



Hillside Copper Mine  
Groundwater Management Plan  
Program for Environment Protection and Rehabilitation (PEPR)

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## **GROUNDWATER MANAGEMENT PLAN**

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## Table of Contents

<b>1.</b>	<b>INTRODUCTION.....</b>	<b>1</b>
1.1	ENVIRONMENTAL MANAGEMENT SYSTEM .....	1
1.2	OBJECTIVES.....	1
1.3	REGULATORY REQUIREMENTS .....	1
1.3.1	Natural Resources Management Act 2004 (SA) .....	1
1.3.2	Environment Protection Act 1993 (SA).....	2
<b>2.</b>	<b>GROUNDWATER CONDITIONS .....</b>	<b>2</b>
<b>3.</b>	<b>GROUNDWATER OUTCOMES .....</b>	<b>3</b>
<b>4.</b>	<b>BASELINE MEASUREMENTS .....</b>	<b>4</b>
<b>5.</b>	<b>UNCERTAINTY ASSESSMENT .....</b>	<b>14</b>
<b>6.</b>	<b>KEY RISKS.....</b>	<b>15</b>
<b>7.</b>	<b>CONTROL MEASURES .....</b>	<b>16</b>
7.1	GROUNDWATER QUALITY.....	16
7.2	RSF AND TSF CONTROL MEASURES.....	17
<b>8.</b>	<b>CONSULTATION .....</b>	<b>18</b>
<b>9.</b>	<b>RESPONSE PROCEDURES .....</b>	<b>18</b>
9.1	OPERATIONAL RESPONSE PROCESS.....	18
9.2	EXCEEDANCE PROTOCOL .....	18
9.3	CRITERIA FOR GROUNDWATER.....	19
9.4	COMMUNITY RESPONSE PROCESS .....	20
<b>10.</b>	<b>MONITORING PROGRAM .....</b>	<b>20</b>
<b>11.</b>	<b>REPORTING .....</b>	<b>26</b>
<b>12.</b>	<b>PERFORMANCE INDICATORS .....</b>	<b>26</b>
<b>13.</b>	<b>CONTINUAL IMPROVEMENT .....</b>	<b>26</b>
<b>14.</b>	<b>REVIEW.....</b>	<b>26</b>
<b>15.</b>	<b>REFERENCES.....</b>	<b>27</b>
<b>16.</b>	<b>APPENDICES .....</b>	<b>28</b>



### List of Tables

Table 1: SWL and water elevations 7 March 2017 .....	7
Table 2: Actions to be taken to check groundwater related assumptions during early operations .....	15
Table 3: Trigger and Response for groundwater levels .....	19
Table 4: Trigger and Response for groundwater quality .....	20
Table 5: Basement aquifer monitoring locations and actions.....	22
Table 6: Unconfined aquifer monitoring locations and actions.....	23
Table 7: Groundwater analyte list.....	23

### List of Figures

Figure 1: Potentiometric surface map, basement aquifer, using March 2017 data.....	6
Figure 2: DTW levels in eight vertical groundwater investigation wells (August 2012 – August 2017) .....	8
Figure 3: Modelled water elevation contours after 5 years of operation .....	9
Figure 4: Modelled water elevation contours after 8 years of operation .....	10
Figure 5: Modelled water elevation contours after 13 years of operation .....	11
Figure 6: Model calculated discharges.....	12
Figure 7: Potentiometric surface map, basement aquifer, water levels after 200,000 days recovery .....	13
Figure 8: Pit water level recovery – water level rise versus time after cessation of mining .....	14
Figure 9: Groundwater monitoring locations .....	24
Figure 10: Groundwater monitoring locations and PAF cells to be encapsulated in RSFs .....	25

### List of Appendices

Appendix 1: Correspondence Records	
Appendix 2: Groundwater Management Plan Requirements Checklist	



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**Revision History**

Version No.	Date Published	Details
1.0	07/06/2017	First draft
2.0	11/07/2017	Management and Technical Review
3.0	31/07/2017	Distributed to HMCV website and DPC review
4.0	05/10/2017	Incorporating responses to feedback
5.0	20/12/2017	Approved by Management – Ready for PEPR submission

## Definition of Terms

ACR	Annual Compliance Report
AHD	Australian Height Datum
DDD	Directional Dust Deposition (including both ambient and mine related dust)
DEWNR	Department of Environment, Water & Natural Resources
DPC	Department of the Premier and Cabinet
DSD	Department of State Development, South Australia
DSPC	Dewatering and Seepage Collection Pond
DTW	Depth to Water
EFS	Extended Feasibility Study
EML	Extractive Minerals Lease 6439
EMS	Environmental Management System
EP Act	The Environment Protection Act 1993 (SA)
EPA	Environment Protection Authority, South Australia
GHG	Greenhouse Gas Emissions
GWMP	Groundwater Management Plan
HMCV	Hillside Mine Community Voice
MAR	Managed Aquifer Recharge
Mining Act	South Australian Mining Act 1971
ML	Mineral Lease 6438
MPL	Miscellaneous Purposes Licence 146
NATA	National Association of Testing Authorities
NRM	Natural Resources Management
NRM Act	Natural Resources Management Act 2004 (SA)
PAF	Potentially Acid Forming
RSF	Rock Storage Facility
RWP	Raw Water Pond
SWL	Standing Water Level
TSF	Tailings Storage Facility
YPC	Yorke Peninsula Council

## 1. INTRODUCTION

Rex Minerals Limited plans to develop and operate the Hillside Mine, situated 12 kilometres south of the township of Ardrossan. Conventional open cut mining techniques will be employed using trucks and excavators to deliver ore to a processing plant that will produce a copper concentrate.

This Groundwater Management Plan (GWMP) provides a description of the measures to be implemented by the Hillside Mine to manage the impacts to groundwater and comply with the conditions outlined within the Mineral Lease 6438 (ML), Extractive Minerals Licence 6439 (EML) and Miscellaneous Purposes Lease 146 (MPL) conditions and other statutory requirements.

### 1.1 ENVIRONMENTAL MANAGEMENT SYSTEM

Rex Minerals is committed to minimising the impact of its operations on the local environment and community, and is developing a comprehensive Environmental Management System (EMS), that will be based on the International Standard 14001:2015 Environmental Management Systems. This GWMP is a component of the Hillside Mine EMS.

### 1.2 OBJECTIVES

The objective of this Plan is to provide the framework for:

- ensuring compliance with all relevant statutory requirements;
- Rex Minerals Policies and Standards;
- implementing tools and practices to manage and minimise the impact to groundwater;
- providing details on groundwater management responsibilities; and
- maintaining an effective response mechanism to deal with issues and complaints.

### 1.3 REGULATORY REQUIREMENTS

The Hillside Mine has been assessed under the *Mining Act 1971* (Mining Act). In addition to the primary approval and regulation of mining projects via the Mining Act, there are several South Australian and Commonwealth Acts and regulatory processes that apply to activities associated with mining projects. Those of relevance to groundwater management are as follows.

#### 1.3.1 Natural Resources Management Act 2004 (SA)

The primary objective of the *Natural Resources Management Act 2004* (NRM Act) is to assist in the achievement of ecologically sustainable development in South Australia, by establishing an integrated scheme to promote the use, management and protection of natural resources. Provisions of the NRM Act relate to control of plant and/or animal pests and diseases, soil conservation and land care and protection of surface and underground water resources. The NRM Act is administered by Department of Environment, Water & Natural Resources (DEWNR) and the NRM Council.

Under the NRM Act, permits are required for the construction of water harvesting/extracting facilities (such as wells) and water licences are required, along with any endorsed water allocation for water use from any prescribed water resource. The Hillside Mine ML is not within a prescribed water resources area. In areas that are not prescribed, there is no requirement to hold a water licence or authorisation to extract water for mining purposes.

However, well construction permits are required for the installation of sinking of water wells (bores).

### 1.3.2 Environment Protection Act 1993 (SA)

The *Environment Protection Act 1993* (EP Act) provides the regulatory framework to protect South Australia's environment, including land, air and water. The EPA SA authorises other Government agencies to administer the EP Act under delegation through a suite of legislative and non-legislative policies and regulatory tools.

The Environment Protection (Water Quality) Policy 2015 provides additional provisions under Section 25 of the EP Act specific to water which imposes a duty on all persons undertaking an activity that pollutes, requiring them to take all reasonable and practicable measures to prevent or minimise any resulting environmental harm. In determining what measures are required to be taken, consideration must be given to:

- The nature of the pollution or potential pollution and the sensitivity of the receiving environment.
- The financial implications of the various measures that might be taken as those implications relate to the class of persons undertaking activities of the same or a similar kind.
- The current state of technical knowledge and likelihood of successful application of the various measures that might be taken.

## 2. GROUNDWATER CONDITIONS

The following Hillside Mine ML (Second Schedule) conditions relate to Groundwater.

### Groundwater

26. The Tenement Holder must ensure there is no adverse change to the environmental values of water within the basement fractured rock aquifer outside of the Land as a result of mining operations.
27. The Tenement Holder must ensure there is no adverse change to the environmental values of the basement fractured rock aquifer within or outside of the Land as a result of mining operations after mine completion.
28. The Tenement Holder must obtain approval from the Director of Mines in writing before developing any:
  - 28.1 Groundwater cut-off wellfield; or
  - 28.2 MAR.

Note: The Groundwater modelling indicates that Condition 28 is not required, however to ensure consistency with the approved MLP, Rex will provide a calibrated transient groundwater model post start of dewatering and in the unlikely event that cut-off wells and MAR are required, Rex will obtain approval from the Director of Mines in writing.

### Additional Information in the Program

33. In accordance with section 70B (2)(d) of the Act it is a condition of the grant of the Mining Tenement that a proposed PEPR submitted in accordance with Part 10A of the Act must include reports from suitably qualified independent experts on the following matters:

- 33.1. The capacity of the Tenement Holder to achieve compliance with the Act and the Program in light of its management systems, personnel, policies, procedures, practices and resources.
- 33.2. The effectiveness of the proposed strategies in the proposed PEPR achieving the environmental outcomes identified in the proposed PEPR, including but not limited to reports from:
  - 33.2.7. an Independent Hydrogeology Expert (ie. for verification of predictive ground water models, ground water management and the extent of ground water mounding underneath the TSF).

