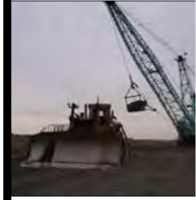
WATER MANAGEMENT ASSESSMENT

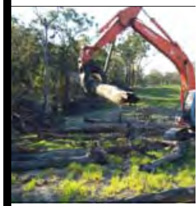
INCLUDING:

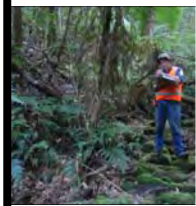
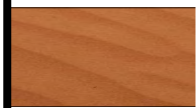
APPENDIX A: POLLUTION CONTROL DAM ASSESSMENT

APPENDIX B: WATER BALANCE

APPENDIX C: WATER QUALITY





APPENDIX 6

Centennial Newstan Pty Ltd

Awaba Colliery
Water Management Assessment
May 2010

FUTURE POWER | Centennial Coal

Contents

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Appendices

Glossary

Aquifer	Underground water storage within either disturbed or undisturbed strata.
Average Recurrence Interval	A statistical estimate of the average period in years between the occurrence of a flood of a given size or larger, eg. floods with a discharge as big as, or larger than, the 100-year ARI flood event will occur on average once every 100 years. ARI is equal to the reciprocal of annual flood risk, e.g. an annual flood risk of 1/100 has an ARI of 100 years.
Barnes Dam	An underground water storage location. Discharges from Barnes Dam are via LDP005.
Boot Wash	Location where personnel can wash their safety boots.
Bord and Pillar	A mining system whereby coal is extracted leaving ‘pillars’ of untouched coal to support the strata above.
Bore	A constructed connection between the surface and a source of underground water that enables the underground water to be transferred to the surface either naturally or through artificial means
Clean catchment areas	Catchments in which there are no exposed surfaces containing coal or mined carbonaceous material.
Clean water	Waters on the premises that have not come into physical contact with coal, or mined carbonaceous material.
Coal Handling Plant	A facility where coal is screened and prepared for transport off-site.
Dewatering	Transfer of water from underground workings to the surface.
Dirty catchment areas	Catchments in which coal mined carbonaceous materials are present or areas where the topsoil has been disturbed.
Dirty water	Water on the premises that has come into physical contact with coal, mined carbonaceous materials or otherwise contains elevated sediment load.
Electrical Conductivity	A measure of concentration of dissolved salts in water.
Fish Tank	Underground water storage tank located in the proximity of Barnes Dam.
Fractures	Cracks within the strata either natural or resulting from underground works.
Groundwater	Water held in strata that is not overlying the strata of the coal seam, or within the coal seam.

Infiltration	Natural flow of surface water through ground surfaces as a result of rainfall events.
Inbye	Direction towards the mining face of the coal seam.
In-Seam Coal Storage Bin	Coal Storage Bin located at the end of the coal conveyor south of the workshop.
Interburden	The strata between coal seams.
Licensed Discharge Point	A location where Awaba Colliery discharges water in accordance with conditions stipulated within the site Environment Protection License.
Net extraction	Difference between water transferred to, and from, the underground water storage.
Oil Water Separator	Device designed to separate oil and suspended solids from water.
Overburden	The strata between the recoverable topsoil and the upper coal seam.
pH	A measure of the acidity / alkalinity or water as a result of potential hydrogen ion concentration.
Pollution Control Dam	A dam located downstream of the pit top facilities. LDP009 is located on the spillway of this dam.
Recharge	Inflow of water from surrounding strata into underground workings through infiltration. This can be as a result of rainfall events or from surrounding aquifers.
Sediment-laden water	Water that has a high level of suspended solids.
Steady state condition	A condition in which the system has achieved equilibrium.
Surface Water	Water that is derived from precipitation or pumped from underground and may be stored in dams, rivers, creeks and drainage lines.
Temporary storage	Volume of storage available within a dam between the permanent water level and the overflow level.
Total Suspended Solids	Particles that are suspended in a measured volume of water.
Turbidity	A measure of water cloudiness caused by the amount of suspended matter in the water.
Underground water	Water stored in underground aquifers. During the mining process a proportion of this water is released and managed by the underground settling and pumping system.

Abbreviations

AEMR	Annual Environmental Management Report
AHD	Australian Height Datum
ARI	Average Recurrence Interval
CHP	Coal Handling Plant
DECCW	Department of Environment, Climate Change and Water
DOP	Department of Planning
EA	Environmental Assessment
EC	Electrical Conductivity
EP&A Act	Environmental Planning and Assessment Act 1979
EPL	Environment Protection Licence
kL	Kilolitres
LDP	Licensed Discharge Point
m	Metres
MB	Monitoring bore
ML	Megalitres
MTpa	Million Tonnes per annum
NOW	New South Wales Office of Water
NMQMS	National Water Quality Management Strategy
PA	Project Approval
POEO Act	Protection of the Environment Operations Act 1997
ROM	Run of Mine
STP	Sewage Treatment Plant
T	Tonnes
TSS	Total Suspended Solids
WMAct	Water Management Act 2000

Executive Summary

The operation owned by Centennial Newstan at Awaba Colliery is an underground operation for which the management of both surface and underground water is an important issue.

The objective of this water management assessment was to assess the existing conditions with respect to both surface and groundwater and to determine the potential impact of the proposed operations on current and proposed water management systems.

The aspects of the water system that were investigated included:

- Clean water management.
- Dirty water management.
- Underground water management.
- Overall site water balance.
- Water quality.

The key component of the Project that would potentially impact water management was determined to be the construction of additional storage associated with the Pollution Control Dam. It was determined that the construction of this facility will reduce the number of discharges through LDP009 from an average annual rate of 1.0 ML/year to 0.2 ML/year.

It was determined that the removal of Barnes Dam (and LDP005) would also have an impact on water management but to a lesser extent. As a result of the removal of this dam, discharges through 10 South to the Eraring Ash Dam would increase from an average annual of 82 ML/year to 173.6 ML/year. A review of inflows to the Ash Dam indicated that the impact of Awaba Colliery would increase from approximately 2% to 3% of the total daily inflows. Therefore it was considered that changes to the water management system at Awaba Colliery would have minimal impact on the Ash Dam.

To provide greater flexibility for Awaba Colliery in maintaining an underground water level of -2 m AHD, an increased pumping capacity of 1.2 ML/day has been recommended. In the event that this is adopted, the impact of Awaba Colliery on the Eraring Ash Dam would increase to 8.5% of the total inflows. Again this is not considered to be a significant impact on the Ash Dam.

1. Introduction

Awaba Colliery is a small underground coal mine operated by Centennial Newstan Pty Ltd (Newstan), a wholly owned subsidiary of Centennial Coal Company Ltd (Centennial). The mine entry and primary surface facilities are located approximately one kilometre south of the Awaba village and 5.5 kilometres south west of Toronto on Wilton Road on the western side of Lake Macquarie, near Newcastle NSW.

Awaba Colliery has been producing coal by bord and pillar method since 1947. The site is situated on crown land under lease to Centennial for the purpose of mining under Consolidated Coal Lease CCL746, and is adjacent to the Newstan-Eraring haul road owned by Eraring Energy. The locality of the mine is illustrated on Figure 1.1.

At present, it is anticipated that the Project will recover approximately 2.0 million tonnes of coal which will be extracted from those areas depicted in Study Area 2 and Study Area 3 (refer to Section 1.1) over a period of approximately five years or more, depending on actual mining conditions and relevant market drivers. The application for the proposed Project is supported by an Environmental Assessment ("EA").

Awaba Colliery is a small operation with approximately 100 employees and contractors, historically producing around 800,000 tonnes of thermal coal annually. Since commencing mining operations in 1947, over 30 million tonnes of coal has been won from the Great Northern Seam using a combination of first workings development, pillar extraction, pillar quartering, and pillar stripping.

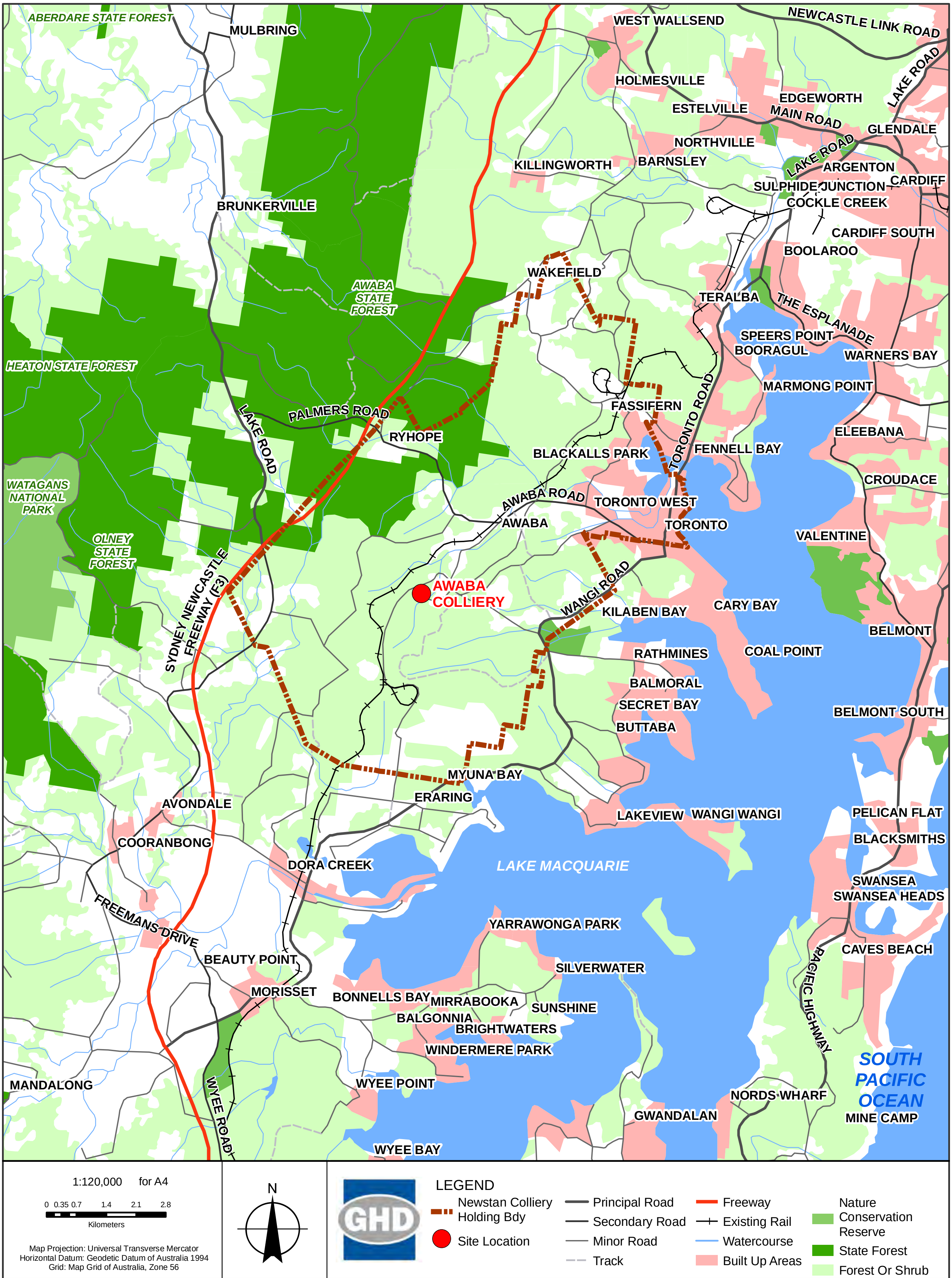
A form of pillar extraction of narrow panels is used to recover coal in pillars developed previously by bord and pillar methods. Development of bords (roadways) and pillars is ongoing but in some areas were developed many years ago. This mining method currently utilises continuous miners. Mine planning ensures panels are not extracted where depth of cover or surface constraints preclude total extraction. This mining method has been developed in consultation with the Department of Primary Industries – Mineral Resources (now known as Industry and Investment, NSW (I&I)) and has been used successfully to date, and is proposed to be continued for the Project.

Mining operations commenced at the Awaba Colliery in 1947, prior to the commencement of any planning controls, and have continued without abandonment since that time. Consequently, the Awaba Colliery presently operates pursuant to section 109(1) of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and clause 6B(1) of the *State Environmental Planning Policy (Major Development) 2005*. An application for a Part 3A Project Approval has been lodged by Centennial for the *Awaba Colliery Mining Project (the "Project"),* which seeks approval from the Minister of Planning to allow an extension of underground mining and the ongoing use of associated surface operations. A detailed description of the Project and the Project Application Area *(the "Application Area")* (including focus study areas) is detailed further in Sections 1.1 and 1.2 below.

Minimal changes are proposed to existing surface operations, with one proposed additional surface disturbance relating to increased pollution control dam capacity located in a previously disturbed area. No significant changes to coal handling are proposed.

Underground mining areas requiring approval to allow continued mine operations and production are outlined in Sections 1.1 and 1.2 below.

At present, it is anticipated that the Project will recover approximately 2.0 million tonnes of coal which will be extracted from those areas depicted in Study Area 2 and Study Area 3 (refer Section 1.1) over a period of approximately five years or more, depending on actual mining conditions and relevant market drivers. The application for the proposed Project is supported by an Environmental Assessment (“EA”).



Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

LOCATION	Awaba
SEAM	Great Northern
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Awaba Colliery

Locality Plan

Centennial Awaba

DATE 20-04-2010

Figure 1.1

GIS Filename: G\22\15033\GIS\MAPS\Deliverables\Surface Water Assessment\2215033_FIG1-1_Locality_20100420.mxd

1.1 Project Application Area

The **Project Application Area** (the "Application Area") is illustrated on Figure 1.2. The Application Area has been identified as the footprint of the proposed Project including proposed mining areas and related surface operations that are considered relevant to the continuation of Awaba Collieries operations, as well as, the existing workings areas that will continue to be relied upon for ventilation and other mining related purposes, access to proposed mining areas or for any required emergency evacuation.

The Application Area has been broken into a number of Study Areas based on the types of activities to be undertaken for the Project. These Study Areas are outlined below. The extent of the existing workings has not been included as a Study Area as it is considered inappropriate to obtain retrospective approval for historical operations. Additionally, there are no activities proposed in these areas for the Project and ongoing management of these areas is covered by the existing Awaba Colliery Mining Lease conditions.

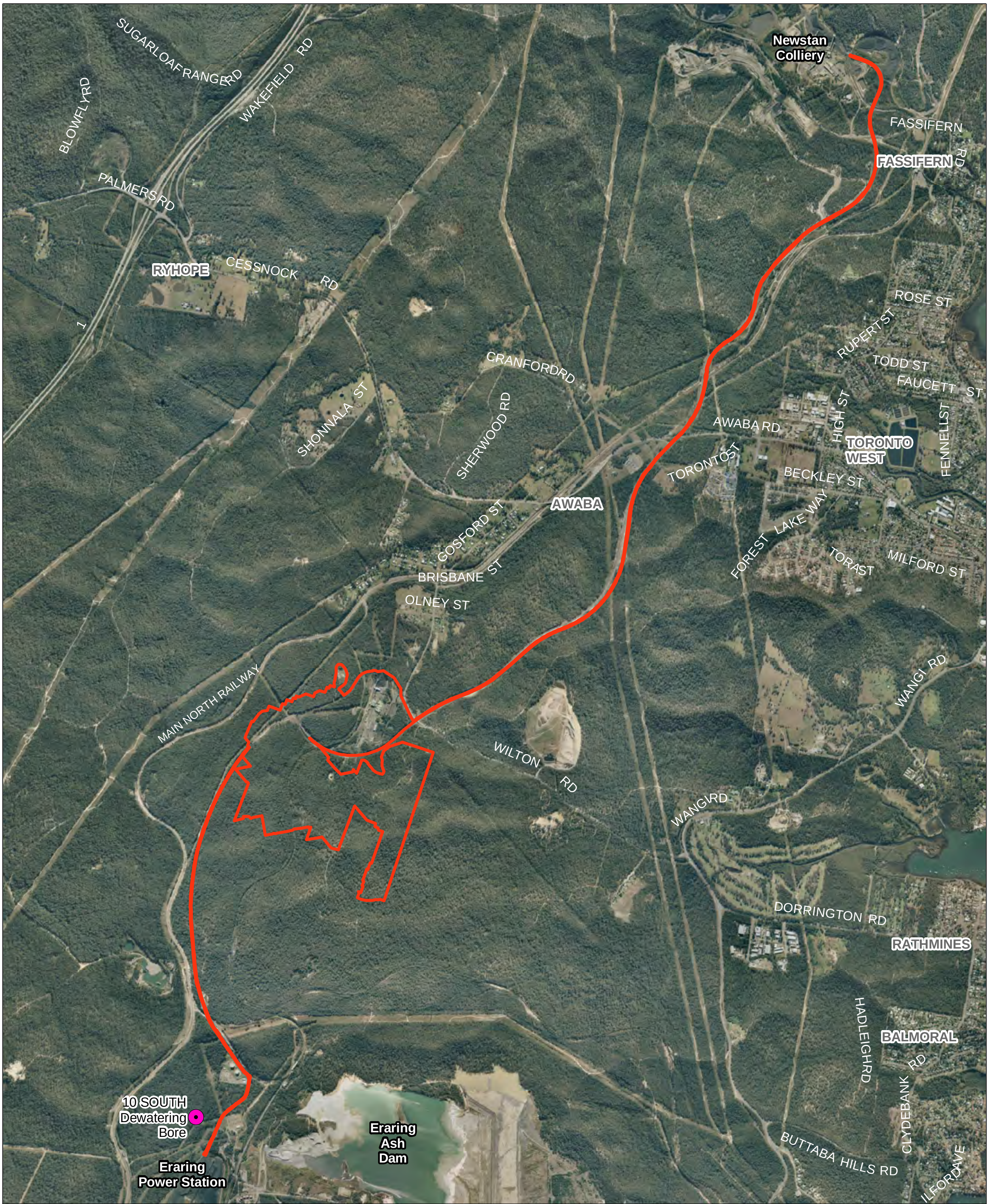
Study Area

The Study Areas that have been assessed as part of this EA are shown on Figure 1.3 and include the following:

- Study Area 1 – Surface Facilities and Ancillary Infrastructure – This area includes the colliery pit top facilities (including office and amenities buildings, existing coal crushing plant, workshop and storage areas) ventilation shafts, an existing quarry and mine dewatering bore (10 South Bore).
- Study Area 2 – Continued Mining within Existing Main South Area staged SMP Approval Areas (including the Remaining Coal to be Mined within Stage 2 and the Revised Stage 3) – The impacts associated with mining in these areas have previously been assessed in Subsidence Management Plan (SMP) Applications. The Stage 2 Area application was approved by Industry and Investment in September 2008, with the SMP Application for the Revised Stage 3 Area submitted to I&I in December 2009 awaiting approval. These areas are defined by a 26.5 degree angle of draw (as per DPI-MR SMP Guidelines, 2003). The outcomes from the SMP assessment will be summarised along with any impacts that are not considered to have been adequately addressed for this EA. It is important to note that, in relation to Stage 2 Area, only the coal remaining from the 1st of August will require approval for this Project.
- Study Area 3 – Proposed Project Mining Areas - Consideration of the proposed Mining Area (East B Area) defined as the proposed workings plus 26.5 degree angle of draw (i.e. as per DPI-MR SMP Guidelines, 2003).
- Study Area 4 – Existing Internal Private Haul Road – This haul road will be utilised for transporting coal from the Awaba Colliery operations to Newstan Collieries existing Run of Mine Stockpile or Rail Loop and subsequently transported to the Port of Newcastle or Port Kembla for shipping to export markets (to be undertaken in accordance with the Newstan Colliery development consent) and also to the Eraring Power Station. It is noted that a modification to the Newstan Colliery development consent (DA 73-11-98) will be applied for under Section 96(1A) of the EP&A Act to allow for the preparation of coal sourced from the Awaba Colliery using the existing Newstan Colliery infrastructure.

This water management assessment has considered Study Areas 1, 2 and 3. The surface water component has considered Study Area 1 only (including the colliery pit top facilities, ventilation shaft, an existing quarry and mine dewatering bore (10 South Bore)) while the ground water assessment considered Study Areas 2 and 3.

In general, potential environmental impacts associated with mine access, ventilation and other services provided through the existing workings areas to the active and proposed mining areas will also be addressed in the EA.



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0 0.15 0.3 0.6 0.9 1.2

Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

GHD

LEGEND

Project Application Area

Dewatering Bore

LOCATION	Awaba
SEAM	Great Northern
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Awaba Colliery

Project Application Area

Centennial Awaba

DATE 02-09-2010

Figure 1.2

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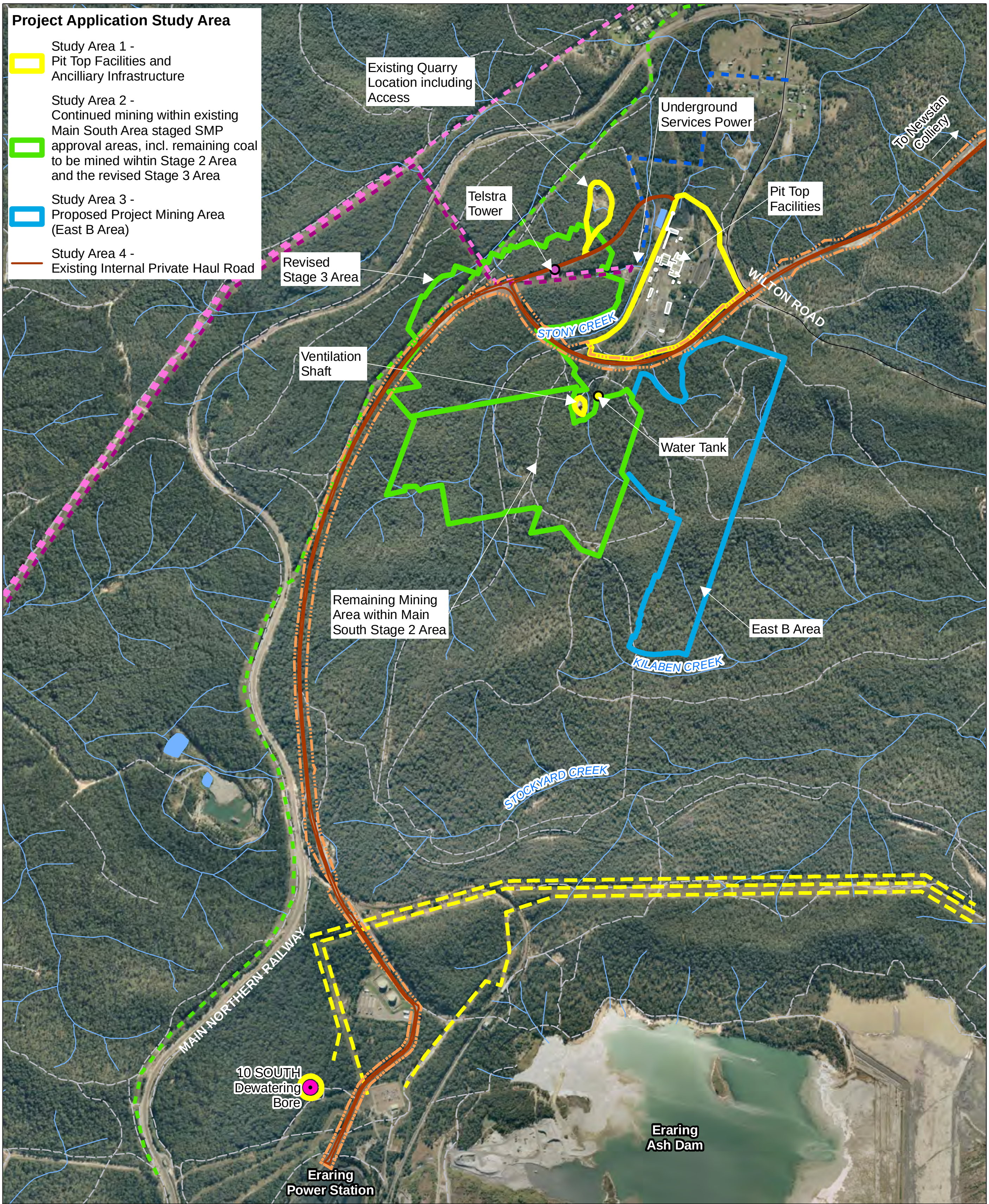

1:20,000 for A4

0 60 120 240 360 480
Meters

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

Watercourse	Haul Road Area	132kv Powerline (Energy Aust.)
Road	11kv Powerline (Awaba)	33kv Powerline (Energy Aust.)
Tracks	11kv Powerline (Energy Aust.)	66kv Powerline (Rail Corp)
		Dewatering Bore

LOCATION	Awaba
SEAM	Great Northern
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Awaba Colliery

Project Application Study Areas Detailed

Centennial Awaba

DATE 02-09-2010

Figure 1.3

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1.2 Description of Project

Awaba Colliery is seeking an approval from the Minister of Planning under the provisions of Part 3A of the EP&A Act to:

- Continue bord and pillar development and pillar extraction by continuous miners within the “Main South Area” (being the remaining sections of Stage 2 and Revised Stage 3, refer Study Area 2);
- Extend bord and pillar development and pillar extraction by continuous miners into the “East B” Area (refer Study Area 3);
- Produce, handle and distribute up to 880,000 tonnes of Run of Mine coal per annum (financial year) using existing surface facilities;
- Continue the use of existing ancillary surface facilities (all Study Areas);
- Expand the existing final Pollution Control Dam (refer Study Area 1);
- Continue the delivery of coal to the Newstan Colliery and/or the Eraring Power Station using the existing private haul road/transport facilities (refer Study Area 4).

The proposed East B Area contains a proportion of coal that extends beyond the existing footprint of mining at Awaba Colliery and includes areas of both existing workings and areas requiring new workings to be developed. Subsequently, areas of new workings are lateral extensions to the mine footprint which will require new development approval (being sought under the current Part 3A application). The East B area is located to the east of the Main South Stage 2 Area. The overlying surface in the East B Area is predominantly bush land on crown land leased to Centennial Newstan and contains no significant surface infrastructure. This area forms *Study Area 3* for the Project, as illustrated on Figure 1.3.

Mining will also be continued at Awaba Colliery in two (2) separate areas, these have been outlined below and illustrated as *Study Area 2* on Figure 1.3:

- Remaining sections of Stage 2 of the Main South Area (currently being mined) – this area was approved by I&I in September 2008 following an SMP application (as modified) under the NSW *Mining Act, 1992*.
- Revised Stage 3 Area (of Main South Area) – this area has recently undergone a number of specialist surveys relating to a SMP application submitted in December 2009 (approval currently awaited from I&I prior to December 2010).

At present, it is anticipated that the Project will recover approximately 2.0 million tonnes of coal which will be extracted from those areas depicted in Study Area 2 and Study Area 3 (see Figure 1.3) over a period of approximately five years or more, depending on actual mining conditions and relevant market drivers.

All existing ancillary surface facilities, supporting infrastructure, workings and their associated uses will continue to be relied upon by the Awaba Colliery (no significant change) as outlined further below. These aspects of the Project will continue to be used until such time as the Awaba Colliery is placed on care and maintenance, and thereafter throughout that phase also. When the Awaba Colliery is placed on care and maintenance, this will be done in accordance with the *Life of Mine Plan* approved by I&I NSW in 2009, until such time that a final Detailed Life of Mine Strategy has been developed.

Annual production, handling and distribution of approximately 880,000 tonnes per financial year is required.

Awaba Colliery requires approval to deliver coal via the private haul road to the Newstan Colliery ROM coal stockpile (in addition to the Rail Loop stockpile). This is assessed within Study Area 4. Newstan Colliery has submitted an application to modify its development consent in order to process coal received from the Awaba Colliery

Existing mining areas, will continue to be utilised for ongoing mining operations including (but not limited to) mine access, emergency management and underground services and infrastructure.

Proposed Changes in Water Management

The Project will include the expansion of the existing Pollution Control Dam (PCD), such that the dam will have a capacity to store a 1 in 10 year Annual Recurrence Interval 24 hour storm. This expansion will improve water management at Awaba Colliery by increasing the site's dirty water storage capacity. Construction of the enlarged PCD will be undertaken in an area of the site that has previously been disturbed, and forms part of *Study Area 1* detailed in Section 1.3 below.

The 10 South Bore will continue to be used for groundwater management and underground dewatering under both operational and care and maintenance conditions.

No increase in potable water demand rate is required.

The domestic wastewater generation rate from the Pit Top facilities will be similar to that which currently exists as there is no plan for an increase or significant change in staff numbers. Disposal of the domestic wastewater will remain as currently exists at site.

Continuing Mine Operations

For the purposes of environmental assessment, further to the information above regarding continued mining areas, it is noted that the following aspects of mine operations are proposed to continue and remain unchanged. Existing mining operations are presented in detail in Section 3 of the *Environmental Assessment (EA)* and, where relevant, components are discussed further in this specialist report.

- Coal Handling, preparation and stockpiles – No changes are proposed to the current coal handling, preparation or stockpile procedures to the existing operations.
- Mine support facilities and site access – No changes are proposed to the current infrastructure and facilities, with the only exclusion being the expansion of the Pollution Control Dam (PCD) mentioned earlier above, with related water management considerations. Mine access from Wilton Road will continue to be utilised and no significant change is anticipated from current use.
- Plant and equipment – No changes are proposed to the typical plant and equipment used at the Awaba Colliery.
- Transportation procedures – No changes are proposed to the current transport procedures. The Project will continue to use the Newstan-Eraring private haul road to transport coal from the operations to Newstan and Eraring.

- Mining methodology – There will be no significant changes to current mining methods for the Project. This includes predicted subsidence levels and operational structure. Production rates may be slightly increased from approximately 800,000 to 880,000 tonnes per annum (financial year), depending on mining efficiency and market demands.
- Operational water management – the domestic wastewater generation rate from the Pit Top facilities will be similar to that which currently exists as there is no plan for an increase or significant change in staff numbers. Disposal of the domestic wastewater will remain as currently exists at site.
- Mine dewatering procedures – the 10 South Bore will continue to be used for groundwater management and dewatering during both continued operation and care and maintenance conditions.

1.3 Objectives of this Report

The objectives of this water management assessment are to:

- Assess the potential impacts of construction and operation of the Project on water management.
- Address the Director General's Requirements of Part 3A of the EP&A Act in relation to water management.

The Director General's Requirements have identified a number of key issues relating to Water. Table 1.1 outlines the nominated requirements and where they have been addressed within this report.

Table 1.1 Director General's Requirements

Director General's Requirements	Where addressed in this report
A detailed site water balance, including a description of site water demands, water supply and disposal methods	Sections 4.7 and 5.3, Appendix B
Detailed modelling and assessment of potential impacts on: ◗ The quality and quantity of existing surface water and groundwater sources. ◗ Affected licensed water users and basic landholder rights. ◗ The hydrological value of watercourses.	Sections 4.3, 4.4, 4.8 and 5
A detailed description of the proposed water management system (including all infrastructure and storages) and water monitoring program.	Sections 4.2, 5 and 6.3
A detailed description of measures to minimise all water discharges.	Sections 5.1 and 6.1
A detailed description of measures to mitigate surface water and groundwater	Section 6

Director General's Requirements	Where addressed in this report
impacts.	

1.4 Scope of Work

The scope of work for this investigation included:

- Confirmation of surface and groundwater management systems.
- Assessment of the surface water system within Study Area 1.
- Review of surface water quality data.
- Establishment of a hydrogeologic model.
- Establishment of a detailed site water balance.
- Application of the detailed site water balance to quantify the water budget for Awaba Colliery for the Project.

2. Legislation

2.1 Legislation

The *Environmental Planning and Assessment Act 1979* administered by the NSW Department of Planning outlines the core legislation relating to planning and development activities in NSW and provides the statutory framework under which development proposal are assessed. Under this legislation, Part 3A provides for the control of major projects that require approval from the Minister for Planning. Part 3A has therefore been identified as the application pathway for the Awaba Colliery approval.

The following section provides a brief overview of the legislation and policy documents relevant to surface water investigations for the Project.

Environmental Planning and Assessment Act 1979

Part 3A of the EP&A Act outlines the environmental assessment requirements applicable to major projects.

This report provides the results of a surface water impact assessment for the Project, which was undertaken to satisfy the requirement relevant to surface water for the Project.

Protection of the Environment Operations Act 1997

The objectives of the *Protection of Environment Operations Act 1997* (POEO Act) are to protect, restore and enhance the quality of the environment. Some of the mechanisms that can be applied, under the POEO Act, to achieve these objectives include reduction of pollution at source and monitoring and reporting of environmental quality.

Environmental Protection Licences (EPL's), issued under the POEO Act, are a means by which the impact on the environment is regulated. For Awaba Colliery, the relevant Environmental Protection Licence is EPL 443.

Water Act 1912

The *Water Act 1912* governs access, trading and allocation of licences associated with both surface and underground water for water sources where a water sharing plan has not been put in place. The elements to which the *Water Act 1912* applies include extraction of water from a river, extraction of water from underground sources, aquifer interference and capture of surface runoff in dams.

Water Management Act 2000

The *Water Management Act 2000* (WMAct) is intended to ensure that water resources are conserved and properly managed for sustainable use benefitting both present and future generations. It is also intended to provide formal means for the protection and enhancement of the environmental qualities of waterways and their in-stream uses as well as to provide for protection of catchment conditions.

2.2 Policy

National Water Quality Management Strategy: Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000)

The *National Water Quality Management Strategy* (NWQMS) provides a national framework to improving water quality in Australia's waterways. The main policy objective of the NWQMS is to achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development. The NWQMS process involves community and government development and implementation of a management plan for each catchment, aquifer, estuary, coastal water or other water body. This includes use of high-status national guidelines with local implementation. National guidelines relevant to the Project are provided for water quality benchmarks and groundwater management.

National Water Quality Management Strategy Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC 2000)

As part of the NWQMS, there are a number of policies, procedures and guidelines that are nationally accepted for the undertaking of monitoring and reporting of water quality. This applies to fresh, groundwater and marine waters. For the Project these would be applied to surface and groundwater sampling.

Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DECCW, 2004)

The *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* lists the sampling and analysis methods to be used when acquiring water samples when complying with an environmental protection legislation, licence or notice.

Managing Urban Stormwater: Soils and Construction (Vol. 1)

Managing Urban Stormwater: Soils and Construction (Vol 1) outlines the basic principles for the design and construction of sediment and erosion control measures. This document relates particularly to urban development sites however it is relevant to the Project as it provides guidance on the configuration of erosion and sedimentation controls required during construction of the Project.

Managing Urban Stormwater: Soils and Construction (Vol. 2E)

Managing Urban Stormwater: Soils and Construction (Vol 2E) provides guidelines, principles and recommended minimum design standards for good management practice in erosion and sediment control during the construction and operation of mines and quarries. Volume 2E provides guidance in the application of the principles and practices of erosion and sediment control described in Volume 1 of Managing Urban Stormwater: Soils and Construction to mines and quarries.

Managing Urban Stormwater: Source Control (EPA 1998)

The intent of this document is to provide guidance to local and state government agencies and developers as well as community and business groups on a range of source control (water quality and quantity) techniques that can be adopted to minimise impacts of works on the surface water environment. It highlights the need for pollutant control using sustainable cost-effective structural and non-structural methods such as swales, basins and gross pollutant traps.

This document provides guidance to the Project for the selection of suitable source control measures where appropriate.

3. Methodology

To establish the potential impact of the Project, the existing hydrologic, hydraulic and water quality conditions needed to be established.

3.1 Desktop Study

For the desktop component of the assessment a number of tasks were undertaken including:

- Identification of waterways and drainage lines within the study area based on the Department of Lands topographic information, in accordance with the *Water Management Act* 2000.
- Review of the existing Site Water Management Plan.
- Review of the Annual Environmental Management Report (AEMR) 2008.
- Review of existing Water Management maps including the documentation of clean and dirty water catchment delineation.
- Search of the NSW Groundwater Bore Database to identify nearby beneficial users of groundwater.
- Development of a groundwater model.
- Development of a water balance model.

3.2 Field Investigations

A site inspection was conducted on 7 April 2010 to confirm the extent of clean and dirty water catchments and presence of water management measures implemented on site.

4. Existing Environment

4.1 Coal Production Process

The coal production process at Awaba Colliery comprises extraction, transfer to surface facilities, processing (crushing and screening) and transportation off site. A schematic of the coal production process is provided in Figure 4.1 while Figure 4.2 indicates the location of the pit top facilities.

4.2 Water Management

Awaba Colliery is located within the Stony Creek catchment, which contributes to Lake Macquarie. Awaba Colliery's Environmental Protection Licence (EPL) 443 therefore includes both volumetric and concentration limits for the discharge of water off site.

