts in the Surat CMA: approach and methods

Table 7 Summary of the OGIA Regional Groundwater Flow Model Construction

Component	Description
Platform	Modflow-USG with modifications for: • simulation of water desaturation due to gas production in coal seams around CSG wells • more accurate representation of CSG wells using a descending MODFLOW drain methodology • simulation of reinjection of treated CSG water into the Precipice Sandstone
Domain	The numerical model domain extends beyond the boundaries of the Surat CMA (refer Figure 4), with an extent of 460 km x 650 km.
Layering	The model comprises 35 layers, of which layers 25 to 35 represent the Bowen Basin formations (Table 8). Layer 1 represents the overlying Tertiary strata. The individual coal seams are not discretely modelled. The layers representing the coal seams are modelled with a dual-domain set-up to encourage strong vertical head gradients.
Parameterisation	Initial hydraulic parameters were assigned in a two-step upscaling process: • hydraulic properties are assimilated from local measurements and assigned to pilot points using numerical permeameters. • the hydraulic properties are spatially interpolated from the pilot points to all of the nodes of the model grid. The initial parameter estimates were then calibrated through comparison with a range of groundwater level and other observation targets incorporated into the regional model calibration workflow. Maps of the final calibrated horizontal and vertical hydraulic conductivities for the model layers relevant to the Project are included in Appendix D.
Faults	35 regional scale faults represented as “non-neighbourhood connections” to simulate flow from one stratigraphic unit to another across the fault plane. The fault width and damage zone was estimated from geophysical logs where available. The Arcturus and Inderi faults, located to the southwest of the Project area was not explicitly incorporated.
Calibration	Three stage calibration of the groundwater flow model: • **Steady-state pre-development (1947)**: to replicate conditions that existed prior to the commencement of any significant groundwater extraction. • **Steady-state pre-CSG (1995)**: to replicate groundwater conditions prior to the commencement of CSG extraction. • **Transient (1995-2020)**: to replicate the initiation and expansion of CSG, initially in the Bandanna Formation (Bowen Basin) and then including the Walloon Coal Measures (Surat Basin)
Uncertainty analysis	Calibration-constrained uncertainty analysis that attempts to express all heterogeneity in a manner that is geologically sensible remaining consistent with historical system response. Performed as Null Space Monte Carlo Analysis using PEST and ultimately providing 550 realisations.

Table 8 OGIA Groundwater Model Layering Relevant to the Study Area (after OGIA, 2023)

Model Layer	Formation	Classification
1	All Alluvium and Basalt (including Main Range Volcanics)	Partial aquifer
27	Rewan Group	Tight aquitard
28	Bandanna Formation non-productive zone	Interbedded aquitard
29	Upper Bandanna Formation	Interbedded aquitard
30	Lower Bandanna Formation	Interbedded aquitard
31	Lower Bowen 1	Interbedded aquitard

7.2. Predicted Magnitude and Extent of Groundwater Drawdown

Figure 45 to Figure 47 present the maximum predicted magnitude and extent of drawdown at any time from the OGIA (2023) modelling for the Project Case, with Figure 48 to Figure 50 presenting similar maps for the Cumulative Case. Figure 51 and Figure 52 present the combined maximum drawdown for model layers 29 and 30 - representing the production interval of the Bandanna Formation - for the Project Case and Cumulative Case respectively. These maps are analogous to the method used by OGIA to define the immediately impacted area and long term affected area for the Bandanna Formation for the Surat CMA UWIR (OGIA, 2021a).

The maps of maximum drawdown show:

- **Cainozoic Formations (model layer 1, inclusive of the alluvium and Tertiary Strata)** – The maximum predicted drawdown does not exceed 0.2 m (*Water Act* 2000 spring trigger threshold) in the in either the Project Case or the Cumulative Case.
- **Rewan Formation (model layer 27)** – In the Project Case, the maximum predicted drawdown exceeds 0.2 m, but is less than 2 m in a swathe through the central to northwestern portion of the Project area. In the Cumulative Case, the maximum predicted drawdown in excess of 0.2 m extends throughout the southern portion of the Study area, with a maximum magnitude less than 5 m, corresponding closely to the areas where the Project and the adjacent Mahalo development are simulated.
- **Upper Non-productive Bandanna Formation (model layers 28)** - In the Project Case, the maximum predicted drawdown in the upper non-productive part of the Bandanna Formation is predicted to exceed 5 m but less than 10 m within a small area in the southwest of the Project area. The aerial extent where the maximum predicted drawdown exceeds 0.2 m and extends beyond the Project area boundary to the west by a maximum of approximately 4 km. For the Cumulative Case, the predicted drawdown reaches a maximum magnitude exceeding 100 m, however this occurs outside of the Project area and is attributable the adjacent Mahalo development. The spatial extent of predicted drawdown exceeding 0.2 m covers much of the Study area where the Bandana Formation is modelled to exist.
- **Bandanna Productive Zone (model layers 29 and 30)** - The greatest magnitude of drawdown is predicted for these layers as they are the modelled target zone for CSG production. In the Project Case the maximum magnitude of predicted drawdown does not exceed 100 m (roughly 70 m), however in the Cumulative Case the maximum magnitude of predicted drawdown is roughly 270 m. In the Project Case, the extent of the maximum predicted drawdown exceeding 0.2 m covers the Project area and predominantly extends up the Denison Trough to the northwest of the Project area. In the Cumulative Case, maximum predicted drawdown extends across most of the Study area and in some areas beyond the 25 km buffer of the Project area.
- **Lower Permian (model layer 31)** – In the Project Case the maximum predicted drawdown does not exceed 0.2 m, and in the Cumulative Case the maximum predicted drawdown does not exceed 2 m. The latter occurs within the Mahalo Development.

The maximum magnitude of drawdown is not predicted to exceed 0.2 m in any other model layers in the Study area.

Figure 45 Surat CMA UWIR Model - Project Case Drawdown: Cainozoic and Rewan Formation

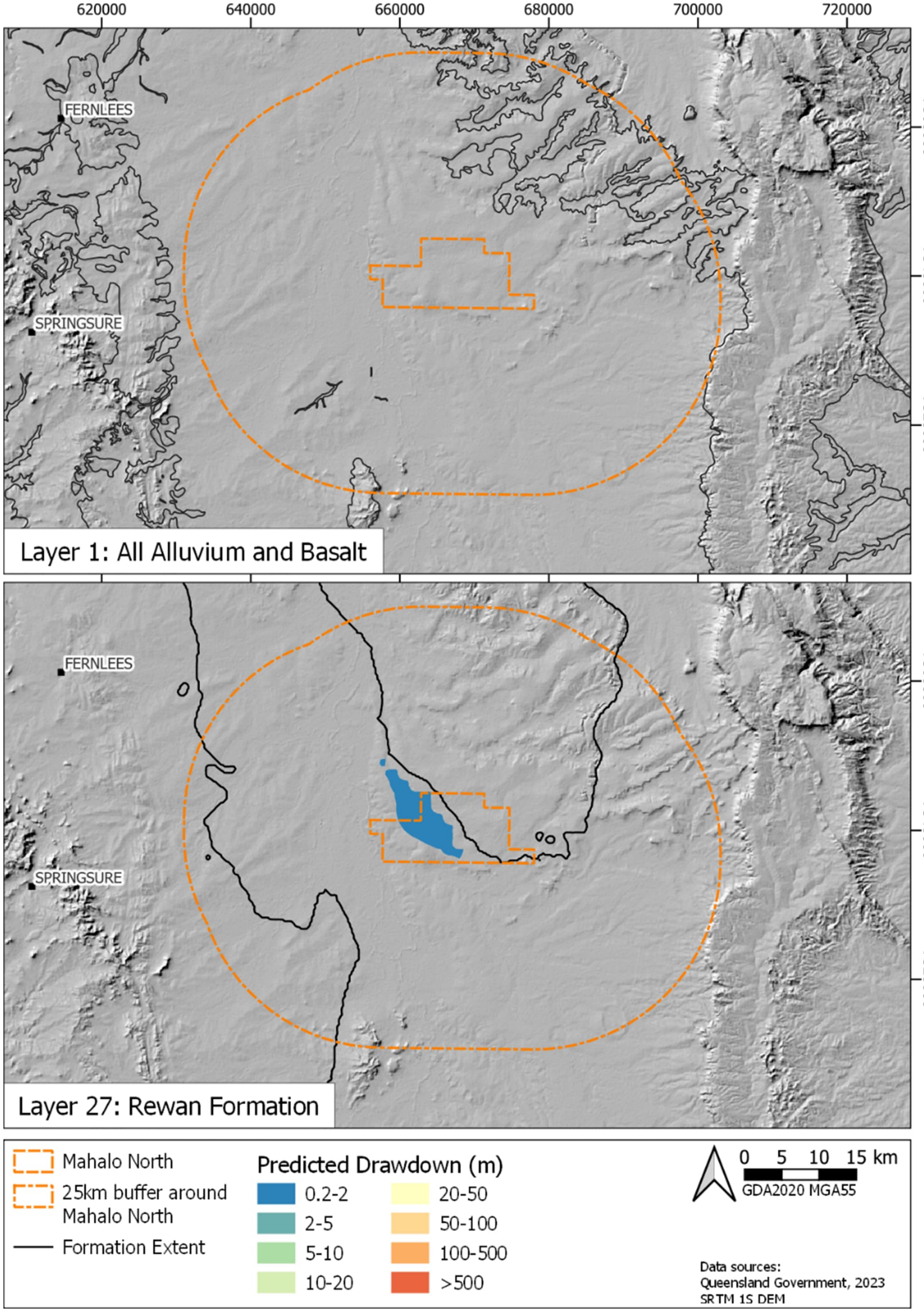


Figure 46 Surat CMA UWIR Model - Project Case Drawdown: Bandanna Formation

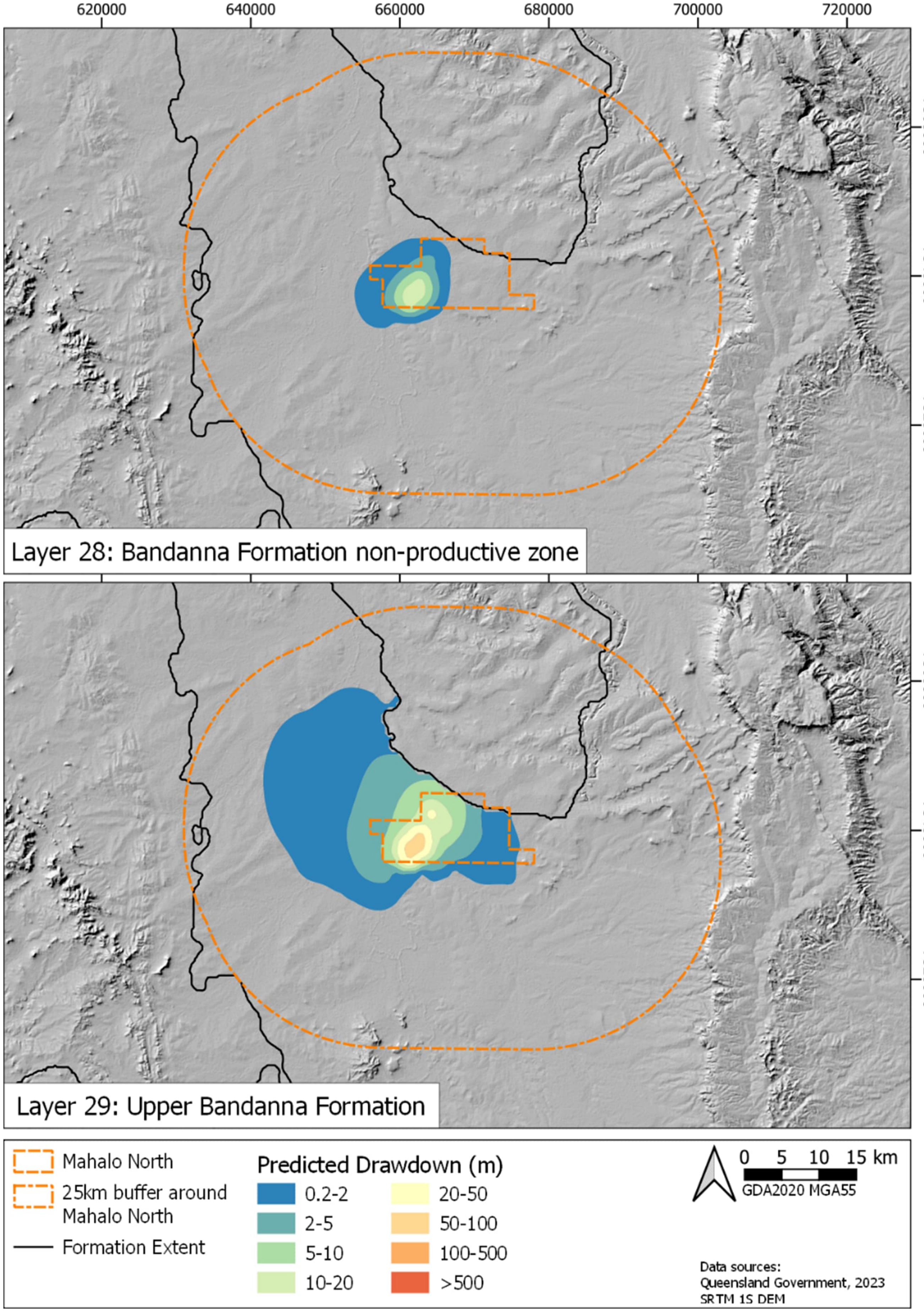


Figure 47 Surat CMA UWIR Model - Project Case Drawdown: Bandanna Formation and Lower Permian

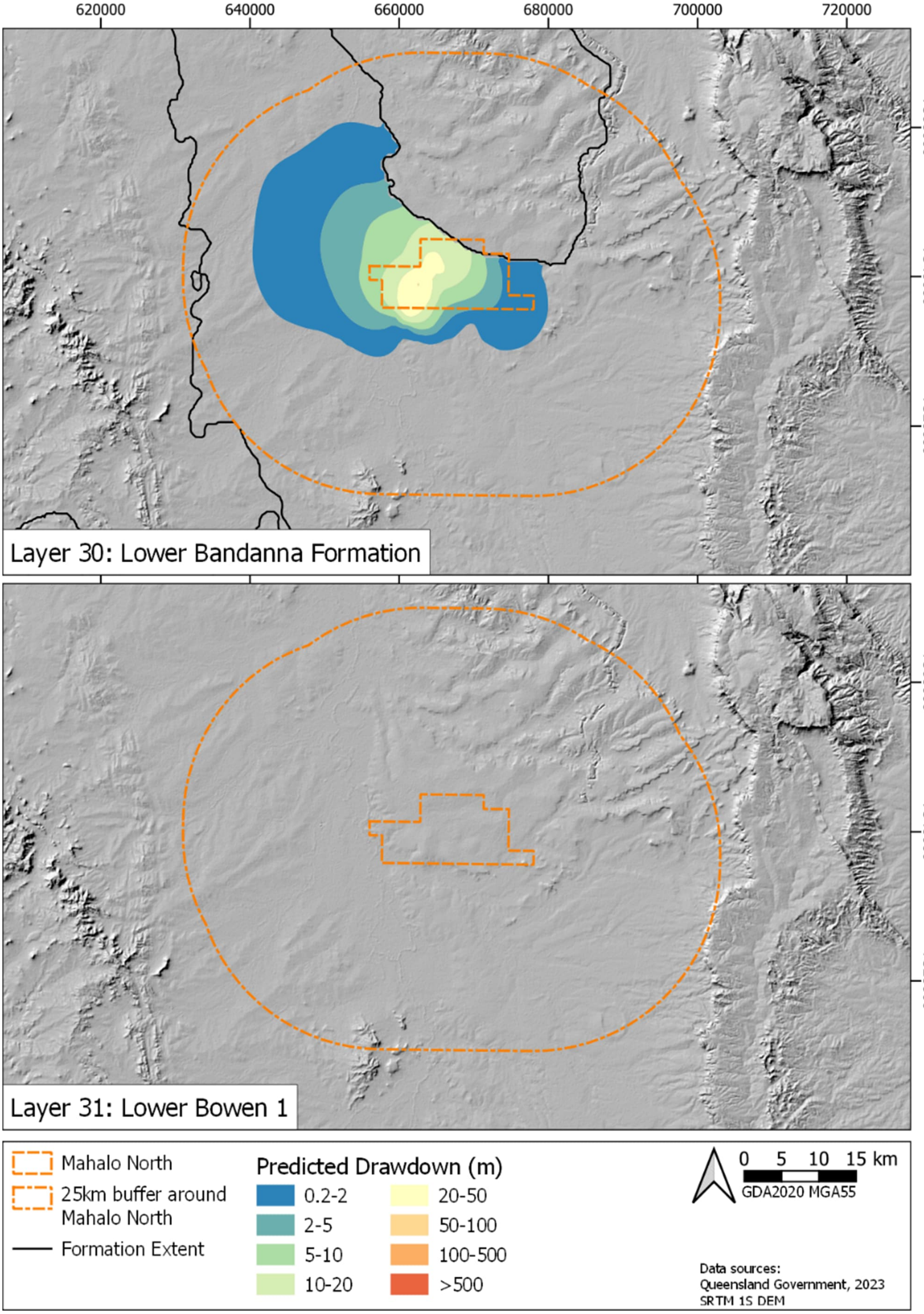


Figure 48 Surat CMA UWIR Model - Cumulative Case Drawdown: Cainozoic and Rewan Formation

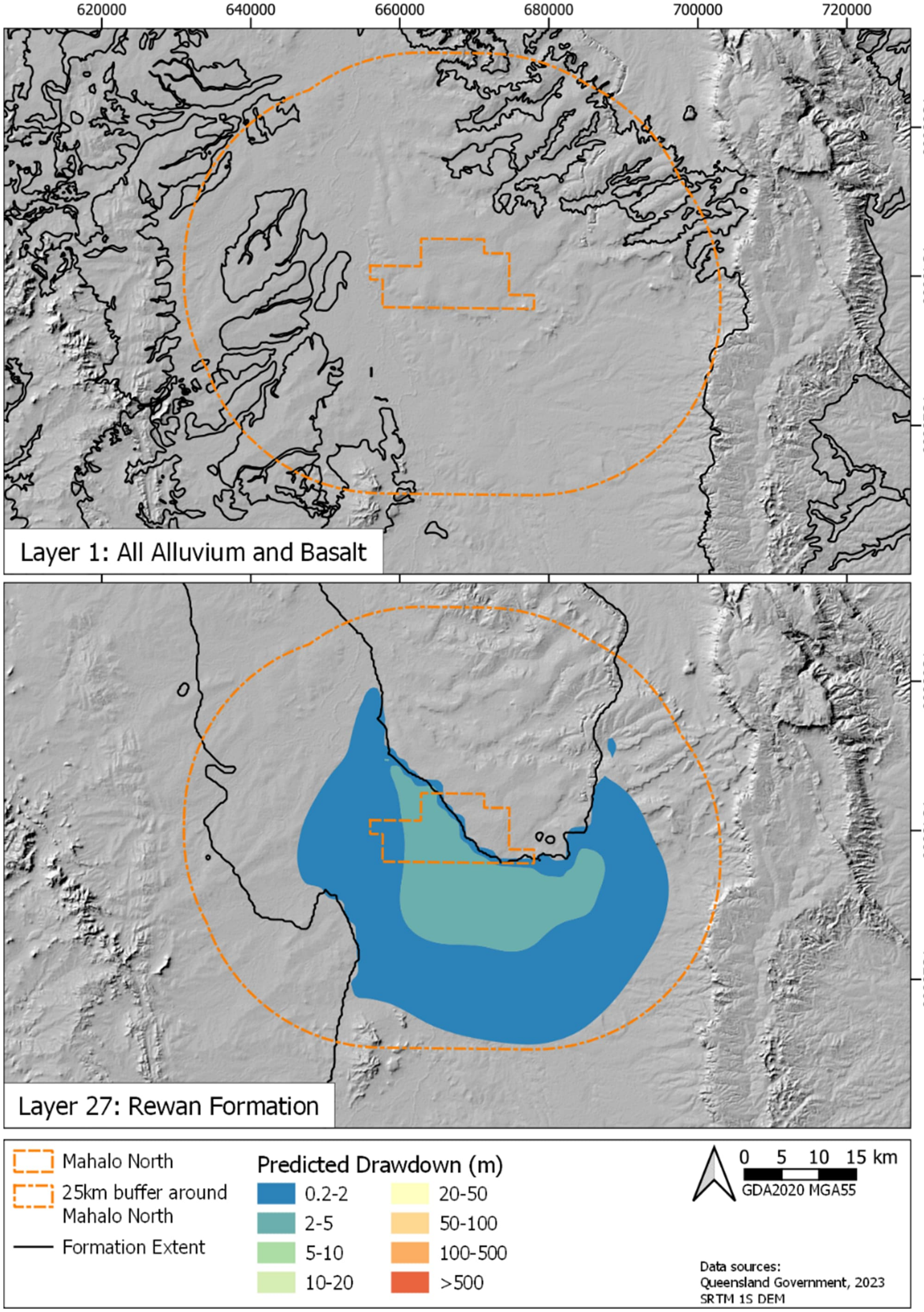


Figure 49 Surat CMA UWIR Model - Cumulative Case Drawdown: Bandanna Formation

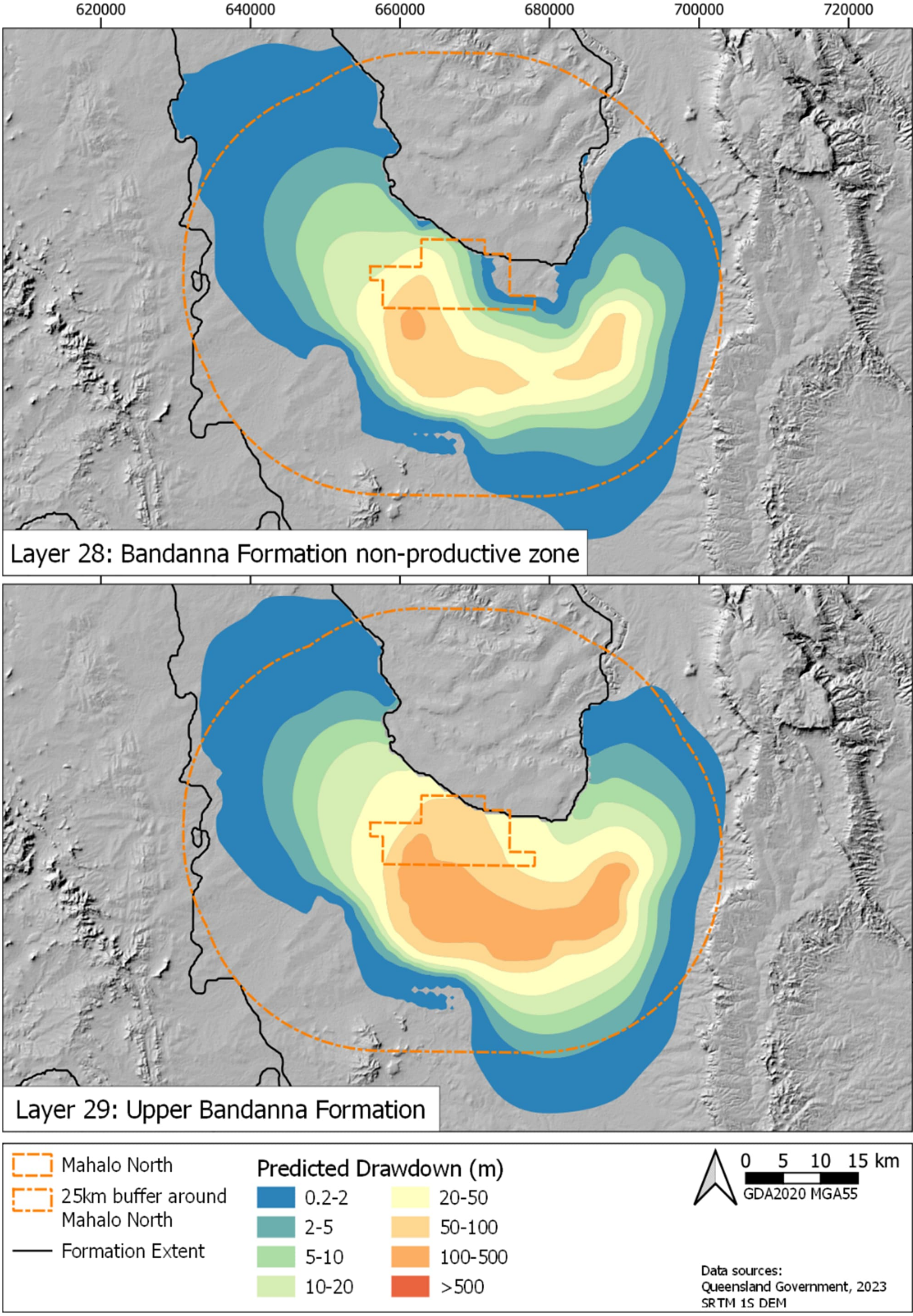


Figure 50 Surat CMA UWIR Model - Cumulative Case Drawdown: Bandanna Formation and Lower Permian

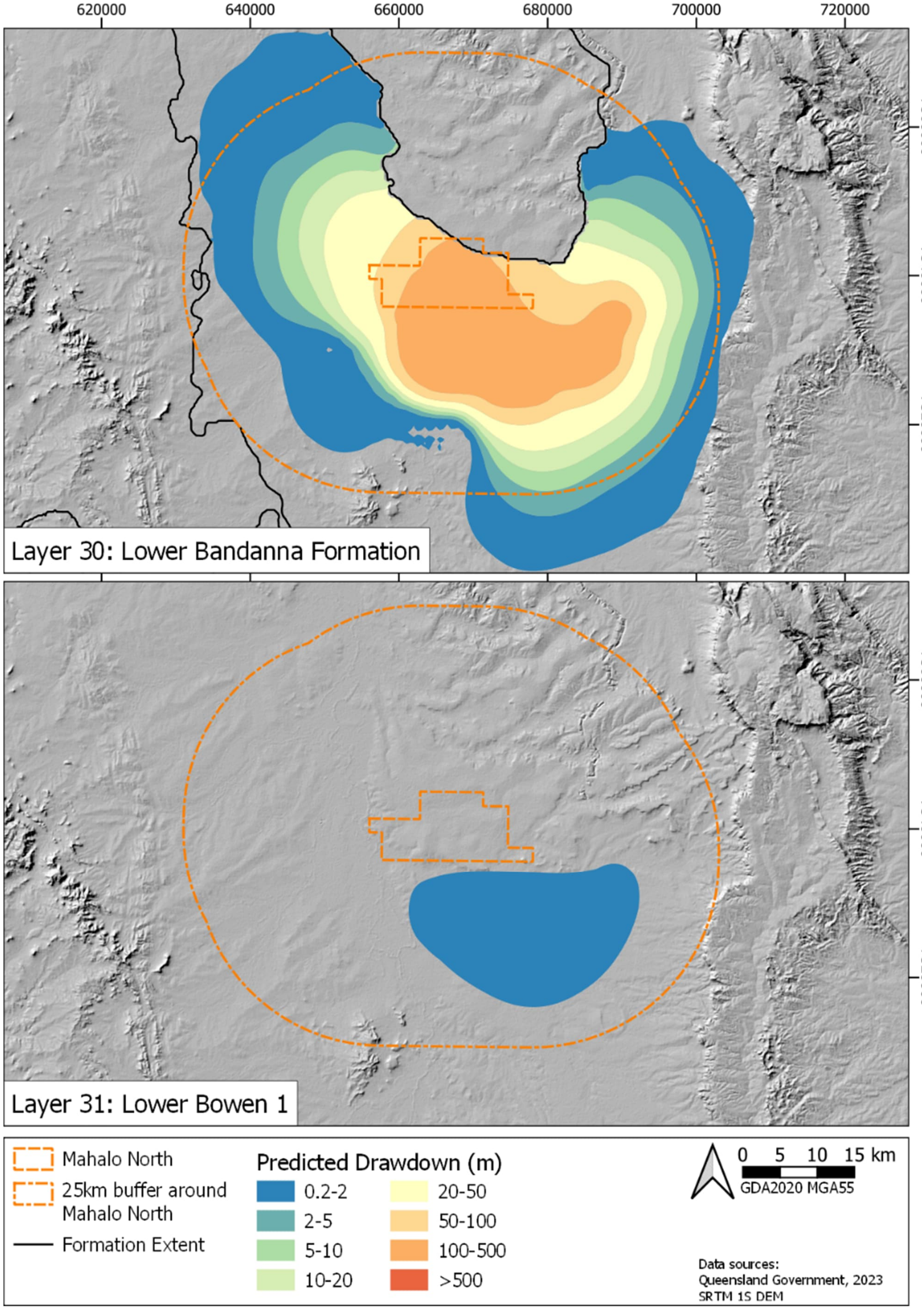


Figure 51 Surat CMA UWIR Model - Project Case Drawdown: Bandanna Formation Combined

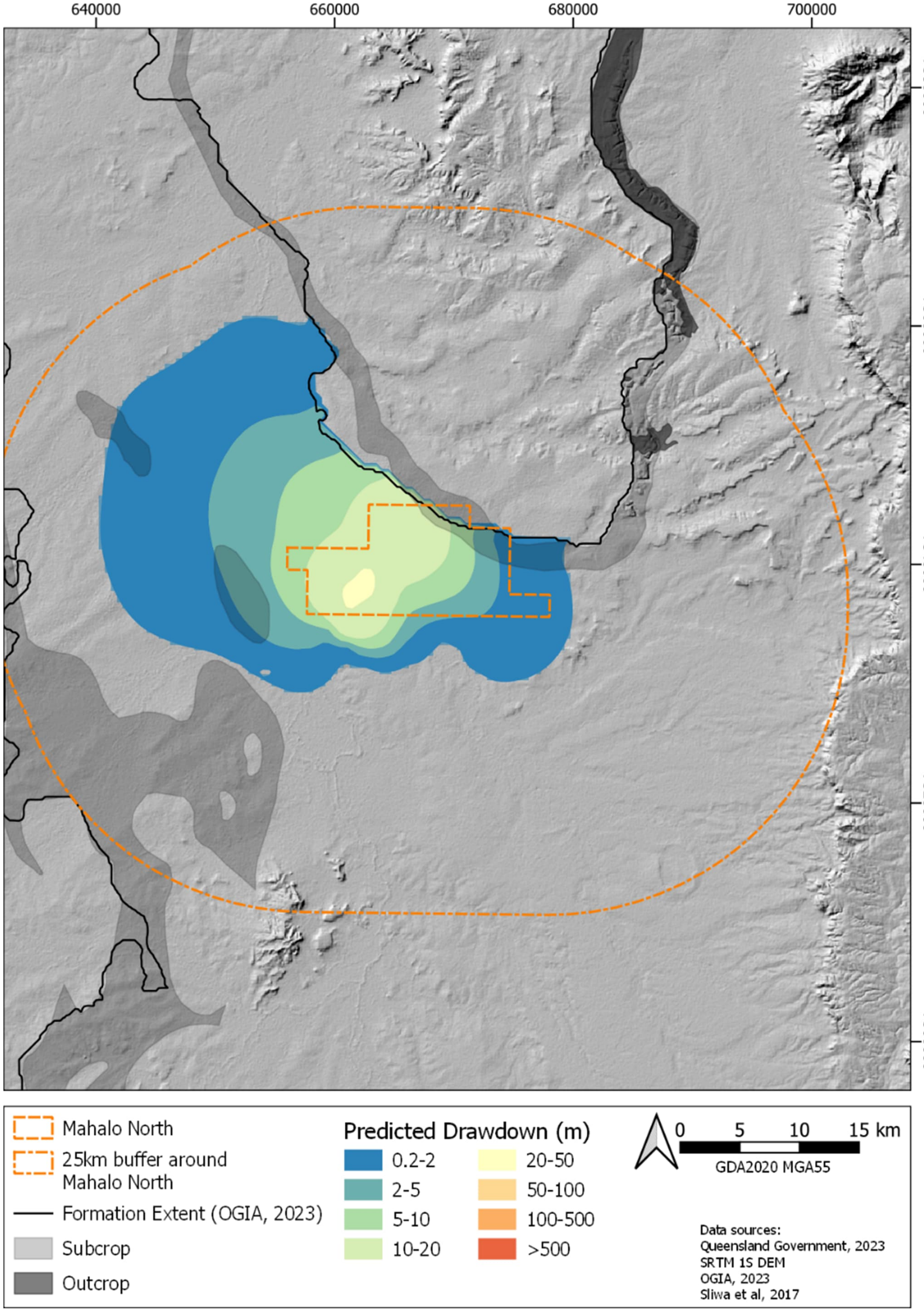
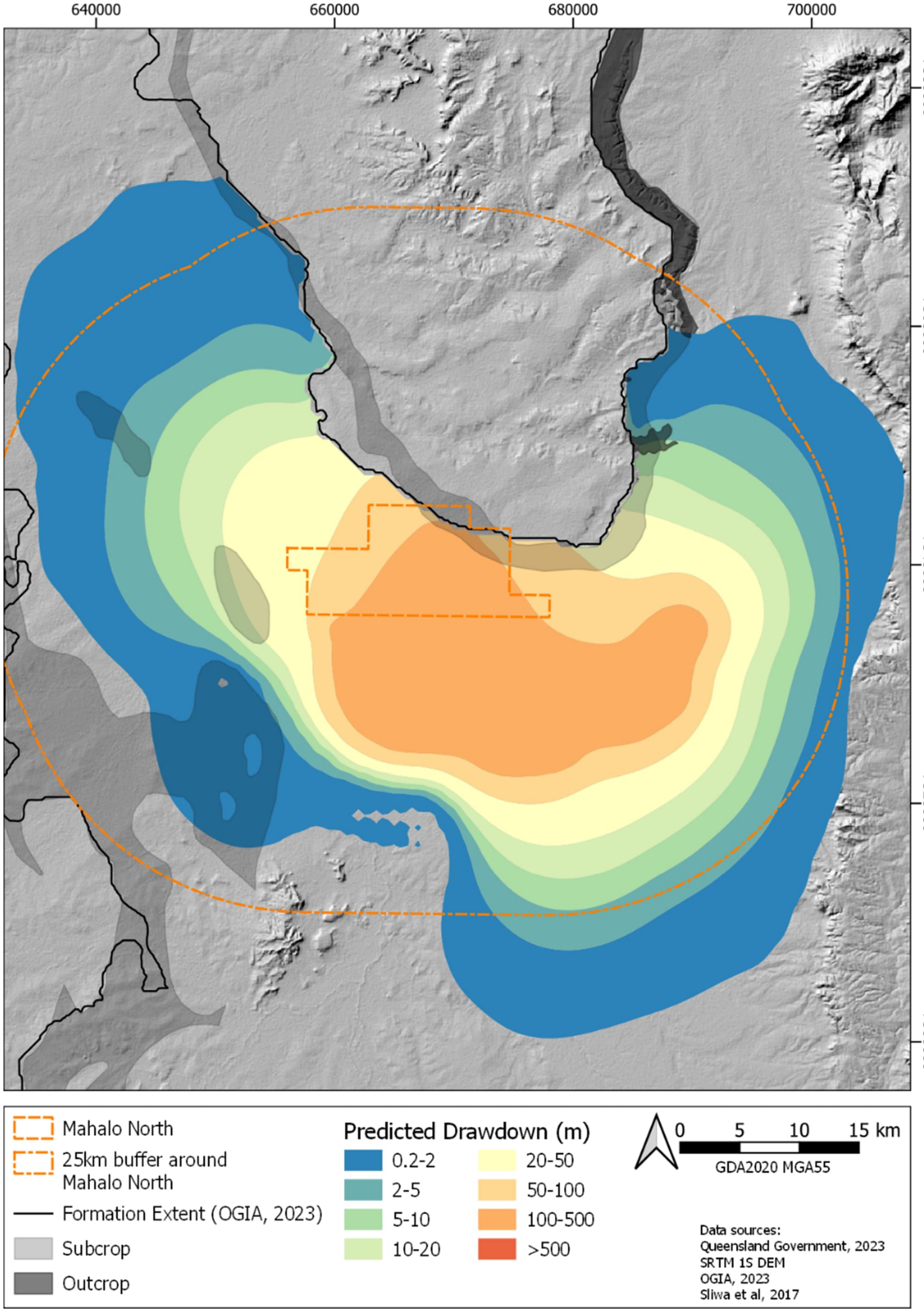


Figure 52 Surat CMA UWIR Model - Cumulative Case Drawdown: Bandanna Formation Combined



7.2.1. Uncertainty Analysis

OGIA (2023) provided predicted drawdown for the Cumulative Case across the entire Surat CMA UWIR model domain and for all model time slices, but for key layers only. In the Project area, these key layers included:

- Model Layer 1 – Cainozoic formations including alluvium and basalt
- Model Layer 29 – Upper Bandanna Formation
- Model Layer 30 – Lower Bandanna Formation

While model output was provided for the 5th, 50th and 95th percentiles of the 550 model predictions comprising the uncertainty analysis, only the 5th and 95th percentiles have been considered herein as they represent the most likely and worst-case predictions, which are most relevant to impact assessments. Table 9 compares the maximum magnitude of drawdown for the deterministic (base case) model with the 50th and 95th percentile predictions for each of the key layers provided by OGIA, with the extent of the predicted 5 m drawdown contour for the Bandanna Formation (maximum of Layer 29 and Layer 30) shown on Figure 53.

The maximum predicted drawdown in the surficial layer does not exceed 0.2 m, including the 95th percentile prediction.

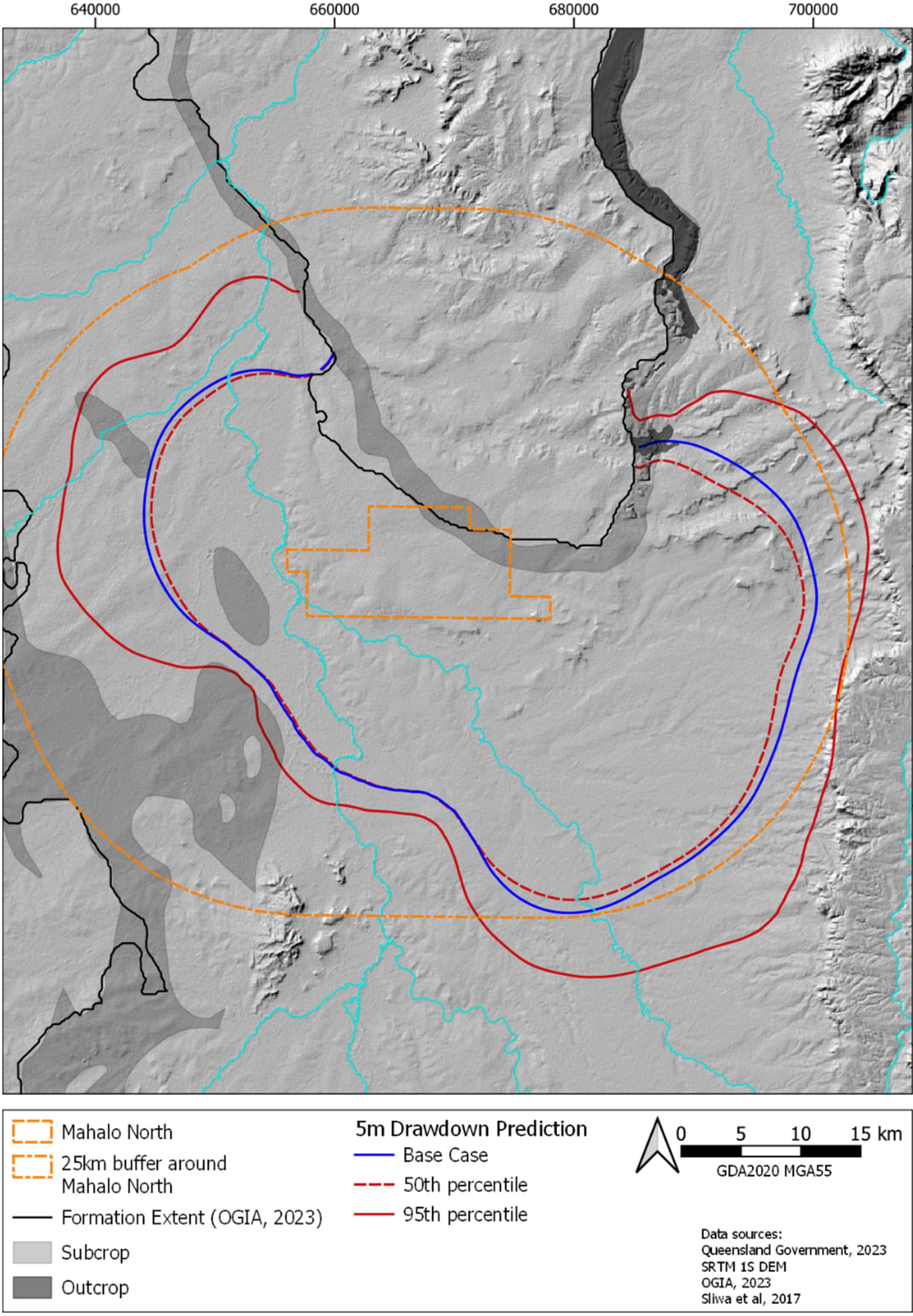
In the Bandanna Coal Measures, the maximum predicted drawdown exceeds 200 m in both the Upper and Lower Bandanna Formation, with approximately 50 m greater magnitude in predicted drawdown in the Lower Bandanna Formation compared with the Upper Bandanna Formation due to its greater depth. The extent of greater than 5 m predicted drawdown is generally slightly greater for the base case and compared with the 50th percentile prediction, except for downdip to the southwest of the Project area where they are similar. The extent of the 5 m drawdown prediction for the 95th percentile is up to approximately 8.3 km greater than the base case.

The uncertainty analysis indicates that the base case model predictions provide a good representation of the most likely outcome. The worst case (95th percentile) is unlikely to significantly affect the potential impacts associated with the Project.

Table 9 Uncertainty Analysis – Maximum magnitude of Predicted Drawdown in the Study Area

Model layer	Represented Hydrostratigraphic Unit(s)	Maximum predicted drawdown (m)		
		Base Case	50th Percentile	95th Percentile
1	Cainozoic formations including alluvium and basalt	0.05	0.04	0.12
29	Upper Bandanna Formation	209.9	209.6	229.5
30	Lower Bandanna Formation	268	261.3	290.6

Figure 53 Surat CMA UWIR Model – Uncertainty Analysis: Bandanna Formation Combined



7.2.2. Site-specific Groundwater Flow Model

A site-specific numerical groundwater flow model was constructed to assess uncertainties relating to mapped faults local to the Project and the hydraulic properties of the Tertiary Strata on the predicted drawdown on the surficial aquifers, with which GDEs would be associated. Construction of the site-specific model is summarised in Table 10, and a report detailing the model construction is provided in Appendix G.

The Arturus Fault (refer Figure 12) has been explicitly modelled to transect the Bandanna Formation and the Rewan Group. It would provide a conduit directly from the base of the Tertiary Strata to the production zone if it was hydraulically conductive. Drawdown would also be propagated through the Tertiary Strata via the sub-crop of the coal seams in the north of the Project area.

- Maximum magnitudes of predicted drawdowns for the base case site-specific model and the nine sensitivity cases are presented in
- Table 11. The extent of 5 m predicted drawdown for each of the simulations is presented as Figure 54.
- The drawdown predictions from the site-specific model can be summarised as follows:
- The maximum predicted drawdown from the site-specific model does not exceed 0.2 m in the uppermost model layers, representing the alluvium and the Tertiary Strata, in any of the scenarios modelled. This is consistent with the predictions provided by OGIA (2023).
- The spatial extent of the predicted 5 m drawdown contour is less in the sites-specific model compared to the OGIA (2023) project case. This is as a result of the lower hydraulic conductivity of the Bandanna coals in the site-specific model compared with the Surat CMA UWIR model. The lower hydraulic conductivity has also resulted in the site-specific model predicting greater maximum magnitudes of drawdown compared with the UWIR model. The site-specific model underwent transient calibration to the Mahalo North-1 pilot production.
- The influence of the Arcturus fault on the predicted drawdown is evident on the site-specific model as it attenuates the predicted drawdown to the southwest of the Project area.
- Predicted drawdown in the Bandanna Formation is limited to the northeast where the coals pinch out and sub-crop beneath the Tertiary Strata.
- A hydraulically conductive fault does not significantly increase the predicted drawdown in the surficial layers of the model. This is predominantly due to the small magnitude of drawdown predicted in the Bandanna Formation coals at the location of the fault due to the low hydraulic conductivity of the coals.
- Increasing the vertical hydraulic conductivity of the Tertiary Strata does not significantly increase the predicted drawdown in the surficial model layers. This is predominantly due to the small magnitude of drawdown predicted in the Bandanna Formation coals where they subcrop beneath the Tertiary Strata in the north of the Project area due to the low hydraulic conductivity of the coals.

Table 10 Summary of the Site-specific Groundwater Flow Model Construction

Component	Description
Platform	MODFLOW-USG with modifications for: • simulation of water desaturation due to gas production in coal seams around CSG wells (using van Genuchten equation with Bubble Point using MODFLOW USG functionality). • Horizontal wells using Drain boundary condition
Domain	The numerical model domain covers an area of approximately 12,000km2. Model grid measures approximately 104km x 115 km, centred on the Project area. The parent grid cells are 1,000 m x 1,000 m, refined to 500m along major rivers and to 250 m within the Project area (to more accurately represent the horizontal wells) and along the Inderi fault.
Layering	The model comprises 13 layers. Layers 5 to 12 represent the individual coal seams and their respective interburden in the Project area based on the Comet Ridge geological model. Layers 1and 2 represents the overlying Tertiary Strata and Quaternary alluvium. Layers 3 and 4 represent the Rewan Group and Clematis Group. Layer 13 represents the lower Bowen Basin formations.
Parameterisation	Initial hydraulic parameters were assigned based on: • History matching of water extraction and pressure drawdown during production of the Mahalo North-1 pilot • Average values obtained from OGIA regional model for the area represented by the site-specific model. • The initial parameter estimates were then adjusted during history matching (calibration) to steady-state (long term) measurements in available water bores. Calibrated Base Case model hydraulic parameters as follows:
Faults	The Inderi and Arcturus faults, located to the southwest of the Project area were explicitly incorporated.
Calibration	Two stage calibration of the groundwater flow model: • **Steady-state -** to replicate groundwater heads per the potentiometric surfaces presented as Figure 26, Figure 27 and Figure 28. • **Transient -** history matching of the drawdown and water extraction volumes of the Mahalo North-1 pilot production.
Uncertainty analysis	Targeted uncertainty analysis to test the most critical geological features and parameterisation which were expected to have the greatest potential of causing an impact on the local users and surficial aquifers. Nine sensitivity analyses as follows: • **Sensitivity Case 1** – Hydraulic conductivity of the Arcturus fault increased to $2x10^{-3}$ m/day (1 order of magnitude greater than Bandanna Formation) and Ss to $1x10^{-6}$. Expected to increase drainage of the Tertiary Strata • **Sensitivity Case 2 -** kh/kv in Arcturus fault decreased to $6x10^{-7}$ m/day (1 order of magnitude less than Bandanna Formation). Expected to act as a barrier and increase the magnitude of drawdown in the Bandanna Formation, providing a greater head difference to induce drawdown down the fault. • **Sensitivity Case 3** – Specific Storage in the Tertiary Strata decreased to $1x10^{-6}$ (Ss) / 0.5 (Sy). Expected to increase the magnitude of drawdown in the Tertiary Strata.

Calibrated Base Case model hydraulic parameters (Parameterisation):

Unit	Kh (m/d)	Kv (m/d)	Ss (1/m)	Sy (-)
Alluvium	20	2	1e-3	0.1
Basalt	0.6	0.1	1e-5	0.03
Rewan	3.5e-3	4e-7	6.3e-6	0.02
Clematis	0.3	0.03	1e-5	0.05
Bandanna Coals	2.0e-4	6e-6	1e-5	0.005
Bandanna Interburden	1e-5	1e-7	1e-5	0.01
Lower Bowen	5e-4	7e-7	7e-6	0.01

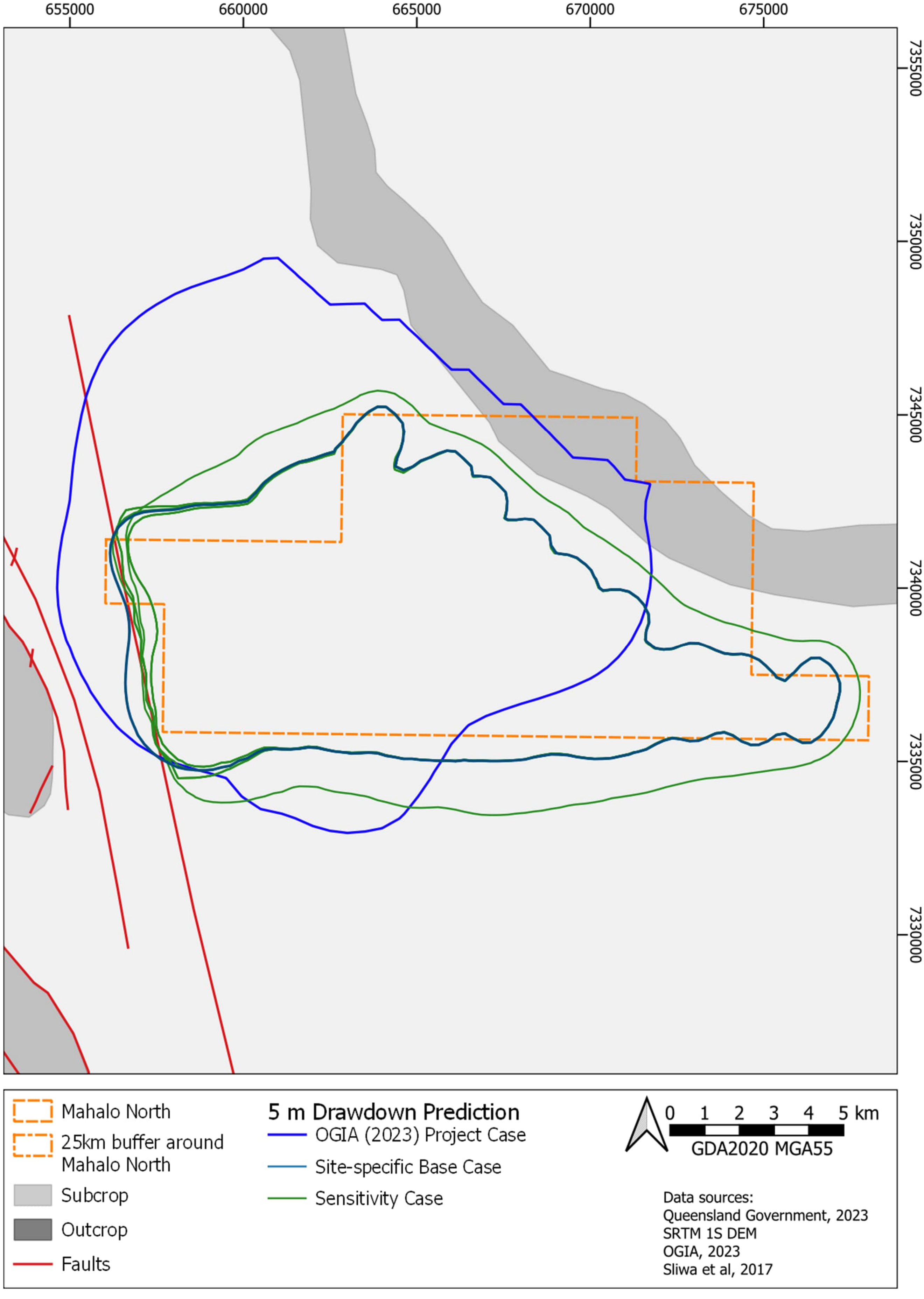
Component	Description
	• **Sensitivity Case 4** – Vertical Hydraulic conductivity of the Tertiary Strata increase by one order of magnitude, to 1 m/day. Expected to increase the magnitude of drawdown in the Tertiary Strata. • **Sensitivity Case 5** – Cases 1 and 3 combined. • **Sensitivity Case 6** – Cases 2, 3 and 4 combined. • **Sensitivity Case 7** – Cases 2 and 3 combined • **Sensitivity Case 8** – Cases 2, 3 and 4 combined • **Sensitivity Case 9** – Horizontal hydraulic conductivity in Bandanna increased to 1x10^{-3} m/day. Fault parameters as per Case 1. Expected to result in a more extensive cone of depression, resulting in greater drawdown at the location of the fault.

Table 11 Site-specific model – Maximum Magnitude of Predicted Drawdown

Model layer	1	2	13
Represented Hydrostratigraphic Unit(s)	Quaternary Alluvium / Tertiary Strata	Tertiary Strata	Pollux Seam*
	Maximum predicted drawdown (m)		
Base Case	0.01	0.02	282.7
Sensitivity Case 1	0.01	0.04	270.7
Sensitivity Case 2	0.01	0.02	283.0
Sensitivity Case 3	0.01	0.02	281.2
Sensitivity Case 4	0.01	0.02	282.7
Sensitivity Case 5	0.1	0.04	270.7
Sensitivity Case 6	0.1	0.04	270.7
Sensitivity Case 7	0.01	0.02	283.0
Sensitivity Case 8	0.01	0.02	283.0
Sensitivity Case 9	0.03	0.08	296.1

* Lowermost coal seam represented in the model

Figure 54 Site-specific and OGIA Model - Comparison of Drawdown Predictions



7.3. Predicted Impacts to Environmental Values

The *Water Act 2000* identifies the bore trigger threshold for water level decline as 5 m for a consolidated aquifer and 2 m for an unconsolidated aquifer. For spring impacts, the trigger threshold is defined as a water level decline of 0.2 m. Since the *Water Act 2000* does not define a trigger threshold for terrestrial GDEs, the spring trigger threshold has been utilised (in alignment with the JIF).

7.3.1. Potential Impacts to Water Supply Bores

Potential long-term impacts to groundwater bores have been assessed against the *Water Act 2000* bore trigger threshold of 2 m for an unconsolidated aquifer (i.e. alluvium) and 5 m for a consolidated aquifer (i.e. the Tertiary Strata and the Bowen Basin units) using the outputs and drawdown predictions from the UWIR numerical model. The maximum predicted drawdown has been used for this assessment, irrespective of the timing of the predicted drawdown.

Many of the groundwater bores within the vicinity of the Project area are constructed to intersect multiple formations. The assessment has been made using the bore attribution described in Section 5.1 and shown on Figure 37. However, given the uncertainties in the attributed formations, and for conservatism in undertaking the impact assessment, the potential impacts against the OGIA bore attribution have also been assessed. Where bores were attributed to multiple formations, the impacts have been assessed against the maximum predicted drawdown for each model layer that the bore is attributed to. For example, if the bore is attributed to the basalt (layer 1) and the Bandanna Formation (layers 29 and 30), the maximum predicted drawdown at the bore's location in model layers 1, 29 and 30 was extracted, and the maximum of those values was assigned to the bore for the purposes of assessing potential impacts.

Only active water supply bores have been included in the assessment (per Figure 37).

Table 12 summarises the numbers of bores for which the maximum predicted drawdown exceeded the *Water Act 2000* trigger threshold for both the Project Case and the Cumulative Case.

For the Project Case no bores are predicted to be impacted using either the aquifer attribution assigned by this study or by OGIA (2023). Sensitivity Case 9 of the site-specific model prediction results in the predicted drawdown exceeding the trigger threshold in one bore located within the Project area.

For the Cumulative Case, only two bores are predicted to exceed the *Water Act 2000* trigger threshold for both attributions, however only one bore is common to both datasets.

The bore predicted to be impacted in the site-specific model and the UWIR model, and common to both interpretations is located within the Project area and is identified to be 100 m deep, with two thin coal seams present at 64 mbgl and 85 mbgl, which roughly corresponds to the top Bandanna Formation coal seam (Aries seam) in the Comet Ridge geological model. The UWIR model does not discretise the individual coal seams and therefore, under responsible tenure holder rules for the Surat CMA, the Project will be responsible for make good obligations.

The other two bores are located more than 10 km from the Project boundary with the majority of predicted drawdown again due to the effects of other tenure holders.

The locations of the bores where the trigger threshold is predicted to be exceeded are shown on Figure 55.

Table 12 Numbers of Bores with Predicted Drawdown Exceeding the *Water Act 2000* Trigger Thresholds

Hydrostratigraphic Unit(s)	Model Layer(s)	Project Case[!]		Cumulative Case – Base Case	
		This study*	OGIA	This study*	OGIA
Alluvium and Tertiary Strata	1	0	0	0	0
Rewan Formation	27	0	0	0	0
Bandanna Formation Non-productive zone	28	0	0	0	0
Bandanna Formation	29,30	0	0	2	2
All underlying units	31	0	0	0	0

[!] Includes both the Surat CMA UWIR model predictions and the site-specific model predictions
* refers to the registered water bore formation attribution performed for this study.

7.3.2. Potential Impacts to Springs

The closest identified springs are roughly 27.5 km to the east of the closet Project area boundary. These springs are identified to be sourced from the Clematis Sandstone. The Clematis Sandstone is not present in the Project area and there is no drawdown predicted in the Clematis Sandstone in either the Project Case or the Cumulative Case.

There are no springs identified within the maximum extent of drawdown exceeding the *Water Act 2000* spring trigger threshold (0.2) for the Rewan Formation (model layer 27), the Bandanna Formation (model layers 28, 29 and 30) or the underlying Bowen Basin Formations (model layer 31) for either the Project Case or the Cumulative Case

There are no predicted impact to springs from the exercise of underground water rights by the Project.

7.3.3. Potential Impacts to Watercourse Springs and Associated Aquatic GDEs

Mapped areas of aquatic GDEs associated with the watercourses are identified to have intermittent groundwater connectivity. The majority of mapped aquatic GDEs are identified to be associated with alluvial or basalt aquifers, which are both included in layer 1 of the Surat CMA UWIR model.

In the absence of specific trigger values for watercourse springs, the 0.2 m drawdown value applied to springs is used as a screening value. Predicted drawdown values in layer 1 of the model do not exceed 0.2 m, for either the Project Case or the Cumulative Case.

There are some areas where consolidated sedimentary rock aquifers with an intermittent groundwater connectivity regime were identified. These areas were outside of the study area, and are associated with local scale groundwater flow systems. They will therefore not be affected by predicted water level drawdown.

There will be no predicted impact to watercourse springs and associated aquatic GDEs from the exercise of underground water rights by the Project.

7.3.4. Potential Impacts to Terrestrial GDEs

Since there is no trigger threshold for terrestrial GDEs defined by the *Water Act 2000*, the spring trigger threshold of 0.2 m is adopted.

Terrestrial GDEs are potentially located in the riparian zones of watercourses, and likely source groundwater from the alluvial aquifers. Site-specific investigations of woody vegetation across the Project area (Watermark Eco, 2024) (Section 5.2.2) concluded that the Brigalow and eucalypts across the Project area utilise moisture from the shallow soil profile, consistent with previous studies. Furthermore, the regional water table depth and salinity (30,000 µS/cm) render vegetation use unlikely, therefore the woody vegetation is unlikely to be groundwater dependent.

The predicted drawdown in the surficial layer of the model, representing the alluvium and the Tertiary Strata did not exceed the adopted trigger threshold (0.2 m) in the either the Project Case or the Cumulative Case model predictions.

There will be no planned discharges to watercourses from the Project and no changes to surface hydrogeological regimes as a result of the Project.

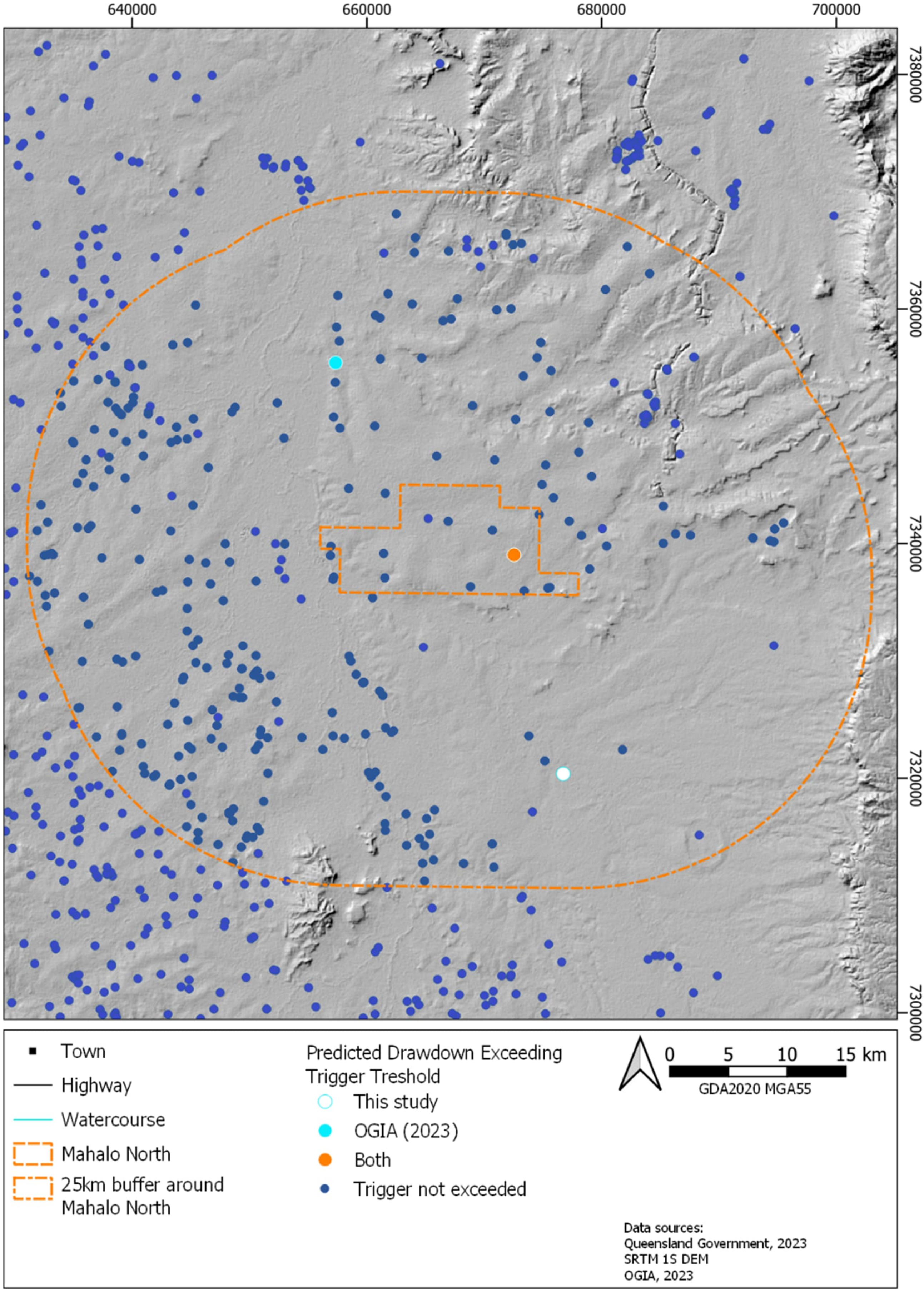
There will therefore be no impact to terrestrial GDEs from the exercise of underground water rights by the Project.

7.3.5. Potential Impacts to Subterranean Fauna

Numerical modelling, including 95th percentile from the uncertainty analysis, predicts a maximum drawdown of less than 0.2 m of drawdown to the surficial layer in the model, within which subterranean fauna would be associated. The alluvial aquifers with which subterranean fauna would most likely be associated are seasonally variable, with observed water level fluctuations of up to 1 m (refer to RN 165180 in Appendix A).

Therefore, it is unlikely that subterranean fauna will be impacted by the Project.

Figure 55 Cumulative Case - Bores where *Water Act 2000* Trigger Threshold is Predicted to be Exceeded



7.4. Potential Impacts to Formation Integrity and Surface Subsidence

The extraction of water and gas from the subsurface will result in compaction of the strata from which they are produced. This compaction can be translated through the overlying rock and result in subsidence of the land surface.

Australia Pacific LNG (APLNG, 2018) describes a model of simple elastic theory to estimate compaction based on the drawdown resulting from CSG production, the thickness of the formation and the formation compressibility. The model was used to calculate the compressibility (equivalent to the specific storage) of the coals based on the magnitude of ground motion measured using interferometric synthetic aperture radar (InSAR). The model assumed that all the compaction occurs within the coal and that all the compaction is translated into subsidence. The model is shown diagrammatically as Figure 56. APLNG found good agreement between the calculated compressibility and the expected specific storage. This analytical method of calculating subsidence is consistent with the analytical method employed by OGIA in 2021 UWIR (OGIA, 2021a)

The potential magnitude of subsidence associated with the Project activities has been calculated using the APLNG (2018) model but applied to model layers 27 (Rewan Formation), 28 (Upper Bandanna Formation) and 29 (Lower Bandanna Formation) rather than just the coal thicknesses. The model was parameterised with:

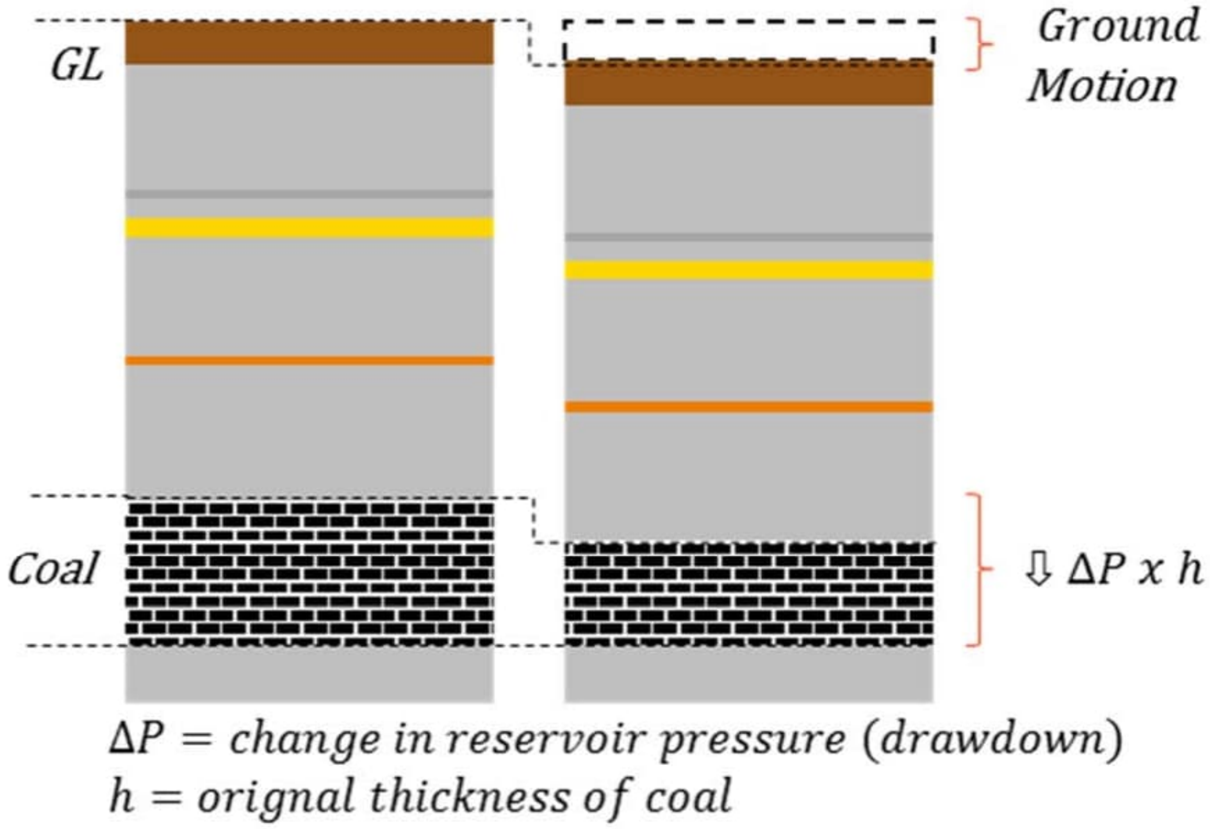
- Maximum predicted groundwater level drawdowns from the deterministic OGIA (2023) cumulative model, as shown on Figure 45 to Figure 50.
- Specific storage grids from the UWIR model
- Thickness grids from the UWIR model. The thickness of each of layer 29 and 30 was assumed to be half the total Bandanna Formation thickness.

Model layer 28 was excluded as the thickness was not explicitly available and was included in the thicknesses of layers 29 and 30. Because there is greater predicted drawdown for layers 29 and 30 compared with layer 28, this is a conservative assumption and will result in greater predicted compaction.

The predicted maximum magnitude of subsidence was approximately 2 mm (0.002 m) for the Project Case, which is predicted to occur within the southwestern sector of the Project area where the coals are deepest. For the Cumulative Case, the maximum predicted subsidence was 20 mm (0.02 m), however this occurred in association with the Mahalo development to the south where the coal seams are deeper and predicted drawdown is greater. In the Cumulative Case, the maximum predicted subsidence within the Project area was roughly 10 mm (0.01 m).

While the 2021 UWIR includes a significantly improved assessment of the magnitude of subsidence associated with CSG development in the Surat CMA compared with the 2019 UWIR, it does not include a risk assessment framework. However, in the 2019 UWIR, OGIA used three risk categories of likelihood for which low risk was less than 0.1 m of subsidence (OGIA, 2019). Based on the OGIA (2019) categories, the risk associated with subsidence due to the Project is low. Based on the maximum predicted magnitudes of subsidence, the potential for impacts to formation integrity and the water resource is considered negligible.

Figure 56 Diagrammatic Representation of Linear Elastic Theory to Estimate the Magnitude of Subsidence (APLNG, 2018)



7.5. Predicted Impacts to Groundwater Quality

Potential impacts to groundwater quality due to the Project may occur due to:

- Impacts of drilling fluids on the formation water quality;
- Seepage from CSG water storages potentially impacting on the water quality within the underling water table aquifer; or
- Potential localised groundwater quality impacts from chemical and fuel spills during transport, transfer and storage.

The latter two of these potential impacts are most likely to be realised at the major facilities, i.e. at the planned gas compression facility, where activities and fluid storage are concentrated.

Figure 30 identifies the water table depth at the facilities to be greater than 25 mbgl, specifically (from the underlying gridded data) 44 mbgl. There is therefore a very low potential for leaks or spills to reach the water table following detection and management (Section 8.5 and Section 8.6).

Epic Environmental (Epic, 2023) prepared a chemical risk assessment for the Project to evaluate the potential risk and effects of drilling fluids and water treatment products and their constituent chemicals on MNES. The chemical risk assessment identified twelve chemicals that were deemed to be potentially hazardous to the environment. The assessment included consideration of both surface and sub-surface pathways for contamination. The assessment found that with management measures such as adopting the DNRME Code of Practice and implementing a site-specific environmental management plan (refer Sections (8.2 and 8.6), impacts to MNES would be unlikely to highly unlikely.

The Project will undertake its development in ways consistent with the wider CSG industry in Queensland and will employ very similar management and mitigation measures. These include drilling and well construction in accordance with the DNRME Code of Practice, the prohibition of oil based drilling mud and BTEX chemicals, and undertaking operations in accordance with Environmental Management Plans (see Sections 8) including spill response procedures.

The potential for the Project to impact groundwater quality is low.

8. Proposed Monitoring and Management Strategies

This section provides details of proposed strategies to monitor and manage potential impacts to groundwater.

8.1. Groundwater Monitoring

Groundwater level monitoring is the key leading indicator of CSG production-related impacts on the hydrogeological system and associated receptors. In terms of groundwater monitoring, the Project will:

- Water quality and water level monitoring of the bores installed by the Project will continue monthly until a minimum of two years worth of data has been collected
- When identified as a responsible tenure holder in a UWIR, comply with obligations under the Water Monitoring Strategy and Springs Impact Mitigation Strategy, and any other obligations identified in a UWIR
- Comply with *Water Act 2000* requirements for bore baseline assessments. Baseline assessments for all on-tenure bores will be completed in accordance with the bore baseline assessment guideline (DES, 2022a) and the Project's Baseline Assessment plan
- In accordance with an approved site-specific assessment for a GDE identified to be at high or very high risk in accordance with the JIF.

Reporting of groundwater monitoring activities will be undertaken in accordance with conditions of project approval and other regulatory requirements.

8.2. CSG Production Well Construction and Operation

CSG production wells will be designed, constructed, operated and decommissioned in accordance with the DNRME Code of Practice. This code outlines mandatory requirements and good practice to reduce the risk of environmental harm. CSG production wells will be designed to:

- Prevent any interconnection between target hydrocarbon-bearing formations and aquifers
- Ensure that gas is contained within the well and associated pipework and equipment without leakage
- Ensure zonal isolation between different aquifers is achieved
- Not introduce substances that may cause environmental harm.

A chemical risk assessment has been undertaken for the Mahalo Project (Section 9.4), to consider drilling fluids used in CSG production well drilling (and water treatment).

Drilling fluids and additives used during drilling activities will be water-based, appropriate for the well design and local geological conditions, and will be used in accordance with the mandatory requirements and good practice guidelines outlined in the DNRME Code of Practice, as well as the Safety Data Sheets (SDS) provided with each fluid/additive. With relation to drilling fluids, the mandatory requirements include the name, type and quantity of each drilling additive used on each well throughout the life of the well to be recorded.

8.3. Potential Impacts to Water Supply Bores

Chapter 3 of the *Water Act 2000* identifies the make good obligations for resource tenure holders. The Project will comply with all make good obligations under the *Water Act 2000*. When future UWIRs for the Surat CMA identify the Project as the responsible tenure holder for bores exceeding the *Water Act 2000* bore trigger threshold within the immediately impacted area (i.e. within 3 years following the release of the UWIR), the Project will undertake the required bore assessments in accordance with the Bore Assessment Guideline (DES, 2022b), and enter into make good agreements as necessary.

Should the Project be approved as a controlled action with respect to water supply bores under the EPBC Act, management measures will be implemented in accordance with the conditions of approval and will align with the Coal Seam Gas – Joint industry framework (JIF–APPEA, 2021).

8.4. Potential Impacts to GDEs

Groundwater model predictions, including sensitivity analyses indicate that GDEs will not be impacted by the Project.

No management measures are proposed. However, should a future UWIR assign the Project as a responsible tenure holder, the Project will comply with its obligations under the State regulatory regime.

Should the Project be approved as a controlled action with respect to aquatic GDEs, terrestrial GDES or subterranean GDEs under the EPBC Act, management measures will be implemented in accordance with the conditions of approval and will align with the JIF (APPEA, 2021).

8.5. CSG Water Management

CSG water will be managed in accordance with the Mahalo North Project CSG Water Management Plan (RDM Hydro, 2023). The plan has been prepared to meet the requirements of the DEHP (2012) CSG Water Management Policy.

Produced and treated water will be monitored in accordance with EA conditions, site-specific management plans and End of Waste Code requirements, as required.

