Groundwater Management Plan

Risk Statement: High

This document will be reviewed on a yearly basis, unless a process change occurs earlier than this period.

Revision Summary

First Issue	Issue Date	Implementation Requirements	Approved By
1	10 Oct 14	Development of document following granting of PA 11_0060.	MP

Version No.	Revision Date	Revision Details	Approved By
2	03 Oct 16	Review of document following completion of trigger level values being assessed by SRK. Convert to Northparkes template.	MP
3	10 Oct 17	Updated references to NSW Department of Industry and replaced "AEMR" with the current report "AR"	MP
4	31 May 18	Minor updates	C Dingle
5	28 July 2020	Eliminate duplication of information between the WMP and GWMP. Update groundwater monitoring locations to reflect operation changes. Update groundwater quality triggers based on groundwater quality review.	C Higgins
6	30 Aug 2021	Address recommendations from 2020 Independent Environmental Audit	C Higgins
7	Aug 2023	Update following approval of MOD6 and to include EPL updates. Reviewed and approved by Department of Planning & Environment 23 Aug 23.	C Higgins
7.01	Dec 2024	Annual review and update to Evolution	D Shaw
8	June 2025	Annual review, update groundwater monitoring locations to reflect operational changes (L Westcott	C Higgins

Approval Position	Publicly available locations
Department of Planning, Housing and Infrastructure	Evolution Mining Website

Associated Documents to be reviewed	
Water NPO-ENV-MPL-0010 Surface Water NPO-ENV-MPL-0002	

Table of Contents

Tables

Figures

1. OVERVIEW

This Groundwater Management Plan (GWMP) forms Appendix C of the Northparkes Water Management Plan (WMP). This GWMP applies to all groundwater related activities undertaken at Northparkes Mines, as approved under DC 11_0060.

The WMP document hierarchy is presented as Figure 1.

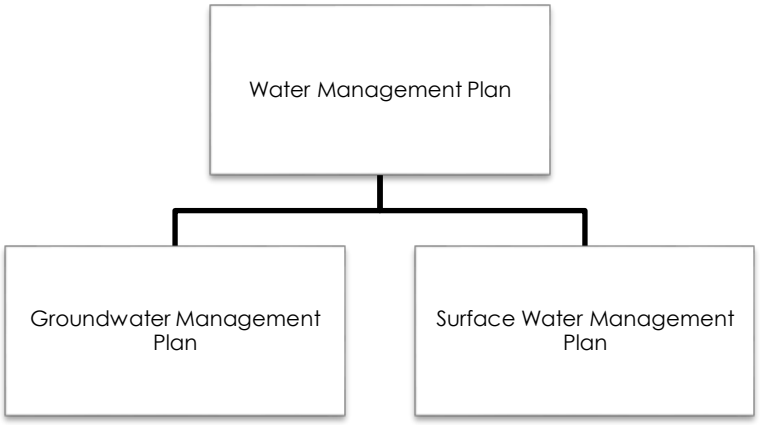

Figure 1 WMP document hierarchy

This GWMP describes:

- The regulation requirements relating to groundwater.
- The surrounding groundwater environment, including baseline data.
- The Northparkes Mines groundwater management system.
- The groundwater monitoring program and other monitoring requirements.
- Groundwater assessment criteria and trigger levels.

2. PURPOSE

The purpose of this GWMP is to comply with the relevant parts of Schedule 3, Condition 24 and Schedule 6, Condition 3 of DC 11_0060.

3. STATUTORY REQUIREMENTS

The overarching statutory requirements for water management are detailed in the WMP. The purpose of this section is to summarise the statutory requirements for groundwater management, that are addressed in this GWMP.

3.1 Environmental Planning and Assessment Act 1979

This GWMP has been developed in accordance with Schedule 3, Condition 23 and Schedule 6, Condition 3 of DC 11_0060, as well as the Statement Of Commitments (SoC) from the Northparkes Mines Step Change Project Environmental Assessment (EA) (Golder Associates, 2013). Table 1 summarises where relevant conditions and commitments are addressed within this GWMP.

