WHITEHAVEN COAL

Narrabri Coal Operations Pty Ltd

ABN: 15 129 850 139

Narrabri Coal Mine
Stage 2 Longwall Project

Surface Water Assessment

Prepared by:
WRM Water & Environment Pty Ltd

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Surface Water Assessment

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EXECUTIVE SUMMARY

The Narrabri Coal Mine is located in the Namoi River catchment and within its tributary catchments of Kurrajong Creek and Pine Creek. Pine and Kurrajong Creeks, which originate in the hills immediately to the west of the Mine Site, are ephemeral, generally flowing for short periods after significant rainfall events or protracted wet periods. Base flows in these creeks are insignificant. Approximately 3115ha (60%) of the Mine Site (on its eastern side) has been previously disturbed and is now primarily cleared for grazing and wheat cultivation. The remaining 2095ha (40%) on the western side is predominantly forested with woodlands dominated by cypress pine and box gum trees.

Narrabri Coal Operations Pty Ltd (the Proponent) proposes to convert the approved Narrabri Coal Mine from a continuous miner operation with an approved annual production rate of 2.5Mtpa (Stage 1) to a longwall mining operation with a maximum annual production rate of 8Mtpa (”the Longwall Project”). The potential surface water impacts of the existing mine and proposed mine extension are as follows.

- Potentially dirty and contaminated water could be generated from the Pit Top Area.
- Underground mining would result in saline groundwater being pumped to the surface for treatment and disposal. Groundwater volumes are expected to vary from 0.22 megalitres per day (ML/d) in the first year to about 3.83 ML/d in Year 18. The groundwater is expected to have elevated concentrations of both salt and possibly metals and would not be suitable for off-site release without treatment.
- Mine subsidence could cause over bank ponding and potentially erosion of the creeks and waterways that cross the areas of the Mine Site that are undermined.

Pit Top Surface Water Management Strategy

A surface water management plan has been developed to manage runoff from the Pit Top Area and the dewatered groundwater in-flows of the Longwall Project. The general principles for the various construction and mining phases of the Narrabri Coal Mine to manage surface water are as follows.

- The fullest separation possible of ‘clean’, ‘dirty’, ‘contaminated’ and ‘saline’ water runoff.
- Minimise the area of surface disturbance, thus minimising the volume of ‘dirty’ or ‘contaminated’ runoff.
- Runoff from potentially contaminated catchments would be collected in storage basins (SB’s) and not released off site. Water collected in the storage basins would be processed through the water conditioning plant for use around the Mine Site for coal processing and dust suppression.
- Runoff from the potentially dirty catchments would be collected in the existing sediment dams (SD’s). The sediment dams would be sized to achieve required stormwater quality for storms up to the 95%ile five day storm event. Water collected in the sediment dams would be used during the construction phase of the Longwall Project, as well as to augment shortfalls in supplies expected in the first few years of mining. After this time, the water collected in the dams would be released to the downstream receiving water within 5 days of a runoff event.

- All saline water dewatered from the underground workings would be contained within the Pit Top Area of the Mine Site without releasing it to the natural watercourses. The saline water would be treated in a water conditioning plant for use in coal processing and underground dust suppression. Treated water in excess of Mine Site requirements would be piped to the Namoi River for discharge at the adopted water quality compliance criteria.
- The concentrated brine by-product of the water conditioning plant would be stored and evaporated in lined brine storage ponds on the Pit Top Area without releasing it to the environment. At the completion of the Longwall Project, it is predicted that up to 2 000ML of concentrated brine solution would remain and this would be re-injected back into the underground void.

Pit Top Surface Water Management Controls

The proposed surface water management controls for the Mine Site are as follows.

- Potentially contaminated runoff from the stockpiling and crushing/sizing area would be collected in the previously constructed storage basin SB1. An additional storage basin SB2 would be constructed down-slope of SB1 to ensure all potentially contaminated runoff from the catchment is collected. SB1 and SB2 would be pumped to the previously constructed Dam A1 within the rail loop.
- Dam SB3 would be constructed to collect potentially contaminated runoff from the proposed Reject Emplacement Area. Runoff collected in SB3 would be pumped to Dam A1.
- The coal reject may generate saline leachate and testing of the reject would be undertaken to determine the propensity of the material to generate saline, or otherwise contaminated leachate. In the event that the testing indicates the reject has a propensity to generate saline leachate, or leachate with elevated concentrations of other contaminants, the base of each cell would be constructed to be effectively impermeable ($<1\times10^{-9}$m/sec).
- Dewatered groundwater would be pumped to Dam A1.
- A water conditioning plant, incorporating ultra-filtration and reverse osmosis circuits, would be constructed to treat dewatered groundwater in-flows to produce water of quality suitable for on-site use in underground mining, coal processing and dust control and for off-site release.
- The highly saline brine by-product of the water conditioning plant would be evaporated in the previously constructed Ponds A2, A3 and half of Pond B (B2). Additional brine storage ponds (BR1 to BR5) would be constructed on an as needed basis within the nominated Brine Storage Area.
- The treated water (raffinate) would be stored in Dam B1, Dam C and Dam D for use on site for dust suppression and potable water. Water in excess of the Mine Site requirements would be piped to the Namoi River. Discussions are currently being held for Proponent to participate in the ‘Cap and Pipe Bores’ program to offset any potential salt loads in the Namoi River.
- A dedicated pipeline to the Namoi River would be constructed to supply the Longwall Project with water during the early years of the mine life. The pipeline would also be used to release treated water from Dam D directly to the Namoi River.

- A series of previously constructed sediment dams (SD1 to SD5) would collect potentially dirty runoff from the Pit Top Area. Additional sediment dams SD6 and SD7 would be constructed to collect and treat water draining from the ventilation shaft area and disturbed portion of the Brine Storage Area. Water collected in the sediment dams would be harvested for on-site use during the early years of mine life
- Construction of the road crossings over Kurrajong Creek Tributary 1 would occur when the creek is not flowing and an extended period of dry weather has been forecast. Any loose material generated during the construction program would be removed and the area would be revegetated as soon as practicable at the completion of construction.

Surface Water Management Strategy Assessment

Daily and annual water balance models of the water management system and the various Pit Top Area water storages were developed to determine:

- the reliability of the various storages to supply the Mine Site water requirements during the early years of the Longwall Project (Year 2);
- the frequency and volume of potentially dirty spills from the various water storages;
- the frequency and volume of clean water releases to the Namoi River;
- the required size and behaviour of the brine storage ponds; and
- the volume of brine potentially to be reinjected back into the underground void at the end of the Longwall Project.

The results of the water balance modelling show the following:

- For Year 2 of the Longwall Project operations, the Pit Top Area water storages can augment the groundwater in-flows to supply the operational water requirements for only the wettest (10%ile) years. The majority of the time, there would be insufficient runoff from the Mine Site catchments to meet demand. Water obtained from the Namoi River under a Water Licence would be used to augment supplies during these periods. Later in the mine life, as the expected groundwater in-flows increase and exceed the Mine Site water demands there would be an excess of water available, reducing the reliance on the off-site sources and Pit Top Area water storages.
- There are no uncontrolled spills from the three storages basins within the potentially contaminated catchment of the Mine Site. Therefore, the adopted storage volume and pumping strategy for these dams are appropriate.
- Uncontrolled spills from the Sediment Dams (SD1, SD2, SD3 and SD4) occur only once or twice over the 104 year simulation period for the Year 2 scenario when water is being harvested for Mine Site use. For the Year 18 scenario, uncontrolled spills do not occur because all water is released to the downstream creeks within 5 days of the runoff event. At this stage, the water quality collected within the sediment dams is expected to achieve the water quality compliance criteria.
- Sediment Dam SD6 at the initial ventilation shaft area spills an average of 1 year in 3. This satisfies the average annual sediment basin overflow frequency criteria given in DECC (2008).

- Three excess brine storage ponds BR1, BR2 and BR3 would be required to contain the brine concentrate. Dam B2 would be operational prior to Year 3, Dam BR1 would be required in Year 4, BR2 would be required in Year 7 to Year 9 and the third excess brine storage would be required between Year 13 and Year 16.
- Pumping would cease from the sediment dams to augment Mine Site supplies in Year 3 or Year 4. It is expected that the rehabilitation program from these catchments would be fully completed by this stage and therefore runoff quality would be acceptable.
- Off-site releases of raffinate water are expected to commence in Year 6 to Year 8.
- Off-site releases of raffinate water are expected to peak in Year 18 at 761ML/y for the base case groundwater in-flow scenario and in Year 19 at 1171ML/y for the upper bound groundwater in-flow scenario.

Dewatered Groundwater Contingency Plan

Aquaterra (2009) recommend that contingency plans be developed should groundwater in-flows be significantly higher than what has been modelled although they noted that the likelihood of this scenario is low. The excess groundwater in-flow contingency plan is as follows.

- Additional water conditioning plant capacity would be installed;
- The BR4 and BR5 excess brine storages would be constructed;
- Additional treated water would be released to the Namoi River.

The Proponent intends to investigate options for using the excess raffinate produced by the water conditioning plant, eg. for irrigation, once the expected rate of dewatering becomes clearer. Again, water balance modelling suggests that releases off site would not be required until 6 to 8 years after the commencement of the Longwall Project. An effluent disposal management plan would be developed in accordance with DECC (2003) guidelines for any alternate irrigation option that may be proposed.

Mine Subsidence Management Strategy

Ditton Geotechnical Services (DGS, 2009) developed three estimates of ground subsidence associated with the proposed Stage 2 longwall mining operation. The ‘credible worst case’ of the three scenarios (Case 3) involved maximum subsidence over the long wall panels and minimum subsidence over the chain pillars. Case 1 and Case 2 had significantly less differential settlement because less subsidence over the longwall panels or more subsidence over the chain pillars were assumed.

A close inspection of post mine subsidence contours along all of the waterways indicate that major changes in channel geomorphology due to changes in channel location (avulsions) are unlikely across the mine subsidence zone. However, the associated impacts with the increased ponding, erosion and sedimentation resulting from mine subsidence are as follows:

- the potential for short term loss of riparian vegetation due to ponding;
- the potential for Aboriginal sites to be inundated or disturbed by erosion or sedimentation; and

- the potential for water ponding over salt producing soils to increase the salinity of downstream flows.

A range of strategies that are tailored to each location and consider the geomorphic characteristics, vegetation, soil types and Aboriginal sites are required to mitigate the impact of mine subsidence. For the high risk and moderate risk riparian management zones, it is proposed to survey the creek channels within 6 months of being crossed by a longwall panel. If the survey shows that differential settlement would cause significant erosion or over bank ponding, the following strategies may be applied:

- Visible cracks in the bed of the creek would be filled in where necessary.
- Contour banks that cross chain pillars would be removed. An assessment on the need to replace the contour banks would be made. Given that the Proponent owns the majority of the land over the mine subsidence zone, lower stocking rates and higher vegetation covers are expected.
- Estimates of the extent of over bank ponding would be made.
  - If little vegetation of significance is impacted and minimal salt producing soils are evident, the ponding would be left as is.
  - If vegetation of significance is to be impacted or salt producing soils are evident within the ponded area, the channel across the chain pillars may be excavated to reduce the extent of ponding. Care would be taken to ensure that Aboriginal sites or significant vegetation is not impacted by the excavation.
- The creek channels draining into the mine subsidence zone and on the downstream side of the chain pillars would be monitored for erosion following each runoff-producing storm event. Any erosion would be repaired and remedial measures, such as check dams or drop structures, would be constructed if necessary.

For the low risk management zones, the creek channel will be monitored for signs of sediment build-up or erosion in excess of natural processes. A photographic record will be kept of the creek channels to track their long term behaviour. If necessary, excess sediment would be removed and remedial erosion protection measures would be installed.

Monitoring Strategy

The Proponent has a comprehensive monitoring program in place across the Mine Site that incorporates:

- the collection of rainfall and meteorological data;
- the collection of water quality and water level data in the water management dams and creeks.

Detailed monitoring of the creeks should be undertaken as each longwall panel is being mined. Following mine subsidence, the creeks should be surveyed at regular intervals to determine the rate and ultimate level of the area. Photographs of the creek should be taken prior to mine subsidence and after mine subsidence following significant rainfall events to assess whether erosion has occurred. A log of the when inspections occur (and photographs taken) should be kept together with an assessment of the changes in erosion.

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1. INTRODUCTION

The Narrabri Coal Mine is located about 30km south-southeast of Narrabri and about 10km north-northwest of Baan Baa in north-western New South Wales. A locality plan of the Mine Site, which coincides with the extent of ML 1609, is shown in **Figure 1.1**.

Narrabri Coal Operations Pty Ltd (the Proponent) proposes to convert the approved Narrabri Coal Mine from a continuous mining operation with an approved annual production rate of 2.5Mtpa (Stage 1) to a longwall mining operation with a maximum annual production rate of 8Mtpa (Stage 2) (the Longwall Project). Longwall mining would involve the sequential development of heading gate roads approximately 305m apart oriented north-south from the main headings ("West Mains") and developed for the full distance to the northern and southern boundaries of ML 1609 (up to 4.2km). Once each set of roadways are fully developed, the longwall equipment would be installed and the coal recovered as the longwall unit retreats back towards the West Mains between the two roadways. All coal would be conveyed back to the Pit Bottom Area for transfer to the surface via the approved conveyor drift.

As part of the Environmental Assessment for the Longwall Project, R.W. Corkery & Co Pty Ltd (on behalf of the Proponent) requested WRM Water & Environment Pty Ltd (WRM) to undertake a surface water impact assessment and compile a Surface Water Management Plan (SWMP) for the Stage 2 Longwall Project. This report ("the study") has been prepared in response to that request. This study is largely based on the Stage 1 surface water study, also undertaken by WRM (WRM, 2007) but includes a more detailed assessment of the impacts of mine subsidence on the various waterways that cross the Mine Site and a revised water management strategy for the dewatered groundwater. The study also updates the Mine Site water balance using the predictions of groundwater in-flows (Aquaterra, 2009) and the "as-constructed' water management infrastructure.

The study also addresses the comments/recommendations given in Attachment 1 of the Adequacy Review letter dated 25 September 2009from the Department of Environment and Climate Change with respect to water management. In particular, the discharge limits for treated water has been improved and a Salt Load Strategy has been developed. Additional work has also been undertaken on the Subsidence Risk Assessment.

This report is structured as follows.

- **Section 2** describes the regional and local catchment and drainage characteristics in and around the Mine Site.
- **Section 3** describes the available climate (temperature, relative humidity and wind speed), rainfall, evaporation, runoff, flooding and water quality data at the Mine Site.
- **Section 4** presents the findings of the literature review undertaken for the study.
- **Section 5** describes the objectives of the surface water management strategy at the Mine Site. In addition, the adopted target guidelines for Mine Site water quality are also presented.
- **Section 6** presents the existing and proposed surface water management controls for the Mine Site to minimise or mitigate the potential impacts of the project. This includes the management of surface water across the mine subsidence zone.
- **Section 7** presents water balance calculations detailing the predicted behaviour of the various Pit Top Area water storages.

- **Section 8** discusses the surface water harvestable right of the Mine Site, and how much water the Longwall Project would be collecting in existing and new storages.
- **Section 9** assesses the surface water monitoring requirements for the Mine Site.
- **Section 10** presents the conclusions of the study.
- **Section 11** is a list of references.

2. CATCHMENT CHARACTERISTICS

2.1 REGIONAL CATCHMENTS

The Mine Site is located in the Namoi River catchment and within the tributary catchments of Kurrajong Creek, Pine Creek and Tulla Mullen Creek (see **Figure 1.1**). The Namoi River flows in a north-westerly direction approximately 3km to 5km to the east of the eastern boundary of the Mine Site.

The Namoi River stretches for over 350 km, with a catchment extending from the Great Dividing Range in the east to Walgett in the west where the Namoi discharges into the Barwon River. Some of the Namoi's major tributaries include the Peel River, Mooki River, Manilla River, Coxs Creek, Baradine Creek and Pian Creek. It has a total catchment area of approximately 42,000 km^2 to Walgett.

The closest Namoi River gauging station to the Mine Site is located at Turrawan, approximately 4km downstream of its confluence with Tulla Mullen Creek (see **Figure 1.1**). At the Turrawan gauging station the Namoi River has a catchment area of approximately 24,110 km^2. The catchment area at the confluence with Pine Creek is approximately 24,320 km^2.

The Namoi River catchment has been used extensively for agricultural activities for over 100 years. It is one of Australia's most developed irrigation areas, supporting significant cotton and broad acre 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 catchment, namely 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.

2.2 LOCAL CATCHMENTS

The Mine Site is located within the catchments of Kurrajong and Pine Creeks as shown in **Figure 2.1**. Pine Creek and its tributaries traverse through the northern part of the Mine Site, before entering the Namoi River 4.7km downstream of the Turrawan gauging station. Kurrajong Creek originates in the south-western corner of the Mine Site and together with its tributaries traverse the southern portion of the Mine Site, draining to Tulla Mullen Creek, which in turn drains into the Namoi River approximately 4km upstream of the Turrawan gauging station. The local catchment boundaries and drainage paths of the Mine Site are shown in **Figure 1.1**.

The total catchments areas of Pine and Kurrajong Creeks are 76 km^2 and 62 km^2 respectively. Pine and Kurrajong Creeks, which originate in the hills immediately to the west of the Mine Site, are ephemeral, generally flowing for short periods after significant rainfall events or protracted wet periods. Base flows in these creeks are insignificant.

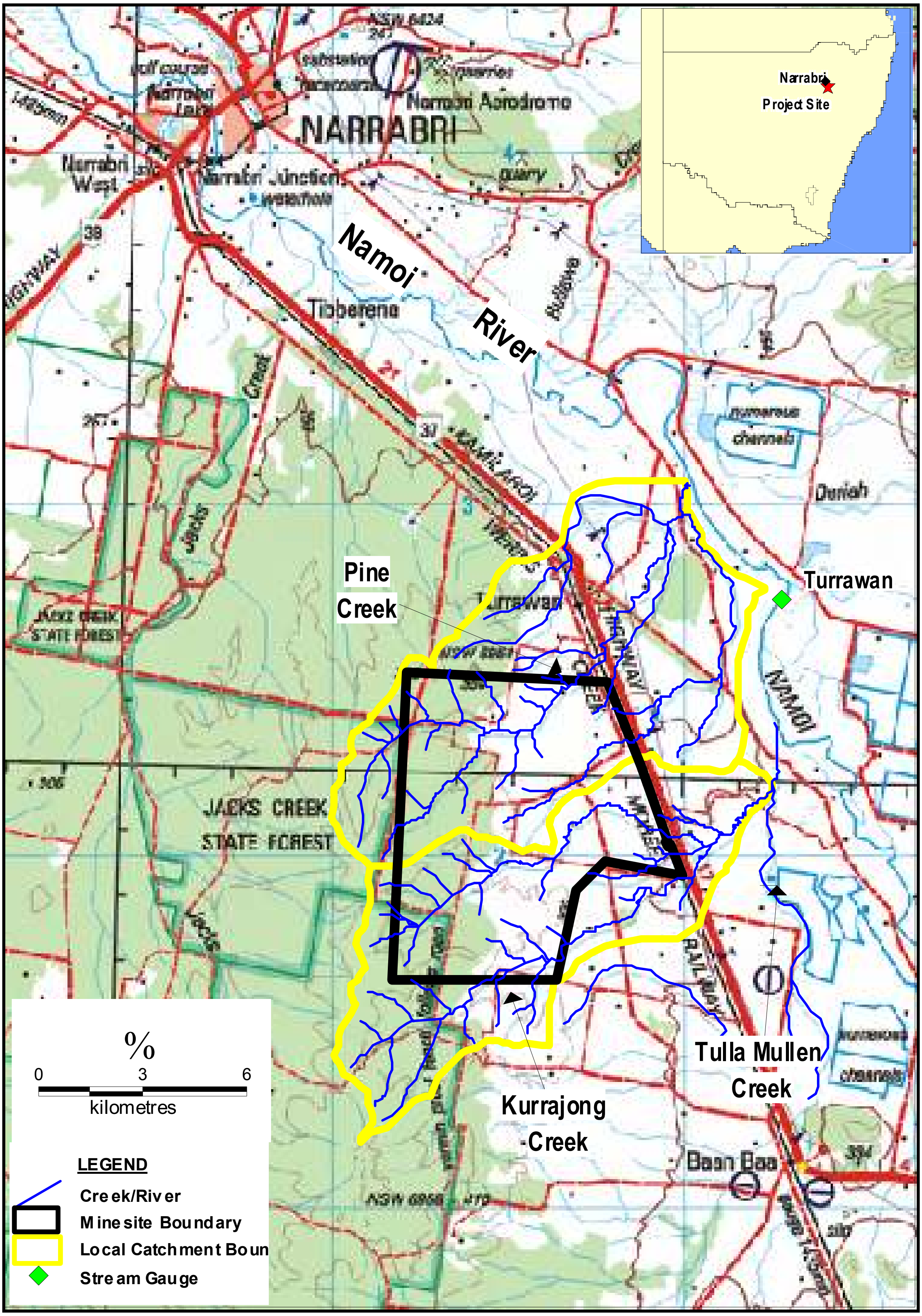

Figure 2.1 Locality Plan and Local Catchments Mine Site

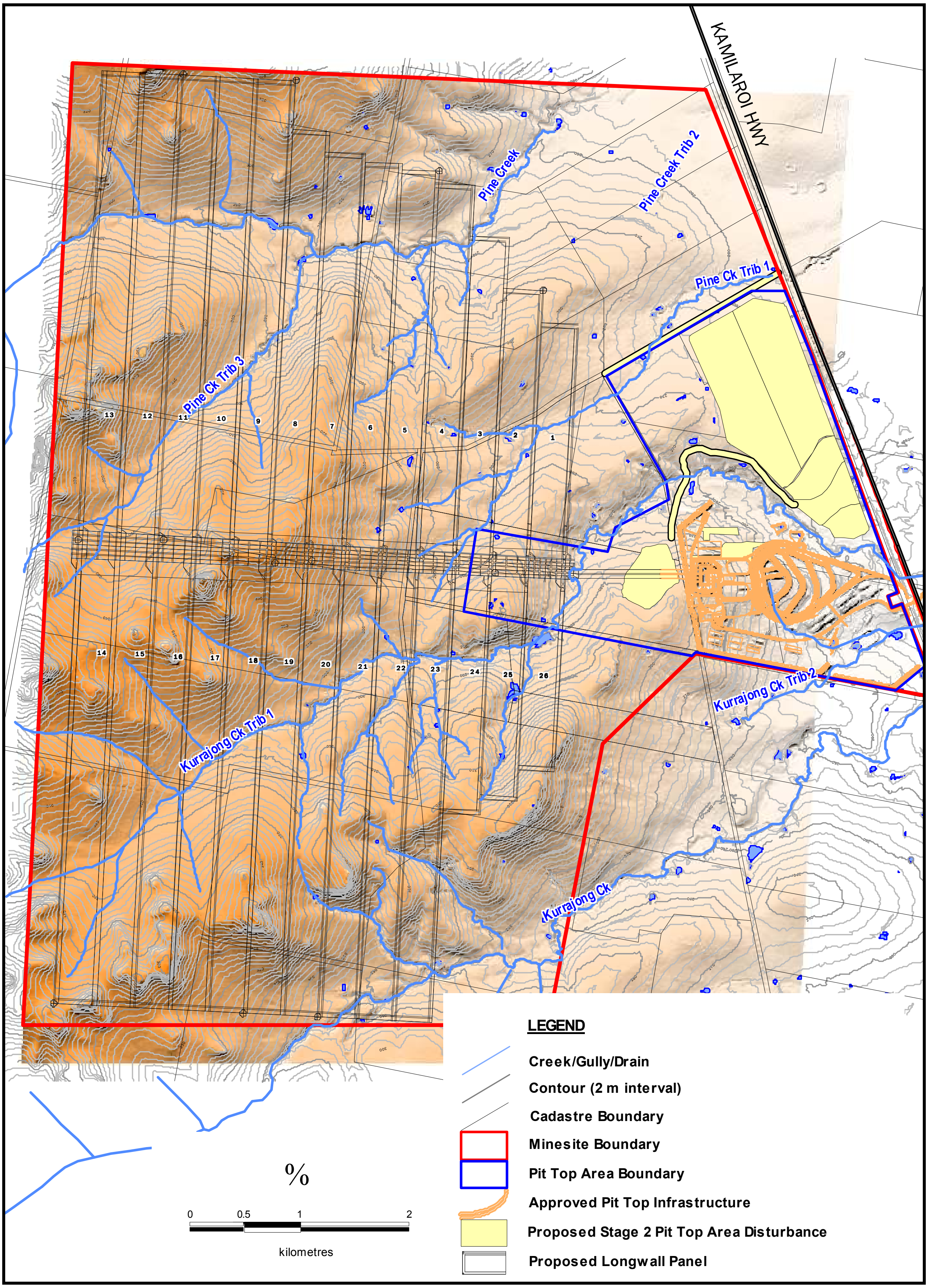

Figure 2.2 Mine Site Layout

2.2.1 Mine Site

Figure 2.1 shows the Mine Site and the critical surface and underground components of the proposed longwall mining operation. **Figure 2.1** also differentiates between those activities or infrastructure already approved for the Stage 1 Operations and those proposed for the Stage 2 Longwall Operations. The Mine Site covers an area of 5210 ha, which coincides with the extent of ML 1609. Of this, the Pit Top Area covers 757 ha, including an area of approximately 160ha where additional brine storage ponds may be constructed (Brine Storage Area).

