APPENDIX D

# SURFACE WATER ASSESSMENT

# Wilpinjong Extension Project

## Surface Water Assessment

Wilpinjong Coal Pty Ltd

1052-01-B9, 25 November 2015

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|---|---|
| **Report Title** | Wilpinjong Extension Project Surface Water Assessment |
| **Client** | Wilpinjong Coal Pty Ltd |
| **Report Number** | 1052-01-B9 |

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# Contents

## List of Figures

# List of Tables

# List of Abbreviations

| Abbreviation | Definition |
|---|---|
| % | Percent |
| µs/cm | microSiemens per centimetre |
| AEP | Annual exceedance probability |
| AIP | Aquifer Interference Policy |
| ANZECC | Australia and New Zealand Environment Conservation Council |
| ARMCANZ | Agriculture and Resource Management Council of Australia and New Zealand |
| AWBM | Australian Water Balance Model |
| BoM | Bureau of Meteorology |
| CHPP | Coal Handling & Preparation Plant |
| CWD | Clean Water Dam |
| D/S | Downstream |
| Dams Safety Act | Dams Safety Act, 1978 |
| DECC | Department of Environment and Climate Change |
| DoE | Department of the Environment |
| DPI | Department of Primary Industries |
| DSC | Dam Safety Committee |
| DSITIA | Department of Science, Information Technology, Innovation and the Arts |
| EC | Electrical Conductivity |
| EIS | Environmental Impact Statement |
| EL | Environmental Licence |
| EPBC Act | Environment Protection and Biodiversity Conservation Act, 1999 |
| EPL | Environment Protection Licence |
| ESC | Erosion and Sediment Control |
| ESD | Ecologically sustainable development |
| ETL | Electricity Transmission Line |
| ha | Hectares |
| HRSTS | Hunter River Salinity Trading Scheme |
| HUAWSP | Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources |
| km | Kilometres |
| $km^2$ | Square kilometres |
| L/s | Litres per second |
| m | Metre |
| mAHD | Metres above Australian Height Datum |

| | |
|---|---|
| mg/L | Milligrams per litre |
| MIA | Mine infrastructure area |
| ML | Mining Lease |
| ML | Megalitres |
| ML/day | Megalitres per day |
| ML/year | Megalitres per year |
| mm | Millimetre |
| MNES | Matters of National Environmental Significance |
| MOV | Maximum operating volumes |
| Mtpa | Million tonnes per annum |
| MWD | Mine water dam |
| NSW | New South Wales |
| NTU | Nephelometric turbidity units |
| OEH | NSW Office of Environment and Heritage |
| OPSIM | Operational Simulation Model |
| PoEO Act | Protection of the Environment Operations Act, 1997 |
| RO | Reverse osmosis |
| ROM | Run-of-mine |
| RWD | Recycled Water Dam |
| SEARs | Secretary's Environmental Assessment Requirements |
| SRLUP | Strategic Regional Land Use Plan |
| TDS | Total Dissolved Solids |
| TFP | Tailings Filter Press |
| the IESC | The Independent Expert Scientific Committee |
| the Project | The Wilpinjong Extension Project |
| TSS | Total Suspended Solids |
| U/S | Upstream |
| UCML | Ulan Coal Mines Limited |
| w/w | By Weight |
| Water Act | Water Act, 1912 |
| WCM | Wilpinjong Coal Mine |
| WCPL | Wilpinjong Coal Pty Limited |
| WM Act | Water Management Act, 2000 |
| WMP | Water Management Plan |
| WMS | Water Management System |
| WRM | WRM Water & Environment Pty Ltd |
| WSP | Water Sharing Plan |

# 1 Introduction

## 1.1 BACKGROUND

The Wilpinjong Coal Mine (WCM) is an approved open cut coal mine in the Western Coalfields of New South Wales (NSW), approximately 40 kilometres (km) north-east of Mudgee. WRM Water & Environment Pty Ltd (WRM) was engaged by Wilpinjong Coal Pty Limited (WCPL) to undertake a surface water impact assessment for the Wilpinjong Extension Project (the Project).

The WCM has seven approved open cut mining areas, named Pit 1 through to Pit 7. For the purposes of WCPL internal mine planning, Pit 3 has been divided into two separate pits (Pit 3 in the north and Pit 7 in the south). Advancing mine pits are generally backfilled with overburden as mining progresses. Fine rejects (tailings) disposal occurs in remnant voids at the northern ends of Pit 1 (TD1 and TD2) and Pit 2 (TD3, TD4 and TD5). Future tailings disposal is planned for two more remnant voids (TD6 and TD7) within the Pit 2 area. However, tailings disposal is now largely undertaken as part of run-of-mine (ROM) waste emplacement since installation of a Tailings Filter Press (TFP).

## 1.2 OVERVIEW OF THE PROJECT

The Project would include the following activities:

- open cut mining of ROM coal from the Ulan Coal Seam and Moolarben Coal Member in Mining Lease (ML) 1573 and in new Mining Lease Application areas in Exploration Licence (EL) 6169 and EL 7091;
- approximately 800 hectares (ha) of open cut extensions, including:
    - approximately 500 ha of incremental extensions to the existing open cut pits in areas of ML 1573 and EL 6169;
    - development of a new open cut pit of approximately 300 ha in EL 7091 (Pit 8);
- continued production of up to 16 million tonnes per annum (Mtpa) of ROM coal;
- continued use of the WCM Coal Handling and Preparation Plant (CHPP) and general coal handling and rail loading facilities and other existing and approved supporting mine infrastructure;
- production and rail transport of approximately 13 Mtpa of thermal product coal to domestic and export customers (within existing maximum and annual average daily rail limits);
- relocation of a section of the TransGrid Wollar to Wellington 330 kilovolt (kV) electricity transmission line (ETL) to facilitate mining in Pit 8;
- various local infrastructure relocations to facilitate the mining extensions (e.g. realignment of Ulan-Wollar Road and associated rail level crossing, relocation of local ETLs and services);
- construction and operation of additional mine access roads to service new mining facilities located in Pits 5 and 8;
- construction and operation of new ancillary infrastructure in support of mining including: mine infrastructure areas, ROM pads, haul roads, electricity supply, communications installations, light vehicle roads, access tracks, remote crib huts, up-catchment diversions, dams, pipelines and other water management structures;
- extension of the approved mine life by approximately seven years (i.e. from approximately 2026 to 2033);

- a peak operational workforce of approximately 625 people;
- ongoing exploration activities; and
- other associated minor infrastructure, plant and activities.

## 1.3 STUDY METHODOLOGY AND DOCUMENT STRUCTURE

This study has been prepared to assess the potential surface water impacts from the Project and to develop measures that would avoid, minimise and monitor potential impacts.

This report contains a further 10 sections:

- Section 2 provides a description of the regulatory framework relevant to this assessment;
- Section 3 provides a description of the existing surface water environment;
- Section 4 provides an overview of the existing site water management system;
- Section 5 provides an overview of the proposed site water management strategy and infrastructure;
- Section 6 provides an overview of the mine water balance model used to simulate the performance of the mine water management system;
- Section 7 presents an assessment of the proposed water management system;
- Section 8 presents an assessment of the potential surface water impacts of the Project;
- Section 9 presents an assessment of potential cumulative surface water impacts;
- Section 10 details the proposed management, mitigation and monitoring strategies for the Project; and
- Section 11 is a list of references.

# 2 Assessment Requirements and Regulatory framework

## 2.1 OVERVIEW

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

- Strategic Regional Land Use Policy (SRLUP), which considers potential impacts on agricultural land;
- *Water Management Act 2000 (*WM Act), *Water Act 1912* (Water Act) and associated water sharing plans (WSP), which relate to the sustainable management of water resources;
- *National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Environment Conservation Council [ANZECC] and the Agriculture and Resource Management Council of Australia and New Zealand [ARMCANZ], 2000) and the NSW Government Water Quality and River Flow Objectives, which provide information on the environmental values of receiving waters and the definition of protection level based on ecosystem condition;
- *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), which considers impacts on Matters of National Environmental Significance (MNES), including water resources. The Australian Government established the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (the IESC) under the EPBC Act in 2012 to provide scientific advice on mining proposals. The IESC has published information guidelines that outline the information necessary for the IESC to provide advice to government regulators;
- *Dams Safety Act 1978* (Dams Safety Act), which relates to the design, construction, monitoring and management requirements of any prescribed dams on the site or in the surrounding area;
- *Managing Urban Stormwater Soils and Construction – Volume 2E Mines and Quarries*, (Department of Environment and Climate Change [DECC], 2008) and *Managing Urban Stormwater, Soils and Construction*, (Landcom, 2004), which provide guidelines on suitable management measures for erosion and sediment control;
- *Protection of the Environment Operations Act 1997* (POEO Act), which relates to the minimisation of pollution from the mine water management systems and discharge criteria; and
- NSW Flood Prone Land Policy and the Mid-Western Regional Local Environmental Plan which aim to minimise flood risks and impacts.

The design of infrastructure for the Project has considered the requirements of the above legislation, plans, policies and regulations. Further discussion on the regulatory framework with respect to surface water is provided in the following sections.

## 2.2 STRATEGIC REGIONAL LAND USE POLICY

The SRLUP aims to identify, map and protect valuable residential and agricultural land from the impacts of mining. Implementation of the policy includes a Gateway process to closely examine the potential impacts of new mining proposals on strategic agricultural land and equine and viticulture critical industry clusters.

The Gateway process was not completed for the Project as a Site Verification Certificate was issued for the site in October 2014 (SVC 6667). The Site Verification Certificate certifies that there is no biophysical strategic agricultural land in the Project open cut extension areas.

## 2.3 WATER MANAGEMENT ACT 2000 & WATER ACT 1912

The Water Act and WM Act establish licensing regimes for the management of water resources in NSW. The licensing and approvals provisions of the WM Act apply to water sources that are the subject of a WSP. The Water Act continues to apply to water sources that are not the subject of a WSP.

The objective of the WM Act is the sustainable and integrated management of the State's water for the benefit of both present and future generations. The WM Act provides clear arrangements for controlling land based activities that affect the quality and quantity of the State's water resources. It provides for four types of approval:

- water use approval – which authorises the use of water at a specified location for a particular purpose, for up to 10 years;
- water management work approval;
- controlled activity approval; and
- aquifer interference activity approval – which authorises the holder to conduct activities that affect an aquifer such as approval for activities that intersect groundwater, other than water supply bores and may be issued for up to 10 years.

In accordance with Division 2 of the *Water* Management *(General) Regulation 2011,* water use, water management work and controlled activity approvals are not required for a State Significant Development approved under Division 4.1 of the *Environmental Planning and Assessment Act 1997* (EP&A Act).

With respect to surface water, the Project is located within the Wollar Creek Water Source under the WM Act, as identified in the Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources (2009) (HUAWSP).

### 2.3.1 Aquifer Interference Activity Approvals

For aquifer interference activities, the WM Act requires that the activities avoid or minimise their impact on the water resource and land degradation, and where possible the land must be rehabilitated. The Aquifer Interference Policy (AIP) (Department of Primary Industries [DPI], 2012) states that a water licence is required for the aquifer interference activity regardless of whether water is taken directly for consumptive use or incidentally. Activities may induce flow from adjacent groundwater sources or connected surface water. Flows induced from other water sources also constitute take of water. In all cases, separate access licences are required to account for the take from all individual water sources. In accordance with Schedule 5 of the *Water Management (General) Regulation 2011*, a water licence is not required for prospecting activities undertaken under the *Mining Act 1992* where the water take is less than 3 megalitres per year (ML/year). Further information on the AIP is provided in the Groundwater Assessment prepared by HydroSimulations (2015) (Appendix C of the Environmental Impact Statement [EIS]).

### 2.3.2 Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009

The HUAWSP commenced on 1 August 2009. The plan area comprises 39 water sources in the Hunter River catchment. The water sources of the Goulburn Extraction Management Unit of the HUAWSP, including the Wollar Creek Water Source, are shown in Figure 2.1.

The WSPs allow for some extraction of water from the river and groundwater without a Water 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 a Water Access Licence. Each Water Access Licence specifies a share component. The share components of specific purpose licences, such as town water supply or stock and domestic are expressed as ML/year. 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 relevant Water Sources and their total share components at the start of the HUAWSP.

Extractions from the Wollar Creek Water Source are subject to Total Daily Extraction Limits which limit the daily extraction volume depending upon the river flow rate.

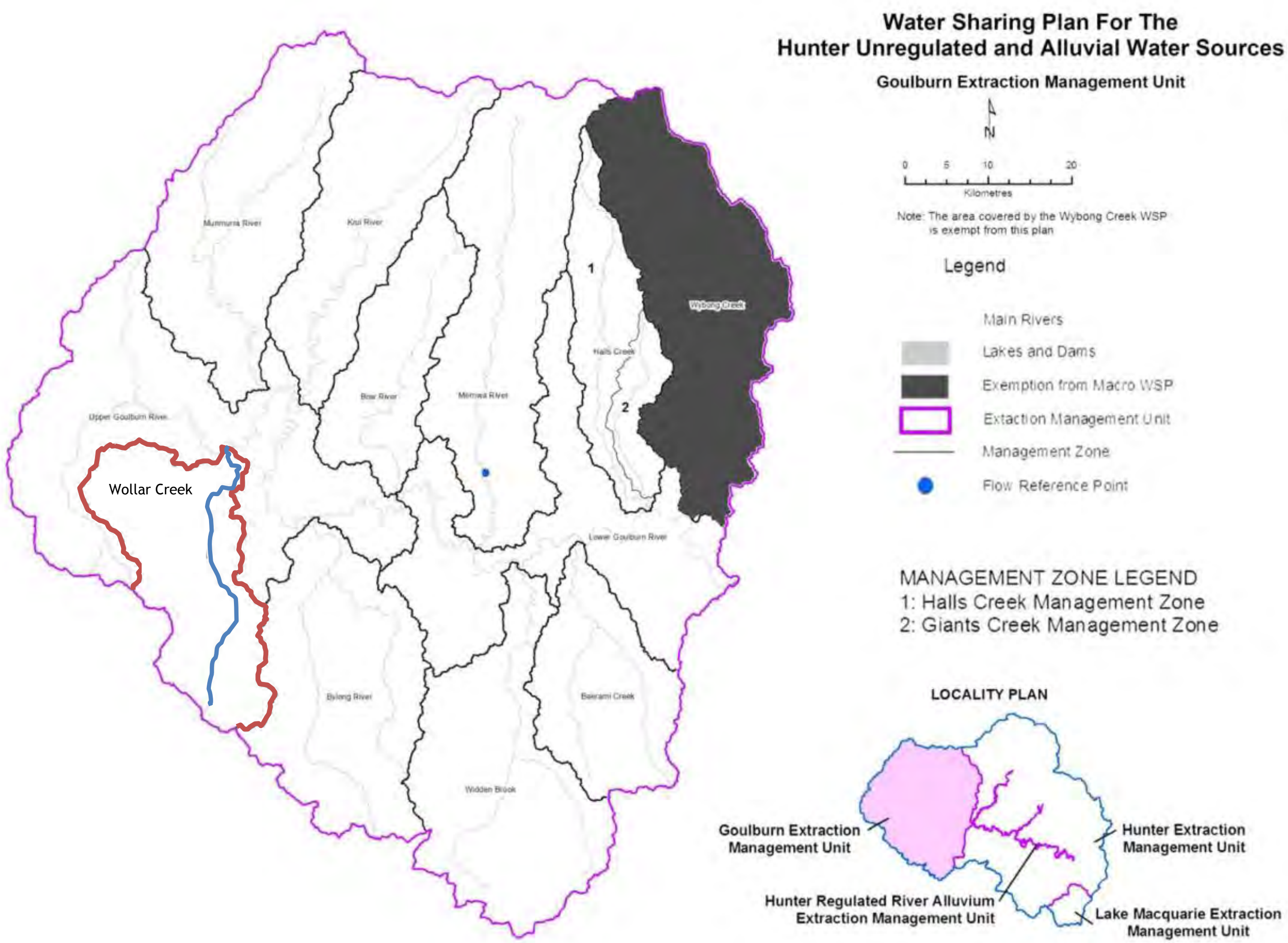



**Figure 2.1 – Hunter Unregulated and Alluvial Water Sources (Source: NOW, 2009)**

Table 2.1 – Wollar Creek water source share components for different licence categories

| Access Licence Category | Wollar Creek Water Source Share Component Zone 1 | Total Share Component in the Hunter Unregulated and Alluvial Water Source Zone 2 |
|---|---|---|
| Domestic & Stock Access (ML/year) | 19 | 736.5 |
| Unregulated River Access (Unit Shares) | 78 | 80,619 |
| Aquifer Access (Unit Shares) | 1,354 | 80,400 |
| Local Water Utility (ML/year) | 0 | 5,597 |
| Major Utility (ML/year) | 0 | 346,700 |

The Report Card for the Wollar Creek Water Source (NSW Department of Water and Energy, 2009) provides the following information:

- area – 532 square kilometres ($km^2$);
- hydrological stress – High;
- relative instream value (within catchment) – Low;
- relative economic significance of irrigation (within catchment) – Low;
- risk to instream value (from extraction) – Low; and
- total surface water entitlement (78 ML/year) (8 licences).

WCPL owns all property along Wilpinjong Creek downstream of the WCM and there is no privately owned land on the reach of Wollar Creek downstream of the confluence with Wilpinjong Creek. There are therefore no known private water users on Wilpinjong Creek or Wollar Creek downstream of the Project.

## 2.4 AUSTRALIAN GUIDELINES FOR FRESH AND MARINE WATER QUALITY

The ANZECC and 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 (now the Office of Environment and Heritage [OEH]) published online the *NSW Water Quality and River Flow Objectives* that provide guidance to technical practitioners in 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.

## 2.5 COMMONWEALTH ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) prescribes the Commonwealth's role in environmental assessment, biodiversity conservation and the management of protected areas.

The EPBC Act is administered by the Department of the Environment (DoE) (formerly Sustainability, Environment, Water, Populations and Communities) and provides protection for listed Matters of National Environmental Significance (MNES). There are currently nine MNES:

- World Heritage properties;
- National Heritage places;
- wetlands of international importance;
- listed threatened species and ecological communities;
- listed migratory species;
- protection of the environment from nuclear actions;
- Commonwealth marine areas;
- The Great Barrier Reef Marine Park; and
- water resources, in relation to coal seam gas development and large coal mining development.

The approved Wilpinjong Coal Project was referred to the DoE in 2005, and was determined as not a controlled action (EPBC 2005/2309). The proposed action to extend open cut coal mining and processing operations at the WCM was referred to the Commonwealth Minister in February 2015 (EPBC 2015/7431) (the proposed action).

The Project is not within a World Heritage property or National Heritage place, does not have wetlands of international importance, does not relate to nuclear actions, and is not within either Commonwealth marine areas or the Great Barrier Reef.

The MNES of potential relevance to the Project with respect to the surface water impact assessment is water resources.

A referral including a supporting assessment of significance for each threatened species and community must be made to the DoE to obtain confirmation of whether or not a project constitutes a “controlled action”. A controlled action is a proposed development or activity that will have, or is likely to have, a significant impact on MNES. Similarly, the referral is likely to require the inclusion of information on the potential impacts that the project may have upon water resources to confirm whether or not the project constitutes a controlled action. The Project was deemed a controlled action on 12 March 2015.

The EPBC Act establishes an environmental assessment and approval process for controlled actions. The Commonwealth Minister for the Environment has the power to accredit the Environmental Impact Assessment process under the NSW EP&A Act to meet the assessment requirements of the EPBC Act. On 26 February 2015, the Commonwealth Minister for the Environment reached a Bilateral Agreement with the NSW Government which accredits the NSW planning approvals system for the assessment of a Controlled Action and its impacts upon MNES. However, the ultimate approval authority remains with the Commonwealth Minister for the Environment. The Controlled Action cannot be carried out until the Minister has granted approval under section 133 of the EPBC Act.

It should be noted that the action that requires assessment under the EPBC Act relates to those aspects of the proposed Project that would include extension of open cut mining operations and consequent additional disturbance areas, and associated surface infrastructure that is necessary to support the extension of open cut mining.

The action does not include the approved WCM that has either been previously referred and determined not to be a Controlled Action or previously determined not to require referral under the EPBC Act but has received all relevant State approvals. In addition the elements of the Project which require EPBC Act approval exclude the continuation of mining operations in the open cut pits and associated activities which are currently authorised by existing approvals (including modifications and exploration activities).

The surface water impact assessment has been prepared to be consistent with the requirements of the IESC '*Information Guidelines for Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals*' (IESC, 2015).

## 2.6 DAMS SAFETY ACT 1978

The Dams Safety Act establishes the role of the Dams Safety Committee (DSC) to ensure the safety of dams in NSW, including surveillance of prescribed dams, which are those listed in Schedule 1 of the Dams Safety Act. The DSC is empowered with various enabling functions under the Dams Safety Act and *Mining Act 1992*. The DSC has a general responsibility for the safety of all dams, and a special responsibility for prescribed dams. Determination of whether a dam is a prescribed dam is based on an assessment of its consequence category, which considers potential downstream impacts of dam failure. A number of tailings dams at the WCM are already prescribed dams. Detailed design of proposed dams for the Project will include assessment of consequence categories to determine whether any of the dams are required to be prescribed under the Dams Safety Act.

The *Dams Safety Act 2015* was assented on 28 September 2015. The *Dams Safety Act 2015*, once fully implemented, will replace the Dams Safety Act and encourage the application of risk management and the principles of cost benefit analysis in relation to dam safety.

## 2.7 MANAGING URBAN STORMWATER SOILS AND CONSTRUCTION

*Managing Urban Stormwater: Soils and Construction* (Landcom, 2004) provides guidance on best practice management measures for erosion and sediment control during construction and other land disturbance activities. *Managing Urban Stormwater Soils and Construction – Volume 2E Mines and Quarries* (DECC, 2008) provides specific advice on appropriate measures and design standards for mining operations. The design of erosion and sediment control measures for the Project has been based on the recommended approaches and design criteria from these documents.

## 2.8 PROTECTION OF THE ENVIRONMENT OPERATIONS ACT 1997

The POEO Act is the key piece of environment protection legislation administered by the NSW Environment Protection Authority (EPA). The POEO Act enables the government to set protection of the environment policies that provide environmental standards, goals, protocols and guidelines. The POEO Act also establishes a licensing regime for pollution generating activities in NSW. Under section 48, an environment protection licence (EPL) is required for "scheduled activities", which includes coal mining. An EPL is currently held for the existing WCM operations. An amended EPL for the Project will be sought by Peabody. The POEO Act also includes a duty to notify relevant authorities of pollution incidents where material harm to the environment is caused or threatened.

## 2.9 FLOOD PRONE LAND POLICY

The primary objective of the NSW Flood Prone Land Policy is to reduce the impact of flooding and flood liability on owners and occupiers of property and to reduce private and public losses resulting from floods. Similarly, the Mid-Western Regional Local Environmental Plan aims to minimise flood risk and to ensure development of flood-prone land is compatible with flood hazard and does not adversely affect other properties or the environment through increased flooding, erosion or siltation.

Gilbert & Associates (2014) undertook flood modelling of Wilpinjong Creek and Cumbo Creek for a range of design flood events for the purpose of identifying flood mitigation works for the approved WCM. The Project open cut extensions are not located within the extent of flooding in the 1 in 1,000 annual exceedance probability (AEP) design flood.

However, the proposed connection of the realigned TransGrid Wollar to Wellington 330 kV ETL to the existing ETL, and relocation of the Ulan-Wollar road, are located within the 1 in 1,000 AEP design flood extent.

There are no private landholders located in the vicinity of the WCM on either Wilpinjong or Wollar Creeks who could be affected by impacts on flooding.

## 2.10 SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS

The Secretary's Environmental Assessment Requirements (SEARs) for the Project were issued on 9 December 2014 (State Significant Development [SSD] 6764). The Guidelines for preparing Assessment Documentation relevant to the EPBC Act were issued following the Federal Minister's decision that the Project is a controlled action. This surface water impact assessment has been prepared in accordance with the SEARs related to surface water, the various agency comments which supported the SEARs and the Guidelines for preparing Assessment Documentation relevant to the EPBC Act. Table 2.2 lists the SEARs, associated agency comments and EPBC Act requirements that are relevant to this assessment and the sections of this report in which they are addressed.

This report only addresses the surface water aspects of these SEARs. The groundwater aspects are addressed within the Groundwater Assessment (HydroSimulations, 2015).

Table 2.2 - Secretary's Environmental Assessment Requirements relevant to surface water

| Agency | SEARs relevant to surface water | Location where addressed in Surface Water Impact Assessment |
|---|---|---|
| NSW Department of Planning & Environment | The Environmental Impact Statement (EIS) for the development must comply with the requirements in Clauses 6 and 7 of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000*. In particular, the EIS must include: | |
| | – a full description of the development, including: | Section 1.2 |
| | • a water management strategy, having regard to the EPA's and DPI's requirements; | Section 4, 5 |
| | – an assessment of the likely impacts of the development on the environment, focusing on the specific issues identified below, including: | Section 8, 9 |
| | • a description of the existing environment likely to be affected by the development, using sufficient baseline data; | Section 3 |
| | • an assessment of the likely impacts of all stages of the development, including any cumulative impacts, taking into *consideration* any relevant laws, environmental planning instruments, guidelines, policies, plans and industry codes of practice; | Section 8, 9 |
| | • a description of the measures that would be implemented to mitigate and/or offset the likely impacts of the development, and an assessment of: | Section 10 |
| | ○ whether these measures are consistent with industry best practice, and represent the full range of reasonable and feasible mitigation measures that could be implemented; | |
| | ○ the likely effectiveness of these measures, including performance measures where relevant; and | |
| | ○ whether contingency plans would be necessary to manage any residual risks; | |
| | – a description of the measures that would be implemented to monitor and report on the environmental performance of the development if it is approved. | Section 10 |
| | The EIS must address the following specific issues: | |
| | – an assessment of the likely impacts of the development on the quantity and quality of the region's surface and groundwater resources, having regard to OEH's, EPA's and DPI's requirements (see Attachment 2); | Section 8 |
| | – an assessment of the likely impacts of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users; and | Section 8 |

| Agency | SEARs relevant to surface water | Location where addressed in Surface Water Impact Assessment |
|---|---|---|
| | – an assessment of the likely flooding impacts of the development. | Section 8.6 |
| MNES, EPBC Act (Requirements from the Federal Government) | **The Environment Including MNES** | |
| | The Assessment Documentation must include a description of the environment and management practices of the proposal site and the surrounding areas and other areas that may be affected by the action. Include all relevant MNES protected by controlling provisions of Part 3 of the EPBC Act (see Attachment 2 for MNES specific to the project): | Section 3, 4 |
| | … | |
| | (h) A description of the water resource environment relevant to the coal seam gas development or large coal mining development. | Section 3, 4 |
| | a. Refer to the Independent Expert Scientific Committee's (IESC) Information Guidelines for Proposals Relating to the Development of Coal Seam Gas and Large Coal Mines where there is a Significant Impact on Water Resources, available at http://www.iesc.environment.gov.au/publications/information-guidelines-independent-expert-exientific-committee-advice-coal-seam-gas. | |
| | b. Note: Advice will be requested from the IESC in regards to the proposal. | |
| | **Impacts** | |
| | (a) The Assessment Documentation must include a description of all of the relevant impacts of the action on MNES (identified in Section 2). Impacts during the construction, operational and (if relevant) the decommissioning phases of the project must be addressed, and the following information provided: | Section 8 |
| | i. a description of the relevant impacts of the action; | Section 8 |
| | ii. a detailed analysis of the nature and extent of the likely direct, indirect and consequential impacts relevant to MNES, including likely short-term and long-term impacts - refer to the Significant Impact Guidelines 1.1 - Matters of National Environmental Significance for guidance on the various types of impacts that need to be considered; | Section 8 |
| | iii. a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible; | Section 8 |
| | iv. any technical data and other information used or needed to make a detailed assessment of the relevant impacts; | Section 3, 4 |
| | v. an explanation of how Indigenous stakeholders' views of the action's impacts to biodiversity and cultural heritage have been sought and considered in the assessment. Including where relevant, how guidelines published by the Commonwealth in relation to consulting with Indigenous peoples for proposed actions that | Appendices E and G of the EIS |

| Agency | SEARs relevant to surface water | Location where addressed in Surface Water Impact Assessment |
|---|---|---|
| | are under assessment have been considered and applied; and | |
| | vi. where the proposal is a coal seam gas development or large coal mining development and likely to significantly impact on a water resource – refer to the IESC's Information Guidelines for Proposals Relating to the Development of Coal Seam Gas and Large Coal Mines where there is a Significant Impact on Water Resources, available at http://www.iesc.environment.gov.au/publications/information-guidelines-independent-expert-scientific-committee-advice-coal-seam-gas | |
| | (b) The Assessment Documentation should identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities (including known potential future expansions or developments by the proponent and other proponents in the region and vicinity). | Section 9 |
| | (c) The Assessment Documentation should also provide a detailed assessment of any likely impact that this proposed action may facilitate on the relevant MNES at the local, regional, state and national scale. | Section 8, 9 |
| | **Avoidance and Mitigation Measures/Alternatives** | |
| | The Assessment Documentation must include, and substantiate, specific and detailed descriptions of the proposed avoidance and mitigation measures, based on best available practices and must include the following elements: | |
| | a) A consolidated list of avoidance and mitigation measures proposed to be undertaken to prevent or minimise for the relevant impacts of the action on MNES, including: | Section 10 |
| | i. a description of proposed avoidance and mitigation measures to deal with relevant impacts of the action, including mitigation measures proposed to be taken by State/Territory governments, local governments or the proponent; | |
| | ii. assessment of the expected or predicted effectiveness of the mitigation measures, including the scale and intensity of impacts of the proposed action and the on-ground benefits to be gained through each of these measures; | |
| | iii. a description of the outcomes that the avoidance and mitigation measures will achieve; | |
| | iv. any statutory or policy basis for the mitigation measures; and | |
| | v. the cost of the mitigation measures. | |
| | b) A detailed outline of a plan for the continuing management, mitigation and monitoring of relevant MNES impacts of the action, including a description of the outcomes that will be achieved and any provisions for independent environmental auditing. | Section 10 |

| Agency | SEARs relevant to surface water | Location where addressed in Surface Water Impact Assessment |
|---|---|---|
| | Where appropriate, each project phase (construction, operation, decommission) must be addressed separately. It must state the environmental outcomes, performance criteria, monitoring, reporting, corrective action, contingencies, responsibility and timing for each environmental issue. | |
| | c) The name of the agency responsible for endorsing or approving each mitigation measure or monitoring program. | Section 10 |
| | **Residual Impacts** | |
| | The Assessment Documentation must provide details of: | Section 8.8 |
| | (a) The likely residual impacts on MNES that are likely to occur after the proposed activities to avoid and mitigate all impacts are taken into account. | |
| | i. Include the reasons why avoidance or mitigation of impacts is not reasonably achieved; and | |
| | ii. Identify the significant residual impacts on MNES. | |
| NSW Office of Water (now DPI Water) | It is recommend that the EIS be required to include: | |
| | – 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, for the proposed extension. | Section 8.2, Appendix C and Attachment 6 of the EIS |
| | – Assessment of any volumetric water licensing requirements (including those for ongoing water take following completion of the Project). | Section 8.2, Appendix C and Attachment 6 of the EIS |
| | – The identification of an adequate and secure water supply for the proposed extension. Confirmation that water can be sourced from an appropriately authorised and reliable supply. This is to include an assessment of the current market depth where water entitlement is required to be purchased. | Section 8.2 |
| | – A detailed and consolidated site water balance. | Section 7 |
| | – A detailed assessment against the NSW Aquifer Interference Policy (2012) using the NSW Office of Water's assessment framework. | Section 8 |

| Agency | SEARs relevant to surface water | Location where addressed in Surface Water Impact Assessment |
|---|---|---|
| | – 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. | Section 8 |
| | – Full technical details and data of all surface and groundwater modelling, and an independent peer review. | Section 6, 7 |
| | – Proposed surface and groundwater monitoring activities and methodologies. | Section 10 |
| | – Proposed management and disposal of produced or incidental water. | Section 5, 7 |
| | – Details surrounding the final landform of the site, including final void management (where relevant) and rehabilitation measures. | Section 8.4 |
| | – Assessment of any potential cumulative impacts on water resources, and any proposed options to manage the cumulative impacts. | Section 9.3 |
| | – Consideration of relevant policies and guidelines. | Section 2 |
| | – Assessment of whether the activity may have a significant impact on water resources, with reference to the Commonwealth Department of Environment Significant Impact Guidelines. | Section 8 |
| | – 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. | |
| | – A statement of where each element of the SEARs is addressed in the EIS (i.e. in the form of a table). | Section 2.10 |
| | The EIS is required to: | |
| | – Demonstrate how the proposal is consistent with the relevant rules of the Water Sharing Plans including rules for access licences, distance restrictions for water supply works and rules for the management of local impacts in respect of surface water and groundwater sources, ecosystem protection (including groundwater dependent ecosystems), water quality and surface-groundwater connectivity. | Section 8.2 and Appendix C of the EIS |
| | – Provide a description of any site water use (amount of water to be taken from each water source) and management including all sediment dams, clear water diversion structures with detail on the location, design specifications and storage capacities for all the existing and proposed water management structures. | Section 5, 5.3, 7 |

| Agency | SEARs relevant to surface water | Location where addressed in Surface Water Impact Assessment |
|---|---|---|
| | – Provide an analysis of the proposed water supply arrangements against the rules for access licences and other applicable requirements of any relevant WSP, including:<br>• Sufficient market depth to acquire the necessary entitlements for each water source.<br>• Ability to carry out a "dealing" to transfer the water to relevant location under the rules of the WSP.<br>• Daily and long-term access rules.<br>• Account management and carryover provisions. | Section 8.2 and Appendix C of the EIS |
| | – Provide a detailed and consolidated site water balance. | Section 7 |
| | – Identification of water requirements for the life of the mine in terms of both volume and timing (including predictions of potential ongoing groundwater take following the cessation of operations at the site - such as evaporation loss from open voids or inflows). | Section 6.5 |
| | – Details of the water supply sources for the proposal including any proposed surface water and groundwater extraction from each water source as defined in the relevant Water Sharing Plan/s and all water supply works to take water. | Section 8.2 |
| | – Explanation of how the required water entitlements will be obtained (i.e. through a new or existing licence/s, trading on the water market, controlled allocations etc). | Section 8.2 |
| | – Information on the purpose, location, construction and expected annual extraction volumes including details on all existing and proposed water supply works which take surface water (pumps, dams, diversions etc). | Section 4.7, 8.2 |
| | – Details on all bores and excavations for the purpose of investigation, extraction, dewatering, testing and monitoring. All predicted groundwater take must be accounted for through adequate licensing. | Appendix C of the EIS |
| | – Details on existing dams/storages (including the date of construction, location, purpose, size and capacity) and any proposal to change the purpose or existing dams/storages. | Section 4, 5 |
| | – Details on the location, purpose, size and capacity of any new proposed dams/storages. | Section 5 |
| | – Applicability of any exemptions under the Water Management (General) Regulation 2011 to the project. | Section 8.2 |
| | Water allocation account management rules, total daily extraction limits and rules governing environmental protection and access licence dealings also need to be considered. | Section 8.2 |

| Agency | SEARs relevant to surface water | Location where addressed in Surface Water Impact Assessment |
|---|---|---|
| | The Harvestable Right gives landholders the right to capture and use for any purpose 10% of the average annual runoff from their property. The Harvestable Right has been defined in terms of an equivalent dam capacity called the Maximum Harvestable Right Dam Capacity (MHRDC). The MHRDC is determined by the area of the property (in hectares) and a site-specific run-off factor. The MHRDC includes the capacity of all existing dams on the property that do not have a current water licence. Storages capturing up to the harvestable right capacity are not required to be licensed but any capacity of the total of all storages/dams on the property greater than the MHRDC may require a licence. | Section 8.2 |
| | The predictive assessment of the impact of the proposed project on surface water sources should include the following: | |
| | – Identification of all surface water features including watercourses, wetlands and floodplains transected by or adjacent to the proposed project. | Section 8.2 |
| | – Identification of all surface water sources as described by the relevant water sharing plan. | Section 8.2 |
| | – Detailed description of dependent ecosystems and existing surface water users within the area, including basic landholder rights to water and adjacent/downstream licensed water users. | Section 8.2 |
| | – Description of all works and surface infrastructure that will intercept, store, convey, or otherwise interact with surface water resources. | Section 5 |
| | – Assessment of predicted impacts on the following:<br>• flow of surface water (including floodwater), sediment movement, channel stability, and hydraulic regime,<br>• water quality,<br>• flood regime,<br>• dependent ecosystems,<br>• existing surface water users, and<br>• planned environmental water and water sharing arrangements prescribed in the relevant water sharing plans. | Section 8 |
| | The EIS should address the potential impacts of the project on all watercourses likely to be affected by the project, existing riparian vegetation and the rehabilitation of riparian land. It is recommended the EIS provides details on all watercourses potentially affected by the proposal, including: | Section 8 |
| | – Scaled plans showing the location of:<br>• wetlands/swamps, watercourses and top of bank;<br>• riparian corridor widths to be established along the creeks; | Section 3 |

| Agency | SEARs relevant to surface water | Location where addressed in Surface Water Impact Assessment |
|---|---|---|
| | • existing riparian vegetation surrounding the watercourses (identify any areas to be protected and any riparian vegetation proposed to be removed); | |
| | • the site boundary, the footprint of the proposal in relation to the watercourses and riparian areas; and | |
| | • proposed location of any asset protection zones. | |
| | – Photographs of the watercourses/wetlands and a map showing the point from which the photos were taken. | Section 3 |
| | – A detailed description of all potential impacts on the watercourses/riparian land. | Section 8 |
| | – A detailed description of all potential impacts on the wetlands, including potential impacts to the wetlands hydrologic regime; groundwater recharge; habitat and any species that depend on the wetlands. | Section 8 |
| | – A description of the design features and measures to be incorporated to mitigate potential impacts. | Section 5, 10 |
| | – Geomorphic and hydrological assessment of water courses including details of stream order (Strahler System), river style and energy regimes both in channel and on adjacent floodplains. | Section 3 |
| EPA | The environmental outcomes of the project in relation to water should be: | |
| | – There is no pollution of waters (including surface and groundwater); and | Sections 8.2, 8.3 |
| | – Polluted water (including process/tailings waters, wash down waters, polluted stormwater or sewerage) is captured onsite and collected, treated and beneficially reused, where safe and practical to do so. | Section 5 |
| | The EIS should document the measures that will achieve the above outcomes in the construction, operation and post operations phases of the project. Construction activities will need to demonstrate best practice sediment and erosion control and management in accordance with the reference document *Managing Urban Stormwater: Soils and Construction* (NSW Landcom). | Sections 5, 10 |
| | The EIS should: | |
| | 1. 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 |
| | 2. Describe any drainage lines, creeks lines etc that will be impacted by the project. | Section 3 |
| | 3. Provide a water balance for the Project 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. | Section 5.3, 6 7 |

| Agency | SEARs relevant to surface water | Location where addressed in Surface Water Impact Assessment |
|---|---|---|
| | 4. Describe the Project including position of any intakes and discharges, volumes, water quality and frequency of all water discharges (e.g. surface water discharge to a river/creek, groundwater, irrigation of waste water, etc.). | Section 5, 6 |
| | 5. Assess the nature and degree of impact that any proposed discharges may have on the receiving environment. Assessment for discharge to surface waters should be guided by *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (DEC,2006) using local Water Quality Objectives determined from the *NSW Water Quality and River Flow Objectives* (DEC, 2006). Demonstrate how the proposal will be designed and operated to:<br>• protect the Water Quality Objectives for receiving waters where they are currently being achieved;<br>• contribute towards achievement of the Water Quality Objectives over time where they are not currently being achieved. | Section 8 |
| | 6. Where the proponent intends to undertake the assessment using site-specific water quality trigger values, detail the water quality of a reference site that has been selected based on the site-specific considerations outlined in ANZECC (2000). | Section 3 |
| | 7. Identify potential impacts on watercourses and the management/mitigation measures that will be implemented where mining activities occur in proximity to or within a watercourse. | Section 8, 10 |
| | 8. Identify whether any discharge, or the location of the Project, will cause erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses. | Section 8.1 |
| | 9. If the discharge requires treatment prior to disposal, any treatment measures should be described and the predicted water quality outcomes documented. Include a detailed process diagram/flowchart of the proposal specifying all water inputs, outputs and discharge points. | Section 5, 6 |
| | 10. Demonstrate that all practical options to avoid discharge have been investigated and implemented and outline measures that have been taken to reduce the pollutant load of the discharge so that the environmental impact is minimised where a discharge is necessary. | Section 5, 10 |
| | 11. Describe how stormwater will be managed both during and after construction including a layout of the proposed stormwater system in accordance with *Managing Urban Stormwater, Soils and Construction – Volume 1* (Landcom, 2004) and *Volumes 2A to 2e* (DECC, 2008), The EIS should:<br>• Provide the proposed general location of all water management structures. These should be clearly indicated on appropriately scaled maps.<br>• Demonstrate how clean, dirty and contaminated water will be managed (separated) on site throughout the life of the Project. | Section 5, 6 |

| Agency | SEARs relevant to surface water | Location where addressed in Surface Water Impact Assessment |
| --- | --- | --- |
| | • Provide detailed water management strategies for all disturbance areas including the management of channel and overland flows into and within the disturbance area.<br>• Provide the proposed sizing of all water storage dams, sediment dams and other dams as required and justification for the sizing utilised.<br>• Identify contingency measure which may be implemented during extreme rainfall events. | |
| | 12. Where the management of sediment basins requires the use of flocculants the EIS should include information about the type, toxicity and management of flocculants proposed to treat captured water before discharge. | Section 5 |
| | 13. 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 ambient waters (http://www.environment.nsw.gov.au/ieo/index.htm). Where groundwater may be impacted the assessment should identify appropriate groundwater environmental values. | Section 3.6, 3.7 |
| | 14. 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 (http://www.mincos.gov.au/publications/australian_and_new_zealand_guidelines_for_fresh_and_marine_water_quality). | Section 3.6, 3.7 |
| | 15. State any locally specific objectives, criteria or targets which have been endorsed by the NSW Government. | Section 3.6, 3.7 |
| | 16. Assess impacts on groundwater and groundwater dependent ecosystems. The assessment should be guided by the principles in *The NSW State Groundwater Policy Framework Document* (DWLC, 1997). *Assessment and Management of Groundwater Contamination* (DEC, 2007) provides guidance on assessing and managing groundwater contamination. Assess impacts against relevant water quality guidelines for:<br>• potentially impacted environmental values and beneficial uses using local Water Quality Objectives;<br>• contamination, such as investigation levels specified in *National Environment Protection Measure Guideline on the Investigation Levels for Soil and Groundwater* (EPHC, 1999). | Appendices C, E and F of the EIS |
| | 17. Provide plans for any proposed relocation/realignment of all creeks and/or drainage lines including design, timelines and completion criteria and sufficient evidence to demonstrate that the proposed plans are achievable/sustainable, reasonable and feasible in the short and the long term. | Section 5 |

| Agency | SEARs relevant to surface water | Location where addressed in Surface Water Impact Assessment |
|---|---|---|
| | 18. Assess any irrigation areas proposed for wastewaters produced in accordance with the EPA Guideline "The Use of Effluent by Irrigation". | Section 4, 5 |
| | 19. Describe how predicted impacts on surface water, groundwater and aquatic ecosystems will be monitored and assessed over time, including monitoring locations, relevant parameters, and sampling frequency. The EIS should:<br>• Include a Trigger Action Response Plan, or similar response management plan to identify appropriate trigger values and criteria and provide appropriate response actions if impacts are identified through the monitoring program.<br>• Identify the process for identifying any trends in the monitoring data obtained<br><br>Note: Water quality monitoring should be undertaken in accordance with the *Approved Methods for the Sampling and Analysis of Water Pollutant in NSW* (DEC, 2004). *Groundwater Sampling and Analysis: Field Guide* (Geosciences Australia, 2009) provides guidance on the design of a groundwater sampling program. | Section 10 |
| Office of Environment and Heritage | 5. The EIS must map the following features relevant to water and soils including:<br>a) Acid sulphate soils (Class 1, 2, 3, or 4 on the Acid Sulphate Soil Planning Map).<br>b) Rivers, streams, wetlands, estuaries (as described in Appendix 2 of the Framework for Biodiversity Assessment).<br>c) Groundwater.<br>d) Groundwater dependent ecosystems.<br>e) Proposed intake and discharge locations. | Section 3, 4, 5 and Appendix C of the EIS |
| | 6. The EIS must describe background conditions for any water resource likely to be affected by the Wilpinjong Extension Project, including:<br>a. Existing surface and groundwater. | Section 3 |
| | b. Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations. | Section 3.5 |
| | c. Water Quality Objectives (as endorsed by the NSW Government http://www.environment.nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters. | Section 3.6, 3.7 |

| Agency | SEARs relevant to surface water | | Location where addressed in Surface Water Impact Assessment |
|---|---|---|---|
| | | d. 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 3.6, 3.7 |
| | 7. | The EIS must assess the impacts of the Wilpinjong Extension Project on water quality, including: | Section 8.3 |
| | | a. The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the Wilpinjong Extension Project 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 8.3 and Appendix C of the EIS |
| | | b. Identification of proposed monitoring of water quality. | Section 10 |
| | 8. | The EIS must assess the impact of the Wilpinjong Extension Project on hydrology, including: | |
| | | a. Water balance including quantity, quality and source. | Section 6, 7 |
| | | b. Effects to downstream rivers, wetlands, estuaries, marine waters and floodplain areas. | Section 8 |
| | | c. Effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems. | Appendices C, E and F of the EIS |
| | | 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 (eg river benches). | Section 8 |
| | | e. Changes to environmental water availability, both regulated/licensed and unregulated/rules-based sources of such water. | Section 8.2 |
| | | 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 10 |
| | | g. Identification of proposed monitoring of hydrological attributes. | Section 10 |

| Agency | SEARs relevant to surface water | Location where addressed in Surface Water Impact Assessment |
|---|---|---|
| | 9. The EIS must map the following features relevant to flooding as described in the Floodplain Development Manual 2005 (NSW Government 2005) including:<br>a. Flood prone land<br>b. Flood planning area, the area below the flood planning level.<br>c. Hydraulic categorisation (floodways and flood storage areas). | Section 3.8, 8.6 |
| | 10. 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. | Section 3.8, 8.6 |
| | 11. The EIS must model the effect of the proposed Wilpinjong Extension Project (including fill) on the flood behaviour under the following scenarios:<br>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. | Section 3.8, 8.6 |
| | 12. Modelling in the EIS must consider and document:<br>a. The impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood.<br>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.<br>c. Relevant provisions of the NSW Floodplain Development Manual 2005. | Section 3.8, 8.6 |
| | 13. The EIS must assess the impacts on the proposed Wilpinjong Extension Project on flood behaviour, including:<br>a. Whether there will be detrimental increases in the potential flood affectation of other properties, assets and infrastructure.<br>b. Consistency with Council floodplain risk management plans.<br>c. Compatibility with the flood hazard of the land.<br>d. Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land.<br>e. Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or | Section 3.8, 8.6 |

| Agency | SEARs relevant to surface water | Location where addressed in Surface Water Impact Assessment |
|---|---|---|
| | downstream of the site.<br>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.<br>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.<br>h. Whether the proposal incorporates specific measures to manage risk to life from flood.<br>i. Emergency management, evacuation and access, and contingency measures for the development considering the full range or 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.<br>j. Any impacts the development may have on the social and economic costs to the community as consequence of flooding. | |

DEC = Department of Environment and Conservation

# 3 Existing surface water environment

## 3.1 REGIONAL DRAINAGE NETWORK

The WCM is located within the Upper Goulburn River catchment, part of the Hunter River basin (see Figure 3.1). The Hunter River basin has a catchment area of approximately 22,000 $km^2$.

The WCM is located to the south of Wilpinjong Creek, a headwater tributary of Wollar Creek which joins the Goulburn River approximately 8 km to the north east. The catchment area of Wollar Creek at the confluence with the Goulburn River is approximately 530 $km^2$. The catchment area of the Goulburn River at the confluence is approximately 1,149 $km^2$.

The main tributaries of Wollar Creek are shown in Figure 3.2.


**Figure 3.1 – Regional drainage overview**

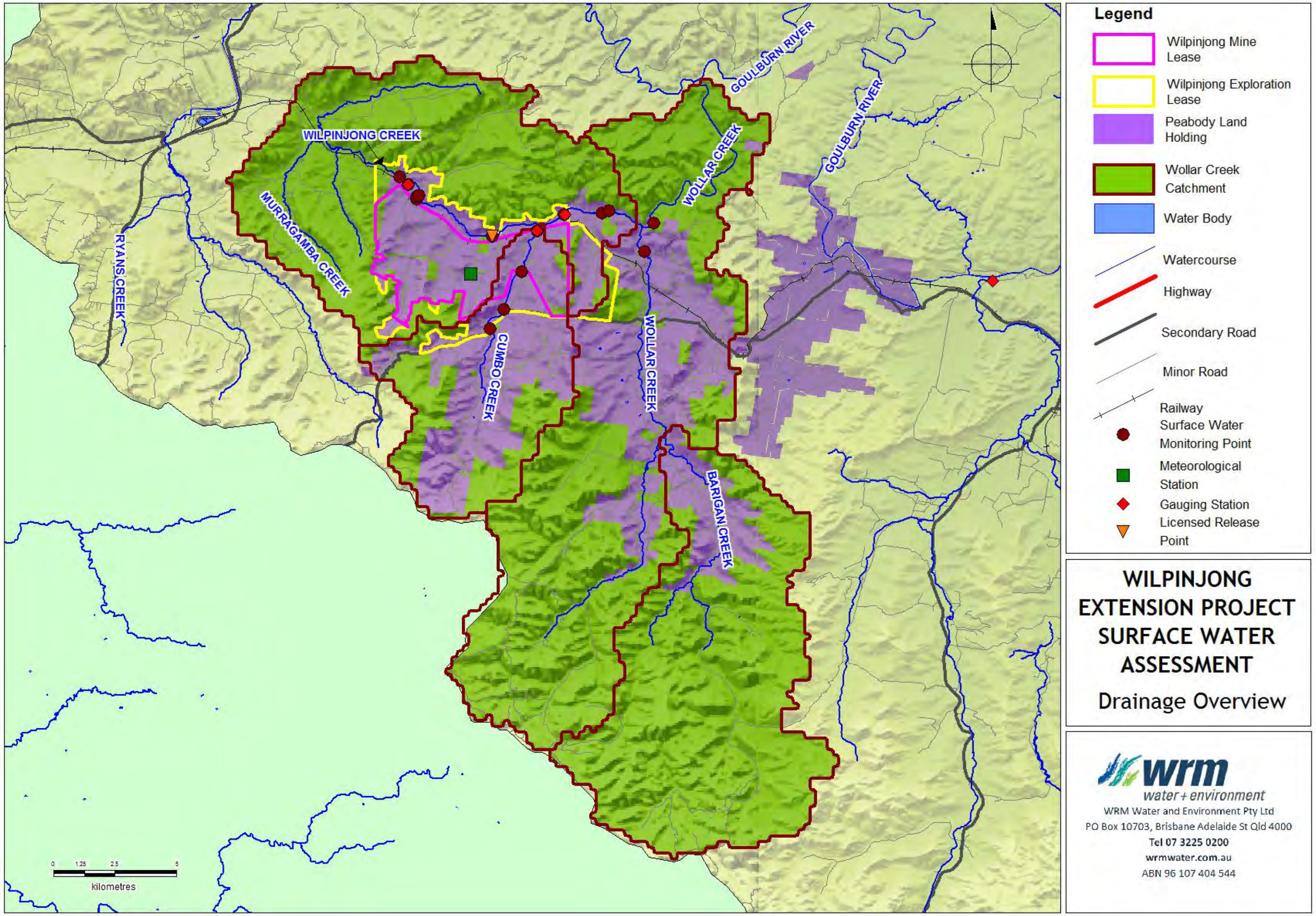



**Figure 3.2 – Wollar Creek catchment**

## 3.2 LOCAL DRAINAGE NETWORK

The upstream reaches of Wilpinjong Creek flow west from the Goulburn River National Park toward its confluence with Murragamba Creek, approximately 5 km upstream of the WCM. It flows in a south-easterly direction, before turning generally easterly as it passes the WCM, toward its confluence with Wollar Creek, approximately 4 km downstream of the WCM.

Wilpinjong Creek forms a series of semi-permanent soaks fed primarily by drainage from the surrounding alluvial plain and colluvium which is recharged by runoff from the adjacent sandstone plateau (Gilbert & Associates, 2013). As shown in Figure 3.3, there are areas of reed growth along the creek bed which form wide swampy areas in places. Vegetation on the banks and overbank areas is predominantly grass with occasional trees and little in-stream vegetation.

**Figure 3.3 – Photograph of Wilpinjong Creek channel**

The local drainage network in the vicinity of the Project area is shown in Figure 3.4. The mining area itself is drained by a number of north-flowing headwater tributaries of Wilpinjong Creek, including Cumbo Creek. Other streams delineated on 1:25,000 scale maps of the areas include Planters Creek, Narrow Creek and Bens Creek.

These streams, and other unnamed gullies crossing the Project area, have been described as spring-fed semi-perennial streams in their upper reaches near the Munghorn Gap Nature Reserve, transitioning to wide, ill-defined ephemeral drainage paths in the lower reaches near Wilpinjong Creek (Gilbert & Associates, 2013).

Most of these streams have been either diverted or intercepted by the approved mining operations, and the pre-mine catchment areas of Wilpinjong and Cumbo Creeks have been reduced by the development of open cut pits as part of the approved WCM.

Cumbo Creek (see Figure 3.5), the largest tributary crossing the site, is a 5$^{th}$ order stream, and has a pre-mine catchment area of approximately 70 km$^2$. The downstream reaches of

Cumbo Creek are approved to be relocated and the existing alignment mined as part of approved mining operations.

As shown in Figure 3.4, all other tributaries crossing the site are 1st or 2nd order streams. The unnamed drainage line west of Slate Gully Road (see Figure 3.6), which will be impacted by mining associated with the proposed Pit 8, is a 2nd order stream. The unnamed drainage line is ephemeral. The unnamed drainage line was inspected as part of the aquatic ecology surveys which found that the drainage line was restricted to occasional small dams and many reaches of the creek appeared to have been grazed recently (Bio-Analysis, 2015). The unnamed drainage line was given a poor rating for aquatic habitat (Bio-Analysis, 2015).

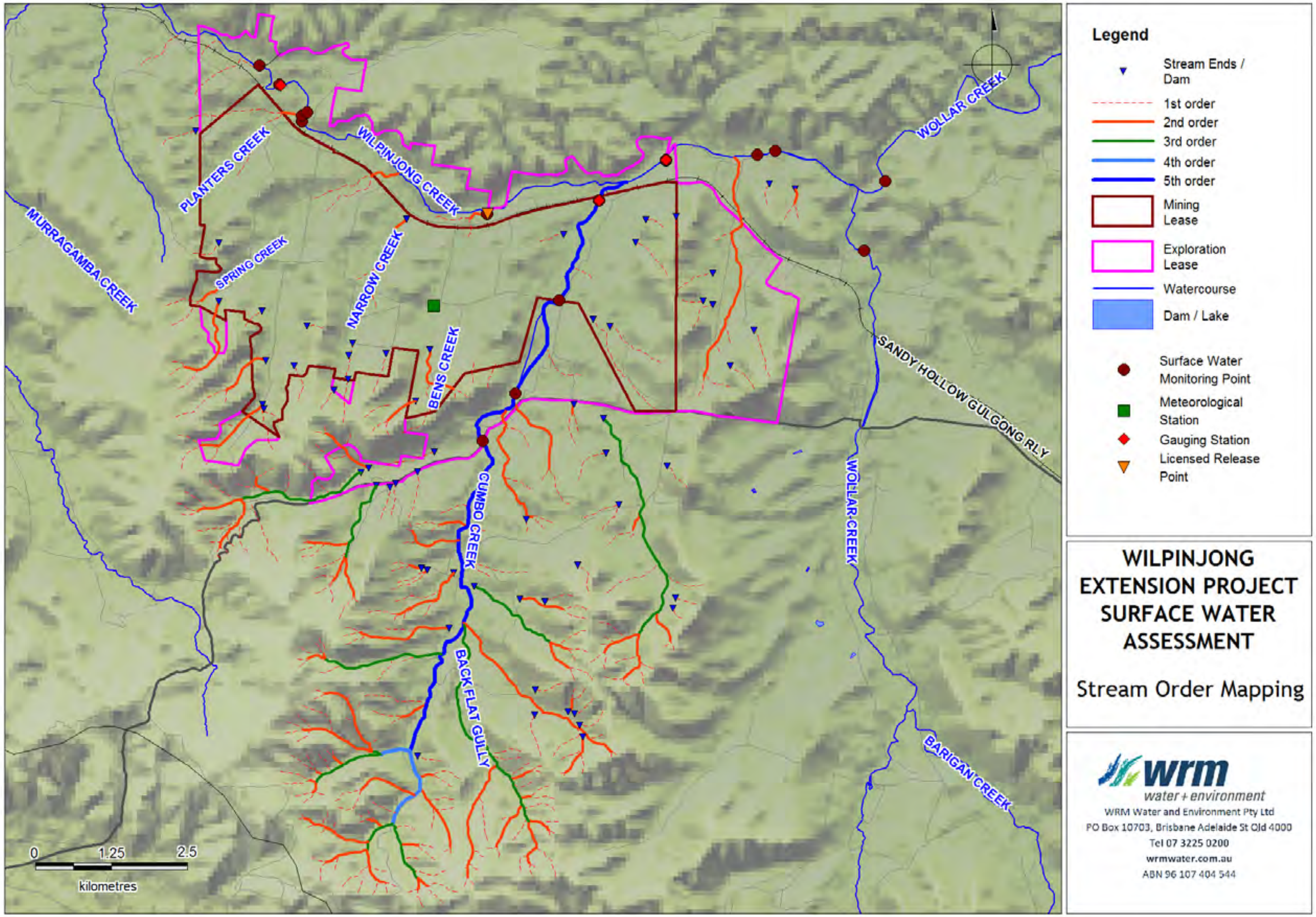



**Figure 3.4 – Local stream network and stream order**

**Figure 3.5 – Photograph of Cumbo Creek**

**Figure 3.6 – Photograph of Slate Gully**

## 3.3 TOPOGRAPHY AND LAND USE

Wilpinjong Creek is incised into a valley between the sandstone plateaus of the Munghorn Gap Nature Reserve to the south, and the Goulburn River National Park to the north.

The WCM is located on the alluvial/colluvial flats associated with the gullies draining the southern escarpment. The valley flats have typical gradients toward Wilpinjong Creek of approximately 1 in 65 (1.5 percent [%]). The escarpment rises approximately 100 metres (m) from the valley floor to elevations exceeding 450 m Australian Height Datum (mAHD) on the plateau.

The existing operations at the Moolarben Coal Complex are located less than 10 km to the north west of the Project outside of the Wilpinjong Creek catchment. While approval has been granted for mining activities immediately to the west and upstream of the WCM, the mine has not operated in the Wilpinjong Creek catchment in the past.

The sandstone plateaus are heavily forested. The valley flats in the nearby area is used for cattle and sheep grazing with intermittent cropping, principally for fodder.

## 3.4 RAINFALL AND EVAPORATION

Table 3.1 shows summary details of the Bureau of Meteorology (BOM) rainfall stations and also the nearest BOM station which records pan evaporation. The closest long-term rainfall station is located approximately 7 km from the Project at Wollar (Barigan St [062032]). Long-term daily rainfall records are also available for the Gulgong Post Office station (062013), located 34 km from the Project.

Pan evaporation has been recorded at Scone, which is approximately 100 km from the Project site.

Table 3.1 – Rainfall and evaporation station details

| Station No. | Station Name | Elevation (m) | Easting (m E) | Northing (m S) | Distance from Site (km) | Opened | Closed |
|---|---|---|---|---|---|---|---|
| 062032* | Wollar (Barigan St) | 366 | 777600 | 6415830 | 7 | 1901 | - |
| 062013* | Gulgong Post Office | 475 | 738065 | 6416845 | 34 | 1881 | - |
| 061089* | Scone SCS | 216 | 304585 | 6451040 | 100 | 1950 | - |
| - | WCM Weather Station | 397 | 770641 | 6418078 | On-site | 2006 | - |

*Source: BOM

In order to extend the rainfall and evaporation datasets for the water balance calculations, a synthetic climate dataset was also obtained for the nearest available co-ordinate near the Project area from the Queensland Department of Science, Information Technology, Innovation and the Arts (DSITIA's) Data Drill service (Jeffrey et al., 2001). The Data Drill "accesses grids of data derived by interpolating the BOM's station records. Interpolations are calculated by splining and kriging techniques. The data in the Data Drill are all synthetic; there are no original meteorological station data left in the calculated grid fields. However, the Data Drill does have the advantage of being available for any set of coordinates in Australia". The Data Drill service accesses data stored in the enhanced climate data bank. The key advantage of adopting the Data Drill data is that it has been adjusted to remove accumulated totals over multiple days and to fill periods of missing data using rainfall from nearby stations. However, the interpolation techniques can result in some reduction in the variance of the climate record compared to the observed data.

Rainfall statistics for the BOM stations, Data Drill and WCPL weather stations are summarised in Table 3.2.

Table 3.2 – Rainfall station details

| Month | Gulgong Post Office (BoM 062013) | | Wollar (Barigan St) (BoM 062032) | | Data Drill | | WCM Weather Station | |
|---|---|---|---|---|---|---|---|---|
| | Rainfall (mm) | No. Rain Days | Rainfall (mm) | No. Rain Days | Rainfall (mm) | No. Rain Days | Rainfall (mm) | No. Rain Days |
| Commence | Apr 1881 | | Jan 1901 | | Jan 1889 | | 2006 | |
| End | Oct 2015 | | Oct 2015 | | July 2015 | | Mar-2015 (station still open) | |
| No. Years | 133+ | | 114+ | | 126+ | | 10 (to-date) | |
| January | 70.3 | 5.9 | 66.7 | 4.9 | 69.6 | 9.3 | 52.3 | 6.8 |
| February | 61.9 | 5.5 | 63.1 | 4.5 | 63.7 | 8.4 | 78.2 | 11.3 |
| March | 54.8 | 5.2 | 52.2 | 4.3 | 54.1 | 7.6 | 50.7 | 7.6 |
| April | 44.3 | 4.6 | 39.5 | 3.8 | 40.2 | 7.3 | 31.3 | 8.6 |
| May | 45.1 | 5.8 | 37.7 | 4.0 | 40.3 | 8.2 | 32.3 | 8.1 |
| June | 50.8 | 7.3 | 44.0 | 4.8 | 47.2 | 9.9 | 63.5 | 13.0 |
| July | 49.1 | 7.8 | 42.5 | 5.0 | 44.9 | 10.6 | 43.6 | 13.1 |
| August | 46.0 | 7.0 | 41.3 | 4.7 | 45.9 | 9.9 | 35.5 | 8.4 |
| September | 46.3 | 6.6 | 40.3 | 4.4 | 43.6 | 9.2 | 42.3 | 8.3 |
| October | 55.3 | 6.6 | 51.1 | 5.1 | 52.9 | 9.5 | 39.9 | 7.9 |
| November | 59.6 | 6.3 | 55.7 | 4.9 | 57.2 | 9.5 | 75.6 | 10.4 |
| December | 67.5 | 6.4 | 59.0 | 4.9 | 61.7 | 9.6 | 114.9 | 11.4 |
| **Annual** | **651** | **75** | **588** | **55** | **618** | **109** | **660.3** | **115** |

Source: BOM, SILO, WCPL (note average annual rainfall is calculated from calendar years with complete datasets - and therefore may not match the sum of average monthly rainfalls) mm = millimetres

Mean annual rainfall in the Data Drill dataset is 618 mm. However, as shown in Figure 3.7, annual rainfall can vary significantly from year to year, with annual totals ranging from 228 mm in 1919 to 1218 mm in 1950.

Table 3.3 compares recent monthly rainfall data (January 2013 to July 2015) between the four stations. The table shows the monthly rainfall totals and number of rain days is fairly consistent for the Gulgong Post Office, Data Drill and WCM Weather Station datasets. The Wollar (Barigan St.) station has recorded a significantly lower number of rain days compared to the other three stations.

Table 3.3 - Rainfall station details (Jan 2013 to Jul 2015)

| Month | Gulgong Post Office (BoM 062013) | | Wollar (Barigan St) (BoM 062032) | | Data Drill | | WCM Weather Station | |
|---|---|---|---|---|---|---|---|---|
| | Rainfall (mm) | No. Rain Days | Rainfall (mm) | No. Rain Days | Rainfall (mm) | No. Rain Days | Rainfall (mm) | No. Rain Days |
| Jan 2013 | 101.4 | 6 | 73.6 | 4 | 78 | 7 | 91.2 | 6 |
| Feb 2013 | 46.7 | 7 | 54.2 | 3 | 54.5 | 6 | 53 | 6 |
| Mar 2013 | 84.3 | 9 | 61.4 | 4 | 64.4 | 9 | 73 | 9 |
| Apr 2013 | 1.2 | 3 | 12.2 | 2 | 7.8 | 3 | 13.8 | 3 |
| May 2013 | 22.6 | 7 | 17.4 | 2 | 21.3 | 6 | 20 | 7 |
| Jun 2013 | 83.3 | 13 | 77.9 | 7 | 79.9 | 14 | 90.6 | 19 |
| Jul 2013 | 25.4 | 10 | 20.8 | 5 | 20.7 | 8 | 18.6 | 9 |
| Aug 2013 | 11.5 | 8 | 6.6 | 3 | 7.1 | 5 | 6.8 | 10 |
| Sep 2013 | 49.3 | 3 | 33 | 2 | 34.4 | 3 | 38 | 2 |
| Oct 2013 | 6.6 | 5 | 8.8 | 3 | 8.6 | 5 | 6.6 | 4 |
| Nov 2013 | 25.8 | 9 | 78.6 | 5 | 64.8 | 10 | 52.8 | 10 |
| Dec 2013 | 28.4 | 6 | 27.6 | 3 | 29.2 | 3 | 31.8 | 5 |
| ***2013 TOTAL*** | ***468.5*** | ***86*** | ***472.1*** | ***43*** | ***470.7*** | ***79*** | ***496.2*** | ***90*** |
| Jan 2014 | 37.8 | 4 | 15.6 | 3 | 18.7 | 5 | 21.6 | 2 |
| Feb 2014 | 40.9 | 7 | 60 | 5 | 63.2 | 7 | 101.8 | 7 |
| Mar 2014 | 63.1 | 10 | 112.6 | 7 | 103.7 | 14 | 133.2 | 13 |
| Apr 2014 | 54.2 | 9 | 62.8 | 5 | 65.4 | 8 | 48.8 | 8 |
| May 2014 | 28.5 | 8 | 13.8 | 2 | 15.5 | 6 | 16.8 | 6 |
| Jun 2014 | 39.6 | 9 | 29.8 | 5 | 30.4 | 9 | 30.2 | 7 |
| Jul 2014 | 31.8 | 11 | 28.6 | 3 | 28.1 | 7 | 32.6 | 7 |
| Aug 2014 | 25.7 | 7 | 28.8 | 4 | 28 | 5 | 20.4 | 4 |
| Sep 2014 | 19.7 | 6 | 14.6 | 2 | 15.6 | 6 | 23.2 | 5 |
| Oct 2014 | 19.5 | 5 | 15.4 | 3 | 15.2 | 4 | 20 | 5 |
| Nov 2014 | 30.8 | 7 | 24.4 | 4 | 24.6 | 5 | 44.2 | 7 |
| Dec 2014 | 106.8 | 12 | 124.8 | 9 | 134.2 | 14 | 190.2 | 14 |
| ***2014 TOTAL*** | ***498.4*** | ***95*** | ***531.2*** | ***52*** | ***542.6*** | ***90*** | ***683.0*** | ***85*** |
| Jan 2015 | 86.2 | 10 | 127.6 | 9 | 120.5 | 14 | 190.8 | 16 |
| Feb 2015 | 18.5 | 4 | 11.6 | 3 | 17.2 | 7 | 3.6 | 5 |
| Mar 2015 | 30 | 5 | 9.4 | 3 | 15.3 | 10 | 32.4 | 5 |
| Apr 2015 | 94.4 | 13 | 108.4 | 10 | 108.2 | 15 | 106.4 | 14 |
| May 2015 | 50.3 | 10 | 42.8 | 4 | 43.4 | 9 | 52 | 12 |
| Jun 2015 | 64.6 | 11 | 42.8 | 6 | 44.6 | 10 | 48.6 | 11 |
| Jul 2015 | 62.1 | 14 | 38 | 6 | 37.9 | 11 | 38.4 | 12 |
| ***2015 TOTAL (to July)*** | ***406.1*** | ***67*** | ***380.6*** | ***41*** | ***387.1*** | ***76*** | ***472.2*** | ***75*** |

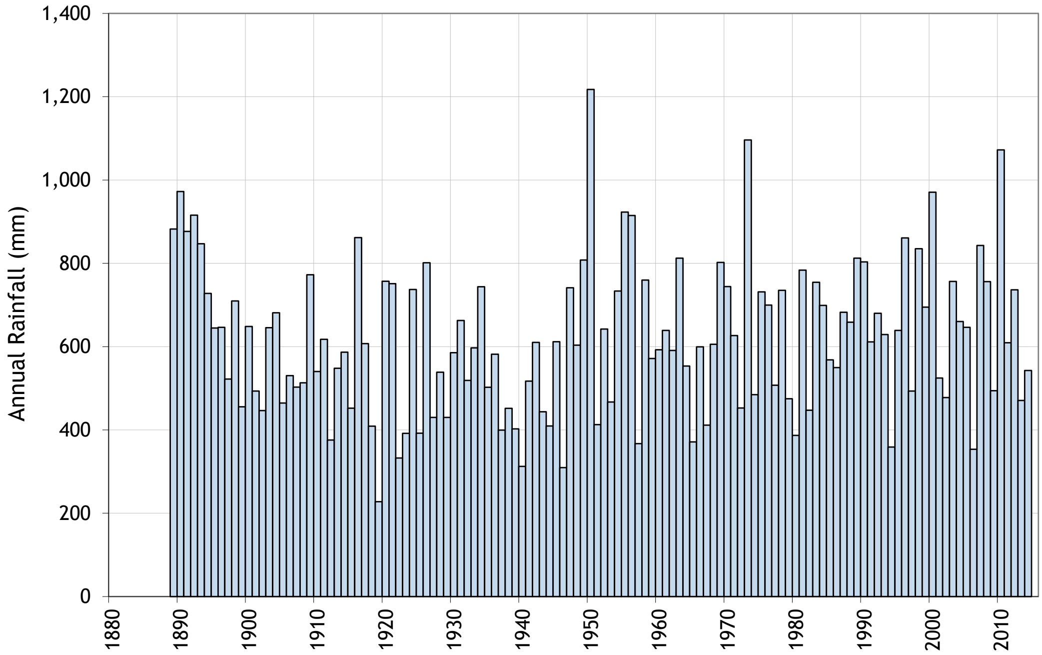



**Figure 3.7 – Annual rainfall totals (Data Drill)**

Table 3.4 compares the annual distribution of average monthly Data Drill pan evaporation to the Scone SCS monthly average. There is very little spatial variation in pan evaporation across the region.

