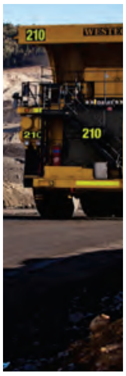
MOOLARBENCOAL

Moolarben Coal Complex
Open Cut Optimisation Modification

Environmental Assessment



APPENDIX E

Site Water Balance and Surface Water Assessment

YANCOAL
兖煤澳大利亚有限公司

Moolarben Coal Complex

Open Cut Optimisation Modification
Site Water Balance and
Surface Water Assessment

Moolarben Coal Operations c/o Resource Strategies

0926-21-F, 26 October 2017

Report Title	Moolarben Coal Complex – Open Cut Optimisation Modification
Client	Moolarben Coal Operations c/o Resource Strategies
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For and on behalf of WRM Water & Environment Pty Ltd
Level 9, 135 Wickham Tce, Spring Hill
PO Box 10703 Brisbane Adelaide St Qld 4000
Tel 07 3225 0200

David Newton
Director/Principal Engineer

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1 Introduction

1.1 BACKGROUND

The Moolarben Coal Complex is located approximately 40 kilometres (km) north of Mudgee in the Western Coalfields of New South Wales (NSW). The location of the Moolarben Coal Complex is shown in Figure 1.1.

Moolarben Coal Operations Pty Ltd (MCO) is the operator of the Moolarben Coal Complex on behalf of the Moolarben Joint Venture (Moolarben Coal Mines Pty Ltd [MCM], Sojitz Moolarben Resources Pty Ltd and a consortium of Korean power companies). MCO and MCM are wholly owned subsidiaries of Yancoal Australia Limited (Yancoal).

The Moolarben Coal Complex comprises four approved open cut mining areas (OC1 to OC4), three approved underground mining areas (UG1, UG2 and UG4) and other mining related infrastructure (including coal processing and transport facilities).

Mining operations at the Moolarben Coal Complex are currently approved until 31 December 2038 in accordance with Project Approval (05_0117) (Moolarben Coal Project Stage 1) (as modified) and Project Approval (08_0135) (Moolarben Coal Project Stage 2) (as modified).

This report, prepared by WRM Water & Environment Pty Ltd, provides an assessment of surface water impacts of a proposed modification to the current approvals which aims to optimise mining operations. A summary of the Moolarben Coal Complex and the proposed modification is provided below.

1.2 MOOLARBEN COAL COMPLEX HISTORY

The Moolarben Coal Project (Stage 1) was approved by the NSW Minister for Planning on 6 September 2007 (Stage 1 Project Approval [05_0117]). Thirteen modifications to Project Approval (05_0117) have since been approved.

Stage 1 of the Moolarben Coal Project comprises open cut operations in OC1, OC2 and OC3, underground mining operations in UG4 and the handling, processing and rail transport of coal from both Stage 1 and Stage 2.

The Moolarben Coal Project Stage 2 was approved by the Planning Assessment Commission (as delegate of the NSW Minister for Planning) on 30 January 2015 (Stage 2 Project Approval [08_0135]). Two modifications to Project Approval (08_0135) have since been approved.

Stage 2 of the Moolarben Coal Project comprises open cut operations in OC4 and underground operations in UG1 and UG2. All run-of-mine (ROM) coal produced by the Stage 2 operations is transported to the Stage 1 coal handling and processing facilities.

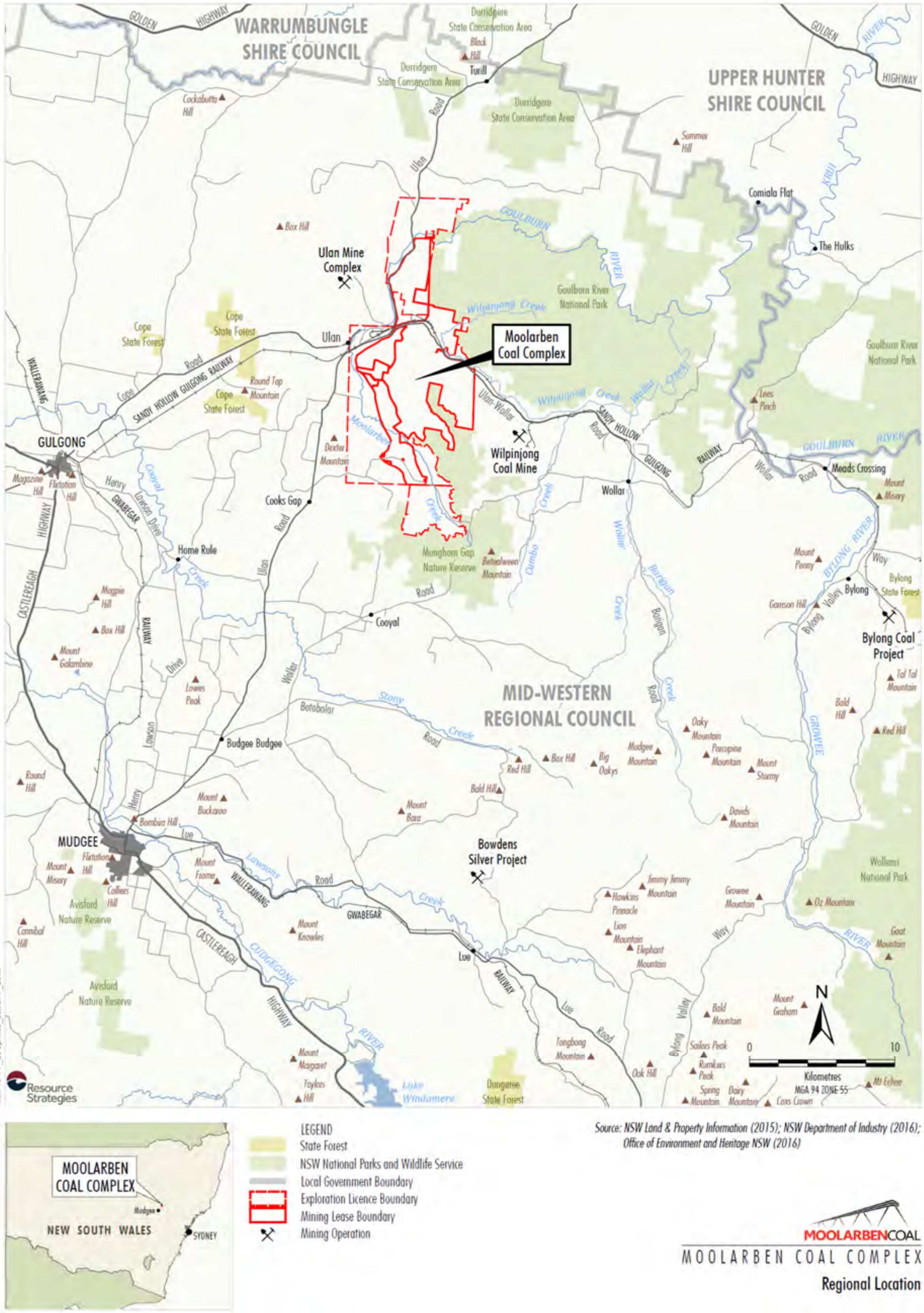


Figure 1.1 – Moolarben Coal Complex – locality plan

1.3 MODIFICATION OVERVIEW

The modification involves the changes to the currently approved Moolarben Coal Complex operations described below. The extent of proposed changes to surface disturbance is shown in Figure 1.2.

1.3.1 Annual production limits

Review of the mine schedule and planning indicates MCO can optimise its operations to increase annual coal production volumes with no material change to the existing mining fleet. As a result, the ROM coal production from the open cuts would increase as follows:

- increase in combined ROM coal production from the Stage 1 open cuts (OC1, OC2 and OC3) from 8 to 10 million tonnes per annum (Mtpa);
- increase in ROM coal production from the Stage 2 open cut (OC4) from 12 to 16 Mtpa; and
- an associated increase in the combined Stage 1 and Stage 2 open cut ROM coal limit from 13 to 16 Mtpa.

The increased open cut production limits would result in the following additional changes to the approved Moolarben Coal Complex:

- increase in the coal processing (washing) limit from 13 to 16 Mtpa;
- increase in the combined open cut and underground ROM coal limit from 21 to 24 Mtpa;
- increase in the product coal limit from 18 to 22 Mtpa;
- increase in product coal rail movements (one additional train per day on average and two additional trains per day at peak); and
- increase in the annual rate of coal reject production.

1.3.2 Open cut pit limits

To facilitate safe and efficient mining, and in consideration of the latest resource drilling results, there would be minor changes to the OC2 and OC3 pit limits, as follows:

- minor increase to the pit limit in the south west of OC2 (to avoid leaving a potentially geotechnically unstable section of hill between the current pit limit and Moolarben Creek);
- straightening of the western pit limits of OC3, resulting in both minor extensions and minor reductions in pit limits; and
- minor extensions to the northern and eastern limits of OC3.

1.3.3 Final landforms

The revised mine sequence and pit limits would result in the following change to the final landform:

- the approved OC3 out-of-pit emplacement would no longer be required for permanent out of pit waste rock emplacement, with waste rock extracted during the initial development of OC3 to be used as backfill material (some waste rock may be temporarily emplaced in this area during initial OC3 establishment); and
- some areas of the final landform in OC2 and OC3 would be rehabilitated to woodland, rather than agricultural land.

1.3.4 Mine infrastructure

The modification involves the following minor changes to infrastructure at the Moolarben Coal Complex, which would result in extensions to the approved extent of surface development:

- relocation of the OC3 mine infrastructure area (MIA) (including access tracks, power, services, communications, explosives reload facilities and pipelines) to within the approved disturbance footprint of the OC3 out-of-pit emplacement (portions of the currently approved MIA footprint would no longer be required);
- revised alignment and widening of the haul road from OC2 to OC3, with the revised width of the haul road corridor determined by the distance required for haul trucks to safely pass, and to allow for water management infrastructure (portions of the currently approved haul road footprint would no longer be required);
- new internal road from OC2 to OC4 to allow for the occasional transfer of mining equipment (i.e. no waste or coal haulage is proposed);
- additional thickener and Belt Press Filters within the Coal Handling and Preparation Plant (CHPP) footprint; and
- new bypass conveyor to enable coal from the open cuts of suitable quality to be bypassed (i.e. not washed/processed at the CHPP).

Other minor surface infrastructure would also be developed within the extent of approved surface development:

- new coal stockpiles and extensions to existing stockpiles at OC1, OC3, OC4 and the CHPP area;
- upgrade of the train loadout conveyor and bin to facilitate more efficient train loading;
- installation of water treatment facilities adjacent to the existing rail loop area to support the controlled release of water under Environmental Protection Licence (EPL) release conditions, with an increase in the rate of controlled releases, when required;
- construction of pipelines from the water treatment facilities to a relocated EPL controlled release point at the confluence of Bora Creek and the Goulburn River Diversion;
- construction of temporary stockpiles of material excavated during construction activities for use in final landform shaping and rehabilitation; and
- ongoing exploration activities within Mining Leases.

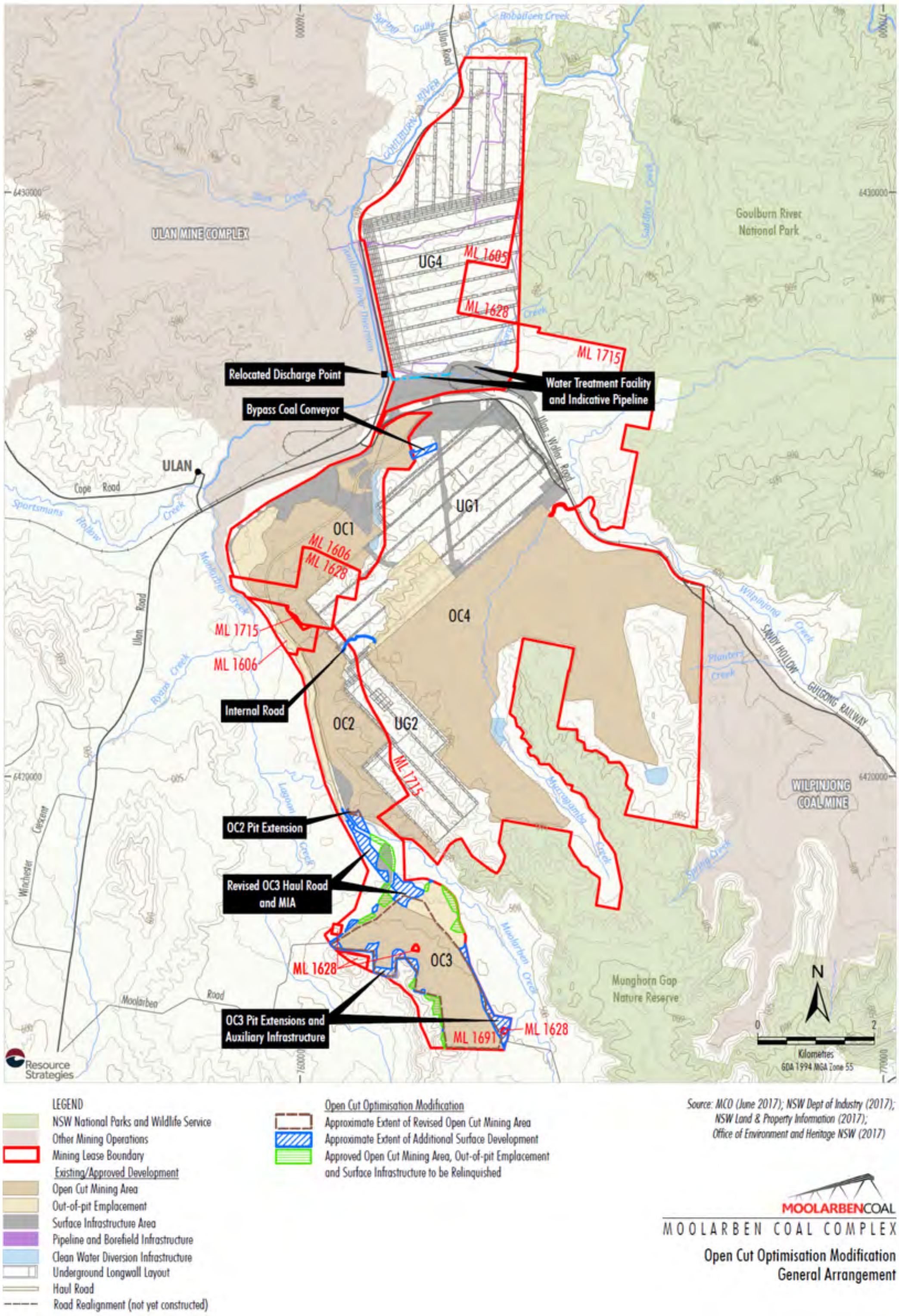


Figure 1.2 – Extent of proposed changes to surface disturbance

1.4 STUDY METHODOLOGY AND DOCUMENT STRUCTURE

This study assesses the potential surface water impacts of the proposed modification and describes proposed measures to manage and monitor these potential impacts.

