NEW HOPE GROUP

ENVIRONMENTAL AUTHORITY GROUNDWATER MONITORING AND MANAGEMENT PROGRAM

New Acland Coal Mine

APRIL 2023

Contents

Tables

Figures

1. Introduction

1.1. Background

This Groundwater Monitoring and Management Program (GMMP) has been prepared to address Condition D24 of Environmental Authority (EA) EPML00335713 for the New Acland Coal Mine (NAC), which operates on Mining Lease (ML) 50170, ML 50216, and ML 50232.

It sets out the groundwater monitoring program established for compliance with the EA, and the associated groundwater impact triggers that will invoke further assessment and groundwater impact management. The GMMP and will be administered as a specialised environmental management plan for NAC's mining operations.

It is important to note that NAC is subject to several approvals and conditions related to groundwater monitoring and management outside of the EA. These include:

- Commonwealth EPBC Act Approval for the NAC Stage 3 Project on ML 50232 (EPBC 2007/3423) and its associated Groundwater Management and Monitoring Plan developed under EPBC Act approval condition 13;
- Condition 10 of the Queensland Coordinator-General (CG)'s imposed conditions on the Stage 3 Project as outlined within the CG's December 2014 Evaluation Report for the Stage 3 Project;
- The relevant Associated Water Licence (AWL) (dated 20 October 2022) conditions for the Stage 3 Project and the AWL's Underground Water Monitoring Program (UWMP); and
- NAC's obligations identified in the Underground Water Impact Report (UWIR) for the Surat Cumulative Management Area (Surat CMA).

As such, the GMMP established under the EA will be required to incorporate elements of those approvals conditions as relevant; for example, in the establishment of EA groundwater level trigger threshold criteria based on numerical groundwater model predictions that are subject to ongoing routine revision under the AWL and EPBC Act approval.

1.2. Objectives

The objectives of this GMMP, per EA Condition D24, are to:

- identify all potential sources of groundwater contamination from mining activities including construction and rehabilitation activities (**Section 3.3**);
- present the NAC hydrogeological conceptual groundwater model (**Section 2**);
- identify all environmental values that must be protected (**Section 2.5**);
- include details of groundwater levels in all identified aquifers present across and adjacent to the site to confirm existing groundwater flow paths (**Section 2.3.3**);
- provide estimates of the groundwater inflow to rehabilitated landforms and surface water ingress to groundwater from flooding events using the groundwater model (**Section 3.2.1.2**);
- describe groundwater monitoring and data analysis that will be undertaken to achieve the following objectives under the EA (**Sections 4**, **6** and **7**):
    + detect any impacts to groundwater level due to the mining activities, including construction and rehabilitation activities;

  + detect any impacts to groundwater quality due to the mining activities, including construction and rehabilitation activities;
  + determine compliance with EA conditions D14 and D16; and
  + determine trends in groundwater quality;
- provide groundwater management and monitoring methodologies (**Section 4.4**);
- provide a quality assurance and control program (**Section 5**); and
- prescribe a process that is carried out every two (2) years and results in an updated GMMP, that at a minimum includes identification of improvements to the GMMP and addresses any comments provided by the administering authority (Department of Environment and Science, DES) (**Section 7.2**).

1.3. Document Structure

The GMMP is structured as follows.

- Section 2: describes the hydrogeologic setting including existing groundwater levels and flowpaths information, and presents the hydrogeological conceptual model.
- Section 3: describes NAC's potential impacts on groundwater to set the context for the GMMP.
- Section 4: describes the EA groundwater monitoring program including monitoring locations, monitoring frequency, and the parameters to be recorded/analysed.
- Section 5: sets out the Quality Assurance and Quality Control procedures for the groundwater monitoring program.
- Section 6: sets out the groundwater impact triggers and protocols for investigating, and if required, mitigating the impacts on groundwater from NAC's operations.
- Section 7: describes the process of continual reporting, review and improvement (update) of the GMMP to ensure it continues to meet its objectives.

1.4. Relevant Conditions

The EA conditions relevant to this GMMP are detailed in **Table 1.**

Table 1 EA conditions relevant to this GMMP

Approval	Condition Number	Details[1]
EA	D1	Conditions D2 to D6 apply to all activities. Conditions D7 to D11 apply to mining activities on ML50232. Conditions D12 to D23 apply to mining activities on ML50170 and ML50216. Conditions D22 and D24 to D27 apply to all mining activities.
EA	D2	The environmental authority holder must not release contaminants to groundwater.

[1] Footnotes have been included in this table, where relevant, to cross reference specific requirements of the conditions against the sections of this GMMP addressing those specific requirements. More general obligations have not been cross referenced given that they are addressed more generally by this GMMP.

EA	D3	All determinations of groundwater quality and biological monitoring must be performed by an appropriately qualified person.
EA	D4	Monitoring and sampling of groundwater must comply with the latest edition of the administering authority's Monitoring and Sampling Manual.
EA	D5	The construction, maintenance and management of groundwater bores (including groundwater monitoring bores) must be undertaken in a manner that prevents or minimises impacts to the environment and ensures the integrity of the bores to obtain accurate monitoring.
EA	D6	The location of monitoring bores must take into consideration the location of any voids, Tailings Storage Facilities, hazardous waste rock dumps, heap leach pads, location and depth of aquifers and hydro geological factors within the host rocks which may allow the movement of hazardous contaminants.
EA	D7	Groundwater quality and levels must be monitored at the locations and frequencies defined in Table D1 - Groundwater monitoring locations and frequency (ML50232) for quality characteristics identified in Table D2 - Groundwater quality triggers and limits (ML50232).[2]
EA	D8	Groundwater levels when measured at the monitoring locations specified in Table D1 - Groundwater monitoring locations and frequency (ML50232) must not exceed the groundwater level trigger change thresholds specified in Table D3 - Groundwater level monitoring (ML50232, ML50216 and ML50170).
EA	D9	If quality characteristics of groundwater from compliance bores identified in Table D1 - Groundwater monitoring locations and frequency exceed any of the trigger levels stated in Table D2 - Groundwater quality triggers and limits or exceed any of the groundwater level trigger threshold stated in Table D3 - Groundwater level monitoring (ML50232, ML50216 and ML50170), the holder of this environmental authority must compare the compliance monitoring bore results to the interpretation bore results and complete an investigation in accordance with the ANZECC and ARMCANZ 2000.
EA	D10	Results of monitoring of groundwater from compliance bores identified in Table D1 - Groundwater monitoring locations and frequency must not exceed any of the limits defined in Table D2 - Groundwater quality triggers and limits as a result of mining activity.
EA	D11	Within two (2) years of this environmental authority taking effect, the environmental authority holder must submit to the administering authority: (a) all contaminant trigger levels listed as TBA in Table D2 – Groundwater quality triggers and limits; and (b) all levels listed as TBA in Table D3 – Groundwater level monitoring (ML50232, ML50216 and ML50170).
EA	D12	Groundwater quality must be monitored every six (6) months at the locations defined in Table D4 – Groundwater Monitoring Bores (ML50216 and ML50170) and shown in Figure D1 – Groundwater monitoring points (ML50216 and ML50170) for quality characteristics identified in Table D5 – Groundwater limits (ML50216 and ML50170)

[2] Refer to section 4 of this GMMP.

EA	D13	For new monitoring bores identified in Table D4 – Groundwater Monitoring Bores (ML50216 and ML50170), groundwater quality must be monitored every three (3) months until twelve (12) monitoring events have been completed for quality characteristics identified in Table D5 – Groundwater limits (ML50216 and ML50170).
EA	D14	If the contaminant limits specified in Table D5 – Groundwater limits (ML50216 and ML50170) are exceeded at any time at any compliance bore, groundwater quality monitoring as per condition D10 must occur every three (3) months, until such time as no limits have been exceeded on three (3) consecutive three-monthly monitoring events. NOTE: Groundwater monitoring can recommence at six (6) monthly intervals once three (3) consecutive three-monthly monitoring events compliant with the limits set under Table D5 – Groundwater Limits have been achieved.
EA	D15	Standing groundwater levels must be monitored monthly at the locations defined in Table D4 – Groundwater Monitoring Bores (ML50216 and ML50170).
EA	D16	Results of groundwater quality monitoring, conducted in accordance with conditions D12, D13 and D14, must not be exceeded at the same monitoring bore on three (3) consecutive monitoring events for any single contaminant limit specified in Table D5 – Groundwater Limits (ML50216 and ML50170).
EA	D17	If the contaminant limits specified in Table D5 – Groundwater Limits are exceeded on three (3) consecutive occasions, the environmental authority holder must notify the administering authority within 1 Business day of receiving the results.
EA	D18	If bore groundwater levels, monitored under condition D15, exceed any of the groundwater level trigger thresholds stated in Table D3 – Groundwater Limits (ML50232, 50216 and ML50170), the environmental authority holder must compare the compliance monitoring bores to the interpretation bore results and complete an investigation in accordance with the ANZECC and ARMCANZ 2000
EA	D19	If an exceedance is determined under condition D16 or an exceedance is identified in condition D18, at any monitoring bore: (a) an investigation must be completed and a written report provided to the administering authority within sixty (60) days of becoming aware of the exceedance or difference; and (a) the report must include a determination of whether the exceedance or difference is caused by: (i) mining activities authorised under this environmental authority; or (ii) natural variation; or (iii) neighbouring land use resulting in groundwater impacts.
EA	D20	If the investigation under condition D19 determines that the exceedance was a result of the mining activities, including rehabilitation, authorised under this environmental authority, then further investigation must be undertaken to establish whether environmental harm has occurred or may occur, and the extent thereof.
EA	D21	If an investigation undertaken under condition D19 determines that environmental harm has or may occur, the holder of this environmental authority must:

		(a) implement immediate mitigation measures to reduce the potential for environmental harm; (b) develop long-term mitigation measures to address any existing groundwater contamination and prevent recurrence of groundwater contamination which must be implemented in a reasonable time period, and (c) provide a report of the completed mitigation measures and proposed long-term mitigation measures to the administering authority within twenty-eight (28) days of submission of the report under condition D19.
EA	D22	The results of groundwater monitoring conducted under Condition D7, Condition D12, Condition D13, Condition D14 and Condition D15 must be submitted to the administering authority via WaTERS by 1 April each year for the monitoring conducted in the calendar year prior.
EA	D23	The location and Surface RL of new bores, identified in Table D4 – Groundwater Monitoring Bores (ML50216 and ML50170), must be provided to the administering authority within one (1) month of installation. New monitoring bores must be installed by 28 February 2023.
EA	D24	An updated Groundwater Monitoring and Management Program (GMMP) must be developed by 1 April 2023 and implemented. The GMMP must: (a) identify all potential sources of groundwater contamination from mining activities including construction and rehabilitation activities; (b) include a hydrogeological conceptual groundwater model; (c) identify all environmental values that must be protected; (d) include details of groundwater levels in all identified aquifers present across and adjacent to the site to confirm existing groundwater flow paths; (e) include estimates of the groundwater inflow to rehabilitated landforms and surface water ingress to groundwater from flooding events using the groundwater model; (f) ensure all potential groundwater impacts, including groundwater contamination and groundwater drawdown due to mining activities including construction and rehabilitation activities are identified, monitored, and mitigated; (g) ensure adequate groundwater monitoring and data analysis is undertaken to achieve the following objectives: (i) detect any impacts to groundwater level due to the mining activities, including construction and rehabilitation activities; (ii) detect any impacts to groundwater quality due to the mining activities, including construction and rehabilitation activities; (iii) determine compliance with conditions D14 and D16; and (iv) determine trends in groundwater quality; (h) include groundwater management and monitoring methodologies that must also be implemented for the duration of all mining activities, including construction and rehabilitation activities; (i) include a quality assurance and control program that must also be implemented for the duration of all mining activities, including construction and rehabilitation activities; and

		(j) include a process that must be carried out every two (2) years and results in an updated GMMP, that at a minimum includes identification of improvements to the GMMP and addresses any comments provided by the administering authority.
EA	D25	An Annual Groundwater Monitoring Report (AGMR) is required to be completed and submitted to the administering authority on a yearly basis by 1 April of each year (excluding exploration activities). The AGMR must include: (a) the water monitoring data; (b) analysis based on applying the groundwater quality and standing water level of all groundwater monitoring bores (including compliance and interpretation) listed within Table D1: Groundwater monitoring locations and frequency (ML50232) and Table D4 – Groundwater Monitoring Bores (ML50216 and ML50170); (c) an assessment of long-term water quality and water level trends at all groundwater monitoring bores (including compliance and interpretation) listed in Table D1: Groundwater monitoring locations and frequency (ML50232) and Table D4 – Groundwater Monitoring Bores (ML50216 and ML50170); (d) details of any review undertaken of the groundwater conceptual model; and (e) an assessment of any differences between the groundwater level impact predicted and actual impacts for any corresponding period.
EA	D26	Notwithstanding the requirements of conditions D13 to D21 (inclusive), groundwater level increases or decreases as measured in monitoring bores, when caused by seepage from Tailings Storage Facility or environmental dam must be notified within fourteen (14) days from becoming aware of the cause of the seepage to the administering authority.
EA	D27	The following information must be recorded in relation to all groundwater quality and water level sampling: (a) the date on which the sample was taken; (b) the time at which the sample was taken; (c) the monitoring bore at which the sample was taken; and (d) The results of all monitoring.

2. Project Setting and Conceptual Hydrogeological Model

This section describes the hydrogeological setting of NAC's operations, largely sourced from the conceptual hydrogeological model report for the NAC Stage 3 Project on ML 50232 (SLR, 2018a), and supplemented by the conceptual hydrogeological model report for the Stage 1 and Stage 2 Mine area (SLR, 2021a). Full technical detail supporting the following summary of the hydrogeological setting can be found in the SLR (2018a and 2021a) reports. The conceptual hydrogeological model is presented as **Figure 1**, and is summarised below.

2.1. Location, Topography and Surface Drainage

NAC is located in the Clarence-Moreton Basin of Southeast Queensland, and within the southeastern-most extent of the Surat Cumulative Management Area (CMA). The broader region is topographically dominated by the Great Dividing Range to the northeast east and southeast, the plains and gently sloping terrain of the Darling Downs in the area of the Mine, and the relatively flat Condamine River Valley to the far west. The region has a subtropical climate characterised by hot, humid summers and mild to cool winters, with annual rainfall dominated by the warmer summer months. However, in the topographically elevated areas at the northeast, east and southeast the climate tends to trend towards a more temperate classification due to orographic effects associated with the Great Dividing Range. Long term climate trends indicate that the region has generally been wetter than average prior to 1990 and drier than average since around 1990, with the drier period punctuated by short very wet periods such as in 2010-11 and 2021-22.

The surface drainage systems of the region are generally westwards draining creeks across most of the area, originating in the Great Dividing Range and flowing into the Condamine River Valley. The main drainage features include Oakey Creek in the south of the NAC area, Lagoon Creek in the NAC area (a tributary to Oakey Creek that flows south-westwards across the Project Area), and Myall Creek to the north. The creeks are typically ephemeral in nature and do not have significant baseflow components associated with groundwater. However, discharge of treated Toowoomba wastewater into a tributary of Oakey Creek means that to the southwest of NAC, Oakey Creek has a constant flow and is likely to act as a groundwater recharge source (i.e. a losing stream) to the underlying alluvium.

2.2. Geological Setting

2.2.1. General

The western Clarence-Moreton Basin is considered to be an eastern hydrogeological extension to the Surat Basin, with the Walloon Coal Measures continuous between the Surat and Clarence-Moreton basins.

The stratigraphy of the NAC area consists of Jurassic-aged sedimentary rocks which dip in a southwesterly direction and of which the Walloon Coal Measures is the youngest. The Jurassic formations have been either partly eroded, or exposed, over much of the Study Area. Overlying the Jurassic formations in places are Cenozoic aged Main Range Volcanics rocks (typically basalt), and Cenozoic aged accumulations of unconsolidated and semi-consolidated alluvial sediments adjacent modern watercourses. Underlying the Walloon Coal Measures are the fine sandstones, siltstones and mudstones of the Durabilla Formation, which are then in turn underlain by the relatively thick Marburg Sandstone unit, considered equivalent to and continuous with the Hutton Sandstone of the Surat Basin. The Marburg Sandstone is underlain by the Evergreen Formation and the Helidon Sandstone, which both lie at significant depth in relation to NAC's operations.

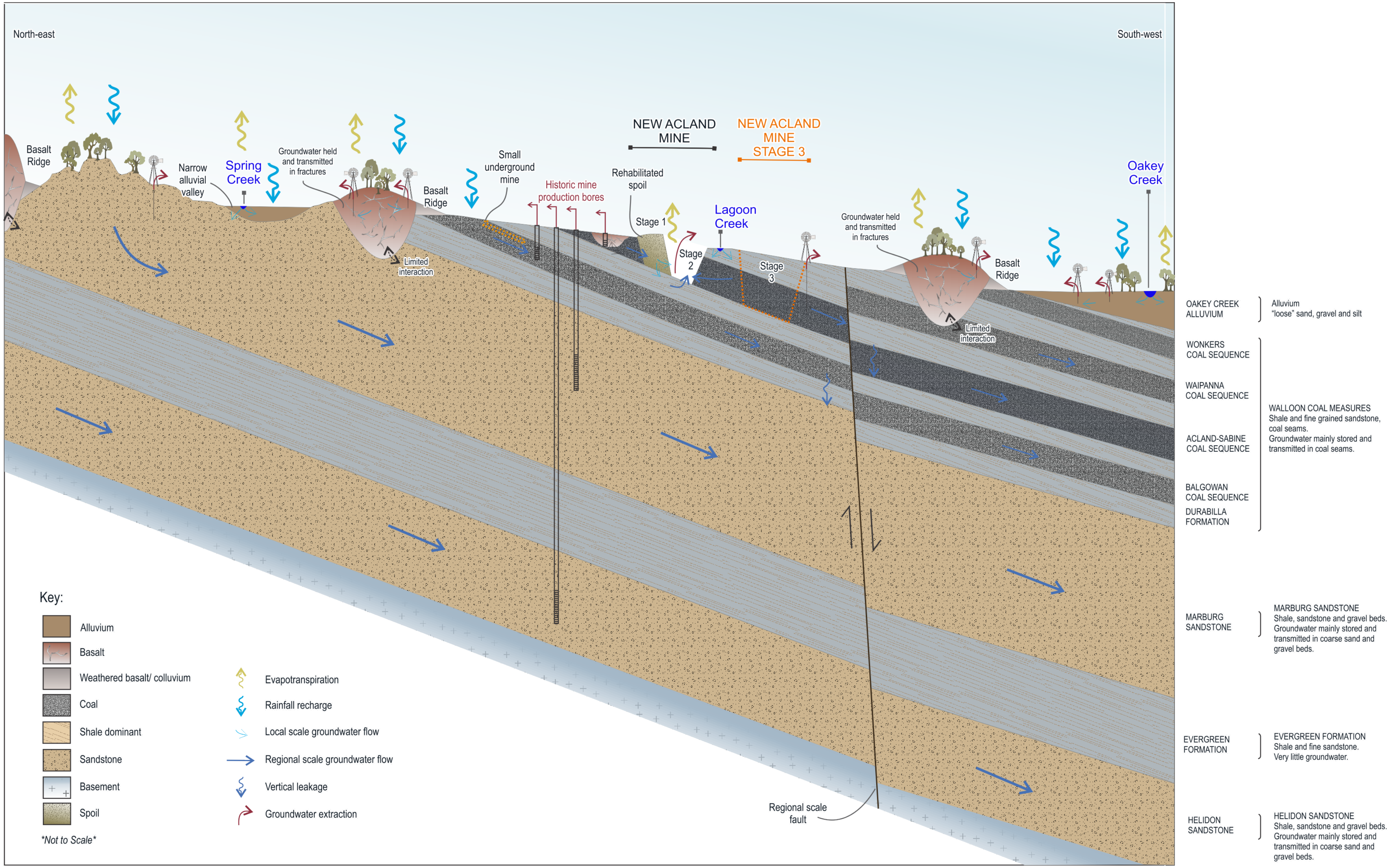


Figure 1 Conceptual Hydrogeological Model

Structural geological faulting is well known in the NAC area and surrounds from a number of studies as well as extensive NAC drilling data. Many of the fault structures in the Jurassic aged geological units have formed and are spatially controlled by the reactivation of deeper faulting in the older underlying basement rock. The most common structures present are steeply dipping (60-80°) normal faults, with two major northwest-southeast trending faults with throws of up to 50 m present at the Mine.

2.2.2. Walloon Coal Measures

The Walloon Coal Measures comprise a series of coal seam packages separated by intervals of thicker interburden. In the NAC area and immediate surrounds, these coal seam packages include (from youngest to oldest):

- the Waipanna Coal Sequence which outcrops to a minor extent in the southwest of the NAC Stage 3 Project Area on ML 50232;
- the Acland Coal Sequence which forms the surficial coal sequence over much of the NAC area and is the primary coal resource targeted by NAC's mining activities; and
- the Balgowan Coal Sequence.

Each coal sequence typically is comprised of between 25 and 50m of interbedded thin coal seams, siltstones and fine sandstones, and separated from the next coal sequence by around 25 to 35 m of non-coal siltstone, mudstone and fine sandstone interburden.

2.3. Hydrogeological Setting

2.3.1. Aquifer Identification

Studies specific to the Surat CMA and supported by the Queensland Government registered groundwater bore database analysis and NAC's own groundwater investigation and monitoring programs across and surrounding the NAC area, indicate that the Cenozoic alluvium and Main Range Volcanics as well as the Marburg Sandstone and Helidon Sandstone form the major aquifers of the region. The alluvium and Main Range Volcanics aquifers are largely absent within and adjacent the NAC area. However, the alluvial aquifer becomes significant both to the north and south of the NAC area associated with major surface water drainage features (Myall and Oakey Creeks, respectively), and the Main Range Volcanics aquifer becomes prevalent northwest and west of NAC. Alluvium to the immediate north of NAC is associated with Spring and Cain Creeks, tributaries of Myall Creek. It should be noted that the same alluvial aquifer is associated with both Cain Creek and Spring Creek, given that Spring Creek flows into and becomes Cain Creek just to the northwest of NAC, which in turn flows into Myall Creek further downstream (northwest) of Cain Creek.

Various studies and NAC investigations show that the individual coal sequences of the Walloon Coal Measures form discreet aquifers in their own right, separated by non-coal aquitard-forming interburden rocks. This concept is supported by drilling data, water level and water quality data from adjacent monitoring bores, and aquifer pumping test analysis.

As well as groundwater within the coal sequences being constrained to the coal seams, the groundwater resources of the alluvium, Main Range Volcanics and Marburg Sandstone appear to be constrained within more permeable zones/horizons of those geologic units, with the less-permeable zones having aquitard-like properties in their own right. For this reason, it is expected that horizontal permeabilities of the major aquifers of the NAC area and surrounds are significantly greater than vertical permeabilities.

The hydrogeological classifications of the various units present at and surrounding NAC are shown in **Table 2**. Note that the lowermost units Evergreen Formation and Helidon

Sandstone lie at significant depth in relation to NAC's current and future activities and so are of little relevance to the GMMP.

Table 2 Hydrostratigraphy of the NAC Area and Surrounds

Geologic Unit		Dominant Hydrostratigraphic Classification
Alluvium		Aquifer (in coarser grained horizons)
Main Range Volcanics		Aquifer (where vesicular or fractured)
Walloon Coal Measures	Waipanna Coal Sequence	Aquifer (coal seams)
	Interburden	Aquitard
	Acland Coal Sequence	Aquifer (coal seams)
	Interburden	Aquitard
	Balgowan Coal Sequence	Aquifer (coal seams)
Durabilla Formation		Aquitard
Marburg Sandstone		Aquifer
Evergreen Formation		Aquitard
Helidon Sandstone		Aquifer

2.3.2. Groundwater Recharge

NAC is located in a general rainfall-sourced groundwater recharge area for many aquifers in the Surat CMA. Calculated recharge rates generally range from 1.3 mm/yr to 6.7 mm/yr, with highest recharge rates in the Main Range Volcanics and lowest recharge rates for the Walloon Coal Measures. The calculated recharge rates for the alluvium and Marburg Sandstone aquifers were 4.1 and 4.5 mm/yr, respectively.

2.3.3. Groundwater Levels and Flow Paths

2.3.3.1. Alluvium

In the vicinity of NAC, there is little to no evidence of groundwater presence within the limited distribution of coarser grained alluvial sediments associated with Lagoon Creek that might form an aquifer. Two EA bores recently installed into the Lagoon Creek alluvium in the northern parts of ML 50232 (LCA1 and LCA2) show the alluvium to be thin, clay dominated, and dry. Seven km downstream of NAC where the Lagoon Creek alluvium is more geomorphologically developed, specific groundwater investigations have shown that whilst alluvial sands and gravels are shown to be present in the lowermost 1 m of the 5 m thick alluvial intersection, they are not groundwater bearing the water table lies within the underlying weathered Walloon Coal Measures. In the specific drilling investigation assessing the Lagoon Creek alluvium just outside the southwest corner of ML 50232, groundwater was only encountered in two of the four drillholes, and was not associated with the alluvial material but the underlying weathered Walloon Coal Measures. Ongoing routine monitoring results from the non-EA GW14a bore since installation in that investigation showed that the alluvium remained effectively dry for an extended period of time (years), with the water table sitting at the interface between the alluvium and the underlying weathered bedrock at greater than 5 m below ground surface level. The water table was shown to rise above the base of the alluvium in the bore only after an extended very wet climatic period in 2021-22, with maximum saturation of the alluvium of approximately 0.5 m recorded, averaging 0.3 m.

2.3.3.2. Main Range Volcanics

The Main Range Volcanics is subject to direct mining related affects in the western parts of ML 50170 and ML 50216, where it is both directly intercepted at the edge of mining pits, and subject to small volumes of groundwater bore extraction for Mine potable water supply. The fact that the potable supply bore extraction has occurred uninterrupted for many years, despite the close proximity of mining activities, is considered an indication of the limited effect to the extractive use environmental value despite intersection of the unit within Mine pits.