Mean annual pan evaporation is significantly higher than mean annual rainfall.

Table 3.4 - Comparison of mean monthly pan evaporation (Data Drill/Scone)

| Month | Data Drill Pan Evap (mm/month) | Scone SCS Pan Evap (mm/month) |
|---|---|---|
| January | 236 | 220 |
| February | 188 | 175 |
| March | 167 | 152 |
| April | 111 | 105 |
| May | 70 | 68 |
| June | 48 | 48 |
| July | 53 | 56 |
| August | 77 | 84 |
| September | 109 | 117 |
| October | 154 | 158 |
| November | 191 | 183 |
| December | 234 | 220 |
| **Annual** | **1,638** | **1,586** |

Figure 3.8 shows that rainfall is relatively evenly distributed throughout the year. While average monthly pan evaporation is similar to rainfall in the winter months, it is significantly higher in the summer months (especially in December and January).

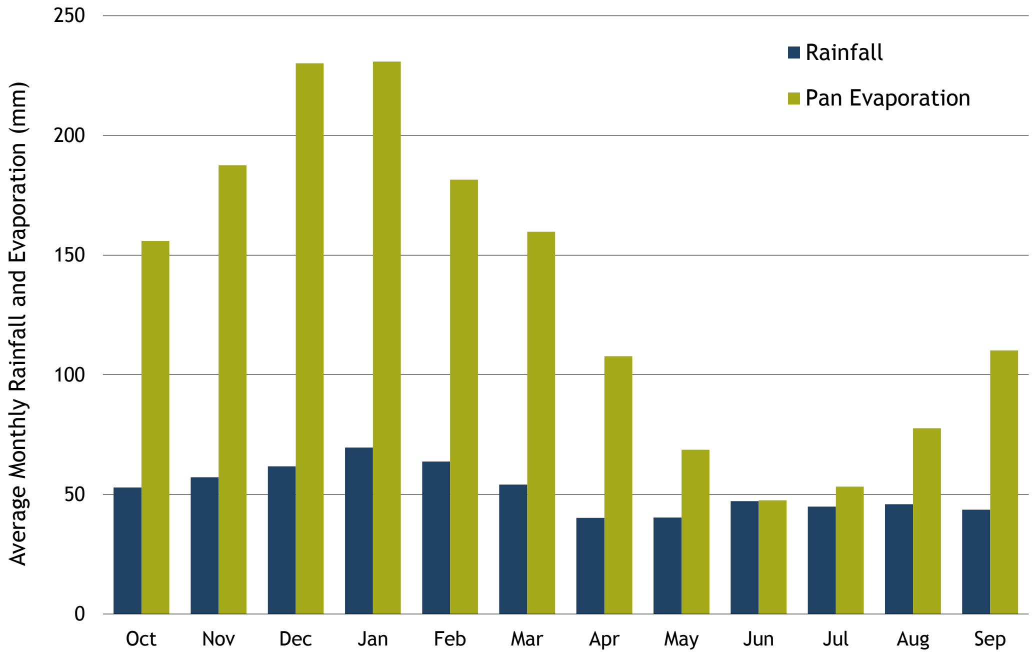



**Figure 3.8 – Average monthly rainfall and pan evaporation (Data Drill)**

### 3.4.1 Evaporation factors

Soil moisture evapotranspiration losses in the Australian Water Balance Model (AWBM) model have been estimated using pan evaporation with a pan factor of 0.85. This factor has been applied uniformly across all land use types.

The following open water evaporation factors have been applied to the water balance model:

- For water storages - 0.9; and
- For open cut pits - 0.7.

## 3.5 STREAMFLOW

### 3.5.1 Regional flow characteristics

The nearest active streamflow gauging station operated by the DPI Water is the Goulburn River at Coggan (210006) gauge located approximately 85 km downstream of the Project area. The gauge has been operating since 1913, and has a catchment area of approximately 3,340 $km^2$. Its location is shown in Figure 3.2.

The streamflow recorded in the Goulburn River at Coggan is shown in Figure 3.9. The flow frequency curve in Figure 3.10 shows that daily streamflow has exceeded 4.9 ML/day (or 0.15 $ML/day/km^2$) for 90% of the flow record, and median daily flow is over 40 ML/day (or 1.20 $ML/day/km^2$). Mean annual runoff at this gauge (8,780 ML/annum or 20.1 mm/annum) is approximately 3.1% of mean annual rainfall.

Wollar Creek streamflow was recorded at the Wollar Gauge (GS210082) between 1969 and 1997. This gauge had a catchment area of 274 $km^2$. Wollar Creek streamflow was ephemeral over its period of operation, with flow occurring over approximately 82% of the streamflow record. Median daily flow was 1.7 ML/day, or 0.62 $ML/day/km^2$. Mean annual runoff at this gauge was estimated to be 2.4% of mean annual rainfall (WCPL, 2005).

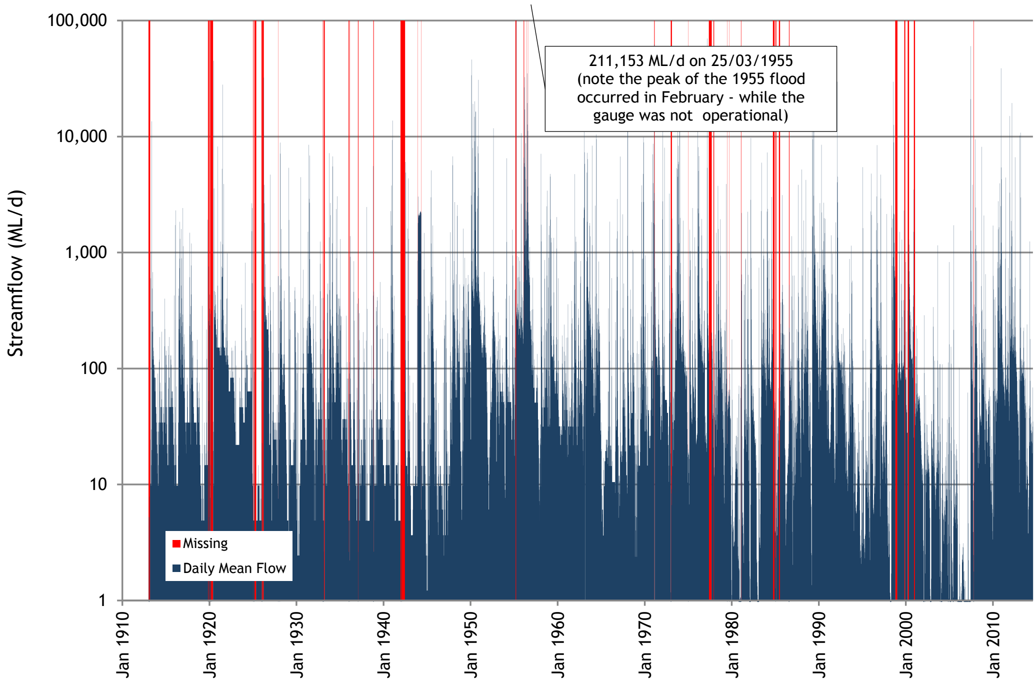



**Figure 3.9 - Recorded streamflow - Goulburn River at Coggan**

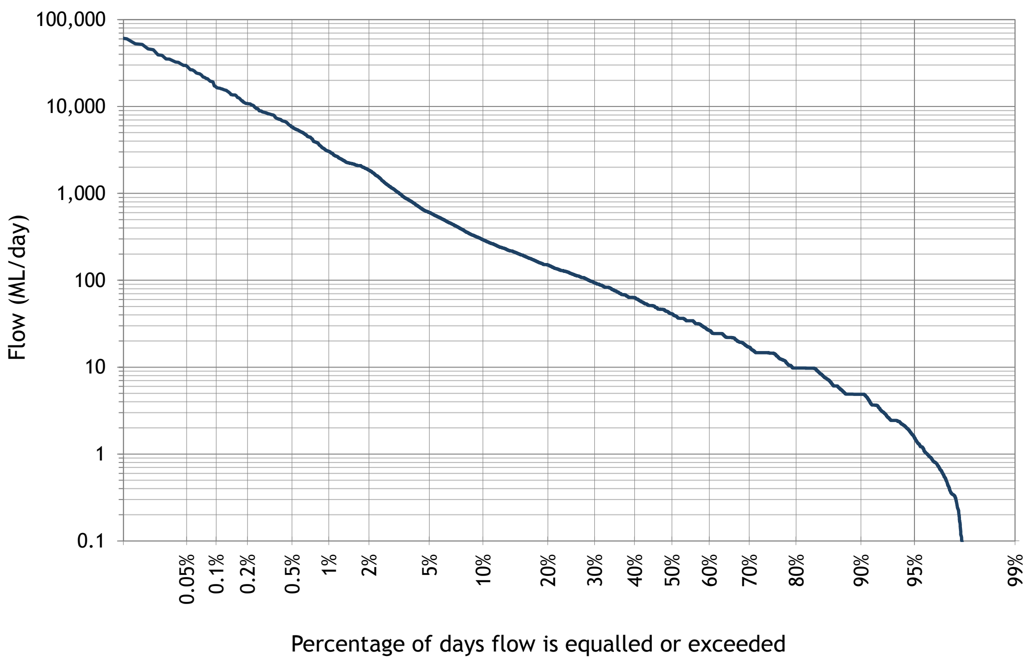



**Figure 3.10 - Flow frequency curve - Goulburn River at Coggan**

### 3.5.2 Local streamflow

WCPL monitors streamflow in Wilpinjong Creek both upstream and downstream of the licensed discharge location. Water level is also monitored on Cumbo Creek immediately upstream of its confluence with Wilpinjong Creek and at the upstream Project boundary.

Table 3.5 shows details of the DPI Water and WCPL streamflow monitoring sites. The WCPL monitoring locations are shown in Figure 3.11. The recorded flow data at each location is presented in Figure 3.12 to Figure 3.15. Note that no rating curve is available for the Cumbo Creek gauge and the data is recorded as 'depth above cease to flow level', rather than flow.

Table 3.5 - Streamflow monitoring site details

| Monitoring Site | Description | Catchment area ($km^2$) | Frequency | Period of Record |
|---|---|---|---|---|
| *DPI Water monitoring site* | | | | |
| 210006 | Goulburn River @ Coggan | 3,340 | daily (up to 1973)<br>sub-daily (from 1973) | 1913-2014 |
| *WCPL monitoring site* | | | | |
| WILGSU | Wilpinjong Creek U/S Gauging Station | 81 | continuous | 2007-2014 |
| WILGSD | Wilpinjong Creek D/S Gauging Station | 168 | continuous | 2007-2014 |
| CCGSD | Cumbo Creek D/S Gauging Station | 67.5 | continuous | 2007-2015 |
| CCGSU | Cumbo Creek U/S Gauging Station | | continuous | 2015 |

Given the limited data period for the Cumbo Creek U/S Gauging Station (i.e. 2 months), it has not been analysed further in this report.

U/S = upstream D/S = downstream

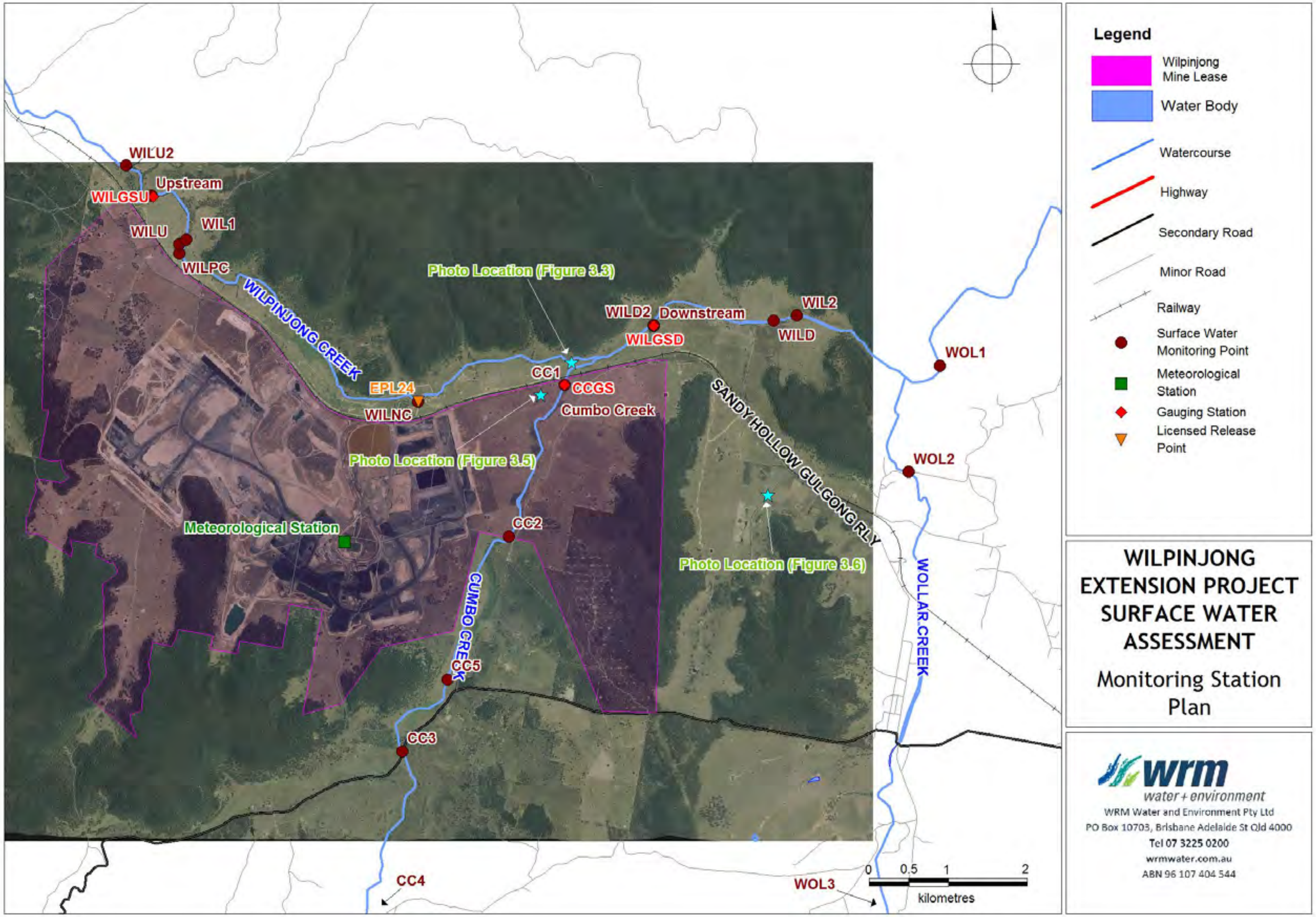



**Figure 3.11 – Streamflow monitoring locations**

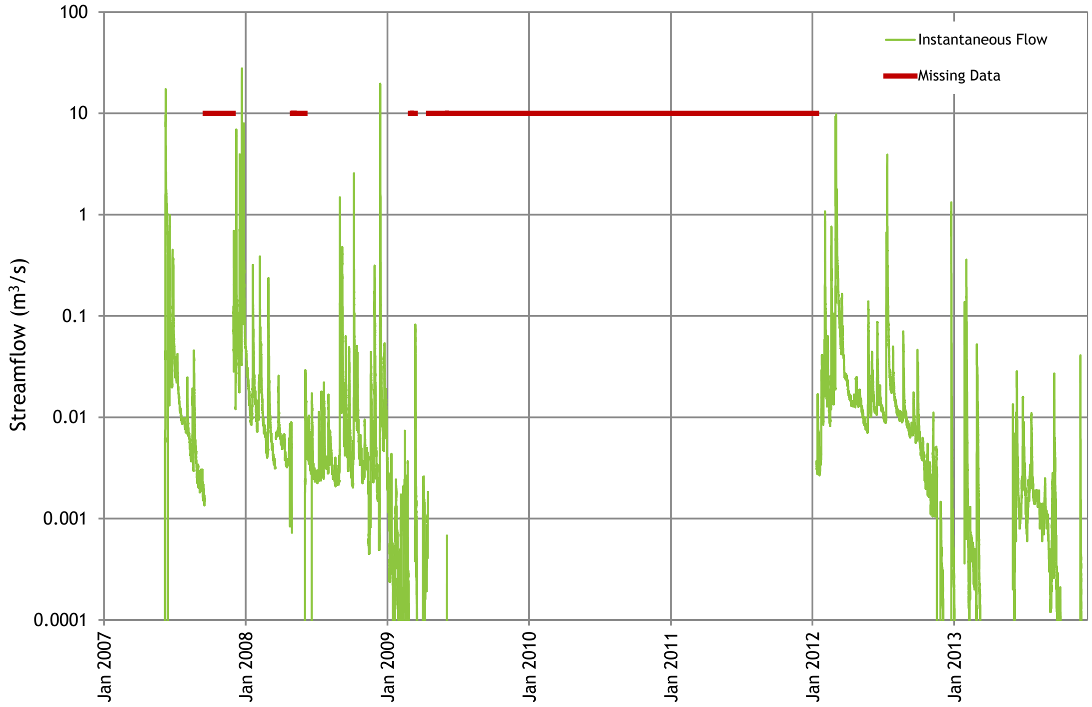



**Figure 3.12 – Recorded streamflow – Wilpinjong Creek U/S 2007-2014**

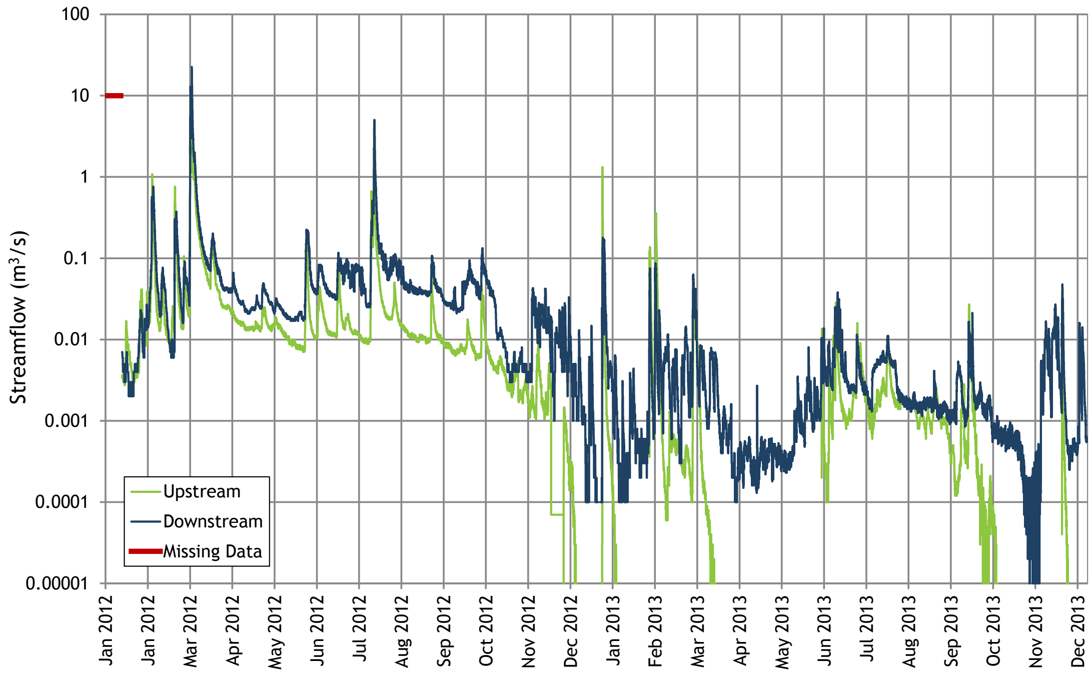
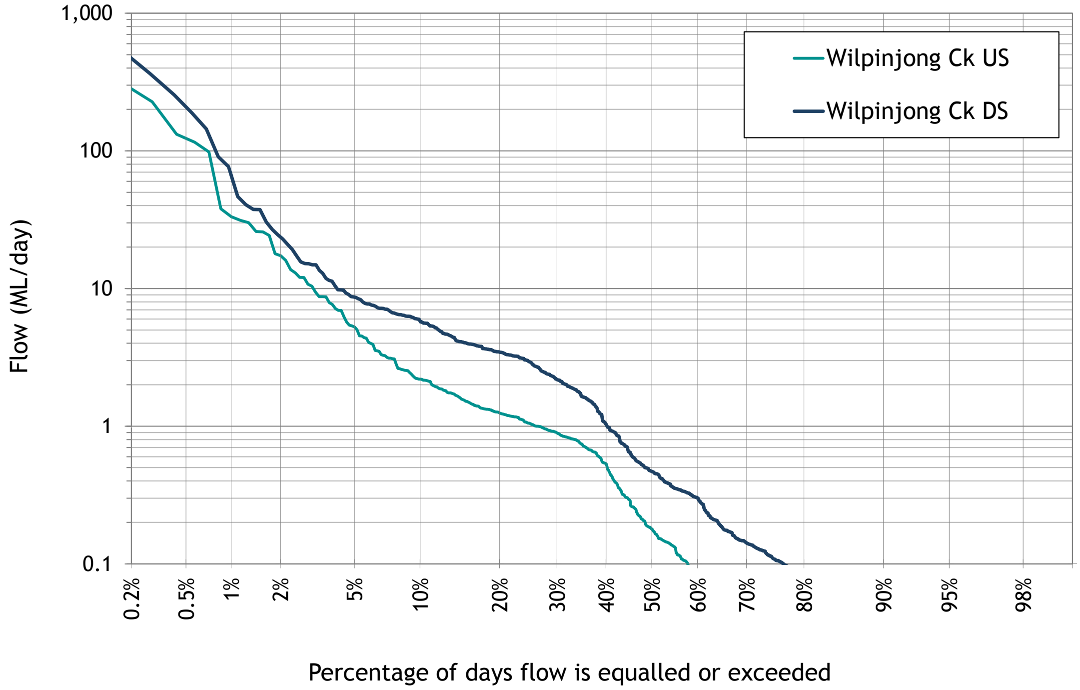
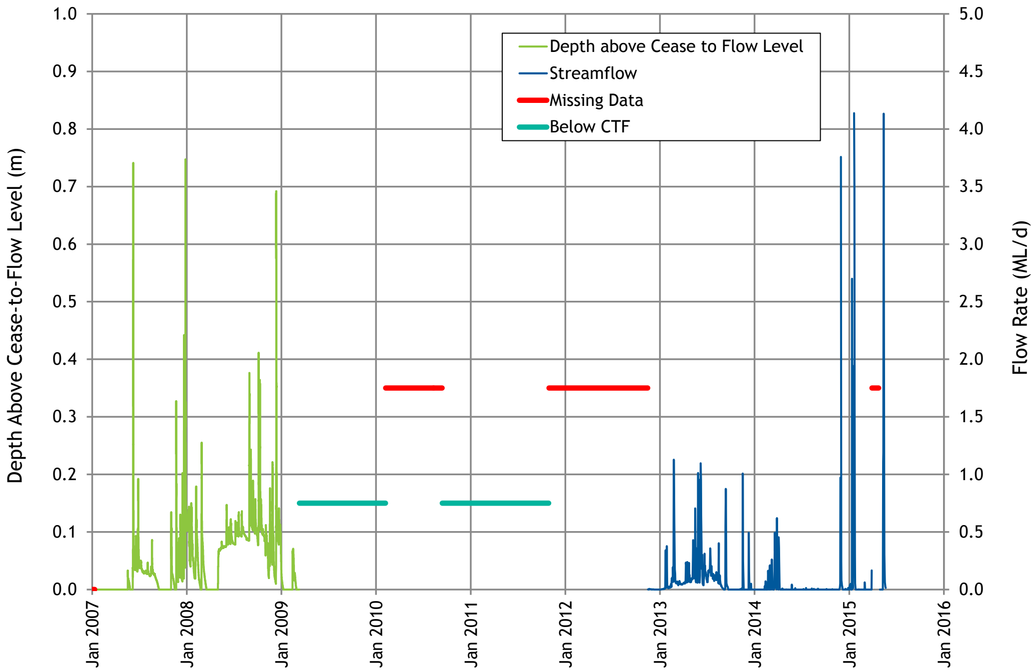



**Figure 3.13 – Recorded streamflow – Wilpinjong Creek U/S and D/S 2012 to 2013**




## Figure 3.14 - Frequency curves - Wilpinjong Creek gauges (2011-2014 common record)




## Figure 3.15 - Recorded stream height and flow - Cumbo Creek Downstream

Wilpinjong Creek is generally a gaining stream, however, there have been occasions when in some sections there has been brief reversal of gradient between the stream water level and the water table level (HydroSimulations, 2015).

The monitoring results show Wilpinjong Creek and Cumbo Creek are ephemeral. However, the approved mine release of Reverse Osmosis Plant (RO) treated water into Wilpinjong Creek (in accordance with EPL 12425) increases flow downstream of the release point. Between 2011 and 2014, the median daily flow in Wilpinjong Creek was approximately 0.2 ML/day upstream of the confluence with Cumbo Creek and 0.5 ML/day downstream of the confluence with Cumbo Creek. The relatively higher median flow at the downstream gauge is primarily due to the increased catchment area at this location (particularly including inflows from Cumbo Creek) rather than approved discharges from the WCM RO Plant.

## 3.6 SURFACE WATER QUALITY

### 3.6.1 Overview

WCPL has undertaken a water quality monitoring program since 2004 at various locations, including on-site dams and receiving waters. A summary of the WCM surface water quality monitoring program is provided in Table 3.6.

A summary of the water quality sampling results for dams and receiving waters is presented in the following sections.

Table 3.6 - Summary of WCM surface water quality monitoring program

| Site Name | Site Description | Frequency | Typical Suite of Parameters | Period of Record* |
|---|---|---|---|---|
| EPL24 | Wilpinjong Ck approx. at Narrow Creek confluence | Continuous (during discharge) | pH, EC | During discharges |
| WIL-U | Wilpinjong Ck approx. 100m U/S of Planters Ck confluence | Monthly | pH, EC, sulphate, turbidity | 18/06/2007 - 11/12/2014 |
| WIL-U2 | Wilpinjong Ck U/S of Planters Ck confluence | Monthly | pH, EC, sulphate, turbidity | 04/01/2010 - 23/01/15 |
| WIL 1 | Wilpinjong Ck U/S of Planters Ck confluence | Intermittent | Acidity, alkalinity, metals, chloride, dissolved oxygen, pH, EC, total magnesium, total potassium, sodium, sulphate, total nitrogen, total phosphorus, TDS, TSS, turbidity | 16/07/2004 - 20/01/2006 |
| WIL-PC | Wilpinjong Ck at Planters Ck confluence | Monthly | pH, EC, sulphate, turbidity | 20/04/2006 - 20/09/13 |
| WIL-NC | Wilpinjong Ck at Narrow Ck confluence | Monthly | pH, EC, sulphate, turbidity | 04/01/2010 - 23/01/15 |
| WIL-D2 | Wilpinjong Ck D/S of Cumbo Ck confluence | Monthly | pH, EC, sulphate, turbidity | 04/01/2010 - 23/01/15 |
| WIL-D | Wilpinjong Ck D/S of Cumbo Ck confluence | Monthly | pH, EC, sulphate, turbidity | 20/02/2006 - 23/01/15 |
| WIL 2 | Wilpinjong Ck U/S of Cumbo Ck confluence | Intermittent | Acidity, alkalinity, metals, chloride, dissolved oxygen, pH, EC, total magnesium, total potassium, sodium, sulphate, total nitrogen, total phosphorus, TSS, turbidity | 30/06/2004 - 20/01/2006 |
| WILGSU | Wilpinjong Ck U/S gauging station | Continuous | pH, EC, water level | 08/06/2006 - 23/01/15 |
| WILGSD | Wilpinjong Ck D/S gauging station | Continuous | pH, EC, water level | 08/06/2006 - 23/01/15 |
| CC1 | Cumbo Creek at gauging station (approx. 500m U/S of Wilpinjong Ck confluence | Monthly | pH, EC, sulphate, turbidity | 30/06/2004 - 23/01/15 |
| CC2 | Cumbo Creek at ML1573 upstream boundary | Monthly | pH, EC, sulphate, turbidity | 30/06/2004 - 23/01/15 |
| CC3 | Cumbo Creek at Wollar Road | Monthly | pH, EC, sulphate, turbidity | 16/07/2004 - 23/01/15 |
| CC4 | Cumbo Creek at Upper Cumbo Road | Monthly | Acidity, alkalinity, calcium, chloride, pH, EC, total magnesium, total potassium, sodium, sulphate, total nitrogen | 30/06/2004 - 28/11/2005 |

| Site Name | Site Description | Frequency | Typical Suite of Parameters | Period of Record* |
|---|---|---|---|---|
| CC5 | Cumbo Creek between ML1573 boundary and Wollar Road | Intermittent | Acidity, alkalinity, calcium, chloride, pH, EC, total magnesium, total potassium, sodium, sulphate, total nitrogen, total phosphorus, TSS, turbidity | 30/06/2004 - 11/11/2004 |
| CCGSD | Cumbo Creek Downstream gauging station | Continuous | pH, EC, water level | 15/02/2006 - 23/01/15 |
| CCGSU | Cumbo Creek Upstream gauging station | Continuous | pH, EC, water level | 7/08/2015 - 7/10/15 |
| WOL1 | Wollar Ck D/S of Wilpinjong Ck confluence | Monthly | pH, EC, sulphate, turbidity | 12/07/2004 - 23/01/15 |
| WOL2 | Wollar Ck U/S of Wilpinjong Ck confluence | Monthly | pH, EC, sulphate, turbidity | 30/06/2004 - 23/01/15 |
| WOL3 | Wollar Ck U/S of Barigan Ck confluence | Intermittent | Acidity, alkalinity, metals, chloride, pH, EC, total magnesium, total potassium, sodium, sulphate, total nitrogen, total phosphorus, TSS, turbidity | 12/07/2004 - 20/01/2006 |
| Sediment Dams | Site storages mainly near and D/S of CHPP | Monthly | pH, EC, sulphate, turbidity | 23/01/2008 - 13/06/2012 |
| Clean Water Dam (CWD) | Site water storage | Monthly | pH, EC, sulphate, turbidity | 23/01/2008 - 13/06/2012 |
| Recycled Water Dam (RWD) | Site water storage | Intermittent | pH, EC, sodium, sulphate | 23/01/2008 - 13/06/2012 |
| Pit 1 North | Open cut pit water | Monthly | pH, EC, sodium, sulphate | 03/02/2008 - 06/01/2010 |
| Pit 2 West | Site water storage | Intermittent | Alkalinity, metals, chloride, pH, EC, total iron, sulphate, TDS, TSS, total phosphorus, turbidity | 01/01/2011 - 10/09/2012 |
| Ed's Lake | Site water storage | Intermittent | pH, EC, sulphate, turbidity | 06/01/2010 - 13/06/2012 |
| Spot samples | DWD, Pit 1 Dam, CWD, Pit 4, Pit 2 West, Pit 5, Ed's Lake, NB Void | - | Full suite | March and April 2015 |

* Represents total period of record of monitoring. Not all parameters have been monitored for the total period of record.

Ck = creek, EC = Electrical Conductivity, TDS = Total Dissolved Solids and TSS = Total Suspended Solids.

### 3.6.2 Local waterways

A summary of the water sampling results for local waterway storages is provided in Table 3.7 and Figure 3.16 to Figure 3.39.

Statistics for the continuous data from the Wilpinjong upstream (WILGSU) and downstream (WILGSD) gauging station have been presented separately in Table 3.7.

For comparison, Table 3.7 also includes water quality trigger values for 'Protection of Aquatic Ecosystems' and 'Primary Industries (Livestock Drinking Water)' from the Guidelines (ANZECC and ARMCANZ, 2000), which provides a framework for water quality assessment and management. Exceedances of the guideline trigger values can be as a result of natural catchment conditions and/or land use modification (including mining and non-mining related changes).

The figures also compare the data to the 80th percentile of data from WCPL's baseline data set. This dataset is described in the site surface water management and monitoring plan, and comprises data from pre-mining (2004) to the end of 2009 (prior to approval being granted for an increased mining rate in early 2010).

Average pH in local creeks has a tendency towards slightly alkaline levels.

Average EC (a measure of salinity) was elevated in all streams. EC is particularly high in Cumbo Creek and Wilpinjong Creek D/S, with some readings exceeding 10,000 micro Siemens per centimetre (µs/cm). This is likely due to the contribution of saline baseflow associated with Permian coal measure formations or the underlying Shoalhaven Group. Alluvial groundwaters are generally more saline than the coal seam waters and this suggests the alluvial waters are sourced from Permian sediments and are concentrated through evapotranspiration (HydroSimulations, 2013).

Figure 3.16 and Figure 3.17 show plots of recorded EC in grab samples at all sites in Wilpinjong Creek. No obvious trend is evident in the data with time, although EC is typically higher in downstream samples (likely due to the influence of Cumbo Creek which joins Wilpinjong Creek between the two stations).

Recorded sulphate data shows similar behaviour, with average values in Wilpinjong Creek below the ANZECC and ARMCANZ (2000) Primary Industries guideline value, while average values in Cumbo Creek are above the lower bound ANZECC and ARMCANZ (2000) guideline value.

Table 3.7 – Summary of WCM water quality data – local waterways

| Monitoring Site | Value | pH | EC (µS/cm) | Turbidity (NTU) | Sulphate (mg/L) |
|---|---|---|---|---|---|
| Wilpinjong Ck U/S (Sites WIL-U2, WIL-U, WIL 1, WIL-PC) | No. of samples | 183 | 188 | 155 | 80 |
| | Min. | 5.1 | 150 | 1.5 | 4 |
| | 80th %ile | 7.5 | 2,466 | 34 | 71 |
| | Max. | 10.3 | 12,190 | 473 | 279 |
| | Median | 7.0 | 1,120 | 15 | 43 |
| Wilpinjong Ck U/S (Site WIL_GS_U) | No. of samples | 848 | 848 | 12 | 12 |
| | Min. | 4.1 | 159 | 6 | 4 |
| | 80th %ile | 7.4 | 1,656 | 117 | 37 |
| | Max. | 9.2 | 4,425 | 203 | 135 |
| | Median | 7.2 | 1,063 | 90 | 11 |

| Monitoring Site | Value | pH | EC (µS/cm) | Turbidity (NTU) | Sulphate (mg/L) |
|---|---|---|---|---|---|
| Wilpinjong Ck D/S (Sites WIL-NC, WIL-D2, WIL 2, WIL D) | No. of samples | 226 | 231 | 191 | 112 |
| | Min. | 6.4 | 310 | 0.7 | 5 |
| | 80th %ile | 8.0 | 4,070 | 15.0 | 801 |
| | Max. | 9.3 | 7,550 | 4,000 | 1,680 |
| | Median | 7.8 | 2,650 | 4 | 434 |
| Wilpinjong Ck D/S (Site WIL_GS_D) | No. of samples | 881 | 881 | 12 | 12 |
| | Min. | 4.3 | 571 | 1.5 | 117 |
| | 80th %ile | 8.1 | 4,794 | 36.2 | 1,454 |
| | Max. | 8.6 | 7,397 | 117 | 1,860 |
| | Median | 7.9 | 3,415 | 13 | 1,049 |
| Cumbo Ck (Sites CC1, CC2, CC3, CC4, CC5) | No. of samples | 256 | 259 | 103 | 191 |
| | Min. | 6.7 | 100 | 0.1 | 23 |
| | 80th %ile | 8.2 | 6,064 | 9.8 | 1,980 |
| | Max. | 9.4 | 10,500 | 1,770 | 3,160 |
| | Median | 8.0 | 4,510 | 2.0 | 1,570 |
| Wollar Ck U/S (Sites WOL2, WOL3 | No. of samples | 124 | 126 | 85 | 45 |
| | Min. | 6.5 | 90 | 0.6 | 105 |
| | 80th %ile | 8.0 | 3,430 | 13.4 | 617 |
| | Max. | 9.9 | 6,540 | 70 | 842 |
| | Median | 7.7 | 1,895 | 6.2 | 467 |
| Wollar Ck D/S (Site WOL1) | No. of samples | 100 | 102 | 81 | 44 |
| | Min. | 6.2 | 200 | 0.6 | 137 |
| | 80th %ile | 8.4 | 2,338 | 7.1 | 665 |
| | Max. | 9.8 | 3,680 | 200 | 1,120 |
| | Median | 8.1 | 1,905 | 3.6 | 496 |
| ANZECC (2000) Guideline Trigger Values | Protection of Aquatic Ecosystems | 6.5 - 8.0 | 30 - 350 | 2 - 25 | - |
| | Primary Industries (Livestock Drinking Water) | 6 - 9 | 2,850 | - | 1,000 |

NTU = Nephelmetric Turbidity Units and mg/L = milligrams per litre.

