proposed

Mt Arthur
UNDERGROUND PROJECT

Appendix 9

Surface Water Assessment

Mt Arthur Coal

Mt Arthur Coal Underground Project
Surface Water Assessment

December 2007

Umwelt
Environmental Consultants

Mt Arthur Coal Underground Project Surface Water Assessment

Prepared by

Umwelt (Australia) Pty Limited

on behalf of

Mt Arthur Coal

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1.0 Introduction

Mt Arthur Coal Pty Limited (Mt Arthur Coal) operates an open cut coal mine south of Muswellbrook in the upper Hunter Valley of NSW (refer to **Figure 1.1**). The existing operations consist of three mining areas, the Bayswater No. 2 mining area (extraction complete), the Bayswater No. 3 mining area and the Mount Arthur North (MAN) mining area (refer to **Figure 1.2**). Mt Arthur Coal has been investigating a potential underground coal mining resource within the Bayswater No. 3 mining area and the adjacent Exploration Licence (EL) 5965 (refer to **Figure 1.2**) which it has held since 1996. These investigations have identified a substantial underground mining resource and the company is now seeking approval for an underground coal mining operation in this area. The proposed Mt Arthur Coal Underground Project will access the coal reserve through approved open cut pits and will build on Mt Arthur Coal's existing infrastructure, including the coal handling and preparation plant (CHPP) and rail loading facility.

Umwelt (Australia) Pty Limited (Umwelt) has been commissioned by Mt Arthur Coal to prepare an Environmental Assessment (EA) as part of the project application for the Underground Project. This Surface Water Assessment has been undertaken as part of the overall EA for the project.

1.1 Proposed Mining Operations

The Underground Project will involve longwall mining operations in five coal seams over a 21 year approval life. Further coal resources will remain within the project area after this initial 21 years of mining and Mt Arthur Coal intends to continue mining beyond this period, should future approvals be granted. The five target seams for the initial 21 year period are the:

- Woodlands Hill seam;
- Glen Munro seam;
- Arrowfield seam;
- Bowfield seam; and
- Piercefield seam.

'Punch longwall' mining techniques will be used in the Woodlands Hill and Glen Munro seams, meaning that the gate roads for longwall blocks will have access directly into the coal seam from open cut voids. Further open cut works will be required in both the Saddlers Pit and Belmont Pit in the Bayswater No. 3 mining area prior to the commencement of underground mining from these pits. These open cut works will be completed in accordance with the existing development consent for the Bayswater No. 3 mining area.

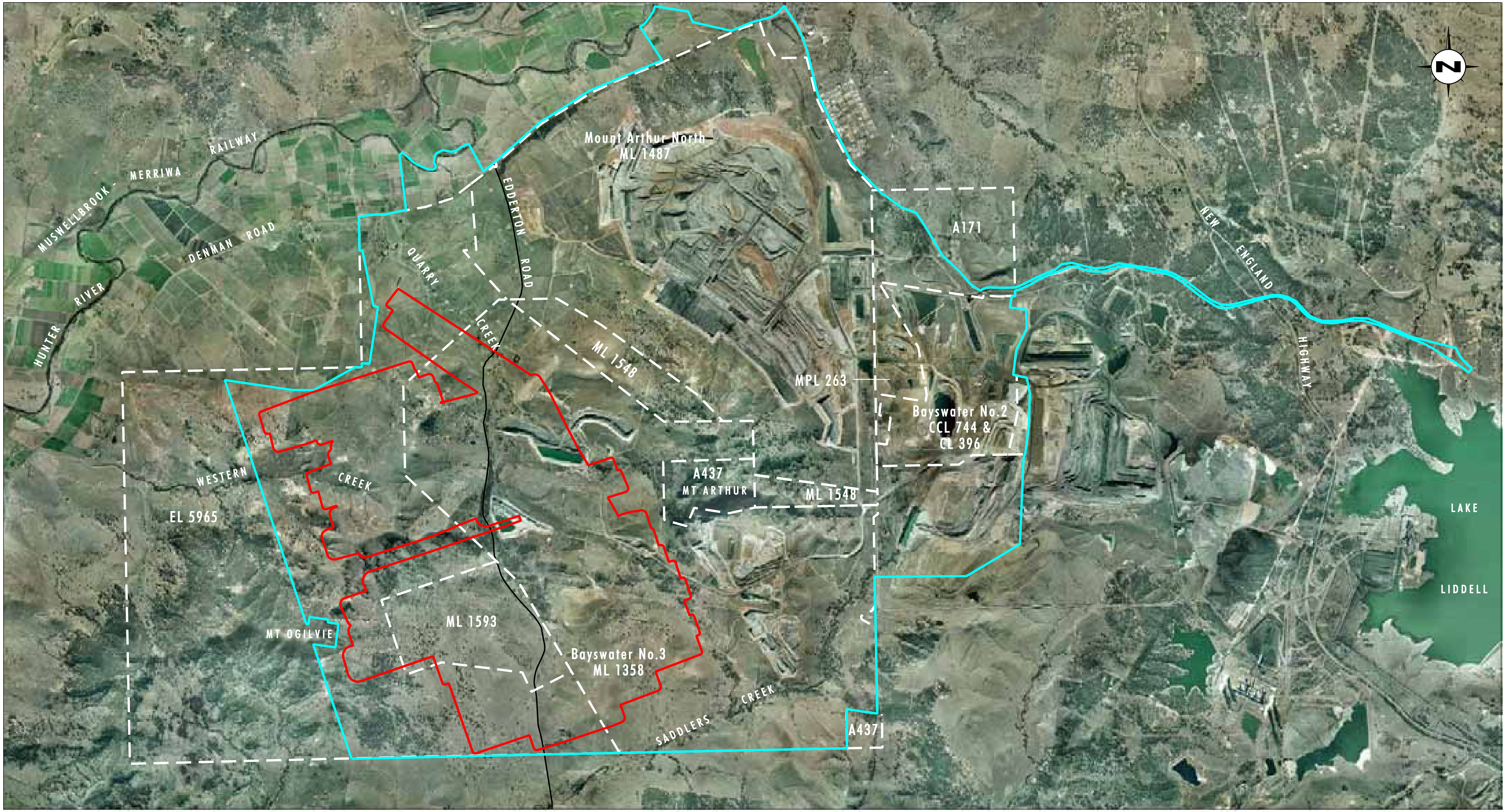
The Arrowfield, Bowfield and Piercefield coal seams are deeper and cannot be accessed directly from the open cut mining pits. A drift will be established from the base of the North Saddlers Pit in the Bayswater No. 3 mining area to provide access into these seams. The concept mine plans for the Woodlands Hill and Glen Munro seams are shown on **Figure 1.3**, with the concept mine plans for the Arrowfield, Bowfield and Piercefield seams shown on **Figure 1.4**.

Base Source: NSW Road Directory

0 10 20 30km
1:700 000

FIGURE 1.1

Locality Plan



Base Source: Mt Arthur Coal

0 1 2 4km
1:90 000

Legend

- Mining and Exploration Lease Boundaries
- Project Application Boundary
- Subsidence Affectation Area

FIGURE 1.2

Mt Arthur Coal Operations and Proposed Underground Mining Area

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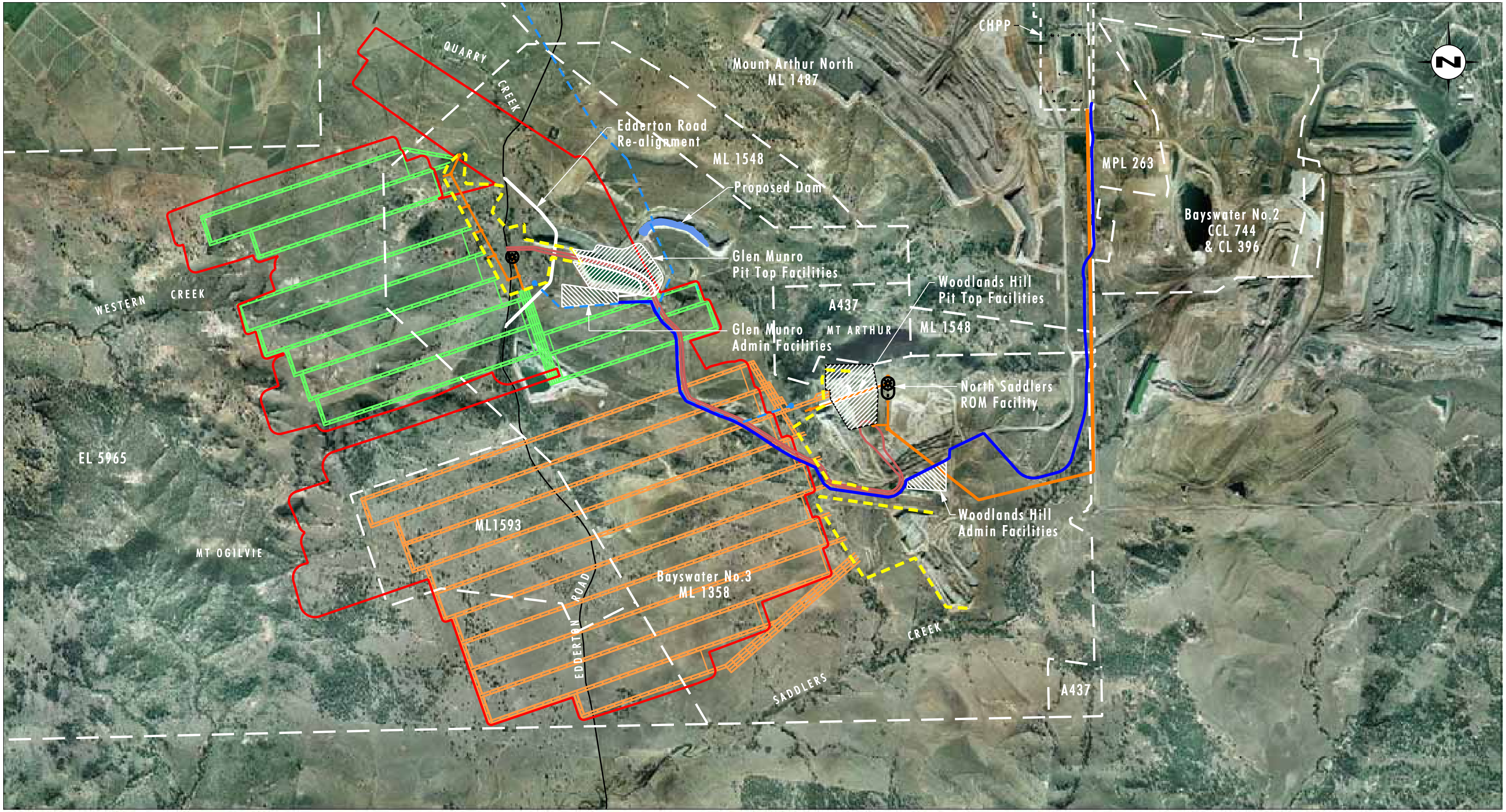

Source: Mt Arthur Coal

0 1 2 3km
1:60 000

Legend

- Mining and Exploration Lease Boundaries
- Subsidence Affectation Area
- Woodlands Hill Seam Concept Mine Layout
- Glen Munro Seam Concept Mine Layout
- Approved Open Cut
- Mine Access Road
- Surface Conveyor
- Haul Road
- Clean Water Supply

FIGURE 1.3

Woodlands Hill and Glen Munro Mine Plan and Surface Facilities

File Name (A4): R20_V1/2051_212.dgn

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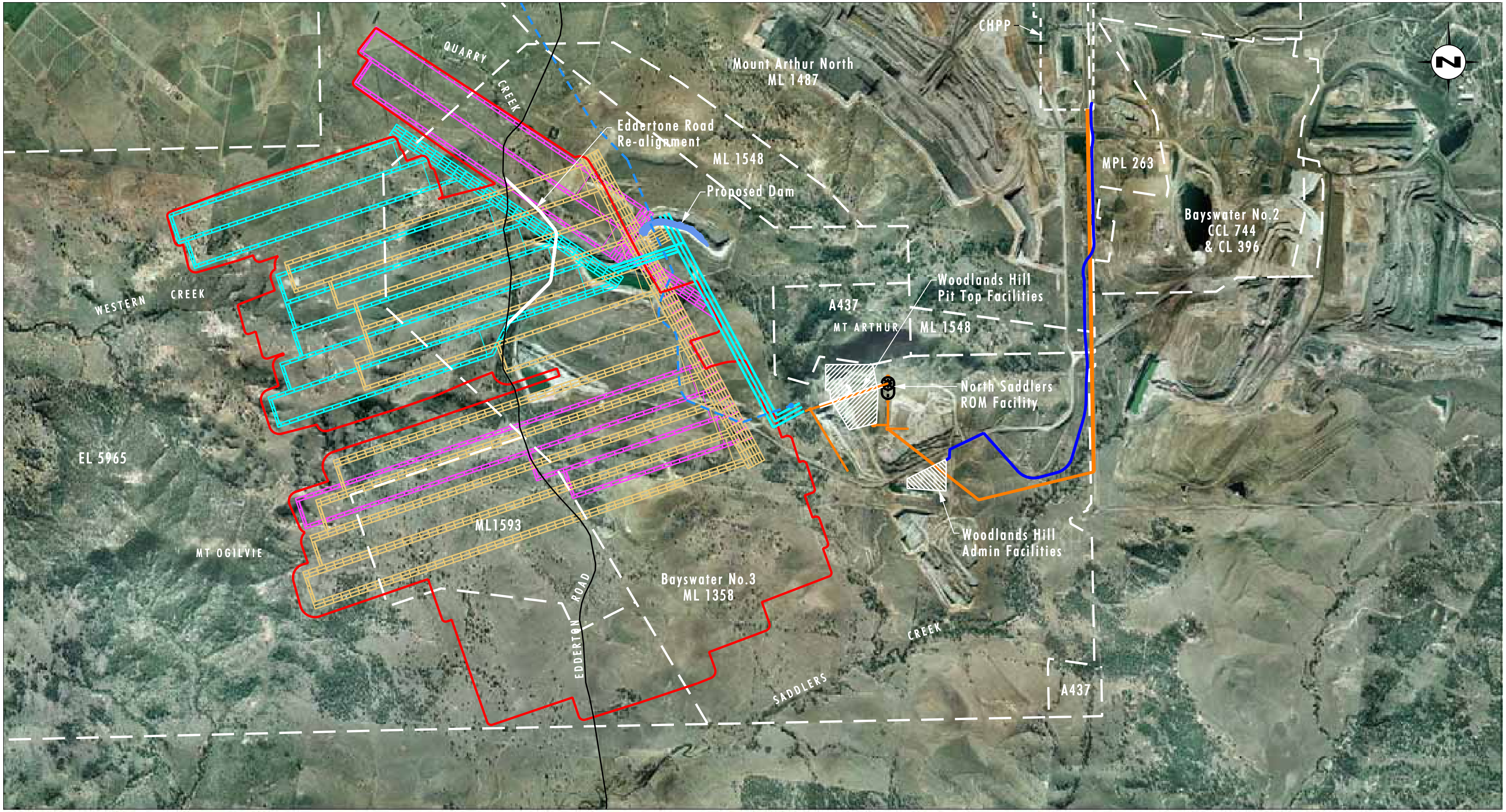


Source: Mt Arthur Coal

Legend

- Mining and Exploration Lease Boundaries
- Subsidence Affectation Area
- Arrowfield Seam Concept Mine layout
- Bowfield Seam Concept Mine Layout
- Piercefield Seam Concept Mine Layout
- Mine Access Road
- Surface Conveyor
- Haul Road
- Clean Water Supply

FIGURE 1.4

Arrowfield, Bowfield and Piercefield Mine Plan and Surface Facilities

File Name (A4): R20_V1/2051_213.dgn

A range of ancillary mining infrastructure will be required above the underground mining area including ventilation fan facilities, access tracks, service boreholes (power etc), gas drainage facilities, dewatering boreholes and other similar mining infrastructure. The exact locations in which these facilities are required to be located will be determined as the Underground Project progresses and will be dependent on mining operation needs. Conceptual localities for some of the surface facilities are shown on **Figures 1.3** and **1.4**.

The 21 year concept mine plan for the Underground Project will result in extraction of approximately 160 million tonnes of coal at a production rate of approximately eight million tonnes per annum (Mtpa). The annual production rate is expected to vary between six and eight Mtpa depending on the seam, mining conditions and the timing of longwall panel changeovers.

1.2 Mine Infrastructure

The Underground Project has been designed to maximise the use of existing Mt Arthur Coal infrastructure, including the existing CHPP and rail facility. Some upgrade works and extensions will be required to these existing facilities, with some new Underground Project specific infrastructure also required.

The pit-top facilities required for the Underground Project will include office, workshop, store and bathhouse facilities. These facilities will be constructed primarily in previously mined areas as shown on **Figures 1.3** and **1.4**.

Coal from the underground mining operations will be crushed and sized at a new ROM coal facility to be constructed on previously mined land in the Saddlers Pit surface facility area as shown on **Figure 1.3**. After passing through this facility, coal will be delivered by overland conveyor to the existing CHPP (refer to **Figure 1.3**). The CHPP will require some upgrade works (including a new plant module, additional stockpiling areas and associated handling facilities) to provide sufficient capacity for the coal from the Underground Project, however this will not result in disturbance of any previously undisturbed land and will be undertaken within the existing Mt Arthur Coal Complex water management system.

Coal from the Underground Project will be transported from the site via Mt Arthur Coal's existing rail facility and potentially by the existing overland conveyor to Bayswater Power Station. These facilities will not require any upgrades. Although no upgrades are required to the rail facility, it is proposed to extend an existing passing lane on the Antiene rail spur to provide additional train movement capacity. The extended passing lane will be located to the east of the New England Highway near the intersection of the Antiene spur with the Main Northern Railway. The passing lane will be constructed within the existing rail corridor.

Vehicular access to the Underground Project will be via the existing Mt Arthur Coal site access, with an additional section of internal access road constructed to connect this road to the Underground Project facilities. The location of this access road is shown on **Figure 1.3**.

A number of other site services will also be required for the Underground Project, including power lines, water pipelines, waste management infrastructure (including a new water storage dam formed in part of the Belmont Pit), a new pipeline from the Hunter River water extraction point and minor internal access roads. The proposed locations of some of these services are shown on **Figures 1.3** and **1.4**, with further services to be established during the life of the Underground Project as the need arises.

1.3 Potential Surface Water Impacts

The key features of the project that have the potential to impact on the surface water management requirements for Mt Arthur Coal are summarised below and discussed in further detail in **Sections 3.0** to **5.0**.

The extensions of the Saddlers and Belmont Pits to enable underground mining from the highwalls of these pits will result in landform changes associated with the required open cut mining operations, including the realignment of Edderton Road. These works will be undertaken under the Bayswater No. 3 development consent. The water management controls for these works will be consistent with the Bayswater No. 3 development consent and relevant Mining Operations Plans (MOPs).

There will be specific creek and drainage line impacts associated with the proposed underground mining undertaken as part of the Underground Project. These impacts will result from subsidence of the landform including changes to the surface profile and surface cracking. Associated with these changes will be works to ensure that the landform and drainage lines remain free draining. These works have the potential to impact on water flow and quality of downstream creeks. The area predicted to be impacted by subsidence based on the current conceptual longwall layout is referred to as the predicted subsidence affectation area and is shown on **Figures 1.2** to **1.4**.

The out of pit mining support infrastructure also has the potential to result in some minor impacts including road and conveyor crossings over drainage lines, the Hunter River pipeline and construction/installation of ancillary mining infrastructure such as dewatering bores, ventilation shafts, gas drainage infrastructure and associated services.

The project also has the potential to impact on the existing mine water management system and water balance for Mt Arthur Coal. The project will result in construction of additional infrastructure within the mine water management system and will also result in changes to the water balance, through additional groundwater inflow and increases in water demand.

1.4 Water Planning Context

Although works approvals are not required under the *Water Management Act 2000* for approvals under Part 3A of the *Environmental Planning and Assessment Act 1979* (the approval path for this project) the project has been assessed against the relevant requirements of the following water planning polices/plans:

- State Water Management Outcomes Plan (SWMOP) (DNR, undated);
- Hunter Catchment Blueprint (HCB) (DLWC, 2003);
- *Water Management Act 2000*; and
- *Water Act 1912*.

The details of the assessment against the SWMOP and HCB are included in **Section 6.3** of this document. The details of the assessment against the *Water Management Act 2000* and the *Water Act 1912* are included in **Section 7.3** and in the EA.

2.0 Existing Mt Arthur Coal Water Management System

A summary of the key components of the water management system at Mt Arthur Coal is shown on **Figure 2.1**. **Figure 2.1** also shows the mine in relation to surrounding catchments.

The existing mine water management system will continue to be used to control and treat runoff from the site with all pit water and mine surface runoff directed to the water management system. The site will also continue to use the hierarchy of water sources as shown on **Figure 2.2**. The system will be modified over the life of the mine to reflect the progression of mining operations. The capability of the mine water management system to contain and manage water associated with the proposed project and future mining operations is addressed in **Section 4.0**.

2.1 Water Supply and Storage

The primary sources of water supply to Mt Arthur Coal are catchment inflows to open cut mining areas, groundwater make and water sourced from off-site water. Mt Arthur Coal has a defined hierarchy of water use. This hierarchy is represented in **Figure 2.2**. Mt Arthur Coal aims to use water on site in preference to importing water from external sources. This on-site water includes catchment runoff, groundwater inflows and recycled water, followed by water stored on site in pits and dams. If water is required to be imported to site to meet operational requirements treated effluent from Muswellbrook Shire Council is imported first, followed by industrial water sources such as mine water from Drayton Mine. If additional water is required on site, water is extracted from the Hunter Regulated River Water Sourced utilising Water Access Licences (WALs).

2.1.1 Groundwater

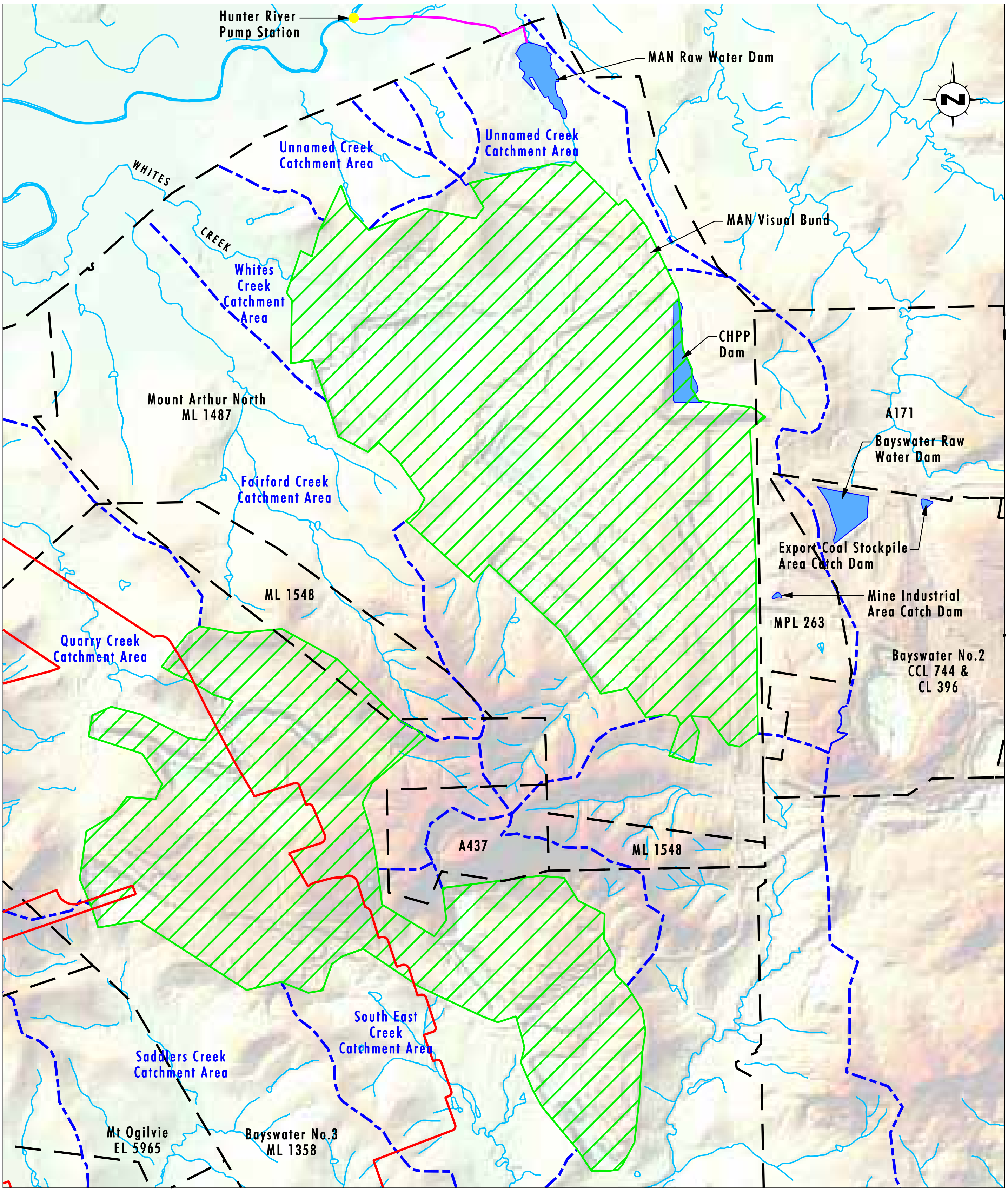
Groundwater inflows for the MAN and Bayswater No 3 mining areas were predicted in the MAN Environmental Impact Statement (EIS) (URS, 2000). Monitoring on site indicates that these predictions suitably represent the current groundwater inflows to the pits. Current (2006) groundwater inflows on site are estimated to total approximately 900 ML/year. The groundwater from the open cut pits and the predicted inflows from the exploration adit are extracted under Part 5 licences of the *Water Act 1912* (refer to **Table 2.1**) which currently provide for extraction of up to 1150 ML/year.

Table 2.1 - Groundwater Licences

Licensed Area	Licence Number	Extraction Allocation (ML/year)
MAN	20BL168155	750
Bayswater No. 3	20BL170620	250
Exploration Adit	20BL171156	150
Total		**1150**

2.1.2 Catchment Runoff

The water management system captures runoff from the footprint of the mining disturbance area. This area is defined on **Figure 2.1** and contains the open cut mining pits, overburden



Source: Mt Arthur Coal

0 1 2 2.5km
1:50 000

Legend

- Mining and Exploration Lease Boundary
- Subsidence Affectation Area
- Catchment Boundary
- Mining Area
- Hunter River Pipeline

FIGURE 2.1

Mt Arthur Coal Water Management System - Key Components

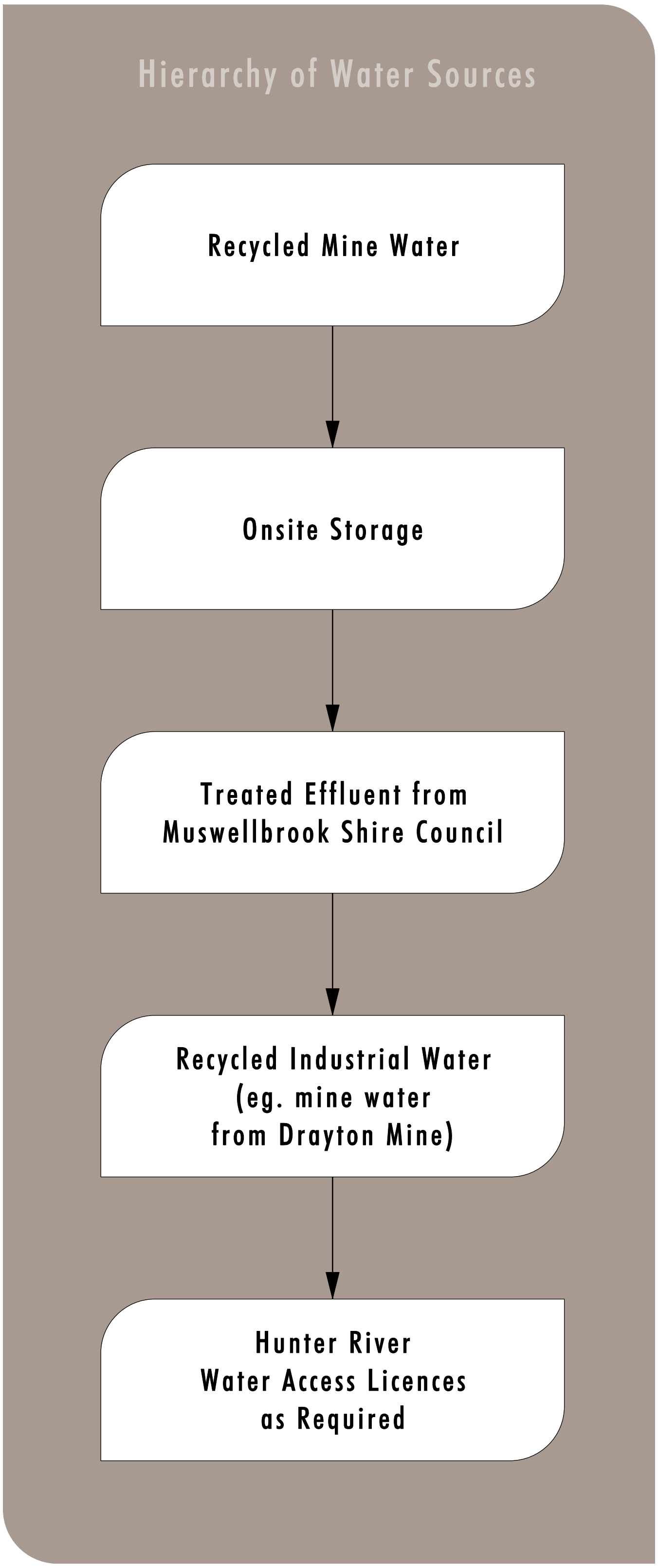


FIGURE 2.2

Hierarchy of Water Sources

emplacement areas, haul road routes and infrastructure areas. The current catchment area of the water management system is approximately 1860 ha.

2.1.3 External Water Supply

Mt Arthur Coal supplements on site supply with external water from the following locations:

- supply of treated effluent from Muswellbrook Shire Council;
- outsourced supply of mine water from industrial water sources such as Drayton Mine;
- Hunter Regulated River Water Source Water Access Licences (WALs); and
- Small amounts of potable water from Muswellbrook Shire Council.

Mt Arthur Coal has a defined hierarchy of water sources. These are shown on **Figure 2.2**.

Mt Arthur Coal currently receives treated effluent from Muswellbrook Shire Council for use on site and has used this treated effluent on site for the past eleven years. Muswellbrook Shire Council also supplies a proportion of treated effluent to the Muswellbrook Golf Club. The effluent supplied to Mt Arthur Coal is initially treated on site in a constructed wetland and then transferred to the Bayswater Raw Water Dam for use. Approximately 780 ML of effluent was sourced during 2005 and approximately 660 ML during 2006. A long-term arrangement to source treated effluent from Muswellbrook Shire Council is currently being negotiated by Mt Arthur Coal with Council. The available supply of effluent from Muswellbrook Shire Council is expected to be on average 750 ML/year, ranging from 600 ML/year to 900 ML/year depending on meteorological conditions and other water users.

Mt Arthur Coal has also historically sourced water from the neighbouring Drayton Mine. This water is mine water quality and is suitable for use in dust suppression or in the CHPP. Water sourced from Drayton Mine is stored in the Bayswater Raw Water Dam prior to use on site. Approximately 615 ML of water was sourced from Drayton Mine during 2005 with approximately 25 ML of water sourced during 2006. The volume of supply from Drayton Mine depends on meteorological conditions and will vary from year to year.

When required, water can be extracted from the Hunter River to the MAN Raw Water Dam in accordance with Mt Arthur Coal's water licences with this allocation only used when water is not available from other sources. No Hunter River water was utilised by site during 2005, with approximately 1060 ML utilised during 2006.

All of the current surface water licences held by Mt Arthur Coal are under the *Water Act 1912*. These licences are currently in the process of being transferred to WALs under *Water Management Act 2000*.

