Mt Arthur Coal

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Appendix C – Surface Water Assessment

HYDROLOGY AND WATER MANAGEMENT CONSULTANTS

Gilbert & Associates Pty Ltd

FINAL REPORT

MT ARTHUR COAL OPEN CUT MODIFICATION

Surface Water Assessment

Prepared for: **Hunter Valley Energy Coal**

Apr-13
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PO Box 2143
Toowong, Qld. 4066

Tel: (07) 3367 2388
Fax: (07) 3367 2833

A.C.N 085 419 852
A B N 62 085 419 852

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1.0 INTRODUCTION

Hunter Valley Energy Coal (HVEC) owns and operates the Mt Arthur Coal Mine (refer Figure 1). HVEC is proposing to modify its Project Approval (PA 09_0062) under section 75W of the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979* (the Modification). The area of assessment for this report (i.e. the Modification Area) is illustrated on Figure 2.

Specifically, the Modification comprises the following:

- a four year continuation of the open cut mine life from 2022 to 2026 at the currently approved maximum rate of 32 million tonnes per annum (Mtpa);
- an increase in open cut disturbance areas;
- use of the conveyor corridor for overburden emplacement;
- duplication of the existing rail loop;
- an increase in the maximum number of train movements per day from 24 to 38;
- the relocation of the load point for the overland conveyor which delivers coal to Macquarie Generation's Bayswater Power Station;
- the relocation and upgrade of the explosives storage, magazine and associated facilities; and
- the construction of additional offices and a control room and a small extension to the run-of-mine (ROM) coal stockpile footprint.

Coal would continue to be washed at the existing Coal Handling and Processing Plant (CHPP), with the product coal either railed to the port of Newcastle or transported by conveyor to the nearby Bayswater Power Station. A proportion of ROM coal would bypass the CHPP (i.e. would not need washing). Tailings (fine reject) material from the CHPP would initially continue to be deposited into the nearby West Cut open cut void, until stage one of the approved turkeys nest style tailings storage facility is completed within the Bayswater No. 2 area. Overburden and other mining waste, including coarse reject from the CHPP, would continue to be placed in areas adjacent to and within completed open cut areas.

Water for the CHPP, dust suppression and other non-potable uses would be obtained from a variety of sources, including mine water storage dams, decommissioned open cuts, active open cuts, underground mining areas, water sourced from Muswellbrook treated sewage effluent, recovery from the tailings storage and water imported to site from the Hunter River using water licences held by HVEC. Potable water would continue to be drawn from Muswellbrook town water.

This Surface Water Assessment report has been prepared to support an Environmental Assessment (EA) for the Modification.

MT ARTHUR COAL OPEN CUT MODIFICATION

FIGURE 1

Regional Location

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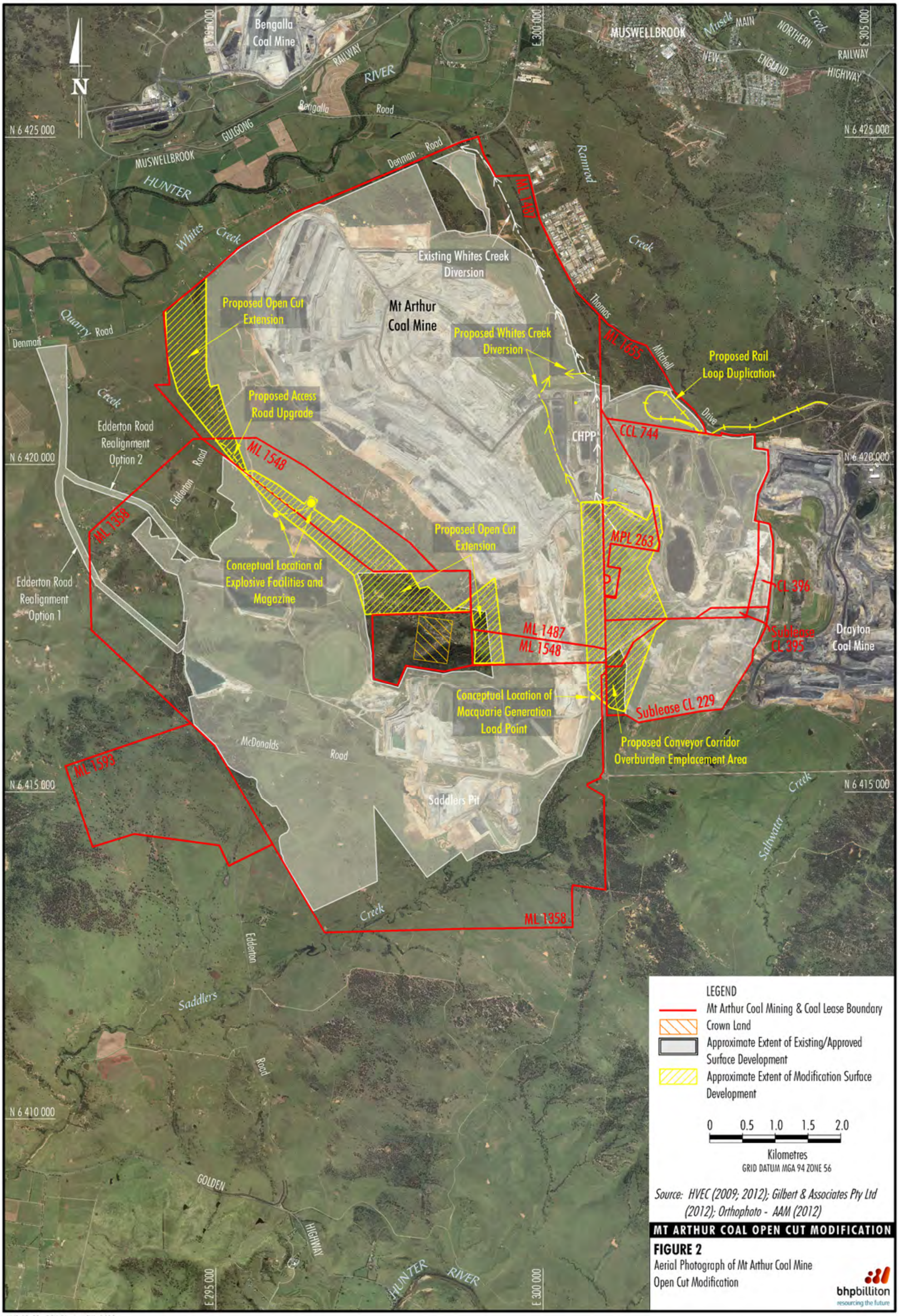
HVE-11-01 OCM EA_App SW_001B



MT ARTHUR COAL OPEN CUT MODIFICATION

FIGURE 2

Aerial Photograph of Mt Arthur Coal Mine Open Cut Modification

HVE-11-01_OCM EA_App SW_101D

The Surface Water Assessment has drawn on the results of a hydrogeological study completed for the Modification by Australasian Groundwater and Environmental Consultants (AGE) (2012). HVEC provided information on the existing mining and processing operations and the layout of Mt Arthur Coal Mine. HVEC provided information on proposed future operations and the future layout of the site as part of the Modification.

This assessment has been prepared in accordance with the Director-General's Requirements (DGRs) for the Modification (issued by the NSW Department of Planning and Infrastructure [DP&I] on 30 April 2012). In relation to surface water, the DGRs require:

***Water Resources** – including:*

- *detailed assessment of potential impacts on the quality and quantity of existing surface and ground water resources, including:*
  - *…*
  - *impacts on affected licensed water users and basic landholder rights; and*
  - *impacts on riparian, ecological, geo-morphological and hydrological values of watercourses, including environmental flows and potential flooding impacts;*
- *a detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume, salinity and frequency of any water discharges), water supply infrastructure and water storage structures;*
- *an assessment of proposed water discharge quantities and quality/ies against receiving water quality and flow objectives;*
- *assessment of impacts of salinity from mining operations, including disposal and management of coal rejects and modified hydrogeology, a salinity budget and the evaluation of salt migration to surface and groundwater sources;*
- *identification of any licensing requirements or other approvals under the Water Act 1912 and/or Water Management Act 2000;*
- *demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP);*
- *a description of the measures proposed to ensure the modified project can operate in accordance with the requirements of any relevant WSP or water source embargo;*
- *a detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts; and*
- *compliance with the Hunter River Salinity Trading Scheme;*

The surface water assessment has been prepared to address the DGRs and in consideration of the NSW Office of Water's (NOW) agency comments (Appendix A).

2.0 EXISTING SURFACE WATER HYDROLOGY

2.1 Site Location, Topography, Land Use and Drainage

The Mt Arthur Coal Mine is located in the central Hunter Valley, approximately 5 kilometres (km) southwest of Muswellbrook. The Mining Lease, Coal Lease, Consolidated Coal Lease and Mining Purposes Lease boundaries cover an area of approximately 85 square kilometres (km^2) and are located south of the Hunter River (refer Figures 1 and 2). The site topography comprises mostly undulating hills, with Mount Arthur rising as the dominant landscape feature. Surface elevations vary from approximately 140 metres (m) Australian Height Datum (AHD) along Denman Rd to the north of the Modification Area and up to 482 m AHD at Mount Arthur.

Land use other than coal mining in the local area includes residential and rural residential dwellings and industrial operations, while alluvial lands near the Hunter River are utilised for crop production including vineyards and orchards, thoroughbred breeding and cattle grazing. Much of the surrounding lands have been cleared of original vegetation cover and are predominantly grassland. Areas of original and remnant vegetation are scattered throughout the Modification Area especially on Mount Arthur and within the upper portion of Saddlers Creek Catchment.

Surface drainage generally comprises ephemeral creeks with headwaters within the Modification Area flowing north and south-westwards, ultimately draining into the Hunter River. Quarry Creek, Ramrod Creek, Fairford Creek, Whites Creek and several small unnamed creeks flow northwards into the Hunter River on the northern side of the existing mining operations. Saddlers Creek has its headwaters in the south of the Modification Area. Saddlers Creek flows generally to the south-west and joins the Hunter River downstream of Denman. The Hunter is one of the largest coastal catchments in NSW, with a catchment area of approximately 22,000 km^2.

2.2 Climate

Mt Arthur Coal Mine experiences a dry temperate climate with an annual average rainfall of approximately 618 millimetres (mm). Long-term historical rainfall data is available from numerous established Bureau of Meteorology (BoM) stations in the surrounding region. The closest station with a long-term record is located in Muswellbrook at Lower Hill Street (station number 61053 with 142 years of record). Rainfall statistics calculated from rainfall recorded at Muswellbrook are summarised in Table 1.

Whilst rainfall is spread throughout the year, it is on average greater in the summer months. The highest recorded monthly rainfall was 377.6 mm recorded in February 1955. The highest daily rainfalls have been recorded during late summer (January to March) and early winter (May and June). The maximum rainfalls recorded in the second half of the year have, by comparison, been significantly lower (refer Table 1).

Table 1
Summary of Monthly Rainfall Statistics – mm
(Muswellbrook 61053 [Lower Hill St] – 1870 to 2012)*

Month	Mean	Median	10th Percentile	90th Percentile	Highest Monthly	Lowest Monthly	Highest Daily
January	69.6	59.0	17.9	139.3	250.5	0.3	110.5
February	66.9	48.7	7.6	134.6	377.6	0.0	161.8
March	52.8	41.1	7.6	105.0	249.9	0.0	152.1
April	43.5	34.6	5.2	84.2	191.9	0.0	77.5
May	41.5	27.9	5.8	95.6	262.4	0.0	122.7
June	51.3	35.0	9.9	113.0	284.4	0.0	111.8
July	44.2	35.2	6.9	94.5	193.7	0.0	78.7
August	38.8	30.6	7.2	74.7	213.4	0.0	54.1
September	40.7	30.9	9.5	79.9	172.1	0.0	81.5
October	48.6	42.2	10.1	89.7	189.0	0.0	86
November	56.1	48.6	9.7	104.9	205.0	0.0	58
December	67.0	60.2	18.0	134.7	224.9	0.0	93.6
Annual Total	**622.3**	**611.8**	**397.4**	**837.8**			

* Data source: BoM (2012) Climate Data Online.

Thematic mapping of evaporation published by the BoM (2001) indicates that areal average potential evaporation at the Mt Arthur Coal Mine is approximately 1,740 mm per annum (mm/a) (refer Table 2 below). Evaporation data measured at the nearest BoM pan evaporation station at Scone (approximately 30 km north of the Mine) from 1965 to 2012 averages 1,583 mm/a.

Table 2
Monthly Potential Evapotranspiration and Evaporation at Scone SCS – mm

Month	Average Monthly Point Potential*	Mean Evaporation at Scone**
January	220	217
February	210	175
March	165	155
April	130	105
May	80	68
June	65	48
July	70	56
August	95	84
September	125	117
October	165	155
November	195	183
December	220	220

* Point potential is defined as the evapotranspiration that would take place if there was an unlimited supply of water from an area so small that local effects do not alter air mass properties.
** Data source: BoM (2012).

A comparison between mean monthly rainfall and potential evapotranspiration over the data period indicates that the area has an excess evaporative capacity over rainfall in all months on average (refer Table 3). There is significant variability in monthly rainfall and there will be periods when rainfall will exceed evaporation. These wetter periods may occur at any time during the year and may last for several months.

Table 3
Average Monthly Rainfall and Evapotranspiration – mm

Month	Average Monthly Point Potential Evapotranspiration	Mean Monthly Rainfall*	Potential Rainfall Excess
January	220	69.6	-150.4
February	210	66.9	-143.1
March	165	52.8	-112.2
April	130	43.5	-86.5
May	80	41.5	-38.5
June	65	51.3	-13.7
July	70	44.2	-25.8
August	95	38.8	-56.2
September	125	40.7	-84.3
October	165	48.6	-116.4
November	195	56.1	-138.9
December	220	67.0	-153
Annual Total	**1740**	**622.3**	**-1117.7**

* Muswellbrook Lower Hill Street, BoM (2012) Climate Data Online.

Maps published by the Institution of Engineers Australia (IEAust) (1987) indicate that rainfall intensity generally tends to reduce with distance from the coast. Rainfall intensity is also locally affected by the orographic influence of the Great Dividing Range. Short duration[1] rainfall intensity data from nearby Muswellbrook has been compared with representative areas in the Hunter Valley and nearby coastal centres of NSW in Table 4 below.

Table 4
Comparative Rainfall Intensities – mm per hour

Location	1 in 2 year ARI, 1 hour	1 in 10 year ARI, 1 hour	1 in 50 year ARI, 1 hour	1 in 100 year ARI, 1 hour
Scone	24.5	34.2	44.5	52
Muswellbrook	22.7	32.5	44.4	49.8
Maitland	29.9	43.6	59	66
Newcastle	35	49.5	66	73
Sydney	41.9	63	87	97

ARI = Average Recurrence Interval.
Data source: IEAust (1987).

2.3 Catchments

The Modification Area is located wholly within the Hunter River catchment, which is one of the six major regulated river basins in NSW. Flow regulation in the Hunter River is provided by three main water storages – Glenbawn, Glennies Creek and Lostock. These storages are operated by the NSW State Water Corporation to provide flows for irrigation and other uses, including mining and power generation in the valley. Glenbawn Dam also provides flood mitigation in the lower Hunter River with a substantial reserve storage held for this purpose. The NSW Office of Environment and Heritage (OEH) administers a salt trading scheme on the Hunter River under a regulation attached to the NSW *Protection of Environment Operations Act, 1997,* the *Protection of Environment Operations (Hunter River Salinity Trading Scheme) Regulation, 2002*. The scheme is used by a number of coal mines and power stations – it is known as the Hunter River Salinity Trading Scheme (HRSTS) (refer Section 2.9).

[1] Short duration (one-hour) storm event data was assessed because of its significance to flows in small local catchments such as those at the Mount Arthur Coal Complex.

All creeks within the Mt Arthur Coal Mine mining tenements appear to be ephemeral. The western and northern parts of the Modification Area are drained by creeks flowing northward to the Hunter River (refer Figure 2). Some of the creeks' catchments have been modified by mining, including Quarry Creek, Fairford Creek, Whites Creek, a small unnamed tributary and Ramrod Creek. The pre-mine catchment areas of these creeks have been reduced by the development of open cut pits as part of the Mt Arthur Coal Mine (refer Table 5). Quarry Creek, which has an estimated total current catchment area of 19 km^2, drains the westernmost portion of the Modification Area. Fairford Creek, a tributary of Whites Creek, currently has a catchment of 8.6 km^2. Whites Creek, which prior to mining drained an estimated catchment area of 21.5 km^2, has been diverted to the east of the existing mine infrastructure area. Small unnamed tributaries include a catchment draining the area north of the Northern Open Cut currently about 2 km^2. The Ramrod Creek catchment drains some 32.4 km^2 downstream of the existing mine rail loop and the neighbouring Drayton Coal Mine.

Table 5
Local Catchments – Summary Details

	Total Catchment Area prior to mining (km^2)*	**Current Catchment Area (as of January 2012) (km^2)†**
Quarry Creek	22.0	18.8
Fairford Creek	10.8	8.6
Whites Creek	21.5	2.9
Whites Creek Diversion	n/a	3.6
Unnamed Creeks	4.2	1.8
Ramrod Creek	33.4	32.4
Saddlers Creek	99.0	91.3

* Derived from 1:25,000 scale Muswellbrook topographic map.
† Using a January 2012 contour plan supplied by HVEC.

Catchments to the south of the Modification Area are bounded by Mount Arthur and an associated ridgeline. Southward flowing tributary gullies report to Saddlers Creek which flows generally in a south-westerly direction (refer Figure 2) towards the Hunter River near Denman. Saddlers Creek has a current total catchment area of 91.3 km^2.

Within the Modification Area all creeks are first order streams (according to the Strahler classification system), with the exception of the headwaters of Saddlers Creek which is first and second order.

2.4 Runoff and Streamflow

As noted in Section 2.3, local streams appear on the basis of site observations to be ephemeral. No local creeks are presently gauged. The only local creek with recorded streamflow data is Saddlers Creek at GS210043 (refer Figure 3) which operated between 1956 and 1981. Summary station details are provided in Table 6.

Table 6
Saddlers Creek Gauging Station – Summary Details

Station Number	210043
Period of Record	25/1/56 to 31/10/81
Catchment Area	78 km^2
Average Recorded Flow	1,187 ML/a
Average Rainfall for Recorded Flow Period	618 mm/a
Days with Missing Data	15%
Zero Flow Days	35%
Estimated Baseflow Index*	10%

* Volume of baseflow as a proportion of total flow – derived from daily streamflow hydrograph analysis.
Data from NOW (2012).
Note:
ML/a = megalitres per annum.
% = percent.

A small, although not negligible, spring-fed baseflow component is indicated from analysis of the streamflow record suggesting some flow persistence after rainfall in Saddlers Creek. A low catchment yield of less than 3% is indicated by the data, although this is probably affected by the missing flow data tending to be during periods of higher flow.

The closest gauging stations on the Hunter River are located upstream at Muswellbrook Bridge (GS210002) and downstream at Denman (GS210055) (refer Figure 3). GS210002 has a catchment area of 4,220 km^2 with data available since 1913 (with a large data gap from 1928 to 1960), while GS210055 has a catchment area of 4,530 km^2 with data available since 1959.

2.5 Surface Water Usage

The main surface water usage in the region is from the Hunter River. The Hunter River catchment drains a total of 22,000 km^2. Extraction and use of water from the Hunter River is subject to regulation under the Hunter River Water Sharing Plan (WSP) which was enacted under the NSW *Water Management Act, 2000* in 2004. The key objective of the WSP is to provide water to support ecological processes and environmental flows in the river, manage water access licences, water allocation, trading of licences and allocations, extraction of water, operation of dams and the overall management of flows.

Glenbawn Dam, which is located approximately 30 km upstream of the Mt Arthur Coal Mine near Scone, is used to regulate flows downstream including reaches near the mine. Water is extracted from the Hunter River for basic landholder stock and domestic rights, while extraction licences for mining, industry, water utility provision, high security entitlements and general security entitlements (HSE and GSE) have also been issued. Significant volumes of water are also taken and stored for power station use in Lake Liddell. Downstream of the Mt Arthur Coal Mine, the Hunter River is the major regional source of farm water supply for irrigation, stock watering and domestic use.

Agricultural properties located immediately north of the Modification Area contain on-stream dams which are used for irrigation and stock watering on Whites Creek, Fairford Creek and the un-named creeks to the north-east of the mine area. The majority of these properties are owned by HVEC. Two current private extraction entitlements for less than 16 megalitres (ML) of water each for irrigation have been licensed by NOW on two adjoining properties on Ramrod Creek downstream of the Modification Area. Water usage downstream of the mine area on Saddlers Creek includes stock watering and irrigation from on-stream dams (Dames & Moore, 2000b). Agricultural users in the region surrounding the mine area may also rely on groundwater bores to provide water for irrigation, stock watering and domestic usage.

2.6 Harvestable Right

Landholders in most NSW rural areas are allowed to collect a proportion of the rainfall runoff on their property and store it in one or more dams up to a certain size. This is known as a 'harvestable right'. Maximum harvestable right dam capacity is the total dam capacity allowed under the harvestable right for a given property. It is based on 10% of the average regional rainfall runoff and takes into account local evaporation rates and rainfall periods.

The regulations (made under the *NSW Water Management Act, 2000*) relating to harvestable right exclude capture of drainage and/or effluent in accordance with best management practice, and dams constructed to control or prevent soil erosion. None of the storages on-site are used to harvest runoff from land and all storages are used to contain contaminated drainage, mine water or effluent in accordance with best management practice or are used to control soil erosion. It is concluded therefore that all of these storages should be excluded from consideration as a component of the harvestable right calculation.

2.7 Flooding

The north-western portion of the Modification Area bordering Denman Road, in the vicinity of Fairford and Whites Creeks, is quite low-lying, with elevations as low as 135 m AHD. The potential for flooding in these areas from the Hunter River in large or extreme floods has therefore been investigated. The February 1955 flood is widely acknowledged as the largest flood in the region since European settlement. It is estimated[2] that it was equivalent to a 100 year ARI event. Flow records from GS210001[3] (Hunter River at Singleton) indicate a peak daily flow at this location of approximately 867,000 ML – this is more than twice the peak daily flow of approximately 374,000 ML recorded at the same station during the June 2007 floods. Recorded flood levels along the Hunter River for the 1955 flood have been sourced from Muswellbrook Shire Council. A peak flood level of 135.73 m AHD was recorded adjacent to Whites Creek (with the level falling downstream towards Fairford Creek).

