APPENDIX A

SURFACE WATER ASSESSMENT

Boggabri Coal Project Modification - Surface Water Assessment

March 2013

Boggabri Coal Pty Ltd

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Revision	Details	Date	Amended By
00	Draft	18 July 2012	L Doeleman, N Harcombe
01	Final Draft incorporating Resource Strategies comments	12 August 2012	L Doeleman, N Harcombe
02	Final incorporating Boggabri Coal comments from October 2012 and updates from Resource Strategies	14 March 2013	L Doeleman, N Harcombe

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Reviewer: R Leslie...

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Approved by: R Leslie...

Signed: ....

Date: 14 March 2013 ....

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1. Introduction

Parsons Brinckerhoff Australia Pty Limited (PB) was engaged by Boggabri Coal Pty Ltd (Boggabri Coal) and Tarrawonga Coal Pty Ltd (TCPL) to undertake a Surface Water Assessment for a proposed modification to the Boggabri Coal Project (the Modification). The Surface Water Assessment will support the Environmental Assessment (EA) for the Modification.

The Boggabri Coal Mine is located in the Gunnedah Basin, approximately 15 km north-east of the town of Boggabri in north-west New South Wales (Figure 1-1). The Boggabri Coal Mine is owned and operated by Boggabri Coal, which is a wholly owned subsidiary of Idemitsu Australia Resources Pty Ltd. The Boggabri Coal Mine open cut, overburden emplacement areas and the majority of the mine-related infrastructure are located in Coal Lease (CL) 368.

1.1 Background

1.1.1 Boggabri Coal Project

In July 2012, Project Approval (09_0182) was granted for the Boggabri Coal Project by the Planning Assessment Commission of NSW (PAC) under delegation from the NSW Minister for Planning and Infrastructure pursuant to Section 75J of the NSW *Environmental Planning & Assessment Act, 1979* (EP&A Act).

The Boggabri Coal Project includes the continuation of mining at the Boggabri Coal Mine, and upgrades to the Boggabri Coal Mine infrastructure facilities, including the construction and use of a coal handling and processing plant (CHPP), by-pass crusher, associated coal stockpiles and private rail loop and spur.

Figure 1-2 shows the proposed Boggabri Coal Project mining landform, as described in the Boggabri Coal Project EA.

Under Project Approval 09_0182, the Boggabri Coal Mine is approved to extract up to 8.6 million tonnes per annum (Mtpa) run-of-mine (ROM) coal and transport up to 7 Mtpa product coal from the site until 31 December 2033.

Water management for the Boggabri Coal Mine would be conducted in accordance with the Water Management Plan, which is required under Schedule 3, Condition 38 of Project Approval 09_0182.

1.1.2 Tarrawonga Coal Project

The Tarrawonga Coal Mine is located immediately south of the Boggabri Coal Mine. It is owned and operated by TCPL, which is a joint venture between Whitehaven Coal Limited (70% interest) and Boggabri Coal (30% interest). The Tarrawonga open cut, overburden emplacement areas and the majority of the mine-related infrastructure are located in Mining Lease (ML) 1579.

In January 2013, Project Approval (11_0047) was granted for the Tarrawonga Coal Project by the PAC under delegation from the NSW Minister for Planning and Infrastructure pursuant to section 75J of the EP&A Act.

The Tarrawonga Coal Project involves continued development of open cut mining operations at the Tarrawonga Coal Mine to facilitate a ROM coal production rate of up to 3 Mtpa for a 17 year project life (i.e. until 2029).

A key component of the Tarrawonga Coal Project is the construction and use of a services corridor (including a haul road) linking it to the Boggabri Coal Mine (Figure 1-3). Coal trucks would use the services corridor to access the upgraded Boggabri Coal Mine Infrastructure Area (MIA) in CL 368. At these facilities, coal from the Tarrawonga Coal Project would be processed and loaded onto trains for off-site transport. Up to 1.5 Mtpa of Tarrawonga coal would be processed through the Boggabri CHPP, with the remaining 'bypass' coal (i.e. approximately 1.5 Mtpa) being stockpiled separately before being loaded onto trains.

The Tarrawonga Coal Project also involves the extension of the Tarrawonga Northern Emplacement area to the north into CL 368 and its integration with the southern part of the Boggabri waste rock emplacement (Figure 1-3). TCPL would apply for a new ML for this area (i.e. MLA 3 on Figure 1-3) or would transfer part of the existing CL 368 from Boggabri Coal to TCPL. This would mean that the extended Tarrawonga Northern Emplacement area would become part of the Tarrawonga Coal Mine and would be administered under TCPLs Project Approval and mining tenements.

1.1.3 The Modification

The Continuation of Boggabri Coal Mine Environmental Assessment (Boggabri EA) did not describe the receipt of coal from the Tarrawonga Coal Project at the Boggabri MIA in CL 368, or the associated processing at the Boggabri CHPP and transport along the private rail spur. As such, a modification to the Project Approval (09_0182) for the Boggabri Coal Project is required (the Modification) in order to assess and authorise these activities.

As part of the Modification, the Boggabri MIA would be expanded in order to provide additional coal stockpiling areas and haul roads necessary to receive and process the Tarrawonga coal. These changes would extend the stockpile areas and associated haul roads slightly to the east and would require an adjustment to the boundary between CL 368 and ML 1579, as well as requiring the relocation of the existing Tarrawonga water storages (i.e. Sediment Dam [SD] 17, Sediment Basin [SB] 6 and SB 7) which are located on the western toe of the Tarrawonga Northern Emplacement. In place of these dams a new haul road and diversion drain would be constructed, with the new lease boundary to be located between the two. Runoff from the Tarrawonga Northern Emplacement would enter the new drain and travel in a southerly and then westerly direction into a new 50 ML capacity Tarrawonga sediment dam. A lease boundary adjustment would also be required around this new storage so that it would be contained within TCPL tenements. Figure 1-4 shows the key features of the existing and proposed Boggabri MIA including the proposed lease boundary adjustments.

The processing of Tarrawonga coal at the Boggabri Coal Mine would also result in an increased raw water make-up requirement. The Surface Water Assessment (PB, 2010) conducted for the Boggabri EA was based on a CHPP production rate of 3 Mtpa. As part of the proposed Modification the CHPP production rate would be increased to 3.5 Mtpa, with 1.5 Mtpa of the coal to be supplied from the Tarrawonga Coal Mine and 2 Mtpa from Boggabri. Some additional water demand would also be associated with handling of the Tarrawonga bypass coal and for dust suppression on haul roads and stockpiles in and near the expanded MIA.

The integration of the Boggabri and Tarrawonga waste rock emplacements would result in alterations to the surface water management system described in the Boggabri EA. The new lease boundary between the Boggabri Coal Mine and the Tarrawonga Coal Mine (MLA 3) would cross the emplacement in an east-west direction. In general terms, the ridgeline of the emplacement area would define the boundary between the water management systems for the two mines, and runoff from the southern batter of the Boggabri emplacement that drains south to MLA 3 would be incorporated into the Tarrawonga water management system.

1.2 Purpose of this report

The Modification would result in changes to the surface water management regime described in the Boggabri EA, due to the:

- adjustments to the Boggabri MIA in order to provide additional coal stockpiling areas and haul roads necessary to receive and process the Tarrawonga coal
- increased water demand associated with processing of Tarrawonga coal
- integration of the Tarrawonga Northern Emplacement area with the southern extent of the Boggabri waste rock emplacement (Figure 1-3).

This report documents the revised surface water assessment, including revised site water balance modelling and revised hydrologic modelling of the local catchment, to support the EA for the Modification.

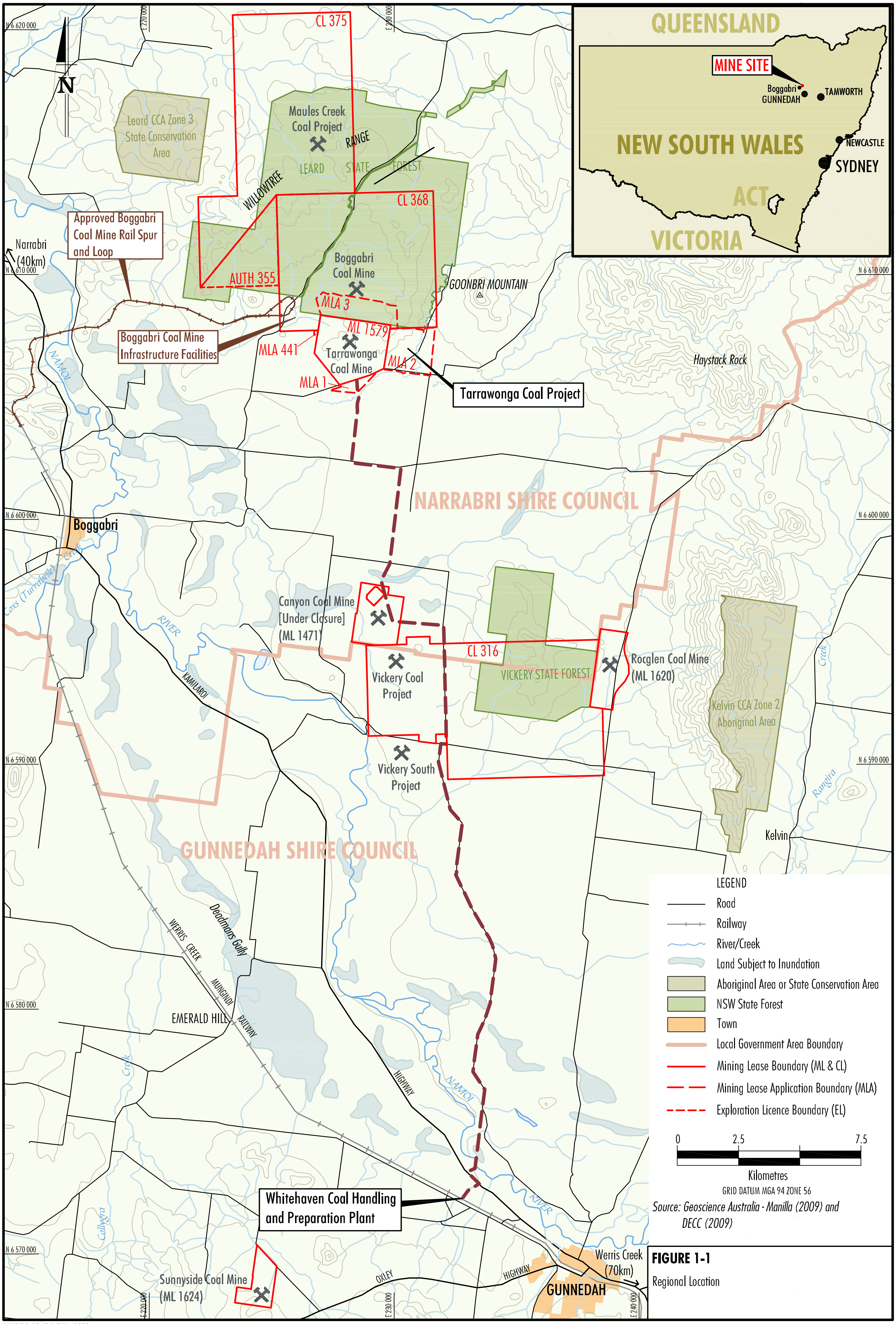

FIGURE 1-1
Regional Location

WHC-12-08_BM SWA_102B

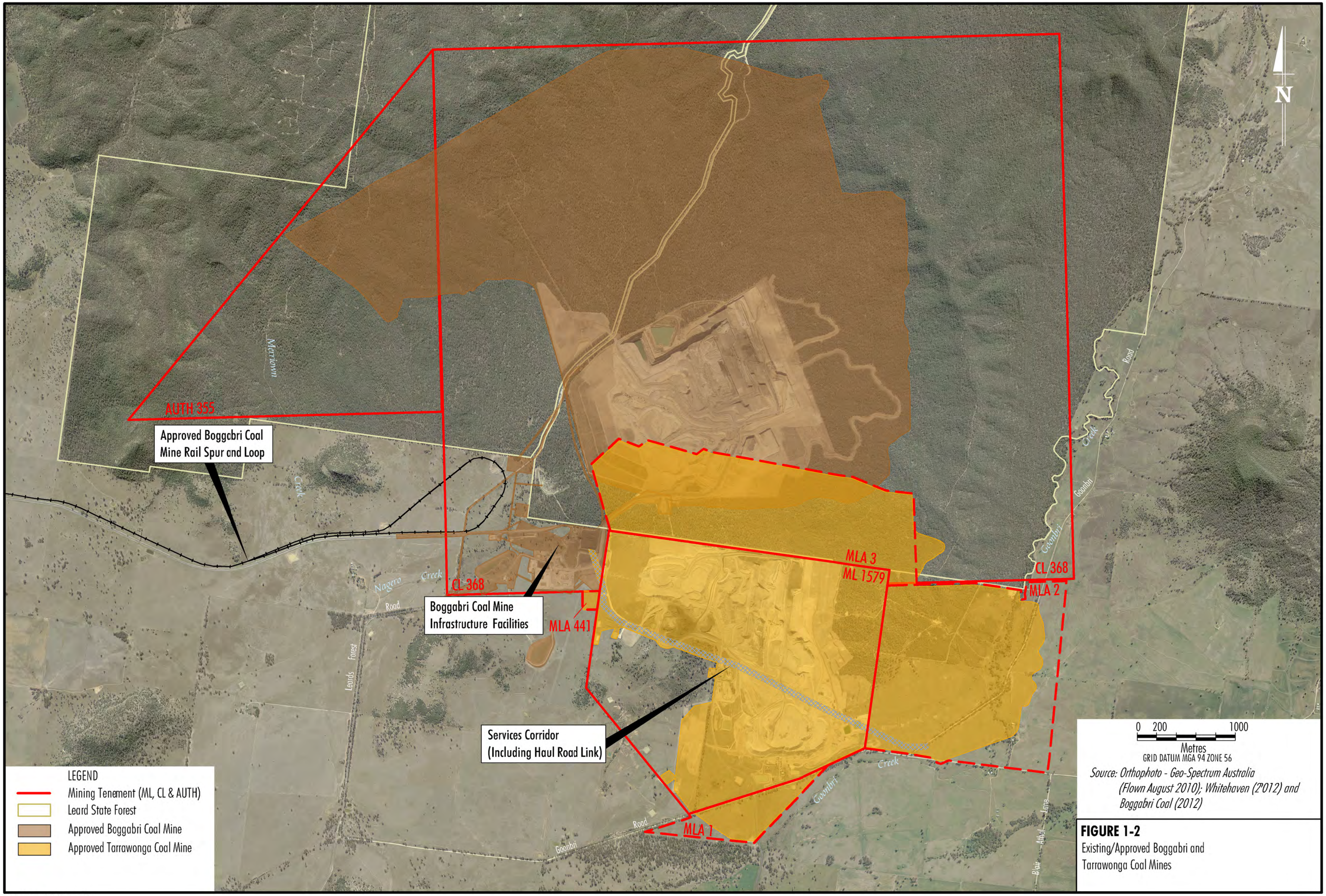

FIGURE 1-2
Existing/Approved Boggabri and Tarrawonga Coal Mines

WHC-12-08_BM SWA_103B

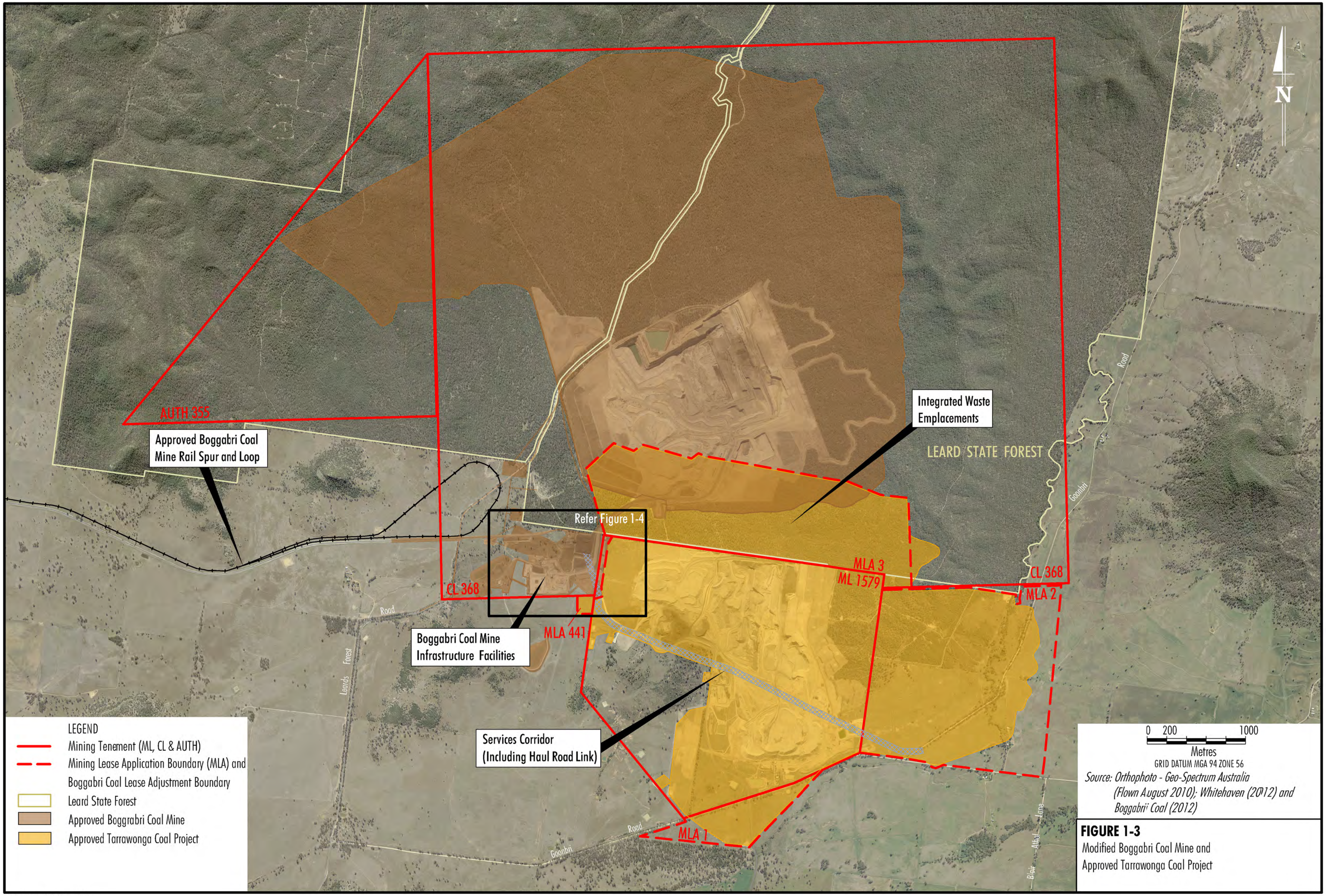

FIGURE 1-3
Modified Boggabri Coal Mine and Approved Tarrawonga Coal Project

WHC-12-08_BM SWA_104B

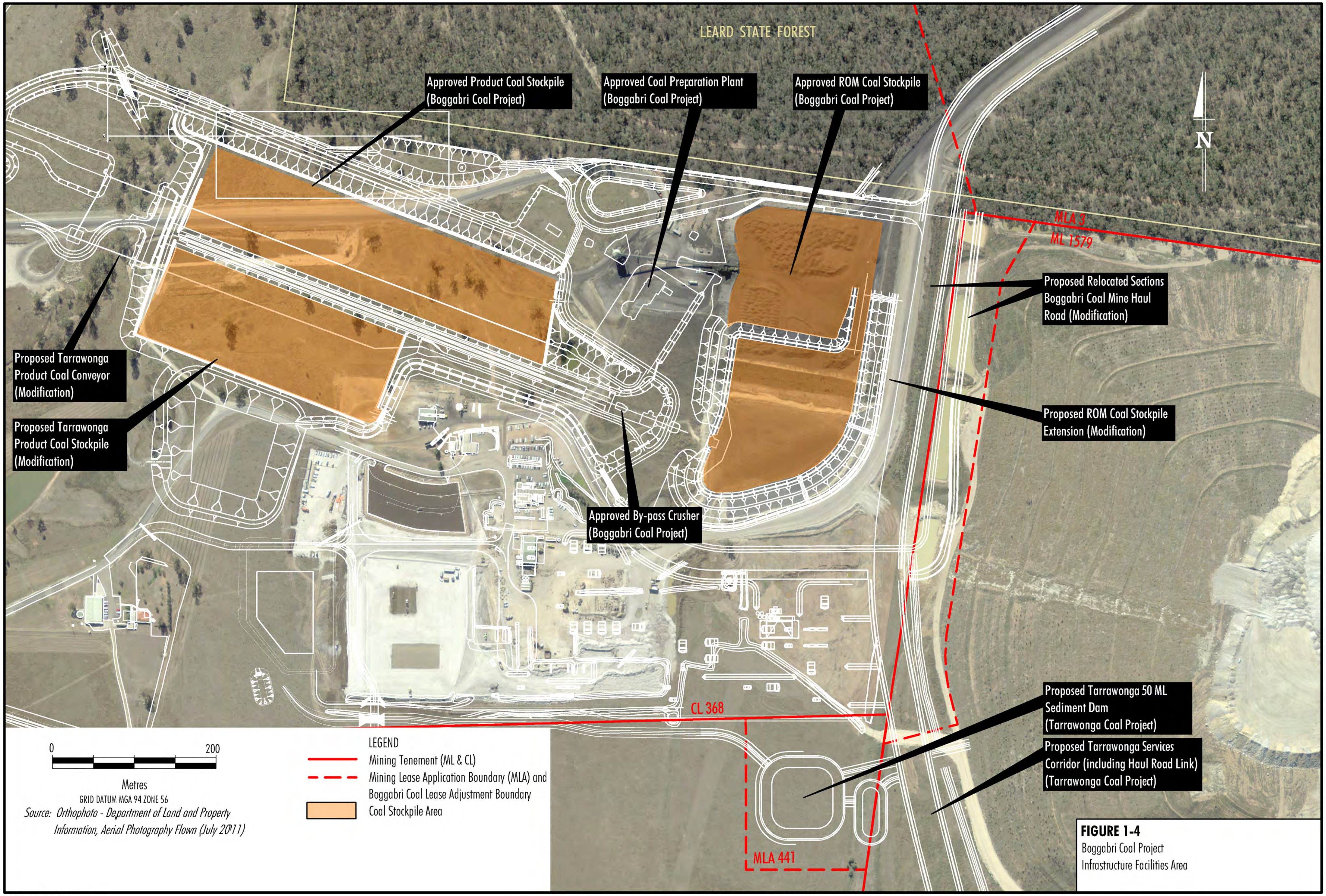

FIGURE 1-4
Boggabri Coal Project
Infrastructure Facilities Area

WHC-12-08_BM SWA_101B

2. Existing surface water environment

The following section builds upon the characterisation of the existing surface water environment, as described in the Surface Water Assessment (PB, 2010). The following additional information has been obtained since finalisation of the Boggabri EA:

- rainfall and evaporation data for the period October 2010 to December 2011
- water quality monitoring data for the period October 2010 to March 2012
- water made available under the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2003 for the start of the 2012 / 2013 water year.

2.1 Climate

Daily rainfall and evaporation data for the site for the 122 year period between 1 January 1889 and 31 December 2011 was obtained from the Bureau of Meteorology (BOM) Data Drill service. The Data Drill accesses grids of data derived by interpolating the BOM's station records. The data in the Data Drill are all synthetic, and there are no original meteorological station data left in the calculated grid fields. However, the Data Drill has the advantage of being available for any set of coordinates in Australia (BOM, 2006).

The Data Drill is considered superior to individual BOM station records and site meteorological station data for long-term water balance modelling purposes because it draws on a greater dataset, both spatially and in time. The Data Drill is also considered superior for modelling purposes as it does not contain gaps.

Plots of Data Drill sourced annual rainfall and annual lake evaporation for the 122 year period between 1889 and 2011 are provided in Figure 2-1 and Figure 2-2 respectively. A plot of Data Drill sourced average daily lake evaporation for each month of the year is provided in Figure 2-3. Summary statistics of Data Drill sourced annual rainfall and evaporation are provided in Table 2-1. Note that the climate data has been updated to include the additional data available since completion of the Boggabri EA Surface Water Assessment in October 2010.

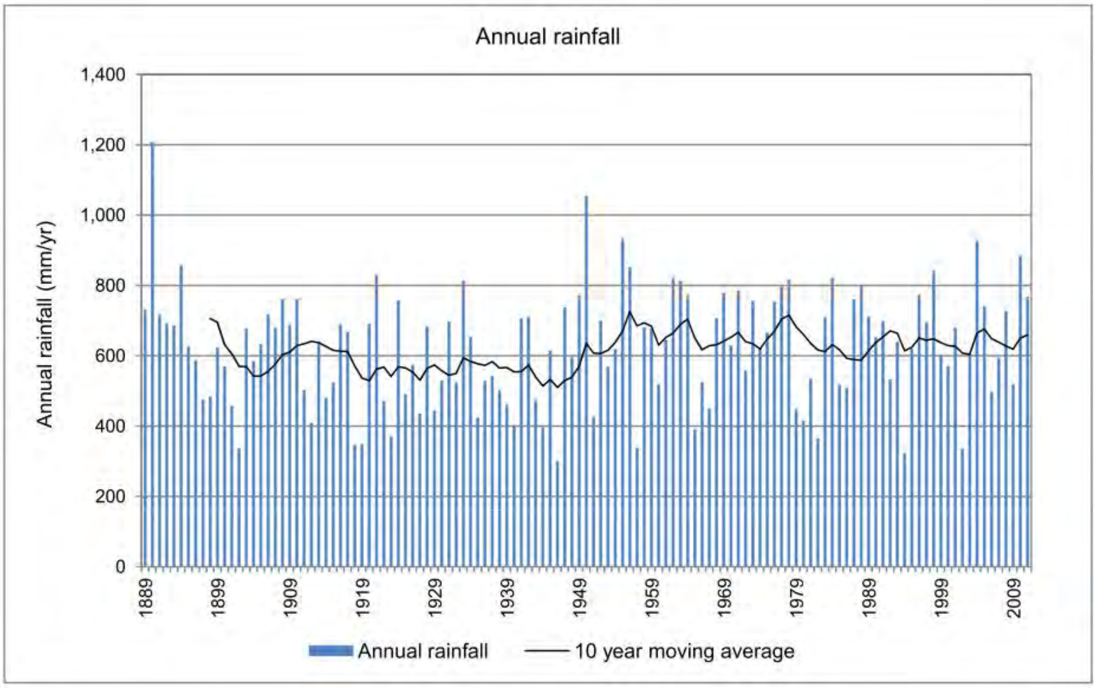

Figure 2-1 Annual rainfall for Boggabri from 1889 to 2011 (Data Drill)

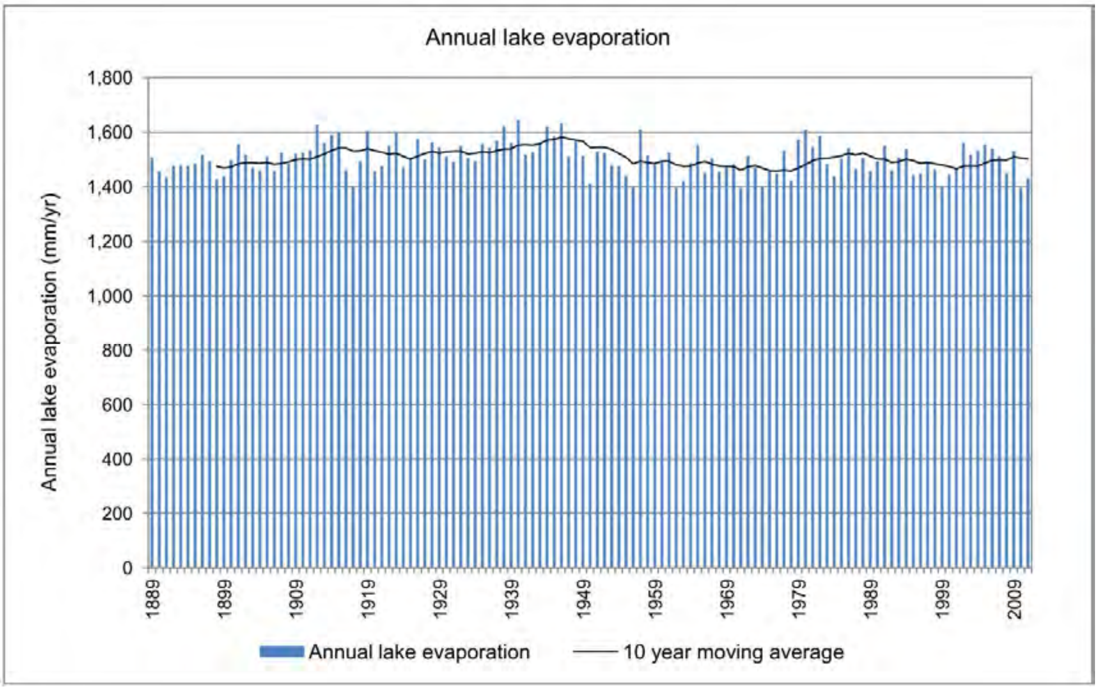

Figure 2-2 Annual lake evaporation for Boggabri from 1889 to 2011 (Data Drill)

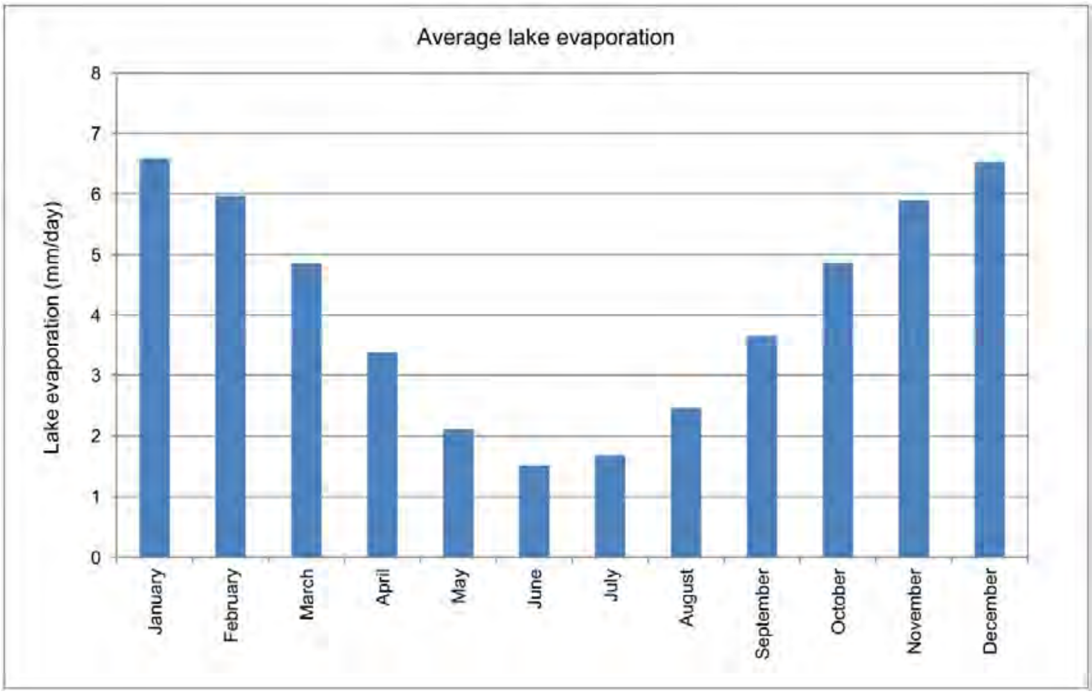

Figure 2-3 Average daily lake evaporation for Boggabri from 1889 to 2011 (Data Drill)

Table 2-1 Annual rainfall and evaporation statistics for Boggabri from 1889 to 2011 (Data Drill)

Percentile	Annual rainfall (mm/yr)	Annual pan evaporation (mm/yr)	Annual potential evapotranspiration (mm/yr) [1]	Annual lake evaporation (mm/yr) [2]
minimum	299	1,527	1,253	1,393
5th percentile	350	1,671	1,310	1,404
10th percentile	410	1,736	1,333	1,435
50th percentile	633	1,852	1,408	1,503
90th percentile	813	1,875	1,533	1,581
95th percentile	850	1,988	1,567	1,607
maximum	1,208	2,237	1,634	1,643

[1] Potential evapotranspiration calculated using the Penman-Monteith formula given in Irrigation and Drainage paper No. 56 (Food and Agriculture Organization of the United Nations, 1998).

[2] Lake evaporation calculated using Morton formula for shallow lakes given in the Journal of Hydrology, Volume 66, page 1-77, paper (Morton, 1983).

Daily rainfall data has been recorded at the Boggabri Coal Mine meteorological station since July 2006. The site meteorological station data has not been used for long-term water balance modelling because the data is only available for a relatively short period. However, the site meteorological station data will be useful in the future to undertake annual water balance modelling and to verify the water balance model results against site observations.

2.2 Design rainfall data

2.2.1 Intensity-frequency-duration rainfall data

Design intensity-frequency-duration (IFD) rainfall data for the mine site area was obtained from the BOM website, and is provided in Table 2-2. This information is typically utilised in the minimum sizing of contaminated water sediment dams (i.e. 100 year ARI 72 hour volume typical for no spills principal).

Table 2-2 IFD data for Boggabri

	Rainfall intensity (mm/hr)						
Duration	**1 year ARI**	**2 year ARI**	**5 year ARI**	**10 year ARI**	**20 year ARI**	**50 year ARI**	**100 year ARI**
5 mins	70.7	92.9	123	144	171	209	240
10 mins	53.6	70.4	93.5	109	129	158	181
20 mins	39.3	51.6	68.3	79.3	93.9	115	131
30 mins	31.9	41.8	55.3	64.1	75.9	92.6	106
1 hr	21.1	27.7	36.6	42.4	50.2	61.2	70.2
2 hrs	13.2	17.3	22.9	26.6	31.5	38.4	44
3 hrs	9.84	12.9	17.1	19.9	23.6	28.8	33
6 hrs	5.91	7.77	10.3	12	14.3	17.4	20
12 hrs	3.58	4.71	6.29	7.34	8.73	10.7	12.3
24 hrs	2.19	2.9	3.9	4.58	5.47	6.73	7.77
48 hrs	1.33	1.76	2.39	2.82	3.39	4.20	4.86
72 hrs	0.95	1.26	1.73	2.04	2.46	3.06	3.55

2.2.2 Five day rainfall depths

Five day rainfall depths for the mine site have been estimated based on the values provided for Gunnedah in the guidelines *Managing Urban Stormwater – Soils and Construction – Volume 1* (Landcom, 2004) and are provided in Table 2-3. These depths are typically utilised in the sizing of dirty water sediment dams (the 90th percentile storm event is recommended for a sediment dam with duration of disturbance greater than 3 years and with a standard receiving environment).

