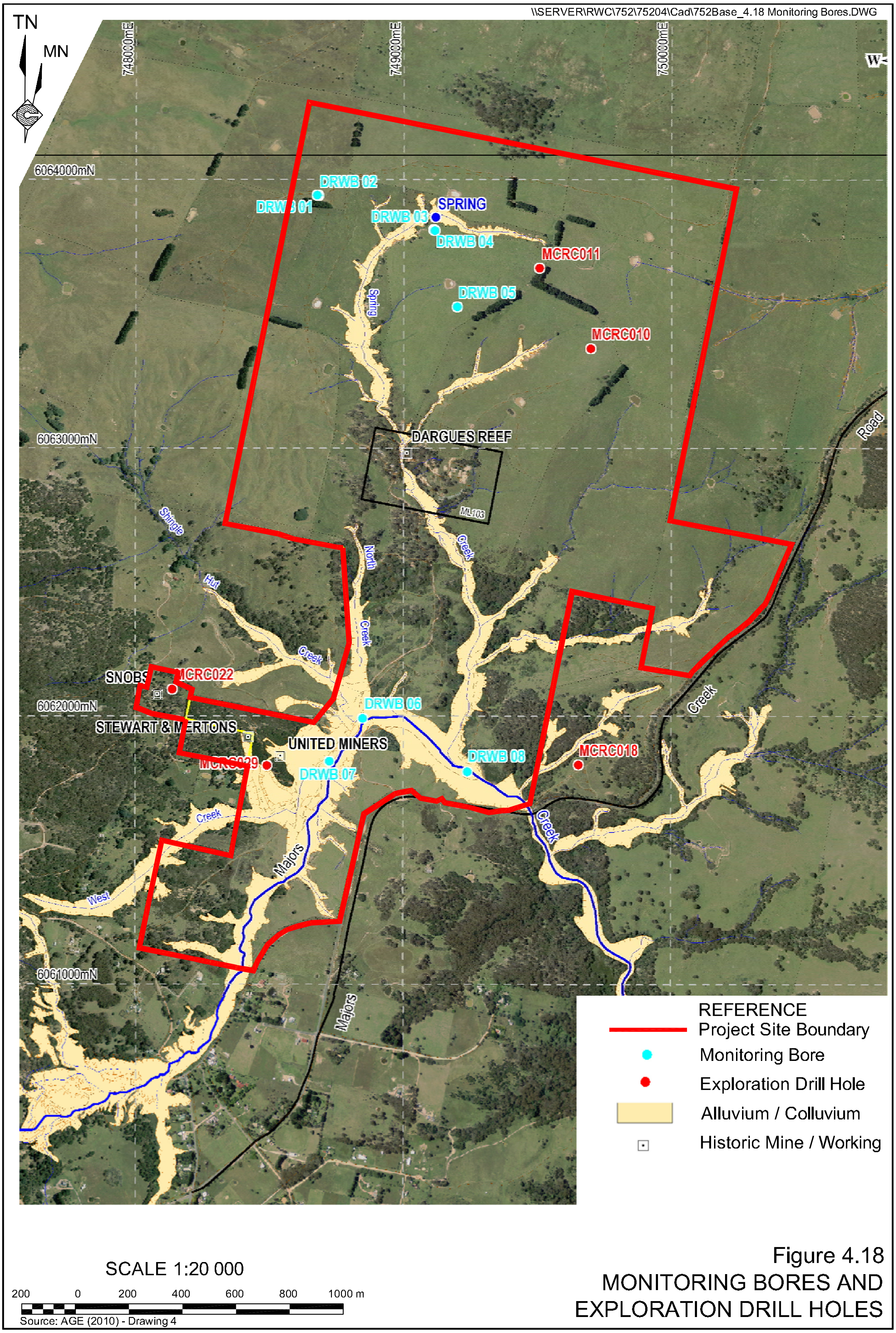


Figure 4.18
MONITORING BORES AND EXPLORATION DRILL HOLES

Table 4.17
Monitoring Bore Locations and Construction Details

Bore	Location		Elevation (RLm)		Depth	Screen	Static Water Level			Aquifer
	mE	mN	Ground	TOC[1]	(m)	(mbGL)[2]	Date	(mbGL)[2]	(mAHD)	
DRWB01	748681.1	6063944.8	714.65	715.20	67	61.0 – 7.0	25/04/10	9.41	705.8	granodiorite
DRWB02	748676.6	6063945.8	714.67	715.24	15.9	9.9 – 15.9	25/04/10	9.42	705.8	regolith
DRWB03	749111.8	6063817.2	712.35	712.91	66.1	60.1 – 66.1	25/04/10	8.64	704.3	granodiorite
DRWB04	749115.8	6063814.4	712.72	713.29	16.5	10.5 – 16.5	25/04/10	8.61	704.7	regolith
DRWB05	749200.3	6063530.7	721.89	721.87	15.58	9.6 – 15.6	25/04/10	dry		regolith
DRWB06	748848.7	6061994.6	632.34	632.98	6.45	3.45 – 6.45	20/04/10	1.24	631.7	alluvium
DRWB07	748724.7	6061835.4	636.72	637.17	11.25	5.25 – 11.25	20/04/10	4.23	632.9	alluvium
DRWB08	749240.0	6061796.4	627.38	628.01	11.22	5.12 – 11.12	20/04/10	1.93	626.1	Alluvium

Note 1: TOC = top of casing
Note 2: mbGL = metres below ground level
Note 3: co-ordinate projection MGA 94, Zone 56

Source: AGE (2010) – Table 2.

In addition to the monitoring bores constructed during the groundwater assessment, groundwater levels within a further 52 existing exploration drill holes were measured. **Figure 4.19** presents the location of the measured exploration drill holes and Appendix 5 of AGE (2010) presents additional information in relation to each drill hole.

Standing Groundwater Levels

Standing groundwater levels were measured in all monitoring bores constructed for the groundwater assessment, as well as 54 existing exploration drill holes. **Figure 4.19** presents an overview of the measured standing water levels and the interpreted groundwater level contours within and surrounding the Project Site. In summary, standing water levels have an elevation of approximately 715m AHD in the northern section of the Project Site. In the southern section of the Project Site, standing water levels have an elevation of approximately 627m AHD or approximately 88m lower than in the northern section of the Project Site.

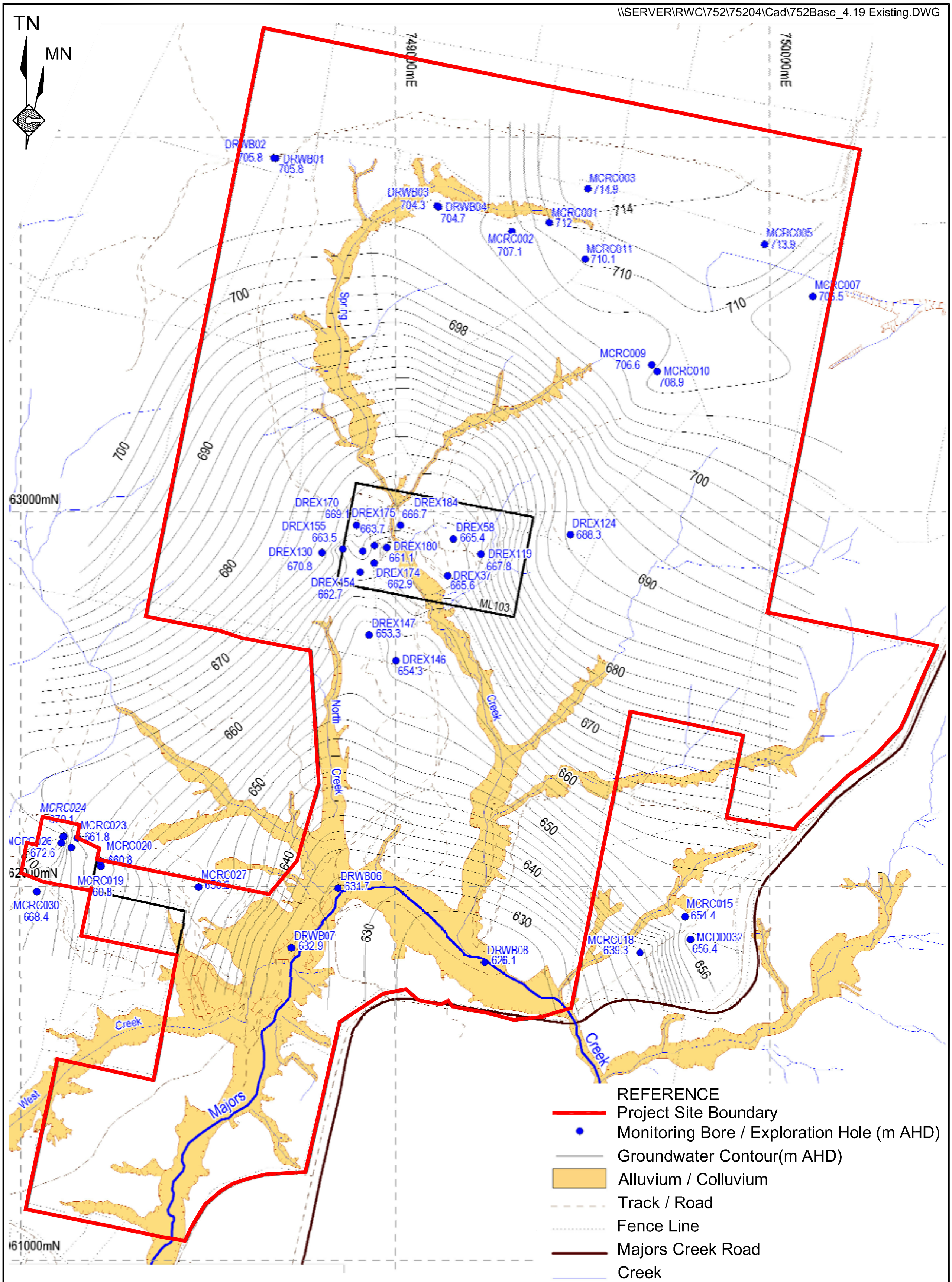
Hydraulic Testing

Falling / rising head tests were conducted on the monitoring bores. These tests involved adding or removing a quantity of water to the bore and measuring the water level response using a vibrating wire piezometer at 2 second intervals to determine the hydraulic conductivity of the material surrounding the bore. **Table 4.18** presents a summary of the hydraulic conductivity determined as a result of these tests.

Table 4.18
Falling / Rising Head Test Results

Bore ID	Aquifer	Hydraulic Conductivity	
		m/sec	m/day
DRWB01	Granodiorite	5.52×10^{-9}	4.68×10^{-4}
DRWB03		1.01×10^{-9}	8.69×10^{-5}
DRWB02	Regolith (weathered zone)	2.34×10^{-7}	2.02×10^{-2}
DRWB04		1.52×10^{-6}	1.31×10^{-1}
DRWB07	Alluvium/Regolith	6.09×10^{-7}	5.26×10^{-2}
DRWB08		5.60×10^{-7}	4.84×10^{-2}

Source: AGE (2010) – Table 3.



REFERENCE
- Project Site Boundary
- Monitoring Bore / Exploration Hole (m AHD)
- Groundwater Contour(m AHD)
- Alluvium / Colluvium
- Track / Road
- Fence Line
- Majors Creek Road
- Creek

SCALE 1:15 000

250 0 250 500 750 m

Source: AGE (2010) - Drawing 5

Figure 4.19
EXISTING GROUNDWATER LEVEL CONTOURS

Groundwater Quality

Groundwater samples were collected from each of the monitoring bores. In addition, samples were also collected from the spring in Spring Creek (see following sub-section) and from the existing Dargues Reef Shaft (**Figure 4.18**).

During sampling operations, a disposable bailer was used and at least three times the volume of the bore was removed prior to the sample being collected. In addition, with the exception of samples from DRWB03, no samples were collected until the pH and electrical conductivity (EC) of the water being removed had stabilised. In the case of DRWB03, the pH and EC failed to stabilise and a sample was collected anyway.

Table 4.19 presents the results of the groundwater monitoring program together with the Australian and New Zealand Environment and Conservation Council guidelines (ANZECC, 2000) for aquatic ecosystems associated with upland rivers in south-east Australia.

Table 4.19
Groundwater Quality Data

Sample ID		DRWB 01	DRWB 03	Dargues Shaft	DRWB 02	DRWB 04	Spring 1	DRWB 07	DRWB 08	ANZECC Guideline (2000)
Sample Date		22/04/10	21/04/10	21/12/09	22/04/10	22/04/10	22/04/10	22/04/10	22/04/10	
Aquifer	Unit	Granodiorite			Regolith			Alluvium		
pH value	pH	8.2	12.2	7.11	7.3	7.0	7.4	7.0	7.6	6.5 – 7.5
Electrical Conductivity	uS/cm	530	4300	1260	1300	360	270	630	410	30 - 350
Bicarbonate Alkalinity as $CaCO_3$	mg/L	199	<0.1		133	70.7	79.1	127	123	
Carbonate Alkalinity as $CaCO_3$	mg/L	<0.1	187		<0.1	<0.1	<0.1	<0.1	<0.1	
Hydroxide Alkalinity as $CaCO_3$	mg/L	<0.1	654		<0.1	<0.1	<0.1	<0.1	<0.1	
Total Alkalinity as $CaCO_3$	mg/L	199	841	516	133	71	79	127	123	
Chloride	mg/L	44	48		300	51	22	57	32	
Sulphate	mg/L	15	50		35	14	10	110	37	
Calcium	mg/L	54	150		110	26	17	56	42	
Magnesium	mg/L	14	<0.05		48	10	6.5	24	7.3	
Sodium	mg/L	34	310		58	22	23	31	24	
Potassium	mg/L	1.3	14		1.8	0.6	0.3	1.4	1.1	
Nitrate as N	mg/L	0.14	1.3		3.2	2.1	2.8	<0.01	<0.01	0.7
Nitrite as N	mg/L	0.02	0.03		<0.01	<0.01	<0.01	<0.01	<0.01	
Total Oxidized Nit. as N	mg/L	0.16	1.3		3.2	2.1	2.8	<0.01	<0.01	
Total Phosphorus as P	mg/L	0.16	0.21		0.71	0.06	0.14	0.27	0.41	0.02
Arsenic	mg/L	0.001	0.0055	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	0.013
Cadmium	mg/L	<0.0005	<0.0005	<0.0001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.00002
Chromium	mg/L	<0.001	0.039	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0001
Copper	mg/L	0.0006	0.0011	0.005	0.0007	<0.0005	<0.0005	0.0007	0.0005	0.0014
Lead	mg/L	0.0012	0.00019	0.002	<0.00005	0.00006	<0.00005	<0.00005	<0.00005	0.0034
Mercury	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0006
Nickel	mg/L	0.002	0.004	<0.001	0.003	<0.001	<0.001	0.002	0.003	0.011
Zinc	mg/L	0.012	0.006	0.054	0.006	0.014	<0.005	0.12	<0.005	0.008

Note: Shaded cells = exceedance of the ANZECC (2000) guideline

Source: AGE (2010) – After Table 5

The pH and EC for DRWB03 failed to stabilise prior to sampling and, as a result, the elevated pH and EC values recorded for that sample are not considered to be representative of the pH or EC of surrounding groundwater.