Table 1 Groundwater Management Plan Statutory Requirements

Condition	Requirement	Section
DC 11_0060 Schedule 3 Condition 23	(iii) Groundwater Management Plan, that includes: • detailed baseline data on groundwater levels, yield and quality in the region and privately-owned groundwater bores that could be affected by the project;	4
	• groundwater assessment criteria, including trigger levels for investigating and potentially adverse groundwater impacts;	8
	• a program to monitor and report on: – groundwater inflows to the block cave, sub-level caves and open cut mining operations	6.1
	– the seepage/leachate from water storages, emplacements and final voids;	6.2
	– background changes in groundwater yield/quality against mine- induced changes;	6.2
	– impacts of the project on: – regional and local (including alluvial) aquifers;	6.2
	– groundwater supply of potentially affected landowners; and	6.2
	– riparian vegetation;	6.2
	– a program to validate the groundwater model for the project; and comparison of monitoring results with modelled predictions; and	11.1
	• a plan to respond to any exceedances of the groundwater assessment criteria.	8.4
DC 11_0060 Schedule 6 Condition 3	The Applicant must ensure that the management plans required under this approval are prepared in accordance with the relevant guidelines, and include: a) detailed baseline data	7
	b) a description of • the relevant statutory requirements (include any relevant approval, licence or lease conditions);	3
	• any relevant limits or performance measures/criteria	8
	• the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures	8
	c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria	5
	d) a program to monitor and report on the: • Impacts and environmental performance of the project; • Effectiveness of any management measures (see c above)	6
	e) a contingency plan to manage any unprecedented impacts and their consequences;	8.4

Condition	Requirement	Section
	f) a program to investigate and implement ways to improve environmental performance of the project overtime;	8.4, 11
	g) a protocol for managing and reporting any; • incidents; • complaints; • non compliances with statutory requirements; and • exceedances of the impact assessment criteria and/or performance criteria; and	8.4
	h) a protocol for periodic review of the plan	11
Statement of Commitments for Step Change Project **Groundwater**		
SoC 6.9.1	NPM commit to the continuation of the existing approved groundwater monitoring program as part of the project.	Ongoing, 6.2
SoC 6.9.2	In additions to the continuation of the existing groundwater monitoring program, NPM commit to the following additional groundwater monitoring and management measures: • The extent of dewatering, impacts on current users and future resources will be monitored throughout the life of the project in accordance with a revised groundwater monitoring program.	Ongoing, 6.2
	• Monitor dewatering volumes to verify that volumes are within licensed allocations.	Ongoing, 6.1
	• The existing water monitoring program will be updated for the project in accordance with relevant approval requirements.	Ongoing, 6.2
	• Trigger levels, regarding declines in groundwater levels and the degradation of groundwater quality, will be reviewed to manage the potential impacts as part of the updated monitoring program. Where monitoring results indicate levels in excess of the trigger values, an investigation appropriate for the situation will be conducted to assess the need to implement management/mitigation/remedial measures.	8

3.2 Protection of the Environment Operation Act 1997

Northparkes holds EPL 4784, which stipulates groundwater monitoring requirements that form the basis of the groundwater monitoring program detailed in Section 6.2.

3.3 Water Act 1912

Northparkes holds a number of bore licences under the Water Act 1912 for monitoring bores at Northparkes Mines.

The conditions of bore licences typically required that the bore are maintained and are appropriately sealed in the event they are decommissioned in accordance with relevant industry guidelines, including *Minimum construction requirements for water bores in Australia* (Australian Government 2012).

Table 2 Northparkes bore licences

Licence number	Issue date	Expiry date	Note
80BL155192	9-Aug-94	Perpetuity	Monitoring Bore 80BL155192 E265-P103
80BL236021	17-Apr-94	Perpetuity	Monitoring Bore 80BL236021 MB01
80BL236023	17-Apr-94	Perpetuity	Monitoring Bore 80BL236023 MB03
80BL237290	15-Apr-97	Perpetuity	Monitoring Bore 80BL237290 MB04, MB05, MB06, MB07
80BL241019	18-Oct-02	Perpetuity	MBPWD1, MBPWD2, MBPWD3, W6, W11, W13, E22, MBOPP1, MBOPP2, MBOPP3, MBOPP4, MBOPP5 are capped due to Estcourt tailings dam. MB13 bore is still in operation.
80BL241020	21-Oct-02	Perpetuity	E48 bore is capped.
80BL241021	22-Oct-02	Perpetuity	E26-P89, E268-P71AS
80BL241023	21-Oct-02	Perpetuity	MB08, E27, W7, W5, W1, W14 bores are no longer in existence. These bores are capped. MB10 is operational.
80BL241039	22-Oct-02	Perpetuity	W15 is capped and no longer exists. MB11 and MB12 are in operation.
80BL241042	22-Oct-02	Perpetuity	E26-P147, E26-OPEN CUT MINE, E26-D129W1 are capped. E26-P149 and E26-P139 are in operation.
80BL241045	22-Oct-02	Perpetuity	E31R-P123 and W12 are capped and no longer exists.
80BL244990	16-Jul-08	Perpetuity	Monitoring Bore 80BL244990 MB19 & MB20
80BL244991	16-Jul-08	Perpetuity	Monitoring Bore 80AL244991 MB17
80BL244992	17-Jul-08	Perpetuity	Monitoring Bore 80BL244992 MB18
80BL620200	7-Sep-11	Perpetuity	Monitoring Bore 80AL620200 MB21, MB22 & MB23
80BL620201	9-Sep-11	Perpetuity	Monitoring Bore 80BL620201 MB06
80BL620202	9-Sep-11	Perpetuity	Monitoring Bore 80BL620202 MB24 & MB25
80BL620203	9-Sep-11	Perpetuity	Monitoring Bore 80BL620203 MB26 & MB27
80BL620405	22-May-14	Perpetuity	Monitoring Bore 80BL620405 MB28 & MB29
80BL620406	22-May-14	Perpetuity	Monitoring Bore 80BL620406 W30
80BL620407	22-May-14	Perpetuity	Monitoring Bore 80BL620407 W31 & W32
80BL620408	22-May-14	Perpetuity	Monitoring Bore 80BL620408 W26 and W27 are no longer operational