Table 2-3 5-day rainfall depths for Boggabri

Percentile	5-day rainfall depth (mm)
75th percentile	20.0
80th percentile	24.1
85th percentile	30.2
90th percentile	38.4
95th percentile	53.0

2.3 Catchment description

2.3.1 Regional catchment

Boggabri Coal Mine is contained within the catchments of Nagero Creek and Bollol Creek. Nagero Creek and Bollol Creek are both small tributaries of the Namoi River, which is part of the Barwon-Darling River system.

The Namoi River catchment is bounded by the Great Dividing Range in the east, the Liverpool Ranges and Warrumbungle Ranges in the south, and the Nandewar Ranges and Mount Kaputar to the north. Major tributaries of the Namoi River include Coxs Creek, Mooki River, Peel River, Cockburn River, Manilla River and Macdonald River, which all join the Namoi River upstream of Boggabri.

The Namoi River catchment has an area of approximately 42,000 km^2. The catchment extends over 350 km in an east-west direction between the Great Dividing Range and the Barwon River. The Namoi River catchment area to Boggabri is approximately 22,600 km^2, contributing to a mean annual streamflow of 906,470 ML/yr at the Boggabri gauging station (ID 419012).

Split Rock Dam on the Manilla River and Keepit Dam on the Namoi River are the two main water storages in the Namoi River catchment. These structures allow the delivery of flows to meet the needs of water users downstream.

2.3.2 Local catchment

Nagero Creek

The Boggabri Coal Mine mining area and mine infrastructure area (MIA) are located within the catchment of an unnamed drainage line that is commonly referred to as Nagero Creek.

The Nagero Creek catchment is bounded by the Willowtree range to the north-east and falls generally to the south-west. The catchment area is approximately 4,250 ha to the point where Nagero Creek meets the Namoi River floodplain, approximately 1 km downstream of the site.

The majority of the Nagero Creek catchment upstream of the Boggabri Coal Mine site is contained within the Leard State Forest. Leard State Forest has been selectively logged in the past, but is generally forested with the exception of Boggabri Coal Mine, Tarrawonga Coal Mine and Leard Forest Road. The majority of the Nagero Creek catchment downstream of the Boggabri Coal Mine site comprises cleared farm land.

From the south-western corner of the Boggabri Coal Mine site, Nagero Creek flows approximately 5 km west to the Namoi River.

Nagero Creek is an ephemeral stream. The cross-section comprises a well-defined incised channel up to approximately 15 m wide bank to bank and 3 m deep. The banks are well vegetated, and the bed comprises sand and/or rock.

Downstream of the Boggabri Coal Mine site, Nagero Creek becomes indistinct as it flows across the Namoi River floodplain. These alluvial flats become swampy following rainfall, and natural ponds (such as the ‘Slush Holes’) and farm dams store water for long periods.

Bollol Creek

The spillway of Boggabri Coal Mine's contaminated water storage dam MW3 discharges to Bollol Creek. However, the maximum operating level in MW3 has been set to allow adequate freeboard to the spillway level so that overflows will not occur during prolonged wet periods. As such, discharges from MW3 to the Bollol Creek catchment are not proposed.

The southern portion of the approved irrigation area is located in the Bollol Creek catchment; however, the approved irrigation system is not currently operational.

2.4 Surface water quality

Surface water quality in the local catchment is monitored by Boggabri Coal as per the conditions of Environment Protection License (EPL) No. 12407 and Project Approval 09_0182. Periodic surface water monitoring is undertaken at nine sampling locations:

- Nagero Creek upstream and downstream of existing mine operations (two locations).
- Within existing sediment and mine water dams (seven locations).

Monitoring is undertaken for pH, electrical conductivity, total suspended solids, oil and grease, nitrate, nitrogen (total), phosphorus (total) and reactive phosphorus. A plan showing existing surface water monitoring sites is provided in Figure 2-4.

2.4.1 EPL concentration limits

Concentration limits for surface water emissions specified under Boggabri Coal's current EPL No. 12407 are provided in Table 2-4.

Table 2-4 Concentration limits for emissions to water (as per EPL No. 12407)

	Concentration limit		
Pollutant	**50th percentile**	**90th percentile**	**100th percentile**
Oil & grease (mg/L)	-	-	10
pH	-	-	6.5-8.5
Total suspended solids (mg/L)	20	35	50

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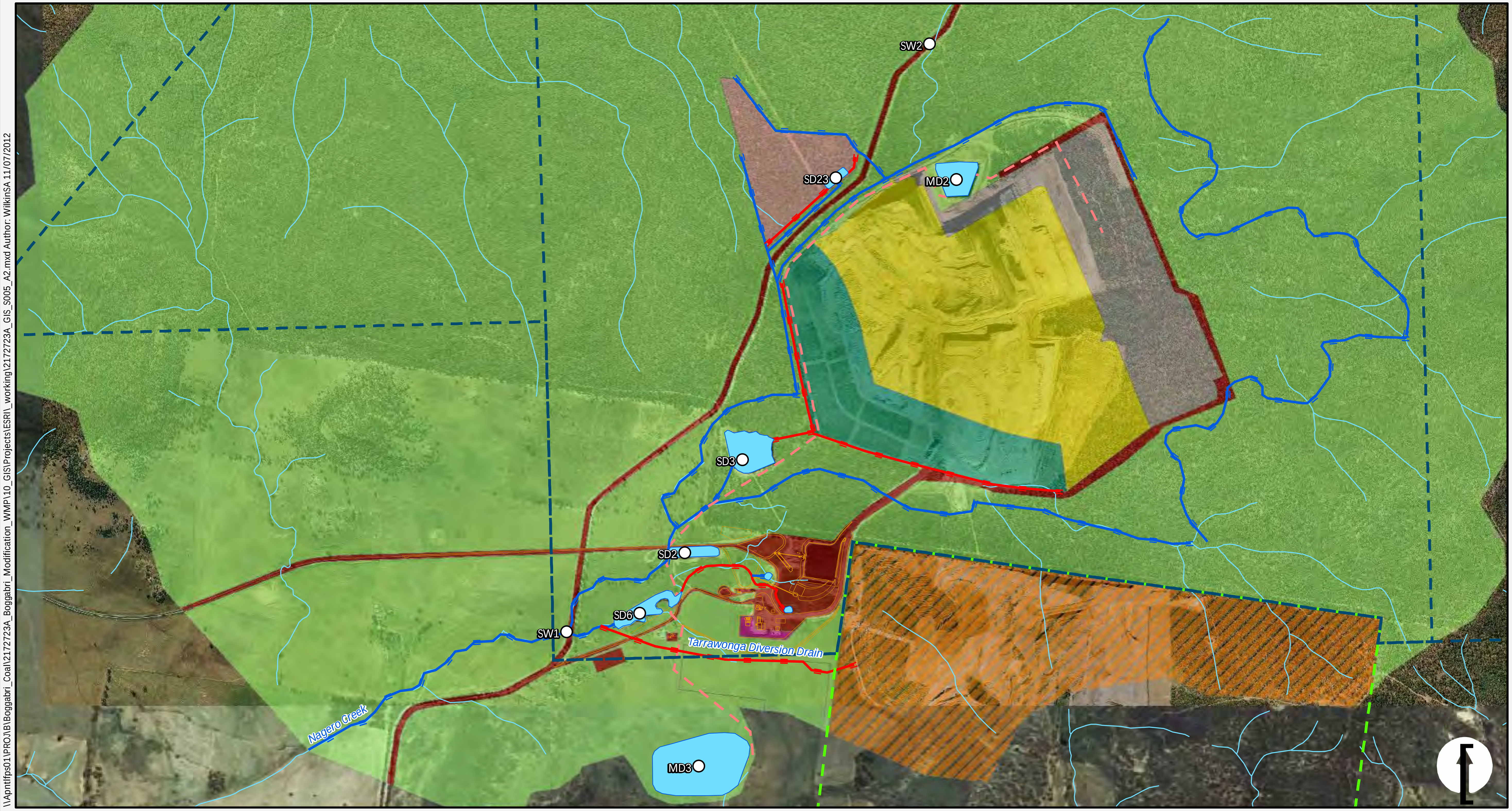
BOGGABRI COAL PTY LTD



Existing Surface Water Monitoring Sites
Mine Infrastructure
Drainage
Boggabri Coal Mining Tenement
Tarrawonga Mining Lease Boundary
Clean Water
Dirty Water
Pump
Water Storages
Future Road / Industrial
Mining Void
Rehabilitated Spoil Dump
Road / Industrial
Tarrawonga Coal Mine
Topsoil Stockpile
Undisturbed
Unshaped Spoil Dump

Figure 2-4
Existing Surface Water Monitoring Sites

2.4.2 Nagero Creek water quality

Ambient water quality monitoring is undertaken upstream of the mine at monitoring site 'SW2' to establish background conditions of Nagero Creek. Water quality monitoring in Nagero Creek downstream of the mine is undertaken at 'SW1'.

A snapshot of the monitoring data for key parameters in Nagero Creek at 'SW2' (upstream of the mine) and 'SW1' (downstream of the mine) collected by Boggabri Coal between July 2008 and March 2012 is provided in Table 2-5.

Table 2-5 Summary of ambient water quality monitoring data – Nagero Creek at SW2 (upstream of mine site) and SW1 (downstream of mine site)

		Compound					
Monitoring Site	Sample date	pH	Electrical conductivity (µS/cm)	Suspended solids (mg/L)	Total Nitrogen as N (mg/L)	Total Phosphorus as P (mg/L)	Oil & grease (mg/L)
SW1	23/09/2008	6.7	231	2,070	3.8	0.38	-
SW1	06/10/2008	7.4	127	169	3.1	0.29	-
SW1	13/12/2008	7.7	174	158	1.2	-	-
SW1	17/02/2009	7.3	59	160	1.9	0.12	<5
SW1	31/07/2010	7.4	211	124	2.5	0.33	<5
SW1	10/08/2010	7.9	98	128	2.4	0.24	<5
SW1	10/12/2010	7	136	-	2.5	0.08	-
SW1	Feb 2012*	8.2	991	47	11.0	0.11	<5
SW1	Mar 2012*	8.1	747	42	4.6	0.05	<5
SW2	23/09/2008	5.9	56	99	0.7	0.19	-
SW2	06/10/2008	7	72	32	0.6	0.13	-
SW2	13/12/2008	7.8	86	66	0.8	-	-
SW2	17/02/2009	7.1	33	110	0.5	0.11	<5
SW2	Feb 2012 ^	7.7	406	8	0.6	0.06	<5
SW2	Mar 2012 ^	7.5	479	8	0.6	0.04	<5

Note. ^ Results presented for these months are the average results based on samples taken daily during the month. Results are based on laboratory results not field results.

For samples collected between 2008 and 2010, only one sample was collected per sampling location. For February and March 2012, there are more detailed results available as sampling was undertaken three to four times per day and a laboratory result was also recorded daily. Table 2-5 summarises the one off samples and an average value for the months of February and March 2012 based on analysis of more frequent results. Full records of surface water monitoring undertaken at 'SW1' and 'SW2' are provided in Appendix A.

A summary of the results collected at 'SW2' which represents the ambient water quality of Nagero Creek (taking into account the daily data points recorded in February and March 2012) is provided below:

- pH ranged from 5.9 to 7.8
- electrical conductivity ranged from 33 to 542 µS/cm

- suspended solids concentrations ranged from <5 to 110 mg/L
- when oil and grease had been sampled, it was not detected (<5 mg/L).

Background suspended solids concentrations at 'SW2' exceeded the limits specified under EPL No. 12407 (100th percentile limit of 50 mg/L for TSS, refer to Table 2-4). The background pH was lower than the range specified under the EPL No. 12407 on one occasion (100th percentile range of 6.5 to 8.5, refer to Table 2-4).

A summary of the results collected at 'SW1' located downstream of Boggabri Coal Mine are provided below:

- pH ranged from 6.7 to 9.1
- electrical conductivity ranged from 59 to 1,120 µS/cm
- suspended solids concentrations ranged from 6 to 2,070 mg/L
- when oil and grease had been sampled, it was not detected (<5 mg/L).

2.4.3 Surface water quality within the water management system

A summary of surface water quality monitoring data collected by Boggabri Coal between July 2008 and January 2012 is provided in Table 2-6. This includes results of the frequency based monitoring and wet weather discharge monitoring. Full analytical reports for the monitoring sites listed in Table 2-6 are provided in Appendix A. The analytical reports also include additional monitoring data for metals, cations, hydrocarbons and volatile organic compounds at selected monitoring sites.

Table 2-6 Summary of surface water quality monitoring data

Monitoring Site	Sample date	Compound					
		pH	Electrical conductivity (µS/cm)	Suspended solids (mg/L)	Total Nitrogen as N (mg/L)	Total Phosphorus as P (mg/L)	Oil & grease (mg/L)
SD1	21/04/2010	8.2	391	120	1	0.1	<10
SD2	17/07/2008	8.1	310	44	33.3	13	-
SD2	23/09/2008	6.8	337	273	3.4	<0.01	-
SD2	06/10/2008	7.3	247	382	1.3	0.1	-
SD2	21/04/2010	7.7	276	296	2.1	0.24	6
SD2	28/10/2010	8.2	353	190	2.6	0.36	<5
SD2	21/07/2011	8.4	607	24	3.1	0.18	<5
SD2	19/01/2012	8.2	502	166	1.9	0.21	<5
SD3	17/07/2008	8.1	818	46	0.9	0.15	-
SD3	06/10/2008	7.2	295	656	6	1.72	-
SD3	21/04/2010	7.7	446	30	1.9	0.34	<10
SD3	10/08/2010	7.4	310	280	4.9	0.25	<5
SD3	28/09/2010	7.6	373	112	5.2	0.67	6
SD3	06/10/2010	7.4	413	390	1.4	0.4	<5
SD3	28/10/2010	7.9	400	102	2.6	0.22	<5

Monitoring Site	Sample date	Compound					
		pH	Electrical conductivity (µS/cm)	Suspended solids (mg/L)	Total Nitrogen as N (mg/L)	Total Phosphorus as P (mg/L)	Oil & grease (mg/L)
SD3	07/01/2012	7.6	299	85	-	-	-
SD3	08/01/2012	7.2	279	19	-	-	-
SD3	19/01/2012	8.2	542	50	1.4	<0.01	<5
SD3	21/02/2012	8.1^	990^	134^	-	-	-
SD3	05/03/2012	8.2^	841^	440^	-	-	-
SD3	06/03/2012	7.5^	545^	56^	-	-	-
SD3	10/03/2012	8.9^	1,189^	55^	-	-	-
SD3	12/03/2012	8.6^	881^	45^	-	-	-
SD4	02/08/2011	8.3	2,900	25	0.5	0.06	<5
SD4	23/01/2012	8.4	2,380	26	0.4	<0.01	<5
SD6	06/10/2008	7.1	355	60	1.5	0.23	-
SD6	16/10/2008	7.8	394	-	1	0.31	<5
SD6	17/07/2008	8.1	507	165	1.7	0.26	-
SD6	16/02/2010	7.7	222	307	2.4	0.4	<5
SD6	21/04/2010	7.9	277	13	0.8	0.15	<10
SD6	28/09/2010	8.3	263	20	1.1	0.17	5
SD6	28/10/2010	8.3	273	18	1.3	<0.01	<5
SD6	15/11/2010	8.3	282	24	1.7	0.07	<5
SD6	10/12/2010	7.7	236	-	1.4	<0.01	-
SD6	21/07/2011	8.2	401	8	1.4	0.01	<5
SD6	19/01/2012	8.3	266	49	1.0	0.06	<5
SD6	28/02/2012	7.8	228	42	1.4	0.29	<5
SD6	29/02/2012	7.8	232	108	0.8	0.07	<5
SD6	01/03/2012	7.8	234	77	0.8	0.07	<5
SD6	02/03/2012	7.7	255	154	2.6	0.38	<5
SD6	03/03/2012	7.6	230	193	0.7	0.08	<5
SD6	04/03/2012	7.4	235	110	0.7	0.10	<5
SD6	05/06/2012	7.5	228	118	0.7	0.05	<5
SD23	02/08/2011	7.5	184	44	3.0	0.38	<5
SD23	14/01/2012	7.7	222	24	-	-	-
SD23	19/01/2012	7.9	181	52	0.5	0.02	<5
SD23	28/02/2012	7.9	174	13	0.9	0.18	<5
SD23	29/02/2012	7.9	177	28	0.3	0.04	<5
SD23	01/03/2012	7.5	117	24	0.3	0.02	<5
SD23	02/03/2012	7.9	176	9	0.9	0.13	<5
SD23	03/03/2012	7.8	175	16	0.3	0.03	<5
SD23	04/03/2012	7.7	166	16	0.3	<0.01	<5
SD23	05/03/2012	7.7	165	27	0.5	0.07	<5
SD23	09/03/2012^	7.9	146	48	-	-	-
MW2	16/02/2010	8.9	1,330	22	7.9	<0.01	<5

Monitoring Site	Sample date	Compound					
		pH	Electrical conductivity (µS/cm)	Suspended solids (mg/L)	Total Nitrogen as N (mg/L)	Total Phosphorus as P (mg/L)	Oil & grease (mg/L)
MW2	17/07/2008	8.8	1,300	38	7.8	<0.01	-
MW2	16/10/2008	8.6	1,300	-	9.1	0.13	<5
MW2	21/04/2010	8.8	1,350	12	8.3	0.05	<10
MW2	15/11/2010	9.1	1,410	16	7.5	0.06	<5
MW2	02/08/2011	8.7	1,800	8	0.5	0.16	<5
MW2	23/01/2012	8.8	1,470	17	12.8	<0.01	<5
MW3	21/07/2011	8.7	749	11	0.7	0.02	<5
MW3	19/01/2012	8.2	532	38	2.5	0.10	<5
MW3*	March 2012	8.3	494	107	1.4	0.09	<5
Detection limit		*0.01*	*1*	*1*	*0.1*	*0.01*	*5*
Minimum		*6.8*	*117*	*8*	*0.7*	*<0.01*	*<5*
Maximum		*9.1*	*1,800*	*656*	*33.3*	*13*	*6*

Note. ^ Results presented for these months are the average results based on samples taken daily during the month. Results are based on laboratory results not field results.

Monitoring site ‘MW2’ is located at mine water dam MW2. This is the ‘turkey’s nest’ dam that stores contaminated mine water pumped from the mining void. Monitoring at this site has been undertaken on seven occasions and indicates that mine water has elevated salt levels (electrical conductivity of 1,300-1,800 µS/cm) and is alkaline (pH of 8.6 to 9.1). The additional monitoring data from site ’MW2’ that is provided in Appendix A indicates that mine water also has high levels of sodium (sodium concentration of 331 mg/L) and high levels of carbonates (bicarbonate alkalinity as $CaCO_3$ of 451 mg/L).

2.5 Downstream surface water users

2.5.1 Namoi Water Management Area

Boggabri Coal Mine is located within the Namoi Water Management Area, which includes two surface water sources. The Upper Namoi Regulated River Water Source includes the regulated river sections between Split Rock Dam and Keepit Dam. The Lower Namoi Regulated River Water Source includes the regulated river sections downstream of Keepit Dam to the Barwon River, including the regulated sections of the Gunidgera/Pian system. Boggabri Coal Mine drains to the Lower Namoi Regulated River Water Source.

The main landuse in the Namoi Water Management Area is agriculture, accounting for approximately 96% of water consumption from the Namoi River. Mining, manufacturing and households account for approximately 2% of consumption, and ‘other’ users account for the remaining 2% of consumption (Australian Government National Water Commission, 2005). The majority of agricultural water consumption is for irrigation of cotton.

Water sharing in the Namoi Water Management Area is regulated by the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2003, made under the Water Management Act 2000. The Water Sharing Plan sets out rules for how water is shared between the environment and water users and different categories of water access licences. Water is shared amongst different categories of water access licences by means of Available Water Determinations (AWD).

For the Lower Namoi, AWDs provide allocations of water equal to 100% of the share component of domestic and stock, and local water utility access licences and 1 ML per unit share for high security access licences, in all but the most exceptional drought years. However, the water made available to general security access licences is reviewed monthly and depends upon the amount of water held in Split Rock and Keepit Dams. The water made available to supplementary water access licences is set at the start of each water year.

A summary of the AWDs made at the start of the 2012 / 2013 water year under the Water Sharing Plan is provided in Table 2-7.

Table 2-7 Available Water Determinations 2012 / 2013 under the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources

Access licence category	No. of WAL's	Total share component	Cumulative AWD	Water made available (ML)
Lower Namoi Regulated River Water Sources				
Domestic and Stock	101	1,745 ML	100% of share component	1,745
Domestic and Stock (Domestic)	4	17 ML	100% of share component	17
Domestic and Stock (Stock)	22	257 ML	100% of share component	257
Local Water Utility	1	2,271 ML	100% of share component	2,271
Regulated River (General Security)	239	246,392 unit shares	0.0391 ML per share	9,634
Regulated River (High Security)	11	3,418 unit shares	1 ML per share	3,418
Regulated River (High Security) (Research)	1	486 ML	100% of share component	486
Supplementary Water	211	115,469 unit shares	1 ML per share	115,469
Upper Namoi Regulated River Water Sources				
Domestic and Stock	14	76 ML	100% of share component	76
Domestic and Stock (Domestic)	5	11 ML	100% of share component	11
Domestic and Stock (Stock)	1	5 ML	100% of share component	5
Local Water Utility	2	515 ML	100% of share component	515
Regulated River (General Security)	82	9,724 unit shares	1 ML per share	9,724
Regulated River (High Security)	5	80 unit shares	1 ML per share	80

Source: NSW Department of Water and Energy, Water Access License Statistics (www.wma.dwe.nsw.gov.au)

Long term extraction factors for the Namoi Regulated River are given in the document Water Availability in New South Wales Murray-Darling Basin Regulated Rivers (NSW Department of Water and Energy, 2009). The estimated long term extraction factors under the 'ultimate development scenario' for high security, general security and supplementary license categories are 0.95, 0.76 and 0.18, respectively.

However, AWDs for general security licenses in the Lower Namoi Regulated River have been much lower in recent years than the long term extraction factor. A summary of AWD announcements for the four year period from 2004 to 2008 is provided in the Water Sharing Plan in the Upper and Lower Namoi Regulated Rivers: Progress Report 2004 to 2008 (NSW Department of Water and Energy, 2009). Due to extended low flows, AWD announcements for general security licences in the Lower Namoi Regulated River were set at zero for a period of 17 months between February 2006 and July 2007. When water was made available for general security licences, AWD announcements for this category of licence in the Lower Namoi Regulated River ranged from zero to a maximum of 0.117 ML per share in September 2005.

Boggabri Coal and Whitehaven/TCPL currently hold general security and supplementary water access licenses for the Lower Namoi Regulated River Water Source. Boggabri Coal and Whitehaven/TCPL also currently hold water access licenses for the Lower Namoi Groundwater Source and the Upper Namoi Zone 4 Groundwater Source. Details of water access licenses held by Boggabri Coal Mine and Whitehaven/TCPL are provided in Sections 5.3.3 and 5.3.4.

Boggabri Coal currently utilises groundwater allocations to supplement an onsite water deficit, and to supply high quality water for potable applications and vehicle washdown. Groundwater is currently pumped to the mine site from Lovton Bore, and pumped to the rail loading facility to the west of the site from Daisymede Bore. The approved pump station on the Namoi River and associated pipeline to the mine have not yet been constructed, but once installed would enable Boggabri Coal to access surface water from the Namoi River in accordance with its (and Whitehaven/TCPLs) surface water licences.

The Namoi River pump station and associated pipeline would be designed and constructed with sufficient additional capacity to allow water from the Namoi River to be pumped to the Tarrawonga Coal Mine site if required (via an offtake pipeline at the Boggabri Coal Mine site). This would avoid the need for a separate pipeline from the Tarrawonga Coal Mine to the Namoi River. The consideration of water volumes, licensing and water balance implications for water pumped from the Namoi River and Boggabri Coal Mine to the Tarrawonga Coal Mine site is not assessed in this document as it is not relevant to the proposed Modification of the Boggabri Coal Mine.

2.5.2 Nagero Creek

Water from the Nagero Creek catchment is currently used by properties located along Therribri Road, Manilla Road and Leard Forest Road. This water is mainly used to fill small farm dams and for stock watering.

2.6 Soil characteristics

Soil characteristics have been assessed in the Soil Survey and Land Resource Impact Assessment (GSS, 2009), which formed part of the Boggabri EA. The soil assessment identified the following soil units within the Project Boundary:

- **Grey Brown Gradational Loam**. These moderately drained soils range from slightly acidic to neutral in the upper layers to strongly acidic to moderately alkaline at depth. The soils are generally non saline with poor to moderate fertility characteristics. The topsoil is non-sodic tending to moderately sodic in the subsoil. These soils are found on the waning mid to lower slopes within the Leard State Forest.

- **Light Brown Uniform Gravelly Sand**. These well drained soils range from moderately acidic to strongly acidic at depth. The soils are generally non saline with poor fertility characteristics. The topsoil and subsoil are non-sodic. These soils are found on the upper slopes, crests and ridgelines within the Leard State Forest.

- **Light Brown Duplex Loam**. These moderately drained soils range from moderately acidic in the upper layers to strongly alkaline at depth. The soils are generally non saline with poor fertility characteristics. The topsoil is non-sodic whilst the subsoil is sodic to very sodic. These soils are found on the waning lower slopes within the Leard State Forest and nearby grazing land.

- **Brown Gradational Clay**. These poorly drained soils range from neutral to strong alkaline in the upper layers to moderate to strong alkaline at depth. The soils are generally non saline with good fertility characteristics. The topsoil is non-sodic tending to highly sodic in the subsoil. These soils are found on the lower slope, flats and flood plain of the higher quality grazing and cropping soil.

The Grey Brown Gradational Loams, Light Brown Duplex Loams and Brown Gradational Clay showed a similar pattern, with the upper layers being non dispersive and non sodic, and the subsoils tending to be highly dispersive and highly sodic with depth. The Light Brown Uniform Gravelly Sands were found to be non dispersive and non saline throughout the soil profile (GSS, 2009).

The potential for acid generation from regolith material (i.e. topsoil and subsoil) was found to be low. This does not include acid potential within the overburden material, or the current level of acidity within the soil (GSS, 2009).

Acid Sulphate Soils, which are the main cause of acid generation within the soil mantle, are commonly found less than 5 m above sea level, particularly in low-lying coastal areas. There has been little history of acid generation from regolith material in the Boggabri area, which is located approximately 250 km from the coast (GSS, 2009).

2.7 Overburden and potential coal reject characteristics

The geochemical characteristics of overburden and potential reject materials from the coal washery have been assessed in The Boggabri Continuation of Mining Project Geochemical Assessment of Overburden and Potential Reject Materials (RGS, 2009), which formed part of the Boggabri EA. The geochemical assessment concluded that:

Overburden

- Most overburden is likely to have negligible total sulphur content and is therefore classified as Non Acid Forming (NAF) barren. Overburden also appears to have excess acid buffering capacity typical of a moderate Acid Neutralising Capacity (ANC) value, which should more than compensate for any acid that could potentially be generated from the small amount of overburden materials with uncertain acid generating classification.

- Most overburden materials generated at the Project are likely to be NAF and have a high factor of safety with respect to potential acid generation. The overburden can therefore be regarded as a NAF unit.
- The concentration of total metals in overburden solids is well below applied guideline criteria for soils and is unlikely to present any environmental issues associated with revegetation and rehabilitation.
- Most overburden materials will generate slightly alkaline and relatively low salinity runoff and seepage following surface exposure. The major ion chemistry of initial surface runoff and seepage from overburden materials is likely to be dominated by sodium, bicarbonate, chloride and sulphate.
- The concentration of dissolved metals in initial runoff and seepage from overburden materials is unlikely to present any significant environmental issues associated with surface and ground water quality as a result of the Project.
- Most overburden materials are sodic and likely to have structural stability problems related to potential dispersion. Some near surface and conglomerate overburden materials are likely to be less sodic and may be the most suitable materials for revegetation and rehabilitation activities (as a growth medium). For all other sodic overburden materials, it is likely that treatment would be required if these were to be considered for use as vegetation growth medium.

Potential coal rejects

- Most potential coal reject materials are likely to have negligible total sulphur content and are therefore classified as NAF barren. These materials have a high factor of safety with respect to potential acid generation.
- A small proportion of the potential coal reject materials located near the Braymont Seam have a relatively high total sulphur content and negligible buffering capacity and are classified as Potentially Acid Forming - High Capacity (PAF-HC).
- The concentration of total metals in potential coal reject solids is well below applied guideline criteria for soils and is unlikely to present any environmental issues associated with revegetation and rehabilitation.
- Most potential coal reject materials will generate slightly alkaline and relatively low salinity runoff and seepage following surface exposure. The exception is potential coal reject material from the Braymont seam (and potentially the Jeralong seam) where PAF materials may generate acidic and more saline runoff and seepage.
- The major ion chemistry of initial surface runoff and seepage from potential coal reject materials is likely to be dominated by sodium, bicarbonate, chloride and sulphate, although for PAF materials, calcium and sulphate may become more dominant. For PAF materials, the initial concentration of soluble sulphate in runoff and seepage is expected to remain within the applied water quality guideline criterion (1,000mg/L), although further exposure to oxidising conditions could lead to increased soluble sulphate concentrations.
- The concentration of dissolved metals in initial runoff and seepage from potential coal reject materials is unlikely to present any significant environmental issues associated with surface and ground water quality as a result of the Project.

- Most potential coal reject materials are sodic and likely to have structural stability problems related to potential dispersion. These materials are unlikely to be suitable for use as a vegetation growth medium.

Reject materials generated through the processing of Tarrawonga coal at the Boggabri CHPP would be disposed at Boggabri Coal Mine using the management methods described in the Boggabri EA.

The coal rejects that would be generated through the processing of the Tarrawonga coal are expected to have very similar geochemical characteristics to the Boggabri rejects, as the two mining operations predominantly mine the same coal seams.

3. Existing surface water management system

This section provides an overview of the existing water management system at Boggabri Coal Mine, as at November 2011.

3.1 Existing clean water system

Clean water diversion drains are currently located around the upslope perimeters of the mine working area to divert runoff from undisturbed catchments to the east and north of the pit.

3.2 Existing dirty water system

Dirty water runoff from disturbed areas of the mine site is currently captured in sediment dams. These sediment dams are generally ‘wet basins’, comprising a ‘settling zone’ for temporary treatment storage and a ‘sediment zone’ for storage of sediment.

Details of existing dirty water sediment dams are provided in Table 3-1.

Table 3-1 Summary of Year 0 dirty water storages

Storage	Location / description	Stored water	Design storm criteria	Runoff coefficient	Catchment area (ha)	Existing capacity (ML)
SD1	Sediment dam located in MIA	Dirty runoff from MIA	90^{th} %ile 5 day	0.75	9.3	1.0
SD3	Sediment dam located south-west of spoil dump	Dirty runoff from spoil dump	90^{th} %ile 5 day	0.4 to 0.75	103.7	35.0
SD5	Sediment dam located in MIA	Dirty runoff from MIA	90^{th} %ile 5 day	0.75	2.8	1.4
SD6	Sediment dam located downstream of MIA (referred to as Nagero Dam)	Runoff from grassed areas near MIA, and overflows from SD1 and SD5	90^{th} %ile 5 day	0.4 to 0.75	20.1	55.0
SD23	Sediment dam located near topsoil stockpile	Dirty runoff from topsoil stockpile	90^{th} %ile 5 day	0.75	29.4	12.7

EPL No. 12407 requires that water quality monitoring of dirty water sediment dams be undertaken as soon as practicable after a discharge.

Discharge from Tarrawonga Coal Mine

Tarrawonga Coal Mine has its northern waste rock emplacement area and coal processing area situated east of Boggabri Coal Mine’s MIA. Dirty runoff from these areas is currently captured in a series of dams at Tarrawonga Coal Mine. However, during prolonged wet periods, overflows from these dams currently discharge to the west to SD1 and SD6 at Boggabri Coal Mine.

3.3 Existing contaminated water system

Contaminated water is water originating from direct surface runoff on coal stockpiles and the mining void, as well as groundwater inflows to the mining void.

Contaminated mine water is currently reused onsite for dust suppression. Surplus contaminated water is currently stored in onsite contaminated water storages or in-pit. Details of existing contaminated water storages are provided in Table 3-2.

Table 3-2 Summary of Year 0 contaminated water storages

Storage	Location / description	Stored water	Design storm criteria	Runoff coefficient	Catchment area (ha)	Existing capacity (ML)
SD2	Contaminated water dam located in MIA	Contaminated runoff from ROM stockpile	100 yr ARI 72 hr	0.75	14.5	14.1
SD4	Contaminated water dam located at rail loading facility west of mine site	Contaminated runoff from existing rail loading facility	100 yr ARI 72 hr	0.75	2.3	8.1
MW2	Mine water dam located north-west of mining void (turkey's nest dam)	Contaminated mine water pumped from pit	-	-	-	175
MW3	Mine water dam located south of MIA	Surplus contaminated water pumped from SD2 and MW2, and clean runoff from small grassed catchment	-	-	-	161 (max operating level 105 ML)

Mining voids

Runoff from rain falling on mine working areas and groundwater inflows are collected within the mining void. Stored water within the void is currently pumped to MW2, and then onto MW3.

Irrigation area

The approved irrigation system at Boggabri Coal Mine is not currently operational.

4. Surface water management system

This section describes the water management system concept for the Boggabri Coal Mine, and where relevant describes how the proposed Modification would affect the approved system. Representative 'snapshots' are used to illustrate the progressive expansion of the mine over time. The snapshots correspond to Years 1, 5, 10 and 21 in the mine life, however, it should be noted that the Tarrawonga Coal Project has a 17 year mine life and as a result the Year 21 snapshot is for Boggabri only.

A water balance analysis and local catchment hydrological analysis for the water management system for the Year 1, 5, 10 and 21 'snapshot' landforms is also provided.

This section builds upon the approved surface water management system for the Boggabri Coal Project described in the Boggabri EA, and also draws on published information on the surface water management system for the Tarrawonga Coal Project.

For the Boggabri Year 1 landform, information on the Tarrawonga surface water management system has been obtained from the Tarrawonga Coal Mine Modification Surface Water Assessment (Gilbert and Associates, March 2010). For the Boggabri Year 5 to 21 landforms, information on the Tarrawonga surface water management system has been obtained from the Tarrawonga Coal Project Surface Water Assessment (Gilbert and Associates, October 2011), which was conducted as part of the Tarrawonga EA.

4.1 Changes to Boggabri Coal Project surface water management system

The Boggabri Coal Project Surface Water Assessment (PB, 2010) describes and assesses the key elements of the surface water management system for the Boggabri Coal Project. This surface water management system was approved in July 2012 as per Project Approval 09_0182, subject to the implementation of the relevant conditions (e.g. preparation of a Water Management Plan).

Some alterations to the approved surface water management system are required to account for the changes in surface water catchment areas associated with the integrated waste rock emplacement and to accommodate the changes to the MIA required to receive the Tarrawonga coal. Further details are provided below.