In summary, the groundwater monitoring indicates the following in relation to the existing groundwater quality within and surrounding the Project Site.

- Groundwater associated with the alluvial aquifer, with an EC of less than 630µS/cm, is suitable for human consumption. However, groundwater within the granodiorite and regolith aquifers is suitable only for stock watering.
- Groundwater within the granodiorite and regolith aquifers has nitrate levels in excess of the ANZECC guidelines while water within all aquifers has phosphorus and, in some cases, zinc levels in excess of the ANZECC guidelines. Elevated phosphorous, and possibly zinc, levels are considered to be as a result of previous land use practices, including the use of phosphorus and zinc-based fertilisers.

Groundwater Recharge, Discharge and Flow Directions

Recharge within the regolith and granodiorite aquifers depend on rainfall infiltrating the regolith aquifer and gradually migrating to the fractured rock system. Monitoring has shown that the regolith and fractured rock system are in hydraulic connection, with water levels in the paired monitoring bores showing the same elevation. As a result, AGE (2010) state that groundwater in the regolith is not perched.

Recharge within the alluvial aquifer in Majors Creek is primarily from the regolith and granodiorite aquifer system, surface runoff and incident rainfall.

The groundwater flow direction within the Project Site is typically from the north to south **Figure 4.19**.

Discharge from the granodiorite and regolith aquifers is primarily associated with Majors Creek. AGE (2010) note that base flow in Majors Creek, namely flow that is not associated with or immediately follows rainfall events, is primarily associated with groundwater discharge from the granodiorite or regolith aquifers.

In addition, a small spring is located in the upper section of Spring Creek (**Figure 4.18**). This spring is associated with discharge from the granodiorite and regolith aquifers. The Proponent has installed a V-notch weir within Spring Creek in the vicinity of the Dargues Reef Shaft. Flows across that weir have been monitored since April 2009 and indicate that Spring Creek has a base flow of approximately 0.3L/s. AGE (2010) state that this is primarily associated with discharge at the spring located approximately 1km upstream of the weir.

4.4.2.4 Surrounding Groundwater Users

AGE (2010) undertook a search of the NSW Office of Water- administered database of bores within a 5km radius of the Project Site. That search identified 13 registered bores within the search area (**Figure 4.18**). In addition, the Proponent undertook a census of existing privately owned bores and wells in the vicinity of the Project Site. A total of 25 bores or wells were identified. It is noted that there may be some overlap between the bores identified during the search for registered bores and those identified during the bore census.

The majority of bores in the vicinity of the Project Site are located within the village of Majors Creek, with three bores identified to the southwest and west of the Project Site and one bore identified to the east of the Project Site (**Figure 4.20**).

The database search and bore census indicates that majority of bores are within regolith or granodiorite aquifers and may be up to 30m deep. Groundwater use includes stock watering, watering of gardens and domestic use.

The closest bores to the proposed Dargues Reef Mine are Bores 16 and 17 located approximately 1.4km to 1.7km to the west of the mine respectively.

Finally groundwater modelling (see Section 4.5.5.6) indicates that groundwater from the granodiorite and regolith aquifers discharge to creeks and drainage lines within the Shoalhaven Catchment.

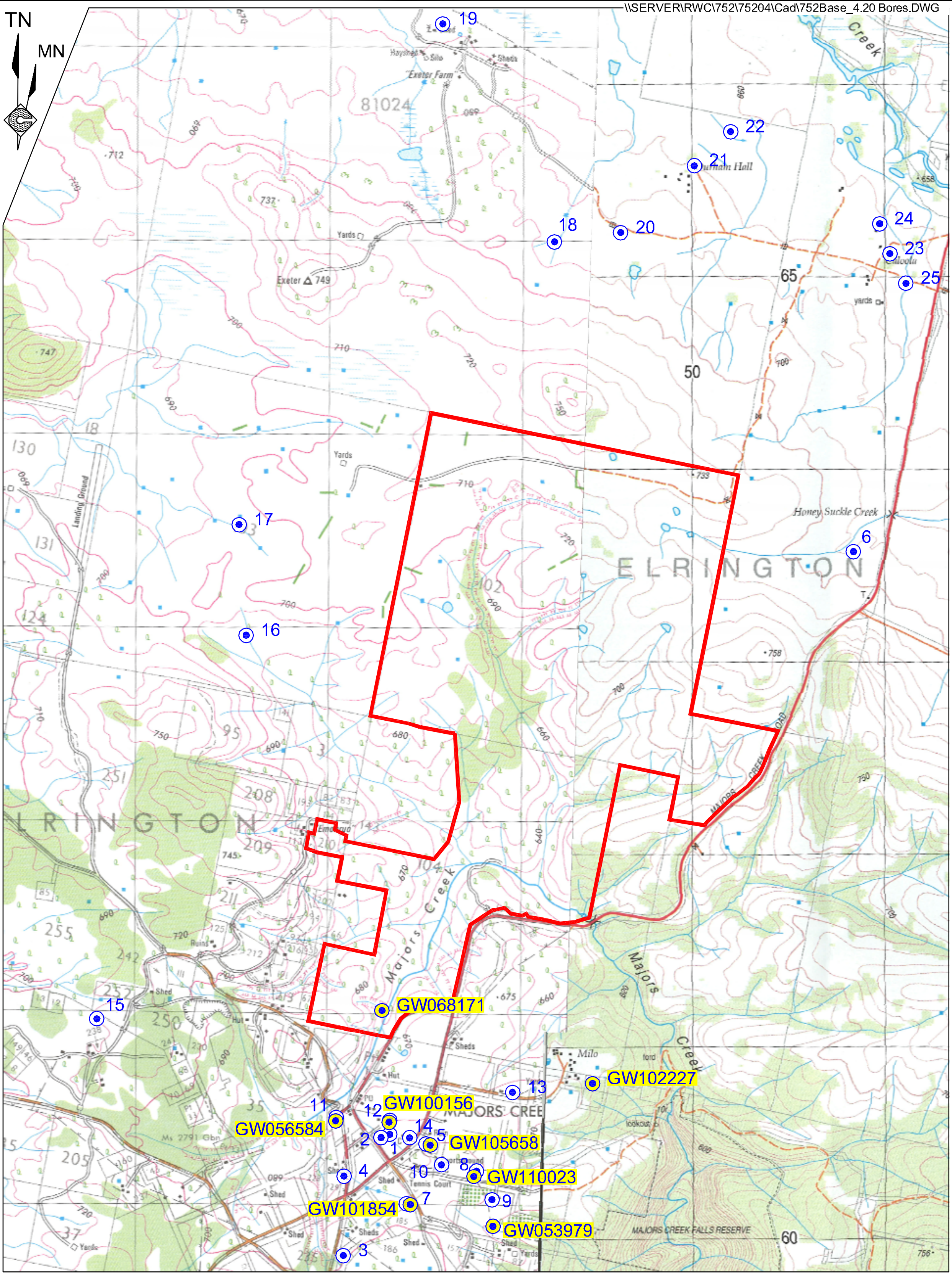
4.4.3 Management and Mitigation Measures

The Proponent would implement the following management and mitigation measures to ensure that groundwater users are not adversely impacted as a result of reduced groundwater availability and that environmental impacts are reduced to an acceptable level.

- Undertake consultation with the owners of bores that are predicted to be adversely impacted by the Project to ensure that those impacts are adequately mitigated or the owners compensated. Options include deepening or redrilling and re-equipping the existing bores or providing additional water from another source to compensate for the reduced groundwater supply.
- Release water source primarily from the harvestable rights dams at the rates identified in **Table 4.20** into Majors Creek at the confluence of Majors and Spring Creeks. These environmental discharges are to continue from the commencement of mining operations until 2 years after the cessation of dewatering operations.
- Negotiate an appropriate arrangement with the owners of Lot 210, DP755934 to allow construction or equipping of a bore to access groundwater within the Snobs workings prior to construction of that bore and extraction of water.
- Monitor groundwater levels in surrounding, privately-owned bores on request. The Proponent would ensure that all landholders in the vicinity of the anticipated zone of groundwater drawdown are briefed on the anticipated impacts and that an appropriate monitoring program is negotiated. In addition, a similar offer would be made to all other land owners with bores in the vicinity of the Project Site.

The Proponent would also undertake a review of the numerical groundwater model within 2 years of the commencement of mining operations to confirm the accuracy of the model and anticipated impacts. In the event that the actual impacts are significantly greater than those presented in AGE (2010), than the Proponent would consult with the NOW in relation the revised modelling results and would develop appropriate management and mitigation measures to address those impacts.

\\SERVER\RWC\752\75204\Cad\752Base_4.20 Bores.DWG



Note: There may be some duplication between bores identified during the bore census & those registered on the DECCW's database.

SCALE 1:30 000

500 0 500 1000 1500 m

Base Map Source: Canberra 1:250 000 Topographic Map

REFERENCE
Project Site Boundary
1 Surrounding Bore & Identifier (bore census)
GW101854 Registered Bore & Identifier (DECCW Database)

Figure 4.20
SURROUNDING BORES AND WELLS

In addition, the Proponent would implement the following hydrocarbon and chemical management and mitigation measures to minimise the potential for groundwater contamination associated hydrocarbon or chemical use.

- Store all hydrocarbon and chemical products within a bunded area complying with the relevant Australian Standard.
- Refuel all equipment within designated, sealed areas of the Project Site, where practicable.
- Undertake all maintenance works involving hydrocarbons, where practicable, within designated areas of the Project Site such as the maintenance workshop.
- Direct all water from wash-down areas and workshops to oil/water separators and containment systems.
- Ensure all hydrocarbon and chemical storage tanks are either self-bunded or bunded with an impermeable surface and a capacity to contain a minimum 110% of the largest storage tank capacity.

Finally, the Proponent would implement the following management and mitigation measures to minimise the potential for groundwater contamination associated with management of tailings material.

- Design and construct the tailings storage facility as described in Section 2.7 and in accordance with the requirements of the relevant government agencies. Key design parameters would be as follows.
  - Construct the floor and walls of the tailings storage facility in a manner that would achieve a permeability of less than $1x10^{-9}$m/sec.
  - Ensure that the tailings storage facility embankment is keyed into the underlying material in a manner that would prevent down slope migration of potentially contaminated groundwater from the facility.
  - Place residue uniformly around the perimeter of the tailings storage facility via several slurry spigots.
  - Construct seepage collection structures at the foot of the tailings storage facility embankment and ensure that any captured seepage is automatically pumped back to the tailings storage facility.
  - Install piezometers at appropriate intervals at the base of the tailings storage facility embankment and monitor these regularly to assess the integrity of the facility (see Section 4.5.6).

4.4.4 Assessment Methodology

4.4.4.1 Conceptual Groundwater Model

Prior to commencing detailed modelling, AGE (2010) constructed a conceptual groundwater model to provide an idealised and simplified representation of how the groundwater system operates given the available data. **Figure 4.21** presents an overview of the conceptual groundwater model which includes the following components.

- An approximately 15m thick veneer of regolith aquifer over a fractured granodiorite aquifer.

- Thin alluvial aquifer associated with Majors Creek.
- Recharge of the regolith aquifer from infiltration of incident rainfall.
- Recharge of the underlying granodiorite aquifer through seepage from the regolith aquifer and infiltration of incident rainfall.
- Recharge of the alluvial aquifer through seepage from the regolith and granodiorite aquifer, infiltration of incident rainfall and surface runoff.
- Discharge from all aquifers into streams and at springs, with limited evapotranspiration.

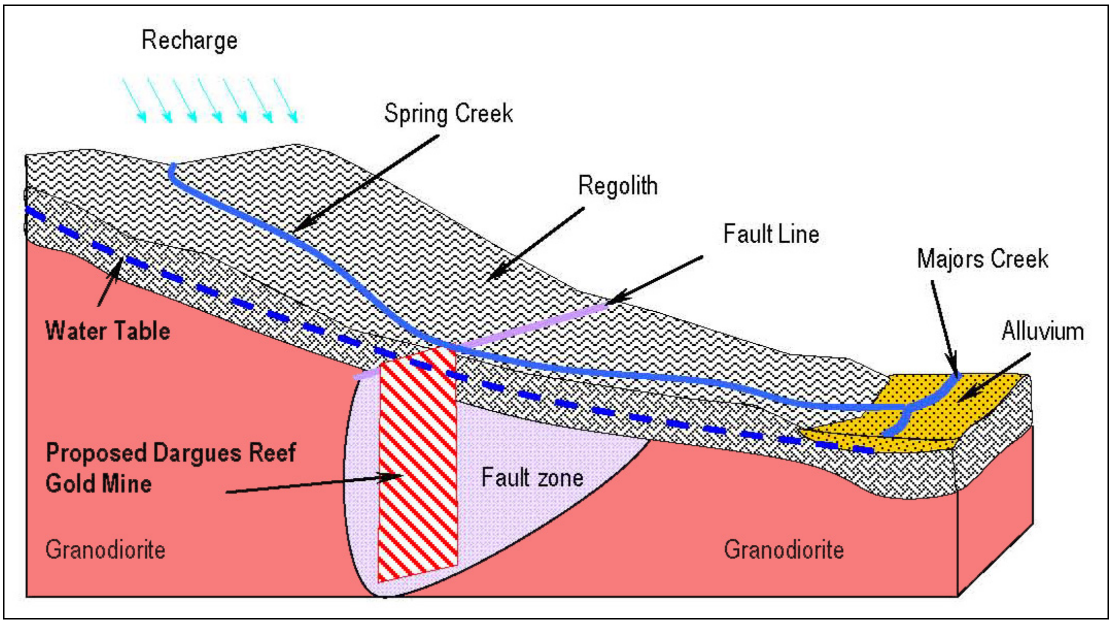


Figure 4.21
Conceptual Groundwater Model

Source: AGE (2010) – Figure 10.