The location of Awaba Colliery's discharge points are indicated on Figure 4.3 and include:

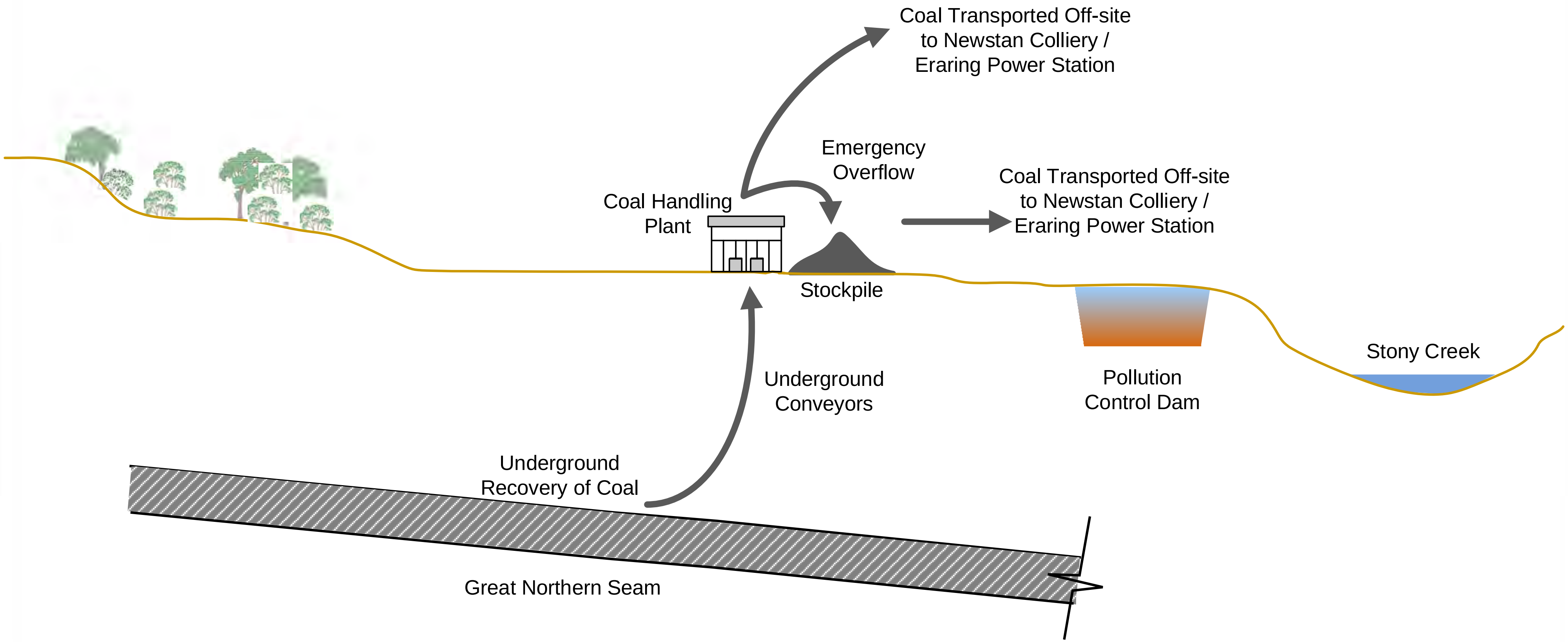
- LDP001 - No longer in use / decommissioned. Borehole still exists.
- LDP002 - No longer in use / decommissioned. Removed.
- LDP003 - No longer in use / decommissioned. Rehabilitated.
- LDP004 - No longer in use / decommissioned. Borehole still exists.
- LDP005 - Barnes Dam no longer in use as at March 2010. Borehole still exists.
- LDP006 - No longer in use / decommissioned. Rehabilitated.
- LDP007 - No longer in use / decommissioned. Borehole still exists.
- LDP008 - Discharge of irrigation water and stormwater runoff adjacent to utilisation area.
- LDP009 - Discharge of mine water from the Pollution Control Dam into Stony Creek.
- 10 South – Discharge of mine water to Eraring Ash Dam.

The existing water management system at Awaba Colliery has been developed progressively over the life of the mine and enables transfer between surface and underground water storages as outlined in the schematic provided in Figure 4.4.

The objectives of this water management system are primarily related to the separation of clean and dirty water. Diversion of clean water runoff around the pit top, to avoid contamination, reduces the volume of water reporting to the dirty water management system.

This water management assessment documents the measures that have been put in place to achieve the water management objectives including sedimentation ponds, oil water separators, clean water diversions, maintenance practices for hardstand areas, regular monitoring of water quality and identification of potential risks to water quality.

Within the water management system there are five (5) categories of water including underground (mine) water, dirty water, clean water, sewage and potable water. These categories contribute to either the surface or underground water system as outlined in Figure 4.4.



Coal Movement

LOCATION	Awaba
SEAM	Great Northern
DRAWN	MJP
CHECKED	
APPROVED	
SCALE	

Awaba Colliery
Coal Process Schematic

Centennial

DATE 16-04-2010

Figure 4.1

1:3,000 for A4

0 0.01 0.02 0.04 0.06 0.08
Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

10m Contours
Watercourse
Pollution Control Structures

LOCATION	Awaba
SEAM	Great Northern
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Awaba Colliery

Surface Features

Centennial
Awaba

DATE 13-05-2010

Figure 4.2

GIS Filename: G\22\15033\GIS\MAPS\Deliverables\Surface Water Assessment\2215033_FIG4-2_SiteFeats_20100422.mxd

1:20,000 for A4

0 0.05 0.1 0.2 0.3 0.4
Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

LEGEND

- Discharge Point
- Watercourse
- Pit Top Facilities and Ancilliary Infrastructure

LOCATION	Awaba
SEAM	Great Northern
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Awaba Colliery

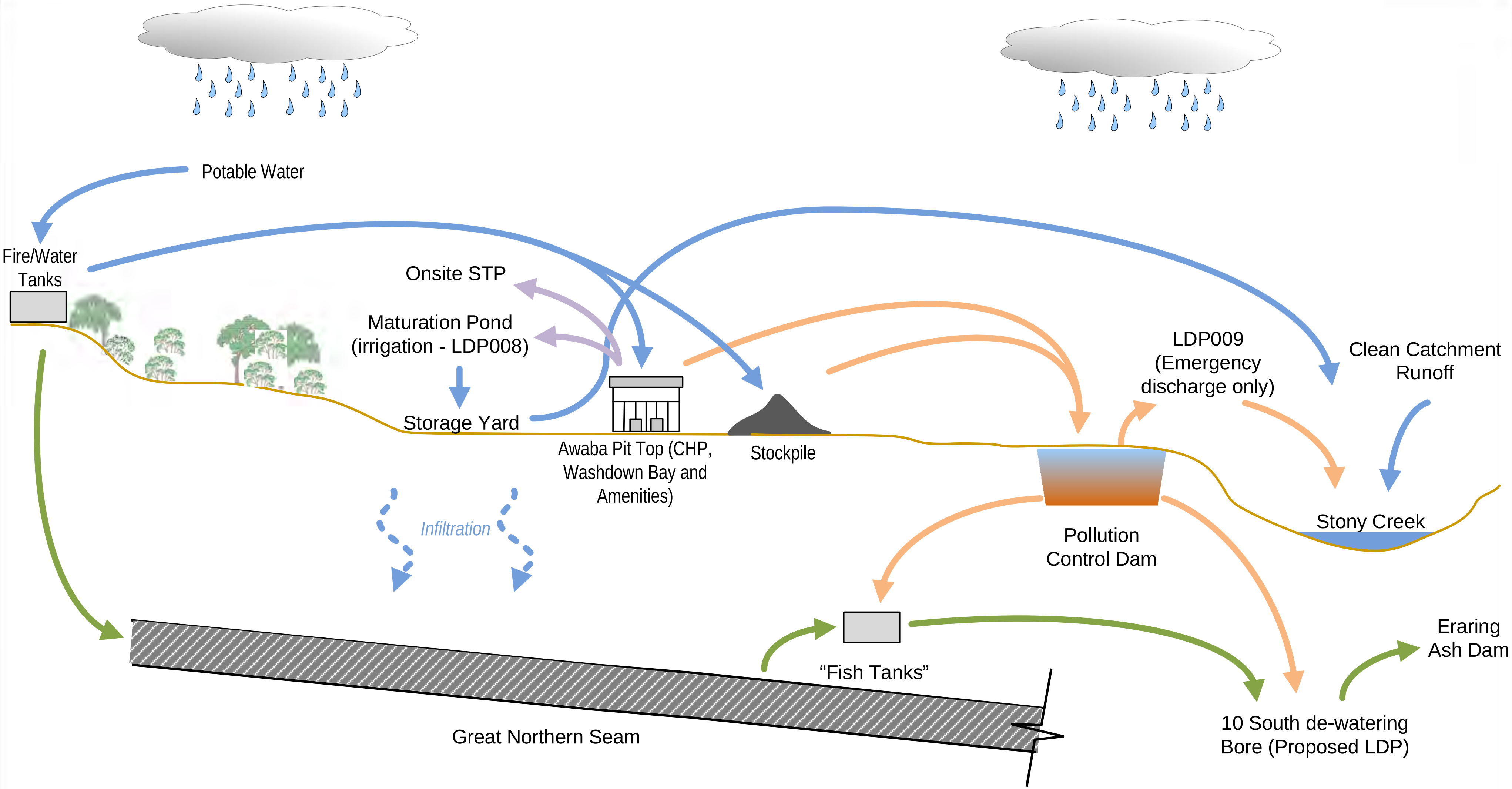
Discharge Point Locations

Centennial Awaba

DATE 13-05-2010

Figure 4.3

GIS Filename: G\22\15033\GIS\MAPS\Deliverables\Surface Water Assessment\2215033_FIG4-3_LDPs_20100422.mxd



Legend	
Dirty Water	
Clean Water	
Underground Water	
Sewage Water	

LOCATION	Awaba
SEAM	Great Northern
DRAWN	MJP
CHECKED	
APPROVED	
SCALE	

Awaba Colliery
Water Management Schematic

Centennial

DATE 16-04-2010

Figure 4.4

4.3 Surface Water

The surface water system at Awaba Colliery, includes clean and dirty water elements.

Clean Water Management

The management of clean water includes diversion of external catchment runoff as well as management of clean surfaces within the pit top.

Buildings

Roof runoff from the administration, bathhouse and workshop buildings is collected through downpipes and directed to the underground piped stormwater network. This network discharges directly into Stony Creek. To maintain the nominated clean hardstand areas as clean catchments, regular sweeping of these areas is undertaken. These areas are also regularly inspected to ensure that they remain clean.

External Catchment runoff

External catchment clean water is managed through a series of diversion drains that intersect the runoff (to the north of the pit top area) before it enters disturbed areas. These diverted flows are either directed around the pit top area or conveyed within a piped network beneath the pit top prior to discharge into Stony Creek. The application of these measures enables the reduction of the volume of water contributing to the dirty water system.

The clean water catchment area is indicated in Figure 4.5 while the diversion structure locations are provided in Figure 4.6.

In order to determine the performance of the existing diversion structures, the catchment area contributing to each was determined and the peak flow then estimate using the Probabilistic Rational Method. The capacity of each diversion structure was then compared to the peak flow rate and the outcomes are provided in Table 4.1. From this it can be seen that the existing clean water diversions have sufficient capacity to cater for flows up to the 100 year ARI with the exception of downstream of the Maturation Pond.

Table 4.1 Clean Water Structure Diversion Capacities

Diversion Location	Contributing Catchment Area (ha)	Peak Flow (100 Year m^3/s)	Capacity of existing diversion structure (m^3/s)
Downstream of Maturation Pond	4.8	0.9	0.6*
Rear of Storage Yard	6.0	1.1	5.0
Southern External Catchment	12.4	2.0	3.0

* This equates to approximately a 20 year ARI capacity.

1:5,000 for A4

0 0.02 0.04 0.08 0.12 0.16
Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

GHD

LEGEND

- Pit Top Overall Catchment
- Dirty Water Catchment
- Pollution Control Structures
- 10m Contours
- Watercourse

LOCATION	Awaba
SEAM	Great Northern
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Awaba Colliery

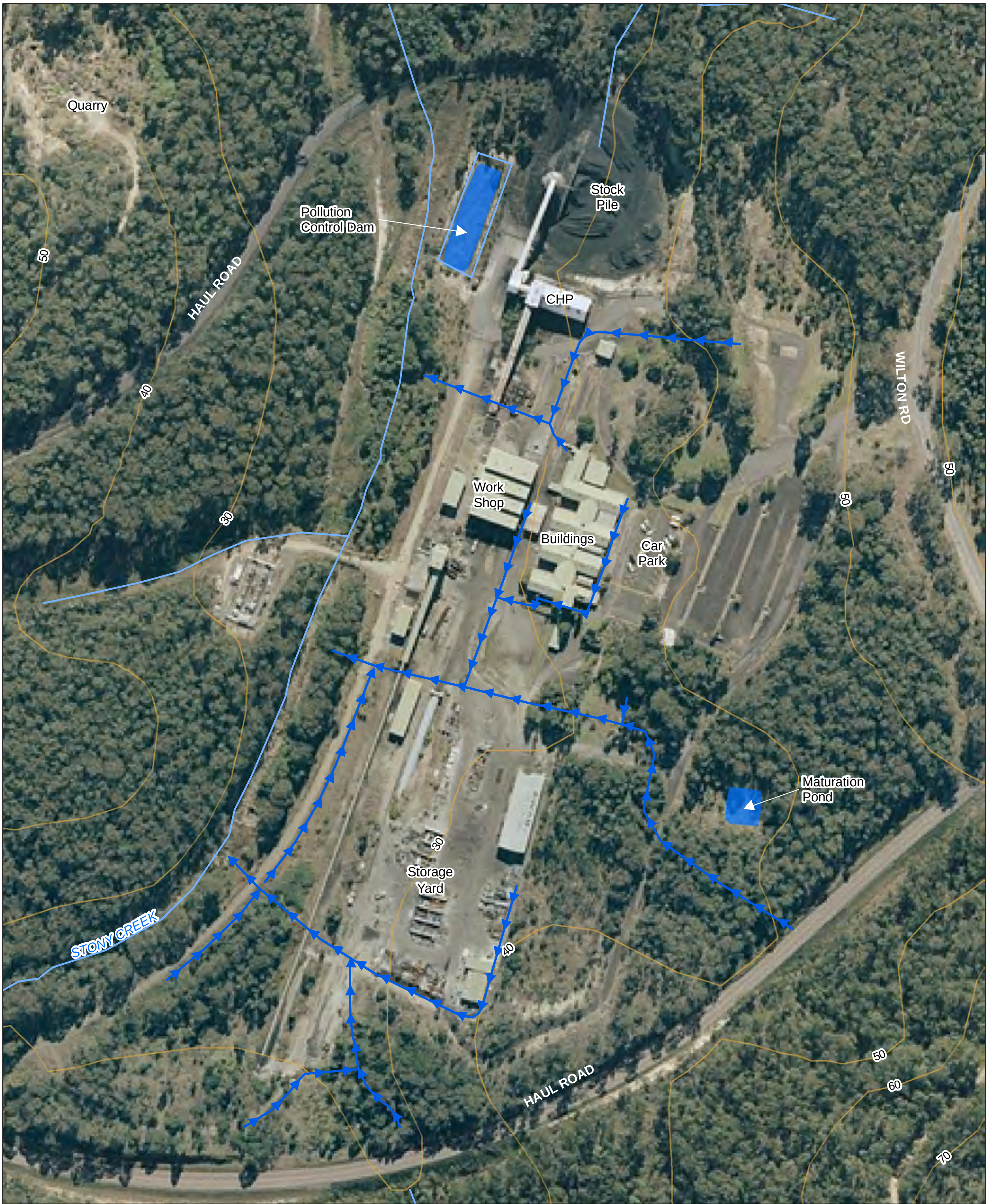
Water Catchments

Centennial Awaba

DATE 13-05-2010

Figure 4.5

GIS Filename: G:\22\15033\GIS\MAPS\Deliverables\Surface Water Assessment\2215033_FIG4-5_Catchments_20100422.mxd



1:3,000 for A4 0 0.01 0.02 0.04 0.06 0.08 Kilometers Map Projection: Universal Transverse Mercator Horizontal Datum: Geodetic Datum of Australia 1994 Grid: Map Grid of Australia, Zone 56	N	LEGEND Pollution Control Structures 10m Contours Watercourse Clean Water Diversions

LOCATION	Awaba
SEAM	Great Northern
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Awaba Colliery

Clean Water Diversions

Centennial Awaba

DATE 13-05-2010

Figure 4.6

GIS Filename: G\22\15033\GIS\MAPS\Deliverables\Surface Water Assessment\2215033_FIG4-6_CleanWater_20100422.mxd

Dirty Water Management

Dirty water runoff from the boot wash, diesel parking bund, washdown bay, stockpile and coal handling plant is collected in a series of collection sumps, pipes, an oil water separator and open drains and then directed to the Pollution Control Dam. The dirty water diversions are shown on Figure 4.7.

Oil Water Separator

Runoff from the washdown bay and diesel tank area is directed to the oil water separator for treatment prior to discharge into the Pollution Control Dam.

In-Seam Coal Storage Bin

The in-seam coal storage bin is located on the surface above the conveyor drift. Water from the boot wash and diesel parking bay, as well as general water make from the pit bottom area, is collected at the bottom of the conveyor drift in the in-seam coal storage bin. This water is then pumped to the Pollution Control Dam.

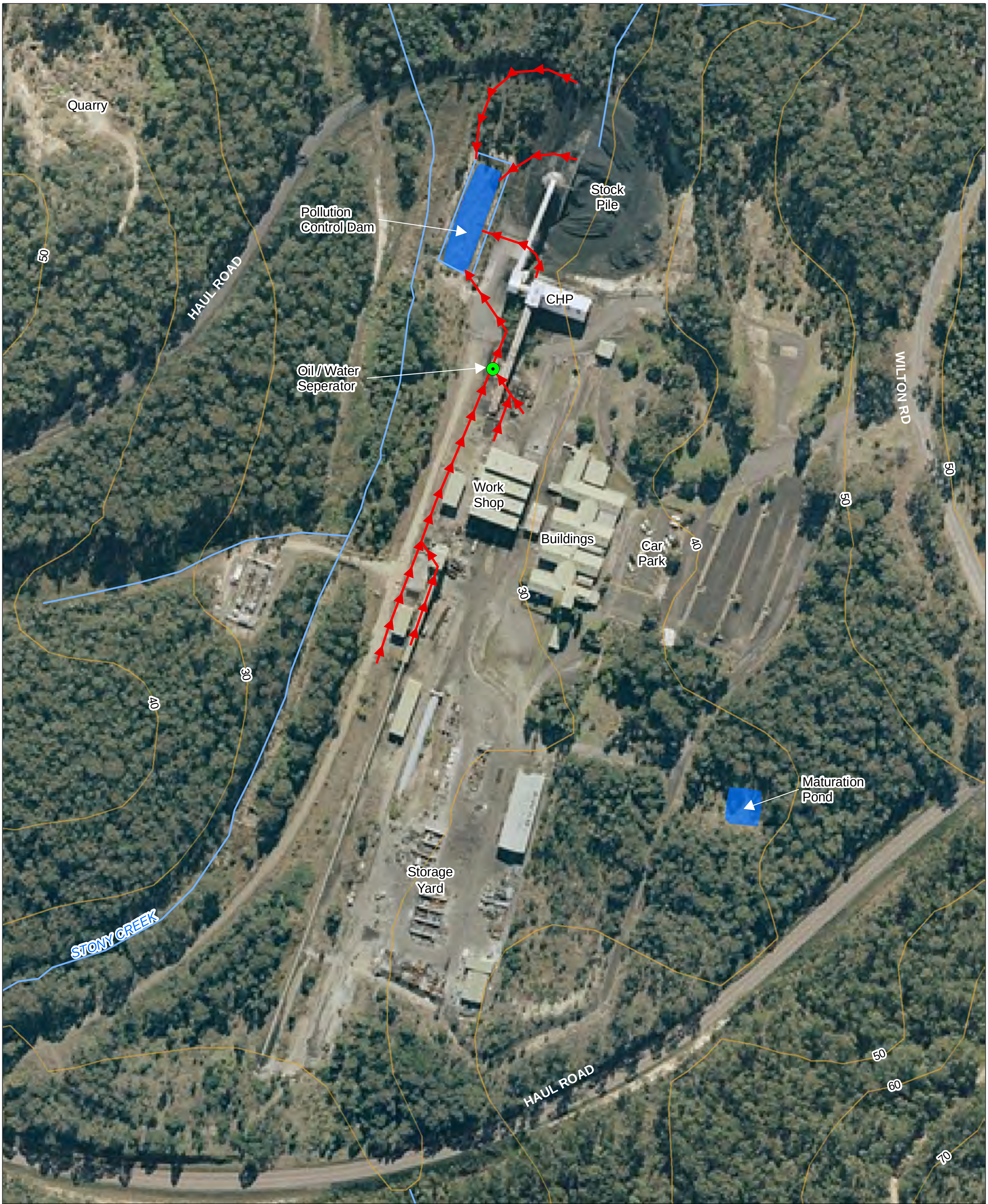
Pollution Control Dam

The Pollution Control Dam is the final structure for the management of dirty water prior to discharge (through LDP009) to Stony Creek. The performance of this structure therefore, has an impact on the downstream environment.

The performance of this structure was previously assessed by GHD. Through this investigation it was determined that the Pollution Control Dam had a total capacity in the order of 3.2 ML to cater for an overall catchment area of approximately 2.4 hectares. At the time of this investigation, some improvements to the controls applied to the pollution control dam had already been undertaken.

Prior to 20 February 2009, the pumping capacity for removal of dirty water was limited to 1 litre per second (L/s). Pumping commenced once a water level of 26.96m AHD had been reached and ceased at the low water level of 26.90m AHD. This operational system only provided approximately 0.8 ML for the temporary storage of runoff during a rainfall event. Consideration was given to the potential for overtopping for a range of storm events.

The storm events considered included the 1, 2, 5, 10, 20, 50 and 100 year Average Recurrence Interval (ARI) storms for durations ranging from 5 minutes through to 24 hours. It was determined that in its current form, the Pollution Control Dam overtopped in events resulting in rainfall greater than those documented in Table 4.2.



1:3,000 for A4

0 0.01 0.02 0.04 0.06 0.08
Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

GHD

LEGEND

- Pollution Control Structures
- 10m Contours
- Watercourse
- Dirty Water Diversions
- Oil / Water Seperator

LOCATION	Awaba
SEAM	Great Northern
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Awaba Colliery

Dirty Water Diversions

Centennial Awaba

DATE 13-05-2010

Figure 4.7

GIS Filename: G\22\15033\GIS\MAPS\Deliverables\Surface Water Assessment\2215033_FIG4-7_CleanWater_20100422.mxd

Table 4.2 Existing Capacity of Pollution Control Dam

ARI	Duration	Average Intensity (mm/hr)
1 Year	Up to 1 hour duration	26.1
2 Year	Up to 30 minute duration	49.3
5 Year	Up to 30 minute duration	63.1
10 Year	Up to 20 minute duration	87.3
20 Year	Up to 10 minute duration	138
50 Year	Up to 10 minute duration	161
100 Year	Up to 10 minute duration	179

On 20 February 2009, the capacity of pumping from the Pollution Control Dam was increased to 11L/s however the same level controls were retained. This resulted in only a minor increase in the performance of the Pollution Control Dam with overtopping occurring under the same conditions for all events with the exception of the 1 year ARI event. For this recurrence interval, overtopping now occurred for events greater than the 2 hour duration (average intensity 17.3 mm/hr) rather than the 1 hour duration.

EPL 443 does not place any volumetric limits on discharges from LDP009 as discharge through this location will be as a direct result of a rainfall event. To minimise the impact on the downstream environment (using reasonable and practicable measures) GHD investigated the storage capacity required within the Pollution Control Dam to cater for a 1 in 10 year ARI 24 hour duration storm event.

The outcomes of this investigation are provided in Appendix A and discussed in more detail within Section 5.1.

Quarry

The location of the existing on-site quarry is such that there are no external catchments contributing to this area therefore no clean water diversions are required for the quarry. Consideration was also given to the management of dirty water runoff generated from within the quarry in accordance with *Managing Urban Stormwater: Soils and Construction (Vol 2E).*

Managing Urban Stormwater: Soils and Construction (Vol 2E) recommends that erosion and sediment control works, for areas of disturbance with durations exceeding three years, cater for runoff generated from events up to and including the 20 year ARI. This means that any measures put in place should be hydraulically and structurally stable in the 20 year event. For the quarry, this requires management of a maximum of 0.2 m^3/s through measures such as catch drains, levels spreaders, check dams and sedimentation fences.

The existing measures that have been put in place include re-shaping of the maintenance track east of the quarry and installation of sediment fences adjacent to the access track.

Surface Water Management Structures

Details of the water management structures associated with the Awaba Colliery pit top are provided in Table 4.3. The capacity of individual structures was not considered as part of this assessment as the catchment areas contributing to each structure will not be altered as a result of the Project. The capacity of the overall system is discussed in Section 4.7.

Table 4.3 Awaba Colliery Pit Top Water Management Structures

Location	Capacity (ML)
Oil Water Separator	0.06
In-Seam Coal Storage Bin	0.06*
Pollution Control Dam	3.2

* Estimated.

Watercourses

There are a number of named and un-named watercourses that either originate in or pass through the lease boundary area associated with Awaba Colliery. Each of these watercourses contribute to Lake Macquarie and the named watercourses include Lords Creek, Stockyard Creek, Kilaben Creek, Stony Creek and Palmers Creek.

Of these watercourses, only Stony Creek is directly impacted as a result of discharge from the pit top however mine workings are located beneath several other watercourses. The impact on these other watercourses has been assessed by Hunter Eco as part of the Environmental Assessment process.

Stony Creek

The Awaba Colliery pit top is located in the upper reaches of Stony Creek which discharges into Lake Macquarie. Adjacent to the pit top, Stony Creek is reasonably well defined with a width in the order of 5 to 10 metres and the invert of the creek is well vegetated with phragmites and/or typha. At approximately 600 metres downstream of the pit top, the channel loses definition with the creek line discharging into a swampy environment of up to 50 metres wide.

Overall, Stony Creek is generally well vegetated and stable. The quality of water being discharged into Stony Creek has also been considered and is discussed in Section 4.8 of this report while the hydrologic impact is discussed in Section 5.1.

4.4 Underground Water

The underground mine water management system is amended from time to time to adapt to the current mining conditions. Within the current area of operations (pre March 2010), water in the underground workings is collected and then transferred to the underground storage (Barnes Dam) to allow the settling of fines prior to being pumped to the surface through LDP005. There is also some discharge through the existing 10 South de-watering bore. Discharges through 10 South contribute to the Eraring Ash Dam.

A detailed hydrogeologic model has been developed by GHD for Awaba Colliery to enable documentation of the behaviour of underground water and the resulting mine water make for the colliery. The outcomes of this investigation were incorporated into the Water Balance Assessment discussed in Sections 4.7 and 5.3 and provided in Appendix B.

The capacity of Barnes Dam was estimated from the floor contours contained within the hydrogeologic model and determined to be approximately 5 ML.

10 South

The 10 South bore is a 300mm diameter bore that extends approximately 33.8m from the surface to the Great Northern seam. While this bore currently has the capacity to extract 5.5 L/s (175 ML/year) from the underground workings, the average discharges over the past four years varied as indicated in Table 4.4. These discharges are conveyed to the Eraring Ash Dam through the existing open channel used by Eraring to convey their ash to the Ash Dam.

Table 4.4 10 South Annual Discharges

Date	Annual Discharge (ML)
June 2007 to December 2007	98.9
2008	131.4
2009	84.9
January 2010 – April 2010	51.4

4.5 Potable Water

Potable water is provided to Awaba Colliery by Hunter Water Corporation to the potable water/fire tanks.

Potable Water / Fire Tanks

There are three existing 200,000 litre tanks located east of the Awaba Colliery pit top, however one of these tanks has been isolated due to cracking and leaking. Subsequently, there are two 200,000 litre tanks to which Hunter Water Corporation provide potable water.

Potable water is supplied to the offices and bathhouse (under head pressure) as well as the underground working face and other surface facilities such as the washdown bay and coal handling plant (via a pump station). A connection to the sprinkler system associated with the stockpile area is provided within the coal handling plant.

The stored potable water is also available for fire fighting on both the surface and underground.

4.6 Waste Water

Waste water at Awaba Colliery includes both grey water and sewage.

Grey Water

Grey water from the bathhouse and other buildings contributes to the maturation pond prior to being discharged through the irrigation system to the east of the pit top area as indicated on Figure 4.2. Runoff from the irrigation area (LDP008) is then considered to be clean and contributes to the clean water diversions prior to discharge into Stony Creek.

Sewage

The treatment of sewage at Awaba Colliery is managed through both a pit top and an underground system, designed to be self sustaining. Sewage from the pit top buildings is treated through an on-site septic system located on the western side of the workshop while underground sewage is managed by air operated toilets.

4.7 Water Balance

A detailed operational water balance was undertaken giving consideration to a broad range of data including rainfall, evaporation and water transfer rates and is provided in Appendix B.

The water balance was developed for the existing conditions (pre March 2010) and calibrated against data for discharges from LDP005 and 10 South. The calibrated model was then amended to reflect the proposed conditions (post March 2010) associated with the Project.

Results

The results of the water balance assessment for existing conditions, as provided in Table 4.5, indicated that increases in rainfall had only a minor impact on discharges through LDP005 and 10 South. There were however, increases in the discharges through LDP009 in years of high rainfall.

Table 4.5 Existing Conditions Water Balance Results

	Average Year (1995)	Dry Year (1993)	Wet Year (2007)
Inputs (Rainfall/Runoff) (ML/year)	246.11	66.93	362.53
Outputs (Evaporation) (ML/year)	0.04	0.04	0.04
Discharge through LDP009 (ML/year)	0.00	0.00	4.19
Discharge through LDP005 (ML/year)	121.5	115.5	129.0
Discharge through 10 South (ML/year)	154.7	151.3	157.5

Results for the proposed conditions are discussed in Section 5.2 of this report while the calibration and detailed results are provided in the Water Balance Assessment report in Appendix B.

4.8 Water Quality

In reviewing the water quality associated with the Awaba Colliery pit top, consideration was given to six monitoring locations. These locations are referred to as ‘Upstream’, ‘Downstream’, Lake Macquarie, LDP009, LDP005 and 10 South.

‘Upstream’ is considered to be the most representative of the background of Stony Creek and is located upstream of LDP009 but downstream of the Newstan - Eraring Haul Road. It is influenced by discharges from Barnes Dam (LDP005 – decommissioned in March 2010). ‘Downstream’ is located downstream of LDP009, within Stony Creek while Lake Macquarie is located approximately 8.5 km downstream of LDP009.

Period of Data

The period of data reviewed for each of the monitoring locations is provided in Table 4.6. These locations are generally sampled monthly and analysed for pH, EC (Electrical Conductivity), TSS (Total Suspended Solids), oil and grease and turbidity. A sample of the data assessed is provided in Appendix C.

Table 4.6 Monitoring Location Data Period

Monitoring Location	From Date	To Date
Upstream	March 2002	March 2010
Downstream	January 2002	March 2010
Lake Macquarie	August 2008	October 2008
LDP005	January 2002	March 2010
LDP009	February 2007	March 2010
10 South	January 2003	March 2010

Default Trigger Values

ANZECC/ARMCANZ (2000) default trigger values that apply to this site are outlined in Table 4.7. They include stressor trigger values for lowland or coastal rivers and default freshwater trigger values for the protection of 95% aquatic species.

Table 4.7 ANZECC/ARMCANZ (2000) Default Trigger Values

Parameter	Trigger Value	Comment
pH	6.5 – 8.0	Lowland river, SE Australia (Table 3.3.2, ANZECC/ARMCANZ 2000)
Electrical Conductivity (EC)	< 2200 µS/cm	Lowland river, SE Australia (Table 3.3.3, ANZECC/ARMCANZ 2000). NSW coastal rivers typically 200-300 µS/cm
TSS	< 50 mg/L	Lowland river, NSW (Table 8.2.12, ANZECC/ARMCANZ 2000). NSW coastal rivers 6 mg/L
Turbidity	< 50 NTU	Lowland river, SE Australia (Table 3.3.3, ANZECC/ARMCANZ 2000). NSW coastal rivers 6 NTU

Parameter	Trigger Value	Comment
Total Nitrogen (TN)	0.35 mg/L	NSW coastal river (Table 3.3.2, ANZECC/ARMCANZ 2000)
Nitrogen Oxides	0.04 mg/L	Lowland river, SE Australia (Table 3.3.2, ANZECC/ARMCANZ 2000)
Total Phosphorus (TP)	0.025 mg/L	NSW coastal river (Table 3.3.2, ANZECC/ARMCANZ 2000)
Aluminium	0.055 mg/L	Applies for pH > 6.5
Arsenic	0.013 mg/L	Guideline for As(V)
Boron	0.37 mg/L	
Copper	0.0014 mg/L	
Iron	0.3 mg/L	Due to insufficient data, the Canadian guideline level is used as an interim indicative working level, as recommended by ANZECC/ARMCANZ (2000)
Lead	0.0034 mg/L	
Manganese	1.9 mg/L	
Zinc	0.008 mg/L	

Note that a hardness correction factor, as outlined in Table 3.4.4 of ANZECC/ARMCANZ (2000), should be applied to the heavy metal criteria if the surface water hardness of the receiving water body exceeds 60 mg/L $CaCO_3$. For Awaba Colliery the 80th percentile total hardness ($CaCO_3$) recorded in the period between September 2009 and March 2010 was 309 mg/L, which is classified as "very hard" in Table 3.4.4 of ANZECC/ARMCANZ (2000). The heavy metal trigger levels were revised as a result of this are provided in Table 4.8.

Table 4.8 ANZECC/ARCMCANZ (2000) Revised Heavy Metal Trigger Values

Parameter	Trigger Value	Comment
Copper	0.0073 mg/L	0.0014 mg/L x 5.2 in accordance with Table 3.4.4 of ANZECC/ARMCANZ (2000).
Lead	0.040 mg/L	0.0034 mg/L x 11.8 in accordance with Table 3.4.4 of ANZECC/ARMCANZ (2000).
Zinc	0.042 mg/L	0.008 mg/L x 5.2 in accordance with Table 3.4.4 of ANZECC/ARMCANZ (2000).

EPL 443

The concentration limits specified in EPL 443 are provided in Table 4.9.

Table 4.9 EPL 443 Concentration Limits

Parameter	Discharge Limit
pH	6.5 – 8.5
TSS	50 mg/L
Oil and Grease	10 mg/L

Surface Water Quality Data

pH

'Upstream' and 'Downstream'

Surface water within the Stony Creek tributary, as indicated by pH results reported for monitoring locations 'Upstream' and 'Downstream', is generally slightly alkaline.

Over 77% and 94% of the reported 'Upstream' and 'Downstream' results respectively are within the ANZECC/ARMCANZ (2000) trigger value range for lowland rivers and over 98% for both locations are within the EPL 443 discharge limit range.

LDP009

Discharges through LDP009 have been limited to event based discharges with the exception of the period between October 2008 and December 2008 during which underground water was transferred from Newstan Colliery. For all discharges through LDP009, the discharge was generally slightly alkaline although all reported pH levels were within the EPL 443 discharge limit range.

LDP005 and 10 South

Over 97% of reported results through LDP005 and 10 South were within the ANZECC/ARMCANZ (2000) trigger value range for lowland rivers and over 99% for both locations are within the EPL 443 discharge limit range.

EC

'Upstream' and 'Downstream'

Reported EC levels indicate that surface water within the Stony Creek tributary is fresh to brackish, with ECs ranging from 186 to 2810 µS/cm at 'Upstream' and 190 to 3410 µS/cm at 'Downstream'. It should be noted that EC levels at 'Downstream' consistently exceeded those reported at 'Upstream' for the period between August 2008 and January 2009.

Reported EC levels at 'Upstream' and 'Downstream' were relatively variable. This is unlikely to be attributable to tidal variations since the tributary is above the Stony Creek tidal limit. It is possible that the EC variability is attributable to the interaction, within the Stony Creek tributary, of rainfall runoff with the licensed discharge of groundwater extracted from the Great Northern seam workings through the recently decommissioned LDP005.

LDP009

The discharge through LDP009 between October 2008 and December 2008 was generally brackish, with ECs ranging from 3160 to 3440 μS/cm. This discharge is likely to have raised the EC at 'Downstream' during late 2008. By comparison, the event based discharges outside this period were determined to be primarily fresh with ECs in the order of 270 μS/cm.

LDP005 and 10 South

The median ECs of 2580 and 6095 resulted in brackish and saline discharges from LDP005 and 10 South respectively. This indicates that the removal of LDP005, which contributes to Stony Creek, may reduce the percentage of brackish water within the watercourse.

Consideration was given to the potential impact of the discharge of saline water through 10 South, into the Eraring Ash Dam. The current Environmental Protection Licence (EPL 1429) for Eraring does not contain a limit on the concentration limits for EC. A comparison to the 50th percentile ECs within Lake Macquarie was undertaken. It was determined that discharges through 10 South were 85% lower than 50th percentile concentrations within the Lake.

TSS

'Upstream' and 'Downstream'

TSS concentrations were generally similar at 'Upstream' and 'Downstream'. 96% of the reported concentrations at 'Upstream' (between January 2006 and March 2010) were less than the EPL 443 discharge limit (50 mg/L) and the ANZECC/ARMCANZ (2000) maximum trigger value for NSW lowland rivers, while approximately 50% of results were less than the recommended trigger value for coastal lowland rivers (6 mg/L). At monitoring location 'Downstream', over 98% of reported TSS concentrations were less than the EPL discharge limit and ANZECC/ARMCANZ (2000) maximum trigger value for NSW lowland rivers, while 63% of results were less than the recommended trigger value for coastal lowland rivers.

LDP009

TSS concentrations through LDP009 for event based discharges outside the period between October 2008 and December 2008 exceeded the concentration limits nominated in EPL 443 and the ANZECC/ARMCANZ (2000) maximum trigger value for NSW lowland rivers.

Conversely, the TSS concentration within the period October 2008 and December 2008 was consistently less than or equal to reported concentrations within the Stony Creek tributary and were consistently below both the EPL discharge limit and ANZECC/ARMCANZ (2000) maximum trigger value for NSW lowland rivers. It is further noted that over 80% of results were less than the recommended trigger value for coastal lowland rivers.