Integrated waste rock emplacement

The Boggabri EA shows the approved waste rock emplacement for the Boggabri Coal Mine (Figure 1-2). Surface runoff from the southern batter of the emplacement is shown and described as being captured by diversion drains, with the runoff being incorporated into the Boggabri Coal Project surface water management system. 'Clean' runoff from undisturbed areas between the southern extent of the waste rock emplacement and the southern boundary CL 368 were to be intercepted by a 'clean water' diversion drain and directed around the mine disturbance areas and then off-site.

As described in the Tarrawonga EA, the existing Tarrawonga Coal Mine Northern Emplacement would be extended to the north and east, forming an integrated landform with the southern part of the Boggabri Coal Mine waste rock emplacement (Figure 1-3).

The extension of the Tarrawonga Northern Emplacement would occur within MLA 3 (Figure 1-3) and would form part of the Tarrawonga Coal Mine (i.e. reducing the size of the Boggabri Coal Mine). Surface water management within MLA 3 and ML 1579 would be the responsibility of TCPL, as described and assessed in the Tarrawonga Coal Project EA. Runoff from the southern batter of the Boggabri emplacement that drains south to MLA 3 would be incorporated into the Tarrawonga water management system.

The surface water management system for the Tarrawonga Coal Project would include up-catchment dams and diversion drains which would intercept runoff from undisturbed areas up-slope of MLA 3 (i.e. to the east of MLA 3, within CL 368) (Figure 1-3) and direct these waters around the mine disturbance areas. The details of these water management features would be described in the Tarrawonga Coal Project Water Management Plan, which is expected to be revised by TCPL within 6 months of receipt of approval for the Tarrawonga Coal Project.

Mine Infrastructure Area

The Boggabri MIA would be expanded as part of the Modification in order to provide the additional coal stockpiling areas and haul roads necessary to receive and process the Tarrawonga coal. These changes would extend the stockpile areas and associated haul roads to the east and would require an adjustment to the boundary between CL 368 and ML 1579, as well as requiring the relocation of the existing Tarrawonga water storages (i.e. SD17, SB6 and SB7).

4.2 Objectives

The design criteria and underlying principles of the surface water management system would not change as a result of the proposed Modification. A summary of these principles and key objectives is provided below, with further detail contained in the Boggabri EA.

The Boggabri Coal Mine water management system has been designed to segregate clean runoff, dirty runoff and contaminated water generated from rainfall events and mining operations. The following definitions have been adopted for the various runoff types:

- **Clean water** is defined as runoff from undisturbed catchments located upslope of the mine site.
- **Dirty water** is defined as runoff from disturbed areas within the mine site and includes runoff from waste rock emplacements, topsoil stockpiles, haul roads and the MIA. This water contains high levels of suspended solids.
- **Contaminated water** is defined as runoff generated from coal stockpiles and the mining void, as well as groundwater inflows to the mining void. This water contains high levels of suspended solids and is mildly saline.

Clean water runoff from undisturbed catchments will be diverted around the mine working area and into Nagero Creek as much as practical. Where it is not practical to provide diversion drains, highwall dams will capture clean runoff to minimise inflows to the mining void. Water captured in highwall dams will be pumped out to Nagero Creek, however, they will overtop to the mining void during large storm events.

Dirty water runoff will be captured in sediment dams to encourage the settling of suspended solids. Runoff from large storm events will overtop sediment dams and discharge to Nagero Creek. Captured water will either be released to the creek or pumped to mine water dams for storage and reuse. This will depend on water quality and the site water balance. It is expected that captured water will be suitable for release following settling of suspended solids, however, as there is still the potential for waste rock emplacement runoff to have elevated acidity, salinity, dissolved metals and oils and greases, sediment dams will be provided with manually operated valves on the outlet pipes so that discharge to the creek can be prevented if water quality is not suitable (e.g. to allow for flocculation).

Overflows from the Tarrawonga sediment dams on the western side of the Tarrawonga Northern Emplacement that flow towards the west will be diverted along the eastern edge of the Boggabri MIA to the south and into a new 50 ML capacity sediment dam, from where they will be discharged directly to Nagero Creek via TCPL's licensed discharge point. A minor lease adjustment will be required by TCPL in this area to incorporate the new sediment dam into the TCPL mining tenement.

As described in the Boggabri EA Surface Water Assessment (PB, 2010), contaminated water will be captured in mine water dams for storage and reuse and will not be released to Nagero Creek. The water management system will aim to reuse as much contaminated water as possible on site, and contaminated water will be used as a priority for dust suppression and CHPP make-up water (excluding the minimum CHPP raw water component). In the first few years of mining (before the CHPP becomes operational), it is expected that significant volumes of surplus contaminated water would be stored in-pit once the mine water dams are at capacity as an annual water surplus is predicted under average climatic conditions.

The approved irrigation system, which was proposed in the Boggabri EA to dispose of surplus water, is not currently operational. As discussed above, when the capacity of mine water dams is reached, surplus contaminated mine water will be stored in-pit in a temporary storage. The temporary storage will be a segregated void area within the advancing mining pit area and will have a capacity of approximately 1,012 ML. The temporary storage will be required until the irrigation system is implemented, or until the CHPP becomes operational and the site moves to an annual water deficit under average climatic conditions. After the CHPP becomes operational, water would still be stored in-pit during extreme wet weather events when the capacity of the mine water dams is reached, however, the existing mine water dams will be upsized to minimise the frequency and magnitude of in-pit flooding.

4.3 Design criteria

4.3.1 Dirty water sediment dams

Dirty water sediment dams at the Boggabri Coal Mine will be sized based on the criteria recommended in the guidelines *Managing Urban Stormwater - Soils and Construction - Volume 2E Mines and Quarries* (DECCW, 2008).

The Managing Urban Stormwater guidelines recommend that Type F/D sediment basins be provided for catchments with fine or dispersible soils. These are 'wet basins', comprising a 'settling zone' for temporary treatment storage and a 'sediment zone' for storage of sediment.

The Managing Urban Stormwater guidelines recommend that the 'settling zone' be sized to capture the 90th percentile 5 day duration storm event, and the 'sediment zone' be sized at 50% of the 'settling zone' volume. This sizing is based on a site disturbance duration of more than 3 years and a standard receiving environment, and results in an average sediment dam overflow frequency of 2 to 4 overflows per year. For sizing purposes, a runoff coefficient of

0.75 has been adopted for disturbed areas such as overburden emplacement areas and topsoil stockpiles. A runoff coefficient of 0.4 has been adopted for undisturbed areas.

The sediment dam in the upgraded MIA (SD8) has also been sized based on the criteria recommended in the Managing Urban Stormwater guidelines. It has been assumed that the MIA sediment dam would not capture contaminated runoff, and that any contaminated runoff from the MIA would instead drain to the CHPP contaminated water sediment dams. It is assumed that any contaminated water from the vehicle washdown bay in the MIA would be recirculated within the washdown bay system, or pumped to the CHPP contaminated water sediment dams rather than being discharged to the MIA sediment dam. A runoff coefficient of 0.85 has been adopted for disturbed areas in the upgraded MIA, which are expected to comprise mainly hardstand surfaces. A runoff coefficient of 0.75 was adopted for the existing MIA which comprises a mix of hardstand surfaces and grassed surfaces.

Key design features of dirty water sediment dams are as follows:

- configured as Type F/D basins, as described in the guidelines *Managing Urban Stormwater - Soils and Construction - Volume 1* (Landcom, 2004)
- ‘settling zone’ for temporary treatment storage
- ‘sediment zone’ for sediment storage
- slotted riser and discharge pipe with valve arrangement to allow manual operation of pipe (alternatively a mobile pump pumped out system only)
- slotted riser and discharge pipe sized to drawdown ‘settling zone’ over 3 days.

Dirty water sediment dams are to be maintained in a drawn down state as much as practical, thus ensuring that sufficient capacity is available in the ‘settling zone’ to capture water from subsequent storm events. Water will only be temporarily stored in the ‘settling zone’ of dirty water sediment dams. If water stored in the sediment dam is not suitable for discharge, or is to be reused onsite to supplement a deficit during dry periods, the sediment dam water will be pumped to the much larger mine water dams for long term storage for onsite reuse. The exception is SD3, that will be upsized to provide an additional ‘reuse zone’ for long term storage for onsite reuse. For SD3, water can be stored in the ‘reuse zone’ on a long term basis, but the ‘settling zone’ would need to be maintained in a drawn down state.

The capacity of SD8 located in the MIA has changed since finalisation of the Boggabri EA, in order to accommodate the changes associated with the additional coal stockpiling areas and haul roads. The capacity of SD7 that captures runoff from the overburden emplacement area has changed slightly compared to the Boggabri EA as a result of the changed landform. The required minimum capacity of SD3 that captures runoff from the overburden emplacement area has reduced significantly compared to the Boggabri EA as a result of the changed landform, however, the ultimate capacity of this dam remains at 100 ML in order to store sediment dam water onsite for reuse. The other dirty water sediment dam capacities remain unchanged compared to the Boggabri EA.

4.3.2 Contaminated water dams

Contaminated water sediment dams

Contaminated water sediment dams capture runoff from the coal stockpile pads in the existing coal crushing and handling area and the proposed CHPP. Water stored in contaminated water dams will be reused onsite, or pumped to mine water dams for storage.

Contaminated water dams have been designed to store runoff from a 100 year ARI 72 hour duration storm event, with a 20% allowance for sediment storage. A runoff coefficient of 0.85 has been adopted for disturbed areas in the proposed CHPP, which are expected to comprise mainly hardstand surfaces. A runoff coefficient of 0.75 was adopted for the existing coal crushing and handling area which comprises a mix of hardstand surfaces and grassed surfaces.

Key design features of contaminated water sediment dams are as follows:

- ‘sediment zone’ for storage of sediment
- ‘storm zone’ for storage of the design storm
- pump and pipeline system to draw down the ‘storm zone’ and transfer water to mine water dams.

Contaminated water sediment dams are to be pumped out to the mine water dams. Contaminated water sediment dams are to be maintained in a drawn down state as much as practical, thus ensuring that sufficient capacity is available to capture water from subsequent storm events and minimising the risk of a wet weather overflow. The exception is SD10 that has been provided with an additional ‘reuse zone’ for storage of 10 days of CHPP demand. For SD10, water can be stored in the ‘reuse zone’ on a long term basis, but the ‘storm zone’ would need to be maintained in a drawn down state.

The capacities of SD10 and SD12 located in the CHPP have changed since finalisation of the Boggabri EA in order to accommodate the additional coal stockpiling areas and haul roads. The other contaminated water sediment dams remain unchanged from the Boggabri EA.

Mine water dams

Mine water dams hold water of similar quality to the contaminated water sediment dams, however, generally only receive runoff from a small surface water catchment (i.e. they are primarily a permanent storage facility and are likely to have a ‘turkey’s nest’ configuration). The mine water dams are intended to receive and store contaminated water pumped from the sediment dams, contaminated storage dams or in-pit area. They may also hold clean water ‘top-up’ sourced from imported water during dry periods when the site is in a water deficit.

Mine water dam sizings are based on the water balance modelling, with the dams being sized to achieve retention of contaminated water generated within the site and a level of pit dewatering that is considered reasonable to Boggabri Coal under historical climate conditions.

Mine water dams will be operated so that they do overflow under normal operating conditions. However, a spillway will be provided in the event of an emergency overflow.

The capacities of mine water dams MW3 and MW5 remain unchanged from the Boggabri EA. The Boggabri EA proposed to upsize existing mine water dam MW3 to 600 ML in Year 1. However, it is now proposed to upsize MW3 to 600 ML at the beginning of Year 3, and to provide a temporary 1,012 ML in-pit mine water storage in the interim period until MW3 is upsized.

4.3.3 Clean water dams

Highwall dams

Clean water highwall dams capture runoff from undisturbed catchments ahead of the pit in order to reduce inflows to the pit. Highwall dams are pumped out to the creek system.

Clean water highwall dams are sized to capture runoff from the 100 year ARI 72 hour storm event for the remanent catchment, assuming a runoff coefficient of 0.4 for undisturbed areas. Extreme events in excess of this capacity will spill into the pit. Pump out systems for highwall dams are sized to empty the dam within 10 days.

The clean water highwall dams remain unchanged from the Boggabri EA.

4.4 Staging of the water management system

The components of the water management system would evolve as the project expands, to be compatible with the mine landform and schedule. The development of the mine water management system over the mine's 21-year life is illustrated through snapshots at four stages of the mine landform: Year 1, 5, 10 and 21.

Water management system concepts are provided in Figure 4-1, Figure 4-2, Figure 4-3 and Figure 4-4 for the Year 1, 5, 10 and 21 snapshot landforms, respectively. The concept plans show how the footprints of different land uses are proposed to change over the life of the project. The concept plans also show the flow paths of clean, dirty and contaminated water and the locations of sediment dams, contaminated water storages and highwall dams.

Flow diagrams are provided in Figure 4-5, Figure 4-6, Figure 4-7 and Figure 4-8 for the Year 1, 5, 10 and 21 snapshot landforms, respectively. The flow diagrams show the general connectivity between water sources, demands and storages.

4.4.1 Catchment areas

A summary of catchment areas is provided in Table 4-1. Catchment boundaries are shown on the concept plans provided in Figure 4-1, Figure 4-2, Figure 4-3 and Figure 4-4 for the Year 1, 5, 10 and 21 landforms respectively.

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BOGGABRI MODIFICATION ENVIRONMENTAL ASSESSMENT
BOGGABRI COAL PTY LTD

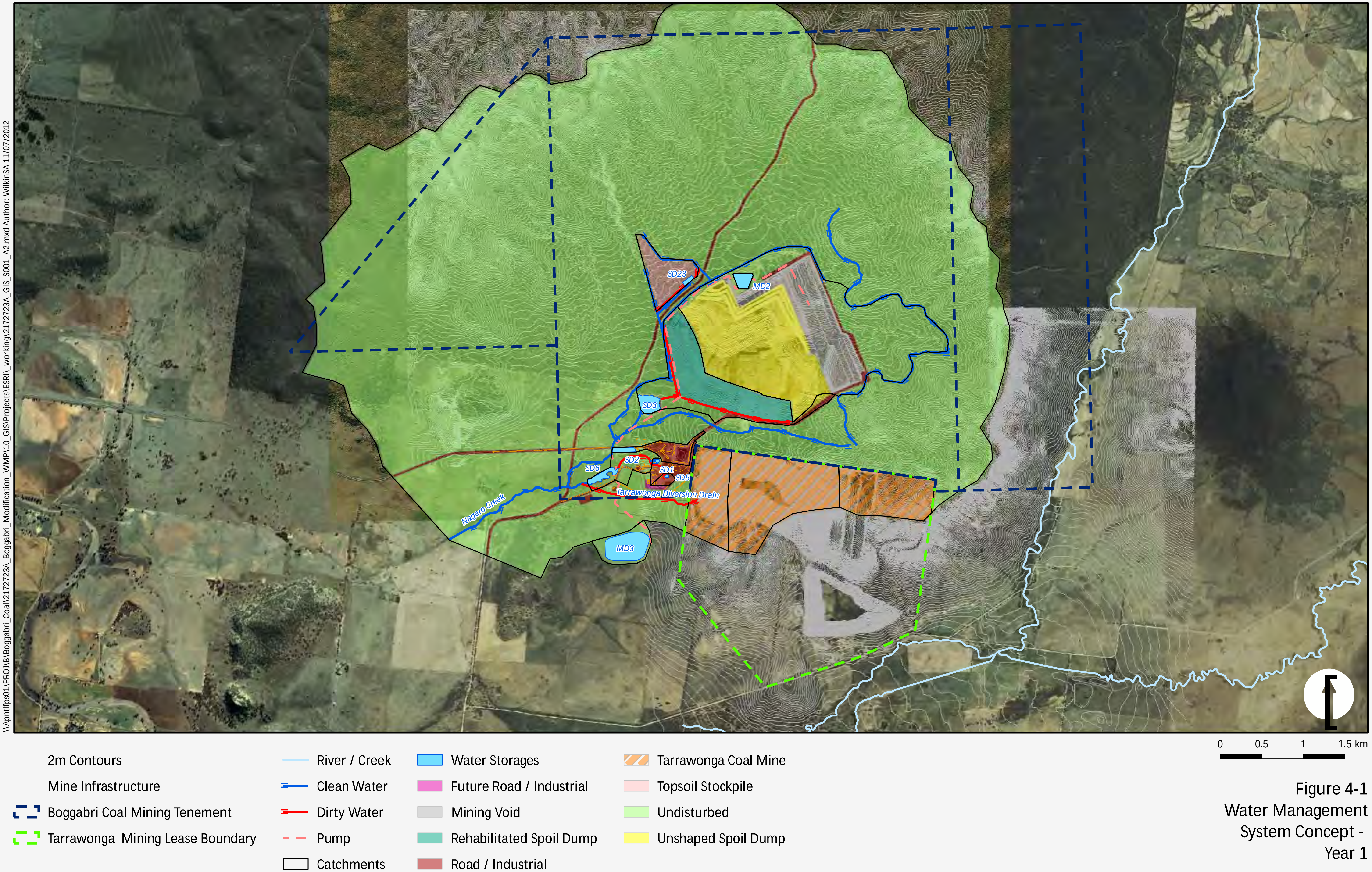

Figure 4-1
Water Management System Concept - Year 1

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BOGGABRI MODIFICATION ENVIRONMENTAL ASSESSMENT
BOGGABRI COAL PTY LTD

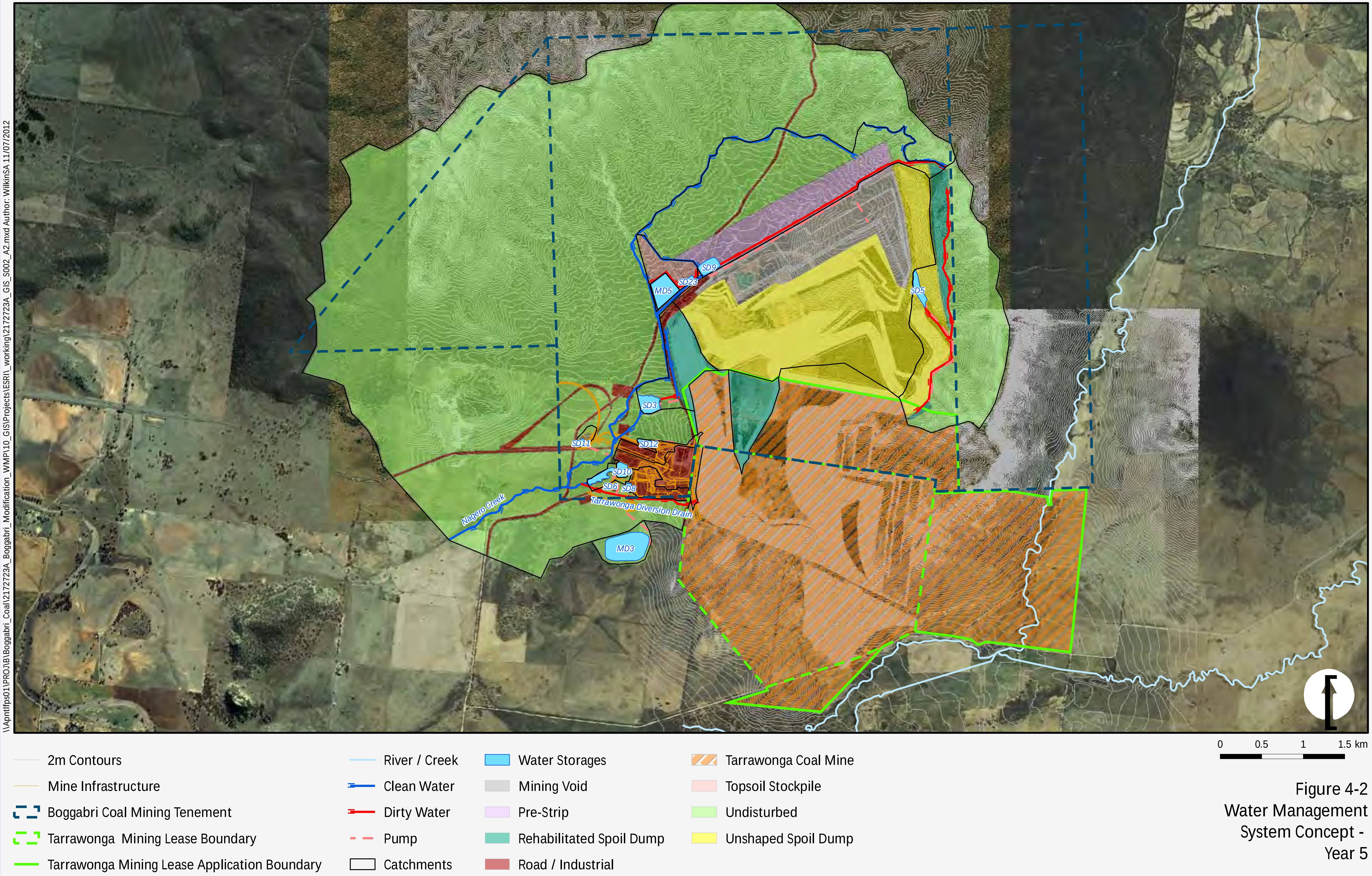


Figure 4-2
Water Management System Concept - Year 5

PARSONS BRINCKERHOFF

BOGGABRI MODIFICATION ENVIRONMENTAL ASSESSMENT
BOGGABRI COAL PTY LTD

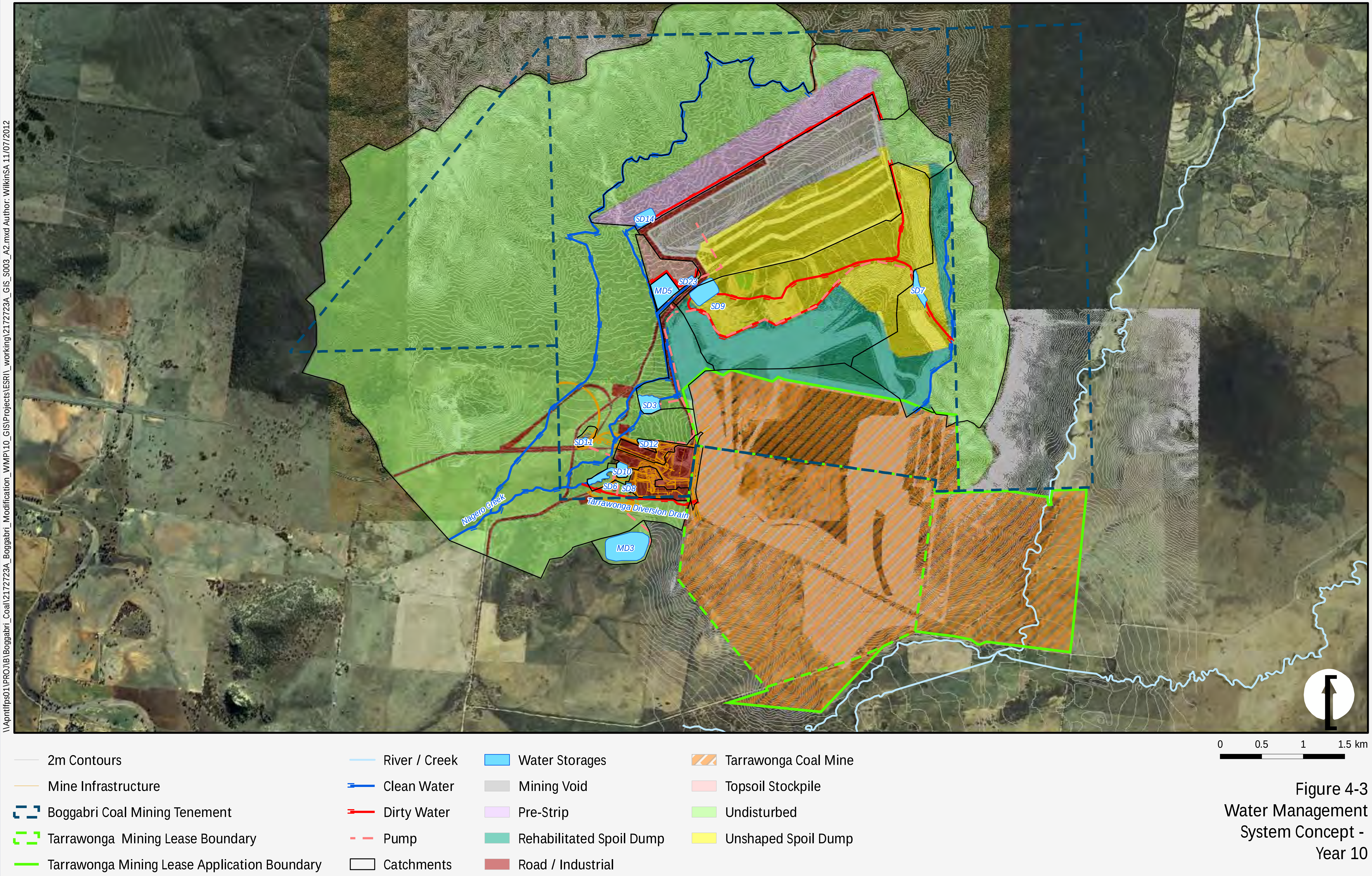
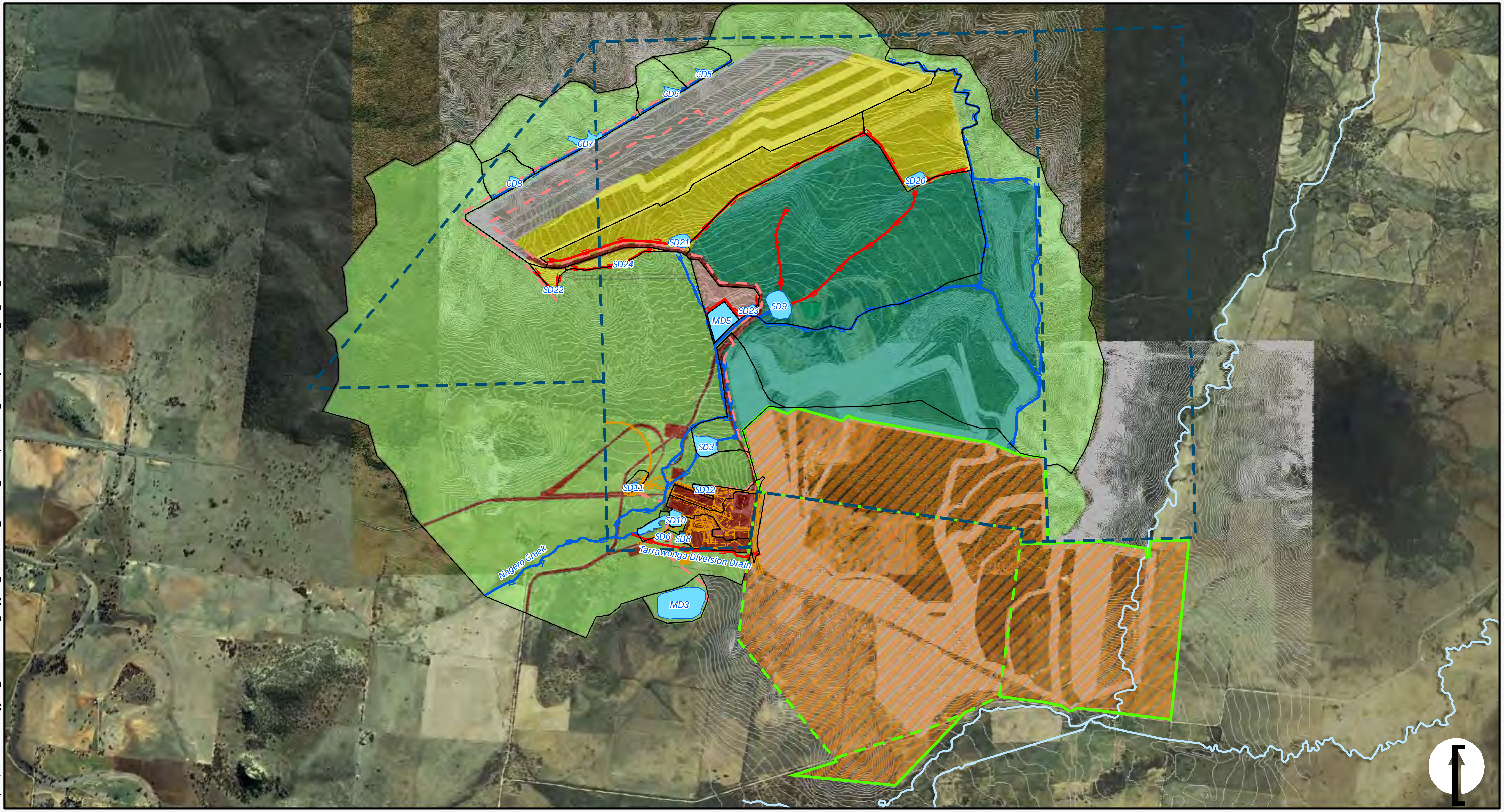


Figure 4-3
Water Management System Concept - Year 10

PARSONS BRINCKERHOFF

BOGGABRI MODIFICATION ENVIRONMENTAL ASSESSMENT
BOGGABRI COAL PTY LTD

\\Apntlfps01\PROJ\B\Boggabri_Coal\2172723A_Boggabri_Modification_WMP\10_GIS\Projects\ESRI_working\2172723A_GIS_S004_A2.mxd Author: WilkinSA 11/07/2012



2m Contours
Mine Infrastructure
Boggabri Coal Mining Tenement
Tarrawonga Mining Lease Boundary
Tarrawonga Mining Lease Application Boundary
River / Creek
Clean Water
Dirty Water
Pump
Catchments
Water Storages
Mining Void
Rehabilitated Spoil Dump
Road / Industrial
Tarrawonga Coal Mine
Topsoil Stockpile
Undisturbed
Unshaped Spoil Dump