Mt Arthur Coal is located adjacent to River Reach 1A of Management Zone 1 of the Hunter River Regulated Water Source. River Reach 1A is from the upstream reaches of Glenbawn Dam to the confluence of the Hunter River and the Goulburn River at Denman. Water is made available to water users by use of WALs.

Mt Arthur Coal as at January 2007 held 15 licences for extraction from the Hunter River, with a combined equivalent allocation of 3107 unit shares of regulated river (general security) access licences and 342 unit shares of regulated river (high security) access licences (refer to **Table 2.2**).

Table 2.2 - Mt Arthur Coal Water Licences as at January 2007 – Hunter Regulated River Water Source

Surface Water Licence Number	General Security Shares	High Security Shares
20SL035881	243	
20SL060829	220	
20SL022486	66	
20SL040254	360	
20SL027213	171	
20SL026185	330	
20SL035927	270	
20SL041380	360	192
20SL033423	183	
20SL037072	147	
20SL060751	533	150
20SL030340	171	
20SL045865	18	
20SL033701	27	
20SL044756	8	
Total	**3107**	**342**

In addition to the general and high security shares above, Mt Arthur Coal has an allocation of approximately 150 unit shares of supplementary water. Mt Arthur Coal is currently acquiring additional WALs totalling 950 general security shares.

The amount of water that can be extracted from the Hunter Regulated River Water Source using WALs is based on Available Water Determinations (AWD) which are announced at least annually by the NSW Government. At full supply levels, 1 ML of water can be extracted for each WAL unit held.

The Water Sharing Plan for the Hunter Regulated River Water Source (DNR, 2004) discusses the methods by which AWDs are set. The Plan indicates that the AWDs aim to set a minimum allocation of 75 per cent of high security water and 0 per cent of general security water in all but the worst drought years. Water under the AWDs is sourced by ordering water from Department of Water and Energy (DWE). This water is released from Glenbawn Dam specifically for extraction by the licence holder.

If the AWDs were set at 75 per cent for high security and 0 per cent for general security (i.e. the 'minimal' level), Mt Arthur Coal would have an available water allocation of approximately 260 ML/year from the Hunter River with existing available licences. However, in these circumstances the water licences allow further water to be extracted from the river during periods of uncontrolled flow to supplement the AWDs. Mt Arthur Coal's current WAL extraction rights during uncontrolled flows theoretically equate to approximately 3190 ML/year during periods of minimum AWDs. As such, the total of controlled and uncontrolled water theoretically available equates to approximately 3450 ML/year. With the additional 950 general security unit shares being purchased, Mt Arthur Coal's total of controlled and uncontrolled water extraction rights would equate to approximately 4400 ML/year.

An assessment based on historical flows recorded for River Reach 1A at the Hunter River at Muswellbrook Bridge Department of Natural Resources (DNR) Gauge (Station number

210003) between February 2002 and January 2007 and trigger values for uncontrolled flow events released by the then DNR in April 2007 indicates that this volume would have been available for all years in the analysis period for extraction under the current AWDs and Customer Self Regulated uncontrolled flow management. The current pumping station at Mt Arthur Coal's Hunter River extraction point is rated at 15.6 ML/day (i.e. 180 L/s). A licence application has been recently approved by DWE for a second pump to be installed at the extraction point. The second pump will have a pump capacity of 70 ML/day (i.e. 800 L/s). The analysis indicates that based on historical river flows and with careful management Mt Arthur Coal's current WALs (i.e. 3107 general security, 342 high security) would allow extraction of up to approximately 3450 ML/year during periods where AWDs were set to the target minimum level, using extraction rights for AWDs and uncontrolled flow events.

Potable water for the site is sourced from the Muswellbrook Shire Council mains. Wastewater from the administration offices, workshops and bathhouse is collected by a series of gravity and rising mains and treated on site using a package treatment plant. The treated effluent from the plant is reused on site as process water.

2.1.4 Water Management System Storages

There are five major dams, open cut mining pits and voids, numerous minor sediment dams and numerous highwall catch dams within the Mt Arthur Coal water management system. The major storages are shown on **Figure 2.1** and their characteristics are detailed in **Table 2.3**.

Table 2.3 - Characteristics of Major Storages

Dam Name	Catchment Area (ha)	Capacity (ML)	Maximum Surface Area (ha)
MAN Raw Water Dam	80	1123	13.3
Bayswater Raw Water Dam	29	1025	10.7
CHPP Dam	187	200	7.8
Mine Industrial Area Catch Dam	7	15	0.5
Export Coal Stockpile Area Catch Dam	27	20	0.6
Sub-Total (Dams)	**330**	**2383**	**32.9**
Open Cut Mining Pits and Voids	-	~5000	35
Total	**-**	**~7383**	**68**

Historically Mt Arthur Coal has used a number of other water storage areas, including significant use of in pit sumps. As such historically the total evaporative surface area of water storages has been as high as approximately 70 hectares. Recent water strategies implemented on site have endeavoured to reduce this evaporative surface area and as a result limit the potential evaporative surfaces on site to 35 hectares. This will assist in reducing evaporation and improve on site water availability.

2.2 Water Demands

The current water demands for the Mt Arthur Coal site include:

- wash plant (CHPP);

- haul road dust suppression;
- stockpile dust suppression;
- washdown water; and
- potable water.

The current water demands for each of the aspects listed above is detailed in **Sections 2.2.1** to **2.2.4**.

Water is also lost on site through evaporation from dam water surfaces.

2.2.1 Wash Plant

The wash plant is the major water user at Mt Arthur Coal with net water usage for 2006 estimated to be 1554 ML to wash 7.0 Mt of ROM coal (i.e. 222 L/t ROM). This water demand is primarily made up of water losses to evaporation and losses in product. During 2006 and the start of 2007 a focus on water management in the wash plant and tailings dams has allowed considerable efficiencies in water use to be realised. As such net water losses for the washing process for the current open cut operations are approximately 174 L/t ROM.

2.2.2 Haul Road Dust Suppression

The volume of water required for dust suppression will vary according to prevailing climatic conditions, the extent of haul road development and the usage of the haul roads. Mine water is currently drawn from fill points around the mine to suppress dust on mine haul roads and unsealed site roads. Water cart usage for dust suppression is recorded on site. It is estimated that approximately 1340 ML of water was used for dust suppression during 2005. In 2005 Mt Arthur Coal watered approximately 18 kilometres of 30 metre wide haul road. Approximately 74 ML/km of water was used for dust suppression during 2005. It is estimated that approximately 1130 ML of water was used for dust suppression during 2006. This equates to approximately 63 ML/km of water was used for dust suppression during 2006. The reduction in water requirements during 2006 is primarily due to two reasons: a focus on water requirements and monitoring on site; and trials using bituminous surfactants on the haul roads (from mid December 2005 to the end of 2006). Based on these trials, water savings of approximately 40 per cent may be possible using bituminous surfactants.

2.2.3 Washdown and Stockpile Dust Suppression

Monitoring on site indicates that approximately 1.0 ML/day is used for washdown and stockpile dust suppression water demands. An additional 0.19 ML/day is used at the export coal stockpile and load out facilities. As such a total of 1.19 ML/day (i.e. 429 ML/year) is used for materials handling and washdown at Mt Arthur Coal. It is estimated that an additional demand of approximately 120 ML/year for materials handling and washdown water will be required for the Bayswater No. 3 mining area (when open cut mining is being undertaken in the Saddlers and Belmont Pits).

2.2.4 Potable Water

Potable water is supplied from the Muswellbrook Shire Council mains for use as drinking water and in the amenities such as the bathhouse. Potable water usage on site is in the order of 60 ML/year.

2.3 Management of Surface Water

2.3.1 Pit Water Controls

A series of diversion and catch drains have been constructed around the perimeter of the MAN mining area, the Bayswater No.3 mining area, the Bayswater No. 2 mining area and emplacement areas. These drains ensure that the inflow of clean water runoff into the pits is minimised and conversely that no discharge of dirty water occurs from the pits into the surrounding creeks and drainage lines.

The network of diversion and catch drains will continue to be developed as the pits and emplacement areas expand in accordance with the MAN EIS (URS, 2000), Bayswater EIS (Resource Planning Limited, 1993), development consent conditions, Environment Protection Licences (EPLs) and relevant MOPs.

2.3.2 Mining and Overburden Emplacement Area Controls

Runoff from active mining areas is collected in catch drains and directed through sediment dams to remove suspended sediment prior to reuse on site. Runoff from overburden emplacement areas is also collected in catch drains and directed through sediment dams prior to reuse or discharge from site.

A drainage channel and underground culvert direct runoff from a section of undisturbed catchment of Whites Creek through the Mt Arthur Coal CHPP and stockpile areas to separate clean water flows from dirty water runoff from the CHPP and stockpile areas. A diversion drain is located downstream of this culvert adjacent to the MAN visual bund (refer to **Figure 2.1**). This diversion drain also collects flows from undisturbed catchments to the north of the MAN mining area. The diversion drain conveys the clean water runoff around the MAN Raw Water Dam to an un-named creek which flows into the Hunter River immediately downstream of the Bengalla Link Road.

Diversion drains, temporary catch drains and sediment dams have been constructed in the active emplacement areas of both MAN and Bayswater mining areas to control surface runoff.

Similarly diversion drains and sediment dams have been constructed to collect and treat runoff from rehabilitated sections of the emplacement areas prior to overflowing into natural drainage lines downstream of the mining area.

2.3.3 Mine Infrastructure Area Controls

Runoff from mine infrastructure areas is directed through diversion drains and collected in catch dams directly downstream of each area. The CHPP and coal stockpile area, mine industrial area and export coal stockpile areas are directed to catch dams of 200 ML, 15 ML and 20 ML respectively (refer to **Table 2.2**). Water collected in these dams is transferred to the Bayswater Raw Water Dam for reuse in the mine water management system.

2.4 Discharges to the Hunter River

Mt Arthur Coal currently has a licence under the Hunter River Salinity Trading Scheme (HRSTS) to discharge water to the Hunter River. This licence has not been used to date. DECC currently manages the HRSTS on a daily basis with the oversight of an Operations Committee. The aim of the scheme is to manage saline water discharges in order to minimise impacts on other water users and the aquatic ecosystems of the Hunter River and its tributaries. The HRSTS provides for controlled discharges based on volume and electrical conductivity during high or flood flows in the Hunter River. The volume of mine water that can be discharged is controlled by flows in the river, salt loads of discharge water and available salt credits. Mt Arthur Coal is in the upper sector of the HRSTS (between Muswellbrook and Glennies Creek). In this sector the scheme has a target salinity level of 900 µS/cm.

Mt Arthur Coal currently holds 39 credits for discharging under the HRSTS, with 15 credits currently held under the EPL for Bayswater No. 2 and No.3 (EPL Number 113), and 24 held under the MAN EPL (EPL Number 11457). These credits are valid until 30 June 2007, after which time allocation of credits will reduce by 5 and 8 per year for EPL 113 and EPL 11457 respectively until depletion, unless supplemented by the purchase of more credits.

Mt Arthur Coal's EPLs permit controlled discharges into the Hunter River. Mt Arthur Coal's discharge point is fitted with calibrated volume and electrical conductivity meters. Discharges from this location are controlled via manually operated valves that are only opened by the Environment and External Affairs Manager or nominee. As discussed above, this discharge point has not been used by Mt Arthur Coal to date.

3.0 Surface Water Impacts and Management Methods

3.1 Sediment and Erosion Control Measures

This surface water assessment has been conducted on the basis that erosion and sediment control measures will be implemented as part of detailed construction plans and management plans for all surface infrastructure works, including major infrastructure, haul roads and services.

The sediment and erosion control measures implemented during the construction phase and detailed in site management plans will be carried out in accordance with appropriate statutory requirements, including the existing Mt Arthur Coal development consents, Mining Lease conditions, MOPs, and EPLs. The control measures will be established to a standard consistent with Managing Urban Stormwater: Soils and Construction (NSW Landcom 2004) (the Blue Book) and Guidelines for Establishing Drainage Lines on Rehabilitated Minesites (Draft) (DLWC, 1999).

The erosion and sediment control measures proposed to be adopted to control the quality of runoff from the site include:

- construction and regular maintenance of catch drains, silt fences and sediment dams to minimise sediment generation and contain sediment downslope of disturbed areas;
- placement of oil management systems downslope of key infrastructure and high traffic hardstand areas;
- clearly identifying, delineating and minimising areas required to be disturbed and ensuring that disturbance is limited to those areas. Clearing vegetation only as required to achieve the works and minimising machinery disturbance outside of these areas;
- applying gypsum, where required, to reduce the dispersibility of the subsoils that will be disturbed and to minimise the potential for tunnel erosion and surface rilling of disturbed or reshaped areas. The application rate to be determined by additional localised soil testing as required;
- ensuring that where possible all drainage and sediment and erosion control works are designed and constructed to be free draining to minimise the potential for ponding, infiltration and tunnel erosion;
- establishing a stable vegetative cover on all areas as soon as possible and regularly maintaining these areas;
- construction of drains upslope of areas to be disturbed to convey clean runoff away from most disturbed areas;
- diversion of surface and road runoff away from disturbed areas where possible;
- constructing access road and earthworks cut and fill batters at slopes (of 1V:3H or less, where possible) to maximise long term stability;
- limiting the number of roads and tracks established;

- reshaping, topsoiling and vegetating road and cut and fill batters as soon as practical;
- progressively stripping and stockpiling topsoil for later use in rehabilitation; and
- rehabilitating disturbed areas as soon as possible.

The proposed in pit water management controls are detailed in **Section 3.2.1** and include sediment and erosion control measures for these areas.

Where necessary, sediment fences will be placed around the downslope batter of topsoil stockpiles to reduce the potential for sediment transport from the stockpile.

Stockpiles that are to remain undisturbed for periods of greater than six months will be grassed.

3.2 Surface Water Infrastructure

All open cut mining in Saddlers and Belmont Pits will be carried out in accordance with the Bayswater No 3 development consent conditions and relevant MOPs.

Runoff from the sub-catchments external to Saddlers Pit will be diverted around the northern side of the pit towards the west through an existing diversion structure and to an existing dam before being released to existing drainage lines. This will prevent the inflow of external runoff water into the pit (refer to **Section 2.3**).

Diversion drains will be constructed to the south of Belmont Pit to divert runoff from undisturbed catchment areas away from the pit (refer to **Section 2.3**).

These water management controls will be maintained for the life of the Underground Project as access to the underground workings will be via Saddlers and Belmont Pits.

3.2.1 Entrance to Underground Workings

Underground mining areas in the Woodlands Hill seam will be accessed directly from the highwall in Saddlers Pit. Similarly, mining in the Glen Munro seam will be accessed directly from the highwall in Belmont Pit. After mining is complete in the Glen Munro seam a drift will be required from Saddlers Pit to provide access to the Arrowfield, Bowfield and Piercefield seams.

To prevent surface water runoff entering the underground workings, a series of diversion drains, catch drains and sumps will be constructed. Five sumps are proposed to be constructed in Saddlers Pit and three sumps will be constructed in Belmont Pit. The drift entrance will be contoured to ensure that no runoff reports to the entry.

The water collected in the sumps will be pumped to a central storage dam in each pit prior to either reuse in pit for dust suppression/process water or transfer to the Mt Arthur Coal water management system.

Dirty water returned from the underground workings will also be collected in the sumps.

All pumps and sumps will be designed to safely store runoff from a 100 year Average Recurrence Interval (ARI) critical duration storm event and be able to pump from the pit floor to the Mt Arthur Coal water management system. The system will be designed to ensure that adequate freeboard exists between the design top water level of each sump and the invert of the entries to the longwalls. The water management system for each mine entry will be constructed prior to the entry being utilised for access to the underground workings and will remain operational until each gateway is sealed after underground mining is completed in that area.

3.2.2 Infrastructure

As shown on **Figures 1.2** to **1.4** a range of infrastructure associated with the proposed underground mining activities will need to be constructed. This infrastructure will include:

- Belmont Water Dam (located within Belmont Pit) (refer to **Section 3.2.2.1**);
- North Saddlers ROM facility (located within Saddlers Pit) (refer to **Section 3.2.2.2**);
- clean water supply pipeline from Hunter River (located outside of open cut pits) (refer to **Section 3.2.2.3**);
- CHPP upgrade (located within Mt Arthur Coal water management system) (refer to **Section 3.2.2.4**);
- access roads and service corridor (located within Saddlers and Belmont Pits and out of pit) (refer to **Section 3.2.2.5**);
- overland conveyors including the Saddlers Creek crossing (located within Saddlers and Belmont Pits and out of pit) (refer to **Section 3.2.2.6**);
- pit top facilities (located within and adjacent to Saddlers and Belmont Pits) (refer to **Section 3.2.2.7**): and
- ancillary mining surface infrastructure and services (located primarily outside of open cut pits) (refer to **Section 3.2.2.8**).

In addition to infrastructure within and surrounding the mining area some works will be undertaken to construct the extended passing lane on the Antiene rail spur (refer to **Section 3.2.2.9**).

3.2.2.1 Belmont Water Dam

It is proposed to construct a new dam (refer to **Figure 1.4**) in the east Belmont Pit to store clean water (including water pumped from the Hunter River as required) prior to use in the operation. This dam will be formed by construction of a wall across the open cut pit. The proposed dam will have a storage capacity of approximately 180 ML and will be contained within the Belmont Pit and will have no impact upon the surrounding catchment areas. As the proposed dam lies within the mine water management system area no additional soil and water management controls will be required.

3.2.2.2 North Saddlers ROM Facility

It is proposed to construct a ROM Facility in the north of Saddlers Pit. Coal processed through the facility will be temporarily stored at a stockpile with a capacity of up to 500,000 tonnes. After passing through the ROM facility crushing plant, sized coal will be delivered by overland conveyor to the Mt Arthur Coal CHPP. The North Saddlers ROM Facility will be located on previously mined land in the Saddlers Pit area. The stockpile will be within the Mt Arthur Coal water management system and will have no impact on surrounding catchment areas. Sediment and erosion control measures, in accordance with **Section 3.1,** will be implemented at the ROM facility. No additional controls will be required.

3.2.2.3 Hunter River Clean Water Supply Pipeline

It is proposed to construct a new Hunter River extraction pump station near the intersection of Edderton Road and Denman Road. This river extraction pump station would utilise the existing Surface Water Licences held by Mt Arthur Coal (refer to **Section 2.1.3**). The river extraction pump station will be connected to the operations via an approximately 5.5 kilometre long pipeline to the Belmont Water Dam (refer to **Section 3.2.2.1**). The final location and design of this pump station will be determined in consultation with DWE. Approval is also sought to upgrade the existing Hunter River pump station utilised by Mt Arthur Coal.

During the construction period for these facilities sediment and erosion control methods (as outlined in **Section 3.1**) will be used to minimise potential erosion and sediment transportation.

3.2.2.4 CHPP Expansion

All ROM coal from the underground operations will be delivered by conveyor to the existing Mt Arthur Coal CHPP which will require some upgrades to provide sufficient capacity. The upgrade works required to achieve this increased capacity will include:

- increasing the capacity of the existing CHPP. These capacity increases will be achieved by minor changes to the CHPP which are not expected to significantly change the environmental impacts of the facility;
- construction of a new 300,000 tonne raw coal stockpile with a stacker-reclaimer system;
- construction of a new approximately 440,000 tonne product coal stockpile with a stacker-reclaimer system; and
- expansion of the open cut ROM coal stockpile area to cater for approximately 650,000 tonnes of ROM coal.

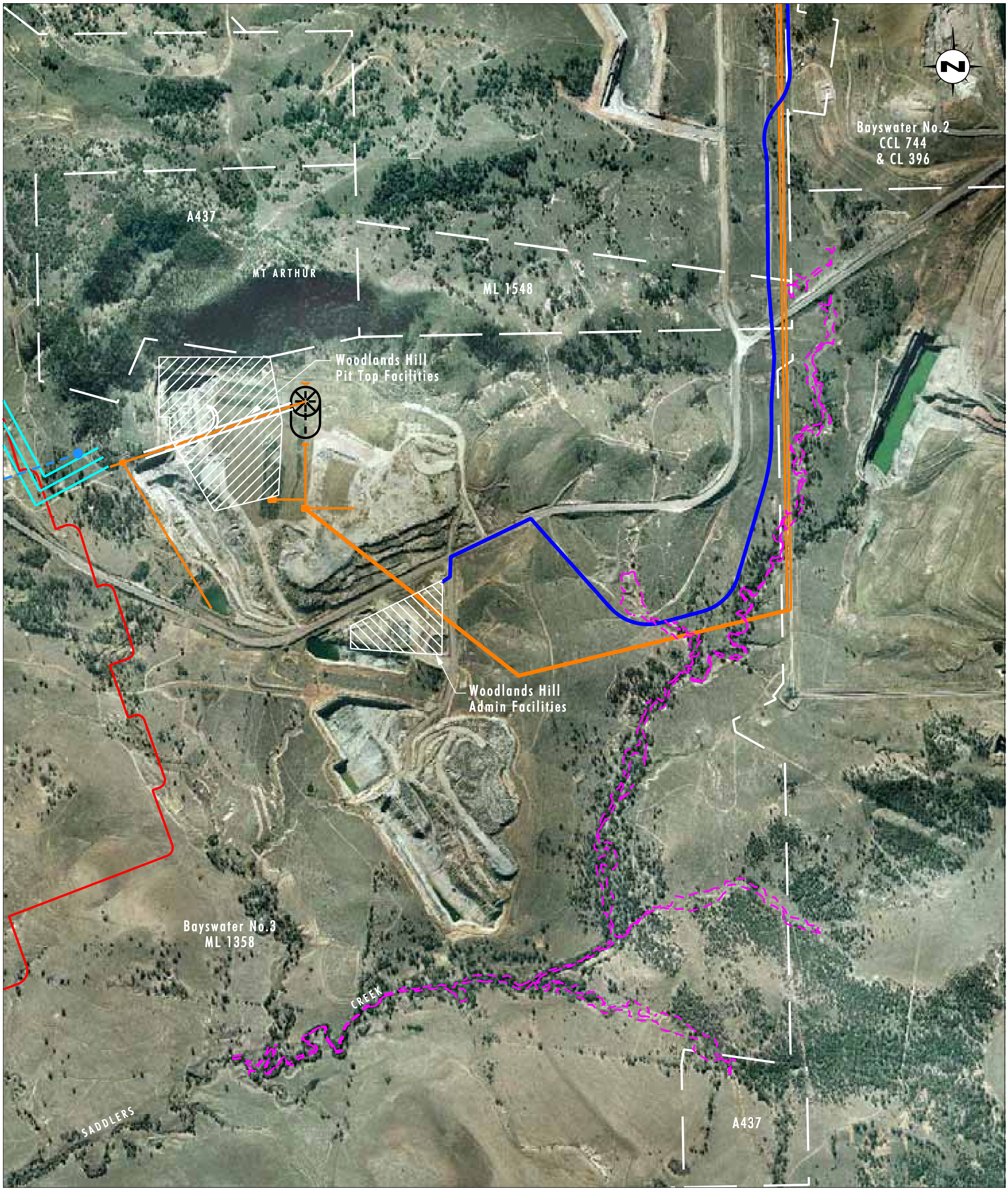
All works required for the construction of the above mentioned facilities will be undertaken on previously disturbed land and form part of the Mt Arthur Coal water management system catchment area.

The runoff from the CHPP area will continue to be captured in the site water management system, treated and reused on site. Existing controls around the CHPP will be used to capture and treat runoff.

3.2.2.5 Access Roads and Services Corridor

A vehicle access road will be constructed from the existing mine access road to the underground mining operations. The access road will be sealed with formalised road batters/retaining systems and drainage infrastructure, including culverts and scour protection.

A service corridor will be located alongside the road. The 100 year ARI storm event flood extent in proximity of the road was determined for Saddlers Creek for the South Pit Extension EA (Umwelt, 2007) (refer to **Figure 3.1**). The tributary (shown on **Figure 3.1**) and its catchment area which the access road crosses will be removed as part of the South Pit



Source: Mt Arthur Coal

0 0.5 1 1.25km
1:25 000

Legend

- Mining and Exploration Lease Boundaries
- Subsidence Affectation Area
- 100 year Storm Event ARI Flood Extent
- Mine Access Road
- Surface Conveyor
- Clean Water Supply

FIGURE 3.1

Saddlers Creek 100 year Storm Event ARI Flood Extent

File Name (A4): R20_V1/2051_315.dgn

Extension Project (Umwelt, 2007). As such, flooding will not occur along this tributary and all services and the access road will be located above the 100 year ARI flood level for Saddlers Creek. The vehicle access road does not cross Saddlers Creek. Water management controls will be constructed for the road in accordance with the Blue Book (Landcom, 2004).

3.2.2.6 Overland Conveyors

An overland conveyor will be constructed as part of the Underground Project to convey ROM coal from the Saddlers Pit ROM facility to the CHPP (refer to **Figure 1.3** and **Figure 3.1**). The conveyor will cross Saddlers Creek in two locations. These crossings will be designed so as to not adversely influence flood levels, flows or velocities in the downstream sections of Saddlers Creek. As shown on **Figure 3.1**, the extent of the 100 year ARI flood level for Saddlers Creek in this area is limited. Water management controls for the conveyor will be constructed for the road in accordance with the Blue Book (Landcom, 2004).

The conveyor and its associated light vehicle road will be designed to minimise impacts on Saddlers Creek and surrounding drainage lines. As part of the conveyor construction a catch tray (or similar) will be installed on the underside of the conveyor where it passes over the creek to ensure that any spillage cannot enter the creek. A sump will be constructed near the creek to recover spillage from the conveyor system.

3.2.2.7 Pit Top Facilities

In and adjacent to both Saddlers and Belmont Pits, a series of buildings containing control rooms, administration staff, bathhouses, stores and workshops will be constructed. All of these facilities will be located within the mine water management system catchment area. Runoff from the roofs and surrounds will be reused on site. Control systems (e.g. hydrocarbon controls) will be placed downslope of key infrastructure and high traffic usage hardstand areas, including workshops to manage runoff prior to it flowing into the mine water management system for reuse.

3.2.2.8 Ancillary Surface Mining Infrastructure

There are a number of ancillary surface mining infrastructure components required to support the proposed underground mining operations. These include:

- ventilation fans;
- service boreholes;
- dewatering boreholes;
- unsealed access roads;
- pumps and drainage works; and
- services, including power and telecommunications.

Each of these infrastructure components will require varying degrees of disturbance to the landform surface. It is proposed that for all works detailed above construction sediment and erosion control plans are developed with the detailed designs. These plans will incorporate the requirements listed in **Section 3.1**.

3.2.2.9 Antiene Rail Spur Passing Lane Extension

The existing passing lane on the Antiene Rail Spur will be extended involving construction of an additional length of rail line adjacent to the existing rail line and within the existing rail corridor. Water management controls will be constructed for the passing lane in accordance with the Blue Book (Landcom, 2004) for both the construction and operational phases.

3.3 Water Management for Subsidence Areas

3.3.1 Existing Catchment Areas and Watercourses

The subsidence affectation area (refer to **Section 1.3**) is located within the catchments of Quarry, Western, Southern, Saddlers and South-east Creeks (refer to **Figure 3.2**) (Note: Some creeks are not named on the topographical maps and have therefore been named for the purposes of this document). Quarry Creek has a catchment area of approximately 2230 hectares and drains in a northerly direction to the Hunter River. Western Creek has a catchment area of approximately 1400 hectares and flows in a westerly direction to the Hunter River. Southern Creek has a catchment area of approximately 780 hectares, flows in a southerly direction and is a tributary of Saddlers Creek. South-east Creek is also a tributary of Saddlers Creek and has a catchment area of approximately 480 hectares. South-east Creek flows in a southerly direction to join Saddlers Creek to the south-east of the subsidence affectation area. Saddlers Creeks flows in a south-west direction and is a tributary of the Hunter River. The catchment area of Saddlers Creek, including the Southern and South-East Creek catchment areas, is approximately 8670 hectares.

The boundaries of the subcatchments are shown on **Figure 3.2** and the subcatchment areas are listed in **Table 3.1**.

Table 3.1 - Catchment Areas

Creek	Total Catchment Area (ha)	Catchment Area within Subsidence Affectation Area (ha)
Quarry Creek	2230	860
Western Creek	1400	150
Southern Creek	780	440
Saddlers Creek	8670	830
South-East Creek	480	170

3.3.1.1 Quarry Creek

Quarry Creek has a catchment area of approximately 2230 hectares, is a third order stream (refer to **Figure 3.3**) and flows in a northerly direction to the Hunter River. Land use within the catchment is predominately grazing with some vineyards and irrigated pasture areas. The catchment is intersected by Denman Road in the north-west and Edderton Road passes through the catchment in the south.