The following Hillside Mine MPL (Second Schedule) conditions relate to Groundwater.

### **Groundwater**

5. The Tenement Holder must ensure there is no adverse change to the environmental values of the groundwater within the shallow Cainozoic age sediments outside of the Land as a result of site operations.
6. The Tenement Holder must ensure there is no adverse change to the environmental values of the groundwater within the shallow Cainozoic age sediments within or outside of the Land after mine completion.

The MPL groundwater conditions are no longer applicable as the PEPR design does not have a concentrate pipeline nor a return sea water line, see Section 2.5 of PEPR.

There are no EML conditions (Second Schedule) that relate to groundwater.

### **3. GROUNDWATER OUTCOMES**

The following Hillside Mine ML (Sixth Schedule) conditions relate to groundwater.

Schedule 6, conditions 20 and 21.4 relate to seepage from the Tailings Storage Facility (TSF), the Rock Storage Facility (RSF) and ore stockpiles. The designs include very low permeability barriers to prevent seepage, more information on the design of these structures is provided in Section 3 of the PEPR. Additional information on how these engineered structures will be managed and monitored is provided in Section 5 of the PEPR.

### **Groundwater strategies**

31. The Tenement Holder must provide a calibrated groundwater model in the proposed PEPR.
32. The Tenement Holder must establish a program for the establishment and ongoing calibration of the transient groundwater model using data obtained from groundwater monitoring within the PEPR.
33. The Tenement Holder must provide a calibrated transient groundwater model within 1 year from the approval of the PEPR.
34. The Tenement Holder must establish a program for the ongoing calibration of the pit lake geochemistry and hydrogeological models using data obtained from operational monitoring to address any assumptions and uncertainty within the model.

### Groundwater criteria

35. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(d) of the Regulations in relation to the Second Schedule Conditions 26 and 27:
  - 35.1 Establish representative baseline water quality data for the basement fractured rock aquifer underlying the Land.
  - 35.2 Establish compliance groundwater monitoring bores adjacent to the lease boundaries that are of sufficient density and depth to detect movement of groundwater off the Land.

The following Hillside Mine MPL (Sixth Schedule) conditions relate to groundwater.

### Groundwater Strategies

9. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) of the Regulations in relation to the Groundwater Outcome Schedule 2 - Condition 5;
  - 9.1 design and management strategies are to be provided for pipeline leak detection which includes automation of operational controls for the monitoring and control of all pipelines on the related Mineral Lease and this Mining Tenement. This should include (but is not limited to);
    - 9.1.1 continuous and automatic monitoring of pressures, flow rates and any other parameters for the prompt detection and resolution of abnormal operating conditions in any pipeline or processing plant equipment;
    - 9.1.2 continuous and automatic monitoring of process plant functions, including tank levels, flow rates, pressures and fluid quantities;
    - 9.1.3 the integration of data through a central computer-based control and monitoring system.

The MPL groundwater strategies are no longer applicable as the PEPR design does not have a concentrate pipeline nor a return sea water line within the MPL, see Section 2.5 of PEPR.

There are no EML conditions (Sixth Schedule) that relate to groundwater.

## 4. BASELINE MEASUREMENTS

Baseline measurements for the Hillside Mine were obtained from the following sources:

- DEWNR WaterConnect database, ([www.waterconnect.sa.gov.au](http://www.waterconnect.sa.gov.au)).
- Rex Minerals independent consultants' reports.
- Rex Minerals groundwater assessments and monitoring activities (surface water levels have been collected monthly since installation and will continue until commencement of dewatering operations). Data obtained from groundwater investigations conducted on and in the vicinity of the Land have been used to develop dewatering and pit level recovery models. Information to be collected in accordance with this Plan will be used to assess the model predictions and will also be used as input data for model refinement (if necessary).

Groundwater investigations carried out by Rex Minerals included the drilling of a series of holes across the site. These holes were completed as test and monitoring wells into the basement aquifer.

These holes penetrated a sedimentary cover sequence of unconsolidated Quaternary age sand spreads and inland dunes, undifferentiated Tertiary age sediments, Tertiary age sediments of the Rogue Formation and Muloowurtie Formation, highly weathered basement rock (saprolite) and partially weathered and fresh basement rocks. Groundwater was not encountered in the unconsolidated sediments and Tertiary age units.

A potentiometric surface map for the basement aquifer using March 2017 monitoring data is presented in Figure 1 and the data used in the preparation of this map is presented in Table 1.

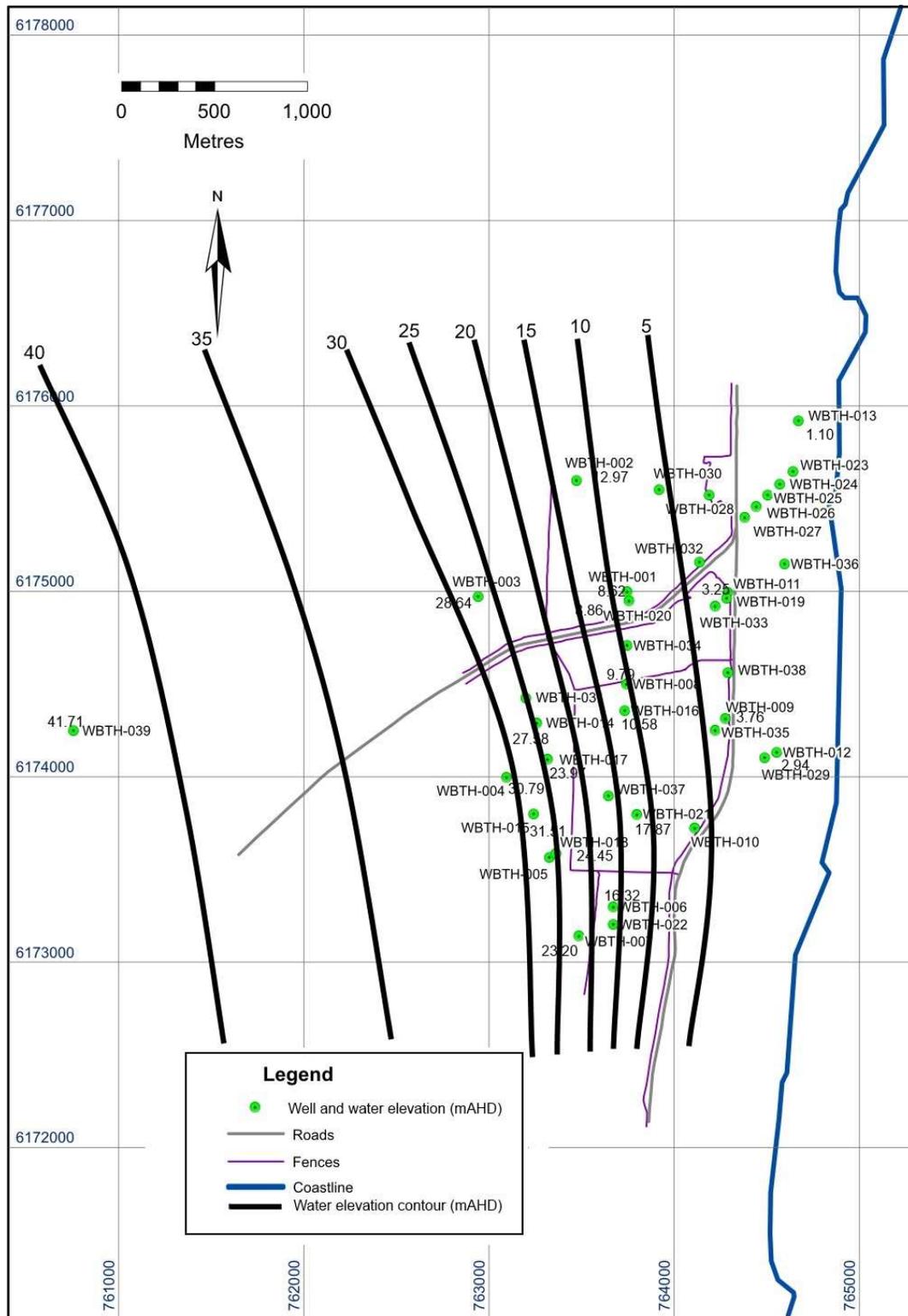


Figure 1: Potentiometric surface map, basement aquifer, using March 2017 data

Table 1: SWL and water elevations 7 March 2017

Hole number	Easting	Northing	Ground elevation (mAHD)	Casing height (mAGL)	Elevation TOC (mAHD)	SWL (mTOC)	Water elevation (mAHD)
WBTH-001	763748.7	6175001	36.909	0.94	37.849	29.23	8.619
WBTH-002	763475.3	6175600	44	0.7	44.7	31.73	12.97
WBTH-003	762943.9	6174973	59.4	0.82	60.22	31.58	28.64
WBTH-004	763099.4	6173999	43.1	0.45	43.55	12.76	30.79
WBTH-006	763674.1	6173297	42.018	1.13	43.148	26.83	16.318
WBTH-007	763490.3	6173141	44.1	0.63	44.73	21.53	23.2
WBTH-008	763747.9	6174500	44.194	0.84	45.034	35.24	9.794
WBTH-009	764279.7	6174315	31.2	0.78	31.98	28.22	3.76
WBTH-011	764292.8	6174995	23.1	0.58	23.68	20.43	3.25
WBTH-012	764559.3	6174134	27.084	0.81	27.894	24.95	2.944
WBTH-013	764675.4	6175921	23.592	0.81	24.402	23.3	1.102
WBTH-014	763260.1	6174293	44	0.66	44.66	17.08	27.58
WBTH-015	763244.4	6173800	43.4	0.8	44.2	12.69	31.51
WBTH-016	763737.9	6174359	45.6	0.7	46.3	35.72	10.58
WBTH-017	763319	6174096	35	0.65	35.65	11.68	23.97
WBTH-018	763364.3	6173589	44.691	0.95	45.641	21.19	24.451
WBTH-019	764288.8	6174964	23.869	1.2	25.069	21.83	3.239
WBTH-020	763759.3	6174952	39.181	1.23	40.411	31.55	8.861
WBTH-021	763675	6173204	42.795	0.96	43.755	25.89	17.865
WBTH- 039	760760	6174252	81.43	0.33	81.76	40.05	41.71

Rex Minerals continues to monitor depth to water (DTW) on a monthly basis from 23 vertical groundwater investigation wells located across the site. Figure 2 presents water level hydrographs for eight of these from the period August 2012 to August 2017.