0 0.5 1 1.5 km

Figure 4-4
Water Management System Concept - Year 21

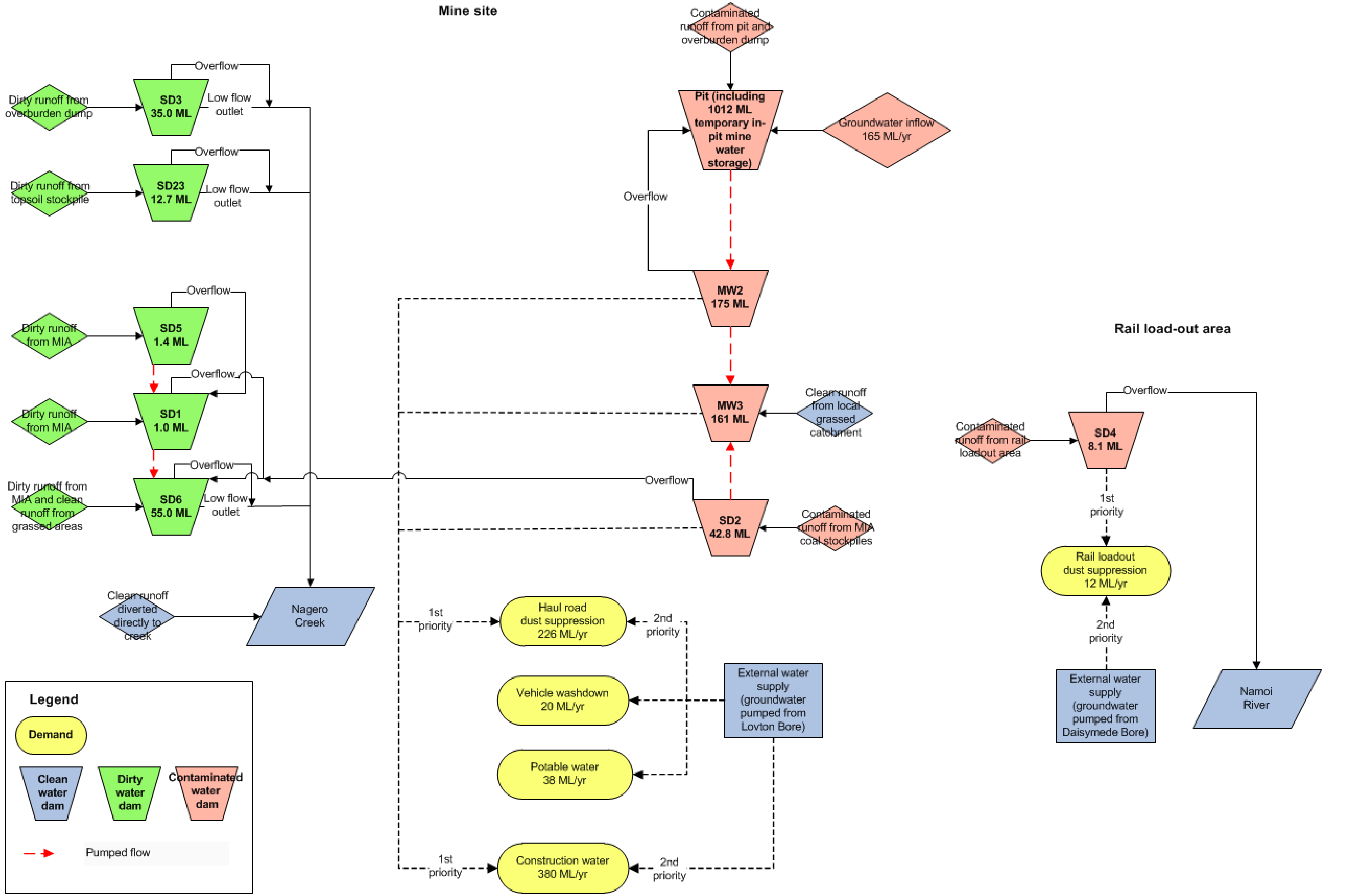


FIGURE 4-5
WATER BALANCE MODEL SCHEMATIC – YEAR 1

PARSONS BRINCKERHOFF

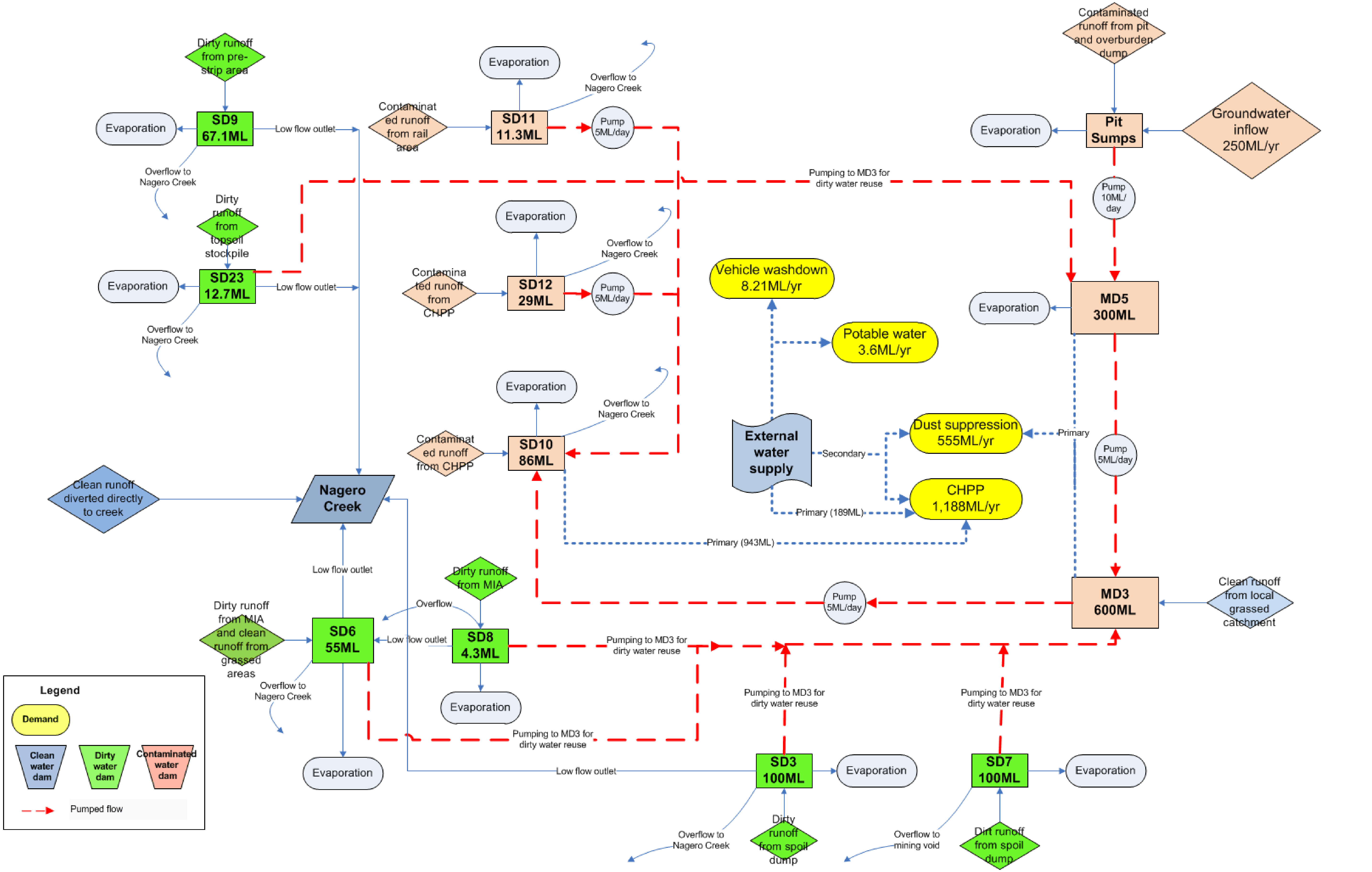


FIGURE 4-6
WATER BALANCE MODEL SCHEMATIC – YEAR 5

PARSONS BRINCKERHOFF

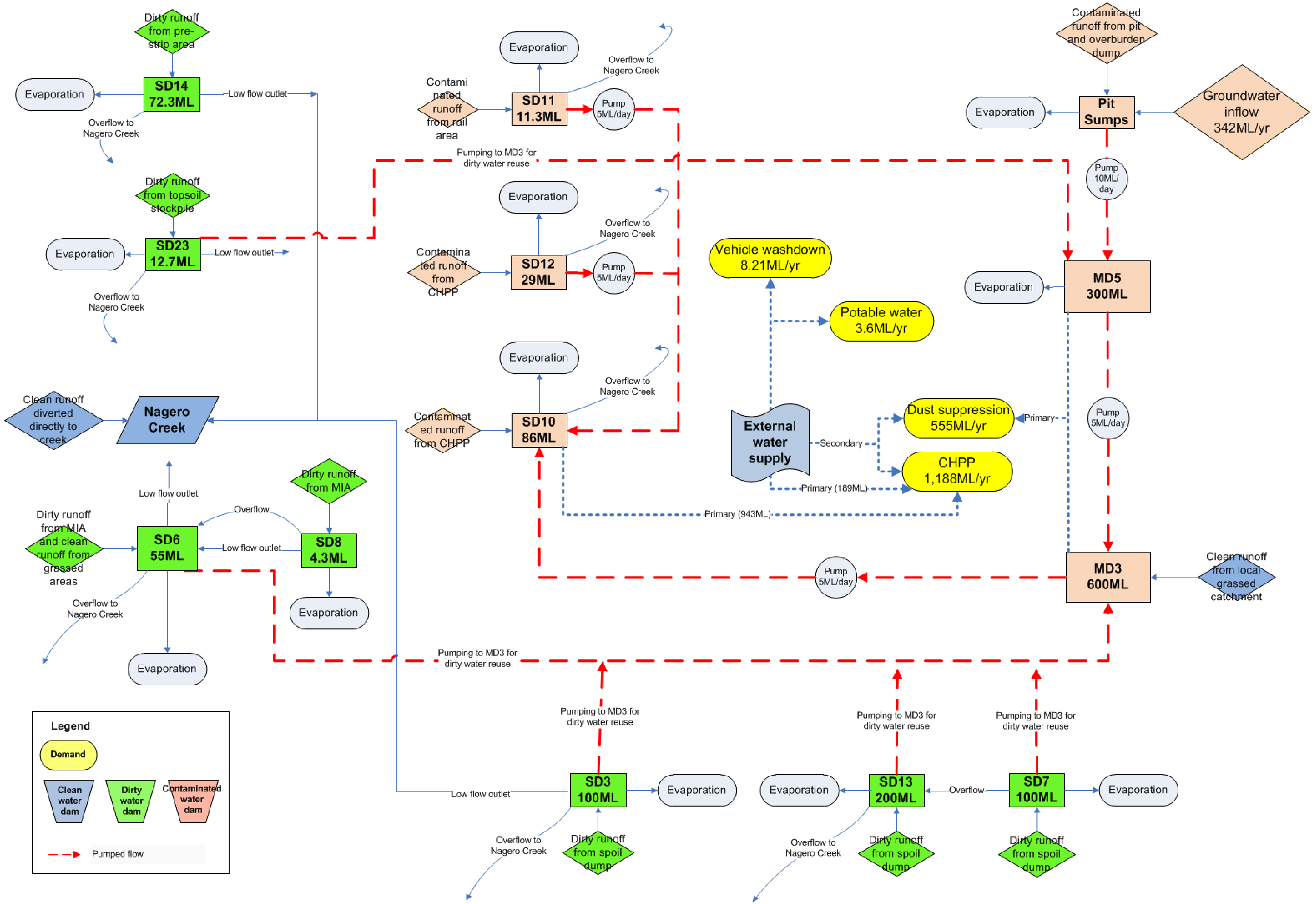


FIGURE 4-7
WATER BALANCE MODEL SCHEMATIC – YEAR 10

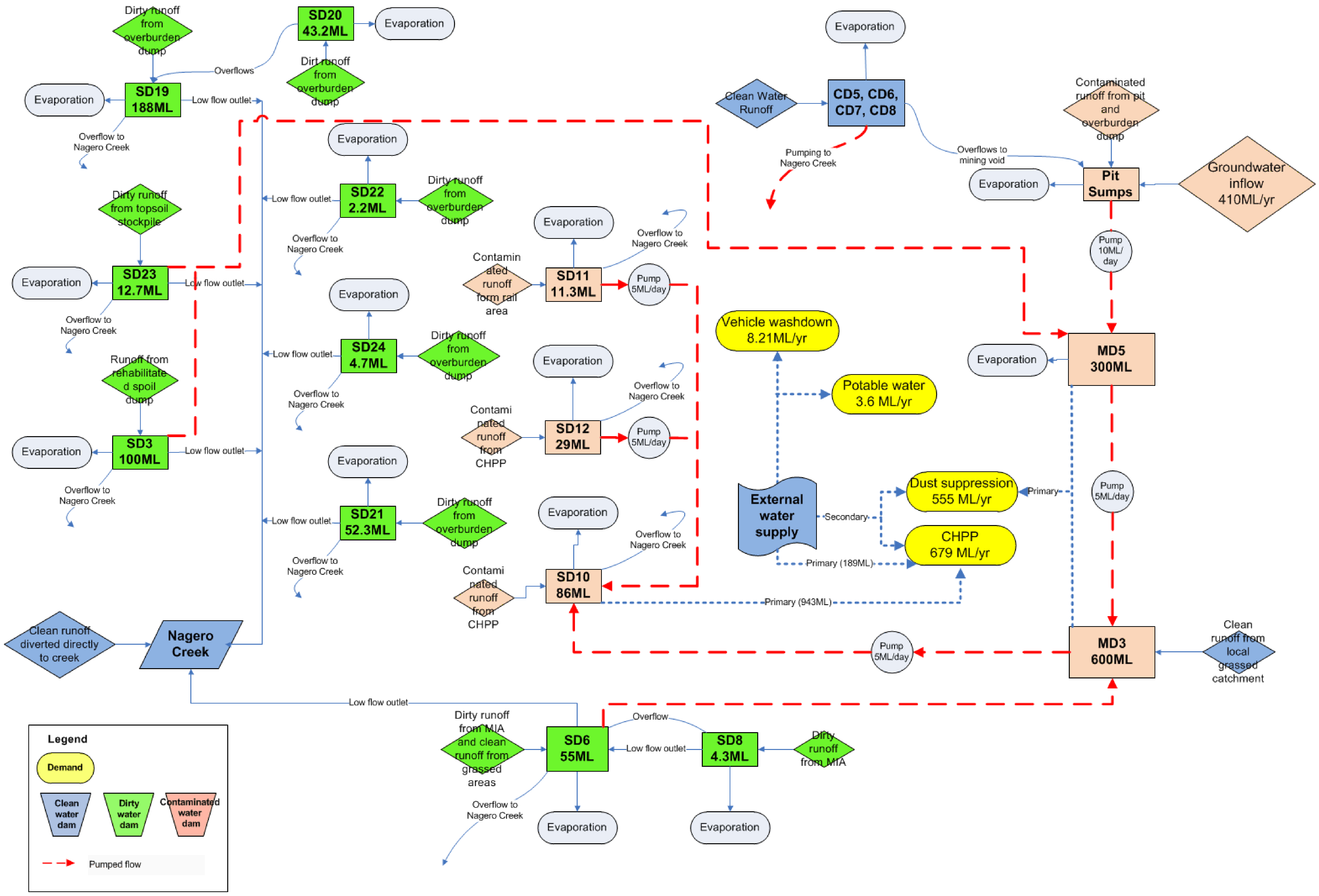


FIGURE 4-8
WATER BALANCE MODEL SCHEMATIC – YEAR 21

Table 4-1 Subcatchment areas for Nagero Creek catchment to the study catchment outlet

Storage type	Storage name	Catchment area (ha)			
		Year 1	Year 5	Year 10	Year 21
Boggabri Coal Mine contaminated water system	MW2	3.2	-	-	-
	MW3	23.5	23.1	23.1	23.1
	MW5	-	8.0	8.0	8.0
	SD2	14.5	-	-	-
	SD10	-	32.7	32.7	32.7
	SD11	-	3.5	3.5	3.5
	SD12	-	14.1	14.1	14.1
	Pit	369.8	517.2	398.5	530.4
	Subtotal	*411.0*	*598.6*	*479.9*	*611.8*
Boggabri Coal Mine dirty water system	SD1	9.3	-	-	-
	SD3	103.7	99.7	56.4	54.1
	SD5	2.8	-	-	-
	SD6	20.1	7.7	7.7	7.7
	SD7	-	275.1	314.3	-
	SD8	-	17.4	17.4	17.4
	SD9	-	291.4	-	-
	SD13	-	-	367.7	-
	SD14	-	-	313.6	-
	SD19	-	-	-	434.2
	SD20	-	-	-	100.0
	SD21	-	-	-	121.1
	SD22	-	-	-	5.1
	SD23	29.4	20.9	20.9	20.9
	SD24	-	-	-	10.9
	Subtotal	*165.3*	*712.2*	*1,098.0*	*771.4*
Boggabri Coal Mine clean water system	CD5	-	-	-	19.9
	CD6	-	-	-	20.7
	CD7	-	-	-	102.9
	CD8	-	-	-	18.3
	Subtotal	*0.0*	*0.0*	*0.0*	*162.4*
Boggabri Coal Mine rehabilitation direct to Nagero Creek		0.0	0.0	0.0	425.1
Tarrawonga Coal Mine to Nagero Creek	Via western boundary of ML1579 (LDP1)	52.8	146.0	414.0	108.0
	Via northern boundary of ML1579 (LDP4)	57.8	0.0	0.0	0.0
	Subtotal	110.6	146.0	414.0	108.0
Natural catchment		3,476.0	2,454.0	2,128.9	1,721.9
Total		**4,163**	**3,911**	**4,121**	**3,801**

Note. Dash (-) indicates that the storage does not exist for the landform.

From Table 4-1 it can be seen that the combined clean, dirty and contaminated water catchment area contributing to the Boggabri Coal Mine water management system generally increases over the life of the Project from 576 ha in Year 1 to 1,546 ha in Year 21. The natural catchment area to Nagero Creek generally decreases over the life of the Project from 3,476 ha in Year 1 to 1,722 ha in Year 21 as the disturbed mining area increases. In Year 21, a rehabilitated area of 425 ha is released directly to the creek system.

The Tarrawonga Coal Mine catchment area to Nagero Creek that discharges across the western boundary of ML1579 (at Tarrawonga's LDP1, EPL 12365) increases from approximately 53 ha in Year 1 to 414 ha in Year 10. This increase occurs as the Tarrawonga northern emplacement area expands as the Tarrawonga pit moves to the east. The Tarrawonga Coal Mine catchment area to Nagero Creek that discharges across the western boundary of ML1579 decreases from 414 ha in Year 10 to 108 ha in Year 21 when the majority of the rehabilitated landform at Tarrawonga Coal Mine drains to Goonbri Creek rather than Nagero Creek. In Year 21, only the western batter slopes of the Tarrawonga rehabilitated northern emplacement area drain to Nagero Creek.

The Tarrawonga Coal Mine catchment area to Nagero Creek that discharges across the northern boundary of ML1579 (at Tarrawonga's LDP4, EPL 12365) decreases from approximately 58 ha in Year 1 to zero in Years 5 to 21. In Years 5 to 21, runoff is captured in Tarrawonga dams UWD1 and UWD2 and reused onsite at Tarrawonga Coal Mine or pumped out to Goonbri Creek as the integrated waste rock emplacement landform does not allow for gravity drainage to the north to the Nagero Creek catchment.

4.4.2 Storage capacities

Preliminary sizing for storages is summarised in Table 4-2, Table 4-3, Table 4-4 and Table 4-5 for the Year 1, 5, 10 and 21 snapshot landforms, respectively.

Table 4-2 Preliminary storage capacities for Year 1 landform

Storage	Location / description	Stored water	Design criteria	Additional sediment allowance	Runoff coefficient	Catchment area (ha)	Required minimum capacity (ML)	Proposed capacity (ML)	Notes
Dirty water dams									
SD1	Sediment dam located in MIA	Dirty runoff from MIA	90th %ile 5 day	50%	0.75	9.3	4.0	1.0	Shortfall in storage provided in SD6
SD3	Sediment dam located south-west of spoil dump	Dirty runoff from spoil dump	90th %ile 5 day	50%	0.4	103.7	23.9	35.0	Existing capacity 35.0 ML
SD5	Sediment dam located in MIA	Dirty runoff from MIA	90th %ile 5 day	50%	0.75	2.8	1.2	1.4	Existing capacity 1.4 ML
SD6	Sediment dam located downstream of MIA (Nagero Dam)	Runoff from grassed areas near MIA, and overflows from SD1 and SD5	90th %ile 5 day	50%	0.75	20.1	8.7	55.0	Existing capacity 55.0 ML
SD23	Sediment dam located near topsoil stockpile	Dirty runoff from topsoil stockpile	90th %ile 5 day	50%	0.75	29.4	12.7	12.7	
Contaminated water dams									
SD2	Contaminated water dam located in existing coal crushing and handling area	Contaminated runoff from ROM stockpile	100yr ARI 72hr	20%	0.75	14.5	32.9	32.9	
SD4	Contaminated water dam located at rail loading facility west of mine site	Contaminated runoff from existing rail loading facility	100yr ARI 72hr	20%	0.75	2.3	5.2	8.1	Existing capacity 8.1 ML
MW2	Mine water dam located north-west of mining void (turkey's nest dam)	Contaminated water pumped from pit						175	Existing capacity 175 ML
MW3	Mine water dam located south of MIA	Surplus contaminated water						161 (max operating level 105 ML)	Existing capacity 161 ML
In-pit	Temporary in-pit storage	Contaminated runoff and groundwater make captured in the mining void sumps	Water balance (Pollution Reduction Program)					1,012	Temporary storage (required in absence of irrigation system) (sized as part of the Pollution Reduction Program in March 2012)

Table 4-3 Preliminary storage capacities for Year 5 landform

Storage	Location / description	Stored water	Design criteria	Additional sediment allowance	Runoff coefficient	Catchment area (ha)	Required minimum capacity (ML)	Proposed capacity (ML)	Notes
Dirty water dams									
SD3	Sediment dam located south-west of spoil dump	Dirty runoff from spoil dump	90th %ile 5 day	50%	0.4	99.7	23.0	100	Upsized to 100 ML to provide storage for reuse
SD6	Sediment dam located downstream of MIA (Nagero Dam)	Runoff from grassed areas near MIA, and overflows from SD8	90th %ile 5 day	50%	0.75	7.7	3.3	55	Existing capacity 55.0 ML
SD7	Sediment dam located in eastern spoil dump	Dirty runoff from spoil dump and clean runoff from undisturbed catchment	90th %ile 5 day	50%	0.4 to 0.75	275.1	80.8	92.3	Sized for Year 10 catchment
SD8	Sediment dam located in MIA	Dirty runoff from MIA	90th %ile 5 day	50%	0.85	17.4	8.5	8.5	
SD9	Sediment dam located in pre-strip	Dirty runoff from cleared area ahead of mining	90th %ile 5 day	50%	0.4	291.4	67.1	67.1	
SD23	Sediment dam located near topsoil stockpile	Dirty runoff from topsoil stockpile	90th %ile 5 day	50%	0.75	20.9	9.0	12.7	Sized for Year 1 catchment
Contaminated water dams									
SD10	Contaminated water dam located in CHPP	Contaminated runoff from product coal stockpile	100yr ARI 72hr	20%	0.85	32.7	84.1	116.6	Includes additional 32.5 ML for storage of 10 days CHPP demand (refer Table 5-8)
SD11	Contaminated water dam located at rail loop	Contaminated runoff from rail loop	100yr ARI 72hr	20%	0.85	3.5	9.0	9.0	In absence of train loading area design, nominal catchment area assumed
SD12	Contaminated water dam located in CHPP	Contaminated runoff from ROM coal stockpile	100yr ARI 72hr	20%	0.85	14.1	36.2	36.2	
MW5	Mine water dam (turkey's nest dam)	Contaminated water pumped from pit	Water balance	0%	-	-	-	300	
MW3	Mine water dam located south of MIA	Surplus contaminated water, sediment dam water for reuse	Water balance	0%	-	-	-	600	

Table 4-4 Preliminary storage capacities for Year 10 landform

Storage	Location / description	Stored water	Design criteria	Additional sediment allowance	Runoff coefficient	Catchment area (ha)	Required minimum capacity (ML)	Proposed capacity (ML)	Notes
Dirty water dams									
SD3	Sediment dam located south-west of spoil dump	Dirty runoff from spoil dump	90th %ile 5 day	50%	0.4	56.4	13.0	100	Upsized to 100 ML to provide storage for reuse
SD6	Sediment dam located downstream of MIA (Nagero Dam)	Runoff from grassed areas near MIA, and overflows from SD8	90th %ile 5 day	50%	0.75	7.7	3.3	55	Existing capacity 55.0 ML
SD7	Sediment dam located in eastern spoil dump	Dirty runoff from spoil dump and clean runoff from undisturbed catchment	90th %ile 5 day	50%	0.4 to 0.75	314.3	92.3	92.3	
SD8	Sediment dam located in MIA	Dirty runoff from MIA	90th %ile 5 day	50%	0.85	17.4	8.5	8.5	
SD13	Sediment dam located in spoil dump	Dirty runoff from spoil dump and clean runoff from undisturbed catchment	90th %ile 5 day	50%	0.75	367.7	158.8	158.8	
SD14	Sediment dam located in pre-strip	Dirty runoff from cleared area ahead of mining	90th %ile 5 day	50%	0.4	313.6	72.3	72.3	
SD23	Sediment dam located near topsoil stockpile	Dirty runoff from topsoil stockpile	90th %ile 5 day	50%	0.75	20.9	9.0	12.7	Sized for Year 1 catchment
Contaminated water dams									
SD10	Contaminated water dam located in CHPP	Contaminated runoff from product coal stockpile	100yr ARI 72hr	20%	0.85	32.7	84.1	116.6	Includes additional 32.5 ML for storage of 10 days CHPP demand (refer Table 5-8)
SD11	Contaminated water dam located at rail loop	Contaminated runoff from rail loop	100yr ARI 72hr	20%	0.85	3.5	9.0	9.0	In absence of train loading area design, nominal catchment area assumed
SD12	Contaminated water dam located in CHPP	Contaminated runoff from ROM coal stockpile	100yr ARI 72hr	20%	0.85	14.1	36.2	36.2	
MW5	Mine water dam (turkey's nest dam)	Contaminated water pumped from pit	Water balance	0%	-	-	-	300	
MW3	Mine water dam located south of MIA	Surplus contaminated water, sediment dam water for reuse	Water balance	0%	-	-	-	600	

Table 4-5 Preliminary storage capacities for Year 21 landform

Storage	Location / description	Stored water	Design criteria	Additional sediment allowance	Runoff coefficient	Catchment area (ha)	Required minimum capacity (ML)	Proposed capacity (ML)	Notes
Dirty water dams									
SD3	Sediment dam located south-west of spoil dump	Dirty runoff from spoil dump	90th %ile 5 day	50%	0.4	54.1	12.5	100	Upsized to 100 ML to provide storage for reuse
SD6	Sediment dam located downstream of MIA (Nagero Dam)	Runoff from grassed areas near MIA, and overflows from SD8	90th %ile 5 day	50%	0.75	7.7	3.3	55	Existing capacity 55.0 ML
SD8	Sediment dam located in MIA	Dirty runoff from MIA	90th %ile 5 day	50%	0.85	17.4	8.5	8.5	
SD19	Sediment dam located in spoil dump	Dirty runoff from spoil dump	90th %ile 5 day	50%	0.75	434.2	187.6	187.6	
SD20	Sediment dam located in spoil dump	Dirty runoff from spoil dump	90th %ile 5 day	50%	0.75	100.0	43.2	43.2	
SD21	Sediment dam located in spoil dump	Dirty runoff from spoil dump	90th %ile 5 day	50%	0.75	121.1	52.3	52.3	
SD22	Sediment dam located in spoil dump	Dirty runoff from spoil dump	90th %ile 5 day	50%	0.75	5.1	2.2	2.2	
SD23	Sediment dam located near topsoil stockpile	Dirty runoff from topsoil stockpile	90th %ile 5 day	50%	0.75	20.9	9.0	12.7	Sized for Year 1 catchment
SD24	Sediment dam located in spoil dump	Dirty runoff from spoil dump	90th %ile 5 day	50%	0.75	10.9	4.7	4.7	
Contaminated water dams									
SD10	Contaminated water dam located in CHPP	Contaminated runoff from product coal stockpile	100yr ARI 72hr	20%	0.85	32.7	84.1	116.6	Includes additional 32.5 ML for storage of 10 days CHPP demand (refer Table 5-8)
SD11	Contaminated water dam located at rail loop	Contaminated runoff from rail loop	100yr ARI 72hr	20%	0.85	3.5	9.0	9.0	In absence of train loading area design, nominal catchment area assumed
SD12	Contaminated water dam located in CHPP	Contaminated runoff from ROM coal stockpile	100yr ARI 72hr	20%	0.85	14.1	36.2	36.2	
MW5	Mine water dam (turkey's nest dam)	Contaminated water pumped from pit	Water balance	0%	-	-	-	300	

Storage	Location / description	Stored water	Design criteria	Additional sediment allowance	Runoff coefficient	Catchment area (ha)	Required minimum capacity (ML)	Proposed capacity (ML)	Notes
MW3	Mine water dam located south of MIA	Surplus contaminated water, sediment dam water for reuse	Water balance	0%	-	-	-	600	
Clean water dams									
CD5	Highwall dam located ahead of pit	Undisturbed catchment runoff	100yr ARI 72hr	0%	0.4	19.9	20.1	20.1	
CD6	Highwall dam located ahead of pit	Undisturbed catchment runoff	100yr ARI 72hr	0%	0.4	20.7	20.9	20.9	
CD7	Highwall dam located ahead of pit	Undisturbed catchment runoff	100yr ARI 72hr	0%	0.4	102.9	103.7	103.7	
CD8	Highwall dam located ahead of pit	Undisturbed catchment runoff	100yr ARI 72hr	0%	0.4	18.3	18.4	18.4	

4.4.3 Licensed discharge points

A summary of proposed discharge points is provided in Table 4-6, Table 4-7, Table 4-8 and Table 4-9 for the Year 1, 5, 10 and 21 snapshot landforms, respectively. Discharges are subject to licensing approvals and conditions from the relevant authorities.

Table 4-6 Summary of proposed discharge points for Year 1

EPL point	Discharge type	Storage	Location / description	Stored water
Point 3	Discharge to waters and Wet weather discharge	SD3	Sedimentation dam located south-west of spoil dump	Dirty runoff from spoil dump
Point 1	Discharge to waters and Wet weather discharge	SD6	Sedimentation dam located downstream of MIA (Nagero Dam)	Runoff from grassed areas near MIA, and overflows from SD1 and SD5
Point 40	Discharge to waters and Wet weather discharge	SD23	Sedimentation dam located near topsoil stockpile	Dirty runoff from topsoil stockpile
Point 2	Wet weather discharge	SD2	Contaminated water dam located in existing coal crushing and handling area	Contaminated runoff from ROM stockpile
Point 4	Wet weather discharge	SD4	Contaminated water dam located at rail loading facility west of mine site	Contaminated runoff from existing rail loading facility

Table 4-7 Summary of proposed discharge points for Year 5

EPL point	Discharge type	Storage	Location / description	Stored water
Point 3	Discharge to waters and Wet weather discharge	SD3	Sedimentation dam located south-west of spoil dump	Dirty runoff from spoil dump
Point 1	Discharge to waters and Wet weather discharge	SD6	Sedimentation dam located downstream of MIA (Nagero Dam)	Runoff from grassed areas near MIA, and overflows from SD8
Point 40	Discharge to waters and Wet weather discharge	SD23	Sedimentation dam located near topsoil stockpile	Dirty runoff from topsoil stockpile
TBA	Wet weather discharge	SD8	Sediment dam located in MIA	Dirty runoff from MIA
TBA	Discharge to waters and Wet weather discharge	SD9	Sediment dam located in pre-strip	Dirty runoff from cleared area ahead of mining
TBA	Wet weather discharge	SD10	Contaminated water dam located in CHPP	Contaminated runoff from product coal stockpile
TBA	Wet weather discharge	SD11	Contaminated water dam located at rail loop	Contaminated runoff from rail loop
TBA	Wet weather discharge	SD12	Contaminated water dam located in CHPP	Contaminated runoff from ROM coal stockpile

Table 4-8 Summary of proposed discharge points for Year 10

EPL point	Discharge type	Storage	Location / description	Stored water
Point 3	Discharge to waters and Wet weather discharge	SD3	Sedimentation dam located south-west of spoil dump	Dirty runoff from spoil dump
Point 1	Discharge to waters and Wet weather discharge	SD6	Sedimentation dam located downstream of MIA (Nagero Dam)	Runoff from grassed areas near MIA, and overflows from SD8
Point 40	Discharge to waters and Wet weather discharge	SD23	Sedimentation dam located near topsoil stockpile	Dirty runoff from topsoil stockpile
TBA	Wet weather discharge	SD8	Sediment dam located in MIA	Dirty runoff from MIA
TBA	Discharge to waters and Wet weather discharge	SD13	Sediment dam located in spoil dump	Dirty runoff from spoil dump and clean runoff from undisturbed catchment
TBA	Discharge to waters and Wet weather discharge	SD14	Sediment dam located in pre-strip	Dirty runoff from cleared area ahead of mining
TBA	Wet weather discharge	SD10	Contaminated water dam located in CHPP	Contaminated runoff from product coal stockpile
TBA	Wet weather discharge	SD11	Contaminated water dam located at rail loop	Contaminated runoff from rail loop
TBA	Wet weather discharge	SD12	Contaminated water dam located in CHPP	Contaminated runoff from ROM coal stockpile

Table 4-9 Summary of proposed discharge points for Year 21

EPL point	Discharge type	Storage	Location / description	Stored water
Point 3	Discharge to waters and Wet weather discharge	SD3	Sedimentation dam located south-west of spoil dump	Dirty runoff from spoil dump
Point 1	Discharge to waters and Wet weather discharge	SD6	Sedimentation dam located downstream of MIA (Nagero Dam)	Runoff from grassed areas near MIA, and overflows from SD8
Point 40	Discharge to waters and Wet weather discharge	SD23	Sedimentation dam located near topsoil stockpile	Dirty runoff from topsoil stockpile
TBA	Wet weather discharge	SD8	Sediment dam located in MIA	Dirty runoff from MIA
TBA	Discharge to waters and Wet weather discharge	SD19	Sediment dam located in spoil dump	Dirty runoff from spoil dump
TBA	Discharge to waters and Wet weather discharge	SD20	Sediment dam located in spoil dump	Dirty runoff from spoil dump
TBA	Discharge to waters and Wet weather discharge	SD21	Sediment dam located in spoil dump	Dirty runoff from spoil dump

EPL point	Discharge type	Storage	Location / description	Stored water
TBA	Discharge to waters and Wet weather discharge	SD22	Sediment dam located in spoil dump	Dirty runoff from spoil dump
TBA	Discharge to waters and Wet weather discharge	SD24	Sediment dam located in spoil dump	Dirty runoff from spoil dump
TBA	Discharge to waters	CD5 to CD8	Highwall dams located ahead of pit	Clean runoff from undisturbed catchment
TBA	Wet weather discharge	SD10	Contaminated water dam located in CHPP	Contaminated runoff from product coal stockpile
TBA	Wet weather discharge	SD11	Contaminated water dam located at rail loop	Contaminated runoff from rail loop
TBA	Wet weather discharge	SD12	Contaminated water dam located in CHPP	Contaminated runoff from ROM coal stockpile

The LDP's in Table 4-6, Table 4-7, Table 4-8 and Table 4-9 for the Modification remain the same as those required for the Boggabri EA. The only exception is that a discharge point has not been included for the approved irrigation area recirculation dam (MW4), as the approved irrigation system was not included in this site water balance.

4.5 Erosion and sediment controls

A Surface Water Management Plan will be prepared and implemented during the construction, operation and rehabilitation phases of the Boggabri Coal Mine in accordance with Condition 38 of Schedule 3 of Project Approval 09_0182. Erosion and sediment controls will be documented in the Plan and will be to a standard consistent with Managing Urban Stormwater - Soils and Construction - Volume 1 (Landcom, 2004), Managing Urban Stormwater - Soils and Construction - Volume 2E Mines and Quarries (DECC, 2008) and Guidelines for Establishing Drainage Lines on Rehabilitated Minesites (Draft) (DLWC, 1999).

These controls will include:

- Minimising forward clearing, particularly areas around flow lines, drainage lines and watercourses.
- Minimising site disturbance by containing machinery access to areas required for approved construction works, access tracks or materials stockpiles.
- Staging construction activities where practical, so that land disturbance is confined to the minimum possible area.
- Completing work and rehabilitating disturbed areas quickly and progressively.
- Minimising erosion from drainage lines which can be very vulnerable to the erosive effects of concentrated flow.
- Intercepting and diverting clean water runoff from undisturbed areas so that it does not flow onto disturbed areas.

- Passing clean water through the site without mixing it with dirty runoff from disturbed areas.
- Treating highly dispersive soils with gypsum to reduce the potential for tunnel erosion and surface rilling of disturbed areas.
- Limiting erosion potential within earthworks areas by managing runoff fetches and velocities, with measures such as diversion banks.
- Locating sediment traps such as silt fences and check dams downstream of disturbed areas.
- Treating runoff from large areas of construction (greater than 2,500 m^2) in sediment dams, prior to discharge to watercourses.
- Providing shaker ramps and rock pads at the construction exit to remove excess mud from truck tyres / under-bodies.

A Soil Management Protocol will also be prepared and implemented in accordance with Condition 36 of Schedule 3 of Project Approval 09_0182. It will incorporate management strategies for topsoil stripping and handling, topsoil respreading, post disturbance regrading, and seedbed preparation are outlined in the soil assessment (GSS, 2009), which formed part of the Boggabri EA.

5. Water balance analysis

A revised long term water balance analysis has been undertaken for the Boggabri Coal Mine water management system to incorporate the proposed Modification.

The water balance model was built using GoldSim software, and incorporated the Australian Water Balance Model (AWBM) to simulate catchment runoff. The model was built for the Year 1, 5, 10 and 21 'snapshot' landforms.

5.1 Changes to site water balance

The Surface Water Assessment conducted for the Boggabri EA (PB, October 2010) details the site water balance and management system for the Boggabri Coal Project.

The proposed Modification would result in the following changes relevant to the Boggabri Coal Project site water balance:

- An increase in water demand at the CHPP associated with the processing of up to 1.5 Mtpa ROM coal from the Tarrawonga Coal Mine in Years 2 to 17 of the Tarrawonga Coal Project (i.e. 2014 to 2030) and 2 Mtpa from the Boggabri Coal Mine.
- Reduced area of surface runoff from the Boggabri Coal Mine waste rock emplacement, due to the integration of the waste rock emplacements.

In addition to the above changes associated with the Modification, the CHPP water demand and the water usage rate for dust suppression at the Boggabri Coal Mine have been increased. These increases are based on more detailed project design and engineering work that has occurred since the Surface Water Assessment was undertaken in 2010. These increases have been incorporated into the revised site water balance.

5.2 Methodology

5.2.1 GoldSim water balance model

Water balance models were previously developed for the Year 1, 5, 10 and 21 'snapshot' landforms for the Boggabri EA. For this assessment, the Boggabri EA models were combined into a single model spanning the 21-year life of the mine. The model was updated to reflect the modified landform for Years 5, 10 and 21. Catchment areas, dam capacities and demands were also revised and updated in the model.

The updated GoldSim model comprising the Year 1, 5, 10 and 21 'snapshot' landforms was simulated at a daily timestep for a 21-year duration (i.e. the life of the mine). The model was simulated for 103 realisations (i.e. sequences) of rainfall and evaporation data, developed by 'stepping through' the Data Drill sourced historical rainfall and evaporation data for the period 1 January 1889 to 31 December 2011. The first realisation started on 1 January 1889, the second realisation on 1 January 1890 etc. Note that the 21-year duration realisations overlap each other by one year. The model parameters (catchment and landuse breakdown, demands and groundwater inflows etc.) were varied in the model between the 'snapshot' years.