LDP005 and 10 South

For discharges through LDP005 and 10 South, 98% of the reported concentrations below the EPL 443 discharge limit (50 mg/L) and the ANZECC/ARMCANZ (2000) maximum trigger value for NSW lowland rivers. Additionally, approximately 88% and 50% of results for LDP005 and 10 South respectively were less than the recommended trigger value for coastal lowland rivers (6 mg/L).

Turbidity

'Upstream' and 'Downstream'

Turbidity levels reported at the 'Upstream' monitoring location were generally higher than those reported at 'Downstream'. At monitoring location 'Downstream', all reported results (with the exception of three) were less than the ANZECC/ARMCANZ (2000) maximum trigger value for NSW lowland rivers (50 NTU), while approximately 50% of reported turbidity levels were less than or equal to the recommended trigger value for coastal lowland rivers (6 NTU). However, at monitoring location 'Upstream', the turbidity exceeded the ANZECC/ARMCANZ (2000) maximum trigger value for NSW lowland rivers on seven occasions between March 2007 and March 2010, while less than 45% of reported turbidity levels were less than the recommended trigger value for coastal lowland rivers.

LDP009

Turbidity of event based discharges through LDP009 outside the period between October 2008 and December 2008 exceeded the ANZECC/ARMCANZ (2000) maximum trigger value for NSW lowland rivers.

During the period between October 2008 and December 2008, the turbidity of the LDP009 discharge was consistently less than the turbidity within Stony Creek as well as the recommended trigger value for coastal lowland rivers.

LDP005 and 10 South

For discharges through LDP005 and 10 South, 95% and 97% respectively of the reported concentrations below the EPL 443 discharge limit (50 mg/L) and the ANZECC/ARMCANZ (2000) maximum trigger value for NSW lowland rivers. Additionally, approximately 53% and 65% of results for LDP005 and 10 South respectively were less than the recommended trigger value for coastal lowland rivers (6 mg/L).

Oil and Grease

Reported oil and grease concentrations at the 'Upstream', 'Downstream' monitoring locations as well as through LDP009 were consistently below the laboratory detection limit and/or less than the EPL discharge limit (10 mg/L).

Heavy Metals

An assessment of heavy metals was undertaken for six monitoring locations ('Upstream', Lake Macquarie, LDP009, LDP005 and 10 South). The data considered is provided in Appendix C with a discussion on particular metals provided below.

Copper

Both total and dissolved copper were measured at the 'Upstream' location between the period of September 2009 and March 2010. The total copper levels were all below the default

ANZECC/ARMCANZ (2000) trigger value and therefore consideration was not given to the revised trigger level resulting from the 'water hardness'. For dissolved copper, approximately 35% of the reported results exceeded the default ANZECC/ARMCANZ (2000) trigger values however with the application of the 'water hardness' factor, all results were found to be below the revised trigger value.

LDP009

The reported concentrations for total copper through LDP009 were all above the default ANZECC/ARMCANZ (2000) trigger value however with the application of the 'water hardness' factor, all results were found to be below the revised trigger value.

LDP005 and 10 South

60% and 75% of discharges through LDP005 and 10 South respectively recorded concentrations for total copper above the default ANZECC/ARMCANZ (2000) trigger value. With the application of the 'water hardness' factor, it was determined that all of the LDP005 discharges were below the revised trigger level however for 10 South 25% of the recorded discharges were still over the revised level.

Zinc

Approximately 80% of the total zinc and 45% of the dissolved zinc recorded results were determined to be above the default ANZECC/ARMCANZ (2000) trigger values. However, with the application of the 'water hardness' factor, the recorded results were within the revised value range.

LDP009

All zinc concentrations reported for discharges through LDP009 were found to be above both the default ANZECC/ARMCANZ (2000) trigger value and the revised (for 'water hardness') trigger value.

LDP005 and 10 South

All of the recorded concentrations discharged through LDP005 and 10 South were above default ANZECC/ARMCANZ (2000) trigger value. With the application of the 'water hardness' factor, this was reduced to 47% and 25% of recorded concentrations that exceeded the revised trigger value.

Arsenic

No adjustment, as a result of 'water hardness' is applied in Table 3.4.4 ANZECC/ARMCANZ (2000) to arsenic therefore the default trigger values were applied. A review of the recorded results indicated that for both total and dissolved arsenic, these were within the default ANZECC/ARMCANZ (2000) trigger values.

LDP009

All recorded concentrations of arsenic through LDP009 were found to be below the default ANZECC/ARMCANZ (2000) trigger values.

LDP005 and 10 South

All recorded concentrations of arsenic through LDP005 and 10 South were found to be below the default ANZECC/ARMCANZ (2000) trigger values.

Lead

As with arsenic, no adjustment for 'water hardness' is applied in Table 3.4.4 ANZECC/ARMCANZ (2000) to lead therefore the default trigger values were applied. A review of the recorded results indicated that for both total and dissolved lead, these were within the default ANZECC/ARMCANZ (2000) trigger values.

LDP009

All recorded concentrations of lead through LDP009 were found to be above the default ANZECC/ARMCANZ (2000) trigger values, however with the application of the 'water hardness' factor, the recorded results were within the revised value range.

LDP005 and 10 South

All recorded concentrations of lead through LDP005 were found to be below the default ANZECC/ARMCANZ (2000) trigger values while 13% of the discharges through 10 South were above the default trigger values. With the application of the 'water hardness' factor, all recorded discharges complied with the revised trigger value.

Ambient Water Quality Data – Lake Macquarie

In determining trigger values for Awaba Colliery, consideration was also given to the quality of water within Lake Macquarie. As there are numerous contributors to the Lake and historically this receiving water body has been subjected to the discharge of a number of pollutants, it was considered appropriate that the 50th percentile be applied to the existing water quality results. Further, heavy metal concentrations within the Lake may also be a product of natural sources within the catchment.

For the period between August and October 2008, a number of water quality samples were collected by Centennial Coal within Lake Macquarie. Comparison between the 50th percentile of these values and the default ANZECC trigger values was undertaken and is presented in Table 4.10. The shaded sections indicate the parameters for which the 50th percentile levels within Lake Macquarie exceed the default ANZECC trigger values.

Table 4.10 Ambient Trigger Values

Parameter	50th Percentile	ANZECC Trigger Value
pH	7.6	6.5 – 8.0
TSS	82 mg/L	6 – 50 mg/L
EC	40,100 µS/cm	125 – 2200 µS/cm
Turbidity	34 NTU	6 – 50 NTU
Aluminium	1.29 mg/L	0.055 mg/L

Parameter	50th Percentile	ANZECC Trigger Value
Arsenic	0.005 mg/L	0.013 mg/L
Boron	3.25 mg/L	0.37 mg/L
Copper	0.012 mg/L	0.0014 mg/L
Iron	1.44 mg/L	0.03 mg/L
Lead	0.017 mg/L	0.0034 mg/L
Manganese	0.087 mg/L	1.9 mg/L
Zinc	0.07 mg/L	0.008 mg/L
Aluminium (dissolved)	0.05 mg/L	0.055 mg/L
Arsenic (dissolved)	0.0015 mg/L	0.013 mg/L
Boron (dissolved)	3.08 mg/L	0.37 mg/L
Copper (dissolved)	0.003 mg/L	0.0014 mg/L
Iron (dissolved)	0.86 mg/L	0.03 mg/L
Lead (dissolved)	0.002 mg/L	0.0034 mg/L
Manganese (dissolved)	0.034 mg/L	1.9 mg/L
Zinc (dissolved)	0.008 mg/L	0.008 mg/L

Recommended Trigger Values

In determining appropriate trigger values for physical and chemical stressors and toxicants, the preferred ANZECC/ARMCANZ (2000) approach follows the order:

- Use of biological data.
- Local reference data.
- Tables of default values provided in ANZECC/ARMCANZ (2000).

Since no biological toxicology data exists for Stony Creek or its tributaries, guideline levels must be derived from local reference data or, if insufficient, from tables of default values. According to ANZECC/ARMCANZ (2000), a minimum of 24 data values (generally taken over the previous two years over a number of seasons and flow conditions) should exist for a reference site in order to calculate site specific criteria.

Site specific criteria have been calculated for most analytes from the 80th percentile concentrations of recent data reported for 'Upstream'. These criteria are provided in Table 4.11 along with the 50th percentile from ambient data and the default ANZECC/ARMCANZ (2000) trigger values.

According to ANZECC/ARMCANZ (2000), if the default trigger value is less than (or more conservative than) a reliable site-specific criterion, then the site-specific value becomes the guideline. As shown in Table 4.11, this applies to Copper and Zinc only. For pH, TSS and oil and grease, the EPL discharge limits apply. Where 'Upstream' data are consistently below the laboratory detection limit, the 80th percentile concentration has not been calculated.

Table 4.11 outlines the recommended trigger values for nutrients and heavy metals and provides comments on the source of this trigger values.

Table 4.11 Recommended Trigger Values

Parameter	50th Percentile (Ambient) [(a)]	80th Percentile (Site Specific) [(b)]	Default Trigger Value [(c)]	Recommended Trigger Value
pH	7.6[(d)]	8.0	6.5 – 8.5[(e)]	6.5 – 8.5
Electrical Conductivity (EC)	40100	2420	< 2200 µS/cm	< 2200 µS/cm
TSS	82	9	< 50 mg/L[(f)]	< 50 mg/L
Turbidity	34	29.4	< 50 NTU	< 50 NTU
Total Nitrogen (TN)	-[(g)]	-[(g)]	0.35 mg/L	0.35 mg/L
Nitrogen Oxides	-[(g)]	-[(g)]	0.04 mg/L	0.04 mg/L
Total Phosphorus (TP)	-[(g)]	-[(g)]	0.025 mg/L	0.025 mg/L
Aluminium	1.29	-[(g)]	0.055 mg/L	0.055 mg/L
Arsenic	0.005	0.01	0.013 mg/L	0.013 mg/L
Boron	3.25	-[(g)]	0.37 mg/L	0.37 mg/L
Copper	0.012	0.004	0.0073 mg/L	0.004 mg/L
Iron	1.44	-[(g)]	0.3 mg/L	0.3 mg/L
Lead	0.017	-[(g)]	0.04 mg/L	0.04 mg/L
Manganese	0.087	-[(g)]	1.9 mg/L	1.9 mg/L
Zinc	0.07	0.016	0.042 mg/L	0.016 mg/L

(a) Based on data for ambient location (Lake Macquarie). Generally 50th percentile concentration/level, unless indicated.
(b) Based on data for upstream location 'Upstream'. Generally 80th percentile concentration/level, unless indicated.
(c) ANZECC/ARMCANZ (2000) trigger values, unless indicated.
(d) 20th percentile – 80th percentile of upstream pH levels.
(e) EPL range.
(f) EPL concentration is 50 mg/L.
(g) Insufficient data.

5. Impact Assessment

As discussed in Section 1.2, the proposed surface works associated with this Project is limited to maintaining existing operations and the expansion of the Pollution Control Dam.

5.1 Surface Water

As no change to the surface infrastructure (with the exception of the Pollution Control Dam) within the pit top area is proposed, it is anticipated that there will be no impact on the existing surface water behaviour.

Quarry

While no changes are proposed for the existing quarry, the function of this facility is to provide material for on-site remedial works. Consequently there is a potential that winning of material from this location may result in an increase in sediment laden water being discharged due to increased disturbance of the quarry base. The existing measures are not considered to be appropriate for the current form of the quarry and therefore additional measures are required.

This could include re-shaping of the base of the quarry to retain runoff and incorporation of a sediment trap at the top of the existing access track location. At times of further work, a review of the existing mitigation measures and consideration of additional measures (as required) is also recommended. All measures should be consistent with the recommendations of *Managing Urban Stormwater: Soils and Construction (Vol 2E).*

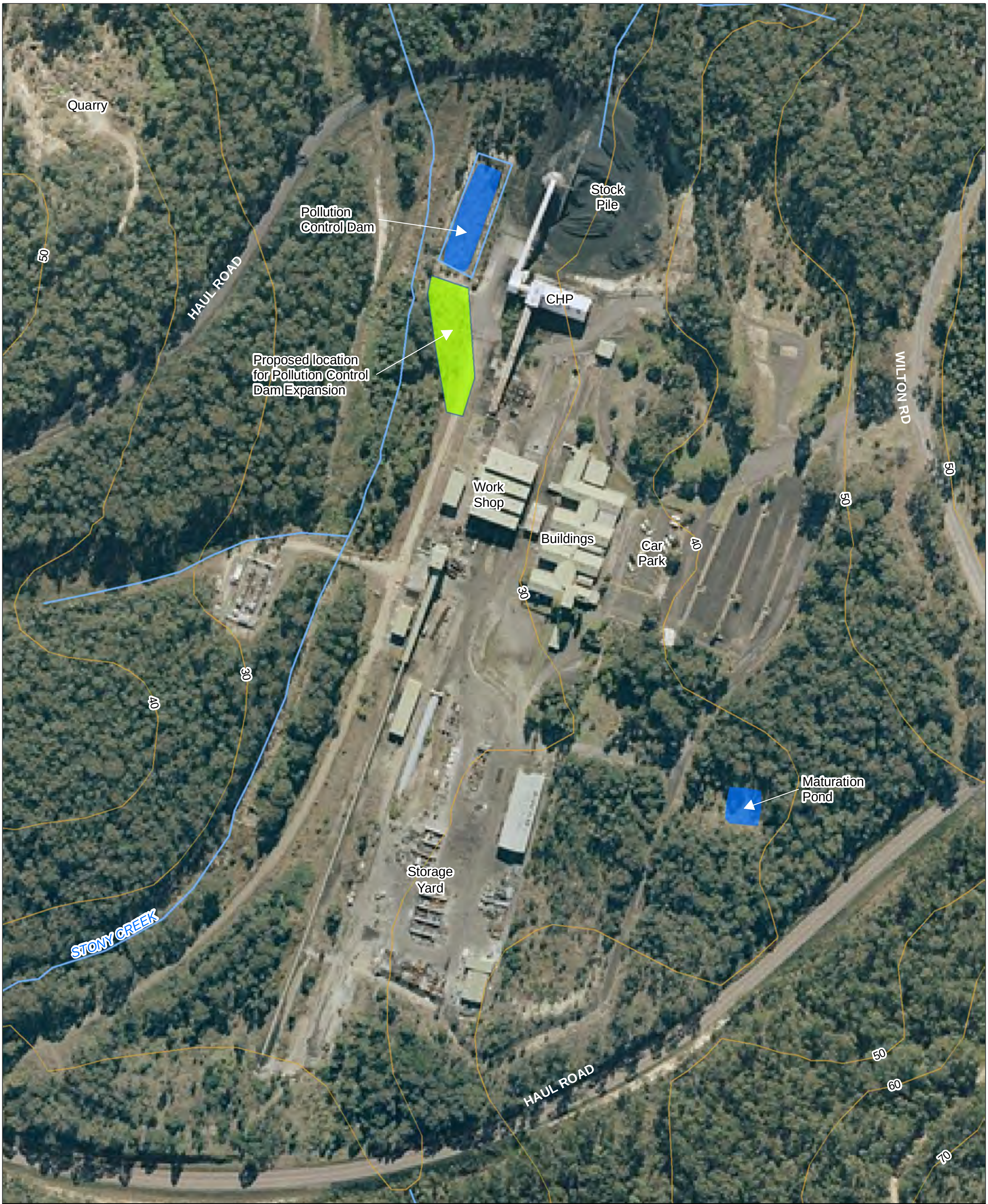
Pollution Control Dam

As indicated in Section 4.3, the capacity of the existing Pollution Control Dam is limited and discharges will occur during what are considered to be reasonably regular rainfall events. In addition, the review of water quality being discharged through LDP009 (as discussed in Section 4.8) indicated that during event based discharges the level of TSS exceeded the conditions of EPL 443.

The options for increasing the capacity (to cater for the 1 in 10 year 24 hour design storm event) of the Pollution Control Dam are provided in Appendix A. These included lowering of the existing control water level and increasing the storage available through the construction of additional dams. Of the proposed options, Awaba Colliery have nominated Option 2, which included lowering of the existing pollution control dam water level by 0.5m and the construction of an additional storage, as the preferred option.

The predicted temporary storage capacity for the final form of the Pollution Control Dam as a result of adopting this option (refer Figure 5.1) was determined to be:

- 1.3 ML as a result of lowering the water level by 0.5m.
- 3.0 ML as a result of construction of an additional storage.
- 4.3 ML total.



1:3,000 for A4

0 0.01 0.02 0.04 0.06 0.08
Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- 10m Contours
- Watercourse
- Pollution Control Structures
- Pollution Control Dam Expansion

LOCATION	Awaba
SEAM	Great Northern
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Awaba Colliery

Proposed Surface Works

Centennial Awaba

DATE 13-05-2010

Figure 5.1

GIS Filename: G:\22\15033\GIS\MAPS\Deliverables\Surface Water Assessment\2215033_FIG5-1_ProSurface_Wks_20100506.mxd

As with the assessment of the existing capacity of the Pollution Control Dam, this investigation considered the 1, 2, 5, 10, 20, 50 and 100 year Average Recurrence Interval (ARI) storms for durations ranging from 5 minutes through to 24 hours. The results of the increased storage options are provided in Table 5.1.

Table 5.1 Increased Performance of Pollution Control Dam

ARI	Lower water level by 0.5m	Lower water level and additional storage
1 Year	Up to 12 hour duration	Up to 72 hour duration
2 Year	Up to 12 hour duration	Up to 72 hour duration
5 Year	Up to 1 hour duration	Up to 72 hour duration
10 Year	Up to 1 hour duration	Up to 24 hour duration
20 Year	Up to 30 minute duration	Up to 12 hour duration
50 Year	Up to 30 minute duration	Up to 6 hour duration
100 Year	Up to 30 minute duration	Up to 6 hour duration

In addition to this, the performance of the increased storage option was assessed within the water balance. The outcomes of this are discussed in Section 5.3.

Stony Creek

While it was indicated in Section 4.3 that Stony Creek is generally well vegetated and stable, the limited capacity of the Pollution Control Dam results in the contribution of TSS over the level nominated in EPL 443 as a result of event based discharges.

While the impact of Awaba Colliery on Stony Creek was negligible, the improved performance of the Pollution Control Dam (which decreases the number of annual event based discharges) will further assist in reducing the impact of the Colliery on the Creek.

Hydrologic Impacts

Awaba Colliery does not harvest any clean catchment runoff nor does it extract water from any of the watercourses within the lease area. The hydrologic impact of Awaba Colliery on watercourses is therefore considered to be negligible as there is no removal of clean runoff from the overall natural surface water system.

5.2 Underground Water

Based on the conceptual hydrogeological model outlined in the Water Balance Assessment Report in Appendix B, groundwater in the vicinity of Awaba Colliery occurs primarily within the coal seams. The orientation and dip of the coal seams affect the groundwater flow characteristics.

The hydrogeological model did not estimate any substantial increase in water make i.e. loss of groundwater from the surrounding aquifers, as a result of the project.

The search of the NSW Groundwater Bore Database identified 16 registered bores within approximately 7 km of the Awaba Colliery pit top. Bore construction details are limited, however three stock or test bores (not owned by Centennial) within 3 km of the north western boundary of the Awaba Colliery workings appear to be screened across coal seams. Since these bores are beyond the outcrop of the Great Northern Seam, which Awaba Colliery mines, it is likely that they intercept the Fassifern Seam and will not be impacted by the Project.

Overall, the bore search indicates that groundwater usage in the area by local landholders is limited.

10 South

As part of the progressive development of mine water management, some changes to underground water transfers have occurred (March 2010). This has resulted in the replacement of the Barnes Dam underground storage with Fish Tanks. These Fish Tanks collect underground water which is then transferred to the underground storage area associated with the 10 South bore. Subsequently, discharges through LDP005 have ceased while discharge through 10 South (at a rate of 5.5 L/s) has continued and is now the only location where underground water is now discharged.

The operation of 10 South is discussed in more detail with the Water Balance report (Appendix B). Through the hydrogeologic model and detailed water balance, it was determined that an increase in discharge through 10 South may be required in order to maintain a safe water level within the underground workings. The recommended de-watering rate through 10 South is 1.2 ML/day (or 440 ML/year).

5.3 Water Balance

By comparing the information provided in Table 5.2 (proposed conditions) to the data within Table 4.5 (existing conditions) it can be seen that construction of the expansion of the Pollution Control Dam will result in a decrease in discharges through LDP009 in years of higher rainfall.

It can also be seen that the removal of Barnes Dam and LDP005 will result in an increase in discharges through 10 South to the Eraring Ash Dam.

Table 5.2 Proposed Conditions Water Balance Results

	Average Year (1995)	Dry Year (1993)	Wet Year (2007)
Inputs (Rainfall/Runoff) (ML/year)	246.11	66.93	362.53
Outputs (Evaporation) (ML/year)	1.38	1.37	1.38
Discharge through LDP009 (ML/year)	0.00	0.00	0.69
Discharge through 10 South (ML/year)	173.5	173.5	173.5

LDP009

A review of the discharges through LDP009, for the full assessment period of January 1987 to February 2010, for both the existing and proposed conditions was undertaken. Through this it was determined that construction of the additional storage associated with the Pollution Control Dam will reduce the average number of discharges from 1.04 per year to 0.17 per year.

10 South

The impact of discharges to the Eraring Ash Dam (from 10 South) was also investigated as part of the water balance assessment. A previous investigation by Connell Wagner into the Ash Dam determined that it had a capacity of 4,000 ML with inflows in the order of 14.07 ML/day from Eraring and an allowable maximum controlled discharge of 47.52 ML/day.

In order to assess the potential impact of discharges from 10 South for the existing conditions, conversion of the average annual discharge to a daily discharge was required. These daily discharges were then compared to the inflows to the Ash Dam and it was found that Awaba Colliery contributes less than 2% of the inflows.

In the event that the pumping capacity at 10 South is not increased, the increased duration in pumping through this discharge point would increase the contribution to the Eraring Ash Dam to approximately 3%.

Under both the existing and proposed conditions (with no increase in pump capacity), discharges from Awaba Colliery (through 10 South) contribute only a minor portion of inflows into the Eraring Ash Dam. The impact of Awaba Colliery on the Ash Dam is therefore considered to be minimal.

To provide greater flexibility for Awaba Colliery to enable the maintenance of an underground water level of -2 m AHD, an increased pumping capacity of 1.2 ML/day has been recommended. In the event that this is adopted, the impact of Awaba Colliery on the Eraring Ash Dam would increase to 8.5% of the total inflows. Again this is not considered to be a significant impact on the Ash Dam.

5.4 Water Quality

A reduction in the number of event based discharges through LDP009, due to the increased temporary storage capacity associated with the Pollution Control Dam, will result in a reduction in the annual pollutant load contributing to Stony Creek.

As indicated in Section 4.8, the quality of event based discharges in relation to pH, EC and oil and grease are within the concentration limits of EPL 443. Therefore the improvements to the Pollution Control Dam will have negligible impact on these pollutants. However for TSS and turbidity, the concentrations of these pollutants during event based discharges exceeded the concentration limits nominated in EPL 443. Consequently the improvements proposed for the Pollution Control Dam will reduce the volume of sediment being discharged into Stony Creek in times of high rainfall.

Within Section 4.8, the comparison of ANZECC/ARMCANZ (2000) trigger values and Lake Macquarie ambient values indicated that there were numerous parameters for which Lake Macquarie exceeded the ANZECC/ARMCANZ (2000) guideline values. This is potentially due to historical discharges from heavy industry such as the Pasminco Sulphide Factory and power stations (Wangi and Eraring).

The assessment of water quality data at 'Upstream', 'Downstream' and LDP009 indicated that the quality of water leaving the Awaba Colliery lease area was generally better than the water quality in Lake Macquarie. The exceptions to this included TSS, Arsenic (total and dissolved), Manganese (total and filtered), Aluminium (dissolved) and zinc (dissolved). However for each of these (with the exception of TSS) the quality of the Awaba Colliery discharges were within the limits of the ANZECC/ARMCANZ (2000) trigger values.

6. Mitigation Measures

6.1 Surface Water

Maintenance

To maintain the nominated clean hardstand areas as clean catchments, regular sweeping of these areas is undertaken. These areas are also regularly inspected to ensure that they remain clean.

Pollution Control Dam

To improve the management of surface water at Awaba Colliery, the capacity of the Pollution Control Dam is proposed to be increased. This has been nominated as works to be undertaken as part of the Project but it is also a mitigation measure to reduce the discharge of dirty water from Awaba Colliery to the downstream environment.

During the construction of the additional storage associated with the Pollution Control Dam, a number of sediment and erosion control measures will be required. It is recommended that these measures be determined during the detail design phase and be in accordance with the recommendations of both *Managing Urban Stormwater: Soils and Construction (Vol 1*) and *Managing Urban Stormwater: Soils and Construction (Vol 2E)*.

Quarry

It is recommended that shaping of the base of the quarry be undertaken to enable the retention of dirty water runoff generated during rainfall events up to the 20 year ARI design event as well as installation of a sediment trap near the existing access track.

If is further recommended that the existing sediment and erosion control measures associated with the quarry be monitored monthly to ensure their integrity and performance. Additionally, at times when additional material is being won from the quarry monitoring of these measures should be increased to weekly.

10 South

While 10 South is not a surface feature, water discharged from this location contributes to the Eraring Ash Dam. Due to the minor contribution of Awaba Colliery to the overall inputs into the Ash Dam, no mitigation measures have been proposed for this location.

6.2 Underground Water

Water Make

It is anticipated that there will not be any substantial increase in water make into the workings (from rainfall recharge and aquifers) as a result of the Proposal. Further, it is unlikely that the Proposal will impact beneficial users of coal seam groundwater in the vicinity of Awaba Colliery since the groundwater being used does not appear to be from the Great Northern Seam.

Nevertheless, it is recommended that monthly monitoring of underground water levels be undertaken to monitor changes in the level of water stored in underground depressions and to verify that the rate of extraction at 10 South is sufficient.

6.3 Water Quality

The construction of the Pollution Control Dam will reduce the likelihood of discharges of dirty water to Stony Creek.

To enable ongoing assessment of water quality discharged from Awaba Colliery, the existing monitoring program will be maintained for the life of the Project. This monitoring program is outlined in Table 6.1.

Table 6.1 Monitoring Program

Location	Frequency	Monitored Parameters
LDP001	No longer discharging	
LDP002	No longer discharging	
LDP003	No longer discharging	
LDP004	No longer discharging	
LDP005	No longer discharging	
LDP006	No longer discharging	
LDP007	No longer discharging	
LDP008	Monthly	pH, TSS, oil and grease, EC, turbidity
	Bi-Annual	pH, TSS, oil and grease, sulphate, TP, TN, turbidity, TDS, EC, BOD, Ca, Mg, Na, K, NOx, total hardness. Total: Cu, Pb, Hb, Ni, Co, Se, Ag, Zn, Al, As, Ba, B, Cd, Fe, Mn, Chloride, Cr, Cyanide, Flouride, Ammonia as N. Filtered: Cu, Pb, Hg, Ni, Co, Se, Ag, Zn , Al, As, Ba, B, Cd, Fe, Mn, Cr
LDP009	Event based	pH, TSS, oil and grease, sulphate, TP, TN, turbidity, TDS, EC, BOD, Ca, Mg, Na, K, NOx, total hardness. Total: Cu, Pb, Hb, Ni, Co, Se, Ag, Zn, Al, As, Ba, B, Cd, Fe, Mn, Chloride, Cr, Cyanide, Flouride, Ammonia as N. Filtered: Cu, Pb, Hg, Ni, Co, Se, Ag, Zn , Al, As, Ba, B, Cd, Fe, Mn, Cr
10 South	Monthly	pH, TSS, oil and grease, EC, turbidity
	Bi-Annual	pH, TSS, oil and grease, sulphate, TP, TN, turbidity, TDS, EC, BOD, Ca, Mg, Na, K, NOx, total hardness. Total: Cu, Pb, Hb, Ni, Co, Se, Ag, Zn, Al,

Location	Frequency	Monitored Parameters
		As, Ba, B, Cd, Fe, Mn, Chloride, Cr, Cyanide, Flouride, Ammonia as N. Filtered: Cu, Pb, Hg, Ni, Co, Se, Ag, Zn , Al, As, Ba, B, Cd, Fe, Mn, Cr
Upstream	Monthly	pH, TSS, oil and grease, EC, turbidity
Downstream	Monthly	pH, TSS, oil and grease, EC, turbidity

In accordance with Section 7.4.4.2 of ANZECC, it is recommended that natural background concentrations be established from water quality data collected for at least 24 samples. These samples would preferably be collected on a monthly basis over a period of two (2) years. Therefore it is recommended that sampling continue to be undertaken at 'Upstream' and 'Downstream' associated with Stony Creek.

It is also recommended that sampling be taken at one (1) other reference site in the Jigadee Creek catchment area within the Awaba lease area. Sampling at this location would also include the collection of at least 24 samples preferably taken monthly over a period of two (2) years.

In the event that monthly sampling could not occur (due to the ephemeral nature of same of the watercourse), the review of the ANZECC assessment would completed once the analysis of the 24 samples had occurred.

The samples would be analysed for:

- ph, EC, TSS, turbidity, oil and grease, major cations/anions.
- Total nitrogen (including NOx and ammonia), TP
- Total hardness
- Metals (total/dissolved): Al, As, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn, Hg.

7. References

Connel Wagner*, Eraring Power Station Ash Dam Water Forecast for Dense Phase Slurry Proposal,* August 2007.

Department of Environment and Climate Change, 2008 *Managing Urban Stormwater Volum 2E Mines and Quarries.*

Department of Environment and Heritage, Canberra, ANZECC / ARMCANZ 2000, *National Water Quality Management Strategy: Australian and New Zealand guidelines for fresh and marine water quality.*

Department of Water and Energy 2000, *Water Management Act 2000.*

Environmental Protection Authority 1998*, Managing Urban Stormwater.*

Landcom 2004b, *Managing Urban Stormwater: Soils and Construction Volume 1*, 4th Edition March 2004, NSW.

Appendix A

Pollution Dam Assessment

Assessment of Pollution Control Dam Capacity

Pollution Control Dam: Options for Augmentation

11 August 2009

Jeffrey Dunwoodie
Centennial Coal
PO Box 1000
TORONTO NSW 2283

Our ref: 22/14622/87756
Your ref:

Dear Jeff

Awaba Pollution Control Dam Assessment

This report provides as assessment of the previous and existing capacities of the Pollution Control Dam (PCD) at Awaba Colliery and proposes possible options for augmentation of the existing system.

1 PART 1 – Assessment of Existing and Required Capacities

Assessment of the documentation provided and liaison with Awaba staff indicated that the catchment contributing to the PCD is limited to the dirty water generating areas, consisting of site infrastructure, stockpiles and hardstand areas of the Awaba Colliery. The ponds volumes assessed by GHD closely agree with values provided for site.

The dam incorporates a pumping system that is triggered at two levels. Pumping commences at a water level of 26.96m RL and ceases when the volume reaches a low water level of 26.90m RL. Retention capacities of the dam have been assessed assuming the dam is maintained at the low water level.

The total capacity of the PCD prior to 20 February 2009 was assessed as 3,187m^3. At the time the dam volume was maintained at a volume of 2,404m^3 therefore the retention capacity of the dam was 783m^3. The retention capability of the dam was further increased by the pumping capacity from the dam of 1L/s.

The retention capacity of the dam prior to 20 February 2009, including the offset of pumping at 1L/s, correlates to the Average Recurrence Intervals (ARI's) and storm durations presented in Table 1-1 below.

Table 1-1 Retention Capacity of Dam

	ARI			
Storm Duration	**1 Year**	**2 Years**	**5 Years**	**10 Years**
5 min				
6 min				
10 min				
20 min				
30 min				
1 hr				
2 hr				
3 hr				
6 hr				
12 hr				
24 hr				

	No overflow from PCD
	Overflow from PCD

On 20 February 2009 the retention capacity of the dam was increased by augmentation of the capacity of the pump from 1L/s to 11L/s. The retention capacity of the dam alone remains to be 783m^3.

The current retention capacity of the dam, including the offset of pumping at 11L/s, correlates to the ARI's and storm durations in Table 1-2 below.

Table 1-2 Current Retention Capacity of Dam

	ARI			
Storm Duration	**1 Year**	**2 Years**	**5 Years**	**10 Years**
5 min				
6 min				
10 min				
20 min				
30 min				
1 hr				
2 hr				
3 hr				
6 hr				
12 hr				
24 hr				

	No overflow from PCD
	Overflow from PCD

The volume of runoff generated in the 10 year ARI 24 hour storm event would be approximately 4,485m^3, however, 950m^3 would be offset by continuous pumping from the dam of 11 L/s. Therefore the final retention volume required for the catchment is 3,535m^3. Augmentation of 2,752m^3 from the current system is required to obtain this retention volume.

2 PART 2 – Options for Augmentation

Numerous options for the incorporation of additional storage in conjunction with the existing Pollution Control Dam (PCD) at the Awaba mine site have been examined. The following details the initial assessment of options.

- Required storage volume for the 10 year ARI 24 hour event (from Part 1) 3,535m^3.
- Existing capacity (from Part 1) 783m^3.
- Required additional capacity (from Part 1) 2,752m^3.

2.1 Option 1 - Lower Existing Control Level by 1m

The information provided by site indicates the pond invert level is 24.5m with a pump switch “off” level of 26.9m. Should the pump switch off level be lowered by 1m then an additional 1,035m^3 of storage is available but this in isolation of other works would not achieve the required volume. Since the volume for storing coal fines below the pump “off” level will be reduced, the removal of coal fines may need to be undertaken more frequently than currently to retain the required water storage capacity above the pump “off” level.

To reduce the frequency of cleaning yet still obtain an increase in storage volume, a better total works balance maybe achieved by reducing the pump switch off level by only 0.5m in conjunction with the undertaking of other works. This would increase the storage in the pond by only 525m^3.

2.2 Option 2 - Lower Existing Pump Control Level by 0.5m and Construct a New Pond

Works involved would include:

- Modify the pump switch “off” level to 26.4m (0.5m below the existing level).
- Construct a new pond at either end of the existing pond to dimensions approximately the same as for the existing pond, refer to Figure 1.
- Construct an overflow from the existing pond to the new pond at invert level of approximately 27.2m AHD. The overflow would be a trapezoidal weir approximately 2m in length.
- Construct a new pump in the new pond. This pump would have an “off” level set at 24.5mAHD and would discharge to the current LDP. This would enable the new pond to be kept dry. This new pump would not be optional since the pump “off” level is below that proposed for the existing dam.
- Install piping from the new pump in the new pond to transfer water from the new pond to the current LDP.

The increased storage volumes would be:

– Increase in existing pond 525m^3.
– Approximate volume in new pond 3,000m^3.
– Total increase in capacity 3,525m^3.

Hence, this configuration can provide the required storage capacity and design optimisation could reduce the increase in capacity to the minimum required value.

Additional optional works that could be considered to minimise the amount of coal fines likely to be carried from the existing dam to the new pond through the overflow include:

– Use of an under-overflow weir located within the existing dam adjacent to the overflow. Forcing water to pass through this form of overflow structure would assist to retain floating coal fines in the existing dam.
– Installation of a floating curtain made from a fine filter such as a geofabric could be installed at the overflow to trap the floating coal fines and prevent them discharging into the new pond.

Additional optional works that could be considered to minimise the amount of coal fines likely to be discharged from the existing dam include:

– Use of an under-overflow weir located within the existing dam upstream of the overflow/LDP. Forcing water to pass through this form of overflow structure would assist to retain floating coal fines in the existing dam.
– Installation of a floating curtain made from a fine filter such as a geofabric could be installed upstream of the overflow/LDP to trap the floating coal fines and prevent them discharging into the new pond.
– Installation of a floating curtain or underflow weir around the pump in the existing dam to trap as much floating fines as practical.

2.3 Option 3 – Lower Existing Pump Control Level by 0.5m and Construct Two New Ponds

Works involved would include:

- Modifying the pump switch of levels to 26.4m (0.5m below the existing level).
- Constructing two new ponds, located at both ends of the existing pond. The ponds would have an invert level of approximately 26.5m sloping towards the existing pond.
- Install two 300mm diameter pipes from the invert of the new ponds to just above the modified pumping level of the existing pond, refer to Figure 2.

The increased storage volumes would be:

- Increase in existing pond 525m^3.
- Volume in proposed PCD A 1,185m^3.
- Volume in proposed PCD B 1,130m^3.
- Total increase in capacity 2,840m^3.

This configuration can provide the required storage capacity and design optimisation could reduce the increase in capacity to the minimum required value.

An advantage of this configuration is that a new pump station will not be required. As the water level rises above the pumping level, water will backup through the pipes and into the new dams. Water in the new dams will then naturally drain back into the main existing dam as water is pumped out via the existing pump system.

As with Option 2, additional optional works that could be considered to minimise the amount of coal fines likely to be discharged would include:

- Use of an under-overflow weir located within the existing dam upstream of the overflow/LDP. Forcing water to pass through this form of overflow structure would assist to retain floating coal fines in the existing dam.
- Installation of a floating curtain made from a fine filter such as a geofabric could be installed upstream of the overflow/LDP to trap the floating coal fines and prevent them discharging into the new pond.
- Installation of a floating curtain or underflow weir around the pump in the existing dam to trap as much floating fines as practical.

2.4 Option 4 - Raising the Overflow / Spillway Level of Existing Dam by 500mm

Works involved would include:

- Raising the embankment of the existing dam and extending the embankment in both directions across the haul road and to the south, as sketched in Figure 3.