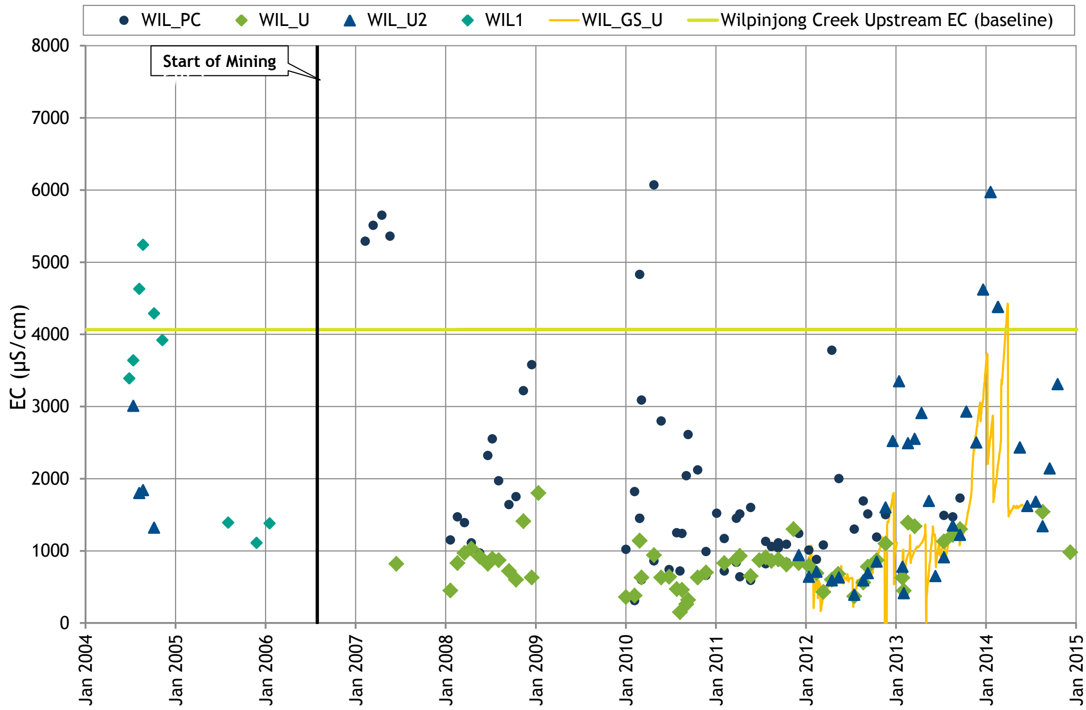



**Figure 3.16 – EC - Wilpinjong Creek Upstream**

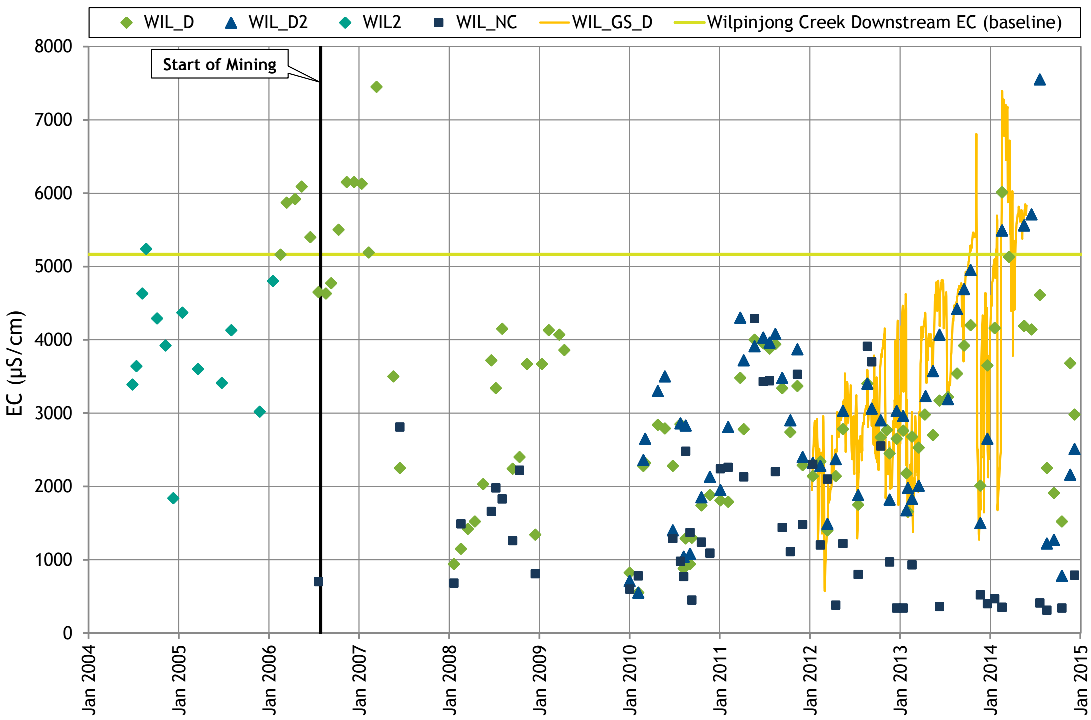



**Figure 3.17 – EC - Wilpinjong Creek Downstream**

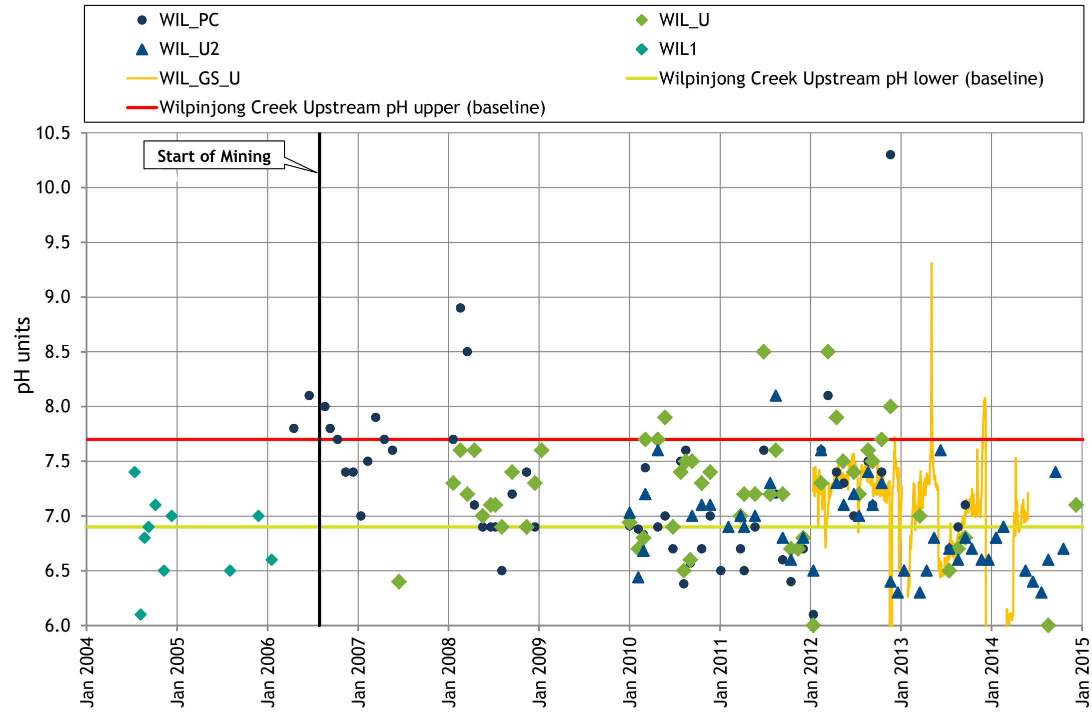



**Figure 3.18 - pH - Wilpinjong Creek Upstream**

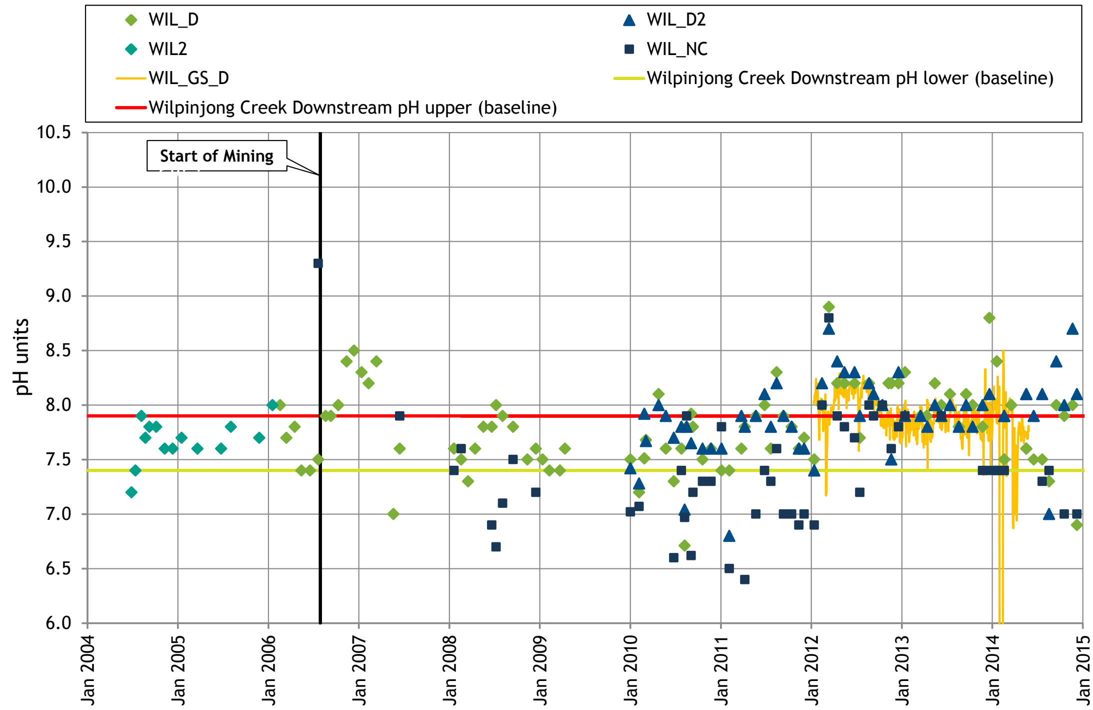



**Figure 3.19 - pH - Wilpinjong Creek Downstream**

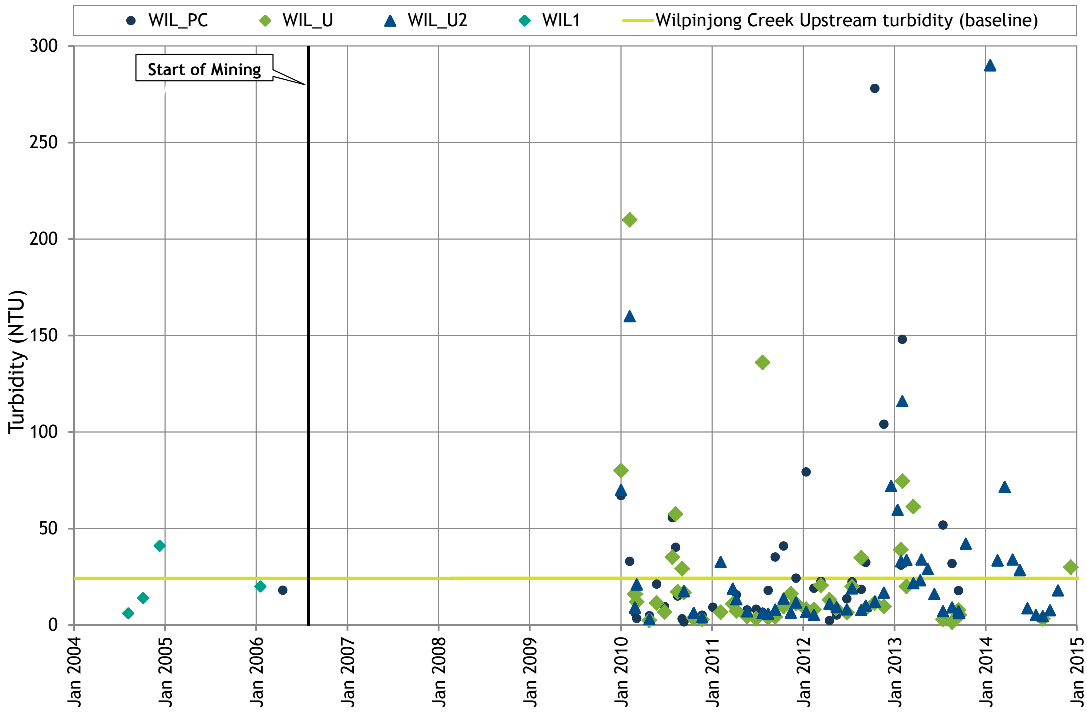



**Figure 3.20 - Turbidity - Wilpinjong Creek Upstream**

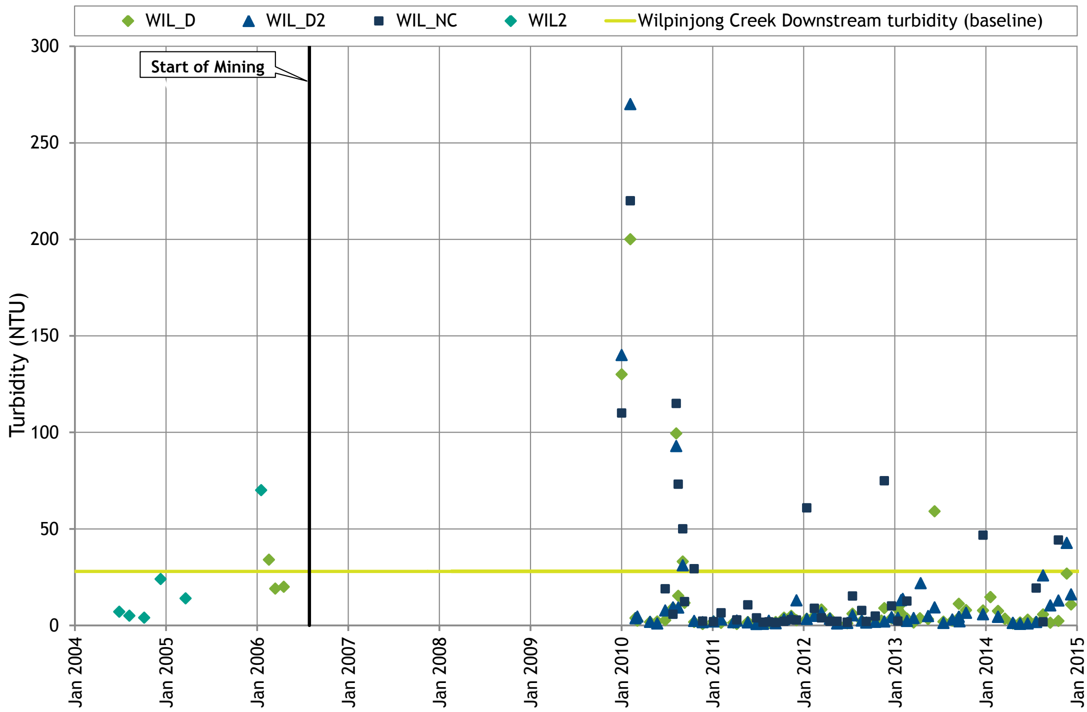



**Figure 3.21 - Turbidity - Wilpinjong Creek Downstream**

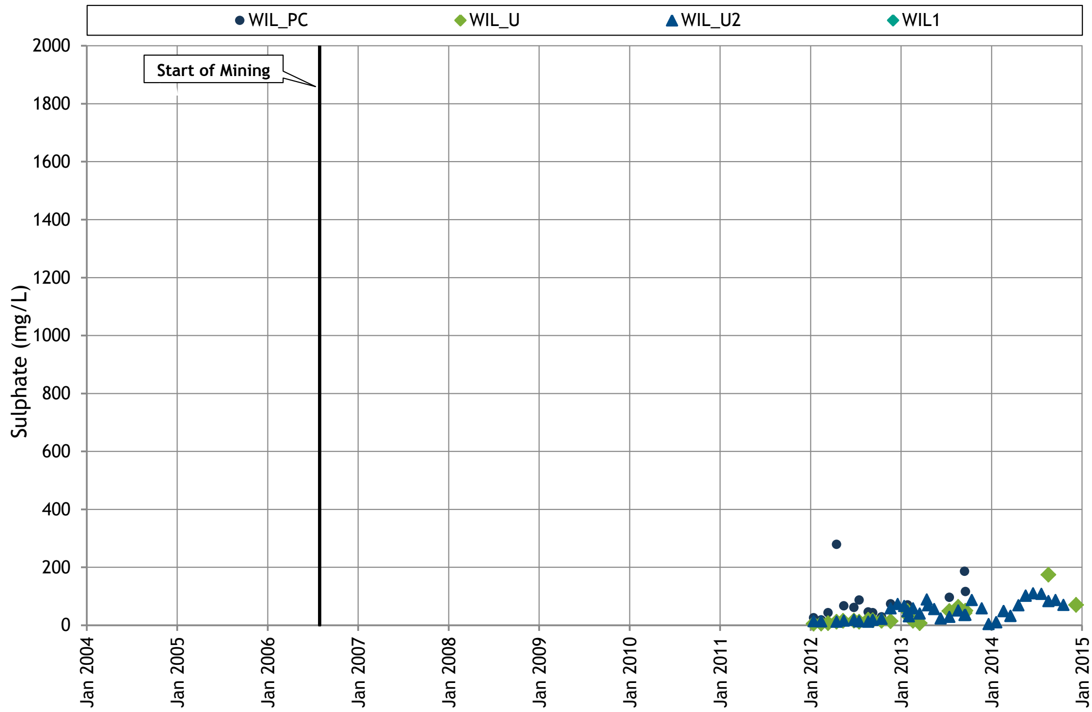



**Figure 3.22 - Sulphate - Wilpinjong Creek Upstream**

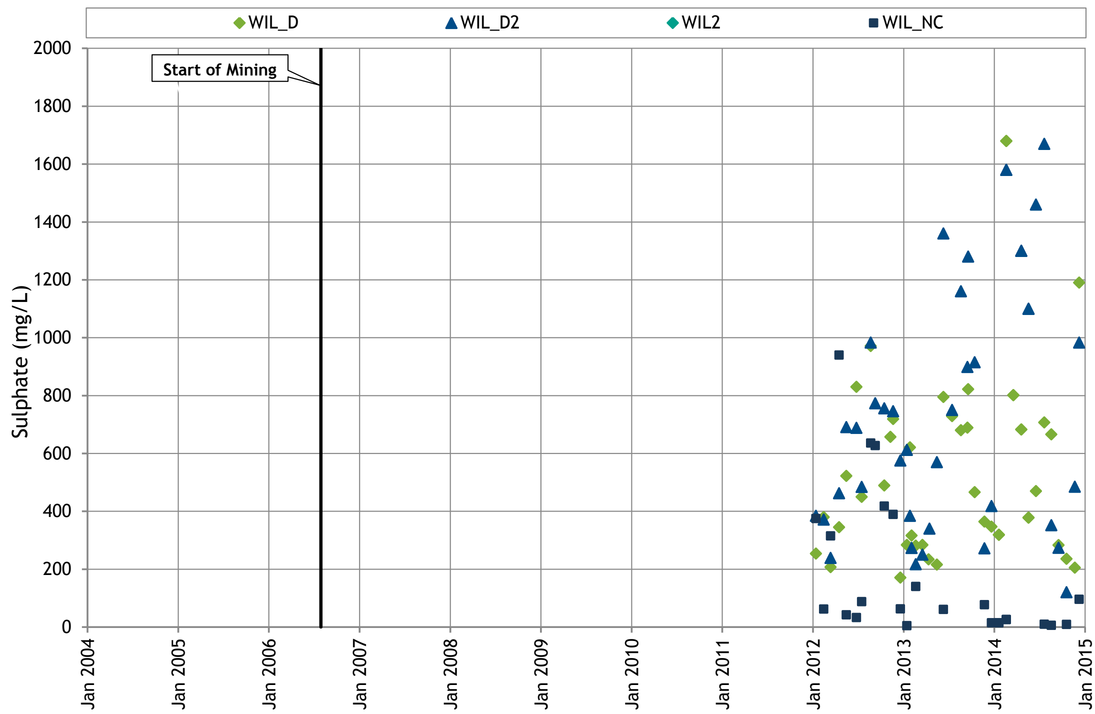



**Figure 3.23 - Sulphate - Wilpinjong Creek Downstream**

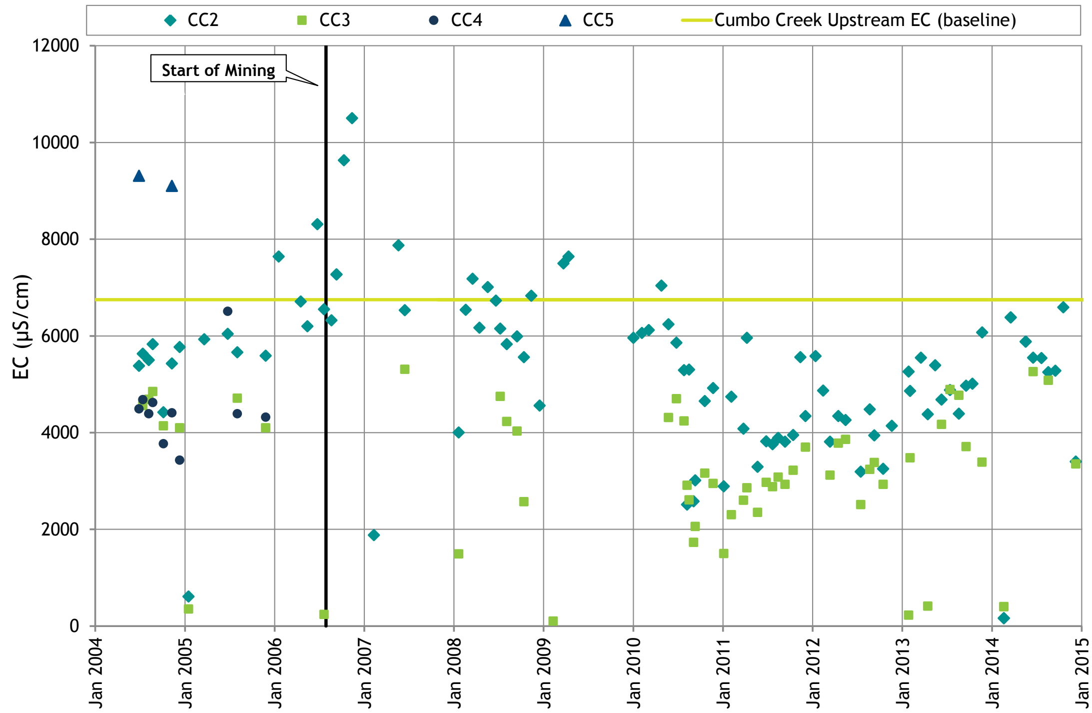



**Figure 3.24 - EC - Cumbo Creek Upstream**

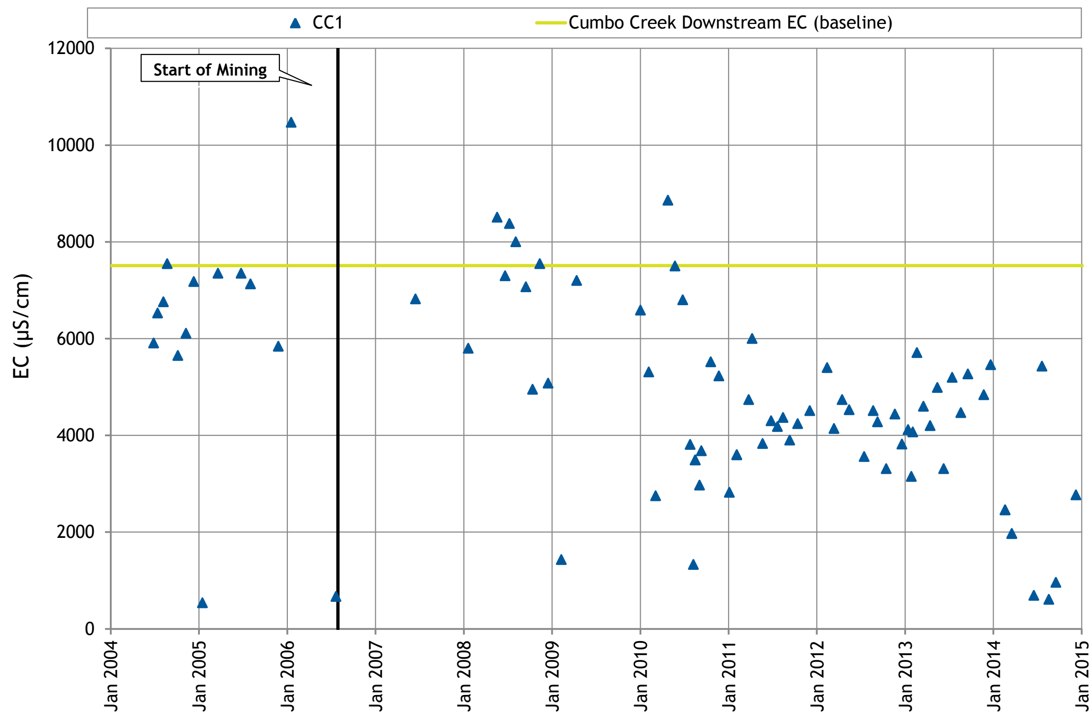



**Figure 3.25 - EC - Cumbo Creek Downstream**

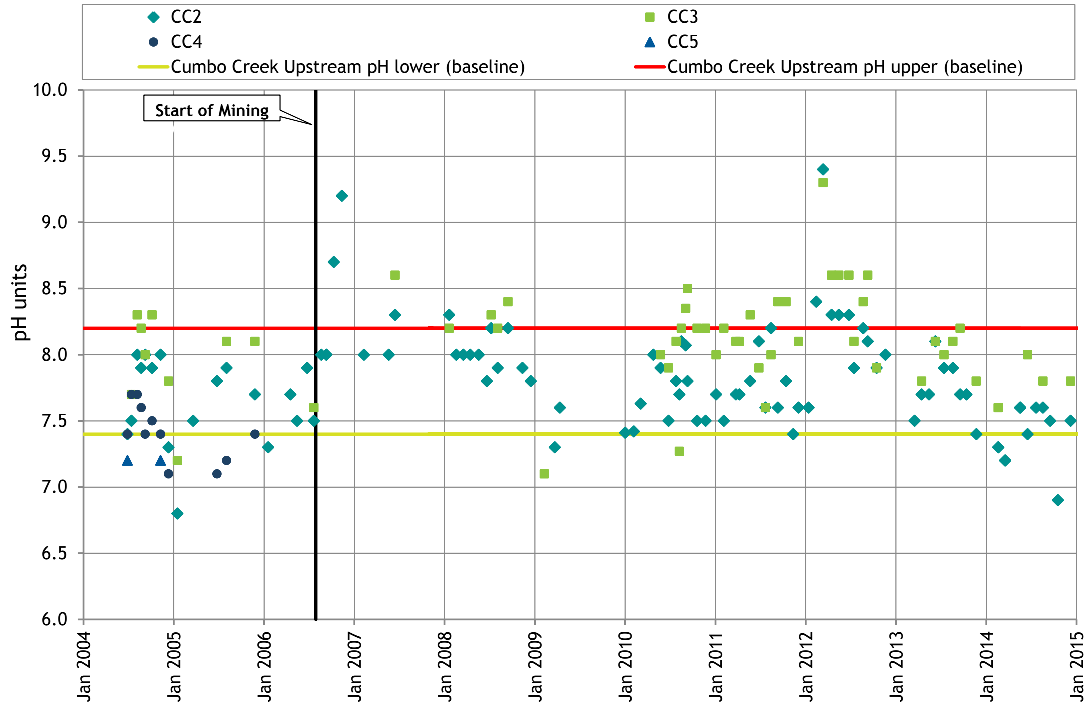



**Figure 3.26 - pH - Cumbo Creek Upstream**

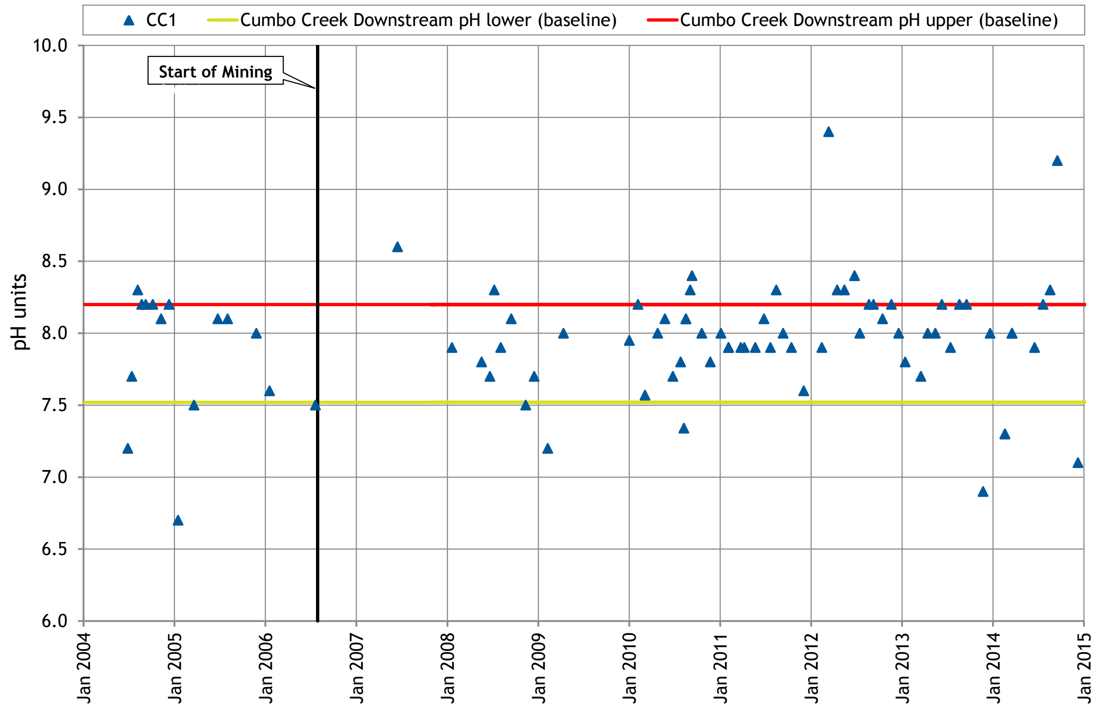



**Figure 3.27 - pH - Cumbo Creek Downstream**

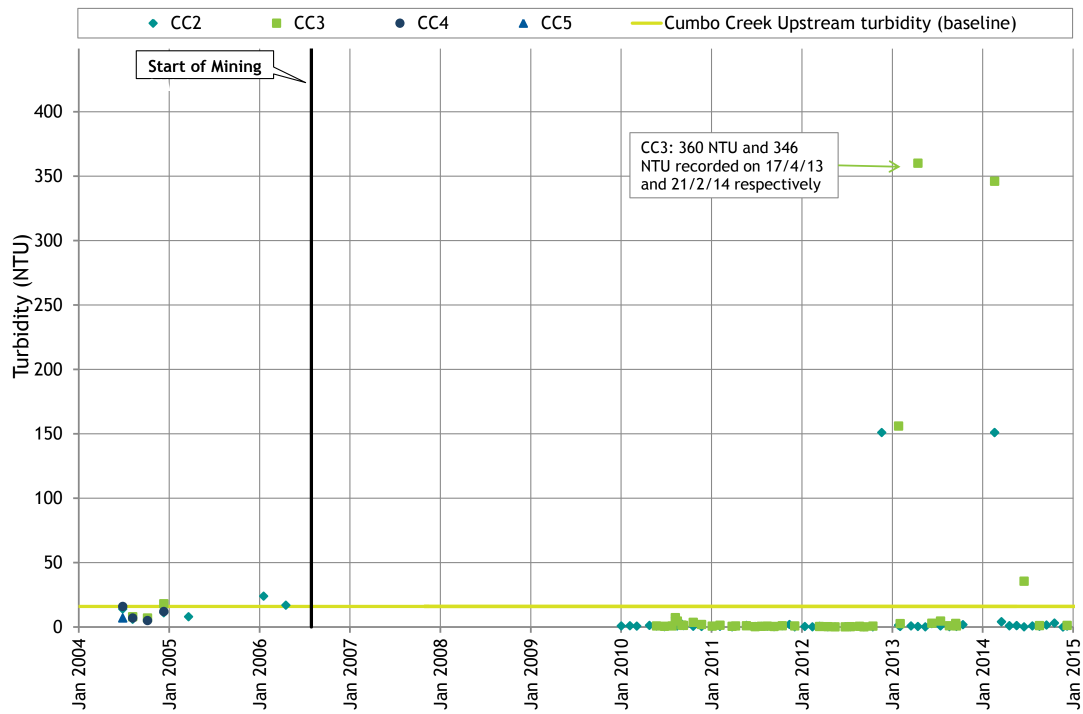



**Figure 3.28 – Turbidity - Cumbo Creek Upstream**

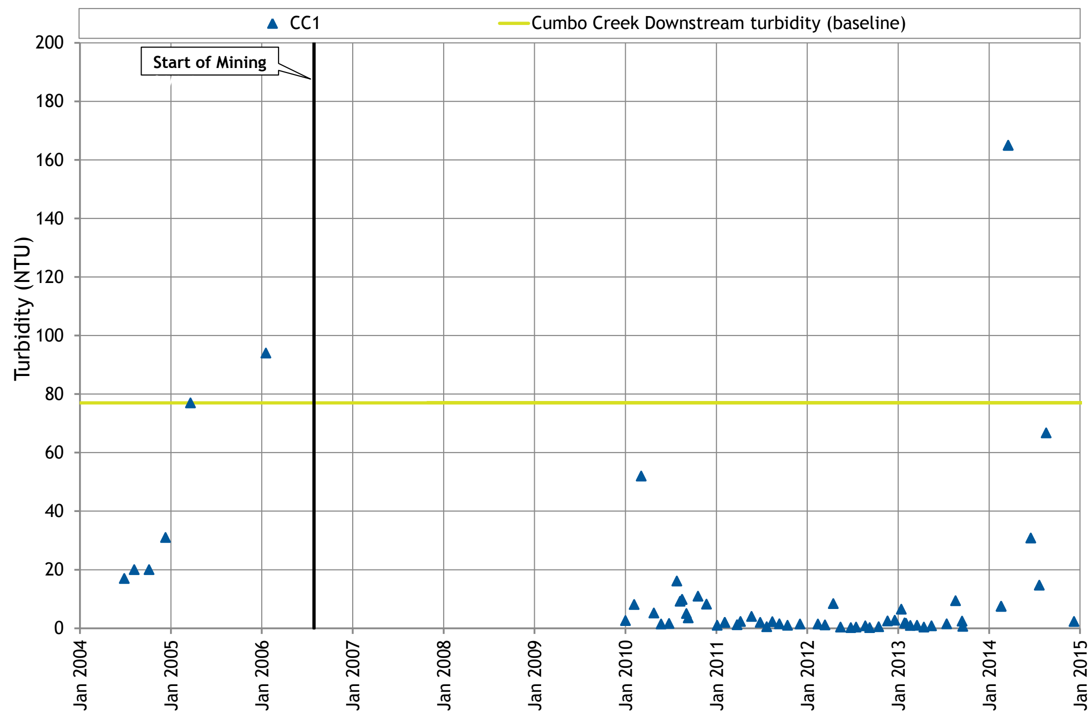



**Figure 3.29 – Turbidity - Cumbo Creek Downstream**

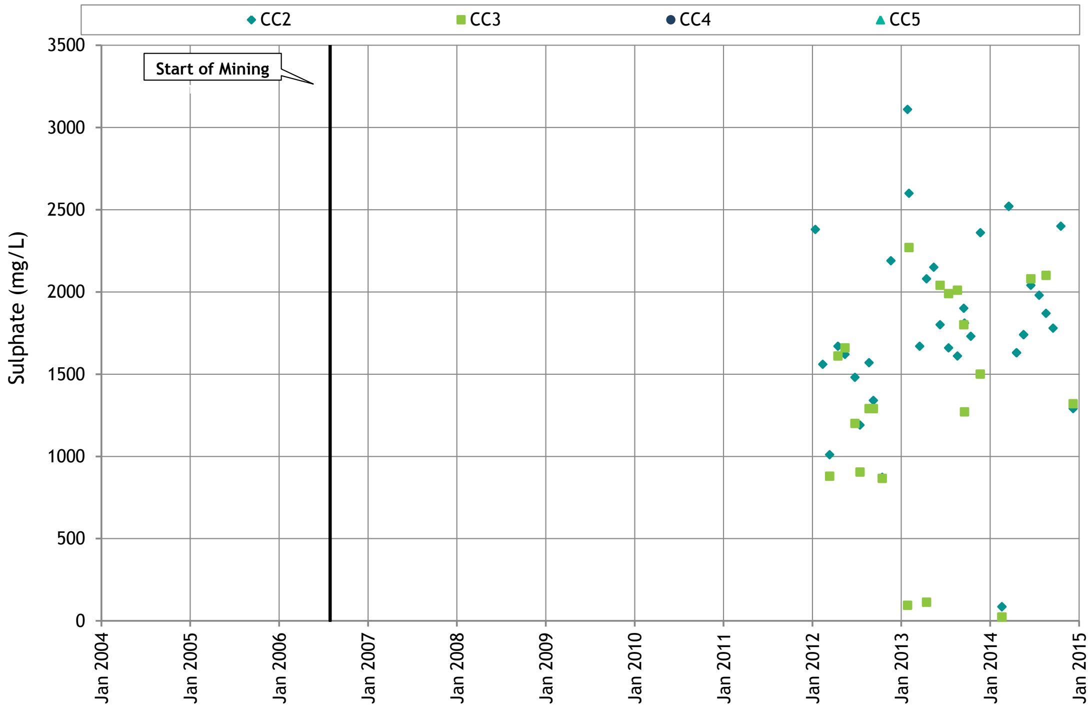



**Figure 3.30 - Sulphate - Cumbo Creek Upstream**

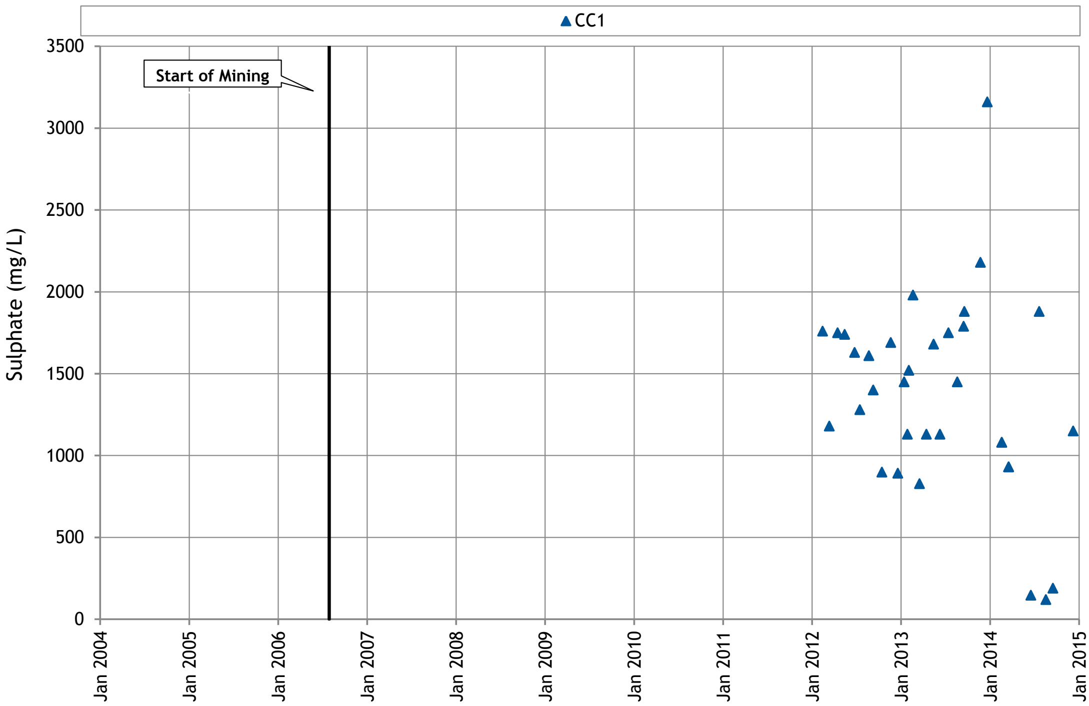



**Figure 3.31 - Sulphate - Cumbo Creek Downstream**

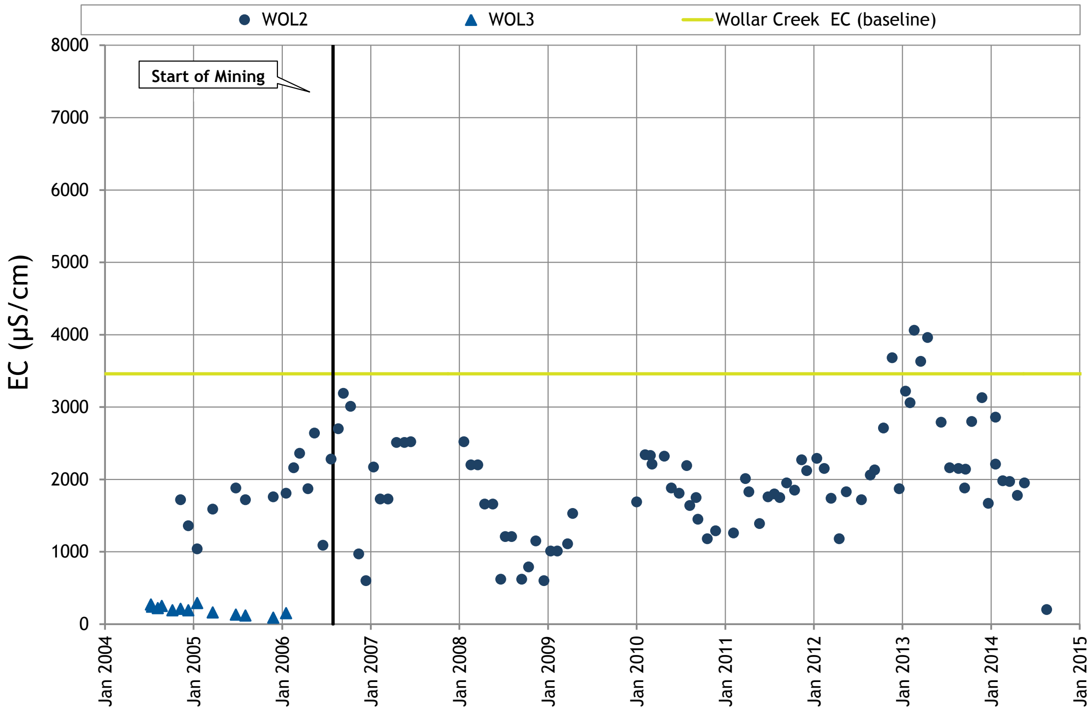



**Figure 3.32 - EC - Wollar Creek Upstream**

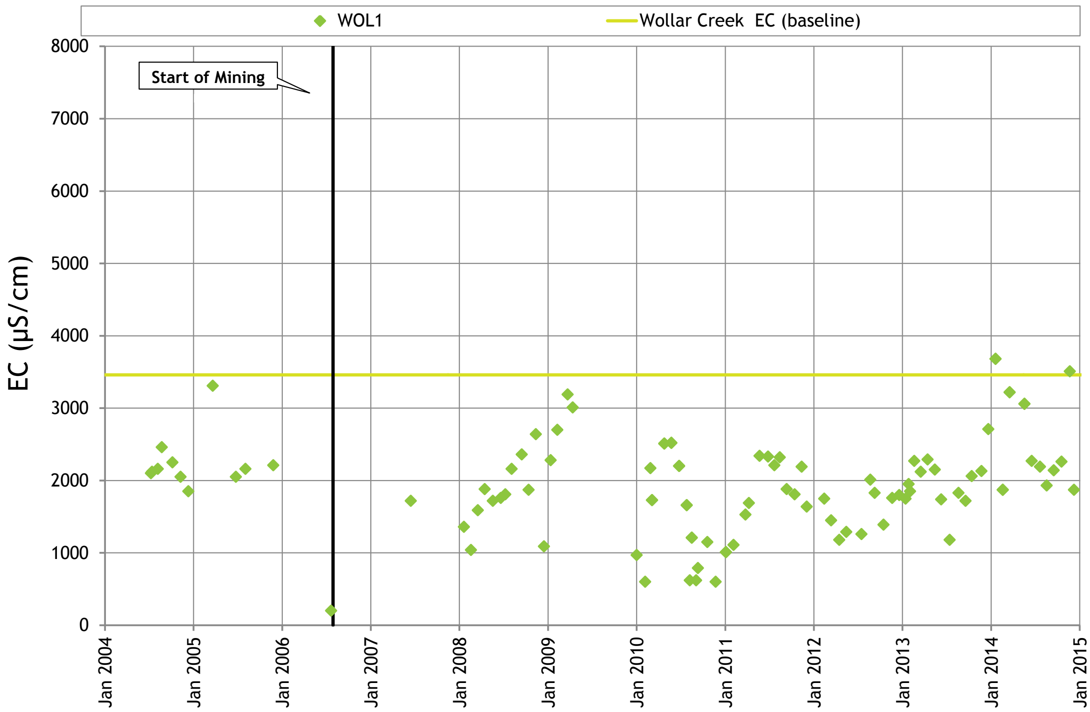



**Figure 3.33 - EC - Wollar Creek Downstream**

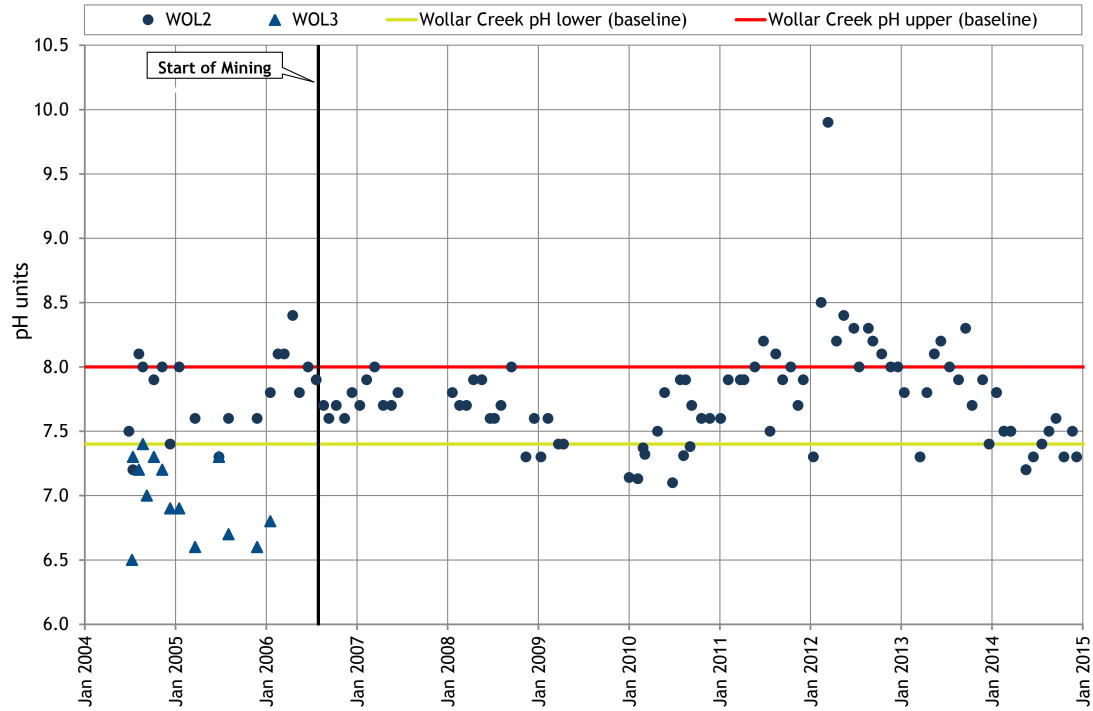



**Figure 3.34 - pH - Wollar Creek Upstream**

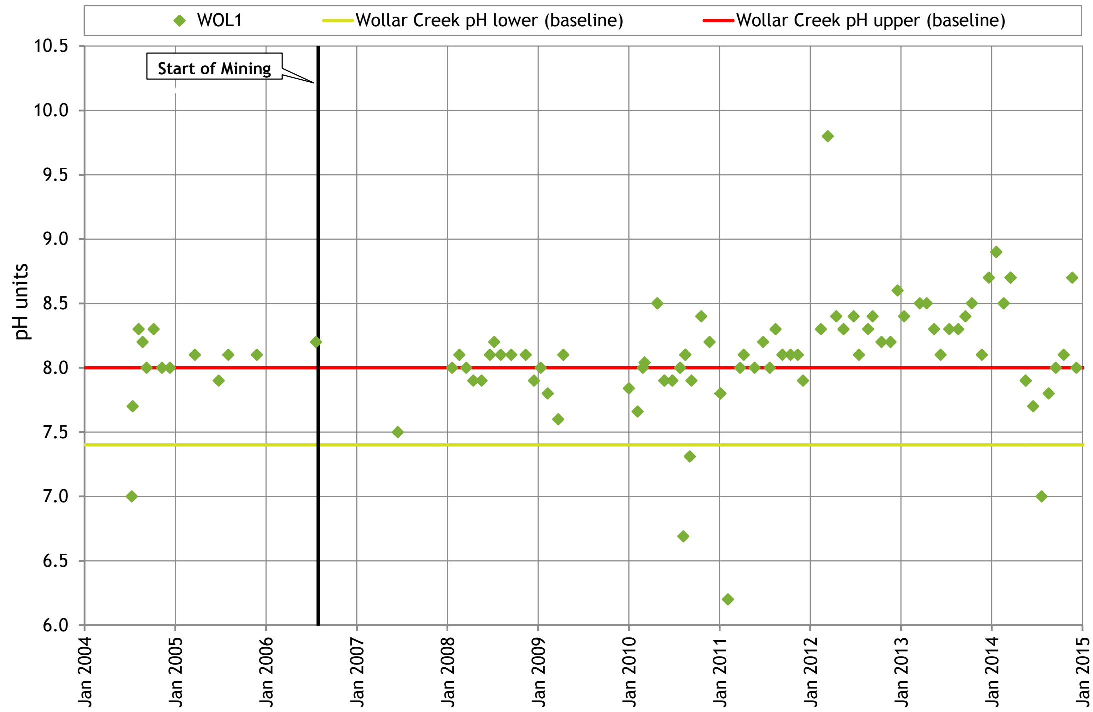



**Figure 3.35 - pH - Wollar Creek Downstream**

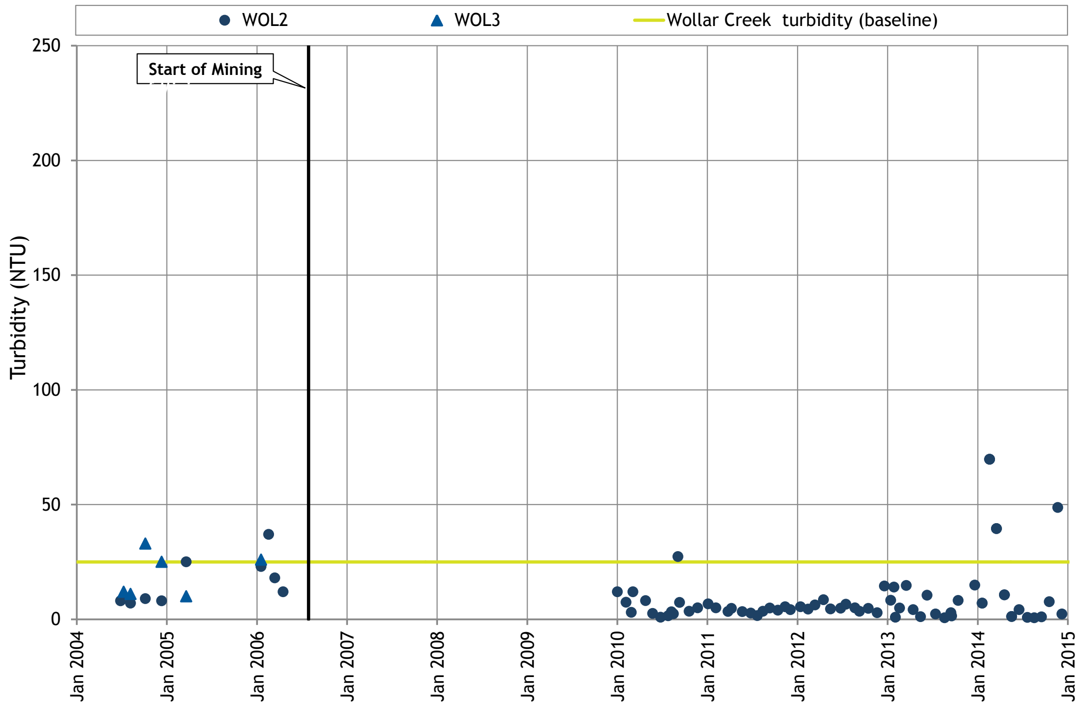



**Figure 3.36 - Turbidity - Wollar Creek Upstream**

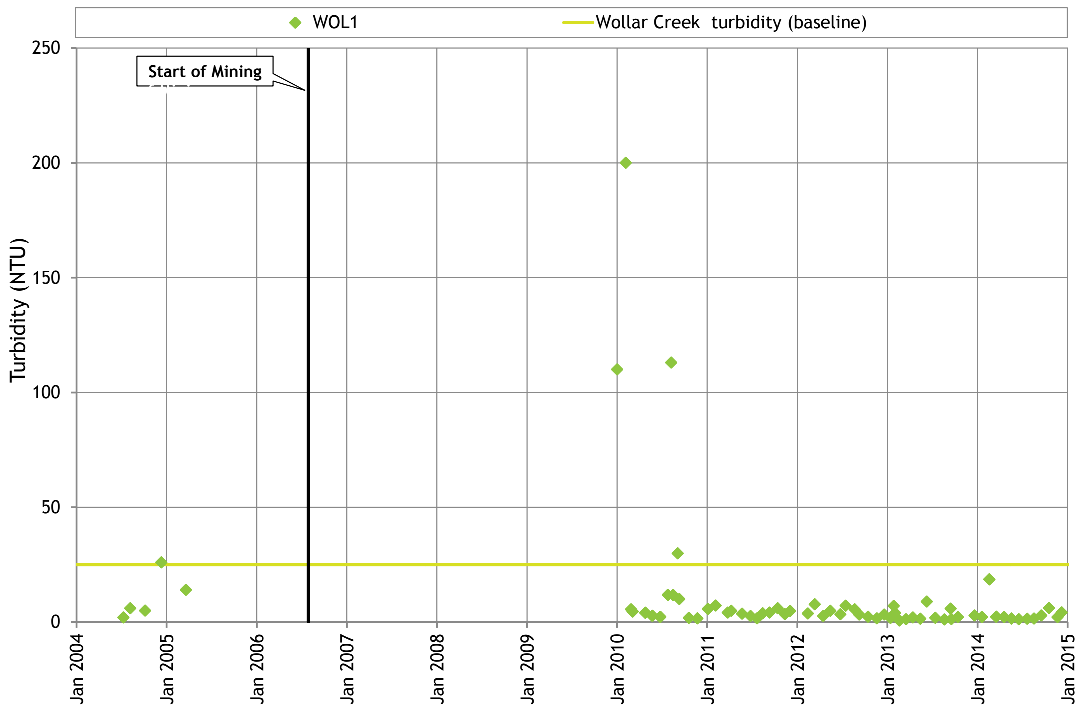



**Figure 3.37 - Turbidity - Wollar Creek Downstream**

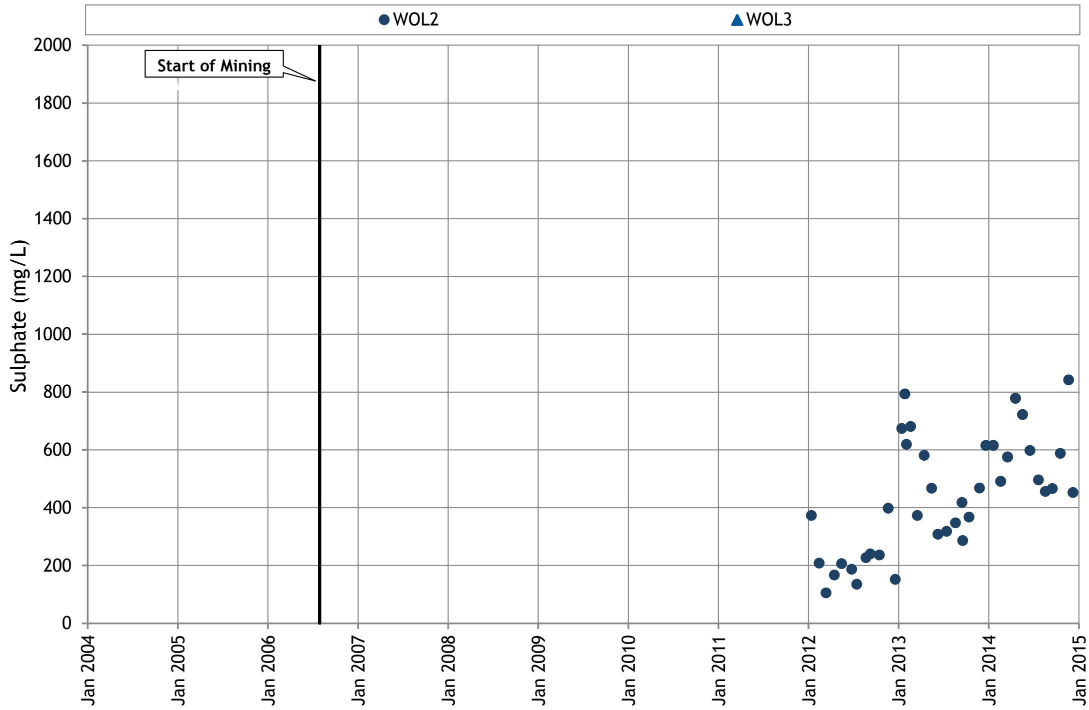



**Figure 3.38 - Sulphate - Wollar Creek Upstream**

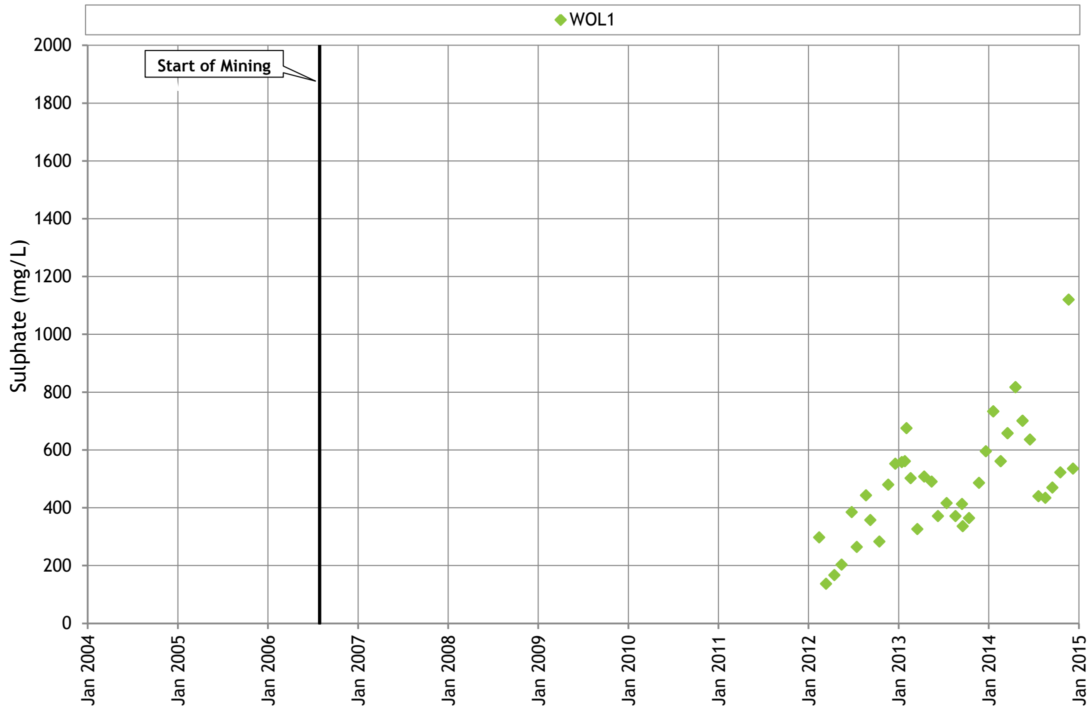



**Figure 3.39 - Sulphate - Wollar Creek Downstream**

### 3.6.3 Salinity-flow relationship in Wilpinjong Creek

The flow and salinity data presented in Figure 3.40 and Figure 3.41 show that in Wilpinjong Creek, salinity generally reduces with increased streamflow.

The figures show that salinity is markedly higher at the Wilpinjong Creek DS gauge across all flows, which is probably due to the contribution of the saline groundwater seepages from Permian and/or basement rock material in the Cumbo Creek catchment. Shallow saline groundwater has been noted in the Cumbo Creek catchment since the 1800's, and it is believed that dryland salinity is a natural feature of the landscape (DIPNR, 2003)

In the range of flows between 0.5 ML/day and 10 ML/day (a range of flows over which RO plant discharges are likely), median salinity is usually ($10^{th}$ percentile to $90^{th}$ percentile) in the range 465 µS/cm to 790 µS/cm at the Wilpinjong Creek upstream gauge, and 1,730 µS/cm to 3,550 µS/cm at the Wilpinjong Creek downstream gauge.

The RO discharge point is located in between the two gauges, approximately 3.4 km upstream of the Wilpinjong Creek DS gauge and 2.6 km upstream of the Cumbo Creek confluence (see Figure 3.11). The current EPL limit is 500 µS/cm which is generally lower than the salinity of flows at the Wilpinjong Creek US sampling point and well below observations at the Wilpinjong Creek DS gauge. As a result, approved releases from the discharge point tend to significantly reduce salinity in Wilpinjong Creek downstream of the Cumbo Creek confluence compared to what they would be without discharge.

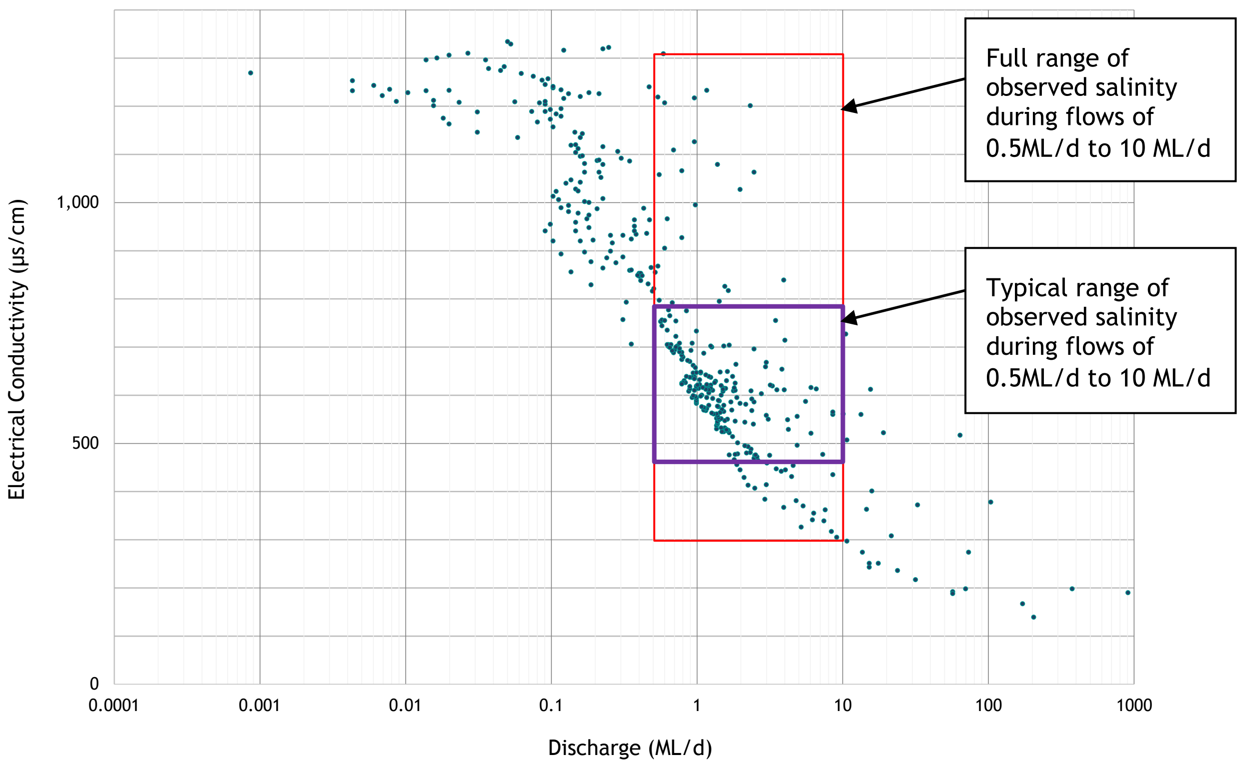



**Figure 3.40 - Salinity-flow relationship Wilpinjong Creek US**

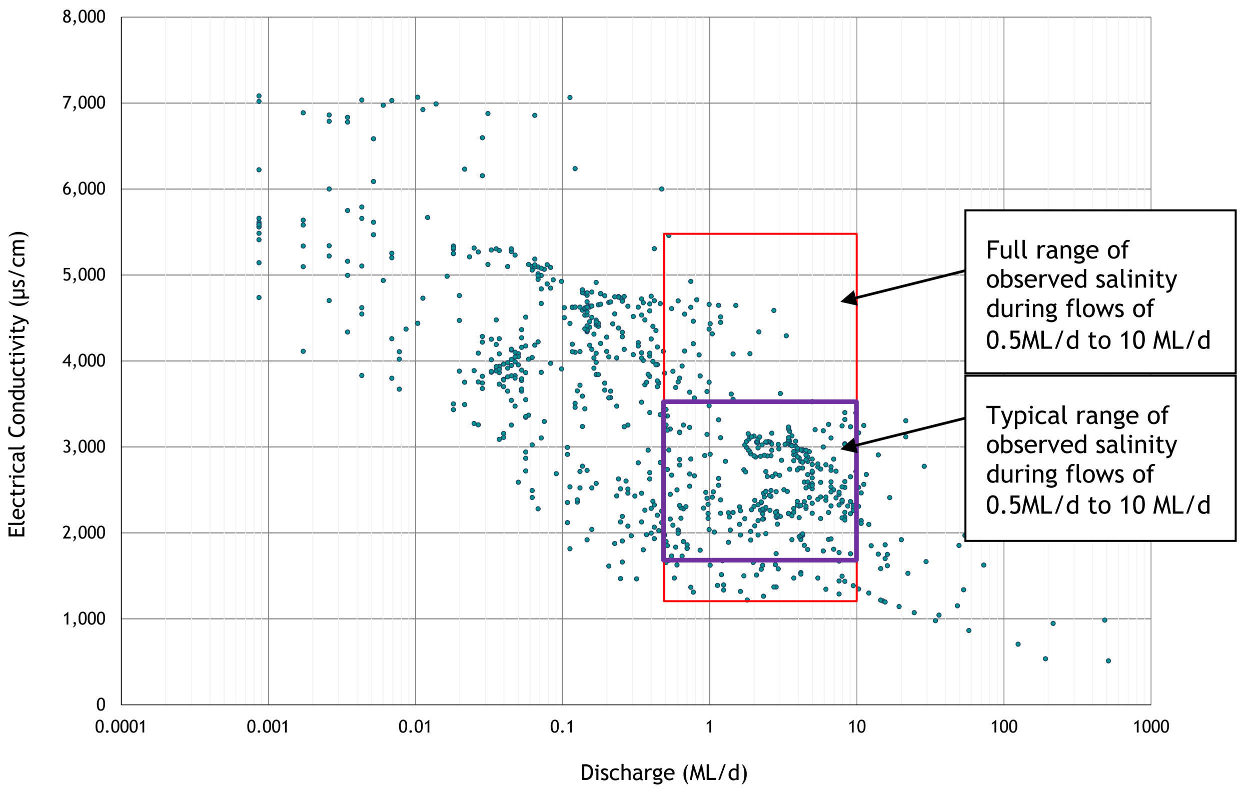



**Figure 3.41 - Salinity-flow relationship Wilpinjong Creek DS**

### 3.6.4 On-site dams

A summary of the results of analysis of water sampling undertaken in site storages up to 2012 is provided in Table 3.8. An additional spot sample of each of the site storages was taken in 2015 (Table 3.9).

The dams at WCM are generally classified as mine water dams or sediment dams. Mine water dams hold water influenced by mining activities, including pit water and tailings return water. Sediment dams usually capture runoff from disturbed areas such as overburden dumps and rehabilitation, but not mine affected water. However, the dams labelled as sediment dams have been used to store mine-affected water in the past, and this is reflected in the observed water quality. Review of Table 3.9 indicates that mine water dams pH readings range between 3.8 and 9.5, with average readings between 6.8 and 7.7; EC ranges between 560 and 4,060 µS/cm, with an average between 2,118 and 3,067 µS/cm; turbidity readings range between 0.8 and 140 NTU, with averages between 6 and 45 NTU; and sulphate readings range between 138 and 2,460 mg/L, with an average between 695 and 1,995 mg/L.

Note that averages relate to the readings at a given dam, so a range of averages gives the spectrum of averages across the dams that were monitored.

The minimum pH value of 4.1 in Ed’s Lake was recorded on a single occasion in 2010 – the next lowest value was 6.9. A number of low pH values were recorded in the CWD from April to September 2010, ranging from 3.8 to 4.4. Prior to and after this time recorded pH values have been higher, not falling below 6.3.

A single elevated value of pH (9.5) was recorded in Pit 1 in March 2009 – subsequent recorded values have not risen above 8.0.

The recorded ranges of EC, turbidity and sulphate are typical for open cut coal mining operations.

Table 3.8 - Summary of WCM water quality data - site storages and pits (pre-2013)

| Monitoring Site | Value | pH | EC (µS/cm) | Sulphate (mg/L) |
|---|---|---|---|---|
| Pit 2 West | No. of samples | 15 | 15 | |
| | 20th %ile | 6.3 | 2,554 | |
| | Median | 6.9 | 2,580 | |
| | 80th %ile | 7.2 | 2,640 | |
| | Minimum | 6.1 | 2,520 | |
| | Maximum | 7.3 | 2,650 | |
| Ed's Lake | No. of samples | 23 | 25 | 13 |
| | 20th %ile | 7.1 | 2,038 | 346 |
| | Median | 7.3 | 2,210 | 703 |
| | 80th %ile | 7.5 | 2,312 | 876 |
| | Minimum | 4.1 | 560 | 138 |
| | Maximum | 7.7 | 3,320 | 1,590 |
| RWD | No. of samples | 48 | 48 | 17 |
| | 20th %ile | 7.3 | 2,270 | 968 |
| | Median | 7.6 | 2,820 | 1,280 |
| | 80th %ile | 8.3 | 2,952 | 1,338 |
| | Minimum | 6.9 | 1,890 | 887 |
| | Maximum | 8.5 | 3,250 | 1,420 |
| CWD | No. of samples | 28 | 28 | 16 |
| | 20th %ile | 6.5 | 2,466 | 1,250 |
| | Median | 8.0 | 2,765 | 1,360 |
| | 80th %ile | 8.4 | 3,088 | 1,490 |
| | Minimum | 3.8 | 2,030 | 1,000 |
| | Maximum | 8.5 | 3,420 | 1,590 |
| Pit 1 | No. of samples | 14 | 14 | |
| | 20th %ile | 6.8 | 2,530 | |
| | Median | 7.4 | 2,895 | |
| | 80th %ile | 7.9 | 3,674 | |
| | Minimum | 6.2 | 2,310 | |
| | Maximum | 9.5 | 4,060 | |
| Pit 4 | No. of samples | 1 | 1 | |
| | 20th %ile | 5.8 | 3,410 | |
| | Median | 5.8 | 3,410 | |
| | 80th %ile | 5.8 | 3,410 | |
| | Minimum | 5.8 | 3,410 | |

| Monitoring Site | Value | pH | EC (µS/cm) | Sulphate (mg/L) |
|---|---|---|---|---|
| | Maximum | 5.8 | 3,410 | |
| Pit 5 | No. of samples | 1 | 1 | |
| | 20th %ile | 7.4 | 2,920 | |
| | Median | 7.4 | 2,920 | |
| | 80th %ile | 7.4 | 2,920 | |
| | Minimum | 7.4 | 2,920 | |
| | Maximum | 7.4 | 2,920 | |

Table 3.9 - Summary of WCM water quality data - site storages and pits (2015)

| Monitoring Site | Value | pH | EC (µS/cm) | Sulphate (mg/L) |
|---|---|---|---|---|
| Pit 2 West | No. of samples | 3 | 3 | 2 |
| | 20th %ile | 7.5 | 1,533 | 1,410 |
| | Median | 8.0 | 3,390 | 1,425 |
| | 80th %ile | 8.0 | 3,480 | 1,440 |
| | Minimum | 7.2 | 295 | 1,400 |
| | Maximum | 8.0 | 3,540 | 1,450 |
| Ed's Lake | No. of samples | 1 | 1 | 1 |
| | 20th %ile | 7.0 | 880 | 289 |
| | Median | 7.0 | 880 | 289 |
| | 80th %ile | 7.0 | 880 | 289 |
| | Minimum | 7.0 | 880 | 289 |
| | Maximum | 7.0 | 880 | 289 |
| RWD | No. of samples | 1 | 1 | 1 |
| | 20th %ile | 8.3 | 3,510 | 1,630 |
| | Median | 8.3 | 3,510 | 1,630 |
| | 80th %ile | 8.3 | 3,510 | 1,630 |
| | Minimum | 8.3 | 3,510 | 1,630 |
| | Maximum | 8.3 | 3,510 | 1,630 |
| CWD | No. of samples | 1 | 1 | 1 |
| | 20th %ile | 8.2 | 3,330 | 1,600 |
| | Median | 8.2 | 3,330 | 1,600 |
| | 80th %ile | 8.2 | 3,330 | 1,600 |
| | Minimum | 8.2 | 3,330 | 1,600 |

| Monitoring Site | Value | pH | EC (µS/cm) | Sulphate (mg/L) |
|---|---|---|---|---|
| | Maximum | 8.2 | 3,330 | 1,600 |
| Pit 1 | No. of samples | 1 | 1 | 1 |
| | 20th %ile | 7.6 | 6,670 | 4,220 |
| | Median | 7.6 | 6,670 | 4,220 |
| | 80th %ile | 7.6 | 6,670 | 4,220 |
| | Minimum | 7.6 | 6,670 | 4,220 |
| | Maximum | 7.6 | 6,670 | 4,220 |
| Pit 4 | No. of samples | 2 | 2 | 2 |
| | 20th %ile | 6.5 | 3,744 | 1,916 |
| | Median | 6.6 | 3,960 | 2,120 |
| | 80th %ile | 6.6 | 4,176 | 2,324 |
| | Minimum | 6.5 | 3,600 | 1,780 |
| | Maximum | 6.6 | 4,320 | 2,460 |
| Pit 5 | No. of samples | 1 | 1 | 1 |
| | 20th %ile | 7.6 | 1,060 | 411 |
| | Median | 7.6 | 1,060 | 411 |
| | 80th %ile | 7.6 | 1,060 | 411 |
| | Minimum | 7.6 | 1,060 | 411 |
| | Maximum | 7.6 | 1,060 | 411 |

## 3.7 ENVIRONMENT PROTECTION LICENCE (EPL) – RELEASE CONDITIONS

A RO Plant treats all water from the retention dams before it is discharged to Wilpinjong Creek. Construction of the RO Plant was completed in June 2012, and approved water releases commenced on 16 June 2012.

A summary of the current WCM EPL conditions in relation to surface water release are provided in Table 3.10 and Table 3.11.

Table 3.10 – EPL release conditions

| EPA ID No. | Type of Discharge Point | Location Description |
|---|---|---|
| 24 | Discharge to waters; discharge water quality monitoring | Discharge to Wilpinjong Creek from RO Plant (see Figure 3.42) |

Table 3.11 – Water release concentration limits

| Parameter | Units | Limit/Range |
|---|---|---|
| Conductivity | µs/cm | 500 |
| Oil & grease | mg/L | 10 |
| pH | - | 6.5 – 8.5 |
| Total suspended solids | mg/L | 50 |
| Discharge volume | ML/day | 5 |

The water discharge must not exceed 5 ML/day. Note that pH and conductivity are measured before the treated water from the RO Plant flows past a valve (divert valve) that either directs the water to Wilpinjong Creek or to an on-site storage dam. When the pH and conductivity of the treated water are within the EPL limits then the divert valve remains open and allows the treated water to flow to Wilpinjong Creek. Alternatively, if pH and/or EC are outside the EPL limits, then the divert valve closes and redirects the treated water to an on-site storage dam. It takes up to 30 seconds for the divert valve to close once a high/low pH or conductivity level is recorded. Occasionally, short-term exceedances occur during this short window (the total volume discharged during closure at half the licensed rate, would be only 0.8 kL). Inspections of the divert valve and associated monitoring equipment are undertaken daily and consist of a visual inspection and testing the monitoring probes in calibration solutions to confirm they are recording accurately. At a minimum of once a month, the monitoring equipment associated with the diversion valve is calibrated. The timing and interval between calibrations is based on the observed performance of the divert valve when inspected. Based on the continuation of these measures, there is very little risk of the RO Plant discharging treated water to Wilpinjong Creek that does not meet the EPL concentration limits.


**Figure 3.42 – WCM EPL Discharge Point 24**

## 3.8 FLOODING

Anecdotal advice provided by landholders indicates that major floods in the past have not resulted in extensive flooding outside the creek banks (Gilbert & Associates, 2005).

The largest known flood occurred in February 1955. The available rainfall records for the area confirm that it would have been the largest event since rainfall records started late in the 19th century. Local knowledge confirms that there has not been any event since which has been particularly significant in terms of inundation or damage to property along Wilpinjong Creek (Gilbert & Associates, 2005).

The Sandy Hollow-Gulgong Railway embankment was constructed during the Second World War and acts as an existing flood barrier between Wilpinjong Creek and the WCM (i.e. the embankment levels have been selected to provide immunity to floods significantly larger than the 1 in 100 year AEP criteria used for culvert sizing). There is no memory of the railway embankment having been overtopped during the 1955 flood or at any other time since (Gilbert & Associates, 2005).

Gilbert & Associates (2014) undertook flood modelling of Wilpinjong Creek and Cumbo Creek for a range of design flood events. The extent of flooding in the 1 in 1,000 AEP design flood is compared to the lease boundaries in Figure 3.43. The figure shows that all Project open cut extensions are located outside the extent of flooding in the 1 in 1,000 AEP design flood. However, the proposed connection of the realigned TransGrid Wollar to Wellington 330 kilovolt ETL to the existing ETL and the relocation of Ulan-Wollar road are located with the 1 in 1,000 AEP design flood extent.

On this basis, it has not been considered necessary to model the 1 in 10 year and 1 in 100 year AEP design floods as per the OEH's input to the SEARs.

There are no private landholders located in the vicinity of the WCM on either Cumbo Creek, Wilpinjong Creek or Wollar Creek which suggests no potential for flood related impacts on private land.

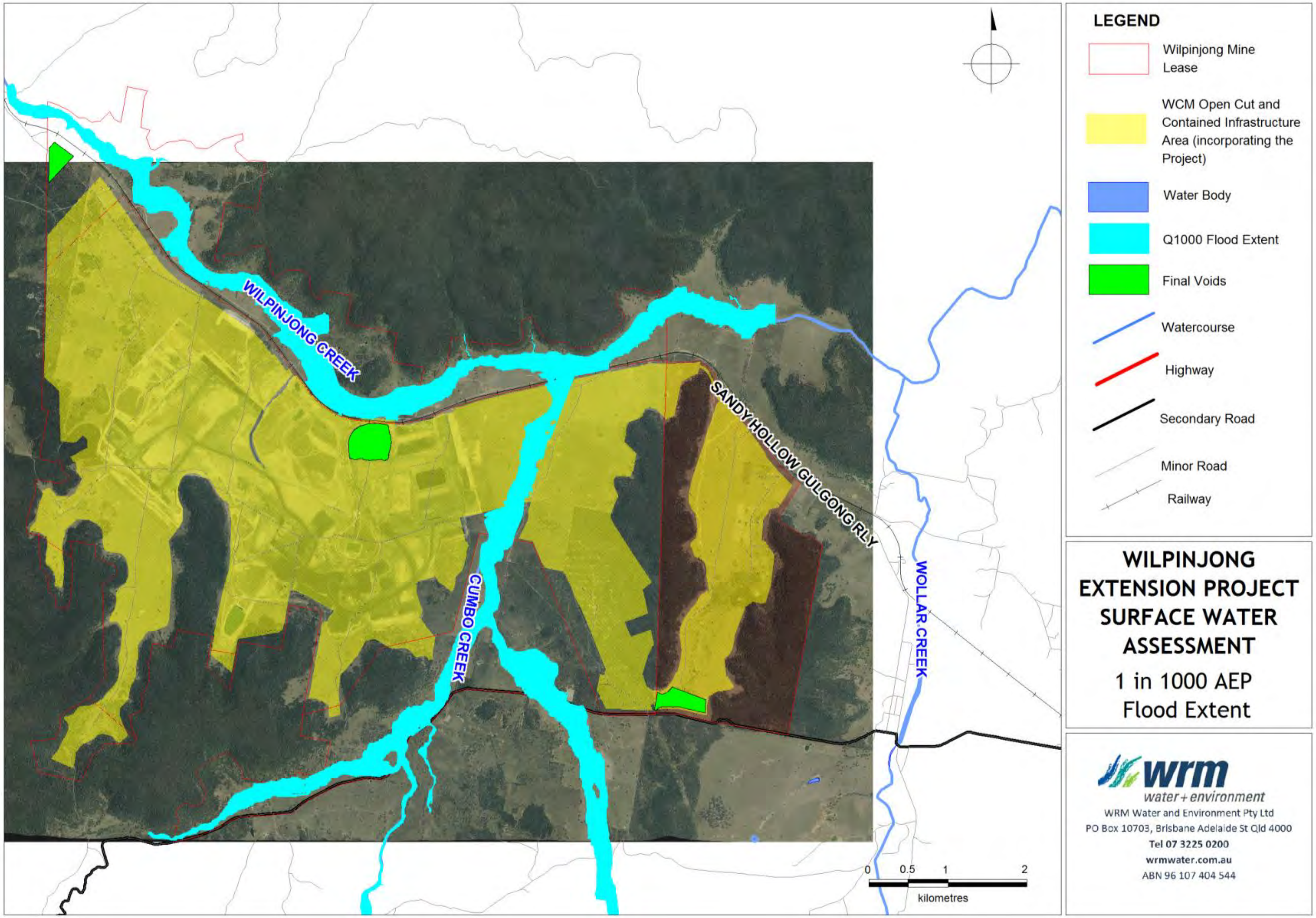



**Figure 3.43 – 1 in 1,000 AEP flood extent**

# 4 Existing water management strategy and infrastructure

## 4.1 OVERVIEW

This section describes the objectives of the WCM water management system, and provides details of the existing water management infrastructure.

## 4.2 TYPES OF WATER GENERATED ON SITE

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 when compared to natural runoff. The strategy for the management of surface water at the WCM is based on the separation of water from different sources based on observed and anticipated water quality.

Water at the WCM is categorised into five types, based on source and associated water quality:

- 'external water' – external water is sourced external to the mining operation. This may include water from a dam or pipeline, or non-raw water from another source such as a neighbouring mine or borefield. External water is generally sourced from a third party, however it may be from sources which are Peabody owned and managed (such as borefields). However, given that some of these water sources are operated separately from the mining operations, they have been classified as external sources of water.
- 'groundwater' – groundwater is water that collects or flows beneath the earth's surface, filling the porous spaces in soil, sediment and rocks. Groundwater usually enters the mine workings through the mining pit.
- 'mine water' – mine water is water of lesser quality than raw water and is generally re-used on site. Mine water is managed in accordance with EPL 12425. Mine water can include the following:
    - groundwater inflows and runoff from mine workings;
    - CHPP process water including recycled water from the coal waste areas including tailings dams; and
    - surface drainage water captured in dam from catchment areas containing industrial material (e.g. workshop area and coal stockpile areas). These surface catchments are classified as 'industrial' catchment areas.
- 'surface water' – surface water is runoff from disturbed catchments that if managed in accordance with the site's Erosion and Sediment Control (ESC) Plan can be discharged from site. Surface water typically does not contain any potential contaminants (other than suspended sediment). Surface water would typically include runoff from rehabilitated overburden and pre-strip areas, as well as potentially from active overburden areas (dependant on water quality and EPL conditions).
- 'diverted water' – diverted water is runoff from the surrounding catchment that is diverted around the mine site.

## 4.3 WATER MANAGEMENT SYSTEM OBJECTIVES AND STRATEGY

The existing WCM water management system is based on the collection, storage and use of water collected from areas used for the mining and handling of coal and mine waste rock. These areas include:

- open cut pits;
- non-rehabilitated or partially rehabilitated portions of the overburden dumps;
- tailings disposal areas;
- coal handling areas (i.e. ROM pad, CHPP, haul roads); and
- runoff from undisturbed areas which cannot be reasonably diverted around mine areas and therefore report to one of the above areas.

The existing WCM water management system is operated in accordance with WCM's Water Management Plan (WMP) (WCM, 2014).

Key objectives of the surface water management strategy for each type of water are as follows:

- 'external water' – ensure that external water allocation and associated infrastructure is sufficient to meet site demands and is prioritised for use after mine water and groundwater supplies;
- 'mine water' – minimise uncontrolled discharges in wet periods and ensure adequate supplies are maintained for site demand during dry periods;
- 'groundwater' – understand and manage groundwater inflows to the water management system;
- 'surface water' – maintain water quality leaving the ESC structures to a quality as close to background levels as reasonably possible; and
- 'diverted water' – ensure that it is separated from the mine water and surface water systems, and allowed to pass uninterrupted down the catchment.

Depending on the climatic conditions that are experienced during the mine life and the ability to temporarily store water in mine water storages, tailings storages and open cut pits, there is likely to be periods when licensed discharge of treated water to Wilpinjong Creek would be required to manage surplus water. Under these circumstances, water would continue to be discharged following RO Plant treatment in accordance with EPL 12425.

There may also be periods when the availability of water on-site is such that RO Plant treatment and licensed discharge would cease, and there may also be a need to source water externally from the approved water supply borefield or from nearby mining operations under agreement.

WCPL currently has an in principle agreement with the nearby Ulan Mine Complex to source excess water from this mining operation (by pipeline) if required in the future. WCPL would continue to investigate opportunities for water sharing between the WCM, Moolarben Coal Complex and Ulan Mine Complex. Water sharing that involves both the provision of water during surplus periods as well as receiving water during deficit periods would be investigated.

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

## 4.4 WATER MANAGEMENT SYSTEM COMPONENTS AND LAYOUT

The key components of the existing Water Management System (WMS) at the WCM site are as follows:

- Water storages
  - Ed's Lake
  - Clean Water Dam (CWD)
  - Recycled Water Dam (RWD)
  - Pit 1S Dam
  - Pit 2 West void
- Pits/tailings dams
  - Pit 2
  - Pit 3
  - Pit 4
  - Pit 5 North
  - Pit 5 South
  - TD3/TD4/TD5/TD6
- Other infrastructure
  - CHPP/industrial area
  - RO plant – located adjacent to Pit 2 West

A plan showing the locations of the existing WCM water management system is provided in Figure 4.1. A summary of the existing water storages is provided in Table 4.1. The details provided in Table 4.1 are based a combination of information provided by WCM and estimation from recent topographical data.

Table 4.1 - Key water storage/pit characteristics - existing WMS

| Storage/pit name | Full supply volume (ML) | Full supply surface area (ha) |
|---|---|---|
| *Dams/voids* | | |
| Ed's Lake | 52 | 1.0 |
| CWD | 40 | 1.8 |
| RWD | 394 | 5.5 |
| Pit 1S Dam | 536 | 6.4 |
| Pit 2 West | 2,694 | 21.1 |
| *Pits* | | |
| Pit 1 | 408 | 7.3 |
| Pit 2E | 897 | 4.8 |
| Pit 3 | 574 | 6.4 |
| Pit 4 | 816 | 11.2 |
| Pit 5 North | 5,026 | 41.1 |
| Pit 5 South | 864 | 11.7 |
| Pit 7 | 266 | 6.3 |

ML = megalitres

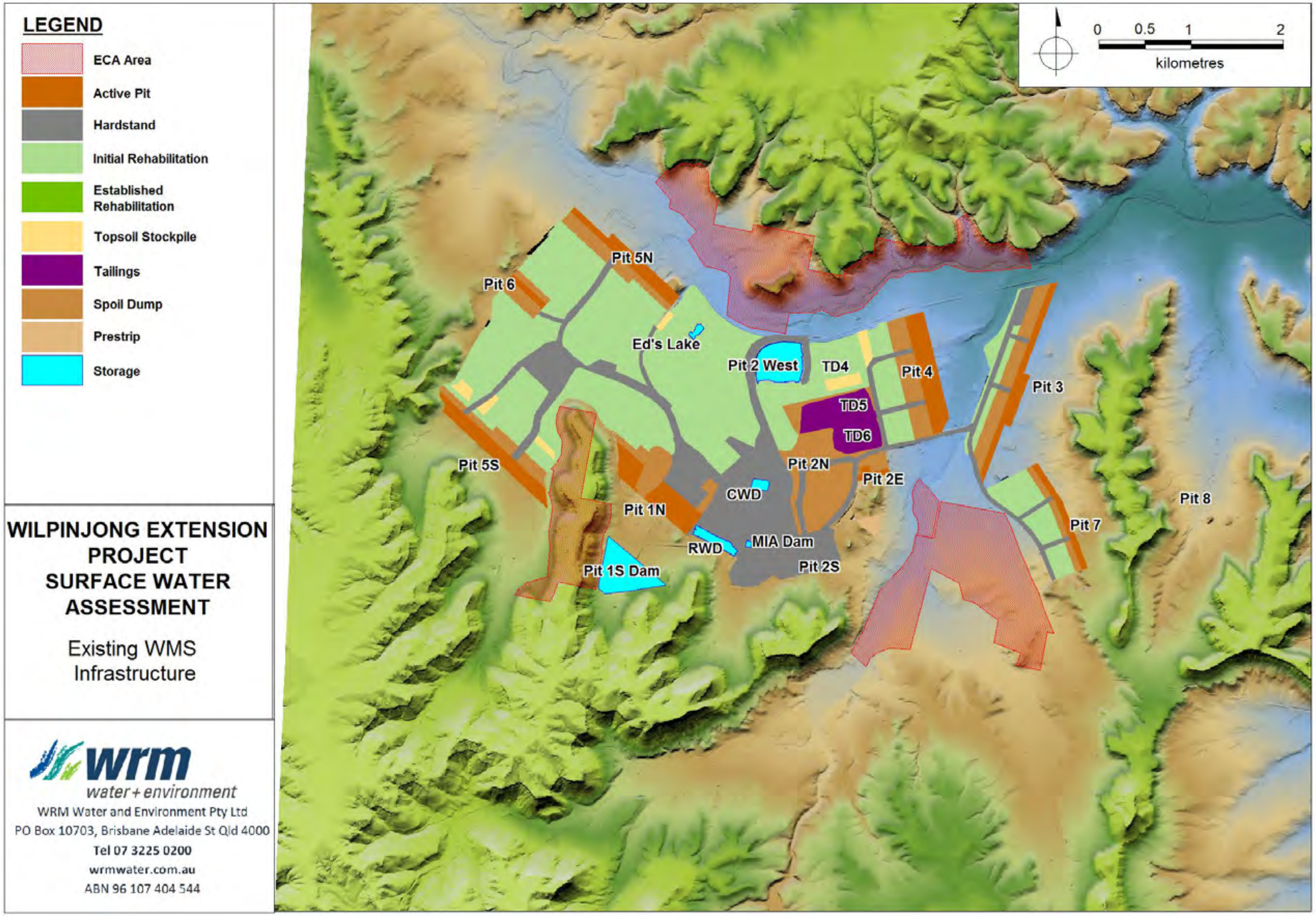



**Figure 4.1 – Existing water management storages**

## 4.5 TAILINGS DISPOSAL STRATEGY

WCPL have recently completed commissioning of a TFP. This changes the management of waste from disposal of a wet tailings slurry in tailings dams, to a dry disposal system. The tailings filter cake produced by the TFP is mixed with the coarse rejects and transported to mine voids for co-disposal with mine waste rock.

Note that there will be very short periods when the TFP will be undergoing maintenance, and wet tailings will instead be directed to TD6 or TD7. This has not been represented in the water balance model, as the effect on the water balance will be negligible.

## 4.6 REVERSE OSMOSIS (RO) PLANT OPERATION

Excess mine water accumulating on site is released after treatment in the RO plant located adjacent to Pit 2 West. The plant is supplied with feed water from Pit 2 West, and if quality allows, directly from nearby pits. RO plant permeate is discharged to Wilpinjong Creek in accordance with the requirements of the EPL, which prescribes water quality (maximum EC of 500 µS/cm EC) and daily discharge (maximum of 5 ML/day) limits. Permeate is mixed with a proportion of feed water prior to discharge to produce treated water which meets the discharge criteria (i.e. once mine water is combined with permeate it is considered treated). Backwash from the RO plant is discharged to Pit 2 West, and concentrate is pumped to Pit 1 South for use in dust suppression and process water circuits.

In July 2013, WCPL submitted an application to modify Project Approval 05-0021 under section 75W of the EP&A Act (Modification 5) which sought upgrade of the RO Plant to a water treatment facility with the addition of pre-filtration and flocculation/dosing facilities to improve plant efficiency. Modification 5 was approved by the Planning Assessment Commission (as a delegate of the NSW Minister for Planning and Infrastructure) on 7 February 2014 however the upgrades have not yet been made. Therefore, references to RO plant in this document should also be read as water treatment facility, when these upgrades are implemented in future.

As described in Section 3.6.3, the current EPL limit of 500 µS/cm is generally lower than the salinity of flows at the Wilpinjong Creek U/S sampling point and well below observations at the Wilpinjong Creek D/S gauge. As a result, approved releases from the discharge point tend to significantly reduce salinity in Wilpinjong Creek downstream of the Cumbo Creek confluence compared to what they would be without discharge. There may be opportunity to increase the efficiency of the RO Plant in future by raising the EPL limit of 500 µS/cm to better align with the range of baseline water quality in Wilpinjong Creek.

The following concentrate, backwash and permeate percentages generally represent the operation of the RO plant:

- Permeate – 56.5% of feed;
- Concentrate – 23.5% of feed; and
- Backwash – 20% of feed.

The RO plant has a theoretical maximum discharge capacity of around 3.5 ML/day. However, due to technical issues, the RO plant is currently operating at an average daily discharge rate of around 0.85 ML/day. WCPL propose to implement pre-treatment measures to improve the performance of the RO plant. These works are expected to be completed by 2016, and should increase the output of the plant to 3.5 ML/day.

Releases from the WCM incorporating the Project (via the RO Plant) have been modelled as follows:

- Year 2015 – 0.85 ML/day; and
- Year 2017+ – 3.5 ML/day.

Daily RO plant discharge volumes (monthly averages) from July 2012 to December 2014 are shown in Figure 4.2.

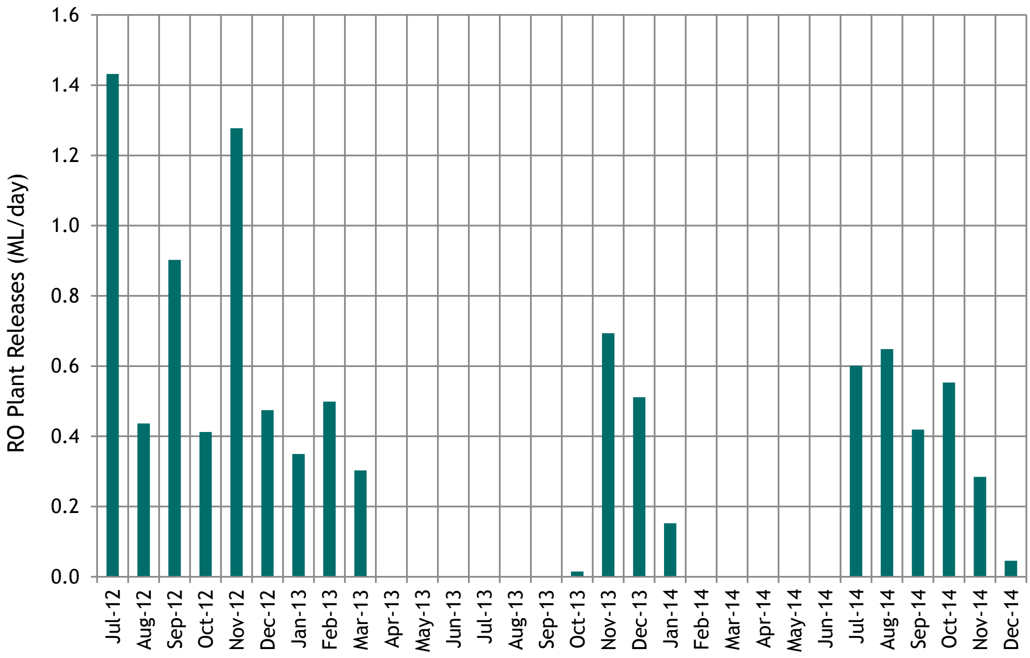



**Figure 4.2 – Historical reverse osmosis plant releases**

## 4.7 WATER SUPPLY AND SEWAGE DISPOSAL

The WCM water supply system consists of collection of runoff from open cut mining areas, groundwater inflows to the open cut pits, runoff collected from associated disturbance areas (including overburden emplacements), water recovered from settling tailings as seepage to adjacent open cut pits and small amounts of concentrate generated through operation of the RO Plant.