A new site water balance model for the Moolarben Coal Complex (incorporating the Open Cut Optimisation Modification [the Modification]) has been developed using a computer-based operational simulation model (OPSIM) software. The OPSIM model provides a high level of flexibility in assessing the behaviour of the site water management system under a wide range of climatic conditions. The new model has been used to consider the implications of the following components of the Modification on the Moolarben Coal Complex site water balance:

- increases in annual production limits;
- increases to the open cut pit limits;
- changes to the sequence of mining; and
- minor changes to mine infrastructure footprints.

The new model has also been used to evaluate the implications of the increased groundwater inflows (HydroSimulations, 2017) on controlled release requirements. Following some preliminary analysis, an increase in the total controlled release volume from 10 megalitres per day (ML/day) to 20 ML/day has been evaluated.

This report contains a further six sections:

- Section 2 provides a description of the existing surface water environment;
- Section 3 provides an overview of the existing site water management system;
- Section 4 describes the proposed water management strategy and infrastructure;
- Section 5 details the mine water balance model configuration and assumptions;
- Section 6 presents the outcomes from the water management system assessment;
- Section 7 presents the impact assessment;
- Section 7.5 describes the proposed management and monitoring strategy for the proposed modification;
- Section 8 is a list of references.

2 Existing surface water environment

2.1 REGIONAL DRAINAGE NETWORK

The Moolarben Coal Complex is within the Upper Goulburn river catchment. The upper Goulburn River has a catchment area of approximately 2,455 square kilometres (km^2) to the Ulan-Cassilis Road Bridge.

Moolarben Creek is the primary tributary of the upper Goulburn River catchment. Moolarben Creek flows in a northerly direction along the western boundary of the Moolarben Coal Complex and joins Sportsmans Hollow Creek at the village of Ulan to form the headwater of the Goulburn River. Moolarben Dam is located on Moolarben Creek, approximately 1.5 km upstream of the Sportsman Hollow Creek confluence.

Wilpinjong Creek drains in a south-easterly direction along the north-eastern boundary of the Moolarben Coal Complex and joins Wollar Creek, before joining the Goulburn River approximately 26 km downstream of the Moolarben Coal Complex. The Goulburn River flows in an easterly direction, eventually joining the Hunter River approximately 150 km downstream of the Moolarben Coal Complex.

2.2 LOCAL DRAINAGE NETWORK

The local drainage network in the vicinity of the Moolarben Coal Complex is shown in Figure 2.1. The majority of Stage 1 mining operations, including OC1, OC2 and OC3, are located within the Moolarben Creek catchment. The Moolarben Creek catchment has an area of about 126 km^2 to Ulan-Cassilis Road near Ulan. Moolarben Creek is located to the west of OC2 and flows between OC2 and OC3.

The upper reaches of the Moolarben Creek catchment are characterised by steep, heavily forested slopes draining into a cleared and relatively flat floodplain. The Moolarben Creek catchment to Ulan-Cassilis Road includes the Moolarben Dam, constructed in 1957 to supply water to the Ulan Power Station (decommissioned in 1968). The dam has a catchment area of about 109 km^2 and a surface area of about 6 hectares (ha).

The majority of the Stage 1 infrastructure area including the CHPP, product stockpile pad and the rail loop are located within the Bora Creek Catchment. Bora Creek is a small tributary of the Goulburn River with a catchment area of about 6.7 km^2 to Ulan-Cassilis Road. Bora Creek drains in a westerly direction along the northern boundary of the CHPP area.

The majority of the Stage 2 mining operations including Open Cut 4 are located within the Murragamba and Eastern Creek catchments. Murragamba and Eastern Creeks have a combined catchment area of about 31.5 km^2. Both creeks drain in a north-easterly direction into Wilpinjong Creek to the east of the Moolarben Coal Complex. The Murragamba and Eastern Creek catchments are typically characterised by steep and heavily forested headwaters, draining into a flat and mostly cleared floodplain.

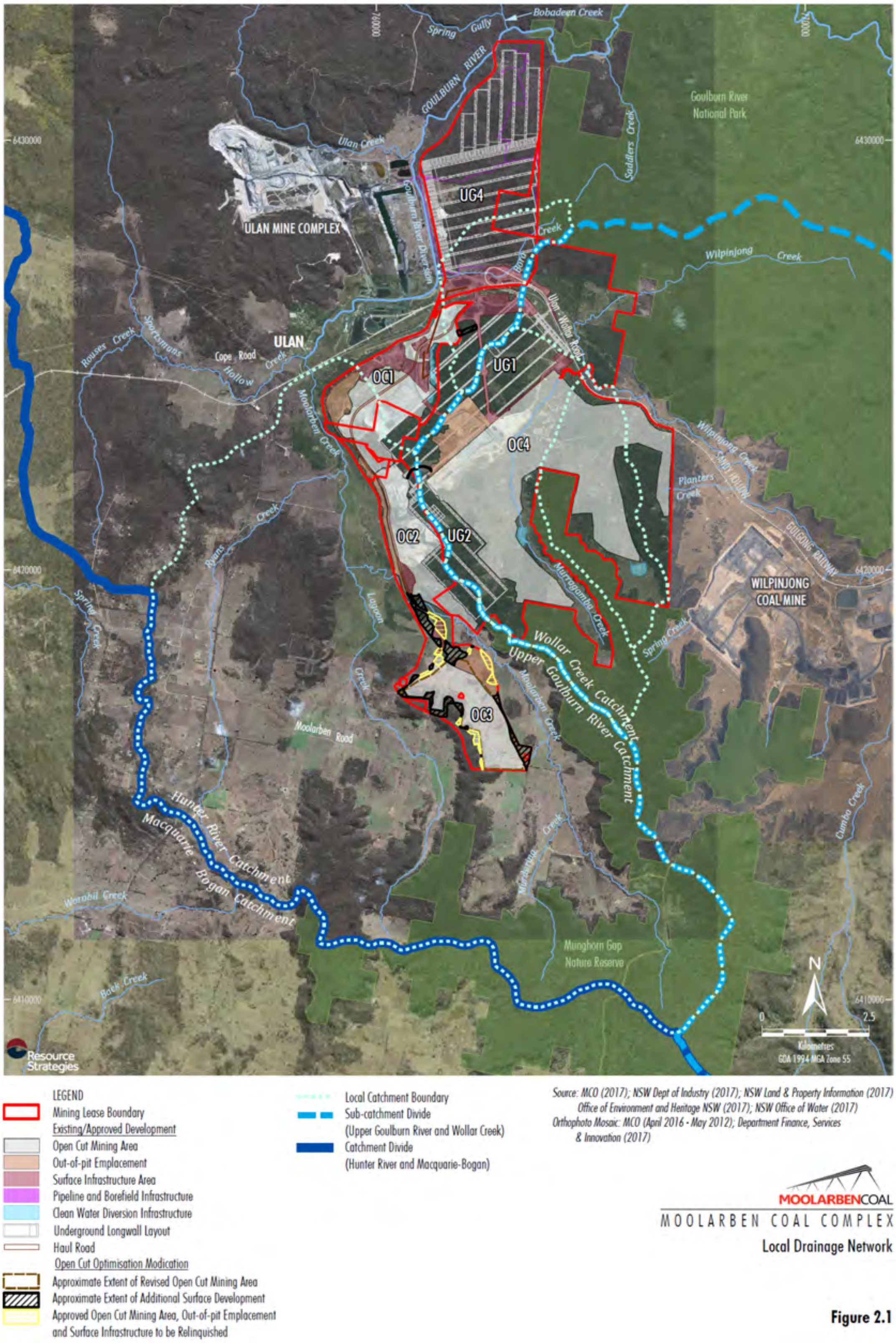


Figure 2.1 – Local drainage network

2.3 STREAMFLOW

The nearest long-term streamflow gauging station is the Department of Primary Industries – Water (DPI Water) Goulburn River at Coggan (gauge no. 210006) located approximately 70 km downstream of the Moolarben Coal Complex. This gauging station has been operating since October 1912.

MCO had previously collected streamflow data at three monitoring sites (SW05 – Moolarben Creek, SW11 – Bora Creek and SW15 – Wilpinjong Creek), however these gauges were lost due to flooding in November 2010. SW05 was replaced by a monitoring site (in May 2013) maintained by Ulan Coal Mine Limited (UCML) downstream of Moolarben Dam and MCO has access to this data through a data sharing agreement. SW15 was replaced in May 2013 and SW11 in December 2013.

MCO installed another two flow monitoring stations on Murragamba Creek and Eastern Creek in May 2013.

Wilpinjong Coal Pty Ltd (WCPL) maintain gauging stations on Wilpinjong Creek and Cumbo Creek. MCO has access to this data through a data sharing agreement with WCPL.

The locations of the stream monitoring stations are shown in Figure 2.2. Table 2.1 shows details of the streamflow monitoring sites. Analysis of stream flow data is presented in the Controlled Water Release Impact Assessment (2017).

Table 2.1 - MCO stream flow monitoring sites

Monitoring site	Description	Easting	Northing	Frequency	Period of record
SW05	Moolarben Coal at Ulan-Cassilis Road	758,483	6,424,620	Sub-daily	Feb 2010 to Nov 2010
SW11	Bora Creek at Ulan-Cassilis Road	761,496	6,426,927	Sub-daily	Feb 2010 to Nov 2010 May 2013 to current
SW15	Wilpinjong Creek at Red Hill	764,653	6,425,304	Sub-daily	Feb 2010 to Nov 2010 Dec 2013 to current
SW04	Murragamba Creek at Wollar Road	764,690	6,424,595	Sub-daily	May 2013 to current
SW17	Eastern Creek	765,331	6,423,985	Sub-daily	May 2013 to current
SW05 (UCML)	Moolarben Creek at Moolarben Dam	758,587	6,423,638	Sub-daily	May 2013 to current
WILGSU	Wilpinjong Creek U/S Gauging Station	768,229	6,422,436	Continuous	2007 to current
WILGSD	Wilpinjong Creek D/S Gauging Station	774,547	6,420,809	Continuous	2007 to current
CCGSD	Cumbo Creek D/S Gauging Station	773,421	6,420,057	Continuous	2007 to current
CCGSU	Cumbo Creek U/S Gauging Station	772,714	6,418,142	Continuous	2015 to current

U/S = upstream and D/S = downstream

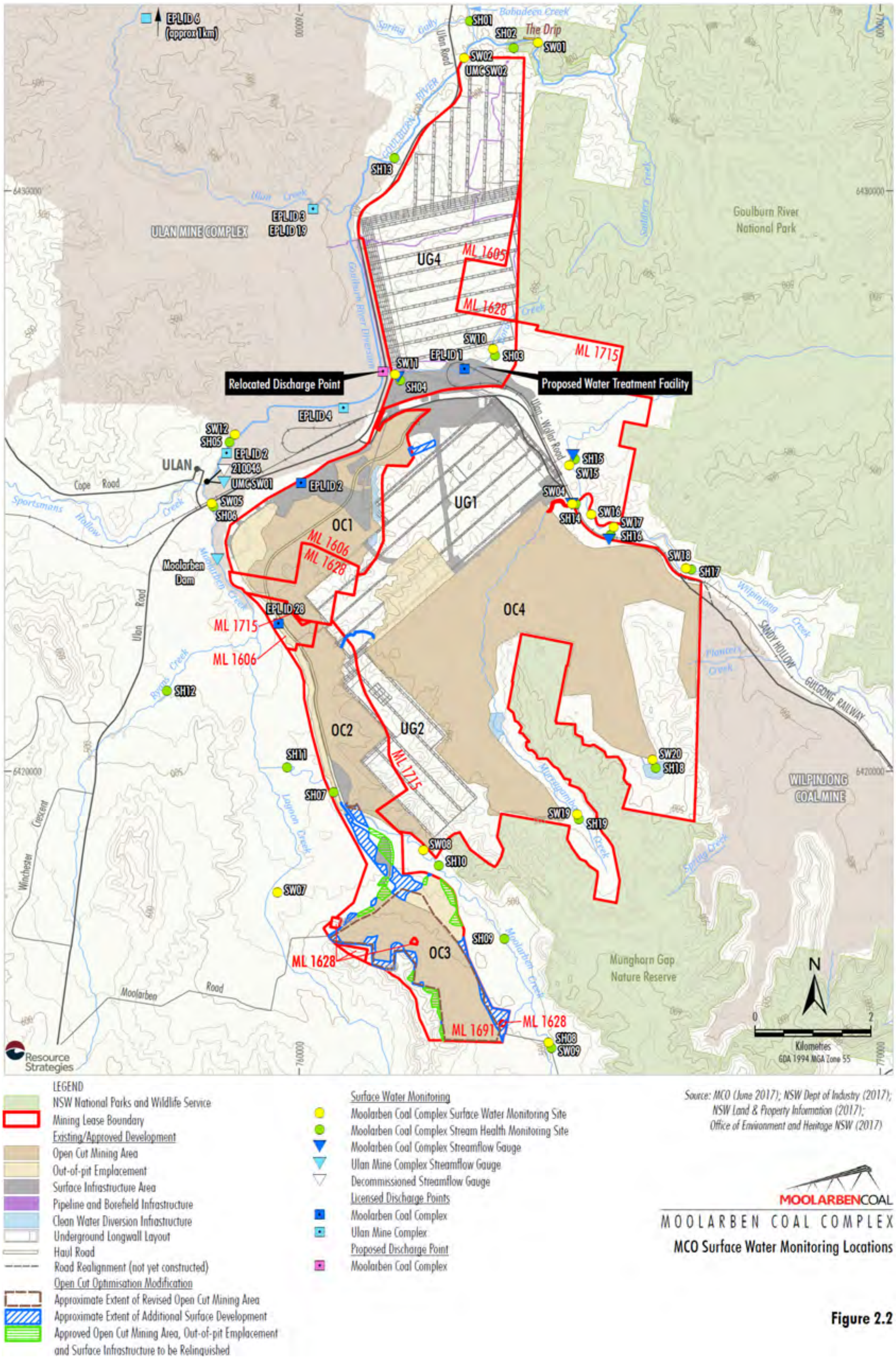


Figure 2.2 – MCO surface water monitoring locations

2.4 SURFACE WATER QUALITY

Surface water quality monitoring has been undertaken for the Moolarben Coal Complex since 2005. Water quality monitoring has been undertaken in the Goulburn River, Bora Creek, Moolarben Creek, Murragamba Creek, Eastern Creek, Lagoon Creek, Ryan's Creek and Wilpinjong Creek (see Figure 2.2). A summary of relevant water quality data is presented in the Controlled Water Release Impact Assessment (Advisian, 2017).

2.5 MINE WATER QUALITY MONITORING

Mine water quality sampling is conducted on a monthly basis at 8 sites across the Moolarben Coal Complex. Mine water quality monitoring is separated into the following categories:

- Mine water dams;
- Open cut; and
- Underground (UG1).

