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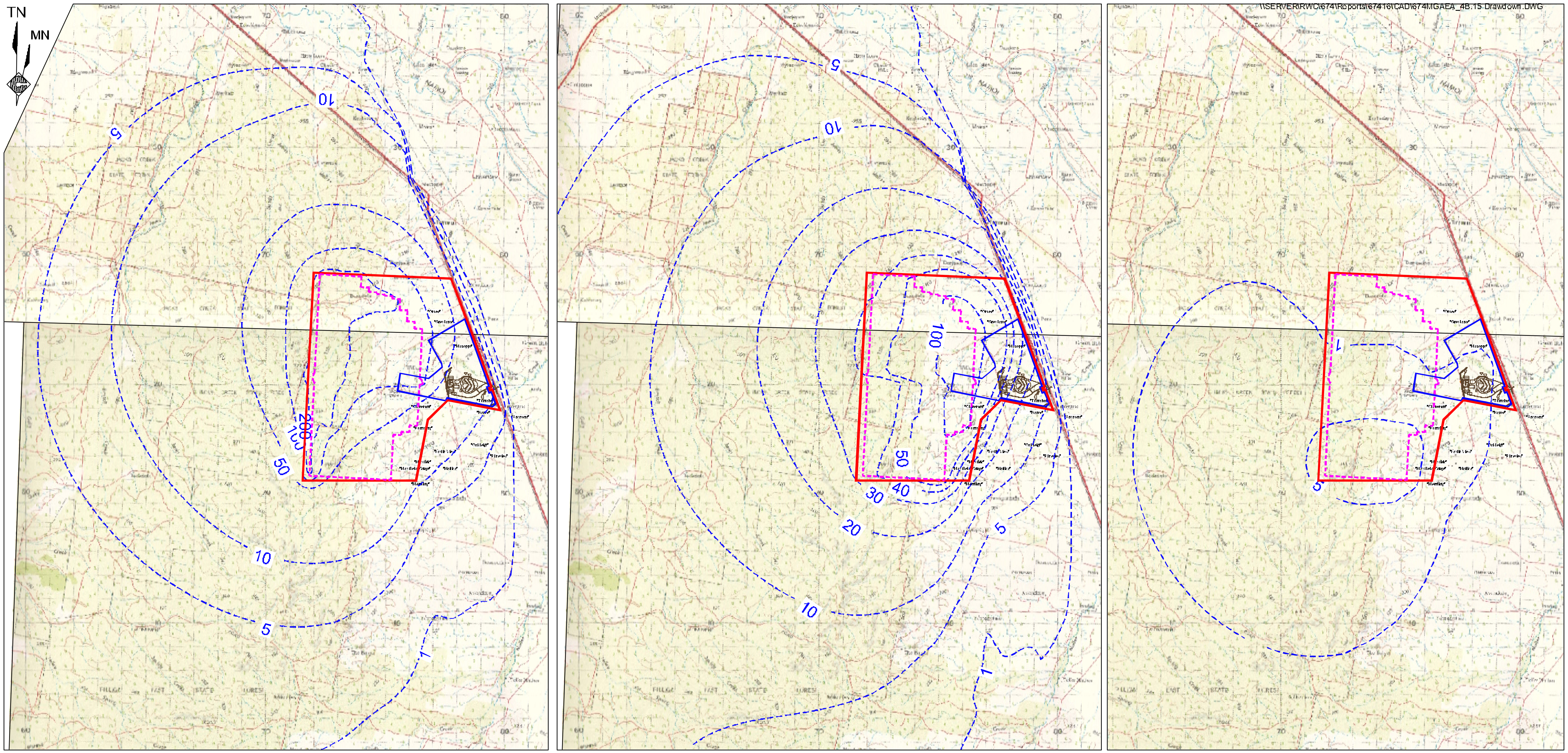

Year 15 | Year 29 | Year 130

REFERENCE
Mine Site Boundary
Indicative Limit of Underground Workings
Pit Top Area Boundary
3 Groundwater Drawdown Contour (m AHD)

SCALE 1:175 000
2.5 0 2.5 5.0 7.5 km
Source: Aquaterra (2009) - Figures 6.19, 6.20 & 6.24

Figure 4B.15
PREDICTED GROUNDWATER DRAWDOWN IN HOSKISSONS COAL SEAM

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- Within the Garrawilla Volcanics, a drawdown of generally less than 5m is predicted adjacent to the mine at the end of mining. A 1m drawdown is predicted to extend between 5km and 8km to the west of the Mine Site.
- Drawdown in the water table within the regolith (Layer 1) at the end of mining is predicted to be less than 1m outside the Mining Area and limited to areas close to the mine. Maximum drawdown is limited to around 5m, and these only occur in the immediate vicinity of the Mining Area.
- Drawdown in the Namoi Valley alluvium (Layer 1) is predicted to be less than 0.1m.

- Aquaterra (2009) reports no drawdown in the Jurassic sediments of the Great Artesian Basin, ie. Purlawaugh Formation and Pilliga Sandstone.
- At the end of the 100 year recovery period, water levels in all the main hydrogeological units are predicted to have recovered to levels almost equivalent to those recorded at the start of mining.

The impact associated with the predicted drawdowns is further considered in the following sub-sections.