4.4.4.2 Groundwater Discharge Zones

Groundwater modelling assumed groundwater discharge from the following locations.

- Natural springs and creeks.
- Dewatering of the proposed Dargues Reef Mine during mining operations. The rate of dewatering would be dependent on the rate of groundwater inflow to the mine.

- Removal of groundwater for mining-related purposes from the existing Snobs, Stewart and Mertons and United Miners workings. The location of the workings in shown in **Figure 4.18** and **Figure 4.22** presents a section through the workings. AGE (2010) estimate that the total volume of the workings is approximately 82 000m^2, from which approximately 49 000kL of water would be recoverable. For the purposes of modelling the Project-related groundwater impacts, AGE (2010) assumed that groundwater would be extracted from each of the workings as follows.
  - Snobs workings - 1.25L/s or 39.4ML/year.
  - Stewart and Mertons workings - 0.5L/s or 15.8ML/year.
  - United Miners workings - 0.75L/s or 23.7ML/year.

  As a result, the groundwater model assumed a total of 78.9ML/y would be extracted from the existing workings.

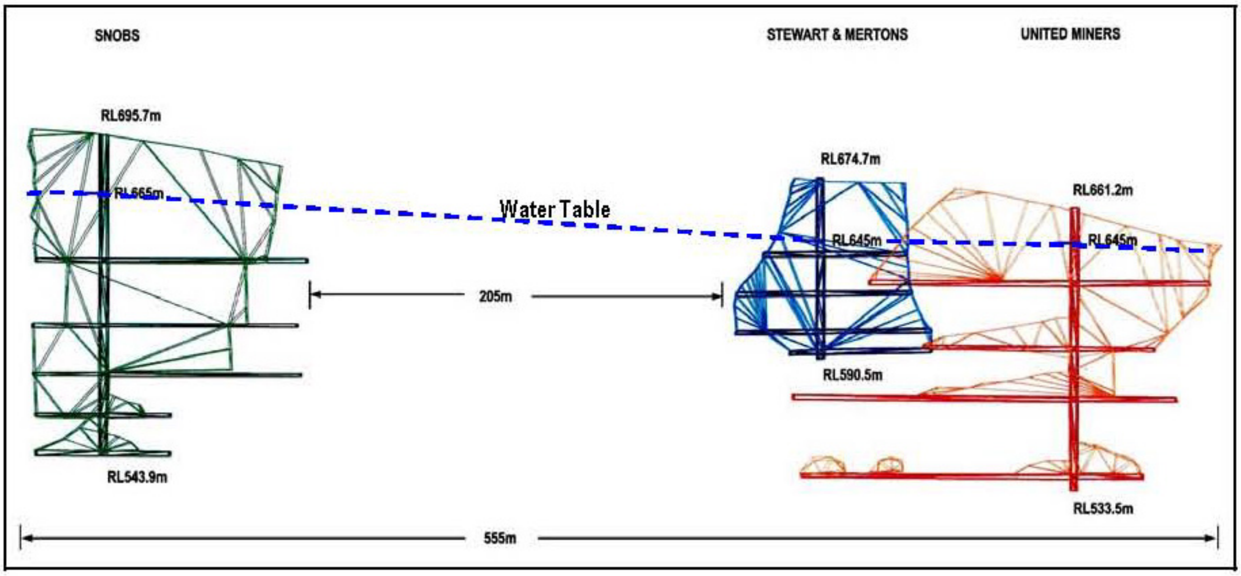


Figure 4.22
Section through Historic Workings

Source: AGE (2010) - Figure 9

4.4.4.3 Model Development

In order to determine the likely groundwater-related impacts associated with the Project AGE (2010) developed a numerical groundwater model using MODFLOW SURFACT. The MODFLOW code is the most widely used code for groundwater modelling and is presently considered an industry standard.

The groundwater model is described in detail in Section 12.3 of AGE (2010). In summary, however, the model was constructed with the following parameters and assumptions.

- An aerial extent of approximately 7km by 6km.
- The model was rotated approximately 30º to the west to align it with the northwesterly major drainage lines and southeasterly direction of groundwater flow.

- The model comprised cells which varied in size from 12.5m by 12.5m within the vicinity of Dargues Reef and the historic workings to 100m by 120m at the perimeter of the model.
- Seven model layers were created, with the first representing the alluvial aquifer with a thickness of 1m to 3m, the second representing the regolith aquifer with its base 15m below surface and the remaining layers representing the granodiorite aquifer with the base of the model at 600m below surface.
- Zones of higher hydraulic conductivity were incorporated based on the location of faults and lineaments either mapped or interpreted from geophysical data by the Proponent.
- The edges of the model were assumed to be no-flow boundaries.
- Recharge rates were determined during model calibration.
- Drain cells were constructed to simulate discharge to creeks. A nominally high drain conductance of 1 000m^2/day was applied to the drain cells.
- Dewatering of the proposed Dargues Reef Mine was simulated using drain cells which were progressively moved downwards, in monthly increments, to reflect the proposed 5 year mining schedule provided by the Proponent. For the purposes of modelling, it was assumed that during mining, all mined areas were open voids. However, following the completion of mining operations and during recovery of the groundwater levels, mined areas were assumed to have been backfilled, with a remaining permeability of 35%.
- Extraction of water from the existing workings was simulated using the Fractured Well package of SURFACT using an equivalent well diameter of 12m to take into account the storage of groundwater within the workings.
- Two specific yields, namely the drainable porosity, were assumed for the granodiorite aquifer. These were 0.001 and 0.01. AGE (2010) state that these reflect the expected range of specific yields for a granodiorite-hosted aquifer.

4.4.4.4 Model Calibration

In order to ensure that the groundwater model reflected as accurately as possible the actual hydraulic parameters of the aquifers within and surrounding the Project Site, the model was calibrated using the PEST software and associated utilities. This permitted model parameters to be adjusted until model-generated groundwater levels fit the observed levels as closely as possible. Section 12.4.1 of AGE (2010) provides a detailed description of the calibration procedure and results. However, the following provides a brief summary of the inputs and results of the calibration.

- Groundwater level measurements from 35 existing exploration holes the monitoring bores were used. These were assumed to reflect the long term average groundwater levels.

- Comparing the results of the calibrated model with the observed groundwater levels gave a root mean squared error of 3.9m. AGE (2010) state that given the observed head loss within the model domain is 88m, that this error level is considered acceptable.
- Recharge rates were determined to be approximately 45mm/year (6.3% of the annual rainfall) on the upper, flatter slopes and hill tops, 20mm/year (2.8% of the annual rainfall) to the steeper side slopes and 3mm/year (0.5% of the annual rainfall) to the low lying and thin alluvial areas adjacent to Majors Creek, that is the groundwater discharge zone. Recharge was applied uniformly throughout the year to correspond with the fairly evenly distribution of rainfall pattern.
- Hydraulic conductivities for each aquifer and for faults within the regolith and granodiorite aquifers were determined with reference to measured values, where available, and results of the calibrations. Table 9 of AGE (2010) presents the assumed hydraulic conductivities.

4.4.5 Assessment of Impacts

4.4.5.1 Inflow to Dargues Reef Mine

The Proponent anticipates that decline development would result in the decline achieving the maximum proposed depth extent of 500m below surface after approximately 2 years, with mining operations continuing for a further 3 years. The groundwater model simulated development of the mine in 60 one month increments, with all water estimated to flow into the mine removed as it is produced.

Figure 4.23 presents the estimated groundwater inflow into the proposed mine for specific yields of 0.001 and 0.01. In summary, the model predicts the following.

- Initial inflows would be expected to be between approximately 7.5L/s and 8.5L/s.
- As the decline progresses, the inflows would be expected to increase to be between approximately 9.0L/s and 10.0L/s until completion of the decline at the end of Year 2.
- Following completion of the decline, groundwater inflows are predicted to decline exponentially to approximately 7.2L/s at the end of Year 5.

AGE (2010) note that the predicted inflows are potentially a conservative overestimate as some faults may act as barriers to groundwater flow rather than conduits. It is also noted that the predicted inflows to the proposed mine would report to the mine sump and be pumped to the surface. It is anticipated that the following losses, amongst others, would occur.

- Water loss through moisture contained within ore and waste rock removed from the mine is estimated to be, on average, approximately 0.6L/s.
- Water loss through the ventilation system is estimated to be between approximately 0.14L/s and 0.18L/s.

As a result, it is likely that between approximately 9L/s and 6L/s would be pumped to the surface and would be available for mining-related purposes. It is noted that in developing the mine water balance, a conservative estimate of 4L/s has been used to take into account potential overestimates in the modelled inflows to the proposed mine (see Section 4.6.5).

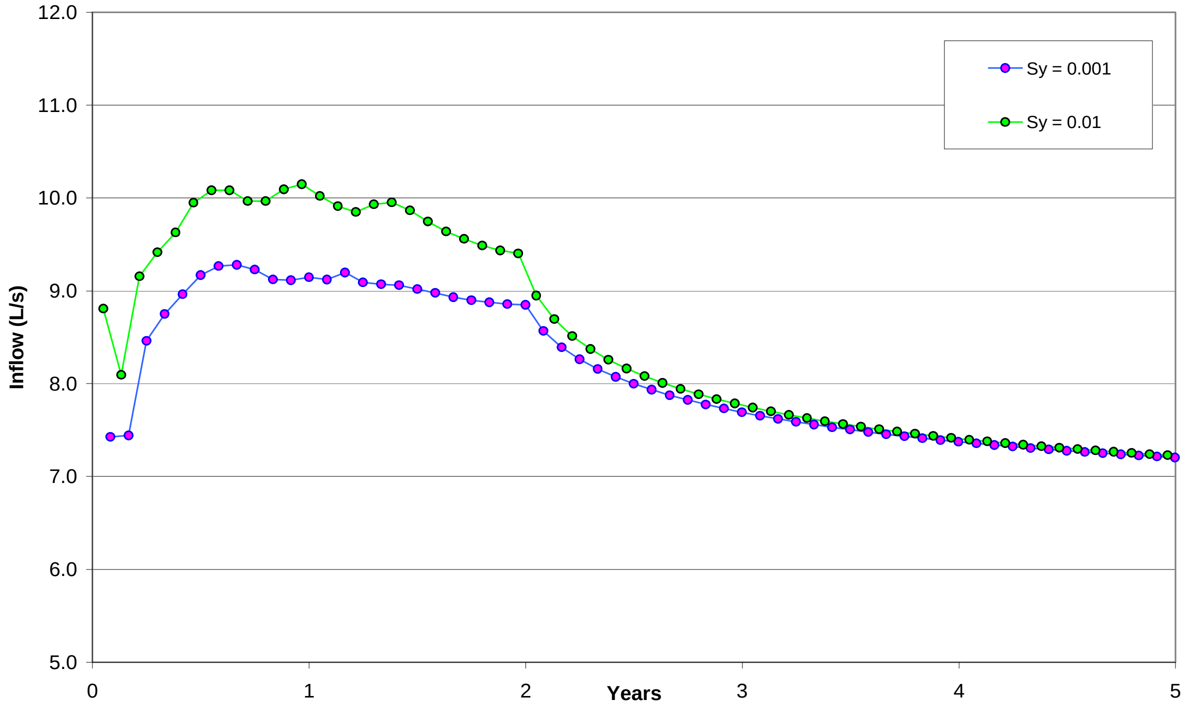


Figure 4.23
Predicted inflow to Dargues Reef Mine

Source: AGE (2010) – Figure 13.

4.4.5.2 Impact of Pumping from the Historic Workings

The model assumed a total extraction from the Snobs, Stewart and Mertons and United Miners workings of 2.5L/s, or 78.9ML/year, for the 5 year life of the mining operations. **Figure 4.24** presents the estimated drawdown hydrographs for each of the workings. The results of the modelling may be summarised as follows.

- Snobs workings – the groundwater level is predicted to fall approximately 70m to approximately 592m AHD or approximately 48m above the base of the workings.
- Stewart and Mertons workings - the groundwater level is predicted to fall approximately 28m to approximately 618m AHD or approximately 27m above the base of the workings.
- United Miners workings – the groundwater level is predicted to fall approximately 23m to approximately 622m AHD or approximately 88m above the base of the workings.

It is noted, however, that the model assumed continuous pumping from the underground workings. As indicated in Section 2.10.2.6, the Proponent would extract water for mining-related purposed from the historic workings only when insufficient water is available from the higher priority water sources, namely the proposed Dargues Reef Mine and the harvestable rights dams.