Approximately 3115 ha (60%) of the Mine Site (on its eastern side) has been previously disturbed and is now primarily cleared for grazing and wheat cultivation. The remaining 2 095ha (40%) on the western side is predominantly forested with woodlands dominated by cypress pine and box gum trees. Both of these catchments would be considered to be slightly to moderately disturbed. **Table 2.1** shows the proportions of the Mine Site that currently drain to each of the local sub-catchments. **Table 2.2** shows the existing cleared and forested areas within the Mine Site in each of the local sub-catchments.

Table 2.1 Mine Site and Pit Top Areas Draining to Each Local Sub-Catchment

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

Table 2.2 Cleared and Forested Areas within the Mine Site in Each Local Sub-Catchment

Sub- Catchment	Cleared Area		Forested Area	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Pine Creek	655	12.6	1088	20.9
Pine Creek Trib 1	708	13.6	53	1
Pine Creek Trib 2	80	1.5	-	-
Kurrajong Creek	592	11.4	238	4.6
Kurrajong Creek Trib 1	846	16.2	716	13.7
Kurrajong Creek Trib 2	234	4.5	-	-
Total	3115	59.8	2095	40.2

2.2.2 Pine Creek

Figure 2.2 to **Figure 2.7** show photographs of Pine Creek and its tributaries across the Mine Site taken in February 2009. The channel of Pine Creek and the channels of its tributaries are generally small, shallow and ill defined across the Mine Site and as such convey only a small percentage of the total flow during flood events with the majority of flow draining over bank at a shallow depth. The banks of the channels tend to be vertical indicating that the soils are highly dispersive adjacent to the drainage lines. Significant erosion of the channels is evident at a number of locations, particularly on Pine Creek Tributary 1 and an adjacent gully that crosses Greylands Road, as shown in **Figure 2.4**. Erosion of this gully appears to be due to the construction of the road but it has been exacerbated by contour banks in the upper catchment that have substantially increased the catchment flows at the road.

The bed of Pine Creek and its tributaries generally consists of the same material as the surrounding soils (within the same horizon). Some sand deposits are evident in places. There is a large basalt outcrop exposed on the bed of a small gully draining into Pine Creek over longwall panel LW5, as shown in **Figure 2.5**. It appears that the gully drains along the western edge of the outcrop. The extent and depth of the outcrop is not known.

Figure 2.3 Pine Creek Tributary 1 (Longwall Panel 2)

Figure 2.4 Pine Creek Tributary 1 (Downstream of Longwalls)

Figure 2.5 Gully draining into Pine Creek Tributary 1 (Longwall Panel 3)

Figure 2.6 Pine Creek Gully (Longwall Panel 5)

Figure 2.7 Pine Creek (Longwall Panel 8)

Figure 2.8 Pine Creek (Downstream Longwall Panels)

2.2.3 Kurrajong Creek

Figure 2.8 to **Figure 2.11** show photographs of Kurrajong Creek and its tributaries across the Mine Site. The main channel of Kurrajong Creek varies from a well grassed, shallow channel in the upper reaches (**Figure 2.9**) to a heavily incised channel about 1 to 2m deep with vertical banks downstream of the proposed longwall panels (**Figure 2.8**). The Kurrajong Creek Tributary 1 channel is similar with a small, shallow channel in the upper reaches and extensive erosion downstream of the proposed longwall panels (**Figure 2.10**). It appears that the erosion of both of these reaches is associated with the construction and overflow of the on-stream farm dams. Kurrajong Creek Tributary 2 has a small but defined low flow channel again with vertical banks. Kurrajong Creek Tributary 2 would not be affected by mine subsidence but crosses the Pit Top Area.

Figure 2.9 Kurrajong Creek (Downstream of Longwall Panels)

Figure 2.10 Kurrajong Creek (Longwall Panel 22)

Figure 2.11 Kurrajong Creek Trib 1 (above West Mains)

Figure 2.12 Kurrajong Creek Trib 2 (On Pit Top Area)

2.2.4 Existing Local Water Storages

There are approximately 53 farm dams on the Mine Site. The locations of these dams are shown in **Figure 2.12**. The Proponent's landholdings within the Mine Site are also shown. The storage capacities of each of these dams are shown in **Table 2.3** and **Table 2.4**.

The total storage capacity of all the existing farm dams located within the Mine Site is estimated at 121.2ML. The individual storage capacities of these dams vary from approximately 0.5ML to 22.5ML. 34 of these dams, with a total capacity of 60.7ML, are located within Pine Creek and its tributary catchments. The remaining 20 dams, with a total capacity of 60.5ML, are located within Kurrajong Creek and its tributaries catchments. A total of 35 farm dams are located within the Proponent's landholdings that have a combined storage capacity of approximately 88.7ML.

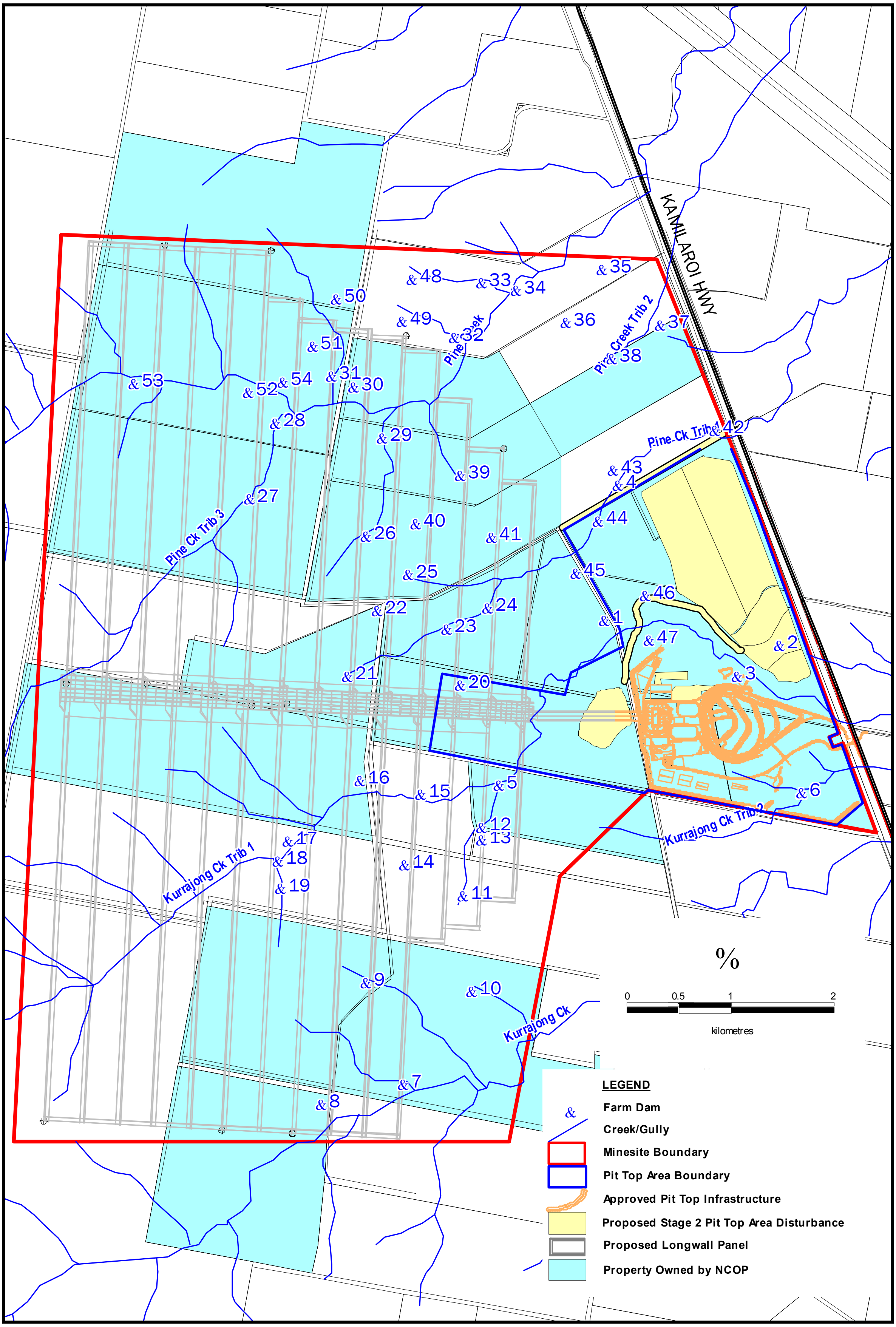

Figure 2.13 Locations of Farm Dams within the Mine Site

Table 2.3 Pine Creek Farm Dam Storages Capacities

Catchment	Dam Number	Estimated Storage Capacity (ML)
Pine Creek	26	2
	29	2.2
	30	0.5
	31	1
	32	2
	33	2
	34	3
	35	1.5
	36	1.5
	39	2.5
	40	1.5
	48	1
	49	0.5
	50	0.5
	51	1
	52	6
	53	2
	54	0.5
Sub-Total	**18 Dams**	**24.2**
Pine Creek Tributary 1	20	1
	21	2
	22	1.5
	23	0.5
	24	2
	25	2
	41	0.5
	42	3
	43	2
	44	5
	45	1.5
	4	5
Sub-Total	**12 Dams**	**26**
Pine Creek Tributary 2	38	3
	37	3
Sub-Total	**2 Dams**	**6**
Pine Creek Tributary 3	27	2
	28	2.5
Sub-Total	**2 Dams**	**4.5**
Total	**34 Dams**	**60.7**

Table 2.4 Kurrajong Creek Farm Dam Storages Capacities

Catchment	Dam Number	Estimated Storage Capacity (ML)
Kurrajong Creek	7	5
	8	1
	9	2
	10	0.5
	2	3
Sub-Total	**5 Dams**	**11.5**
Kurrajong Creek Tributary 1	11	2
	12	2
	13	2
	14	1.5
	15	2
	16	1
	17	1
	18	2
	19	1.5
	46	1
	47	0.5
	1	2
	3	3
	5	22.5
Sub-Total	**14 Dams**	**44**
Kurrajong Creek Trib 2	6	5
Sub-Total	**1 Dam**	**5**
TOTAL	**20 Dams**	**60.5**

2.2.5 Existing Local Water Use

The existing surface water use on and surrounding the Mine Site (via the numerous small farm dams) is to provide watering points for stock. There are a number of individual rural homesteads in the vicinity of the Mine Site (but there are no towns). No large scale irrigation infrastructure is evident to suggest that crops on the Mine Site were ever irrigated from the existing dams. There are also no farm dams on Kurrajong Creek and its tributaries or Pine Creek tributary 1 downstream of the Narrabri Coal Mine. There are two small dams on Pine Creek downstream of the Mine Site.

3. AVAILABLE DATA

3.1 CLIMATE

A weather station was installed at the Mine Site in June 2006 recording rainfall, air temperature, relative humidity, wind speed, wind direction, and solar radiation. The two and a half years of available data at this station is too short to be representative of the long term climate behaviour at the site.

The nearest long term weather station to the Mine Site is at the Narrabri West Post Office (Station No. 053030) and is located approximately 25km north-northwest of the Pit Top Area. This station is operated by the Commonwealth Bureau of Meteorology and has recorded temperature, humidity, wind speed and rainfall since 1891. A comparison between climate data measured at the Narrabri West Post Office over the common period of recorded data and at the site indicates that the Narrabri West Post Office is indicative of the climate at the site.

Table 3.1 summarises average monthly temperature, relative humidity and wind speed for the Mine Site, based on 113 years of data (1891 – 2004) at Narrabri West Post Office station.

Table 3.1 Summary Climate Data, Narrabri West Post Office (Station No. 053030)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ave. Daily Max. Temp (°C)	33.8	33.2	31.2	27.2	22.4	18.7	18.0	19.9	23.4	27.1	30.1	33.0
Ave. Daily Min. Temp (°C)	19.3	19.1	16.4	11.9	8.4	5.2	3.7	4.6	7.6	11.7	14.8	17.7
Ave. 9am Daily Temp (°C)	25.1	24.0	22.6	18.8	13.5	9.6	8.3	10.9	15.8	20.1	22.0	24.6
Ave. 9am Rel. Humidity (%)	61	66	63	63	75	82	81	73	63	57	58	56
Ave. 9am Wind Speed (km/h)	16.8	17.4	17.1	14.7	12.9	12.6	11.7	13.1	16.3	18.5	18.1	18.6

The following is of note regarding the climate at the Mine Site.

- Seasonal temperature fluctuations are typical for the region with the highest maximum daily temperatures being recorded in the summer months of December, January and February (33.0^{0}C to 33.8^{0}C) and the lowest maximum daily temperatures being recorded in the winter months of June, July and August (18.0^{0}C to 19.9^{0}C).
- The average relative humidity recorded at 9am varies between 56% and 82% throughout the year. The relative humidity is highest during the winter months and lowest during the summer months.
- The wind speed follows similar seasonal patterns to temperature with the highest values recorded in the summer months and the lowest values recorded in the winter months.

3.2 RAINFALL AND EVAPORATION

Rainfall and evaporation data have been recorded at the Mine Site since June 2006. This data was extended using rainfall data obtained from the Queensland Department of Natural Resources and Mines (NR&M) Data Drill (Database), for the 116 year period 1 January 1889 to 31 December 2008. Data Drill data takes into consideration the spatial difference in rainfall between the nearest rainfall station at Narrabri and the Mine Site. The data set also contains no gaps in record and as such is preferable to raw rainfall data.

Figure 3.1 shows a comparison between mean monthly rainfalls recorded at the Mine Site and the Data Drill (SILO) data over the common period of July 2006 and December 2008. The figure shows the general trend in monthly rainfall is the same. However, the SILO data is generally lower particularly in December and February when two significant short duration storm events were recorded at the Mine Site but were not registered in the SILO data. Given that there is only two and a half years available for comparison, the SILO data is expected to provide a reasonable representation of the long term rainfall at the Mine Site.

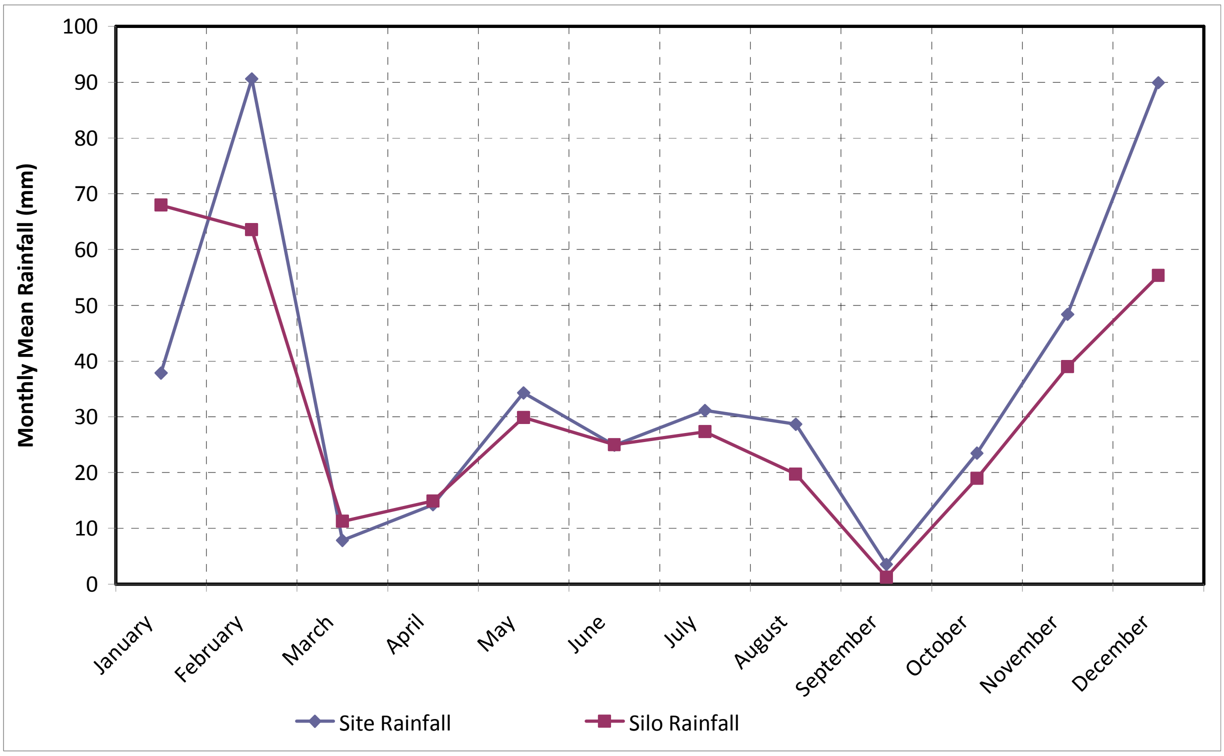

Figure 3.1 Site Rainfall and Silo Rainfall Monthly Mean Rainfall Comparison, June 2006 to December 2008

Table 3.2 shows the long term seasonal variation in average monthly rainfall and potential evaporation for the Mine Site based on 119 years (1889 to 2008) of interpolated data from the NR&M Data Drill.

Table 3.2 Mean Monthly Rainfall and Potential Evaporation Data of the Mine Site

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ave. Monthly Rainfall (mm)	78.8	59.4	50.1	34.5	43.5	46.1	41.8	37.6	37.5	50.4	56.6	63.1
Ave. Monthly Potential Evaporation (mm)	199.3	165.0	151.7	104.8	73.6	53.0	57.9	76.6	104.7	145.7	173.2	198.7

The mean and median annual rainfalls at the Mine Site are estimated at 599mm and 562mm respectively. The annual rainfalls on the Mine Site can vary considerably from year to year. Based on the 119 years of record, the 10% and 90% annual rainfalls at the Mine Site are estimated at 397mm and 839mm respectively.

The mean monthly rainfalls at the Mine Site vary during the year from a low of 34.5mm in April to a high of 78.8mm in January. The summer average monthly rainfalls (50.1mm to 78.8mm) are generally higher than the equivalent winter month rainfalls (34.5mm to 46.1m).

The mean and median annual potential evaporation at the Mine Site is estimated at 1504mm and 1482mm respectively. Evaporation varies seasonally, with high evaporation rates occurring in the months between October and March. The values in **Table 3.2** indicate that the potential evaporation rate during the summer months is greater (up to 3 to 4 times) than the evaporation rate during the winter months. In addition, average potential evaporation exceeds average rainfall for all months of the year.

3.3 RUNOFF

Runoff data is not available for water courses draining the Mine Site. However, anecdotal evidence suggests the creeks flow for short periods during heavy rainfall events (1 to 2 days) with little to no base flow occurring after this time.

3.4 WATER QUALITY

3.4.1 Regional Water Quality Data

Water quality data is available for the Namoi River at the Turrawan gauging station (Station No. 419023) for the period 15 October 1976 to 28 October 1986. The Turrawan gauging station is located between the Kurrajong Creek and Pine Creek confluences with the Namoi River. The location of the Turrawan gauging station is shown in **Figure 1.1**. **Table 3.3** shows a summary of available water quality data for the Namoi River at Turrawan gauging station. Over this 10 year period, the ANZECC & ARMCANZ default trigger values were exceeded 87% of the time for electrical conductivity (EC), 50% of the time for pH and 17% of the time for turbidity.

Additional water quality monitoring was undertaken at 22 sites throughout the Namoi River catchment during 2000 and 2001 (DLWC, 2002). Three of these sites, including at the Namoi River at Gunnedah, Coxs Creek at Boggabri and Narrabri Creek (Namoi River) at Narrabri are of relevance to water quality at the Mine Site. Of the samples tested over this period, the ANZECC & ARMCANZ default trigger values for electrical conductivity (EC) were exceeded 100% of the time at the two Namoi River stations and 97% of the time at the Coxs Creek station. The default trigger value for Turbidity was exceeded between 69% and 88% of the time at the three locations and total phosphorus (TP) was exceed between 97% and 100% of the time.

Table 3.3 Water Quality Data, Namoi River at Turrawan

Parameter	Years Data	Mean	Median	Min	Max	10th Percentile	90th Percentile
Electrical Conductivity (µS/cm)	10	545	538	275	1720	330	716
pH	10	8.0	8.0	7.4	8.8	7.6	8.4
Temperature (°C)	10	19.6	20.5	10	30	11.0	26.5
Turbidity (NTU)	9	15.6	5.4	2	130	2.0	40.4

Insufficient water quality data is available at the Turrawan station to derive a relationship between water quality and flow rates in the Namoi River. However, continuous water quality data, measuring EC, is available between 1995 and 2005 at the Gunnedah Station (GS419001), located 63 km upstream of the Narrabri Coal Mine. A plot of daily flows against EC at this station is shown in **Figure 3.2**.