Produced water, treated water and brine will be stored in above ground tanks. Water levels within the tanks will be monitored to ensure they do not exceed operational limits.

8.6. Chemical and Fuel Management

The following measures will be implemented to minimise the potential for impacts of a chemical or fuel spill to groundwater:

- Fuel, oil and chemicals will be stored, transported and handled in accordance appropriate standards including *AS3780:2008 – The storage and handling of corrosive substances, AS1940:2004 – The storage and handling of flammable and combustible liquids, AS3833:2007 – Storage and handling of mixed classes of dangerous goods in packaged and intermediate bulk containers*
- Storage areas will be sealed, bunded, and adequately ventilated
- Storage and refuelling areas will be preferentially located away from watercourses and other sensitive areas and will be outside of the 100 year ARI flood extent.

In addition, the following monitoring and reporting will be undertaken:

- All chemical, oil and fuel storage areas will be inspected and managed in accordance with the requirements of the Project Environmental Management Plan (to be developed)
- Spills will be contained immediately and managed in accordance with the requirements of the Project Environmental Management Plan and a Spill Response Procedure
- Emergencies will be managed in accordance with the procedures in the Project Environmental Contingency Plan
- Incidents will be immediately recorded and investigated and the Regulator notified.

8.7. Reporting

The Project will report in accordance with:

- Relevant conditions of approval issued by the State and included in the EA;
- Relevant conditions of approval issued by the Federal Minister for the Environment under the EPBC Act;
- As the responsible tenure holder where identified in the Surat CMA UWIR; and
- In accordance with JIF reporting requirements.

9. Risk Assessment

The risks to groundwater environmental values have been assessed based on the predicted impacts described in Section 6. The quantification of the risk was based on the accepted method of assessing the likelihood versus the consequence to identify the significance of the risk. The definitions used for each of the categories used for the assessment are provided in Table 13. Potential risks that could impact human well-being were assessed using the community-related consequences and environmental risks were assessed against the environment-related consequences.

Uncertainties in the assessment of risks have not been explicitly explored as the uncertainty in the likelihood of water level drawdown has been comprehensive assessment, and the presence of potential receptors (hence the consequence) have been field validated for groundwater bores and GDEs.

Table 13 Risk Matrix

				Likelihood				
				Remote	**Unlikely**	**Possible**	**Likely**	**Frequent**
		Community	**Environment**	Conceivable, but only in extreme circumstances	Event is unlikely to occur during lifespan of the project	Event may occur in the lifespan of the project	Event is likely to occur during lifespan of the project	Recurring event during lifespan of the project
Consequence	**Extreme**	Extensive irreversible impacts to the community or social wellbeing. Long term social unrest.	Extensive permanent impact on/off site or damage to critically endangered species, habitats, ecosystems	High	Very High	Very High	Very High	Very High
	Critical	Extensive reversible impacts to the community or social wellbeing. Prolonged community outrage.	Extensive long (>10years) term partially reversible impact on/off site or damage to endangered species, habitats, ecosystems	High	High	High	Very High	Very High
	Serious	Impact to the community or social wellbeing. High levels of community tension.	Long term (>10years) reversible impacts on/off site to vulnerable or near threatened species, habitats	Medium	Medium	High	High	High
	Moderate	Small scale impacts to the community or social wellbeing. Isolated examples of community tension.	Medium/short term (1-5 years) impact on/off site to low risk/least concern/common regional species, habitats, ecosystems	Low	Medium	Medium	Medium	Medium
	Minor	Minor community impact – readily dealt with.	Minor near source impact on/off site – readily dealt with (<1 year)	Low	Low	Low	Medium	Medium

Table 14 Risk Assessment

Potential impact		Pre-mitigated risk			Controls	Residual risk		
		Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Depressurisation due to CSG production	Decline in water level/pressure reduces availability of water in water supply bores	Possible	Moderate	Medium	• Queensland *Water Act 2000* and the requirement for 3-yearly UWIRs with annual reviews • Surat CMA UWIR (e.g. OGIA, 2019a), including the Water Monitoring Strategy and the Springs Impact Management Strategy • *Water Act 2000*, specifically bore baseline assessment requirements and make good measures • Queensland *Environment Protection Act 1994* • Environmental authority conditions • Commonwealth Government conditions of approval	Possible	Minor	Low
	Decline in water level/pressure reduces ecosystem function associated with aquatic ecosystems (springs, baseflow reaches)	Unlikely	Moderate	Medium		Remote	Moderate	Low
	Decline in water level/pressure reduces ecosystem function associated with terrestrial GDEs	Unlikely	Moderate	Medium		Possible	Minor	Low
	Decline in water level/pressure reduces habitat for subterranean GDEs	Unlikely	Minor	Low		Remote	Minor	Low
	Decline in water level causes subsidence that affect formational integrity or surface infrastructure	Remote	Minor	Low		Remote	Minor	Low
Drilling and construction of production wells	Creation of wellbore pathways increasing predicted drawdown in overlying formations	Possible	Minor	Low	• DNRME Code of Practice Well integrity management plan • Environmental authority conditions	Unlikely	Minor	Low
	Creation of wellbore pathways resulting in degradation of groundwater quality	Possible	Minor	Low		Unlikely	Minor	Low
Surface activities	Spills or leaks of chemicals during transfer or storage impacting on groundwater quality	Possible	Moderate	Medium	• Environmental authority conditions • Queensland Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (DES, 2016)	Unlikely	Minor	Low
	Leakage of stored water resulting in degradation of underlying shallow groundwater quality	Possible	Moderate	Medium		Unlikely	Minor	Low

10. Assessment Against the Significant Impact Criteria

The potential groundwater impacts associated with the Project has been assessed, and a summary of the findings with respect to the *Significant impact guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources* (Commonwealth of Australia, 2013a) has been provided in Table 15 (hydrological characteristics) and Table 16 (water quality). A significant impact is defined as "*an impact which is important, notable, or of consequence, having regard to its context or intensity*".

The general criteria (5.2) (DoEE, 2013b) identifies that an action is likely to have a significant impact on a water resource if there is a real, or not remote, chance or possibility that it will directly or indirectly result in a change to: the hydrology of a water resource, the water quality of a water resource, that is of sufficient scale or intensity as to reduce the current or future utility of the water resource for third party users, including environmental and other public benefit outcomes, or to create a material risk of such reduction in utility occurring.

The P&G Act imparts underground water rights for petroleum tenure holders, and in summary states that the holder of a petroleum tenure may take or interfere with underground water. Comet Ridge intends to exercise its underground water rights to extract CSG from the Project area.

The assessment found that predicted water level drawdown from CSG production:

- May result in the exceedance of the *Water Act 2000* trigger threshold in one active water supply bores due to the Project as a standalone development. When considered in a cumulative context, drawdown is predicted to exceed the trigger threshold in two bores. Potential impacts to authorised water bores will be managed in accordance with the responsible tenure holder obligations of the most recent UWIR and the make good provisions of Chapter 3 of the *Water Act 2000*.
- Is unlikely to impact aquatic GDEs, terrestrial GDEs or stygofauna.

It is therefore concluded that the Project **will not** have a significant impact on the water resources.

Table 15 Summary of Potential Impacts Against the Significant Impact Criteria 1.3 – Changes to Hydrological Characteristics

Parameter	Discussion
Flow regime (volume, timing, duration and frequency of surface water flows)	The Project will not extract water from or discharge water to surface water courses. The production of CSG must necessarily result in the reduction of the formation pressure within the target reservoir, which may induce leakage from overlying and underlying formations. The Project will target coal seams of the Bandanna Formation. The production wells will be drilled and constructed in accordance with the DNRME Code of Practice, which will limit the potential for fluid extraction from overlying formations. An assessment of potential water level drawdown from the Project on surficial was assessed with the Surat CMA UWIR model (OGIA, 2023) and a Project-specific model to assess uncertainties. Neither model predicted drawdown in excess of 0.2m to the water table. There is therefore unlikely to be a reduction in baseflow associated with CSG production by the Project, and hence the Project would not change the flow regime of surface water flows.
Recharge rates to groundwater	The Project is located in an area where alluvium, Tertiary sediments, and basalts, as well as a number of Bowen Basin units outcrop. These outcrop areas are considered to be the location where diffuse rainfall recharge occurs. It is unlikely that recharge rates will be modified as a result of Project activities.
Aquifer pressure or pressure relationship between aquifers. Groundwater table and potentiometric surface levels Inter-aquifer connectivity	The Project will target coal seams of the Bandanna Formation. The production of CSG must necessarily result in the reduction of the formation pressure within the target reservoir. Because the Bandanna Formation is overlain and underlain by low permeability aquitards, there will be a greater reduction in the reservoir formation as compared with overlying and underlying aquifers, hence there will be changes to the pressure relationships between aquifers, specifically the coal seams will be at a significantly lower pressure than the overlying and underlying formations, inducing potential groundwater movement vertically towards the depressurised coal seams. The Surat CMA UWIR model (OGIA, 2023), used to assess potential drawdown, with predicted water level drawdown associated with the Project. limited to the Bandanna Formation and Rewan Formation. This will change potentiometric surface levels, resulting in localised groundwater flow towards the production area. The predicted drawdown in the surficial model layer was less than 0.2 m, with seasonal or cyclic water levels observed at magnitudes greater than 2 m in the surficial formation(s), therefore the predicted drawdown will not affect the groundwater table. The production wells will be drilled and constructed in accordance with the DNRME Code of Practice, which will limit the potential for fluid extraction from overlying formations. No hydraulic fracture stimulation will be undertaken by the Project that could potentially result in anthropogenic connection of formations.
Groundwater/surface water interactions	Water level and groundwater chemistry data indicate hydraulic connection between surface water courses and alluvial aquifers, and variable connection with the underlying Tertiary aquifers. CSG water production for the Project is limited to the coal seams of the Bandanna Formation. The Surat CMA UWIR model (OGIA, 2023), used to assess potential drawdown, with predicted water level drawdown associated with the Project limited to the Bandanna Formation and Rewan Formation. The predicted drawdown in the surficial model layer, representing the alluvium and the Tertiary Strata was less than 0.2 m, with seasonal or cyclic water levels observed at magnitudes greater than 2 m in the surficial formation(s). The small magnitude of predicted groundwater level drawdown will not affect groundwater/surface water interactions.

Parameter	Discussion
	The Project will not extract water from or discharge water to surface water courses.
Coastal processes	The Project is located in central Queensland, nearly 300 km from the nearest coastline. Given the distance to the coast, no predicted impacts in terms of groundwater-surface water interactions, or changes to coastal processes will occur.

Table 16 Summary of Potential Impacts Against the Significant Impact Criteria 1.4 – Changes to Water Quality

Parameter	Discussion
Create risks to human or animal health or to the condition of the natural environment as a result of the change in water quality	No changes to groundwater quality are anticipated as a result of the Project. The production wells will be drilled and constructed in accordance with the DNRME Code of Practice. The DNRME Code of Practice identifies mandatory requirements and good practice to reduce the potential for causing environmental harm during well drilling and construction. Produced and treated water will be stored in engineered above ground tanks. Water will be managed in accordance with the CSG Water Management Plan, EA conditions and the relevant End of Waste Code(s). It is unlikely that the Project would result in a risk to human or animal health or to the condition of the natural environment as a result of the change in water quality.
Substantially reduce the amount of water available for human consumptive uses or for other uses, including environmental uses which are dependent on water of the appropriate quality	Groundwater use from bores within the Project area and immediate surrounds is primarily for stock watering purposes and from bores accessing the Tertiary Strata. The primary use is for stock watering purposes. One bore is predicted to experience drawdown in exceedance of the *Water Act 2000* trigger threshold as a result of the Project alone, and two bores when the petroleum industry is considered in a cumulative sense. As per the requirements of the *Water Act 2000*, bore baseline assessments will be performed prior to the commencement of production and any impacts will be managed in accordance with the Project's obligations under the most recent UWIR. This assessment provides lines of evidence that the Comet River is temporally hydraulically disconnected from the regional water table. While drawdown of the water table may occur, this will not influence baseflow to Comet River or to the water available to GDEs due to the hydraulic disconnection. The Project will utilise irrigation as the primary means of managing produced water. As surface water discharge or injection will not be utilised, there is negligible potential to impact on the natural water qualities of the shallow aquifers.
Causes persistent organic chemical, heavy metals, salts or other potentially harmful substances to accumulate in the environment	Produced and treated water will be stored in structures design and constructed in accordance with *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (DES, 2016a). Water will be managed in accordance with the CSG Water Management Plan, EA conditions and the relevant End of Waste Code(s). The production wells will be drilled and constructed in accordance with the DNRME Code of Practice). The DNRME Code of Practice identifies mandatory requirements and good practice to reduce the potential for causing environmental harm during well drilling and construction. Hydraulic fracture stimulation will not be undertaken by the Project.

Parameter	Discussion
Seriously affects the habitat or lifestyle of a native species dependent on a water resource	This assessment provides lines of evidence that the Comet River is temporally hydraulically disconnected from the regional water table. While drawdown of the water table may occur, this will not influence baseflow to Comet River or to the water available to GDEs due to the hydraulic disconnection. The Project will utilise irrigation as the primary means of managing produced water. As surface water discharge or injection will not be utilised, there is negligible potential to impact on the natural water qualities of the shallow aquifers.
Causes the establishment of an invasive species (or the spread of an existing invasive species) that is harmful to the ecosystem function of the water resource	No changes to surface water or groundwater availability or quality have been identified that may cause the establishment or spread of invasive species. This assessment provides lines of evidence that the Comet River is temporally hydraulically disconnected from the regional water table. While drawdown of the water table may occur, this will not influence baseflow to Comet River or to the water available to GDEs due to the hydraulic disconnection. Produced and treated water will be stored in structures design and constructed in accordance with *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (DES, 2016a). Water will be managed in accordance with the CSG Water Management Plan, EA conditions and the relevant End of Waste Code(s).
There is a significant worsening of local water quality (where current local water quality is superior to local or regional water quality objectives)	The Project will utilise irrigation as the primary means of managing produced water. As surface water discharge or injection will not be utilised, there is negligible potential to impact on the natural water qualities of the shallow aquifers. The production wells will be drilled and constructed in accordance with the DNRME Code of Practice. Thes DNRME Code of Practice identifies mandatory requirements and good practice to reduce the potential for causing environmental harm during well drilling and construction. Hydraulic fracture stimulation will not be undertaken by the Project.
High quality water is released into an ecosystem which is adapted to a lower quality of water	The Project will utilise irrigation as the primary means of managing produced water. Beneficial use activities such as irrigation will be undertaken in accordance with operational procedures to ensure compliance with the End of Waste Code(s) and EA conditions. Surface water discharge or water injection are not proposed for management of produced water.

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Appendix A IESC Checklist

Checklist Item		Section(s) 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 (including terrestrial and aquatic GDEs); and past, present and reasonably foreseeable coal mining and CSG developments.		Section 1.1 Section 4.1 Section 3.2 Section 4 Section 3
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
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 4
Regulatory context		
Describe the statutory context, including information on the proposal's status within the regulatory assessment process and any applicable water management policies or regulations		Section 2
Describe how potentially impacted water resources are currently being regulated under state or Commonwealth law, including whether there are any applicable standard conditions.		Section 2.1.1 Section 2.2.3 Section 2.1.4
Describe existing water quality guidelines, environmental flow objectives and other requirements (e.g., water planning rules) for the surface water catchments and groundwater basins within which the development proposal is based.		Section 2.2.4
Describe public health, recreation, amenity, Indigenous, tourism and/or agricultural values for each water resource, and the plans relevant to their management and protection.		Section 2.2.4 Table 2
Drilling and hydraulic stimulation		
Describe the scale of fracturing (number of wells, number of fracturing events per well), types of wells to be stimulated (vertical versus horizontal), and other forms of well stimulation (e.g., cavitation, acid flushing).		Section 1.1
Describe proposed measurement and monitoring of fracture propagation, and specify associated uncertainties and challenges.		Not relevant
Identify water source(s) for drilling and hydraulic stimulation, and specify the volumes of fluid and mass balance (quantities/volumes).		Section 1.1
Describe the rules (e.g., water sharing plans) covering access to each water source to be used for drilling and hydraulic stimulation, and how the project proposes to comply with them		Section 1.1
Quantify and describe the quality and toxicity of flowback and produced water and how it will be treated and managed.		CSG Water Management Plan (RDM Hydro, 2023)
Assess the potential for inter-aquifer leakage or contamination, and describe the risks to water-dependent assets if such leakage or contamination occurs.		Chemical Risk Assessment (Epic Environmental, 2023)
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. - identification of hydrogeological sequences and characteristics.	Section 4.1 Section 4.2 Section 4.3 Table 4 Figure 11

Checklist Item		Section(s) Addressed
		Figure 12 Figure 15
	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.	Section 4.2
	Describe the likely recharge, discharge and flow pathways for all hydrogeological units likely to be impacted by the proposed development	Section 4.5 Section 4.6.2 Figure 26 Figure 27 Figure 28
	Describe the existing water quality of all aquifers in the project area.	Section 4.7 Section 4.7.2 Figure 31 Figure 32 Figure 33 Figure 34
	For groundwaters, surface waters and ecological water-dependent assets that have been identified in the risk-based assessment, present data that are sufficient to establish pre-development (baseline) conditions and that have been collected at an appropriate sampling frequency and spatial coverage of monitoring sites, ideally over a period sufficiently long to characterise the impacts of climatic variability.	Section 4.7.2 Watermark Eco (2024)
	Provide data from surveyed boreholes to demonstrate the varying depths of the hydrogeological units and associated standing water levels or potentiometric heads, including directions of groundwater flow, contour maps and hydrographs.	Figure 26 Figure 27 Figure 28 Figure 29 Figure 30 Figure 22 Figure 23 Figure 24 Appendix C
	Present information from site-specific studies (e.g., geophysical, coring/wireline logging) to characterise 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).	Section 4.3.1
	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 0 Appendix B
	Provide hydrochemical characterisation (e.g., acidity/alkalinity, electrical conductivity, metals and major ions) and a suitable suite of environmental tracers (e.g., heat; stable isotopes of water; tritium, helium, strontium isotopes) (e.g., Kurukulasuriya et al. 2022; OWS 2020) commensurate with the risks of the proposed development to water resources and water-dependent assets.	Section 4.7

Checklist Item		Section(s) Addressed
	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. This should include time-series data for water levels and water quality that represent seasonal and climatic cycles.	8.1 (Ongoing commitment)
	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.	8.1 (Ongoing commitment)
Surface water context	Provide data for the hydrological regime of all watercourses, standing waters and springs across the site, including: • spatial, temporal and seasonal trends in streamflow and/or standing water levels • spatial, temporal and seasonal trends in water quality data (such as turbidity, acidity, salinity, relevant organic chemicals, metals, metalloids and radionuclides).	Section 3.2 Section 4.7.1 Figure 31
Ecological context	Provide clear statements of the goals of the baseline data, specifying how the information will address knowledge gaps (e.g., current ecological condition of water-dependent assets in the project area, potential impact pathways) and justifying the choice of parameters and measures.	Watermark Eco (2024)
	Describe and justify the sampling program (e.g., sampling frequency, locations of impact and control sites) and collection methods for gathering appropriate baseline data on all ecological water-dependent assets that have been identified in the risk-based assessment.	Watermark Eco (2024)
	Ensure ecological sampling methods reflect best practice, are quantitative if needed, and comply with relevant state or national monitoring guidelines	Watermark Eco (2024)
	Identify potential aquatic and terrestrial GDEs, using the method outlined by Eamus et al. (2006) and information from the GDE Toolbox (Richardson et al. 2011), the GDE Atlas (CoA 2023) and the GDE Explanatory Note (Doody et al. 2019).	Section 5.2 Appendix E
	Present information on the distribution of potential aquatic and terrestrial GDEs within and near the project area, and explain how their groundwater dependence has been ground-truthed and on which hydrogeological units they are likely to depend (see Doody et al. 2019).	Section 5.2 Watermark Eco (2024)
Modelling of water storage and movement	Undertake groundwater modelling in accordance with the Australian groundwater modelling guidelines (Barnett et al. 2012), including independent peer review.	Section 7.1 Appendix G Section 7.2.1 Section 7.2.2 OGIA (2021b) OGIA (2021c) Section 7.2
	Describe each hydrogeological unit as incorporated in the groundwater model, including the thickness, storage and hydraulic characteristics, and linkages between units, if any.	
	Undertaken groundwater modelling in accordance with the *Australian Groundwater Modelling Guidelines* (Barnett et al. 2012), including independent peer review.	
	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.	
	Select and justify appropriate boundary conditions across the model domain to enable a comparison of groundwater model outputs to seasonal field observations.	
	Where possible, calibration should incorporate measurements of both potentiometric head (or pressure) and flux, such as measured mine inflows or measured discharges to streams or springs.	
	Undertake sensitivity analysis of boundary conditions and hydraulic and storage parameters, and justify the conditions applied in the final groundwater model. Where the interaction between surface water and groundwater is important, parameters describing their connectivity, such as riverbed conductance, should be assessed.	
	Assess the potential impacts of the proposal, including how impacts are predicted to change over time and any residual long-term impacts	
	Undertake an uncertainty analysis of key predictive outputs (i.e., quantities of interest as per Peeters and Middlemis 2023).	

Checklist Item		Section(s) Addressed
	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.	
	For each relevant hydrogeological unit, describe 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.	
Subsidence	Provide predictions of subsidence impacts on surface topography, water-dependent assets, groundwater (including enhanced connectivity between aquifers) and the movement of water across the landscape (see CoA 2014b; CoA 2014c).	Section 7.4
Environmental Impact Assessment		
Risk-based assessment	Describe the intensity, duration, magnitude, timing and geographic extent of each potential impact, specifying the impact's significance and consequences, especially on the environmental condition and human values of each water resource.	Section 7.3
	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 the project's impacts.	Section 9
	Include a systematic and evidence-based assessment of • the sources of environmental impacts in the project area • the exposure pathways by which impacts may be transferred from these sources to water resources (receptors), presented as one or more IPDs based on ecohydrological conceptualisation • the likely response of each receptor, especially when the impact(s) may be severe and likely to cause irreversible damage (posing a high risk) • 'hot spots', or areas in the project area (e.g., where vulnerable receptors occur close to impact sources) where risks are especially high • 'hot moments', or periods during and after the project (e.g., when activities are likely to generate major impact) when risks are especially high.	Section 6 Section 7.3.2 Section 7.3.3 Section 7.3.4 Section 7.3.5
	Specify where and how each risk can be avoided or mitigated (or, as a last resort, requires appropriate offsets and/or a conservation payment), and: • provide evidence (preferably from equivalent activities and regions) for the feasibility and effectiveness of mitigation or offset methods • describe how monitoring will be able to demonstrate the effectiveness of the mitigation measures.	Section 8
	Specify all sources of uncertainty in the assessments of each risk and describe how information has been and will be collected to reduce this uncertainty.	Section 9
	Investigate relevant context for the risk assessment, such as bioregional assessments, Commonwealth and state water resource plans (e.g., Murray–Darling Basin Plan, Hunter River Salinity Trading Scheme) and state processes such as those that apply in the Surat Cumulative Management Area and the Commonwealth's Joint Industry Framework on Coal Seam Gas.	Section 8.4
	Assess residual risks remaining after the implementation of the proposed mitigation and management options, to determine whether these effectively reduce risks to an acceptable level based on the identified environmental objectives	Table 14
Cumulative impacts	Describe the risks of potential cumulative impacts of all past, present and reasonably foreseeable actions and activities that are likely to impact on water resources, including from multiple stressors arising from the proposed action.	Section 7.2
	Assess the cumulative impacts on potentially affected water-dependent assets and water resources, considering:	Section 7.3

Checklist Item		Section**(s)** Addressed
	the full extent of potential impacts from the proposed project (including whether there are alternative options for infrastructure and mine configurations which could reduce impacts) • all stages of the development, including exploration, operations and post-closure/rehabilitation • the likely spatial magnitude and timeframe over which cumulative impacts will occur (ensuring that the analysis has sufficiently broad geographic and temporal boundaries to include all potentially significant impacts) • opportunities to work with other water users to avoid or mitigate potential cumulative impacts to meet specified environmental objectives.	
Monitoring and Management		
Describe proposed mitigation and management actions, and their adequacy, for each significant impact identified, including any proposed mitigation or offset measures for long-term impacts post mining.		
Propose adaptive management measures and management responses, giving details of trigger action response plans (TARPs) for valued assets and water resources that are at greater risk of impacts from the proposed development.		Section 8.4
Describe a robust groundwater monitoring program using dedicated groundwater monitoring bores – including nested arrays where there may be connectivity between hydrogeological units – and targeting specific aquifers, providing information on the groundwater regime and on recharge and discharge processes and identifying changes in quantities and quality of groundwater over time.		Section 8.1
Identify and justify dedicated sites to monitor hydrology, water quality, and channel and floodplain geomorphology before, during and for a suitable period after the proposed development.		Not proposed (no surface water releases)
Water and Salt Balances		
Describe the proposed development's water requirements and on-site water management infrastructure, including modelling to demonstrate the infrastructure's adequacy under a range of potential climatic conditions, including extremes associated with predicted climate change.		CSG Water Management Plan (RDM Hydro, 2023)
Provide salt balance modelling that includes stores and the movement of salt between stores, and takes into account seasonal and long-term variation.		
Indicate the vulnerability to contamination (e.g., from salt production and salinity) of, and the likely impacts of contamination on, the identified water-dependent ecological assets.		
Identify how produced water, brine and waste from water treatment plants that are stored on site during operations will be managed and disposed of after operations cease, where applicable		
Provide estimates of the quality and quantities of operational discharges under dry, median and wet conditions, potential emergency discharges due to unusual events, and the likely impacts on water-dependent ecological assets		

Appendix B Project groundwater monitoring bore completion report

Comet Ridge Limited

Mahalo North

Groundwater Monitoring Bore Completion Report

4 November 2024 - Final

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Tables

Figures

1. Introduction

RDM Hydro Pty Ltd was engaged by Comet Ridge Limited (Comet Ridge) to provide technical supervision of the installation of six groundwater monitoring bores. The drilling program was undertaken between 6 August to 22 August 2024 to install monitoring bores with the following objectives (RDM Hydro, 2024):

- To Improve understanding of the presence of potential groundwater dependent ecosystems (GDE) through confirmation/identification of the water table depth and chemistry,
- To improve understanding of the hydraulic connectivity between shallow groundwater systems and the regional water table, and
- To provide site-specific data to validate the conceptual hydrogeological model that underpins the numerical groundwater flow modelling completed for the referral
- To ensure compliance with the Commonwealth Government 's advice on the Mahalo North referral, by enabling the collection of water quality samples

2. Bore Locations

Bore locations were targeted to higher potential GDE locations following a remote sensing based multicriteria analysis (RDM Hydro, 2024). The bore locations are shown on Figure 1 with coordinates and construction details provided in Table 1.

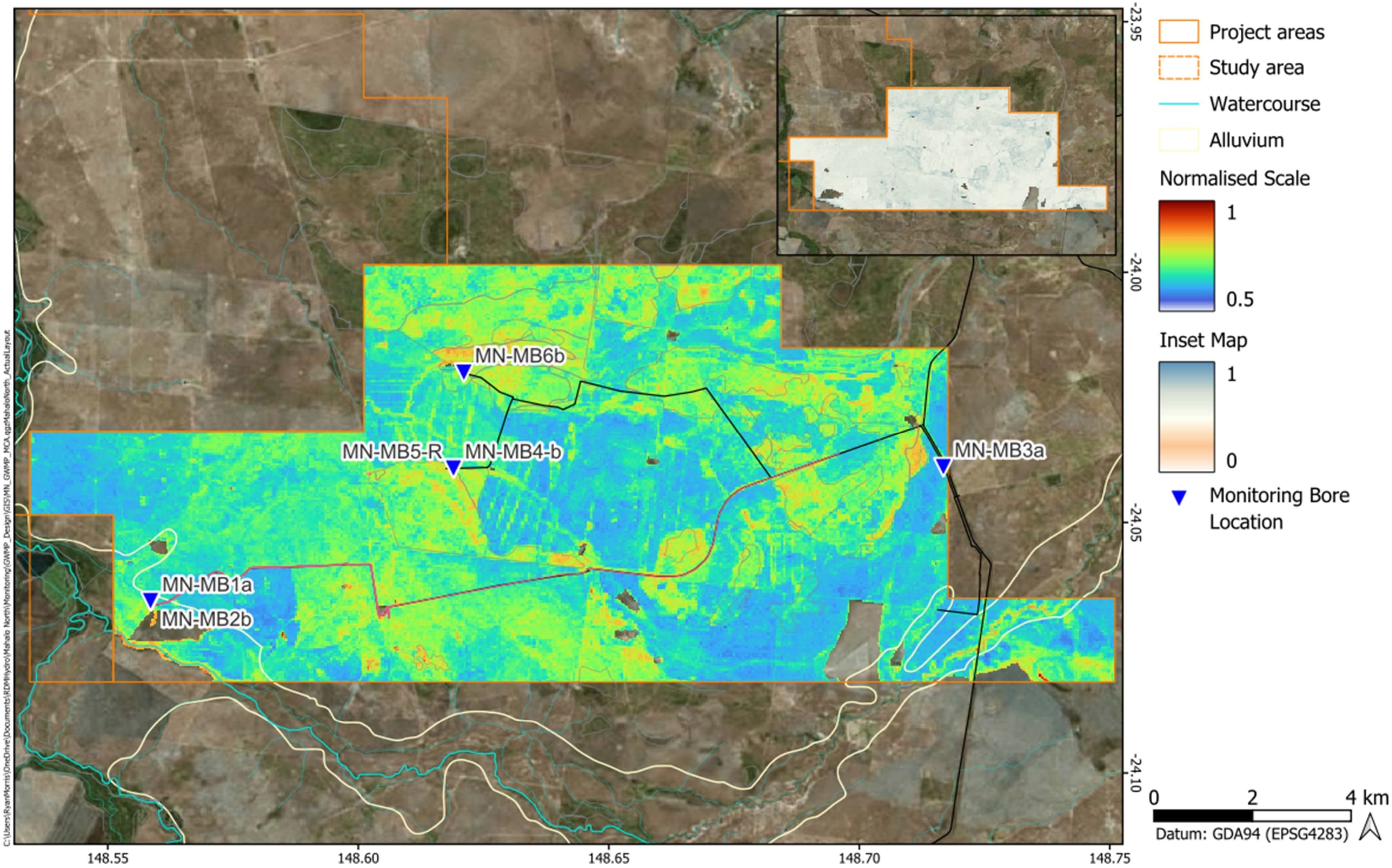
MN-MB2b was abandoned and not constructed due to adverse ground conditions (refer Section 3.8).

Table 1 Monitoring bore summary

Bore ID	Property	GDA2020 MGA 55 Easting	GDA2020 MGA 55 Northing	Elevation (GL mAHD)	Spud Date	End Date	Drilled depth (mbgl)	Constructed depth (mbgl)	Screened Interval (mbgl)	Casing height (mbgl)	Standing water level (mbgl)	Electrical Conductivity (µs/cm)
MN-MB1-a	Meroo Downs	658464.7	7337611.6	178.25	20/08/2024	21/08/2024	17.1	17	10.1 - 16.1	-0.87	7.97	33,400
MN-MB2-b	Meroo Downs	658453.5	7337617.9	178.6	21/08/2024	22/08/2024	24	-	-	0	-	-
MN-MB3-a	Togara	674586.1	7340392.6	233.1	10/08/2024	11/08/2024	25.1	25.1	18.3 - 24.3	-0.8	Dry	Dry
MN-MB4-B	Togara	664644	7340479.9	205.86	6/08/2024	8/08/2024	37	20	16.0 - 19.0	-0.89	19.98	Insufficient water to sample
MN-MB5-R	Togara	664636.8	7340479.7	205.92	8/08/2024	9/08/2024	34.4	34.1	27.1 - 33.1	-0.75	21.46	51,900
MN-MB6-b	Togara	664873.2	7342602.8	206.805	9/08/2024	10/08/2024	30	30	23.0 - 29.0	-0.815	21.36	30,000

! shallowest water level measured during the drilling program

Figure 1 Monitoring bore locations



3. Drilling and Construction

3.1. Bore construction licensing

The monitoring bores were drilled under the *Petroleum and Gas (Production and Safety) Act 2004*.

3.2. Access and lease preparation

Access tracks and leases were not prepared for the drilling program. Access was via existing tracks. Bores were drilled adjacent to the tracks.

3.3. Drilling contractor and licensed driller

The bores were drilled and constructed by Legion Drilling. The bores were drilled by Jonathan Newby under the supervision of Connor Barratt (Licence No. 3610) who holds a Class 1R (geotechnical investigation and monitoring bores only) water bore driller's license in Queensland. Mr Barratt's licence is endorsed for auger, rotary air, rotary mud and sonic drilling.

3.4. Drilling and construction

Bores were drilled and constructed in accordance with *Minimum Construction Requirements for Water Bores in Australia, Edition 4*.

The monitoring bore installation program was completed using a rig package comprising:

- Comacchio MC-T405 4wd truck mounted top-head drive drilling rig running 3m joints of REMET 50 mm drill pipe. Pipe joint loading was manual and make- and-break was semi-automated.
- Sullair 375 cfm/250 psi portable compressor
- Small rigid bodied truck used to move personnel and construction materials.

A photograph of the complete package on location is provided as Figure 2.

The top 1.5 m of the hole was drilled with a solid auger and thereafter drilling continued using rotary air methods with a combination of 127 mm diameter blade bit and downhole hammer depending on ground conditions. No stabilisers or other bottom hole assembly was utilised. The general sequence of drilling and construction for the bore was as follows:

- Install temporary nominal 125 mm PVC collar with diverter to 1.5 m depth,
- Drill until indications of water were observed or total depth was called by the hydrogeologist,
- Pull out of hole, cleaning when required,
- Construct bore,
- Install steel monument cover and surface concrete slab, and
- Develop bore.

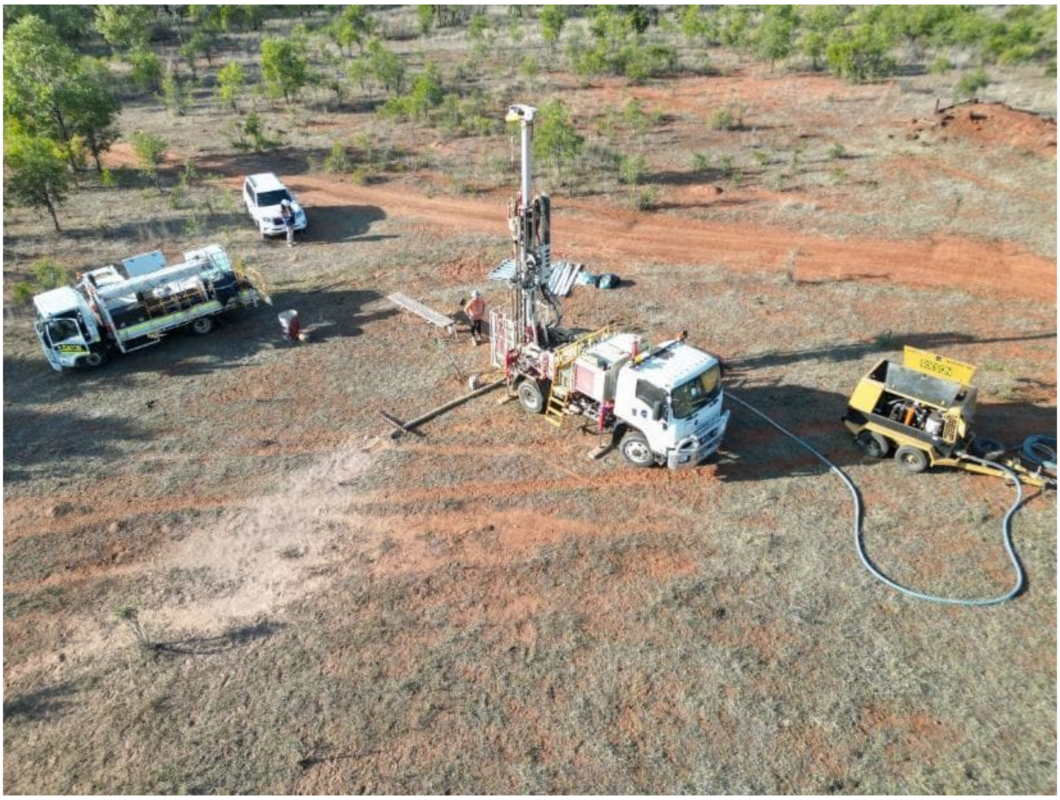
3.5. Bore construction

A standard monitoring bore construction method was employed, although depths were varied based on the target interval.

The standard bore construction is as follows, with specific depths shown on the attached composite bore logs.:

- **Above ground:** 100mm square section, yellow painted steel lockable lidded monument cover surrounded by 500mm diameter concrete slab and 3 or 4 cattle panels
- **Grout:** bentonite-cement grout seal from ground level to the top of the bentonite seal. Town water sourced from the Rolleston washdown facility was used as make-up water for the grout (1,110 µS/cm; pH 8.17). Grout was poured from surface as the seals were always above the water level.
- **Bentonite seal:** minimum 1 m total length, made from Cetco 5mm inhibited pellets.
- **Gravel pack:** Nominal 2 mm graded quartzitic sand (Sunstate Sands Australia Pool Blend) nominally base of hole to 1m above the screens.
- **Casing:** 50 mm diameter PN18 uPVC threaded casing, 3m lengths. Total length variable. Plastic bow centralisers (KwikZip) at the top and bottom of the screen and 15m intervals to surface.
- **Screens:** 50 mm diameter PN18 uPVC machine slotted screens with 0.5 mm aperture, usually 6 m in length.
- **Sump:** 1m 50mm diameter PN18 uPVC with end cap

Figure 2 Rig package in standard drilling set-upon MN-MB6-b



3.6. Bore development

The ability to develop the bores was constrained by negligible to low water production rates. MN-MB5-R and MN-MB6-b were developed by bailing the bores dry approximately 24 hours after they were constructed. This assisted in removing solids from within the cased hole.

MN-MB1-a was developed through combination of a brief airlift followed by pumping with the sampling pump at the maximum achievable rate. The returned water was essentially free of solids at the end of the development, however the sump was effectively filled with sediment which could not be cleared.

MN-MB3-a was not developed as it was dry at the end of the drilling program.

3.7. Bore Survey

Following completion, the location and elevation of the bores was surveyed with a Trimble Catalyst DGPS, with a reported horizontal and vertical accuracy of better than 0.1 m.

3.8. Issues with drilling and construction

The following difficulties were met during the drilling and construction of the groundwater monitoring bores at Mahalo North:

- The compressor had issues with overheating and shutting down while drilling MN-MB5-R and MN-MB3a. The compressor (375 cfm/250 psi) was potentially underrated for the combination of rods and bits used when depths exceeded 30 m.
- Low water yields (<0.1 L/s) were encountered in the alluvium MN-MB2-b. This resulted in very sticky hole conditions when the underlying clays were drilled. The clays ultimately smeared up the borehole walls and the drill pipe and could not be cleared from the hole despite six wiper trips. The bore was ultimately abandoned due to these conditions.
- Moisture was encountered at approximately 17.5 m in MN-MB4-b, which created similar sticky conditions described above. These conditions were exacerbated by overnight rain which resulted in the hole standing open for ~36 hours. Attempts to clear the hole, including using foam (Mudex Foam Plus) mixed with town water were unsuccessful. The bore was ultimately plugged back to 18 m and constructed as the shallow bore of the nest. The deeper bore was drilled and constructed in a single day and although similarly sticky conditions occurred, wiper trips and no added water allowed the bore (MN-MB5-R) to be constructed to target depth (35 m) bar ~0.5 m of collapsed material in the bottom of the hole.

Figure 3 Drill pipe covered in clay smear (MN-MN2-b)

4. Hydrogeological Logging

Cuttings samples were routinely collected every 1m from the blooie line and were laid out for lithological description by the field hydrogeologist. Photographs of the cuttings are included in the attachments. Cuttings from MN-MB4b were disturbed by cattle and washed away by rain before they could be photographed.

Observations of hydrogeological (e.g. indications of moisture) and drilling conditions (hard bands, chatter, changes in rate of penetration) were noted while drilling.

The Tertiary-aged basalts were not always present where expected or were very thin. Groundwater was not observed within the basalt in the bores drilled as part of this program.

Free water was not observed while actively drilling. Moist conditions were noted through the decrease in dust generated and the rolling of cuttings into balls. Some free water was observed in MN-MB1-a/MN-MB2-b and MN-MB4-b after returning to depth during a wiper trip.

While drilling MB-MB2-b, MN-MB1-a – approximately 10 m distant – started airlifting water due to the formation becoming pressurised when the diverter became plugged with wet clays. No air was observed escaping through the ground surface. The ability to pressure up the formation with only unconsolidated sediments above attests to the low permeability and structural integrity of the overlying material.

Composite bore logs are included in the attachments.

5. Testing and analysis

5.1. Water levels

Initial water levels were measured from top of casing using an Solinst Model 101 water level meter. Measurements were made from the top of the PVC casing and are included in Table 1.

MN-MB1-a, MN-MB5-R and MN-MB6-b had made water by the end of the drilling program.

There was 2 cm of water in the sump of MN-MB4-b upon demobilisation from the site.

MN-MB3-a was dry upon demobilisation.

5.2. Hydraulic testing

Testing of the hydraulic conductivity of the formation was performed by measuring the rate of water level recovery following drilling in MN-MB5-R and MN-MB6-6. Water level measurements were performed at 4 hourly intervals using a temporarily installed Solinst Levelogger 5 water level logger installed on a non-stretching polyester cord. The logger was removed following testing. A slug test was performed on MN-MB1-a using a solid mandrel slug.

Displacement was calculated from the water level logger data. The data was parsed to ensure that time zero represented the maximum displacement in accordance with the translation method (Butler, 1998). All tests exhibited overdamped responses typical of low to moderate hydraulic conductivity formations.

Aqtesolv® for Windows (Hydrosolve, 2007), a groundwater industry standard hydraulic analysis package, was used to analyse the data, with the Bouwer-Rice (1976) the primary solution used to calculate hydraulic conductivity. This is a straight-line solution that assumes a quasi-steady-state by neglecting storativity (Hydrosolve, 2007).

The straight-line methods readily allow observation of the double straight-line effect in bores that may be screened across the water table due to filter pack drainage (Bouwer, 1989). This effect was observed in the MN-MB1-a response. The type-curve was fitted to the late time data which represents the formation response rather than that of the gravel pack.

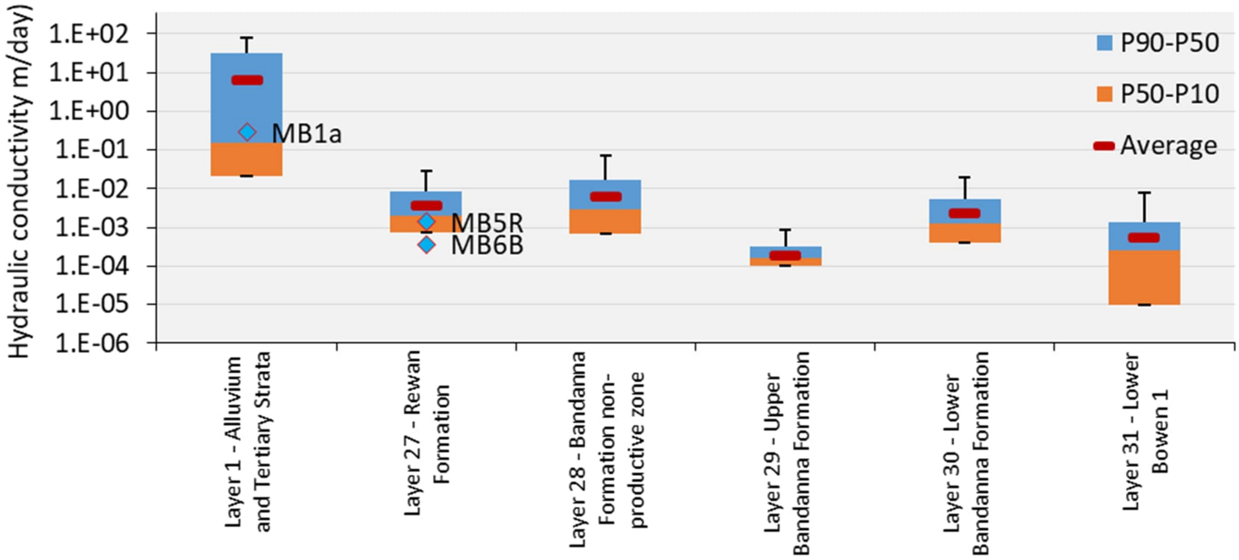
Output of the analysis is included in the attachments, with calculated hydraulic conductivities summarised in Table 2.

Comparison to the OGIA model values for the Mahalo North Project area shown on Figure 4, which identifies that the Rewan Formation hydraulic conductivity may be lower than the range used in the model.

Table 2 Calculated hydraulic conductivities

BoreID	Analysis solution	Hydraulic conductivity (m/day)
MN-MB1-a	Bouwer-Rice (1976)	0.3
MN-MB5-R	Bouwer-Rice (1976)	0.0015
MN-MB6-b	Bouwer-Rice (1976)	0.0004

Figure 4 Comparison of hydraulic testing results with OGIA model ranges from the Mahalo North area.



5.3. Groundwater Sampling

Initial groundwater quality samples were collected 22 August 2024. There was insufficient water in MN-MB4-b to lift a sample to surface. MN-MB3-a was dry.

Samples were collected by low flow methods using a 42 mm diameter stainless steel Solinst© double valve pump powered by a 12V oil-less compressor.

Field parameters (electrical conductivity, temperature and pH) were measured using a TPS© WP81 field water quality meter that was calibrated prior to the collection of the samples. Samples were collected when field parameters were stable.

Samples were collected in new laboratory supplied containers, of materials (plastic or glass) and preservatives specific to the required analyses.

A field blind duplicate (DUP) was collected from MN-MB5-R. The duplicate results show good repeatability of the analysis.

A rinsate sample was collected after routine cleaning of the double valve pump using town water. Laboratory supplied rinsate water was poured over the pump and collected directly into the appropriate containers.

Samples were stored on ice in the field and during transport, and overnight in a refrigerator, prior to delivery to the Australian Laboratory Services (ALS) in Brisbane. Samples were submitted to ALS under chain-of-custody protocols. ALS is National Association of Testing Authorities (NATA) accredited for the analyses performed.

The results of the initial water quality samples are provided in Table 3. The results indicate that the water is saline.

Table 3 Initial water quality sample results

Chemical Group	Parameter	Unit	Sample ID / Limit of reporting	MN-MB1-a	MN-MB5-R	MN-MB6-b	DUP*	Rinsate
				22/08/2024	22/08/2024	22/08/2024	22/08/2024	22/08/2024
Physicochemical parameters	pH Value	pH Unit	0.01	7.56	7.34	7.08	7.47	6.12
	Electrical Conductivity @ 25°C	µS/cm	1	33400	51900	30000	52000	8
	Total Dissolved Solids @180°C	mg/L	10	27200	36800	23600	36500	-
Major and minor ions	Total Hardness as CaCO3	mg/L	1	13100	8100	5970	8120	7
	Hydroxide Alkalinity as CaCO3	mg/L	1	<1	<1	<1	<1	<1
	Carbonate Alkalinity as CaCO3	mg/L	1	<1	<1	<1	<1	<1
	Bicarbonate Alkalinity as CaCO3	mg/L	1	379	169	188	165	6
	Total Alkalinity as CaCO3	mg/L	1	379	169	188	165	6
	Sulfate as SO4 - Turbidimetric	mg/L	1	896	240	308	277	<1
	Chloride	mg/L	1	12400	19000	10900	21000	3
	Calcium	mg/L	1	1500	786	545	793	1
	Magnesium	mg/L	1	2280	1490	1120	1490	1
	Sodium	mg/L	1	2830	9380	4880	9370	6
	Potassium	mg/L	1	18	44	38	45	<1
	Fluoride	mg/L	0.1	0.2	0.4	0.4	0.4	<0.1
Trace elements (dissolved)	Antimony	mg/L	0.001	<0.005	<0.005	0.006	<0.005	<0.001
	Arsenic	mg/L	0.001	<0.005	<0.005	<0.005	<0.005	<0.001
	Barium	mg/L	0.001	0.113	0.517	0.369	0.512	0.053
	Lithium	mg/L	0.001	0.042	0.079	0.025	0.078	<0.001
	Molybdenum	mg/L	0.001	<0.005	0.114	0.065	0.116	<0.001
	Strontium	mg/L	0.001	38.1	25.5	19.4	25.2	0.020
	Boron	mg/L	0.05	0.64	3.06	1.34	3.04	<0.05
Nutrients	Ammonia as N	mg/L	0.01	<0.01	0.09	0.05	0.08	<0.01
	Nitrite as N	mg/L	0.01	<0.01	<0.05	0.03	<0.05	<0.01
	Nitrate as N	mg/L	0.01	1.21	0.20	0.09	0.21	<0.01
	Nitrite + Nitrate as N	mg/L	0.01	1.21	0.20	0.12	0.21	<0.01
	Reactive Phosphorus as P	mg/L	0.01	0.02	<0.05	<0.01	<0.05	<0.01
Hydrocarbons	Methane	µg/L	10	<10	<10	<10	<10	-

* DUP = field blind duplicate of MN-MB5-R*

Bore Details – MN-MB1-a

MN-MB1-a Comet Ridge Limited - Mahalo North

UTM ZONE: GDA2020 MGA55 **REGISTERED NUMBER:** Not available **DRILLED DEPTH (mBGL):** 17.1
EASTING: 658464.7 **DATE SPUDDED:** 8/20/2024 **CONSTRUCTED DEPTH (mBGL):** 17
NORTHING: 7337611.6 **DATE COMPLETED:** 8/21/2024 **DRILLER:** Legion Drilling **LOGGED BY:** Ryan Morris

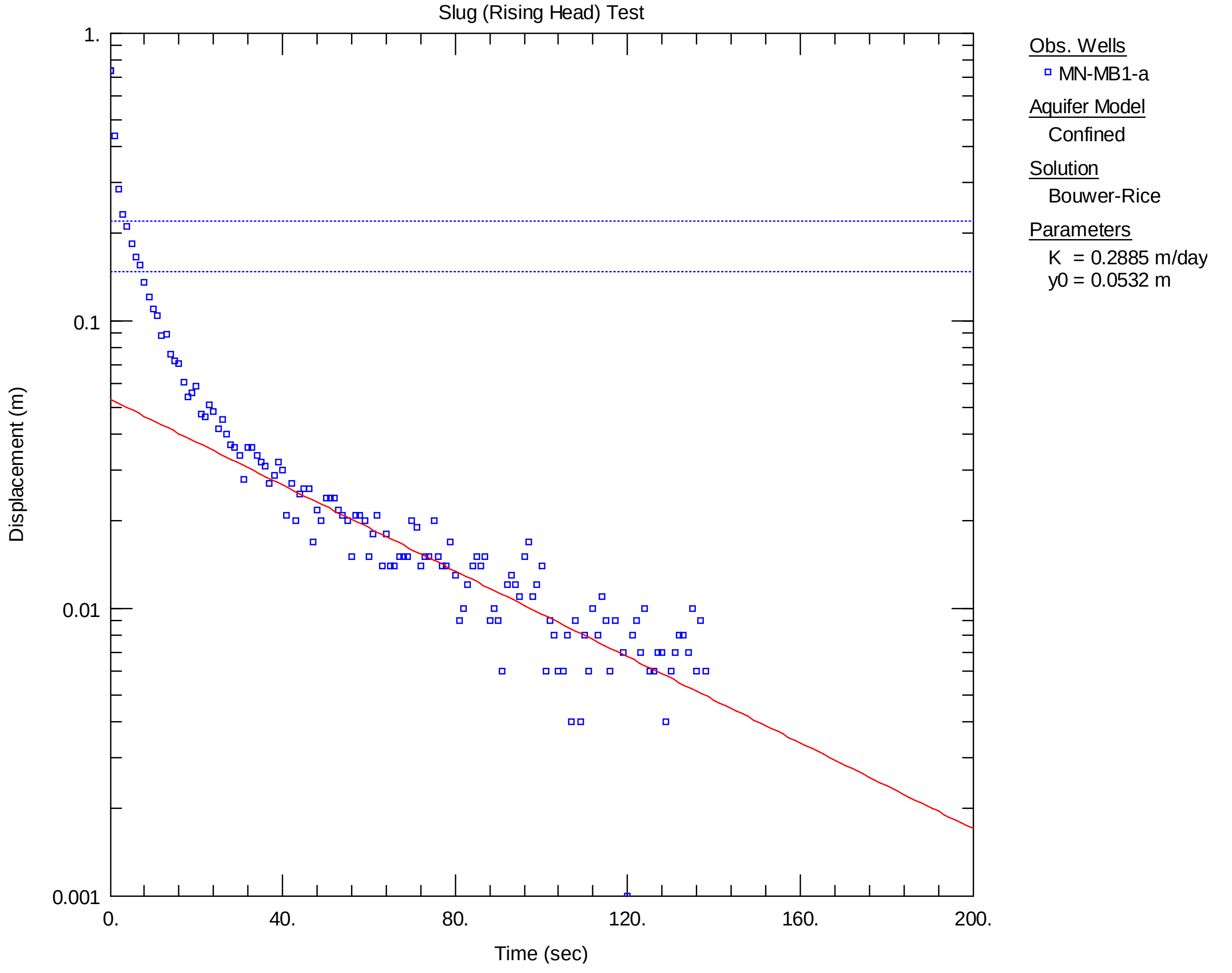
DEPTH (metres)	Formation	LITHOLOGY	DRILLING OBSERVATIONS	BORE CONSTRUCTION
				Steel monument
0	ALLUVIUM	BLACKSOIL, dark brown clayey sand, low plasticity, low strength. SAND quartzitic, fine to medium, sub-rounded		0-17m: 127mm diameter air drilled hole
	ALLUVIUM	CLAYEY SAND, brown, SAND fine to medium, CLAY moderately stiff. Some fine to medium gravel, sub-rounded, low sphericity	Drilling with blade bit	
	ALLUVIUM	CLAY, brown, stiff, low plasticity	No dust, trace moisture	0-8m: 5% bentonite cement grout -0.87-10m: 50mm PN18 uPVC casing, centralised
5	ALLUVIUM	CLAYEY SAND, light brown, SAND fine	Loose sand, ROP very high	8-9m: Bentonite
10	ALLUVIUM	SAND, light brown to yellow brown, fine to medium, quartzitic, some fine gravel, sub-angular. Loose	Ochre coloured, moist, medium sand Some hole collapse, moisture on connection	
	REWAN	SILTSTONE, dark grey, hard - indurated?	Decreased ROP, much harder, poor returns, larger angular chips. Wet	9-17m: Nom 3mm washed, rounded gravel 10-16m: 50mm PN18 uPVC screens, machine slotted, 0.5mm aperture
15	REWAN	moderately weathered, becoming clayey		
	REWAN	SILTY CLAY, grey and light brown, soft, moderate plasticity		16-16.95m: Sump
		EOH @ 17m		End Cap

Water level: 7.97
Electrical conductivity: 33400
0.3

Shallowest water level measured (mbgl) during drilling program (10-22 October 2024)

Electrical conductivity (uS/cm)


0m
17m


Slug (Rising Head) Test
Displacement (m)
1.
0.1
0.01
0.001
0.
40.
80.
120.
160.
200.
Time (sec)
Obs. Wells
MN-MB1-a
Aquifer Model
Confined
Solution
Bouwer-Rice
Parameters
K = 0.2885 m/day
y0 = 0.0532 m

Bore Details – MN-MB2-b

MN-MB2-b

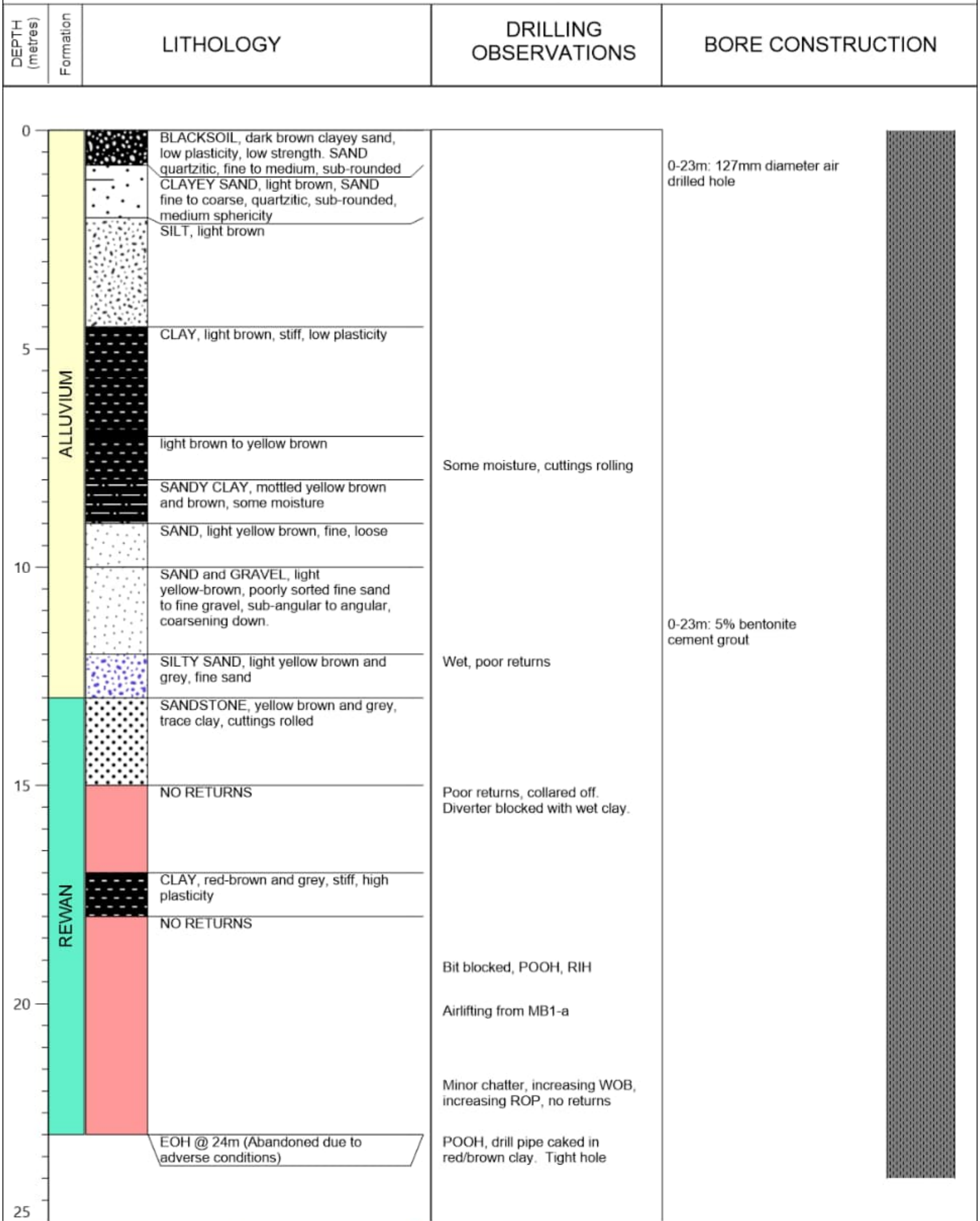
Comet Ridge Limited - Mahalo North

UTM ZONE: GDA2020 MGA55
EASTING: 658453.5
NORTHING: 7337617.9

REGISTERED NUMBER: Not available
DATE SPUDDED: 8/21/2024
DATE COMPLETED: 8/22/2024

DRILLED DEPTH (mBGL): 24
CONSTRUCTED DEPTH (mBGL): -
DRILLER: Legion Drilling

LOGGED BY: Ryan Morris

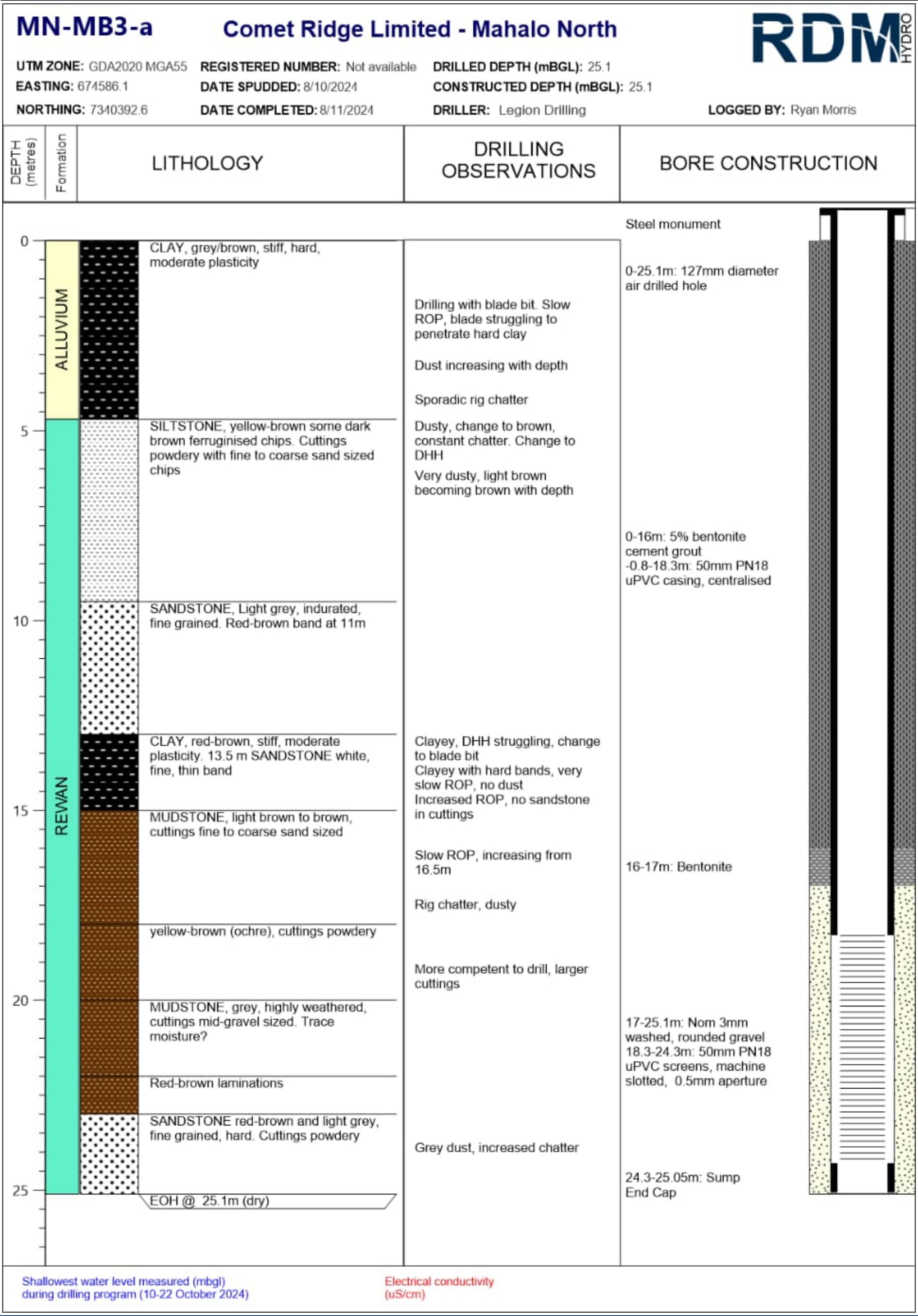


Shallowest water level measured (mbgl) during drilling program (10-22 October 2024)

Electrical conductivity (uS/cm)


0m
20m

Bore Details – MN-MB3-a


MN-MB3-a
Comet Ridge Limited - Mahalo North
RDM HYDRO
UTM ZONE: GDA2020 MGA55
EASTING: 674586.1
NORTHING: 7340392.6
REGISTERED NUMBER: Not available
DATE SPUDDED: 8/10/2024
DATE COMPLETED: 8/11/2024
DRILLED DEPTH (mBGL): 25.1
CONSTRUCTED DEPTH (mBGL): 25.1
DRILLER: Legion Drilling
LOGGED BY: Ryan Morris
DEPTH (metres)
Formation
LITHOLOGY
DRILLING OBSERVATIONS
BORE CONSTRUCTION
0
5
10
15
20
25
ALLUVIUM
REWAN
CLAY, grey/brown, stiff, hard, moderate plasticity
SILTSTONE, yellow-brown some dark brown ferruginised chips. Cuttings powdery with fine to coarse sand sized chips
SANDSTONE, Light grey, indurated, fine grained. Red-brown band at 11m
CLAY, red-brown, stiff, moderate plasticity. 13.5 m SANDSTONE white, fine, thin band
MUDSTONE, light brown to brown, cuttings fine to coarse sand sized
yellow-brown (ochre), cuttings powdery
MUDSTONE, grey, highly weathered, cuttings mid-gravel sized. Trace moisture?
Red-brown laminations
SANDSTONE red-brown and light grey, fine grained, hard. Cuttings powdery
EOH @ 25.1m (dry)
Drilling with blade bit. Slow ROP, blade struggling to penetrate hard clay
Dust increasing with depth
Sporadic rig chatter
Dusty, change to brown, constant chatter. Change to DHH
Very dusty, light brown becoming brown with depth
Clayey, DHH struggling, change to blade bit
Clayey with hard bands, very slow ROP, no dust
Increased ROP, no sandstone in cuttings
Slow ROP, increasing from 16.5m
Rig chatter, dusty
More competent to drill, larger cuttings
Grey dust, increased chatter
Steel monument
0-25.1m: 127mm diameter air drilled hole
0-16m: 5% bentonite cement grout
-0.8-18.3m: 50mm PN18 uPVC casing, centralised
16-17m: Bentonite
17-25.1m: Nom 3mm washed, rounded gravel
18.3-24.3m: 50mm PN18 uPVC screens, machine slotted, 0.5mm aperture
24.3-25.05m: Sump
End Cap
Shallowest water level measured (mbgl) during drilling program (10-22 October 2024)
Electrical conductivity (uS/cm)


0m
25m

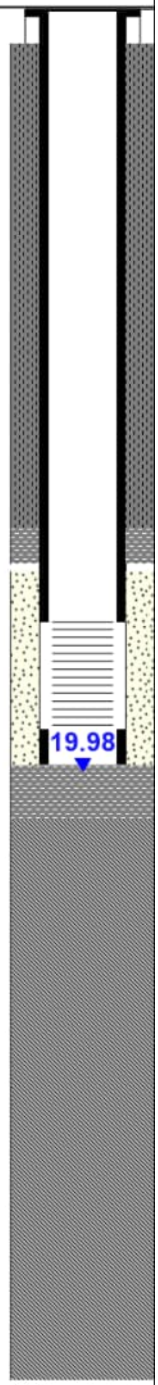
Bore Details – MN-MB4-b

MN-MB4-b

Comet Ridge Limited - Mahalo North

UTM ZONE: GDA2020 MGA55
EASTING: 664644
NORTHING: 7340479.9
REGISTERED NUMBER: Not available
DATE SPUDDED: 8/6/2024
DATE COMPLETED: 8/8/2024
DRILLED DEPTH (mBGL): 37
CONSTRUCTED DEPTH (mBGL): 20
DRILLER: Legion Drilling
LOGGED BY: Ryan Morris

DEPTH (metres)	Formation	LITHOLOGY	DRILLING OBSERVATIONS	BORE CONSTRUCTION
0	TERTIARY	SANDY CLAY, dark brown tending to grey	Drilling with blade bit	Steel monument; 0-37m: 127mm diameter air drilled hole
		CLAY, brown, grey and light brown. Stiff	Brown dust, decreased ROP; Decreased dust, trace moisture	
5		BASALT, brown. Extremely weathered. With yellow brown clay.		0-13.4m: 5% bentonite cement grout; -0.89-16m: 50mm PN18 uPVC casing, centralised
		CLAY, light brown to brown. Stiff.	Very dusty, brown and grey; Less chatter, finer cuttings; Tight hole with DHH on POOH	
10		BASALT, dark grey with yellow brown weathering. Clay brown to yellow brown	Increased chatter, change to light grey	
	REWAN	MUDSTONE, grey to light brown, indurated	Refusal with blade bite, change to DHH	13.4-14.4m: Bentonite
15				14.6-20m: Nom 3mm washed, rounded gravel; 16-19m: 50mm PN18 uPVC screens, machine slotted, 0.5mm aperture
		CLAY, grey to red-brown, some moisture	Decreased dust, some moisture; Stop for 30 mins. No water on restart	
20		SILTSTONE and SANDSTONE, grey and light brown, dry, hard. Sandstone fine grained.	Hard, dusty	19-19.95m: Sump; End Cap; 20-21.5m: Bentonite
25		MUDSTONE, brown, cuttings platy (clayey)	Change to dark brown. Rig chatter, small decrease in dust; No dust, moisture	
		As above, but light grey and purple		21.5-37m: Collapse
30		CLAY, brown, stiff, moderate plasticity.	No returns and poor hole cleaning. POOH, change to blade; Cuttings collaring, no returns	
35		EOH at 37m		



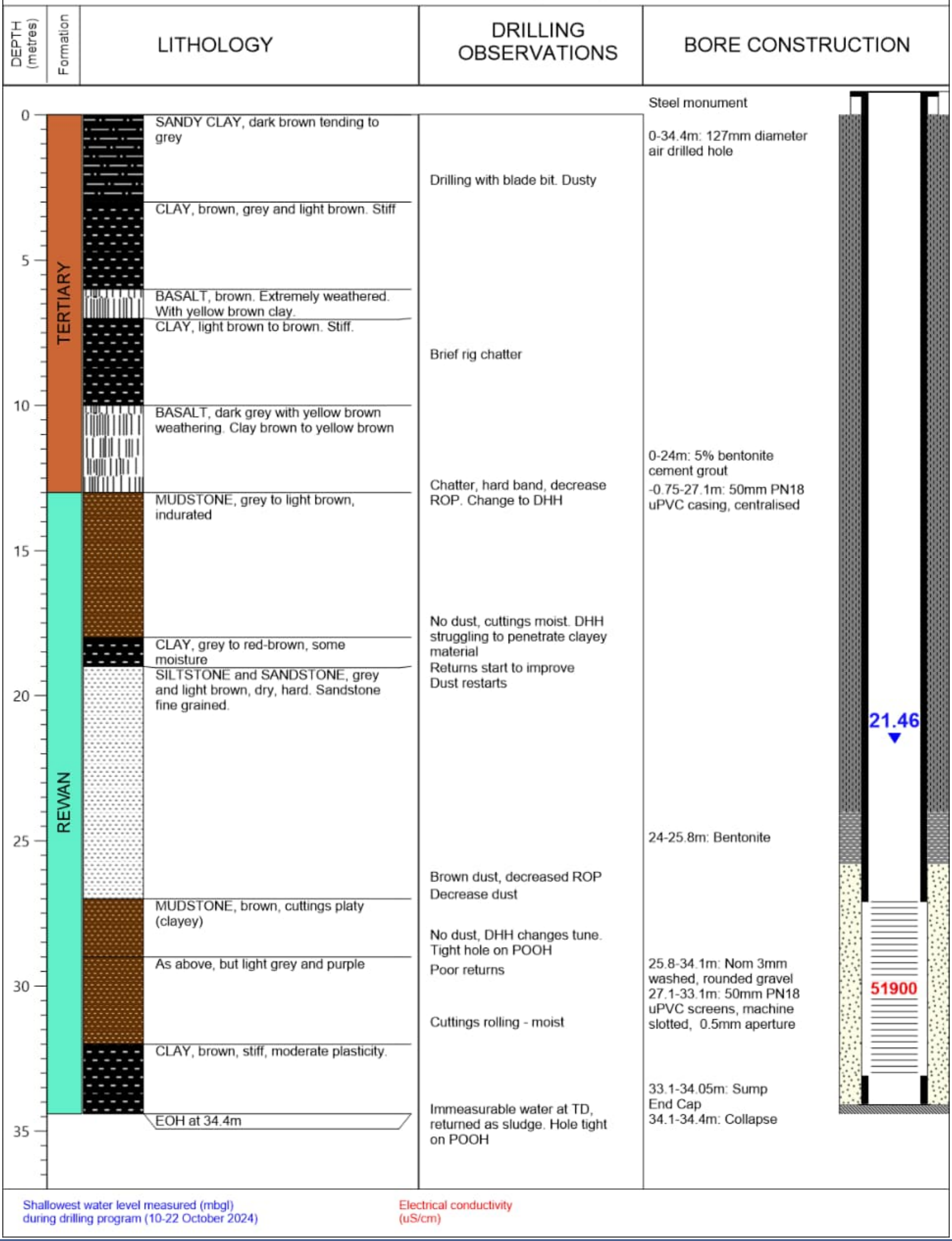
Shallowest water level measured (mbgl) during drilling program (10-22 October 2024)

Electrical conductivity (uS/cm)