Quarry Creek extends from the edge of the Bayswater No. 3 mining area (refer to **Figure 3.2**) approximately 8.3 kilometres to the north-west to the Hunter River. The north-western section of the Bayswater No. 3 mining lease also forms part of the catchment area. The natural catchment area of Quarry Creek has been reduced by the development of open cut mining pits in the upper catchment area (refer to **Figure 3.2**). There is one major dam located along the creek approximately 1.3 kilometres downstream of the subsidence

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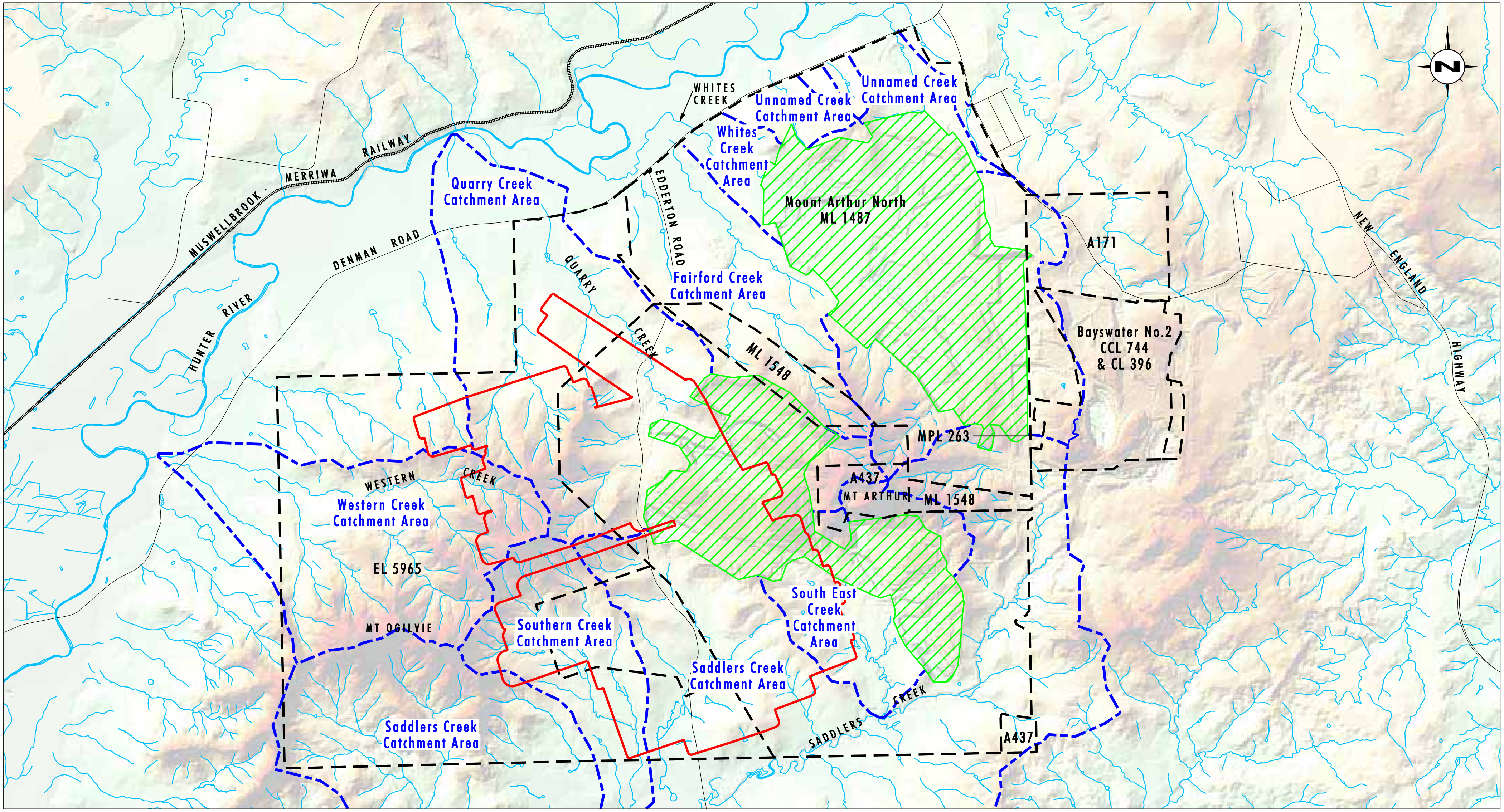


Source: Mt Arthur Coal, LPI NSW

0 1 2 4km
1:90 000

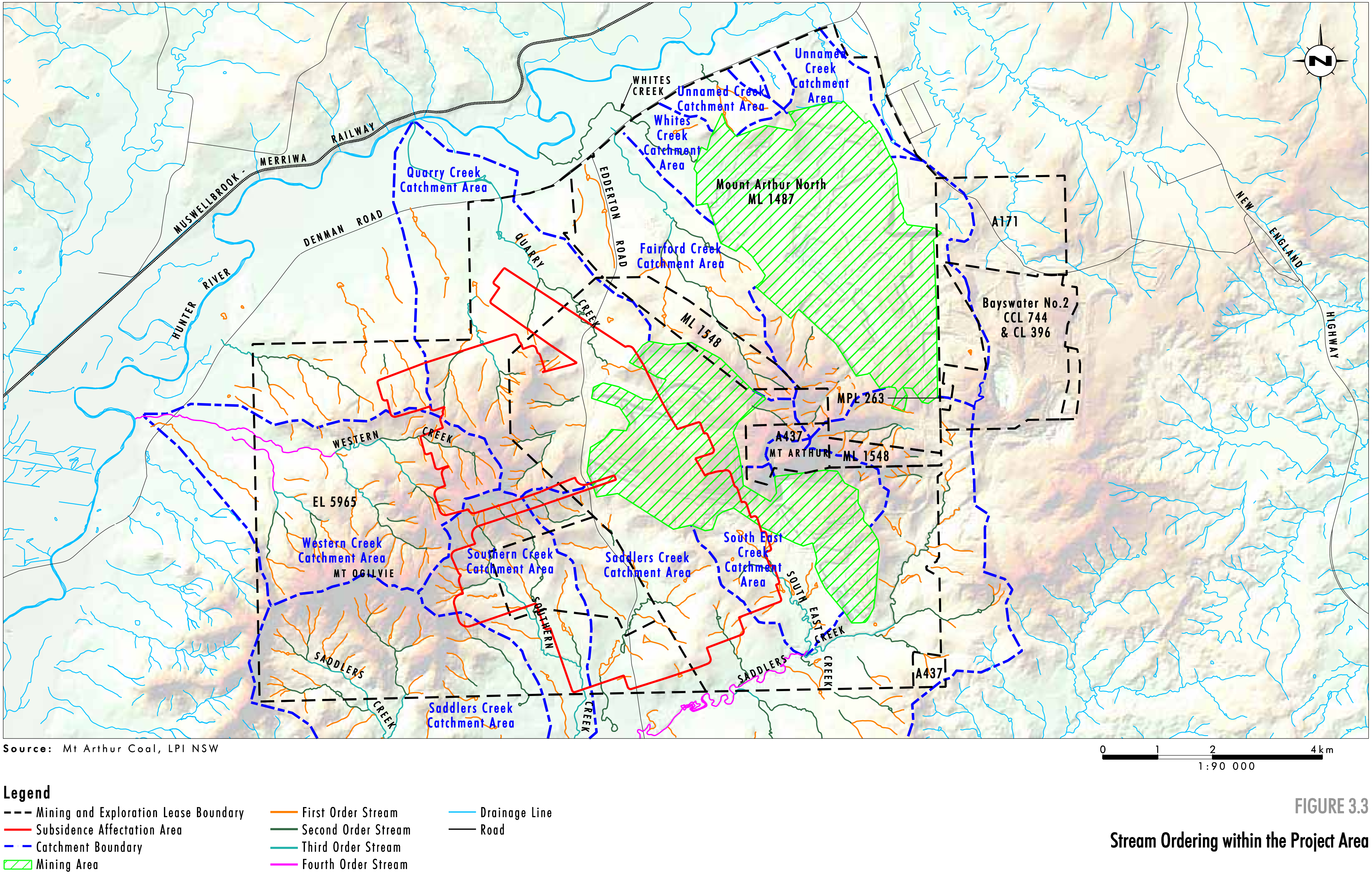
Legend

- Mining and Exploration Lease Boundary
- Subsidence Affectation Area
- Catchment Boundary
- Mining Area
- Drainage Lines
- Drainage Line
- Road

FIGURE 3.2

Subcatchment Areas

File Name (A4): R20_V1/2051_193.dgn



Source: Mt Arthur Coal, LPI NSW

FIGURE 3.3

Stream Ordering within the Project Area

affectation area. This dam is located adjacent to Roxburgh Vineyard. The dam releases water downstream via Quarry Creek to the Hunter River. There are numerous harvestable rights dams located within the catchment area.

The catchment has slopes varying from 0.7 per cent to 3 per cent in the north-west to 29 per cent in the south.

Quarry Creek is an ephemeral creek system with flows only occurring in the creek during storm events or after prolonged periods of heavy rain. Generally the creek system experiences very low flows, with some pools of permanent or semi-permanent water present in the downstream reaches. Based on site inspection and aerial photograph interpretation, the creek appears to be generally in poor condition with erosion of the creek bed and banks and the majority of riparian vegetation being cleared. There are isolated sparse pockets of riparian vegetation along the creek banks.

Two soil landscape units occur in the catchment area based on soil landscape mapping completed for the Singleton 1:250,000 Soil Landscapes Map sheet (digital mapping provided by Department of Natural Resources (DNR), 2005) and described in Kovac and Lowrie (1991) (refer to **Figure 3.4**). These landscapes include:

- Liddell Soil Landscape which is dominant over the subsidence affectation area, occurring over undulating terrain; and

- Bayswater Soil Landscape occurring in the northern and southern portions of the subsidence affectation area, associated with drainage lines.

In the Quarry Creek catchment area, the Liddell Soil Landscape occurs over most of the subsidence affectation area and typically comprises Yellow Soloths with Yellow Solodic Soils on the upper slopes. Earthy and Silicious Sands occur on lower slopes with silicious parent rock. The topsoil ranges from brown sand to brown loam, while the different subsoils may include sandy clay, light clay, sandy loam and loamy sand. The depth to bedrock typically ranges from 50 centimetres to 110 centimetres. The soils of the Liddell Soil Landscape are susceptible to minor to severe sheet erosion and minor levels of rill erosion. In drainage lines moderate levels of gully erosion up to 1.5 metres depth can occur and leaching of salts may occur. The Soloths and Solodic soils characteristically have a higher erodibility (moderate to high) than that of the Sands (low). Similarly, soil salinity is higher for the Soloths and Solodic soils (high) in comparison to the Sands (low). The soil types within this soil landscape have low fertility, are poorly to well drained and have a low to moderate available water holding capacity. Typical soil pH ranges between 6.0 to 6.5 and mass movement hazard is low (Kovac and Lowrie, 1991).

The Bayswater Soil Landscape occurs along the main channel of the creek. Soil types present on slopes within this landscape include Yellow Solodic Soils as well as Red, Yellow and Brown Podzolic Soils. Within the drainage lines, soil types include Alluvial Soils and Brown and Yellow Earths. Also present are Yellow Solodic Soils with Red-brown Earth intergrades. The depth to bedrock varies between 40 centimetres to 300 centimetres. The topsoil within this landscape is variable between the different soil types, however, it is commonly described as sandy clay loam. Slopes occurring within the Bayswater soil landscape commonly experience moderate levels of sheet and gully erosion. Yellow Solodic Soils are highly erodible and as such these soils are often associated with gullies up to three metres deep. The soils within this landscape are described as having a moderate to high erodibility of both the top-soil and sub-soil. Mass movement hazards are low. Salinity of the different soil types within this landscape vary markedly, ranging from high to low. The fertility of all soil types is low and the pH generally ranges between 5.5 and 6.5, although the sub-

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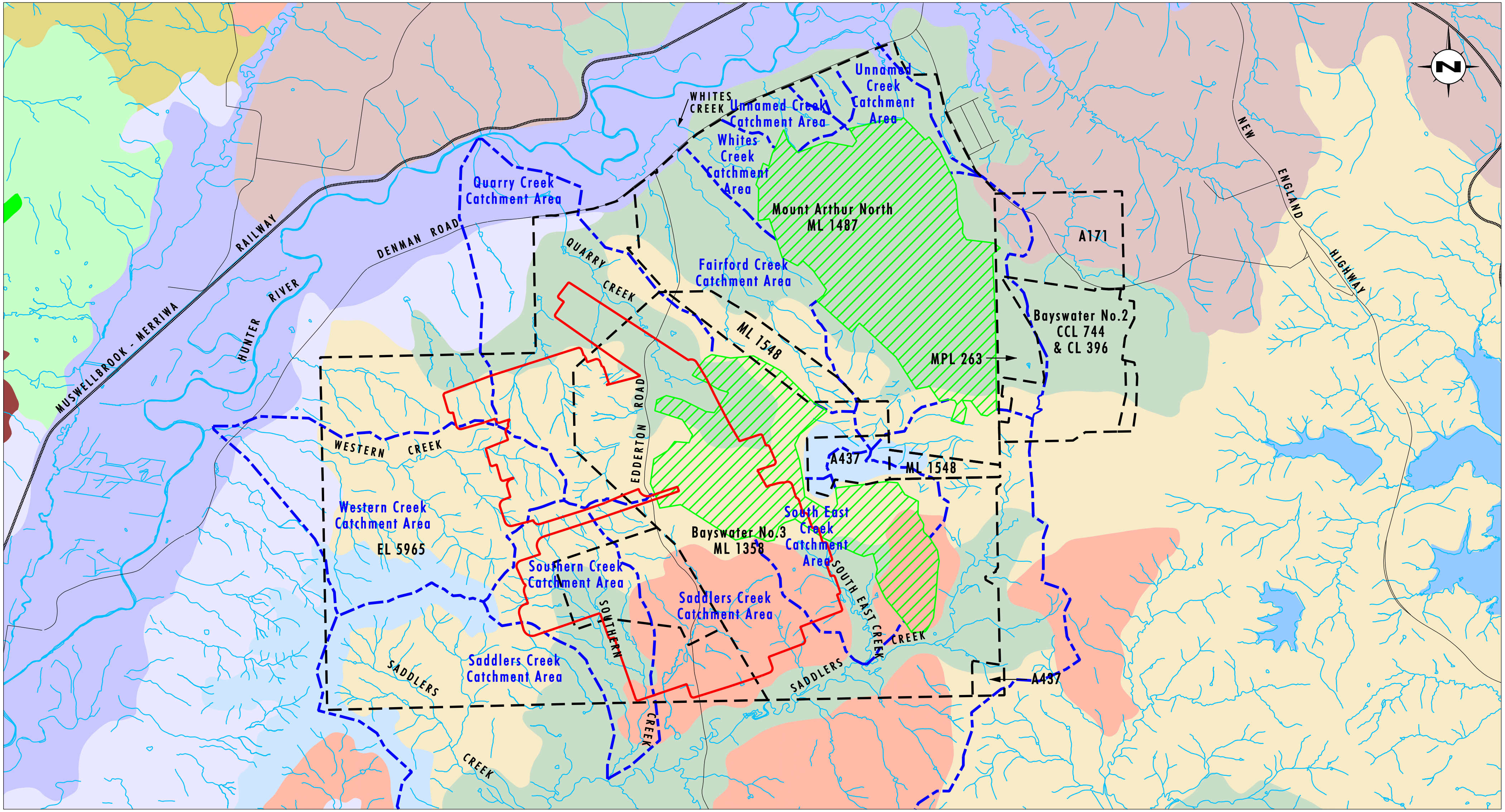

Source: Mt Arthur Coal, Department of Natural Resources
Base Source: LPI NSW

0 1 2.5 5km
1:100 000

Legend

- Mining and Exploration Lease Boundary
- Subsidence Affectation Area
- Catchment Boundary
- Mining Area
- Hunter Soil Landscape
- Roxburgh Soil landscape
- Dartbrook Soil Landscape
- Sandy Hollow Soil Landscape
- Castle Rock Soil Landscape
- Brays Hill Soil Landscape
- Lees Pinch Soil Landscape
- Growee Soil Landscape
- Bayswater Soil Landscape
- Liddell Soil Landscape
- Ogilive Soil Landscape
- Water
- Drainage Line
- Road

FIGURE 3.4

Soil Landscape Map

File Name (A4): R20_V1/2051_216.dgn

soil of the Yellow Solodic soils may have a pH up to 9.5. The soils are typically well drained, with permeability described as moderate (Kovac and Lowrie, 1991).

Approximately 860 hectares (39 per cent) of the catchment area of Quarry Creek lies within the subsidence affectation area. This area is predominately grazing pastures. The progressive stream ordering of Quarry Creek and its tributaries within the subsidence affectation area are shown on **Figure 3.3**.

3.3.1.2 Western Creek

Western Creek has a catchment area of approximately 1400 hectares, is a fourth order stream and flows in a westerly direction into the Hunter River. Land use within the catchment consists primarily of grazing pastures (refer to **Figure 3.2**). The catchment is intersected by Denman Road in the west.

Western Creek extends from approximately 800 metres west of the Bayswater No. 3 mining lease boundary approximately 7.1 kilometres in a westerly direction to its confluence with the Hunter River (refer to **Figure 3.2**). The catchment area covers the central western section of EL 5965. There are numerous harvestable rights dams located within the catchment area.

The catchment area has slopes ranging from 1.2 per cent to 6 per cent in the north-west to 10 per cent to 45 per cent in the south-east, approaching Mt Ogilvie.

Western Creek is an ephemeral creek system with flows only occurring in the creek during storm events or after prolonged periods of heavy rain. Generally the creek system experiences very low flows, with some pools of permanent or semi-permanent water present in the downstream reaches. Based on site inspection and aerial photograph interpretation, the creek appears to be generally in poor condition with erosion of the creek bed and banks and the majority of riparian vegetation being cleared. Western Creek has sections with thin riparian vegetation, however the majority of the tributaries are cleared grazing land. The catchment area also shows signs of erosion with earth contour banks being constructed on the hills adjacent to the creek to control and assist in the remediation/prevention of surface erosion. The upstream sections of the creek appear to be generally in good condition, however, there are signs of significant gully erosion of the banks and tributaries in the middle to lower reaches.

One soil landscape type has been identified in Western Creek catchment within the subsidence affectation area based on the Singleton 1:250,000 Soil Landscapes Map sheet (digital mapping provided by DNR, 2005) (refer to **Figure 3.4**). This soil landscape is the Liddell Soil Landscape. The soils of the Liddell Soil Landscape are described by Kovac and Lowrie (1991) and are susceptible to minor to severe sheet erosion and minor levels of rill erosion, with the presence of drainage lines potentially leading to moderate levels of gully erosion up to 1.5 metres depth as well as leaching of salts. The soil types within this soil landscape have a low fertility, are poorly to well drained and have a low to moderate available water holding capacity. Typical soil pH is between 6.0 and 6.5 and mass movement hazard is low. A more detailed description of this soil landscape is included in **Section 3.3.1.1**.

Approximately 150 hectares (11 per cent) of the catchment area of Western Creek lies within the subsidence affectation area.

3.3.1.3 Southern Creek

Southern Creek has a catchment area of approximately 780 hectares, is a third order stream (refer to **Figure 3.3**) and flows in a southerly direction into Saddlers Creek. Land use within the catchment is primarily grazing pasture.

Southern Creek extends from the central portion of the EL approximately 4.5 kilometres to the south flowing into Saddlers Creek. The catchment area covers the south-eastern section of EL 5965. There are numerous harvestable rights dams located within the catchment area.

The catchment area has slopes ranging from 1 per cent to 4 per cent in the south to 20 per cent to 46 per cent in the north, near Mt Ogilvie.

Southern Creek is an ephemeral creek which shows signs of erosion along its entire length, with more prominent gully erosion on the minor tributaries in the lower reaches. There are no significant areas of riparian vegetation along the creek.

Three soil landscapes have been identified within the Southern Creek catchment area of the subsidence affectation area (refer to **Figure 3.4**). The Liddell Soil Landscape is present in the upstream sections of the catchment, the Bayswater Soil Landscape is present in the middle sections (refer to **Section 3.3.1.1** for detailed descriptions) and the Brays Hill Soil Landscape is present at the downstream section of the catchment.

The Brays Hill Soil Landscape, as described by Kovac and Lowrie (1991) typically occurs over undulating hills to the west of Muswellbrook, with Red Clays the predominant soil type in mid to upper slopes, while the mid to lower slopes may have Black Earths, Grey Clays and Brown Clays present. The lower slopes are characterised by the Yellow (orange) Solodic Soils, while Alluvial Soils occur in the drainage depressions. The topsoil and sub-soils are highly variable between these soil types, but typically there is a strong clay component. The depth to bedrock ranges between 35 centimetres and 120 centimetres. Soil erodibility is generally low to moderate, however the Yellow (orange) Solodic Soils have a moderate (subsoil) to high (topsoil) erodibility. Minor sheet erosion may result after land clearing, while drainage lines may experience moderate gullying. Minor rilling may occur in depressions where the Red and Grey Clays are present. Mass movement hazards are moderate to low. pH varies between 6.0 and 9.0 and salinity is typically low, except for the Yellow (orange) Solodic Soils where it is high. The soils have generally high fertility except for the Yellow (orange) Solodic Soils which have low fertility. The soils are moderately to highly permeable and have a low to moderate available water holding capacity.

Approximately 440 hectares (57 per cent) of the catchment area of Southern Creek lies within the subsidence affectation area.

3.3.1.4 Saddlers Creek

Saddlers Creek has a catchment area of approximately 8670 hectares (including the subcatchments of Southern and South-East Creeks), is a fourth order stream and drains in a south-westerly direction into the Hunter River (refer to **Figures 3.2** and **3.3**). Land use within the catchment area is primarily grazing pastures and mining (upper catchment).

Saddlers Creek extends from approximately 180 metres south of the MAN open cut mining area south-west for approximately 18 kilometres to its confluence with the Hunter River. There is one major dam on the creek. This dam is located immediately upstream of Edderton Road. In addition, there are numerous harvestable rights dams located within the catchment area.

The catchment area has slopes ranging from 2 per cent to 11 per cent in the south to 15 per cent to 31 per cent in the north, towards Mt Ogilvie.

Saddlers Creek is an ephemeral creek system with flows only occurring in the creek during storm events or after prolonged periods of heavy rain although minor groundwater inflow contributes to maintenance of pools within the creek. Generally the creek system experiences very low flows, with some pools of permanent or semi-permanent water present in the downstream reaches. The creek has significant areas with riparian vegetation. There are significant erosion scarps along sections of the main creek banks and significant erosion of some of the creek's tributaries.

The soil types present in the Saddlers Creek catchment within the subsidence affectation area are dominated by the Brays Hill Soil landscape, with the Bayswater Soil Landscape present along the main channel of the creek (refer to **Figure 3.4**). These soil landscapes are susceptible to sheet and gully erosion and experience a low likelihood of mass movement. These soil landscapes are described in more detail in **Sections 3.3.1.1** and **3.3.1.3** and shown on **Figure 3.4**.

Approximately 830 hectares (10 per cent) of the catchment area of Saddlers Creek lies within the subsidence affectation area.

3.3.1.5 South-east Creek

South-east Creek has a catchment area of approximately 480 hectares, is a third order stream, with numerous first order tributaries and two second order tributaries. The creek flows in a southerly direction to Saddlers Creek (refer to **Figures 3.2** and **3.3**). Land use within catchment area is primarily agricultural pastoral lands with some mine support infrastructure and access roads present.

South-east Creek extends from the current Saddlers Pit boundary approximately 3.1 kilometres to the south-east to its confluence with Saddlers Creek. The catchment area covers the central section of the Bayswater No. 3 mining lease and has been substantially modified with the Saddlers Pit located in the upper reaches of the catchment area. There are numerous harvestable rights dams located within the catchment area. Part of the catchment area has been removed by mining and further open cut mining is approved and planned for this area.

The slopes within the catchment area range from 3 per cent to 11 per cent in the south to 6 per cent to 15 per cent in the north-east.

South-east creek is an ephemeral creek which is generally in good condition with signs of only minor erosion in the upper and lower reaches. Downstream of the subsidence affectation area the creek has limited amounts of riparian vegetation near its confluence with Saddlers Creek.

Three soil landscapes have been identified in this subcatchment within the subsidence affectation area, with the Brays Hill Soil Landscape dominating the site, the Bayswater Soil Landscape found lining the main creek channel, and the Liddell Soil Landscape present in the north-east of the subcatchment near Mt Arthur (refer to **Figure 3.4**). Soil landscape mapping identifies that all soil types are susceptible to sheet and gully erosion (Kovac and Lowrie, 1991).

Approximately 170 hectares (35 per cent) of the catchment area of South-east Creek lies within the subsidence affectation area.

3.3.2 Predicted Subsidence Impacts

Subsidence predictions for the proposed project and the potential range of impacts resulting from subsidence have been documented by Mine Subsidence Engineering Consultants (MSEC) (2007) (refer to Appendix 5 of the EA). These predictions have been used in determining the potential impact of the proposed underground mining operation on the surface drainage regime of the area. The predictions have also been used in determining management and mitigation measures that are to be implemented as part of the proposed project. **Sections 3.3.3** to **3.3.5** discuss the potential impacts of underground mining on surface water drainage and detail the proposed mitigation measures to be implemented. The different mechanisms of subsidence are discussed further below.

Longwall mining typically results in subsidence bowls forming on the surface. These subsidence bowls typically form a continuous relatively smooth landform on the surface, with resulting changes to grades and elevations. In a subsided landform there will also be areas on the surface of compression (above the centre of the longwall panel) and tension (at the edges of the longwall panel). At the areas of tension surface cracking may occur.

In areas to be undermined with low depths of cover, the continuous relatively smooth subsided landform, as described above, does not always occur. In these areas underground mining has the potential to result in irregular subsidence profiles where the collapsed zone extends to the surface. It is considered for this project that where the depth of cover is less than 100 metres (refer to **Figure 3.5**) the collapsed zone may extend to the surface and the subsidence profile may become irregular, resulting in bumps and steps at the surface (MSEC, 2007). This effect will be most pronounced in areas with less than 50 metres depth of cover (refer to **Figure 3.5**). These bumps and steps will also be accompanied by higher strains and potentially result in interconnective cracking.

Interconnective cracking occurs when the strata overlying the coal seam is cracked sufficiently to connect to the surface. When this occurs surface runoff may be provided with a flowpath from the surface to the underground mining operation. The result is potential capture of surface flows into the underground mining operation. Again, this impact is most pronounced in areas with less than 50 metres depth of cover where the most significant interconnective cracking is predicted (refer to **Figure 3.5**).

3.3.3 Topographic and Catchment Changes

Analysis of subsidence predictions (MSEC, 2007) indicates that the proposed multi-seam mining, although resulting in cumulative subsidence of up to approximately 5.7 metres in some areas, will not significantly alter the catchment boundaries from those that currently exist as shown on **Figure 3.2**.

3.3.4 Farm Dams, Roads and Culverts

The proposed area to be undermined is primarily used for grazing. Associated with this are a number of public roads, farm dams and access tracks. This infrastructure has the potential to be impacted upon as a result of the subsidence from the proposed underground mining.

There is one major road (Edderton Road), 32 culverts and 92 farms dams (primarily owned by Mt Arthur Coal) located within the subsidence affectation area (refer to **Figure 3.5**).

Analysis has been undertaken of the likely impacts on the drainage of this existing infrastructure during the life of the project. This analysis indicates that remediation works may include:

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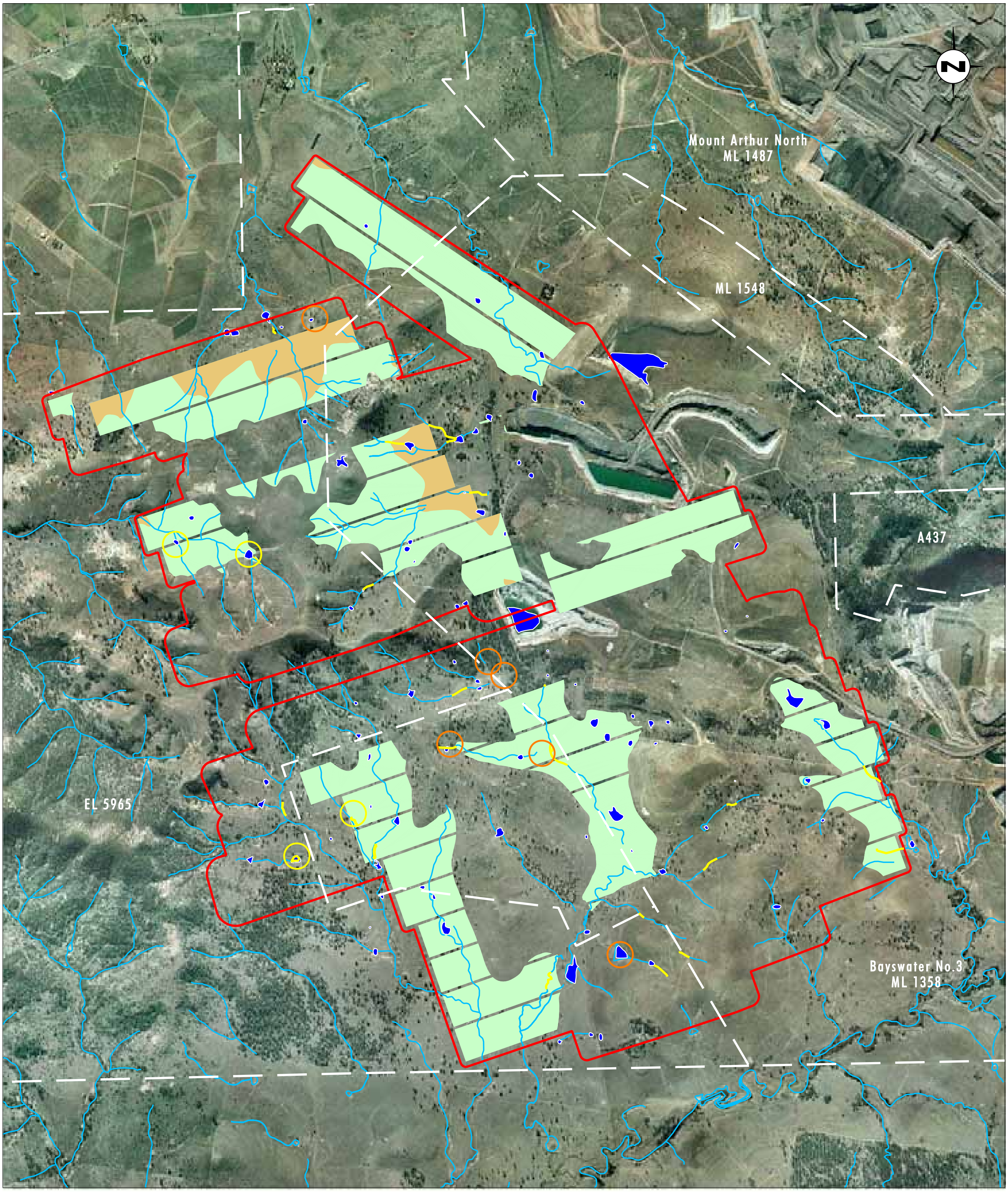


Source: Mt Arthur Coal, 2006 and MSEC 2007

0 0.5 1 2km
1:45 000

Legend

- Mining and Exploration Lease Boundary
- Subsidence Affectation Area
- Area <100m Depth of Cover
- Area <50m Depth of Cover
- Mt Arthur Coal Owned Farm Dams Potentially Requiring Spillway Works
- Privately Owned Farm Dams Potentially Requiring Spillway Works
- Areas with Potential Changes to Drainage
- Dam
- Drainage Line

FIGURE 3.5

Indicative Surface Impact Areas

File Name (A4): R20_V1/2051_286.dgn

- reshaping of farm dam embankments; and
- works as required to ensure that drainage is maintained at all roads, access tracks and culverts.

Reconstruction of roads, access tracks and culverts and reshaping of dams is addressed in detail in the subsidence assessment (refer to Appendix 5 of the EA) (MSEC, 2007).

Figure 3.5 shows the farm dams that may require reshaping of spillways and embankments to ensure current drainage paths are maintained based on the subsidence predictions.

3.3.5 Drainage Lines

3.3.5.1 Surface Mitigation and Remediation Works

There are numerous drainage lines proposed to be undermined during the 21 year mine life (refer to **Figure 3.5**). These drainage lines range from first order to third order tributaries and form part of the subcatchment areas described in **Section 3.3.1**. As indicated on **Figure 3.3**, the majority of drainage lines occurring within the subsidence affectation area are first and second order.

The soil characteristics of the subsidence affectation area along the creeklines are typically shallow (ranging from 40 centimetres to 110 centimetres to bedrock), susceptible to minor to severe sheet erosion and minor levels of rill erosion. The soils typically have low fertility.

The majority of the drainage lines in the subsidence affectation area are currently in poor condition and show signs of erosion. In places the creek banks are deeply incised (up to three metres). The soil characteristics and site inspections indicate that the creek lines are all subject to erosion with the potential for erosion being significantly increased when the vegetative cover is removed.

Modelling of a typical drainage line located in the Quarry Creek catchment area (considered to be representative of drainage lines within the subsidence affectation area) indicates that the drainage lines are typically subject to velocities in the range of 1.0 m/s to 2.8 m/s during major storm events. These velocities are typically non-scouring in vegetated channels. However, as indicated by field inspection when the vegetative cover is removed some scouring and erosion will occur.

All of the drainage lines within the subsidence affectation area have either limited or no riparian vegetation. Where riparian vegetation is present this vegetation is either thin or located in isolated pockets along each drainage line.

The predicted subsidence has the potential to result in increased in channel ponding and out of channel ponding along the drainage lines. Analysis indicates that the majority of any ponding that may occur will be in channel and to depths ranging up to 300 millimetres. This is due to the steepness of the existing landform and channel geometry. Analysis indicates that there are limited areas where the predicted continuous subsidence profiles may result in out of channel ponding. In these areas works may be required to ensure that out-of-channel ponding does not occur. These works will need to maintain channel grades and take into consideration channel stabilities and existing channel characteristics.

In areas where the depth of cover is less than 100 metres it is considered that there is a high potential for interconnective cracking and irregular subsidence to occur. In areas where cracking occurs, remediation works (e.g. tilling) will be undertaken to close the cracks at the surface and as such limit potential ingress of surface runoff into the proposed underground mining operations. Based on the conceptual longwall layout shown on **Figures 1.3** and **1.4**, the areas that will potentially require surface works to remediate interconnective cracking, steep grades and out of channel ponding are shown on **Figure 3.5** and include all drainage lines within areas of less than 100 metres depth of cover.

In areas where irregular subsidence occurs the landform will need to be smoothed to ensure that it is free draining. The smoothed landform will be established by reshaping into the existing and post-mining landform slope characteristics.

Subsidence remediation works will result in ground disturbance and will reduce vegetative cover in the short term. As discussed above, this has the potential to result in erosion. Sediment and erosion controls will be implemented for all remediation works as described in **Section 3.1** to effectively manage these potential impacts.

3.3.5.2 Proposed Remediation Protocols

Due to the expanse of the subsidence affectation area and the range of variables influencing the potential surface water impacts and potential works areas (refer to **Figure 3.5**) it is proposed to implement and refine monitoring and remediation protocols as part of the Subsidence Management Plan process throughout the life of the project to ensure that surface water impacts are minimised. An outline of the proposed remediation protocol is included below.