- Section 4B.2.5.6 considers the impact of the predicted drawdown on the three GWMAs which occur within the Mine Site.
- Section 4B.2.5.7 considers the impacts associated with the predicted drawdown on local groundwater availability and use.
- Section 4B.2.5.8 considers the impacts associated with the predicted drawdown on base flows to the Namoi River.
- Section 4B.2.5.9 considers the impacts associated with the predicted drawdown on groundwater dependent ecosystems.

4B.2.5.5 Predicted Impacts on Groundwater Quality

4B.2.5.5.1 Mine Dewatering

The average water quality of mine inflows would be a composite blend of the water qualities from all groundwater sources contributing to inflows. Aquaterra (2009) notes, however, that groundwater quality would initially be dominated by the groundwater from the Hoskissons Coal Seam and the underlying Arkarula Formation. Over time, as proportionally more groundwater flows from the higher units and from more distant parts of the area of predicted drawdown impact, the groundwater quality would change to reflect an increased contribution from those areas.

Aquaterra (2009) calculates the contribution from each unit by identifying the change in groundwater storage within each layer for each 1 year time step in the base case model, and multiplying this volume change by the average salinity for that layer, summing the totals and dividing by the total mine inflow volume for that time step to determine an average salinity value. This method gives equal weight to both close and distant changes in storage in the model, and hence may underestimate the proportional effect of salinity in the Hoskissons Coal Seam and the other Permian units close to the workings.

Aquaterra (2009) modelled the change in water quality within the underground void based on an initial groundwater salinity (TDS) of 6 000mg/L (which provides an average of all salinity measurements for the Hoskissons Coal Seam, ie. including one low salinity measurement of 2000mg/L) and 8 000mg/L (which weights the average in favour of the higher salinity measurements). Aquaterra (2009) suggests that the actual average salinity of inflows is likely to be between these two calculations.

Figure 4B.16 presents the results of this modelling which predicts that an initial average inflow salinity of between 6 500mg/L to 8 000mg/L, decreasing to around 4 500mg/L (Year 20) before steadily rising again to around 6000mg/L by the end of mining. Aquaterra (2009) notes that while some variation in the salinity of water flowing into the underground mine is expected each year due to periodic short-term inflows of higher or lower salinities, the salinity of day to day in-flows is not expected to vary dramatically.

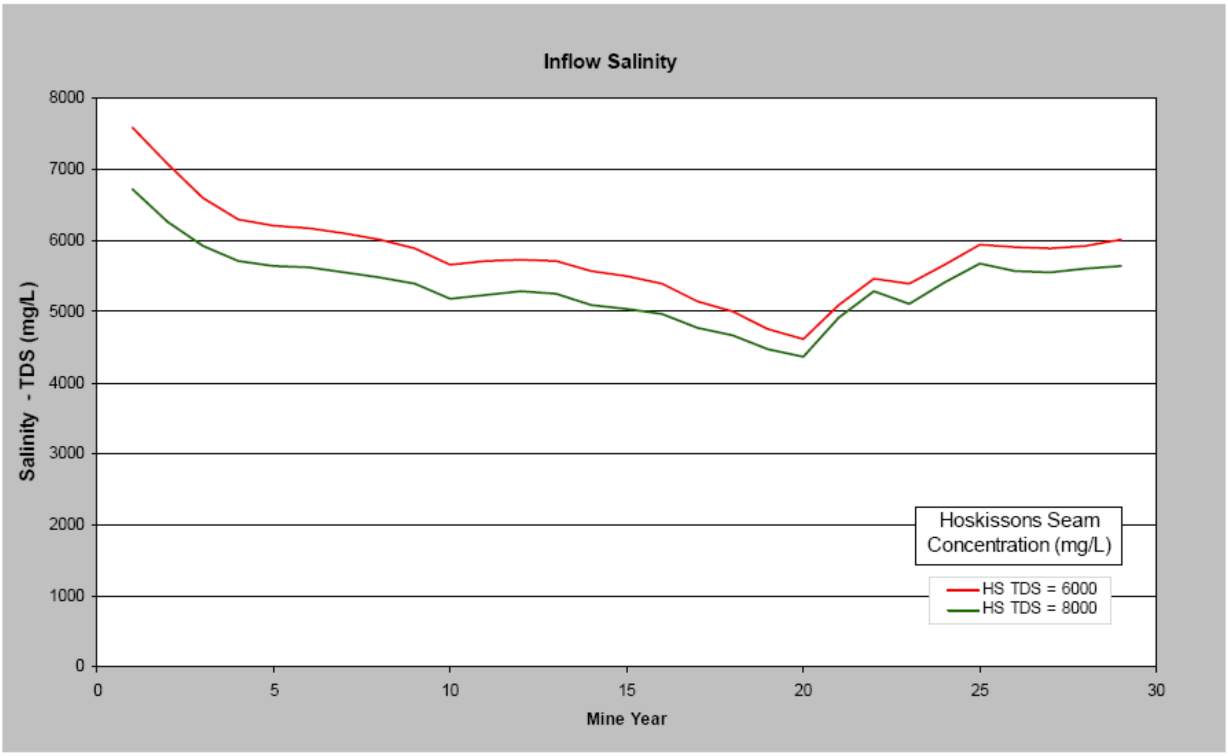


FIGURE 4B.16
PREDICTED CHANGES IN GROUNDWATER SALINITY

Source: Modified after Aquaterra (2009) – Figure 7.1

Further review of **Figure 4B.16** suggests that the groundwater quality of the Mining Area would be generally improved as lower salinity water is drawn from the units higher in the geological sequence into the void space of the underground mine.