A summary of the mine water sampling results is provided in Table 2.2. Review of Table 2.2 indicates the following:

- Mine water dams
    - pH readings range between 7.4 and 8.5 (20^{th} and 80^{th} percentiles), with a median value of 8.2;
    - Electrical Conductivity (EC) readings range between 1,105 and 1,547 microSiemens per centimetre (µs/cm) (20^{th} and 80^{th} percentiles), with a median value of 1,256 µS/cm;
    - Turbidity readings range between 5.1 and 29.4 Nephelometric Turbidity Units (NTU) (20^{th} and 80^{th} percentiles), with a median value of 11.4 NTU; and
    - Total Suspended Solids (TSS) readings range between 5 and 18 milligrams per litre (mg/L) (20^{th} and 80^{th} percentiles), with a median value of 6 mg/L.
- Open cut
    - pH readings range between 6.4 and 8.1 (20^{th} and 80^{th} percentiles), with a median value of 7.1;
    - EC readings range between 1,004 and 1,514 µS/cm (20^{th} and 80^{th} percentiles), with a median value of 1,224 µS/cm;
    - Turbidity readings range between 10.6 and 50.3 NTU (20^{th} and 80^{th} percentiles), with a median value of 23.9 NTU; and
    - TSS readings range between 5 and 18 mg/L (20^{th} and 80^{th} percentiles), with a median value of 6 mg/L.
- Underground (UG1)
    - pH readings range between 6.9 and 8.2 (20^{th} and 80^{th} percentiles), with a median value of 8.0;
    - EC readings range between 1,269 and 1,460 µS/cm (20^{th} and 80^{th} percentiles), with a median value of 1,296 µS/cm;
    - Turbidity readings range between 24.2 and 65.6 NTU (20^{th} and 80^{th} percentiles), with a median value of 37.5 NTU; and
    - TSS readings range between 9 and 43 mg/L (20^{th} and 80^{th} percentiles), with a median value of 18 mg/L.

Table 2.2 - Mine water quality data

Site	Sampling Period	pH - field				EC (µS/cm) - field				Turbidity (NTU) - field and lab				TSS (mg/L) - lab			
		No. of samples	20th %ile	Median	80th %ile	No. of samples	20th %ile	Median	80th %ile	No. of samples	20th %ile	Median	80th %ile	No. of samples	20th %ile	Median	80th %ile
Mine Water Dams																	
111		51	7.0	8.1	8.5	51	1,152	1,290	1,600	22	4.0	9.3	13.2	51	5	6	14
112		24	7.6	8.3	9.1	24	1,154	1,236	1,558	22	13.9	23.6	46.3	22	5	19	36.2
113		17	7.9	8.1	8.4	17	954	1,074	1,128	15	4.5	8.1	13.9	15	5	5	8
204		4	8.1	8.6	8.6	4	1,152	1,192	1,242	4	2.0	3.5	4.4	4	5	5	5
401		7	8.2	8.5	8.5	7	1,273	1,508	1,641	6	8.8	11.1	28.7	6	5	7	13
COMBINED		**103**	**7.4**	**8.2**	**8.5**	**103**	**1,105**	**1,256**	**1,547**	**69**	**5.1**	**11.4**	**29.4**	**98**	**5**	**6**	**18**
Open Cut																	
OC1 Pit		4	6.6	7.4	7.8	5	991	1,131	1,361					4	7	20	35
OC1 North Pit		9	6.3	6.9	7.2	9	1,123	1,261	1,664	9	15.8	44.6	51.3	8	8	26	59
OC4 Pit		3	8.2	8.3	8.4	3	1,022	1,052	1,115	3	6.2	10.1	16.9	3	5	5	9
COMBINED		**16**	**6.4**	**7.1**	**8.1**	**17**	**1,004**	**1,224**	**1,514**	**12**	**10.6**	**23.9**	**50.3**	**15**	**2**	**12**	**39**
Underground																	
UG1		5	6.9	8.0	8.2	5	1,269	1,296	1,460	4	24.2	37.5	65.6	4	9	18	43

2.6 ENVIRONMENTAL PROTECTION LICENCE (EPL) - RELEASE CONDITIONS

A summary of the current EPL 12932 (May 2016) release locations in relation to surface water release conditions are provided in Table 2.3. The two types of discharge points are summarised as follows:

- Discharge to waters: This generally relates to controlled discharge from three nominated storages.
- Stormwater discharge: This generally relates to uncontrolled or controlled discharge from stormwater control structures (sediment dams).

Table 2.3 - EPL release locations

Release point	Type of discharge point	Location description
1	Discharge to waters	Controlled discharge to Bora Creek from WP13
2	Discharge to waters	Controlled discharge to Goulburn River from OC1 106
28	Discharge to waters	Controlled discharge to Moolarben Creek from OC2 202
24	Stormwater discharge	Stormwater discharge from OC1 101, OC1 102, OC1 103, OC1 104 & OC1 105
26	Stormwater discharge	Stormwater discharge from WP03, WP04, WP05, WP06, WP07, WP08 & WP14
29	Stormwater discharge	Stormwater discharge from OC2 206, OC2 209, OC2 210
30	Stormwater discharge	Stormwater discharge from EPA ID 30
31	Stormwater discharge	Stormwater discharge from EPA ID 31
33	Stormwater discharge	Stormwater discharge from EPA ID 33
35	Stormwater discharge	Stormwater discharge from EPA ID 35

Condition L2.4 of the EPL specifies separate licensed discharge concentration limits for each types of discharge point, as provided in Table 2.4 and Table 2.5.

Table 2.4 - Discharge concentration limits - RP 1, 2 & 28

Pollutant	Unit of measure	50th percentile concentration limit	100th percentile concentration limit
Electrical Conductivity	µS/cm	800	900
pH	pH units	-	6.5 – 8.5
Total Suspended Solids	mg/L	-	50
Turbidity	NTU	-	25

Table 2.5 – Discharge concentration limits – RP 24, 26, 29, 30, 31, 33 & 35

Pollutant	Unit of measure	50th percentile concentration limit	100th percentile concentration limit
pH	pH units	-	6.5 – 8.5
Total Suspended Solids	mg/L	-	50
Turbidity	NTU	-	25

Condition L2.5 states that the TSS and turbidity limits for the stormwater discharge release points (Table 2.5) do not apply when the discharge occurs solely as a result of rainfall measured at the premises which exceeds a total of 44 millimetres (mm) of rainfall over any consecutive five day period. A 44 mm rainfall depth is defined by "Managing Urban Stormwater: Soils and Construction" (Landcom 2004) as the rainfall depth in millimetres for a 95th percentile five day rainfall event for the Central Tablelands consistent with the storage capacity (recommended minimum design criteria) for Type D sediment retention basins for mines and quarries (Vol 2E of Landcom 2004).

In addition, Condition L2.6 states that the concentration limit for TSS and turbidity for the stormwater discharge release points (Table 2.5) is deemed not to have been breached where

- The sample complies with the turbidity limit at the time of the discharge; and
- The NSW Environment Protection Authority (EPA) is advised within 3 working days of completion of TSS testing, of any results above the compliance limit.

The purpose of Condition L2.6 is to expedite the assessment and subsequent discharge of water from the sediments dams.

The EPL permits a maximum discharge of 10 ML/day from Point 1 (WP13), Point 2 (OC1 106) and 1 kilolitre per day (kL/day) from OC2 202. A combined limit of 10 ML/day applies to all three discharge points.

MCO proposes to vary EPL 12932 to alter the location and increase the discharge permitted from Point 1 (and the total discharge limit) to 20 ML/day.

3 Existing water management strategy and infrastructure

3.1 OVERVIEW

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

3.2 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 Moolarben Coal Complex is based on the separation of water from different sources based on observed and anticipated water quality.

Water at the Moolarben Coal Complex is categorised into four types, based on source and associated water quality:

- **Clean water** is defined as runoff from catchments that are not disturbed by mining operations.
- **Sediment water** is defined as runoff from disturbed areas within the mine site and includes runoff from spoil dumps, haul roads and part of the MIA. This water typically contains high levels of suspended solids.
- **Mine water** is defined as runoff generated from coal stockpiles, the CHPP, parts of the MIA and the mining void, as well as groundwater inflows to the mining void.
- **Effluent water** is defined as treated water discharged from the mine sewage treatment plant (STP).

The proposed water treatment plant (WTP) introduces two additional types of water:

- **Permeate water** is the treated water produced by the proposed WTP. This water is expected to have very low contaminant concentrations.
- **Brine water** is the by-product produced by the WTP. This water is expected to have elevated contaminant concentrations.

3.3 OBJECTIVES OF THE WATER MANAGEMENT SYSTEM

The key objectives of the water management system at the Moolarben Coal Complex are to:

- preferentially segregate clean water runoff, sediment water runoff and mine water;
- preferentially reuse mine water for dust suppression and coal washing;
- provide sufficient on-site storage to avoid unlicensed discharges of water;
- capture sediment water from unrehabilitated overburden areas to settle coarse suspended solids; and
- maximise diversion of clean water runoff where practicable.

There is likely to be periods when licensed discharge of treated water to the receiving environment would be required to manage surplus water at the Moolarben Coal Complex (e.g. during periods of elevated rainfall). Under these circumstances, water would be discharged in accordance with EPL 12932 (incorporating the proposed amendments discussed in Section 2.6).

There may also be periods when the availability of water on-site is such that treatment and controlled water release would cease, and water would be sourced from the approved water supply borefield or externally from nearby mining operations under agreement.

The water management system will continue to evolve over time to meet the changing requirements of the Moolarben Coal Complex. 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.

3.4 WATER MANAGEMENT SYSTEM COMPONENTS AND LAYOUT

The key components of the existing Water Management System (WMS) at the Moolarben Coal Complex are as follows:

- Water storages
    - 16 storages at the wash plant area (WP)
    - 9 storages at the OC1
    - 9 storages at the OC2
    - 4 storages at the OC4
- Pits
    - OC1 Pit North
    - Mod 9 Pit
    - OC2 Pit
    - OC4 Pit

A summary of the existing water storages is provided in Table 4.2.

3.5 REJECTS DISPOSAL STRATEGY

Coarse and fine rejects generated at the Moolarben Coal Complex are co-disposed with overburden material in open cut voids. An emergency tailings dam (ETD) is located adjacent to the CHPP to cater for emergency tailings storage (if required). Tailings in the emergency storage dam are periodically removed and disposed with open cut spoil.

3.6 WATER SUPPLY AND DEMANDS/LOSSES

Moolarben Coal Complex water supply sources include collection of runoff from open cut mining areas, runoff collected from associated disturbance areas (including overburden emplacements), groundwater inflows to the open cut pits and underground mining areas, and dewatering from borefields ahead of mining.

MCO also has an agreement with nearby UCML (the Ulan Water Sharing Agreement [UWSA]) to source excess water from the Ulan mining operation (by pipeline) if required.

Water demands/losses on site include:

- Water requirements for the CHPP; including water lost to product, coarse and fine rejects, wash down water and water for stockpile dust suppression;
- Haul road dust suppression;
- Supply to the underground mining area UG1; and
- Evaporation losses.

Details of the proposed water supply and demands/losses over the life of the Moolarben Coal Complex are provided in Section 5.

4 Proposed water management strategy and infrastructure

4.1 PROPOSED MINING PHASES

The Moolarben Coal Complex water management system will change over the 21-year mine life, including changes in catchment areas, production profile and site water demands. To represent the evolution of the mine layout over time, the Moolarben Coal Complex (incorporating the Modification) was modelled in five discrete stages. The adopted mining phases are summarised in Table 4.1.

Table 4.1 - Proposed mining phases

Representative mine phase	Applied range of mine life	Phase duration
Phase 1	Year 2018 – 2019	2 years
Phase 2	Year 2020 – 2021	2 years
Phase 3	Year 2022 – 2024	3 years
Phase 4	Year 2025 – 2029	5 years
Phase 5	Year 2030 – 2038	9 years

4.2 PROPOSED WATER MANAGEMENT COMPONENTS AND LAYOUT

Figure 4.1 to Figure 4.5 show indicative locations of the proposed key features of the mine, including infrastructure related to the management of water on-site for the adopted phases of mining (as described in Table 4.1). The main components of water-related infrastructure include:

- sediment dams to collect and treat runoff from overburden emplacement areas;
- clean water diversion drains and dams 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 and underground mining areas and to collect runoff from the CHPP and coal stockpile area; and
- a water treatment facility and associated infrastructure to be constructed adjacent to the rail loop to allow surplus water stored on site to meet the water quality concentration limits of EPL 12932 and provide water for on-site use.

The above infrastructure would be developed progressively over the life of the Moolarben Coal Complex and would be subject to detailed design based on the mining sequence during operations.

The components of the water management strategy over the life of the Moolarben Coal Complex (incorporating the Modification) are summarised in Table 4.2 and Table 4.3.

Details of the proposed model including the schematised layout, system operating rules, modelled demand and supply are provided in Section 5.

Table 4.2 -Storage details for Phase 1

Storage name	Storage type	Storage capacity (ML)	Overflows to
CHPP			
WP01	Mine water	15.0	WP12
WP02	Mine water	6.0	WP01
WP03	Sediment	1.0	WP14
WP04	*To be decommissioned*		
WP05	*To be decommissioned*		
WP06	Sediment	1.0	Bora Creek /WP13
WP07	Sediment	0.5	Bora Creek
WP08	Sediment	1.3	Bora Creek
WP09	Sediment	0.7	Bora Creek
WP10	Mine water	2.3	WP18
WP12	Mine water	3.4	Bora Creek
WP13	Sediment	24.6	Bora Creek
WP14	Sediment	6.7	Wilpinjong Creek
WP15	Mine water	90.7	Bora Creek
WP16	Mine water	130.9	Bora Creek
WP17	Mine water	8.6	WP10
WP18	Mine water	27.8	WP01
Emergency Tailing Dam (ETD)	Mine water	19.8	WP02
OC1			
101	Sediment	5.0	Moolarben Creek
102	Sediment	5.7	Moolarben Creek
103	Sediment	4.0	Goulburn River
104	Sediment	1.4	Goulburn River
105	Sediment	2.4	Goulburn River
106	Sediment	93.8	Goulburn River
107	Mine water	91.3	Goulburn River
111	Mine water	234.4	106
112	Mine water	48.8	107
UG01 (UG1 Boxcut Sump)	Mine water	58.8	-

Storage name	Storage type	Storage capacity (ML)	Overflows to
OC2			
201	Mine water	20.4	Moolarben Creek
202	Sediment	12.6	Moolarben Creek
203	Sediment	11.3	202
204	Mine water	250	201
206	Sediment	14.0	203
209	Mine water	535	OC2 Pit
210	Sediment	4.7	Moolarben Creek
211	Sediment	12.0	Moolarben Creek
212	Sediment	18.2	Moolarben Creek
213	Sediment	150	OC2 Pit
OC3			
301	Mine water	22.9	Moolarben Creek
302	Mine water	246.9	OC3 Pit
303	Sediment	17.6	Moolarben Creek
304	Sediment	2	Moolarben Creek
305	Sediment	10.6	Moolarben Creek
306	Sediment	8.2	Moolarben Creek
OC4			
401	Mine water	520	403
403	Sediment	27.7	Murragamba Creek
404	*No longer exists*		
405	Sediment	35.0	OC4 Pit
406/407	Sediment	51.2	OC4 Pit
408	Sediment	2.8	Murragamba Creek
426	Sediment	4.0	Wilpinjong Creek
UG1			
UG02	Sediment	1.2	Wilpinjong Creek
UG03	Sediment	1.5	Wilpinjong Creek
UG04	Sediment	2.8	Wilpinjong Creek

ML = megalitres

Table 4.3 - Proposed storage details (Phase 2 to Phase 5)

Storage name	Storage type	Storage capacity (ML)	Overflows to
	PHASE 2		
OC1			
114	Sediment	73.9	112
OC2			
214	Sediment	13.0	Moolarben Creek
OC3			
307	Sediment	9.8	Moolarben Creek
308	Sediment	3.3	Moolarben Creek
309	Sediment	1.7	Moolarben Creek
OC3 Pit (increases in storage capacity)	Mine water	149	-
OC4			
405	*No longer exists*		
409/410	Sediment	44.8	OC4 Pit
411	Sediment	32.1	OC4 Pit
OC4 Pit (increases in storage capacity)	Mine water	555.4	-
	PHASE 3		
OC1			
115	Mine water	286.4	WP18
OC3			
Final Void	Mine water	175	Moolarben Creek
OC4			
409/410/412	Sediment	82.9	OC4 Pit
411	*No longer exists*		
413	Sediment	16.3	OC4 Pit
OC4 Pit	Mine water	560.9	-

Storage name	Storage type	Storage capacity (ML)	Overflows to
	PHASE 4		
OC4			
401 (relocated)	Mine water	550	OC4 Pit
403	*No longer exists*		
410/411/413	*No longer exists*		
415	Sediment	100.5	417
416	Sediment	29.7	OC4 Pit
417	Sediment	38.9	OC4 Pit
418	Mine water	207	OC4 Pit
OC4 Pit	Mine water	560.9	-
	PHASE 5		
OC4			
416	*No longer exists*		
419/420/421	Sediment	51.2	417
422	Sediment	63.1	OC4 Pit
423/424	Sediment	53.5	OC4 Pit
425	Sediment	32.5	OC4 Pit
427	Sediment	17.2	OC4 Pit
OC4 Pit	Mine water	332.7	-

4.3 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).