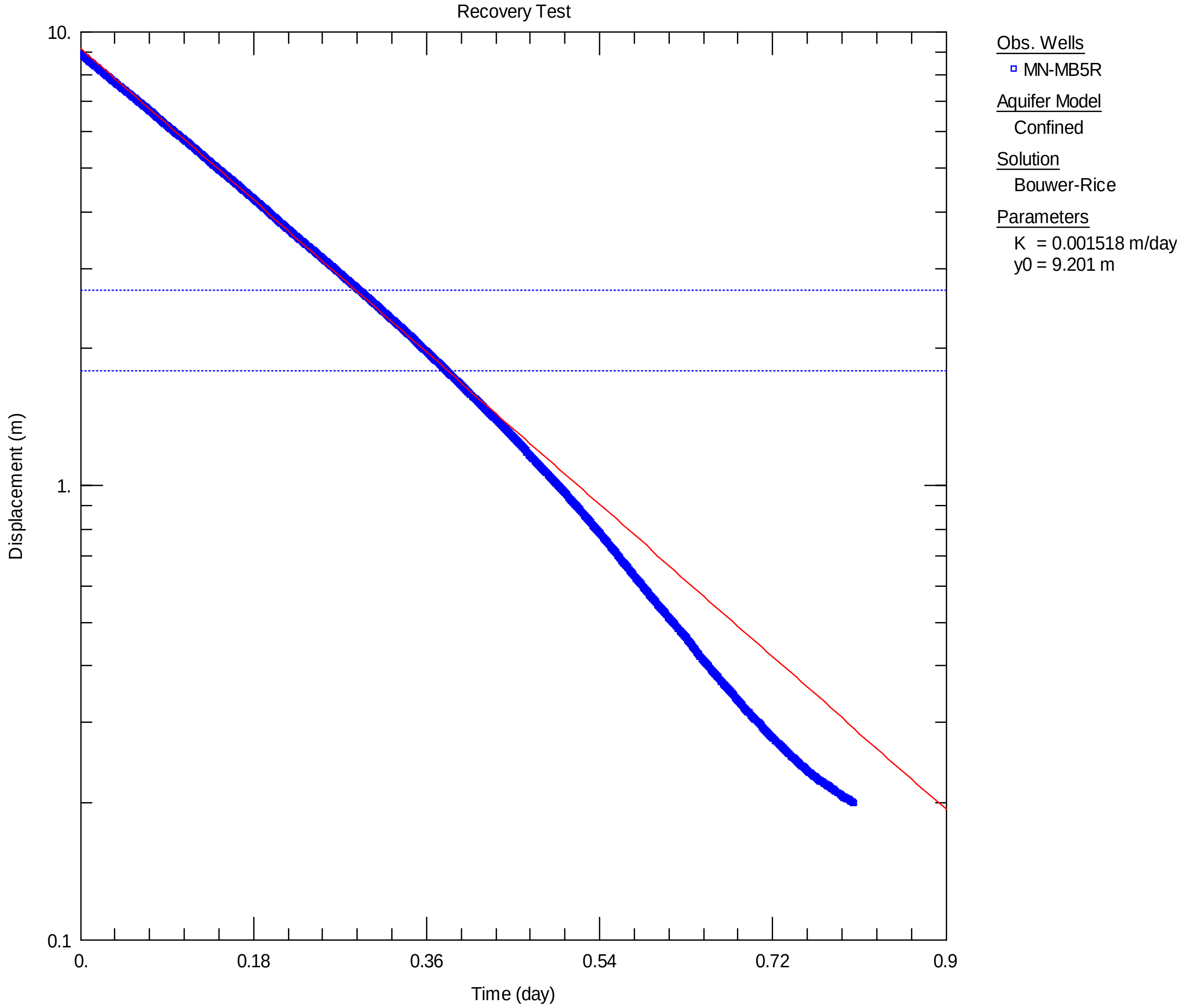
Bore Details – MN-MB5-R

MN-MB5-R — Comet Ridge Limited - Mahalo North

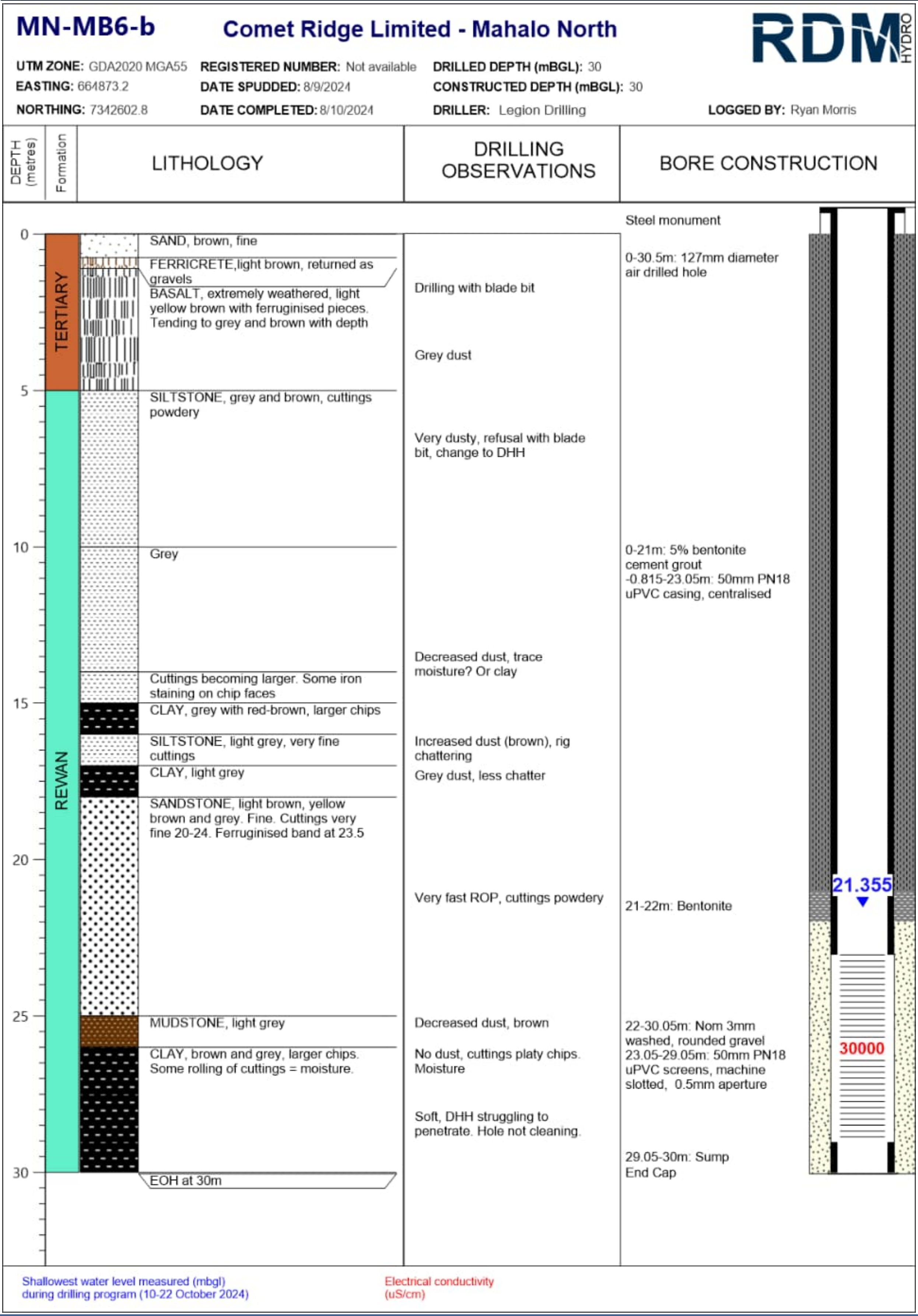
UTM ZONE: GDA2020 MGA55 **REGISTERED NUMBER:** Not available **DRILLED DEPTH (mBGL):** 34.4
EASTING: 664636.8 **DATE SPUDDED:** 8/8/2024 **CONSTRUCTED DEPTH (mBGL):** 34.1
NORTHING: 7340479.7 **DATE COMPLETED:** 8/9/2024 **DRILLER:** Legion Drilling **LOGGED BY:** Ryan Morris



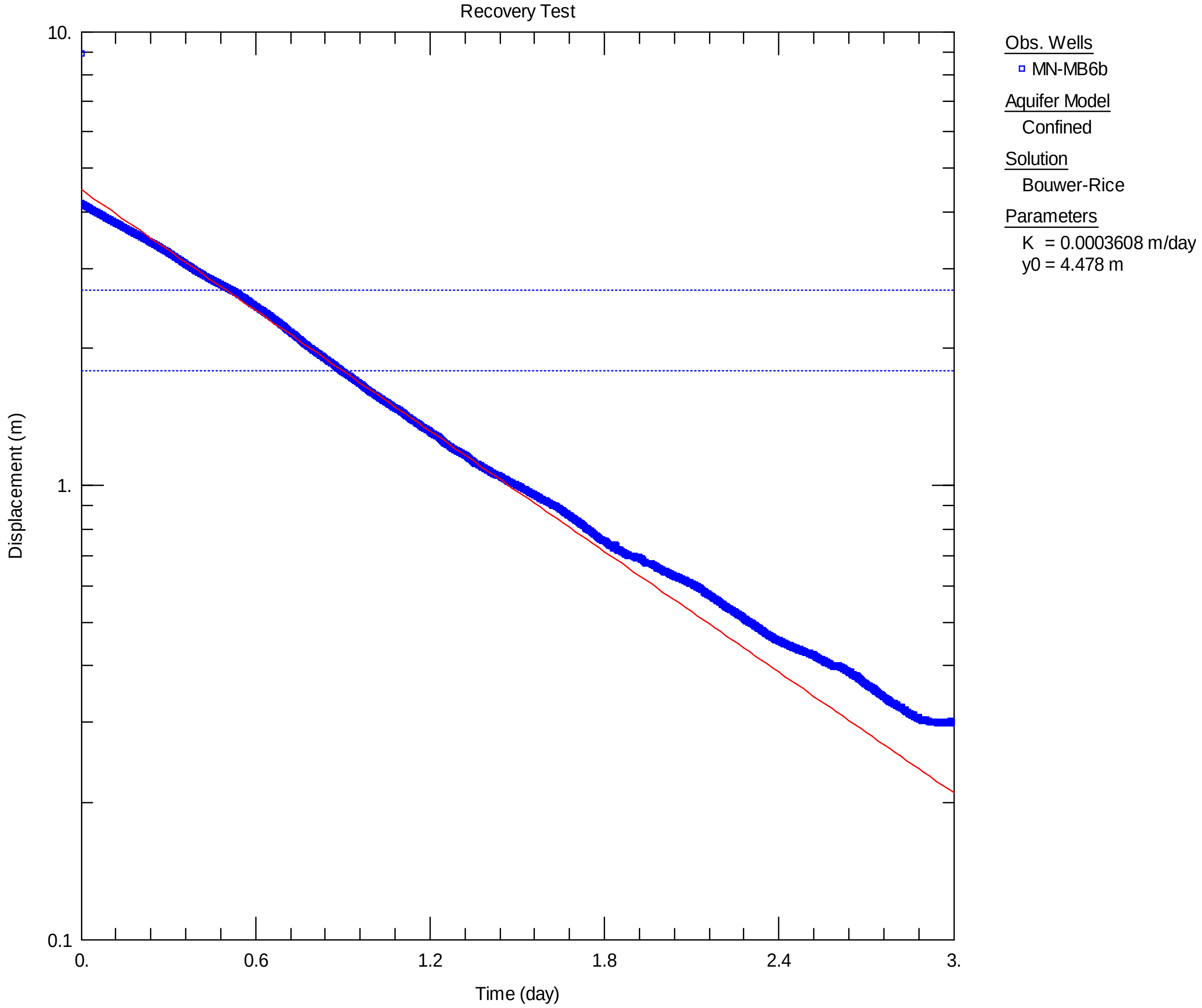

0m
24m


Recovery Test
Displacement (m)
10.
1.
0.1
0.
0.18
0.36
0.54
0.72
0.9
Time (day)
Obs. Wells
MN-MB5R
Aquifer Model
Confined
Solution
Bouwer-Rice
Parameters
K = 0.001518 m/day
y0 = 9.201 m

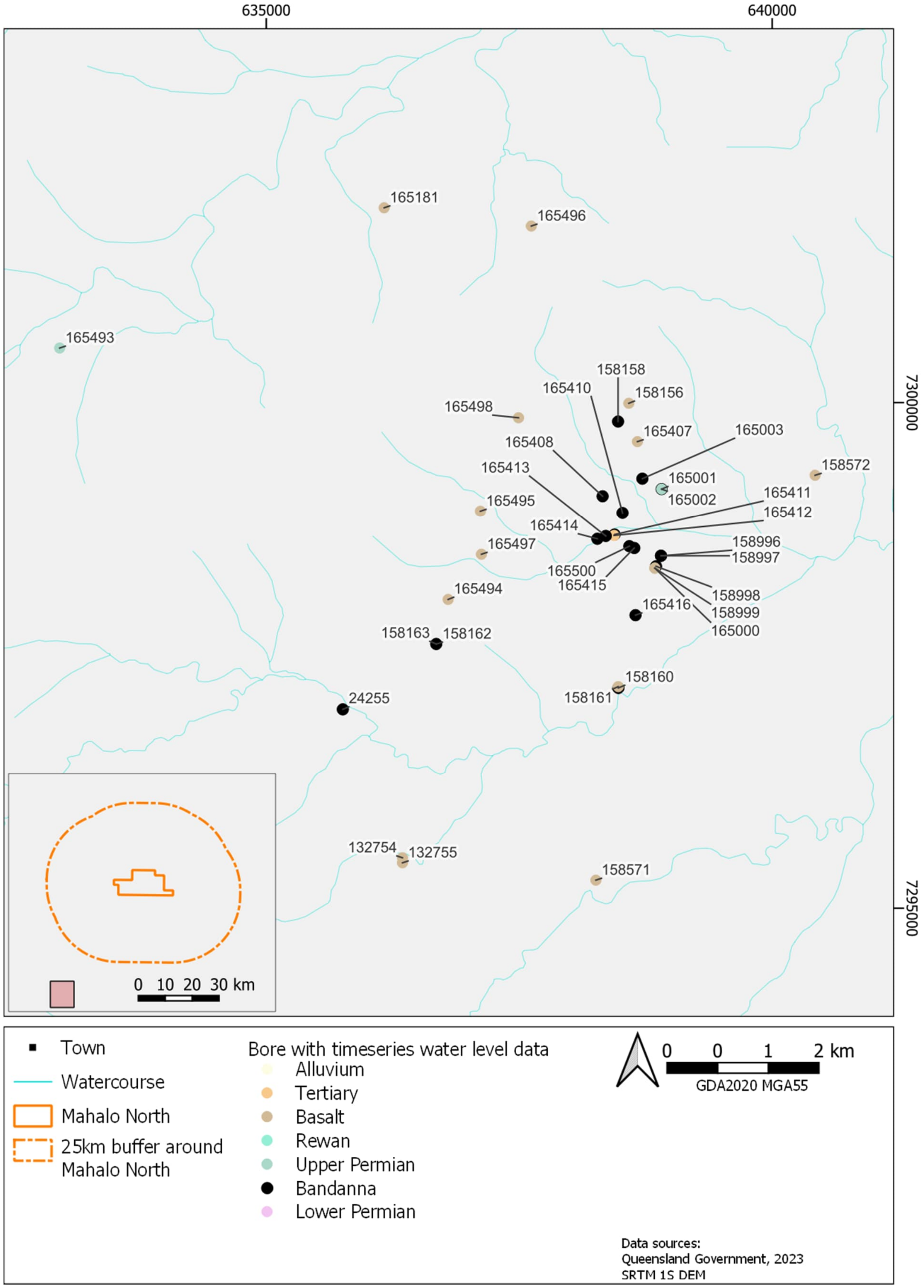
Bore Details – MN-MB6-b

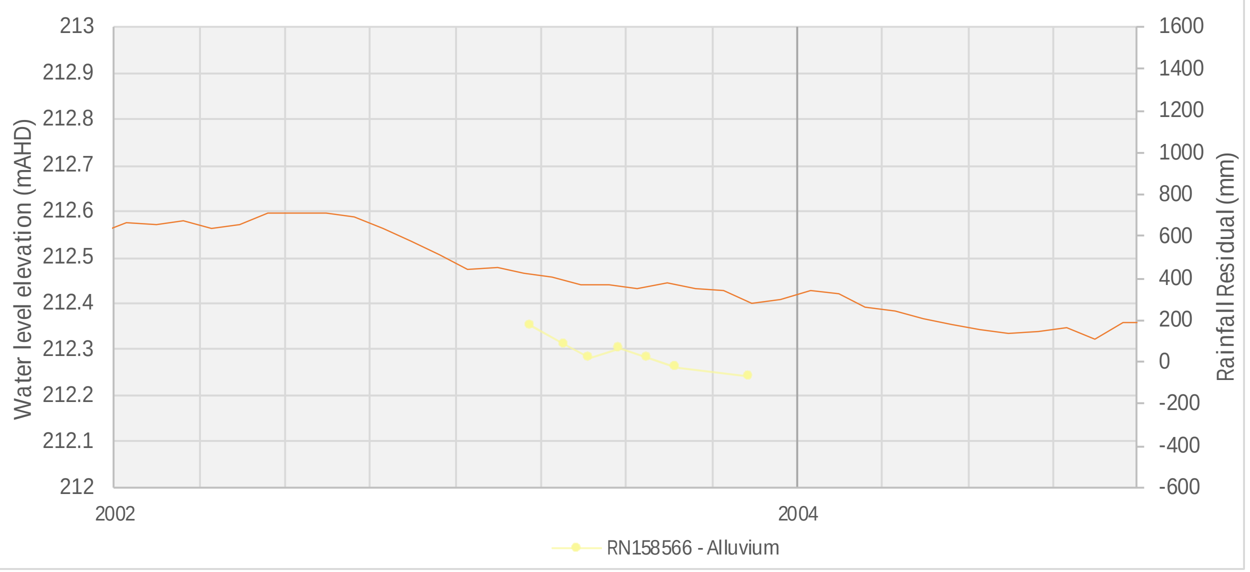

MN-MB6-b
Comet Ridge Limited - Mahalo North
RDM HYDRO
UTM ZONE: GDA2020 MGA55
EASTING: 664873.2
NORTHING: 7342602.8
REGISTERED NUMBER: Not available
DATE SPUDDED: 8/9/2024
DATE COMPLETED: 8/10/2024
DRILLED DEPTH (mBGL): 30
CONSTRUCTED DEPTH (mBGL): 30
DRILLER: Legion Drilling
LOGGED BY: Ryan Morris
DEPTH (metres)
Formation
LITHOLOGY
DRILLING OBSERVATIONS
BORE CONSTRUCTION
0
5
10
15
20
25
30
TERTIARY
REWAN
SAND, brown, fine
FERRICRETE,light brown, returned as gravels
BASALT, extremely weathered, light yellow brown with ferruginised pieces. Tending to grey and brown with depth
SILTSTONE, grey and brown, cuttings powdery
Grey
Cuttings becoming larger. Some iron staining on chip faces
CLAY, grey with red-brown, larger chips
SILTSTONE, light grey, very fine cuttings
CLAY, light grey
SANDSTONE, light brown, yellow brown and grey. Fine. Cuttings very fine 20-24. Ferruginised band at 23.5
MUDSTONE, light grey
CLAY, brown and grey, larger chips. Some rolling of cuttings = moisture.
EOH at 30m
Drilling with blade bit
Grey dust
Very dusty, refusal with blade bit, change to DHH
Decreased dust, trace moisture? Or clay
Increased dust (brown), rig chattering
Grey dust, less chatter
Very fast ROP, cuttings powdery
Decreased dust, brown
No dust, cuttings platy chips. Moisture
Soft, DHH struggling to penetrate. Hole not cleaning.
Steel monument
0-30.5m: 127mm diameter air drilled hole
0-21m: 5% bentonite cement grout
-0.815-23.05m: 50mm PN18 uPVC casing, centralised
21-22m: Bentonite
22-30.05m: Nom 3mm washed, rounded gravel
23.05-29.05m: 50mm PN18 uPVC screens, machine slotted, 0.5mm aperture
29.05-30m: Sump End Cap
21.355
30000
Shallowest water level measured (mbgl) during drilling program (10-22 October 2024)
Electrical conductivity (uS/cm)

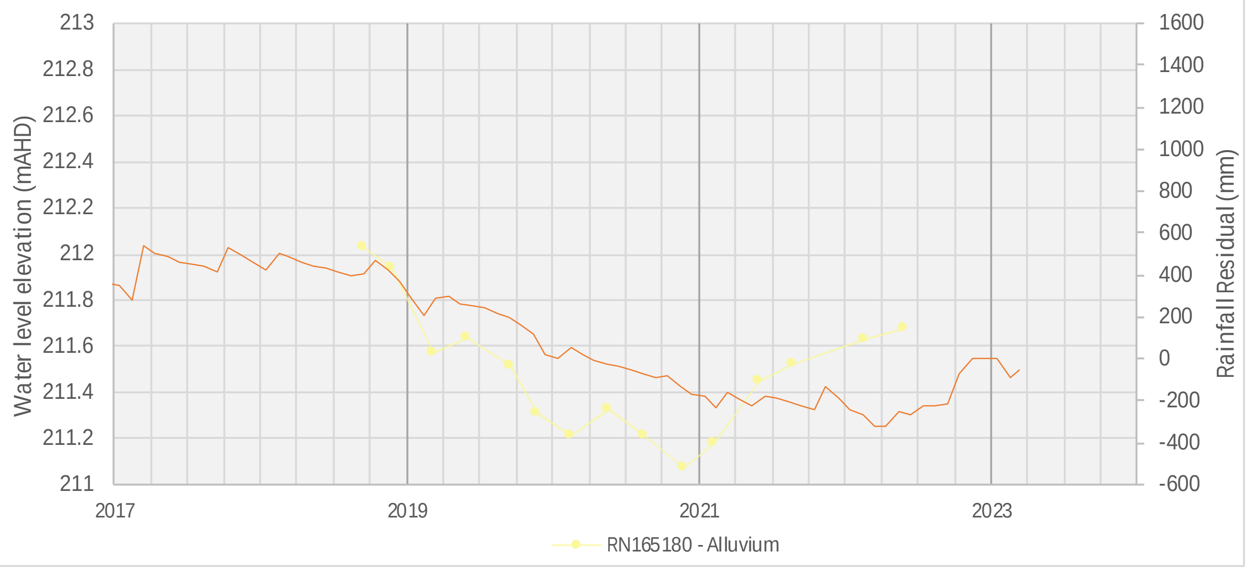

0m
30m

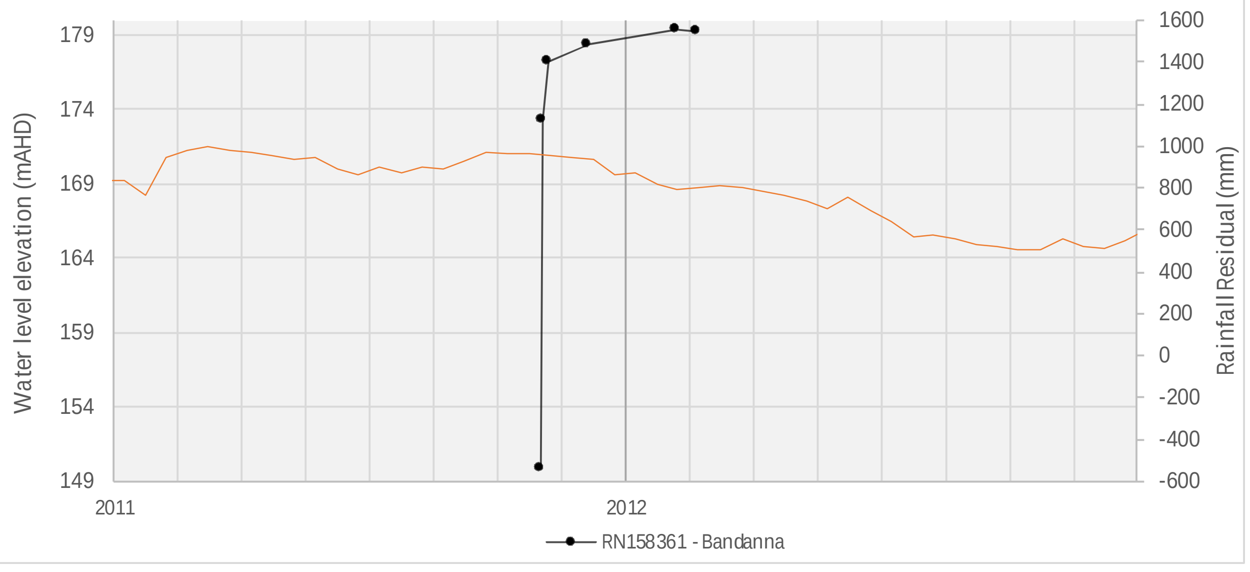

Recovery Test
Displacement (m)
Time (day)
10.
1.
0.1
0.
0.6
1.2
1.8
2.4
3.
Obs. Wells
MN-MB6b
Aquifer Model
Confined
Solution
Bouwer-Rice
Parameters
K = 0.0003608 m/day
y0 = 4.478 m

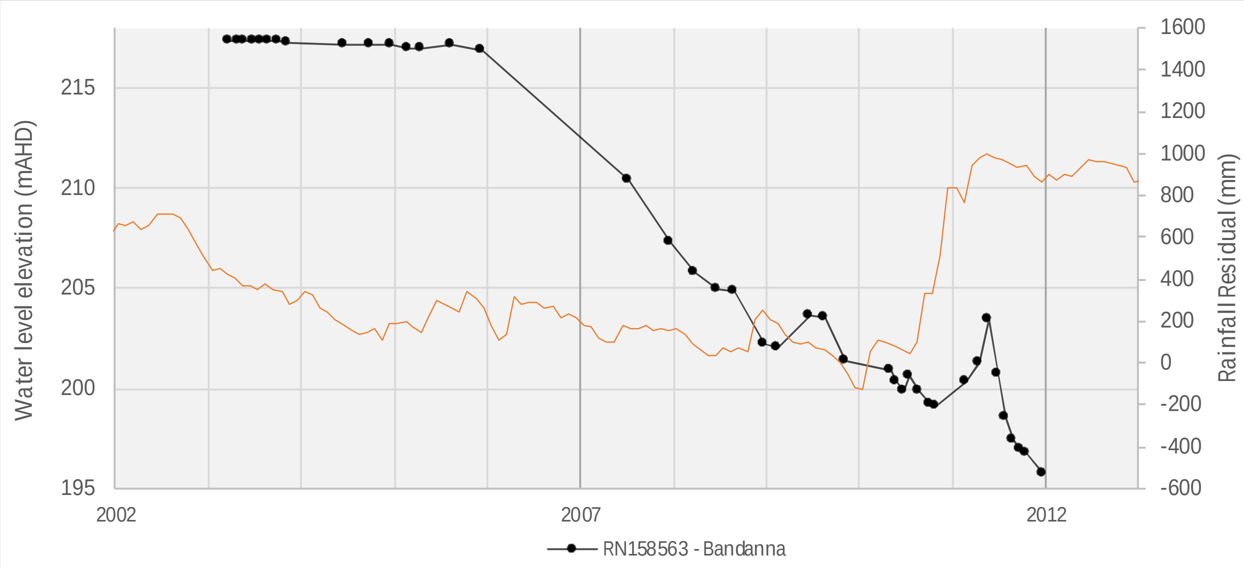
Appendix C Individual Water Level Hydrographs

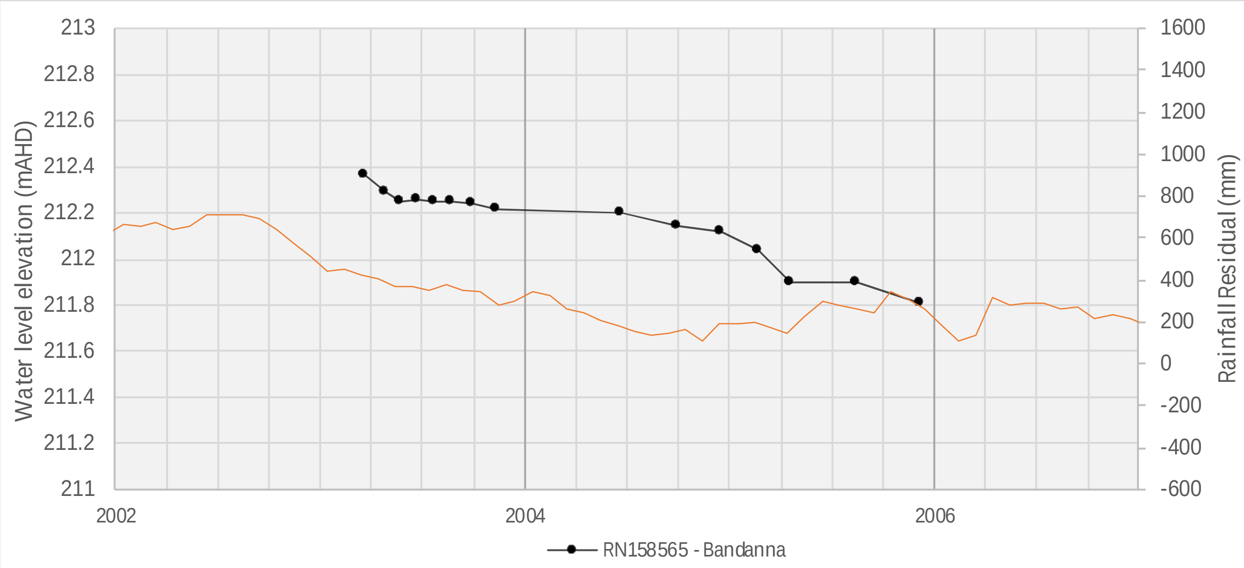


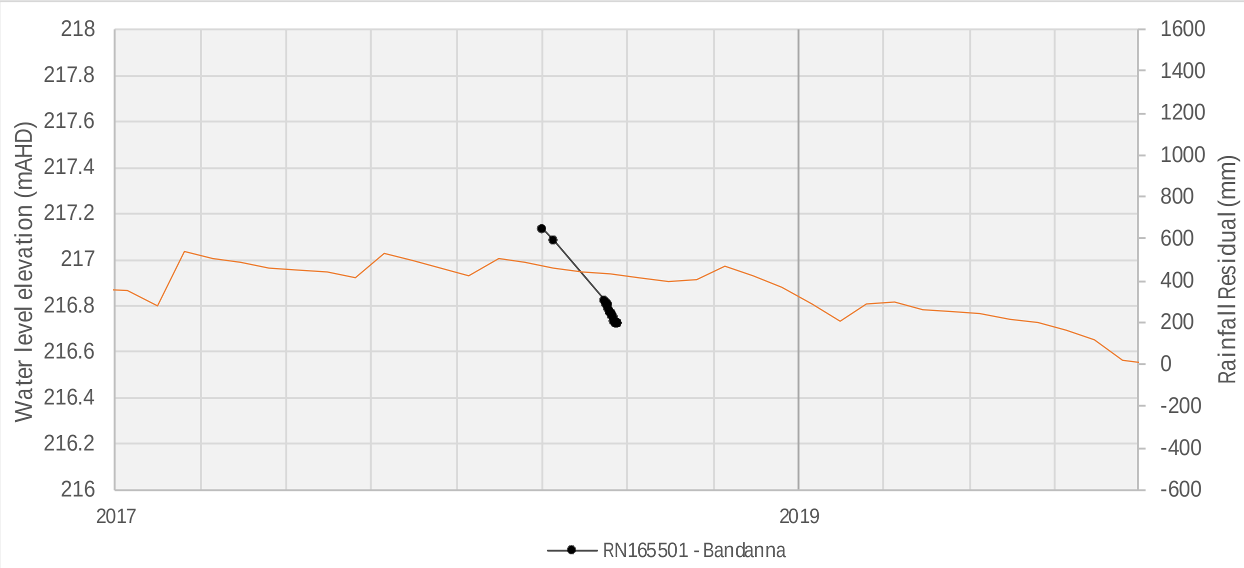

Water level elevation (mAHD)
Rainfall Residual (mm)
RN158566 - Alluvium

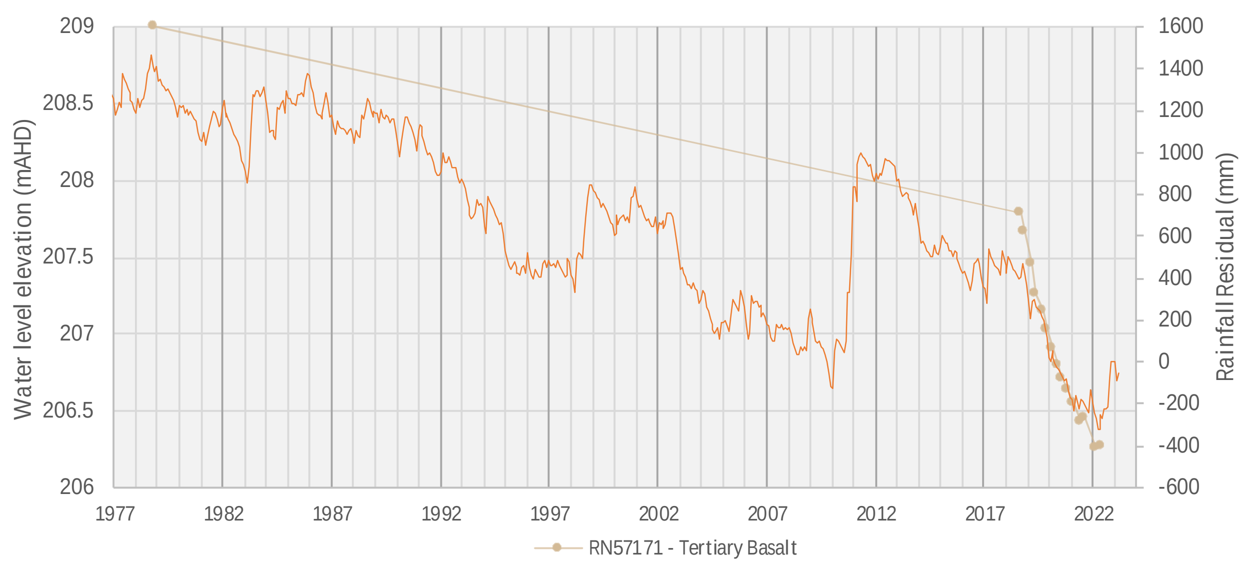

Water level elevation (mAHD)
Rainfall Residual (mm)
RN165180 - Alluvium

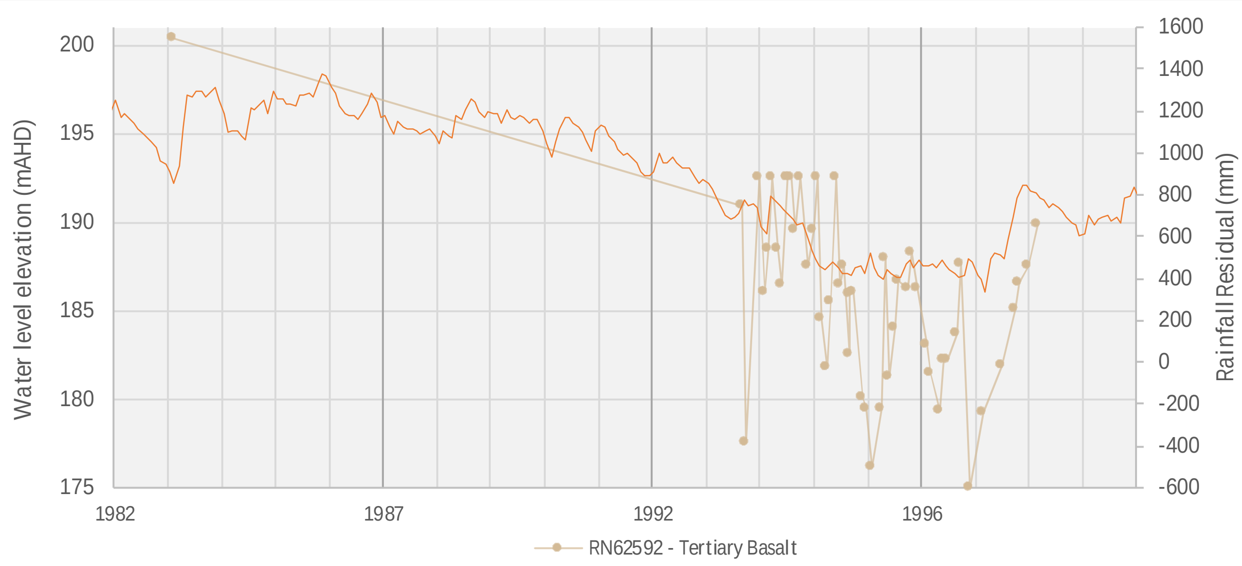

Water level elevation (mAHD)
Rainfall Residual (mm)
RN158361 - Bandanna

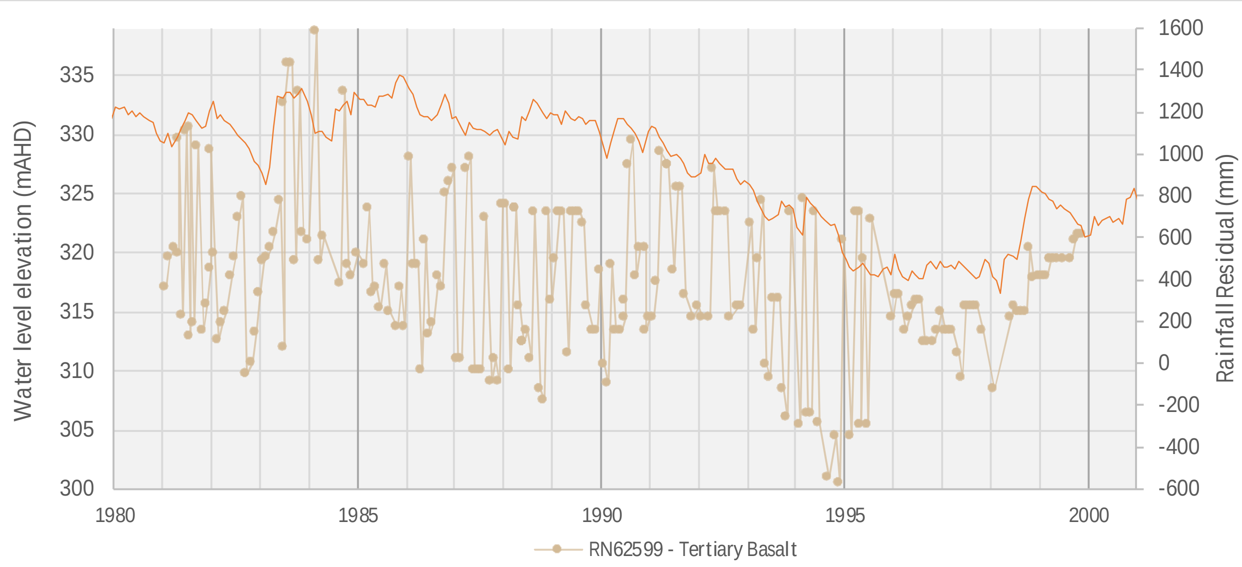

Water level elevation (mAHD)
215
210
205
200
195
Rainfall Residual (mm)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2002
2007
2012
RN158563 - Bandanna

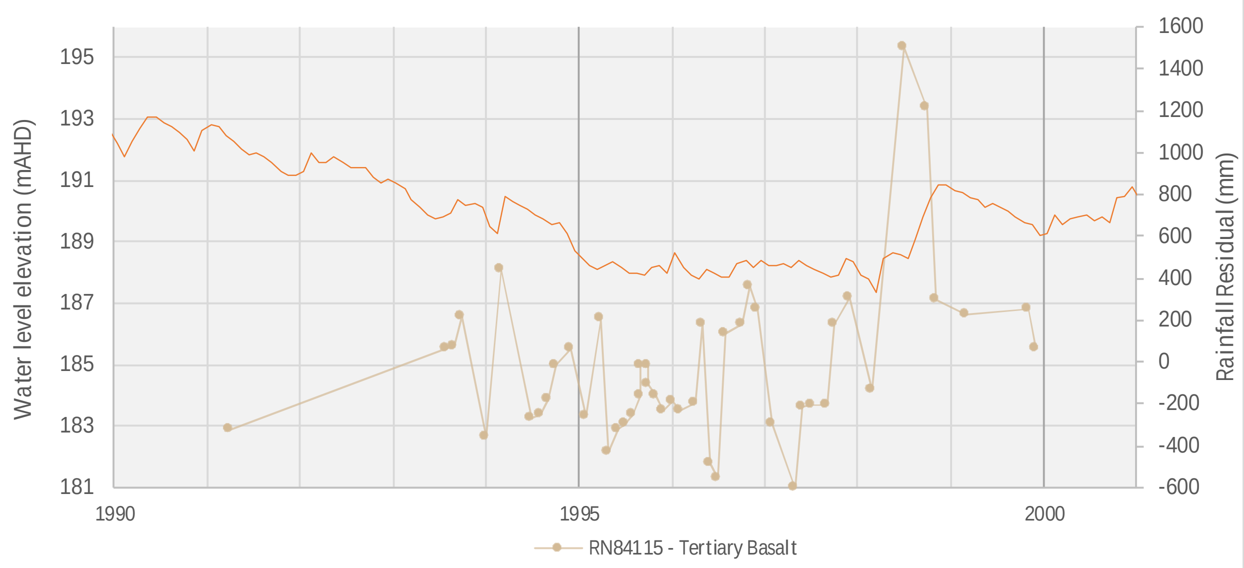

Water level elevation (mAHD)
213
212.8
212.6
212.4
212.2
212
211.8
211.6
211.4
211.2
211
Rainfall Residual (mm)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2002
2004
2006
RN158565 - Bandanna

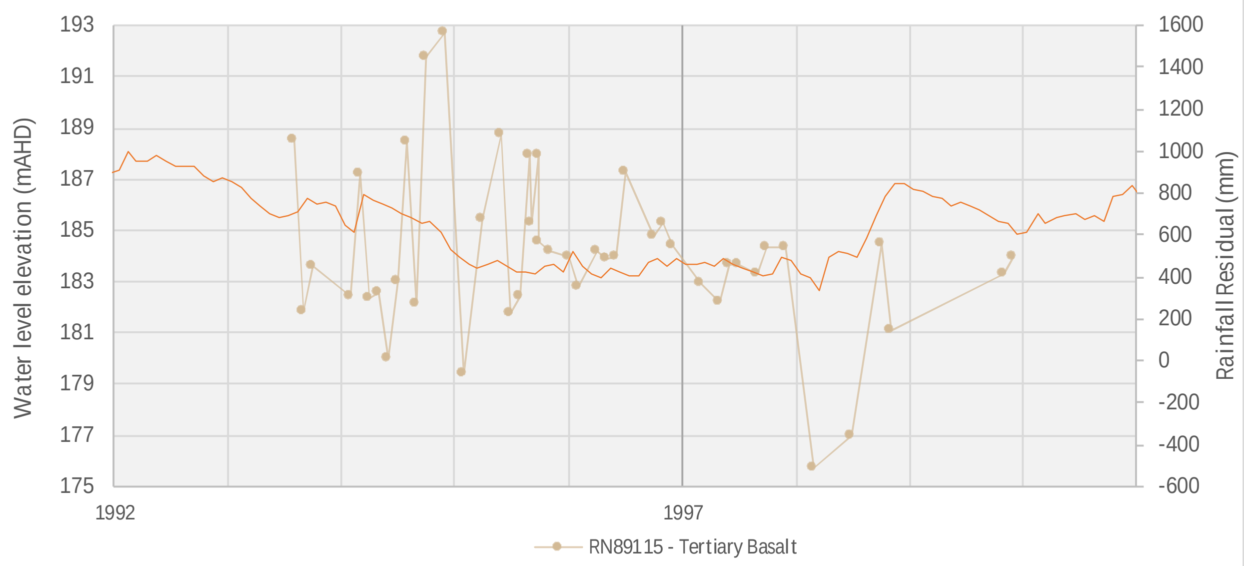

Water level elevation (mAHD)
218
217.8
217.6
217.4
217.2
217
216.8
216.6
216.4
216.2
216
Rainfall Residual (mm)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2017
2019
RN165501 - Bandanna

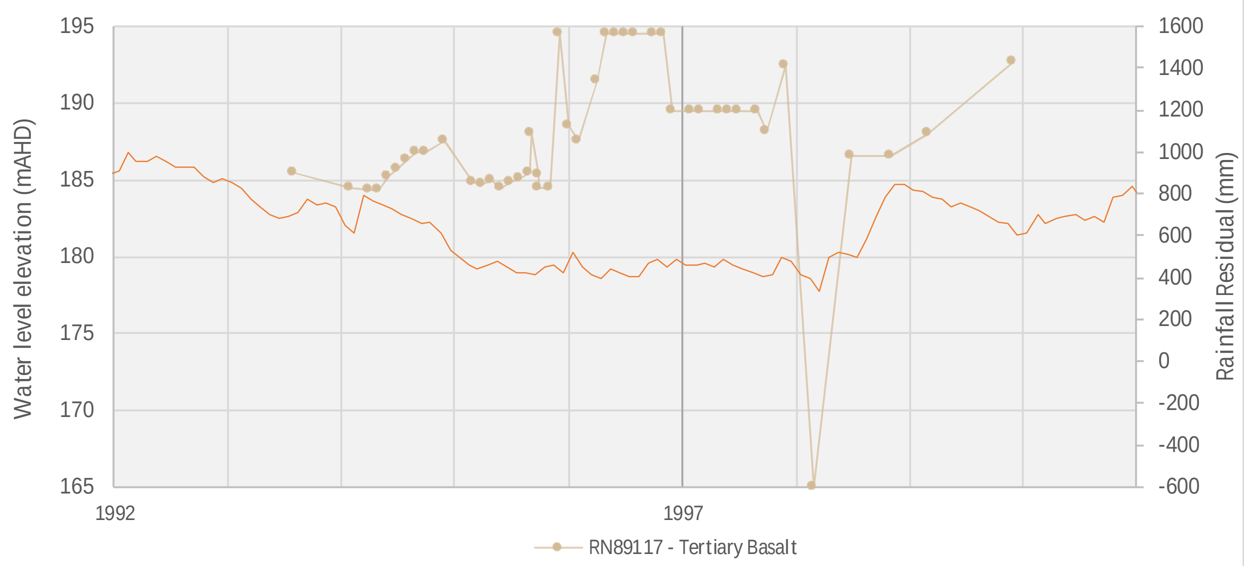

Water level elevation (mAHD)
Rainfall Residual (mm)
RN57171 - Tertiary Basalt

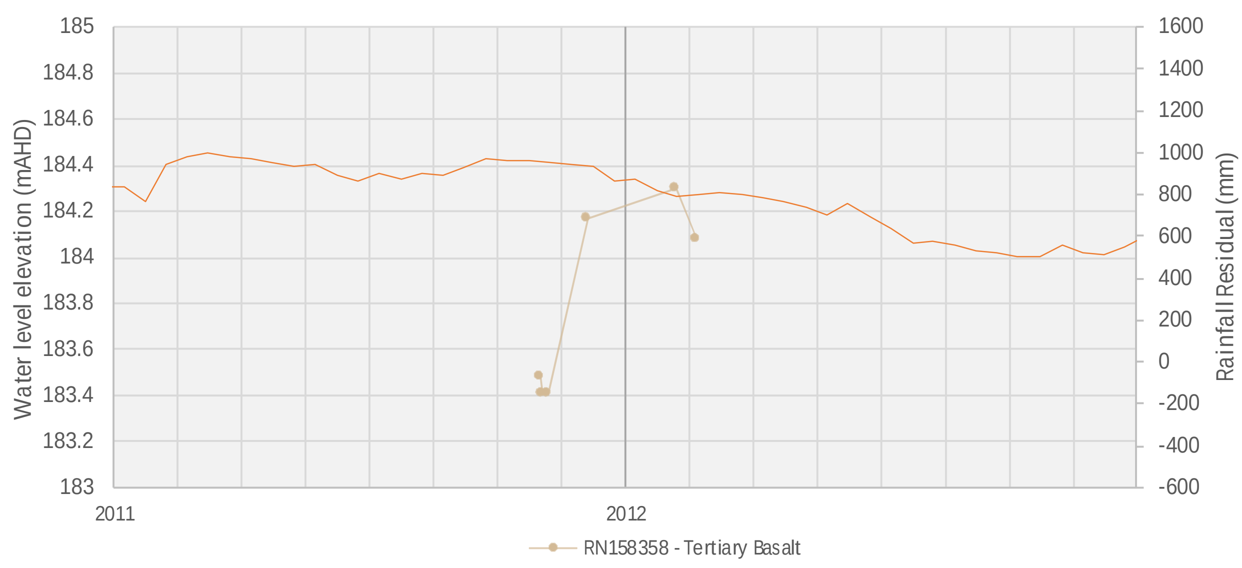

Water level elevation (mAHD)
Rainfall Residual (mm)
RN62592 - Tertiary Basalt

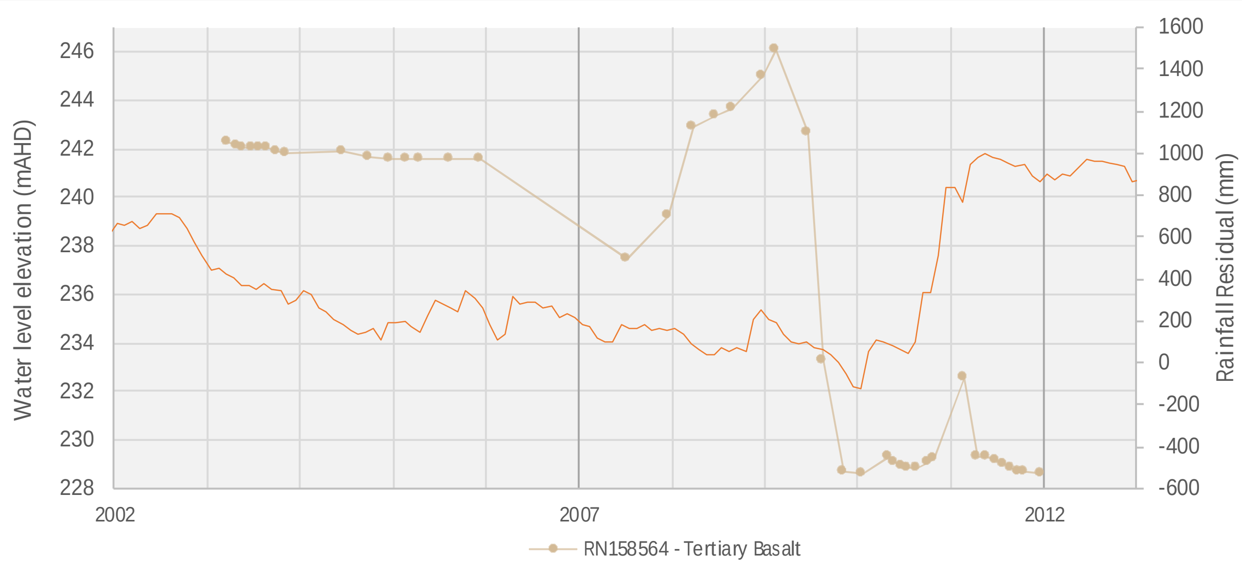

Water level elevation (mAHD)
Rainfall Residual (mm)
RN62599 - Tertiary Basalt

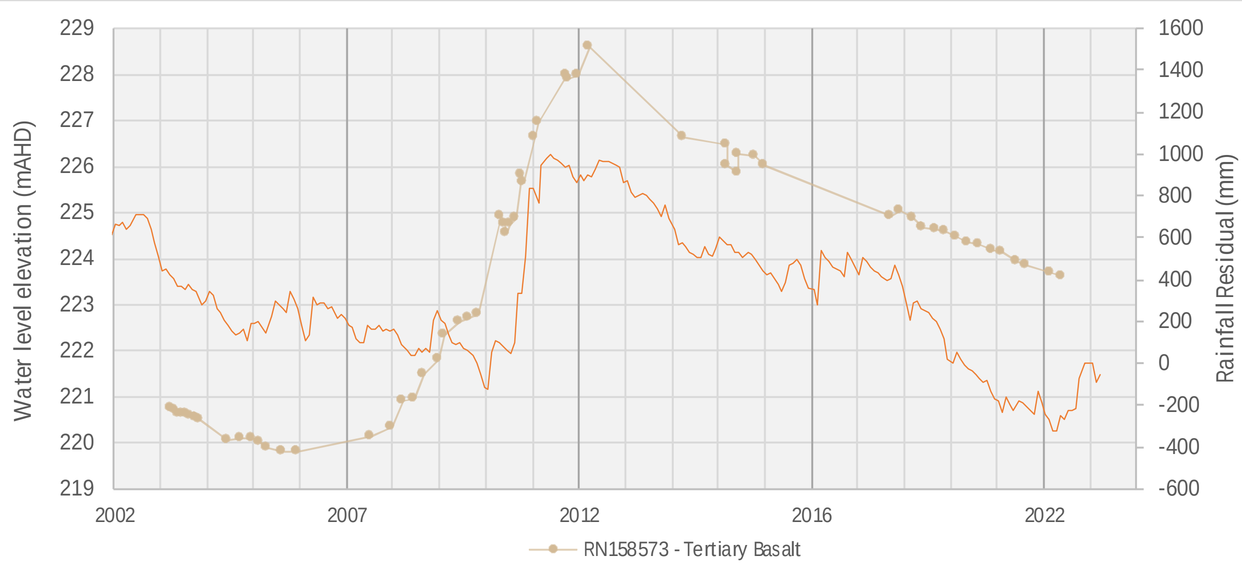

Water level elevation (mAHD)
195
193
191
189
187
185
183
181
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
1990
1995
2000
RN84115 - Tertiary Basalt

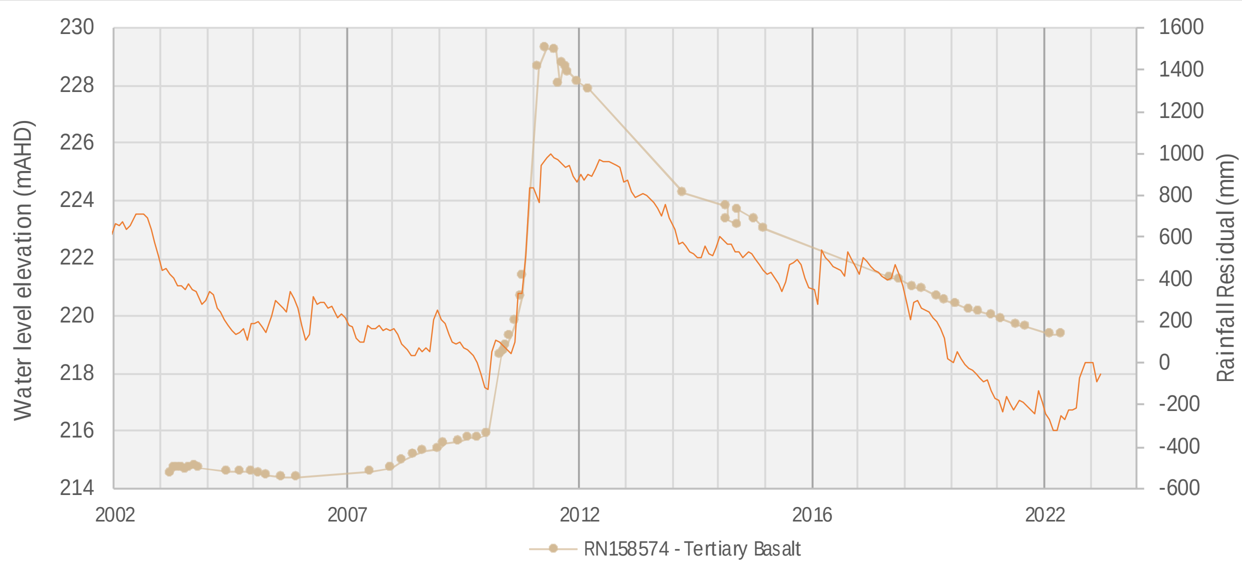

Water level elevation (mAHD)
193
191
189
187
185
183
181
179
177
175
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
1992
1997
RN89115 - Tertiary Basalt

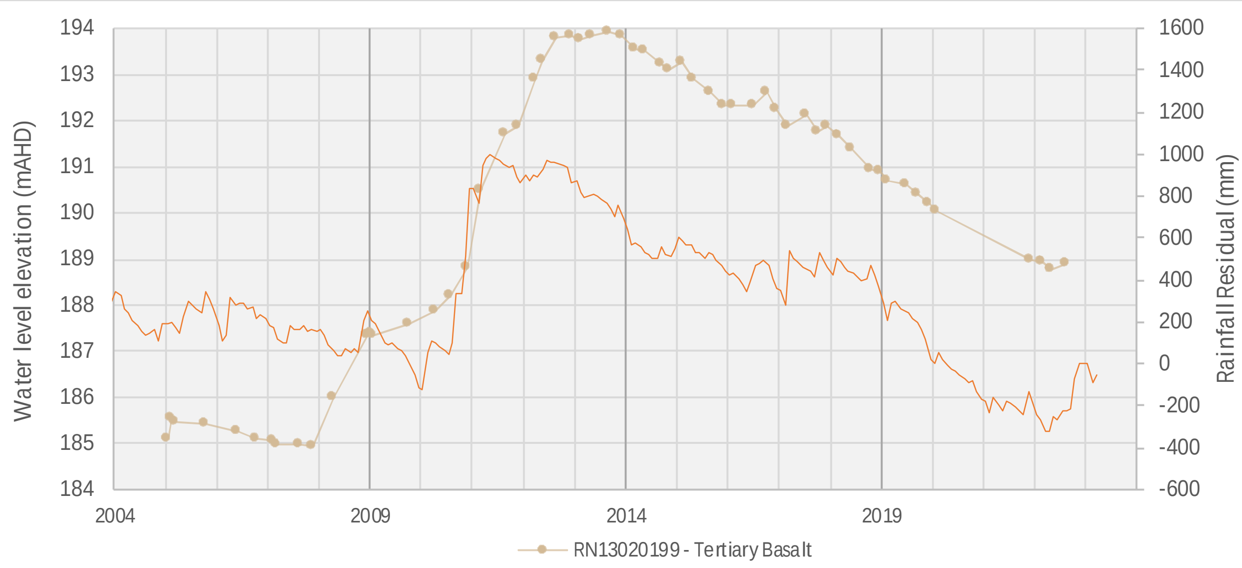

Water level elevation (mAHD)
195
190
185
180
175
170
165
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
1992
1997
RN89117 - Tertiary Basalt

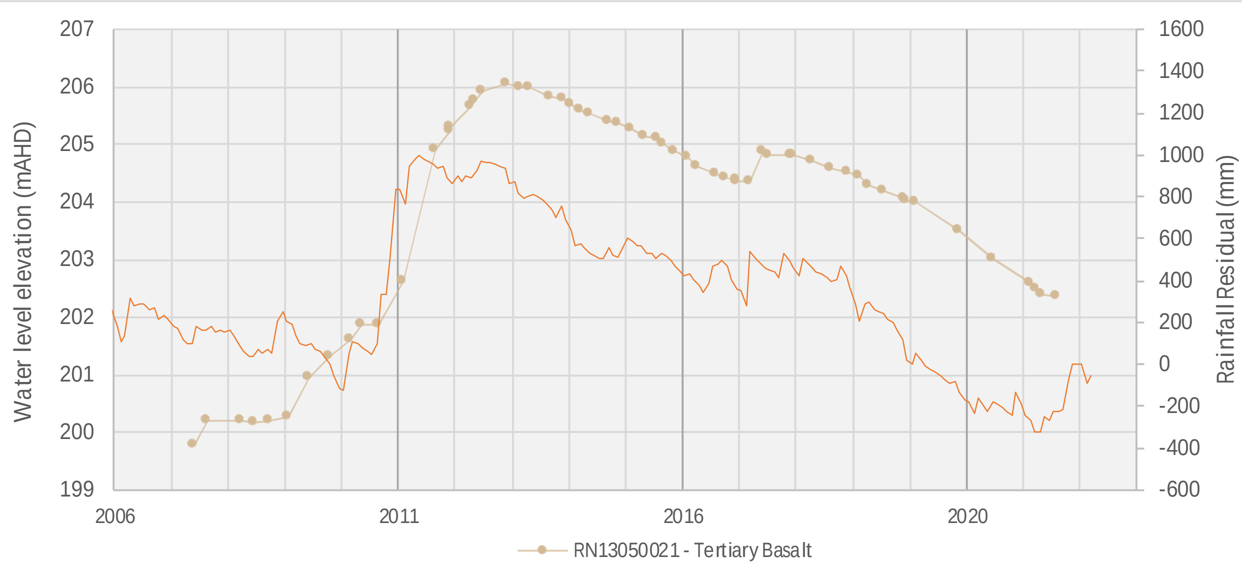

Water level elevation (mAHD)
185
184.8
184.6
184.4
184.2
184
183.8
183.6
183.4
183.2
183
Rainfall Residual (mm)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2011
2012
RN158358 - Tertiary Basalt

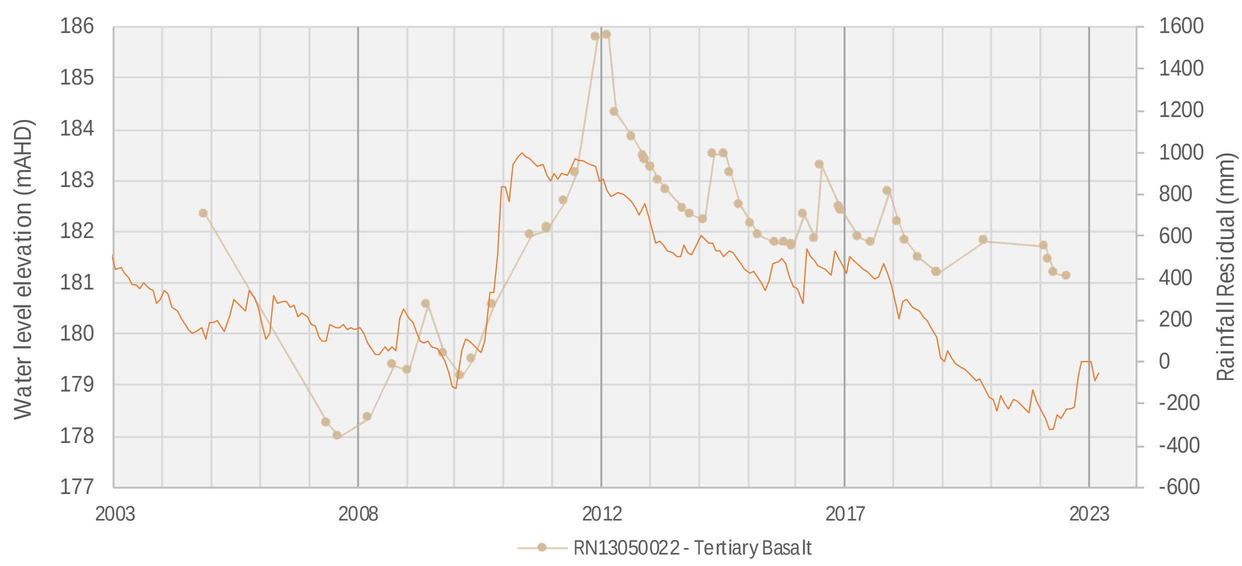

Water level elevation (mAHD)
246
244
242
240
238
236
234
232
230
228
Rainfall Residual (mm)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2002
2007
2012
RN158564 - Tertiary Basalt

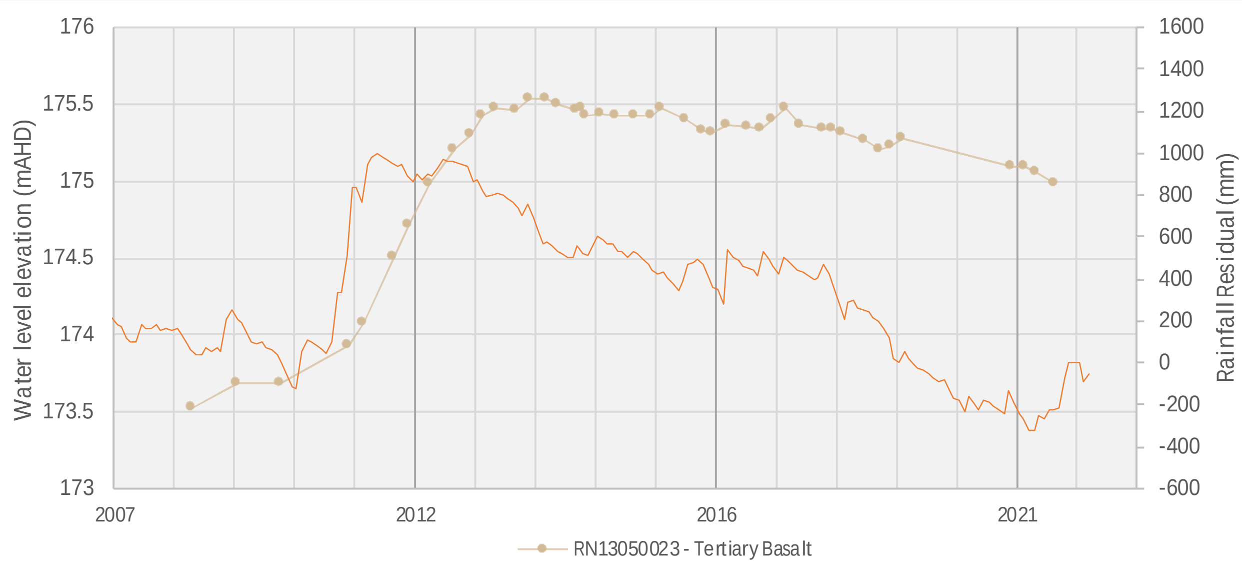

Water level elevation (mAHD)
229
228
227
226
225
224
223
222
221
220
219
Rainfall Residual (mm)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2002
2007
2012
2016
2022
RN158573 - Tertiary Basalt

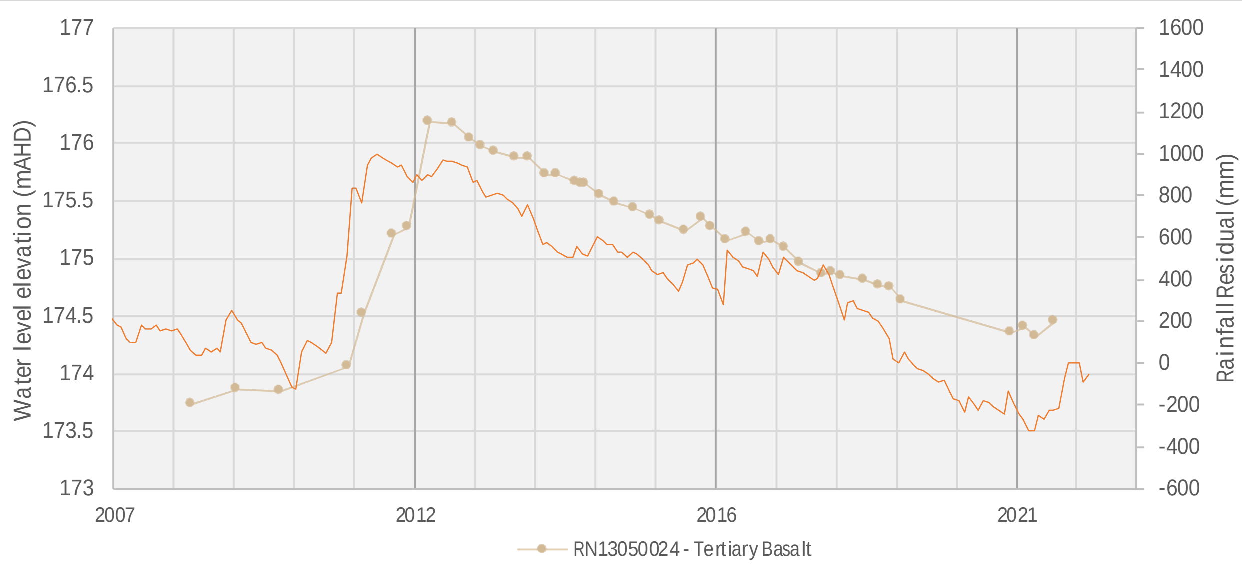

230
228
226
224
222
220
218
216
214
Water level elevation (mAHD)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
2002
2007
2012
2016
2022
RN158574 - Tertiary Basalt

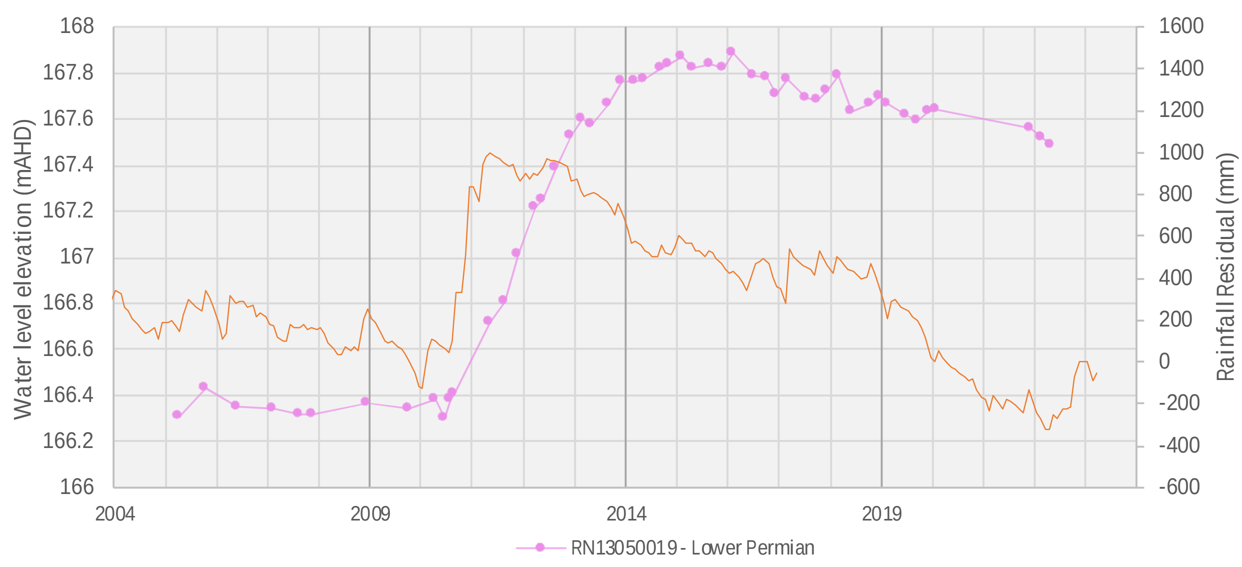

194
193
192
191
190
189
188
187
186
185
184
Water level elevation (mAHD)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
2004
2009
2014
2019
RN13020199 - Tertiary Basalt

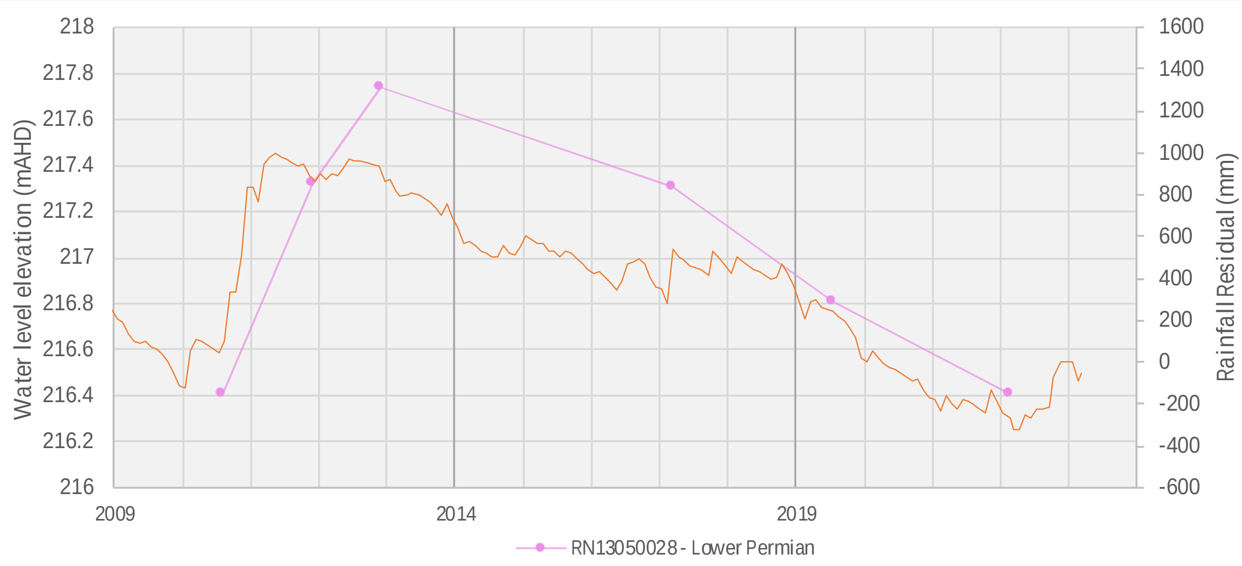

207
206
205
204
203
202
201
200
199
Water level elevation (mAHD)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
2006
2011
2016
2020
RN13050021 - Tertiary Basalt

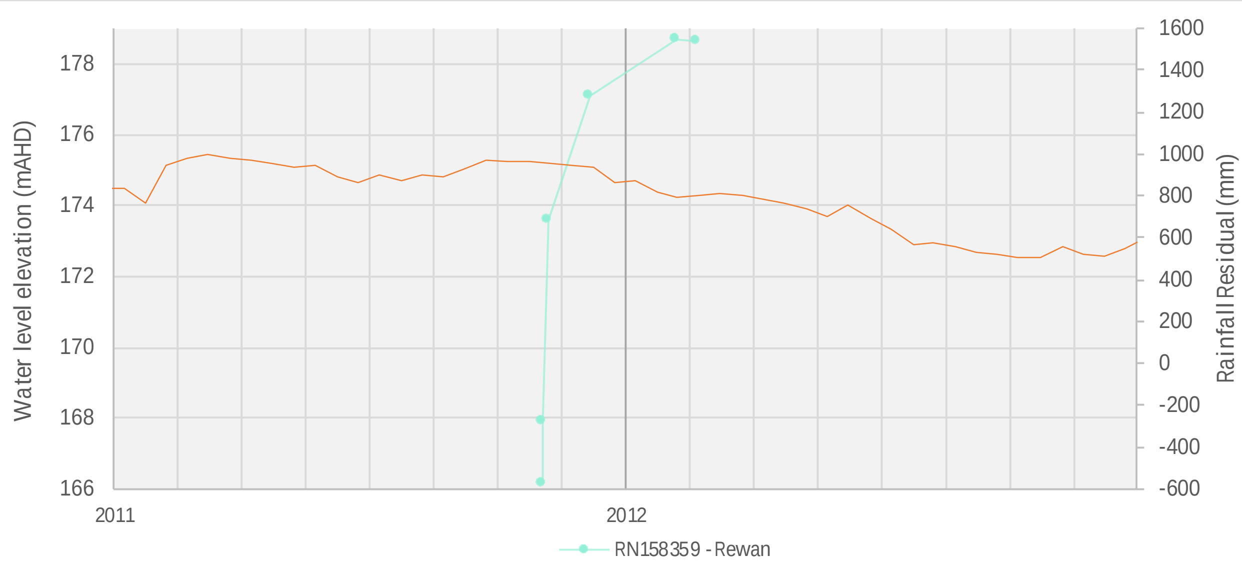

Water level elevation (mAHD)
Rainfall Residual (mm)
186
185
184
183
182
181
180
179
178
177
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2003
2008
2012
2017
2023
RN13050022 - Tertiary Basalt

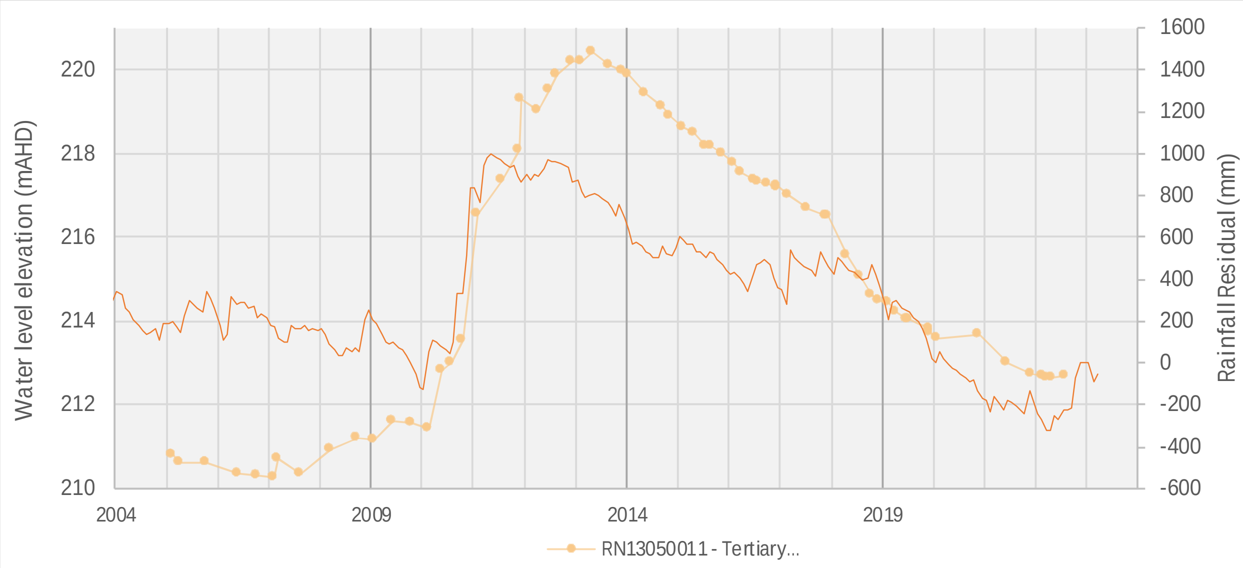

Water level elevation (mAHD)
Rainfall Residual (mm)
176
175.5
175
174.5
174
173.5
173
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2007
2012
2016
2021
RN13050023 - Tertiary Basalt