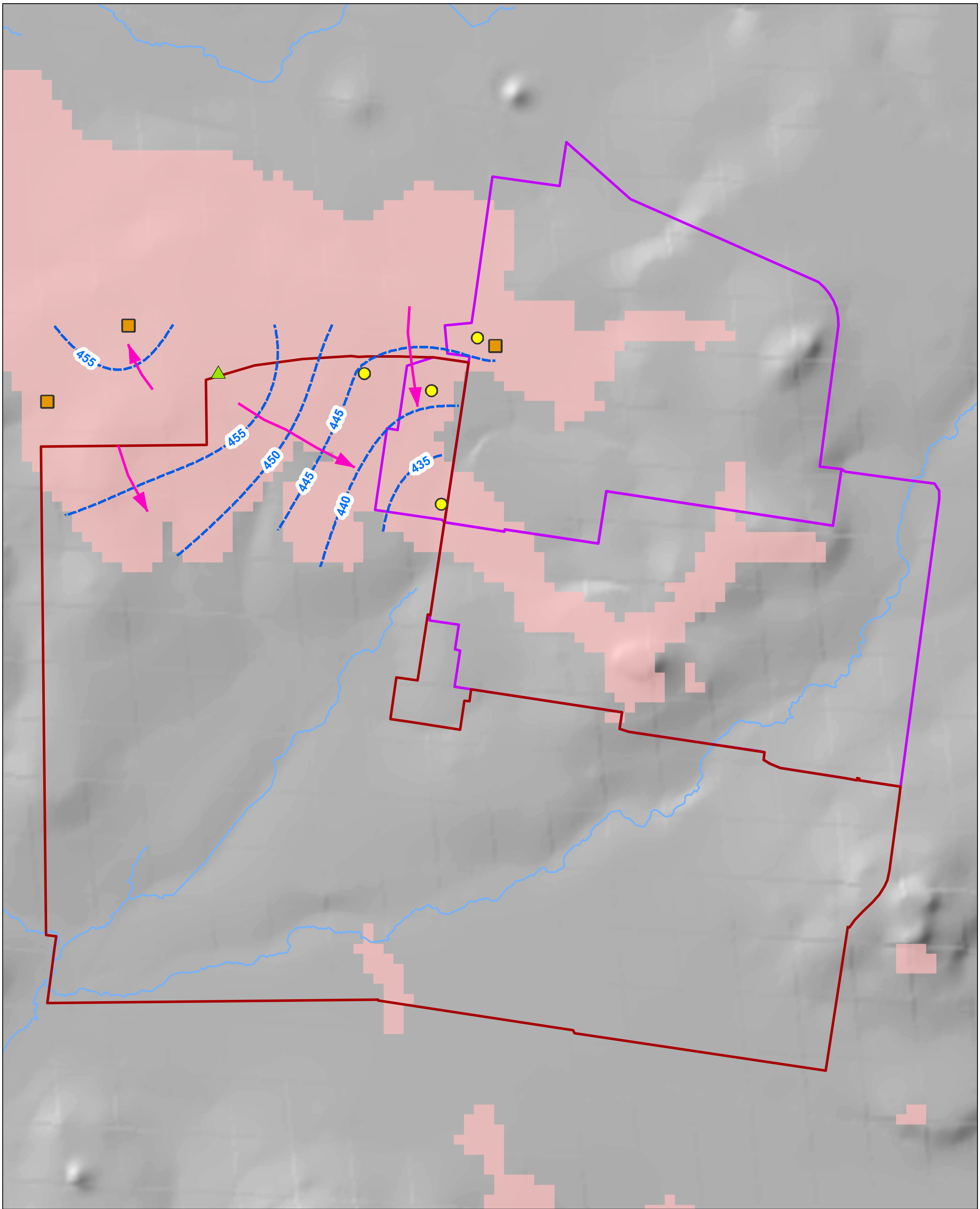
Pre-mining potentiometric surface plots for the Main Range Volcanics aquifer were generated as part of the Stage 3 Project's conceptual hydrogeological model (SLR, 2018a) for the pre-1990 time period (using all available data pre-1990). The pre-1990 potentiometric surface generated for the Main Range Volcanics aquifer showed a general northeast to west-southwest hydraulic gradient where the aquifer occurs immediately west of NAC, with groundwater elevations decreasing from approximately 440 mAHD to 435 mAHD (SLR, 2018a).

Groundwater elevation contours for the Main Range Volcanics have been constructed for the NAC Area using October 2022 monitoring data and are shown on **Figure 2**. The potentiometric surface map indicates that groundwater flow in the Main Range Volcanics is from the northwest at groundwater elevations above 455 mAHD, flowing east-southeast towards the New Acland Mine with groundwater elevations of approximately 430 mAHD recorded on ML 50216. This is likely due to the small volumes of groundwater extraction occurring within the western parts of NAC's operation (i.e. the potable water supply bores and minor pit inflows) lowering the potentiometric surface in this area.

2.3.3.3. Acland Coal Sequence

Pre-mining potentiometric surface plots for the Acland Coal Sequence were generated as part of the Stage 3 Project's conceptual hydrogeological model (SLR, 2018) for the pre-1990 time period (using all available data pre-1990). The pre-1990 potentiometric surface generated for the Acland Coal Sequence shows a general southwestwards gradient decreasing from 420 mAHD in the northeast of NAC to 390 mAHD further to the southwest. In the vicinity of the Acland township, the pre-1990 groundwater level data for the Acland Coal Sequence was also noted as likely to be influenced by historical underground mining activities targeting that geologic unit (SLR, 2018). This influence is partially evident in the data as steep gradients in the potentiometric contours in the vicinity of the Mine and Stage 3 Project Area (SLR, 2018a).

Groundwater elevation contours for the Acland Coal Sequence have been constructed for the NAC Area using October 2022 water level data and measured elevation of in-pit sumps, and are shown on **Figure 3**. The potentiometric surface map indicates that groundwater flow in the Acland Coal Sequence is distinctly towards mining activities (pit voids) in the west, southwest and south of MLs 50170 and 50216. The contour map shows the extent of Acland Coal Sequence potentiometric surface disruption related to NAC's mining activities, which appears to be limited to within 1 to 2 km of the NAC mining areas in the Acland Coal Sequence. As would be expected, the active mining areas appear to exert the dominant control on groundwater movement within the vicinity of the Mine, forming a local groundwater sink. This would be expected to draw in groundwater from the surrounding area towards the mining area, which is apparent in the groundwater potentiometric contours that indicate southwards flow from the northern part of ML 50170, southwestwards flow on ML 50216, southeastwards flow in the western part of ML 50232, and southwards flow in the eastern part of ML 50232. Inferred groundwater flow lines show groundwater flow in the Acland Coal Sequence has a major flow component towards most recent working areas, with much of the groundwater flowing towards the open mine pits which act as a groundwater sink.



0 1 2 km

Coordinate System:	AGD 1984 AMG Zone 56
Scale:	1:50,000 at A4
Project Number:	620.11303
Date:	20-Jun-2023
Drawn by:	NT

SLR

Potentiometric Surface - October 2022
Inferred GW Flow Direction

MRV Bores

EA Compliance
EA Interpretation
Other Non-EA Bore
Modelled Formation Extent (SLR, 2018)

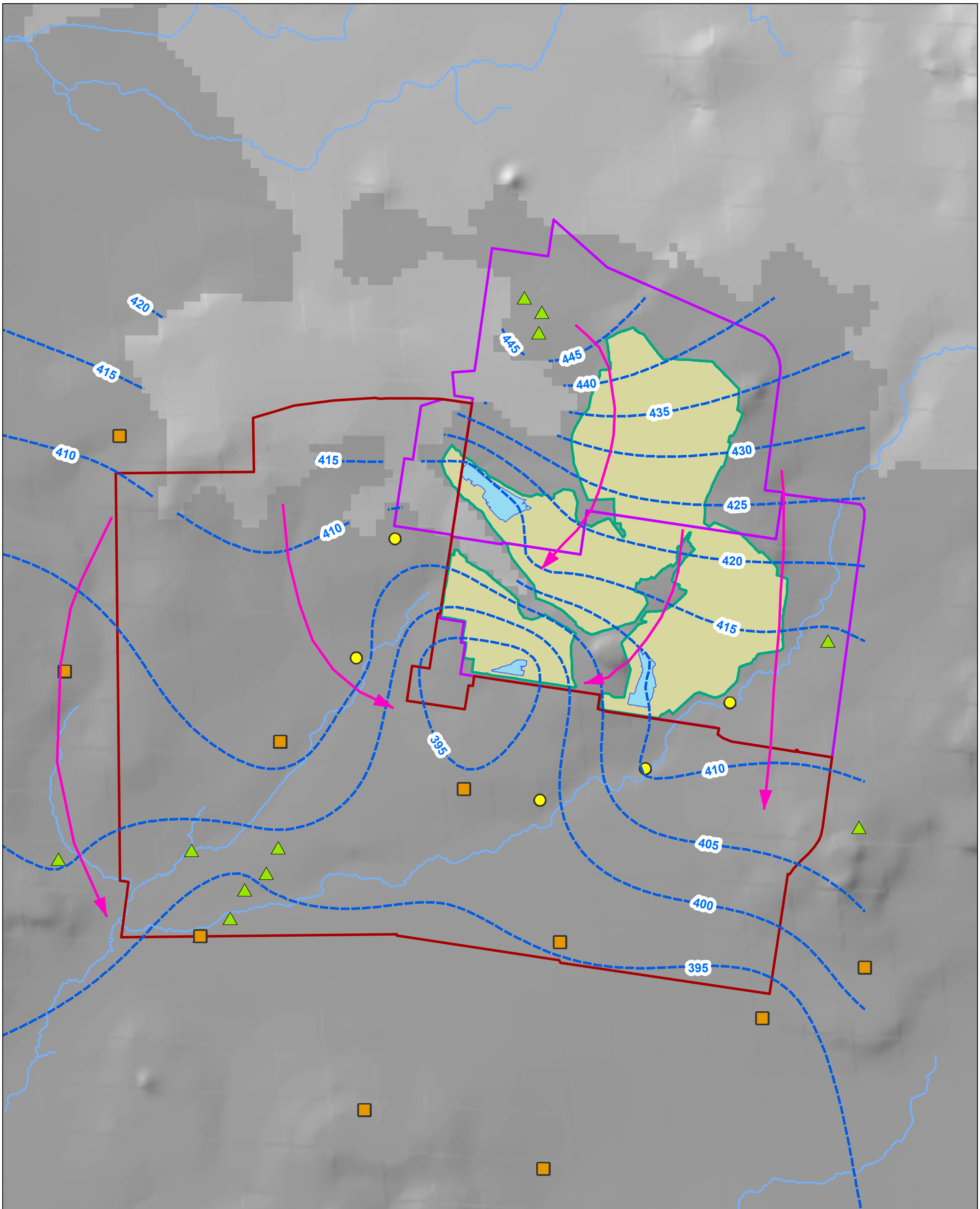
MLs 50170 and 50216
ML 50232
Surface Drainage

NEW ACLAND MINE
EA GROUNDWATER MONITORING AND MANAGEMENT PLAN

MAIN RANGE VOLCANICS POTENTIOMETRIC SURFACE AND GW FLOW DIRECTION OCTOBER 2022

FIGURE 2

H:\Projects-SLR\620-BNE\620-BNE\620.11303 NAC03 GW Support\06 SLR Data\01 CADGIS\EA GMMP\62011303_F02_MRV GW Flow.mxd



Coordinate System: AGD 1984 AMG Zone 56
Scale: 1:60,000 at A4
Project Number: 620.11303
Date: 20-Jun-2023
Drawn by: NT

Potentiometric Surface - October 2022
Infererd GW Flow Direction

ACS Bores

EA Compliance
EA Interpretation
Other Non-EA Bore

MLs 50170 and 50216
ML 50232
Existing Pit Shells
Oct 2022 In-Pit Void Waterbody
Surface Drainage

SLR

NEW ACLAND MINE
EA GROUNDWATER MONITORING AND MANAGEMENT PLAN

ACLAND COAL SEQUENCE POTENTIOMETRIC SURFACE AND GW FLOW DIRECTION OCTOBER 2022

FIGURE 3

H:\Projects-SLR\620-BNE\620-BNE\620.11303 NAC03 GW Support\06 SLR Data\01 CADGIS\EA GMMP\62011303_F03_ACS GW Flow.mxd

2.3.3.4. Balgowan Coal Sequence

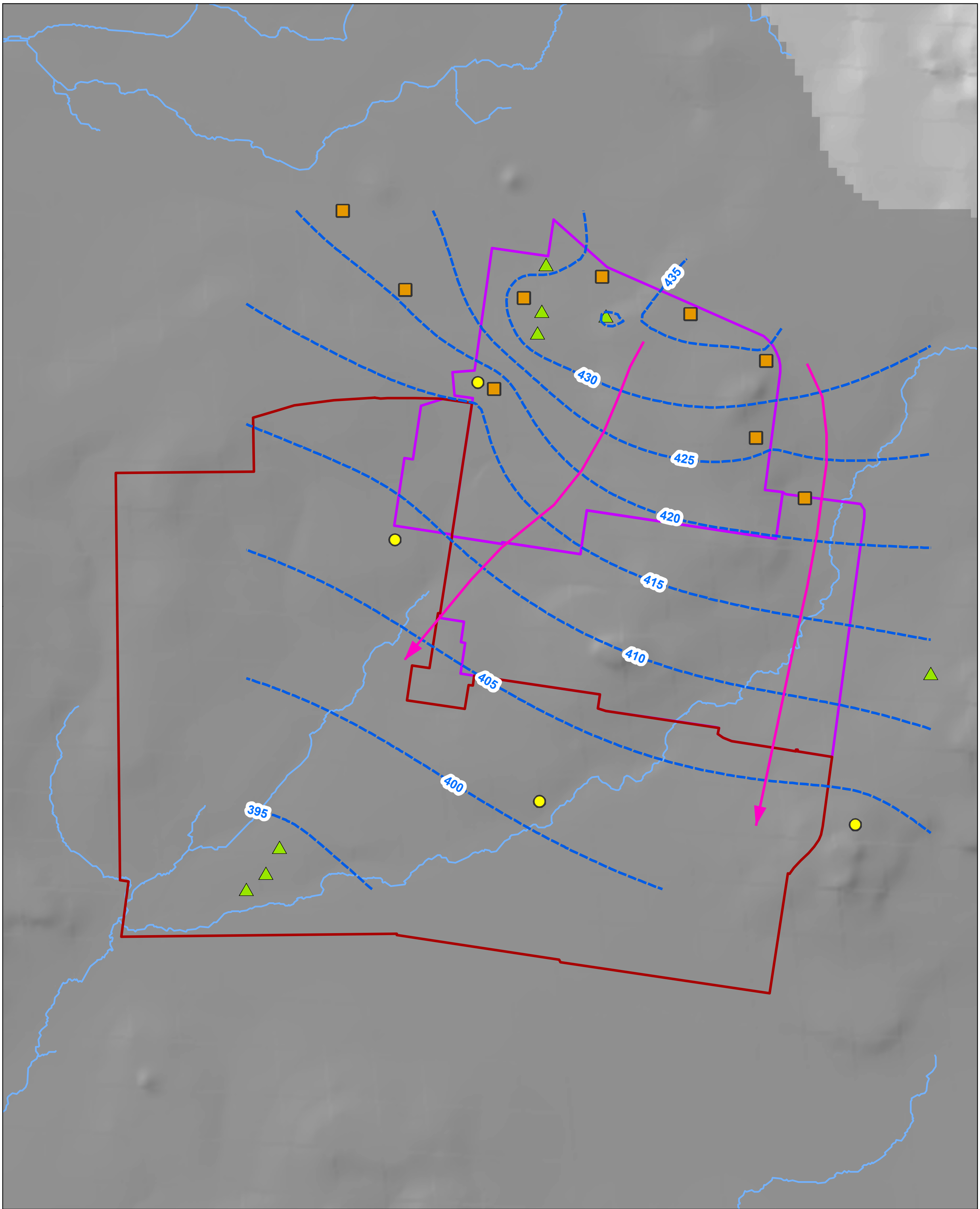
As part of the Stage 3 Project conceptual hydrogeological model (SLR, 2018a) a potentiometric surface plot for the Balgowan Coal Sequence of the Walloon Coal Measures was only generated for 2016 (representing the current period at the time of writing the report). Insufficient data was available to compile a pre-mining potentiometric surface for earlier time periods including pre-NAC mining. The 2016 potentiometric surface for the Balgowan Coal Sequence was noted to be complicated by a distinct lack of data in areas other than the unit's easternmost extent. Regardless, highest groundwater elevations of up to 440 mAHD were recorded in the north of NAC, decreasing to the west, southwest and south to around 390 mAHD. Consistent with the other Walloon Coal Measures units, a general west-southwestwards hydraulic gradient was reported (SLR, 2018a).

Groundwater elevation contours for the Balgowan Coal Sequence have been constructed for the NAC area using October 2022 water level data, and are shown on **Figure 4**. Balgowan Coal Sequence groundwater potentiometric contours indicate south-southwestwards flow from the northern part of the ML 50170 area at above 430 mAHD potentiometric levels, flowing across ML 50170, ML 50216, and then ML 50232 down to potentiometric levels below 395 mAHD in the southwest of ML 50232.

2.3.3.5. Marburg Sandstone

The pre-1990 potentiometric surface generated for the Marburg Sandstone aquifer by SLR (2018a) shows two flow components over the majority of the Study Area and centred on the general alignment of Oakey Creek (SLR, 2018a). The first a general southwestwards hydraulic gradient from 560-570 mAHD in the northeast of the Study Area to 340 mAHD in the west of the Study Area, and a second west-northwestwards gradient from 500 mAHD in the southeast of the Study Area to 340 mAHD in the west. The hydraulic gradients are relatively steep in the east of the Study Area, but flatten out towards the west away from the Great Dividing Range.

Groundwater elevation contours for the Marburg Sandstone have been constructed for the NAC area using September 2020 water level data, and are shown on **Figure 5**. The potentiometric surface shows west-southwestwards groundwater flow from north of ML 50170 at groundwater elevations above 420 mAHD, across ML 50170, ML 50216 and then ML 50232 down to potentiometric levels below 340 mAHD in the southwest of ML 50232.



0 1 2 km

Coordinate System:	AGD 1984 AMG Zone 56
Scale:	1:60,000 at A4
Project Number:	620.11303
Date:	20-Jun-2023
Drawn by:	NT

SLR

- Potentiometric Surface - October 2022
- Infererd GW Flow Direction

BCS Bores

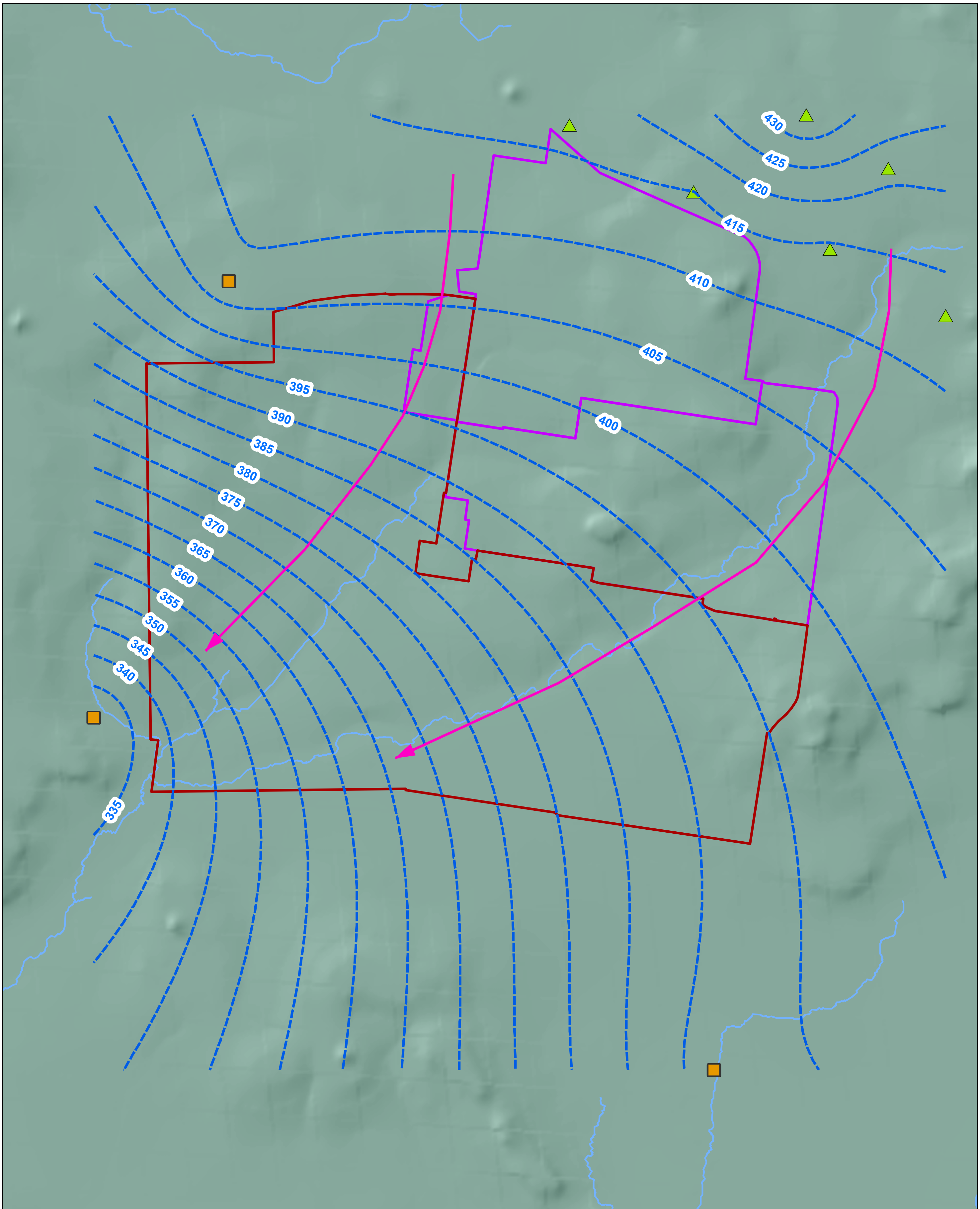
- EA Compliance
- EA Interpretation
- Other Non-EA Bore
- MLs 50170 and 50216
- ML 50232
- Surface Drainage

NEW ACLAND MINE
EA GROUNDWATER MONITORING AND MANAGEMENT PLAN

BALGOWAN COAL SEQUENCE POTENTIOMETRIC SURFACE AND GW FLOW DIRECTION OCTOBER 2022

FIGURE 4

H:\Projects-SLR\620-BNE\620-BNE\620.11303 NAC03 GW Support\06 SLR Data\01 CADGIS\EA GMMP\62011303_F04_BCS GW Flow.mxd



0 1 2 km

Coordinate System:	AGD 1984 AMG Zone 56
Scale:	1:65,000 at A4
Project Number:	620.11303
Date:	21-Jun-2023
Drawn by:	NT

SLR

Potentiometric Surface - October 2022

Infererd GW Flow Direction

Marburg Sst Bores

EA Interpretation

Other Non-EA Bore

MLs 50170 and 50216

ML 50232

Surface Drainage

NEW ACLAND MINE
EA GROUNDWATER MONITORING AND MANAGEMENT PLAN

MARBURG SANDSTONE POTENTIOMETRIC SURFACE AND GW FLOW DIRECTION SEPTEMBER 2022

FIGURE 5

H:\Projects-SLR\620-BNE\620-BNE\620.11303 NAC03 GW Support\06 SLR Data\01 CADGIS\EA GMMP\62011303_F05_Marburg GW Flow.mxd

2.3.4. Hydrogeological Role of Faults

Investigations into the hydrologic function of major faults at the Mine and within the Stage 3 Project area have shown that the faults act as partial barriers to horizontal groundwater flow, significantly restricting horizontal groundwater movement across the alignment of the faults. This is evident from both specific pumping tests targeting particular faults, as well as observations made from within the Mine pits and at monitoring bores adjacent the Mine. In the Walloon Coal Measures, as groundwater flow is dominantly within the 25 to 50 m thick coal sequences, it is likely that the amount of vertical throw of individual faults has a significant role to play in the degree of restriction the fault provides to horizontal groundwater flow. Within the Stage 3 Project Area on ML 50232, the MDL_01 Fault in the southwest has been shown in specific hydrogeological investigations to have sufficient throw to completely disrupt the lateral continuity of the coal sequences, and as a result act as a partial barrier to groundwater flow during groundwater extraction from one side of the fault (see Appendix C of SLR, 2018a).

There is little anecdotal evidence of significant groundwater inflows to the Mine pits when faults are intersected. However, intersection of the major F5 Fault within the South Pit of the Mine in 2013 was observed to be coincident with groundwater drawdown at nearby Mine monitoring bores and temporary visual evidence of minor groundwater inflows to the pit from the vicinity of the fault (SLR, 2018a). Observations of fault hydrogeological behaviour immediately following this event are primarily based upon visual analysis of the fault within the active mine pit, where it has been subject to considerable mining-related stresses such as blasting and earthworks prior to the observations being made. These stresses have a large potential for disrupting the fault properties from their in-situ nature within the immediate surrounds of the disturbance. Therefore, observation made within the disturbance area, after the disturbance has occurred, must be considered within the context of it being a stressed system and not in situ.

Correlation of the timing of water level drawdown at monitoring bore 81P, which is located on the southern side of the F5 fault, with mining breaking through the F5 fault from the north in 2013, supports the concept that the F5 fault forms a barrier to groundwater flow across (perpendicular to) the fault, limiting groundwater drawdown propagation from mining activities on the north side of the F5 fault from monitoring bores on the south side of the F5 fault. If the F5 fault acted as a conduit for groundwater flow along the fault alignment, groundwater level drawdown should have propagated from the mine pit to monitoring bore 81P prior to mining breaking through the fault, as a result of the drawdown created by earlier mining. However, such drawdown did not occur until after the fault had been breached by the mine workings. The drawdown propagation to bore 81P after breaching of the fault is entirely consistent with the expected drawdown propagation within a coal seam aquifer once that seam is intersected by the mine pit, and as such, the fault itself does not need to act as a conduit for groundwater to explain the groundwater level response at bore 81P.

The F5 fault was also exposed at the Mine in the northern edge/high wall of Centre Pit in 2019/2020, resulting in sudden observed groundwater drawdown of the Balgowan Coal Sequence at the 18PcR monitoring bore located 1.1 km north of Centre Pit. Prior to exposure of the fault, groundwater levels at the bore had been relatively stable (i.e. showing no influence from Centre Pit). Subsequent investigation found that the Balgowan Coal Sequence is 60 m upthrown by the F5 fault at the northern boundary of Centre Pit, and the Sequence therefore north of the fault lies at a similar elevation to the mined Acland Coal Sequence south of the fault within Centre Pit. Exposure of the F5 fault in the northern highwall allowed groundwater flow from the Balgowan Coal Sequence into Centre Pit, resulting in observed drawdown at the nearby 18PcR bore. Stable groundwater elevations for all other Balgowan Coal Sequence monitoring bores indicated that the drawdown effects were localised to Centre Pit and bore 18PcR. The stable groundwater elevations at bore 18PcR prior to mining disturbance of the fault indicate that the fault was forming an effective hydraulic barrier between Centre Pit and the Balgowan Coal Sequence north of Centre Pit, until the barrier was breached by mining, further supporting the notion that the faults act as partial barriers to horizontal groundwater flow in the Walloon Coal Measures.

2.3.5. Regional Groundwater Use

The groundwater resources within and surrounding the NAC area are prescribed under the *Water Act 2000* subordinate legislation – the *Water Regulation 2016* and several Water Plans (the Water Plan (Condamine and Balonne) 2004, and the Water Plan (Great Artesian Basin and Other Regional Aquifers) 2017). Under the *Water Regulation 2016* and the Water Plans, three Groundwater Management Areas (GMAs) have been declared in the Study Area, and within these GMAs a water licence is generally required to take underground water, with the exception of Stock and Domestic usage which is exempt from licensing. The GMAs in the Study Area include:

- Oakey Creek GMA, covering the Oakey Creek Alluvium aquifer;
- Condamine and Balonne GMA, covering the Main Range Volcanics (Upper Condamine basalts) aquifer within and surrounding the NAC area; and
- Eastern Downs GMA, covering the Walloon Coal Measures, Marburg Sandstone and Helidon Sandstone aquifers within and surrounding the NAC area.

The groundwater resources surrounding NAC in general can be considered to be highly developed, especially the shallowest aquifer at any given location. The DRDMW registered bore database (GWDB) report a relatively dense distribution of third party groundwater bores across the majority of region surrounding NAC, mostly classified as being for Stock and Domestic use. There are also over 46,800 ML/year in nominal entitlements for non-Stock and Domestic usage in the vicinity of NAC. However, NAC's surveys of landholders surrounding NAC's operations (discussed below) show that actual usage may be somewhat less than the allocated volumes, with actual usage reported to NAC by surveyed landholders being approximately 13% of the usage estimated for the region in previous studies (i.e. OGIA, 2016).