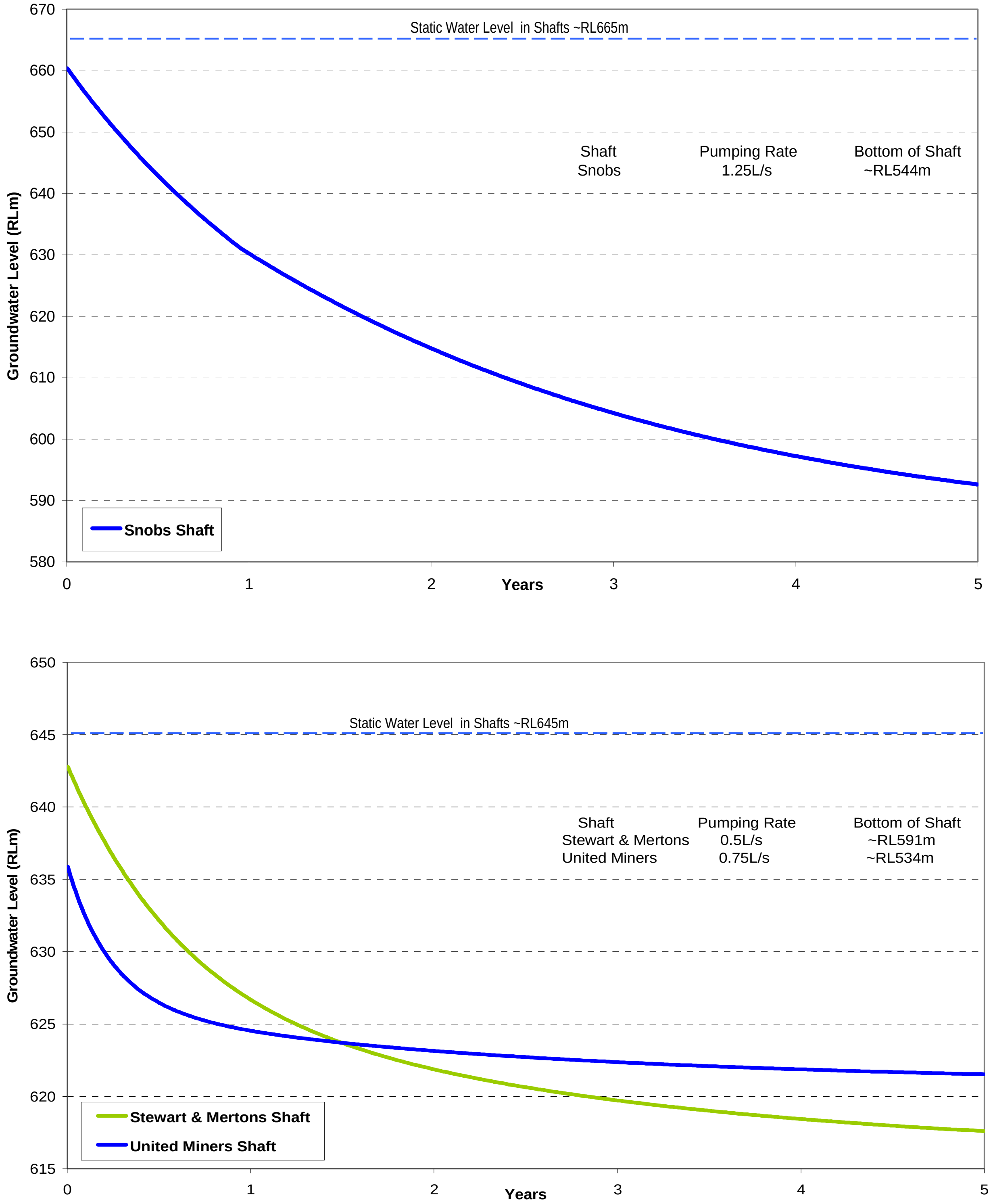


Figure 4.24
Predicted Groundwater Drawdown – Historic Workings

Source: AGE (2010) – Figures 14 and 15.

4.4.5.3 Impact on Piezometric Surface Levels

Figure 4.25 presents the anticipated piezometric or groundwater level surface at the end of mining operations, namely at the end of Year 5 and **Figure 4.26** presents the anticipated piezometric drawdown or the difference between the modelled pre-mining piezometric surface and the piezometric surface at the end of Year 5. These results may be summarised as follows.

- The 1m drawdown contour, or the maximum radius of measurable impact, extend approximately 2.5km from the proposed mine.
- Dewatering of the proposed mine is anticipated to have a more significant impact on groundwater levels than extraction of water from the historic workings.
- The drawdown pattern would be broadly concentric, with some influence from faulting.
- There would be between 1m to 5m of drawdown in the alluvium and underlying regolith along Majors Creek over a 1.5km reach of the creek.
- The entire reach of Spring Creek is expected to be within the 1m drawdown contour.
- The 1m drawdown contour extends approximately 1.4km into the Shoalhaven catchment.

4.4.5.4 Impact on Groundwater Discharge

Base flow, namely that flow that is not associated with individual rainfall events in surrounding creeks is largely dominated by groundwater inflows, either directly to the creek or to the alluvial aquifer, from the granodiorite or regolith aquifers. As noted in Section 4.4.5.3, an approximately 1.5km long section of Majors Creek and the majority of the reach of Spring Creek is expected to be within the 1m drawdown contour (**Figure 4.26**). Majors Creek, Spring Creek and a number of small unnamed drainage lines within the Shoalhaven Catchment were modelled as a groundwater discharge zones. The results of the modelling for Majors Creek are presented in **Figure 4.27** and the modelled reduction in groundwater discharge at all discharge locations is presented in **Table 4.20**. These results may be summarised as follows.

- The pre-mining groundwater discharge from the granodiorite and regolith aquifer to Majors Creek is approximately 3.5L/s. This is expected to decrease gradually during the 5 year life of the mining operations to approximately 1.8L/s, or a reduction of approximately 1.7L/s. Following the completion of mining operations at the end of Year 5, the rate of discharge is expected to recover rapidly to 0.3L/s by Year 8 or three years after the completion of mining operations.
- The pre-mining groundwater discharge from Majors Creek and the alluvial aquifer to the granodiorite aquifer is approximately 1.0L/s. This is expected to increase gradually during the 5 year life of the mining operations to approximately 1.1L/s, or an increase of approximately 0.1L/s. Following completion of mining, this is expected to recover completely within 12 months.

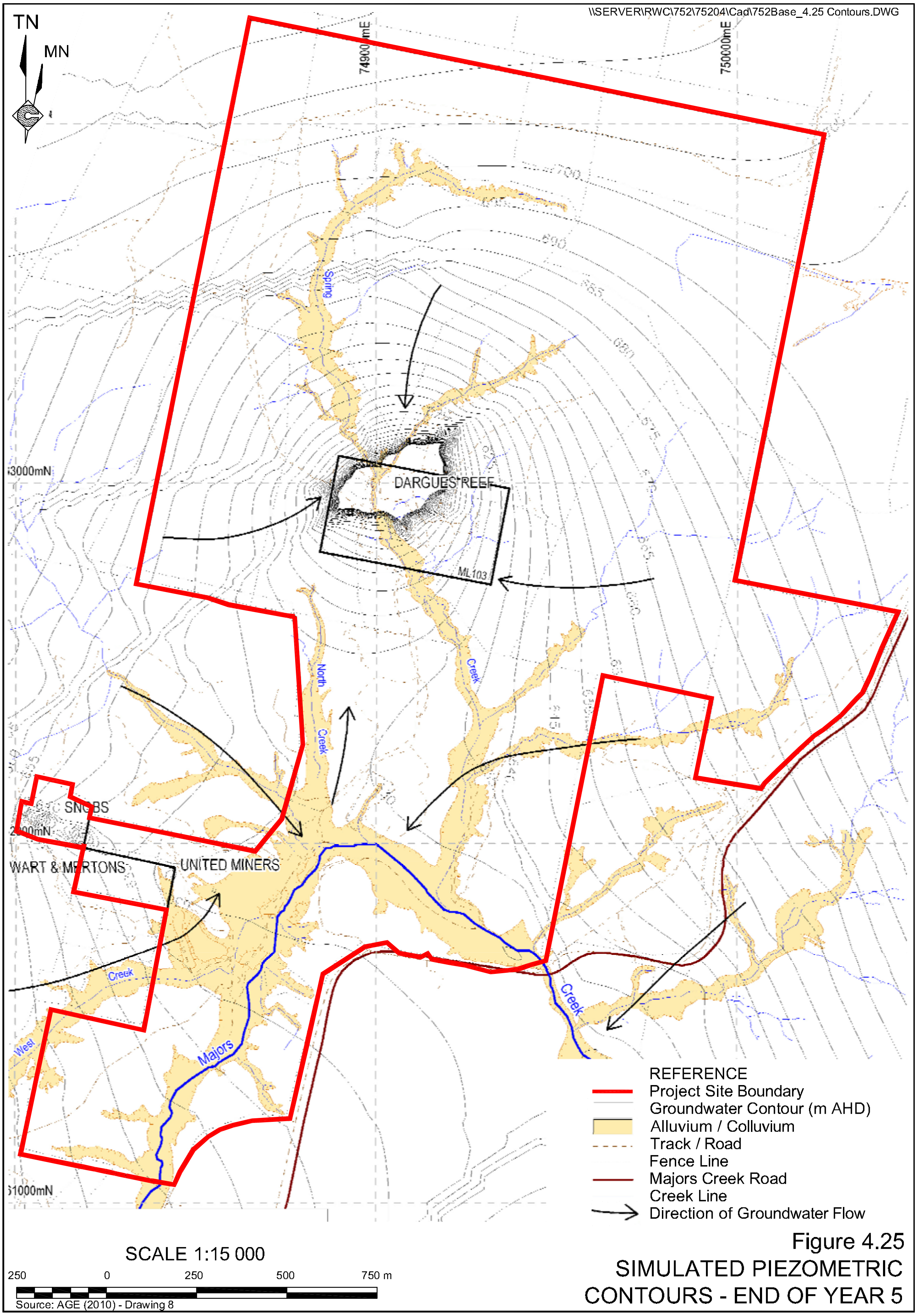


Figure 4.25
SIMULATED PIEZOMETRIC CONTOURS - END OF YEAR 5

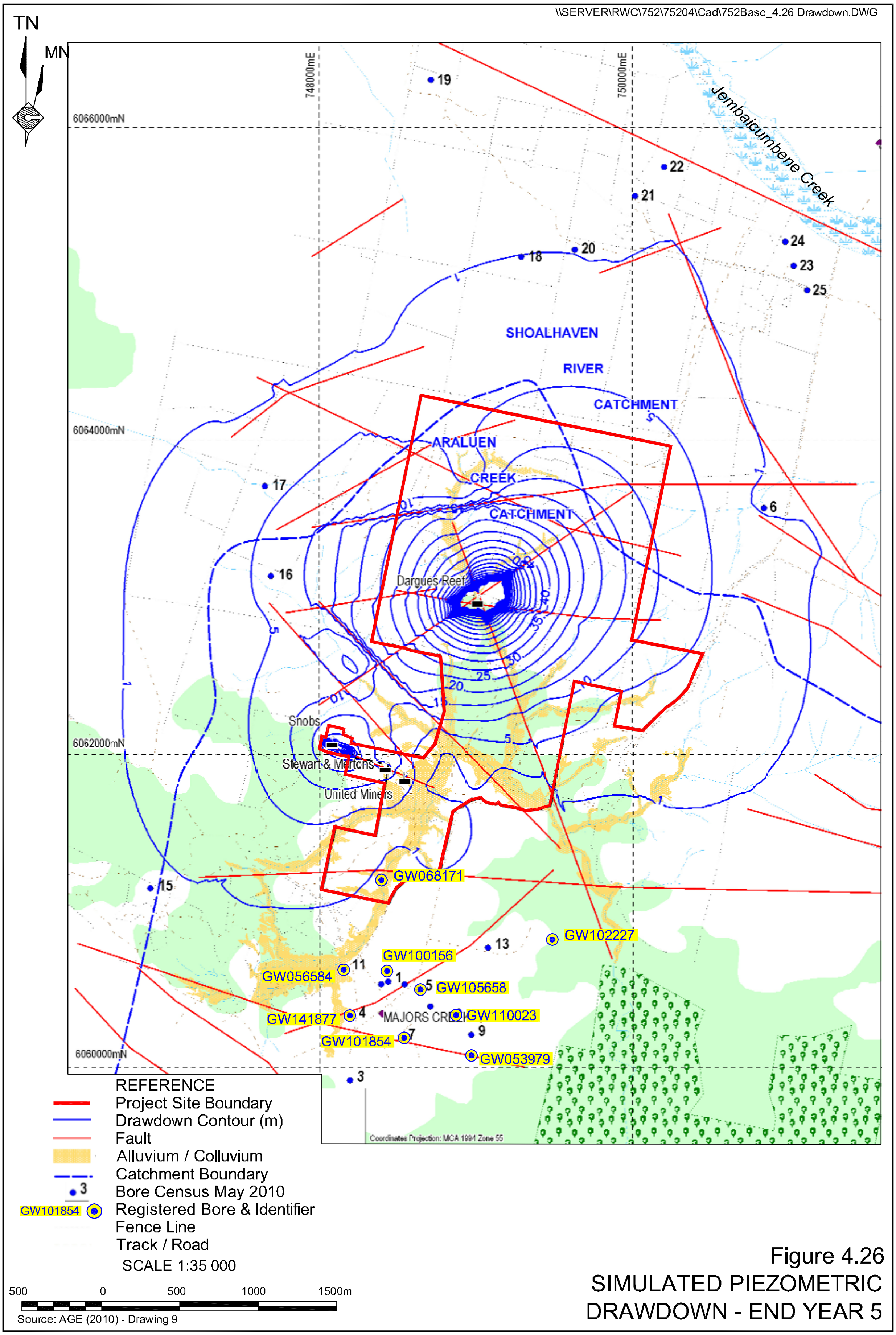


Figure 4.26
SIMULATED PIEZOMETRIC DRAWDOWN - END YEAR 5

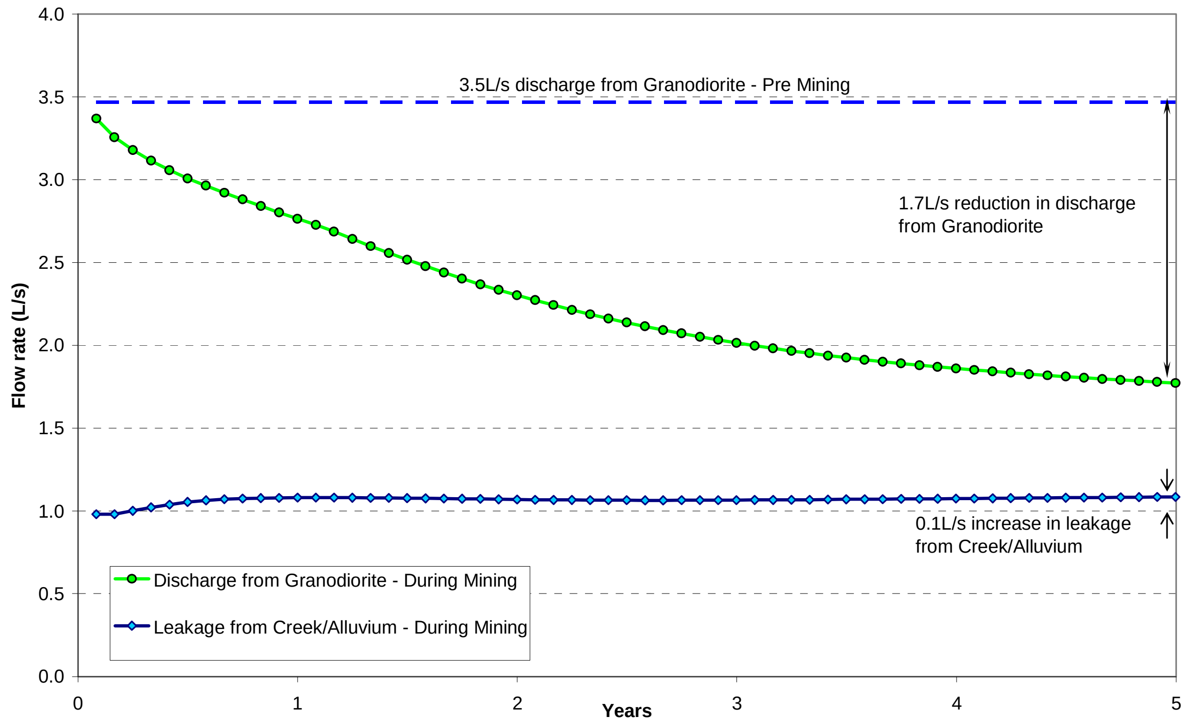


Figure 4.27
Simulated Majors Creek Discharge and Recharge

Source: AGE (2010) – Figure 16.