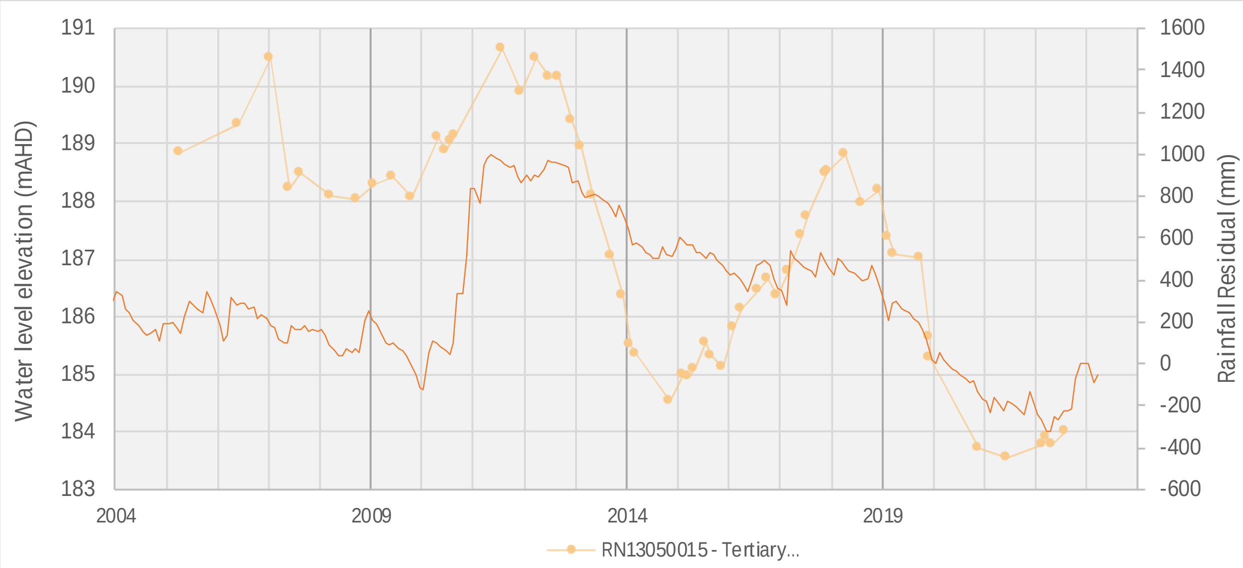

Water level elevation (mAHD)
Rainfall Residual (mm)
177
176.5
176
175.5
175
174.5
174
173.5
173
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2007
2012
2016
2021
RN13050024 - Tertiary Basalt

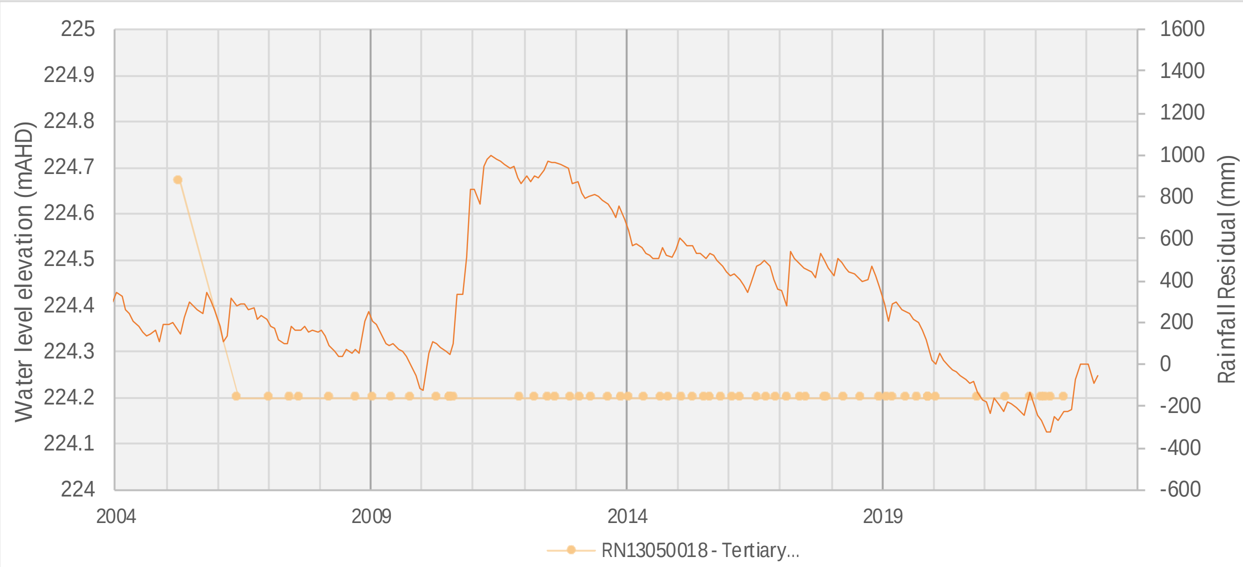

Water level elevation (mAHD)
168
167.8
167.6
167.4
167.2
167
166.8
166.6
166.4
166.2
166
Rainfall Residual (mm)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2004
2009
2014
2019
RN13050019 - Lower Permian

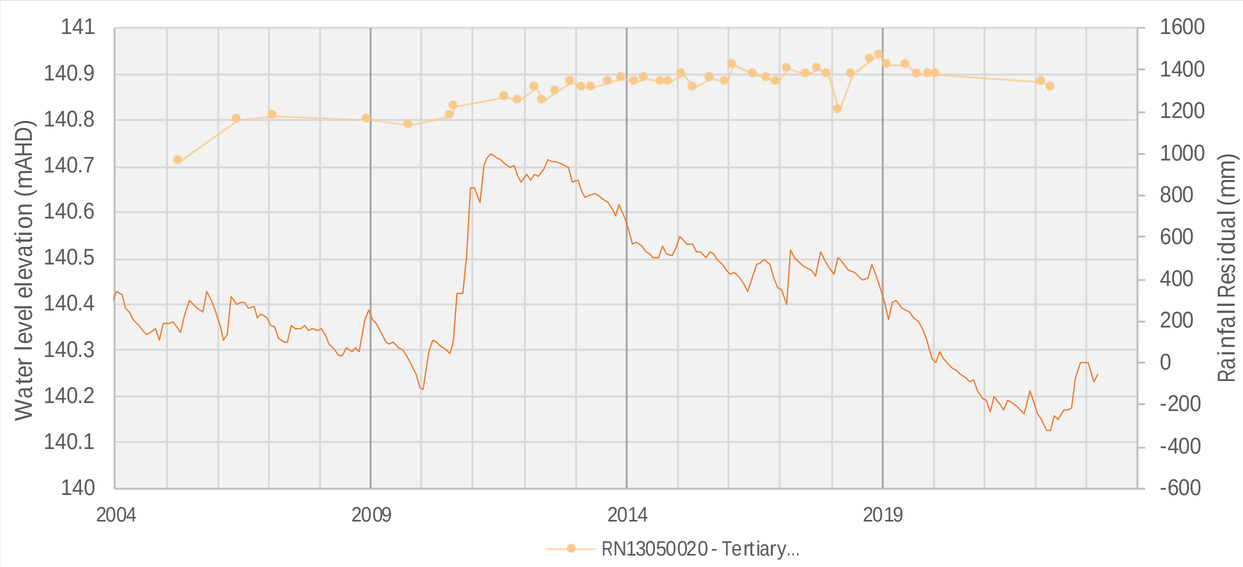

Water level elevation (mAHD)
218
217.8
217.6
217.4
217.2
217
216.8
216.6
216.4
216.2
216
Rainfall Residual (mm)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2009
2014
2019
RN13050028 - Lower Permian

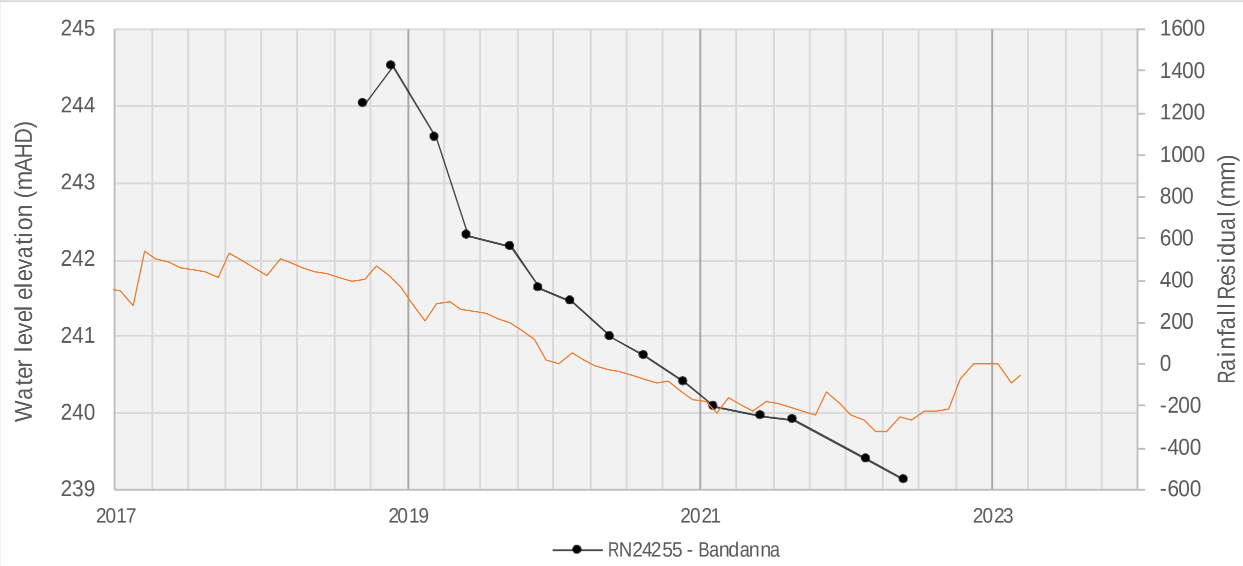

Water level elevation (mAHD)
178
176
174
172
170
168
166
Rainfall Residual (mm)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2011
2012
RN158359 - Rewan

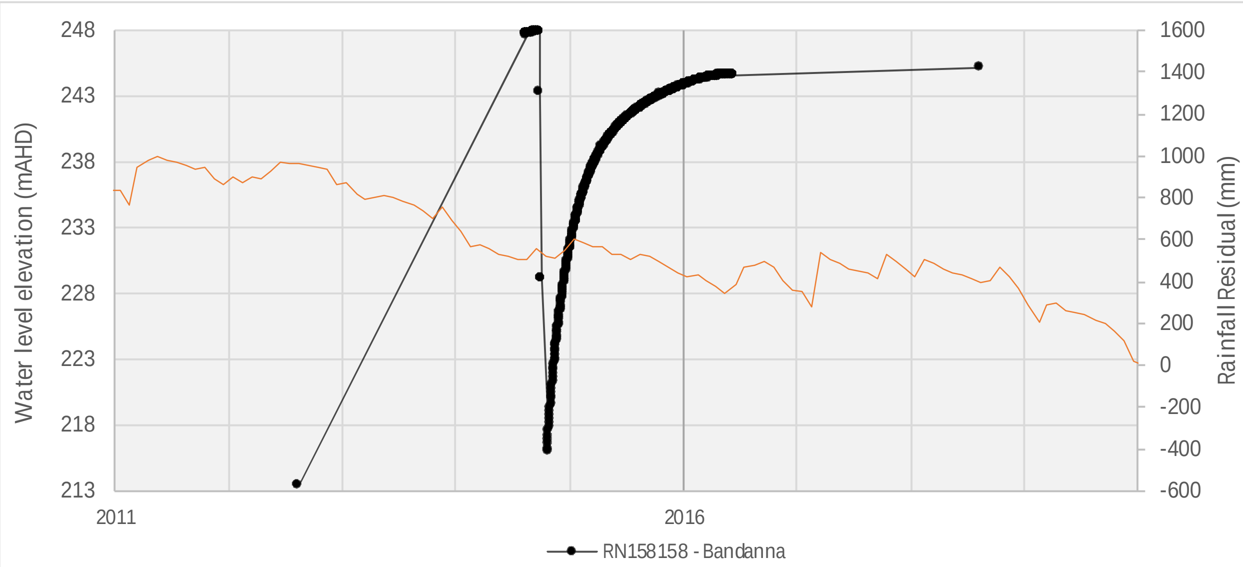

Water level elevation (mAHD)
Rainfall Residual (mm)
RN13050011 - Tertiary...

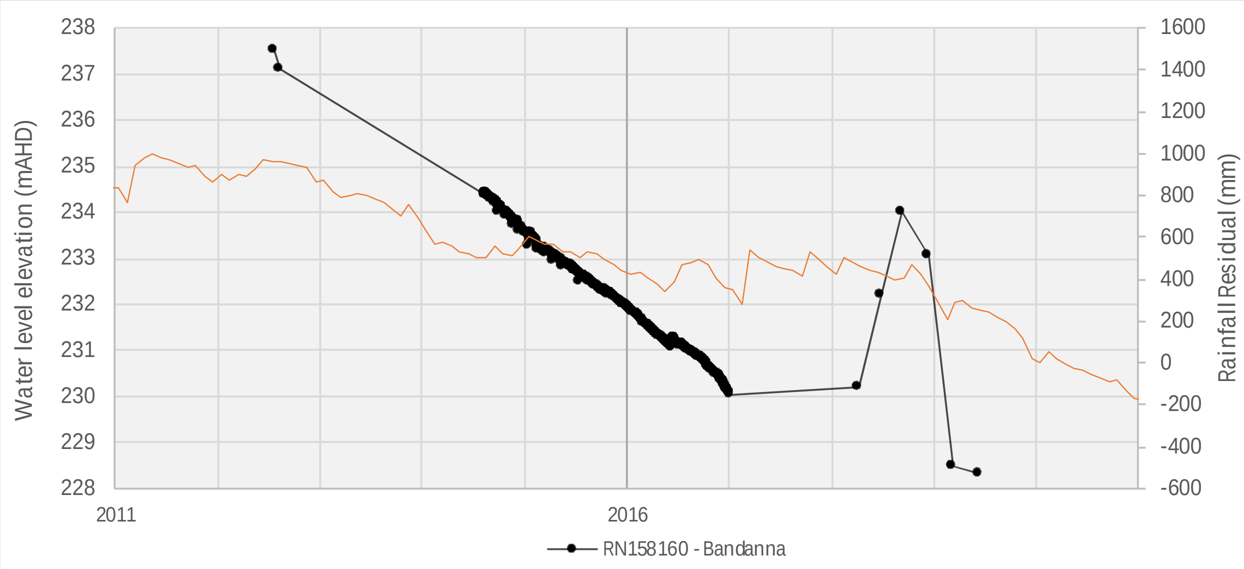

Water level elevation (mAHD)
Rainfall Residual (mm)
RN13050015 - Tertiary...

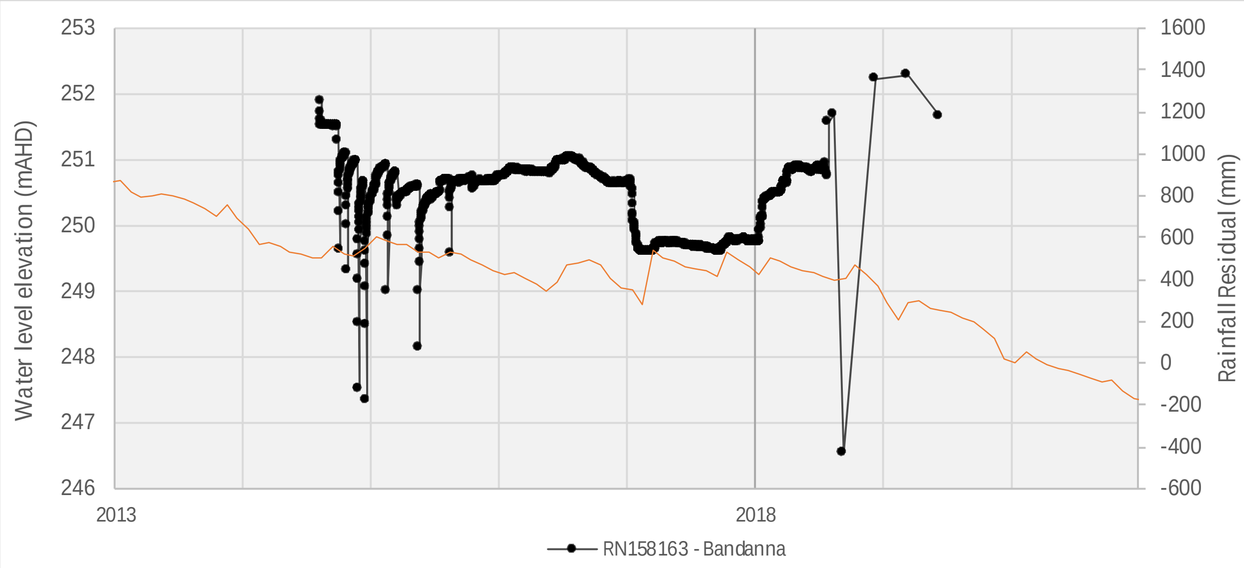

Water level elevation (mAHD)
Rainfall Residual (mm)
RN13050018 - Tertiary...

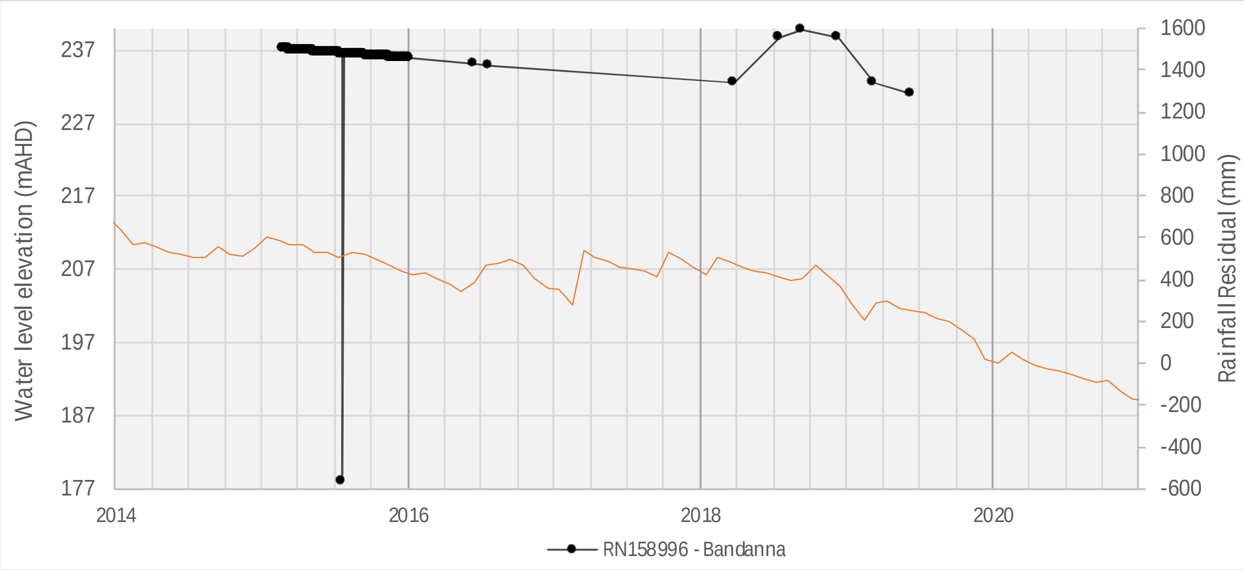

141
140.9
140.8
140.7
140.6
140.5
140.4
140.3
140.2
140.1
140
Water level elevation (mAHD)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
2004
2009
2014
2019
RN13050020 - Tertiary...

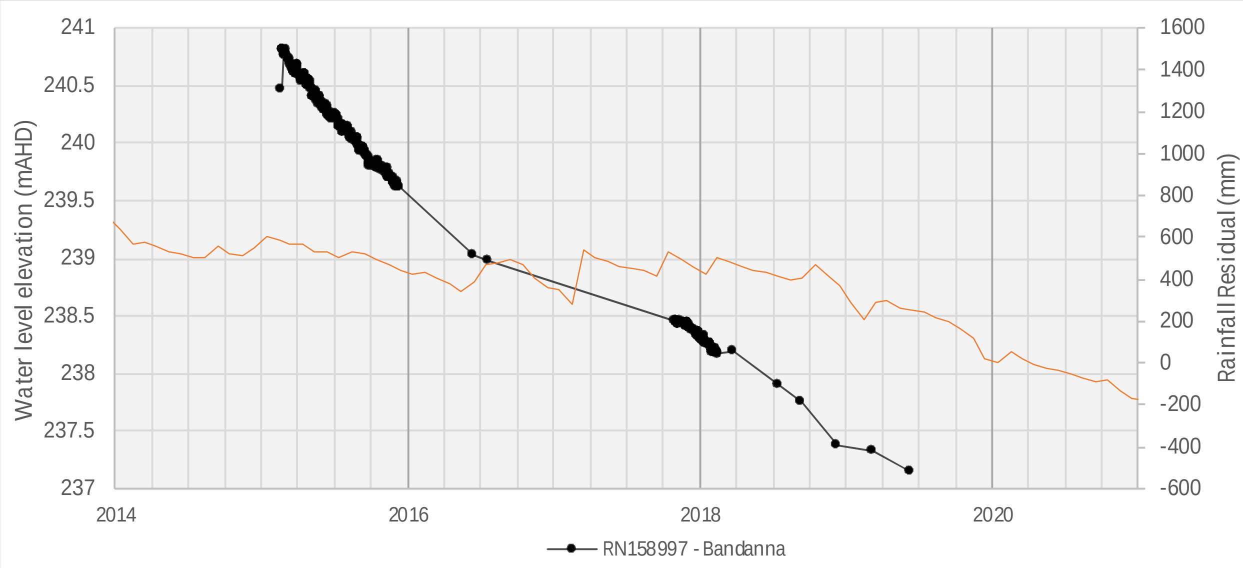

245
244
243
242
241
240
239
Water level elevation (mAHD)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
2017
2019
2021
2023
RN24255 - Bandanna

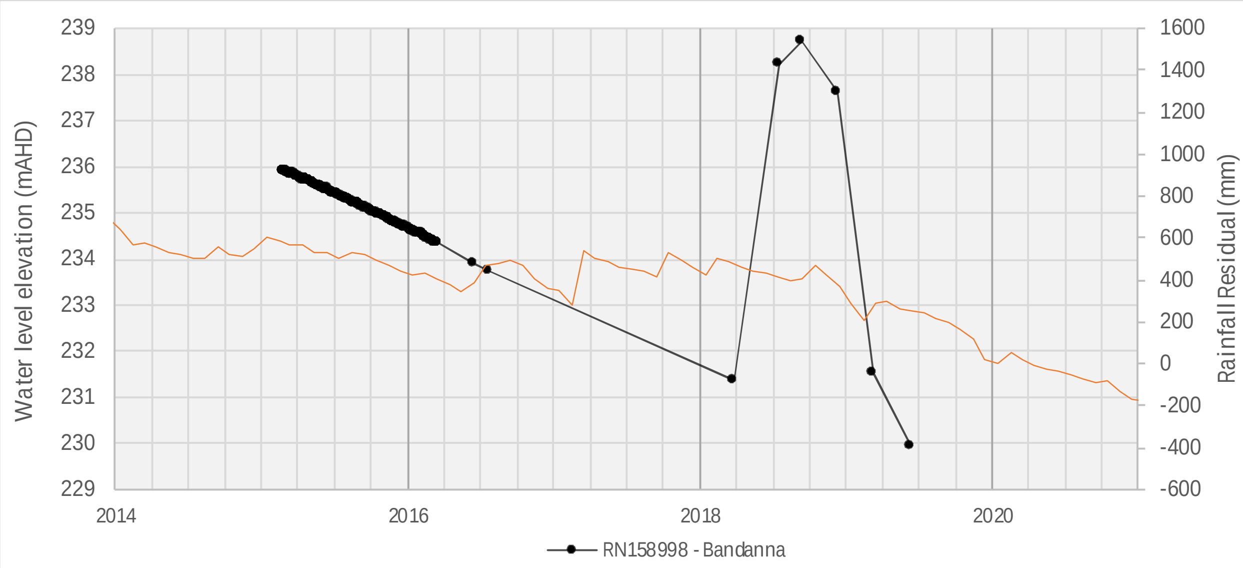

248
243
238
233
228
223
218
213
Water level elevation (mAHD)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
2011
2016
RN158158 - Bandanna

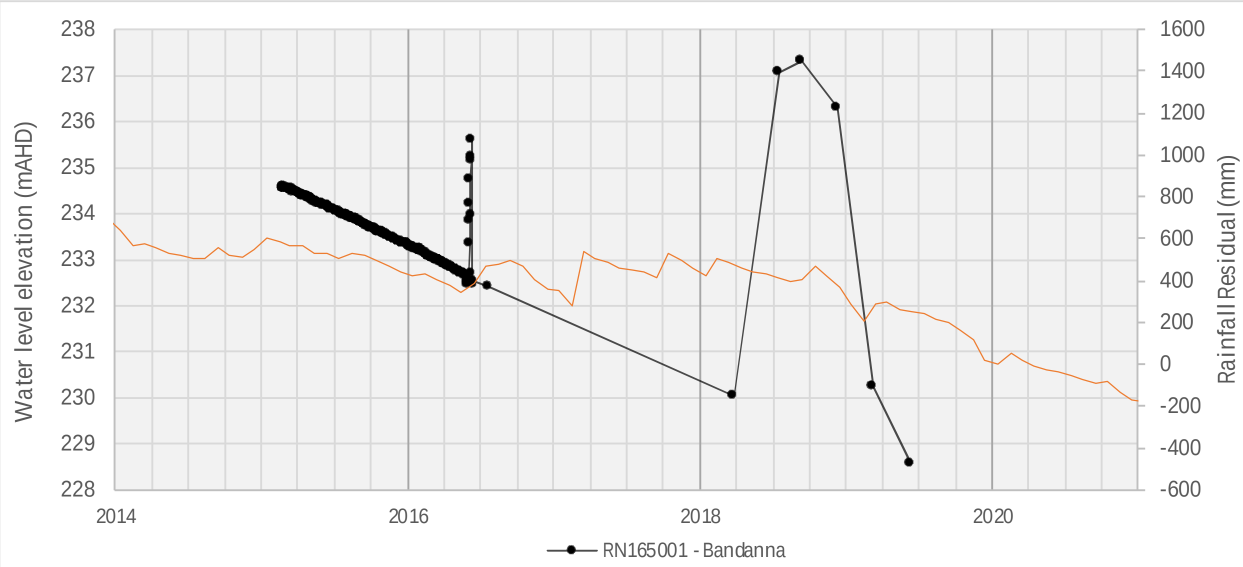

Water level elevation (mAHD)
238
237
236
235
234
233
232
231
230
229
228
2011
2016
Rainfall Residual (mm)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
RN158160 - Bandanna

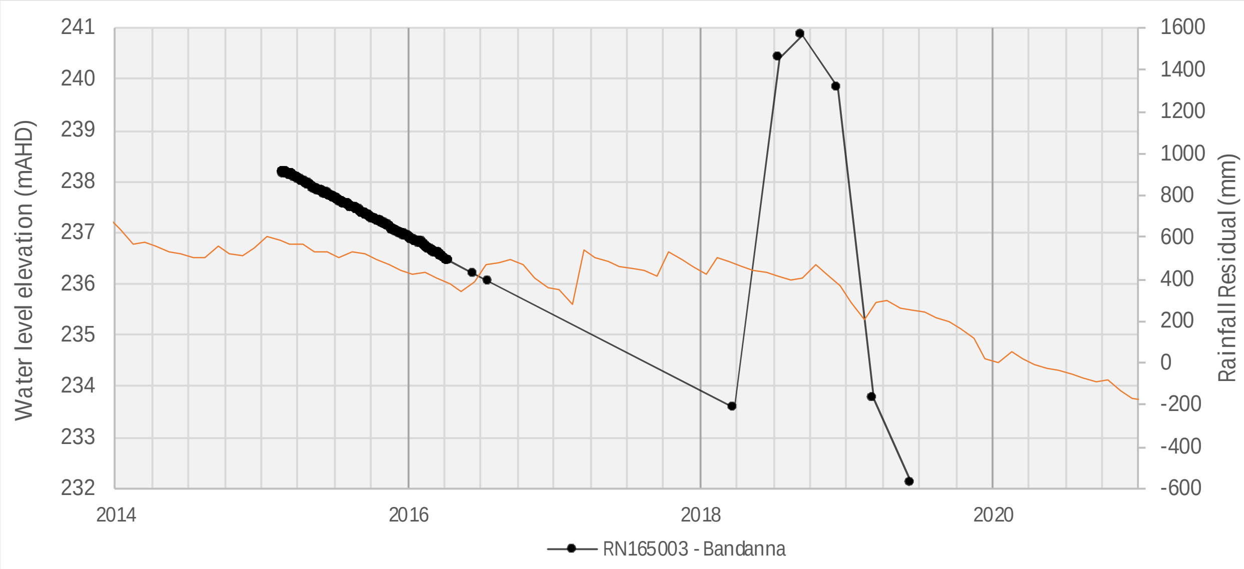

Water level elevation (mAHD)
253
252
251
250
249
248
247
246
2013
2018
Rainfall Residual (mm)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
RN158163 - Bandanna

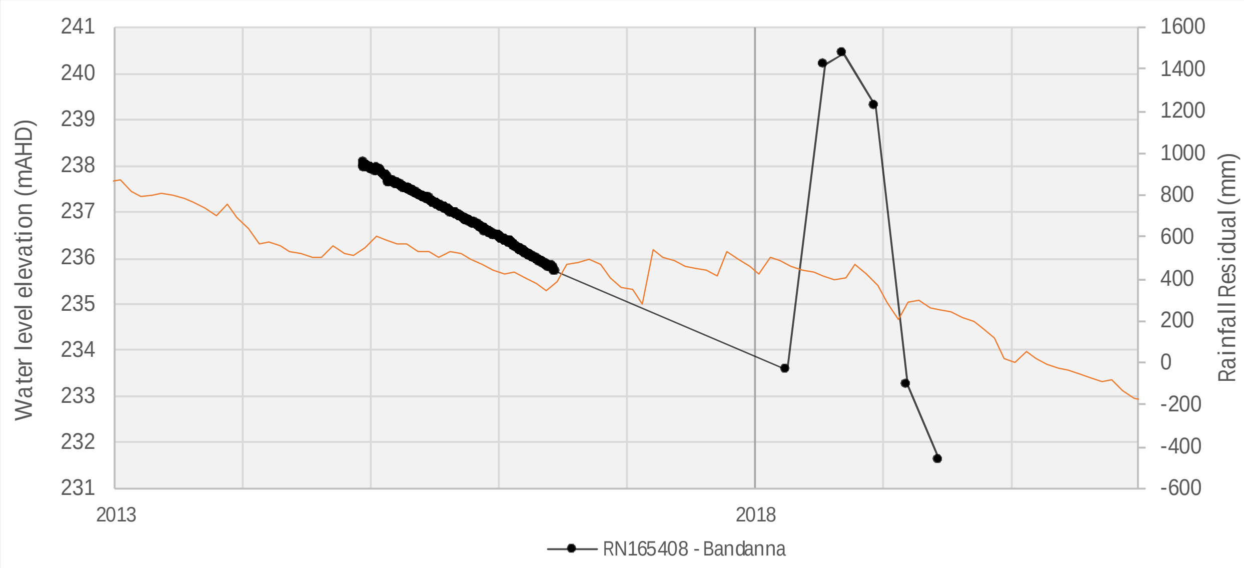

Water level elevation (mAHD)
237
227
217
207
197
187
177
2014
2016
2018
2020
Rainfall Residual (mm)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
RN158996 - Bandanna

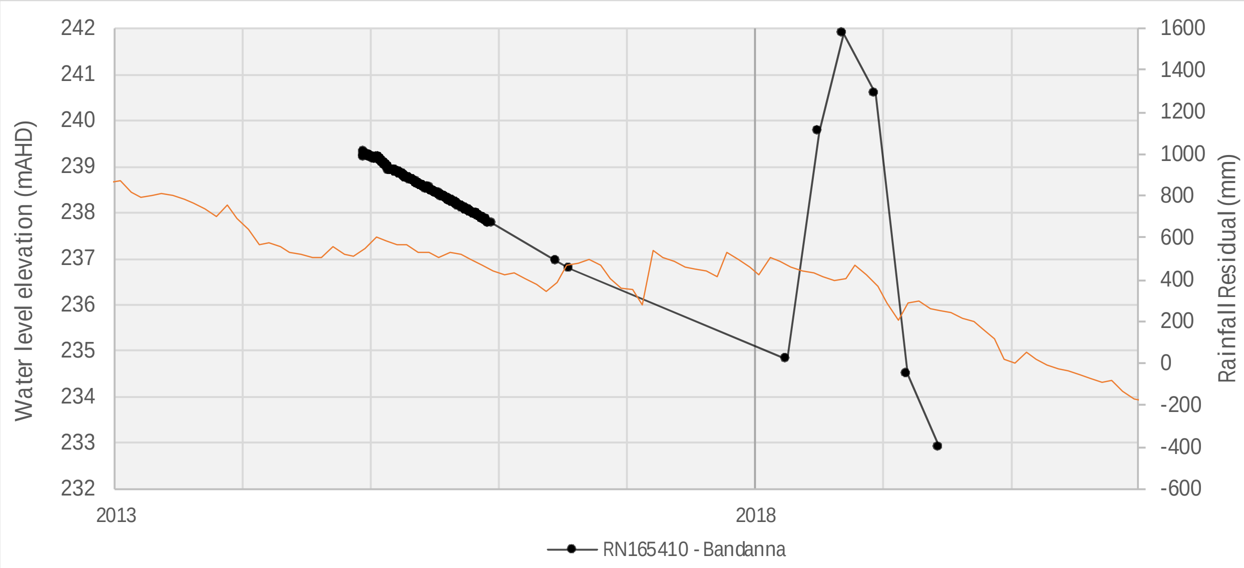

Water level elevation (mAHD)
241
240.5
240
239.5
239
238.5
238
237.5
237
Rainfall Residual (mm)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2014
2016
2018
2020
RN158997 - Bandanna

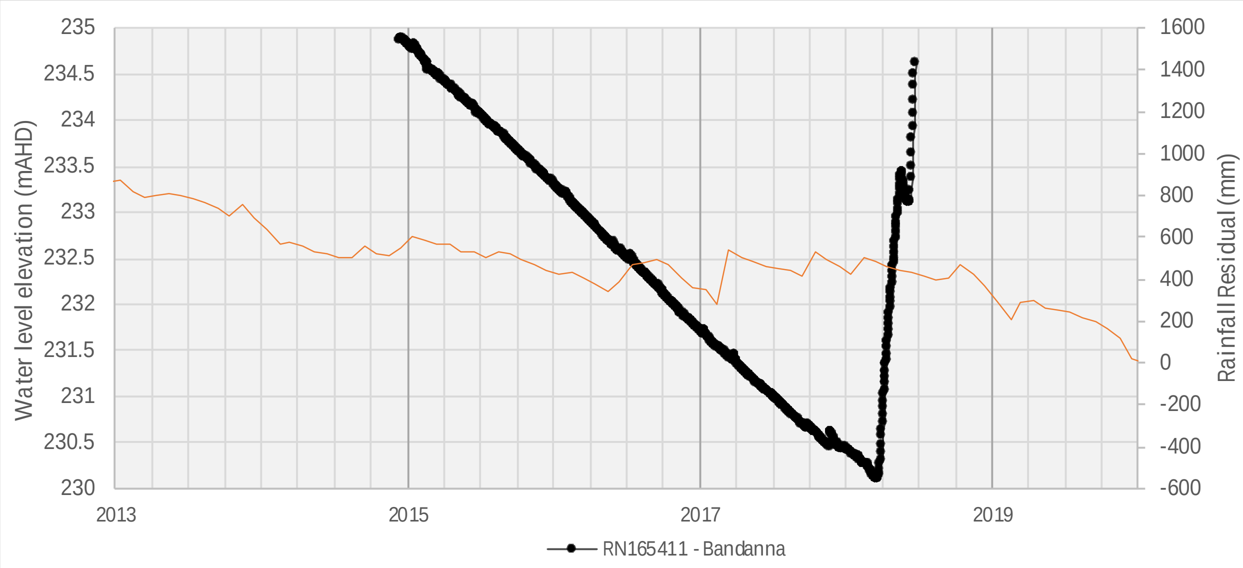

Water level elevation (mAHD)
239
238
237
236
235
234
233
232
231
230
229
Rainfall Residual (mm)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2014
2016
2018
2020
RN158998 - Bandanna

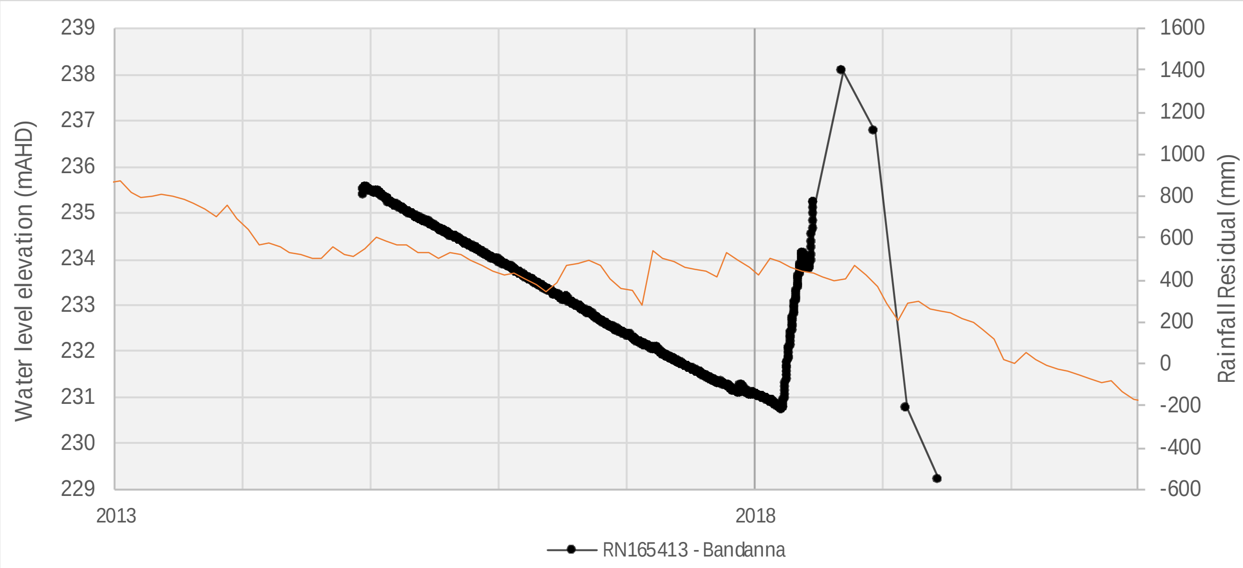

Water level elevation (mAHD)
238
237
236
235
234
233
232
231
230
229
228
Rainfall Residual (mm)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2014
2016
2018
2020
RN165001 - Bandanna

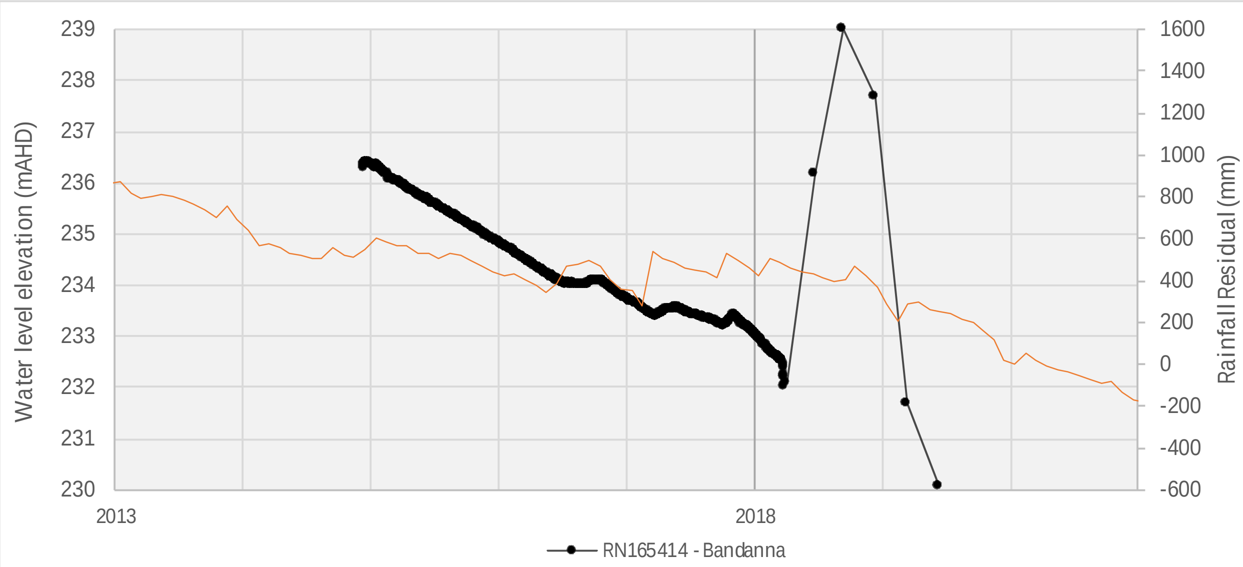

Water level elevation (mAHD)
Rainfall Residual (mm)
241
240
239
238
237
236
235
234
233
232
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2014
2016
2018
2020
RN165003 - Bandanna

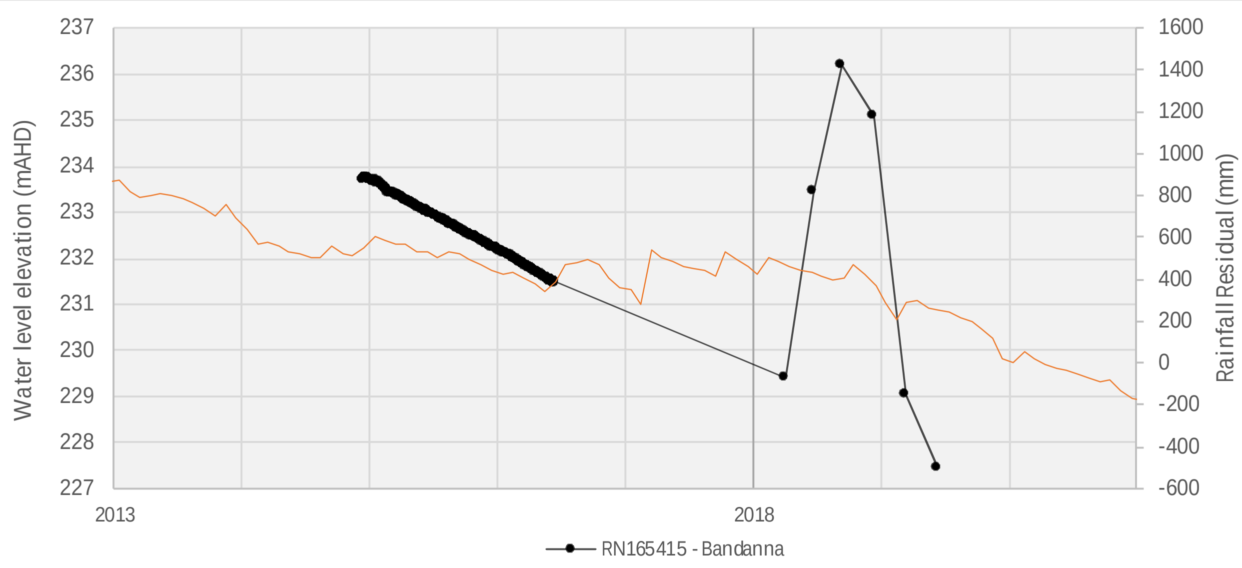

Water level elevation (mAHD)
Rainfall Residual (mm)
241
240
239
238
237
236
235
234
233
232
231
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2013
2018
RN165408 - Bandanna

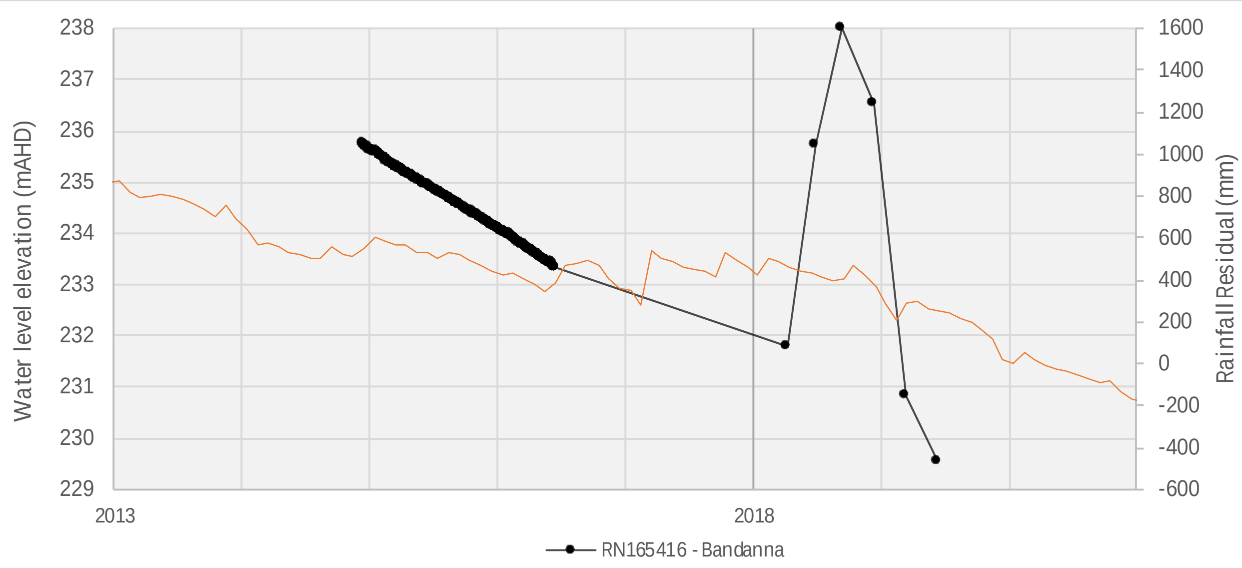

Water level elevation (mAHD)
Rainfall Residual (mm)
242
241
240
239
238
237
236
235
234
233
232
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2013
2018
RN165410 - Bandanna

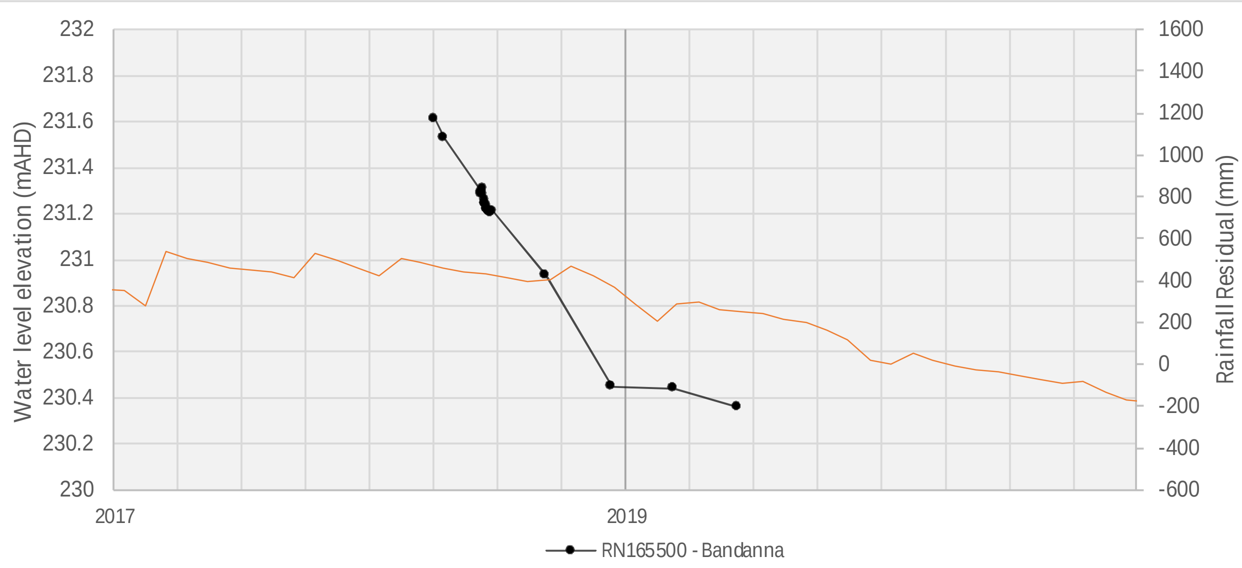

235
234.5
234
233.5
233
232.5
232
231.5
231
230.5
230
Water level elevation (mAHD)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
2013
2015
2017
2019
RN165411 - Bandanna

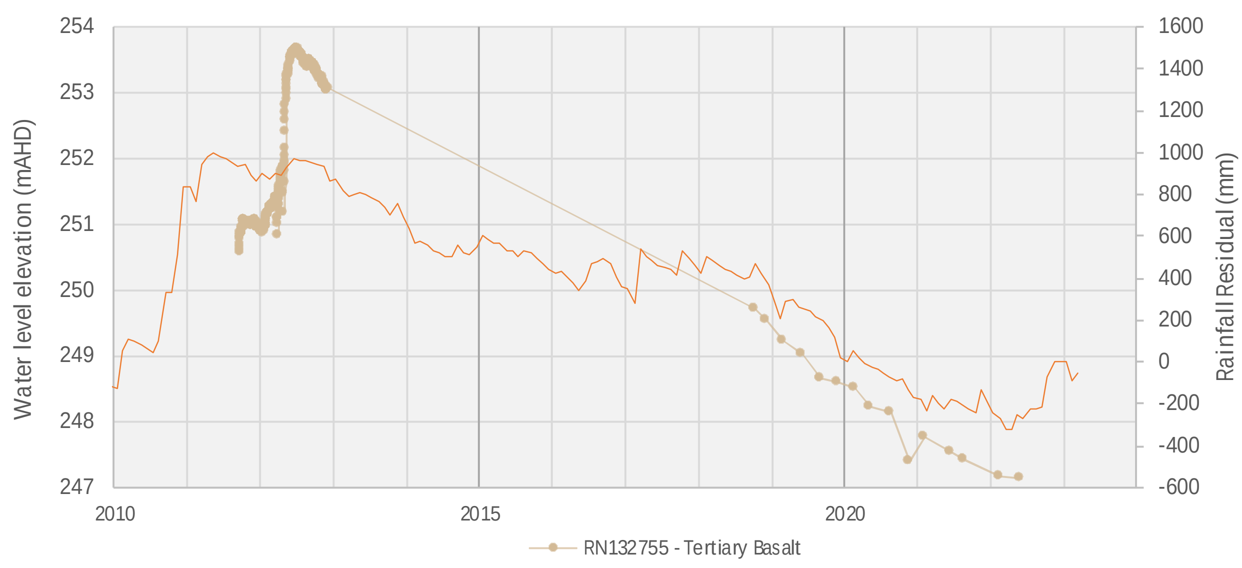

239
238
237
236
235
234
233
232
231
230
229
Water level elevation (mAHD)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
2013
2018
RN165413 - Bandanna

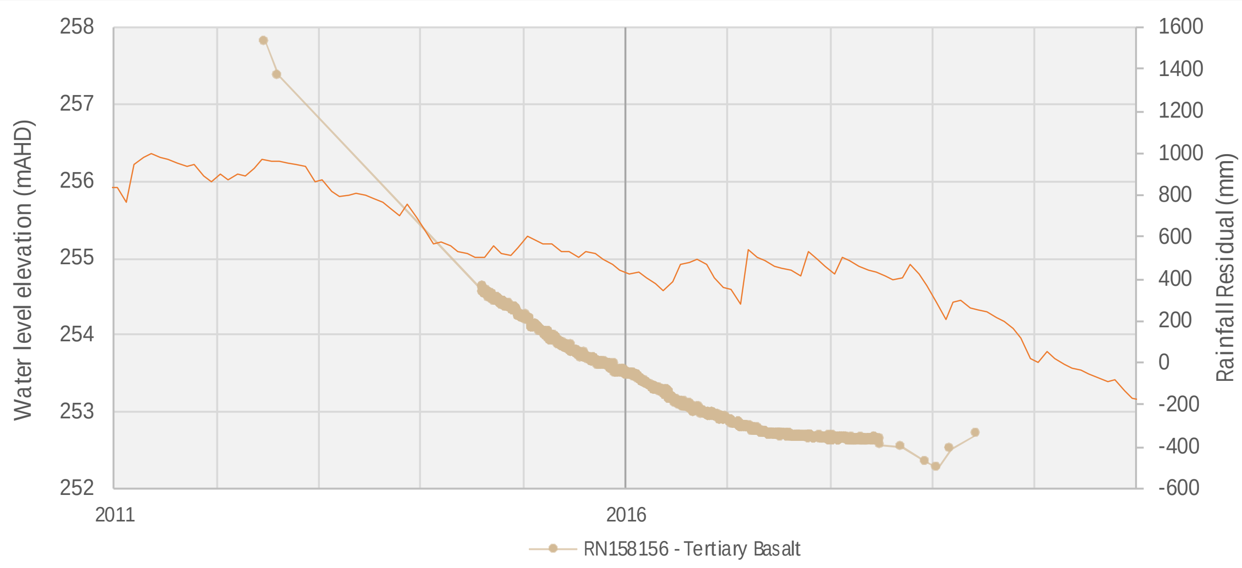

239
238
237
236
235
234
233
232
231
230
Water level elevation (mAHD)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
2013
2018
RN165414 - Bandanna

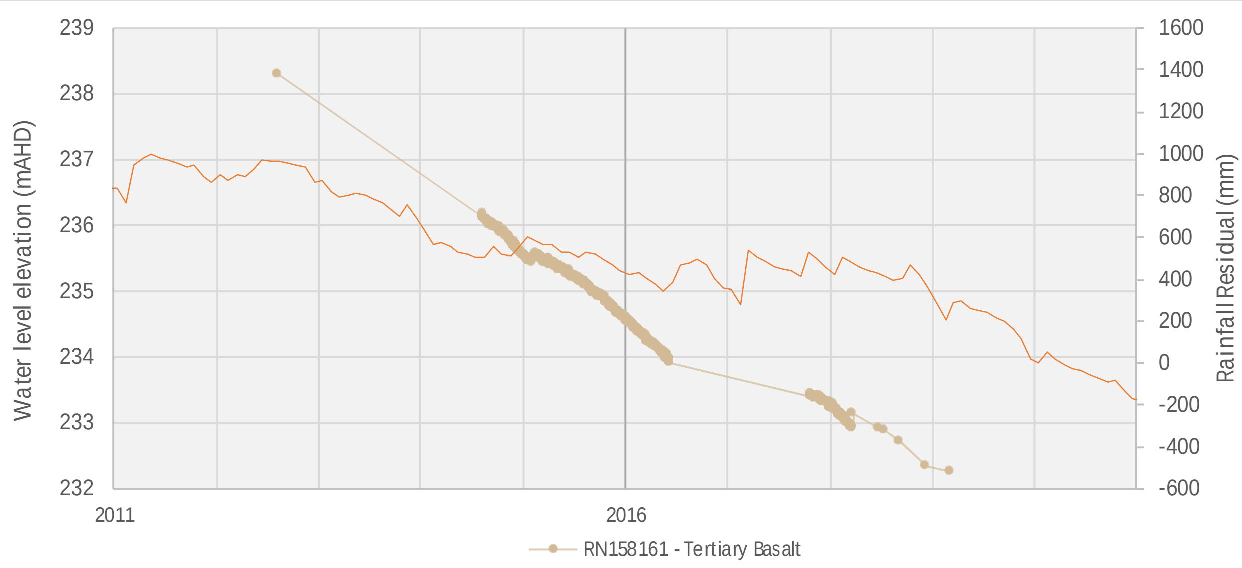

Water level elevation (mAHD)
237
236
235
234
233
232
231
230
229
228
227
2013
2018
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
RN165415 - Bandanna

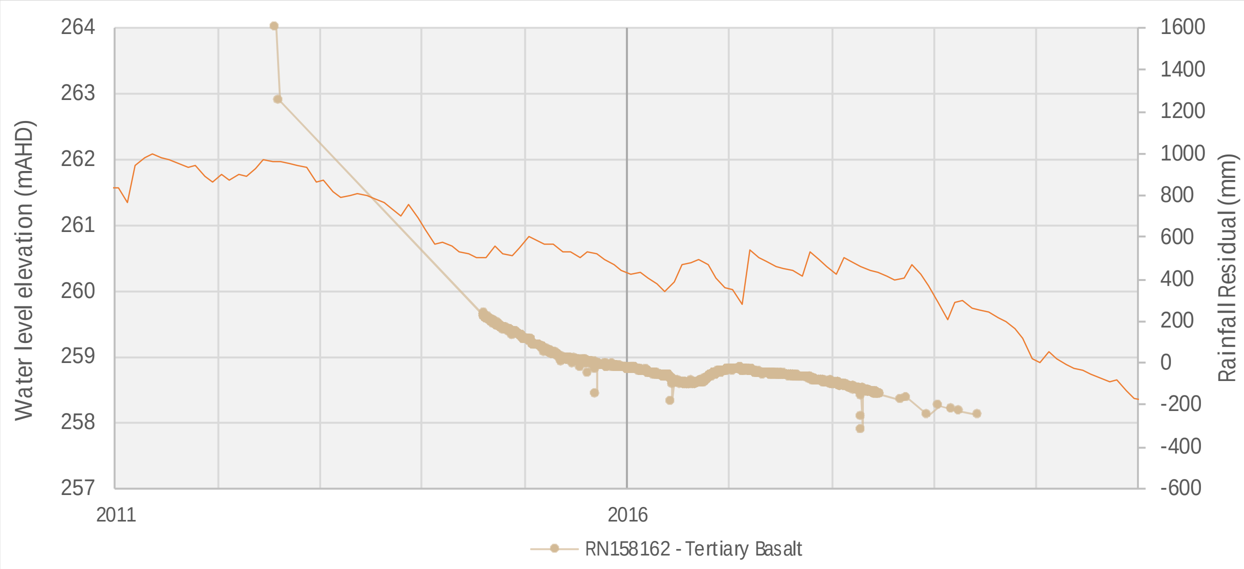

Water level elevation (mAHD)
238
237
236
235
234
233
232
231
230
229
2013
2018
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
RN165416 - Bandanna

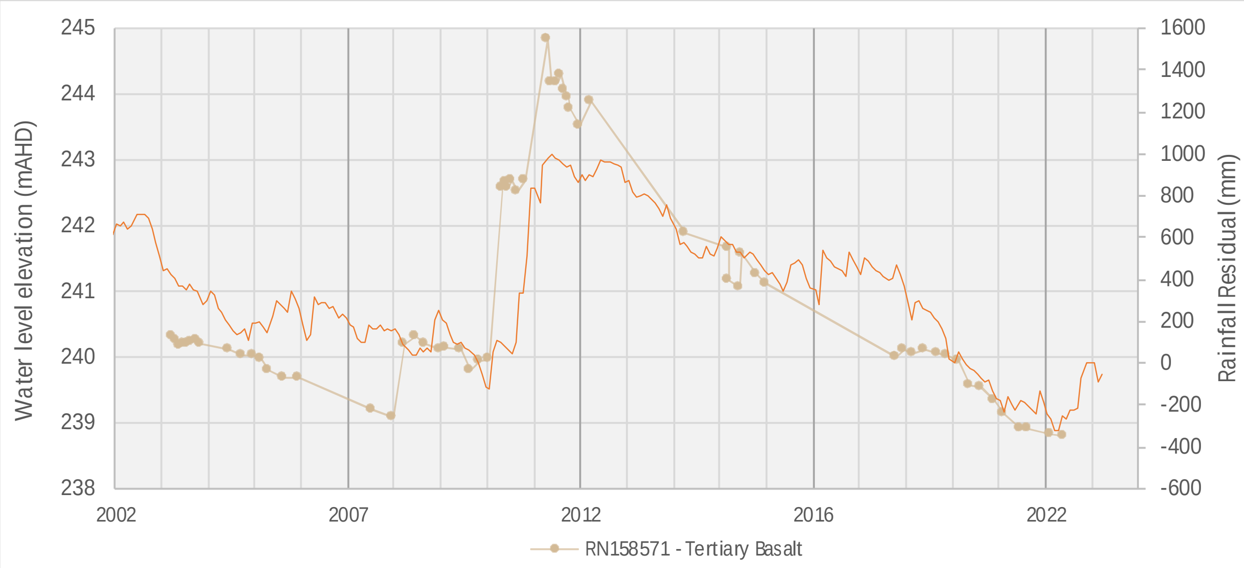

Water level elevation (mAHD)
232
231.8
231.6
231.4
231.2
231
230.8
230.6
230.4
230.2
230
2017
2019
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
RN165500 - Bandanna


254
253
252
251
250
249
248
247
Water level elevation (mAHD)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
2010
2015
2020
RN132755 - Tertiary Basalt


258
257
256
255
254
253
252
Water level elevation (mAHD)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
2011
2016
RN158156 - Tertiary Basalt


239
238
237
236
235
234
233
232
Water level elevation (mAHD)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
2011
2016
RN158161 - Tertiary Basalt


264
263
262
261
260
259
258
257
Water level elevation (mAHD)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
2011
2016
RN158162 - Tertiary Basalt


245
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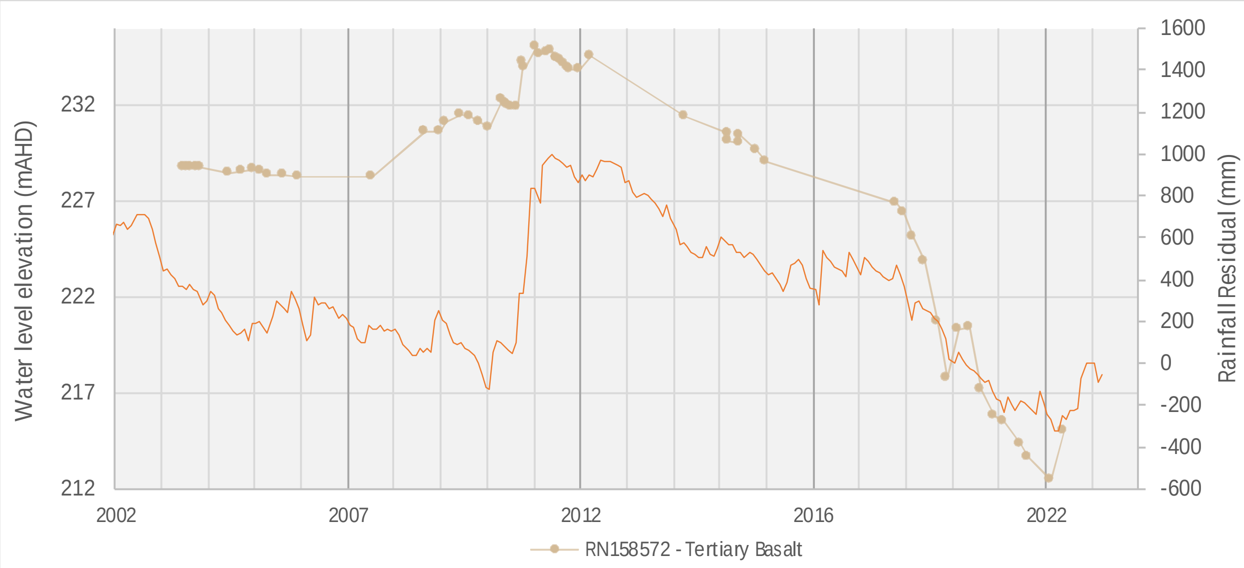
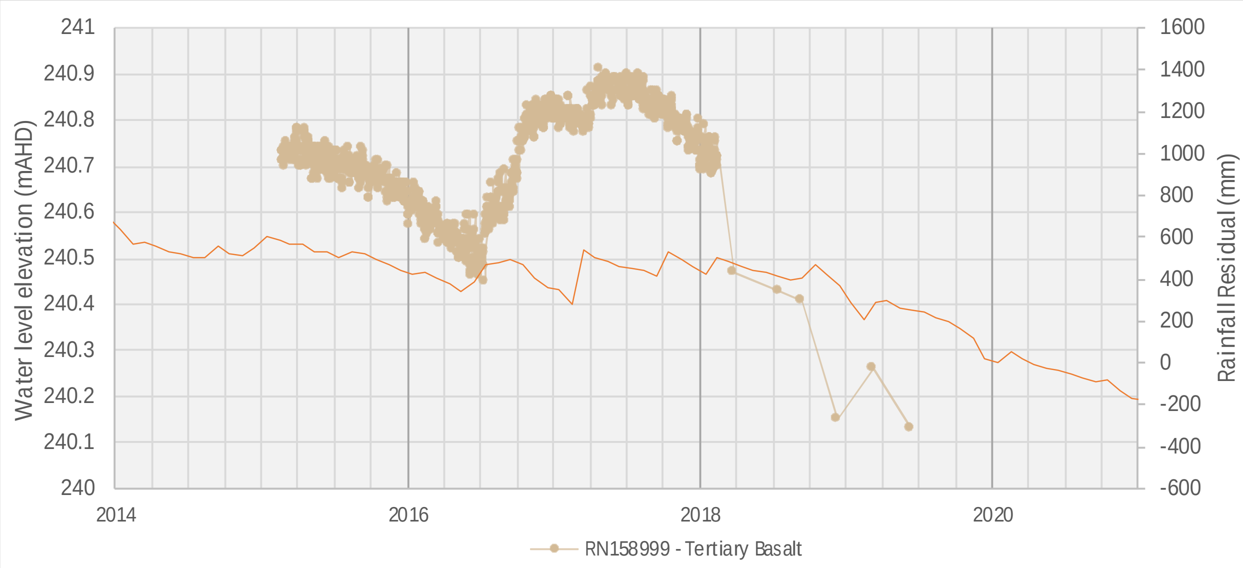
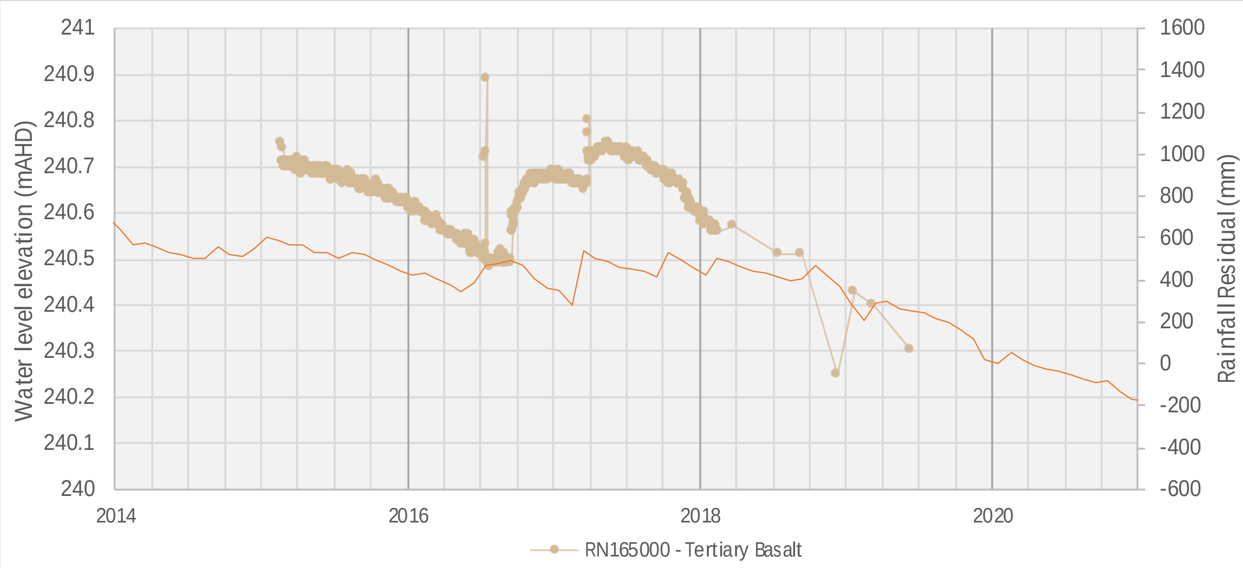
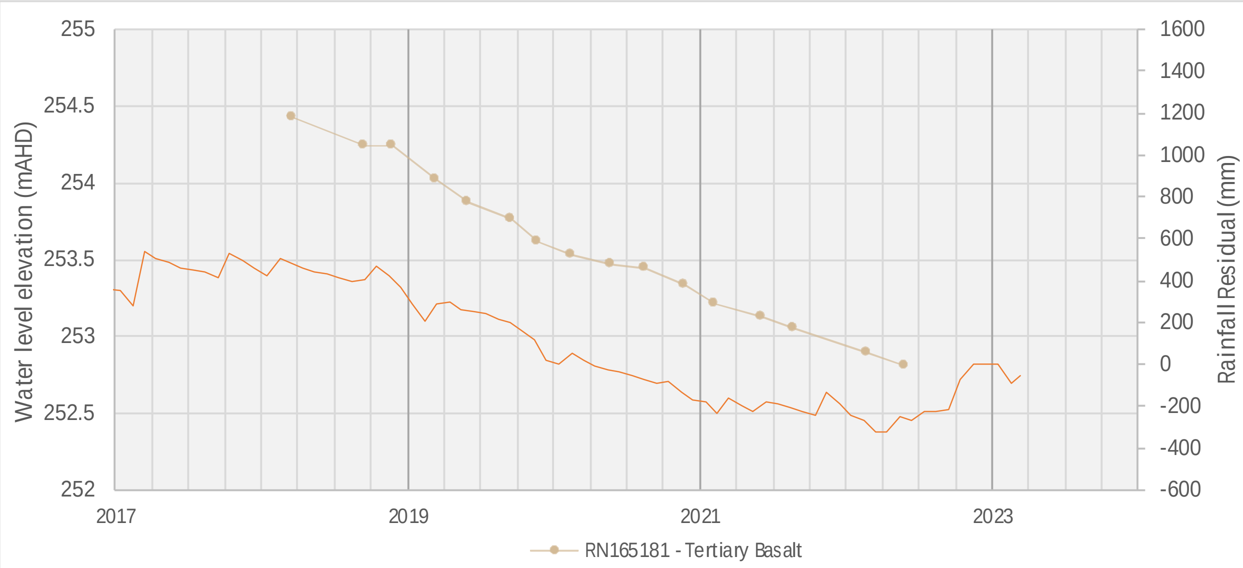
243
242
241
240
239
238
Water level elevation (mAHD)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
2002
2007
2012
2016
2022
RN158571 - Tertiary Basalt


232
227
222
217
212
Water level elevation (mAHD)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
2002
2007
2012
2016
2022
RN158572 - Tertiary Basalt


Water level elevation (mAHD)
241
240.9
240.8
240.7
240.6
240.5
240.4
240.3
240.2
240.1
240
Rainfall Residual (mm)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2014
2016
2018
2020
RN158999 - Tertiary Basalt


Water level elevation (mAHD)
241
240.9
240.8
240.7
240.6
240.5
240.4
240.3
240.2
240.1
240
Rainfall Residual (mm)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2014
2016
2018
2020
RN165000 - Tertiary Basalt