The system would, in large rainfall events, pond water in the area of regrowth to the north of the existing dam, the truck loading area and also to the south of the existing pond. The advantage of this configuration is that a new pump station will not be required. However, clean up after such an event would be required and may be extensive. Also this option would in our opinion, cause a greater site operational disruption than Options 2 and 3.

2.5 Option 5 – Retaining Existing Dam and Overflowing to Two New Ponds

This option would involve the retention of the existing dam together with the construction of two additional ponds. The dam and ponds would be configured so that:

- Water initially flows into the existing dam.
- The existing dam overflows to one of the new ponds.
- Water then flows from the initial new pond to the second new pond.
- Water would be discharged from the second new pond to the LDP (possibly a new LDP).

The new ponds would be constructed in locations similar to those shown in Figure 1. The logic for the arrangement would be to maximise the detention to maximise the retention of coal fines.

To minimise costs associated with this option the following is suggested:

- The pump in the existing dam would be relocated to the second of the new ponds.

- The configuration would be arranged so that flow gravitates from the existing dam through the first new pond into the second new pond and then is pumped to the LDP. To achieve this there would be new pipes (probably 3 of 375mm diameter pipes or equivalent at an invert level of around 26.4 mAHD) installed to connect the existing dam to the first new pond and also a piped connection between the two new ponds. To achieve gravity flow the second new pond would have an invert of around 24.5 mAHD. The first new pond could have an invert of around 25.0 mAHD.

The increased storage volumes would be:

- Increase in existing pond 525m^3.
- Volume in proposed first pond 950m^3.
- Volume in proposed second pond 1,130m^3.
- Total increase in capacity 2,613m^3.

With optimisation during design advancement it should be possible to obtain the additional 139 m^3 of storage.

As with Options 2 and 3 it would be possible to install a combination of underflow weirs and/or curtains to reduce the amount of coal fines transported through the ponds and discharged.

We are unable to determine whether this configuration would be able to achieve a discharge standard of 50 mg/L. The achieved standard is generally dependent upon coal characteristics rather than detention time, as long as the detention exceeds several minutes and there is minimal turbulence to retain coal in suspension. Should there be some results of settling tests or jar tests this could be examined.

3 Recommendations

We suggest that Option 2 or 5 be adopted. To progress one of these options we suggest:

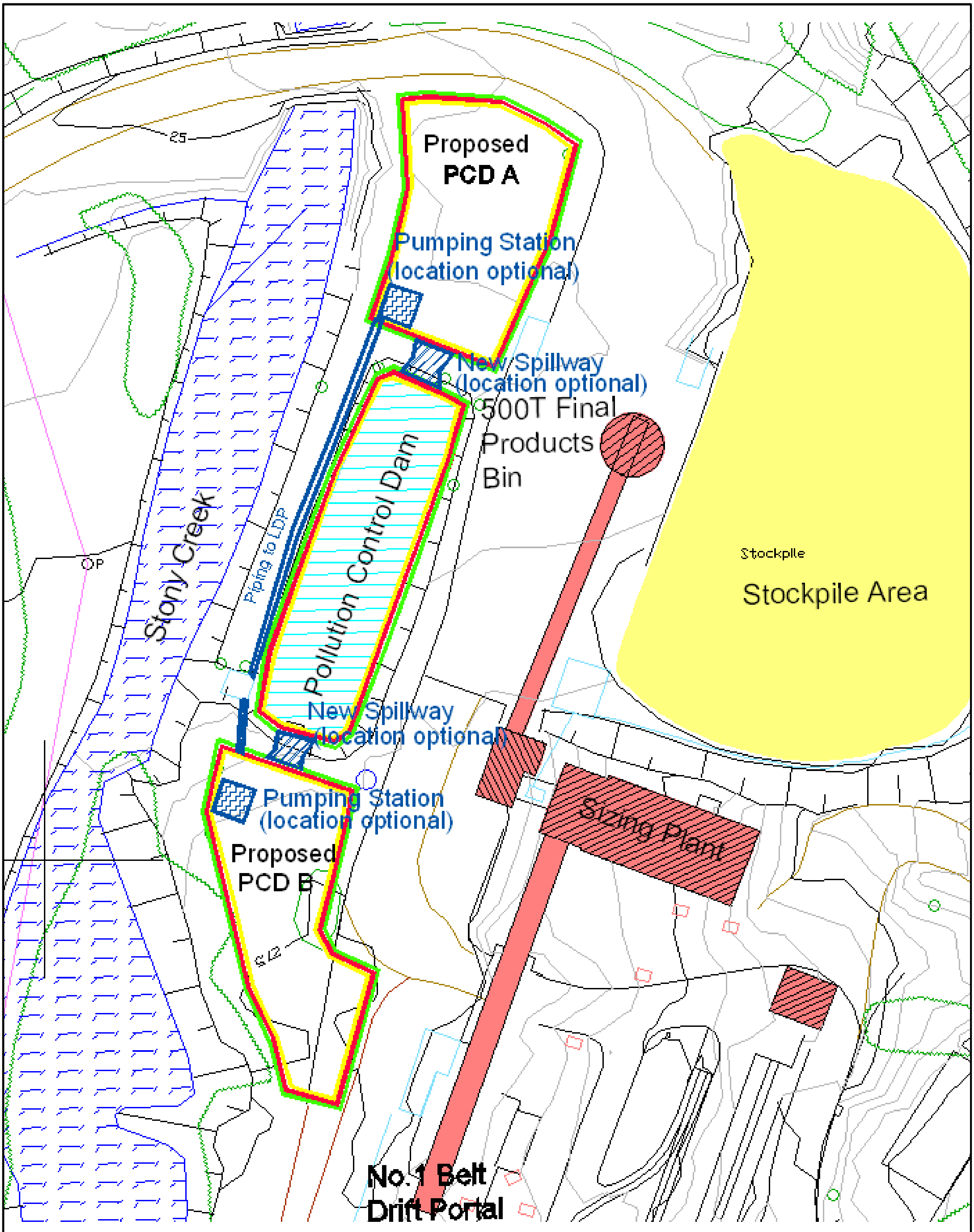
- Underground services be located using available site plans.
- A survey is completed for the proposed end, as the plans and dams levels provided to GHD are not consistent.
- A preliminary cost estimate be prepared to get an in principle budget approval within Awaba.

Yours sincerely

for

Ian Joliffe
Project Director, Principal Water Engineer
02 4979 9934

Attachment: Figures 1 - 3



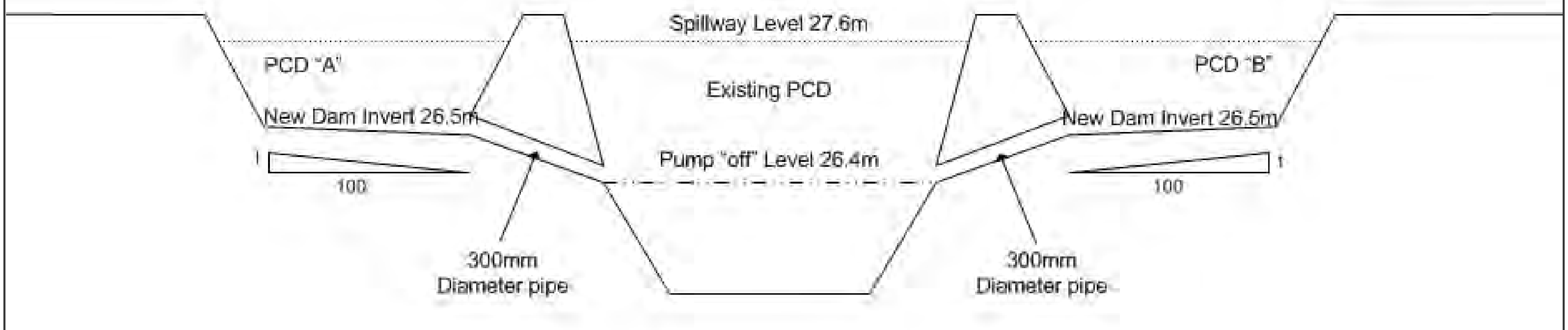
LEGEND

Awaba Colliery
Location of Proposed Pollution
Control Dams

DATE 07-08-2009

Figure 1

GIS Filename: G:\22\14622\GIS\Maps\Figure1.mxd



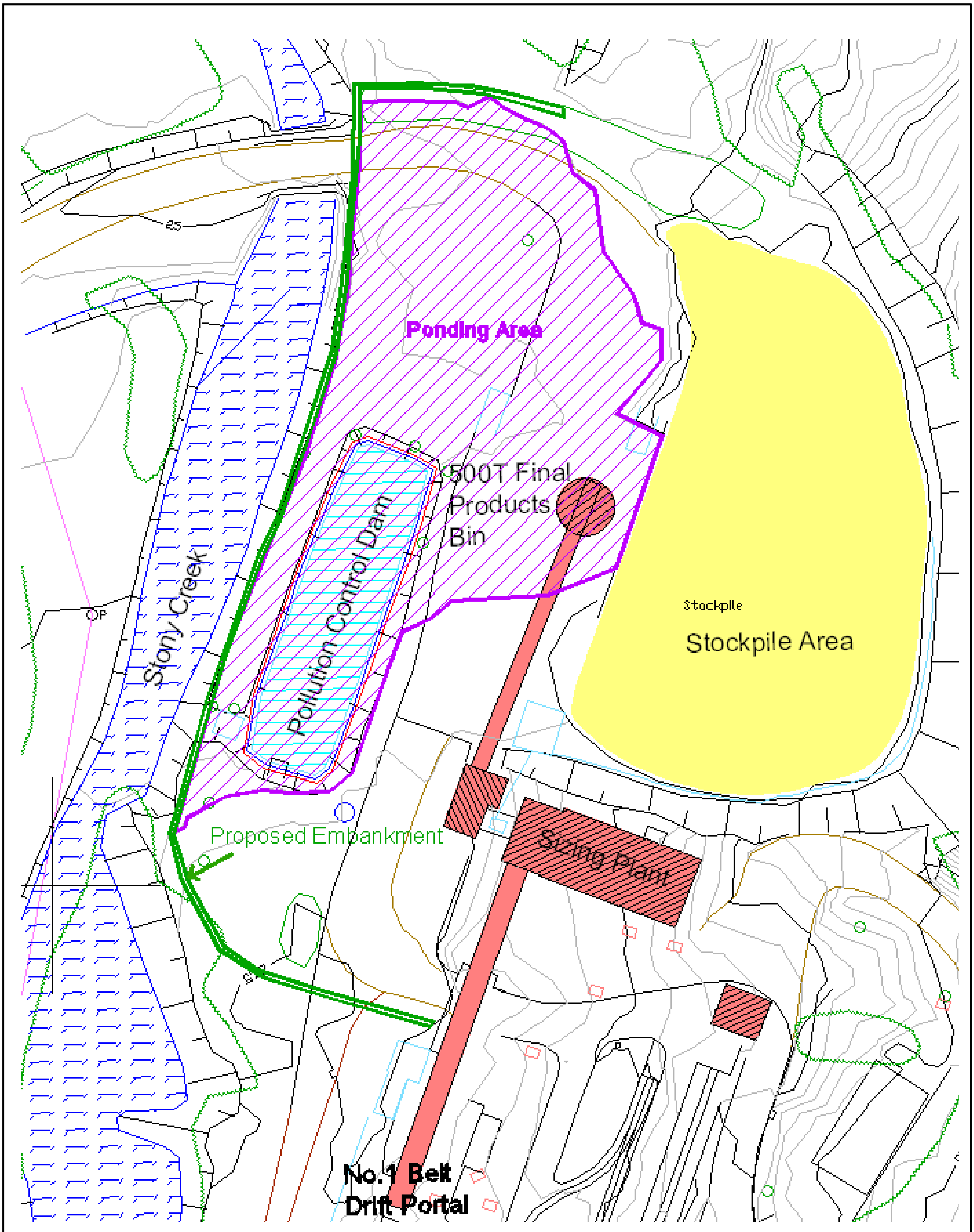
LEGEND

Awaba Colliery
Schematic of Option 3 Configuration

DATE 11-08-2009

Figure 2

GIS Filename: G:\22\14622\GIS\Maps\Figure2



LEGEND

Awaba Colliery
Estimated Ponding Extent
and Embankment Location

DATE 07-08-2009

Figure 3

GIS Filename: G:\22\14622\GIS\Maps\Figure3.mxd

Appendix B

Water Balance

Centennial Newstan Pty Ltd

Awaba Colliery
Water Balance Assessment

May 2010

FUTURE POWER | Centennial Coal

Contents

Table Index

Figure Index

Appendices

Glossary

Aquifer	Underground water storage within either disturbed or undisturbed strata.
Average Recurrence Interval	A statistical estimate of the average period in years between the occurrence of a flood of a given size or larger, eg. floods with a discharge as big as, or larger than, the 100-year ARI flood event will occur on average once every 100 years. ARI is equal to the reciprocal of annual flood risk, e.g. an annual flood risk of 1/100 has an ARI of 100 years.
Barnes Dam	An underground water storage location. Discharges from Barnes Dam are via LDP005.
Boot Wash	Location where personnel can wash their safety boots.
Bord and Pillar	A mining system whereby coal is extracted leaving ‘pillars’ of untouched coal to support the strata above.
Bore	A constructed connection between the surface and a source of underground water that enables the underground water to be transferred to the surface either naturally or through artificial means
Clean catchment areas	Catchments in which there are no exposed surfaces containing coal or mined carbonaceous material.
Clean water	Waters on the premises that have not come into physical contact with coal, or mined carbonaceous material.
Coal Handling Plant	A facility where coal is screened and prepared for transport off-site.
Dewatering	Transfer of water from underground workings to the surface.
Dirty catchment areas	Catchments in which coal mined carbonaceous materials are present or areas where the topsoil has been disturbed.
Dirty water	Water on the premises that has come into physical contact with coal, mined carbonaceous materials or otherwise contains elevated sediment load.
Fish Tank	Underground water storage tank located in the proximity of Barnes Dam.
Fractures	Cracks within the strata either natural or resulting from underground works.
Groundwater	Water held in strata that is not overlying the strata of the coal seam, or within the coal seam.
Infiltration	Natural flow of surface water through ground surfaces as a result of rainfall events.

Inbye	Direction towards the mining face of the coal seam.
In-Seam Coal Storage Bin	Coal Storage Bin located at the end of the coal conveyor south of the workshop.
Interburden	The strata between coal seams.
Licensed Discharge Point	A location where Angus Place discharges water in accordance with conditions stipulated within the site Environment Protection License.
Net extraction	Difference between water transferred to, and from, the underground water storage.
Oil Water Separator	Device designed to separate oil and suspended solids from water.
Overburden	The strata between the recoverable topsoil and the upper coal seam.
Pollution Control Dam	A dam located downstream of the pit top facilities. LDP009 is located on the spillway of this dam.
Recharge	Inflow of water from surrounding strata into underground workings through infiltration. This can be as a result of rainfall events or from surrounding aquifers.
Sediment-laden water	Water that has a high level of suspended solids.
Steady state condition	A condition in which the system has achieved equilibrium.
Surface Water	Water that is derived from precipitation or pumped from underground and may be stored in dams, rivers, creeks and drainage lines.
Temporary storage	Volume of storage available within a dam between the permanent water level and the overflow level.
Underground water	Water stored in underground aquifers. During the mining process a proportion of this water is released and managed by the underground settling and pumping system.

Abbreviations

AEMR	Annual Environmental Management Report
AHD	Australian Height Datum
ARI	Average Recurrence Interval
BOM	Bureau of Meteorology
CHP	Coal Handling Plant
DECCW	Department of Environment, Climate Change and Water
DOP	Department of Planning
DWTS	Delta Water Transfer Scheme
EA	Environmental Assessment
EP&A Act	Environmental Planning and Assessment Act 1979
EPL	Environment Protection Licence
kL	Kilolitres
LDP	Licensed Discharge Point
m	Metres
MB	Monitoring bore
ML	Megalitres
MTpa	Million Tonnes per annum
NOW	New South Wales Office of Water
NMQMS	National Water Quality Management Strategy
PA	Project Approval
POEO Act	Protection of the Environment Operations Act 1997
REA	Reject Emplacement Area
ROM	Run of Mine
STP	Sewage Treatment Plant
SWMP	Surface Water Management Plan
T	Tonnes
WMAct	Water Management Act 2000

Executive Summary

Awaba Colliery, operated by Centennial Coal Company Pty Ltd, is an underground operation for which the management of both surface and underground water is an important issue. This water balance assessment was undertaken to confirm the existing water management systems. As part of this assessment, the development of both a water balance numerical model and a hydrogeologic model was undertaken.

Inputs into both of these models were based on information provided by Awaba Colliery and further estimations based on the available data. The hydrogeological model and the water balance model were then calibrated against the recorded information primarily relating to historical discharges and underground water levels.

For the existing conditions (pre March 2010), it was determined that the average annual discharges from Awaba Colliery through LDP009, LDP005 and 10 South were 1.0, 85.5 and 82.0 ML/year respectively.

For the proposed conditions, the calibrated model was adjusted to reflect the increase in capacity of the Pollution Control Dam and the removal of Barnes Dam and subsequently LDP005. The resulting predicted average annual discharges through LDP009 and 10 South were determined to be 0.2 and 173.6 ML/year respectively.

From this it can be seen that there will be a decrease in discharges through LDP009 however there will be an increase in discharges through 10 South. The increase in discharge through 10 South will occur as a result of the increase in pump operation to cater for the increase in underground water storage at 10 South.

10 South discharges into the Eraring Ash Dam and consequently, consideration was given to the potential impact of both the existing and proposed discharges (with no increase in pump capacity). The Ash Dam receives daily inflows from Eraring in the order of 14.07ML/day and has a total capacity of 4,000 ML.

When compared to the total inflows into the Ash Dam, Awaba Colliery currently contributes around 2% of the total inflow however this will increase to approximately 3% for the proposed conditions.

Under both the existing and proposed conditions, discharges from Awaba Colliery (through 10 South) contribute only a minor portion of inflows into the Eraring Ash Dam.

To provide greater flexibility for Awaba Colliery in maintaining an underground water level of -2 m AHD, an increased pumping capacity of 1.2 ML/day has been recommended. In the event that this is adopted, the impact of Awaba Colliery on the Eraring Ash Dam would increase to 8.5% of the total inflows. Again this is not considered to be a significant impact on the Ash Dam.

1. Introduction

The Awaba Colliery is operated by Centennial Coal Company Pty Ltd, through a company called Centennial Newstan Pty Ltd. The Colliery is located approximately 1 kilometre south of Awaba township and 5.5 kilometres south west of Toronto on Wilton Road as indicated on Figure 1.1.

1.1 Study Area

This water balance assessment has given consideration to the overall water management system associated with Awaba Colliery and includes all water transfers associated with:

- Existing mining activities.
- Proposed mining activities.
- Surface operations.

1.2 Objectives of this Report

The objectives of this water balance are to:

- Quantify the water budget in relation to the surface water and groundwater management systems for existing operations.
- Revise the water budget in relation to the water management system for future operations.

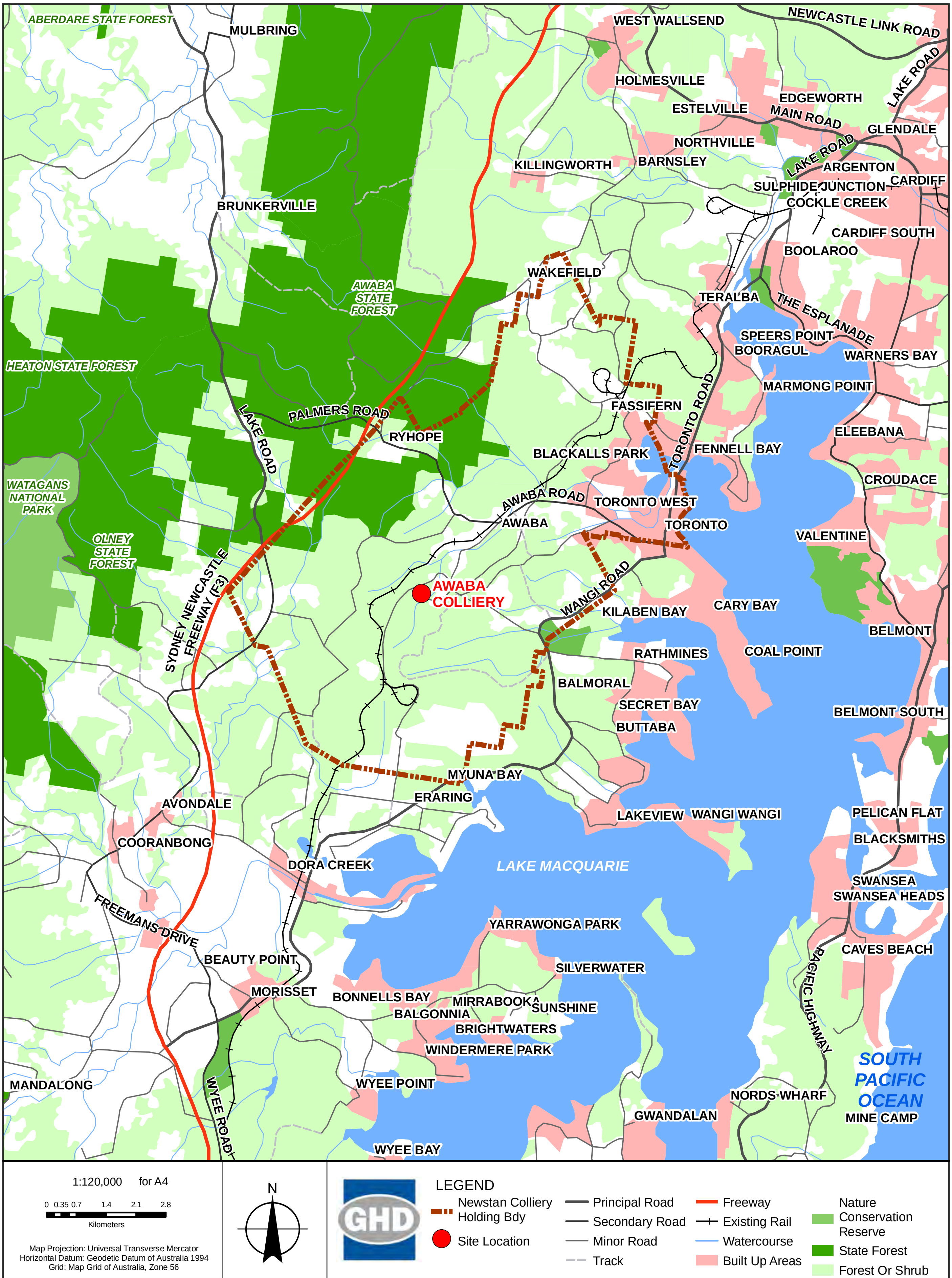
Overview of Site Operations

The site features associated with operations at Awaba Colliery are provided on Figure 1.2 and include:

- Underground mining.
- Coal processing at the Coal Handling Plant (CHP).
- Loading of coal for export from site by road.
- Mechanical maintenance activities – undertaken near the Administration area and at a workshop.
- Office and administrative activities.

Historical Mining Activities

Awaba Colliery commenced bord and pillar operations within the Great Northern Seam in 1947 using hand-mining techniques. Over 30 million tonnes of coal has been won from these workings using a combination of first workings development, pillar extraction, pillar quartering and pillar stripping.



LOCATION	Awaba
SEAM	Great Northern
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Awaba Colliery

Locality Plan

Centennial Awaba

DATE 04-05-2010

Figure 1.1

GIS Filename: G\22\15033\GIS\MAPS\Deliverables\Water Balance Report\2215033_WB_FIG1-1_Locality_20100504.mxd

1:3,000 for A4 0 0.01 0.02 0.04 0.06 0.08 Kilometers Map Projection: Universal Transverse Mercator Horizontal Datum: Geodetic Datum of Australia 1994 Grid: Map Grid of Australia, Zone 56	N	LEGEND Pollution Control Structures 10m Contours Watercourse

LOCATION	Awaba
SEAM	Great Northern
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Awaba Colliery

Surface Features

Centennial Awaba

DATE 13-05-2010

Figure 1.2

GIS Filename: G\22\15033\GIS\MAPS\Deliverables\Water Balance Report\2215033_WB_FIG1-2_SiteFeats_20100504.mxd

Existing Mining Activities

Current mining operations include extraction of coal at a rate of approximately 850,000 tonnes per annum utilising a mining system that includes the development of minimum size pillars in a pillar quartering system.

Future Mining Activities

Through productivity improvements, there is a potential that the coal extraction rate could increase to 880,000 tonnes per annum using the existing mining method. No additional change in extraction rates have been proposed, however to increase the life of the mine additional extraction areas have been proposed and are addressed as part of the documentation currently being prepared as part of a Part 3A application under the *Environmental Planning and Assessment Act 1979.*

Site Water Management

Awaba Colliery is located within the Stony Creek catchment, which contributes to Lake Macquarie. Awaba Colliery's Environmental Protection Licence (EPL) 443 therefore includes both volumetric and concentration limits for the discharge of water off site.

The location of Awaba Colliery's discharge points are indicated on Figure 1.3 and include:

- LDP001 - No longer in use / decommissioned. Borehole still exists.
- LDP002 - No longer in use / decommissioned. Removed.
- LDP003 - No longer in use / decommissioned. Rehabilitated.
- LDP004 - No longer in use / decommissioned. Borehole still exists.
- LDP005 - Barnes Dam no longer in use as at March 2010. Borehole still exists.
- LDP006 - No longer in use / decommissioned. Rehabilitated.
- LDP007 - No longer in use / decommissioned. Borehole still exists.
- LDP008 - Discharge of irrigation water and stormwater runoff adjacent to utilisation area.
- LDP009 - Discharge of mine water from the Pollution Control Dam into Stony Creek.
- 10 South – Discharge of mine water to Eraring Ash Dam.

The primary objective of water management at Awaba Colliery is the separation of clean and dirty water and the effective management of water through collection, treatment and discharge. This is managed through a number of separate water systems including:

- Surface infrastructure.
- Underground infrastructure.
- Potable water supply.
- Wastewater collection and treatment.

Figure 1.3 Licensed Discharge Point Locations

Water Management Associated with Mining Operations

There are numerous water movements associated with the coal mining operations at the Awaba Colliery. The main water movements include:

- Rain falling on vegetated areas within the lease area and generating clean water runoff. Where clean water runoff is directed towards the pit top, diversions have been put in place to convey it through to Stony Creek. No clean water runoff is harvested at Awaba Colliery.
- Runoff from disturbed areas is deemed to be dirty water runoff and is directed through the dirty water management system. Discharges from the dirty water system pass through licensed discharge points (LDPs).
- Potable water is provided to both underground and surface facilities from the on site water tanks.
- Water that seeps into the underground workings is extracted and pumped to the underground water storages.

Other Water Management

Potable water is provided to Awaba Colliery by Hunter Water Corporation to the potable water/fire tanks. The water tanks supply water to the offices, bathhouse, underground working face and other surface facilities such as the washdown bay and coal handling plant. A connection to the sprinkler system associated with the stockpile area is provided within the coal handling plant.

Waste water at Awaba Colliery includes both grey water and sewage. Grey water from the bathhouse and other buildings contributes to the maturation pond while sewage from the pit top buildings is treated through an on site septic system.

Site Geology and Hydrogeology

The geology within the Awaba Colliery lease area affects both the mining operations and management of water. Water management is affected as the stratigraphy will influence the potential for infiltration into the workings. The location of regional aquifers in relation to the workings also affects the management of water on-site.

The stratigraphy at Awaba Colliery is reported within the Subsidence Management Plan (2005) as:

- Triassic Narrabeen Group sandstones, siltstones and conglomerates in topographically higher areas.
- Teralba Conglomerate sandstone with minor siltstone and mudstone.
- Great Northern Seam coal measures.
- Underlying Awaba Tuff siltstone and sandstone.

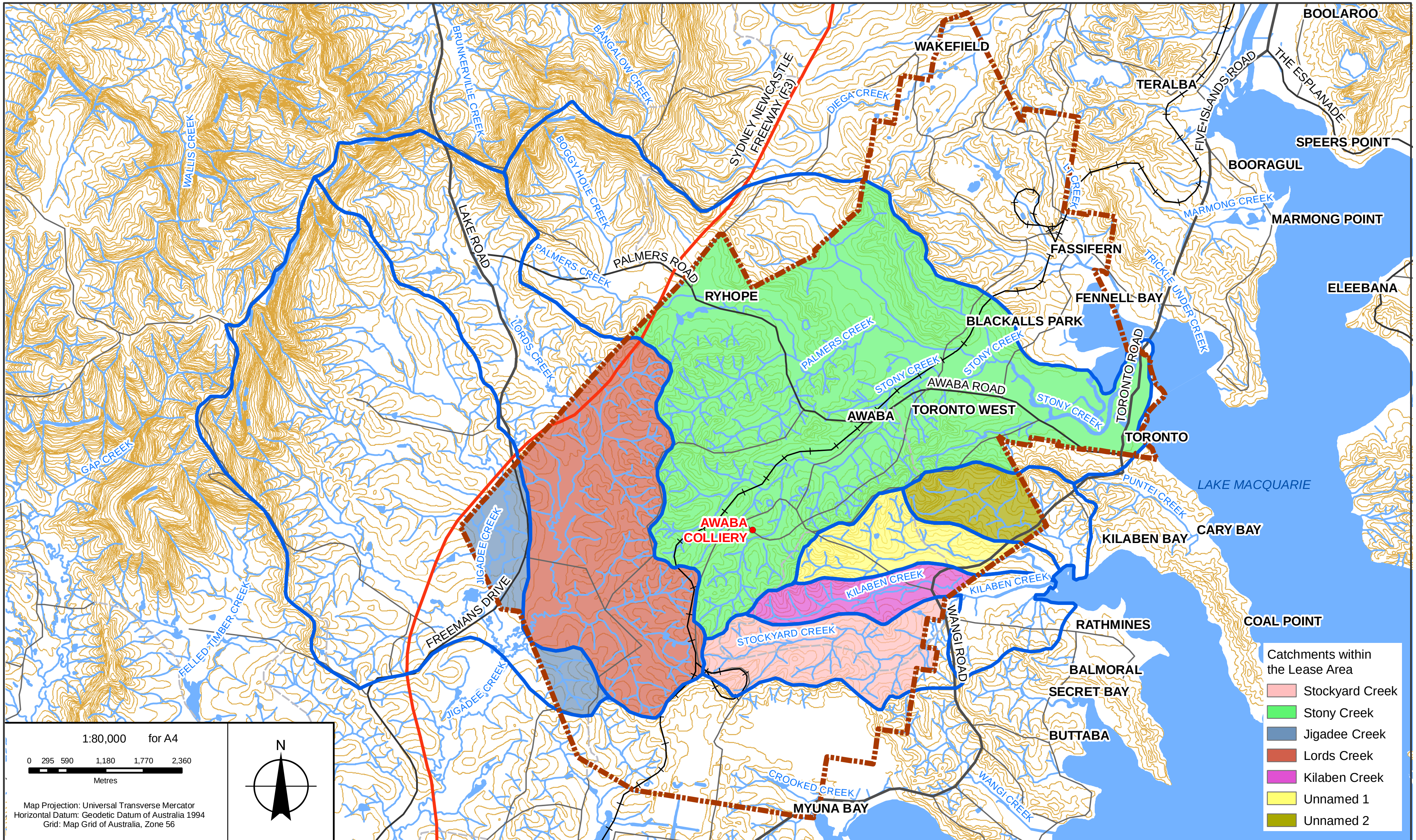
There is no regional aquifer located above the Great Northern Seam and the existing workings have been generally dry with minimal groundwater inflow.

Site Hydrology

Surface water runoff within the Awaba Colliery lease area is conveyed within a number of natural and constructed flow paths. The natural flow paths (watercourses) that originate in or pass through the lease boundary area, contribute to Lake Macquarie. The named watercourses include Lords Creek, Stockyard Creek, Kilaben Creek, Stony Creek and Palmers Creek as shown in Figure 1.4.

Also shown on Figure 1.4 are the overall catchment areas associated with these watercourses. From this it can be seen that the pit top, existing mining areas and proposed mining areas are primarily located within the Stony Creek catchment.

Awaba Colliery does not extract water from any natural water course however it does discharge into Stony Creek, through LDP009, during some rainfall events.



LEGEND

- Newstan Colliery Holding Bdy
- Watercourse Area
- Catchment Bdys
- Watercourse
- Contours 10m
- Site Location
- Freeway
- Principal Road
- Secondary Road
- Minor Road
- Track

LOCATION	Awaba
SEAM	Great Northern
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Awaba Colliery

Watercourses within Awaba Colliery Lease Area

Centennial Awaba

DATE 05-04-2010

Figure 1.4

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2. Water Management

The water management system at Awaba Colliery is comprised of surface, potable, waste and underground elements. Schematics of the surface, underground and potable and wastewater systems are provided in Figure 2.1, Figure 2.2 and Figure 2.3 while Figure 2.4 provides a schematic of the overall water management system.

2.1 Existing Operations in Mining Lease Area

Surface Water System

Surface water consists of runoff that contributes to surface water storages. At Awaba Colliery these include the Pollution Control Dam, in-seam coal storage bin and maturation pond.

Inputs

The inputs into the surface water system consist of:

- Runoff from the contributing catchment areas (both clean and dirty) as a direct result of runoff.

Outputs

The outputs from the surface water system are:

- Evaporation.
- Discharge of clean catchment runoff into Stony Creek.
- Discharges through LDP009 from the Pollution Control Dam into Stony Creek.
- Transfer of water to underground storage.

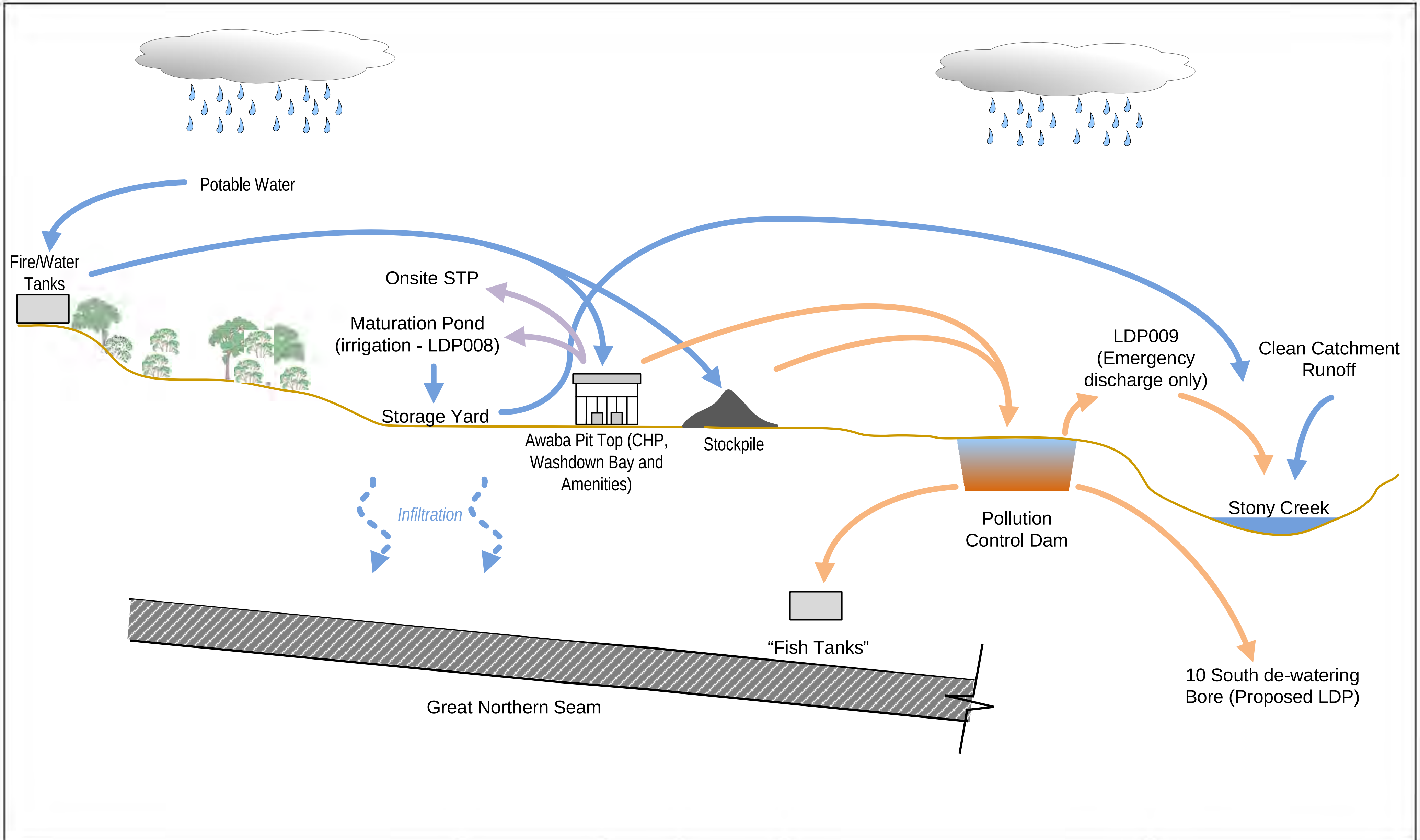
Facilities

The facilities that manage surface water are provided in Table 2.1

Table 2.1 Surface Water Management Structures

Location	Capacity (ML)
Oil Water Separator	0.06
In Seam Coal Storage Bin	0.06*
Final Pollution Control Dam	3.2

* Estimated.