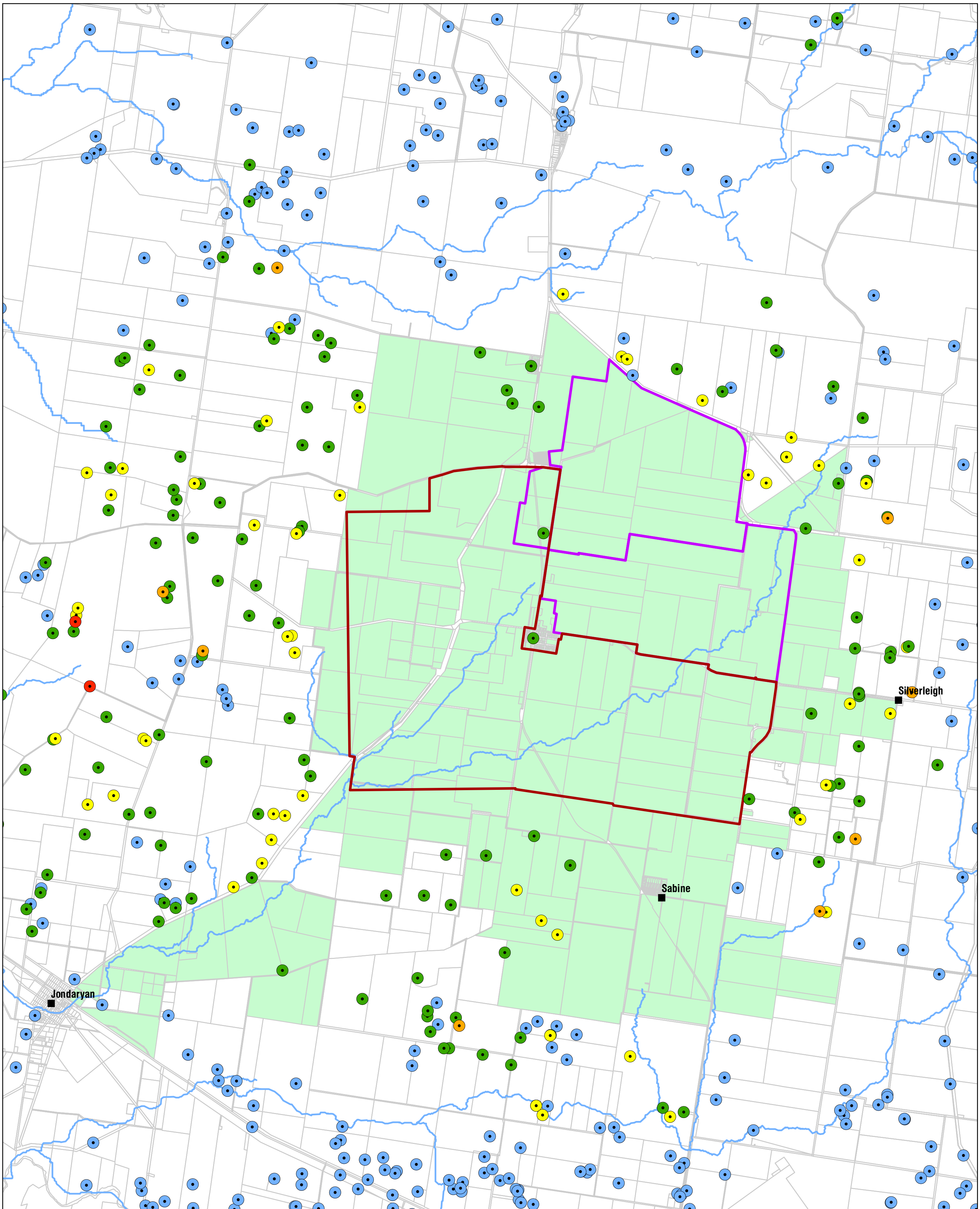
Between 2015 and 2018, NAC undertook a landholder bore Baseline Assessment Program (BAP; SLR, 2015) to characterise each and every private bore located within the area predicted to be subject to groundwater drawdowns exceeding the relevant *Water Act 2000* bore trigger thresholds in NAC's 2018 Stage 3 Project Associated Water License groundwater modelling. It was the intent of the BAP to provide the necessary information required for NAC to determine if any landholder bores might be unduly affected by operation of the Project so that NAC could proceed to developing make good agreements with those landholders if necessary. The BAP surveyed approximately 150 third-party bores on approximately 40 properties and collected information such as bore construction, condition, usage, source aquifer, and water level and quality information. A breakdown of the surveyed bores by aquifer is provided as **Table 3;** as shown, approximately one third of surveyed bores access the Main Range Volcanics, and a further one third of surveyed bores access the (undifferentiated) Walloon Coal Measures.

Figure 6 presents a locality plan for BAP surveyed bores on properties subject to the BAP, and GWDB registered bores on properties not subject to the BAP.

Table 3 BAP Surveyed Bores (to June 2017)

Aquifer	Number of Bores[1]	Percentage of Bores
Alluvium	4	3%
Main Range Volcanics	46	31%
Walloon Coal Measures (undifferentiated)	45	31%
Marburg Sandstone	23	16%
Helidon Sandstone	1	<1%
Walloon Coal Measures + Marburg Sandstone	2	1%
Unknown Aquifer[2]	26	18%

1. Includes both active and inactive bores
2. Insufficient information available to classify



0 1 2 km

Coordinate System:	AGD 1984 AMG Zone 56
Scale:	1:100,000 at A4
Project Number:	620.11303
Date:	20-Jun-2023
Drawn by:	NT

SLR

■ Localities

Reg Bores on Non-BAP Properties

BAP Surveyed Bores

- Operational
- Abandoned but Useable
- Abandoned and Destroyed
- Govt Monitoring Bore

MLs 50170 and 50216

ML 50232

Land Ownership

- Acland Pastoral Co (NHG)
- Other Third Party Property
- Surface Drainage

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THIRD PARTY BORES

FIGURE 6

H:\Projects-SLR\620-BNE\620-BNE\620.11303 NAC03 GW Support\06 SLR Data\01 CADD\GIS\EA GMMP\62011303_F06_ThirdPartyBores.mxd

2.4. Mining History

The NAC area has a long history of coal mining, with several underground coal mines within and adjacent to the NAC area in operation from the early 20th century until the 1980's. These mines were of relatively small scale and generally worked single seams or seam groups of up to 1.5 m thickness within the Acland Coal Sequence or Balgowan Coal Sequence of the Walloon Coal Measures.

NAC commenced operation in 2002 in the north of ML 50170, and has generally proceeded in a southwesterly direction down-dip in the targeted Acland Coal Sequence. Operations in ML 50170 and ML 50216 were put on Care and Maintenance in November 2021, before Stage 3 operations in ML 50232 commenced in April 2023. The Mine progressively rehabilitates (i.e. backfill with spoil, contour the landform and replant native vegetation) the exhausted pits as mining progresses, such that a significant portion of historical Mine pits are now rehabilitated.

2.4.1. Mine Water Supply Bore Usage

NAC's water supply for coal washing was sourced from groundwater bores at the Mine prior to commissioning of the Wetalla recycled wastewater pipeline in 2009. Between 2003 and 2011, the Mine generally extracted between 50 and 150 ML/month from a combination of the Main Range Volcanics, Walloon Coal Measures, Marburg Sandstone and the Helidon Sandstone, with this usage significantly declining since the commissioning of the Wetalla recycled wastewater pipeline. Since 2011, usage has generally amounted to between 0.5 and 1.0 ML/month for potable supply from only the Main Range Volcanics aquifer as well as sporadic usage associated with maintenance of the borefields for emergency water supply. The current usage of the Main Range Volcanics aquifer potable supply, approximating 0.7 ML/month, is anticipated to continue into the future.

2.4.2. Mine Pit Inflows

Groundwater inflows from the Walloon Coal Measures to the Mine's working pits have been observed to be relatively small since the start of the Mine. Active dewatering prior to mining and/or significant water management infrastructure are not required to manage these inflows. Most groundwater inflow evaporates from the Mine pit faces and floors without being physically quantified or needing management. The small groundwater inflow volumes that are captured by the Mine's pits are managed through in-pit sumps and occasional pumping to water carts for re-use at the Mine for dust suppression purposes.

Numerical groundwater modelling was utilised to estimate the Mine's associated water take for the 2020 and 2021 reporting periods as part of NAC's *Mineral Resources Act 1989* reporting obligations. The results of this modelling estimated a groundwater inflow to the Mine workings of 335 ML (0.7 ML/day) in the 15-month 2020 reporting period, and 115 ML (0.3 ML/day) in the 12-month 2021 reporting period (i.e. less than the conservative inflow estimates for the 2013-2015 period derived from water balance modelling as described above). Declining rates of groundwater inflow in 2021 as compared to 2020 were considered reflective of the slowdown in mining activities that occurred in 2021 prior to the cessation of active mining in ML 50170 and ML 50216 in November 2021.

2.4.3. Groundwater System Response to Mining

Groundwater monitoring adjacent the Mine as part of EA requirements as well as other general Mine groundwater monitoring has shown varying responses to mining activities to date.

Most monitoring bores on the western side of the Mine show some degree of response to Mine water supply extraction prior to commissioning of the Wetalla recycled wastewater pipeline in 2009, especially those monitoring bores installed in the Marburg Sandstone. However, since 2010, cessation of Mine water supply extraction has resulted in groundwater levels in the Marburg Sandstone gradually recovering to be now close to pre-mining levels. Similar to the Marburg Sandstone, monitoring bores in the Main Range Volcanics and Walloon Coal Measures on the western side of the Mine show a clear drawdown response to Mine water supply extraction between 2002 and 2010, followed by recovery to pre-mining conditions after 2010, with a particular recovery of groundwater levels in response to a very wet climatic event in late 2010/early 2011 and again in 2021/22.

Mine monitoring bores in the Walloon Coal Measures aquifers show some drawdown response to mining, particularly in the southeast of the Mine area. However, in general these drawdowns are of lesser magnitude and extent than drawdowns associated with historical water supply extraction at the Mine. Different responses to mining are seen between the mined Acland Coal Sequence and the underlying non-mined Balgowan Coal Sequence, supporting the concept of a degree of hydraulic separation between the coal sequences. It is also apparent that there is significant recovery of groundwater levels in the Walloon Coal Measures aquifers as well as the rehabilitated spoil-filled mined out areas, as mining has moved further south.

2.5. Groundwater Environmental Values

A framework for identifying and setting Environmental Values (EVs) and Water Quality Objectives (WQOs) is established through the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* — the EPP (Water and Wetland Biodiversity). The EPP (Water and Wetland Biodiversity) Part 3 S7 (3) includes a process for establishing the environmental values of waterways and identifying corresponding water quality objectives, as listed below:

For particular water, the indicators and water quality guidelines for an environmental value are—

(a) decided using the following documents—

(i) site specific documents for the water;

(ii) the QWQ guidelines;

(iii) the AWQ guidelines;

(iv) other relevant documents published by a recognised entity;

2.5.1. Potentially Relevant Environmental Values

NAC lies in the Condamine River Basin of the Murray-Darling Basin. In October 2020, environmental values (EVs) and water quality objectives (WQOs) for Queensland waters in the Murray-Darling and Bulloo basins were included in schedule 1 of the EPP (Water and Wetland Biodiversity).

The Queensland Murray-Darling and Bulloo Basin Healthy Water Management Plans (HWMPs) are part of the package of documents developed by the Queensland Government to meet the Commonwealth water quality requirements under the Murray-Darling Basin Plan 2012. The HWMP for the Condamine River basin (which applies to NAC) identifies the environmental, economic, social, cultural, spiritual and ceremonial values associated with the rivers, creeks, waterholes, floodplains, overflow channels, lakes, wetlands and groundwaters of the Condamine region. These are referred to under the EPP Water and Wetland Biodiversity as EVs and are the qualities that make water suitable for supporting aquatic ecosystems and human use. The HWMP also identifies and maps the levels of aquatic ecosystem protection to inform the management of different types of aquatic ecosystems.

Management goals are established in the HWMP for the Condamine River Basin as the objectives and outcomes for water resources. They focus on achieving locally appropriate water quality target values (water quality objectives) that have been established at a sub-catchment level to protect identified aquatic ecosystem and human use environmental values for the waters. Targets to maintain the extent of wetlands and riparian forest in the plan area are included in the HWMP to help protect these important ecosystems.

To enable the accurate and comprehensive depiction of environmental values that apply to groundwater in accordance with the HWMP, groundwater aquifer units and sub-aquifer chemistry zones are presented in the EPP Water and Wetland Biodiversity. The EVs established in the EPP Water and Wetland Biodiversity for the different groundwater zones that are relevant to the aquifers of the NAC Area are outlined in **Table 4**.

For the aquatic ecosystem EV, the EPP Water and Wetland Biodiversity identifies four levels of protection according to the current condition of waters. The four levels of protection are high ecological value, slightly disturbed, moderately disturbed and highly disturbed, and each level of protection is assigned a specific management intent under the EPP Water and Wetland Biodiversity. No high ecological value waters or slightly disturbed waters are identified in the NAC area, meaning all groundwaters in and immediately surrounding NAC are considered moderately disturbed or highly disturbed in relation to aquatic ecosystem EVs.

Table 4 Environmental Values of Groundwaters in the Condamine River Basin relevant to the New Acland Coal Mine

Groundwater Zone	**Relevant Aquifer in the vicinity of NAC**	**Environmental Values**							
		Aquatic ecosystems	Irrigation	Farm supply/use	Stock water	Aquaculture	Drinking water	Industrial use	Cultural, spiritual and
Wooloowins	Alluvium (if saturated)	✓	✓	✓	✓	✓	✓	✓	✓
Lower Condamine basalts	Main Range Volcanics (basalt)	✓	✓	✓	✓	✓	✓	✓	✓
South East Walloons	Walloon Coal Measures 5km south-southeast of NAC	✓	✓	✓	✓	✓	✓	✓	✓
North East Walloons	Walloon Coal Measures at NAC	✓	✓	✓	✓	✓	✓	✓	✓
Southeastern Hutton Outcrop	Marburg Sandstone where at outcrop north/northeast of NAC	✓	✓	✓	✓		✓	✓	✓
Eastern Central Area	Marburg Sandstone and Helidon Sandstone underlying the Walloon Coal Measures	✓	✓	✓	✓		✓	✓	✓

2.5.2. Identified Environmental Values

Based on the conceptualisation of the groundwater system at NAC and immediate surrounds, and the documented groundwater usage adjacent NAC's operations, the EVs considered relevant are outlined in **Table 5**.

Table 5 Relevant Environmental Values

Environmental Value	Basis
Irrigation	BAP survey results show privately owned bores used at some properties near to NAC for crop irrigation.
Farm supply/use	BAP survey results show privately owned bores used at some farms near to NAC for crop spraying, domestic toilet supply and to irrigate domestic gardens.
Stock watering	BAP survey results show privately owned bores are used extensively near to NAC for watering stock.
Industrial use	Privately owned bores used at some locations near to NAC to support industrial activities, including NAC's historical water supply in support of coal processing.

There remains no evidence that the other groundwater EVs identified in the EPP Water and Wetland Biodiversity are relevant to NAC for the following reasons:

- Aquatic ecosystems – groundwater does not discharge to surface water features or support GDEs in or near to the NAC area.
- Aquaculture – no aquaculture activities are known near to the NAC area.
- Drinking water – groundwater has not been recorded as being utilised for human drinking near to the NAC area; its elevated natural salinity in all aquifers likely generally precludes this use.
- Cultural, spiritual and ceremonial values – there is no evidence available that groundwater supports these values near to the NAC area.

2.5.2.1. Irrigation

The landholder bore surveys undertaken by NAC in the BAP have identified a total of 14 bores (9 operational) on 10 individual properties that have an intended use for crop irrigation. Target aquifers for these bores are:

- Myall Creek Alluvium (1 bore);
- Oakey Creek Alluvium (1 bore);
- Main Range Volcanics (7 bores);
- Undifferentiated Walloon Coal Measures (2 bores);
- Marburg Sandstone (2 bores); and
- Unknown aquifer (1 bore).

None of these bores are located in local proximity (immediately neighbouring) to NAC. Although not considered an EV of groundwater in the immediate vicinity of NAC, irrigation use is considered a groundwater EV for the broader area surrounding NAC.

Many of the irrigation bores documented in the BAP were also considered by those landholders to also be available for stock watering purposes.

2.5.2.2. Farm supply/use

Farm supply/use of groundwater is assumed to be the use of groundwater on farms for purposes other than the other specific farm-type uses defined in other the relevant EVs (i.e. irrigation and stock watering).

The landholder bore surveys undertaken by NAC in the BAP have identified many bores (>50) where the bore owners (farm landholders) consider the bore purpose includes farm supply/use such as domestic supply (typically toilet flushing), garden watering, machinery washing, and spraying. It should be noted that most of these bores are also considered by those landholders as stock watering supply bores (i.e. a stock & domestic classification in the GWDB).

Seven bores near to NAC, all of which access the Marburg Sandstone, were assessed in the BAP as being utilised for farm supply/use based on landholder discussions. All of these bores were also considered by those landholders as stock watering supply bores (i.e. a stock & domestic classification in the GWDB). However, it is considered that the elevated groundwater salinities in the area close to NAC may limit the use of groundwater for the farm supply/use EV in this area.

2.5.2.3. Stock watering

The landholder bore surveys undertaken by NAC in the BAP have identified that by far the most prevalent use of groundwater in the Study Area is for stock watering, typically beef cattle. Therefore this EV is considered the most relevant to groundwater in and surrounding the NAC area. A total of 169 bores were assessed in the BAP as having a stock watering purpose based on landholder discussions, although 57 of these (i.e. 33%) were recorded as non-operational. Target aquifers for these bores were recorded as:

- Myall Creek Alluvium (2 bores)
- Oakey Creek Alluvium (2 bores)
- Main Range Volcanics (47 bores)
- Walloon Coal Measures
  - Undifferentiated (20 bores)
  - Waipanna Coal Sequence (15 bores)
  - Acland Coal Sequence (20 bores)
  - Balgowan Coal Sequence (3 bores)
  - Marburg Sandstone (31 bores)
  - Unknown aquifer (29 bores)

On properties close to NAC, 18 bores were assessed in the BAP as being utilised for stock watering based on landholder discussions, although only 10 of these were operational. 15 of these bores are installed into the Marburg Sandstone, with one installed into the undifferentiated Walloon Coal Measures (likely the Balgowan Coal Sequence based on location and depth) and two having an unknown source aquifer but considered likely to access the Marburg Sandstone based on location and depth.

2.5.2.4. Industrial use

The landholder bore surveys undertaken by NAC in the BAP identified a single private landholder property and bore, located approximately 12 km southwest of NAC, that is currently used for industrial purposes. Although the source aquifer for this bore is unconfirmed, this bore likely accesses groundwater from the Main Range Volcanics aquifer and is utilised for providing dust suppression water to a nearby basalt quarry.

In the township of Oakey to the southeast of the Project and outside of the BAP survey area, anecdotal evidence suggests that industrial uses of groundwater from the deeper Marburg Sandstone and Helidon Sandstone aquifers also occurs, including use by the Oakey Abattoir.

NAC currently utilises groundwater for industrial purposes at the Mine, including small mine pit groundwater inflows from the Walloon Coal Measures (mainly the Acland Coal Sequence) that are captured within in-pit sumps and utilised by NAC for dust suppression, and water supply from a bore accessing the Main Range Volcanics that is used to feed an RO plant on site to produce potable water. There has also been historical industrial groundwater use by NAC for coal processing prior to 2009, with groundwater sourced from a series of bores adjacent the Mine that were installed in the Main Range Volcanics, Walloon Coal Measures, Marburg Sandstone, and Helidon Sandstone aquifers. Water for coal processing is no longer sourced from groundwater since the commissioning of a recycled waste water pipeline from Toowoomba in 2009.

3. Potential Groundwater Impacts

3.1. Overview

This section describes the potential impacts from NAC's operations on the groundwater system.

The dominant form of potential groundwater impact from NAC's mining operations is groundwater level drawdown. As excavation of the active mine pits proceeds below the water table within the Walloon Coal Measures, groundwater will discharge into the pits which target the Acland Coal Sequence. This passive dewatering of the Acland Coal Sequence aquifer will result in the lowering of groundwater levels in the aquifer in the immediate vicinity of NAC's operations. Groundwater levels in the other aquifers around the site may also be affected by dewatering the Acland Coal Sequence due to mining induced through-flow and leakage of groundwater from these aquifers to the Acland Coal Sequence. Furthermore, the edges of mine pits may directly intersect the edge of the Main Range Volcanics unit in places, and as a result, it is predicted that there may be direct groundwater level impacts to this aquifer.

Future mining is planned to advance in a general north to south direction in ML 50232, generally down-dip in the Walloon Coal Measures. Impacts on groundwater levels will vary spatially over time as the mined area migrates down-dip across ML 50232. The greatest impacts on groundwater levels surrounding future mining will occur around the end of mining when the working pits are at their deepest relative extents. This corresponds to the Life of Mine Plan when the deepest areas of working will result in the most widespread groundwater level drawdown. Further discussion is provided in **Section 3.2**.

Groundwater drawdown associated with NAC's mine pits has the potential to result in groundwater chemistry changes through the induced movement of groundwater towards those pits, particularly in the Acland Coal Sequence aquifer. Where existing groundwater quality is naturally variable in an aquifer, this induced movement has the potential to move water of differing quality into other areas. Additionally, NAC's activities that have the potential to directly release contaminants to groundwater include fuel and waste storage, including mine waste (spoil and tailings). Further discussion is provided in **Section 3.3**.

3.2. Impacts on Groundwater Quantity and Levels

NAC has developed a numerical groundwater model pursuant to various Stage 3 Project approval conditions (in particular the Associated Water License, AWL) to assist in the prediction of impacts on groundwater levels from NAC's mining activities. Consistent with those approval conditions, the model is subject to a regular and continual review and improvement process that will result in updated impact predictions throughout the duration of NAC's operations.

3.2.1. Model Predictions

3.2.1.1. Overview

The most recent update to the NAC numerical groundwater model occurred in 2021 as part of routine Associated Water Take reporting (SLR, 2021b). That updated model was based on the model development documented in SLR (2018b), with updates to the 2021 version limited to only an update of the mine plans to reflect:

- mine pit timing and mine pit extent changes on MLs 50170 and 50216 that occurred between the 2018 and 2021 modelling; and
- the delay in commencement of the Stage 3 Project on ML 50232.

The following outlines the key outcomes of the 2021 version of the model, supplemented with outcomes from the 2018 model as relevant (i.e. where those outcomes were not developed in the 2021 update). Discussion in the following sections makes reference to the 5th, 50th (median) and 95th percentile predictions for the model. These percentiles represent the uncertainty associated with the model predictions as outlined in **Table 6** below.

Table 6 Outline of the Presentation of Model Predictive Uncertainty

Prediction Percentile	Probability of Equalling or Exceeding the Model Prediction	Narrative Descriptor[1]	Description[1]
5th	95%	Very Likely	Likely to occur even in extreme conditions
50th	50%	About as likely as not	About an equal chance of occurring as not
95th	5%	Very unlikely	Not likely to occur even in extreme conditions

1. As per Table 2 of the draft *IESC Explanatory Note, Uncertainty Analysis in Groundwater Modelling* (IESC, 2018)

3.2.1.2. Predicted Groundwater Inflow

Total combined predicted groundwater inflows to the NAC mining pits from the 2021 updated numerical model are provided in **Figure 7**. As shown, median (50th percentile) predicted pit inflows range from 0 to 1.75 ML/day, with higher predicted inflows occurring during simulated implementation of the Stage 3 Project. The inflow peak during the Stage 3 project occurs around the year 2032 and corresponds to the Willeroo pit intersecting historical abandoned underground coal mine workings; in reality these inflows would be managed by dewatering the workings prior to the pit intersecting them.

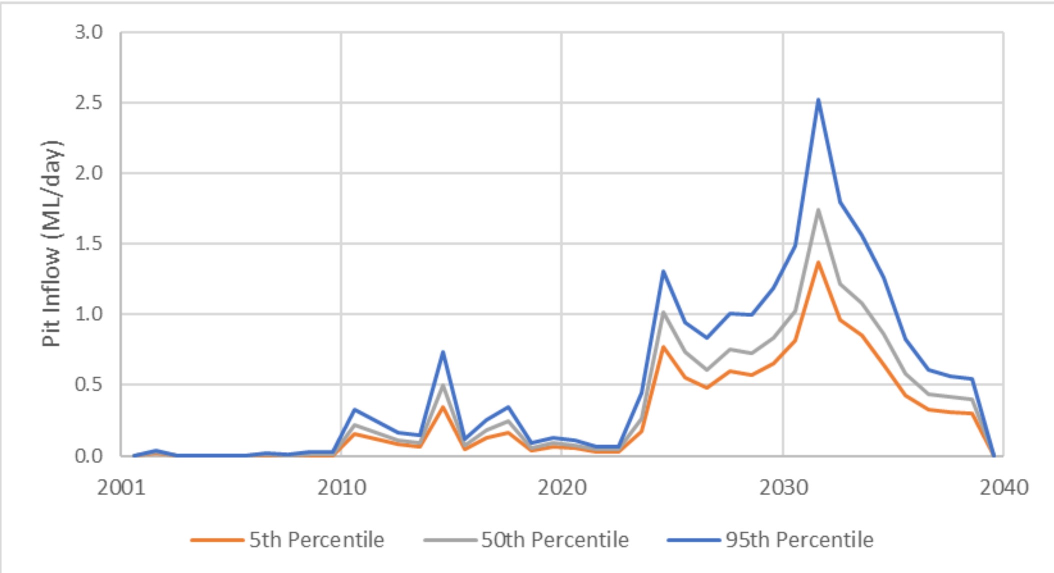


Figure 7 Predicted Mine Pit Inflows (Active Mining)

Direct groundwater inflows to the NAC mine pits during active mining will occur from the Acland Coal Sequence, and also from the Main Range Volcanics to a significantly lesser degree (i.e. only in cases where the pit extents encroach on the Main Range Volcanics, mainly at the southern and western extent of Stage 2's Centre Pit and in the north of the Stage 3 Project's Manningvale West). These inflows will cause direct groundwater drawdown in these aquifers. These direct groundwater drawdowns are also predicted to propagate to other hydrostratigraphic units through induced vertical leakage. This leakage causes changes in groundwater storage volumes within each hydrostratigraphic unit, and resulting groundwater level drawdown.

In the post-mining period, ongoing groundwater inflows to the rehabilitated depressed landforms are controlled by the relationship between any established lakes in the landforms, which are dominantly controlled by surface water (rainfall and runoff) inputs, and the recovered groundwater levels in the surrounding aquifers. Where lakes form in the depressed landforms with hydraulic heads below the hydraulic head in the surrounding groundwater system, those lakes may have an inwards flux of water from the groundwater system (groundwater take). Conversely, an opposite head gradient between the lakes and groundwater would result in the potential for an outwards flux of water to the groundwater system. NAC's Progressive Rehabilitation and Closure Plan (PRCP), and the Post Mining Rehabilitation Groundwater Take Management Plan required by AWL condition 5, will specifically address the post mining period. However, as part of the 2018 numerical groundwater model, a coupled groundwater/surface water model for the residual voids (depressed landforms) was used to assess the water balance associated with the voids as a means of assessing post mining groundwater fluxes. As reported in SLR (2018b), the results indicate as follows.

- All three depressed landforms are predicted to contain long term persistent lakes that have generally stabilised within 20 years from the cessation of mining.
- Void lake water levels would generally fluctuate by +/- 5 m post-mining, due to the effect of rainfall (and therefore surface water runoff input) variability. The Manning Vale East and Willeroo depressed landforms are predicted to form lakes with maximum depths of approximately 10 to 12 m. The Manning Vale West depressed landform is predicted to contain the deepest void lake, at approximately 30 m maximum depth. This prediction is primarily due to the base of that depressed landform being lower in elevation than the other two depressed landform.
- Runoff and rainfall capture accounts for between 87% and 97% of the predicted water inflow to the post-mining depressed landforms. Groundwater inflow to all three depressed landforms would therefore be significantly lower than rainfall and runoff inputs over the simulated long-term post-mining period. All three depressed landforms are predicted to form net groundwater sinks in the long term. Net groundwater inflow rates into the depressed landform are predicted by in the long term to be:
  + 0.11 ML/day for the Manning Vale West depressed landform,
  + 0.08 ML/day for the Willeroo depressed landform, and
  + 0.01 ML/day for the Manning Vale East depressed landform, noting there is some uncertainty in this prediction in the 2018 modelling, with variable groundwater inflow/outflow predicted.
- Evaporation from the void lakes is predicted to be the only form of water loss from the Manning Vale West and Willeroo depressed landform lakes, whilst maximum predicted infiltration to the local groundwater system (in addition to evaporation), where it is predicted to occur, accounts for just over 2% of the total predicted water lost from the Manning Vale East depressed landform. Any infiltration to the groundwater system would likely be ultimately re-captured by the other two depressed landforms that form permanent groundwater sinks.

