

Surface Water Impact Assessment Drayton South Coal Project

Hansen Bailey Environmental Consultants
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For and on behalf of
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Executive Summary

Overview

WRM Water & Environment was commissioned by Hansen Bailey Environmental Consultants on behalf of Anglo American Coal to prepare a surface water impact assessment for the Drayton South Coal Project (the Project). The assessment is to form part of an Environmental Impact Statement being prepared by Hansen Bailey to support an application under Division 4.1, Part 4 of the *Environmental Planning and Assessment Act 1979* to facilitate the continuation of the existing Drayton Mine by the development of an open cut coal mining operation and associated infrastructure within the Drayton South area. The study area comprises an overall area of approximately 3,670 ha and includes the existing Drayton Mine and the proposed Drayton South disturbance footprint and transport corridor.

Existing Environment

The Project is drained by Saddlers Creek and Saltwater Creek, two minor tributaries of the Hunter River. The main drainage feature is Saddlers Creek, which commences on the existing Drayton Mine and is situated within close proximity to the north western boundary of the proposed Drayton South disturbance footprint. Saltwater Creek commences on the Drayton Mine and drains to the east of Drayton South. The proposed Drayton South disturbance footprint is generally confined to a minor tributary, which drains into Saltwater Creek downstream of Plashett Dam located on the neighbouring AGL Macquarie site. The Hunter River is situated to the south of the Project.

Water Quality

A water management system has been developed to minimise or mitigate the impact of the Project on the downstream water quality. The water management system includes:

- a mine affected water management system to collect water that may contain high total dissolved solid (salt) concentrations and reuse to satisfy on site demand for dust suppression and coal washing;
- a tailings water management system to manage the inflows to and outflows from the Coal Handling and Preparation Plant and tailings storage facility;
- a dirty water management system to ensure potentially sediment-laden runoff from disturbed areas is separated from clean area runoff and collected in sediment dams for treatment;
- a clean water management system to divert water undisturbed by mining, or from fully rehabilitated areas, around the Project disturbance footprint; and
- a hydrocarbon water management system.

Water Management System

The main features of the water management system include:

- the construction of the Transfer Dam at Drayton South to receive water pumped from active mine areas and used for dust suppression;
- pumping capacity to transfer water between the Transfer Dam and South Void, where South Void will be used as the primary storage for water over the Project life;
- if raw water supply is required, water can be pumped in from the Hunter River and deposited in the Transfer Dam;
- Drayton Mine Access Road Dam will be the main repository to supply water to the CHPP;

- the Rail Loop Dam, collecting mine affected runoff from the existing Drayton Mine site facilities and coal stockpiles, will be pumped to the Access Road Dam;
- a dust suppressant will be used to minimise road watering use and prevent dust nuisance;
- the preferred option for management of tailings will be to dispose of coarse rejects in the North Void while fine tailings will be disposed of in the East (South) Void and into the East (North) Void, when mining is completed;
- runoff from overburden emplacement areas and haul roads will be collected in sediment dams. Water collected in the sediment dams will be retained on site for reuse or released to the downstream environment after a period of settlement (if the stored water quality meets the relevant standards); and
- runoff from undisturbed areas will be managed through the use of temporary high wall dams and drains to divert clean runoff around the disturbed area.

Water Balance

A numerical water balance model was used to design and assess the effectiveness of the mine water management system, including a sensitivity analysis of runoff parameters and modelling of salinity levels. The model identifies water supply and discharge requirements based on the Project's expected catchment runoff (both quantity and quality) and water demands. The water balance modelling shows the Project:

- will have at least a 90% chance in each year of meeting operational demands from catchment runoff and dewatered groundwater;
- will have less than a 10% chance at any point in time of water building up in the mining areas to potentially impact on production;
- will not impact on downstream water quality due to spills from the main mine water storages that potentially contain elevated salinity levels;
 - Access Road Dam, Savoy Dam, Transfer Dam and the South Void, do not spill over the modelled Project life when operated in accordance with the proposed rules.
 - There is a 1% chance in each year that the Rail Loop Dam will spill approximately 30-35 ML, and at least a 90% chance in each year that it won't spill at all. The minor spills that were modelled over the life of the Project are expected to occur as a result of the daily time step of the model. In reality, pumps will have been turned on throughout the day when the water level exceeded its pump out threshold to prevent the spill.

A long term water balance simulation of the Drayton South final void predicted the equilibrium final void water level will be approximately 19 m below the void spill height and hence is never likely to fill or spill and will reach an equilibrium salinity level of between 4,250 mg/L to 8,800 mg/L of total dissolved solids.

Flooding

The Project is not prone to Hunter River flooding. No part of the disturbance footprint (with the exception of the pumping infrastructure) will be impacted by Hunter River flooding. The Project disturbance boundary is located outside of the Probable Maximum Flood extent of Saddlers Creek.

Loss of Catchment Flows

During and after the life of the Project, there is a potential for catchment flows to surrounding waterways including the Hunter River, Saddlers Creek and Saltwater Creek to be reduced. The following is of note:

- The greatest loss of Saddlers Creek catchment occurs about Year 12 of the Project. At this time, the catchment contributing runoff to Saddlers Creek would reduce by 520 ha (or 5% of the total catchment area).
- Following completion of rehabilitation, approximately 215 ha of catchment will be returned to Saddlers Creek. As such, the Drayton South final void will permanently reduce the Saddlers Creek catchment by 305 ha (or 3% of the total catchment area).
- Mining at Drayton South will remain to the north of the ridgeline between the Saddlers Creek and Saltwater Creek catchments; hence no additional catchment will be removed from Saltwater Creek by the Project.
- The Project will not have a significant impact on the Hunter River flows. Under mining conditions, the Project will reduce the catchment draining to the Hunter River at Liddell by a maximum of 0.03%. For post-mining conditions, the final voids will reduce the Hunter River catchment to Liddell by 0.02%.
- There are four main gullies of Saddlers Creek that will be impacted by mining. These gullies will be reconstructed as part of the final landform with much of the original catchments reformed with the exception of the final void.

Mitigation and Management Measures

Should offsite water be required, a pump and pipeline on the Hunter River immediately downstream of the Golden Highway will be utilised to access the 198 unit general security allocation Anglo American currently owns. The category of the Water Access Licences will be transferred as required.

In addition to the design elements for the Drayton South water management system, the following measures are proposed to further mitigate and manage surface water impacts:

- a dust suppressant applied to haul roads, ramps and the mine site facilities will be used to minimise water use and the need for offsite supplies. The water balance modelling found that the use of the proposed dust suppressant agent (that has an application rate of 0.015 L/m²/hr) will greatly reduce the risk of requiring water from offsite;
- a comprehensive restoration program developed in consultation with Hunter-Central Rivers Catchment Management Authority is currently being progressed for Saddlers Creek to mitigate the impact of the loss of catchment flows. Although the loss of catchment flows is a residual impact, the restoration program would leave Saddlers Creek in a much better condition at the end of the Project;
- surface water monitoring and response programs for Drayton South, developed generally in accordance with the existing Drayton Mine Environmental Monitoring Plan; and
- the water balance model will be updated and used to continually improve the water management system over the Project life.

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1 Introduction

1.1 PROJECT DESCRIPTION

Drayton Mine is located approximately 13 km south of the township of Muswellbrook in the Upper Hunter Valley of NSW (see Figure 1.1). Drayton Mine has been operating in the Muswellbrook community for over 30 years and runs out of coal in 2015. WRM Water & Environment (WRM) was commissioned by Hansen Bailey on behalf of Anglo American Coal (Anglo American) to complete a surface water impact assessment as part of the Environmental Impact Statement (EIS) for the Drayton South Project (the Project).

The Project will allow for the continuation of the existing Drayton Mine for up to 15 years, by developing an open cut mining area within EL 5460. The Project will extract up to 6.4 Million tonnes per annum (Mtpa) of export quality thermal coal by utilising existing Drayton Mine assets and infrastructure.

The Project addresses the reasons provided by the NSW Planning Assessment Commission (PAC) for the refusal of the previous Application. The mine plan is defined by ridgelines nominated in the 'Drayton South Coal Project PAC Review Report' issued in December 2013. The Project will remain behind the ridgelines nominated by the PAC. Significantly, this at least doubles the buffer setback distance from the Coolmore and Woodlands thoroughbred horse studs and is at least 2 km from the horse stud operational areas.

The Project generally includes:

- continuation of operations at Drayton Mine as currently approved with minor additional mining within the existing East, North and South Mining Areas for a period of 15 years;
- development of a new open cut mining area with EL 5460 mining up to 6.4 Mtpa Run-Of-Mine (ROM) coal;
- ongoing employment of a workforce of up to 500 full time equivalent employees;
- utilisation of the existing Drayton Mine equipment fleet;
- storage of water, and emplacement of tailings and rejects generated by the Project in existing Drayton Mine voids;
- utilisation of the existing Drayton Mine infrastructure including the CHPP, rail loop and associated infrastructure, workshops, bath houses and administration offices;
- construction of a transport corridor to the new mining area;
- continued utilisation of the Antiene Rail Spur off the Main Northern Railway Line to transport product coal to the Port of Newcastle for export;
- realigning and upgrading a section of Edderton Road;
- continuation of mutually beneficial arrangements with neighbours AGL Macquarie and Mt Arthur Coal Mine;
- installation of further water management and power reticulation infrastructure to support the new mining areas; and
- progressive rehabilitation of disturbed areas as mining operations are completed.

The conceptual layout of the Project is shown in Figure 1.2.

1.2 SCOPE OF WORK

The scope of work completed by WRM for this assessment includes:

- addressing the Secretary's Environmental Assessment Requirements (SEAR's) relating to surface water, issued on 19 December 2014;
- identifying the surface water values;
- identifying the potential surface water impacts;
- identifying and developing surface water control measures;
- developing and analysing a site water balance;
- a flood assessment of the Hunter River and Saddlers Creek; and
- developing a surface water monitoring plan.

1.3 STUDY AREA

The study area comprises an overall area of approximately 3,670 ha within the Project Boundary (Figure 1.2). This area includes the existing Drayton Mine, the proposed Drayton South disturbance footprint and the transport corridor proposed to link both parts of the site. The study area is smaller than the previous Application because mining at Drayton South is now proposed to remain to the north of the ridgeline nominated by PAC, subsequently reducing the disturbance boundary.

1.4 RELATED STUDIES

The studies which are to be read in conjunction with this assessment include the following:

- the EIS groundwater impact assessment;
- the EIS ecology impact assessment; and
- the EIS agricultural impact statement.

1.5 REPORT STRUCTURE

This report includes a further six sections:

- Section 2 provides an overview of the regulatory framework;
- Section 3 describes the existing environment with respect to surface water resources and the existing water management system at Drayton Mine;
- Section 4 describes the Project and the proposed water management system;
- Section 5 presents an analysis of the site water balance;
- Section 6 describes the potential impacts of the Project on surface water resources;
- Section 7 outlines the proposed mitigation measures of the Project;
- Section 8 presents a summary of the conclusions of the surface water impact assessment; and
- Section 9 provides a list of references.

The report also includes three appendices describing the calibration of the water balance model, the storage characteristics and operating rules of the water management system within the study area.

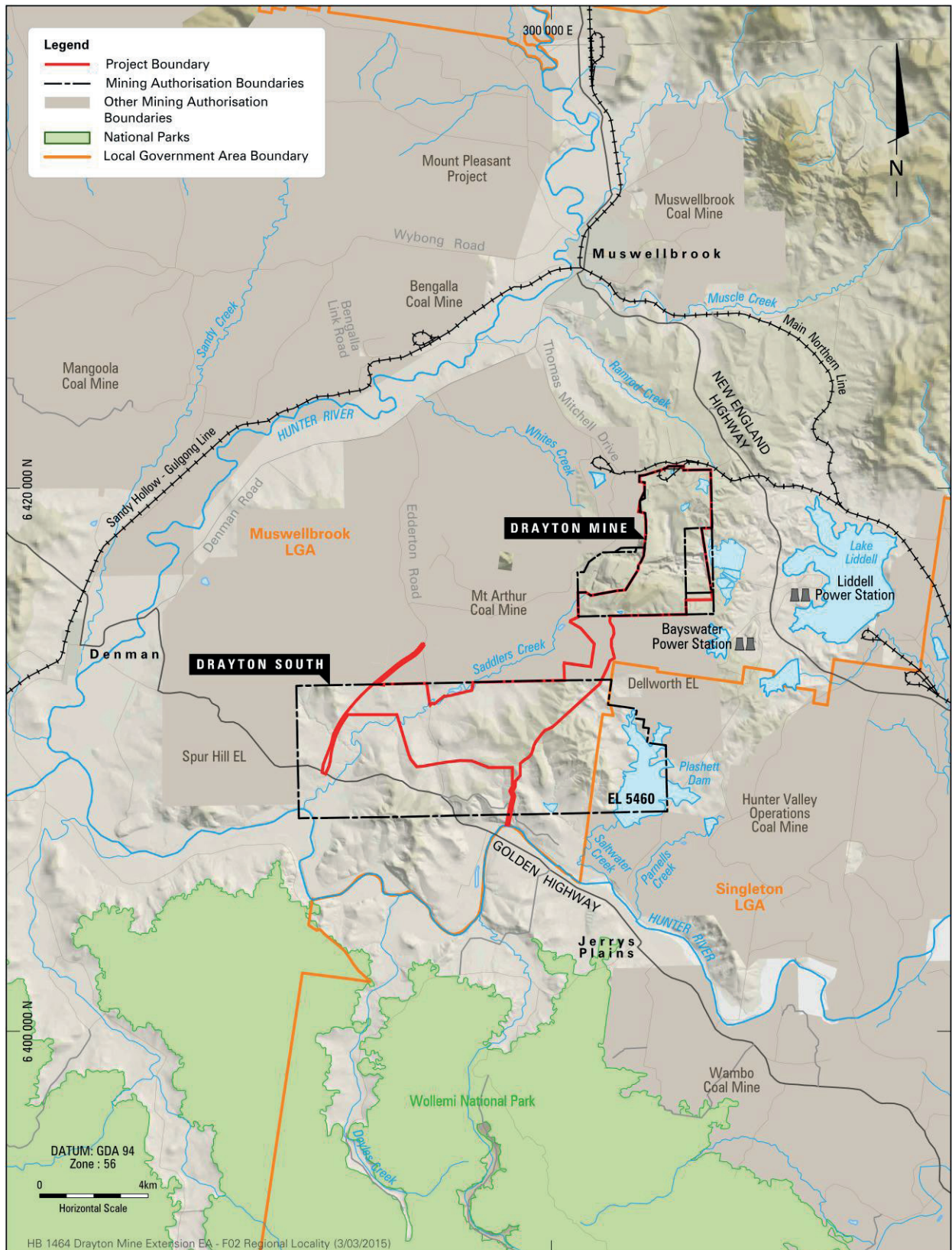


Figure 1.1 - Locality map

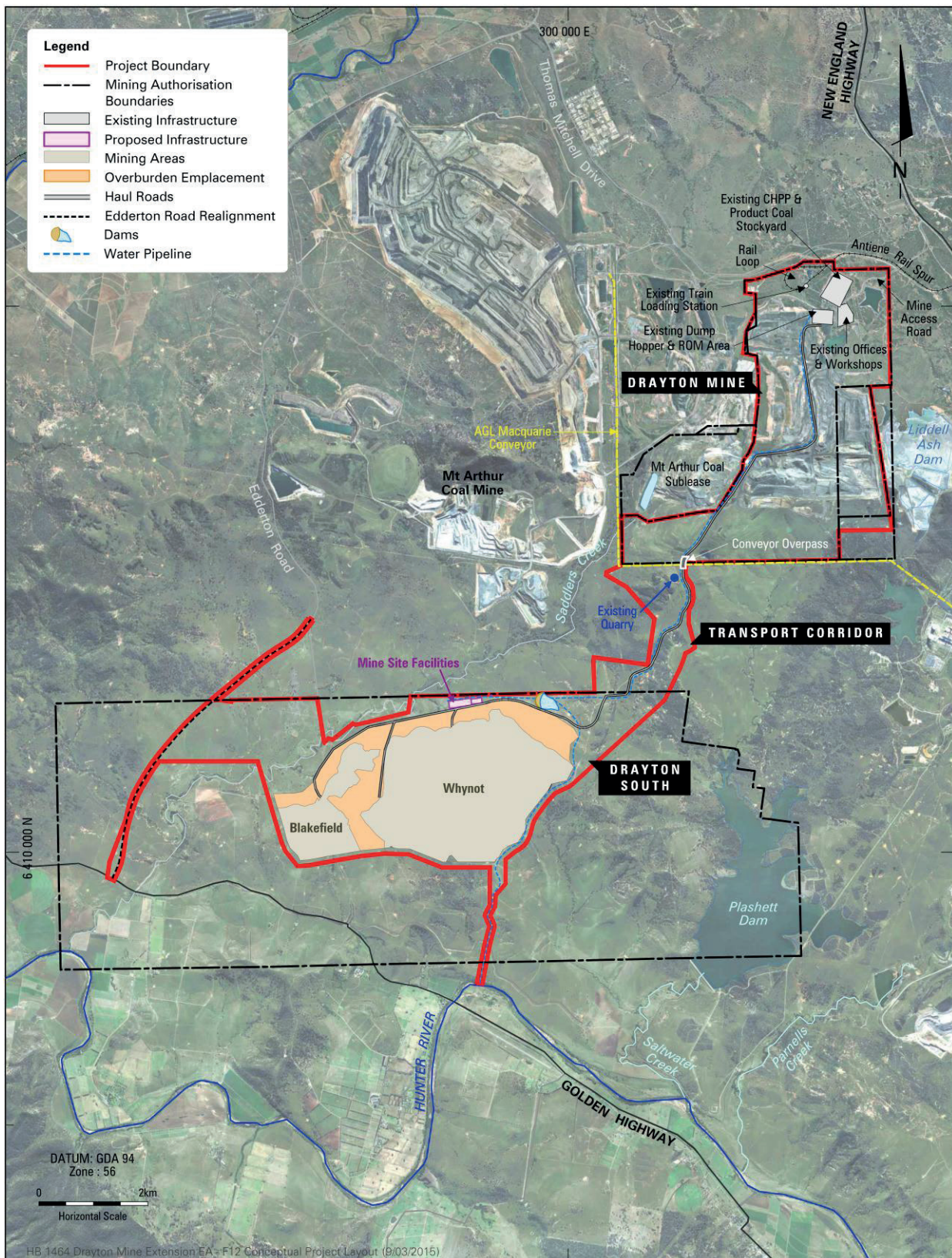


Figure 1.2 - Conceptual project layout

2 Regulatory framework

2.1 REGULATORY DOCUMENTS

The following legislation, plans, policies and regulations are relevant to the Project for surface water management:

- the Water Management Act 2000 (WM Act), Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation 2002, Water Sharing Plan for the Hunter Regulated River Water Source 2003 (HRRWSP) and Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009 (HUAWSP) with respect to:
 - the taking of waters from the Hunter River Regulated Water Source;
 - the taking of waters from the Hunter River Unregulated and Alluvial Water Source;
 - the capture of clean water runoff;
 - the use of the final voids at Drayton Mine as a water storage; and
 - the construction and use of a pump station on the Hunter River.
- the objectives of the State Water Management Outcomes Plan (SWMOP) and Hunter-Central Rivers Catchment Action Plan (CAP);
- the Protection of the Environment Operations Act 1997, relevant to the Environment Protection Licence (EPL) that will be required.
- National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000) and the ANZECC Guidelines and Water Quality Objectives in NSW (DEC, 2006) with respect to defining the environmental values of receiving waters and the definition of protection level based on ecosystem condition;
- *Dams Safety Act 1978* (Dams Safety Act) with respect to the design, construction, monitoring and management requirements of any prescribed dams on the site or in the surrounding area, including Plashett Dam;
- *Managing Urban Stormwater Soils and Construction - Volume 2E Mines and Quarries*, (DECC, 2008) and *Managing Urban Stormwater, Soils and Construction*, (Landcom, 2004) with respect to the design of erosion and sediment control measures;
- *Water Act 1912* (Water Act) with respect of any water contained in fractured rock aquifers and basement rocks; and
- NSW Flood Prone Land Policy.

2.2 WATER LICENSES

Water Access Licences will be required for any water taken from the Hunter River and used for the Project.

Additionally, any water occurring naturally on or below the surface of the ground which is taken by the Project will be required to be the subject of a Water Access Licence unless it is subject to an exemption.

2.3 WATER SUPPLY WORKS APPROVAL

All dams, pipes, pumping stations and other water supply works which would ordinarily require water supply works approvals under the WM Act will be exempt if a project approval is granted under Division 4.1 of Part 4 of the EP&A Act (see section 89J of the

EP&A Act). The impact and environmental issues relating to these elements are included in this assessment.

2.4 EXCLUDED WORKS

Dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice or required by a public authority (other than Landcom or the Superannuation Administration Corporation or any of their subsidiaries) to prevent the contamination of a water source, that are located on a minor stream are excluded works and accordingly, are not required to be the subject of water supply works approval and there is no requirement for a Water Access Licence to take water and use water from them.

2.5 WATER SHARING PLANS

New South Wales Water Sharing Plans (WSPs) establish rules for sharing water between the environmental needs of the river or aquifer and water users, and between different types of water use such as town supply, rural domestic supply, stock watering, industry and irrigation.

NOW are progressively developing WSPs for rivers and groundwater systems across NSW following the introduction of the WM Act. The purpose of the plans is to protect the health of rivers and groundwater, while also providing water users with perpetual access licences, equitable conditions, and increased opportunities to trade water through separation of land and water.

The WSPs relevant to the Project include the:

- Water Sharing Plan for the Hunter Regulated River Water Source 2009 (HRRWSP); and
- Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009 (HUAWSP).

2.5.1 Water Sharing Plan for the Hunter Regulated River Water Sources 2009

The WSP for the Hunter Regulated River commenced on 1st July 2004 and applies for a period of 10 years to 30th June 2014. It is a legal document made under the WM Act.

The Hunter River water source is located in the central eastern area of NSW and drains an area of some 17,500 km². The Hunter River rises in the Mount Royal Range north east of Scone and travels approximately 450 km to the sea at Newcastle. The river is regulated from Glenbawn Dam to Maitland, a distance of about 250 km. Glennies Creek is regulated by Glennies Creek Dam, which also provides water to the lower reaches of the Hunter River.

The HRRWSP applies to rivers regulated by Glenbawn and Glennies Creek Dams. The water source is divided into three management zones. These are:

- the Hunter River from Glenbawn Dam to its junction with Glennies Creek (Management Zone 1);
- the Hunter River downstream of its junction with Glennies Creek (Management Zone 2); and
- Glennies Creek downstream of Glennies Creek Dam (Management Zone 3).

The Project is located within Management Zone 1 of the HRRWSP.

The HRRWSP allows for the extraction of water from the Hunter River without an access licence to provide basic landholder rights, which include domestic and stock rights, as well as Native Title rights.

All water extraction that is not for basic landholder rights must be authorised by an access licence. Each access licence specifies a share component. The share components of specific purpose licences, such as town water supply, stock and domestic are expressed as

ML/yr. The share components of high security, general security and supplementary Water Access Licences are expressed as a number of unit shares. Table 2.1 shows the categories of access licences in the HRRWSP and their total share components at the commencement of the WSP. Note that the supplementary and utility water share components shown in Table 2.1 are combined Zone 1, 2 and 3 shares.

Table 2.1 - Hunter Regulated River Water Source share components for different licence categories

Access Licence Category	Total Share Component in the Hunter		
	Zone 1	Zone 2	Zone 3
Stock & Domestic (ML/yr)	725	827	186
General Security (Unit Shares)	75,035	47,078	6,050
High Security (Unit Shares)	10,378	10,016	1,765
Supplementary Water (Unit Shares)		49,000	
Local Water Utility (ML/yr)		10,832	
Major Utility (ML/yr)		36,000	

Anglo American currently owns two general security Water Access Licenses (WAL1066 and WAL491) totalling 198 units from the Hunter River.

2.5.2 Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009

The HUAWSP commenced on 1st August 2009 and applies for a period of 10 years to 31st July 2019. It is a legal document made under the WM Act.

In total there are 39 water sources covered by the HUAWSP and nine of these are further sub-divided into management zones. The water source of Saddlers Creek and the alluvial aquifers associated with Saddlers Creek are contained within the Jerrys Management Zone of the Hunter Extraction Management Unit (EMU). The alluvial aquifers associated with the Hunter River are contained within the Up-stream Glennies Creek Management Zone (alluvial water source 1) of the Hunter Regulated River Alluvium EMU.

The total licensed water entitlement within the Jerrys management zone has a share component of 10,278 ML/year. The majority of this entitlement (76%) is currently categorised for industrial purposes with the remainder used for irrigation purposes. The total licensed groundwater entitlement within the Hunter Regulated River Alluvium EMU has a share component of 8,714 ML/year. The majority of this entitlement (36%) is currently categorised for irrigation purposes and 7% is used for industrial purposes.

2.6 NSW FLOOD PRONE LAND POLICY

The NSW Government's Flood Policy is directed at providing solutions to existing flooding problems in developed areas, and ensuring that new developments are compatible with the flood hazard and do not create additional flooding problems in other areas. Under the Policy, the management of flood prone land remains the responsibility of local government. To facilitate this, the Government has published the "Floodplain Development Manual: The Management of Flood Liable Land", New South Wales Government, April 2005 (the Manual), to provide guidance to Councils in the implementation of the Policy, and provides funding in support of floodplain management programs.

Muswellbrook Shire Council has developed a draft flood study (Worley, 2014) in accordance with the Manual to define the flood prone areas along the Hunter and Goulburn Rivers. The study includes the Hunter River within the vicinity of the Project but does not include the side tributaries that cross the Project Boundary. Flood risk management studies have yet been prepared to define the flood planning area for the shire. However, Council's existing Development Control Plan and the Local Environment Plan (2009) include measures to manage development within flood prone land, which may be updated once these flood risk management studies have been completed.

2.7 SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS

All applications for Project Approval under Part 4.1 of the EP&A Act must be accompanied by an EIS prepared in accordance with the SEAR's. This impact assessment, which forms part of the EA, addresses the SEARs concerning surface water. Table 2.2 lists the SEAR's that are relevant to this assessment and the sections of this report where those SEAR's are addressed.

This report only addresses the surface water aspects of these SEARs. The groundwater aspects are addressed in the Groundwater Impact Assessment prepared for the Project EIS.

Table 2.2 - Secretary's Environmental Assessment Requirements

Requirement	Report Section
NSW Planning and Environment	
<ul style="list-style-type: none"> an assessment of the water balance over the life of the development (including post mining) and the availability of water supplies to meet operational requirements; 	Section 5
<ul style="list-style-type: none"> an assessment of the likely impacts of the development on the quantity and quality of existing surface and groundwater resources, having regard to the EPA's and NOW's requirements (see Attachment 2); 	Section 6
<ul style="list-style-type: none"> an assessment of the likely impacts of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users; 	Section 6
<ul style="list-style-type: none"> an assessment of the likely flooding impacts of the development; and 	Sections 3.6 and 6.2
<ul style="list-style-type: none"> a detailed description of the measures that would be implemented to minimise water discharges and mitigate surface and groundwater impacts (including the rehabilitation measures for Saddlers Creek). 	Section 4 & Section 7
NSW EPA	
1 Describe the proposal including position of any intakes and discharges, volumes, water quality and frequency of all water discharges.	Sections 4 & 5
2 Demonstrate that all practical options to avoid discharge have been implemented and environmental impact minimised where discharge is necessary.	Sections 4 & 5
3 Where relevant include a water balance for the development including water requirements (quantity, quality and source(s)) and proposed storm and wastewater disposal, including type, volumes, proposed treatment and management methods and re-use options.	Sections 4 & 5
4 Describe existing surface and groundwater quality. An assessment needs to be undertaken for any water resource likely to be affected by the proposal.	Section 3.5.3
5 State the Water Quality Objectives for the receiving waters relevant to the proposal. These refer to the community's agreed environmental values and human uses endorsed by the NSW Government as goals for	Section 3.5.1

Requirement	Report Section
ambient waters. Where groundwater may be impacted the assessment should identify appropriate groundwater environmental values.	
6 State the indicators and associated trigger values or criteria for the identified environmental values. This information should be sourced from the ANZECC (2000) Guidelines for Fresh and Marine Water Quality	Section 7.5.2
7 State any locally specific objectives, criteria or targets which have been endorsed by the NSW Government	N/A
8 Include a water balance for mining operations for mine operations at 5 yearly intervals, including water requirements (quantity, quality and source(s)) and proposed storm and wastewater disposal, including type, volumes, proposed treatment and management methods and re-use options.	Sections 4 & 5
9 Describe the nature and degree of impact that any proposed discharges will have on the receiving environment	Section 6.4
10 Assess impacts against the relevant ambient water quality outcomes. Demonstrate how the proposal will be designed and operated to; <ul style="list-style-type: none"> ○ protect the Water Quality Objectives for receiving waters where they are currently being achieved; and ○ contribute towards achievement of the Water Quality Objectives over time where they are not currently being achieved. 	Section 6.4
11 Where a discharge is proposed that includes a mixing zone, the proposal should demonstrate how wastewater discharged to waterways will ensure the ANZECC (2000) water quality criteria for relevant chemical and non-chemical parameters are met at the edge of the initial mixing zone of the discharge, and that any impacts in the initial mixing zone are demonstrated to be reversible.	N/A - Controlled discharges under the HRSTS are not proposed.
12 Assess impacts on groundwater and groundwater dependent ecosystems	N/A
13 Describe how stormwater will be managed both during and after construction.	Section 4
14 Describe in detail any water storage ponds, or basins, proposed to be constructed during the whole mine operational life. Provide location of the proposed storage(s), estimated volume capacities and expected water quality.	Sections 4 & 5
15 Describe in detail how water storage ponds or sedimentation basins will be monitored and managed to maximise free-board, and to treat suspended solids and other potential pollutants.	Sections 4.3.3 & 7.5
16 Describe under exactly what circumstances, if any, these storages would be discharged or allowed to overtop, and what the receiving environment for any discharges would be.	Section 4
17 Describe how predicted impacts will be monitored and assessed overtime. Including a Trigger Action Response Plan, or similar response management plan, that will be implemented in response to any adverse impacts identified from the activity. This plan is to identify appropriate trigger values for the site and provide appropriate response actions to be implemented if adverse impacts are identified through the monitoring program.	Sections 7.5 & 7.6
18 Water quality monitoring should be undertaken in accordance with the Approved Methods for the Sampling and Analysis of Water Pollutant in NSW (2004)	N/A - Controlled discharges under the HRSTS are not proposed.
19 Describe in detail, including maps or plans of all water quality monitoring locations, water quality parameters and proposed monitoring	Section 7.5

Requirement	Report Section
frequencies.	
20 if a wastewater discharge is proposed it must be justified and it must be demonstrated that controlled discharges can be managed in compliance with the requirements of the HRSTS.	N/A - Controlled discharges under the HRSTS are not proposed.
NSW Trade & Investment Resources and Energy	
Where a void is proposed to remain as part of the final landform, the assessment is to provide details in regards to the following: Outcomes of the surface and groundwater assessments in relation to the likely final water level in the void. This should include an assessment of the potential for fill and spill along with measures required (sic) be implemented to minimise associated impacts to the environment and downstream water users.	Section 5.10
The EIS must assess surface water flow and flooding regimes and how these will be impacted and mitigated by the project both during and after mining has ceased. This is to include an evaluation of potential impacts from the final void on both surface and groundwater quality and flow regimes.	Sections 6.2, 6.3 & 5.10
NSW Office of Environment and Heritage	
7. The EIS must describe background conditions for any water resource likely to be affected by the development, including:	
a. Existing surface and groundwater.	Sections 3.5.2 & 3.5.3
b. Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations.	Sections 5.6.6 & 5.6.7
c. Water Quality Objectives (as endorsed by the NSW Government including groundwater as appropriate that represent the community's uses and values for the receiving waters.	Section 3.5.1
Indicators and trigger values/criteria for the environmental values identified at(c) in accordance with the ANZECC(2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government.	Section 7.5.2
8. The EIS must assess the impacts of the development on water quality, including:	
a. The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the development protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction.	Section 6 Section 5
b. Identification of proposed monitoring of water quality.	Section 7.5
9. The EIS must assess the impact of the development on hydrology, including:	
a. Water balance including quantity, quality and source.	Section 5
b. Effects to downstream rivers, wetlands, estuaries, marine waters and floodplain areas.	Section 6
c. Effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems.	EIS Biodiversity Assessment
d. Impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (e.g. river benches).	Report, Groundwater Impact Assessment &

Requirement	Report Section
	Stygofauna Impact Assessment, Section 7.3
	Section 6.5
e. Changes to environmental water availability, both regulated/licensed and unregulated/rules based sources of such water.	Section 4 & Section 5.10.4
f. Mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and re-use options.	Section 7.5
g. Identification of proposed monitoring of hydrological attributes.	
10. The EIS must map the following features relevant to flooding as described in the Floodplain Development Manual 2005 (NSW Government 2005) including:	Sections 3.6 & 6.2
a. Flood prone land	
b. Flood planning area, the area below the flood planning level.	
c. Hydraulic categorisation (floodways and flood storage areas).	
11. The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 1 in 10 year, 1 in 100 year flood levels and the probable maximum flood, or an equivalent extreme event.	Sections 3.6 & 6.2
12. The EIS must model the effect of the proposed development (including fill) on the flood behaviour under the following scenarios:	Sections 3.6 & 6.2 - proposed development is outside of Saddlers Creek PMF
a. Current flood behaviour for a range of design events as identified in 8) above. The 1 in 200 and 1 in 500 year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change.	
13. Modelling in the EIS must consider and document:	
a. The impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood,	Sections 3.6 & 6.2
b. Impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land. This may include redirection of flow, flow velocities, flood levels, hazards and hydraulic categories.	
c. Relevant provisions of the NSW Floodplain Development Manual 2005.	
14. The EIS must assess the impacts on the proposed development on flood behaviour, including:	Sections 3.6 & 6.2
a. Whether there will be detrimental increases in the potential flood affection of other properties, assets and infrastructure.	
b. Consistency with Council floodplain risk management plans.	
c. Compatibility with the flood hazard of the land.	
d. Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land.	
e. Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site.	
f. Whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.	
g. Any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the SES and Council.	
h. Whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the SES and Council,	

Requirement	Report Section
<ul style="list-style-type: none"> i. Emergency management, evacuation and access, and contingency measures for the development considering the full range of flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of Council and the SES j. Any impacts the development may have on the social and economic costs to the community as consequence of flooding. 	
<p>3E. The description of existing water quality/hydrology in the EIS must be based on suitable data (meaning data collection may be required) and must include:</p> <ul style="list-style-type: none"> a. Water chemistry. b. A description of receiving water processes, circulation and mixing characteristics and hydrodynamic regimes. c. Lake or estuary flushing characteristics. d. Sensitive ecosystems or species conservation values. e. Specific human uses and values (e.g. fishing, proximity to recreation areas). f. A description of any impacts from existing industry or activities on water quality. g. A description of the condition of the local catchment e.g. erosion, soils, vegetation cover. h. An outline of baseline groundwater information, including, for example, depth to water table, flow direction and gradient, groundwater quality, reliance on groundwater by surrounding users and by the environment. i. Historic river flow data. 	<p>Section 3.5.2 Section 3.5.3 N/A Section 3.5.1 Section 3.5.2 Section 3 N/A Section 3.5.3</p>
<p>3F. The assessment of the development on water quality and hydrology in the EIS must include:</p> <ul style="list-style-type: none"> a. Water circulation, current patterns, water chemistry and other appropriate characteristics such as clarity, temperature, nutrient and toxicants, and potential for erosion. b. Changes to hydrology (including drainage patterns, surface runoff yield, flow regimes, and groundwater). c. Disturbance of acid sulphate soils and potential acid sulphate soils. d. Stream bank stability and Impacts on macro invertebrates, e. Water quality and hydrology modelling and/or monitoring, where necessary. 	<p>Section 6.4 Section 6.3 EIS Geochemistry Impact Assessment Section 7.3 Section 5</p>
<p>3G. The proposed monitoring of water quality must be undertaken in accordance with the Approved Methods for the Sampling and Analysis of Water Pollutant in NSW 2004. The EIS must include a water quality and aquatic ecosystem monitoring program that includes;</p> <ul style="list-style-type: none"> a. Adequate data for evaluating maintenance, or progress towards achieving, the relevant Water Quality Objectives. b. measurement of pollutants Identified or expected to be present. 	<p>Section 7.5</p>
NSW Office of Water	
<ul style="list-style-type: none"> • Details of water proposed to be taken (including through inflow and seepage) from each surface and groundwater source as defined by the relevant water sharing plan. 	<p>Section 6.5</p>
<ul style="list-style-type: none"> • Assessment of any volumetric water licensing requirements (including those for ongoing water take following completion of the project). 	<p>Sections 5.6.6 & 6.5</p>
<ul style="list-style-type: none"> • The identification of an adequate and secure water supply for the life of the project. Confirmation that water can be sourced from an 	<p>Sections 5.6.6 & 6.5</p>

Requirement	Report Section
appropriately authorised and reliable supply. This is to include an assessment of the current market depth where water entitlement is required to be purchased.	
<ul style="list-style-type: none"> A detailed and consolidated site water balance. 	Section 5
<ul style="list-style-type: none"> A detailed assessment against the NSW Aquifer Interference Policy (2012) using the NSW Office of Water's assessment framework. 	N/A
<ul style="list-style-type: none"> Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, wetlands, and groundwater dependent ecosystems, and measures proposed to reduce and mitigate these impacts. 	Sections 6, 6.5 Section 7
<ul style="list-style-type: none"> Full technical details and data of all surface and groundwater modelling, and an independent peer review. 	Section 5, EIS Groundwater Impact Assessment
<ul style="list-style-type: none"> Proposed surface and groundwater monitoring activities and methodologies. 	Section 7.5
<ul style="list-style-type: none"> Proposed management and disposal of produced or incidental water. 	Section 4
<ul style="list-style-type: none"> Details of the surrounding final landform of the site, including final void management (where relevant) and rehabilitation measures. 	Section 4.5
<ul style="list-style-type: none"> Assessment of any potential cumulative impacts on water resources, and any proposed options to manage the cumulative impacts. 	Section 6.6
<ul style="list-style-type: none"> Consideration of relevant policies and guidelines. 	Section 2
<ul style="list-style-type: none"> Assessment of whether the activity may have a significant impact on water resources, with reference to the Commonwealth Department of Environment Significant Impact Guidelines. 	EIS Groundwater Impact Assessment
<ul style="list-style-type: none"> If the activity may have a significant impact on water resources, then provision of information in accordance with the Information Guidelines for Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals, including completion of the information requirements checklist. 	This document.
<ul style="list-style-type: none"> A statement of where each element of the SEARs is addressed in the EIS (i.e. in the form of a table). 	This table, main EIS document

3 Existing surface water environment

3.1 REGIONAL DRAINAGE NETWORK

The regional drainage network in the vicinity of the Project is shown in Figure 1.1. The Project is located north of the Hunter River approximately 10 km north west of the village of Jerrys Plains and approximately 13 km south of the township of Muswellbrook. The Hunter River has a catchment area of approximately 13,400 km² to Jerrys Plains, which is immediately downstream of the study area. The catchment extends some 110 km to the north and 140 km to the west and includes the major tributaries of the Pages River, Dart Brook and the Goulburn River.

The Hunter River is a regulated river supplying water from Glenbawn Dam to a range of industrial and agricultural users as well as town water supplies. Glenbawn Dam is located on the upper headwaters of the Hunter River.

Two major tributaries, Glennies Creek and Wollombi Brook, drain into the Hunter River some 10 km downstream of the Project. The total catchment area of the Hunter River to Singleton, located 30 km downstream, which includes these two tributaries, is 16,400 km².

3.2 LOCAL DRAINAGE NETWORK

Figure 3.1 shows the topography and the location of tributaries draining the study area.

3.2.1 Drayton Mine

Drayton Mine is located in the upper headwaters of four minor watercourses;

- Ramrod Creek;
- Bayswater Creek;
- Saltwater Creek; and
- Saddlers Creek.

The northern areas of Drayton Mine drain via four minor gullies to the Ramrod Creek catchment. Three of the gullies converge around 1.5 km downstream of Drayton Mine and the fourth converges about 6 km downstream. Ramrod Creek drains into the Hunter River 10 km to the north west of the study area immediately downstream of Muswellbrook.

The eastern areas of the existing Drayton Mine drain to or previously drained to Bayswater Creek (prior to mining operations). Almost all of the Bayswater Creek catchment within Drayton Mine is an active mining area and does not drain offsite. Bayswater Creek drains into Lake Liddell and the headwater dams upstream of the ash dam on land owned and operated by AGL Macquarie.

The southern areas of Drayton Mine are located within the pre-mine Saltwater Creek and Saddlers Creek catchments. The Saddlers Creek and Saltwater Creek catchments at Drayton Mine are either active mining areas and no longer drain offsite or remain undisturbed. Saltwater Creek drains into Plashett Dam on land owned by AGL Macquarie. Saddlers Creek drains to the Hunter River.

3.2.2 Drayton South

The main drainage feature at Drayton South is Saddlers Creek. Saddlers Creek is a first and second order watercourse at Drayton Mine under the Strahler stream classification system (Strahler, 1957). It is a third and fourth order watercourse as it crosses Drayton South. Prior to the commencement of mining in the area, Saddlers Creek had a catchment of about 97.1 km².