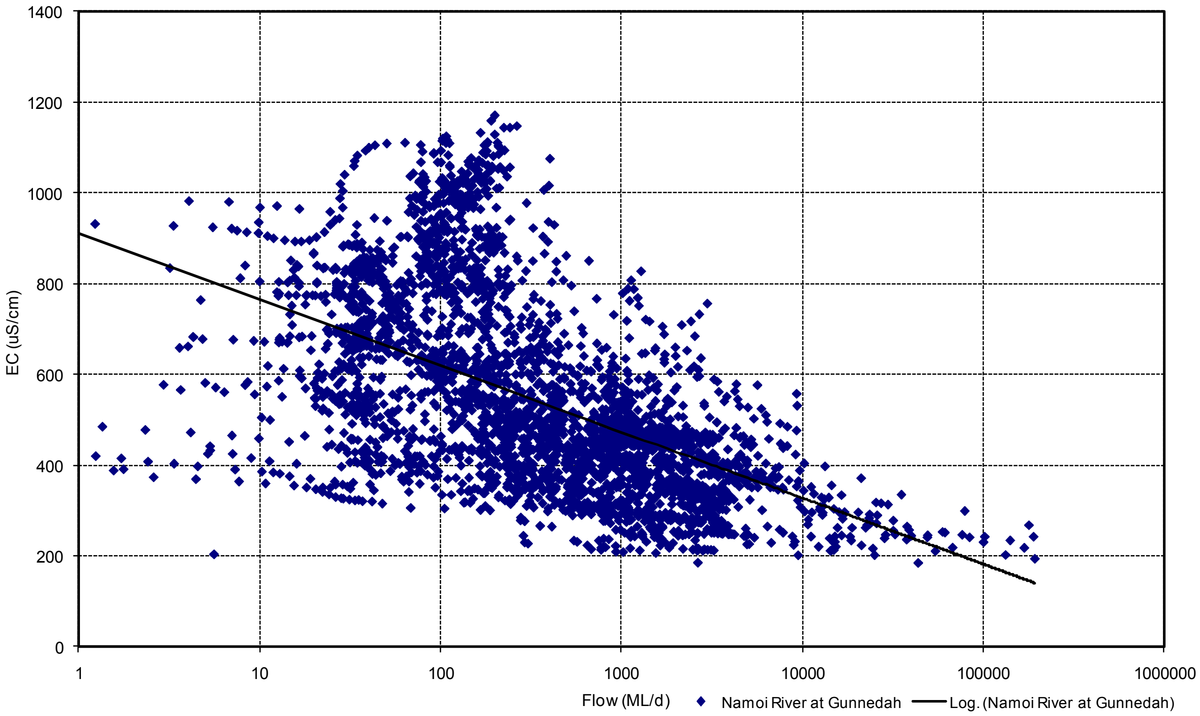

Figure 3.2 Daily Flow and Electrical Conductivity Comparison, Namoi River at Gunnedah

The following is of note:

- EC varies between 200µS/cm and 1200µS/cm at Gunnedah with the majority of elevated EC values occurring when flows are lower than 1000 ML/d.
- There is a strong relationship between flow rate and EC with high flows, associated with floods, measuring lower EC values.
- Higher EC values tend to occur when there are limited releases from Keepit Dam to supply the downstream irrigation demand and the majority of the flow is being generated from the downstream catchments of the Peel and Mooki Rivers. This generally occurs during the winter months.
- Elevated EC values can occur for many months during low flow periods.

3.4.2 Local Catchment Water Quality Data

Table 3.4 shows a summary of water quality data collected in Kurrajong Creek and Pine Creek and their tributaries across the Mine Site during four storm events in July 2006, September 2008, December 2008 and February 2009. The locations of the water quality monitoring sites are shown in **Figure 10.1**. Data recorded at these stations have not been affected by the construction activities at the mine and are expected to be representative of background data.

Table 3.4 Water Quality Data for the Local Catchments in the Project Area

Parameter	No. Samples	Mean	Median	Min	Max	10th Percentile	80th Percentile
Electrical Conductivity (µS/cm)	23	227	125	55	1300	65	301
pH	23	7.2	7.1	6.5	8.2	6.7	7.6
Total Suspended Solids (mg/L)	23	76	38	6	320	14.2	139
Oil & Grease (mg/L)	<2	<2	<2	<2	<2	<2	<2

Table 3.5 compares the background water quality of the creeks draining the Narrabri Coal Mine to the default trigger values for chemical and physical stressors in NSW upland rivers assuming the catchments are slightly disturbed (ANZECC & ARMCANZ, 2000). The results show the following:

- Electrical conductivity (EC) in the local creeks is lower than in the receiving waters of the Namoi River and generally lower than the default ANZECC & ARMCANZ EC trigger values. The default EC trigger value of 350 µS/cm (for upland rivers) was exceeded in the local creeks four times over the monitoring period.
- pH is generally neutral to slightly alkaline and within the bounds of the ANZECC (2000) trigger values.
- ANZECC & ARMCANZ (2000) does not specify trigger values for oils and greases or Total Suspended Solids (TSS). The range of default trigger values given for Turbidity of between 2 and 25 NTU (ANZECC & ARMCANZ, 2000) can be used to indicate likely acceptable TSS values. At present, insufficient data is available to draw a correlation between TSS and turbidity. Both parameters would be measured in the future to allow a correlation to be made.
- Nutrients, such as phosphorus, are not currently monitored because the surrounding agricultural areas are likely to generate significantly higher nutrient levels in comparison to the mine.

3.5 FLOODING

WRM (2007) completed a flood study of Kurrajong Creek Tributary 1 to the north of the Pit Top Area for the approved Stage 1 Narrabri Coal Mine. The infrastructure developed for Stage 1 was outside the 100 year average recurrence interval (ARI) flood extent for Kurrajong Creek Tributary 1 except for a small section of the rail adjacent to the Kamilaroi Highway. The impact of the constriction caused by the rail loop was not significant.

Table 3.5 Comparison of Background Water Quality Concentrations and ANZECC & ARMCANZ Trigger Values of the Mine Site

Parameter	ANZECC & ARMCANZ (2000) Trigger Value		Local Creek Background Concentration	
	Upland	Lowland	Median	80th Percentile
pH	6.5 – 8.0	6.5 – 8.0	7.1	7.6
Electrical Conductivity (µS/cm)	30-350	125 – 2200	125	301
Total Suspended Solids (mg/L)	-		38	139
Tubidity (NTU)	2 - 25	6 – 50		
Phosphorus (µg/L)	20	50		
Oil and Grease (mg/L)	-		<2	<2

The proposed Longwall Project infrastructure is also outside the modelled 100 year ARI flood extent. Flood modelling of Kurrajong Creek Tributary 1 upstream of the Stage 1 modelling area was not warranted because the proposed infrastructure would be a minimum of 100m away from the creek and a minimum of 2m in elevation higher than the adjacent creek bank.

The Mine Site is not susceptible to flooding from the Namoi River as it is located some 20m in elevation above the Namoi River floodplain.

3.6 LONGWALL PROJECT GROUNDWATER IN-FLOWS

3.6.1 Predicted In-flow Rates

Aquaterra (2009) developed and calibrated a MODFLOW-SURFACT numerical groundwater model to predict mine in-flows and to determine the impacts on groundwater levels and base flows, both locally and regionally in the area of interest. Details of the development, calibration and results of the model are given in Aquaterra (2009). The mine in-flows would need to be dewatered from the underground workings and pumped to the surface during the operational phase of the Longwall Project.

The predicted daily rates of dewatered groundwater from the underground workings over the projected 29 year life of the mine using the calibrated MODFLOW-SURFACT model are shown in **Figure 3.3**. Results are shown for the base case (using the calibrated hydraulic parameters) as well as for three uncertainty scenarios using adjusted hydraulic parameters. Aquaterra (2009) noted that there is a high level of uncertainty in the prediction of groundwater in-flows as there is no prior experience with longwall mining in the Gunnedah Basin. Consequently, a conservative approach has been taken in the modelling to predict possible in-flow rates. A summary of the three uncertainty scenarios is given below.

- The sensitivity to in-flows when subsidence fracturing is extended to the Garrawilla Volcanics.
- The sensitivity to in-flows when the vertical permeabilities in the subsidence zones above the longwall goafs are increased above the calibrated values.
- The sensitivity to in-flows when hydraulic parameters assumed within the fracture zone reduce slightly with time as settling and/or redistribution of fines occur.

For the base case, Aquaterra predicted moderate rates of groundwater in-flows, commencing at 0.2 ML/d in Year 1, and increasing to a peak rate of 3.8 ML/d in Year 18. Thereafter, in-flow rates are predicted to decline as water is allowed to recover into the goaf areas of completed longwall panels in areas down dip of the active longwall panel.

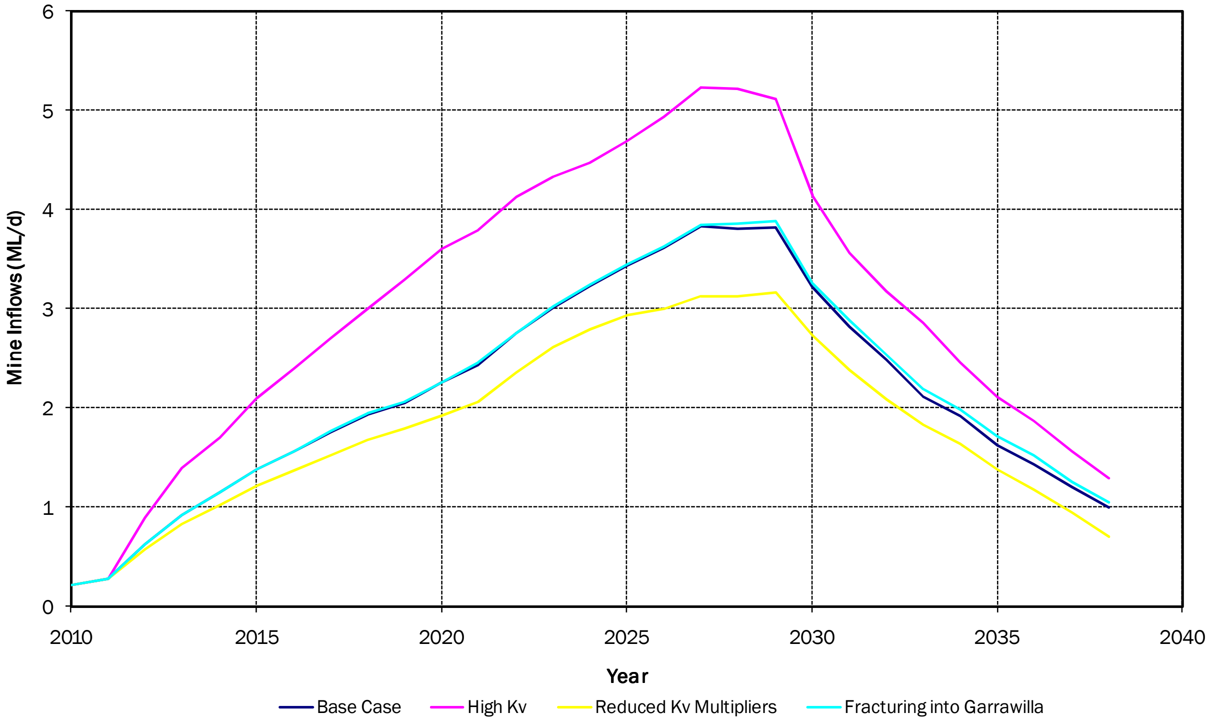

Figure 3.3 Predicted Groundwater In-flows

For the uncertainty scenarios, the modelling shows that if connected fracturing extends up into the Garrawilla Volcanics, a slight increase in the peak in-flow rate to 3.9 ML/d may occur. In the unlikely event that vertical permeabilities are increased by a greater amount than anticipated in the subsidence zones above the longwall goafs, in-flow rates peaking at up to 5.2 ML/d may occur. If some ‘self healing’ of the upper fracture zones occur, resulting in lower hydraulic conductivities, then groundwater in-flows are expected to peak at around 3.2 ML/d.

3.6.2 Groundwater Quality

The groundwater quality likely to be encountered is variable both in terms of key field parameters such as salinity and pH, and also in terms of major and minor hydro-chemical constituents. These quality data indicate that a range of groundwater types exist that are related to their associated geology. Aquaterra (2009) estimated that the dewatered groundwater is likely to have the following characteristics:

- The pH would range from neutral to mildly alkaline.
- The total dissolved solids (TDS) of the initial average in-flow are expected to be in the range 7000 to 8000 mg/L, decreasing through the mine life to around 4000 mg/L. However, the final average in-flow TDS could range from as low as 2000 mg/L to greater than 6000 mg/L.
- Dissolved metal concentrations (Cu, Pb, Ni, Zn and Mn) generally exceed the 95% level of protection trigger values for freshwater ecosystem protection (ANZECC & ARMCANZ, 2000).

The water quality testing to date suggest the quality of dewatered groundwater would not be suitable for releases off site without treatment.

3.7 MINE SITE WATER DEMANDS

Table 3.6 shows the expected Mine Site water demands for Year 2 and Year 18 of the Longwall Project based on a comprehensive review of the expected dust suppression requirements for the various components of the underground and surface operations for each year of operation. The review showed that Mine Site water demand peaks in the second year of operation at 346ML per year when the longwall unit first commences operation and there is limited opportunity to recycle the dust suppression water. The Mine Site requirements would be relatively uniform at about 323ML after the third year of operation. Year 18 water requirements are shown because dewatered groundwater is expected to peak in that year.

Table 3.6 Annual Mine Site Water Requirements

Demand	**Year 2 (ML)**	**Year 18 (ML)**
Underground Dust Suppression	337	465
Surface Coal Processing	56	100
Site Dust Suppression	27	27
Potable Water	20	20
Underground Recycle Water	-89	-284
Industrial Recycle	-5	-5
Total	346	323

The Proponent has purchased a water licence to enable water to be pumped from the Namoi River to supplement Mine Site water demand when required. A pipeline would be constructed to transfer the water from the Namoi River to the Mine Site.

4. LITERATURE REVIEW

4.1 PREVIOUS SURFACE WATER STUDIES

This study is based on the surface water study developed as part of the Environmental Assessment (EA) for the approved Stage 1 Narrabri Coal Mine (WRM, 2007) updated to include the revised dewatered groundwater management strategy and assesses the impact of mine subsidence on the water ways that cross the site in more detail.

Previous surface water studies have been undertaken by URS (2007) and Coffey Geotechnics (2008). The URS report outlined the detailed designs and developed operating rules for the evaporation basins proposed as part of the approved Stage 1 Narrabri Coal Mine. This report supersedes the operation rules presented in the URS report. Coffey Geotechnics prepared the surface water management plan for the construction phase of the Stage 1 Narrabri Coal Mine. The plan was largely based on the surface water study developed as part of the EA.

4.2 RELEVANT LEGISLATION AND GOVERNMENT POLICIES

Based on a review of available literature, the following state legislation and government policies may have some relevance to surface water management issues for the Longwall Project.

- *Protection of the Environment Operations Act* (1997).
- *Water Management Act* (2000).
- *Soil Conservation Act* (1938).
- *Environmental Planning and Assessment Act* (1979).
- *Catchment Management Authorities Act* (2003).
- Namoi Regulated River Water Sharing Plan (2004).
- Farm Dams Policy (1999).
- Environmental Guidelines, Use of Effluent by Irrigation (2004).
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000).
- NSW Salinity Strategy (2000).
- Namoi Catchment Action Plan (2007).

The Surface Water Management Plan for the Mine Site addresses the surface water quantity and quality issues identified in the above documents, as required.

4.3 NAMOI CATCHMENT ACTION PLAN TARGETS

The Namoi Catchment Management Authority (CMA) has developed a Catchment Action Plan (CMA, 2007) for the Namoi Valley that outlines the strategic framework to guide natural resource management in the valley. The Catchment Action Plan establishes catchment and management targets which address significant impacts on the four key regional ‘resources’ – native plants and animals, surface and ground water ecosystems, the landscape and people and their communities. The management targets define the desired outcomes for each resource and management actions provide the strategies to achieve these targets. The plan has outlined four water ecosystem management targets as follows:

1 From 2006, there would be an improvement in riverine structural stability, and the condition and extent of native riverine vegetation in priority riverine areas.

2 From 2006, maintain or improve surface and ground water quality suitable for irrigation, raw drinking water and aquatic ecosystem protection at Gunnedah, Narrabri and Goangra (near Walgett); Target values are as determined by:

   a) Australian & New Zealand Environmental Conservation Council Guidelines 2000, for Irrigation Water - Electrical conductivity range of 650 –1300µS/cm; and Aquatic Ecosystem Protection - mean values of Total Endosulphan < 0.03 µS/Litre and Atrazine < 0.7 µS/Litre.
   b) MDBC; River Salinity of 550 µS/cm 50% of the time and < 1000 µS/cm 80% of the time at Goangra (at time of writing the CAP).

3 From 2006, protect and assist the recovery of threatened or priority native aquatic species in identified priority areas.

4 From 2006, oversee and review water management planning and other processes under the Water Management Act 2000, so that Water Management Plans, including Water Sharing Plans (WSPs), result in fair and reasonable access to surface and ground water sources for the environment (water dependant ecosystems), economic uses (agricultural, industrial, town water supply) and social values (recreation, cultural).

The water quality targets within the Catchment Action Plan are based on the recommendations given in the NSW Salinity Strategy developed by the NSW Government in 2000. The Salinity Strategy identified end of valley salinity targets for the Namoi Valley as a concentration in terms of electrical conductivity (EC) as well as a total annual load in tonnes/year. The recommended 50th percentile and 80th percentile salinity targets given in the NSW Salinity Strategy are shown in **Table 4.1**.

The Proponent proposes to work within the framework outlined in the Namoi Catchment Action Plan (CMA, 2007) and the NSW Salinity Strategy for the Longwall Project to ensure that the ability to achieve these targets is not compromised.

Table 4.1 Namoi River at Goangra Salinity Targets

	NSW 2010 Interim Target		**Equivalent MDBC 2015 target**	
Percentile	**50th %ile**	**80th %ile**	**50th %ile**	**80th %ile**
EC (µS/cm)	550	1,000	565	1,030
Salt Loads (Tonnes/yr)	55,000	158,000	58,000	167,000

5. PIT TOP AREA SURFACE WATER MANAGEMENT OBJECTIVES

5.1 SURFACE RUNOFF CHARACTERISTICS

For the purposes of surface water management, the surface water generated at the Narrabri Coal Mine is divided into four types based on water quality.

- **'Clean'** – surface runoff from the Mine Site areas where water quality is unaffected by mining operations. Clean water includes runoff from undisturbed areas and any fully rehabilitated areas.
- **'Dirty'** – surface runoff water from the Mine Site areas that are disturbed by mining operations. This runoff may contain silt and sediment, but does not contain contaminated material. However, this runoff must be of sufficient quality prior to discharge into natural water courses, if required.
- **'Contaminated'** – surface water from areas affected by mining operations and potentially containing chemicals of various types used in the mining operations. There are restrictions on the use and release of this water. Contaminated water areas include sumps, stockpile areas, service ponds and fuel storage areas. Rainfall and resulting runoff from these areas are also potentially contaminated and therefore must be managed to avoid discharge of potentially contaminated water into the natural water courses.

- **'Saline'** – water pumped from the underground workings containing concentrations of total dissolved solids (TDS) above that considered fresh water by ANZECC & ARMCANZ (2000) criteria.

The locations of the potentially dirty and contaminated catchments on the Pit Top Area are shown in **Figure 5.1.**

5.2 PIT TOP AREA SURFACE WATER MANAGEMENT STRATEGY

5.2.1 General

The main principles of the Pit Top Area Surface Water Management Strategy are to separate the 'clean', 'dirty', 'contaminated' and 'saline' water generated on the Mine Site and to provide targeted strategies to minimise the impact of each water quality type. A description of the strategies for each water type is given below.

5.2.2 Contaminated Water Management Strategy

The main area of disturbance on the Pit Top Area that may generate contaminated runoff is the stockpiling, crushing and sizing area and the surface facilities area (See **Figure 5.1**), which is confined to a 36 ha site containing:

- the conveyor and transport drift portals;
- the ROM and product stockpiles;
- the coal processing plant;
- the rail load-out bin;
- the sub-station; and
- the surface facilities area.

The other area of disturbance that may generate contaminated runoff is the proposed Reject Emplacement Area. Information on the coal seams to date suggests that the majority of the material placed in the Reject Emplacement Area would be coarse reject (16mm to 125mm) from the floor of the workings. However, up to 10% is expected to be the filter cake produced by the dewatering and thickening of the ultra-fine reject, which may generate runoff containing coal fines.

Runoff from potentially contaminated catchments would be collected in storage dams and not released off site. Water collected in the storage dams would be pumped to the evaporation ponds for processing in the water conditioning plant. The quality of the water collected within the contaminated water storage dams would be monitored. Only water that achieves the water quality compliance criteria, given in **Section 5.3,** would be released to the downstream environment.

5.2.3 Dirty Water Management Strategy

Figure 5.1 shows the locations of the catchments containing potentially dirty water runoff on the Pit Top Area. The majority of these areas were disturbed during the construction phase of the Stage 1 Narrabri Coal Mine and the mitigation measures for these areas are described in the Construction Phase Surface Water Management Plan (Coffey, 2008). Much of the disturbed areas have now been revegetated and minimum disturbance of these areas are expected during the operational phase of the Longwall Project. However, elevated sediment loads are expected until the revegetation becomes fully established.

Runoff from the potentially dirty catchments would be collected in the existing sediment dams. The sediment dams have been sized to achieve required stormwater quality for storms greater than the 95%ile five day storm event. Water collected in the sediment dams would be used during the construction phase of the Longwall Project, as well as to supplement shortfalls in supplies expected in the first few years of mining. After this time, the water collected in the dams would be released to the downstream receiving water after a period of settling. Any water released from the sediment dams would achieve the water quality compliance criteria given in **Section 5.3**.

5.2.4 Saline Groundwater Management Strategy

The general principles involved in managing the dewatered groundwater from the underground workings are as follows:

- All saline water dewatered from the underground workings would be contained on site without releasing it to the natural watercourses. The saline water would be treated in a water conditioning plant for use in coal processing and coal dust suppression around the Mine Site.
- The treated water in excess of Mine Site requirements would be piped to the Namoi River at or better than the adopted water quality compliance criteria.
- The concentrated brine by-product of the water conditioning plant would be evaporated in storage dams on site without releasing it to the environment. At the completion of the Longwall Project, it is predicted that there would be concentrated brine solution retained within the brine storage ponds and this would be re-injected back into underground void.

5.3 WATER QUALITY COMPLIANCE REQUIREMENTS

The Environmental Protection Licence for the approved Stage 1 Narrabri Coal Mine (No.12789) stipulates that the licensee must comply with Section 120 of the *Protection of the Environment Operations Act 1997*. In effect, this Act requires that the licensee not pollute. The Proponent has implemented a monitoring program to collect and test water samples in the creeks both upstream and downstream of the Mine Site to assess compliance with this condition. The Stage 1 water quality license conditions are proposed for the Stage 2 Longwall Project. In addition, measurable water quality targets for the release of treated raffinate water to the Namoi River are proposed.

Table 5.1 shows the recommended end-of-pipe water quality compliance release limits for the Narrabri Coal Mine Stage 2 Longwall Project. Values are shown for both for pH, total dissolved solids (TDS) and metal toxicants (dissolved). For pH and toxicants, the ANZECC & ARMCANZ (2000) default trigger levels for 95% level of species protection for slightly to moderately disturbed catchments is proposed. For TDS, a maximum TDS concentration of 350 mg/L (550 µS/cm) is proposed. Note that the proposed two stage water treatment process for the dewatered groundwater would aim for a TDS concentration of 250 mg/L and treated water at this concentration would mostly be released. The higher concentration of 350 mg/L is proposed as an upper limit value. The proposed salinity target is more stringent than the Namoi Catchment Action Plan and NSW Salinity Strategy targets (See **Section 4.3**) and is also consistent with the ANZECC & ARMCANZ (2000) default trigger values. Note that background TDS concentrations within the Namoi River substantially exceed the adopted target values.