- The measured pre-mining base flow within Spring Creek is approximately 0.3L/s. AGE (2010) state that this base flow is expected to cease during the life of the mining operations and for up to 5 years following the completion of mining.
- As noted in Section 4.4.5.3, the 1m piezometric drawdown contour shown on **Figure 4.28** extends approximately 1.4km into the upper Shoalhaven Catchment. AGE (2010) note that the anticipated piezometric drawdown would extend below the upper catchment of a number of small, unnamed creeks, reducing discharge from the granodiorite aquifer to these creeks. The estimated reduction in discharge would increase slowly to be approximately 0.42L/s at the end of mining operations. This would recover gradually 0.32L/s by Year 8 or three years after the completion of mining operations.

As a result, the anticipated reduced base flow in Majors and Spring Creeks as a result of the Project is expected to increase gradually from nil at the commencement of mining operations to approximately 2.1L/s at the end of mining operations at the end of Year 5. This would recover rapidly to be 0.9L/s in Year 7 or 2 years after the completion of mining operations. As a result, the Proponent would ensure that a maximum of approximately 2.1L/s would be released at the confluence of Majors and Spring Creeks from the commencement of mining operations until 2 years after the completion of dewatering operations.

The Proponent contends that a combined reduction in base flow within the Shoalhaven Catchment is not significant or measurable. As a result, no compensatory flows are proposed in that catchment.

Table 4.20
Estimated Project-related Reduction in Groundwater Discharge

From	To	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Moruya Catchment (L/s)							←End of mining operations				
Granodiorite aquifer	Spring Creek	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Granodiorite aquifer	Majors Creek	0.7	1.2	1.5	1.6	1.7	1.2	0.6	0.3	0.1	0.05
Alluvial aquifer	Granodiorite aquifer	0.05	0.1	0.1	0.1	0.1	0	0	0	0	0
Total	**L/s**	**1.05**	**1.6**	**1.9**	**2.0**	**2.1**	**1.5**	**0.9**	**0.6**	**0.4**	**0.35**
	ML/year	**33.1**	**50.4**	**59.9**	**63.0**	**66.2**	**47.3**	**28.3**	**18.9**	**12.6**	**11.0**
Proposed Environmental Release (ML/year)		**33.1**	**50.4**	**59.9**	**63.0**	**66.2**	**47.3**	**28.3**	**-**	**-**	**-**
Shoalhaven Catchment (L/s)											
Granodiorite aquifer	Shoalhaven Catchment	0	0.1	0.2	0.31	0.42	0.42	0.4	0.32	0.22	0.1
Source: AGE (2010) - After Table 10											

4.4.5.5 Impact on Groundwater Users

Figure 4.26 presents the location of bores surrounding the Project Site. Two bores, namely Bore 16 and Bore 17 are located within the anticipated 1m drawdown contour. As a result, the standing water levels and yields from these bores would be expected to decrease as a result of the Project. The Proponent has commenced negotiations with the owners of those bores, with a view to reaching an agreed outcome. Potential outcomes may include deepening or re-equipping bores, drilling new bores or providing water from the mine water supply for the duration of the anticipated impacts.

In addition, Bores 6, 15, 18 and 20 and Registered Bore GW068171 are located in the vicinity of the 1m drawdown contour. AGE (2010) note that this contour is typically considered to be the limit of Project-related impacts because groundwater levels may vary naturally by up to 1m. However, in light of the proximity of these bores to the anticipated 1m drawdown contour, the Proponent has also commenced negotiations with the owners of these bores with a view to monitoring standing water levels and yields within the bores. In the event that groundwater supply from the bores is adversely impacted by the Project, the Proponent would negotiate an appropriate arrangement with the owner of the bore in question.

Finally, it is noted that no other groundwater users or bores are expected to be adversely impacted by the Project.

4.4.5.6 Impact on Groundwater Dependent Ecosystems

AGE (2010) identifies that groundwater inflows to Majors and Spring Creeks would be reduced by up to approximately 1.8L/s and 0.3L/s respectively. As noted in the non-Aboriginal Heritage Assessment, summarised in Section 4.8. Majors and Spring Creeks have been significantly disturbed by previous gold-mining operations. In addition, as indicated on **Figure 4.14**, Gaia (2010) indicate that significant sections of both creek lines are classified as “Largely Disturbed Land”. As a result, the Project is not expected to result in adverse impacts to groundwater dependent ecosystems as none are likely to exist within the Project Site.

4.4.5.7 Impact on Groundwater Quality

The Project is not expected to have any adverse impacts of groundwater quality for the following reasons.

- As identified in Sections 2.5.2 and 2.7.4, characterisation of the waste rock and tailings material indicated that both these materials are non-acid generating. As result, acidic leachate is not expected to be generated during mining, processing or tailings storage operations or from the final landform.
- Management and mitigation measures identified in Section 4.4.3 represent industry best practice would reduce the potential for groundwater contamination from chemicals and hydrocarbons to an acceptable level.
- The Proponent is not aware of cyanide or mercury being used during previous mining operations. As a result, disturbance or ongoing management of contaminated material as a result of the Project is not anticipated.
- The Braidwood Granodiorite is not known to contain significant concentrations of metals or metalloids that may pose a risk to the environment. As a result, as the Project would not result in the release of naturally-occurring elements that would result in adverse environmental impacts.
- As indicated in Section 2.6.6, no hazardous chemicals would be used during processing operations. As a result, the tailings material is not expected to generate leachate that would have significant adverse environmental impacts.

As a result, the Project would not result in adverse impacts on groundwater quality within or surrounding the Project Site. It is therefore concluded that a significant change in the quality of groundwater in the granodiorite, regolith or alluvial aquifers, is not expected to occur as a result of the Project.

4.4.5.8 Impact on Majors Creek Village Water Supply

It is noted that the village of Majors Creek is upstream of the Project Site. It is also noted that the bore census and search of the registered bore database indicated a number of bores or wells exist within the village of Majors Creek (**Figure 4.26**). However, the predicted extent of the drawdown of the piezometric groundwater level would not extend to the village of Majors Creek. As a result, the Proponent contends that no groundwater users within Majors Creek would be adversely impacted by the Project.

4.4.5.9 Impact on Araluen Village Water Supply

During the Proponent's community consultation it was identified that the community was concerned that the Project may result in a significant adverse impact on the water supply for the village of Araluen and surrounding water users, located approximately 20km downstream and approximately 500m lower in elevation than the Project Site. AGE (2010) note that the Project Site is at the very head of the Araluen Creek catchment and that previous groundwater studies at Araluen indicated that the total sustainable yield of the alluvial aquifers associated with Araluen Creek is between 8 028ML/year and 8 218ML/year. As a result, a reduced base flow of approximately 2.1L/s or approximately 66ML/year in Majors and Spring Creeks would not result in a significant impact on groundwater or surface water supplies at Araluen.

4.4.5.10 Groundwater Recovery

AGE (2010) modelled groundwater recovery following cessation of dewatering activities within the proposed mine and from the Snobs, Stewart and Mertons and United Miners workings at the end of Year 5. **Figure 4.28** presents the results of that modelling. In summary, groundwater levels are expected to rise significantly during the first year following the cessation of mining operations, with the rate of recovery slowing after that period. AGE (2010) note that groundwater levels are expected to be fully recovered within 5 years of the completion of mining operations.

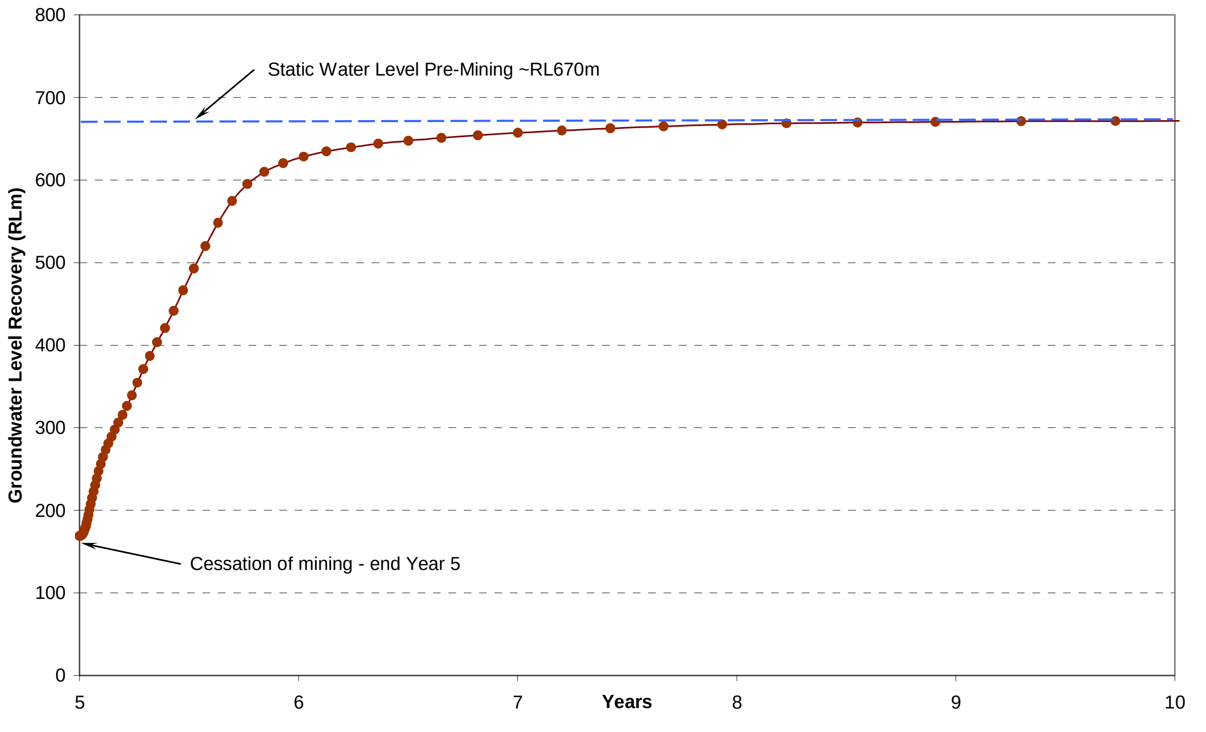


Figure 4.28
Anticipated Recovery of Groundwater Level – Dargues Reef Mine

Source: AGE (2010) – Figure 17.

In addition, Appendix 6 of AGE (2010) presents annual estimates of the groundwater drawdown contours during mining operations, namely Years 1 to 5, and following mining operations, namely Years 6 to 8. That modelling indicates that following the completion of mining operations and associated dewatering activities that the cone of depression shallows rapidly. This is reflected by the predicted rapid rise in water levels within the proposed Dargues Reef Mine. However, the extent of the cone of the depression remains broadly the similar during the Years 6 to 8 as it was during the final stages of mining operations. This is because the deepest sections of the lowered groundwater levels recover first, with the last few metres of recovery expected to take up to 5 years after the completion of mining operations to recover fully.

4.4.6 Monitoring

The Proponent would undertake the monitoring program identified in **Table 4.21** to provide on-going assessment of the impact of the Project and a proactive indicator of any adverse impacts on the groundwater regime, should they eventuate.

Table 4.21
Proposed Groundwater Monitoring Program

Monitoring Location[1]	Groundwater Level		Groundwater Quality		Pumping/discharge Volume
	Manual	Data loggers	Field	Laboratory	
Tailings storage facility piezometers	monthly			monthly	
Tailings storage facility collection pond	monthly			monthly	continuous
DRWB01	quarterly	Yes – 6 hourly	quarterly	6 monthly	
DRWB02	quarterly	Yes – 6 hourly	quarterly	6 monthly	
DRWB03	quarterly	Yes – 6 hourly	quarterly	6 monthly	
DRWB04	quarterly	Yes – 6 hourly	quarterly	6 monthly	
DRWB05	quarterly				
DRWB06	quarterly	Yes – 6 hourly	quarterly	6 monthly	
DRWB07	quarterly	Yes – 6 hourly	quarterly	6 monthly	
DRWB08	quarterly				
MCRC010	quarterly				
MCRC011	quarterly				
MCRC018	quarterly				
MCRC022	quarterly	Yes – 6 hourly			
MCRC029	quarterly	Yes – 6 hourly			
Snobs	quarterly		quarterly	6 monthly	continuous
Stewart & Mertons	quarterly				continuous
United Miners	quarterly		quarterly	6 monthly	continuous
Dargues Reef Mine			quarterly	6 monthly	continuous
Landowner Bores	quarterly		quarterly		
Note 1: See **Figure 4.16** for monitoring locations					
Source: AGE (2010) – Table 12.					

In summary, the monitoring program would include the following.

- Quarterly monitoring of groundwater levels in the bores, exploration holes and workings identified in **Table 4.21** using manual methods.
- Continuous monitoring of groundwater levels in 8 bores/exploration holes using an automated standing water level monitor to determine the groundwater response following rainfall events.
- Monthly monitoring of standing water levels and the following parameters within piezometers installed around the base of the tailings storage facility embankment and within the collection pond.
  - Alkalinity.
  - Major cations and anions.
  - Metals – (iron, lead, chromium, cadmium, zinc, arsenic, copper and nickel).
- Quarterly monitoring in the field of pH, temperature and EC of groundwater in the bores, exploration holes and workings identified in **Table 4.21.**
- Six monthly monitoring in the laboratory of groundwater in the bores, exploration holes and workings identified in **Table 4.21** for the following parameters.
  - Alkalinity.
  - Major cations and anions.
  - Nutrients – (ammonia, nitrate, nitrite).
  - Metals – (iron, lead, chromium, cadmium, zinc, arsenic, copper and nickel).
- Continuous monitoring of the volumes of all water pumped or permitted to flow around the Project Site using inline meters. This would include water pumped or permitted to flow:
  - from the Dargues Reef Mine to the surface and visa versa;
  - from the harvestable rights dams;
  - from the historic workings; and
  - to and from the tailings storage facility.