Dirty Water
Clean Water
Sewage Water

LOCATION	Awaba
SEAM	Great Northern
DRAWN	MJP
CHECKED	
APPROVED	
SCALE	

Awaba Colliery
Surface Water Schematic

Centennial

DATE 16-04-2010

Figure 2.1

Underground Water System

Mining at Awaba Colliery interacts with the Great Northern Seam. Although this seam would be considered a water bearing zone, there is limited groundwater inflow into the workings therefore the mine is considered to be a dry mine.

For the purposes of this water balance, the recent (March 2010) changes to underground water movement have not been considered in the assessment of the existing system but rather as part of the proposed conditions.

Inputs

The inputs into the underground water system consist of:

- Natural recharge of the active underground workings.
- The pumping of water from the Pollution Control Dam into underground storage.

Outputs

The outputs from the underground water system are:

- The pumping of water from the active workings to the underground storage tanks.
- Discharge of water (via Barnes Dam) through LDP005.
- Pumping of water from the underground storage tanks to 10 South de-watering bore and subsequently the Eraring Ash Dam.

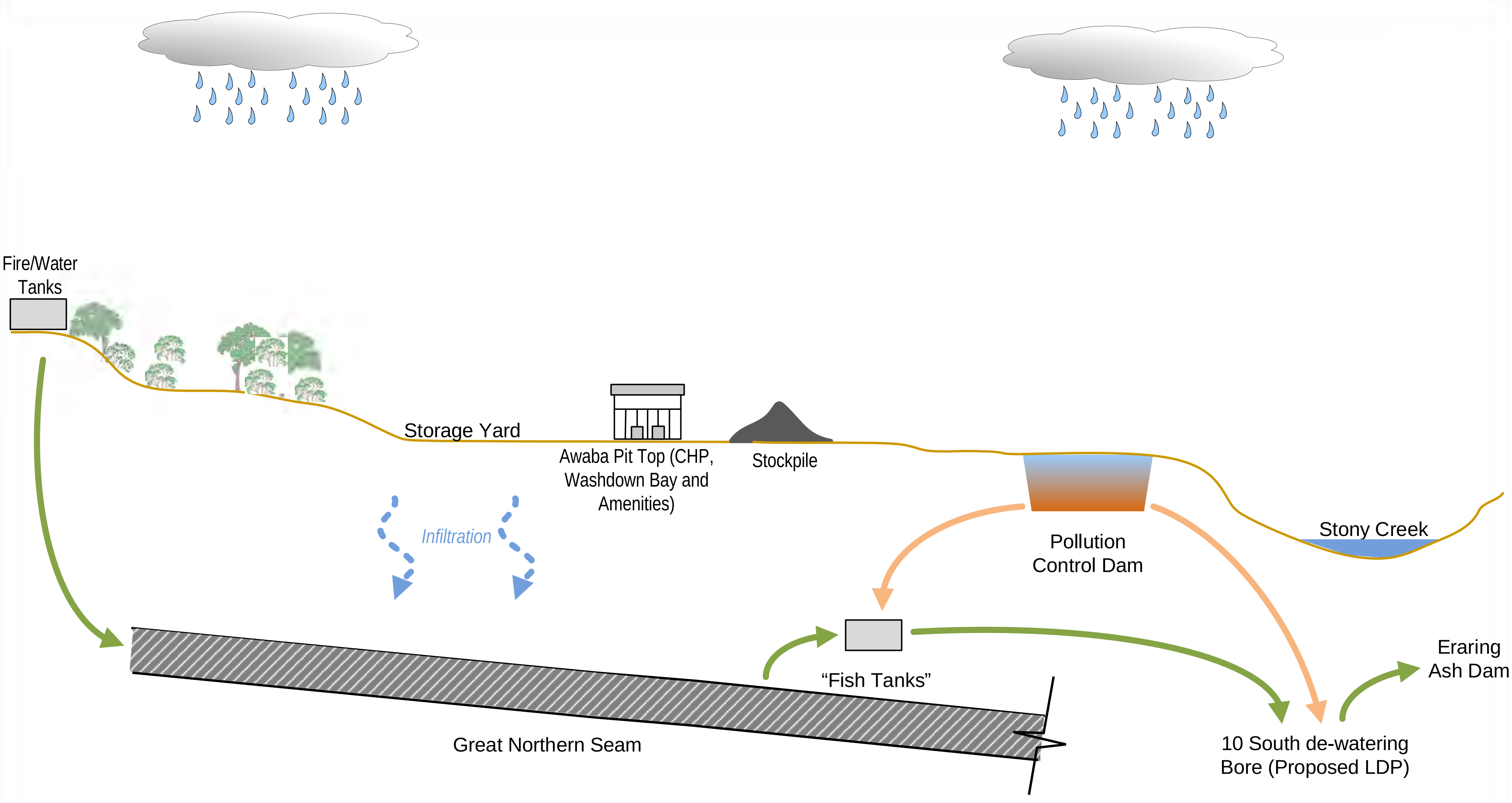
Facilities

To improve management of underground water, recent changes to these facilities have been undertaken. The facilities to store water underground are outlined in Table 2.2.

Table 2.2 Underground Water Management Structures

Location	Capacity (ML)
Barnes Dam	5 (1)
Fish Tank	0.009

(1) Estimated from the floor contours contained within the hydrogeological model.



Dirty Water
Clean Water
Underground Water
Sewage Water

LOCATION	Awaba
SEAM	Great Northern
DRAWN	MJP
CHECKED	
APPROVED	
SCALE	

Awaba Colliery
Underground Water Management Schematic

Centennial

DATE 16-04-2010

Figure 2.2

Potable and Wastewater systems

The potable and waste water systems are a component of the surface water system at Awaba Colliery.

Inputs

The inputs into the potable and waste water systems consist of:

- Potable water provided to water / fire tanks to service buildings and surface facilities.

Outputs

The outputs from the potable and waste water system are:

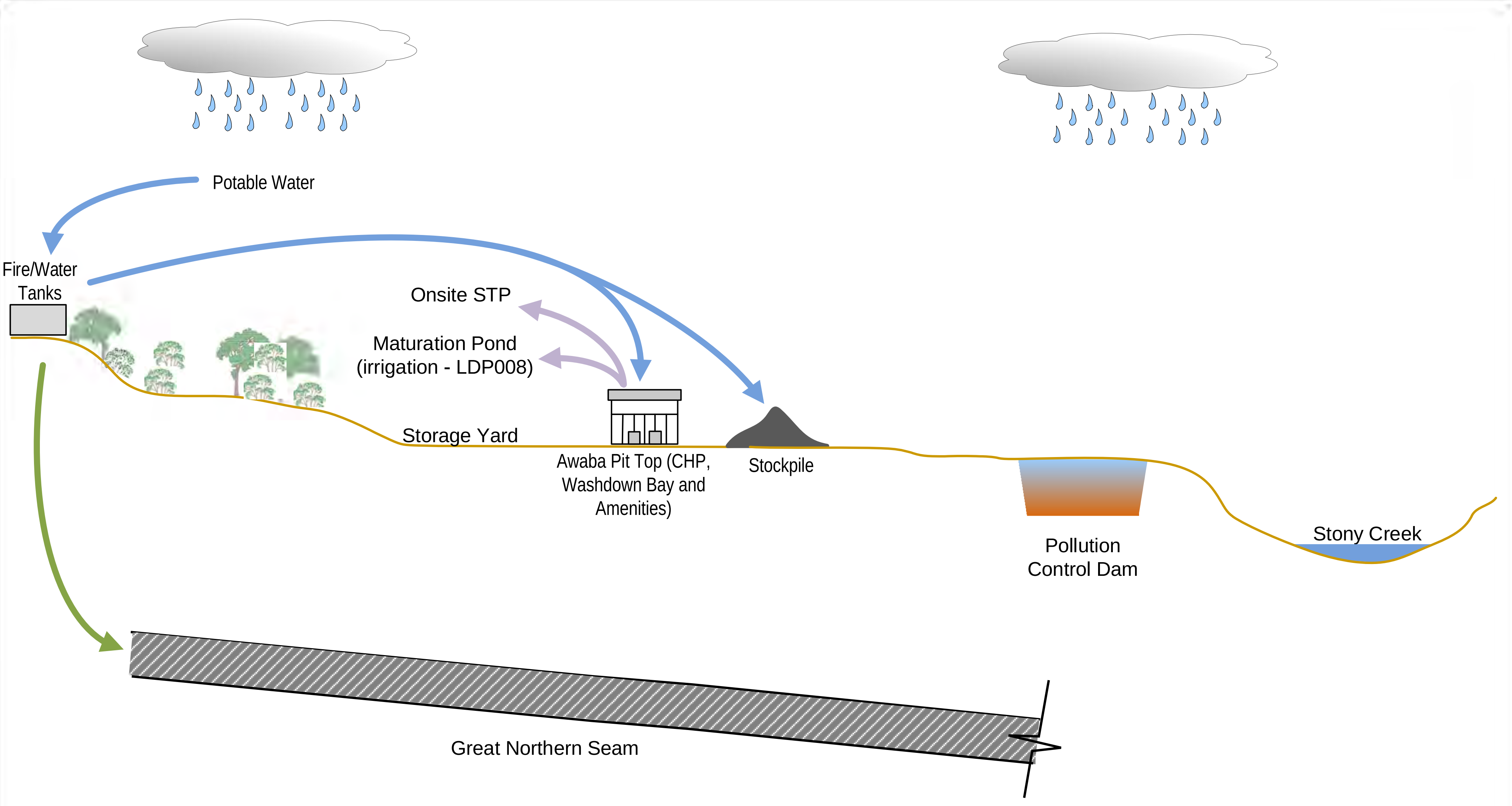
- Grey water from buildings directed to the Maturation Pond.
- Sewage transferred to on-site septic system (pit top buildings).
- Evaporation from the Maturation Pond.
- Discharges through LDP008 from the irrigation area associated with the Maturation Pond.

Facilities

The facilities that manage potable and waste water are detailed in Table 2.3.

Table 2.3 Potable and Waste Water Management Structures

Location	Capacity (ML)
Water / Fire Tanks	0.4
Maturation Pond	0.59
On-site septic system	TBA
Air operated toilets (underground)	TBA



- Dirty Water
- Clean Water
- Underground Water
- Sewage Water

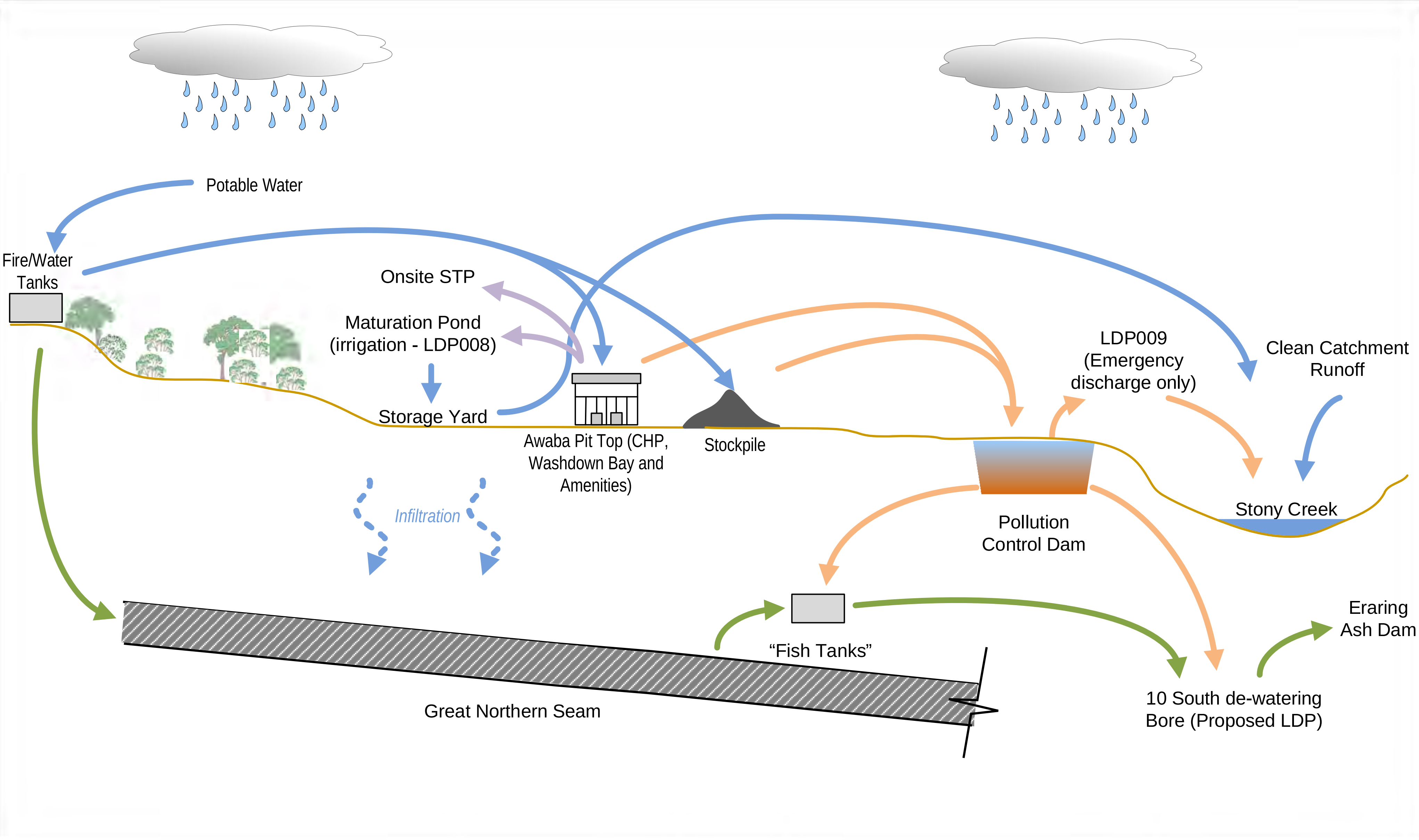
LOCATION	Awaba
SEAM	Great Northern
DRAWN	MJP
CHECKED	
APPROVED	
SCALE	

Awaba Colliery
Potable and Waste Water Schematic

Centennial

DATE 16-04-2010

Figure 2.3



Dirty Water
Clean Water
Underground Water
Sewage Water

LOCATION	Awaba
SEAM	Great Northern
DRAWN	MJP
CHECKED	
APPROVED	
SCALE	

Awaba Colliery
Water Management Schematic

Centennial

DATE 16-04-2010

Figure 2.4

2.2 Future Operations in Existing Mining Lease Area

The future operations proposed at Awaba Colliery, as part of the current Part 3A Major Projects application under the *NSW Environmental Assessment and Planning Act 1979* (EP&A Act), are provided in Table 2.4.

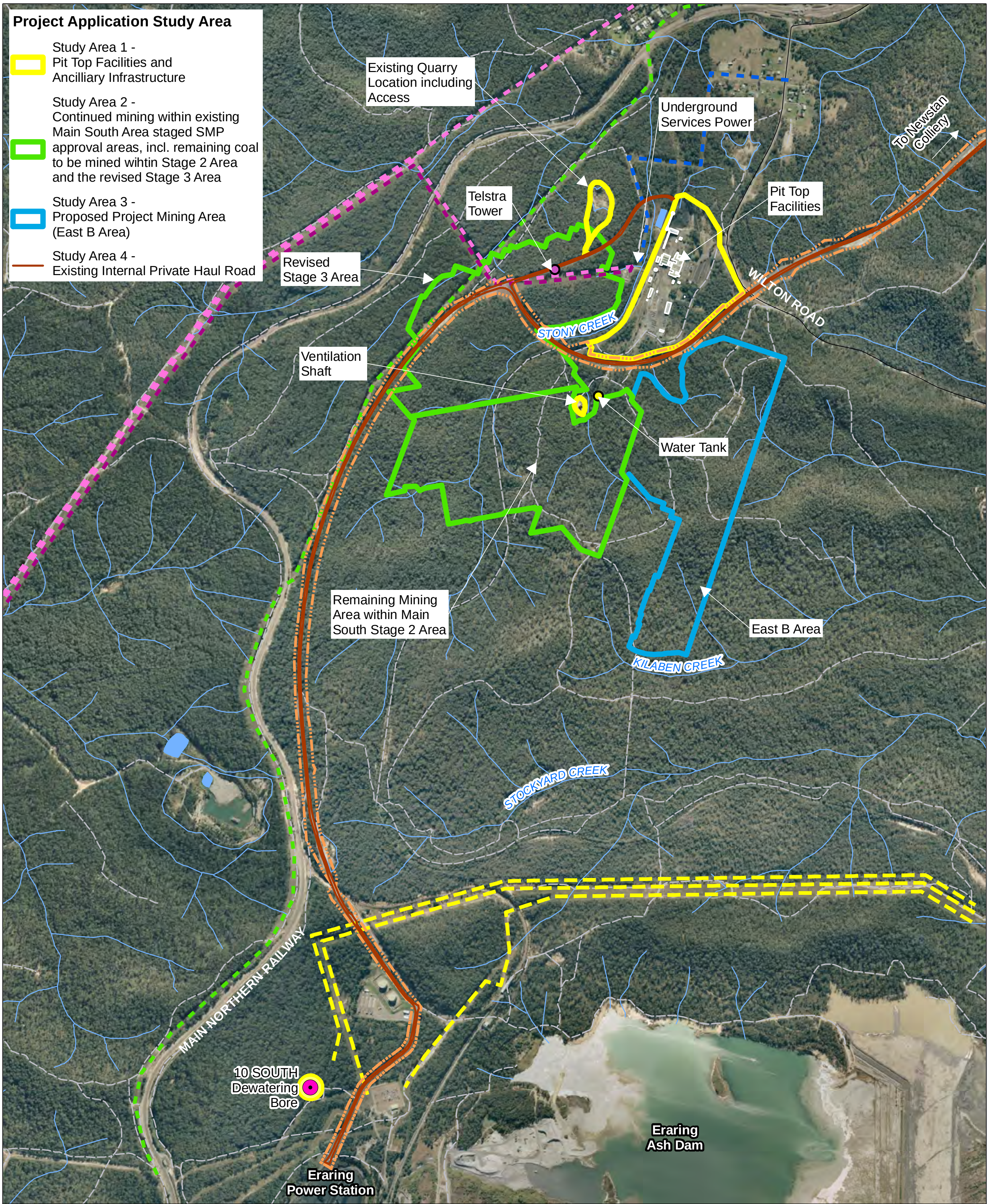
Table 2.4 Project Description

Development Component	Present Operations	Proposed Works
Mining Method	Bord and Pillar development and Pillar Extraction within narrow panels by continuous miners (developed in consultation with the Department of Industry and Investment).	No change.
Mining Areas	Mining is ongoing in existing/historical working areas. (Study area 2 on Figure 2.5).	Proposed East B area includes both existing/historical working areas and new mining areas. (Study area 3 on Figure 2.5).
Predicted Subsidence in Mining Areas	Predicted maximum subsidence is assessed to be less than 200mm (upper limited).	No change.
Production	Approximately 850,000 tonnes per annum.	Potential productivity changes could increase to 880,000 tonnes per annum.
Hours of Operation	24 hours per day, 7 days per week.	No change.
Employment	Approximately 100 employed personnel.	No change.
Coal Preparation	On-site crushing.	No change.
Land Preparation	Minimal land preparation for exploration due to well established underground mine with adequate surface support infrastructure. Existing quarry provides material for on-site remedial works.	No change for mining areas.
Infrastructure	Existing infrastructure includes mine access, ventilation, coal handling, coal preparation, coal transport, workshop, administration buildings, water management and pollution control.	Increase in capacity of Pollution Control Dam.
Mine Access	Access is obtained from Wilton Road.	No change.
Product Coal Transport	Coal from either the Final Product Bin or stockpile is trucked along a private	No change.

Development Component	Present Operations	Proposed Works
	haul road to either Newstan or Eraring Power Station.	
Water Management	Diversion of clean water around dirty areas. Surface dirty water is directed to the Pollution Control Dam prior to transfer to the underground dirty water system and discharged through 10 South. An emergency discharge is located on the Pollution Control Dam weir.	Increase in capacity of Pollution Control Dam.
Rehabilitation	Undertaken in accordance with the existing Life of Mine Plan approved by the Department of Industry and Investment. Primarily relates to the filling of sink holes.	No change.

From the details provided in Table 2.4, it can be seen that minimal changes to the existing operations are proposed for the future operations with the exception of the expansion of the Pollution Control Dam. In addition to this, as noted in Section 2.1, Barnes Dam has recently (March 2010) been decommissioned and replaced with an underground tank (the Fish Tank).

For the purposes of this site water balance, both the existing and proposed water management systems have been assessed.



1:20,000 for A4

0 62.5 125 250 375 500
Meters

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Watercourse
- Road
- Tracks
- Haul Road Area
- 11kv Powerline (Awaba)
- 11kv Powerline (Energy Aust.)
- 132kv Powerline (Energy Aust.)
- 33kv Powerline (Energy Aust.)
- 66kv Powerline (Rail Corp)
- Dewatering Bore

LOCATION	Awaba
SEAM	Great Northern
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Awaba Colliery

Project Application Study Areas Detailed

Centennial Awaba

DATE 02-09-2010

Figure 2.5

GIS Filename: G\22\15033\GIS\MAPS\Deliverables\Water Balance Report\2215033_WB_FIG2-5_StudyArea_20100506.mxd

3. Data

For both the hydrogeological and detailed water balance models, a range of data and site operational information was required.

3.1 Underground Water Model

The underground water model was constructed using floor contours of the Great Northern Seam, topographic contours and coal seam outcrop, deterioration and faulting information provided by Centennial.

Underground water sources and sinks were limited to injection and extraction pumping data and rainfall / evaporation data. This information was also provided by Centennial.

Underground water level data provided by Centennial were used to calibrate the hydrogeological model. Further details regarding the conceptualisation of the hydrogeological model are given in Section 4.

3.2 Water Balance Model

Extent of Water Balance Model

The application of grey water from the Maturation Pond over an irrigated area is considered to have minimal to no effect on the site water balance as runoff from the irrigated area is minimal. Consequently, the water balance for Awaba Colliery has been developed including only the pit top infrastructure and mining operations.

Data Available from Awaba Colliery

Data and site operational information has been made available by Awaba Colliery for this assessment. From this provided information, input data for the water balance was derived. Table 3.1 and Table 3.2 indicate the information provided while Table 3.3 outlines the data derived from this information.

Table 3.1 Data Sources

Item	Comment
General Operational Data	Provided by Centennial
Pollution Control Dam Storage Capacities and Operations	Provided by Centennial
Areas of water storages	Measured from provided plans
Catchment areas	Derived from provided topographic information
Maximum water transfer rates	Provided by Centennial
CHP water usage	Estimated by GHD

Item	Comment
Stockpile Dust Suppression Water Usage	Provided by Centennial
Underground water usage	Provided by Centennial
Coal production data	Provided by Centennial
Site Potable Water Demand	Provided by Centennial
Building Usage Rates	Provided by Centennial
Washdown Bay	Estimated by GHD
Fish Tank	Estimated by hydrogeological model
Barnes Dam	Estimated by hydrogeological model
10 South Storage Area	Estimated by hydrogeological model
In Seam Bin Information	Provided by Centennial

Table 3.2 Modelling Parameter Data

Parameter	Value
Mine Operations	Coal produced typically on 7 days/week 6 weeks of non-workdays per year
Potable water provided to underground	90% of daily
Potable water required for non workday	15% of annual
Pasture/grassed initial loss	10 mm
Impervious areas initial loss	2.5 mm
Existing Pollution Control Dam capacity	3.19 ML
Proposed Pollution Control Dam capacity	6.2 ML
Pollution Control Dam catchment area	2.4 ha
Maturation Pond capacity	NA
Barnes Dam capacity	5 ML(1)
Fish Tank capacity	9 kL(2)
Existing ROM coal production rate	0.8 Mta
Design ROM coal production rate	0.88 Mta
In-situ coal moisture	6.1%
Impervious catchment	5.4 ha
Pervious catchment	31.4 ha

Parameter	Value
In-seam bin catchment	0.48 ha
10 South storage area	Infinite
Rainfall factor	1

(1) Estimated from the hydrogeological model.

(2) While the physical size of the Fish Tank has been estimated at 9kL, within the water balance model a capacity of 5ML has been adopted. This is due to the time step within the model and the operational criteria that inflow and outflow from the Fish Tank will be equal.

Table 3.3 Modelling Parameter Data

Parameter	Annual Value	Daily Value
Annual total potable water demand (2009)	44.6 ML/yr	
Total workday potable water demand (323 days/year)	43.74 ML/yr	135.4 kL/day
Total non-workday potable water demand (42 days/year)	0.85 ML/yr	20.31 kL/day
Building usage (workday)	5.5 ML/yr	15.17 kL/day
Coal Handling Plant (workday and non-workday)	0.88 ML/yr	2.4 kL/day
Stockpile dust suppression (workday and non-workday)	1.15 ML/yr	3.15 kL/day
Underground current operations (workday)	39.68 ML/yr	135.4 kL/day
Washdown Bay (workday and non-workday)	2.19 ML/yr	6 kL/day
Building usage (non-workday)	0.18 ML/yr	0.48 kL/day
Underground Current Operations (non-workday)	3.03 ML/yr	20.31 kL/day
10 South Bore pump capacity		475.2 kL/day
Barnes Dam pump capacity		1632.96 kL/day
In-seam bin pump capacity		1278.72 kL/day
Pollution Control Dam priority 1 pump capacity		320 kL/day
Pollution Control Dam priority 2 pump capacity		916 kL/day
Water Make from current underground operations	0 ML/yr	
Water make from old underground operations	0 ML/yr	
Local water make into Barnes Dam	109.5 ML/yr	0.3 ML/day
Local water make into 10 South	109.5 ML/yr	0.3 ML/day

Operational Precedences for Water Transfer

In developing the detailed site water balance, a number of operational precedences were adopted. The rules adopted for the analysis of water transfers is provided in Table 3.4.

Table 3.4 Operational Precedence for Water Transfer

Feature	Comments
Water Supply	Water from Hunter Water Potable Supply. ◗ Work day inflow is 98% of total annual potable water demand. ◗ Non-work day inflow is 2% of the total annual potable water demand.
Tanks	Maintained full. Receives potable water which is distributed (with no more allocated than available) to: ◗ Buildings. ◗ Washdown. ◗ Coal Handling Plant (via pump). ◗ Underground operations.
Buildings	Inflow from tanks. Discharges to: ◗ Maturation Pond. ◗ Septic System.
Maturation Pond	Inflow from buildings. Outflow (irrigation) is equal to the inflow.
Septic System	Inflow from buildings.
Washdown Bay	Inflow from tanks. 50% of the inflow is 'lost' from the system. 50% of the inflow directed as runoff to the Pollution Control Dam.
Coal Handling Plant	Inflow from tanks. 50% of the inflow is 'lost' from the system. 50% of the inflow directed as runoff to the Pollution Control Dam.
Stockpile Dust Suppression	Losses to evaporation and voids within the stockpile coal.
Current Underground Operations	Inflow from tanks (approx 90% of annual supply). Inflow of in-situ coal moisture same as outflow of ROM coal exported. Inflow of water make into underground operations is 0 ML/yr due to the direction of water make to Barnes Dam. Outflow to: ◗ Barnes Dam. ◗ 10 South storage area.
In-Seam Bin and Pump	Inflow from surface runoff. Outflow (via pumping at 14.8l/s maximum) to Pollution Control dam

Feature	Comments
	continues until bin is empty.
Pollution Control Dam (existing conditions)	Maintained at level of 26.4m AHD. Inflow from runoff and In-seam bin. Outflow to: ◗ Evaporation. ◗ LDP009 overflows. ◗ Pumping to Barnes Dam. ◗ Pumping to 10 South. The operational rules on the dam pumps are: ◗ When the capacity is between the maintained water level and 2,199 m^3 pump 1 operates at a rate of 3.7 L/s with flow to 10 South Storage Area. ◗ When the capacity of the dam exceeds 2,199 m^3 both pump 1 and 2 operate at maximum rates of 3.7 and 10.6 L/s respectively with flow to both 10 South and Barnes Dam.
Pollution Control Dam (proposed conditions)	Maintained at level of 26.4m AHD. Inflow from runoff and In-seam bin. Outflow to: ◗ Evaporation. ◗ LDP009 overflows. ◗ Pumping to 10 South. ◗ Pumping to Fish Tank. The operational rules on the dam pumps are: ◗ When the capacity is between the maintained water level and 2,199 m^3 pump 1 operates at a rate of 10.6 L/s with flow to 10 South storage area. ◗ When the capacity of the dam exceeds 2,199 m^3 both pump 1 and 2 operate at maximum rates of 10.6 and 3.7 L/s respectively with flow to both 10 South Storage Area and Fish Tank.
Barnes Dam (existing conditions)	Inflow from underground workings and Pollution Control Dam when pump 2 operates (existing conditions). Nominal capacity for Barnes Dam is 5ML over which pumping occurs at a maximum rate of 18.9L/s until it is empty. Outflows to LDP005.
Fish Tank (proposed conditions)	At full capacity, tank is pumped to 10 South at a maximum rate of 15L/s. When pump 2 from Pollution Control Dam is in operation, Fish Tank pump cannot operate.

Feature	Comments
10 South	Operates as a reservoir with unlimited capacity. Inflow from: ◗ Mine water make. ◗ Underground operations. ◗ Pollution Control Dam. Outflows (at a rate of 5.5L/s) to Eraring Ash Dam via 10 South bore.

Sourced Data

Topography

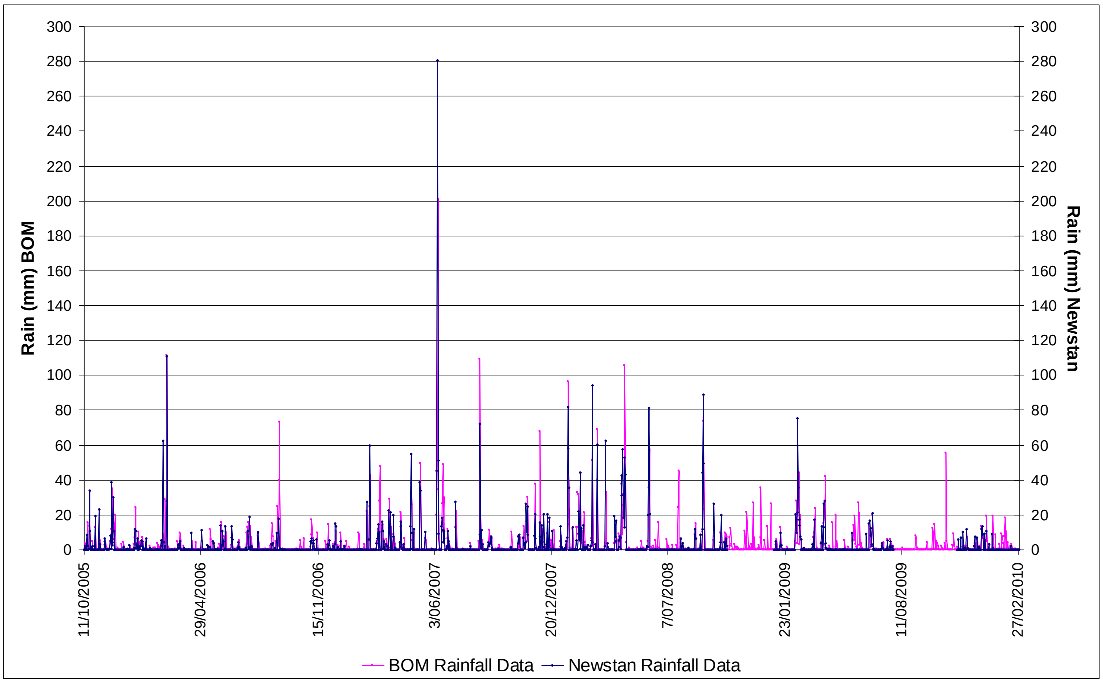
The topographic information used in establishing catchment areas included the provided site survey information and Department of Lands contours for the area.

Rainfall

While rainfall data was made available by Awaba Colliery for the Newstan Meteorological Station, this data only extended from approximately October 2005 to April 2010. Additionally, a review of this data indicated that there were periods of no records for a total of seven months during that five year period.

For the purposes of the water balance assessment, a more complete record period was required and therefore data from the Bureau of Meteorology (BOM) Cooranbong (Avondale) Station (located approximately 14 kilometres to the south west of Awaba Colliery) was obtained and reviewed. The period of data obtained extended from 1944 through to 2010 however due to gaps within this data, the period between January 1987 and February 2010 was adopted.

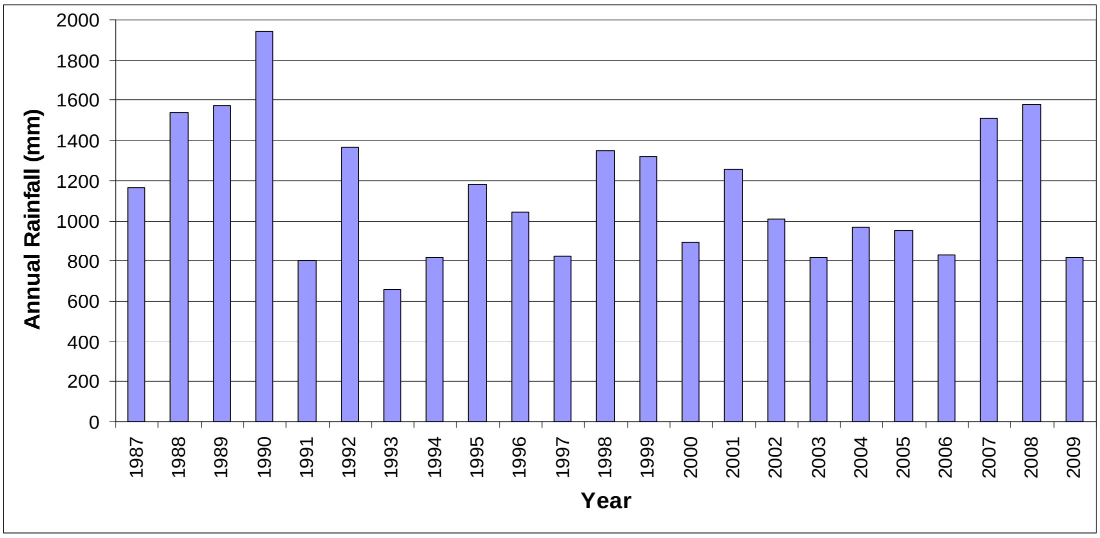
A comparison between the Newstan and BOM data was undertaken for the period between 2005 and 2010 and the outcomes are provided in Graph 3.1. It was determined that the two sets of rainfall data are comparable and therefore adoption of the Cooranbong station rainfall data will provide a reasonable representation of the rainfall at Awaba Colliery.



Graph 3.1 Comparison of Newstan and Cooranbong Rainfall

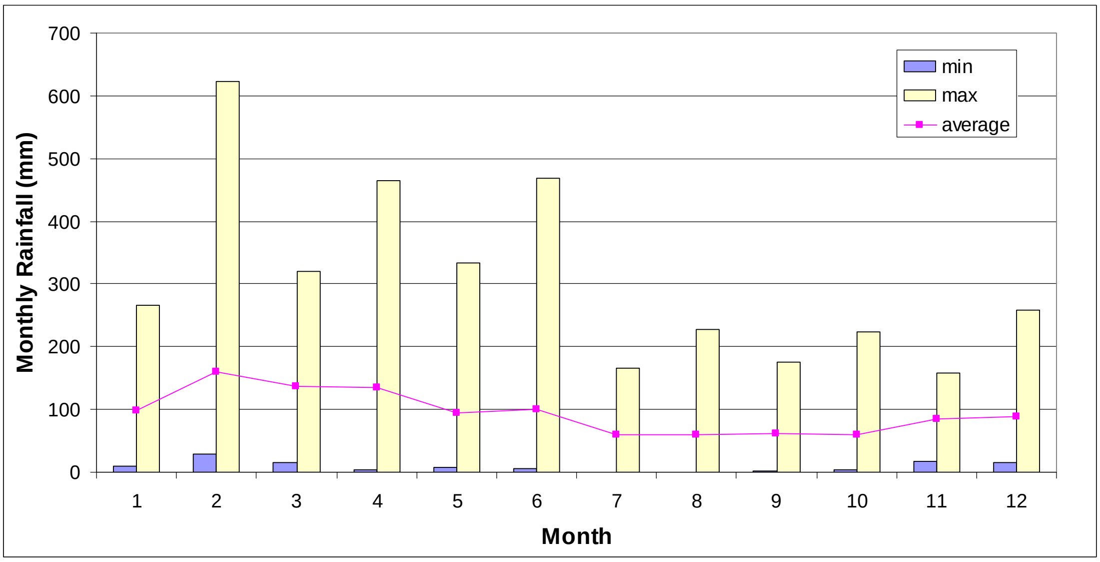
The Cooranbong data was checked for consistency and a summary of the annual rainfall is given in Graph 3.2. The statistics for this rainfall data set were:

- Minimum annual rainfall - 658 mm in 1993.
- Average annual rainfall - 1139 mm.
- Median annual rainfall - 1007 mm.
- Maximum annual rainfall - 1943 mm in 1990.