3.2.1.3. Predicted Groundwater Level Drawdown

Detailed cumulative (i.e. all NAC mining) groundwater drawdown maps resulting from the 2018 groundwater model predictions are presented in the 2018 numerical groundwater model report (SLR, 2018b). The maps presented in that report present predicted groundwater drawdowns at multiple time periods, and for both the median and 95th percentile model results for each aquifer in and surrounding NAC. Given that this process has resulted in the generation of over 200 drawdown prediction maps, for the purposes of this GMMP, maps have been generated to show the extent of predicted cumulative drawdown for each aquifer at the end of mining (i.e. when the groundwater drawdown spatial extent is assumed to be at its peak) from the updated 2021 model.

Chapter 3 of the *Water Act 2000* provides the framework for managing impacts on underground water that are associated with resource operations including coal seam gas (CSG) and mining activities. This underground water management framework ensures that a bore owner is not disadvantaged by such operations. The framework includes bore trigger thresholds to effectively identify areas where bore owners may be at risk. The bore trigger threshold is defined as, for an aquifer, a decline in the water level in the aquifer that is (relevantly):

- a 5 m decline for consolidated aquifers (being an aquifer consisting predominantly of consolidated sediment, such as sandstone); or
- a 2 m decline for unconsolidated aquifers (being an aquifer other than a consolidated aquifer, such as shallow alluvial aquifers).

In accordance with Chapter 3 of the *Water Act 2000*, the 2 m trigger threshold applies to the unconsolidated alluvial aquifers surrounding NAC. In addition, although the Main Range Volcanics would be considered a consolidated aquifer, NAC considers that the 2 m trigger threshold is also appropriate for this aquifer, which based on experience gathered through various hydrogeological programs associated with the Project, can be somewhat limited in thickness and degree of saturation, and therefore has limited available drawdown for third party use, compared to deeper consolidated aquifers (i.e. Walloon Coal Measures or Marburg Sandstone). As outlined in Chapter 3 of the *Water Act 2000*, the 5 m trigger threshold is appropriate for consideration of drawdown impacts associated with the Walloon Coal Measures and Marburg Sandstone aquifers, which are typically significantly thicker, deeper and also typically possess significantly larger degrees of available drawdown.

Also shown on the maps presented herein are the location of known third party (i.e. non-NAC) bores for the relevant aquifers, whose locations are either confirmed by NAC via the BAP, or indicative and based on DRDMW and OGIA recorded locations in the case of properties yet to be subject to surveys in the BAP at June 2017.

Predicted Impacts on the Alluvial Aquifer

The 2021 groundwater model does not predict any groundwater drawdown of 1 m or more for the alluvium in the 50th percentile (median) case. For the 95th percentile case, the model predicts small areas of groundwater drawdown exceeding 1 m, but less than 2 m, in the Cain Creek / Spring Creek alluvium northwest of NAC (**Figure 8**).

Predicted Impacts on the Main Range Volcanics Aquifer

Stage 3 Project mining activities simulated in the 2021 groundwater model include direct interception of the basalt in the north of ML 50232, and therefore direct groundwater impacts to that aquifer. The 2021 groundwater model predicts that the extent of groundwater drawdown of 2 m or greater for the Main Range Volcanics is limited to the area of the aquifer within and immediately adjacent the north of the Stage 3 Project Area (ML 50232), for both the 50th percentile (median) and 95th percentile model cases (**Figure 9**). There is comparatively little difference between the 50th percentile and 95th percentile drawdown extents.

It should be noted that the vast majority of the land area subject to groundwater drawdown of 2 m or greater for the Main Range Volcanics in the 2021 groundwater model is owned by the New Hope Group through NAC's related entity, Acland Pastoral Co Pty Ltd (APC), with impacts to private users restricted to four bores on one private property at the northwestern most part of the 2 m drawdown extent. This property and the four associated bores have previously been subject to a bore baseline assessment under the BAP as shown in **Figure 9**.

Predicted Impacts on the Acland Coal Sequence Aquifer

The Acland Coal Sequence forms the target coal resource for NAC's mining and is therefore subject to direct mining impacts, and accordingly would be expected to show the largest groundwater impacts for all the hydrostratigraphic units in the NAC area and surrounds.

The 2021 groundwater model predicts that the extent of groundwater drawdown of 5 m or greater for the Acland Coal Sequence extends to approximately 6 km southwest of ML 50232 for the 50^{th} percentile (median) model case, and a further 2 km for the 95^{th} percentile case (**Figure 10** and **Figure 11**).

As shown in **Figure 10** and **Figure 11**, most third party bores in the Acland Coal Sequence are located close together near the edge of the geological unit's extent (i.e. near the outcrop) and the large majority of the aquifer subject to groundwater drawdown of 5 m or greater is devoid of bores accessing the Acland Coal Sequence. This circumstance is due to the fact that the Acland Coal Sequence becomes buried by additional Walloon Coal Measures units to the west and southwest of ML 50232, as well as the Main Range Volcanics and the Oakey Creek Alluvium (SLR, 2018a). Since third party bores typically target the shallowest available groundwater resource, the Acland Coal Sequence for the most part does not form the primary water supply aquifer for third parties away from the areas where the unit is at outcrop.

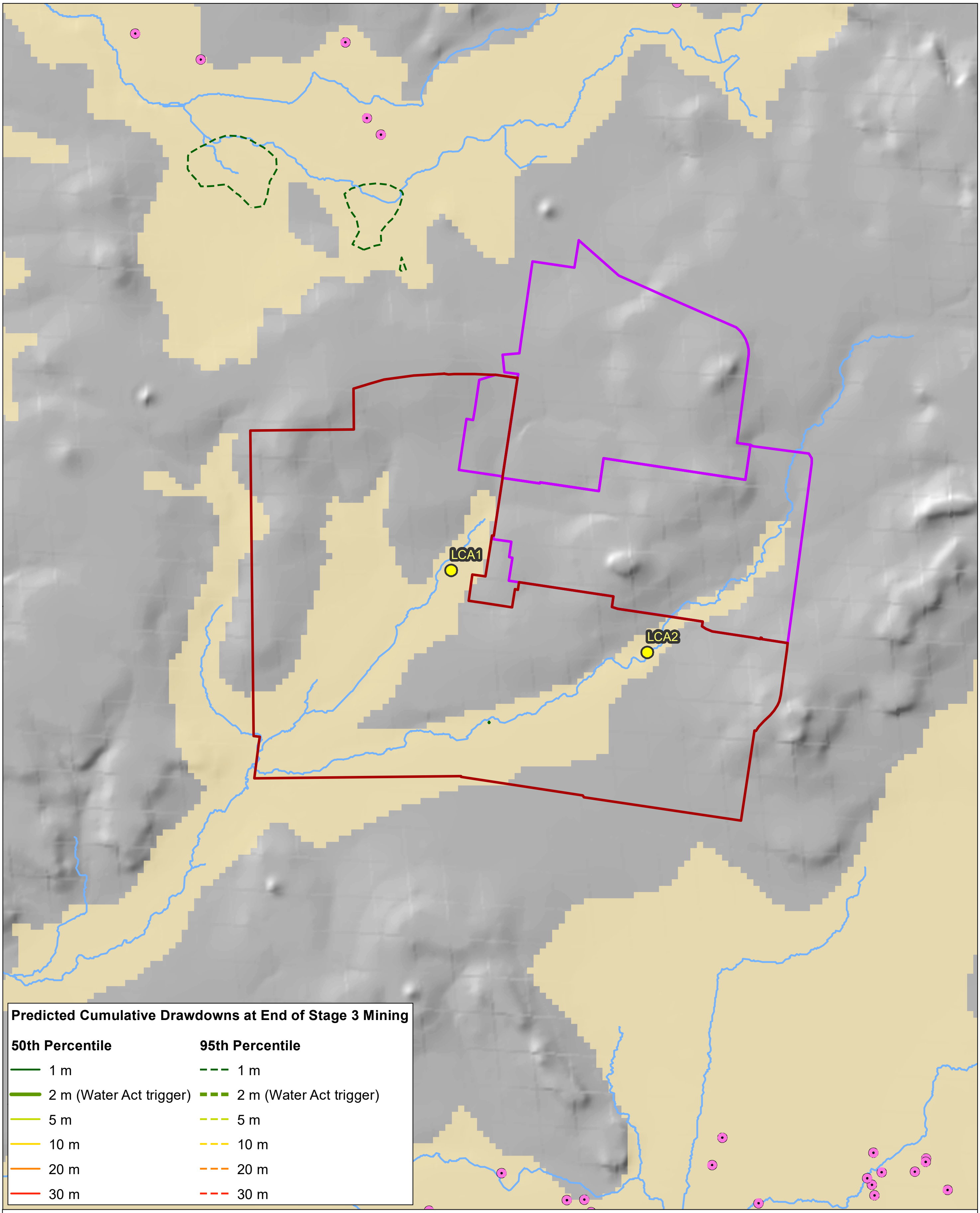
Predicted Impacts on other Walloon Coal Measures Aquifers

The 2021 groundwater model predicts there will be no groundwater drawdown of 5 m or greater for the Waipanna Coal Sequence for any of the model cases (**Figure 12**), with 50^{th} percentile model predictions indicating drawdowns of less than 2 m.

The 2021 groundwater model predicts that there will be no drawdown equal to or exceeding the 5 m Water Act drawdown trigger threshold for the Balgowan Coal Sequence for any of the model cases (**Figure 13**). As shown on **Figure 13**, third party use of the Balgowan Coal Sequence aquifer for water supply is also quite limited.

Predicted Impacts on the Marburg Sandstone Aquifer

The 2021 groundwater model does not predict any groundwater drawdown above 1 m for the Marburg Sandstone for any of the model cases (**Figure 9**). As shown on **Figure 9**, third party use of the Marburg Sandstone aquifer for water supply is focussed to the areas north and east of the Stage 3 Project area (ML 50232) where the aquifer lies at shallower depths.



0 1 2 km

Coordinate System:	AGD 1984 AMG Zone 56
Scale:	1:80,000 at A4
Project Number:	620.11303
Date:	21-Jun-2023
Drawn by:	NT

SLR

EA Bore

Compliance

3rd Party Bores - Alluvium

Indicative (DNRM / OGIA)

Surface Drainage

ML 50170 and ML 50216

ML 50232

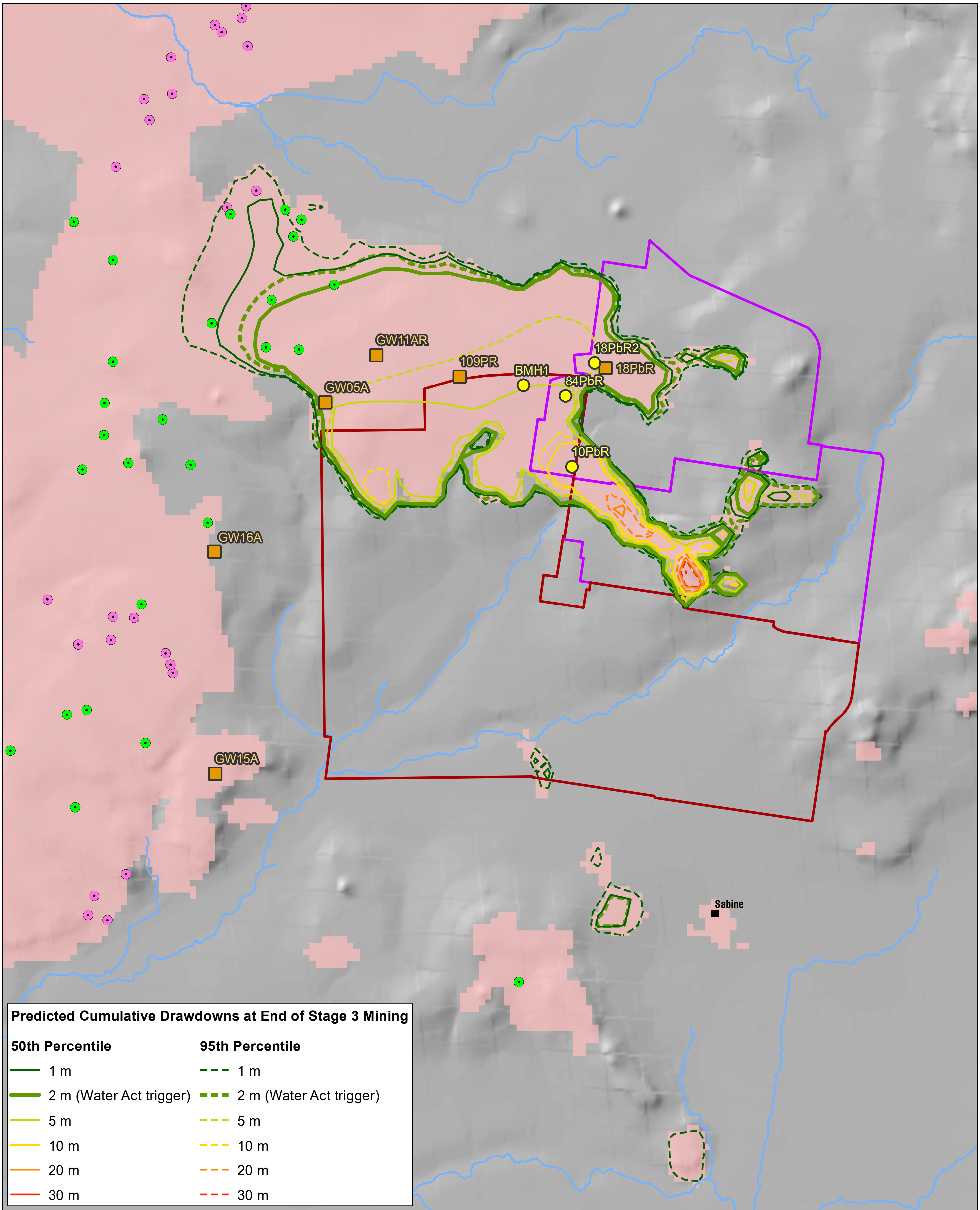
Modelled Formation Extent (SLR, 2018)

NEW ACLAND MINE
EA GROUNDWATER MONITORING AND MANAGEMENT PLAN

ALLUVIUM PREDICTED DRAWDOWN & MONITORING NETWORK

FIGURE 8

H:\Projects-SLR\620-BNE\620-BNE\620.11303 NAC03 GW Support\06 SLR Data\01 CADGIS\EA GMMP\62011303_F08_AlluviumMonitoringNetwork.mxd



0 1 2 km

Coordinate System:	AGD 1984 AMG Zone 56
Scale:	1:80,000 at A4
Project Number:	620.11303
Date:	21-Jun-2023
Drawn by:	NT

SLR

Localities

EA Bore

Compliance

Interpretation

3rd Party Bores - Basalt

Surveyed by the NHG

Indicative (DNRM / OGIA)

Surface Drainage

ML 50170 and ML 50216

ML 50232

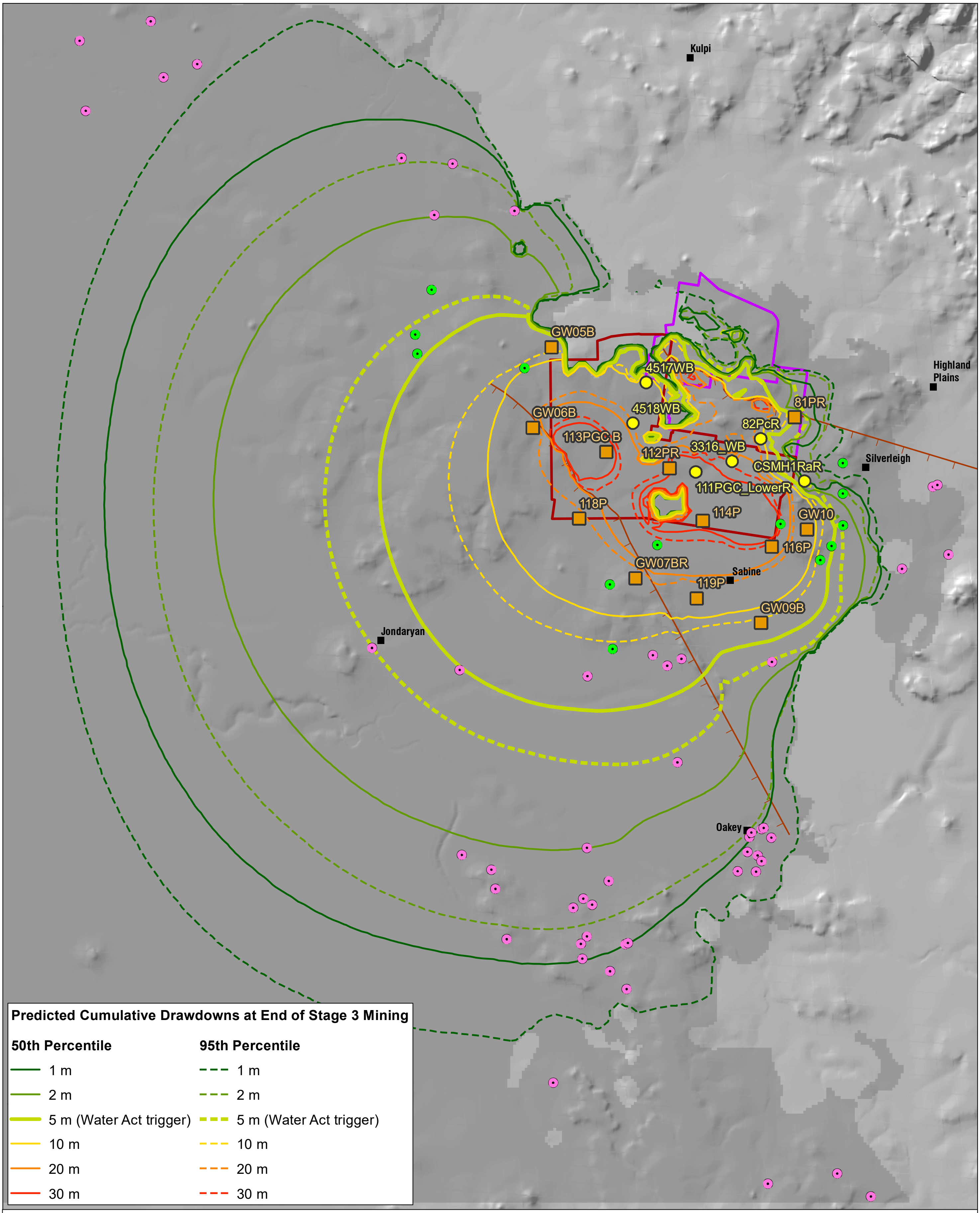
Modelled Formation Extent (SLR, 2018)

NEW ACLAND MINE EA GROUNDWATER MONITORING AND MANAGEMENT PLAN

MAIN RANGE VOLCANICS PREDICTED DRAWDOWN & MONITORING NETWORK

FIGURE 9

H:\Projects-SLR\620-BNE\620.11303 NAC03 GW Support\06 SLR Data\01 CADGIS\EA GMMP\62011303_F09_BasaltMonitoringNetwork.mxd



N

0 2.5 5 km

Coordinate System:	AGD 1984 AMG Zone 56
Scale:	1:175,000 at A4
Project Number:	620.11303
Date:	13-Jun-2023
Drawn by:	NT

SLR

Localities

Major Fault

EA Bore

Compliance

Interpretation

3rd Party Bores - Acland Coal Sequence

Surveyed by the NHG

Indicative (DNRM / OGIA)

ML 50170 and ML 50216

ML 50232

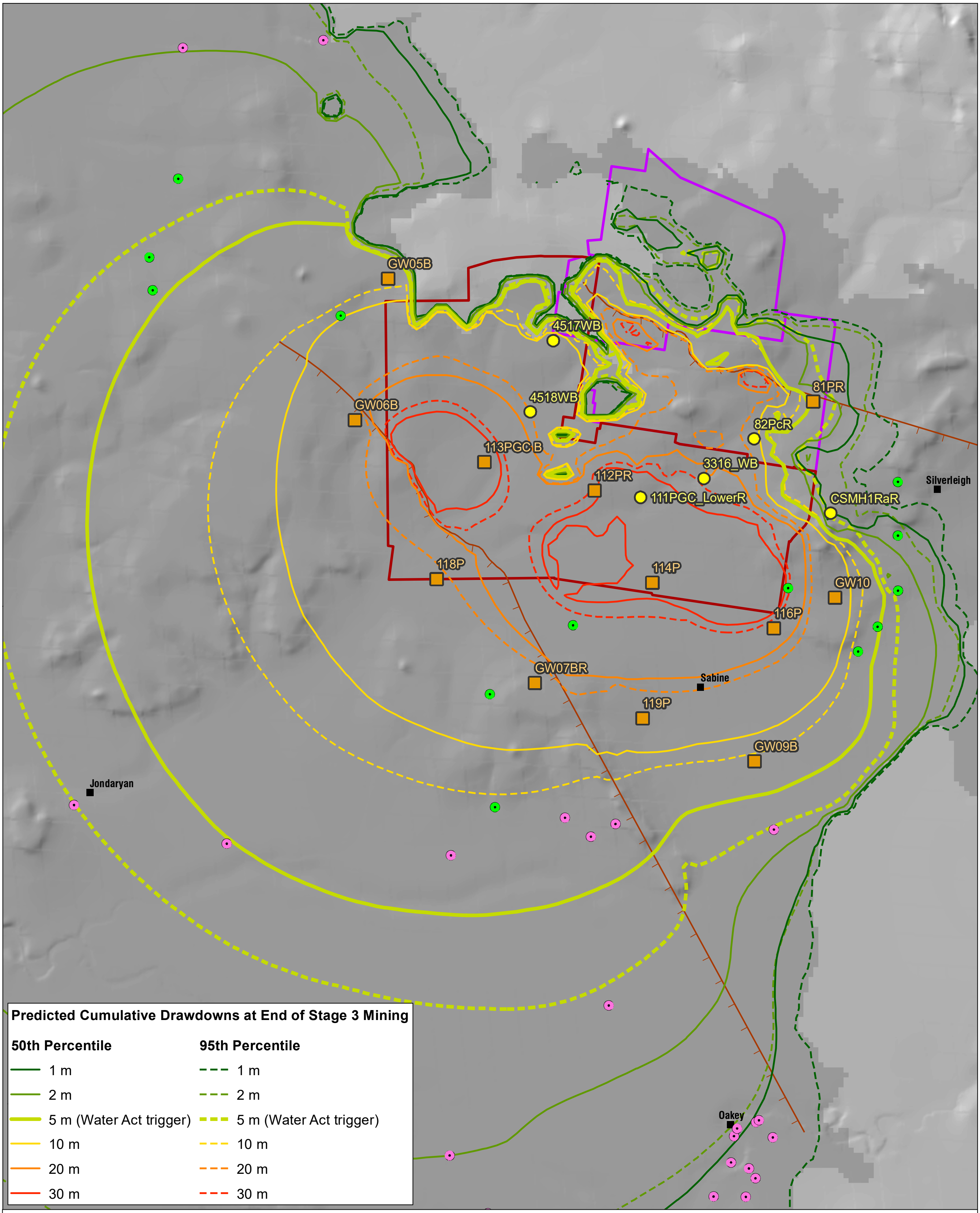
2017 Modelled Formation Extent (SLR, 2018)

NEW ACLAND MINE EA GROUNDWATER MONITORING AND MANAGEMENT PLAN

ACLAND COAL SEQUENCE PREDICTED DRAWDOWN & MONITORING NETWORK

FIGURE 10

H:\Projects-SLR\620-BNE\620.11303 NAC03 GW Support\06 SLR Data\01 CADGIS\EA GMMP\62011303_F10_AclandMonitoringNetwork.mxd



0 1 2 km

Coordinate System: AGD 1984 AMG Zone 56
Scale: 1:100,000 at A4
Project Number: 620.11303
Date: 20-Jun-2023
Drawn by: NT

SLR

Localities
Major Fault

EA Bore
Compliance
Interpretation

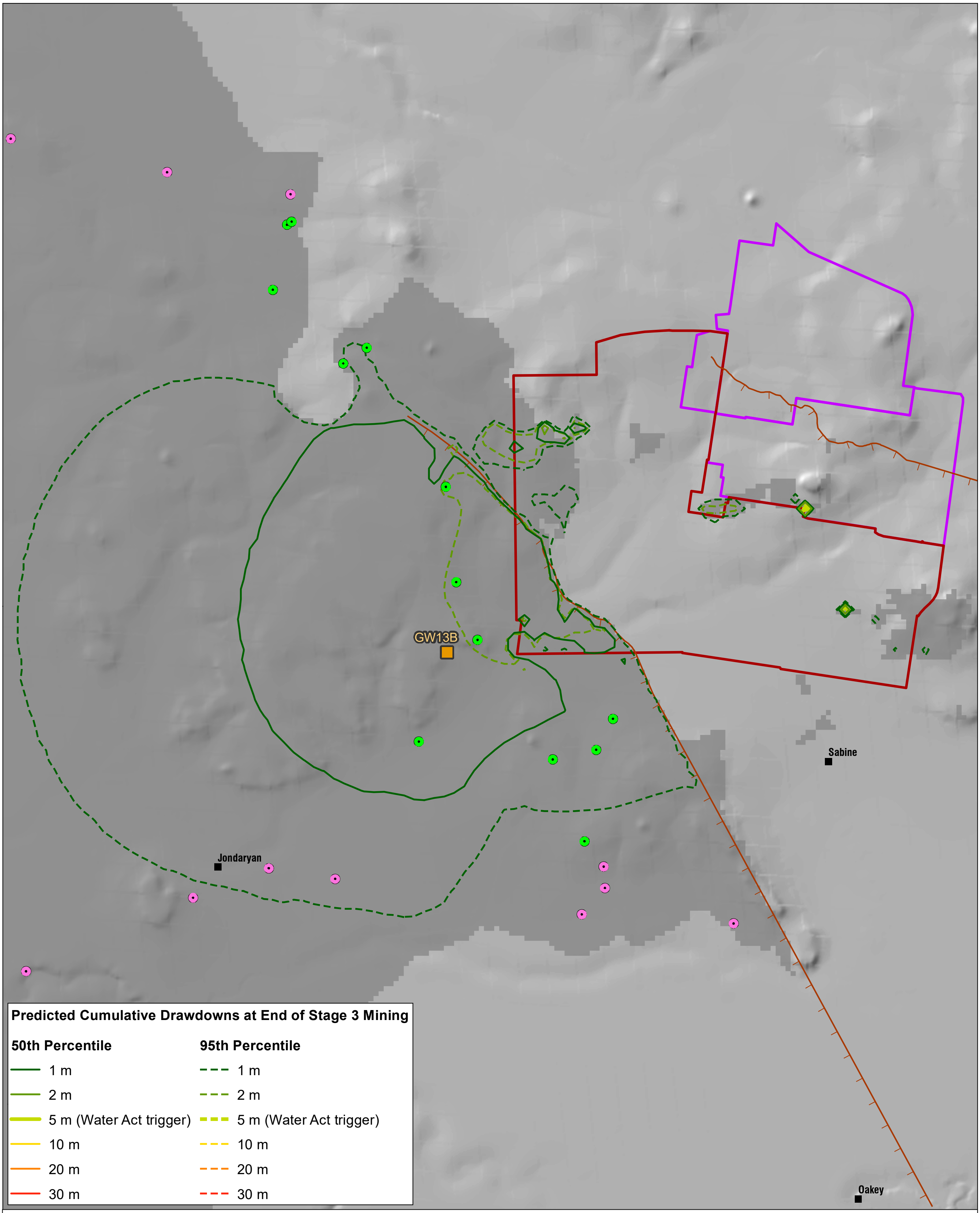
3rd Party Bores - Acland Coal Sequence
Surveyed by the NHG
Indicative (DNRM / OGIA)
ML 50170 and ML 50216
ML 50232
2017 Modelled Formation Extent (SLR, 2018)