Data collected during the groundwater monitoring program would be reviewed on receipt and managed with other environmental monitoring data and would be reported in the Annual Environmental Management Report that would be prepared for the Project. In particular, the following would be implemented to ensure that adverse impacts associated with the Project are monitored and unexpected impacts identified and appropriate action implemented in a timely manner.

- Review of all data on receipt against previous monitoring results. Where the review indicates a sudden or unexpected change, then further investigations would be initiated.

- A formal assessment of the groundwater model would be undertaken within two years of the commencement of mining operations to ensure that the observed groundwater data matches the expected groundwater impacts.
- Annual analysis of monitoring data and trends in the site's Annual Environmental Management Report.
- If groundwater leakage from the tailings storage facility is identified during the monitoring program, relevant government agencies would be notified and amendments would be made to the tailings management procedures within the Project Site. These would ensure that measures would be implemented to reduce the volume of water discharged and to capture any water discharged for return to the tailings storage facility.

Finally, the frequency of monitoring and the parameters to be monitored would reviewed following the initial 12 months of the groundwater monitoring program.

4.5 SURFACE WATER

4.5.1 Introduction

The DGRs issued by the Department of Planning require that the *Environmental Assessment* include an assessment of "**soil and water -** *including a detailed site water balance and potential water quality impacts on the environment and other land users*"

Based on the risk assessment undertaken for the Project (see Section 3.3), specific surface water-related impacts that may result as a consequence of the Project (without the implementation of the safeguards, controls and mitigation measures presented in this section) include the following.

- Reduction in environmental flows.
- Pollution of downstream waters as a result of discharge of dirty, saline or contaminated water.
- Changes to hydrology of creeks and drainage lines.
- Changes to local flood regimes.
- Soil erosion and/or increased sediment load in waterways.

The surface water assessment was undertaken by Strategic Environmental and Engineering Consulting (SEEC). This section of the *Environmental Assessment* provides a summary of the assessment report which is presented in full as Part 4 (Volume 1) of the *Specialist Consultant Studies Compendium* and referred to hereafter as "SEEC (2010a)". It is noted that SEEC also prepared the Soils and Land Capability Assessment. That report, presented in full as Part 8 (Volume 2) of the Specialist Consultants Studies Compendium and referred to as SEEC (2010b), includes data relied upon during the assessment of surface water related impacts.

The surface water assessment was managed by Mr Andrew Macleod BSc(Hons), CPSS, CPESC of SEEC.

4.5.2 Existing Environment

4.5.2.1 Local and Project Site Drainage and Catchments

The existing drainage and catchments within and surrounding the Project Site are described in detail in Section 4.1.2 and are shown on **Figures 4.2** and **4.3**. In summary, the southern section of the Project Site occurs within the Moruya Catchment, with surface waters draining to Majors Creek, either directly or via Spring Creek.

Surface waters within the northern-most section of the Project Site, within the Shoalhaven Catchment, flow generally northwards, merging with the Shoalhaven River, again, either directly or via Jembaicumbene or Back Creeks. It is noted that no surface disturbing activities are proposed within the Shoalhaven Catchment. As a result, the Surface Water Assessment has focused on surface water impacts within the Moruya Catchment. It is, however, noted that the Groundwater Assessment has determined that, at the end of the mining operations, the extent of groundwater impacts would extend into the Shoalhaven Catchment and may result in marginally reduced surface water flows within that catchment. These impacts, however, would be temporary, with groundwater levels expected to be largely recovered within 1 year of the cessation of mining operations and fully recovered within 3 years.

4.5.2.2 Existing Water Storages and the Proponent's Harvestable Right

Figure 4.3 presents the existing surface water storages within the Project Site. In summary, SEEC (2010a) estimate that to total volume of existing surface water storages within the Project Site is approximately 9ML.

As indicated in Section 2.2.4, the Proponent proposes to construct 8 dams to harvest surface water for use for mining-related purposes. Those dams would be constructed in accordance with the Proponent's Harvestable Right which, based on the location and size of the Project Site, permit extraction of water from dams on ephemeral first or second order streams with a total capacity of 34.5ML. Construction of those dams forms a component of this application and construction and management of the dams is described in detail in Section 2.2.4.

4.5.3 Assessment Criteria

The *Moruya River Water Quality and River Flow Objectives*, published by NOW, identifies Majors and Spring Creeks as "uncontrolled streams" and "upland rivers". **Table 4.22** presents the water quality and river flow criteria that have been adopted as part of this assessment. These are based on the objectives identified in the above document.

4.5.4 Management and Mitigation Measures

The following management and mitigation measures would be implemented to minimise the potential for adverse Project-related impacts on surface waters within and surrounding the Project Site. For convenience, these measures have been divided into general management and mitigation measures, sediment and erosion control measures and water quality measures. Proposed surface water monitoring is described in Section 4.5.7.

Table 4.22
Relevant Water Quality and River Flow Objectives

Objective	Indicator	Criteria
Water Quality Objectives		
Aquatic Ecosystems	Total phosphorus	20 µg/L
	Total nitrogen	250 µg/L
	Salinity (electrical conductivity)	30–350 µS/cm
	Turbidity	2–25 NTU
	pH	6.5–8.0
	Chemical contaminants or toxicants	Based on ANZECC 2000 Guidelines
	Biological assessment indicators	Based on ANZECC 2000 Guidelines
Visual Amenity	Visual clarity and colour	Natural visual clarity should not be reduced by more than 20%.
Primary and Secondary Contact Recreation	Faecal coliforms	No significant Project-related adverse change
	Enterococci	
	Algae & blue-green algae	
	Nuisance organisms	
	Chemical contaminants	
	Visual clarity and colour	
	Surface films	
Livestock water supply	Algae & blue-green algae	No significant Project-related adverse change
	Salinity (electrical conductivity)	
	Thermotolerant coliforms (faecal coliforms)	
	Chemical contaminants	
River Flow Objectives		
Protect pools in dry times	Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flows.	No significant Project-related adverse change
Protect natural low flows	Protect natural low flows	
Protect important rises in water levels	Protect or restore a proportion of moderate flows (‘freshes’) and high flows.	
Maintain wetland and floodplain inundation	Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems.	
Mimic natural drying in temporary waterways	Mimic the natural frequency, duration and seasonal nature of drying periods in naturally temporary waterways.	
Maintain natural flow variability	Maintain or mimic natural flow variability in all streams.	
Maintain natural rates of change in water levels	Maintain rates of rise and fall of river heights within natural bounds.	
Manage groundwater for ecosystems	Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems.	
Minimise effects of weirs and other structures	Minimise the impact of instream structures.	
Minimise effects of dams on water quality	Minimise downstream water quality impacts of storage releases.	
Make water available for unforeseen events	Ensure river flow management provides for contingencies.	
Maintain or rehabilitate estuarine processes and habitats	Maintain or rehabilitate estuarine processes and habitats.	

Source: After *Moruya River Water Quality and River Flow Objectives*, published by NOW and SEEC (2010a) - Tables 10 and 11

General Management and Mitigation Measures

- Prepare a detailed *Surface Water, Sediment and Erosion Control Plan,* including a description of surface water management structures and procedures to ensure that the criteria identified in Section 4.4.3 and any additional criteria included in the Environment Protection Licence or project approval, assuming that they are granted, are achieved.
- Ensure that the site access road is treated using chemical dust suppressants or similar to ensure that regular watering is not required.

Sediment and Erosion Control Measures

- Ensure that best-practice erosion and sediment control measures as identified in Landcom (2004) and DECC (2008) are implemented during both the construction and operational stages of the Project.
- Construct appropriate sediment basins of sufficient size to contain a five-day, 75^{th} percentile rain depth of 18mm during construction of the Project and a 20-day, 90^{th} percentile rain depth of 73.7mm during operation of the Project.
- Ensure that sediment basins have a minimum of 0.6m of freeboard and a spillway that is sized and lined for stability in a 100-year annual recurrence interval (ARI) rain event.
- Ensure that water discharged from the sediment basins has a total suspended sediment concentration of less than 50mg/L. SEEC (2010a) notes that achieving this commitment may require flocculation.
- Ensure that accumulated water within sediment basins is removed from the basins within 5 days of the end of a rain event.
- Ensure that water within the sediment basins is not used for mining-related activities unless the volume of the sediment basins have been included in the harvestable right calculations.
- Ensure that the upper limit of the Sediment Storage Zone, as defined in Landcom (2004), is identified with a peg and accumulated sediment removed as required.
- Ensure that surface water flows are diverted away from disturbed areas and that potentially sediment-laden flows from disturbed areas are diverted to sediment basins. All diversion structures would be sized and lined for stability in a 10-year ARI time-of-concentration rain event during construction of the Project and the 20-year ARI time-of-concentration rain event during operation of the Project.
- Ensure that disturbed areas are stabilised through the use of vegetation or artificial covers to achieve a long-term C-factor of 0.05 (equivalent to 70% grass cover). Where such areas are to be subjected to channelized water flows, they should be stabilised within 10 days of completion of construction and before they convey any flows.

- Inspect all surface water control structures at least quarterly and following any rainfall event of more than 10mm in 24-hours to ensure their adequacy and identify where remedial action is required.
- Ensure that all roads within the Project Site are constructed in accordance with DECC (2008b).
- Construct table drains along the sides of roads within the Project Site, with regular turn-out drains constructed at-grade approximately every 50m.
- Continue to maintain and upgrade, as required, the existing soil conservation measures in areas of active and stabilised gullying.

Water Quality Measures

- Ensure that the tailings storage facility is effectively sealed to prevent leakage.
- Ensure that potential surface water run on onto the tailings storage facility is diverted around the facility using a surface water diversion structured designed to effectively convey the 100-year ARI, time-of-concentration flow from the upstream catchment.
- Ensure that all fuel and chemical storage, delivery and handling areas are appropriately sealed and bunded and that overflow pipes are installed in a manner that would minimise the potential for pollution in the event of overfilling.

4.5.5 Site Water Balance

4.5.5.1 Introduction

In order to demonstrate a suitable water supply for the Project, SEEC (2010a) prepared a water balance. This sub-section provides an overview of the proposed water sources, the Project's water requirements, the modelling methodology and the results of that modelling.

4.5.5.2 Water Requirements

As described in Section 2.10.2.6, the Project would require a maximum of approximately 130ML of water per year, principally for processing operations. Other water uses would include underground operations, equipment wash down, etc.

It is noted that as the majority of mining-related water is for processing operations, the amount of makeup water required will be proportional to the mine's production rate. As noted in Section 2.4.6, production is anticipated to increase from approximately 161 000t/year in Year 1 to a maximum production rate of approximately 354 000t/year in Year 4 before decreasing to approximately 108 000t/year in Year 5. As a result, the amount of makeup water that would be required would also increase to a maximum of approximately 130ML/year, in Year 4 before decreasing towards the end of the life of the Project. For the purposes of this assessment, the maximum water requirement of 130ML/year has been assumed.

In addition to the above makeup water requirements, the Proponent would require water for dust suppression operations. SEEC (2010a) estimate that based on an assumed 3ha of exposed, unsealed surfaces and a watering requirement of 4mm/m^2/day, that approximately 0.12ML/day of water would be required for dust suppression purposes. Taking into account the fact that dust suppression is only required on non-rain days, SEEC (2010a) estimate that approximately 18.4ML /year would be required for dust suppression purposes.

Finally, as identified in Section 4.4.3, the Proponent proposes to release water at the confluence of Majors and Spring Creeks at the rates identified in **Table 4.20** to compensate for the expected Project-related reduction in groundwater discharge to those creeks. That water would be released from the commencement of mining operations until 2 years after the cessation of mine dewatering operations.

As a result, the anticipated maximum Project-related water requirement would be approximately 215ML/year.

4.5.5.3 Water Sources

As indicated in Section 2.10.2.6, the Proponent would obtain the required make up or new water for mining-related purpose from the following sources.

1. Groundwater that would be removed from the proposed Dargues Reef Mine during mining operations. This water would be preferentially used for mining-relate purposes
2. Surface water from the proposed harvestable rights dams, to be preferentially used for environmental flows.
3. Groundwater from the historic Snobs, Stewart and Mertons and United Miners workings, to be preferentially used for mining-related purposes.

The Groundwater Assessment (AGE, 2010) determined that between 9L/s and 10L/s of groundwater would flow into the proposed Dargues Reef Mine during construction of the decline, reducing to approximately 7L/s during the final stages of mining operations (see Section 4.4.5.1 and **Figure 4.23**). However, the Proponent anticipates that water losses associated with circulation of mine ventilation air and removal of broken rock from the mine would account for approximately 1L/s of that water. In addition, further water losses are expected as a result of water retention within the proposed mine. As a result, for the purposes of this water balance, the Proponent has conservatively assumed that 4L/s, or 126ML/year, of water would be required to be removed from the proposed mine and would therefore be available for mining-related purposes.

As a result, additional water would be required for mining-related purposes from other sources. The Proponent anticipates that this water would preferentially be drawn from the historic Snobs, Stewart and Mertons and United Miners workings (**Figure 2.3**). A maximum of 79ML/year of water would be extracted from the historic workings.

The maximum water requirement for mining-related purposes is anticipated to be approximately 148ML. The proposed Dargues Reef and historic workings are conservatively estimated to be capable of providing approximately 205ML/year. As a result, these sources are expected to be able to adequately supply the Project's mining-related water requirements. The Proponent would be able to adjust extraction rates from the historic workings to ensure that there is not an oversupply of water that would be required to be discharged.

In addition, the Proponent would preferentially extract water for environmental release from each of the harvestable rights dams in a manner that would draw each down at approximately the same rate. As indicated in Section 2.2.4, the Proponent proposes to construct eight dams under its harvestable right. These dams, together with all other water storages within the Project Site, with the exception of the tailings storage facility, would have a combined volume of less than 34.5ML. SEEC (2010a) undertook an assessment of the capacity of the proposed dams to provide sufficient water for the proposed environmental flows.