The required controls and protocols will utilise standard erosion and sediment control techniques to manage surface water during remediation (refer to **Section 3.1**).

Underground mining is proposed to commence in the northern most panels of the Woodlands Hill Seam (refer to **Figure 1.3**). These panels are located in the upper reaches of the Southern and Saddlers Creek sub-catchment areas. These longwall panels will cross three second order tributaries and two first order tributaries. All of these tributaries have depths of cover less than 100 metres to the Woodlands Hill seam. These longwall panels have upstream catchment areas of 220 hectares and 180 hectares in the Southern and Saddlers Creek sub-catchment areas respectively. Typical maximum runoff rates from these catchment areas have been calculated using the Rational Method (Institution of Engineers (IEAust), 1987) for a 1 year ARI storm event to be in the order of 1.50 m^3/s to 1.70 m^3/s respectively. The land to be undermined by these two longwalls is owned by Mt Arthur Coal.

Due to the low depth of cover above these two longwalls it is considered that irregular surface profiles and interconnective cracking may occur after mining of these two longwalls. Similarly due to the steepness of the catchment areas (5 per cent to 22 per cent), extent of potential works areas (refer to **Figure 3.5**) and surrounding topography it is not considered practical to divert runoff from upstream catchment areas around the potential works areas. As such it is proposed that all remediation works are managed in stream. This situation is considered typical of the majority of the drainage lines within the project area.

It is proposed to refine and implement procedures as part of the Subsidence Management Plan process to manage the drainage line remedial works after subsidence has occurred. These procedures will include:

- preparation of guidelines for the remediation of potential worst case subsidence failure – i.e. block/step failure or continuous landform. This will depend on the depth of cover, geological stratigraphy and will need to consider:
    - regrading block edges to a maximum of 1:6 dependent on existing landform, channel characteristics and soil stability (vertical: horizontal batter slopes);

  - ensuring a free draining landform;
  - ensuring slopes are of suitable grades to reduce erosion potential; and
  - future longwall mining in downslope areas and in future seam extraction;

- subsidence monitoring as determined in consultation with the Department of Primary Industries (DPI) as part of the subsidence management plan process. The monitoring regime will consider relevant factors such as depth of cover (e.g. areas with less than 100 metres depth of cover);
- monitoring of surface cracking and equipment held ready for prompt and fast remediation of surface cracking;
- management of surface water runoff post mining until completion of remediation. The volumes of runoff likely to be encountered in a rainfall event and how to control this water will need to be considered. This may include temporary sealing of cracks, using upstream coffer dams to contain/control runoff over the area being remediated and/or conveyance of flows through/past the remediation area;
- sediment and erosion controls;
- treatment of soils with gypsum, if required, to reduce dispersibility;
- revegetation techniques and maintenance; and
- construction of sediment dams/controls downstream of disturbed areas to collect sediment.

3.3.5.3 Contingency Measures

In areas where block/step failure may occur, it is likely that substantial drainage works will be required. In these areas there is a high probability of both in and out of channel ponding to occur. Major reshaping works within the drainage channels are likely to be required. These works will be undertaken to remove the likelihood of stream capture, out of channel ponding and potential for scouring/head cut to occur at the upstream and downstream boundaries of the block/step failure zone.

As discussed in **Section 3.3.5.2**, remediation protocols will be implemented to address subsidence remediation works relating to drainage systems. In areas of low depths of cover that may be subject to block/step failure (i.e. <50 metres cover) additional contingency measures will be implemented. These may include measures such as:

- an increased monitoring frequency so that any areas of block/step failure are identified shortly after occurring;
- ensuring that suitable earthworks equipment is available on site for timely repair of any significant impact areas; and
- reviewing on a regular basis the drainage controls in place (e.g. temporary upstream dams) to identify and repair works or further controls required.

3.3.6 Potential Impact on Downstream Water Users

Land use surrounding the project area is primarily mining and grazing but also includes irrigated pasture/fodder crops, residential/rural residential, horse studs, dairies, vineyards and olive groves.

Any surface water licences within the vicinity of the project area not accessing the Hunter Regulated River Water Source are currently managed under the *Water Act 1912*. Correspondence with the then DNR (P Clarke, 28 July 2006 pers. comm.) indicated that access to Surface Water Licence information registered under the *Water Act 1912* are subject to privacy laws and as such were not able to be supplied for the purposes of this assessment.

Groundwater is extracted at several locations in and around the project area to support the aforementioned land uses. Groundwater licences are discussed in Appendix 10 of the EA.

A review of land ownership indicates that the drainage lines downstream of the proposed underground mining area to their confluences with the Hunter River are primarily owned by Mt Arthur Coal or Drayton. It is estimated that the total areas to be undermined, with privately owned land downstream, include approximately 150 hectares (approximately 11 per cent) of the Western Creek catchment area, approximately 860 hectares (approximately 38 per cent) of the Quarry Creek catchment area and approximately 830 hectares (approximately 10 per cent) of the Saddlers Creek catchment area. There is some potential that during the time between mining and completion of surface cracking remediation works that some minor stream capture may occur during rainfall events. As such there is potential to influence the volume of runoff available for harvestable rights at downstream properties. However, this potential is limited as the catchment areas upstream of the initial mining areas are small, sequential mining will affect only short sections (< 300 metres) of creek at any time and only a proportion of the water flowing along the drainage lines during storm events would be lost due to subsidence cracking.

As any cracking will appear very rapidly on the surface after longwall mining, regular checking and resealing of in channel cracks will be undertaken. These progressive resealing works will significantly reduce the potential for loss of surface flows due to subsidence cracking.

4.0 Water Balance

The water balance for the Mt Arthur Coal existing approved operations (including the MAN and Bayswater mining areas) has been estimated based on information regarding site water demands and sources provided by Mt Arthur Coal and on information about future development of open cut operations contained in the MAN EIS (URS, 2000) and proposed South Pit Extension EA (Umwelt, 2007).

To explore the water balance for Mt Arthur Coal, a water balance model has been configured to replicate the existing mining and coal handling characteristics, as detailed in **Section 2.0**. This model has been setup to be able to model current and future mining operations and associated water balances (refer to **Appendix 1**).

Using the current and predicted water supply and demands for the current operations (including the proposed South Pit Extension (Umwelt, 2007)) and the proposed Underground Project a preliminary water balance was determined for a range of meteorological conditions. The preliminary water balance was developed to identify the potential changes in water surplus and deficit periods.

Water balance conditions for future operations, for both the existing approved operations (including the South Pit Extension) and the existing approved operations combined with the proposed Underground Project were then modelled for select years that define the changing site water balance. This analysis was undertaken using daily rainfall and evaporation data for Scone for the 34 year period from 1973 to 2006 (refer to **Appendix 1**). Scone is the closest meteorological station that has a significant record of rainfall and evaporation data (refer to **Figure 4.1**). The modelling does not take into account any additional water that is imported to the site, with this being tracked separately, but allows for water importation to be taken into consideration when assessing water deficits.

The model outputs were used to develop a relationship between annual rainfall and the predicted net water surplus/demand for the mine (refer to **Appendix 1**). These relationships were then used to refine the preliminary water balance.

Scone daily rainfall and evaporation data is only available for the last 34 years. Comparison with Denman rainfall data indicates that Denman and Scone rainfall characteristics since 1973 are similar (refer to **Appendix 1**). There is no evaporation data available for Denman. Analysis of the Denman rainfall record which dates back to 1894, indicates that the period since 1973 has experienced higher average annual rainfall than the period 1894 to present.

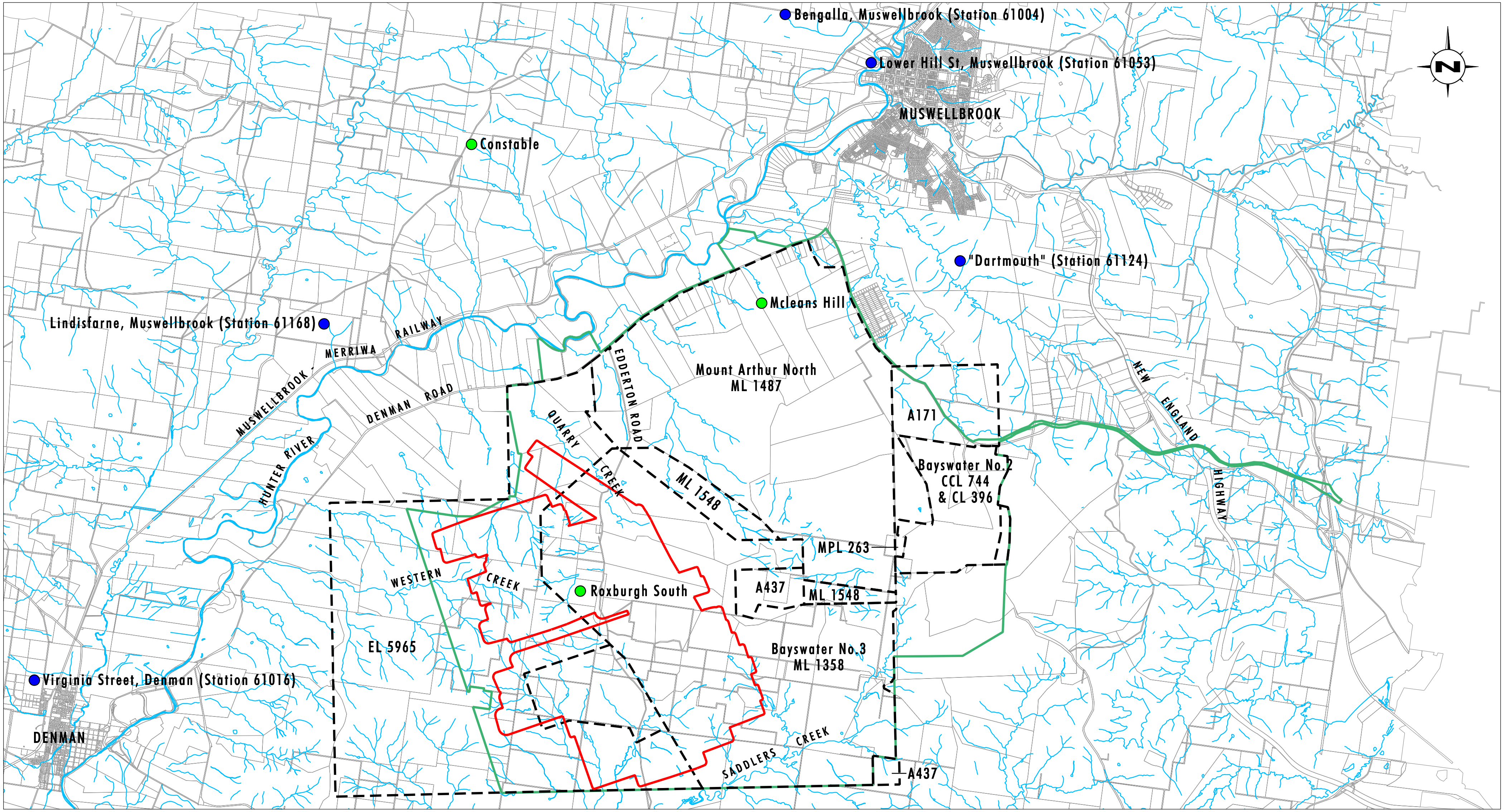
To take this into account, a Net Water Demand versus Annual Rainfall relationship has been developed. This relationship has been used to determine the net water surplus/demand at the mine and to explore the impact of rainfall variability over the available 113 years of Denman rainfall data. The results of this analysis are shown in **Appendix 1**.

4.1 Topographical, Catchment and Water Storage Data

Base topographic information for the Mt Arthur Coal site as shown on **Figure 2.1** was derived from three dimensional digital terrain information of the site (as of June 2006) which was provided by Mt Arthur Coal.

External and internal catchment boundaries were determined using the above topographic data and aerial photography and information about future development stages of the open cut operations based on the MAN EIS (URS, 2000) and the proposed South Pit Extension

Umwelt
Environmental Consultants



Source: BOM, 2004
Base Source: LPI NSW

Legend

- Mining and Exploration Lease Boundary
- Project Application Boundary
- Subsidence Affectation Area
- Mt Arthur Station
- BOM Station

FIGURE 4.1

Location of Rainfall Stations

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(Umwelt, 2007). A comparison of the topographical information and the MAN EIS (URS, 2000) indicates that the current MAN pit development is close to Year 7 of the EIS predictions.

As approved open cut mining progresses, changes to the topography through future open cut mining and associated reshaping and rehabilitating of the mined areas will result in changes in catchment areas. This will result in changes in the volume of water that is captured in the mine water management system. The planned changes to the mine water management system catchment area are based on the approved mining operations for MAN and Bayswater, and the proposed South Pit Extension (Umwelt, 2007). These changes are listed in **Table 4.1** for key stages of the preliminary water balance assessment.

Table 4.1 - Mine Water Management System Catchment Area for Existing and Future Mining Stages

Calendar Year	Underground Project Year	Mine Water Management System Catchment Area (ha)
2005	-4	1860
2009	1	2510
2011	3	2700
2022	14	3060
2026	18	2150

As shown in **Table 4.1**, the catchment area of the mine water management system is planned to increase from approximately 1860 hectares to a maximum of 3060 hectares in 2022. Modelled reductions in the catchment area of the mine water management system between 2022 and 2026 are due to completion and rehabilitation of approved open cut mining at MAN.

The catchment area of the mine water management system will reduce significantly at the end of the existing open cut mining operations assuming that they cease at the end of their current approvals (including proposed South Pit Extension (Umwelt, 2007)). This will result in the total catchment area of the mine water management system with the Underground Project during 2028 and 2029 being approximately 1630 hectares.

The proposed Underground Project will not directly result in changes to the catchment area of the mine water management system.

Dam and storage areas identified in **Table 2.3** have been used in the water balance assessment.

As part of the Underground Project two new water storage dams will be built on site. These are the Belmont Pit Dam and the Saddlers Pit Dirty Water Dam. These dams will have a combined storage volume of approximately 360 ML and surface area of approximately 17 hectares. As such the evaporative area of site water storages will increase from approximately 35 hectares to approximately 52 hectares as a result of the Underground Project.

4.2 Sources and Sinks

4.2.1 Groundwater Sources

The following water sources (refer to **Section 2.1**) have been included in the assessment:

- Groundwater inflows into MAN pits (MAN EIS URS, 2000);
- Groundwater inflows into Bayswater pits (MAN EIS URS, 2000);
- Groundwater inflows into the Proposed South Pit Extension (Umwelt, 2007); and
- Groundwater inflows into the Exploration Adit (supporting documentation for Part 5 Application (*Water Act 1912*), 2006).

The predicted changes to these groundwater sources over time are summarised in **Table 4.2**.

Table 4.2 - Groundwater Inflow Predictions

	Groundwater Sources (ML/year)				
Calendar Year	MAN	Bayswater No. 3	Exploration Adit	Proposed South Pit Extension	Total
2007	751	150	112	0	1013
2009	849	150		0	999
2022	1206	150		110	1466
2026	1206	150		110	1466

In addition to the groundwater sources shown in **Table 4.2**, the proposed Underground Project will increase the predicted groundwater inflows on site. The predicted inflows are detailed in the Underground Project Groundwater Assessment (refer to Appendix 10 of the EA) (Mackie Environmental Research, 2007) and summarised in **Table 4.3**.

Table 4.3 - Predicted Underground Project Groundwater Inflows

Calendar Year	Underground Project Year	Predicted Underground Project Groundwater Inflow (ML/year)
2009	1	355
2011	3	492
2022	14	2057
2026	18	1577
2029	21	1904

4.2.2 External Water Supply

The base modelling does not take into account any additional water that is imported to the site, with this water being tracked separately, but allows for water importation to be taken into consideration when assessing water deficits. The existing sources of external water are detailed in **Section 2.1.3**.

It is proposed that Mt Arthur Coal will continue to draw water from Muswellbrook Shire Council effluent and Drayton Mine as discussed in **Section 2.1.3** and possibly from other industrial sources, if available.

Mt Arthur Coal will also continue to utilise its Hunter River WALs as required (refer to **Section 2.1.3**).

4.2.3 Water Sinks

The current water demands for the existing approved operations and the proposed South Pit Extension (Umwelt, 2007) are detailed in **Section 2.2** and consist of:

- wash plant (CHPP) – 174 L/t open cut ROM;
- materials handling, including stockpile and process dust suppression and plant washdown – 417 ML/year;
- haul road dust suppression – estimated to range from approximately 900 ML/year to 1500 ML/year depending on climatic conditions, including haul roads in MAN and Bayswater mining areas. The site has recently undertaken a number of actions to reduce haul road dust suppression water including trialling of bituminous dust suppression products;
- potable water demand – approximately 60 ML/year; and
- evaporation from dam surfaces which varies with climatic conditions.

The Underground Project will result in increased water demands including:

- CHPP demand – increase in total water demand including water lost to product and tailings and materials handling. Total demand (including washing of open cut coal) after commencement of the Underground Project ranges from 1120 ML/year to 3270 ML/year depending on production levels. Predicted water usage rates are 174 L/t ROM open cut coal and 115 L/t ROM underground coal;
- high quality underground development water of 82 ML/year;
- high quality underground longwall water of 437 ML/year, with 99 ML/year recovered for reuse on site;
- underground conveyor water of 140 ML/year;
- underground surface facilities and general water (including dust suppression) of 22 ML/year; and
- potable water demand increasing from approximately 60 ML/year to 67 ML/year with commencement of the Underground Project.

4.3 Model Calibration

The water imported to site and the decrease in water stored on site for 2006 was compared to the results from the water balance model for 2006 to check the calibration of the water balance model.

The following site data for 2006 allowed the water deficit to be estimated:

- decrease in total water stored on site – 183 ML;
- external water sourcing:
  - Drayton Mine – 25 ML;
  - Muswellbrook Shire Council treated effluent – 660 ML; and
  - Hunter River allocations – 1056 ML;

As such a water deficit of approximately 1924 ML has been estimated for the site for 2006.

The current water balance for the site (2006) operations calculated using the water model is shown in **Table 4.4** for a dry (10th percentile), average and wet (90th percentile) rainfall year (Scone rainfall and evaporation data).

Table 4.4 - Current Water Balance (No External Sources) (2006 Operations)

Rainfall Year	Water Deficit (ML)
10th Percentile	2210 (1710)*
Average	1290
90th Percentile	200

* Using dust suppressants

The recorded rainfall at Scone for 2006 was 303 millimetres. This is equivalent to a 1st percentile rainfall year. Using the site water balance model (refer to **Appendix 1**) the water balance for 2006 has been calculated to be -1951 ML with the use of dust suppressants (i.e. the predicted balance for a 1st percentile rainfall year). This calculation is based on the detailed model run and results for the 2005 operations (refer to Graph A.1 of **Appendix 1**) taking into consideration of differences in production, haul road dust suppression requirements and evaporative surface areas between 2005 and 2006.

When comparing the value predicted by the water balance model (i.e. -1951 ML) to the measured site water balance for 2006 (i.e. -1924 ML) there is a difference of 27 ML (approximately 1 per cent). As such it is considered that the developed model provides a good estimate of actual water demand.

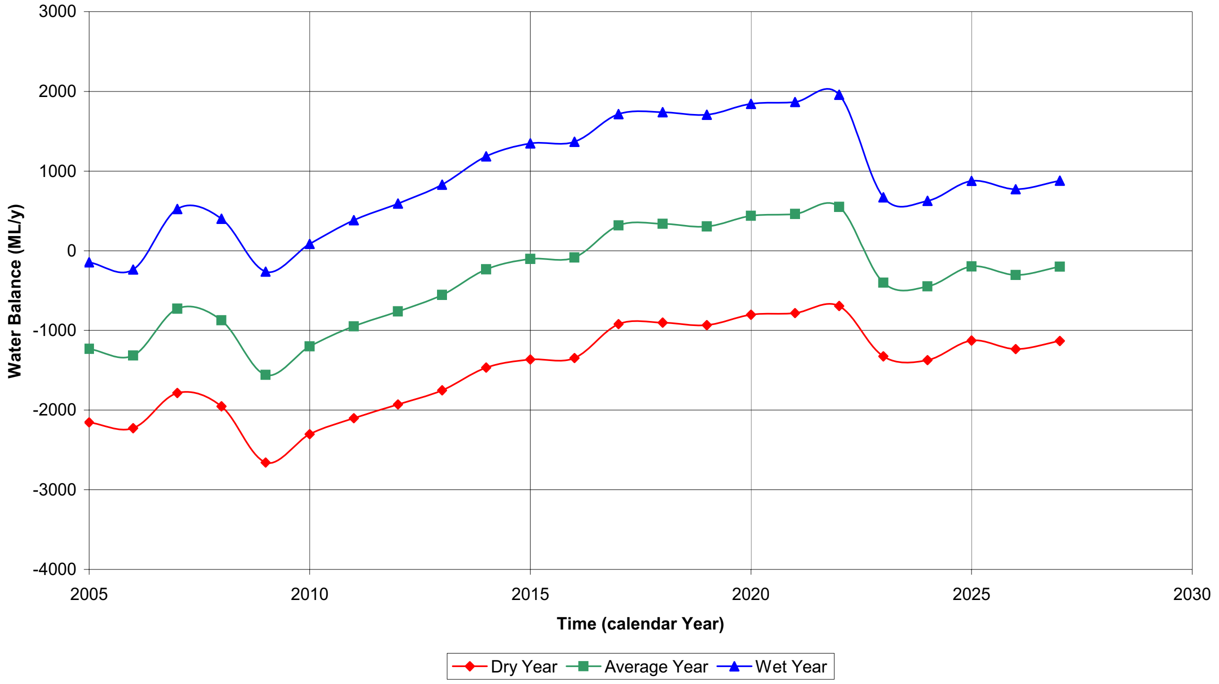
4.4 Water Balance for Existing Approved Operations

4.4.1 Results using Short Term Paired Rainfall and Evaporation (Scone, 1973 to 2006) Data

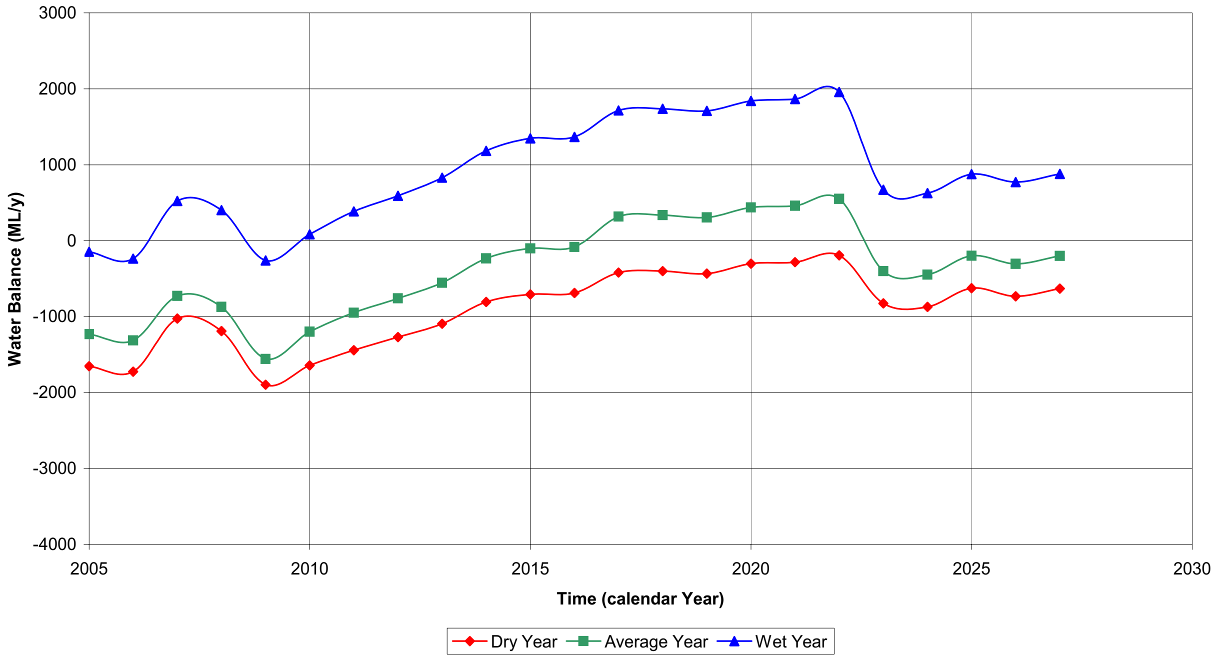
The model results (refer to **Appendix 1**) based on the Scone meteorological data were used to determine net water demand/surplus versus rainfall relationships for the mine. These relationships were then used to model and calibrate the existing site water balance for the approved operations (including the proposed South Pit Extension (Umwelt, 2007)).

The three lines on **Graph 4.1** represent a range of different meteorological conditions based on Scone meteorological data:

Graph 4.1 - Predicted Mt Arthur Coal Water Balance (existing operations)



Graph 4.2 - Predicted Mt Arthur Coal Water Balance (existing operations)
(dust suppressants used during dry rainfall years)



GRAPHS 4.1 & 4.2

- ’Dry’ rainfall year (i.e. 10th percentile rainfall year, approximately 416 millimetres);
- ’Average’ rainfall year (i.e. 50th percentile rainfall year, approximately 615 millimetres); and
- ’Wet’ rainfall year (i.e. 90th percentile rainfall year, approximately 816 millimetres).

Graph 4.1 indicates that the mine will typically have a net water demand for all average and dry rainfall years up to 2015. This net water demand is expected to peak in 2009 with an estimated water deficit of 2660 ML/year needed to meet demand during a dry (10th percentile) rainfall year.

After 2009 the site is predicted to have a water surplus during wet (90th percentile) rainfall years of up to approximately 1960 ML/year. However, during dry (10th percentile) rainfall years the site is predicted to continue to have a water deficit of between approximately 690 ML/year and approximately 2300 ML/year.

Analysis of haul road watering requirements has indicated that water demand can be reduced by up to 40 per cent (refer to **Section 2.2.2**) by using dust suppressants. The revised predicted water balance using haul road dust suppressants during dry periods (refer to **Graph 4.2**) is predicted to reduce the peak net water demands during a dry (10th percentile) rainfall year in 2009 from 2660 ML/year to 1900 ML/year.

4.4.2 Results using Long Term Rainfall (Denman, 1894 to 2006) Data

Denman historical rainfall data has been investigated to indicate what variability long term climatic conditions may have on the water balance. Extreme dry periods will influence catchment runoff, evaporation and haul road dust suppression demands which directly impact on the water balance for the Mt Arthur Coal open cut operations.

Using the Denman meteorological data, modelling indicates that the mine in its current configuration is typically a net water user (refer to **Appendix 1**). If rainfall was consistent with that recorded between 1936 and 1941, i.e. the worst five year drought period on record, the mine would have experienced a worst case single year water demand of approximately 2640 ML/year for the existing (2005) mine configuration. This water deficit is approximately 485 ML/year more than that predicted using the shorter term rainfall record from Scone (refer to **Appendix 1**) (i.e. a 23 per cent higher net water deficit).

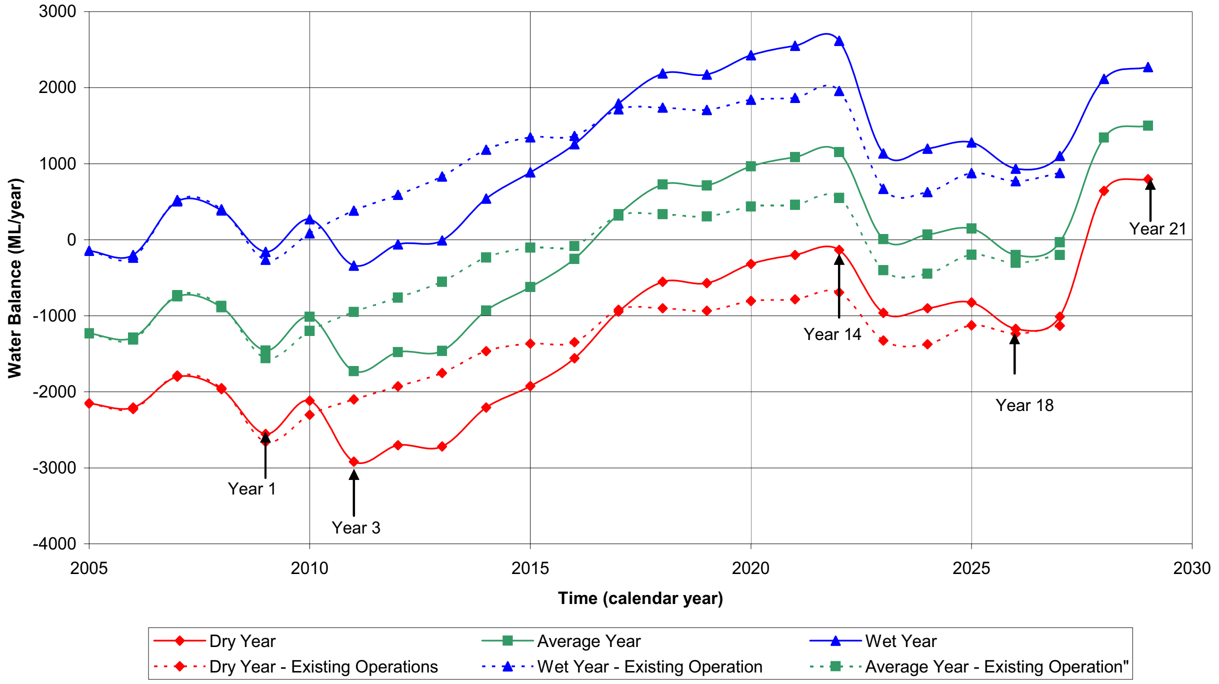
For the 2009 operations (i.e. the year with the predicted worst case water deficit) modelling indicates that if a similar drought as between 1936 to 1941 occurred that the site would need to meet a worst case net water demand for a single year of approximately 3235 ML/year. If haul road dust suppression agents were used it is estimated that this net water deficit would reduce to approximately 2475 ML/year.

4.5 Water Balance for Existing Approved Operations with the Underground Project

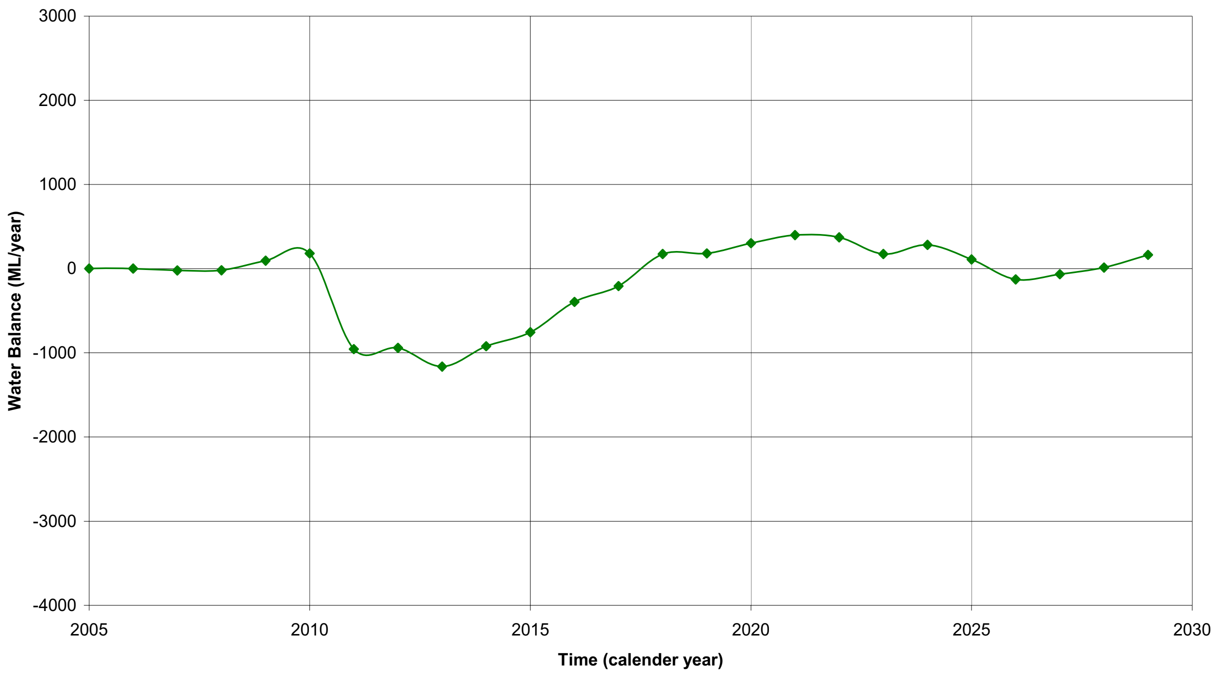
4.5.1 Results using Short Term Paired Rainfall and Evaporation (Scone, 1973 to 2006) Data

Graph 4.3 shows the predicted water balance for the Mt Arthur Coal water management system including the proposed Underground Project. **Graph 4.4** shows the predicted water balance for the proposed Underground Project alone.