The GoldSim model was used to calculate the volume of water in storages at the end of each day, accounting for daily rainfall-runoff inflow, groundwater inflow, evaporation from the storage, water usage, pumping between storages in the form of a pumping policy and storage overflow, if it occurs.

5.2.2 AWBM runoff model and parameters

The Australian Water Balance Method (AWBM) (Boughton, 1993) was used to derive catchment runoff time series from undisturbed, disturbed and rehabilitated catchments for use in the water balance.

The AWBM is a partial area saturation overland flow model. The use of partial areas divides the catchment into regions (contributing areas) that produce runoff during a rainfall-runoff event and those that do not. These contributing areas vary within a catchment according to antecedent catchment conditions, allowing for the spatial variability of surface storage in a catchment. The use of the partial area saturation overland flow approach is simple, and provides a good representation of the physical processes occurring in most Australian catchments (Boughton, 1993). This is because daily infiltration capacity is rarely exceeded, and the major source of runoff is from saturated areas. A schematic layout of the AWBM is provided in Figure 5-1.

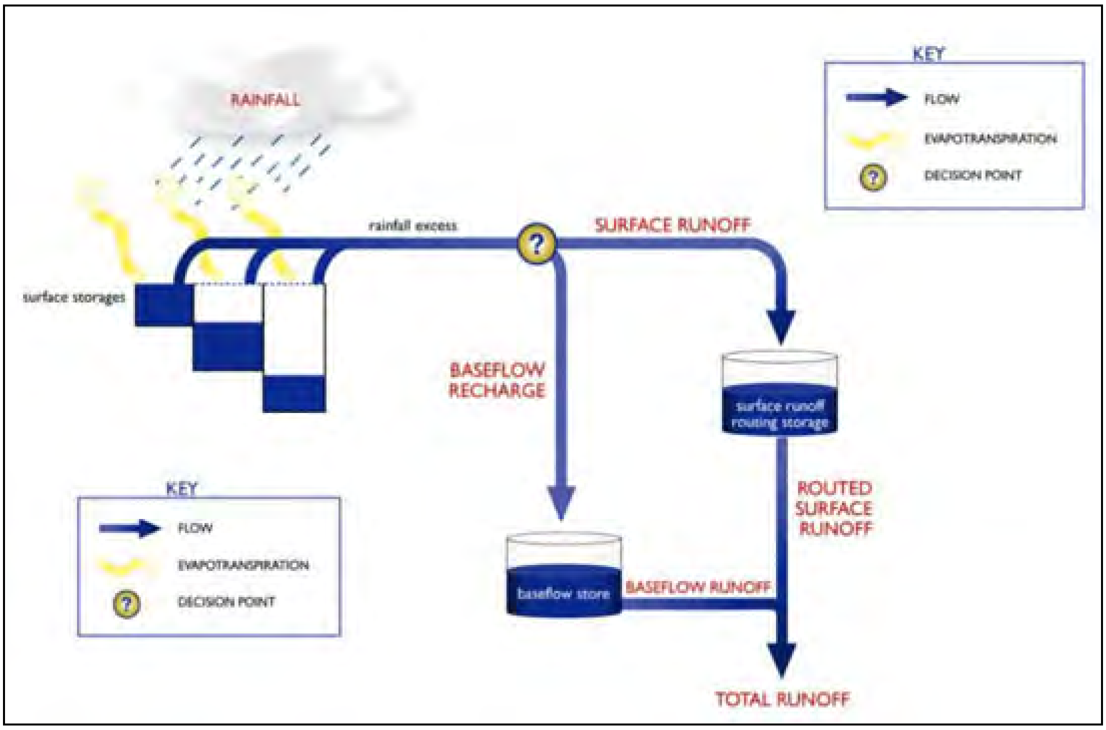


Figure 5-1 Schematic layout of the AWBM rainfall-runoff model (Source: CRC for Catchment Hydrology, 2004)

To implement the AWBM in a given catchment, a set of 9 parameters must be defined as summarised in Table 5-1. These parameters define the generalised model for a particular catchment. The parameters are usually derived for a gauged catchment by a process of calibration where the recorded streamflows are compared with calculated streamflows. The parameters are adjusted to produce the best match between the means and standard deviations of the daily streamflows, to match the difference in peak flow discharge.

Table 5-1 Description of AWBM parameters

Parameter	Description
A1, A2, A3	Partial areas represented by surface storages
C1, C2, C3	Surface storage capacities
K_s	Daily surface flow recession constant
BFI	Baseflow index
K_{base}	Daily baseflow recession constant

Adopted AWBM parameters are provided in Table 5-2, and are the same as those adopted in the Surface Water Assessment (PB, October 2010). The adopted parameters for industrial, undisturbed and rehabilitated waste rock emplacement areas are taken from the report entitled Boggabri Coal Mine 2008 Site Water Balance (PB, 2009). The adopted parameters for the mining void and waste rock emplacement areas are based on past project experience on mine sites in New South Wales. It has been assumed that the rehabilitated waste rock emplacement will have infiltration characteristics similar to undisturbed ground.

Due to the absence of gauged runoff data from the site, calibration of AWBM parameters has not been undertaken for each land use. The use of best judgement engineering parameters is typical for mining sites.

Table 5-2 AWBM parameters

Landuse	BFI	K_{base}	A1	A2	A3	C1	C2	C3
Undisturbed	0.2	0.98	0.134	0.433	0.433	5.7	57.8	115.7
Rehabilitated spoil	0.2	0.98	0.134	0.433	0.433	5.7	57.8	115.7
Industrial	0	1	0.134	0.433	0.433	2.3	22.9	45.7
Mining void	0	1	0.2	0.2	0.6	5	70	90
Active spoil	0.8	0.7	0.3	0.3	0.4	30	60	120
Pre-strip	0.2	0.98	0.134	0.433	0.433	4.6	46.5	93.0

5.2.3 Model assumptions

The following assumptions were made in the water balance analysis:

- Annual groundwater inflows have been adopted and distributed uniformly to obtain daily groundwater inflow rates for the water balance simulation. Annual groundwater inflow estimates have been sourced from the Groundwater Assessment (AGE, October 2010), which formed part of the Boggabri EA.

- A pumping policy based on the existing and proposed infrastructure was assumed for inclusion in the water balance model. It has been assumed that pumping occurs at an average pump rate and no allowance has been made to modify the pump rate depending on storage capacity (with the exception of the pit dewatering system, as temporary pumps would be employed under extreme wet conditions). Pump rating curves have not been discretely modelled, and therefore the model does not represent delays that could occur when transporting water around the site.

- It has been assumed that the low flow outlets from dirty water sediment dams remain open throughout the simulation. Low flow outlets have been represented in the water balance model so that the dams empty over a period of three days. When sediment dam water is to be reused onsite to supplement a deficit, the model assumes that sediment dam water is pumped to MW3 rather than being released to the creek.

- It has been assumed that the bottom half of the 'sediment zone' of dirty water sediment dams and contaminated water sediment dams is half full of sediment throughout the simulation. Water that ponds in the top half of the 'sediment zone' evaporates over time and cannot be used to supply dust suppression water and CHPP make-up water.

- It has been assumed that all dams are empty at the start of the simulation (with the exception of deposited sediment, as above).

- No allowance has been made for seepage from water storages, or for moisture loss from product coal.

- It has been assumed that all runoff within the water management system drains to a storage, and that the diversion drains capture all runoff from their local catchments. It is assumed that there is no bypass of diversion drains.

- The approved irrigation system has not been included in the model, as the irrigation system is not currently operational.

- The Tarrawonga Coal Mine catchment area to Nagero Creek that discharges across the western boundary of ML1579 (at Tarrawonga's LDP1) has been assumed to pass through three Tarrawonga dams (SD17 – 62.8 ML, SB6 – 0.8 ML, SB7 – 4.6 ML). These three dams have been included in the water balance model as a single 68.2 ML lumped storage. Storage capacities of these Tarrawonga basins are based on information provided in the Tarrawonga Coal Project EA Surface Water Assessment (Gilbert and Associates, October 2011). It has been assumed that the only outflows from the dam are evaporation and overflows to Nagero Creek. No controlled releases have been considered, and no outflows for reuse at Tarrawonga Coal Mine have been considered.

- It has been assumed that adequate groundwater / surface water allocations or alternative water sources are available to makeup the site water deficit (an infinite supply has been adopted in the model).

- While the model assesses the performance of the system under historical extremes that may reasonably be expected to reoccur in the future, it does not specifically quantitatively incorporate the potential impact of future climate change on runoff.

5.2.4 Operating rules

Operating rules adopted in the water balance are outlined below. Operating rules in Years 1 to 2 are different to those adopted in Years 3 to 21. In Years 1 to 2, when the CHPP is not operational, the site is in an annual surplus under median climatic conditions. In Years 3 to 21, the CHPP is operational and the site is in an annual deficit under median climatic conditions. In Years 3 to 21 it is also assumed that the out-of-pit mine water storage capacity onsite will have increased significantly compared to Years 1 to 2.

Years 1 to 2 (CHPP not operational)

- Water stored in the 'settling zone' of dirty water sediment dams is discharged to the creek system following the settling of suspended solids (i.e. the 'settling zone' is maintained in a drawn down state). It is assumed that sediment dam water is not reused onsite.
- Pumping from the pit sump to MW2 ceases if the volume stored in MW2 exceeds 90% capacity. During prolonged periods of wet weather it is assumed that runoff and groundwater inflows will be stored in-pit once MW2 exceeds 90% capacity.
- Pumping from MW2 to MW3 starts if the volume stored in MW2 exceeds 50% capacity. Pumping from MW2 to MW3 ceases if the volume stored in MW3 exceeds 50% capacity.
- Pumping from SD2 to MW3 starts if the volume stored in SD2 exceeds the 'sediment storage' capacity (i.e. the 'storm zone' is maintained in a drawn down state). Pumping from SD2 to MW3 ceases if the volume stored in MW3 exceeds 65% capacity (note that 105 ML is the design maximum operating level for MW3 prior to upgrade).
- Dust suppression and general construction water demands for the main mine site are sourced from the following storages in order of priority:
  - MW2 or MW3 (sourced from dam with highest volume to total capacity ratio)
  - imported raw water.
- Dust suppression demands for the existing rail loading facility located west of the main mine site are sourced from the following storages in order of priority:
  - SD4
  - imported raw water.
- Potable water, construction camp water and vehicle washdown water demands are sourced from imported raw water regardless of the site water balance.

Years 3 to 21 (CHPP operational)

- Water stored in the 'settling zone' of dirty water sediment dams is discharged to the creek system following the settling of suspended solids or transferred to mine water dams for reuse (i.e. the 'settling zone' is maintained in a drawn down state). Sediment dam water can be reused onsite to supplement a deficit if required. It is assumed that water from sediment dams can be pumped to MW3 when MW3 is less than 50% capacity. When MW3 is at 50% capacity or greater, sediment dam water is released to the creek and is not reused onsite (to avoid an accumulation of water onsite during wet periods, and to maintain spare capacity in mine water storages for collection of contaminated runoff).
- Pumping from the pit sump to MW5 ceases if the volume stored in MW5 exceeds 90% capacity. During prolonged periods of wet weather it is assumed that runoff and groundwater inflows will be stored in-pit once MW5 exceeds 90% capacity.
- Pumping from MW5 to MW3 starts if the volume stored in MW5 exceeds 50% capacity. Pumping from MW5 to MW3 ceases if the volume stored in MW3 exceeds 80% capacity.

- Pumping from SD10 to MW3 starts if the volume stored in SD10 exceeds the 'sediment storage' and 'reuse zone' capacity (i.e. the 'storm zone' is maintained in a drawn down state). Pumping from SD10 to MW3 ceases if the volume stored in MW3 exceeds 92% capacity.

- Pumping from SD12 to MW3 starts if the volume stored in SD12 exceeds the 'sediment storage' capacity (i.e. the 'storm zone' is maintained in a drawn down state). Pumping from SD12 to MW3 ceases if the volume stored in MW3 exceeds 92% capacity.

- Pumping from clean water highwall dams to the creek system starts if the volume stored in the highwall dam exceeds zero.

- Dust suppression demands for the main mine site are sourced from the following storages in order of priority:
  - MW5 or MW3 (sourced from dam with highest volume to total capacity ratio)
  - imported raw water.

- CHPP make-up water demands (excluding the minimum raw water component) are sourced from the following storages in order of priority:
  - SD10 (sourced from MW3 or MW5 as required)
  - imported raw water.

- Potable water, vehicle washdown and CHPP raw water demands are sourced from imported raw water regardless of the site water balance.

The current water balance model includes only basic operating rules, suitable for conceptual design and impact assessment. The proposed water management system and operating rules should be refined and optimised as detailed design proceeds, and water quality and groundwater characteristics are confirmed from ongoing monitoring programs.

Operating rules should be developed to manage competing interests including water retention for use around site, water retention for dilution and maintaining spare capacity for containment of storm events.

5.2.5 Pump rates

The following average daily pump rates were adopted in the water balance model:

- Pit sump to MW2 / MW5 – maximum of 5 ML/day under normal conditions, increasing to a maximum of 10 ML/day when there is more than 200 ML stored in-pit

- MW2 / MW5 to MW3 – maximum 5 ML/day

- SD2, SD10, SD11 and SD12 to MW3 – maximum 5 ML/day each

- Low flow outlet / pumping from sediment dams – sized to empty settling zone over 3 day period

- Pumping from sediment dams to MW3 for reuse – sized to empty settling zone over 3 day period

- Clean water highwall dams to creek system – sized to empty dam over 10 day period.

5.3 Water sources

Water sources for the Project comprise:

- Groundwater inflows to the mining void
- Rainfall runoff
- Groundwater and surface water allocations.

5.3.1 Groundwater inflow to mining void

Estimated seepage rates of groundwater into the existing approved mine and the mine extension have been provided in the Groundwater Assessment undertaken by AGE (2010) for the Boggabri EA. Seepage rates have been provided for each quarter year over the life of the mine.

A summary of the groundwater inflows adopted in the water balance model are provided in Table 5-3.

Table 5-3 Estimated groundwater inflows to mining void

Project year	Average daily inflow (ML/day)	Annual inflow (ML/yr)
1	0.451	165
2	0.501	183
5	0.686	250
10	0.938	342
21	1.123	410

From Table 5-3 it can be seen that groundwater inflow to the mining void will increase over the life of the Project.

Groundwater that collects in the mining void will be pumped to MW2 / MW5 for onsite reuse.

5.3.2 Rainfall runoff

Contaminated surface water runoff is captured in dams or the mining void and stored for onsite reuse. The volume of contaminated surface water runoff is dependent on the rainfall depth and the catchment area of the mining void and industrial areas.

Dirty water runoff is also captured in sediment dams for settling of suspended solids prior to release to Nagero Creek or onsite reuse. It is proposed to reuse runoff from selected sediment dams when the CHPP becomes operational after July 2014.

5.3.3 Groundwater allocations

Boggabri Coal currently holds licenses for the Lower Namoi Groundwater Source and the Upper Namoi Zone 4 Namoi Valley Groundwater Source. Details of these water access licenses are provided in Table 5-4.

Table 5-4 Summary of Water Access License's for groundwater currently held by Boggabri Coal

Source	WAL category	WAL No.	Share component
Groundwater			
Namoi Groundwater Source – Lovton Bore	Low security	90BL253854 (yet to be converted to a WAL)	142 unit shares
Upper Namoi Zone 4 Groundwater Source – Daisymede Bore	Low security	WAL 15037	172 unit shares
Upper Namoi Zone 4 Groundwater Source	Aquifer	WAL 24103	275 unit shares
Upper Namoi Zone 4 Groundwater Source and Lower Namoi Groundwater Source	Aquifer	WAL 12691	219 unit shares
Upper Namoi Zone 4 Groundwater Source and Lower Namoi Groundwater Source	Supplementary	WAL 14483	131 unit shares
Groundwater - pit interference			
Namoi Groundwater Source - Aquifer Interference Licence	NA	90BL255995	700 ML

A total of 808 unit shares of groundwater would be available to Boggabri Coal from the aquifer and low security category groundwater licenses. An additional 131 unit shares of groundwater would potentially be available to Boggabri Coal from the supplementary category groundwater license. The actual volume of groundwater available would depend on the AWD's made under the Water Sharing Plan.

Boggabri Coal currently utilises groundwater pumped from Lovton Bore (90BL253854) and Daisymede Bore (WAL15037) for existing operations.

Groundwater pumped from Lovton Bore is currently treated in an onsite treatment plant and used for potable water and vehicle washdown, as well as dust suppression when there is a site water deficit.

Groundwater pumped from Daisymede Bore is currently used for dust suppression at the existing rail loading facility located west of the site. Note that the infrastructure to pump groundwater from Daisymede Bore to the mine site does not currently exist, and would need to be installed in order to utilise these existing entitlements at the main mine site.

5.3.4 Surface water allocations

Boggabri Coal currently holds general security and supplementary water access licenses for the Lower Namoi Regulated River Water Source. Details of these water access licenses are provided in Table 5-5.

Table 5-5 Summary of Water Access License's for surface water currently held by Boggabri Coal

Source	WAL category	WAL No.	Share component
Lower Namoi River	General security	WAL 2571	51 unit shares
Lower Namoi River	General security	WAL 2595	243 unit shares
Lower Namoi River	Supplementary water	WAL 2596	26.1 unit shares
Lower Namoi River	Supplementary water	WAL 2572	5.6 unit shares

Boggabri Coal does not currently utilise surface water allocations for existing operations. The approved pump station on the Namoi River and associated pipeline to the mine have not yet been constructed, but once installed would enable Boggabri Coal to access surface water from the Namoi River in accordance with its surface water licences.

Whitehaven/TCPL currently holds general security and supplementary water access licenses for the Lower Namoi Regulated River Water Source. Details of these water access licenses are provided in Table 5-6.

Table 5-6 Summary of Water Access License's for surface water currently held by Whitehaven/TCPL

Source	WAL category	WAL No.	Share component
Lower Namoi River	General security	WAL 13051	96 unit shares
Lower Namoi River	General security	WAL 2577	144 unit shares
Lower Namoi River	General security	WAL 21366	350 unit shares
Lower Namoi River	Supplementary water	WAL 13052	10.5 unit shares
Lower Namoi River	Supplementary water	WAL 2578	17.7 unit shares

A total of 294 unit shares of river water would be available to Boggabri Coal from the general security category water access licenses. An additional 31.7 unit shares of river water would potentially be available to Boggabri Coal from the supplementary category water access licenses.

A total of 590 unit shares of river water would be available to Whitehaven/TCPL from the general security category water access licenses. An additional 28.2 unit shares of river water would potentially be available to Whitehaven/TCPL from the supplementary category water access licenses.

The actual volume of river water available would depend on the AWD's made under the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2003. As discussed in Section 2.5.1, for the Lower Namoi the AWD for general security category water access licences is reviewed monthly and depends upon the amount of water held in Split Rock and Keepit Dams. The AWD for supplementary category water access licences is set at the start of each water year. Refer to Section 2.5.1 for information on recent AWD's made under the Water Sharing Plan.

5.4 Water demands

Water demands comprise:

- Construction water.
- Potable water (for drinking water and amenities)
- Dust suppression water
- Vehicle washdown water
- CHPP make-up water (including raw water and mine water components)

5.4.1 Construction water

Water will be required for the construction of the CHPP and MIA upgrades. Boggabri Coal has estimated that 1 ML/day of general construction water will be required from September 2012 to July 2014. Mine water will be used as a priority for general construction water.

Potable water will also be required for the accommodation camp from September 2012 to July 2014. Boggabri Coal has estimated that 0.04 ML/day potable water will be required based on 200L/pp/day for 200 people for the accommodation camp. Potable water will be sourced from groundwater entitlements, and will be treated in an onsite water treatment plant prior to use for potable applications.

The proposed Modification would not result in any material changes to the construction water demand.

The Boggabri EA did not consider construction water in the site water balance, as construction demand estimates were not available in 2010 when the Boggabri EA Surface Water Assessment was prepared. Construction demand estimates are now available and have been incorporated into the revised site water balance.

5.4.2 Potable water

Potable water is utilized in the administration building and amenities. Boggabri Coal has estimated that approximately 2.9 ML/yr of potable water will be required at the site during Year 1 based on 35L/pp/day for 230 people. Boggabri Coal has estimated that approximately 3.6 ML/yr of potable water will be required at the site during Years 5, 10 and 21 based on 35L/pp/day for 285 people. Potable water will be sourced from groundwater entitlements, and will be treated in an onsite water treatment plant prior to use for potable applications.

Potable water is also required for the construction accommodation camp (refer to Section 5.4.1).

Wastewater from the administration building and amenities will be treated in an onsite Envirocycle treatment plant and irrigated to an adjacent vegetated area. Wastewater generated by the onsite Envirocycle treatment plant has not been considered in the water balance analysis.

The proposed Modification would not result in any material changes to the potable water demand. However, the potable water demands have been reduced slightly based on more detailed project design and engineering work that has occurred since the Surface Water

Assessment was undertaken in 2010. This slight decrease has been incorporated into the revised site water balance for the Modification.

5.4.3 Dust suppression

Water is required for dust suppression on haul roads and other disturbed areas. Dust suppression for the CHPP coal stockpiles, coal crushing areas, and coal loading areas and MIA are accounted for in the CHPP demands (refer to Section 5.4.5).

The haul road dust suppression demand for Year 1 has been estimated based on recent usage information for 2011 and 2012 provided by Boggabri Coal. Boggabri Coal has provided estimates of dust suppression demands for Years 5, 10 and 21.

A summary of the haul road dust suppression demands adopted in the water balance model for Year 1, 5, 10 and 21 is provided in Table 5-7.

Table 5-7 Haul road dust suppression demand estimates

Project year	Dust suppression demand (ML/yr)
1	226
5	555
10	555
21	555

In addition to the above, a demand of 12 ML/yr has been assumed to apply in Years 1 and 2 of the project for dust suppression at the existing rail loading facility to the west of the main mine site. It is assumed that this facility would not be operational after Year 2.

For the purposes of the water balance analysis, it has been assumed that dust suppression water will not be required on days with more than 10 mm of rainfall.

Mine water will be used as a priority for dust suppression.

The proposed Modification would not result in any material changes to the haul road dust suppression demand. However, the dust suppression demands have been revised since the Surface Water Assessment was undertaken in 2010. The Year 1 demand has increased from 162 ML/yr for the Boggabri EA to 226 ML/yr for the revised site water balance based on recent water usage data supplied by Boggabri Coal. The demand for Years 5 to 21 ranged from 493 ML/yr to 636 ML/yr for the Boggabri EA, but has changed to a constant demand of 555 ML/yr for the revised site water balance based on more detailed project design and engineering work that has occurred since the Surface Water Assessment was undertaken in 2010.

5.4.4 Vehicle washdown

Water is required for vehicle washdown in the MIA. Washdown water is recycled, however, water is required to make-up evaporative losses. Boggabri Coal estimates that approximately 20 ML/yr of vehicle washdown make-up water will be required at the site for Year 1, and 8.2 ML/yr for the remainder of the mine life once the CHPP becomes operational.

Make-up water for vehicle washdown will be sourced from raw water, and will be treated in an onsite water treatment plant prior to use.

The proposed Modification would not result in any material changes to the water demand for vehicle washdown. However, the vehicle washdown demands have been revised since the Surface Water Assessment was undertaken in 2010. The demand for Years 5 to 21 has decreased from 20 ML/yr for the Boggabri EA to 8.2 ML/yr for the revised site water balance based on more detailed project design and engineering work that has occurred since the Surface Water Assessment was undertaken in 2010. The demand for Year 1 has not changed.

5.4.5 Coal handling and preparation plant

Boggabri Coal has estimated that a peak of approximately 1,188 ML/yr of water will be required in the CHPP (net of return water) based on a peak annual processing rate of 3.5 Mtpa. This water is required for coal washing, dust suppression and washdown water etc. Of the net demand of 1,188 ML/yr, Boggabri Coal have estimated that a minimum of 189 ML/yr would need to be sourced from raw water and that the remaining 999 ML/yr would be sourced from mine water as a priority (or raw water when there is a water deficit). Raw water for the CHPP would be sourced from groundwater and /or surface water entitlements.

The CHPP will be operational after Year 2, and will process up to a 3.5 Mtpa of coal from Boggabri Coal Mine and Tarrawonga Coal Mine. The CHPP will only process coal from Tarrawonga Coal Mine in Years 2 to 18 of the Boggabri project, as the Tarrawonga Coal Project has a 17 year project life (i.e. until 2029).

The breakdown of CHPP demands is summarised in Table 5-8.

Table 5-8 CHPP demand estimates

	Coal washery feed (Mtpa)			CHPP net demand (ML/yr)		
Project year	**Tarrawonga component**	**Boggabri component**	**Total**	**Tarrawonga component**	**Boggabri component**	**Total**
1	0	0	**0**	0	0	**0**
5	1.5	2.0	**3.5**	509	679	**1,188**
10	1.5	2.0	**3.5**	509	679	**1,188**
21	0	2.0	**2.0**	0	679	**679**

Note. ^ CHPP will become operational after Year 2.

The above CHPP demand estimates have been revised since the Surface Water Assessment was undertaken in 2010. The peak CHPP demand has increased from 615 ML/yr for the Boggabri EA to 1,188 ML/yr for this Modification. The increase is attributed to an increase in the peak coal washing rate from 3.0 Mtpa for the Boggabri EA to 3.5 Mtpa for this Modification, as well as more detailed information on the CHPP design becoming available since the Surface Water Assessment was undertaken in 2010.

5.4.6 Summary

A summary of estimated water demands for Years 1, 5, 10 and 21 is provided in Table 5-9. The breakdown of the Boggabri and Tarrawonga demand components is also provided in Table 5-9.

Table 5-9 Summary of estimated water demands

Demand (ML/yr)	Project year			
	Year 1	Year 5	Year 10	Year 21
Boggabri component				
Construction water ^	380	0	0	0
Potable water	2.9	3.6	3.6	3.6
Dust suppression - haul roads	226	555	555	555
Dust suppression - rail loading facility west of site	12	0	0	0
Vehicle washdown	20	8.2	8.2	8.2
CHPP ^^	0	679	679	679
Subtotal	*641*	*1,246*	*1,246*	*1,246*
Tarrawonga component				
CHPP ^^	0	509	509	0
Subtotal	*0*	*509*	*509*	*0*
Total	**641**	**1,755**	**1,755**	**1,246**

Notes. ^ Construction water required from September 2012 to July 2014. ^^ CHPP becomes operational in July 2014.

5.5 Water balance results

External water requirements

A summary of the annual volumes of water required from external sources is provided in Table 5-10 for Years 1, 2, 5, 10 and 21 based on the 103 water balance realisations. Results for Year 3 are also provided as this is the year that the CHPP comes online in mid-year. In Table 5-10 the 95th percentile results represent very dry climatic conditions and the 5th percentile results represent very wet climatic conditions. Under wet climatic conditions, a large proportion of site demands can be met by mine water, which is why external water requirements are significantly lower for wet conditions.

Table 5-10 Estimated volume of water required from external sources to make-up demands

Landform	Total external water requirement (ML/yr)					
	5th percentile (very wet)	10th percentile (wet)	50th percentile (median)	90th percentile (dry)	95th percentile (very dry)	Greatest result (driest)
Year 1	47	48	61	151	160	177
Year 2	42	43	200	352	387	424
Year 5	221	314	1,020	1,376	1,412	1,475
Year 10	215	237	804	1,226	1,289	1,368
Year 21	213	213	223	542	636	744

Note: External water requirements given in Table 5-10 include both Boggabri and Tarrawonga demand components. Refer to Table 5-9 for breakdown between Boggabri and Tarrawonga demands.

The estimated total external water requirements provided in Table 5-10 do not account for the supply of water from water entitlements currently held by Boggabri Coal or Whitehaven/TCPL.

From Table 5-10 it can be seen that of the ‘snapshot’ landforms considered, the external water requirement peaks in Year 5, with a 95th percentile result of 1,412 ML/yr and a greatest result of 1,475 ML/yr. External water requirements are lower in Year 3 than Year 5 as it is assumed that the CHPP only comes online half-way through the year. Although demands are the same in Years 5 and 10, external water requirements decrease slightly between Years 5 and 10 as groundwater make increases. External water requirements decrease in Year 21 as CHPP demands decrease in Year 21 as water is no longer required for processing Tarrawonga coal.

Pit flooding and mine water storage

The simulated daily time series of water stored in the pit over the life of the mine is provided in Figure 5-2. The percentiles shown in the daily time series plots are daily percentile ranks of the daily results based on 103 water balance realisations.

The simulated daily time series of the water stored in the combined MW2 / MW5 and MW3 mine water storages over the life of the mine is provided in Figure 5-3. As for Figure 5-2, the percentiles shown in the daily time series plots are daily percentile ranks of the daily results based on 103 water balance realisations. The combined capacity of MW2 and MW3 is 336 ML in Years 1 and 2 (MW2 - 175ML, MW3 - 161 ML). The combined capacity of MW5 and MW3 is assumed to be 900 ML for Years 3 to 21 (MW5 - 300 ML, MW3 - 600 ML).

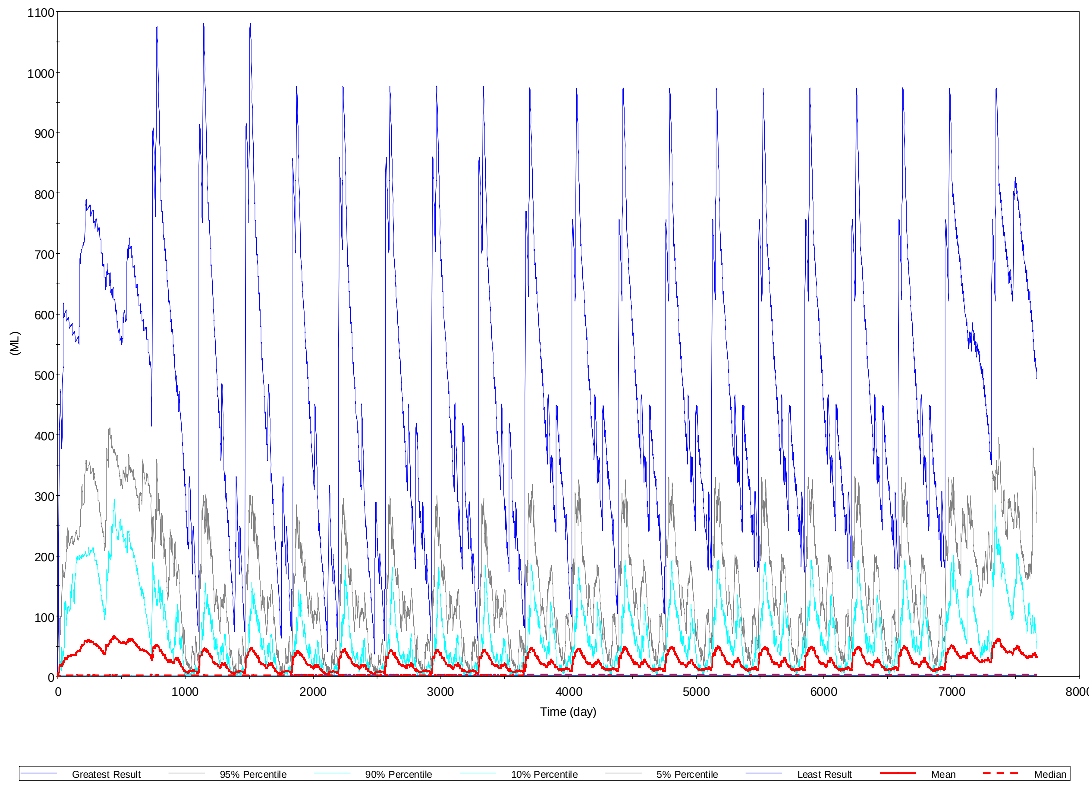


Figure 5-2 Simulated time series of water stored in pit

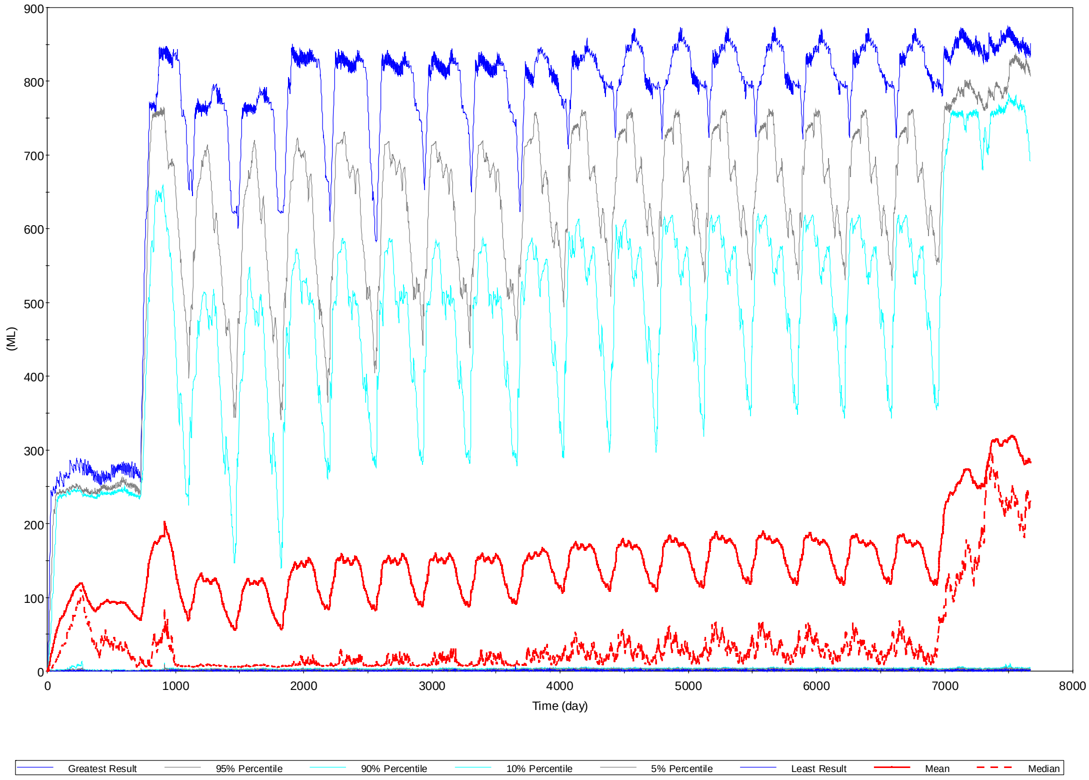


Figure 5-3 Simulated time series of combined water stored in MW2 / MW5 and MW3

From Figure 5-2 and Figure 5-3 it can be seen that in Years 1 and 2, water is stored in-pit for extended periods of time as dewatering is limited by the available mine water storage capacity in MW2 and MW3. In Years 1 and 2, surplus water would be stored in a temporary in-pit mine water storage of approximately 1,012 ML capacity (identified as a requirement from water balance modelling undertaken for the Pollution Reduction Program in March 2012, which was based on previous much lower demand estimates). The temporary storage will be a segregated void area within the advancing mining pit area. After Year 2, the CHPP becomes operational (significantly increasing demands) and there is additional mine water storage available in MW5 and MW3. Between Years 3 and 18, the pit can be dewatered reasonably quickly to mine water dams MW5 and MW3. The volumes of water stored in-pit between Years 3 and 18 are lower for the Modification compared to the Boggabri EA, as demands are increased compared to the Boggabri EA. After Year 18, water is stored in-pit for longer periods compared to Years 3 to 18, particularly during extremely wet periods. This is because after Year 18, CHPP demands decrease as Tarrawonga coal is no longer processed in the CHPP).