Water level elevation (mAHD)
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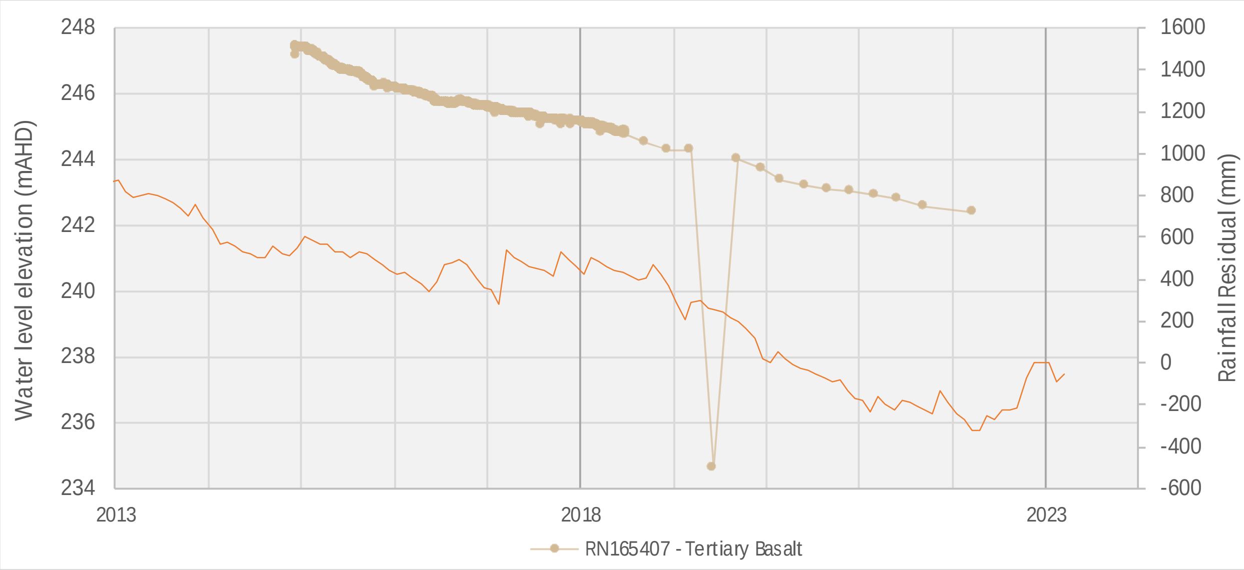
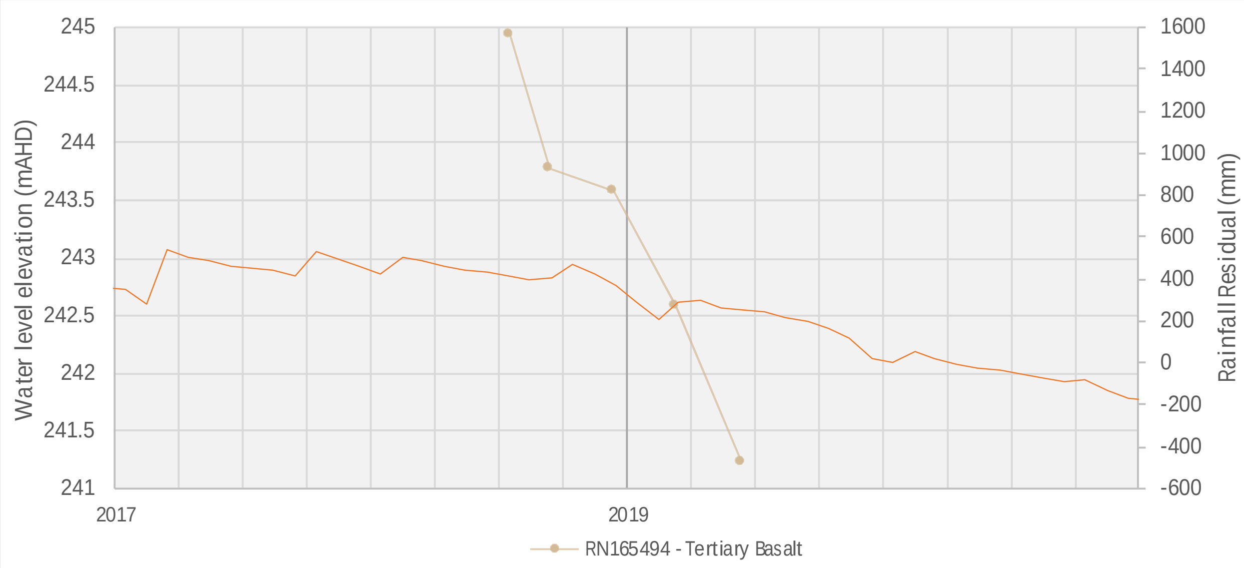
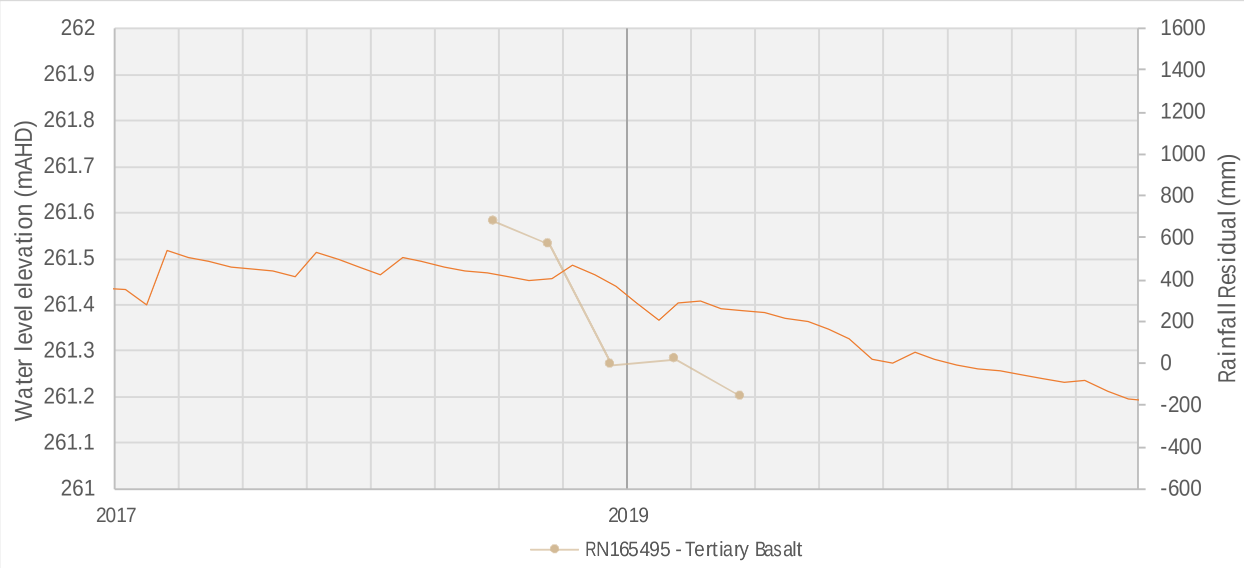
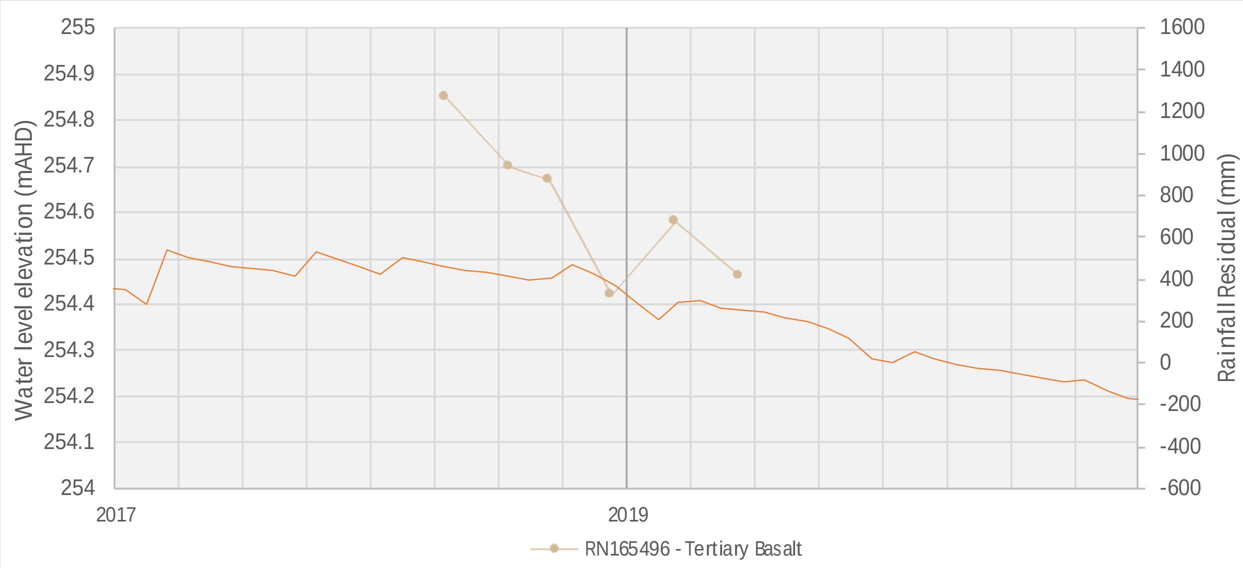
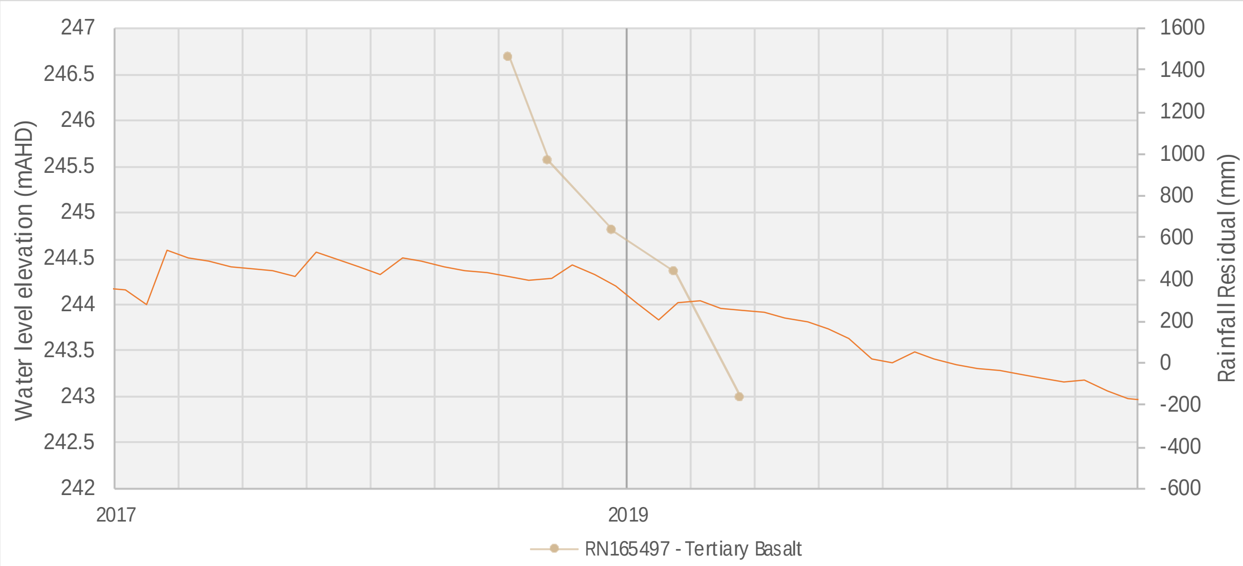
254.5
254
253.5
253
252.5
252
Rainfall Residual (mm)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
2017
2019
2021
2023
RN165181 - Tertiary Basalt

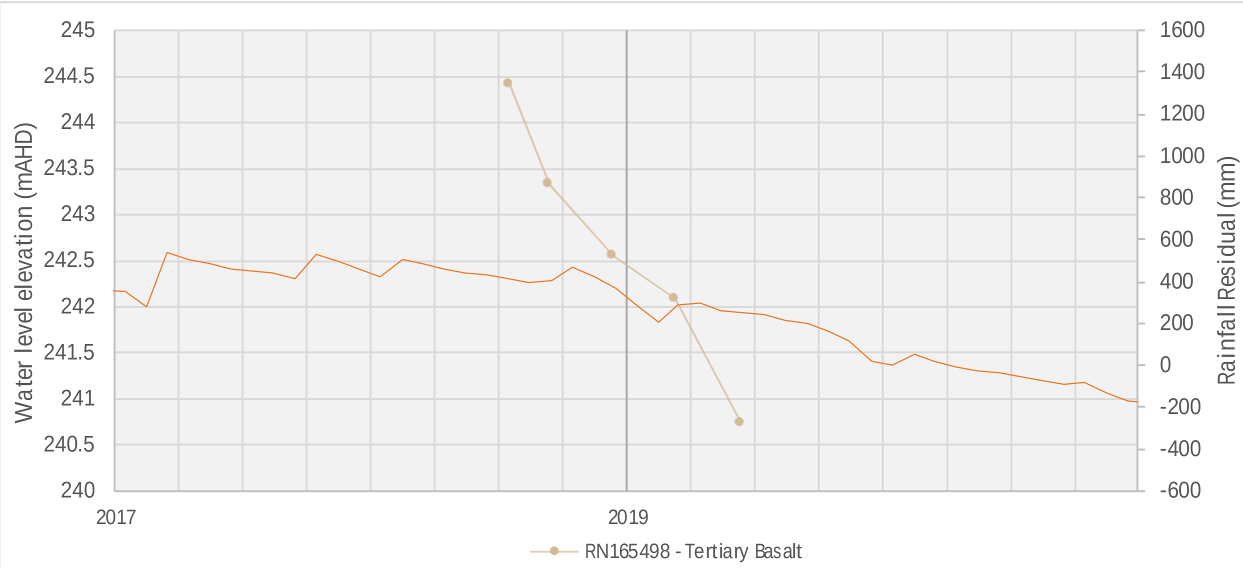

248
246
244
242
240
238
236
234
Water level elevation (mAHD)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
2013
2018
2023
RN165407 - Tertiary Basalt

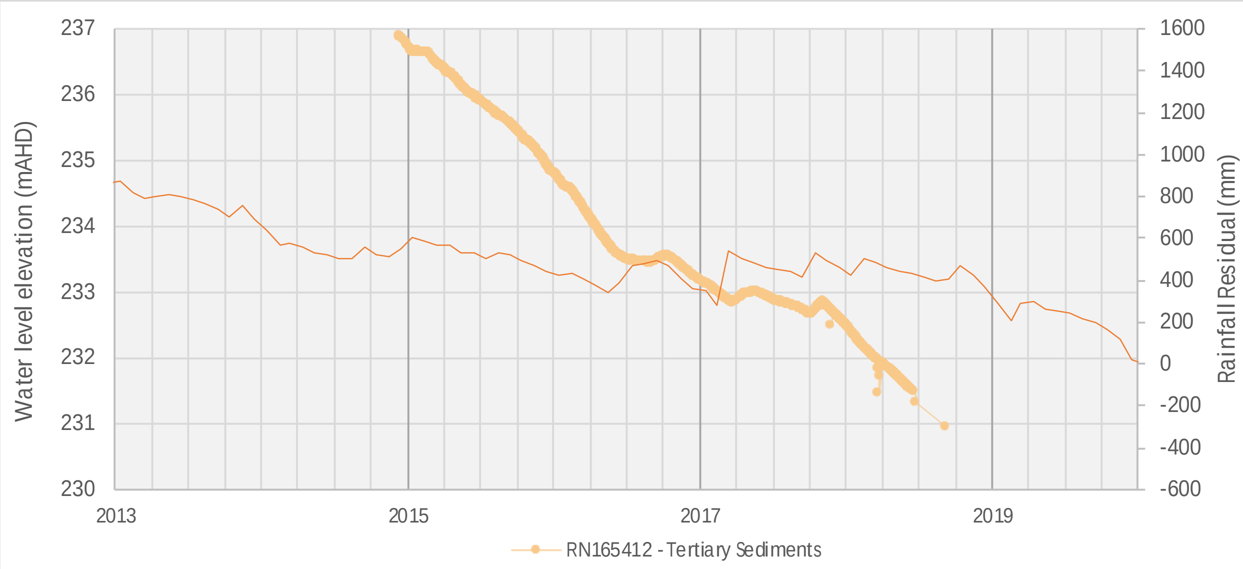

245
244.5
244
243.5
243
242.5
242
241.5
241
Water level elevation (mAHD)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
2017
2019
RN165494 - Tertiary Basalt

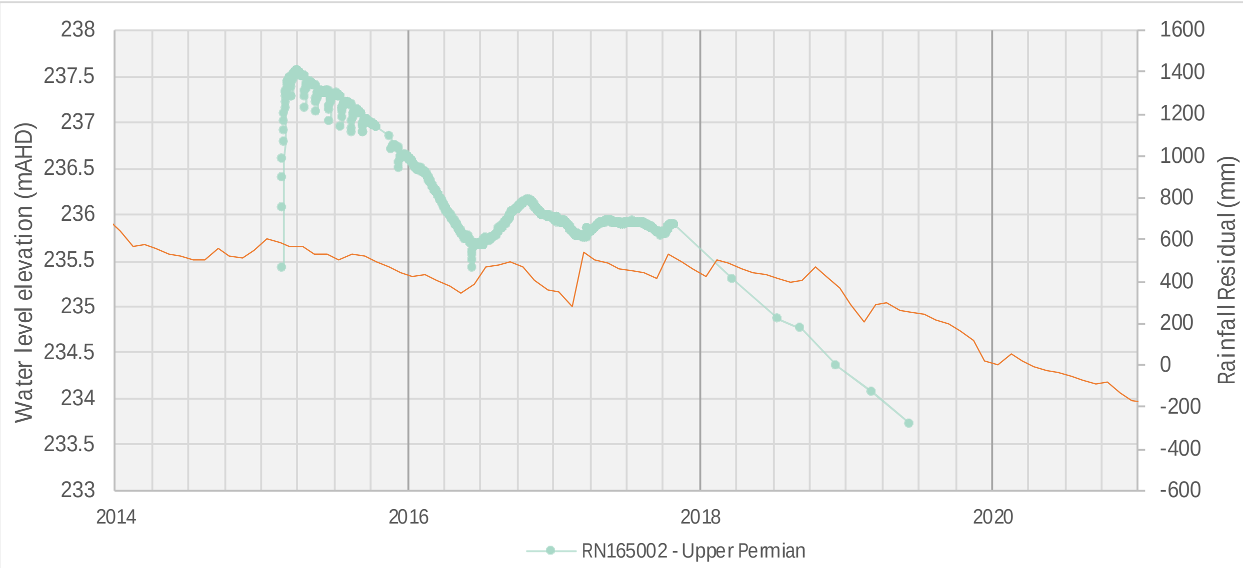

262
261.9
261.8
261.7
261.6
261.5
261.4
261.3
261.2
261.1
261
Water level elevation (mAHD)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
2017
2019
RN165495 - Tertiary Basalt

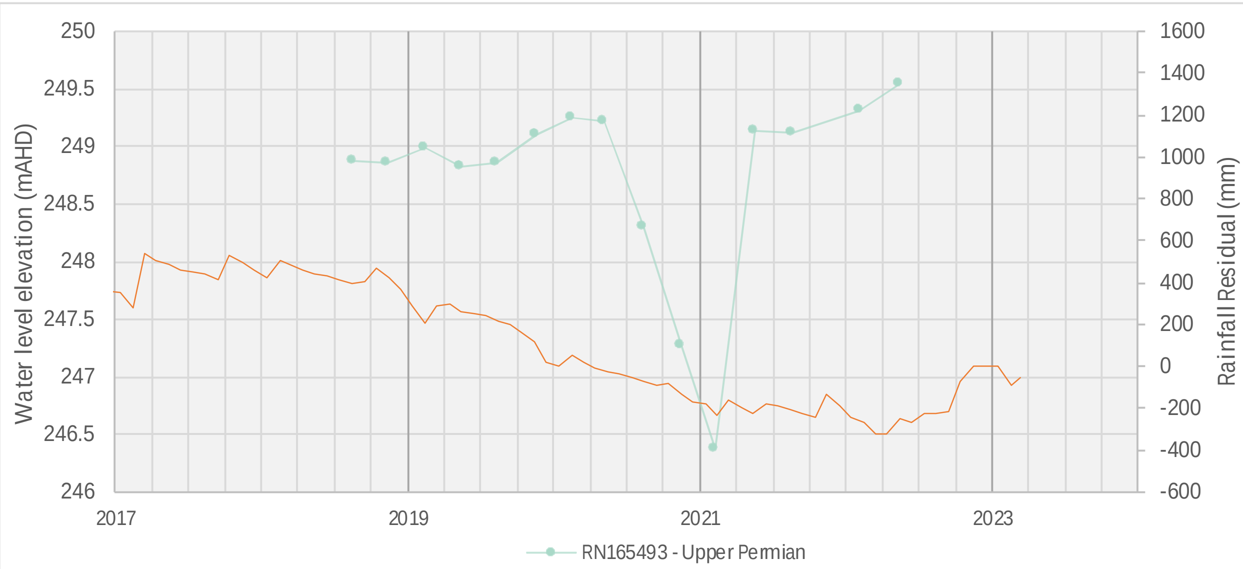

Water level elevation (mAHD)
255
254.9
254.8
254.7
254.6
254.5
254.4
254.3
254.2
254.1
254
2017
2019
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
RN165496 - Tertiary Basalt


Water level elevation (mAHD)
247
246.5
246
245.5
245
244.5
244
243.5
243
242.5
242
2017
2019
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
RN165497 - Tertiary Basalt

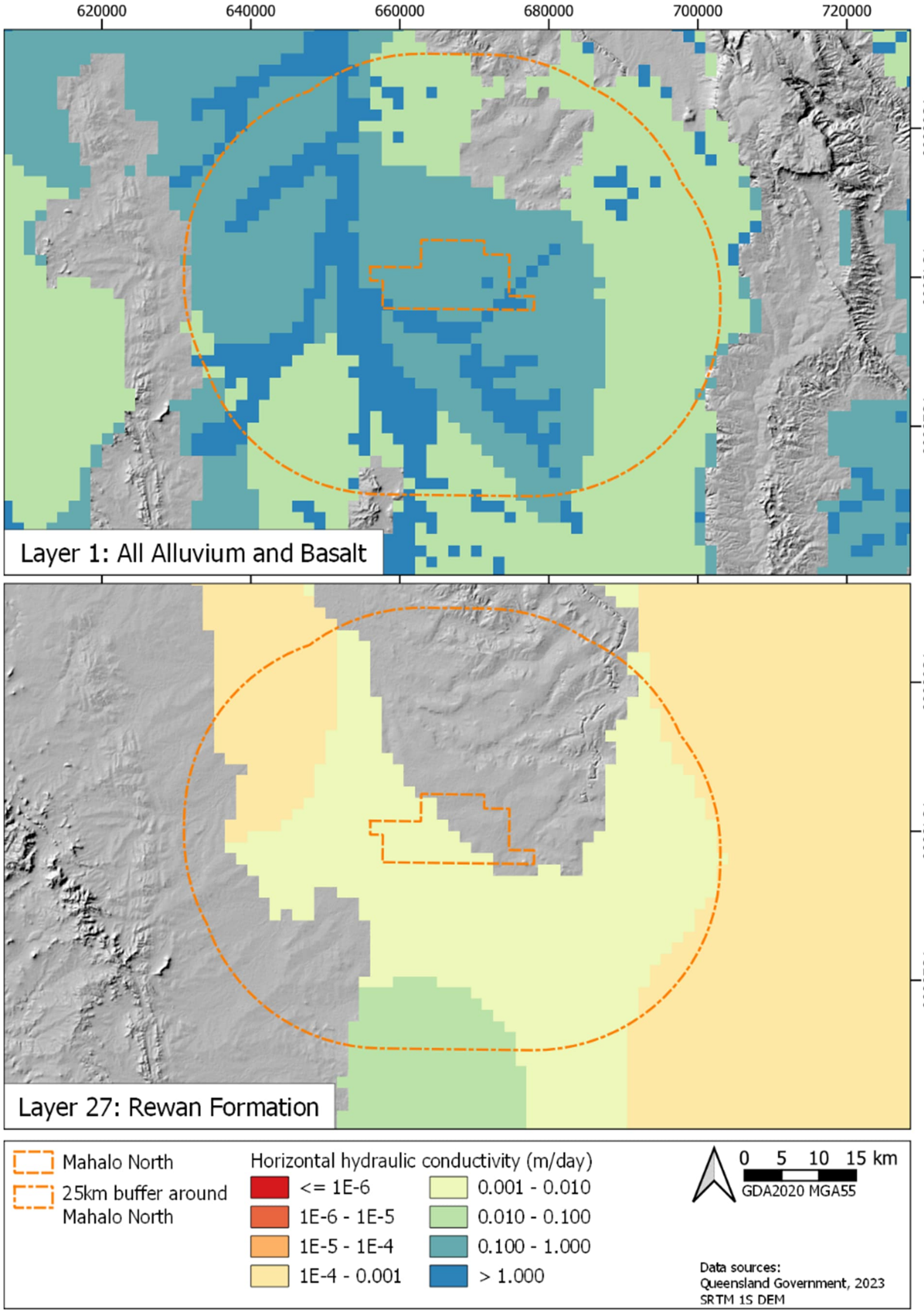

Water level elevation (mAHD)
245
244.5
244
243.5
243
242.5
242
241.5
241
240.5
240
2017
2019
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
RN165498 - Tertiary Basalt

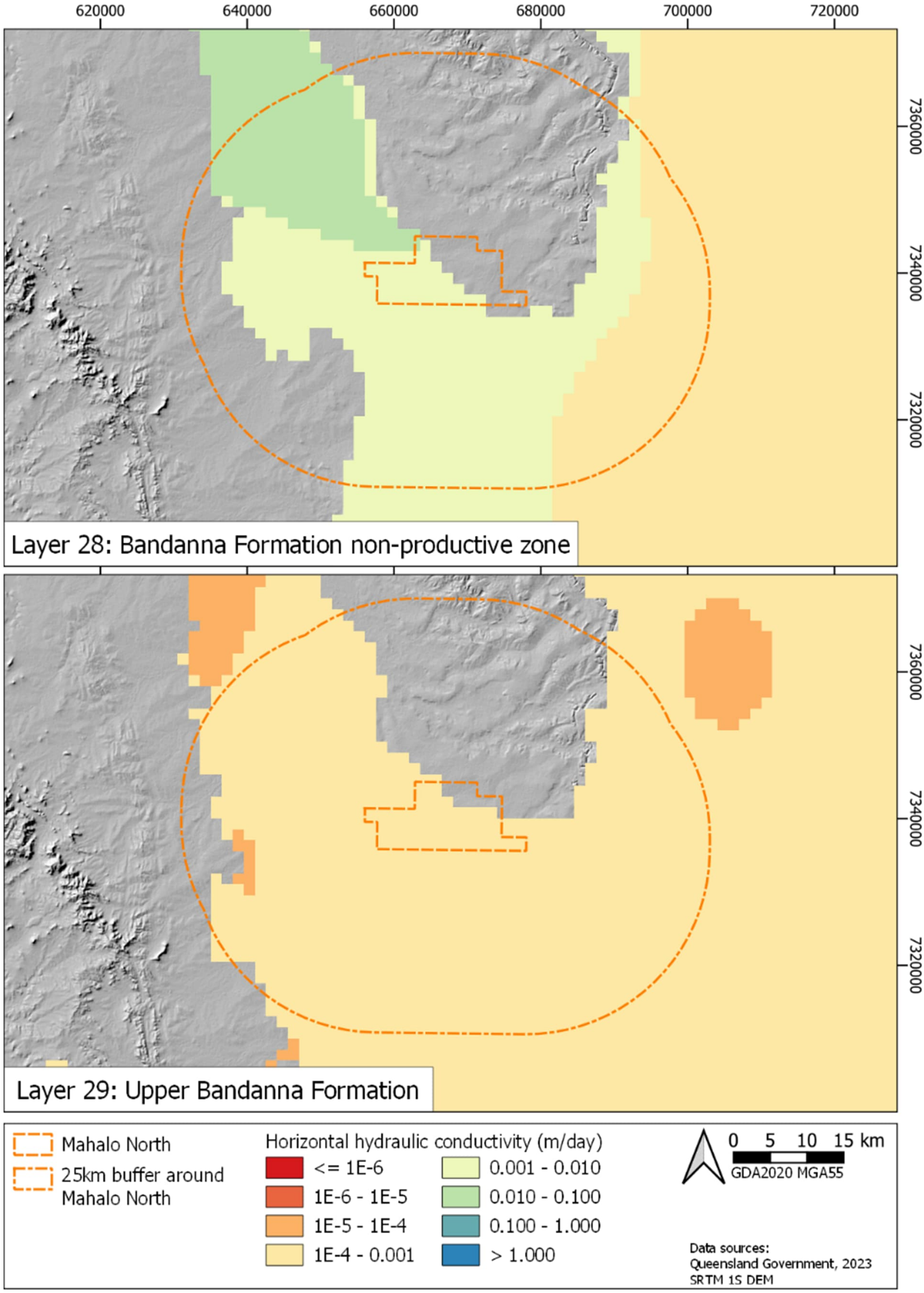

Water level elevation (mAHD)
237
236
235
234
233
232
231
230
2013
2015
2017
2019
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
RN165412 - Tertiary Sediments

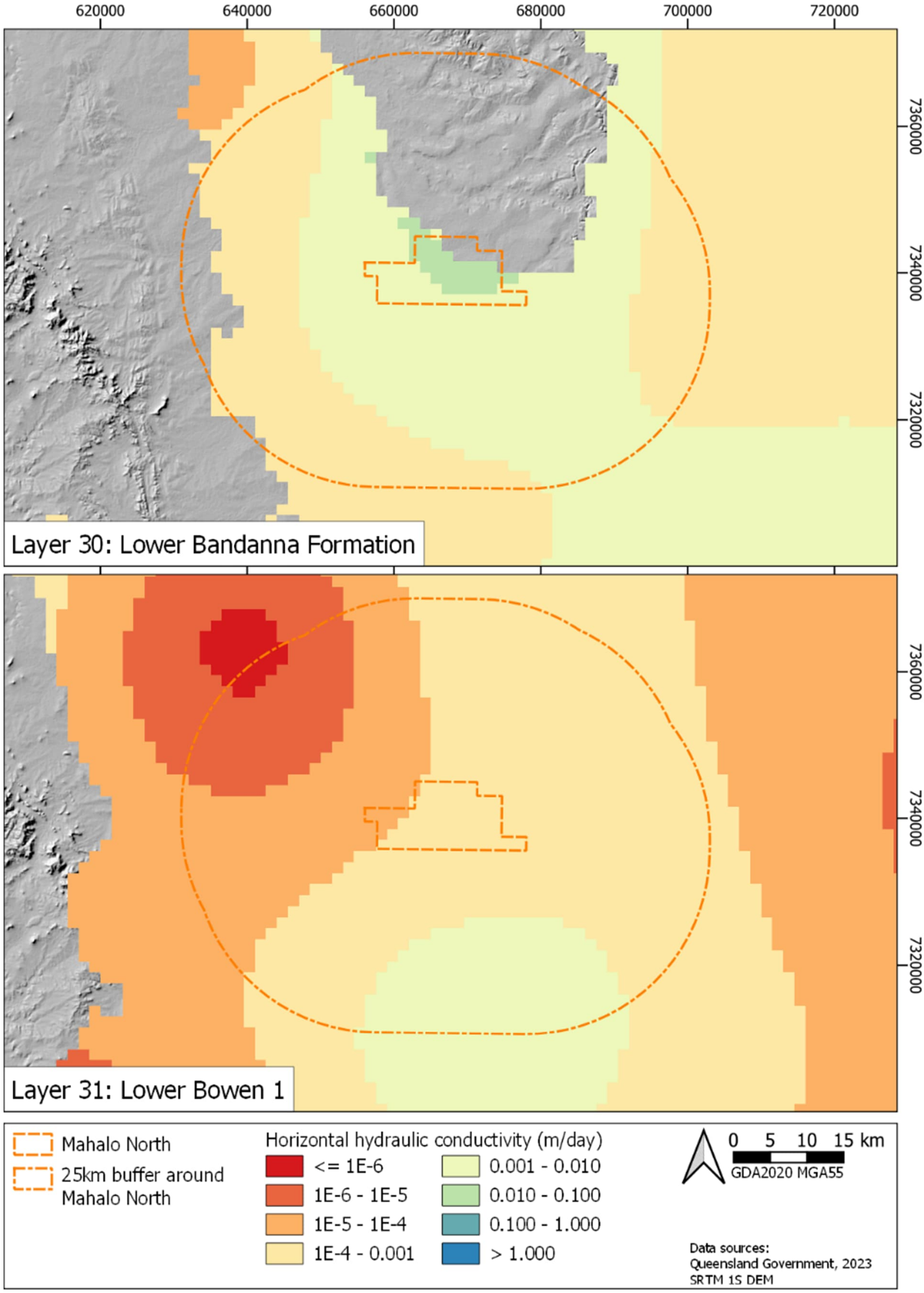

Water level elevation (mAHD)
238
237.5
237
236.5
236
235.5
235
234.5
234
233.5
233
2014
2016
2018
2020
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
RN165002 - Upper Permian


Water level elevation (mAHD)
250
249.5
249
248.5
248
247.5
247
246.5
246
2017
2019
2021
2023
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
Rainfall Residual (mm)
RN165493 - Upper Permian

Appendix D OGIA Model Hydraulic Parameter Maps


620000
640000
660000
680000
700000
720000
7360000
7340000
7320000
Layer 1: All Alluvium and Basalt
Layer 27: Rewan Formation
Mahalo North
25km buffer around Mahalo North
Horizontal hydraulic conductivity (m/day)
<= 1E-6
1E-6 - 1E-5
1E-5 - 1E-4
1E-4 - 0.001
0.001 - 0.010
0.010 - 0.100
0.100 - 1.000
> 1.000
0 5 10 15 km
GDA2020 MGA55
Data sources:
Queensland Government, 2023
SRTM 1S DEM


620000
640000
660000
680000
700000
720000
7360000
7340000
7320000
Layer 28: Bandanna Formation non-productive zone
Layer 29: Upper Bandanna Formation
Mahalo North
25km buffer around Mahalo North
Horizontal hydraulic conductivity (m/day)
<= 1E-6
1E-6 - 1E-5
1E-5 - 1E-4
1E-4 - 0.001
0.001 - 0.010
0.010 - 0.100
0.100 - 1.000
> 1.000
0 5 10 15 km
GDA2020 MGA55
Data sources:
Queensland Government, 2023
SRTM 1S DEM


620000
640000
660000
680000
700000
720000
7360000
7340000
7320000
Layer 30: Lower Bandanna Formation
Layer 31: Lower Bowen 1
Mahalo North
25km buffer around Mahalo North
Horizontal hydraulic conductivity (m/day)
<= 1E-6
1E-6 - 1E-5
1E-5 - 1E-4
1E-4 - 0.001
0.001 - 0.010
0.010 - 0.100
0.100 - 1.000
> 1.000
0 5 10 15 km
GDA2020 MGA55
Data sources:
Queensland Government, 2023
SRTM 1S DEM

Appendix E GDE Remote Sensing Multicriteria Analysis

Method

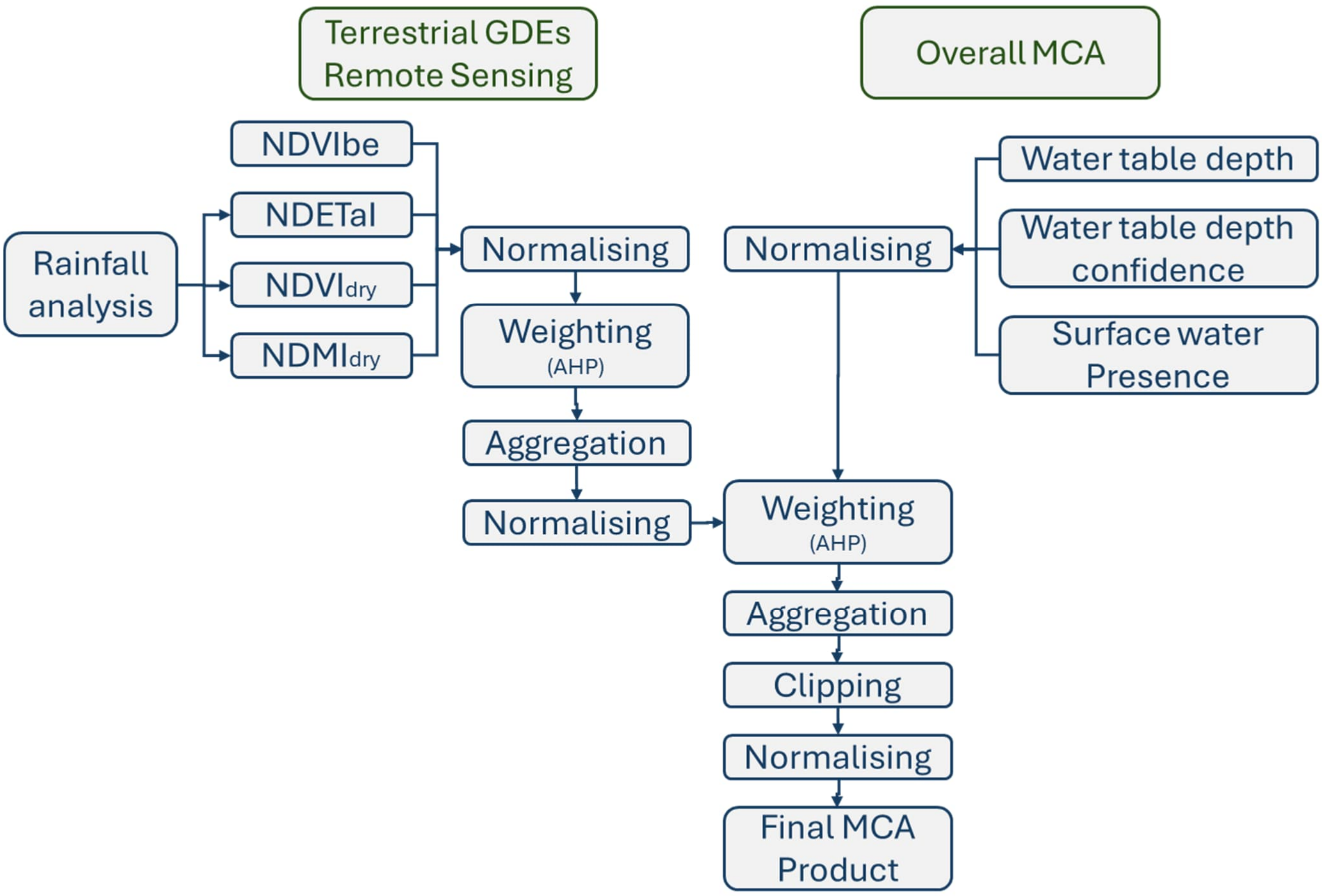
A multicriteria analysis (MCA) was performed to rank the Project area and surrounds with respect to the potential presence of groundwater dependent ecosystems (GDEs). The MCA was performed in two parts:

- In accordance with Doody et al. (2019), remote sensing was used to identify areas of persistent water availability which could identify the presence of, in particular, terrestrial GDEs. The component of the assessment was broadly based on the methods described by Fildes et al (2023) but modified for the hydrogeological environment of the study area.
- The potential terrestrial GDE mapping was combined with other indicators, such as water table depth and presence of surface water, to incorporate the aquatic GDEs in the assessment.

Figure 57 outlines the workflow performed for the MCA. Each component of the workflow is discussed in the following sections. The output of the MCA was used to inform:

- The selection of locations for the installation of groundwater monitoring bores
- The selection of locations for field-based assessment of terrestrial GDEs.

Figure 57 Multicriteria analysis workflow



Input parameters

The following sections describe the input parameters and the methods with which they were processed for the MCA.

NDVIlbe

The Landsat "Barest Earth" product (LBE) was developed primarily for mineral mapping where a statistical technique was used to produce a "barest state" mosaic of the landscape Australia wide using over 30 years of Landsat data and processed to a 30 m spatial resolution. Roberts, Wilford and Ghattas (2019) suggest that areas which remain "green" indicate areas of persistent vegetation which alludes to the potential permanence of a water source. LBE maintains the spectral integrity between the acquisition wavelengths (Fildes et al., 2023), hence it is possible to derive a high temporal resolution long-term Normalised Difference Vegetation Index (NDVI) using the equation:

$$NDVI = \frac{NIR - Red}{NIR + Red} \quad \text{Equation 1}$$

Where: $NDVI$ = normalised difference vegetation index
NIR = near infrared band
Red = visible light red band

The raw calculated NDVI always ranges from -1 to 1. It was normalised across the study area (Figure 60) using Equation 4.

NDVI is well known and widely used simple, but effective index for quantifying green vegetation. Unsurprisingly it shows strong greenness in the heavily vegetated Expedition Ranges, intensive agricultural areas adjacent to and to the west of the Comet River and in the north central parts of the study area where there are widespread State forests.

NDETaI

While evapotranspiration (ET) is a complex interplay between temperature, humidity, windspeed, soil, plant type and water availability, the persistency of higher ET particularly during the dry season is grossly assumed to allude to the continued availability of water. On the further assumption that this source of water is groundwater, the spatial variation in ET in the landscape can be used as a line of evidence for the potential presence of GDEs.

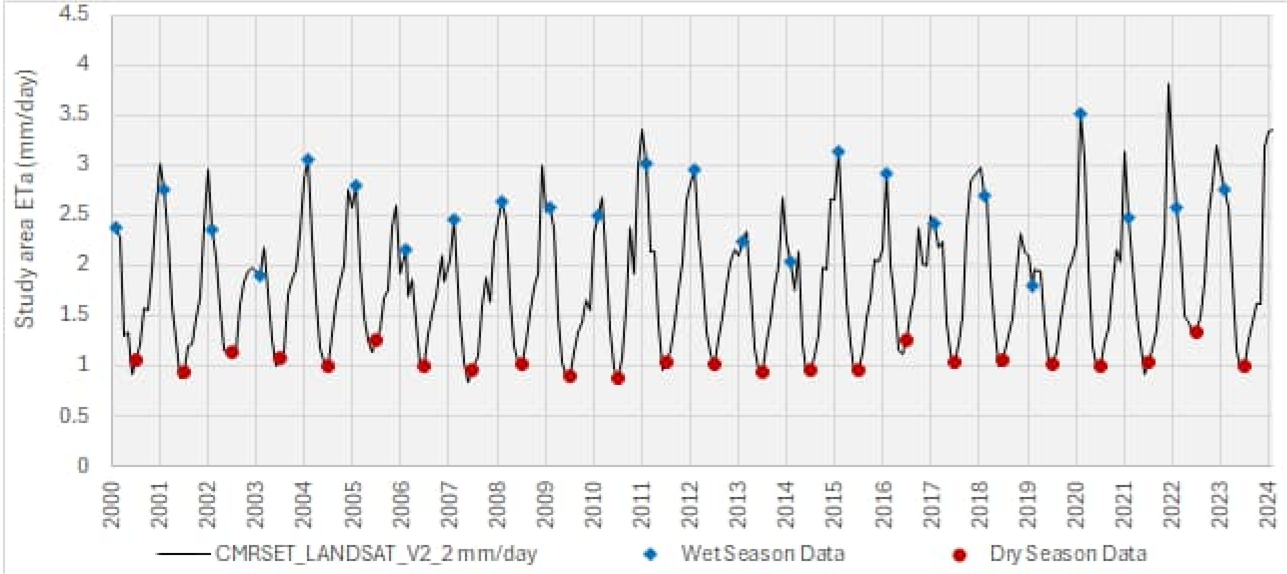
The national-scale, 30 m resolution actual ET (ETa) dataset generated using the CSIRO MODIS reflectance-based scaling evapotranspiration (CMRSET) algorithm (Guerschman et al, 2022) was downloaded from TERN (McVicar et al., 2024) for every February and July from 2000 to 2023, representing the wet and dry seasons respectively across the study area (Figure 58). Following the methodology described by Fildes et al. (2023), the normalised difference index between the wet and dry period measured ETa was calculated using the following formula:

$$NDETaI = \frac{ETa_{MeanDry} - ETa_{MeanWet}}{ETa_{MeanDry} + ETa_{MeanWet}} \quad \text{Equation 2}$$

Where: $NDETaI$ = normalised difference ETa index
$ETa_{MeanDry}$ the mean of the dry data sets
$ETa_{MeanWet}$= the mean of the wet data sets

The normalised (Equation 4) distribution of NDETaI across the study area is presented as Figure 61. This shows that the greatest NDETa is associated with large surface water storages and pit lakes within the Blackwater mine voids. Areas associated with broadacre agricultural activities generally have elevated ETa relative to surrounding areas.

Figure 58 Monthly average ETa across the study area and monthly data sets used



NDVIdry and NDMIdry

NDVI and normalised difference moisture index (NDMI) were derived from Sentinel-2 data downloaded from Sentinel Hub. The downloaded data was a composite of cloud free images over August to October 2017, which corresponded to the end of an extended dry period across the region (Figure 59). The Sentinel-2 data is only available from October 2016 onwards. As described above, the persistence of “greenness” the increased presence of moisture after a dry period alludes to potential source of water other than precipitation.

$NDVI_{dry}$ was calculated using Equation 1, normalised using Equation 4, with the normalised image presented as Figure 62.

NDMI is calculated using the near infrared (NIR) and the short wave infrared (SWIR) bands. The combination of the NIR with the SWIR reduces variability introduced by the internal structure of the leaf dry matter content relative to NDVI (sentinelhub, 2024). The $NDMI_{dry}$ input was calculated using the following equation:

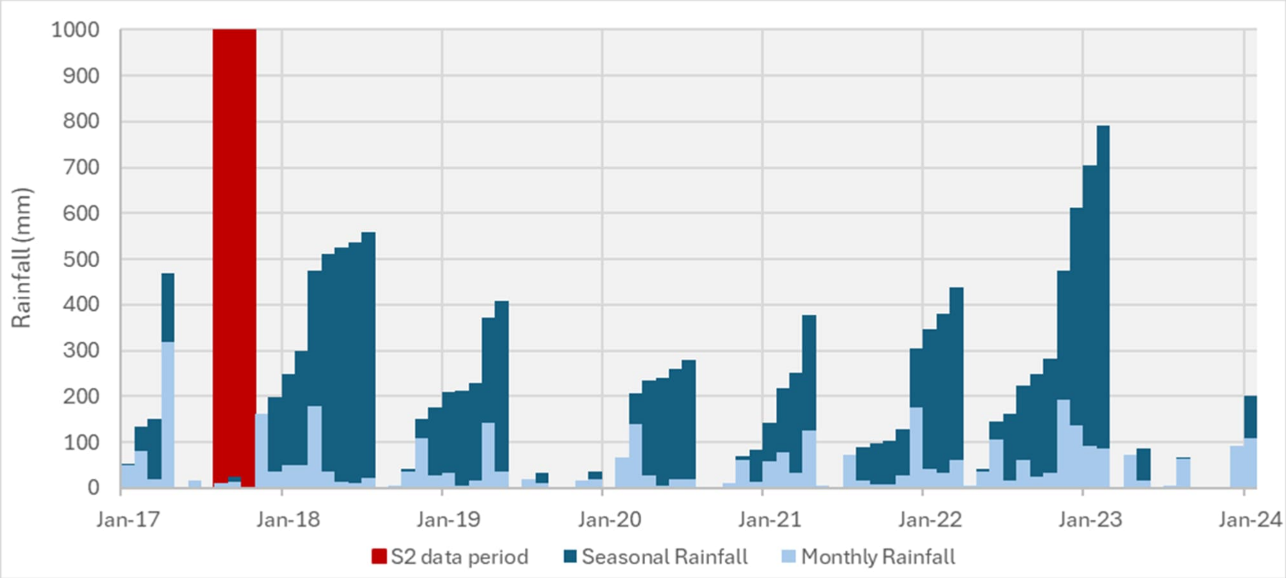
$$NDVI = \frac{NIR - SWIR}{NIR + SWIR} \quad \text{Equation 3}$$

Where: $NDVI$ = normalised difference vegetation index
NIR = near infrared band

$SWIR$ = short wave infrared band

The normalised NDMIdry is presented as Figure 63. It shows a similar distribution to the NDVI datasets and NDETaI.

Figure 59 Rainfall and data period for NDVI and NDMI



Surface water presence

The Digital Earth Australia (DEA) Landsat multi year water observation frequency was used to identify areas of surface water presence. The presence of surface water is predominantly associated with the main channel of the Comet River, off-stream water agricultural water storages and low-lying areas adjacent to water courses which are generally used for intensive agriculture. It confirms the non-perenniality of the watercourses in the study area

The frequency of water presence was normalised using Equation 4 and the normalised spatial distribution is presented as Figure 64, noting that this map is scaled differently to the others due to the infrequent presence of surface water in the study area.

Of importance is the absence of data in areas with steep topography, such as the western flank of the Expedition Ranges and the batters of the Blackwater mine pits. When aggregating the MCA, these areas were assumed as 0 in the normalised input. This is considered justified as they are areas where the slope would not allow water to accumulate.

Water table depth and confidence

The construction of water table depth input is described in Section **Error! Reference source not found.**. However, rather than normalising this input with Equation 4, the water table depth was classified between zero and one based on Table 17, which provides greater importance to shallower water table depths. The classified water table depth input layer is presented as Figure 65.

The water table confidence input the Kriging variance output from Surfer© which was normalised such that higher variance (uncertainty) ranked higher. The normalised (Equation 4) water table depth confidence input is included as the inset on Figure 29.

Table 17 Water table depth classification

Mapped water table depth (mbgl)	Class
<= 5	1
5 – 10	0.8
10 – 15	0.6
15 – 20	0.4
>20	0

Normalisation

Actual output ranges for each input layer to the MCA, and at various stages in the workflow, were rescaled to positive values between 0 and 1 for standardisation (normalisation) between outputs (Fildes et al., 2023). The normalisation was performed using the following formula:

$$X' = \frac{X - X_{min}}{X_{max} - X_{min}} \quad \text{Equation 4}$$

Where: X' = normalised index value
X = value to be scaled
X_{min} = minimum unscaled dataset value
X_{max} = minimum unscaled dataset value

Weighting

Normalised inputs were weighted using the analytic hierarchy process (AHP) as described by Saaty (1977) to generate the MCA. Fildes et al. (2023) identify AHP to be used extensively in spatial MCAs. They recognised that using the AHP does not eliminate expert biases, however it does provide a structured approach to weighting of inputs.

The AHP uses pairwise comparisons of the relative importance between each input parameter through pairwise comparisons using a numerical scale (Table 18). Usually, the pairwise comparisons are agreed by a group of experts, however that was not available for this assessment. The AHP also produces a consistency ratio to ensure relationships are logically related rather than being randomly chosen. A consistency ratio of less than 10% is considered an acceptable level of consistency. Values greater than 10% require re-evaluation of the pairwise comparison.

The AHP matrices for the two performed weightings are included as Table 19 and Table 20. Both AHP analyses returned consistency ratios of 2% and are therefore considered to have an acceptable level of consistency.

Table 18 The fundamental scale for pairwise comparisons (Saaty, 1977)

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two elements contribute equally to the objective
3	Moderate Importance	Experience and judgment slightly favour one element over another
5	Strong Importance	Experience and judgment strongly favour one element over another
7	Very Strong Importance	One element is favoured very strongly over another; its dominance is demonstrated in practice
9	Extreme Importance	The Evidence favouring one element over another is of the highest possible order of affirmation
Intensities of 2, 4, 6, and 8 can be used to express intermediate values		
Intensities 1.1, 1.2, 1.3, etc. can be used for elements that are very close		

Table 19 Terrestrial GDE AHP matrix

Layers	NDVIlba	NDETal	NDVI	NDMI	AHP layer relative weight
NDVIlba	1	1	2	2	0.33
NDETal	1	1	2	2	0.33
NDVI	0.5	0.5	1	2	0.20
NDMI	0.5	0.5	0.5	1	0.14

Table 20 Overall MCA AHP matrix

Layers	Terrestrial GDEs	Surface water presence	Water table depth	Water table depth confidence	AHP layer relative weight
Terrestrial GDEs	1	1	3	5	0.39
Surface water presence	1	1	3	5	0.39
Water table depth	0.33	0.33	1	3	0.15
Water table depth confidence	0.2	0.2	0.33	1	0.07

Aggregation

The normalised layers, together with the AHP derived weighting were aggregated using the following formula (Fildes et al., 2023):

$$MCA = \sum_{j} (w_j \times x_{ij}) \quad \text{Equation 5}$$

Where: MCA = final weighted output
w_j = AHP relative weight of the jth input parameter
x_i = normalised value for each grid cell value of the jth input parameter

This method of aggregation is termed a weighted linear combination method, which Diaz-Alcaide and Martinez-Santos (2019, in Fildes et al., 2023) indicate is frequently used in groundwater potential mapping research.

The aggregated potential terrestrial GDE layer is presented as Figure 66. This map has been presented with a different colour range to the input layers and is also presented from 0.5 to 1 to highlight areas of highest ranking in the MCA. The inset map is presented as the same colour scale as the input layers and shows little variability in the lower potential areas.

Similarly, the normalised overall MCA shows a predominance of areas that rank in the 0.25 to 0.4 range due to a few small features, primarily associated with water storages that skew the data normalised data. With the exception of surface water storages and the intensive agricultural areas, there were no standout features outside of the study area.

Clipping

Following the final aggregation and to overcome the skewing of the data, the aggregated inputs were masked to the exclude high intensity agricultural and industrial activities which are likely to significantly affect water presence in the environment. This mostly affected the areas adjacent to the Comet River where much of the land use comprises cropping on the Comet River alluvium and areas adjacent to the floodplain. The purpose of the masking was to shift focus on the more natural areas within the project areas.

The resulting masked aggregated data was then clipped to the boundaries of the project area and was then re-normalised (Figure 69). GDE potential across the Project Area can be broadly described as follows

The areas of highest GDE potential are associated with Humboldt Creek in the far southwestern corner of the Project area and with the unnamed tributary to Humboldt Creek that transects the southeastern corner of the Project Area.

Relatively higher areas of GDE potential corresponding to the areas of remnant vegetation in the northern portion of the Project Area, the central west and near the eastern boundary.

Windrows of remnant vegetation map as higher potential relative to the cleared areas adjacent to them.