2.8 Local and Regional Surface Water Quality

2.8.1 Monitoring Program

HVEC have conducted an extensive water quality monitoring program and have compiled a database of water quality observations with site data from 1995. This includes monitoring undertaken for the Mount Arthur North Coal Project Environmental Impact Statement (Coal Operations Australia Limited, 2000) and the Mt Arthur Coal Consolidation Project (the Consolidation Project) EA (HVEC, 2009). Baseline water quality monitoring has been undertaken at numerous sites, including local creeks and mine site water storage dams. Monitoring locations include sites on Quarry Creek, Fairford Creek, Whites Creek, Whites Creek Diversion, sediment dams, the Environmental Dam, the Bayswater Main Dam, Ramrod Creek and Saddlers Creek (refer Figure 3 for monitoring locations). There is also a significant amount of data available from water quality monitoring studies conducted by others on the Hunter River.

2 As advised by Patrick Quinlan, Muswellbrook Shire Council Development Planner, via email.
3 Data for GS210055 and GS210002 near the Modification Area were not available for this flood.

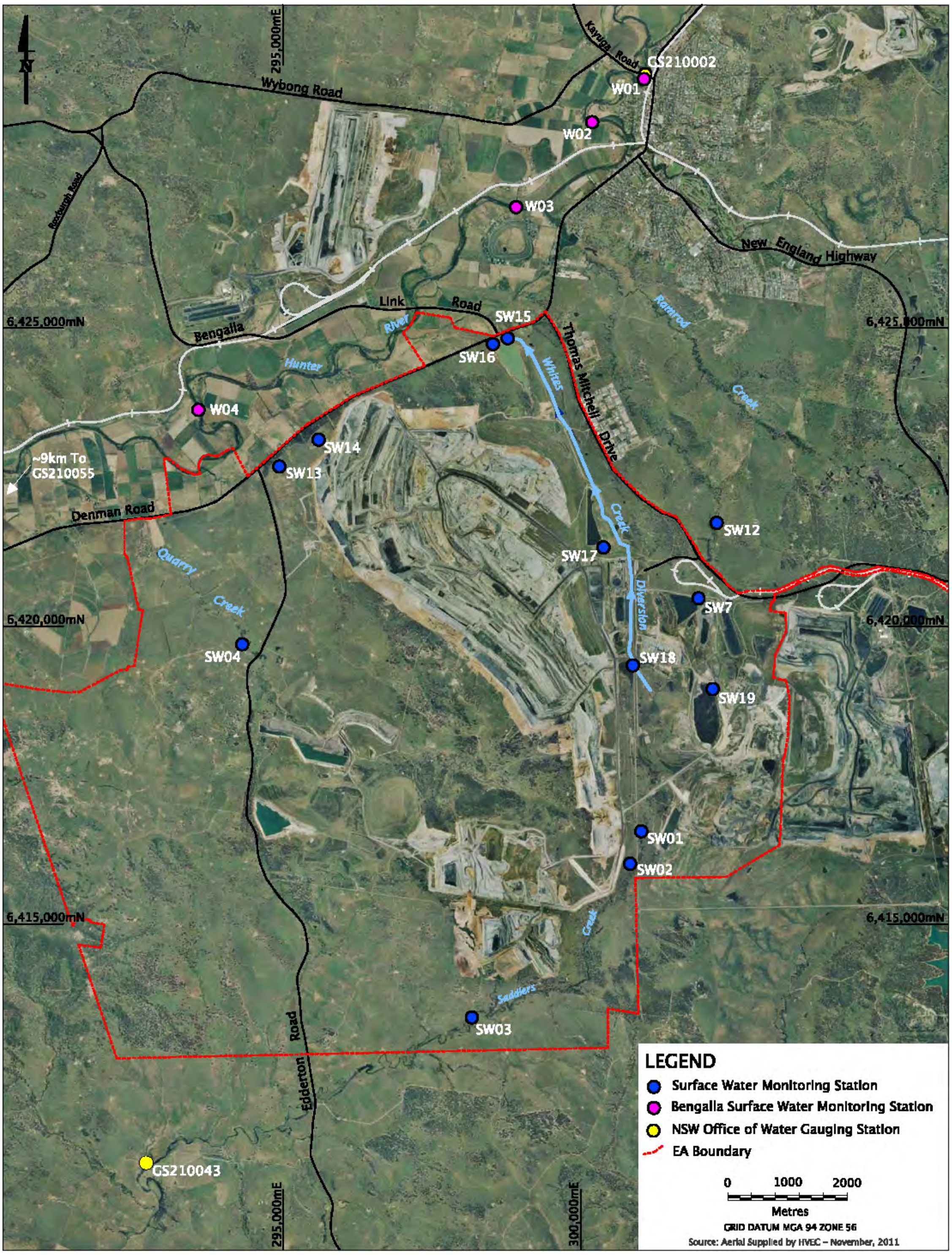


Figure 3 Water Quality Monitoring Locations

2.8.2 Local Creeks

Surface water quality data from the Mt Arthur Coal Mine database has been compared to the Australian and New Zealand Environment and Conservation Council (ANZECC) (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (herein referred to as the 'Guidelines'), which provides a framework for water quality assessment and management (refer Table 7). Median pH, electrical conductivity (EC), turbidity, total dissolved solids (TDS), filtered iron, nitrate and sulphate data from the Mt Arthur Coal Mine database were compared with guideline trigger values for protection of aquatic ecosystems in south-eastern Australian upland rivers and guideline values for Primary Industries water supplies (livestock drinking water quality). These parameters were chosen for assessment due to their potential for impact by mining related activity and by use of Muswellbrook treated effluent as part of the mine's water supply. Table 7 provides summary statistics for these parameters.

Median pH in local creeks has a tendency to trend towards alkaline levels. Median EC (a measure of salinity) was elevated relative to guideline trigger values at all monitoring locations. A large variability in EC values was observed at most sites. Median turbidity levels were below the upper bound guideline trigger level for protection of aquatic ecosystems at all monitoring locations except for Fairford Creek. A large variability in turbidity was observed at all sites. Median TDS concentrations displayed the same general trend as EC. The highest concentrations were observed at upstream Saddlers Creek and Quarry Creek. Median filtered iron concentrations were highest at the monitoring location on Fairford Creek. Median nitrate levels were well below the recommended guideline level for protection of aquatic ecosystems at all monitoring locations except Fairford Creek. Median sulphate concentrations were highest at the Saddlers Creek and Ramrod Creek monitoring locations and lowest at Fairford and Quarry Creeks. A large variability in recorded values of sulphate was noted at all sites.

Water quality monitoring time series plots are shown in Appendix B.

Table 7
Summary of Statistics of Local Creek Baseline Water Quality Data

Parameter	Site:	SW1	SW2	SW3	SW4	SW12	SW13	SW15	SW18	ANZECC (2000) Guidelines (mg/L)	
	Location:	Saddlers In	Saddlers In	Saddlers Out	Quarry Creek	Ramrod Creek	Fairford Creek	Whites Creek Diversion	Above Whites Creek	Protection of Aquatic Ecosystems	Primary Industries (Livestock Drinking Water)
	Dates Sampled:	7/1/95 - 23/1/12	2/6/95 - 23/1/12	2/6/95 - 23/1/12	2/6/95 - 23/1/12	6/7/99 - 23/1/12	2/4/01 - 23/1/12	18/9/02 - 23/1/12	8/11/04 - 23/1/12		
pH	min	6.4	6.8	6.6	6.9	7.0	6.1	7.2	6.9	6.5 to 8.0*	-
	max	8.4	8.6	8.7	9.1	9.6	9.0	9.7	9.3		
	median	7.2	7.7	8.0	8.3	7.9	7.4	8.3	8.4		
	mean	7.3	7.7	8.0	8.3	7.8	7.4	8.4	8.3		
EC (µS/cm)	min	1,000	1,360	760	490	980	120	232	1,090	30 to 350*	-
	max	17,000	16,300	11,000	17,000	7,000	1,150	8,790	5,180		
	median	8,500	8,010	6,220	9,010	5,130	325	3,260	3,180		
	mean	8,244	7,501	6,007	9,122	5,107	418	3,215	3,091		
Turbidity (NTU)	min	1.0	0.1	0.2	0.1	0.6	6.2	0.7	0.9	2 to 25*	-
	max	228	765	56	36	61	587	1110	73		
	median	7.4	3.9	2.0	2.2	2.4	28	5.0	3.5		
	mean	19	23	4.7	4.7	5.8	102	32	5.8		
TDS (mg/L)	min	1,310	850	550	310	610	150	305	700	-	<2,000 to <4,000
	max	14,000	15,600	6,920	11,000	4,900	700	6,000	3,830		
	median	6,840	6,400	3,900	5,500	3,605	280	2,350	2,120		
	mean	6,434	5,876	3,751	5,573	3,579	288	2,222	2,138		
Filtered Iron (mg/L)	min	0.01	0.01	0.00	0.01	0.00	0.15	0.01	0.001	-	-
	max	5.86	0.50	0.50	0.58	0.37	11.00	1.70	0.11		
	median	0.04	0.05	0.05	0.05	0.05	1.73	0.05	0.05		
	mean	0.15	0.10	0.05	0.05	0.05	2.42	0.07	0.04		
Nitrate (mg/L)	min	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	<0.7**	1,500
	max	5.3	5.3	3.1	5.3	3.1	20.0	7.0	1.1		
	median	0.2	0.4	0.2	0.4	0.1	1.1	0.1	0.2		
	mean	0.5	0.6	0.5	0.8	0.3	2.7	0.4	0.2		

Table 7 (Continued)
Summary of Statistics of Local Creek Baseline Water Quality Data

Parameter	Site:	SW1	SW2	SW3	SW4	SW12	SW13	SW15	SW18	ANZECC (2000) Guidelines (mg/L)	
	Location:	Saddlers In	Saddlers In	Saddlers Out	Quarry Creek	Ramrod Creek	Fairford Creek	Whites Creek Diversion	Above Whites Creek	Protection of Aquatic Ecosystems	Primary Industries (Livestock Drinking Water)
	Dates Sampled:	7/1/95 - 23/1/12	2/6/95 - 23/1/12	2/6/95 - 23/1/12	2/6/95 - 23/1/12	6/7/99 - 23/1/12	2/4/01 - 23/1/12	18/9/02 - 23/1/12	8/11/04 - 23/1/12		
Sulphate (mg/L)	min	220	44	0.4	14	240	1	25	270	-	1,000 to 2,000
	max	4,280	6,100	3,420	2,350	4,400	250	2,190	1,610		
	median	2,700	2,440	380	250	1,220	10	799	910		
	mean	2,567	2,419	426	333	1,331	20	753	890		

Source: Mt Arthur Coal Mine Database supplied by HVEC.

* For slightly disturbed south-east Australia (NSW) Upland Rivers.

** At 95% level of species protection.

Note:

µS/cm = microSiemens per centimetre.

mg/L = milligrams per litre.

NTU = nephelometric turbidity units.

2.8.3 Mine Water Storages

Water quality in mine water storages is variable, depending on prevailing climatic conditions and mining operations. Water quality monitoring time series plots are shown in Appendix B, while Table 8 provides summary statistics for mine water storage monitoring locations shown in Figure 3. The mine water management system is predominantly maintained as a closed system, with controlled releases occurring only from the Environmental Dam under a licence issued by the OEH as part of the HRSTS.

Table 8
Summary of Statistics of Mine Water Storage Baseline Water Quality Data

Parameter	Site:	SW7	SW14	SW16	SW17	SW19
	Location:	Bayswater Main Dam	Whites Creek Sed. Dam	Environmental Dam	CHPP Dirty Water Dam	West Cut Void
	Dates Sampled:	6/2/95 – 23/1/12	17/6/02 - 23/1/12	18/11/02 - 23/1/12	13/1/04 - 23/1/12	2/3/01 - 20/3/08
pH	min	6.9	6.8	7.2	7.3	6.1
	max	10	10.1	10.0	10.2	8.5
	median	8.6	8.5	8.5	8.6	7.7
	mean	8.6	8.6	8.5	8.7	7.7
EC (µS/cm)	min	1,360	120	290	910	1,770
	max	7,100	8,690	5,300	6,660	10,030
	median	3,470	2,230	1,220	3,290	6,385
	mean	3,433	2,216	1,796	3,160	6,152
Turbidity (NTU)	min	0.5	2.1	2.3	0.8	1.8
	max	51	1,870	59	54	27
	median	5.8	44	15	6.1	9.8
	mean	7.6	287	18	10	11.3
TDS (mg/L)	min	710	140	180	600	1,400
	max	5,800	7,300	3,600	5,390	9,000
	median	2,400	1,245	754	2,350	4,900
	mean	2,438	1,501	1,152	2,233	4,766
Filtered Iron (mg/L)	min	0.01	0.01	<0.01	0.01	0.01
	max	0.17	0.66	0.25	0.50	0.50
	median	0.02	0.05	0.05	0.05	0.03
	mean	0.03	0.08	0.04	0.04	0.05
Nitrate (mg/L)	min	0.01	<0.01	0.01	0.01	0.1
	max	9.2	20.0	3.9	1.0	6.6
	median	0.7	0.2	0.1	0.2	1.4
	mean	1.5	0.5	0.3	0.3	1.8
Sulphate (mg/L)	min	100	5	7	59	680
	max	3,000	2,900	1,300	2,950	5,465
	median	1,000	198	220	975	2,300
	mean	1,078	262	308	960	2,428

Source: Mt Arthur Coal Mine Database supplied by HVEC.

Over the period of available data, pH in mine water storages has ranged from 6.1 to 10.2, while EC has varied between 120 and 10,030 µS/cm and was highest at the West Cut Void (tailings storage). Median values are typical of other mines in the area with moderate salinity. Turbidity has varied from 0.5 to 1,870 NTU with all storages typically exhibiting a large range in observed concentration. TDS displays the same general trend as EC and has varied from 140 to 9,000 mg/L and was highest at the West Cut Void. Iron ranged from non-detectable (< 0.01) to 0.66 mg/L in storages, while median values are low. Nitrate concentrations vary from non-detectable (< 0.01) to 20 mg/L and were highest at the Whites Creek sediment dam and at the Bayswater Main Dam where treated effluent water from Muswellbrook Shire Council enters the water management system. Recorded sulphate ranges from 5 to 5,465 mg/L, with a peak recorded in the West Cut Void.

2.8.4 Hunter River

Salinity, as indicated by EC has been monitored continuously by the NOW at Muswellbrook Bridge (GS210002) upstream of the Modification Area since early 1992 and at Denman (GS210055) downstream of the Modification Area since early 1993. EC at both sites has been highly variable due to varying flow and ranges from 93 µS/cm to 1,011 µS/cm at the Muswellbrook site, and from 119 µS/cm to 1,178 µS/cm at the Denman gauging station. The median conductivity at the upstream and downstream sites is 447 µS/cm and 512 µS/cm respectively. EC is influenced by flow as is illustrated in Figure 4 below which shows a generally inverse correlation with flow. There is however considerable scatter evident in the correlation relationship at small flows indicating complex behaviour (Gilbert & Associates Pty Ltd, 2009).

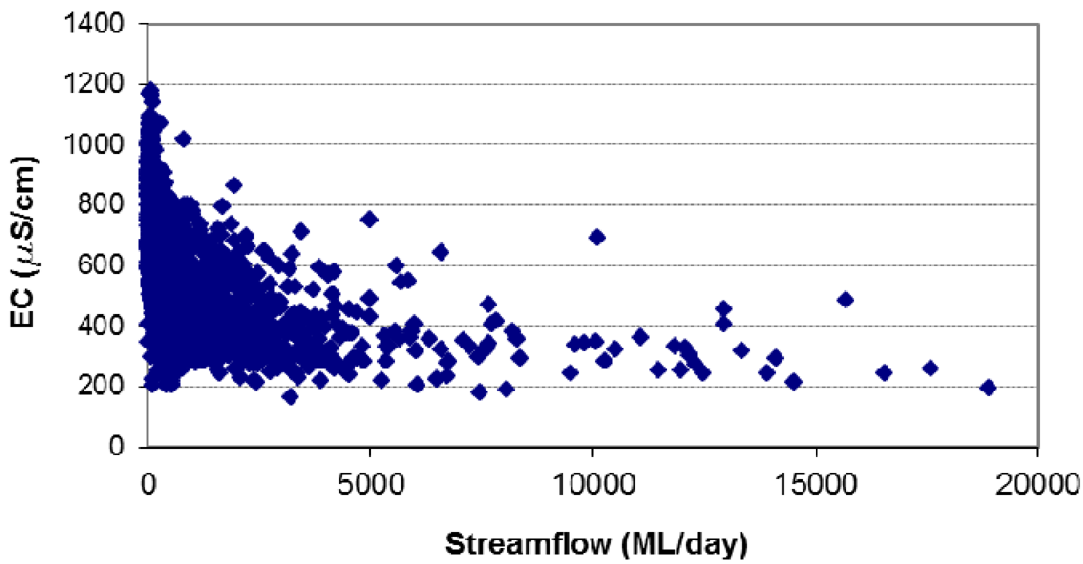


Figure 4 Recorded Electrical Conductivity-Flow Relationships – Hunter River at Denman

2.9 Hunter River Salinity Trading Scheme

The HRSTS was originally established by the then NSW Department of Land and Water Conservation and Hunter River Trust in 1995 as a pilot trial to manage salinity discharges to the Hunter, such that salt concentrations would be held below irrigation and environmental standards. The scheme is now managed by the NOW under a statutory regulation attached to the NSW *Protection of Environment Operations Act, 1997*. The *Protection of Environment Operations (Hunter River Salinity Trading Scheme) Regulation, 2002* came into effect on 1 December 2002, and the stated objectives include:

(a) to minimise the impact of discharges of saline water on irrigation, other water uses and on aquatic ecosystems in the Hunter River catchment:

(i) at the lowest overall cost to the community, and

(ii) in a way that provides ongoing financial incentives to reduce pollution, and

(b) to facilitate sustainable water management by industry in the Hunter River catchment.

The scheme attempts to achieve these objectives by prohibiting releases of saline waters during periods of low flow and controlling releases of saline water during periods of high flow such that specific salinity targets at various points in the river are not exceeded. The scheme is administered by personnel at NOW, which is responsible for setting and announcing conditions for allowable discharge rates and duration of discharge during periods of high flows in accordance with the salinity targets. The operational parameters used to regulate the scheme are advised on a daily basis for each of the various sections of the Hunter River. NOW can apply discount factors and other controls to ensure that the salinity targets are met during announced discharge periods.

Participants in the scheme are issued with tradeable discharge credits. Each credit entitles the holder to a 0.1% share of the available salt discharge capacity announced during high flow periods. The total allowable discharge is determined by NOW on a day-to-day basis, by reference to salinity targets for the Hunter River catchment – i.e. an EC of 600 µS/cm at Denman and 900 µS/cm at Glennies Creek and Singleton.

The amount of saline water that may be discharged from a given discharge licence holder is determined by reference to the salinity of the discharge waters, the river flow, the number of credits held and any overriding limit that may be applied as a condition of the licence. HVEC presently holds 16 credits.

3.0 SURFACE WATER MANAGEMENT

3.1 Existing Water Management System

The water management system at the Mt Arthur Coal Mine prescribes the system to effectively source, capture, divert, store, monitor, utilise and reticulate water on-site. The water management system includes supplies drawn from clean water imported under licence to the mine from the Hunter River, mine water collected from runoff from the mine site, water sourced under agreement from the neighbouring Drayton Coal Mine, water recycling from the CHPP, treated effluent from Muswellbrook and fresh water from the potable water supply system (drawn from Muswellbrook town water).

The water management system is illustrated in schematic form in Figure 5, while Figure 6 shows the layout of the site as at late 2011.

The existing Mt Arthur Coal Mine Project Approval requires the preparation and implementation of a Water Management plan, including a Site Water Balance, Erosion and Sediment Control Plan, Surface Water Monitoring Program, Groundwater Monitoring Program and Surface and Groundwater Response Plan. These plans have been prepared, submitted to the DP&I and were approved by the DP&I in August 2012.

Water supply for the CHPP and other non-potable uses on-site is obtained from a network of on-site storages (dams and open cut pits), which provide containment for mine water, runoff and seepage from overburden emplacement areas and runoff from other areas disturbed by the operations. The catchment area of the existing water management system totals approximately 40 km^2. The total capacity of the existing on-site water storages totals approximately 13,500 ML. The CHPP, which is the dominant user of water on-site, incorporates a tailings thickener and water recovery system to maximise water recycling. The other significant water use is dust suppression on haul roads and coal stockpile areas. These water requirements are met principally from on-site storages. Potable water is sourced from the Muswellbrook Shire Council mains supply or delivered by water tanker.