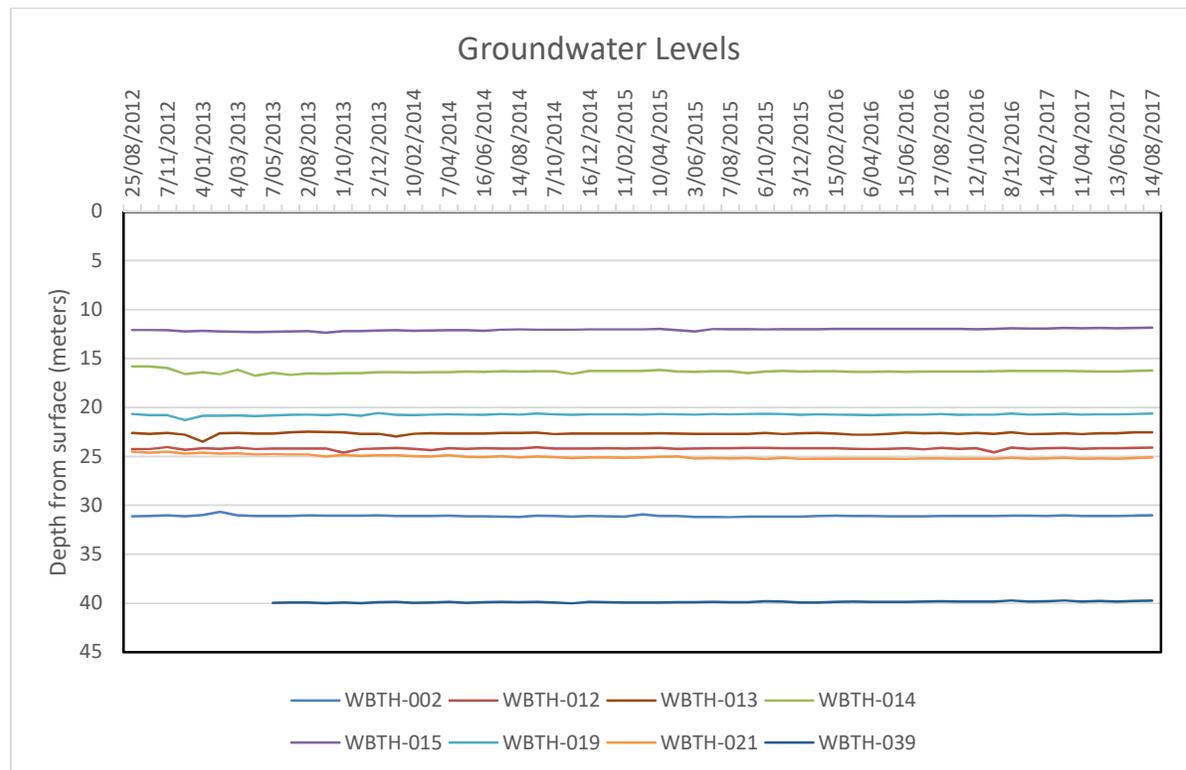


Figure 2: DTW levels in eight vertical groundwater investigation wells (August 2012 – August 2017)

Additional wells were subsequently installed during various investigations, some of which have been used for monitoring (see Figure 1). The new groundwater investigation monitoring network (see Figure 9) uses some of these and is to be augmented by others.

Mining is to occur by open pit methods. Groundwater control will occur through the use of in-pit drains and sumps with collected water being pumped to the return water dam and processing circuit.

Baseline groundwater modelling for the proposed Hillside Mine was undertaken by independent expert, Aldam in 2015 (refer to Appendix 3.4B of the PEPR - EFS Groundwater Modelling Report, January 2015) to provide estimates of water to be removed from the pit, and to assess the extent of the cone of depression that will develop during the operational phase of the Project.

In this report, the potentiometric surface due to mining was presented for years 5, 8 and 13 of the proposed 13 years of operation. These are presented as Figure 3, Figure 4 and Figure 5 respectively. Modelled discharge rates (pit dewatering rates) are shown graphically in Figure 6.