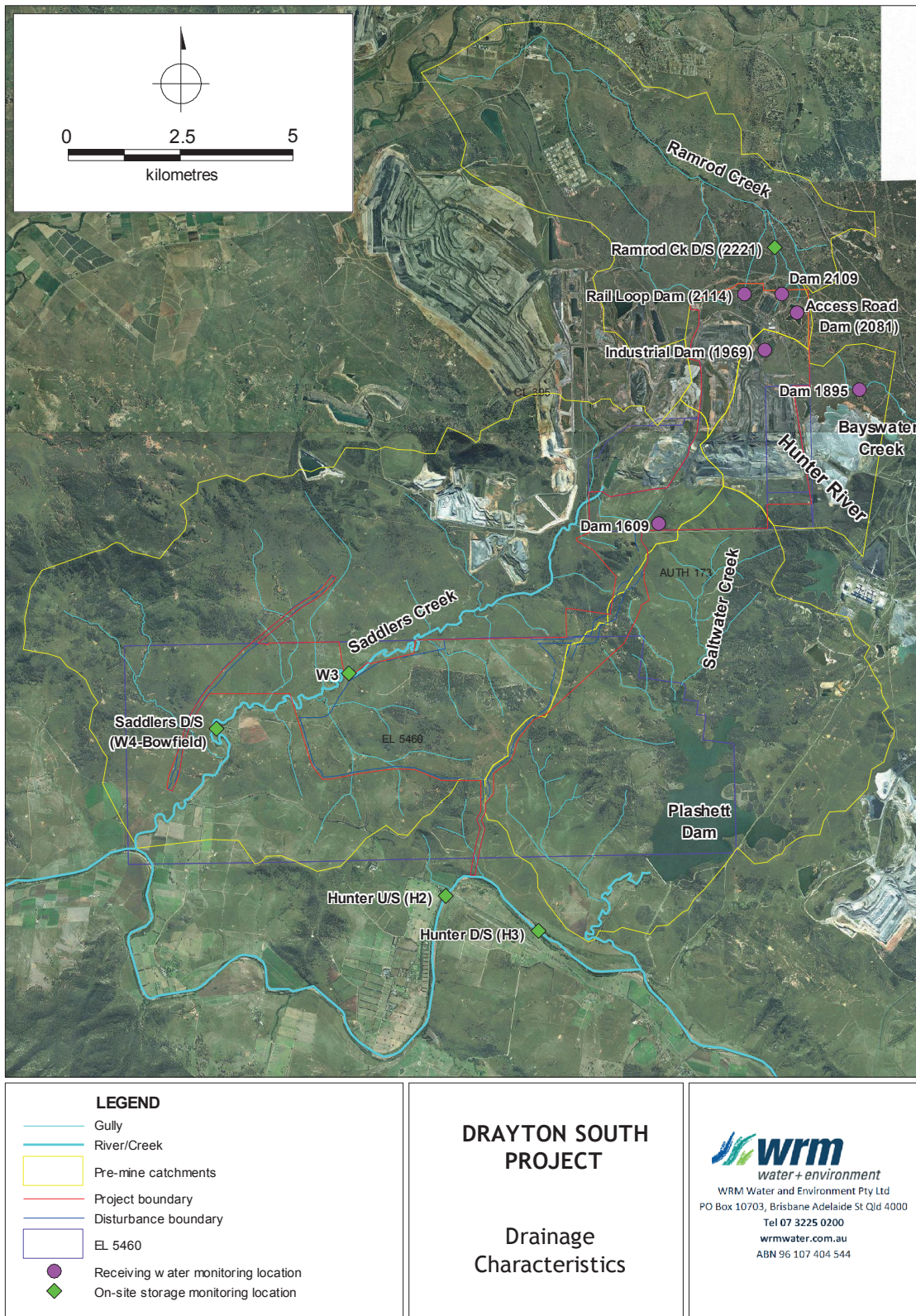


Figure 3.1 - Topography and drainage characteristics of the study area

Approximately 9.5 km² of the catchment is currently being mined by Mt Arthur Coal Mine and a further 4.6 km² is being mined at Drayton Mine. That is, 15% of the original catchment is currently taken up by mining and no longer drains to the Saddlers Creek catchment. It is understood that almost all of the Saddlers Creek catchment within Mt Arthur Coal Mine's leases to the north of Saddlers Creek will be mined.

Plate 3.1 shows a photograph of Saddlers Creek at the Edderton Road crossing. The creek is ephemeral, with a generally well defined channel that has a thick covering of long grass across a broad base. There are several pools on the base that would hold water for a period following rainfall. The channel banks are well defined but have little remnant vegetation. Erosion is evident along several sections of the stream bank which appear to be caused by the loss of vegetation and the highly dispersive soils. Erosion resulting from stock access is also evident.



Plate 3.1 - Saddlers Creek at Edderton Road

The channel meanders across a small floodplain with a relatively tight geometry. There are several oxbows adjacent to the main channel indicating that the channel has actively eroded in the past. A dam on the creek some 800 m upstream of Edderton Road (on the Mt Arthur Coal Mine lease) appears to overflow onto the northern floodplain, which would limit the water draining to the channel immediately below it and could potentially cause a major change in the channel alignment in time.

Several first and second order (minor) gullies and one third order gully drain into Saddlers Creek across the Drayton South area. The gullies have similar characteristics to Saddlers Creek in that they have a relatively broad base with active areas of bank erosion indicative of the dispersive soils. The gullies are generally devoid of remnant vegetation. As part of historic agricultural activities in the area, contour banks have been constructed across much of land within the Drayton South area to divert overland flows to these gullies. The gullies are therefore carrying much higher catchment flows than under pre-disturbance conditions.

The eastern side of the Drayton South area drains via first and second order (minor) gullies to Plashett Dam or directly to Saltwater Creek downstream of Plashett Dam. The pre-mine and pre-power station catchment area of Saltwater Creek to its confluence with the Hunter River is 53.2 km². Plashett Dam is a 65,000 ML storage that captures some 40.9 km² (77%) of the Saltwater Creek catchment and is integral to the operations at AGL

Macquarie. It receives pumped inflows from the Hunter River and is designed to spill infrequently. That is, Saltwater Creek downstream of Plashett Dam receives runoff from only 23% of the original catchment.

Two minor gullies also drain directly to the Hunter River.

3.3 FARM DAMS

There are 39 existing farm dams within the Drayton South area, none of which are prescribed dams under the Dams Safety Act. These farm dams are mostly less than 1 ML in capacity located at the end of contour banks and appear to act as sediment sumps. Contour banks are evident across Drayton South, suggesting sheet erosion is prominent.

There is one significant farm dam located on Saddlers Creek, 600 m upstream from Edderton Road (on the Mt Arthur Coal Mine lease), that has a capacity of approximately 15 ML to 20 ML.

The total capacity of the existing farm dams within the Drayton South EL 5460 is expected to be less than 50 ML.

3.4 RAINFALL AND EVAPORATION

Table 3.1 shows summary details of Bureau of Meteorology (BOM) rainfall recording stations in the vicinity of the Project. The locations of the various stations are shown in Figure 1.1.

Table 3.1 - BOM Rainfall Stations in the Vicinity of the Project

Station No.	Station Name	Elevation (m)	Lat. (°S)	Long. (°E)
061086	Jerrys Plains Post Office	90	32.497	150.909
061053	Muswellbrook (Lower Hill St)	143	32.261	150.885
061016	Denman (Palace Street)	105	32.388	150.689

Table 3.2 shows mean monthly rainfalls for the three rainfall stations shown in Figure 1.1. Note that the mean monthly values have been calculated over varying periods, depending on the length of available record. The mean annual rainfall in the area of interest ranges from 592.9 to 644.7 mm, with maximum monthly rainfalls occurring during the summer months.

Table 3.2 also shows mean monthly evaporation (based on a Class A evaporation pan) recorded at Jerrys Plains Post Office (Station No. 061086), located some 16 km to the south of Drayton Mine. Mean annual evaporation is 1,641 mm, which is more than double mean annual rainfall.

Figure 3.2 shows the annual distribution of average monthly rainfall and evaporation in the local area. Mean evaporation is similar to mean rainfall in the winter months, but substantially exceeds rainfall for the remainder of the year.

Table 3.2 - Mean monthly rainfall and evaporation

Month	Mean Monthly Rainfall (mm)			Mean Monthly Evaporation (mm)
	Muswellbrook (Lower Hill St) (061053) [1870 -]	Jerrys Plains Post Office (061086) [1884 -]	Denman (Palace Street) (061016) [1887 -]	Jerrys Plains Post Office (061086) [10 years data]
January	69.6	77.1	72.2	220.1
February	66.9	73.1	66.5	169.5
March	52.8	59.7	54.2	155
April	43.5	44	40.1	120
May	41.5	40.7	36.3	89.9
June	51.3	48.1	42.4	60
July	44.2	43.4	38.8	71.3
August	38.6	36.1	34.7	80.6
September	40.7	41.7	38.8	111
October	48.6	51.9	48	164.3
November	56.1	61.9	55.5	195
December	67	67.5	64.6	204.6
Total	620.8	644.7	592.9	1,641.30

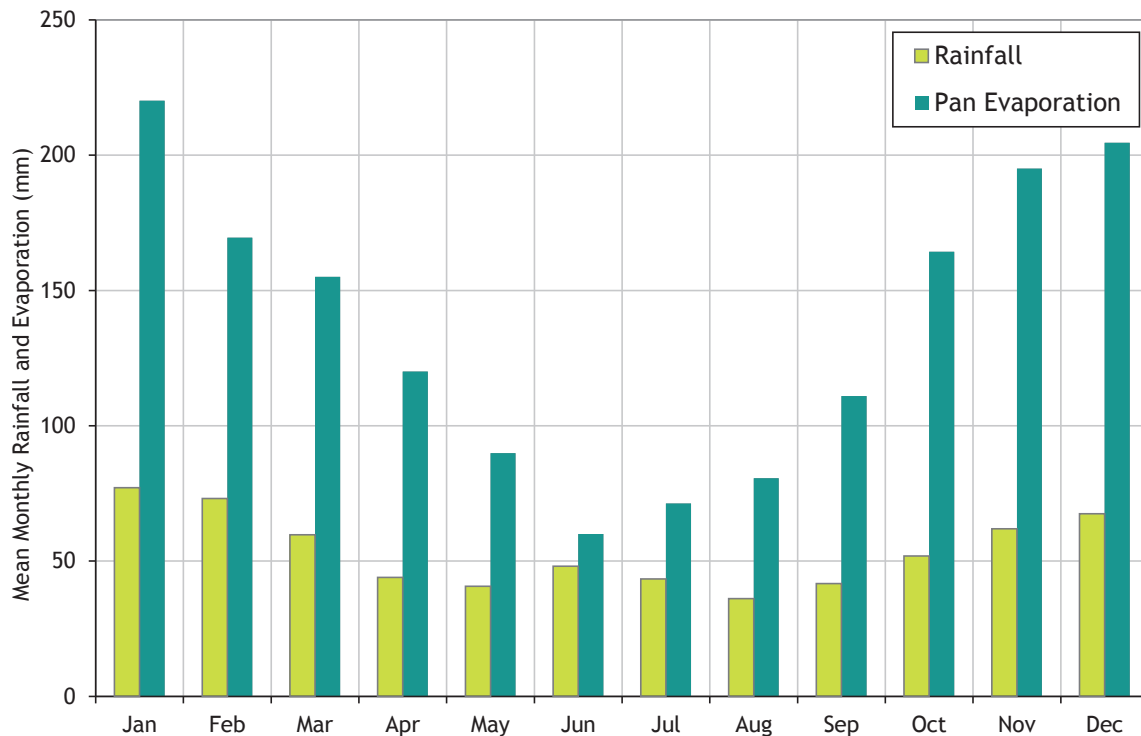


Figure 3.2 - Distribution of monthly rainfall and evaporation (Jerrys Plains Post Office)

3.5 WATER QUALITY AND QUANTITY

3.5.1 Environmental values of receiving waters

The Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) have prepared a guideline for water quality management for use throughout Australia and New Zealand based on the philosophy of ecologically sustainable development (ESD). The guideline is called the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ, 2000) and is often referred to as the 'ANZECC guideline'.

The NSW Department of Environment and Climate Change and Water has prepared a website entitled *NSW Water Quality and River Flow Objectives* that provides guidance to technical practitioners with applying the ANZECC guidelines in NSW.

The guideline defines the 'environmental values' of receiving waters as those values or uses of water that the community believes are important for a healthy ecosystem. The environmental values of the receiving waters of the Hunter River and Saddlers Creek for which water quality objectives are set are regarded as:

- aquatic ecosystem;
- visual amenity;
- secondary contact recreation;
- primary contact recreation (assess opportunities to achieve as a longer term objective, 10 years or more);
- livestock water supply;
- irrigation water supply;
- homestead water supply;
- drinking water; and
- aquatic foods (cooked).

The ANZECC guidelines specify three levels of protection, from stringent to flexible, corresponding to whether the condition of the particular ecosystem is:

- of high conservation value;
- slightly to moderately disturbed; or
- highly disturbed.

The receiving waterways adjacent to the study area are regarded as slightly to moderately disturbed. The water quality trigger values of four objectives (aquatic ecosystem, livestock water supply, irrigation and drinking water supply) that are identified as most relevant to this study are shown in Table 3.3.

3.5.2 Baseline water quality data

3.5.2.1 Regional water quality

Water quality data for Electrical Conductivity (EC) is available for the Hunter River at the Liddell gauging station (Station No. 210083) for the period February 1991 to October 2014. The Liddell Creek gauging station is located about 9 km downstream of the study area. Figure 3.7 shows the relationship between daily stream flow and EC at the Liddell station. The logarithmic trend line for flows above 1,000 ML/d is also shown. There is a strong relationship between flow rate and EC, with high flows (associated with floods) measuring lower EC values. There is a broad scatter of EC for low flows below 1,000 ML/d. Higher EC values would tend to occur when there are limited releases from Glenbawn Dam and the majority of flow is being generated from the downstream catchments.

Table 3.3 - Water quality trigger/guideline values

Parameter	Unit	Trigger Value				
		Irrigation	Livestock Drinking	Eco-system	Recreational	Drinking
pH	pH	-	-	6.5 - 8.5	5.0-9.0	6.5 - 8.5
EC (25°C)	µS/cm	1,000 *a	-	25-2200	-	<1,500
DO (% Saturation)	%	-	-	85-110	-	>80
Total Dissolved Solids (TDS)	mg/L	-	2,000*a	-	1,000	1,000
Turbidity	NTU	-	-	6-50	6	
Calcium (Ca)	mg/L	-	1000	-	-	
Sodium (Na)	mg/L	115*c		-	300	
Magnesium (Mg)	mg/L	-	2,000*b	-	-	
Sulphate as SO ₄	mg/L	-	1000	-	400	
Chloride as Cl	mg/L	175*c	-	-	400	
Arsenic	mg/L	0.1*f	0.5	0.013*ae	0.05	
Barium	mg/L		-	-	1	
Cadmium	mg/L	0.01*f	0.01	0.0002*e	0.005	
Chromium	mg/L	0.1*f	1	0.001*e	0.05	
Copper	mg/L	0.2*f	0.4*a	0.0014*e	1	
Iron	mg/L	0.2*f	-	-	0.3	
Lead	mg/L	2*f	0.1	0.0034*e	0.05	
Manganese	mg/L	0.2*f	-	1.9*e	0.1	
Nickel	mg/L	0.2*f	1	0.011*e	0.1	
Zinc (Zn)	mg/L	2*f	20	0.008*e	5	
Mercury	mg/L	0.002*f	0.002	0.0006*e	0.001	
Ammonia	mg/L	-	-	0.9	0.01	
Total Phosphorus	mg/L	0.05*f	-	0.025	-	
Total nitrogen	mg/L	5	-	0.35	-	
Nitrate-N	mg/L	-	400	0.7*e	10	
Nitrite-N	mg/L		30		1	

Notes: - No Trigger Value recommended.

*a Lowest recommended value.

*b Cattle (insufficient information on other livestock)

*c Sensitive crops

*d Upland River

*e 95% of species protected

*f Long term Trigger Value

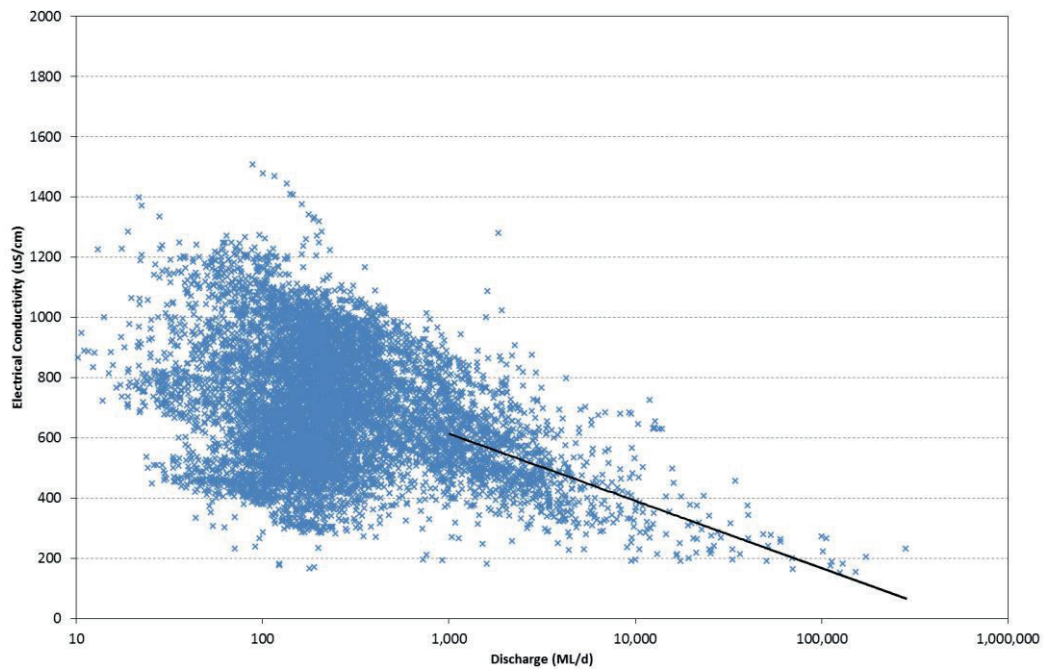


Figure 3.3 - Stream flow and electrical conductivity relationship for the Hunter River at Liddell

3.5.2.2 Drayton South catchments

Anglo American has monitored background water quality in Saddlers Creek and some minor catchments in the study area since 1998. The locations of the water sampling locations are shown in Figure 3.1. A summary of water quality for Saddlers Creek and for the Hunter River adjacent to the project site is given in Table 3.4. Note that sampling at the Hunter River sites only commenced in August 2012.

The 80th percentile value represents 80% of samples are below the given value, and similarly the 20th percentile value represents 20% of samples are below the given value. The sampling results show the following:

- Catchment runoff is slightly alkaline with median pH ranging from 8.0 to 8.4 in Saddlers Creek and 8.3-8.4 in the Hunter River;
- Saddlers Creek EC and total dissolved solids (TDS) concentrations are very high and substantially exceed ANZECC and ARMCANZ default trigger values. The salts are sodium dominated; and
- Recorded total suspended solids (TSS) concentrations for Saddlers Creek and the Hunter River are low.

Table 3.4 - Drayton South water quality

Parameter		Saddlers Creek		Hunter River	
		W3	W4	H2	H3
pH	20%ile	7.9	8.1	8.1	8.2
	Median	8.0	8.2	8.3	8.4
	80%ile	8.2	8.4	8.4	8.5
	N	178	59	21	21
Electrical Conductivity (μ S/cm)	20%ile	6144	3968	664	652
	Median	7295	6880	829	823
	80%ile	8470	8614	1024	981
	N	178	59	21	21
Total Dissolved Solids (mg/L)	20%ile	3960	2640	440	440
	Median	4764	4530	560	550
	80%ile	5515	5584	690	660
	N	176	57	21	21
Total Suspended Solids (mg/L)	20%ile	5	4	10	9
	Median	14	6	18	18
	80%ile	38	10	29	27
	N	178	59	21	21
Calcium (mg/L)	20%ile	76	43	37	37
	Median	100	58	48	47
	80%ile	110	73	54	54
	N	59	19	8	8
Chloride (mg/L)	20%ile	1374	743	86	82
	Median	1880	1730	114	108
	80%ile	2318	2298	168	168
	N	59	19	8	8
Iron (filterable) (mg/L)	20%ile	0.05	0.05	0.05	0.05
	Median	0.05	0.05	0.05	0.05
	80%ile	0.12	0.14	0.05	0.05
	N	59	19	8	8
Iron (total) (mg/L)	20%ile	0.13	0.11	0.24	0.37
	Median	0.41	0.33	0.61	0.55
	80%ile	0.94	0.76	2.05	2.38
	N	58	19	8	8
Sulphur as SO ₄ (mg/L)	20%ile	348	150	28	29
	Median	520	237	34	34

Parameter	Saddlers Creek		Hunter River		
	W3	W4	H2	H3	
Magnesium (mg/L)	80%ile	614	333	40	40
	N	59	19	8	8
	20%ile	236	93	27	27
	Median	319	195	38	36
	80%ile	354	252	43	44
	N	59	19	8	8

3.5.2.3 Downstream of Drayton Mine

A summary of the water quality tested in the catchments downstream of Drayton Mine is given in Table 3.5. Drayton Mine does not discharge water to any of these catchments. Rather the catchments are mostly undisturbed with small areas of previously rehabilitated mining areas. The following is of note:

- runoff is generally saline with EC ranging from 1,742 to 4,774 $\mu\text{S}/\text{cm}$. The EC of Bayswater Creek and Ramrod Creek is measured in dams, which would elevate recorded levels compared to streamflow;
- pH is slightly alkaline ranging from 7.5 to 9.2; and
- TSS is generally low.

Table 3.5 - Downstream Drayton Mine water quality

Parameter	Bayswater Dam (1895)	Ramrod Creek (2221)	
pH	10%ile	9.20	8.48
	Median	8.80	7.9
	90%ile	8.21	7.52
EC ($\mu\text{S}/\text{cm}$)	10%ile	4774	3296
	Median	3310	2220
	90%ile	2045	1742
TSS (mg/l)	10%ile	20	60.4
	Median	6	19
	90%ile	1	4

3.5.2.4 Drayton Mine

Anglo American monitors water quality in all water storages at Drayton Mine. A summary of the water quality tested in the various water storages at Drayton Mine is given in Table 3.6. The summary is based on monthly samples collected between January 2008 and July 2011. The results indicate that runoff draining Drayton Mine catchments has similar water quality characteristics to the natural catchments with runoff that is saline and slightly alkaline.

Table 3.6 - Drayton Mine water quality

Parameter		Savoy Dam	Industrial Dam	Access Road Dam	Rail Loop Dam	West Void
pH	10%ile	8.28	8.60	8.60	8.30	8.00
	Median	8.00	8.20	8.20	8.10	7.85
	90%ile	7.70	7.90	7.64	7.70	7.60
EC ($\mu\text{S}/\text{cm}$)	10%ile	6440	5710	5404	5864	8335
	Median	5240	4720	4780	4990	7805
	90%ile	4580	4010	4354	2990	6865
TSS (mg/l)	10%ile	14.8	47.6	85.4	57.8	15.0
	Median	6.0	16.0	12.0	12.0	7.0
	90%ile	2.2	6.0	4.0	4.4	3.5

3.5.3 Baseline water quantity data

3.5.3.1 Hunter River

Figure 3.4 shows the flow-duration relationship for the recorded Hunter River flows, closest to Drayton South, at the Liddell gauge (GS 210083). The Liddell gauge is located approximately 9.0 km downstream of Drayton South and has an upstream catchment area of 13,400 km². Data has been collected at Liddell since 1969. The flow-duration relationship indicates that flow is non-zero all of the time, which is characteristic of regulated river systems. The median flow is about 270 megalitres per day (ML/d) and flows exceed 1,000 ML/d some 8% of the time. The volumetric runoff coefficient (rainfall to runoff relationship) of the Hunter River flows to Liddell is approximately 4%.

3.5.3.2 Saddlers Creek

Figure 3.5 shows the flow-duration relationship for the recorded flows in Saddlers Creek at the Bowfield Gauge (GS210043). Bowfield Gauge is located at the same site as W4, shown in Figure 3.1. Stream water level was recorded at this station between 1956 and 1981. However, very few stream gaugings greater than 10 ML/d were taken to derive an accurate relationship between water level and stream flow. As such, there is likely to be a high level of uncertainty associated with the data in Figure 3.5. Notwithstanding, the figure shows that the creek is ephemeral with flow recorded some 63% of the time and is dry 37% of the time.

Extended periods of baseflow are evident indicating that the system is fed by groundwater flows. The median flow is 0.09 ML/d and the highest recorded daily flow over the period of record was 1,137 ML/d.

NSW Office of Water

HYFLOW V169 Output 04/11/2013

Time Weighted Discharge Rate Duration Curve.
 Discharge Rate in Megalitres/Day, Mean Values. Interval 1 Days

Site 210083.CP HUNTER R @ LIDDELL 01/01/1969..01/01/2014

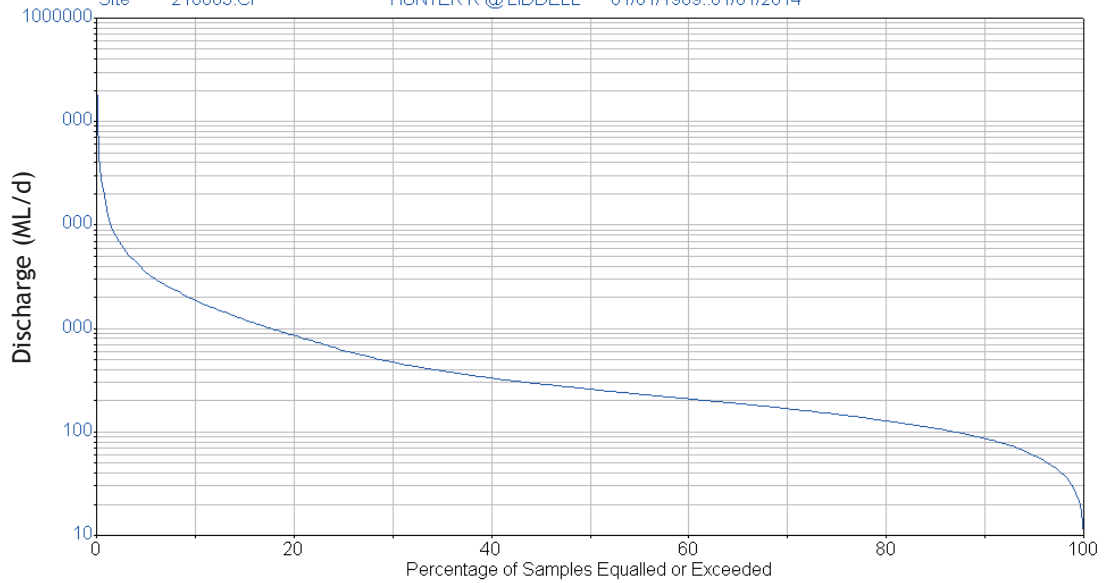


Figure 3.4 - Recorded flow-duration relationship for the Hunter River at Liddell (1969-2013)

NSW Office of Water

HYFLOW V146 Output 15/12/2009

Time Weighted Stream Discharge Duration Curve.
 Stream Discharge in Megalitres/Day, Mean Values. Interval 1 Days

Site 210043 SADDLERS CK BOWFIELD 01/01/1956..01/11/1981

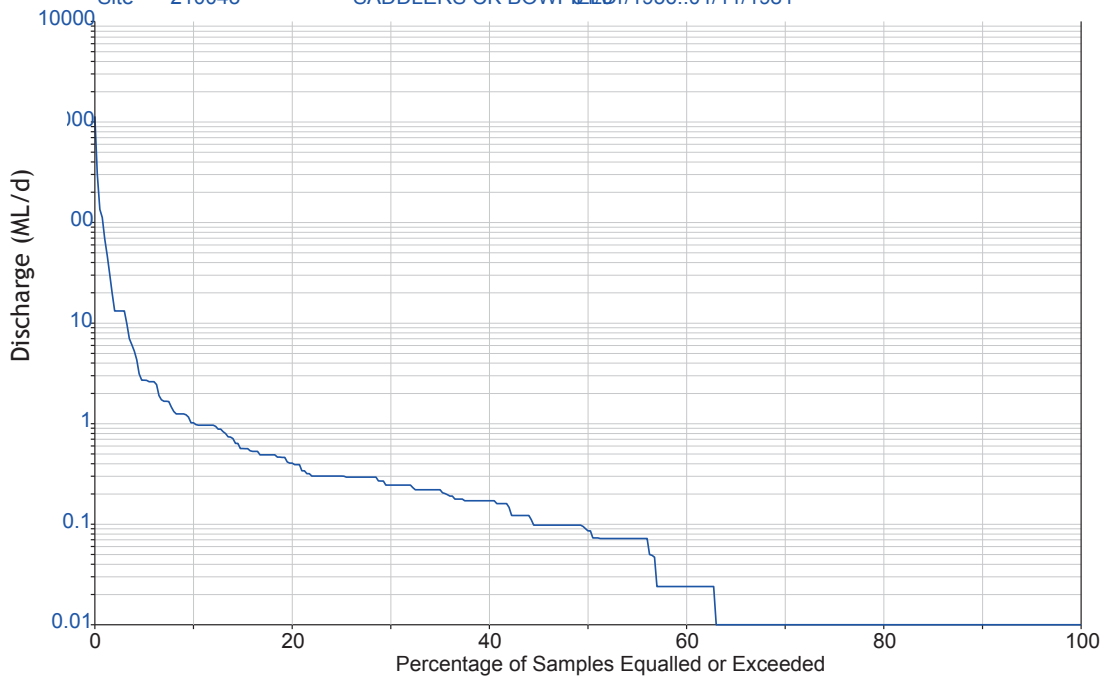


Figure 3.5 - Derived flow-duration relationship for Saddlers Creek at Bowfield (1956-1981)

3.6 SADDLERS CREEK FLOODING

The proposed Project disturbance boundary has been located outside the predicted probable maximum flood (PMF) extent of Saddlers Creek. Flood modelling of Saddlers Creek has been undertaken to define the location of the proposed disturbance area. Design flood discharges, flood levels and flood extents were estimated for Saddlers Creek across the Drayton South project area for pre-mine conditions to ensure a conservative assessment was undertaken. These conditions assume that both Drayton Mine and Mt Arthur Coal Mine were not built and the entire catchment drains to Saddlers Creek. This assessment would over-estimate the extent of flooding under existing conditions as existing mining has reduced the contributing catchment area.

3.6.1 Estimation of discharges

The XP-RAFTS rainfall runoff routing model was used to estimate 1%, 0.2% annual exceedance probability (AEP) events and PMF design discharges along Saddlers Creek across the project area for pre-mine conditions. XP-RAFTS model is proprietary software that is widely used throughout Australia for flood studies.

Discharges were estimated at the upstream location where Saddlers Creek crosses the Project Boundary (Location A shown in Figure 3.6) and at a further two points along Saddlers Creek (Locations B and C shown in Figure 3.6) using design rainfalls obtained from Australian Rainfall and Runoff (Pilgrim, 1987). PMF rainfalls were obtained from the Commonwealth Bureau of Meteorology (BOM, 2006). The XP-RAFTS model consisted of three sub areas representing the catchments draining to location A, B and C. XP-RAFTS model parameters adopted for all design events are as follows:

- catchment Manning's 'n' = 0.07;
- catchment slope = 1%;
- percentage impervious = 0%;
- initial rainfall loss = 15mm;
- continuing rainfall loss = 3mm/hr;
- channel velocity = 0.75m/s; and
- channel routing storage coefficient = 0.25.

The XP RAFTS model results were validated against Rational Method estimates for the 1% AEP event at the three locations. Rational Method parameters were estimated using the recommended methodology in Australian Rainfall and Runoff (Pilgrim, 1998) for eastern NSW. Details of the Rational Method calculations and the corresponding XP-RAFTS model estimates are provided in Table 3.7. The XP-RAFTS model discharges compare well to the Rational method estimates and have been adopted for the assessment.

3.6.2 Estimation of flood levels

The Hydrologic Engineering Centre River Analysis System (HEC-RAS) hydraulic model was used to estimate design flood levels along Saddlers Creek at Drayton South under pre-mining conditions. The model consists of 112 cross-sections, extracted from a digital elevation model of the area. The locations of the model cross-sections are shown in Figure 3.6. Figure 3.7 shows a representative cross-section of Saddlers Creek (XS 70). The supplied LIDAR data was taken by Atlas (Aust) Pty Ltd on behalf of Whelan Insites and has a vertical accuracy of ± 150 mm.

A Manning's 'n' value (representing the hydraulic roughness of the waterway) of 0.08 was adopted for the main channel and 0.1 for the floodplain of Saddlers Creek. This is a conservatively high estimate of roughness, given the existing channel vegetation, to provide conservatively high flood levels and flood extent.

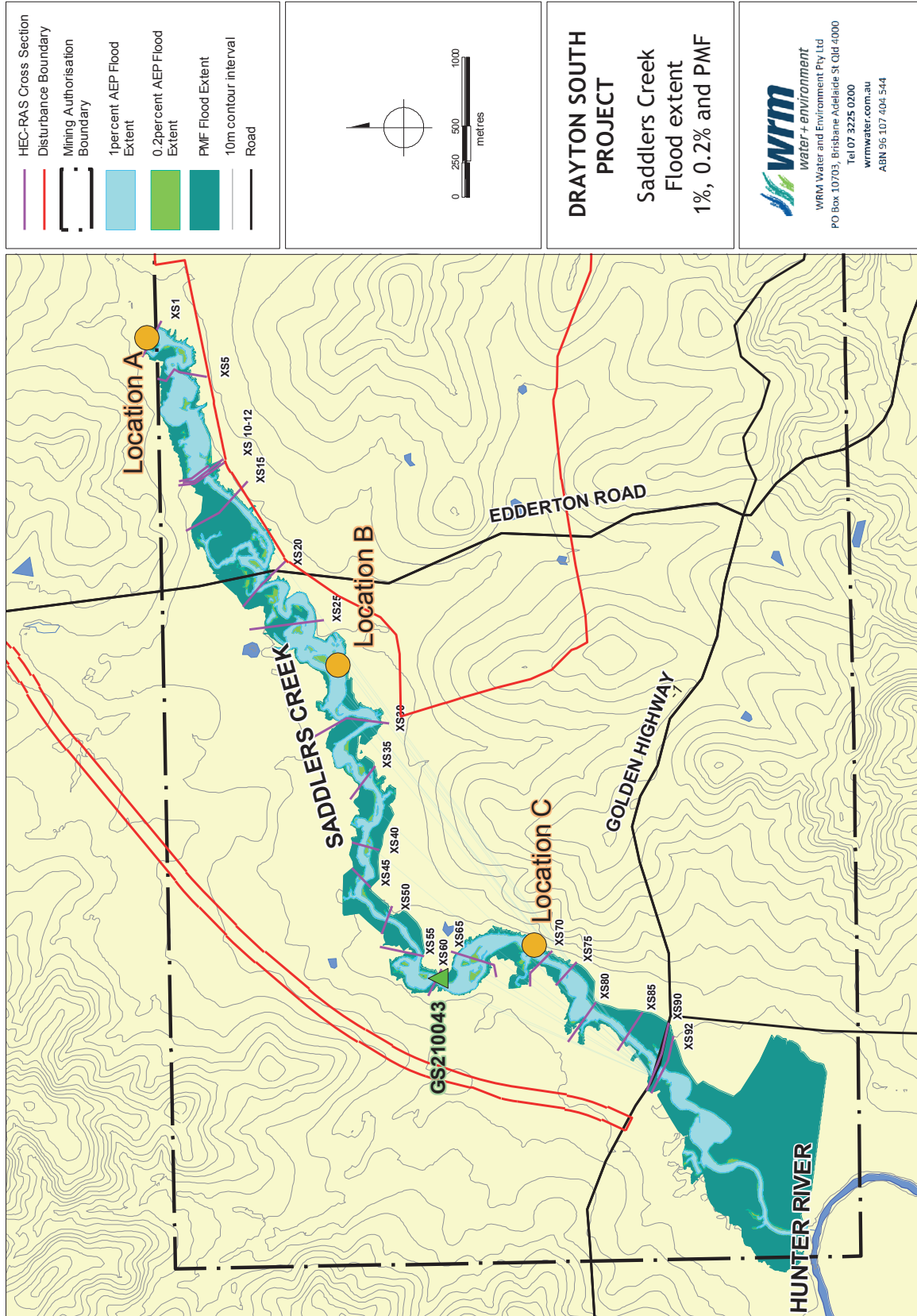


Figure 3.6 - Saddlers Creek flood extents, 1%, 0.2% and Probable Maximum Flood

Table 3.7 - Saddlers Creek design discharges, XP-RAFTS model and Rational Method

Parameter	Location A	Location B	Location C
Catchment Area (km ²)	33.2	50.4	76.9
Rational Method			
- Time of Concentration (hrs)	2.88	3.37	3.96
- Runoff Coefficient C ₁₀	0.2	0.2	0.2
- F _y	1.47	1.47	1.47
- C ₁₀₀	0.29	0.29	0.29
- I ₁₀₀ (mm/hr)	25.7	23.6	21.8
- Q ₁₀₀ (m ³ /s)	70	97	137
XP-RAFTS Model			
- Q ₁₀₀ (m ³ /s)	66	100	147
- Q ₅₀₀ (m ³ /s)	102	155	226
- PMF (m ³ /s)	460	680	990

The downstream boundary condition for the HEC-RAS model was based on a normal depth calculation, using the average longitudinal bed slope of Saddlers Creek in the area of interest of approximately 0.4%. This represents the scenario where there is no coincident flooding in the Hunter River at the time of a Saddlers Creek flood event. The top of bank of the Hunter River at the Saddlers Creek confluence is some 25m below the minimum elevation of where mining will commence and therefore will not impact on the project.

Estimated design flood levels along Saddlers Creek are shown in Table 3.8. Figure 3.6 shows the estimated extent of flooding for the three design events.

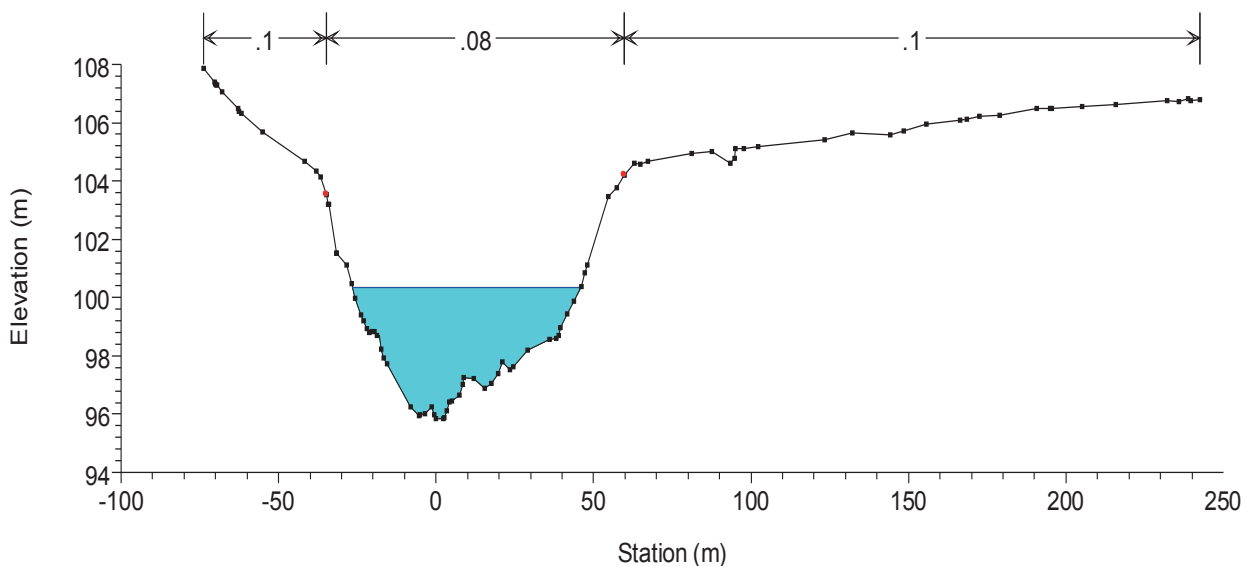


Figure 3.7 - Saddlers Creek HEC-RAS Model (XS70) 100 Year ARI Flood Level

Table 3.8 - Saddlers Creek peak flood levels, 1%, 0.2% AEP and probable maximum flood

Cross-Section	Peak Flood Level (m AHD)		
	1% AEP	0.2% AEP	PMF
XS1	133.44	133.91	136.00
XS5	131.83	132.25	134.13
XS10	128.91	129.14	130.12
XS11	128.62	128.75	129.57
XS12	125.97	126.58	128.69
XS15	124.6	125.23	126.92
XS20	120.24	120.92	122.60
Edderton Road			
XS25	117.23	117.47	118.96
XS30	112.27	112.78	115.35
XS35	110.64	111.39	113.98
XS40	108.69	109.21	112.13
XS45	107.29	108.11	111.45
XS50	106.27	106.99	110.05
XS55	104.95	105.18	107.50
XS60	103.40	103.88	106.55
XS65	101.22	101.77	105.52
Bowfield Gauge			
XS70	100.11	100.86	104.60
XS75	99.28	99.99	103.54
XS80	98.78	99.61	103.11
XS85	97.92	98.65	101.7
XS90	96.85	97.40	100.38
Golden Highway			
XS92	96.67	97.22	99.75

3.7 EXISTING WATER MANAGEMENT SYSTEM

3.7.1 Overview

The existing Drayton Mine water management system is operated in accordance with the Drayton Water Management Plan (WMP) (Anglo American, 2009) and the Anglo Environment Water Management System Standard.