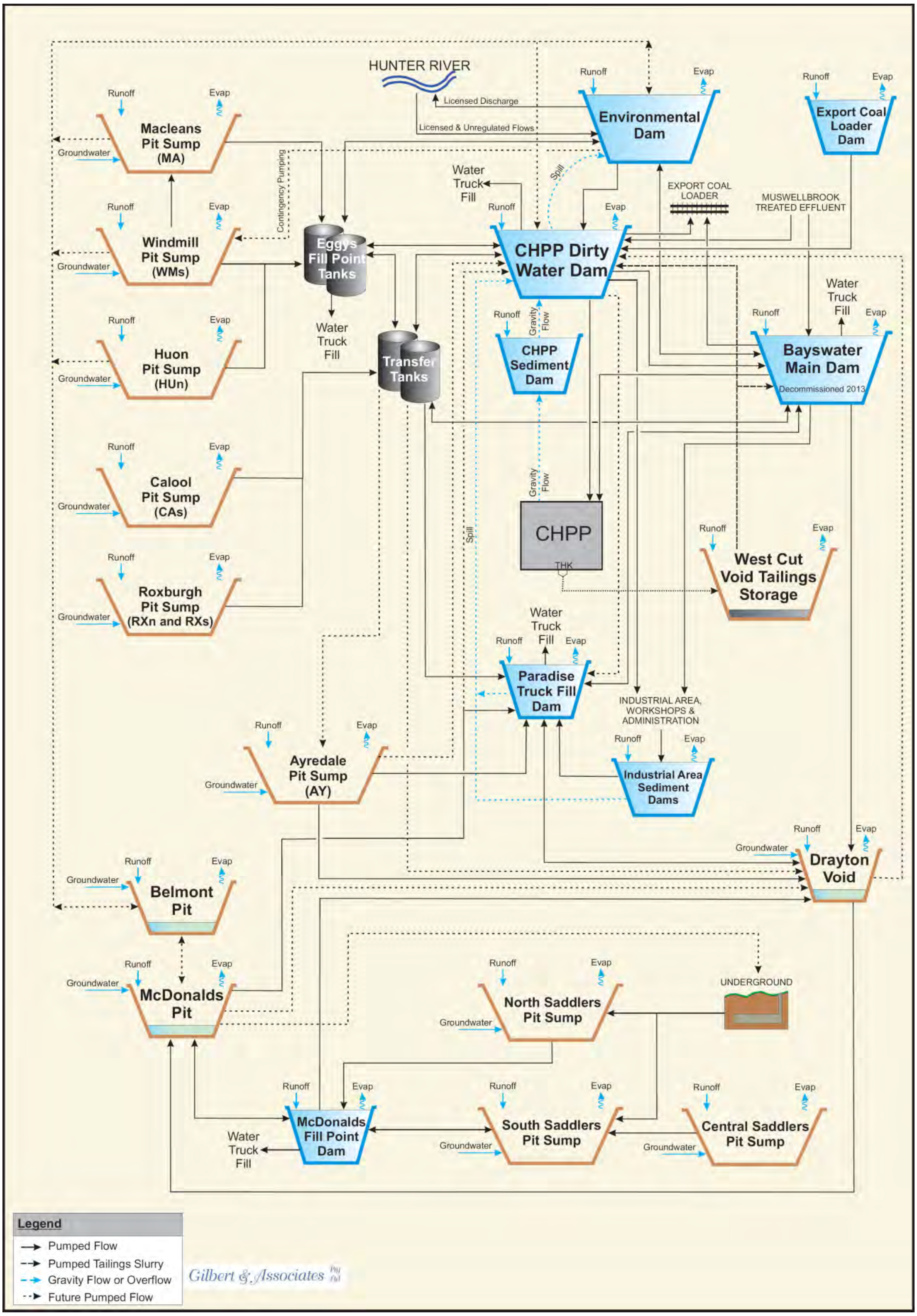


Figure 5 Water Management System Schematic

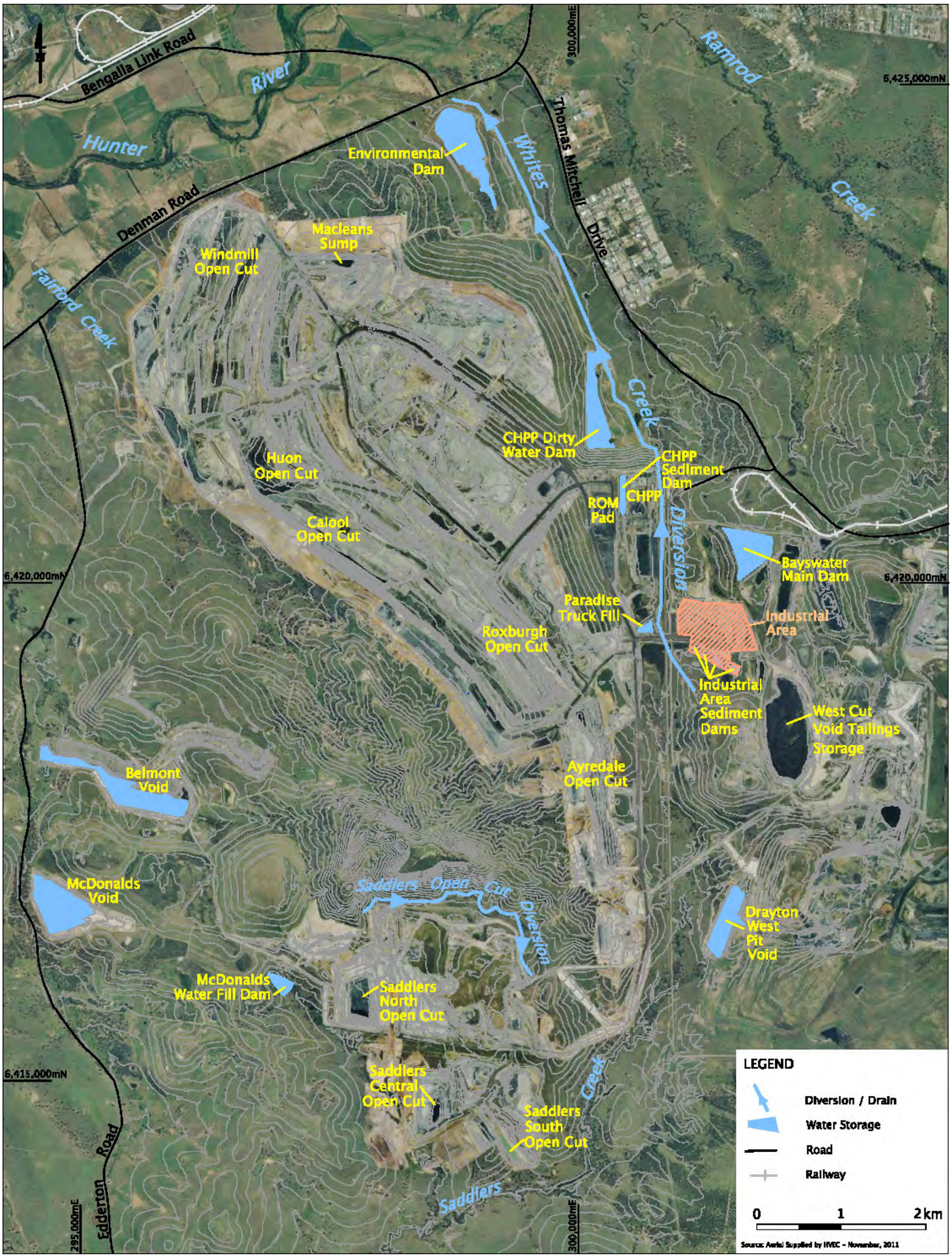


Figure 6 **Existing (late 2011) Site Layout**

The network of on-site storages incorporates separation of undisturbed area runoff from mine water catchment areas. Runoff from areas disturbed by mining is diverted into on-site storages. These storages are used as priority sources of water for the CHPP and dust suppression. Runoff from haul roads and open cut pre-strip operations is either directed to on-site storages or is treated in sediment traps. Runoff from the CHPP area collects in an adjacent sediment pond which overflows to the CHPP Dirty Water Dam, from where it is recycled for site use. Runoff from the industrial (workshops and administration) area collects in a series of sediment dams which are periodically dewatered to a nearby mine water storage dam for site re-use. Treated effluent pumped from Muswellbrook is directed into the Bayswater Main Dam. Domestic wastewater is collected and treated in an on-site package plant, prior to being directed to a wetland and then the Bayswater Main Dam. Sludge is then removed and trucked offsite by a licensed contractor to appropriate waste handling facilities. Effluent and sludge from septic pump-out systems installed at Bayswater No 3, and in-pit crib areas are collected by licensed contractors and treated offsite at licensed facilities.

HVEC has secured access to treated effluent from Muswellbrook at a rate of up to 835 ML/a (dependent on other stakeholder uses and seasonal effects) until at least 1 July 2019.

Historically, the majority of off-site make-up supplies have been obtained from licensed extraction from the Hunter River. HVEC presently holds 5,741 ML/a of Hunter River GSE and 2,197 ML/a of HSE. The volume of water that can be extracted from the Hunter River by licence holders is limited by available water determinations (AWDs) which are announced by NOW on 1 July each year (the start of the water year) and then periodically thereafter. At 100% AWD, the full licence volume may be extracted by a licensee in that water year. Historically, during time of drought, AWDs on the Hunter River may fall to 0% for GSE and 75% for HSE. However, these AWDs refer only to regulated river flow (i.e. water released from Glenbawn Dam when ordered by the licensee). During periods of naturally high river flow, NOW may announce ‘off-allocation’ conditions during which AWDs are temporarily suspended and licensees may extract (at a limited rate per day) up to their licensed volume. Water can be drawn by HVEC from a pump station on the Hunter River in the north of the Modification Area and pumped at a rate of up to 34.6 ML per day (ML/day) to the Environmental Dam.

Site excess water is transferred as a priority to the McDonalds, Belmont and Drayton West Pit Void storages. When these are at high levels, water is transferred from the Bayswater Main Dam to the Environmental Dam from where controlled releases to the Hunter River can occur under the HRSTS (refer Section 2.9).

Water liberated from CHPP tailings (fine rejects) discharged to the West Cut Void is lost to seepage into adjacent overburden stockpiles. Australian Tailings Consultants (ATC) (2011) indicates that this seepage reports to the Drayton West Pit Void (refer Figure 6). Consistent with the Consolidation Project, HVEC is planning to progressively develop an engineered tailings storage in place of the West Cut Void to increase tailings storage capacity and improve tailings storage and water recovery efficiency (refer Section 3.6).

HVEC is planning to decommission the Bayswater Main Dam in 2013. Water presently reticulated to this storage (including Muswellbrook treated effluent) would thereafter be directed to the CHPP Dirty Water Dam. The CHPP Dirty Water Dam would then become the principal source of water for the CHPP.

The available water sources and the relatively large surface catchment area and storage capacity for mine water have provided HVEC with significant flexibility to manage its water system over a wide range of operational and climatic conditions.

3.2 Water Management System – Issues, Principles and Approach

The Modification does not involve any increase in the maximum mining rate from that specified in the Consolidation Project.

Water management for the Modification would continue to be based on adherence to well-established, best water management practices in the Australian mining industry (Minerals Council of Australia, 1997). These principles are:

- Efficient use of water based on the concepts of ‘reduce, re-use and recycle’.
- Avoiding or minimising contamination of clean water streams and catchments.
- Protecting downstream water quality for beneficial uses.

As is the case for the current operations, the Modification would result in different water types being produced from different areas or parts of the operation.

The principal types of water would be:

- Water dewatered from open cut pits.
- Water dewatered from the underground.
- Runoff and seepage from overburden emplacement areas.
- Runoff and seepage from ROM and product coal stockpiles.
- Supernatant and rainfall yield from the tailings disposal areas.
- Haul road and hardstand area runoff.
- Runoff from the industrial area, workshop and vehicle re-fuelling area.
- Effluent from the domestic sewage treatment facility.
- Runoff from rehabilitated and revegetated areas.

The management of these waters is dependent on quality, generation rate and the inherent capacity for it to be re-used and/or recycled. The water quality characteristics of the different water types has been assessed from existing experience at the Mt Arthur Coal Mine and other coal mines in the region (refer Table 9).

Ongoing development of the West Cut Tailings storage in conjunction with access to the Drayton West Pit Void will see tailings water reclaimed for re-use in the water management system via the CHPP Dirty Water Dam. Water recovered from the open cuts and underground operations would continue to be pumped to mine water storages and would also be used to supplement supply to the CHPP. During abnormally wet periods leading to an excess of water being generated on-site, when the volume of water being held on-site was in excess of that required to ensure water supply security and there was an increased risk of disruption to mining as a result of excess water being held in open cut pits, water would be transferred to the Environmental Dam with a view to controlled release under the HRSTS at the next opportunity.

A pump and pipeline system is proposed to connect the Belmont Void storage to the Environmental Dam, with flow in both directions. Separate pumped transfer is also planned between the Belmont and McDonalds Void storages, between McDonalds and the Drayton West Pit Void and from McDonalds to the CHPP Dirty Water Dam. This system is currently proposed for commissioning in 2013. This will provide an efficient means of transferring water from and to these void storages to the Environmental Dam and CHPP dirty water dam for maintaining operational water supply. This will also provide a means of transferring water from the Macleans, Windmill, Huon, Calool and Roxburgh open cut areas (via the Environmental Dam) to the Belmont and McDonalds (via Belmont) Void storages for later re-use, reducing reliance on licensed extraction from the Hunter River.

Runoff from haul roads, hardstand and pre-strip areas would either be directed to existing mine water storages (where feasible) or would be captured in sediment retention storages sized to trap silt and other settleable material. During drier weather, water in the sediment dams would be used for dust suppression around the mine. Following prolonged wet periods, water in the sediment retention dams could be released following settlement. Sediment dams would be sized in accordance with the existing Mt Arthur Coal Mine Erosion and Sediment Control Plan and with Landcom (2004) and NSW Department of Environment and Climate Change (DECC) (2008).

Runoff from workshop, industrial and vehicle re-fuelling areas, which has the highest potential to contain elevated hydrocarbons, would, after passing through an oil-water separator, continue to be captured in downslope dams and recycled to the mine water management system. Treated effluent from site would continue to be recycled to the Bayswater Main Dam via the existing wetland until it is decommissioned and thereafter to the CHPP Dirty Water Dam.

Table 9
Indicative Water Quality Characteristics

Water Source/Type	Water Quality Characteristics
Water from open cut pits	Water removed from the open cuts is likely to be saline due to naturally high salt concentrations in groundwater inflows. Some salts will also be leached out of the in-pit overburden emplacements. Moderate suspended solids concentrations are likely to be present in open cut mine water following significant rainfall/runoff events. Past experience at the Mt Arthur Coal Mine suggests salinity of water from the open cut would be similar to groundwater salinity in the range 1,750 to 6,500 mg/L.
Water from the underground mine	Water removed from the underground will be predominantly groundwater which is likely to have high EC values in the range of 3,500 mg/L to 5,500 mg/L, with an average pH typically about 7.5.
Drainage from overburden emplacement areas	Drainage from overburden emplacement areas will report either to the open cut mine workings/voids, or to sediment dams constructed around the perimeter. Based on the results of previous geochemical investigations (Dames & Moore, 2000a), it is expected that the water quality of overburden drainage would be better than ANZECC Guideline trigger values for stock water. Leach test EC values were all below 340 µS/cm.
Drainage from ROM and product coal stockpiles	Runoff and seepage from the ROM and product coal stockpiles is likely to contain elevated concentrations of salt and potentially products of sulphide oxidation (predominantly sulphate salts and possibly reduced pH) and will report to the CHPP Dirty Water Dam for re-use in the mine water management system.
Supernatant and internal runoff from the tailings (fine rejects) disposal area	Tailings supernatant will contain salts washed from the coal and reagents (i.e. flocculant) used in the washing process. Based on past experience it is expected that tailings decant water will be moderately saline and the pH will be neutral to slightly alkaline.
Runoff from haul road and hardstand areas	Runoff from these areas is likely to contain elevated levels of fine sediment (wash load) and possibly elevated salinity.
Runoff from the mine infrastructure area, export coal loader, workshop and vehicle re-fuelling area	Runoff from these areas is likely to contain elevated levels of fine sediment and possibly hydrocarbons (from minor spills of fuels and oils), Low levels of oil and grease have been recorded in samples from a downstream dam to date.
Effluent from the domestic sewage treatment plant	Effluent from the sewage treatment plant is likely to have elevated levels of suspended solids, nutrients and Biochemical Oxygen Demand (BOD). Typical water quality parameters from domestic sewage treatment plants are: suspended solids 10-30 mg/L, total nitrogen 25-50 mg/L, total phosphorus 10-15 mg/L and BOD 5-10 mg/L.
Runoff from rehabilitated and revegetated areas	Runoff from rehabilitated areas of the mining operations may initially have elevated suspended solids concentrations, which would then be expected to decline over time as the rehabilitated landform matures.

Runoff from rehabilitated and revegetated areas would initially either be directed to mine water storages or to sediment retention storages prior to being allowed to drain to local drainages. These areas would be allowed to free-drain as the landform becomes sustainable.

3.3 Modification Water Management System

The water management system at the Mt Arthur Coal Mine comprises the mine and process water circuits (including wastewater and tailings water) and the interlinked mine dewatering, water transfer and drainage containment works which are used as water sources for the mining operations. The water management system is shown in schematic form on Figure 5. Pumped flows between storages are indicated on Figure 5.

3.3.1 System Inflows

The site water sources include groundwater inflows to the underground (when commenced) and open cut mines, which need to be removed to facilitate safe and efficient mining. Groundwater inflows to both open cut and underground mining activities are predicted to vary over the mine life as mining progresses. Groundwater inflow predictions for the open cut and underground operations were provided by AGE (2012) and are plotted on Figure 7. Water removed from the active mine workings would be pumped to existing mine water supply storages for use in the CHPP and for dust suppression. The mine surface workings would become a sink for incident rainfall and runoff from the open cut and its adjacent un-diverted catchment. This water would also need to be pumped out to enable ongoing safe and efficient access for mining.

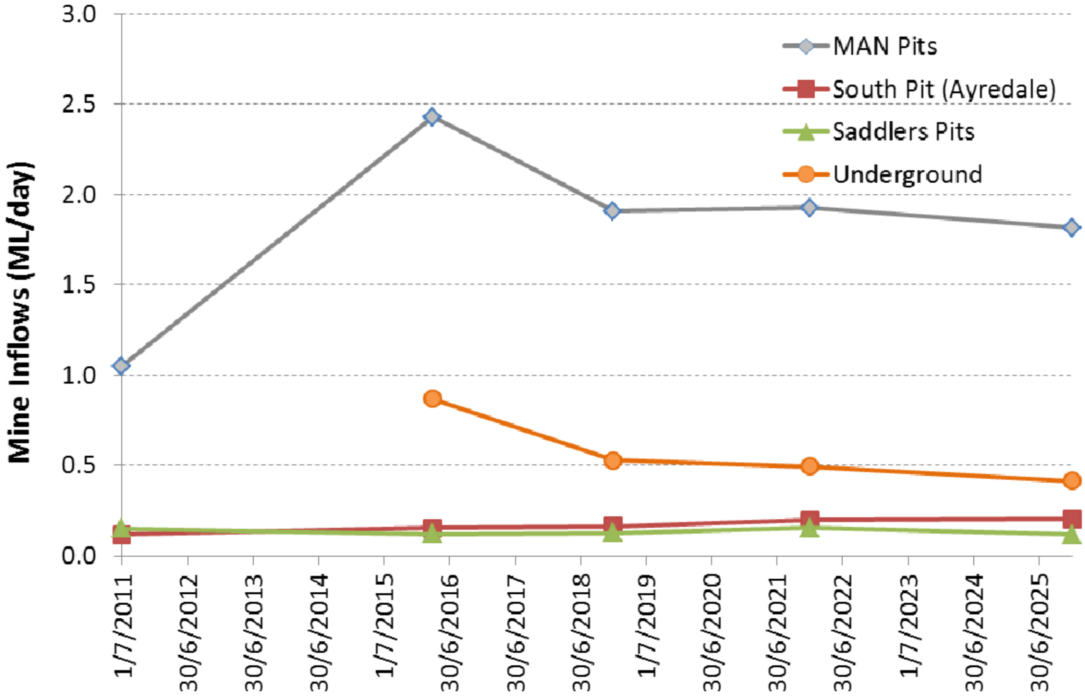


Figure 7 Predicted Mine Groundwater Inflows

Sumps would be excavated in the floor of the active mine open cut pits as part of routine mining operations to facilitate efficient dewatering.

Drainage from overburden emplacement areas would be collected and directed to water storages for use on-site. Where possible, overburden would be placed in worked out areas of the active pits. Drainage from these in-pit overburden emplacement areas would report to the floor of the active pit which advances down dip. Water draining out of the overburden results from both surface runoff and from water infiltrating and seeping through the overburden. Research in the Bowen Basin Queensland (Issacs, 1999) suggests that infiltration and seepage through coal overburden emplacement areas is the main source of drainage.

Supernatant from the tailings storage areas would be captured either directly or via the Drayton West Pit Void and returned to the Bayswater Main Dam for re-use. Incident rainfall over the storage area and the contributing catchment would contribute additional water which would combine with the supernatant generated by the settling and consolidation of the tailings.

3.3.2 Water Use

Water would be required to operate the CHPP, for dust suppression on haul roads and the ROM area, for dust emission control sprays in coal hoppers, and coal stockpile areas and in the industrial area, principally for wash down of mobile plant as well as for potable requirements. Water would also be used in the underground mine to control dust emissions in active mine areas and for cooling of mine equipment. Some water may also be used for irrigating vegetation establishment areas, fire fighting and other minor non-potable uses. The demand for dust suppression will vary with climatic conditions, with the length of haul roads and area of hardstand that will need to be watered and the planned commissioning of additional water trucks, which will evolve as mining progresses. Similarly the CHPP water demand will vary in accordance with coal production and coal type. CHPP water demands have been calculated using the planned CHPP ROM feed schedule and the following estimates of ROM, product coal and rejects moisture contents and yields (as advised by HVEC):

- ROM coal (feed) moisture – 4% to 9% mass percentage (w/w) (median 5.5%).
- Product coal moisture – 9% to 13% w/w (median 11%).
- Coarse rejects moisture – 15% to 25% w/w (median 20%).
- Tailings solids concentration – 30% to 50% w/w (typical 37.5%).
- Bypass coal moisture increase – 3.5% typical.
- Product yield – 70% typical.
- Tailings yield – 11% typical.
- Stockpile irrigation area – 8 hectares (ha).

Water usage rates for other demands have generally been based on monitored data (refer Table 10 and Figure 8).

Table 10
Estimated Water Use

Component	Current Rate (2012)	Estimated Future Rate
CHPP Make-up (after thickener recycling)	268 L/tonne feed (4,420 ML/a)*	268 L/tonne feed average (up to 7,900 ML/a average @ 29.8 Mt/a CHPP feed)
Haul Road Use	2,260 ML/a*	0% – 50%
Industrial Area	1,175 ML/a**	Negligible change
Export Coal Loader (stockpiles)	18 ML/a**	Negligible change
Underground Use	0 ML/a*	340 ML/a***

* Based on Mar-2011 to Sep-2012 data.
** Based on 2011-2012 monitored usage.
*** Based on rate in Umwelt (2008).
Note:
L/tonne = litres per tonne.

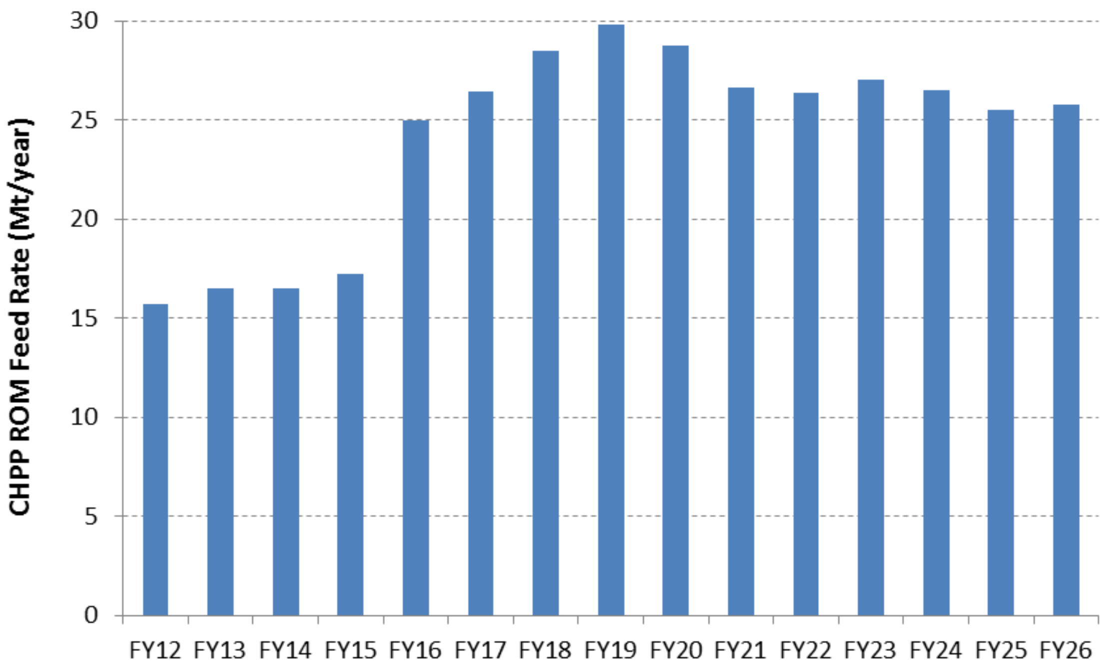


Figure 8 Planned CHPP ROM Coal Feed Rate

3.3.3 Operational Management and Objectives

The water management system would operate predominantly as a closed self-contained system. The water balance of the system would fluctuate with climatic conditions and as the extent and status of the mining operation evolves over time. Depending on the climatic conditions that are experienced during the mine life and the ability to temporarily store water in active open cut pits, there may be periods where discharge of water to the Hunter River may be the best option for managing the system. Under these circumstances, water would be discharged under licence and in accordance with the HRSTS (refer Section 2.9).