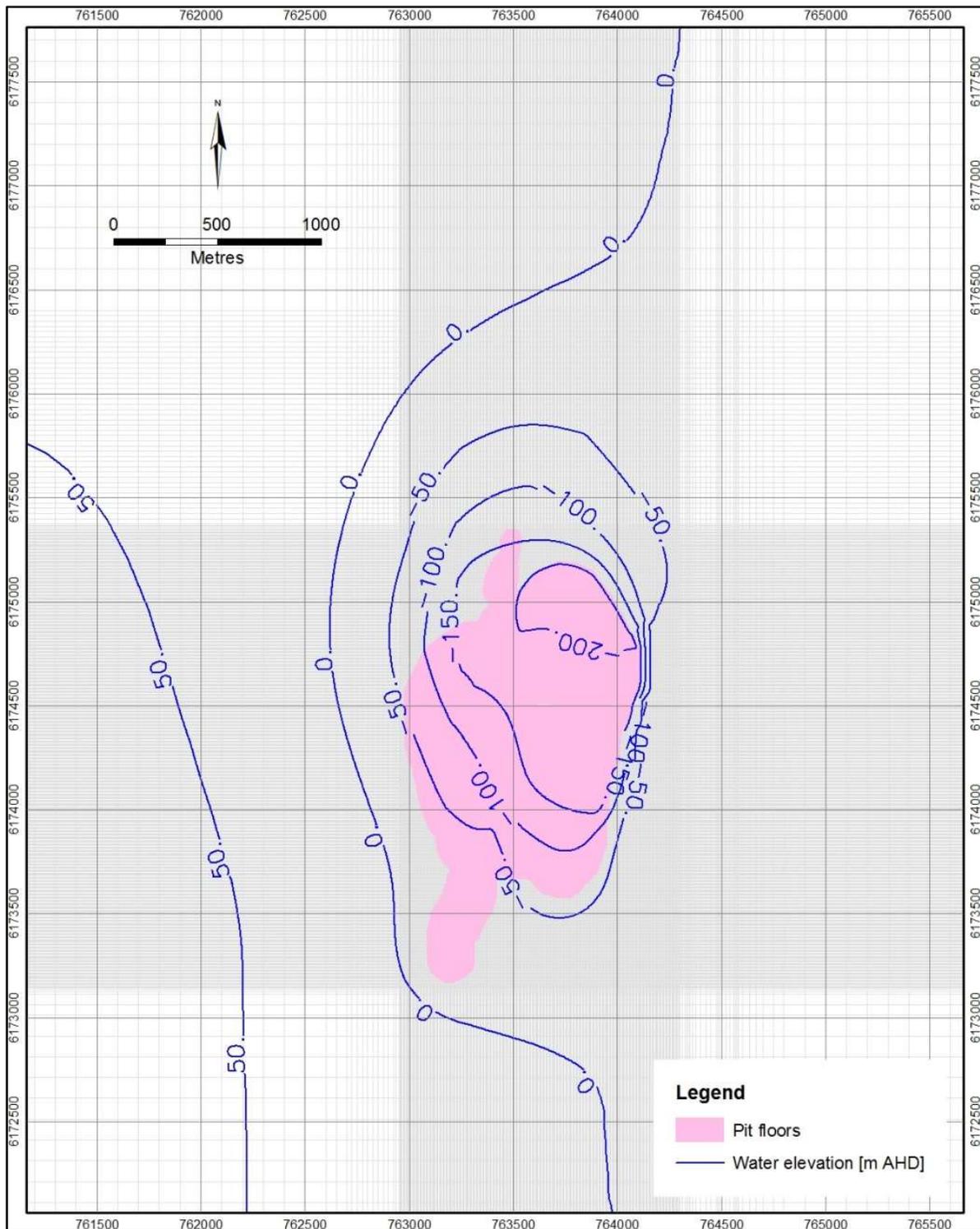


Figure 3: Modelled water elevation contours after 5 years of operation

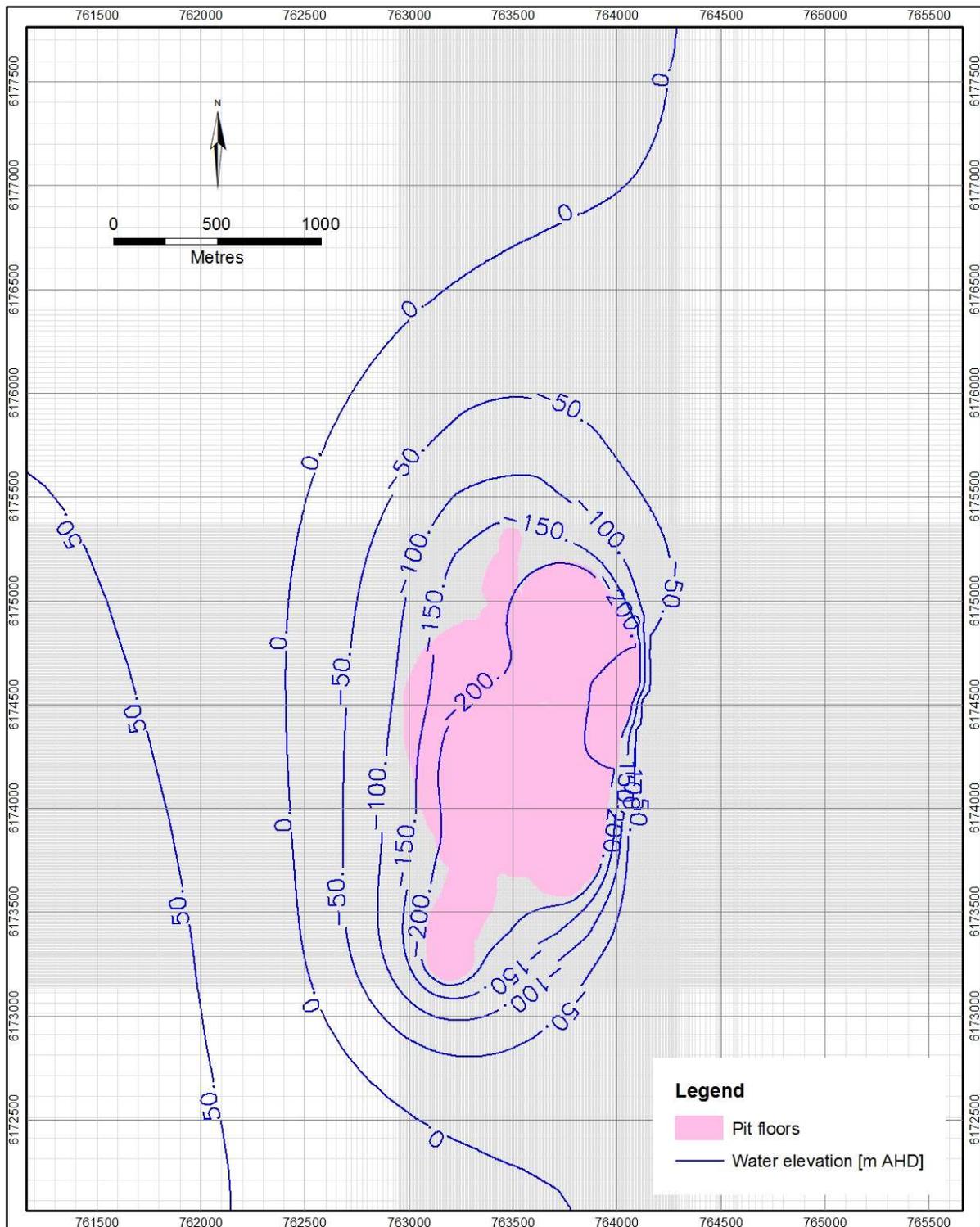


Figure 4: Modelled water elevation contours after 8 years of operation

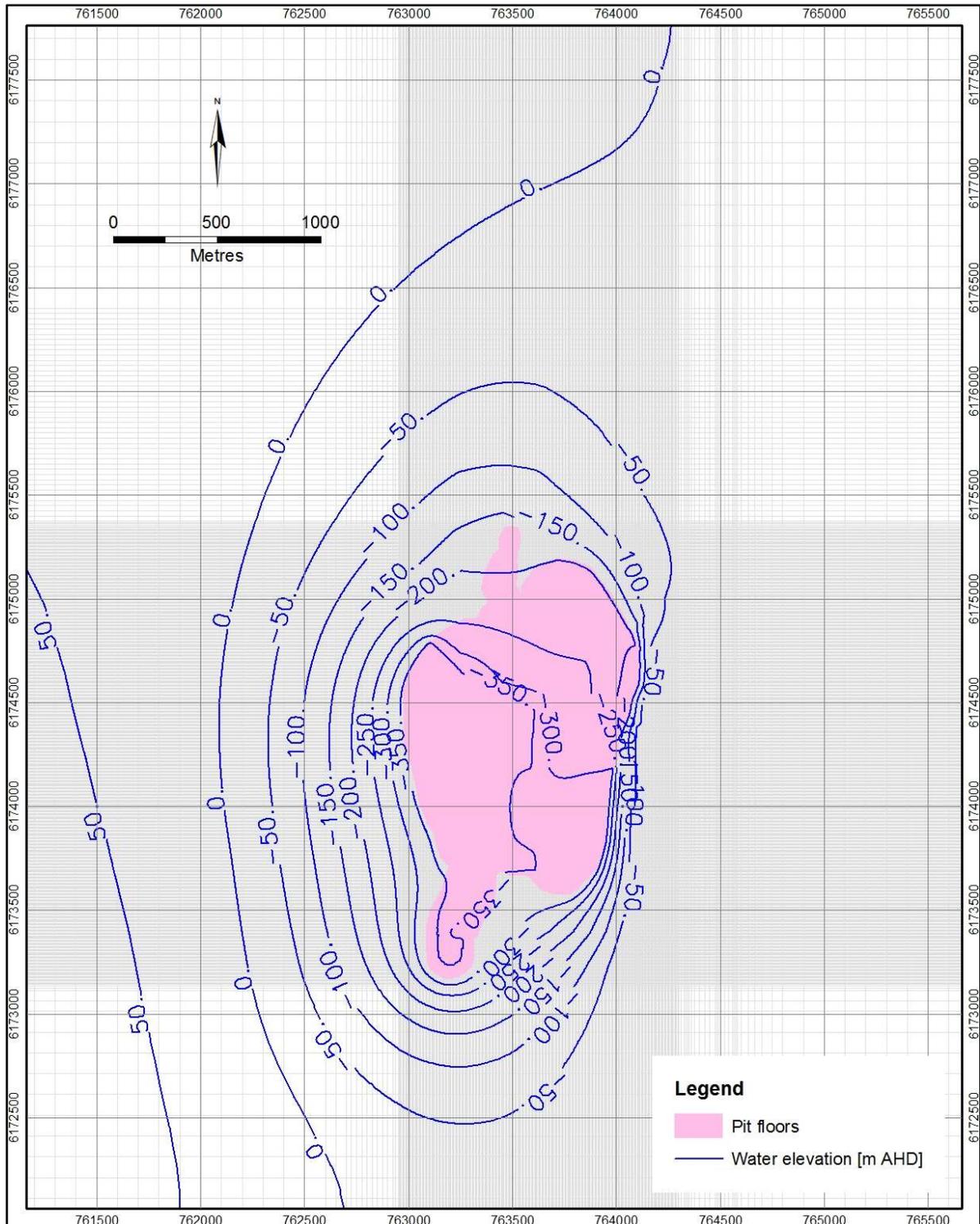


Figure 5: Modelled water elevation contours after 13 years of operation

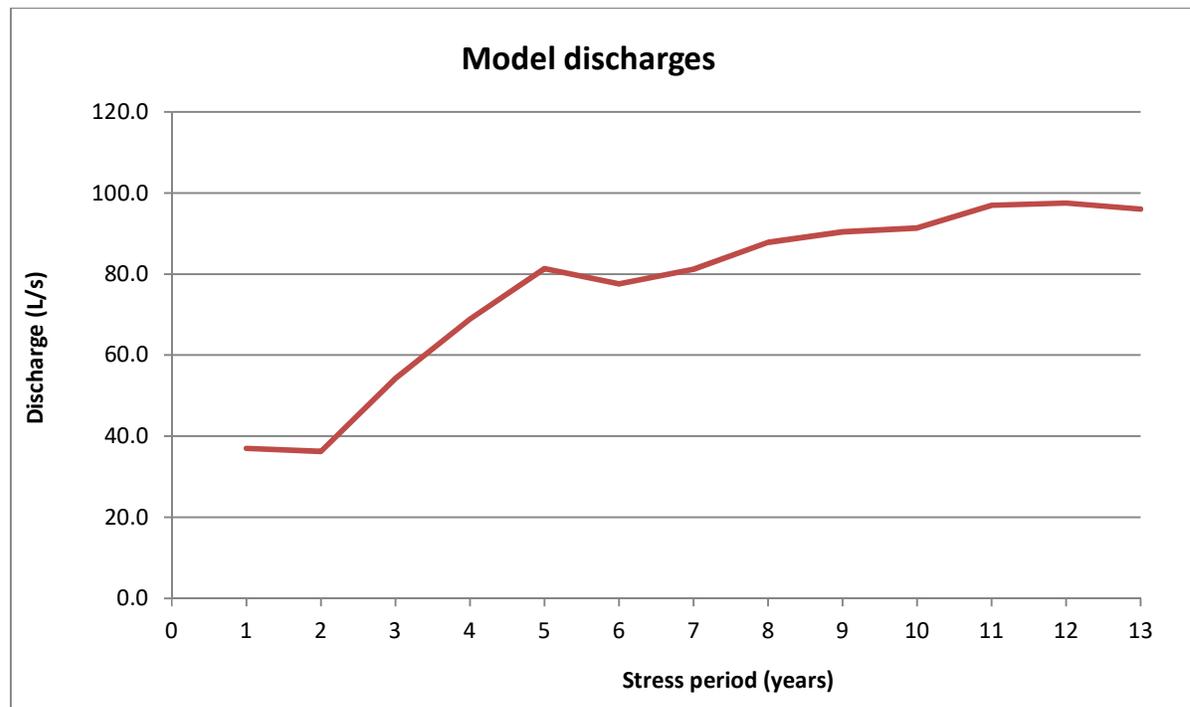


Figure 6: Model calculated discharges

On completion of mining, the pumping of water from the pit will cease and the pit will begin to fill due to groundwater inflows and also rainfall and surface runoff.

Numerical modelling indicates that evaporation will result in a pit lake forming in perpetuity. This is documented in the report “DFS Groundwater Investigations Report” (Aldam Geoscience, 2013).

In that report, the potentiometric surface for the basement aquifer 200,000 days (548 years) after the cessation of mining was presented. It is reproduced in this document as Figure 7.

A graph of pit water level recovery (the rise of water level in the pit over time) was also presented and is reproduced in this document as Figure 8.

The modelled water elevation contours and discharge rates presented above (in Figure 3, Figure 4, Figure 5 and Figure 6) constitute the baseline dataset for monitoring groundwater water levels and dewatering rates. The data will be used to satisfy Sixth Schedule - Condition 33 of the ML, which states that a calibrated transient groundwater model will be generated within one year from the approval of the PEPR.

Note: The accuracy of this calibrated transient groundwater model may not reflect the final calibrated model as it would usually require one year of active dewatering. Most of mining activities in the first 12 months will be conducted above the water table. The data collected will be compared with this baseline dataset to assess the validity of modelling and the accuracy of predictions.