Figure 60 Normalised NDVIIbe

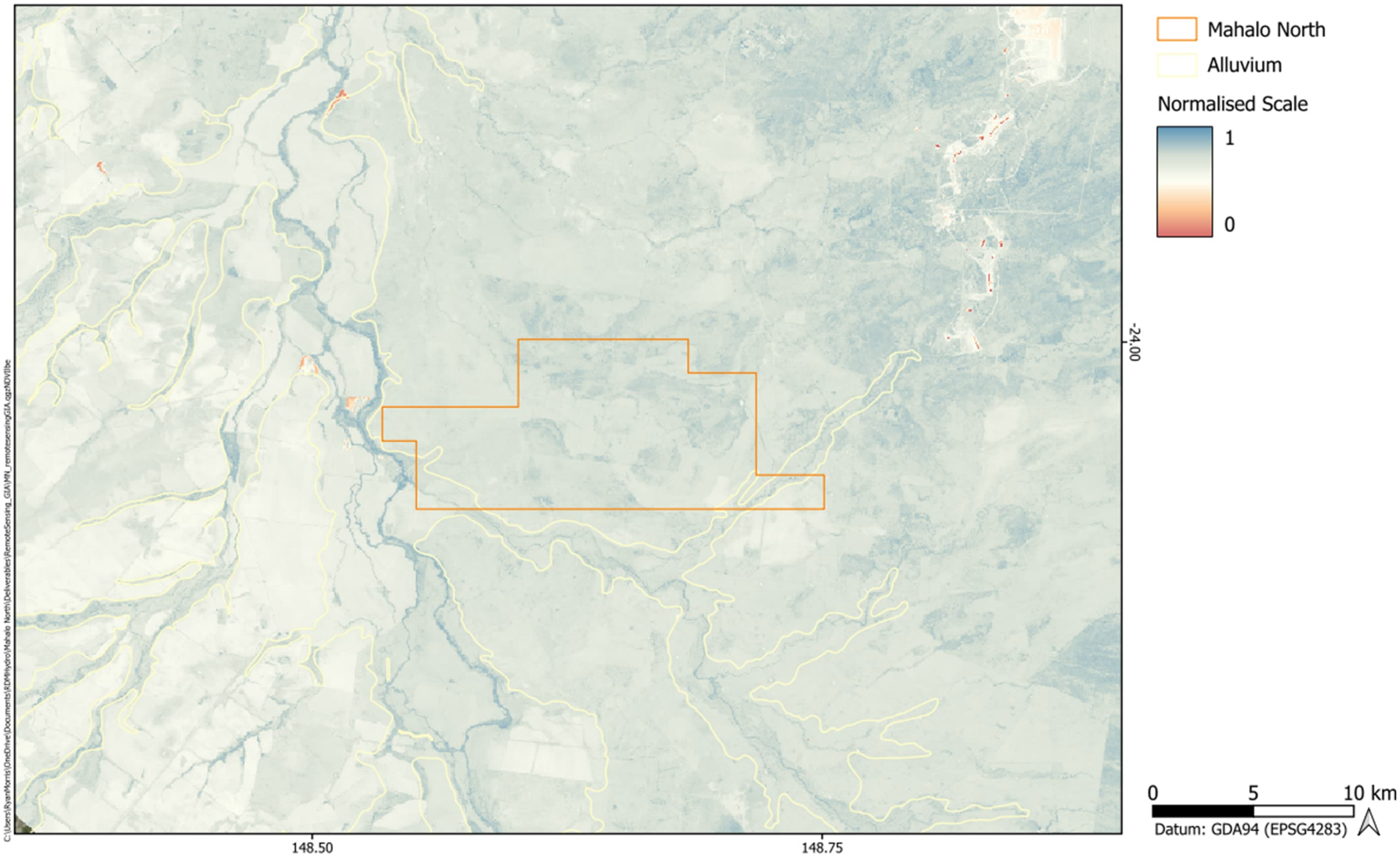


Figure 61 Normalised NDETaI

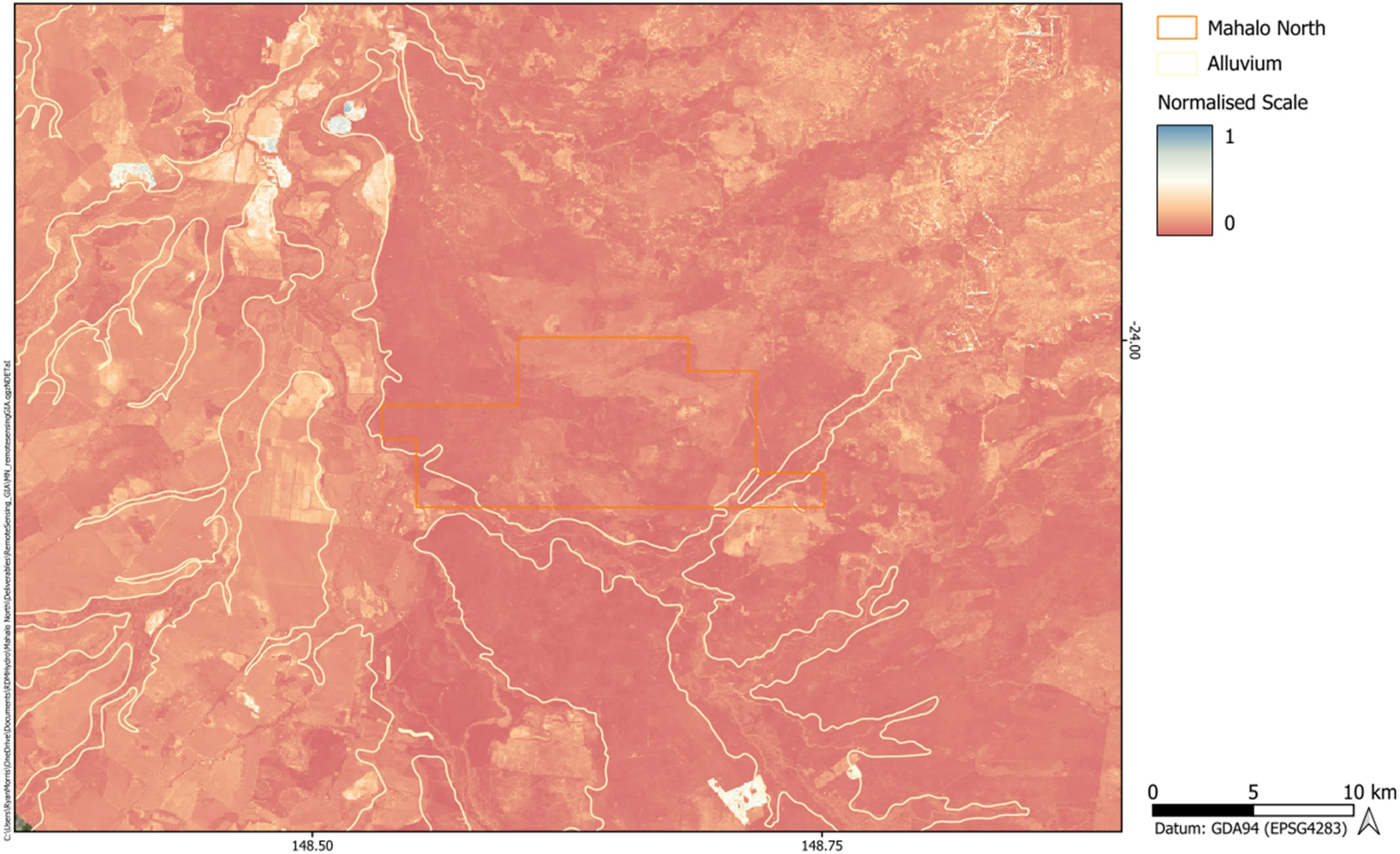


Figure 62 Normalised NDVI

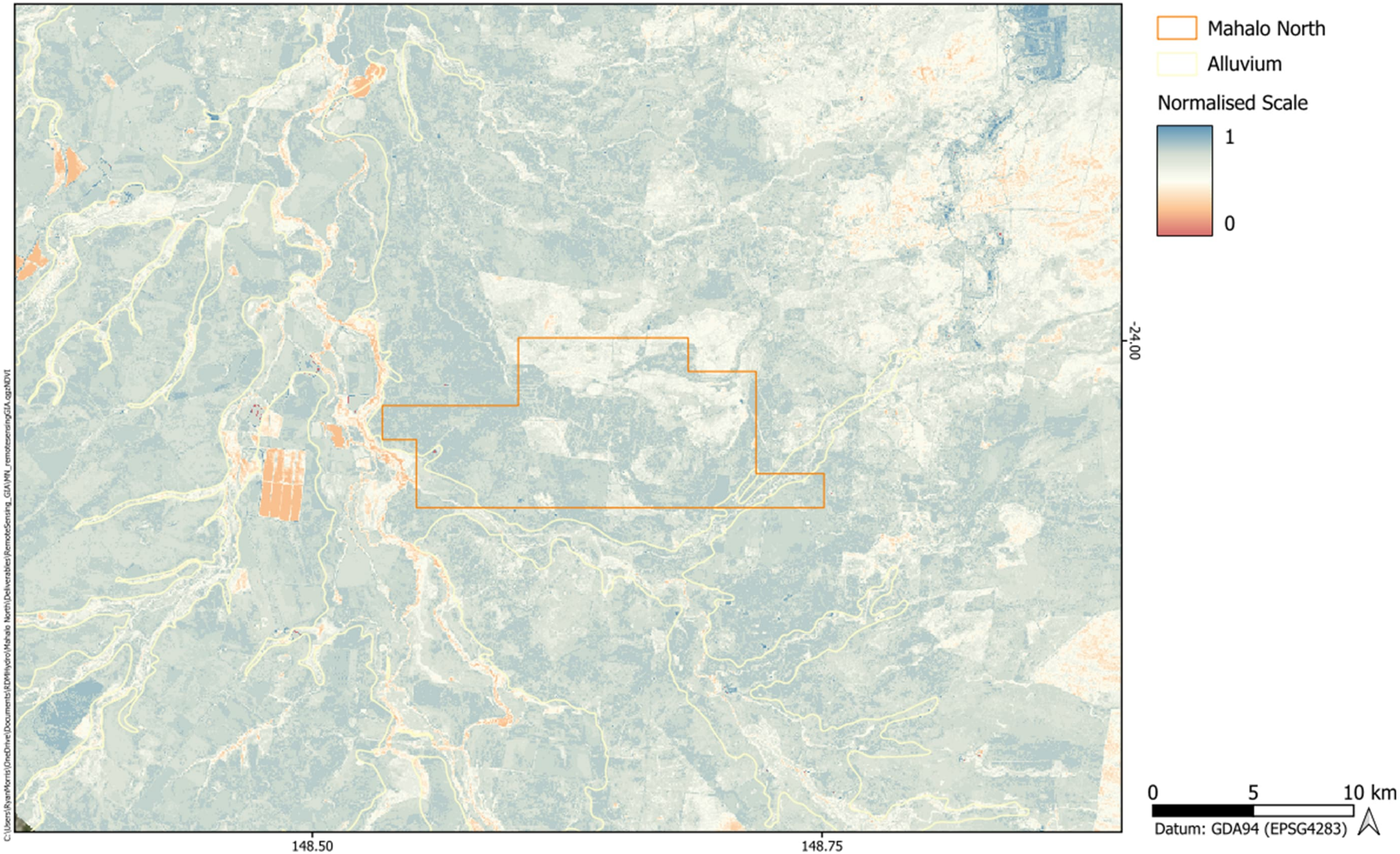


Figure 63 Normalised NDMI

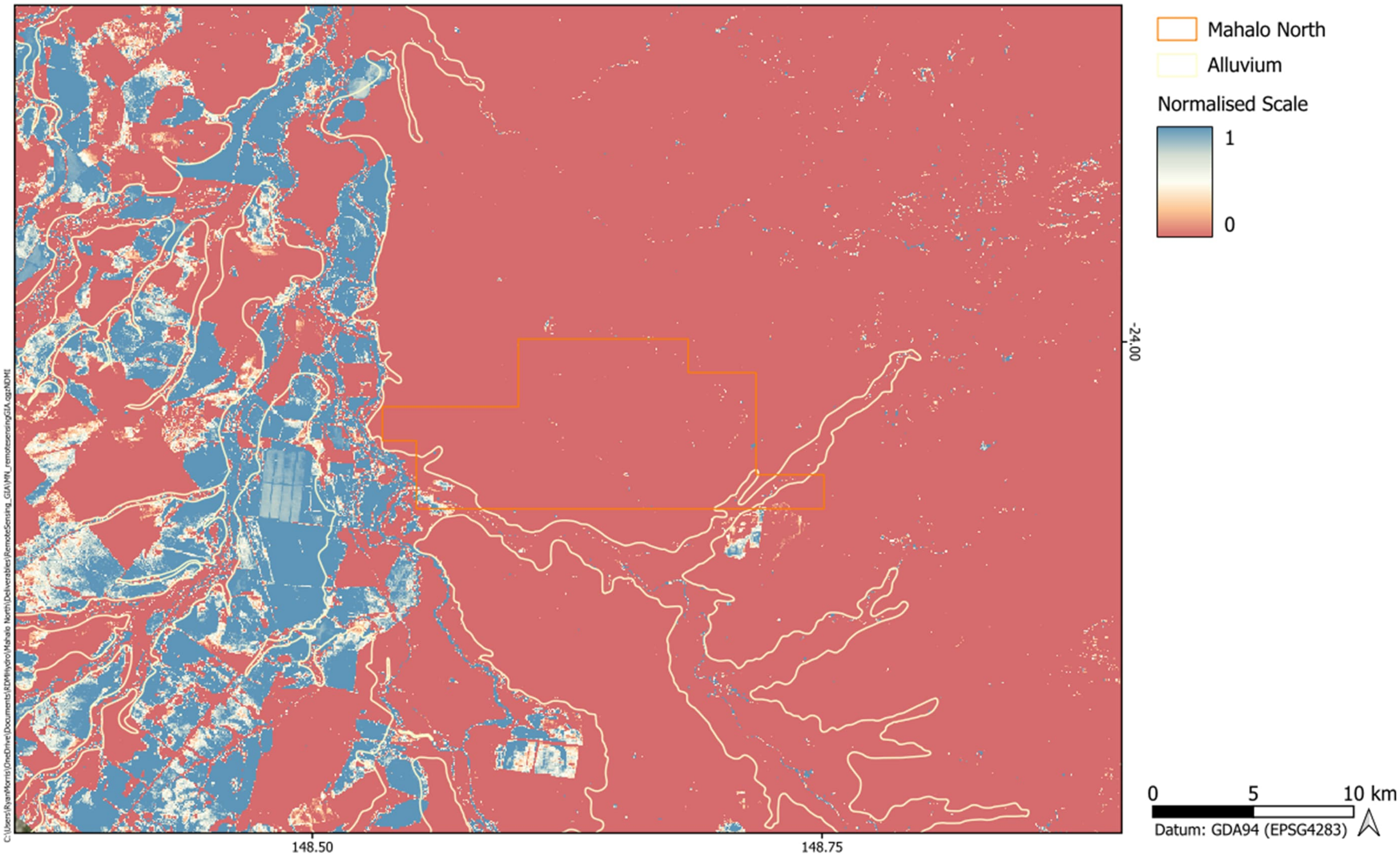


Figure 64 Normalised surface water presence

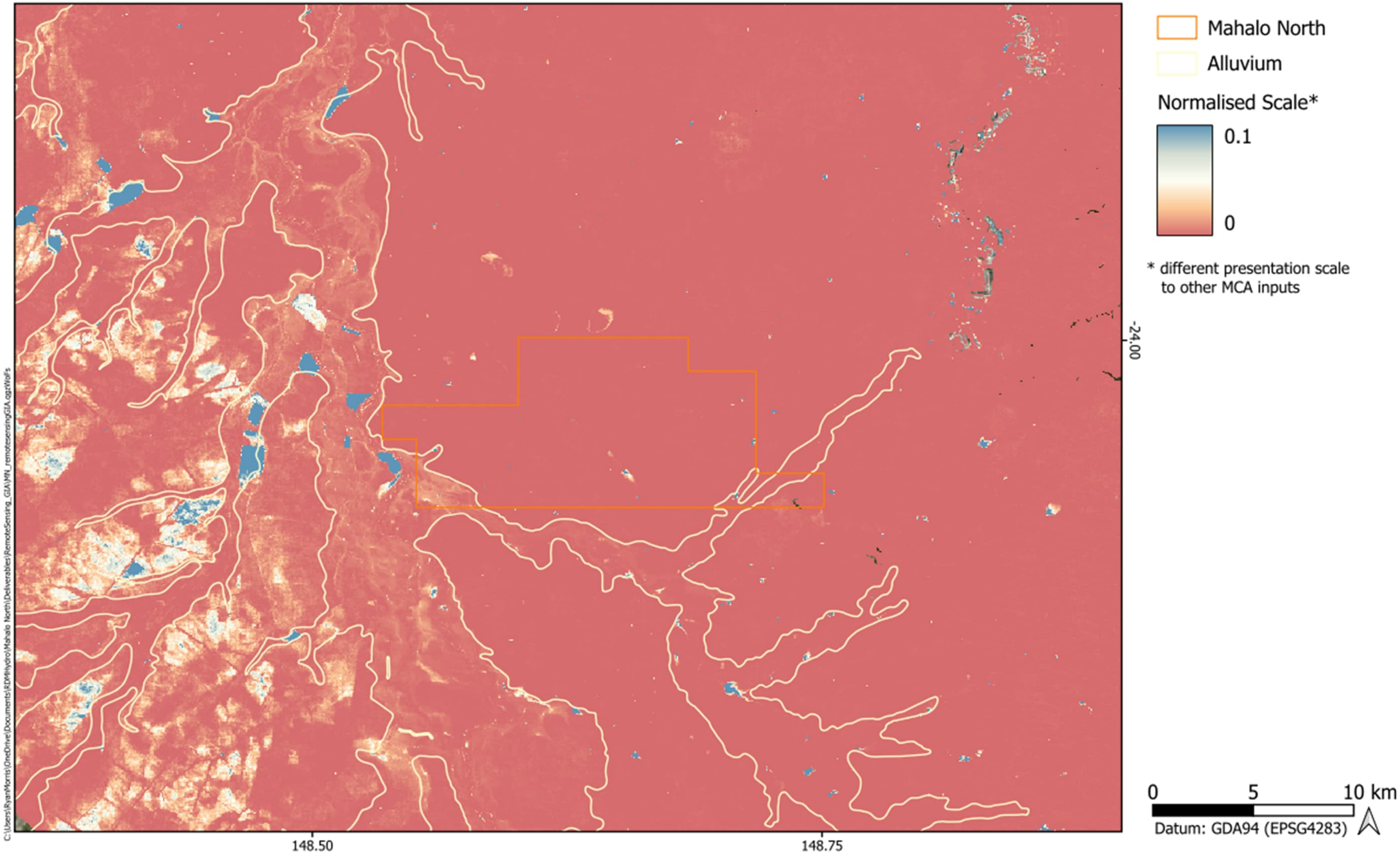


Figure 65 Classified water table depth

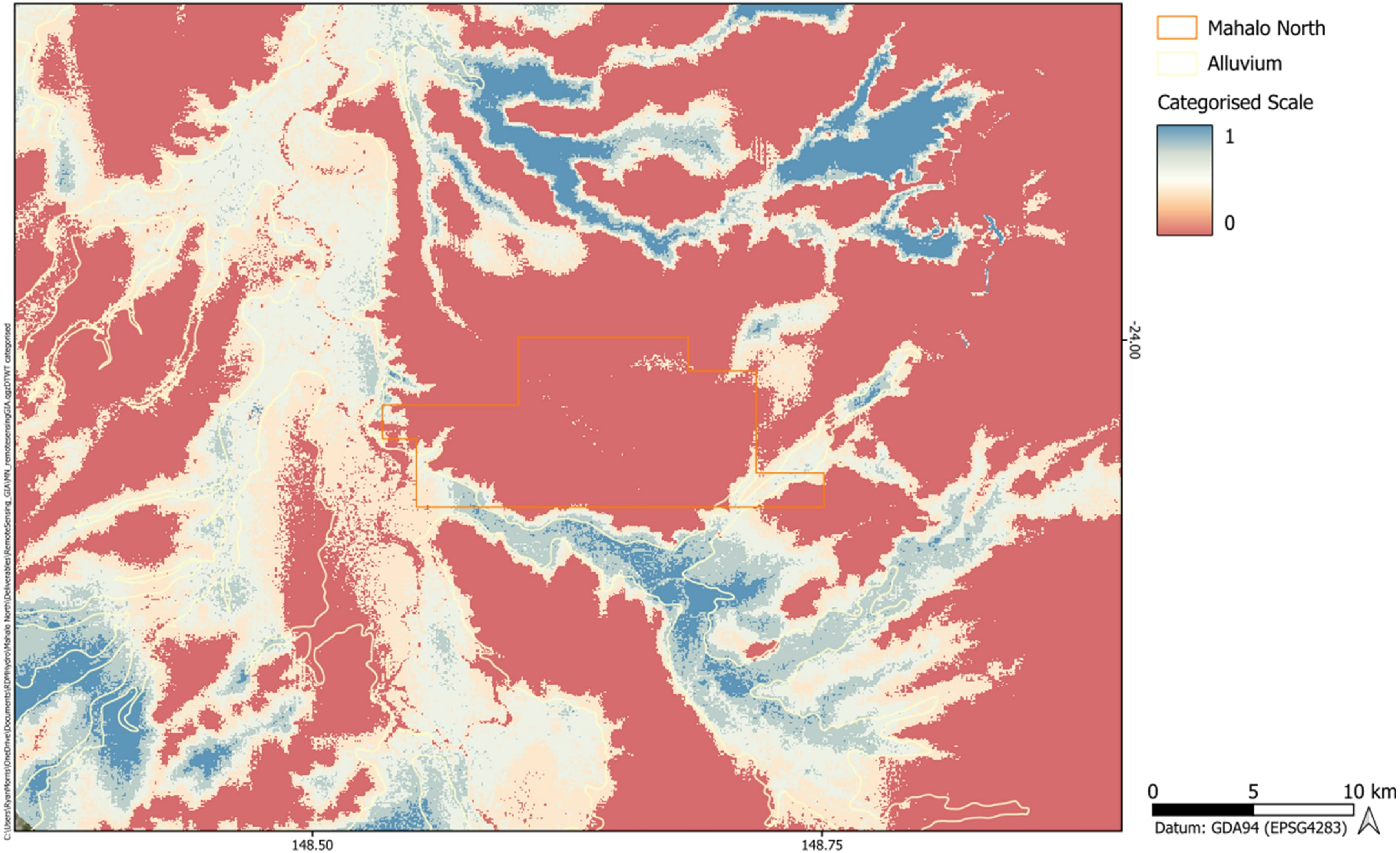


Figure 66 Normalised potential terrestrial GDE aggregation

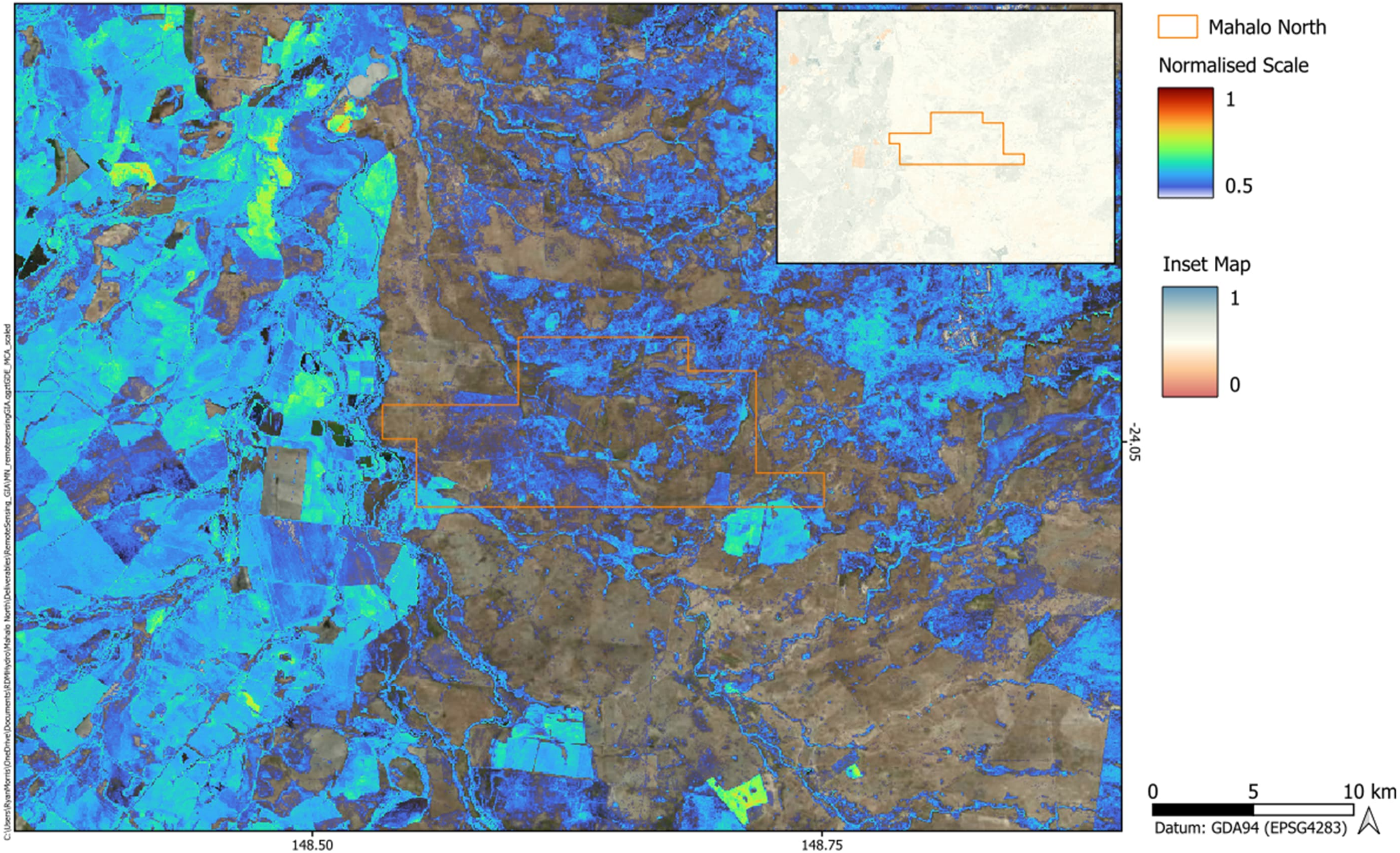


Figure 67 High intensity land use mask areas

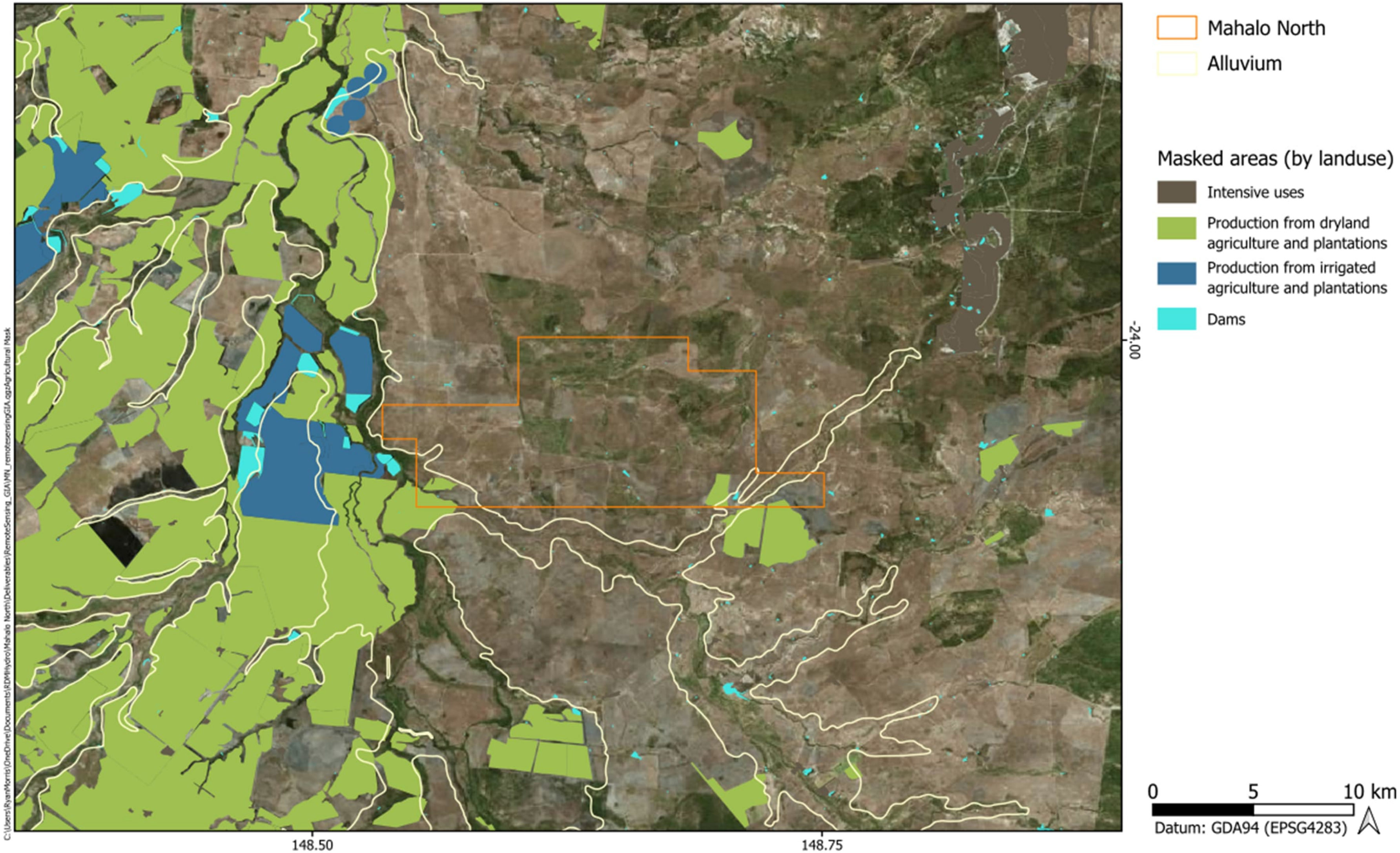


Figure 68 Clipped and rescaled overall MCA

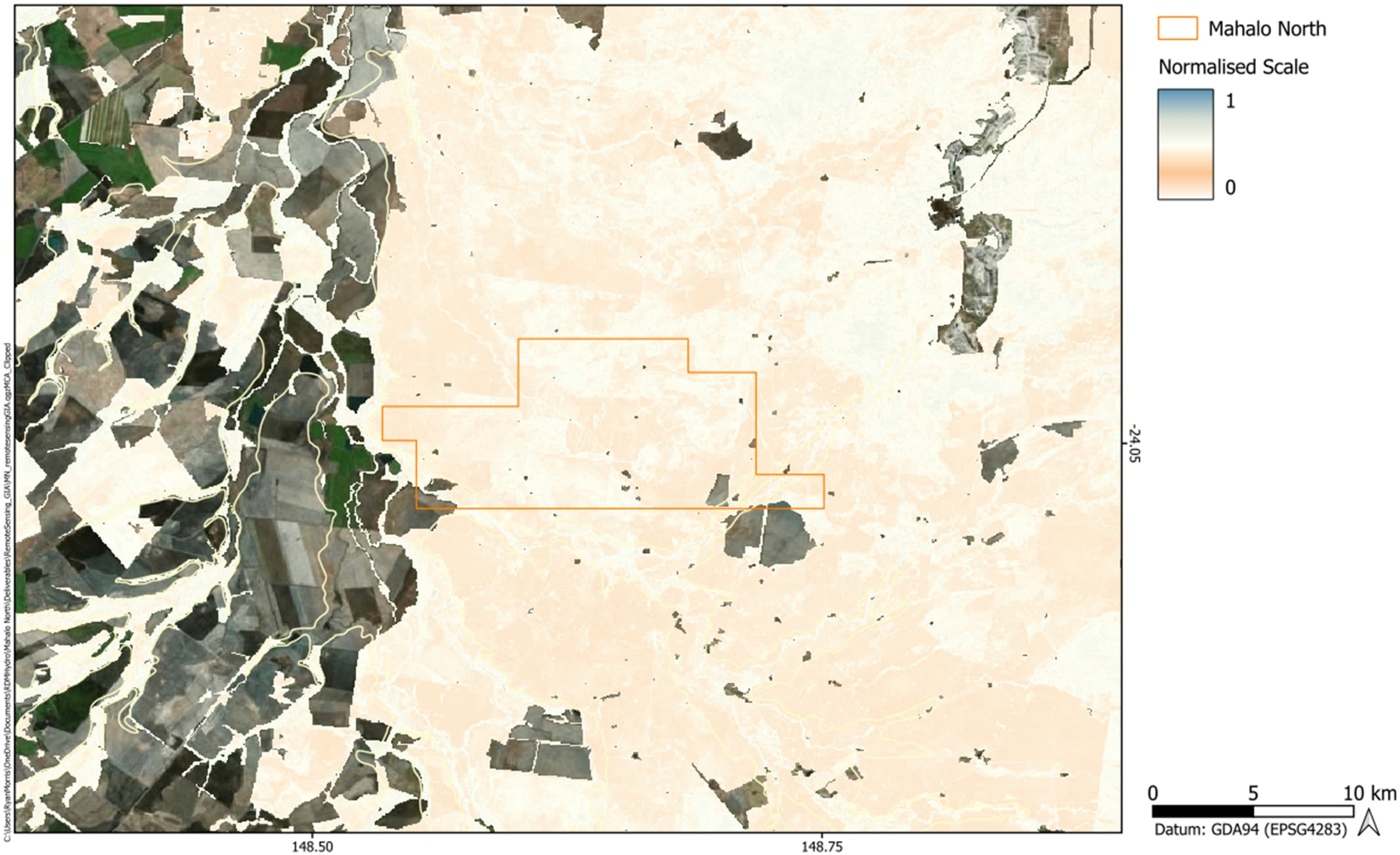
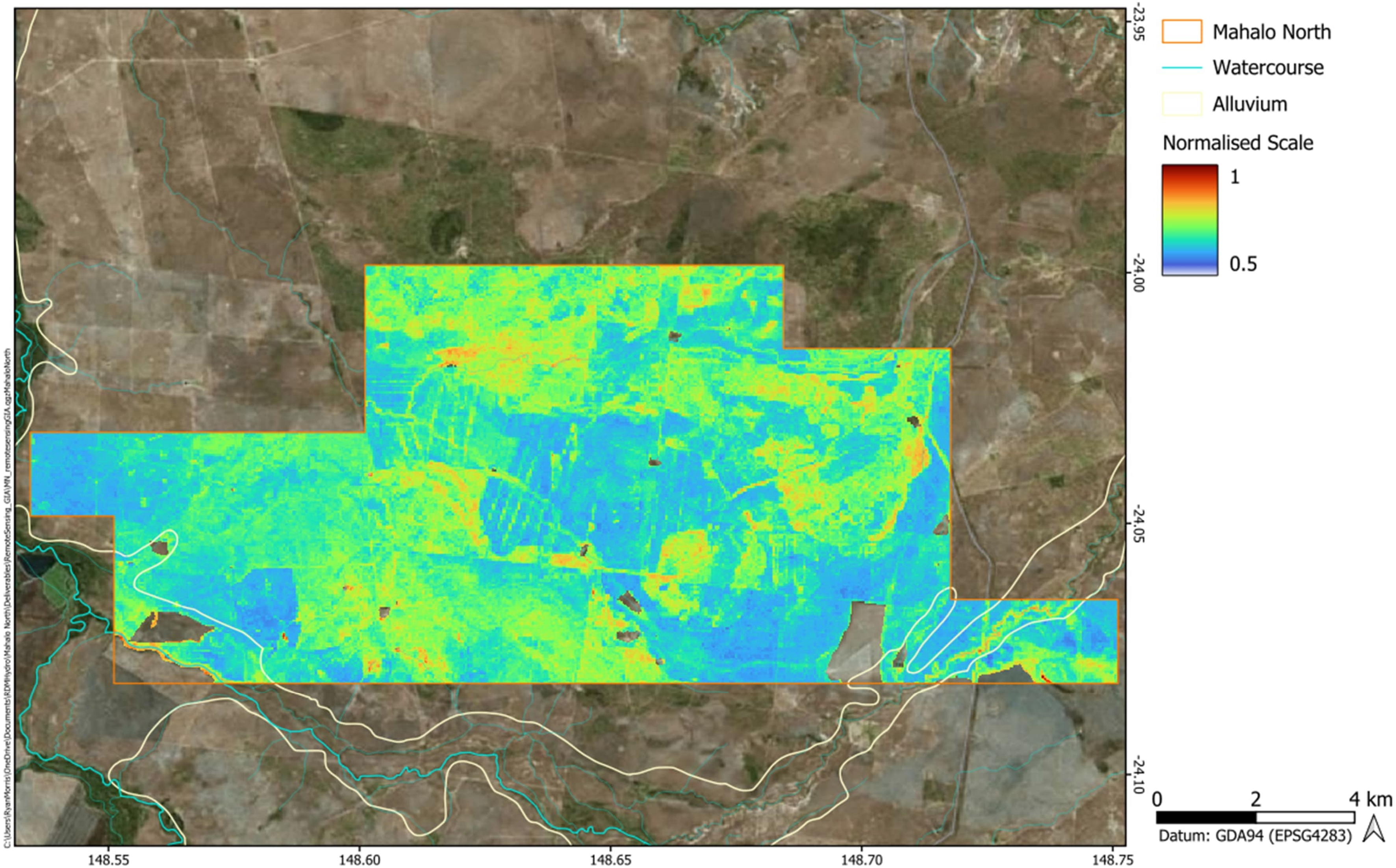


Figure 69 Rescaled MCA focussed on the Mahalo North Project area



Appendix F Regional Ecosystem Mapping – Dominant Canopy Species

Name	Substrate	Biodiversity Status	Mapped Remant Extents (2021) (Ha)	Short Description	Wetland System	Structure	Species 1	Species 2	Species 3	Species 4	Species 4	Species 5	Species 6	Species 7
11.3.1	Alluvium (flood plain) - heavy clays	Endangered	80000	Acacia harpophylla and/or Casuarina cristata open forest on alluvial plains	Not a Wetland	Open Forest	Acacia harpophylla	Casuarina cristata	Eucalyptus coolibah	Eucalyptus populnea	Brachychiton spp.			
11.3.2	Alluvium (flood plain)	Of concern	499000	Eucalyptus populnea woodland on alluvial plains	Contains Palustrine	Woodland	Eucalyptus populnea	Eucalyptus crebra	Eucalyptus melanophloia					
11.3.3	Alluvium (flood plain) - heavy clays	Of concern	271000	Eucalyptus coolabah woodland on alluvial plains	Not a Wetland	Woodland	Eucalyptus coolabah	Eucalyptus populnea						
11.3.4	Alluvium (flood plain)	Of concern	178000	Eucalyptus tereticornis and/or Eucalyptus spp. woodland on alluvial plains	Not a Wetland	Woodland	Eucalyptus tereticornis	Corymbia tessellaris	Corymbia clarksoniana	Eucalyptus crebra	Eucalyptus melanophloia	Eucalyptus platyphylla	Angophora floribunda	Lophostemon suaveolens
11.3.6	Alluvium (flood plain)	Of concern	30000	Eucalyptus melanophloia woodland on alluvial plains	Not a Wetland	Woodland	Eucalyptus melanophloia	Corymbia tessellaris						
11.3.11	Alluvium (flood plain)	Endangered	2000	Semi-evergreen vine thicket on alluvial plains	Not a Wetland	Closed Forest	Eucalyptus tereticornis	Eucalyptus raveretiana						
11.3.25	Alluvium (creek channel)	Of concern	531000	Eucalyptus tereticornis or E. camaldulensis woodland fringing drainage lines	Riverine	Woodland	Eucalyptus camaldulensis	Eucalyptus tereticornis	Casuarina cunninghamiana	Eucalyptus coolibah	Angophora floribunda	Melaleuca bracteata	Corymbia clarksoniana**	
11.4.1	Alluvium (flood plain) - heavy clays	Endangered	2000	Semi-evergreen vine thicket +/- Casuarina cristata on Cainozoic clay plains	Not a Wetland	Closed Forest	Casuarina cristata	Planchonella cotinifolia	Lysiphyllum hookeri					
11.4.2	Alluvium (flood plain) - heavy clays	Of concern	34000	Eucalyptus spp. and/or Corymbia spp. grassy or shrubby woodland on Cainozoic clay plains	Not a Wetland	Woodland	Eucalyptus populnea							
11.4.8	Clay plain	Endangered	67000	Eucalyptus cambageana woodland to open forest with Acacia harpophylla or A. argyrodendron on Cainozoic clay plains	Contains Palustrine	Woodland	Eucalyptus cambageana	Acacia harpophylla						
11.4.9	Alluvium (flood plain) - heavy clays	Endangered	89000	Acacia harpophylla shrubby woodland with Terminalia oblongata on Cainozoic clay plains	Contains Palustrine	Woodland	Cadellia pentastylis	Eucalyptus populnea	Casuarina cristata					
11.5.2	Tertiary residuals (sand, clay and gravels)	No concern at present	189000	Eucalyptus crebra, Corymbia spp., with E. moluccana woodland on lower slopes of Cainozoic sand plains and/or remnant surfaces	Not a Wetland	Woodland	Eucalyptus crebra	Corymbia clarksoniana	Corymbia citriodora	Eucalyptus molluccana				
11.5.3	Tertiary residuals (sand, clay and gravels)	No concern at present	366000	Eucalyptus populnea +/- E. melanophloia +/- Corymbia clarksoniana woodland on Cainozoic sand plains and/or remnant surfaces	Not a Wetland	Woodland	Eucalyptus populnea	Eucalyptus melanophloia	Corymbia clarksoniana	Eucalyptus cambageana				
11.5.5	Lateritic plateaus, gravels and residuals	No concern at present	138000	Eucalyptus melanophloia, Callitris glaucophylla woodland on Cainozoic sand plains and/or remnant surfaces. Deep red sands	Not a Wetland	Woodland	Eucalyptus melanophloia	Eucalyptus populnea						
11.5.9	Lateritic plateaus, gravels and residuals	No concern at present	238000	Eucalyptus crebra and other Eucalyptus spp. and Corymbia spp. woodland on Cainozoic sand plains and/or remnant surfaces	Not a Wetland	Woodland	Eucalyptus crebra	Eucalyptus melanophloia	Corymbia citriodora	Corymbia clarksoniana				
11.5.15	Tertiary residuals (sand, clay and gravels)	Endangered	15000	Semi-evergreen vine thicket on Cainozoic sand plains and/or remnant surfaces	Not a Wetland	Closed Forest	Acacia harpophylla	Eucalyptus thozetiana	Flindersia australis	Flindersia collina	Brachchition sp			
11.5.16	Tertiary residuals (sand, clay and gravels)	Endangered	4000	Acacia harpophylla and/or Casuarina cristata open forest in depressions on Cainozoic sand plains and remnant surfaces	Palustrine	Open Forest	Acacia harpophylla	Casuarina cristata						
11.5.18	Tertiary residuals (sand, clay and gravels)	Of concern	3000	Micromyrtus capricornia open shrubland on Cainozoic sand plains and/or remnant surfaces	Not a Wetland	Open Shrubland								
11.5.20	Alluvium (flood plain)	No concern at present	152000	Eucalyptus moluccana and/or E. microcarpa and/or E. woollsiana +/- E. crebra woodland on Cainozoic sand plains	Not a Wetland	Woodland	Eucalyptus moluccana	Eucalyptus microcarpa	Eucalyptus woollsiana					
11.7.1	Lateritic plateaus, gravels and residuals	Of concern	76000	Acacia harpophylla and/or Casuarina cristata and Eucalyptus thozetiana or E. microcarpa woodland on lower scarp slopes on Cainozoic lateritic duricrust	Not a Wetland	Woodland	Eucalyptus thozetiana							
11.7.2	Lateritic plateaus, gravels and residuals	No concern at present	358000	Acacia spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone	Not a Wetland	Woodland	Acacia shirleyi	Acacia harpophylla						
11.8.4	Undulating basalt plains	No concern at present	151000	Eucalyptus melanophloia woodland to open woodland on Cainozoic igneous rocks.	Not a Wetland	Woodland	Eucalyptus melanophloia	Eucalyptus crebra	Eucalyptus orgadophila	Corymbia erythrophloia				
11.8.5	Undulating basalt plains	No concern at present	344000	Eucalyptus orgadophila open woodland on Cainozoic igneous rocks	Not a Wetland	Open Woodland	Eucalyptus orgadophila	Corymbia erythrophloia						
11.8.7	Undulating basalt plains	Of concern	2000	Shrubland to low open forest on Cainozoic igneous rocks	Not a Wetland	Shrubland	Acacia aprepta	Acacia julifera						
11.8.11	Undulating basalt plains	Of concern	169000	Dichanthium sericeum grassland on Cainozoic igneous rocks	Not a Wetland	Tussock Grassland	Corymbia erythrophloia							

11.9.1	Fine grained sandstones	Endangered	53000	Acacia harpophylla-Eucalyptus cambageana woodland to open forest on fine-grained sedimentary rocks	Not a Wetland	Open Forest	Eucalyptus cambageana	Eucalyptus thozetiana	Acacia harpophylla						
11.9.5	Fine grained sandstones	Endangered	161000	Acacia harpophylla and/or Casuarina cristata open forest to woodland on fine-grained sedimentary rocks	Not a Wetland	Open Forest	Acacia harpophylla	Casuarina cristata							
11.9.7	Fine grained sandstones	Of concern	103000	Eucalyptus populnea, Eremophila mitchellii shrubby woodland on fine-grained sedimentary rocks	Not a Wetland	Woodland	Eucalyptus populnea								
11.10.1	Sandstone hills, plateus and escarpments	No concern at present	851000	Corymbia citriodora woodland on coarse-grained sedimentary rocks	Not a Wetland	Woodland	Eucalyptus crebra	Eucalyptus hendersonii							
11.10.3	Coarse grained sandstones	No concern at present	335000	Acacia shirleyi or A. catenulata open forest on coarse-grained sedimentary rocks. Crests and scarps	Not a Wetland	Open Forest	Acacia shirleyi	Acacia catenulata							
11.10.5	Sandstone hills, plateus and escarpments	No concern at present	27000	Eucalyptus sphaerocarpa +/- E. mensalis, E. saligna open forest on coarse-grained sedimentary rocks. Tablelands	Not a Wetland	Open Forest	Eucalyptus sphaerocarpa	Eucalyptus saligna	Eucalyptus mensalis						
11.10.12	Sandstone hills, plateus and escarpments	No concern at present	44000	Eucalyptus populnea woodland on medium to coarse-grained sedimentary rocks	Not a Wetland	Woodland	Eucalyptus populnea								
11.10.13	Sandstone hills, plateus and escarpments	No concern at present	391000	Eucalyptus spp. and/or Corymbia spp. open forest on scarps and sandstone tablelands	Not a Wetland	Open Forest	Eucalyptus cloeziana	Eucalyptus melanoleuca	Eucalyptus sphaerocarpa	Corymbia bunites					

Appendix G Site-specific Groundwater Flow Model Construction Report

TERRA SANA CONSULTANTS

GROUNDWATER MODELLING REPORT

Mahalo North Project

PREPARED FOR COMET RIDGE LIMITED

TERRA SANA CONSULTANTS

Mahalo North Groundwater Modelling Report

Comet Ridge Limited

Document Control

Issue No	Date	Prepared by	Reviewed by	Distributed to	Version
0	12 September 2023	Dr Przemeck Nalecki, Principal Hydrogeologist.	Dr Grazia Gargiulo, Principal Consultant.	Simon Garnett, Environmental Advisor. Ryan Morris, Principal Hydrologist	Draft
1	14 September 2023	Dr Przemeck Nalecki, Principal Hydrogeologist.	Dr Grazia Gargiulo, Principal Consultant.	Simon Garnett, Environmental Advisor. Ryan Morris, Principal Hydrologist	Final

Abbreviations

Abbreviation	Description
AGMG	Australian Groundwater Modelling Guidelines National Centre for Groundwater Research and Training, National Water Commission, June 2012
AHD	Australian Height Datum
bgl	below ground level
BHP	Bottom Hole Pressure
CMA	Cumulative Management Area
Comet	Comet Ridge Limited
CSG	Coal Seam Gas
DTM	Digital Terrain Model
GDEs	Groundwater Dependent Ecosystems
GIA	Groundwater Impact Assessment
GIA Report	Mahalo North CSG Development. Groundwater Impact Assessment" prepared by RDM Hydro, 2023
OGIA	Office of Groundwater Impact Assessment
PEST	Model-Independent Parameter Estimation
Project	Mahalo North Project
SP	Stress Period
TSC	Terra Sana Consultants
UWIR	Underground Water Impact Report

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1. Introduction

Terra Sana Consultants Pty Ltd (TSC) was engaged by Comet Ridge Limited (Comet) to undertake numerical groundwater modelling for the Mahalo North Project.

2. Background

Comet proposes to develop the Mahalo North Project (herein referred to as "The Project") to produce Coal Seam Gas (CSG) from coals within the Bandanna Formation in the Bowen Basin, QLD.

The Project is planned to commence in 2024, with the first well production expected to begin in October of the same year. The development plan includes 34 horizontal wells, each with a vertical intercept, as well as surface facilities and associated infrastructure.

This report is a technical description of a site groundwater numerical model developed to support Groundwater Impact Assessment (GIA) required for the Project.

This report should be read in conjunction with the GIA Report (refer to "Mahalo North CSG Development. Groundwater Impact Assessment" prepared by RDM Hydro, 2023). All the geological and hydrogeological information and conceptual model required to develop this numerical model are described and discussed in the GIA Report.

The GIA Report also sets the context for and describes the details of Surat Cumulative Management Area (CMA) Underground Water Impact Report (UWIR) numerical groundwater flow model developed by the Office of Groundwater Impact Assessment (OGIA) and used to provide the potential Project case and Cumulative case drawdown predictions for the proposed development.

The model described in this report (referred to as the site-specific numerical groundwater model in The GIA Report) was used to supplement the results of the OGIA modelling.

Its primary purpose is to focus on evaluating the uncertainties associated with the local geological structures not included in the OGIA model and the hydraulic properties of the Tertiary Strata. This is particularly significant as most groundwater receptors are situated in these surficial aquifers.

3. Groundwater Modelling Objectives

The main objective of this site-specific groundwater model was to complement the OGIA model predicted groundwater impacts and assess the uncertainties related to the mapped local faults in close proximity to the Project area and the hydraulic properties of the Tertiary Strata on the predicted drawdown in the surficial aquifers.

To accomplish this objective, the model:

- Utilised site-specific geological data provided by Comet.
- Incorporated unsaturated flow modeling code to represent dual phase flow (water and gas) in a single phase Modflow model.

- Undergone history matching to the results of CSG pilot test data from the Project site.
- Presented the outcomes of a series of focused uncertainty analyses conducted to address the primary goal of the modeling exercise.
- Generated time-series model output for selected locations of interest for the GIA report.

4. Modelling Approach

Applied modelling workflow have been separated into stages, presented graphically in the Figure 1 below.

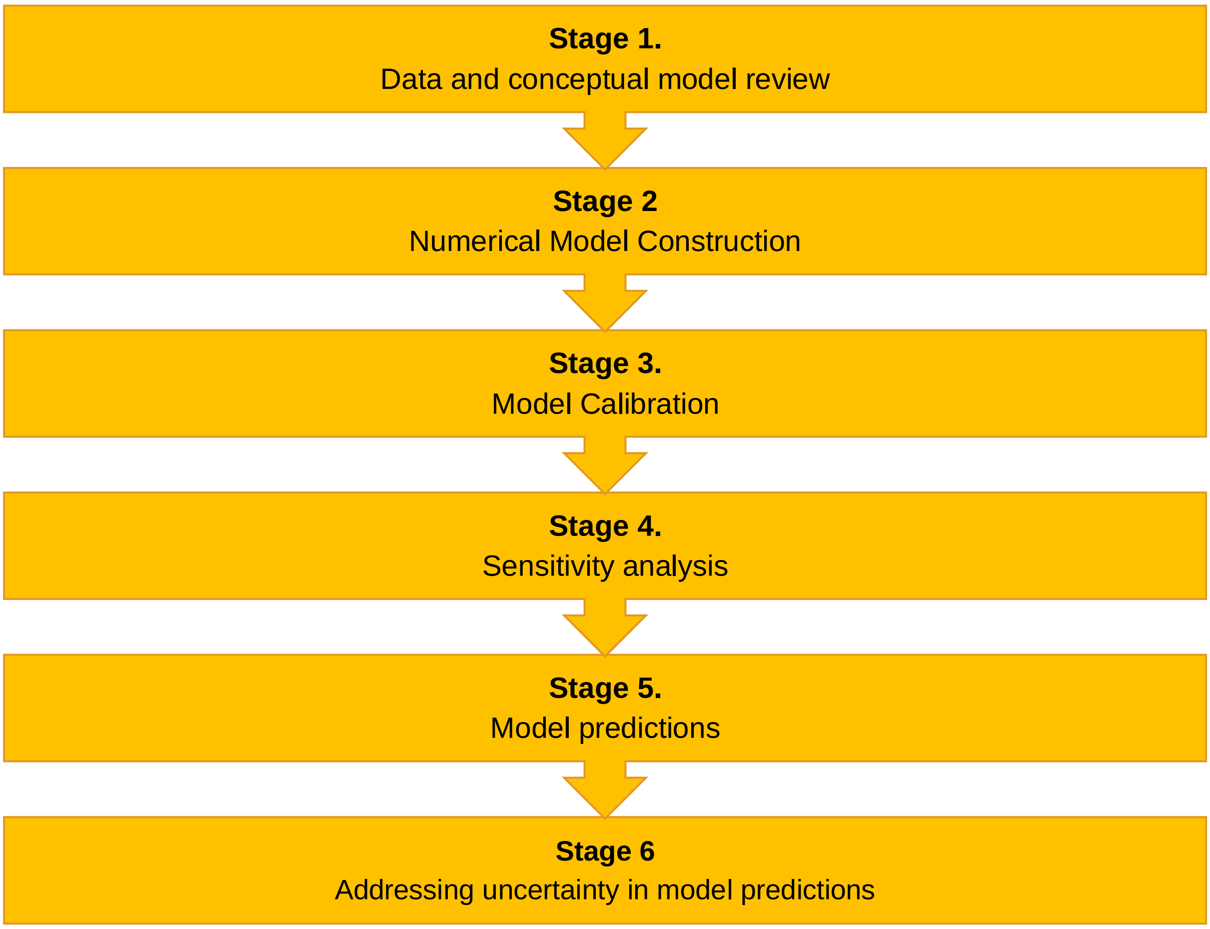


Figure 1. Numerical Modelling Workflow.

The stages depicted in Figure 1, adhere to the recommended best practice approach outlined in Australian Groundwater Modelling Guidelines (AGMG), National Centre for Groundwater Research and Training, National Water Commission, June 2012. A detailed description of these stages is provided later in this report.

5. Model Confidence Level Classification

According to (AGMG), the model confidence level is typically dependent on a set of criteria, including:

- Data availability.

- Calibration procedures.
- The consistency between the calibration procedures and predictive analysis.
- Level of stresses applied in the predictive model.

Based on the understanding of the project, data and information collected during the model development, the current level of confidence in the model can be classified as a Class 1 model.

The rationale for this classification is presented in Table 1 below, which relies on the classification level guidelines presented in AGMG.

Table 1. Model confidence level justification.

Compliance Criteria	Comment
Data	• Observations and temporary measurements from the Project site are limited. • There is only a limited data representing aquifer response to hydraulic stress.
Calibration	• Calibration is considered reasonable however calibration data-set used for calibration is of limited temporal extent compared to the predictive model time frame
Prediction	• Predictive model time frame far exceeds that of calibration. • Level of hydraulic stress applied in the predictive model is of different spatial extent than the one available in the calibration dataset.

In many situations, a Class 1 model is developed as an initial stage of the modelling investigation where there is insufficient data to support a model of Class 2 or 3. In these situations, the Class 1 model serves as an initial assessment of the problem and it is subsequently refined and improved to higher classes models as additional data becomes available (often from a monitoring campaign that demonstrates groundwater response to a development).

6. Conceptual Model Summary

The summary of the Conceptual model presented here is a copy of the conceptual model section presented in the GIA Report. This summary of the conceptual model is presented here only for the completeness of this technical report. All the details presented below are discussed in more detail in the GIA Report.

- The target for the CSG production is the Bandanna Formation of the Bowen Basin. The Bandanna Formation dips to southwest through the Project area, and subcrops beneath the Tertiary-aged strata in the north of the Project area. The Bandanna Formation comprises interbedded mudstone and siltstone with relatively thin coal seams that are regionally distinguishable but not regionally continuous. The coal seams are water (and gas) bearing, whereas the interburden forms aquitards. Small scale faulting may connect the individual coal seams.

- The Project will target CSG development at depth of roughly 120 m below ground level (bgl) to 220 mbgl. CSG will be produced via pairs of lateral and vertical wells. The laterals will be approximately 1,500 m long.
- The Tertiary-aged strata comprises basalt and sediments, which cover the majority of the Project area. The Tertiary Strata forms the main productive aquifer in the region. The aquifer is heterogeneous with limited lateral and vertical connectivity between individual water beds as evidenced by the variability in groundwater chemistry and water level responses to rainfall recharge.
- Quaternary-aged alluvium is associated with the Comet River and its larger tributaries. The alluvium is hydrogeologically dynamic, with fluctuations in water level (observed up to 1 m) directly related to rainfall events, and exhibiting water quality similar to surface water.
- The Rewan Formation, a regional scale aquitard, separates the Bandanna Formation from the overlying Tertiary Strata downdip of the sub-crop. At depth, the Bandanna Formation is significantly more saline that the Tertiary Strata, providing evidence of the low permeability of the Rewan Formation on sub-regional scale.
- There is a fault (Arcturus fault) to the southwest of the Project area. This fault may provide a conduit between the production zone and the Tertiary Strata. The hydraulic nature (sealing or conductive) of the fault is uncertain.
- The regional water table is hosted by the Tertiary Strata and is estimated to be at depths of between 20 mbgl and 40 mbgl across the Project area.
- It appears to be a downward hydraulic gradient between the Tertiary Strata and the underlying Bowen Basin geology. The hydraulic gradient between the Tertiary Strata and the alluvium varies depending on rainfall and location.
- The watercourses within the Project area are ephemeral and typically flow only during significant rainfall events. Pooled water may remain after significant rainfall events.
- Potential terrestrial Groundwater Dependent Ecosystems (GDEs) associated with the watercourses, if groundwater dependent at least in part, would likely source the groundwater from the alluvial sediments.
- The closest Spring complexes are present over 25 km to the west of the Project area and are associated with the Clematis Group. There is no mapped Clematis Group within the Project area.
- Groundwater is primarily used for stock purposes, with some irrigation use, and predominantly from the Tertiary Strata. There are no licensed groundwater allocations within the Project area.

7. Numerical Model Development

7.1. Software

The model was developed in MODFLOW-USG under Groundwater Vistas software version 8.30.

MODFLOW-USG (UnStructured Grids) allows to discretise the model domain with any grid geometry and varying degrees of cell sizes. This allows for definition of smaller cell size around the areas of interest which are not “carried through” the whole model structure, resulting in more accurate outcomes and reduced run-times.

7.2. Model Extent

The spatial model extent has been selected based on the following criteria:

- Model edges are sufficiently removed from the proposed development site to encapsulate expected (based on OGIA results) and possible impacts from Field Development activities.
- Model boundaries are aligned along surface water drainage lines (as much as possible).
- East model boundary is placed beyond the surface water divide to properly generate the location of surface water divide and provide adequate recharge to the model along the Clematis outcrops along the Expedition Range.
- West model boundary is placed along the major fault in the area.
- North and South model boundaries are placed at approximately 40 to 60 km away from the development site, sufficient to have no impact on model predicted groundwater drawdown.
- All model boundaries are position in such way to encapsulate OGIA predicted cumulative impacts.

The full model extend is approximately 115km by 110km. It is schematically presented in Figure 2.

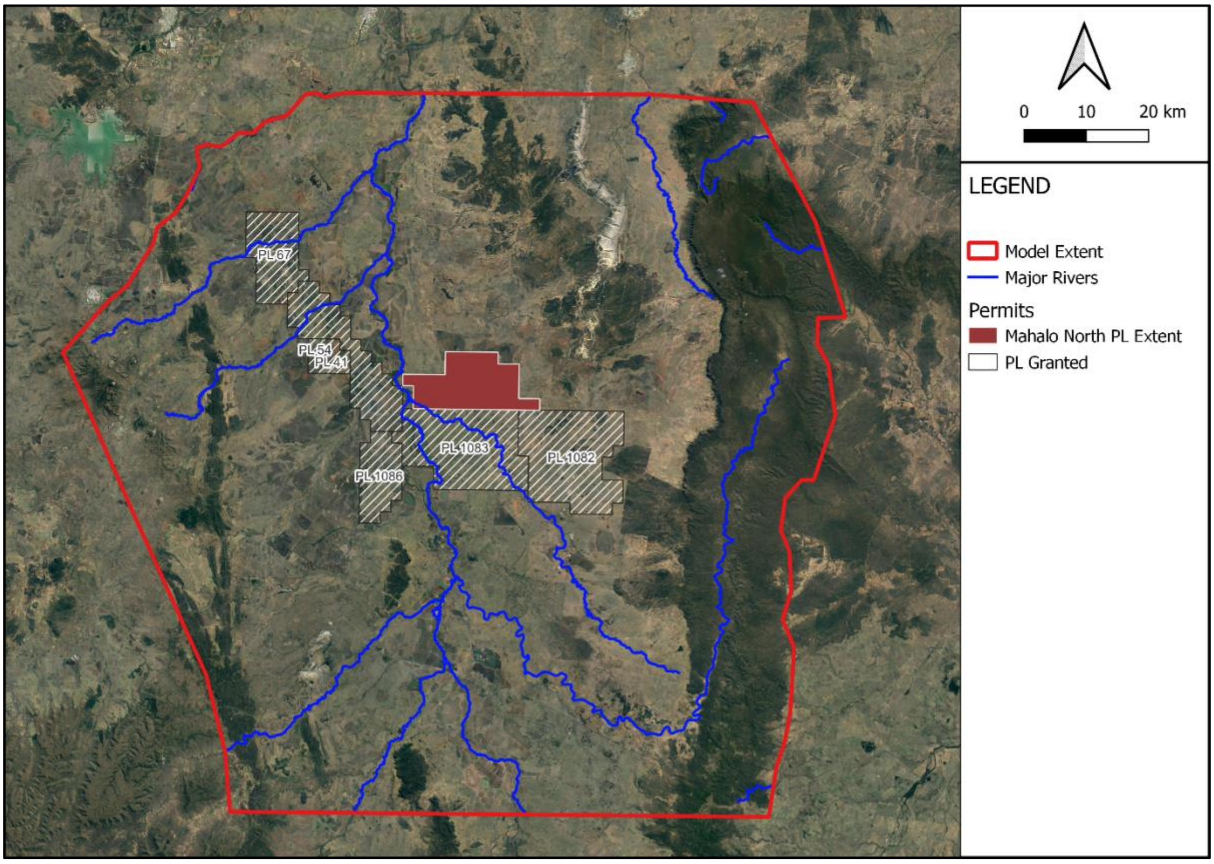


Figure 2. Model extent outline.

7.3. Model Grid

Model grid has been designed using unstructured grid and Quadtree Refinement approach. The outline of the model grid is presented in Figure 3 below.

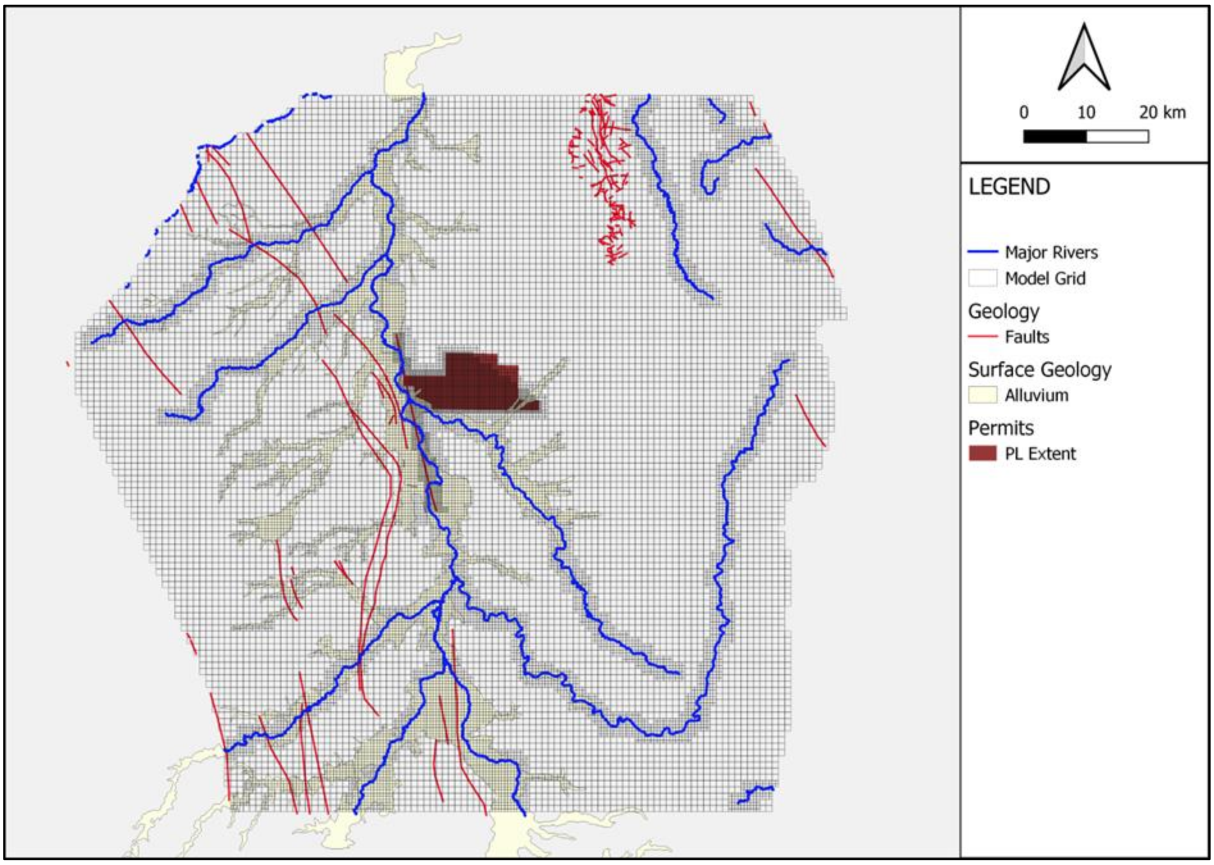


Figure 3. Model grid including mesh refinements at the location of the Mahalo North development.

The model grid size varies from 1000m x 1000m ("parent" grid size or refinement level 1) to 250m x 250m (refinement level 3).

The model cell size refinements level and their corresponding cell sizes are as follows:

- Level 1 refinement - 1000m x 1000m is the original uniform grid size covering the main area of the model away from any significant geological and hydrogeological features.
- Level 2 refinement – 500m x 500m is a refinement applied along the alluvial deposits and major rivers in the area.
- Level 3 refinement – 250m x 250m is a refinement applied to the proposed CSG wells and the Arcturus fault (for model results uncertainty analyses).

An initial attempt was made to use Quadtree Refinement on "per layer" basis. This approach allowed for greater model mesh refinements along the CSG production wells and the Arcturus fault, while maintaining a manageable number of model cells to ensure reasonable model run times.

However, this approach resulted in significant numerical instabilities during the test runs, caused by the presence of thin coal seams and their locally steep dipping gradients.

After a significant amount of time was dedicated to resolving this issue, the model design was reverted to the refinement configuration described earlier, in which all model layers share the same level of refinement. The final model consists of a total of 344,227 cells (nodes) distributed across 13 numerical layers.

7.4. Model Layers

The model consists of 13 numerical layers. The stratigraphic details of the layers are presented in Table 2 below.

Table 2. Model layers.

Model Layer	Main Hydro stratigraphy
1	Introduced to the model to accommodate Alluvial deposits. Outside of alluvium this layer represents the tertiary deposits and outcropping solid geology where appropriate.
2	Tertiary unit consisting of Basalt flows and Tertiary sediments.
3	Rewan
4	Rewan immediately above Bandanna. The layer is introduced for numerical reasons to smooth out transition between thick Rewan Formation and thin individual coal seams modelled within the Bandanna sequence.
5	Bandanna – Aries II
6	Bandanna Interburden
7	Bandanna – Aries III
8	Bandanna Interburden
9	Bandanna – Castor
10	Bandanna Interburden
11	Bandanna – Pollux
12	Bandanna Interburden
13	Lower Bowen

Model layer type was set to:

- Convertible Type 5 (USG unsaturated flow) for the coal seams.
- Convertible Type 4 (USG upstream water table) for the rest of the layers.

Layer elevations were based on regional data provided by OGIA and complemented with local data provided by Comet.

The merging of the two datasets was carried out in Surfer (by Golden Software) using “Mosaic” functionality, which allowed to “cut out” parts of OGIA surface grids and insert Comet datasets into these “holes” for the particular layers. The full dataset created was then gridded together to smooth out the edges along the merging lines.

- Layer 1 was introduced into the model to accommodate alluvial deposits within the modelled area. Within the alluvium, the thickness of the layer was set to constant 5m. Outside of the alluvial deposits, the layer represents the same geological and hydrogeological settings as Layer 2.
- Layer 2 primary represents Tertiary deposits including Basalt flows and Tertiary deposits. Northern and western parts of this layer represent outcropping older deposits where appropriate and eastern edge represents Clematis Sandstone outcrops (see Appendix A).

- Layer 3 represents Rewan Formation. Layer top and bottom were interpolated from layer elevation data provided by OGIA. Outside of Rewan deposits (particularly the eastern and northern parts of the model) the layer was set to a nominal 1m thickness and represents top of subcropping Lower Bowen deposits (Appendix A).
- Layer 4 represents Rewan immediately above Bandanna. The layer is introduced for numerical reasons to smooth out transition between thick Rewan Formation and thin individual coal seams modelled within the Bandanna sequence. Its thickness has been generally set to 3m.
- Layer 5 represents the Aries II seam. Layer top and bottom were interpolated from data provided by Comet. Its thickness outside of the development area was set to 0.55m, being an average of the thickness within the development area.
- Layer 6, 8 and 10 represent respective coal seams interburdens. These Layers' tops are equivalent to overlaying seams bottom elevation and layers bottom are equivalent underlying seams tops. Outside of the data extent provided by Comet, the thickness of the respective interburdens are set to an average of their thicknesses within the Comet data extent.
- Layer 7, 9 and 11 represent Aries III, Castor and Pollux seams. The logic applied to generate their geometry was the same as applied to Aries II seam described above.
- Layer 12 represent a layer between the bottom of Pollux seam and the base of the Bandanna Formation. Its thickness is an equivalent to the bottom elevation of the Pollux seam the the top of Lower Bowen data provided by OGIA.
- Layer 13 represents Lower Bowen deposits. The layer varies in thickness between 200m and 3000m and represents amalgamated Lower Bowen formations.

8. Boundary conditions

Groundwater entering and leaving the model is represented using boundary conditions, which have been applied in accordance with the conceptual model and understanding of groundwater flow regime in the area. The boundary conditions applied in the model are discussed below.

8.1. Rivers

The major rivers in the model area were represented using river boundary conditions but set up in a way which allowed for removal of water from the system only. This approach was consistent with the conceptual model and measurements from the gauging stations, suggesting intermittent flow following the major rainfall events only.

The river stage (elevation) was set to 2m below the Digital Terrain Model (DTM) elevation, with river bottom set at the same elevation to allow for water removal only (no recharge from the river). The river conductance applied in the model was based on the assumption of vertical K of river-bed of 1e-2 m/d. River width was assumed a constant 10m throughout, and river length within the model cell was calculated as a length of river polygon located within that particular cell.

The location of river boundary conditions in the model is present in the Figure 4.

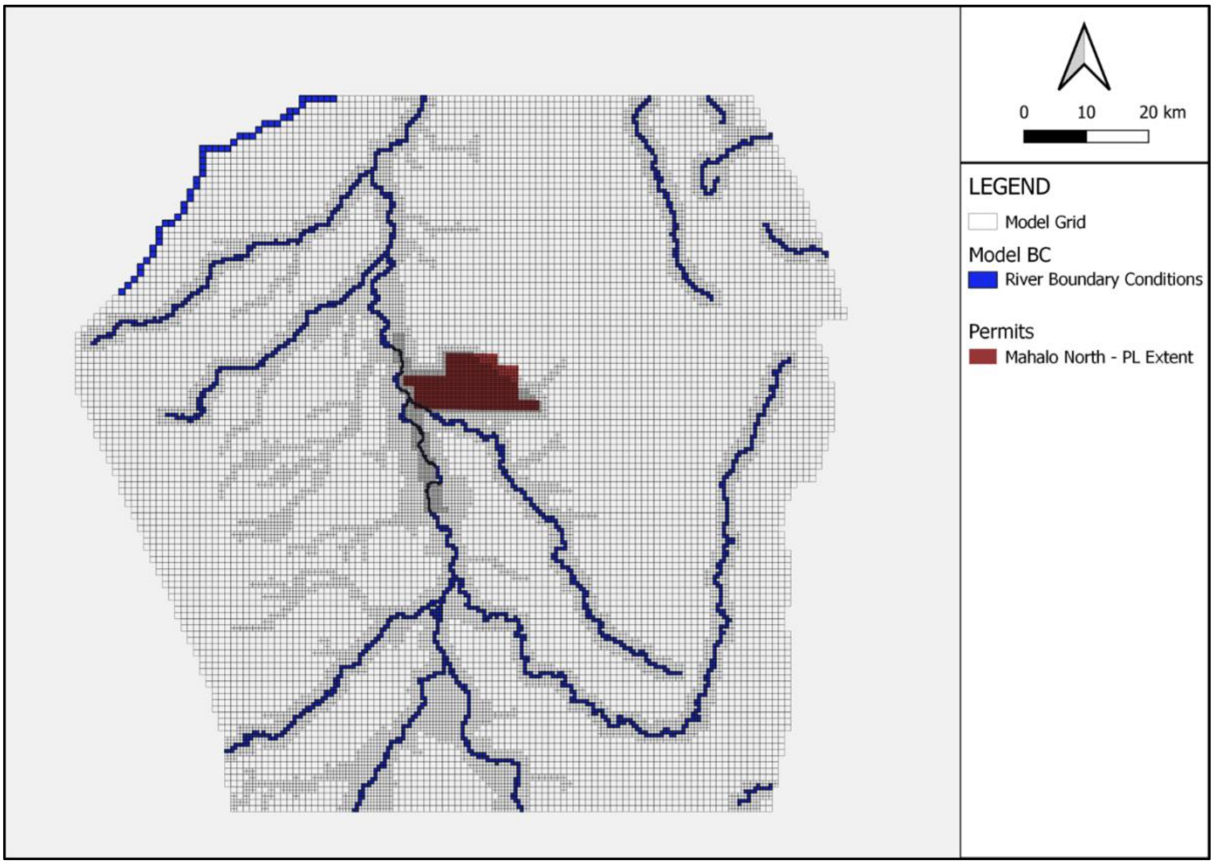


Figure 4. River boundary conditions (Blue cells).

8.2. Recharge

Rainfall recharge to the groundwater system was represented as 8 distinctive zones (Figure 5) representing recharge to each of the outcropping geological formations (7 zones), plus an extra zone number 8 located within the hills on the western edge of the model.

The recharge values applied in the particular zone were estimated using PEST (Model-Independent Parameter Estimation Software) during the steady-state calibration (history matching) of the model.

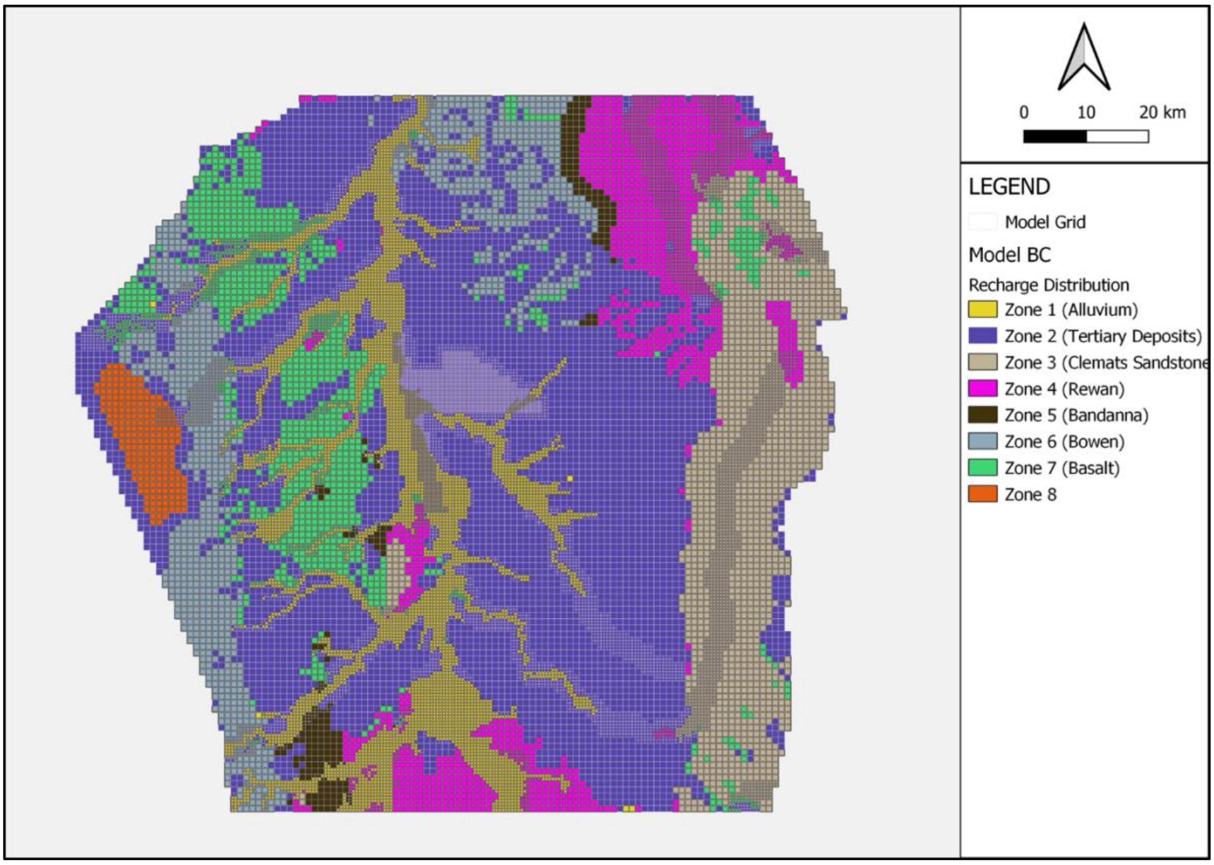


Figure 5. Recharge zonation in the model.

8.3. Evapotranspiration

Groundwater evapotranspiration was applied uniformly across the entire model to simulate groundwater plant intake and evaporation from shallow water table. The evapotranspiration rate was set to 1.0 e-4 m/d and extinction depth was set to 2m.

8.4. Faults

There is a number of regional faults cutting through Bandanna Formation and Rewan, within the area covered by the model domain. All faults except the closest fault to the development area (Arcturus fault) were set as flow barriers with fault zone thickness varying between 25m (major fault structures) and 10m (smaller faults within the regional faulting system) and hydraulic conductivity of 1e-9 m/d. Arcturus fault was specifically designed in a way that its hydraulic conductivity and storage parameters can be tested during uncertainty analyses to test its impact on the groundwater head within the shallow aquifers in the area (Alluvium, Basalt and Tertiary deposits).

8.5. Bandanna Outflow

Constant Head cells have been placed along the northern edges of the modelled coals to assist with simulating correct groundwater gradient and outflows towards the north. The constant head cells at these locations provide only the outflow capacity for the groundwater flow.

8.6. CSG Wells

CSG wells were represented using drain boundary condition in Modflow. The elevation of the drains was lowered during well operation in a way that approximately 2 years into production the bottom hole pressure in a well was assumed to reach 50 psi (approximately 35m head), using an exponential equation to simulate faster Bottom Hole Pressure (BHP) decrease in the early phase of the well operation.

Drain conductance was set to 1 m^2/d to allow water to flow into the wells without any restrictions. This approach effectively assumes no skin effects associated with the wells, which provides a conservative assumption from the point of view of the extent of simulated cone of depression resulting from Field Development.

The well placement was based on Comet provided sectors and nominal development well locations. Majority of the wells were placed in the lowest seam (Pollux) based on the well type curve nomenclature, except for the A-central location where the wells were positioned in Aries III seam.

8.7. Two-phase Flow

The presence of a gas phase in the vicinity of CSG production wells has an impact on flow of water towards production wells. Dual phase flow (gas and water) results in reduction of water relative permeability as water saturation of coal seams decreases during gas production. This has an important effect on propagation of cone of depression away from those wells.

The modelling approach adopted for this study was based on methodology presented in (OGIA). This method is implemented into MODFLOW-USG using a modified form of the van Genuchten equation that allows desaturation to commence at a user-specified pressure head (equivalent to pressure at which gas desorption commences).

8.8. Model Pinch-outs

In parts of the proposed development, coal seams coalesce and hence there is a good hydraulic connection between them in the absence of the interburden. In these parts of the model the interburden was removed using Modflow USG "pinch-out" functionality, effectively connecting directly model nodes from the neighbouring coal layers and omitting the in-between interburden (equivalent on non-neighbour connections in Eclipse).

9. Hydraulic Parameters

The initial values of hydraulic parameters adopted for the model were based on data provided by OGIA, complemented with the results from a single well model history matching (Bandanna Coals).

Data provided by OGIA contained spatially distributed values of horizontal (kh) and vertical hydraulic conductivity (kv) and Specific Storage (Ss).

Processing of OGIA data included:

- selection of the area within approximately 25km from the development site,
- statistical analysis of the values of kh, kv and Ss.

Average values obtained through the analysis were applied to the geological formations within this model. Hydraulic parameters of Bandanna coals were based on the history matching exercise described in Section 9.1 Single well model history matching. Specific yield values for the particular geological units were estimated based on the literature data and experience from other Bowen Basin developments.

While applying hydraulic conductivity data to coal interburden, it was assumed that horizontal hydraulic conductivities in OGIA provided data for the Bandanna formation is likely to be more representative for kh for coals, while vertical hydraulic conductivity for the Bandanna formation be more representative for the kv for interburden.

The summary of the applied parameters is presented in Table 3 below.

Table 3. Value of hydraulic parameters used in the model.

Stratigraphy	Kh (m/d)	Kv (m/d)	Ss (1/m)	Sy (-)
Alluvium	20	2	1e-3	0.1
Basalt	0.6	0.1	1e-5	0.03
Rewan	3.5e-3	4e-7	6.3e-6	0.02
Clematis	0.3	0.03	1e-5	0.05
Bandanna Coals	2.0e-4	6e-6	1e-5	0.005
Bandanna Interburden	1e-5	1e-7	1e-5	0.01
Lower Bowen	5e-4	7e-7	7e-6	0.01

10. Model Calibration

Model calibration workflow included two stages:

- Single well model history matching aiming at replicating historical groundwater head changes recorded in Mahalo 1 during its testing in 2022.
- Steady state calibration of the regional model, representing pre-development conditions and aiming at replicating the general pattern of the groundwater potentiometric surface and the directions of groundwater flow consistent with the conceptual model in the area. Steady state calibration provided initial conditions for the subsequent transient model prediction.

Model calibration was carried out with the assistance of PEST.

10.1. Single Well Model History Matching

A single well model was constructed to calibrate (history match) groundwater heads and water production rates measured during Mahalo 1 pilot testing in 2022.

Mahalo-1 well schematic is presented below in Figure 6.

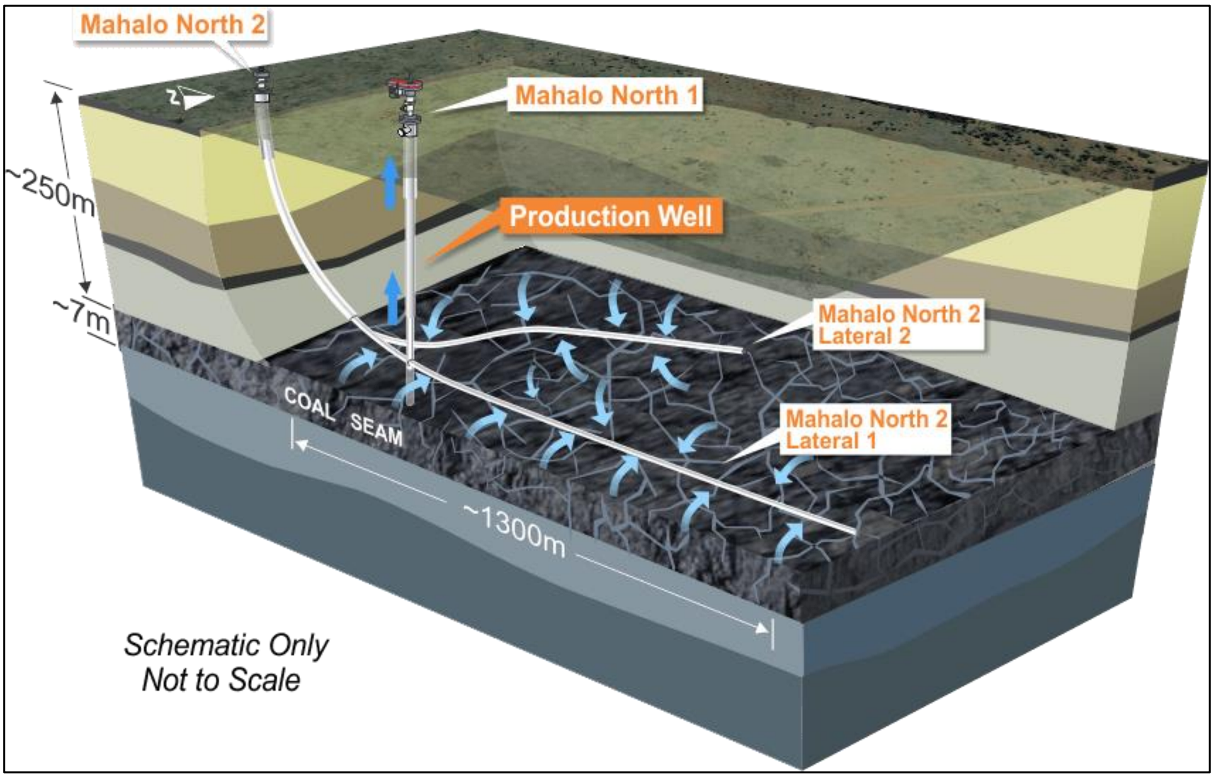


Figure 6. Mahalo - 1 well schematic.

Available pilot test data included (Figure 7):

- BHP, converted to groundwater head.
- Water production rates.
- Gas production rates (used only to estimate desorption pressure as MODFLOW is a single-phase model)

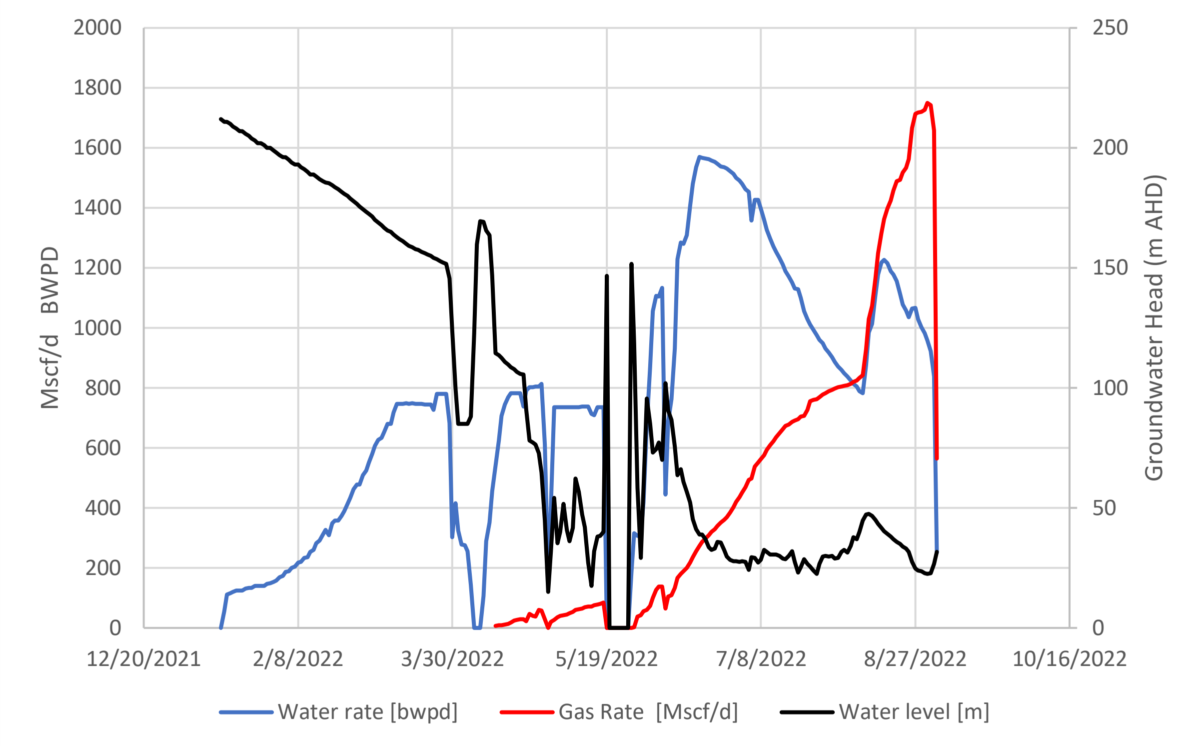


Figure 7. Mahalo 1 pilot test data.

To calibrate Mahalo-1, a single layer model of 5km x 5km was set up in Modflow USG using unstructured grid. Model cell size varied between 100m along model edges and 3.1m along and around Mahalo 1 well.

Model layer type was set to Type 5 to implement unsaturated flow characteristic with a bubble point (Modflow terminology as explained above in Boundary Conditions Section).

Available water rates have been converted from bwpd to m^3/d to unify with other Modflow units. Other parameters adopted for the modelling are summarised in Table 4 below. Mahalo 1 well was simulated using Modflow DRAIN package, with drain elevation following groundwater head elevation reported daily in Mahalo 1 pilot test data set.

Table 4. Mahalo 1 single well model assumptions

Parameter	Value	Unit	Comment
Surface Elevation @ Mahalo North 1	230	mAHD	approximate
Overburden thickness	250	m	approximate
Coal Seam Thickness	7	m	
Coal Top Elevation	-20	mAHD	
Coal Bottom Elevation	-27	mAHD	
Lateral 1 Length	1300	m	
Laterl 2 Length	584	m	
Total In-seam	1884	m	
Initial BHP	302	psi	from production data
Psi to mH2O conversion	0.70307	m/psi	
Initial Water Column	212.3	m	
Initial Head	188.8	mAHD	

Parameter	Value	Unit	Comment
Desorption Pressure (expressed in elevation for Modflow)	114.6	mAHD	from production data

Unsaturated flow parameters required for van Genuchten equation (Alpha, Beta, water residual saturation and Brooks-Correy exponent) were adopted from OGIA (refer to Groundwater Modelling Report, Surat CMA, October 2019).

History matching was carried out with the assistance of PEST. PEST was allowed to modify hydraulic conductivity, storage, drain conductance and unsaturated flow parameters during the calibration runs, in which it was trying to match groundwater head and water production rates to the values recorded during the pilot test.

The results of the calibration are presented in the Figure 8 and Figure 9. PEST estimated parameters are presented in Table 5.

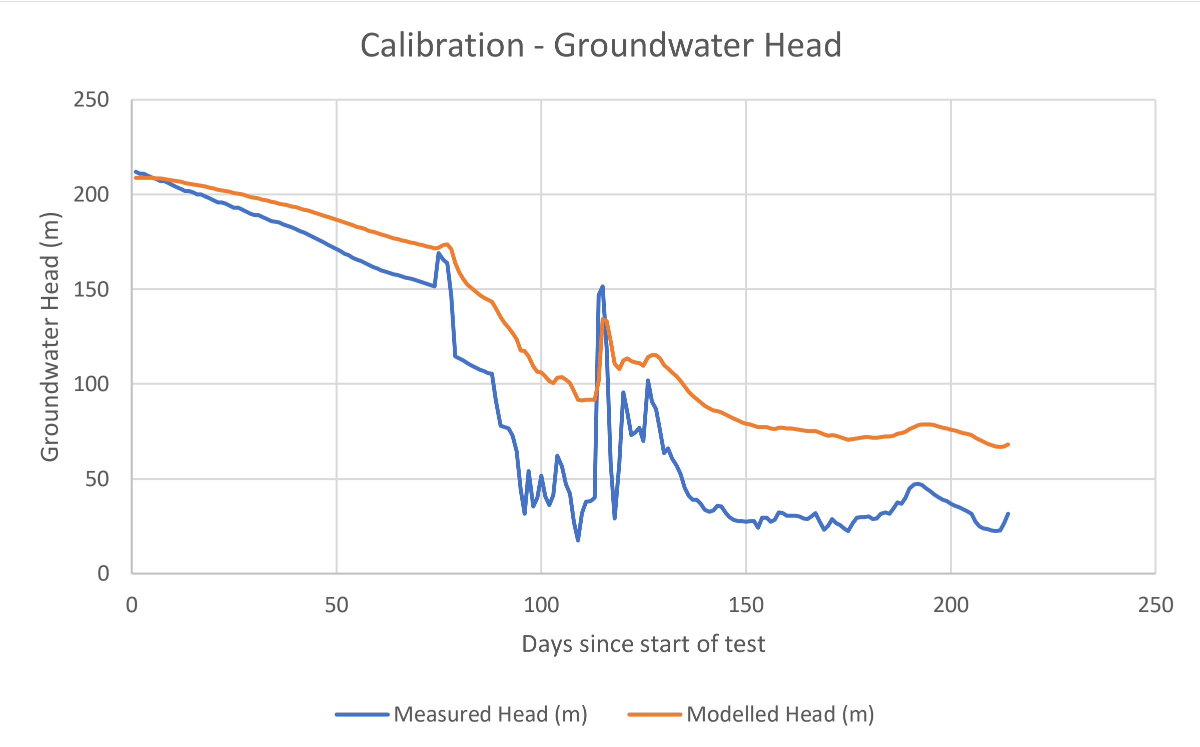


Figure 8. Mahalo 1 - Calibration results - Groundwater Head

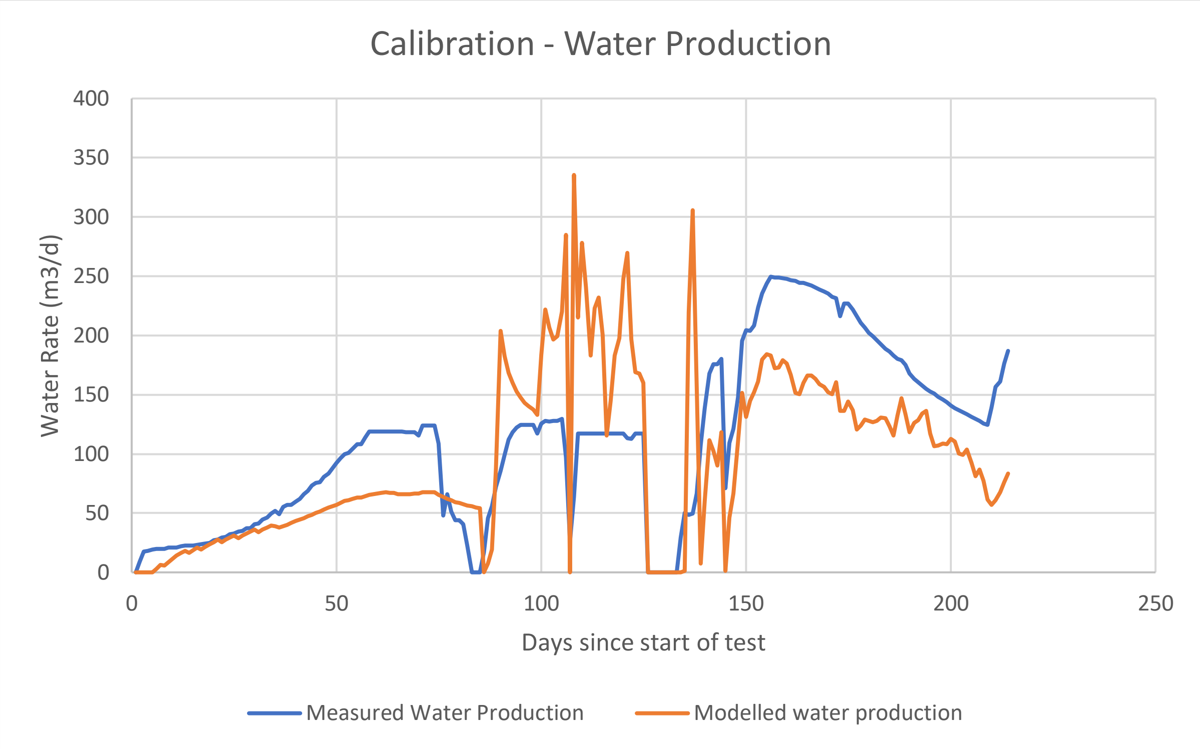


Figure 9. Mahalo 1 - Calibration results - Water Production.

Table 5. Mahalo 1 single well model calibrated parameters

Parameter	Value
Hydraulic conductivity	2e-4 m/d
Specific Storage	4.8 e-5 1/m
Drain conductance	7.9 e-3 m2/d
Alpha	1e-2
Beta	3.68
Sw	0.1
Brook	4.91

Calibrated parameters were then applied to Bandanna coals in the regional model.