There may also be periods when the availability of water on-site is insufficient for future site requirements and under these circumstances water would be sourced externally. Water could be sourced either opportunistically from, and subject to, an agreement with the adjacent Drayton Coal Mine, from Muswellbrook treated effluent or from the Hunter River using licences held by HVEC (refer Section 3.1).

The water management system would continue to evolve over time to meet the changing requirements of the mine. The successful performance of the water management system, as with any mine water management system would involve having a combination of adequate water infrastructure and the necessary management and monitoring procedures in place to achieve the performance objectives.

Consistent with the Consolidation Project, the broad objectives of the system are:

1. To maintain a low risk of uncontrolled discharge occurring from the process water (CHPP) or mine water systems over the mine life.

2. To minimise the need to export water and salt to the Hunter River by maximising re-use on-site.

3. To minimise the need to extract water from the Hunter River by optimising the re-use and recycling of water on-site and by maximising the use of Muswellbrook treated effluent and water reclaimed from the tailings storage.

4. To minimise risks of disruption to mining operations by efficient mine dewatering.

5. To ensure that effective control over emission of airborne particulates is not interrupted due to lack of water by maintaining a reliable water supply.

6. To ensure uninterrupted operation of the CHPP by maintaining a reliable water supply.

HVEC would be guided in its decisions on sourcing or discharging water using a life-of-mine water balance model (refer Section 4.1) which would enable prediction of future water supply security and risks of excess open cut pit water.

3.4 Site Drainage Management Through Mine Life

The approach to managing runoff from catchment areas which are undisturbed by surface mining activities is to divert them around surface mining and other disturbance areas and to isolate mine area runoff from undisturbed areas. The objective of this strategy is to prevent the contamination of water and to reduce the subsequent volumes of water that would otherwise need to be managed on-site. Over the life of the mine, this would involve the continued construction of diversion bunds and drains around the open cut mine and overburden emplacement areas so as to divert runoff from undisturbed and rehabilitated areas to off-site drainages. Toe drains and isolation bunds would also continue to be constructed around the perimeter of out-of-pit overburden emplacements and other areas disturbed by mining to collect and convey drainage from these areas to containment storages, thereby isolating mine drainage from undisturbed area runoff. Diversions and drains would continue to be constructed with capacities consistent with their design life and a risk of overtopping determined as part of the on-going revision of the Site Water Management Plan in consultation with the relevant authorities. Drains would continue to be designed to minimise risk of erosion due to high flow velocities by appropriate design of grades, cross-sections and use of vegetation and/or rip-rap. Energy dissipation dams and/or level spreaders would be constructed downstream of all diversions.

The layout and extent of the main drainage management works are shown on Mining Stage Plans, Figure 6 and Figures 9 to 12. These Stage Plans differ subtly from those presented in the Consolidation Project EA (HVEC, 2009) with changes to the timing of open cut and overburden emplacement, however the overall progression of mining operations remains unchanged (generally from east to west), with the final extent of open cut operations located further westwards as indicated on Figure 2. The concepts presented are subject to final design in the Mining Operations Plan and Site Water Management Plan in consultation with the relevant authorities.

Existing Mine Layout (late 2011)

Figure 6 shows the existing mine layout. Mining is occurring in two areas – the Northern Open Cut (Ayredale, Roxburgh, Calool, Huon, Windmill and Macleans mining areas) and Saddlers open cut (South, Central and North mining areas). Overburden is being placed behind mining operations which are advancing down dip (westwards, with the exception of Saddlers Central which is advancing southwards). Runoff and seepage from the overburden emplacements and other areas disturbed by mining activity reports to adjacent active open cut mining areas.

Upslope diversions exist to the north of Saddlers open cut (directing upslope runoff eastwards to a tributary of Saddlers Creek) and to the south-west of the Northern Open Cut (directing runoff westwards to Fairford Creek).

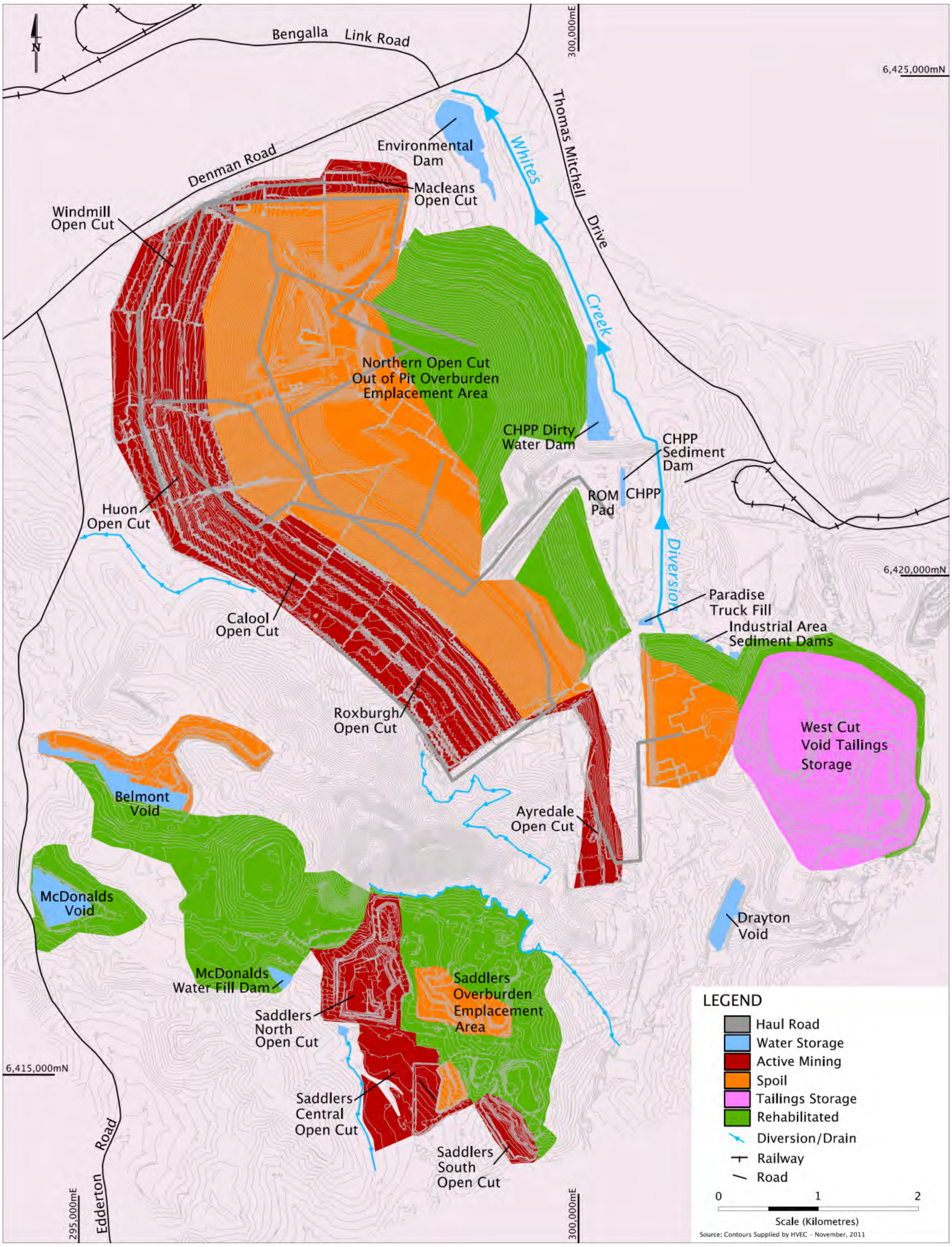


Figure 9 **2016 Site Layout**

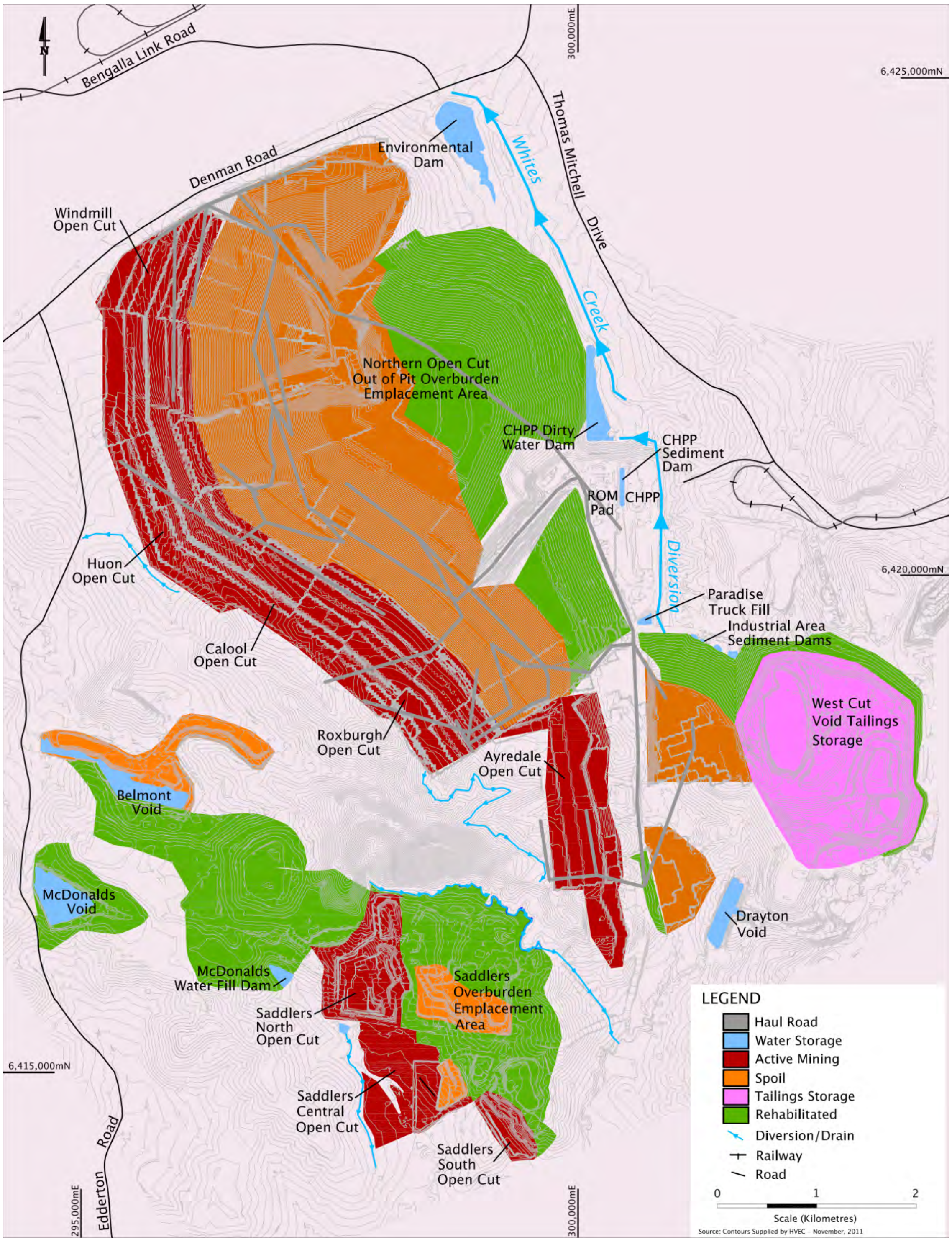


Figure 10 2018 Site Layout

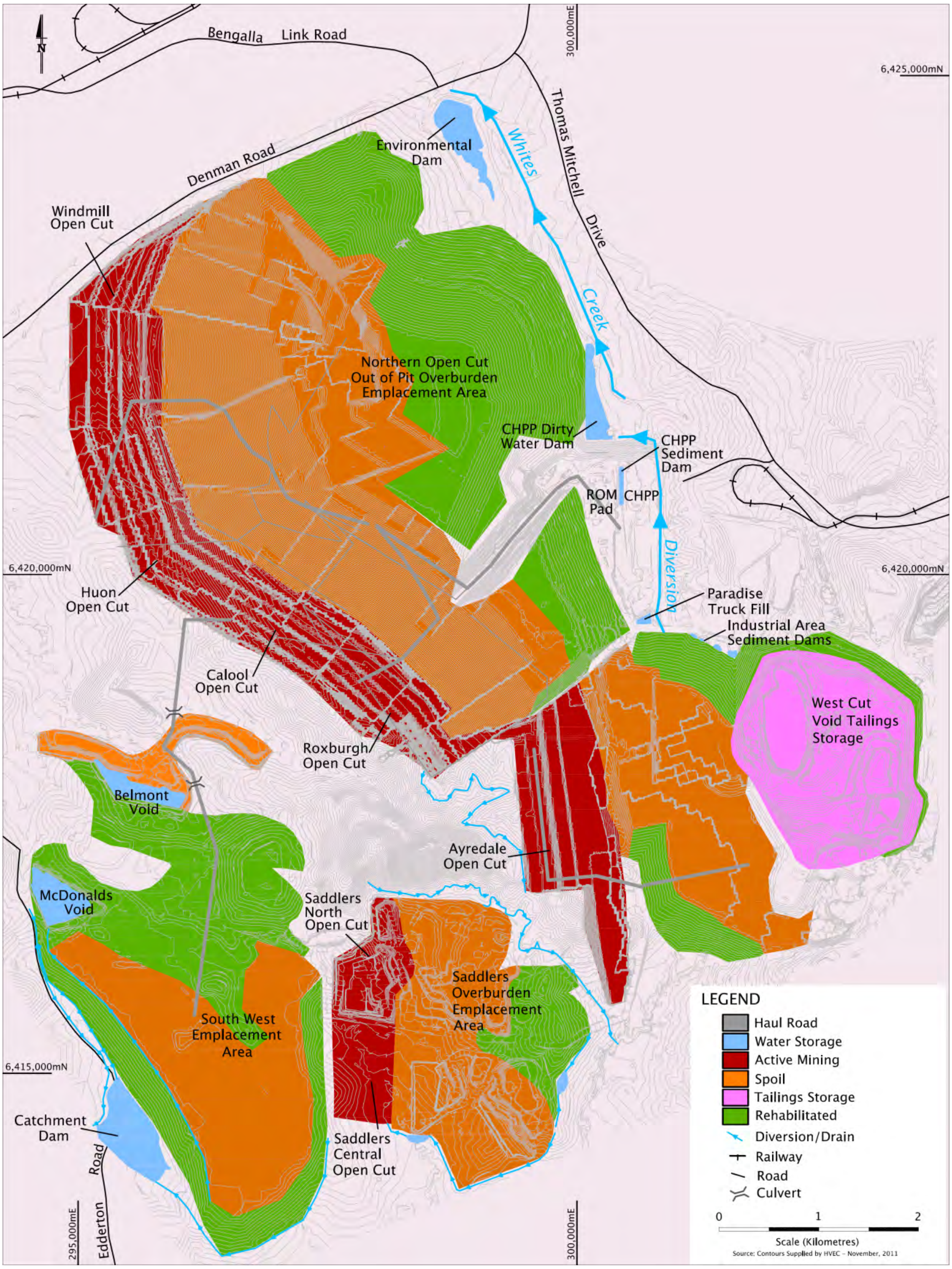


Figure 11 2022 Site Layout

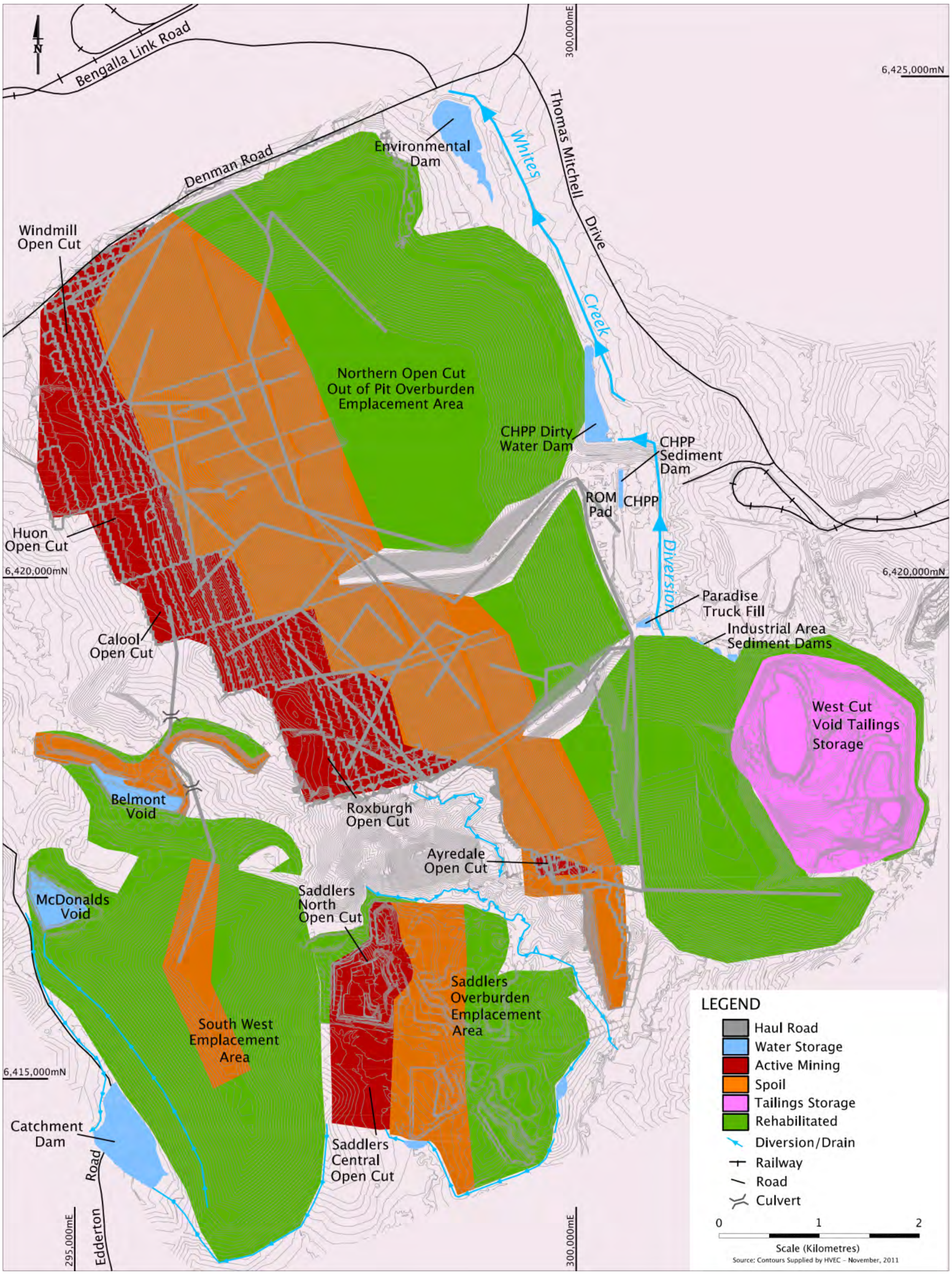


Figure 12 2026 Site Layout

2016 Layout

Figure 9 shows the planned mine layout in 2016. Mining is advancing westwards in the Northern Open Cut. Mining would also have advanced westwards in Saddlers open cut (Central and North).

Overburden would continue to be placed behind (generally east of) open cut operations. A new overburden emplacement east of the Ayredale open cut would have been commissioned with runoff from active waste reporting to the Industrial Area Sediment Dams (north of the emplacement), the CHPP Dirty Water Dam (north-west of the emplacement) and Ayredale open cut. Runoff and seepage from overburden emplacements and other areas disturbed by mining activity would continue to report to adjacent active open cut mining areas. It is envisaged that by this stage, runoff from a portion of the rehabilitated north-eastern Northern Open Cut out-of-pit overburden emplacement area would be able to be directed via a sediment dam off-site.

Upslope diversions southwest of the Northern Open Cut would have been consumed by the advancing mine; with a small diversion of the headwaters of Fairford Creek required around the western extremity of the open cut and a diversion required around the south-western extremity of the Ayredale open cut. Diversions around the Saddlers open cut pits would remain.

The West Cut Void would have undergone expansion for continued tailings disposal until the end of the mine life.

In terms of differences between this Stage Plan and that presented in the Consolidation Project EA (HVEC, 2009), these include:

- development of a new overburden emplacement east of the Ayredale open cut;
- no overburden emplacement adjacent to the McDonalds Void (as was planned for the Consolidation Project); and
- the northern part of the Northern Open Cut will not have progressed as far west (as was planned for the Consolidation Project) while the southern part would have progressed slightly further west.

2018 Layout

Figure 10 shows the planned mine layout in 2018. Mining in the Northern Open Cut would have advanced further westwards, with continued placement of overburden behind (east of) open cut operations as well as in the overburden emplacement east of Ayredale open cut. Mining would also have advanced westwards in Saddlers open cut, with overburden placed behind open cut operations.

Runoff and seepage from in-pit overburden emplacement areas and most areas disturbed by mining activity would continue to report to adjacent active open cut mining areas or mine storages. Runoff from the waste emplacement east of the Ayredale open cut would continue to report to the Industrial Area Sediment Dams, the CHPP Dirty Water Dam and Ayredale open cut.

Upslope diversions would remain substantially unchanged from the 2016 layout, with the diversion of the headwaters of Fairford Creek shortened and a small portion of the diversion around the Ayredale open cut reconstructed at a higher level upslope of a planned haul road.

2022 Layout

Figure 11 shows the planned mine layout in 2022. Mining in the Northern Open Cut would have advanced further westwards, with continued placement of overburden behind (east of) open cut operations as well as in the overburden emplacement east of Ayredale open cut. In addition, overburden from the Northern Open Cut would be hauled to the South West Emplacement Area which would be extended to the north and south to accommodate this material.