4B.2.5.5.2 Brine Re-injection

Aquaterra (2009) undertook a particle tracking exercise on the recovery model to assess the potential for re-injected brine to migrate from the goaf to hydrogeological units of the Gunnedah Basin, Great Artesian Basin and/or Namoi Alluvium Ground Water Management Areas. The particle tracking considers that at the completion of mining and dewatering ceases, groundwater will start to flow back into the drawdown zone created by the 29 years of dewatering. Hence, groundwater will flow radially towards the mine area from the outer edges of the drawdown "cone". However, as the groundwater levels become elevated within the goaf area during the 2 year brine re-injection period, there will also be an inner region where groundwater will have the potential to initially flow outwards from the goaf area into the drawdown zone. The particle tracking concentrated on this inner region, looking at the distances travelled by particles, and also whether there is any upward migration to higher model layers. (Further detail on the particle tracking methodology and modelling is provided by Aquaterra (2009) – *Section 6.5.9*).

The results of the particle tracking indicate the following.

- Groundwater flow directions within the Jurassic strata will generally trend away from the Mining Area. The distance predicted to be travelled by particles in the simulated 100 year recovery period is limited to less than 1km from the Mining Area in all directions.
- Groundwater flow directions within the Permian – Triassic strata, initially trend away from the goaf area. The distance predicted to be travelled by particles in the simulated 100 year recovery period is limited to less than 2km from the Mining Area to the north and less than 1km elsewhere.
- In most cases, the particle tracking shows that particles stay within the layer from which they started. Where interchange between geological units does occur, the movement is downward to the underlying layer. No upward migration to a higher layer occurs.

On the basis of the above, it is predicted that the migration of brine would be restricted to less than 2km, and in most cases less than 1km from the Mining Area, in 100 years after cessation of mining. Importantly, there would be no upward migration to the higher quality aquifers of the formations of the Great Artesian Basin GWMA.

4B.2.5.6 Predicted Impacts on Groundwater Management Areas

Potential Impacts on the Upper Namoi Alluvium GWMA

As discussed in Section 4B.2.5.4, the Longwall Project would result in negligible drawdown in the Quaternary Alluvium due to the presence of a significant barrier of low permeability strata between the Namoi River alluvium and the proposed mine footprint. There would be no measurable impact in the volume of water held within the Upper Namoi Alluvium GWMA.

Section 4B.2.5.8 considers the impacts of the Longwall Project on base flows to the Namoi River.

Potential Impacts on Intake Beds of the Great Artesian Basin GWMA

The groundwater modelling of Aquaterra (2009) predicts minimal change (<0.03ML/day) in outflow to the GAB. Furthermore, the Pilliga Sandstone, recognised as a major intake bed to the GAB, is believed to be dry within the Mine Site and therefore, even in the highly unlikely event that continuous sub-surface cracking from longwall mining does extend beyond the floor of the underlying Purlawaugh Formation, which is recognised as a major regional aquitard, the intake beds would be insulated from groundwater depressurisation occurring within the underlying Permian coal measures.

On the basis of the above, the Longwall Project would have no measurable impact on the volume of water held within the intake beds of the Great Artesian Basin GWMA. In order to account for any theoretical loss in water availability within the geological units which make up the intake beds of the GAB (0.03ML/day), as a result of the minor drawdown predicted within the Jurassic sediments, and in accordance with the Water Sharing Plan which requires any removal of water to be licensed, the Proponent holds WAL AL811436 for 248MLpa within this GWMA.

Particle tracking has confirmed that saline water (brine) would not migrate from the goaf upward into the GAB formations following brine re-injection.

Potential Impacts on Intake Beds of the Gunnedah Basin GWMA

The groundwater modelling of Aquaterra (2009) predicts that impacts associated with the Longwall Project would be largely restricted to the hydrogeological units of the Gunnedah Basin GWMA. As illustrated by **Figure 4B.15**, the most significant impact on groundwater levels would be observed within the Hoskissons Coal Seam (measurable drawdown predicted up to 20km from the Mine Site at the completion of mining). Aquaterra (2009) also predicts that there would be measurable drawdown in the overlying hydrogeological units of the Gunnedah Basin (as changing hydraulic gradients draw water vertically and horizontally towards the void space of the underground workings). The drawdown in the Triassic units of the Gunnedah Basin GWMA are less pronounced than those within the coal seam and are typified by those predicted within the Napperby Formation. A measurable drawdown (of ≥1m) is predicted to extend to approximately 10km from the Mining Area, however, the level of drawdown quickly reduces from a maximum of 20m immediately adjacent to the Mining Area.

As a consequence of drawdown impacts being predominantly restricted to the hydrogeological units of the Gunnedah Basin GWMA, and the negligible impact of the predicted drawdowns on the volume of water held within the Upper Namoi Alluvium, and intake beds of the Great Artesian Basin GWMAs, it is concluded that the vast majority of mine in-flows would originate from the Gunnedah Basin GWMA. Therefore, the Longwall Project is predicted to reduce the volume of water held within the Gunnedah Basin GWMA each year.