4.4 CLEAN WATER MANAGEMENT SYSTEM FOR OC4

Murragamba and Eastern Creeks are partially located within the approved OC4 footprint. A clean water management system, in accordance with current approvals, will be implemented to minimise surface runoff from undisturbed areas of these catchments entering the open cut pits. For the purposes of the site water balance model, it has been assumed that the upstream clean water works are effective in preventing clean catchment runoff from entering the open cut pits.

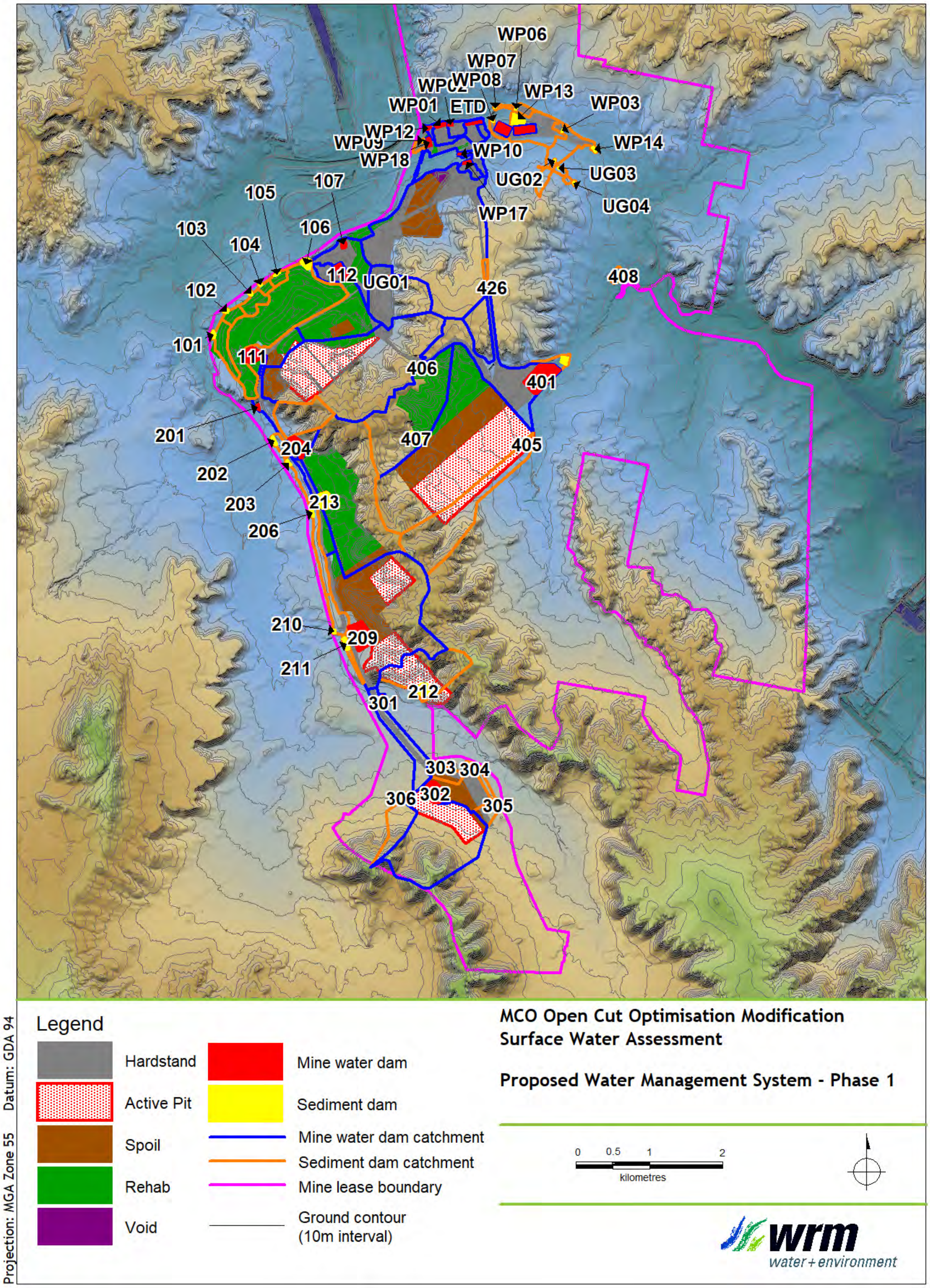


Figure 4.1 – Proposed water management system – (Phase 1)

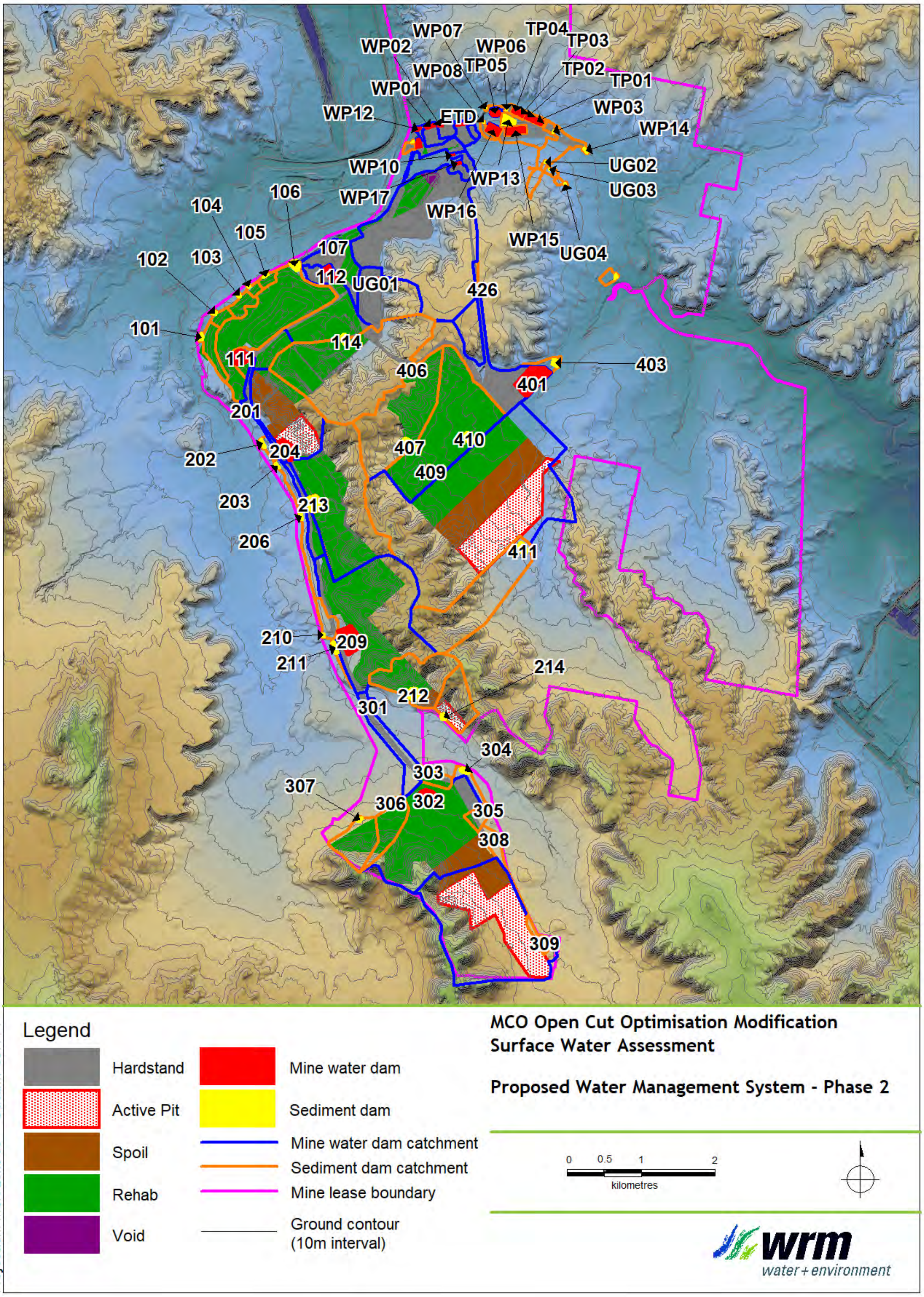


Figure 4.2 – Proposed water management system – (Phase 2)

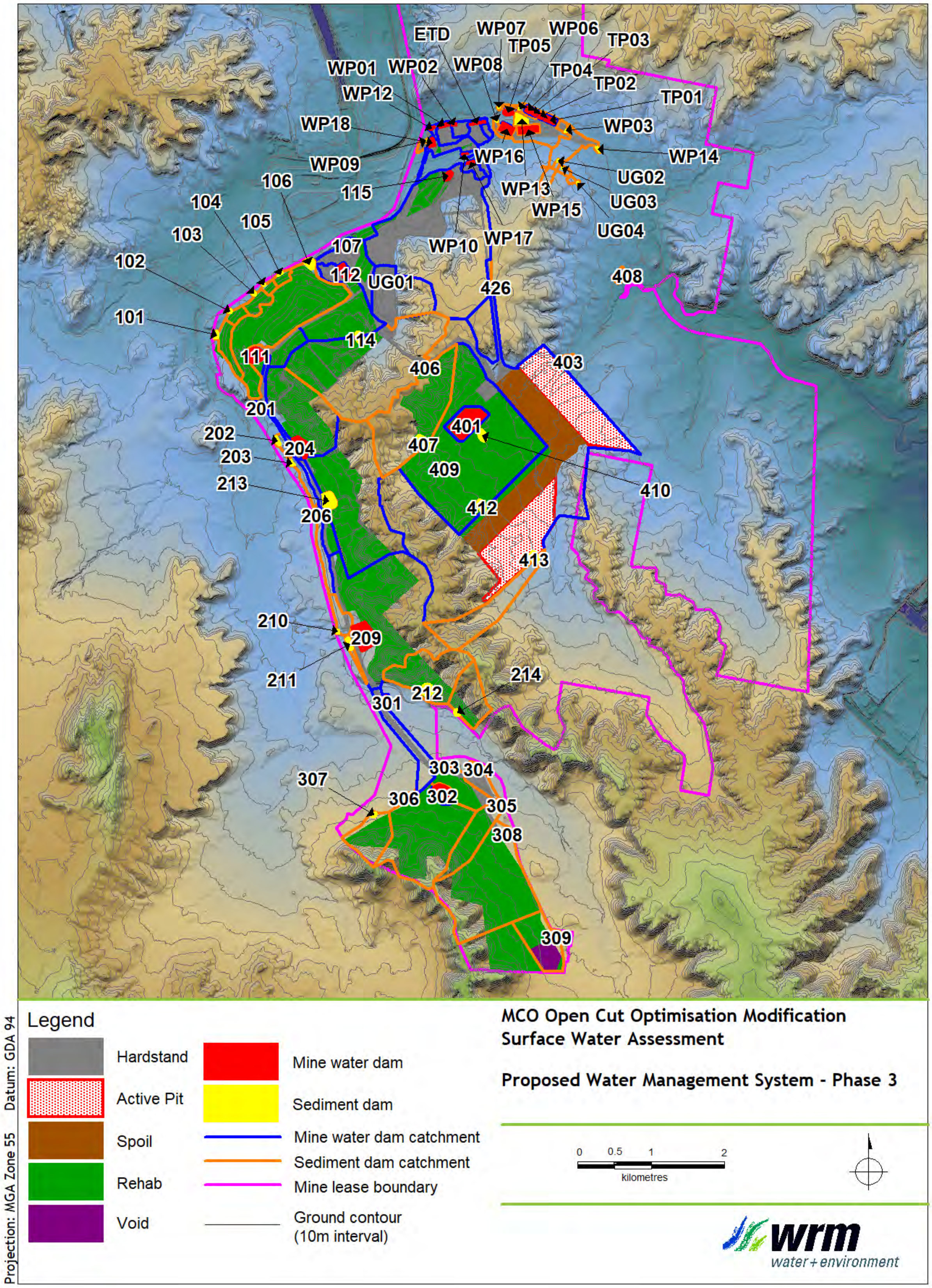


Figure 4.3 – Proposed water management system – (Phase 3)