4.5.5.4 Modelling Methodology

The water balance was determined using software developed by SEEC called RATES. That software uses 100 years of daily rainfall data and takes into account the daily runoff, infiltration, evaporation and water demand patterns. Section 5.3.1 of SEEC (2010a) presents the assumptions and inputs used during the modelling. In summary, these are as follows.

- Initial rainfall loss of 5mm per day and ongoing rainfall loss of 85% to account for infiltration and groundwater recharge.
- Daily rainfall records from the Bureau of Meteorology's Braidwood Wallace Street station from 1 January 1903 to 31 December 2002. Evaporation data have also been drawn from this station. No shading or covering to reduce evaporation of water storages is assumed.
- Water removed for environmental releases sourced from the proposed harvestable right dams at a maximum rate of 2.1L/s or 66/2ML/year.
- In the event that water is not available from the harvestable rights dams then water for environmental releases is sourced from the historic workings.

4.5.5.5 Modelling Results

The results of the water balance modelling are presented in Section 5.3.2 of SEEC (2010a) and may be summarised as follows.

- The primary and secondary water sources provided sufficient water for the proposed mining operations for 86.5% of days modelled.
- During the driest year in the 100 years modelled, approximately 66ML of water would have been required to have been drawn from the historic workings for a maximum of 270 days. It is noted that the Groundwater Assessment assumed groundwater extraction from the historic workings of 78.8ML/year.
- On average, approximately 12ML/year of water would be required to be drawn from the historic workings.

4.5.5.6 Conclusion

In summary, the modelling indicates the following.

- During the 100 year modelling period, the harvestable right dams would be able to supply water for environmental flows 97% of the time.
- During the driest year on record, the harvestable right dams would have run dry for a total of 182 days and approximately 33ML would have been reqired to be drawn from the historic workings. As noted in Section 5.5.4.3, there would be sufficient capacity from the historic workings to meet that demand even at maximum production.
- The harvestable rights dams would have been able to supply 100% of the water for environmental releases on 71 or the 100 years modelled.

Finally, SEEC (2010a) notes that the results of the water balance modelling are conservative for the following reasons.

- The modelling assumes a constant rate of release of 2.1L/s. In reality, that rate of release would vary in accordance with the identified rates in **Table 4.20.**
- It is probability that the period during which the maximum rate of release would coincide with a year with rainfall similar to the driest year in the 100 year modelled is low.

4.5.6 Assessment of Impacts

4.5.6.1 Introduction

This sub-section provides an overview of the surface water impact assessment presented in SEEC (2010a). The sub-section focuses particularly on anticipated sediment and erosion control and water quality and river flow-related impacts and the modelling undertaken to determine the anticipated impacts.

4.5.6.2 Sediment and Erosion Control

The susceptibility of soils within the Project Site to erosion was determined based on information obtained during the soils assessment presented in (SECC (2010b)). The erosion hazard was determined using the Revised Universal Soil Loss Equation (RUSLE). That assessment predicted the following.

- An annual soil loss of 260t/ha/year (Soil Loss Class 3 – moderate erosion hazard) over the area proposed for the access road, box cut and processing infrastructure. This equates, in the absence of adequate control measures, to a potential impact of 6 630t/year of soil erosion.
- An annual soil loss of 576t/ha/year (Soil Loss Class 5 – high erosion hazard) on steeper land within the footprint the proposed tailings storage facility. This equates to 7 488t/year of soil erosion in the absence of adequate control measures.

SEEC (2010a) state that the potential sediment and erosion control risks may be adequately managed through implementation of the mitigation and management measures identified in Section 4.5.4 of this document and Section 7.1 of SEEC (2010a). As a result, SEEC (2010a) conclude that Project-related sediment and erosion control impacts would not be significant.

4.5.6.3 Modifications to Drainage Paths

It is noted that the tailings storage facility would be constructed in the headwaters of an unnamed ephemeral drainage line that forms a tributary to Spring Creek. As identified in Section 2.7.2, the floor and embankment of the facility would have a permeability of less than $1x10^{-9}$m/day. In addition, surface waters from upslope of the facility would be diverted around the facility and would be directed to natural drainage downstream of the facility within the same catchment.

In light of the above, SEEC (2010a) indicate that the modification of the natural drainage path would be very localised and would not divert any water from one catchment to another. As a result, the impact would not be significant.

4.5.6.4 Modifications to Groundwater Recharge

SEEC (2010a) note that the Project would result in construction of a number of areas of impervious surfaces, including roads, hardstand and concrete areas and buildings. As a result, groundwater recharge may be marginally reduced during the life of the Project. However, as these structures would be largely removed at the end of the Project, the pre-mining recharge rates would be re-established. As a result, reduced recharge-related impacts would be temporary and would not be significant. In addition, any temporary impacts would be compensated for by the return of approximately 2.1L/s of base flow at the confluence of Majors and Spring Creeks.

4.5.6.5 Discharge of Pollutants

Introduction

SEEC (2010a) assessed the existing surface water quality and the anticipated surface water quality following development of the Project using the computer program *Model for Urban Stormwater Improvement Conceptualisation* (MUSIC). This sub-section provides an overview of the methodology used during that modelling and the results of the assessment.

Modelling Methodology

The following assumptions were used during modelling of surface water quality.

- The MUSIC modelling domain was established based on a proposed area of disturbance of approximately 24ha (the proposed disturbance area). It is noted that the proposed tailings storage facility and box cut were excluded from modelling because both structures would be internally draining.
- Climate assumptions used during the modelling were prepared by the Sydney Catchment Authority for the Shoalhaven Catchment. Section 6.2.5.3 of SEEC (2010a) presents a detailed overview of the climate assumptions used.
- Land use was assumed to be agricultural, with 99% of the modelled area assumed to be pervious.

- Infiltration rates were based on Macleod (2008) and assumed 0.5m of sandy loam. SEEC (2010a) state that the properties of the two soil landscape units observed within the Project Site, namely the Braidwood and the Bushy Hill Soil Landscape Units (see Section 4.12) were sufficiently similar to allow them to be treated as a single unit for the purposes of the surface water quality modelling.
- Assumed water quality parameters from disturbed sections of the Project Site are presented in Table 8 of SEEC (2010a), which, in turn is based on water quality parameters prepared by the Sydney Catchment Authority for the Shoalhaven Catchment.
- Sediment basins were assumed to be constructed and operated in accordance with Landcom (2004) and DECC (2008a) requirements. The total assumed capacity of the basins was 6 000m^3, with a surface area of 4 000m^2.
- The site access road was assumed to be constructed in accordance with DECC (2008b), including roadside table drains with at-grade turn-out drains every 50m on both sides of the road. The site access road was assumed to be 75% impervious.
- The offices, processing areas, workshops, yards, storage areas and haul road were assumed to have an effective impervious area that is 50% of their total area.
- The roofs of buildings were assumed to be plumbed into an 40 000L rainwater tank and that water was assumed to be used at a rate of 2 835L/day, based on the anticipated number of employees.

Modelling Results

Table 4.23 presents the results of the MUSIC modelling. The results may be summarised as follows.

- Water flow – the Project is expected to increase annual surface water flows by 1.3% or approximately 1.7ML/year. SEEC (2010a) state that this increase is not significant.
- Total suspended solids – the Project is expected to reduce the amount of suspended solids discharged annually from the proposed disturbance area by approximately 85% or 6 860kg/year.
- Total phosphorus – the Project is expected to reduce the amount of phosphorus discharged annually from the proposed disturbance area by approximately 72% or 17.12kg/year.
- Total nitrogen – the Project is expected to reduce the amount of nitrogen discharged annually from the proposed disturbance area by approximately 52% or 84.1kg/year.
- Gross pollutants – the Project is expected to reduce the amount of gross pollutants or large material such as vegetation or rubbish to nil.

Table 4.23
MUSIC Modelling Results

MUSIC Model Number	Description	Flow (ML/yr)	TSS[1] (kg/yr)	TP[1] (kg/yr)	TN[1] (kg/yr)	GP[1] (kg/yr)
1	Pre-development	48.1	8,050	23.9	161	23.3
2	Operational stage without surface water management	64.4	24,300	21.9	137	1,810
3	Operational stage including surface water management	49.8	1,190	6.78	76.9	0
2 vs 3	Treatment Train Effectiveness	-23%	-95%	-69%	-44%	-100%
1 vs 3	Pre-development vs Operational stage comparison	+3.5%	-85%	-72%	-52%	-100%
Note 1: TSS = total suspended solids; TP = total phosphorus; TN = total nitrogen; GP = gross pollutants						
Source: SEEC (2010a) – Table 9.						

4.5.6.6 Compliance with Moruya River Water Quality and River Flow Objectives

Table 4.24 presents a summary of the assessment of Project-related impacts against the Moruya River Water Quality and River Flow Objectives.

Table 4.24
Impact Assessment - Moruya River Water Quality Objectives

Page 1 of 3

Objective	Indicator	Impact Assessment
Water Quality Objectives		
Aquatic Ecosystems	Total phosphorus	The Project would result in reduced discharge of phosphorus, nitrogen and suspended solids
	Total nitrogen	
	Turbidity	
	Salinity (electrical conductivity)	Project Site soils are non saline. As a result, Project-related impacts would be negligible.
	pH	There are no known acid generating materials within the Project Site and the Project's EPL would control the pH of discharge water. As a result, Project-related impacts would be negligible.
	Chemical contaminants or toxicants	All contaminants would be appropriately contained. As a result, Project-related impacts would be negligible.
	Biological assessment indicators	The Project is unlikely to discharge waters which might affect riparian ecology. In addition, natural base- and storm-flow regimes would be maintained to limit potential ecological impacts. As a result, Project-related impacts would be negligible.
Visual Amenity	Visual clarity and colour	Suspended sediment loads are predicted to be reduced. As a result, Project-related impacts would be negligible.

Table 4.24 (Cont'd)
Impact Assessment - Moruya River Water Quality Objectives

Page 2 of 3

Objective	Indicator	Impact Assessment
Water Quality Objectives (Cont'd)		
Primary and Secondary Contact Recreation	Faecal coliforms	Modelling predicts a beneficial effect on water quality because of the reduction in pollutants presently generated by agricultural land uses. As a result, Project-related impacts would be negligible.
	Enterococci	
	Chemical contaminants	
	Visual clarity and colour	
	Algae & blue-green algae	
	Nuisance organisms	The Project is unlikely to discharge waters which might affect biological activity or create conditions that might increase the numbers of nuisance organisms. As a result, Project-related impacts would be negligible.
	Surface films	Suspended sediment and gross pollutant loads are predicted to be reduced. As a result, Project-related impacts would be negligible.
Livestock water supply	Algae & blue-green algae	The Project is unlikely to modify water quality or flow conditions that might encourage algal growth. As a result, Project-related impacts would be negligible.
	Salinity (electrical conductivity)	Project Site soils are non saline. As a result, Project-related impacts would be negligible.
	Thermotolerant coliforms (faecal coliforms)	The Project would be unlikely to modify water quality or flow conditions that might increase the levels of thermotolerant coliforms. As a result, Project-related impacts would be negligible.
	Chemical contaminants	All contaminants would be appropriately contained. As a result, Project-related impacts would be negligible.
River Flow Objectives		
Protect pools in dry times	Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flows.	AGE (2010) estimate that the Project could reduce the base flow in Majors and Spring Creeks by up to 2.1L/s due to reduced groundwater discharge. This, however, would be mitigated through a compensatory discharge of 2.1L/s.
Protect natural low flows	Protect natural low flows	
Protect important rises in water levels	Protect or restore a proportion of moderate flows ('freshes') and high flows.	The Project would not involves any harvesting of surface above the Proponent's existing Harvestable Right. As a result, Project-related impacts would be negligible.
Maintain wetland and floodplain inundation	Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems.	The Project would not significantly alter existing surface water runoff within the Project Site. As a result, Project-related impacts would be negligible.
Mimic natural drying in temporary waterways	Mimic the natural frequency, duration and seasonal nature of drying periods in naturally temporary waterways.	The Project would be unlikely to impact the existing frequency, duration or seasonality of drying periods in creeks within the Project Site. As a result, Project-related impacts would be negligible.
Maintain natural flow variability	Maintain or mimic natural flow variability in all streams.	

Table 4.24 (Cont'd)
Impact Assessment - Moruya River Water Quality Objectives

Page 3 of 3

Objective	Indicator	Impact Assessment
River Flow Objectives (Cont'd)		
Maintain natural rates of change in water levels	Maintain rates of rise and fall of river heights within natural bounds.	The Project would increase the amount of impervious surfaces within the Project Site. However, proposed sedimentation basins would act to temporarily detain that additional runoff. As a result, Project-related impacts would be negligible.
Manage groundwater for ecosystems	Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems.	Groundwater inflows into Majors and Spring Creeks are expected to be reduced by approximately 2.1L/s. However, the Proponent proposes to release approximately 2.1L/s as a compensatory flow, into Majors Creek. As a result, Project-related impacts would be negligible.
Minimise effects of weirs and other structures	Minimise the impact of instream structures.	No instream structures, other than those permitted under the Proponent's Harvestable Right and the tailings storage facility, would be constructed.
Minimise effects of dams on water quality	Minimise downstream water quality impacts of storage releases.	Not applicable. Any releases of water from small, harvestable-right dams on the Project Site would be via the surface-level overflow.
Make water available for unforeseen events	Ensure river flow management provides for contingencies.	Surface water harvesting would only be up to the Proponent's Harvestable Right and groundwater losses would be either negligible or compensated from through a compensatory release of 2.1L/s to Majors Creek. As a result, Project-related impacts would be negligible.
Maintain or rehabilitate estuarine processes and habitats	Maintain or rehabilitate estuarine processes and habitats.	Not applicable.
Source: SEEC (2010a) – After Section 6.2.6		

4.5.6.7 Erosion Management

It is noted that the Proponent and preceding owners of the land within the northern section of the Project Site have undertaken soil conservation works in the vicinity of areas of active gullying on Spring Creek. These works have partially stabilised the gullies and the Proponent would continue to implement and maintain such works. As a result, SEEC (2010a) state that the Project would not result in any significant adverse soil conservation or erosion management-related impacts.

4.5.6.8 Sewage Management

As indicated in Section 2.8, a biocycle or similar sewage treatment plant would be installed within the Project Site to appropriately treat waste water generated by the Proponent's employees and contractors. This would result in treated effluent being used to irrigate sections of the Project Site. SEEC (2010a) state that soils within the Project Site are well suited to surface or near-surface irrigation of treated wastewater.