To account for the predicted annual reduction in the volume of groundwater held within the Gunnedah Basin GWMA, the Proponent is currently finalising the acquisition of an Aquifer Interference Licence No. 90BL254679 under the *Water Act 1912* with an allocation of 818MLpa. Based on the groundwater modelling of Aquaterra (2009), this allocation would be sufficient for the predicted mine in-flows up to Year 11 of the Longwall Project (see **Figure 4B.12**). Prior to Year 11, the Proponent would have had opportunity to validate the measured actual mine in-flows and compare these to the predicted in-flow rates. In the event

that the actual in-flow rate equals or exceeds that predicted, the Proponent would obtain additional allocation or an additional water access licence for the extraction of the groundwater as mine in-flow.

4B.2.5.7 Predicted Impacts on Water Use and Availability

Drawdown associated with the Longwall Project is predicted in the fractured rock aquifers above the mine up to the base of the Garrawilla Volcanics, with greatest impacts in geological units close to the Hoskissons Coal Seam, and less impact on higher units. Yields and available drawdown may therefore be affected at any existing groundwater bores close to the mine which are screened in the formations predicted to be affected by groundwater drawdowns.

A search of the database of registered groundwater bores revealed a number of registered bores within the predicted impact zone, however a field inspection undertaken by Aquaterra (2009) identified that many are either non-existent, abandoned or destroyed. As there would be no drawdown within the Namoi Alluvium, within which the majority of the bores of the region are screened, the potential for impact on groundwater users would be limited to the small number of bores screening the lower units of the geological sequence, eg. Napperby Formation, Digby Formation and Hoskissons Coal Seam.

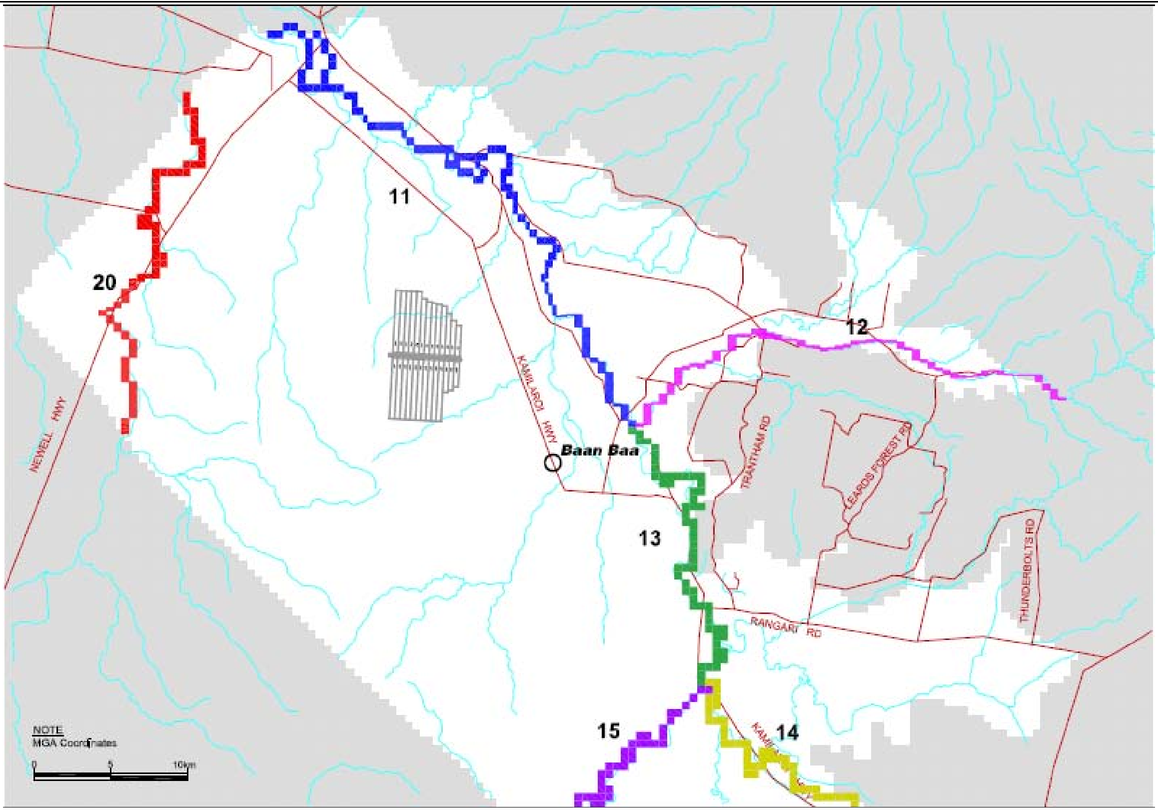
The potential for impact on the small number of bores screening the aquifers of these lower geological units has to a large degree been mitigated by the Proponent's acquisition of properties within the anticipated zone of impact. However, in the event that drawdown associated with the Longwall Project is determined to impact on the yield of a non-project related bore, the Proponent has committed to mitigating these impacts (or compensating the bore holder). Assessment of potential impacts would be undertaken on a case by case basis, with possible mitigating measures discussed with each affected bore holder.