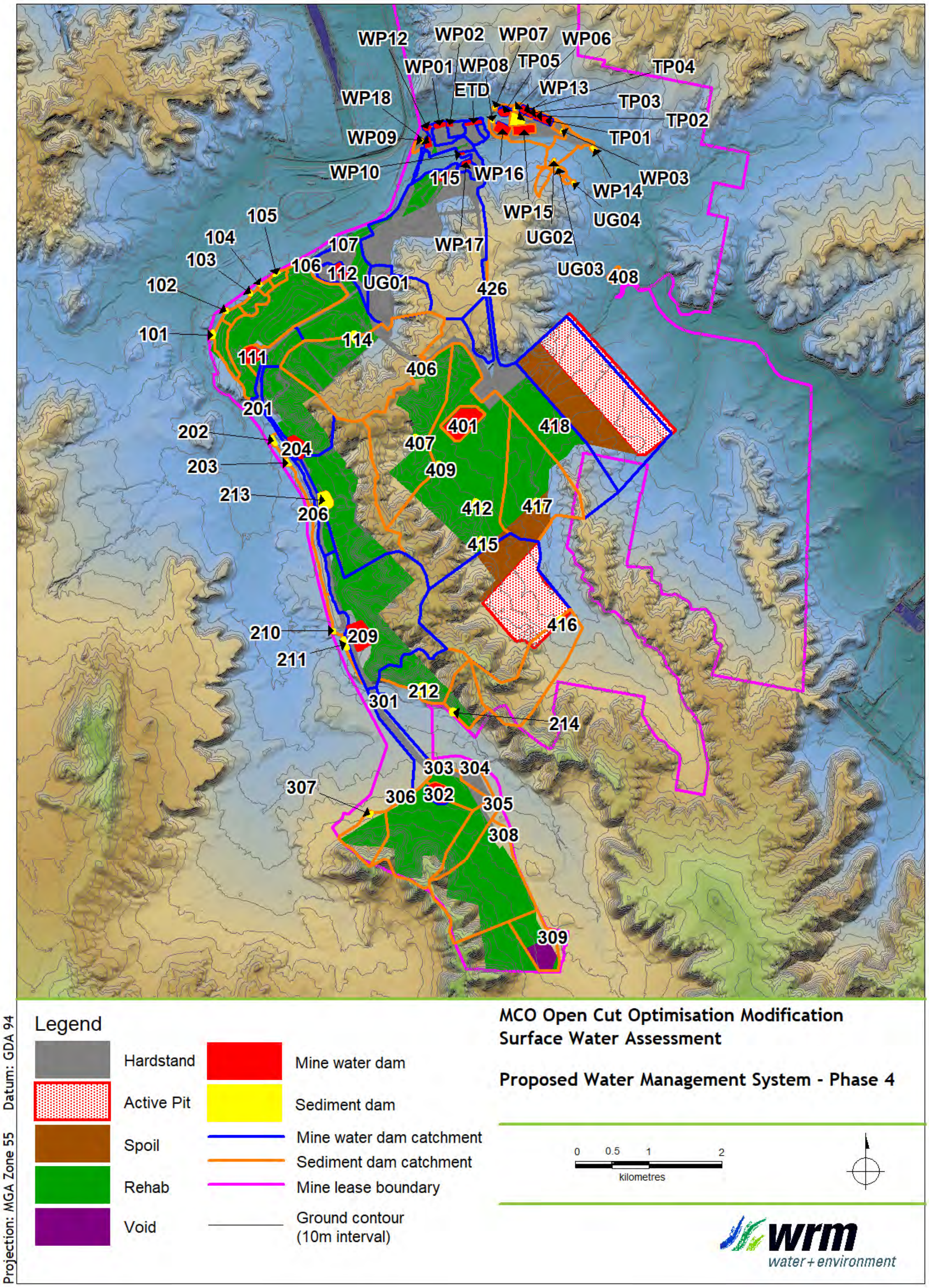


Figure 4.4 - Proposed water management system - (Phase 4)

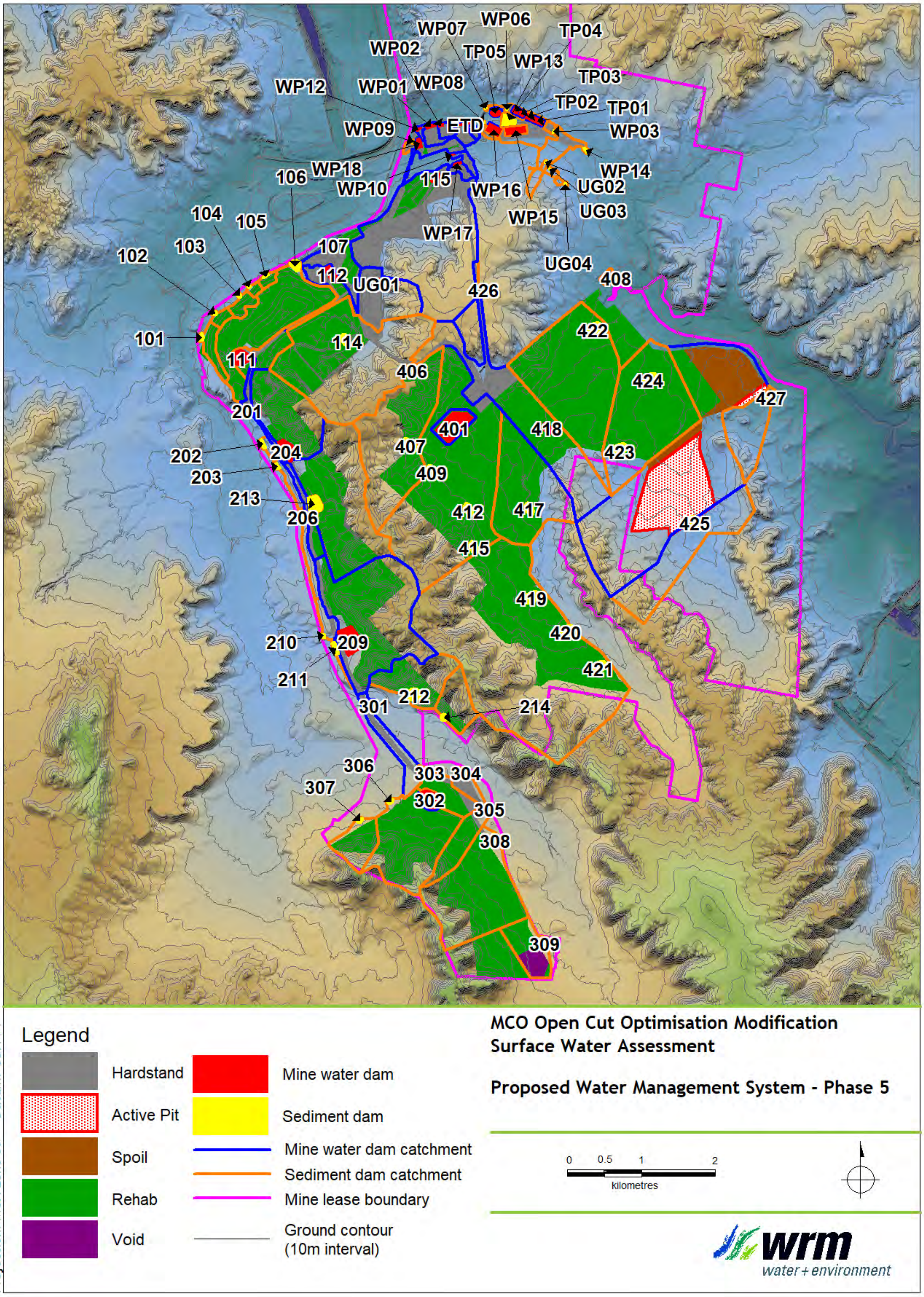


Figure 4.5 – Proposed water management system – (Phase 5)

5 Mine water balance model configuration

5.1 OVERVIEW

The OPSIM was used to assess the mine water balance under varying rainfall and catchment conditions throughout the development of the Moolarben Coal Complex (incorporating the Modification). The OPSIM model dynamically simulates the operation of the water management system and keeps 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 water supply and demand/losses included in the model are given in Table 5.1.

Table 5.1 - Simulated water supply and demand/losses

Water Supply	Water Demand/Losses
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
Groundwater inflows to underground operations	Underground and MIA demands
Borefield dewatering inflows	Controlled water releases
UWSA supply	Overflows and discharges from sediment dams

5.2 CLIMATE DATA

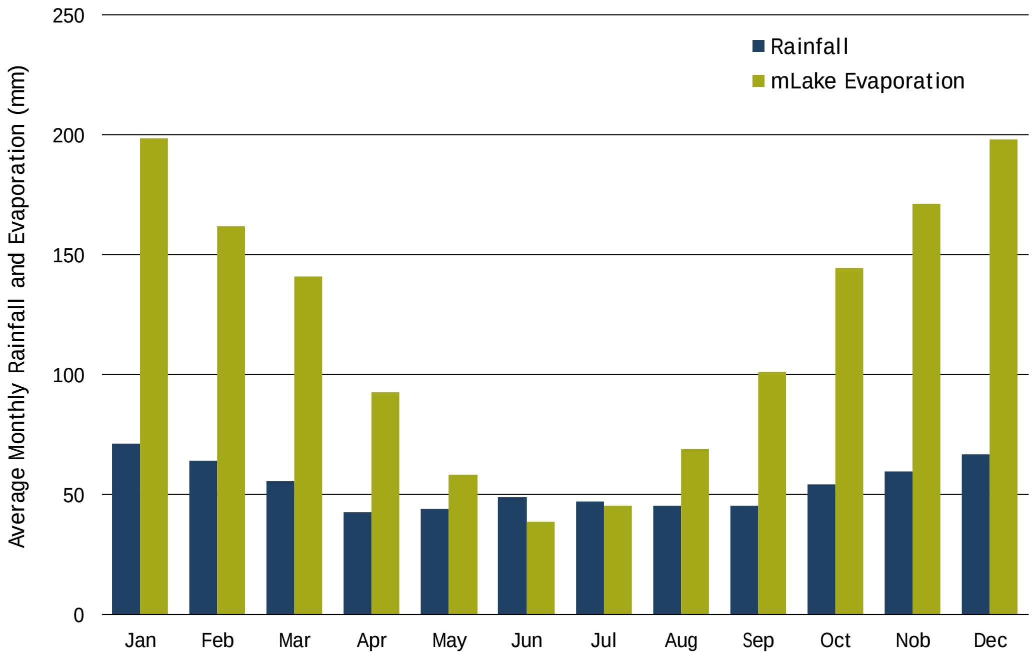
Long term daily rainfall data at the Ulan Water rainfall station from January 1889 to December 2016 (128 years) was obtained from the Patched Point Data service, which is an Australian climate database developed by the Queensland Government.

Morton’s equation for Lake evaporation has been used to estimate evaporation losses from storages. Table 5.2 shows the long-term monthly averages for Morton’s evaporation and monthly Patched Point rainfall data.

Figure 5.1 shows the annual distribution of monthly rainfall and evaporation. Mean evaporation is similar to mean rainfall in the winter months, but substantially exceeds rainfall for the remainder of the year.

Table 5.2 - Long-term average rainfall and evaporation (1889 - 2016)

Month	SILO Patch Point rainfall (Ulan Water) (mm)	Morton's Lake evaporation
January	71.4	198.5
February	64.0	161.8
March	55.5	141.0
April	42.6	92.9
May	44.3	58.2
June	49.1	38.9
July	47.2	45.6
August	45.4	69.3
September	45.5	101.2
October	54.2	144.4
November	59.6	171.4
December	66.8	198.0
TOTAL	**646**	**1,421**



m Lake Evaporation = Morton's Lake Evaporation.

Figure 5.1 - Distributions of monthly rainfall and evaporation (Data source: DSITIA, 2017)

5.3 CONCEPTUAL WATER MANAGEMENT SYSTEM OPERATION

A schematised plan for the Moolarben Coal Complex water management system configuration at each phase is shown in Figure 5.2 to Figure 5.11[1]. These rules have been based on a combination of existing water management procedures, as well as proposed rules for the new storages and pits that generally align with these existing management procedures.

5.4 SIMULATION METHODOLOGY

The simulation used the 'forecast' simulation type in OPSIM. The model was run on a daily timestep for 21 years, to match the operational phase of the mine life, incorporating five different representative stages (see Section 4.1). Although the catchment areas will continuously change as the mine progresses, the adopted approach of modelling discrete stages will provide a reasonable representation of site conditions over the 21 year period.

The forecast simulation type allows the model configuration to change over the modelled 21 years by linking the representative stages, reflecting variations in the water management system over time such as catchments, production and groundwater inflows.

The changes in the physical layout and site catchment areas are summarised in Section 4.2.

To assess the effects of varying climatic conditions, the forecast model was run for 108 realisations (with each realisation corresponding to the 21 year mine life), using 128 years of climatic data available from January 1889 to December 2016. A different rainfall input sequence is applied to each realisation. The first realisation adopts climatic data from 1889 to 1909, the second from 1890 to 1910 and so on through the 128 years of climatic data. A percentile analysis of the resultant realisations can then be undertaken at user-defined confidence intervals to assess the behaviour of the various storages over extended dry and wet periods, reflecting the full range of climatic conditions experienced in the last 128 years.

[1] The schematics do not show transfers between storages located in OC1/OC2 to/from storages located in OC3/OC4.

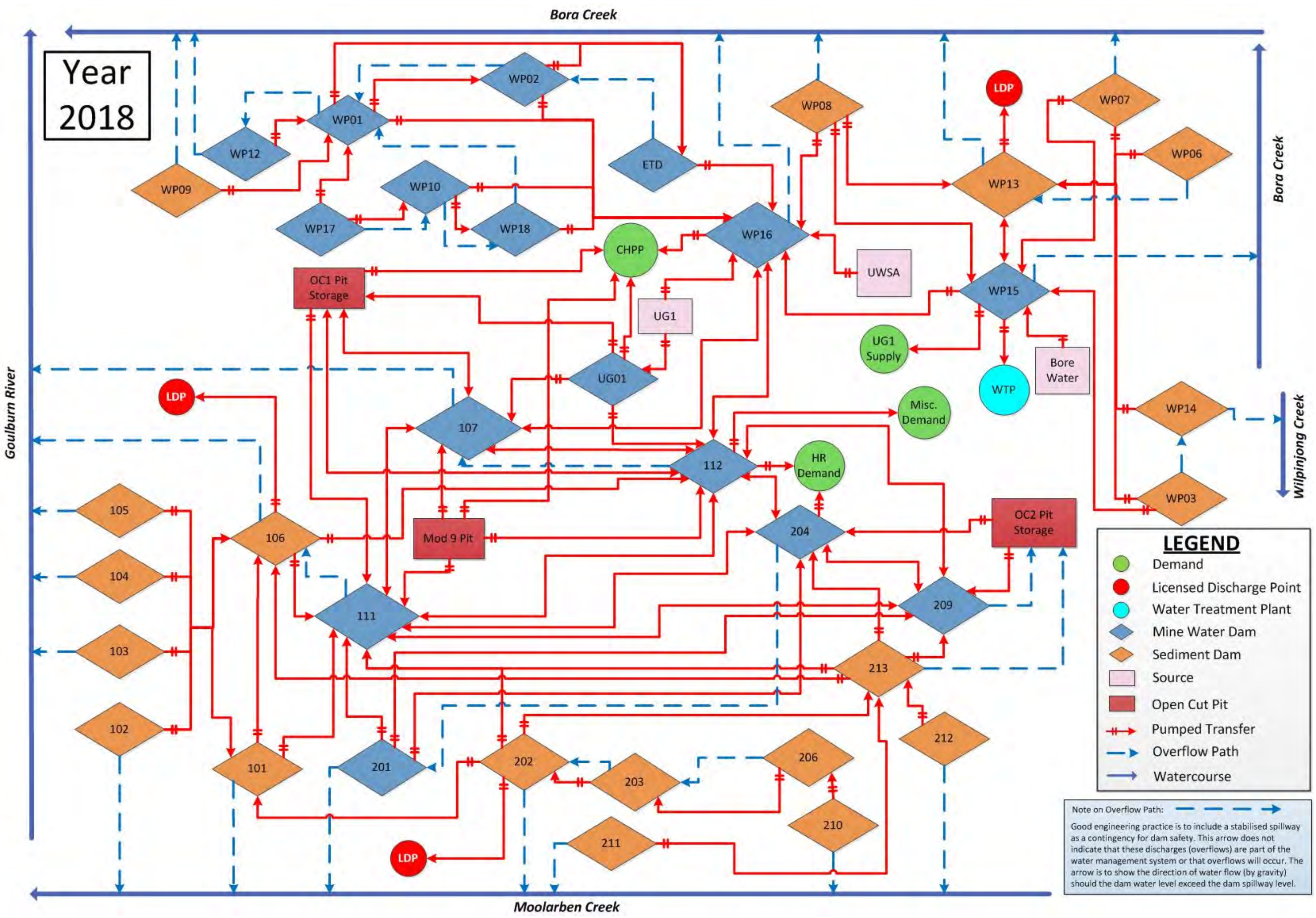


Figure 5.2 – Water management system schematic – WP, OC1 and OC2 (Phase 1)