4.5.7 Monitoring

The Proponent would prepare a detailed *Surface Water, Sediment and Erosion Control Plan*, including surface water monitoring. In summary, the surface water monitoring program would be undertaken at the following locations (**Figure 4.3**).

- Location 1 – Majors Creek upstream of the confluence of Spring and Major's Creek.
- Location 2 – Majors Creek downstream of the confluence of Spring and Major's Creek.
- Location 3 – downstream of the tailings storage facility. It is noted that this sampling location would be incorporated into the *Tailings Management Plan*.
- Location 4 – Spring Creek downstream of main Project infrastructure and sediment basin outlets.
- Compensatory flow discharge point.

Sampling would be undertaken quarterly for the following.

- Field measurements.
  - Field pH.
  - Field Electrical Conductivity.
  - Dissolved Oxygen.
  - Oxidation Reduction Potential.
  - Temperature.
- Laboratory analysis.
  - pH.
  - Electrical Conductivity.
  - Total Suspended Solids.
  - Major cations i.e. sodium, potassium, calcium.
  - Major anions i.e. chloride and sulphate.
  - Total Kjeldahl Nitrogen (organic nitrogen plus ammonia nitrogen).
  - Total Oxidized Nitrogen (also referred to as NOx-N = nitrate + nitrite nitrogen forms).
  - Ammonia Nitrogen.
  - Total Phosphorus and Reactive Phosphorus.
  - Metals (aluminium, arsenic, total iron and filterable iron, zinc).

In addition, the Proponent would monitor the volume of water discharged as part of the Proponent's commitment to implement a compensatory base flow within Majors Creek. The results of the monitoring program would be presented in the *Annual Environmental Management Report* that would be prepared for the Project.

4.6 ABORIGINAL HERITAGE

4.6.1 Introduction

The DGRs issued by the Department of Planning require that the *Environmental Assessment* include an assessment of "***Heritage** – both Aboriginal and non-Aboriginal*". In addition, the DECCW and Palerang Council identified key issues to be assessed in relation to Project-related impacts on Aboriginal heritage (see **Appendix 2**).

Based on the risk assessment undertaken for the Project (see Section 3.3), specific Aboriginal heritage-related impacts that may result as a consequence of the Project (without the implementation of the safeguards, controls and mitigation measures presented in this section) include the following.

- Destruction of impacted site.
- Cumulative reduction of the in-situ archaeological record.
- Loss or destruction of items of heritage significance.

An Aboriginal Heritage Impact Assessment has been completed by Mr John Appleton (BA (Hons)) of Archaeological Surveys & Reports Pty Ltd to address the DGRs and assess the impact of the Project on items of Aboriginal heritage significance. That report, which is referred to hereafter as ASR (2010a) is presented in full as Part 5a (Volume 2) of the *Specialist Consultant Studies Compendium.* This section of the *Environmental Assessment* provides a summary of that report. It is noted that Mr Appleton also undertook the Non-Aboriginal Heritage Assessment (ASR, 2010b) which is discussed in detail in Section 4.7.

4.6.2 Consultation with the Aboriginal Community

4.6.2.1 Relevant Guidelines

ASR (2010a) states that consultation with the Aboriginal community was undertaken in accordance with the document *Guidelines for Aboriginal Cultural Heritage Impact and Community Consultation* published by then Department of Environment and Climate Change in 2005 (the 2005 Guidelines). It is noted that the DECCW has subsequently released further consultation guidelines, namely *Aboriginal Cultural Heritage Consultation Requirements for Proponents* dated April 2010 (the 2010 Guidelines).

As indicated in Section 4.6.2.2, ASR commenced consultation with the Aboriginal community in January 2010. In addition, the Planning Focus Meeting for the Project was held on 18 March 2010. As a result, the Aboriginal heritage assessment was substantially commenced prior to the commencement of the 2010 Guidelines. Finally, the DGRs issued by the Department of Planning on 23 April 2010 and the Environmental Assessment Requirements issued by the DECCW 1 April 2010 both require that consultation be undertaken in accordance with the 2005 Guidelines.

4.6.2.2 Consultation Program

The following presents a summary of the consultation undertaken for the Aboriginal Heritage Impact Assessment. For convenience, the description of the consultation activities has been divided into stages 1 to 4 in accordance with the descriptions provided in the 2005 and 2010 Guidelines.

Stage 1 – Notification and Registration of Interest

On 10 February 2010 ASR wrote to the following organisations requesting that they provide lists of Registered Aboriginal Stakeholders. Responses were received from those organisations marked with an asterisk.

- the Office of the Registrar administering the *Aboriginal Land Rights Act 1983**;
- the Aboriginal Heritage Planning Officer, DECCW (Dubbo);
- Palerang Council*; and
- NSW Native Title Services.

In addition, an advertisement was placed in the *Tallaganda News* (published 3 February 2010), the *Queanbeyan Age* (published 5 February 2010) and the *Canberra Times* (published 30 January 2010) inviting all Aboriginal stakeholders with an interest in the Project to register their interest.

As a result of the above, the following 11 organisations or individuals were identified as potentially having an interest in the Project.

- Ngunawal Elders Corporation.
- Ngunawal Heritage Aboriginal Corporation.
- Buru Ngunawal Aboriginal Corporation Traditional Carer Group.
- Konanggo Aboriginal Cultural Heritage Services.
- Yurwang Gundana Consultancy Cultural Heritage Services.
- King Browns Tribal Group Pty Ltd.
- Bega Traditional Elders Council (formerly Yulembruk Merung Ngarigo Consultancy Pty Ltd).
- Walbunja Aboriginal Corporation.
- Batemans Bay LALC.
- Ngambri LALC.
- Little Gudgenby River Tribal.

A letter was provided to each of the above on 22 March 2010 providing.

- an overview of the Project; and
- a suggested survey methodology.

As a result of the consultation, one of the registered organisations, namely the Ngambri Local Aboriginal Land Council (LALC) withdrew from the consultation process. Responses indicating a desire to be consulted and participate in the survey were received from the remaining registered organisations.

Stage 2 – Presentation of Information about the Project

During Stage 1, ASR contacted or was contacted by a number of the registered organisations in relation to the Project and the proposed survey methodology. As a result of that consultation, it became apparent that there was 'some differences of opinion' between some of the stakeholders. ASR concluded that that holding a meeting to discuss the Project would only lead to even greater animosity. As a result ASR elected to provide the information that would otherwise have been presented at a stakeholder meeting by mail. That information was presented in the letters described in Stage 1 and sent on 22 March 2010.

During preparation for the survey, ASR agreed with the registered stakeholders that it would be appropriate that each would be engaged in the survey for 1 day.

Stage 3 – Gathering Information about Cultural Significance

Section 4.6.4 presents an overview of the survey methodology used during the field survey and Section 4.6.5 presents a summary of the results of the field survey which was undertaken between Tuesday 4 May and Monday 10 May 2010.

In addition, following completion of the field survey, each of the registered stakeholders who assisted with the survey were requested to provide a written summary of the results of the survey on the day that they attended and an overview of any additional relevant information for inclusion in the Aboriginal Heritage Impact Assessment. The following registered stakeholders provided written responses. Responses were accepted up until the draft report was finalised on 27 July 2010.

- Konanggo Aboriginal Cultural Heritage Services.
- Ngunawal Heritage Aboriginal Corporation.
- Buru Ngunawal Aboriginal Corporation.

None of the responses included any additional information other than the information obtained during the field survey.

Stage 4 – Review of Draft Cultural Heritage Assessment Report

A draft hard copy of the Aboriginal Heritage Assessment report was provided to each of the registered stakeholders on 2 August 2010, with a request to review the report and provide feedback by close of business 1 September 2010. As of 3 September 2010, responses had been received from the following organisations and individuals. Copies of that correspondence is presented in Appendix xiii of ASR (2010a) and feedback and recommendations included in that correspondence has been considered during finalisation of ASR (2010a).

- Buru Ngunawal Aboriginal Corporation.
- Ngunawal Heritage Aboriginal Corporation.
- Batemans Bay Local Aboriginal Land Corporation.

4.6.3 Previously Identified Sites and Predictive Model

4.6.3.1 Previously Identified Sites

A search was made of the Aboriginal Heritage Information Management System (AHIMS) Site Register maintained by the Culture and Heritage Division of DECCW for all sites within a search area of 5km east-west and 6km north-south, centred on the Project Site.

The search identified one site, an open camp site, located to the west of Red Hill outside the Project Site. ASR (2010a) states that this is probably an artefact scatter.

No other relevant surveys were identified by ASR (2010a).

4.6.3.2 Predictive Model

In developing a predictive model for site distribution within the Project Site, ASR (2010a) notes that the following factors are likely to affect the distribution of items of Aboriginal heritage significance.

- The location(s) where Aboriginal people are most likely to have been.
- The location(s) where Aboriginal people were most likely to have left evidence of their activities.
- The degree to which remaining evidence is observable in the present record.

ASR (2010a) note that Aboriginal people would have been most likely to visit those areas that were richest in resources, including available water, food resources, stone raw material sources, shelter, suitable surfaces for rock art and proximity to mythological natural features. In addition, Aboriginal people would have been likely to have visited areas along identified access or travel routes. ASR (2010a) state that the Project Site contains:

- no reliable water source;
- no exposures of suitable store raw material;
- no rock overhangs; and
- in the absence of both water and shelter, there were unlikely to be any places where potential archaeological deposits (PADs)would be likely to occur.

In addition, ASR (2010a) notes that the Project Site has been extensively disturbed. This disturbance included large scale clearing of vegetation, large and small scale alluvial and hard rock mining, establishment (and abandonment) of settlements and other structures and ongoing agricultural and mineral exploration-related operations. Also, as indicated in Section 4.1.2.3, erosion within the Project Site is a naturally active process that has been exacerbated by previously land use practices. As a result, the potential for the preservation of objects of Aboriginal heritage significance has been reduced, although some ground disturbing activities may actually expose artefacts that may not otherwise have been visible.

As a result, ASR (2010a) propose the following predictive model for sites of Aboriginal heritage significance within the Project Site.

- Isolated artefacts - may be present and visible anywhere.

- Low-density artefact scatters - may be present and visible anywhere, however debitage would be unlikely to be visible.
- Scarred and carved trees – may occur on any trees over 150 years old.
- Engravings and/or grinding grooves – unlikely to occur.
- PADs– unlikely to occur.
- Shelters, overhangs and art sites – unlikely to occur.
- Stone quarries – unlikely to occur.
- Shell middens – unlikely to occur.
- Burials – unlikely to occur.
- Bora rings – unlikely to occur.
- Stone arrangements – unlikely to occur.
- Cultural associations – none are known.

4.6.4 Survey Methodology

The field survey was undertaken from Tuesday 4 May to Monday 10 May 2010. As indicated in Section 4.6.2.2, 10 Aboriginal organisations requested to participate in the survey. As there was 'some differences of opinion' between a number of the organisations and individuals who registered an interest in the Project, ASR (2010a) arranged for each organisation to provide a representative for one day of the survey. **Table 4.25** presents the agreed roster for the survey. Those organisations marked with an asterisk did not arrive for the survey as agreed.

Table 4.25
Survey Roster

Date	Organisation
4 May 2010	• Ngunawal Heritage Aboriginal Corporation* • Buru Ngunawal Aboriginal Corporation Traditional Carer Group*
5 May 2010	• Konanggo Aboriginal Cultural Heritage Services* • Walbunja Aboriginal Corporation
6 May 2010	• Bega Traditional Elders Council* • Batemans Bay LALC*
7 May 2010	• Ngunawal Elders Corporation • Yurwang Gundana Consultancy Cultural Heritage Services
10 May 2010	• King Browns Tribal Group Pty Ltd • Little Gudgenby River Tribal
Note 1: * indicates an organisation that participated in the survey.	
Source: ASR (2010a) – After Section 6.1	

At the start of each survey day, Mr John Appleton would meet the Aboriginal representatives as agreed at 9.30am outside the Majors Creek Hotel. When the representatives did not arrive, Mr Appleton would wait until 9.50 before commencing the survey. Prior to commencing the survey, Mr Appleton would discuss and agree with the Aboriginal representatives present on the day the area to be surveyed and the type of sites that may be found. On the second and subsequent survey days, Mr Appleton would also show the Aboriginal representatives any previously identified sites.

Field surveys were undertaken on foot, with particular emphasis made on examining disturbed or exposed areas, including vehicle tracks, dams and stock pads and areas of erosion. In addition, mature trees of an age to support scars or carvings were identified and inspected. Field surveys commenced each day after 9.30am and were typically complete by 3.30pm. The weather was generally dry and sunny with light ideal for observing any artefactual material present.

All sites identified were measured and described in a field log, photographed and their location recorded using a hand held GPS. Table 1 of ASR (2010a) presents an overview of the effectiveness of the survey.

4.6.5 Survey Results

The results of the Aboriginal Heritage Impact Assessment are presented on **Figure 4.29** and **Table 4.26**. In summary, five sites of Aboriginal heritage significance were identified. None of the sites would be disturbed by the Project. However, one site, namely GT OS1, was located in close proximity to the downstream toe of the tailings storage facility embankment. In light of this, the Proponent redesigned the facility slightly to ensure a minimum 20m buffer between the recorded location of the artefact and toe of the embankment. In addition, the proposed transmission line would be constructed in close proximity to GT OS2. The Proponent has committed to implement the management and mitigation measures identified in Section 4.6.6.

Table 4.26
Aboriginal Heritage Survey Results

Site Identifier	Site Classification	Description
GT OS1	Open Scatter	Three artefacts within 50m of each other comprising a silcrete flake and core and a metasedimentary flake.
GT OS2	Open Scatter	Two artefacts comprising silicified metasedimentary proximal fragment of a flake and a metasedimentary core/scraper.
GT OS3	Isolated artefact	Single artefact comprising a quartz proximal fragment of a flake.
GT OS4	Open Scatter	Three artefacts comprising a black chert flake, a quarts flaked piece and a silcrete flake
GT OS5	Isolated artefact	Single artefact comprising a silcrete flake
Note 1: **Figure 4.27** presents the location of each identified site.		
Source: ASR (2010a) – Table 2		

ASR (2010a) notes that a single site, namely an “open camp site” or artefact scatter was identified in the vicinity of the Project Site during a search of the AHIMS database and that the identified sites within the Project Site may be considered representative of that single site.