4B.2.5.8 Predicted Impacts on Namoi River Base Flows

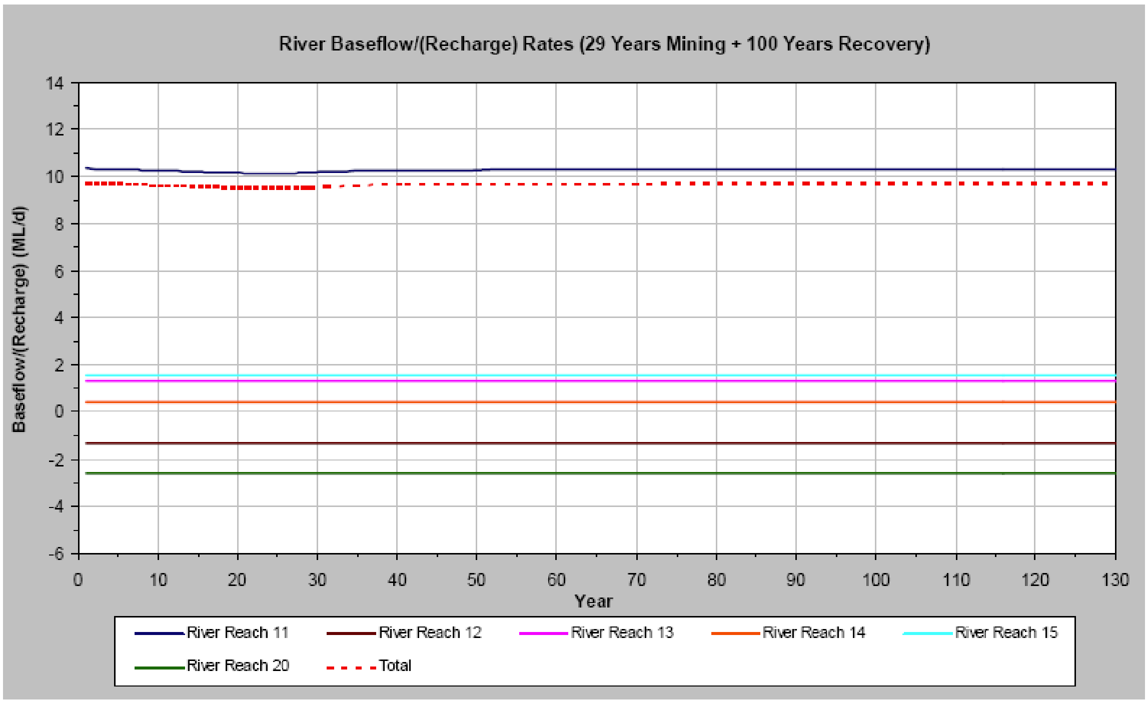
The impacts of the Longwall Project on the groundwater base flow discharges to Namoi River (Reaches 11, 13 and 14), Maules Creek (Reach 12) and Jacks Creek (Reach 20) have been assessed by Aquaterra (2009) for each of six river reaches designated on **Figure 4B.17**. Most of the river reach base flows remain stable during the mining period with a very minor reduction predicted in Reach 11 of the Namoi River (increasing to a maximum of 0.22ML/day at the completion of mining). The maximum predicted base flow impact during mining represents about a 2% reduction in the pre-mining base flow in Reach 11, but an insignificant percentage of total stream flow in the Namoi River (Aquaterra, 2009).

4B.2.5.9 Predicted Impacts on Groundwater Dependent Ecosystems

It is anticipated that the Purlawaugh Formation would insulate shallow groundwater from any mining-induced groundwater depressurisation of the underlying Permian coal measures. Therefore it is not anticipated that there would be significant impact to groundwater dependent ecosystems due to the Longwall Project.



Defined Reaches of the Namoi River



Modelled Impacts on Base Flows

FIGURE 4B.17

PREDICTED CHANGES TO NAMOI RIVER BASE FLOWS

Source: Modified after Aquaterra (2009) – Figures 6.7 & 6.25

It is acknowledged that shallow surface cracking may impact locally upon shallow groundwater such as the sporadic perched systems that exist at the base of the weathered zone, eg. "Mayfield Spring". It is likely, however, that these effects would not be permanent as the surface cracking would not be continuous to the underground workings. Any storage that is drained would be rapidly restored by recharge from rainfall, as the discontinuous fractures close up or become in-filled with fine sediment.

4B.2.5.10 Regulatory Compliance

An embargo currently exists on the issuing of new industrial bore licences within the intake beds of the Great Artesian Basin GWMA. In compliance with the Water Sharing Plan for this GWMA, the Proponent holds a Water Access Licence (WAL AL811436 for 248MLpa) for any incidental draw of groundwater. The licenced quantity of 248MLpa far exceeds the predicted incidental drawdown in the intake beds of the GAB.

An embargo also currently exists on the issuing of new industrial bore licences within the Upper Namoi Alluvium GWMA. However, the predictive modelling of Aquaterra (2009) has shown that there would be a negligible impact on the alluvium associated with the Namoi River and therefore the purchase of a Water Access Licence is not considered necessary.

Mining activities would be undertaken beneath the existing groundwater table in the Permian Coal Measures. An Aquifer Interference Licence has been obtained by the Proponent for 818MLpa for the incidental groundwater make of the underground mine which would be dewatered over the life of the Longwall project. The mine inflows are predicted to be below the 818MLpa level for at least 11 years. The Proponent would monitor flows and would purchase additional licences to cover the then predicted upper quantity of groundwater inflow.