Graph 4.3 - Predicted Site Water Balance (with Underground Project)



Graph 4.4 - Proposed Underground Project Predicted Water Balance



GRAPHS 4.3 & 4.4

Graph 4.3 indicates that the mine will typically have a net water demand for dry rainfall years. This net water demand is estimated to peak in 2011 with up to 2920 ML/year needed to meet demand during a dry (10th percentile) rainfall year.

After 2013 the mine will range between having a net water demand to a net water surplus depending on meteorological conditions. The peak water surplus is predicted in 2020 with a net water surplus of 2620 ML/year during a wet (90th percentile) rainfall year.

Analysis of haul road watering requirements has indicated that water requirements can be reduced by up to 40 per cent during dry periods (refer to **Section 2.2.2**). The revised predicted water balance using haul road dust suppressants in dry years (refer to **Graph 4.5**) is predicted to reduce the net water demands in 2011 from 2920 ML/year to 2260 ML/year.

The analysis indicates that with the Underground Project the predicted maximum net water deficit for the site will be increased from approximately 1900 ML/year to approximately 2260 ML/year during a dry (10th) percentile rainfall year (with use of dust suppressants).

Similarly the analysis indicates that the predicted maximum net water surplus for the site will increase from approximately 1960 ML/year to approximately 2620 ML/year.

4.5.2 Results using Long Term Rainfall (Denman, 1894 to 2006) Data

Extreme dry periods, as exist in the Denman rainfall data have the potential to impact on catchment runoff, evaporation and haul road dust suppression requirements. These factors are not expected to significantly impact upon the predicted water balance for the proposed Underground Project. This is because the Underground Project will not influence catchment areas or significantly affect haul road dust suppression requirements (refer to **Sections 4.1** and **4.2**). The Underground Project will increase the water lost to evaporation through an increase of approximately 50 per cent in the dam storage surface areas (by approximately 50 per cent) (refer to **Section 4.1**).

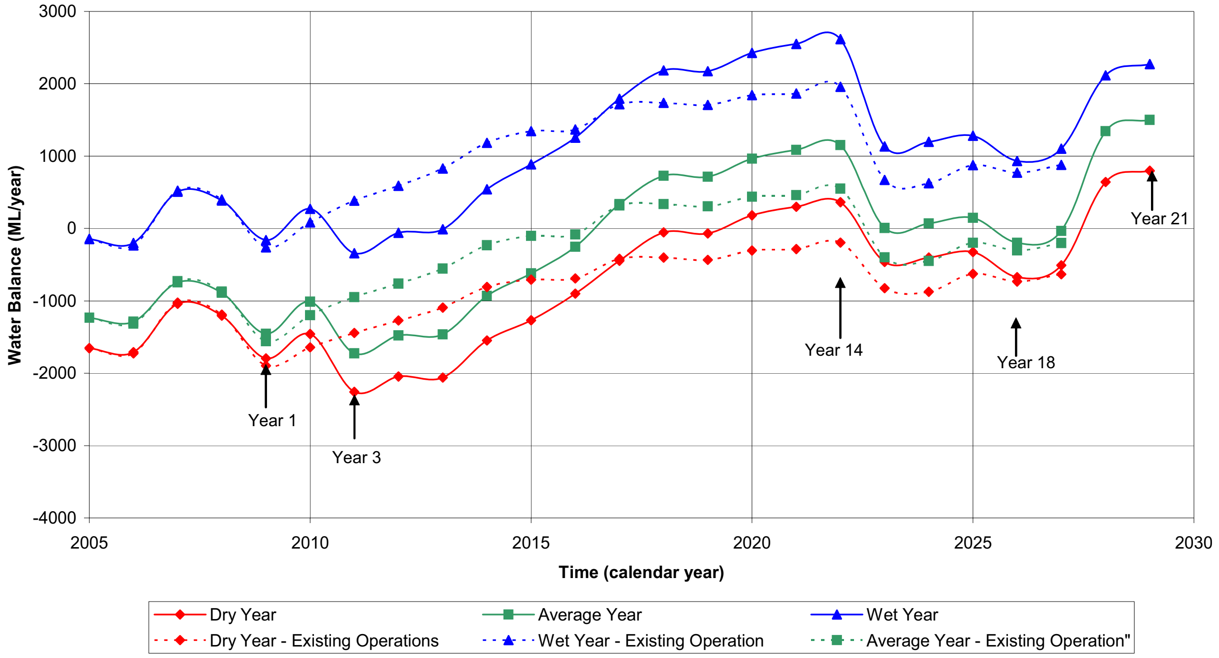
If the single worst case water demand year, Year 3 of the Underground Project, coincided with a rainfall year equivalent to the worst in Denman's record the maximum water deficit would be in the order of 3542 ML/year or approximately 2782 ML/year with the use of haul road dust suppressants.

4.6 Summary of Estimated Water Balance Impacts

The predicted maximum water deficits with the Underground Project are in the order of approximately 350 ML/year higher than the predicted maximum water deficits for the existing open cut operations alone. This increase is primarily due to the increase in coal production from 15 Mtpa ROM to 23 Mtpa ROM (refer to **Section 4.2.3**).

During dry rainfall years Mt Arthur Coal expects to be able to continue to utilise existing water storages (with a total storage of approximately 2500 ML, excluding mining pits and voids) and source between 600 ML/year to 900 ML/year of treated effluent from Muswellbrook Shire Council effluent (refer to **Section 2.1.3**). Analysis also indicates that up to approximately 3450 ML/year can be sourced from the Hunter River utilising current Mt Arthur Coal WALs as water allocations and uncontrolled flows (refer to **Section 2.1.3**). This would increase to approximately 4400 ML/year with the finalisation of current licence acquisitions (refer to **Section 2.1.3**). As such, using water stored on site in the existing dam storages and the currently available external supply sources, it is expected that Mt Arthur Coal will be able to meet the predicted worst case dry rainfall year water deficit.

Graph 4.5 - Predicted Site Water Balance (with Underground Project)
(dust suppressants used during dry rainfall years)



GRAPH 4.5

The deficit could also be reduced by modifying mining operations to suit available water. This could potentially include such measures as reducing production levels, reducing the length of haul road that needs to be watered or implementing measures to reduce evaporation from dam surfaces (refer to **Section 7.2**).

The water balance assessment also indicates that the predicted maximum site water surplus during a 90th percentile wet year would increase from 1960 ML/year (refer to **Section 4.4.1**) to 2620 ML/year (refer to **Section 4.5.1**). As part of the Underground Project Mt Arthur Coal would increase the total dam storage volume of site by approximately 360 ML.

In extremely wet rainfall years (i.e. in excess of 90th percentile rainfall) the site may have a net water make which may require discharges to the Hunter River via the HRSTS if sufficient storage volume is not available in on site storages. This is only likely to occur if extended wet periods occur as mining voids can be used as additional water storages.

4.7 Final Voids

At the end of the proposed Underground Project open cut mining voids will remain in Belmont Pit, Saddlers Pit (Central and South) and Saddlers Pit (North). The predicted final landform for these voids is shown in the main text of the EA.

Water balance models were run for each of the predicted final voids to determine their long term (final) water levels. Each void was modelled as a single module, using the daily water balance model developed for the Mt Arthur Coal water management system. The values determined for initial losses, evaporation factors and power functions in the calibration of the water balance model were used in the analysis of the final voids.

Stage storage relationships and catchment areas of the proposed final voids were determined using the predicted final landform contours. The characteristics of each void are listed in **Table 4.5**.

Table 4.5 - Final Void Characteristics

Final Void	Catchment Area (ha)	Maximum Void Storage Volume (ML)	Maximum Water Level (mAHD)
Belmont	137	7300	195
Saddlers (Central & South)	39	5750	145
Saddlers (North)	52	6830	165

The model was run with inputs into each void of runoff from rainfall on the catchment area, direct rainfall onto the void water surface and direct evaporation from the void water surface. Groundwater inflows for the final voids were calculating using information on predicted groundwater inflows in the Bayswater EIS (Resource Planning, 1993). It is considered that the predicted groundwater inflows are conservative as when the void water levels rise, groundwater inflows will decrease. For the purposes of this assessment it has been assumed that groundwater inflows would continue providing a conservative assessment of final void water levels.

The Scone daily matched rainfall and evaporation data for 34 years (1973 to 2006) was used (refer to **Appendix 1**). The model was run for 238 years with the 34 years of meteorology data repeated in series seven times. As discussed in **Appendix 1**, this period has higher average annual rainfall than that recorded for Denman between 1894 and 2006 and is therefore considered to be a long term upper estimate of rainfall and inflow conditions.

The results of the modelling are listed in **Table 4.6** and indicate that all the voids would find equilibrium well below the maximum void storage volume.

Table 4.6 - Final Void Modelling Results

Final Void	Equilibrium Volume (ML)	Percentage Full by Volume (%)	Equilibrium Water Level (mAHD)	Equilibrium Freeboard (m)
Belmont	2522	35%	184	11
Saddlers (Central & South)	2347	41%	128	17
Saddlers (North)	4066	60%	153	12

Model results indicate that over the modelled 238 year period none of the final voids would reach water levels high enough to spill. It is considered that the final water levels in the voids would be considerably lower than those modelled above as the groundwater inflows to the final voids would not be expected to remain static but instead would decrease with increasing void water levels. As such it is considered that the final voids configurations outlined in the main text of the EA will contain the predicted groundwater inflows and not discharge to the surrounding drainage system.

5.0 Water Quality and Salt Balance

The current salt balance for Mt Arthur Coal (including MAN and Bayswater mining areas) has been assessed based on information regarding the site water balance (refer to **Section 4.0**) and water quality monitoring information from the Mt Arthur Coal water management system and surrounding catchment areas (refer to **Section 5.1**).

As part of determining the baseline conditions for the salt balance for the approved operations, including the proposed South Pit Extension (Umwelt, 2007), the site salt balance has been compared to the estimated pre-mining catchment salt export (i.e. the salt export that would occur if the mining operation did not exist).

5.1 Water Quality

5.1.1 Surrounding Watercourses

A surface water quality monitoring program has been undertaken at Mt Arthur Coal since 1995 covering most of the project area. This program was extended in 2005 to provide further baseline data for the Underground Project. Surface water quality has been monitored at seventeen locations including sites to the north, west and south of Mt Arthur Coal (shown on **Figure 5.1**) and within the mine water management system. Several monitoring locations were established around the MAN and Bayswater sites in 1995, with monitoring points on Fairford, Saddlers, Ramrod and Whites Creeks established in the early 2000s.

These sites are monitored for analytes including pH, electrical conductivity, alkalinity, aluminium, iron, arsenic, barium, cadmium, calcium, chromium, copper, iron, magnesium, molybdenum, nitrates, oil & grease, potassium, sodium, sulfates, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), phosphorus, turbidity and zinc. Detailed results of the monitoring program are shown in **Appendix 2**. Monitoring also includes flow (by way of observation). However, there are limited observation points as the creeks are ephemeral.

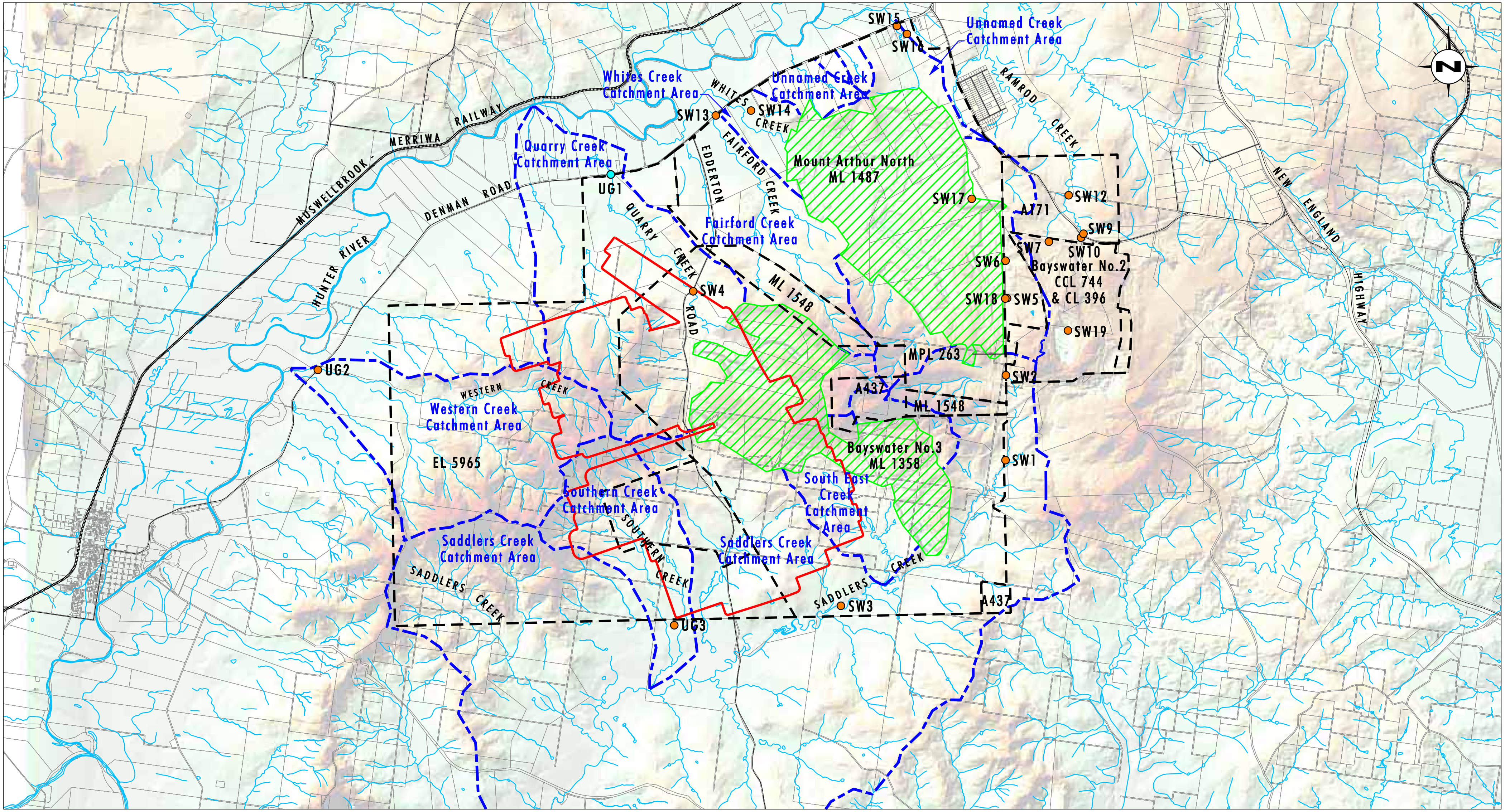
In Quarry Creek the pH ranges from 7.6 to 9.1, and electrical conductivity ranges from 490 μS/cm to 14,630 μS/cm. Analysis indicates that when runoff occurs in the catchment area the electrical conductivity averages 8720 μS/cm in the creek.

Typically the pH in Saddlers Creek ranges from 6.7 to 8.7, with electrical conductivity ranging from 760 μS/cm to 17,000 μS/cm. Analysis indicates that when runoff occurs in the catchment area the electrical conductivity averages 5680 μS/cm in the creek.

Water quality monitoring indicates that in Fairford Creek the pH has ranged from 6.1 to 9 and electrical conductivity has ranged from 120 μS/cm to 1110 μS/cm. Analysis indicates that when runoff occurs in the catchment area, average electrical conductivity in the creek is 440 μS/cm.

Whites Creek water quality ranges from neutral to alkaline with pH ranging from 6.9 to 10.1 and electrical conductivity ranging from 82 μS/cm to 10,000 μS/cm. Analysis indicates that when runoff occurs in the catchment area, average electrical conductivity in the creek is approximately 6500 μS/cm.

Typically in Ramrod Creek the pH ranges from 6.5 to 9.6, with electrical conductivity ranging from 450 μS/cm to 12,000 μS/cm. Analysis indicates that when runoff occurs in the catchment area the average electrical conductivity is approximately 5000 μS/cm in the creek.



Source: Mt Arthur Coal
Base Source: LPI NSW

0 1 2.5 5km
1:110 000

Legend

- Mining and Exploration Lease Boundary
- Subsidence Affectation Area
- Catchment Boundary
- Mining Area
- Surface Water Monitoring Locations
- Drainage Line
- Road

FIGURE 5.1

Surface Water Monitoring Locations

File Name (A4): R20_V1/2051_215.dgn

The water quality monitoring results described above and detailed in **Appendix 2** indicate that the existing water quality in the fresh water catchment surrounding the project area exceeds the Australian and New Zealand Environment and Conservation Council (ANZECC) trigger values for pH and electrical conductivity for upland rivers in slightly disturbed ecosystems (i.e. pH of 6.5 to 7.5 and 30 µS/cm to 350 µS/cm) (ANZECC, 2000). It is considered that this is possibly due to a combination of the substantial historical disturbance by agriculture in the catchment areas and soil types. The analysis indicates that ANZECC trigger values are not suitable for use as impact assessment criteria for the project and that future water quality for the project should be compared against the baseline water quality data for the site.

5.1.2 Mine Water Management System Water Quality

Water quality within the Mt Arthur Coal water management system has been monitored at the MAN Raw Water and CHPP Water Dams since 2002 and 2004 respectively and at Bayswater Raw Water Dam since 1995. Water quality in mine water storage dams is highly variable, depending on rainfall and groundwater inflow and mining operations. Time series graphs of the water quality monitoring data for these sites are included in **Appendix 2**.

Over the period of record the water quality in the dams has ranged from neutral to alkaline (pH ranged from 7.2 to 10.2) and electrical conductivity ranged from 290 µS/cm to 7100 µS/cm.

The range in water quality of the mine water at Mt Arthur Coal is consistent with recorded ranges in water quality in the surrounding natural drainage system as discussed in **Section 5.1.1**.

Surface water monitoring has also been undertaken on the external water supplies utilised by Mt Arthur Coal. Monitoring of water quality parameters of the Muswellbrook Shire Council effluent and Drayton Mine water commenced in 1997 and includes faecal coliforms, faecal streptococci, pseudomonas, nitrates and total phosphorus. Monitoring of pH and conductivity for Muswellbrook Shire Council effluent commenced on 6 January 2003 and for Drayton Mine water on 21 December 2005. The results are shown in **Appendix 2**. The Muswellbrook Shire Council effluent and Drayton Mine water were found to range from neutral to alkaline, with pH ranging from 6.6 to 10.5 and 7.1 to 9 respectively. Electrical conductivities were found to range from 490 µS/cm to 3920 µS/cm and 336 µS/cm to 5,570 µS/cm respectively.

The Mt Arthur Coal water management system is managed as a contained system. Water quality monitoring data from site indicates that the water quality in the two major dams, i.e. Bayswater Raw Water Dam and the MAN Raw Water Dam, have remained fairly constant over the monitoring periods (refer to **Appendix 2**). Conductivity in these dams has typically been in the order of 3000 µS/cm to 4000 µS/cm. It is noted that electrical conductivity in the dams varies over time, principally in response to changes in water volumes stored in the dams. Monitoring also indicates that the electrical conductivity of the dams while varying is not increasing over time. As such it is considered that although the salt concentrations in the dams may vary over time, the overall salt load in the dams has remained reasonably constant.

5.2 Pre-Mining Catchment Salt Export

An analysis of rainfall and electrical conductivity data for creeks in the surrounding area (refer to **Section 5.1**) indicates that the salinity of flows (i.e. after rainfall events) is on average approximately 3200 mg/L. Runoff volumes from the current site water management system catchment area of 1860 hectares, have been estimated using an average annual runoff rate of approximately 0.7 ML/hectare. This rate is consistent with average annual runoff volumes for the area quoted in the NSW Farm Dams calculator for the site (DNR, undated). Using average salinity and runoff volumes generated by the water balance model (refer to **Section 4.0**) the salt load in the runoff generated during an average rainfall year has been estimated at approximately 2.24 tonnes of salt per hectare. This salt would be exported from the natural catchment areas of the site to local creeks and drainage lines if the mining operation did not capture and reuse this water. On this basis, the amount of salt that would have been exported from the site if the mining area was not present is estimated at approximately 4170 tonnes per year in an average rainfall year.

5.3 Salt Export for Existing Approved Operations

The site imports water from Muswellbrook Shire Council treated effluent, Muswellbrook Potable Supply, Drayton Mine and the Hunter River with these sources containing varying amounts of salt. Based on water quality monitoring data and supply volume information (refer to **Sections 4.0** and **5.1**) the amount of salt imported from each of these sources have been calculated for the existing approved operations. The salt loads have been calculated by converting electrical conductivity (EC) readings to total dissolved salts (TDS). A conversion factor of 0.6 (i.e. TDS (mg/L) = EC (µS/cm) x 0.6) was used.

A review of the water imports to site during 2005 (refer to **Section 4.0**) indicates that approximately 3153 tonnes of salt was imported to site.

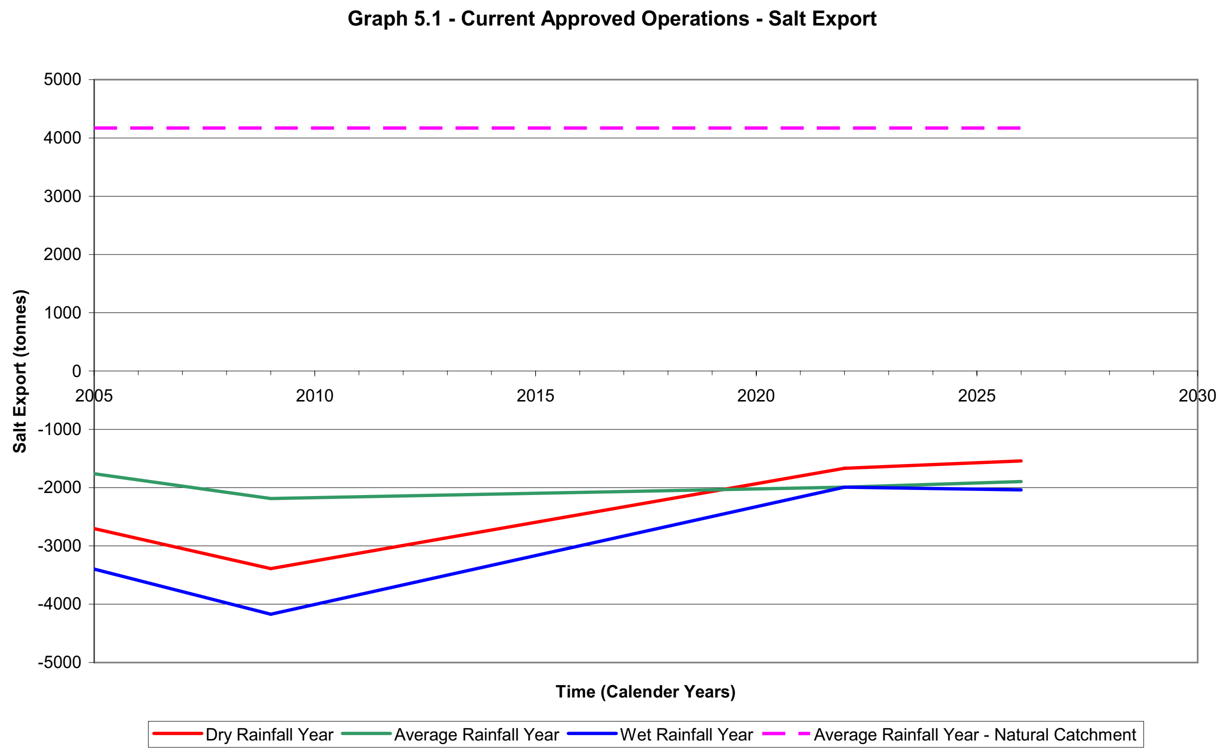
The future predicted water imports for the site were determined based on the predicted site net water deficit (refer to **Section 4.0**), with water being drawn preferentially from Muswellbrook Shire Council effluent, Drayton Mine (except in dry rainfall years) and the Hunter River to meet predicted site water deficits.

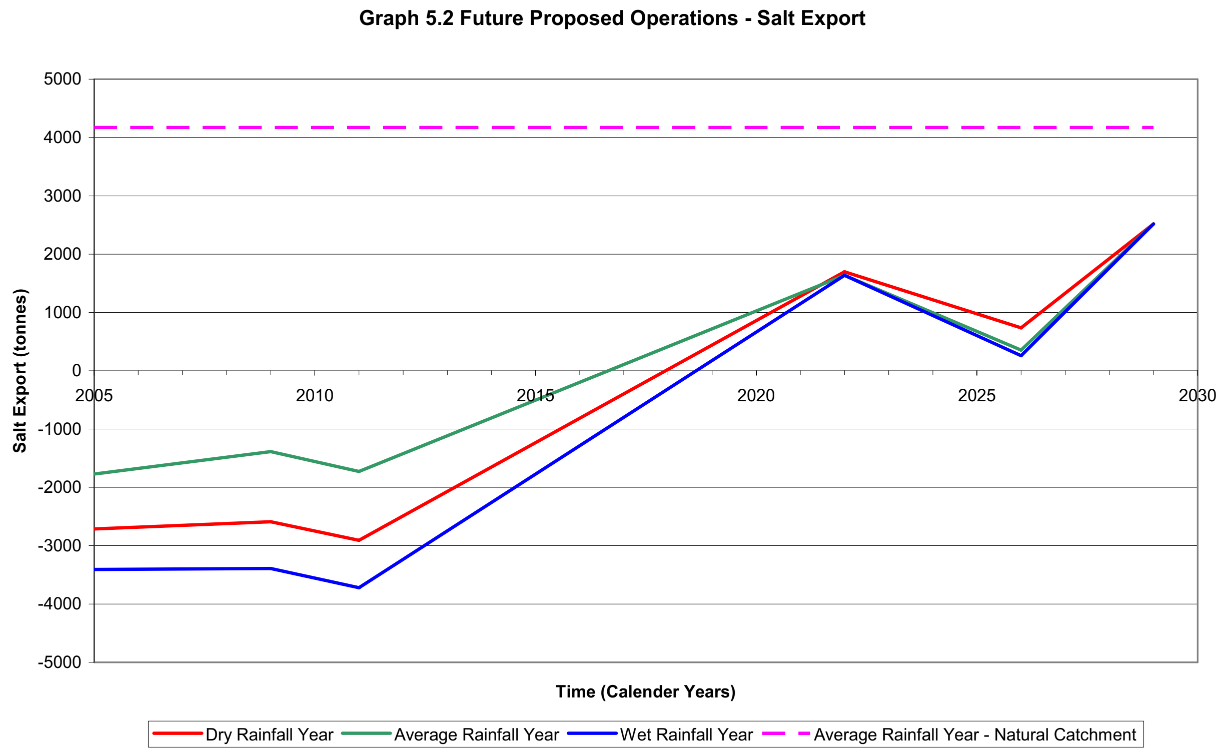
As part of pit dewatering operations groundwater inflows are pumped from the open cut pits into the Mt Arthur Coal water management system. In 2005 approximately 900 ML of groundwater was pumped from the open cut pits with an average salt concentration of approximately 2700 mg/L. On this basis it is estimated that groundwater extracted from the open cut pits during 2005 contained approximately 2430 tonnes of salt. The salt transferred to the site as a result of groundwater pumping has been estimated as described above for the future predicted water balance.

As part of the mining operations water containing salt is transported off site in product coal and locked up in coarse reject disposal and tailings dams in the interstitial spaces between the fine sediment. Based on washing 7.0 Mt of ROM coal and coarse reject/tailings production of approximately 2.5 Mt, it is estimated that approximately 5974 tonnes of salt was transported off site or locked up in tailings during 2005. The salt transported off site in product coal and locked up in tailings dams has also been estimated for the future predicted water balance.

Graph 5.1 shows the calculated net salt balance for the existing operations including the proposed South Pit Extension (Umwelt, 2007).

The analysis of the salt balance for the existing operations indicates that the site is predicted to range between a net salt export of approximately -4170 tonnes (i.e. wet rainfall year for 2009) and approximately -1544 tonnes (i.e. dry rainfall year for 2026).


Graph 5.1 - Current Approved Operations - Salt Export
Salt Export (tonnes)
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
2005
2010
2015
2020
2025
2030
Time (Calender Years)
Dry Rainfall Year
Average Rainfall Year
Wet Rainfall Year
Average Rainfall Year - Natural Catchment


Graph 5.2 Future Proposed Operations - Salt Export
Salt Export (tonnes)
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
2005
2010
2015
2020
2025
2030
Time (Calender Years)
Dry Rainfall Year
Average Rainfall Year
Wet Rainfall Year
Average Rainfall Year - Natural Catchment

GRAPHS 5.1 & 5.2

This is compared to an estimated pre-mining catchment salt balance of +4170 tonnes exported from the area in runoff (refer to **Section 5.2**). As a result, the continued operation of the mine is predicted to significantly reduce salt loads exported to downstream systems.

5.4 Salt Export with Underground Project

The salt export from the site with the Underground Project was calculated for each of the modelled mine stages and for dry, average and wet rainfall years. The salt export was estimated using information regarding the site water balance (refer to **Section 4.0**) and water quality monitoring information from the Mt Arthur Coal water management system and surrounding catchment areas (refer to **Section 5.1**). The estimated salt export for the site was calculated using the same methods as for the salt export for the existing approved operations described in **Section 5.3**, which is by determining salt imported to the site in imported water and groundwater transfers, and salt exported from the site (via product coal) or locked up on site (in tailings).

The future predicted water imports for the site were determined based on the predicted site net water deficit (refer to **Section 4.0**) and with water being drawn preferentially from Muswellbrook Shire Council treated effluent, Drayton Mine (except in dry rainfall years) and the Hunter River to meet predicted site water deficits.

The results for the analysis for a dry, an average and a wet rainfall year are shown on **Graph 5.2**.

The analysis indicates that the site with the Underground Project is estimated to range between a salt export of approximately -3721 tonnes (i.e. wet rainfall year for Year 3) and approximately +2516 tonnes (i.e. dry, average and wet rainfall year for Year 21). This compares to an existing approved operation (including the South Pit extension) estimated salt export of between approximately -4170 tonnes and approximately -1544 tonnes (refer to **Section 5.3**) and a natural catchment salt export of approximately +4170 tonnes (refer to **Section 5.2**).

5.5 Summary of Estimated Salt Export Impacts

The analysis indicates that the proposal will continue to result in a significantly lower salt export from the site compared to the estimated pre-mining catchment area salt export of approximately +4170 tonnes (refer to **Sections 5.2**, **5.3** and **5.4**).

6.0 Summary of Potential Impacts on Existing Environment

6.1 Mt Arthur Coal Water Management System

As discussed in **Section 4.0**, future mine plans indicate that the catchment area of the Mt Arthur Coal water management system, which is currently approximately 1860 hectares, will increase to approximately 3055 hectares and then decrease to approximately 1630 hectares by Year 21 of the Underground Project. As mining and rehabilitation of mined areas progresses and overburden emplacement areas are satisfactorily rehabilitated and made externally draining, annual catchment yields in the surrounding creek systems will increase. As such, flows in these creek systems will also start to more closely replicate flows that existed prior to Mt Arthur Coal mine being developed. These changes to the landform and catchments are part of the approved mine plans for the MAN and Bayswater No. 3 mining areas.