The mine water supply system also includes a water supply borefield located to the north of the mine area  Five existing production bores have been developed to date and are licensed to each provide up to 110 ML annually (equivalent to 3.5 litres per second [L/s] if pumped continuously). Additional production bores may be established as required over the life of the mine.

WCPL also has an in principle agreement with the nearby Ulan Coal Mines Ltd (UCML) to source excess water from this mining operation (by pipeline) if required in the future (subject to approval).

Potable water is trucked to the site to supply drinking water and ablution facilities in the office and crib areas. Sewage treatment occurs at a domestic sewage treatment facility located near the mine administration area and at the CHPP (septic system). Treated effluent is irrigated in accordance with the EPL.  A minor portion of effluent from remote crib areas is trucked off site by a waste contractor.

The existing sewage treatment facilities and treated/grey water spray areas would continue to be operated in accordance with the Environmental Guidelines: Use of Effluent by Irrigation (NSW DEC, 2004). Treated/grey water from the offices and bath house would continue to be re-used as irrigation water on vegetated areas within the rail loop and/or the CHPP area. Additional wastewater treatment plants, sized for approximately three shifts of 30 people each day, would be constructed at the new mine infrastructure areas. Effluent from the additional Project wastewater treatment plants would be managed as above for the existing sewage treatment facilities, and would be re-used as irrigation for rehabilitated areas in the vicinity of the Project mine infrastructure areas.

# 5 Proposed water management strategy and infrastructure

## 5.1 PROPOSED MINING PHASES

The Project open cut extensions are scheduled to commence in Year 2017, with mining occurring under existing approvals up until that time. For the purposes of this assessment, the water management system has been modelled in accordance with the Modification 6 approval up until Year 2017, followed by the Project proposal from Year 2017 to Year 2033. To represent the evolution of the mine layout over time, the Project was modelled in five stages, as shown in Table 5.1.

Table 5.1 - Proposed mining phases

| Approval/ Proposal | Phase | Applied Mine Plan Snapshot | Start Year | End Year | No. of Years |
|---|---|---|---|---|---|
| MOD 6 | 1 | 2016 | 2015 | 2016 | 2 |
| Project | 2 | 2018 | 2017 | 2018 | 2 |
| | 3 | 2020 | 2019 | 2021 | 3 |
| | 4 | 2024 | 2022 | 2025 | 4 |
| | 5 | 2028 | 2026 | 2030 | 5 |
| | 6 | 2031 | 2031 | 2033 | 3 |

## 5.2 PROPOSED WATER MANAGEMENT COMPONENTS AND LAYOUT

Figure 5.1 to Figure 5.6 show indicative locations of the proposed key features of the mine, including infrastructure related to the management of water on the Project site for the six adopted phases of mining (as described in Table 5.1). The main components of water-related infrastructure include:

- sediment dams to collect and treat runoff from overburden emplacement areas;
- clean water diversion drains to divert runoff from undisturbed catchments around areas disturbed by mining;
- surface water drains to divert sediment-laden runoff from overburden emplacement areas to sediment dams; and
- a mine-affected water system to store water pumped out of the open cut mining areas and to collect runoff from the CHPP and coal stockpile area.

The above infrastructure would be developed progressively of the life of the Project and would be subject to detailed design based on the mining sequence documented in the relevant Mining Operations Plan required by DRE.

The key components of the proposed WMS at the WCM site are as follows:

- Mine water storages
    - Expansion of Pit 1S Dam during 2015/2016
    - ROM Dam 1 through to ROM Dam 8
    - Pit 8 Mine Water Dam (MWD)
    - Mine Infrastructure Area (MIA) Dam
- Sediment Dams
    - SD1A / SD1B
    - SD2A / SD2C / SD2D / SD2E
    - SD3A / SD3B / SD3C / SD3D / SD3E
    - SD4A / SD4B / SD4C / SD4D / SD4E / SD4F
    - SD5A / SD5B / SD5C / SD5D / SD5E
    - SD6A / SD6B / SD6C / SD6D
    - SD7A / SD7B / SD7C / SD7D / SD7E
    - SD8A / SD8B / SD8C / SD8D / SD8E / SD8F
- Various upstream diversion structures.

A summary of the proposed mine water storages is provided in Table 5.2. The proposed capacity of Pit 1S Dam is based on advice provided by WCM. ROM Dams are storages that collect runoff and seepage from ROM stockpiles and have been sized in order to contain mine water under all climatic conditions.

Details of the sizing of the proposed sediment dams is provided in Section 5.3.

Table 5.2 - Key water storage/pit characteristics - proposed WMS

| Storage/pit name | Full supply volume (ML) |
|---|---|
| Pit 1S Dam (expanded) | 1,500 |
| ROM Dam 1 | 20 |
| ROM Dam 2 | 20 |
| ROM Dam 3 | 20 |
| ROM Dam 5 | 20 |
| ROM Dam 6 | 20 |
| ROM Dam 7 | 20 |
| ROM Dam 8 | 20 |
| Pit 8 MWD | 20 |
| MIA Dam | 20 |

Details of the proposed model including the schematised layout, system operating rules, modelled demands and inflows which are provided in Section 6.2.

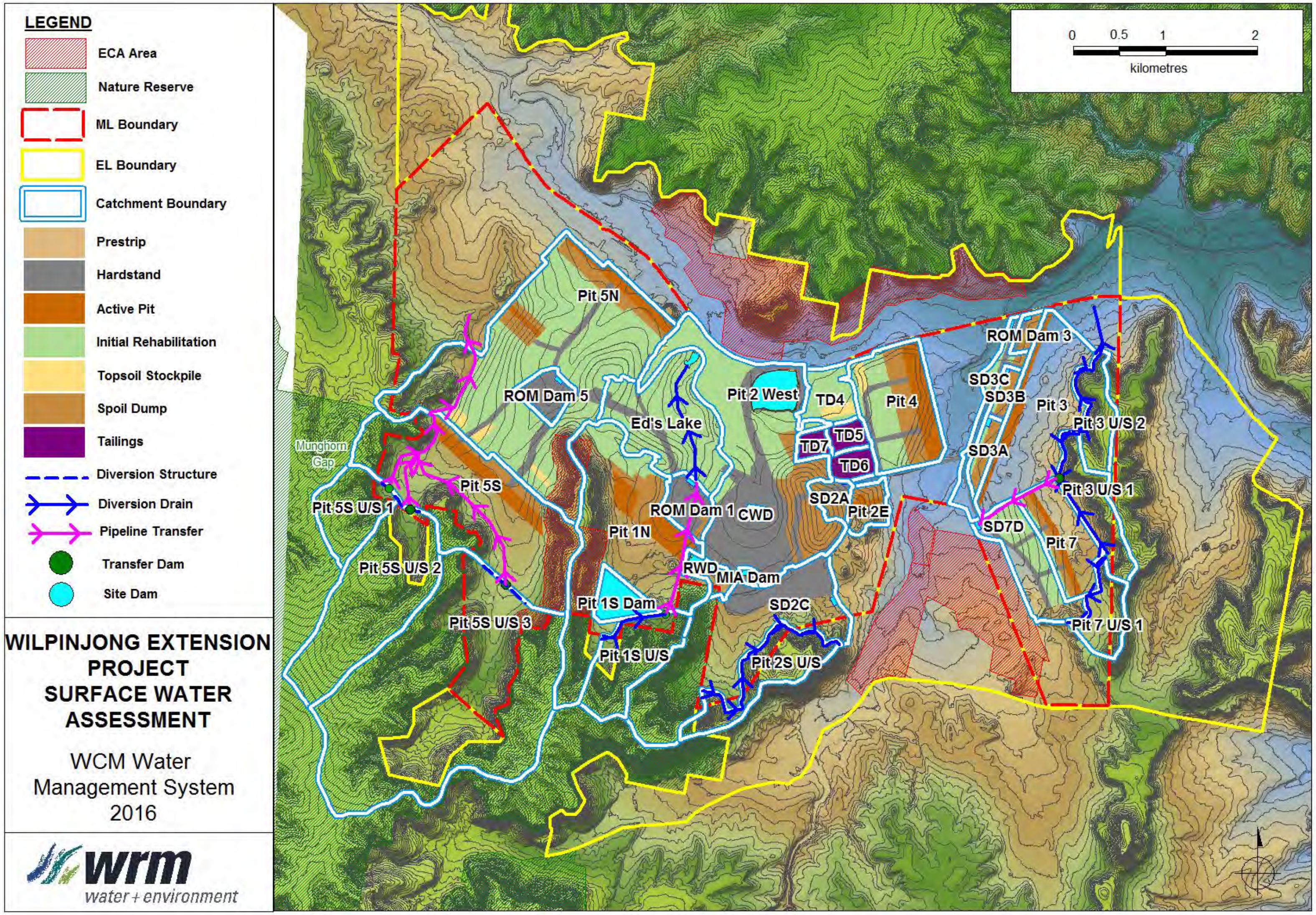



Figure 5.1 – Proposed water management system – Year 2016 (Phase 1)

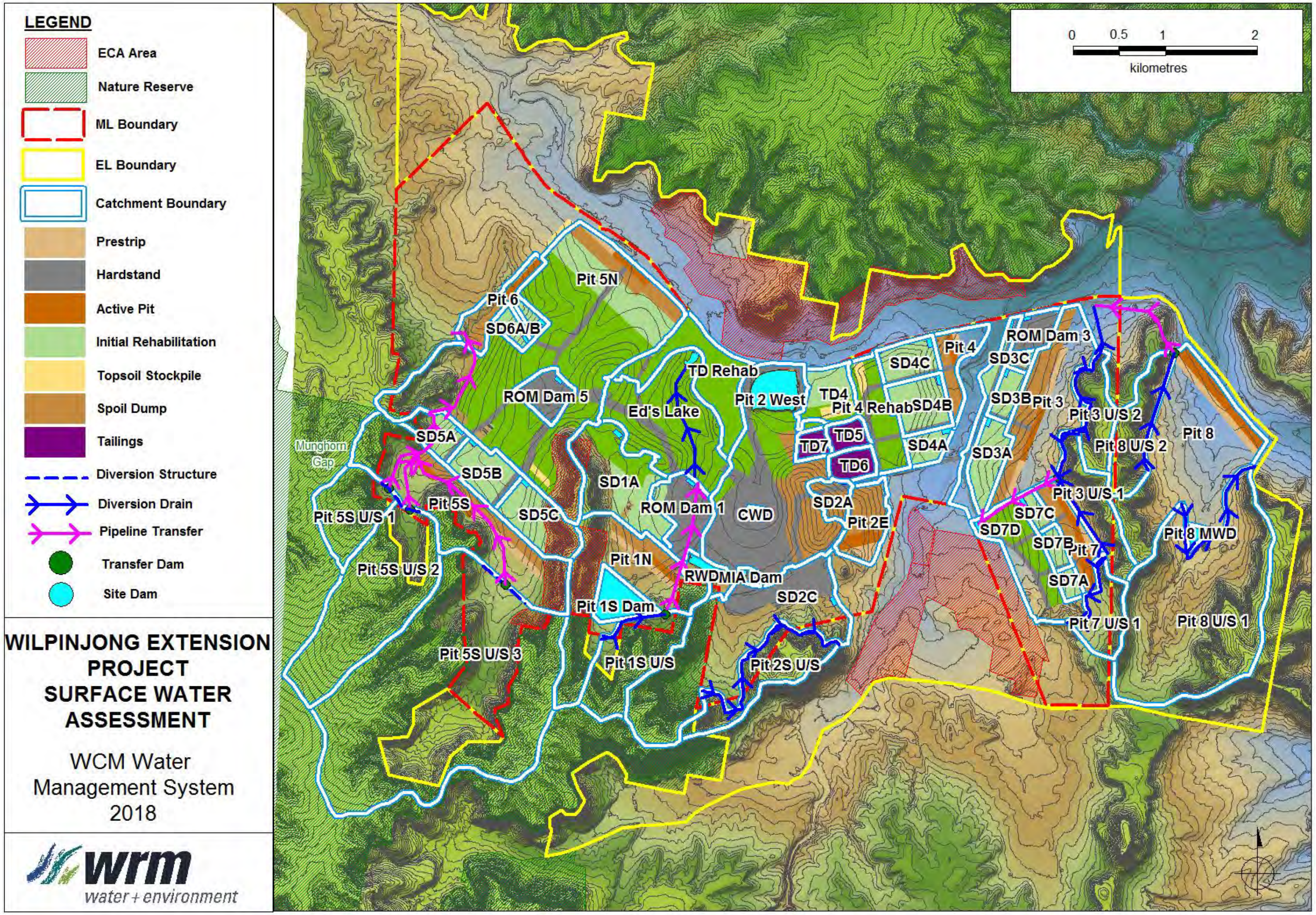



**Figure 5.2 – Proposed water management system – Year 2018 (Phase 2)**

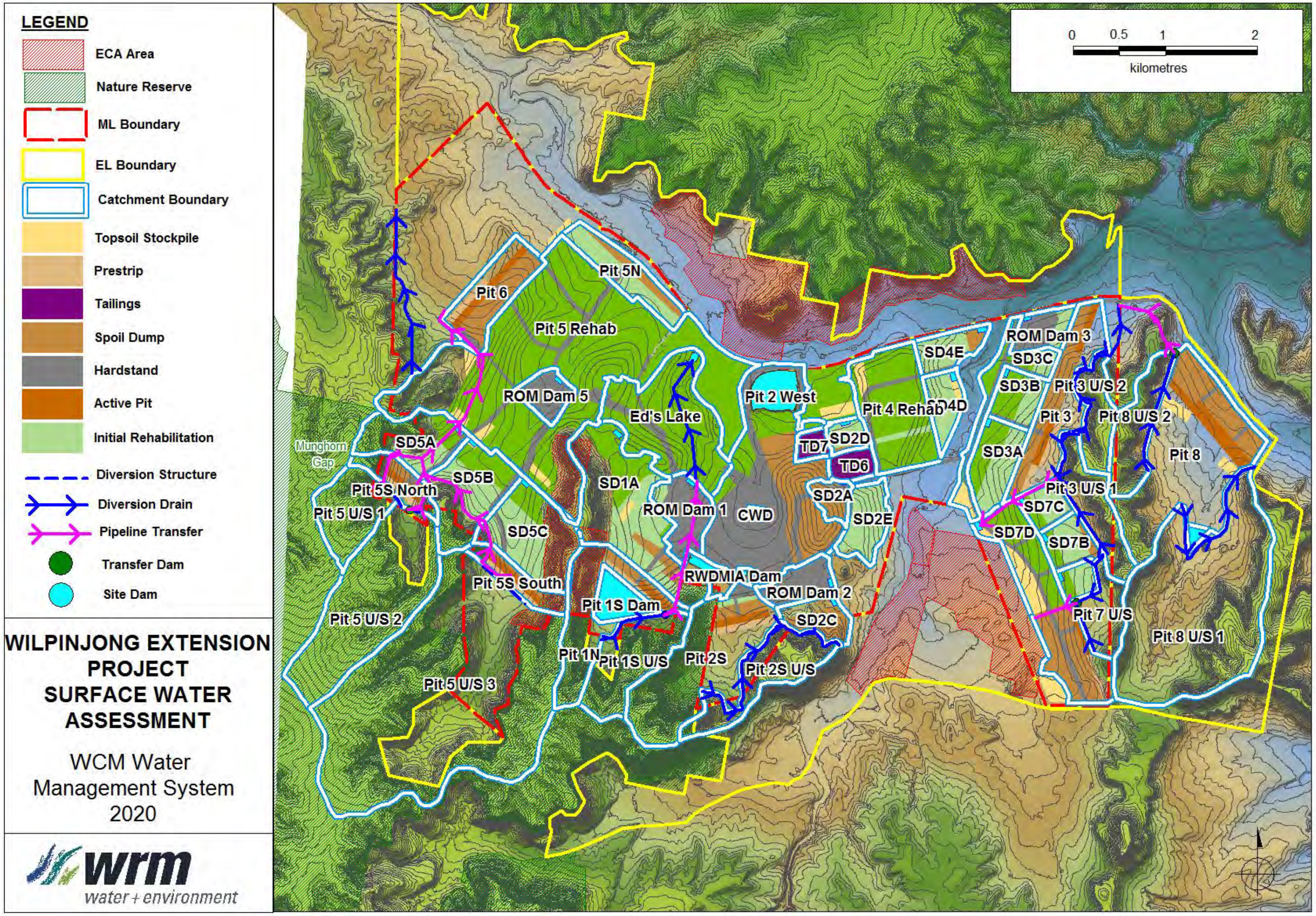



**Figure 5.3 – Proposed water management system – Year 2020 (Phase 3)**

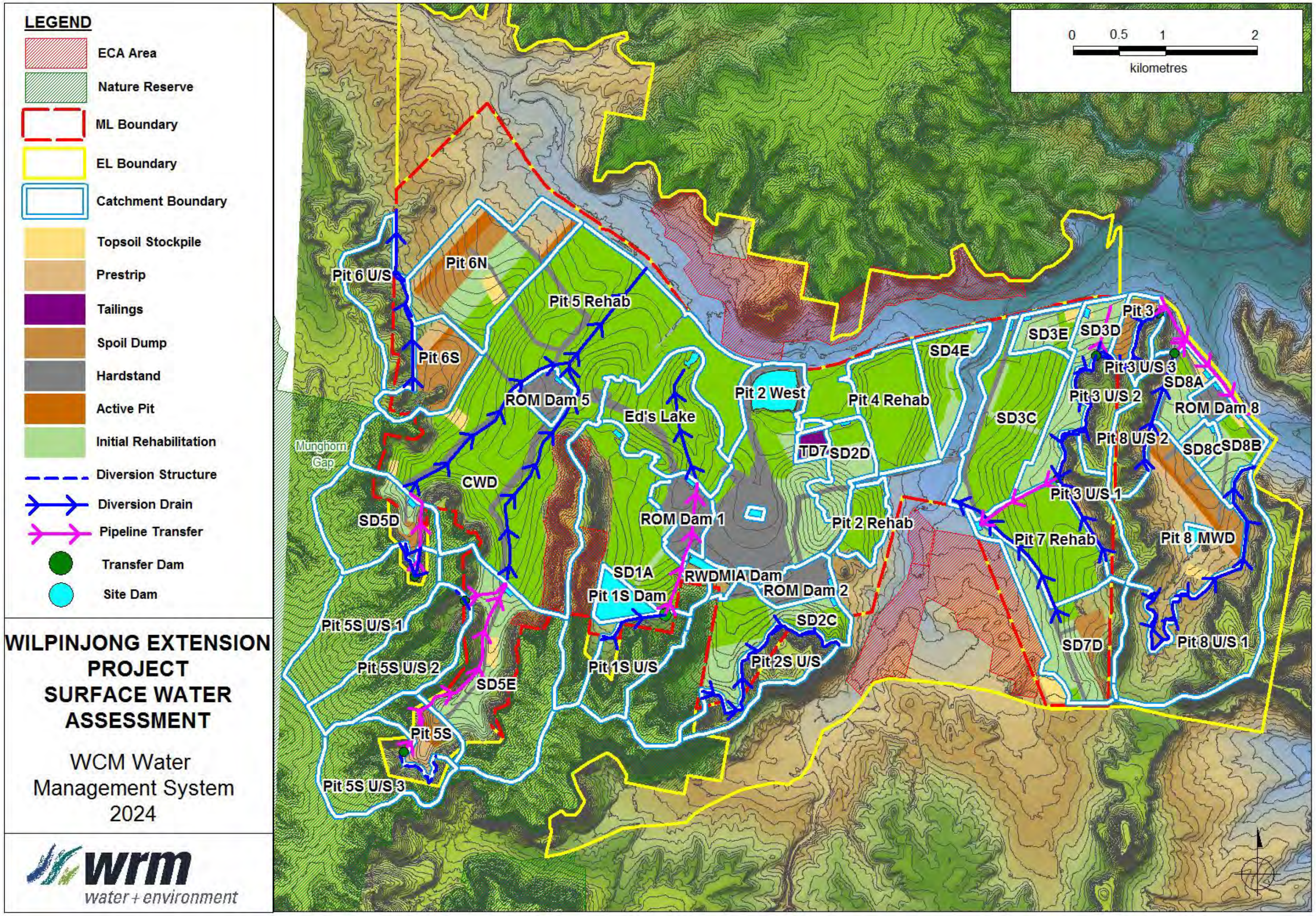



**Figure 5.4 – Proposed water management system – Year 2024 (Phase 4)**

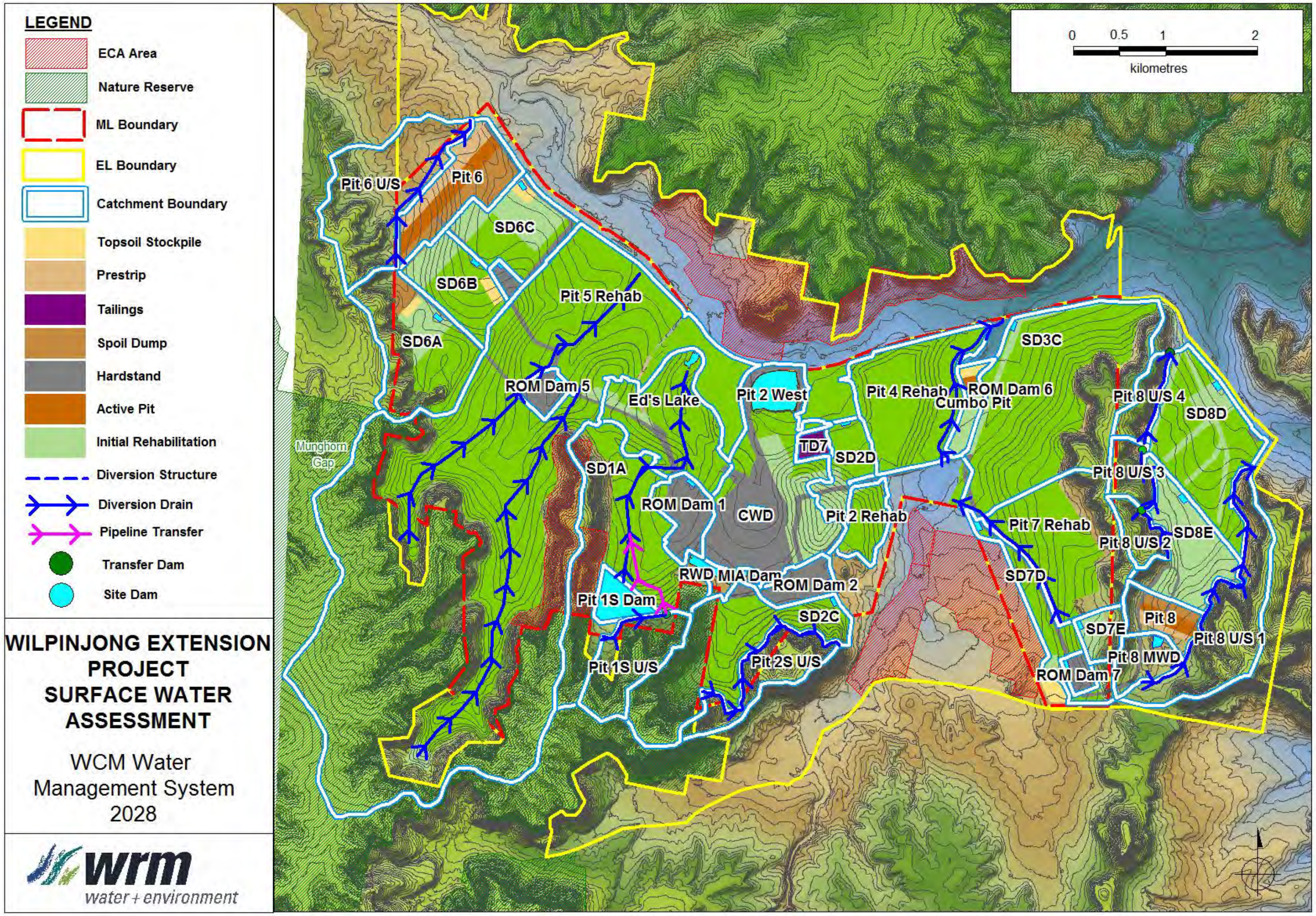



Figure 5.5 – Proposed water management system – Year 2028 (Phase 5)

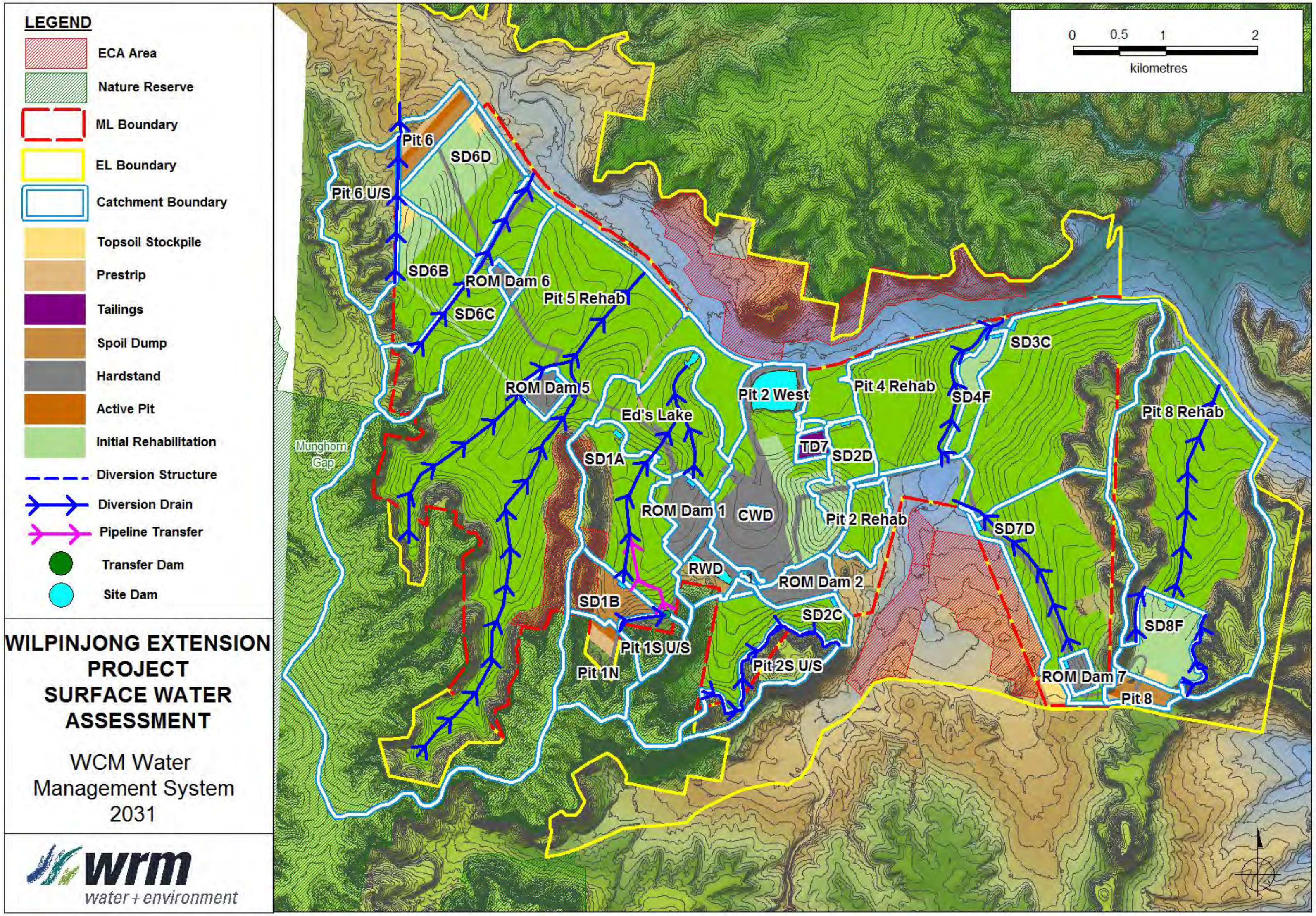



**Figure 5.6 – Proposed water management system – Year 2031 (Phase 6)**

## 5.3 SEDIMENT DAMS

### 5.3.1 Sizing

Conceptual sediment dam locations have been proposed based on the current mine plans and are shown in Figure 5.1 to Figure 5.6. There are a total of 38 sediment dams proposed over the life of the Project. The locations and sizes of these dams may be modified as the design and staging of overburden dump rehabilitation is refined and finalised.

The sediment dams will be sized in accordance with current recommended design standards in the following guidelines:

- Managing Urban Stormwater, Soils and Construction (Landcom, 2004); and
- Managing Urban Stormwater, Soils and Construction, Mines and Quarries (DECC, 2008).

The sediment dam volumes will be 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 90$^{th}$ percentile 5-day duration rainfall at Scone (35.9 mm) with an adopted volumetric event runoff coefficient for disturbed catchments of 0.64; and
- solids storage volume = 50% of settling zone volume.

The adopted design standard does not provide 100% containment for runoff from disturbed areas. Hence, it is possible that overflows will occur from sediment dams if rainfall exceeds the design standard.

Table 5.3 provides the adopted sediment dam volumes and the associated pump requirements to restore the settling zone capacity within 5 days. Note that current design guidelines (DECC, 2008) allow for the adoption of larger dam sizes to allow for dewatering over a longer period to reduce the required pumping rate.

Table 5.3 – Sediment dam sizing

| Sediment dam | Maximum catchment area (ha) | Total volume required (ML) | 5-day pump requirement (L/s) |
|---|---|---|---|
| SD1A | 136.6 | 41.2 | 95 |
| SD1B | 45.1 | 13.6 | 31 |
| SD2A | 15.1 | 4.6 | 11 |
| SD2C | 198.0 | 59.7 | 138 |
| SD2D | 44.9 | 13.5 | 31 |
| SD2E | 34.4 | 10.4 | 24 |
| SD3A | 44.1 | 13.3 | 31 |
| SD3B | 29.2 | 8.8 | 20 |
| SD3C | 41.0 | 12.4 | 29 |
| SD3D | 68.7 | 20.7 | 48 |
| SD3E | 29.0 | 8.7 | 20 |

| Sediment dam | Maximum catchment area (ha) | Total volume required (ML) | 5-day pump requirement (L/s) |
|---|---|---|---|
| SD4A | 15.6 | 4.7 | 11 |
| SD4B | 34.5 | 10.4 | 24 |
| SD4C | 26.0 | 7.8 | 18 |
| SD4D | 24.9 | 7.5 | 17 |
| SD4E | 51.6 | 15.6 | 36 |
| SD4F | 31.0 | 9.3 | 22 |
| SD5A | 55.8 | 16.8 | 39 |
| SD5B | 73.1 | 22.0 | 51 |
| SD5C | 81.0 | 24.4 | 57 |
| SD5D | 103.2 | 31.1 | 72 |
| SD5E | 234.2 | 70.6 | 163 |
| SD6A/B | 17.4 | 5.2 | 12 |
| SD6A | 135.9 | 41.0 | 95 |
| SD6B | 100.4 | 30.3 | 70 |
| SD6C | 88.7 | 26.7 | 62 |
| SD6D | 117.7 | 35.5 | 82 |
| SD7A | 14.5 | 4.4 | 10 |
| SD7B | 26.5 | 8.0 | 18 |
| SD7C | 21.1 | 6.4 | 15 |
| SD7D | 114.5 | 34.5 | 80 |
| SD7E | 24.5 | 7.4 | 17 |
| SD8A | 37.4 | 11.3 | 26 |
| SD8B | 37.1 | 11.2 | 26 |
| SD8C | 13.3 | 4.0 | 9 |
| SD8D | 148.3 | 44.7 | 103 |
| SD8E | 83.7 | 25.2 | 58 |
| SD8F | 67.1 | 20.2 | 47 |

### 5.3.2 Sediment dam collection system - operating rules

The model operating rules for the sediment dam collection system are based on the recommendations in the guidelines 'Managing Urban Stormwater Soils and Construction Guideline: Mines and Quarries' (DECC 2008). The operating rules are as follows:

- runoff from disturbed areas will be captured in sediment dams and, if capacity is available, pumped to mine water storages;
- pump capacities will be sized to empty sediment dams in 5 days;
- runoff from rehabilitated areas established for more than two years will be directed to a sediment dam and released off-site; and
- sediment dams will overflow when rainfall exceeds the design criteria (90$^{th}$ percentile 5 day rainfall).

# 6 Mine water balance model configuration

## 6.1 OVERVIEW

A computer-based operational simulation model (OPSIM) was used to assess the dynamics of the mine water balance under conditions of varying rainfall and catchment conditions throughout the development of the Project. The OPSIM model dynamically simulates the operation of the water management system and keeps complete account of all site water volumes and representative water quality on a daily time step.

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 6.1.

Table 6.1 – 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 to open cut operations | Dust suppression demand |
| External water supply | Mine infrastructure area demand |
| | RO plant discharges |
| | Other spills/discharges |

## 6.2 CONCEPTUAL WATER MANAGEMENT SYSTEM OPERATION

The proposed period of operation for each water storage in the water management system is presented in Figure 6.1. These rules have been based on a combination of existing water management procedures advised by WCPL for the components of the existing water management system described in Section 4, as well as proposed rules for the new storages and pits that generally align with these existing management procedures.

A schematised plan for the modelled Project's water management system configuration at each phase is shown in Figure 6.2 to Figure 6.7 and operating rules are provided in Table 6.2.

The MIA dam has a very small catchment area and discharges to the Pit 2 West dam. Therefore the MIA dam has not been explicitly included in the OPSIM model and instead its catchment area has been incorporated into the catchment area for the Pit 2 West dam.

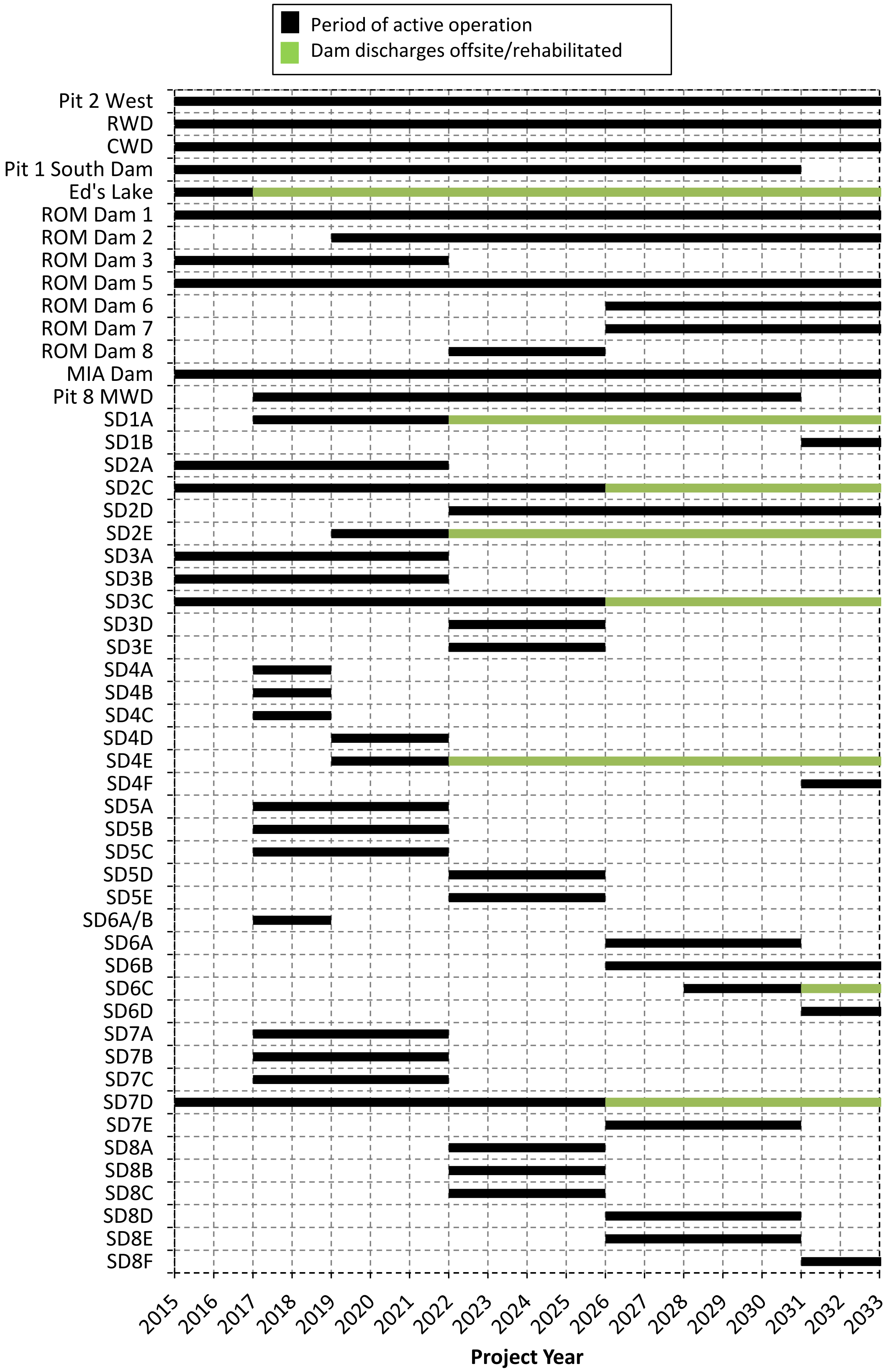



**Figure 6.1 - Existing and proposed Project storages - periods of operation**

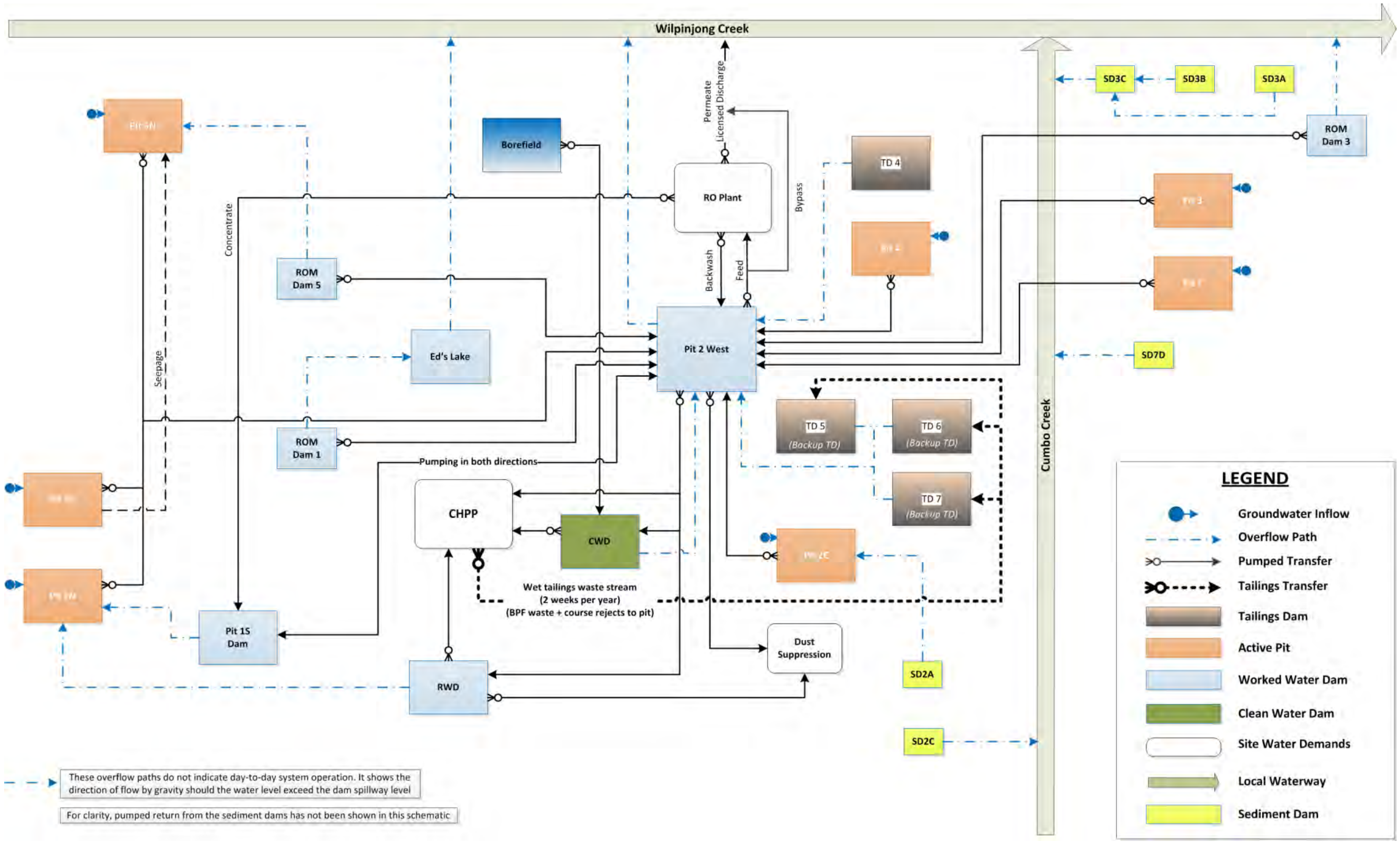



**Figure 6.2 – Water management system schematic – Year 2016 (Phase 1)**

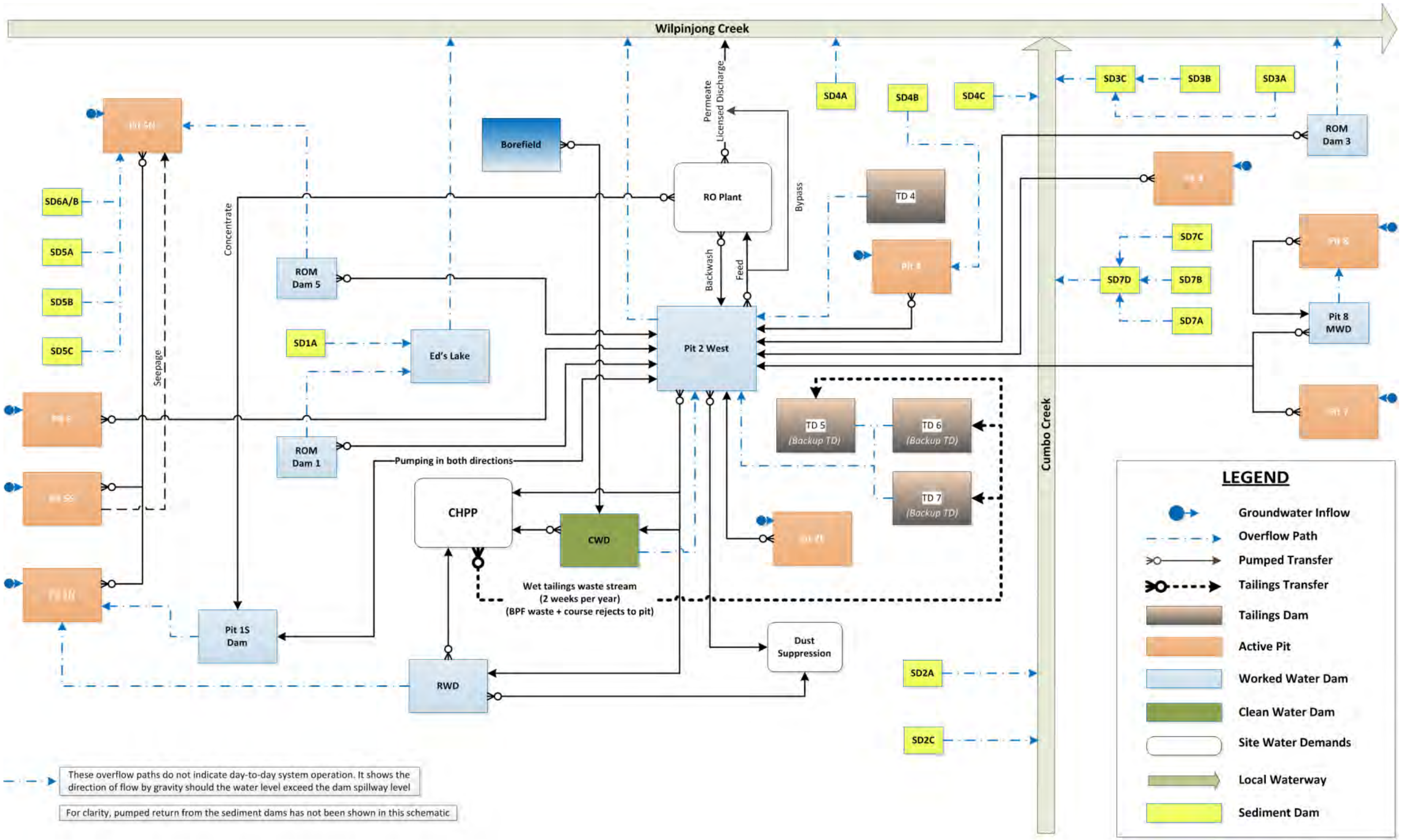



**Figure 6.3 – Water management system schematic – Year 2018 (Phase 2)**

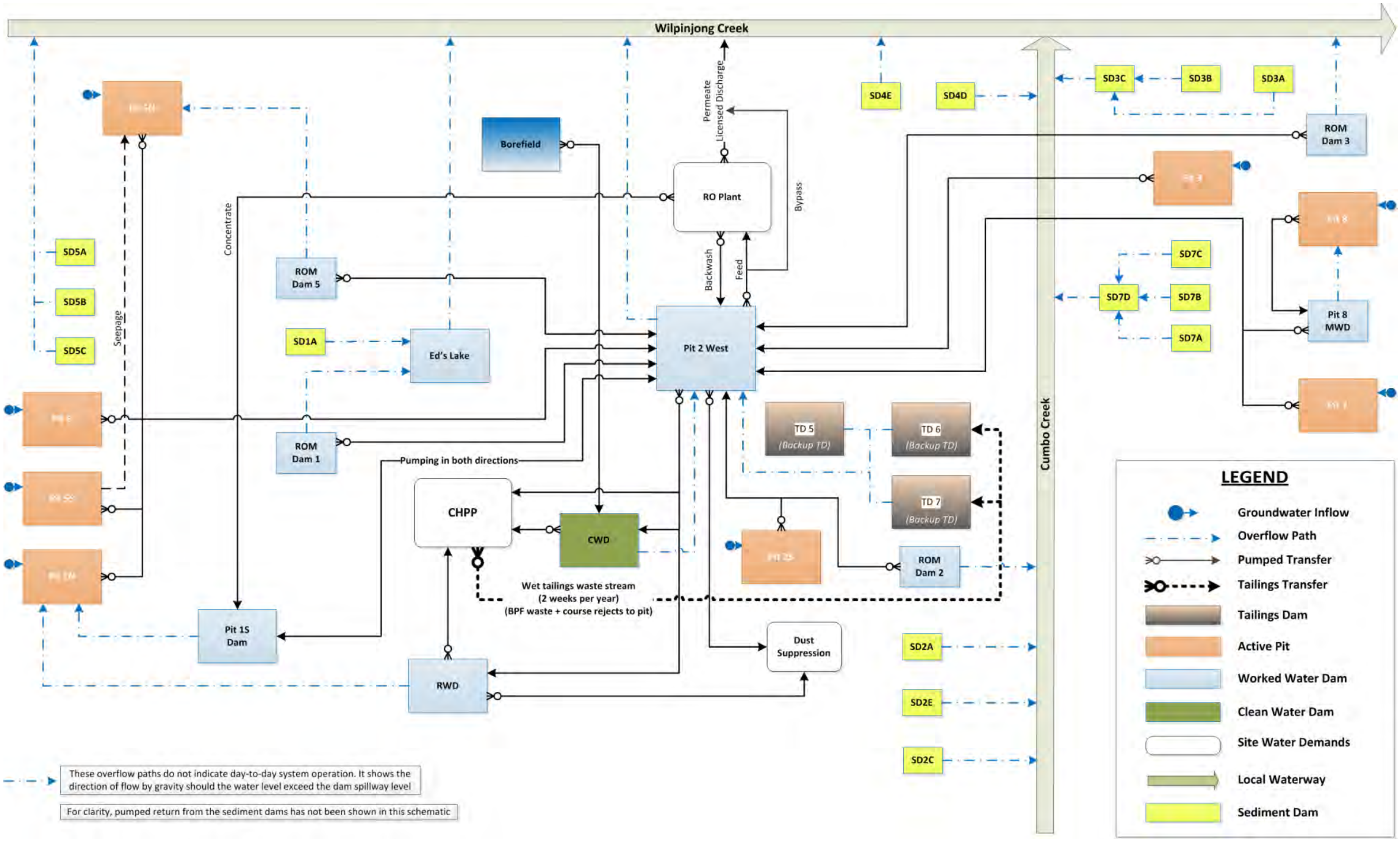



**Figure 6.4 – Water management system schematic – Year 2020 (Phase 3)**

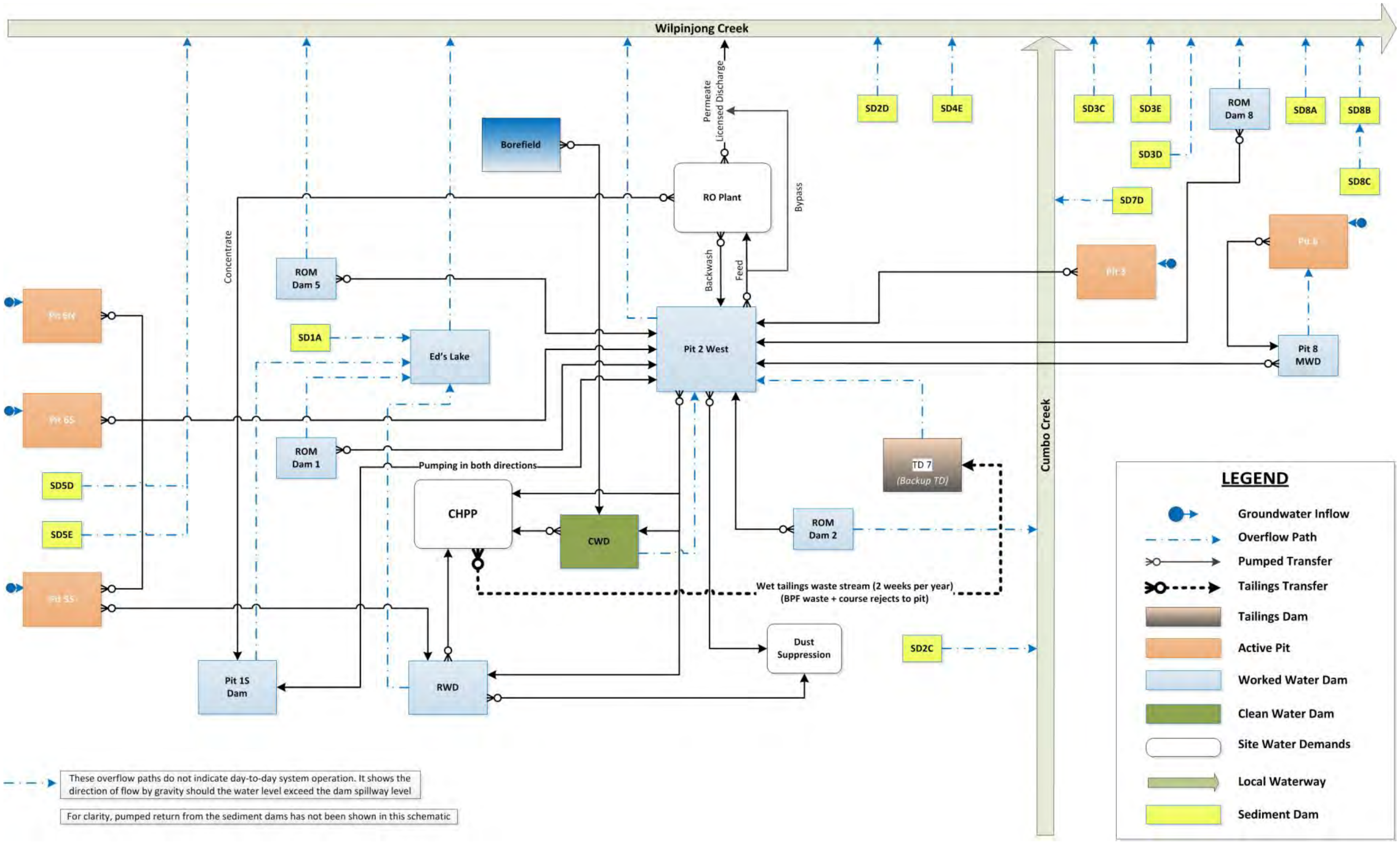



**Figure 6.5 – Water management system schematic – Year 2024 (Phase 4)**

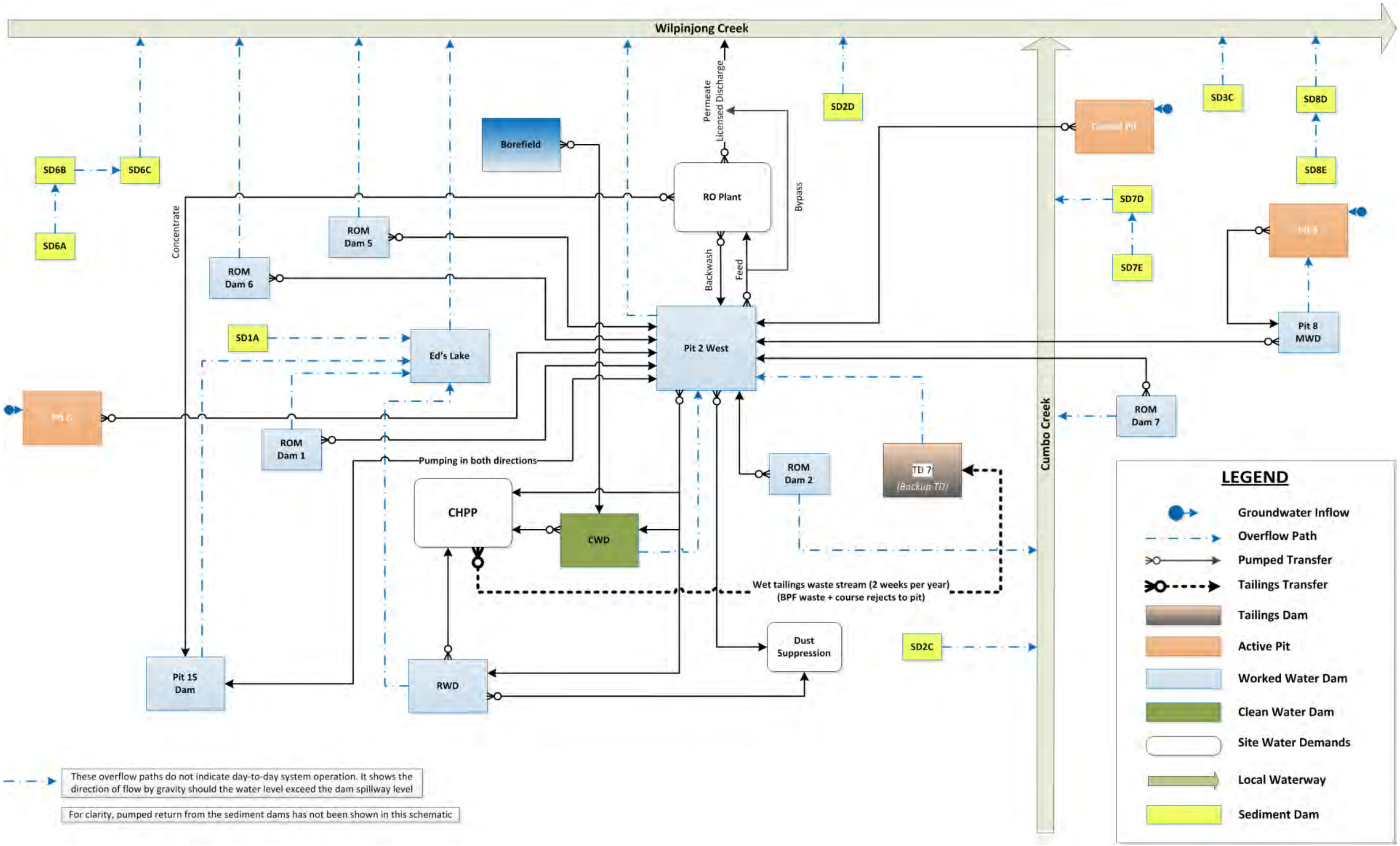



**Figure 6.6 – Water management system schematic – Year 2028 (Phase 5)**

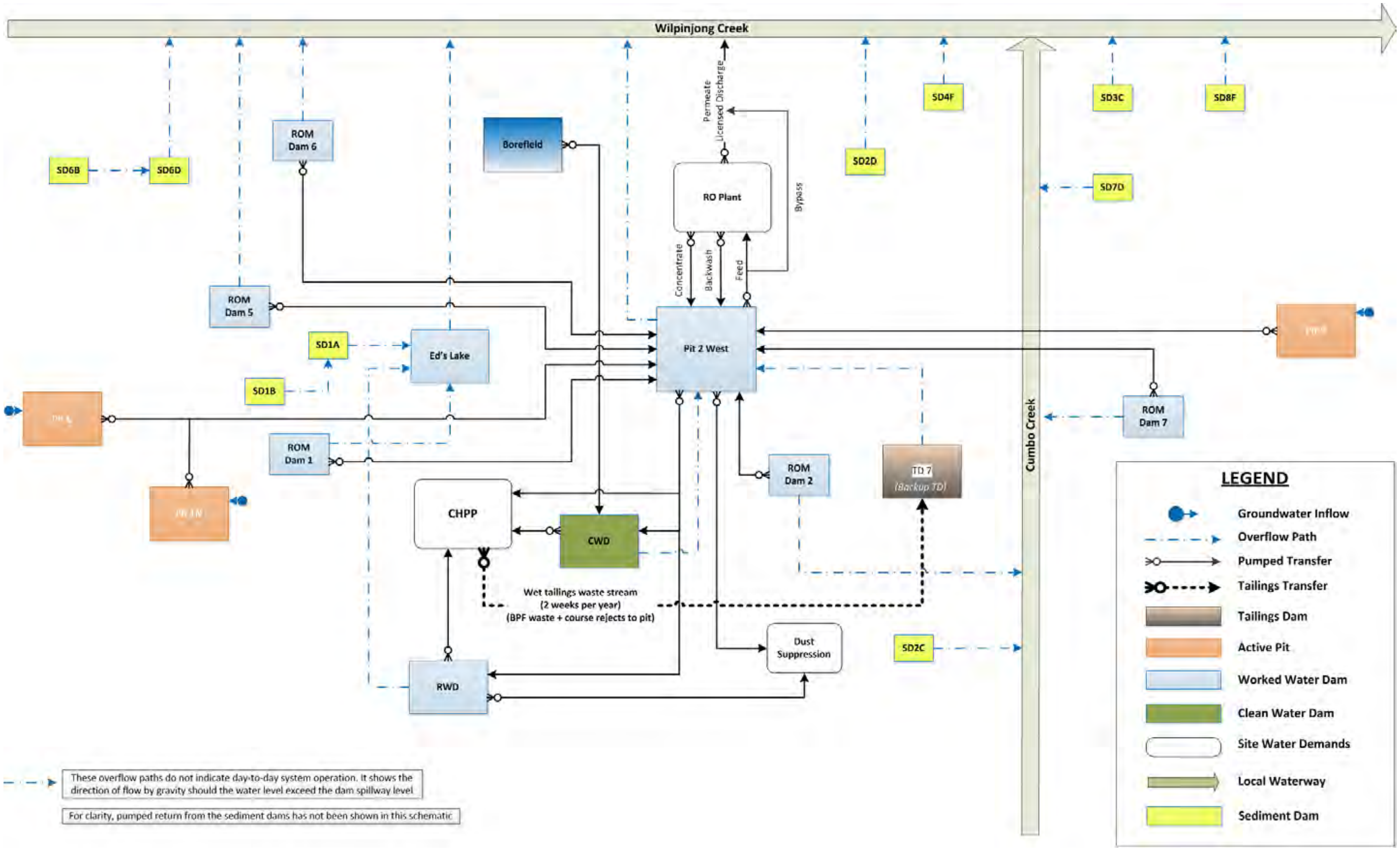



**Figure 6.7 – Water management system schematic – Year 2031 (Phase 6)**

Table 6.2 - Water management system operating rules

| Item | Node Name | Operating Rules |
|---|---|---|
| ***1.0*** | ***Water Supply*** | |
| 1.1 | Bore Water Supply | • Supply from production bores as required (refer to Section 4.7 for details of the modelling approach for water supply). (Or alternatively supply under WCPL's in-principle agreement with UCML to source excess mine water if required)<br>• The borefield supply is modelled to supply water when the key water management storages (Pit 2 West and Pit 1S Dam) are empty. In practice, the bore water supply would be triggered before these storages empty to provide an operational buffer |
| ***2.0*** | ***Water Demands*** | |
| 2.1 | CHPP | • Supplied from CWD, Pit 2 West & RWD |
| 2.2 | Dust Suppression | • Supplied from Pit 2 West, RWD and Pit 5 standpipe (not modelled) |
| ***3.0*** | ***Reverse Osmosis Plant*** | |
| 3.1 | RO Plant | • Supplied from Pit 2 West<br>• Backwash to Pit 2 west<br>• Concentrate to Pit 1 South (up to Phase 5 (2028)) and Pit 2 West (Phase 6 (2031))<br>• Permeate combined with bypass flow & discharged to Wilpinjong Creek<br>• Triggers levels for the plant are modelled as follows:<br>○ RO Plant active when the inventory in Pit 2 West exceeds 1,300 ML<br>○ RO Plant inactive when the inventory in Pit 2 West reduces below 500 ML<br>• Refer to Section 4.6 for details on the modelled RO plant release rates |
| ***4.0*** | ***Open-Cut Operations*** | |
| 4.1 | Pit 1N | • Active between Phase 1 (2016) and Phase 3 (2020), as well as Phase 6 (2031)<br>• Receives groundwater inflows, at varying rates over the Project life<br>• Continuous dewatering to Pit 2 West at a nominal maximum rate of 8,640 kilolitres per day (kL/day) (100 L/s) |
| 4.2 | Pit 2 South | • Active during Phase 3 (2020)<br>• Receives groundwater inflows, at varying rates over the Project life<br>• Continuous dewatering to Pit 2 West at a nominal maximum rate of 8,640 kL/day (100 L/s) |
| 4.3 | Pit 2 East | • Active between Phase 1 (2016) and Phase 2 (2018)<br>• Receives groundwater inflows, at varying rates over the Project life<br>• Continuous dewatering to Pit 2 West at a nominal maximum rate of 8,640 kL/day (100 L/s) |

| Item | Node Name | Operating Rules |
|---|---|---|
| 4.4 | Pit 3 | • Active between Phase 1 (2016) and Phase 4 (2024)<br>• Receives groundwater inflows, at varying rates over the Project life<br>• Continuous dewatering to Pit 2 West at a nominal maximum rate of 7,776 kL/day (90 L/s) |
| 4.5 | Pit 4 | • Active between Phase 1 (2016) and Phase 2 (2018)<br>• Receives groundwater inflows, at varying rates over the Project life<br>• Continuous dewatering to Pit 2 West at a nominal maximum rate of 46,656 kL/day (3 @ 180 L/s) – note that high dewatering rate is required due to seepage from Pit 2 West |
| 4.6 | Pit 5 North | • Active between Phase 1 (2016) and Phase 3 (2020)<br>• Receives groundwater inflows, at varying rates over the Project life<br>• Receives seepage inflows from Pit 5 South<br>• Continuous dewatering to Pit 2 West at a nominal maximum rate of 15,552 kL/day (180 L/s)<br>• Pit backfilled and rehabilitated by Year 2024 |
| 4.7 | Pit 5 South | • Active between Phase 1 (2016) and Phase 4 (2024)<br>• Receives groundwater inflows, at varying rates over the Project life<br>• Continuous dewatering to Pit 2 West at a nominal maximum rate of 15,552 kL/day (180 L/s)<br>• Seeps to Pit 5 North at a nominal rate of 12,960 kL/day (150 L/s) |
| 4.8 | Pit 6 | • Active between Phase 2 (2018) and Phase 6 (2031)<br>• Receives groundwater inflows, at varying rates over the Project life<br>• Continuous dewatering to Pit 2 West at a nominal maximum rate of 7,776 kL/day (90 L/s) |
| 4.9 | Pit 7 | • Active between Phase 1 (2016) and Phase 2 (2020)<br>• Receives groundwater inflows, at varying rates over the Project life<br>• Continuous dewatering to Pit 2 West at a nominal maximum rate of 7,776 kL/day (90 L/s) |
| 4.10 | Pit 8 | • Active between Phase 2 (2018) and Phase 6 (2031)<br>• Receives groundwater inflows, at varying rates over the Project life<br>• Continuous dewatering to Pit 8 MWD or Pit 2 West at a nominal maximum rate of 7,776 kL/day (90 L/s) |
| ***5.0*** | ***Water Storages*** | |
| 5.1 | RWD | • Receives pumped inflows from Pit 2 West<br>• Supplies CHPP and dust suppression demands<br>• Overflows to Pit 1N (up to Year 2020 and during Year 2031) and Ed's Lake (Year 2024 to Year 2028)<br>• Maximum operating level is 300 ML (412.6 mAHD), cease pumping in when above this volume |
| 5.2 | CWD | • Receives pumped inflows from Pit 2 West<br>• Can be supplied from Borefield water source if required<br>• Supplies CHPP |

| Item | Node Name | Operating Rules |
|---|---|---|
| | | • Overflows to Pit 2 West<br>• Normal operating level is 35 ML (395.9 mAHD), pump from Pit 2 West to make up this volume<br>• Maximum operating level is 40 ML (396.2 mAHD), cease pumping in when above this volume |
| 5.3 | Ed's Lake | • Receives overflows from SD1A, RWD, Pit 1S Dam and ROM Dam 1<br>• Overflows to Wilpinjong Creek<br>• Catchment area rehabilitated by 2017 |
| 5.4 | Pit 1S Dam | • Proposed expansion of storage from 535 ML to 1,500 ML during Years 2015/2016<br>• Consumed by open cut operations by Phase 6 (2031)<br>• Receives pumped inflows from Pit 2 West and RO Plant concentrate inflows<br>• Overflows to Pit 1N and Ed's Lake<br>• Maximum operating volume is 420 ML (during Year 2016) and 1,320 ML (from Year 2018 onwards), cease pumping from Pit 2 West if above this volume |
| 5.5 | Pit 2 West | • Receives pumped inflows from Pit 1S Dam, pit dewatering, active sediment dam pumping, ROM dams and Pit 8 MWD<br>• Receives backwash from RO plant and CHPP<br>• Supplies haul road dust suppression, RO plant demands<br>• Pumped transfers to CWD, RWD & Pit 1S Dam<br>• Overflows to Wilpinjong Creek<br>• Maximum operating volume is 2,280 ML, cease pumping in when above this volume |
| 5.6 | ROM Dam 1 | • Storage active between Phase 1 (2016) and Phase 6 (2031)<br>• Actively dewatered to Pit 2 West to remain empty<br>• Overflows to Ed's Lake |
| 5.7 | ROM Dam 2 | • Storage active between Phase 3 (2020) and Phase 6 (2031)<br>• Actively dewatered to Pit 2 West to remain empty<br>• Overflows to Cumbo Creek |
| 5.8 | ROM Dam 3 | • Storage active between Phase 1 (2016) and Phase 3 (2020)<br>• Actively dewatered to Pit 2 West to remain empty<br>• Overflows to Wilpinjong Creek |
| 5.9 | ROM Dam 5 | • Storage active between Phase 1 (2016) and Phase 6 (2031)<br>• Actively dewatered to Pit 2 West to remain empty<br>• Overflows to Pit 5N and Wilpinjong Creek |
| 5.10 | ROM Dam 6 | • Storage active between Phase 5 (2028) and Phase 6 (2031)<br>• Actively dewatered to Pit 2 West to remain empty<br>• Overflows to Wilpinjong Creek |
| 5.11 | ROM Dam 7 | • Storage active between Phase 5 (2028) and Phase 6 (2031)<br>• Actively dewatered to Pit 2 West to remain empty<br>• Overflows to Cumbo Creek |
| 5.12 | ROM Dam 8 | • Storage active during Phase 4 (2024)<br>• Actively dewatered to Pit 2 West to remain empty<br>• Overflows to Wilpinjong Creek |

| Item | Node Name | Operating Rules |
|---|---|---|
| 5.13 | Pit 8 MWD | • Receives pit dewatering from Pit 8<br>• Actively dewatered to Pit 2 West to remain empty<br>• Overflows to Pit 8 |
| ***6.0*** | ***Water Storages*** | |
| 6.1 | SD1A | • Storage active between Phase 2 (2018) and Phase 6 (2031)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 8,250 kL/day (95 L/s)<br>• Overflows to Ed's Lake |
| 6.2 | SD1B | • Storage active during Phase 6 (2031)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 2,720 kL/day (31 L/s)<br>• Overflows to SD1A |
| 6.3 | SD2A | • Storage active between Phase 1 (2016) and Phase 3 (2020)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 910 kL/day (11 L/s)<br>• Overflows to SD2A (Phase 1) or Cumbo Creek |
| 6.4 | SD2C | • Storage active between Phase 1 (2016) and Phase 6 (2031)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 12,000 kL/day (138 L/s)<br>• Overflows to Cumbo Creek |
| 6.5 | SD2D | • Storage active between Phase 4 (2024) and Phase 6 (2031)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 2,700 kL/day (31 L/s)<br>• Overflows to Wilpinjong Creek |
| 6.6 | SD2E | • Storage active during Phase 3 (2020)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 2,100 kL/day (24 L/s)<br>• Overflows to Cumbo Creek |
| 6.7 | SD3A | • Storage active between Phase 1 (2016) and Phase 3 (2020)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 2,660 kL/day (31 L/s)<br>• Overflows to SD3C |
| 6.8 | SD3B | • Storage active between Phase 1 (2016) and Phase 3 (2020)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 1,760 kL/day (20 L/s)<br>• Overflows to SD3C |
| 6.9 | SD3C | • Storage active between Phase 1 (2016) and Phase 6 (2031)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 2,470 kL/day (29 L/s)<br>• Overflows to Wilpinjong Creek |
| 6.10 | SD3D | • Storage active during Phase 4 (2024)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 4,140 kL/day (48 L/s)<br>• Overflows to Wilpinjong Creek |
| 6.11 | SD3E | • Storage active during Phase 4 (2024)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 1,750 kL/day (20 L/s)<br>• Overflows to Wilpinjong Creek |

| Item | Node Name | Operating Rules |
|---|---|---|
| 6.12 | SD4A | • Storage active during Phase 2 (2018)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 940 kL/day (11 L/s)<br>• Overflows to Wilpinjong Creek |
| 6.13 | SD4B | • Storage active during Phase 2 (2018)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 2,080 kL/day (24 L/s)<br>• Overflows to Pit 4 |
| 6.14 | SD4C | • Storage active during Phase 2 (2018)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 1,560 kL/day (18 L/s)<br>• Overflows to Cumbo Creek |
| 6.15 | SD4D | • Storage active during Phase 3 (2020)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 1,500 kL/day (17 L/s)<br>• Overflows to Cumbo Creek |
| 6.16 | SD4E | • Storage active during Phase 3 (2020) and Phase 4 (2024)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 3,100 kL/day (36 L/s)<br>• Overflows to Wilpinjong Creek |
| 6.17 | SD4F | • Storage active during Phase 6 (2031)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 1,870 kL/day (22 L/s)<br>• Overflows to Wilpinjong Creek |
| 6.18 | SD5A | • Storage active between Phase 2 (2018) and Phase 3 (2020)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 3,360 kL/day (39 L/s)<br>• Overflows to Pit 5N and Wilpinjong Creek |
| 6.19 | SD5B | • Storage active between Phase 2 (2018) and Phase 3 (2020)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 4,400 kL/day (51 L/s)<br>• Overflows to Pit 5N and Wilpinjong Creek |
| 6.20 | SD5C | • Storage active between Phase 2 (2018) and Phase 3 (2020)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 4,880 kL/day (57 L/s)<br>• Overflows to Pit 5N and Wilpinjong Creek |
| 6.21 | SD5D | • Storage active during Phase 4 (2024)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 6,200 kL/day (72 L/s)<br>• Overflows to Wilpinjong Creek |
| 6.22 | SD5E | • Storage active during Phase 4 (2024)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 14,100 kL/day (163 L/s)<br>• Overflows to Wilpinjong Creek |
| 6.23 | SD6A/B | • Storage active during Phase 2 (2018)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 1,050 kL/day (12 L/s)<br>• Overflows to Pit 5N |

| Item | Node Name | Operating Rules |
|---|---|---|
| 6.24 | SD6A | • Storage active during Phase 5 (2028)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 8,200 kL/day (95 L/s)<br>• Overflows to SD6B |
| 6.25 | SD6B | • Storage active during Phase 5 (2028) and Phase 6 (2031)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 6,050 kL/day (70 L/s)<br>• Overflows to SD6C |
| 6.26 | SD6C | • Storage active during Phase 5 (2028) and Phase 6 (2031)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 5,350 kL/day (62 L/s)<br>• Overflows to Wilpinjong Creek |
| 6.27 | SD6D | • Storage active during Phase 6 (2031)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 7,100 kL/day (82 L/s)<br>• Overflows to Wilpinjong Creek |
| 6.28 | SD7A | • Storage active between Phase 2 (2018) and Phase 3 (2020)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 870 kL/day (10 L/s)<br>• Overflows to SD7D |
| 6.29 | SD7B | • Storage active between Phase 2 (2018) and Phase 3 (2020)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 1,600 kL/day (18 L/s)<br>• Overflows to SD7D |
| 6.30 | SD7C | • Storage active between Phase 2 (2018) and Phase 3 (2020)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 1,270 kL/day (15 L/s)<br>• Overflows to SD7D |
| 6.31 | SD7D | • Storage active between Phase 1 (2016) and Phase 6 (2031)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 6,900 kL/day (80 L/s)<br>• Overflows to Cumbo Creek |
| 6.32 | SD7E | • Storage active during Phase 5 (2028)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 1,480 kL/day (17 L/s)<br>• Overflows to SD7D |
| 6.33 | SD8A | • Storage active during Phase 4 (2024)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 2,250 kL/day (26 L/s)<br>• Overflows to Wilpinjong Creek |
| 6.34 | SD8B | • Storage active during Phase 4 (2024)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 2,250 kL/day (26 L/s)<br>• Overflows to Wilpinjong Creek |
| 6.35 | SD8C | • Storage active during Phase 4 (2024)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 800 kL/day (9 L/s)<br>• Overflows to SD8B |

| Item | Node Name | Operating Rules |
|---|---|---|
| 6.36 | SD8D | • Storage active during Phase 5 (2028)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 8,940 kL/day (103 L/s)<br>• Overflows to Wilpinjong Creek |
| 6.37 | SD8E | • Storage active during Phase 5 (2028)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 5,050 kL/day (58 L/s)<br>• Overflows to SD8D |
| 6.38 | SD8F | • Storage active during Phase 6 (2031)<br>• Dewaters to Pit 2 West if capacity available, at a rate of 4,050 kL/day (47 L/s)<br>• Overflows to Wilpinjong Creek |
| ***7.0*** | ***Tailings Storages*** | |
| 7.1 | TD 4 | • Undergoing rehabilitation by Year 2016, rehabilitated and decommissioned by Year 2020<br>• No active dewatering |
| 7.2 | TD 5 | • Undergoing rehabilitation by Year 2016, rehabilitated by Year 2024<br>• No active dewatering |
| 7.3 | TD 6 | • Backup tailings facility<br>• Decommissioned and rehabilitated by Year 2024<br>• No active dewatering |
| 7.4 | TD 7 | • Backup tailings facility<br>• No active dewatering |

## 6.3 SIMULATION METHODOLOGY

The water balance model has been run using two types of simulation methodologies: 'static' and 'forecast'.