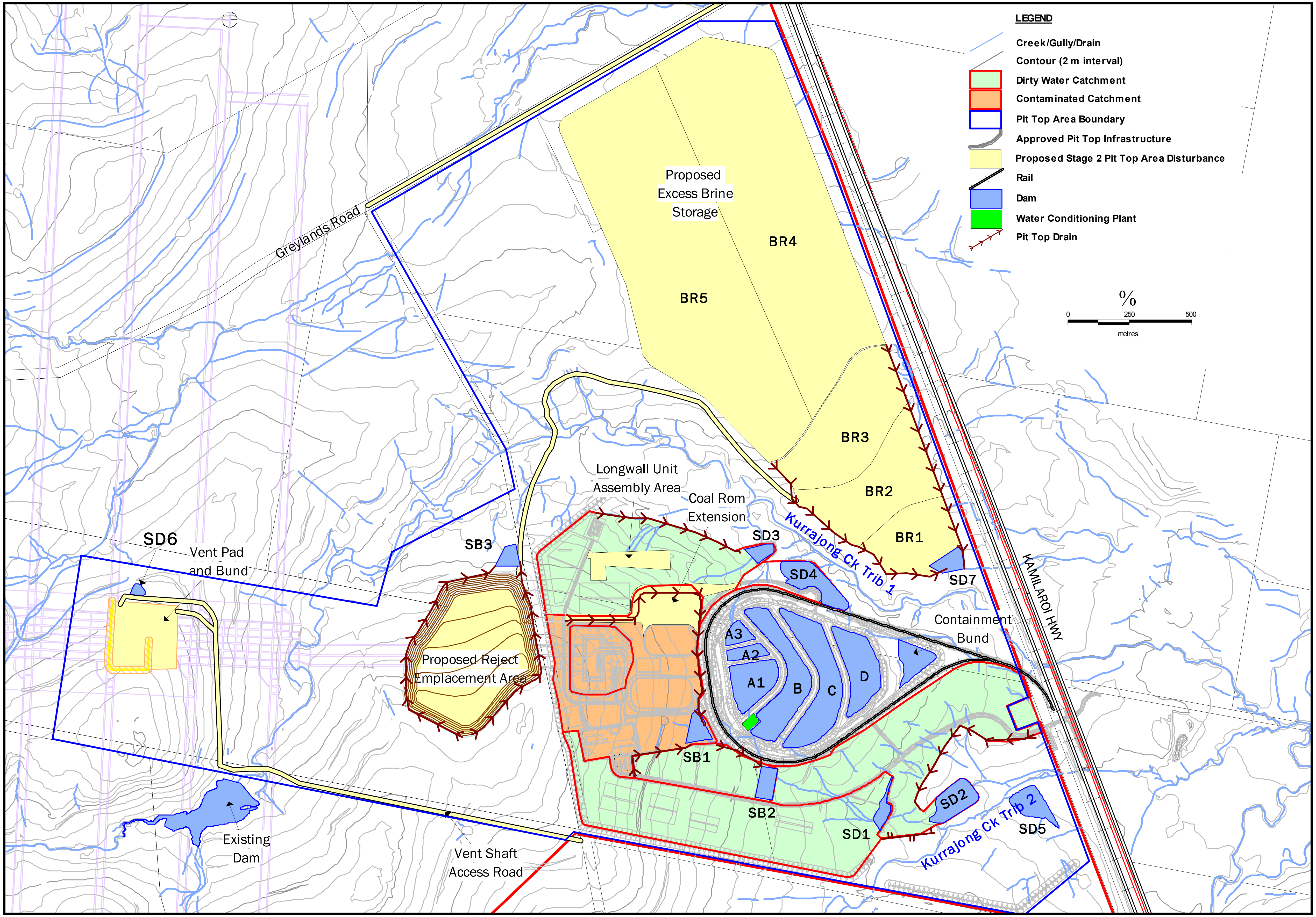

Figure 5.1 Pit Top Surface Water Management Plan

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Table 5.1 Water Quality Compliance Targets

Quality Characteristic	units	Target
pH	pH Units	6-5 - 8
TDS	mg/l	350
Aluminium #	µg/L	55
Ammonia (as N)	µg/L	900
Antimony	µg/L	9
Arsenic #	µg/L	13
Boron #	µg/L	370
Beryllium#	µg/L	0.13
Cadmium #	µg/L	0.2
Chromium #	µg/L	1
Cobalt #	µg/L	1.4
Copper #	µg/L	1.4
Fluoride (# only)	µg/L	2000
Iron #	µg/L	300
Lead #	µg/L	3.4
Manganese #	µg/L	1900
Mercury #	µg/L	0.1
Molybdenum #	µg/L	34
Nickel #	µg/L	11
Selenium #	µg/L	5
Uranium #	µg/L	0.5
Vanadium	µg/L	6
Zinc #	µg/L	8

ANZECC & ARMCANZ (2000) default trigger values for slightly-moderately disturbed catchments

5.4 SALINITY OFFSETS

The proposal to release treated groundwater to the Namoi River has the potential to negatively impact on the ability meet the 2010 interim NSW Salinity Strategy load based targets. While the quality of water released will enhance the quality of water flowing past the proposed discharge site, discussions with the Department of the Environment Climate Change and Water (DECCW) Armidale Office has determined that a salinity offset is likely to be required for this salt so that there is no net increase in the salt load into the Namoi River and indeed the downstream Murray Darling system.

Further discussions indicated that one option would be for the Proponent to participate in, and be credited with, contribution to the current 'Cap and Pipe Bores' Program run through the NSW Office of Water (NOW) under the Great Artesian Basin Sustainability Initiative. Conceptually, participation in the scheme would see the Proponent contributing to the cost of capping and piping bores identified by NOW. The Proponent would then seek to be credited with the amount of salt that would otherwise have flowed into the environment equivalent to the amount of salt contained in the water that would otherwise have been discharged.

Discussions have been held with the NOW office which administers the program in Inverell in regard to some of the practical aspects of the program including the availability of suitable bores in the Namoi catchment. It was identified in these discussions that while a number of suitable bores would be available for funding, a framework would be needed on which to establish a ‘salt’ banking protocol that would be used. A salt banking protocol would enable the Proponent to be credited with the salt contained in water that would otherwise have discharged to the surface in water from the Artesian Basin by means of the money the Proponent had contributed to the scheme for capping and piping.

The Proponent would be in a position to annually accrue these salt volumes and then offset this saved salt against the quantities of salt it would discharge in future years into the Namoi River. The net effect at the end of mine life would be that there was a net zero result and that the Proponent had effectively offset its full salt discharge. At that stage the bore could be kept Capped and Piped with a net benefit to the environment or NOW could use the banked water for other purposes. Narrabri would pass on title of that water to NOW.

The Proponent sees this as a win-win opportunity for both The NSW Office of Water and also the Proponent. A positive outcome for the NSW Office of Water is anticipated given the following outcomes.

- It will have access to funds to Cap and Pipe additional bores in excess of that allowed by funds currently available, that is, works that have not yet qualified will be able to be undertaken in advance of that they otherwise would, increasing the benefit to the environment and preserving the water of the Great Artesian Basin.
- At the end of the mine life when there will be no possibility of discharge from the mine that water removed from discharge from otherwise uncapped and unpiped bores by application of the Proponent’s funds will be available for use by NOW or alternatively will be forever retained in the Great Artesian Basin to the benefit of the environment as a whole (that is there will be a net removal of salt from the environment).

A positive outcome for the Proponent is anticipated given the following outcomes.

- It has the ability to offset the salt load it will contribute to the Namoi River in those years where treated water discharge is required from the mine.

In conceptual terms the Proponent understands that a system of accounting for the salt discussed as above needs to be agreed between the Proponent, NSW Office of Water and the relevant section of the DECCW. The Proponent proposes to contribute funds directly to the Cap and Pipe Bores Program (to be administered by NOW) and that on an individual bore basis calculations be made on the reduction of surface salt load that can be directly attributed to the expenditure of these funds. The Proponent would then ‘bank’ this salt as a credit to its account on an annual basis. In future times when discharge is required the Propoent would draw down on this accumulated credit to the value of the salt contained in its discharge waters. It is proposed that once an agreed process was in place to ‘bank’ the salt credits available to it, the Proponent would undertake an annual review and include a balance in the Annual Environmental Management Report (AEMR) which is prepared annually and widely distributed. Should it at any time become apparent that the Proponent will discharge in excess of its salt credit it will undertake to investigate the potential for further offsets or other means to ensure a net balance of salt load within the catchment.

6. PROPOSED SURFACE WATER MANAGEMENT CONTROLS

6.1 GENERAL

Surface water management infrastructure has been constructed within the Pit Top Area as part of the Stage 1 Narrabri Coal Mine and is described in detail in URS (2007). The change in the mining method from the use of continuous miners to a longwall operation with its consequent subsidence and increased groundwater inflows has resulted in a significant change to the proposed dewatered groundwater management strategy. The water management infrastructure developed as part of the Stage 1 Project in conjunction with additional infrastructure and controls to be implemented as part of the Stage 2 project would be used to achieve the surface water management objectives outlined in **Section 5**.

Surface water management controls have been developed for the Pit Top Area as well as the ventilation shaft, brine storage and gas drainage areas across the remainder of the Mine Site.

6.2 PIT TOP SURFACE WATER MANAGEMENT INFRASTRUCTURE

Figure 5.1 shows the locations of the existing and proposed water management system elements and controls on the Pit Top Area. The general features of the surface water management infrastructure for the Pit Top Area that were constructed as part of the Stage 1 Mine are as follows.

- A series of water storages (Dam A1, A2, A3, B, C and D) within the rail loop to collect, store and dispose of dewatered groundwater and dirty runoff from the Pit Top Area.
- A storage basin (SB1) to collect dirty and contaminated runoff from the stockpiling and coal processing area.
- A sump in the box cut to collect runoff draining into the box cut and to temporarily store groundwater pumped from underground.
- A series of sediment dams (SD1, SD2, SD3, SD4 and SD5) to collect and treat runoff from the periphery of the Pit Top Area that has been disturbed during the construction phase.
- A containment bund to collect runoff from within the rail loop.
- A series of drains to collect runoff from the Pit Top Area and divert it to the various Pit Top Area water storages.
- A water conditioning plant to treat dewatered groundwater to a sufficient quality for Mine Site use and potentially for use off site**.**

The following additional water management infrastructure would be constructed as part of the Stage 2 operations.

- SB1 would be increased in capacity (to 20ML) and a new storage basin (SB2) would be constructed immediately downstream of SB1 to provide sufficient storage capacity (30ML) to contain potentially contaminated runoff from the stockpiling and coal processing area and prevent it from being released off site.

- A new storage basin (SB3) of 15ML capacity would be constructed to contain potentially contaminated runoff from the proposed Reject Emplacement Area and prevent it from being released off site.
- A new sediment dam (SD6) of 4ML capacity would be constructed to collect and treat potentially dirty runoff from the first ventilation shaft area before it is released off site.
- New brine storage evaporation dams would be progressively constructed to hold and contain the excess brine generated from the water treatment process in excess of the capacity of the existing evaporation dams.
- A new sediment dam SD7 would be constructed to collect and treat potentially dirty runoff from the construction of the brine storage ponds.

A description of the existing and proposed surface water management controls is given below.

6.3 RAIL LOOP WATER STORAGES AND BRINE STORAGE PONDS

6.3.1 Configuration

Figure 5.1 shows the locations of the existing rail loop water storages. These were originally constructed within the rail loop as a depository for dewatered groundwater from the Stage 1 underground operations and potentially dirty runoff from the Pit Top Area. The clay lined Pond B would be split into Pond B1 and Pond B2 as part of the Longwall Project. Each pond is approximately 5m deep, has 1:3 (V:H) side slopes and 5m wide crests. The ponds are designed to spill internally with Ponds containing saline or contaminated water overflowing to ponds containing cleaner water. The storage volumes and surface areas of the evaporation ponds at full supply level are given in **Table 6.1**.

Table 6.1 Existing Evaporation Pond Specifications

Pond	Surface Area @ Spillway (ha)	Storage Volume (ML)	Spill Location
A1	3.17	129.8	B2
A2	0.98	30.6	B2
A3	0.93	30.8	A2
B1	1.0	40.0*	C
B2	4.85	165.0*	C
C	6.63	218.3	D
D	4.15	128.4	Containment
Total	21.71	747.0	

* Preliminary estimate pending final design.

It is proposed to construct a series of additional storages to contain the excess brine generated from the water conditioning plant if and when they are required. The locations of the excess brine storage ponds are shown in **Figure 5.1**. These storages would be designed if and when they are required. The preliminary storage volumes and surface areas of the excess brine storage ponds adopted for this assessment are given in **Table 6.2**. Note that BR4 and BR5 are identified as contingency storages because the water balance modelling indicates that they would not be required unless dewatered groundwater rates significantly exceed the base case in-flow rates predicted by Aquaterra (2009).

Table 6.2 Proposed Excess Brine Storage Pond Specifications

Pond	Surface Area @ spillway (ha)	Storage Volume (ML)
BR1	8.5	470
BR2	13.7	748
BR3	16.2	898
BR4	~55	-
BR5	~65	-

6.3.2 Operating Rules

The operating rules for the rail loop water storages and brine storage ponds are summarised below.

- Pond A1 would receive all saline groundwater pumped from the underground workings and all potentially contaminated runoff from the storage basins SB1, SB2 and SB3. Pond A1 would be the primary feed to the water conditioning plant. Pond A1 is lined with HDPE with a maximum permeability of 1 x 10^{-14} m/sec.
- Pond B1 would be the primary storage structure for treated water from the water conditioning plant. Water in Pond B1 would be used for underground dust suppression and for potable water after further treatment. Water may also be 'shandied' with water in Pond A1 or from Pond D for use in surface coal handling and site dust suppression.
- The HDPE lined Ponds A2, A3 and B2 would receive the concentrated brine from the water conditioning plant.
- Ponds BR1, BR2 and BR3 would be constructed if and when required to store the excess concentrated brine from the water conditioning plant.
- The clay lined Pond C and Pond D are to be the primary storage ponds for clean or potentially dirty water harvested from the storage dams on the Pit Top Area. The maximum permeability of the clay liner is 1 x 10^{-9} m/day. These ponds would also store the excess low salinity, treated water (raffinate) from the water conditioning plant prior to use.
- Water in excess of the storage capacity of Pond B1, Pond C and Pond D would be released to the Namoi River via a dedicated pipeline.

- To prevent any of the brine storage dams from overflowing, each dam would maintain a 0.5m freeboard from the spillway, which is equivalent to contain the 100 year 72 hour storm event (0.26m) and any wave run up.
- The spillway for each brine storage would be sufficient to convey the 10,000 year ARI critical duration storm event without overtopping the dam wall.

The behaviour of the rail loop water storages and brine storage ponds under this operating scenario is described in **Section 8**.

6.3.3 Concentrated Brine Storage and Disposal

It is proposed to contain and evaporate the concentrated brine solution within HDPE lined storages on the Pit Top Area until mining has been completed without releasing it to the environment. The brine storage ponds would be constructed in stages on an as needed basis. Each new storage would be operational to maintain a freeboard storage volume sufficient to contain at least the 20th percentile annual rainfall (740mm) and process inputs within the previous storage. Each new storage would take approximately 3 to months to construct.

The brine may evaporate from the ponds over time as evaporation exceeds rainfall for all months of the year. However, it is predicted that it would be necessary to dispose of the brine solution remaining within storage at the completion of mining by pumping it back underground into the coal seam when the final longwall panel has been mined (after 30 years).

Note that the by-product of the water conditioning plant is expected to produce a brine solution that has a TDS concentration of about 20,000 to 30,000 mg/L. At these concentrations, it is unlikely that the salts would crystallise out of solution even though salt concentrations would increase with continual evaporation. Salt crystals begin to form at TDS concentrations of about 230,000 mg/L, some 10 times the expected concentration of the brine produced as part of the Longwall Project. Therefore the brine would need to be managed as a liquid at all stages of the Longwall Project.

6.3.4 Raffinate Disposal

When (or if) dewatered groundwater in-flows exceed the volume of water required to supply the Mine Site demand, it would be necessary to dispose of the treated raffinate water off site. The water balance modelling, described in **Section 8**, indicates that off-site disposal would be required about 7 to 10 years after the commencement of the Longwall Project. It is proposed to release the treated raffinate water directly to the Namoi River via a pipeline. The water released would be treated to a sufficient quality to comply with the water quality criteria given in **Section 5.6** and would be released at a constant rate when required. Discussions are currently being held for NCOP to participate in the 'Cap and Pipe Bores' program to offset any potential salt loads in the Namoi River.

Figure 6.1 shows a ranked plot of historical daily recorded flows in the Namoi River at Boggabri over the period 1990 to 2009. The 1990 to 2009 period of record was selected because the majority of the irrigation infrastructure in the catchment would have been constructed by then and the Murray Darling Basin Commission cap on diversions had been imposed. The ranked plot of the daily Namoi River flows assuming an added discharge of 3 ML/day of dewatered groundwater from the Mine Site over the historical period of record is also shown. The adopted discharge rate of 3 ML/d from the Mine Site is the daily rate that is expected to occur in Year 20 of Mine Site operations assuming the expected upper bounds of the predicted dewatered groundwater rates are achieved. Discharges both prior to this year and subsequent to this year would be less than this value and would also be significantly lower for the base case groundwater in-flows. However, the comparison provides an indication of the expected change in flow behaviour that may occur in the 'worst' year under the worst case groundwater inflow conditions. The results show the following.

- Over 70% of daily flows exceed 100ML/day and therefore the minor increase in flow resulting from the mine discharge is insignificant.
- The mine discharges could potentially increase the frequency of low flows, which could increase the reliability of stock and domestic users and improve environmental flows in the catchment.
- Available water quality data (see **Section 3.4**) indicates that higher EC values occur during low flow periods and that these EC values generally exceed the adopted water quality compliance requirement for this mine. Therefore, the releases are expected to reduce the salinity concentrations during periods of low flows.

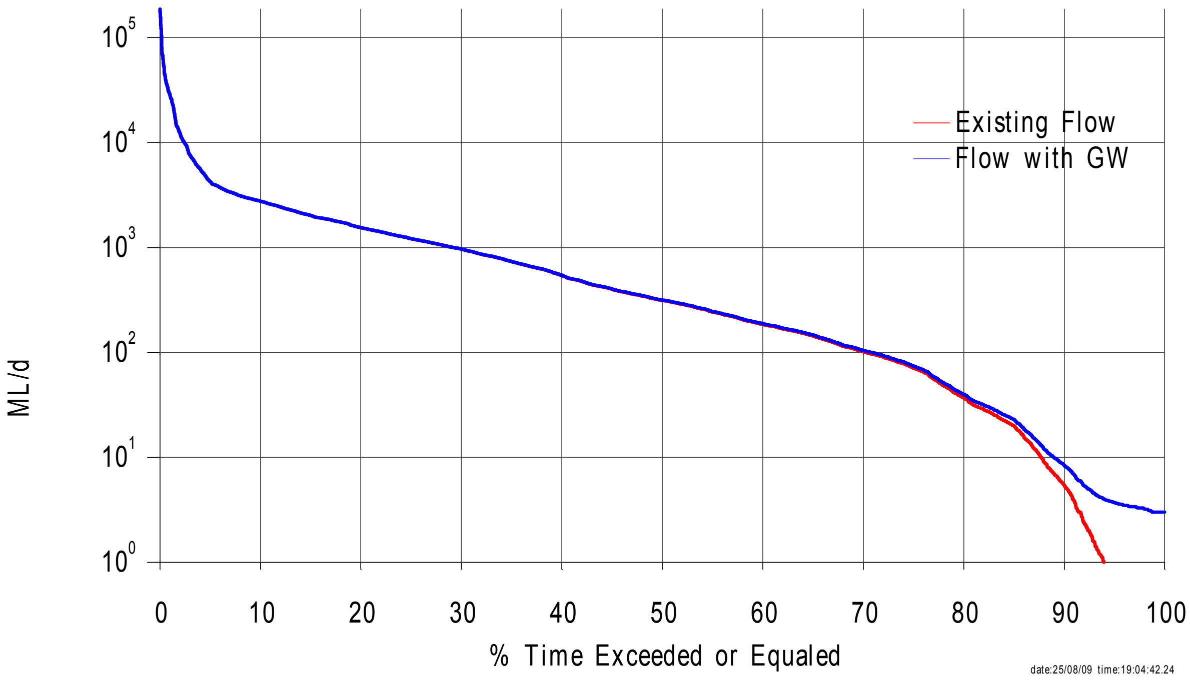

Figure 6.1 Ranked Plot of Daily Namoi River Flows at Boggabri, 1990 to 2009

6.3.5 Excess Groundwater In-flow Contingency Plan

Aquaterra (2009) recommended that contingency plans be developed should groundwater in-flows be significantly higher than what has been modelled although they noted that the likelihood of this scenario is low. The excess groundwater In-flow contingency plan is as follows.

- Additional water conditioning plant capacity would be installed;
- The BR4 and BR5 brine storages, shown in **Figure 5.1** would be constructed;
- Additional treated water would be released to the Namoi River.

Preliminary investigations by GSS Environmental regarding the potential to irrigate the dewatered groundwater (and the raffinate water) onto the Proponent's landholding established that the vast majority of soils on the Mine Site are unsuitable for long term sustainable irrigation regardless of the quality of irrigated water. Further discussions with GSS Environmental found that there is a much greater potential to irrigate on the Namoi alluvium, although some pre-treatment of the dewatered groundwater to lower the salinity levels would be necessary.

The Proponent intends to investigate options of either purchasing land or entering into a commercial arrangement to supply an off-site irrigator once the expected rates of dewatered groundwater is clearer. Again, water balance modelling suggests that releases off site would not be required until 7 to 10 years after the commencement of mining. An effluent disposal management plan would be developed in accordance with DECC (2003) guidelines for any irrigation option that is proposed.

6.4 PIT TOP AREA DAMS

6.4.1 Contaminated Catchment Storage Dams (SB1, SB2 and SB3)

Figure 5.1 shows the existing location of SB1 and the proposed locations of SB2 and SB3. SB1 is located to the south of the product coal stockpile areas adjacent to the rail loop and collects and stores potentially dirty/contaminated runoff from the entire Pit Top Infrastructure Area. SB2 is located downstream of SB1 and collects overflows from SB1 only. The catchment draining to SB2 is essentially clean and would be diverted around the dam. SB3 would collect runoff from the proposed Reject Emplacement Area. **Figure 2.15** in ***Section 2*** of the Environmental Assessment gives details of the configuration of the proposed Reject Emplacement Area.

The exact area covered by the Reject Emplacement Area would be dependent upon the proportion of stone and/or oversize material within the ROM coal, as well as the amount of coal to be washed. The Proponent has allocated an area of approximately 25 ha for the Reject Emplacement Area as shown in **Figure 5.1**. However, the catchment of the area would vary over time as the reject material would be placed in sections that would be progressively rehabilitated. Catch banks and drains would be used around each section to collect potentially dirty water draining from the reject area and direct it to Dam SB3 and to divert clean water around the dam. At any one time, there is likely to be no more than two sections that would drain to SB3 as one is being filled with reject and the other is being prepared. The coal reject may generate saline leachate and testing of the reject would be undertaken to determine the propensity of the material to generate saline, or otherwise contaminated leachate. In the event that the testing indicates the reject has a propensity to generate saline leachate, or leachate with elevated concentrations of other contaminants, the base of each cell would be constructed to be effectively impermeable. To achieve a permeability of $1x10^{-9}$m/sec or less, the Proponent would either;

- compact a layer of clayey material (at least 300mm thick) over the base of each cell, taking care to ensure that any rocks and/or coarse or sharp material is removed or compacted within the cell batter; or
- in the event insufficient in-situ material of suitable impermeability is not available, additional clay would be imported or an impermeable plastic liner used.