4B.2.6 Groundwater Monitoring and Contingency Plans

4B.2.6.1 Groundwater Monitoring

The current baseline monitoring program of groundwater quality and standing water level would be continued, with a modified network of monitoring points finalised prior to commencement of mining.

An updated groundwater monitoring program would be prepared following the receipt of project approval. Monitoring to be included in this updated program would include.

- The volume of groundwater pumped to surface from all extraction bores, sumps within the underground workings and the box cut sump would be measured/recorded at least weekly.
- The volumes of water introduced to the mine for longwall mining operations would be measured/recorded at least weekly.
- Dewatered groundwater quality. The EC and pH of samples collected from each groundwater extraction point would be measured on a monthly basis.

- In-situ groundwater quality. More detailed chemical analyses would be undertaken of the groundwater of each extraction point measuring the following parameters:
  - Physical parameters: EC, TDS, TSS and pH;
  - Major cations: calcium, magnesium, sodium and potassium;
  - Major anions: carbonate, bicarbonate, sulphate and chloride;
  - Dissolved metals: aluminium, arsenic, boron, cobalt, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, selenium, zinc;
  - Nutrients: ammonia, nitrate, phosphorus, reactive phosphorus; and
  - Other: fluoride, cyanide.
- Quarterly manual monitoring, or continuous automated monitoring, of water levels from the network of monitoring bores.
- Quarterly monitoring of the spring discharges.

All monitoring results would be reviewed annually and summarised/evaluated in each Annual Environmental Management Report together with an assessment of the need to modify the parameters measured or monitoring frequency. It is fundamental that only meaningful data is collected.

In addition to the above, which is designed to assess general impacts of drawdown, the Proponent would implement a comprehensive monitoring program to investigate the subsidence impacts as they develop above longwall panels LW1 to LW3. Several multi-level vibrating wire piezometers are already in place, strategically placed within proposed chain pillars between LW1 and LW2 and just outside LW1, to enable ongoing monitoring. Additional multi-level vibrating wire piezometers and extensometers are proposed and monitoring of these would be conducted in conjunction with the subsidence monitoring recommended by DGS (2009).

4B.2.6.2 Contingency Plans

The Proponent is committed to addressing and mitigating impacts on groundwater as they occur. The following contingency plans, which build on those already in place for the Stage 1 Narrabri Coal Mine, would be implemented.

Water Levels

In the event that groundwater level drawdown in any bore in the alluvium, regolith or the Garrawilla Volcanics exceed predicted drawdown by 15% or more for any consecutive three month period, the monitoring data would immediately be referred to an approved hydrogeologist for review. The reviewer would then assess the data to establish the nature of the exceedance and the reasons for it, and recommend an appropriate response action plan for implementation in consultation with the relevant government agency.

In the event that an existing water supply is deemed by the hydrogeologist to be adversely affected drawdown generated by the Longwall Project, the Proponent would mitigate, or compensate for this impact through the provision of a replacement water supply.

The exact nature of impact mitigation or compensation would be developed on a case by case basis and would be referred to the relevant government agency in the event that mitigation or compensatory measures are unable to be negotiated.

Groundwater Quality

Should the water quality of the mine inflows or dewatering discharge indicate an inflow salinity of more than 20% above that predicted by the Aquaterra (2009) modelling (see **Figure 4B.16**), all relevant monitoring data would be provided to an approved experienced hydrogeologist for review and assessment of the impact on other users or the environment. If remedial action is recommended by the reviewer on the basis of the water quality, the recommended action would be implemented in consultation with the relevant government agency(ies) as appropriate.

4B.3 SURFACE WATER

The surface water assessment was undertaken by WRM Water & Environment Pty Ltd. The full surface water assessment is presented as Part 3 of the Specialist Consultant Studies Compendium, with the relevant information from the assessment summarised in the following subsections. The assessment is referred to as WRM (2009) throughout this document. A peer review of the water balance modelling component was undertaken by Mr Lindsay Gilbert, Director of Gilbert and Associates Pty Ltd. A copy of Mr Gilbert's review is included behind the surface water assessment in this compendium.

4B.3.1 Introduction

Based on the risk analysis undertaken for the project (see Section 3.3 and **Table 3.5**), the potential surface water impacts requiring assessment and their unmitigated risk rating are as follows.

- Discharge of sediment-laden or turbid water from the Mine Site (high risk).
- Temporary degradation of downstream water quality through discharge/spill of saline or contaminated water (high risk).
- Long term contamination of downstream water quality through major or repeated discharge/spill of saline or contaminated water (extreme risk).
- Altered flooding patterns and indirect impacts on native vegetation communities and ecosystems (moderate risk).
- Erosion of natural drainage lines (moderate risk).
- Erosion of rehabilitated final landform (moderate risk).
- Reduced flows to downstream agricultural land (low risk) and native vegetation (low risk).

In addition, the Director-General's Requirements issued by the DoP require that the assessment of surface water demonstrate "*how the company would manage mine water, especially any mine water brought to the surface*" and refer to the following policies, guidelines and plans:

- *Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ ARMCANZ);*
- *Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC/ ARMCANZ);*
- *Namoi Catchment Action Plan (DPI);*
- *Managing Urban Stormwater: Soils & Construction (Landcom);*
- *Technical Guidelines: Bunding and Spill Management (DECC); and*
- *Environmental Guidelines: Use of Effluent by Irrigation (DECC).*

The following sub-sections describe and assess the existing drainage and surface water environment, identify the surface water management issues, proposed surface water controls, safeguards and mitigation measures and an assessment of the residual impacts following the implementation of these safeguards and mitigation measures.