The static water balance results are based on a long-term simulation (126 years) with the model configuration fixed to a particular phase of mine development. These results provide an indication of the relative magnitude of inflows and outflows at that particular phase of mining.

The forecast water balance results are generated by running multiple climate sequences through the model and taking a statistical representation of the results for the different climate cases modelled. These results more accurately reflect the actual performance of the system because they take into account the dynamic nature of the mine phases, groundwater inflows and CHPP throughputs. In these runs the model configuration changes over time to reflect the changes due to mine development.

The forecast water balance model has been run on a daily timestep for a 19 year period, corresponding to the period of proposed mining operation for the Project. The model was run for multiple climate sequences, each referred to as a "realisation". Each realisation is based on a 19 year sequence extracted from the historical rainfall data. The first of 108 realisations is based on rainfall data from 1889 to 1907. The second is based on data from 1890 to 1908, and so on. This approach provides the widest possible range of climate scenarios covering the full range of climatic conditions represented in the historical rainfall record.

The model configuration changes over the life of the Project, reflecting changes in the water management system over time. The different stages of the mine life are linked in the model to reflect variations over time such as catchments, ROM coal production and groundwater inflows. Six different representative stages of mine life were modelled (Years 2016, 2020, 2024, 2028 and 2031). Although the catchment areas will continuously change as the Project progresses, the adopted approach of modelling discrete stages provides a reasonable representation of conditions over the life of the Project.

The changes in the physical layout and site catchment areas are shown in the mine stage plans provided in Figure 5.1 to Figure 5.6. The operational rules at each modelled stage are summarised in Table 6.2.

## 6.4 COAL PRODUCTION

The projected annual coal production schedule at the WCM is shown in Table 6.3. The production schedule for Year 2015 to Year 2016 is based on the MOD 6 approval. The production schedule for Year 2017 to Year 2033 is based on the Project proposal.

For ease of comparison, the tonnages presented in Table 6.3 represents equivalent tonnages at the CHPP feed moisture content (7.5%), and not the actual wet tonnages (which varies between feed coal, product coal and the various waste streams).

Table 6.3 – Proposed CHPP production schedule

| Phase | Year | CHPP Feed (Mt*) | CHPP Product (Mt*) | Coarse Reject (Mt*) | Tailings (Mt*) |
|---|---|---|---|---|---|
| 1 | 2015 | 9.20 | 6.20 | 2.60 | 0.40 |
| | 2016 | 9.00 | 5.90 | 2.60 | 0.52 |
| 2 | 2017 | 8.90 | 6.00 | 2.37 | 0.53 |
| | 2018 | 8.80 | 5.80 | 2.47 | 0.53 |
| 3 | 2019 | 8.35 | 5.57 | 2.28 | 0.50 |
| | 2020 | 8.25 | 5.02 | 2.74 | 0.49 |
| | 2021 | 6.50 | 4.26 | 1.85 | 0.39 |
| 4 | 2022 | 6.95 | 4.31 | 2.22 | 0.42 |
| | 2023 | 6.40 | 4.30 | 1.72 | 0.38 |
| | 2024 | 7.00 | 4.52 | 2.06 | 0.42 |
| | 2025 | 6.51 | 4.34 | 1.78 | 0.39 |
| 5 | 2026 | 6.00 | 3.62 | 2.02 | 0.36 |
| | 2027 | 5.75 | 3.63 | 1.78 | 0.35 |
| | 2028 | 5.00 | 3.07 | 1.63 | 0.30 |
| | 2029 | 4.25 | 2.57 | 1.43 | 0.25 |
| | 2030 | 3.55 | 1.96 | 1.38 | 0.21 |
| 6 | 2031 | 3.00 | 1.61 | 1.21 | 0.18 |
| | 2032 | 3.00 | 1.60 | 1.22 | 0.18 |
| | 2033 | 1.64 | 0.85 | 0.69 | 0.10 |

*Note: * For ease of comparison, tabulated tonnages are total tonnes at the CHPP feed moisture content (7.5%). Actual wet tonnages will differ depending on the applied moisture content.*

*Mt = million tonnes.*

## 6.5 SITE WATER DEMANDS

A summary of the water demands for the Project is provided below.

### 6.5.1 Coal handling & preparation plant (CHPP)

The following average material moisture contents have been advised by WCPL and applied to the CHPP inputs and outputs:

- ROM coal feed – 7.5% weight for weight (w/w);
- Product coal – 10.32% w/w;
- Coarse reject – 14.65% w/w; and
- Tailings filter cake (with TFP) – 35% w/w.

The projected process CHPP water requirements have been calculated for each year of mining, based on the proposed CHPP feed, plant yield and associated moisture contents for each waste stream. An example CHPP water balance for Year 2017 is provided in Table 6.4.

Table 6.4 – CHPP water balance – Year 2017

| Item | Mtpa (wet) | t/day (wet) | Total moisture (%) | Dry solids (t/day) | Moisture (kL/day) |
|---|---|---|---|---|---|
| Plant feed | 8.90 | 24,384 | 7.50 | 22,555 | 1,829 |
| Product | 6.18 | 16,955 | 10.32 | 15,205 | 1,750 |
| Rejects | 2.57 | 7,037 | 14.65 | 6,006 | 1,031 |
| Tailings | 0.75 | 2,066 | 35.00 | 1,343 | 723 |
| **Process plant makeup requirement (kL/day)** | | | | | **1,675** |
| **Process plant makeup requirement (ML/annum)** | | | | | **611** |
| **Process plant makeup requirement (net ML/ROM tonne)** | | | | | **68.7** |

Table 6.5 and Figure 6.8 show projected process CHPP water requirements based on the provided production schedule and average material moisture contents given. Note that the calculated water usages are based on the TFP being active.

Table 6.5 - Net CHPP water requirements (with TFP active)

| Phase | Year | CHPP Feed (Mt*) | CHPP Water Requirement (ML/year) | Net L/ROM tonne (ML/Mt) | Net L/ROM tonne (ML/Mt) |
|---|---|---|---|---|---|
| 1 | 2015 | 9.20 | 582 | 63.3 | 65.8 |
| | 2016 | 9.00 | 615 | 68.3 | |
| 2 | 2017 | 8.90 | 611 | 68.7 | 69.3 |
| | 2018 | 8.80 | 614 | 69.8 | |
| 3 | 2019 | 8.35 | 578 | 69.2 | 70.4 |
| | 2020 | 8.25 | 595 | 72.1 | |
| | 2021 | 6.50 | 454 | 69.8 | |
| 4 | 2022 | 6.95 | 499 | 71.8 | 70.1 |
| | 2023 | 6.40 | 440 | 68.8 | |
| | 2024 | 7.00 | 492 | 70.3 | |
| | 2025 | 6.51 | 451 | 69.3 | |
| 5 | 2026 | 6.00 | 435 | 72.5 | 72.4 |
| | 2027 | 5.75 | 407 | 70.8 | |
| | 2028 | 5.00 | 360 | 72.0 | |
| | 2029 | 4.25 | 306 | 72.0 | |
| | 2030 | 3.55 | 266 | 74.9 | |
| 6 | 2031 | 3.00 | 228 | 76.0 | 76.6 |
| | 2032 | 3.00 | 229 | 76.3 | |
| | 2033 | 1.64 | 127 | 77.4 | |

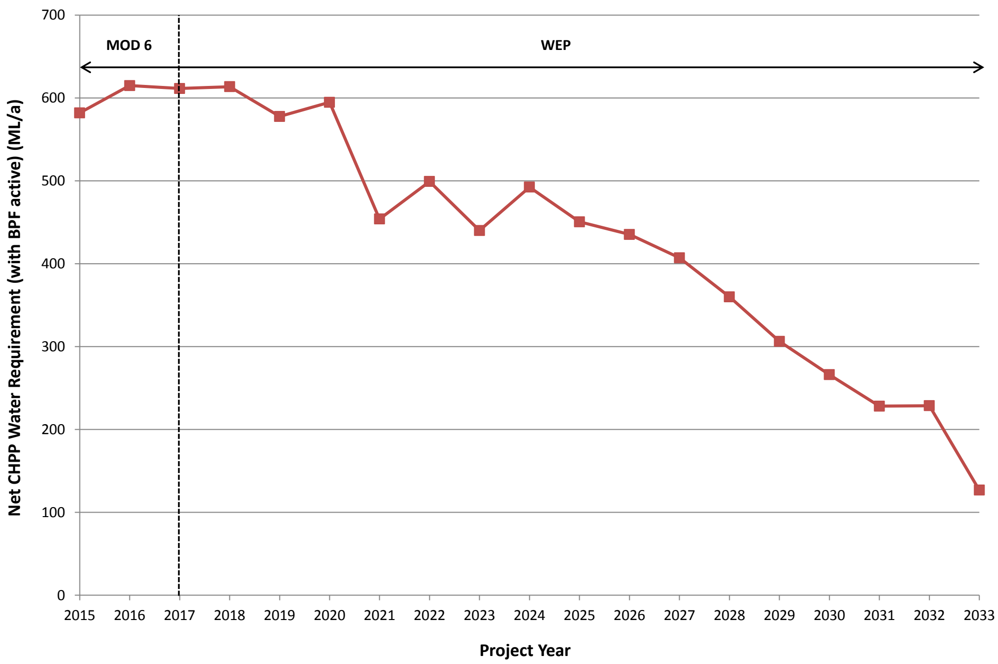



**Figure 6.8 - Net CHPP water requirement (with TFP active)**

### 6.5.2 Haul road dust suppression

Haul road dust suppression watering rates will vary over the life of the Project, as the haul road areas vary with each stage of mine development. Haul road footprints have been calculated from the mine plans for each mine stage. The following rules were applied to determine the dust suppression rate on any given day of the historical rainfall record:

- Use daily evaporation rates sourced from the SILO Data Drill evaporation dataset (Morton's estimate of wet environment areal evapotranspiration over land was used);
- For a dry day (zero rainfall), the haul road watering rate is equal to the daily evaporation rate;
- For a rain day when rainfall is less than the daily evaporation rate, watering rate is reduced and is only required to make up the remaining demand to the daily evaporation rate;
- For a rain day when rainfall exceeds the daily evaporation rate, no haul road watering is required;
- It was assumed that 22 m of the haul road width would be watered; and
- Only a percentage of haul road length would be active at any time. This has been estimated to be 80% (on average) over the life of the Project based on experience at the existing/approved WCM.

Estimates of haul road dust suppression requirements at each mine stage are presented in Table 6.6.

Table 6.6 – Haul road dust suppression

| Mine Stage | Haul Road Length (km)[a] | Percentage of Haul Road that is Active | Active Haul Road Area (ha)[b] | Average Daily Haul Road Dust Suppression Demand (kL/day)[c] | Annual Haul Road Dust Suppression Demand (ML/year) |
|---|---|---|---|---|---|
| 2016 | 25.0 | 80 | 44.1 | 1,428 | 522 |
| 2018 | 33.0 | 80 | 58.7 | 1,902 | 695 |
| 2020 | 37.7 | 80 | 66.3 | 2,150 | 785 |
| 2024 | 36.6 | 80 | 64.3 | 2,086 | 762 |
| 2028 | 25.7 | 80 | 45.2 | 1,467 | 536 |
| 2031 | 23.8 | 80 | 42.0 | 1,361 | 497 |

a - Based on Peabody general arrangement figures
b - Based on haul road width of 22 m
c - Dust suppression rates are based on daily rainfall and evaporation (Morton's wet environment estimates) rates from Data Drill

### 6.5.3 Industrial use and vehicle washdown

We have assumed that minor industrial water usage is included in the Process Plant makeup water requirement shown in Table 6.5.

### 6.5.4 Demand summary

A summary of the Project demands are presented in Table 6.7.

Table 6.7 - Site water demand summary

| Phase | Year | CHPP Net Demand (ML/year) | Dust Suppression (ML/year) | Total Demand (ML/year) | Phase Averaged Total Demand (ML/year) |
|---|---|---|---|---|---|
| 1 | 2015 | 582 | 522 | 1,104 | 1,121 |
| | 2016 | 615 | 522 | 1,137 | |
| 2 | 2017 | 611 | 695 | 1,306 | 1,308 |
| | 2018 | 614 | 695 | 1,309 | |
| 3 | 2019 | 578 | 785 | 1,363 | 1,346 |
| | 2020 | 595 | 785 | 1,380 | |
| | 2021 | 454 | 785 | 1,295 | |
| 4 | 2022 | 499 | 762 | 1,261 | 1,233 |
| | 2023 | 440 | 762 | 1,202 | |
| | 2024 | 492 | 762 | 1,254 | |
| | 2025 | 451 | 762 | 1,213 | |
| 5 | 2026 | 435 | 536 | 971 | 891 |
| | 2027 | 407 | 536 | 943 | |
| | 2028 | 360 | 536 | 896 | |
| | 2029 | 306 | 536 | 842 | |
| | 2030 | 266 | 536 | 802 | |
| 6 | 2031 | 228 | 497 | 725 | 692 |
| | 2032 | 229 | 497 | 726 | |
| | 2033 | 127 | 497 | 624 | |

## 6.6 WATER SOURCES

### 6.6.1 Groundwater inflows

Groundwater inflows to the open cut mining areas over the life of the Project were adopted based on estimates provided by HydroSimulations (2015). The estimates for the open cut pits have been corrected for evaporation from pit walls.

Evaporative losses from pit walls have been estimated using the area of proposed active mining face (length multiplied by seam thickness), multiplied by the average annual evaporation (Morton's estimate of wet environment areal evapotranspiration over land was used).

Additional evaporative losses are accounted for separately within the model. They are calculated daily based on the surface area of water ponded at the bottom of the pit. These additional evaporative losses are not included in the estimate below.

The adopted groundwater inflow rates for water balance modelling are the average for each representative phase, as shown in Table 6.8.

Table 6.8 – Adopted groundwater inflows – combined pits

| Project Year | Total groundwater intercepted (ML/year) | Estimated evaporative losses (ML/year) | Net groundwater inflows (ML/year) |
|---|---|---|---|
| 2015 | 1,235 | 159 | 1,076 |
| 2016 | 1,078 | 159 | 921 |
| 2017 | 1,109 | 305 | 965 |
| 2018 | 1,187 | 305 | 883 |
| 2019 | 1,137 | 254 | 883 |
| 2020 | 858 | 254 | 604 |
| 2021 | 706 | 254 | 452 |
| 2022 | 638 | 193 | 445 |
| 2023 | 662 | 193 | 469 |
| 2024 | 680 | 193 | 487 |
| 2025 | 521 | 193 | 328 |
| 2026 | 482 | 94 | 388 |
| 2027 | 616 | 94 | 522 |
| 2028 | 726 | 94 | 632 |
| 2029 | 626 | 94 | 533 |
| 2030 | 429 | 94 | 335 |
| 2031 | 380 | 62 | 318 |
| 2032 | 332 | 62 | 270 |
| 2033 | 137 | 62 | 75 |

## 6.7 SIMULATION OF RUNOFF

The OPSIM model uses the Australian Water Balance Model (AWBM) (Boughton, 1993) to estimate runoff from rainfall. The AWBM is a saturated overland flow model which allows for variable source areas of surface runoff.

The AWBM uses a group of connected conceptual storages (three surface water storages and one groundwater storage) to represent a catchment. Water in the conceptual storages is replenished by rainfall and is reduced by evaporation. Simulated surface runoff occurs when the storages fill and overflow. 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 subsurface store. Runoff depth calculated by the AWBM model is converted into runoff volume by multiplying the contributing catchment area.

The model parameters define the storage depths (C1, C2 and C3), the proportion of the catchment draining to each of the storages (A1, A2 and A3), and the rate of flux between them (Kb, Ks and BFI) (Boughton & Chiew, 2003). Catchments across the site have been characterised into the following land use types (Figure 5.1 to Figure 5.6):

- natural/undisturbed;
- roads/hardstand;
- overburden;
- open cut;
- rehabilitated overburden; and
- tailings.

The AWBM model parameters are shown in Table 6.9. These parameters are based on those adopted for previous water balance investigations (undertaken by others), and have been verified during the calibration process (refer Section 6.9). The parameters for the natural catchment were calibrated to recorded streamflow in Wilpinjong Creek gauge WILGSU (Gilbert & Associates, 2013). The remainder were initially taken from literature-based guideline values or experience with similar projects, and then adjusted during the calibration process (Gilbert & Associates, 2013).

Table 6.9 – Adopted AWBM parameters for various catchment types

| Parameters | Natural/ undisturbed | Roads/ hardstand | Over-burden | Open cut | Rehab over-burden | Tailings |
|---|---|---|---|---|---|---|
| A1 | 0.01 | 1.0 | 0.05 | 0.1 | 0.012 | 1.0 |
| A2 | 0.65 | - | 0.95 | 0.9 | 0.63 | - |
| A3 | 0.34 | - | - | - | 0.358 | - |
| C1 | 6 | 3 | 5 | 5 | 6 | 2 |
| C2 | 120 | - | 65 | 15 | 120 | - |
| C3 | 160 | - | - | - | 160 | - |
| BFI | 0.3 | - | 0.7 | 0.2 | 0.3 | - |
| $k_b$ | 0.975 | - | 0.99 | 0.95 | 0.97 | - |
| $k_s$ | 0.5 | - | 0.15 | 0.1 | 0.5 | - |
| Long term $C_v$* | 2.2% | 51.7% | 8.6% | 30.6% | 2.2% | 54.9% |

* Average volumetric runoff - this is an output of the AWBM model and is effectively a measure of the total runoff divided by the total rainfall.

## 6.8 SALINITY

The Project OPSIM model has been configured to use salinity as an indicator of water quality. This has been achieved by assigning representative EC to runoff from catchments and other inflow sources of water.

The representative salinity for runoff from the various catchment types are largely based on information provided in previous studies and the very limited available water quality monitoring data for the site storages. The values are similar to values adopted at other coal mines in the area.

The adopted salinities applied to the model are given in Table 6.10. Note that these values apply only to active mining operations and not to the post-rehabilitation landform. Their basis is summarised below:

- Natural/undisturbed: average recorded EC for the upstream Wilpinjong Creek sampling location.
- Roads/hardstand: within recently observed Pit 2 West EC range (in the absence of catchment-specific information).
- Overburden catchments: In the absence of site-specific data, has been selected as between the undisturbed value (1,600 µs/cm) and the observed typical Pit 2 West EC (3,000 µs/cm). Note that this results in a value which is considerably higher and therefore more conservative than the salinity indicated from leachate testing of waste rock samples (GEM, 2015).
- Rehabilitated catchments: in the absence of an extensive record of site-specific rehabilitated catchments runoff water quality data, a value between the undisturbed catchment value and the overburden catchment value has been chosen while rehabilitation is establishing. The Geochemistry Assessment (GEM, 2015) for the Project indicates that, with the implementation of management strategies, the long-term runoff salinity from rehabilitated catchments would be consistent with the salinity of the natural/undisturbed catchments. This is also consistent with the completion criteria in the existing WCM Mining Operations Plan which requires runoff from rehabilitated areas to be within the range of water quality recorded from analogue sites and does not pose a threat to downstream water quality.
- Mining pit/tailings: Based on the limited recent water quality samples of the open cut pits and groundwater (refer to Table 3.8).
- The sample data does not differentiate between groundwater and surface runoff, and the adopted salinity is therefore likely to be conservatively high.
- Pit groundwater inflows: As per mining pit/tailings. This is slightly higher and therefore more conservative than the groundwater inflow quality reported in the Groundwater Assessment (HydroSimulations, 2015).
- Bore water: Assumed same as pit groundwater inflows.

Table 6.10 – Adopted salinity

| Water Source | EC (µS/cm) | Comment |
|---|---|---|
| Natural/undisturbed catchments | 1,600 | Based on average recorded EC in Wilpinjong Creek upstream (Table 3.7) |
| Roads/hardstand catchments | 3,000 | Based on recent observed Pit 2 West EC range |
| Overburden catchments | 2,500 | Estimated to be between the undisturbed value and the observed typical Pit 2 West EC |
| Rehabilitated catchments | 2,000 | Estimated to be between the undisturbed catchment value and the overburden catchment value |
| Mining pit/tailings catchment | 3,000 | Based on available pit WQ samples |
| Pit groundwater inflows | 3,000 | Based on available pit WQ samples and HydroSimulations (2015) |
| Bore water | 3,000 | Assumed to be similar to pit groundwater inflows |

## 6.9 MODEL CALIBRATION

Calibration of the Project OPSIM water balance model was undertaken against observations of the gross system behaviour made over the period January 2013 to December 2014. Key parameters and assumptions were as follows:

- daily rainfall data obtained from the on-site rainfall recording station;
- pan evaporation data from the Data Drill;
- AWBM parameters as per Section 6.7;
- daily RO plant discharge based on recorded outflows;
- constant CHPP demand over the calibration period, estimated using recorded tonnages and estimates of average moisture contents as per Section 6.5.1; and
- haul road dust suppression demand estimated using the approach outlined in Section 6.5.2.

The model was calibrated against the total site inventory, which includes recordings of storage volume in Pit 2 West, RWD, CWD and Ed's Lake. Calibration against individual storages was not possible given significant and highly variable rates of pumping between storages within the system and variable rates of leakage between water storages and open cuts through backfilled waste rock. The initial calibration pass used the predicted groundwater inflows presented in Table 9 of the Mod 5 Surface Water Assessment document. These are summarised in Table 6.11.

Table 6.11 – Predicted groundwater inflow rates (Modification 5 Surface Water Assessment)

| Project Year | Pit 1 (ML/day) | Pit 2 (ML/day) | Pit 3 (ML/day) | Pit 4 (ML/day) | Pit 5 (ML/day) | Pit 6 (ML/day) | Total (ML/day) |
|---|---|---|---|---|---|---|---|
| 2013 | - | - | 1.84 | 0.75 | 2.18 | - | 4.77 |
| 2014 | - | - | 1.81 | 0.74 | 2.31 | - | 4.86 |

However, the predicted groundwater inflow rates resulted in a poor calibration, with significant over-estimation of the total site inventory over the calibration period. This suggests the previous groundwater model was likely conservative with respect to inflow estimates in the calibration period. To achieve a satisfactory calibration, the total groundwater inflow rates were amended as follows:

- January to June 2013 – 1.0 ML/day;
- July to December 2013 – 3.5 ML/day;
- January to June 2014 – 3.25 ML/day; and
- July to December 2014 – 2.5 ML/day.

The step changes in inflow are consistent with the expansion of mine operations in Pit 3, Pit 4 and Pit 7. Inflow predictions prepared by HydroSimulations (2015) using a new contemporary groundwater model indicate that the adopted inflow rates described above are reasonable. The adopted inflow rates are adjusted for evaporation from the pit wall and are generally within approximately 10% of the revised inflow rates provided by HydroSimulations (adjusted for evaporation from the pit wall) over the calibration period as shown in Figure 6.9. Based on the adopted groundwater inflows, the updated model calibration results are shown in Figure 6.9. The calibration results indicate the following:

- The modelled total site inventory is generally consistent with the observed inventory for the site as a whole over the calibration period, if we adopt the adjusted groundwater inflows.
- The model generally reflects the increase in total site inventory following significant rainfall events, and decreases in total site inventory during dry periods.

This suggests the site water balance model is suitable for modelling the total site inventory. Its capability for modelling the inventory of individual storages has not been verified however, with the management measures in place for the transfer of water between storages and pits, modelling of the total inventory is considered acceptable for the purposes of this assessment (i.e. to ascertain ability of water management system to contain site water and potential for in-pit storage).

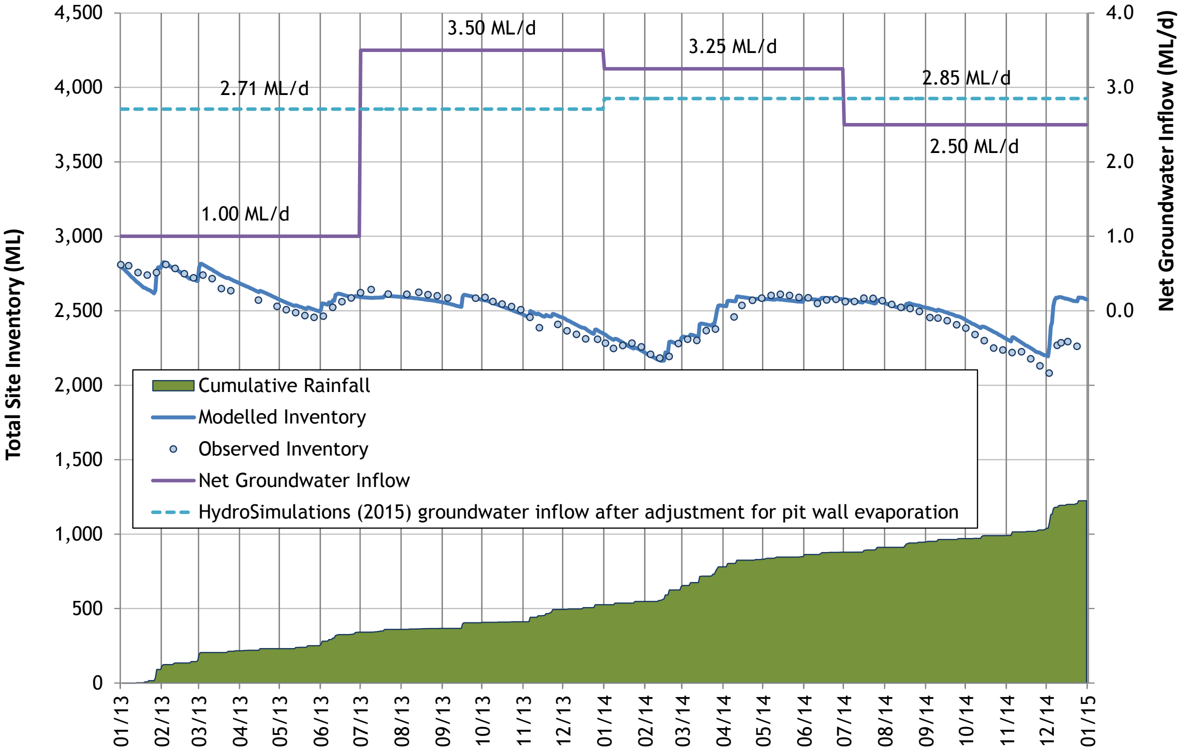



**Figure 6.9 - Final model calibration results - revised groundwater inflows**

# 7 Water management system assessment

## 7.1 OVERVIEW

An assessment of the Project's mine water management system was undertaken using the water balance model, using the following key performance indicators:

- mine water inventory – the risk of accumulation (or reduction) of the overall mine water inventory at the Project, and the associated water volumes (Section 7.3.2);
- in-pit storage – the risk of accumulation of water in the mining pits, and the associated water volumes (Section 7.3.3);
- external raw water requirements – the risk of requiring imported external water to supplement on-site mine water supplies (Section 7.3.4);
- uncontrolled spillway discharges – the risk of uncontrolled discharges from the site storages to receiving waters (Section 7.3.6); and
- overall site water balance (Section 7.3.1).

The use of a large number of climate sequences reflecting the full range of historical climatic conditions provides an indication of the system performance under very wet, very dry and average climatic conditions. Consideration of the potential implications of climate change on system performance is provided in Section 8.7.

It is important to note that investigation outcomes are dependent on the accuracy of input assumptions. There is inherent uncertainty with respect to some key site characteristics (e.g. catchment yield/ runoff, mining area groundwater inflows) which cannot be accurately determined with the available data. The sensitivity analysis presented in Appendix A has been used to help understand the potential implications of model uncertainty.

## 7.2 INTERPRETATION OF RESULTS

The tabulated water balance results in the following sections provide the average inflows and outflows of all realisations over the life of the Project. It should be recognised that the following items are subject to climatic variability:

- runoff;
- evaporation;
- external water requirements; and
- controlled releases/discharges.

The modelling methodology of a forecast simulation is described in Section 6.3. It should be noted that these results provide a statistical analysis of the water management system's performance over the 19 years of mine life, based on 107 realisations with different climatic sequences.

The 50$^{th}$ percentile represents the median of all daily results, the 10$^{th}$ percentile represents 10% exceedance (i.e. wet conditions) and the 90$^{th}$ percentile results represent 90% exceedance (i.e. dry conditions). There is an 80% chance that the result will fall within the 10$^{th}$ and 90$^{th}$ percentiles and a 98% chance the result will fall between the 1$^{st}$ and 99$^{th}$ percentiles. Importantly, note that a percentile trace shows the chance of a result exceeding a particular value on each day, and does not represent continuous results from a single model realisation e.g. the 50$^{th}$ percentile trace does not represent the model time series for median climatic conditions.

## 7.3 WATER BALANCE MODEL RESULTS

### 7.3.1 Overall water balance

Water balance results for all of the 108 modelled realisations are presented in Table 7.1, averaged over each model phase.

The results show that on average over the life of the Project:

- average external water supply is minimal, with an annual average demand in the final three phases of 1 to 2 ML;
- the largest demand from the water management system is initially CHPP usage (for the first phase), and dust suppression usage for the five remaining phases;
- the average annual combined mine water demand (including CHPP make-up and dust suppression) supplied from the water management system ranges between approximately 698 ML/year and 1,334 ML/year, with the highest demand in Year 2020;
- overflows do not occur from the mine water system;
- the average annual RO Plant discharge ranges between approximately 276 ML/year and 949 ML/year, with the highest discharge in Year 2018;
- the average annual overflow volume from the sediment dams ranges between 30 ML/year and 171 ML/year, and is highest in Year 2018; and
- the combined average annual overflow volume from diverted and rehabilitated catchments ranges between 115 ML/year and 618 ML/year, and is highest in Year 2031.

Note that the results presented in Table 7.1 are for the average of all realisations and will include wet and dry periods distributed throughout the mine life. Rainfall yield for each stage is affected by the variation in climatic conditions within the adopted climate sequence.

The simulated performance of the Project water management system under different climatic scenarios (i.e. median, low and high rainfall scenarios) is presented in Table 7.2.

Table 7.1 - Average annual water balance - all realisations

| | Year 2016 | Year 2018 | Year 2020 | Year 2024 | Year 2028 | Year 2031 |
|---|---|---|---|---|---|---|
| **Water inputs (ML/year)** | | | | | | |
| Catchment Runoff | 1,676 | 1,954 | 2,074 | 2,063 | 1,847 | 1,898 |
| Direct Rainfall | 418 | 445 | 405 | 326 | 302 | 201 |
| Groundwater inflows | 973 | 924 | 646 | 432 | 482 | 190 |
| External water supply | 0 | 0 | 0 | 2 | 1 | 2 |
| **GROSS WATER INPUTS** | **3,067** | **3,323** | **3,126** | **2,823** | **2,632** | **2,291** |
| **Water outputs (ML/year)** | | | | | | |
| Evaporation from water surfaces | 669 | 782 | 742 | 601 | 594 | 412 |
| CHPP demand | 609 | 613 | 542 | 471 | 355 | 195 |
| Dust suppression demand | 525 | 698 | 791 | 770 | 543 | 503 |
| RO Plant discharge | 276 | 949 | 663 | 454 | 517 | 739 |
| Storage overflows - mine water dams | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage overflows - sediment dams | 129 | 171 | 159 | 61 | 30 | 30 |
| Outflows- rehabilitated catchments | 0 | 47 | 219 | 385 | 451 | 578 |
| Outflows - diverted catchments | 115 | 204 | 221 | 158 | 89 | 40 |
| **GROSS WATER OUTPUTS** | **2,323** | **3,464** | **3,337** | **2,900** | **2,579** | **2,497** |
| **Water balance (ML/year)** | | | | | | |
| Change in storage volumes | 744 | -141 | -211 | -77 | 53 | -206 |

Table 7.2 – Indicative Project water management system performance

| | 90%ile (Low) Rainfall 19-Year Period (Cycle 24) | 50%ile (Median) Rainfall 19-Year Period (Cycle 75) | 10%ile (High) Rainfall 19-Year Period (Cycle 58) |
|---|---|---|---|
| **Average water inputs (ML/year)** | | | |
| Catchment Runoff | 1,894 | 1,991 | 2,218 |
| Direct Rainfall | 293 | 347 | 398 |
| Groundwater inflows | 549 | 549 | 549 |
| External water supply | 0 | 0 | 0 |
| **GROSS WATER INPUTS** | **2,737** | **2,887** | **3,165** |
| **Average water outputs (ML/year)** | | | |
| Evaporation from water storages | 590 | 612 | 674 |
| CHPP demand | 438 | 438 | 438 |
| Dust suppression demand | 649 | 631 | 631 |
| RO Plant discharge | 506 | 674 | 792 |
| Storage overflows - mine water dams | 0 | 0 | 0 |
| Storage overflows – sediment dams | 36 | 52 | 152 |
| Outflows – rehabilitated catchments | 346 | 353 | 310 |
| Outflows - diverted catchments | 177 | 129 | 198 |
| **GROSS WATER OUTPUTS** | **2,742** | **2,889** | **3,195** |

Note: The difference between the total average inflows and total average outflows is the change in water stored on-site relative to existing stored water volumes.

### 7.3.2 Mine water dam inventory

Figure 7.1 shows the combined forecast inventory for the key mine water storages (Pit 2 West and Pit 1S Dam) over the 19 year forecast.

To prevent uncontrolled discharges from the mine water storages, maximum operating volumes (MOV) have been set for the mine water storages. The MOV is the volume at which pumping from the open cut pits and sediment dams into the mine water system ceases. This was included as an operating rule in the OPSIM model. Also shown is the combined Full Supply Volume (FSV), which is the combined capacity of these dams.

The initial MOV volumes for Pit 2 West and Pit 1S Dam are 2,280 ML and 420 ML, respectively. From Year 2016 onwards, the MOV for Pit 1S Dam increases to 1,320 ML until its decommissioning in Year 2031.

The forecast modelling results for the combined mine water dams show the 10%ile mine water inventory will be around the MOV (i.e. the effective capacity of the mine water system) over the first 4 to 5 years of the simulation.

The results indicate that the site is very sensitive to climatic conditions, which is to be expected given the relatively large catchments reporting to the site storages and pits. This response to climatic conditions decreases over time, as additional catchments are rehabilitated and diverted around the water management system.

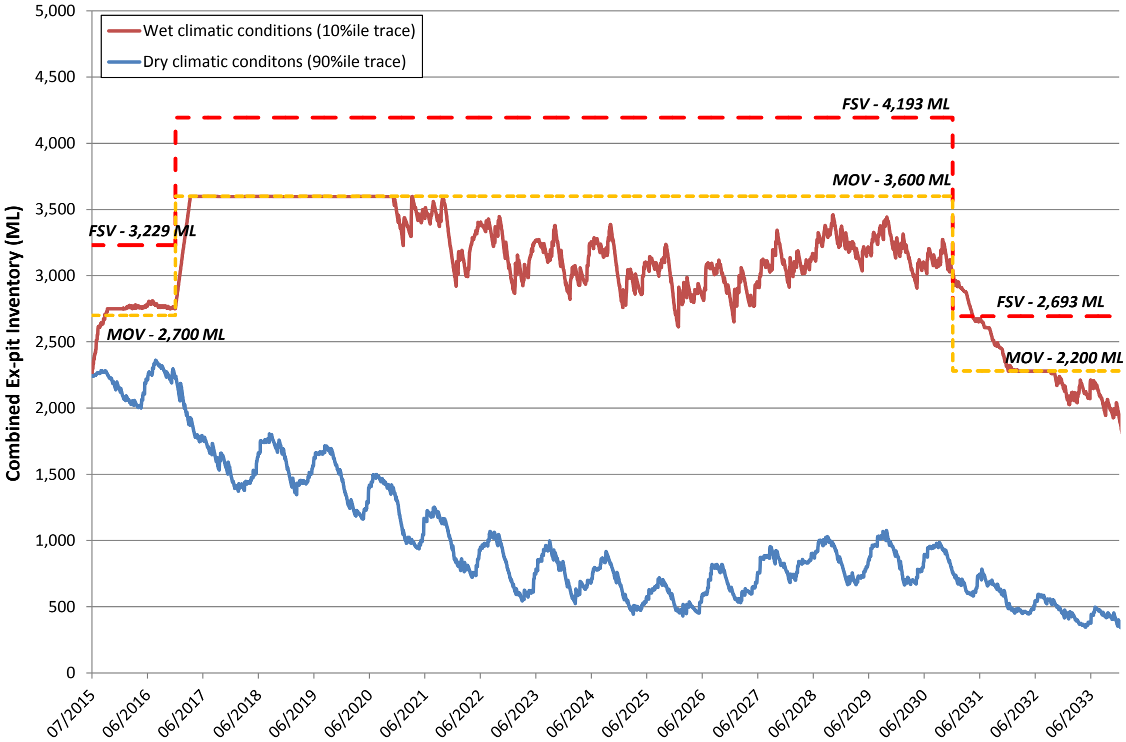



**Figure 7.1 - Forecast mine water inventory**

### 7.3.3 In-pit storage

Figure 7.2 shows the forecast inventory for the combined mining pits over the next 19 year simulation. A build-up of water in the mining pit generally occurs when the mine water storages are too full to accept additional pit water.

The forecast modelling results for the combined mining pit inventory are summarised as follows:

- The 1%ile combined pit inventory reaches around 3,200 ML by the start of Year 2017.
- The 10%ile combined pit inventory reaches around 1,360 ML by the start of Year 2017.

The results show that there is a chance that significant quantities of water will need to be stored in-pit in order to supplement the site storages, particularly in the first 5 years of the simulation.

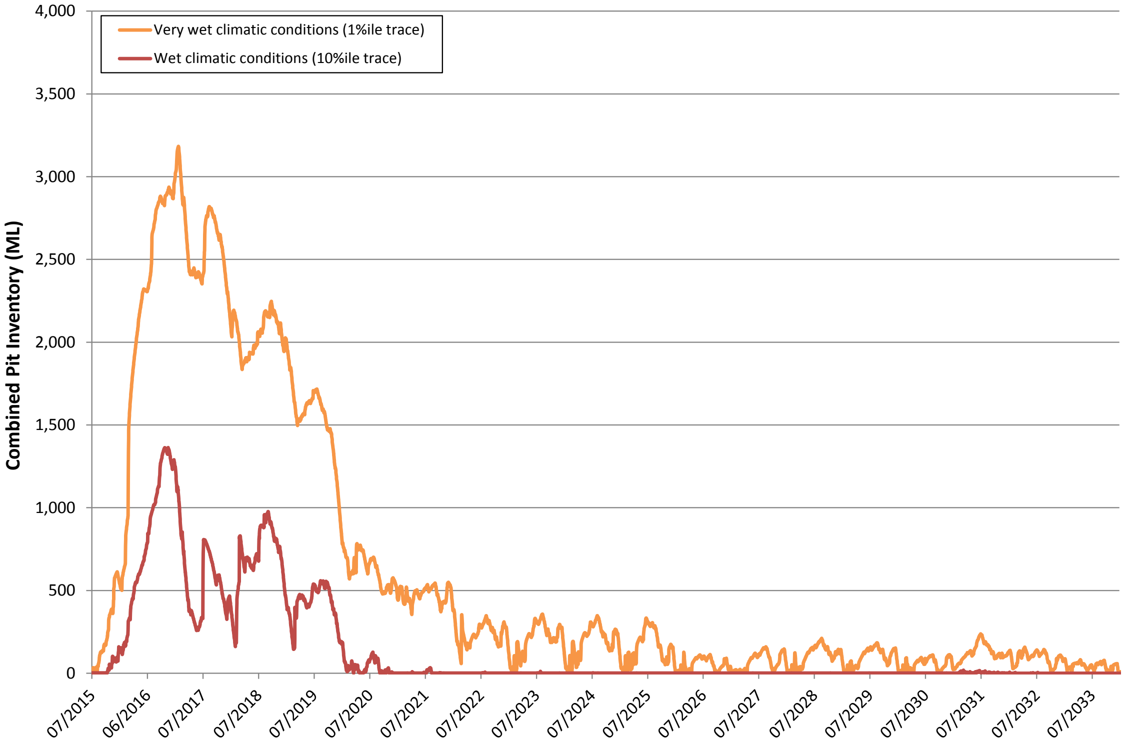



**Figure 7.2 - Forecast pit water inventory**

The modelling results show the following:

- During the simulation period, the 1% ile inventory for:
    - Pit 1N will reach around 420 ML.
    - Pit 2E will reach around 50 ML.
    - Pit 2S will reach around 170 ML.
    - Pit 3 will reach around 450 ML.
    - Pit 4 will reach around 390 ML.
    - Pit 5N will reach around 2000 ML.
    - Pit 5S will reach around 430 ML.
    - Pit 6N will reach around 280 ML.
    - Pit 6S will reach around 65 ML.
    - Pit 7 will reach around 210 ML.
    - Pit 8 will reach around 150 ML.
- During the simulation period, the 10% ile inventory, for,:
    - Pit 1N will reach around 75 ML.
    - Pit 2E will reach around 10 ML.
    - Pit 2S will reach less than 5 ML.
    - Pit 3 will reach around 145 ML.
    - Pit 4 will reach around 210 ML.
    - Pit 5N will reach around 840 ML.
    - Pit 5S will reach around 220 ML.
    - Pit 6N will reach around 150 ML.
    - Pit 6S will reach less than 5 ML.
    - Pit 7 will reach around 100 ML.
    - Pit 8 will reach less than 5 ML.

The predicted operational risk of more than 200 ML of water stored in each of the open pits over the life of the Project (i.e. potential disruption to mining operations) is summarised in Table 7.3.

Table 7.3 - Estimate of Project risk of disruption to mining operations

| Open Cut Pit | Percentage of Days where Volume Stored In-pit is Greater than 200 ML | | |
|---|---|---|---|
| | Median for Modelled Simulations (%) | 95th Percentile for Modelled Simulations (%) | Highest for Modelled Simulations (%) |
| Pit 1 - North | 0.0 | 1.5 | 4.2 |
| Pit 2 - East | 0.0 | 0.0 | 0.0 |
| Pit 2 - South | 0.0 | 0.0 | 0.9 |
| Pit 3 | 0.0 | 2.4 | 5.1 |
| Pit 4 | 0.0 | 3.1 | 5.3 |
| Pit 5 - South | 1.0 | 13.0 | 17.1 |
| Pit 5 - North | 0.0 | 12.6 | 16.1 |
| Pit 6 | 0.0 | 4.5 | 7.0 |
| Pit 7 | 0.0 | 0.0 | 7.6 |
| Pit 8 | 0.0 | 0.0 | 0.2 |

### 7.3.4 External makeup requirements

Water from external sources is to meet operational water demands, primarily during extended dry climatic periods. In addition to the water captured within the water management system from surface runoff within the operational areas and groundwater inflows, water will also need to be sourced from the external sources (such as via the existing/approved WCM borefield).

A key objective of the mine site water management system is to maximise the reuse of on-site surface water runoff and groundwater inflows. Recycling mine water will minimise the volume of water from external sources that is required to satisfy site demands. However, the volume of water captured on site is highly variable dependent upon climatic conditions. Hence, the required makeup water volume from the external sources is likely to vary significantly from year to year.

Figure 7.3 and Figure 7.4 shows the total monthly and annual modelled demand for water from external sources over the 19 year simulation.

The modelling results show that from Year 2020 onwards, up to 130 ML/year may be required from external sources during very dry climatic conditions. This equates to a maximum monthly requirement of up to 35 ML/month. However under most climatic conditions, there is no external water requirement (i.e. external water requirements under both dry and median climatic conditions are zero).

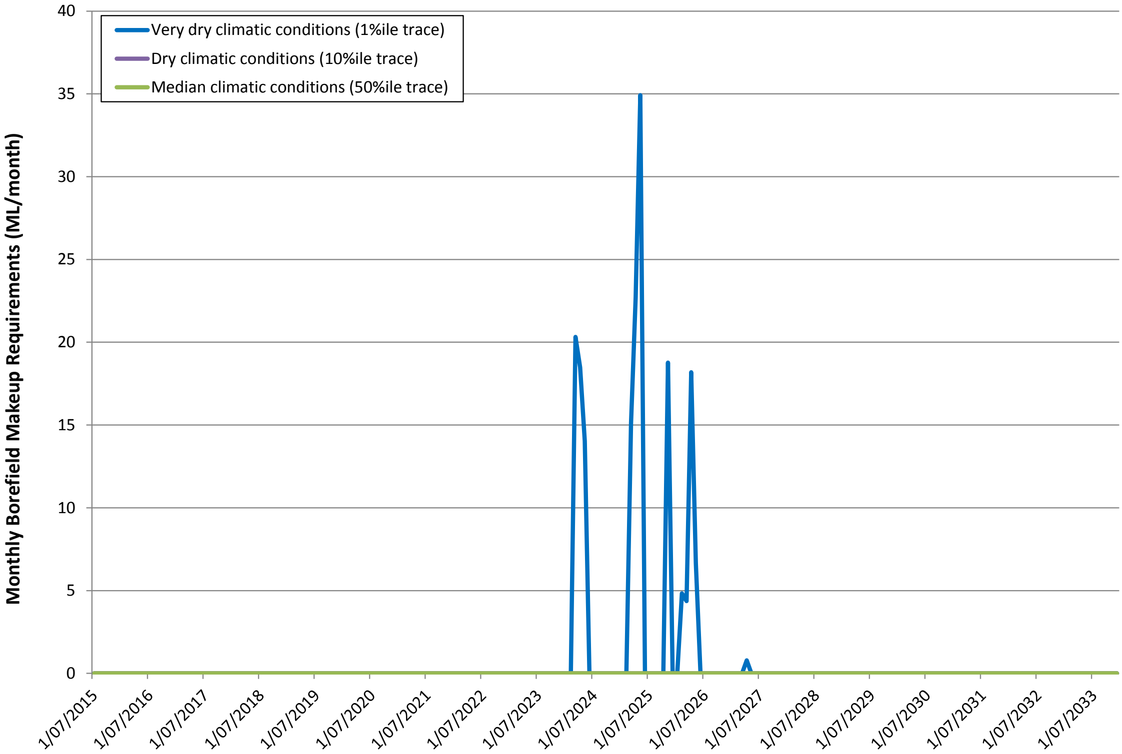



**Figure 7.3 - Forecast monthly external water requirements**

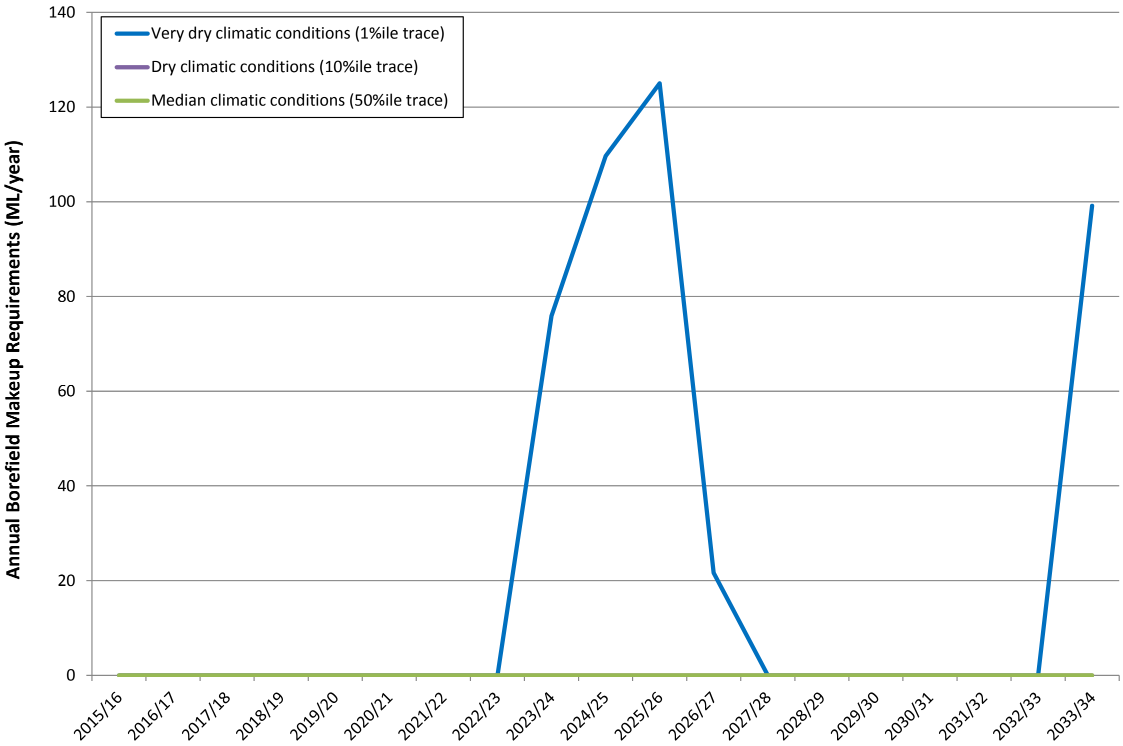



**Figure 7.4 – Forecast annual external water requirements**

### 7.3.5 Reverse osmosis plant discharges

The water balance model is configured to discharge treated water, in accordance with the rules outlined in Section 4.6. The potential for controlled releases from the Project has been assessed using a forecast assessment simulation. The predicted annual controlled discharge volume is provided in Table 7.4 and Figure 7.5. The results show that:

- During both very wet climatic conditions (1%ile) and wet climatic conditions ($10^{th}$ %ile), modelled controlled releases are between 270 ML/year and 1,280 ML/year. Under these climatic conditions, the RO Plant operates almost 100% of the time.
- During median climatic conditions ($50^{th}$ %ile), modelled controlled releases are between 220 ML/year and 1,280 ML/year, with the peak in Year 2031.
- During both dry climatic conditions ($90^{th}$ %ile) and very dry climatic conditions (99%ile), modelled controlled releases only occur in the first three years of the simulation, with a peak annual discharge of around 545 ML/year.

Table 7.4 - Summary of simulated RO Plant discharges

| Operational period | Annual RO Plant discharge (ML/year) | | | | |
|---|---|---|---|---|---|
| | 1%ile | 10%ile | 50%ile | 90%ile | 99%ile |
| Phase 1 (Year 2015-16) | 280 to 790 | 270 to 700 | 270 to 560 | 265 to 545 | 250 to 535 |
| Phase 2 (Year 2017-18) | 1,275 to 1280 | 1,270 to 1,275 | 1,000 to 1,250 | 0 to 540 | 0 to 300 |
| Phase 3 (Year 2019-21) | 1,275 to 1280 | 1,270 to 1,275 | 425 to 770 | 0 | 0 |
| Phase 4 (Year 2022-25) | 1,275 to 1280 | 1,260 to 1,265 | 220 to 410 | 0 | 0 |
| Phase 5 (Year 2026-30) | 1,275 to 1280 | 1,260 to 1,275 | 360 to 660 | 0 | 0 |
| Phase 6 (Year 2031-33) | 1,275 to 1280 | 1,275 to 1,280 | 550 to 1,280 | 0 | 0 |

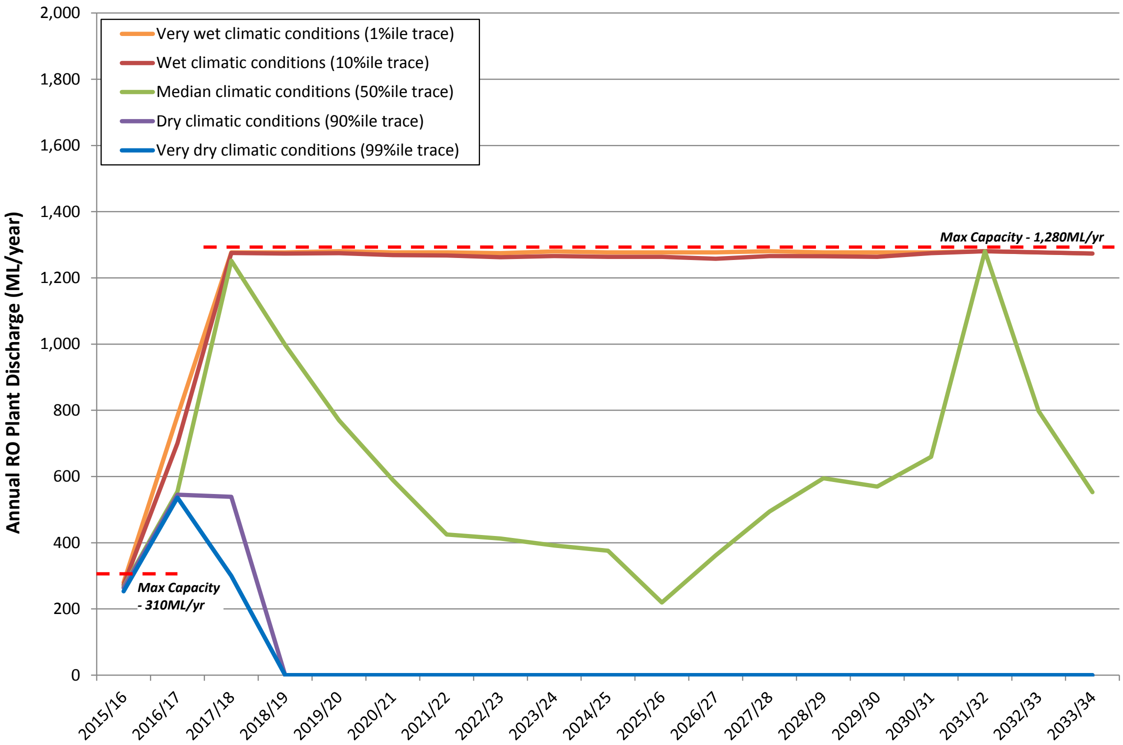



**Figure 7.5 - Forecast annual controlled releases**

### 7.3.6 Uncontrolled spills - mine water system

The model of the water management system has been configured to ensure no uncontrolled discharge of water from mine water storages to the receiving environment. As such, the modelled results show no spills from the mine water system under any climatic scenarios, including during very wet climatic scenarios (1%ile).

### 7.3.7 Sediment dams

As described in Section 5.3, the adopted design standard for sediment dams does not provide 100% containment for captured runoff. Hence, it is possible that overflows will occur from sediment dams if rainfall exceeds the design standard.

The potential for overflows from the proposed sediment dams has been assessed using a forecast assessment simulation. The predicted monthly and annual combined sediment dam overflows is provided in Figure 7.6 and Figure 7.7. The results show that:

- During very wet climatic conditions (1%ile) where rainfall events often exceed the required design standard, modelled sediment dams overflows are between 180 ML/year and 1,470 ML/year (up to 390 ML/month). The majority of the overflows occur in the first 5 to 6 years of the simulation.
- During wet climatic conditions (10%ile) where rainfall events sometimes exceed the required design standard, modelled sediment dams overflows are between 10 ML/year and 575 ML/year (up to 75 ML/month). The majority of the overflows occur in the first 5 to 6 years of the simulation.
- During median climatic conditions (50%ile) where very few rainfall events exceeding the design standard occur, modelled sediment dam overflows are between 0 ML/year and 100 ML/year.
- During both dry climatic conditions (90%ile) and very dry climatic conditions (99%ile) where few or no rainfall events exceeding the design standard occur, modelled sediment overflows are negligible.

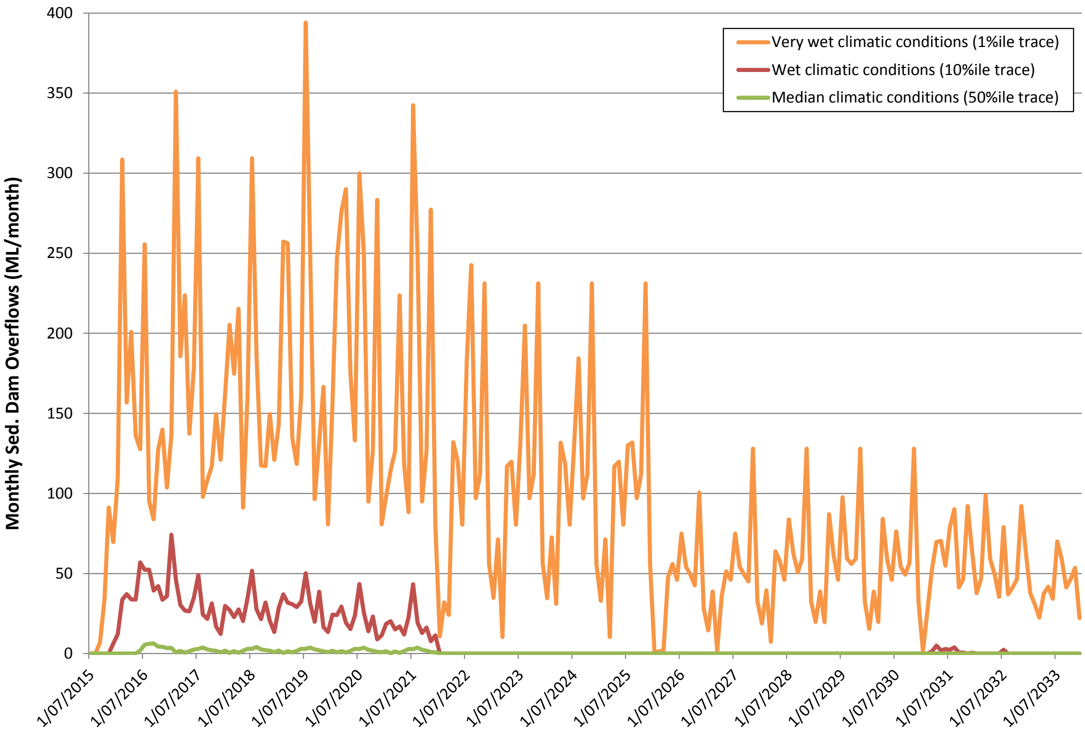



**Figure 7.6 - Forecast monthly sediment dam overflows**

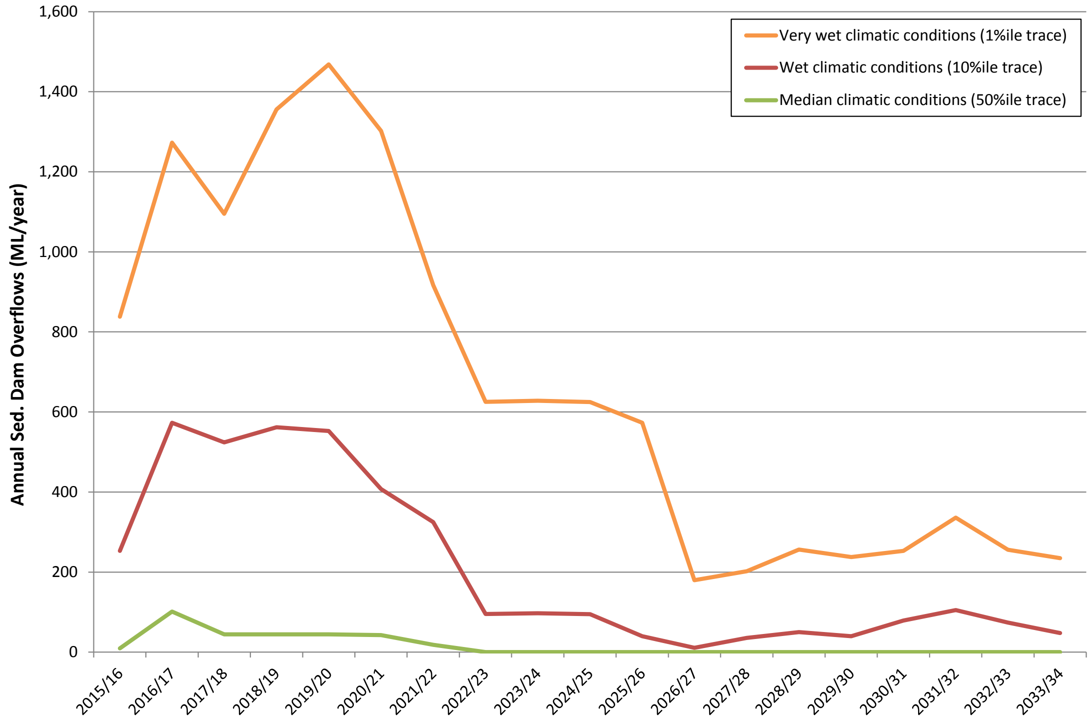



**Figure 7.7 – Forecast annual sediment dam overflows**

### 7.3.8 Surface runoff salt balance

To assess the impact of the Project on the receiving water salt load, the OPSIM model was run as a forecast simulation. Figure 7.8 shows a schematic diagram of the salt inputs and outputs from the Project.