Runoff and seepage from in-pit overburden emplacement areas and most areas disturbed by mining activity would continue to report to adjacent active open cut mining areas. Runoff from the waste emplacement east of the Ayredale open cut would continue to report to the Industrial Area Sediment Dams, the CHPP Dirty Water Dam and Ayredale open cut. Runoff from the haul road linking the Northern Open Cut to the South West Emplacement Area would be directed along the road to either the Northern Open Cut or the Belmont open cut void; while drainage from upslope of the road (through two gully lines) would be directed under the road via culverts.

Runoff from the majority of the South West Emplacement Area would be directed to the adjacent McDonalds open cut void. A portion of the overburden emplacement area would drain to the south towards a tributary gully of Saddlers Creek. A catchment dam would be constructed at the head of this gully to capture runoff and seepage from this overburden emplacement area and return captured water to the McDonalds open cut void by pumping. The catchment reporting to this dam would be reduced by construction of diversion and collection drains as indicated on Figure 11. The sizing of this dam would be subject to detailed design as part of development of the Site Water Management Plan.

Only the clean water diversions west of Ayredale open cut and north of Saddlers open cut would remain at this time because, given the topography, the benefit of such diversions to the west of the advancing Northern Open Cut is considered low.

In terms of differences between this Stage Plan and that presented in the Consolidation Project EA (HVEC, 2009), these include:

- continued development of the new overburden emplacement east of the Ayredale open cut; and
- active overburden emplacement within the South West Emplacement Area (planned to be rehabilitated by this stage in HVEC, 2009).

2026 Layout

Figure 12 shows the planned mine layout in 2026. Mining in the Northern Open Cut would have advanced further westwards to encompass most of the Fairford Creek catchment. Overburden from the Northern Open Cut would continue to be placed to the east of the open cut and in the enlarged South West Emplacement Area (this emplacement is, however, generally consistent with that in the Consolidation Project EA [HVEC, 2009]). Mining would also have continued in Saddlers open cut, with overburden placed behind the open cut operations.

Runoff and seepage from in-pit overburden emplacements and most areas disturbed by mining activity would continue to report to adjacent active open cut mining areas. Runoff from the majority of the South West Emplacement Area would be directed to the adjacent McDonalds and Belmont open cut voids or to the Saddlers open cut. A portion of the overburden emplacement area would continue to drain to the catchment dam and return captured water to the McDonalds open cut void by pumping. Runoff from the Saddlers overburden emplacement area should be able to be directed to the Saddlers open cut; this would include the construction of toe drains/bunds around the southern perimeter of the emplacement. If directing runoff from this portion of the overburden emplacement area into Saddlers open cut proved impractical by such means, appropriately sized catchment dams would be constructed downslope of the emplacement area in the tributary of Saddlers Creek in conjunction with Landcom (2004) and DECC (2008) guidelines.

Upslope diversions would remain unchanged from the 2022 layout.

It is envisaged that by this stage, runoff from the majority of the rehabilitated overburden emplacement areas east of Ayredale open cut would be able to be directed via sediment dams off-site, draining north to Whites Creek Diversion or south to the headwaters of Saddlers Creek. The active portions of this emplacement area would drain to the Ayredale open cut.

Post mining final landform drainage is described in Section 6.1.

3.5 Overburden Emplacement Area Drainage Management

Overburden would be placed in worked out portions of the mine and in designated areas adjacent to the workings. The final surfaces of the overburden emplacements would be constructed to form a regular pattern of ridges and batters. The batters (constructed no steeper than 4 horizontal:1 vertical slope, consistent with the Consolidation Project) would be shaped into a network of constructed berms which would form "contour" drains at a maximum spacing of 150 m downslope. Where possible these drains would direct flow to the intersection of the overburden emplacement area and the natural surface. Otherwise flow would be directed to gully lines constructed down the batter. Sediment traps and settling dams would be constructed at the end of contour drains and gully lines to reduce suspended sediment prior to passive drainage off-site. These settling dams and ponds would also be constructed at intervals along the gully lines to retard flows and to settle sediment carried in runoff - particularly during the vegetation establishment phase. The settling ponds would be provided with low flow outlets so that the ponds would slowly drain following rainfall-runoff events. This would achieve a staged approach to removal of suspended sediments from water. Wide shallow by-wash spillways would also be provided to facilitate low energy overflows during the more intense or prolonged rainfall events. Settling dams would be designed in accordance with Landcom (2004) and DECC (2008). Within the gully lines where high energy flows or high flow volumes are likely to concentrate, specific hydraulic works such as rip-rap scour protection blankets, drop structures or other energy dissipation devices would be installed. A combination of riparian vegetation and rock mulching would be used to stabilise flow pathways in other flow areas in pool and riffle areas respectively.

The final top surfaces of overburden emplacements would also be designed with a network of small drains, directing runoff to the head of batter gully lines.

Freshly placed overburden will have a relatively high infiltration capacity. Water infiltrating the material would either be retained in the pore space or would seep through the overburden. A proportion of rainfall that infiltrates through the surface of the overburden would be returned to the atmosphere as evapotranspiration. As vegetation becomes established on the rehabilitated overburden emplacements, the hydrological balance would tend to change with a greater proportion of rainfall contributing to evapotranspiration and a reduced proportion of seepage. As the surface vegetation matures, moisture levels in the near surface root zone would increase compared to the non-vegetated condition with the result that surface runoff may tend to increase. The erosion potential associated with increased runoff would tend to reduce by the stabilising and insulating effect of the vegetation, with the result that sediment movement off the rehabilitated and revegetated overburden emplacement areas would tend to reduce.

3.6 Tailings Disposal and Water Recovery

Two rejects streams (coarse and fine) are produced by the CHPP. HVEC have estimated that on average approximately 30% by weight of ROM coal feed to the CHPP becomes rejects, with 19% by weight of ROM coal feed becoming coarse and the remainder fine. HVEC have indicated that these proportions should be reasonable estimates for the life of mine.

Coarse reject, which has a particle size classification equivalent to a gravel with some silt and clay, is placed as a dry fill incorporated in overburden emplacement areas. It is envisaged that this disposal process would continue for the life of mine.

Fine reject or tailings, which has a particle size classification equivalent to a clayey silt, is pumped as a slurry at nominally 37.5% solids by weight after thickening in the CHPP (i.e. thickener underflow) to the West Cut Void tailings storage. Water released from settling tailings presently infiltrates into the overburden emplacement abutting the western side of the West Cut Void and eventually flows into the Drayton West Pit Void (ATC, 2011). Generally there is no water ponded in the present tailings storage area.

A life of mine tailings storage facility expansion design report has recently been undertaken (ATC, 2011) which details the engineering of the West Cut Void such that disposal of tailings can continue for the life of the Modification. The expansion involves four separate stages of embankment construction, the first of which would be to the north-west and south-west up to 235 m AHD while allowing uninterrupted filling of the existing West Cut Void. Additional confining embankments would subsequently be constructed in Stage 2 to the north and east of the West Cut Void up to 250 m AHD to form a large tailings storage facility with up to 330 ha surface area. Stages 3 and 4 would lift the embankment level up to 265 m AHD and 280 m AHD respectively (consistent with the Consolidation Project).

Stage 1 tailings discharge would occur to the original West Cut Void as well as from the south-west embankment of the area to “blanket” the overburden at this end of the storage and develop a water pond (water released from settling tailings and surrounding area rainfall runoff) at the northern end of the storage from where water could be reclaimed by pumping to the Bayswater Main Dam or CHPP Dirty Water Dam. In the interim, seepage would continue to be managed by recovery from the Drayton West Pit Void. Once Stage 2 is complete, a ring main would be installed on the embankments such that tailings can be disposed of around the perimeter of the facility. This method of discharge should force the water to pond at or near the centre of the storage from where it would be recovered and transferred to the Bayswater Main Dam or CHPP Dirty Water Dam. Such peripheral discharge would also promote sub-aerial beaching conditions to occur, leading to increased tailings densities, improved storage efficiency and a tailings deposit that is more readily rehabilitated at the end of the mine life.

The planned maximum embankment level of 280 m AHD is consistent with the existing approved operation (HVEC, 2009).

4.0 SIMULATED PERFORMANCE OF WATER MANAGEMENT SYSTEM

4.1 System Simulation Model

The ability of the water management system to achieve its operational objectives was assessed by simulating the dynamic behaviour of its water balance over the entire mine life under the variable climatic conditions that may be encountered. The water balance model developed for the Mt Arthur Coal Mine simulates all the inflows, outflows, transfers and changes in storage of water on-site on a daily continuous basis from mid-2012 to mid-2026 (the end of the Modification). The general components and linkages of the water management system simulated by the model are shown in schematic form on Figure 5.

The model was set up to run over a large number of different daily rainfall sequences compiled from the historical regional record from 1892 onwards. Each sequence comprised a 14-year period (2012 to 2026). The sequences were formed by moving along the historical record one year at a time with the first sequence comprising the first 14 years in the record. The second sequence comprised years 2 to 16 in the record while the third sequence comprised years 3 to 17 and so on. The start and end of the historical record was 'linked' so that additional sequences which included years from both the beginning and end of the historical record were combined to generate additional rainfall sequences. Using this methodology 120, 14-year sequences of daily rainfall and evaporation were formulated for use in the model simulations.

The model was based on a water balance model previously developed and recently updated for the Mt Arthur Coal Mine, focussing on water supply security. Model operating "rules", storage linkages and pump rates were based on this model which was developed in consultation with HVEC personnel. The key aim in the model is to maintain supply to the CHPP (from the Bayswater Main Dam or CHPP Dirty Water Dam), to the truckfill dams and the underground operations. The model operates using a series of operating trigger volumes in the water storage dams and voids. In general, when the volume in a storage rises above a "high" trigger volume, the model attempts to pump water to other storages or (ultimately) to the Environmental Dam for release. When the volume in the Bayswater Main Dam, CHPP Dirty Water Dam, the Environmental Dam and the truckfill dams falls below a "low" trigger volume, the model attempts to pump water to these key storages from other storages and from licensed extraction from the Hunter River (in the case of the Environmental Dam).

In order to simulate possible future variations in available water from the Hunter River, the model was integrated with output from the Hunter River IQQM. The IQQM is the model used by the NOW to develop AWDs through the water year (July-June). The IQQM was run using the same climatic data period and mine life sequences as the water balance model, to generate simulated future AWDs and daily streamflow in the Hunter River. Available NOW "rules" governing the declaration of "off-allocation" conditions (refer Section 3.1) were incorporated in the model so as to also simulate these events. Where available, recorded historical flows in the Hunter River were used instead of IQQM output.

The model includes the ability to simulate controlled discharge (licensed release) under the HRSTS. IQQM simulated or recorded actual flows for the Hunter River at Singleton were used, along with relationships between flow and salinity (EC) developed from historical recorded data, to simulate EC in the river and to model allowable release using the 16 credits currently held by HVEC (and assumed unchanged into the future). Water was assumed able to be discharged from the Environmental Dam whenever the total volume of water held in all storages exceeded 10,000 ML or there was more than 500 ML held in all active open cuts (depending on simulated flow in the Hunter River at that point in time). A salinity of 754 mg/L was assumed for Environmental Dam water (based on the median of recorded TDS values). A peak discharge rate of 5,200 litres per second was assumed based on data supplied by HVEC.

The Australian Water Balance Model (AWBM) (Boughton, 2004) was used to simulate runoff from rainfall on the various catchments and landforms across the mine area. The AWBM is a nationally-recognised catchment-scale water balance model that estimates streamflow from rainfall and evaporation. Modelling of the following six different sub-catchment types was undertaken:

- Natural Surface/Undisturbed.
- Overburden Emplacements.
- Rehabilitated Areas.
- Hardstand.
- Open Cut/Mine.
- Tailings.

AWBM parameters for undisturbed areas were taken from model calibrations undertaken for a nearby stream, while parameters for the remaining sub-catchments were taken from literature-based guideline values or experience with similar projects. Catchment areas were calculated from future Mining Stage Plans provided by HVEC and assumed to vary linearly between the dates represented by the Stage Plans. Figure 13 shows the variation in calculated total catchment and total sub-catchment areas over the mine life. Figure 13 shows that by 2026 the mine total catchment would total approximately 40 km^2. Figure 13 also shows that this is a reduction compared with the currently approved operation (HVEC, 2009).

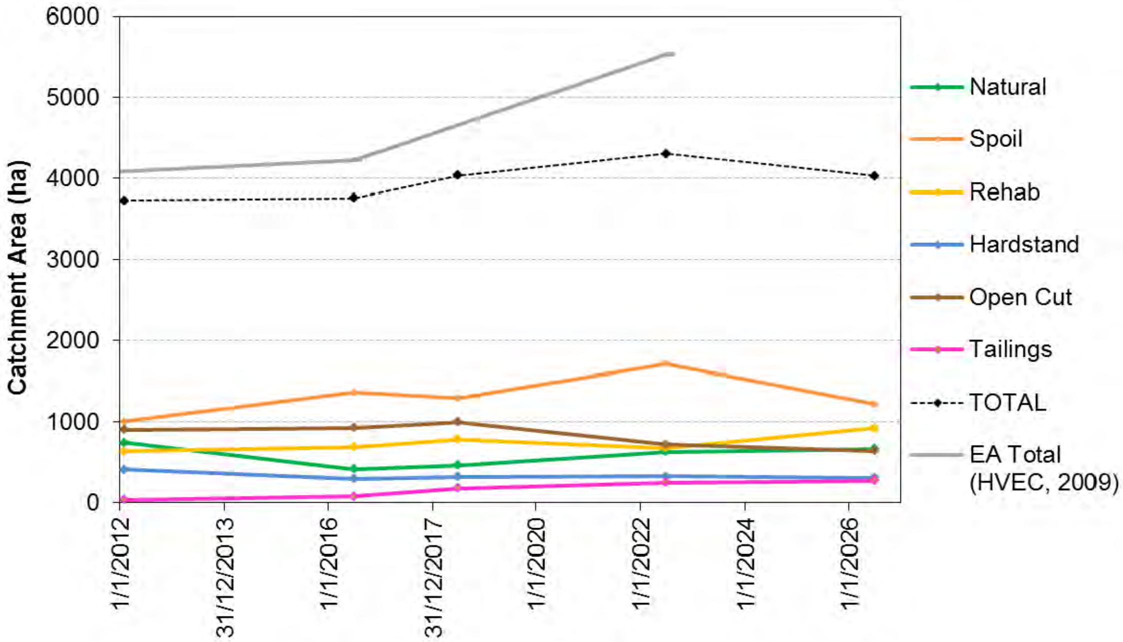


Figure 13 Mine Catchment Area with Time

Total CHPP demand was calculated based on advised ROM coal, rejects and product moistures, stockpile watering area and the CHPP feed rate given in Table 10 and Figure 8 (refer Section 3.3.2). Figure 14 shows the variation in calculated CHPP demand over the mine life for one particular climatic sequence (stockpile watering demand is calculated based on evaporation rate). The calculated peak demand shown in Figure 14 is lower than the anticipated peak demand of 10,230 ML/a given in HVEC (2009) for the approved operation.

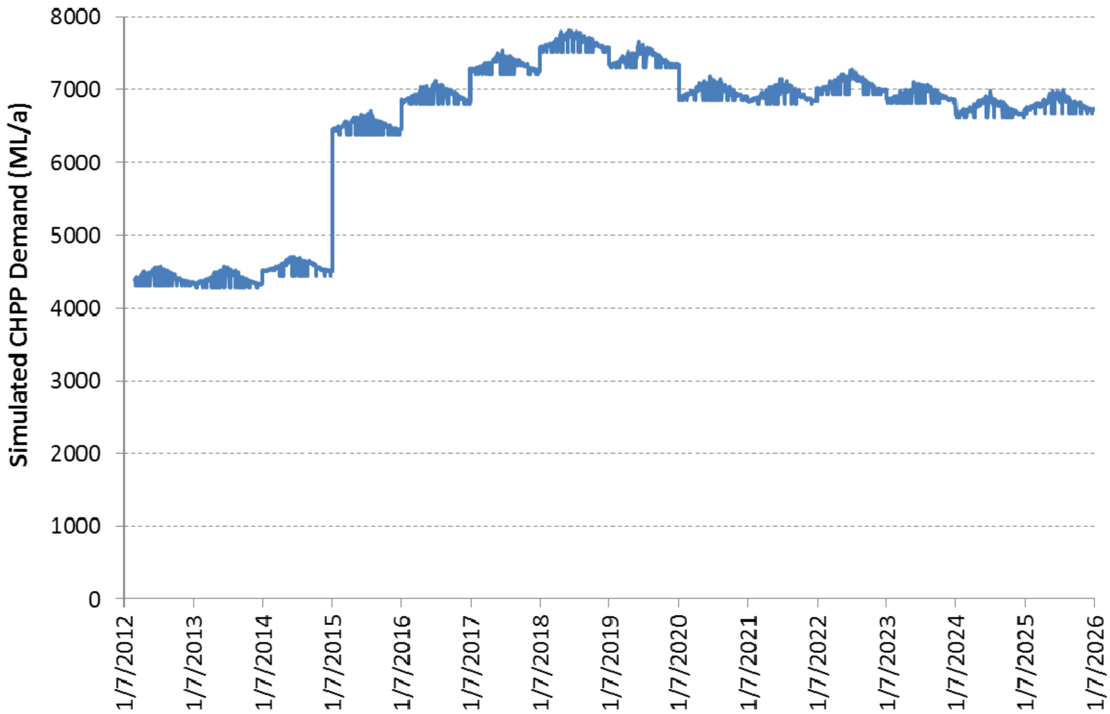


Figure 14 Simulated CHPP Water Demand

Monitored haul road water usage was used to develop a correlation with pan evaporation (to give a modelled change with changing climate) and this was used in the model to calculate haul road water demand on a given day. Demand was increased into the future in line with planned expansions in the fleet of water trucks, as advised by HVEC.

Demand for underground operations was estimated as 340 ML/a by halving the estimates in Umwelt (2008)[4]. It was assumed that 50 ML/a of the 340 ML/a used in the underground mining operations is recovered as detailed in Umwelt (2008).

Other future water demands used in the model are as given in Table 10.

The model assumes 985 ML/a treated effluent supplied from Muswellbrook.

Model groundwater inflows were taken from predicted inflow rates by others as detailed in Section 3.3.1. Open cut groundwater inflows were simulated subject to evaporative losses within the open cut.

Modelling assumed that the Drayton West Pit Void was available for use as an additional water storage, subject to 1,000 ML of existing water stored in the pit being kept in reserve for Drayton Coal Mine. Future Mining Stage Plans (Figures 9 to 12) indicate that the Drayton West Pit Void will ultimately become part of a waste emplacement. It was assumed that the void would be removed from the water management system by mid-2020.

Monitoring data provided by HVEC indicate that approximately 8,600 ML was held in the mine water storages near the end of August 2012. This was taken as the starting condition in the model.

Current HVEC Hunter River licensed allocations of 5,741 ML/a GSE and 2,197 ML/a HSE were assumed unchanged for the mine life.

4.2 Simulated System Performance

4.2.1 Overall Water Balance

Figures 15 and 16 below summarise model predicted system inflows and outflows for the mine life averaged over all climatic sequences.

[4] Underground rates were halved on the basis of a proposed 4 Mt/a underground mining rate, compared with an 8 Mt/a rate assumed in Umwelt (2008).

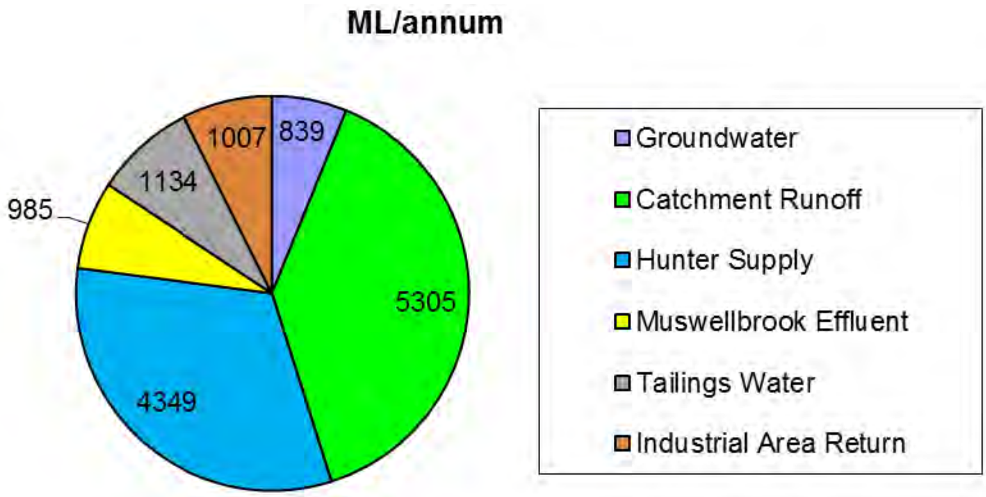


Figure 15 Average Model System Inflows

Note: Groundwater includes underground mine water

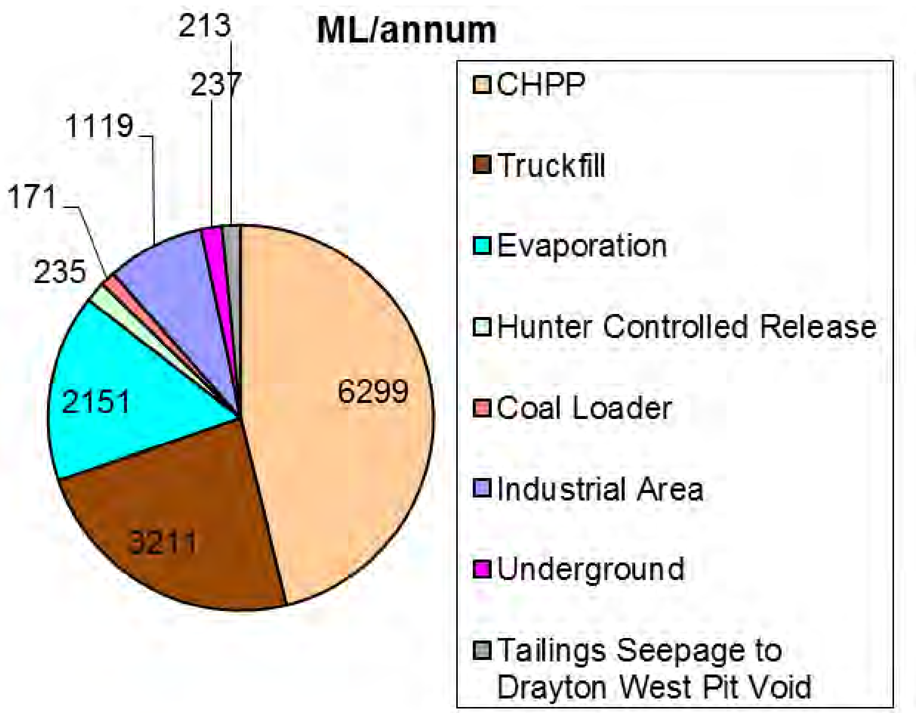


Figure 16 Average Model System Outflows

Predicted average inflows total 13,619 ML/a while average outflows total 13,636 ML/a (the difference between these two represents change in storage and spills from sediment dams which is not plotted). When compared with average inflows and outflows from Gilbert & Associates Pty Ltd (2009) for the approved operation, the above values are lower as a result of comparatively less catchment area (refer Figure 13) and lower CHPP water demand.