NEW ACLAND MINE
EA GROUNDWATER MONITORING AND MANAGEMENT PLAN

ACLAND COAL SEQUENCE PREDICTED DRAWDOWN & MONITORING NETWORK

FIGURE 11

H:\Projects-SLR\620-BNE\620-BNE\620.11303 NAC03 GW Support\06 SLR Data\01 CADGIS\EA GMMP\62011303_F11_AclandMonitoringNetwork.mxd



0 1 2 km

Coordinate System:	AGD 1984 AMG Zone 56
Scale:	1:100,000 at A4
Project Number:	620.11303
Date:	13-Jun-2023
Drawn by:	NT

SLR

■ Localities

Major Fault

EA Bore

Interpretation

3rd Party Bores - Waipanna Coal Sequence

Surveyed by the NHG

Indicative (DNRM / OGIA)

ML 50170 and ML 50216

ML 50232

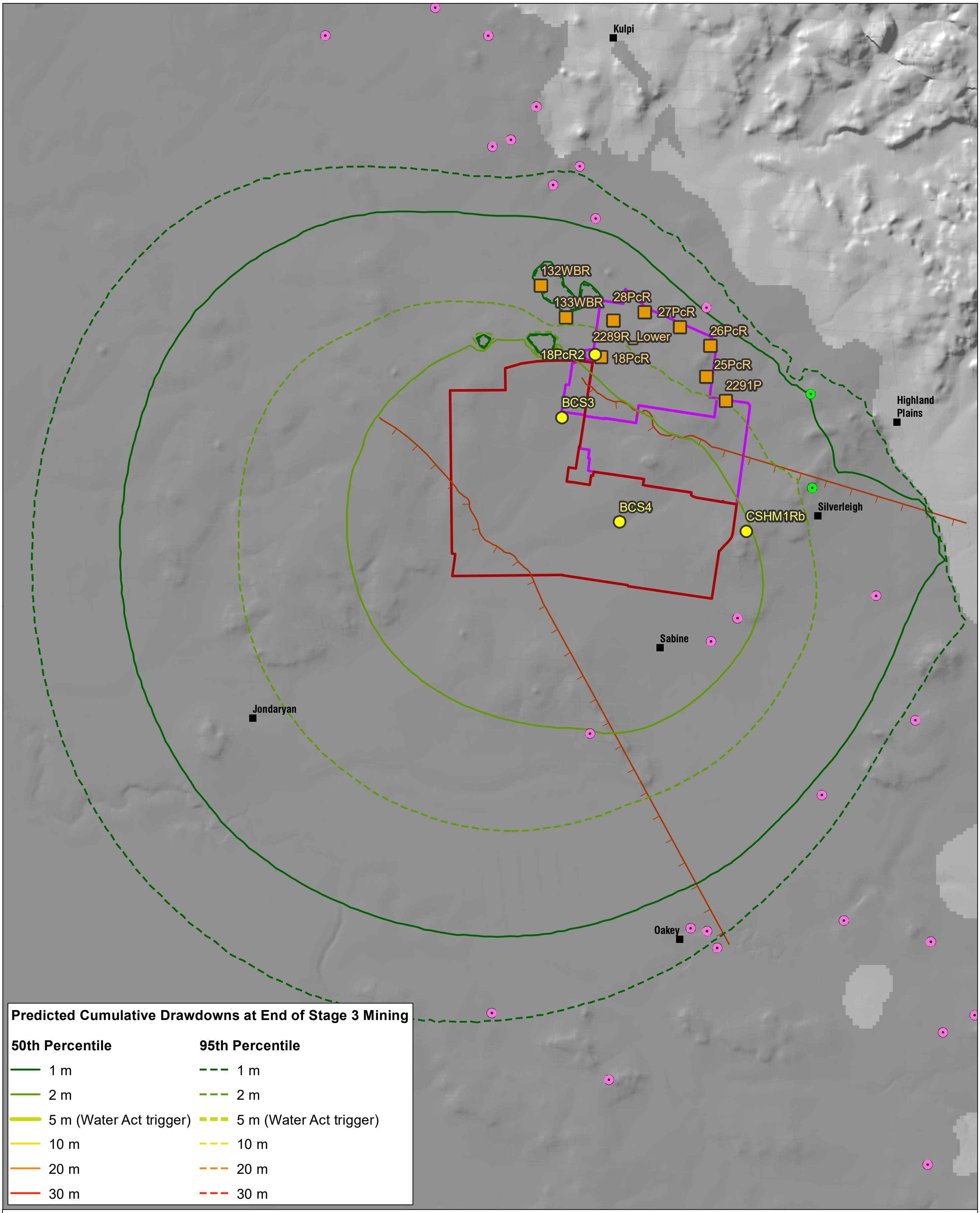
2017 Modelled Formation Extent (SLR, 2018)

NEW ACLAND MINE
EA GROUNDWATER MONITORING AND MANAGEMENT PLAN

WAIPANNA COAL SEQUENCE PREDICTED DRAWDOWN & MONITORING NETWORK

FIGURE 12

H:\Projects-SLR\620-BNE\620-BNE\620.11303 NAC03 GW Support\06 SLR Data\01 CADGIS\EA GMMP\62011303_F12_WaipannaMonitoringNetwork.mxd



0 2.5 5 km

Coordinate System:	AGD 1984 AMG Zone 56
Scale:	1:150,000 at A4
Project Number:	620.11303
Date:	21-Jun-2023
Drawn by:	NT

SLR

Localities
Major Fault

EA Bore
Compliance
Interpretation

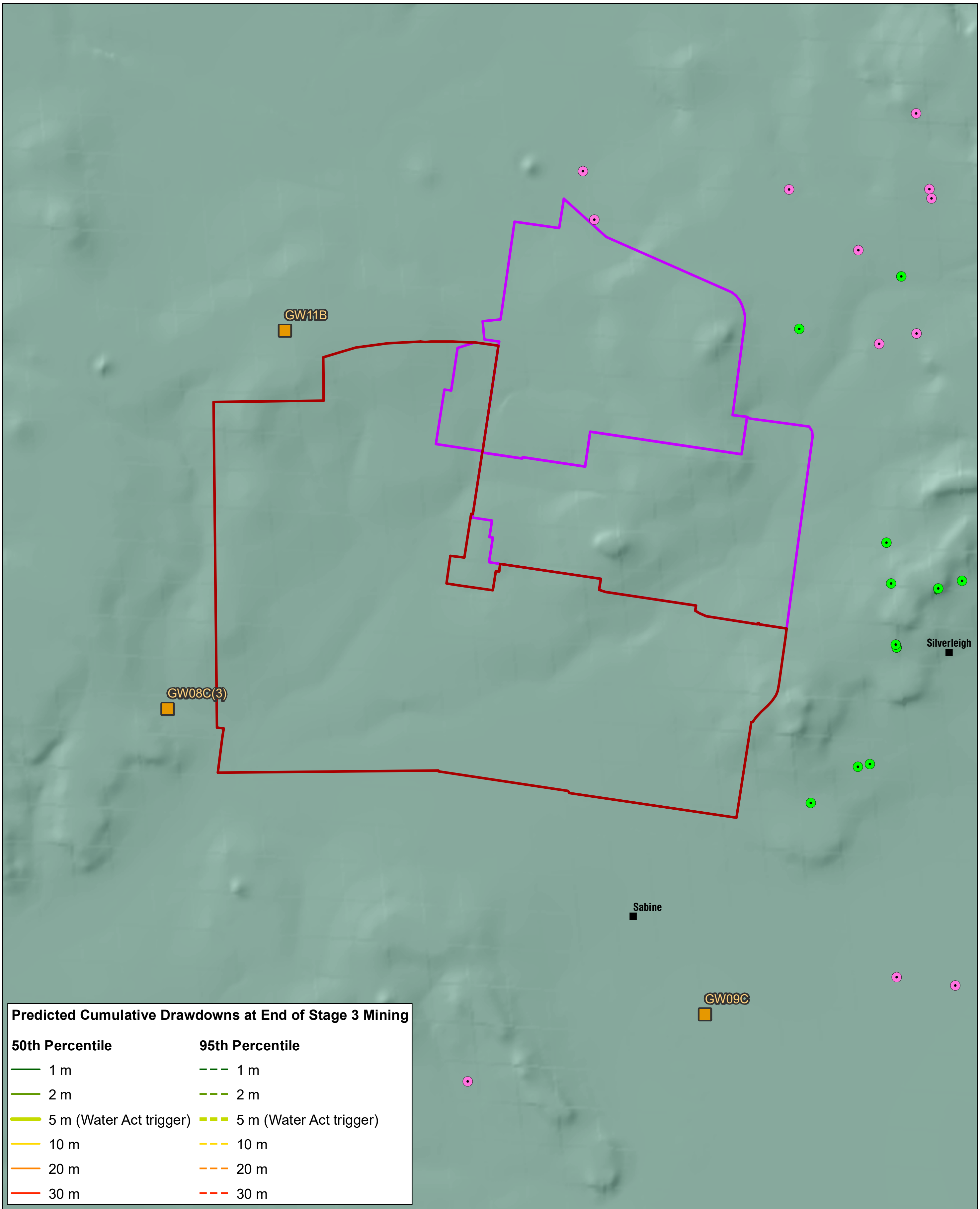
3rd Party Bores - Balgowan Coal Sequence
Surveyed by the NHG
Indicative (DNRM / OGIA)
ML 50170 and ML 50216
ML 50232
2017 Modelled Formation Extent (SLR, 2018)

NEW ACLAND MINE EA GROUNDWATER MONITORING AND MANAGEMENT PLAN

BALGOWAN COAL SEQUENCE PREDICTED DRAWDOWN & MONITORING NETWORK

FIGURE 13

H:\Projects-SLR\620-BNE\620-BNE\620.11303 NAC03 GW Support\06 SLR Data\01 CADGIS\EA GMMP\62011303_F13_BalgowanMonitoringNetwork.mxd



H:\Projects-SLR\620-BNE\620-BNE\620.11303 NAC03 GW Support\06 SLR Data\01 CADGIS\EA GMMP\620011303_F14_MarburgMonitoringNetwork.mxd

Coordinate System:	AGD 1984 AMG Zone 56
Scale:	1:75,000 at A4
Project Number:	620.11303
Date:	21-Jun-2023
Drawn by:	NT

SLR

NEW ACLAND MINE EA GROUNDWATER MONITORING AND MANAGEMENT PLAN

MARBURG SANDSTONE PREDICTED DRAWDOWN & MONITORING NETWORK

FIGURE 14

Predicted Impacts on the Helidon Sandstone Aquifer

The Helidon Sandstone aquifer is not represented in the groundwater model as it lies some 200 m below the base of the Marburg Sandstone aquifer, and separating these two units is the relatively low permeability Evergreen Formation. Therefore, NAC's future mining activities are not anticipated to have any impact on the Helidon Sandstone aquifer. NAC's bore abstraction from this aquifer has substantially reduced after 2011, resulting in the recovery of groundwater levels and the alleviation of some resource pressure on this GAB aquifer.

3.2.1.4. Predicted Post Mining Impacts

As discussed above, the 2018 groundwater model included an assessment of the long term post mining impacts associated with the proposed final landform (three depressed landforms). The results of that study in terms of post mining impacts to groundwater levels were reported in SLR (2018b) and are summarised as follows.

- No long term groundwater drawdown exceeding the relevant *Water Act 2000* bore trigger thresholds for the alluvium, Balgowan Coal Sequence or Marburg Sandstone aquifers is predicted by the 2018 model.
- The 2018 model only predicts a very limited extent of drawdown exceeding the relevant *Water Act 2000* bore trigger threshold for the Waipanna Coal Sequence.
- The 2018 model does predict drawdown exceeding the relevant bore trigger thresholds outside of the mine leases in the long term for both the Main Range Volcanics and the Acland Coal Sequence. However, the number of third party bores captured within the extent of bore trigger threshold drawdown is limited to three bores in the Acland Coal Sequence and one bore in the Main Range Volcanics, all of which would have already been subject to drawdown impacts during NAC's active mining phase and therefore potential make good obligations.

3.3. Impacts on Groundwater Quality

3.3.1. Groundwater Movement Induced Quality Changes

Groundwater drawdown associated with NAC's mine pits has the potential to result in groundwater chemistry changes through the induced movement of groundwater towards those pits, particularly in the Acland Coal Sequence aquifer. Where existing groundwater quality is naturally variable in an aquifer, this induced movement has the potential to move water of differing quality into other areas. It is important to recognise such groundwater chemistry changes may be either negative (where poorer quality groundwater is mobilised into areas with naturally better quality groundwater) or positive (where better quality groundwater is mobilised into areas with naturally poorer quality groundwater). These processes have been previously documented as occurring in some Acland Coal Sequence monitoring bores adjacent the existing Mine's operations as part of routine reviews of the Mine's EA groundwater monitoring program. The results of these reviews have indicated that any groundwater chemistry changes are both spatially isolated and temporally short lived, and likely related to hydrogeologic and hydrochemical compartmentalisation of the Acland Coal Sequence aquifer, rather than induced changes in fluxes between aquifers. Any groundwater quality changes that have been detected to date as a result of the existing Mine operations return towards background levels relatively quickly. Therefore, consistent with the results of monitoring of Mining operations that have been underway since 2002, groundwater quality is not anticipated to be significantly affected in the long term as a result of mining activities.

As described in the Stage 3 Project's conceptual hydrogeological model report (SLR, 2018a), there is relatively little difference in natural groundwater chemistry between the different hydrostratigraphic units in the Acland region, and a generally broad spread of water chemical types for any one aquifer unit. Therefore, any changes in groundwater fluxes between units as a result of NAC's operations are considered unlikely to manifest as significant changes in groundwater quality. Furthermore, given that groundwater drawdown and induced groundwater movement in all aquifers besides the Acland Coal Sequence is very limited, the potential for impacts on water quality within all aquifers other than the Acland Coal Sequence from NAC's mining activity is considered negligible.

Furthermore, groundwater level drawdown also has the somewhat less likely potential to result in oxidation of the aquifer matrix that results in release of the matrix chemical constituents into groundwater, and this type of oxidation effect may also occur within mine spoil dumps. At a single monitoring bore location, these potential groundwater quality changes may manifest as one or a combination of:

- changes to groundwater salinity (measured as electrical conductivity (EC) or Total Dissolved Solids (TDS);
- changes to groundwater pH;
- modification of the ionic composition of the groundwater; and
- changes to the concentration of metal and metalloids in groundwater (particularly if significant pH changes arise).

3.3.2. Potential Sources of Contamination During Mining

NAC's activities that have the potential to directly release contaminants to groundwater include fuel and waste storage, including mine waste (spoil and tailings). Blasting activities also have the potential to release nitrogen compounds such as ammonia to groundwater. NAC's activities that have the potential for direct groundwater quality impacts through contaminant release (e.g. fuel spills) are managed through established industry standard practices such that any spills would be minor, localised and subject to standard onsite remediation and management. More significant potential sources of contaminants include spoil and tailings. Tailings will be emplaced within purpose designed and engineered in pit tailings facilities, whilst spoil emplacements are subject to continual rehabilitation (contouring and capping with topsoil) over the life of the NAC's operations as part of the mining plan. The inwards hydraulic gradients within the local groundwater system created by active mine pits will prevent any migration of seepage from spoil and/tailings to the groundwater system offsite.

Groundwater quality will continue to be monitored throughout the life of the NAC's operations under this GMMP to identify trends and assess whether impacts are occurring over time.

3.3.3. Potential Sources of Contamination Post Mining

In the post mining phase, the main potential groundwater contamination source is the final landform and its residual voids. The Progressive Rehabilitation and Closure Plan (PRCP), and the Post Mining Rehabilitation Groundwater Take Management Plan required by AWL condition 5, will specifically address potential contamination sources in the post mining period.

As part of the 2018 numerical groundwater model, the coupled groundwater/surface water model for the final voids was also used to assess the salt balance associated with the voids as a means of assessing any long term water quality (salinity) risks. As reported in SLR (2018b), the results indicate as follows.

- Salinities in the void lakes are predicted to generally increase over time primarily as a result of evaporation from the void lakes, with cyclical fluctuations in the longer term due to the effect of rainfall (and therefore runoff) variability based off the historic rainfall record.
- The Manning Vale East void lake salinity stabilises at approximately 10,000 to 12,000 mg/L in the long term.
- The Manning Vale West and Willeroo void lake salinities reach approximately 20,000 to 25,000 mg/L in the long term.

The lower predicted lake salinity in the Manning Vale East void as compared to the Manning Vale West and Willeroo void lakes is considered to be a result of the reduced groundwater inflow volume to the Manning Vale East void in comparison to the other two voids. This leads to the predicted salinity in the Manning Vale East void lake increasing in concentration at a lower rate than the Manning Vale West or Willeroo void lakes.

Since all three void lakes are predicted to form groundwater sinks in the long term at rates of between 0.01 and 0.11 ML/day (refer **Section 3.2.1**), the voids will continue to collect groundwater post-mining, and therefore, any local changes to the quality of groundwater that might occur as a result of mining are unlikely to migrate away from the residual voids.

From an acid rock drainage perspective, it is unlikely that any water captured in the Project's final voids will become acidic from oxidation of pyrites in the Walloon Coal Measures aquifer because of the neutralising effect of the surrounding sediments which are naturally alkaline. To date, NAC has not experienced any occurrences of acid rock drainage at the Mine.

4. Groundwater Monitoring Program

4.1. Monitoring Bore Types

Table D1 of the EA requires the EA groundwater monitoring network to consist of several monitoring bore types with different purposes and condition compliance protocols (**Table 7**). The EA monitoring bore types therefore identified in this GMMP are outlined below.

4.1.1. Compliance Bores

Compliance bores in this GMMP are monitoring bores used to monitor compliance with the EA's groundwater quality limits. These bores are installed into the aquifer units that are directly intercepted by NAC's previous or future mining activities (i.e. Main Range Volcanics, Acland Coal Sequence and Balgowan Coal Sequence) and are generally located downgradient, in the context of pre-mining groundwater flow, of mining activities.

4.1.2. Interpretation Bores

Interpretation bores in this GMMP are monitoring bores that are not used to monitor compliance with the EA's groundwater quality limits, but instead to inform the assessment of groundwater system response to mining and to provide additional data in the event of a compliance breach at the Compliance bores. These bores are installed into all the aquifer units that are in the vicinity of NAC and potentially affected by NAC's ongoing activities. Note that Interpretation bores are subject to the same monitoring protocols (**Section 4.4**) as Compliance bores.

4.2. Monitoring Network Details

4.2.1. General

Table 7 summarises the complete set of bores that will be monitored in the EA groundwater monitoring program. Full bore location and construction details are provided in **Appendix B** and **Figure 8** through **Figure 14** present locality plans by aquifer. Note that consistent with the EA:

- the monitoring ID and location of bores specified in this GMMP will be consolidated with those specified in the EA (i.e. consistent with the note to Table D1 of the EA, it is intended that the EA will be updated on finalisation of this GMMP for consistency with this GMMP), and
- all monitoring bores will be confirmed within two years of the EA coming into effect (i.e. August 2024) and consequential updates and consolidation to EA Tables D1, D3 and EA Table D5.

Monitoring bore locations have been chosen based on ensuring all potential groundwater impacts from mine dewatering are identified (using model drawdown predictions), the location of mine water and waste storage facilities, presence of aquifers and receptors of interest, and regulatory agency feedback and approval conditions. The monitoring program has been established prior to the commencement of the Stage 3 Project's mining schedule to ensure there is sufficient baseline information on groundwater levels and quality for the majority of bores.

Table 7 EA Groundwater Monitoring Network

Monitoring Bore	Easting (GDA2020)	Northing (GDA2020)	Aquifer	EA Bore Type	Notes
LCA1	369697	6979412	Lagoon Creek Alluvium	Compliance (MLs 50216 & 50170)	
LCA2	372818	6978110	Lagoon Creek Alluvium	Compliance (MLs 50216 & 50170)	
GW09A	373834	6972473	Oakey Creek Alluvium	Interpretation (ML 50232)	
10PbR	370484	6981068	Main Range Volcanics	Compliance (MLs 50216, 50170 & 50232)	
84PbR	370357	6982189	Main Range Volcanics	Compliance (MLs 50216, 50170 & 50232)	
BMH1	369717	6982364	Main Range Volcanics	Compliance (MLs 50216, 50170 & 50232)	
18PbR	371016	6982646	Main Range Volcanics	Interpretation (MLs 50216 & 50170)	
18PbR2	370842	6982719	Main Range Volcanics	Compliance (MLs 50216 & 50170)	
109PR	368697[$]	6982504[$]	Main Range Volcanics	Interpretation (ML 50232)	Replacement for EA bore 109P as required by the AWL
GW05A	366560	6982088	Main Range Volcanics	Interpretation (ML 50232)	
GW11AR	367370	6982844	Main Range Volcanics	Interpretation (ML 50232)	Replacement for damaged EA bore GW11A
GW15A	364804	6976179	Main Range Volcanics	Interpretation (ML 50232)	
GW16A	364791	6979715	Main Range Volcanics	Interpretation (ML 50232)	
GW13B	365170	6976135	Waipanna Coal Sequence	Interpretation (ML 50232)	
81PcR	375004[$]	6979643[$]	Acland Coal Sequence	Interpretation (MLs 50216, 50170 & 50232)	Replacement for EA bore 81P as required by the AWL
82PcR	373699	6978817	Acland Coal Sequence	Compliance (MLs 50216, 50170 & 50232)	

Monitoring Bore	Easting (GDA2020)	Northing (GDA2020)	Aquifer	EA Bore Type	Notes
CSMH1Ra	375371	6977418	Acland Coal Sequence	Compliance (ML 50232)	
4517WB	369834	6980859	Acland Coal Sequence	Compliance (MLs 50216, 50170 & 50232)	
4518WB	369372	6979439	Acland Coal Sequence	Compliance (MLs 50216, 50170 & 50232)	
111PGC_LowerR	371565	6977740	Acland Coal Sequence (lower)	Compliance (MLs 50216 & 50170)	
112PR	370658	6977872	Acland Coal Sequence	Interpretation (ML 50232)	Replacement for damaged EA bore 112PGC
113PGCB	368460	6978439	Acland Coal Sequence	Interpretation (ML 50232)	
114P	371804	6976043	Acland Coal Sequence	Interpretation (ML 50232)	
116P	374221	6975134	Acland Coal Sequence	Interpretation (ML 50232)	
118P	367507	6976115	Acland Coal Sequence	Interpretation (ML 50232)	
119P (119PGC)	371608	6973341	Acland Coal Sequence	Interpretation (ML 50232)	
3316_WB	372826	6978116	Acland Coal Sequence	Compliance (MLs 50216, 50170 & 50232)	
GW05B	366544	6982090	Acland Coal Sequence	Interpretation (ML 50232)	
GW06B	365887	6979279	Acland Coal Sequence	Interpretation (ML 50232)	
GW07BR	369457	6974038	Acland Coal Sequence	Interpretation (ML 50232)	Replacement for damaged EA bore GW07B.
GW09B	373836	6972486	Acland Coal Sequence	Interpretation (ML 50232)	
GW10	375443	6975740	Acland Coal Sequence	Interpretation (ML 50232)	

Monitoring Bore	Easting (GDA2020)	Northing (GDA2020)	Aquifer	EA Bore Type	Notes
18PcR	371016	6982646	Balgowan Coal Sequence	Interpretation (MLs 50216, 50170 & 50232)	
18PcR2	370824	6982725	Balgowan Coal Sequence	Compliance (MLs 50216 & 50170)	
2289_Lower	371373	6983732	Balgowan Coal Sequence	Interpretation (MLs 50216, 50170 & 50232)	
2291P	374728	6981339	Balgowan Coal Sequence	Interpretation (MLs 50216, 50170 & 50232)	
25PcR	374143	6982061	Balgowan Coal Sequence	Interpretation (MLs 50216, 50170 & 50232)	
26PcR	374265	6982980	Balgowan Coal Sequence	Interpretation (MLs 50216, 50170 & 50232)	
27PcR	373360	6983538	Balgowan Coal Sequence	Interpretation (MLs 50216, 50170 & 50232)	
28PcR	372305	6983985	Balgowan Coal Sequence	Interpretation (MLs 50216, 50170 & 50232)	
BCS3	369833	6980842	Balgowan Coal Sequence	Compliance (MLs 50216 & 50170)	
BCS4	371561	6977722	Balgowan Coal Sequence	Compliance (MLs 50216 & 50170)	
CSMH1Rb	375334	6977442	Balgowan Coal Sequence	Compliance (MLs 50216 & 50170)	
132WBR	369207	6977442	Balgowan Coal Sequence	Interpretation (MLs 50216 & 50170)	
133WBR	369953	6984776	Balgowan Coal Sequence	Interpretation (MLs 50216 & 50170)	
GW08C	365816	6977063	Marburg Sandstone	Interpretation (ML 50232)	
GW09C	373837	6972499	Marburg Sandstone	Interpretation (ML 50232)	
GW11B	367564	6982706	Marburg Sandstone	Interpretation (ML 50232)	
3307_WBR	372514	6982680	Rehabilitated Spoil	Interpretation (ML 50232)	Replacement for damaged EA bore 3307WB

$ Coordinates approximate; bore not yet installed.

4.2.2. Revisions / Updates to the Monitoring Network

It is recognised that updates to a projects groundwater monitoring network are necessary from time to time. Reasons for this may include physical damage to a particular bore or it becoming otherwise compromised, or new information becoming available which changes the understanding of the system. Although there are no monitoring bores currently located within areas expected to be subject to direct physical disturbance as part of future mining activities, as discussed in **Section 7**, the GMMP review and improvement process will identify where updates to the network are necessary, and sufficient rework of the underlying modelling and impacts assessment will be undertaken to ensure no net loss of integrity of the program or protection to environmental values.

4.3. Post Mining

The post mining period is specifically covered by the requirements for NAC to:

- develop a and a Progressive Rehabilitation and Closure Plan (PRCP) in accordance with State regulatory requirements; and
- develop a Post Mining Rehabilitation Groundwater Take Management Plan required pursuant to condition 5 of the AWL.

The GMMP groundwater monitoring program will continue unchanged in the post-mining period until relinquishment of the EA and ML's, with the exception of incorporating any additional requirements that may arise through the PRCP and Post Mining Rehabilitation Groundwater Take Management Plan development and regulatory approvals processes.

Where the post mining landform is to include residual void lakes, the post mining monitoring program will also include additional monitoring of each of the three depressed landforms as follows.

- Void Water Level
  - Monthly survey of the void lake water level consistent with the frequency of groundwater level monitoring at groundwater bores.
- Void Water Quality
  - 6-Monthly sampling of the void lake water quality consistent with the frequency and parameter suite (**Section 4.4.2.2**) for groundwater quality monitoring at groundwater bores.

In the post-mining period, the PRCP and Post Mining Rehabilitation Groundwater Take Management Plan will require that the GMMP Review and Improvement Process outlined in **Section 7** continues unchanged.

The GMMP will continue to be implemented during the post-mining period until such time as mining lease relinquishment is achieved, in accordance with relevant State and Commonwealth regulatory approvals associated with satisfactory completion of implementation of the PRCP and Post Mining Rehabilitation Groundwater Take Management Plan. These statutory obligations will include assessment and demonstration that the ongoing risk to groundwater associated with the final landform has been successfully managed and mitigated.