3.4 Water Management Act 2000

Northparkes hold a number of licences and approvals under the *Water Management Act 2000* for external raw water supply as discussed in the WMP.

The licences and works approvals relevant to this GWMP are 80WA718412 and WAL34955 for the interception of groundwater by the open cut pits and underground mine workings from the Lachlan Fold Belt MDB Groundwater Source.

Northparkes is required to maintain a written record of the volume of water extracted, which is addressed in the WMP.

3.5 Guidelines and policies

3.5.1 NSW Aquifer Interference Policy

The *NSW Aquifer Interference Policy* (AIP 2012) clarifies the water licensing and approval requirements for the taking of water from an aquifer by mining. A WAL is required if it is taken incidentally by the aquifer interference activity (such as groundwater filling a void). Sufficient WALs must be held to account for all water take, including the take of water that continues after mining until the aquifer system reaches equilibrium.

This management plan seeks to provide methodology for the management and monitoring of groundwater sources in accordance with the relevant licences as described in Section 6.1.

3.5.2 Australian and New Zealand Guidelines for Fresh Water Quality

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018) provide guidance for assessing and managing ambient water quality in a wide range of water resource types and according to specified environmental values, such as aquatic ecosystems, primary industries, recreation and drinking water. A revised Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) was published in 2018 after a scientific review of the ANZECC (2000a) guidelines.

ANZG (2018) has been used in the development of groundwater trigger values as presented in Section 8.

3.5.3 Groundwater Sampling and Analysis – A Field Guide

Groundwater Sampling and Analysis – A Field Guide (Geoscience Australia 2009) aims to present a set of standard groundwater sampling protocols that focus on a range of groundwater quantity and quality issues throughout Australia.

Requirements of this guideline relevant to the groundwater monitoring program are described in Section 6.2.

4. ENVIRONMENT

4.1 Local hydrogeology

Northparkes Mines is covered by a veneer of unconsolidated colluvium and alluvium of Tertiary-Quaternary age and predominantly underlain by the Ordovician-Devonian age rocks of the Lachlan Fold Belt. The Lachlan Fold Belt is a poor groundwater source, with low yielding and poor water quality bores. Pre-mining groundwater levels observed in 1983 indicate a northerly regional groundwater flow towards Wombin State Forest (Golder Associates 2013).

4.2 Groundwater bore search

A search of the Australian Groundwater Explorer (Bureau of Meteorology 2020; http://www.bom.gov.au/water/groundwater/explorer/map.shtml) identified a number of registered groundwater bores near Northparkes Mines, as shown in Figure 2.

The nearest privately owned registered groundwater bores are located to the south east of Northparkes Mines. Based on the groundwater modelling described in Golder Associates (2013), no drawdown in the water table or pressure head cumulatively greater than 2 m is predicted at any existing privately owned bores. The nearest privately owned bores are regularly monitored as part of the groundwater monitoring program described in Section 6.

4.3 Riparian vegetation and groundwater dependent ecosystems

The closest high priority Groundwater Dependent Ecosystem (GDE) is Lambert Springs located greater than 50 km south-east of the site boundary. This is outside the modelled 4.5 km radius of dewatering predicted by Golder Associates (2013). Areas of River Red Gum Woodland, which is a potential GDE, occur within 7.5 km of the site boundary, however are outside of the proposed disturbance area. The River Red Gum Woodland has an area of approximately 2.1 ha and an additional number of small areas along the Bogan River (Umwelt, 2013a).

Dewatering from mining operations is not expected to impact surface flow or riparian vegetation in the Bogan River or its tributaries through a reduction in baseflow contribution to these creeks. Umwelt (2013a) indicated that due to the presence of perched aquifers within the shallow groundwater environment, the connectivity between alluvial areas of the creeks and rivers and the groundwater environment within the site boundary is expected to be low.