Model results for high rainfall (90th percentile), median and low rainfall (10th percentile) sequences were extracted from model results and are summarised in Table 11 below.

Table 11
Water Balance Model Results
(Averaged over Mine Life ML/annum)

	10th Percentile Rainfall Sequence (Dry)	Median Rainfall Sequence	90th Percentile Rainfall Sequence (Wet)
Inflows**			
Catchment Runoff	4,418	5,583	5,643
Groundwater	847	843	860
Hunter River Licensed Extraction	4,828	4,697	4,339
Muswellbrook Treated Effluent	985	985	985
Tailings Water	1,134	1,134	1,134
Industrial Area Return*	1,044	1,056	1,057
Outflows**			
CHPP Use	6,478	6,505	6,497
Truckfill (Dust Suppression) Use	3,233	3,324	3,232
Evaporation	2,021	2,206	2,208
Release to Hunter River	174	327	232
Coal Loader Use	18	18	18
Industrial Area Use	1,160	1,173	1,174
Underground Use	247	270	262
Tailings Storage Seepage to Drayton West Pit Void	174	212	187

* Assumed to be 90% of Industrial Area water use.

** Note that this excludes change in storage and spills from sediment dams.

Figure 17 shows the model predicted total volume of water held in all storages (including open cut pits) versus time for the mine life.

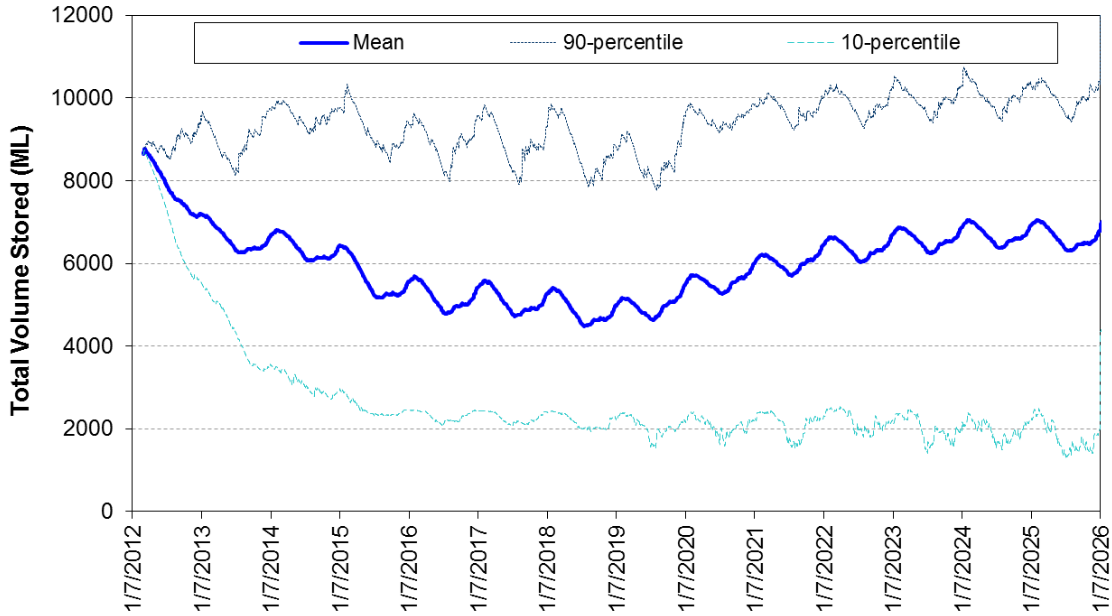


Figure 17 Predicted Total Stored Water Volume

4.2.2 Water Supply

The simulated average water supply reliability for various mine water demands and supply source contributions are summarised in Table 12.

Table 12
Simulated Water Supply Performance

Simulated Performance Indicator	Simulated Value (Averaged over all years in all sequences)
Supply Reliability* to:	
CHPP	96.9%
Haul road dust suppression	96.7%
Underground	87.8%
Coal loader	95.2%
Industrial area	95.3%
Average supply source contribution (% of total):	
Catchment runoff	39.0%
Hunter River licensed extraction	31.9%
Tailings water	8.3%
Groundwater**	6.2%
Muswellbrook treated effluent	7.2%
Industrial Area Return	7.4%

* Reliability expressed as volume of supply divided by volume of demand.
** Groundwater inflow includes underground mine water return (proportion of water supplied).

The above predicted supply reliabilities are mostly slightly higher than were predicted in Gilbert & Associates Pty Ltd (2009) for the approved operation. The catchment runoff supply source contribution is reduced from that in Gilbert & Associates Pty Ltd (2009) because of comparatively less catchment area (refer Figure 13), while the contribution of Hunter River licensed extraction has increased in order to maintain a reliable supply.

Model predicted supply reliability assumes that the water supply system would be operated in an unchanged way even if water supplies were drawn down as a result of drought. In reality (as occurred in 2006 to 2007) HVEC would investigate and undertake measures such as purchase of additional Hunter River water entitlements on the open market or conversion of GSE to HSE (in accordance with NOW conversion rules). HVEC would use the water balance model to forecast water supply reliability on an on-going basis and assess the need to undertake such measures (refer Section 7).

Model results indicate that on average the majority of site supply would be provided by catchment runoff (as was predicted for the approved operation – Gilbert & Associates Pty Ltd [2009]). Supply from Hunter River licensed extraction would vary through the mine life as indicated in Figure 18 below, which shows average annual calendar year extraction and modelled extremes (annual maxima and minima). Predicted Hunter River extraction correlates with CHPP demand.

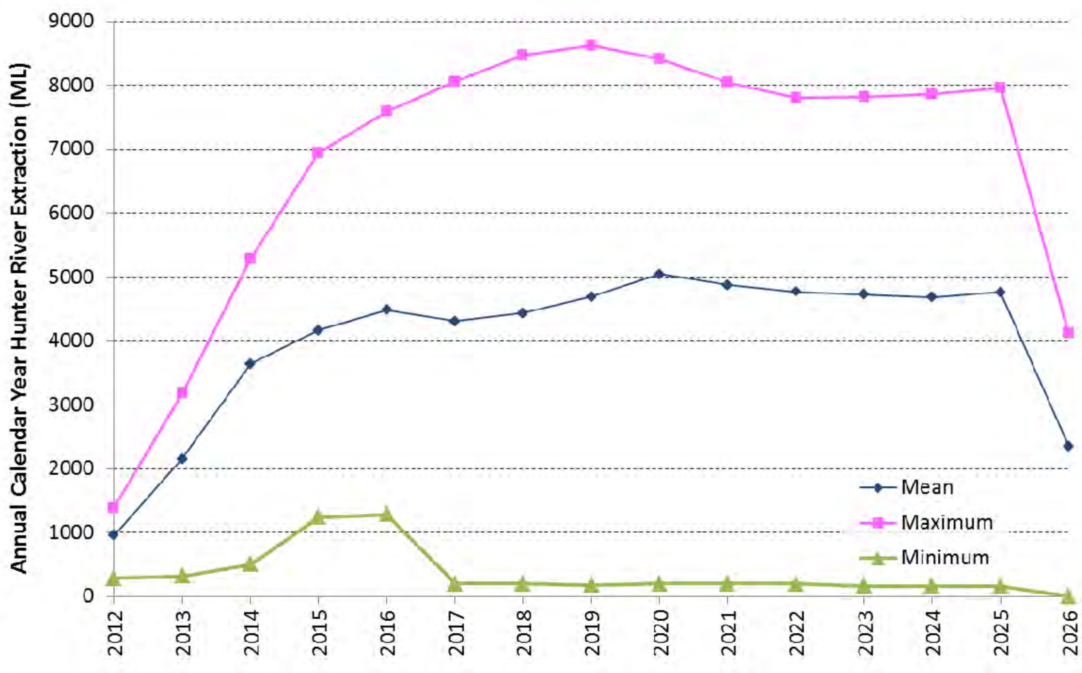


Figure 18 Predicted Annual (Calendar Year) Hunter River Extraction

Predicted Hunter River extraction is somewhat higher than predicted for the approved operation (Gilbert & Associates Pty Ltd, 2009) as a result of the reduced catchment area (refer Figure 13).

4.2.3 Controlled Releases

Figure 19 shows model predicted annual (calendar year) releases from the Environmental Dam – annual median and 90th percentile values (i.e. those values that would only be exceeded in 10% of years). Model results indicate that in 50% of modelled climate scenarios, there was no predicted release in any year, while in 90% of modelled climate scenarios, the annual release did not exceed 960 ML. On average, approximately 4 days per year of release were predicted. The predicted discharge rate over all climate scenarios and years averaged 235 ML/a (compared with 351 ML/a predicted for the current approved operation – Gilbert & Associates Pty Ltd [2009]). Any controlled releases from the Mt Arthur Coal Mine would be made in accordance with the Mt Arthur Coal Mine Environmental Protection Licence and the requirements of the HRSTS.

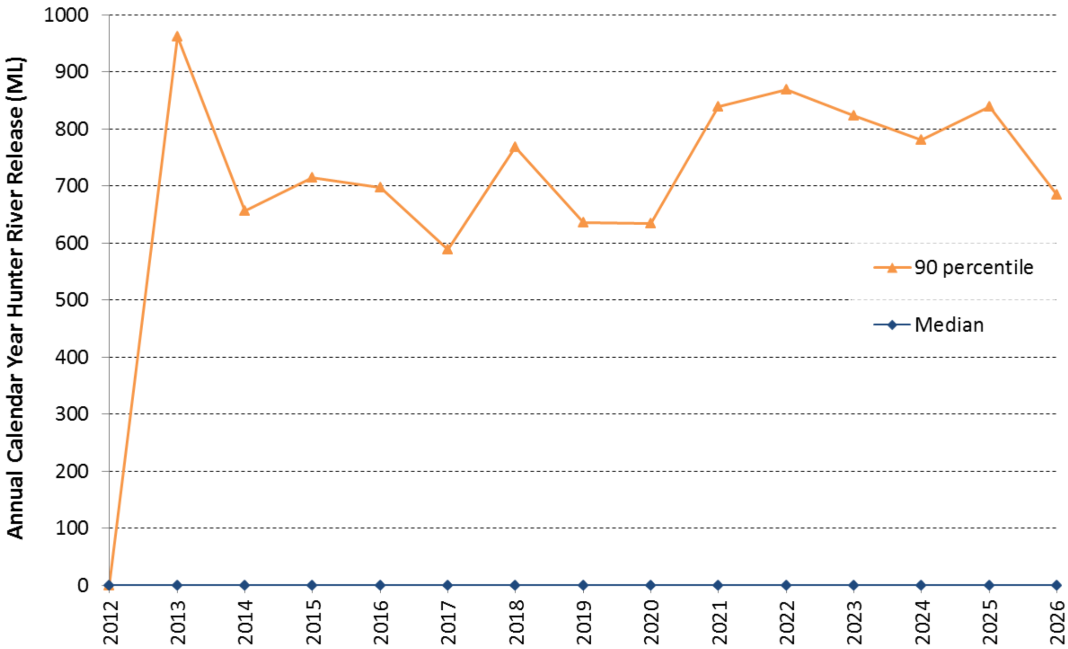


Figure 19 Predicted Annual Hunter River Controlled Discharge

The above predicted values are generally less than the annual release volumes predicted by Gilbert & Associates Pty Ltd (2009) for the Consolidation Project until 2017 and similar thereafter.

4.3 Water Management Implications

A significant component of inflow to the water management system would be derived from drainage from the overburden emplacement areas which will, by 2022, cover an estimated 1.75 km^2 (refer Figure 13) – similar to the 1.5 km^2 predicted at that time for the approved operation (Gilbert & Associates Pty Ltd, 2009). Management of these areas would be an important aspect of both water management and the ultimate rehabilitation requirements of the mine. Detailed catchment plans should be developed in advance of mining. These plans should address sediment and erosion control measures required for the initial development (clearing and initial overburden stripping operations), overburden emplacement areas and landform drainage design and re-vegetation scheduling. Drainage design would need to accommodate the changing hydrological response of overburden emplacement areas following rehabilitation and the need to optimise the diversion of runoff from rehabilitated areas away from active mine disturbance areas.

The water balance for the Mt Arthur Coal Mine would be affected by climatic conditions. The system has the flexibility to accommodate this variability through transient storage in the substantial storage volume available on-site and through the ability to both discharge excess water off-site and to import water to reduce risk of shortfall. Discharge water to the Hunter River is regulated by the HRSTS to ensure that salinity levels in the river do not exceed target levels required to meet defined beneficial uses. The ability to discharge water to the Hunter River is also dependent on the number of salt credits held (currently 16) and the ability to source water from the Hunter River is dependent upon the licence volume held (currently 7,938 ML/a HSE and GSE total). By monitoring and reviewing the operational performance of the water management system, and using the developed water balance model as a tool, it would be possible to assess the adequacy of the credits and licence volume held by HVEC and to purchase additional credits/licence as required.

5.0 ASSESSMENT OF THE MODIFICATION SURFACE WATER IMPACTS

The potential impacts of the Modification on local and regional surface water resources are:

- Changes to flows in local creeks due to expansion and subsequent capture and use of drainage from mine area catchments.
- Potential for export of contaminants (principally sediments and soluble salts) in mine area runoff and accidental spills from containment storages (principally sediments, soluble salts, oils and greases), causing degradation of local and regional water courses.
- Short term increases in salinity in the Hunter River during periods of licensed discharge under the HRSTS.

5.1 Flow Regime in Local Creeks

The effect of runoff capture from the Modification Area on local creek catchment yield would be in direct proportion to the change in contributing catchment areas which are summarised in Table 13 below.

Table 13
Changes to Contributing Catchment of Local Creeks

Creek	Total Catchment Area prior to Mining (km^2)	Catchment Area for Maximum Extents of EA† (km^2)	Catchment Area for Maximum Extents of Modification (km^2)
Quarry Creek	22.0	18.6	16.5
Fairford Creek	10.8	2.7	1.4
Whites Creek	21.5	2.2	3.6
Unnamed Creeks	4.2	2.8	3.3
Ramrod Creek	33.4	32.2	31.6
Saddlers Creek	99.0	88.1	89.6

† Catchment extents as written in the Consolidation Project Surface Water Assessment (Gilbert & Associates Pty Ltd, 2009).

The catchment areas reporting to Whites Creek/the Whites Creek diversion and to the unnamed creeks to the north of the Environmental Dam are actually greater for the Modification at maximum extent than for the calculated maximum extent for the approved operation reported in Gilbert & Associates Pty Ltd (2009). These increases have occurred in recent years as a result of progressive rehabilitation of waste emplacements. Runoff from these rehabilitated areas has been directed to these catchments. Ongoing rehabilitation of waste emplacements will result in further increases in the catchments reporting to these creeks with time (in the future).

The catchment area of Saddlers Creek at maximum Modification extent may also been seen to have increased compared with the calculated maximum extent reported in Gilbert & Associates Pty Ltd (2009) because of the redesign of waste emplacements. This includes proposed diversion and collection drains (indicated on Figure 11) on the South West Emplacement Area.

Drayton South Coal Project is also located within the catchment area of Saddlers Creek. At maximum extent the Drayton South Coal Project would result in a decrease of Saddlers Creek catchment area of approximately 14% (13.45 km^2) while the Drayton South Coal Project final void would result in a decrease in Saddlers Creek catchment area of approximately 10% (9.9 km^2) (WRM Water & Environment Pty Ltd, 2012). Table 14 below summarises the cumulative impacts to the catchment area reporting to Saddlers Creek due to both Mt Arthur Coal and Drayton South Coal Project for maximum extent and final landform. It has been conservatively assumed that the maximum extent occurs at the same point in time for both mines. The Modification results in a slightly larger catchment for the maximum extent while final landform remains unchanged from the EA. Therefore, the Modification would not increase the potential cumulative impact on the catchment area reporting to Saddlers Creek.

Table 14
Cumulative Impact to Catchment Area of Saddlers Creek

<table>
<tr><th></th><th>Mining Stage</th><th>Total Catchment Area prior to Mining (km^2)</th><th>Catchment Area for Maximum Extents of EA† (km^2)</th><th>Catchment Area for Maximum Extents of Modification (km^2)</th></tr>
<tr><td rowspan="2">Mt Arthur Coal</td><td>Maximum Extent</td><td rowspan="6">99.0</td><td>88.1</td><td>89.6</td></tr>
<tr><td>Final Landform</td><td colspan="2">93.5</td></tr>
<tr><td rowspan="2">Drayton South Coal Project</td><td>Maximum Extent</td><td colspan="2">85.55</td></tr>
<tr><td>Final Landform</td><td colspan="2">89.10</td></tr>
<tr><td rowspan="2">Cumulative</td><td>Maximum Extent</td><td>74.65</td><td>76.15</td></tr>
<tr><td>Final Landform</td><td colspan="2">83.60</td></tr>
</table>

† Catchment extents as written in the Consolidation Project Surface Water Assessment (Gilbert & Associates Pty Ltd, 2009).

The catchments of the remaining existing natural creeks are reduced during maximum Modification development compared with the catchments calculated for the approved operation (Gilbert & Associates Pty Ltd, 2009). Average flow rates would be expected to reduce in proportion. The catchment area changes as a result of the Modification given in Table 13 and consequent effects on average flow rates are unlikely to have a material effect on riparian flows or licensed extraction from Ramrod Creek.

The sum total decrease in catchment area for the Modification at maximum extent (compared with the calculated maximum extent reported in Gilbert & Associates Pty Ltd [2009]) is 0.6 km^2. This represents less than 0.02% reduction in the catchment reporting to the Hunter River nearby. Average flow rates in the Hunter River would be expected to reduce in proportion.

5.2 Flooding

The Modification involves the extension of the Northern Open Cut to the north-west of the mine area. This extension (refer Figure 2) is above the recorded 1955 peak flood levels (based on data provided by Muswellbrook Shire Council) in the Hunter River (plus 0.5 m freeboard) and therefore no additional flood mitigation works are proposed for the Modification.

5.3 Release of Contaminants in Drainage Off-Site

Sediment dams capturing runoff from areas of pre-strip and rehabilitation would be designed in accordance with the Erosion and Sediment Control Plan and the provisions for sediment retention basins in Landcom (2004) and DECC (2008). Runoff from the planned haul road linking the Northern Open Cut to the South West Emplacement Area would be directed along the road to open cuts. Sediment controls would be implemented during out-of-pit haul road construction in accordance with the guidelines in Landcom (2004), including the use of sediment basins, sediment filters and filter strips. The batters of the haul road would be selectively constructed of coarse rock overburden material to minimise potential for sediment generation following construction. Sediment controls would be maintained following construction until outer surfaces had stabilised and road surface drainage had been completed.

The catchment dam downslope of the South West Emplacement Area in the headwaters of Saddlers Creek (refer Figures 11 and 12) would be constructed with adequate capacity to capture catchment runoff so as to maintain an acceptably low risk of spill until upslope areas had been stabilised by rehabilitation (no spills were predicted in water balance modelling for a dam capacity of approximately 290 ML). This dam would be dewatered by pumping to nearby water storages in between rainfall events. The dam would be subject to detailed design as part of ongoing development and revision of the Site Water Management Plan.

Upslope diversion drains would be designed to minimise the risk of erosion due to high flow velocities by appropriate design of grades, cross-sections and use of vegetation and/or rip-rap. Energy dissipation dams and/or level spreaders would be constructed downstream of all diversions. Sediment controls would be implemented during out-of-pit haul road construction in accordance with the Erosion and Sediment Control Plan and Landcom (2004) guidelines.

5.4 Salinity in Hunter River Due to Controlled Releases

The water management system would continue to be developed in accordance with best management principles including minimising contamination of site water, maximising re-use of mine water on-site and managing water so that any releases from site are controlled in accordance with the HRSTS. By segregation and preferential re-use of the more saline water on-site, off-site discharges of salt to the Hunter River would be controlled. If the proposed water management system is maintained, no other significant contaminant would be discharged from site. Water with other contaminants (e.g. hydrocarbons) would normally be retained, treated and re-used on-site.

It is estimated that, for the period of the Modification an average 235 ML/a controlled release to the Hunter River under the HRSTS would occur (reduced from a predicted 351 ML/a). From the water balance model results, it is possible to calculate the amount of salt that would be released from the site (i.e. a salt budget). Based on a median TDS of 754 mg/L (from Environmental Dam monitoring, refer Table 8), this represents an average salt discharge of 177 tonnes per annum (tpa) (a reduction of 88 tpa compared with predictions in Gilbert & Associates Pty Ltd [2009]). It should be emphasised that discharges would occur during periods of high or flood flow (as mandated in the HRSTS) and would therefore not affect river low flows.

6.0 POST MINING SURFACE WATER MANAGEMENT

6.1 Concepts for Final Landform Drainage

Figure 20 shows the final landform drainage plan[5]. The final landform includes a remnant void from the Northern Open Cut. Dominant final reshaped landforms also include the overburden emplacement areas to the east and south of the Northern Open Cut final void and the South West Emplacement Area. The rehabilitated tailings storage (West Pit) located in the Bayswater No. 2 colliery area forms an elevated final landform above the surrounding surface. The Saddlers open cut would be backfilled as part of the Modification.

Post mining runoff from rehabilitated and revegetated areas of the mine would be directed to the local drainage network. Drainage control works and a stable drainage system as described in Section 3.5 would be designed to direct runoff from the rehabilitated mine area to local creeks. Around the outer edge of the final void, isolation bunds would be constructed for safety. The drainage density of the decommissioned mine area would be returned to as close as possible to the existing site. All areas of the site, with the exception of the final void and its surrounding catchment would be free draining. The aim of this is to maintain the effective catchment contribution and yield to the Hunter River following the cessation of mining. The total catchment reporting to the Northern Open Cut final void is estimated to be approximately 14.2 km^2. The catchment area reporting to the final voids for the currently approved operations was estimated to be approximately 15.9 km^2 (Gilbert & Associates Pty Ltd, 2009). Therefore the Modification would result in a reduction in catchment area reporting to the final landform of approximately 10% compared to the currently approved operations.