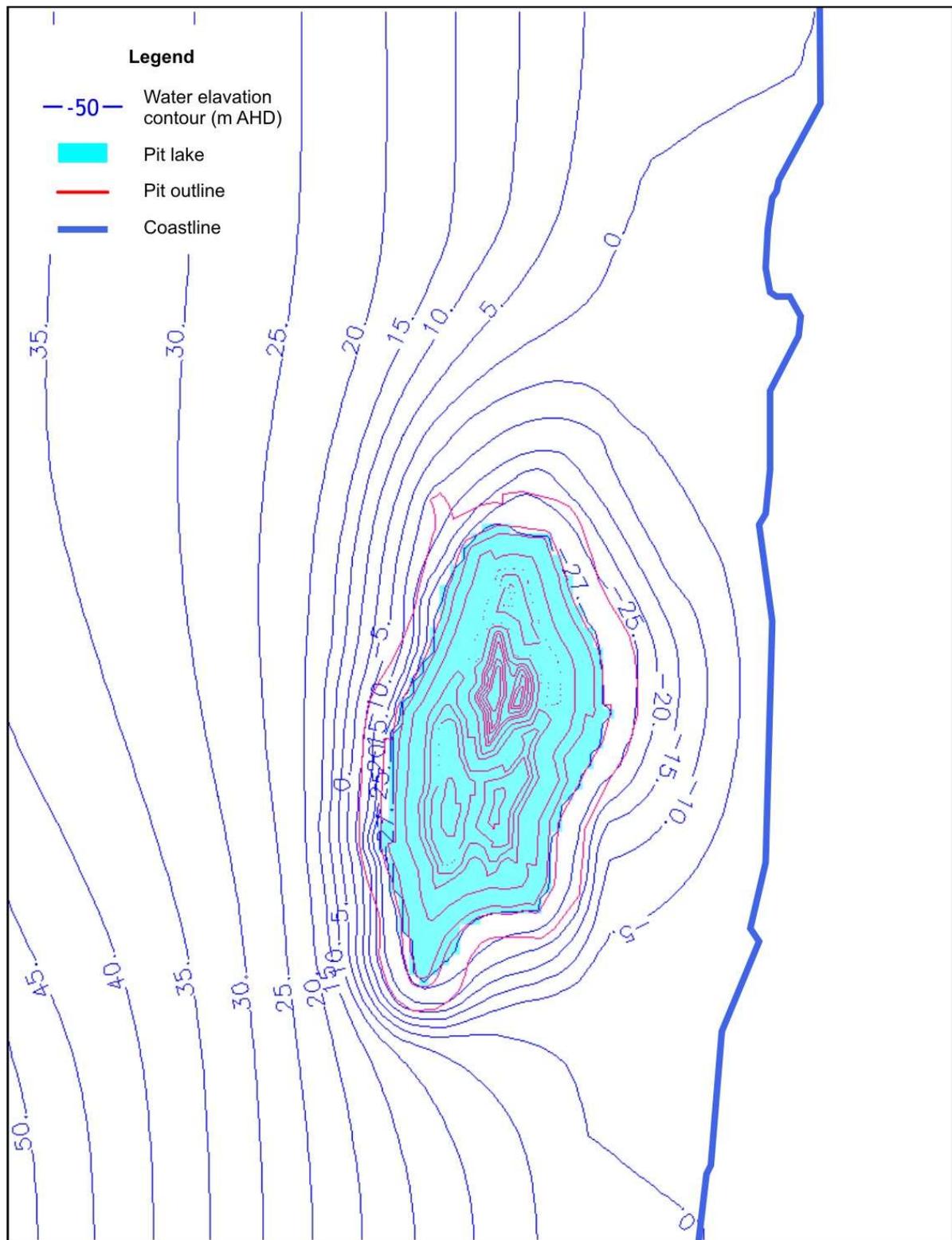


Figure 7: Potentiometric surface map, basement aquifer, water levels after 200,000 days recovery

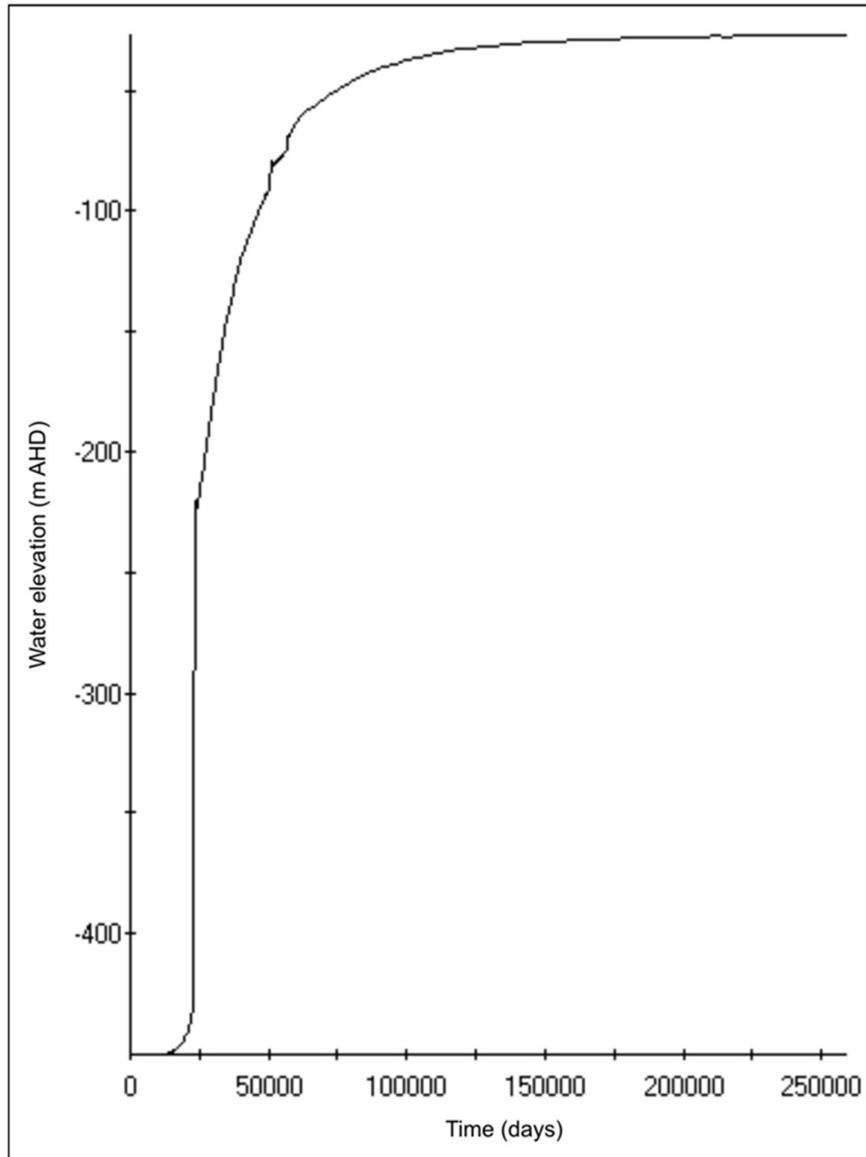


Figure 8: Pit water level recovery – water level rise versus time after cessation of mining

## 5. UNCERTAINTY ASSESSMENT

Key assumptions made in predicting groundwater impacts due to mining at the Hillside Mine and in recommending mitigation and management controls include:

- Mining occurs as scheduled.
- Aquifer hydraulic properties are as used in the model.
- Initial calibration is valid.
- Climate parameters do not change.
- Pit depth and geometry is as specified in the EFS.

Of these key assumptions, the greatest uncertainty relates to dot point three, ie. initial calibration is valid.

The actions presented in Table 2 will be taken during the early operational phase to check that these assumptions are satisfactory.

Table 2: Actions to be taken to check groundwater related assumptions during early operations

Assumption	Action
Baseline groundwater quality data are representative.	Collect groundwater quality data and assess against baseline data (see Section 10 for details).
Baseline groundwater levels will decline as predicted by the model.	Record DTW in all active monitoring wells as per the requirements in Table 6.  Record pump hours, pit floor level elevations pumping rates and volumes of water pumped from the pit.  Simulate pumping from the pit floor on a bench (by bench) basis of the discharge rates recorded to plot the cone of depression due to dewatering.  Obtain field monitoring data of water elevations from monitoring wells and compare with the groundwater model.
TSF leakage, if any, will be directed toward the pit.	Measure water levels from the unconfined aquifer monitoring wells as per the requirements in Table 6.  If water is present in wells down gradient of the TSF, monitor water levels as per the requirements in Table 6.  Plot water elevation contours and define the flow path, (which should be shown to be toward the pit).  Verify TSF (and other) seepage will be captured by the pit.

## 6. KEY RISKS

Potential groundwater impacts associated with the Hillside Mine operations include:

- Contamination of groundwater due to open pit mining activities.
- Discharge of contaminated water by excessive leakage through the embankment or base of the TSF.
- Inappropriate abandonment of drill holes and wells leading to the contamination of groundwater.
- Offsite movement of contaminated groundwater from the mine at closure.
- Reduction in groundwater quality for potential future users.

## 7. CONTROL MEASURES

The Hillside Assessment Report (DSD, 2014), states that DEWNR considers that the model used by Rex Minerals is a Class 1 model according to criteria established in the Australian Model Guidelines, as Rex Minerals has limited datasets to advance to a more complex Class 2 or Class 3 model.

DPC requires that Rex Minerals acquire additional data during mining operations which would allow ongoing calibration of the groundwater flow model to provide increased confidence in modelling predictions.

### 7.1 GROUNDWATER QUALITY

The following groundwater design strategies will be implemented:

- “Groundwater Calibration Program” will be established for ongoing calibration of the transient groundwater model obtained from groundwater data to:
  - Model the potentiometric surface of the basement aquifer over the Life of Mine.
  - Provide data for ongoing calibration of the baseline transient groundwater model.
  - Provide ongoing calibration of the baseline pit lake geochemistry model.
- “Groundwater Monitoring Wells” for baseline and ongoing monitoring will be situated adjacent to lease boundaries, the open pit perimeter, the TSF, RSFs, Decant Storage and Collection Pond (DSPC) and Raw Water Pond (RWP) and adjacent to the Processing Plant and will be of sufficient density and depth to detect movement of groundwater. The installation of an additional groundwater well on the south-eastern side of the pit will be investigated during operations.
- Fuel, oil and explosives will be stored in accordance with EPA and Australian Standards and storage areas will be kept in good operating condition during operations.
- Backfilling, drill hole abandonment and decommissioned water wells will be rehabilitated in accordance with DMITRE and DEWNR requirements.