Salt inputs to the Project include salts in the groundwater inflows, catchment runoff, direct rainfall, and external water. Salt outputs from the Project include salts which are lost through the process plant in the product material, site demands (including dust suppression) and offsite discharges RO Plant, overflows from the sediment dam system and runoff from rehabilitated/diverted catchments (there are no modelled offsite discharges of untreated mine water). Salt inflows from direction rainfall were assumed to be zero.

Table 7.5 shows the average annual salt balance for the Project. The results indicate the following:

- the largest contributor to the Project salt load is from runoff, however the groundwater inflows also contribute significant salt load to the Project; and
- net loss from the CHPP demand and dust suppression usage contributes the greatest salt loss from the Project.

An assessment of the impacts of the Project on total salt loads delivered to receiving waters is provided in Section 8.3.3.

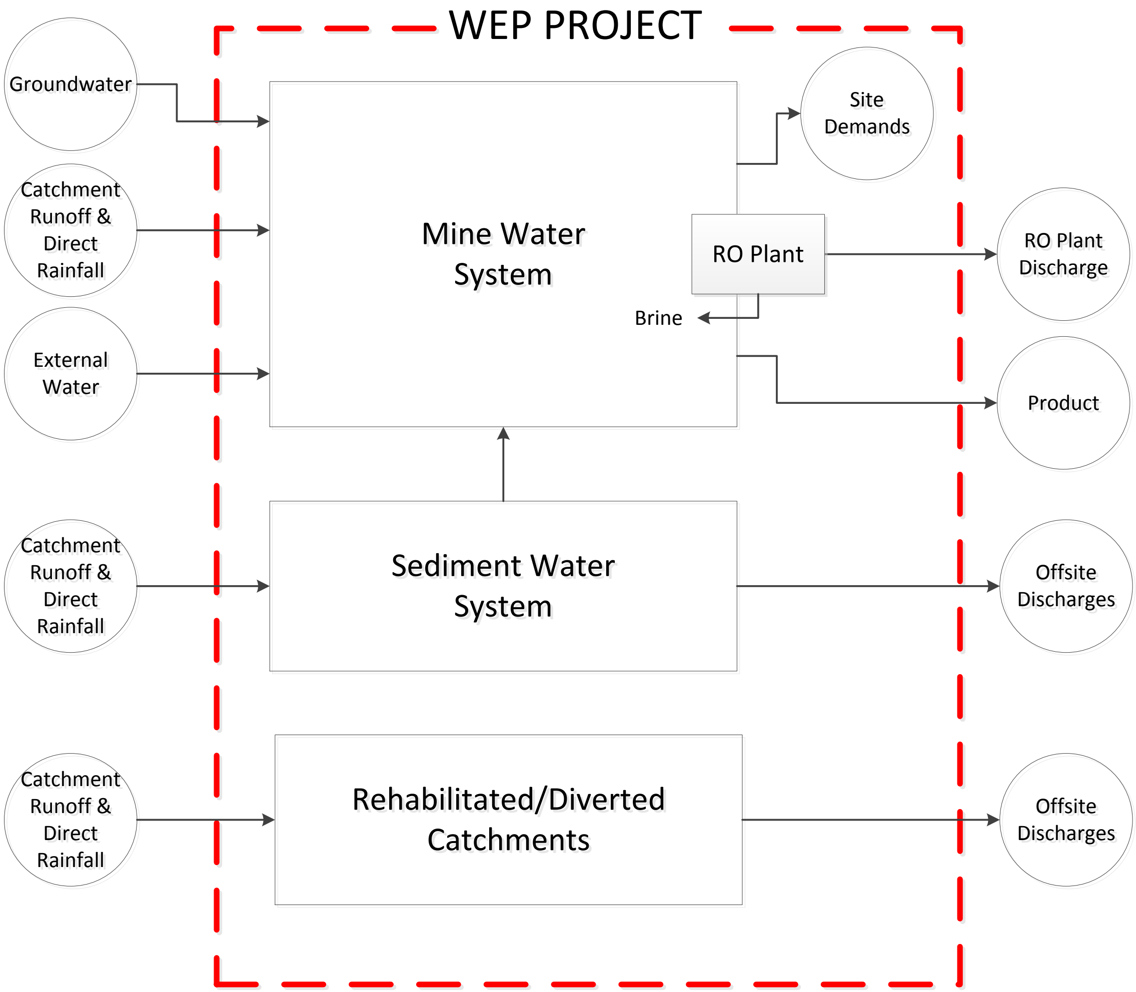



Figure 7.8 - Project surface water salt load schematic

Table 7.5 - Average annual salts balance during the Project - all realisations

| | Year 2016 | Year 2018 | Year 2020 | Year 2024 | Year 2028 | Year 2031 |
|---|---|---|---|---|---|---|
| **Salt inputs (tonnes/year)** | | | | | | |
| Catchment Runoff | 4,558 | 5,140 | 5,395 | 5,310 | 4,633 | 4,763 |
| Direct Rainfall | 0 | 0 | 0 | 0 | 0 | 0 |
| Groundwater inflows | 2,919 | 2,772 | 1,939 | 1,296 | 1,446 | 569 |
| External water supply | 0 | 0 | 0 | 7 | 2 | 6 |
| **GROSS SALT INPUTS** | **7,477** | **7,912** | **7,334** | **6,613** | **6,081** | **5,338** |
| **Salt outputs (tonnes/year)** | | | | | | |
| Evaporation from water storages | 0 | 0 | 0 | 0 | 0 | 0 |
| ***Onsite salt disposal or loss*** | | | | | | |
| CHPP demand | 805 | 1,742 | 1,908 | 1,916 | 1,431 | 1,791 |
| Dust suppression demand | 724 | 1,952 | 2,736 | 3,084 | 2,123 | 4,459 |
| ***Total*** | ***1,529*** | ***3,694*** | ***4,644*** | ***5,000*** | ***3,554*** | ***6,250*** |
| ***Offsite salt flux*** | | | | | | |
| RO Plant discharge | 134 | 474 | 332 | 227 | 258 | 369 |
| Storage overflows - mine water dams | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage overflows - sediment dams | 359 | 481 | 439 | 137 | 68 | 73 |
| Outflows- rehabilitated catchments | 0 | 126 | 569 | 975 | 929 | 1,188 |
| Outflows- diverted catchments | 184 | 327 | 353 | 253 | 142 | 64 |
| ***Total*** | ***677*** | ***1,408*** | ***1,693*** | ***1,592*** | ***1,397*** | ***1,694*** |
| **GROSS SALT OUTPUTS** | **2,206** | **5,102** | **6,337** | **6,592** | **4,951** | **7,944** |
| **Salt retained on site (tonnes/year)** | | | | | | |
| Change in salt storage in WMS structures | 5,271 | 2,810 | 997 | -21 | 1,130 | -2,606 |

## 7.4 MODEL SENSITIVITY

The sensitivity analysis presented in Appendix A examined the sensitivity of the performance of the water management system in terms of:

- overall site water balance;
- mine water inventory;
- in-pit storage;
- external raw water requirements;
- RO plant discharges;
- potential for uncontrolled spillway discharges from mine water dams; and
- sediment dam overflows.

The model of the water management system has been configured to ensure no uncontrolled discharge of water from mine water storages to the receiving environment. As such, all sensitivity run outcomes show no spills from the mine water system.

The key modelling results from the sensitivity assessment are provided in Appendix A. The main differences in results (with respect to the performance of the water management system) are generally associated with changes in in-pit storage, external water requirements and RO plant discharges.

A summary of the modelling outputs for the 1 and 10$^{th}$ percentile results are provided in Table 7.6.

Table 7.6 - Summary of sensitivity analysis results

| Scenario | Peak in-pit inundation volume (ML) | | Peak annual external supply volume (ML) | | Peak annual RO discharge volume (ML) | |
|---|---|---|---|---|---|---|
| | 1% ile | 10% ile | 1% ile | 10% ile | 1% ile | 10% ile |
| Base case | 3,180 | 1,365 | 125 | 0 | 1,280 | 1,280 |
| Increased groundwater (+10%) | 3,290 | 1,440 | 135 | 0 | 1,280 | 1,280 |
| Decreased groundwater (-10%) | 3,050 | 1,320 | 270 | 0 | 1,280 | 1,280 |
| Increased rejects MC (+10%) | 3,030 | 1,330 | 430 | 0 | 1,280 | 1,280 |
| Decreased rejects MC (-10%) | 3,265 | 1,450 | 85 | 0 | 1,280 | 1,280 |
| High runoff (+7.5%) | 3,390 | 1,605 | 125 | 0 | 1,280 | 1,280 |
| Low runoff (-3%) | 2,880 | 1,225 | 175 | 0 | 1,280 | 1,280 |

The sensitivity analysis results indicate the following:

- The peak in-pit inundation volume for the 1 percentile result ranges between 2,880 ML and 3,390 ML, compared with the base case volume of 3,180 ML. This equates to a variation of +/- 10%. The highest peak in-pit inundation volume occurs for the high runoff scenario.
- The peak in-pit inundation volume for the 10$^{th}$ percentile result ranges between 1,225 ML and 1,605 ML, compared with the base case volume of 1,365 ML. This equates to a variation of +17.5% /- 10%. The highest peak in-pit inundation volume also occurs for the high runoff scenario.

- The peak annual external water supply volume for the 1 percentile result ranges between 85 ML and 430 ML, compared with the base case volume of 125 ML. The highest peak annual external water supply volume occurs for the increased rejects moisture content scenario.
- The peak annual external water supply volume for the 10th percentile result is zero for all scenarios.
- For both the 1 and 10th percentile results, the peak annual RO discharge volume is 1,280 ML under all scenarios. This represents the RO plant running at full capacity during wet climatic conditions, regardless of the scenario.
- There are no discharges from mine water storages to the receiving environment under any scenario.

The sensitivity analysis results do not indicate significant variation in water management system performance (compared to the base case) as a result of varying groundwater inflows, rejects moisture content and runoff parameters. The proposed water management system generally operates in a similar manner as for the base case.

# 8 Impact assessment

## 8.1 POTENTIAL IMPACTS

The potential incremental impacts of the Project on surface water resources include:

- a reduction in regional water availability due to capture of runoff within onsite storages and the open cut pits; and
- adverse impacts on the quality of surface runoff draining from the disturbance areas to the various receiving waters surrounding the Project, during both construction and operation of the Project.

An assessment of each of these potential impacts of the Project is provided in the following sections.

The assessment of surface water impacts has been undertaken based on commonly applied methodologies for the simulation of hydrologic and hydraulic processes using currently available data. The adopted approach is considered suitable for quantifying impacts to a level of accuracy consistent with current industry practice.

## 8.2 REGIONAL WATER AVAILABILITY

### 8.2.1 Wollar Creek Water Source

Water taken from the Wollar Creek Water Source by the Project is required to be licensed by way of a water access licence under the HUAWSP.

Schedule 5 of the Water Management (General) Regulation 2011 provides a number of exemptions for requiring a water access licence for taking water from a water source.

### 8.2.2 Excluded Works

Schedule 5, clause 12 of the Water Management (General) Regulation 2011 provides that a water access licence is not required for water take by an “excluded work” as outlined in Schedule 1.

Schedule 1 lists a number of exemptions, two of which potentially apply to this Project:

- Dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice to prevent the contamination of a water source, that are located on a minor stream.
- Dams solely for the control or prevention of soil erosion:

  (a) from which no water is reticulated (unless, if the dam is fenced off for erosion control purposes, to a stock drinking trough in an adjoining paddock) or pumped, and

  (b) the structural size of which is the minimum necessary to fulfil the erosion control function, and

  (c) that are located on a minor stream.

All streams potentially diverted by the Project open cut extensions are 2$^{nd}$ order and below (as shown in Figure 3.4). On this basis, all water captured in the site water management system is considered to be exempt from licencing requirements.

It is noted that small parts of undisturbed catchment would lie between the proposed up-catchment diversion structures and the progressive extent of the Project disturbance boundary. However, given the site-specific issues with constructing up-catchment diversion structures (e.g. the suitability of in-situ sandy soils in some areas and the associated engineering and materials selection and placement that may be required for these diversions), the proposed approach of establishing engineered diversions that would remain for extended periods until rehabilitated areas are suitable to become free draining is considered best practice.

Notwithstanding the above, consideration of Peabody's potentially available harvestable rights, and a comparison to a conservative assumption that the excluded works exemptions are not applied to the areas between the ultimate extent of the Project disturbance boundary and the proposed up-catchment diversion structures, is presented in Section 8.2.3.

### 8.2.3 Harvestable Rights

Under the WM Act, landholders in most rural areas are permitted to collect a proportion of the 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 runoff for their landholding without requiring a licence. The harvestable rights provisions are based on the assumption that the dam capacity is the same as this portion of the annual runoff.

The DPI Water Harvestable Rights calculator estimates the harvestable right dam capacity at the Project site as 0.07 ML/ha.

Considering Peabody's total contiguous landholdings of 18,500 ha (see Figure 8.1) and a harvestable rights multiplier value for the region of 0.07 ML/ha, the total harvestable right potentially available to Peabody is 1,295 ML.

Peabody's landholding includes approximately 450 existing farm dams (see Figure 8.1) with an estimated combined total surface area of 24.2 ha. Based on an average depth of 1.5 m, the total capacity of existing farm dams is estimated at 363 ML. Of this capacity, approximately 60 ML is held in dams within the proposed mining area. Subtracting the capacity of farm dams (300ML) from the harvestable right leaves an available harvestable rights volume of 995 ML.

The undisturbed area between the proposed up-catchment diversion structures and the ultimate extent of the Project disturbance boundary is estimated at maximum to be approximately 5.1 $km^2$. Applying the DPI Water runoff coefficient to the maximum historical annual rainfall (1,096 mm, which occurred in the 1949/1950 water year) gives an estimated maximum annual runoff depth of 117 mm. The estimated maximum annual volume of undisturbed area runoff captured and requiring licensing is therefore 598 ML/year.

Based on this conservative evaluation, even if this runoff water was captured by the Project under the maximum historical rainfall water year it would still fall within the estimated Harvestable Right available to Peabody and would not require licensing.

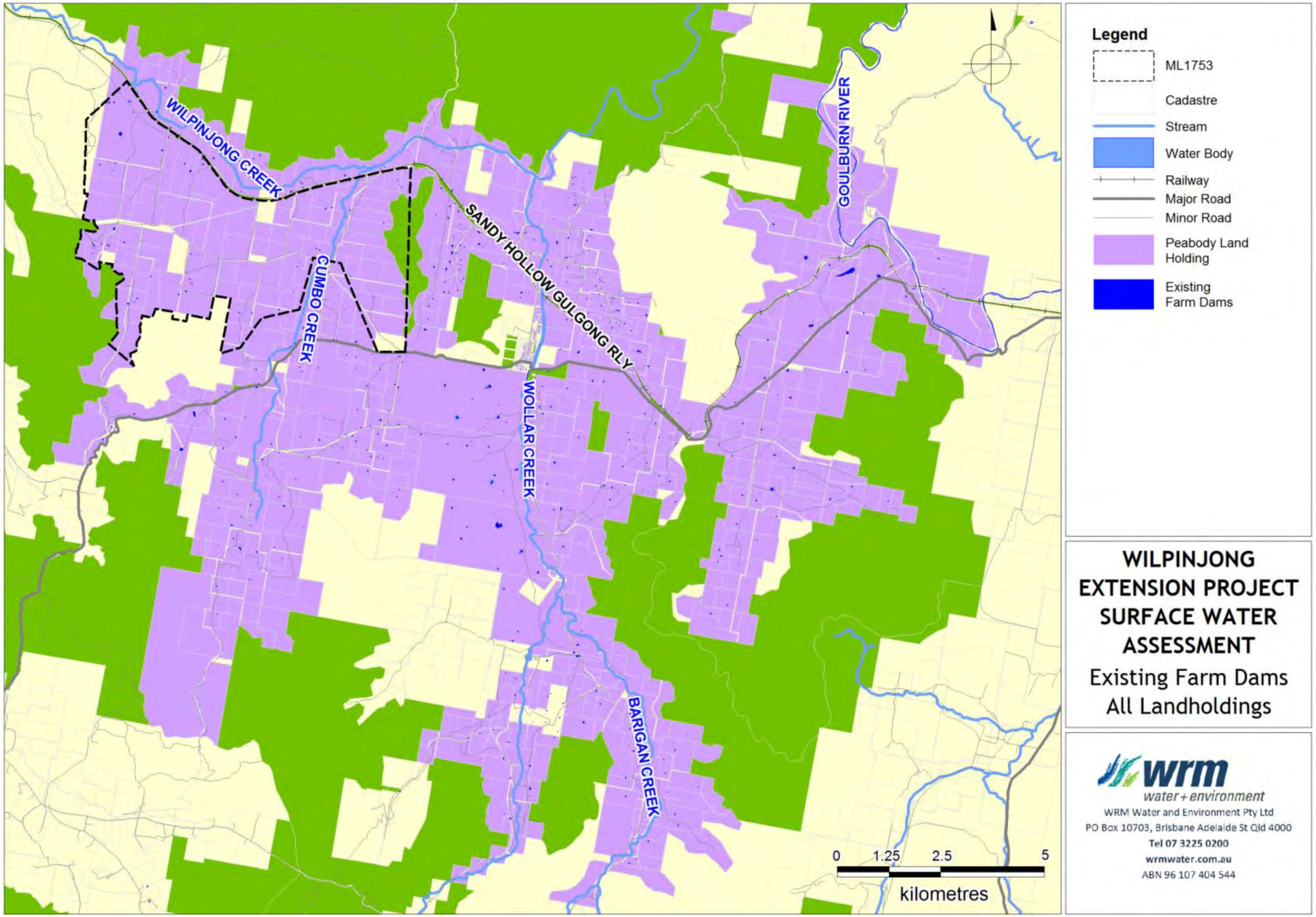



**Figure 8.1 – Existing landholdings for estimation of Harvestable Rights**

## 8.3 WATER QUALITY IMPACTS

### 8.3.1 Construction impacts

Key activities during construction of the Project will include land clearing and earthworks associated with construction of haul roads, public road relocations, ETL relocations and mine infrastructure areas. The potential impacts during construction of the Project primarily relate to the potential for release of sediment in surface runoff due to land disturbance from construction activities. The management of surface runoff during construction of the Project will be in accordance with a Construction Water Management Plan (CWMP). The CWMP will identify the erosion and sediment control measures to be implemented on the site, taking into account the staging of construction works. The CWMP will also identify requirements for storage of fuels and other potential contaminants to minimise the risk of release of other pollutants.

Water use from construction activities will be very small compared to the operational water requirements. All water required for construction will be obtained from the site water management system or appropriately licensed groundwater bores.

### 8.3.2 Operational impacts

The results of the water balance modelling indicate that under the current model assumptions and configuration, there are no uncontrolled spills of mine-affected water. Therefore the mine water management system is sufficient to prevent adverse impacts on the environmental values of the receiving waters.

Some overflow of water from sediment dams may occur during wet periods that exceed the design standard of the sediment control system (see Section 5.3.1). In some cases these overflows would report to the pit and in others, depending on the status of mining and rehabilitation in the area, these overflows would flow to the surrounding environment. Overflows would only occur during significant rainfall events which will also generate runoff from surrounding undisturbed catchments. Hence, it is unlikely that sediment dam overflows will have a measurable impact on receiving water quality.

Water treated in the RO plant will continue to be released to Wilpinjong Creek in accordance with the EPL. The existing EPL criteria has been selected such that the released water will generally be better than the receiving water quality. Given the EPL limit of 500 µS/cm is much lower than baseline salinity downstream in Wilpinjong Creek, there may be opportunity to raise the limit in future without causing a downstream impact on water quality.

With the implementation of management measures in the existing WCM WMP, the potential adverse impacts of the Project on downstream water quality would be too small to measure.

### 8.3.3 Surface water salt load impacts on receiving catchments

The surface water salt load to the receiving environment could potentially be impacted in two ways:

- an increase in salt load due to overflows from dams containing salts accumulated from saline overburden and groundwater inflows; and
- a reduction in salt loads due to the capture of salt in catchment runoff intercepted by the water management system.

Sediment dams would only spill following extended periods of significant rainfall that exceed the dam design criteria. Under these conditions, it is likely that the quality of water collected in sediment dams would be improved by fresh surface runoff inflows, and the total impact on downstream salinity will be small.

The water model balance results show that the untreated mine water is unlikely to flow into the receiving environment. It is therefore likely that salt will accumulate within the water management system, and the total salt load released from the Project to the receiving environment during operations will be less than that released by pre-mine conditions.

Runoff from rehabilitated areas would continue to be captured by sediment dams until water quality is within the range of water quality recorded from analogue sites and does not pose a threat to downstream water quality. Therefore, the total salt load released from the final landform to the receiving environment would be generally consistent with pre-mine conditions.

### 8.3.4 Geochemistry

A Geochemistry Assessment was conducted for the Project by GEM (2015).

The results of the Geochemistry Assessment indicate that the waste rock and coal rejects generated from the Project would have similar geochemical characteristics as those generated by the existing/approved WCM (GEM, 2015).

The analysis of water extracts from selected waste rock samples indicated most metals would be relatively insoluble under the prevailing neutral to slightly alkaline pH conditions. Molybdenum (Mo) and selenium (Se) are however likely to be soluble under these prevailing pH conditions (GEM, 2015).

The Geochemistry Assessment (GEM, 2015) concluded that the waste rock materials generated from the Project would typically be neutral to slightly alkaline and generally non-saline.

The overburden is expected to range from non-sodic to moderately sodic (GEM, 2015).

The Geochemistry Assessment (GEM, 2015) concluded that the waste rock materials generated from the Project would generally be expected to be non-acid forming (NAF). The acid base accounting test work indicates however that a small quantity of overburden associated with the lower plies of the Ulan Seam would be potentially acid forming and coal from the Goulburn and Turill Seams would be potentially acid forming or potentially acid forming-low capacity (GEM, 2015).

The Geochemistry Assessment (GEM, 2015) recommends the following management strategies and monitoring:

- Development of a testing program to confirm the waste rock scheduled to be placed within the final outer surface of the back-filled mine voids (i.e. outer 2 m) and the elevated waste rock emplacement (i.e. outer 5 m) is NAF.
- Continued pH monitoring of the decant water in the tailings dams. If acid generation is observed, alkali material (i.e. crushed limestone, agricultural lime) should be added to the surface of the tailings at an application rate adequate to neutralise the generated acid.
- Continued testing of the coarse reject and tailings in accordance with the WCM Life of Mine Tailings Strategy to confirm the geochemical characteristics of these materials and the co-disposal material.
- Inclusion of total alkalinity/acidity, arsenic (As) and Mo into the existing water quality monitoring regime for the WCM.

Based on the successful implementation of management strategies and monitoring recommended in the Geochemistry Assessment (GEM, 2015), the risk of elevated dissolved solids and other contaminants impacting downstream waters is considered to be low.

## 8.4 FINAL LANDFORM

Where relevant, the existing WCM Rehabilitation objectives would be modified or built upon for the Project. As a result, the proposed post mining final landform plan (at the completion of mining) is generally consistent with the approved final landform for the WCM.

Therefore, the risk of potential geomorphological changes to Wilpinjong and Wollar Creeks due to the Project final landform is considered to be negligible.

The key difference between the approved final landform and the proposed final landform associated with the Project, is the location and catchment areas of the final voids. Accordingly, a final void analysis is presented in Section 8.4.1.

### 8.4.1 Final voids

At the completion of mining, final voids will be retained at Pit 6, Pit 2 West and Pit 8 (see Figure 8.2). The landform will be shaped to minimise the surface water catchment draining to each void.

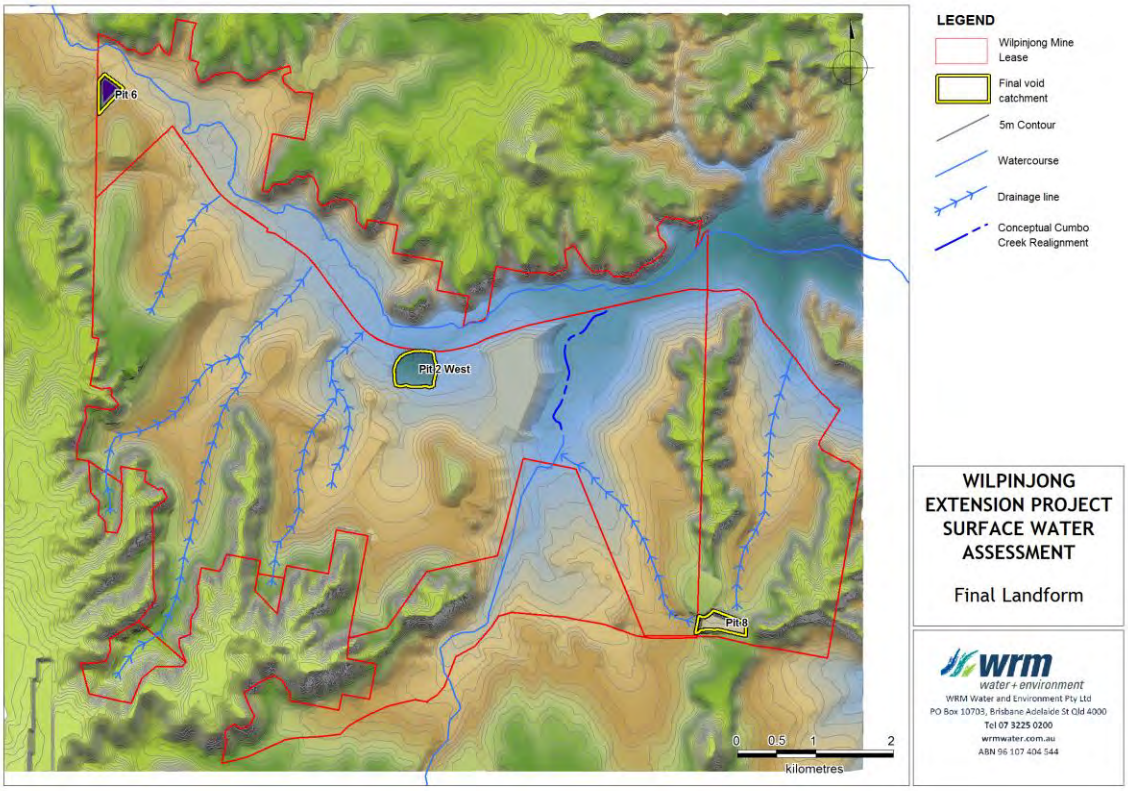



**Figure 8.2 – Locations of final voids**

The accumulation of surface runoff combined with groundwater inflows may result in the formation of a pond of water in the void which will rise until the average rate of inflow is balanced by evaporation from its surface.

The long-term behaviour of the voids was simulated using the OPSIM software. Groundwater inflows and outflows were modelled using storage level vs flow relationships developed from the groundwater model by HydroSimulations. Evaporation has been calculated on a daily time step from the daily water surface area and is adjusted for salinity using Morton's equation.

The simulated water level in Pit 8 reaches a maximum of approximately 2 m, which is 33 m below the crest of the void. The void would regularly be dry during periods of low rainfall.

The results in Figure 8.3 to Figure 8.4 show that void water levels in Pit 2 and Pit 6 are expected to reach equilibrium within approximately 100 years. To confirm whether the surface water system in the voids have stabilised within the simulation period (267 years), the OPSIM simulation period was extended by another 200 years by looping the data drill rainfall and evaporation data. The results confirm that predicted pit water levels have stabilised within the original simulation period (267 years based on the time from the end of the mine life to the year 2300). The maximum void water levels are expected to be well below the crest of the void.

Surface and groundwater inflows will also bring salt into the voids over the long term. The salinity of the ponds will gradually increase over time – and eventually reach very high levels.

The Pit 2 West void pond will have a significantly larger surface area than the Pit 6 void pond, resulting in significantly higher water surface evaporation, and a lower equilibrium water depth. The Pit 2 West will reach an equilibrium at a stored volume near 375ML, around half of that for Pit 6 (750ML).

Groundwater inflows (a key source of salt inflows) to Pit 2 West are predicted to be higher than for Pit 6 (60kL/day instead of 20kL/day at equilibrium), due partly to the lower ponded water depths. The combination of higher salt inflows and lower stored water volumes are therefore expected to result in significantly higher long-term salinities in Pit 2 West void than in Pit 6 void.

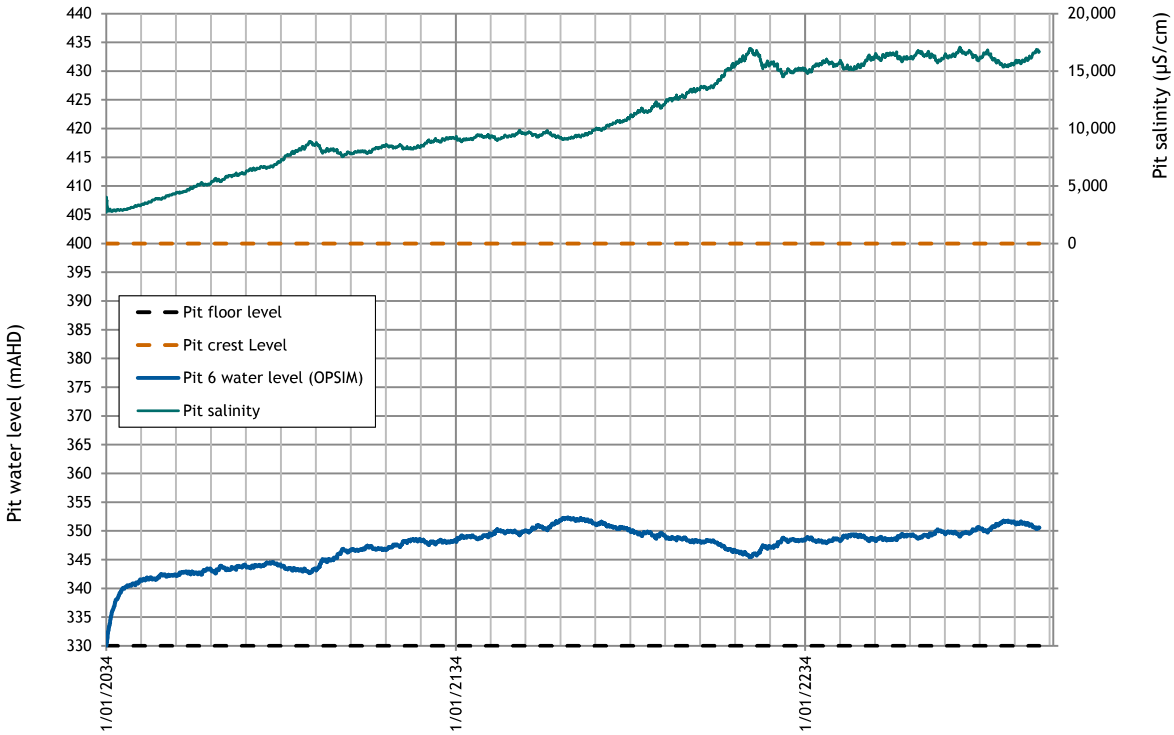



**Figure 8.3 – Modelled water level and salinity in Pit 6**

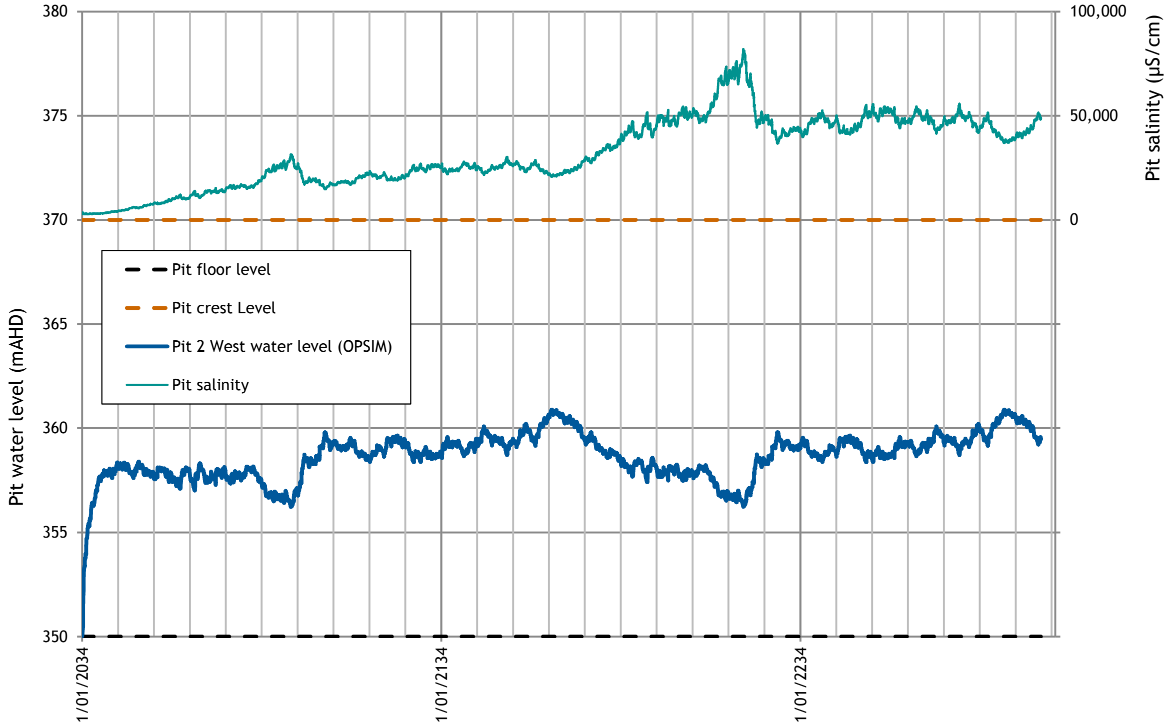



**Figure 8.4 – Modelled water level and salinity in Pit 2 West**

## 8.5 FLOW REGIME IN RECEIVING WATERS

During active mining operations, the mine water management system would continue to capture runoff from areas that would have previously flowed to the receiving waters of Wilpinjong Creek, Cumbo Creek and Wollar Creek.

Previous assessment indicated that the maximum catchment area intercepted by the existing/approved WCM is 24.1 $km^2$ (Gilbert & Associates, 2013). Under the modified water management system for the Project, the catchment area of the containment system will peak in 2018 at 23.8 $km^2$.

In practice, during operations, continued approved releases from the RO plant are likely to significantly compensate for catchment excision losses, and during dry periods releases will typically continue to result in an increase in flows downstream of the mine.

The expected maximum catchment area loss will gradually reduce as the area captured in the water management system reduces over time. Table 8.1 shows the residual catchment area captured at the completion of active mining operations (i.e. reporting to the approved final voids).

Table 8.1 – Catchment area captured at end of mine life

| Catchment | Total Catchment Area ($km^2$) | Existing/ Approved WCM ($km^2$) | WCM including the Project (km2) | Increase in Excised Catchment due to the Project ($km^2$) |
|---|---|---|---|---|
| Wilpinjong Creek to Wollar Creek confluence | 213.8 | 0.2 | 0.3 | 0.1 |
| Cumbo Creek to Wilpinjong Creek confluence | 69.3 | 0.1 | Nil | Nil |
| Wollar Creek to Goulburn River confluence | 530.6 | 0.2 | 0.3 | 0.1 |
| Goulburn River to Hunter River confluence | 7,965 | 0.2 | 0.3 | 0.1 |

The expected reduction in groundwater baseflow to nearby streams due to the Project is predicted to peak post mining (HydroSimulations 2015). The maximum post mining baseflow reductions modelled by HydroSimulations (2013 and 2015) are presented in Table 8.2. The use of these values is considered conservative as the maximum baseflow losses are a temporal impact and baseflow losses would be lower under some flow conditions. The table shows the approved WCM operations are expected to result in a reduction of post-mining groundwater baseflow of 0.37ML/day. The Project is expected to slightly further reduce groundwater baseflow downstream of the site.

Table 8.2 – Modelled groundwater baseflow Loss (HydroSimulations, 2013 and 2015)

| Catchment | Existing/ Approved WCM (ML/day) | WCM including the Project (ML/day) | Increase in Baseflow Loss due to the Project (ML/day) |
|---|---|---|---|
| Wilpinjong Creek to Wollar Creek confluence | 0.37 | 0.37 | Nil |
| Wollar Creek to Goulburn River confluence | 0.37 | 0.40 | 0.03 |
| Goulburn River to Hunter River confluence | 0.37 | 0.41 | 0.04 |

The predicted maximum effect of runoff capture and potential reduction of baseflow on flow frequency in Wilpinjong Creek (at the confluence with Wollar Creek) is presented on Figure 8.5. The flow frequency curves have been developed using the AWBM model, which is calibrated to flow data in Wilpinjong Creek from 2012-2014. The WCM is estimated to result in approximately 37% more days with less than 0.1 ML/day flow relative to pre-mining conditions. However, the WCM results in negligible changes to the frequency of higher flows (e.g. greater than 1 ML/day). The maximum incidence of days with less than 0.1 ML/day flow for the WCM (incorporating the Project) would be effectively unchanged from the impacts of the existing/approved WCM. The Project would therefore have no measurable incremental impact on flow in Wilpinjong Creek.

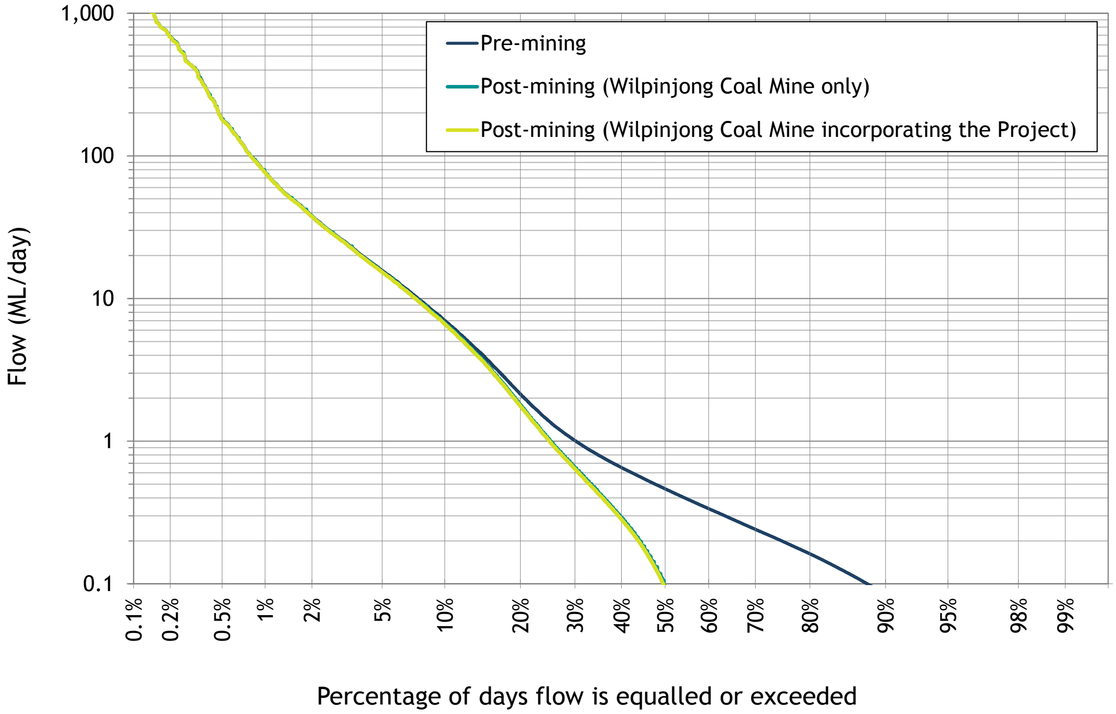



**Figure 8.5 – Wilpinjong Creek flow frequency**

While the Project is anticipated to have some small incremental increase in the baseflow losses of Wollar Creek and the Goulburn River (Table 8.2), the significant additional catchment of these larger streams means potential impacts on flow frequency are expected to be negligible.

The WCM (incorporating the Project) is located outside the Murragamba, Cooyal and Moolarben Creek catchments. HydroSimulations (2015) concludes that baseflow the Project would have negligible impacts on baseflow in these creeks. The Project would therefore have negligible impacts on flow frequency in these creeks.

There are no private surface water users on Wilpinjong or Wollar Creeks downstream of the WCM. Any impact on other private water users (i.e. downstream on the Goulburn River) will be too small to measure.

No change to the maximum daily volume of water approved to be discharged under EPL 12425 is currently proposed for the Project. Therefore the Project is not expected to cause impacts on downstream flows or the morphology of Wilpinjong Creek beyond the potential impacts of the existing approval.

Potential reductions to baseflow in Wilpinjong Creek are within Peabody's existing Water Access Licence entitlements under the HUAWSP, which could be retired at the completion of the Project.

## 8.6 FLOOD IMPACTS

There are no private landholders located in the vicinity of the WCM on either Wilpinjong or Wollar Creeks.

As described in Section 3.8, all Project open cut extensions would be outside the extent of flooding in the 1 in 1,000 AEP flood event, and the Project is therefore unlikely to affect flood conditions.

The Project open cut extensions are not located within the extent of flooding in the 1 in 1,000 AEP design flood. The proposed connection of the realigned TransGrid Wollar to Wellington 330 kilovolt ETL to the existing ETL, and relocation of the Ulan-Wollar road, are located with the 1 in 1,000 AEP design flood extent. However, this infrastructure is already located within the 1 in 1,000 AEP flood extent and therefore the relocation of these elements for the Project is not anticipated to have any impact on flood levels or velocity during events up to and including the 1 in 1,000 AEP flood.

## 8.7 CLIMATE CHANGE

Consideration of the potential implications of climate change involves complex interactions between climatic, biophysical, social, economic, institutional and technological processes.

The weight of scientific opinion supports the proposition that the world is warming due to the release of emissions of carbon dioxide and other greenhouse gases from human activities including industrial processes, fossil fuel combustion, and changes in land use, such as deforestation (Pew Centre on Global Climate Change, undated).

Although understanding of climate change has improved markedly over the past several decades, climate change projections are still subject to uncertainties such as (CSIRO, 2015):

- scenario uncertainty, due to the uncertain future emissions and concentrations of greenhouse gases and aerosols;
- response uncertainty, resulting from limitations in our understanding of the climate system and its representation in climate models; and
- natural variability uncertainty, the uncertainty stemming from unperturbed variability in the climate system.

The following sources for climate change projections have been considered for the WEP:

- Climate Change in Australia (CCiA), produced by CSIRO and the Australian Bureau of Meteorology.

- The NSW and ACT Regional Climate Modelling (NARCliM) Project is a research partnership between the NSW and ACT governments and the Climate Change Research Centre at the University of NSW.

The CCiA report presents climate change projections for Australia. The NARCliM Project presents climate change projections for NSW and ACT only. The WEP is located in the 'Eastern Australia' region for the CCiA Project and the 'Central West' region for the NARCliM Project.

High global emission scenario projections for annual average rainfall are presented in Table 8.3, which indicates that the NARCliM (2015) and CSIRO (2015) rainfall projections are quite variable, particularly for the 2080/2090 forecast. CSIRO (2015) are projecting a drier climate whereas NARCliM (2015) are projecting a generally wetter climate.

Table 8.3 – Climate change projections – percentage change in rainfall

| Period | NARCliM Projections | | CSIRO Projections | | |
|---|---|---|---|---|---|
| | 2020-2039 | 2060-2079 | 2030^ | 2090^ | 2090* |
| Summer | -1.1 | +13.2 | -2.0 | -2.0 | 4.0 |
| Autumn | +14.7 | +13.5 | -4.0 | -7.0 | -8.0 |
| Winter | -4.2 | +5.4 | -3.0 | -10.0 | -16.0 |
| Spring | -7.6 | -5.8 | -2.0 | -10.0 | -16.0 |
| Annual | +0.2 | +7.6 | -1 | -7.0 | -10.0 |

^ Emissions under the RCP4.5 scenario which assumes a slow reduction in emissions that stabilises $CO_2$ concentration at about 540 parts per million (ppm) by 2100.
* Emissions under the RCP8.5 scenario which assumes an increase in emissions leading to a $CO_2$ concentration of about 940 ppm by 2100.

The implications of climate change predictions on water management are unlikely to be significant over the Project life because they are small relative to high natural climatic variability.

Longer term climate change predictions do however have potential implications for post mine water management and specifically the water balance of the final voids.

A reduction in overall rainfall would translate to reduced surface water runoff inflows to the voids and reduced incident rainfall over the surface of the voids. As a consequence there would be a lower average water level in the void and no increased risk of spill.

In the event of an overall increase in rainfall, the average water level in the void would be expected to increase. However, given the large simulated freeboard in each of the WEP pit voids (Section 8.4.1), the mild predicted increase in rainfall under the NARCliM 2060 – 2079 predictions (i.e. maximum of 7.6%) would result in negligible increase to the risk of spill.

The CCiA report describes that, by 2030, warming (for mid-range global emission scenarios) is projected to be about 0.6 to 1.3 degrees Celsius (°C) over most of Australia, with slightly less warming in some coastal areas, and slightly more warming inland (CSIRO, 2015). By 2090, annual average temperatures are projected to increase by 0.6 to 5.1°C with spatial variations similar to those for 2030 (CSIRO, 2015) depending on the emission scenarios examined. This is generally consistent with the findings of the NARCliM (2015) report which describes that mean temperatures in the Central West area are projected to rise by 0.7°C by 2030 and 2.1°C by 2090. The increases are occurring across the region with the greatest increase during summer (NARCliM, 2015).

In the long term, higher temperatures would result in a higher rate of evaporation. As a consequence there would be a lower average water level in the void and no increased risk of spill.

The 1 in 1,000 AEP design flood, which has been considered in this assessment, provides a more conservative assessment than the 1 in 200 year and 1 in 500 year flood levels recommended by OEH as proxies for climate change.

Further sensitivity testing for key site water balance parameters has been conducted and is described in Appendix A.

## 8.8 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

Based on the detailed assessment presented above, and in consideration of the IESC Information Guideline Requirements and the Significant Impact Guidelines 1.3 (Commonwealth of Australia, 2013), the action (as defined in Section 2.5) would not result in significant changes to the quantity or quality of water available to third party uses or the environment.

Accordingly, the action would not have a significant impact on water resources on a local, regional, state or national scale.

There is minimal uncertainty regarding the assessment above given:

- the number of surface water and groundwater assessments conducted in the vicinity of the action (i.e. for the WCM and neighbouring Moolarben Coal Complex and Ulan Mine Complex);
- the period of operational experience at the WCM;
- the comprehensive nature of this study; and
- the management and mitigation measures proposed for the action (Section 10).

# 9 Cumulative surface water impacts

## 9.1 OVERVIEW

An assessment has been undertaken of the potential cumulative impacts of the Project with those projects; proposed, under development or already in operation in the vicinity of the Project.

Cumulative impacts may be relevant at a local or regional level:

- Localised cumulative impacts may result from multiple existing or proposed mining operations in the immediate vicinity of the Project. Localised cumulative impacts include the effect from concurrent operations that are close enough to potentially cause additive effect on the receiving environment.
- Regional cumulative impacts include the Project's contribution to impacts that are caused by mining operations throughout the region or at a catchment level. Each coal mining operation in itself may not represent a substantial impact at a regional level; however the cumulative effect on the receiving environment may warrant consideration.

## 9.2 RELEVANT PROJECTS

Projects which are currently operating in the upper Goulburn River catchment and have been considered in the cumulative impact assessment are listed in Table 9.1. Projects currently under assessment or recently determined are listed in Table 9.2.

The relevant projects are located in the Goulburn River catchment, upstream of the Wollar Creek confluence. The locations of these projects are shown in Figure 9.1.

Numerous other mining projects are located downstream in the Hunter River Valley.

Table 9.1 – Existing projects considered in the cumulative impact assessment

| Project Proponent | Description | Operational Status | Relationship to the WCM ML | |
|---|---|---|---|---|
| | | | Timing | Location |
| Moolarben Coal Complex (Stage 1) - Yancoal Australia | Open cut and underground coal mine. | Open cut operating, underground not yet operating | May have overlapping operations with the construction and operations of the Project. | 12 km to the north-west of the Project Boundary. Located within Goulburn River catchment. |
| Ulan Mine Complex - Glencore | Underground coal mine with an open cut reserve. | Operating | May have overlapping operations with the construction and operations of the Project. | 16 km to the north-west of the Project Boundary. Located within Goulburn River catchment. |

Table 9.2 – New or developing projects considered in the cumulative impact assessment

| Project Proponent | Description | Operational Status | Relationship to the Project ML | |
|---|---|---|---|---|
| | | | Timing | Location |
| Moolarben Coal Complex - (Stage 2) Yancoal | Proposed expansion to both the open cut and underground operations. Combined yield of 17 Mtpa. | Approved | May have overlapping operations with the construction and operations of the Project. | North-west of the Project Boundary. Located within Goulburn River catchment. |
| Ulan Mine Complex - Glencore | Proposed expansion to the underground mine and recommence open cut mining. Combined yield of 20 Mtpa. | Operating | May have overlapping operations with the construction and operations of the Project. | 16 km to the north-west of the Project Boundary. Located within Goulburn River catchment. |
| Bylong Coal Project | Proposed greenfield open cut and underground mine. Combined yield of 6.5 Mtpa. | EIS exhibited | May have overlapping operations with the construction and operations of the Project. | 25 km to the south-east of the Project Boundary. Located within Goulburn River catchment. |

## 9.3 CUMULATIVE IMPACTS – SURFACE WATER RESOURCES

### 9.3.1 Surface water flows

As detailed in Section 8.5, the Project will result in no change to the approved maximum catchment excisions associated with the WCM.

The existing and proposed Moolarben Coal Complex and Ulan Mine Complex also capture runoff from the Goulburn River catchment, upstream of the Wollar Creek confluence. However, the total captured area of all these mines (approved WCM incorporating the Project, Moolarben Coal Complex and Ulan Mine Complex) combined would represent around 6.4% of the Goulburn River catchment to the Wollar Creek confluence (Wilpinjong - 23.8 km$^2$, Moolarben – 0.45 km$^2$, Ulan – 15.2 km$^2$). In addition, these mines have discharge licences which return captured surface water, as well as groundwater collected in underground workings, to the Goulburn River catchment. Site discharges reduce the impact on surface water volumes. The discharge volumes reported in Annual Reviews/AEMRs for 2013/14 from the two nearby projects were as follows:

- Ulan: 3,826 ML discharged (EPL 394, Limit of 10,950 ML/year).
- Moolarben: Zero discharge (EPL 12932, Limit of 10 ML/day) (Moolarben reported runoff capture of 542 ML for 2013/2014).

Based on the relatively small captured catchment area and the discharge of captured water from the three existing mine sites, the cumulative net impact on surface flow volumes would be too small to measure.

Note that the catchment area of the Goulburn River to the confluence of the Bylong River (immediately downstream of the Bylong Project) is 3,340 km$^2$. The total captured area of all four mining projects (approved WCM incorporating the Project, Moolarben Coal Complex, Ulan Mine Complex and Bylong Coal Project) would be less than 1.5% of the Goulburn River catchment to the Bylong River confluence.

The discharge of water from the three existing mines would potentially have an impact on the flow-duration behaviour of the Goulburn River because runoff that occurs during a rainfall event is collected and discharged over an extended period. Similarly, intercepted groundwater from the existing mines may be discharged as a continuous flow. However, any such impacts are a consequence of existing approved operations.

The Project does not propose to discharge untreated mine water to the receiving watercourses and hence will not contribute to any localised or regional impacts, beyond the small loss of catchment area.

### 9.3.2 Water quality

Cumulative impacts of potential mine water discharges further downstream in the regulated section of the Hunter River are managed through the Hunter River Salinity Trading Scheme (HRSTS). However, the HRSTS does not apply to the upper Goulburn River where the Project is located. Impacts of any discharges from existing operations in the upper Goulburn River catchment are regulated through EPLs for each operation.

The mine water management system for the Project has been designed for no-discharge (except for RO treated water), with passive release of water from the sediment dam system occurring only after rainfall that exceeds the design standard. The on-site containment and recycling of water with potentially elevated levels of contaminants will ensure that the Project does not contribute to localised or regional cumulative impacts.

### 9.3.3 External water requirements

Water requirements for the Project will be supplied from captured runoff, groundwater inflows and recycled water on the site. Potable water is also brought to site as required. Any shortfall in water availability from these sources will be obtained from licensed bores.

WCPL would continue to investigate opportunities for water sharing between the WCM, Moolarben Coal Complex and Ulan Mine Complex. Water sharing that involves both the provision of water during surplus periods as well as receiving water during deficit periods would be investigated.

Licensed water volumes are determined through a WSP, developed under the WM Act. The WSP establishes rules for sharing water between the environmental needs of the river or aquifer and water users and hence considers cumulative impacts at the catchment scale. By complying with licence restrictions on water consumption, the Project will not create unexpected cumulative impacts on water availability.

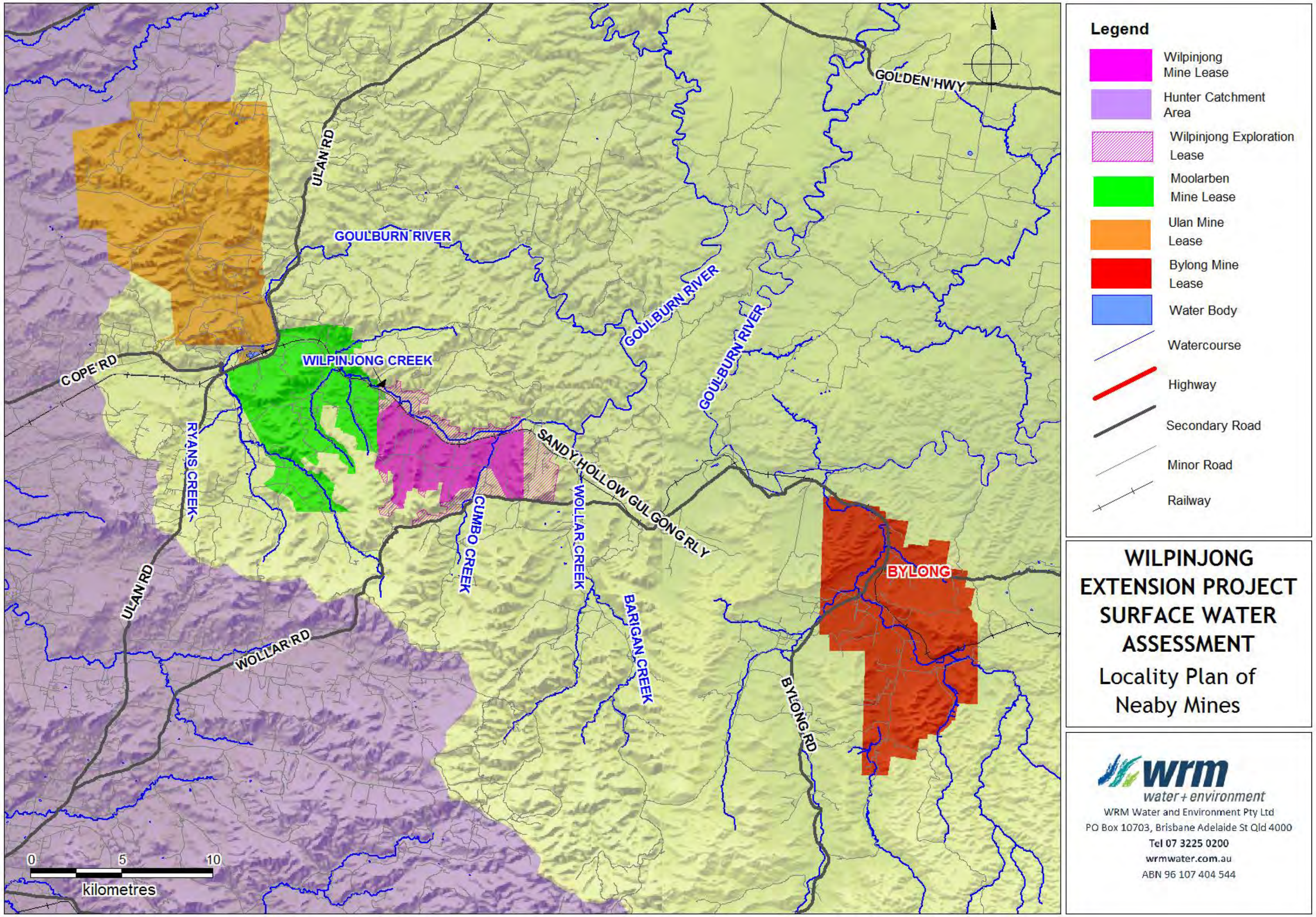



**Figure 9.1 – Locations of nearby mines**

# 10 Mitigation, management and monitoring

## 10.1 OVERVIEW

The impacts of the Project on surface water resources can generally be managed and mitigated through the implementation of the existing water management strategy at the WCM (Section 4).

An overview of each of the key management measures that would apply to the Project is provided below as well as a description of any new/updated measures.

## 10.2 WATER FLOW MANAGEMENT MEASURES

### 10.2.1 Up-catchment control structures

The existing surface water runoff controls to prevent up-catchment runoff water from entering open cut mining operational areas would be generally retained for the Project. Details of up-catchment runoff water control structures to be developed for the Project are discussed in Section 5.

Permanent up-catchment diversion bunds/drains would remain around final voids to minimise their drainage catchment so far as is reasonable and feasible (Section 8.4).

## 10.3 WATER QUALITY MANAGEMENT

The Project water management system would continue to maintain separation between runoff from areas undisturbed by mining and water generated within active mining areas. An objective of the on-site water management for the WCM is to operate such that there is no mine water storage overflow.

The water management system would include a combination of permanent structures (e.g. final void diversion bunds) that would continue to operate post-mine closure, and temporary structures that would only be required until the completion of the rehabilitation works (e.g. sediment dams).

The existing water quality monitoring sites for the approved WCM are considered sufficient for the Project.

### 10.3.1 Erosion and sediment control

Sediment dam sizing and operating rules are described in Section 5.3. Sediment dams would be sized consistent with the sizing criteria at the WCM. Following rainfall events, accumulated water would be transferred to mine water storages until the design capacity of the sediment dam is restored.

The site sediment and erosion control system would continue to be managed in accordance with the WCM Erosion and Sediment Control Plan (part of the overarching WMP). The WMP (including the Erosion and Sediment Control Plan) would be reviewed and updated for the Project.

Sediment dams would be maintained until such time as vegetation successfully establishes on topsoiled areas and where runoff has similar water quality characteristics to areas that are undisturbed by mining activities.

### 10.3.2 Concentrate management

RO Plant concentrate would continue to be managed in accordance with the existing measures at the WCM, which are described in Section 4.6. Management measures for RO Plant concentrate would continue to be refined as additional water balance modelling and monitoring is undertaken.

### 10.3.3 Final void modelling

It is recommended that additional final void modelling is undertaken prior to mine closure using updated climate change predictions to confirm the long term final void water balance findings in Section 8.4.1.

## 10.4 WATER MANAGEMENT PLAN

The existing WCM WMP would be reviewed and revised to incorporate the Project. The WMP describes the operational site water management system and would include provisions for review of the site water balance, erosion and sediment controls, water monitoring and management.

The Water Management Plan would describe the water management protocols and response procedures for the water management system that would be adhered to throughout the operation of the Project. The water management protocols (to avoid overflows or releases from contained water storages) are described in Sections 4.3 and 4.4.

### 10.4.1 Site water balance

Review and progressive refinement of the site water balance would continue to be undertaken on a regular basis over the life of the Project to record the status of inflows (water capture), storage and consumption (e.g. CHPP usage, return water from co-disposal areas, dust suppression and RO plant discharges) and to optimise water management performance.

The results of site water balance reviews would be reported in the Annual Review.

### 10.4.2 Erosion and Sediment Control Plan

The Erosion and Sediment Control Plan would be reviewed and updated for the Project.

The Erosion and Sediment Control Plan identifies activities that could cause soil erosion and generate sediment and describe the specific controls (including locations, function and structure capacities) to minimise the potential for soil erosion and transport of sediment off-site (as described above in Section 10.3.1).

### 10.4.3 Surface water management and monitoring plan

The existing surface water monitoring program, which is included in the WCM Surface Water Management and Monitoring Plan of the WMP, is considered sufficient for the purposes of monitoring potential impacts associated with the Project.

Water quality monitoring would continue to be undertaken in accordance with the Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC and ARMCANZ, 2000) and Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DEC, 2004).

### 10.4.4 Surface and Ground Water Response Plan

The existing Surface and Ground Water Response Plan, which is included in the WMP for the WCM, would be reviewed and revised for the Project.

The Surface and Ground Water Response Plan would describe any additional measures and procedures that would be implemented over the life of the Project to respond to any potential exceedances of surface water related criteria and contingent mitigation, compensation, and/or offset options if downstream private surface water users (of which there are none on Wilpinjong Creek, Cumbo Creek or Wollar Creek downstream of the WCM) or riparian vegetation are adversely affected by the Project.

# 11 References


| | |
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# Appendix A – Water balance sensitivity testing model results

## Contents

# A1 High/Low groundwater inflows

## A1.1 HIGH GROUNDWATER INFLOWS

For this scenario, the groundwater inflows to the mining pits have been increased by 10%, compared to the volumes presented in Section 6.6.1. All other parameters have remained unchanged.