Figure 3.8 shows a schematic of Drayton Mine's water management system and the various connection and flow paths between the water storages. Figure 3.9 shows the locations of the major water storages and the three active mining areas at Drayton Mine; East Pit, North Pit and South Pit.

Drayton Mine's water management system is based on a closed system, as it does not possess a discharge licence. However there is an existing water sharing agreement between Anglo American and Mt Arthur Coal (MAC) to transfer up to 600 ML of excess mine water to the neighbouring Mt Arthur Coal Mine. This water is transferred via pipeline from Drayton Mine to Mt Arthur Coal Mine. Recorded volumes of transfers are contained in Drayton Mine's Annual Review.

All mine water is stored onsite in established dams and voids and is utilised by the mining operation primarily for coal processing and dust suppression purposes.

3.7.2 Water storages

Table 3.9 shows details of the main water management storages at Drayton Mine. These dams are connected by a pipe network, which enables a transfer of water according to mine operational requirements. The West Void, currently subleased to Mt Arthur Coal Mine, is used as a repository for excess water on the mine for later reuse. The agreement between Drayton Mine and MAC allows Drayton Mine to store water within the West Void until January 2017, upon which time any stored water has to be pumped back to the Drayton Mine. The agreement also allows 600 ML per annum to be transferred to Mt Arthur Coal Mine when required.

The Access Road dam is a prescribed dam listed under Schedule 1 of the Dams Safety Act, which requires the proponent (Anglo American) monitor and manage the dam to ensure it is safe to the downstream community.

3.7.3 Tailings disposal system

Anglo American has approval to place raw tailings within the East Void. The East Void will be separated into the East (South) Void, which will store tailings, and the East (North) Void, in which mining will continue under the current approval for Drayton Mine.

Approximately 3 million cubic meters (Mm^3) of dewatered tailings is proposed to be placed in the East (South) Void to 2017. Tailings emplacement and capping will be up to 106 mAHD. Subsequently, 1,500 ML of water will be stored to increase the in-pit level to 114 mAHD behind an in situ pillar to enable mining to the north.

Following the completion of tailings emplacement by Anglo American, AGL Macquarie has the opportunity to then complete filling the East Void to the currently approved design level with fly ash material. Alternatively, the water will be pumped away to South Void so the tailings in East void can be capped and rehabilitated in accordance with standards developed by the Department of Trade and Investment, Regional Infrastructure and Services - Division of Resources and Energy (DTIRIS - DRE).

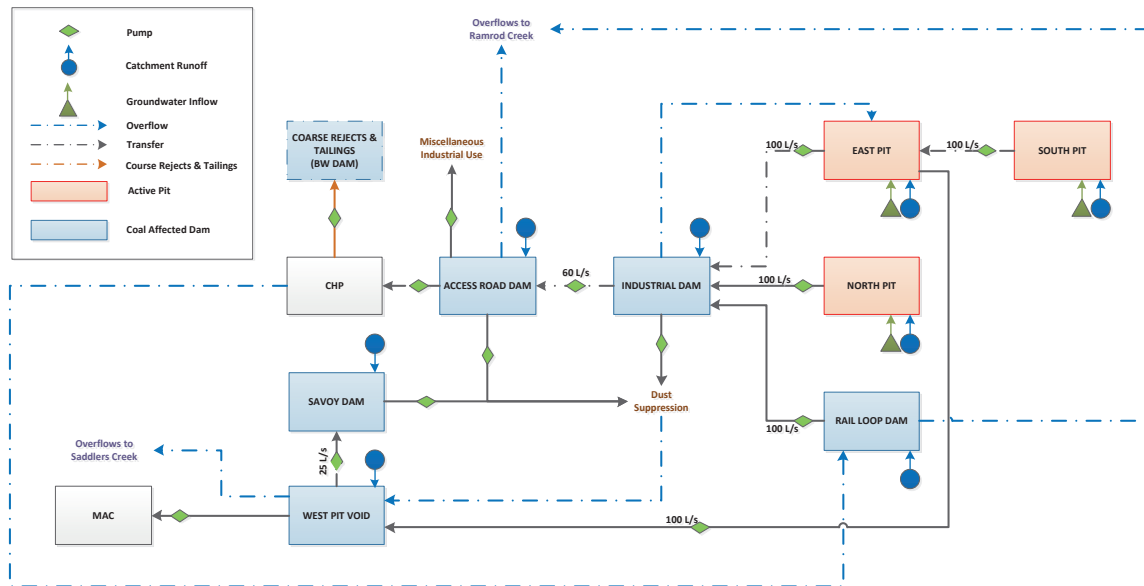


Figure 3.8 - Drayton Mine water management system schematic

Table 3.9 - Capacities of Drayton Mine water storages

MINE WATER STORAGE	Storage Capacity (ML)	Supply Source	Water Use
Access Road Dam (2081)	750	<ul style="list-style-type: none"> Pumped transfers from Industrial Dam Mine site and rehabilitated catchment runoff 	<ul style="list-style-type: none"> CHPP Use Industrial Use Stockpile and haul road dust suppression
Industrial Dam (1969)	750	<ul style="list-style-type: none"> Pumped transfers from active mining areas and Rail Loop Dam Mine site and rehabilitated catchment runoff 	<ul style="list-style-type: none"> Pumped transfers to Access Road Dam Haul Road dust suppression Industrial washdown
Rail Loop Dam (2114)	18	<ul style="list-style-type: none"> Industrial and mine site catchment runoff 	<ul style="list-style-type: none"> Pumped transfers to Industrial Dam Stockpile and haul road dust suppression
Savoy Dam (1609)	140	<ul style="list-style-type: none"> Mine site, and rehabilitated catchment runoff 	<ul style="list-style-type: none"> Pumped transfers to Industrial Dam Haul road dust suppression
West Void (SW13)	4043	<ul style="list-style-type: none"> Rehabilitated and spoil catchment runoff Pumped transfers of excess water from active mining areas 	<ul style="list-style-type: none"> Pumped transfers to Industrial Dam Pumped to Mt Arthur Coal Mine



Figure 3.9 - Drayton Mine water management dams

4 Surface water management system

4.1 OVERVIEW

4.1.1 Drayton South

The conceptual mine plan layout and water management infrastructure for year 4, year 6, and year 12 of the Project is given in Figure 4.1 to Figure 4.3 and the final landform is provided in Figure 4.4.

Mining operations are proposed to commence in the Whynot and Blakefield mining areas generally progressing in a north to south sequence.

Open cut mining and progressive rehabilitation continues throughout the life of the Project. The majority of the Blakefield and Whynot mining areas will be rehabilitated by Year 15. Following Year 15 of the Project (the final year of mining), the remainder of the site will be progressively rehabilitated to achieve the conceptual final landform (Figure 4.4).

During the construction phase of the Project, the transport corridor, mine site facilities, required water management and power reticulation infrastructure will be established. The realignment of Edderton Road will be undertaken prior to Year 4.

4.1.2 Drayton Mine

Figure 4.5 shows the proposed mine layout of the proposed Drayton Mine final landform. The existing Drayton Mine CHPP facilities will continue to be used after the completion of mining at Drayton Mine to process the coal and store the tailings for the Project. The proposed system to manage the tailings is described in Section 4.3.2.

MAC holds a sublease area over part of CCL 229. The land within the sublease is subject to an agreement between Anglo American and MAC that provides for the ongoing management activities to this area including overburden emplacement, water management, spontaneous combustion management and the development of rehabilitation and the final landform.

Under the existing Sublease Agreement and associated schedules, MAC is obliged to manage the area to achieve agreed outcomes to achieve the desired final landform and manage the rehabilitation of any land that is disturbed by their activities in the sublease area. This is also stipulated in the conditions of the Mt Arthur Coal Mine Project Approval.

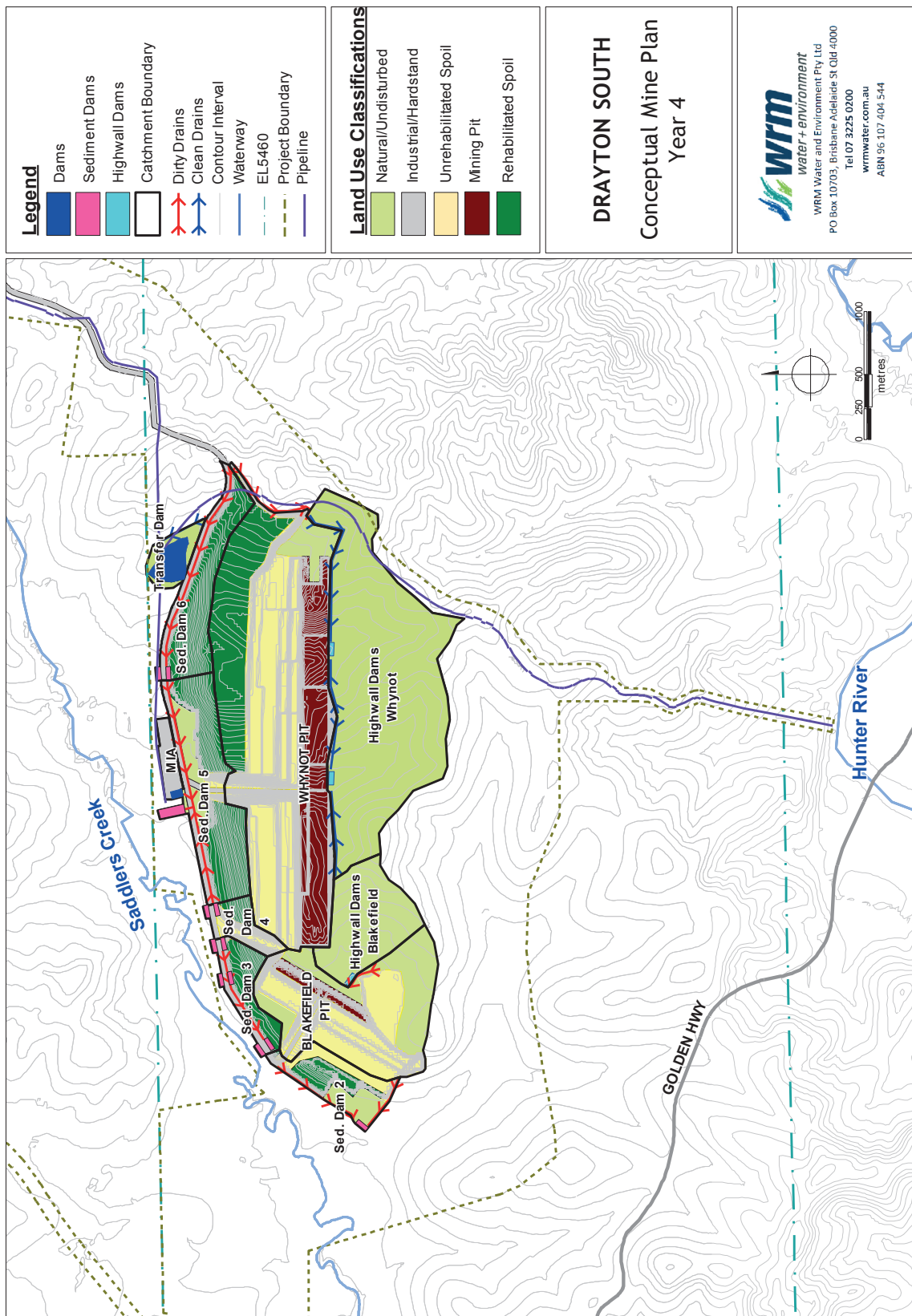


Figure 4.1 - Drayton South conceptual mine plan and water management system, Year 4

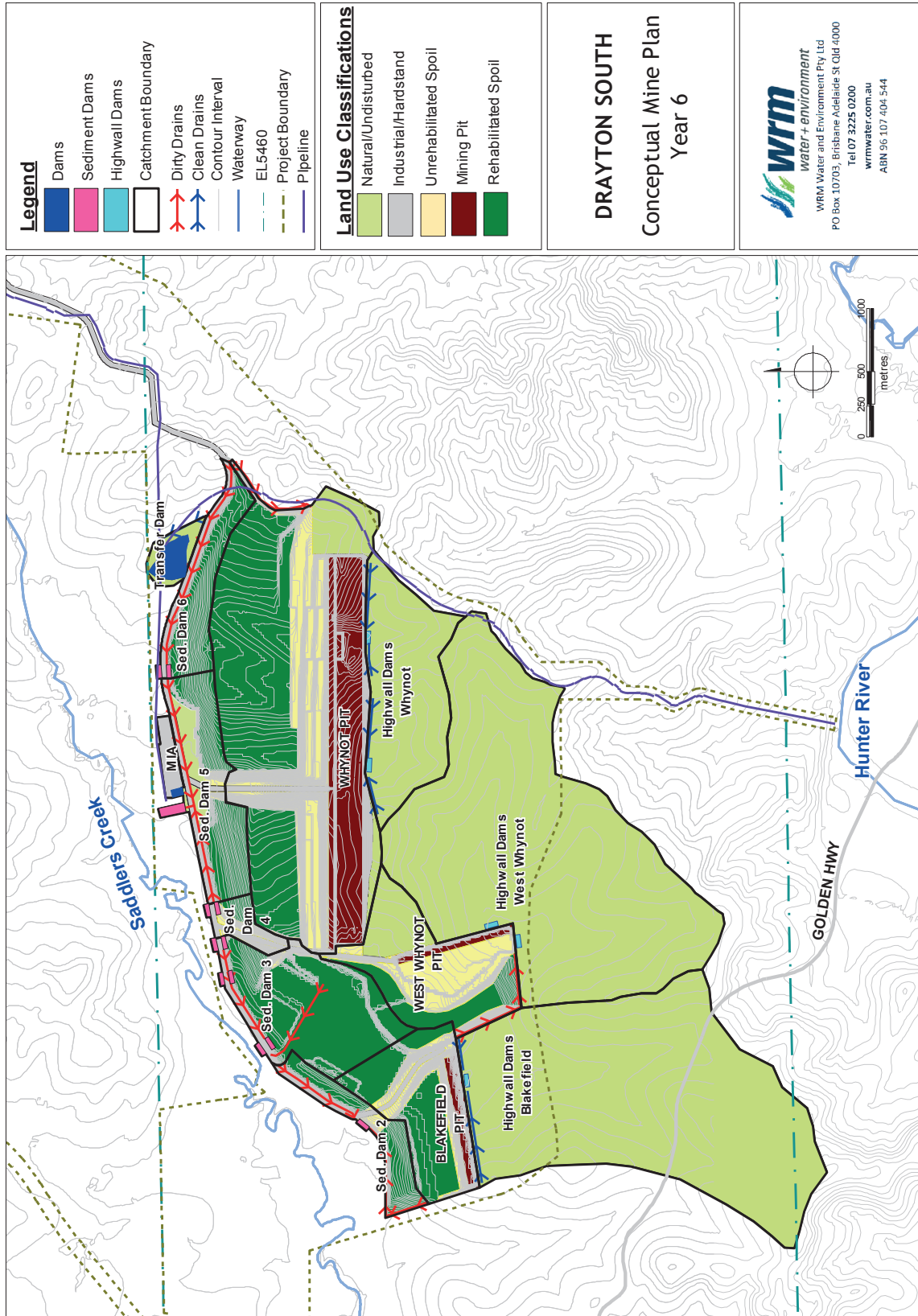


Figure 4.2 - Drayton South conceptual mine plan and water management system, Year 6

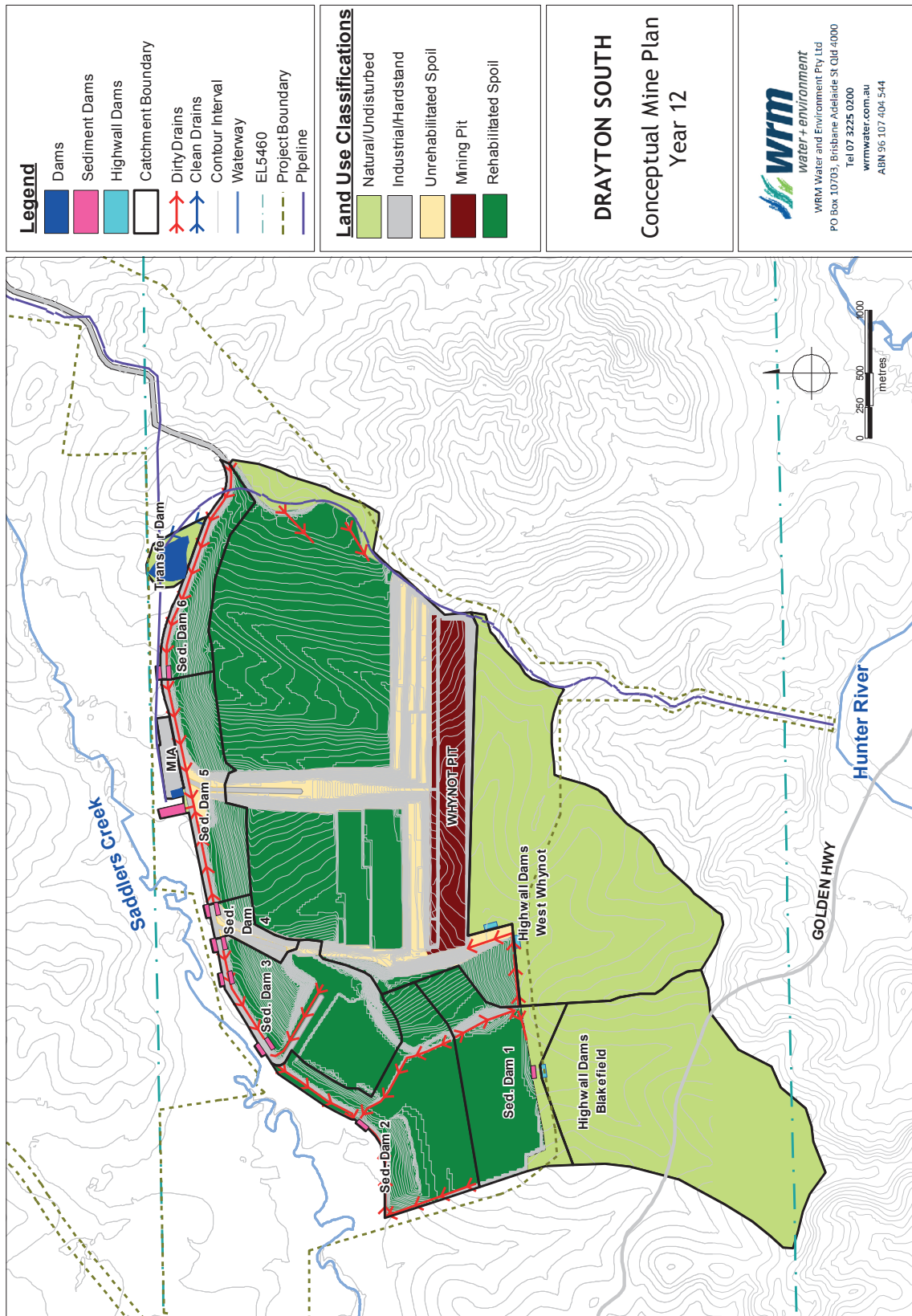


Figure 4.3 - Drayton South conceptual mine plan and water management system, Year 12

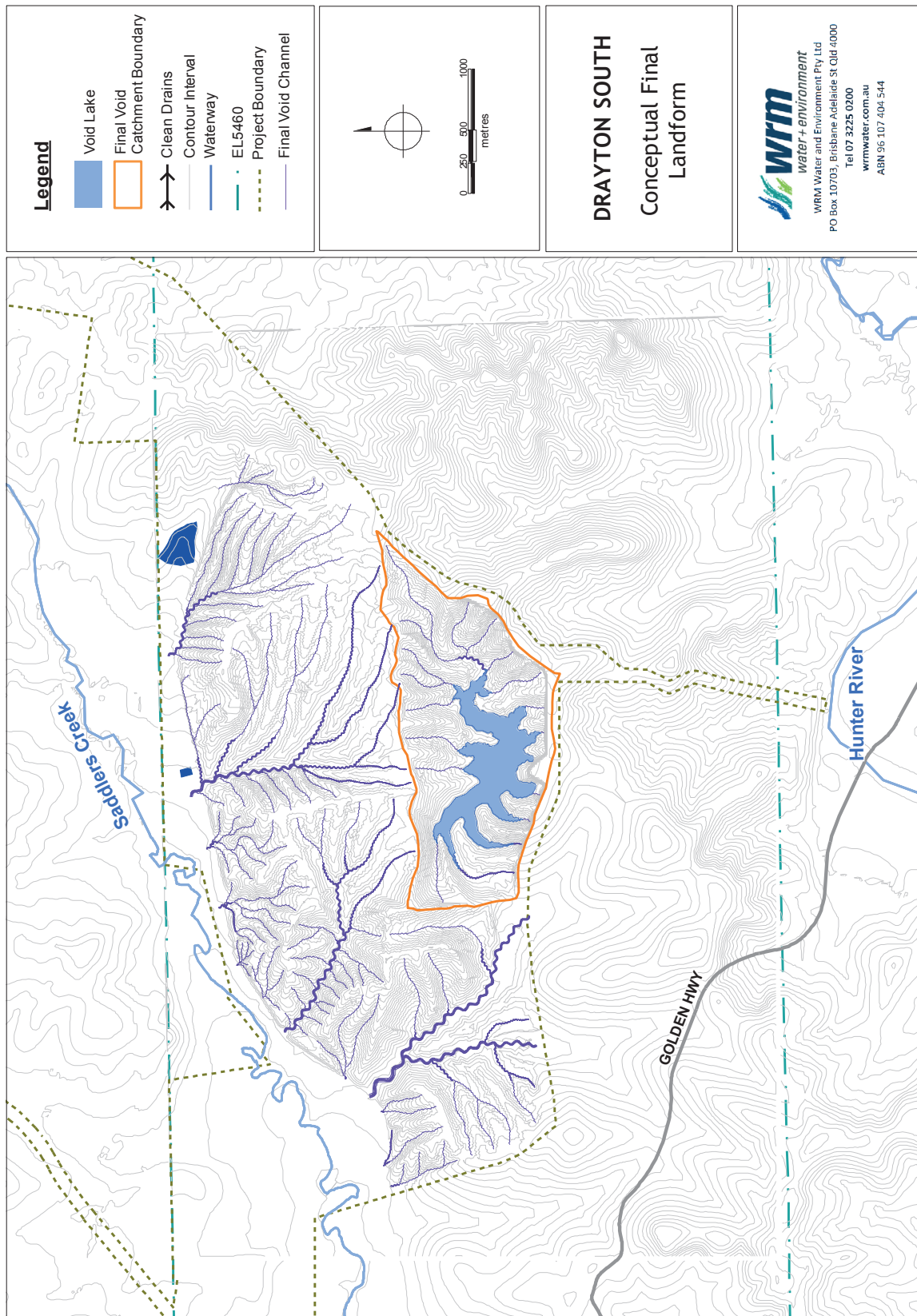


Figure 4.4 - Drayton South conceptual final landform

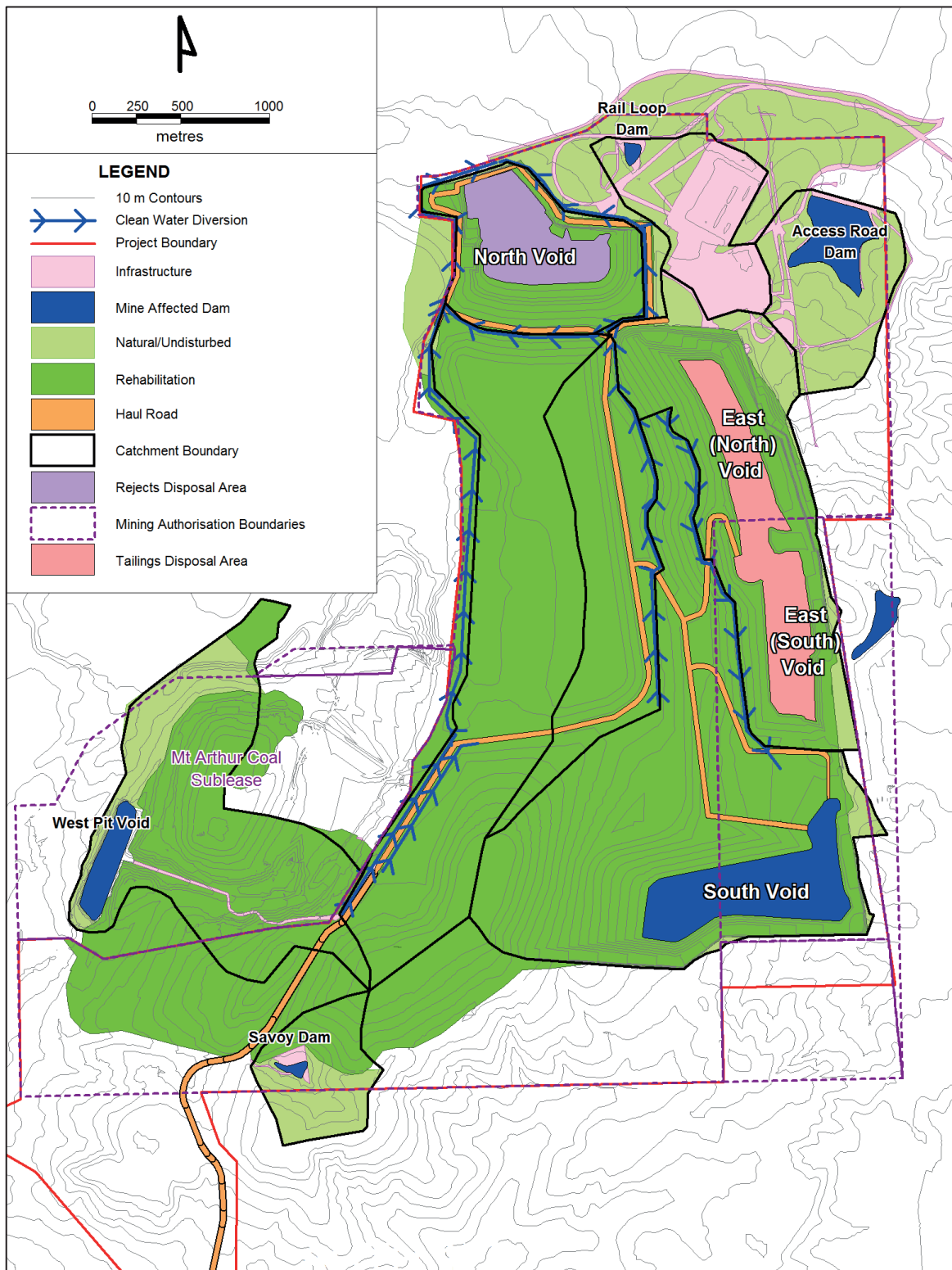


Figure 4.5 - Drayton Mine conceptual final landform

4.2 SURFACE WATER MANAGEMENT STRATEGY

Land disturbance associated with mining has the potential to adversely affect the quality of surface runoff in downstream receiving waters through increased sediment loads. In addition, runoff from active mining areas (including coal stockpiles, etc.) may have increased concentrations of salts and other pollutants compared to natural runoff. The surface water management principles are based on the categorisation of water generated within the study area based on water quality, and include:

- a mine water management system to collect and use water that may contain high total dissolved solid (salt) concentrations, generally through coming into contact with coal such as in the open cut mining area or from the coal stockpile. Mine water will primarily be used to satisfy on site demand for dust suppression and coal washing;
- a tailings water management system to manage the inflows to and outflows from the Coal Handling and Preparation Plant (CHPP) and tailings storage facility;
- a dirty water management system to ensure potentially sediment-laden runoff from disturbed areas is separated from clean area runoff and collected in sediment dams for treatment;
- a clean water management system to divert water undisturbed by mining, or from fully rehabilitated areas, around the Drayton South disturbance footprint; and
- a hydrocarbon water management system for water that has come in contact with oils, greases and chemicals of various types at the approved and proposed mine site facilities.

4.3 SURFACE WATER MANAGEMENT

4.3.1 Mine water management system

A summary of the proposed mine water management system for the Project is given below:

- water collected in the active mining areas within Drayton South will be pumped to the Transfer Dam;
- water stored in the Transfer Dam will be used for dust suppression;
- mine affected water in excess of the Transfer Dam capacity will be pumped back to the South Void for storage;
- raw water pumped in from the Hunter River will be deposited in the Transfer Dam, if required;
- the South Void will be the main repository for excess water for the Project;
- South Void water will be transferred to the Access Road Dam, which will be the main repository to supply water to the CHPP. Water may also be transferred back to the Transfer Dam from the South Void if required to supply the Drayton South operational demands; and
- the Rail Loop Dam, collecting mine affected runoff from the Drayton mine site facilities and coal stockpiles, will be pumped to the Access Road Dam.

A numerical water balance model was used to design the operating rules and assess the effectiveness of the mine water management system. The model identifies water supply and discharge requirements based on the Project's expected catchment runoff and water demands. The water balance model is discussed in detail in Section 5.

4.3.2 Tailings water management system

At the completion of coal mining operations within the presently operated Drayton Mine area, three voids will remain including the North, East and South Voids (see Figure 4.5). It

is proposed that rejects and tailings generated at the CHPP from the Drayton South operation will be deposited in two of these voids and the third will be used for water storage.

Rejects will be trucked from the CHPP whilst tailings will be pumped via a pipeline and deposited within an allocated void. Decant water recovered from the tailings (30% of tailings moisture) will be recycled within the site water management system and returned for consumption in the CHPP. The remaining 70% of tailings moisture and the moisture within the coarse rejects would evaporate or become entrained. Contingent upon a commercial agreement with AGL Macquarie, there are three possible scenarios for rejects and tailings disposal for which approval is being sought. These scenarios are outlined below. For this report, Scenario 2 has been assessed as the base case. For each scenario, Drayton Mine will dispose of tailings in the East (South) Void as currently approved to a level of 104 m AHD, which is forecast to occur in 2017. This area will then be capped and rehabilitated by Drayton Mine to a level of 106 m AHD as per the Deed of Agreement with AGL Macquarie.

Under all scenarios the water collected in the tailings disposal area will be given priority to supply the CHPP.

4.3.2.1 Scenario 1

Under Scenario 1, the East (South) Void will be utilised for tailings disposal as approved for the existing operations of Drayton Mine and capped and rehabilitated to a level of 106 m AHD. The East (South) Void, which is situated on land owned by Macquarie Generation, will then be used at their discretion, potentially for the deposition of power station ash from nearby power stations, to a height of 120 m AHD. AGL Macquarie will be responsible for the rehabilitation of East (South void) under Scenario 1.

Under Scenario 1, the North Void will be utilised for co-disposal of rejects and tailings and capped and rehabilitated at 204 m AHD.

The South Void will be utilised as a water storage area for the life of the Project. This void is situated on land owned by AGL Macquarie. Currently Drayton Mine has a legal agreement with AGL Macquarie to utilise the South Void until 1 January 2023. As such, Anglo American will consult further with AGL Macquarie regarding the utilisation of the South Void, and enter into a commercial arrangement which satisfies the needs of both parties prior to 2023.

4.3.2.2 Scenario 2

This scenario assumes that AGL Macquarie is granted planning approval to raise their current ash dam wall to increase its storage capacity or make other arrangements and confirm that they will no longer require the East (South) Void for ash disposal.

In Scenario 2, the East (South) Void will be utilised for tailings disposal as approved for the existing operations of Drayton Mine and capped to a level of 106 m AHD in 2017. Following this, the East Void will continue to be used by Anglo American for the emplacement of tailings generated by the Project, up to a level of 135 m AHD. Given that East (South) Void is located on land owned by AGL Macquarie, Anglo American will enter into a new commercial arrangement for the Project to occupy this void until closure of operations. Anglo American will be responsible for the rehabilitation of East (South void) under Scenario 2.

The North Void will be allocated as an emplacement area for rejects generated from the processing of Drayton South coal. The North Void will be graded to be free draining, capped and rehabilitated at 184 m AHD.

The South Void will be utilised as a water storage area for the life of the Project. This void is situated on land owned by AGL Macquarie. Currently Drayton Mine has a legal agreement with AGL Macquarie to utilise the South Void until 1 January 2023. As such Anglo American will consult further with AGL Macquarie regarding the utilisation of the South Void, and enter into a commercial arrangement which satisfies the needs of both parties prior to 2023.

4.3.2.3 Scenario 3

This scenario assumes that AGL Macquarie decide to utilise both the East (South) and South Voids which are located on their land. As such, water will be stored in the South Void until 1 January 2023 when the current commercial agreement with AGL Macquarie expires. Occupation and utilisation of the East (South) and South Voids would then be transferred back to AGL Macquarie. The voids, which are situated on land owned by AGL Macquarie, will then be used at their discretion, potentially for the deposition of power station ash or storage of water.

From 2023, water for the Drayton Complex (Drayton Mine and Drayton South) will be stored in East (North) Void to 100 m AHD and within the Drayton South area.

The North Void will be allocated as a co-disposal emplacement area for rejects and tailings generated from the Drayton South mining areas. The North Void will be separated into two cells for emplacement of each coal waste material and then filled, graded to be free draining, capped and rehabilitated at 204 m AHD. Some rejects will also be trucked to the southern side of the North Void and blended with the final landform to assist with infill of existing ramps and roads in this area.

4.3.3 Dirty water management system

Surface runoff water from areas that are disturbed by mining operations (including out-of-pit overburden and haul roads) is managed by the dirty water management system as it may contain high sediment loads. Mining and overburden emplacement operations will be managed to ensure that runoff from these areas is not significantly affected by coal contact and hence will not contain contaminated material or high salt concentrations.

4.3.3.1 Sediment dams

The design of sediment control measures for the Project will be based on the principle of ensuring that runoff from disturbed areas is also separated from clean area runoff and collected in sediment dams for treatment. Design of proposed erosion and sediment control measures will be based on the recommended design standards in the following guidelines and included in the relevant Project management plans:

- Managing Urban Stormwater, Soils and Construction, (Landcom, 2004);
- Managing Urban Stormwater, Soils and Construction, Volume 2E Mines and Quarries (DECC, 2008); and
- Managing Urban Stormwater, Soils and Construction, Volume 2C Unsealed Roads (DECC, 2008a).

Sediment dam locations have been proposed based on the mine plans and are shown in Figure 4.1 to Figure 4.3. Note that these sediment dam locations and catchments are conceptual only and in reality, it may be more beneficial to develop a greater number of smaller dams, each capturing smaller catchment areas to manage surface water runoff from disturbed mining areas.

The sediment dam volumes are based on the following design standards and methodology:

- “Type F” sediment basins consistent with SD 6-4 (page 6-19, Landcom 2004);
- total sediment basin volume = settling zone volume + sediment storage volume. The sediment storage volume is the portion of the basin storage volume that progressively fills with sediment until the basin is de-silted. The settling zone is the minimum required free storage capacity that must be restored within 5 days after a runoff event;
- sediment basin settling zone volume based on 90th percentile 5-day duration rainfall at Scone (35.9mm) with an adopted volumetric event runoff coefficient for disturbed catchments of 0.64; and
- sediment storage volume = 50% of settling zone volume.

The resulting sediment dam volume requirement equates to 0.35 ML per hectare of catchment. Table 4.1 provides the adopted sediment dam volumes and the associated pump requirements to restore the settling zone capacity within 5 days.

Total Suspended Solids (TSS), which is a measure of the amount of solids suspended in water, will be used as the water quality parameter for design. TSS can only be measured in a laboratory. To provide instantaneous measurements a relationship between TSS and turbidity will be developed.

Where TSS concentration in sediment dams after a runoff event is less than the selected water quality design criteria (usually set at 50 mg/L), sediment dams may be dewatered to receiving waters. Where TSS exceeds the water quality objective, water in basins must be either:

- flocculated to reduce TSS to less than the water quality objective;
- pumped to another water storage with available capacity; or
- pumped into the mine water management system.

For rainfall events that exceed the design condition, it is possible that the sediment dams may overflow with suspended sediment concentrations that exceed the water quality design criteria. The potential for such overflows is acknowledged in the design methodology. The EPL will include a licensed discharge point for wet weather discharge at the outlet of each sediment dam. Concentration limits for TSS in the EPL may only be exceeded where preceding rainfall exceeds the design standard (35.9 mm of rainfall in 5 days).

All surface water diversion drains, outlets, contour drains, catch drains and other waterways will be designed to convey peak runoff discharge rates for a 5% AEP storm event (DECC, 2008). All drains are typically trapezoidal in section with 3H:1V channel batters and are designed to convey runoff at non erosive velocities of less than 1.5 m/s.

Table 4.1 - Sediment dam sizing

Sediment Dam	Maximum Catchment Area Throughout Project Life (ha)	Total Volume Required (ML)	Day Pump Requirement (L/s)
1	104.9	36.1	84
2	115.2	39.7	92
3	107.0	36.9	85
4	16.1	5.5	13
5	67.7	23.3	54
6	45.3	15.6	36

4.3.3.2 Haul roads and site access roads

The location and layout of the haul road between Drayton South and the existing Drayton Mine will be determined during detailed design. An erosion and sediment control plan will be developed in accordance with DECC (2008a) as part of the detailed design. The general management principles of the plan are as follows:

- the haul road will be sited along the ridgeline wherever possible to minimise the requirement for cross drainage structures and steep gradients;
- where cross drainage structures are required, the upslope catchment will be diverted to prevent it from crossing the road;
- any cross drainage structures will be designed to convey the 20% AEP event without being overtopped;

- dissipating structures will be constructed downstream of any cross drainage to ensure concentrated flows are below erosive flows;
- table drains will be constructed at a gradient to minimise erosion or erosion protection measures will be installed where necessary. Mitre drains will be used to minimise the catchment area draining to the table drains;
- the mitre drains will discharge to well vegetated areas or sediment control structures and not directly to a drainage line; and
- a dust-a-side will be used to minimise dust by coagulating the finer particles together and thus minimising turbid runoff.

Runoff from the haul road is not expected to be mine water affected. Spillage from coal haul trucks is expected to be minimal given the maximum gradient of the haul road will be less than the access ramps from the mining areas. The haul road will be monitored visually for any potentially contaminated material.

4.3.3.3 Construction phase control measures

Erosion and sediment control measures required for the construction phase will include the following:

- where practicable, runoff from undisturbed catchments will be diverted around the construction activities via diversion drains and banks to discharge into the natural watercourses;
- runoff from disturbed areas will be retained on site in sediment dams and allowed to settle prior to discharge into the natural system;
- prior to disturbance of land, appropriate erosion and sediment controls will be established;
- during construction, a number of temporary sediment dams may be used to collect runoff from disturbed areas. Disturbed area runoff accumulating in these dams will be used for dust suppression purposes; and
- excess water accumulating in the dams will be treated or allowed to settle and discharged to receiving waters (once water quality is acceptable), or pumped to an alternate storage.

A combination of temporary and permanent clean and dirty water drains will also be established during construction to divert runoff from undisturbed areas and collect runoff from disturbed areas. Additional erosion and sediment control measures will be used for other small disturbance areas including silt fences, hay bales and other measures consistent with current best practice standards. Details of construction phase erosion and sediment controls will be provided in relevant management plans for the Project.

4.3.4 Clean water management system

A series of temporary highwall dams and drains will be constructed to divert clean water around the Drayton South disturbance footprint as shown in Figure 4.1 to Figure 4.3. The highwall dams will be sized as Type F sediment basins consistent with SD 6-4 (page 6-19, Landcom 2004). Given the size of these dams and their temporary nature, none of the highwall dams are expected to be prescribed dams under the *Dams Safety Act 1978*.

Water collected in the highwall dams will be pumped to Saddlers Creek within 5 days of a runoff event.

4.3.5 Hydrocarbon water management system

The approved Drayton mine site facilities and the proposed mine site facilities at Drayton South may produce runoff that contains hydrocarbons. These areas include:

- the vehicle and equipment wash-down area;
- workshop;

- fuel, oil and grease storages; and
- refuelling bays.

Runoff from these areas on the mine site facilities will be managed as follows:

- runoff will drain to a triple interceptor (or similar) to reduce hydrocarbons to acceptable levels before draining to the downstream dams. The oily fraction would enter a containment system for removal as necessary.
- storage tank areas would have an impermeable surface and bunding in accordance with AS1940;
- all oil, grease, fuel and hydrocarbon products would be securely stored.
- refuelling, oiling and greasing would take place in designated areas only.

In event of a spill, the contaminated soil at the site of the spill would be collected and transported to a licensed waste disposal facility or remediated safely onsite.

4.3.6 Potable water

Potable Water on the Drayton Mine is supplied via a pipeline from Muswellbrook Shire Council. The current supply arrangement is proposed for the Project. Potable water requirements at the Drayton South facilities will be sourced from the existing Drayton potable water supply, and transported by truck to the Drayton South facilities, within potable water standard requirements. As the existing Drayton Mine workforce will continue to be utilised there will be no increase in potable water required for the Project.

4.4 WATER MANAGEMENT STORAGEES

Table 4.2 shows details of the main water management storages within the study area. The catchment areas and land use draining to the various dams are given in Section 5.5.2.1. The dams are connected by a pipe network, which enables the transfer of water according to mine operational requirements. The operational rules of the various storages, including the sources of water pumped to and from each storage are given in Appendix B. The stage-storage-surface area of each dam is given in Appendix C.

The operating rules have been developed to either maintain a storage volume to enable supplies to be met or to prevent uncontrolled spills from occurring. The limits were approximated through modelling and are generally based on the receiving storages ordering water to meet demand or to prevent an uncontrolled spill.