[5] Developed from final landform contour plan provided by HVEC. It is understood that the plan is a high-level conceptual final landform which would form the basis for rehabilitation design in the unlikely event that the Mount Arthur Coal Complex was to close at 2026.

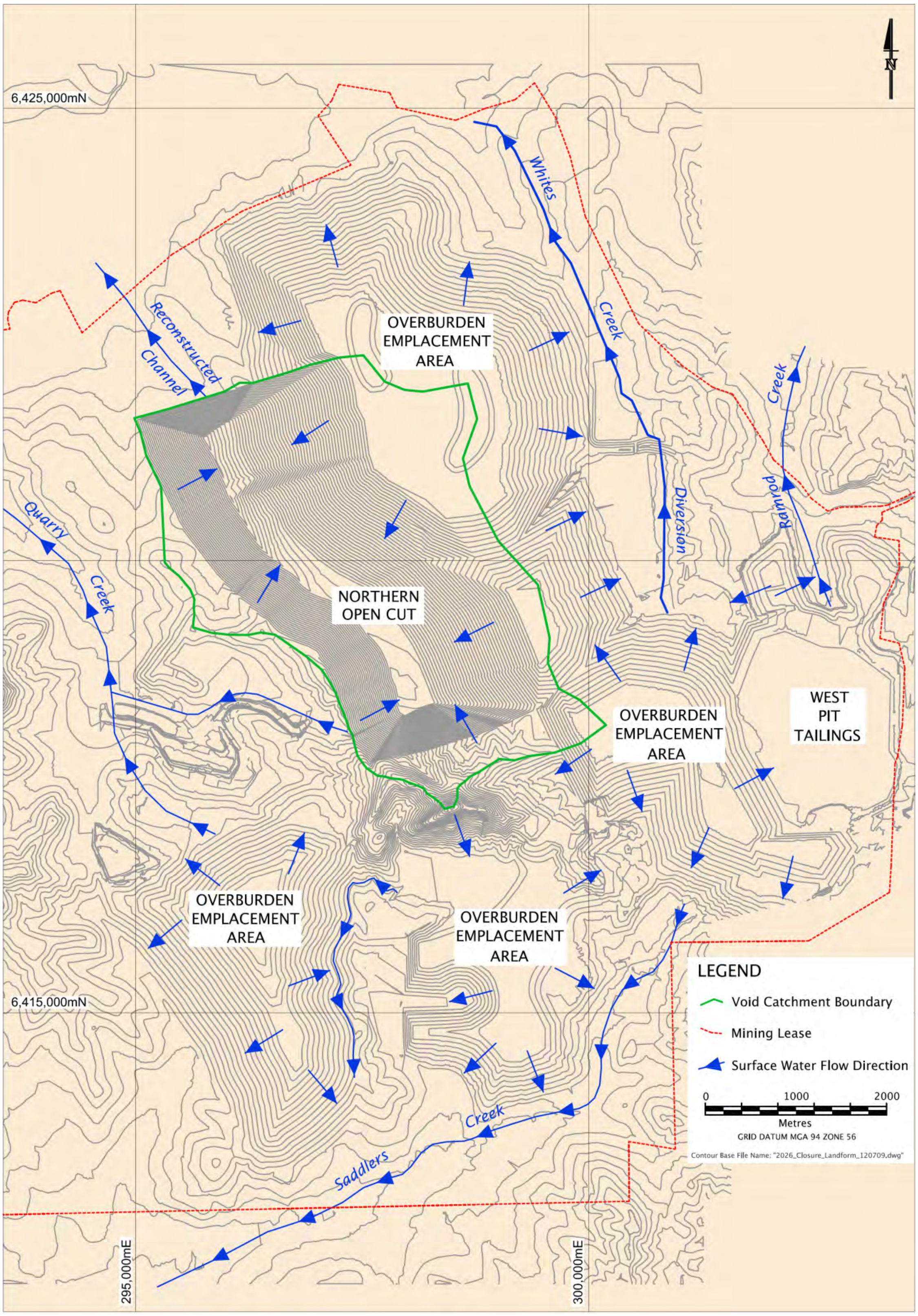


Figure 20 Final Landform Drainage Plan

The final landform includes reconstruction of the channel of Fairford Creek over overburden placed within the north-eastern portion of the Northern Open Cut. Creek reconstruction would be designed and planned to integrate with mining operations. Creek reconstruction would involve controlled placement of overburden within the creek corridors, including a zone of selected overburden placed by paddock dumping methods which would be spread and compacted in lifts using mine plant so as to minimise long term settlement of the overburden. The surface topography of the reconstructed creek would generally mimic existing topographic and channel form, which would be determined by detailed survey prior to mining. Pre-stripping activities in the creek areas (prior to mining) would recover existing alluvial/colluvial material which would be preserved and used in creek reconstruction. The reconstructed creek would be revegetated with native species prevalent within the existing creek channel. Sediment basins would be established downstream of and possibly at intermediate points within the reformed channel and maintained until vegetation establishment. Temporary stabilisation measures (e.g. rip-rap) may also be required. Reconstructed creek design would include detailed hydrologic modelling of the creek catchment, which includes significant areas of rehabilitated overburden and other mine areas, to ensure that the reconstructed channel was stable in a wide range of flows.

At mine completion, all mine infrastructure would be decommissioned and removed from the mine area and former infrastructure sites and associated landforms would be progressively rehabilitated and become free draining to local catchments.

6.2 Final Void Model Findings

Inflows to the final void comprise incident rainfall over the void lake surface, runoff and seepage from the sides of the void and its adjacent contributing catchment and seepage from coal seam groundwater and overburden infiltration. A final void water balance model has been developed for the final void to predict the long term behaviour of the final void water body.

Post recovery groundwater seepage rates (including overburden infiltration) to the voids were advised by AGE (2012). Inflow rates were estimated for different final void water levels (reducing with rising water level). Maximum groundwater and seepage inflow rates of 1.41 ML/day were estimated.

Rainfall runoff from the void catchment was estimated using the AWBM applied to the final void sub-catchments (in a manner similar to the mine water balance model – refer Section 4.1). Daily rainfall and evaporation data was taken from regional records and data from the beginning of the record added to data after 2011 to generate additional years for the model simulation.

Model results are shown in Figure 21 below, in terms of predicted final void water levels versus time.

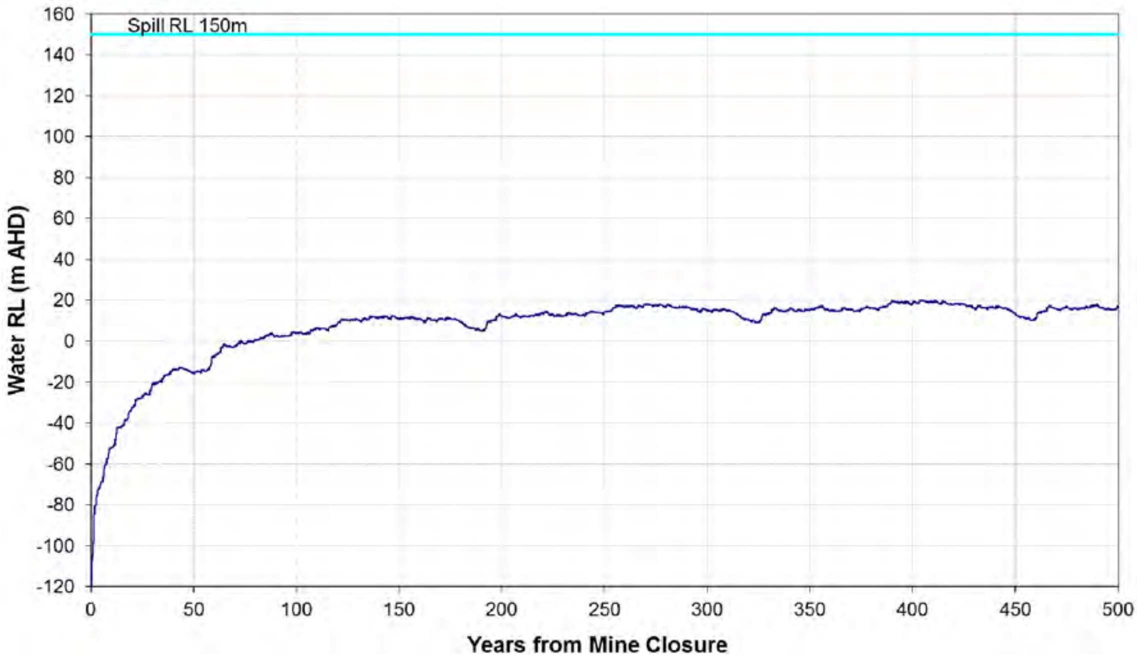


Figure 21 Predicted Final Void Water Levels

Figure 21 shows that predicted water levels in the Northern Open Cut final void would take more than 200 years to stabilise at a level more than approximately 135 m below spill level. No spill is predicted in the long term from the final void. The long term final void water level is below the regional groundwater level and should therefore form a sink for groundwater. The salinity of void waters would slowly increase with time, as a result of ongoing slow migration of saline groundwater and flushing of residual salts from the overburden. In the longer term, salt concentrations would also be affected by concentration driven by evaporation.

The above findings are generally consistent with those documented by Gilbert & Associates Pty Ltd (2009) for the approved operation, with the exception that only the Northern Open Cut void would be retained for the Modification (i.e. Saddlers Pit would be backfilled). The former Belmont and McDonalds Pits will be retained as water storages.

7.0 SURFACE WATER MONITORING AND OTHER RECOMMENDATIONS

The following recommendations are unchanged from those given in Gilbert & Associates Pty Ltd (2009):

- HVEC currently undertake extensive monitoring of surface water in the mine area catchments and of the associated operational water management system. The current monitoring, review and reporting system should continue throughout the mine life and information should be added to the water quality database on a continual basis.
- Surface water monitoring results should continue to be reported in the Annual Environmental Management Report.
- The site water balance should be reviewed at least annually to update predictions of water supply security and the need to release water. Cumulative flow meters should be installed on all major pumped water streams shown in Figure 5 and flows recorded monthly. This data should be used, together with monitored levels in water storages, in the water balance reviews to calibrate various components of the model, including the rainfall runoff component (following periods of rainfall) and open cut groundwater inflows (during periods of low or no rainfall).
- A geomorphological survey should be conducted along those reaches of creeks that will be mined through and which are planned for reinstatement over mine overburden backfill. This data would be able to be used in design of creek reconstruction.

In accordance with the existing Project Approval for the Mt Arthur Coal Mine – Open Cut Consolidation Project Statement of Commitments, a real-time surface water monitoring station, continuously measuring streamflow, EC and turbidity, should be established downstream of the mine on Saddlers Creek, upstream of any water off-takes.

8.0 REFERENCES

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APPENDIX A
NSW Office of Water's Agency Comments

Key issues to be addressed in the EIS for the proposal include:

- *Adequate, secure and appropriately authorised water supply is available for all activities for the life of the mine.*
- *Compliance with the rules in the Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources and relevant legislation, water management policies and guidelines.*
- *Assessment of risks to the Hunter Regulated Alluvium which may be posed by the mining extension, including extended and cumulative depressurisation of the alluvial groundwater source, and impacts to groundwater quality which may result from extension of the mining operation.*
- *Development of adequate baseline monitoring (minimum of fortnightly data sampling for at least 2 years prior to mine operations, and appropriate scaled real time monitoring) of all surface water and groundwater sources and dependent ecosystems within and adjacent to the mining operation area for calibration of models and development of trigger criteria.*
- *Predictive assessments of potential impacts to surface water and groundwater sources, basic landholder's rights to water, adjacent licensed water users and dependent ecosystems and ongoing monitoring to enable comparison with predictions.*
- *Mitigation strategies to address impacts on surface water and groundwater sources and dependent ecosystems for the operational and post mining phases of the proposal and final landform*

…

Surface Water Assessment

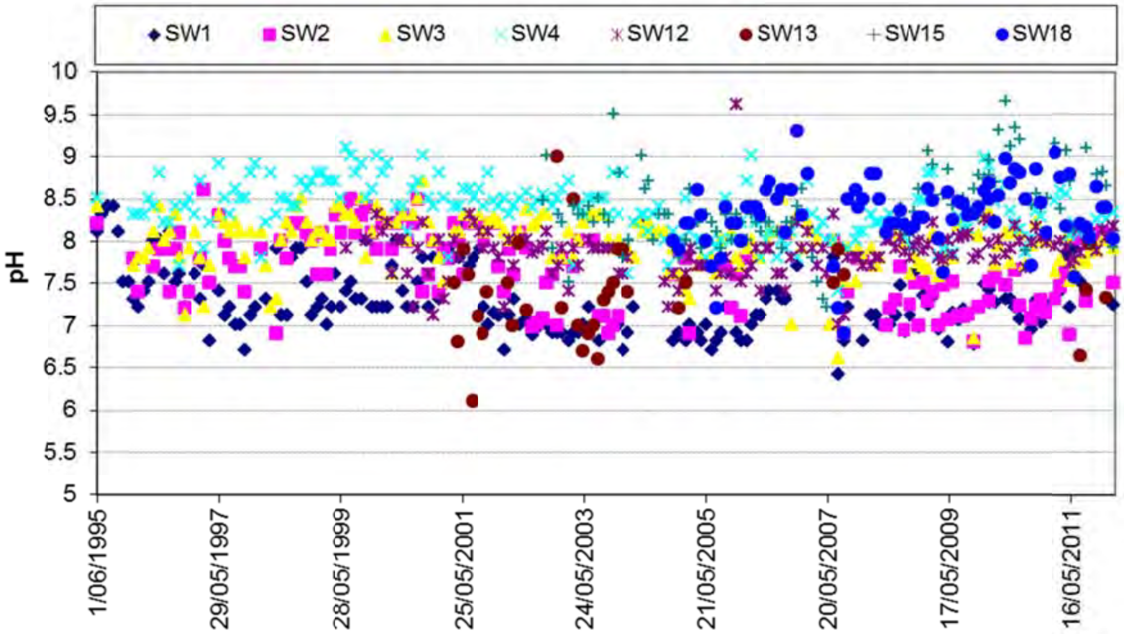
To ensure the sustainable and integrated management of surface water sources and protection of riparian areas and waterfront land, as defined in the WMA, an assessment of surface water sources within and adjacent to the mine area must include but is not limited to the following:

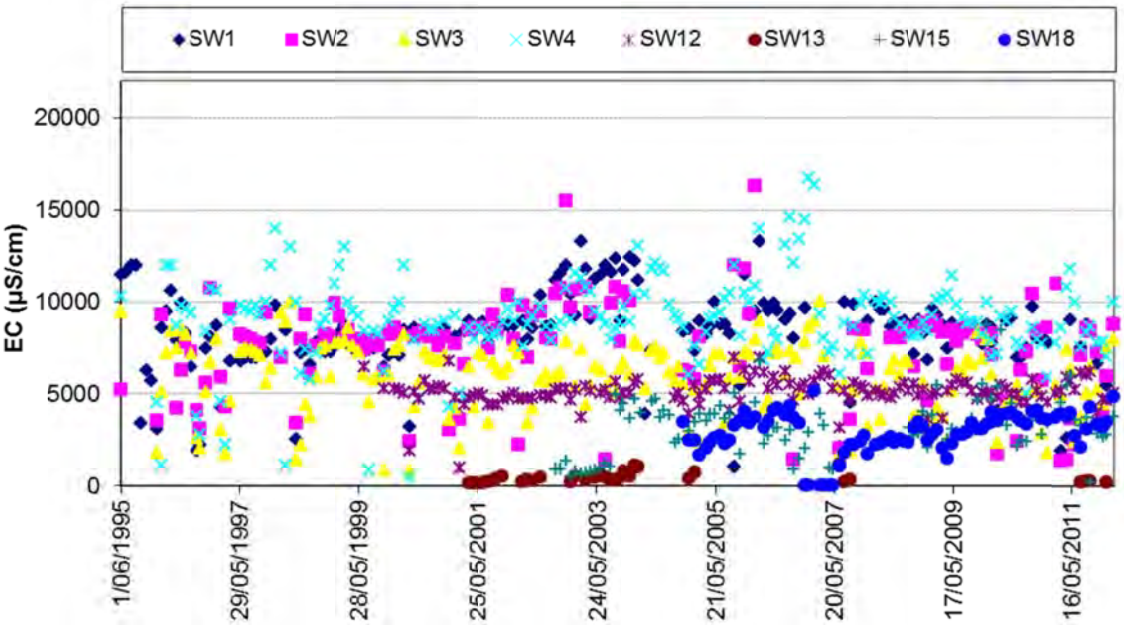
- *Details of all watercourses and existing surface water users within the area (including the environment) and details of any potential impacts on these users;*
- *Baseline monitoring (minimum of fortnightly data sampling for at least 2 years prior to mine operations) for surface water quantity and quality for all watercourses;*
- *Geomorphic assessment of water courses including details of stream order (using the Strahler System), river style and energy regimes both in channel and on any adjacent floodplains;*
- *Detailed description of all potential environmental impacts in terms of vegetation, sediment movement, channel stability, water quality and hydraulic regime,*
- *Description of the design features and measures to be incorporated into the proposal to guard against long term actual and potential environmental disturbances, particularly in respect of maintaining the natural hydrological regime and sediment movement patterns and the identification of riparian buffers;*
- *Details of the impact on water quality and remedial measures proposed to address any possible adverse effects, and*
- *Determination of critical thresholds for negligible impacts to surface water sources and dependent ecosystems.*

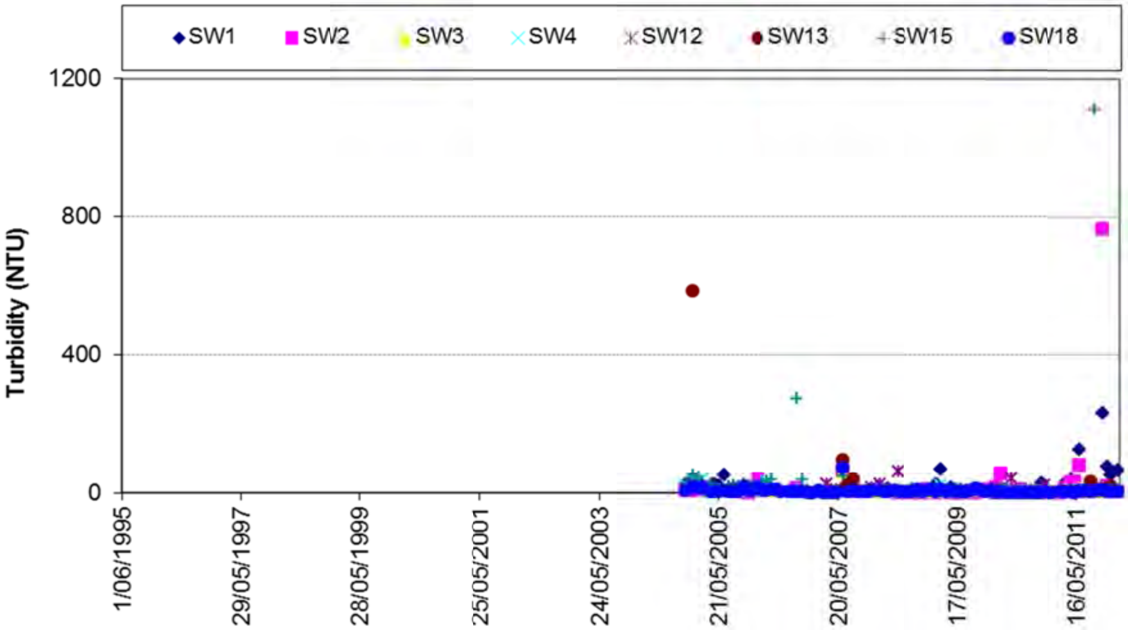
APPENDIX B
WATER QUALITY MONITORING DATA