### A1.1.1 Overall water balance

Table A.1 - Average annual water balance - all realisations - high GW inflows

| | Year 2016 | Year 2018 | Year 2020 | Year 2024 | Year 2028 | Year 2031 |
|---|---|---|---|---|---|---|
| **Water inputs (ML/year)** | | | | | | |
| Catchment Runoff | 1,675 | 1,953 | 2,072 | 2,060 | 1,846 | 1,898 |
| Direct Rainfall | 422 | 451 | 412 | 332 | 308 | 202 |
| Groundwater inflows | 1,070 | 1,016 | 711 | 475 | 530 | 209 |
| External water supply | 0 | 0 | 0 | 1 | 0 | 2 |
| **GROSS WATER INPUTS** | **3,166** | **3,419** | **3,194** | **2,868** | **2,685** | **2,311** |
| **Water outputs (ML/year)** | | | | | | |
| Evaporation from water storages | 687 | 800 | 759 | 615 | 610 | 413 |
| CHPP demand | 609 | 613 | 542 | 471 | 355 | 195 |
| Dust suppression demand | 525 | 698 | 791 | 770 | 543 | 503 |
| RO Plant discharge | 276 | 993 | 721 | 488 | 549 | 777 |
| Storage overflows - mine water dams | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage overflows - sediment dams | 136 | 180 | 172 | 64 | 32 | 30 |
| Outflows - rehabilitated catchments | 0 | 47 | 219 | 386 | 454 | 579 |
| Outflows - diverted catchments | 115 | 204 | 221 | 158 | 89 | 40 |
| **GROSS WATER OUTPUTS** | **2,348** | **3,535** | **3,425** | **2,952** | **2,632** | **2,537** |
| **Water balance (ML/year)** | | | | | | |
| Change in storage volumes | 818 | -116 | -231 | -84 | 53 | -226 |

## A1.1.2 Mine water dam inventory

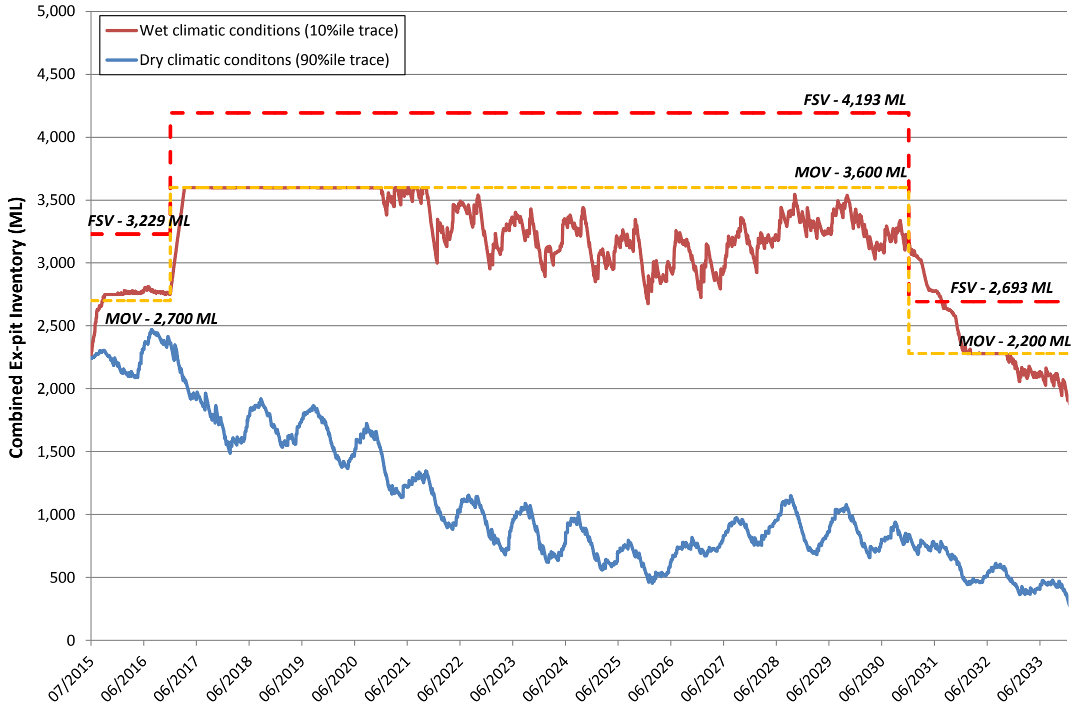



**Figure A.1 Forecast mine water inventory - high groundwater inflows**

## A1.1.3 Pit inundation

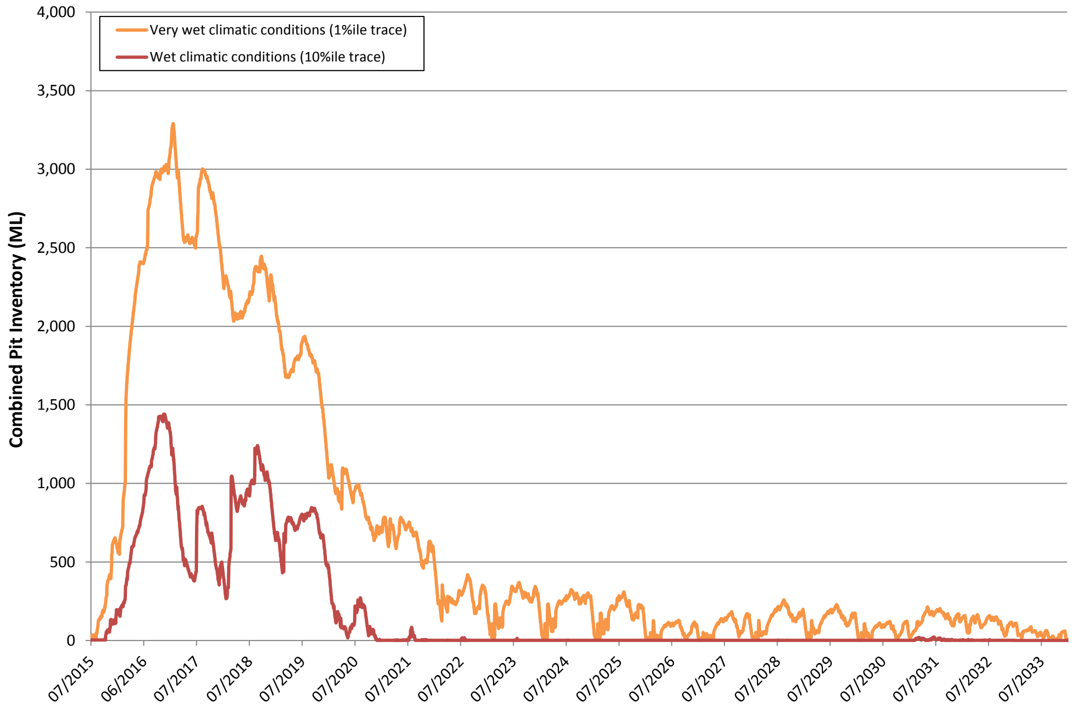


Figure A.2  Forecast pit water inventory – high GW inflows

#### A1.1.4 External makeup requirements

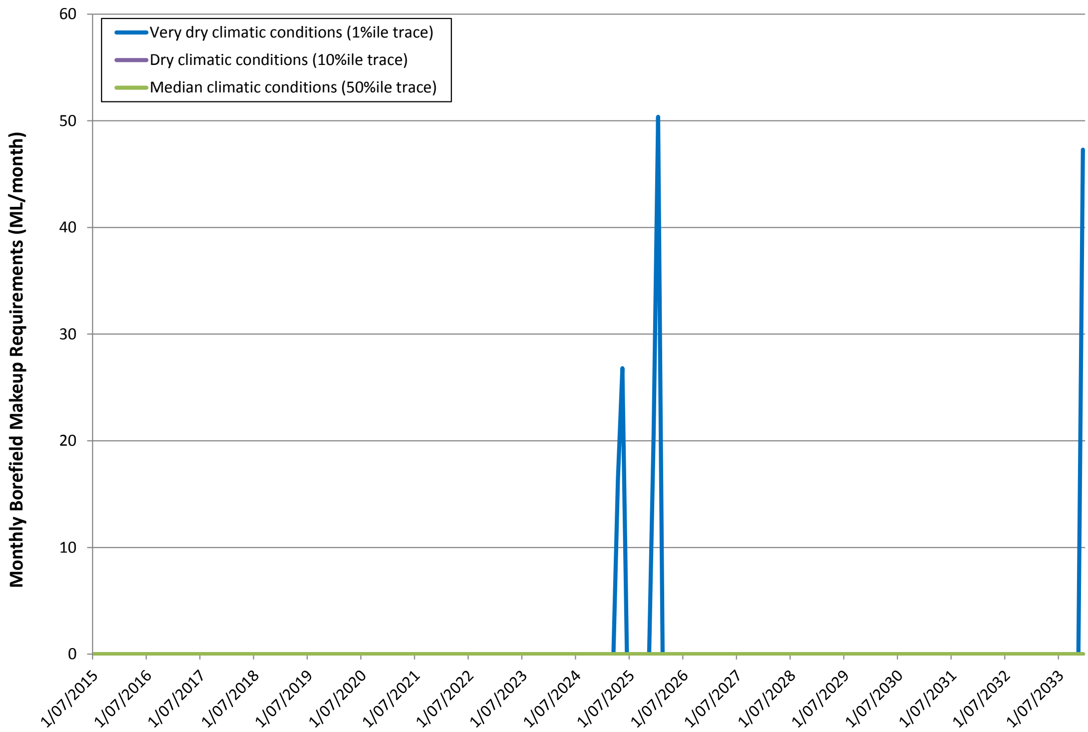



Figure A.3 - Forecast monthly external water requirements – high GW inflows

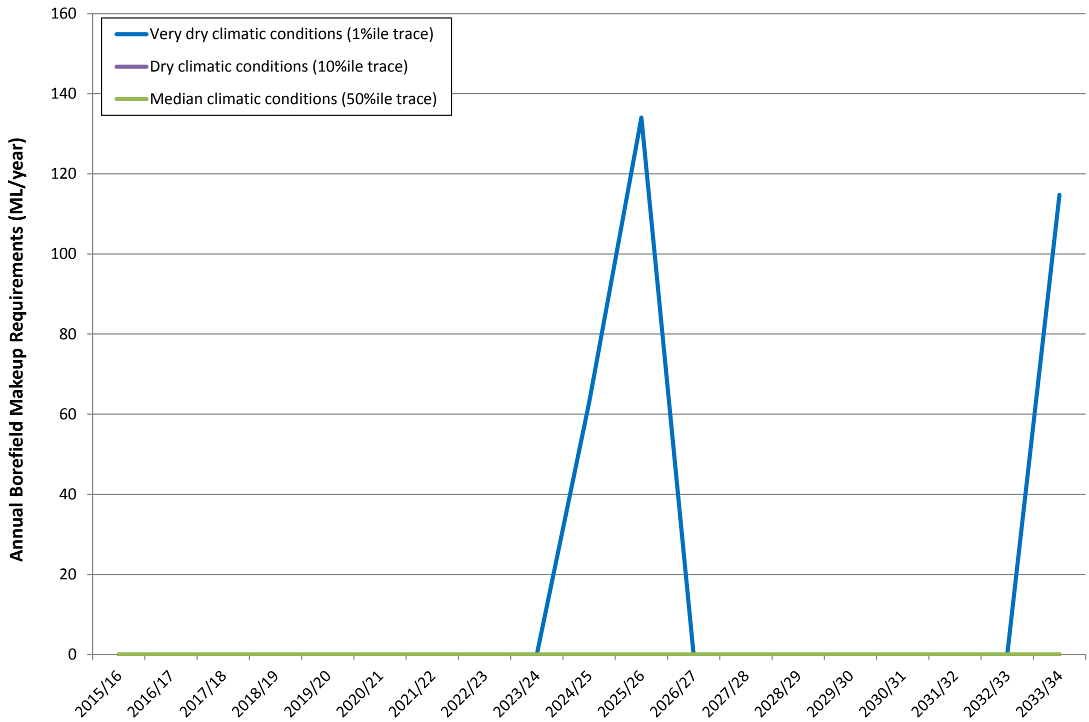


**Figure A.4 - Forecast annual external water requirements - high GW inflows**

### A1.1.5 RO Plant discharges

Table A.2 - Summary of simulated RO Plant discharges - high GW inflows

| Operational period | Annual RO Plant Discharge (ML/year) | | | | |
|---|---|---|---|---|---|
| | 1%ile trace | 10%ile trace | 50%ile trace | 90%ile trace | 99%ile trace |
| Phase 1 (Year 2015-16) | 280 to 760 | 270 to 680 | 270 to 555 | 265 to 545 | 255 to 535 |
| Phase 2 (Year 2017-18) | 1,275 to 1280 | 1,270 to 1,275 | 1,060 to 1,265 | 0 to 625 | 0 to 355 |
| Phase 3 (Year 2019-21) | 1,270 to 1280 | 1,270 to 1,275 | 510 to 955 | 0 | 0 |
| Phase 4 (Year 2022-25) | 1,275 to 1280 | 1,265 to 1,270 | 315 to 460 | 0 | 0 |
| Phase 5 (Year 2026-30) | 1,275 to 1280 | 1,255 to 1,275 | 385 to 755 | 0 | 0 |
| Phase 6 (Year 2031-33) | 1,275 to 1280 | 1,275 to 1,280 | 545 to 1,280 | 0 | 0 |

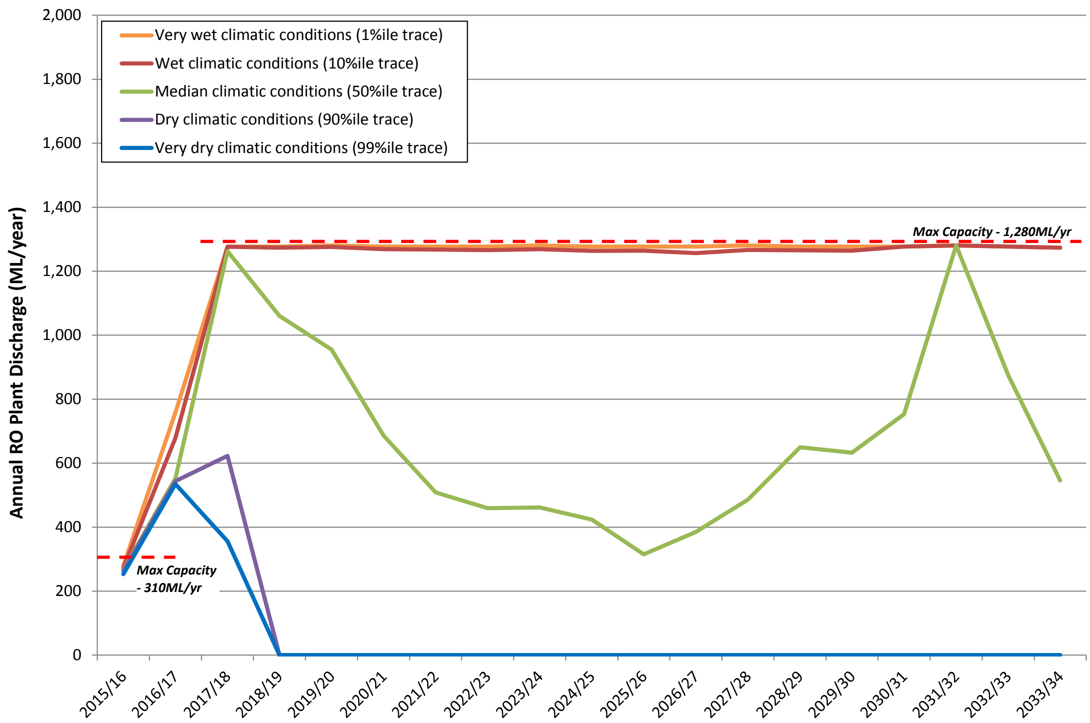



**Figure A.5 - Forecast annual controlled releases - high GW inflows**

### A1.1.6 Uncontrolled spills - mine water system

The model of the water management system has been configured to ensure no uncontrolled discharge of water from mine water storages to the receiving environment. As such, the modelled results show no spills from the mine water system.

### A1.1.7 Uncontrolled spills - sediment dams

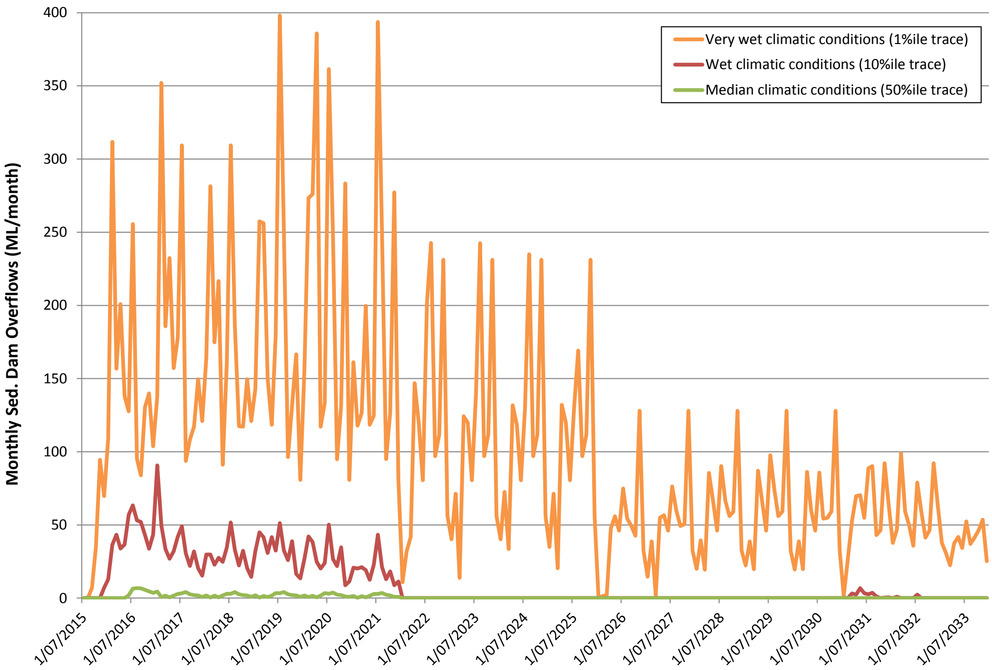



**Figure A.6 - Forecast monthly sediment dam overflows - high GW inflows**

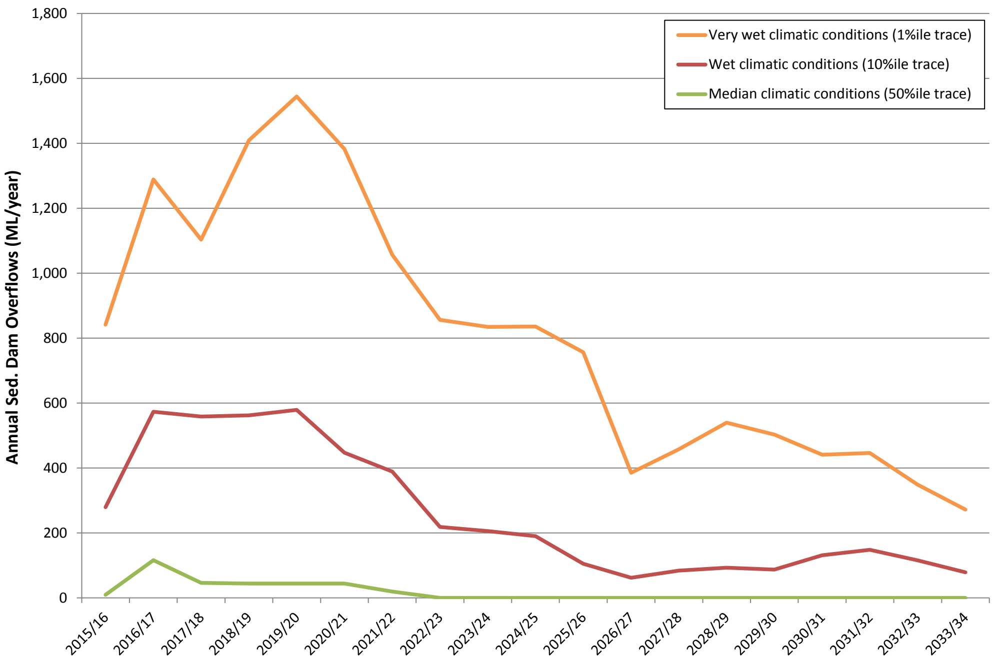



**Figure A.7 - Forecast annual sediment dam overflows - high GW inflows**

## A1.2 LOW GROUNDWATER INFLOWS

For this scenario, the groundwater inflows to the mining pits have been decreased by 10%, compared to the volumes presented in Section 6.6.1. All other parameters have remained unchanged.

### A1.2.1 Overall water balance

Table A.3 - Average annual water balance - all realisations - low GW inflows

| | Year 2016 | Year 2018 | Year 2020 | Year 2024 | Year 2028 | Year 2031 |
|---|---|---|---|---|---|---|
| **Water inputs (ML/year)** | | | | | | |
| Catchment Runoff | 1,677 | 1,955 | 2,077 | 2,066 | 1,848 | 1,899 |
| Direct Rainfall | 415 | 440 | 399 | 319 | 295 | 200 |
| Groundwater inflows | 876 | 832 | 582 | 389 | 434 | 171 |
| External water supply | 0 | 0 | 0 | 0 | 0 | 0 |
| **GROSS WATER INPUTS** | **2,968** | **3,227** | **3,057** | **2,779** | **2,579** | **2,271** |
| **Water outputs (ML/year)** | | | | | | |
| Evaporation from water storages | 652 | 766 | 725 | 582 | 577 | 409 |
| CHPP demand | 609 | 613 | 542 | 471 | 355 | 195 |
| Dust suppression demand | 525 | 698 | 791 | 770 | 543 | 503 |
| RO Plant discharge | 277 | 904 | 606 | 429 | 488 | 693 |
| Storage overflows - mine water dams | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage overflows - sediment dams | 121 | 163 | 148 | 57 | 28 | 28 |
| Outflows - rehabilitated catchments | 0 | 47 | 219 | 384 | 448 | 574 |
| Outflows - diverted catchments | 115 | 204 | 221 | 158 | 89 | 40 |
| **GROSS WATER OUTPUTS** | **2,299** | **3,395** | **3,252** | **2,851** | **2,528** | **2,442** |
| **Water balance (ML/year)** | | | | | | |
| Change in storage volumes | 669 | -168 | -195 | -72 | 51 | -171 |

### A1.2.2 Mine water dam inventory

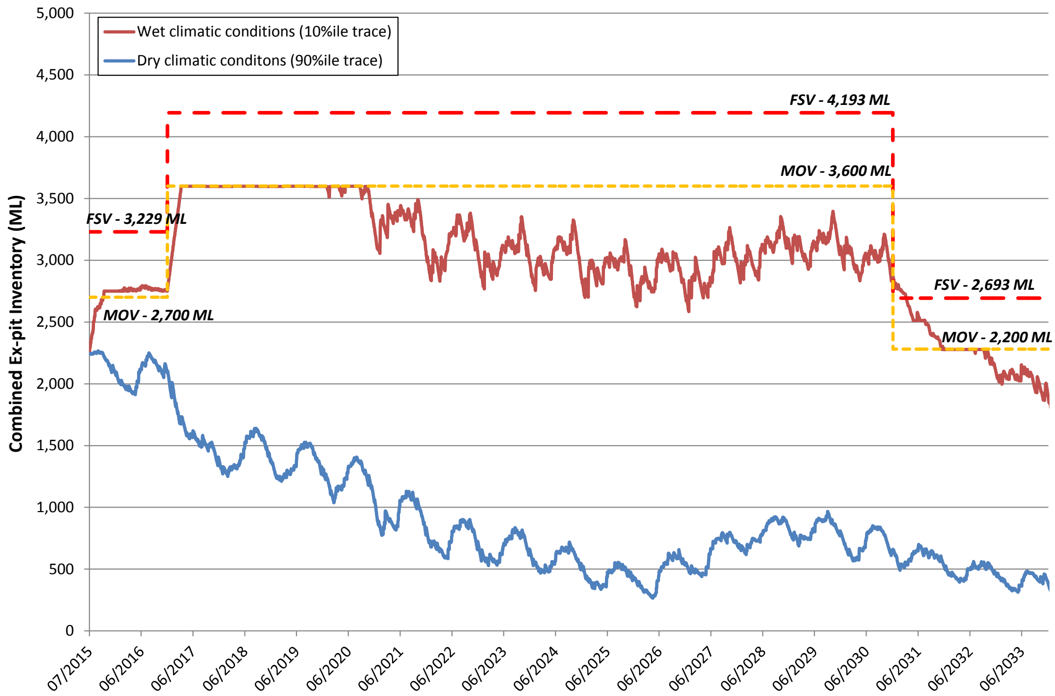



**Figure A.8 Forecast mine water inventory - low groundwater inflows**

### A1.2.3 Pit inundation

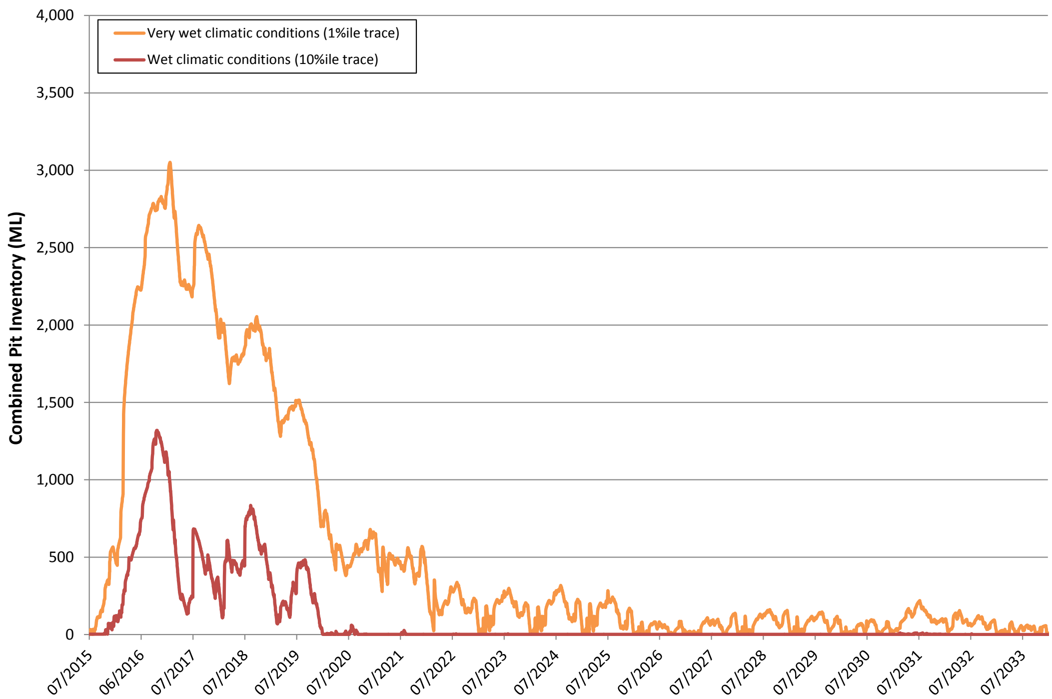



**Figure A.9 Forecast pit water inventory - low GW inflows**

### A1.2.4 External makeup requirements

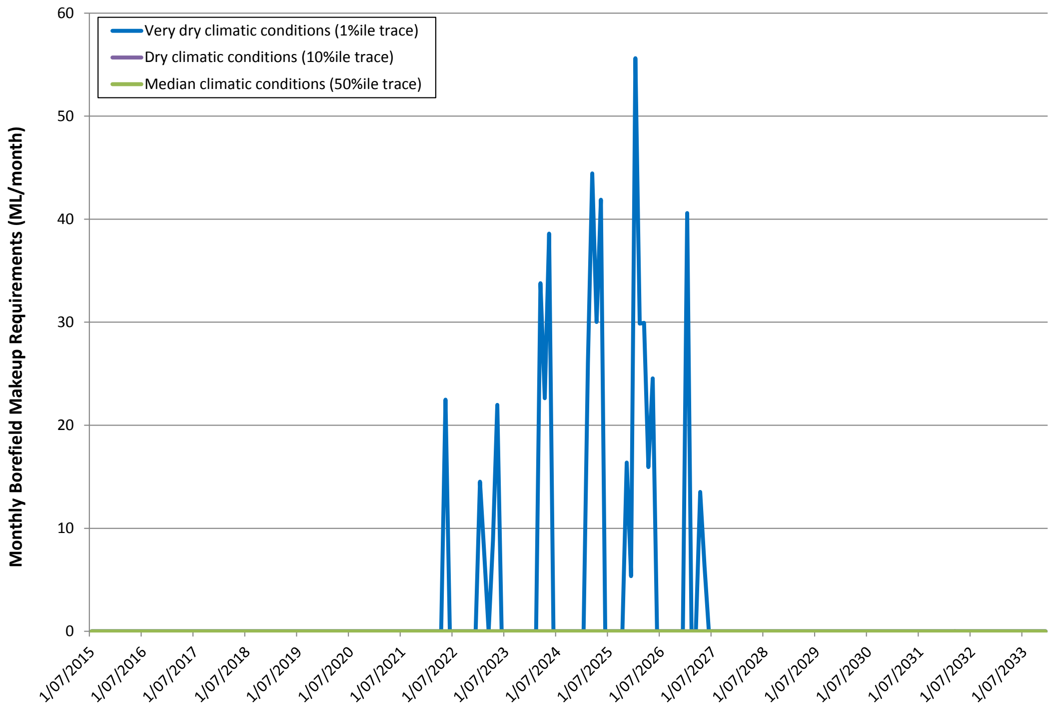



**Figure A.10 - Forecast monthly external water requirements - low GW inflows**

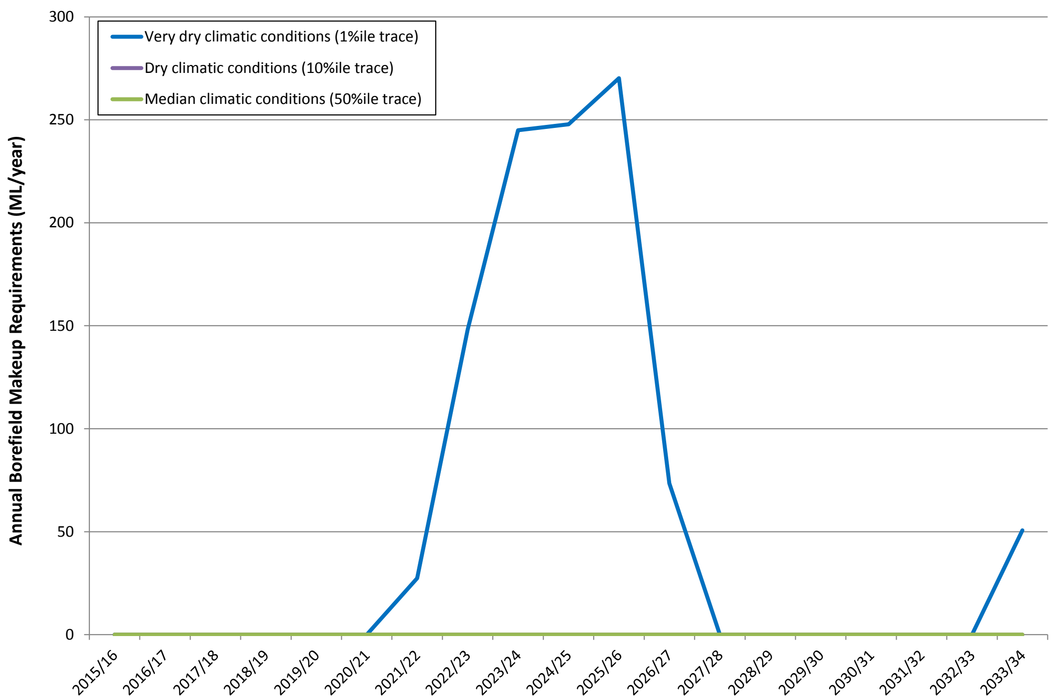



**Figure A.11 - Forecast annual external water requirements - low GW inflows**

### A1.2.5 RO Plant discharges

Table A.4 – Summary of simulated RO Plant discharges – low GW inflows

| Operational period | Annual RO Plant Discharge (ML/year) | | | | |
|---|---|---|---|---|---|
| | 1%ile trace | 10%ile trace | 50%ile trace | 90%ile trace | 99%ile trace |
| Phase 1 (Year 2015-16) | 280 to 785 | 275 to 725 | 265 to 560 | 265 to 545 | 255 to 535 |
| Phase 2 (Year 2017-18) | 1,275 to 1280 | 1,275 to 1,280 | 795 to 1,210 | 0 to 385 | 0 |
| Phase 3 (Year 2019-21) | 1,275 to 1280 | 1,265 to 1,270 | 380to 710 | 0 | 0 |
| Phase 4 (Year 2022-25) | 1,275 to 1280 | 1,260 to 1,265 | 15 to 385 | 0 | 0 |
| Phase 5 (Year 2026-30) | 1,275 to 1280 | 1,260 to 1,275 | 285 to 630 | 0 | 0 |
| Phase 6 (Year 2031-33) | 1,275 to 1280 | 1,275 to 1,280 | 555 to 1,005 | 0 | 0 |

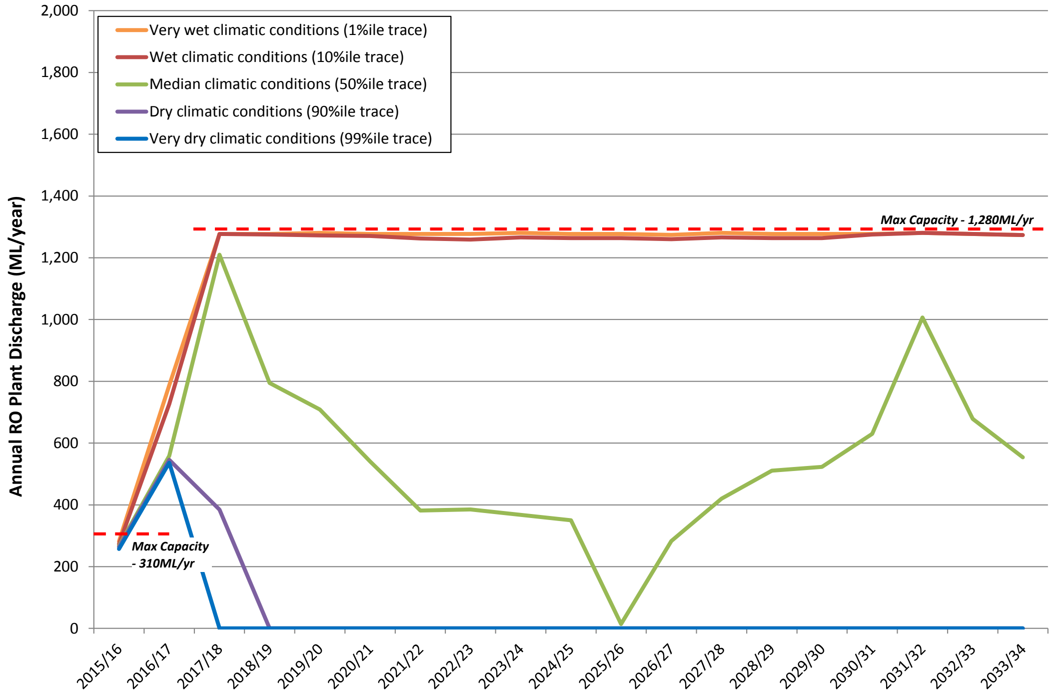



**Figure A.12 – Forecast annual controlled releases – low GW inflows**

### A1.2.6 Uncontrolled spills - mine water system

The model of the water management system has been configured to ensure no uncontrolled discharge of water from mine water storages to the receiving environment. As such, the modelled results show no spills from the mine water system.

### A1.2.7 Uncontrolled spills - sediment dams

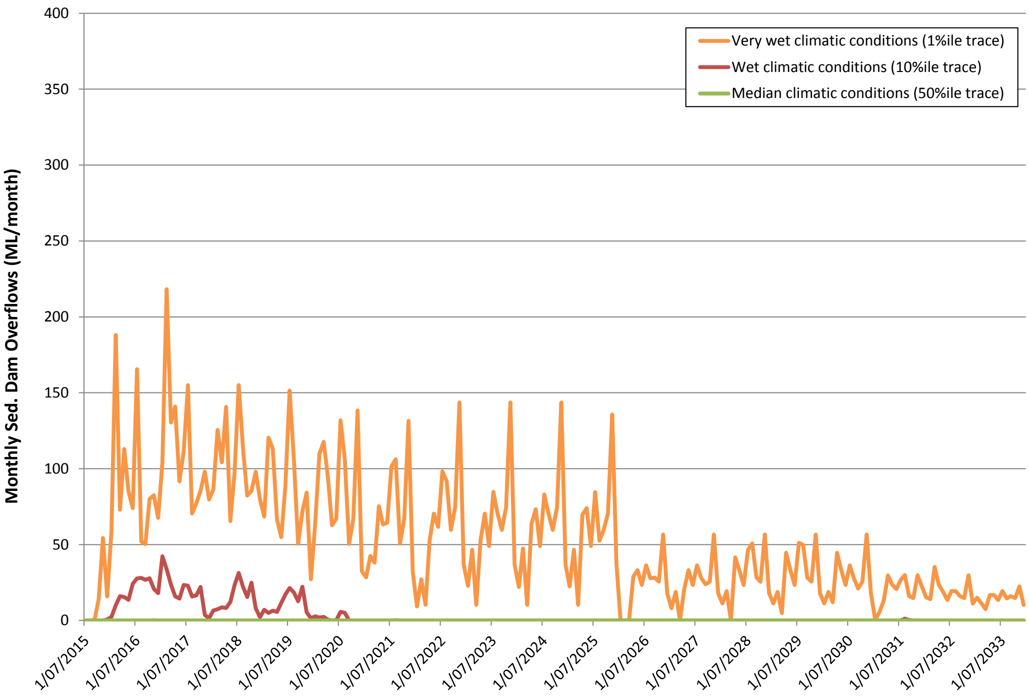



**Figure A.13 - Forecast monthly sediment dam overflows - low GW inflows**

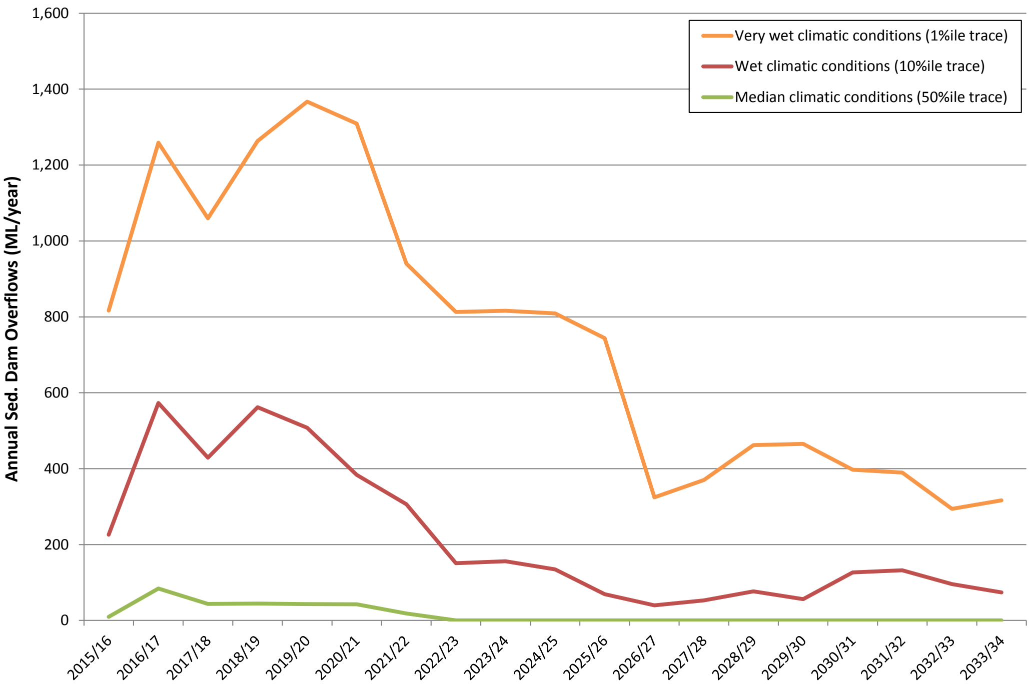



**Figure A.14 - Forecast annual sediment dam overflows - low GW inflows**

# A2 High/Low rejects moisture content inflows

## A2.1 HIGH REJECTS MOISTURE CONTENT

For this scenario, the rejects moisture content has been increased by 10%, compared to the values presented in Section 6.5.1. All other parameters have remained unchanged.

### A2.1.1 Overall water balance

Table A.5 - Average annual water balance - all realisations - high rejects MC

| | Year 2016 | Year 2018 | Year 2020 | Year 2024 | Year 2028 | Year 2031 |
|---|---|---|---|---|---|---|
| Water inputs (ML/year) | | | | | | |
| Catchment Runoff | 1,678 | 1,956 | 2,079 | 2,071 | 1,849 | 1,900 |
| Direct Rainfall | 414 | 438 | 394 | 310 | 289 | 199 |
| Groundwater inflows | 973 | 924 | 646 | 432 | 482 | 190 |
| External water supply | 0 | 0 | 0 | 12 | 3 | 3 |
| **GROSS WATER INPUTS** | **3,065** | **3,318** | **3,119** | **2,824** | **2,623** | **2,291** |
| Water outputs (ML/year) | | | | | | |
| Evaporation from water storages | 645 | 760 | 714 | 560 | 561 | 407 |
| CHPP demand | 743 | 749 | 661 | 575 | 431 | 234 |
| Dust suppression demand | 525 | 698 | 791 | 770 | 543 | 503 |
| RO Plant discharge | 277 | 880 | 581 | 399 | 466 | 667 |
| Storage overflows - mine water dams | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage overflows - sediment dams | 118 | 159 | 146 | 55 | 26 | 27 |
| Outflows - rehabilitated catchments | 0 | 47 | 219 | 383 | 445 | 571 |
| Outflows - diverted catchments | 115 | 204 | 221 | 158 | 89 | 40 |
| **GROSS WATER OUTPUTS** | **2,423** | **3,497** | **3,333** | **2,900** | **2,561** | **2,449** |
| Water balance (ML/year) | | | | | | |
| Change in storage volumes | 642 | -179 | -214 | -76 | 62 | -158 |

## A2.1.2 Mine water dam inventory

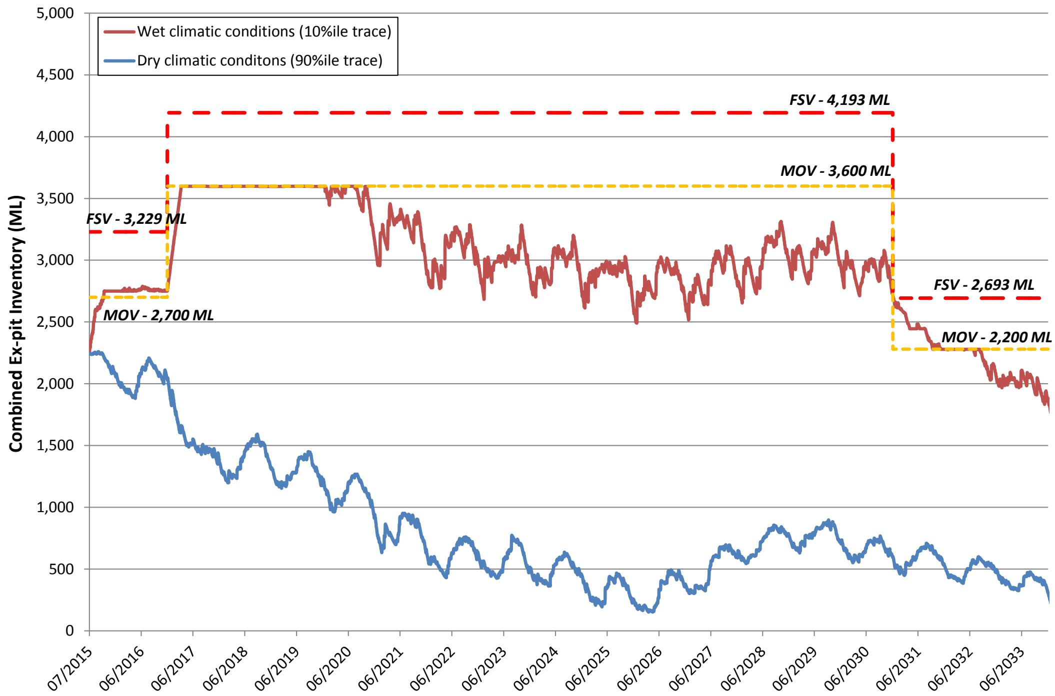



**Figure A.15 Forecast mine water inventory - high rejects MC**

## A2.1.3 Pit inundation

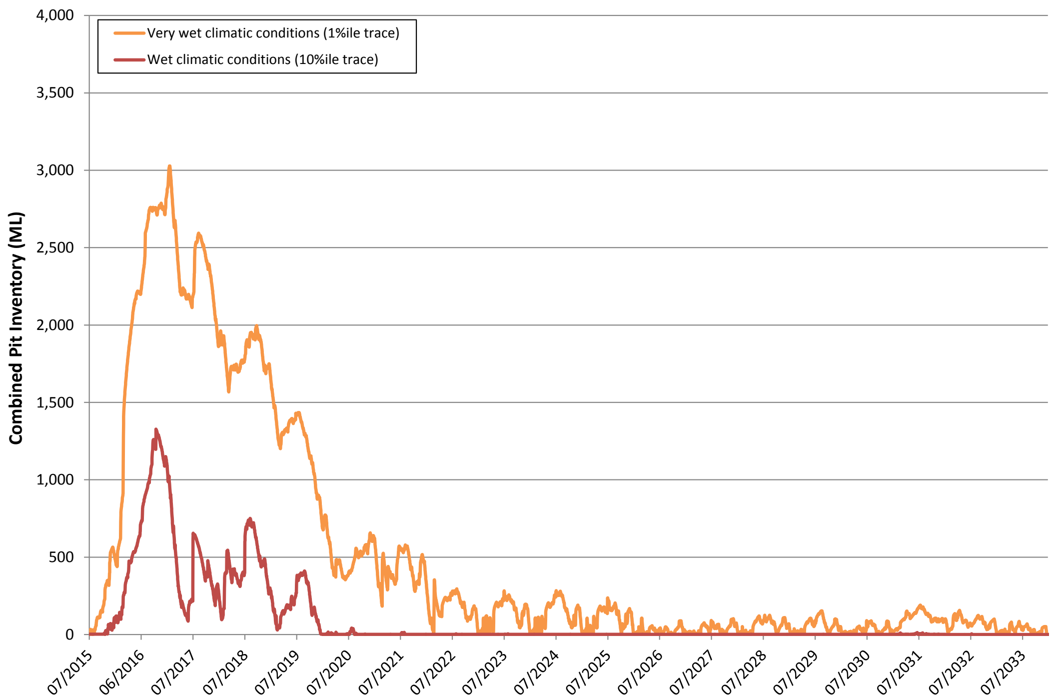



**Figure A.16 Forecast pit water inventory - high rejects MC**

### A2.1.4 External makeup requirements

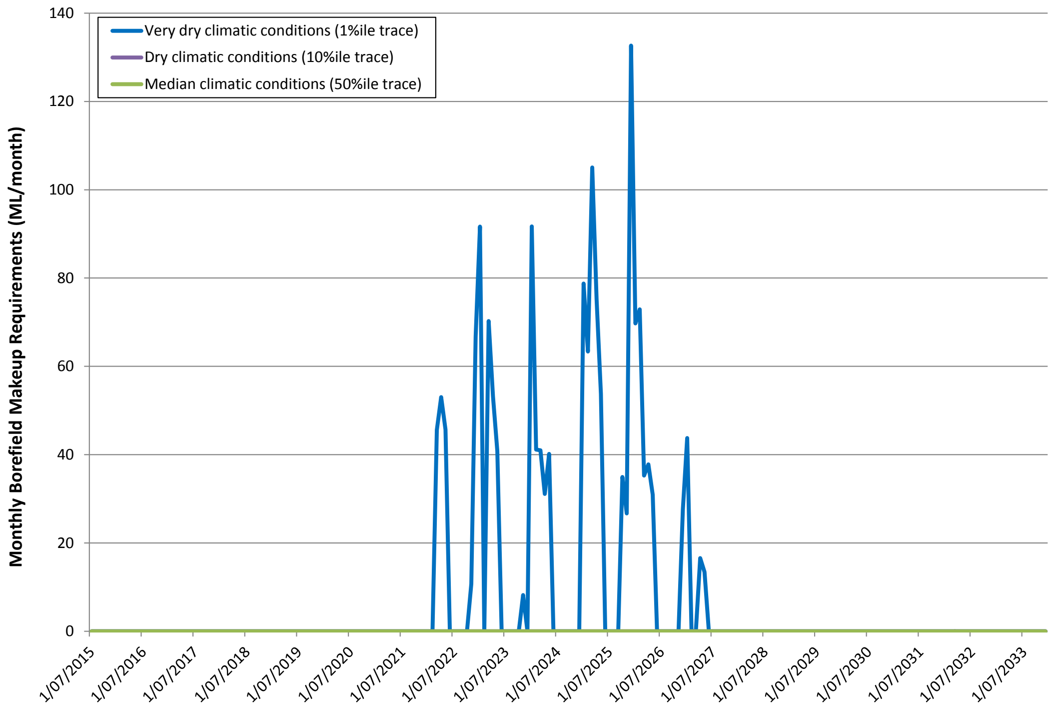



**Figure A.17 - Forecast monthly external water requirements - high rejects MC**

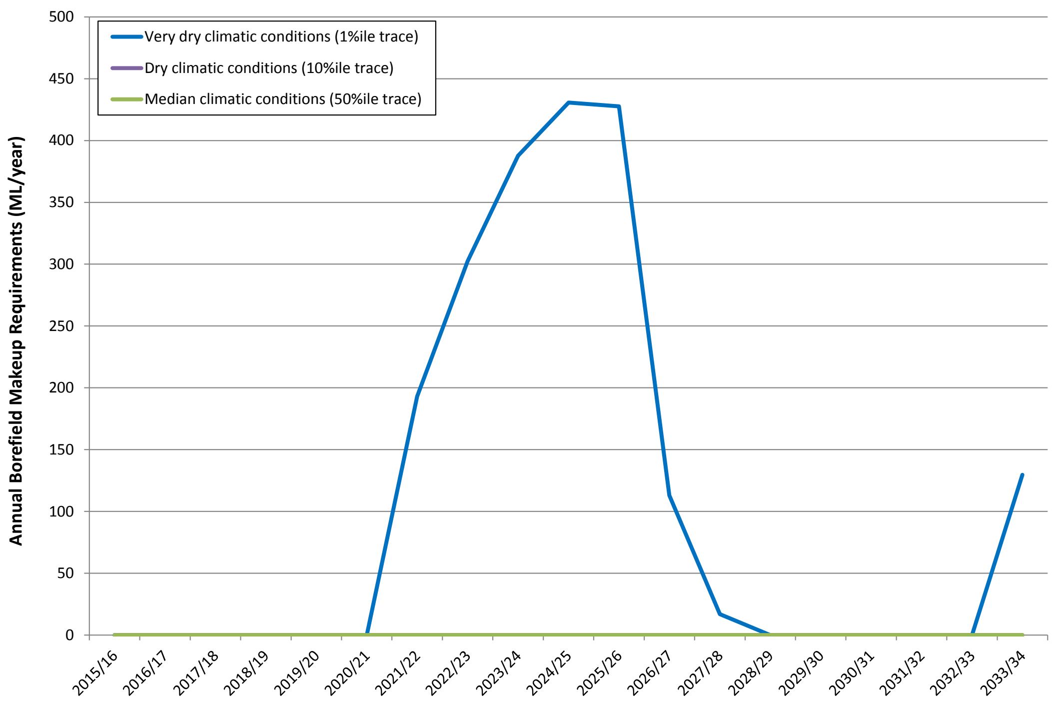



**Figure A.18 - Forecast annual external water requirements - high rejects MC**

## A2.1.5 RO Plant discharges

Table A.6 - Summary of simulated RO Plant discharges - high rejects MC

| Operational period | Annual RO Plant Discharge (ML/year) 1%ile trace | 10%ile trace | 50%ile trace | 90%ile trace | 99%ile trace |
|---|---|---|---|---|---|
| Phase 1 (Year 2015-16) | 280 to 785 | 275 to 730 | 265 to 560 | 265 to 560 | 255 to 535 |
| Phase 2 (Year 2017-18) | 1,275 to 1280 | 1,270 to 1,275 | 750 to 1,130 | 0 to 360 | 0 |
| Phase 3 (Year 2019-21) | 1,275 to 1280 | 1,265 to 1,270 | 3405 to 675 | 0 | 0 |
| Phase 4 (Year 2022-25) | 1,265 to 1280 | 1,250 to 1,265 | 5 to 330 | 0 | 0 |
| Phase 5 (Year 2026-30) | 1,275 to 1280 | 1,255 to 1,275 | 75 to 630 | 0 | 0 |
| Phase 6 (Year 2031-33) | 1,275 to 1280 | 1,275 to 1,280 | 400 to 935 | 0 | 0 |

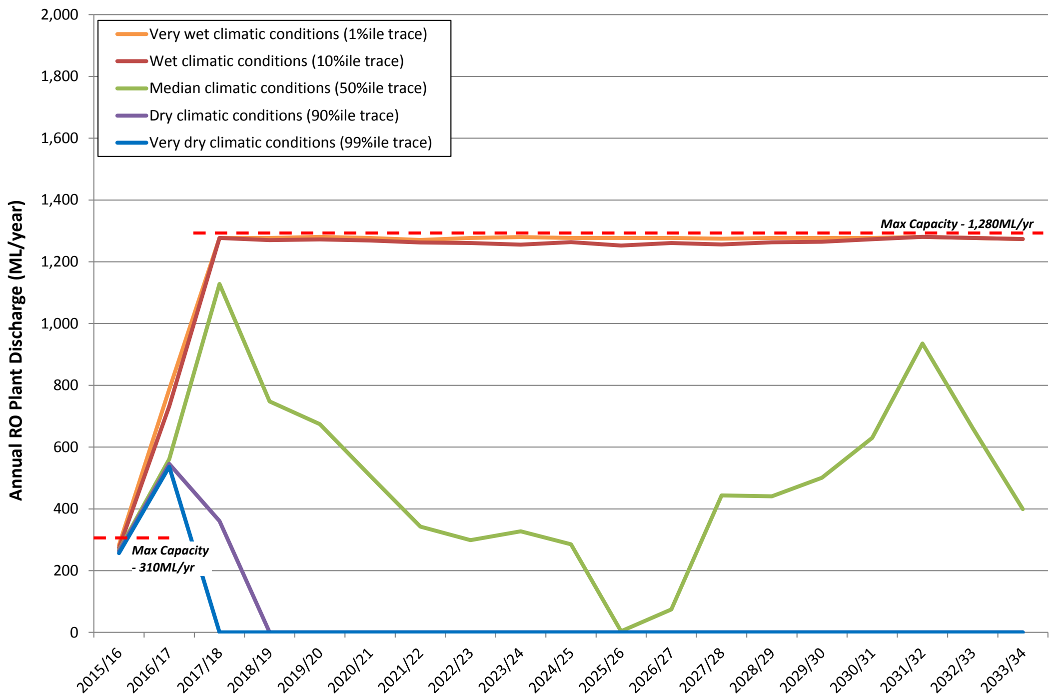
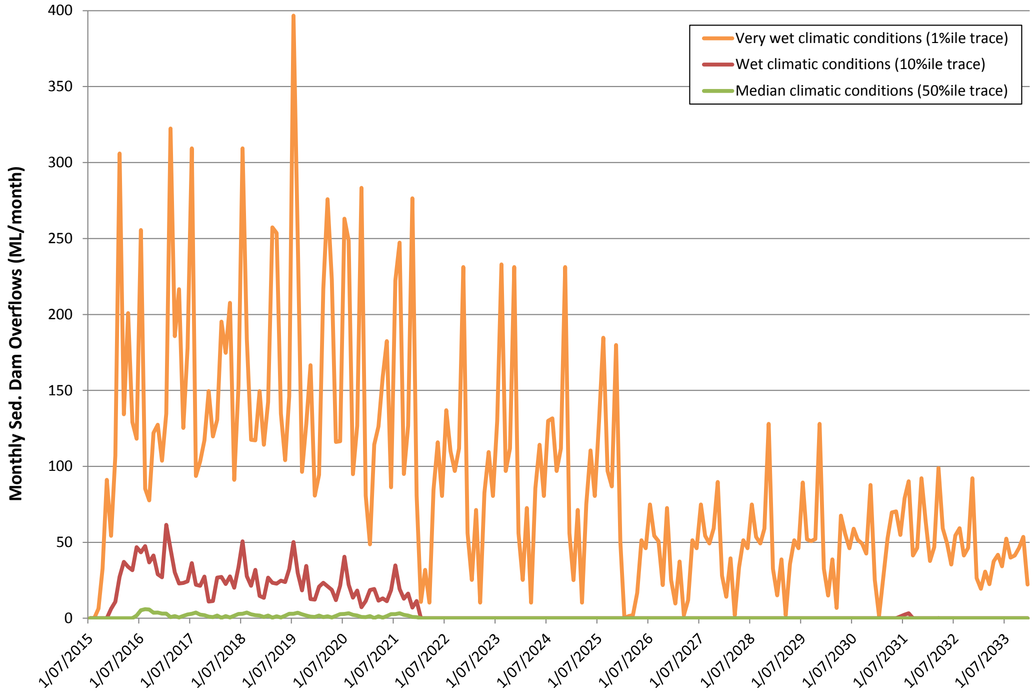



**Figure A.19 - Forecast annual controlled releases - high rejects MC**

### A2.1.6 Uncontrolled spills – mine water system

The model of the water management system has been configured to ensure no uncontrolled discharge of water from mine water storages to the receiving environment. As such, the modelled results show no spills from the mine water system.




### A2.1.7 Uncontrolled spills – sediment dams

**Figure A.20 – Forecast monthly sediment dam overflows – high rejects MC**

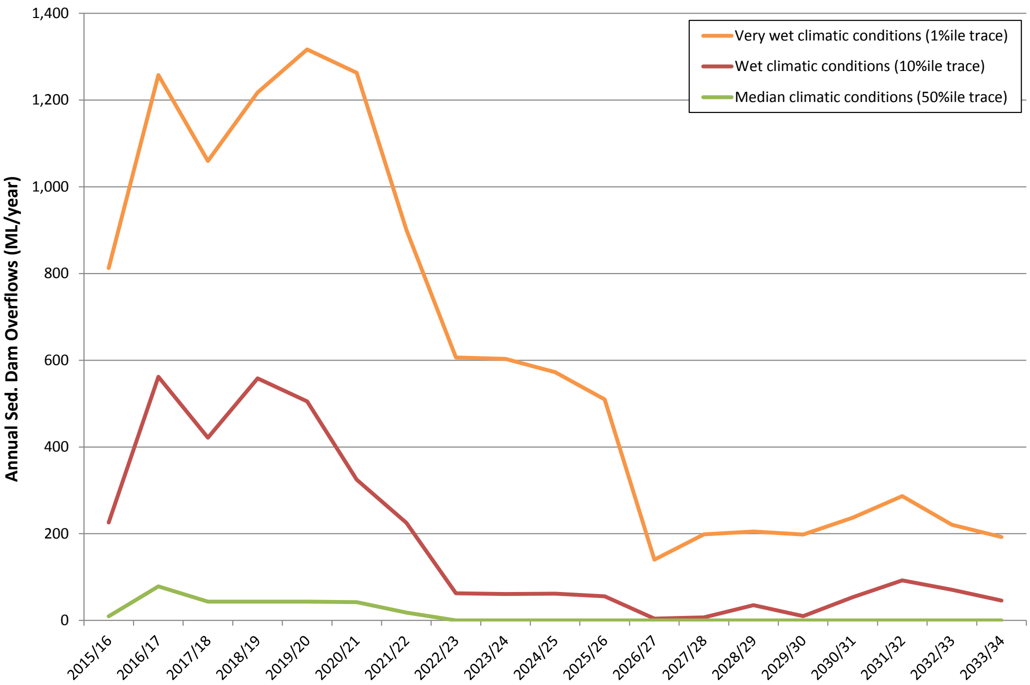



**Figure A.21 – Forecast annual sediment dam overflows – high rejects MC**

## A2.2 LOW REJECTS MOISTURE CONTENT

For this scenario, the rejects moisture content has been decreased by 10%, compared to the values presented in Section 6.5.1. All other parameters have remained unchanged.

### A2.2.1 Overall water balance

Table A.7 - Average annual water balance - all realisations - low rejects MC

| | Year 2016 | Year 2018 | Year 2020 | Year 2024 | Year 2028 | Year 2031 |
|---|---|---|---|---|---|---|
| **Water inputs (ML/year)** | | | | | | |
| Catchment Runoff | 1,675 | 1,952 | 2,071 | 2,058 | 1,846 | 1,898 |
| Direct Rainfall | 422 | 451 | 413 | 335 | 311 | 202 |
| Groundwater inflows | 973 | 924 | 646 | 432 | 482 | 190 |
| External water supply | 0 | 0 | 0 | 0 | 0 | 2 |
| **GROSS WATER INPUTS** | **3,070** | **3,327** | **3,130** | **2,825** | **2,639** | **2,292** |
| **Water outputs (ML/year)** | | | | | | |
| Evaporation from water storages | 689 | 801 | 761 | 623 | 616 | 414 |
| CHPP demand | 510 | 512 | 455 | 394 | 300 | 165 |
| Dust suppression demand | 525 | 698 | 791 | 770 | 543 | 503 |
| RO Plant discharge | 276 | 996 | 722 | 508 | 558 | 786 |
| Storage overflows - mine water dams | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage overflows - sediment dams | 136 | 180 | 174 | 66 | 33 | 31 |
| Outflows - rehabilitated catchments | 0 | 47 | 219 | 387 | 454 | 580 |
| Outflows - diverted catchments | 115 | 204 | 221 | 158 | 89 | 40 |
| **GROSS WATER OUTPUTS** | **2,251** | **3,348** | **3,343** | **2,906** | **2,593** | **2,519** |
| **Water balance (ML/year)** | | | | | | |
| Change in storage volumes | 819 | -111 | -213 | -81 | 46 | -227 |

### A2.2.2 Mine water dam inventory

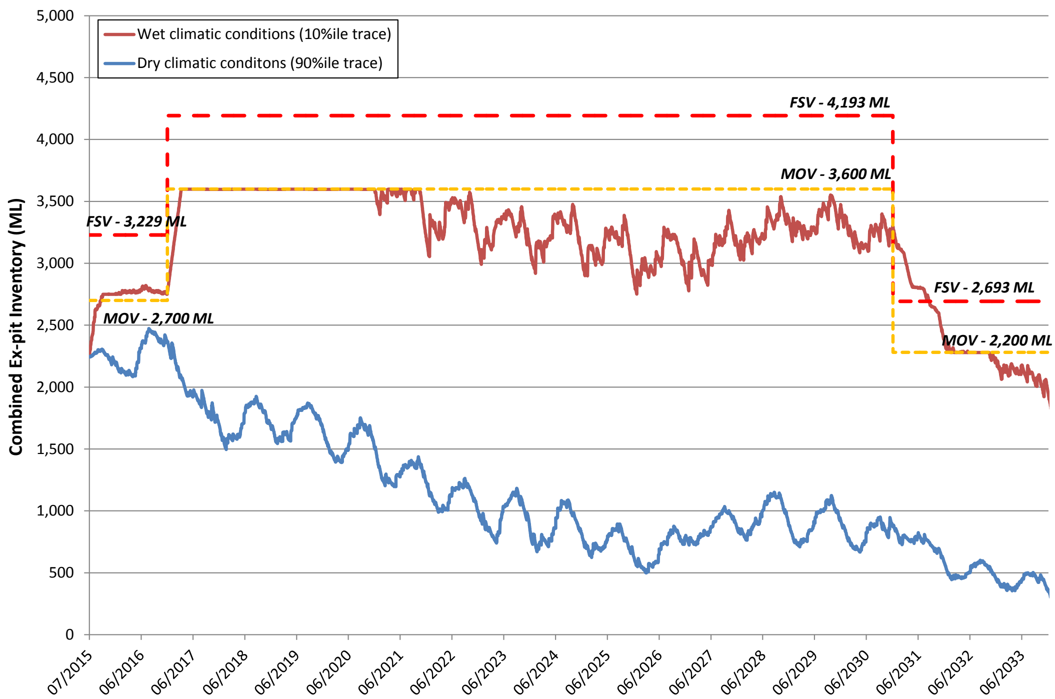



Figure A.22 Forecast mine water inventory - low rejects MC

### A2.2.3 Pit inundation

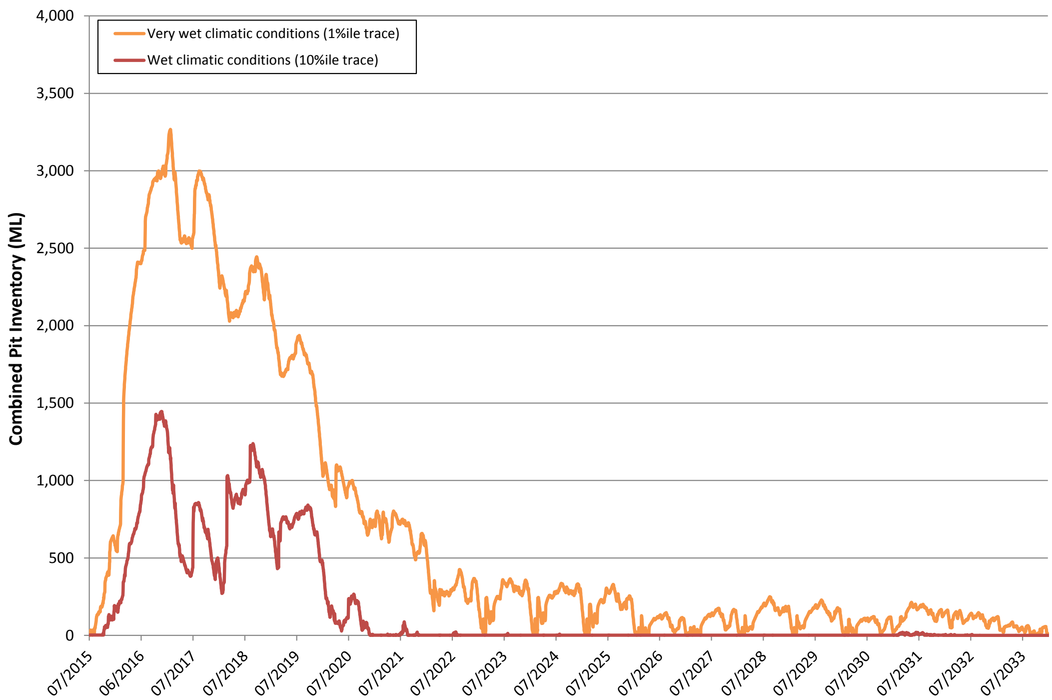



Figure A.23 Forecast pit water inventory - low rejects MC

### A2.2.4 External makeup requirements

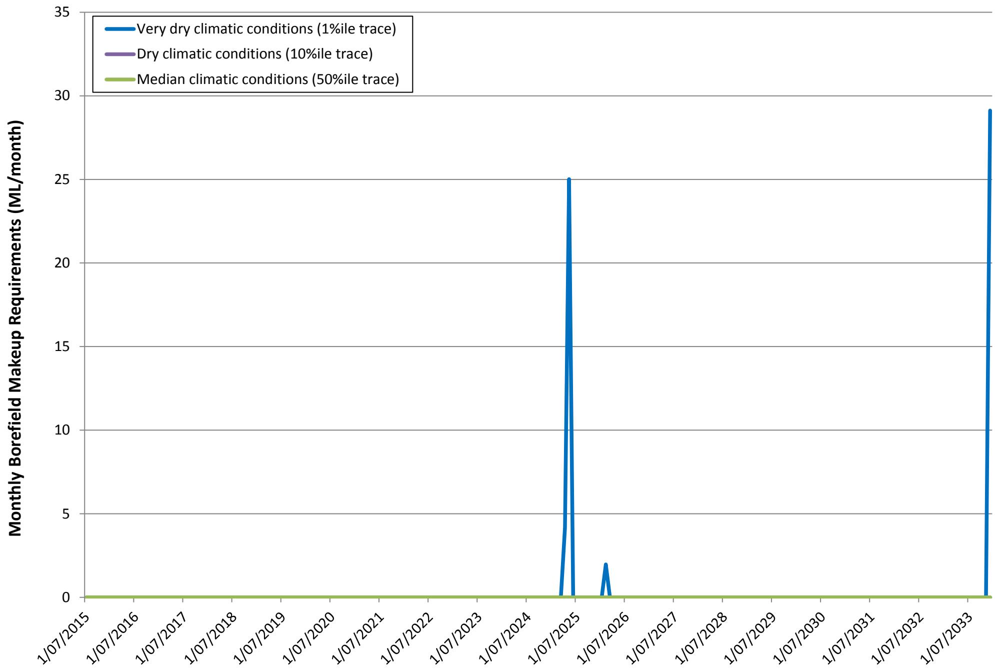



**Figure A.24 - Forecast monthly external water requirements - low rejects MC**

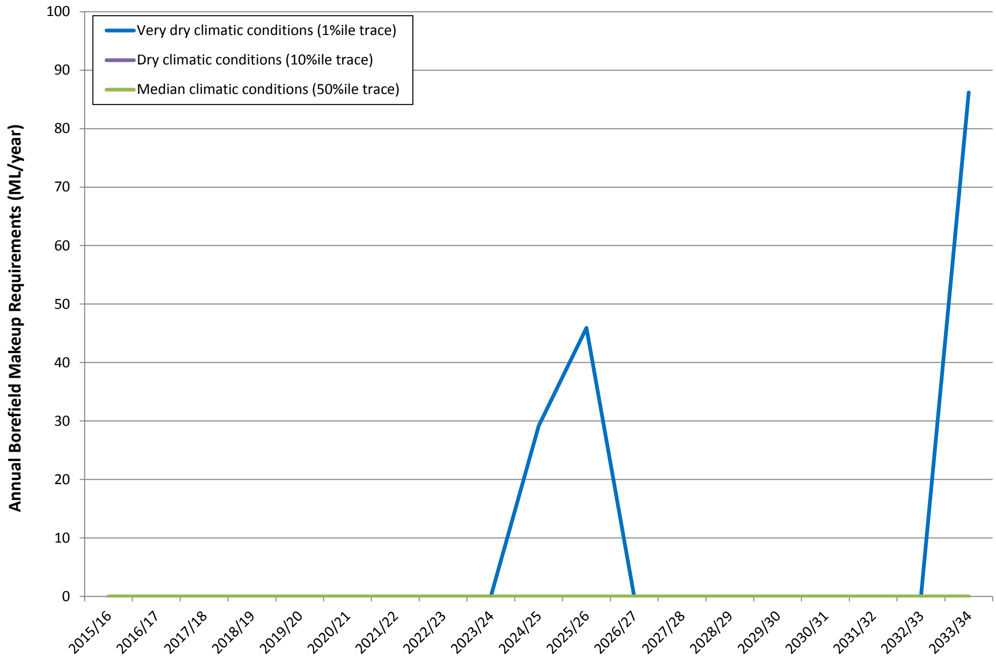



**Figure A.25 - Forecast annual external water requirements - low rejects MC**

### A2.2.5 RO Plant discharges

Table A.8 - Summary of simulated RO Plant discharges - low rejects MC

| Operational period | Annual RO Plant Discharge (ML/year) | | | | |
|---|---|---|---|---|---|
| | 1%ile trace | 10%ile trace | 50%ile trace | 90%ile trace | 99%ile trace |
| Phase 1 (Year 2015-16) | 280 to 760 | 275 to 680 | 265 to 550 | 265 to 545 | 255 to 535 |
| Phase 2 (Year 2017-18) | 1,275 to 1280 | 1,270 to 1,275 | 960 to 1,265 | 0 to 625 | 0 to 355 |
| Phase 3 (Year 2019-21) | 1,270 to 1280 | 1,270 to 1,275 | 515 to 950 | 0 | 0 |
| Phase 4 (Year 2022-25) | 1,275 to 1280 | 1,265 to 1,270 | 360 to 490 | 0 | 0 |
| Phase 5 (Year 2026-30) | 1,270 to 1280 | 1,265 to 1,275 | 400 to 820 | 0 | 0 |
| Phase 6 (Year 2031-33) | 1,275 to 1280 | 1,275 to 1,280 | 560 to 1,280 | 0 | 0 |

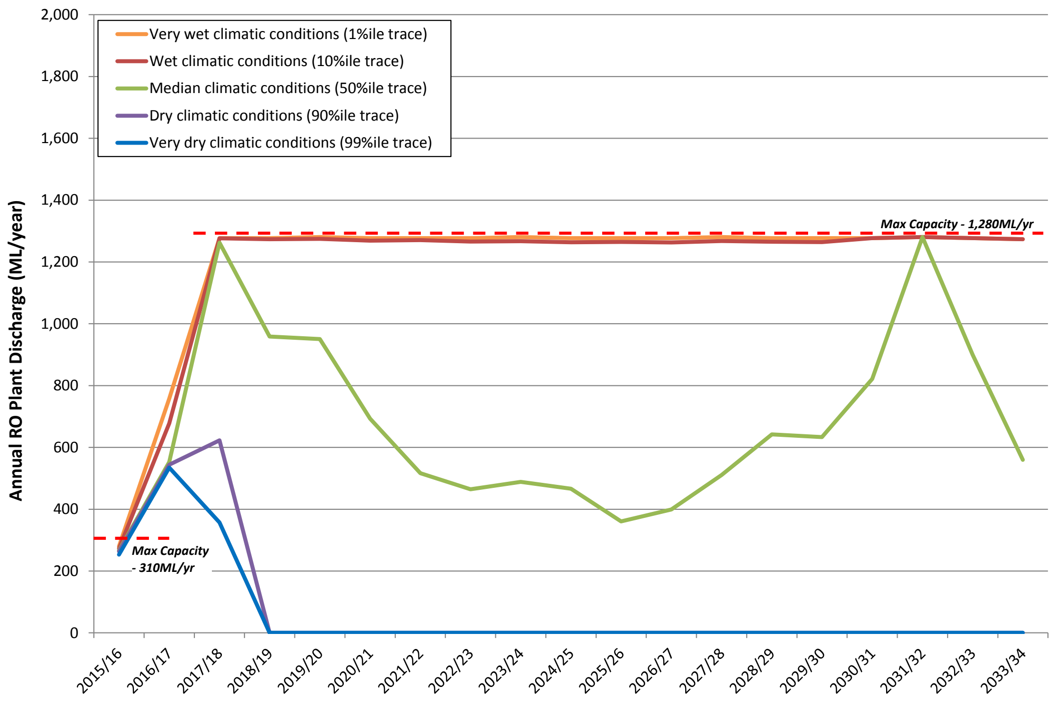



**Figure A.26 - Forecast annual controlled releases - low rejects MC**

### A2.2.6 Uncontrolled spills - mine water system

The model of the water management system has been configured to ensure no uncontrolled discharge of water from mine water storages to the receiving environment. As such, the modelled results show no spills from the mine water system.