Graph 3.2 Annual Rainfall at Cooranbong

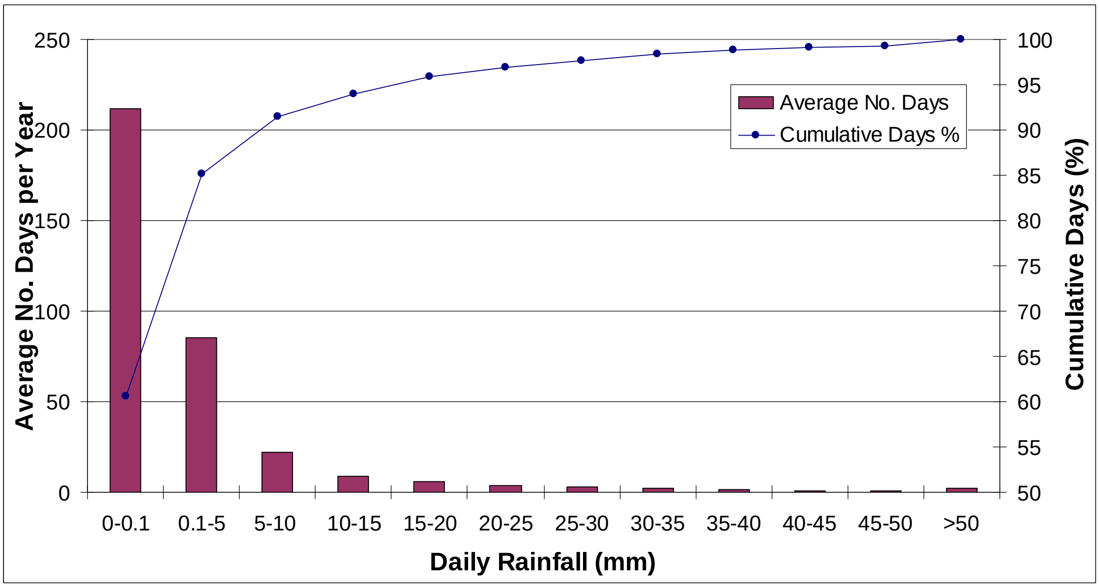
The monthly rainfall statistics were also determined for the period of record and selected statistics are provided in Graph 3.3. The average monthly rainfalls were observed to vary from a low of approximately 60 mm in July to a high of approximately 160 mm in February. Graph 3.3 shows a significant variation in the maximum recorded monthly rainfalls with the maximum monthly value being approximately 623 mm in February to a lowest maximum monthly value of approximately 158 mm in November.



Graph 3.3 Monthly Rainfall Statistics

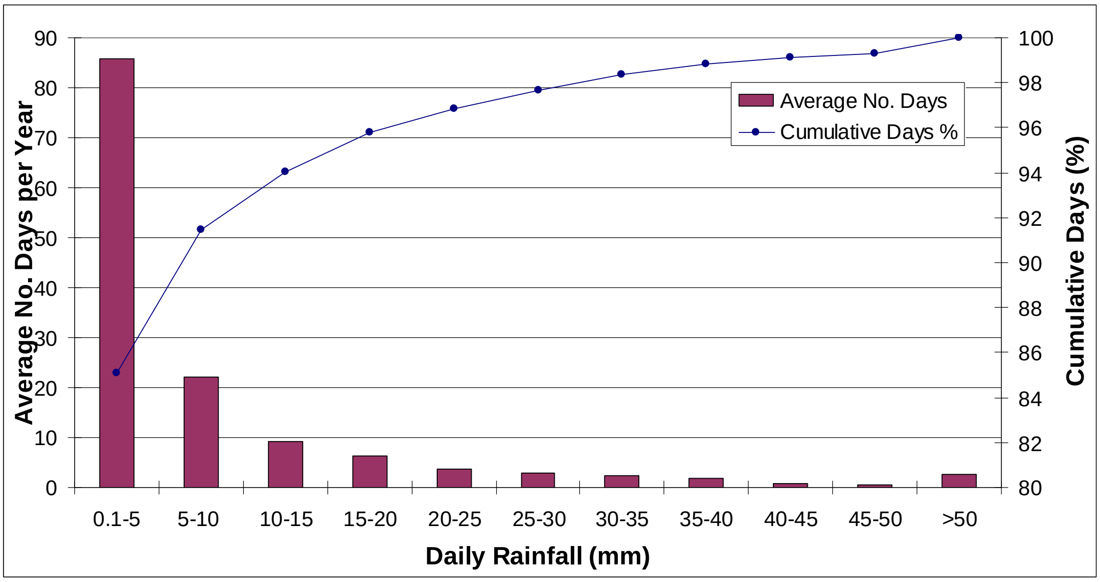
An analysis of the rainfall data was undertaken to enable an understanding of the likely rainfall patterns at the site. For various intervals of daily rainfall, the average number of days per year which fall within each interval are presented in Graph 3.4. The graph also presents the cumulative days per year as a percentage against the same rainfall intervals.

As presented in Graph 3.4, the average number of non rainfall days per year is approximately 212, which is greater than 60% of days in a year while the number of rain days receiving less than 5 mm of rainfall is approximately 25%.



Graph 3.4 Number of Rain Days of Various Magnitudes

The data presented within Graph 3.4 was amended to exclude days without recorded rainfall to enable a more detailed view of the data. As presented in Graph 3.5, the amount of rain falling on any one day decreases for rainfall greater than 5 mm. On average, approximately 15% of days in the year (or 52 days) receive greater than 5 mm of rain with approximately 3% of days in the year (or 11 days) receiving greater than 25 mm of rain.



Graph 3.5 Daily Rainfall Magnitudes

Evaporation Data

In addition to the provision of rainfall data from the Newstan Meteorological Station, Awaba Colliery also provided the daily evaporation data. This information was reviewed for the five years of data and average monthly evaporation rates determined for use within the Goldsim model. The average daily evaporation for Awaba Colliery is presented in Graph 3.6.

Graph 3.6 Average Daily Evaporation Rates

These evaporation rates were then compared to the evaporation maps available from the BOM. In particular, the months of January and July were considered as shown in Figure 3.1.

Figure 3.1 Bureau of Meteorology January Evaporation Maps

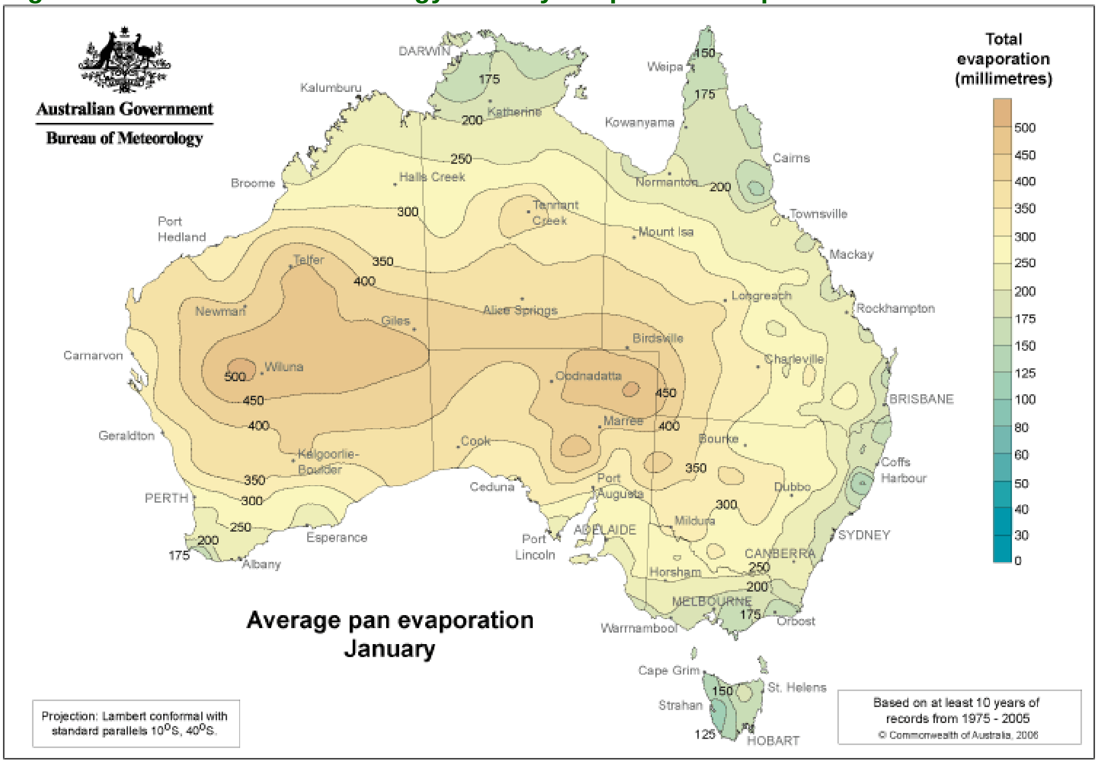
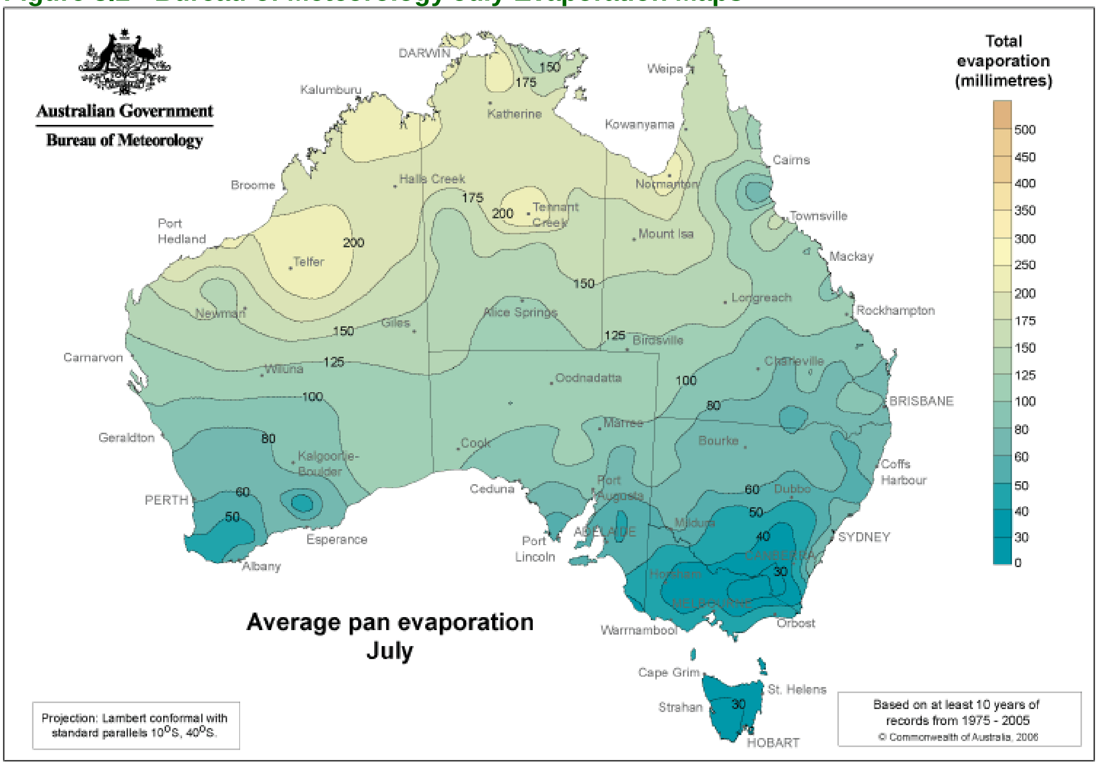


Figure 3.2 Bureau of Meteorology July Evaporation Maps



For both January and July, the monthly average evaporation was assessed and converted to daily evaporation as well as potential minimum and maximums as outlined in Table 3.5.

Table 3.5 Evaporation Data

Month	BOM Monthly Average (mm)	BOM Daily Average (mm)	BOM Daily Minimum (mm)	BOM Daily Maximum (mm)	Newstan Daily Average (mm)
January	150 - 175	5.2	4.8	5.6	4.2
July	50 - 60	1.8	1.6	1.9	2.2

By comparing the average daily from the Newstan Meteorological Station for January and July to the daily average as determined from the BOM data, it can be seen that there is a reasonable correlation between the two sets of data. Therefore the Newstan Meteorological Station data was adopted for the mine water balance.

The average annual evaporation rate was approximately 1333 mm, compared to the annual average rainfall of 1139 mm. This gives an annual deficit (difference between annual rainfall and annual evaporation) of approximately 194 mm.

4. Modelling Representation

This section of the report discusses the development of both the hydrogeological and water balance models for the existing and proposed conditions at Awaba Colliery.

4.1 Hydrogeological Model

The strata of the Newcastle Coal Measures above and including the Great Northern Seam at Awaba have been divided into two hydrogeological units (in order of sequence):

- Narrabeen Sandstone (Triassic) and Teralba Conglomerate (Permian), extending up to almost 100 m thick along the ridgeline to the north of the 10 South bore.
- Great Northern Seam (Permian) of average thickness 3 m. The floor of the Great Northern Seam dips to the south west and extends down to an elevation of approximately -30 m AHD.

The Great Northern Seam is underlain by Awaba Tuff and the Fassifern Seam. It was considered appropriate to vertically limit the model to the floor of the Great Northern Seam since the underlying Awaba Tuff is known to create a barrier to water flow.

Figure 4.1 shows the spatial extent of the hydrogeological model. The northern boundary is created by outcropping of the Great Northern Seam. The remaining boundaries are generally defined by areas of seam splitting, deterioration and/or fracturing. Figure 4.1 shows how the Great Northern Seam has almost been mined to its economic extent in this area.

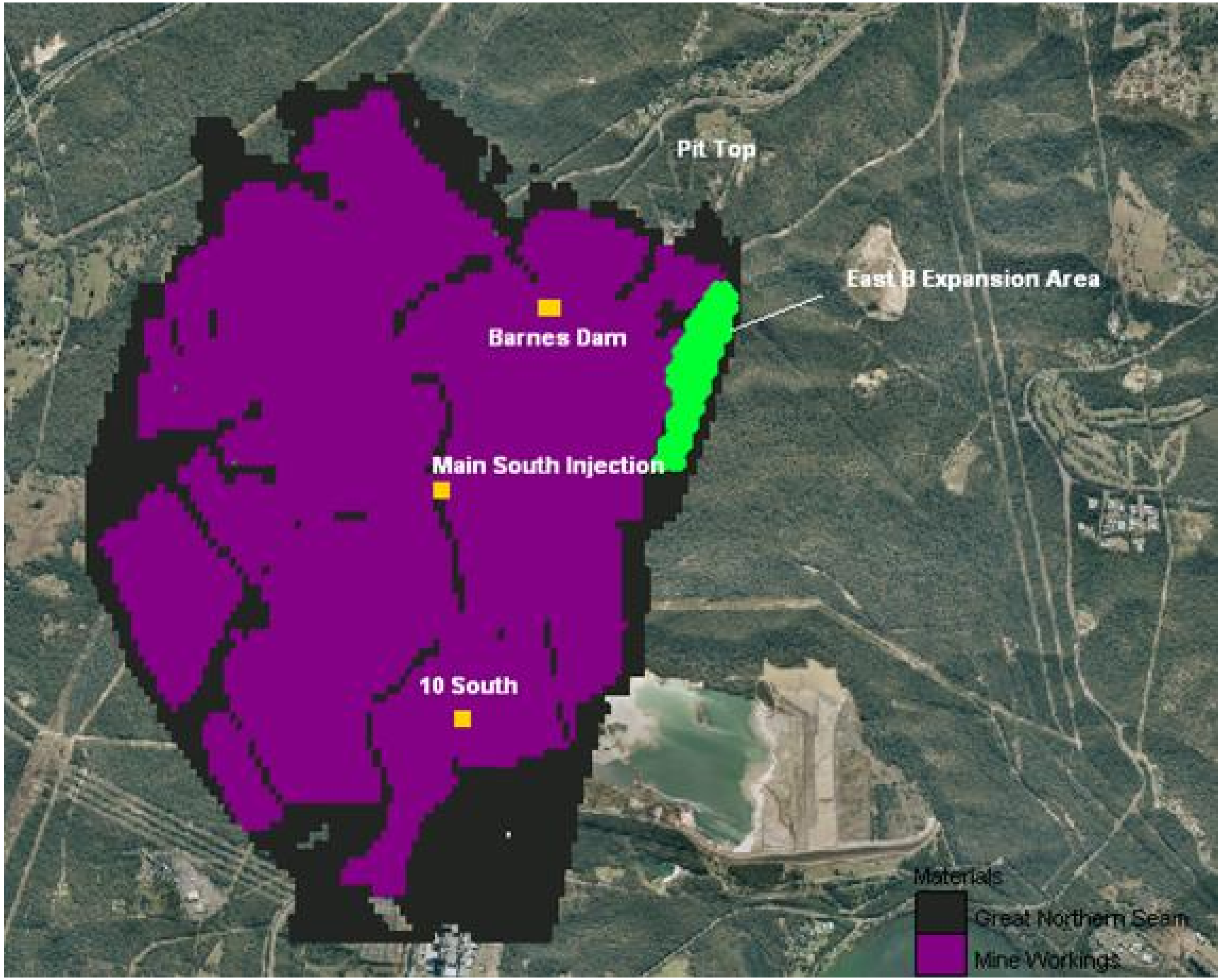
Flow Boundaries

The flow boundaries have been defined geologically as outlined above. Groundwater cannot pass across the geological no-flow boundaries. No constant or general head boundaries have been defined.

Conceptualisation of Groundwater Flow

Water enters the strata via rainfall recharge to the surface and via the injection of water from the Pollution Control Dam. Prior to March 2010, water from the Pollution Control Dam was injected into the workings at Barnes Dam and main south (shown in Figure 4.1). Since March 2010, water from the Pollution Control Dam generally by-passes Barnes Dam and all is directed to main south. In addition, since March 2010 there has been an underground transfer of water make from the Barnes Dam area to main south.

The flow of underground water within the Great Northern Seam and mine workings generally follows the orientation and dip of the seam. Underground water storages form in depressions in the floor of the mine workings. The main underground water storages are at Barnes Dam and 10 South (locations shown in Figure 4.1). Extraction bores are used to dewater the underground storages and discharge the water at the surface. Since March 2010, the 10 South bore is the only dewatering bore that remains active.



LOCATION	Awaba
SEAM	Great Northern
DRAWN	SG
CHECKED	
APPROVED	
SCALE	

Awaba Colliery
Extent of Hydrogeologic Model

Centennial

DATE 16-04-2010

Figure 4.1

Numerical Modelling

The above conceptual understanding of the hydrogeology at Awaba was used in developing a MODFLOW numerical hydrogeological model of underground water flow. MODFLOW is a finite difference flow model from the United States Geological Survey (USGS) and is an industry standard code for numerical groundwater modelling. The model was built using the Groundwater Modelling System (GMS) software. GMS is a three-dimensional user interface for the MODFLOW groundwater modelling code.

Note that due to limitations in historical data, the numerical model is a preliminary representation of the underground water system developed for the purposes of impact assessment and dewatering requirements. It has been developed with reference to the Groundwater Flow Modelling Guideline (Murray-Darling Basin Commission, 2000), however cannot satisfy all aspects of this guideline.

A two layered model was constructed:

- Layer 1 – Unconfined Conglomerate/Sandstone.
- Layer 2 – Confined Great Northern Seam.

Each layer of the model was initially divided into 100 by 100 equally sized cells, of dimensions 60 m (north-south) by 43 m (east-west). Active and inactive cells were defined by the geological boundaries. Only the active area of Layer 2 is shown in Figure 4.1.

Spatial elevation data for the topography was used to establish the top elevation of Layer 1. The bottom elevation of Layer 2 was established by Great Northern Seam floor contours. The top of Layer 1 (base of Layer 1) was 3 m above the floor of the Great Northern Seam.

The model was divided into three material types:

- Conglomerate/Sandstone Overburden.
- Great Northern Seam (unmined coal).
- Mined Area.

The properties adopted for each material are given in Table 4.1. These values were derived from data presented in the Statement of Environmental Effects – Groundwater for Newstan Colliery (Australasian Groundwater & Environmental Consultants Pty Ltd, 2007), and from model calibration. Differences in hydraulic conductivity between adjacent cells were limited where possible to avoid numerical instability caused by large differences in hydraulic conductivity between adjacent cells. Note that the property data presented in Table 4.1 are consistent with the values adopted by GHD for the hydrogeological model of the old workings at Newstan Colliery to the north of Awaba (GHD, 2009).

Table 4.1 Material Properties for Numerical Hydrogeological Model

Material	K_h (m/d)	S_s (1/m)	S_y	n_e
Overburden	0.05	0.00001	0.1	0.05
Great Northern Seam	0.5	0.00001	0.15	0.15

Material	K_h (m/d)	S_s (1/m)	S_y	n_e
Workings	50	0.00001	0.5	0.5

K_h = horizontal hydraulic conductivity

S_s = specific storage

S_y = specific yield

n_e = effective porosity

Well cells were assigned to simulate water injection into and extraction from the Great Northern Seam. The following extraction data were available:

- 10 South and LDP5 (June 2007 to March 2010).
- LDP4 (June 2007 to May 2008).
- LDP7 (July 2007 to May 2009).

Injection rates were calculated based on the volume of runoff entering the Pollution Control Dam and the pump capacities. Injection into the workings therefore coincided with net runoff and occurred at two injection wells (shown in Figure 4.1):

- Barnes Dam.
- Main South Injection.

4.2 Water Balance

The model used to represent the Awaba Colliery water balance was Goldsim Version 9.6 (Goldsim Technology 2007). This software is a graphical object orientated system simulation software for completing either static or dynamic systems. It is like a “visual spreadsheet” that allows one to visually create and manipulate data and equations.

Simulation, in this context, is defined as a process of creating a model of an existing or proposed system (such as a mine water management system) in order to identify and understand the factors that control the system performance or predict (forecast) the future behaviour of the system.

A model representation of the existing mine water cycles was created using Goldsim and the results verified, as best as practical, for discharges through LDP005 and 10 South prior to March 2010 when LDP005 was decommissioned.

Once the model operation was verified as representing the site conditions prior to March 2010, it was modified to include the future operations and decommissioning of LDP005.

Water Cycle Modelling

The water balance modelling was completed using:

- Daily time steps used for the analysis – daily rainfall data was the shortest period data available.
- Runoff from catchments was represented by an initial loss/runoff factor – this was used to convert daily rainfalls into surface runoff values when the daily rainfall has exceeded the initial loss of rainfall (infiltration which is subsequently transpired by vegetation).

Model Structure

The model was configured to represent the water cycles as a series of elements each containing preset rules and data, that were linked to represent the water transfer around the water cycles.

The overall structure of the model is shown in Appendix A for the existing water cycle and Appendix B for the proposed water cycle.

Model Data and Operational Rules

The data provided in Table 3.3 was incorporated into the model and the water transfer rates shown in Table 3.4 were entered as maximum values that could occur on any single day. In the event that the model determined the required daily water transfer rate was less than the maximum specified daily value for any element, the model adopted the reduced transfer volume. The rules identified in Table 3.4 were specified within the model to determine the priorities adopted within the model for water transfers.

Goldsim Representation

Existing Operations

The operation of the water cycle (prior to March 2010) associated with coal production, as provided in Figure 4.2, was modelled in Goldsim. To undertake the modelling the following simplifications were incorporated:

- Transfer rates were modelled using daily time steps. In reality, transfer rates are determined during the day on an "as needs basis" and may operate over periods smaller than a day.
- The daily coal production rate was determined from the achieved yearly production rate of 850,000 tonnes per annum.
- The pumping rates to the underground were 135.4 kL and 20.31 kL per day on work and non-work days. This was based on underground demand being 90% of the total demand. In reality the demand for the underground workings varies daily.
- The demand of the CHP was assumed to be 2.4 kL per day. In reality this value varies daily.
- Dust suppression rates were determined as 3.15 kL per day, as indicated as an average value by Awaba Colliery staff. In reality the dust suppression rates would vary daily.
- Operating rules/precedences were established within the model in accordance with advice from Awaba Colliery staff.

There was limited data available for the following segments of the model. The values for these portions of the model were therefore adjusted to replicate anecdotal site information.

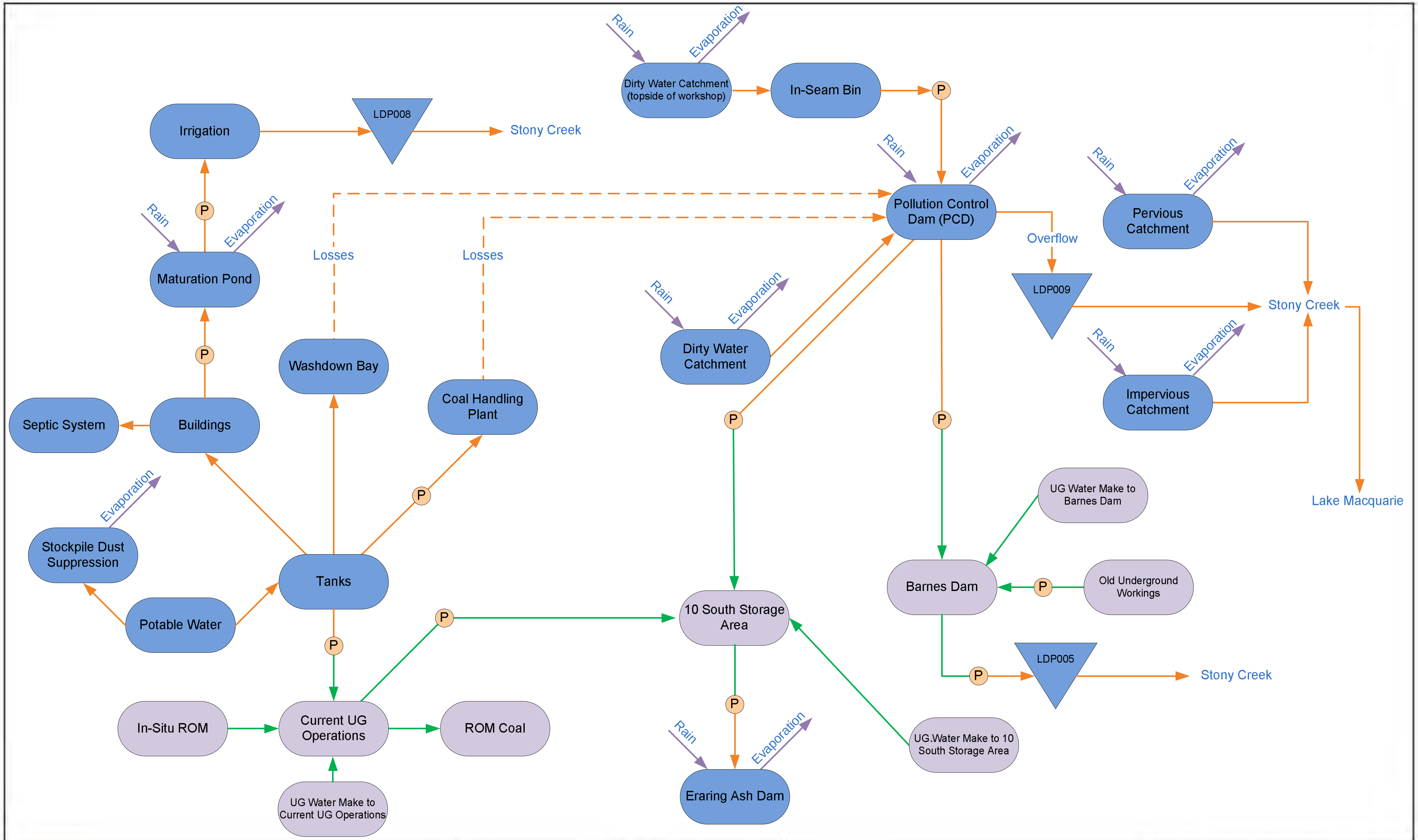
- In-seam bin volume.
- Fish Tank volumes and operation level.
- Barnes Dam volumes and operation level.
- 10 South storage area volume.

Proposed Operations

The existing conditons Goldsim model was modified to represent the proposed conditions of the water cycle on-site following the expansion of the Pollution Control Dam (to the increased capacity of 6.2ML), decommissioning of Barnes Dam and establishment of the Fish Tank as indicated in Figure 4.3.

Amendments to the model to represent these changes were limited to:

- Amendment of storage capacities.
- Amendment of pumping rules (in accordance with Table 3.4).
- Removal LDP005.
- Increase in coal production rate from 0.85 Mtpa to 0.88 Mtpa.



SURFACE
UNDERGROUND
SURFACE COMPONENT
UNDERGROUND COMPONENT
P PUMP

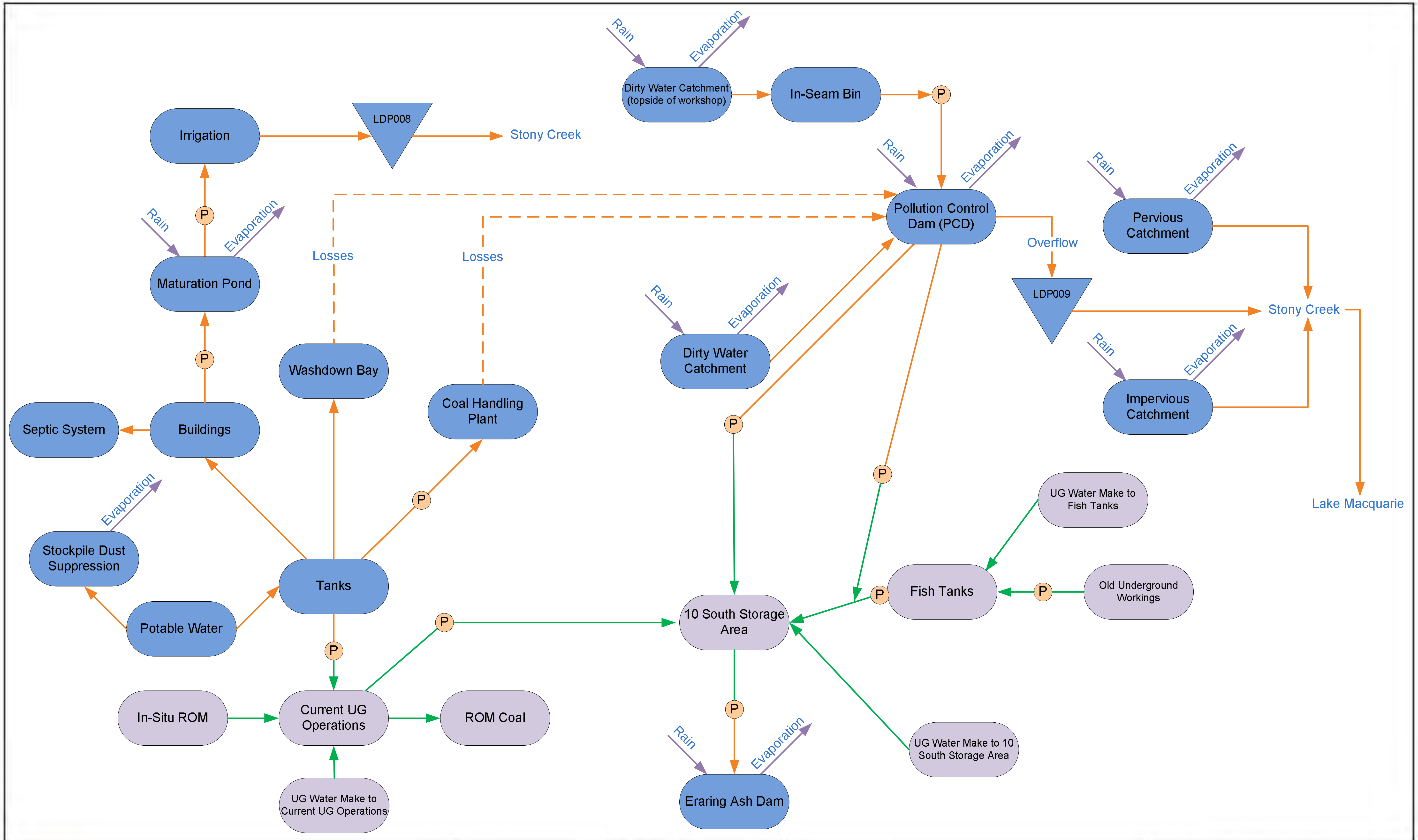
LOCATION	Awaba
SEAM	Great Northern
DRAWN	LH
CHECKED	
APPROVED	
SCALE	

Awaba Colliery
Detailed Water Cycle – Existing Operations

Centennial

DATE 16-04-2010

Figure 4.2



SURFACE
UNDERGROUND
SURFACE COMPONENT
UNDERGROUND COMPONENT
P PUMP

LOCATION	Awaba
SEAM	Great Northern
DRAWN	LH
CHECKED	
APPROVED	
SCALE	

Awaba Colliery
Detailed Water Cycle – Proposed Operations

Centennial

DATE 16-04-2010

Figure 4.3

5. Modelling Results

5.1 Hydrogeological Model

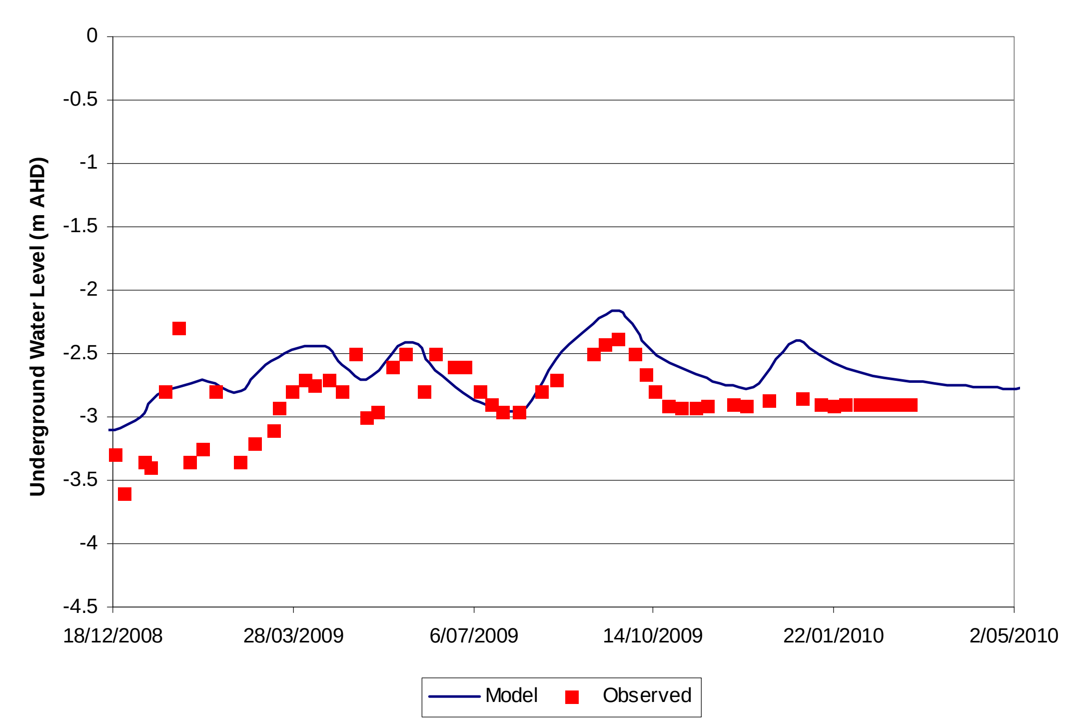
Calibration

Note that hydrogeological models are based on a conceptual representation of the natural hydrogeological environment and assumptions have to be made. In particular, assumptions were necessary due to the limited observed water level data for model calibration and the limited information regarding the overburden. Assumptions and limitations are outlined as follows:

- Aquifer hydrogeological properties do not change spatially or with time for a particular material type.
- No other sources or sinks, other than those already outlined, have been considered (such as creeks or streams).
- There is no vertical seepage of groundwater from the Great Northern Seam into the underlying Awaba Tuff.
- No groundwater level data for the overlying conglomerate were available. It was assumed that the conglomerate did not initially contain permanent groundwater.
- Steady state conditions could not be established due to historical and ongoing disturbances and stresses to the underground water system. Therefore, only transient calibration was undertaken and initial heads were established from observation data. This rendered early model output relatively unreliable.

The model was initially run for 1034 days from 1 June 2007 to 31 March 2010 for transient calibration. Model calibration was carried out by comparing model output and available underground water level data (mainly the water level in the 10 South storage, as measured in the 503 bore) and was used to adjust hydraulic conductivities and net rainfall recharge.

Graph 5.1 shows MODFLOW model output plotted against observed data for the 10 South storage (measured in the 503 bore). In this case, a recharge value of 1% net rainfall was adopted.



Graph 5.1 MODFLOW Calibration

Following the transient calibration process, the hydrogeological model was used to estimate water make into the workings in the vicinity of the Proposal area. This is an input into the detailed water balance. Water make is attributable to seepage into the underground void from surrounding strata and incorporates the effects of rainfall recharge. The following output was obtained from the period 1 January 2009 to 31 March 2010. Since an initial steady state calibration was not undertaken, the output for the period up to 1 January 2009 was excluded.

- Underground water make into Barnes Dam (pre March 2010 conditions): ranges from approximately 0.03 ML/day to 0.3 ML/day.
- Underground water make into 10 South Dam (pre March 2010 conditions): ranges from approximately 0.04 ML/day to 0.12 ML/day.

Note that the period 1 January 2009 to 31 March 2010 was a lower than average rainfall period and therefore slightly higher flow rates were adopted for the detailed water balance.

It is considered that water make will likely not increase as a result of pillar extraction of existing workings. In addition, it is unlikely that the first workings proposed for the East B area will generate much water make. The MODFLOW model predicted that this area would be relatively dry during mining.

Predictive Simulations

The hydrogeological model was also run over a ten year period up to 30 June 2020 to assess future dewatering requirements. This covers the period of the proposed operations (1 July 2010 to 30 June 2015), plus five years under care and maintenance. Based on the seam floor contours at 10 South dam, it is considered that the long term underground water level in this area should generally remain below approximately -2 to -1 m AHD to avoid flooding of workings to the west.