Figure 2 Registered groundwater bores

5. GROUNDWATER MANAGEMENT

The groundwater management system includes measures that are implemented to comply with the statutory requirements described in Section 3 and assessment criteria described in Section 8.

5.1 Underground and open cut mining

Underground mining results in drawdown of groundwater levels as the underground workings intercept deeper aquifers and groundwater is pumped to the surface. Continuation of underground mining in E26 and E48 and the commencement of approved underground mining in E22 will result in a drawdown in groundwater pressure in the vicinity of the workings. Given the low conductivity and flow rates it is not anticipated that the subsidence zone will detrimentally impact the regional groundwater flow regime, and the drawdown zone will be confined to within the Project Disturbance Boundary (Umwelt, 2013).

Open cut mining results in drawdown of groundwater levels as mining intercepts shallow aquifers that are pumped out of the open cut workings. Development of any open cut mining in the approved E28, E28NE, E31 and E31N or E26 will likely result in groundwater drawdown in the vicinity of the workings. Drawdown will continue as long as open cut areas continue to be dewatered. As dewatering ceases it is anticipated groundwater levels will slowly re-stabilise. Campaign open cut mining recommenced in 2023 with E31 and E31N, following 13 years since the completion of E22 open cut.

Monitoring of the volume of groundwater intercepted by mining operations is described in Section 6.1.

5.2 Tailings storage and waste rock emplacements

Tailings are a mixture of solid residue from the mineral extraction process and water, that is emplaced in specially designed storage facilities. Waste rock is material extracted during mining operations that is not suitable for mineral processing. Water in the tailings and waste rock emplacements typically have elevated metal and mineral concentrations and has the potential to leach into the surrounding environment.

Groundwater quality is protected through the following management practices;

- Preparation of base layers for waste rock emplacements to reduce risk of infiltration from runoff through the waste rock into the groundwater.
- Preparation of base layers for the tailings storage facilities to reduce the risk of infiltration of seepage through the tailings profile into the groundwater.

Water levels around the TSFs have the potential to increase due enhanced recharge due to thinning or removal of the regolith near the tailings dams, pore squeezing due to the weight of tailings on the ground surface and actual leakage from the TSFs (Golder Associates, 2013).

Tailings storage facility, water storage and waste rock emplacement area designs will be developed with consideration of their proximity to subsidence zones. This will aim to avoid the encroachment of subsidence zones into these areas causing permanent changes in rock hydraulic characteristics, which may cause seepage of water beneath the structures.

5.3 Storage and use of chemicals and hydrocarbons

To reduce the risk of contamination from the use and storage of chemicals and hydrocarbons, these products will be stored in bunded areas in accordance with the relevant Australian Standards.

6. MONITORING REQUIREMENTS

6.1 Interception of groundwater

The volume of groundwater intercepted by block cave and open cut mining operations cannot be directly measured. The volume of water pumped from the underground mining areas is measured with a flow meter. This volume is used to estimate the volume of intercepted groundwater, after accounting for water transferred underground for mining operations.

Total volume intercepted during open cut operations varies depending on rainfall, runoff and evaporation, as well as other water inputs for mining and ancillary processes, such as dust suppression.

6.2 Groundwater monitoring program

The groundwater monitoring program is the monitoring of standing water levels and water quality at monitoring bores. The program is intended to monitor the indirect influence of potential:

- Seepage or leachate from water storages and emplacements and final voids by observation of water levels and changes in water quality at nearby bores. There are no final voids currently at Northparkes Mines.
- Background changes in groundwater yield/quality against mine- induced changes by monitoring of regional bores outside the predicted zone of influence.
- Impacts of the project on regional and local (including alluvial) aquifers by monitoring bores at various locations screened at various depths.
- Impacts of the project on groundwater supply of potentially affected landowners by monitoring nearby privately owned bores.
- Impacts of the project on riparian vegetation, by monitoring bores between the site and riparian vegetation identified in the EA.