4.4. Monitoring Protocols

The groundwater monitoring network will:

- be installed and maintained under the supervision of a person possessing appropriate qualifications and experience in the fields of hydrogeology and groundwater monitoring program design to be able to competently make recommendations about these matters; and
- be constructed in accordance with methods prescribed in the latest edition of the 'Minimum Construction Requirements for Water Bores in Australia' by an appropriately qualified and licensed water bore driller.

Groundwater monitoring will be undertaken by appropriately qualified personnel. Groundwater level measurements, sample collection, storage and transportation will be undertaken in accordance with procedures conforming to the current industry standard: AS/NZS 5667.1, .11 1998. Further detail is provided in **Section 5**.

4.4.1. Groundwater Level Monitoring

Groundwater level monitoring will be conducted at least monthly for each bore, consistent with EA requirements. Monitoring will be undertaken using a conventional groundwater level monitoring e-tape by appropriately qualified personnel in each GMMP monitoring bore.

Further detail is provided in **Section 5**.

4.4.2. Groundwater Quality Monitoring

4.4.2.1. General

Groundwater quality sampling will be undertaken:

- On a 6-monthly frequency basis for bores where baseline\background parameter concentrations and triggers have been established in the EA and monitoring results for any particular bore are below the relevant bore specific groundwater quality triggers and limits (**Section 6.1.4**).
- On a 3-monthly frequency basis for bores where monitoring results for any particular bore are above the relevant bore specific groundwater quality triggers and limits (**Section 6.1.4**), until such time as no limits have been exceeded on three (3) consecutive three-monthly monitoring events.
- On a 3-monthly frequency basis for bores where water quality baseline\background parameter concentrations and triggers are not yet established in the EA, until a statistically sufficient dataset is collected from which to define baseline criteria and triggers in accordance with the DES (2021) groundwater quality assessment guideline.

Groundwater quality sampling will be undertaken in accordance with the protocols and QA/QC procedures outlined in:

- Australian Standard AS/NZS 5667.11:1998 Water quality – Sampling – Guidance on sampling of groundwaters;
- Groundwater Sampling and Analysis—A Field Guide (Geoscience Australia, 2009); and
- Department of Environment and Heritage Protection (EHP) Monitoring and Sampling manual – Version 2 (September 2010).

Field measurement of water quality parameters will be undertaken using appropriate field equipment that is maintained and calibrated in accordance with the manufacturer's recommendations.

Groundwater sample analysis will continue to be undertaken by a laboratory accredited by the National Association of Testing Authorities (NATA). The sample analysis will include duplicates and blanks consistent with industry standard QA/QC procedures.

Further detail is provided in **Section 5**.

4.4.2.2. Parameter Suite

As described in **Section 0**, potential impacts from NAC's activities have been identified as primarily groundwater level drawdown as a result of mining. NAC's impact on groundwater levels has the potential to result in groundwater quality changes. Groundwater quality changes may occur where groundwater level drawdown results in changes in aquifer potentiometric head gradients sufficient to cause significant alteration of groundwater flow systems that moves groundwaters of different quality into different areas of the hydrogeologic system. Furthermore, groundwater level drawdown also has the somewhat less likely potential to result in oxidation of the aquifer matrix that results in release of the matrix chemical constituents into groundwater, and this type of oxidation effect may also occur within overburden spoil dumps. Blasting activities also have the potential to release nitrogen compounds such as ammonia to groundwater.

The groundwater quality parameter suite identified below therefore has been selected to detect these potential changes in groundwater following a comprehensive geochemical review of monitoring data collected since the commencement of mining (Geochemical Scientific, 2020). The groundwater quality parameter suite comprises:

- Physico-chemical Parameters
  - Salinity as EC (field measured) and TDS (laboratory)
  - pH (field measured)
  - Redox Potential (field measured for interpretive purposes only, i.e. not required by the EA)
  - Dissolved Oxygen (field measured for interpretive purposes only, i.e. not required by the EA)
  - Temperature (field measured for interpretive purposes only, i.e. not required by the EA)
- Major Ions (laboratory)
  - Sodium (Na)
  - Calcium (Ca)
  - Potassium (K)
  - Magnesium (Mg)
  - Chloride (Cl)
  - Sulphate (SO_4)
  - Bicarbonate (HCO_3)
  - Carbonate (CO_3) (for interpretive purposes only, i.e. not required by the EA)
- Metals and Metalloids (laboratory)

  + Aluminium (Al)
  + Arsenic (As)
  + Barium (Ba) (for interpretive purposes only, i.e. not required by the EA)
  + Copper (Cu)
  + Fluorine (F)
  + Iron (F)
  + Ferrous Iron (Fe^{2+}) (for interpretive purposes only, i.e. not required by the EA)
  + Manganese (Mn)
  + Selenium (Se)
- Nutrients (laboratory)
  + Total Nitrogen (Total N)
  + Nitrate (NO3)
  + Nitrite (NO2)
  + Ammonia (NH3) (for interpretive purposes only, i.e. not required by the EA)
  + Total Kjeldahl Nitrogen (TKN) (for interpretive purposes only, i.e. not required by the EA)
- Dissolved Gases (laboratory)
  + Hydrogen Sulphide (H2S) (for interpretive purposes only, i.e. not required by the EA)

4.4.3. Groundwater Data Management

The data gathered from the groundwater monitoring program will be collated into a database managed by NAC Environmental Department site personnel. The data management system will include:

- a site plan showing sample locations;
- tabulated results of the monitoring compared with applicable background/trigger levels;
- all data collected during each monitoring round;
- a record of chain of custody of the samples from sampling through to analysis;
- laboratory analysis certificates;
- groundwater monitoring program reports, and
- a description of the procedures, methods and calculations used.

Further detail is provided in **Section 5**.

5. Quality Assurance / Quality Control

NAC recognises that robust QA/QC procedures are a critical component of the GMMP. QA/QC procedures adopted by NAC in the GMMP will include:

- Field based procedures for:
  - Equipment calibration;
  - Equipment decontamination;
  - Groundwater level measurement methods; and
  - Groundwater quality sampling methods.
- Groundwater quality laboratory-based procedures for:
  - Laboratory accreditation;
  - Sample analysis replication; and
  - Sample quality assurance.
- Data management and data quality assurance procedures.

5.1. Field Procedures

Field procedures have been developed to be compliant with:

- Groundwater Sampling and Analysis—A Field Guide (Geoscience Australia, 2009);
- DES 2018. Monitoring and Sampling Manual: Environmental Protection (Water) Policy. Brisbane: Department of Environment and Science Government.
- Australian and New Zealand Standard AS/NZS 5667.1:1998 Water quality - Sampling - Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples (AS/NZS5667).

5.1.1. Qualified Personnel

Groundwater monitoring will be undertaken by appropriately qualified personnel with experience in conducting groundwater monitoring and sampling programs in accordance with the above listed Guidelines.

5.1.2. Equipment Calibration

The field water quality (i.e. pH, EC, DO and Redox) meter used during the program implementation will be calibrated to the relevant calibration standard solutions daily, and prior to each day's work. Daily calibration records will be noted in a dedicated register and provided with the monitoring event report (see **Section 5.1.7**) for record keeping purposes.

5.1.3. Equipment Decontamination

All field equipment used in the execution of the GMMP monitoring program will be thoroughly decontaminated before and after conducting any field measurements and sampling at each and every bore. This decontamination process includes the water level dip-meter probe and tape, field water quality meter, and water quality sample pumps and tubing.

5.1.4. Groundwater Level Measurements

5.1.4.1. Manual Measurements

Manual groundwater level measurements will be collected prior to any disturbance for groundwater quality sample collection at any bore.

Manual groundwater level measurements will be collected using an industry standard groundwater level e-tape. The e-tape will be checked for operational readiness before each use, including a test of the probe function prior to use in the field. Measurements of the groundwater level will be taken from the top of the PVC casing at each bore, a point permanently marked at the top of the PVC casing at each bore to provide repeatability and consistency between monitoring events.

5.1.5. Groundwater Quality Sampling

5.1.5.1. Bore Purging Procedures

In accordance with the above listed Guidelines, appropriate groundwater sampling procedures require that stagnant water that has been standing in the bore casing be purged prior to collection of a groundwater sample, so that sample is representative of the groundwater within the aquifer screened by the bore. This is due to the fact that the stagnant water in the bore column can become physically and chemically altered from that held within the aquifer. The following purge methods will be adopted during the program depending on the characteristics of each bore being sampled (e.g. bore depth, water column height, and rate of inflow to the bore):

- Three bore volumes/parameter stabilisation via a conventional submersible purge pump; or
- Low-flow sampling using specialised low-flow sampling equipment.

In conventional bore purging prior to sampling, industry standards dictate that a minimum of three bore volumes of groundwater should be purged from the bore prior to sampling. However, NAC will monitor field water quality parameters of EC, pH, temperature, dissolved oxygen and redox during purging, and sampling will only be undertaken once parameters have also stabilised in addition to three bore volumes being purged.

5.1.5.2. Field Measurements

Recording of field water quality parameters (i.e. EC, pH, temperature, dissolved oxygen and redox) will be undertaken using appropriate field water quality equipment using a flow through cell, after bore purging is confirmed to be satisfactorily complete with parameter stabilisation confirmed. The equipment will be calibrated prior to use as outlined in **Section 5.1.2**.

5.1.5.3. General Sample Collection Procedures

Following confirmation of field parameter (EC, pH, temperature, dissolved oxygen and redox) stabilisation identifying representative aquifer water is being produced from the bore, groundwater samples will be collected from each bore in the monitoring program. Groundwater samples will be collected as follows.

- Only collected once parameter stabilisation has been confirmed.
- Collected in accordance with the relevant guidelines.

- Placed into laboratory supplied bottles containing the appropriate preservative solutions for the analyte suite to be tested.
- Clearly labelled with the Bore ID, sampling date/time and field personnel initials.
- Field filtered to 0.45 µm where relevant for particular bottles/analytes (e.g. dissolved metals).
- Placed onto ice in a cooler box with ice immediately after sampling for transfer to the analytical laboratory.

Following sampling, all equipment will be cleaned and decontaminated in preparation for moving to the next bore.

5.1.5.4. Sample Duplicates

Duplicate samples are used to check and provide consistency in laboratory analytical processes. Duplicate samples involve the collection of a second set of samples from a bore in an identical manner to the primary samples. The duplicate samples will be tested for the same analytical suite as the primary samples. Additionally, duplicate samples will be collected as "blind duplicates", where an alternate naming convention is adopted for the duplicates so that the analytical laboratory cannot match a duplicate sample to its relevant primary sample. The blind duplicate sample will be clearly matched to its relevant primary sample in the field documentation (see **Section 5.1.6**).

One duplicate sample will be collected for every 10 primary samples per monthly monitoring event.

5.1.5.5. Sample Blanks

Blank samples are used to identify if any possible sample contamination has occurred during the sample collection and storage/shipping process. Blank samples will be tested for the same analytical suite as the primary samples. Two types of sample blanks will be adopted in the program:

- Container blank.

  Also known as a 'field blank'. Laboratory supplied ultra-pure water is placed into sample containers whilst in the field and stored/transported to the analytical laboratory in the same manner as the primary samples. The container blank testing is used to identify if any contamination of samples may have occurred as a result of the sample collection process or use of non-sterile sample containers.

  One container blank will be collected per monitoring event.

- Equipment / rinsate blank.

  Following field equipment cleaning/decontamination in the field, laboratory supplied ultra-pure water is poured over and through the field equipment and then placed into sample containers and stored/transported to the analytical laboratory in the same manner as the primary samples. The equipment blank testing is used to identify if any contamination of samples may have occurred as a result of insufficient equipment cleaning/decontamination processes.

  One equipment blank will be collected per purging pump per event.

5.1.5.6. Storage and Chain of Custody

Groundwater sample bottles will be placed onto ice in a cooler box immediately after sampling for transfer to the analytical laboratory. Sample transfer will occur under industry standard Chain of Custody (CoC) protocols/documentation and within the relevant holding times for each parameter. Copies of each CoC form will be taken in the field prior to shipping the samples and the CoC forms will be included with the monitoring report (see **Section 5.1.7**) for record keeping purposes.

5.1.6. Field Documentation

NAC recognises that robust field documentation is a key component of field program execution. NAC will compile all field documentation at the conclusion of each monitoring event in conjunction with the monitoring report (see **Section 5.1.7**). A Field Sheet (field documentation) will be developed by the field team for use during the monitoring program at each bore being monitored. The Field Sheet will be used to record the following information.

- Identification of which bore is represented by the field sheet.
- Date and time of the resting standing water level measurement pre-purging/sampling.
- Date and time when purging commenced.
- Details of the purging method including pump/intake depth.
- Records of field water quality parameters during purging at routine time intervals.
- Colour and odour of purged water during purging at routine time intervals.
- Purge time, volume and standing water level during purging at routine time intervals.
- Observations of any degassing of water during purging.
- Sample collection date, time and ID, including the ID of any QA/QC (e.g. duplicate) samples taken.
- A daily Calibration Record for the field water quality meter.
- A Daily Report emailed to the NAC Environment Department project manager.
- A completed Chain of Custody (CoC) record for samples.
- A digital photographic record for each bore, containing:
  - The condition of the bore headworks and general surrounding area, and
  - The water sample at the time of sampling.

  Each photograph will contain clear identification of the bore ID that is the subject of the photograph.

5.1.7. Reporting

Following each monitoring event, a factual Monitoring Report will be prepared for record keeping purposes. The Monitoring Report will contain the following information.

- Summary details regarding the dates of the field program covered by the report.
- Identification of staff who undertook the program and their relevant qualifications.
- Details of any monitoring restrictions encountered during the program.
- A summary table of measured standing water levels.

- A summary table of final field groundwater quality measurements.
- A summary of the water quality sampling.
- Details of sample QA/QC.
- Details regarding logger downloads.
- Appendices containing:
  + Laboratory analytical results sheets;
  + Field Sheets for each bore;
  + The daily Calibration Record for the field water quality meter;
  + Copies of the Chain of Custody (CoC) form(s); and
  + The photographic record for each bore.

5.2. Laboratory Procedures

5.2.1. Accreditation

Groundwater sample analysis will be undertaken by a laboratory accredited by the National Association of Testing Authorities (NATA).

5.2.2. Sample analysis replication and Sample quality assurance

The sample analysis will include duplicates and blanks collected in the field consistent with industry standard QA/QC procedures compliant with the relevant guidelines, as described in **Sections 5.1.5.4** and **5.1.5.5**.

Additionally, the NATA accredited laboratories will employ as standard practice an internal QA/QC program (intra-lab QC) that will include laboratory control samples, method blanks, matrix spikes, laboratory duplicates and surrogates, at frequencies at or above those recommended in the NEPM (2013) guidelines.

The intra-lab QC testing regime is designed by each NATA accredited laboratory and may vary slightly between laboratories, however samples are typically analysed at the following frequencies.

- Method Blanks – one (1) analysed within each process lot of twenty (20) samples;
- 10% Laboratory Duplicates – two (2) analysed within each process lot of twenty (20) samples;
- Laboratory Control Samples – one (1) analysed within each process lot of twenty (20) samples; and
- 5% Matrix Spikes – one (1) analysed within each process lot of twenty (20) samples.

5.3. Data Management and Data Quality Assurance Procedures

5.3.1. Data Management and Storage

The data gathered from the GMMP groundwater monitoring program will be collated into a dedicated electronic database managed by the NAC Environment Department. Data will be entered into the database no later than 24 hours after it is received by the NAC Environment

Department. The database will be routinely backed up in accordance with NAC's electronic information backup procedures.

5.3.2. Data Quality Assurance

A multi-tier process for GMMP data quality assurance after data collection will be implemented as follows.

1. Within the dedicated electronic database managed by the NAC Environment Department, flags will be implemented to automatically identify data that breaches any of the groundwater level or groundwater quality triggers established in the EA (see **Section 6.1**) and thus automatically notify the NAC Environment Department personnel to enact the Groundwater Impact Investigation Procedure (see **Section 6.2**), the first step of which is to confirm the data validity.

2. The GMMP Annual Groundwater Monitoring Report (see **Section 7.1**) will include a thorough review of the groundwater monitoring database that will include identification of any spurious data through comparison with baseline data and statistical trend and outlier analysis in accordance with the procedures identified in DES (2021).

3. Any formal investigation into the potential for environmental harm enacted as a result of a trigger breach (see **Section 6.1**) followed by implementation of the Groundwater Impact Investigation Procedure (see **Section 6.2**), will include identification of any spurious data through comparison with baseline data and statistical trend and outlier analysis in accordance with the procedures identified in DES (2021).

Should any of the above result in identification of spurious data, the NAC Environment Department will implement an investigation into the source of the data error, including review of the data collection procedures (**Section 5.1**), and where relevant the laboratory procedures (**Section 5.2**), to identify the source of the error, where possible. Where the error source is conclusively identified, the procedures identified in this GMMP will be updated where necessary, to mitigate the error occurring again.

6. Groundwater Impact Triggers and Investigation Protocols

6.1. Groundwater Compliance Criteria and Triggers

Compliance criteria for groundwater levels and quality (i.e. triggers and limits), where not already established in the EA and this GMMP, will be developed using statistical analysis of the baseline data and the predicted impacts presented in the latest version of NAC's numerical groundwater model.

The triggers and limits will be used to determine if the groundwater impact investigation procedure should be initiated as per the EA.

These trigger and limits include:

- Exceeding groundwater quality triggers and limits in the relevant conditions of the EA;
- Exceeding the groundwater level trigger thresholds in the relevant conditions of the EA, which may indicate variance from the predicted groundwater drawdown effects presented in the latest version of NAC's groundwater model or subsequent impact assessment updates; or
- when a legitimate complaint is received from a local landholder who is a groundwater user.

6.1.1. Groundwater Level Reference Values

Pursuant to EA condition D11, groundwater level reference values will be established for each monitoring bore within 2 years of commencement of the EA (i.e. by August 2024) where reference values are not already provided herein. Reference values will be established on the basis of statistical analysis of the baseline water level dataset collected at each bore over a period of at least 12 months prior to August 2024. The statistical analysis will include a thorough QA/QC of the baseline dataset to filter outliers. Measured drawdown during the life of NAC's operations will be calculated on a bore by bore basis, by comparing the measured water level (in mAHD) for a bore at any point in time during operations with the reference value for that bore. This simple calculation will occur automatically within NAC's groundwater monitoring database (see **Section 5.3.1**)

Reference values already established in the EA (**Table 8**) are based on statistical trend analysis of the baseline water level dataset collected at each bore to April 2020 using the non-seasonal Mann-Kendall test. The statistical analysis has included a thorough QA/QC of the baseline dataset to filter data outliers (errors) using Tukey's method (1977). A manual outlier analysis was also conducted to confirm or correct the statistical outlier analysis. The results of the statistical trend and outlier analysis are provided in **Appendix B** and show that most bores were subject to existing water level trends prior to April 2020, either positive (upward) or negative (downward). Previous analysis as reported in SLR (2018a) indicates these existing trends are related to a combination of extensive regional third party groundwater extraction, climatic influences, and for monitoring bores close to the Mine, the effects of current and historic mining activities.

Since baseline groundwater level data for each monitoring bore is subject to existing trends, groundwater level reference values already established in the EA have been calculated as the average measured water level over the 12-month period between May 2019 and April 2020. This method takes into account both antecedent level trends as well as observed climatic-driven seasonal groundwater level variability.

A summary of the statistical trend analysis results as well as the reference groundwater level values already established in the EA (Table D3) are provided in **Table 8**.

Table 8 Groundwater Level Reference Values (based on EA Table D3)

Monitoring Bore	Aquifer	Bore Status at June 2023	Water Level Statistical Trend[3]	Reference Value (mAHD)[4]
LCA1	Lagoon Creek Alluvium	Active	TBC	TBA
LCA2	Lagoon Creek Alluvium	Active	TBC	TBA
GW09A	Oakey Creek Alluvium	Active	TBC	TBA
10PbR	Main Range Volcanics	Active	TBC	TBA
84PbR	Main Range Volcanics	Active	TBC	TBA
BMH1	Main Range Volcanics	Active	Downward	440.0
18PbR	Main Range Volcanics	Active	TBC	TBA
18PbR2	Main Range Volcanics	Active	TBC	TBA
109PR	Main Range Volcanics	Not Yet Installed	TBC	TBA
GW05A	Main Range Volcanics	Active	TBC	TBA
GW11AR	Main Range Volcanics	Recently Installed	TBC	TBA
GW15A	Main Range Volcanics	Active	TBC	TBA
GW16A	Main Range Volcanics	Active	TBC	TBA
GW13B	Waipanna Coal Sequence	Active	TBC	TBA
81PcR	Acland Coal Sequence	Not Yet Installed	TBC	TBA
82PcR	Acland Coal Sequence	Recently Installed	TBC	TBA
CSMH1Ra	Acland Coal Sequence	Active	TBC	TBA
4517WB	Acland Coal Sequence	Active	No Trend	404.5
4518WB	Acland Coal Sequence	Active	Downward	409.0
111PGC_LowerR	Acland Coal Sequence (lower)	Recently Installed	TBC	TBA
112PR	Acland Coal Sequence	Recently Installed	TBC	TBA
113PGCB	Acland Coal Sequence	Active	TBC	TBA
114P	Acland Coal Sequence	Active	Upward	381.7
116P	Acland Coal Sequence	Active	Upward	389.6

[3] Seasonal Mann-Kendall test using data to April 2020. TBC = to be calculated (not yet assessed)
[4] Pursuant to EA condition D11, reference values will be completed within 2 years of commencement of the EA (i.e. by August 2024)

Monitoring Bore	Aquifer	Bore Status at June 2023	Water Level Statistical Trend[3]	Reference Value (mAHD)[4]
118P	Acland Coal Sequence	Active	Downward	393.0
119P	Acland Coal Sequence	Active	Downward	392.0
3316_WB	Acland Coal Sequence	Active	TBC	TBA
GW05B	Acland Coal Sequence	Active	TBC	TBA
GW06B	Acland Coal Sequence	Active	TBC	TBA
GW07BR	Acland Coal Sequence	Recently Installed	TBC	TBA
GW09B	Acland Coal Sequence	Active	TBC	TBA
GW10	Acland Coal Sequence	Active	TBC	TBA
18PcR	Balgowan Coal Sequence	Active	TBC	TBA
18PcR2	Balgowan Coal Sequence	Active	TBC	TBA
2289_Lower	Balgowan Coal Sequence	Active	TBC	TBA
2291P	Balgowan Coal Sequence	Active	TBC	TBA
25PcR	Balgowan Coal Sequence	Active	TBC	TBA
26PcR	Balgowan Coal Sequence	Active	Upward	434.5
27PR	Balgowan Coal Sequence	Active	TBC	TBA
28PR	Balgowan Coal Sequence	Active	TBC	TBA
BCS3	Balgowan Coal Sequence	Active	TBC	TBA
BCS4	Balgowan Coal Sequence	Active	TBC	TBA
CSMH1Rb	Balgowan Coal Sequence	Active	TBC	TBA
132WBR	Balgowan Coal Sequence	Active	TBC	TBA
133WBR	Balgowan Coal Sequence	Active	TBC	TBA
GW08C	Marburg Sandstone	Active	TBC	TBA
GW09C	Marburg Sandstone	Active	TBC	TBA
GW11B	Marburg Sandstone	Active	TBC	TBA
3307_WBR	Rehabilitated Spoil	Recently Installed	TBC	TBA

6.1.2. Groundwater Level Drawdown Triggers

6.1.2.1. Monitoring Bores

The predictive results of the 2018 version of the NAC numerical groundwater model (SLR, 2018b) have been utilised to develop bore specific water level drawdown triggers (termed the level trigger threshold in the EA) for some monitoring bores as identified in Table D3 of the EA. These level trigger thresholds have been based on the following criteria.

- Level trigger thresholds have been calculated using the latest version of the NAC groundwater model (SLR, 2018b), and using the cumulative impact predictions (as opposed to incremental Stage 3-only predictions) so they are directly comparable to real-world measurements.
- Level trigger thresholds are based on the difference between the predicted water level at the commencement of Stage 3 mining activities (time zero), and the minimum (lowest) predicted water level at any time during the life of the Stage 3 Project (i.e. represent predicted groundwater level 'drawdown' as a result of Stage 3 operations).
- Level trigger thresholds have been assigned based on a drawdown value equal to the maximum 95th percentile model drawdown prediction at each bore over the life of Stage 3.

The groundwater level trigger thresholds have been developed with due consideration of the following complicating factors.

- Groundwater System Recovery from Stage 1 and 2 Operations:

  For the Balgowan Coal Sequence and Marburg Sandstone aquifers, although groundwater drawdown arising from the Stage 3 Project on ML 50232 is predicted (i.e. incremental Stage 3 Project-only drawdown), this is actually offset in the cumulative impacts model scenario (i.e. the model predictions that include the existing 2001 through 2021 Mine operations on ML 50170 and ML 50216) by recovery of groundwater levels related to the cessation of historic Mine-related groundwater pumping in 2010, as well as recovery of groundwater levels following the completion and rehabilitation of Stage 1 and 2 mining. Therefore, although groundwater drawdown arising from the Stage 3 Project is predicted for the Balgowan Coal Sequence and Marburg Sandstone, in a cumulative impact scenario (i.e. real-world) sense there is no predicted drawdown for those aquifers since groundwater levels are recovering overall (i.e. rising) and the drawdown from the Stage 3 Project is masked and therefore unmeasurable. Drawdown triggers established in this GMMP therefore need to take these Stage 1 and Stage 2 related recovery trends into account and this is done by adopting the cumulative model predictions for trigger development.

- Non-Mining Antecedent Trends:

  As described in the conceptual hydrogeological model report (SLR, 2018b), the groundwater system in the vicinity of NAC is subject to existing groundwater drawdown trends associated primarily with large volumes of third-party groundwater extraction. Therefore, ongoing drawdown will be measured in NAC monitoring bores that is not related to NAC's activities (i.e. greater than that predicted in either the incremental Stage 3 Project-only or cumulative model scenarios) and drawdown triggers established in this GMMP need to take these antecedent drawdown trends into account. This is achieved by the existing simulation of these third-party groundwater extractions in the numerical groundwater model.

It should be noted that the bore specific level trigger thresholds incorporate the model's simulation of antecedent non-mining related trends such as regional third-party groundwater extraction and climatic influences, so that the triggers can be accurately compared to real-world monitoring measurements during the lifespan of the NAC's operations. Thus some bores in the GMMP are assigned level trigger thresholds that are greater than 1 m, where the influence from NAC's operation is predicted to be less than 1 m (95^{th} percentile) but the combined influence of mining and non-mining trends is predicted to be greater than 1 m (95^{th} percentile).

Should the level trigger thresholds at any bore be exceeded at any time over the life of NAC's operations, it would result in implementation of the groundwater impact investigation procedure detailed in **Section 6.2** below.

The bore specific level trigger thresholds for each monitoring bore identified in Table D3 of the EA are presented in **Table 9**. Where level trigger thresholds are not yet defined (denoted 'TBA') in **Table 9**, consistent with the EA requirements these will be proposed following 12 months of monitoring of the new bores and based on the latest version of the NAC numerical groundwater model available at the time.