A net hydraulic gradient will be maintained toward the open pit after lease relinquishment. The following groundwater management controls will be implemented:

- High groundwater salinity precludes the beneficial use apart from industrial purposes, refer to Section 3 of the PEPR, Appendix 3.4B. Note; this groundwater does not meet any “Environmental Values” categories as defined by the Australian and New Zealand Environment Conservation Council (ANZECC) or Agriculture and Resources Management Council of Australia and New Zealand (ARMCANZ) in the Australian Water Quality Guidelines for Fresh and Marine Waters 2000.
- Sampling from “Groundwater Monitoring Bores” (both basement aquifer and unconfined aquifer) to analyse for salinity, pH and metal concentrations and to provide ongoing calibration of the pit lake geochemistry. Sampling to be conducted prior to operations to establish baseline and six monthly during operations (where water is present). Samples will be sent to a National Association of Testing Authorities (NATA) accredited laboratory for analysis.
- “Depth to Water Monitoring” will be conducted quarterly using an electronic dip-meter, converted to elevations Australian Height Datum (AHD) for use in the calculation of hydraulic gradients and flow paths, and the identification of water level trends.

- A calibrated “Transient Groundwater Model” will be provided within one year from when dewatering commences. In addition, recalibration of the model will be ongoing on an annual basis for the Life of Mine to verify flow is toward the pit.
- Discharge rates and volumes will be recorded from the open pit to plot the cone of depression due to dewatering and the groundwater model will be simulated on a bench (by bench) basis.
- Standard Operating Procedures (SOP) developed for fuel management procedures including spill and emergency response and clean up requirements.
- Site inductions and training for relevant personnel (employees, contractors and subcontractors); will include the correct usage of fuel storage, spill response and clean-up protocols and training for selected personnel in the sampling and depth to water monitoring from groundwater wells.
- Regular inspections and housekeeping of areas to ensure integrity of bunded and spill containment areas, housekeeping and correct use of storage and distribution areas.
- Groundwater monitoring will continue for a period of one year post closure and remedial action conducted if there is a reduction in water quality in adjacent pastoral bores.
- Groundwater Assessment Report (for closure) will be prepared by a suitably qualified independent, expert (Hydrogeology Expert) to verify that groundwater levels, quality and the open pit hydraulic gradient demonstrates achievement of the outcome and to confirm closure cover is constructed in accordance with approved design.

## 7.2 RSF AND TSF CONTROL MEASURES

Groundwater quality will be protected from potential contaminants entering either the basement aquifer or the unconfined aquifer from the RSFs and/or the TSFs through design as follows:

- Verification of construction and operation of TSF by a suitably qualified Independent Expert (Geotechnical Engineering Expert):
  - For the initial stage of TSF construction.
  - For each subsequent stage of TSF construction including the cover system.
  - On an annual basis for operations or as specified by the Director of Mines.
- Rework and compact materials used to construct the base and sides of the TSF to achieve a permeability value of  $1 \times 10^{-9}$  m/s.
- Armouring the TSF with inert waste rock.
- Store release cover design on the TSF to prevent ingress of surface water to penetrate the cover system.
- Potentially Acid Forming (PAF) material encapsulated in the RSF with appropriate separation from base, top and sides of external surface, refer to Figure 10.
- On Project completion, a suitably qualified Independent Expert (Mine Waste Cover System Expert) will be commissioned to certify that the TSF closure capping is in accordance with the design and plans adopted for the TSF.

## **8. CONSULTATION**

This Plan is being prepared in consultation with Department of the Premier and Cabinet (DPC), Environment Protection Authority (EPA), Yorke Peninsula Council (YP Council), the Hillside Mine Community Voice (HMCV) consultation group and directly with local landowners.

## **9. RESPONSE PROCEDURES**

### **9.1 OPERATIONAL RESPONSE PROCESS**

Groundwater impacts identified will result in the implementation of the Control Measures outlined in Section 7.

### **9.2 EXCEEDANCE PROTOCOL**

To address the ML Second Schedule Conditions 26 and 27 (see Section 2), Rex will establish baseline water quality data for the basement fractured rock aquifer and establish groundwater monitoring bores strategically located adjacent to the lease boundaries to detect the movement of groundwater off the mine lease.

The South Australia, Environment Protection (Water Quality) Policy 2015 defines Environmental values of waters in clause 6 as follows:

1. For the purposes of this policy, waters may have 1 or more of the following environmental values:
  - a. aquatic ecosystems;
  - b. recreation and aesthetics;
  - c. drinking water for human consumption;
  - d. primary industries—irrigation and general water uses;
  - e. primary industries—livestock drinking water;
  - f. primary industries—aquaculture and human consumption of aquatic foods.

Within this definition, the groundwater quality of the basement aquifers does not meet any of the above environmental values. The highest salinity for background groundwater with a defined environmental value has a background total dissolved solids (TDS) level of 3,000 mg/L or more, but less than 13,000 mg/L (EPA (Water Quality) Policy, 2015).

All groundwater tested from the basement aquifer at Hillside has TDS values of between 18,000 mg/L and 110,000 mg/L with a median of 36,000 mg/L and hence has no environmental application value.

The key assumptions for the Hillside Mine are:

1. The direction of groundwater flow will be towards the pit. Therefore, groundwater level monitoring will need to show that groundwater flows towards the pit.
2. The low permeability TSF liner materials will act as a barrier for potential leakage of TSF fluids. Any leakage that does occur will flow to the pit which will act as a sink in perpetuity.

### 9.3 CRITERIA FOR GROUNDWATER

The following criteria have been adopted for the GWMP.

#### Criteria for Groundwater Levels

Groundwater monitoring will show that groundwater flow is towards the pit. Responses to exceedance of the groundwater levels criteria is presented in Table 3.

Table 3: Trigger and Response for groundwater levels

Trigger	Response
<b>Leading Criteria:</b> groundwater levels are different to those predicted by the calibrated transient model.	<ul style="list-style-type: none"> <li>Recalibrate the model until a match with measured data is obtained.</li> </ul>
<b>Compliance Criteria:</b> groundwater level measurement shows that groundwater flow is toward the pit.	<ul style="list-style-type: none"> <li>The Senior Environmental Coordinator will continue to monitor the groundwater levels.</li> <li>No response required.</li> </ul>

Exceedance of groundwater quality is determined by Conditions 26 and 27 in the Second Schedule of the Hillside Mine ML. That is, “no adverse change to the environmental values of water within the basement fractured rock aquifer”.

Rex will monitor groundwater quality. The development of a hydraulic gradient from the basement aquifer to the pit will ensure that mining operations will not impact groundwater in this aquifer. The presence of a thick layer of saprolite (confining layer) will ensure that contamination from the surface operations including possible TSF leakage will discharge to the pit and not enter the basement aquifer.

#### Criteria for Groundwater Quality

Monitoring of groundwater salinity (conductivity), pH and soluble copper will show no significant changes from the monitoring bores background level. Background levels will be established prior to commencing mine dewatering for the basement aquifer and when water is encountered in the unconfined aquifer sediments (note that the establishment of baseline in the unconfined aquifer may be impossible since it is dry). Responses to exceedances of the groundwater quality criteria are presented in Table 4. Changes in groundwater quality in the basement aquifer cannot be due to mining as groundwater flow will be toward the pit (due to dewatering). Hence, exceedances in quality that require a response will only apply to the unconfined aquifer (sediments).

Table 4: Trigger and Response for groundwater quality

Trigger	Response
<p><b>Leading Criteria:</b> The average of a water quality indicator for a specific monitoring well from water encountered in the unconfined aquifer wells will not exceed two standard deviations of baseline mean conditions for three consecutive events.</p>	<ul style="list-style-type: none"> <li>• The Senior Environmental Coordinator will undertake additional sampling to verify data.</li> <li>• If three sampling events exceed the leading criteria for the same indicator, Rex will engage a hydrogeologist to investigate the potential causes and recommend action to confirm that the water will flow to the pit.</li> </ul>
<p><b>Compliance Criteria:</b> No compliance criteria.</p>	

#### 9.4 COMMUNITY RESPONSE PROCESS

Any groundwater issues and/or complaints raised in relation to this Plan will be recorded by Rex Minerals into the site event management database in accordance with the Complaints Management Procedure EC Pro 320. The database will include reporting, incident/event notification, close out action tracking, inspections, and audits.

### 10. MONITORING PROGRAM

Groundwater monitoring is to occur via dedicated groundwater monitoring wells completed in the basement aquifer adjacent to the pit perimeter and at distance from the pit. In addition to the compliance monitoring, operational monitoring wells will be completed in the unconfined aquifer near the TSF, the RSF, the decant storage and collection pond, and adjacent to the processing plant.

Monitoring locations are shown in Figure 9. Summaries of monitoring locations and actions are presented in Table 5 (basement aquifer) and Table 6 (unconfined aquifer).

The objectives of the basement aquifer monitoring are to show no movement of groundwater off the land, to provide data for the ongoing calibration of the transient groundwater model, and to provide information for the ongoing calibration of the pit lake geochemistry and hydrogeological models. This will also demonstrate achievement of the groundwater outcomes.

The objectives of the unconfined aquifer monitoring are to assess the magnitude and significance of potential seepage from the TSF, decant storage and collection pond, the processing plant, and to demonstrate that seepage if occurring will flow toward the pit.

Depth to water monitoring is to be conducted quarterly using an electronic dip-meter and will be carried out by trained Hillside Mine staff. Measurements will be from a designated reference point at each well, with the reference point elevation survey levelled to Australian Height Datum (AHD). All depth to water measurements will be converted to elevations AHD and entered into the Rex Minerals monitoring database for use in the calculation of hydraulic gradients and flow paths, and for the identification of water level trends. For the unconfined aquifer wells, dry conditions will be recorded as zero depth to water.

Groundwater will be analysed for general water quality indicators and potential contaminants as outlined in Table 7. Baseline data will be collected from the basement wells prior to the commencement of mining. The unconfined groundwater monitoring wells will be sampled and analysed when saturated and sampling conditions occur and in addition will include total recoverable hydrocarbons to detect any seepage from lubricants, fuels and other hydrocarbons used in mining activities.

For the basement aquifer wells, groundwater chemistry will be monitored six monthly through the collection of samples by bailer, low flow sampling or high flow sampling depending on well completion and the availability of water in the well for sample collection. Samples will be sent to a NATA accredited laboratory for analysis under approved transport protocols. The groundwater wells outside the Project area will not be influenced by mining activities and therefore will not be sampled, instead groundwater levels for the basement aquifer wells will be recorded quarterly.