6. Local catchment hydrological analysis

A hydrological analysis has been undertaken for the Boggabri Coal Mine local catchment to incorporate the proposed Modification.

Hydrological models were built using XPSWMM software. The models were built for the Year 1, 5, 10 and 21 'snapshot' landforms.

6.1 Methodology

6.1.1 XPSWMM hydrologic model

XPSWMM hydrological models were previously developed for the Year 1, 5, 10 and 21 'snapshot' landforms for the Boggabri EA. For this assessment of the Modification, the Boggabri EA model was updated with the revised Year 1, 5, 10 and 21 landform information. Catchment areas and dam capacities were also revised and updated in the model.

XPSWMM is a graphics based stormwater computer model that utilises a proprietary self-modifying dynamic wave solution algorithm to adjust time steps when appropriate. The 'RUNOFF' mode of the model allows for hydrology generation and the 'HYDRAULICS' mode allows hydraulic simulation of open and closed conduits, including detention basins.

Hydrology

Design rainfall for the 5, 20 and 100 year ARI storm events was generated using Australian Rainfall and Runoff (AR&R) Volumes 1 (2001) and 2 (1987). The RUNOFF mode of XPSWMM was used to estimate runoff hydrographs for these storm events from the corresponding design rainfall inputs.

In the absence of long-term stream flow data, calibration of the XPSWMM model was not undertaken.

Hydraulics

The HYDRAULICS mode in XPSWMM was used to route the runoff hydrographs through the water management system. The Laurenson Non-Linear Runoff Routing method was adopted.

Sediment dams have been represented in the XPSWMM model as storage nodes. However, other hydraulic structures within the site (such as culverts) have not been included in the XPSWMM model.

Sediment dams from the northern waste rock emplacement area at the adjacent Tarrawonga Coal Mine have also been included in the model.

6.1.2 Model parameters

Hydrological parameters

Infiltration losses have been estimated in the XPSWMM model using the Horton Loss model in the initial loss / continuing loss mode. Loss parameters adopted for the various landuse types are provided in Table 6-1. These parameters are the same as those adopted for the Boggabri EA.

Table 6-1 Infiltration parameters adopted in XPSWMM model

Parameter	Landuse					
	Undisturbed	Industrial / roads	Rehabilitated spoil dump	Unshaped spoil dump	Mining void	Pre-strip
Impervious area Manning's n	0.014	0.014	0.014	0.014	0.014	0.014
Pervious area Manning's n	0.10	0.03	0.03	0.02	0.02	0.03
Pervious area initial loss (mm)	20	20	20	10	2.5	20
Pervious area continuing loss (mm/hr)	2.5	2.5	2.5	1	0.5	1.5
Catchment imperviousness (%)	0	90	0	0	0	0

Hydraulic parameters

A manning's roughness of 0.035 has been adopted in the XPSWMM model for diversion drains. This parameter value is the same as that adopted for the Boggabri EA.

A free outfall was adopted in the XPSWMM model as the downstream boundary condition.

6.1.3 Model assumptions

The following assumptions were made in the hydrological analysis:

- The model was run for the Year 1, 5, 10 and 21 'snapshot' landforms. No allowance has been made for changes in catchment areas or landuse types between these landforms.
- Low flow discharge pipes from dirty water sediment dams are assumed to remain open. Low flow discharge pipes have been represented in the model as pipes, sized so that the dams empty over a 3 day period.
- Pumps between sediment dams and mine water dams are assumed to remain off.
- It has been assumed that the 'sediment zone' of sediment dams is half full of sediment at the beginning of the design storm event. The 'settling zone' is assumed empty at the beginning of the design storm event. This is a conservative approach for estimating potential reductions in downstream peak flows as result of the project. However, this approach would underestimate downstream peak flows if sediment dams are full at the start of the storm event.

6.2 Results

The XPSWMM hydrologic model of the local catchment was run for the 5, 20 and 100 year ARI design storm events (for various storm durations). A summary of the peak flows rates in the local catchment is provided in Table 6-2, Table 6-3 and Table 6-4 for the Year 1, 5, 10 and 21 'snapshot' landforms, respectively.

Table 6-2 Estimated 5 year ARI peak flow rates at key locations

	Peak flow (m^3/s)			
Location	Year 1 landform	Year 5 landform	Year 10 landform	Year 21 landform
Nagero Creek downstream of SD6	38.9	26.9	12.0	27.9
Nagero Creek at outlet ^	53.0	41.4	36.3	36.1

Note. ^ The catchment outlet is the location where Nagero Creek meets the Namoi River floodplain, approximately 1 km downstream of the Project Boundary.

Table 6-3 Estimated 20 year ARI peak flow rates at key locations

	Peak flow (m^3/s)			
Location	Year 1 landform	Year 5 landform	Year 10 landform	Year 21 landform
Nagero Creek downstream of SD6	78.9	52.8	29.9	43.0
Nagero Creek at outlet ^	104.3	80.1	79.0	69.2

Note. ^ The catchment outlet is the location where Nagero Creek meets the Namoi River floodplain, approximately 1 km downstream of the Project Boundary.

Table 6-4 Estimated 100 year ARI peak flow rates at key locations

	Peak flow (m^3/s)			
Location	Year 1 landform	Year 5 landform	Year 10 landform	Year 21 landform
Nagero Creek downstream of SD6	128.1	94.5	62.4	80.7
Nagero Creek at outlet ^	171.4	137.6	130.1	118.5

Note. ^ The catchment outlet is the location where Nagero Creek meets the Namoi River floodplain, approximately 1 km downstream of the Project Boundary.

From Table 6-2 to Table 6-4 it can be seen that the estimated peak flows at the catchment outlet reduce over the life of the project. The estimated 100 year ARI peak flow reduces from 171 m^3/s for the Year 1 landform to 119 m^3/s for the Year 21 landform (a reduction of 32 %). The catchment outlet is the location where Nagero Creek meets the Namoi River floodplain, approximately 1 km downstream of the Project Boundary.

The estimated 100 year ARI peak flow for the Year 21 landform at the catchment outlet was 136 m^3/s for the Boggabri EA compared to 119 m^3/s for the Modification. The peak flow has reduced for the Modification as there is reduced surface runoff from the Boggabri Coal Mine waste rock emplacement discharging to Nagero Creek due to the integration of the Boggabri and Tarrawonga waste rock emplacement landforms. In Year 21, the majority of the rehabilitated Tarrawonga final landform now discharges south towards Bollol Creek rather than discharging to the north and east towards Nagero Creek.

7. Potential impacts of the Modification on existing surface water environment

7.1 Water demand

The Boggabri Coal Mine water management system would be designed to reuse as much contaminated water onsite as possible. Contaminated water will be used as a priority to meet construction, dust suppression and CHPP make-up water demands. Water from external sources will only be used to meet these demands when there is an onsite water deficit. As contaminated water is not suitable to meet vehicle washdown, potable water and the CHPP raw water component demands, this water will be sourced from external sources.

A summary of the estimated volumes of water required from external sources is provided in Table 7-1 for the Year 1, 5, 10 and 21 landforms.

Table 7-1 Summary of external water requirements

Landform	Demand (ML/yr)	External water requirement (ML/yr) ^				
		5^{th} percentile (very wet)	10^{th} percentile (wet)	50^{th} percentile (median)	90^{th} percentile (dry)	95^{th} percentile (very dry)
Year 1	641	47	48	61	151	160
Year 5	1,755	221	314	1,020	1,376	1,412
Year 10	1,755	215	237	804	1,226	1,289
Year 21	1,246	213	213	223	542	636

Note. ^ External water requirements do not account for water supplied from Boggabri Coal's existing entitlements.

The water balance analysis indicates that the annual water surplus / deficit varies significantly throughout the life of the Project, and is highly dependent on rainfall throughout the year, total rainfall and soil wetness / dryness. As for the Boggabri EA, there is expected to be a water surplus in Year 1 under median climatic conditions, and a deficit in Years 5, 10 and 21 under median climatic conditions.

The highest requirements for external water were estimated for the Year 5 landform, when CHPP and dust suppression demands are at their greatest but groundwater make is not as high as the later years of the mine life. For the Year 5 landform, a total of 1,020 ML/yr would be required from external sources to meet the 50^{th} percentile requirement (representative of median climatic conditions) and a total of 1,412 ML/yr would be required from external sources to meet the 95^{th} percentile requirement (representative of very dry climatic conditions). The requirements for external water reduce slightly between Years 5 and 10 as groundwater make increases. The requirement for external water reduces significantly between Years 10 and 21 as the CHPP demand decreases in Year 21 as water is no longer required for processing Tarrawonga coal.

A total of 808 unit shares of groundwater would be available to Boggabri Coal from the current aquifer and low security category groundwater licenses. An additional 131 unit shares of groundwater would potentially be available to Boggabri Coal from the supplementary category groundwater license.

A total of 294 unit shares of river water would be available to Boggabri Coal from the general security category water access licenses. An additional 31.7 unit shares of river water would potentially be available to Boggabri Coal from the supplementary category water access licenses.

A total of 590 unit shares of river water would be available to Whitehaven/TCPL from the current general security category water access licenses. An additional 28.2 unit shares of river water would potentially be available to Whitehaven/TCPL from the supplementary category water access licenses.

The actual volume of water available to Boggabri Coal and Whitehaven/TCPL would depend on the AWD's made under the Water Sharing Plan.

In the event that the existing water entitlements held by Boggabri Coal and Whitehaven/TCPL are not adequate to meet demands under drier conditions, additional licences could be obtained through the open water trading market (either temporarily or permanently).

In accordance with Schedule 3, Condition 38 of Project Approval 09_0182, Boggabri Coal will prepare a Site Water Balance as part of the Water Management Plan for the Boggabri Coal Project within six months of Project Approval. The Site Water Balance is required to include details of the security of water supply, and will be prepared in consultation with the DP&I, Office of Environment and Heritage, NSW Office of Water, Namoi Catchment Management Authority and the Community Consultative Committee.

7.2 Local hydrology

7.2.1 Catchment area

The Project will result in modifications to the local catchment. The area of undisturbed (or rehabilitated) catchment draining to Nagero Creek will reduce over the life of the Project, as the area draining to the mine sites dirty and contaminated water management systems increases. A summary of catchment areas is provided in Table 7-2.

Table 7-2 Modifications to Nagero Creek catchment breakdown over life of the Project

	Catchment area (ha) ^			
Landform	**Boggabri contaminated water system**	**Boggabri dirty water system**	**Boggabri clean water system, rehabilitated area direct to Nagero Creek and natural catchment**	**Tarrawonga catchment**
Year 1	411	165	3,476	111
Year 5	599 (46%)	712 (332%)	2,454 (-29%)	146 (32%)
Year 10	480 (17%)	1,098 (565%)	2,129 (-39%)	414 (273%)
Year 21	612 (49%)	771 (367%)	2,309 (-34%)	108 (-3%)

Note. ^ Percentage change from Year 1 is given in brackets

7.2.2 Peak flow rates

A summary of estimated peak flow rates is provided in Table 7-3 for the Year 1, 5, 10 and 21 landforms where Nagero Creek meets the Namoi River floodplain, approximately 1 km downstream of the Project Boundary.

Table 7-3 Summary of estimated peak flow rates at catchment outlet

	Peak flow rate (m^3/s) ^		
Landform	**5yr ARI**	**20yr ARI**	**100yr ARI**
Year 1	53.0	104.3	171.4
Year 5	41.4 (-22%)	80.1 (-23%)	137.6 (-20%)
Year 10	36.3 (-32%)	79.0 (-24%)	130.1 (-24%)
Year 21	36.1 (-32%)	69.2 (-34%)	118.5 (-31%)

Note. ^ Percentage change from Year 1 is given in brackets

The hydrologic analysis indicates that peak flow rates at the catchment outlet will reduce over the life of the Project. The reduction in peak flow rates may be attributed to dirty runoff being captured in sediment dams and slowly released to Nagero Creek or reused on site, which attenuates peak flow rates. This affect generally increases over the life of the project, as the catchment area contributing to the dirty water system generally increases. During Years 5, 10 and 21, dirty water from the waste rock emplacement catchment is reused onsite to supplement a water deficit. During extended wet periods when water is not required to supplement a deficit, dirty water may be released to Nagero Creek following settling of suspended solids in sediment dams and water quality testing.

The reduction in peak flow rates may also be attributed to contaminated runoff being stored onsite for reuse, rather than being discharged to Nagero Creek. This affect increases over the life of the Project, as the catchment area contributing to the contaminated water system generally increases.

The estimated reduction in peak flow rates over the life of the project is greater for the Modification compared to the Boggabri EA. The estimated 100 year ARI peak flow for the Year 21 landform at the catchment outlet was 136 m^3/s for the Boggabri EA compared to 119 m^3/s for the Modification. The peak flow has reduced for the Modification as there is reduced surface runoff from the Boggabri Coal Mine waste rock emplacement discharging to Nagero Creek due to the integration of the Boggabri and Tarrawonga waste rock emplacement landforms. The majority of the rehabilitated Tarrawonga final landform now discharges south towards Bollol Creek rather than discharging to the north and east towards Nagero Creek.

7.2.3 Runoff volumes

A summary of estimated annual runoff volumes is provided in Table 7-4 for the Year 1, 5, 10 and 21 landforms where Nagero Creek meets the Namoi River floodplain, approximately 1 km downstream of the Project Boundary. Runoff to Nagero Creek includes clean water runoff that is diverted around the mine site, discharges from sediment dams that capture dirty water runoff from disturbed areas, and discharges from established rehabilitation areas.

Table 7-4 Summary of estimated annual runoff volumes at catchment outlet based on 103 water balance realisations

Landform	Annual runoff volume (ML/yr)				
	5th percentile	10th percentile	50th percentile (median)	90th percentile	95th percentile
Year 1	646	701	1,803	5,316	6,585
Year 5	478 (-26%)	560 (-20%)	1,441 (-20%)	4,435 (-17%)	5,539 (-16%)
Year 10	447 (-31%)	552 (-21%)	1,507 (-16%)	4,816 (-9%)	6,297 (-4%)
Year 21	432 (-33%)	490 (-30%)	1,252 (-31%)	4,532 (-15%)	5,836 (-11%)

Note. ^ Percentage change from Year 1 is given in brackets

The water balance analysis suggests that annual median runoff volumes in Nagero Creek at the catchment outlet will generally reduce over the life of the Project.

The reduction in annual runoff volumes may be attributed to dirty runoff being captured in sediment dams. Water stored in the ‘settling zone’ is generally slowly released to Nagero Creek. However, water stored in the ‘sediment zone’ is retained and evaporates over time, causing an overall reduction in the volume of runoff discharged to Nagero Creek. In Years 5, 10 and 21, water stored in the ‘settling zone’ can also be reused onsite if the site is in a water deficit. The reduction in annual runoff volumes may also be attributed to contaminated runoff being stored onsite for reuse, rather than discharged to Nagero Creek.

The reduction in annual runoff volumes will result in a reduction in environmental flows in Nagero Creek downstream of the site. The maximum reduction in median flows will be experienced during Year 21 of the Project, when median stream flows can be expected to reduce from 1,803 ML/yr in Year 1 to 1,252 ML/yr in Year 21 at the point where Nagero Creek meets the floodplain compared to Year 1. This is a reduction of 551 ML/yr (or 31%) compared to Year 1.

The maximum annual median runoff volume reduction of 551 ML/yr (or 31%) for Nagero Creek at the catchment outlet is approximately 0.06% of the mean annual stream flow for the Namoi River at Boggabri of 906,470ML/yr. As such the reduction in runoff volumes associated with the Project is not expected to have a significant impact on environmental flows in the Namoi River.

The estimated reduction in runoff volumes over the life of the project is greater for the Modification compared to the Boggabri EA. The estimated median runoff volume in Nagero Creek at the catchment outlet for the Year 21 landform was 1,690 ML/yr for the Boggabri EA compared to 1,252 ML/yr for the Modification. The runoff volume reduced for the Modification as there is reduced surface runoff from the Boggabri Coal Mine waste rock emplacement discharging to Nagero Creek due to the integration of the Boggabri and Tarrawonga waste rock emplacement landforms. The majority of the rehabilitated Tarrawonga final landform now discharges south towards Bollol Creek rather than discharging to the north and east towards Nagero Creek.

7.3 Water quality

Management strategies for topsoil stripping and handling, topsoil respreading, post disturbance regrading, erosion and sediment control, and seedbed preparation will be implemented during the construction, operation and rehabilitation phases to control the quality of runoff from the Project site. With the implementation of these strategies, mine infrastructure construction activities, both at the mining area and over and adjacent to the Namoi River along the rail spur and power line route, are not expected to significantly impact surface water quality.

The proposed water management system for the Project has been designed to segregate clean runoff, dirty runoff and contaminated water generated from rainfall events and mining operations.

Contaminated water is defined as runoff generated from coal stockpiles and the mining void, as well as groundwater inflows to the mining void. Key contaminants include suspended solids and soluble salts. Contaminated water will not be discharged to Nagero Creek, and will instead be stored onsite for reuse. It is therefore considered unlikely that this water will adversely impact surface water quality downstream of the site.

Dirty water is defined as runoff from disturbed areas within the mine site and includes runoff from the unshaped waste rock emplacement areas and haul roads. The key pollutant associated with dirty runoff is suspended solids. Dirty water sediment dams are proposed to capture this water and to encourage settling of suspended solids prior to release of water to Nagero Creek. Based on the findings of the Geochemical Assessment (RGS, 2009) undertaken for the Boggabri EA, runoff from waste rock emplacements is not expected to significantly impact surface water quality downstream of the site (refer to Section 2.7 for findings of the Geochemical Assessment).

The proposed Modification is not expected to significantly alter downstream water quality compared to the mining operations currently approved for the Boggabri Coal Project.

Runoff from overburden areas captured in sediment dams will be released to the creek system when water quality discharge criteria have been met as determined by monitoring, or will be transferred to mine water dams for reuse on site. Runoff from the expanded CHPP areas will be directed to SD10 and SD12 and will be reused on site to meet demands as a priority. Runoff captured in SD10 and SD12 will not be discharged to the creek system.

8. Surface water monitoring

A surface water quality monitoring program is already in place at the site in accordance with the conditions of the EPL No. 12407.

In accordance with Schedule 3, Condition 38 of Project Approval 09_0182 the existing monitoring program will be revised to include new sediment dams and mine water storages and will form part of the Water Management Plan for Boggabri Coal Project.

The surface water quality monitoring program for the Boggabri Coal Project is summarised in Table 8-1.

Table 8-1 Proposed surface water quality monitoring program

Location	Parameter	Frequency
Sediment dams	Visual inspection and in situ measurement of pH, EC, turbidity ^	Daily
	pH, EC, nitrate, nitrogen (total), oil and grease, phosphorus (total), reactive phosphorus, TSS, dissolved metals	Quarterly, correction action event
Mining void	pH, EC	Quarterly
Nagero Creek upstream of site (SW2) ^^	pH, EC, nitrate, nitrogen (total), oil and grease, phosphorus (total), reactive phosphorus, TSS, dissolved metals	Quarterly, correction action event
Nagero Creek downstream of site (SW1)	pH, EC, nitrate, nitrogen (total), oil and grease, phosphorus (total), reactive phosphorus, TSS, dissolved metals	Quarterly, correction action event
MW3	pH, standing water level	Weekly

Notes: ^ Refer to Section 4.3.1 for the proposed strategy for operation of dirty water sediment dams.
^^ Monitoring at location SW2 will not be possible after Year 5.

It is proposed to continue monitoring upstream of the site at location 'SW2' until Year 5. It will not be possible to continue monitoring at 'SW2' after Year 5, as this location will be disturbed by mining. However, it is expected that by Year 5 there will be sufficient monitoring data (approximately 8 years of data) from 'SW2' to establish baseline water quality. Other upstream locations are not considered suitable for water quality monitoring due to very low stream flows.

8.1 Concentration limits

The water quality monitoring data collected to date indicates that the background surface water runoff has naturally elevated suspended solids concentrations that are above the limits set by EPL No. 12407 for Boggabri Coal Mine. This can be demonstrated at baseline monitoring site 'SW2' that is located upstream of existing mining operations. Baseline water quality monitoring data is provided in Section 2.4.

It is therefore proposed that water quality concentration limits for the Project be based on the monitoring data collected to date at baseline monitoring site 'SW2'.

9. Conclusion

This report documents the revised surface water assessment for the proposed modification to the Boggabri Coal Project (the Modification), including revised site water balance modelling and revised hydrologic modelling of the local catchment.

The Modification would result in changes to the surface water management regime described in the Boggabri EA, due to the:

- increased water demand associated with processing of up to 1.5 Mtpa ROM coal from Tarrawonga Coal Mine in Years 2 to 17 of the Tarrawonga Coal Project (i.e. 2014 to 2030)
- adjustments to the Boggabri MIA and CHPP area in order to provide additional coal stockpiling areas and haul roads necessary to receive and process the Tarrawonga coal
- integration of the Tarrawonga Northern Emplacement area with the southern extent of the Boggabri waste rock emplacement.

The key effects of these changes are:

- an increased CHPP water demand at the site and an increased water deficit in Years 2 to 17 of the Tarrawonga Coal Project (i.e. 2014 to 2030) due to the processing of Tarrawonga coal at the CHPP
- reduced area of surface runoff from the Boggabri Coal Mine waste rock emplacement draining to dirty water sediment dams SD3 and SD7, due to the integration of the Boggabri and Tarrawonga waste rock emplacements
- reduced runoff volumes and peak flow rates to Nagero Creek downstream of the mine site, due to the integration of the Boggabri and Tarrawonga waste rock emplacements
- increased combined capacity of contaminated water sediment dams SD10 and SD12 located in the CHPP to accommodate the expanded CHPP area, and to store 10 days of CHPP demand
- increased capacity of dirty water sediment dam SD8 located in the MIA to accommodate the expanded MIA.

Water management for the Boggabri Coal Project will be conducted in accordance with the Water Management Plan, which is required under Schedule 3, Condition 38 of Project Approval 09_0182. The Water Management Plan for the Boggabri Coal Project would be suitable for the Modification, with only minor adjustments required to accommodate the above changes.

10. References

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Environment Protection Licence No. 12407, issued by the NSW EPA under Section 55 of the Protection of the Environment Operations Act 1997.

Appendix A

Water quality monitoring data

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES0810297**	Page	: 1 of 3
Client	: **BOGGABRI COAL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR JOE RENNICK	Contact	: Victor Kedicioglu
Address	: 135 MERTON STREET BOGGABRI NSW, AUSTRALIA 2382	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: joe.rennick@boggabricoal.com.au	E-mail	: victor.kedicioglu@alsenviro.com
Telephone	: 67434027	Telephone	: +61-2-8784 8555
Facsimile	: 67434496	Facsimile	: +61-2-8784 8500
Project	: EP L 12407 SURFACE WATER	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 18-JUL-2008
Sampler	: JOE RENNICK	Issue Date	: 28-JUL-2008
Site	: BOGGABRI		
		No. of samples received	: 4
Quote number	: ----	No. of samples analysed	: 4

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Inorganics
Sarah Millington	Senior Inorganic Chemist	Inorganics

General Comments

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When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key : CAS Number = Chemistry Abstract Services number

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

Analytical Results

Sub-Matrix: WATER			Client sample ID	MW3	SD2	SD3	NAGERO DAM	----
			Client sampling date / time	17-JUL-2008 11:00	17-JUL-2008 10:45	17-JUL-2008 11:15	17-JUL-2008 10:30	----
Compound	CAS Number	LOR	Unit	ES0810297-001	ES0810297-002	ES0810297-003	ES0810297-004	----
EA005: pH								
pH Value	----	0.01	pH Unit	8.80	8.10	8.14	8.06	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	1300	310	818	507	----
EA025: Suspended Solids								
^ Suspended Solids (SS)	----	1	mg/L	38	44	46	165	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.010	mg/L	0.094	0.042	<0.010	0.018	----
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.010	mg/L	6.19	1.28	<0.010	0.169	----
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N	----	0.010	mg/L	6.28	1.32	<0.010	0.187	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	1.6	32.0	0.9	1.5	----
EK062: Total Nitrogen as N								
^ Total Nitrogen as N	----	0.1	mg/L	7.8	33.3	0.9	1.7	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	13.0	0.15	0.26	----

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES0814091**	Page	: 1 of 3
Client	: **BOGGABRI COAL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR JOE RENNICK	Contact	: Charlie Pierce
Address	: 135 MERTON STREET BOGGABRI NSW, AUSTRALIA 2382	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: joe.rennick@boggabricoal.com.au	E-mail	: charlie.pierce@alsenviro.com
Telephone	: 67434027	Telephone	: +61-2-8784 8555
Facsimile	: 67434496	Facsimile	: +61-2-8784 8500
Project	: EPL 12407 SURFACE WATER	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 25-SEP-2008
Sampler	: J.R.	Issue Date	: 07-OCT-2008
Site	: BOGGABRI		
		No. of samples received	: 3
Quote number	: ----	No. of samples analysed	: 3

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

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- General Comments
- Analytical Results

NATA Accredited Laboratory 825

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WORLD RECOGNISED ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Hoa Nguyen	Inorganic Chemist	Inorganics
Sarah Millington	Senior Inorganic Chemist	Inorganics

General Comments

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LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

Analytical Results

Sub-Matrix: **WATER**			Client sample ID	SW3	SD2	SW1	----	----
			Client sampling date / time	23-SEP-2008 08:00	23-SEP-2008 08:15	23-SEP-2008 08:30	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES0814091-001**	**ES0814091-002**	**ES0814091-003**	----	----
EA005: pH								
pH Value	----	0.01	pH Unit	**5.85**	**6.80**	**6.69**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**56**	**337**	**231**	----	----
EA025: Suspended Solids								
^ Suspended Solids (SS)	----	1	mg/L	**99**	**273**	**2070**	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	**0.01**	**0.02**	**0.16**	----	----
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.01	mg/L	**0.05**	**1.28**	**2.24**	----	----
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.06**	**1.29**	**2.40**	----	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.6**	**2.1**	**1.4**	----	----
EK062: Total Nitrogen as N								
^ Total Nitrogen as N	----	0.1	mg/L	**0.7**	**3.4**	**3.8**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.19**	<0.01	**0.38**	----	----

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES0814765**	Page	: 1 of 4
Client	: **BOGGABRI COAL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR JOE RENNICK	Contact	: Charlie Pierce
Address	: 135 MERTON STREET BOGGABRI NSW, AUSTRALIA 2382	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: joe.rennick@boggabricoal.com.au	E-mail	: charlie.pierce@alsenviro.com
Telephone	: 67434027	Telephone	: +61-2-8784 8555
Facsimile	: 67434496	Facsimile	: +61-2-8784 8500
Project	: EPI 12407 SURFACE WATER	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 08-OCT-2008
Sampler	: JR	Issue Date	: 17-OCT-2008
Site	: BOGGABRI		
		No. of samples received	: 6
Quote number	: ----	No. of samples analysed	: 6

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

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- Analytical Results

NATA WORLD RECOGNISED ACCREDITATION

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Signatories

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Signatories	*Position*	*Accreditation Category*
Hoa Nguyen	Inorganic Chemist	Inorganics

General Comments

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- **EK057G, It has been noted that NO2 is greater than NOX (for sample ID 9 WS3) however this difference is within the limits of experimental variation.**
- **EK059G & EKO58G: LOR raised for NOx and NO3 on sample ID (SW1 and SW3) due to sample matrix.**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	SW1	SW3	SD3	SD2	SD6
			Client sampling date / time	06-OCT-2008 12:40	06-OCT-2008 13:00	06-OCT-2008 12:15	06-OCT-2008 12:30	06-OCT-2008 12:40
				ES0814765-001	ES0814765-002	ES0814765-003	ES0814765-004	ES0814765-005
EA005: pH								
pH Value	----	0.01	pH Unit	7.44	7.02	7.20	7.26	7.10
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	127	72	295	247	355
EA025: Suspended Solids								
^ Suspended Solids (SS)	----	1	mg/L	169	32	656	382	60
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	0.05	0.03	0.05	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.01	mg/L	<0.05	<0.05	1.83	0.97	0.43
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.05	<0.01	1.88	0.97	0.43
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	3.1	0.6	4.1	0.4	1.1
EK062: Total Nitrogen as N								
^ Total Nitrogen as N	----	0.1	mg/L	3.1	0.6	6.0	1.3	1.5
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	0.29	0.13	1.72	0.10	0.23

Analytical Results

Sub-Matrix: WATER			Client sample ID	TARRAWONA DISCHARGE	----	----	----	----
			Client sampling date / time	06-OCT-2008 12:00	----	----	----	----
Compound	CAS Number	LOR	Unit	ES0814765-006	----	----	----	----
EA005: pH								
pH Value	----	0.01	pH Unit	6.97	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	750	----	----	----	----
EA025: Suspended Solids								
^ Suspended Solids (SS)	----	1	mg/L	12	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	0.04	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.01	mg/L	0.32	----	----	----	----
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	0.36	----	----	----	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.6	----	----	----	----
EK062: Total Nitrogen as N								
^ Total Nitrogen as N	----	0.1	mg/L	1.0	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	0.07	----	----	----	----

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES0815378**	Page	: 1 of 6
Client	: **BOGGABRI COAL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: J. MCDONOUGH	Contact	: Charlie Pierce
Address	: 135 MERTON STREET BOGGABRI NSW, AUSTRALIA 2382	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: jmcdonough@pb.com.au	E-mail	: charlie.pierce@alsenviro.com
Telephone	: +61 02 65718328	Telephone	: +61-2-8784 8555
Facsimile	: +61 02 67434496	Facsimile	: +61-2-8784 8500
Project	: ----	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: 45259	Date Samples Received	: 17-OCT-2008
Sampler	: ----	Issue Date	: 29-OCT-2008
Site	: BOGGABRI		
		No. of samples received	: 5
Quote number	: ----	No. of samples analysed	: 5

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

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- General Comments
- Analytical Results
- Surrogate Control Limits

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Signatories

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Signatories	*Position*	*Accreditation Category*
Celine Conceicao	Spectroscopist	Inorganics
Edwandy Fadjar	Senior Organic Chemist	Organics
Hoa Nguyen	Inorganic Chemist	Inorganics
Sarah Millington	Senior Inorganic Chemist	Inorganics

General Comments

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- **EK50G: Matrix spike failed for NH3 due to sample matrix (confirm by re-analysis).**
- **EP080: Level of Reporting raised for toluene due to ambient background levels in the laboratory.**
- **TDS by method EA-015 may bias high for sample ID 'SD6' due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.**

Analytical Results

Sub-Matrix: WATER			Client sample ID	LV1	MW2	SD6	DMH1	DMB1
			Client sampling date / time	16-OCT-2008 15:00	16-OCT-2008 15:00	16-OCT-2008 15:00	16-OCT-2008 15:00	16-OCT-2008 15:00
Compound	CAS Number	LOR	Unit	ES0815378-001	ES0815378-002	ES0815378-003	ES0815378-004	ES0815378-005
EA005: pH								
pH Value	----	0.01	pH Unit	7.45	8.59	7.75	7.03	6.91
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	1020	1300	394	2290	3500
EA015: Total Dissolved Solids								
^ Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	614	814	----	1640	2580
Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	----	----	572	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	78	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	451	314	122	741	425
Total Alkalinity as CaCO3	----	1	mg/L	451	392	122	741	425
ED041: Sulfate (Turbidimetric) as SO4 2-								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	8	65	4	41	196
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	75	110	42	335	905
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	22	14	11	87	128
Magnesium	7439-95-4	1	mg/L	8	11	5	57	90
Sodium	7440-23-5	1	mg/L	238	282	59	384	540
Potassium	7440-09-7	1	mg/L	7	9	10	3	3
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	0.004	----	<0.001	0.004
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	0.0004	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.009	0.002	----	0.030	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	0.002	----	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	0.069	0.011	----	0.084	0.020
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	----	<0.05	0.88
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	----	----	0.002	----	----
Cadmium	7440-43-9	0.0001	mg/L	----	----	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	----	----	0.007	----	----
Copper	7440-50-8	0.001	mg/L	----	----	0.016	----	----
Lead	7439-92-1	0.001	mg/L	----	----	0.006	----	----
Nickel	7440-02-0	0.001	mg/L	----	----	0.009	----	----
Zinc	7440-66-6	0.005	mg/L	----	----	0.022	----	----

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	LV1	MW2	SD6	DMH1	DMB1
			Client sampling date / time	16-OCT-2008 15:00	16-OCT-2008 15:00	16-OCT-2008 15:00	16-OCT-2008 15:00	16-OCT-2008 15:00
				ES0815378-001	ES0815378-002	ES0815378-003	ES0815378-004	ES0815378-005
EG020T: Total Metals by ICP-MS - Continued								
Iron	7439-89-6	0.05	mg/L	----	----	**6.92**	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.10**	<0.01	**0.11**	<0.01	<0.01
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	**0.15**	<0.01	**0.03**	<0.01
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.01	mg/L	<0.01	**6.76**	**0.15**	**2.73**	**0.16**
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	**6.92**	**0.15**	**2.76**	**0.16**
EK062: Total Nitrogen as N (TKN + NOx)								
Total Nitrogen as N	----	0.1	mg/L	**0.2**	**9.1**	**1.0**	**3.2**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	**0.13**	**0.31**	<0.01	<0.01
EN055: Ionic Balance								
^ Total Anions	----	0.01	meq/L	**11.3**	----	**3.71**	**25.1**	**38.1**
Total Anions	----	0.01	meq/L	----	**12.9**	----	----	----
^ Total Cations	----	0.01	meq/L	**12.3**	**14.1**	**3.78**	**25.8**	**37.4**
^ Ionic Balance	----	0.01	%	**4.16**	----	**0.90**	**1.36**	**0.99**
Ionic Balance	----	0.01	%	----	**4.44**	----	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	----	<5	<5	----	----
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	**4**	<2	**5**	<2	<2
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	----	<20	<20	----	----
EP080: BTEX								
Benzene	71-43-2	1	µg/L	----	<1	<1	----	----
Toluene	108-88-3	2	µg/L	----	<5	<5	----	----
Ethylbenzene	100-41-4	2	µg/L	----	<2	<2	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	----	<2	<2	----	----
ortho-Xylene	95-47-6	2	µg/L	----	<2	<2	----	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	----	**96.8**	**93.4**	----	----
Toluene-D8	2037-26-5	0.1	%	----	**92.4**	**86.0**	----	----
4-Bromofluorobenzene	460-00-4	0.1	%	----	**80.6**	**97.1**	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	Recovery Limits (%) High
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	80	120
Toluene-D8	2037-26-5	88	110
4-Bromofluorobenzene	460-00-4	86	115