The dams have also been assigned a maximum operating volume (MOV) to minimise the risk of an uncontrolled spill during a severe rainfall event. The MOV has been calculated by the dam requiring sufficient storage volume below the full supply level to accommodate the catchment area of the dam multiplied by the 1% AEP 48 hour rainfall event assuming no rainfall losses. If these MOV's are exceeded, the Surface Water Response Plan will be triggered, as described in Section 7.6.

The Rail Loop Dam does not have sufficient capacity to capture this volume of runoff but includes an automatic pump back system to the Industrial Dam to minimise the probability of spill. It is proposed to increase the capacity of the Rail Loop Dam at the Drayton Mine to 43 ML as part of the Project or divert some of this catchment into the existing mine water management system of Drayton Mine. Whilst the current automatic pump back system has been working, the increased capacity will reduce the likelihood of an uncontrolled spill, should the pump back system fail.

The new Transfer Dam will be designed and constructed by a suitably qualified and experienced person in accordance with the requirements of the Dams Safety Act.

A preliminary assessment of the Project dams would suggest that the dams would be in the low or very low flood consequence category. The Transfer Dam is located in first and second order watercourses that drain to Saddlers Creek respectively. There is no population at risk along Saddlers Creek or the minor watercourses. A detailed assessment of the flood consequence of these dams will be undertaken during detailed design.

The Industrial Dam is a 750 ML storage currently used as a pit water repository to supply water for haul road dust suppression, industrial wash down and as a back up to the Access Road Dam to supply water to the CHPP. The Industrial Dam will be removed as mining progresses in the existing East Pit of Drayton Mine. It is proposed to shift the current functions from the Industrial Dam to the Access Road Dam. That is:

- pit water will be pumped directly to the Access Road Dam;
- pit water will be transferred to the West Pit void if the Access Road Dam is full;
- haul road dust suppression will be taken from the Access Road Dam, with back up from the Savoy Dam;
- industrial wash down water will be taken from the Access Road Dam; and
- the Rail Loop dam will be pumped to the Access Road Dam.

Any water remaining in the Industrial Dam at the time of decommissioning will be pumped to other storages on Drayton Mine.

Table 4.2 - Water storages within the study area

Mine Water Storage	Storage Capacity (ML)	Maximum Operating Volume (ML)
Access Road Dam (2081)	750	610
Rail Loop Dam (2114)	43	0*
Savoy Dam (1609)	140	52
North Void	18,900	18,700
East Void	40,756	40,300
South Void	14,788	14,100
Transfer Dam	255	225

* The Rail Loop Dam currently has an automatic pump back system to minimise potential for spills.

4.5 FINAL LANDFORM

Figure 4.4 shows the configuration and the major drainage catchments of the indicative final landform at Drayton South. The final landform and drainage configuration have been designed to replicate the surrounding geomorphic landform using the Geofluv method. This method attempts to design erosion resistant upland slopes and related stream channels and to integrate them into a functional and stable landform. The design of the final landform may be refined prior to the completion of mining once there is a better understanding of the overburden material characteristics. The general drainage characteristics of the final landform at Drayton South are as follows:

- the Transfer Dam will be removed and rehabilitated;
- the overburden emplacement area will be rehabilitated so that the northern face will drain directly to Saddlers Creek;
- the remaining overburden emplacement area catchment will drain into the final void of the Whynot mining area; and
- the catchment draining to the final void is 264 ha.

The final landform for Drayton Mine will be similar to that shown in Figure 4.5 and will ensure the rehabilitation of all major infrastructure and the final capping and rehabilitation of fine tailings and coarse rejects disposal areas.

5 Water balance

5.1 OVERVIEW

The site water balance will vary from year to year depending on climatic conditions and the progression of proposed mining operations. A detailed computer simulation model of the site water management system was developed using the OPSIM software. The model simulates the operation of the water management system on a daily basis using different historical sequences of recorded rainfall data. This provides an understanding of the behaviour of the system under different climatic conditions.

The site water balance was developed assuming that mining and rehabilitation to final landform has been completed at the Drayton Mine.

A forecast model run was undertaken which simulates the continuous development of the Project over the Project life for different climate sequences. The forecast run indicates the likelihood of the system achieving different performance levels.

5.2 MODELLING METHODOLOGY

The model has been configured to simulate the operations of all major components of the water management system. The simulated inflows and outflows included in the model are given in Table 5.1.

Table 5.1 - Simulated inflows and outflows to the mine water management system

Inflows	Outflows
Direct rainfall on water surface of storages	Evaporation from water surface of storages
Catchment runoff	CHPP demand
Groundwater inflows	Dust suppression demand
Raw water supply from Hunter River	Vehicle wash down
	Offsite spills from storages

The OPSIM water balance model of the Drayton Mine water management system, previously developed to assess the impact of the proposed changes to the tailings disposal system (Water Solutions, 2011), was used as the basis for the assessment. For this study, the runoff parameters in the OPSIM model were recalibrated to match the recorded and modelled storage volumes over the period 2007 to 2011. Details of the OPSIM model configuration and calibration is given in Appendix A. A description of the existing Drayton Mine water management system is given in Section 3.6.

The calibrated model was updated to include Drayton South and then run as a dynamic forecast simulation model. The 15 year Project life of Drayton South was modelled, i.e. 2016-2030, using historical climatic data from the SILO Data Drill service (Jeffrey et al. 2001). The dynamic configuration allows the simulation to change over the modelled Project life, reflecting changes in the water management system over time.

Concept mine plans for the Project have been provided for three representative years of the Project life which were linked in the model to reflect variations over time such as catchments, ROM coal production and groundwater seepage. Descriptions of the water management system over the life of the Project are given in Section 4. The operational rules and physical layout for each representative year of mining at Drayton South (Figure 4.1 to Figure 4.3) and Drayton Mine (shown in Figure 4.5) are applied to a range of years shown in Table 5.2. The operational rules at each modelled stage are provided in Appendix B. Although the catchment areas are expected to continuously change as Drayton

South is progressively rehabilitated, the simplification is expected to reasonably represent conditions over the 15 year period.

Table 5.2 - Application of representative mine stages to full Project life

Representative Mine Plan	Applied Range of Project life
Year 4	Year 1 - Year 5
Year 6	Year 6 - Year 10
Year 12	Year 11 - Year 15

To assess the effects of varying climatic conditions, the model was run for multiple cycles with each cycle corresponding to the 15 year Project life. A different rainfall input sequence was applied to each cycle. Of the 126 years of historical climatic data available from January 1889 to December 2014, there are 112 “blocks” of data, each 15 years in length. The first “block” of data, from January 1889 to December 1903, is applied to the first cycle of the model. The second “block” of data, offset by one year, is then applied from January 1890 to December 1904 to the second cycle. Each subsequent cycle of the model has the rainfall data offset by one year, until the mine water system has been tested for 112 cycles against 126 years of rainfall data. A statistical analysis of the 112 cycles can then be undertaken to assess the behaviour of the various storages over extended dry and wet periods.

The adopted rainfall sequence for the simulations was based on a synthetic rainfall data set interpolated from point observations by the Bureau of Meteorology (SILO Data Drill, Jeffrey et al., 2001).

The OPSIM model also undertakes a mass balance of salt loads in all of the major storages within the study area to enable an assessment of the long term build up salts.

5.3 MODEL CONFIGURATION

5.3.1 Operational rules

Appendix B shows the adopted operating rules for the OPSIM water balance simulation, including details of pump capacities and when transfers are activated or deactivated. The operating rules have been developed to either maintain a sufficient storage volume to enable supplies to be met or to prevent uncontrolled spills from occurring. Note that to simplify the water balance model, the transfer from the Transfer Dam to the South Void at Drayton Mine has been modelled as a direct transfer, when in reality, this transfer would occur via the Savoy Dam. For modelling purpose, Savoy Dam is assumed to be dewatered to South Void.

5.3.2 Storage curves

Stage-storage curves of the Drayton South pits and final landform were determined from the provided mine plans. The Transfer Dam capacity and associated storage curve was provided by Anglo American.

5.3.3 Storage capacities

The following storage capacities have been adopted for the water balance modelling:

- Mine water dams and voids - as per Section 4.4.
- Sediment dams - as per Section 4.3.3 above.
- Highwall Dams - varied (based on the storage volume requirement for sediment dams, i.e. 0.34 ML/ha).

5.3.4 Starting inventories

Table 5.3 shows the storage inventories adopted as initial conditions in the water balance model. These are based on the current (December 2014) recorded inventory at Drayton Mine. It is assumed that the current inventory in West Void (BW13), which will be subleased to Mount Arthur Coal, and the Industrial Dam at Drayton Mine is transferred into South Void prior to the start of mining at Drayton South, and hence do not form part of the water management system and are not modelled.

Table 5.3 - Inventories at model commencement

Storage	Starting Inventory (ML)
Access Road Dam	427
South Void	995*
East Void	3,138
North Void	25
Savoy Dam	66
Rail Loop Dam	10
Transfer Dam	10^

*includes the current Industrial Dam and West Void inventory.

^assumed - required to ensure demands are met at start of simulation.

5.3.5 Tailings management

Modelling has been undertaken for Scenario 2 tailings disposal option (base case) only (see Section 4.3.2).

Previous modelling of the water management system (WRM, 2012) showed that the Scenario 1 tailings disposal system did not significantly impact on the water balance and therefore has not been remodelled. That is, the results for Scenario 2 are effectively the same as for Scenario 1.

Scenario 3 resulted in a greater risk of in-pit inundation impacting mining operations, resulting from a reduction in out of pit storage capacity. Anglo American will temporarily sacrifice an active mining area to store the additional water if required. The current production schedule has the flexibility to cater for this scenario.

5.4 WATER DEMANDS

5.4.1 Dust suppression

Table 5.4 shows the predicted dust suppression water requirements for each mine stage. The rate of coal stockpile dust suppression is considered constant over the Project life. The adopted haul road dust suppression demand at each stage is dependent on the length of the haul roads and ramps. The length of the haul road at Drayton Mine and the Drayton South mine site facilities are assumed not to change. Only the length of haul roads, ramps and internal routes at Drayton South change over the Project life. The following is of note with regards to haul road dust suppression rates:

- dust suppression is applied at a constant rate throughout the year for each representative mine stage scenario. No adjustments for summer and winter watering requirements were made;
- a dust suppressant agent will be applied to haul roads, ramps and mine site facilities to minimise water use. Based on information provided by Anglo American, water requirements for dust suppression will be applied at an application rate of 0.015 L/m²/hr when used in conjunction with the dust suppressant agent;

- haul road and ramp lengths were estimated from the Project mine plans (shown in Figure 4.1 to Figure 4.3) and the Drayton Mine final landform (Figure 4.5). Industrial areas were adopted from the Drayton South Expansion Water Management Design Criteria (Anglo American, 2011b);
- the adopted road watering application rate, for internal routes and mine working areas is 0.2 L/m²/hr (Anglo American, 2011b). Dust suppressant agents are not proposed for the mine working areas; and
- Drayton Mine haul roads were assumed to be 14 m wide, Drayton South haul roads and ramps assumed to be 26 m wide and trucks were assumed to operate 23 hrs/day, (Anglo American, 2011b).

Dust suppression demands at Drayton South are sourced from the Transfer Dam, while demands at the existing Drayton Mine are sourced from the Access Road Dam.

Table 5.4 - Projected haul road dust suppression demand

Demand (kL/d)	Stage		
	Yr 4	Yr 6	Yr 12
Drayton Mine Haul Road	96.1	96.1	96.1
Coal Stockpile Dust Suppression	31.9	31.9	31.9
Drayton Mine Site Facilities	3.2	3.2	3.2
Drayton South Haul Road	106.9	176.7	112.8
Drayton South Mine Face/Route	804.3	1469.2	1,237.2
Drayton South Mine Site Facilities	3.2	3.2	3.2
Total (kL/d)	1,045.6	1,780.3	1,484.4

5.4.2 CHPP demand

Water is required at the CHPP for coal processing, washdown and other associated uses. Table 5.5 shows the predicted annual production schedule and the CHPP makeup requirement for each year of Project life. The adopted CHPP makeup rates for water balance modelling are the average over each representative stage, as shown in Table 5.5. The following operational characteristics were used to estimate CHPP water requirements:

- raw feed coal total moisture content: 8% w/w;
- product coal total moisture content: 10% w/w;
- rejects total moisture content: 15% w/w;
- tailings total moisture content: 65 % w/w;
- tailings split: 48.59% (ratio of fine rejects/total rejects using dry weights); and
- plant efficiency: the projected ratio of product coal/raw feed (by dry weights) ranges from 70% to 78% over the 15 year Project life.

CHPP water demand is sourced from the Access Road Dam. It was assumed that 30% of the tailings moisture will be decanted and returned to the CHPP. The remaining 70% would evaporate or become entrained with the tailings. Moisture within the rejects was assumed to be lost to the system.

Table 5.5 - Projected CHPP water balance

Years of Project life	ROM Coal Mined (ktpa)	CHPP Makeup Requirement (ML/yr)	Representative Mine Stage	Average CHPP Demand for each Representative Mine Stage (ML/yr)
1	2,501	639		
2	1,950	507		
3	4,063	1,043	Year 4	873
4	4,176	1,102		
5	4,200	1,076		
6	5,728	1,498		
7	5,757	1,525		
8	5,523	1,464	Year 6	1545
9	6,217	1,628		
10	6,159	1,611		
11	6,036	1,545		
12	6,137	1,529		
13	6,352	1,586	Year 12	1373
14	5,573	1,369		
15	3,413	836		

5.4.3 Industrial Use

The industrial demands for the Project were provided by Anglo American (2011b) and are as follows:

- Drayton mine site facilities - 1,120 kL/d; and
- Drayton South mine site facilities - 112 kL/d (assumed to be half the requirement of Drayton Mine and 80% recovery).

Industrial water use was assumed to be constant throughout the life of the Project.

5.5 WATER SOURCES

5.5.1 Pit groundwater Inflows

Table 5.6 shows the estimated groundwater inflows to the three voids at Drayton Mine (AGE, 2006). The adopted volumes are the estimated pumpable volumes after evaporation from the coal face is taken into account. The groundwater inflows to the East Void were reduced by 10% to account for tailings deposition. No groundwater was dewatered from the North Void.

Table 5.6 - Drayton Mine pumpable groundwater inflows

Void	Groundwater Inflow (ML/yr)
North	391
South	128
East	417*

*Value includes 10% reduction due to tailings deposition.

Table 5.7 shows the adopted groundwater inflows to the Drayton South mining areas (AGE, 2015). The rates shown in Table 5.7 have been adopted for the duration of each representative mine stage, applied as an average daily rate.

Table 5.7 - Drayton South pumpable groundwater inflows

Mining Area	Stage (ML/yr)		
	Yr 4	Yr 6	Yr 12
Whynot	120.1	255.8	246.2
Blakefield	40.5	69.5	0.0
Total	160.6	325.2	246.2

5.5.2 Catchment runoff

5.5.2.1 Catchment and land use areas

Table 5.8 shows the predicted catchment areas that drain to the various water management dams at Drayton Mine based on the final landform given in Figure 4.5. This final landform, and the associated catchment areas and land use types, have been applied over Drayton South's full 15 year life and are assumed to not change. Table 5.8 also shows the catchments and land use classifications reporting to the Drayton South surface water storages, which will change as the site evolves, as shown in Figure 4.1 and Figure 4.3.

Table 5.8 - Storage catchment areas

Stage	Storage	Contributing Catchment (ha)					Total
		Overburden	Undisturbed /Natural	Industrial/ Hardstand	Rehab. Overburden	Mining Pit	
All Yrs	Access Road Dam	-	49	19	-	-	68.0
	Rail Loop Dam	-	17.3	44	-	-	61.3
	Savoy Dam	-	23.2	2.3	16.1	-	41.6
	East Pit	-	23	7.3	43	100	173.3
	North Pit	-	1	8	30	45	84
	South Pit	-	8	13	224	62	307
	Transfer Dam	-	6.8	6.8	-	-	13.6
	MIA Catch Dam	-	-	8.2	-	-	8.2
Y4	Whynot Pit	123.7	13.0	2.5	52.8	72.2	264.3
	Whynot West Pit	-	-	-	-	-	0.0
	Blakefield Pit	55.8	38.6	2.4	-	8.5	105.3
	Sediment Dam 1	-	-	-	-	-	0.0
	Sediment Dam 2	9.1	8.6	1.1	10.7	-	29.5
	Sediment Dam 3	0.5	-	5.3	16.5	-	22.4
	Sediment Dam 4	8.6	-	1.5	4.3	-	14.4

Stage	Storage	Contributing Catchment (ha)					Total	
		Overburden	Undisturbed /Natural	Industrial/ Hardstand	Rehab. Overburden	Mining Pit		
Y6	Sediment Dam 5	3.3	10.7	10.1	43.6	-	67.7	
	Sediment Dam 6	-	-	7.9	37.4	-	45.3	
	Highwall Dams Whynot	-	190.2	-	-	-	190.2	
	Highwall Dams Whynot West	-	-	-	-	-	0.0	
	Highwall Dams Blakefield	-	47.7	-	-	-	47.7	
	Whynot Pit	99.5	28.6	3.7	146.1	92.9	370.9	
	Whynot West Pit	40.2	23.2	2.4	22.9	7.6	96.2	
	Blakefield Pit	19.4	-	3.0	45.6	11.2	79.2	
	Sediment Dam 1	-	-	-	-	-	0.0	
	Sediment Dam 2	2.3	-	4.1	26.8	-	33.2	
	Sediment Dam 3	3.1	-	6.7	89.6	-	99.4	
	Sediment Dam 4	6.6	-	3.8	4.3	-	14.7	
	Sediment Dam 5	3.2	10.7	10.1	43.6	-	67.7	
	Sediment Dam 6	-	-	7.9	37.4	-	45.3	
	Highwall Dams Whynot	-	102.9	-	-	-	102.9	
	Highwall Dams Whynot West	-	395.8	-	-	-	395.8	
	Highwall Dams Blakefield	-	349.7	-	-	-	349.7	
	Y12	Whynot Pit	137.2	26.3	2.4	397.8	85.5	649.2
		Whynot West Pit	-	-	-	-	-	0.0
Blakefield Pit		-	-	-	-	-	0.0	
Sediment Dam 1		-	21.7	-	83.2	-	104.9	
Sediment Dam 2		-	-	-	115.2	-	115.2	
Sediment Dam 3		3.1	-	8.3	95.6	-	106.9	
Sediment Dam 4		8.1	-	3.7	4.4	-	16.1	
Sediment Dam 5		8.4	0.5	9.7	49.0	-	67.5	
Sediment Dam 6		-	-	7.5	37.5	-	45.1	
Highwall Dams Whynot		-	-	-	-	-	0.0	
Highwall Dams Whynot West		-	303.5	-	-	-	303.5	
Highwall Dams Blakefield	-	264.8	-	-	-	264.8		

5.5.2.2 Catchment runoff parameters

Catchment runoff yield parameters were adopted from Appendix A, Table A.13. These parameters were calibrated to the total site water inventory on the Drayton Mine using known site performance and operations from January 2007 to May 2011. The calibrated

parameters were then applied to the Drayton South catchments, described in Section 5.5.2.1.

Catchment runoff water quality parameters were also adopted from Appendix A, Table A.14. Salinity measured as Total Dissolved Solids (TDS) was used to represent water quality from the various catchments. The TDS parameters were also calibrated to the recorded water TDS concentrations on the Drayton Mine and then applied to the Drayton South catchments.

Whilst there is some uncertainty in this approach, the calibrated values give some confidence that the adopted catchment parameters are reasonable.

5.5.3 Raw water

For the purposes of current investigations, the term 'raw water' represents the amount of raw water imported from the Hunter River that is required to sustain the nominated design production rate and associated operational demands for the Project. Any shortfall in mine water is made up from imported raw water - that is, during dry periods, imported raw water is used to ensure that all operational demands are met. It is assumed that water collected on site is used before water is imported from the Hunter River. Hunter River water, if required, will be pumped into the Transfer Dam. Anglo American currently owns two general security Water Access Licenses (WAL1066 and WAL491) totalling 198 units from the Hunter River.

5.6 FORECAST SIMULATION RESULTS

5.6.1 Overview

The OPSIM model was used to assess the performance of the proposed water management system (base case) against the following:

- mine complex storage inventory;
- offsite raw water requirements;
- uncontrolled spills from the mine water storages; and
- the overall water balance within the study area.

Two sensitivity analyses have also been undertaken to assess the impact higher and lower runoff scenarios.

Although considerable care and attention has been paid to ensuring that base information is the best available, there is inherent variability with respect to some key site characteristics (e.g. catchment yield/rainfall runoff, mining area groundwater inflows, tailings return rates). Nevertheless, investigation outcomes are considered to be fair and reasonable, given the current status of base information.

5.6.2 Interpretation of results

The forecast model results indicate the likelihood of the mine water system achieving different levels of performance over the life of the Project. A forecast simulation provides a statistical analysis of the water management system's performance over the 15 year Project life, based on 112 realisations with different climatic sequences. The 50th percentile probability represents the median results, the 10th percentile represent 10% exceedance and the 90th percentile results represent 90% exceedance. There is an 80% chance that the result will fall within the 10th and 90th percentiles and a 98% chance the result will fall between the 1st and 99th percentiles. Importantly, a percentile trace shows the chance of a particular value, and does not represent continuous results from a single model realisation e.g. the 50th percentile trace does not represent the model time series for median climatic conditions.

5.6.3 Average water balance

An indicative water balance for the forecast model is presented in Table 5.9, averaged for all 112 realisations for each stage of modelled Project life (stages are shown in Figure 4.1 to Figure 4.3). Table 5.9 shows the average inflows, outflows and overall water balance for all 112 realisations for each of the mine stages.

Rainfall runoff from the mine water system catchment and active pits represents the largest inflow to the system. Total average annual water inputs are of the order of 3,100 ML to 3,900 ML over the Project life.

Water entrained with tailings represents the largest outflow from the mine water system, followed by evaporation and haul road dust suppression.

The average water balance indicates that on average there is a net surplus of water in each representative stage of Project life. The average additional water supply required for each representative stage from outside the mine water system varies between about 0 and 40 ML. However, the actual volume required in individual years may be outside this range if very wet or very dry conditions are experienced at the site. Section 5.6.6 provides further analysis of the off-site water requirements.

Whilst Table 5.9, provides an indication of the differences in the water balance between stages, application of the nominated volumes for other purposes should be undertaken with caution because they represent average results from 112 realisations (climate sequences). For a statistical analysis of the full range of 112 modelled climatic sequences and realisations, refer to the following sections.

Table 5.9 - Average annual water balance by stage for all realisations

Representative Stage	Volume (ML/yr)					15 Year Total (ML)
	Year 4	Year 6	Year 12	15 Year Total (ML)		
	Annual Average for Year 1-5	Annual Average for Years 6-10	Annual Average for Years 11-15			
Water Inputs						
Rainfall Yield (Direct Rainfall + Catchment Runoff)	1,733	2,136	2,234			30,517
Groundwater Inflow	1,097	1,261	1,182			17,702
ROM Coal	270	470	440			5,903
Raw Water	0	28	36			322
Total	3,100	3,895	3,893			54,444
Water Outputs						
Evaporation	580	588	664			9,160
Dust Suppression	382	650	542			7,869
Industrial Demand	450	450	450			6,750
Sediment Dam Spills	-	18	52			354
Mine Water Dam Spills	1	1	1			12
Tailings*	572	1,013	896			12,405
Product Coal	245	423	405			5,361
Highwall Dam Releases	80	277	188			2,728
Total	2,309	3,420	3,199			44,638
Change in Site Water Inventory	792	476	694			9,806

*70% of tailings moisture assumed lost to the system due to entrainment with tailings or evaporation (tailings decant (30%) retained for use in water storage)

5.6.4 Out-of-pit storage inventory

An assessment of the forecast out-of-pit water storage inventory has been undertaken to determine whether it is sufficient to prevent uncontrolled spills or a build-up of water in the active mining areas. It is also used to determine when off-site supplies are required to meet on-site demand.

Figure 5.1 shows the forecast probability of modelled total out-of-pit inventory on site. The out-of-pit storages include the South Void, Transfer Dam, East Void, Savoy Dam, Rail Loop Dam and the Access Road Dam. The out-of-pit storages (excluding the East Void) have a combined capacity of approximately 15,836 ML. The storages are kept below approximately 14,080 ML to prevent uncontrolled spills. The East Void, used for the disposal of tailings, has a capacity of over 40 GL but is not available to store water as it is used to store tailings. The South Void is the primary out-of-pit storage and has a capacity of 14,788 ML. The maximum operating capacity of the South Void is set at 13,400 ML.

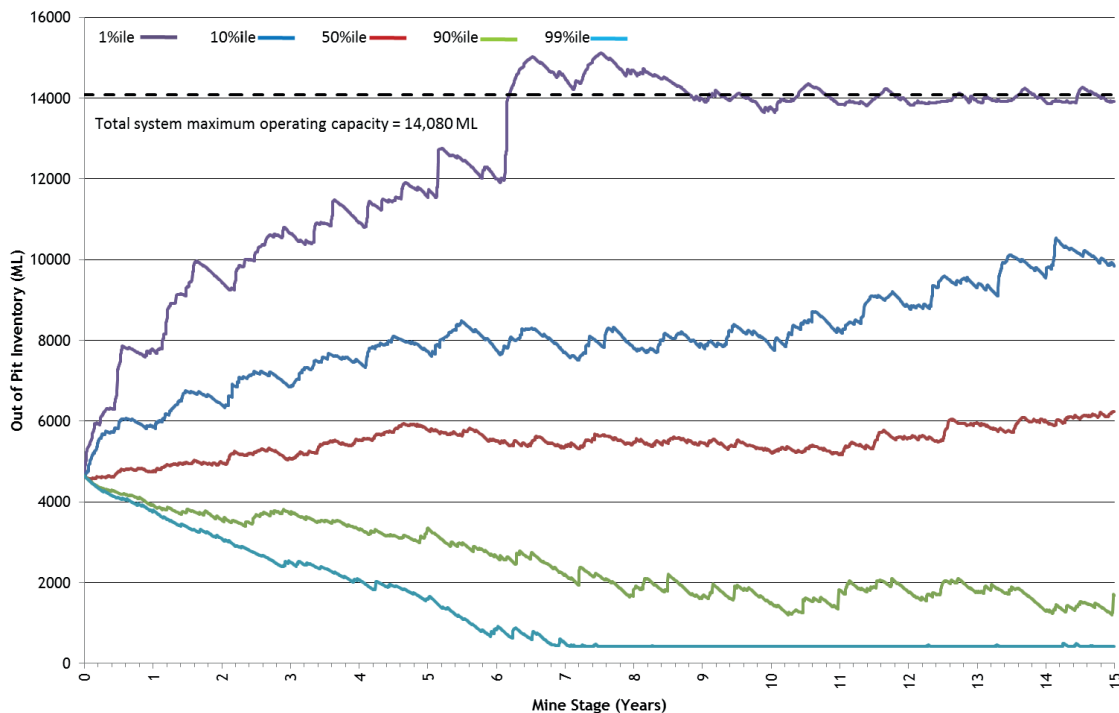


Figure 5.1 - Forecast out-of-pit storage inventory, 99th (very dry), 90th (dry), 50th (median), 10th (wet) and 1st (very wet) percentile traces

The results show that:

- the water management system has a higher risk of accumulating water towards the end of Project life, compared to the beginning;
- the greatest risk of running out of water occurs from about Year 7 onwards after the current inventories are utilised;
- at any point in time from Year 6 onwards, there is a 1% chance (99th percentile results trace) that that the combined out-of pit storages will essentially hold no excess water;
- at the end of Project life, there is a 50% chance that the combined out-of pit storages' inventory will have built up to about 6,000 ML;
- at the end of Project life, there is a 10% chance that the combined out-of pit storages' inventory will have built up to approximately 10,000 ML; and

- there is a 1% chance that the total out-of-pit storages will be at or above their combined MOV at any point in time from about year 7 onwards. Should the out-of-pit inventory reach this threshold then:
 - an active mining area could be temporarily sacrificed for water storage; or
 - dust suppression watering rates could be increased.

5.6.5 In-pit storage Inventory

An assessment of forecast pit inventory has been undertaken to determine the likelihood of water inundating the pit assuming none of the other mitigation measures listed above are used. A build-up of water in the active mining areas generally occurs when the out-of-pit storages are too full to accept additional water from the mining areas, or the catchment runoff draining to the pit is greater than the dewatering pump capacity.

Figure 5.2 show the forecast probability of in-pit storage volume on site over the 15 year life of the Project. The active pits include the Whynot, Whynot West and Blakefield mining areas.

The assessment of the in-pit inventory shows that:

- the risk of accumulating water in-pit is generally low for the first 8 years of Project life. The accumulated water can be managed within pit during this period without impacting on production;
- the risk moderately increases from Year 8 to Year 15 when there is a higher risk that the South Void will be full;
 - there is a 10% chance that the in-pit storage will reach at least 240 ML in Year 10; and
 - there is a 1% chance that the in-pit storage will reach at least 1,060 ML in Year 11.

Interpretation of the results suggests that there is a low chance of a build-up of water over the Project life and that the adopted pit pumping system is adequate. The risk of in-pit inundation is still low but higher towards the end of Project life due to the higher risk that South Void would be full. There is sufficient additional out of pit storage capacity on the Drayton Mine (North Void) to dewater the pit should these very wet conditions prevail at the end of Project life.

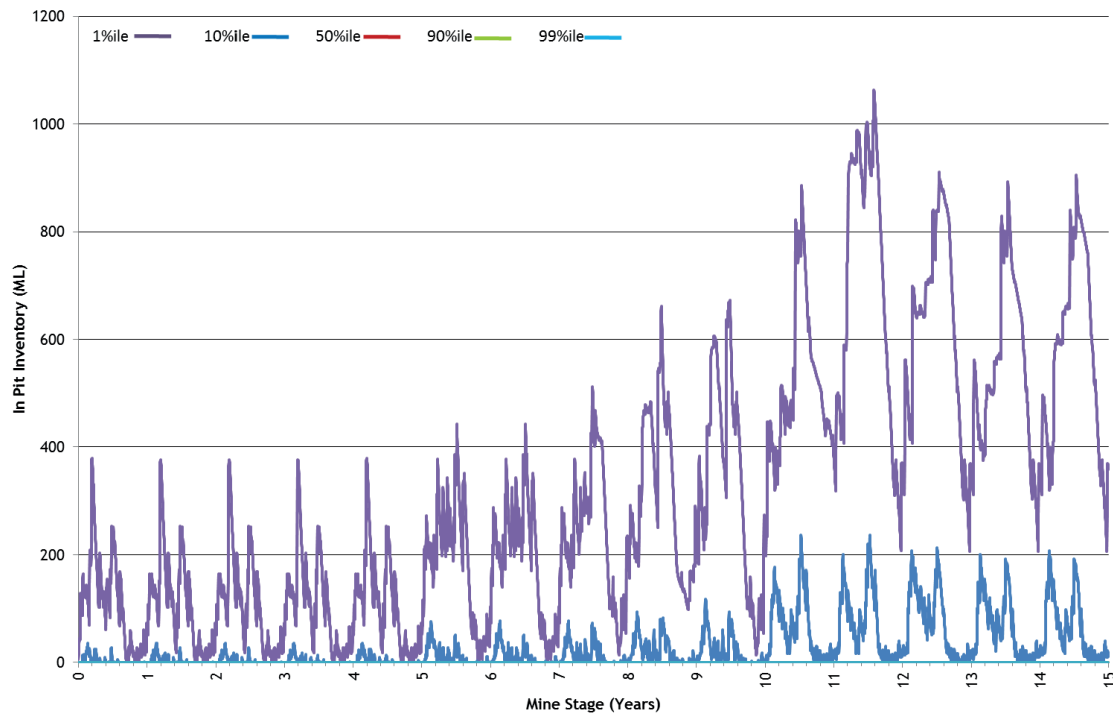


Figure 5.2 - Forecast in-pit storage inventory, 99th (very dry), 90th (dry), 50th (median), 10th (wet) and 1st (very wet) percentile traces.

5.6.6 Offsite water requirements

For the purposes of current investigations, the term ‘site raw water requirements’ represents the amount of imported raw water that is required to sustain the nominated design production rate and associated operational demands for the Project. The simulation of the water management system assumes that any shortfall in water captured on-site is made up from imported raw water - that is, during dry periods imported raw water is used to ensure that all operational demands are met.

This potential requirement for raw water supply has been assessed using a forecast assessment simulation. The forecast probability of annual raw water demand is provided in Figure 5.3. The results show that:

- consistent with the results for the water management system inventory (Section 5.6.4), the highest risk for requiring off-site raw water occurs from about Year 6 onwards when the current site inventories are drained;
- there is at least a 99% chance (1st percentile results trace) from year 1 to 5 that off-site supplies will not be required to supply operational demands;
- there is at least 90% chance (10th percentile results trace) that off-site supplies will not be required for the remainder of Project life; and
- there is a 1% chance in each of the years from Year 8 to Year 14, that at least 860-1000 ML/yr is required.

A discussion of how the forecast raw water requirements are proposed to be met should extremely dry conditions prevail is provided in Section 6.5.2.

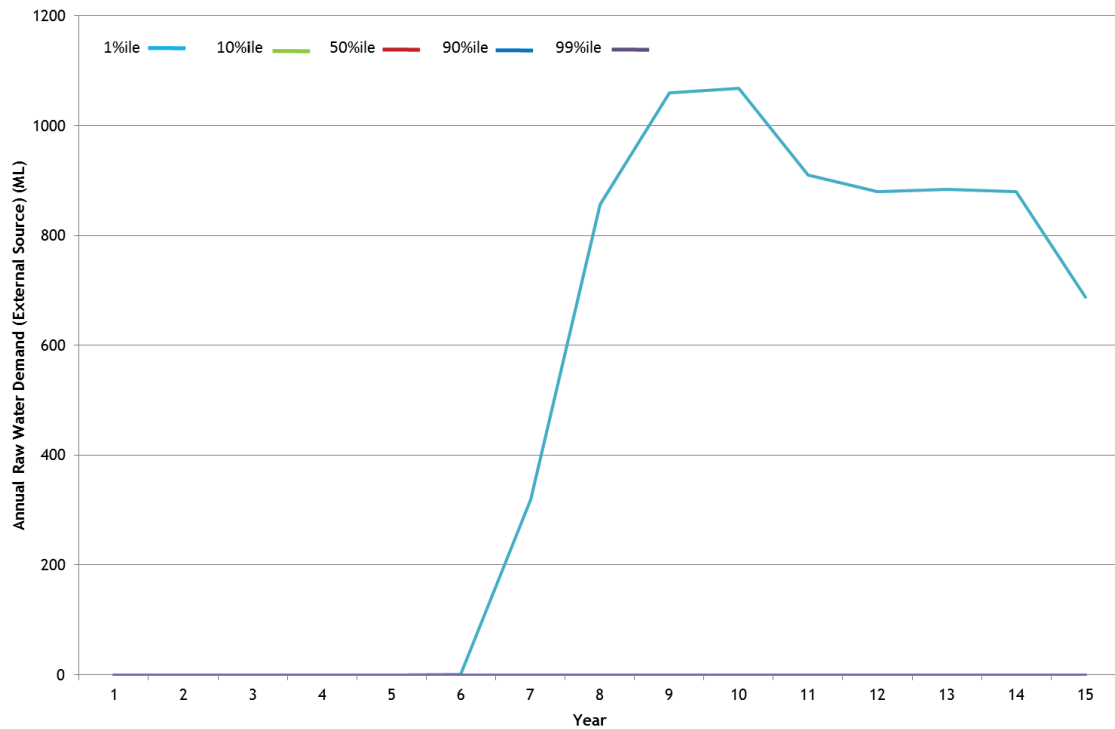


Figure 5.3 - Forecast annual raw water demand, 99th, 90th, 50th, 10th and 1st percentile traces.

5.6.7 Uncontrolled spills from mine water storages

5.6.7.1 Mine water storages

The water balance modelling results indicate that the main mine water storages (Access Road Dam, Savoy Dam, Transfer Dam and the South Void) do not spill over the Project life, for any modelled realisations.

Minor spills of mine affected water were forecast from the Rail Loop Dam over the 15 year period. There is at least a 90% chance in each year that the Rail Loop Dam will not spill. The model predicts that there is a 1% chance that Rail Loop Dam will spill approximately 30 ML of water each year between Year 1 to Year 5 and 35 ML each year between Year 8 to Year 15. It is expected that this spill occurs as a result of the daily time step of the model. In reality, pumps would have been turned on throughout the day when the water level exceeded its pump out threshold to prevent the spill.

5.6.7.2 Sediment dams

The potential for spills from the sediment dams have been assessed using a forecast assessment simulation. The forecast exceedance probability of the annual combined sediment dam discharge volume is provided in Figure 5.4. The results show that:

- there is at least 50% chance in each year that there will be no sediment dam overflows;
- there is a greater change of sediment dam overflow from Year 5 onwards;
- there is at least a 90% chance (10th percentile results trace) in each year after Year 5 that the combined annual sediment dams overflows won't exceed 200 ML; and
- there is at least 99% chance (1st percentile results trace) in each year after Year 11 that the combined annual sediment dam overflows won't exceed 670 ML.

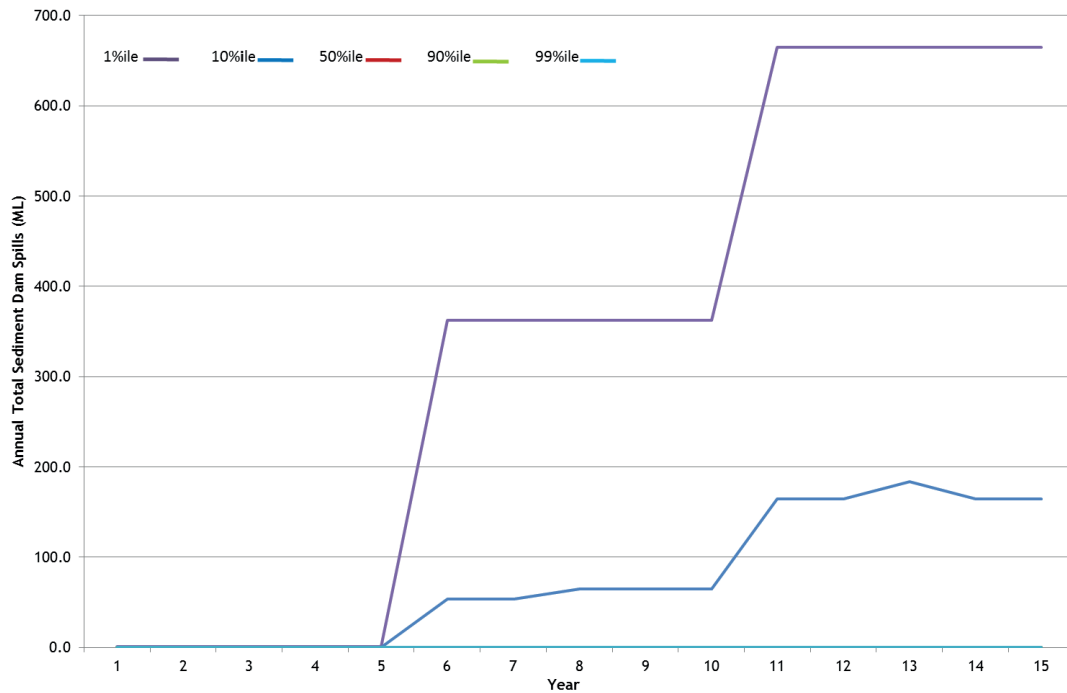


Figure 5.4 Forecast annual combine sediment dam spills, 99th (very dry), 90th (dry), 50th (median), 10th (wet) and 1st (very wet) percentile traces

Table 5.10 shows the forecast spills from the individual dams over the full period of operation for the median result as well as the 90th and 10th percentile confidence limits of the estimate. The results show that:

- the median average annual number of spill days is less than 2 day/year for all sediment dams;
- the median average annual spill volumes is less than 7 ML/year for all sediment dams;
- the 10th percentile average annual number of spill days is less than 1 day/year for Sediment Dam 1 and 2; and
- the 10th percentile average annual number of spill days is less than 5 day/year for Sediment Dam 3, 4, 5 and 6.

5.7 ADAPTIVE MANAGEMENT OF MINE WATER BALANCE

The model results presented above represent the application of the adopted mine water management system rules over the Project life, regardless of climatic conditions. In reality, there are numerous options for adaptive management of the mine water management system to accommodate climatic conditions. For example, when excess water is available on site, it may be possible to increase the application of water for dust suppression. These alternative management approaches would be used to reduce the risks to the Project associated with climatic variability.

Table 5.10 - Forecast spills from sediment dams

Storage	Simulation	Average Annual Spill Volume (ML/yr)	Average Annual Spill Days (days/yr)
Sediment Dam 1	10%ile	18.87	0.65
	50%ile	6.81	0.23
	90%ile	0.00	0.00
Sediment Dam 2	10%ile	5.99	0.66
	50%ile	0.95	0.07
	90%ile	0.00	0.00
Sediment Dam 3	10%ile	11.13	2.99
	50%ile	2.65	0.63
	90%ile	0.00	0.00
Sediment Dam 4	10%ile	2.25	3.91
	50%ile	0.72	1.37
	90%ile	0.01	0.07
Sediment Dam 5	10%ile	9.43	3.99
	50%ile	2.40	1.00
	90%ile	0.00	0.00
Sediment Dam 6	10%ile	6.53	4.83
	50%ile	1.84	1.33
	90%ile	0.01	0.07

5.8 SENSITIVITY ANALYSIS

5.8.1 Overview

The sensitivity of the model results to increased or decreased runoff was undertaken by adjusting the adopted AWBM parameters surface stores (given in Appendix A, Table A.13) by +/- 10%. The resultant long term volumetric runoff coefficient for each land type, with a comparison to the base case, is shown in Table 5.11.