Any leachate would drain laterally along the clay liner and into the drainage lines to SB3 to be pumped to the Rail Loop water storages for Mine Site use. It is proposed to cap the Reject Emplacement Area at the end of mining to minimise leachate from occurring.

Table 6.3 shows summary details of the storage basins. These basins have been sized using the daily water balance model described in **Section 8** to prevent uncontrolled spills to the downstream environment.

Table 6.3 Storage Basin Specifications

Dam	Catchment Area (ha)	Nominated Storage Volume (ML)
SB1	29.7	20
SB2	0	30
SB3*	25	15

* assumes 10 ha draining to basin at any one time.

Note the following:

- The area available for SB1 is constrained by existing infrastructure. Therefore, excess storage volume is provided in SB2 to achieve the storage requirements for SB1, which overflows to SB2.
- A concrete ramp would be constructed within SB1 to enable collected sediment to be removed. Sediment removed from the storage basins would be transported to the Reject Emplacement Area.
- The catchment draining to SB2 is diverted around the dam such that it only receives overflows from SB1.
- For SB3, it is assumed that only 10 ha would drain to the storage dam at any one time. The remainder of the catchment area would be either undisturbed or would be rehabilitated with runoff directed around the storage basin at that time.
- The spillways for all storage dams would have sufficient capacity to pass the 100 year ARI critical duration storm event (assuming it is full) without overtopping the dam walls.
- The water stored in SB1, SB2 and SB2 would be pumped to Dam A1.

The behaviour of the ponds under this operating scenario is described in **Section 8**.

6.4.2 Sediment Dams

Figure 5.1 shows the locations of seven sediment dams on the Pit Top Area. SD1, SD2, SD3, SD4 and SD5 are existing dams. SD6 is a proposed new dam for the ventilation shaft area and SD7 is a proposed new dam for the construction of the excess brine storages. SD1, SD2 SD3, SD4 and SD5 served as sediment dams during the construction phase of the Stage 1 Narrabri Coal Mine. The water collected in these dams was used to supply water for construction purposes and would be used to supplement supplies during the early years of the Longwall Project. The catchments draining to these dams would not be significantly disturbed during the mining phase of the Longwall Project but may collect dirty runoff during the construction phase and during the early years of mining prior to the revegetation becoming established.

Table 6.4 gives the summary details of the configurations of the sediment dams. These dams have been designed to contain the 5 day 95%ile storm event (DECC, 2008) of 52mm assuming a runoff coefficient of 0.74. The following is of note:

- SD1 overflows to SD2, which would overflow to SD5. Excess storage is provided in SD2 to contain the minimum storage requirements for SD1.
- SD5 is not strictly a sediment dam because it partially collects runoff from Kurrajong Creek tributary 2 and therefore it does not meet the minimum storage requirements. It was constructed (from an old farm dam) to supplement Mine Site supplies during the construction phase of the project.
- SD3 overflows to SD4. Excess storage is provided in SD4 to contain the minimum storage requirements for SD3.
- SD7 would be sized once the area of the excess brine storage ponds are confirmed. Upstream catchment clean water would be diverted around the dams prior to construction.
- The spillway of all dams would have sufficient capacity to pass the 100 Year ARI critical duration design flood.
- Water collected in the sediment dams would be pumped to Dam D to be used for Mine Site use when required.
- Any releases from these dams would achieve the water quality compliance criteria given in **Section 5.3**.
- The primary release points for water from the Pit Top Area would be from SD2, SD4, SD6 and SD7.

Table 6.4 Sediment Dam Specifications

Basin	Catchment Area (ha)	Minimum Storage Volume (ML)	Storage Volume (ML)
SD1	32.3	12.4	5.9
SD2	31.5	12.1	55.2
SD3	25.2	9.7	4.7
SD4	4.5	1.7	35
SD5	169.3	65.1	11.2
SD6	7.2	2.8	4

6.5 TRANSPORT DRIFT AND CONVEYOR DRIFT

The transport drift and conveyor drift portal consists of a 250m by 300m, 35m – 40m deep box cut. A pump out sump has been constructed within the box cut area to prevent rainfall runoff within the box cut from entering the portals. The sump would be pumped to Dam A1 or Dam D, depending upon the quality, as the sump begins to fill with water. The pump / sump have the following characteristics:

- Pump Capacity 4.7ML/d;
- Sump Volume 1.5ML;

6.6 SURFACE FACILITIES AREA

The approved Stage 1 surface facilities area may produce runoff that contains hydrocarbons. These areas include:

- the wash-down area;
- workshop;
- fuel, oil and grease storages; and
- refuelling bays.

These areas would be managed as follows.

- Runoff from these areas would drain to a triple interceptor (or similar) to reduce hydrocarbons to acceptable levels before draining to SB1. The oily fraction would enter a containment system for removal as necessary.
- Storage tank areas would have an impermeable surface and bunding capable of containing 110% of the largest tank's capacity in accordance with EPA (2007) guidelines;
- All oil, grease, fuel and hydrocarbon products would be securely stored.
- Refuelling, oiling and greasing would take place in designated areas only.

The following actions would be taken if a major hydrocarbon spill on an unsealed area occurs.

- The contaminated soil at the site of the spill would be collected and transported to an approved waste depot or remediated safely on the Mine Site.
- Pits would be constructed around the spill with sufficient hydraulic gradient to capture seepage water and contaminated material, enabling the pits to be pumped out.
- The local groundwater would be monitored for signs of further contamination.

No new bunded areas are proposed for the Longwall Project operations.

6.7 ACCESS ROADS

Two main access roads would be constructed as part of the Longwall Project; one to access the ventilation shaft area and one to access the proposed brine storage ponds. Both of these access roads cross Kurrajong Creek Tributary 1 (see **Figure 5.1**). Heavy machinery would cross at these locations during the construction phase of the Longwall Project. It is expected that only light traffic would use these roads during the operational phase of the mine.

The ventilation shaft area access road is mostly located along the alignment of an existing road. This road would be upgraded across Kurrajong Creek Tributary 1 with twin 1500mm diameter corrugated metal pipes (or similar) to convey the 2 year ARI design flood. Scour protection in the form of dumped rip rap would be provided on the downstream side of the culvert to prevent erosion from flows that overtop the crossing.

The brine storage ponds access road across Kurrajong Creek Tributary 1 would be constructed as a low level crossing with the base of the road constructed at the creek bed level to prevent upstream ponding. The banks of the creek would be battered to access the creek at this location and some trees may be removed.

Construction of the road crossings over Kurrajong Creek Tributary 1 would occur when the creek is not flowing and an extended period of dry weather has been forecast. Any loose material generated during the construction program would be removed and the area would be revegetated as soon as practicable at the completion of construction.

6.8 GAS DRAINAGE

Groundwater extracted as part of the gas drainage operations would be stored in lined sumps within each area before being pumped back to Dam A1 for treatment through the water conditioning plant. The disturbed area would be bunded to ensure that in the unlikely event of an overflow from the lined sump, the water would not discharge from the disturbed area.

7. MINE SUBSIDENCE IMPACTS

7.1 GENERAL

The following waterways are potentially affected by mine subsidence:

- Pine Creek;
- Pine Creek Tributary 1;
- Pine Creek Tributary 3;
- Kurrajong Creek; and
- Kurrajong Creek Tributary 1.

These creek channels range from first order water courses at the upstream (western) end of the mine subsidence zone to third order watercourses at the downstream (eastern) end under the Strahler stream ordering system (Strahler, 1957) as shown in **Figure 7.5**. A detailed description of the creeks is given in **Section 2.2**. All of the creeks are ephemeral. Therefore, the creeks are likely to be Schedule 1 streams under the DWE guidelines (DIPNR, 2005).

7.2 MINE SUBSIDENCE IMPACT MANAGEMENT OBJECTIVES

The general principles involved in managing the impact of mine subsidence on the various streams and waterways that cross the Mine Site are as follows:

- maintain stream stability where subsidence occurs;
- minimise stream fracture where possible;
- maintain stream channels with minimal incision from bed grade change;
- minimise stream bed grade change to provide stable stream length; and
- maintain stream stability through soft controls, such as vegetation, where possible.

7.3 POTENTIAL IMPACTS

Ditton Geotechnical Services (DGS, 2009) developed three estimates of ground subsidence associated with the proposed longwall mining operation. The ‘credible worst case’ of the three scenarios (Case 3) involved maximum subsidence over the longwall panels and minimum subsidence over the chain pillars. Case 1 and Case 2 had significantly less differential settlement because less subsidence over the longwall panels or more subsidence over the chain pillars were assumed. Based on the results of modelling the three cases, DGS found the following with respect to mine subsidence impacts on the waterways that cross the site.

- Surface cracking and shearing ranging in width from 20 mm to 190 mm could occur.
- Surface gradients are likely to increase or decrease by up to 6% (3^o) along creeks.
- Potential ponding depths of 0.5 m to 1.5 m may develop above several of the longwalls and creeks in the flatter areas of the site.
- Direct hydraulic connection to the surface, due to continuous sub-surface fracturing above the panels, is considered unlikely to occur.
- In-direct or discontinuous sub-surface fracturing could interact with surface cracks where cover depths are <215 m. Creek flows could be re-routed to below-surface pathways and re-surface down-stream of the mining extraction limits in these areas due to this interaction. This behaviour usually only occurs where shallow surface rock is present and unlikely to occur where deep soil profiles exist (as occurs over the majority of the mining area).
- The development of valley closure and associated uplift in valley floors and along creek beds are considered to be unlikely mining impacts due to the absence of incised gorges and significant topographic relief.
- Instability of steep, eroded creek channel banks could be exacerbated by mine subsidence cracking and tilting. Increased erosion (i.e. head cuts) and sedimentation may also develop above chain pillars where surface gradients are predicted to change by more than 2% to 3%.
- Minor, localised, sub-surface flow re-routing could occur along creek beds due to the predicted surface cracking along exposed rock bar areas and re-surface downstream of the affected areas. Remedial works may be required where cracks are unable to ‘self-heal’ through natural sedimentation over time.
- Stock watering dams are likely to be damaged by mine induced cracking and/or shearing, resulting in dam wall breach or storage losses through the floor of the dam storage areas. Repairs to the dams and temporary supplies of water may be required by the stakeholders. Windmills and fences around the dams could also be damaged and require repairs after mining.
- Scattered Aboriginal artefact sites and modified trees exist within the mine subsidence area and are unlikely to be directly impacted by mine subsidence. However, some of the features could be impacted by surface cracking indirectly due to increased erosion and sedimentation.

DGS (2009) presents comprehensive estimates of the predicted mine subsidence contours for the three cases as well as estimates of post mine contours, post mine surface slopes and proposed changes in surface slope (from existing conditions) across the mine subsidence zone. Long section profiles along the bed of the Pine Creek and Kurrajong Creek and their tributaries have also been provided.

7.3.1 Pine Creek Tributary 1

Figure 7.1 shows a visual interpretation of the potential impacts of the Case 3 mine subsidence along Pine Creek Tributary 1 crossing longwall panels 1 to 5**.** The figure shows the 1 m Case 3 post mine contours estimated by DGS as well as the existing 5 m contour for comparison. The impacts of the Case 3 mine subsidence predictions within this area would include the following.

- Substantial in-stream and over bank ponding would occur over longwall panel 1, the most downstream panel. No subsidence is predicted downstream of this panel.
- In-stream ponding over longwall panel 2 and 3 appears to be limited to within the minor tributary of Pine Creek Tributary 1. Limited ponding would occur in the tributary itself. It appears that in-stream ponding mostly occurs where the channels are perpendicular to the longwall panels because the change in channel slope is more significant. No ponding is predicted over longwall panel 4 and 5.
- The existing contour banks crossing the chain pillars would no longer run along contour. Substantial over bank ponding would occur along the contour banks and the direction of flow along banks may change. This could potentially redirect flood flows from the creek channels along the banks.

7.3.2 Pine Creek and Pine Creek Tributary 3

Figure 7.2 shows a visual interpretation of the potential impacts of the Case 3 mine subsidence along Pine Creek and Pine Creek Tributary 3. The impacts of the Case 3 mine subsidence predictions within this area would include the following.

- Significant in-stream ponding would occur along much of Pine Creek over longwall panels 4 to 9. The large areas of ponding shown over longwall panel 4 and 5 is in-stream ponding extending up remnant channels and adjoining tributaries. There is some overbank ponding over longwall panel 5.
- Overland flows from the dam to the north of Pine Creek over longwall panel 6 would no longer enter Pine Creek in its current location (over longwall panel 4). The overland flows would drain directly into Pine Creek, which may cause some bank erosion at that location.
- Significant overbank ponding would occur over longwall panel 7 to the north of Pine Creek. Ponding would generally be less than 0.5m deep.
- Minimal in-stream ponding is predicted within Pine Creek over of longwall panel 10 to 13.
- Existing farm dams over longwall panels 9 and 12 may be damaged by the differential settlement.
- Minimal in-stream ponding would occur within Pine Creek tributary 3, which is most likely due to the tributary draining partially parallel to the longwall panels.
- Minimal ponding is predicted within the existing forested areas.

7.3.3 Kurrajong Creek Tributary 1

Figure 7.3 shows a visual interpretation of the potential impacts of the Case 3 mine subsidence along Kurrajong Creek Tributary 1. The impacts within this area may include the following.

- The spatial extent of the ponding along Kurrajong Creek tributary 1 would be limited to minor in-bank ponding over longwall panels 22 and 25. In-bank ponding over the remaining panels would be minor.
- The existing dam over longwall panel 26 may be damaged by longwall mining.

7.3.4 Kurrajong Creek

Figure 7.4 shows a visual interpretation of the potential impacts of the Case 3 mine subsidence along Kurrajong Creek. Kurrajong Creek drains over longwall panels 21, 22 and 23. The impacts of the Case 3 mine subsidence predictions within this area would include the following.

- Significant in-bank ponding would occur over longwall panel 23. The channel within this area is quite wide and has been heavily disturbed by the remnants of two in-channel dams.
- The existing dam over longwall panel 22 would be damaged by longwall mining.
- Minor overbank ponding would occur over both longwall panel 21 and 22. Ponding depths are generally below 0.5m.

7.3.5 Impact on Channel Morphology

The potential impacts on channel morphology are as follows.

- A close inspection of post mine subsidence contours along all of the waterways that cross the mine subsidence zone indicates major changes in channel geomorphology due to changes in channel location (avulsions) are unlikely across the mine subsidence zone. However, some of the minor (first order) channels may drain into the major watercourses at alternate locations and cause localised bank scour.
- The bed slope of the channels would increase on the eastern (downstream) side of the chain pillars, which could increase channel erosion along these areas. The slope increase and therefore erosion potential is more significant along the channels that are perpendicular to the longwall panels.
- Increased in-stream sedimentation would occur on the downstream (eastern) side of the longwall panels in the areas of in-stream ponding. The increased sediment loads would be due to the channel erosion on the upstream (western) side of the same long wall panel draining from the chain pillars.

7.3.6 Associated Impacts

The impacts associated with the increased ponding, erosion and sedimentation may include:

- the potential for short term loss of riparian vegetation;
- the potential for Aboriginal sites to be inundated or disturbed by erosion or sedimentation; and
- the potential for water ponding over salt producing soils to increase the salinity of downstream flows.

It is noted that the continual action of erosion and sedimentation without mitigation measures is likely to ‘self correct’ the geomorphic characteristics of the waterways over time. However, sedimentation of the downstream waterway may occur.

7.4 MITIGATION STRATEGIES

7.4.1 Risk Management Approach

NCOP propose to adopt a risk management approach to manage impacts of mine subsidence both along waterways and in overbank areas. **Figure 7.1 to Figure 7.4** show that the potential impacts of mine subsidence may be significantly different at each waterway crossing and at each longwall panel. Therefore, a range of mitigation strategies that are tailored to each location and taking into consideration the geomorphic characteristics, vegetation, soil types and Aboriginal sites are required.

In adopting the risk management approach, the recommendations from the Southern Coalfields and Metropolitan Coal Fields Longwall Mining reviews (NPAC, 2009) with regard to the potential values of the impacted waterways have been considered. It is noted that the geology and geomorphology of the waterways investigated in the Metropolitan report are substantially different to those that cross the Narrabri Coal Mine. In determining the potential values, the impacted waterways:

- Do not significantly contribute to the total flows in the Namoi River because the total catchment area of Pine and Kurrajong Creeks is about 0.5% of the total Namoi River catchment to its confluence.
- Are not used as a water source by downstream landholders.
- Are ephemeral, flowing only for short periods (one to two days) following significant rainfall events.
- Have been heavily disturbed with a number of on-stream storages evident across the mine site and substantial riparian vegetation has been cleared.
- Have generally low visual amenity. The upper reaches have little to no channel capacity with no evidence that pools were ever present. The lower reaches of Kurrajong Creek and its tributaries are heavily incised with vertical banks and no pools evident.
- Have generally low ecological significance as no aquatic habitat or species were found during the comprehensive field survey over longwall panel 1 to 7 (Ecotone, 2009). There are no pools of significance (other than the farm dams) and the channels have minimal baseflow.

On this basis, the risk management approach to mine subsidence appears appropriate for the Narrabri Coal Longwall Project.

7.4.2 Risk Management Zones

Riparian Risk Management Zones have been defined through consideration of the potential for increased in-channel and overbank ponding due to mine subsidence and the size and potential environmental significance of the waterway.

- High Risk Management Zones are generally those higher order watercourses at the downstream (eastern) end of the mine site that are highly likely to be affected by one or more of the above impacts outlined in **Section 7.3**.

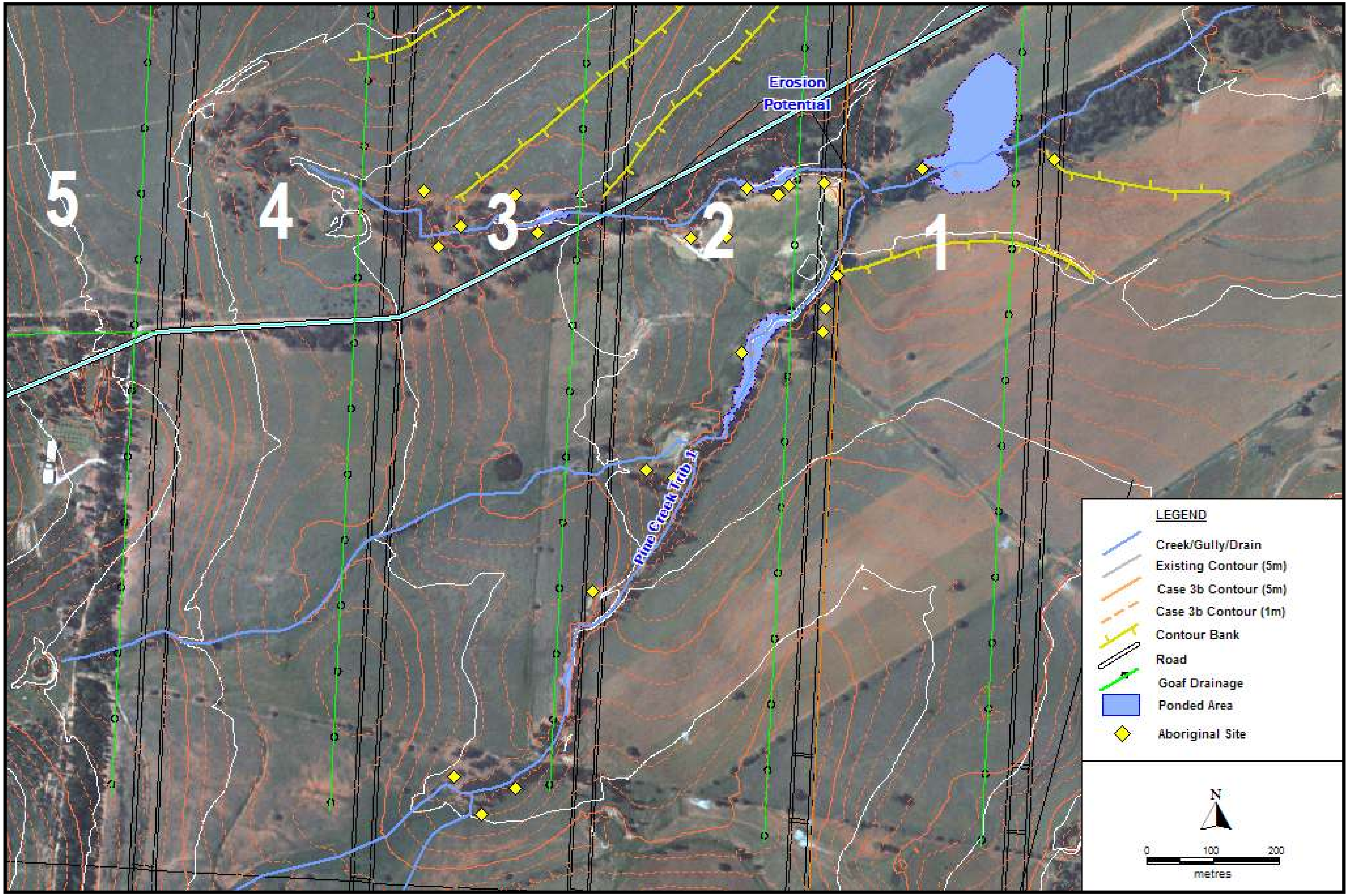

Figure 7.1 Potential Impacts of Mine Subsidence, Pine Creek Tributary 1

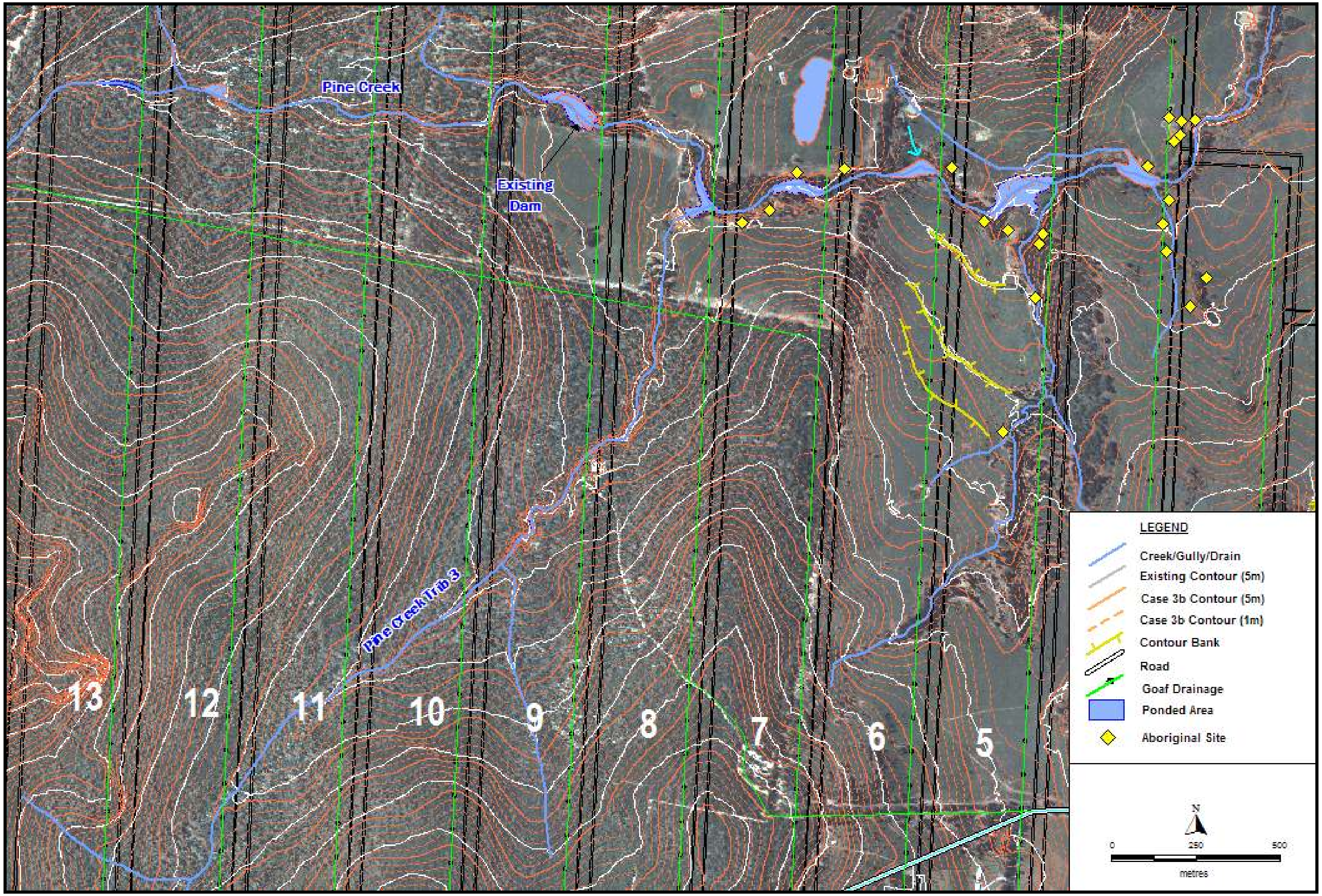

Figure 7.2 Potential Impacts of Mine Subsidence, Pine Creek and Pine Creek Tributary 3