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES0818659**	Page	: 1 of 3
Client	: **BOGGABRI COAL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR JOE RENNICK	Contact	: Charlie Pierce
Address	: 135 MERTON STREET BOGGABRI NSW, AUSTRALIA 2382	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: joe.rennick@boggabricoal.com.au	E-mail	: charlie.pierce@alsenviro.com
Telephone	: 67434027	Telephone	: +61-2-8784 8555
Facsimile	: 67434496	Facsimile	: +61-2-8784 8500
Project	: EPI 12407 SURFACE WATER	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 17-DEC-2008
Sampler	: JR	Issue Date	: 30-DEC-2008
Site	: ----		
		No. of samples received	: 2
Quote number	: ----	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Sarah Millington	Senior Inorganic Chemist	Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key : CAS Number = Chemistry Abstract Services number
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

Analytical Results

Sub-Matrix: WATER			Client sample ID	SW3	SW1	----	----	----
			Client sampling date / time	13-DEC-2008 08:00	13-DEC-2008 08:30	----	----	----
Compound	CAS Number	LOR	Unit	ES0818659-001	ES0818659-002	----	----	----
EA005: pH								
pH Value	----	0.01	pH Unit	7.82	7.60	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	86	174	----	----	----
EA025: Suspended Solids								
^ Suspended Solids (SS)	----	1	mg/L	66	158	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.01	mg/L	0.01	0.03	----	----	----
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	0.01	0.03	----	----	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.8	1.2	----	----	----
EK062: Total Nitrogen as N								
^ Total Nitrogen as N	----	0.1	mg/L	0.8	1.2	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	----	0.01	mg/L	0.01	0.13	----	----	----

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES0902366**	Page	: 1 of 3
Client	: **BOGGABRI COAL PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR JOE RENNICK	Contact	: Charlie Pierce
Address	: 135 MERTON STREET BOGGABRI NSW, AUSTRALIA 2382	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: joe.rennick@boggabricoal.com.au	E-mail	: charlie.pierce@alsenviro.com
Telephone	: 67434027	Telephone	: +61-2-8784 8555
Facsimile	: 67434496	Facsimile	: +61-2-8784 8500
Project	: EPL 12407 SURFACE WATER	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 17-FEB-2009
Sampler	: JR	Issue Date	: 25-FEB-2009
Site	: BOGGABRI		
		No. of samples received	: 2
Quote number	: ----	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Hoa Nguyen	Inorganic Chemist	Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

Analytical Results

Sub-Matrix: WATER			Client sample ID	SW3	SW1	----	----	----
			Client sampling date / time	17-FEB-2009 08:05	17-FEB-2009 08:00	----	----	----
Compound	CAS Number	LOR	Unit	ES0902366-001	ES0902366-002	----	----	----
EA005: pH								
pH Value	----	0.01	pH Unit	**7.08**	**7.27**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**33**	**59**	----	----	----
EA025: Suspended Solids								
^ Suspended Solids (SS)	----	1	mg/L	**110**	**160**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	**0.01**	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.01	mg/L	**0.03**	**0.32**	----	----	----
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.03**	**0.34**	----	----	----
EK061: Total Kjeldahl Nitrogen (TKN)								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.5**	**1.5**	----	----	----
EK062: Total Nitrogen as N								
^ Total Nitrogen as N	----	0.1	mg/L	**0.5**	**1.9**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.11**	**0.12**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	----	0.01	mg/L	**0.05**	**0.03**	----	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	----	----	----

ALS Laboratory Group
Analytical Chemistry Testing Services

Date of Sample	Time	Colliery Site Reference	Field pH	pH	Field EC (µS/cm)	Electrical Conductivity @ 25°C (µS/cm)	Temp	Field TSS	TSS	TDS	Oil & Grease	Sampled by	General Comments/ Observations	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Sulfate as SO4 - Turbidimetric
16-Feb-12	15:10	SW1	7.7	7.79	378	470	28.9	-	17	394	<5	J. Miller & B. Winsor	Turbid	<1	<1	138	138	<1
17-Feb-12	8:00	SW1	7.9		638		19.3	197				J. Miller & B. Winsor						
17-Feb-12	16:00	SW1	7.7		695		26.9	91				J. Miller & B. Winsor						
17-Feb-12	18:30	SW1	8.1	7.86	682	853	27.7	130	187	572	<5	J. Miller & B. Winsor		<1	<1	202	202	86
18-Feb-12	9:30	SW1	7.9		717		22.2	89				B. Winsor & B. Kelly						
18-Feb-12	15:20	SW1	8	7.98	725	886	27.7	62	36	592	<5	B. Winsor & B. Kelly		<1	<1	209	209	84
18-Feb-12	17:15	SW1	7.8		707		27.6	71				B. Winsor & B. Kelly						
19-Feb-12	8:45	SW1	7.8		796		22.2	111				J. Miller & E. Blackburn						
19-Feb-12	14:40	SW1	7.8	8.16	814	997	29.2	82	72	620	<5	J. Miller & E. Blackburn	Sampled at different spot for a more representive result	<1	<1	227	227	108
19-Feb-12	17:10	SW1	8.5		782		28.2	80				J. Miller & E. Blackburn						
20-Feb-12	9:05	SW1	8.3		776		24	94				G. Thomson & J. Miller						
20-Feb-12	12:20	SW1	8.5	8.37	777	965	27.2	88	40	593	<5	G. Thomson & J. Miller		<1	5	215	220	98
20-Feb-12	15:55	SW1	8.42		1020		28.7	79				G. Thomson & J. Miller						
21-Feb-12	7:50	SW1	7.88		900		23.4	219				G. Thomson						
21-Feb-12	11:30	SW1	8.14		950		25.4					G.Thomson		<1	14	203	217	92
21-Feb-12	15:40	SW1	8.48	8.44	960	910	28	114	48	556	<5	G. Thomson						
21-Feb-12	16:40	SW1	8.19		930		27.7	148				G. Thomson						
22-Feb-12	7:55	SW1	8.2		1020		21.3	96				G. Thomson		<1	4	212	216	99
22-Feb-12	10:00	SW1	8.28	8.33	1030	1000	23.4	63	28	676	<5	G. Thomson						
22-Feb-12	15:45	SW1	8.77		1020		25.2	70				G. Thomson						
23-Feb-12	8:15	SW1	7.9		1050		21.4	85				G. Thomson						
23-Feb-12	10:50	SW1	8.19	8.3	1050	1030	24.3	74	28	698	<5	G. Thomson		<1	2	217	219	132
23-Feb-12	15:45	SW1	8.54		1030		29.2	54				G. Thomson						
24-Feb-12	9:10	SW1	8.32		980		21.5	75				J. Miller						
24-Feb-12	14:10	SW1	8.77		980		27.4	56				J. Miller						
24-Feb-12	18:40	SW1	8.73	8.19	740	1040	28.1	49	28	660	<5	J. Miller		<1	<1	212	212	110
24-Feb-12	19:55	SW1	8.56		820		26.2	63				J. Miller						
25-Feb-12	8:20	SW1	8.07		1170		21.1	55				G. Thomson						
25-Feb-12	11:15	SW1	8.33	8.33	1183	1040	22.5	43	21	664	<5	G. Thomson		<1	3	212	215	111
25-Feb-12	15:05	SW1	8.38		1064		23.4	43				G. Thomson						
26-Feb-12	7:20	SW1	8.14		1083		22.2	53				G. Thomson						
26-Feb-12	11:35	SW1	8.31	8.38	1067	1040	22.1	55	26	692	<5	G. Thomson		<1	18	195	213	109
26-Feb-12	15:30	SW1	8.39		1066		22.9	76				G. Thomson						
27-Feb-12	8:45	SW1	8.29		1163		21.4	70				G. Thomson						
27-Feb-12	11:35	SW1	8.49	8.41	1149	1100	23.6	45	28	714	<5	G. Thomson		<1	21	201	222	118
27-Feb-12	15:30	SW1	8.74		1190		27.7	91				G. Thomson						
28-Feb-12	7:25	SW1	8.14		977		21.9	84				G. Thomson						
28-Feb-12	11:25	SW1	8.38	8.36	1066	1020	25.2	84	28	700	<5	G. Thomson		<1	6	208	213	106
28-Feb-12	15:30	SW1	8.68		1068		29.1	75				G. Thomson						
29-Feb-12	7:25	SW1	7.95		1117		21.6	40				B. Winsor						
29-Feb-12	16:05	SW1	7.84	8.1	1037	1000	28.4	62	42	630	<5	B. Winsor		<1	<1	238	238	104
01-Mar-12	8:30	SW1	7.82		534		22.7	68				J. Miller						
01-Mar-12	11:35	SW1	8.25	9.08	662	639	26.7	18	8	426	<5	J. Miller		<1	46	122	168	44
01-Mar-12	16:30	SW1	8.47		1085		30.7	198				J. Miller						
02-Mar-12	8:15	SW1	8.27		1177		23.6	118				G. Thomson						
02-Mar-12	11:35	SW1	8.32	8.42	1181	1110	25.5	148	88	754	<5	G. Thomson		<1	15	229	244	120
02-Mar-12	15:30	SW1	8.48		1158		26.4	80				G. Thomson						
03-Mar-12	8:30	SW1	8.14		844		21.6	67				G. Thomson						
03-Mar-12	11:15	SW1	7.92	8.08	865	810	23.1	43	30	502	<5	G. Thomson		<1	<1	198	198	69
03-Mar-12	15:15	SW1	8.35		917		27.6	117				G. Thomson						
04-Mar-12	8:40	SW1	8.13		1207		22	77				G. Thomson						

04-Mar-12	10:35	SW1	8.04		1180		23.4	69					G. Thomson						
04-Mar-12	11:45	SW1	8.25	8.38	1114	1060	26.3	85	66	618	<5		G. Thomson		<1	9	262	271	101
04-Mar-12	15:00	SW1	8.32		1160		28.7	89					G. Thomson						
05-Mar-12	8:05	SW1	8.14		910		23.3	190					G. Thomson						
05-Mar-12	12:35	SW1	8.29	8.24	846	842	25.7	159	126	598	<5		G. Thomson		<1	<1	214	214	78
05-Mar-12	15:10	SW1	8.33		811		25.7	189					G. Thomson						
05-Mar-12	17:50	SW1	8.25		769		24.5	186					G. Thomson						
06-Mar-12	8:55	SW1	8.02		959		20.5	208					G. Thomson						
06-Mar-12	11:35	SW1	8.02	8.03	993	971	23.6	134	95	554	<5		G. Thomson		<1	<1	211	211	110
06-Mar-12	15:20	SW1	8.53		993		27.8	90					G. Thomson						
07-Mar-12	8:30	SW1	8.17		865		18.8	54					G. Thomson						
07-Mar-12	11:40	SW1	8.26	7.72	830	825	20.9	56	58	508	<5		G. Thomson		<1	<1	191	191	76
07-Mar-12	15:15	SW1	8.39		818		23.8	62					G. Thomson						
08-Mar-12	8:50	SW1	8.39		1095		17.2	71					G. Thomson						
08-Mar-12	11:35	SW1	8.24	8.34	1123	1120	20.9	55	49	720	<5		G. Thomson		<1	5	250	254	116
08-Mar-12	15:15	SW1	8.46		1175		26.2	47					G. Thomson						
09-Mar-12	9:30	SW1	8.06		844		18.9	68					B. Winsor						
09-Mar-12	13:30	SW1	8.42	8.28	1020	921	23.5	78	122	578	<5		B. Winsor		<1	<1	226	226	85
09-Mar-12	16:45	SW1	8.45		1014		25.9	77					B. Winsor						
10-Mar-12	9:10	SW1	8.28		941		18	69					G. Thomson						
10-Mar-12	13:15	SW1	8.58	8.35	933	906	22.6	70	41	562	<5		G. Thomson		<1	4	228	232	84
10-Mar-12	16:50	SW1	8.62		1079		22.5	46					G. Thomson						
11-Mar-12	8:25	SW1	7.97		792		13.5	21					G. Thomson						
11-Mar-12	12:10	SW1	8.18	8.23	752	768	23.4	4	17	406	<5		G. Thomson		<1	<1	176	176	65
11-Mar-12	15:20	SW1	8.31		752		26.1	10					G. Thomson						
12-Mar-12	8:25	SW1	8.39		790		18.7	33					G. Thomson						
12-Mar-12	11:30	SW1	8.34	8.22	783	789	23.3	34	44	402	<5		G. Thomson		<1	<1	182	182	73
12-Mar-12	15:10	SW1	8.45		782		26.9	28					G. Thomson						
13-Mar-12	8:10	SW1	8.16		790		20.1	40					G. Thomson						
13-Mar-12	11:40	SW1	8.34	8.1	764	770	24.1	15	23	474	<5		G. Thomson		<1	<1	178	178	76
13-Mar-12	15:10	SW1	8.23		745		26.4	7					G. Thomson						
14-Mar-12	7:10	SW1	8.18		741		20.5	42					G. Thomson						
14-Mar-12	10:45	SW1	8.34	8.28	735	729	22.8	27	22	490	<5		G. Thomson		<1	<1	175	175	63
14-Mar-12	14:40	SW1	8.56		718		27	21					G. Thomson						
15-Mar-12	7:00	SW1	8.12		764		20.6	48					G. Thomson						
15-Mar-12	10:35	SW1	8.01	8.1	763	770	22.1	19	26	444	<5		G. Thomson		<1	<1	183	183	70
15-Mar-12	15:05	SW1	8.62		744		24.9	29					G. Thomson						
16-Mar-12	9:45	SW1	8.05		746		22.5	16					B. Winsor						
16-Mar-12	13:00	SW1	8.36	8.31	687	681	26.6	30	79	406	<5		B. Winsor		<1	<1	163	163	54
16-Mar-12	14:20	SW1	8.37		674		27.1	17					B. Winsor						
17-Mar-12	9:35	SW1	7.9		626		21.6	27					A. McIntosh						
17-Mar-12	12:50	SW1	7.76	7.95	625	586	22.4	15	12	310	<5		A. McIntosh		<1	<1	155	155	46
17-Mar-12	16:00	SW1	7.74		622		23	11					A. McIntosh						
18-Mar-12	8:35	SW1	7.62		560		19.4	18					A. McIntosh						
18-Mar-12	11:55	SW1	7.7	7.99	571	559	22.1	12	6	354	<5		A. McIntosh		<1	<1	150	150	42
18-Mar-12	14:30	SW1	7.77		572		27.4	11					A. McIntosh						
19-Mar-12	9:05	SW1	7.92		540		17.8	67					A. McIntosh						
19-Mar-12	11:45	SW1	7.89	8.19	537	534	20.7	76	15	340	<5		A. McIntosh		<1	<1	149	149	40
19-Mar-12	15:25	SW1	7.94		543		23.7	126					A. McIntosh						
20-Mar-12	9:10	SW1	7.71		545		19.4	74					A. McIntosh						
20-Mar-12	11:30	SW1	7.6	7.96	550	544	21.3	92	9	236	<5		A. McIntosh		<1	<1	153	153	46
20-Mar-12	15:05	SW1	7.84		515		24.4	95					A. McIntosh						
21-Mar-12	8:45	SW1	7.6		495		19.5	72					A. McIntosh						
21-Mar-12	11:45	SW1	7.66	7.76	495	505	21.7	72	8	322	<5		A. McIntosh		<1	<1	129	149	44
21-Mar-12	15:20	SW1	7.81		489		24.3	82					A. McIntosh						
22-Mar-12	8:45	SW1	7.61		511		19.9	87					A. McIntosh						
22-Mar-12	11:35	SW1	7.63	7.78	559	508	21.6	80	8	208	<5		A. McIntosh		<1	<1	144	144	46
22-Mar-12	15:15	SW1	7.86		520		25.1	50					A. McIntosh						
23-Mar-12	8:25	SW1	7.65		564		20.1	77					A. McIntosh						

23-Mar-12	11:35	SW1	7.8	7.99	621	584	24	70	28	330	<5		A. McIntosh		<1	<1	174	174	39
23-Mar-12	15:10	SW1	7.81		582		25.1	69					A. McIntosh						
24-Mar-12	8:45	SW1	7.94		583		14.9	264					A. McIntosh	Sampled at different spot for a more representive result					
24-Mar-12	12:00	SW1	7.79		607		20.4	118					A. McIntosh						
24-Mar-12	15:20	SW1	7.91	7.94	617	606	23.2	118	38	370	<5		A. McIntosh		<1	<1	206	206	32
25-Mar-12	9:00	SW1											A. McIntosh	No sample due to no flow					
25-Mar-12	12:05	SW1											A. McIntosh	No sample due to no flow					
25-Mar-12	16:00	SW1											A. McIntosh	No sample due to no flow					
26-Mar-12	8:25	SW1	7.6		559		17	89					A. McIntosh						
26-Mar-12	11:35	SW1	7.75	7.89	533	543	20.5	60	24	330	<5		A. McIntosh		<1	<1	142	142	50
26-Mar-12	15:20	SW1	7.92		522		22.4	84					A. McIntosh						
27-Mar-12	8:30	SW1	7.65		561		17.3	160					A. McIntosh	Low flow. Water pooling					
27-Mar-12	11:40	SW1											A. McIntosh	No sample due to no flow.Water pooled.					
27-Mar-12	15:25	SW1											A. McIntosh	No sample due to no flow.Water pooled.					
28-Mar-12	8:40	SW1											A. McIntosh	No sample due to no flow.Water pooled.					
28-Mar-12	11:25	SW1											A. McIntosh	No sample due to no flow.Water pooled.					
28-Mar-12	15:20	SW1											A. McIntosh	No sample due to no flow.Water pooled.					

Chloride	Calcium	Magnesium	Sodium	Potassium	Arsenic	Cadmium	Chromium	Copper	Nickel	Lead	Zinc	Iron	Ammonia as N	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P	Reactive Phosphorus as P	Total Anions	Total Cations
69	31	13	41	12	0.003	<0.0001	<0.001	0.003	0.005	<0.001	0.041	0.37	<0.01	<0.01	<0.01	<0.01	1.3	1.3	0.04	0.02	4.7	4.71
81	19	8	167	9	0.003	<0.0001	0.001	0.004	0.002	0.003	0.038	0.65	0.08	0.31	7.91	8.22	1.9	10.1	0.22	0.02	8.11	9.1
80	19	8	166	7	0.003	<0.0001	<0.001	0.008	<0.001	0.002	0.054	0.22	0.05	0.23	7.21	7.44	1.5	8.9	0.11	0.01	8.68	9.01
87	18	8	199	9	0.003	<0.0001	<0.001	0.002	<0.001	0.002	0.014	0.08	0.04	0.15	11.2	11.4	1	12.4	<0.01	<0.01	10	10.4
88	17	8	204	8	0.003	<0.0001	<0.001	0.002	<0.001	0.002	0.018	0.11	0.03	0.12	9.81	9.93	2.4	12.3	0.17	<0.01	10	10.6
84	16	9	183	8	0.003	<0.0001	0.001	0.003	0.001	0.002	0.022	0.51	0.03	0.12	9.77	9.89	2.2	12.1	0.12	<0.01	9.33	9.7
83	20	10	232	8	0.004	<0.0001	<0.001	0.004	<0.001	0.003	0.028	0.15	0.06	0.1	10.5	10.6	2.2	12.8	<0.01	<0.01	10.6	11
93	19	11	216	7	0.005	<0.0001	<0.001	0.001	<0.001	0.003	0.016	0.05	0.02	0.05	10.8	10.9	1.7	12.6	<0.01	<0.01	10.6	11.4
58	19	11	214	8	0.005	<0.0001	<0.001	0.003	<0.001	0.003	0.02	0.13	0.02	0.05	10.2	10.3	1.9	12.2	0.04	<0.01	8.16	11.4
72	20	12	210	8	0.004	<0.0001	<0.001	0.005	<0.001	0.003	0.016	0.07	0.02	0.04	11.1	11.1	1.7	12.8	0.09	<0.01	9.9	10.3
99	20	12	205	8	0.004	<0.0001	<0.001	0.002	<0.001	0.003	0.011	<0.05	0.05	0.03	10.4	10.4	2.4	12.8	0.13	<0.01	9.32	11.1
110	21	13	216	8	0.004	<0.0001	<0.001	0.001	<0.001	0.002	0.006	<0.05	0.02	0.02	10.4	10.4	1.1	11.5	0.01	<0.01	10.7	11.7
91	19	11	184	7	0.003	<0.0001	<0.001	0.001	<0.001	0.002	<0.005	0.1	0.03	0.02	9.27	9.29	3.4	12.7	<0.01	<0.01	9.7	10
87	18	10	204	7	0.004	<0.0001	<0.001	0.001	0.002	<0.001	0.016	0.15	0.05	0.06	7.54	7.6	1.7	9.3	0.12	<0.01	9.92	10.8
64	18	9	101	9	0.002	<0.0001	<0.001	<0.001	0.003	<0.001	0.08	0.09	0.09	0.05	2.7	2.75	1.4	4.2	0.02	<0.01	6.08	6.26
99	19	11	219	8	0.004	<0.0001	<0.001	0.001	0.003	<0.001	0.013	0.43	0.03	0.07	12.7	12.8	2.9	15.7	<0.01	<0.01	11.4	11.6
77	18	10	144	9	0.002	<0.0001	<0.001	0.008	0.003	<0.001	0.054	0.1	0.03	0.08	5.06	5.14	1.8	6.9	0.02	<0.01	7.94	8.22

84	19	10	215	8	0.002	<0.0001	<0.001	0.002	0.002	<0.001	0.016	0.1	0.04	0.04	12.2	12.2	1.1	13.3	<0.01	<0.01	10.8	11.3
75	16	8	166	7	0.002	<0.0001	<0.001	0.002	0.002	<0.001	0.036	0.23	0.03	0.02	7.27	7.29	1.6	8.9	0.03	<0.01	8.54	8.86
92	16	9	190	7	0.002	<0.0001	<0.001	0.002	0.002	<0.001	0.038	0.06	0.02	0.02	7.4	7.42	2.2	9.6	0.05	<0.01	9.64	9.98
87	15	8	160	6	0.001	<0.0001	<0.001	0.001	0.002	<0.001	0.023	0.1	0.03	0.01	5.12	5.13	0.2	5.3	0.11	0.01	8.22	8.52
101	15	10	274	7	0.004	<0.0001	<0.001	0.002	0.001	<0.001	0.011	<0.05	<0.01	0.03	9.5	9.53	1.9	11.4	0.07	<0.01	11.8	13.7
85	15	9	178	6	0.002	<0.0001	<0.001	0.002	0.002	<0.001	0.008	0.08	<0.01	0.02	5.74	5.76	0.2	6	0.05	<0.01	9.1	9.39
81	15	8	179	6	0.003	<0.0001	<0.001	0.005	0.003	<0.001	0.01	<0.05	0.01	0.02	5.67	5.69	0.7	6.4	0.04	<0.01	9.08	9.35
78	13	7	140	6	0.002	<0.0001	<0.001	0.002	0.002	<0.001	0.006	<0.05	0.02	0.01	3.39	3.4	0.1	3.5	<0.01	<0.01	7.32	7.47
81	14	7	151	6	0.001	<0.0001	<0.001	0.004	0.002	<0.001	0.021	<0.05	0.01	<0.01	4.01	4.01	0.3	4.3	0.02	<0.01	7.73	8
79	14	8	146	6	0.001	<0.0001	<0.001	0.002	0.001	<0.001	0.012	0.08	<0.01	<0.01	3.53	3.53	0.3	3.8	0.05	<0.01	7.62	7.86
71	15	8	132	6	0.001	<0.0001	<0.001	0.001	0.001	<0.001	0.008	<0.05	0.01	<0.01	2.83	2.83	0.4	3.2	<0.01	<0.01	7.01	7.3
82	16	8	145	6	0.001	<0.0001	<0.001	<0.001	0.001	<0.001	0.012	<0.05	0.01	<0.01	3	3	1.2	4.2	0.09	<0.01	7.64	7.92
70	14	7	119	5	0.002	<0.0001	<0.001	0.002	<0.001	0.001	0.012	<0.05	0.01	<0.01	1.4	1.4	1.2	2.6	0.1	<0.01	6.46	6.58
59	15	6	104	6	0.002	<0.0001	<0.001	0.007	<0.001	0.002	0.021	<0.05	0.05	<0.01	0.37	0.37	0.5	0.9	0.03	<0.01	5.72	5.92
56	15	7	97	5	0.002	<0.0001	<0.001	0.002	<0.001	0.001	0.007	<0.05	0.01	<0.01	0.28	0.28	0.4	0.7	0.02	<0.01	5.45	5.67
51	16	6	92	5	0.001	<0.0001	<0.001	<0.001	<0.001	0.001	<0.005	<0.05	0.03	<0.01	0.36	0.36	0.4	0.8	0.03	<0.01	5.25	5.42
50	15	6	98	5	0.002	<0.0001	<0.001	<0.001	0.001	<0.001	<0.005	<0.05	0.01	<0.01	0.18	0.18	0.5	0.7	0.04	0.02	5.43	5.63
42	15	5	91	6	0.002	<0.0001	<0.001	0.001	<0.001	0.001	<0.005	0.05	0.07	<0.01	0.11	0.11	0.4	0.5	0.04	0.02	5.08	5.27
59	17	5	98	6	0.002	<0.0001	<0.001	0.014	0.003	<0.001	<0.005	0.05	0.01	<0.01	0.08	0.08	0.5	0.6	0.05	0.02	5.5	5.68

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51	19	7	98	5	0.003	<0.0001	<0.001	0.001	0.002	<0.001	0.071	0.07	0.02	<0.01	0.02	0.02	0.4	0.4	0.04	<0.01	5.73	5.91
53	22	8	105	4	0.003	<0.0001	<0.001	0.002	0.002	<0.001	0.01	0.2	0.04	<0.01	0.04	0.04	0.4	0.4	0.03	<0.01	6.28	6.43
54	14	5	93	5	0.002	<0.0001	<0.001	<0.001	0.001	<0.001	<0.005	<0.05	0.02	<0.01	0.12	0.12	0.4	0.5	0.03	0.01	5.4	5.28

ALS Laboratory Group
Analytical Chemistry Testing Services

Date of Sample	Time	Colliery Site Reference	Field pH	pH	Field EC (µS/cm)	Electrical Conductivity @ 25°C (µS/cm)	Temp	Field TSS	TSS	TDS	Oil & Grease		Sampled by	General Comments/ Observations	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Sulfate as SO4 - Turbidimetric	Chloride	Calcium	Magnesium	Sodium
17-Feb-12	10:10	SW2	7.8		314		23.5	16					J. Miller & B. Winsor										
17-Feb-12	15:35	SW2	7.9		310		27.9	<1					J. Miller & B. Winsor										
17-Feb-12	16:40	SW2	7.8	7.65	314	382	28.2	<1	14	302	<5		J. Miller & B. Winsor		<1	<1	57	57	<1	79	15	8	39
18-Feb-12	8:00	SW2	7.9		323		19.5	17					B. Winsor & B. Kelly										
18-Feb-12	15:00	SW2	7.8	7.67	318	390	28.8	2	6	318	<5		B. Winsor & B. Kelly		<1	<1	57	57	4	76	16	8	40
18-Feb-12	17:15	SW2	7.8		323		27.7	7					B. Winsor & B. Kelly										
19-Feb-12	8:50	SW2	7.7		327		22.2	16					J. Miller & E. Blackburn										
19-Feb-12	15:00	SW2	7.5	7.64	323	396	29.3	5	<5	312	<5		J. Miller & E. Blackburn		<1	<1	58	58	2	78	18	9	37
19-Feb-12	17:00	SW2	7.7		329		28.5	15					J. Miller & E. Blackburn										
20-Feb-12	9:10	SW2	8		334		22.8	22					G. Thomson & J. Miller										
20-Feb-12	12:40	SW2	8	7.65	334	405	29.3	21	6	294	<5		G. Thomson & J. Miller		<1	<1	65	65	3	85	16	8	48
20-Feb-12	15:45	SW2	7.38		420		29.2	1					G. Thomson & J. Miller										
21-Feb-12	8:40	SW2	7.38		370		22.8	26					G. Thomson										
21-Feb-12	15:30	SW2	7.4	7.64	370	379	24.2	19	<5	244	<5		G. Thomson		<1	<1	76	76	<1	69	18	9	38
21-Feb-12	17:30	SW2	7.45		370		24.4	19					G. Thomson										
22-Feb-12	9:20	SW2	7.63		430		21.3	1					G. Thomson										
22-Feb-12	10:15	SW2	7.6	7.58	430	398	21.3	1	6	316	<5		G. Thomson		<1	<1	69	69	<1	69	21	9	44
22-Feb-12	16:00	SW2	8.04		410		24.7	2					G. Thomson										
23-Feb-12	8:40	SW2	7.24		410		21.2	8					G. Thomson										
23-Feb-12	11:05	SW2	7.41	7.37	410	410	25.5	4	<5	330	<5		G. Thomson		<1	<1	77	77	<1	83	20	10	40
23-Feb-12	15:30	SW2	7.23		420		27.5	<1					G. Thomson										
24-Feb-12	9:40	SW2	7.91		380		20.9	<1					J. Miller										
24-Feb-12	13:40	SW2	7.66		390		29.3	3					J. Miller										
24-Feb-12	19:25	SW2	7.55	7.69	200	421	24.6	14	<5	322	<5		J. Miller		<1	<1	66	66	<1	75	20	10	43
25-Feb-12	9:50	SW2	7.5		432		20.9	5					G. Thomson										
25-Feb-12	11:30	SW2	7.68	763	421	442	23.3	<1	7	320	<5		G. Thomson		<1	<1	64	64	<1	82	20	10	44
25-Feb-12	15:35	SW2	7.7		419		24.1	2					G. Thomson										
26-Feb-12	7:35	SW2	7.9		406		21.2	7					G. Thomson										
26-Feb-12	11:40	SW2	7.88	7.76	410	402	22.1	4	10	298	<5		G. Thomson		<1	<1	64	64	<1	78	18	10	43
26-Feb-12	15:10	SW2	7.91		408		21.5	6					G. Thomson										
27-Feb-12	9:00	SW2	7.85		409		20.8	4					G. Thomson										
27-Feb-12	11:45	SW2	7.8	7.82	412	407	21.9	6	6	330	<5		G. Thomson		<1	<1	73	73	<1	76	19	10	41
27-Feb-12	15:40	SW2	7.88		414		28.2	1					G. Thomson										
28-Feb-12	7:35	SW2	7.58		420		21	2					G. Thomson										
28-Feb-12	11:40	SW2	7.74	7.72	436	417	26.2	<1	<5	254	<5		G. Thomson		<1	<1	70	70	<1	77	17	8	40
28-Feb-12	15:40	SW2	7.8		440		28.6	<1					G. Thomson										
29-Feb-12	9:25	SW2	6.86		456		22.8	<1					B. Winsor										
29-Feb-12	15:50	SW2	7.7	7.64	452	429	28.8	<1	<5	298	<5		B. Winsor		<1	<1	75	75	<1	83	18	10	44
01-Mar-12	8:40	SW2	7.45		534		22.7	68					J. Miller										
01-Mar-12	10:55	SW2	7.59	7.83	461	441	255	1	11	318	<5		J. Miller		<1	<1	79	79	<1	82	20	10	44
01-Mar-12	15:30	SW2	7.97		445		29.7	8					J. Miller										
02-Mar-12	8:20	SW2	7.66		480		23	16					G. Thomson										
02-Mar-12	11:50	SW2	7.8	7.74	468	447	26.2	10	<5	292	<5		G. Thomson		<1	<1	74	74	<1	86	20	11	44
02-Mar-12	15:15	SW2	7.85		470		27.1	11					G. Thomson										
03-Mar-12	8:40	SW2	7.77		453		21	12					G. Thomson										
03-Mar-12	11:25	SW2	7.8	7.65	460	429	23.4	10	6	320	<5		G. Thomson		<1	<1	73	73	<1	84	19	10	43
03-Mar-12	15:20	SW2	7.83		455		28.2	15					G. Thomson										
04-Mar-12	8:30	SW2	7.39		477		21.7	11					G. Thomson										
04-Mar-12	10:20	SW2	7.4	7.47	480	471	23.1	10	<5	344	<5		G. Thomson		<1	<1	75	75	<1	86	20	10	43
04-Mar-12	15:10	SW2	7.43		485		28.1	7					G. Thomson										
05-Mar-12	8:20	SW2	7.37		460		23.1	2					G. Thomson										
05-Mar-12	12:25	SW2	7.7	7.6	455	457	25.7	4	<5	286	<5		G. Thomson		<1	<1	75	75	<1	92	21	11	45
05-Mar-12	15:20	SW2	7.73		460		26	2					G. Thomson										
06-Mar-12	9:30	SW2	7.3		428		20.8	<1					G. Thomson										
06-Mar-12	11:25	SW2	7.5	7.68	445	434	24.1	<1	6	284	<5		G. Thomson		<1	<1	80	80	<1	81	20	10	44
06-Mar-12	15:10	SW2	7.55		450		27.3	2					G. Thomson										
07-Mar-12	8:40	SW2	7.6		454		18.3	4					G. Thomson										
07-Mar-12	11:35	SW2	7.68	7.56	450	451	21.2	1	<5	304	<5		G. Thomson		<1	<1	82	82	<1	84	20	10	47
07-Mar-12	15:25	SW2	7.72		448		23.8	6					G. Thomson										
08-Mar-12	8:35	SW2	7.82		428		16.1	<1					G. Thomson										
08-Mar-12	11:40	SW2	7.57	7.52	464	461	22	4	<5	358	<5		G. Thomson		<1	<1	75	75	<1	89	22	12	52
08-Mar-12	15:25	SW2	7.6		468		25.9	2					G. Thomson										
09-Mar-12	9:45	SW2	7.25		457		17.9	<1					B. Winsor										
09-Mar-12	13:40	SW2	7.45	7.65	466	452	23.5	<1	<5	304	<5		B. Winsor		<1	<1	74	74	<1	89	19	10	47
09-Mar-12	16:35	SW2	7.56		461		23.4	<1					B. Winsor										
10-Mar-12	9:00	SW2	7.62		468		16.7	<1					G. Thomson										
10-Mar-12	13:00	SW2	7.69	7.68	471	458	23.6	<1	<5	304	<5		G. Thomson		<1	<1	76	76	<1	93	19	10	48
10-Mar-12	17:00	SW2	7.79		480		24.2	<1					G. Thomson										
11-Mar-12	8:20	SW2	7.6		494		11.8	<1					G. Thomson										
11-Mar-12	12:20	SW2	7.43	7.59	468	464	24.2	2	<5	288	<5		G. Thomson		<1	<1	74	74	<1	91	19	10	47
11-Mar-12	15:30	SW2	7.5		462		25.9	4					G. Thomson										
12-Mar-12	8:35	SW2	7.64		464		18.2	1					G. Thomson										
12-Mar-12	11:45	SW2	7.62	7.61	462	462	23.5	2	<5	288	<5		G. Thomson		<1	<1	79	79	<1	94	21	11	49
12-Mar-12	15:20	SW2	7.7		470		26.2	<1					G. Thomson										
13-Mar-12	8:20	SW2	7.56		471		19.3	<1					G. Thomson										
13-Mar-12	11:45	SW2	7.41	7.64	467	467	24.2	<1	<5	344	<5		G. Thomson		<1	<1	77	77	<1	98	21	11	49
13-Mar-12	15:20	SW2	7.46		470		26.2	<1					G. Thomson										
14-Mar-12	7:15	SW2	7.77		474		20.5	<1					G. Thomson										
14-Mar-12	10:20	SW2	7.3	7.68	481	474	21.4	2	<5	382	<5		G. Thomson		<1	<1	79	79	<1	96	21	10	51
14-Mar-12	14:30	SW2	7.46		490		26.8	<1					G. Thomson										
15-Mar-12	6:55	SW2	7.55		491		20	<1					G. Thomson										
15-Mar-12	10:30	SW2	7.45	7.61	477	477	21.5	<1	<5	264	<5		G. Thomson		<1	<1	78	78	<1	103	22	11	53
15-Mar-12	15:10	SW2	7.64		472		25.6	<1					G. Thomson										
16-Mar-12	9:30	SW2	7.66		487		21.4	<1					B. Winsor										