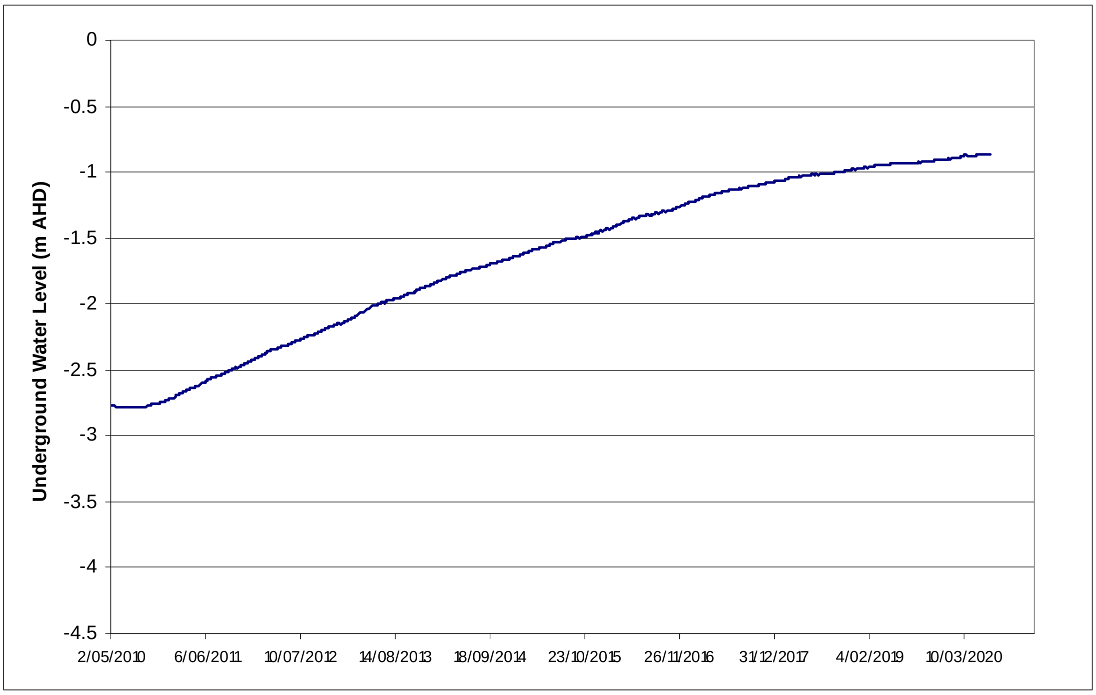
Over this period, the only water extraction from the underground workings was from 10 South, although a small underground transfer from Barnes Dam to 10 South was incorporated into the model to simulate pumping of water make from the fish tanks at Barnes Dam.

Drainage cells were assigned to the East B area and were turned on (i.e. positive conductance) from 1 July 2010 since first workings are proposed in this area. The standard conductance equation was used to establish the drainage rate. Cell rewetting was enabled.

Average daily rainfall for Cooranbong (based on the 1995 year) was used to establish rainfall recharge and injection from the PCD over this period. Note that over this period, all injection from the PCD was directed to main south. Recharge remained at 1% of net rainfall over this period.

Based on a long term extraction rate of 5.5 L/s (0.48 ML/day) at 10 South, underground water levels will rise in this area to approximately -1 m AHD as shown in Graph 5.2. Long term rise would be expected, since during some periods the extraction rate would only cover the water make generated in the Barnes Dam and 10 South areas and would be insufficient to extract the water injected into the underground workings from the Pollution Control Dam. At this extraction rate it is estimated that generally up to 90% of the extracted volume is groundwater that has seeped into the workings, based on the water make predictions from the model.

Due to the gradual predicted rise in underground water level at 10 South, it is recommended that additional pumping capacity be made available to avoid levels exceeding -2 m AHD during periods of heavier rainfall. In order to estimate the likely pump capacity required, the hydrogeologic model was reviewed. Through this it was determined that a daily discharge of 1.2 ML/day would be sufficient to maintain the underground water level at or below -2 m AHD.



Graph 5.2 Long-term Underground Water Level at 10 South

5.2 Water Balance

Calibration

Initially the model was established using the estimated flow rates, water usages and estimated infiltration rates. Adjustments were required to these initial values to more closely replicate the system performance for the period of observed data since 1987 and the results of this modelling are provided in Appendix C.

The results of the calibration indicated that:

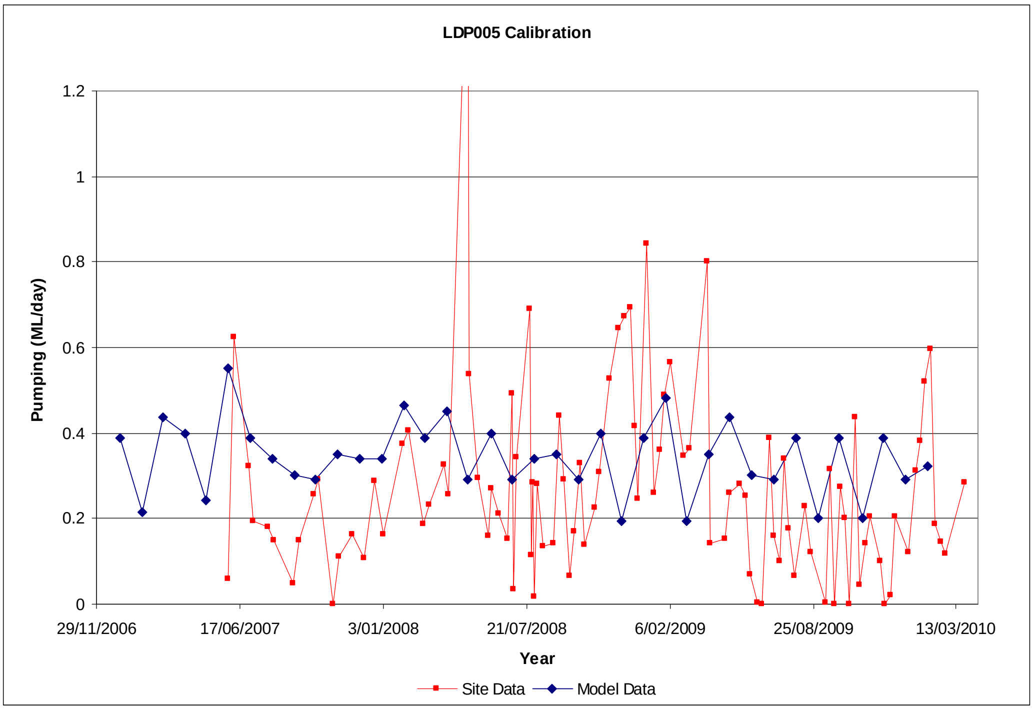
- Rainfall had minimal impact on discharges through LDP005 and 10 South.
- The water make for underground workings should be represented as an inflow to contribute to Barnes Dam.
- LDP009 did not have sufficient data for use in the calibration process.

LDP005

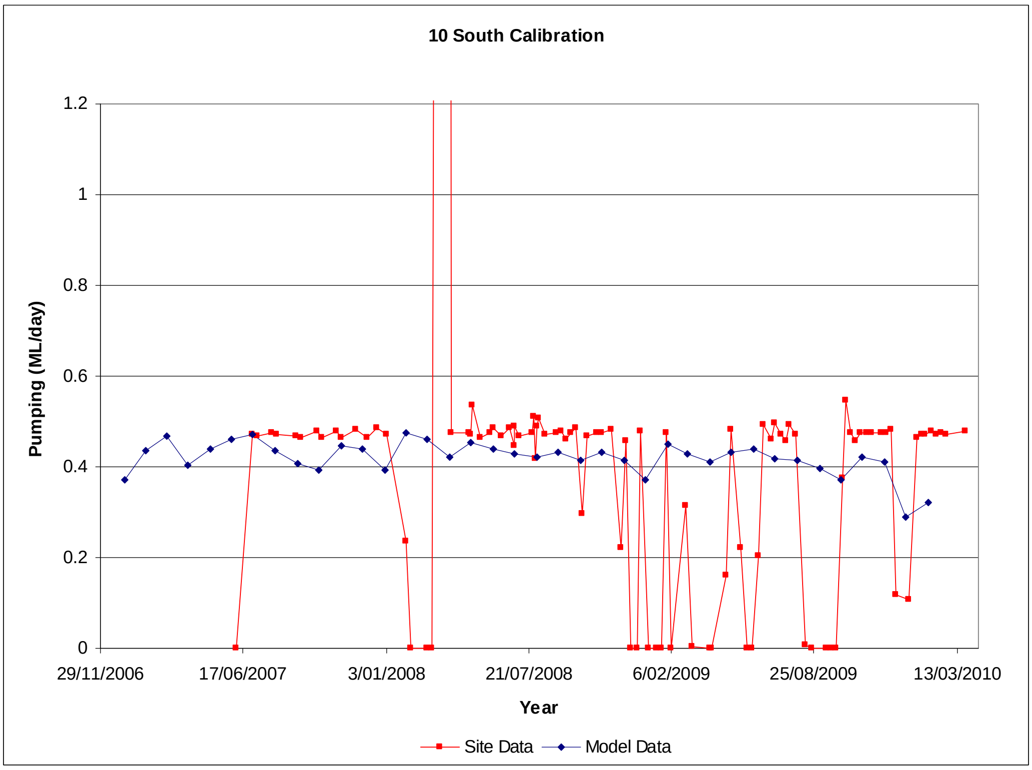
The model outputs (as monthly totals) from February 2009 to January 2010 were compared to the recorded site data for discharges through LDP005 and are provided in Graph 5.3.

10 South

The preliminary modelling results (as monthly totals) from February 2009 to January 2010 were compared to the recorded discharges through the 10 South bore as shown in Graph 5.4.



Graph 5.3 LDP005 Calibration



Graph 5.4 10 South Calibration

Results

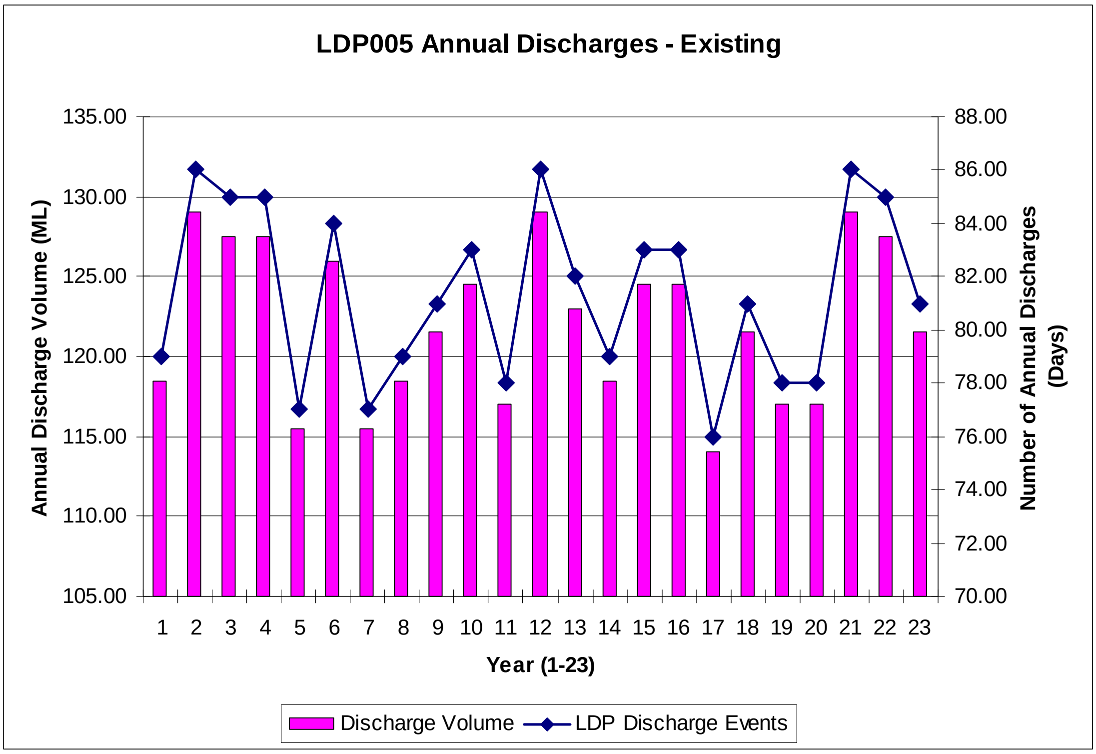
The existing conditions mean predicted values for each of the water transfers over the simulated period are provided on Figure 5.1. Also provided are the respective minimum and maximum values in brackets to give an indication of the range of likely values. Where there is no value in brackets, there was not a range as the transfer rate was static across the simulation period.

A summary of the detailed water balance results is provided in Table 5.1.

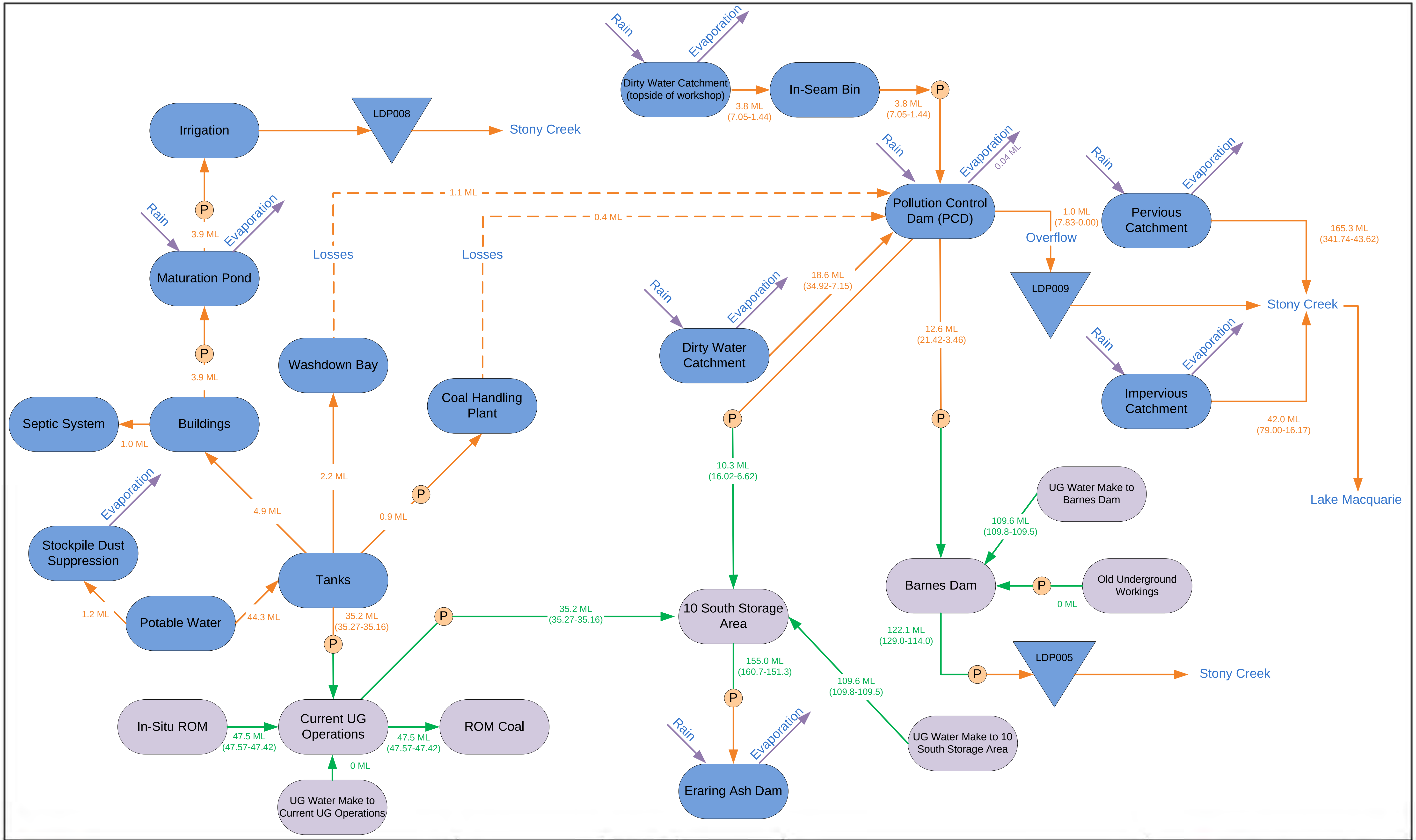
Table 5.1 Discharges

Discharge Point	Average Annual Discharges (ML/yr)	Average Daily Discharges (ML/day)
LDP005	122.09	0.33
LDP009	1.0	0.003
10 South	155.01	0.42

Graph 5.5, Graph 5.6 and Graph 5.7 show the pattern of discharge from LDP005, LDP009 and 10 South respectively for the existing conditions. They also indicated that based on the available information there would be approximately half the analysed years when there would not be any discharge from LDP009 while the discharges from LDP005 and 10 South were reasonably consistent.



Graph 5.5 Predicted LDP005 discharge frequency and discharge volumes



SURFACE

UNDERGROUND

SURFACE COMPONENT

UNDERGROUND COMPONENT

P PUMP

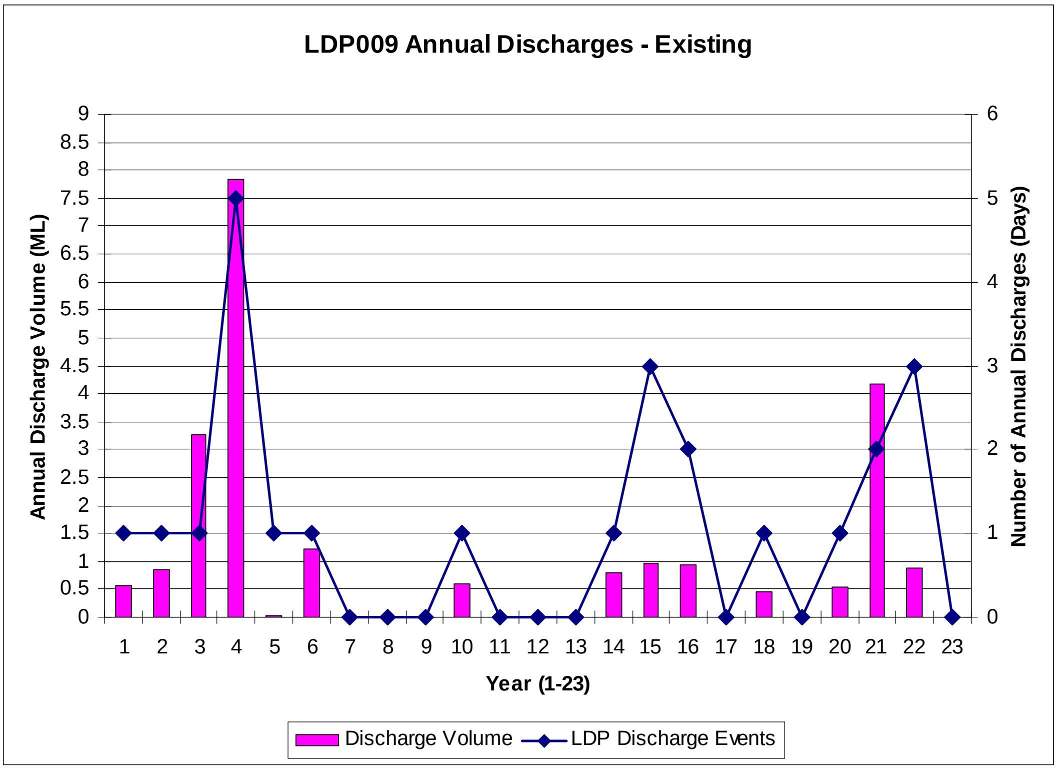
LOCATION	Awaba
SEAM	Great Northern
DRAWN	LH
CHECKED	
APPROVED	
SCALE	

Awaba Colliery
Mean Annual Transfer Rates – Existing Operational Conditions

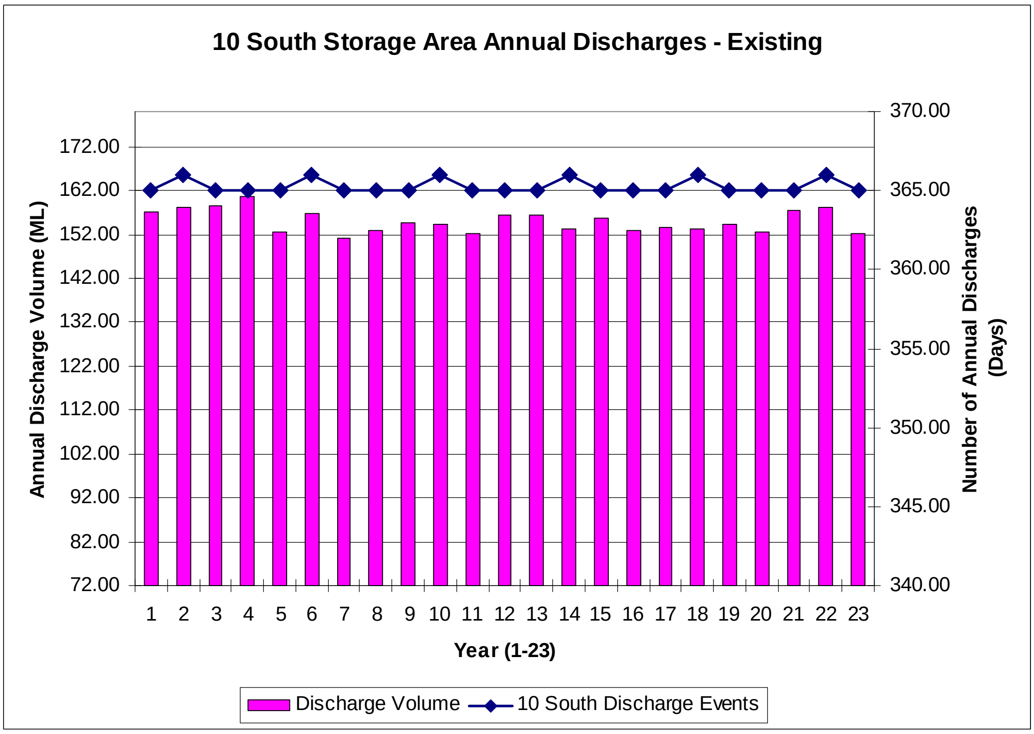
Centennial

DATE 16-04-2010

Figure 5.1



Graph 5.6 Predicted LDP009 discharge frequency and discharge volumes



Graph 5.7 Predicted 10 South discharge frequency and discharge volumes

Operations Including the Proposed Extensions

As discussed in Section 4.2, water balance modelling was completed for both the existing and proposed operation conditions at Awaba Colliery and the modifications made for the proposed operation conditions were also discussed in Section 4.2.

Predicted extraction and water transfer rates for the proposed operational conditions are shown on Figure 5.2 and the detailed results showing the maximum, minimum and mean transfer rates are provided in Appendix C. Additionally, a summary of the detailed water balance results is provided in Table 5.2.

Table 5.2 Annual discharges

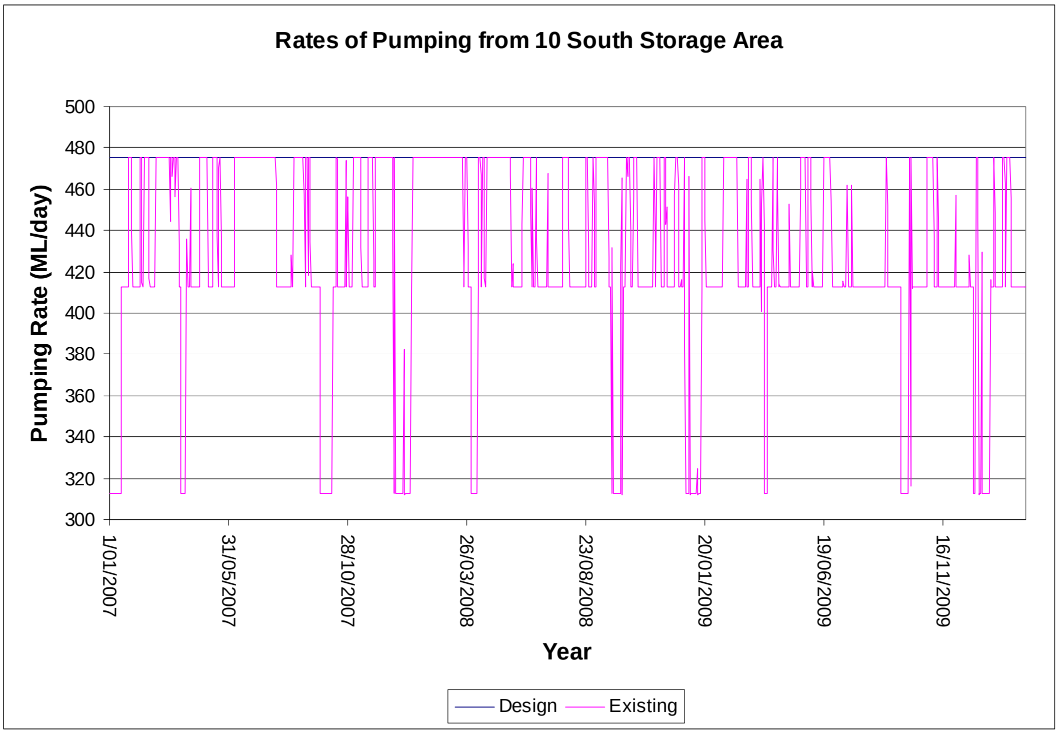
Average over all years	
Through LDP009	0.2 ML/yr
Through 10 South	173.56 ML/yr

By comparing the information provided in Table 5.1 and Table 5.2, it can be determined that the construction of the Pollution Control Dam will result in a decrease in discharge through LDP009. It can also be seen that removal of LDP005 will result in an increase in discharges to the Eraring Ash Dam through 10 South.

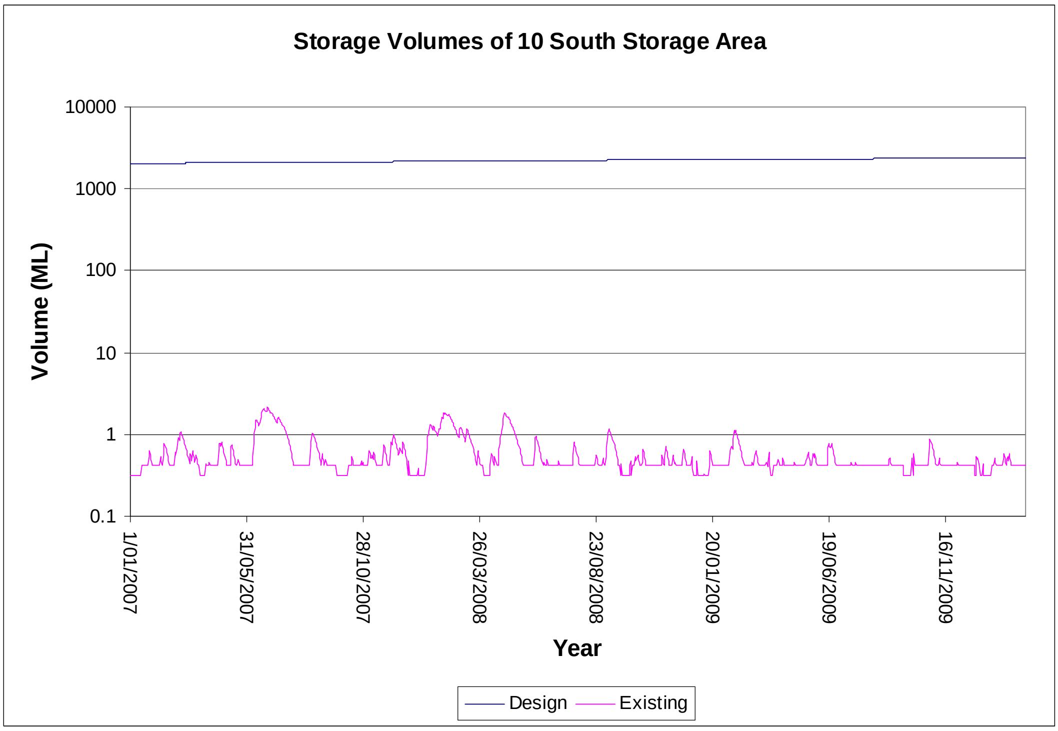
A review of the pumping for the existing and proposed conditions at 10 South (Graph 5.8) indicated that the increase in discharge is primarily a result of an increase in the volume of water contributing to this location. Therefore, while there is no increase in pumping capacity, the pump will operate for greater periods of time and consequently increase the annual discharge.

Consideration was also given to the potential increase in volume of water stored in the vicinity of 10 South.

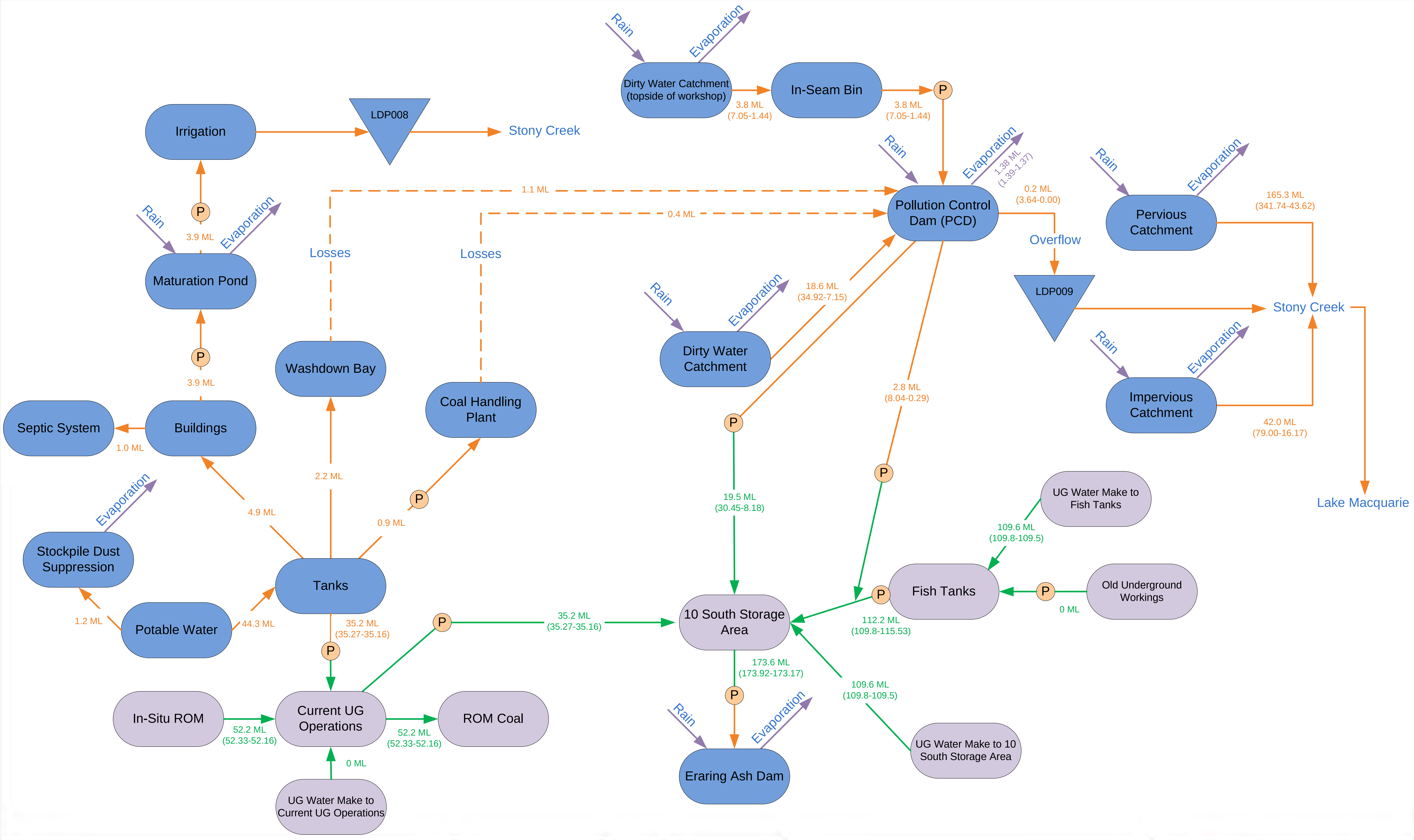
Graph 5.9 shows the storage volumes at 10 South for the existing and proposed conditions. From this it can be seen that the removal of LDP005 will result in a general trend for an increase in water stored at 10 South as well as an increase in discharge.



Graph 5.8 10 South pump operation



Graph 5.9 10 South storage volume



GHD

→	SURFACE
→	UNDERGROUND
	SURFACE COMPONENT
	UNDERGROUND COMPONENT
P	PUMP

LOCATION	Awaba
SEAM	Great Northern
DRAWN	LH
CHECKED	
APPROVED	
SCALE	

Awaba Colliery
Mean Annual Transfer Rates –
Proposed Operational Conditions

Centennial

DATE 16-04-2010

Figure 5.2

5.3 Qualifications on Predictions

Predicted water transfers are based upon a mix of data. Typical data sources for model construction and verification included:

- Relatively reliable data
  - Bureau of Meteorology rainfall data.
  - Monitored rainfall data at Newstan.
  - Monitored evaporation from Newstan.
  - Surface catchment areas based on topographic maps.
  - Annual potable water demands.
  - Monitored discharges.
- Less reliable data
  - Estimates of many water transfer rates based upon pipe diameter, pipe material and power of pump motors.
  - Site infiltration rates for normal and revegetated catchment areas.
  - Estimates of some storage capacities.

As a result of the items listed within the “less reliable data” category there is likely to be a risk that the provided estimates may be inaccurate. It is suggested that the individual predictions given above should be considered reliable to +/-30% until more site data is gathered. Additional data will allow refinement of the data sources and hence the model predictions to be confirmed as reliable.

6. Summary

Preparation of this water balance assessment required:

- Confirmation of the surface and groundwater management systems.
- Establishment of a MODFLOW hydrogeological model.
- Establishment of a Goldsim model to represent the water movement on-site.
- Application of the Goldsim model for the existing and proposed site-conditions.

Inputs into both the hydrogeological and water balance models consisted of information provided by Awaba Colliery and estimations based on available information. The estimations adopted included storage volumes and flow rates of some elements within the system as outlined in Table 3.1.

Calibration of the hydrogeological model was carried out conservatively due to the limited observation data. Calibration was focused on output and observation data for the 10 South dam.

Calibration of the existing conditions water balance model confirmed the performance of the model against recorded discharges through LDP005 and 10 South. The results of this model indicated that the annual discharges through LDP009, LDP005 and 10 South were 1.0, 85.5 and 82.0 ML/year respectively.

For the proposed conditions, the calibrated model was adjusted to reflect the proposed water management system amendments discussed in Section 4.2. The resulting predicted annual discharges through LDP009 and 10 South were determined to be 0.2 and 173.6 ML/year respectively. From this it can be seen that there will be a decrease in discharges through LDP009 (corresponding to the increase in the capacity of the Pollution Control Dam) however there is predicted to be an increase in discharges through 10 South. This is considered to be a result of the increase in pump operation to cater for the increase in stored water volume at 10 South.

Consideration was also given to the impact on the Eraring Ash Dam as a result of discharges though 10 South. The existing capacity of the Ash Dam was found to be approximately 4,000 ML with considerable inflows and outflows. The inflows into the Ash Dam (from Eraring) are in the order of 14.07 ML/day and the maximum controlled discharge from the dam is 47.52 ML/day.

A comparison of the existing and proposed conditions (without an increase in pumping capacity) discharges from Awaba Colliery into the Ash Dam was undertaken. The existing discharge of 155 ML/year (0.42 ML/day) equates to approximately 2% of the total inflows into the Ash Dam while the increased discharge (for the proposed conditions) of 173.6 ML/year (0.46 ML/day) accounts for around 3% of the total inflows.

Under both the existing and proposed conditions, discharges from Awaba Colliery (through 10 South) contribute only a minor portion of inflows into the Eraring Ash Dam.

To provide greater flexibility for Awaba Colliery to enable the maintenance of an underground water level of -2 m AHD, an increased pumping capacity of 1.2 ML/day has been recommended. In the event that this is adopted, the impact of Awaba Colliery on the Eraring Ash Dam would increase to 8.5% of the total inflows. Again this is not considered to be a significant impact on the Ash Dam.