In terms of water quality, the only discharges from the Mt Arthur Coal water management system would be from licensed DECC discharge points which are monitored and controlled. Consequently, potential water quality impacts will be limited to that associated with discharges under the HRSTS. It is intended that future discharges under the HRSTS will be in accordance with the existing licence conditions for Mt Arthur Coal. As a result it is considered that future operations at Mt Arthur Coal will not significantly alter water quality or ecology of downstream systems. It is also considered that the continued operation of Mt Arthur Coal as proposed, will not adversely impact on the potential use of water for downstream users on the local creek systems. Any extractions from the Hunter River will be in accordance with WALs held by Mt Arthur Coal and the Water Sharing Plan for the Hunter Regulated River Water Source. It is considered that the proposed development will not have a significant adverse affect on downstream users.

6.2 Underground Mining Areas

The proposed underground mining will result in surface disturbance and the need for remediation works to be undertaken. These works have the potential to generate short term impacts in terms of water quality while the remediation works are being undertaken and stable vegetated post mining landforms are being achieved. Potential water quality impacts in terms of downstream users and downstream ecosystems will principally be due to the potential for increased sediment generation and export of sediment off site. To mitigate this potential impact it is proposed to implement a number of sediment and erosion control measures (refer to **Section 3.1**).

The implementation of the proposed sediment and erosion control measures will ensure that underground mining and surface remediation works do not have a significant adverse impact on downstream water users or on downstream ecosystems.

6.3 Water Planning Context

The State Water Management Outcomes Plan (SWMOP) and the Hunter Catchment Blueprint (HCB) provide guidelines for water management in NSW and the Hunter Valley respectively and are therefore relevant to the project.

The introduction of the *Water Management Act 2000* led to the development of a Statewide policy on water management known as the SWMOP. This plan provides direction for all water management actions in NSW by setting out the overarching policy context, targets and strategic outcomes for NSW water management.

Catchment Blueprints have been developed by the 'whole of government', with input from the community to provide the overarching planning framework for natural resource management in NSW. The Blueprints are 10 year plans that integrate the management of all natural resources within a specific catchment including native vegetation, water resources and soils. The Blueprints contain objectives, time specific catchment and management targets and a list of management actions to achieve the targets.

The Hunter Catchment Blueprint was finalised in February 2003 and has five First Order Objectives. The First Order Objectives provide a statement of the community's values about the desired state and functioning of natural resources in the Hunter. First order objectives for the Hunter Catchment Blueprint are:

1. Native vegetation, biodiversity and ecological integrity are valued, maintained and enhanced.

2. Water bodies are managed to balance natural ecosystem requirements with community needs.

3. Adverse impacts of salinity on ecosystem health and the community are minimised.

4. The physical structure and vegetation of rivers, estuarine and wetland riparian zones maintain healthy ecosystems while achieving adequate protection from floods.

5. Sustainable agriculture, human settlement, industry and other land uses occur while protecting Aboriginal cultural heritage, ecosystem health, soil and water.

The proposed Underground Project is consistent with the SWMOP and the Hunter Catchment Blueprint first order objectives for the project area and potential downstream interactions. This will be achieved as:

- the project will result in some disturbance of land outside of the mine water management system. However, the proposed surface remediation measures and associated sediment and erosion controls will effectively minimise environmental impacts;

- the mine will continue to have a net salt export considerably less than the surrounding catchment areas and as such will assist in acting as a salinity sink and reducing salinity impacts on ecosystem health and the community;

- similarly to meet on site water demands water is imported to site from waste water sources, including Muswellbrook Shire Council effluent and Drayton Mine. This assists in reducing water quality impacts on the Hunter River and potential water extraction by Mt Arthur Coal;

- the majority of surface infrastructure will be located within the existing mine water management system minimising the potential for off site impacts; and

- the site will continue to minimise water use by improving water efficiencies. The site will continue to import treated effluent and mine water for reuse on site as well as reusing existing water within the mine water management system.

6.4 Cumulative Impacts

Mt Arthur Coal will continue to source external water from Muswellbrook Shire Council Effluent, Drayton Mine and other industrial sources where available, the Hunter River and Muswellbrook Shire potable supplies. Extractions from the Hunter River will be in accordance with WALs and the Water Sharing Plan for the Hunter Regulated River Water Source. Any discharges from the site will continue to be managed under the HRSTS. The net salt export for the site will remain significantly lower than that of the surrounding catchment areas.

The surface water assessment of the predicted subsidence impacts indicates that the catchment boundaries of the creek systems to be undermined will not change significantly and that with appropriate surface remediation works, no significant ponding or storage of surface runoff will occur.

Sediment and erosion control measures are proposed to ensure that there will be no significant impact on downstream water qualities during subsidence remediation and revegetation stages.

On this basis it is considered that the proposed development will not result in adverse cumulative impacts on water use, flows or qualities in the surrounding areas.

7.0 Monitoring, Licensing and Reporting Procedures

7.1 Surface Water Monitoring

The surface water quality monitoring network for Mt Arthur Coal has been extended to provide baseline data for the project (refer to **Section 5.1**).

The monitoring and reporting program will be continued during both the construction and operation phases of the project. Once operational, water storage dams and sediment dams will be monitored (and metered in the case of water storage dams) to ensure that any overflows are to an appropriate standard and in accordance with licence conditions.

All monitoring results will be reported in the Mt Arthur Coal Annual Environmental Management Report (AEMR) which is distributed to DoP, DPI, DWE, DECC and other relevant government agencies and made available to the community through Mt Arthur Coal's website. All monitoring data will be retained in an appropriate database.

The results of the water quality monitoring will be used to review the effectiveness of the Mt Arthur Coal water management systems on an ongoing basis.

Water usage, external sourcing, rainfall on site, dam volumes and discharges from the site will also continue to be monitored for the entire operation to assist in management of the water system.

7.2 Contingency Measures

The Mt Arthur Coal complex will range from being a net water user to being a net water maker over the project life. As a consequence, there is considerable flexibility in managing the volume of water that is stored on site and that is imported to the site. There is also reasonable flexibility in where water to supply the needs of mining operation is sourced providing a wide range of contingency measures that can be implemented. These include varying the rate that water is drawn from external supplies and, if necessary, purchasing additional water access licences and/or seeking new sources of industrial water or recycled effluent.

In addition, Mt Arthur Coal acknowledges that sustained periods of water deficit may require modifications to mining operations to reduce water demands on site during these periods. These modifications may include:

- reduction of haul road lengths for open cut operations and/or use of alternative road dust suppressants;
- reduction of storage dam surface areas or evaporation from dam surfaces;
- concentration of mining operations to underground after underground operations are established during sustained dry periods as underground mining requires less water per tonne of ROM coal than open cut mining;
- delays in the commencement of underground mining to minimise overall water demand; and/or

- changes to production levels.

In addition to the contingency measures listed above Mt Arthur Coal acknowledges the need for high quality water to be used in the underground longwall machinery. It is intended to utilise high quality water from MSC treated effluent for this purpose. If high quality water is not available from MSC treated effluent or under Mt Arthur Coal's WALs, Mt Arthur Coal intends to utilise Hunter River water and/or establish a water treatment plant on site that will be capable of treating and producing the required volume of water. Prior to establishing such a plant, discussions will be held with DWE and DECC and all necessary licences will be obtained.

During wet rainfall years there is a potential for water to be released from the site. There are also several contingency options available regarding water quality treatment. If additional treatment of water is required either prior to reuse or discharge there is sufficient area able to be allocated on site to increase the treatment time/treatment area of site runoff. In addition, flocculation could be used to assist in settling clay particles prior to reuse or discharge of water. It is proposed that the site may either dispose of excess water by allowing treated runoff from rehabilitated/stabilised areas to overflow from sedimentation dams or by discharges from the mine water management system in accordance with the HRSTS.

If surface stabilisation during remediation works is required due to surface rilling, tilling with gypsum or lime during reshaping and prior to revegetation may be required and additional erosion and sedimentation controls will be implemented (refer to **Section 3.1**).

7.3 Licensing Requirements

7.3.1 Water Act and Water Management Act

As yet no water management plans have been finalised for the areas in the vicinity of the project area outside of the Hunter River including surface water and groundwaters. As such the project area is governed by the *Water Act 1912* until such plans are gazetted.

However, water access licences required as part of the water management system to import water to site are governed under the *Water Management Act 2000*. Mt Arthur Coal is currently transferring their Surface Water Licences under the *Water Act 1912* to WALs under the *Water Management Act 2000*.

Groundwater that flows into the open cut pits and the exploration adit will continue to be dewatered under existing Part 5 licences of the *Water Act 1912*. Similarly a licence under Part 5 of the *Water Act 1912* will be required to extract groundwater from the underground workings.

7.3.2 Protection of the Environment Operations Act

The proposed water management system will continue to be licensed under the *Protection of the Environment Operations Act 1997* Section 120 with the existing licences varied to include new activities associated with the Underground Project.

8.0 References

Australian and New Zealand Environment and Conservation Council, 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

Department of Land and Water Conservation, 1999. *Guidelines for Establishing Stable Drainage Lines on Rehabilitated Mine Sites*.

Department of Land and Water Conservation, 2003. *Integrated Catchment Management Plan for the Hunter Catchment 2002*.

Department of Natural Resources, 2004. *Water Sharing Plan for the Hunter Regulated River Water Source*.

Department of Natural Resources, 2005. *Singleton 1:250 000 Soil Landscapes Map Sheet*.

Department of Natural Resources, undated. *State Water Management Outcomes Plan*.

Institution of Engineers Australia, 1987. *Australian Rainfall and Runoff* Volumes 1 and 2– A Guide to Flood Estimation.

Kovac, M. and Lowrie, J.W., 1991. *Soil Landscapes of the Singleton 1: 250 000 Sheet.*

Landcom, 2004. *Managing Urban Stormwater: Soils and Construction*.

Mackie Environmental Research Pty Ltd. 2007. *Mt Arthur Coal Underground Project Environmental Assessment Groundwater Management Studies*. Prepared for Mt Arthur Coal.

Mine Subsidence Engineering Consultants, 2007. *Mt. Arthur Underground Project Report on the Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Natural Features and Items of Surface Infrastructure due to the Extraction of Longwalls in the Woodlands Hill, Glen Munro, Arrowfield, Bowfield and Piercefield Seams at the Mt. Arthur Underground Project in Support of an Environmental Assessment.* Prepared for Mt Arthur Coal.

Resource Planning Limited, 1993. *Bayswater Environmental Impact Statement*.

Umwelt (Australia) Pty Limited, 2007. *South Pit Extension Environmental Assessment.* Prepared for Mt Arthur Coal.

URS, 2000. *Mt Arthur North Environment Impact Statement*. Prepared for Mt Arthur Coal.

APPENDIX 1

Water Model Setup and Graphs

Appendix 1 – Water Model Setup and Graphs

1. Rainfall and Evaporation

For rainfall / runoff and water balance modelling purposes it is important to take evaporation into consideration and use rainfall data that is representative of the project area and that provides an indication of the range of variability in a daily rainfall record over a prolonged period (i.e. preferably in excess of 100 years) if possible. Short term daily rainfall data is available from four Bureau of Meteorology (BOM) Stations within close proximity to the project area (refer to Figure 2.1). These stations are:

- Lower Hill Street, Muswellbrook (Station 61053) (1870 to 2006, significant periods of data gaps);
- 'Dartmouth' (Station 61124) (1880 to 1922);
- Lindisfarne, Muswellbrook (Station 61168) (1960 to 2006); and
- Bengalla, Muswellbrook (Station 61004) (1923 to 1966).

Daily rainfall data is also available from three meteorology stations maintained by Mt Arthur Coal (refer to Figure 2.1). These stations are 'Constable', 'Mcleans Hill' and 'Roxburgh South'. Of these stations 'Mcleans Hill' and 'Roxburgh South' are located within the Mt Arthur Coal mining and exploration lease areas with 'Constable' located approximately 5.4 kilometres to the north east. At these stations daily rainfall has been recorded from 2000 to 2006, however, this record is intermittent due to initial recording problems with the gauges. None of the Mt Arthur Coal meteorology stations record evaporation.

None of the seven stations above have continuous records of daily rainfall for a one hundred year period. None of the BOM Stations in close proximity to the project area record evaporation. The closest BOM Station which has long term daily rainfall records is Denman (Virginia Street, Station 61016) with daily rainfall recorded over a 112 year period from 1894 to 2006.

There are three Bureau of Meteorology stations in the surrounding area which record evaporation. These stations are Scone (Station 61089), Jerrys Plains (Station 61086) and Kerrabee (Murrumbo) (Station 62046). Scone (Station 61089) has the longest complete period of record of rainfall and evaporation record which spans the 34 years from 1973 to 2006.

Comparison of rainfall data for Denman (Virginia Street, Station 61016) and Scone (Station 61089) for the period from 1973 to 2006, shows that the 10th percentile annual rainfall is 441 mm at Denman compared to 407 mm at Scone. The analysis also shows that the average annual rainfall at these stations is 631 mm and 615 mm respectively. As shown in **Table 1**, Denman and Scone, for the period from 1973 to 2006, have similar average annual rainfall indicating that both of these rainfall data sets could be used for water balance prediction purposes for the project.

Table 1 - Comparison of Annual Rainfall Data

Statistic	Denman (Virginia Street, Station 61016)		Scone (Station 61089) (1973 - 2006)	Difference (1973 to 2006)
	(1894-2006) (Complete Record)	(1973-2006)		
10th Percentile Rainfall (mm)	352	441	407	-8%
Average Rainfall (mm)	583	631	615	-3%
90th Percentile Rainfall (mm)	784	806	811	0.5%

Source: Bureau of Meteorology

Annual pan evaporation recorded at Scone (Station 61089) ranges from 1329 mm per year to 2093 mm per year for the period of record (1973 to 2006). Analysis of the historical record shows an expected trend of evaporation increasing during the summer months and decreasing during the winter months. Average daily Scone evaporation data for each month of the year is shown in **Table 2**. An analysis of historical data indicates that average daily evaporation typically exceeds average daily rainfall through all months of the year.

Table 2 - Average Daily Pan Evaporation

Month	Average Daily Pan Evaporation (mm/day)
January	6.3
February	5.0
March	3.6
April	2.5
May	1.9
June	2.0
July	2.9
August	4.3
September	5.7
October	6.9
November	7.4
December	7.2

Evaporation data from Scone (Station 61089) is considered to adequately represent the evaporation rates experienced at Muswellbrook, as evaporation tends to be regionally driven.

2. Water Balance Model Structure

A computer model of the proposed water management system has been developed for Mt Arthur Coal. In this model the water management system is able to be represented by modules that represent catchments and components of the proposed mining operation.

The model operates on a daily time step and has been set up to provide for, or calculate:

- water to be transferred to and from each module;

- runoff volumes entering each of the modules based on daily rainfall;

- evaporative losses from each of the modules based on water storage area and daily evaporation;

- net water usage for dust suppression and processing;

- water imported from external sources;

- overflows from on-site dams; and

- changes in water storage volumes for each module on a daily basis.

The model provides for future development of the mine and also enables a range of management options to be explored and modelled. Operational data, catchment and storage characteristics, rainfall and evaporation data and water usage data are stored in a database that enables data to be readily updated/modified, and subsets of time series data to be easily generated.

The model uses PHP scripting language to utilise the information stored in the database to simulate the responses of the water management system to prevailing climatic conditions. The scripting language used also enables data to be archived and model outputs to be graphed or exported to files for further analysis. Adoption of this system provides considerable flexibility in terms of exploring potential modifications to the water management system and analysing any of the output data that has been generated during a simulation.

The model can be set to run over any daily time period and can be programmed to stop at preset times or when predetermined trigger levels are reached to allow modifications to be made to the water management system.

Runoff is calculated from two components. The first runoff component is direct rainfall onto the dam surfaces, in this case 100 per cent runoff is used (i.e. none of the rainfall is lost). The second component is runoff from overland flow across the catchment areas. For this component of runoff two losses are considered; an initial loss and a continuing loss.

Evaporation is calculated as the direct evaporation from the water surface of the dams.

Rainfall/runoff and evaporation relationships used in the model are:

- Initial Loss = 4 mm/day;

- Continuing Loss = $(\text{Rainfall} – \text{Initial Loss})^{0.79}$;

- Runoff = $1.0 \times (\text{Rainfall} – \text{Initial Loss} – \text{Continuing Loss})^{0.66}$; and

- Evaporation Loss = 0.7 x Pan Evaporation x Wetted Surface Area of Dam/Storage.

The relationships described above for rainfall/runoff and evaporation were developed based on analysis of water management systems for quarrying and mining operations. The variables used for the proposed Mt Arthur Coal water model have been selected to simulate the soil and climatic conditions experienced in the mine water management system.

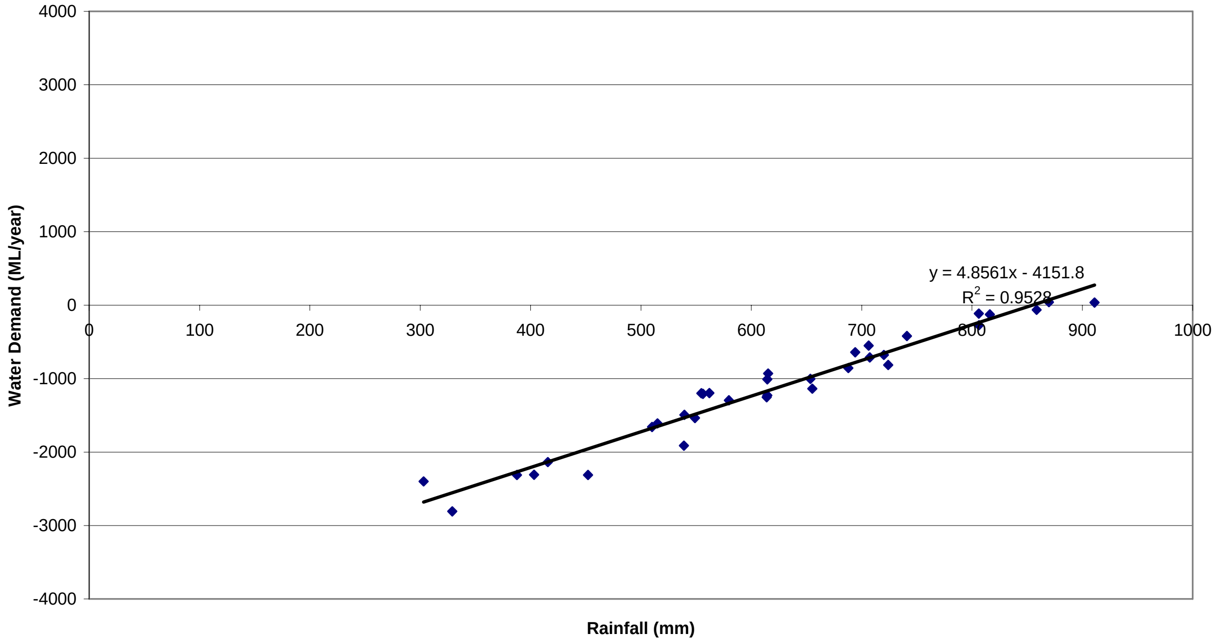
3. Water Balance Model Results

The results from the water balance modelling for both the existing water balance and the water balance with the proposed Underground Project are included below.

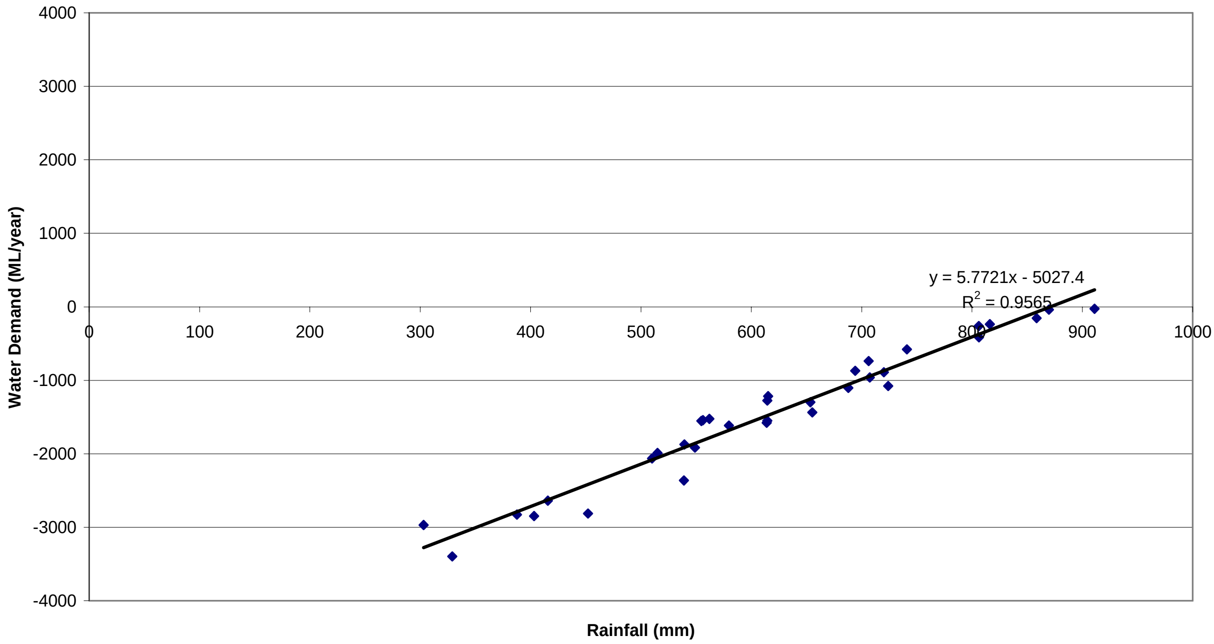
The graphs show the following results:

- Graph A.1 – Existing 2005 Site Water Balance – Annual Rainfall v Net Water Demand (Scone Rainfall);
- Graph A.2 – Existing 2009 Site Water Balance – Annual Rainfall v Net Water Demand (Scone Rainfall);
- Graph A.3 – Existing 2022 Site Water Balance – Annual Rainfall v Net Water Demand (Scone Rainfall);
- Graph A.4 – Existing 2026 Site Water Balance – Annual Rainfall v Net Water Demand (Scone Rainfall);
- Graph A.5 – Predicted Cumulative Water Balance – Existing Operations – 2005, 2009, 2022 and 2026 (Denman Rainfall);
- Graph A.6 – Year 1 Predicted Site Water Balance – Annual Rainfall v Net Water Demand;
- Graph A.7 – Year 3 Predicted Site Water Balance – Annual Rainfall v Net Water Demand (Scone Rainfall);
- Graph A.8 – Year 14 Predicted 2005 Site Water Balance – Annual Rainfall v Net Water Demand (Scone Rainfall);
- Graph A.9 – Year 18 Predicted Site Water Balance – Annual Rainfall v Net Water Demand (Scone Rainfall);
- Graph A.10 – Year 21 Predicted Site Water Balance – Annual Rainfall v Net Water Demand (Scone Rainfall); and
- Graph A.11 – Predicted Cumulative Water Balance – Year 1, 3, 14,18 and 21 Mine Configuration with Underground Project (Denman Rainfall).

Graph A.1 - Existing 2005 Site Water Balance
Annual Rainfall v Net Water Demand

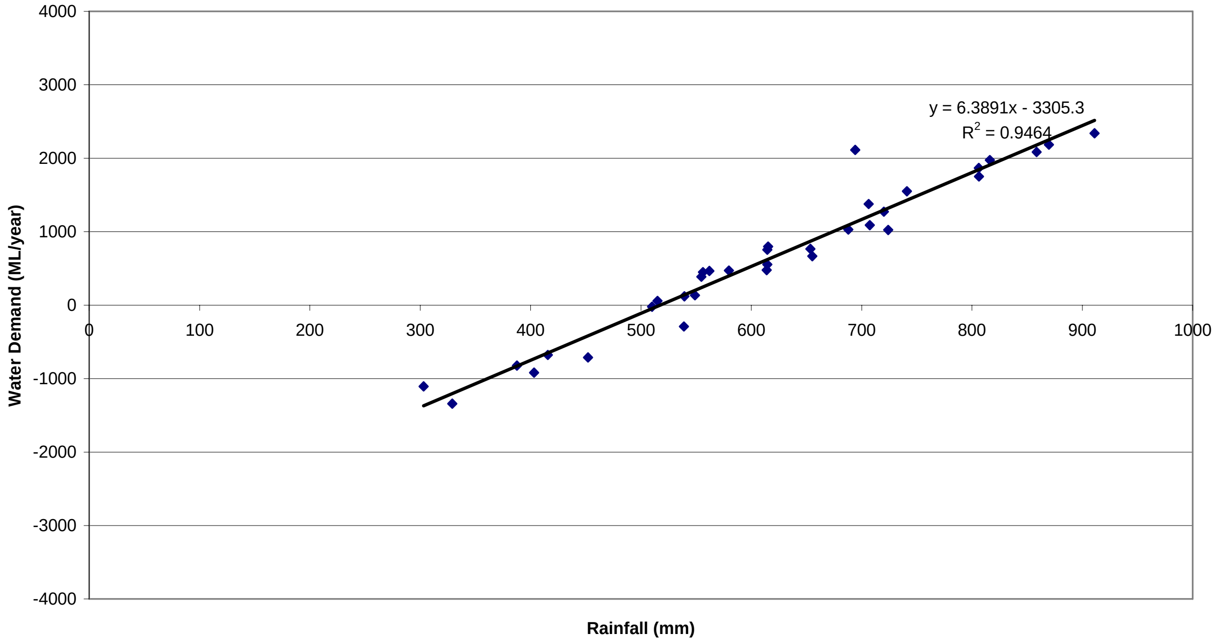


Graph A.2 - Existing 2009 Site Water Balance
Annual Rainfall v Net Water Demand

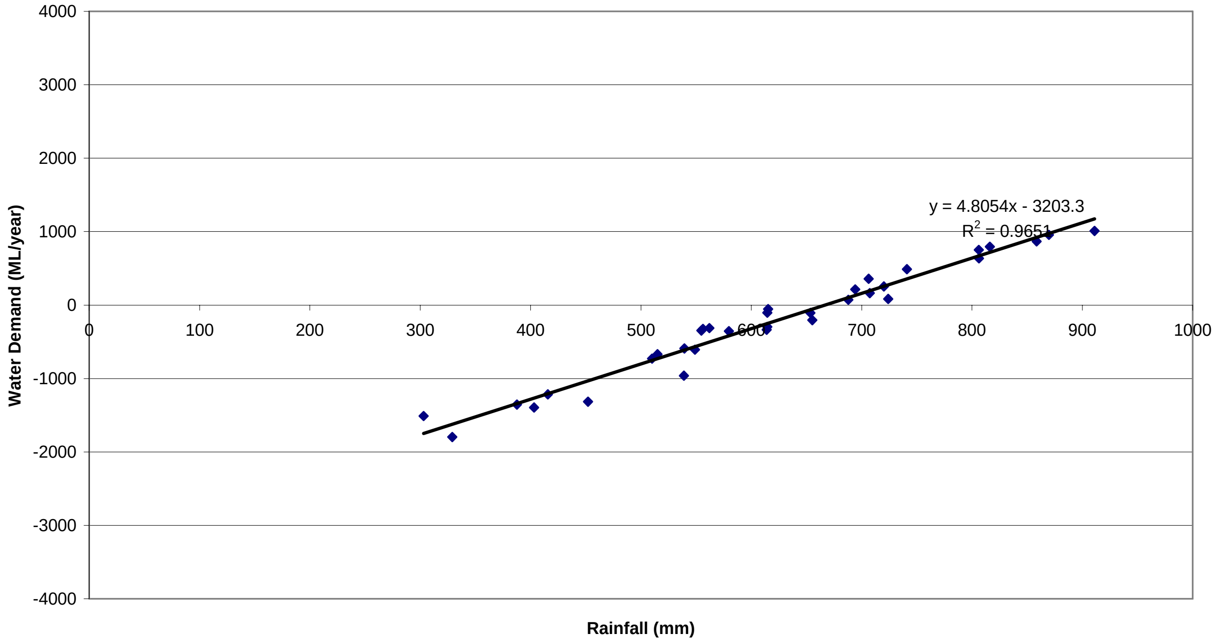


GRAPHS A.1 & A.2

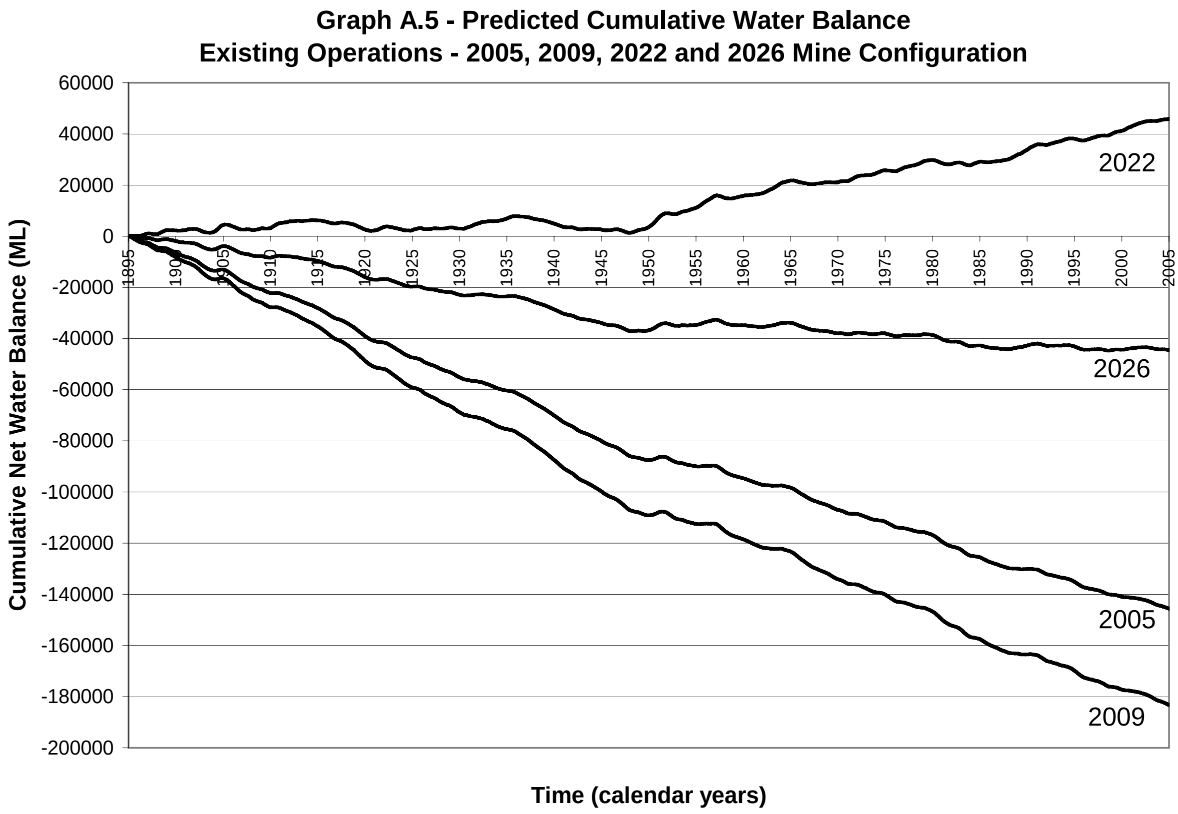
Graph A.3 - Existing 2022 Site Water Balance
Annual Rainfall v Net Water Demand