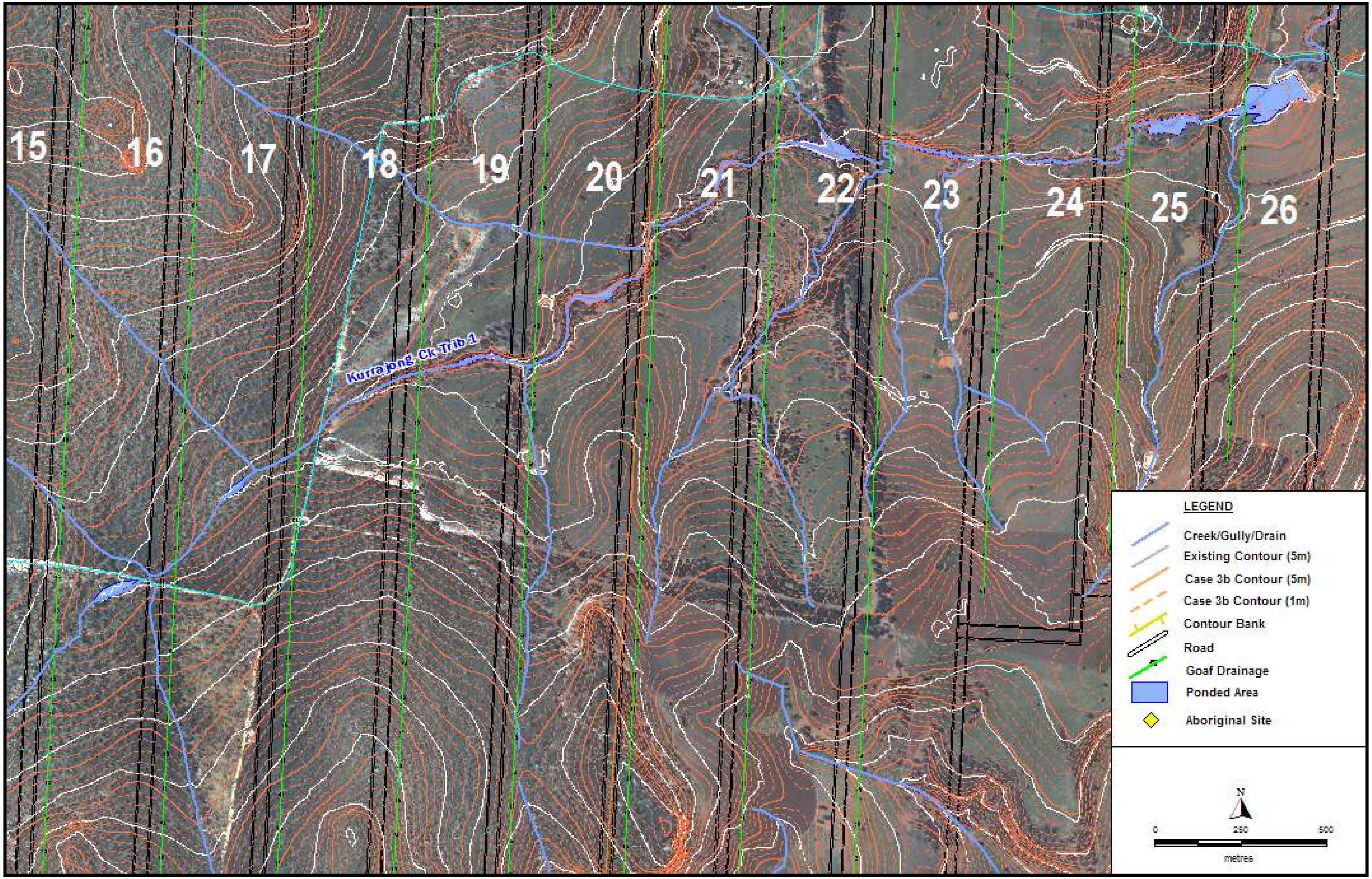

Figure 7.3 Potential Impacts of Mine Subsidence, Kurrajong Creek Tributary 1

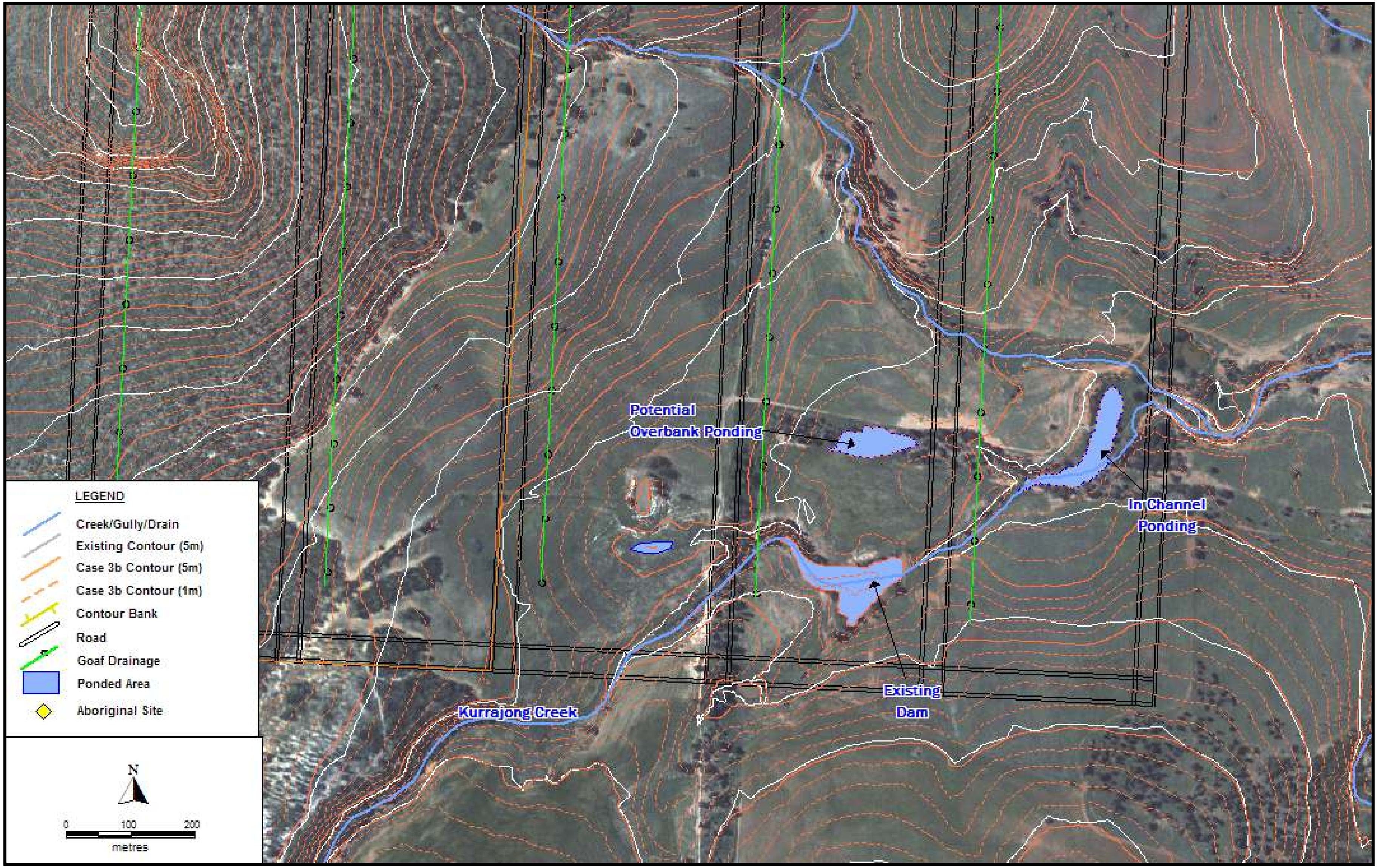

Figure 7.4 Potential Impacts of Mine Subsidence, Kurrajong Creek

- Moderate Risk Management Zones are those sections of the Mine Site creeks and tributaries which cross the retained chain pillars of the underlying longwall panels but have steeper existing channel slopes (≥5º) (the steeper the channel is, the less the area of potential ponding).
- Low Risk Management Zones are those sections of the Mine Site creeks and tributaries which are located off the Mining Area.

Figure 7.5 shows the locations of the expected Riparian High Risk Management Zones across the Mine Site. The location and extent of the predicted in-bank ponding and Strahler (1957) stream orders for each of the waterways are also shown. The moderate risk management zones are defined as those sections upstream of the high risk management zones. The low risk management zones are downstream of the Mining Area.

7.4.3 Mitigation Measures

For the high risk and moderate risk management zones, it is proposed to survey the creek channels within 6 months of being undermined by a longwall panel. If the survey shows that differential settlement may result in significant erosion or over bank ponding, the following strategies may be applied:

- Visible cracks in the bed of the creek would be filled in where necessary.
- Contour banks that cross chain pillars would be removed. An assessment on the need to replace the contour banks would be made. Given that the Proponent owns the majority of the land over the mine subsidence zone, lower stocking rates and higher vegetation covers are expected, which should negate the need to replace the banks.
- Estimates of the extent of over bank ponding would be made.
    - If little vegetation of significance is impacted and minimal salt producing soils are evident, the ponding would be left as is.
    - If vegetation of significance would be impacted or salt producing soils are evident within the ponded area, the channel across the chain pillars may be excavated to reduce the extent of ponding. Care would be taken to ensure that Aboriginal sites or significant vegetation areas are not impacted by the excavation.
- The creek channels draining into the mine subsidence zone and on the downstream side of the chain pillars would be monitored for erosion following each runoff-producing storm event. Any erosion would be repaired and remedial measures, such as check dams or drop structures, would be constructed if necessary.

For the low risk management zones (downstream of the Mine Site), the creek channel will be monitored for signs of sediment build-up or erosion in excess of natural processes. A photographic record will be kept of the creek channels to track their long term behaviour. If necessary, excess sediment would be removed and remedial erosion protection measures would be installed.

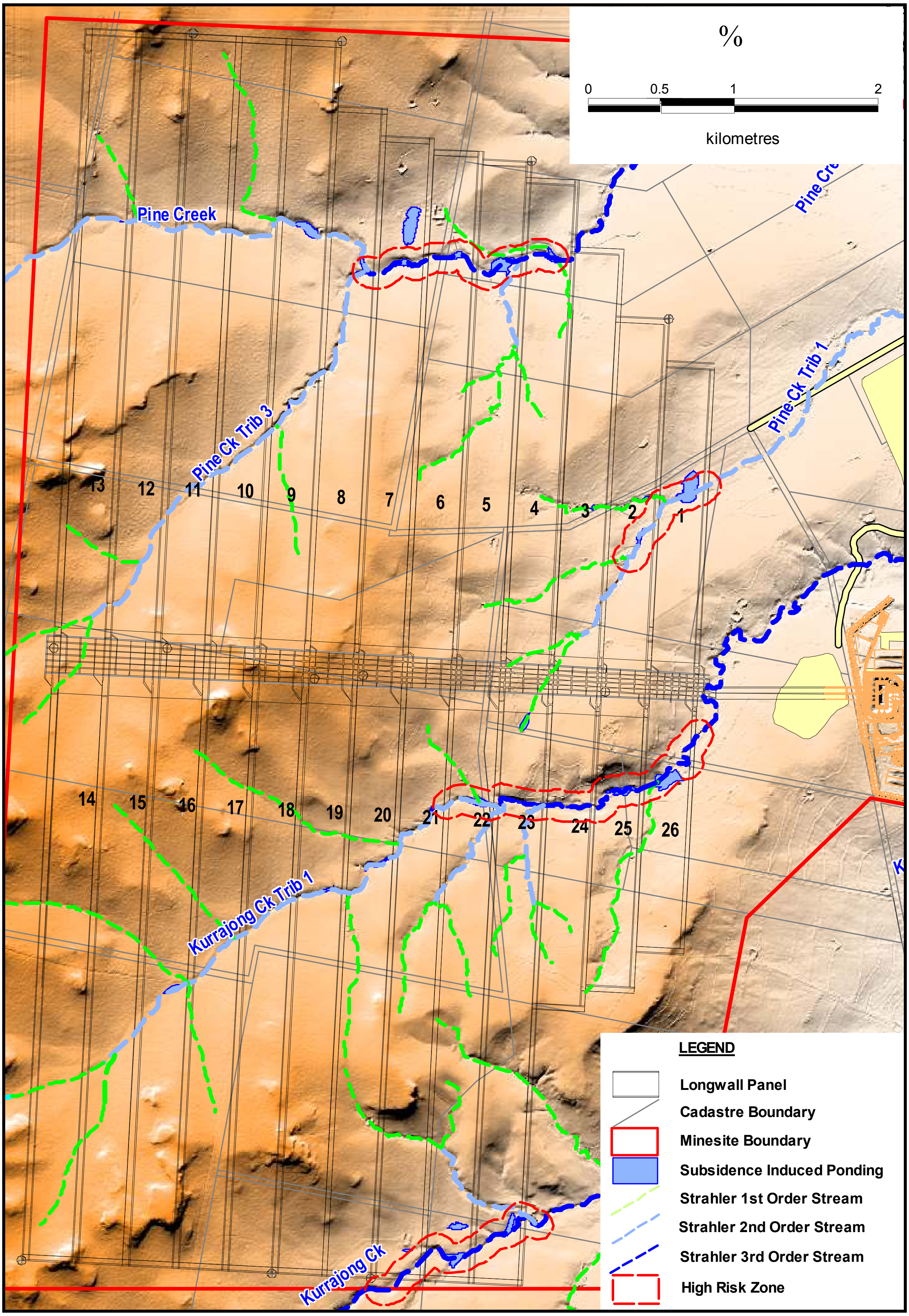

Figure 7.5 Riparian Risk Management Zones and Strahler Stream Orders

8. WATER BALANCE

8.1 GENERAL

A daily and an annual water balance of the water management system and the various Pit Top Area water storages on the Mine Site were undertaken. The daily water balance model was used to determine:

- the reliability of the various storages to supply the Mine Site water requirements during the initial years of mine life (Year 2); and
- the frequency and volume of potentially dirty spills from the various dams for two scenarios;
  - during Year 2 when water is being pumped from the sediment dams to Dam D;
  - during Year 18 when the sediment dams are not pumped back to Dam D.

The Mine Site water demands for Year 2 and Year 18 are given in **Table 3.6**. The dewatered groundwater in-flow rates for these years of operation are 0.28 ML/d and 3.83 ML/d respectively.

An annual water balance was undertaken of the various storages to determine:

- the frequency and volume of clean water releases from Dam D to the Namoi River; and
- the size and behaviour of the brine storage ponds.

An annual water balance model was necessary to determine the size and behaviour of the brine storage ponds because the dewatered groundwater rates vary on an annual basis.

8.2 DAILY WATER BALANCE MODEL

8.2.1 Methodology

An AWBM (Boughton, 2003) rainfall runoff model was developed to determine the runoff volume from the various catchments on the Mine Site. The IQQM (NSW DWE, 2007) water balance model was then used to determine the behaviour of the various storages on the mine including all of the evaporation basins, the mine infrastructure sediment basins and storage dams. Details of the various dams on the Mine Site are given in **Section 6.2**.

The model was run over the 105 year period of daily rainfall data from 1900 to 2004 (inclusive). The use of such a long period of continual data provides a good indication of the behaviour of the various storages over extended dry and wet periods.

8.2.2 Catchment Runoff

Table 8.1 shows the adopted AWBM parameters for the natural catchment. The natural catchment parameters are based on recommendations in Boughton (2003) using an average soil moisture depth of 100mm with no base flow. No data is available to determine the reliability of these parameters, however, the estimated natural catchment runoff coefficient of 0.05 is consistent with estimates in Boughton (2003) for catchments near to the Narrabri Coal Mine.

The stockpiling and crushing/sizing area runoff behaviour was determined using the natural catchment parameters but with the average soil moisture depth reduced to 20mm to achieve a run-off coefficient of 0.25. Again, no data is available to determine the reliability of this estimate.

Table 8.1 Adopted AWBM Parameters, Natural Catchment and Stockpile Areas

‘AWBM’ Model Parameter		Natural Catchment	Stockpile / Hardstand Areas
Surface Stores (mm)	C1	7.5	1.5
	C2	76.2	15.3
	C3	152.4	30.5
Partial Areas	A1	0.134	0.134
	A2	0.433	0.433
	A3	0.433	0.433
Base flow index	BFI	0.0	0.0
Base flow recession constant	Kb	1	1
Surface flow recession constant	Ks	0.0	0.0
Runoff Coefficient	RC	0.05	0.25

8.2.3 Model Configuration and Assumptions

Table 8.2 shows the in-flows to and out-flows from each storage used in the IQQM water balance model. To simplify the model, dams that perform the same role were lumped together as single storage. This simplification is not expected to alter the results of the analysis.

The following assumptions have been used.

- Daily rainfall and evaporation data, as summarised in **Section 3.2** was adopted.
- Evaporation from the brine storage ponds was reduced by 5% to reflect the higher salinity concentrations.
- The catchment draining to SB1, SB3 and the box cut consists entirely of stockpile/hardstand. The other catchments are natural catchments.
- All mine water demands including potable water, underground and surface dust suppression as well as potential future Namoi River releases are taken directly from Dam B1, Dam C or Dam D.
- Dam seepage from all storages was ignored.
- Dam B2 was assumed to be converted into a brine concentrate storage for all scenarios and excess brine would be transferred from Dam B2 to the additional brine storage ponds.
- The water conditioning plant was assumed to generate 80% raffinate (clean) water and 20% brine concentrate. The pumping rate and size of the water conditioning plant varies with the rate of groundwater in-flow. For the 0.28ML/d groundwater in-flow scenario, a 1 ML/d water conditioning plant capacity was assumed. For the 3.83ML/d scenario, a 5 ML/d plant capacity was assumed.
- The pumps were removed from the sediment dams for the Year 18 scenario and the dams were assumed to be drained within 5 days of a runoff event.

Table 8.2 Storage In-flows and Out-flows, Long Term Water Balance

Storage	In-flows	Out-flows
Dam A1	Direct rainfall	Evaporation
	Mine Groundwater In-flows	Water Conditioning Plant Feed Water
	Box Cut Surface Runoff	Spills to Dam B2
	SB1, SB2 and SB3 Pumped Flows	
	Underground Recycle	
Dams A2, A3, B2 and Brine Storages	Direct rainfall	Evaporation
	Water Conditioning Plant Concentrate Flows (Brine)	Spills to C
Dam B1, C & D	Direct rainfall	Evaporation
	Water Conditioning Plant Raffinate Flows	Mine Water Demands
	Spill from Dam B2	Namoi Releases
	Sediment Dam Pumped In-flows	No Spills Allowed
SB1 & 2	Direct rainfall	Evaporation
	Stockpile / Industrial Surface Runoff	Pumped Flows to Dam A1
	Industrial Recycle	Spills to SD1
SB3	Direct rainfall	Evaporation
	Reject Emplacement Area Runoff	Pumped Flows to Dam A1
		Spills to Creek
SD1 & 2	Direct rainfall	Evaporation
	Surface runoff	Spills to SD5
	Spills from SB1 & 2	Pumped Flows to Dam D[#]
SD3 & 4	Direct rainfall	Evaporation
	Surface runoff	Spills to Creek
		Pumped Flows to Dam D[#]
SD5	Direct rainfall	Evaporation
	Surface runoff	Spills to Creek
	Spills from SD2	Pumped Flows to Dam D[#]
SD6	Direct rainfall	Evaporation
	Surface runoff	Spills

[#] Flows are not pumped to Dam D when groundwater in-flows exceed water supply demand

8.2.4 Dam Pump Rates

Table 8.3 shows the pumping rates and restrictions on pumping from each dam on the Mine Site. The pumping restrictions have been designed to prevent the downstream dams (Dam A1 and Dam D) from spilling due to pumped in-flows. The dead storage volume is the volume in the dam that is impractical to pump out. Note that the pumps from the sediment dams (SD1&2, SD3&4 and SD5 were removed from the Year 18 scenario.

Table 8.3 Dam Pump Rates and Restrictions

Dam	Pump Rate (ML/d)	Dead Storage Volume (ML)	Pumping Restrictions
SB1&2	5	1	Pump Cease when Dam A1 volume >115ML
SB3	2.16	1	Pump Cease when Dam A1 volume >115ML
SD1&2	10	1	Pump Cease when Dam B&D volume >280ML
SD3&4	5	1	Pump Cease when Dam B&D volume >250ML
SD5	10	1	Pump Cease when Dam D volume >250ML
SD6	-	-	

8.2.5 Mine Site Water Supply Deficits

During the initial years of operation, the volume of dewatered groundwater is not expected to meet Mine Site water requirements. During this period, Mine Site demand would be met from water pumped from the Namoi River supplemented by water collected in the various sediment dams and storage basins across the Pit Top Area. The greatest difference between Mine Site demand and dewatered groundwater in-flows is expected to occur in Year 2 of Mine Site operations when Mine Site demand would be 440 ML/y (1.2 ML/d) (excluding recycle) and groundwater in-flow rates are 102 ML per year (0.28 ML/d).