7. References

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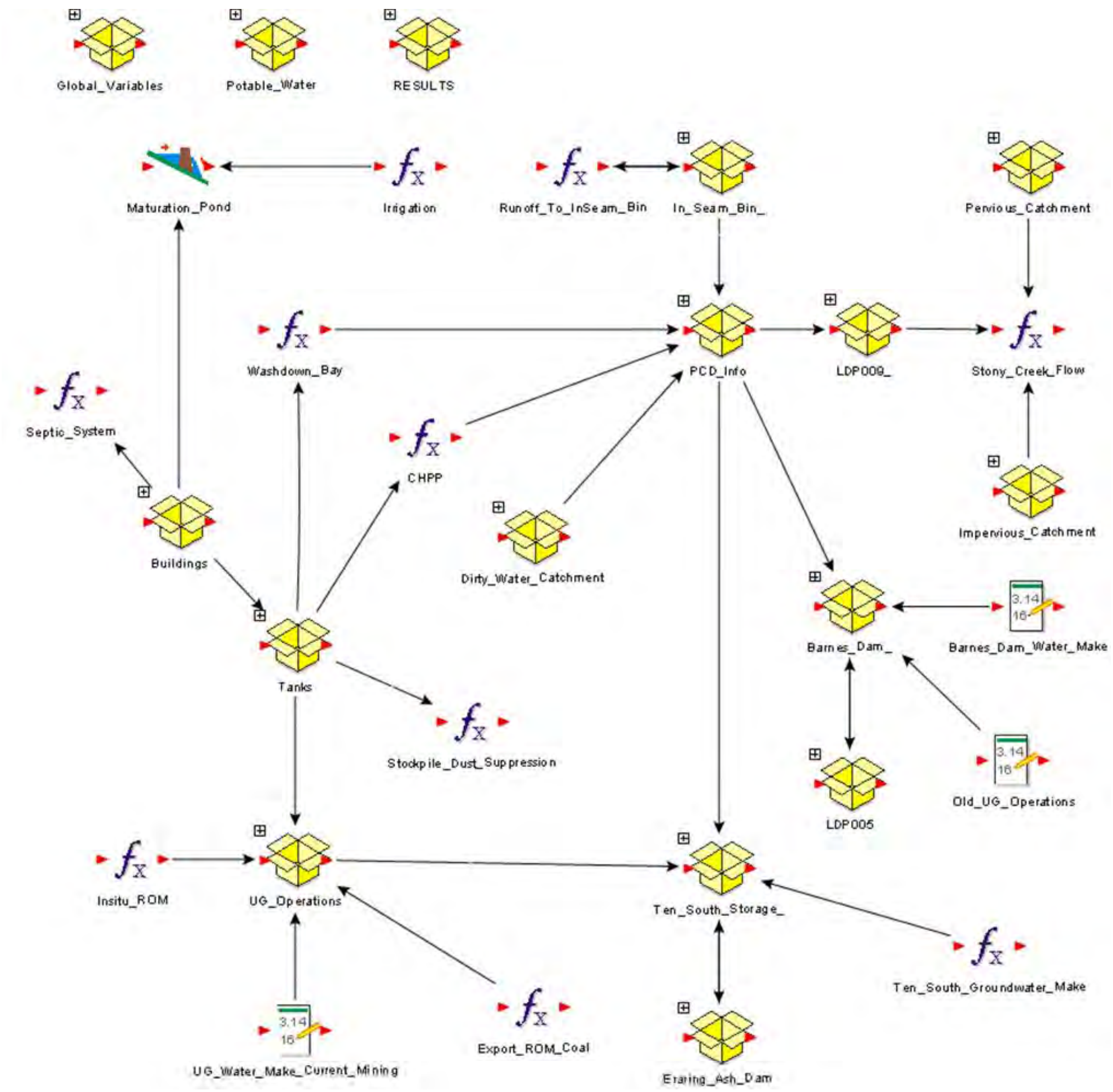
Appendix A

Goldsim - Existing Operations

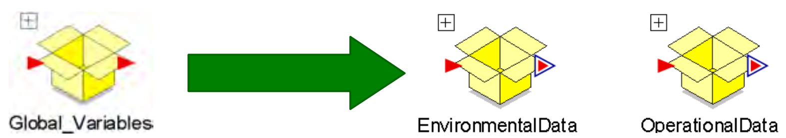
GOLDSIM MODEL LAYOUT

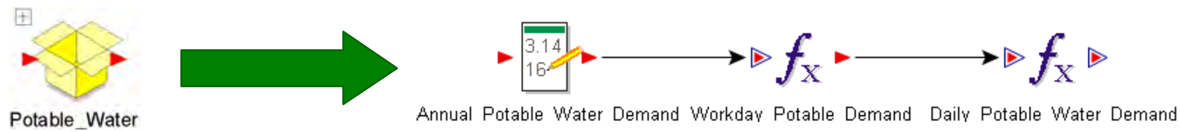
EXISTING OPERATIONS – BROAD SCALE VIEW

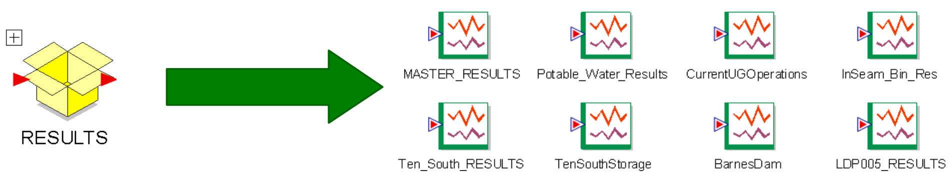


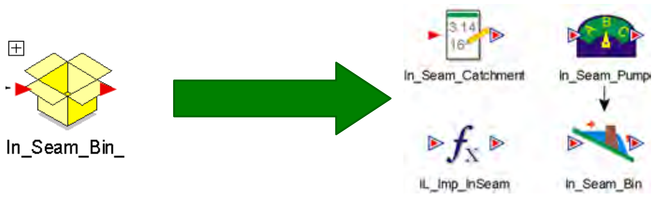
<u>**GOLDSIM MODEL LAYOUT**</u>

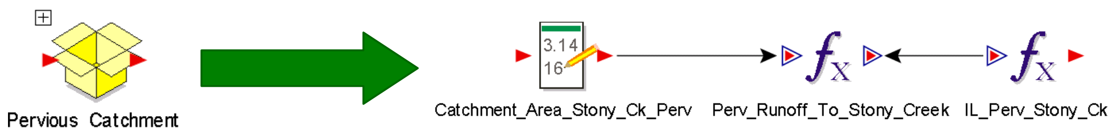
EXISTING OPERATIONS – DETAILED VIEW

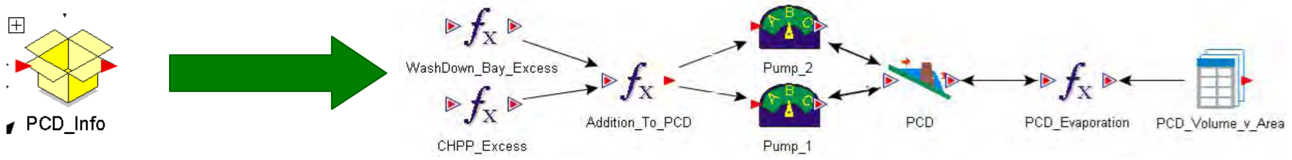








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Pump_2
Pump_1
PCD
PCD_Evaporation
PCD_Volume_v_Area


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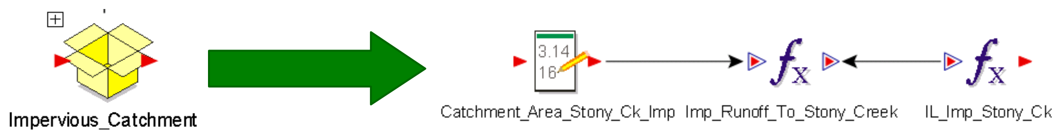
LDP009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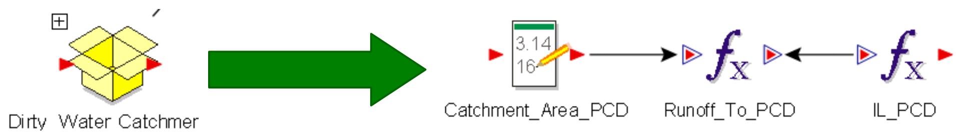
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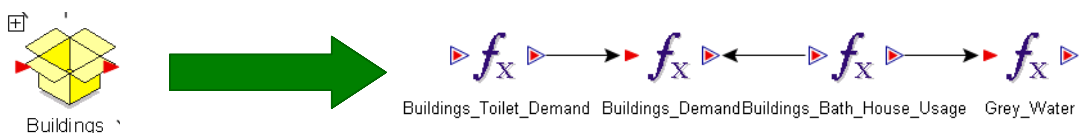
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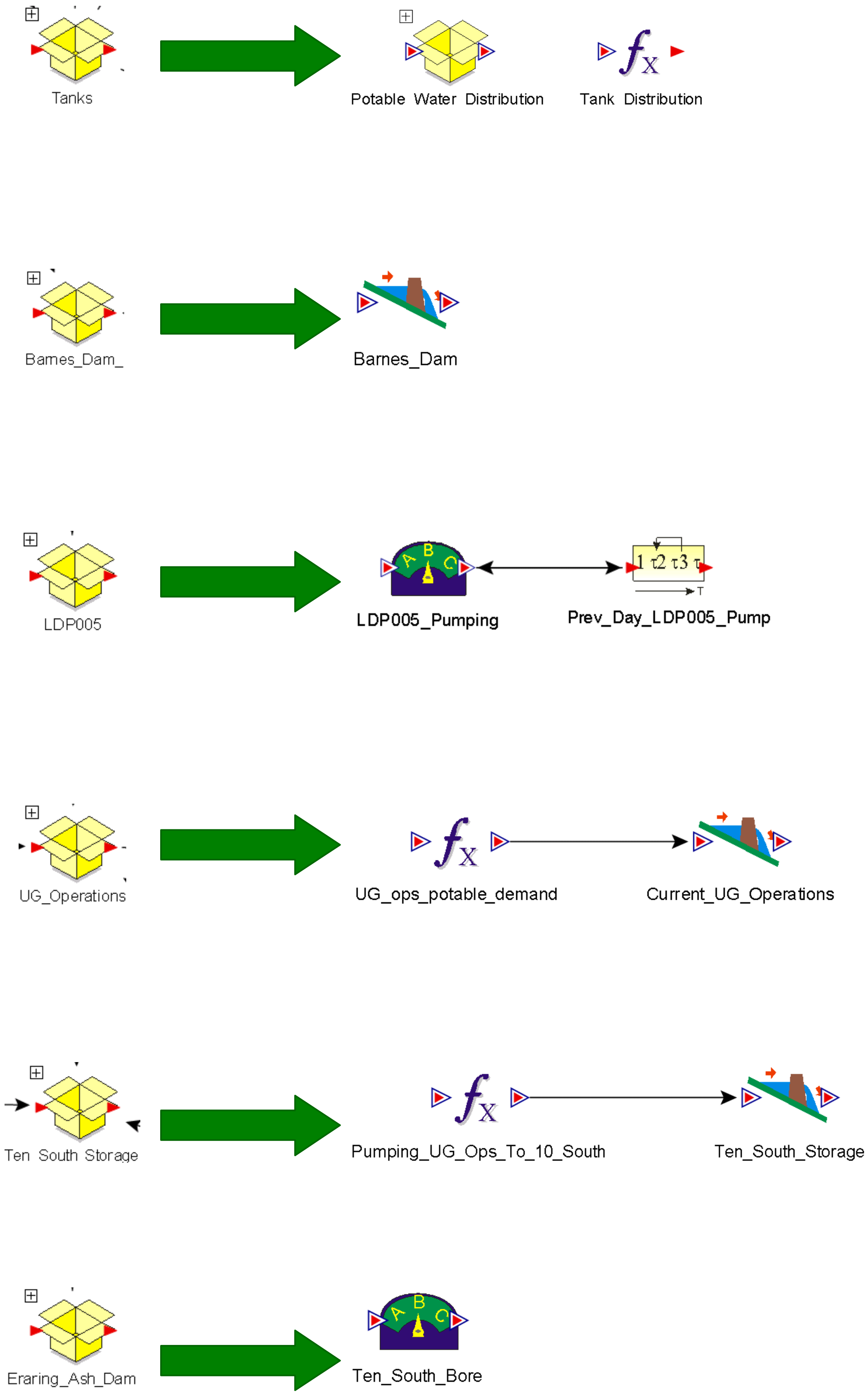
Grey_Water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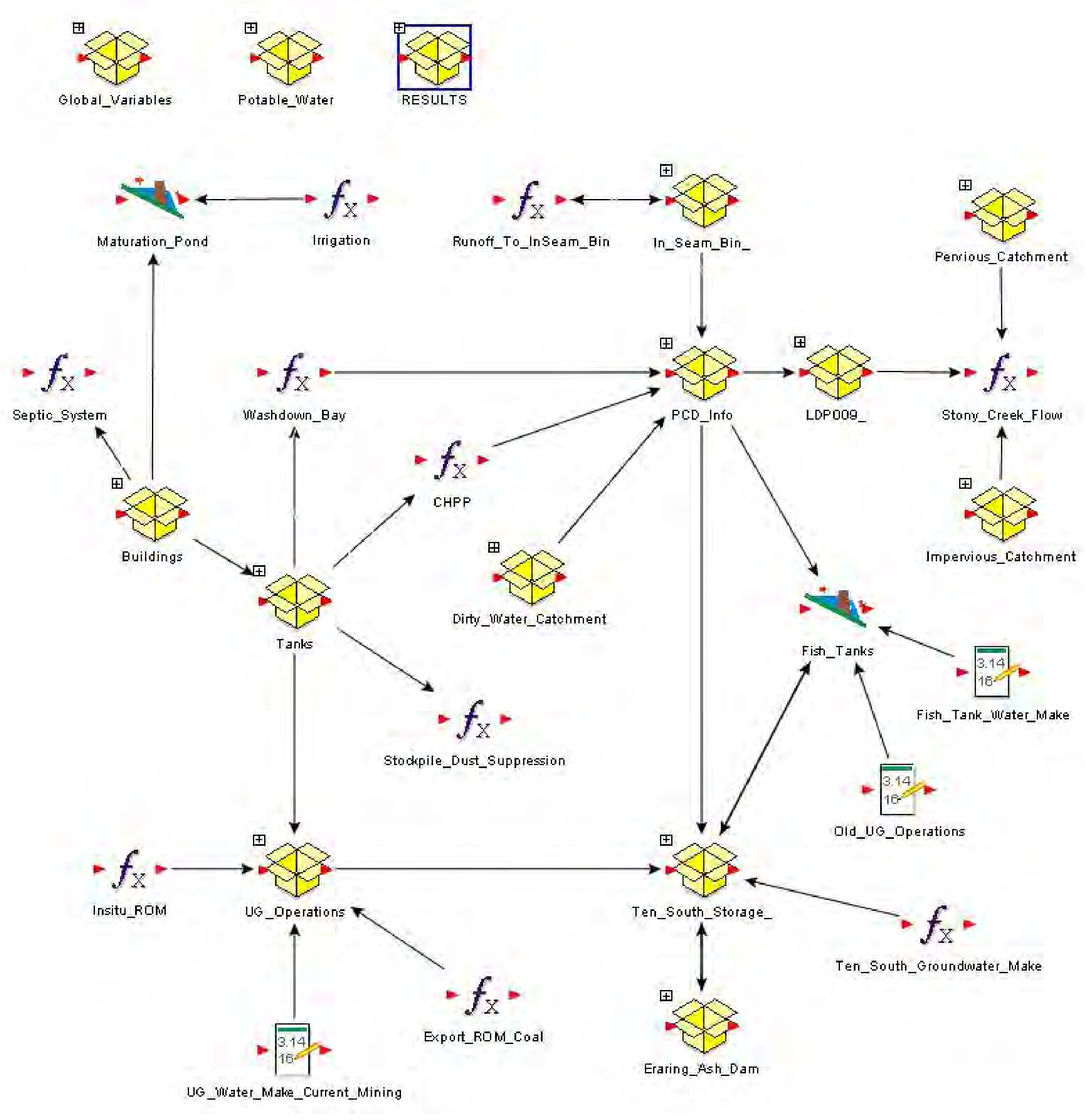
Ten South Storage
Pumping_UG_Ops_To_10_South
Ten_South_Storage
Eraring_Ash_Dam
Ten_South_Bore

Appendix B

Goldsim - Proposed Operations

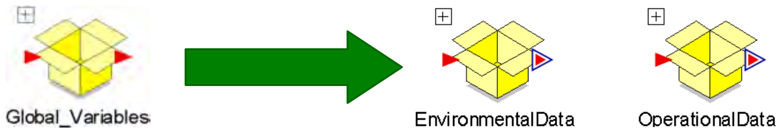
GOLDSIM MODEL LAYOUT

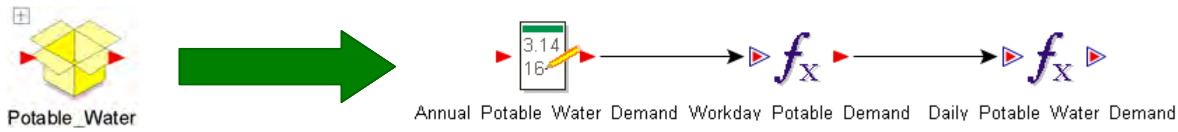
PROPOSED OPERATIONS – BROAD SCALE VIEW

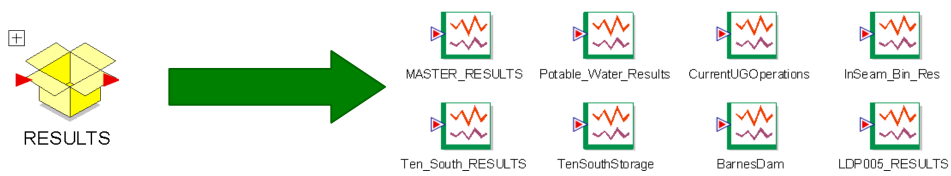


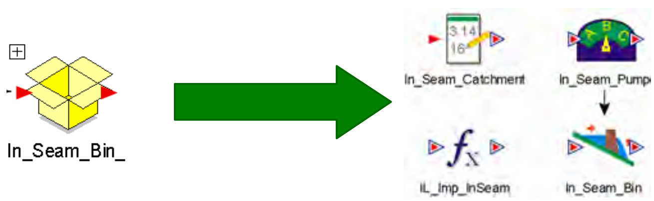
GOLDSIM MODEL LAYOUT

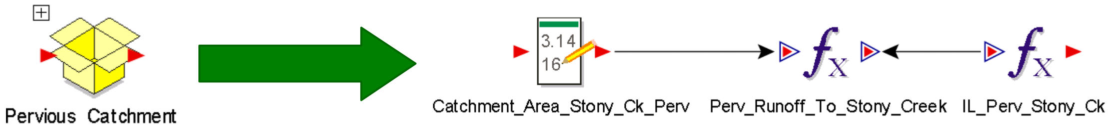
PROPOSED OPERATIONS – DETAILED VIEW

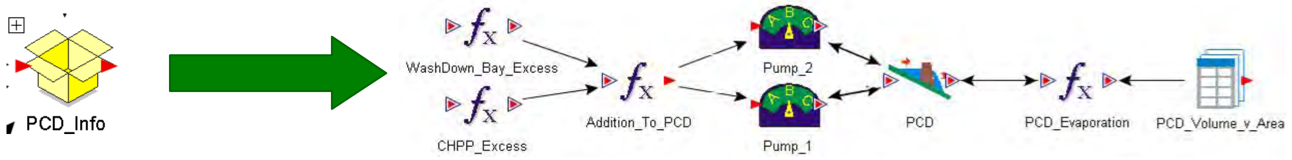








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PCD
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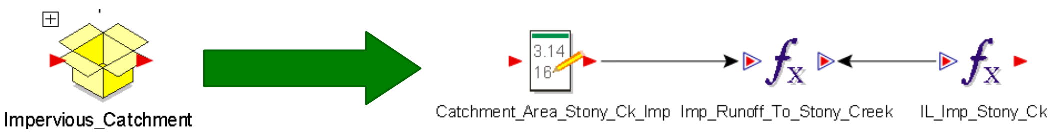
PCD_Volume_v_Area


LDP009_
LDP009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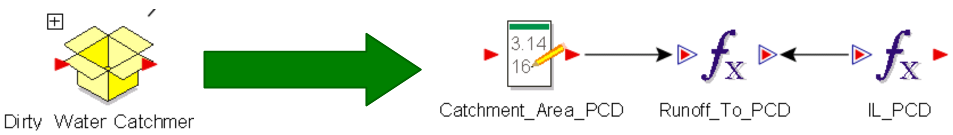
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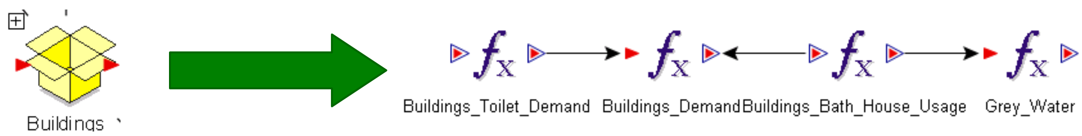
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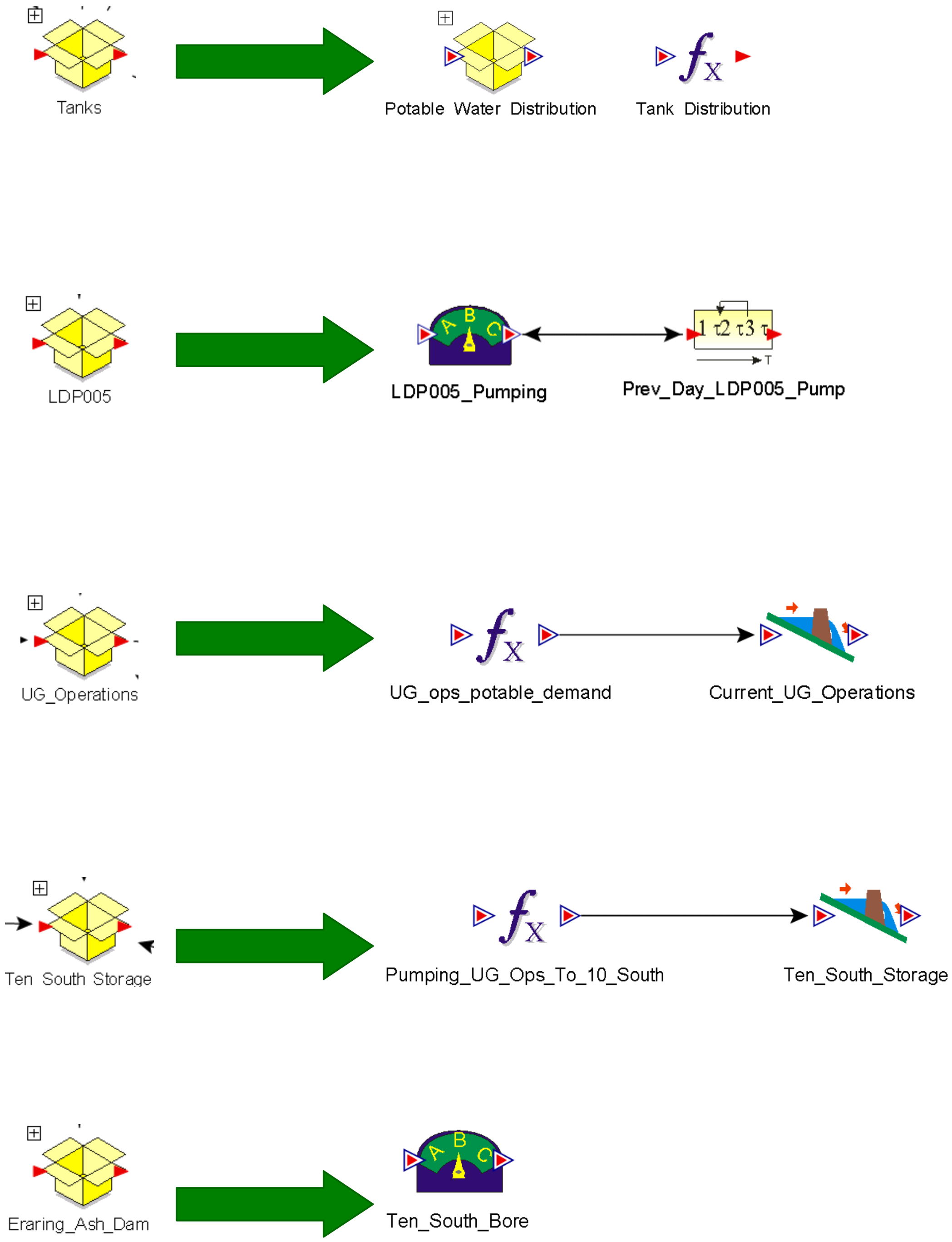

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UG_ops_potable_demand
Current_UG_Operations
Ten South Storage
Pumping_UG_Ops_To_10_South
Ten_South_Storage
Eraring_Ash_Dam
Ten_South_Bore

Appendix C

Goldsim - Results

EXISTING OPERATIONS

	Daily Potable Water Demand	Building Demand	Washdown Bay Demand	Coal Handling Processing Plant	Stockpile Dust Depression Demand	UG Operations Potable Demand	Buildings Toliets Demand	Buildings Bath-house Usage	Insitu ROM	Export ROM Coal	UG Water Make from Current Mining	Pumping from UG Operations to 10 South	Pumping from Pollution Control Dam to 10 South (Pump 1)	10 South Groundwater Make Inflow	10 South Bore	Runoff to Pollution Control Dam	In Seam Bin Pump	LDP009	Pumping from Pollution Control Dam to Barnes Dam (Pump 2)	Washdown Bay Excess	CHPP Excess	Old Underground Operations	LDP005 Pumping	Pervious Runoff to Stony Creek	Impervious Runoff to Stony Creek	Pollution Control Dam Evaporation	Barnes Dam Water Make
Units	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr
Current Operations																											
Mean	44.3	4.9	2.2	0.9	1.2	35.2	1.0	3.9	47.5	47.5	0.0	35.2	10.2	109.6	155.0	18.6	3.7	1.0	12.6	1.1	0.4	0.0	122.1	165.3	42.0	0.0	109.6
Max	44.4	4.9	2.2	0.9	1.2	35.3	1.0	3.9	47.6	47.6	0.0	35.3	16.0	109.8	160.7	34.9	7.0	7.8	21.4	1.1	0.4	0.0	129.0	341.7	79.0	0.0	109.8
Min	44.3	4.9	2.2	0.9	1.1	35.2	1.0	3.9	47.4	47.4	0.0	35.2	6.6	109.5	151.3	7.1	1.4	0.0	3.5	1.1	0.4	0.0	114.0	43.6	16.2	0.0	109.5

PROPOSED OPERATIONS

	Daily Potable Water Demand	Building Demand	Washdown Bay Demand	Coal Handling Processing Plant	Stockpile Dust Depression Demand	UG Operations Potable Demand	Buildings Toliets Demand	Buildings Bath-house Usage	Moisture Content Insitu ROM	Export ROM Coal	UG Water Make from Current Mining	Pumping from UG Operations to 10 South	Pumping from Pollution Control Dam to 10 South (Pump 1)	10 South Groundwater Make Inflow	10 South Bore	Runoff to Pollution Control Dam	In Seam Bin Pump	LDP009	Pumping from Pollution Control Dam to 10 South (Pump 2)	Washdown Bay Excess	CHPP Excess	Old Underground Operations	Fish tanks to 10 South Storage Area	Pervious Runoff to Stony Creek	Impervious Runoff to Stony Creek	Pollution Control Dam Evaporation	Fish Tank Water Make
Units	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr
Proposed Operations																											
Mean	44.3	4.9	2.2	0.9	1.2	35.2	1.0	3.9	52.2	52.2	0.0	35.2	19.5	109.6	173.6	18.6	3.7	0.2	2.8	1.1	0.4	0.0	112.2	165.3	42.0	1.4	109.6
Max	44.4	4.9	2.2	0.9	1.2	35.3	1.0	3.9	52.3	52.3	0.0	35.3	30.4	109.8	173.9	34.9	7.0	3.6	8.0	1.1	0.4	0.0	115.5	341.7	79.0	1.4	109.8
Min	44.3	4.9	2.2	0.9	1.1	35.2	1.0	3.9	52.2	52.2	0.0	35.2	8.2	109.5	173.2	7.1	1.4	0.0	0.3	1.1	0.4	0.0	109.8	43.6	16.2	1.4	109.5

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Appendix C

Water Quality

Upstream Water Quality Data

Date of Sample	pH	TSS	Ec (uS/cm)	Turbidity (NTU)	Arsenic	Copper	Lead	Zinc	Arsenic (dissolved)	Copper (dissolved)	Lead (dissolved)	Zinc (dissolved)	Bicarbonate Alkalinity as CaCO3
24/09/2009	7.80	25	2280	55.8	0.001	0.001	0.00	0.011	0.00	0.001	0.00	0.007	278
8/10/2009	7.08	8	572		0.00	0.002	0.00	0.021	0.00	0.002	0.00	0.008	92
22/10/2009	7.83	6	2080	1.3	0.00	0.00	0.00	0.006	0.00	0.004	0.00	0.00	292
5/11/2009	7.65	4	1870		0.00	0.004	0.00	0.016	0.00	0.001	0.00	0.012	270
19/11/2009	7.59	17	1380	36.7	0.002	0.001	0.00	0.024	0.00	0.001	0.00	0.011	186
2/12/2009	7.88	5	2060		0.00	0.001	0.00	0.013	0.00	0.00	0.00	0.009	295
17/12/2009	7.82	31	2000	4.3	0.001	0.00	0.00	0.010	0.00	0.00	0.00	0.005	296
14/01/2010	8.64	5	2400	6.7	0.00	0.001	0.00	0.011	0.00	0.002	0.00	0.012	270
28/01/2010	7.70	7	1390	18.4	0.00	0.001	0.00	0.012	0.00	0.002	0.00	0.00	215
11/02/2010	8.15	6	2130	5.2									386
25/02/2010	8.02	8	2550		0.00	0.00	0.00	0.008	0.00	0.001	0.00	0.009	362
12/03/2010	8.04	<1	2160	0.3	0.00	0.00	0.00	0.009	0.00	0.00	0.00	0.008	312
80th Percentile	***8.04***	***9***	***2420***	***29.38***	***0.001***	***0.001***	***0.000***	***0.016***	***0.00***	***0.002***	***0.00***	***0.011***	***308.8***
Default ANZECC	***6.5 - 8.0***	***6 - 50***	***125 -2200***	***6 - 50***	***0.013***	***0.0014***	***0.0034***	***0.008***	***0.013***	***0.0014***	***0.0034***	***0.008***	***60***
Hardness						***0.0073***	***0.040***	***0.042***		***0.0073***	***0.040***	***0.042***	

LDP005 Water Quality Data

Date of Sample	pH	TSS	Ec (uS/cm)	Turbidity (NTU)	Arsenic	Copper	Lead	Zinc	Arsenic (dissolved)	Copper (dissolved)	Lead (dissolved)	Zinc (dissolved)
22/04/2004	7.17	1	3170	1.3		0.001	0.01					
27/05/2005	7.3	1	2880	1.1		0.002	0.001	0.146				
8/06/2006	6.96	1	2520	0.4		0.001	0.001	0.057				
24/08/2007	7.56	1	2910	0.4		0.001	0.001	0.022	0.001	0.001	0.001	0.016
8/02/2008	7.92	1	2000	1.8		0.002	0.001	0.021	0.001	0.001	0.001	0.024
22/08/2008	8.71	1	2150	1.8		0.002	0.001	0.093	0.001	0.001	0.001	0.098
16/02/2009	7.65	30	3840	34.6	0.001	0.004	0.001	0.234				
17/02/2009	7.95	24	3820	34.5	0.001	0.003	0.001	0.186				
13/08/2009	7.71	76	2580	98.3		0.004	0.002	0.102	0.001	0.001	0.001	0.018
30/10/2009	7.22	5	2120					0.022	0.001	0.001	0.001	0.011
25/11/2009	7.90	2	2030		0.001	0.001	0.001	0.021	0.001	0.001	0.001	0.013
17/12/2009	7.65	11	2570	11.3	0.001	0.001	0.001	0.230	0.001	0.001	0.001	0.007
20/01/2010	7.82	14	2730	10.8	0.001	0.001	0.001	0.028	0.001	0.006	0.001	0.022
28/01/2010	7.75	7	2600	3.1	0.001	0.002	0.001	0.039	0.001	0.001	0.001	0.007
22/02/2010	7.93	1	2460	6	0.001	0.002	0.001	0.036	0.001	0.001	0.001	0.017
15/03/2010	7.99	9	2600	11	0.001	0.003	0.001	0.039	0.001	0.001	0.001	0.011
80th Percentile	***7.64***	***5.2***	***2910***	***11.38***	***0.001***	***0.003***	***0.001***	***0.154***	***0.001***	***0.001***	***0.001***	***0.022***
Default ANZECC	***6.5 - 8.0***	***6 - 50***	***125 -2200***	***6 - 50***	***0.013***	***0.0014***	***0.0034***	***0.008***	***0.013***	***0.0014***	***0.0034***	***0.008***
Hardness						***0.0073***	***0.040***	***0.042***		***0.0073***	***0.040***	***0.042***

10 South Water Quality Data

Date of Sample	pH	TSS	Ec (uS/cm)	Turbidity (NTU)	Arsenic	Copper	Lead	Zinc	Arsenic (dissolved)	Copper (dissolved)	Lead (dissolved)	Zinc (dissolved)
27/05/2005	7.6	2	7240	1.5	0.001	0.002	0.001	0.023				
8/06/2006	7.01	8	5610	5.8	0.002	0.009	0.016	0.110				
24/08/2007	7.65	3	4810	5.1	0.002	0.001	0.001	0.022	0.001	0.002	0.001	0.011
22/08/2008	8.51	1	5650	1.1	0.001	0.002	0.002	0.021	0.001	0.002	0.005	0.018
13/08/2009	7.49	2	6040	1.9	0.001	0.005	0.001	0.071	0.001	0.002	0.001	0.038
11/02/2010	7.59	17	7940	0.5	0.001	0.012	0.001	0.020	0.001	0.004	0.001	0.022
12/03/2010	7.57	2	9260	0.4	0.001	0.002	0.001	0.019	0.001	0.002	0.001	0.019
80^{th} Percentile	***7.65***	***4***	***7940***	***5.14***	***0.0018***	***0.008***	***0.0018***	***0.055***	***0.001***	***0.0024***	***0.0018***	***0.025***
Default ANZECC	***6.5 - 8.0***	***6 - 50***	***125 -2200***	***6 - 50***	***0.013***	***0.0014***	***0.0034***	***0.008***	***0.013***	***0.0014***	***0.0034***	***0.008***
Hardness						***0.0073***	***0.040***	***0.042***		***0.0073***	***0.040***	***0.042***

Lake Macquarie Water Quality Data

Date of Sample	pH	TSS	Ec (uS/cm)	Manganese Filt	Iron (filt)	Turbidity (NTU)	Aluminium	Arsenic	Boron	Copper	Iron Total	Lead	Manganese Total	Zinc	Aluminium (dissolved)	Arsenic (dissolved)	Boron (dissolved)	Copper (dissolved)	Lead (dissolved)	Zinc (dissolved)
26/08/2008	8.32	10	45800	<0.010	<0.50	6.4	0.21	<0.010	4.77	<0.020	<0.50	<0.010	<0.010	<0.050	<0.10	<0.010	3.08	<0.020	<0.010	<0.050
27/08/2008	7.94	430	44100	<0.010	<0.50	248	9.55	<0.010	3.25	0.036	8.19	0.06	0.186	0.178	<0.10	<0.010	3.09	<0.020	<0.010	<0.050
28/08/2008	8.11	271	39500	<0.010	<0.50	125	2.97	<0.010	3.58	<0.020	3.54	0.024	0.082	0.077	<0.10	<0.010	3.6	<0.020	<0.010	<0.050
29/08/2008	8.05	206	43500	<0.010	<0.50	124	3.46	<0.010	3.25	0.021	3.63	0.028	0.11	0.094	<0.10	<0.010	3.3	<0.020	<0.010	<0.050
5/09/2008	7.06	208	40100	0.081	1.66	125	5.07	0.01	3.64	0.026	5.55	0.032	0.107	0.159	0.61	<0.010	2.94	<0.020	0.026	0.082
8/09/2008	7.16	265	20200	0.013	0.06	181	3.16	0.005	1.69	0.014	3.22	0.021	0.125	0.092	0.08	<0.001	1.73	0.002	0.002	0.014
9/09/2008	7.48	82	13000	0.159	<0.05	63.3	1.66	0.003	1.13	0.008	1.44	0.009	0.254	0.041	0.06	0.001	1.06	0.003	0.001	0.01
10/09/2008	7.58	11	24400	0.036	<0.05	9.8	0.39	<0.001	1.88	0.005	0.25	0.002	0.058	0.013	0.04	0.002	2.04	0.003	<0.001	0.005
11/09/2008	7.67	108	26900	0.013	<0.05	54	1.29	0.002	1.72	0.009	1.38	0.008	0.092	0.035	0.03	<0.001	1.6	0.004	<0.001	0.006
12/09/2008	7.48	13	27300	0.031	<0.05	9.4	0.32	<0.001	1.63	0.005	0.25	0.002	0.048	0.012	0.02	<0.001	2.26	0.003	<0.001	0.006
17/09/2008	7.3	70	46400	<0.010	<0.50	30.6	1.31	<0.010	3.2	<0.020	1.7	0.013	0.08	0.062	<0.10	<0.010	3.08	<0.020	<0.010	<0.050
19/09/2008	7.42	30	48000	<0.010	<0.50	20.1	0.66	<0.010	4.09	<0.010	0.75	<0.010	0.045	<0.050	<0.10	<0.010	3.57	<0.010	<0.010	<0.050
25/09/2008	8.05	31	40100	<0.010	<0.50	11.9	0.26	<0.010	4.07	<0.010	<0.50	<0.010	0.021	<0.050	<0.10	<0.010	3.36	<0.010	<0.010	<0.050
2/10/2008	8.04	85	44700	<0.010	<0.50	34	0.77	0.01	3.94	<0.020	1.16	<0.010	0.056	<0.050	<0.10	<0.010	3.46	<0.020	<0.010	<0.050
10/10/2008	6.92	20	40900	<0.010	<0.50	11.6	0.94	<0.010	2.66	<0.010	1.12	<0.010	0.107	<0.050	<0.10	<0.010	2.86	<0.010	<0.010	<0.050
50th Percentile	7.58	82	40100	0.0335	0.86	34	1.29	0.005	3.25	0.0115	1.44	0.017	0.087	0.0695	0.05	0.0015	3.08	0.003	0.002	0.008

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