All data inputs to the sensitivity model, excluding the AWBM parameters, are as described in Section 5 for the base case scenario.

Table 5.11 - Adopted AWBM model parameters for various catchment types

Long Term Runoff Coefficient	Mine Site	Industrial/ Hardstand	Unrehabilitated Spoil	Rehab. Spoil	Mining Area	Cleared/ Prestrip
Base Case	4.8%	31.2%	13.8%	8.5%	34.8%	34.4%
High Runoff Scenario	5.5%	33.0%	15.1%	9.3%	36.5%	36.1%
Low Runoff Scenario	4.0%	29.8%	12.5%	7.5%	33.5%	33.1%

5.8.2 Results

5.8.2.1 High runoff scenario

The results of the high runoff sensitivity analysis, compared to the base case (for which results are reported in Section 5.6), are provided below. The results of the high runoff scenario show that:

- for the out-of-pit storage inventory (Figure 5.5):
 - there is a 50% chance that the out-of-pit storages total inventory will rise by approximately 2,806 ML (187 ML/yr on average) over the Project life, compared to a build up of 1,588 ML (106 ML/yr on average) for the base case;
 - there is a 10% chance that at least 6,500 ML will accumulate in the out-of-pit storages over the life of the Project, compared to 5,200 ML for the base case;
 - there remains a 1% chance that the out-of-pit storages will exceed the threshold at which water cannot be pumped in after Year 6 of operations and would remain above that threshold for the entire Project life;
- for the in-pit storage inventory (Figure 5.6):
 - there remains a 50% chance there will be no build up of water in the active mining areas;
 - there is a 10% chance that inundation in the combined mining areas would reach a maximum of at least 300 ML over the life of the Project, compared to 240 ML for the base case. It remains likely that this amount could be redistributed around the site and not significantly impact on mining operations;
 - there is a 1% chance that inundation of the mining areas would reach at least 1,740 ML in Year 12 (compared to 1,060 ML in Year 11 for the base case), with the risk of inundation increasing from about Year 7. This would be expected to significantly impact mining operations but would not impact on the downstream environment;
- there remains a 1% chance that offsite supplies will be required for the Project and this is likely to occur from Year 6 onwards (similar to base case), as shown in Figure 5.7;
- there will be at least a 90% chance that no offsite water will be required under this scenario;
- no modelled spill is found except from Rail Loop Dam. The model predicts that there is a 1% chance that Rail Loop Dam will spill approximately 31 ML of water between Year 1 to Year 5 (compared to 30ML with the base case) and 37 ML between Year 8 to Year 15 (compared to 35ML with the base case);
- for the annual combined spill overflows from sediment dams(Figure 5.8):
 - there is a 50% chance that sediment dams will not overflow;
 - there is a 90% chance of annual combine sediment spills of at most 220 ML (compared to 200 ML in base case); and
 - there is a 99% chance of annual combine sediment spills of at most 715 ML (compared to 670 ML in base case).

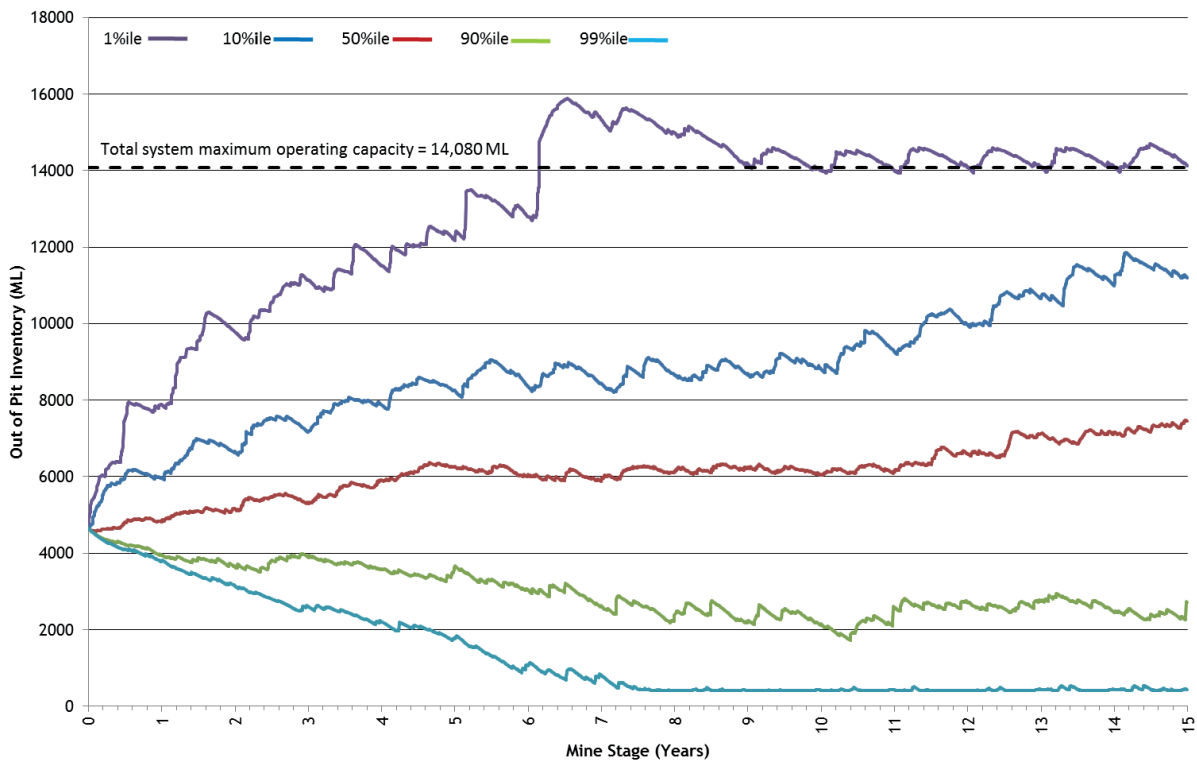


Figure 5.5 - Forecast out-of-pit storage inventory, high runoff scenario

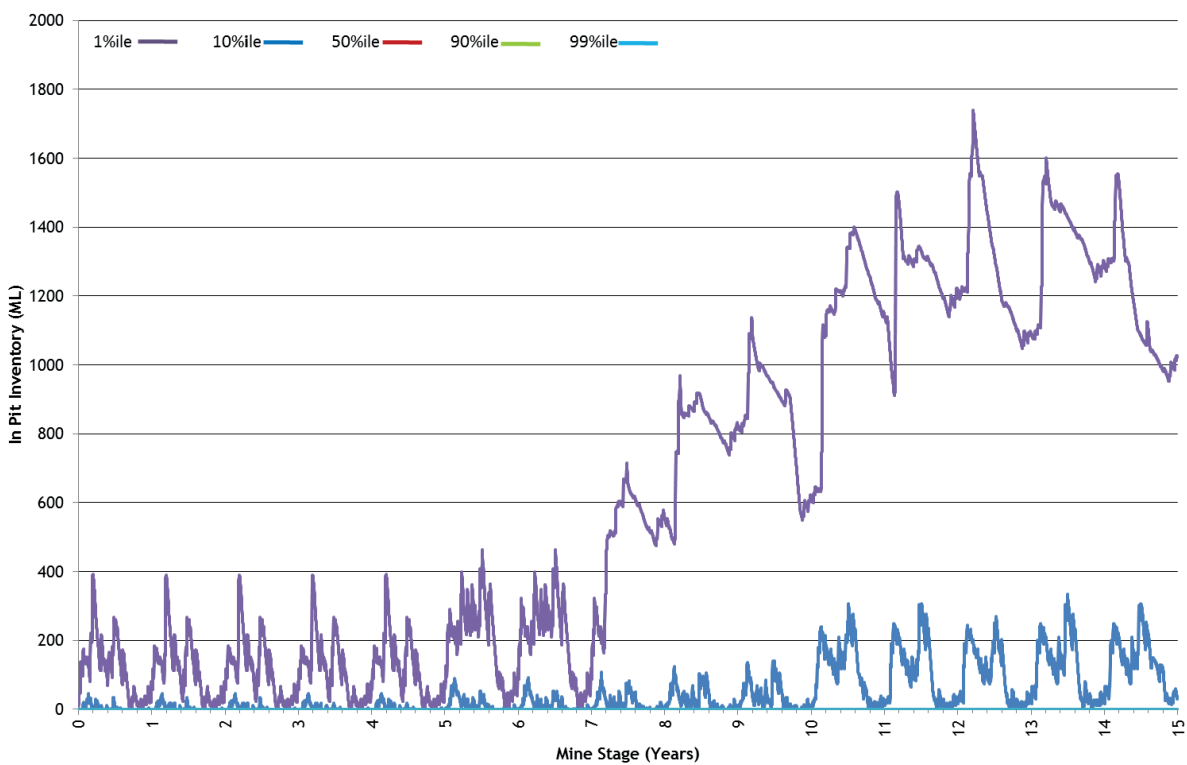


Figure 5.6 - Forecast in-pit storage inventory, high runoff scenario

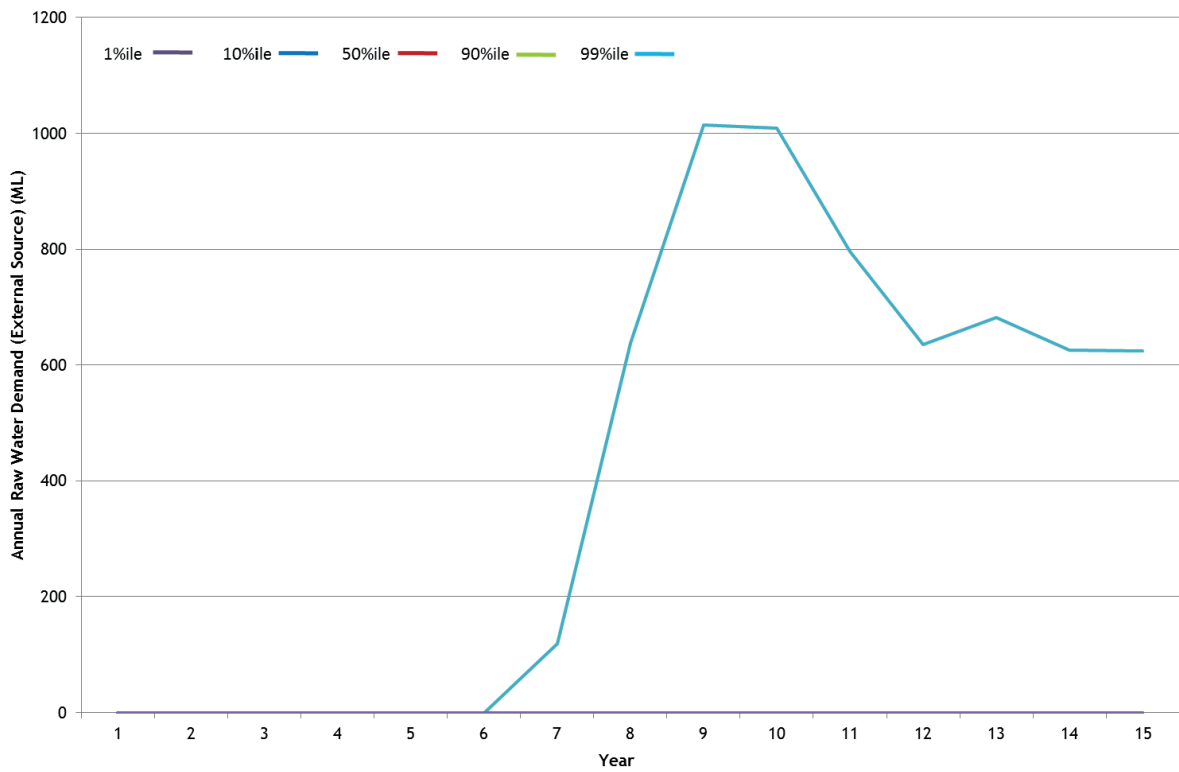


Figure 5.7 - Offsite water requirements, high runoff scenario

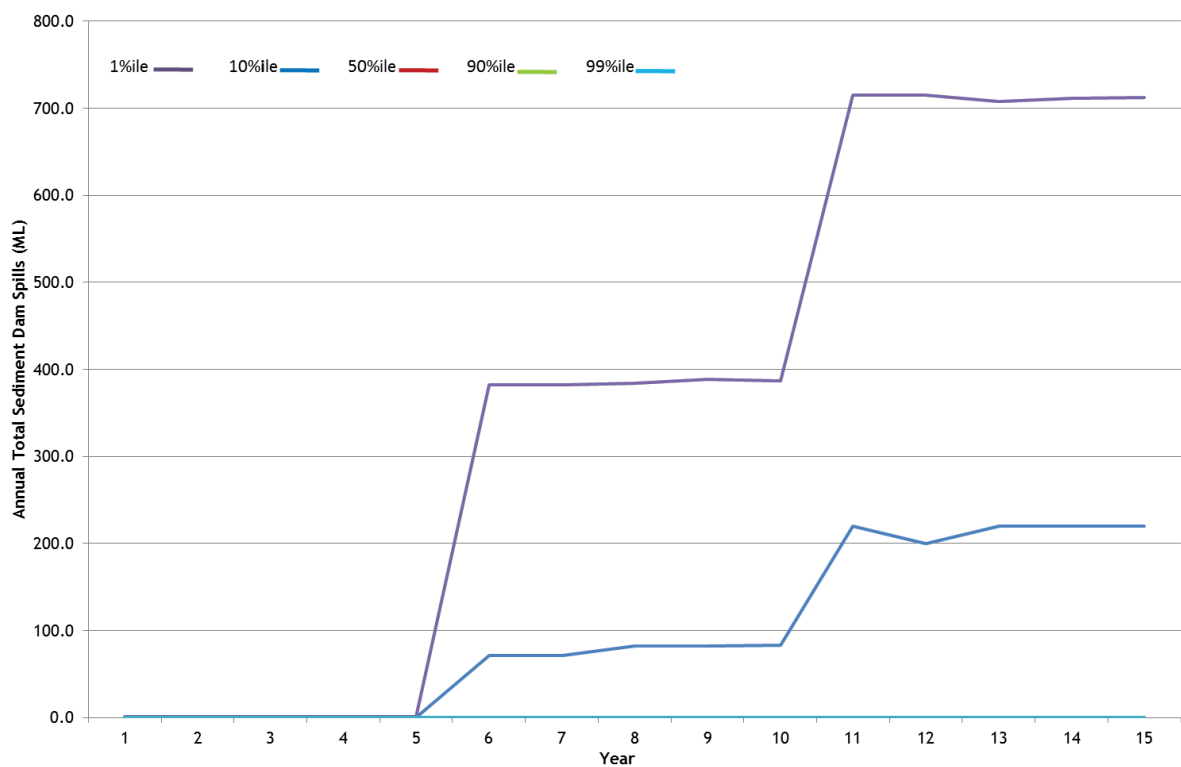


Figure 5.8 - Forecast annual combine sediment dam spills, high runoff scenario

5.8.2.2 Low runoff scenario

The results of the low runoff sensitivity analysis, compared to the base case (for which results are reported in Section 5.6), are provided below. The results of the low runoff scenario show that:

- for the out-of-pit storage inventory (Figure 5.9):
 - there is a 50% chance that the out-of-pit storages total inventory will increase by approximately 482.5 ML (32 ML/yr on average) over the Project life, compared to a build up of 1,588 ML (106 ML/yr on average) for the base case;
 - there is a 10% chance that at least 4,030 ML will accumulate in the out-of-pit storages over the life of the Project, compared to 9,204 ML for the base case;
 - for the majority of Project life, except for in Year 6 and Year 7, there is a less than 1% chance that the out-of-pit storages will reach their combined maximum operating capacity;
- for the in-pit storage inventory (Figure 5.10):
 - there remains a 50% chance there will be no build up of water in the active mining areas;
 - there is a 10% chance that inundation in the combined mining areas would reach a maximum of at least 196 ML over the life of the Project, compared to 240 ML for the base case. It remains likely that this amount could be redistributed around the site and not significantly impact on mining operations;
 - there is a 1% chance that inundation of the mining areas would reach at least 850 ML in each of years 10 to 15 (compared to 1,060 ML in Year 11 for the base case), with the risk of inundation increasing from about Year 10. This would be expected to significantly impact mining operations;
- for the off-site water requirement (Figure 5.11):
 - there will be at least a 50% chance that no offsite water will be required under this scenario in each of years 9 to 11 and years 13 to 15;
 - there will be at least a 90% chance that no offsite water will be required under this scenario in each of years 6 to 8 and Year 12;
 - there will be at least a 99% chance that no offsite water will be required under this scenario in each of years 1 to 5;
 - there is a 1% chance in each of the years from Year 8 to Year 15, that at least 920-1,100 ML/yr is required;
- similar to the base case, no modelled spills occur from the mine affected storages except for the Rail Loop Dam. It is likely that adaptive management of the mine water management system would result in these spills being avoided through the redistribution of water on the Project site, in a similar manner to the base case;
- for the annual combined overflows from sediment dams (Figure 5.12):
 - there remains a 50% chance in each year that sediment dams will not overflow;
 - there is a 90% chance (10th percentile results trace) in each year after Year 5 of annual combine sediment spills of at most 130 ML (compared to 200 ML in base case); and
 - there is a 99% chance (1st percentile results trace) in each year after Year 11 of annual combine sediment spills of at most 615 ML (compared to 670 ML in base case).

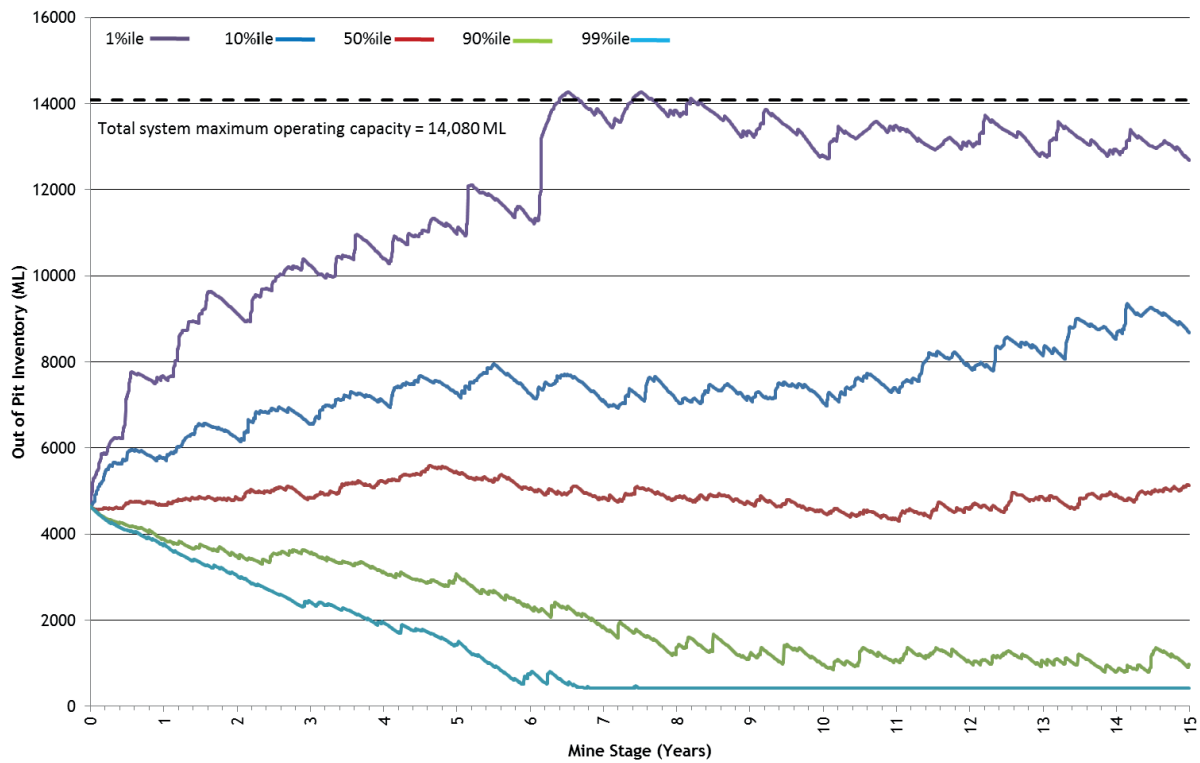


Figure 5.9 - Forecast out-of-pit storage inventory, low runoff scenario

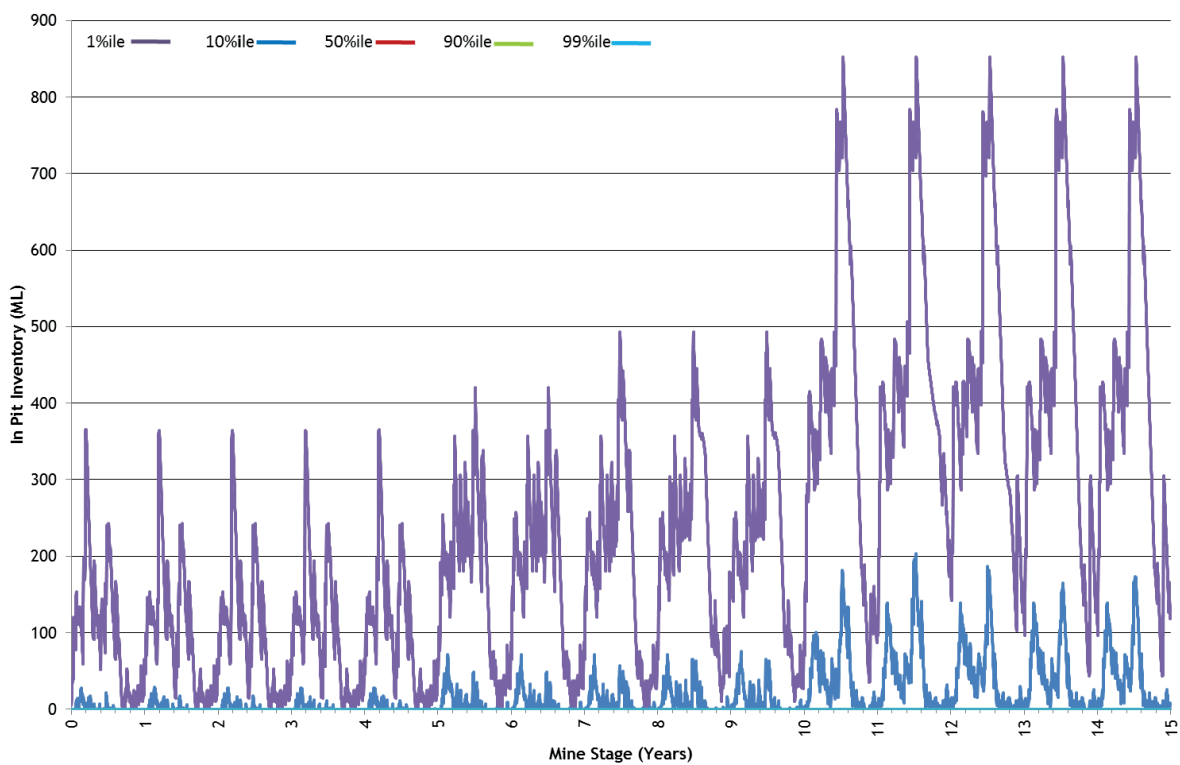


Figure 5.10 - Forecast in-pit storage inventory, low runoff scenario

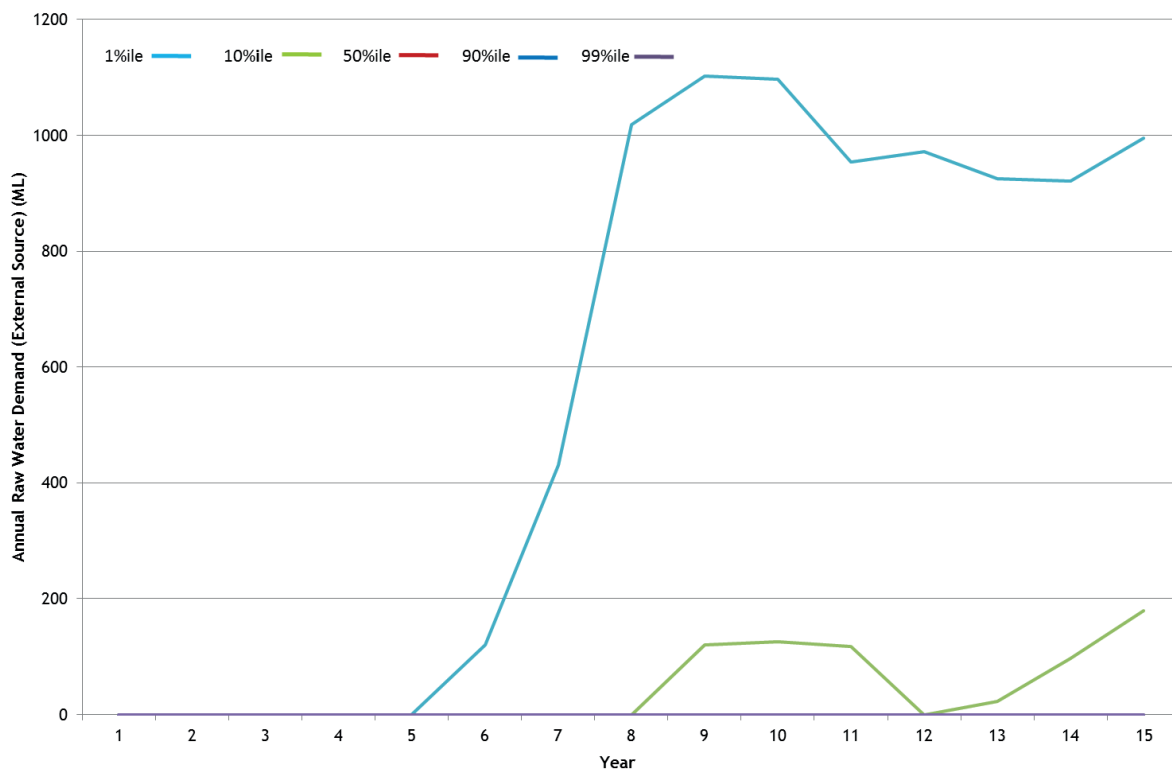


Figure 5.11 - Offsite water requirements, low runoff scenario

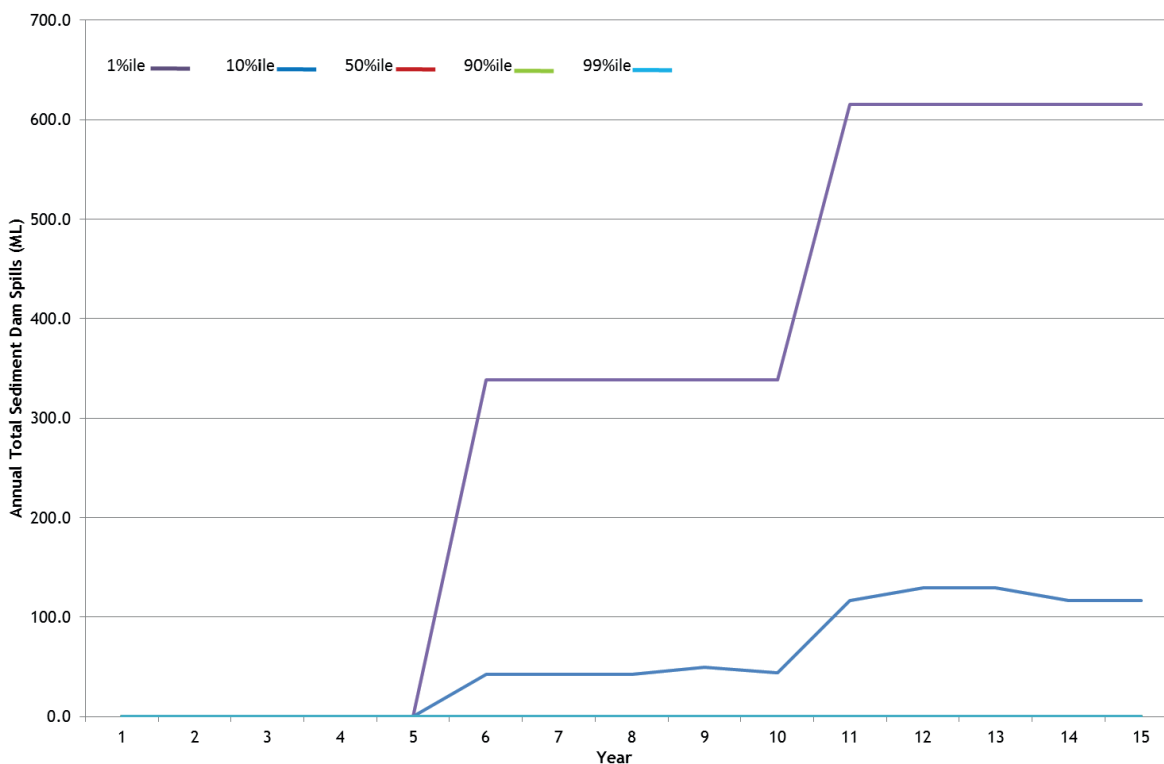


Figure 5.12 - Forecast annual combine sediment dam spills, low runoff scenario

5.8.3 AWBM sensitivity analysis summary

Results for the high and low runoff scenarios show that the Drayton South water balance is robust and continues to operate in accordance with the mine with management principles, detailed in Section 4.2. The results of the two runoff sensitivity models show that:

- no modelled uncontrolled spills occur from the mine water storages, except for the existing Rail Loop Dam. Measures have been developed to prevent uncontrolled spills from is dam;
- there is generally an increase in the risk of requiring water to meet demands in the low runoff scenario, however the forecast chance is small and it is likely the Water Access Licences currently owned by Anglo American will satisfy this supply shortfall under this scenario;
- there is generally an increase in the risk of greater volumes of water accumulating in the active mining areas and in the out-of-pit storages for the high runoff scenario and generally a lower risk for the low runoff scenario. However, there remains at least a 90% chance (10th percentile trace) for both scenarios that inundation of the active mining areas would not be excessive on any particular day and the excess could be likely to be redistributed around the site and not significantly impact on mining operations; and
- for the majority of time after about Year 7, there remains at least a 1% chance on any particular day that mining operations could be significantly affected by water accumulating in-pit in both scenarios.

5.9 SALT BALANCE

5.9.1 Overview

The site water balance model incorporates a mass balance of salt loads in all of the major storages within the Project, to assess the effectiveness of the water management system in managing salinity. Although the site water balance model demonstrates that there will be minimal releases of mine affected water and therefore minimal salts released to the downstream environment, the water balance model can assess the potential for salts to accumulate in the system and where it ultimately reports to.

5.9.2 Sources of salt

Salt loads entering the mine water management system are generated from the following sources:

- catchment runoff to mine site storages;
- groundwater inflows to the open cut pits;
- raw water supply from outside the mine water system; and
- through washing the coal.

The concentrations of salt generated by catchment runoff will vary across the mine site depending upon the level and type of disturbance. The adopted salinity concentrations of the various catchment types are provided in Table A.14. These values are based on the assessment of water quality information currently collected for a number of storages (with non-homogeneous catchments) across the Drayton Complex. The equivalent EC values assuming a typical conversion of 0.75 are also given Appendix A.

Salt will be lost to the mine water system through use either for industrial use, in the CHPP or for dust suppression. Any overflows from the mine water dams would also reduce salt loads within the system, if they occurred.

5.9.3 Average salt balance

Salt inputs to the Project include salts in the raw coal, groundwater inflows, catchment runoff, direct rainfall, and raw water. Salt outputs from the Project include salts which are lost through the CHPP in the rejects and product coal, dust suppression and offsite discharges from the sediment water system.

Salt is also lost from the system internally. The CHPP is a net user of water (which is preferentially sourced from the mine affected water system) that traps water (and salt) in the rejects material. The material is then disposed of within the Drayton Mine North and East voids. The salts that are entrained in the water used for dust suppression are also mostly lost from the system. The increase in salinity of surface runoff from those areas is accounted in the salt balance as an increase in the catchment salt generation rate for these land use classifications (refer A4.8).

A forecast model was used to achieve an indicative salt balance over the on-site storages, presented in Table 5.12, averaged for all 112 realisations for each stage of modelled Project life. Groundwater inflows represent the largest salt inflow to the system. The largest salt flow out of the system is due to the entrainment of moisture and salt in the tailings.

Whilst Table 5.12 provides an indication of the differences in the salt balance between stages, application of the nominated salt loads for other purposes should be undertaken with caution because they represent average results from 112 realisations (climate sequences).

Figure 5.13 shows the forecast probability of modelled total on-site storage salt inventory. The storages include all of the out-of pit storages (the South Void, Transfer Dam, East Void, Savoy Dam, Rail Loop Dam and the Access Road Dam), as well as the active pits and North Void. The median results indicate that, at the end of Project life, there is a 50% chance that the combined out-of pit storages' salt inventory will have increased by about 28,490 tonnes.

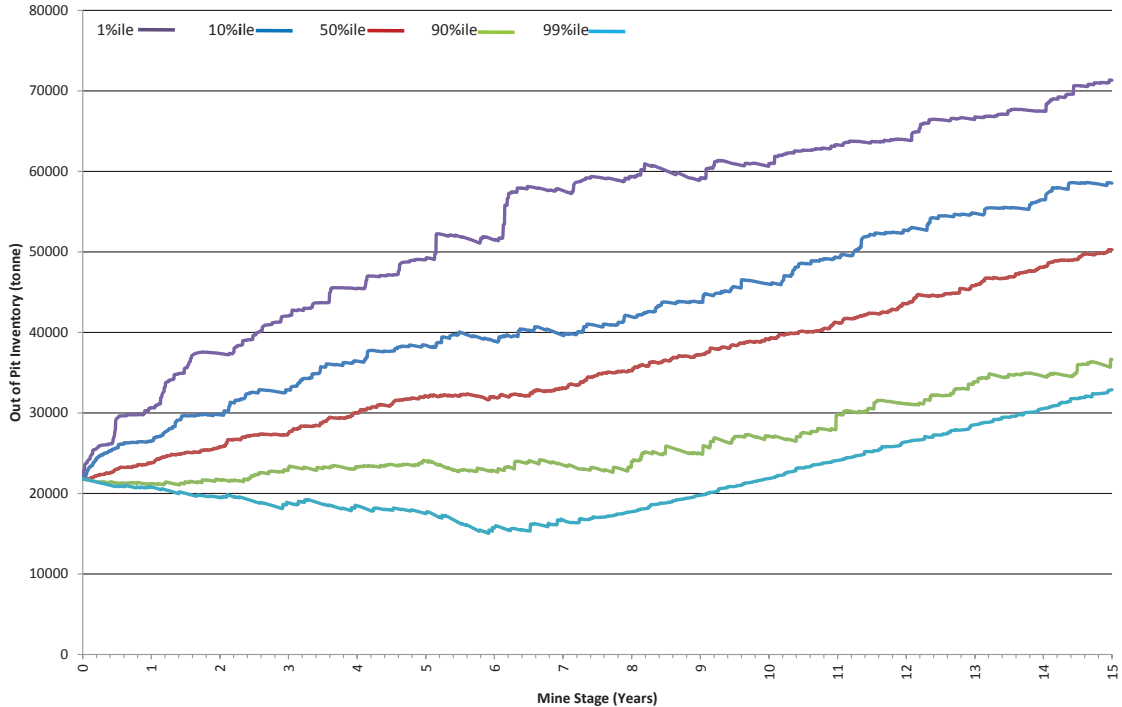


Figure 5.13 - Forecast total on-site storage salt inventory

Table 5.12 - Average annual salt balance (by stage, for all realisations) all on-site storages

Representative Stage	Salt load (t/yr)			Total salt load (t/15 years)
	Year 4 Annual Average for Year 1-5	Year 6 Annual Average Years 6-10	Year 12 Annual Average for Years 11-15	
Salt Inputs				
Rainfall Yield (Direct Rainfall + Catchment Runoff)	3,439	3,869	3,758	55,326
Groundwater Inflow	5,177	5,954	5,580	83,554
ROM Coal	1,276	2,219	2,078	27,861
Raw Water	0	20	25	225
Total	9,891	12,061	11,441	166,965
Salt Outputs				
Evaporation	0	0	0	0
Dust Suppression	1,501	2,373	1,775	28,247
Industrial Demand	2,124	1,819	1,668	28,054
Sediment Dam Spills	0	22	54	381
Mine Water Dam Spills	1	1	1	18
Tailings*	2,951	4,623	3,846	57,104
Product Coal	1,263	1,928	1,738	24,646
Highwall Dam Releases	16	56	38	546
Total	7,857	10,821	9,122	138,996
Change in Salt Load	2,034	1,240	2,320	27,970

*70% of tailings moisture (and salt) assumed lost to the system due to entrainment with tailings or evaporation (tailings decant (30%) retained for use in water storage)

5.10 FINAL VOID STORAGE BEHAVIOUR

5.10.1 Overview

A description of the proposed final landform at Drayton South is provided in Section 4.5 and Figure 4.4 shows the configuration and the major drainage catchments of the indicative final landform at Drayton South.

An OPSIM model was developed to investigate the recovery of water levels and water quality in the Drayton South final void, in consultation with AGE (2015) who were required to provide groundwater inflow information.

5.10.2 Final void groundwater behaviour

The groundwater model of the final landform developed by AGE (2015) consists of two connected components:

- the backfilled overburden will collect and accumulate water sourced from deep percolation of rainfall recharge from the overburden surface and it will also receive groundwater inflow from surrounding geological units; and
- the final void area will collect and accumulate water from direct rainfall and surface runoff from the void catchment and also from the surrounding and underlying backfilled overburden material (once it has saturated). The void will lose water through evaporation from the lake surface and seepage back into the surrounding backfilled overburden.

The modelling of the groundwater system by AGE (2015) predicts the following:

- groundwater from the surrounding geology (i.e. Permian coal measures) migrates into the overburden during recovery, and (combined with rainfall recharge) increases the head within the overburden;
- for the first 30 years, the final void and surrounding overburden will act as a groundwater sink and no outflow of overburden water into the surrounding aquifers will occur;
- after 30 years of recovery a hydraulic gradient is established away from the overburden area (i.e. towards the northwest, west, southwest and south), which induces water to migrate from the overburden into the surrounding geology;
- a hydraulic gradient towards the overburden remains present from the northeast;
- the overburden will act as a 'flow through system', recharged from the north-east and discharging towards the northwest, west, southwest and south;
- rainfall runoff captured in the void prior to about 245 years post mining is predicted to seep into the underlying overburden. The estimated seepage outflow rate for the first 245 years is shown in Figure 5.14;
- after 245 years, the gross outflow of water from the void to the surrounding overburden was approximately 0.2-0.3 ML/d, as shown in Figure 5.14;
- water levels within the final void attain their post-mining equilibrium level of about 128 mAHD after 800 years;
- evaporation from the final void water surface increases from 0 ML/day to a maximum of 1.1 ML/day as the area of the void water surface increases;
- net water movement from the overburden into the void increases from 0 ML/day to a maximum of 0.51 ML/day to replace void water that is lost to evaporation. This is represented graphically in Figure 5.14; and
- the salinity concentration of the water held in the overburden (which then is predicted to seep into the void) was calculated using the relative concentrations of the Permian geology seepage to overburden (Total dissolved solids (TDS) 3,500 mg/L) and of the rainfall recharge to overburden (TDS 2,150 mg/L) and assuming complete mixing occurs (AGE, 2015). The resulting time series of salinity concentration of water stored in the overburden is shown in Figure 5.15.