6.2.1 Methodology

Groundwater monitoring should be undertaken in general accordance with *Groundwater Sampling and Analysis – A Field Guide* (Geoscience Australia 2009). Where practical, low flow sampling techniques should be used for purging and sampling (rather than bailers or submersible pumps) to minimise aquifer disturbance and reduce the volume of groundwater extracted during sampling. In general, the groundwater monitoring methodology includes:

- Gauging (dipping) of groundwater levels prior to purging. At some location, the presence of headworks or fouling of the well casing prevents purging or sampling being undertaken.
- Screen depth sampling of monitoring bores. To limit the disturbance of possible sediments in the base of each bore, the sample tubing at each bore should be lowered to approximately the middle of the screened interval for purging and sample collection.
- Bailing method can be utilised in the event a bore is inaccessible with the pump
- Measurement of groundwater field parameters (pH, EC) using a calibrated water quality meter and a flow cell during purging. The pH and EC readings should be recorded in the field once they have stabilized.
- Transfer groundwater samples into suitably preserved laboratory supplied sample containers once field parameters have stabilised.
- Filtering samples to be analysed for dissolved metals. All sample containers are to be clearly labelled with sample number, sample location and sample date.
- The sample containers are to be transferred to a chilled esky for sample preservation prior to and during shipment to the testing laboratory. A Chain- of-Custody form should be forwarded with the samples to the testing laboratory.
- Decontamination of all non-dedicated sampling equipment between monitoring locations.

6.2.2 Monitoring locations

Groundwater level and quality are monitored at various locations as summarised in Table 3 and Figure 3. Locations required by EPL 4784 are identified in Table 3 in **bold**.

Table 3: Monitoring Bore Locations

Bores	Category
MB10, MB11, MB12, MB13, MB14, **W19, W20, W21,** W24, **W25**	Open Cut Bores
MB01, MB02, MB03, MB05, MB06B, W28, W29, W30, W31, W32, **W33, W34**	TSF Bores
MB17, MB18, MB19, MB20, P101, P102, P103, P104, P139, P145, P149	Underground Bores
Far Hilliers, Moss, Wright, Long Paddock, South Hilliers	Regional Bores

6.2.3 Monitoring parameter and frequency

Groundwater monitoring locations are sampled on a quarterly basis as summarised in Table 4. In addition to the minimum requirements of EPL 4784 (identified in **bold**), Northparkes undertakes more frequent monitoring of some parameters and additional parameters in accordance with the SoC.

Table 4: Groundwater Monitoring Parameters and Frequency

Frequency	Parameter
Quarterly	**Water level, pH, EC**, **copper**
Quarterly (**annually**)	**Total dissolved solids**, hydroxide alkalinity, carbonate alkalinity, **bicarbonate alkalinity**, total alkalinity, **sulfate**, **chloride**, **calcium**, **magnesium**, **sodium**, **potassium** **aluminium**, antimony, **arsenic**, **barium**, **beryllium**, **cadmium**, **chromium**, **cobalt**, , **lead**, manganese, **molybdenum**, **nickel**, **selenium**, **zinc**, nitrate, iron and mercury.
Annually	Fluoride, cyanide

Figure 3 Groundwater monitoring locations

7. BASELINE DATA

7.1 Groundwater levels

There is a lack of long-term pre-mining background data, with reliable groundwater level monitoring commencing in 2005, approximately 10 years after the commencement of mining.

The groundwater impact assessment conducted as part of the Step Change Project (Golder Associates, 2013) indicated that:

- Groundwater levels in the regolith range from about 233 to 273 m AHD. Depending on location and ground elevation, this ranged from 7 to 53 mbgl.
- Groundwater levels in the bedrock range from about 220 to 261 m AHD Depending on location and ground elevation, the groundwater level is equivalent to 9 to 58 mbgl.

Since 2005, groundwater levels at the site have generally shown a steady or increasing trend, particularly around the TSFs. This indicates that:

- Drawdown due to mining operations is localised to the mining areas.
- The TSFs likely influence water levels through mechanisms such as recharge due to thinning or removal of the regolith near the tailings dams, and pore squeezing due to the weight of tailings on the ground surface.
- The less pronounced increasing water levels may also be in response to long term rainfall trends. Noting 2020, 2021, and 2022 as years receiving above average rainfall conditions, the lag in response to rainfall trends may be as much as two years (Golder Associates, 2013).

Long term averages in water levels at individual bores are reported in the Annual Review and reflected in the trigger values (refer to Section 8.1).

The groundwater impact assessment conducted as part of the Step Change Project (Golder Associates, 2013) predicted that:

- The radius of groundwater depressurisation in the bedrock formation would extend approximately 4.5 km from the pits at cessation of current approved mining operations.
- Subsidence zones will have a localised impact on groundwater levels and quality.
- As mining operations cease the underground workings will slowly flood with groundwater and a water level equilibrium will be reached over time.

7.2 Groundwater quality

The groundwater impact assessment conducted as part of the Step Change Project (Golder Associates, 2013) indicated that:

- pH ranged from 6.5 – 9.6.
- TDS ranged from 169 – 28,440 mg/L (These ranges are also variable according to bore depth).
- There is a spatial and temporal variation in water quality across the Northparkes site near the ore bodies.
- No long-term adverse trends have been identified in the groundwater quality at the site.