10.2. Steady-state calibration

Steady-state calibration was carried out using available groundwater head data from water bores in the area, including:

- 44 bores in Alluvium.
- 336 bores in Basalt.
- 40 bores in Tertiary deposits.
- 43 bores in Bandanna.
- 51 bores in Lower Permian.

The location of calibration targets is presented in Figure 10 below, and the details of the bores used in the calibration are presented in Appendix B.

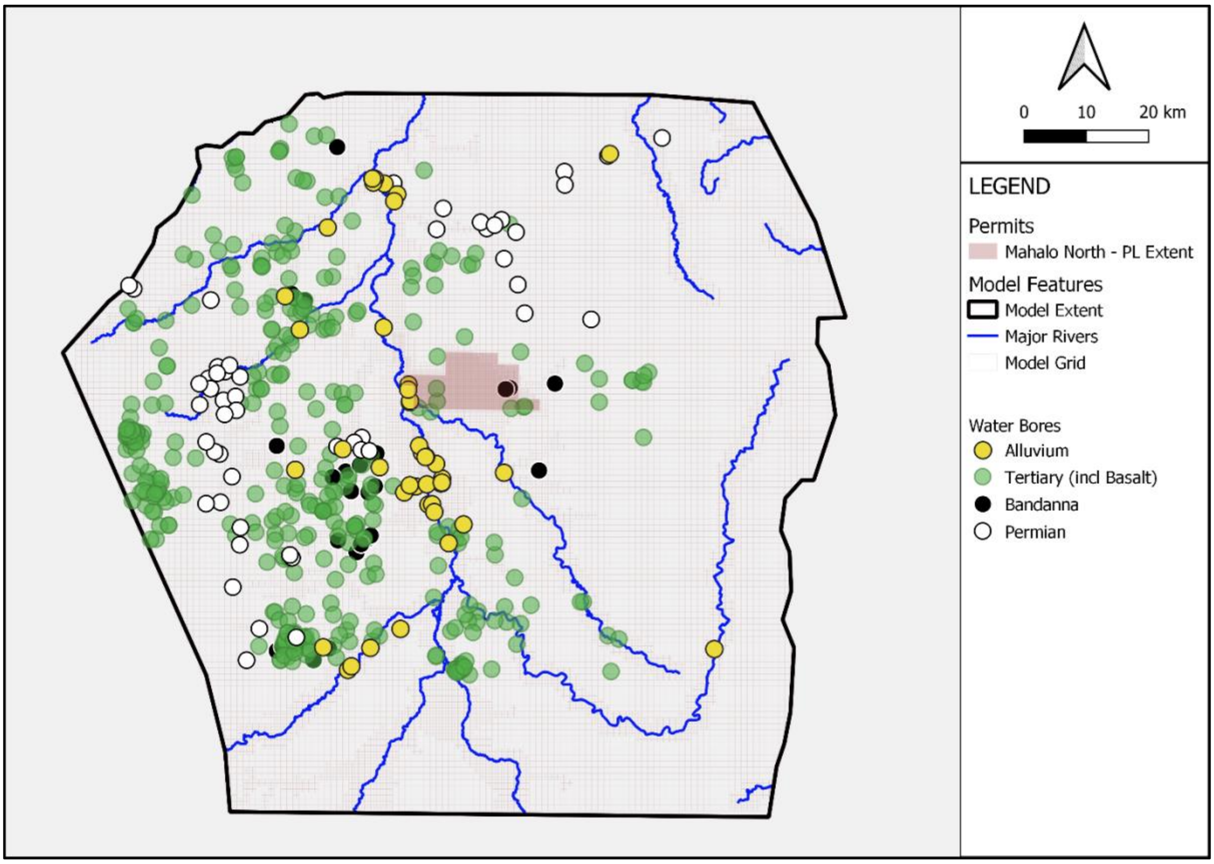


Figure 10. Location of calibration targets (steady-state calibration).

Steady state calibration of the regional model was carried out with PEST. The parameters adjusted during the calibration included:

- Recharge.
- Horizontal hydraulic conductivity.
- Vertical hydraulic conductivity.
- Elevation of constant head boundary conditions located in bandanna coals.

10.3. Steady State Calibration Results

The steady state model was calibrated to groundwater levels considered representative of the pre-mining groundwater conditions. A comparison between observed and computed groundwater head at the calibration targets is presented in Figure 11 below and in Appendix B.

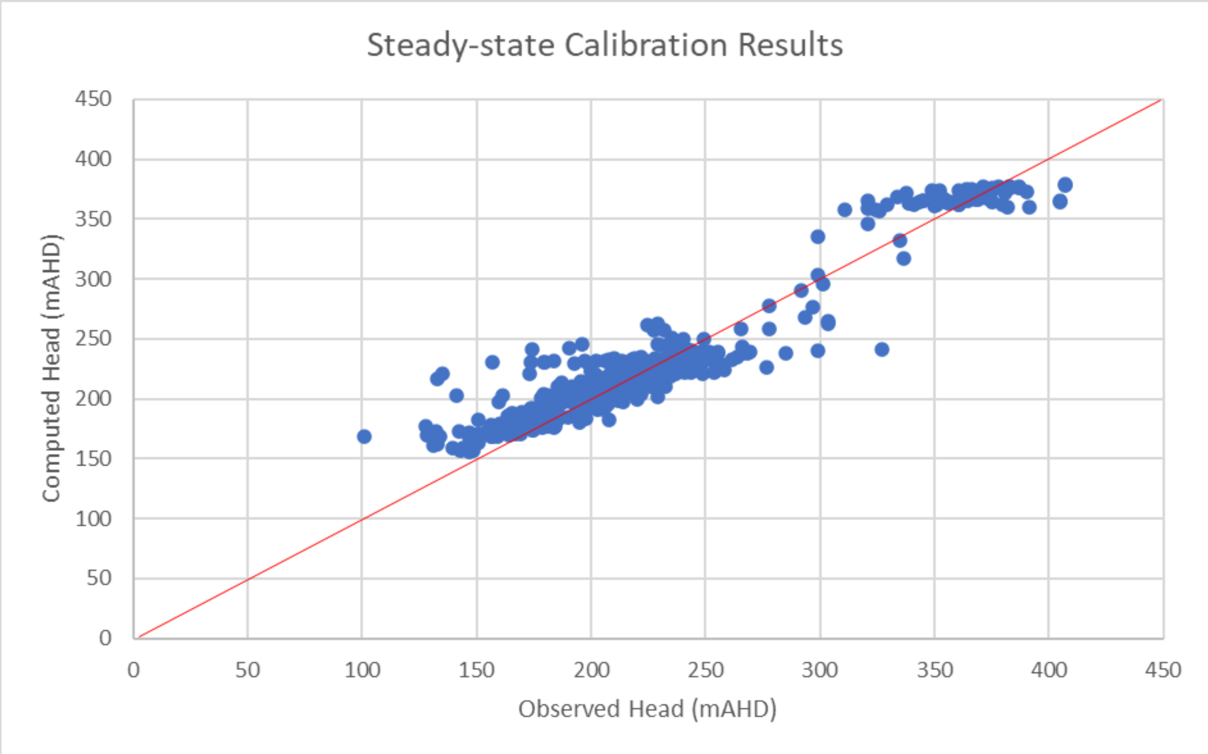


Figure 11. Observed vs. computed groundwater heads. Steady-state model calibration.

Steady-state calibration statistics are presented in Table 6 below.

Table 6. Steady-state calibration statistics.

Summary Statistics for Transient Calibration	
Number of Targets	515
Range in Observed Values	306m
Minimum Residual	-86.3m
Maximum Residual	85.7m
RMS Error	19.1
Scaled RMS Error	6.2%

10.4. Steady State Recharge

Calibrated steady-state groundwater recharge is presented in Table 7 below, recharge distribution in shown in Figure 12. The recharge varies between close to 0% and 3% of average annual rainfall, with the highest recharge applied to the Clematis outcrops and the lowest to Bandanna, Rewan and Lower Bowen outcrops.

Table 7. Calibrated groundwater recharge.

Formation	Model Recharge	% of average annual Rainfall
Alluvium	1e-9	negligible
Basalt / Tertiary deposits	3.13e-6	0.2%
Rewan	1e-9	negligible
Clematis	5e-5	3%
Bandanna	1e-9	negligible
Lower Bowen	1e-9	negligible

10.5. Steady-state Groundwater Heads

Groundwater heads generated by the steady-state model were used as a starting point for the subsequent transient calibration.

The generated initial groundwater heads are presented in Figure 12 below.

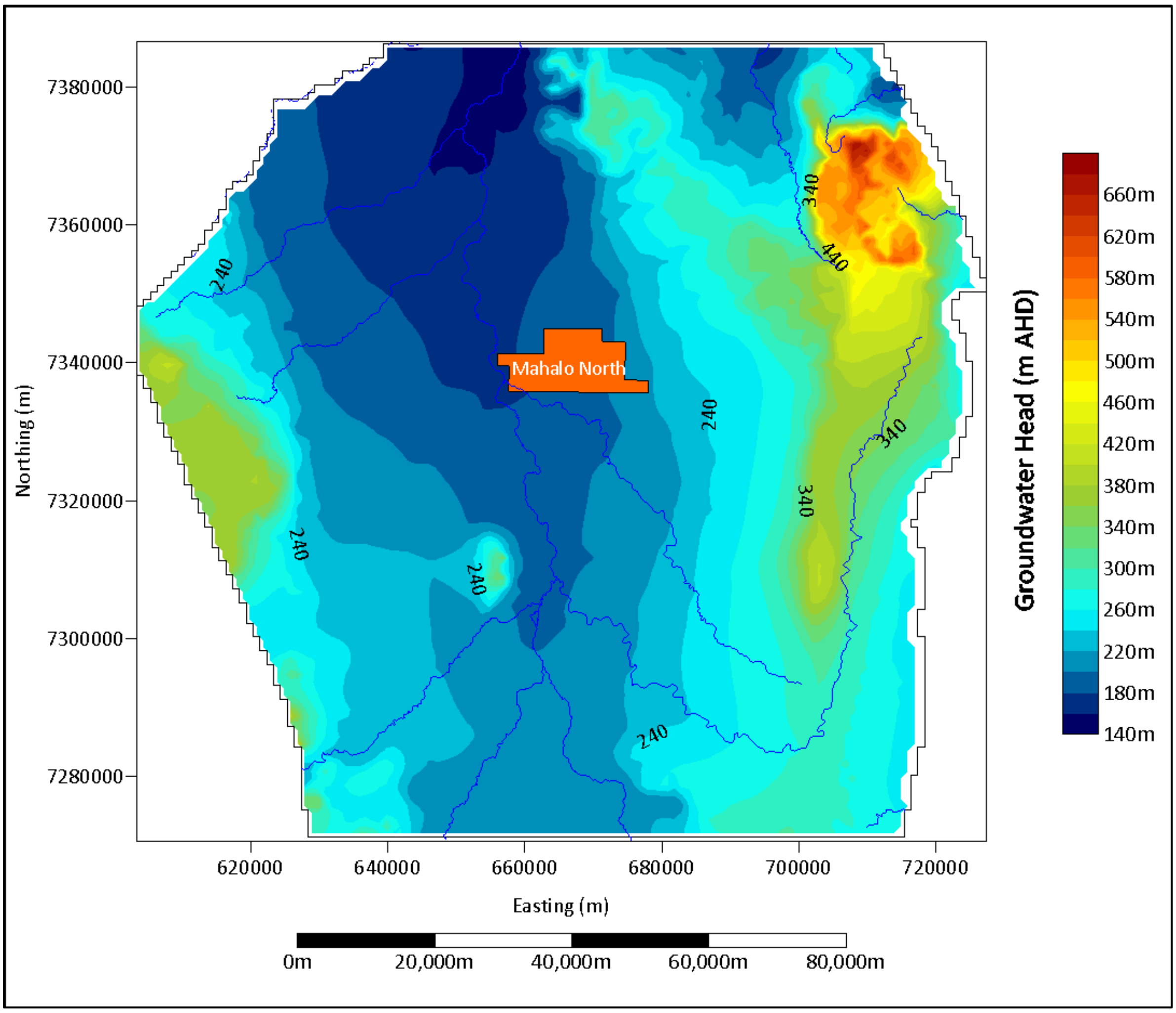


Figure 12. Steady-state model generated elevations of groundwater table (model Layer 1).

10.6. Steady State Water Budget

Steady state water budget for the model, representing groundwater conditions prior to the field development is presented in Table 8 below.

Table 8. Steady-state water budget.

Component	Inflow (m^3/d)	Outflow (m^3/d)
Recharge	106,739	0
EVT	0	43,036

Component	Inflow (m^3/d)	Outflow (m^3/d)
Rivers	0	5,764
Drains	0	57,893
CH	0	46
Totals	106,739	106,739
Error	-3.77e-6	

The difference between calculated model inflows and outflows (the error) is -0.000004. This mass balance error indicates that the model is stable with an accurate and converging numerical solution.

Drain outflow listed in the table above is related to the set of drains located along the eastern edge of the model, on the eastern side of Expedition Range and represent a shallow groundwater outflow to the neighbouring catchment, influenced by the highest (in the model) recharge rates along Clematis outcrops in this area.

11. Sensitivity Analysis

Sensitivity analyses were run on the calibrated transient model. The analysis was carried out with the assistance of PEST.

PEST adjusts the values of each of the selected for the analysis parameters, runs the model and calculates the impact of parameter modification on the model objective function (sum of squared differences between measured and computed head values in the observation bores). The biggest impact of a parameter on the objective function means the greater the sensitivity of model outputs to the selected parameter.

The parameters identified for the sensitivity analyses and their relative sensitivity are presented in Table 9 below and in Figure 13 (please note logarithmic scale on the figure). The parameter number relates to the property zone in which the parameter resides (Appendix A).

Table 9. Parameter sensitivity results.

Parameter Name	Parameter Group	Current Value	Sensitivity
r1	rech	1.00E-09	6.74E+03
r2	rech	3.13E-06	3.60E+04
r3	rech	4.98E-05	1.05E+02
r4	rech	1.00E-09	2.54E+03
r5	rech	1.00E-09	2.54E+03
r6	rech	1.00E-09	1.45E+04
r7	rech	3.13E-06	5.74E+02
r9	rech	4.26E-05	3.03E+01
kx1	kx	20	1.86E-02
kx2	kx	0.6	1.78E-01
kx3	kx	0.3	6.38E-03
kx4	kx	3.47E-03	1.80E-02
kx5	kx	2.00E-04	1.08E-01
kx6	kx	5.00E-04	6.19E-03
kx7	kx	0.6	1.29E-02

Parameter Name	Parameter Group	Current Value	Sensitivity
kz1	kz	2	1.02E-06
kz2	kz	0.1	2.68E-04
kz3	kz	3.00E-02	1.62E-04
kz4	kz	4.00E-07	3.39E-02
kz5	kz	6.00E-06	2.75E-03
kz6	kz	7.00E-07	2.25E-02
kz7	kz	0.1	8.31E-04
kx8	kx	1.00E-05	2.22E-05
kz8	kz	1.00E-07	2.46E-02
ss2	stor	1.00E-05	0.00E+00
ss3	stor	1.00E-05	0.00E+00
ss4	stor	6.30E-06	0.00E+00
ss5	stor	1.00E-05	5.98E+03
ss6	stor	7.00E-06	0.00E+00
ss7	stor	1.00E-05	0.00E+00
ss8	stor	1.00E-05	3.80E+01
sy1	stor	0.1	0.00E+00
sy2	stor	3.00E-02	0.00E+00
sy7	stor	3.00E-02	0.00E+00
sy5	stor	5.00E-03	9.63E-01

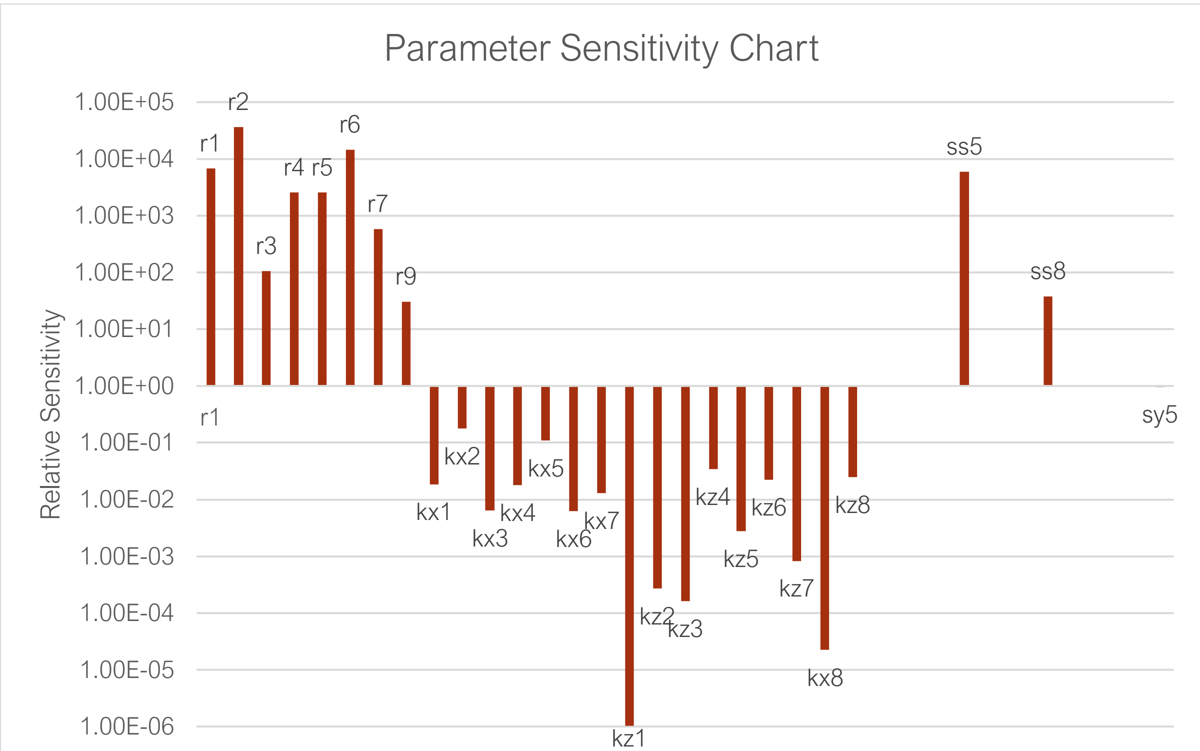


Figure 13. Parameter sensitivity chart.

It should be noted that the sensitivity run assessed parameters impacting model generated groundwater head changes, rather than spatial spread of cone of depression or predicted water production rates.

12. Model Predictions – Base Case

12.1. Model Timing

The Base Case predictive model was run from the end of September 2024 (water production from the proposed development wells starts 1/10/2024) until the end of 2355 (approximately 330 years) to investigate the potential long-term impact of CSG extraction on the surrounding groundwater regime and local groundwater users.

The stress period (SP) length was varied during the simulation as follows:

- Quarterly from the start of the model run until the end of field operation (30/09/2059) to align model input with the well production data provided by Comet.
- Quarterly for an additional year past the end of field production to provide better time resolution during the fastest pace of groundwater recovery following deactivation of the CSG wells.
- The SP length was then increased by a factor of 1.2 until the end of the model run.

Each stress period was divided into 3-time steps, which subsequent length was increasing by factor of 1.2.

12.2. CSG Wells Representation

Comet proposes to drill a total of 34 horizontal wells, each equipped with a vertical intercept for groundwater production. The location of the wells including well number is presented below in Figure 14.

As explained earlier, CSG wells were represented using drain boundary condition in Modflow. The elevation of the drains was lowered during well operation in a way that approximately 2 years into production the bottom hole pressure in a well was assumed to reach 50 psi (approximately 35m head), using an exponential equation to simulate faster BHP decrease in the early phase of the well operation.

Each of the wells has its own calculated function representing pace of groundwater head lowering to accommodate different elevations of initial groundwater head and depths at which the wells are located.

Following the end of the field life, the drain cells were deactivated to allow groundwater recovery process.

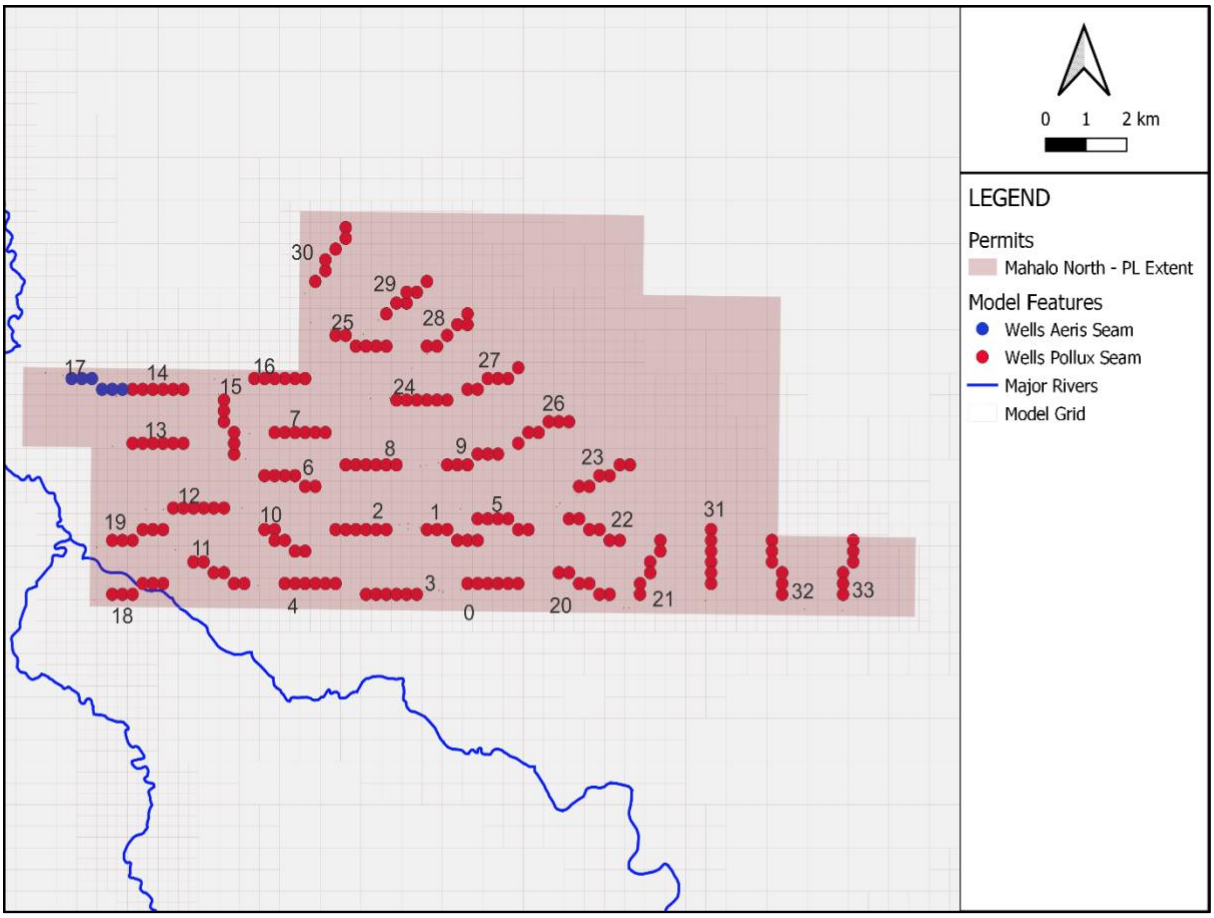


Figure 14. Location of simulated CSG wells.

12.3. Water Production

Comet supplied expected water production rates and volumes are presented in Figure 15.

The plot shows all individual well type curves stacked according to the timing of drilling campaign and well online activity. The cumulative water production volume is also presented, totalling approximately 1.1GL over the life of the field.

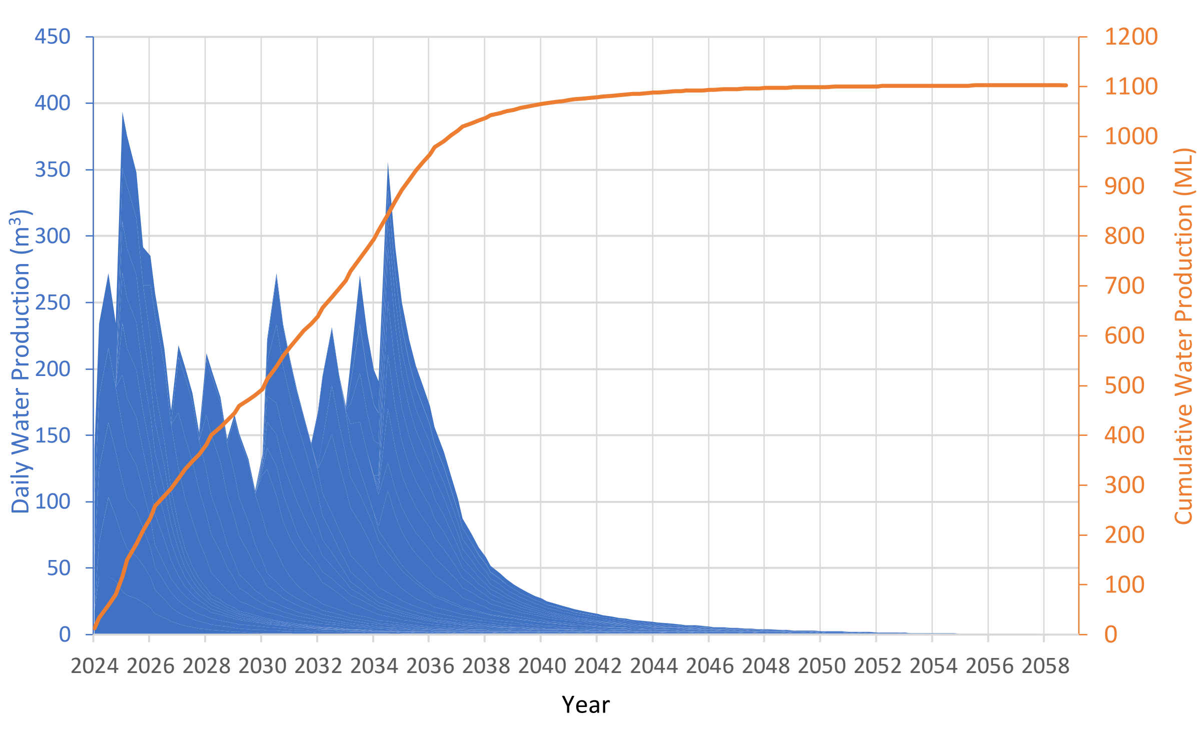


Figure 15. Water production rates and cumulative volume - Comet data.

Model generated cumulative water production is compared to the water production data provided by Comet in Figure 16.

Analysis of the plot indicates a comparatively slower rate of water production in this model when compared to the data provided by Comet. Nevertheless, it's noteworthy that the cumulative volumes closely align between the model and the provided data.

Horizontal wells can not be represented as discrete features in Modflow and are represented as a descending drain boundary condition instead, applied to model cells in which the wells are located. This has implications on simulated well's water extraction dynamics but not so much of cumulative water production volumes.

From the assessment of impact point of view, the "accuracy" of the cumulative water production volumes over the life of the project is most desired and likely to provide adequate long-term assessment of impact which is typically delayed in time.

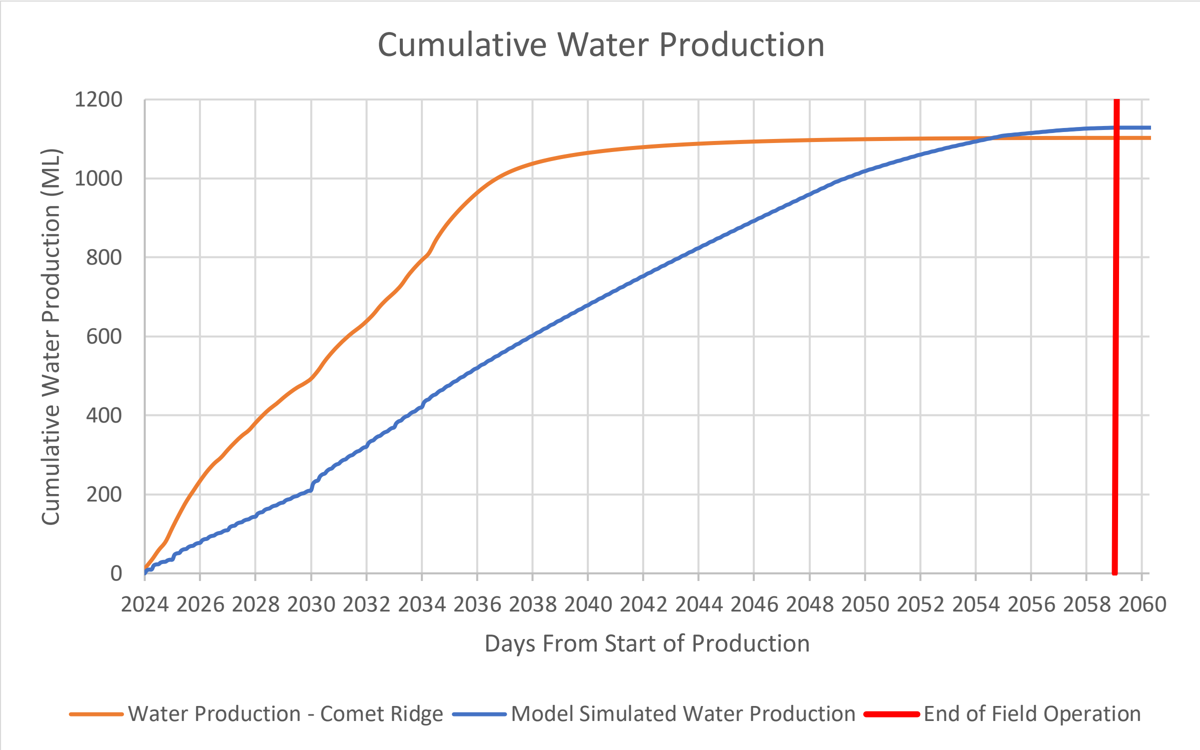


Figure 16. Comparison of model generated cumulative water production with Comet's expected water production – Base Case model.

12.4. Model Computed Drawdown

Presented model computed drawdown represents a maximum drawdown calculated in all model nodes in any time during the simulation. This is a different approach to typically presented drawdown at given time points, however, given the model objectives to demonstrate an impact on shallow aquifers and groundwater receptors (landholder bores, GDEs etc,) this approach is considered more informative as it presents the maximum expected drawdown in one plot, and covers the entire model simulation time and its outputs.

The *Water Act 2000* identifies the bore trigger threshold for water level decline as 5 m for a consolidated aquifer and 2 m for an unconsolidated aquifer. For spring impacts, the trigger threshold is defined as a water level decline of 0.2 m.

There was no drawdown exceeding the trigger threshold identified in surficial aquifers (alluvium, basalt and Tertiary deposits). The maximum drawdown predicted in model layer 2 representing Basalt and Tertiary deposits did not exceed 2cm, and 1cm in Layer 1 representing Alluvium.

Drawdown distribution in Bandanna (Pollux seam) is presented in Figure 17 below for 0.2m, 2m and 5m contours. Maximum drawdown predicted was in order of 300m.

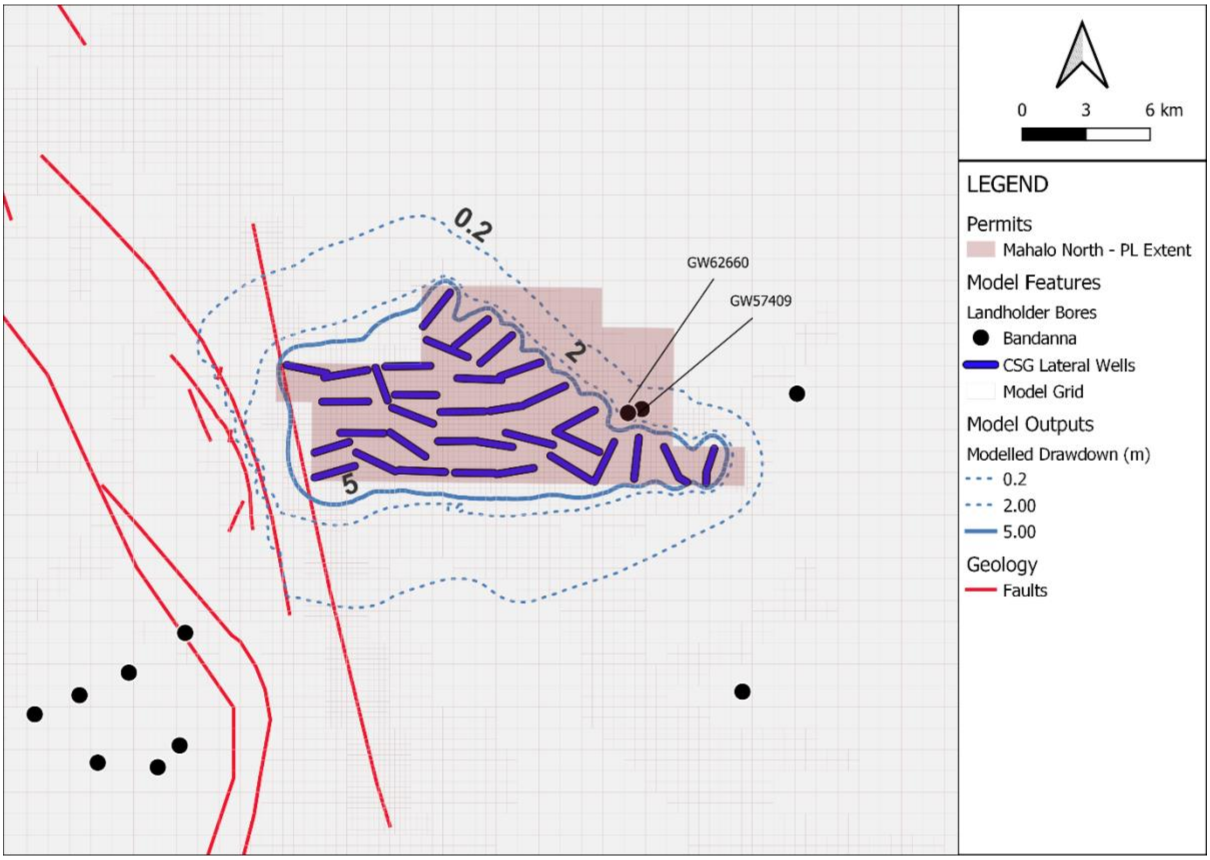


Figure 17. Base Case Scenario simulated drawdown in Bandanna (Pollux seam).

12.5. Groundwater Recovery

Groundwater drawdown and groundwater head recovery over time for the field is presented for Well # 4 (Figure 18).

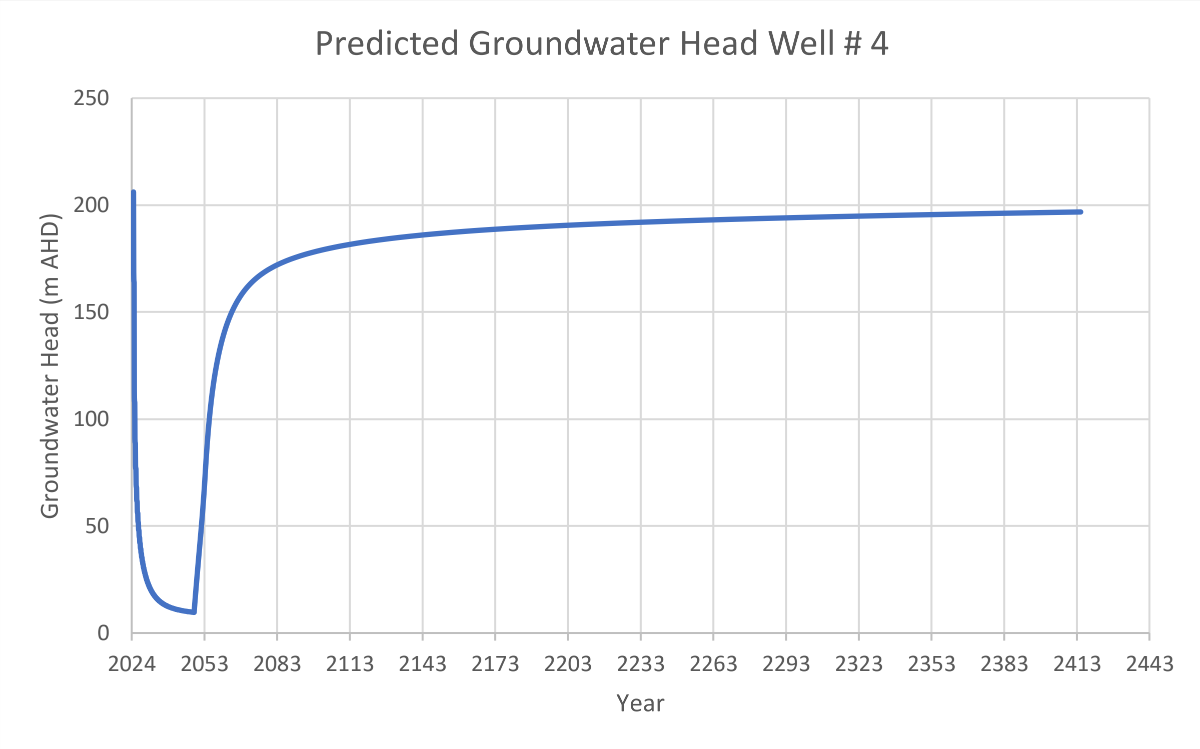


Figure 18. Simulated groundwater drawdown and recovery Well # 4.

The predicted drawdown in the closest to the Project Site landholder bores GW62660 and GW57409* located in Bandanna Coals is presented in Figure 19. It should be noted that the Base Case model predicted drawdown does not exceed 5m trigger threshold in neither of these bores.

Note: Groundwater bore GW57409 is described as "Abandoned and Destroyed" (refer to QLD Globe https://qldglobe.information.qld.gov.au).

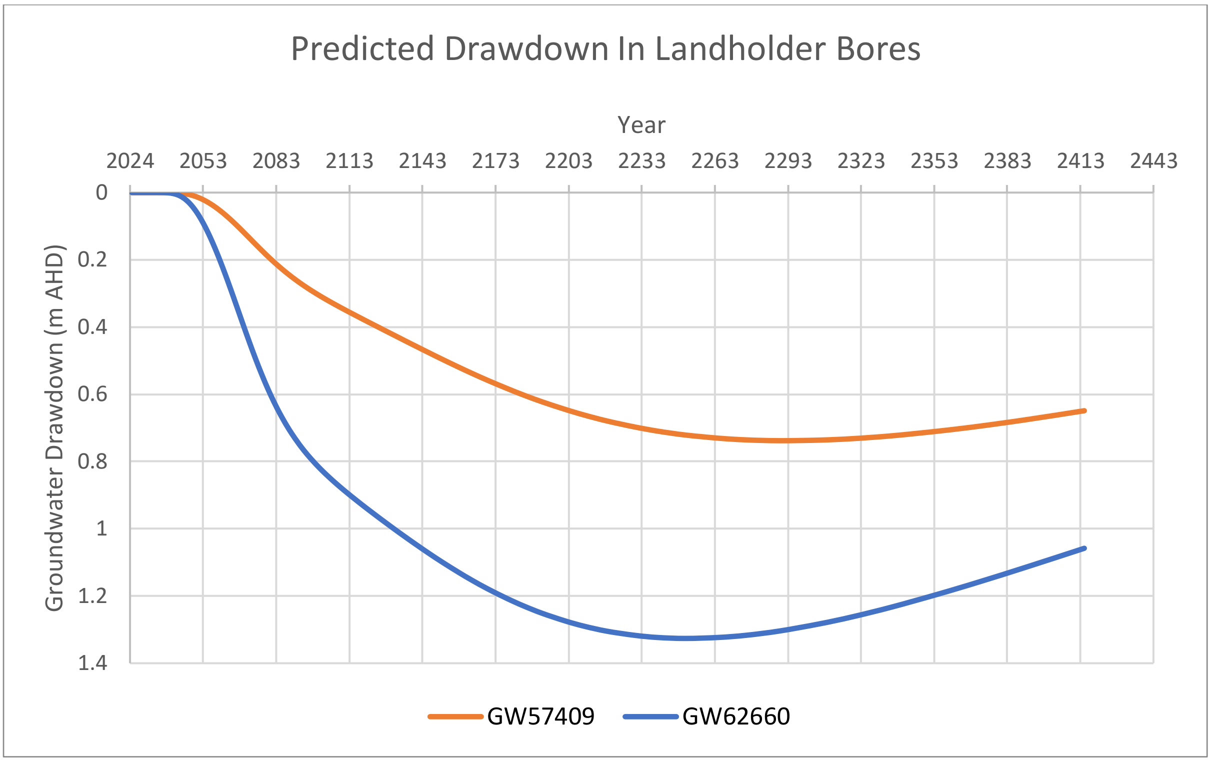


Figure 19. Predicted drawdown in two potentially impacted landholder bores.

12.6. Baseflow Reduction

Since there is very limited impact on the Alluvial aquifer (less than 1 cm), the model simulated reduction in baseflow is also limited. Analysis of model results suggest reduction in baseflow in order of less than 0.01% which can be regarded as negligible.

12.7. Model Budget

Model water budget is presented in Figure 20. Model error is below 1e-6% suggesting very good convergence throughout the run.

In analysing the water budget graphs, it should be noted that in Modflow the release of water from storage is counted as inflow and uptake is counted as outflow (Anderson, Woessner, and Hunt. 2015). Hence, in the field operational phase of the model budget, the storage inflow can be attributable to well dewatering process while in the post-closure phase of the budget, the storage inflow is associated with slowly expanding cone of depression. Storage outflow can be attributed to groundwater head recovery.

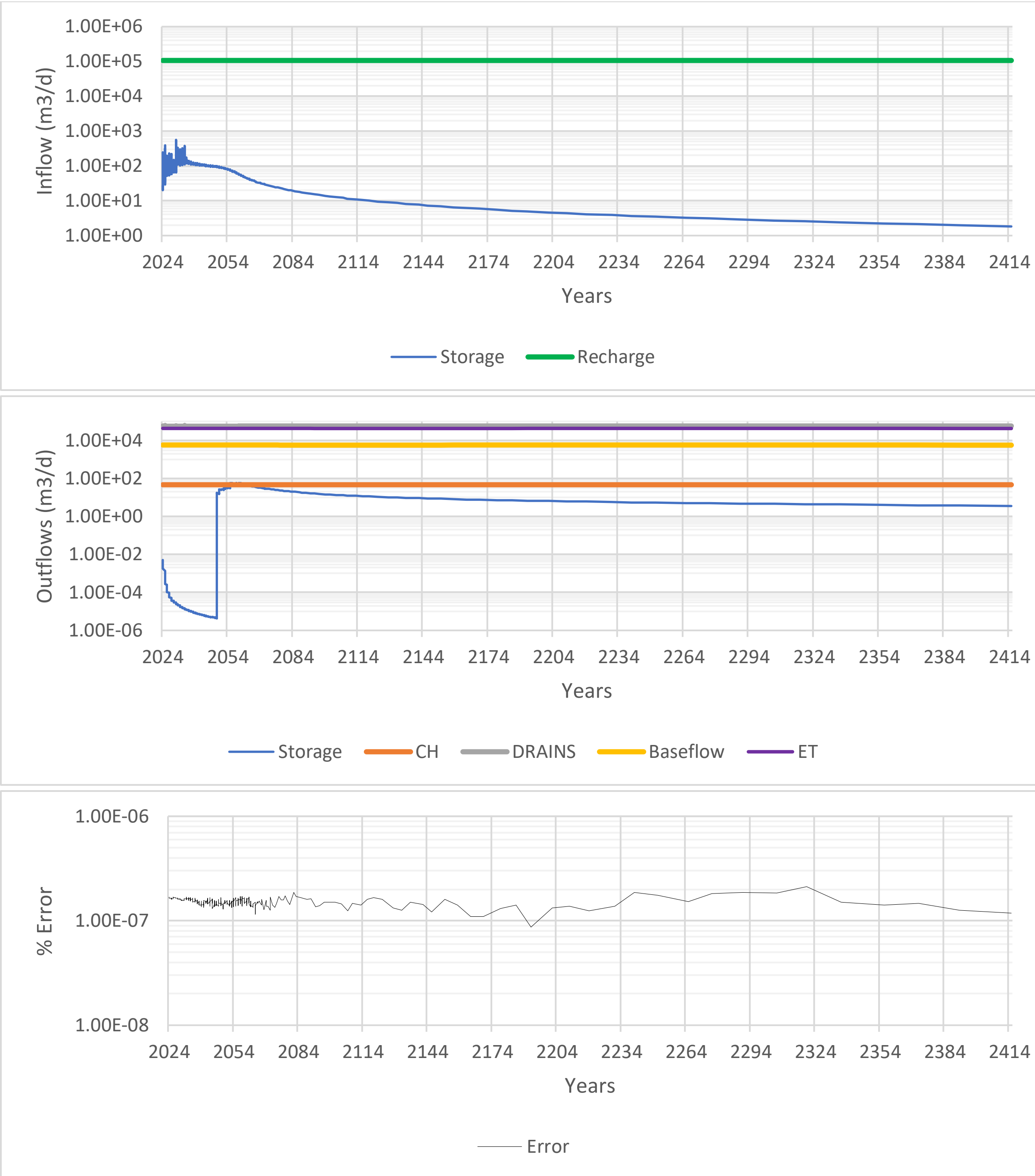


Figure 20. Model water budget - operational phase.

13. Uncertainty Analysis

The objective of the uncertainty analysis was to investigate how uncertainty in the model design and some critical parameter values may impact the predicted drawdown affecting groundwater receptors especially in the surficial aquifers (Alluvium, basalt and Tertiary deposits).

A "targeted" uncertainty analysis was run to complement the results provided by OGIA and specifically test the most critical geological features and parameterisation which were expected to have the greatest potential of causing an impact on the local users and surficial aquifers. Nine sensitivity analyses were run. Their details are presented in Table 10 below:

Table 10. Details of uncertainty analysis runs

Case	Description
Base Case	The predictive model
Uncertainty Case 1	Hydraulic conductivity of the Arcturus fault increased to $2x10^{-3}$ m/day (1 order of magnitude greater than Bandanna Formation) and Ss to $1x10^{-6}$. Expected to increase drainage of the Tertiary Strata. The fault provides a conductive conduit between bandanna coals and the tertiary sediments and alluvium in the deepest parts of the field, where the drawdown magnitude in Bandanna is the greatest. Faults to the east of the Project site are modelled as sealing faults, limiting spread of cone of depression in Bandanna to the east and magnifying the potential of downgradient seepage from Tertiary Strata.
Uncertainty Case 2	Horizontal and vertical hydraulic conductivity in Arcturus fault decreased to $6x10^{-7}$ m/day (1 order of magnitude less than Bandanna Formation). Expected to act as a barrier and increase the magnitude of drawdown in the Bandanna Formation, providing a greater head difference to induce groundwater flow down the fault. The fault provides a seal for the groundwater flow and spread of drawdown and potentially "pushes" the drawdown towards Bandanna subcrops located to the north and north-east from the Project. The Tertiary Strata overlies Bandanna outcrops there and hence there is a potential for the groundwater drawdown in Bandanna to affect groundwater levels in the Tertiart Strata.
Uncertainty Case 3	Specific Storage in the Tertiary Strata decreased to $1x10^{-6}$ (Ss) / 0.5 (Sy). The case has a potential to increase the magnitude of drawdown in the Tertiary Strata due to its low water storage capacity
Uncertainty Case 4	Vertical Hydraulic conductivity of the Tertiary Strata increase by one order of magnitude, to 1 m/day. Expected to increase the magnitude of drawdown in the Tertiary Strata. Similar to case 3, except the tertiary strata is now more conductive.
Uncertainty Case 5	Cases 1 and 3 combined
Uncertainty Case 6	Cases 1, 3 and 4 combined
Uncertainty Case 7	Cases 2 and 3 combined
Uncertainty Case 8	Cases 2, 3 and 4 combined
Uncertainty Case 9	Horizontal hydraulic conductivity in Bandanna increased to 1x10-3 m/day to align with average hydraulic conductivity used in lower bandanna by OGIA. Fault parameters as per Case 1. Expected to result in a more extensive cone of depression in Bandanna, resulting in greater drawdown at the location of the Arcturus fault.

To avoid duplications the uncertainty results do not represent the wide range of possible results in probabilistic sense as this type of result was provided by OGIA. The current uncertainty analysis cases should be considered as "stress test" to the model, in which the critical combinations are tested, particularly in relation to hydraulic characteristic of the Arcturus fault which has not been addressed in OGIA model.

13.1. Model Computed Drawdown

The range of extent of 5m drawdown contour (reportable threshold in consolidated aquifers) in Bandanna (Pollux Seam) is presented in Figure 21 below. The figure shown maximum and minimum extent of the 5m drawdown, based on the simulated uncertainty cases.

Similarly, to the results reported for the Base Case, the presented drawdown is composed of the maximum drawdown achieved during the entire model run, rather than depicting a drawdown at a specific simulation time. This approach allows for better representation of potential impacts that may occur at any given time within the model simulation time.

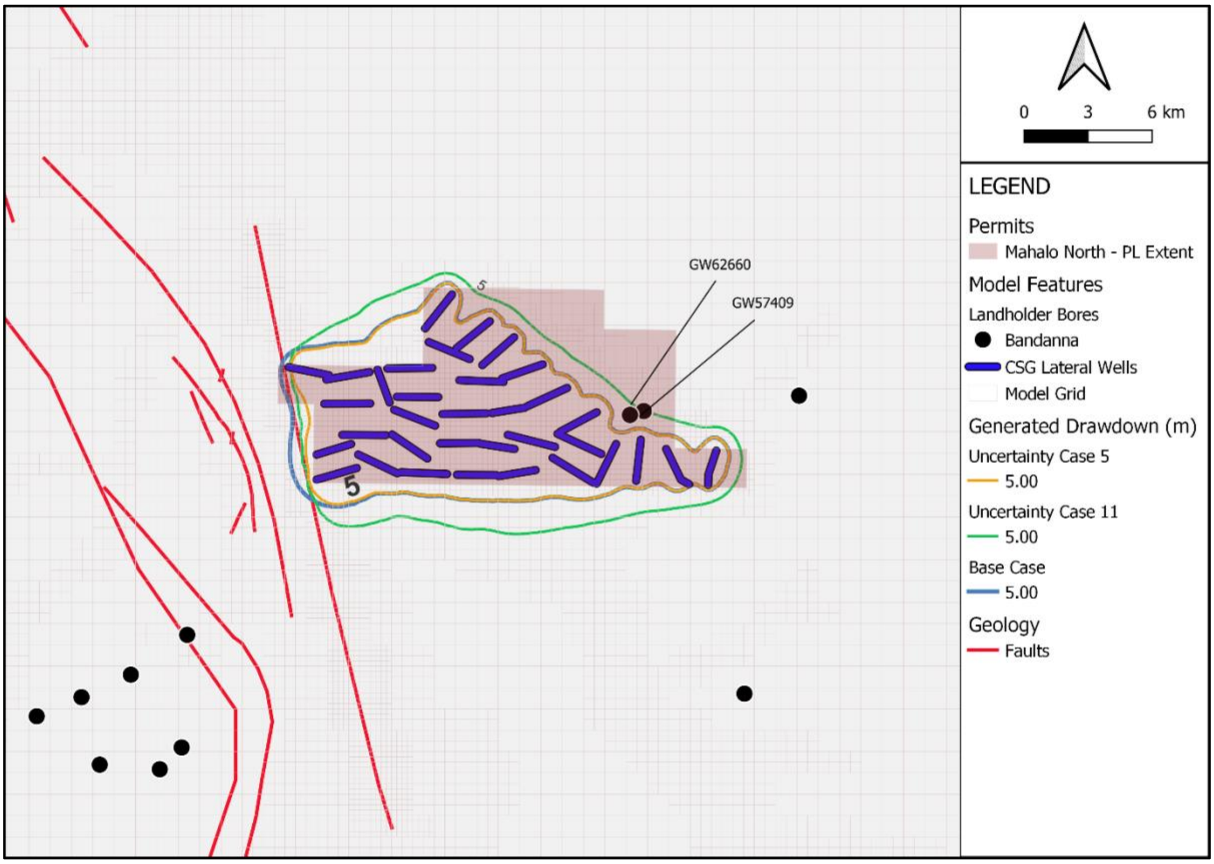


Figure 21. Uncertainty Cases – Bandanna - 5m drawdown contour spatial range.

The comparison of maximum drawdown computed in model layers 1 and 2 (Alluvium and Tertiary Strata) and layer 11 (Pollux seam), is presented in Table 11 below.

Note: Groundwater bore GW57409 is described as "Abandoned and Destroyed" (refer to QLD Globe https://qldglobe.information.qld.gov.au).

Table 11. Maximum predicted drawdown summary

Model layer	1	2	11
Represented Hydro stratigraphic Unit(s)	Quaternary Alluvium / Tertiary Strata	Tertiary Strata	Pollux Seam
	Maximum predicted drawdown (m)		
Base Case	0.01	0.02	282.7
Sensitivity Case 1	0.01	0.04	270.7
Sensitivity Case 2	0.01	0.02	283.0
Sensitivity Case 3	0.01	0.03	281.2
Sensitivity Case 4	0.01	0.02	282.7
Sensitivity Case 5	0.01	0.04	270.7
Sensitivity Case 6	0.01	0.04	270.7
Sensitivity Case 7	0.01	0.02	283.0
Sensitivity Case 8	0.01	0.02	283.0
Sensitivity Case 9	0.03	0.09	296.1

It should be noted that the maximum predicted drawdown in Layers 1 and 2 does not exceed 0.2m threshold in any of the discussed Uncertainty Cases.

The comparison of minimum and maximum drawdown range computed at the location of two drawdown affected landholder bores in Bandanna is presented in Figure 22 below.

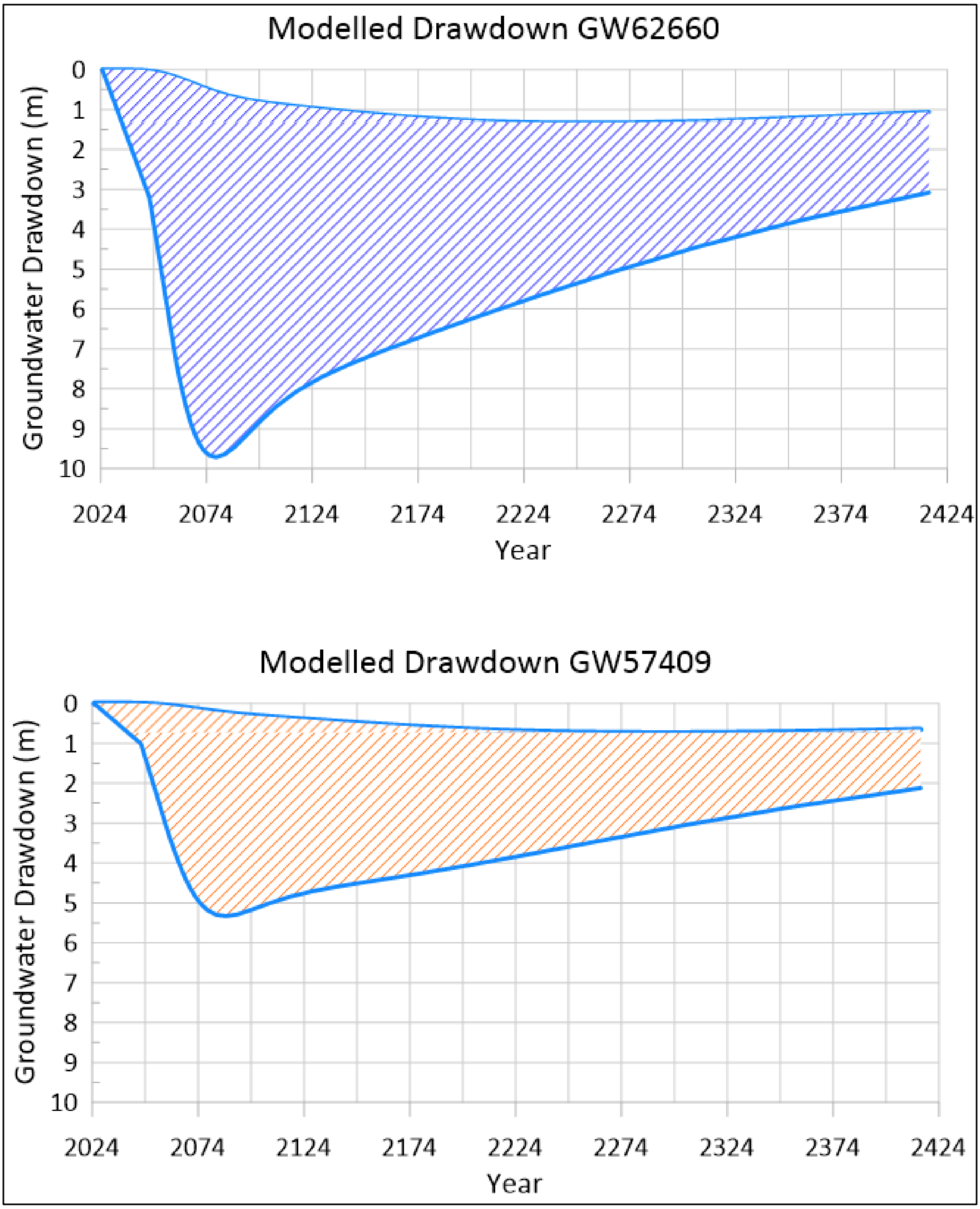


Figure 22. Range of possible drawdown predicted in closest to the Project landholder bores.

Note: Groundwater bore GW57409 is described as “Abandoned and Destroyed” (refer to QLD Globe https://qldglobe.information.qld.gov.au).

13.2. Water Production

Cumulative groundwater extraction volumes generated by the model for the uncertainty cases are presented in Table 12 below.

Table 12. Model generated cumulative water extraction rates.

Model Case	Cumulative Water Extraction over the life of the project (ML)
Base Case	1129
Uncertainty Case 1	1087
Uncertainty Case 2	1133
Uncertainty Case 3	1126
Uncertainty Case 4	1129
Uncertainty Case 5	1087
Uncertainty Case 6	1087
Uncertainty Case 7	1133
Uncertainty Case 8	1133
Uncertainty Case 9	2049

The range of predicted cumulative water extraction rates compared to Comet expected cumulative water extraction is presented in Figure 23 below.

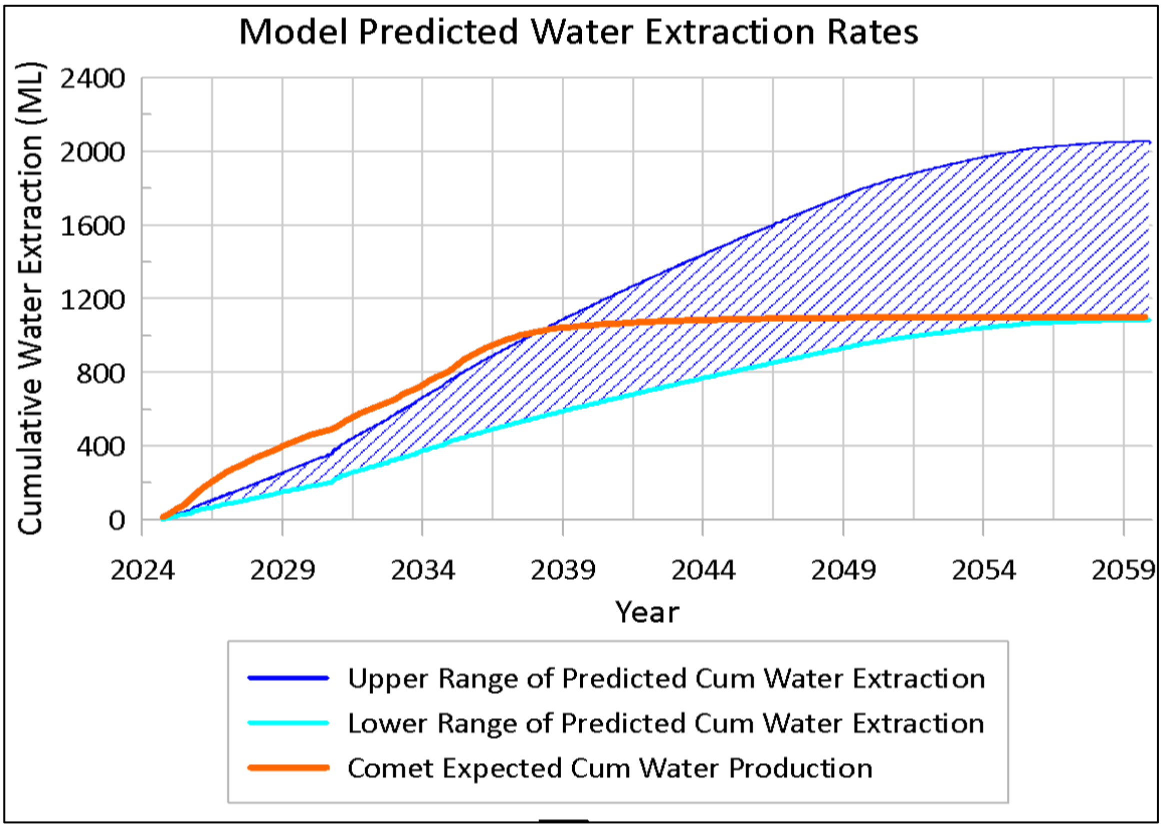


Figure 23. Model computed range of water extraction rates – uncertainty cases.

14. Model Limitations

Groundwater numerical models are powerful tools for simulating and predicting groundwater flow and contaminant transport. However, like any modelling approach, they have certain limitations that need to be considered.
The current model limitations are primary related to:

- Use of single-phase model to address two phase problem. Modflow is a long standing industry standard for groundwater modelling, it is however a single phase model designed to model water phase only (as opposed to Eclipse or TNavigator which have specificity designed modules to simulate CSG production).
- Horizontal well representation in Modflow. Horizontal wells can not be represented as discrete features and are represented in Modflow as a descending drain boundary condition applied to model cells in which the wells are located. This has implications on simulated well's water extraction dynamics (not so much on cumulative production volumes though).
- This site-specific model addresses specific "hand-picked" uncertainty cases so the presented model results should be viewed together with OGIA results for full picture of potential and statistically distributed impact.

15. Conclusions

The site-specific groundwater model was created to complement the OGIA model's predictions regarding groundwater impacts and to evaluate uncertainties associated with mapped faults in proximity to the Project, as well as the hydraulic properties of the Tertiary Strata, with a focus on their impact on predicted drawdown in the surficial aquifers.

Base Case and nine Uncertainty Cases have been run, testing the potential for conductive and sealing properties of the Arcturus Fault, cutting through the western part of the Project site and Tertiary Strata hydraulic parameters combinations which would be encouraging expansion of groundwater drawdown.

Model results indicated no groundwater drawdown exceeding 0.2m trigger threshold in Tertiary Strata or Alluvial aquifer. The maximum drawdown predicted in these surficial aquifers was 9 cm.

Groundwater drawdown in Bandanna coals is likely to approximate 300m in the deepest part of the field. Modelling results indicate that there is a potential for groundwater drawdown in excess of 5m in two of the landholder bores (GW62660 and GW57409) located in close proximity to the Project site.

Based on simulated uncertainty cases, the range of groundwater drawdown likely to be experienced in bore GW62660 is between approximately 1m and 10m, and in bore GW57409 between approximately 1m and just over 5m

The Base Case model achieved relatively good match of simulated Project cumulative water production and data supplied by Comet. The results of uncertainty analyses indicated expected range of cumulative water production between approximately 1 and 2 GL, while Comet expected water production is approximately around 1.1 GL.

16. Limitations

In preparing this report, TSC has relied upon, and presumed accurate, information provided by the Client and sourced from various publicly available reports. TSC has not attempted to verify the accuracy or completeness of any of such information. If the information is subsequently determined to be inaccurate, incomplete or false then it is possible that our conclusions as expressed in this report may change.

17. Bibliography

Anderson, Woessner, and Hunt. 2015. “Applied Groundwater Modelling”.

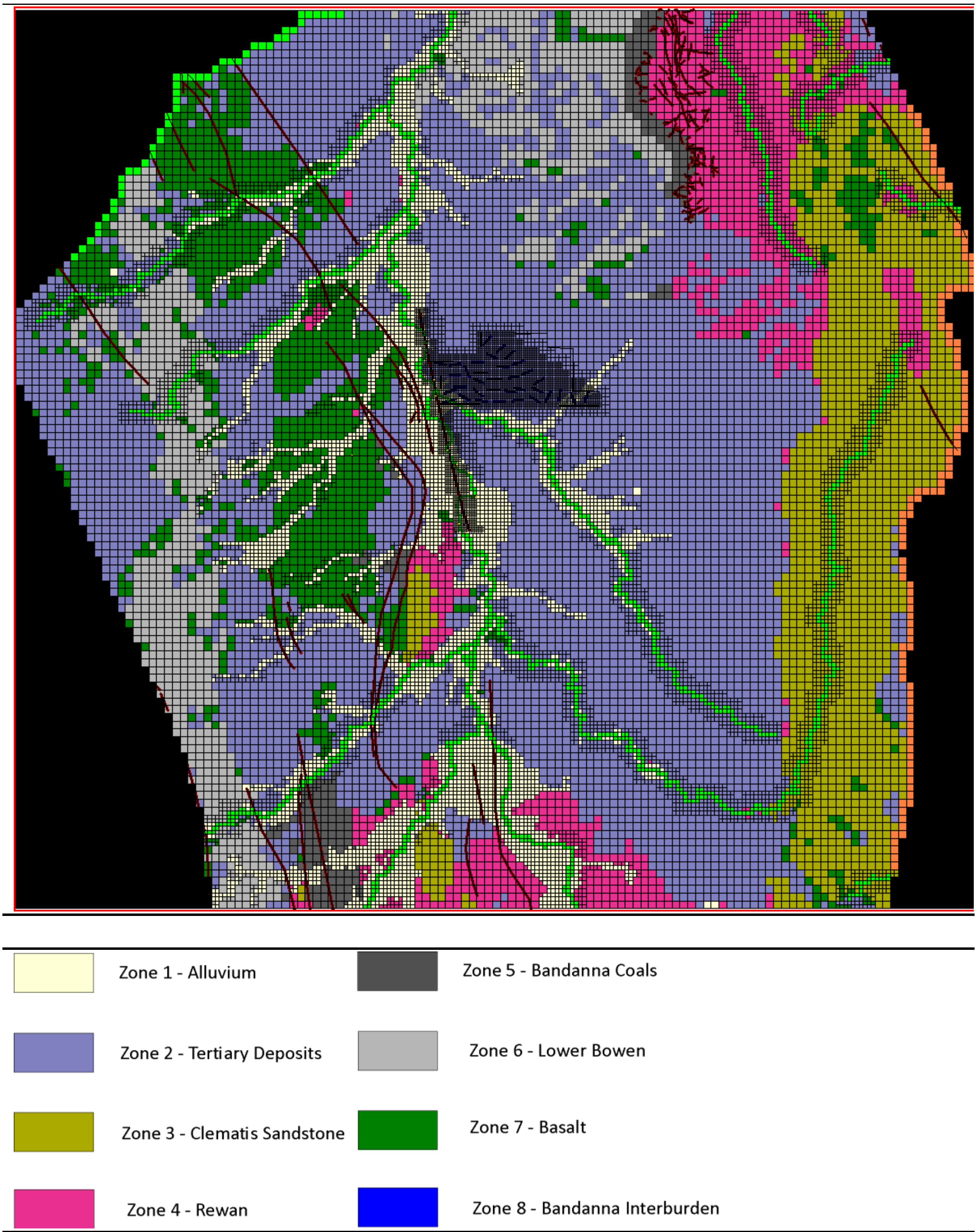
Australian Groundwater Modelling Guidelines National Centre for Groundwater Research and Training, National Water Commission , June 2012

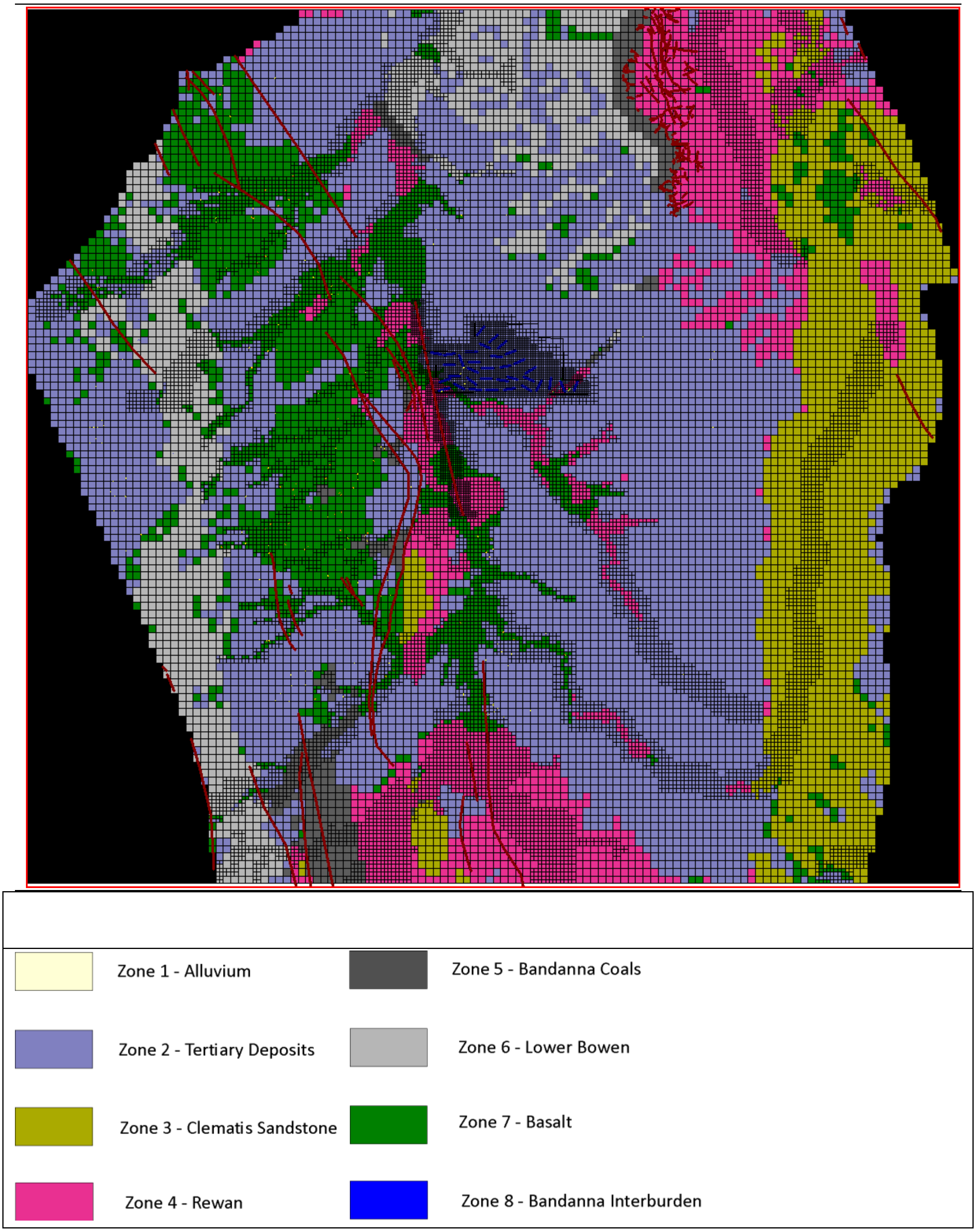
QLD Globe, https://qldglobe.information.qld.gov.au

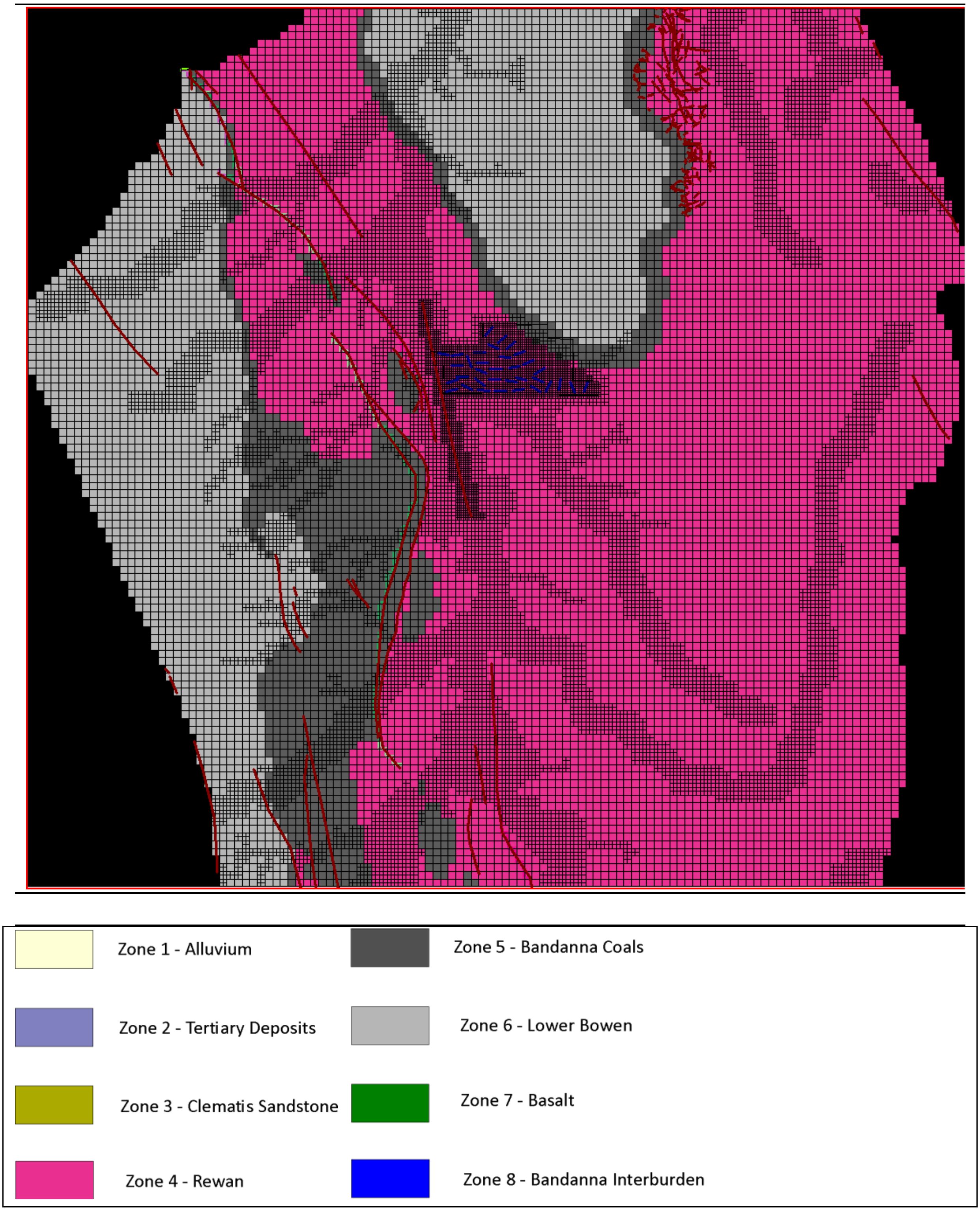
Department of Natural Resources, Mines and Energy, October 2019, “Groundwater Modelling Report, Surat CMA.”