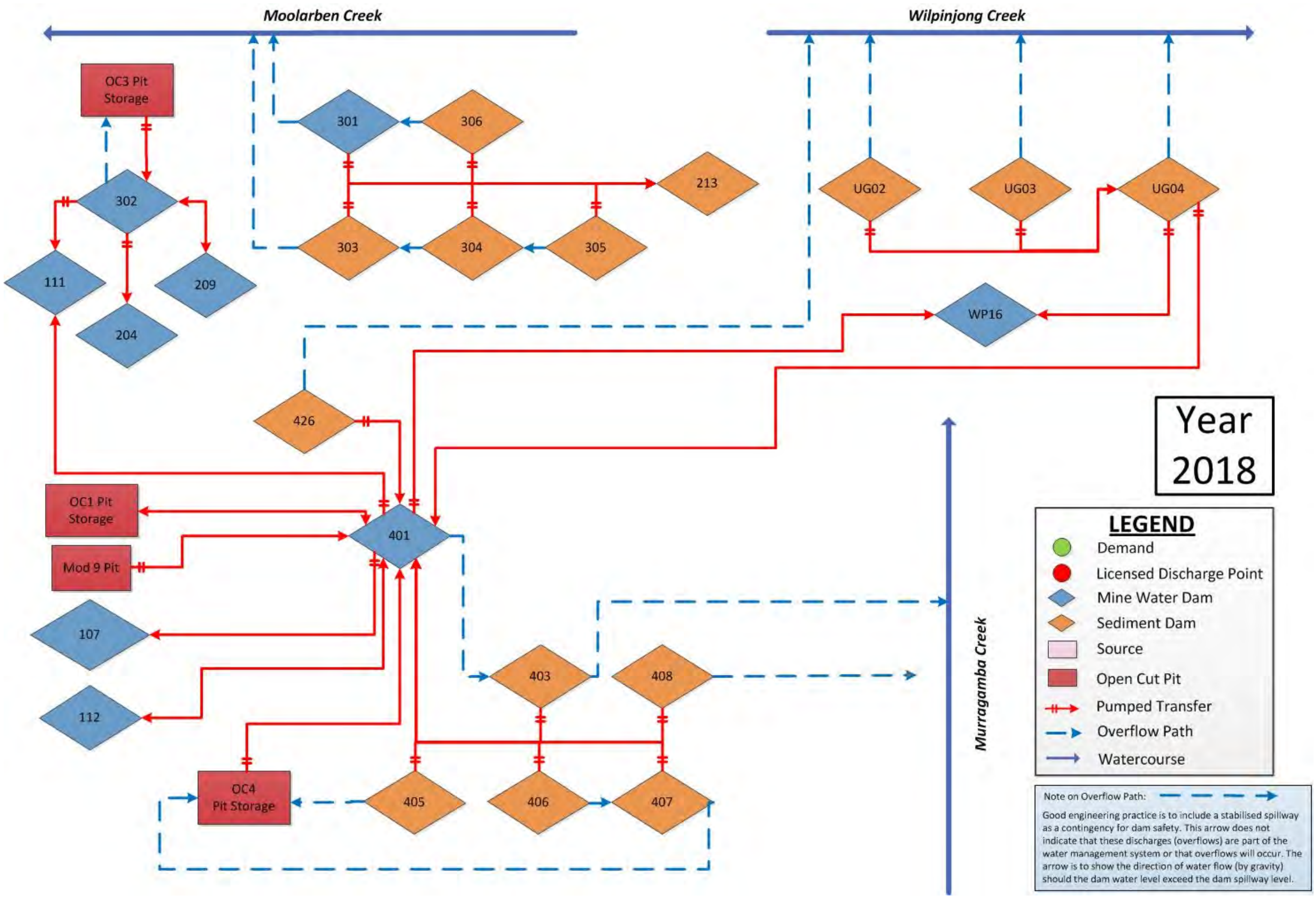


Figure 5.3 – Water management system schematic – OC3 and OC4 (Phase 1)

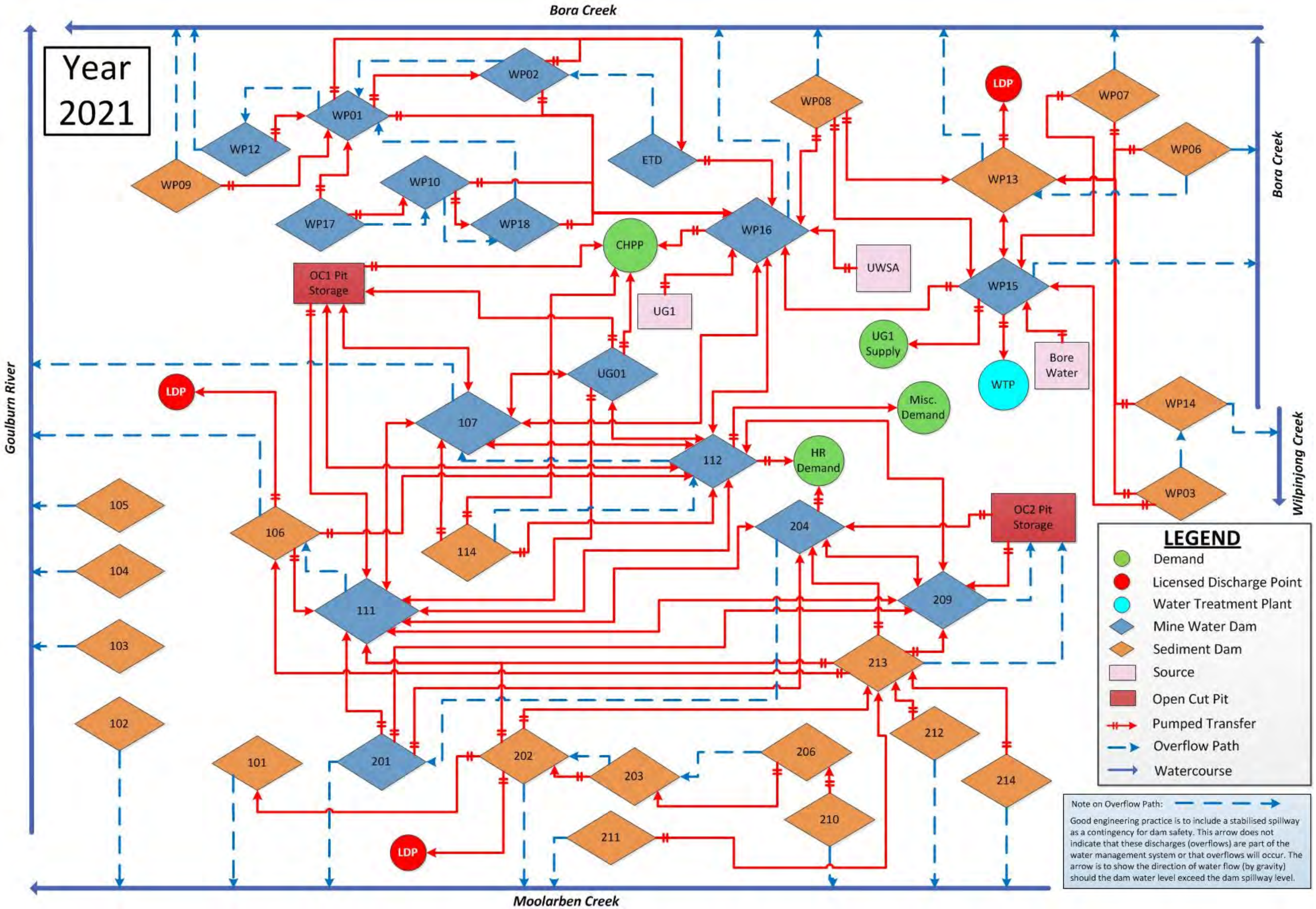


Figure 5.4 – Water management system schematic – WP, OC1 and OC2 (Phase 2)

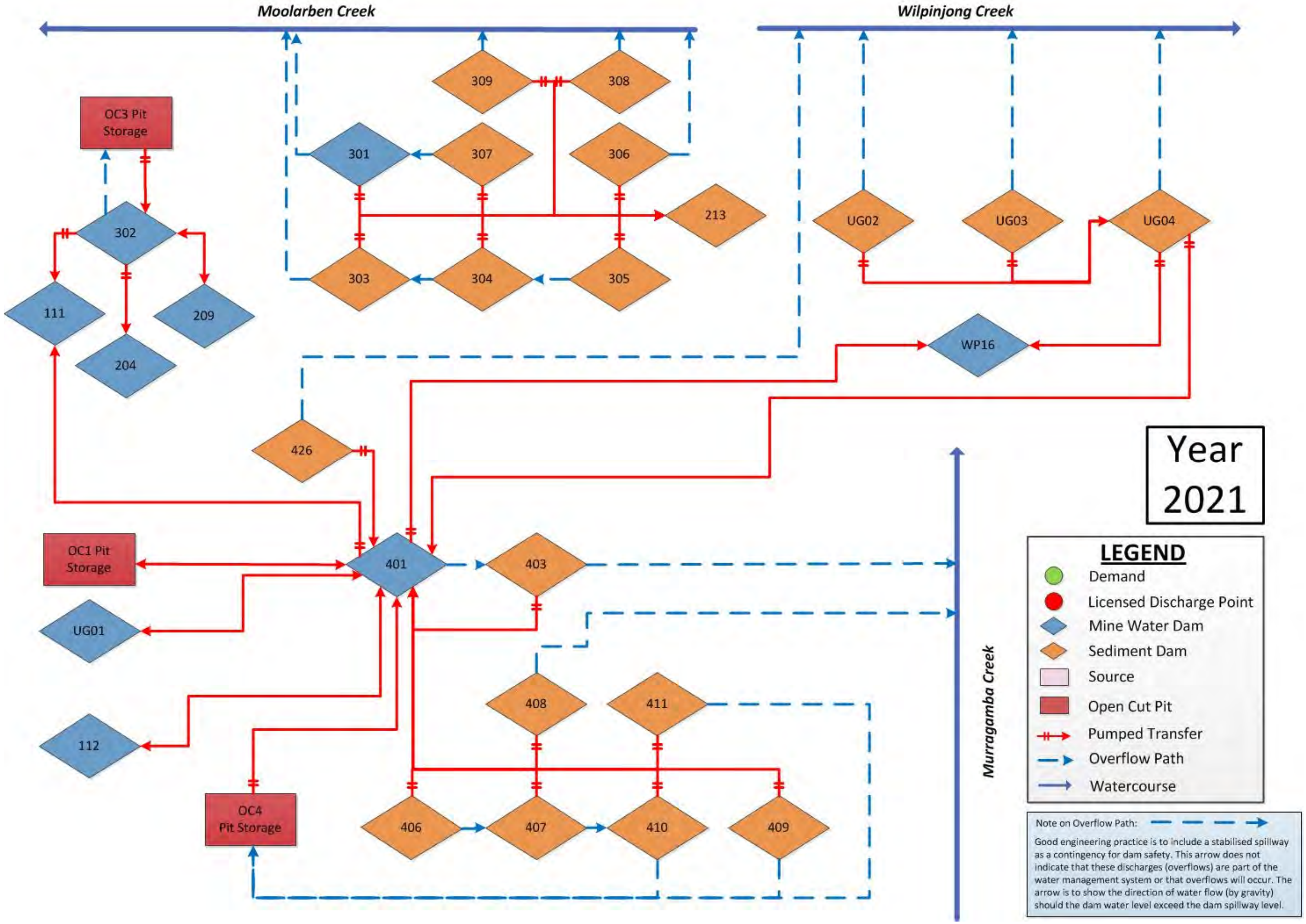


Figure 5.5 – Water management system schematic – OC3 and OC4 (Phase 2)

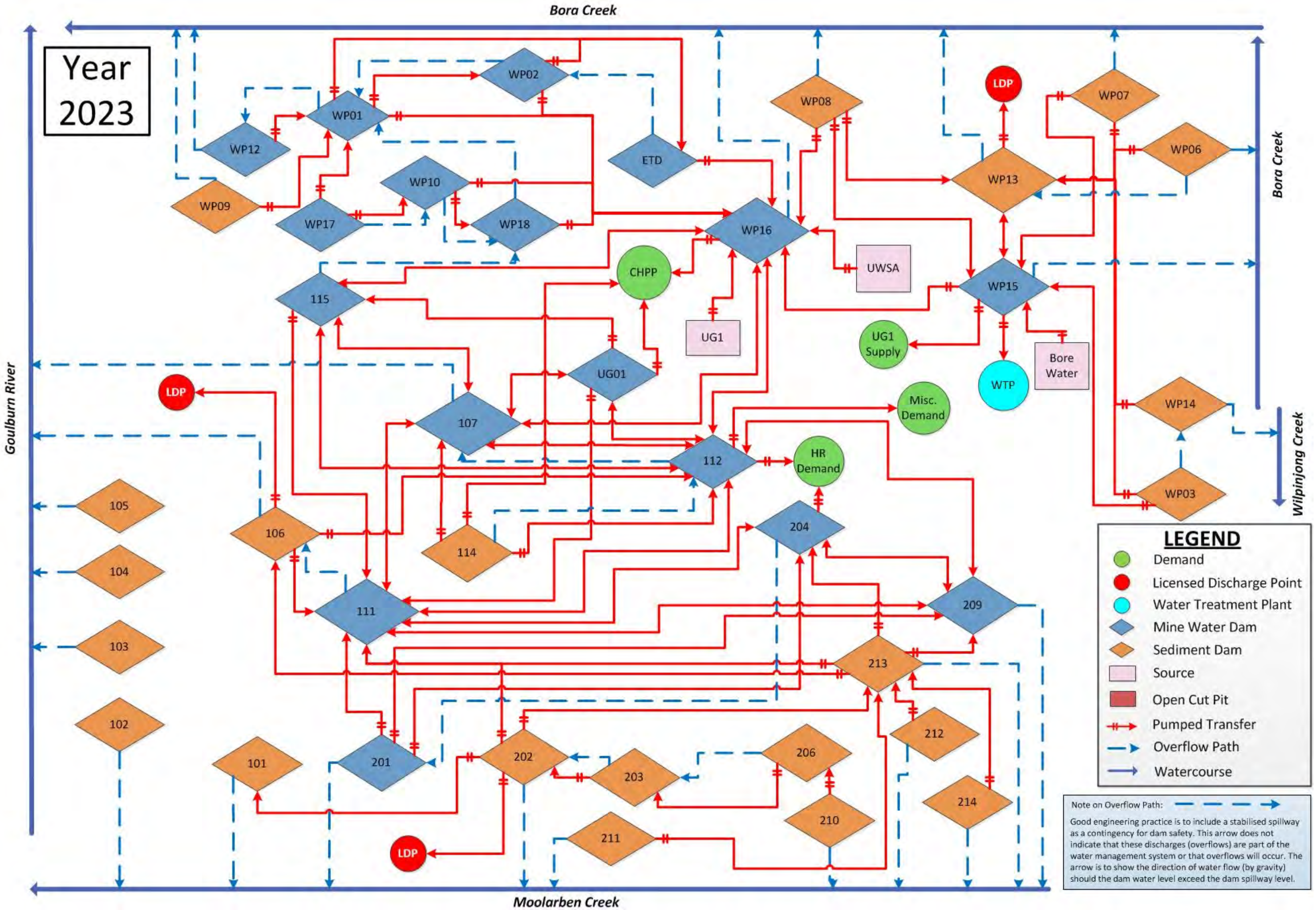


Figure 5.6 – Water management system schematic – WP, OC1 and OC2 (Phase 3)