Long term records of groundwater quality at individual bores are reported in the Annual Review and reflected in the trigger values (refer to Section 8.2).

8. TRIGGERS AND PERFORMANCE CRITERIA

Groundwater assessment criteria are no groundwater impacts more adverse than predicted in the EA (Umwelt 2013):

- No measurable groundwater impact on the surface water system within and in the vicinity of the Project Area as a result of the dewatering activities.
- No measurable change in regional groundwater quality would be observed as a result of the proposed mining operations.
- No impacts to private groundwater users or the alluvial groundwater source.
- No significant impact to any potential GDEs.

8.1 Groundwater levels

Stage 1 triggers were developed based on the minimum (lowest elevation) groundwater level observed during 2018 and 2019 at those locations.

Exceedance of Stage 1 trigger at privately owned regional bores immediately escalates to a Stage 2 trigger.

Trigger values are summarised in Table 5.

8.2 Groundwater quality

Groundwater quality parameters were assessed and triggers developed for individual bores as summarised in Table 5. Trigger levels have been developed based on:

- The maximum (100th percentile) observed value during 2018 and 2019. These have been adopted as Stage 1 triggers. The 100% percentile has been adopted for simplicity and for robustness given the limited data available from 8 quarterly samples. Where the concentration is recorded at the limit of reporting, the value of the limit of reporting for that sample has been adopted.
- The default guideline values from the stock drinking water guidelines (ANZG, 2018). These have been adopted as Stage 2 triggers. Where there are no default guideline values there are no Stage 2 triggers, as exceedance of the Stage 1 trigger would likely coincide with exceedances for other parameters.

Trigger levels are not included for:

- P103 and P104. These bores have become blocked, possibly by corrosion of the well casing and it is no longer possible to obtain a water quality sample..
- MB11 and MB12. These wells are consistently dry or obstructed and no water quality sample has been collected in the last 2 years.
- South Hilliers. It is not possible to obtain a sample for this well as it sits underneath a windmill with no access to the water in the bore.

8.3 Privately owned bores and compensatory water supply

Five privately owned registered groundwater bores to the south east of Northparkes Mines are monitored as part of the groundwater monitoring program. In the event that a complaint is received regarding potential impact on groundwater levels or quality an investigation will be conducted to determine if the activities related to Northparkes have influenced an impact on the landholders groundwater resources.

8.4 Response to trigger level exceedance

The appropriate response to a trigger being exceeded is outlined in the Trigger Action Response Plan in Appendix D of the WMP.