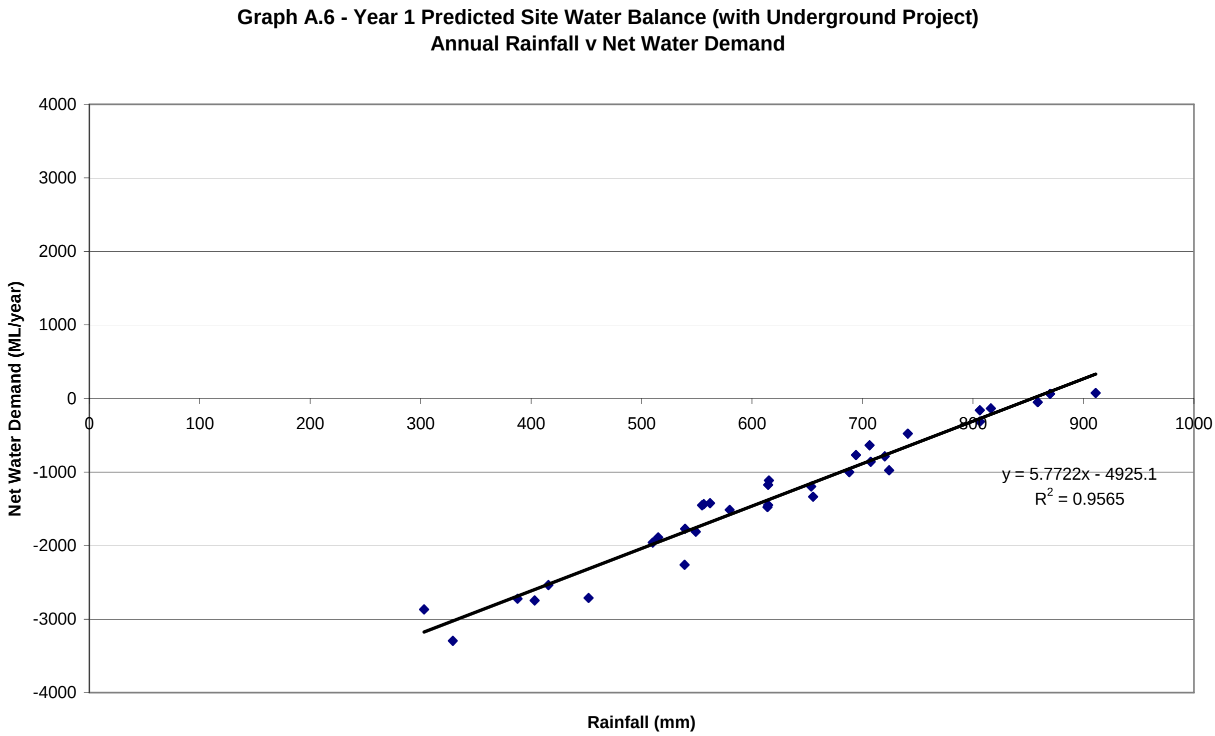


Graph A.4 - Existing 2026 Site Water Balance
Annual Rainfall v Net Water Demand



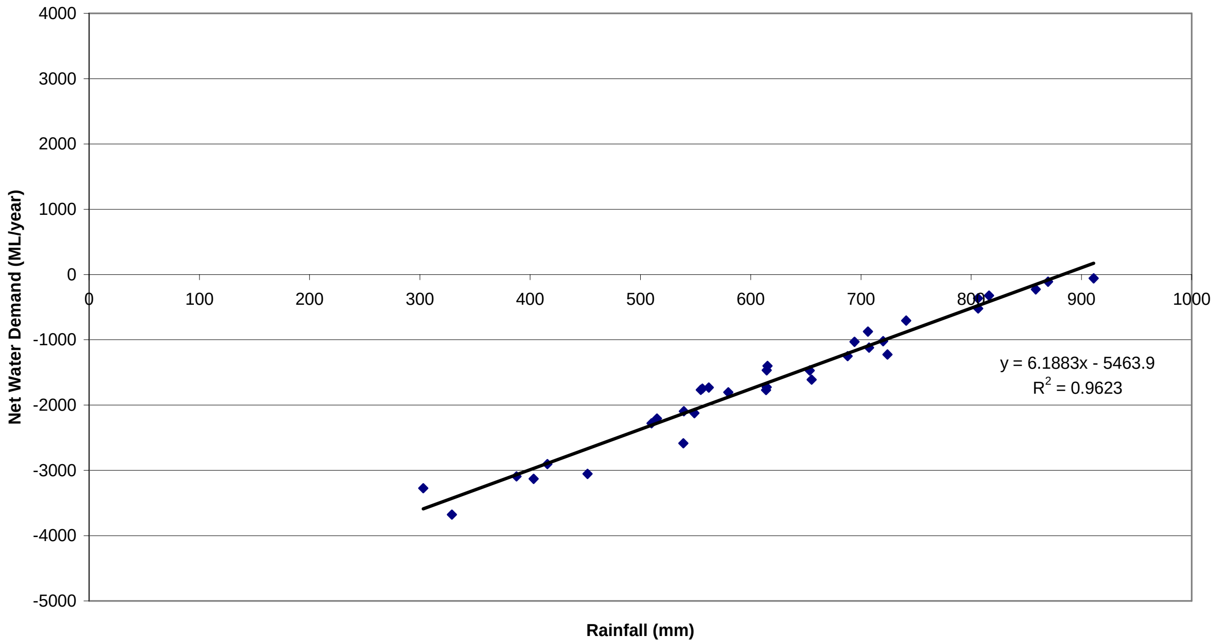
GRAPHS A.3 & A.4


Graph A.5 - Predicted Cumulative Water Balance
Existing Operations - 2005, 2009, 2022 and 2026 Mine Configuration
Cumulative Net Water Balance (ML)
Time (calendar years)
2022
2026
2005
2009
60000
40000
20000
0
-20000
-40000
-60000
-80000
-100000
-120000
-140000
-160000
-180000
-200000
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005

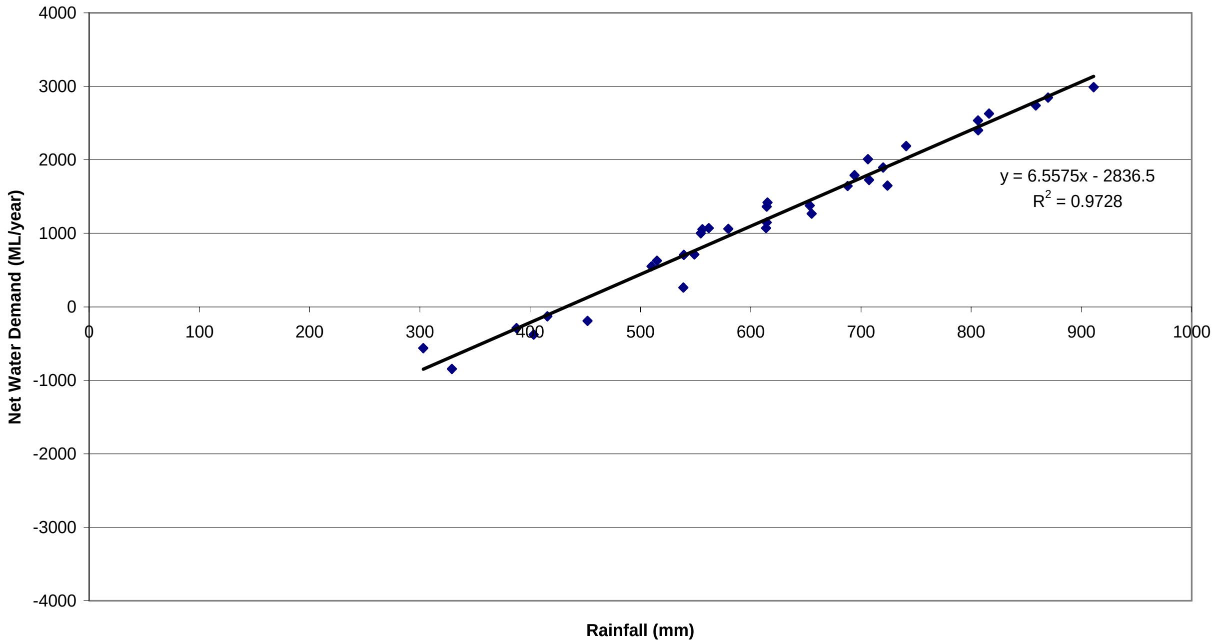

Graph A.6 - Year 1 Predicted Site Water Balance (with Underground Project)
Annual Rainfall v Net Water Demand
Net Water Demand (ML/year)
Rainfall (mm)
y = 5.7722x - 4925.1
R2 = 0.9565
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
0
100
200
300
400
500
600
700
800
900
1000

GRAPHS A.5 & A.6

**Graph A.7 - Year 3 Predicted Site Water Balance (with Underground Project)
Annual Rainfall v Net Water Demand**

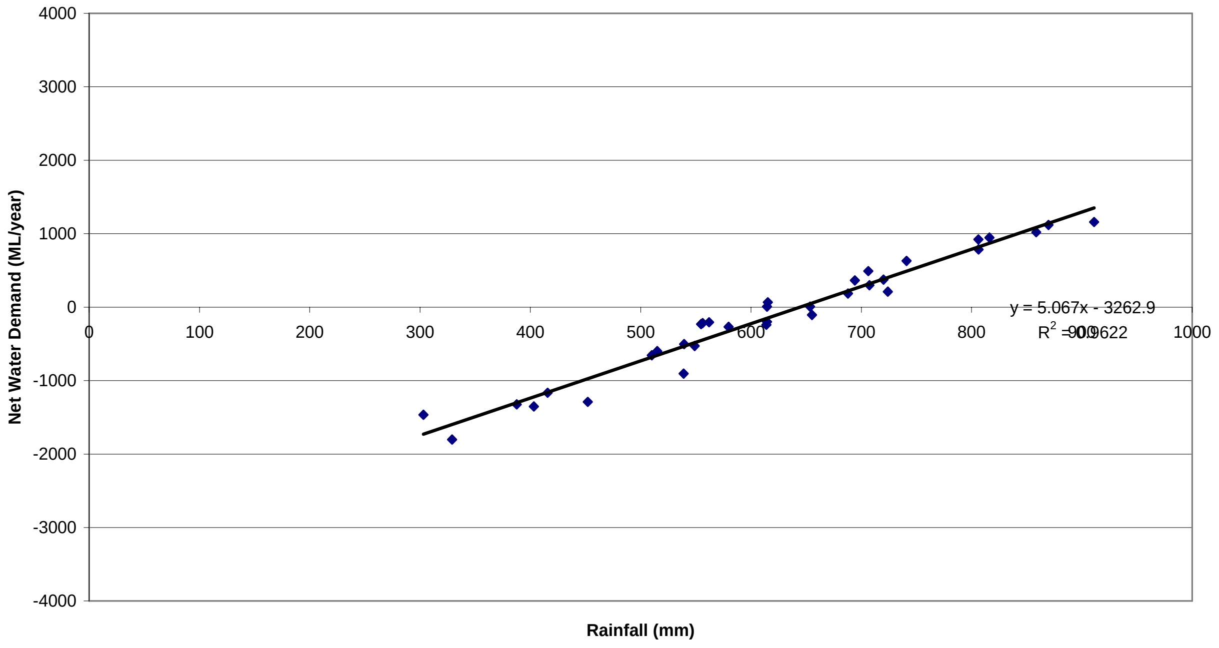


**Graph A.8 - Year 14 Predicted Site Water Balance (with Underground Project)
Annual Rainfall v Net Water Demand**

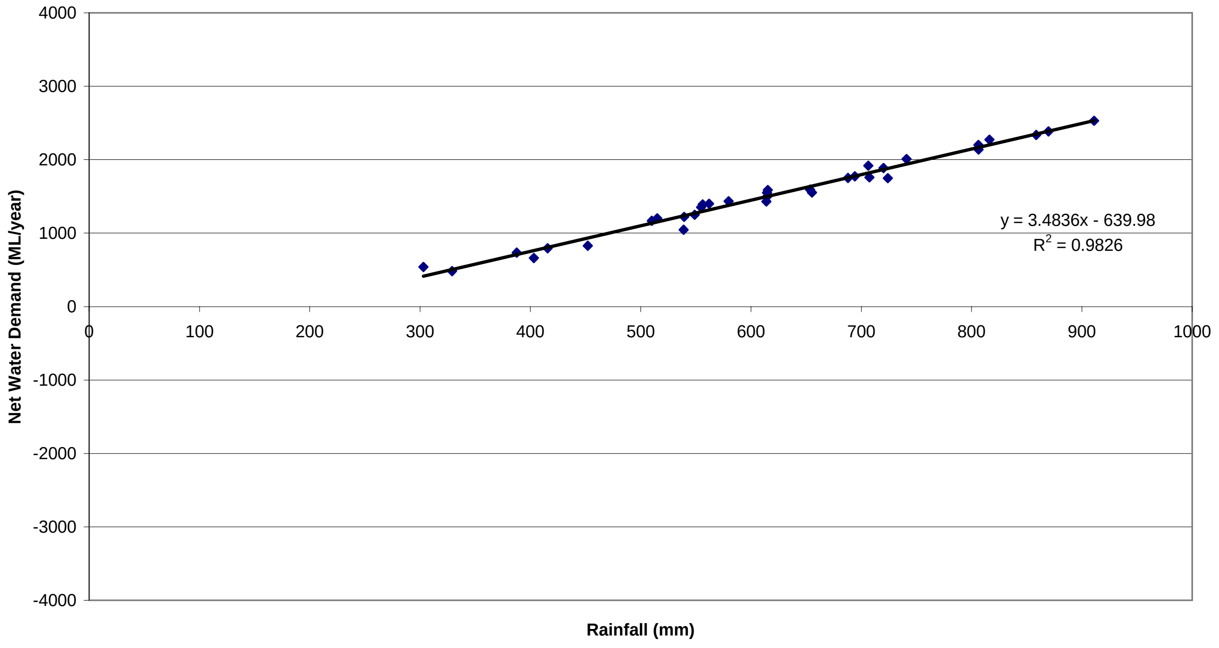


GRAPHS A.7 AND A.8

Graph A.9 - Year 18 Predicted Site Water Balance (with Underground Project)
Annual Rainfall v Net Water Demand

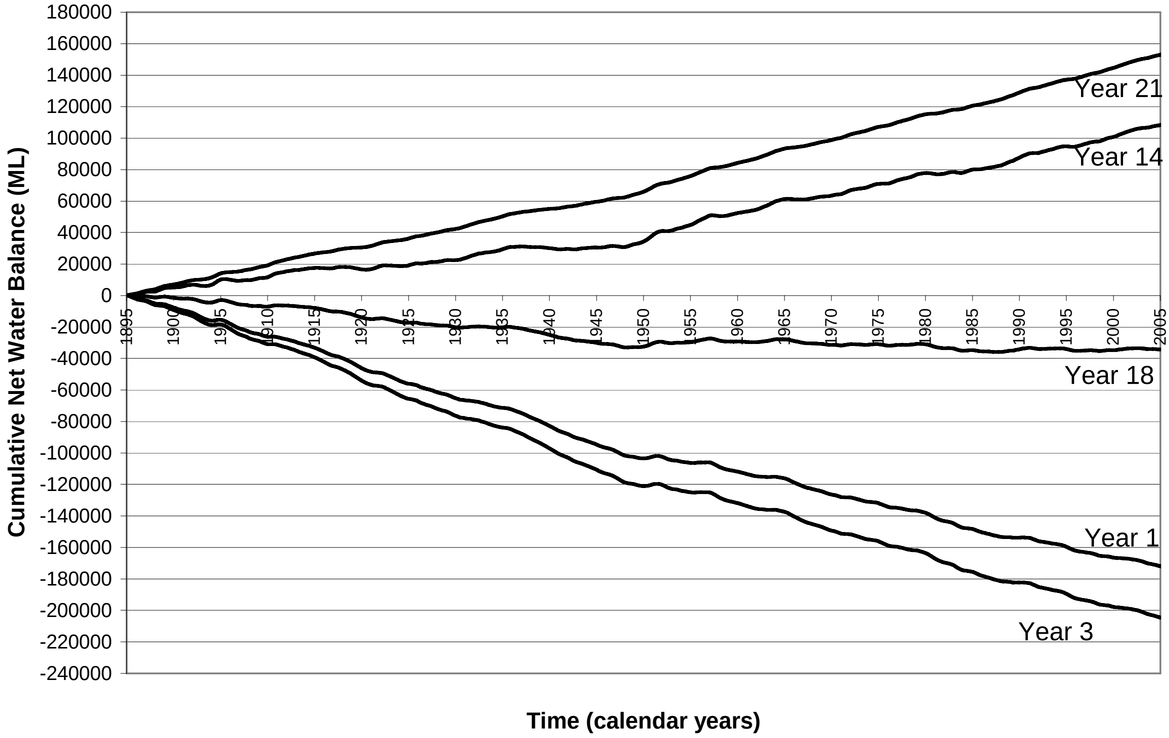


Graph A.10 - Year 21 Predicted Site Water Balance (with Underground Project)
Annual Rainfall v Net Water Demand



GRAPHS A.9 & A.10

Graph A.11 - Predicted Cumulative Water Balance
Year 1, 3, 14, 18 and 21 Mine Configuration with Underground Project



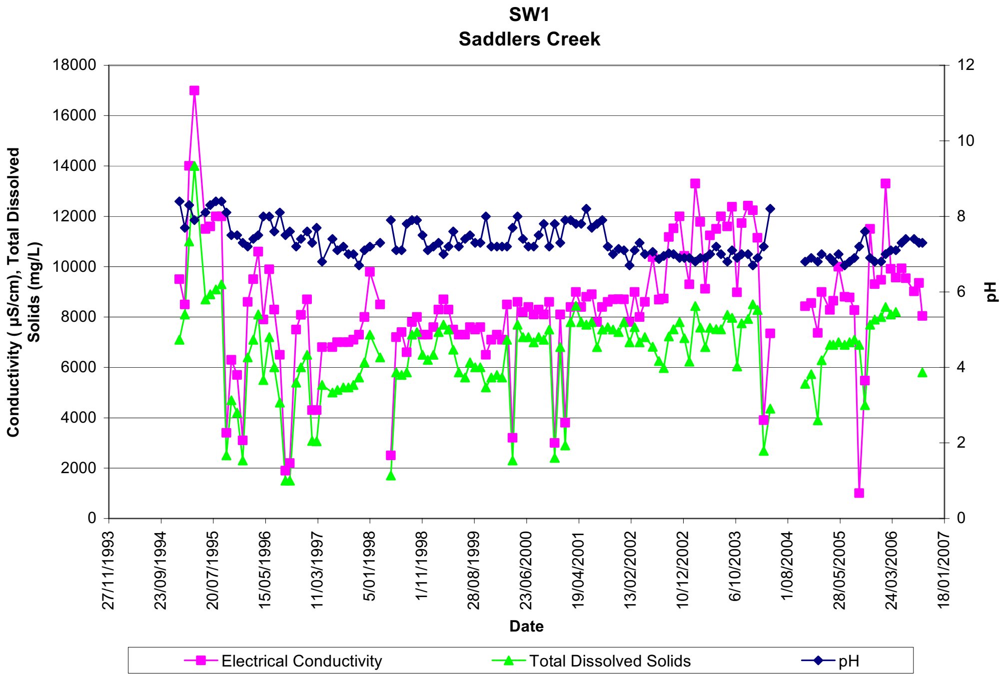
GRAPH A.11

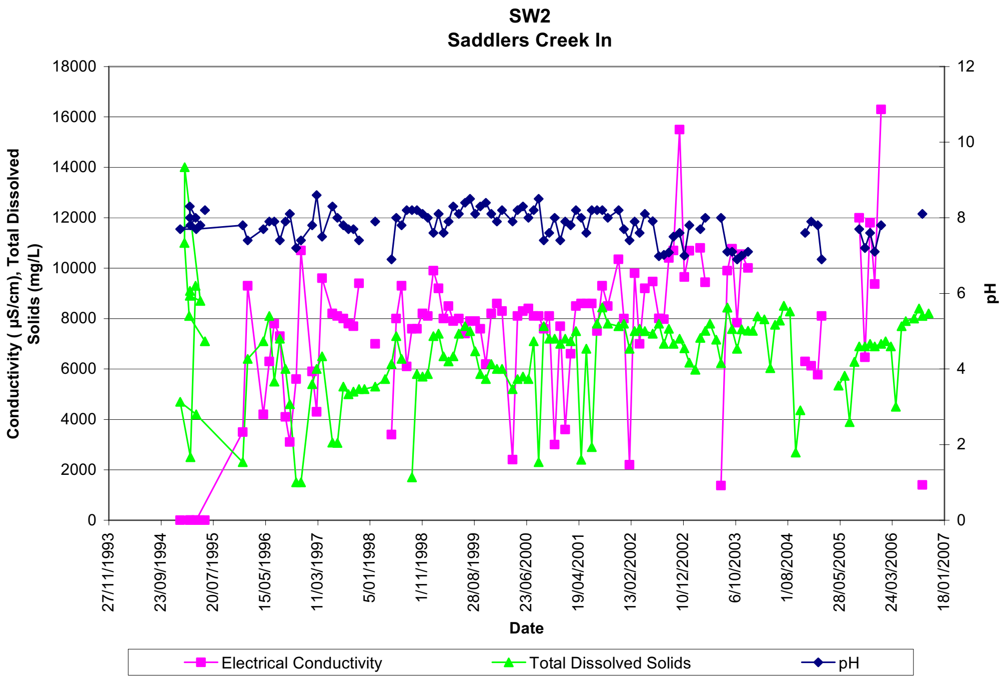
APPENDIX 2

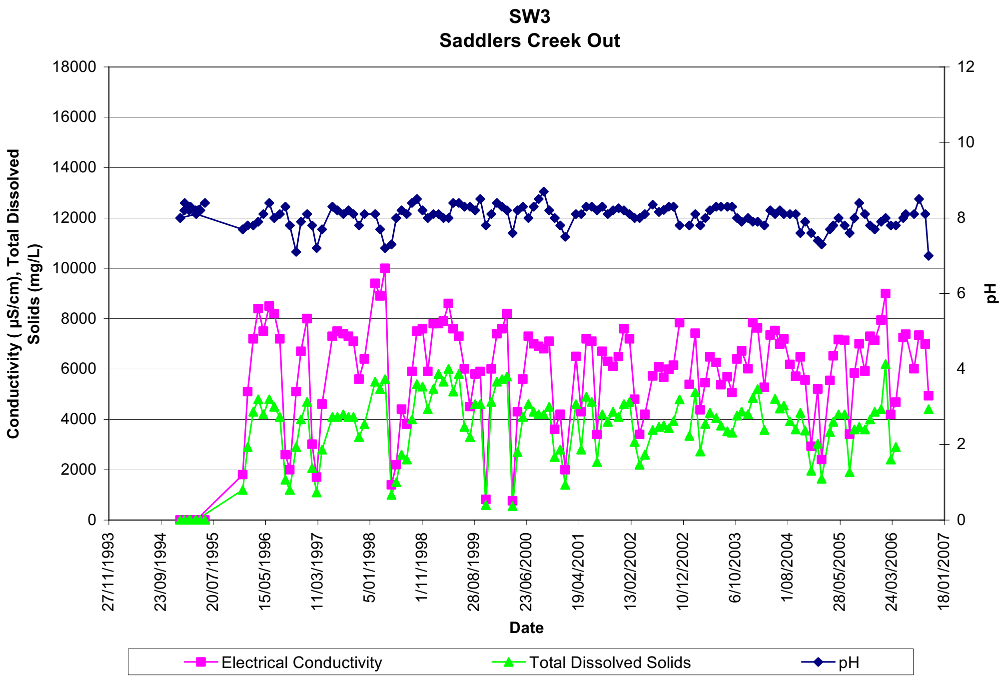
Water Quality Graphs

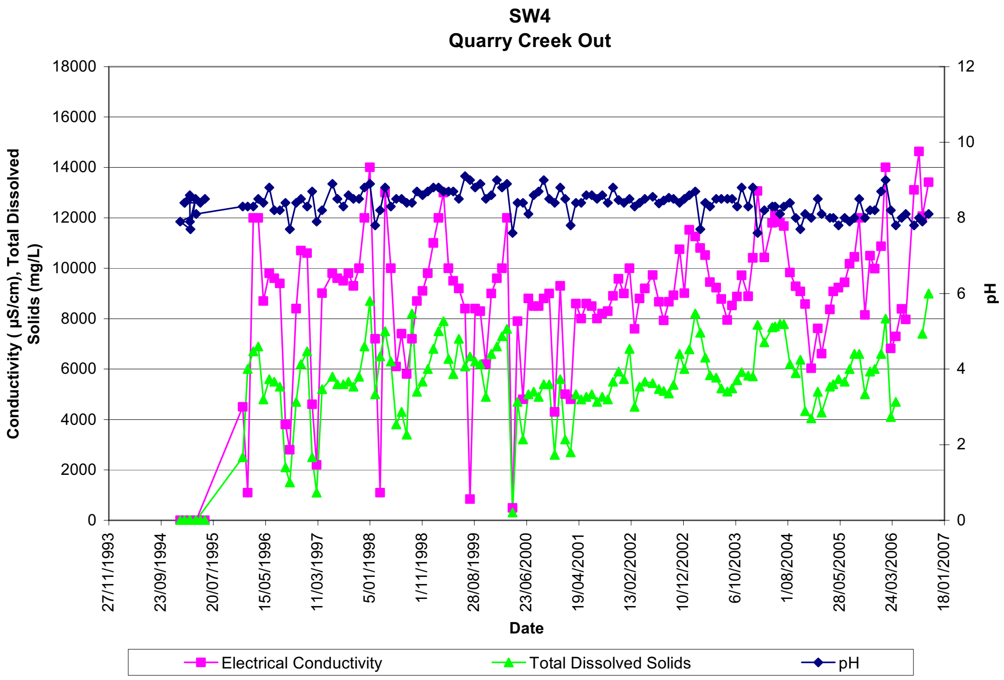
Appendix 2 – Water Quality Graphs

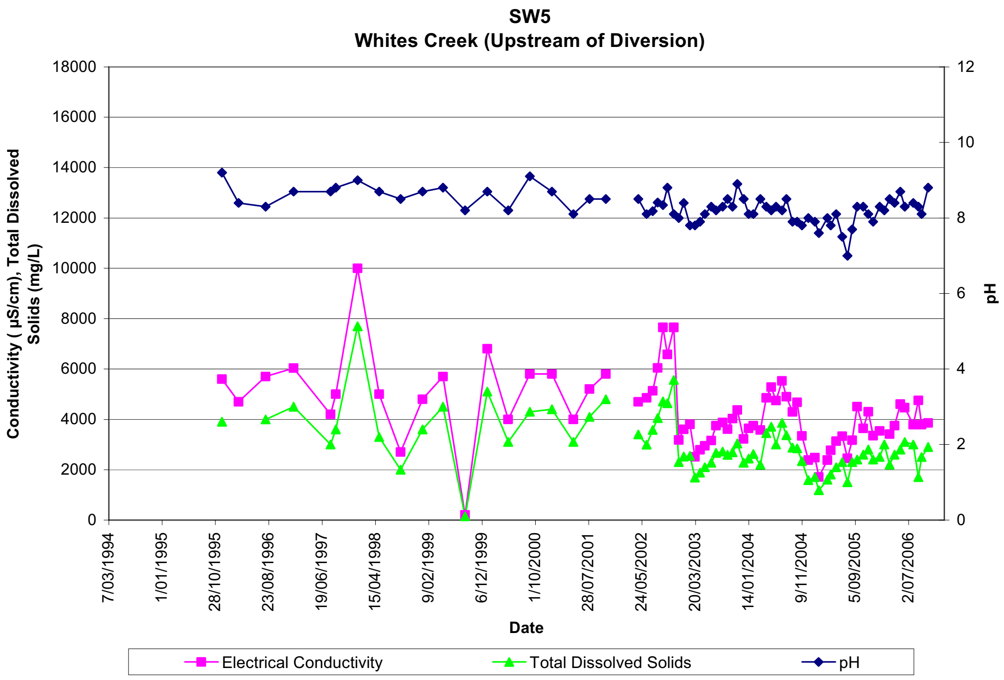
Section 1A - Water Quality - Surrounding Environment

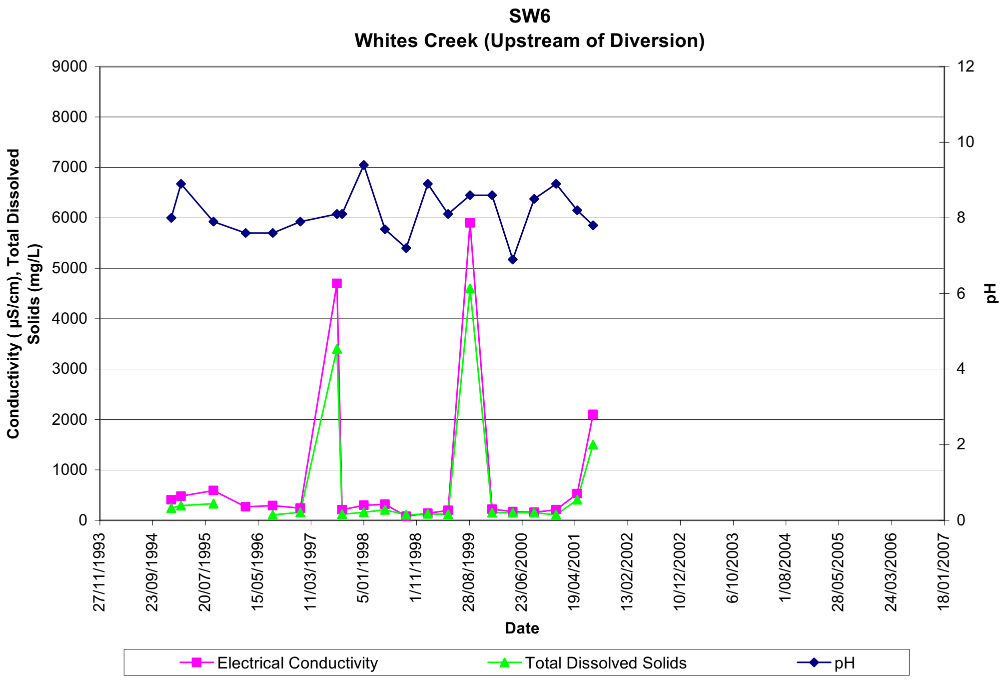


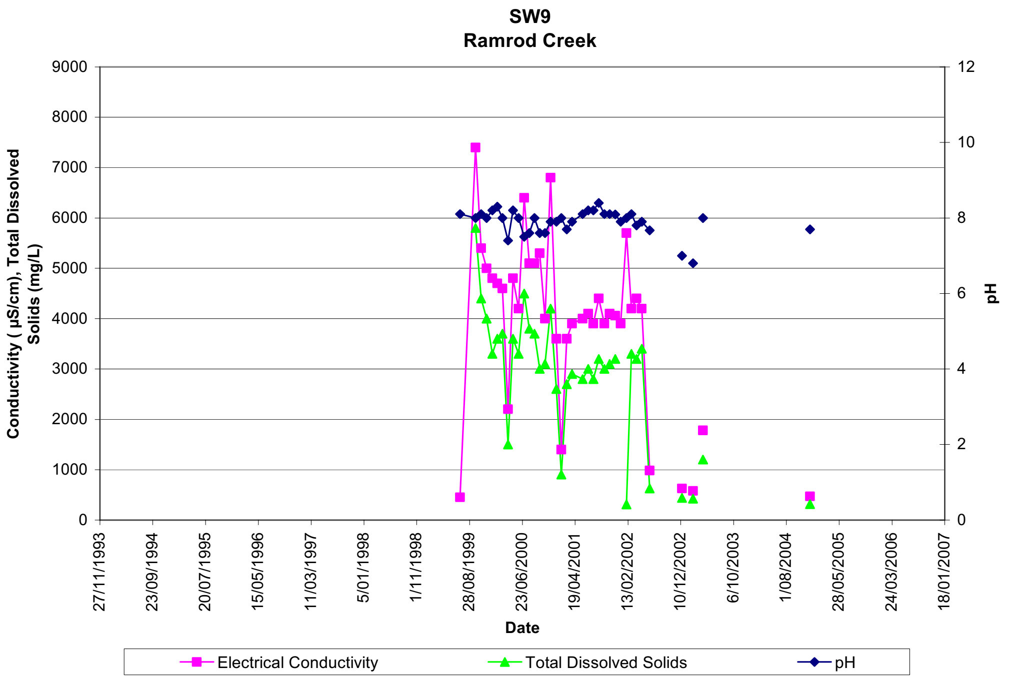


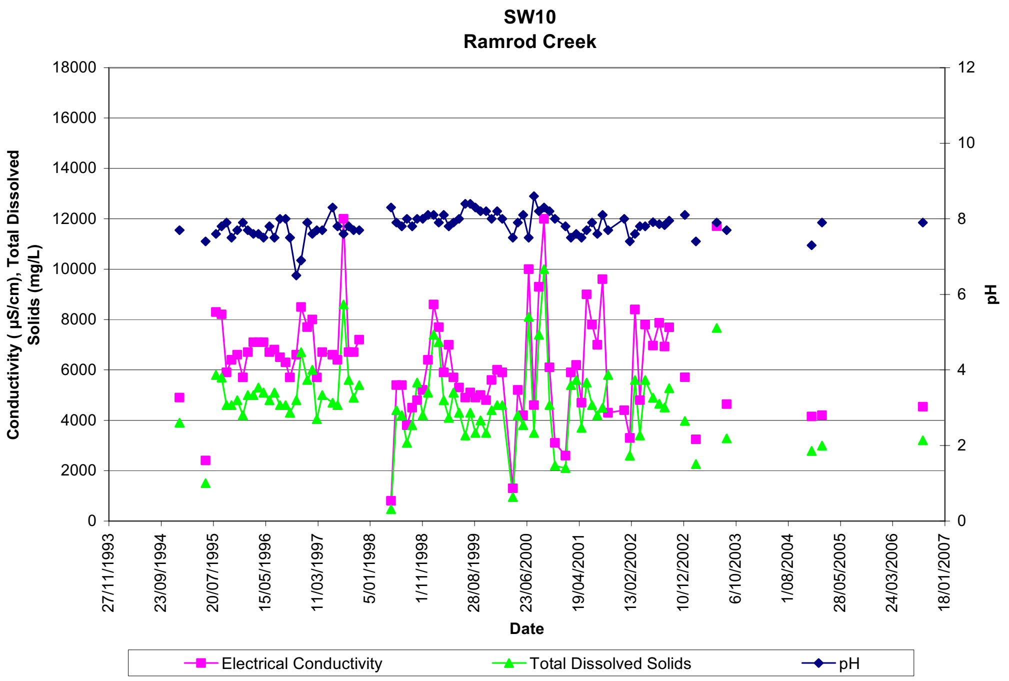

SW3
Saddlers Creek Out
Conductivity (µS/cm), Total Dissolved Solids (mg/L)
pH
Date
27/11/1993
23/09/1994
20/07/1995
15/05/1996
11/03/1997
5/01/1998
1/11/1998
28/08/1999
23/06/2000
19/04/2001
13/02/2002
10/12/2002
6/10/2003
1/08/2004
28/05/2005
24/03/2006
18/01/2007
Electrical Conductivity
Total Dissolved Solids
pH