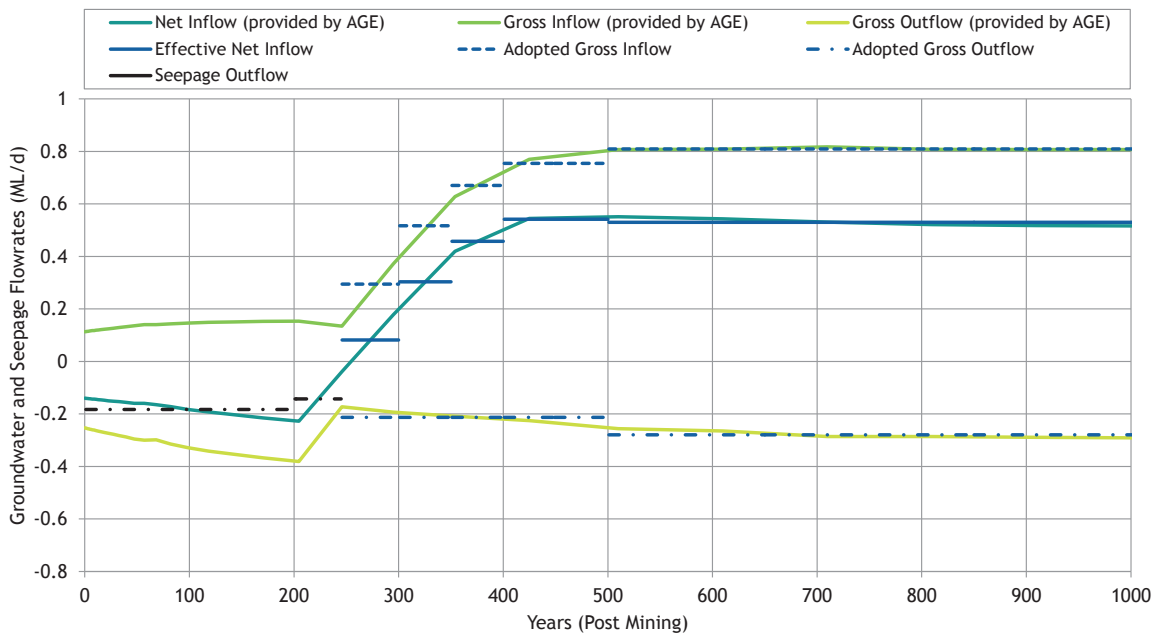


Figure 5.14 - Adopted long term groundwater and seepage inflows and outflows to the final void

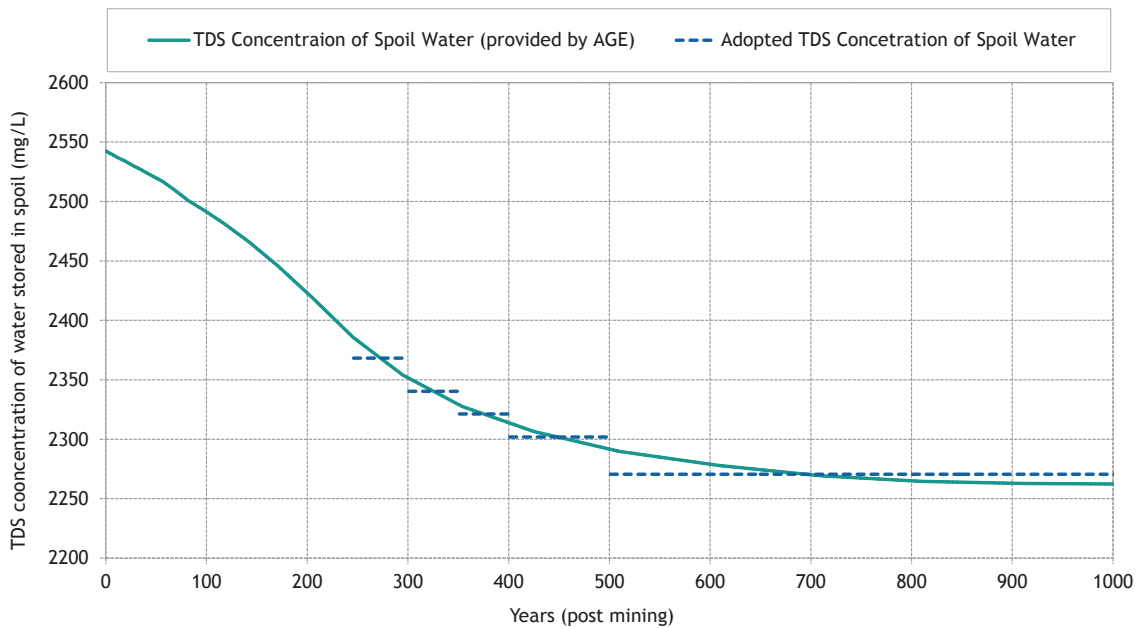


Figure 5.15 - Adopted time series of TDS concentration of water stored in overburden

5.10.3 Drayton South final void OPSIM model configuration

The OPSIM water balance model was developed in consultation with AGE (2015) to achieve acceptable agreement between AGE’s groundwater model of the final void and the surface water model. The OPSIM model was then used to assess the long term build-up of salts in the Drayton South final void. The final void configuration and contributing catchment area are shown in Figure 4.4. To achieve a longer simulation period, which was required to

reach an equilibrium water level, the historical rainfall and evaporation sequences were looped numerous times to create a long term climate record and run as a static simulation.

The configuration of the OPSIM model included:

- the adopted final void catchment area of 264 ha;
- the adopted stage-storage curve was updated based on the final landform contours, shown in Figure 4.4 and provided in Appendix C;
- the final void spill height is approximately 145 mAHD;
- the time series of long term gross groundwater inflows and outflows to the final void, adopted for the OPSIM modelling are shown in Figure 5.14; and
- for the gross inflow of groundwater to the void, which commences from about 245 years post-mining, a time series of TDS concentration was adopted, as shown in Figure 5.15. Prior to about 245 years, there is no groundwater inflow to the void and hence no groundwater salinity input. The TDS concentration leaving the void was calculated by OPSIM assuming full mixing of groundwater and surface water flows.

5.10.4 Final void OPSIM Model Results

The predicted water level and salt concentration represented as TDS in the final void is shown in Figure 5.16 and Figure 5.17, respectively. The results of the assessment are summarised as follows:

- Figure 5.16 and Figure 5.17 show large variations in water level and associated salinity due to the daily 122 year climate sequence, which has been looped and applied to the OPSIM model. The repeated peaks in water level are due to the extended wet periods in 1950 and 1955;
- water begins to accumulate in the final void from around 250 years post-mining onwards (it remains relatively dry until this time);
- the final void water level trends towards approximately 126 mAHD by the end of the 1000 year simulation period. This result is in good agreement with the results produced by AGE(2015), considering the different methodologies and simulation programs used for the surface water and ground water models of the final void;
- the freeboard between the final water level surface and the void spill height is approximately 19 m. Hence, the final void is never likely to fill (nor spill), as a rainfall event causing enough catchment runoff to fill the void is unlikely;
- the salinity in the final void will not begin to increase until saturation of the backfilled spoil occurs and net groundwater inflow to the void begins at about 245 years post-mining;
- the final void reaches an equilibrium salinity level of between 4,250 mg/L to 8,800 mg/L TDS with the occasional spike when the void water levels are low; and
- equilibrium is reached due to the final void acting as a “flow through system”, as described in AGE’s Groundwater Impact Assessment (2015), which provides a pathway for removal of salts from the void.

The potential impacts of the predicted void salinity on the groundwater system are described in AGE’s Groundwater Impact Assessment (2015).

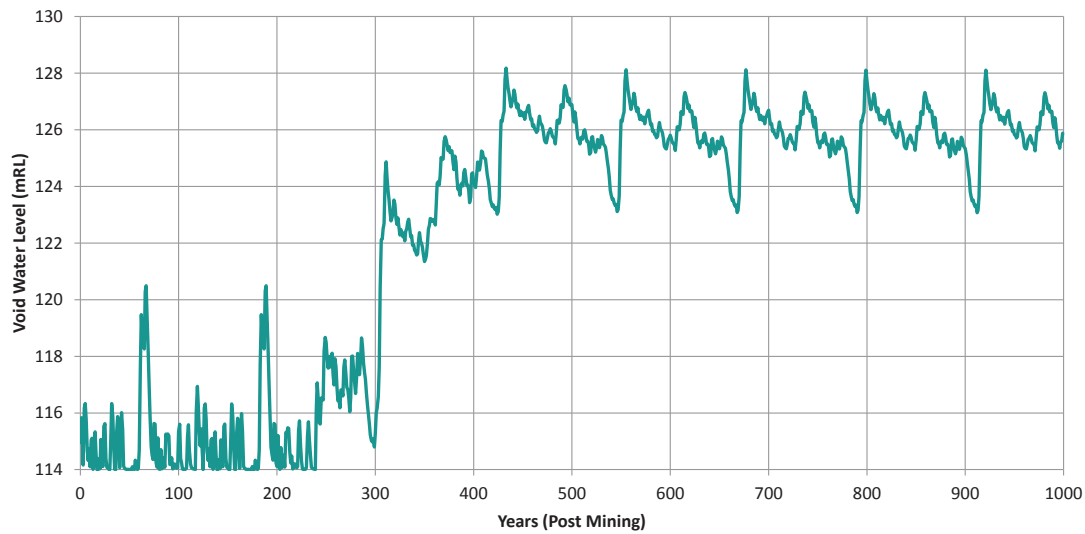


Figure 5.16 - Final void water level

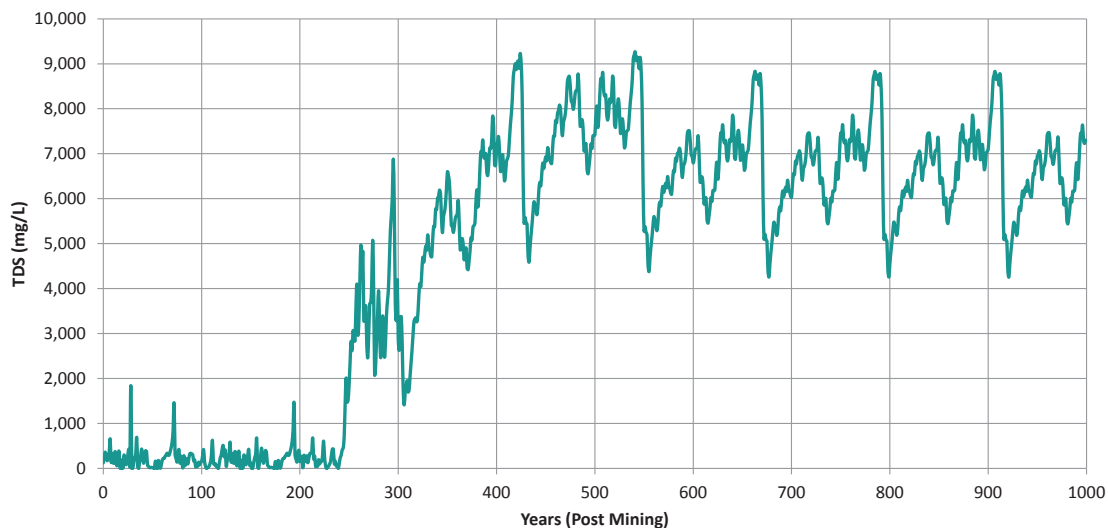


Figure 5.17 - Final void total dissolved solids concentration

5.11 DISCUSSION OF UNCERTAINTY

The water balance model results suggest that the proposed mine site water management system, described in Section 4, will prevent or minimise the potential for mine water to overflow and impact on the water quality in the receiving waters of the Project.

These results need to be interpreted with caution. Whilst the adopted catchment parameters appear reasonable and are based on data collected for an existing operation, there remains some uncertainty with respect to the results.

The purpose of the assessment was to demonstrate that management strategies can be implemented to prevent uncontrolled or controlled spills from the water management system to protect the environmental values of the downstream receiving waters. However, the management system will need to evolve and be operated to recognise the results of future water quality and quantity management programs.

- Should the runoff characteristics (and groundwater inflows) be lower than has been predicted, then Anglo American may need to acquire a WAL from the Hunter River

(or alternatively enter into water sharing agreements with its neighbours) to satisfy mine site demand.

- Should the runoff characteristics (and groundwater inflows) be higher than has been predicted, then Anglo American may need increase dust suppression rates or mine production may be affected.

Under both of these scenarios the environmental values of the downstream receiving waters are managed through existing government regulations.

6 Impact assessment

6.1 POTENTIAL IMPACTS

The potential impacts of the Project are as follows:

- potential to impact on mining operations due to the build-up of water in the active mining areas;
- potential to require offsite water supplies;
- potential to increase Hunter River and Saddlers Creek flood levels and flood extent;
- potential to reduce Hunter River and Saddlers Creek catchment flows; and
- potential to impact on regional and local surface water quality.

An analysis of the potential impact on mining operations and potential requirements for offsite water supplies is discussed in Section 5. An assessment of the other potential impacts is given below.

6.2 FLOODING

6.2.1 Hunter River

The Hunter River crosses the south western corner of EL 5460 and flows within 4.5 km of the western edge of the Project Boundary. Muswellbrook Shire Council has developed a flood study of the Hunter River (Worley, 2014) in accordance with the NSW Floodplain Development Manual. The 1% AEP flood levels in the Hunter River are about 96m AHD at the Saddlers Creek confluence and 85.4m AHD at the Golden Highway bridge crossing. PMF flood levels are about 3m higher at both locations.

The Project Boundary has been set away from the Hunter River so that no part of the study area or disturbance footprint (with the exception of the Hunter River pumping infrastructure) will be impacted by Hunter River flooding. The lowest elevation of the disturbance boundary is about 117m AHD, some 19 m in elevation above the PMF. Therefore the project is not prone to Hunter River flooding.

It is proposed to construct a pipeline to extract water from the Hunter River about 500 m downstream of the Golden Highway Bridge (Bowman's Crossing). The majority of the pipeline infrastructure will be located on the high bank of the Hunter River above the 1% AEP flood level at this location (approx. 85m AHD). The pump station will be designed in accordance with set standards and following consultation with NOW.

6.2.2 Saddlers Creek

Figure 3.6 shows that the Drayton South disturbance boundary is located outside of the PMF extent of Saddlers Creek for pre-mine conditions. That is, none of the disturbance footprint is located on flood prone land as defined by the NSW Flood Prone Land Policy. At its closest point, which is the haul road corridor, the disturbance footprint is located some 25 m from the edge of the pre-mine 1% AEP flood extent and 15m from the edge of the PMF extent. The methodology used to estimate the flood extent is given in Section 3.6. The Project and the adjoining Mt Arthur Coal Mine will reduce the contributing catchment of Saddlers Creek and hence the post-mine flood discharges and flood extent will be reduced from that given in Section 3.6. That is, any infrastructure proposed within disturbance footprint for the Project will not impact on Saddlers Creek flood levels.

6.3 LOSS OF CATCHMENT FLOWS

6.3.1 Saddlers Creek

Table 6.1 shows the changes in the catchment area draining to Saddlers Creek, measured at the Hunter River confluence, over the life of the Project. The runoff collected in the highwall dams will be pumped to Saddlers Creek during mining and will not lead to a loss of catchment flow. The catchments draining to the Transfer Dam, Savoy Dam and the mining areas will not drain offsite during the life of the Project. The sediment dams are normally dewatered to the mine water management system, however releases can be made provided their water quality meets the EPL requirements. Nevertheless, to provide a conservatively high estimate of loss of catchment flows, the sediment dam catchments will be assumed to not drain to the receiving environment during mining operations. At the completion of the Project, the proposed Transfer Dam and sediment dams will be removed and the final void catchment minimised.

Table 6.1 - Changes in Saddlers Creek catchment area

Mine Stage	Catchment Area (ha)							Total
	Open Cut	High Wall Dams	Transfer Dam	MIA Dam	Savoy Dam	Sediment Dams	Undisturbed/ Rehabilitated	
Pre-mine	0	0	0	0	0	0	9718	9718
Existing	189.6*	0	0	0	41.7	0	9676.3	9718
Yr 4	559.2*	237.9	13.4	8.2	41.7	179.3	9237.5	9718
Yr 6	736.1*	848.8	13.4	8.2	41.7	260.5	8545.4	9718
Yr 12	838.6*	568.6	13.4	8.2	41.7	456.3	8629.8	9718
Final	264	0	0	0	41	0	9413	9718

*includes Saddlers Creek catchment component of mining area at Drayton North (South Void and West Void).

The following is of note with respect to the loss of catchment area:

- the pre-mining catchment, shown in Figure 3.1, is based on the 1:25,000 topographic maps prior to the commencement of mining on both Drayton Mine and Mt Arthur Coal Mine and works on the adjoining AGL Macquarie site;
- under existing conditions, the South Pit, West Void and Savoy Dam at Drayton Mine reduce the Saddlers Creek catchment by some 231 ha (2%);
- the greatest loss of Saddlers Creek catchment occurs about Year 12 of the Project. At this time, the catchment contributing runoff to Saddlers Creek would reduce by 520 ha (5%); and
- the final void (plus Savoy Dam) will permanently reduce the Saddlers Creek catchment by 305 ha (3%).

Mt Arthur Coal Mine is also located in the Saddlers Creek catchment. The existing disturbance footprint on Mt Arthur Coal Mine (currently 975 ha) takes up some 10% of the pre-mine Saddlers Creek catchment. It is understood that mining at Mt Arthur Coal Mine will extend in a south westerly direction taking up a further 8% of the catchment between Saddlers Creek and Edderton Road. The drainage and catchment characteristics on the Mt Arthur Coal Mine during the operation and mine closure phases of the Project are not known. Assuming the existing disturbance footprint does not drain to Saddlers Creek and is not returned to the creek at the completion of mining, a total of 15% of the catchment could be removed as a result of both the Project and Mt Arthur Coal Mine. The catchment will reduce by a total of 13% at the completion of the Project.

There are no licensed water users on Saddlers Creek that could be impacted by the reduction in catchment flows. However, the reduction in catchment flows could potentially alter the geomorphic characteristics and ecological value of the Saddlers Creek waterway. Cumberland Ecology (2015) determined that the ecological integrity of the existing Saddlers Creek channel was generally severely or extremely impaired due to existing land use practices. The ecological integrity was sound at one location, which was at the location of greatest disturbance at the existing farm dam 800m upstream of Edderton Road. The habitat value was found to be low with little or no in-stream vegetation or rocks and snags for aquatic fauna. The existing stream morphology is directly related to the ecological integrity and is highly degraded. Measures to improve the ecological value and geomorphic integrity of the waterway and mitigate the impact of the loss of catchment flows are given in Section 7.3.

6.3.2 Saltwater Creek

Plashett Dam on the AGL Macquarie site already has a significant impact on Saltwater Creek catchment flows. The Saltwater Creek catchment is 5,321 ha, 77% of which currently drains to Plashett Dam. Any releases from Plashett Dam are made to a low flow channel and not directly to the Saltwater Creek channel. As a result, the only flows draining to Saltwater Creek under existing conditions is the catchment downstream of Plashett Dam.

A small area (11.7 ha) is removed from the Saltwater Creek catchment under existing conditions due to the South Void at Drayton Mine, upstream of Plashett Dam. No additional catchment will be removed from the Saltwater Creek catchment as a result of the Project because the proposed disturbance footprint will remain to the north of the ridgeline between the Saddlers Creek and Saltwater Creek catchments.

6.3.3 Hunter River

During the life of the Project, the catchment draining to the Hunter River at Liddell will reduce by a maximum of 520 ha, or 0.04%. For post-mining conditions, the final voids will reduce the Hunter River catchment to Liddell by 0.02%.

6.4 SURFACE WATER QUALITY

Land disturbance associated with mining has the potential to adversely affect the quality of surface runoff in downstream receiving waters through increased sediment loads. In addition, runoff from active mining areas (including roads, coal stockpiles, etc.) may have increased concentrations of salts and other pollutants compared to natural runoff. By implementing an effective system of mine water management, the Project will ensure no adverse impact on the receiving waters of Saddlers Creek. Key elements of the proposed water management system include:

- minimise the area of disturbance as much as possible;
- diversion of runoff from undisturbed catchments away from disturbed areas, wherever possible, using surface drains;
- treatment of runoff from overburden emplacements using sedimentation dams prior to discharge from the site; and
- runoff from mining areas (including coal stockpiles) will be collected within mine water dams for recycling on site and will not be released from the site.

Details of the proposed mine water management system are provided in Section 5. Water balance modelling has been undertaken to demonstrate that the operation of the mine water management system will ensure that no controlled or uncontrolled releases occur from the mine water dams. Hence, the Project will not adversely affect surface water quality in downstream receiving waters including downstream water-dependent fauna and flora and therefore having no detrimental impact on the water quality objectives given in Section 3.5.1. The methodology and results of the water balance modelling for the Project are provided in Section 5.

6.5 WATER ALLOCATIONS

6.5.1 Hunter Unregulated and Alluvial Water Source

The water management system for the Project has been designed to minimise the capture of clean runoff wherever possible. Highwall dams are proposed to capture clean water runoff that would have drained into the open cut mining areas. Water collected in these dams will be pumped/drained into Saddlers Creek. The remaining dams are solely for the capture, containment and recirculation of mine affected water consistent with best management practice to prevent the contamination of a water source. These types of dams are “excluded works” and are exempt from the requirement for water supply works approvals and Water Access Licences. Therefore the water captured in these dams is not subject to licencing.

Under the WM Act, landholders in most rural areas are permitted to collect a proportion of the rainfall runoff on their property and store it in one or more dams up to a certain size. This is known as a 'harvestable right'. A dam can capture up to 10 percent of the average regional rainfall runoff for their landholding without requiring a licence. The landholding area required for the purposes of the harvestable right calculation is the Project's contiguous landholding (4,766 ha). Based on the Project's contiguous landholding and a harvestable rights multiplier value of 0.07 ML/ha for the relevant area, the total harvestable right for the Project is 334 ML.

Consultation undertaken by Hansen Bailey with NOW indicated that predicted average annual take from the Hunter Unregulated and Alluvial Water Source (Jerrys Management Zone) was to be calculated based on the following:

- a volumetric runoff coefficient has been estimated using the assumptions underlying the NOW harvestable rights calculator, i.e. average annual rainfall (575 mm from the long term SILO Datadrill synthetic data set), a harvestable rights multiplier of 0.07ML/ha and capturing 10% of average annual runoff:
 - 10% of runoff = 0.07 ML/ha = 7 mm runoff, therefore 100% of runoff = 70 mm. 70mm of runoff/575 mm average annual rainfall = volumetric runoff coefficient of 12%.
- dams on first and second order streams that have diversions to maintain upstream runoff downstream do not need to be considered within licence entitlements;
- dams (or in this case works) on third order streams must obtain necessary licence entitlement;
- the relevant area for calculation of water take during operations is the maximum catchment area draining directly to a third order water course and contained within the Project disturbance boundary (162.5 ha, as shown in Figure 6.1); and
- the relevant area for calculation of water take for post-mining is the final void catchment area (264 ha, as shown in Figure 4.4), which does not intercept third order water courses.

Based on the above, the average annual water take during operations for licensing considerations is 114 ML/yr.

The annual take requiring licensing once the final landform at Drayton South, based on advice from NOW, is 185 ML (or 0 ML if harvestable right is taken into account).

The Jerrys Water Source, to which the Project applies, is a component of the unregulated river water source and is limited by an entitlement of 10,278 units (ML/yr). The predicted average annual impact on the total share component for the Jerrys Water Source under the HUAWS is negligible.

Relevant licences for the water take from the Hunter Unregulated and Alluvial Water Source (Jerrys Management Zone) will be obtained if required.

6.5.2 Hunter Regulated River Water Source

The potential requirement for raw water supply from the Hunter River, under the Hunter Regulated River Water Source, has been assessed using the water balance model in Section 5.6.6. The results show that there is at least a 99% chance in each year from Years 1 to 5 that off-site supplies will not be required to supply operational demands and at least 90% chance in each year that off-site supplies will not be required for the remainder of Project life. There is a 1% chance in each of the years from Year 8 to Year 14, that at least 860-1000 ML/yr is required. Although the risk of requiring off-site water supply is higher towards the end of Project life, there is still only a low chance of this occurring.

Anglo American currently holds two general security Water Access Licenses (WAL1066 and WAL491) totalling 198 units (ML/yr) of volumetric licence water allocation from the Hunter River that will be used to supply the raw water demand. The results of the water balance modelling indicate that there is a reasonable probability that these WAL's will not be required to meet the operational demands of the Project, with a less than 1% chance in each of the first 5 years that this allocation will be required and between a 1%-10% chance for each remaining year.

Should dry conditions prevail at any time over the Project life, there is at least a 90% chance each year that the existing WAL's will be sufficient for the Project. It also shows that the allocation will not be needed for at least the first 6 years of the operation until the existing inventory (assuming they are not replenished by rainfall) are depleted.

Should very dry conditions (1%ile probability) prevail at any time during the life of the Project, Anglo American proposes to negotiate water sharing arrangements with their neighbours such as AGL Macquarie or Mount Arthur Coal to supply the mine site demand. Alternatively a WAL or a temporary transfer will be acquired on the open market.

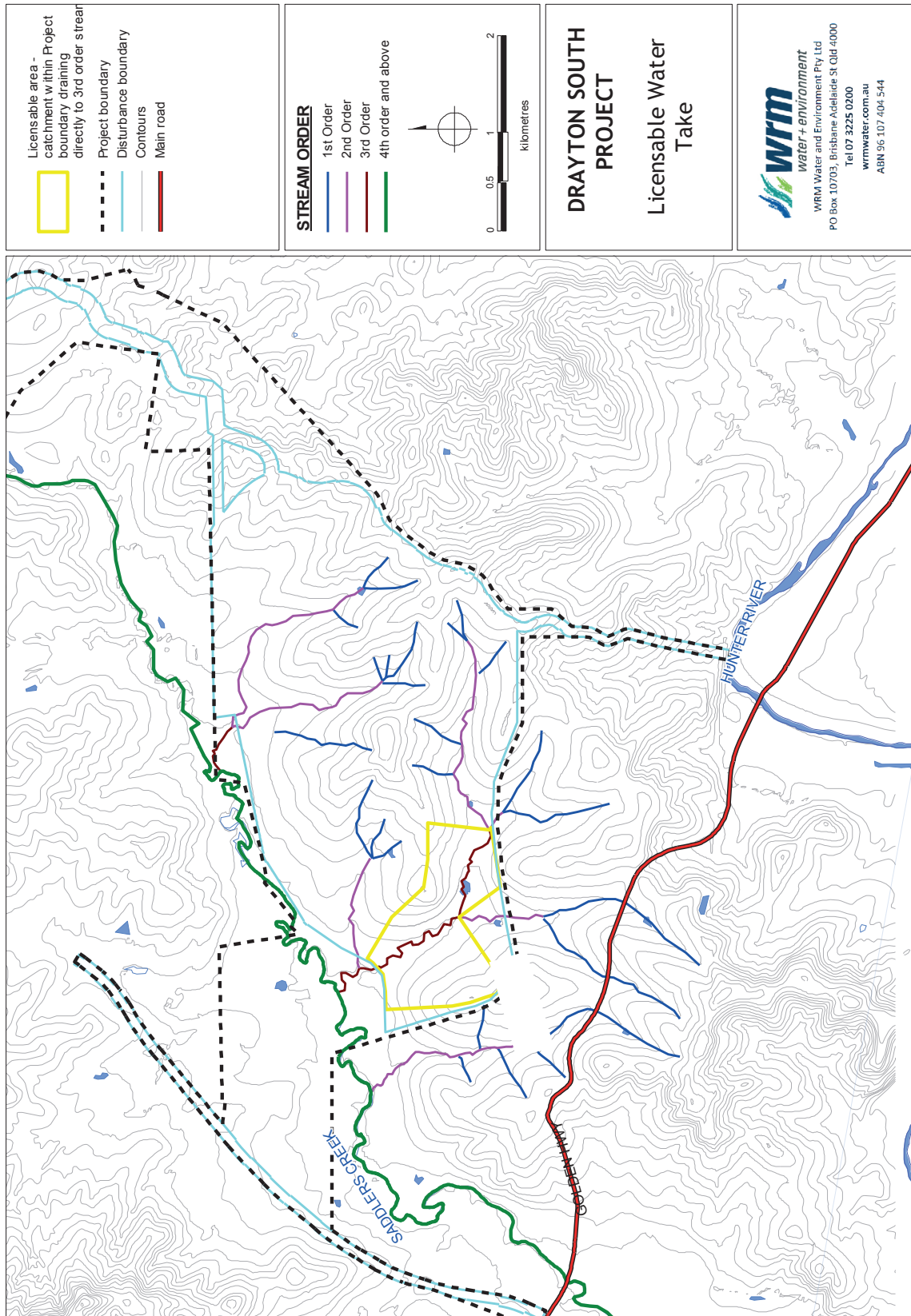


Figure 6.1 - Licensable catchment area during operations

6.6 CUMULATIVE IMPACTS

There are currently numerous mines operating in the Hunter River catchment, both upstream and downstream of the Project, and one other mine operating upstream of the Project in the Saddlers Creek catchment (Mount Arthur Coal). With respect to cumulative impacts on water supply, any take of water from the Hunter River, whether it be for industrial or agricultural use is managed through the Water Sharing Plan for the Hunter Regulated River Water Source. This plan is a legal document made under the WM Act. The water sharing rules in this plan are designed to provide for the environmental needs of the river, as well as directing how water will be allocated and shared among different water users. In other words it has considered the cumulative impacts of ALL water uses in the catchment to ensure the environmental needs of the catchment are satisfied. The Project will comply with the provisions of this plan to ensure the cumulative impacts are minimised.

There will be some loss of catchment and reduction in flow associated with the Project. The final void will be located within the Jerrys Water Source. As stated in Section 6.5.1, the loss of catchment area to Jerrys Water Source under the HUAWSP at the completion of mining is small. Relevant licences for the water take from Jerrys Water Source will be obtained if required. Several final voids in this catchment would be required before an impact on this water source be measurable.

With respect to water quality, the Environmental Protection Licence (EPL) release conditions given under the *Protection of the Environment Operations Act 1997* will ensure cumulative impacts on water quality from the Project and any other project are managed. The water quality release conditions will be based on background water quality in the receiving waters. On this basis, the quality of releases should be no worse than the background water quality of Saddlers Creek or the Hunter River. This would be the case if multiple mines were releasing at the same time.

7 Mitigation and management measures

7.1 MINIMISATION OF OFFSITE WATER USE

It is proposed that a dust suppressant be applied to haul roads, ramps and mine site facilities to reduce dust, minimise water use and the need for offsite supplies. Based on information supplied by Anglo American, road watering requirements when used in conjunction with the proposed dust suppressant agent will be applied at an application rate of 0.015 L/m²/hr. Watering rates of 0.08 L/m²/hr are expected with an alternative dust suppressant agent and much higher rates when no dust suppressant is used.

The water balance modelling found that the use of the proposed dust suppressant agent will reduce the need for importing water from offsite for all but severe drought conditions.

7.2 HUNTER RIVER PUMP SITE

Should it be required, a pump station will be constructed on the Hunter River about 500 m downstream of the Golden Highway Bridge (Bowman's Crossing) to extract water from minesite use. The pump station structure will require a water supply works approval under section 92 of the WM Act. However, the Project will receive the benefit of Section 89J of the EP&A Act if it is approved. This section states that a Project approved under Part 4 of the EP&A Act will be exempt from the requirement to obtain a Controlled Activity Approval under section 91 of the WM Act. If required, the pump station will be located on the high bank of the Hunter River and the inlet will be designed in accordance with set standards and in consultation with NOW.

7.3 RESTORATION OF SADDLERS CREEK

In conjunction with advice from the Hunter-Central Rivers Catchment Management Authority, a comprehensive restoration program for Saddlers Creek will be undertaken to improve its ecological integrity and geomorphic condition, and to mitigate the impact of the loss of catchment flows. This program is currently being progressed in a partnership arrangement between Anglo American and Hunter-Central Rivers Catchment Management Authority. A summary of the restoration program is as follows:

- the retention and improvement of 24 ha of existing vegetation that is situated within the immediate vicinity of Saddlers Creek;
- the regeneration of a wide, dense riparian zone comprised of local provenance species along the length of Saddlers Creek to provide habitat for native fauna and flora;
- the stabilisation of channel banks and flats with rapid growing native groundcover and link with existing communities to form broader habitat corridors;
- the exclusion of stock from the entire length of channel by fencing to prevent direct soil disturbance from their hooves;
- densely vegetating the in-stream with Phragmites and other aquatic vegetation to trap sediment and prevent erosion;
- the creation of pools and sediment bars by creating weirs through the reinstatement of snags and woody debris; and
- soil conservation earthworks to minimise sediment from overbank areas.

The proposed restoration program will leave Saddlers Creek in a much better condition both during and at the completion of the Project. Ongoing monitoring and rehabilitation criteria will confirm the success of the restoration program.

7.4 RECONSTRUCTION AND RESTORATION OF THE SADDLERS CREEK GULLIES

At the completion of mining, the gullies within the disturbance boundary will be rehabilitated to perform in a similar manner to existing conditions. The final landform and drainage configuration have been designed to replicate the surrounding geomorphic landform using the Geofluv™ method. This method attempts to design erosion resistant upland slopes and related stream channels and to integrate them into a functional and stable landform. The design of the final landform may be refined prior to the completion of mining once there is a better understanding of the overburden material characteristics. The general drainage characteristics of the final landform at Drayton South are shown in Figure 4.4.

7.5 SURFACE WATER MONITORING PLAN

Surface water monitoring for the Project will be undertaken to demonstrate compliance with regulatory requirements, as well as improve the understanding and efficiency of the site water management system. The proposed monitoring program for the Drayton Complex addresses the following issues:

- water quality - to understand the quality of water stored on site and demonstrate no adverse impact on receiving waters;
- water balance - to understand the volumes of water associated with key processes on site and comply with conditions of Water Access Licences;
- system integrity - to ensure that the site water management system is operating as intended and minimising safety and environmental risks;
- erosion and sediment control - to demonstrate compliance of the erosion and sediment control system with EPL conditions; and
- stream health monitoring - to ensure that the condition of the drainage lines external to the approved disturbance boundary is not impacted by the project.

The proposed monitoring locations are shown in Figure 7.1. A summary of the proposed surface water monitoring program is provided in Table 7.1. Table 7.1 also shows the trigger levels to undertake investigative or corrective action under the Surface Water Response Plan (see Section 7.6).

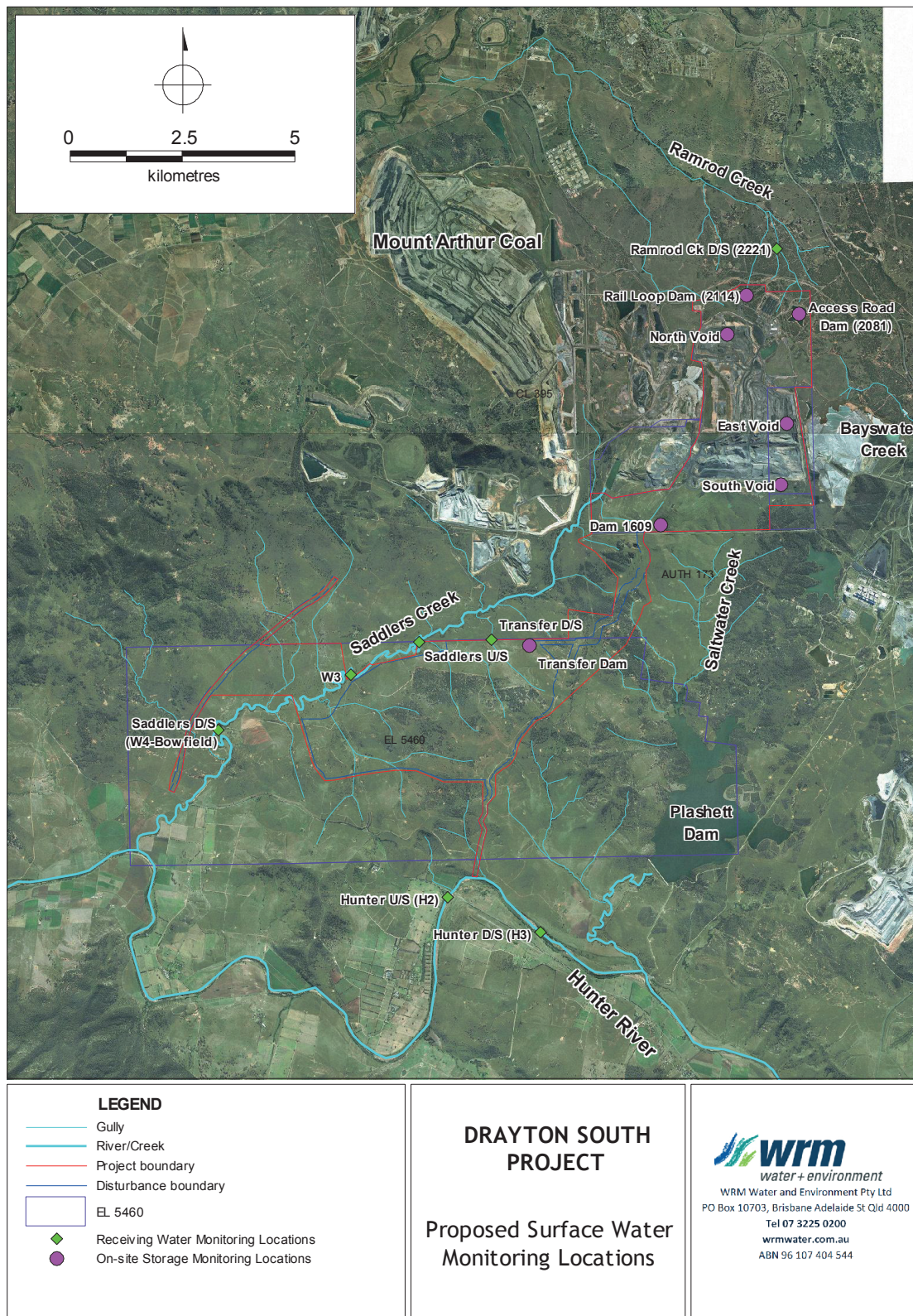


Figure 7.1 - Surface water monitoring locations

Table 7.1 - Surface water monitoring summary

Issue	Monitoring Location	Monitored Parameter	Monitoring Frequency	Trigger Event/Comment
Water quality	Saddlers U/S Hunter U/S (H2)	Water level (gauge plate), pH, EC, Turbidity (Field) + Lab analysis suite (see Table 7.2)	Following 25 mm/d of rain or during release	Upstream Baseline Data
	Saddlers D/S (W4) Hunter D/S (H3) Transfer D/S Ramrod D/S (2221)	Water level (gauge plate), pH, EC, Turbidity (Field) + Lab analysis suite (see Table 7.2)	Following 25 mm/d of rain or during release	Exceedance of water quality trigger values (see Table 7.3)
Water Balance	Mine Water Storages - (Transfer Dam, South Void, East Void, North Void. Access Road Dam, Rail loop Dam)	Water level (gauge plate), pH, EC, Turbidity (Field) + Lab analysis suite (see Table 7.2)	Monthly Daily During Release	Stored volume greater than 50% full and water quality parameter outside range of historical values by > 20% (after at least 1 year data).
	Sediment dams	pH, EC, Turbidity (Field)	When 5 day rainfall > 35.9 mm	Water quality parameter outside license conditions
Water Balance	On site	Lab analysis suite (see Table 7.2)	Daily during release	
	On site	Rainfall	Continuous	1 day rainfall > 25 mm and 5 day rainfall > 35.9 mm
External water supply	On site	Weather forecast	Daily	Forecast heavy rainfall
	CHPP	Raw water volume	Daily	Pro-rata use exceeds licensed volume by >10%.
Mine Water Storages/ water truck fill points	CHPP	CHPP water consumption	Daily	Internal use for water balance and not reported
	Mine Water Storages/ water truck fill points	Total water volume for dust suppression	Daily	Internal use for water balance and not reported
Open Cut Pits	Mine Water Storages	Stored volume	Monthly or following 25 mm/d of rain.	Stored volume exceeds MOV in Table 4.2
	Open Cut Pits	Stored volume and volume of pumping from pit	Monthly	Internal use for water balance and not reported

Issue	Monitoring Location	Monitored Parameter	Monitoring Frequency	Trigger Event/Comment
	Major pipelines	Pumping volume	Daily	Internal use for water balance and not reported
System integrity	Pumps and pipelines	Inspection for leaks / damage / correct operation	Monthly	Observed damage, major leaks or inoperable
	Dams	Inspection of embankment and spillway	Annually	Embankment or spillway damage and structural failure
Erosion & sediment control	Sediment dams	Inspection to assess sediment accumulation	Monthly or when 5 day rainfall > 35.9 mm	Sediment accumulation > 50% of sediment storage capacity
	Sediment dams	Evidence of overflow	5 day rainfall > 35.9 mm	Uncontrolled discharge
	Clean & dirty water drains	Inspection for erosion damage or sediment accumulation	Monthly or when 5 day rainfall > 35.9 mm	Drain inoperable due to erosion of sediment accumulation
Stream Health Monitoring	Saddlers U/S, W3, Saddlers D/S	Photographic monitoring of Creek for vegetation and erosion/sedimentation characteristics	Quarterly	>10% loss of revegetation species. Erosion or sedimentation characteristics obviously degrading over time.

7.5.1 Water quality monitoring

Surface water quality monitoring and sample collection, storage and transportation will be undertaken in accordance with the procedures outlined in the relevant sections of the Australian Standard for Water Quality Sampling AS/NZS5667.1-1998. Laboratory analysis will be undertaken by a laboratory which has relevant accreditation by the National Association of Testing Authorities (NATA), Australia.

Water quality samples will be collected by both field testing using hand held probes that have been regularly maintained and calibrated and laboratory analysis. When sufficient laboratory data is available, appropriate relationships between TDS and EC as well as TSS and turbidity will be derived to assist with making releases and complying with the EPL conditions.

Table 7.2 shows the suite of water quality parameters for laboratory analysis. Samples for laboratory analysis from the surface water quality monitoring program are collected to the Approved Water Sampling Methods: AS/NZS5667.1 and AS/NZS 5667.6. Additional surface water sampling is undertaken following events if recorded 5 day rainfall at the site exceeds 35.9 mm (90th percentile 5-day rainfall total at Scone). Event sampling is undertaken at all regular monitoring sites plus additional sites at the frequencies summarised in Table 7.1. The results will be reported in the Annual Review.

Table 7.2 - Surface water quality - laboratory analysis suite

Parameter
Total dissolved solids
Total suspended solids
Turbidity
Electrical conductivity
Sodium
Magnesium
Potassium
Calcium
Chloride
Sulphate
Bicarbonates

7.5.2 Water quality trigger values

Table 7.3 shows the proposed preliminary criteria for surface water quality which will be used as trigger values for assessing the surface water impacts at the downstream monitoring locations from the Drayton Complex.

Exceedance of the trigger values will initiate an investigation to assess whether the identified exceedance has potentially been caused by the Project.

The approach to the selection of water quality trigger values is as described in the ANZECC guidelines (2000), regarding determination of appropriate guideline trigger values: “For physical and chemical stressors and toxicants in water and sediment, the preferred approach to deriving trigger values follows the order: use of biological effects data, then local reference data (mainly physical and chemical stressors), and finally (least preferred) the tables of default values provided in the Guidelines.” As no biological effects data is available, local reference data has been used as a basis for the selection of the trigger values. The 80th percentile recorded baseline values shown for Saddlers Creek in Table 7.3 are based on monitoring data from May 1998 to August 2014.