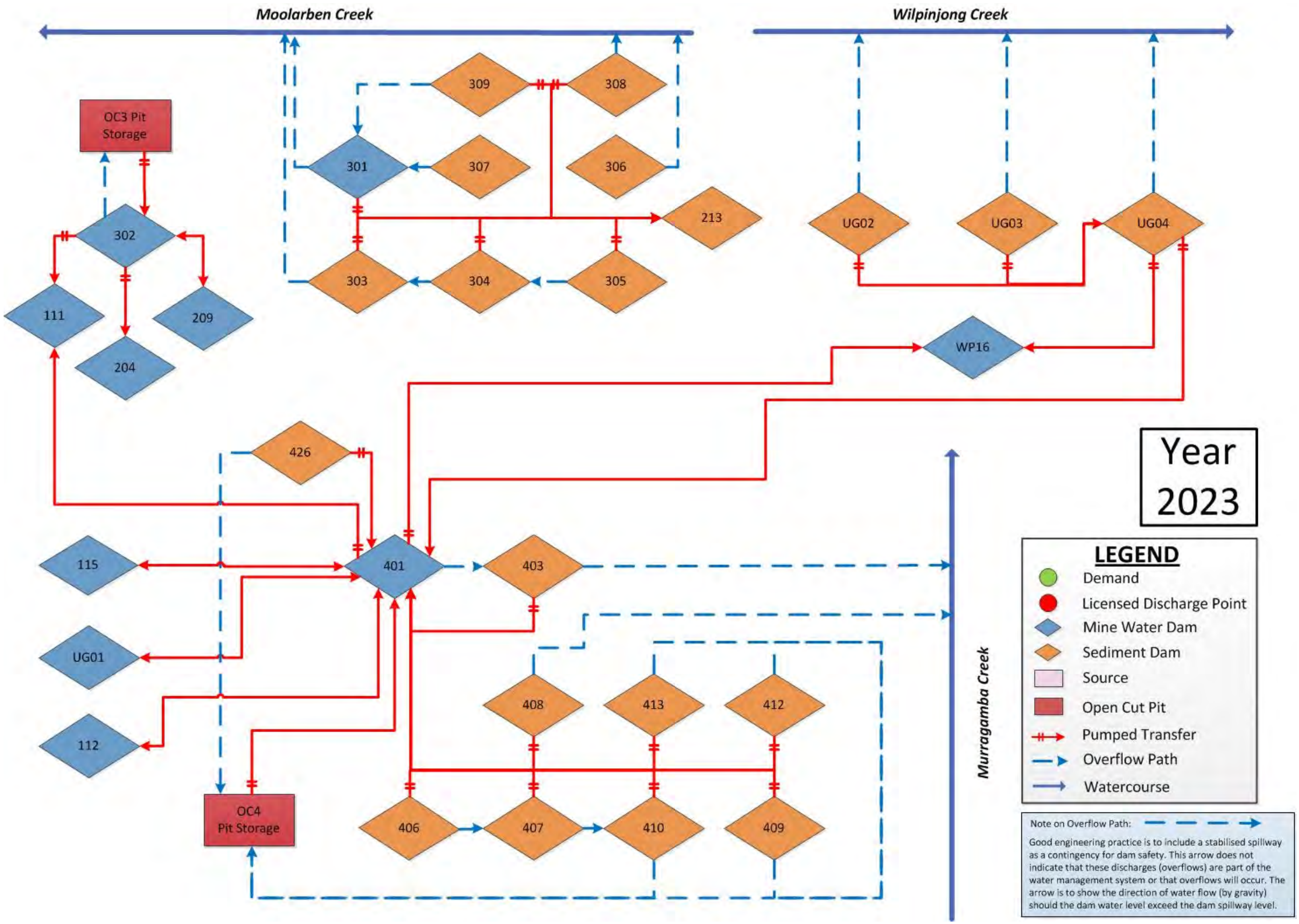


Figure 5.7 – Water management system schematic – OC3 and OC4 (Phase 3)

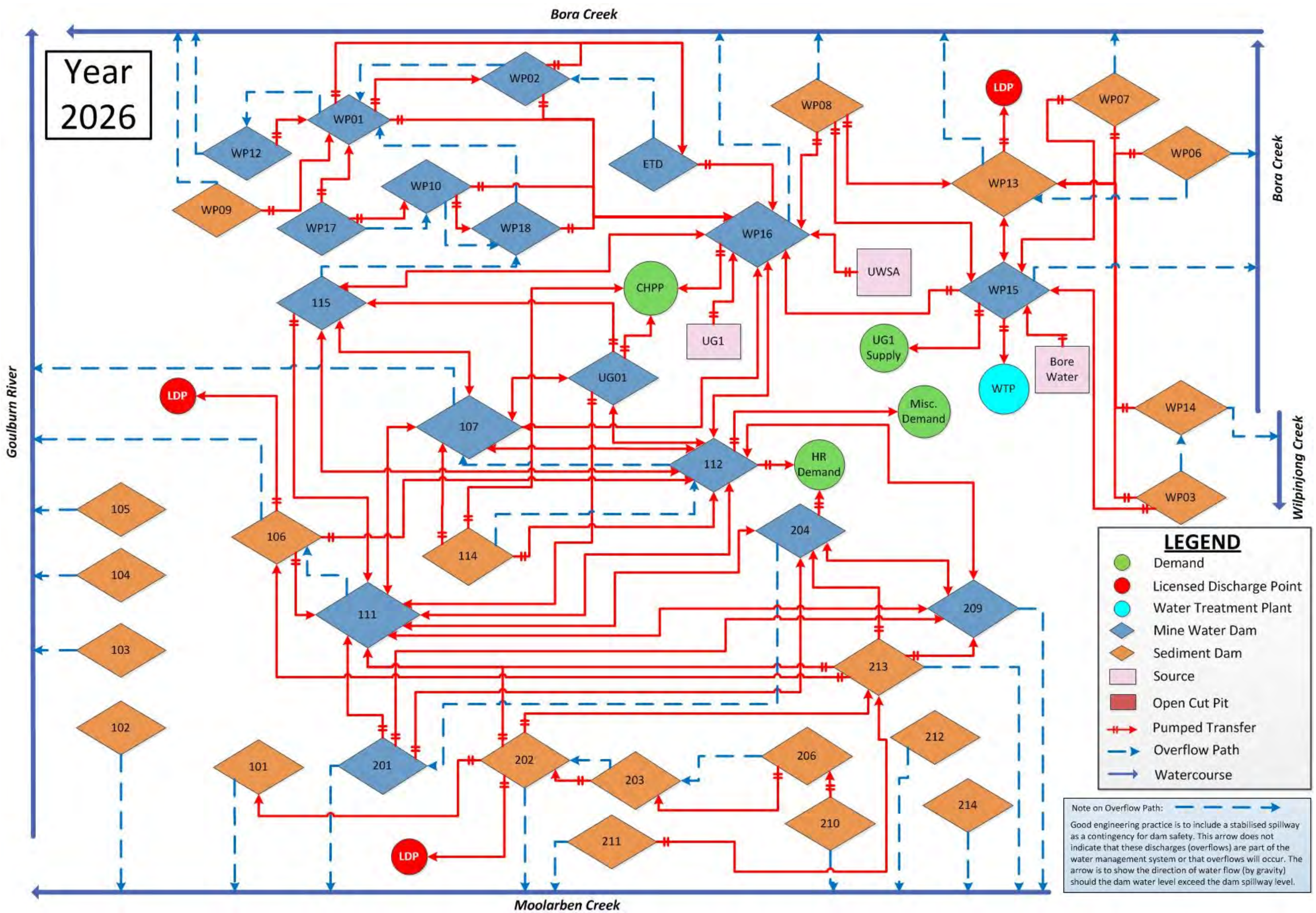


Figure 5.8 – Water management system schematic – WP, OC1 and OC2 (Phase 4)

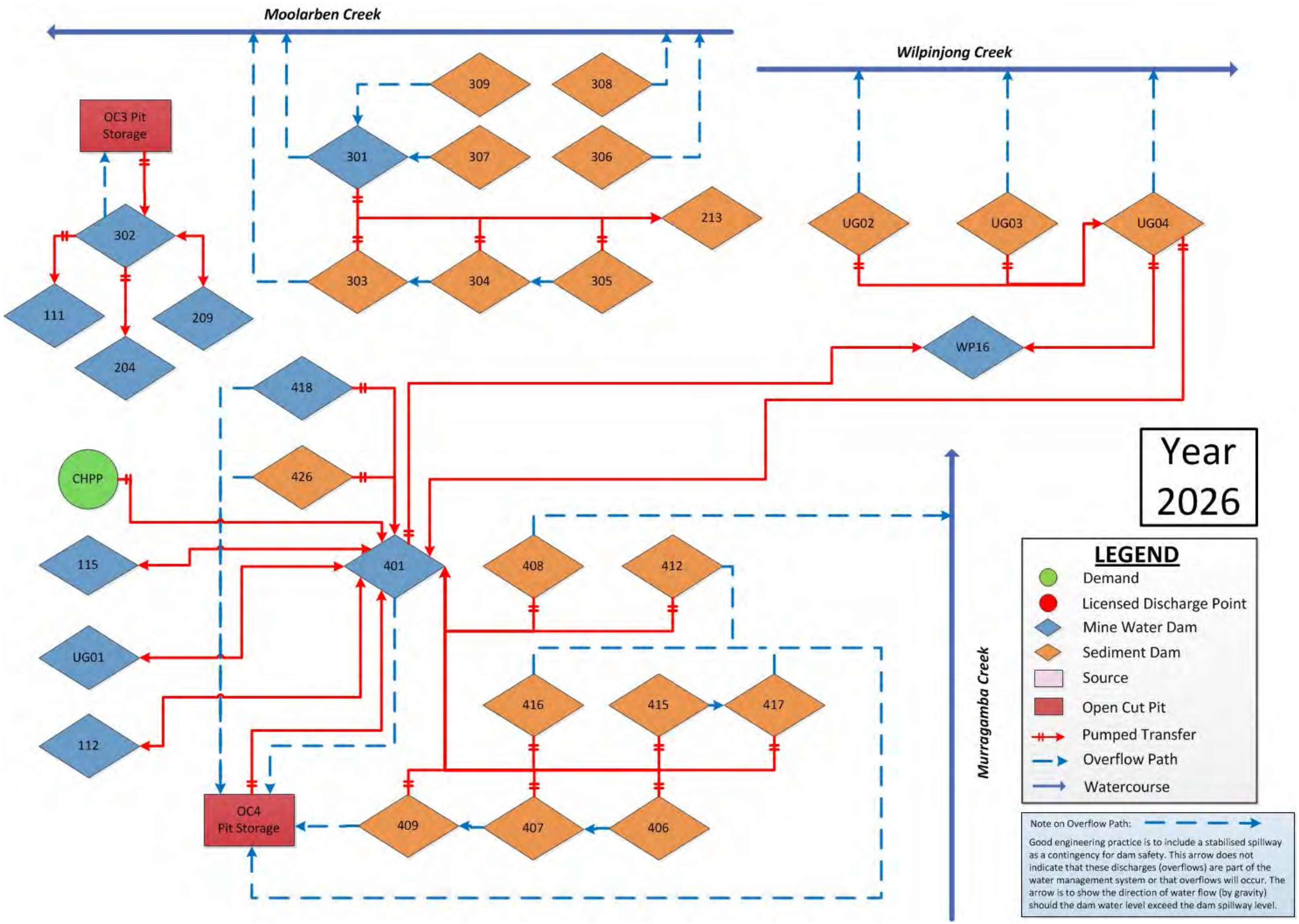


Figure 5.9 – Water management system schematic – OC3 and OC4 (Phase 4)