Location	Level (mbTOC)	EC (µS/cm)	pH - upper	pH - lower	Sulphate (mg/L)	Al (mg/L)	As (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Cu (mg/L)	Pb (mg/L)	Mo (mg/L)	Ni (mg/L)	Se (mg/L)	Sr (mg/L)	U (mg/L)	Zn (mg/L)	Hg (mg/L)	Fluoride (mg/L)	Cyanide (mg/L)
Stage 2																					
All						5	0.5	0.01	1	1	0.4	0.1	0.15	1	0.02		0.2	20	0.002	2	0.007
Stage 1																					
MB01	36.7	6202	8.57	7.02	221	0.04	0.001	0.0001	0.001	0.199	0.012	0.001	0.002	0.002	0.01	5.42	0.015	0.067	0.0001	0.6	**0.132**
MB02	49.0	11337	8.43	6.9	709	0.05	0.001	0.0002	0.001	0.042	0.011	0.004	0.001	0.001	0.01	3.97	0.034	0.129	0.0001	0.5	**0.025**
MB3	44.3	26399	7.6	5.7	4880	3.13	0.001	0.0004	0.001	0.029	0.045	0.014	0.001	0.019	0.01	16	0.011	0.117	0.0003	0.4	**0.01**
MB5	43.0	27771	8.16	6.6	1720	0.1	**0.847**	**0.188**	0.752	0.797	**0.782**	**0.699**	0.01	0.783	0.01	28.3	0.036	0.869	0.0003	0.5	**0.01**
MB6B	38.9	16619	7.87	6.69	651	0.04	0.001	0.0003	0.002	0.001	0.013	0.001	0.002	0.003	0.01	35.8	0.012	0.066	0.0001	0.2	0.004
W26	34.8	17891	7.71	6.74	1430	0.07	0.001	0.0049	0.002	0.001	0.017	0.001	0.008	0.002	0.02	15	0.026	0.181	0.0003	**2.7**	**0.01**
W27	28.5	20738	11.96	11.32	533	0.05	0.001	0.0001	0.001	0.001	0.009	0.001	0.043	0.002	0.01	80.4	0.001	0.021	0.0001	0.4	0.004
W28	24.5	19529	8.33	6.58	833	0.04	0.001	0.0006	0.003	0.001	0.024	0.002	0.003	0.002	0.01	63.2	0.005	0.116	0.0001	0.3	0.004
W29	29.0	24211	13.15	12.64	61	0.14	0.001	0.0003	0.016	0.001	0.034	0.011	**0.37**	0.004	0.01	16	0.001	0.041	0.0001	NVD	**0.008**
W30	44.0	3641	8.29	7.09	131	0.17	0.001	0.0001	0.003	0.001	0.019	0.001	0.007	0.001	0.01	1.1	0.008	0.096	0.0001	0.5	0.004
W31	27.9	933	8.59	7.34	33	1.04	0.002	0.0001	0.001	0.001	0.107	0.001	0.006	0.002	0.01	0.86	0.003	0.129	0.0001	1.2	0.004
W32	30.0	2466	12.22	11.44	232	0.3	0.001	0.0001	0.002	0.001	0.033	0.001	0.042	0.002	0.01	0.596	0.001	0.044	0.0002	0.7	0.004
MB10	37.8	16141	7.94	6.69	1850	0.09	0.001	0.0002	0.002	0.002	0.033	0.002	0.004	0.001	0.01	10.4	0.026	0.149	0.0001	0.8	0.004
MB13	37.1	26568	7.63	6.63	2910	0.05	0.001	0.0014	0.003	0.004	0.031	0.002	0.008	0.003	0.014	28	0.042	0.235	0.0001	0.3	0.004
MB14	29.4	2673	8.08	7.04	57	0.06	0.001	0.0004	0.001	0.001	0.016	0.001	0.008	0.001	0.01	2.3	0.008	0.09	0.0001	1.6	0.004
MB16	34.7	19489	7.48	6.36	1460	0.03	0.001	0.0007	0.001	0.007	0.017	0.001	0.001	0.014	0.01	12.5	0.029	0.106	0.0002	0.5	0.004
W14	26.3	9759	8.27	7.08	1410	0.06	0.001	0.0002	0.002	0.004	0.011	0.003	0.013	0.001	0.02	6.07	0.012	0.085	0.0001	1.2	0.004
W19 (MB21)	40.8	7440	8.69	7.38	589	0.03	0.002	0.0001	0.085	0.003	0.02	0.001	0.006	0.001	0.01	12.6	0.006	0.086	0.0001	0.2	0.004
W20 (MB22)	24.0	15605	8.06	6.29	1790	0.03	0.001	0.0005	0.001	0.004	0.01	0.001	0.003	0.002	0.01	11.6	0.026	0.091	0.0001	0.8	0.004
W21 (MB23)	17.7	15832	11.19	7.12	991	0.1	0.001	0.0001	0.003	0.002	0.019	0.002	0.032	0.002	0.01	19.3	0.001	0.043	0.0001	0.2	0.004
W22 (MB24)	18.7	19670	7.99	6.73	1950	0.04	0.001	0.0004	0.002	0.075	0.013	0.001	0.005	0.002	0.02	13.5	0.015	0.1	0.0003	0.9	**0.024**
W23 (MB25)	32.2	21317	8.4	6.83	2870	0.05	0.002	0.0006	0.001	0.92	0.237	0.001	0.009	0.004	0.02	17.8	0.014	0.298	0.0002	0.9	**0.307**
W24 (MB26)	9.9	2300	9.21	7.56	909	0.05	0.001	0.0001	0.001	0.006	0.021	0.001	0.001	0.001	**0.03**	2.3	0.002	0.059	0.0001	0.9	0.004
W25 (MB27)	10.7	1642	9.75	7.9	588	0.06	0.001	0.0001	0.001	0.001	0.022	0.001	0.001	0.001	0.02	1.41	0.001	0.065	0.0001	1.1	0.004
MB17	32.9	1023	8.75	7.41	39	0.06	0.002	0.0001	0.001	0.001	0.016	0.001	0.089	0.001	0.01	1.62	0.007	0.055	0.0001	**3.4**	0.004
MB18	33.1	5654	9.91	7.91	518	0.06	0.01	0.0002	0.008	0.001	0.122	0.019	0.014	0.003	0.01	5.1	0.001	0.057	0.0001	0.2	0.004
MB19	40.3	16318	8.91	7.32	1560	0.1	0.001	0.0002	0.001	0.004	0.029	0.004	0.012	0.008	0.01	10.6	0.009	0.199	0.0001	1.1	0.004
MB20	43.3	14309	9.1	7.47	1140	0.04	0.002	0.0005	0.006	0.001	0.32	0.004	0.01	0.002	0.01	7.35	0.015	0.135	0.0001	1.5	0.004
P101	36.7	12812	8.01	6.6	4210	0.13	0.003	0.0001	0.005	0.004	0.004	0.002	0.002	0.004	**0.04**	6.35	0.001	0.146	0.0001	0.9	0.004
P102	39.5	32208	8.43	6.64	3160	0.1	0.01	0.001	0.01	0.01	0.019	0.01	0.01	0.01	0.01	37.4	0.01	0.118	0.0001	0.2	0.004
P103	42.9	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD
P104	37.1	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD
P139	41.9	32889	7.94	5.94	3520	0.15	0.01	0.001	0.01	0.013	0.04	0.01	0.01	0.015	0.01	6.94	0.01	0.379	0.0007	0.5	0.004
P145	40.7	221	9.57	6.46	18	0.12	0.004	0.0001	0.001	0.002	0.018	0.004	0.001	0.002	0.01	0.126	0.001	0.692	0.0001	0.6	0.004
P149	56.1	30767	7.38	6.55	3780	0.07	0.001	0.0026	0.002	0.006	0.023	0.001	0.013	0.002	0.014	19.1	0.004	0.782	0.0001	1.1	0.004
Far Hilliers	41.1	809	8.02	5.85	6	0.06	0.002	0.0001	0.001	0.003	0.009	0.001	0.001	0.003	0.01	0.842	0.001	0.124	0.0001	0.4	0.004
Moss	37.2	2645	8.45	6.25	157	0.03	0.001	0.0001	0.001	0.001	0.017	0.001	0.001	0.001	0.01	2.81	0.006	0.17	0.0001	0.4	0.004
Wright	26.9	980	8.39	6.24	6	0.06	0.001	0.0012	0.001	0.004	0.026	0.001	0.001	0.007	0.014	0.841	0.001	0.912	0.0001	0.2	0.004
Long Paddock	53.6	1488	8.7	7.44	11	0.1	0.001	0.0001	0.001	0.001	0.016	0.001	0.001	0.001	0.01	1.35	0.003	0.074	0.0001	NVD	0.004
South Hilliers	38.7	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD	NVD
Notes	Stage 1 trigger value shown in **bold** exceed the default Stage 2 trigger level.																				