Table 7.3 - Preliminary trigger values for water quality assessment

Parameter	Unit	ANZECC Trigger Value				Recorded Baseline Data (80%ile)	Preliminary Trigger Value	Comment
		Irrigation	Livestock drinking	Eco-system ^{*b}	Recreational			
pH	pH	6.0 - 9.0	-	6.5 - 8.0	6.5 - 8.5	8.0 - 8.5	6.5-8.5	Lower bound based on ANZECC guideline for ecosystem protection, upper bound based on Baseline data.
EC	µS/cm	1,000 ^{*a}	-	35-350	-	7682	7700	Baseline data adopted. Rounded up to nearest hundred.
Total Dissolved Solids (TDS)	mg/L	-	2,000 ^{*a}	-	1000	4896	4900	Baseline data adopted. Rounded up to nearest hundred.
Turbidity	NTU	-	-	45689	-	-	-	To be derived based on TSS/Turbidity relationship
TSS	mg/L	-	-	-	-	38	50	DECC 2008 guidelines adopted

Notes: - No Trigger Value recommended.

^{*a} Lowest recommended value.

^{*b} Upland River

^c At surface water monitoring location W1

7.5.3 Water balance monitoring

Storage volume and water quality data will be collected from the various mine water storages to assist in the verification/calibration of the site water balance and salt balance at the Drayton Complex and to minimise the risk of an uncontrolled spill from the mine water dams.

The site water balance will be reviewed annually and updated as additional and/or newer information becomes available with the progression of the mine. Recording the following parameters will assist in validating the assumptions of the water balance model, particularly the AWBM runoff parameters:

- site rainfall;
- dam and in-pit water levels (to be converted to volumes using stage-storage characteristics);
- estimates of volume of any off site discharges;
- pump rates between storages, particularly major pipelines such as pit dewatering pipelines;
- actual demand rates for CHPP makeup water (and losses), industrial use, dust suppression and vehicle washdown during operation of the mine;
- general mine site water management practices; and
- the personnel responsible for ensuring the monitoring of these parameters.

7.5.4 System integrity monitoring

Regular monitoring of the mine site infrastructure such as pumps, pipelines and dams are required to ensure they are working effectively.

One dam at Drayton Mine is currently listed with the NSW Dam Safety Committee under the provisions of the Dams Safety Act, that being the Access Road Dam (2081). As required by the listing of this dam with the Dam Safety Committee, an annual surveillance report is undertaken and submitted. In addition to this report, detail on the status of this dam and a summary of the surveillance report is included in Drayton's Annual Review.

7.5.5 Erosion and sediment control monitoring and maintenance

Site drainage and sediment control structures will be inspected regularly (monthly or following rainfall greater than 25 mm in 24 hours) to check for scouring of diversion drains (and their outlets) and accumulation of sediment in sediment traps (including sediment fences, sediment basins etc.).

- Regular inspections of control structures will be undertaken to ensure they are functioning as designed and required. Maintenance activities will be undertaken in accordance with Section 8.2 of the Blue Book (Landcom, 2004) and will include:
- ensuring proper drainage of the site, including:
 - cleaning catch drains, diversion banks, table drains, and drop-down structures that have become blocked with sediment;
 - checking that drains are operating as intended and any damaged works are repaired where necessary;
- keeping all control structures in good, working condition, ensuring:
 - recent works have not resulted in the diversion of sediment-laden water away from their intended destination;
 - removing accumulated sediment from basins if the design capacity of the settling zone or less remains; and
 - checking that rehabilitated lands have established sufficient ground cover.

7.5.6 Stream health monitoring

The extent of riparian vegetation and extent of erosion and sedimentation deposits will be used as an indicator of stream health and the success of the stream restoration programs described in Section 7.3.

Monitoring is undertaken quarterly by taking photographs at each of the Saddlers Creek surface water monitoring sites. The photographs will be taken at the same location (identified by GPS or permanent photographic ID post) and taken of the relevant bed and bank features looking upstream and downstream. These photographs are documented with the person completing the survey, location, direction and date as well as a log of erosional and depositional features at each location.

7.6 SURFACE WATER RESPONSE PLAN

7.6.1 Trigger event response protocol

The surface water response plan identifies proposed actions to be taken if the monitoring program identifies the occurrence of a trigger event (see Table 7.3). The general protocol for response to trigger events is outlined in Table 7.4.

Table 7.4 - Trigger Event Response Protocol

Step	Procedure
1	Confirm the timing of the event
2	Confirm the general location of the event
3	Confirm the climatic conditions at the time of the event (where relevant)
4	Identify any potential contributing factors
5	Assess the monitoring results and other available information for any anomalies or causes (obtain specialist advice if required)
6	Develop appropriate mitigation and management strategies
7	Consult and seek approval of strategies from Regulatory Authorities where necessary
8	Implement the mitigation and management strategies
9	Review of follow up results
10	Report to the appropriate regulatory authorities

7.6.2 Trigger action response plan

Specific actions to respond to trigger events identified in the monitoring plan are identified in Figure 7.2 to Figure 7.6.

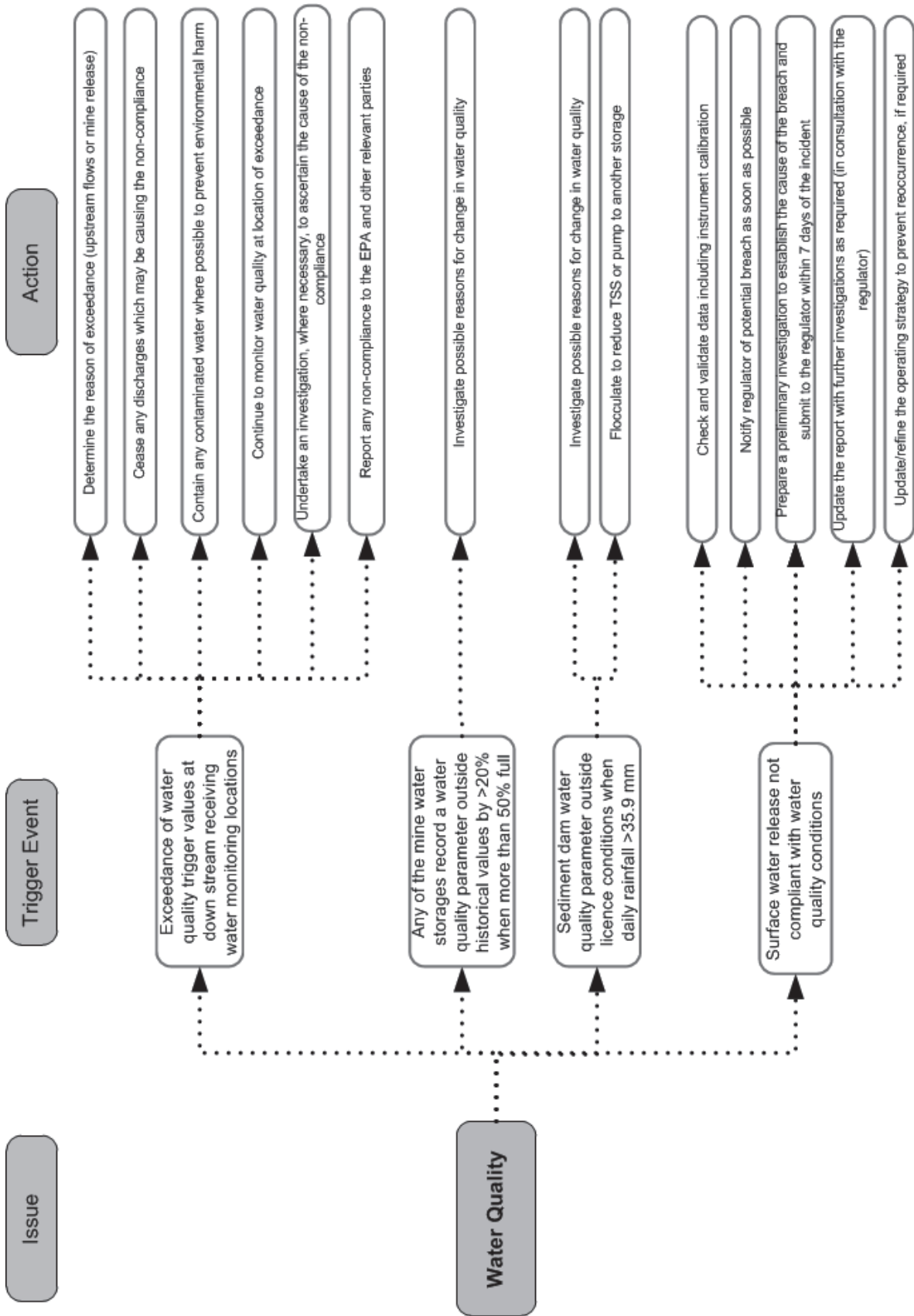


Figure 7.2 - Surface water response actions - water quality

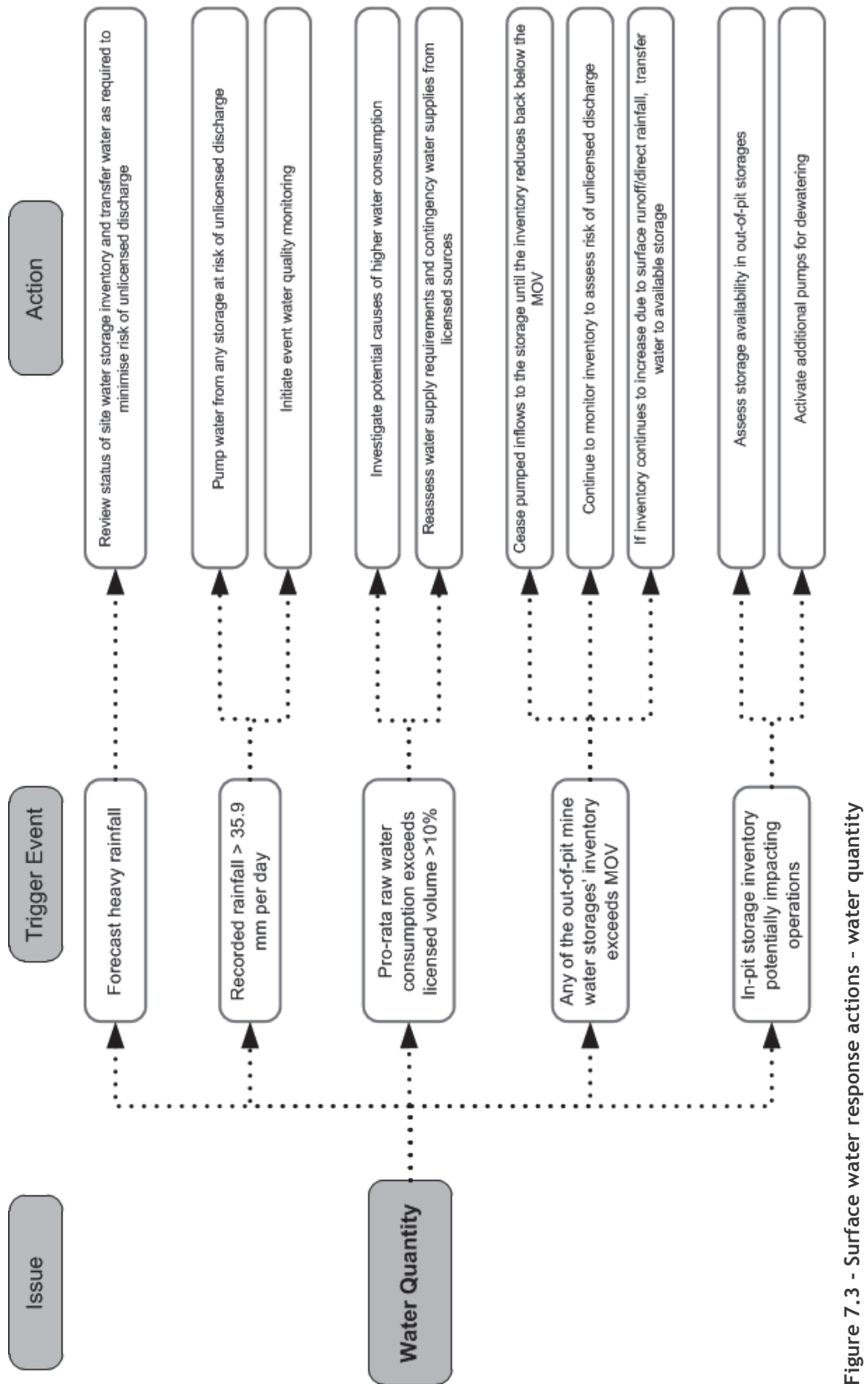


Figure 7.3 - Surface water response actions - water quantity

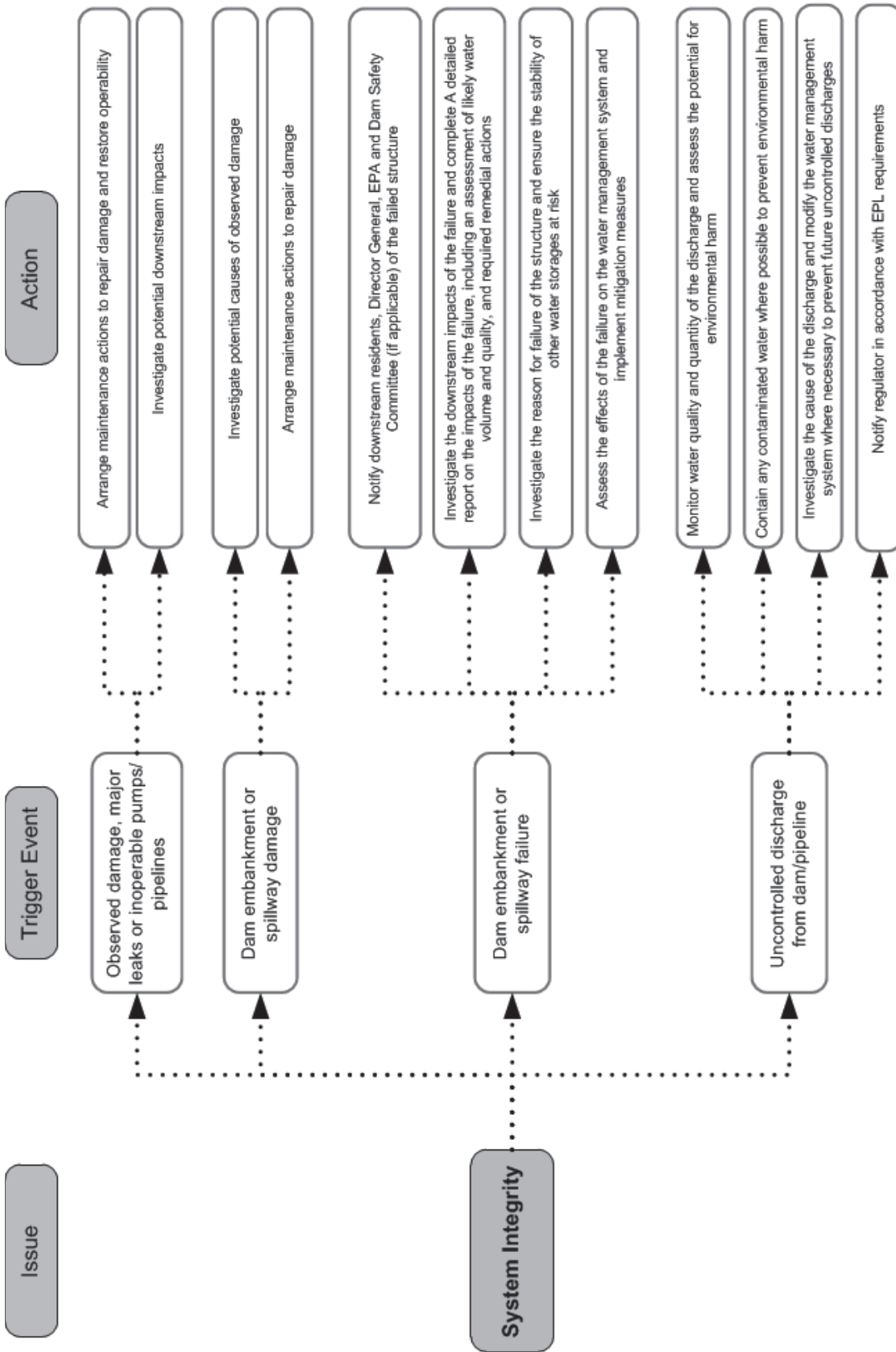


Figure 7.4 - Surface water response actions - system integrity

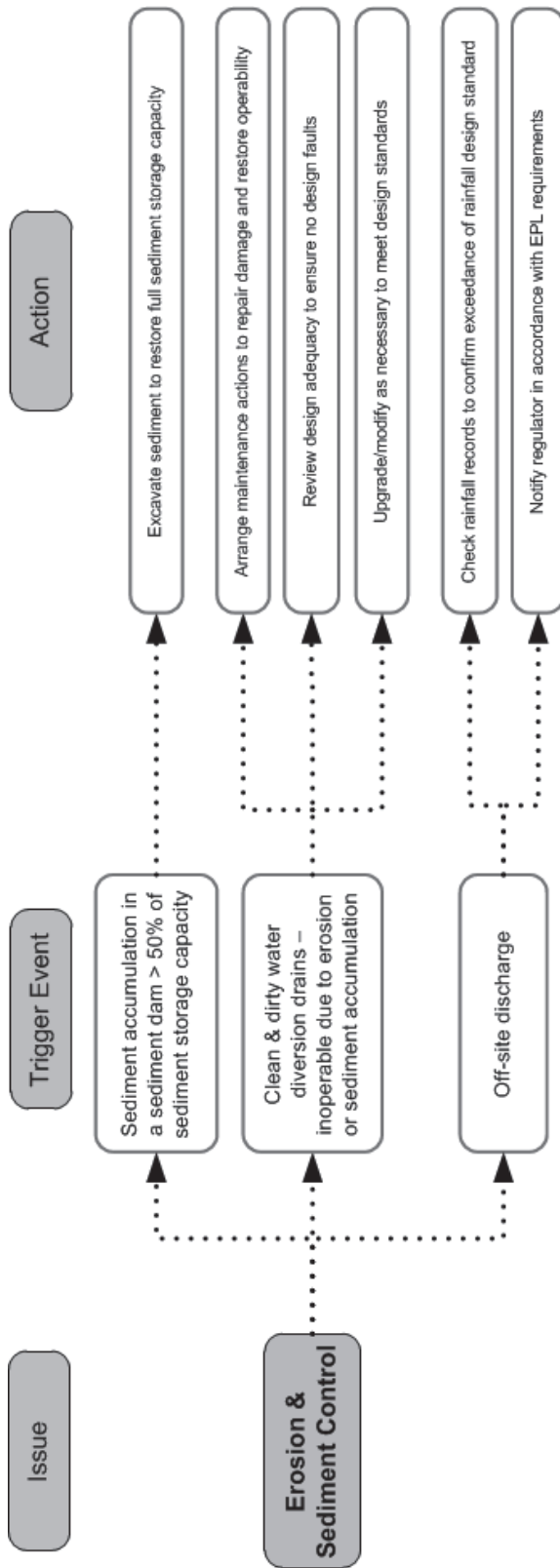


Figure 7.5 - Surface water response actions - erosion and sediment control

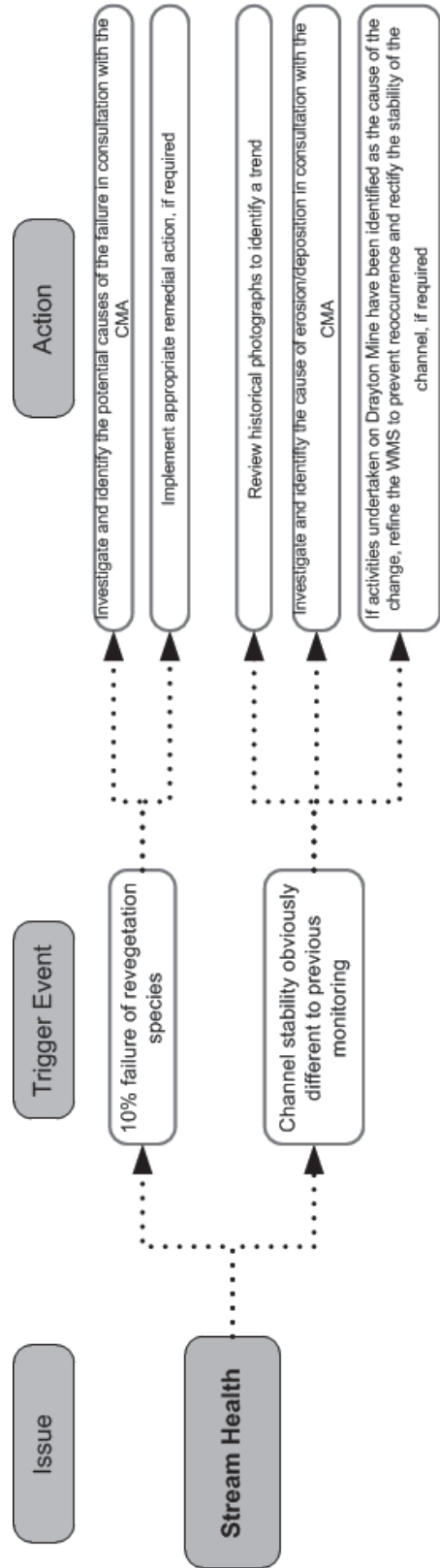


Figure 7.6 - Surface water response actions - stream health

8 Conclusion

A summary of the surface water impact assessment of the Project is as follows:

- the Drayton South disturbance footprint is located outside of the probable maximum flood of both the Hunter River and Saddlers Creek;
- the Project will reduce the Saddlers Creek catchment by a maximum of 5%. At the completion of the mining, the proposed mining areas will be rehabilitated and the final void catchments will be minimised, resulting in a 3% loss of catchment area of Saddlers Creek. No surface water users are impacted by this loss of catchment flow;
- to mitigate the impact of the loss of catchment flows, a comprehensive rehabilitation program is proposed for Saddlers Creek, including an extensive restoration program and in-channel works of reinstating woody debris and snags to encourage pools and sediment bars to form;
- the Project will not have a significant impact on the Hunter River flows. Under mining conditions, the Project will reduce the catchment draining to the Hunter River at Liddell by a maximum of 0.03%;
- the Project will not impact on downstream water quality due to spills from the main mine water storages that potentially contain elevated salinity levels - Access Road Dam, Savoy Dam, Transfer Dam and the South Void, do not spill over the modelled Project life when operated in accordance with the proposed rules. There is a 1% chance in each year that the Rail Loop Dam will spill approximately 30-35 ML, and at least a 90% chance in each year that it won't spill at all. The minor spills that were modelled over the life of the Project are expected to occur as a result of the daily time step of the model. In reality, pumps will have been turned on throughout the day when the water level exceeded its pump out threshold to prevent the spill.
- under the proposed water management system, there is a 99% chance in each year that runoff from the mining catchments and dewatered groundwater can supply all of the water requirements at the Drayton Complex for the first five years of the Project. There is at least 90% chance in each of the remaining years of the Project that off-site supplies will not be required;
- the Hunter River Water Access Licenses currently owned by Anglo American are likely to satisfy any shortfalls should dry conditions prevail. Should very dry conditions (1%ile probability) prevail at any time during the life of the Project, Anglo American proposes to negotiate water sharing arrangements with their neighbours such as AGL Macquarie or Mount Arthur Coal to supply the mine site demand. Alternatively a WAL or a temporary transfer will be acquired on the open market.
- the water balance modelling shows that there are sufficient out of pit storages already available to prevent an accumulation of water in the Drayton South active mining areas.
- the water balance modelling of the final void shows that it will not fill and spill under any foreseeable circumstance.

Overall, the assessment has found that the Project will not have a material impact on the environmental values of the receiving surface waters.

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Appendix A - Water balance model development and calibration

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A1 Methodology

An OPSIM water balance model of the Drayton Mine water management system, previously developed to assess the impact of the proposed changes to tailings disposal system (Water Solutions, 2011), was used for the assessment. The model was updated by recalibrating the runoff parameters to match the storage volumes over the period 2007 to 2011 using available meteorological data for the mine. The model was also updated to include a salt balance. The model was then modified to include the final landform on the Drayton Mine.

The updated model of the Drayton Mine water management system was used to determine:

- The frequency and volume of potential spills from various dams;
- The reliability of the storages to supply operational water requirements; and
- The ability to dewater the mining area.

A2 The OPSIM model

The OPSIM model estimates runoff and evaporation at each of the site water storages on a daily basis using historical climate data. It also simulates the transfer of water between storages, the harvesting of water and the controlled discharge of water if required.

Table A.1 provides a summary of the inflows and outflows included in the OPSIM model. Details of the model configuration, input data and results are provided in the following sections.

Table A.1 - Simulated inflows and outflows to mine water management system

Inflows	Outflows
Direct rainfall on water surface of storages	Evaporation from water surface of storages
Catchment runoff	CHPP demand
Groundwater inflows	Dust suppression demand
	Vehicle washdown
Raw water supply	Offsite spills from storages
	Controlled releases

A3 Meteorology

A3.1 RAINFALL

A representative long-term rainfall sequence for Drayton Mine was obtained from the Bureau of Meteorology's SILO Data Drill. These synthetic data are derived by interpolation of recorded rainfall data between stations as described by Jeffreys et al (2001). Rainfall data from the SILO Data Drill is available from the late 1800s and is corrected for missing data and accumulated totals. Hence, this data is more reliable and easier to use for computer modelling than raw recorded rainfall data.

Figure A.1 shows a comparison of mean monthly rainfall recorded at the Jerrys Plains Post Office rainfall station (#061086), Denman Palace St Gauge (#061016) and the Muswellbrook Lower Hill St gauge (#061053) with the SILO Data Drill rainfalls over the study area from 1889 to 2010. The comparison indicates that the SILO data provides a good representation of recorded rainfall data at Drayton Mine.

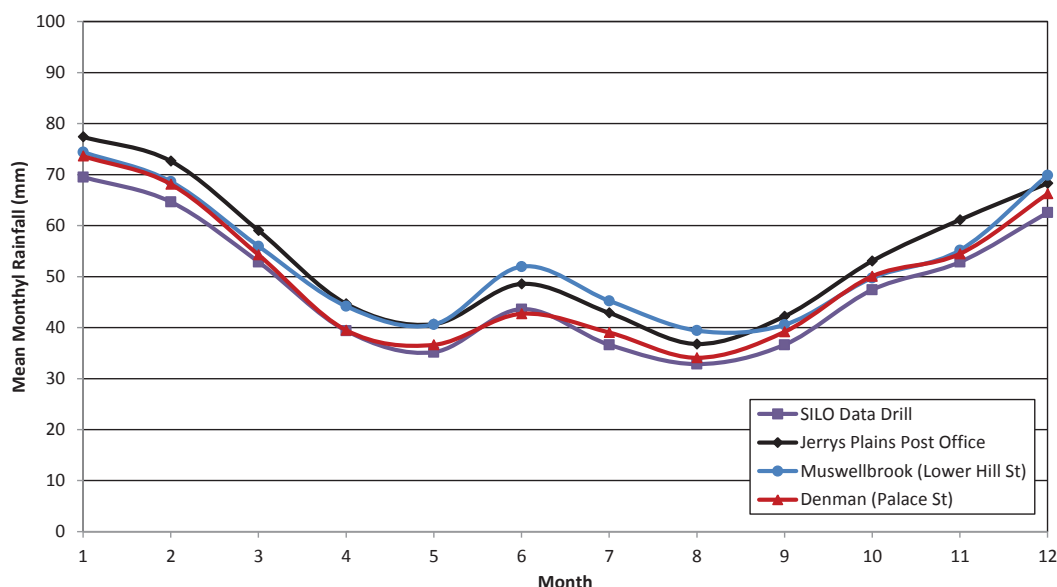


Figure A.1 - Comparison of mean monthly rainfalls of surrounding rainfall stations with SILO Data Drill, 1889 to 2010

A3.2 EVAPORATION

The pan evaporation data for the area was obtained from the SILO Data Drill database (Jeffrey et al., 2001). Pan factors were applied to the pan evaporation data to match Morton’s lake evaporation (Morton, 1983). Morton’s method is regarded as suitable for the estimation of lake evaporation in non-arid areas (Mulder, 1997). Table A.2 shows the adopted pan evaporation and pan factors used to estimate evaporation from the onsite storages.

Table A.2 - Adopted monthly lake evaporation factors

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Average	211	167	148	106	71	53	62	87	117	156	182	215
Monthly Lake Pan Factors	0.9	0.92	0.93	0.87	0.83	0.77	0.78	0.84	0.88	0.92	0.92	0.89

For the mining areas, the values shown in Table A.2 were factored by 0.7 to reflect the likely reduction in evaporation due to the depth of the open cut below surface level. For AWBM soil moisture evapotranspiration, the values shown in Table A.2 were factored by 0.99 to convert to areal evapotranspiration.

A4 Drayton Mine water balance model calibration

A4.1 METHODOLOGY

The calibration model was run over the period January 2007 to mid-2011, for which stored water volumes onsite were available. It was assumed that catchment areas draining to the active mining areas do not change over the calibration period. The change in catchment area over this period is only minor when compared to the total study area catchment so the impact on the water balance of this assumption is not expected to be significant.

A4.2 WATER MANAGEMENT SYSTEM

Figure A.2 shows a schematic of the Drayton Mine water management system over the calibration period. The locations of the various storages and active mining areas are shown in Figure A.3. A summary of the main features of the water management system is as follows:

- Active mining areas are dewatered to the Industrial Dam at a nominal pump rate of 100 L/s;
- CHPP make-up demand is sourced from the Access Road Dam;
- The Rail Loop Dam receives runoff from the CHPP and industrial areas;
- Coal stockpile dust suppression is sourced from the Access Road Dam, which is topped up by water in the Industrial Dam;
- The Industrial Dam supplies the East Pit fill point for haul road dust suppression;
- The Savoy Dam supplies the West Void fill point for haul road dust suppression (via the Turkeys Nest Dam which is not explicitly modelled);
- West Void receives inflows from the active mining areas should additional dewatering be required.

Full details of the operational rules adopted over the calibration period are given in Table A.3

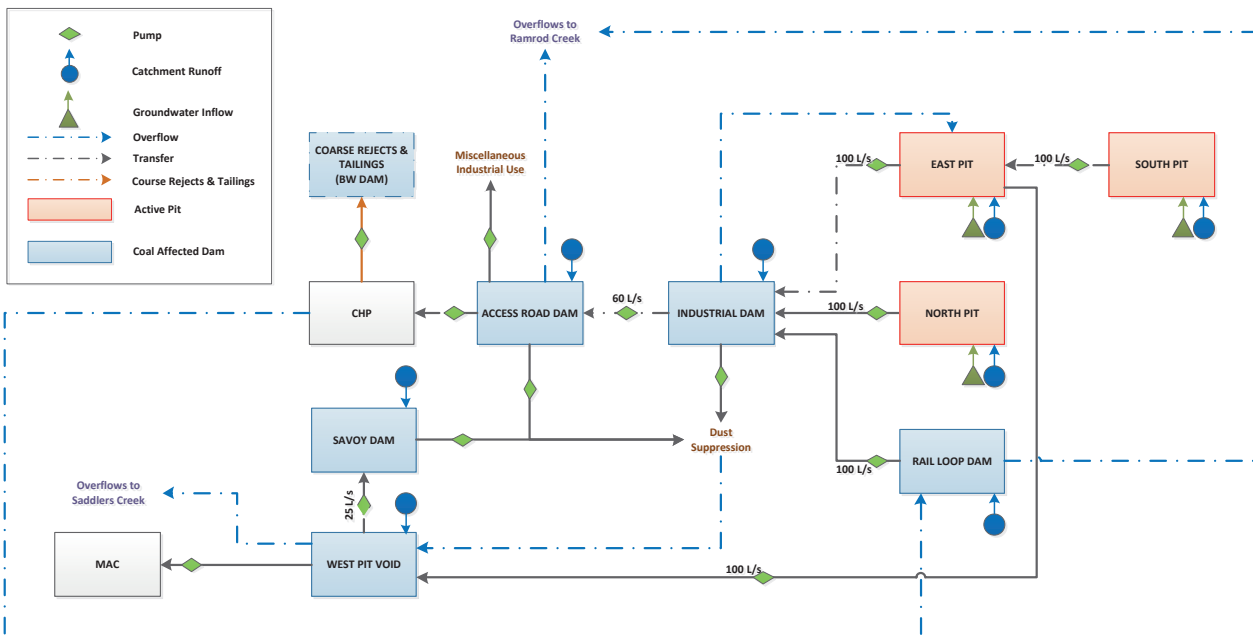


Figure A.2 - OPSIM model schematic of Drayton Mine water management system for the calibration period, January 2007 to May 2011

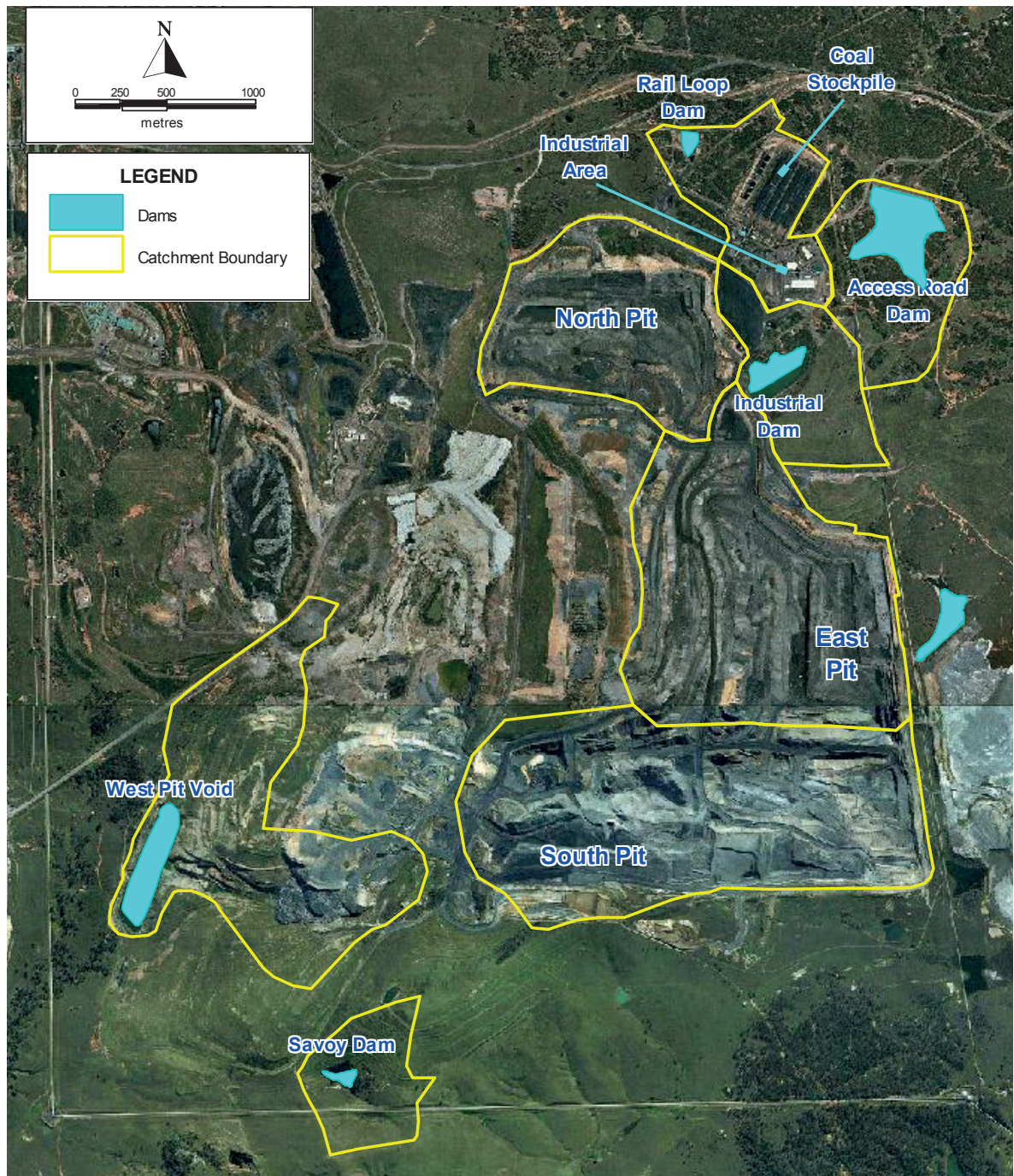


Figure A.3 - Existing Drayton Mine catchment and operational areas

Table A.3 - Adopted Drayton Mine operational guidelines for calibration period 2007-2010

	Operational Description	Operating Rules
1	Supply to Demands	
1.1	CHPP Make Up	Supplied from the Access Rd dam at a rate of 237kL/d 100% loss assumed.
1.2	Miscellaneous Industrial use	Sourced from the Access Road Dam at a rate of 650kL/d. 100% loss assumed.
1.3	Haul Road Dust Suppression	2 Haul Road Fill locations: <ul style="list-style-type: none"> West Void Fill Point: 15% of haul road dust suppression demand is sourced from Savoy Dam at a rate of 292kL/d. East Pit Fill Point: 85% of haul road dust suppression is sourced from the Industrial Dam at a rate of 1,660kL/d. 100% loss assumed.
1.4	Stockpile Dust Suppression	<ul style="list-style-type: none"> Supplied from the Access Rd dam at a rate of 42kL/d. 100% loss assumed.
2	Transfer of Mine Waters	
2.1	North Pit	<ul style="list-style-type: none"> Continuous pumping from pit dewatering pumps (when required) at a nominal maximum rate of 100L/s. Pit dewatering directed to Industrial Dam. Received groundwater inflows at a rate of 550kL/d (200ML/yr).
2.2	South Pit	<ul style="list-style-type: none"> Continuous pumping from pit dewatering pumps (when required) at a nominal maximum rate of 100L/s. Pit dewatering directed to East Pit. Received groundwater inflows at a rate of 450kL/d (164ML/yr).
2.3	East Pit	<ul style="list-style-type: none"> Continuous pumping from pit dewatering pumps (when required) at a nominal maximum rate of 100L/s. Pit dewatering directed to Industrial Dam. Received groundwater inflows at a rate of 1,100kL/d (400ML/yr). If pit water increases above 310 ML then additional direct transfer to West Void at 100L/s
3	Operation of Key Storages	
3.1	Access Road Dam	<ul style="list-style-type: none"> Primary mine water storage for CHPP and industrial use. Receives inflows from the following locations: <ul style="list-style-type: none"> Pumped transfers from Industrial Dam at 60L/s when required. Supplies to the following locations: <ul style="list-style-type: none"> Drayton CHPP

		<ul style="list-style-type: none"> ○ Industrial Area ○ Stockpile Dust Suppression
		<ul style="list-style-type: none"> ● Storage overflows to Ramrod Creek
3.2	Industrial Dam	<ul style="list-style-type: none"> ● Receives inflows from the following locations: <ul style="list-style-type: none"> ● Pumped transfers from East Pit ● Pumped transfers from North Pit ● Pumped transfers from Rail Loop Dam ● Supplies to the following locations: <ul style="list-style-type: none"> ○ East Pit Fill Point for haul road dust suppression. ○ Pumped transfers to the Access Road Dam at 60L/s when required. ● Storage overflows to East Pit.
3.3	Rail Loop Dam	<ul style="list-style-type: none"> ● Mine water collection and transfer storage. ● Receives catchment runoff inflows from the CHPP and industrial areas. ● Supplies to the Industrial Dam at 100L/s. ● Maintained at empty to prevent uncontrolled spills. ● Storage overflows to Ramrod Creek.
3.4	Savoy Dam	<ul style="list-style-type: none"> ● Mine water collection and transfer storage. ● Supplies to West Void Fill Point for haul road dust suppression. ● Receives pumped transfers from West Void at 25 L/s (when required to ensure supply of water for dust suppression).
3.5	West Void	<ul style="list-style-type: none"> ● Receives pumped inflows from East Pit when stored water exceeds 90m AHD. ● Supplies to Savoy Dam when required. ● Storage overflows to Saddlers Creek. ● No other transfers to or from West Void over calibration period.
4	General	<ul style="list-style-type: none"> ● All storages and pits receive local catchment runoff and lose water through evaporation.

A4.3 STORAGES AND MINING AREAS

The adopted capacities of water storages included in the OPSIM calibration model are shown in Table A.4. The full supply volume is the nominal volume available below the spillway crest. The operating volume is the target maximum storage volume to minimise uncontrolled spills. The initial free volume is the observed volume recorded in each storage, applied at the start of the modelling period, i.e. January 2007.

Note that Delpah Dam and A Transfer Dam were included in the previous water balance modelling of the Drayton Mine (Water Solutions, 2011). Advice from personnel on site suggests that these dams do not play a role in the water balance and as such were excluded from the model.

Table A.4 - Capacities of water storages

WATER STORAGE	Full Supply Volume (ML)	Operating Volume (ML)	Initial Free Volume (ML)
Access Road Dam (2081)	750	600	310
Industrial Dam (1969)	750	596	555
Rail Loop Dam (2114)	18	0	11
Savoy Dam (1609)	140	50	140
West Void (SW13)	4043	4043	412

The operating volume of the Rail Loop Dam was set to zero in an attempt to match the number of modelled spills with the actual spills over the calibration period.

The adopted capacities of the active mining areas are shown in Table A.5. The full supply volume is the nominal volume available, above which uncontrolled spills will occur.

Table A.5 - Capacities of mining areas

MINING AREA STORAGE	Full Supply Volume (ML)	Initial Free Volume (ML)
North Pit	17905	0
East Pit	17138	0
South Pit	993	0

The locations of these storages and mining areas are shown in Figure A.3.