Table 9 Groundwater Level Trigger Thresholds (based on EA Table D3)

Monitoring Bore	Aquifer	Bore Status at June 2023	Level Trigger Threshold (m)
LCA1	Lagoon Creek Alluvium	Active	TBA
LCA2	Lagoon Creek Alluvium	Active	TBA
GW09A	Oakey Creek Alluvium	Active	TBA
10PbR	Main Range Volcanics	Active	5.79
84PbR	Main Range Volcanics	Active	5.79
BMH1	Main Range Volcanics	Active	6.14
18PbR	Main Range Volcanics	Active	4.57
18PbR2	Main Range Volcanics	Active	TBA
109PR	Main Range Volcanics	Not Yet Installed	TBA
GW05A	Main Range Volcanics	Active	TBA
GW11AR	Main Range Volcanics	Recently Installed	TBA
GW15A	Main Range Volcanics	Active	TBA
GW16A	Main Range Volcanics	Active	TBA
GW13B	Waipanna Coal Sequence	Active	TBA
81PcR	Acland Coal Sequence	Not Yet Installed	TBA
82PcR	Acland Coal Sequence	Active	TBA
CSMH1Ra	Acland Coal Sequence	Active	TBA
4517WB	Acland Coal Sequence	Active	TBA
4518WB	Acland Coal Sequence	Active	TBA
111PGC_LowerR	Acland Coal Sequence	Recently Installed	TBA
112PR	Acland Coal Sequence	Recently Installed	TBA
113PGCB	Acland Coal Sequence	Active	TBA
114P	Acland Coal Sequence	Active	33.12

Monitoring Bore	Aquifer	Bore Status at June 2023	Level Trigger Threshold (m)
116P	Acland Coal Sequence	Active	23.75
118P	Acland Coal Sequence	Active	15.79
119P	Acland Coal Sequence	Active	14.46
3316_WB	Acland Coal Sequence	Active	TBA
GW05B	Acland Coal Sequence	Active	TBA
GW06B	Acland Coal Sequence	Active	TBA
GW07BR	Acland Coal Sequence	Recently Installed	TBA
GW09B	Acland Coal Sequence	Active	TBA
GW10	Acland Coal Sequence	Active	TBA
18PcR	Balgowan Coal Sequence	Active	TBA
18PcR2	Balgowan Coal Sequence	Recently Installed	TBA
2289_Lower	Balgowan Coal Sequence	Active	TBA
2291P	Balgowan Coal Sequence	Active	TBA
25PcR	Balgowan Coal Sequence	Active	TBA
26PcR	Balgowan Coal Sequence	Active	0.52
27PR	Balgowan Coal Sequence	Active	0.11
28PR	Balgowan Coal Sequence	Active	0.29
BCS3	Balgowan Coal Sequence	Active	TBA
BCS4	Balgowan Coal Sequence	Active	TBA
CSMH1Rb	Balgowan Coal Sequence	Active	3.74
132WBR	Balgowan Coal Sequence	Active	TBA
133WBR	Balgowan Coal Sequence	Active	TBA
GW08C	Marburg Sandstone	Active	TBA
GW09C	Marburg Sandstone	Active	TBA
GW11B	Marburg Sandstone	Active	TBA
3307_WBR	Rehabilitated Spoil	Recently Installed	TBA

6.1.3. Establishment of Water Quality Baseline Criteria

Groundwater quality baseline criteria will be established during EA groundwater quality trigger and limit development, which is required will be completed within 2 years of commencement of the EA (i.e. by August 2024) pursuant to EA condition D11. Baseline criteria will be established based on statistical analysis of the complete baseline water quality dataset collected over a minimum of 12 months at each bore. Baseline criteria will be established in accordance with the methods outlined in DES (2021). The statistical analysis will include a thorough QA/QC of the baseline dataset to filter outliers.

It will be through the implementation of this GMMP that a dataset is collated that will allow a statistically appropriate baseline/background water quality assessment using the DES (2021) groundwater quality assessment guideline. NAC is committed to establishing baseline groundwater quality conditions for these newer bores pursuant to EA condition D11 in accordance with the DES (2021) guideline once a sufficient dataset has been obtained in accordance with this GMMP.

6.1.4. Groundwater Quality Trigger Values

Pursuant to EA condition D17, a breach of a bore specific water quality trigger is confirmed, and the investigation procedure (**Section 6.2.2**) activated, if a groundwater quality limit is exceeded on any three (3) consecutive sampling occasions.

Different sets of groundwater quality triggers and limits are established in the EA for Compliance bores monitoring mining activities in ML 50232, and Compliance bores monitoring mining activities in MLs 50216 and 50170 (refer EA tables D2 and D5, respectively). The relevant Compliance bores for either ML 50232, or MLs 50216 and 50170, are identified in **Table 7**. Note that some bores have two different sets of groundwater quality triggers and limits under EA Table D2 and Table D5, i.e. for the same Compliance bore there may be different compliance criteria depending on if that criteria is relevant to mining activities in ML 50232, or MLs 50216 and 50170.

6.1.4.1. ML 50232

Pursuant to EA Table D2, groundwater quality triggers and limits applicable to mining activities in ML 50232 are established for some groundwater quality monitoring parameters, based on ANZECC (2000) stock watering (beef cattle) guideline limits. These are shown in **Table 10** below. These triggers and limits apply to the relevant EA Compliance bores as specified in **Table 10**.

Table 10 ML50232 Groundwater Quality Limits for Compliance Bores (based on EA Table D2)

Parameter	Units	Contaminant Limit[1]	Relevant Compliance Bores (see Table 7)
Al	mg/l	5.0	84PbR 10PbR BMH1 4517WB 4518WB CSMH1Ra 82PcR 3316WB BCS3 BCS4 18PbR2 18PcR2 LCA1 LCA2 CSMH1Rb 111PGC_Lower
As	mg/l	0.05	
Ca	mg/l	1000	
Se	mg/l	0.02	
Cl	mg/l	TBA	
Cu	mg/l	1.0[2]	
F	mg/l	TBA[5]	
Fe	mg/l	TBA[5]	
NO_3	mg/l	400	
NO_2	mg/l	30	
K	mg/l	TBA[5]	
Mg	mg/l	TBA[5]	
Mn	mg/l	TBA[5]	
Na	mg/l	TBA[5]	
SO_4	mg/l	1000	
HCO_3	mg/l	TBA[5]	
TDS	mg/l	5000[2,3]	
EC	mg/l	7460[2,3,4]	
pH	units	TBA[5]	

NOTE:
1 Based on Stockwater limits defined in ANZECC (2000).
2 Defined for beef cattle based on landholder bore survey results.
3 Existing bores 27PR, 28PR, 2289P and 118P background levels already exceed this limit prior to mine operation.
4 Based on EC to TDS conversion factor of 0.67 as per ANZECC (2000).
5 TBAs to be revised once adequate sampling has been undertaken by NAC which must be completed within 2 years of commencement of the EA to add groundwater bores that measure groundwater quality and the triggers and limits relevant to each bore.

Pursuant to EA condition D11, groundwater quality triggers and limits for parameters marked 'TBA' in EA Table D2 (**Table 10**) will be established within 2 years of commencement of the EA (i.e. by August 2024). Groundwater quality trigger values will be established using the methodology outlined in the DES (2021) groundwater quality assessment guideline. Site-specific (i.e. bore specific) trigger values for all parameters may be established in accordance with the DES (2021) guideline at the time that the triggers and limits for parameters marked 'TBA' are established.

6.1.4.2. ML 50216 and ML 50170

Pursuant to EA Table D5, groundwater quality triggers and limits applicable to mining activities in ML 50216 and ML 50170 are established for groundwater quality monitoring parameters, based work completed by NAC in 2022 in accordance with the DES (2021) guidelines. These are shown in **Table 11** below. These triggers and limits apply to the relevant EA Compliance bores as specified in **Table 11**.

Table 11 ML50216 and ML50170 Groundwater Quality Limits for Compliance Bores (based on EA Table D5)

<table>
<tr><th rowspan="3">Location</th><th>Parameter</th><th>pH (field)</th><th>EC (lab)</th><th>Fluoride</th><th>Sulfate</th><th>Aluminium (dissolved)</th><th>Arsenic (dissolved)</th><th>Copper (dissolved)</th><th>Iron (dissolved)</th><th>Manganese (dissolved)</th><th>Selenium (dissolved)</th><th>Nitrate</th></tr>
<tr><th>Limit type</th><th>Range</th><th>Max</th><th>Max</th><th>Max</th><th>Max</th><th>Max</th><th>Max</th><th>Max</th><th>Max</th><th>Max</th><th>Max</th></tr>
<tr><th>Unit</th><th>pH units</th><th>µS/cm</th><th>mg/L</th><th>mg/L</th><th>mg/L</th><th>mg/L</th><th>mg/L</th><th>mg/L</th><th>mg/L</th><th>mg/L</th><th>mg/L</th></tr>
<tr><td colspan="2">84PbR</td><td rowspan="8">6.5 – 7.5 [A]</td><td>2568 [C]</td><td>0.2 [F]</td><td>338 [F]</td><td rowspan="15">0.055 [G]</td><td rowspan="15">0.013 [G]</td><td rowspan="10">0.0014 [G]</td><td>0.05 [C]</td><td>0.02 [C]</td><td rowspan="15">0.011 [H]</td><td>16.9 [C]</td></tr>
<tr><td colspan="2">82PcR</td><td rowspan="3">9015 [D]</td><td rowspan="3">0.8 [D]</td><td rowspan="3">134 [D]</td><td rowspan="3">0.1 [D]</td><td rowspan="3">0.087 [D]</td><td rowspan="3">5 [D]</td></tr>
<tr><td colspan="2">BCS3</td></tr>
<tr><td colspan="2">BCS4</td></tr>
<tr><td colspan="2">18PcR2</td><td rowspan="4">3456 [E]</td><td rowspan="4">0.4 [E]</td><td rowspan="4">33 [E]</td><td rowspan="4">0.07 [E]</td><td rowspan="4">0.02 [E]</td><td rowspan="4">6.6 [E]</td></tr>
<tr><td colspan="2">18PbR2</td></tr>
<tr><td colspan="2">LCA1</td></tr>
<tr><td colspan="2">LCA2</td></tr>
<tr><td colspan="2">CSMH1Rb</td><td>6.0 – 8.5 [B]</td><td>1703 [F]</td><td>0.8 [D]</td><td>134 [F]</td><td>0.2 [F]</td><td>0.087 [D]</td><td>5 [D]</td></tr>
<tr><td colspan="2">10PbR</td><td rowspan="5">6.5 – 7.5 [A]</td><td>3346 [F]</td><td>0.5 [C]</td><td>57.7 [F]</td><td>0.05 [C]</td><td>0.02 [C]</td><td>50.7 [F]</td></tr>
<tr><td colspan="2">111PGC_Lower</td><td>6937 [F]</td><td>0.1 [F]</td><td>309 [F]</td><td>0.0024 [F]</td><td>4.9 [F]</td><td>0.087 [D]</td><td rowspan="4">5 [D]</td></tr>
<tr><td colspan="2">3316_WB</td><td>5629 [F]</td><td>0.2 [F]</td><td>31 [F]</td><td rowspan="2">0.0014 [G]</td><td>0.6 [F]</td><td>0.23 [F]</td></tr>
<tr><td colspan="2">4517WB</td><td>3084 [F]</td><td>0.33 [F]</td><td>31 [F]</td><td>0.8 [F]</td><td rowspan="2">0.087 [D]</td></tr>
<tr><td colspan="2">4518WB</td><td>4065 [F]</td><td>0.4 [F]</td><td>48 [F]</td><td>0.033 [F]</td><td>1.6 [F]</td></tr>
<tr><td colspan="2">BMH1</td><td>6.0 – 8.5 [B]</td><td>1440 [F]</td><td>0.4 [F]</td><td>18 [F]</td><td>0.0014 [G]</td><td>0.22 [F]</td><td>0.02 [C]</td><td>16.9 [C]</td></tr>
</table>

NOTE:
A. ANZECC Aquatic Ecosystem Guideline for South East Australia. B. ANZECC Livestock Drinking Water Guidelines. C. Lower Condamine Basalt 80^{th} %ile WQO.
D. North East Walloons 80^{th} %ile WQO. E. Woolowins near stream 80^{th} %ile WQO. F. 95^{th} %ile site specific value.
G. ANZECC Aquatic Ecosystem (95-99%) Protection Guideline (ANZG 2018). H. ANZECC Aquatic Ecosystem (95%) Protection Guideline (ANZG 2018).

6.2. Groundwater Impact Investigation Procedure

The groundwater impact investigation procedure will be implemented in response to an exceedance of a relevant trigger (groundwater quality or groundwater level) for any bore type. Groundwater monitoring data set will be reviewed by an appropriately qualified specialist who will determine if further investigation is necessary. The groundwater impact investigation procedure will follow the following framework.

Trigger Exceedance Identified	
Immediate Action	
Increase Monitoring Frequency (GW Level Breach) and/or Notify Administering Authority (DES)	To occur within 1 day from identification of breach
Confirm the Breach	
Review entire database and/or Resample/Re-Test/Re-measure at the affected bore	To occur within 7 days of identification of trigger exceedance or receipt of complaint
Investigation Report	
Commence Investigation into the Potential for Environmental Harm including identification of any required Contingency and Mitigation Measures	Investigation report submitted to Administering Authority (DES) within 60 days of confirmation of breach
Additional Investigations and Monitoring	
Where deemed required by the Investigation Report	Commence within 1 month of submission of the Investigation Report to the Administering Authority (DES)
Immediate Contingency Measures & Long Term Mitigation Planning	
Implementation of Immediate Contingecy Measures and planning of Long Term Mitigation Measures	Report submitted to Administering Authority (DES) within 28 days of submission of the Investigation Report to the Administering Authority (DES)
Long Term Mitigation	
Implementation of Long Term Mitigation Measures where deemed required	Within 3 months of Administering Authority (DES) approval of the Report recommending the Measures

The groundwater impact investigation procedure will apply to an exceedance of a relevant trigger for any bore type (groundwater level trigger thresholds at all bores, or groundwater quality triggers at EA Compliance bores).

6.2.1. Groundwater Levels

In the event that a groundwater level trigger threshold exceedance is identified in a data set for a bore, then the following impact investigation procedure will be implemented.

1) A re-measure will be conducted at the relevant bore within 7 days of the identification of the trigger breach, to confirm the breach by verifying that the data is not anomalous. Anomalous data will be identified through statistical comparison with other data from the subject bore in accordance with the methods described in DES (2021).
2) If the trigger breach is confirmed following a resample/re-test/re-measure, the following actions will be implemented:
    a) The monitoring frequency will be increased to weekly at the relevant bore. The first follow-up measurement will occur within 7 days from confirmation of the trigger breach.
    b) the administering authority of the EA (i.e. DES, or their equivalent entity at the time) will be notified within 7 days of the monitoring date on which the groundwater level breach was confirmed.
3) Once the validity of a trigger breach has been verified, an investigation into the potential for environmental harm in accordance with ANZECC and ARMCANZ (2000) will be completed by an independent and appropriately qualified specialist. The investigation will include as a minimum:
    a) comparison of the results for the bore subject to the breach with those from other bores, including comparison of Compliance bore results against Interpretation bore results;
    b) comparison to model predictions;
    c) comparison to baseline groundwater monitoring results;
    d) a review of mining activities that may be responsible for the breach;
    e) the prevailing and preceding meteorological conditions;
    f) a review of third-party groundwater use;
    g) a review of the physical integrity of the bore (if required); and
    h) assessment of the potential role of faults in the breach.

    The resulting investigation report will be sent to the administering authority of the EA within sixty (60) days of receiving the monitoring results in which the trigger breach was confirmed.

If the investigation into the potential for environmental harm deems that further additional investigation and/or monitoring is required to determine the cause of the 'activation' of the trigger, then the recommended additional investigation and/or monitoring will be actioned within 1 month of receipt of the investigation report that identifies the need for this to occur. Additional investigations recommended may include review of the numerical groundwater model (i.e. a process of continual improvement) that may in turn result in adjustment of the relevant compliance triggers.

The results of the investigation into any breaches of trigger levels, including all associated investigations and resulting proposed management/mitigation actions, will be documented for reporting and audit purposes and submitted to the administering authority of the EA approval within 28 days of receiving the monitoring results in which the trigger breach was confirmed.

If the investigations conclusively establish that triggers have been 'activated' as a result of mining activities, immediate contingency measures to mitigate the impact may need to be implemented as determined by those investigations. Immediate contingency measures may involve:

a) a change in mining operations;

b) a suspension of any mine related groundwater pumping from the aquifer of concern; or

c) the enacting of make good measures for all affected landholders consistent with NAC's obligations under Chapter 3 of the *Water Act 2000* (see **Section 6.3.2**).

If deemed required, proposed long term mitigation measures (along with any immediate contingency measures) will be documented in a report and submitted to the administering authority of the EA within twenty-eight (28) days of submission of the report documenting investigation into the potential for environmental harm. Further discussion on impact mitigation is provided in **Section 6.3**.

The results of the investigation into any breaches of groundwater level drawdown triggers, including all associated investigations and resulting proposed management/mitigation actions, will be documented for reporting and audit purposes and submitted to the administering authorities of the EA for approval within sixty (60) days of receiving the monitoring results in which the trigger breach was confirmed.

Where a breach of a groundwater level drawdown trigger is already being investigated, subsequent results for that parameter which similarly exceed trigger levels would contribute to that investigation but not trigger a new investigation.

6.2.2. Groundwater Quality

In the event that a groundwater quality trigger or limit breach is identified on any three (3) consecutive sampling occasions for a Compliance bore, then the following impact investigation procedure will be implemented.

1) The administering authority of the EA (i.e. DES, or their equivalent entity at the time) will be notified within 1 business day of the monitoring date on which the groundwater quality breach was confirmed.

2) Once the validity of a trigger breach has been verified, an investigation into the potential for environmental harm in accordance with ANZECC and ARMCANZ (2000) will be completed by an independent and appropriately qualified specialist. The investigation will include as a minimum:

    a) comparison of the results for the bore subject to the breach with those from other bores, including comparison of Compliance bore results against Interpretation bore results;

    b) review of groundwater flow pathways;

    c) comparison to baseline groundwater monitoring results;

    d) a review of authorized mining activities that may be responsible for the breach;

    e) the prevailing and preceding natural conditions (eg meteorological conditions);

    f) a review of neighboring land use and groundwater use; and

    g) a review of the physical integrity of the bore network (i.e. when an issue is identified by anomalous monitoring results).

The resulting investigation report will be sent to the administering authority of the EA within sixty (60) days of receiving the monitoring results in which the trigger breach was confirmed.

If the investigation into the potential for environmental harm deems that further additional investigation and/or monitoring is required to determine the cause of the 'activation' of the trigger, then the recommended additional investigation and/or monitoring will be actioned within 1 month of receipt of the investigation report that identifies the need for this to occur. Additional investigations recommended may include a review of the entire NAC groundwater quality database that may result in adjustment of the relevant compliance triggers using the methodology outlined in DES (2021).

The results of the investigation into any breaches of trigger limits, including all associated investigations and resulting proposed management/mitigation actions, will be documented for reporting and audit purposes and submitted to the administering authority of the EA approval within 28 days of receiving the monitoring results in which the trigger breach was confirmed.

If the investigations conclusively establish that triggers have been 'activated' as a result of mining activities, immediate contingency measures to mitigate the impact may need to be implemented as determined by those investigations. Immediate contingency measures may involve:

a) a change in mining operations;
b) a suspension of any mine related groundwater pumping from the aquifer of concern; or
c) the enacting of make good measures for all affected landholders consistent with NAC's obligations under Chapter 3 of the *Water Act 2000* (see **Section 6.3.2**).

If deemed required, proposed long term mitigation measures (along with any immediate contingency measures) will be documented in a report and submitted to the administering authority of the EA within twenty-eight (28) days of submission of the report documenting investigation into the potential for environmental harm. Further discussion on impact mitigation is provided in **Section 6.3**.

Where a breach of a groundwater quality limit trigger is already being investigated, subsequent results for that parameter which similarly exceed trigger limits would contribute to that investigation but not trigger a new investigation.

6.3. Contingency and Mitigation

6.3.1. General

As outlined above, the Impact Investigation Procedure for both groundwater levels and groundwater quality contains a step whereby groundwater impact triggers that are exceeded and deemed to have been 'activated' as a result of mining activities, as identified in a formal investigation of the potential for environmental harm following a trigger breach, may result in the need to implement contingency measures to mitigate these impacts. Such a formal investigation would also include that which is undertaken following activation of a trigger that is deemed to be related to the behaviour of faults. Contingency measures will be identified in the report documenting the investigation of the potential for environmental harm and approved by the EA's administering authority prior to implementation. Contingency measures considered in the investigation of the potential for environmental harm will be assessed and recommended on the basis of providing the best outcome for protection of the groundwater resource and its users in relation to mitigation of the impact.

The selection of the most effective mitigation measures will be based on providing the best outcome for protection of the affected groundwater resource and/or user as determined by the investigation into the potential for environmental harm. The selection of the most effective mitigation measures therefore will only be possible following the completion of the investigation into the potential for environmental harm.

The report documenting investigation into the potential for environmental harm, including the proposed contingency measures, will be submitted to the administering authority of the EA for approval within sixty (60) days of receiving the monitoring results in which the trigger breach was confirmed. If deemed required, proposed long term mitigation measures will be documented in a report and submitted to the administering authority of the EA within twenty-eight (28) days of submission of the report documenting investigation into the potential for environmental harm. The process for obtaining this approval is outlined in **Section 6.2**.

6.3.2. Impacts to Third Party Groundwater Users

In the event that a formal groundwater investigation conclusively identifies that NAC's mining operations have caused a bore of a neighbouring groundwater user to have impaired capacity (as defined in the *Water Act 2000*) (affected groundwater user), to the extent that NAC does not already have a make good agreement with the affected groundwater user, NAC will attempt in 'good faith' to negotiate a make good agreement with the landowner containing suitable mitigation measures. NAC will involve an appropriately qualified specialist to assist with development of the mitigation measures. The development of suitable mitigation measures will be based on the outcomes of the appropriate scientific investigation (i.e. the investigation into the potential for environmental harm).

Possible mitigation measures that may be applied by NAC as part of the make good process include:

- the refurbishment of an existing groundwater bore;
- the installation of a new groundwater bore;
- the establishment of an alternative water supply arrangement; and/or
- the use of another mutually agreed form of mitigation.

Mitigation measures selected will be based on providing the best outcome to the affected groundwater user (landholder) and selected by agreement with that landholder. NAC will ensure the proposed mitigation measures are commensurate with the identified impaired capacity.

NAC may be required to install interim mitigation measures until the permanent mitigation measures have been developed and installed. As required, NAC will seek agreement with the affected groundwater user and pay all reasonable cost for the use of any interim mitigation measures.

If agreement cannot be reached with the affected groundwater user in relation to the proposed mitigation measures, NAC will facilitate a legal disputes resolution for the matter which may include utilising relevant processes under the *Water Act 2000*.

NAC is committed to rectifying any impaired capacity to bores that are legitimately attributed to NAC's mining operations through proper scientific evaluation, in an appropriate timeframe, using accepted and practical mitigation measures, and to the satisfaction of the affected groundwater user.

7. Reporting, Review and Improvement Process

During the life of NAC's operations, data collected through the GMMP will be used to assess NAC's actual impact on groundwater resources, and update and refine NAC's numerical groundwater model and its predictions of future impacts. These outcomes will in turn be used to review and improve this GMMP through a continual Reporting, Review and Improvement process as described herein.

7.1. Annual Groundwater Monitoring Reports

NAC will conduct an annual review of the environmental performance of this GMMP. The annual review will be reported in a publicly available Annual Groundwater Monitoring Report pursuant to EA Condition D25 and will:

- include all raw monitoring data collected over the prior year;
- include a comprehensive review and analysis of the water level and water quality monitoring results for the bores identified in the GMMP over the year, including a comparison of these results against the:
  - relevant EA compliance criteria,
  - monitoring results of previous years, and
  - any other relevance to the Project's EA.
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- compare monitoring data with baseline data and undertake a long term statistical trend and outlier analysis for all bores in accordance with the procedures identified in DES (2021);
- discuss any trends in the monitoring data over the life of the Project;
- present details of any review undertaken of the conceptual model since the previous Annual Monitoring Report; and
- identify any discrepancies between model predicted groundwater level impacts and the actual measured impacts over the same period, and analyse the potential cause of any significant discrepancies.

The Annual Groundwater Monitoring Report will be developed by an appropriately qualified and experienced professional with a report provided on the outcome of the review to the administering authority by the 1st April of each calendar year.

7.2. Review and Improvement

Pursuant to EA Condition D24(j), NAC will undertake a routine review process for this GMMP that may result in an updated or revised GMMP as outlined in this Section. The DES (or their future equivalent entity) will be consulted in relation to any significant changes to this GMMP (i.e. that might require amendment to the EA).

7.2.1. General

The GMMP review and improvement process will involve review of this GMMP to take into account the results of ongoing monitoring data collection, as well as the planned reviews of NAC's numerical groundwater model under the AWL and any resulting updated groundwater impact predictions.

7.2.2. Reviews of the Numerical Groundwater Model

During the life of the NAC's operations, data collected through the groundwater monitoring program will be used to update and refine the groundwater model and its predictions in accordance with AWL condition 25 and the Coordinator-General's imposed condition 12 for the Stage 3 Project. In accordance with AWL condition 25 the groundwater model reviews will be developed by an appropriately qualified and experienced professional according to the schedule presented in **Table 12**.

Table 12 Schedule for Numerical Model Reviews under the AWL

Review	Date for Providing Review Reports to the AWL's Administering Authority
Initial Review	1 July 2024
Other Reviews	1 July 2027 for second review and then every third year thereafter
Final Review	The 3 yearly review prior to the end of mining.

The model review process may in turn result in it being deemed necessary to update this GMMP (and the associated monitoring bore network and/or compliance criteria in the EA) based on any revised groundwater impact predictions arising from the updated model. The requirement for such updates will be determined during the GMMP review process described below.

7.2.3. Review of the GMMP

Revised groundwater level drawdown predictions resulting from the model review process described above may create a discrepancy between the updated model predictions and the groundwater level drawdown triggers established in the EA (**Section 6.1.2**). Furthermore, ongoing implementation of the GMMP may identify the need for a change in the GMMP so that it continues to meet its objectives. Therefore, a review of the GMMP will be completed every two (2) years and this GMMP will then be updated accordingly.

The GMMP Review process will include:

- an assessment of the outcome of the groundwater management and monitoring program against the objectives in the Project's EA and performance against compliance criteria;
- a review of the adequacy of the monitoring locations, frequencies and groundwater quality triggers specified in the EA with respect to any updated groundwater impact predictions; and
- a review of the adequacy of the groundwater monitoring program with respect to any updated post-closure groundwater impact predictions.

The Reviews will be undertaken by an appropriately qualified and experienced professional with a report provided on the outcome of the review to the administering authority of the EA (DES, or their equivalent entity at the time).

7.3. Monitoring Network Maintenance

Over the lifespan of the NAC's operations and in the post closure monitoring period, it is inevitable that groundwater monitoring bores will become unserviceable and need to be replaced. Furthermore, it remains possible that some bores may become disturbed by mining activities, and as a result, may require replacement. The identification of bore replacement requirements would be considered in the Review process detailed in **Section 7**. No such bore are identified at the present time.

NAC will proactively maintain the groundwater monitoring network, replacing bores as necessary, ensuring that the methods of construction, maintenance, management and decommissioning of bores is undertaken in a manner that prevents or minimises impacts to the environment and provides appropriate integrity of the bores to obtain accurate monitoring.

In the event that monitoring bores require replacement or additional monitoring bores are deemed required to supplement the existing network, NAC will ensure that bore installation will:

- occur under the supervision of a person possessing appropriate qualifications and experience in the fields of hydrogeology and groundwater monitoring program design to be able to competently make recommendations about these matters; and
- be constructed in accordance with methods prescribed in the latest edition of the Minimum Construction Requirements for Water Bores in Australia by an appropriately qualified and licensed water bore driller.

8. References

DES, 2021. Using monitoring data to assess groundwater quality and potential environmental impacts. Department of Environment and Science (DES), Queensland Government, Brisbane.

DRDMW, 2017. Minimum standards for the construction and reconditioning of water bores that intersect the sediments of artesian basins in Queensland - WSS/2016/3189 – (Version 1.02 - 19/12/2017), Queensland Department of Natural Resources, Mines and Energy (DRDMW), Queensland Government, Brisbane.

Geochemical Scientific, 2020 Bore Network Integrity and Implications Assessment, prepared for the New Acland Coal Pty Ltd by Geochemical Scientific Pty Ltd.