For the unconfined aquifer wells, groundwater chemistry will be monitored six monthly when depth to water measurements indicate the presence of a water column in the monitoring well sufficient for sample collection. Samples will be collected by bailer, low flow sampling or high flow sampling depending on well completion and availability of water in the well for sample collection. Samples will be sent to a NATA accredited laboratory for analysis under approved transport protocols.

Groundwater sampling equipment will be from reputable environmental equipment suppliers.

All measurements will be taken by Rex Minerals staff or delegates using Rex Minerals equipment (procured or hired for purpose), calibrated in accordance with the manufacturer's specifications.

Field measurements will be entered onto Rex Minerals field data sheets and then transferred to monitoring databases or entered directly to databases using field tablet computer or equivalent.

Results of monitoring will be reported as required by the Rex Minerals EMS and regulatory authorities.

Table 5: Basement aquifer monitoring locations and actions

Site no.	Location	Easting (GDA94) Zone 53	Northing (GDA94) Zone 53	Aquifer	Monitoring action	Frequency	Reason for location	Purpose
B1	Lease boundary north	761941	6177329	Basement	Depth to water	Quarterly	Lease margin	Flow path, gradient
					Groundwater sampling	Six-monthly	Lease margin	Groundwater quality
B2	Lease boundary northeast	764746	6177151	Basement	Depth to water	Quarterly	Lease margin	Flow path, gradient
					Groundwater sampling	Six-monthly	Lease margin	Groundwater quality
B3	Lease boundary east	764673	6174128	Basement	Depth to water	Quarterly	Lease margin	Flow path, gradient
					Groundwater sampling	Six-monthly	Lease margin	Groundwater quality
B4	Lease boundary south	764291	6171753	Basement	Depth to water	Quarterly	Lease margin	Flow path, gradient
					Groundwater sampling	Six-monthly	Lease margin	Groundwater quality
B5	Lease boundary west	759124	6175067	Basement	Depth to water	Quarterly	Lease margin	Flow path, gradient
					Groundwater sampling	Six-monthly	Lease margin	Groundwater quality
B6	Pit crest northwest	763234	6175243	Basement	Depth to water	Quarterly	Lease margin	Flow path, gradient
					Groundwater sampling	Six-monthly	Lease margin	Groundwater quality
B7	Pit crest northeast	763939	6175273	Basement	Depth to water	Quarterly	Lease margin	Flow path, gradient
					Groundwater sampling	Six-monthly	Lease margin	Groundwater quality
B8	Pit crest east	764174	6174274	Basement	Depth to water	Quarterly	Lease margin	Flow path, gradient
					Groundwater sampling	Six-monthly	Lease margin	Groundwater quality
B9	Pit crest south	763278	6173042	Basement	Depth to water	Quarterly	Lease margin	Flow path, gradient
					Groundwater sampling	Six-monthly	Lease margin	Groundwater quality
B10	Pit crest west	762955	6174083	Basement	Depth to water	Quarterly	Lease margin	Flow path, gradient
					Groundwater sampling	Six-monthly	Lease margin	Groundwater quality
B11	TSF – Pit crest west	761766	6174127	Basement	Depth to water	Quarterly	Extra point between B5 and B10	Flow path, gradient
					Groundwater sampling	Six-monthly	Lease margin	Groundwater quality

Table 6: Unconfined aquifer monitoring locations and actions

Site no.	Location	Easting (GDA94) Zone 53	Northing (GDA94) Zone 53	Aquifer	Monitoring action	Frequency	Reason for location	Purpose
S1	TSF northwest	760680	6175962	Unconfined	Depth to water	Quarterly	TSF seepage	Flow path, gradient
					Groundwater sampling	Six-monthly if water present	TSF seepage	Groundwater quality
S2	TSF northeast	762060	6176095	Unconfined	Depth to water	Quarterly	TSF and process plant seepage	Flow path, gradient
					Groundwater sampling	Six-monthly if water present	TSF and process plant seepage	Groundwater quality
S3	Decant pond	762985	6174700	Unconfined	Depth to water	Quarterly	Decant pond seepage	Flow path, gradient
					Groundwater sampling	Six-monthly if water present	Decant pond seepage	Groundwater quality
S4	TSF south	761091	6173232	Unconfined	Depth to water	Quarterly	TSF seepage	Flow path, gradient
					Groundwater sampling	Six-monthly if water present	TSF seepage	Groundwater quality
S5	Lease boundary west	759403	6175038	Unconfined	Depth to water	Quarterly	Background	Flow path, gradient
					Groundwater sampling	Six-monthly if water present	Background	Groundwater quality

Table 7: Groundwater analyte list

Group	Analyte	Wells
Cations and anions	Calcium, Magnesium, Potassium, Sodium, Sulphate, Chloride, Nitrate	Unconfined aquifer
Salinity	Electrical conductivity (EC), total dissolved solids (TDS)	All
Acidity	pH	All
Hydrocarbons	Total recoverable hydrocarbons (TRH) – site S2 (processing plant) only	Unconfined aquifer
Metals	Arsenic, Boron, Copper, Iron, Manganese, Zinc, Uranium	Unconfined aquifer
	Soluble copper	Basement aquifer

Hillside Copper Mine  
 Groundwater Management Plan  
 Program for Environment Protection and Rehabilitation (PEPR)

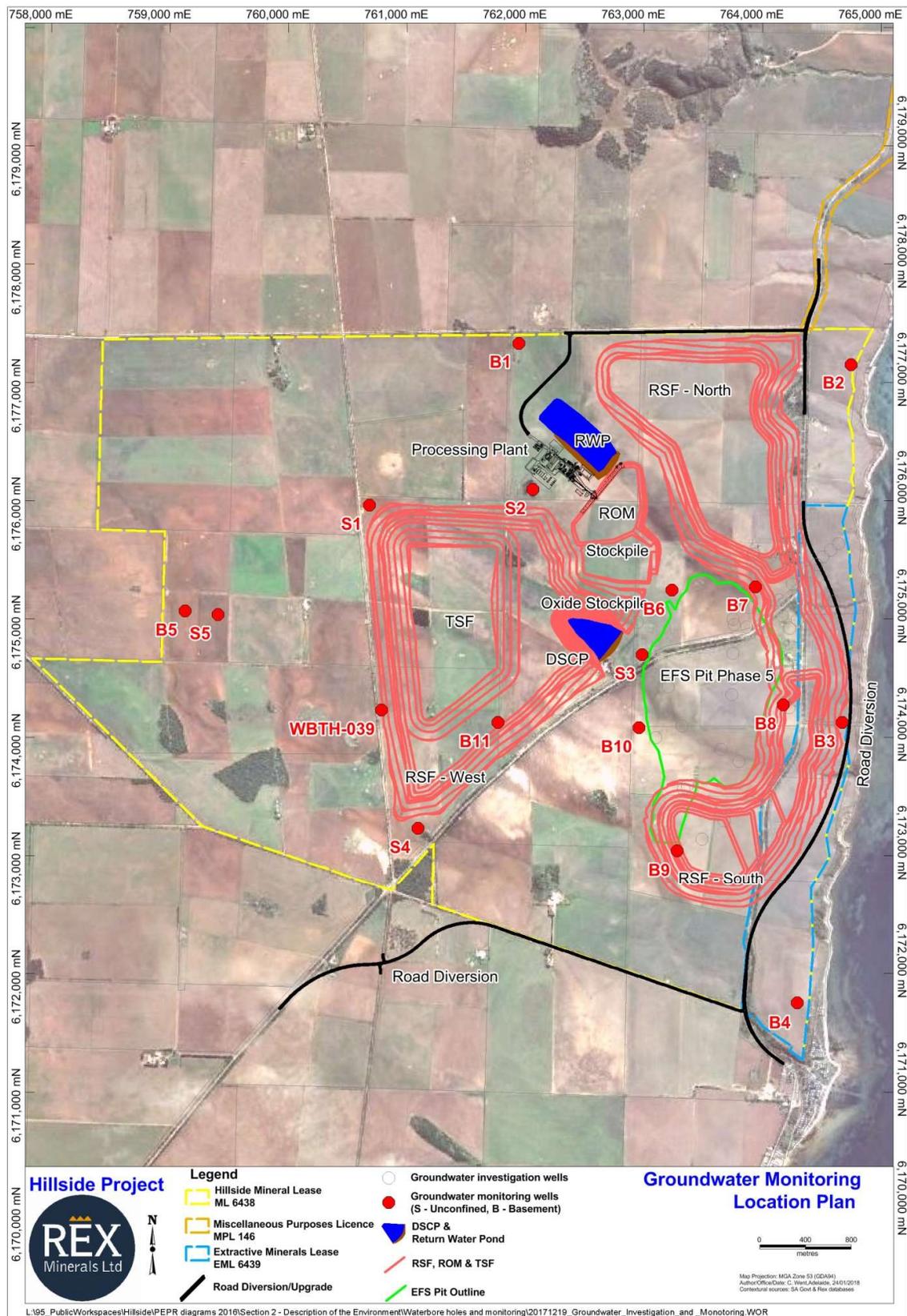


Figure 9: Groundwater monitoring locations

Hillside Copper Mine  
 Groundwater Management Plan  
 Program for Environment Protection and Rehabilitation (PEPR)