The water balance model was run over the 105 year simulation period using a constant groundwater in-flow of 0.28 ML/d to determine the reliability of the various Pit Top Area water storages to meet the constant Mine Site water demand of 1.03 ML/d. The results of the water balance modelling of the Year 2 scenario are shown in **Table 8.4**. The results are shown for a range of wet and dry runoff years representing;

- 10%ile wet year;
- median year;
- 90%ile dry year; and
- 99%ile (driest year on record).

For a 10%ile year, 1 year in 10 are expected to produce more catchment runoff than this year. Similarly, for the 99%ile year, 99 years out of 100 would produce more catchment runoff than this year.

Table 8.4 Annual Mine Site Water Supply from Mine Site Dams, Production Year 2

Runoff Year	Mine Site Water Supplied from Mine Site Dams (ML/yr)	Percentage of Mine Site Demand Met by Mine Site Dams (%)
10%ile	438	99
50%ile	302	68.6
90%ile	205	46.6
99%ile	142	38.4

The results show that the Pit Top Area water storages can augment the groundwater in-flows to supply the water requirements for only the wettest (10%ile) years. The majority of the time, there would be insufficient runoff from the Mine Site catchments to meet demand. Water sourced from the Namoi River (under a Water Licence) would be used to augment supplies during these periods. Later in the mine life, as the expected groundwater in-flows increase and exceed the Mine Site water demands there would be an excess of water available, reducing the reliance on the off-site sources and Pit Top Area water storages.

8.2.6 Pit Top Dam Overflows

Table 8.5 shows the water balance model predictions of the probability and volumes of uncontrolled spills and controlled releases from the various Pit Top Area water storages for Year 2 and Year 18 of the Longwall Project. The following is of note with respect to the water balance modelling results:

- There are no uncontrolled spills from Dam A1 or the brine storage ponds over the simulation period. This suggests that the adopted operating strategy, pump sizes and water conditioning plant capacity is adequate for groundwater in-flows up to 3.83 ML/d.
- There are no uncontrolled spills from the three potentially contaminated dams on the site (SB1, SB2 and SB3) for either scenario. Therefore, the adopted storage volume and pumping strategy for these dams are appropriate.
- Uncontrolled spills from the Sediment Dams (SD1, SD2, SD3 and SD4) occur only once or twice over the simulation period for the year 2 scenario when water is being harvested for Mine Site use. For the Year 18 scenario, uncontrolled spills do not occur because all water is released to the downstream creeks within 5 days of the runoff event.
- Sediment Dam SD6 at the ventilation shaft area spills on average of 1 year in 3. This satisfies the average annual sediment basin overflow frequency criteria given in DECC (2008).
- For the Year 18 scenario, controlled releases of the raffinate water are made from Dam D at a rate of 2.1 ML/d to prevent uncontrolled spills. When less groundwater is dewatered to the surface, the volume of releases made to the Namoi River would be less. The adopted discharge rate is expected to be the upper bound release rate from the Mine Site to the Namoi River under the base case groundwater inflow scenario.

Table 8.5 Mine Site Water Dam Overflows and Controlled Releases

Water Storage	Groundwater In-flow (ML/d)	
	0.28 (Year 2)	3.83 (Year 18)
Dam A1		
%. Years of Uncontrolled Spills	0	0
Median Vol of Spill/spill year (ML)	0	0
Brine Storages (A2, A3 & C)		
%. Years Uncontrolled Spills	0	0[A]
Median Vol of Spill/spill year (ML)	0	0
Raffinate Storages (B&D)		
%. Years Uncontrolled Spills	0	0
Median Vol of Spill/year (ML)	0	0
% Years Controlled Release	0	100
Median Vol of Release/year (ML)	0	763[B]
Storage Dam SB1& SB2		
% Years Uncontrolled Spills	0	0
Median Vol of Spill/spill year (ML)	0	0
Storage Dam SB3		
% Years Uncontrolled Spills	0	0
Median Vol of Spill/spill year (ML)	0	0
Sediment Basin SD1 & SD2		
%. Years Uncontrolled Spills	2	0
Median Vol of Spill/spill year (ML)	2	0
Sediment Basin SD3 & SD4		
%. Years Uncontrolled Spills	1	0
Median Vol of Spill/spill year (ML)	1	0
Sediment Basin SD6		
%. Years Uncontrolled Spills	31.5	31.5
Median Vol of Spill/spill year (ML)	2	2

[A] Includes Brine Storages BR1, BR2 and BR3.
[B] Includes constant Namoi River release of 2.1 ML/d

8.3 ANNUAL MINE SITE WATER BALANCE

8.3.1 General

An annual spreadsheet water balance was developed of:

- Dam A1, the main repository for dewatered groundwater and runoff from the contaminated water storages;

- the proposed brine storage ponds, which includes the Dams A2, A3 and B2 and the proposed new brine storage ponds (BR1 to BR5); and
- the proposed raffinate storage dams B and D

The annual water balance model provides an indication of the annual volume of clean water that would be released from Dam D to the Namoi River during each year of operation. It also provides an approximate timeframe for when the excess brine storages would need to be completed and provides an approximate volume of brine that may need to be reinjected back into the underground void at the end of the Longwall Project. The annual water balance was developed for the base case groundwater in-flow scenario as well as for the upper bound in-flow scenario estimated by Aquaterra (2009) and given in **Figure 3.3**. The various in-flows to and out-flows from the various dams is given in **Table 8.2.** The following should be noted:

- The contaminated catchment runoff volumes pumped to Dam A1 and sediment dam catchment runoff volumes pumped to Dam D were based on the median annual pumped volumes estimated in the daily water balance model.
- The net evaporation losses from Dam A1 and the raffinate dams were based on the median net evaporation losses estimated in the daily water balance model.
- The net evaporation losses from the brine storage ponds are based on the median net evaporation losses estimated in the daily water balance model. However, the evaporation rates have been reduced by 30% at the end of mine life to account for the higher expected salt concentrations.
- The annual volume remaining in Dam A1 after evaporation is assumed to be fed to the water conditioning plant. Approximately 80% of the water conditioning plant water would be ‘clean raffinate’ piped to Dam B1, Dam C or Dam D for use around the Mine Site or for discharging off site. The remaining 20% would be piped to the brine storage ponds for storage and evaporation.
- All of the Mine Site water demands are taken directly from Dam B1 or Dam D.
- Pumping of runoff collected in the sediment dams is assumed to stop when the excess water is no longer required.

8.3.2 Annual Water Balance Results

Table 8.6 and **Table 8.7** show the expected annual in-flows to and out-flows from the various water storages over the Mine Site throughout the life of the Longwall Project for the base case and upper bound groundwater in-flow scenarios. The results show the following:

- For both the base case and upper bound groundwater in-flow scenarios, the three excess brine storages BR1, BR2 and BR3 would be required. The additional storage, BR4 would only be required for the upper bound groundwater inflow scenario and BR5 is unlikely to be required for either scenario.
- For both cases, Dam B2 would be operational prior to the end of Year 2. Dam B2 would be lined with HDPE prior to being operational.
- The first excess brine storage dam (BR1) would be required in Year 4 for both cases.
- The second excess brine storage dam (BR2) would be required in Year 7 to Year 9 and the third excess brine storage between Year 13 to Year 16.

- Pumping would cease from the sediment dams to augment Mine Site supplies in Year 3 or Year 5. It is expected that the rehabilitation program from these catchments would be fully completed by this stage and therefore runoff quality would be acceptable.
- Off-site releases of raffinate water are expected to commence in Year 8 for the base case groundwater scenario or Year 6 for the upper bound groundwater scenario.
- Off-site release of raffinate water is expected to peak in Year 18 at 761 ML/y for the base case groundwater in-flow scenario and in Year 19 at 1171 ML/y for the upper bound groundwater in-flow scenario. The off-site releases estimated in the base case scenario are very similar to the peak off-site release estimated using the daily water balance model.
- At the end of the Longwall Project, there would be 1989 ML to 2237 ML of brine left in storage that would be reinjected back into the underground workings of the longwall goafs for the two scenarios.

9. HARVESTABLE RIGHT

The maximum harvestable right dam capacity for the Mine Site is determined by the following equation.

Harvestable Right = Proponent owned land holding x Multiplier Value
= 3825ha x 0.07
= 267.75ML

The above calculation is based on guidelines provided by the former Department of Natural Resources (DNR) for the determination of the maximum harvestable right for each property. It is noted that the maximum harvestable rights does not include storages that are used on a Mine Site for environmental management purposes (e.g. capture of ‘dirty’ or sediment-laden water). Therefore the existing evaporation basins and storage dams would not count towards the Mine Site’s harvestable right dam capacity calculation.

The total capacity of the existing farm dams on proponent-owned land, given in **Table 2.3, Table 2.4** and the existing and proposed sediment dams given in **Table 6.4**, is 237.2ML. Therefore the harvestable right of land owned by the Proponent is not exceeded.

10. MONITORING

10.1 GENERAL

The Proponent has a comprehensive monitoring program in place across the Mine Site that incorporates:

- the collection of rainfall and meteorological data;
- the collection of water quality and water level data in the water management dams and creeks.

The existing monitoring program should be extended to include the monitoring of the impact of mine subsidence on the various watercourses that cross the mine subsidence zone.

Table 10.1 Annual Water Balance of Mine Site Storage Dams, Base Case Groundwater In-flows

Column	a	b	c	e	g	h	h	j	k	l	m	o	p	q	r	s	t	u	v
	Dam A1 Inflows and Outflows (ML/y					**Brine Dams (A2/A3/B2 + NEW)**					**Raffinate Dams (Dam B1, C & D) (ML/y)**								
Year	**Dewatered Ground Water**	**U/G Recycle**	**SB1,2&3 Runoff**	**Net Evap losses**	**Dam A1 Total**	**Brine Inflow (ML/y)**	**Net Evap Losses (ML/y)**	**Inflow - Evap (ML/y)**	**Accumulative Brine Vol (ML)**	**Extra Brine Storage Req**	**Raffinate Dam Inflow**	**Potable Demand**	**U/G Demand**	**Surface Demand**	**Sed Dam Runoff**	**Net Evap losses**	**Dam D Total**	**Dam B &D Volume (ML)**	**Release**
					(f=sum(a:f)	**(g=fx0.2)**			**(k=sum(J)**		**(k=fx0.8)**						**(t=sum(m:s)**		
2010	80.3	15.1	71.0	-4.0	**162.4**	32.5	-12.4	**20.1**	0.0	**Dam A2/A3**	129.9	-19.7	-209.4	-63.3	100.0	-29.0	**-91.5**	0.0	0.0
2011	102.2	93.6	71.0	-4.0	**262.8**	52.6	-12.4	**40.1**	60.2		210.3	-19.7	-337.2	-83.5	100.0	-29.0	**-159.1**	0.0	0.0
2012	230.6	262.3	71.0	-4.0	**559.9**	112.0	-43.8	**68.2**	128.3	**Dam B1**	447.9	-19.7	-465.0	-121.8	100.0	-29.0	**-87.6**	0.0	0.0
2013	335.8	288.3	71.0	-4.0	**691.1**	138.2	-43.8	**94.4**	222.7	Dam BR1 Reqd	552.9	-19.7	-465.0	-127.7	100.0	-29.0	**11.5**	11.5	0.0
2014	419.8	288.3	71.0	-4.0	**775.0**	155.0	-89.9	**65.1**	287.8		620.0	-19.7	-465.0	-127.7	100.0	-29.0	**78.6**	90.1	0.0
2015	507.4	288.3	71.0	-4.0	**862.6**	172.5	-89.9	**82.6**	370.4		690.1	-19.7	-465.0	-127.7	Pumping to cease	-29.0	**48.7**	138.8	0.0
2016	574.6	288.3	71.0	-4.0	**929.9**	186.0	-89.9	**96.1**	466.5		743.9	-19.7	-465.0	-127.7		-29.0	**102.5**	241.3	0.0
2017	642.4	288.3	71.0	-4.0	**997.7**	199.5	-89.9	**109.6**	576.1		798.1	-19.7	-465.0	-127.7		-29.0	**156.7**	300.0	98.1
2018	708.1	288.3	71.0	-4.0	**1063.4**	212.7	-89.9	**122.8**	698.8	Dam BR2 Reqd	850.7	-19.7	-465.0	-127.7		-29.0	**209.3**	300.0	209.3
2019	748.3	288.3	71.0	-4.0	**1103.5**	220.7	-162.8	**57.9**	756.7		882.8	-19.7	-465.0	-127.7		-29.0	**241.4**	300.0	241.4
2020	823.5	288.3	71.0	-4.0	**1178.8**	235.8	-162.8	**72.9**	829.6		943.0	-19.7	-465.0	-127.7		-29.0	**301.6**	300.0	301.6
2021	890.6	288.3	71.0	-4.0	**1245.9**	249.2	-162.8	**86.3**	916.0		996.7	-19.7	-465.0	-127.7		-29.0	**355.3**	300.0	355.3
2022	1003.8	288.3	71.0	-4.0	**1359.0**	271.8	-162.8	**109.0**	1024.9		1087.2	-19.7	-465.0	-127.7		-29.0	**445.8**	300.0	445.8
2023	1098.7	288.3	71.0	-4.0	**1453.9**	290.8	-162.8	**127.9**	1152.9		1163.1	-19.7	-465.0	-127.7		-29.0	**521.7**	300.0	521.7
2024	1182.2	288.3	71.0	-4.0	**1537.5**	307.5	-162.8	**144.6**	1297.5		1230.0	-19.7	-465.0	-127.7		-29.0	**588.6**	300.0	588.6
2025	1255.6	288.3	71.0	-4.0	**1610.9**	322.2	-162.8	**159.3**	1456.8	Dam BR3 Reqd	1288.7	-19.7	-465.0	-127.7		-29.0	**647.3**	300.0	647.3
2026	1317.7	288.3	71.0	-4.0	**1672.9**	334.6	-215.0	**119.6**	1576.4		1338.3	-19.7	-465.0	-127.7		-29.0	**696.9**	300.0	696.9
2027	1398.0	288.3	71.0	-4.0	**1753.2**	350.6	-215.0	**135.6**	1712.1		1402.6	-19.7	-465.0	-127.7		-29.0	**761.2**	300.0	761.2
2028	1394.5	288.3	71.0	-4.0	**1749.7**	349.9	-215.0	**134.9**	1847.0		1399.8	-19.7	-465.0	-127.7		-29.0	**758.4**	300.0	758.4
2029	1394.3	288.3	71.0	-4.0	**1749.6**	349.9	-215.0	**134.9**	1981.9		1399.7	-19.7	-465.0	-127.7		-29.0	**758.3**	300.0	758.3
2030	1175.3	288.3	71.0	-4.0	**1530.6**	306.1	-215.0	**91.1**	2073.0		1224.5	-19.7	-465.0	-127.7		-29.0	**583.1**	300.0	583.1
2031	1029.3	288.3	71.0	-4.0	**1384.6**	276.9	-215.0	**61.9**	2135.0		1107.7	-19.7	-465.0	-127.7		-29.0	**466.3**	300.0	466.3
2032	911.3	288.3	71.0	-4.0	**1266.6**	253.3	-215.0	**38.3**	2173.3		1013.3	-19.7	-465.0	-127.7		-29.0	**371.9**	300.0	371.9
2033	773.8	288.3	71.0	-4.0	**1129.1**	225.8	-215.0	**10.8**	2184.1		903.3	-19.7	-465.0	-127.7		-29.0	**261.9**	300.0	261.9
2034	700.8	288.3	71.0	-4.0	**1056.1**	211.2	-215.0	**-3.8**	2180.3		844.9	-19.7	-465.0	-127.7		-29.0	**203.5**	300.0	203.5
2035	595.0	288.3	71.0	-4.0	**950.2**	190.0	-215.0	**-25.0**	2155.4		760.2	-19.7	-465.0	-127.7		-29.0	**118.8**	300.0	118.8
2036	527.0	288.3	71.0	-4.0	**882.3**	176.5	-215.0	**-38.5**	2116.8		705.9	-19.7	-465.0	-127.7		-29.0	**64.5**	300.0	64.5
2037	438.0	288.3	71.0	-4.0	**793.3**	158.7	-215.0	**-56.3**	2060.5		634.6	-19.7	-465.0	-127.7		-29.0	**-6.8**	293.2	0.0
2038	365.0	288.3	71.0	-4.0	**720.3**	144.1	-215.0	**-70.9**	1989.5		576.2	-19.7	-465.0	-127.7		-29.0	**-65.2**	228.0	0.0

Table 10.2 Annual Water Balance of Mine Site Storage Dams, Upper Bound Case Groundwater In-flows

Column	a	b	c	e	g	h	h	j	k	l	m	o	p	q	r	s	t	u	v
Year	Dam A1 Inflows and Outflows (ML/y					Brine Dams (A2/A3/B2+ NEW)					Raffinate Dams (Dam B1, C & D) (ML/y)								
	Dewatered GW	UG Recycle	SB1 & SB3 Runoff	Net Evap losses	Dam A1 Total (f=sum(a:f))	Brine Inflow (ML/y) (g=fx0.2)	Net Evap Losses (ML/y)	Inflow - Evap (ML/y)	Accumulative Brine Vol (ML) (k=sum(J)	Extra Brine Storage Req	Raffinate Dam Inflow (k=fx0.8)	Potable Demand	U/G Demand	Surface Demand	Sed Dam Runoff	Net Evap losses	Dam D Total (t=sum(m:s))	Dam B &D Volume (ML)	Release
2010	80.3	15.1	71.0	-4.0	**162.4**	32.5	-12.4	**20.1**	20.1	**Dam A2/A3**	129.9	-19.7	-209.4	-63.3	100.0	-29.0	**-91.5**	0.0	0.0
2011	102.2	93.6	71.0	-4.0	**262.8**	52.6	-12.4	**40.1**	60.2	**Dam B2 reqd**	210.3	-19.7	-337.2	-83.5	100.0	-29.0	**-159.1**	0.0	0.0
2012	329.4	262.3	71.0	-4.0	**658.7**	131.7	-43.8	**87.9**	148.1		526.9	-19.7	-465.0	-121.8	100.0	-29.0	**-8.6**	0.0	0.0
2013	511.0	288.3	71.0	-4.0	**866.3**	173.3	-43.8	**129.4**	277.5	Dam BR1 Reqd	693.0	-19.7	-465.0	-127.7	Pumping to cease	-29.0	**51.6**	51.6	0.0
2014	620.5	288.3	71.0	-4.0	**975.8**	195.2	-89.9	**105.2**	382.8		780.6	-19.7	-465.0	-127.7		-29.0	**139.2**	190.8	0.0
2015	766.5	288.3	71.0	-4.0	**1121.8**	224.4	-89.9	**134.4**	517.2		897.4	-19.7	-465.0	-127.7		-29.0	**256.0**	300.0	146.9
2016	878.4	288.3	71.0	-4.0	**1233.7**	246.7	-89.9	**156.8**	674.0		986.9	-19.7	-465.0	-127.7		-29.0	**345.5**	300.0	345.5
2017	985.5	288.3	71.0	-4.0	**1340.8**	268.2	-162.8	**105.3**	779.3	Dam BR2 Reqd	1072.6	-19.7	-465.0	-127.7		-29.0	**431.2**	300.0	431.2
2018	1095.0	288.3	71.0	-4.0	**1450.3**	290.1	-162.8	**127.2**	906.5		1160.2	-19.7	-465.0	-127.7		-29.0	**518.8**	300.0	518.8
2019	1204.5	288.3	71.0	-4.0	**1559.8**	312.0	-162.8	**149.1**	1055.7		1247.8	-19.7	-465.0	-127.7		-29.0	**606.4**	300.0	606.4
2020	1317.6	288.3	71.0	-4.0	**1672.9**	334.6	-162.8	**171.7**	1227.4		1338.3	-19.7	-465.0	-127.7		-29.0	**696.9**	300.0	696.9
2021	1387.0	288.3	71.0	-4.0	**1742.3**	348.5	-162.8	**185.6**	1413.0		1393.8	-19.7	-465.0	-127.7		-29.0	**752.4**	300.0	752.4
2022	1507.5	288.3	71.0	-4.0	**1862.7**	372.5	-162.8	**209.7**	1622.7	Dam BR3 Reqd	1490.2	-19.7	-465.0	-127.7		-29.0	**848.8**	300.0	848.8
2023	1580.5	288.3	71.0	-4.0	**1935.7**	387.1	-162.8	**224.3**	1847.0		1548.6	-19.7	-465.0	-127.7		-29.0	**907.2**	300.0	907.2
2024	1636.0	288.3	71.0	-4.0	**1991.3**	398.3	-252.4	**145.8**	1992.8		1593.0	-19.7	-465.0	-127.7		-29.0	**951.6**	300.0	951.6
2025	1711.9	288.3	71.0	-4.0	**2067.1**	413.4	-252.4	**161.0**	2153.8		1653.7	-19.7	-465.0	-127.7		-29.0	**1012.3**	300.0	1012.3
2026	1799.5	288.3	71.0	-4.0	**2154.7**	430.9	-252.4	**178.5**	2332.3		1723.8	-19.7	-465.0	-127.7		-29.0	**1082.4**	300.0	1082.4
2027	1909.0	288.3	71.0	-4.0	**2264.2**	452.8	-252.4	**200.4**	2532.7		1811.4	-19.7	-465.0	-127.7		-29.0	**1170.0**	300.0	1170.0
2028	1910.5	288.3	71.0	-4.0	**2265.8**	453.2	-252.4	**200.7**	2733.4	Dam BR4 reqd	1812.6	-19.7	-465.0	-127.7		-29.0	**1171.2**	300.0	1171.2
2029	1865.2	288.3	71.0	-4.0	**2220.4**	444.1	-493.5	**-49.4**	2684.0		1776.3	-19.7	-465.0	-127.7		-29.0	**1134.9**	300.0	1134.9
2030	1511.1	288.3	71.0	-4.0	**1866.4**	373.3	-493.5	**-120.2**	2563.8		1493.1	-19.7	-465.0	-127.7		-29.0	**851.7**	300.0	851.7
2031	1299.4	288.3	71.0	-4.0	**1654.7**	330.9	-493.5	**-162.6**	2401.2		1323.7	-19.7	-465.0	-127.7		-29.0	**682.3**	300.0	682.3
2032	1163.9	288.3	71.0	-4.0	**1519.2**	303.8	-493.5	**-189.7**	2211.5	Dam BR3 Reqd	1215.3	-19.7	-465.0	-127.7		-29.0	**573.9**	300.0	573.9
2033	1043.9	288.3	71.0	-4.0	**1399.2**	279.8	-215.0	**64.8**	2276.4		1119.3	-19.7	-465.0	-127.7		-29.0	**477.9**	300.0	477.9
2034	897.9	288.3	71.0	-4.0	**1253.2**	250.6	-215.0	**35.6**	2312.0		1002.5	-19.7	-465.0	-127.7		-29.0	**361.1**	300.0	361.1
2035	773.8	288.3	71.0	-4.0	**1129.1**	225.8	-215.0	**10.8**	2322.8		903.3	-19.7	-465.0	-127.7		-29.0	**261.9**	300.0	261.9
2036	684.4	288.3	71.0	-4.0	**1039.7**	207.9	-215.0	**-7.1**	2315.8		831.8	-19.7	-465.0	-127.7		-29.0	**190.4**	300.0	190.4
2037	573.1	288.3	71.0	-4.0	**928.3**	185.7	-215.0	**-29.3**	2286.4		742.7	-19.7	-465.0	-127.7		-29.0	**101.3**	300.0	101.3
2038	474.5	288.3	71.0	-4.0	**829.8**	166.0	-215.0	**-49.0**	2237.4		663.8	-19.7	-465.0	-127.7		-29.0	**22.4**	300.0	22.4

10.2 MONITORING LOCATIONS

Figure 10.1 shows the locations of the existing and proposed water quality sampling locations on the various creeks that cross the Mine Site. Additional monitoring of the water quality stored in the various Pit Top Area water storages should be undertaken. The water quality monitoring program has been designed to provide upstream, source and downstream monitoring on the local creeks to assess whether the water quality compliance criteria have been met.