Table 5: Groundwater Triggers

9. REPORTING

Reporting requirements are detailed in the WMP.

10. RESPONSIBILITY

Specific responsibilities are outlined in the WMP.

11. REVIEW

11.1 Groundwater model review

Northparkes undertake an annual review of hydrogeological groundwater level predictions against the monitored data. A review will also be undertaken if the operations timeline or site development varies from what was predicted as part of the most recent revision of the hydrogeological modelling.
Groundwater impacts are compared to the predicted groundwater modelling on an annual basis. Any deleterious discrepancies or variances from predicted groundwater levels will be investigated. If the cause of the variance is determined to be due to mining-related activities, then the groundwater model will require updating.

To date, the volume of groundwater inflows reporting to the mining areas are estimated to be negligible (less than 10 ML/year) and well within the inflows predicted by the groundwater impact assessment conducted as part of the Step Change Project (Golder Associates, July 2013) and the entitlement under WAL34955 of 232 ML/year. Drawdown is similarly well within the predictions, with all monitoring bores steady or trending up, and no drawdown has been detected at neighbouring privately owned water supply bores. Given that observed groundwater impacts are well within those predicted in the groundwater impact assessment conducted as part of the Step Change Project, detailed validation of the groundwater modelled is not considered necessary.

11.2 Plan review

This plan with be reviewed as part of the WMP.

12. RELATED DOCUMENTS

Document Title	Doc ID No.
Water Management Plan	NPO-ENV-MPL-0010
Environment Monitoring and Measuring Schedule	NPO-ENV-REG-0001
Monitoring and Measuring Procedure	NPO-ENV-PRO-0004
Incident Management Procedure	NPO-OHS-PRO-0048

13. REFERENCES

ANZECC and ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

ANZG. (2018). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality Default Guideline Values*. Australian and New Zealand Governments.

Bureau of Meterology (2020) Australian Groundwater Explorer. Retrieved from http://www.bom.gov.au/water/groundwater/explorer/map.shtml

DPI (2012) *NSW Aquifer Interference Policy,* Department of Primary Industries Office of Water
Geoscience Australia (2009) Groundwater Sampling and Analysis – A Field Guide. Retrieved from http://www.ga.gov.au/webtemp/image_cache/GA15501.pdf

Golder Associates, 2013. Northparkes Step Change Project: Groundwater Impact Assessment
Umwelt (2013), *Environmental Assessment: Northparkes Mines Step Change Project*, prepared for North Mining Limited.