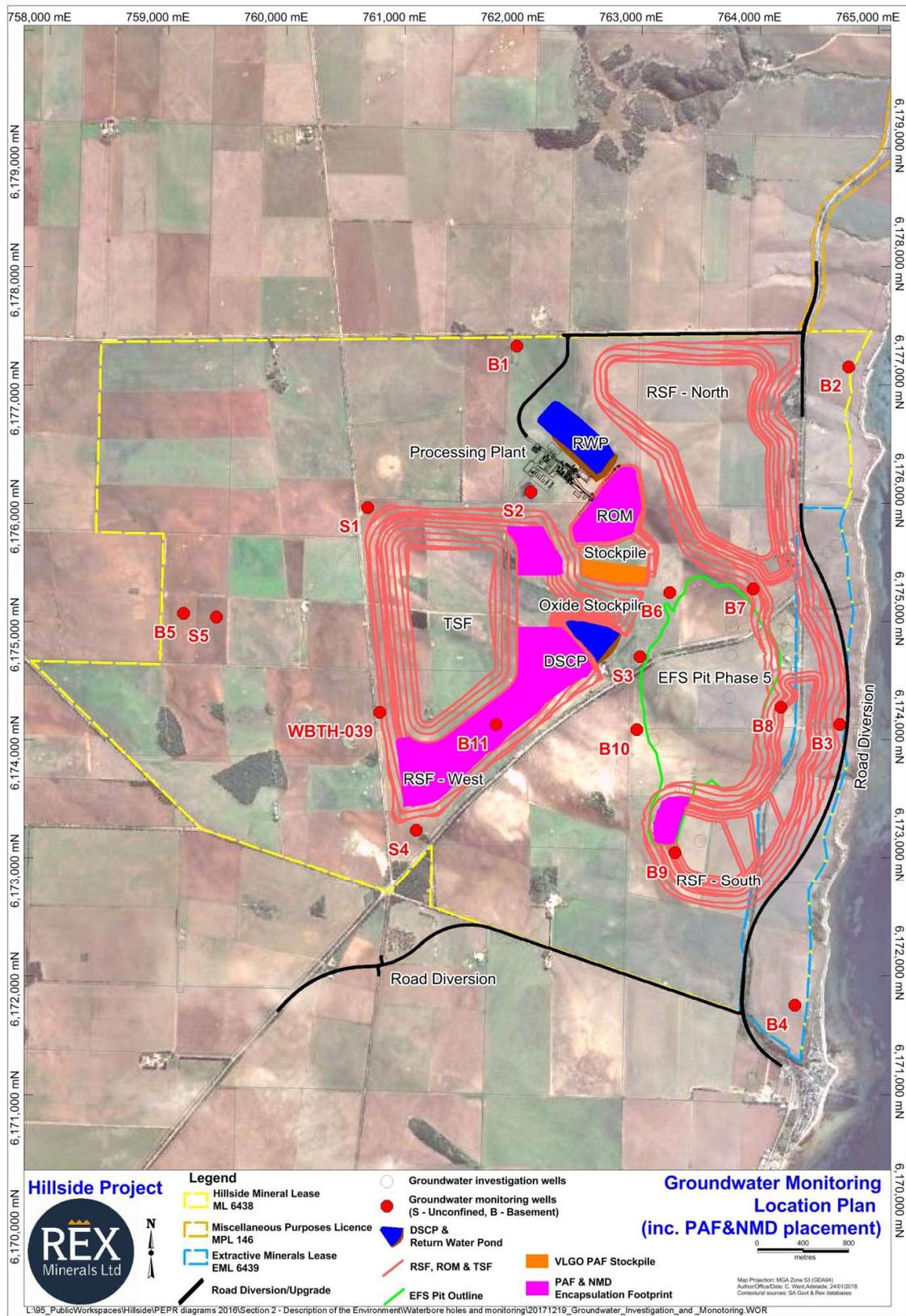


Figure 10: Groundwater monitoring locations and PAF cells to be encapsulated in RSFs

## **11. REPORTING**

Reporting is designed to provide feedback to mine management for operational purposes and to evaluate compliance with the Hillside Mine ML and MPL conditions. Stakeholders will have access to relevant groundwater information and data.

Key stakeholders requiring access to this information include Rex Minerals, state and local government agencies, and the local community.

The Hillside Mine will report on the performance of the GWMP in the ACR and provide regular updates to members of the HMCV consultation group. The ACR will be provided to the HMCV and made available for public information on the Rex Minerals website.

## **12. PERFORMANCE INDICATORS**

The following measurement criteria are used to demonstrate compliance with conditions (or achievement of outcomes) with respect to the ML conditions:

- zero leakage from tanks and chemical storages to the unconfined aquifer;
- the movement of any waters in the unconfined aquifer beneath the TSF, decant seepage and collection pond, tanks and chemical storages is toward the pit;
- the transitioning of the flow path in the basement aquifer from its current west to east direction to radial toward the pit as the pit gets deeper and dewatering occurs.

In the event of an exceedance of the compliance measurement criteria, the results will be conveyed to the DPC within 48 hours and an appropriate response will be instituted as provided in the trigger and response table above.

## **13. CONTINUAL IMPROVEMENT**

Rex Minerals will strive to continually improve on the Hillside Mine's environmental performance by applying the principles of best practice to mining operations, including where cost-effective and practicable, the adoption of new best practice technologies and improved quality control measures. Progress will be monitored using the above noted performance indicators.

## **14. REVIEW**

This Plan will be reviewed, and if necessary revised, to the satisfaction of DPC and in consultation with relevant government agencies, in accordance with the requirements relating to PEPR review and approval:

- following changes to Project approval or licence conditions relating to mining operations, water management or monitoring;
- following any significant groundwater related incident;
- when a relevant/significant improvement has been identified;
- for necessary or any unforeseen changes to groundwater monitoring locations;
- where a risk assessment identifies the requirement to alter the Plan;
- annually.

## 15. REFERENCES

Aldam Geoscience, 2013 “DFS Groundwater Investigations Report.

Aldam Geoscience, 2015 Groundwater Modelling – Revised Pit Configuration 2015.

Department of State Development, (2014). The Hillside Assessment Report 16 July, 2014.

DEWNR WaterConnect database (<https://www.waterconnect.sa.gov.au>)

Environment Protection (Water Quality) Policy 2015 (SA).

International Standard 14001:20015 *Environmental Management Systems*.

## 16. APPENDICES

### Appendix 1: Correspondence Records

Key relevant communications with DPC, YP Council and the community relating to this management plan are detailed below.

Date	Communication with	Action or Outcomes
31/07/2017	DPC	Draft sent to DPC.
31/07/2017	HMCV	Draft uploaded to the HMCV website.
20/08/2017	Public Meeting	Public meeting held to present plan. Written public feedback from both DPC and public received as a result presentation and discussion.
5/12/017	DPC	Feedback from public meeting and DPC was addressed and where applicable incorporated into management plan. A Table of all feedback on each topic and how they were addressed is incorporated in the PEPR in Section 7.

## Appendix 2: Groundwater Management Plan Requirements Checklist

Condition	Requirement	Section
<b>Rex Minerals Hillside Mine Mineral Lease Conditions (ML 6438) Second Schedule</b>		
<b>Groundwater</b>		
26.	The Tenement Holder must ensure there is no adverse change to the environmental values of water within the basement fractured rock aquifer outside of the Land as a result of mining operations.	2, 4, 7, 10, 11
27.	The Tenement Holder must ensure there is no adverse change to the environmental values of the basement fractured rock aquifer within or outside of the Land as a result of mining operations after mine completion.	2, 4, 7, 10,11
28.	The Tenement Holder must obtain approval from the Director of Mines in writing before developing any:	Acknowledged but not applicable to this PEPR
28.1.	Groundwater cut-off wellfield; or	
28.2.	MAR.	
<b>Rex Minerals Hillside Mine Miscellaneous Purposes Licence Conditions (MPL 146) Second Schedule</b>		
<b>Groundwater</b>		
5.	The Tenement Holder must ensure there is no adverse change to the environmental values of the groundwater within the shallow Cainozoic age sediments outside of the Land as a result of site operations.	2, 4, 7, 10, 11
6.	The Tenement Holder must ensure there is no adverse change to the environmental values of the groundwater within the shallow Cainozoic age sediments within or outside of the Land after mine completion.	2, 4, 7, 10, 11
No mine related infrastructure is going to be placed underground, therefore there will be no impacts to groundwater.		
<b>Rex Minerals Hillside Extractive Minerals Lease Conditions (EML 6439) Second Schedule</b>		
There are no Hillside Mine EML conditions (Second Schedule) relating to groundwater.		
<b>Rex Minerals Hillside Mine Mineral Lease Conditions (ML 6438) Sixth Schedule</b>		
<b>Groundwater Strategies</b>		
31.	The Tenement Holder must provide a calibrated ground water model in the proposed PEPR.	2, 4, 10, 12
32.	The Tenement Holder must establish a program for the establishment and ongoing calibration of the transient ground water model using data obtained from groundwater monitoring within the PEPR.	2, 4, 10, 12
33.	The Tenement Holder must provide a calibrated transient groundwater model within 1 year from the approval of the PEPR.	2, 4, 10, 12.

Hillside Copper Mine  
Groundwater Management Plan  
Program for Environment Protection and Rehabilitation (PEPR)

34.	The Tenement Holder must establish a program for the ongoing calibration of the pit lake geochemistry and hydrogeological models using data obtained from operational monitoring to address any assumptions and uncertainty within the model.	2, 4, 10, 12
<b>Groundwater Criteria</b>		
35.	The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(d) of the Regulations in relation to the Second Schedule Conditions 26 and 27:	
35.1.	Establish representative baseline water quality data for the basement fractured rock aquifer underlying the Land.	2, 4 & Table 6 Groundwater Report
35.2.	Establish compliance groundwater monitoring bores adjacent to the lease boundaries that are of sufficient density and depth to detect movement of groundwater off the Land.	2, 4, 7, 10
<b>Rex Minerals Hillside Mine Miscellaneous Purposes Licence Conditions (MPL 146) Sixth Schedule</b>		
<b>Groundwater</b>		
9.	The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) of the Regulations in relation to the Groundwater Outcome Schedule 2 - Condition 5;	
9.1	design and management strategies are to be provided for pipeline leak detection which includes automation of operational controls for the monitoring and control of all pipelines on the related Mineral Lease and this Mining Tenement. This should include (but is not limited to);	N/A*
9.1.1	continuous and automatic monitoring of pressures, flow rates and any other parameters for the prompt detection and resolution of abnormal operating conditions in any pipeline or processing plant equipment;	N/A*
9.1.2	continuous and automatic monitoring of process plant functions, including tank levels, flow rates, pressures and fluid quantities;	
9.1.3	the integration of data through a central computer-based control and monitoring system	
No mine related infrastructure is going to be placed underground, therefore there will be no impacts to groundwater.		
<b>Rex Minerals Hillside Mine Extractive Minerals Lease Conditions (EML 6439) Sixth Schedule</b>		
There are no Hillside Mine EML conditions (Sixth Schedule) relating to groundwater.		

\*Note: No longer applicable to this PEPR as the EFS design does not have a concentrate pipeline nor a return sea water line within the MPL