Middlemis H and Peeters LJM, 2018. Uncertainty analysis—Guidance for groundwater modelling within a risk management framework. A report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Commonwealth of Australia 2018.

National Environmental Protection Council, 2013. National Environmental Protection (Assessment of Site Contamination) Measure 1999 (Amendment 1, 2013) (Amendment 1 2013 NEPM).

OGIA, 2016. Hydrogeological conceptualisation report for the Surat Cumulative Management Area. Report prepared by the Office of Groundwater Impact Assessment, of the Department of Natural Resources and Mines.

SLR, 2015. New Acland Stage 3 Project Baseline Assessment Program. Report prepared for the New Hope Group by SLR Consulting Australia Pty Ltd.

SLR, 2018a. New Acland Stage 3 Project 2017-2018 Groundwater Model Update. Conceptual Hydrogeological Model. Report prepared for the New Hope Group by SLR Consulting Australia Pty Ltd.

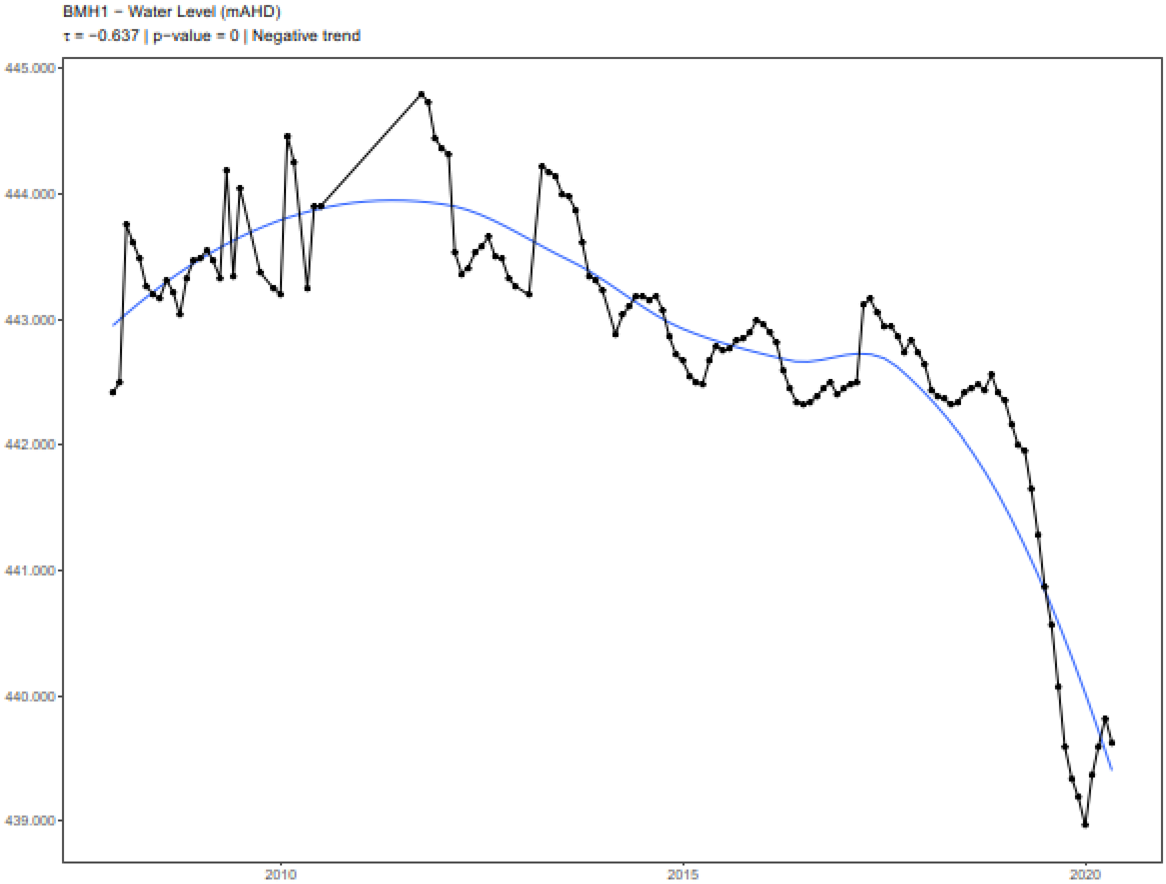
SLR, 2018b. New Acland Stage 3 Project 2017-2018 Groundwater Model Update. Numerical Model Report. Prepared for the New Hope Group by SLR Consulting Australia Pty Ltd.

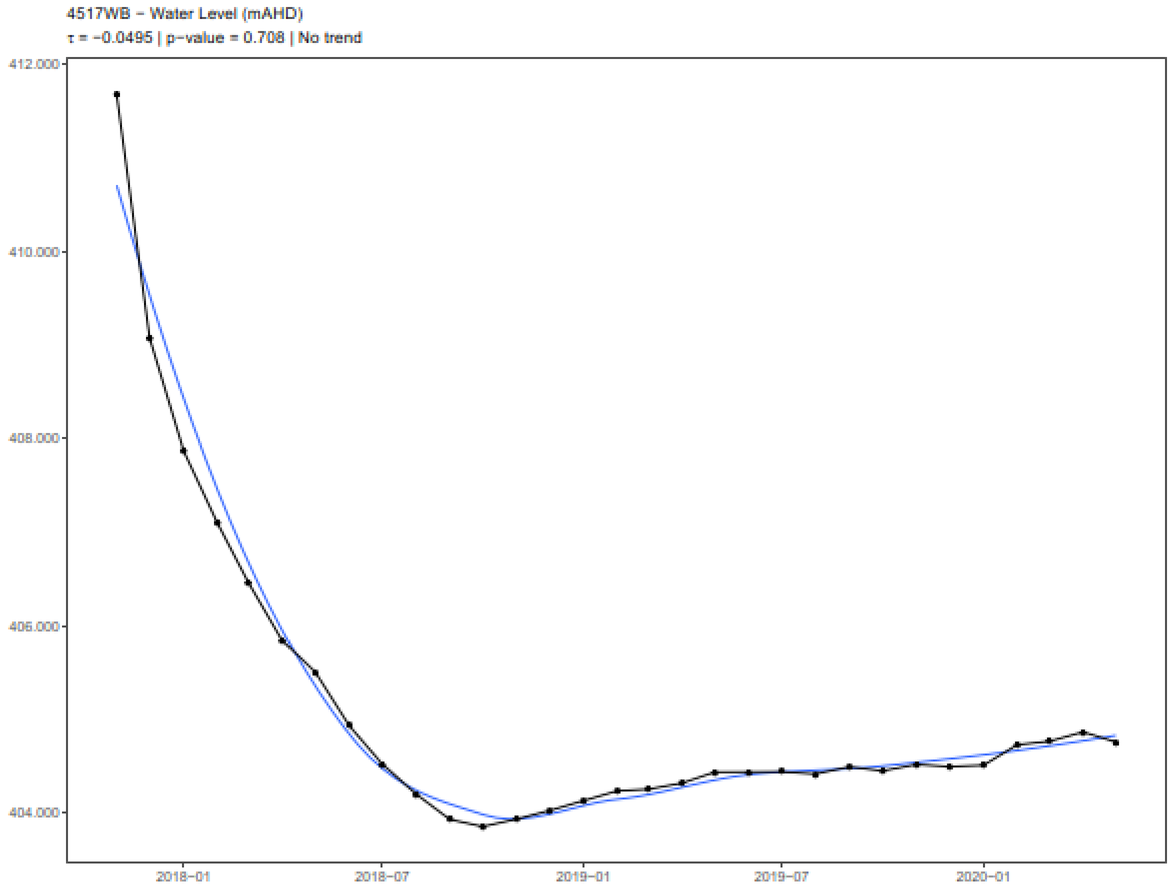
SLR, 2021a. New Acland Coal Mine 2021 Conceptual Hydrogeological Model. Prepared for New Acland Coal Pty Ltd by SLR Consulting Australia Pty Ltd.

SLR, 2021b. New Acland Mine 2020-21 Associated Water Take. Prepared for New Acland Coal Pty Ltd by SLR Consulting Australia Pty Ltd.

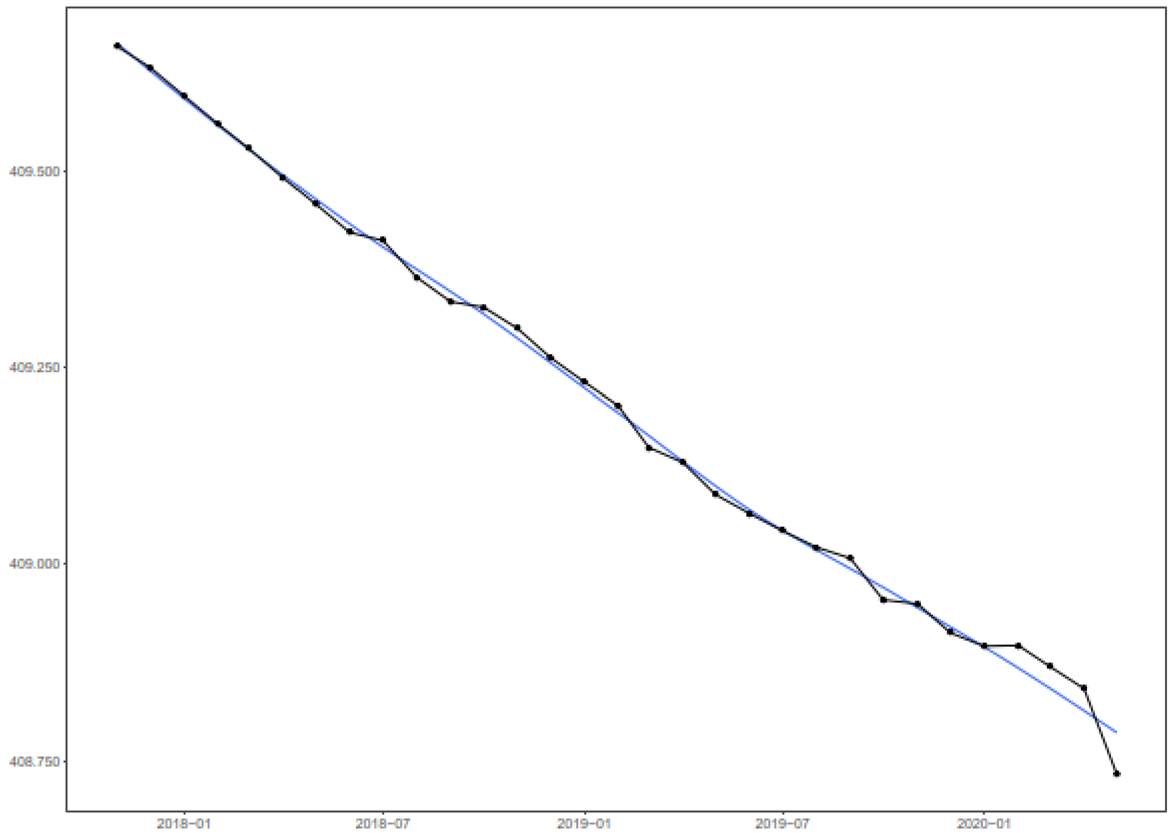
Appendix A EA Groundwater Monitoring Network Details

Appendix B EA Groundwater Level Reference Values Statistical Trend Analysis

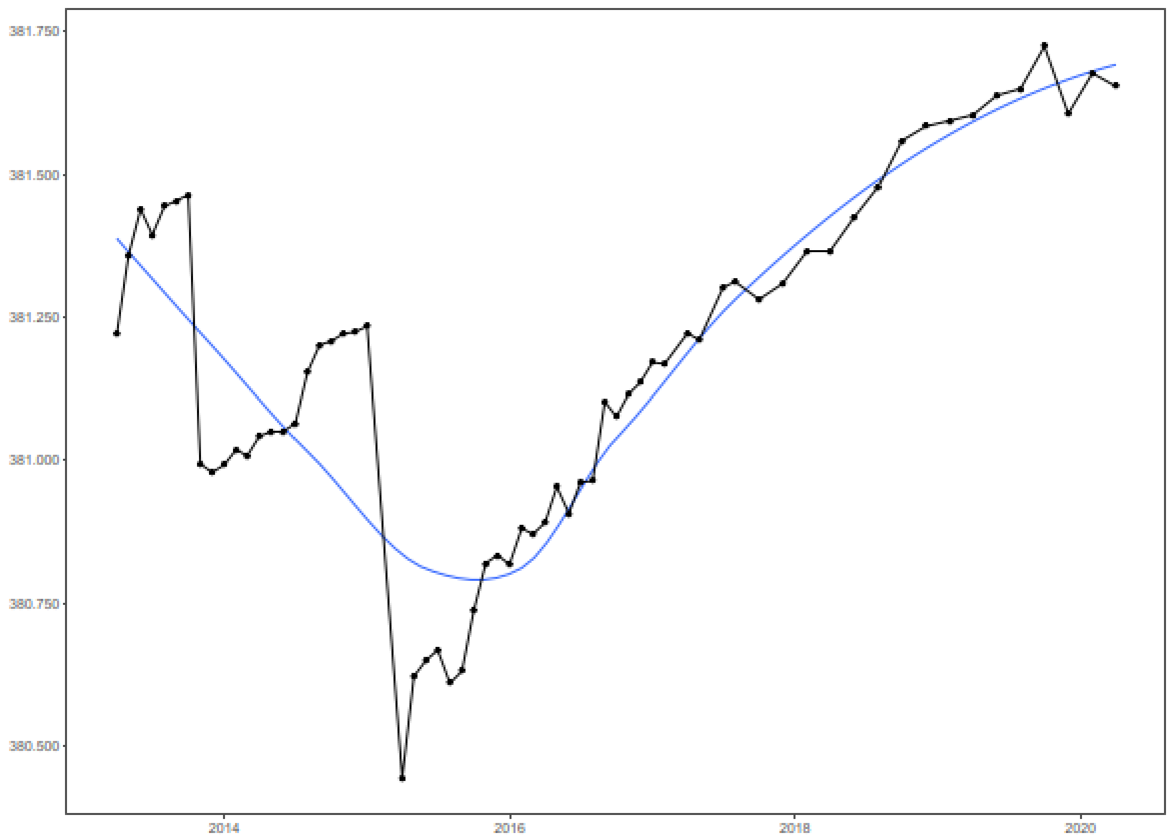

BMH1 − Water Level (mAHD)
τ = −0.637 | p−value = 0 | Negative trend
445.000
444.000
443.000
442.000
441.000
440.000
439.000
2010
2015
2020


4517WB − Water Level (mAHD)
τ = −0.0495 | p−value = 0.708 | No trend
412.000
410.000
408.000
406.000
404.000
2018−01
2018−07
2019−01
2019−07
2020−01

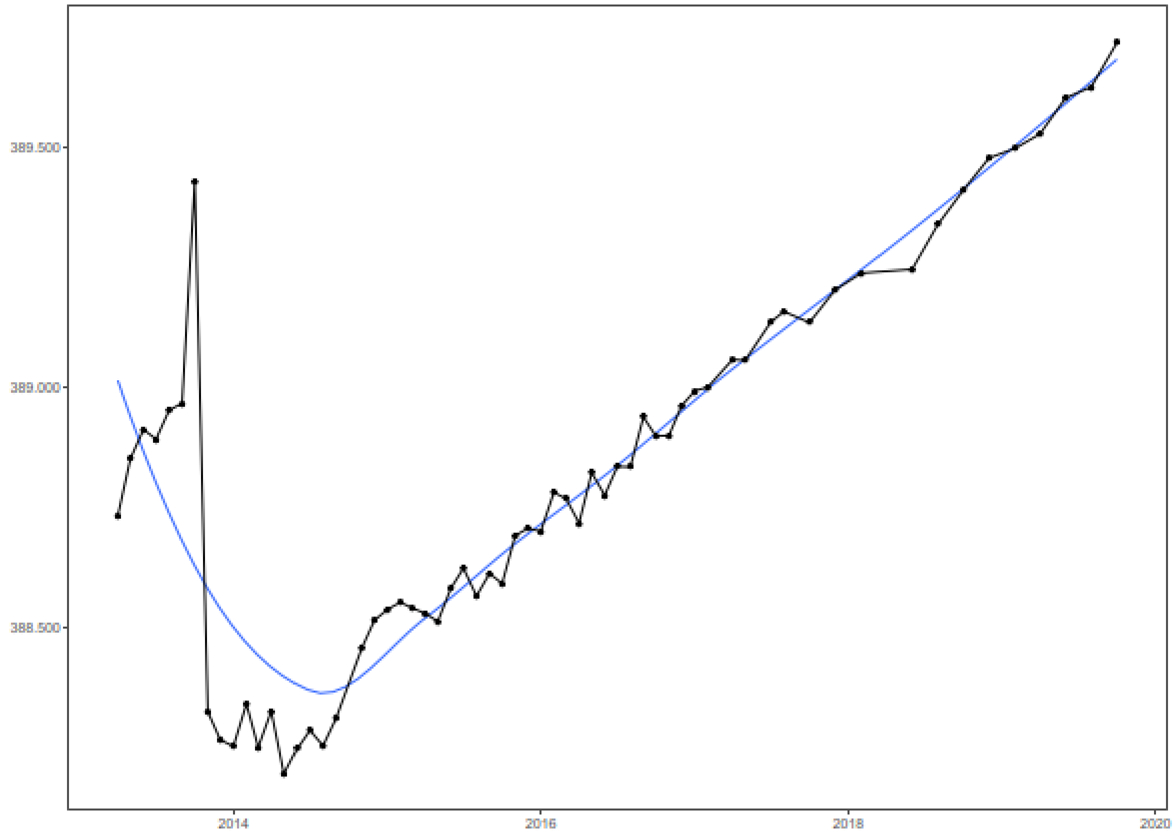
4518WB − Water Level (mAHD)
τ = −0.996 | p−value = 0.0000000000000408 | Negative trend



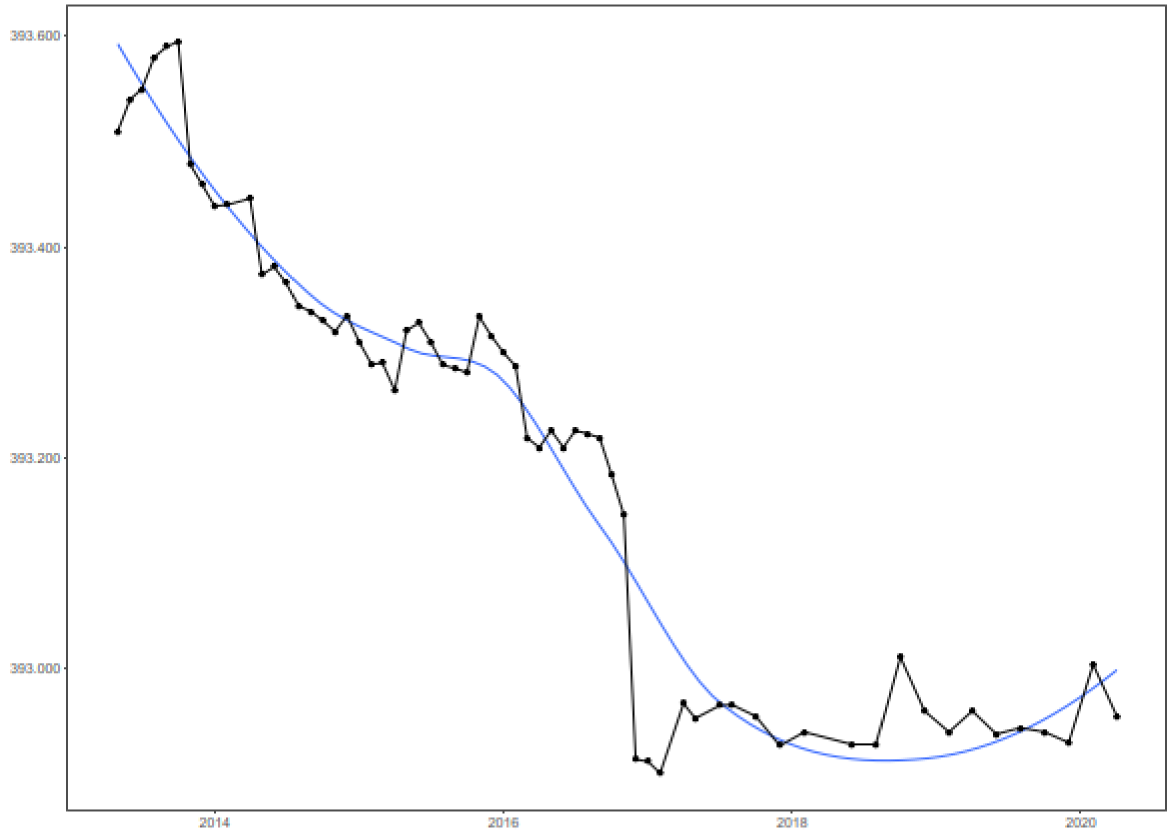
114P − Water Level (mAHD)
τ = 0.391 | p−value = 0.00000441 | Positive trend

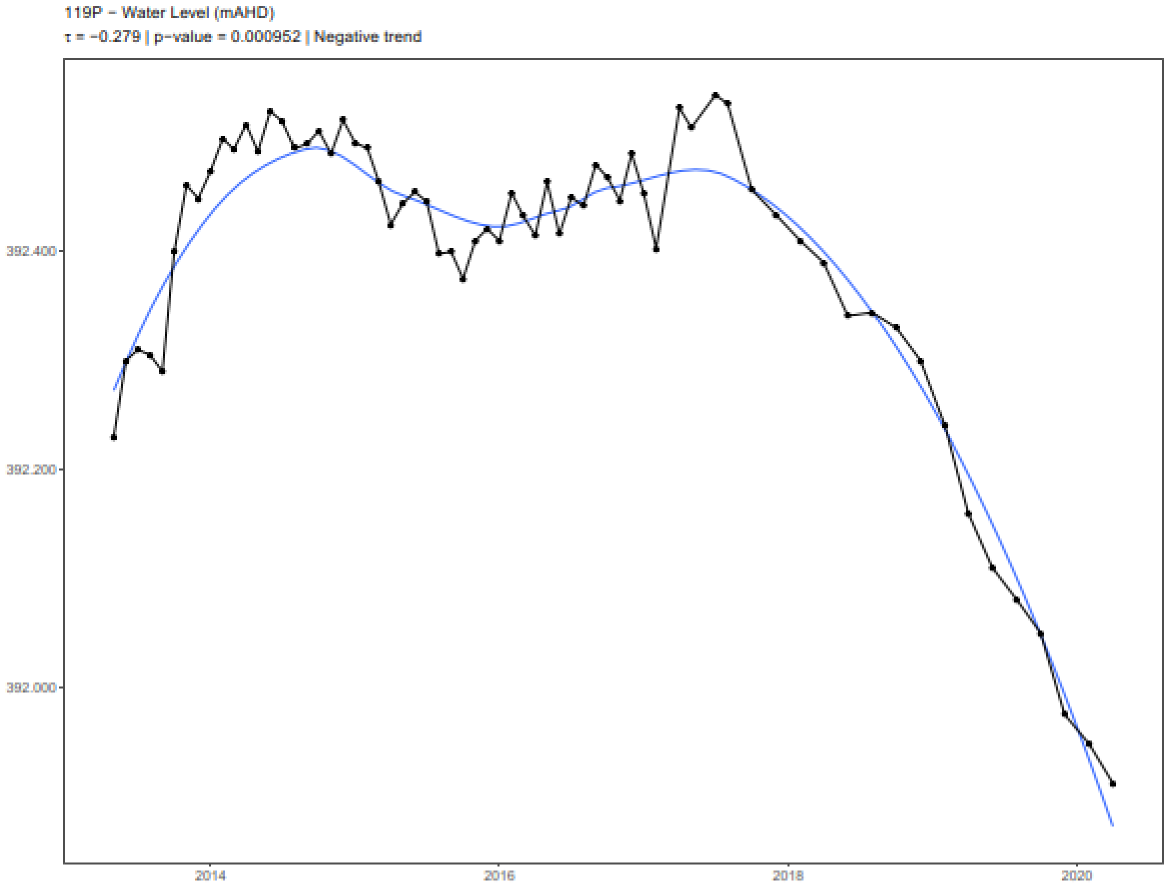


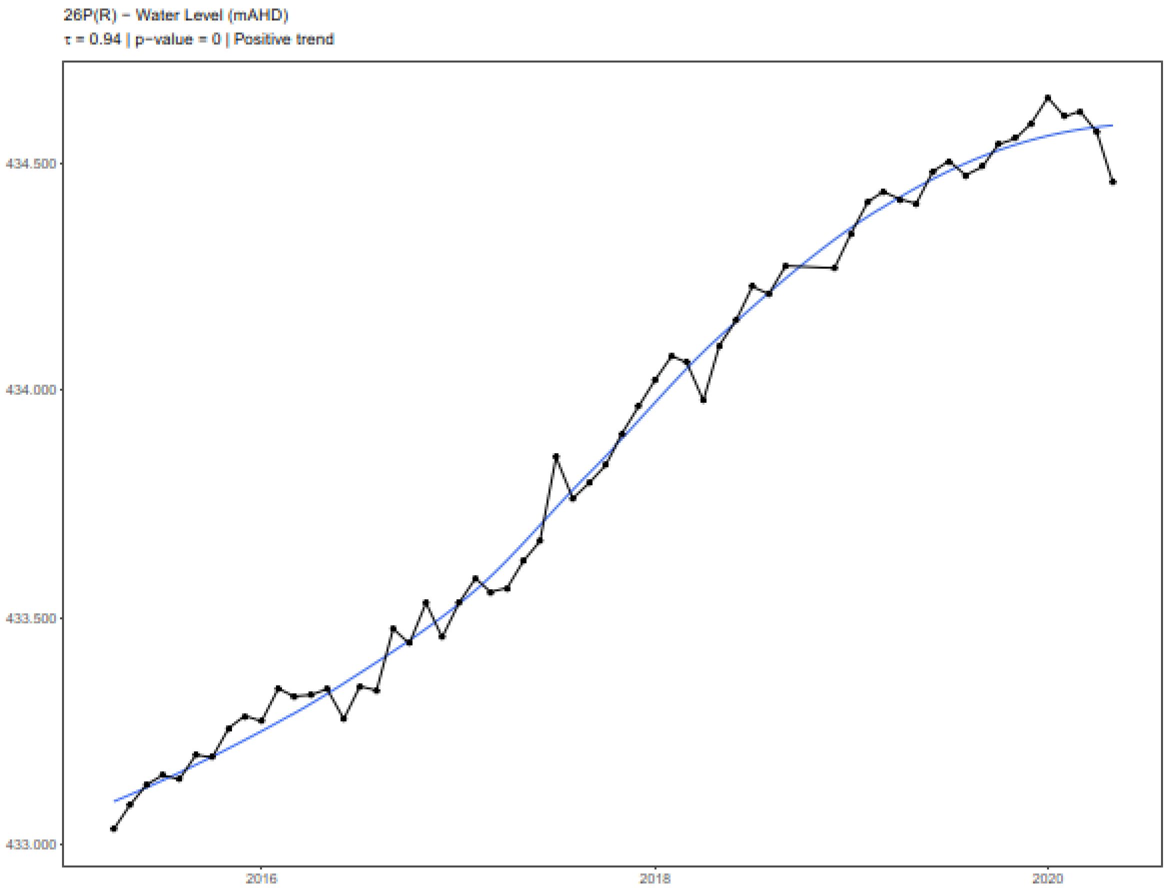
116P – Water Level (mAHD)
τ = 0.674 | p–value = 0 | Positive trend



118P – Water Level (mAHD)
τ = −0.79 | p–value = 0.00000000000000000000371 | Negative trend




119P − Water Level (mAHD)
τ = −0.279 | p−value = 0.000952 | Negative trend
392.400
392.200
392.000
2014
2016
2018
2020


26P(R) − Water Level (mAHD)
τ = 0.94 | p−value = 0 | Positive trend
434.500
434.000
433.500
433.000
2016
2018
2020