### A2.2.7 Uncontrolled spills - sediment dams

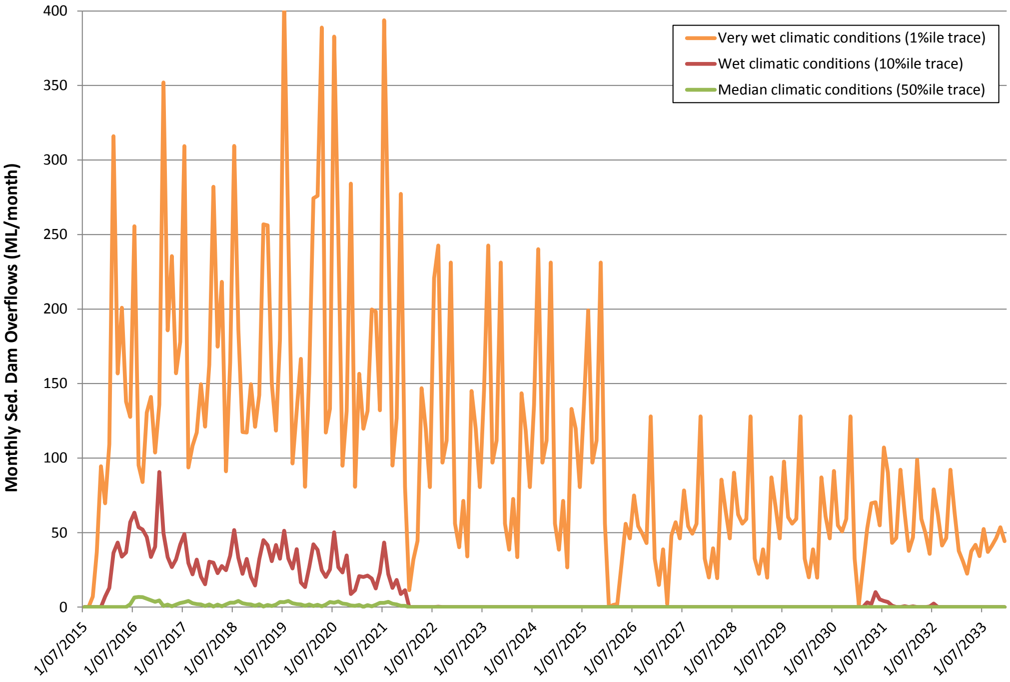



**Figure A.27 - Forecast monthly sediment dam overflows - low rejects MC**

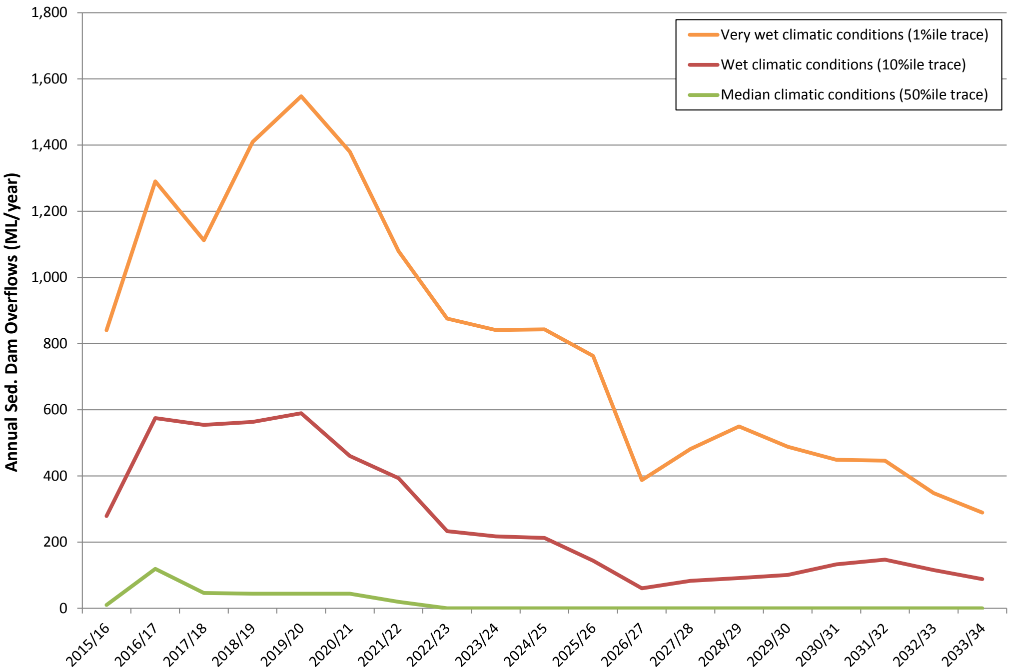



**Figure A.28 - Forecast annual sediment dam overflows - low rejects MC**

# A3 High/Low runoff parameters

## A3.1 HIGH RUNOFF PARAMETERS

For this scenario, the AWBM runoff parameters for the spoil catchment type have been adjusted to result in a higher runoff coefficient (runoff increased by 7.5%). All other parameters have remained unchanged.

### A3.1.1 Overall water balance

Table A.9 - Average annual water balance - all realisations - high runoff parameters

| | Year 2016 | Year 2018 | Year 2020 | Year 2024 | Year 2028 | Year 2031 |
|---|---|---|---|---|---|---|
| **Water inputs (ML/year)** | | | | | | |
| Catchment Runoff | 1,876 | 2,130 | 2,247 | 2,225 | 1,951 | 1,995 |
| Direct Rainfall | 425 | 457 | 418 | 339 | 314 | 205 |
| Groundwater inflows | 973 | 924 | 646 | 432 | 482 | 190 |
| External water supply | 0 | 0 | 0 | 1 | 0 | 2 |
| **GROSS WATER INPUTS** | **3,274** | **3,511** | **3,310** | **2,997** | **2,747** | **2,392** |
| **Water outputs (ML/year)** | | | | | | |
| Evaporation from water storages | 699 | 820 | 774 | 630 | 624 | 420 |
| CHPP demand | 609 | 613 | 542 | 471 | 355 | 195 |
| Dust suppression demand | 525 | 698 | 791 | 770 | 543 | 503 |
| RO Plant discharge | 277 | 1,006 | 777 | 570 | 595 | 821 |
| Storage overflows - mine water dams | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage overflows - sediment dams | 176 | 210 | 205 | 85 | 40 | 43 |
| Outflows - rehabilitated catchments | 0 | 48 | 221 | 393 | 461 | 589 |
| Outflows - diverted catchments | 115 | 204 | 221 | 158 | 89 | 40 |
| **GROSS WATER OUTPUTS** | **2,401** | **3,599** | **3,531** | **3,077** | **2,707** | **2,611** |
| **Water balance (ML/year)** | | | | | | |
| Change in storage volumes | 873 | -88 | -221 | -80 | 40 | -219 |

### A3.1.2 Mine water dam inventory

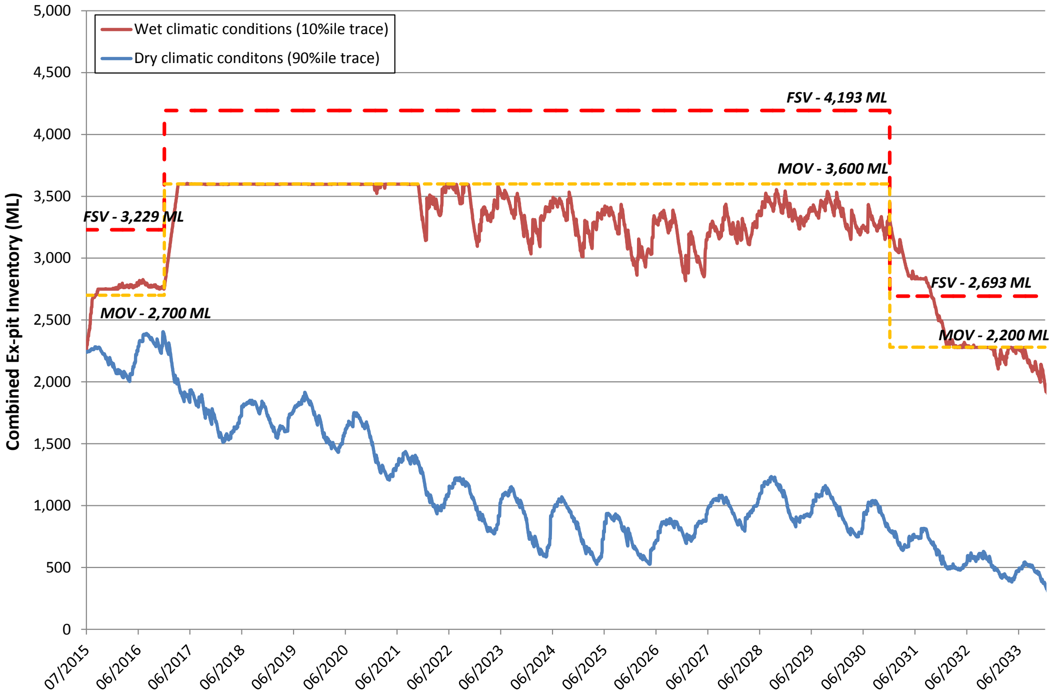



**Figure A.29 Forecast mine water inventory - high runoff parameters**

### A3.1.3 Pit inundation

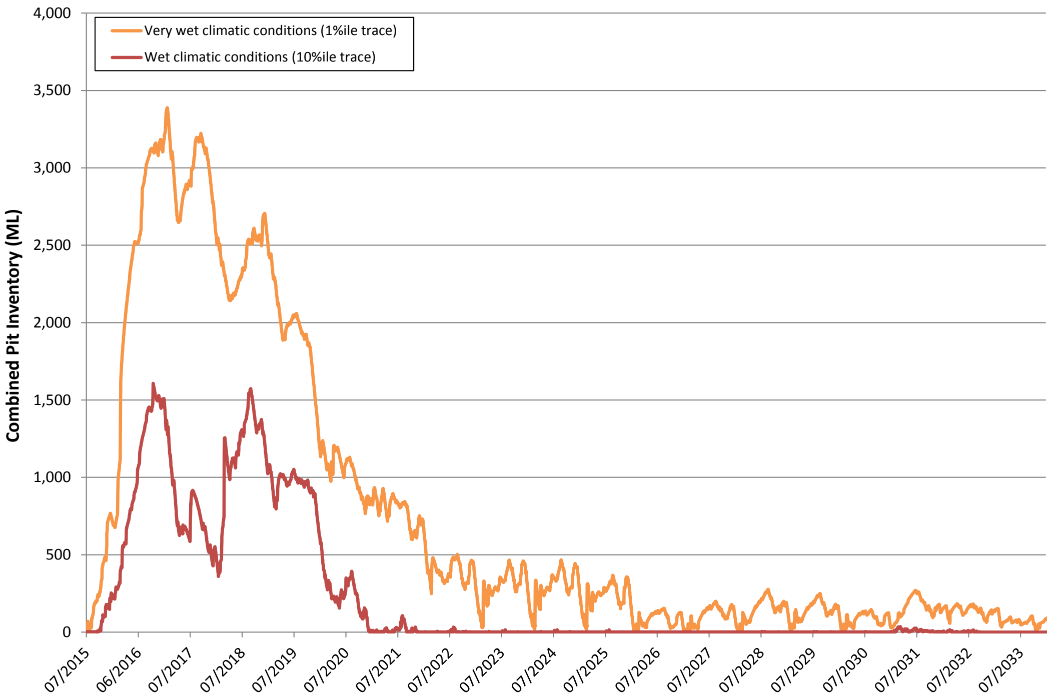



**Figure A.30 Forecast pit water inventory - high runoff parameters**

### A3.1.4 External makeup requirements

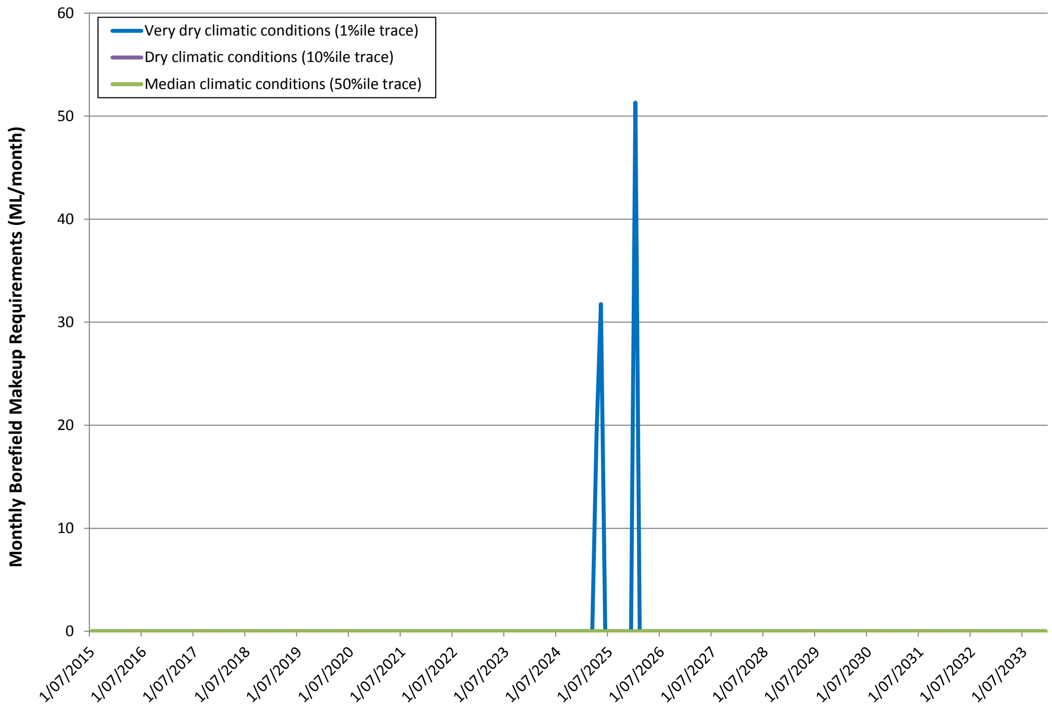



**Figure A.31 - Forecast monthly external water requirements - high runoff parameters**

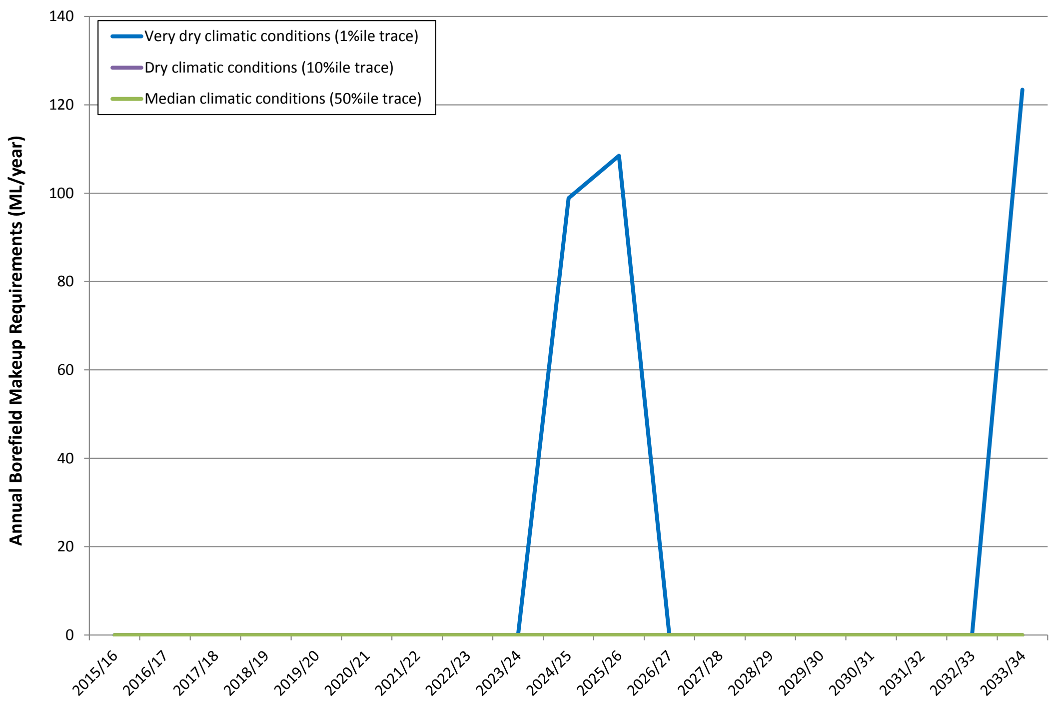



**Figure A.32 - Forecast annual external water requirements - high runoff parameters**

### A3.1.5 RO Plant discharges

Table A.10 - Summary of simulated RO Plant discharges - high runoff parameters

| Operational period | Annual RO Plant Discharge (ML/year) | | | | |
|---|---|---|---|---|---|
| | 1%ile trace | 10%ile trace | 50%ile trace | 90%ile trace | 99%ile trace |
| Phase 1 (Year 2015-16) | 280 to 775 | 275 to 680 | 265 to 550 | 265 to 545 | 250 to 535 |
| Phase 2 (Year 2017-18) | 1,275 to 1280 | 1,270 to 1,275 | 1,145 to 1,265 | 25 to 615 | 0 to 315 |
| Phase 3 (Year 2019-21) | 1,275 to 1280 | 1,270 to 1,280 | 630 to 1,090 | 0 | 0 |
| Phase 4 (Year 2022-25) | 1,275 to 1280 | 1,265 to 1,270 | 470 to 565 | 0 | 0 |
| Phase 5 (Year 2026-30) | 1,275 to 1280 | 1,265 to 1,275 | 425 to 910 | 0 | 0 |
| Phase 6 (Year 2031-33) | 1,275 to 1280 | 1,275 to 1,280 | 630 to 1,280 | 0 to 110 | 0 |

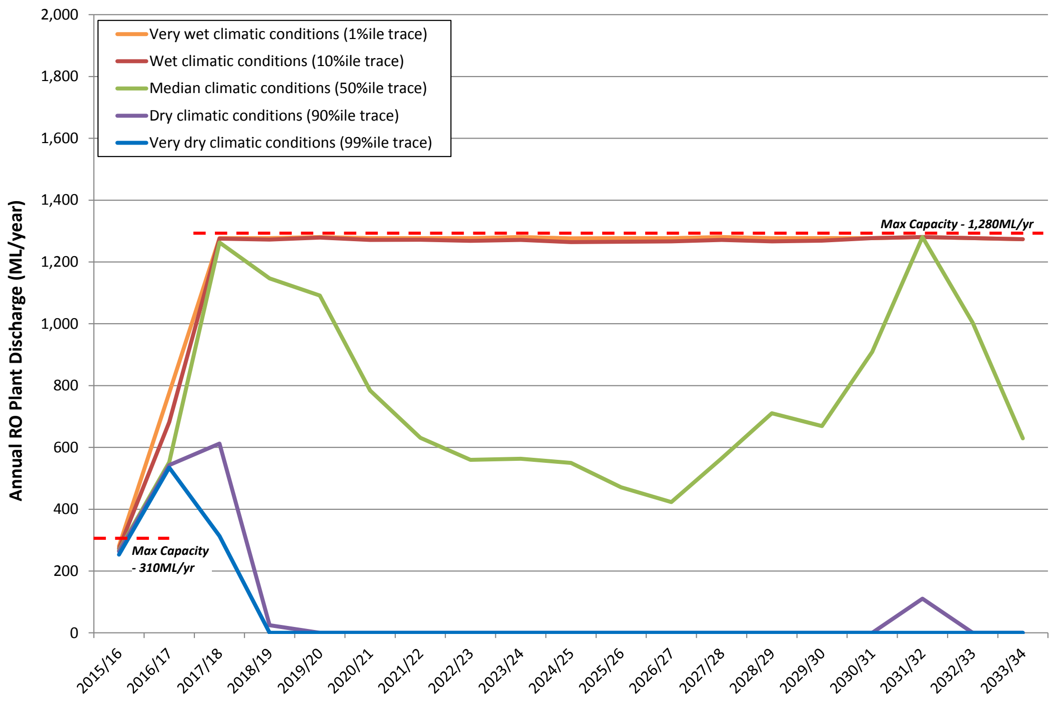



**Figure A.33 - Forecast annual controlled releases - high runoff parameters**

### A3.1.6 Uncontrolled spills - mine water system

The model of the water management system has been configured to ensure no uncontrolled discharge of water from mine water storages to the receiving environment. As such, the modelled results show no spills from the mine water system.

### A3.1.7 Uncontrolled spills - sediment dams

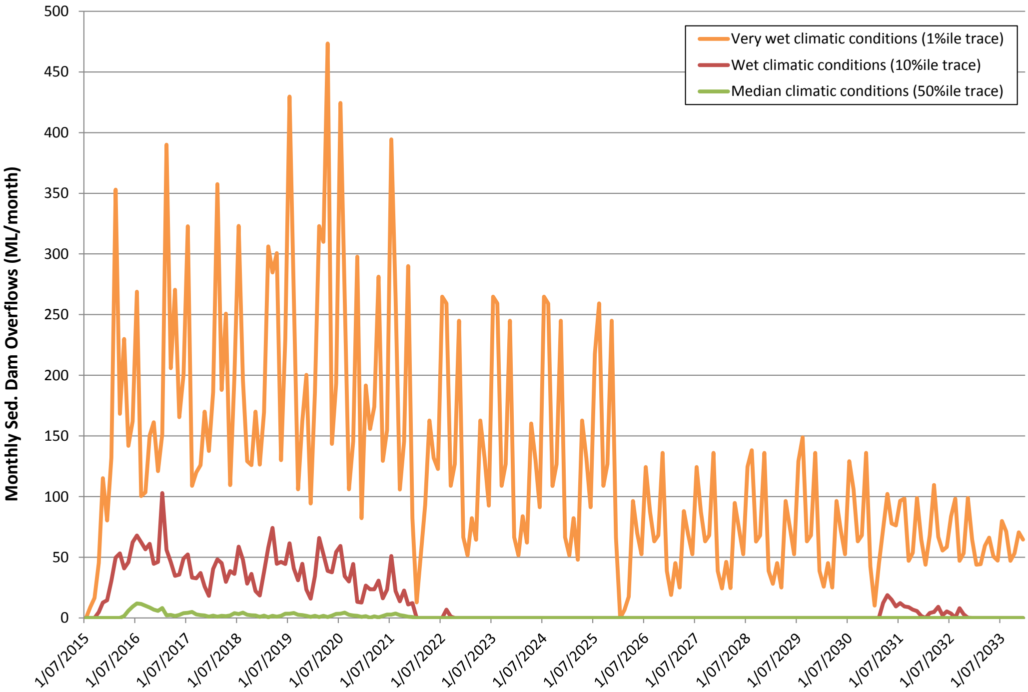



**Figure A.34 - Forecast monthly sediment dam overflows - high runoff parameters**

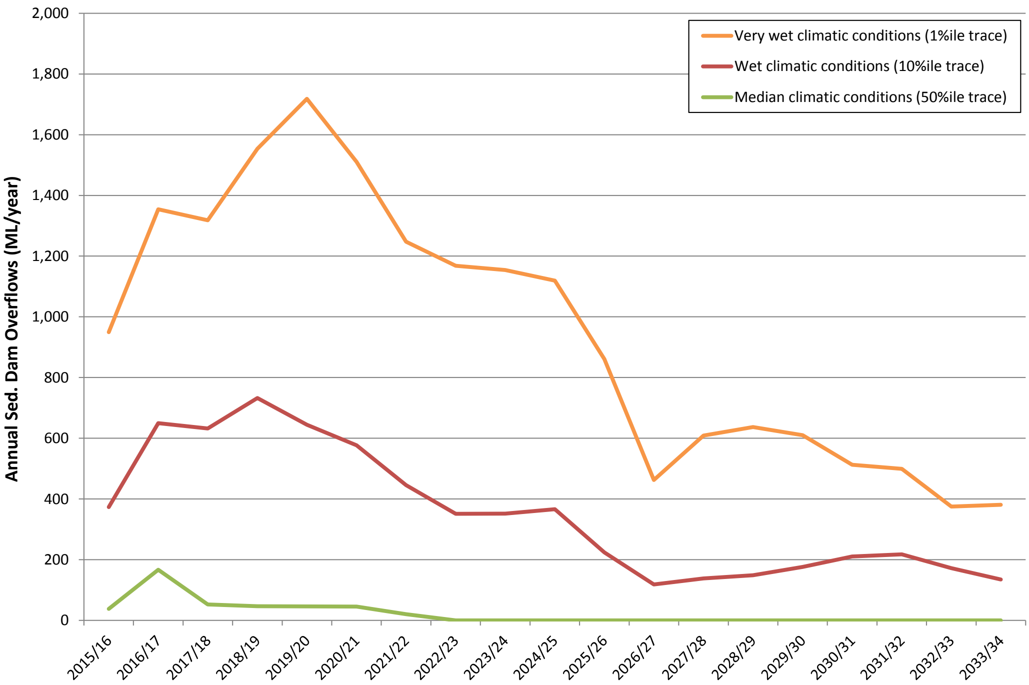



**Figure A.35 - Forecast annual sediment dam overflows - high runoff parameters**

## A3.2 LOW RUNOFF PARAMETERS

For this scenario, the AWBM runoff parameters for the spoil catchment type have been adjusted to result in a lower runoff coefficient (runoff reduced by 3%). All other parameters have remained unchanged.

### A3.2.1 Overall water balance

Table A.11 - Average annual water balance - all realisations - low runoff parameters

| | Year 2016 | Year 2018 | Year 2020 | Year 2024 | Year 2028 | Year 2031 |
|---|---|---|---|---|---|---|
| **Water inputs (ML/year)** | | | | | | |
| Catchment Runoff | 1,604 | 1,884 | 2,004 | 1,996 | 1,803 | 1,857 |
| Direct Rainfall | 417 | 440 | 400 | 322 | 298 | 199 |
| Groundwater inflows | 973 | 924 | 646 | 432 | 482 | 190 |
| External water supply | 0 | 0 | 0 | 3 | 1 | 2 |
| **GROSS WATER INPUTS** | **2,994** | **3,248** | **3,050** | **2,753** | **2,584** | **2,248** |
| **Water outputs (ML/year)** | | | | | | |
| Evaporation from water storages | 662 | 768 | 729 | 591 | 584 | 408 |
| CHPP demand | 609 | 613 | 542 | 471 | 355 | 195 |
| Dust suppression demand | 525 | 698 | 791 | 770 | 543 | 503 |
| RO Plant discharge | 276 | 933 | 619 | 411 | 497 | 697 |
| Storage overflows - mine water dams | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage overflows - sediment dams | 112 | 152 | 134 | 46 | 22 | 21 |
| Outflows - rehabilitated catchments | 0 | 47 | 219 | 381 | 445 | 568 |
| Outflows - diverted catchments | 115 | 204 | 221 | 158 | 89 | 40 |
| **GROSS WATER OUTPUTS** | **2,299** | **3,415** | **3,255** | **2,828** | **2,535** | **2,432** |
| **Water balance (ML/year)** | | | | | | |
| Change in storage volumes | 695 | -167 | -205 | -75 | 49 | -184 |

### A3.2.2 Mine water dam inventory

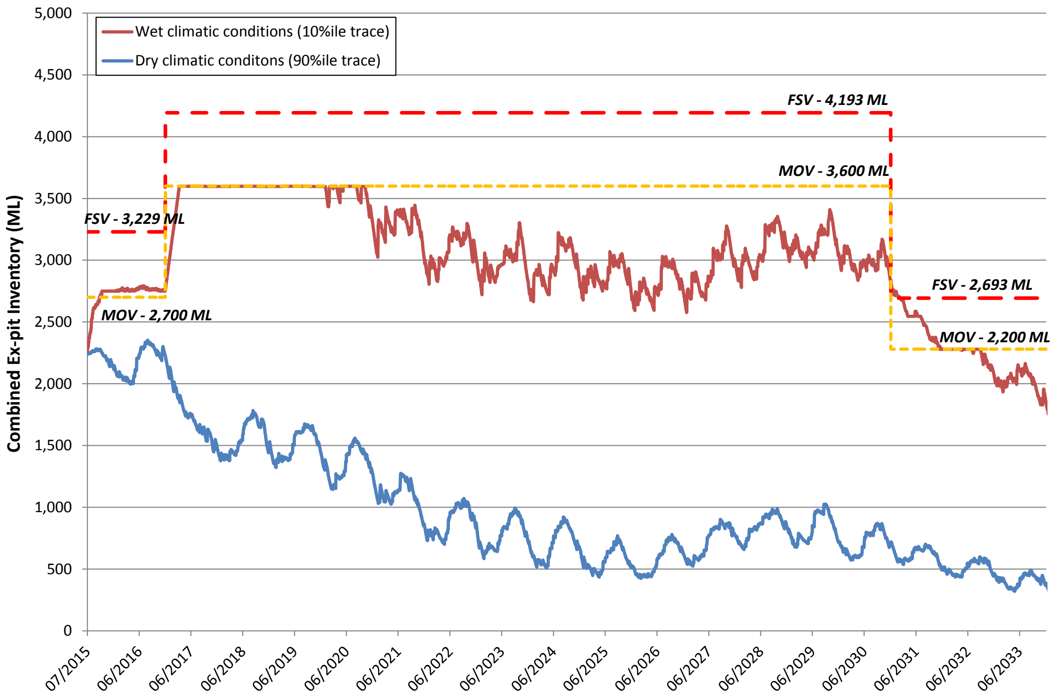



**Figure A.36 Forecast mine water inventory - low runoff parameters**

### A3.2.3 Pit inundation

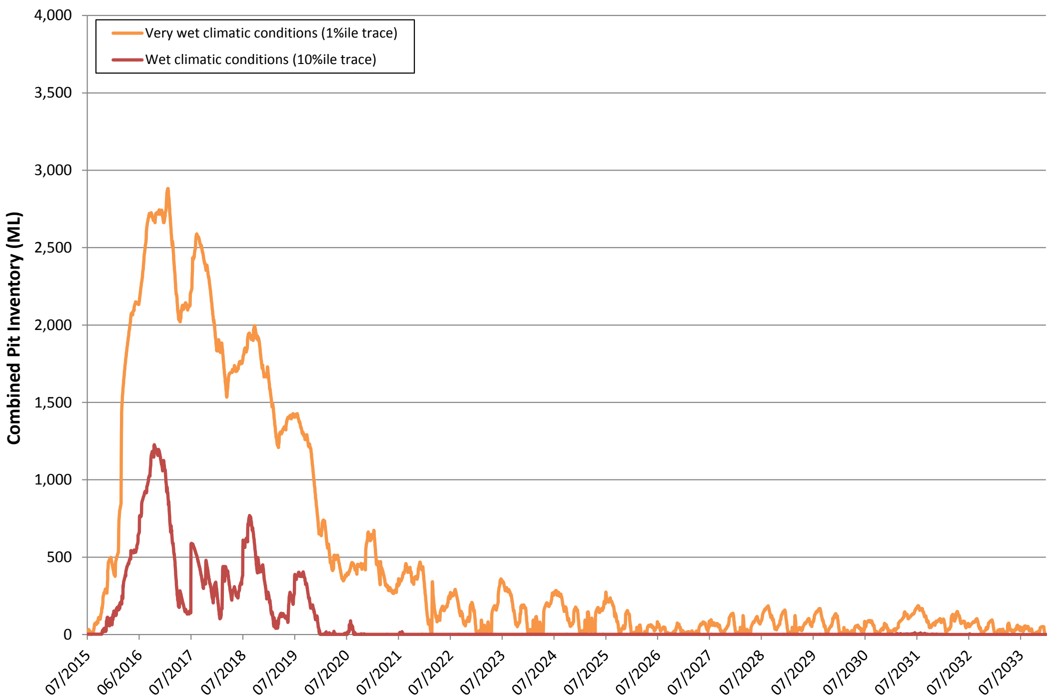



**Figure A.37 Forecast pit water inventory - low runoff parameters**

### A3.2.4 External makeup requirements

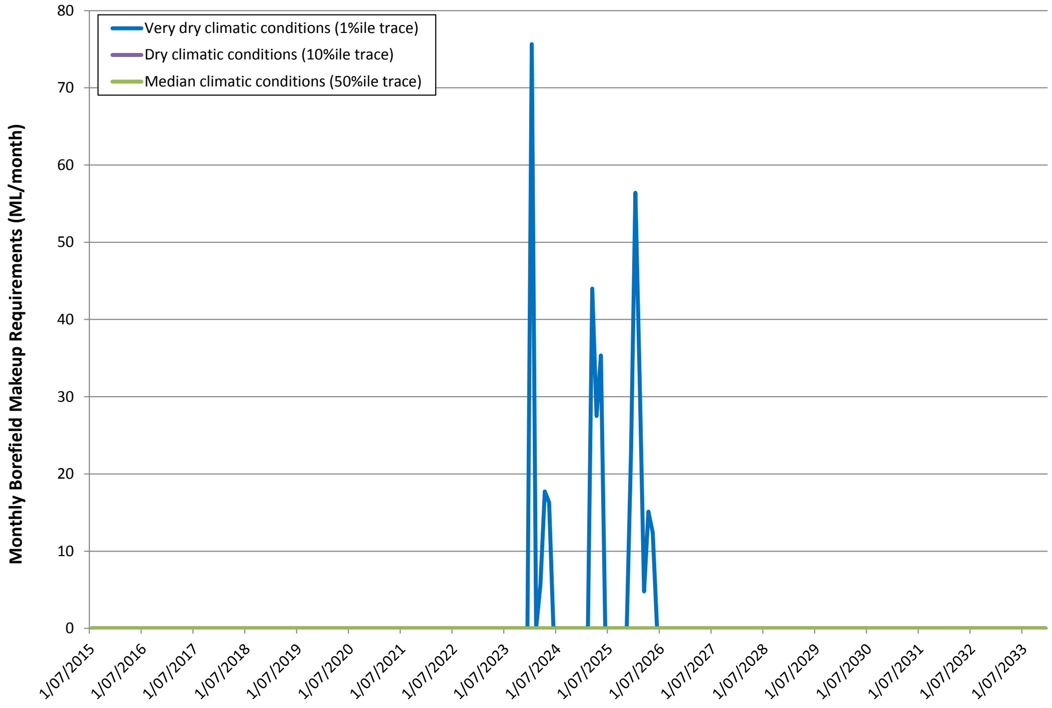



**Figure A.38 - Forecast monthly external water requirements - low runoff parameters**

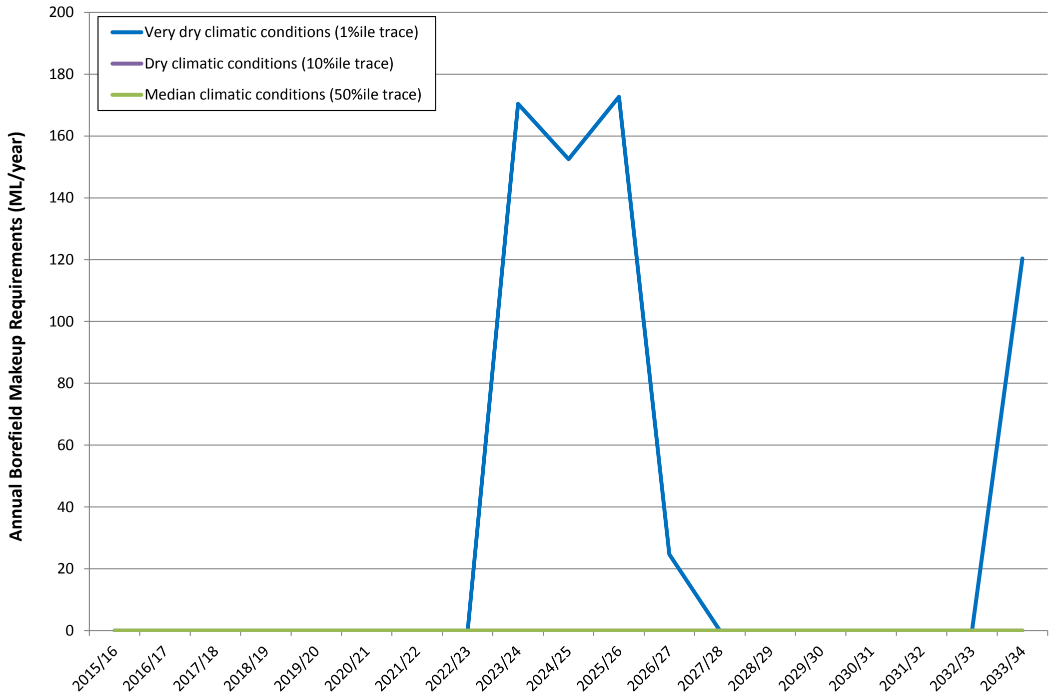



**Figure A.39 - Forecast annual external water requirements - low runoff parameters**

### A3.2.5 RO Plant discharges

Table A.12 - Summary of simulated RO Plant discharges - low runoff parameters

| Operational period | Annual RO Plant Discharge (ML/year) | | | | |
|---|---|---|---|---|---|
| | 1%ile trace | 10%ile trace | 50%ile trace | 90%ile trace | 99%ile trace |
| Phase 1 (Year 2015-16) | 275 to 785 | 275 to 700 | 265 to 555 | 265 to 545 | 255 to 540 |
| Phase 2 (Year 2017-18) | 1,275 to ,1280 | 1,260 to 1,275 | 795 to 1,250 | 0 to 520 | 0 |
| Phase 3 (Year 2019-21) | 1,275 to 1,280 | 1,265 to 1,275 | 385 to 715 | 0 | 0 |
| Phase 4 (Year 2022-25) | 1,275 to 1,280 | 1,260 to 1,265 | 15 to 335 | 0 | 0 |
| Phase 5 (Year 2026-30) | 1,275 to 1,280 | 1,250 to 1,275 | 260 to 630 | 0 | 0 |
| Phase 6 (Year 2031-33) | 1,275 to 1,280 | 1,275 to 1,280 | 505 to 1,080 | 0 | 0 |

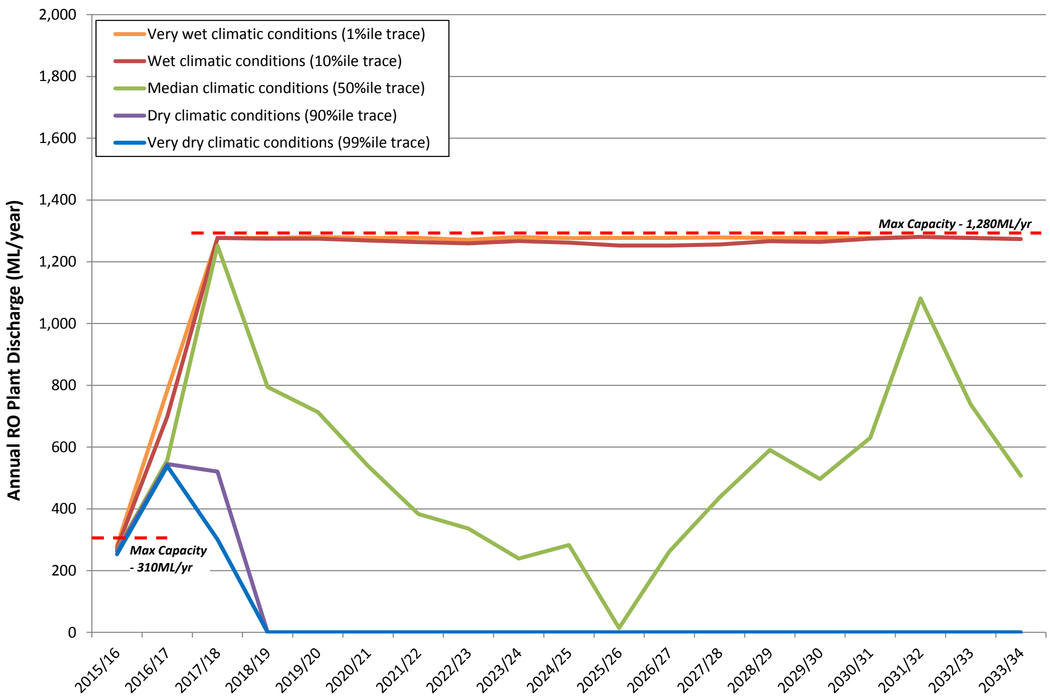



**Figure A.40 - Forecast annual controlled releases - low runoff parameters**

### A3.2.6 Uncontrolled spills - mine water system

The model of the water management system has been configured to ensure no uncontrolled discharge of water from mine water storages to the receiving environment. As such, the modelled results show no spills from the mine water system.

### A3.2.7 Uncontrolled spills - sediment dams

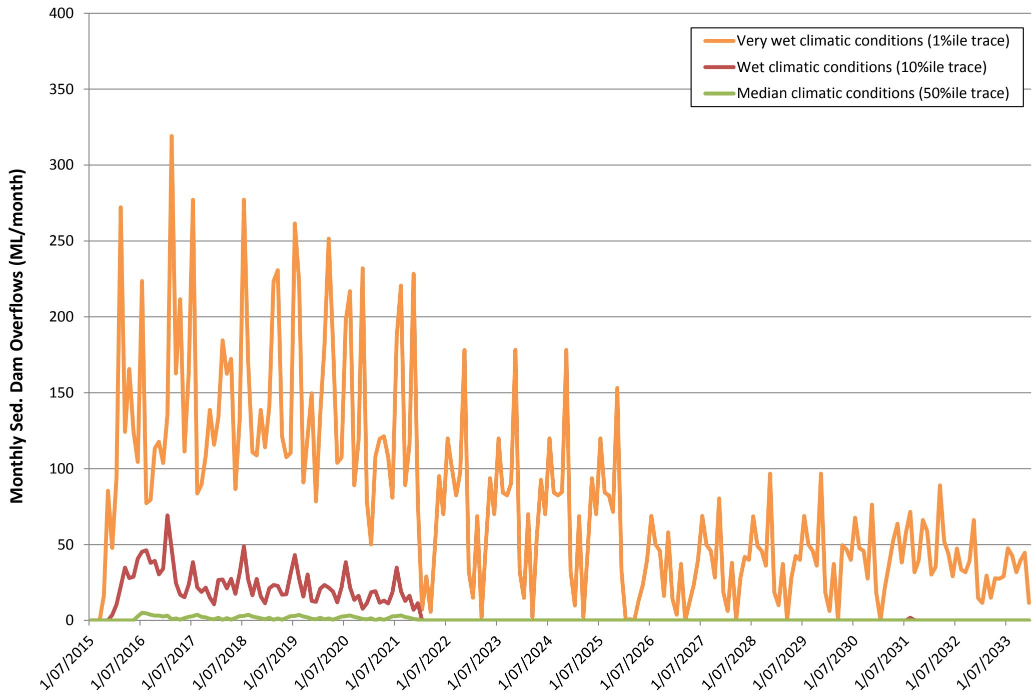



**Figure A.41 - Forecast monthly sediment dam overflows - low runoff parameters**

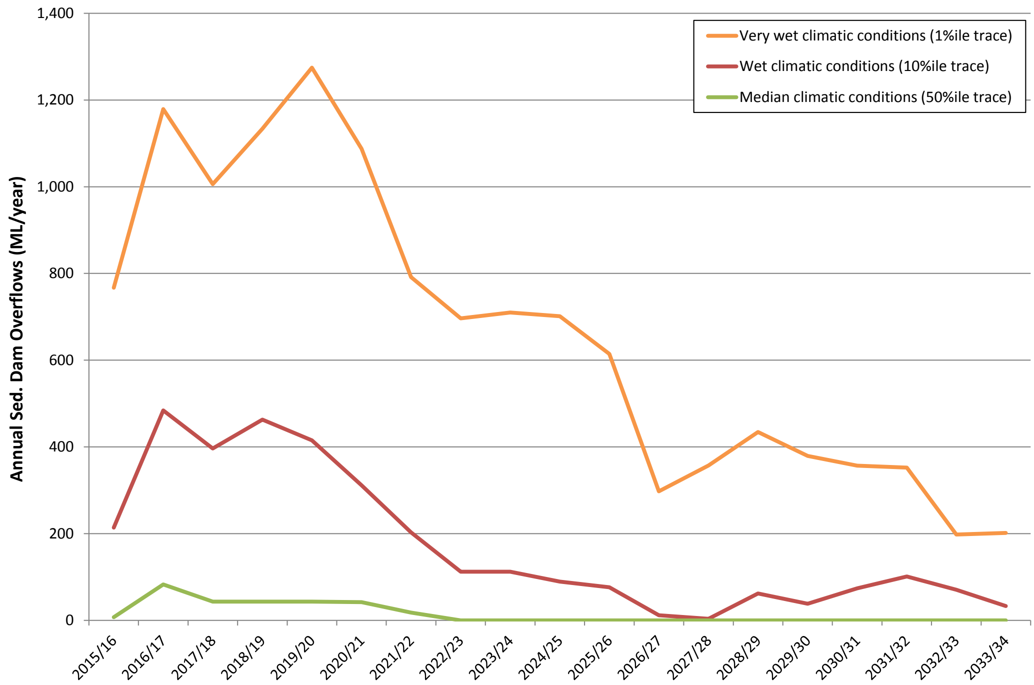



**Figure A.42 - Forecast annual sediment dam overflows - low runoff parameters**

# Appendix B- Catchment Areas

The progressive catchment area for each dam in the mine water management system is reported in the following tables. The catchment areas are shown on Figure 5.1 to Figure 5.6.

Table B.1 - Catchment Areas - Phase 1

| Catchment Type | Area (ha) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Hardstand | Active Pit | Tailings | Spoil Dump | Initial Rehab | Established Rehab | Topsoil Stockpile | Prestrip | Natural |
| AWBM Parameters | Roads/ Hardstand | Open Cut | Tailings | Overburden | Overburden | Rehab Overburden | Rehab Overburden | Rehab Overburden | Natural/ Undisturbed |
| CWD | 2.17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ed's Lake | 14.46 | 0 | 0 | 0 | 107.73 | 0 | 0 | 0 | 0.05 |
| MIA Dam | 3.61 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 |
| Pit 1N | 1.38 | 24.48 | 0 | 16.77 | 23.32 | 0 | 0 | 0 | 166.12 |
| Pit 2 West | 111.77 | 0 | 0 | 45.89 | 96.66 | 0 | 1.27 | 0 | 20.90 |
| Pit 2E | 1.86 | 3.04 | 0 | 4.50 | 0 | 0 | 0 | 0 | 11.08 |
| Pit 3 | 0 | 20.22 | 0 | 0 | 0 | 0 | 0 | 0 | 115.01 |
| Pit 4 | 10.68 | 26.96 | 0 | 26.23 | 35.28 | 0 | 3.62 | 0 | 0.99 |
| Pit 5N | 24.42 | 21.02 | 0 | 26.71 | 242.08 | 0 | 6.74 | 0 | 75.27 |
| Pit 5S - North | 1.65 | 21.62 | 0 | 14.41 | 0 | 0 | 0 | 0 | 216.85 |
| Pit 7 | 1.32 | 8.93 | 0 | 8.08 | 7.06 | 0 | 0 | 0 | 37.26 |
| ROM Dam 1 | 23.53 | 0 | 0 | 3.80 | 0 | 0 | 0 | 0 | 0.12 |
| ROM Dam 3 | 3.47 | 0 | 0 | 6.19 | 0 | 0 | 0 | 0 | 0.37 |
| ROM Dam 5 | 22.14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RWD | 6.99 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7.15 |
| SD2A | 3.39 | 0 | 0 | 11.71 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| SD2C | 39.90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 158.11 |
| SD3A | 0 | 0 | 0 | 11.60 | 4.47 | 0 | 0 | 0 | 0 |
| SD3B | 1.21 | 0 | 0 | 7.23 | 3.56 | 0 | 0 | 0 | 0 |
| SD3C | 13.84 | 0 | 0 | 2.20 | 9.14 | 0 | 0 | 0 | 6.27 |
| SD7D | 8.69 | 0 | 0 | 0 | 29.23 | 0 | 0 | 0 | 25.81 |
| TD4 | 0 | 0 | 0 | 0 | 25.46 | 0 | 4.94 | 0 | 1.30 |
| TD5 | 0 | 0 | 13.53 | 0 | 0 | 0 | 0 | 0 | 0 |
| TD6 | 0 | 0 | 15.53 | 0 | 0 | 0 | 0 | 0 | 0 |
| TD7 | 0 | 0 | 10.68 | 0 | 0 | 0 | 0 | 0 | 0 |

Table B.2 - Catchment Areas - Phase 2

| Catchment Type | Hardstand | Active Pit | Tailings | Spoil Dump | Initial Rehab | Established Rehab | Topsoil Stockpile | Prestrip | Natural |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Area (ha) | | | | |
| AWBM Parameters | Roads/ Hardstand | Open Cut | Tailings | Overburden | Overburden | Rehab Overburden | Rehab Overburden | Rehab Overburden | Natural/ Undisturbed |
| CWD | 2.17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ed's Lake | 14.46 | 0 | 0 | 0 | 0 | 107.73 | 0 | 0 | 0.05 |
| MIA Dam | 3.61 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 |
| Pit 1N | 0 | 3.59 | 0 | 12.97 | 0 | 0 | 0 | 6.60 | 111.59 |
| Pit 2 West | 111.71 | 0 | 0 | 46.02 | 0.18 | 35.92 | 0 | 0 | 22.09 |
| Pit 2E | 2.03 | 6.64 | 0 | 19.53 | 0 | 0 | 0 | 3.81 | 3.46 |
| Pit 3 | 1.67 | 4.33 | 0 | 41.33 | 0.37 | 0 | 0 | 8.30 | 62.34 |
| Pit 4 | 0.85 | 4.30 | 0 | 12.02 | 0 | 0 | 0 | 2.27 | 7.85 |
| Pit 4 Rehab | 8.01 | 0 | 0 | 1.04 | 0 | 31.57 | 0 | 0 | 3.69 |
| Pit 5N | 23.68 | 3.55 | 0 | 20.94 | 43.70 | 210.77 | 0 | 3.03 | 84.70 |
| Pit 5S | 0 | 4.00 | 0 | 23.15 | 0 | 0 | 0 | 6.11 | 129.27 |
| Pit 6 | 2.51 | 3.89 | 0 | 6.96 | 0.84 | 1.95 | 0 | 0 | 12.75 |
| Pit 7 | 1.06 | 11.26 | 0 | 14.23 | 0 | 0 | 0 | 6.45 | 1.98 |
| Pit 8 | 0 | 19.03 | 0 | 0 | 0 | 0 | 0 | 9.73 | 159 |
| ROM Dam 1 | 36.63 | 0 | 0 | 0 | 3.55 | 0 | 0 | 0 | 0 |
| ROM Dam 3 | 16.96 | 0 | 0 | 0 | 0.45 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ROM Dam 5 | 22.14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RWD | 7.22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| SD1A | 0 | 0 | 0 | 0 | 31.01 | 24.59 | 0 | 0 | 29 |
| SD2A | 3.39 | 0 | 0 | 11.71 | 0 | 0 | 0 | 0 | 0 |
| SD2C | 39.90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 158.11 |
| SD3A | 0 | 0 | 0 | 0 | 29.55 | 0 | 0 | 0 | 0 |
| SD3B | 1.52 | 0 | 0 | 0 | 13.63 | 0 | 0 | 0 | 0 |
| SD3C | 14.15 | 0 | 0 | 0 | 12.60 | 0 | 0 | 0 | 6 |
| SD4A | | 0 | 0 | 0 | 14.79 | 0 | 0 | 0 | 1 |
| SD4B | 3.24 | 0 | 0 | 0 | 31.21 | 0 | 0 | 0 | 0 |
| SD4C | 3.42 | 0 | 0 | 0 | 22.54 | 0 | 0 | 0 | 0 |
| SD5A | 2.88 | 0 | 0 | 0 | 10.35 | 0 | 0 | 0 | 10 |
| SD5B | 3.96 | 0 | 0 | 0 | 28.49 | 0 | 0 | 0 | 1 |
| SD5C | 0 | 0 | 0 | 0 | 25.19 | 0 | 0 | 0 | 19 |
| SD6A/B | 0 | 0 | 0 | 0 | 17.37 | 0 | 0 | 0 | 0 |
| SD7A | 0 | 0 | 0 | 0 | 7.54 | 0 | 0 | 0 | 0 |
| SD7B | 1.09 | 0 | 0 | 0 | 9.07 | 0 | 0 | 0 | 0 |
| SD7C | 1.07 | 0 | 0 | 0 | 8.32 | 0 | 0 | 0 | 0 |
| SD7D | 8.69 | 0 | 0 | 0.19 | 0 | 29.23 | 0 | 0.23 | 25 |
| TD Rehab | 1.51 | 0 | 0 | 0 | 0 | 65.69 | 0 | 0 | 0 |
| TD4 | 0 | 0 | 0 | 0.66 | 19.16 | 6.59 | 0 | 0 | 6 |
| TD5 | 0 | 0 | 13.53 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| TD6 | 0 | 0 | 15.53 | 0 | 0 | 0 | 0 | 0 | 0 |
| TD7 | 0 | 0 | 10.68 | 0 | 0 | 0 | 0 | 0 | 0 |

Table B.3 - Catchment Areas - Phase 3

| | Area (ha) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Catchment Type | Hardstand | Active Pit | Tailings | Spoil Dump | Initial Rehab | Established Rehab | Topsoil Stockpile | Prestrip | Natural |
| AWBM Parameters | Roads/ Hardstand | Open Cut | Tailings | Overburden | Overburden | Rehab Overburden | Rehab Overburden | Rehab Overburden | Natural/ Undisturbed |
| CWD | 2.17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ed's Lake | 14.46 | 0 | 0 | 0 | 0 | 107.73 | 0 | 0 | 0.05 |
| MIA Dam | 3.61 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 |
| Pit 1N | 0.80 | 3.20 | 0 | 9.17 | 0 | 0 | 0 | 5.43 | 64.16 |
| Pit 2 West | 111.71 | 0 | 0 | 56.68 | 0.17 | 25.06 | 0 | 0 | 22.29 |
| Pit 2S | 5.45 | 4.19 | 0 | 7.12 | 1.83 | 0 | 0 | 5.16 | 118.43 |
| Pit 3 | 1.81 | 8.58 | 0 | 36.01 | 0 | 0 | 0 | 6.78 | 31.88 |
| Pit 4 Rehab | 8.68 | 0 | 0 | 0.23 | 4.54 | 78.31 | 3.62 | 0 | 0.15 |
| Pit 5 Rehab | 32.52 | 0 | 0 | 0 | 0 | 321.00 | 9.03 | 0 | 72.09 |
| Pit 5N | 1.46 | 0 | 0 | 14.41 | 26.56 | 0 | 0.17 | 0 | 1.90 |
| Pit 5S North | 0.83 | 3.26 | 0 | 5.84 | 0 | 0 | 0 | 3.27 | 14.67 |
| Pit 5S South | 0 | 5.15 | 0 | 4.86 | 0 | 0 | 0 | 5.25 | 11.77 |
| Pit 6 | 4.19 | 8.28 | 0 | 23.64 | 0 | 2.56 | 0.12 | 4.13 | 13.62 |
| Pit 8 | 8.47 | 14.91 | 0 | 33.44 | 0 | 0 | 6.09 | 0 | 124 |
| ROM Dam 1 | 36.63 | 0 | 0 | 0 | 3.54 | 0 | 0 | 0 | 0.01 |
| ROM Dam 2 | 28.27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ROM Dam 3 | 17.55 | 0 | 0 | 0 | 6.89 | 0 | 0 | 0 | 0.06 |
| ROM Dam 5 | 22.14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RWD | 7.22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| SD1A | 2.53 | 0 | 0 | 7.94 | 41.00 | 33.84 | 1.63 | 0 | 49.63 |
| SD2A | 3.39 | 0 | 0 | 11.71 | 0 | 0 | 0 | 0 | 0.00 |
| SD2C | 0 | 0 | 0 | 16.87 | 0 | 0 | 0 | 0 | 10.63 |
| SD2E | 2.03 | 0 | 0 | 0.20 | 29.70 | 0 | 0 | 0 | 2 |
| SD3A | 0 | 0 | 0 | 0 | 25.04 | 19.01 | 0 | 0 | 0 |
| SD3B | 2.86 | 0 | 0 | 0 | 11.11 | 15.12 | 0 | 0 | 0 |
| SD3C | 15.27 | 0 | 0 | 0 | 6.11 | 13.33 | 4.96 | 0 | 1 |
| SD4D | 0 | 0 | 0 | 0 | 21.67 | 0 | 2.38 | 0 | 1 |
| SD4E | 3.12 | 0 | 0 | 5.68 | 17.80 | 0 | 0 | 0 | 0 |
| SD5A | 4.71 | 0 | 0 | 0 | 10.12 | 8.03 | 0.54 | 0 | 32 |
| SD5B | 4.24 | 0 | 0 | 0 | 23.66 | 17.53 | 0.90 | 0 | 27 |
| SD5C | 3.21 | 0 | 0 | 0 | 31.99 | 11.22 | 0 | 0 | 35 |
| SD7A | 0 | 0 | 0 | 0 | 9.36 | 5.01 | 0 | 0 | 0 |
| SD7B | 2.16 | 0 | 0 | 4.75 | 13.00 | 5.92 | 0 | 0 | 1 |
| SD7C | 2.10 | 0 | 0 | 0 | 10.56 | 5.57 | 0 | 0.21 | 3 |
| SD7D | 15.72 | 4.26 | 0 | 35.25 | 0.25 | 29.24 | 13.89 | 3.09 | 10 |
| TD5 | 0 | 0 | 0 | 3.79 | 10.41 | 0 | 0 | 0 | 0 |
| TD6 | 0 | 0 | 15.53 | 0 | 0 | 0 | 0 | 0 | 0 |
| TD7 | 0 | 0 | 10.68 | 0 | 0 | 0 | 0 | 0 | 0 |

Table B.4 - Catchment Areas - Phase 4

| | Area (ha) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Catchment Type | Hardstand | Active Pit | Tailings | Spoil Dump | Initial Rehab | Established Rehab | Topsoil Stockpile | Prestrip | Natural |
| AWBM Parameters | Roads/ Hardstand | Open Cut | Tailings | Overburden | Overburden | Rehab Overburden | Rehab Overburden | Rehab Overburden | Natural/ Undisturbed |
| CWD | 2.17 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 |
| Ed's Lake | 12.45 | 0 | 0 | 0 | 0 | 109.74 | 0 | 0 | 0.05 |
| MIA Dam | 3.61 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 |
| Pit 2 Rehab | 2.02 | 0 | 0 | 0 | 0.74 | 29.16 | 0 | 0 | 2.43 |
| Pit 2 West | 111.71 | 0 | 0 | 0 | 45.82 | 36.28 | 0 | 0 | 22.11 |
| Pit 3 | 1.29 | 1.38 | 0 | 14.18 | 0 | 0 | 0 | 0.67 | 2.03 |
| Pit 4 Rehab | 0.22 | 0 | 0 | 0 | 3.21 | 92.08 | 0 | 0 | 0.01 |
| Pit 5 Rehab | 42.85 | 0 | 0 | 1.50 | 0 | 494.44 | 4.88 | 0 | 139.44 |
| Pit 5S | 0.62 | 3.77 | 0 | 5.36 | 0 | 0 | 0 | 7.19 | 26.32 |
| Pit 6N | 11.84 | 17.33 | 0 | 26.71 | 27.05 | 24.81 | 4.52 | 5.89 | 36.17 |
| Pit 6S | 0 | 4.40 | 0 | 32.54 | 0 | 0.26 | 0 | 7.42 | 20.51 |
| Pit 7 Rehab | 0 | 0 | 0 | 0 | 1.01 | 91.20 | 0 | 0 | 4.78 |
| Pit 8 | 5.66 | 10.78 | 0 | 28.71 | 0 | 0 | 2.91 | 10.51 | 112.53 |
| ROM Dam 1 | 37.00 | 0 | 0 | 0 | 0 | 3.54 | 0 | 0 | 0 |
| ROM Dam 2 | 28.27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.06 |
| ROM Dam 5 | 22.14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ROM Dam 8 | 13.35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 |
| RWD | 7.22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| SD1A | 0 | 0 | 0 | 0 | 5.06 | 100.09 | 0 | 0 | 114 |
| SD2C | 4.62 | 0 | 0 | 0 | 33.75 | 43.53 | 0 | 0 | 88.03 |
| SD2D | 3.39 | 0 | 0 | 0 | 31.04 | 10.40 | 0 | 0 | 0.01 |
| SD3C | 12.63 | 0 | 0 | 0 | 10.50 | 110.27 | 0 | 0 | 1.06 |
| SD3D | 1.72 | 0 | 0 | 0 | 62.52 | 0 | 1.44 | 0 | 3 |
| SD3E | 3.64 | 0 | 0 | 0 | 14.95 | 8.37 | 2.07 | 0 | 0 |
| SD4E | 0 | 0 | 0 | 0 | 17.73 | 33.13 | 0 | 0 | 1 |
| SD5D | 1.38 | 0 | 0 | 5.24 | 9.10 | 0 | 0.54 | 0 | 87 |
| SD5E | 7.53 | 0 | 0 | 0 | 50.22 | 0 | 3.43 | 0 | 173 |
| SD7D | 13.74 | 0 | 0 | 13.39 | 43.83 | 7.83 | 0.35 | 0 | 35 |
| SD8A | 5.97 | 0 | 0 | 0 | 20.07 | 5.42 | 4.69 | 0 | 1 |
| SD8B | 7.05 | 0 | 0 | 0 | 16.64 | 11.52 | 1.89 | 0 | 0 |
| SD8C | 2.35 | 0 | 0 | 0 | 10.93 | 0 | 0 | 0 | 0 |
| TD7 | 0 | 0 | 10.68 | 0 | 0 | 0 | 0 | 0 | 0 |

Table B.5 - Catchment Areas - Phase 5

| Catchment Type | Hardstand | Active Pit | Tailings | Spoil Dump | Initial Rehab | Established Rehab | Topsoil Stockpile | Prestrip | Natural |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Area (ha) | | | | |
| AWBM Parameters | Roads/ Hardstand | Open Cut | Tailings | Overburden | Overburden | Rehab Overburden | Rehab Overburden | Rehab Overburden | Natural/ Undisturbed |
| Cumbo Pit | 0 | 2.10 | 0 | 2.38 | 13.67 | 0 | 4.40 | 0 | 0 |
| CWD | 2.17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ed's Lake | 8.76 | 0 | 0 | 0 | 4.79 | 105.77 | 0 | 0 | 2.91 |
| MIA Dam | 3.61 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 |
| Pit 1S Dam | 0 | 0 | 0 | 0 | 0 | 0.27 | 0 | 0 | 22.61 |
| Pit 2 Rehab | 2.00 | 0 | 0 | 0 | 0.75 | 28.75 | 0 | 0 | 2.87 |
| Pit 2 West | 111.64 | 0 | 0 | 0 | 44.55 | 36.89 | 0 | 0 | 22.87 |
| Pit 4 Rehab | 0.21 | 0 | 0 | 0 | 0.88 | 146.31 | 0 | 0 | 0.52 |
| Pit 5 Rehab | 8.68 | 0 | 0 | 0 | 7.87 | 617.71 | 0 | 0 | 772.00 |
| Pit 6 | 7.05 | 21.81 | 0 | 31.88 | 2.52 | 0 | 0 | 19.70 | 4.90 |
| Pit 7 Rehab | 0 | 0 | 0 | 0 | 0 | 97.66 | 0 | 0 | 63.39 |
| Pit 8 | 2.64 | 7.56 | 0 | 8.27 | 0 | 0 | 0 | 5.97 | 14.06 |
| Pit 8 MWD | 3.41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30.09 |
| ROM Dam 1 | 36.99 | 0 | 0 | 0 | 0 | 3.43 | 0 | 0 | 0 |
| ROM Dam 2 | 28.25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.08 |
| ROM Dam 5 | 18.67 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ROM Dam 6 | 8.20 | 0 | 0 | 0 | 0 | 0.11 | 0 | 0 | 0 |
| ROM Dam 7 | 11.85 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RWD | 7.25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| SD1A | 0 | 0 | 0 | 0 | 0 | 105.42 | 0 | 0 | 113.38 |
| SD2C | 4.65 | 0 | 0 | 0 | 0 | 77.17 | 0 | 0 | 88.08 |
| SD2D | 3.41 | 0 | 0 | 0 | 13.60 | 27.77 | 0 | 0 | 0.08 |
| SD3C | 2.78 | 0 | 0 | 0 | 14.30 | 220.85 | 0 | 0 | 81 |
| SD6A | 6.25 | 0 | 0 | 5.61 | 17.75 | 40.24 | 2.22 | 0 | 64 |
| SD6B | 0 | 0 | 0 | 2.02 | 18.64 | 47.26 | 4.58 | 0 | 0 |
| SD6C | 11.37 | 0 | 0 | 0 | 38.72 | 33.79 | 4.17 | 0 | 1 |
| SD7D | 11.27 | 0 | 0 | 0 | 6.00 | 32.61 | 0.36 | 0 | 9 |
| SD7E | 0 | 0 | 0 | 0 | 10.84 | 0 | 0 | 0 | 14 |
| SD8D | 1.12 | 0 | 0 | 0 | 33.48 | 108.79 | 0 | 0 | 5 |
| SD8E | 2.96 | 0 | 0 | 0 | 78.84 | 0 | 0 | 0 | 12 |
| TD7 | 0 | 0 | 10.67 | 0 | 0 | 0 | 0 | 0 | 0 |

Table B.6 - Catchment Areas - Phase 6

| Catchment Type | Area (ha) Hardstand | Active Pit | Tailings | Spoil Dump | Initial Rehab | Established Rehab | Topsoil Stockpile | Prestrip | Natural |
|---|---|---|---|---|---|---|---|---|---|
| AWBM Parameters | Roads/ Hardstand | Open Cut | Tailings | Overburden | Overburden | Rehab Overburden | Rehab Overburden | Rehab Overburden | Natural/ Undisturbed |
| CWD | 2.17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ed's Lake | 8.80 | 0 | 0 | 0 | 0 | 112.58 | 0 | 0 | 1.98 |
| Pit 1N | 1.22 | 3.02 | 0 | 0 | 0 | 0 | 0 | 4.28 | 69.02 |
| Pit 2 Rehab | 2.00 | 0 | 0 | 0 | 0.75 | 29.17 | 0 | 0 | 2.43 |
| Pit 2 West | 104.42 | 0 | 0 | 0 | 44.64 | 37.49 | 0 | 0 | 22.14 |
| Pit 4 Rehab | 0.21 | 0 | 0 | 0 | 0 | 146.82 | 0 | 0 | 0.05 |
| Pit 5 Rehab | 6.44 | 0 | 0 | 0 | 2.74 | 664.82 | 0 | 0 | 773.93 |
| Pit 6 | 3.97 | 6.92 | 0 | 14.48 | 0.11 | 0 | 0 | 6.53 | 4.98 |
| Pit 8 | 1.73 | 2.88 | 0 | 11.29 | | 0 | 0 | 1.40 | 3.03 |
| Pit 8 Rehab | 1.12 | 0 | 0 | 0 | 0.17 | 221.36 | 0 | 0 | 215.46 |
| ROM Dam 1 | 35.56 | 0 | 0 | 0 | 0 | 3.57 | 0 | 0 | 0.03 |
| ROM Dam 2 | 28.36 | 0 | 0 | 0 | 0 | 0.01 | 0 | 0 | 0.07 |
| ROM Dam 5 | 16.61 | 0 | 0 | 0 | 2.06 | 0 | 0 | 0 | 0.03 |
| ROM Dam 6 | 8.20 | 0 | 0 | 0 | 0 | 0.12 | 0 | 0 | 0 |
| ROM Dam 7 | 11.85 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RWD | 20.80 | 0 | 0 | 0 | 0 | 0.15 | 0 | 0 | 16 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| SD1A | 1.76 | 0 | 0 | 0 | 0 | 103.15 | 0 | 0 | 46.95 |
| SD1B | 2.04 | 0 | 0 | 22.15 | 0 | 0.21 | 0 | 0 | 21 |
| SD2C | 1.35 | 0 | 0 | 0 | 0 | 77.17 | 0 | 0 | 91 |
| SD2D | 3.41 | 0 | 0 | 0 | 13.59 | 27.82 | 0 | 0 | 0.03 |
| SD3C | 2.71 | 0 | 0 | 0 | | 235.56 | 0 | 0 | 80.84 |
| SD4F | 0 | 0 | 0 | 0 | 17.39 | 13.63 | 0 | 0 | 0.02 |
| SD6B | 0 | 0 | 0 | 0 | 19.91 | 56.16 | 5.67 | 0 | 19 |
| SD6C | 6.89 | 0 | 0 | 0 | 2.52 | 96.57 | 0 | 0 | 29 |
| SD6D | 16.95 | 0 | 0 | 0 | 62.86 | 34.54 | 3.28 | 0 | 0 |
| SD7D | 11.37 | 0 | 0 | 0 | 0 | 147.46 | 0.36 | 0 | 83 |
| SD8F | 2.06 | 0 | 0 | 0 | 53.28 | 0 | 2.98 | 0 | 9 |
| TD7 | 0 | 0 | 10.67 | 0 | 0 | 0 | 0 | 0 | 0 |