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16-Mar-12	12:50	SW2	8	7.56	475	480	25.5	<1	<5	318	<5		B. Winsor		<1	<1	76	76	<1	104	22	11	53
16-Mar-12	14:00	SW2	7.66		474		24.6	<1					B. Winsor										
17-Mar-12	9:10	SW2	7.48		478		20.9	30					A. McIntosh										
17-Mar-12	12:05	SW2	7.48	7.63	500	466	21.8	4	<5	256	<5		A. McIntosh		<1	<1	74	74	<1	97	20	11	50
17-Mar-12	15:35	SW2	7.56		496		22.8	<1					A. McIntosh										
18-Mar-12	8:25	SW2	7.39		471		19	8					A. McIntosh										
18-Mar-12	11:35	SW2	7.34	7.4	498	481	22.7	12	<5	300	<5		A. McIntosh		<1	<1	68	68	<1	105	20	11	52
18-Mar-12	14:15	SW2	7.42		489		27.2	9					A. McIntosh										
19-Mar-12	8:35	SW2	7.25		497		17.9	53					A. McIntosh										
19-Mar-12	11:30	SW2	7.44	7.52	507	484	21.8	55	<5	354	<5		A. McIntosh		<1	<1	75	75	<1	104	22	12	50
19-Mar-12	15:20	SW2	7.27		490		23.2	46					A. McIntosh										
20-Mar-12	8:35	SW2	7.52		498		19	94					A. McIntosh										
20-Mar-12	11:20	SW2	7.43	7.41	509	493	22.9	101	<5	314	<5		A. McIntosh		<1	<1	70	70	<1	106	21	11	52
20-Mar-12	15:00	SW2	7.29		497		24.1	64					A. McIntosh										
21-Mar-12	8:35	SW2	7.22		497		19.7	46					A. McIntosh										
21-Mar-12	11:25	SW2	7.2	7.38	496	493	21.6	53	<5	350	<5		A. McIntosh		<1	<1	72	75	<1	104	21	11	53
21-Mar-12	15:10	SW2	7.51		493		24.9	57					A. McIntosh										
22-Mar-12	8:35	SW2	7.31		506		19.7	66					A. McIntosh										
22-Mar-12	11:25	SW2	7.35	7.36	510	498	22.2	64	<5	304	<5		A. McIntosh		<1	<1	66	66	<10	121	22	10	54
22-Mar-12	15:10	SW2	7.2		501		24.1	40					A. McIntosh										
23-Mar-12	8:15	SW2	7.23		521		20	54					A. McIntosh										
23-Mar-12	11:20	SW2	7.34	7.39	511	516	22.9	37	<5	282	<5		A. McIntosh		<1	<1	71	71	<1	113	20	11	52
23-Mar-12	15:05	SW2	7.33		519		24.8	29					A. McIntosh										
24-Mar-12	8:25	SW2	7.24		529		15.7	46					A. McIntosh										
24-Mar-12	11:50	SW2	7.31	7.39	516	523	20.9	54	<5	362	<5		A. McIntosh		<1	<1	72	72	<1	117	22	12	55
24-Mar-12	15:10	SW2	7.46		527		22.9	24					A. McIntosh										
25-Mar-12	8:25	SW2	7.14		522		14.7	74					A. McIntosh										
25-Mar-12	11:25	SW2	7.31	7.5	564	530	18.5	72	<5	378	<5		A. McIntosh		<1	<1	74	74	<1	120	24	12	55
25-Mar-12	13:10	SW2	7.28		525		22.6	42					A. McIntosh										
26-Mar-12	8:20	SW2	7.12		536		17.5	50					A. McIntosh										
26-Mar-12	11:25	SW2	7.74	7.34	534	530	22.2	51	<5	336	<5		A. McIntosh		<1	<1	77	77	<1	121	24	13	51
26-Mar-12	15:10	SW2	7.71		529		23.6	56					A. McIntosh										
27-Mar-12	8:15	SW2	7.48		531		17.7	69					A. McIntosh										
27-Mar-12	11:30	SW2	7.51	7.35	525	534	22.4	63	9	312	<5		A. McIntosh		<1	<1	74	74	<1	119	22	12	56
27-Mar-12	15:15	SW2	7.42		518		22.5	59					A. McIntosh										
28-Mar-12	8:30	SW2	7.32		552		17.8	59					A. McIntosh										
28-Mar-12	11:20	SW2	7.47	7.49	540	542	20.3	71	<5	332	<5		A. McIntosh		<1	<1	73	73	<1	114	22	12	51
28-Mar-12	15:20	SW2	7.48		536		25.3	65					A. McIntosh										

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Potassium	Arsenic	Cadmium	Chromium	Copper	Nickel	Lead	Zinc	Iron	Ammonia as N	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P	Reactive Phosphorus as P	Total Anions	Total Cations
12	0.001	<0.0001	<0.001	0.003	<0.001	0.004	0.043	0.27	0.03	<0.01	0.01	0.01	0.8	0.8	0.08	0.01	3.37	3.41
12	0.001	<0.0001	<0.001	0.005	<0.001	0.004	0.041	0.41	0.04	<0.01	0.01	0.01	0.7	0.7	0.11	0.03	3.37	3.5
11	<0.001	<0.0001	<0.001	0.002	<0.001	0.004	0.024	0.27	<0.01	<0.01	<0.01	<0.01	0.5	0.5	0.03	0.02	3.4	3.53
12	<0.001	<0.0001	<0.001	0.012	0.03	0.004	0.041	0.42	0.02	<0.01	<0.01	<0.01	0.6	0.6	0.08	0.01	3.76	3.85
12	0.001	<0.0001	<0.001	0.003	<0.001	0.005	0.057	0.68	<0.01	<0.01	<0.01	<0.01	0.7	0.7	0.09	0.02	3.46	3.6
13	0.001	<0.0001	<0.001	0.003	<0.001	0.004	0.037	0.25	<0.01	<0.01	<0.01	<0.01	0.4	0.4	0.04	0.03	3.44	3.53
13	0.001	<0.0001	<0.001	0.002	<0.001	0.005	0.025	0.26	0.02	<0.01	<0.01	<0.01	0.6	0.6	0.03	0.01	3.88	3.89
13	<0.001	<0.0001	<0.001	0.002	<0.001	0.004	0.039	0.28	<0.01	<0.01	<0.01	<0.01	0.6	0.6	0.04	0.01	3.43	4.02
12	0.002	<0.0001	<0.001	0.003	<0.001	0.004	0.01	0.2	0.01	<0.01	0.02	0.02	0.6	0.6	0.06	0.01	3.76	3.91
12	0.001	<0.0001	<0.001	0.001	<0.001	0.004	0.006	0.24	0.01	<0.01	<0.01	<0.01	0.5	0.5	0.09	0.02	3.48	3.9
12	0.001	<0.0001	<0.001	0.002	<0.001	0.004	0.01	0.27	0.04	<0.01	0.02	0.02	0.6	0.6	0.03	0.01	3.6	3.72
11	0.001	<0.0001	<0.001	0.001	<0.001	0.003	<0.005	0.22	<0.01	<0.01	<0.01	<0.01	0.6	0.6	0.07	0.01	3.57	3.53
13	0.002	<0.0001	<0.001	0.003	0.005	<0.001	0.057	0.22	<0.01	<0.01	0.01	0.01	0.6	0.6	0.05	<0.01	3.84	3.97
12	0.001	<0.0001	<0.001	0.002	0.005	<0.001	0.824	0.21	<0.01	<0.01	<0.01	<0.01	0.7	0.7	0.03	<0.01	3.89	4.04
14	0.001	<0.0001	<0.001	<0.001	0.004	<0.001	0.009	0.17	<0.01	<0.01	<0.01	<0.01	0.5	0.5	<0.01	0.01	4.02	4.18
13	<0.001	<0.0001	<0.001	0.002	0.003	<0.001	0.03	0.22	0.03	<0.01	0.02	0.02	0.5	0.5	0.02	0.01	3.83	3.97
13	0.001	<0.0001	<0.001	0.001	0.004	<0.001	0.03	0.17	0.04	<0.01	0.01	0.01	0.6	0.6	<0.01	0.01	3.92	4.02
13	0.001	<0.0001	<0.001	0.002	0.004	<0.001	0.052	0.12	0.03	<0.01	0.02	0.02	0.6	0.6	0.03	0.02	4.09	4.24
12	0.001	<0.0001	<0.001	0.002	0.004	<0.001	0.048	0.22	0.02	<0.01	0.61	0.61	0.5	1.1	0.02	0.02	3.88	4.04
12	<0.001	<0.0001	<0.001	0.002	0.005	<0.001	0.037	0.24	<0.01	<0.01	0.03	0.03	0.5	0.5	0.06	0.01	4.01	4.17
12	<0.001	<0.0001	<0.001	0.004	0.004	<0.001	0.052	0.1	<0.01	<0.01	0.03	0.03	0.5	0.5	0.06	0.01	4.01	4.65
12	<0.001	<0.0001	<0.001	0.002	0.003	<0.001	0.011	0.07	<0.01	<0.01	0.05	0.05	0.5	0.6	0.03	0.01	3.99	4.12
12	<0.001	<0.0001	<0.001	0.003	0.005	<0.001	0.012	0.06	0.02	<0.01	0.04	0.04	0.6	0.6	0.18	<0.01	4.14	4.17
11	<0.001	<0.0001	<0.001	0.003	0.004	<0.001	0.009	0.08	0.02	<0.01	0.04	0.04	0.5	0.5	0.01	<0.01	4.05	4.1
12	<0.001	<0.0001	<0.001	0.002	0.003	<0.001	0.03	0.07	<0.01	<0.01	0.06	0.06	0.5	0.6	0.02	0.01	4.23	4.39
13	<0.001	<0.0001	<0.001	0.002	0.003	<0.001	0.022	0.13	<0.01	<0.01	0.03	0.03	0.5	0.5	0.05	0.01	4.3	4.42
13	<0.001	<0.0001	<0.001	0.002	0.003	<0.001	0.031	<0.05	<0.01	<0.01	0.03	0.03	0.5	0.5	0.02	0.01	4.29	4.42
13	<0.001	<0.0001	<0.001	0.002	0.003	<0.001	0.036	0.1	<0.01	<0.01	0.03	0.03	0.6	0.6	0.07	<0.01	4.46	4.64

12	<0.001	<0.0001	<0.001	0.001	<0.001	0.003	0.022	0.08	0.02	<0.01	0.01	0.01	0.6	0.6	0.1	0.01	4.45	4.62
12	0.001	<0.0001	<0.001	0.002	<0.001	0.004	0.022	0.14	0.02	<0.01	<0.01	<0.01	0.5	0.5	0.03	0.01	4.21	4.39
12	<0.001	<0.0001	<0.001	0.006	<0.001	0.005	0.037	0.07	<0.01	<0.01	<0.01	<0.01	0.5	0.5	0.02	0.01	4.32	4.47
12	<0.001	<0.0001	<0.001	0.001	<0.001	0.003	<0.005	<0.05	0.02	<0.01	0.02	0.02	0.6	0.6	0.03	0.01	4.43	4.57
11	<0.001	<0.0001	<0.001	<0.001	0.003	<0.001	<0.005	<0.05	<0.01	<0.01	0.05	0.05	0.4	0.4	0.02	0.01	4.39	4.5
12	<0.001	<0.0001	<0.001	0.001	<0.001	0.003	<0.005	<0.05	<0.01	<0.01	0.05	0.05	0.4	0.4	0.02	0.01	4.43	4.57
12	0.002	<0.0001	<0.001	0.011	0.004	<0.001	<0.005	<0.05	0.01	<0.01	0.04	0.04	0.5	0.5	0.02	0.01	4.73	4.58
12	0.001	<0.0001	<0.001	0.002	0.003	<0.001	0.029	<0.05	<0.01	<0.01	0.05	0.05	0.5	0.6	0.03	0.01	4.61	4.47
12	0.001	<0.0001	<0.001	0.002	0.003	<0.001	0.017	0.08	0.01	<0.01	0.06	0.06	0.6	0.7	0.03	0.01	4.74	4.78
11	0.001	<0.0001	<0.001	0.001	0.003	<0.001	0.014	0.17	0.02	<0.01	0.04	0.04	0.4	0.4	0.02	0.01	4.86	4.86
12	<0.001	<0.0001	<0.001	0.001	0.003	<0.001	<0.005	<0.05	<0.01	<0.01	0.04	0.04	0.4	0.4	<0.01	<0.01	4.95	4.79
12	0.001	<0.0001	<0.001	0.002	0.003	<0.001	<0.005	<0.05	0.02	<0.01	<0.01	<0.01	0.6	0.6	0.03	0.02	4.84	4.83
12	0.001	<0.0001	<0.001	0.001	<0.001	0.003	<0.005	<0.05	0.07	<0.01	0.05	0.05	0.5	0.6	0.02	<0.01	4.67	4.61

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Date of Sample	Time	Colliery Site Reference	Field pH	pH	Field EC (µS/cm)	Electrical Conductivity @ 25°C (µS/cm)	Temp	Field TSS	TSS	TDS	Oil & Grease	Sampled by	General Comments/ Observations	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Sulfate as SO4 - Turbidimetric	Chloride	Calcium	Magnesium
03-Mar-12	9:15	MW3	8.63		498		23.3	59				G. Thomson									
03-Mar-12	11:55	MW3	8.59	8.35	502	485	26.2	71	42	366	<5	G. Thomson		<1	2	117	119	44	40	13	4
03-Mar-12	15:35	MW3	8.54		509		26.4	55				G. Thomson									
04-Mar-12	8:50	MW3	8.32		503		23.3	67				G. Thomson									
04-Mar-12	11:55	MW3	8.33	8.18	503	483	26.1	55	10	350	<5	G. Thomson		<1	<1	127	127	46	40	13	4
04-Mar-12	15:25	MW3	8.51		505		28.3	40				G. Thomson									
05-Mar-12	8:35	MW3	8.48		477		24.7	31				G. Thomson									
05-Mar-12	12:45	MW3	8.49	8.29	486	507	26.6	40	47	336	<5	G. Thomson		<1	<1	127	127	42	41	13	4
05-Mar-12	15:35	MW3	8.6		490		25.1	39				G. Thomson									
06-Mar-12	9:45	MW3	8.27		493		22.3	73				G. Thomson									
06-Mar-12	11:50	MW3	8.48	8.3	500	487	25.2	78	118	378	<5	G. Thomson		<1	<1	132	132	44	37	13	4
06-Mar-12	15:30	MW3	8.54		501		27.6	110				G. Thomson									
07-Mar-12	8:55	MW3	8.46		493		21.2	42				G. Thomson									
07-Mar-12	11:50	MW3	8.5	7.6	492	488	22.9	98	83	404	<5	G. Thomson		<1	<1	138	138	44	38	15	4
07-Mar-12	15:35	MW3	8.52		513		24.1	213				G. Thomson									
08-Mar-12	9:05	MW3	8.48		506		20.3	44				G. Thomson									
08-Mar-12	11:50	MW3	8.44	8.29	491	491	23.6	38	31	374	<5	G. Thomson		<1	<1	125	125	46	39	15	4
08-Mar-12	15:35	MW3	8.46		507		24.5	33				G. Thomson									
09-Mar-12	10:05	MW3	8.41		490		22.8	40				B. Winsor									
10-Mar-12	9:15	MW3	8.52		504		20.7	48				G. Thomson									
10-Mar-12	14:25	MW3	8.7	8.36	513	483	22.1	33	30	334	<5	G. Thomson		<1	3	134	137	45	39	15	5
10-Mar-12	15:00	MW3	8.71		509		24.2	30				G. Thomson									
11-Mar-12	8:40	MW3	8.38		503		15.8	43				G. Thomson									
11-Mar-12	12:35	MW3	8.48	8.36	486	486	26.2	31	12	316	<5	G. Thomson		<1	3	134	137	46	39	15	5
11-Mar-12	15:40	MW3	8.57		492		28.2	34				G. Thomson									
12-Mar-12	8:45	MW3	8.61		487		21.3	47				G. Thomson									
12-Mar-12	11:50	MW3	8.58	8.35	491	487	26.1	37	11	336	<5	G. Thomson		<1	2	136	138	47	41	15	5
12-Mar-12	15:30	MW3	8.61		501		29.2	41				G. Thomson									
13-Mar-12	8:30	MW3	8.48		502		20.5	42				G. Thomson									
13-Mar-12	12:00	MW3	8.61	8.4	490	490	26.1	34	32	380	<5	G. Thomson		<1	4	140	140	45	37	14	5
13-Mar-12	15:30	MW3	8.58		493		29.1	32				G. Thomson									
14-Mar-12	7:00	MW3	8.52		497		21.6	46				G. Thomson									
14-Mar-12	12:10	MW3	8.72	8.45	496	490	25.6	46	37	394	<5	G. Thomson		<1	6	131	137	45	38	14	4
14-Mar-12	15:40	MW3	8.88		496		28.9	80				G. Thomson									
15-Mar-12	8:05	MW3	8.64		493		21.6	39				G. Thomson									
15-Mar-12	11:45	MW3	8.81	8.5	539	492	23.8	82	72	254	<5	G. Thomson		<1	8	130	138	47	42	15	4
15-Mar-12	15:25	MW3	8.8		505		26.4	67				G. Thomson									
16-Mar-12	9:10	MW3	8.52		496		22.5	52				B. Winsor									
16-Mar-12	13:15	MW3	8.76	8.08	492	330	26.1	52	59	330	<5	B. Winsor		<1	<1	121	121	21	22	28	14
16-Mar-12	15:15	MW3										B. Winsor	Unable to access								
17-Mar-12	9:25	MW3	8.56		528		21.8	176				A. McIntosh									
17-Mar-12	12:35	MW3	8.71	7.98	527	494	23.2	961	344	314	<5	A. McIntosh		<1	<1	141	141	44	40	15	5
17-Mar-12	15:50	MW3	8.87		517		23.8	78				A. McIntosh									
18-Mar-12	8:55	MW3	8.59		520		19.7	96				A. McIntosh									
18-Mar-12	12:10	MW3	8.65	8.45	458	491	25.2	590	612	290	<5	A. McIntosh		<1	6	132	138	44	42	15	4
18-Mar-12	14:55	MW3	8.82		531		28.3	675				A. McIntosh									
19-Mar-12	8:55	MW3	8.5		494		19.1	117				A. McIntosh									
19-Mar-12	12:00	MW3	8.89	8.52	510	495	25	355	231	454	<5	A. McIntosh		<1	10	128	138	44	39	14	4
19-Mar-12	15:30	MW3	8.71		504		25.4	515				A. McIntosh									
20-Mar-12	8:55	MW3	8.51		491		20.7	122				A. McIntosh									
20-Mar-12	11:55	MW3	8.9	8.57	509	497	25.9	340	162	404	<5	A. McIntosh		<1	13	140	140	53	40	15	4
20-Mar-12	15:25	MW3	8.71		507		28.1	400				A. McIntosh									
21-Mar-12	8:45	MW3	8.46		489		20.5	126				A. McIntosh									
21-Mar-12	11:05	MW3	8.6	8.38	500	495	24.9	127	51	344	<5	A. McIntosh		<1	4	128	138	45	41	15	4
21-Mar-12	15:30	MW3	8.69		500		27.2	135				A. McIntosh									
22-Mar-12	8:55	MW3	8.47		498		21.5	135				A. McIntosh									
22-Mar-12	11:45	MW3	8.59	8.34	512	497	26.6	231	87	364	<5	A. McIntosh		<1	4	138	142	46	45	16	4
22-Mar-12	15:25	MW3	8.75		448		28.8	97				A. McIntosh									
23-Mar-12	8:35	MW3	8.59		506		22	108				A. McIntosh									
23-Mar-12	11:45	MW3	8.63	8.41	509	505	24.7	43	49	350	<5	A. McIntosh		<1	5	126	131	50	46	14	4
23-Mar-12	15:20	MW3	8.67		508		25.8	116				A. McIntosh									
24-Mar-12	8:55	MW3	8.11		517		18.7	75				A. McIntosh									
24-Mar-12	12:25	MW3	8.74	8.46	513	515	23.9	238	162	376	<5	A. McIntosh		<1	8	133	141	50	44	14	4
24-Mar-12	15:30	MW3	8.17		520		23.2	124				A. McIntosh									
25-Mar-12	8:35	MW3	8.24		506		18.7	159				A. McIntosh									
25-Mar-12	11:45	MW3	8.24	7.93	567	522	21.2	135	103	296	<5	A. McIntosh		<1	<1	126	126	51	48	14	4
25-Mar-12	15:25	MW3	8.43		507		27.2	178				A. McIntosh									
26-Mar-12	8:30	MW3	8.35		509		19	105				A. McIntosh									
26-Mar-12	11:45	MW3	8.66	8.48	537	613	25.6	186	114	346	<5	A. McIntosh		<1	11	131	142	50	44	15	4
26-Mar-12	15:30	MW3	8.52		509		24.4	134				A. McIntosh									
27-Mar-12	8:40	MW3	8.45		536		19.7	117				A. McIntosh									
27-Mar-12	11:50	MW3	8.82	8.66	519	511	27	227	122	360	<5	A. McIntosh		<1	16	119	135	50	45	15	4
27-Mar-12	15:35	MW3	8.74		516		24.1	372				A. McIntosh									
28-Mar-12	8:50	MW3	8.72		528		19.9	127				A. McIntosh									
28-Mar-12	11:35	MW3	8.65	8.42	517	515	23.1	140	54	348	<5	A. McIntosh		<1	7	135	142	50	45	15	4
28-Mar-12	15:25	MW3	8.86		528		27.3	256				A. McIntosh									

Sodium	Potassium	Arsenic	Cadmium	Chromium	Copper	Nickel	Lead	Zinc	Iron	Ammonia as N	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P	Reactive Phosphorus as P	Total Anions	Total Cations
76	4	0.001	<0.0001	<0.001	0.022	0.002	<0.001	0.116	0.21	0.02	0.03	0.75	0.78	0.6	1.4	<0.01	<0.01	4.42	4.39
85	5	0.002	<0.0001	<0.001	0.004	0.002	<0.001	0.015	0.15	0.02	0.02	0.74	0.76	0.6	1.4	<0.01	<0.01	4.62	4.8
83	5	0.002	<0.0001	<0.001	0.002	0.002	<0.001	0.015	0.26	0.02	0.02	0.74	0.76	0.6	1.4	0.03	<0.01	4.57	4.72
84	5	0.002	<0.0001	<0.001	0.002	0.002	<0.001	0.014	0.26	<0.01	0.01	0.77	0.78	0.3	1.1	0.03	<0.01	4.6	4.76
85	5	0.002	<0.0001	<0.001	0.005	0.003	0.003	0.037	0.12	<0.01	<0.01	0.74	0.74	0.3	1	0.03	<0.01	4.75	4.9
94	4	0.001	<0.0001	<0.001	0.001	0.001	<0.001	0.012	0.07	<0.01	0.01	0.75	0.76	0.6	1.4	<0.01	<0.01	4.56	5.27
84	5	0.001	<0.0001	<0.001	0.023	0.002	<0.001	0.028	<0.05	0.02	0.01	0.68	0.69	0.4	1.1	0.04	<0.01	4.77	4.94
85	5	0.002	<0.0001	<0.001	0.009	0.002	<0.001	0.006	<0.05	0.01	0.01	0.67	0.68	0.4	1.1	0.03	<0.01	4.8	4.99
87	5	0.001	<0.0001	<0.001	0.005	0.002	<0.001	0.016	0.13	0.02	0.01	0.68	0.69	0.5	1.2	0.09	<0.01	4.89	5.07
85	5	0.001	<0.0001	<0.001	0.003	0.002	<0.001	0.008	0.18	0.01	<0.01	0.73	0.73	0.4	1.1	0.09	<0.01	4.78	4.94
86	5	0.001	<0.0001	0.001	0.003	0.002	<0.001	0.011	0.1	0.01	<0.01	0.66	0.66	0.4	1.1	<0.01	<0.01	4.75	4.9
88	5	0.002	<0.0001	<0.001	0.002	0.001	<0.001	0.009	0.11	<0.01	<0.01	0.63	0.63	0.7	1.3	<0.01	<0.01	4.92	5.03
22	3	0.002	<0.0001	<0.001	0.002	<0.001	0.002	<0.005	0.24	0.03	<0.01	0.42	0.42	0.8	1.2	0.23	0.12	3.48	3.58
86	5	0.002	<0.0001	<0.001	0.003	<0.001	0.002	0.006	<0.05	0.03	<0.01	0.53	0.53	3.6	4.1	0.48	0.02	4.86	5.03
89	4	0.002	<0.0001	<0.001	0.004	<0.001	0.002	<0.005	<0.05	<0.01	<0.01	1.27	1.27	1	2.3	0.1	<0.01	4.86	5.05
88	4	0.002	<0.0001	<0.001	0.001	<0.001	0.001	<0.005	<0.05	0.01	<0.01	0.61	0.61	0.9	1.5	0.17	<0.01	4.77	4.96
92	4	0.002	<0.0001	<0.001	0.001	0.001	<0.001	<0.005	<0.05	0.02	<0.01	0.44	0.44	0.8	1.2	0.08	<0.01	5.03	5.18
87	5	0.002	<0.0001	<0.001	0.001	<0.001	0.001	<0.005	<0.05	0.02	<0.01	0.62	0.62	0.6	1.2	0.03	<0.01	4.85	4.99
92	4	0.003	<0.0001	<0.001	0.004	<0.001	<0.001	<0.005	<0.05	0.02	<0.01	0.64	0.64	0.7	1.3	0.06	<0.01	5.06	5.23
88	4	0.002	<0.0001	<0.001	0.004	0.002	<0.001	0.007	0.12	<0.01	<0.01	0.7	0.7	0.5	1.2	0.03	<0.01	4.96	4.96
93	5	0.002	<0.0001	<0.001	0.002	0.001	<0.001	0.006	0.1	0.02	<0.01	0.66	0.66	0.7	1.4	0.09	<0.01	5.1	5.2
88	4	<0.001	<0.0001	<0.001	0.001	0.001	<0.001	0.008	0.08	0.02	<0.01	0.72	0.72	0.7	1.4	0.02	<0.01	4.93	4.96
93	4	0.001	<0.0001	<0.001	0.001	0.001	<0.001	<0.005	<0.05	0.02	<0.01	0.66	0.66	0.4	1.1	0.01	<0.01	5.12	5.23
91	5	0.001	<0.0001	<0.001	0.001	<0.001	<0.001	<0.005	<0.05	0.01	<0.01	0.42	0.42	0.7	1.1	0.06	<0.01	5.01	5.16
91	5	0.002	<0.0001	<0.001	0.001	<0.001	<0.001	<0.005	<0.05	0.01	<0.01	0.62	0.62	0.6	1.2	0.07	<0.01	5.15	5.16

ALS Laboratory Group
Analytical Chemistry Testing Services

Date of Sample	Time	Colliery Site Reference	Field pH	pH	Field EC (µS/cm)	Electrical Conductivity @ 25°C (µS/cm)	Temp	Field TSS	TSS	TDS	Oil & Grease		Sampled by	General Comments/ Observations	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Sulfate as SO4 - Turbidimetric	Chloride	Calcium	Magnesium	Sodium
21-Feb-12	8:20	SD3	8.07		990		24.1	134					G.Thomson										
28-Feb-12	11:35	Sed Dam 23	8.48	7.9	104	174	27.6	45	13	374	<5		G.Thomson		<1	<1	63	63	3	10	10	3	20
28-Feb-12	11:50	Sed Dam 6	8.1	7.78	243	228	27.3	128	42	234	<5		G.Thomson		<1	<1	74	74	2	22	13	5	24
29-Feb-12	10:05	Sed Dam 23	8.1		110		27	255					B. Winsor										
29-Feb-12	10:30	Sed Dam 6	8.06		251		27	210					B. Winsor										
29-Feb-12	16:00	Sed Dam 23	8.27	7.89	100	177	32.7	56	28	209	<5		B. Winsor		<1	<1	64	64	4	11	10	4	20
29-Feb-12	16:25	Sed Dam 6	8.13	7.78	257	232	31.4	205	108	361	<5		B. Winsor		<1	<1	73	73	3	20	12	5	23
01-Mar-12	11:05	Sed Dam 23	8.22	7.52	110	117	26.7	43	24	200	<5		J. Miller		<1	<1	69	69	3	11	10	4	20
01-Mar-12	11:20	Sed Dam 6	7.91	7.75	241	234	27.1	228	77	350	<5		J. Miller		<1	<1	73	73	3	23	13	5	24
02-Mar-12	11:45	Sed Dam 23	8.47	7.89	132	176	27	68	9	277	<5		G.Thomson		<1	<1	64	64	4	10	10	4	20
02-Mar-12	12:05	Sed Dam 6	8.11	7.65	244	255	27.9	348	154	334	<5		G.Thomson		<1	<1	66	66	4	24	12	5	22
03-Mar-12	9:20	Sed Dam 6	7.93		236		23	360					G.Thomson										
03-Mar-12	11:35	Sed Dam 23	8.34	7.83	138	175	25.5	58	16	207	<5		G.Thomson		<1	<1	62	62	4	10	10	3	20
03-Mar-12	11:40	Sed Dam 6	8.06	7.62	237	230	25.5	373	193	347	<5		G.Thomson		<1	<1	71	71	5	21	12	5	22
03-Mar-12	15:30	Sed Dam 6	8.04		237		26.8	384					G.Thomson										
04-Mar-12	8:45	Sed Dam 6	7.92		250		23	445					G.Thomson										
04-Mar-12	10:25	Sed Dam 23	7.86	7.66	147	166	24	67	16	205	<5		G.Thomson		<1	<1	60	60	1	9	10	3	18
04-Mar-12	11:50	Sed Dam 6	8.11	7.4	264	235	28.8	427	110	386	<5		G.Thomson		<1	<1	71	71	8	21	12	5	25
04-Mar-12	15:20	Sed Dam 6	8.15		250		30.5	400					G.Thomson										
05-Mar-12	8:30	Sed Dam 6	7.8		220		24.4	384					G.Thomson										
05-Mar-12	12:20	Sed Dam 23	8.49	7.72	143	165	27.7	44	27	210	<5		G.Thomson		<1	<1	60	60	1	9	9	3	18
05-Mar-12	12:40	Sed Dam 6	7.79	7.48	230	228	24.6	392	118	446	<5		G.Thomson		<1	<1	69	69	7	20	12	5	24
05-Mar-12	15:30	Sed Dam 6	8		229		24.2	568					G.Thomson										
05-Mar-12	17:45	SD3	8.21		841		23.7	440					G.Thomson										
06-Mar-12	9:25	SD3	7.5		545		22.2	56					G.Thomson										
09-Mar-12	9:50	Sed Dam 23	7.87		146		21.7	48					B. Winsor										
10-Mar-12	13:10	SD3	8.86		1189		22.3	55					G.Thomson										
12-Mar-12	17:00	SD3	8.55		881		27.5	45					G.Thomson										

Potassium	Arsenic	Cadmium	Chromium	Copper	Nickel	Lead	Zinc	Iron	Ammonia as N	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P	Reactive Phosphorus as P	Total Anions	Total Cations
5	<0.001	<0.0001	<0.001	0.002	<0.001	0.002	<0.005	0.24	0.01	<0.01	<0.01	<0.01	0.9	0.9	0.18	<0.01	1.6	1.74
9	0.002	<0.0001	<0.001	0.002	0.001	0.004	0.01	1.11	0.01	<0.01	<0.01	<0.01	1.4	1.4	0.29	<0.01	2.14	2.33
5	0.001	<0.0001	<0.001	0.001	0.002	<0.001	0.013	0.4	0.02	<0.01	<0.01	<0.01	0.3	0.3	0.04	<0.01	1.67	1.83
10	0.002	<0.0001	<0.001	0.002	0.004	0.001	0.023	1.06	<0.01	<0.01	<0.01	<0.01	0.8	0.8	0.07	<0.01	2.09	2.27
5	<0.001	<0.0001	<0.001	0.004	0.004	<0.001	2	0.49	<0.01	<0.01	<0.01	<0.01	0.3	0.3	0.02	<0.01	1.75	1.83
10	0.002	<0.0001	<0.001	0.003	0.005	<0.001	0.219	1.07	<0.01	<0.01	<0.01	<0.01	0.8	0.8	0.07	<0.01	2.17	2.36
5	<0.001	<0.0001	<0.001	<0.001	0.002	<0.001	0.008	0.42	0.01	<0.01	<0.01	<0.01	0.9	0.9	0.13	<0.01	1.64	1.83
10	0.002	<0.0001	<0.001	0.002	0.004	<0.001	0.019	0.65	0.03	<0.01	<0.01	<0.01	2.6	2.6	0.38	<0.01	2.14	2.22
5	<0.001	<0.0001	<0.001	0.008	0.002	<0.001	0.079	0.38	0.01	<0.01	<0.01	<0.01	0.3	0.3	0.03	<0.01	1.6	1.74
9	0.002	<0.0001	<0.001	0.012	0.004	<0.001	0.104	0.87	<0.01	<0.01	<0.01	<0.01	0.7	0.7	0.08	<0.01	2.12	2.2
5	0.001	<0.0001	0.005	0.003	0.006	0.002	0.031	3.68	0.02	<0.01	<0.01	<0.01	0.3	0.3	<0.01	<0.01	1.47	1.66
9	0.002	<0.0001	<0.001	0.002	0.004	<0.001	0.019	1.11	0.02	<0.01	<0.01	<0.01	0.7	0.7	0.1	<0.01	2.18	2.33
5	0.001	<0.0001	<0.001	0.002	0.002	<0.001	0.02	0.52	0.01	<0.01	<0.01	<0.01	0.5	0.5	0.07	<0.01	1.47	1.61
9	0.002	<0.0001	<0.001	0.003	0.004	<0.001	0.04	1.04	0.03	<0.01	<0.01	<0.01	0.7	0.7	0.05	<0.01	2.09	2.28