A4.4 CATCHMENT AREAS AND LAND USE CLASSIFICATION

The adopted catchment areas reporting to each of the existing Drayton Mine storages are presented in Figure A.4 and detailed in Table A.6.

Table A.6 - Existing Drayton Mine catchment areas

Storage Name	Catchment Area (ha)						
	Mine Site	Cleared	Mining Area	Hardstand	Rehab.	Spoil	Total
North Pit	7.6	14.7	10.9	15.0	0.0	84.5	132.7
South Pit	6.3	11.4	22.2	31.6	0.0	71.4	143.0
East Pit	0.0	5.9	44.4	24.9	0.0	139.1	214.3
Access Rd Dam	48.1	0.0	0.0	19.3	0.6	0.0	68.0
Rail Loop Dam	18.5	0.0	0.0	44.7	0.0	0.0	63.2
Savoy Dam	23.2	0.0	0.0	2.3	15.1	0.0	40.6
Industrial Dam	17.3	0.0	0.0	10.4	29.9	0.0	57.6
West Void	31.4	0.0	9.7	2.2	45.2	76.6	165.2

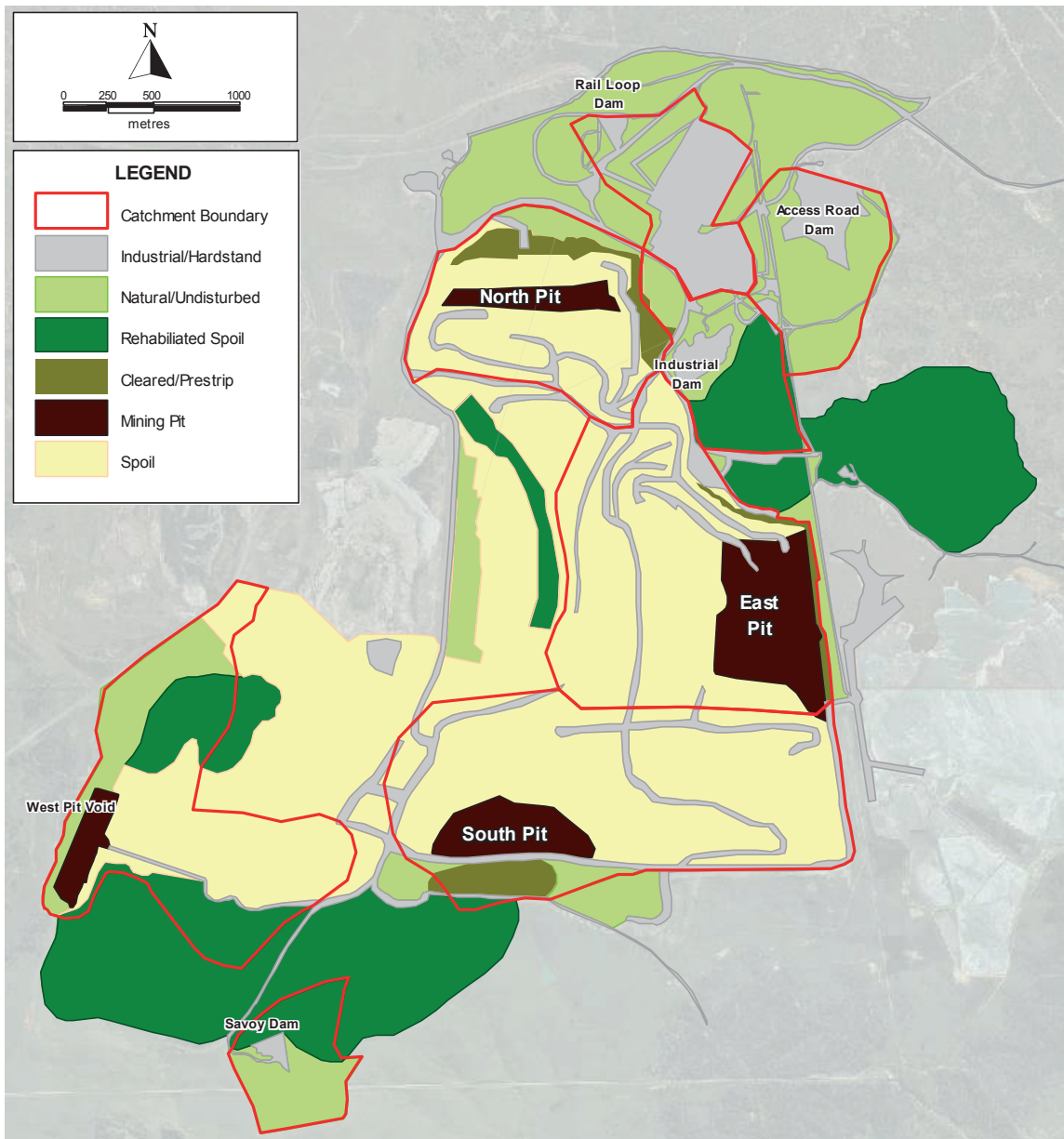


Figure A.4 - Existing Drayton Mine catchments and land use classifications

A4.5 DEMANDS

The adopted total demand over the calibration period is 2,720 kL/d, consisting of the CHPP makeup demand, industrial usage and dust suppression of haul roads and coal stockpiles. Each of these demands is detailed below.

Annual values of the CHPP makeup requirements for 2007 to 2009 were obtained from previous calibration modelling of the Drayton Mine site (Water Solutions, 2011), listed in Table A.7

The volume of water required for CHPP makeup is generally related to the annual coal production tonnages. Insufficient production data was available to conduct a net water balance over the CHPP to assess the net water requirements, so it was assumed that the CHPP makeup requirement would provide an accurate representation.

Table A.7 - Drayton Mine CHPP makeup requirements

Year	ML/yr	kL/d	Source
2007	63	170	Drayton Mine Extension (Water Solutions, 2011)
2008	166	450	Drayton Mine Extension (Water Solutions, 2011)
2009	25*	91	Drayton Mine Extension (Water Solutions, 2011)
Average		237	

*January 2009 to September 2009

Annual values of industrial usage for 2007 to 2010 are provided in Table A.8 . The average industrial demand of 650 kL/d was adopted over the calibration period. The industrial usage demand is sourced from the Access Road Dam and is assumed to be 100% lost.

Table A.8 - Drayton Mine industrial usage

Year	ML/yr	kL/d	Source
2007	130	356	Drayton Mine Extension (Water Solutions, 2011)
2008	272	745	Annual Environment Management Report 2008 (Anglo Coal)
2009	360	986	Annual Environment Management Report 2009 (Anglo Coal)
2010	188	515	Annual Environment Management Report 2010 (Anglo Coal)
Average	238	650	

Annual rates of coal stockpile dust suppression for 2007 to 2010 are provided in Table A.9. The average coal stockpile dust suppression demand of 50 kL/d was adopted over the calibration period, sourced from the Access Road Dam and assumed to be 100% lost.

Table A.9 - Drayton Mine coal stockpile dust suppression usage

Year	ML/yr	kL/d	Source
2007	27	74	Drayton Mine Extension (Water Solutions, 2011)
2008	2	5	Annual Environment Management Report 2008 (Anglo Coal)
2009	6	16	Annual Environment Management Report 2009 (Anglo Coal)
2010	38	104	Annual Environment Management Report 2010 (Anglo Coal)
Average	18	50	

Annual rates haul road dust suppression for 2007 to 2010 are provided in Table A.10. The average haul road dust suppression demand of 1786 kL/d was adopted over the calibration period. Based on advice from onsite personnel, 85% is sourced from East Pit Fill Point (Industrial Dam) and 15% from the West Void Fill Point (Savoy Dam).

Table A.10 - Drayton Mine haul road dust suppression usage

Year	ML/yr	kL/d	Source
2007	470	1288	Drayton Mine Extension (Water Solutions, 2011)
2008	603	1652	Annual Environment Management Report 2008 (Anglo Coal)
2009	814	2230	Annual Environment Management Report 2009 (Anglo Coal)
2010	720	1973	Annual Environment Management Report 2010 (Anglo Coal)
Average	652	1786	

A4.6 GROUNDWATER INFLOWS

The rates of groundwater inflow into the active mining areas were adopted from the previous calibration modelling (Water Solutions, 2011), detailed in Table A.11.

Table A.11 - Drayton Mine groundwater inflows

Mining Area	ML/yr	kL/d
North Pit	200	550
South Pit	165	450
East Pit	400	1100

A4.7 AWBM CALIBRATION

The OPSIM model uses the AWBM model to estimate runoff volumes from onsite catchments, based on available rainfall and evaporation data. The AWBM (Boughton & Chiew, 2003) is a saturated overland flow model which allows for variable source areas of surface runoff. The model uses daily rainfalls and estimates of catchment evapotranspiration to calculate daily values of runoff using a daily water balance of soil moisture. The model has a baseflow component which simulates the recharge and discharge of a shallow groundwater store. Runoff depth calculated by the AWBM model is converted into runoff volume by multiplying the depth and the contributing catchment area. The various parameters of the AWBM model are shown in Table A.12.

To estimate catchment runoff inflows to the OPSIM model, separate AWBM model parameters were developed for the following catchment types:

- Mine site/undisturbed;
- Industrial/hardstand/roads;
- Spoil, unrehabilitated;
- Spoil, rehabilitated;
- Mining area;
- Cleared/prestrip.

Table A.12 - Summary of AWBM model parameters

Parameter Specification	Description
Partial Area Fractions	Parameters A1, A2 & A3. Fraction of catchment area represented by surface storages No. 1, 2 & 3.
Soil Store Capacities	Parameter C1, C2 & C3. Soil moisture storage capacities for smallest store (No. 1), middle store (No. 2) and largest store (No. 3).
Base Flow Index	Parameter BFI. Proportion of runoff directed to baseflow store.
Daily Baseflow Recession Constant	Parameter K. Rate at which water discharges from baseflow store.
Lake to Evapotranspiration Factor	Factor to convert open water evaporation to evapotranspiration.

In the absence of recorded runoff data for the different catchment types, reasonable parameter values were selected based on experience in similar previous studies and expected values of volumetric runoff coefficients. Adopted AWBM model parameter values are shown Table A.13. The overall representation of catchment runoff was validated by matching the stored volume in all storages on the site over the calibration period.

Table A.13 - Adopted AWBM model parameters for various catchment types

AWBM Model Parameter		Mine Site	Industrial/ Hardstand	Unrehabilitated Spoil	Rehab. Spoil	Mining Area	Cleared/ Prestrip
Surface Store Depth (mm)	C1	40	4.08	13	7.7	3	2.4
	C2	85	12.96	48	77	11.75	10.8
	C3	145	0	0	0	0	9.96
	Avg.	100	12.07	41	70.7	10	0.1
Partial Areas	A1	0.2	0.1	0.2	0.1	0.2	0.1
	A2	0.4	0.9	0.8	0.9	0.8	0.9
	A3	0.4	0	0	0	0	0
Base flow index	BFI	0	0	0.85	0.15	0	0
Base flow recession constant	K	1	1	0.7	0.98	1	1
Lake to Evapotranspiration Factor		0.99	0.99	0.99	0.99	0.99	0.99
Long Term Runoff Coefficient	RC	0.048	0.312	0.138	0.085	0.348	0.344

A4.8 WATER QUALITY PARAMETERS

Water quality was modelled in OPSIM as TDS in mg/L. The adopted salinity concentrations of the various catchment types included in the calibration model are provided in Table A.14. These values are based on the assessment of water quality information currently collected for a number of storages (with non-homogeneous catchments) across Drayton Mine. The results of the calibration of the catchment runoff salinities are provided in

Section A4.10. The equivalent EC values assuming a typical conversion of 0.75 are also given.

Table A.14 - Catchment inflow salinity concentrations

Catchment Type	TDS (mg/L)	EC (μ S/cm)
Cleared/Prestrip	2000	2667
Mining Area	4000	5333
Mine site/Undisturbed Catchment	200	267
Industrial/Hardstand	2000	2667
Spoil	2000	2667
Rehabilitated Spoil	1000	1333
Groundwater	4720	6300

A4.9 STORAGE VOLUME CALIBRATION RESULT

The modelled AWBM parameters were calibrated using known site performance and operations from January 2007 to May 2011 at the existing Drayton Mine. The modelled total inventory for the Industrial Dam, Savoy Dam, Access Road Dam, Rail Loop Dam and the North, South and East Pits and West Void were compared to the recorded total inventory. The results of the calibration are shown in Figure A.5.

SIL0 Data Drill rainfall was selected for this calibration as it was found that the provided Drayton Mine data showed consistently higher daily values than surrounding BOM stations, potentially indicating an incorrectly calibrated onsite gauge.

The following is of note with the calibration of the AWBM parameters for the OPSIM model:

- the behaviour of the modelled site inventory over January 2007 to May 2011 is in good agreement with the recorded inventory;
- in September 2009, 2,000ML stored in the West Void was transferred to the ownership of Mt Arthur Coal Mine. This 2000ML has not been removed from the recorded total site inventory to allow direct comparison with the modelled results;
- all demands are met 100% of the time over the calibration period;
- no controlled discharges occurred over the calibration period; and
- the modelled results showed one spill from the Rail Loop Dam in conjunction with the June 2007 rainfall event.

The calibration results are marginally different to the calibration given in Water Solutions (2011) due to the use of more up to date storage volume information. The current calibration parameters generate more runoff than what was proposed by Water Solutions (2011).

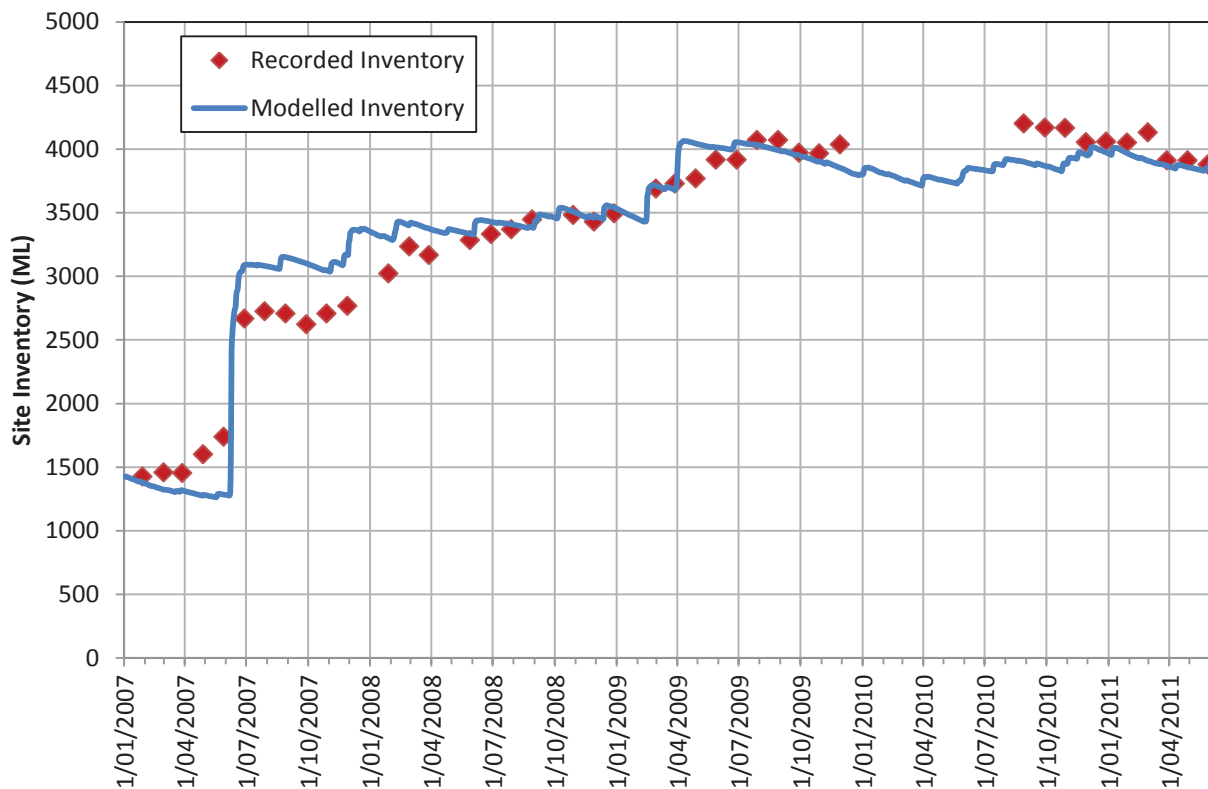


Figure A.5 - Modelled and recorded total inventory (stored volume)

A4.10 WATER QUALITY CALIBRATION RESULTS

The concentration of salts assigned to the various catchment types was calibrated using recorded salinities in onsite storages with non-homogenous catchments from January 2007 to May 2011. Initial salinities were estimated from a linear interpolation of the recorded site data. The modelled water quality for the Industrial Dam, Savoy Dam and Access Road Dam were each compared to the recorded storage salinities. Recorded storage salinities were converted from EC ($\mu\text{S}/\text{cm}$) to TDS (mg/L) assuming a typical conversion of 0.75. The results of the calibration are shown in Figure A.6, Figure A.7 and Figure A.8.

The following is of note with the calibration of the catchment runoff salinities for the OPSIM model:

- the overall TDS calibration in the three storages appears reasonable;
- it is expected that TDS concentrations in the Industrial Dam and Access Road Dam would reflect the mining area and spoil runoff TDS as well as groundwater TDS as they mostly contain pumped inflows from the open cut mining areas; and
- runoff from natural catchments vary greatly with high TDS concentrations measured to the south and lower concentrations in the north.

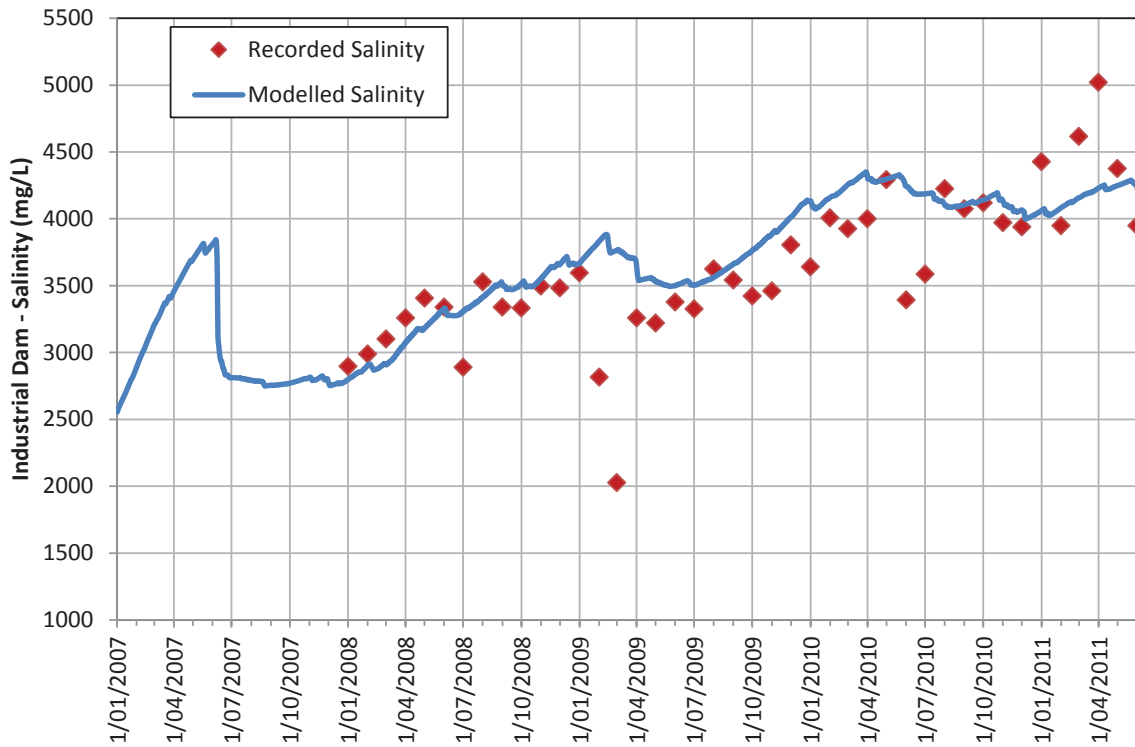


Figure A.6 - Modelled and recorded Industrial Dam Total Dissolved Solids, Jan 2007 to May 2011

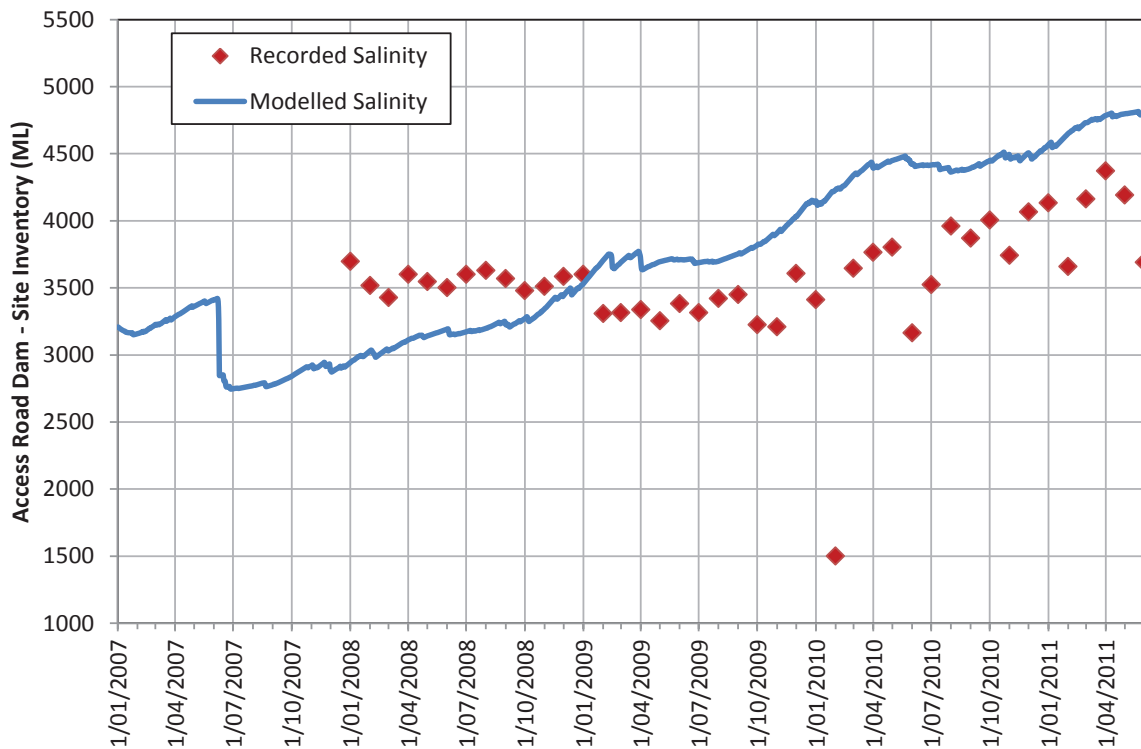


Figure A.7 - Modelled and recorded Access Road Dam Total Dissolved Solids, Jan 2007 to May 2011

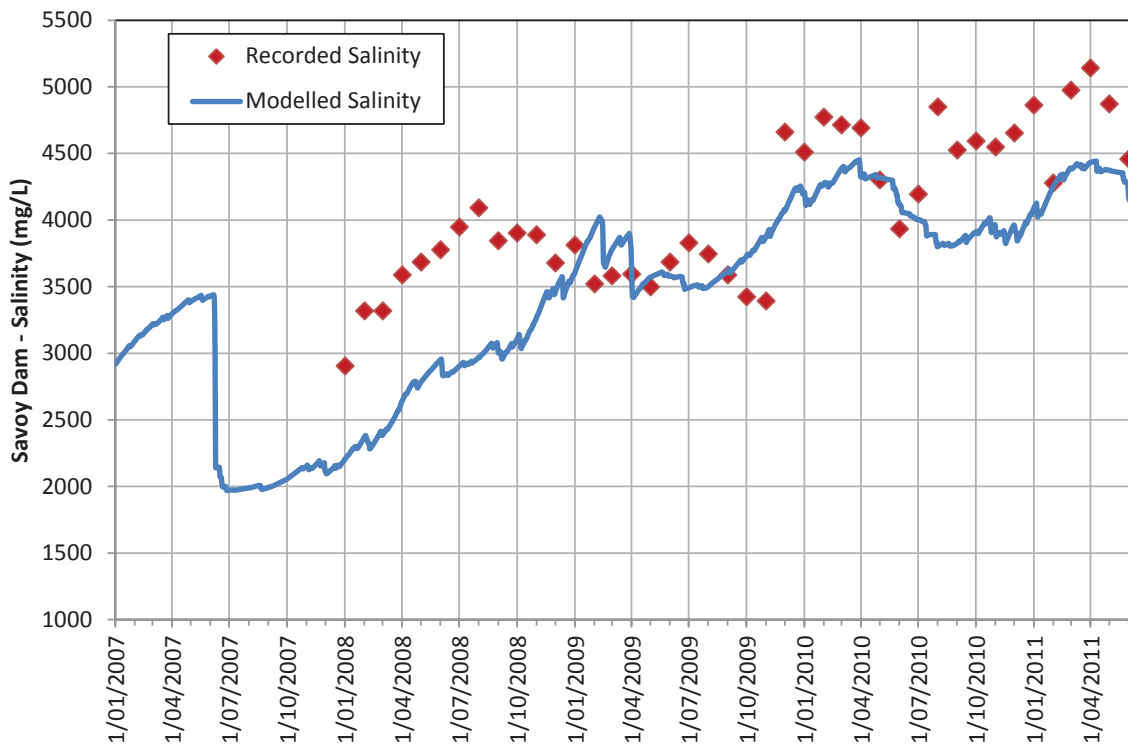


Figure A.8 - Modelled and recorded Savoy Dam Total Dissolved Solids, Jan 2007 to May 2011

A5 Limitations of the water balance model calibration

The results of the OPSIM modelling need to be interpreted with caution. Key limitations of the OPSIM model and known discrepancies between the model and water management practice are outlined below:

- The AWBM parameters adopted for the model appear reasonable based on past experience and the available calibration data for Drayton Mine;
- TDS concentrations applied to study area catchments are based on past experience and the limited water quality data available to date. More water quality information is required to accurately calibrate the water balance model to observed site data; and
- TDS is not necessarily the critical contaminant that will control the operation of the water management system and will need to evolve and be operated to recognise the results of future water quality and quantity monitoring programs.

Appendix B - Operational rules

Item	Name	Operating Rules
1	External Water Supply	
1.1	Raw Water Supply	<ul style="list-style-type: none"> • Supplementary supply source for Transfer Dam, as required.
2	Water Demands	
2.1	CHPP Makeup	<ul style="list-style-type: none"> • Primary supply from Access Road Dam. • Coarse rejects are directed to North Void • Tailings are directed to East Void - 70% moisture entrained, 30% available for decant.
2.2	Drayton Mine Dust Suppression	<ul style="list-style-type: none"> • Supplied from Access Road Dam (see Sections 5.4.1)
2.3	Drayton Mine Industrial Demands	<ul style="list-style-type: none"> • Supplied from Access Road Dam (112 kL/d). 100% loss assumed.
2.4	Drayton South Dust Suppression & Industrial	<ul style="list-style-type: none"> • Supplied from Transfer Dam (see Section 5.4.1 and 5.4.3). • 100% loss assumed.
3	Active Mining Areas	
3.1	Blakefield Pit	<ul style="list-style-type: none"> • Continuous dewatering to Transfer Dam (100 L/s) up to Transfer Dam high alarm level of 200 ML. Receives groundwater inflows (see Section 5.5.1). • Receives overflows from highwall dams.
3.2	Whynot West Pit	<ul style="list-style-type: none"> • Continuous dewatering to Transfer Dam (100 L/s) up to Transfer Dam high alarm level of 200 ML. • Receives groundwater inflows (see Section 5.5.1). • Receives overflows from highwall dams.
3.3	Whynot Pit	<ul style="list-style-type: none"> • Continuous dewatering to Transfer Dam (100 L/s) up to Transfer Dam high alarm level of 200 ML. • Receives groundwater inflows (see Section 5.5.1). • Receives overflows from highwall dams.
4	Water Storages	
4.1	North Void	<ul style="list-style-type: none"> • Receives coarse rejects from CHPP. • Receives groundwater inflows (1,070 kL/d) (see Section 5.5.1).
4.2	East Void	<ul style="list-style-type: none"> • Receives tailings from CHPP. • Dewatered to Access Road Dam (100L/s), up to Access Road Dam high alarm of 480 ML. • Receives groundwater inflows (1143 kL/d) (see Section 5.5.1).
4.3	South Void	<ul style="list-style-type: none"> • Supplies Access Road Dam as required (max. 100L/s). • Supplies Transfer Dam (100 L/s) as required, to maintain Transfer

Item	Name	Operating Rules
		<p>Dam supply for Drayton South demands.</p> <ul style="list-style-type: none"> Receives dewatering from Savoy Dam (max. 60L/s). Receives transfers from Transfer Dam (max. 200L/s), up to high alarm of 13,400 ML. Demands from Transfer Dam (200L/s) at low alarm level of 30ML, to maintain supply source for Access Road Dam. <p>Receives groundwater inflows (350 kL/d) (see Section 5.5.1).</p>
4.4	Access Road Dam	<ul style="list-style-type: none"> Supplies CHPP Makeup demand (see Section 5.4.2). Supplies Drayton Mine industrial demand (1,120 kL/d). Demands from South Void as required (max. 100L/s). Receives dewatering from East Void (max. 100L/s) up to high alarm of 480 ML. Overflows to Ramrod Creek.
4.5	Rail Loop Dam	<ul style="list-style-type: none"> Transfers to Access Road Dam (150 L/s), maintained empty. Overflows to Ramrod Creek.
4.6	Savoy Dam	<ul style="list-style-type: none"> Transfers to South Void, maintained empty. (Note this is a modelling simplification and in reality Savoy Dam will be a transfer point between Transfer Dam and South Void). Overflows to Saddlers Creek.
4.7	Transfer Dam	<ul style="list-style-type: none"> Supplies dust suppression demand and industrial demand at Drayton South. Transfers to South Void when above 50ML (200L/s). Receives dewatering from pits (100L/s per pit), up to high alarm level of 200 ML. Receives pumped transfers from sediment dams, up to high alarm level of 200 ML. Demands from South Void (100L/s) at low alarm level of 50ML, to maintain supply source for demands. Supplementary demand from raw water source, as required, at low alarm level of 50ML, to maintain supply source for demands when South Void is empty. Overflows to Saddlers Creek.
4.8	MIA Catch Dam	<ul style="list-style-type: none"> Continuous dewatering to Transfer Dam (20 L/s). Overflows to Sediment Dam 5.
4.9	Sediment Dams 1-6	<ul style="list-style-type: none"> Continuous dewatering to Transfer Dam, up to Transfer Dam high alarm level of 200 ML. Overflow to Saddlers Creek.
4.10	High Wall Dams	<ul style="list-style-type: none"> Continuous dewatering to Saddlers Creek, maintained empty. Overflow to active mining areas.
5	Receiving Waters	
5.1	Ramrod Creek	<ul style="list-style-type: none"> Receives storage overflows from Rail Loop Dam, Access Road Dam, Savoy Dam

Item	Name	Operating Rules
5.2	Saddlers Creek	<ul style="list-style-type: none">• Receives storage overflows from Transfer Dam and Sediment Dams.• Receives transfers from highwall dams.
6	General	
6.1	Climate	<ul style="list-style-type: none">• All storages and pits receive direct rainfall, local catchment runoff and lose water through evaporation.

Appendix C - Stage-storage curves

C1 Industrial Dam	133
C2 Access Road Dam	133
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C11.2 Year 6	145
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C12.1 Year 6	146
C13 Final void	146

C1 Industrial Dam

Table C.1 - Stage-storage curve - Industrial Dam

Level (mAHD)	Area (ha)	Volume (ML)
218	6.3	0
222	6.4	254
223	6.5	318.5
224	6.8	385
225	7	454
227	7.2	596
229	7.6	750

C2 Access Road Dam

Table C.2 - Stage-storage curve - Access Road Dam

Level (18mAHD)	Area (ha)	Volume (ML)
228	8	0
228.5	8.25	40.6
229	8.5	82.5
229.5	8.75	125.6
230	9	181
230.5	9.25	214
231	9.5	252
231.5	9.75	294
232	10	341
232.5	10.5	392
233	11	448
233.5	11.5	509
234	12	574
234.5	12.75	644
235	13.25	718
235.5	14	750

C3 Savoy Dam

Table C.3 - Stage-storage curve - Savoy Dam

Level (mAHD)	Area (ha)	Volume (ML)
252.2	3.85	0
253	3.9	31
254	3.95	70.3
254.5	4	101
255	4.1	116
255.2	4.2	122
255.4	4.3	127
255.5	4.4	129
255.6	4.5	131
256	5.5	140

C4 Rail Loop Dam

Table C.4 - Stage-storage curve - Rail Loop Dam

Level (mAHD)	Area (ha)	Volume (ML)
220	1.48	0
221	2.52	18

C5 West Void

Table C.5 - Stage-storage curve - West Void

Level (mAHD)	Area (ha)	Volume (ML)
155	4.8	0
160	5.8	265
165	6.6	575
170	7.7	933
175	8.9	1,349
180	9.9	1,819
185	11.3	2,348
190	11.3	2,913
195	11.3	3,478
200	11.3	4,043

C6 East Pit

C6.1 EXISTING

Table C.6 - Stage-storage curve - existing East Pit

Level (mAHD)	Area (ha)	Volume (ML)
80	0.8	0
85	2.2	75
90	7.1	308
95	10.1	738
100	12	1,291
105	13.8	1,934
110	17.4	2,713
115	21	3,674
120	25.6	4,839
125	32.1	6,282
130	38.5	8,046
135	55.6	10,398
140	69	13,512
145	76.1	17,138

C6.2 FINAL LANDFORM

Table C.7 - Stage-storage curve - Final landform East Pit

Level (mAHD)	Area (ha)	Volume (ML)
70	0.00	0.0
75	0.30	8.9
80	2.86	102.5
85	6.01	333.2
90	8.89	705.4
95	11.94	1,223.9
100	16.22	1,935.3
105	20.15	2,851.5
110	23.39	3,938.0
115	27.06	5,197.6
120	31.86	6,669.5
125	36.76	8,389.9
130	40.99	10,336.0
135	44.77	12,480.4
140	48.43	14,810.6
145	52.43	17,330.6
150	59.54	20,171.8
155	68.18	23,414.4
160	78.15	27,088.9
165	86.83	31,233.5
170	95.21	35,795.1
175	103.21	40,756.1

C7 North Pit

C7.1 EXISTING

Table C.8 - Stage-storage curve - existing North Pit

Level (mAHD)	Area (ha)	Volume (ML)
140	0.5	0
145	1.5	52
150	2.5	154
155	4.5	329
160	6.4	602
165	8.4	972
170	12.4	1,492
175	15	2,177
180	21.4	3,087
185	24.7	4,238
190	30.4	5,616
195	42.7	7,443
200	47	9,685
205	52.6	12,174
210	56	14,889
215	64.7	17,905

C7.2 FINAL LANDFORM

Table C.9 - Stage-storage curve - final landform North Pit

Level (mAHD)	Area (ha)	Volume (ML)
65	0.00	0.0
70	0.11	2.8
75	0.40	15.0
80	0.76	43.7
85	1.24	92.9
90	1.89	170.2
95	3.01	298.0
100	3.78	468.1
105	4.49	674.7
110	5.24	917.6
115	6.08	1200.1
120	7.05	1527.5
125	8.10	1906.1
130	9.20	2338.5
135	10.33	2826.7
140	11.50	3372.3
145	12.69	3976.8
150	14.64	4657.2
155	16.36	5432.3
160	17.86	6288.1
165	21.37	7269.2
170	24.01	8404.8
175	27.73	9701.1
180	30.69	11161.9
185	35.48	12827.1
190	38.40	14674.9
195	41.92	16681.8
200	46.82	18900.0

C8 South Void

C8.1 EXISTING

Table C.10 - Stage-storage curve - existing South Void

Level (mAHD)	Area (ha)	Volume (ML)
140	0.5	0
145	0.9	35
150	1.9	105
155	2.8	222
160	4	391
165	5.1	618
170	9.9	993

C8.2 FINAL LANDFORM

Table C.11 - Stage-storage curve - final landform South Void

Level (mAHD)	Area (ha)	Volume (ML)
85	0.00	0.0
90	0.28	7.0
95	0.70	30.7
100	1.29	79.7
105	2.04	162.1
110	3.74	316.4
115	5.30	542.4
120	7.02	850.6
125	8.77	1245.3
130	10.56	1728.5
135	12.63	2308.5
140	14.52	2986.3
145	16.52	3761.6
150	18.63	4639.3
155	21.22	5630.5
160	39.69	7136.9
165	46.36	9283.2
170	54.18	11793.0
175	64.60	14788.4

C9 Transfer Dam

Table C.12 - Stage-storage curve - Transfer Dam

Level (mAHD)	Area (ha)	Volume (ML)
180.0	0.3	0
180.5	0.4	0.0
181.0	0.5	0.1
181.5	0.7	0.4
182.0	0.9	0.9
182.5	1.1	1.6
183.0	1.3	2.8
183.5	1.6	4.6
184.0	1.9	7.1
184.5	2.2	10
185.0	2.6	15
185.5	2.9	20
186.0	3.3	26
186.5	3.7	33
187.0	4.1	41
187.5	4.5	51
188.0	5.0	62
188.5	5.4	74
189.0	5.9	87
189.5	6.4	102
190.0	6.9	119
190.5	7.3	137
191.0	7.8	157
191.5	8.2	179
192.0	8.7	202
192.5	9.2	228
193.0	9.6	255
193.5	10.1	284
194.0	10.6	316

C10 Whynot Pit

C10.1 YEAR 4

Table C.13 - Stage-storage curve - Whynot Pit, Year 4

Level (mAHD)	Area (ha)	Volume (ML)
114	0.03	0
116	0.18	2
118	0.39	8
120	0.66	18
122	5.25	77
124	6.21	192
126	7.08	325
128	7.93	475
130	8.80	642
132	9.77	828
134	10.85	1034
136	13.73	1280
138	15.48	1572
140	16.88	1896
142	19.64	2261
144	21.11	2668
146	22.98	3109
148	24.92	3588
150	26.99	4107

C10.3 YEAR 6

Table C.14 - Stage-storage curve - Whynot Pit, Year 6

Level (mAHD)	Area (ha)	Volume (ML)
104	0.6	0
106	1.3	19
108	1.9	51
110	3.0	100
112	5.1	181
114	6.4	296
116	7.6	436
118	9.1	603
120	11.3	808
122	13.0	1051
124	14.7	1328
126	16.5	1639
128	18.1	1985
130	19.6	2362
132	21.1	2768
134	22.6	3205
136	24.2	3672
138	25.8	4171
140	28.6	4715
142	30.4	5304
144	33.8	5946
146	36.1	6645
148	51.4	7520
150	65.6	8689

C10.5 YEAR 12

Table C.15 - Stage-storage curve - Whynot Pit, Year 12

Level (mAHD)	Area (ha)	Volume (ML)
78	0.29	0
80	1.22	15
82	1.84	46
84	2.49	89
86	3.36	147
88	4.35	225
90	5.48	323
92	8.08	459
94	9.54	635
96	12.32	853
98	13.89	1115
100	15.57	1410
102	19.01	1756
104	20.87	2155
106	22.89	2592
108	27.87	3100
110	30.85	3687
112	33.14	4327
114	36.12	5020
116	38.76	5768
118	40.84	6564
120	53.19	7505
122	59.93	8636
124	64.84	9884

C11 Blakefield Pit

C11.1 YEAR 4

Table C.16 - Stage-storage curve - Blakefield Pit South, Year 4

Level (mAHD)	Area (ha)	Volume (ML)
100	0.12	0
102	0.26	4
104	0.41	10
106	0.63	21
108	0.84	35
110	2.15	65
112	3.44	121
114	4.46	200
116	5.17	297
118	5.83	407
120	6.68	532
122	8.43	683
124	9.12	858
126	9.80	1047
128	10.53	1250
130	17.08	1527
132	18.79	1885
134	19.98	2273
136	21.47	2687
138	23.91	3141
140	25.91	3639
142	27.08	4169
144	28.24	4723

C11.2 YEAR 6

Table C.17 - Stage-storage curve - Blakefield Pit South, Year 6

Level (mAHD)	Area (ha)	Volume (ML)
82	0.12	0
84	0.23	4
86	0.34	9
88	0.47	17
90	0.60	28
92	0.76	41
94	1.08	60
96	1.34	84
98	1.75	115
100	2.06	153
102	2.51	199
104	2.91	253
106	3.33	315
108	3.91	388
110	4.51	472
112	5.34	571
114	7.65	700
116	10.80	885
118	11.74	1110
120	12.64	1354
122	13.47	1615
124	14.29	1893
126	15.12	2187
128	15.93	2497
130	16.88	2826

C12 Whynot West Pit

C12.1 YEAR 6

Table C.18 - Stage-storage curve - Redbank Pit, Year 6

Level (mAHD)	Area (ha)	Volume (ML)
124	0.1	0
126	0.3	4.320
128	0.6	13.927
130	2.6	46
132	4.9	120
134	7.3	242
136	9.0	405
138	10.85	603
140	14.97	861
142	18.20	1193

C13 Final void

Table C.19 - Stage-storage curve - Final Void

Level (mAHD)	Area (ha)	Volume (ML)	
110	1.2	0	
115	7.4	215	
120	19.5	888	
125	34.7	2242	
130	51.4	4395	
135	69.9	7427	
140	88.5	11387	
145	105.20	16229	Full supply level
150	121.44	21895	