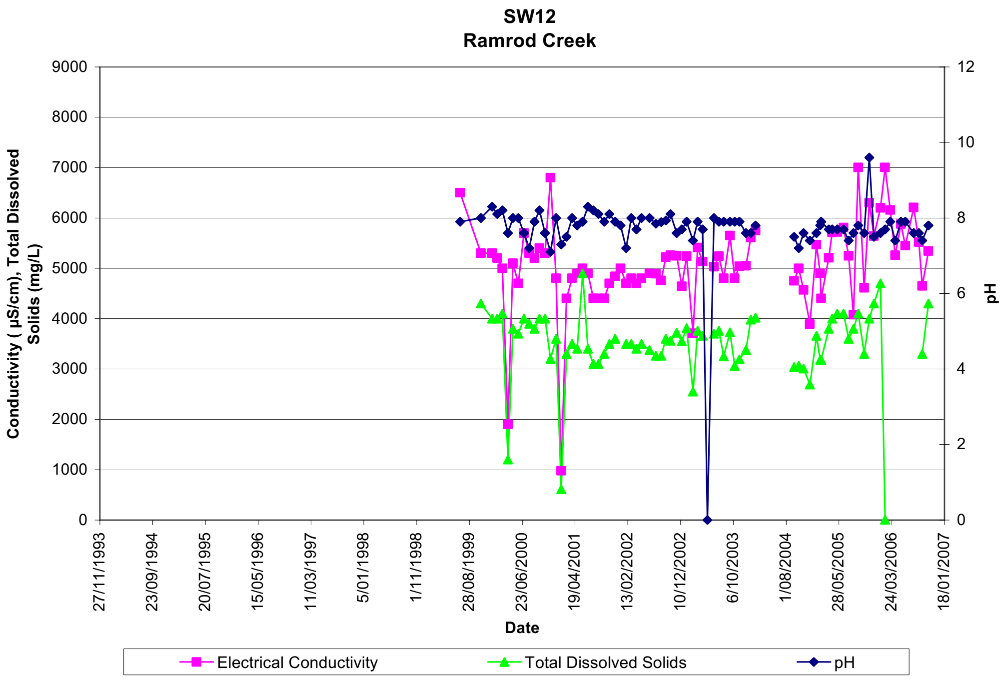

SW4
Quarry Creek Out
Conductivity (µS/cm), Total Dissolved Solids (mg/L)
pH
Date
27/11/1993
23/09/1994
20/07/1995
15/05/1996
11/03/1997
5/01/1998
1/11/1998
28/08/1999
23/06/2000
19/04/2001
13/02/2002
10/12/2002
6/10/2003
1/08/2004
28/05/2005
24/03/2006
18/01/2007
Electrical Conductivity
Total Dissolved Solids
pH

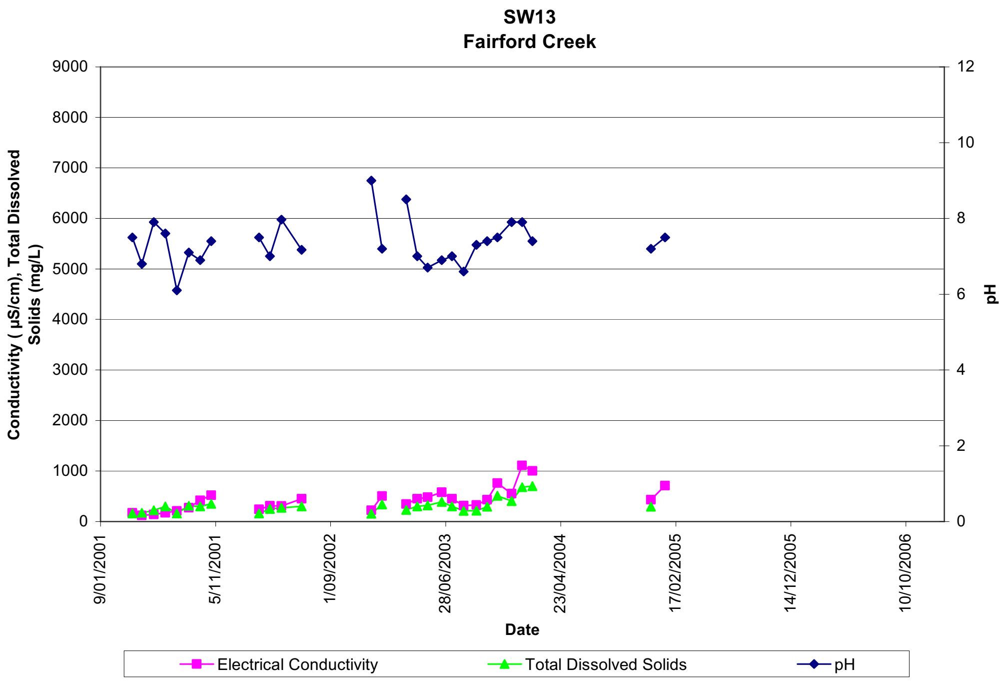

SW5
Whites Creek (Upstream of Diversion)
Conductivity (µS/cm), Total Dissolved Solids (mg/L)
pH
Date
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
2
4
6
8
10
12
7/03/1994
1/01/1995
28/10/1995
23/08/1996
19/06/1997
15/04/1998
9/02/1999
6/12/1999
1/10/2000
28/07/2001
24/05/2002
20/03/2003
14/01/2004
9/11/2004
5/09/2005
2/07/2006
Electrical Conductivity
Total Dissolved Solids
pH

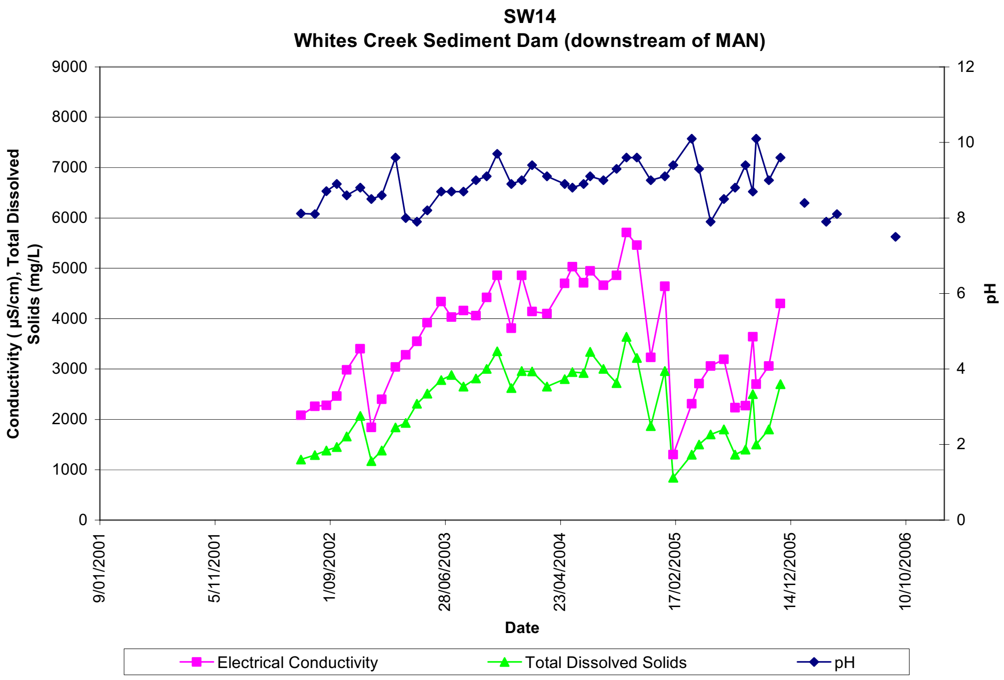

SW6
Whites Creek (Upstream of Diversion)
Conductivity (µS/cm), Total Dissolved Solids (mg/L)
pH
Date
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
2
4
6
8
10
12
27/11/1993
23/09/1994
20/07/1995
15/05/1996
11/03/1997
5/01/1998
1/11/1998
28/08/1999
23/06/2000
19/04/2001
13/02/2002
10/12/2002
6/10/2003
1/08/2004
28/05/2005
24/03/2006
18/01/2007
Electrical Conductivity
Total Dissolved Solids
pH

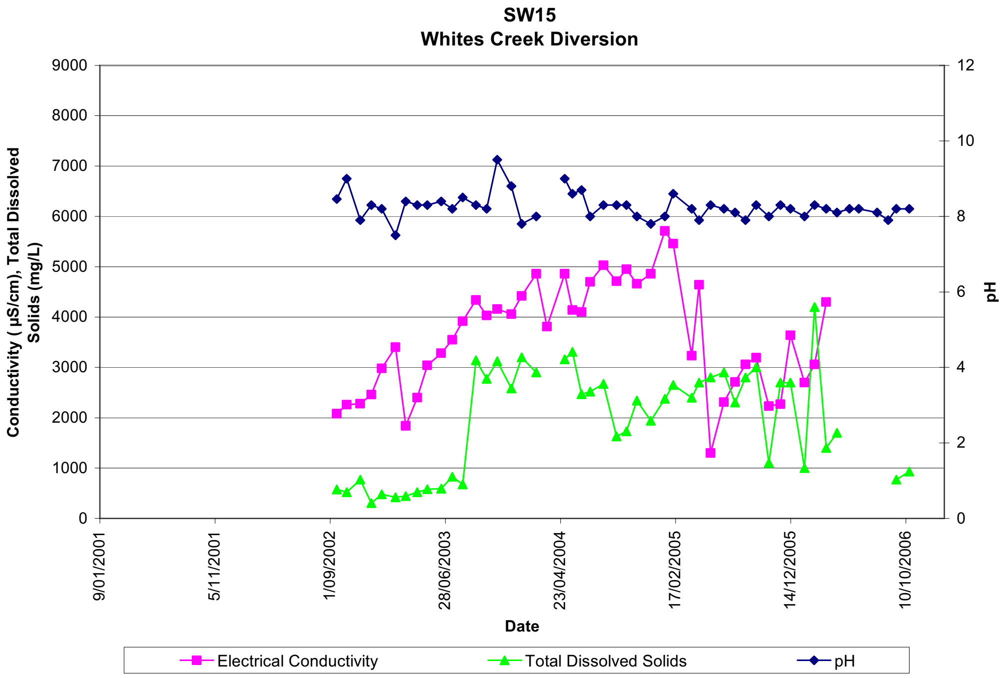

SW9
Ramrod Creek
Conductivity (µS/cm), Total Dissolved Solids (mg/L)
pH
Date
Electrical Conductivity
Total Dissolved Solids
pH

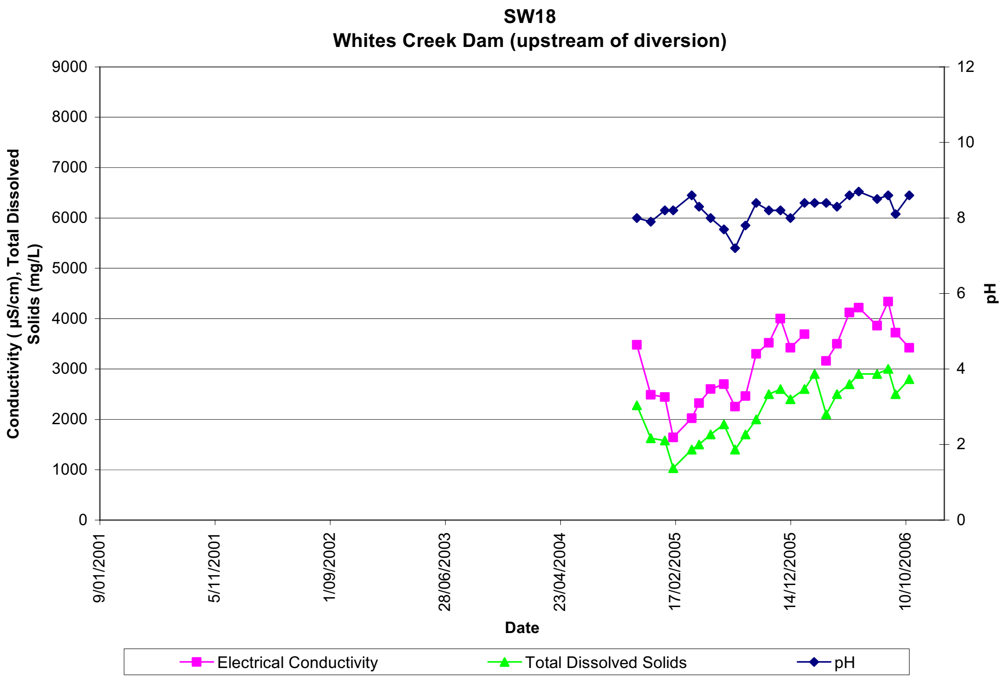

SW10
Ramrod Creek
Conductivity (µS/cm), Total Dissolved Solids (mg/L)
pH
Date
Electrical Conductivity
Total Dissolved Solids
pH


SW12
Ramrod Creek
Conductivity (µS/cm), Total Dissolved Solids (mg/L)
pH
Date
27/11/1993
23/09/1994
20/07/1995
15/05/1996
11/03/1997
5/01/1998
1/11/1998
28/08/1999
23/06/2000
19/04/2001
13/02/2002
10/12/2002
6/10/2003
1/08/2004
28/05/2005
24/03/2006
18/01/2007
Electrical Conductivity
Total Dissolved Solids
pH


SW13
Fairford Creek
Conductivity (µS/cm), Total Dissolved Solids (mg/L)
pH
Date
9/01/2001
5/11/2001
1/09/2002
28/06/2003
23/04/2004
17/02/2005
14/12/2005
10/10/2006
Electrical Conductivity
Total Dissolved Solids
pH

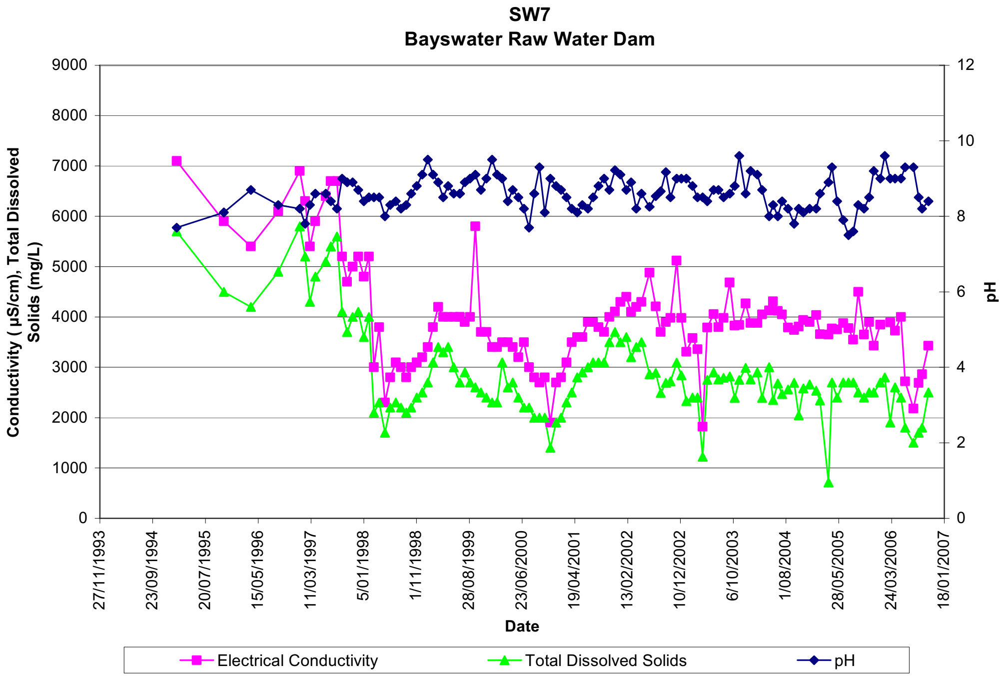

SW14
Whites Creek Sediment Dam (downstream of MAN)
Conductivity (µS/cm), Total Dissolved Solids (mg/L)
pH
Date
9/01/2001
5/11/2001
1/09/2002
28/06/2003
23/04/2004
17/02/2005
14/12/2005
10/10/2006
Electrical Conductivity
Total Dissolved Solids
pH

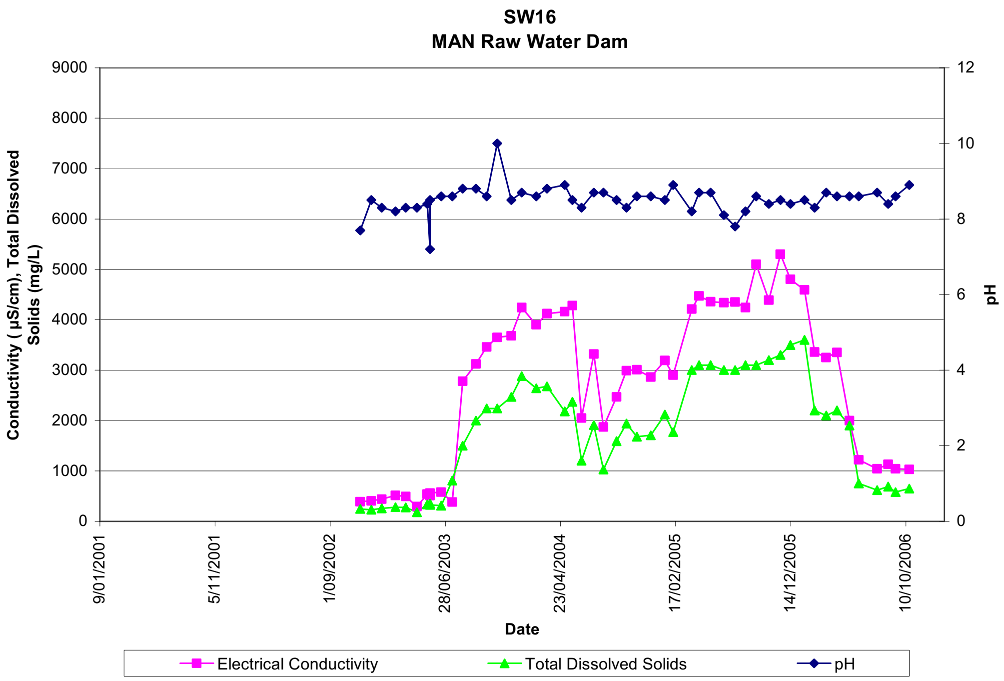

SW15
Whites Creek Diversion
Conductivity (µS/cm), Total Dissolved Solids (mg/L)
pH
Date
9/01/2001
5/11/2001
1/09/2002
28/06/2003
23/04/2004
17/02/2005
14/12/2005
10/10/2006
Electrical Conductivity
Total Dissolved Solids
pH

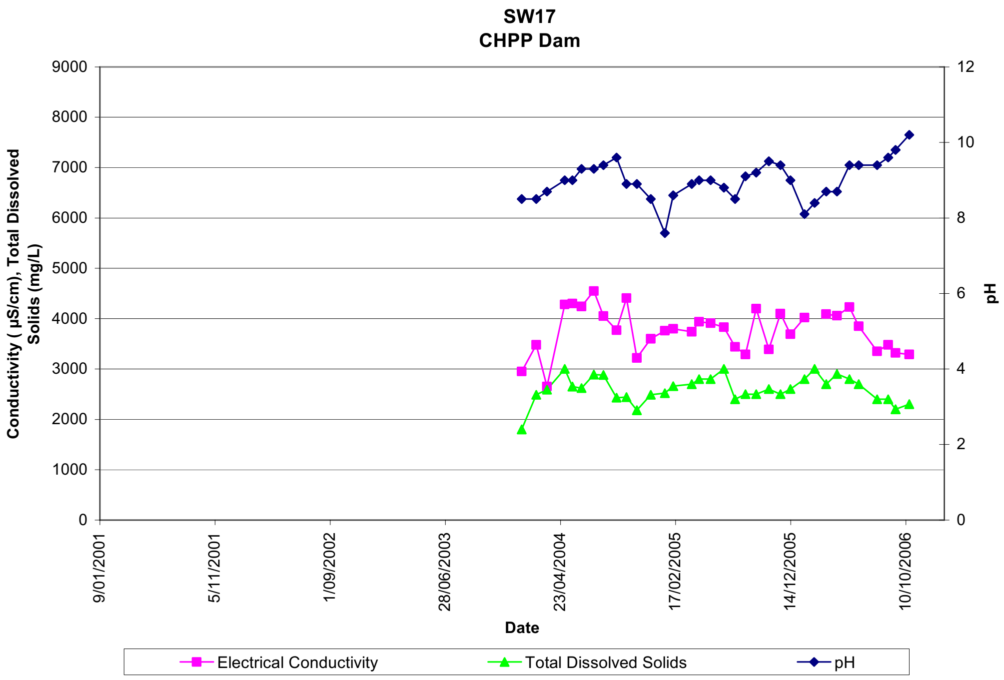


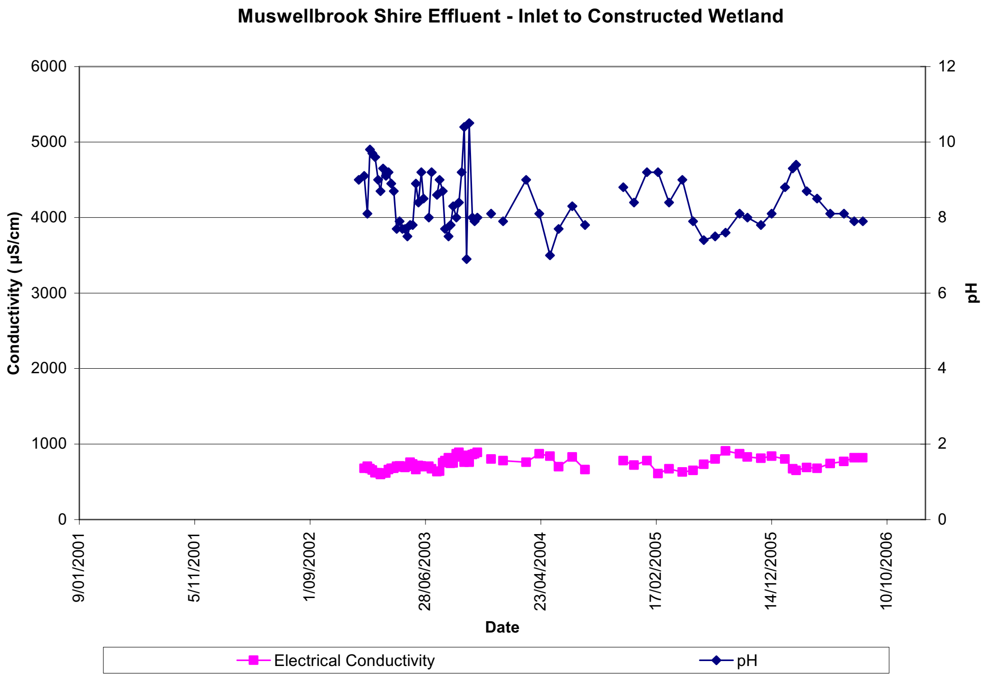
SW18
Whites Creek Dam (upstream of diversion)
Conductivity (µS/cm), Total Dissolved Solids (mg/L)
pH
Date
9/01/2001
5/11/2001
1/09/2002
28/06/2003
23/04/2004
17/02/2005
14/12/2005
10/10/2006
Electrical Conductivity
Total Dissolved Solids
pH

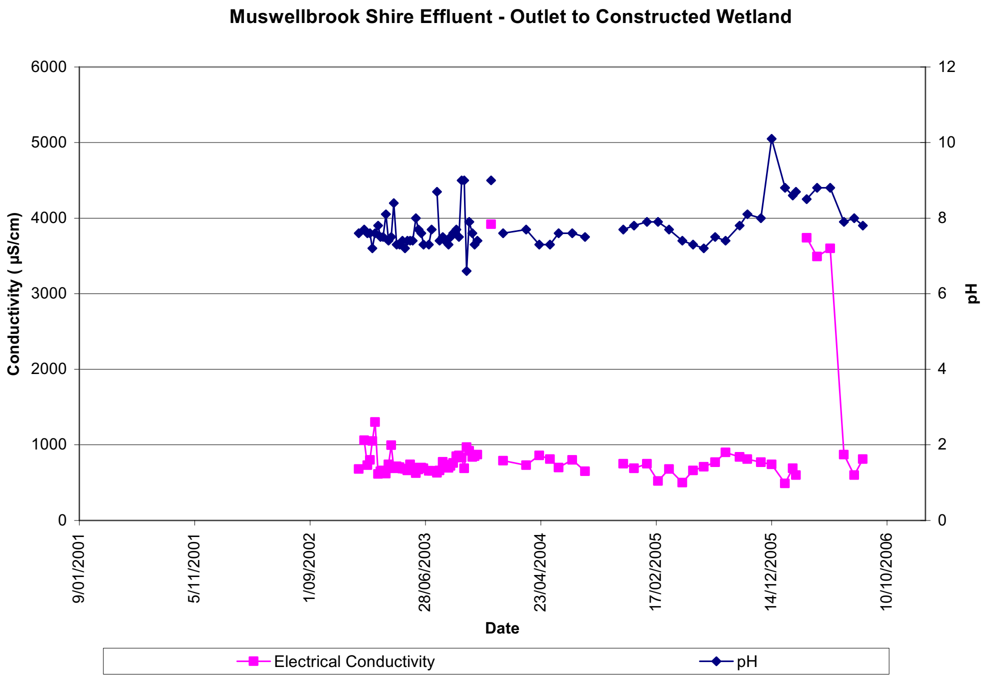
Section 1B - Water Quality - Mt Arthur Mine Water Management System

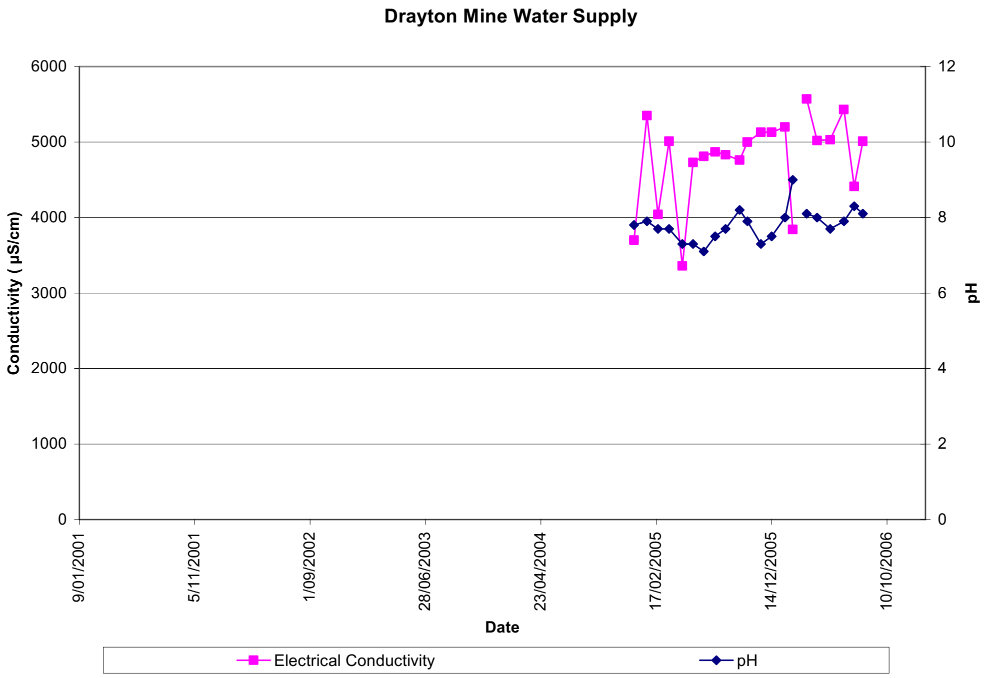





SW17
CHPP Dam
Conductivity (µS/cm), Total Dissolved Solids (mg/L)
pH
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
12
10
8
6
4
2
0
9/01/2001
5/11/2001
1/09/2002
28/06/2003
23/04/2004
17/02/2005
14/12/2005
10/10/2006
Date
Electrical Conductivity
Total Dissolved Solids
pH


Muswellbrook Shire Effluent - Inlet to Constructed Wetland
Conductivity (µS/cm)
pH
6000
5000
4000
3000
2000
1000
0
12
10
8
6
4
2
0
9/01/2001
5/11/2001
1/09/2002
28/06/2003
23/04/2004
17/02/2005
14/12/2005
10/10/2006
Date
Electrical Conductivity
pH


Muswellbrook Shire Effluent - Outlet to Constructed Wetland
6000
5000
4000
3000
2000
1000
0
Conductivity (µS/cm)
12
10
8
6
4
2
0
pH
9/01/2001
5/11/2001
1/09/2002
28/06/2003
23/04/2004
17/02/2005
14/12/2005
10/10/2006
Date
Electrical Conductivity
pH


Drayton Mine Water Supply
6000
5000
4000
3000
2000
1000
0
Conductivity (µS/cm)
12
10
8
6
4
2
0
pH
9/01/2001
5/11/2001
1/09/2002
28/06/2003
23/04/2004
17/02/2005
14/12/2005
10/10/2006
Date
Electrical Conductivity
pH