ATTACHMENT B
WATER QUALITY MONITORING DATA

Local Area Creeks



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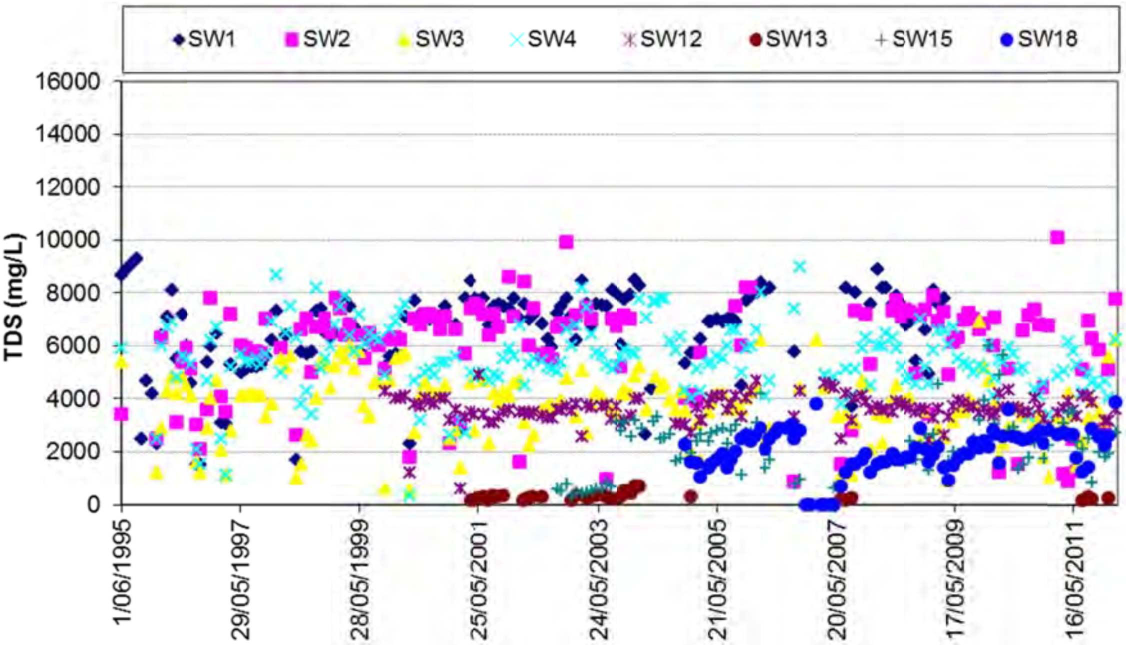
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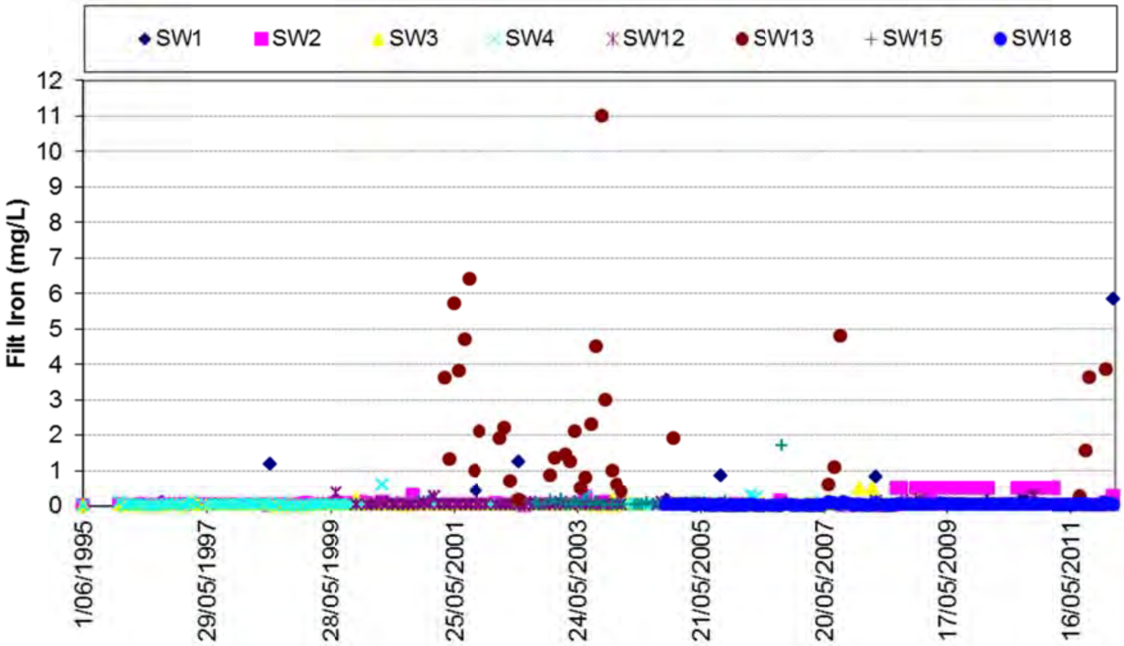
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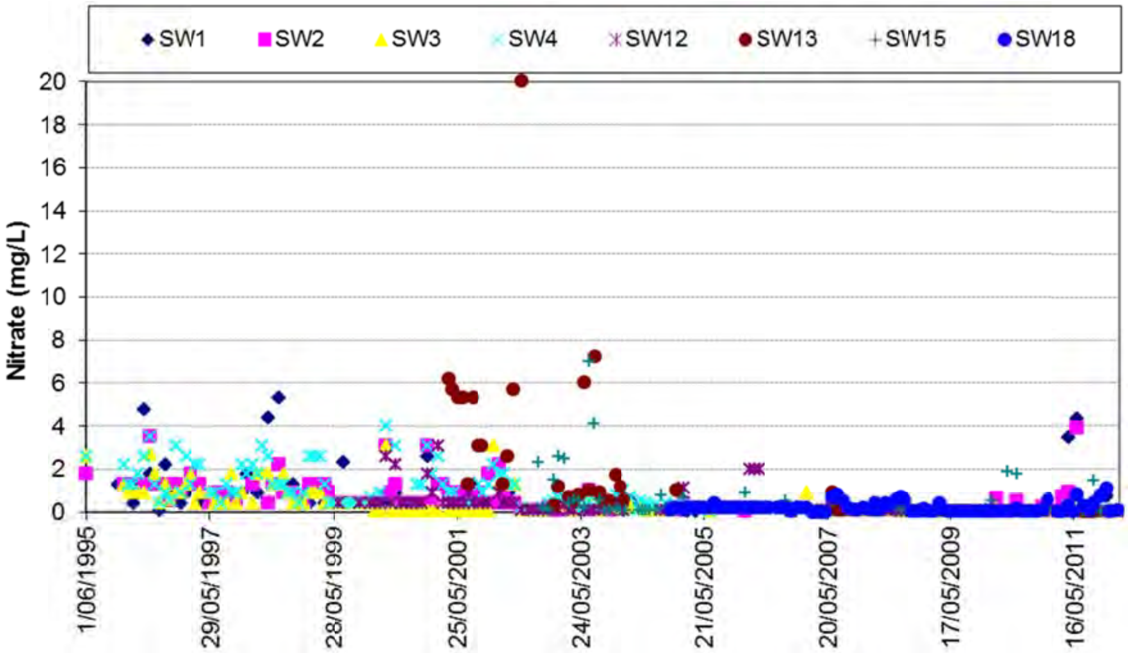
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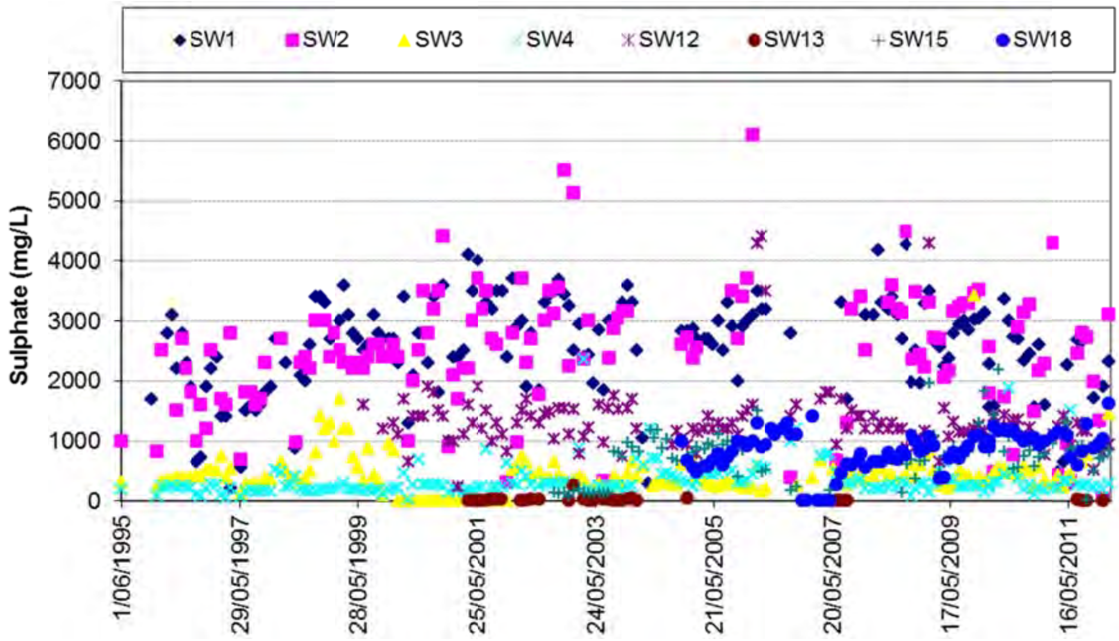
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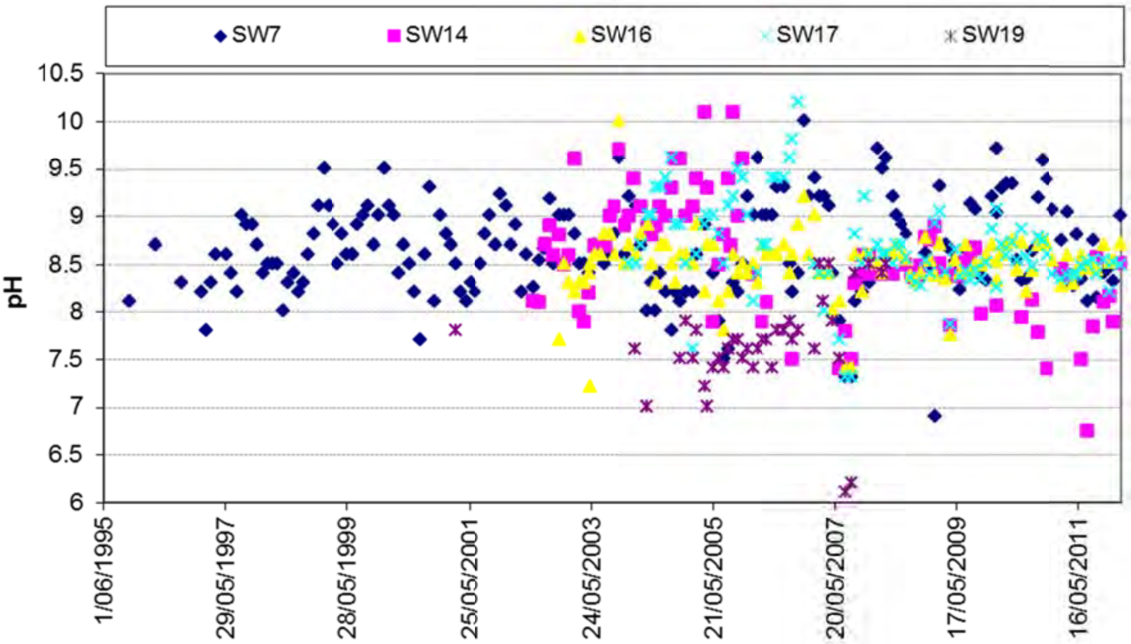

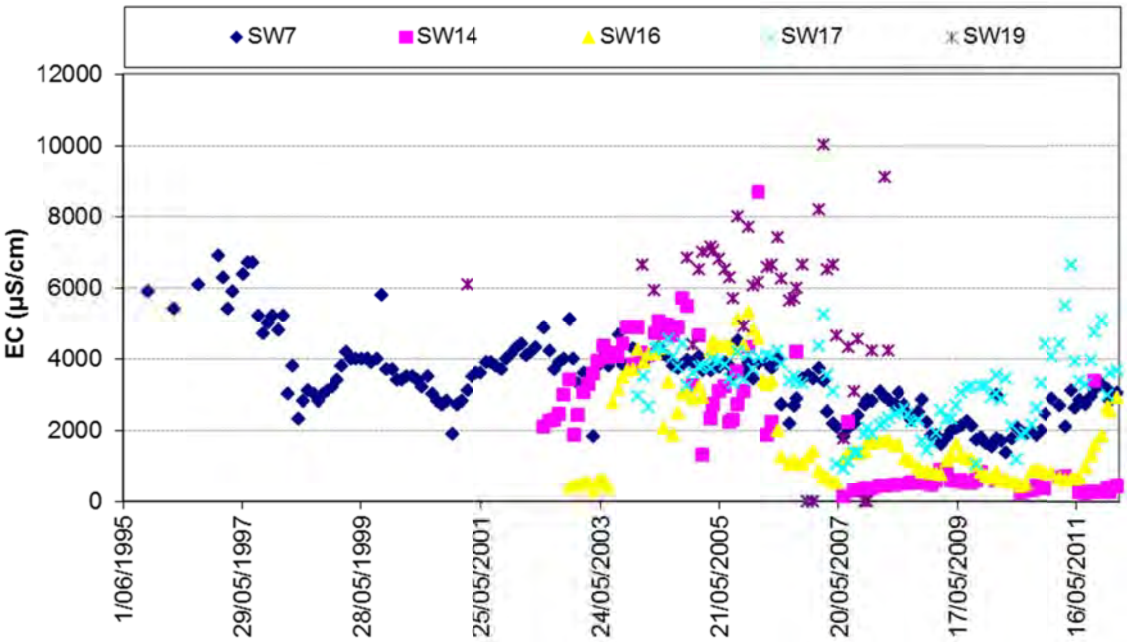

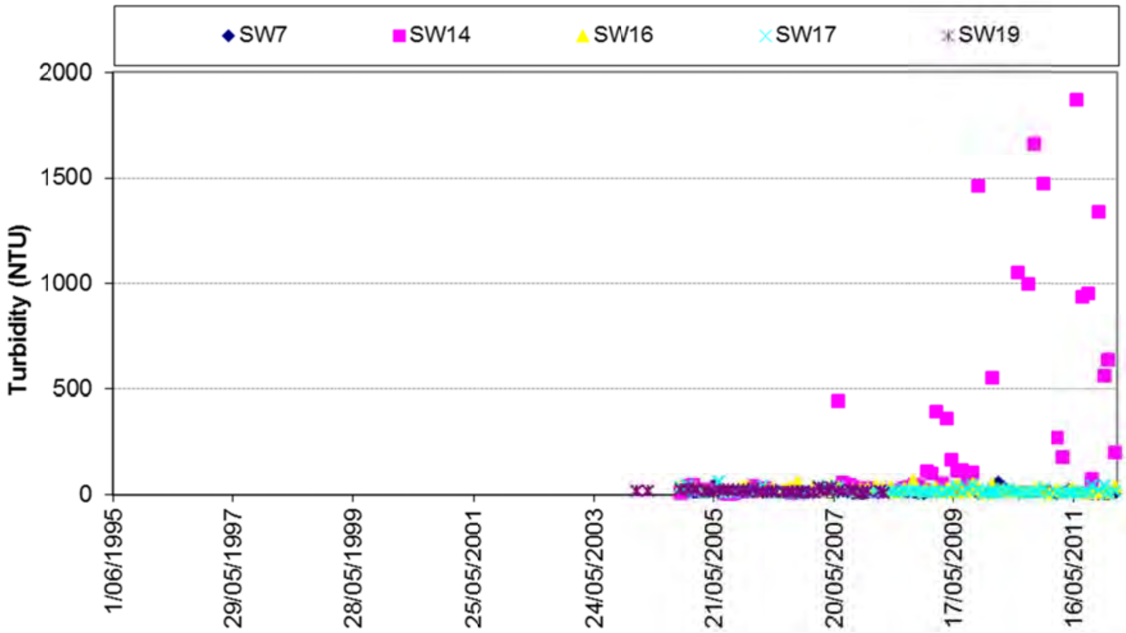
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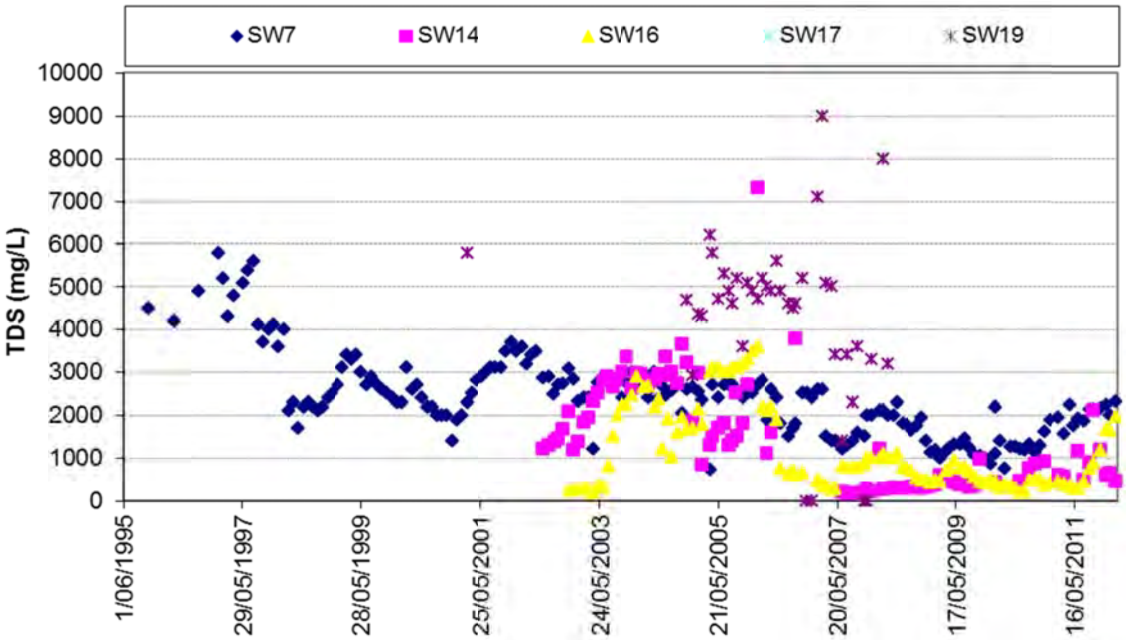
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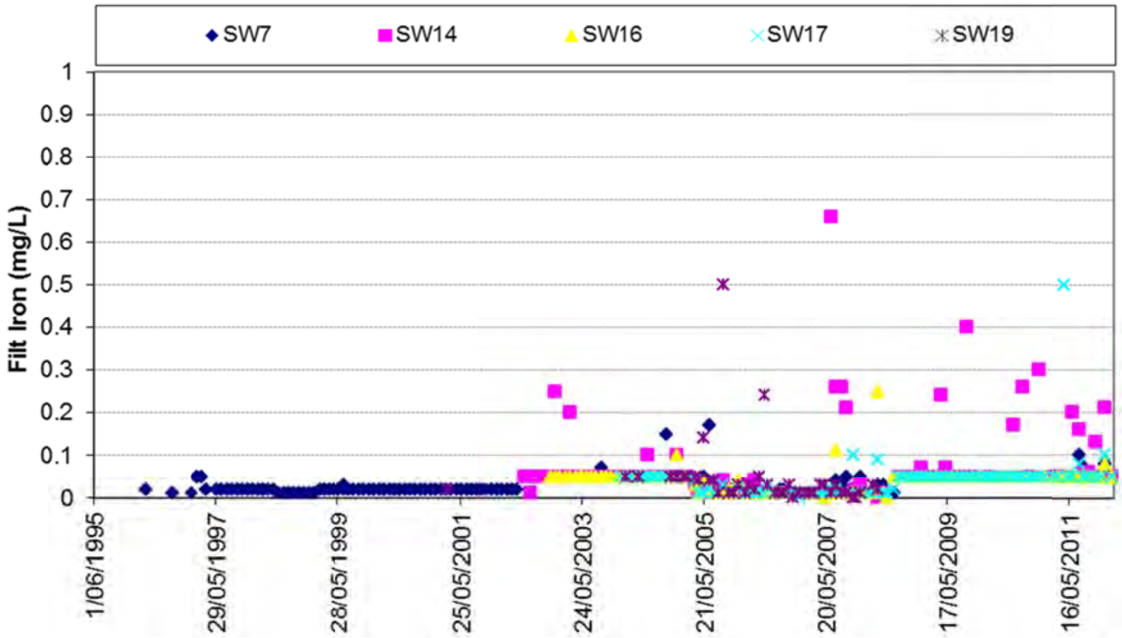
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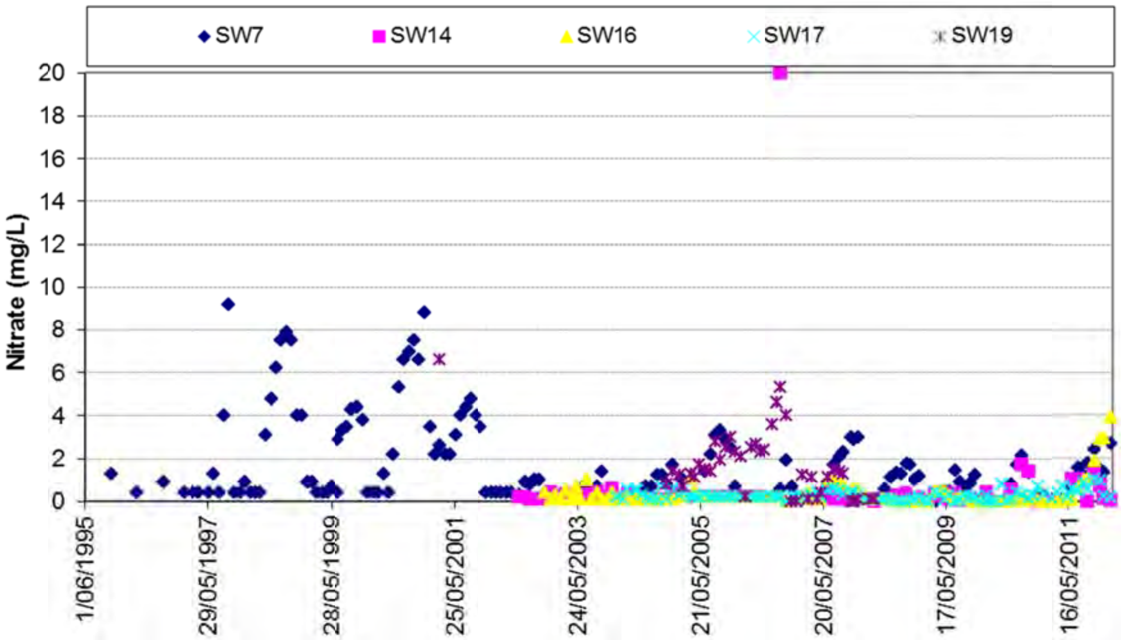
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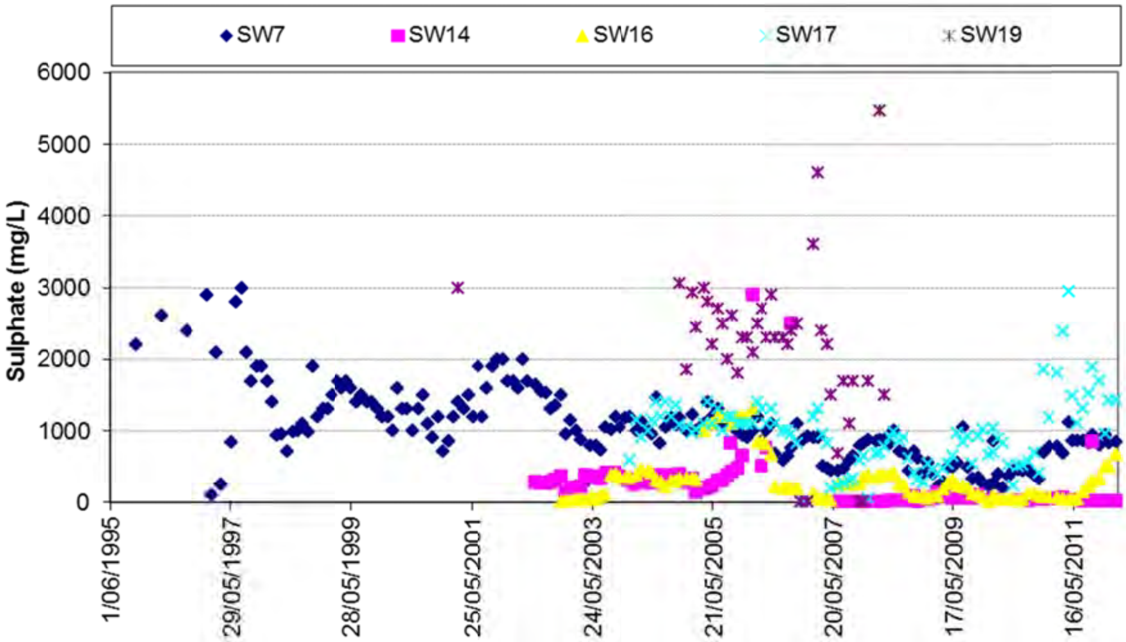
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