10.3 WATER QUALITY MONITORING SCHEDULE

Table 10.1 defines the parameters that should be sampled and the recommended sampling frequency for each sampling location. The proposed water quality monitoring program provides for the assessment of background data for flow events in the various creeks as well as monthly grab samples from the mine water storages on-site to determine whether Mine Site runoff meets the adopted water quality compliance criteria. The samples should be collected in a manner consistent with the Approved Method for Sampling and Analysis of Water Pollutants in NSW (DEC, 2004).

The event-based sampling should enable quantification of any pollutant loads from the Mine Site and their corresponding impact on the local creek water quality.

On-site monthly sampling from the water storages allows for any potential problem areas with respect to pollutant generation on-site to be identified in advance ensuring appropriate remedial action can be taken.

The frequency of monitoring and range of parameters analysed during flow and routine monitoring should be reviewed after the first two years of operations.

Table 10.3 Recommended Water Quality Monitoring Schedule

Location	Parameters	Frequency
Site (Meteorological Monitoring)	- Rainfall - Wind speed and direction - Temperature - Relative humidity - Solar Radiation	Recording every 15 minutes
Rail Loop Water Storages and Brine Storages Ponds	- Water Level - EC - pH - Turbidity - TDS - TSS - Metals - Anion and Cations	Monthly until baseline is established and then quarterly
Sediment Dams and Storage Dams	- Water Level - EC - pH - TSS - TDS - Turbidity	Daily during runoff events
PC, PC1, KC1US, KC1DS, KC2US, KC2DS, KCUS, KCDS	- Water Level - EC - pH - TSS - TDS - Turbidity	Daily during runoff events

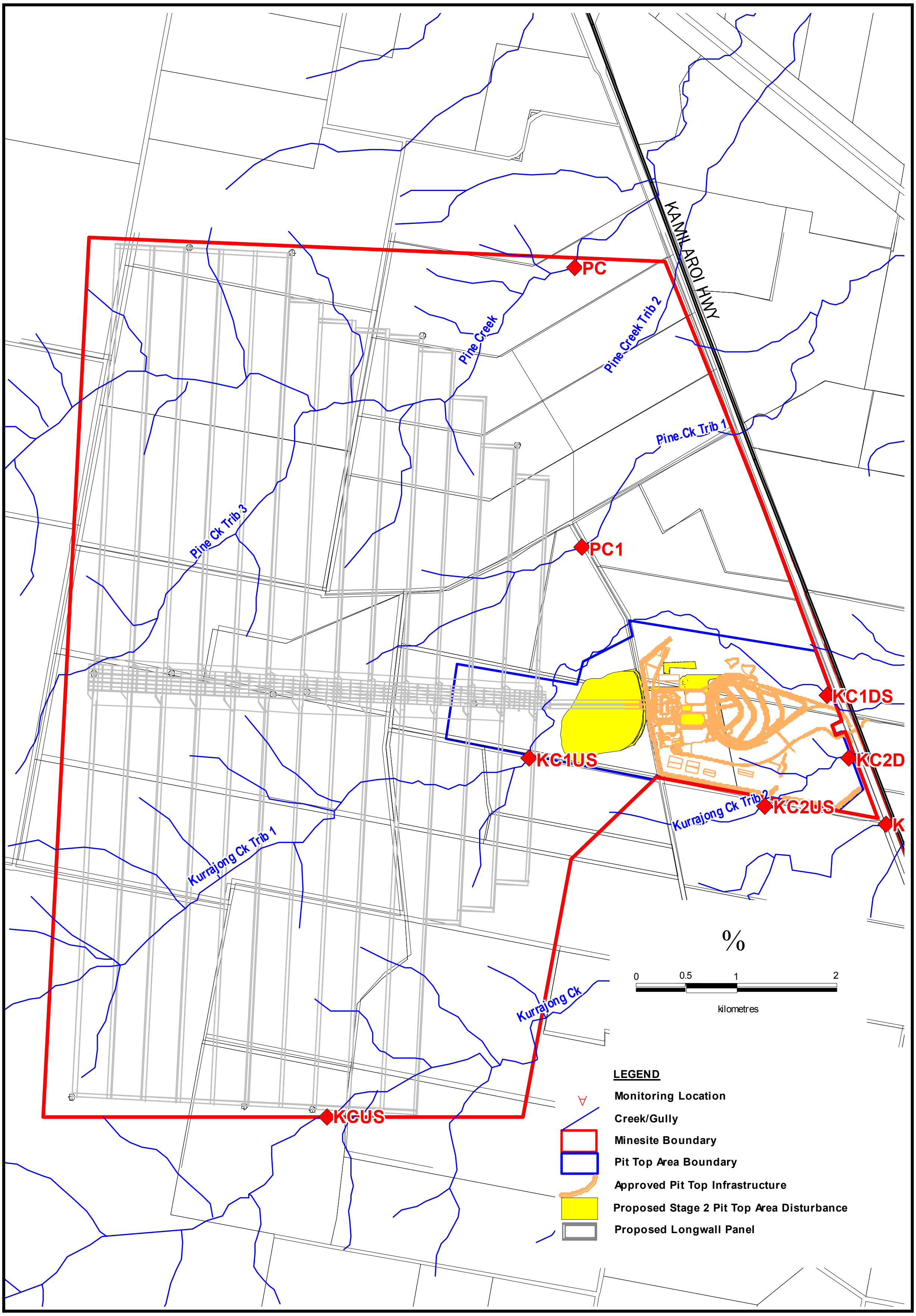

Figure 10.1 Surface Water and Meteorological Monitoring Locations

10.4 MINE SUBSIDENCE IMPACT MONITORING

Detailed monitoring of the creeks should be undertaken as each longwall panel is being mined. Following mine subsidence, the creek should be surveyed at regular intervals to determine the ultimate level of the area. Photographs of the creek should be taken prior to mine subsidence and after mine subsidence following significant rainfall events to assess whether erosion has occurred. A log of when inspections occur (and photographs taken) should be kept together with an assessment of the changes in erosion.

11. SUMMARY OF FINDINGS

11.1 GENERAL

Narrabri Coal Operations Pty Ltd (the Proponent) proposes to convert the approved Narrabri Coal Mine from a continuous miner operation with an approved annual production rate of 2.5Mtpa (Stage 1) to a longwall mining operation with a maximum annual production rate of 8Mtpa (”the Longwall Project”). The potential surface water impacts of the existing mine and proposed mine extension are as follows.

- Potentially dirty and contaminated water could be generated from the Pit Top Area.
- Underground mining would result in saline groundwater being pumped to the surface for treatment and disposal. Groundwater volumes are expected to vary from 0.22 megalitres per day (ML/d) in the first year to about 3.83 ML/d in Year 18. The groundwater is expected to have elevated concentrations of both salt and possibly metals and would not be suitable for off-site release without treatment.
- Mine subsidence could cause over bank ponding and potentially erosion of the creeks and waterways that cross the areas of the Mine Site that are undermined.

11.2 PIT TOP SURFACE WATER MANAGEMENT STRATEGY

The proposed Pit Top Surface Water Management Strategy is to separate the ‘clean’, ‘dirty’, ‘contaminated’ and ‘saline’ water generated on the Mine Site as much as possible and to provide targeted strategies to minimise the impact of each water quality type. A description of the strategies for each water type is given below.

- Runoff from potentially contaminated catchments would be collected in storage basins and not released off-site. Water collected in the storage basins would be pumped to Dam A1 for processing in the water conditioning plant.
- Runoff from the potentially dirty catchments would be collected in the existing sediment dams. The sediment dams would be sized to achieve required stormwater quality for storms greater than the 95%ile five day storm event. Water collected in the sediment dams would be used during the construction phase of the Longwall Project, as well as to augment shortfalls in supplies expected in the first few years of mining. After this time, the water collected in the dams would be released to the downstream receiving water within 5 days of a runoff event.
- All saline water dewatered from the underground workings would be contained within water storages of the Pit Top Area without releasing it to the natural watercourses. The saline water would be treated through a water conditioning plant

for use in coal processing and underground dust suppression. Treated water in excess of Mine Site requirements would be piped to the Namoi River at the adopted water quality compliance criteria.

- The concentrated brine by-product of the water conditioning plant would be stored and evaporated in brine storage ponds without releasing it to the environment. Concentrated brine solution retained within the brine storage ponds at the completion of the Longwall Project would be re-injected back underground void when longwall mining is completed.

11.3 PIT TOP SURFACE WATER MANAGEMENT CONTROLS

The proposed surface water management controls for the Mine Site are as follows.

- Potentially contaminated runoff from the stockpiling and coal processing area would be collected in the previously constructed storage basin SB1. An additional storage basin SB2 would be constructed down-slope of SB1 to ensure all potentially contaminated runoff from the catchment is collected. SB1 and SB2 would be pumped to the previously constructed Dam A1 within the rail loop.
- Dam SB3 would be constructed to collect potentially contaminated runoff from the proposed Reject Emplacement Area. Runoff collected in SB3 would be pumped to Dam A1.
- To prevent leachate infiltrating through the reject and into the underlying soils, the base of each cell of the Reject Emplacement Area would be clay lined and compacted to achieve a maximum permeability of 1×10^{-9} m/day. Any leachate would drain laterally along the clay liner and into the drainage lines to be pumped to the Rail Loop water storages for Mine Site use. It is proposed to cap the Reject Emplacement Area at the end of mining to minimise leachate from occurring.
- Dewatered groundwater would be pumped to Dam A1.
- A water conditioning plant, incorporating ultra-filtration and reverse osmosis circuits, would be constructed to treat dewatered groundwater in-flows to produce water of quality suitable for on-site use and for off-site release.
- The highly saline brine by-product of the water conditioning plant would be evaporated in the previously constructed Ponds A2, A3 and half of Pond B (B2). Additional brine storage ponds (BR1 to BR5) would be constructed on an as needed basis within the nominated Brine Storage Area.
- The treated water (raffinate) would be stored in Dam B1, Dam C and Dam D for use on site for dust suppression and potable water. Water in excess of the Mine Site requirements would be piped to the Namoi River.
- A dedicated pipeline to the Namoi River would be constructed to supply the Longwall Project with water during the early years of the mine life. The pipeline would also be used to release treated water from Dam D directly to the Namoi River.
- A series of previously constructed sediment dams (SD1 to SD5) would collect potentially dirty runoff from the Pit Top Area. Additional sediment dams SD6 and SD7 would be constructed to collect and treat water draining from the ventilation shaft area and disturbed portion of the Brine Storage Area. Water collected in the sediment dams would be harvested on site for use during the early years of mine life.

- Construction of the road crossings over Kurrajong Creek Tributary 1 would occur when the creek is not flowing and an extended period of dry weather has been forecast. Any loose material generated during the construction program would be removed and the area would be revegetated as soon as practicable at the completion of construction.

11.4 SURFACE WATER MANAGEMENT STRATEGY ASSESSMENT

Daily and annual water balance models of the water management system and the various Pit Top Area water storages were developed to determine:

- the reliability of the various storages to supply the Mine Site water requirements during the early years of the Longwall Project (Year 2);
- the frequency and volume of potentially dirty spills from the various water storages;
- the frequency and volume of clean water releases to the Namoi River;
- the required size and behaviour of the brine storage ponds; and
- the volume of brine potentially to be reinjected back into the underground void at the end of the Longwall Project.

The results of the water balance modelling show the following:

- For Year 2 of Longwall Project operations, the Pit Top Area water storages can augment the groundwater in-flows to supply the operational water requirements for only the wettest (10%ile) years. The majority of the time, there would be insufficient runoff from the Mine Site catchments to meet demand. Water obtained from the Namoi River under a Water Licence would be used to augment supplies during these periods. As the expected groundwater in-flows increase and exceed the Mine Site water demands there would be an excess of water available, reducing the reliance on the off-site sources and Pit Top Area water storages.
- There are no uncontrolled spills from the three storages basins within the potentially contaminated catchment of the Mine Site. Therefore, the adopted storage volume and pumping strategy for these dams are appropriate.
- Uncontrolled spills from the Sediment Dams (SD1, SD2, SD3 and SD4) occur only once or twice over the 104 year simulation period for the Year 2 scenario when water is being harvested for Mine Site use. For the Year 18 scenario, uncontrolled spills do not occur because all water is released to the downstream creeks within 5 days of the runoff event. At this stage, the water quality collected within the sediment dams is expected to achieve the water quality compliance criteria.
- Sediment Dam SD6 at the initial ventilation shaft area spills an average of 1 year in 3. This satisfies the average annual sediment basin overflow frequency criteria given in DECC (2008).
- Three excess brine storage ponds BR1, BR2 and BR3 would be required to contain the brine concentrate. Dam B2 would be operational prior to Year 3, Dam BR1 would be required in Year 4, BR2 would be required in Year 7 to Year 9 and the third excess brine storage would be required between Year 13 and Year 16.

- Pumping would cease from the sediment dams to augment Mine Site supplies in Year 3 or Year 4. It is expected that the rehabilitation program from these catchments would be fully completed by this stage and therefore runoff quality would be acceptable.
- Off-site releases of raffinate water are expected to commence in Year 6 to Year 8.
- Off-site releases of raffinate water are expected to peak in Year 18 at 761ML/y for the base case groundwater in-flow scenario and in Year 19 at 1171ML/y for the upper bound groundwater in-flow scenario.

11.5 MINE SUBSIDENCE MANAGEMENT STRATEGY

A range of strategies that are tailored to each location and consider the geomorphic characteristics, vegetation, soil types and Aboriginal sites are required to mitigate the impact of mine subsidence. For the high risk and moderate riparian risk management areas, it is recommended to survey the creek channels within 6 months of being crossed by a longwall panel. If the survey shows that differential settlement would cause significant erosion or over bank ponding, the following strategies should be considered:

- Visible cracks in the bed of the creek would be filled in where necessary.
- Contour banks that cross chain pillars would be removed. An assessment on the need to replace the contour banks would be made. Given that the Proponent owns the majority of the land over the mine subsidence zone, lower stocking rates and higher vegetation covers are expected.
- Estimates of the extent of over bank ponding would be made.
    - If little vegetation of significance is impacted and minimal salt producing soils are evident, the ponding would be left as is.
    - If vegetation of significance is to be impacted or salt producing soils are evident within the ponded area, the channel across the chain pillars may be excavated to reduce the extent of ponding. Care would be taken to ensure that Aboriginal sites or significant vegetation is not impacted by the excavation.
- The creek channels draining into the mine subsidence zone and on the downstream side of the chain pillars would be monitored for erosion following each runoff-producing storm event. Any erosion would be repaired and remedial measures, such as check dams or drop structures, would be constructed if necessary.

For the low risk management zones, the creek channel will be monitored for signs of sediment build-up or erosion in excess of natural processes. A photographic record will be kept of the creek channels to track their long term behaviour. If necessary, excess sediment would be removed and remedial erosion protection measures would be installed.

12. REFERENCES

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Appendix 1

Coverage of Environmental Assessment Requirements and Environmental Issues in the Surface Water Report

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ENVIRONMENTAL REQUIREMENTS RAISED BY THE DIRECTOR-GENERAL RELATING TO SURFACE WATER (02.10.08)

Key Assessment Requirements, Surface Water:	**Relevant Section(s)**
• A description of the existing environment using sufficient baseline data.	Section 2
• Assessment of Potential Impacts	Section 6
• A description of the measures that would be implemented to avoid, minimise, mitigate, rehabilitate/remediate,	Section 6
monitor and/or offset the potential impacts	Section 9
including contingency plans for managing significant risks to the environment	Section 6.3.5
• Demonstrating how the company would manage mine water, especially any mine water brought to the surface	Section 6.2
• Any potential subsidence- induced soil and stream erosion	Section 7
References:	
• National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ)	Section 0
• National Water Quality Management Strategy: Australian Guidelines for Water Quality Monitoring and reporting (ANZECC/ARMCANZ)	Section 9
• Using the ANZECC Guideline and Water Quality Objectives in NSW (DEC	Section 5.4
• State Water Management Outcome Plan	Section 5.1
• Namoi Catchment Action Plan	Section 5.1
• Approved Method for Sampling and Analysis of water pollutants in NSW (DEC)	Section 9
• Managing Urban Stormwater: Soils and Construction (Landcom)	Section 6.4
• Technical Guidelines for Bunding and Spill Management	Section 6.5
• Environmental Guidelines. Use of Effluent by Irrigation (DECC)	Section 6.3.4

ENVIRONMENTAL REQUIREMENTS RAISED BY GOVERNMENT AGENCIES RELATING SURFACE WATER

Government Agency	Paraphrased Requirement	Relevant Section(s)
DECC (16 September 2008)	• Update and Review Water Balance Model	Section 7
	• Beneficial reuse of treated water	Section 6.3.4
	• Identification of Discharge Points with estimates of frequency and volume of discharges and likely water quality limits	Section 9
	• On-site placement of Washery Rejects (wash plant no longer proposed)	Not Relevant
DPI (25 September 2008)	<u>Baseline Environmental Studies</u>	
	• Meteorological – rainfall and wind patterns	Section 3
	<u>Water Management</u>	
	• A detailed hydrological study of the impact catchment areas	Section 8
	• Detailed description of watercourses within the impacted catchment areas	Section 2
	• Integration of water sharing and water strategies or external users	Section 0
	• Contingencies for water storages and diversions around the impacted area	Section 6.3.5
	• Control and management of mine water and runoff water.	Section 6.2
	• Review of flood control strategies to eliminate flooding of the operations	Section 3.5
	<u>Environmental Management and Impact Mitigation</u>	
	• Water	Section 5.2
	• Erosion	Section 7
	• Real time performance monitoring	Section 9
	<u>Fisheries Issues</u>	
	• Aquatic Habitat	Section 2.2
	• Potential Blockage to fish passage	Not Relevant
	• Assessment of the extent of dredging or reclamation activities	Section 7
	• Sedimentation and erosion	Section 6.2 and Section 7.4
Namoi CMA (15 September 2008)	<u>General</u>	
	• <u>Namoi Cap</u>	Section 4.3
	<u>Riparian Areas</u>	
	• Change in hydrology, water quality and quantity of the local creeks with consequential off site impacts	Section 7
Narrabri Council (18 September 2008)	<u>Subsidence</u>	
	• Surface Water Impacts	Section 7

PEER REVIEW

of the

Surface Water Assessment

Prepared by

Mr Lindsay Gilbert
Director of
Gilbert & Associates Pty Ltd

(Note: The attached peer review relates to the assessment report submitted to the Department of Planning for adequacy assessment – August, 2009)

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Gilbert & Associates Pty Ltd

General Manager Technical Services
Whitehaven Coal Limited
PO Box 600
Gunnedah
NSW 2380

26 August 2009

Attention Mr Brian Cullen

Dear Brian

Re Review of Stage 2 Longwall Project – Surface Water Assessment

I have completed my review of the report entitled "Narrabri Coal Mine Stage 2 Longwall Project Surface Water Assessment", Prepared by WRM Water & Environment Pty Ltd, August 2009. My review has comprised an intensive review of the report itself and several earlier drafts. I have also reviewed the approved Stage 1 water surface water assessment report and several supporting reports and have had several face to face meetings with the report's author Mr Greg Roads to discuss details of his analysis and modelling.

The first 4 sections of the report provide introductory and background information. I find the information provided in these sections sufficient to both appreciate the background to the project and to understand the data framework within which the proposed conceptual water management system has been developed and the surface water assessment has been conducted.

<u>Section 5</u> sets out the objectives and strategies proposed for water management around the pit top area. I find the objectives and strategies presented appropriate to the particular circumstances of the project. I believe that the stated objectives would be met if the water management measures outlined later in the report are developed and applied within a well designed water management plan. Section 5 also contains an outline of intended water quality compliance criteria. The water quality targets presented are consistent with my understanding of currently applicable water quality management standards and policies.

<u>Section 6</u> is substantially a description of the conceptual water management system proposed for the Stage 2 project. The Stage 2 water management system would be integrated with the already approved and substantially developed water management scheme for Stage 1. The conceptual water management system proposed allows for significant flexibility to accommodate different outcomes and in particular different possible mine dewatering rates derived from the different groundwater model sensitivity/scenario runs. I endorse this flexible approach given the significant unknowns. The performance capacity of the proposed water management system has been assessed using water balance modelling as reported in Section 8 of the report. The capacities nominated for the various water management system components have been derived from or are consistent with the performance results of the modelling reported in Section 8. I believe the information on capacities should

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be viewed as performance-based rather than absolute and they should be reviewed/revised during final design.

The assessment of the effects of raffinate discharge on flows in the Namoi River in Section 6 show an increase in the frequency of low (<10ML/day) flows and a negligible effect on larger flows. I concur with the conclusion presented that except for potentially beneficial increases to very low flows, there would be insignificant changes to flow in the Namoi River as a result of raffinate discharge. I also concur that raffinate discharge is unlikely to increase measurable salinity (concentrations) in the Namoi River but is likely to decrease salinity in the River during some low flow periods.

Section 7 contains a description of predicted subsidence impacts and an assessment of the effects of subsidence on site surface water resources. I have not inspected the site watercourses, however I find the description of subsidence impacts and the assessment of effects on local creeks credible. I believe the monitoring and remediation strategies are an appropriate basis for establishing an effective subsidence management plan.

Section 8 describes and summarises the results of the water balance modelling conducted for the surface water assessment. Two different modelling approaches are described – one a daily model using the IQQM (with inflows obtained from the AWBM) and the other an averaged annual model developed as a Microsoft Excel spreadsheet. Whilst both approaches have (acknowledged) limitations, their application to this project is considered acceptable given the uncertainty surrounding longwall groundwater yield and water quality. I believe that the modelling is sufficiently robust to demonstrate that the proposed water management strategy (including contingency measures) and the conceptual water management system would have sufficient capacity and flexibility to cater for the climatic conditions and the different scenarios assessed.

Section 9 contains an assessment of the Project water supply and water storages against the harvestable rights policy requirements. I concur with the analysis and conclusion presented.

Section 10 presents a proposed surface water monitoring regime for the project. I agree with the details of the proposed program as far as they go but also recommend that the monitoring effort be extended to include quantification of the site water balance and the performance of the site water management system over time. This would be necessary to support operational management of the water management system and to inform changes which may be required as actual groundwater inflows to the longwall mine become apparent.

Section 11 is a summary and Section 12 is a reference list.

In summary I conclude that:

1. The Surface Water Assessment Report contains sufficient information to understand:
    - the nature of the Project as it is likely to affect surface water resources,
    - the water management system proposed – at a conceptual level; and
    - the nature of foreseeable impacts.

2 The stream condition monitoring and remediation strategies outlined for the Project area creeks and the assessment of the effects of subsidence are an appropriate basis for developing an effective subsidence management plan.

3 The conceptual water management system presented has sufficient capacity and flexibility to cope with the range of climatic and operational conditions assessed.

4 The analyses and modelling carried out for the assessment are appropriate and sufficient to support the interpretation and conclusions reached.

Yours sincerely

Lindsay Gilbert
Director,
Gilbert & Associates Pty Ltd