4B.3.2 The Existing Environment

4B.3.2.1 Regional Drainage

The Mine Site is located in the Namoi River catchment and within the catchments of its tributaries, namely Kurrajong Creek, Pine Creek and Tulla Mullen Creek. The Namoi River flows in a northwesterly direction approximately 3km to 5km to the east of the eastern boundary of the Mine Site.

The Namoi River catchment has been used extensively for agricultural activities for over 100 years and is one of Australia's most developed irrigation areas, supporting significant cotton and broadacre cropping (mainly sorghum, sunflower and wheat) as well as other crops, and some sheep and cattle grazing. There are a number of major storages in the Namoi River catchment, namely the Keepit, Chaffey and Split Rock Dams located on the Namoi, Peel and Manilla Rivers, to provide water for the licensed water users in the region (**Figure 4B.18**).

The Mine Site is located within the catchments of Kurrajong and Pine Creeks. Pine Creek and its tributaries traverse the northern part of the Mine Site, before entering the Namoi River, while Kurrajong Creek and its tributaries originate in the southwestern corner of the Mine Site and traverse the southern part of the Mine Site, draining to Tulla Mullen Creek, which in turn drains into the Namoi River. The total catchments areas of Pine and Kurrajong Creeks are $76km^2$ and $62km^2$ respectively. The local catchment boundaries and drainage paths draining the Mine Site are shown in **Figure 4B.19**.

Pine and Kurrajong Creeks are ephemeral, generally flowing for short periods after significant rainfall events or protracted wet periods. Base flows in these creeks are insignificant. Sections of the local creeks are quite 'active' and are susceptible to high levels of erosion. The drainage paths of the smaller tributaries are poorly defined along some reaches through the Mine Site. Further detail on the structure and hydrological properties of these streams is provided by WRM (2009) – Section 2.2.

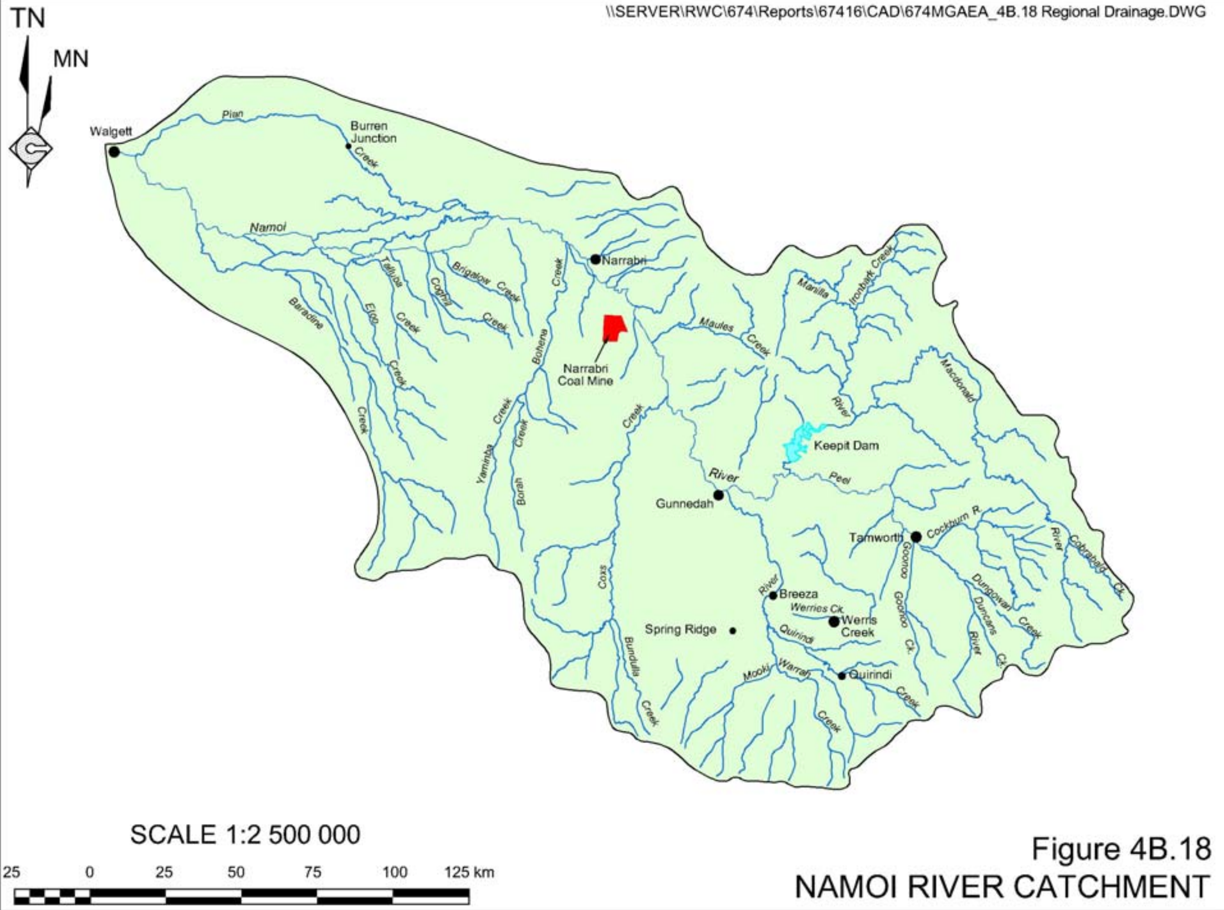


Figure 4B.18
NAMOI RIVER CATCHMENT

4B.3.2.2 Mine Site Drainage

Figure 4B.19 depicts the Mine Site, the location of the Pit Top Area and the local catchment boundaries whilst **Figure 4B.20** presents greater detail of the Pit Top Area and the local drainage paths and catchments within that area.