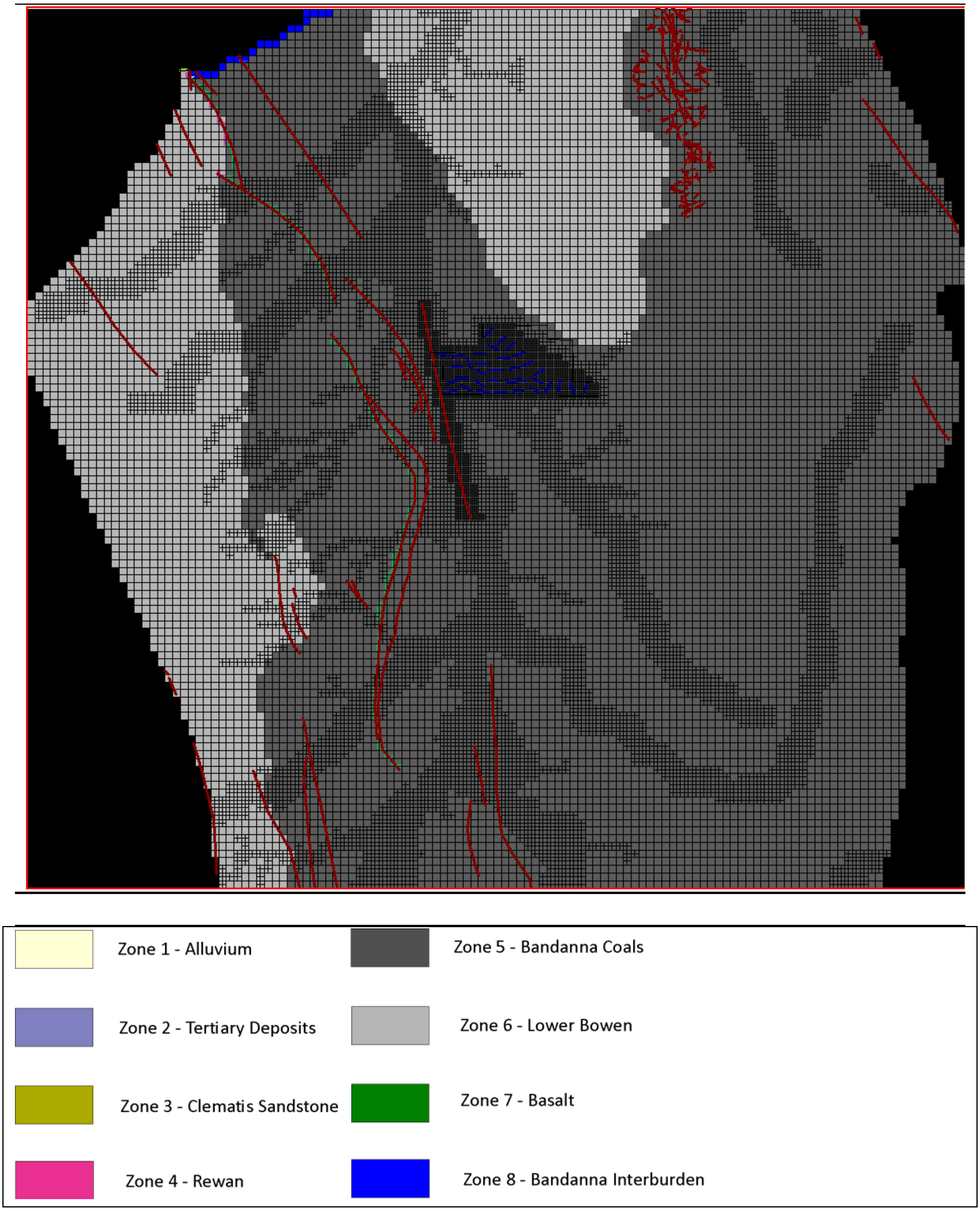
RDM Hydro, 2023. “Mahalo North CSG Development. Groundwater Impact Assessment”

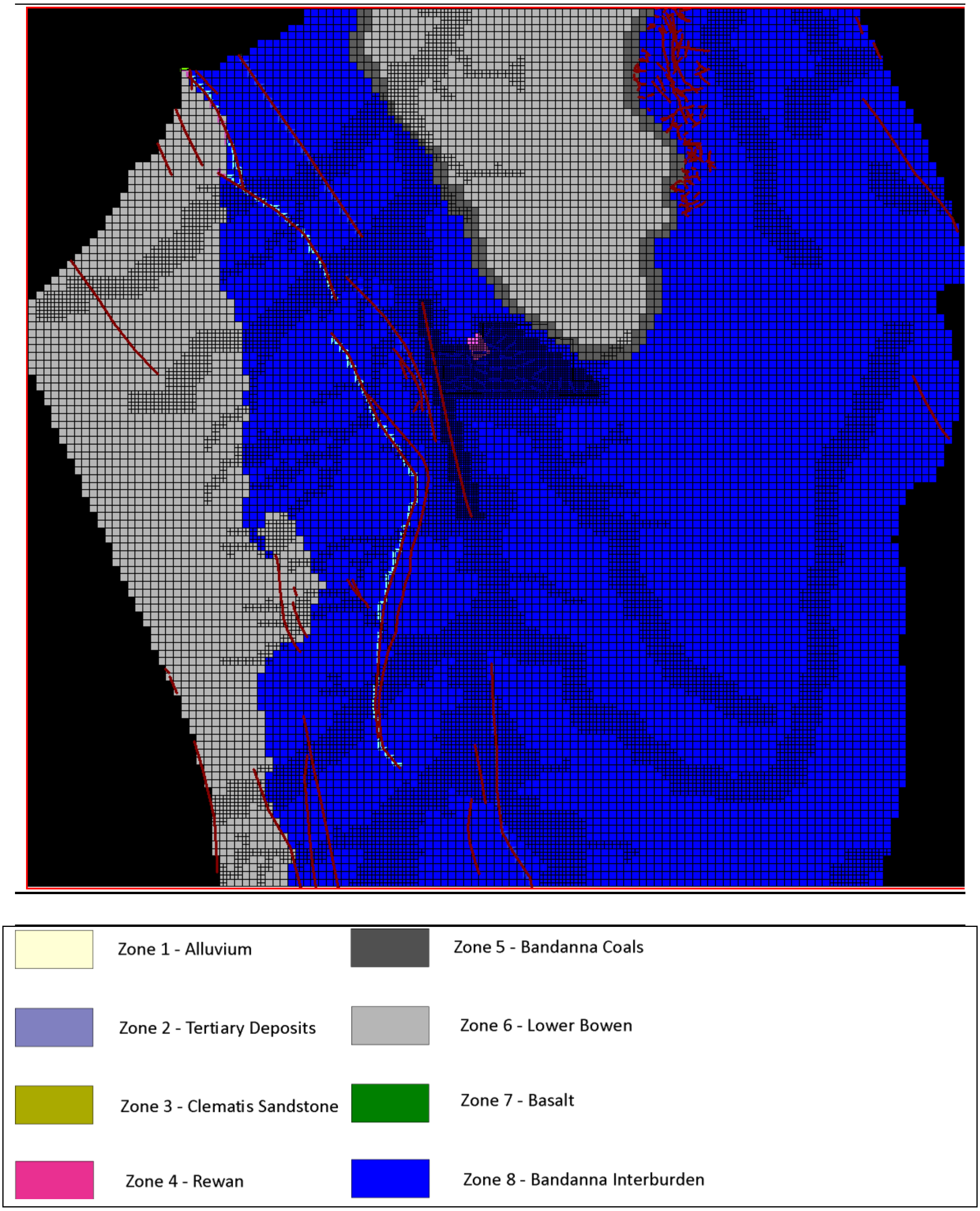
Appendix A – Hydraulic Parameters Distributions

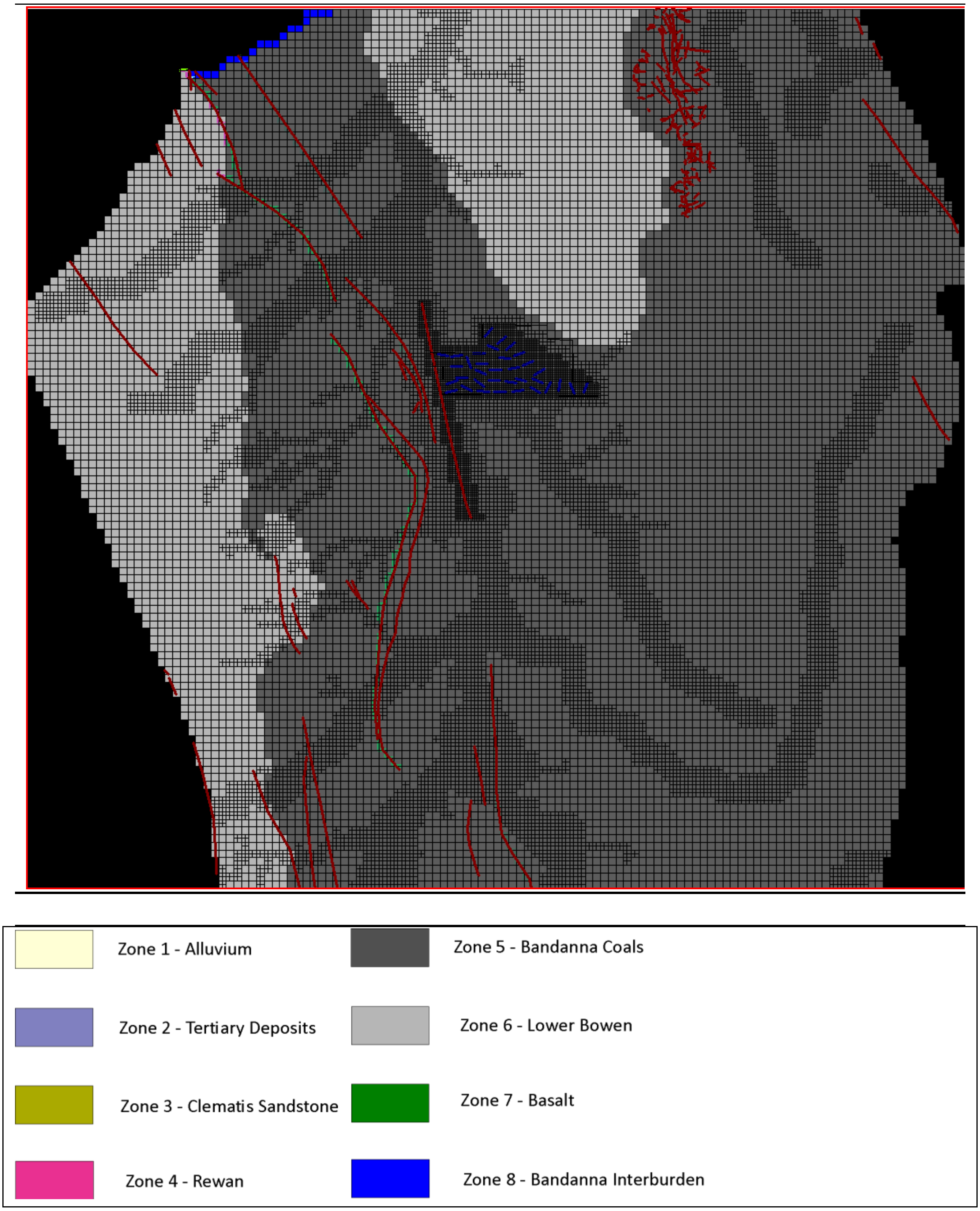


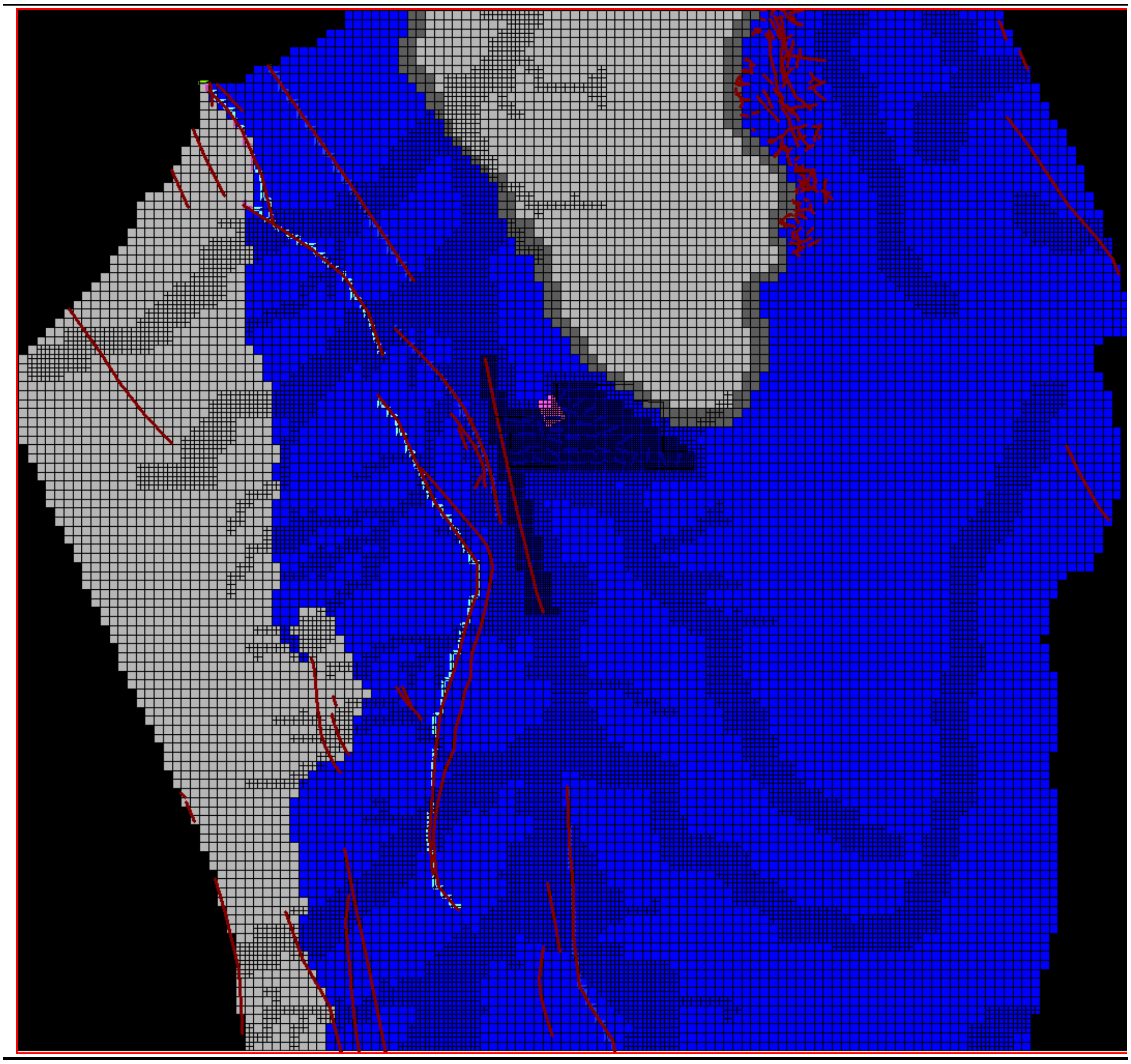

Zone 1 - Alluvium
Zone 5 - Bandanna Coals
Zone 2 - Tertiary Deposits
Zone 6 - Lower Bowen
Zone 3 - Clematis Sandstone
Zone 7 - Basalt
Zone 4 - Rewan
Zone 8 - Bandanna Interburden


Zone 1 - Alluvium
Zone 5 - Bandanna Coals
Zone 2 - Tertiary Deposits
Zone 6 - Lower Bowen
Zone 3 - Clematis Sandstone
Zone 7 - Basalt
Zone 4 - Rewan
Zone 8 - Bandanna Interburden

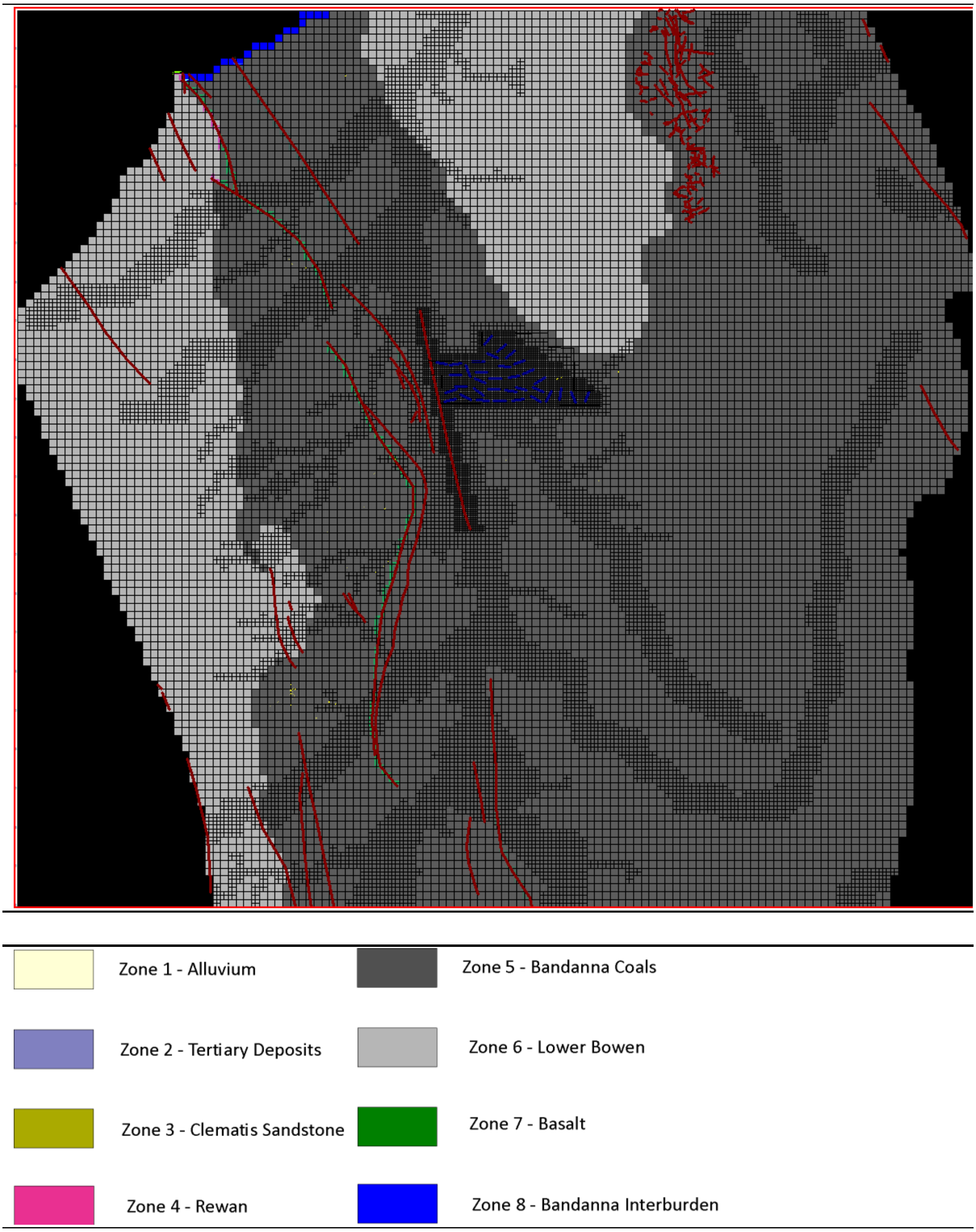

Zone 1 - Alluvium
Zone 2 - Tertiary Deposits
Zone 3 - Clematis Sandstone
Zone 4 - Rewan
Zone 5 - Bandanna Coals
Zone 6 - Lower Bowen
Zone 7 - Basalt
Zone 8 - Bandanna Interburden


Zone 1 - Alluvium
Zone 2 - Tertiary Deposits
Zone 3 - Clematis Sandstone
Zone 4 - Rewan
Zone 5 - Bandanna Coals
Zone 6 - Lower Bowen
Zone 7 - Basalt
Zone 8 - Bandanna Interburden


Zone 1 - Alluvium
Zone 2 - Tertiary Deposits
Zone 3 - Clematis Sandstone
Zone 4 - Rewan
Zone 5 - Bandanna Coals
Zone 6 - Lower Bowen
Zone 7 - Basalt
Zone 8 - Bandanna Interburden



	Zone 1 - Alluvium		Zone 5 - Bandanna Coals
	Zone 2 - Tertiary Deposits		Zone 6 - Lower Bowen
	Zone 3 - Clematis Sandstone		Zone 7 - Basalt
	Zone 4 - Rewan		Zone 8 - Bandanna Interburden


Zone 1 - Alluvium
Zone 5 - Bandanna Coals
Zone 2 - Tertiary Deposits
Zone 6 - Lower Bowen
Zone 3 - Clematis Sandstone
Zone 7 - Basalt
Zone 4 - Rewan
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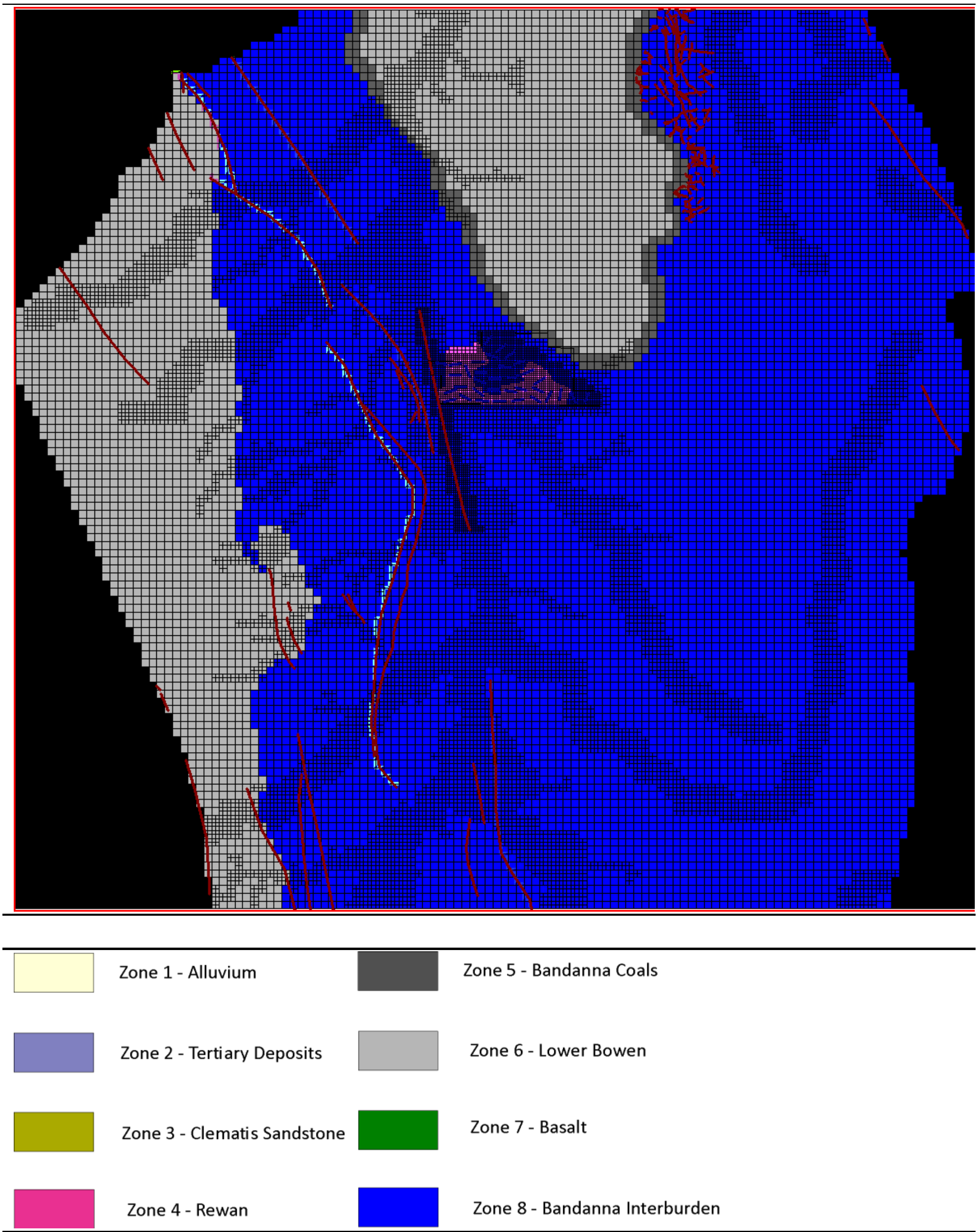
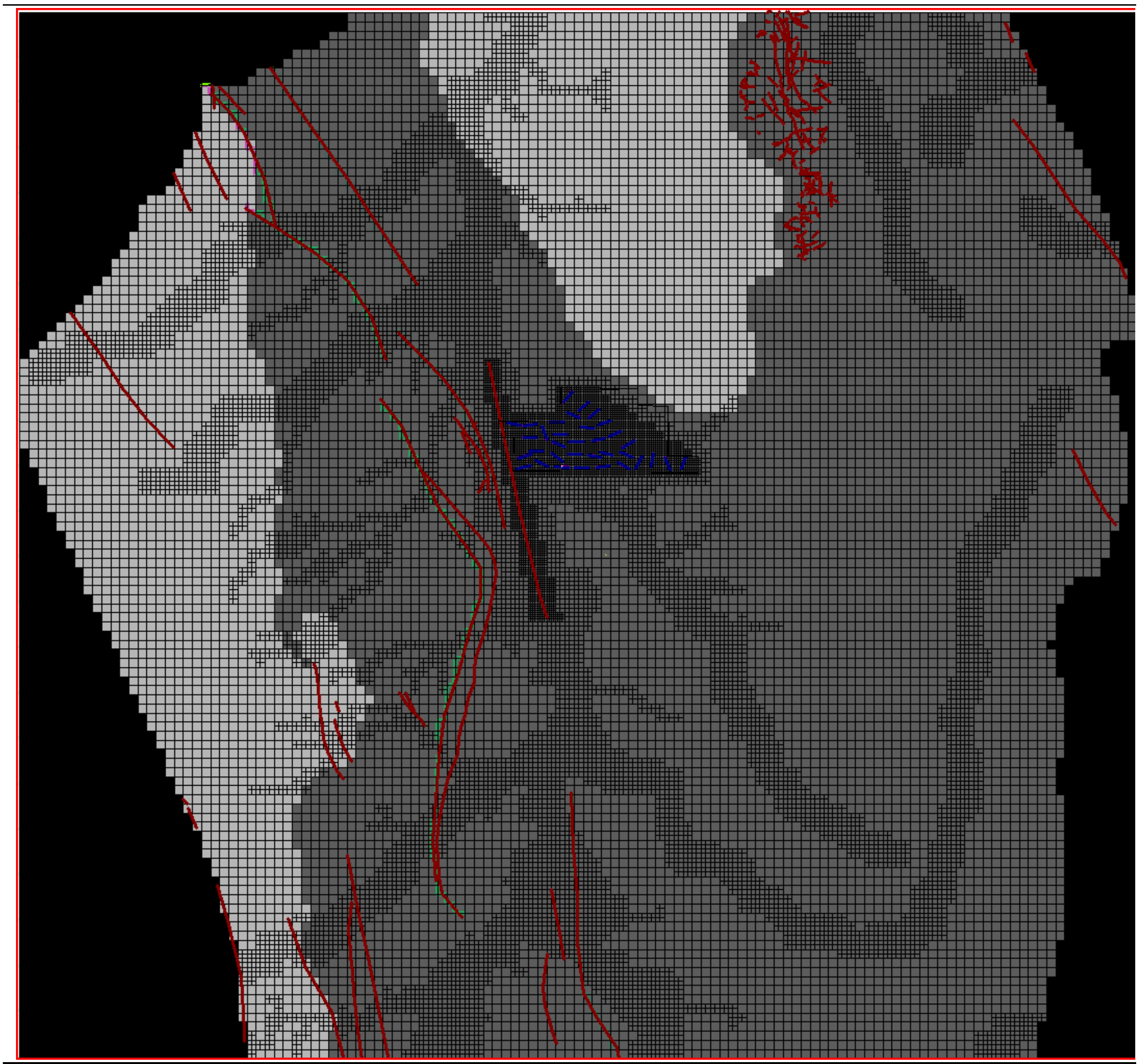
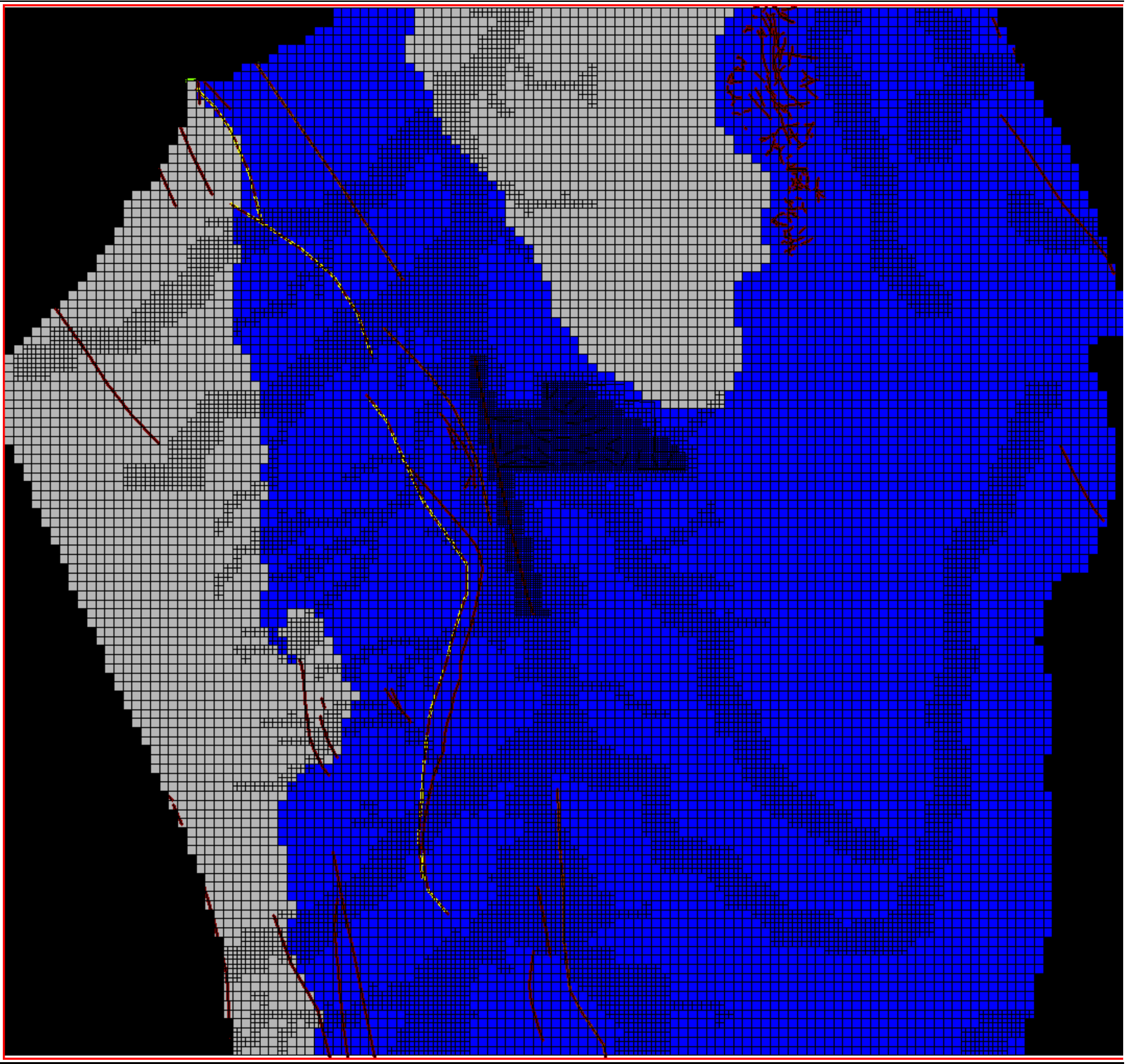
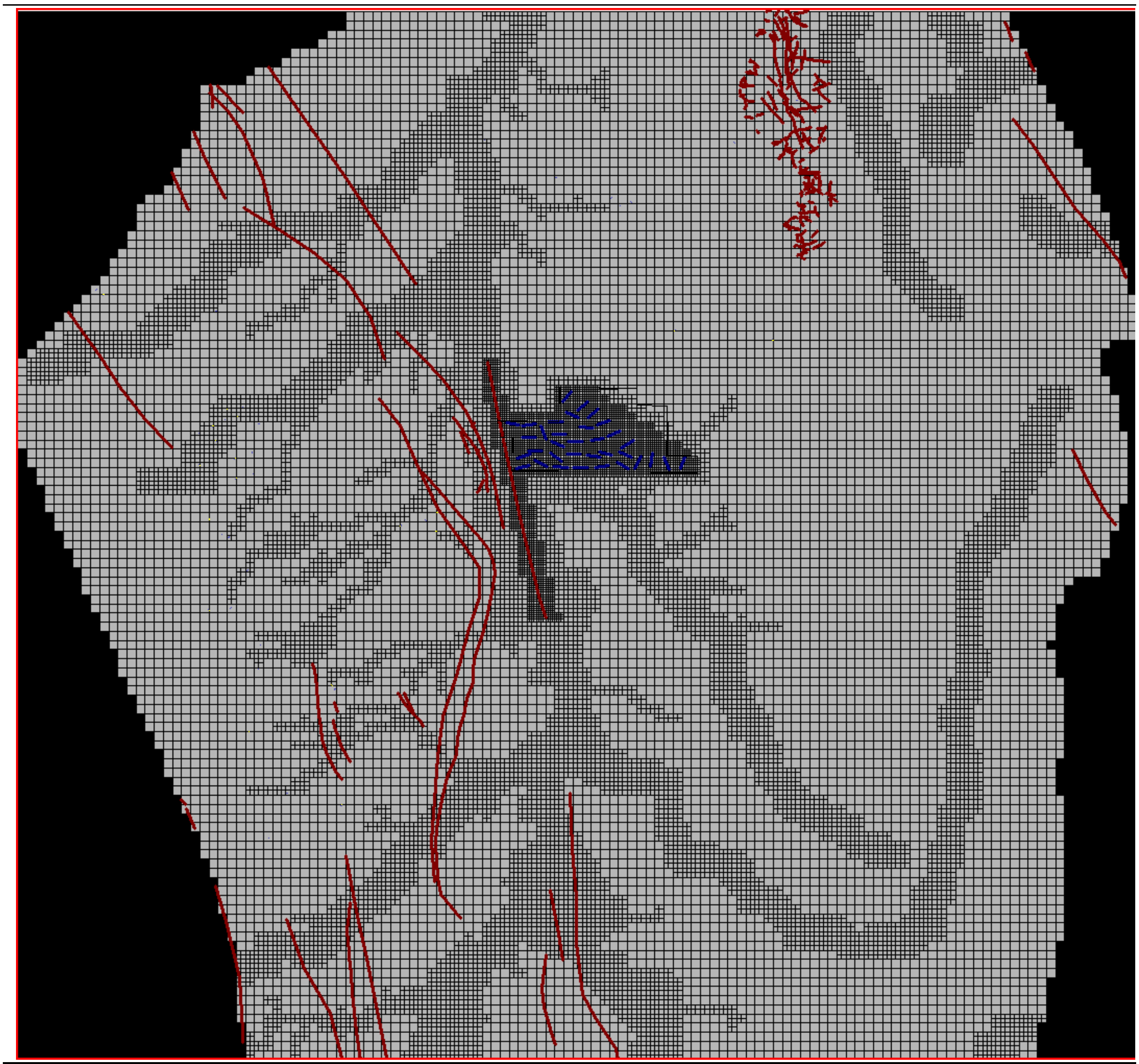

Zone 1 - Alluvium
Zone 5 - Bandanna Coals
Zone 2 - Tertiary Deposits
Zone 6 - Lower Bowen
Zone 3 - Clematis Sandstone
Zone 7 - Basalt
Zone 4 - Rewan
Zone 8 - Bandanna Interburden



	Zone 1 - Alluvium		Zone 5 - Bandanna Coals
	Zone 2 - Tertiary Deposits		Zone 6 - Lower Bowen
	Zone 3 - Clematis Sandstone		Zone 7 - Basalt
	Zone 4 - Rewan		Zone 8 - Bandanna Interburden



Zone 1 - Alluvium	Zone 5 - Bandanna Coals
Zone 2 - Tertiary Deposits	Zone 6 - Lower Bowen
Zone 3 - Clematis Sandstone	Zone 7 - Basalt
Zone 4 - Rewan	Zone 8 - Bandanna Interburden



	Zone 1 - Alluvium		Zone 5 - Bandanna Coals
	Zone 2 - Tertiary Deposits		Zone 6 - Lower Bowen
	Zone 3 - Clematis Sandstone		Zone 7 - Basalt
	Zone 4 - Rewan		Zone 8 - Bandanna Interburden

Appendix B – Calibration Dataset Details

Bore Name	Formation	Easting (m)	Northing (m)	Observed Head (m AHD)	Computed Head (m AHD)
GW24255	Bandanna	635756.999	7296967.004	244.5	237.1
GW31338	Bandanna	650291.999	7314980.004	196.3	211.5
GW31339	Bandanna	650837.999	7315520.004	197.3	207.6
GW47764	Bandanna	648585.999	7312834.004	207.7	219.7
GW47765	Bandanna	649300.999	7314138.004	195.7	214.9
GW47766	Bandanna	645600.999	7314723.004	224.8	216.6
GW47795	Bandanna	635751.999	7329930.004	212.0	207.3
GW47838	Bandanna	651784.999	7328730.004	159.5	197.2
GW47840	Bandanna	647684.999	7322642.004	208.6	204.7
GW57409	Bandanna	673184.999	7339225.004	199.5	214.6
GW57991	Bandanna	650500.999	7322427.004	178.0	200.1
GW57469	Bandanna	680463.999	7339947.004	241.7	228.4
GW62660	Bandanna	672540.999	7339043.004	187.0	213.7
GW62154	Bandanna	646829.999	7325806.004	194.7	203.1
GW62527	Bandanna	645469.999	7377971.004	128.0	177.1
GW89024	Bandanna	651525.999	7323449.004	193.0	197.2
GW90228	Bandanna	644730.999	7324913.004	214.3	203.9
GW103352	Bandanna	649143.999	7326864.004	196.4	201.5
GW103460	Bandanna	643169.999	7319396.004	215.0	213.7
GW158360	Bandanna	638556.999	7353790.004	179.4	184.8
GW158361	Bandanna	638545.999	7353799.004	179.4	184.9
GW158362	Bandanna	640231.999	7353292.004	175.9	182.1
GW158363	Bandanna	640257.999	7353309.004	176.6	182.1
GW158364	Bandanna	638113.999	7354384.004	178.1	186.6
GW158158	Bandanna	638476.999	7299812.004	247.9	230.8
GW158160	Bandanna	638479.999	7297179.004	237.5	233.5
GW158163	Bandanna	636679.999	7297612.004	252.3	235.4
GW158996	Bandanna	638900.999	7298483.004	239.8	231.7
GW158997	Bandanna	638900.999	7298483.004	240.8	231.7
GW158998	Bandanna	638851.999	7298379.004	238.7	231.9
GW158563	Bandanna	641653.999	7295515.004	217.4	231.7
GW158565	Bandanna	643247.999	7297575.004	212.4	227.0
GW165001	Bandanna	638906.999	7299145.004	237.3	231.0
GW165003	Bandanna	638716.999	7299248.004	238.8	231.1
GW165408	Bandanna	638323.999	7299074.004	238.1	231.8
GW165410	Bandanna	638520.999	7298908.004	239.3	231.7
GW165411	Bandanna	638441.999	7298693.004	234.9	232.0
GW165413	Bandanna	638354.999	7298679.004	235.4	232.2
GW165414	Bandanna	638271.999	7298651.004	236.3	232.3

Bore Name	Formation	Easting (m)	Northing (m)	Observed Head (m AHD)	Computed Head (m AHD)
GW165415	Bandanna	638636.999	7298560.004	233.7	231.9
GW165416	Bandanna	638648.999	7297897.004	235.8	232.8
GW165500	Bandanna	638587.999	7298578.004	231.6	232.0
GW165501	Bandanna	644130.999	7297351.004	217.1	225.6
GW5131	Basalt	628287.999	7317341.004	276.8	226.6
GW14866	Basalt	619163.999	7321575.004	382.3	377.0
GW24254	Basalt	640621.999	7298374.004	230.2	229.2
GW24248	Basalt	638245.999	7304110.004	233.9	227.5
GW30324	Basalt	648505.999	7351244.004	156.8	168.1
GW32489	Basalt	644870.999	7338643.004	177.0	182.3
GW32221	Basalt	638057.999	7318692.004	210.9	215.7
GW32222	Basalt	637602.999	7315861.004	228.3	217.3
GW32637	Basalt	645004.999	7317745.004	203.7	211.9
GW32638	Basalt	644124.999	7319896.004	225.9	210.7
GW30694	Basalt	643154.999	7319408.004	221.0	211.8
GW31340	Basalt	661575.999	7315548.004	183.0	191.7
GW31341	Basalt	661544.999	7316121.004	181.0	191.2
GW34485	Basalt	658534.999	7336060.004	160.2	179.0
GW34486	Basalt	660485.999	7335389.004	171.9	180.0
GW34610	Basalt	687573.999	7336984.004	233.7	243.6
GW33021	Basalt	640949.999	7320988.004	199.5	210.5
GW36902	Basalt	663868.999	7360423.004	181.2	176.9
GW36903	Basalt	666498.999	7358998.004	195.1	180.6
GW38766	Basalt	644687.999	7332551.004	173.9	192.1
GW47760	Basalt	649412.999	7326864.004	180.7	196.1
GW47763	Basalt	647319.999	7314355.004	209.5	214.1
GW47508	Basalt	660728.999	7359459.004	169.5	172.7
GW47510	Basalt	657412.999	7358456.004	156.6	168.3
GW47514	Basalt	661566.999	7344291.004	172.0	184.3
GW47799	Basalt	645955.999	7316664.004	201.8	211.9
GW47804	Basalt	638681.999	7323088.004	220.8	208.1
GW47806	Basalt	636957.999	7323513.004	209.9	208.2
GW47808	Basalt	632512.999	7338998.004	203.8	195.6
GW47812	Basalt	631926.999	7336787.004	199.6	197.5
GW47839	Basalt	646729.999	7323357.004	213.8	202.1
GW47724	Basalt	632792.999	7341830.004	199.0	191.6
GW47725	Basalt	635342.999	7341372.004	194.8	190.9
GW47731	Basalt	636491.999	7341538.004	202.8	190.5
GW47743	Basalt	648253.999	7316968.004	192.7	208.1
GW47744	Basalt	651205.999	7318030.004	196.8	200.2
GW47745	Basalt	648638.999	7317401.004	204.8	206.5
GW47757	Basalt	646272.999	7338361.004	183.7	180.7

Bore Name	Formation	Easting (m)	Northing (m)	Observed Head (m AHD)	Computed Head (m AHD)
GW47455	Basalt	654471.999	7323466.004	169.6	188.6
GW47456	Basalt	650765.999	7322824.004	201.7	195.7
GW47457	Basalt	651563.999	7320418.004	198.7	196.1
GW47072	Basalt	646682.999	7336564.004	173.9	182.3
GW57355	Basalt	638839.999	7351233.004	167.7	179.3
GW57356	Basalt	633364.999	7360106.004	159.6	177.7
GW57357	Basalt	640113.999	7352504.004	166.3	176.7
GW57358	Basalt	641376.999	7351066.004	161.7	176.5
GW57359	Basalt	643782.999	7349957.004	163.2	174.1
GW57360	Basalt	643312.999	7348626.004	159.5	175.6
GW57361	Basalt	643828.999	7348838.004	164.8	175.0
GW57368	Basalt	635792.999	7361052.004	160.6	173.8
GW57369	Basalt	638102.999	7361298.004	150.7	170.6
GW57370	Basalt	636714.999	7360490.004	132.3	172.8
GW57372	Basalt	637707.999	7356803.004	156.7	175.4
GW57374	Basalt	633951.999	7351729.004	183.7	183.3
GW57376	Basalt	645216.999	7350657.004	155.7	171.4
GW57378	Basalt	635006.999	7348582.004	179.7	185.4
GW57627	Basalt	635011.999	7353861.004	181.4	180.7
GW57977	Basalt	616858.999	7345713.004	242.0	241.5
GW57410	Basalt	674934.999	7345037.004	228.8	208.9
GW57424	Basalt	675420.999	7336212.004	200.2	209.0
GW57425	Basalt	675594.999	7336267.004	201.2	209.4
GW57443	Basalt	672709.999	7301594.004	201.7	210.8
GW57692	Basalt	648567.999	7316364.004	191.0	206.8
GW57693	Basalt	640783.999	7315579.004	221.0	216.6
GW57445	Basalt	674320.999	7298057.004	208.8	216.4
GW57459	Basalt	670817.999	7312409.004	193.5	202.8
GW57461	Basalt	692894.999	7340484.004	265.7	258.0
GW57462	Basalt	694365.999	7340237.004	303.5	263.0
GW57463	Basalt	694677.999	7340157.004	303.5	264.3
GW57468	Basalt	685259.999	7343192.004	235.3	250.4
GW57258	Basalt	668105.999	7303327.004	190.8	203.2
GW57259	Basalt	667877.999	7301523.004	221.8	203.9
GW57260	Basalt	666536.999	7301813.004	194.8	200.8
GW57261	Basalt	666031.999	7302836.004	178.6	200.1
GW57536	Basalt	636352.999	7377702.004	157.3	173.7
GW57549	Basalt	635319.999	7345148.004	165.5	188.2
GW57550	Basalt	638020.999	7347373.004	178.7	184.8
GW57554	Basalt	638038.999	7346286.004	168.6	185.7
GW57854	Basalt	639180.999	7329897.004	201.0	199.2
GW57353	Basalt	638568.999	7353767.004	176.6	177.1

Bore Name	Formation	Easting (m)	Northing (m)	Observed Head (m AHD)	Computed Head (m AHD)
GW57354	Basalt	637946.999	7352062.004	168.5	179.0
GW57171	Basalt	647440.999	7298477.004	209.0	219.2
GW57172	Basalt	646958.999	7300311.004	226.4	219.5
GW57182	Basalt	645836.999	7299494.004	224.6	220.4
GW57184	Basalt	661372.999	7296081.004	186.2	201.5
GW62592	Basalt	665359.999	7294839.004	200.4	202.6
GW62599	Basalt	611588.999	7331360.004	338.7	363.2
GW62279	Basalt	614012.999	7330607.004	381.0	371.9
GW62608	Basalt	674000.999	7308738.004	185.2	210.2
GW62609	Basalt	676600.999	7304320.004	202.0	220.1
GW62621	Basalt	674952.999	7301324.004	203.5	214.1
GW62661	Basalt	665947.999	7347462.004	195.0	190.3
GW62668	Basalt	612212.999	7331985.004	351.0	362.6
GW62366	Basalt	664482.999	7314867.004	177.0	192.5
GW62151	Basalt	643030.999	7324575.004	198.4	202.1
GW62152	Basalt	644810.999	7322690.004	219.7	205.0
GW62153	Basalt	644390.999	7328595.004	178.2	195.1
GW62190	Basalt	638684.999	7364450.004	159.4	168.7
GW67117	Basalt	629156.999	7315523.004	258.0	224.4
GW67286	Basalt	628528.999	7358374.004	186.0	183.4
GW67312	Basalt	666730.999	7304386.004	189.0	201.1
GW67568	Basalt	648344.999	7317044.004	194.0	207.5
GW84115	Basalt	665466.999	7294756.004	195.4	202.8
GW84855	Basalt	673166.999	7365577.004	215.0	227.4
GW90100	Basalt	630269.999	7372254.004	175.0	180.0
GW90101	Basalt	628933.999	7375121.004	163.6	180.5
GW90102	Basalt	629212.999	7374414.004	177.0	180.4
GW90106	Basalt	620710.999	7322035.004	407.0	378.8
GW90127	Basalt	618344.999	7317181.004	391.3	360.0
GW90128	Basalt	617926.999	7320946.004	352.1	374.4
GW90134	Basalt	657646.999	7357265.004	164.0	169.4
GW90135	Basalt	617141.999	7323939.004	378.0	377.0
GW90151	Basalt	637661.999	7362520.004	167.0	170.5
GW90168	Basalt	628786.999	7362288.004	175.0	182.5
GW90173	Basalt	670288.999	7294023.004	217.5	209.2
GW90191	Basalt	631809.999	7317545.004	234.9	218.3
GW90197	Basalt	642014.999	7320278.004	207.0	211.4
GW90198	Basalt	641073.999	7320396.004	203.0	211.6
GW89030	Basalt	657339.999	7355430.004	147.0	169.9
GW89031	Basalt	661123.999	7359238.004	175.0	173.4
GW89037	Basalt	645047.999	7322482.004	219.0	205.3
GW89335	Basalt	667182.999	7359154.004	176.2	181.5

Bore Name	Formation	Easting (m)	Northing (m)	Observed Head (m AHD)	Computed Head (m AHD)
GW89094	Basalt	636254.999	7341289.004	205.4	191.1
GW90057	Basalt	628320.999	7358901.004	170.0	183.3
GW89115	Basalt	664521.999	7294068.004	192.7	202.4
GW89117	Basalt	664430.999	7293862.004	194.5	202.5
GW90069	Basalt	664908.999	7314265.004	180.1	193.4
GW90211	Basalt	637885.999	7311769.004	240.6	221.7
GW90218	Basalt	637088.999	7365367.004	163.0	171.6
GW90219	Basalt	612418.999	7336591.004	299.0	335.7
GW90225	Basalt	629039.999	7354991.004	194.0	184.3
GW90229	Basalt	643962.999	7321877.004	219.0	208.0
GW90239	Basalt	644718.999	7357143.004	128.1	170.0
GW90243	Basalt	638938.999	7322382.004	211.8	209.0
GW90273	Basalt	663730.999	7300126.004	181.5	199.6
GW90344	Basalt	616656.999	7322671.004	364.0	375.0
GW103567	Basalt	636942.999	7311748.004	248.8	221.6
GW103575	Basalt	640263.999	7315220.004	229.2	217.0
GW103577	Basalt	664440.999	7300669.004	187.4	199.7
GW103857	Basalt	622127.999	7370264.004	189.9	184.5
GW103884	Basalt	661147.999	7355753.004	183.6	175.9
GW103886	Basalt	640498.999	7296337.004	232.0	231.5
GW103887	Basalt	640417.999	7297414.004	229.0	230.7
GW103351	Basalt	650870.999	7328504.004	183.6	187.2
GW103615	Basalt	612520.999	7331268.004	354.6	366.2
GW103628	Basalt	619101.999	7328064.004	379.4	361.7
GW103632	Basalt	647228.999	7324474.004	199.5	200.1
GW103374	Basalt	663339.999	7316943.004	176.7	191.0
GW103375	Basalt	666703.999	7293145.004	208.8	203.6
GW103385	Basalt	612761.999	7349738.004	238.8	246.2
GW103654	Basalt	647499.999	7301712.004	216.1	218.5
GW103388	Basalt	687574.999	7340714.004	249.0	249.4
GW103118	Basalt	667279.999	7299934.004	191.7	203.6
GW103123	Basalt	664285.999	7294005.004	181.5	202.4
GW103414	Basalt	614260.999	7331940.004	361.6	367.9
GW103418	Basalt	617492.999	7321625.004	349.0	373.8
GW103132	Basalt	639114.999	7323777.004	206.0	207.0
GW103426	Basalt	615114.999	7325736.004	407.0	377.6
GW103143	Basalt	632883.999	7297732.004	265.9	243.4
GW103159	Basalt	635396.999	7325977.004	195.9	207.6
GW103444	Basalt	635048.999	7317871.004	219.5	217.1
GW103445	Basalt	635662.999	7318541.004	220.0	216.5
GW103446	Basalt	632329.999	7322231.004	219.0	211.9
GW103451	Basalt	629886.999	7352309.004	194.0	184.4

Bore Name	Formation	Easting (m)	Northing (m)	Observed Head (m AHD)	Computed Head (m AHD)
GW103452	Basalt	619450.999	7330554.004	335.0	332.0
GW103453	Basalt	616354.999	7314951.004	405.0	363.7
GW103456	Basalt	635816.999	7345977.004	180.7	187.4
GW103469	Basalt	673408.999	7335976.004	141.0	203.1
GW103475	Basalt	633411.999	7358807.004	176.0	178.6
GW103484	Basalt	616089.999	7319323.004	361.2	366.4
GW103758	Basalt	661798.999	7361298.004	174.0	173.8
GW103489	Basalt	637127.999	7319361.004	211.0	215.6
GW103491	Basalt	648238.999	7317087.004	197.0	208.0
GW103500	Basalt	639505.999	7348703.004	167.2	182.2
GW103227	Basalt	617811.999	7336754.004	292.0	290.0
GW103512	Basalt	635505.999	7315778.004	225.9	218.0
GW103517	Basalt	661530.999	7337082.004	176.2	182.2
GW103521	Basalt	652228.999	7299358.004	210.0	210.9
GW103785	Basalt	685013.999	7304849.004	231.0	244.0
GW103248	Basalt	637547.999	7296011.004	250.3	234.3
GW103250	Basalt	616783.999	7323021.004	375.0	375.7
GW103536	Basalt	636716.999	7344860.004	179.8	187.6
GW103262	Basalt	612227.999	7334467.004	321.0	346.4
GW103047	Basalt	612544.999	7325479.004	375.5	374.4
GW103104	Basalt	665092.999	7316565.004	175.0	191.8
GW103107	Basalt	645109.999	7320148.004	232.6	209.9
GW103014	Basalt	638575.999	7309562.004	254.5	222.8
GW132369	Basalt	611592.999	7329354.004	353.0	368.7
GW132666	Basalt	612357.999	7329921.004	350.5	369.2
GW132671	Basalt	645194.999	7308427.004	208.3	220.5
GW132672	Basalt	664950.999	7293533.004	161.5	202.7
GW132129	Basalt	612469.999	7330776.004	348.6	367.5
GW132130	Basalt	612583.999	7330529.004	334.0	368.4
GW132131	Basalt	613318.999	7331570.004	372.7	367.8
GW132132	Basalt	613036.999	7331785.004	350.0	366.5
GW132133	Basalt	635473.999	7314731.004	231.1	218.7
GW132134	Basalt	613835.999	7326797.004	371.3	376.7
GW132135	Basalt	616404.999	7324605.004	383.2	377.2
GW132136	Basalt	613952.999	7331469.004	367.8	369.4
GW132680	Basalt	612711.999	7349727.004	236.3	246.3
GW132683	Basalt	633885.999	7352868.004	151.0	182.3
GW132685	Basalt	626381.999	7361272.004	180.0	184.0
GW132686	Basalt	613224.999	7350385.004	229.0	245.5
GW132687	Basalt	617914.999	7350100.004	218.0	224.4
GW132139	Basalt	614700.999	7320357.004	329.0	362.6
GW132141	Basalt	612104.999	7331301.004	343.0	364.6

Bore Name	Formation	Easting (m)	Northing (m)	Observed Head (m AHD)	Computed Head (m AHD)
GW132407	Basalt	648774.999	7351645.004	147.0	167.9
GW132408	Basalt	642086.999	7335869.004	192.9	194.9
GW132694	Basalt	634920.999	7348705.004	180.7	185.3
GW132153	Basalt	613023.999	7332007.004	349.0	365.9
GW132154	Basalt	612967.999	7332069.004	364.8	365.5
GW132155	Basalt	613221.999	7332067.004	374.7	366.3
GW132156	Basalt	612855.999	7332162.004	362.1	364.9
GW132157	Basalt	613080.999	7332037.004	368.0	365.9
GW132159	Basalt	613279.999	7332219.004	360.4	366.0
GW132410	Basalt	647277.999	7310867.004	231.8	220.7
GW132425	Basalt	665610.999	7294572.004	199.5	202.9
GW132426	Basalt	665575.999	7293957.004	205.9	202.9
GW132427	Basalt	665263.999	7293837.004	203.7	202.8
GW132722	Basalt	643610.999	7326390.004	198.0	198.4
GW132170	Basalt	665351.999	7315226.004	180.0	193.3
GW132754	Basalt	636345.999	7295497.004	247.1	236.2
GW132755	Basalt	636345.999	7295448.004	253.7	236.2
GW132205	Basalt	615772.999	7319404.004	321.0	365.1
GW132210	Basalt	651050.999	7298522.004	205.0	213.2
GW132211	Basalt	660975.999	7305557.004	188.0	197.9
GW132481	Basalt	628647.999	7376250.004	174.0	180.5
GW132225	Basalt	611948.999	7332937.004	326.0	356.4
GW132232	Basalt	644688.999	7348922.004	157.0	173.8
GW132517	Basalt	612236.999	7331319.004	345.0	365.0
GW132518	Basalt	612230.999	7331385.004	345.0	364.8
GW132523	Basalt	636264.999	7377332.004	155.0	174.1
GW132525	Basalt	625554.999	7363832.004	195.5	184.3
GW132254	Basalt	635221.999	7303204.004	222.0	229.4
GW132258	Basalt	650414.999	7308985.004	234.0	226.4
GW132259	Basalt	651331.999	7311050.004	224.0	231.4
GW132264	Basalt	632369.999	7316055.004	232.0	218.5
GW132273	Basalt	615475.999	7314867.004	375.0	363.9
GW132274	Basalt	616931.999	7317085.004	404.8	364.8
GW132276	Basalt	616440.999	7322251.004	360.5	373.5
GW132280	Basalt	651120.999	7320700.004	202.0	196.7
GW132283	Basalt	650909.999	7323683.004	196.9	195.3
GW132291	Basalt	643215.999	7319514.004	219.0	211.6
GW132075	Basalt	692908.999	7340473.004	277.7	258.0
GW132077	Basalt	661320.999	7296222.004	183.0	201.5
GW132078	Basalt	615038.999	7324022.004	383.0	375.8
GW132080	Basalt	614767.999	7324211.004	387.0	375.9
GW132084	Basalt	651465.999	7300317.004	200.0	211.6

Bore Name	Formation	Easting (m)	Northing (m)	Observed Head (m AHD)	Computed Head (m AHD)
GW132085	Basalt	636751.999	7312211.004	248.8	221.3
GW132086	Basalt	613906.999	7322464.004	362.0	370.2
GW132314	Basalt	666125.999	7295345.004	201.0	203.2
GW132099	Basalt	618144.999	7342784.004	236.7	246.6
GW132103	Basalt	612541.999	7321091.004	311.0	358.3
GW132335	Basalt	615973.999	7321818.004	349.5	371.5
GW132339	Basalt	672392.999	7304068.004	191.8	209.7
GW132124	Basalt	611889.999	7331891.004	360.4	361.6
GW132660	Basalt	635475.999	7303232.004	193.0	229.3
GW132661	Basalt	670768.999	7301833.004	193.0	208.1
GW132663	Basalt	615741.999	7336476.004	336.5	317.6
GW132664	Basalt	614921.999	7322364.004	337.5	372.0
GW132994	Basalt	634208.999	7311249.004	254.0	222.2
GW132920	Basalt	640485.999	7302906.004	231.0	226.0
GW132929	Basalt	644434.999	7304643.004	223.0	221.3
GW158023	Basalt	639660.999	7351576.004	182.0	178.0
GW158571	Basalt	638257.999	7295276.004	244.8	234.1
GW158572	Basalt	640423.999	7299281.004	235.0	228.3
GW158573	Basalt	644851.999	7297779.004	228.6	221.5
GW158574	Basalt	645325.999	7295906.004	229.3	222.4
GW158358	Basalt	638549.999	7353772.004	184.3	177.1
GW158655	Basalt	664590.999	7293539.004	200.5	202.6
GW158716	Basalt	640911.999	7349331.004	181.0	180.0
GW158717	Basalt	640058.999	7352020.004	180.0	177.2
GW158156	Basalt	638582.999	7299993.004	257.8	228.9
GW158159	Basalt	638481.999	7297180.004	231.5	232.8
GW158161	Basalt	638478.999	7297191.004	238.3	232.8
GW158162	Basalt	636681.999	7297612.004	264.0	234.8
GW158999	Basalt	638839.999	7298361.004	240.9	230.7
GW158493	Basalt	613221.999	7329190.004	390.5	372.7
GW158564	Basalt	641645.999	7295544.004	232.0	230.6
GW165042	Basalt	618407.999	7317176.004	382.0	359.6
GW165085	Basalt	645608.999	7315378.004	212.5	213.7
GW165090	Basalt	622083.999	7352548.004	212.5	209.6
GW165091	Basalt	640624.999	7338640.004	204.8	193.2
GW165096	Basalt	631903.999	7341105.004	201.0	192.9
GW165098	Basalt	633181.999	7339145.004	207.0	195.1
GW165117	Basalt	618082.999	7342765.004	237.5	247.2
GW165118	Basalt	615931.999	7340304.004	277.9	277.4
GW165000	Basalt	638839.999	7298361.004	240.9	230.7
GW165362	Basalt	646667.999	7336555.004	174.0	182.3
GW165371	Basalt	612813.999	7332280.004	357.1	364.4

Bore Name	Formation	Easting (m)	Northing (m)	Observed Head (m AHD)	Computed Head (m AHD)
GW165372	Basalt	613228.999	7332072.004	369.0	366.3
GW165915	Basalt	633272.999	7339056.004	202.0	195.2
GW165916	Basalt	629900.999	7336760.004	229.0	201.9
GW165407	Basalt	638667.999	7299614.004	247.5	229.2
GW165666	Basalt	611629.999	7331536.004	341.0	362.6
GW165422	Basalt	661710.999	7310670.004	203.0	196.1
GW165685	Basalt	657696.999	7349864.004	162.0	174.3
GW165433	Basalt	612738.999	7331640.004	361.1	366.0
GW165438	Basalt	648310.999	7338439.004	170.0	178.5
GW165172	Basalt	612574.999	7332428.004	360.4	362.6
GW165451	Basalt	637820.999	7311860.004	243.6	221.6
GW165715	Basalt	613017.999	7330519.004	352.2	369.6
GW165181	Basalt	636164.999	7301928.004	254.4	229.4
GW165191	Basalt	636265.999	7333124.004	212.0	198.8
GW165995	Basalt	611887.999	7351983.004	240.2	249.3
GW165210	Basalt	661430.999	7339163.004	198.0	183.5
GW165491	Basalt	612089.999	7331562.004	354.8	363.7
GW165494	Basalt	636796.999	7298052.004	244.9	234.3
GW165495	Basalt	637115.999	7298926.004	261.6	232.9
GW165496	Basalt	637618.999	7301748.004	254.9	228.6
GW165497	Basalt	637125.999	7298498.004	246.7	233.4
GW165498	Basalt	637492.999	7299850.004	244.4	230.2
GW165503	Basalt	637125.999	7298499.004	251.0	233.4
GW165504	Basalt	637492.999	7299850.004	248.5	230.2
GW165527	Basalt	651672.999	7309303.004	242.4	231.3
GW165531	Basalt	614311.999	7322733.004	370.4	372.2
GW165535	Basalt	611713.999	7332425.004	320.8	358.6
GW165279	Basalt	635855.999	7335444.004	214.0	197.6
GW165280	Basalt	611647.999	7331915.004	350.0	361.0
GW165562	Basalt	622721.999	7359941.004	198.0	192.1
GW165563	Basalt	633173.999	7358936.004	183.0	178.8
GW165564	Basalt	633353.999	7358727.004	181.0	178.8
GW165829	Basalt	643196.999	7319417.004	223.0	211.7
GW165832	Basalt	616560.999	7322797.004	366.4	375.1
GW165321	Basalt	629883.999	7341049.004	203.0	194.4
GW190115	Basalt	643358.999	7311774.004	230.0	220.4
GW190437	Basalt	616181.999	7322222.004	361.0	373.0
GW190438	Basalt	617091.999	7324650.004	386.7	377.5
GW190234	Basalt	643461.999	7356948.004	169.3	170.9
GW190639	Basalt	636913.999	7296240.004	240.1	234.9
GW190648	Basalt	644854.999	7302798.004	236.9	221.4
GW190353	Basalt	612559.999	7332372.004	356.0	362.7

Bore Name	Formation	Easting (m)	Northing (m)	Observed Head (m AHD)	Computed Head (m AHD)
GW13050021	Basalt	647310.999	7325171.004	198.2	199.3
GW13050022	Basalt	637389.999	7347733.004	177.9	184.8
GW13050023	Basalt	629227.999	7376366.004	173.6	180.2
GW13050024	Basalt	629232.999	7376363.004	173.6	180.2
GW32472	Permian	630905.999	7295470.004	269.6	238.7
GW67118	Permian	629800.999	7314033.004	251.5	238.7
GW103909	Permian	612760.999	7355196.004	213.5	232.0
GW103910	Permian	612014.999	7355729.004	236.3	232.1
GW103135	Permian	628553.999	7324986.004	246.0	237.8
GW103779	Permian	629922.999	7316807.004	255.4	238.4
GW132719	Permian	649432.999	7331274.004	157.0	230.5
GW132720	Permian	648213.999	7330483.004	180.0	230.8
GW132003	Permian	654552.999	7372159.004	133.0	216.9
GW132288	Permian	628683.999	7307224.004	255.3	239.2
GW158589	Permian	638209.999	7311940.004	246.0	236.2
GW165092	Permian	627410.999	7341847.004	206.0	232.0
GW165093	Permian	627181.999	7337253.004	228.0	234.1
GW165094	Permian	624772.999	7340761.004	210.0	233.6
GW165095	Permian	623373.999	7336547.004	237.0	236.4
GW165097	Permian	629144.999	7337886.004	221.0	233.1
GW165866	Permian	626566.999	7328614.004	268.0	237.8
GW165917	Permian	626273.999	7342608.004	210.0	232.1
GW165918	Permian	625124.999	7339124.004	219.0	234.2
GW165693	Permian	681990.999	7374032.004	252.0	238.4
GW165452	Permian	637874.999	7312387.004	240.6	236.2
GW165245	Permian	625791.999	7328995.004	266.0	238.2
GW165246	Permian	624414.999	7330572.004	285.0	238.5
GW165255	Permian	629262.999	7335654.004	222.0	233.9
GW165256	Permian	627380.999	7335000.004	238.0	235.0
GW165276	Permian	623305.999	7339918.004	222.0	234.8
GW165277	Permian	629865.999	7341041.004	197.0	231.6
GW165278	Permian	628178.999	7342881.004	208.0	231.3
GW165560	Permian	626713.999	7320857.004	299.0	239.8
GW13050019	Permian	661449.999	7364750.004	135.0	221.4
GW13050026	Permian	624395.999	7320640.004	327.2	241.5
GW13050028	Permian	626166.999	7341606.004	217.7	232.6
GW57367	Tertiary	635006.999	7362551.004	162.2	174.4
GW57373	Tertiary	645407.999	7360322.004	133.7	168.4
GW57482	Tertiary	665887.999	7294347.004	214.2	203.1
GW57537	Tertiary	638885.999	7373016.004	142.4	173.1
GW57538	Tertiary	640582.999	7372502.004	154.0	171.3
GW57539	Tertiary	643524.999	7369912.004	150.7	165.7

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Bore Name	Formation	Easting (m)	Northing (m)	Observed Head (m AHD)	Computed Head (m AHD)
GW57306	Tertiary	647886.999	7366097.004	149.0	161.4
GW90159	Tertiary	640016.999	7372602.004	147.0	171.9
GW90423	Tertiary	689475.999	7293666.004	232.0	257.5
GW90426	Tertiary	688953.999	7299423.004	227.5	257.5
GW90307	Tertiary	690736.999	7298871.004	229.0	262.9
GW103774	Tertiary	649758.999	7314944.004	201.8	207.2
GW103775	Tertiary	649803.999	7315089.004	201.5	206.8
GW103803	Tertiary	637736.999	7381712.004	149.8	170.0
GW132705	Tertiary	622728.999	7327959.004	299.0	303.4
GW132219	Tertiary	641788.999	7379731.004	130.0	169.7
GW132524	Tertiary	636094.999	7377272.004	155.0	174.2
GW132284	Tertiary	650373.999	7328774.004	172.5	187.5
GW132285	Tertiary	650423.999	7328877.004	171.5	187.4
GW132341	Tertiary	670684.999	7314412.004	179.5	203.5
GW132112	Tertiary	643772.999	7379898.004	101.0	168.4
GW132996	Tertiary	640270.999	7353321.004	178.9	176.0
GW158863	Tertiary	640063.999	7299156.004	234.0	228.7
GW158864	Tertiary	640062.999	7299149.004	239.3	228.7
GW158865	Tertiary	641174.999	7297128.004	225.1	230.2
GW158866	Tertiary	638606.999	7296708.004	239.0	233.0
GW158867	Tertiary	641288.999	7299299.004	231.0	227.4
GW158911	Tertiary	695503.999	7341761.004	297.0	276.9
GW158503	Tertiary	671868.999	7366283.004	200.0	223.4
GW158509	Tertiary	671864.999	7366280.004	200.0	223.4
GW158510	Tertiary	667709.999	7360872.004	208.0	182.7
GW165106	Tertiary	611641.999	7332636.004	324.0	357.5
GW165412	Tertiary	638437.999	7298684.004	236.9	230.8
GW165937	Tertiary	694747.999	7341251.004	293.5	267.8
GW165793	Tertiary	659426.999	7374232.004	133.0	161.8
GW190225	Tertiary	675164.999	7321463.004	192.0	206.8
GW13050011	Tertiary	620761.999	7360714.004	220.4	199.2
GW13050015	Tertiary	684566.999	7304868.004	190.6	242.6
GW13050018	Tertiary	694678.999	7331290.004	224.7	261.3
GW13050020	Tertiary	645771.999	7370040.004	131.0	161.2
GW57406	Permian	675597.999	7351259.004	207.7	232.3
GW103621	Permian	645431.999	7329835.004	184.0	231.4
GW103434	Permian	671868.999	7366282.004	198.7	229.4
GW103435	Permian	672285.999	7360019.004	209.1	229.7
GW103247	Permian	674505.999	7355855.004	202.0	231.6
GW132373	Permian	649331.999	7329290.004	179.5	231.0
GW132976	Permian	650644.999	7329138.004	173.7	230.9
GW158590	Permian	625152.999	7353375.004	211.0	227.7

Bore Name	Formation	Easting (m)	Northing (m)	Observed Head (m AHD)	Computed Head (m AHD)
GW158502	Permian	669501.999	7364883.004	229.0	226.9
GW158504	Permian	674198.999	7364299.004	241.0	231.7
GW158507	Permian	668519.999	7365891.004	226.7	226.0
GW158508	Permian	670768.999	7365426.004	230.0	228.2
GW158515	Permian	662504.999	7368109.004	173.0	221.2
GW165002	Permian	638906.999	7299145.004	237.0	237.0
GW165947	Permian	697678.999	7379449.004	196.2	245.3
GW165973	Permian	688956.999	7376558.004	174.0	240.9
GW165493	Permian	632957.999	7300539.004	249.0	238.1
GW190141	Permian	686277.999	7350262.004	244.0	239.8
GW190290	Permian	682051.999	7371884.004	248.0	238.9
GW32211	Alluvium	662328.999	7324662.004	174.7	186.8
GW32212	Alluvium	662288.999	7323931.004	173.8	187.1
GW47759	Alluvium	646352.999	7329397.004	182.0	193.1
GW47761	Alluvium	652294.999	7326493.004	165.7	188.2
GW47779	Alluvium	638728.999	7326078.004	207.2	204.8
GW47452	Alluvium	660140.999	7320492.004	185.3	188.4
GW47454	Alluvium	658079.999	7323392.004	178.5	186.3
GW57377	Alluvium	652934.999	7348983.004	158.7	170.1
GW57419	Alluvium	672274.999	7325614.004	194.8	200.6
GW57472	Alluvium	665771.999	7317299.004	180.5	193.1
GW57551	Alluvium	639459.999	7348602.004	173.8	182.3
GW57352	Alluvium	637096.999	7353995.004	164.6	178.1
GW57180	Alluvium	655644.999	7300500.004	203.0	206.7
GW62038	Alluvium	657118.999	7336963.004	161.7	178.0
GW62039	Alluvium	657182.999	7337150.004	160.7	177.9
GW62040	Alluvium	656935.999	7339771.004	177.5	177.8
GW62041	Alluvium	656891.999	7338978.004	156.6	177.8
GW62127	Alluvium	650796.999	7297447.004	214.0	214.3
GW62128	Alluvium	659082.999	7328826.004	176.3	183.3
GW62130	Alluvium	661361.999	7327034.004	163.6	185.4
GW67321	Alluvium	662102.999	7323900.004	176.0	187.1
GW67330	Alluvium	706078.999	7297256.004	301.5	295.5
GW84085	Alluvium	656239.999	7322439.004	173.3	187.0
GW84116	Alluvium	659882.999	7323745.004	173.7	186.5
GW103834	Alluvium	660725.999	7320531.004	181.0	188.5
GW103836	Alluvium	661071.999	7319294.004	182.0	189.2
GW132171	Alluvium	663386.999	7314282.004	185.0	192.7
GW132212	Alluvium	659684.999	7328132.004	172.6	184.0
GW132282	Alluvium	657122.999	7323599.004	176.0	186.2
GW132343	Alluvium	653057.999	7372081.004	143.0	156.8
GW132344	Alluvium	651503.999	7372876.004	148.4	156.2

Bore Name	Formation	Easting (m)	Northing (m)	Observed Head (m AHD)	Computed Head (m AHD)
GW132348	Alluvium	651276.999	7372266.004	146.7	156.5
GW132351	Alluvium	655118.999	7370381.004	144.0	158.9
GW132352	Alluvium	651130.999	7372898.004	147.0	156.2
GW132353	Alluvium	654629.999	7369267.004	139.6	159.1
GW158566	Alluvium	643224.999	7297551.004	212.4	224.0
GW165349	Alluvium	662276.999	7324031.004	181.0	187.1
GW165156	Alluvium	659759.999	7328149.004	177.1	184.0
GW165157	Alluvium	658635.999	7329959.004	175.8	182.4
GW165700	Alluvium	659646.999	7328129.004	177.0	184.0
GW165948	Alluvium	689277.999	7376876.004	194.0	198.6
GW165180	Alluvium	647195.999	7293900.004	212.0	221.4
GW165453	Alluvium	647746.999	7294494.004	214.6	220.5
GW165320	Alluvium	643922.999	7365039.004	151.0	162.7