Table 4B.11 lists the proportions of the Mine Site and Pit Top Area that currently drain to each of the local sub-catchments. **Table 4B.12** lists the existing cleared and forested areas within the Project Site in each of the local sub-catchments.

Table 4B.11
Mine Site and Pit Top Areas Draining to Local Sub-Catchments

Sub-Catchment	Mine Site Area Within Catchment	
	Area (ha)	Area (%)
Pine Creek	1743	33.5
Pine Creek Trib 1	761	14.6
Pine Creek Trib 2	80	1.5
Kurrajong Creek	830	15.9
Kurrajong Creek Trib 1	1562	30.0
Kurrajong Creek Trib 2	234	4.5
Total	5210	100
Source: Modified after WRM (2009) – Table 2.1		

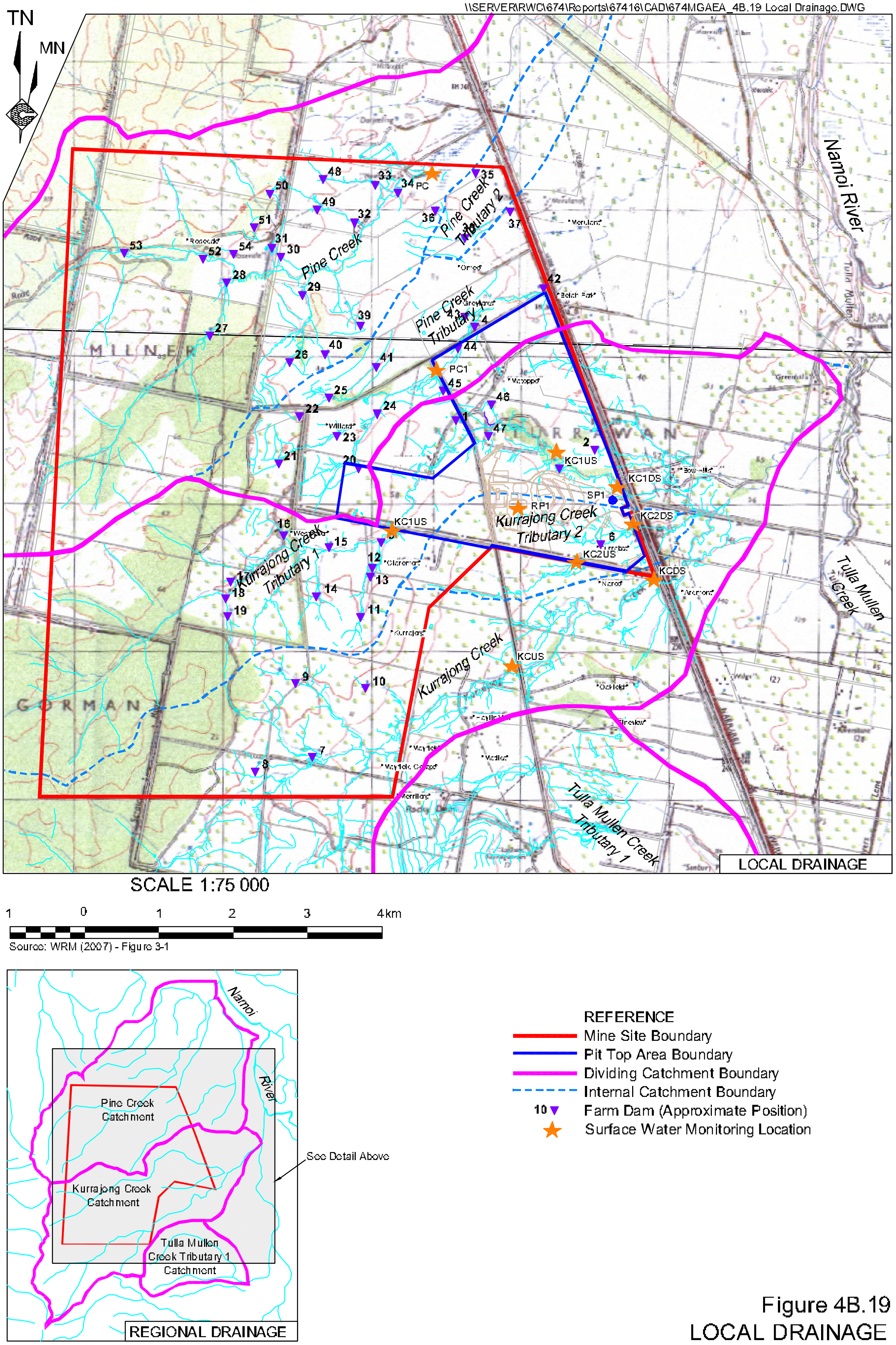


Figure 4B.19
LOCAL DRAINAGE