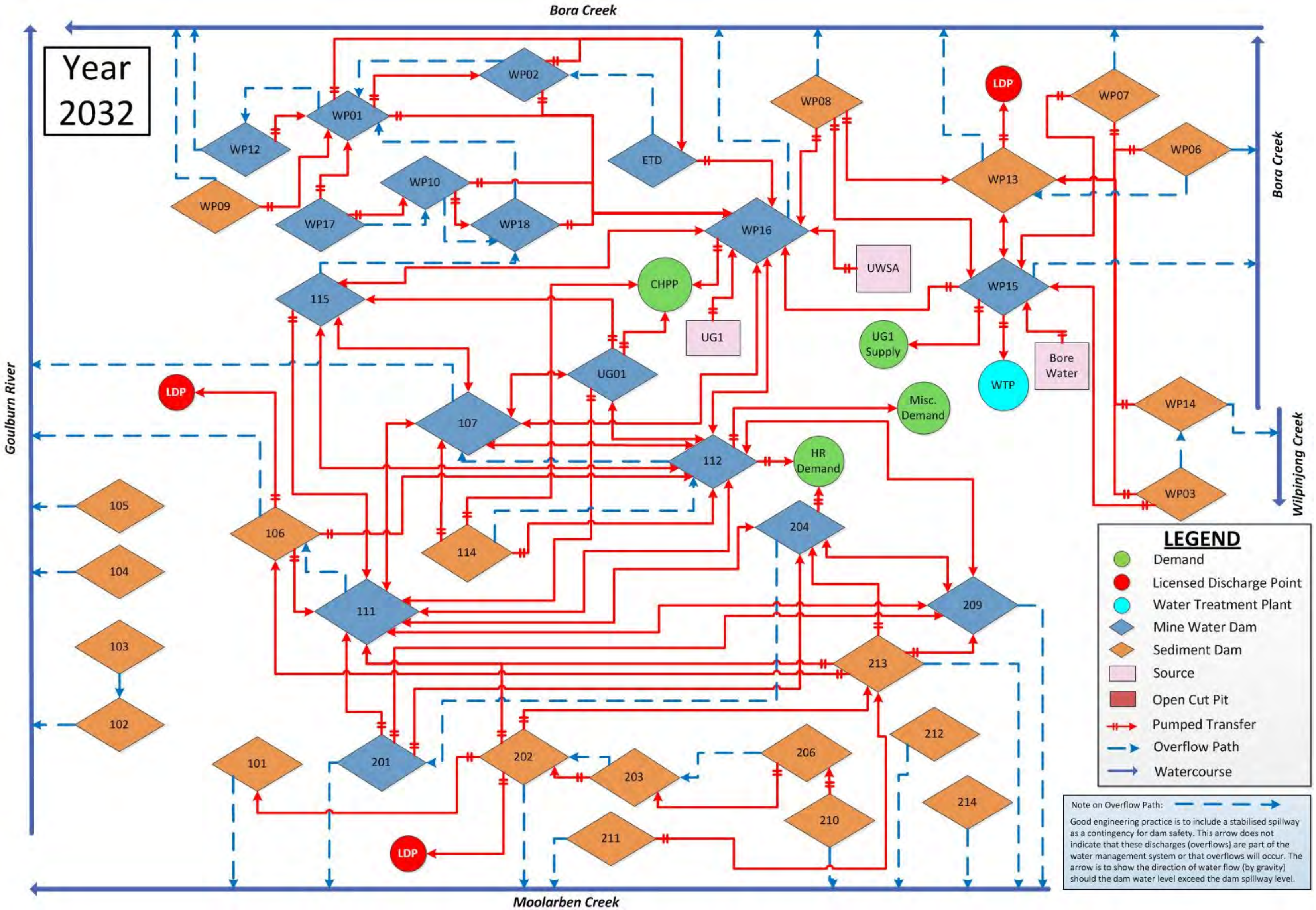


Figure 5.10 – Water management system schematic – WP, OC1 and OC2 (Phase 5)

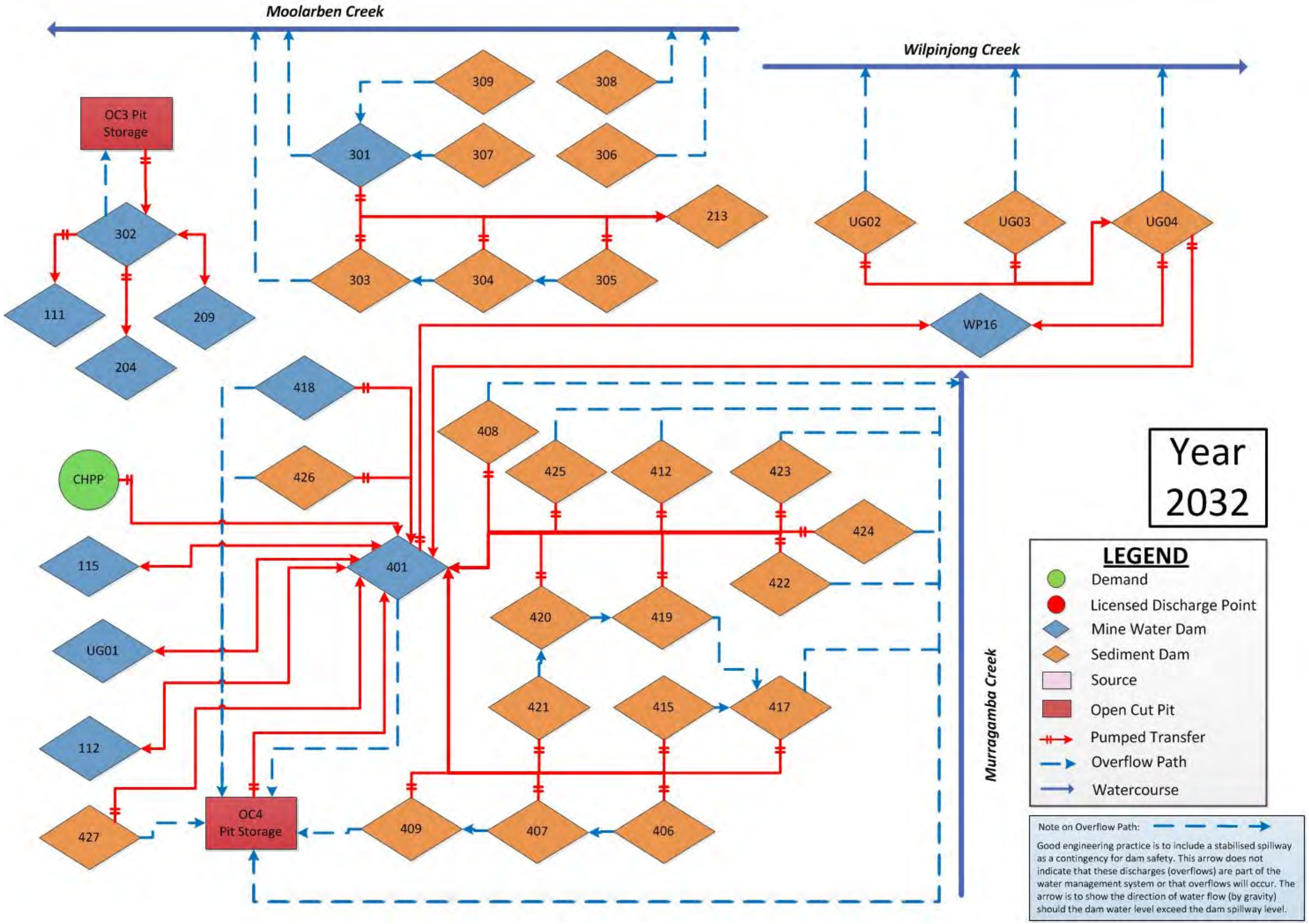


Figure 5.11 – Water management system schematic – OC3 and OC4 (Phase 5)

5.5 WATER DEMANDS

5.5.1 Coal handling and preparation plant (CHPP)

The projected annual coal production schedule over the Moolarben Coal Complex is summarised in Table 5.3. This includes the CHPP washed coal, bypass coal, rejects and product.

Table 5.3 - Forecast annual production data

Phase	Year	Modification			
		Feed (Mt)	Bypass (Mt)	Rejects (Mt)	Product (Mt)
1	2018	14.86	4.50	3.08	16.28
	2019	16.00	6.05	3.46	18.59
2	2020	13.38	10.32	3.01	20.69
	2021	13.64	10.21	2.88	20.97
3	2022	15.08	6.80	3.35	18.53
	2023	7.62	11.33	1.96	16.98
	2024	6.11	11.03	1.47	15.67
4	2025	9.51	14.46	2.21	21.76
	2026	9.38	12.54	2.14	19.77
	2027	7.84	9.13	1.82	15.15
	2028	7.27	8.59	1.69	14.16
	2029	7.04	6.26	1.64	11.66
5	2030	6.85	4.49	1.58	9.76
	2031	5.94	3.90	1.38	8.45
	2032	4.71	3.29	1.08	6.92
	2033	4.20	2.80	0.97	6.03
	2034	3.56	2.44	0.82	5.18
	2035	2.38	1.62	0.55	3.45
	2036	2.08	1.42	0.48	3.02
	2037	1.78	1.22	0.41	2.59
	2038	0.59	0.41	0.14	0.86

Mt = million tonnes

The adopted CHPP demand has been based on a net consumption rate of 80 litres per run-of-mine tonne (L/ROM tonne) based on recent CHPP performance as advised by MCO. The forecast net CHPP consumption over the life of the Moolarben Coal Complex is provided in Table 5.4.

Table 5.4 - Forecast net CHPP consumption

Phase	Year	Feed (Mt)	Net CHPP consumption (ML/a)	Net CHPP consumption (ML/d)
1	2018	14.86	1,189	3.26
	2019	16.00	1,280	3.50
2	2020	13.38	1,071	2.93
	2021	13.64	1,091	2.99
3	2022	15.08	1,206	3.30
	2023	7.62	609	1.67
	2024	6.11	489	1.34
4	2025	9.51	761	2.08
	2026	9.38	750	2.05
	2027	7.84	627	1.72
	2028	7.27	581	1.59
	2029	7.04	563	1.54
5	2030	6.85	548	1.50
	2031	5.94	475	1.30
	2032	4.71	377	1.03
	2033	4.20	336	0.92
	2034	3.56	285	0.78
	2035	2.38	190	0.52
5	2036	2.08	166	0.46
	2037	1.78	143	0.39
	2038	0.59	48	0.13

ML/a = megalitres per annum, ML/d = megalitres per day

5.5.2 Haul road dust suppression

Haul road dust suppression watering rates has been applied to haul road areas that vary as mining progresses. Haul road lengths were measured from the general arrangement figures for each mine stage. The following rules were used to determine the applied dust suppression rate on any given day of the historical rainfall record:

- The assessment used daily evaporation rates sourced from the SILO Datadrill evaporation dataset;
- 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, the watering rate is reduced and is only required to make up the remaining depth 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 35 metres (m) of the haul road width would be watered.

The estimated consumption rates for each phase are summarised in Table 5.5.

Table 5.5 - Forecast haul road dust suppression usage

Phase	Coal haul length (km)	OB haul length (km)	Total haul length (km)	Average annual usage (ML/d)	Average daily usage (ML/d)
1	14.0	11.8	25.8	1,110	3.0
2	14.6	12.5	27.1	1,165	3.2
3	2.9	11.5	14.4	620	1.7
4	3.2	10.1	13.3	570	1.6
5	3.5	11.2	14.7	630	1.7

5.5.3 Underground and miscellaneous water demand

The adopted underground usage and miscellaneous water demand has been provided by MCO, and is summarised in Table 5.6. We have made the following assumptions with regards to these water demands:

- The water supplied to the underground is sourced from the WTP permeate/shandied water;
- 50% of the underground demand is lost and 50% is returned back to the mine WMS; and
- 100% of the miscellaneous demand is lost.

Table 5.6 - Forecast underground and miscellaneous water demand

Phase	Underground demand (ML/a)	Miscellaneous demand (ML/a)	Total demand (ML/a)
1	525	150	675
2	525	150	675
3	525	150	675
4	525	150	675
5	0	150	150

5.6 WATER SOURCES

5.6.1 Groundwater inflows

The adopted groundwater inflows to the open cut and underground mining areas are based on estimates provided by Hydrosimulations, and are summarised in Table 5.7. Predicted groundwater inflows are anticipated to be higher than previously modelled due to (HydroSimulations, 2017):

- Model revision and recalibration.
- The proposed increase in the rate of open cut mining from 13 to 16 Mtpa.
- Proposed increases in the footprints of OC2 and OC3.
- Changes to the sequencing of the approved underground mining areas (including the continued dewatering of UG1 to maintain access as UG4 is mined).
- Differences in the timing of advanced dewatering of the UG4 area via the approved borefield.

An allowance has been made for groundwater losses associated with evaporation along the open cut face. A total face evaporation of 28.4 ML/a, consistent with previous assessments, has been distributed across the active open cut mining areas.

Table 5.7 - Forecast groundwater inflows (not including face evaporation losses)

Phase	Year	Total groundwater inflows	
		ML/a	ML/d
1	2018	2,118	5.80
	2019	2,424	6.64
2	2020	3,859	10.56
	2021	5,040	13.80
3	2022	5,007	13.71
	2023	5,141	14.08
	2024	5,316	14.56
4	2025	6,307	17.27
	2026	6,113	16.74
	2027	886	2.43
	2028	1,332	3.65
	2029	1,848	5.06
5	2030	1,318	3.61
	2031	1,444	3.95
	2032	221	0.61
	2033	253	0.69
	2034	301	0.83
	2035	245	0.67
5	2036	699	1.91
	2037	239	0.65

Phase	Year	Total groundwater inflows	
		ML/a	ML/d
	2038	220	0.60

5.6.2 Borefield inflows

Estimated borefield pumping rates to the mine water management system, provided by MCO, are summarised in Table 5.8. These pumped volumes are in addition to the groundwater inflows.

Table 5.8 -Forecast borefield inflows

Year	Annual borefield inflow (ML/a)
2018	788
2019	788
2020	788
2021	788
2022	631
2023	473
2024	315
2025+	0

5.7 CATCHMENT YIELD PARAMETERS

The OPSIM model uses the Australian Water Balance Model (AWBM) (Boughton, 2004 & 2009) 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 ground water 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 conceptual 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). Catchments across the site have been characterised into the following land use types:

- Natural;
- Hardstand;
- Open cut mining area (Active Pit);
- Overburden emplacement area (Spoil); and
- Rehabilitated overburden emplacement area (Rehab).

The adopted AWBM parameters are shown in Table 5.9. These parameters have been based on previous modelling and calibration of the MCO OPSIM water balance model. The most recent calibration was undertaken in March 2017 against observation in 2016, and resulted in an adjustment to the parameters for the Spoil land use type to better reflect the observed changes in inventory over the wet winter in 2016.

Table 5.9 - Adopted AWBM parameters

Parameter	Natural	Hardstand	Pit	Spoil	Rehab
A_1	0.2	0.1	0.1	0.1	0.2
A_2	0.2	0.9	0.9	0.3	0.2
A_3	0.6	0	0	0.6	0.6
C_1	45	4	4	15	45
C_2	95	16	16	50	95
C_3	150	0	0	110	150
BFI	0.55	0	0	0.2	0.55
K_b	0.7	0	0	0	0.7
K_s	1	1	1	1	1
Long-term volumetric runoff coefficient	5.3%	35.7%	35.7%	9.8%	5.3%

5.8 PROPOSED WATER TREATMENT PLANT SYSTEM

MCO are planning to construct a WTP to assist with managing excess mine water over the life of the Moolarben Coal Complex. For the purposes of this assessment, the following operating characteristics for the proposed WTP have been assumed:

- Feed water throughput: 10 ML/d (max)
- Treatment efficiency: 75%
- Permeate discharge rate: 7.5 ML/d
- Brine discharge rate: 2.5 ML/d

The permeate is then mixed with excess sediment or mine water up to a maximum of 900 µS/cm (median of 800 µS/cm) and in accordance with other EPL criteria prior to discharge at a maximum rate of 20 ML/d. That is, 12.5 ML/d of sediment/mine water can be shandied with the WTP permeate and discharged to the Goulburn River subject to meeting EPL criteria.

Brine will be temporarily stored in dedicated brine storage dams prior to disposal. The brine management strategy may include, but is not necessarily limited to, the following disposal options:

- Disposal via water trucks (i.e. use in haul road dust suppression);
- Storage in isolated dams within the OC2 and OC3 mining areas following completion of mining; and
- Disposal in underground mining areas following completion of mining.

5.9 CATCHMENT AREAS

Catchment types draining to the mine site storages change with mining progression. Mining progression and associated spoil/rehabilitation footprints at each stage were based on the latest mine plans and information provided by MCO. The adopted catchment and land uses for each Phase are summarised in Table 5.10 to Table 5.14 and presented in Figure 4.1 to Figure 4.5.

Table 5.10 - Catchment and land use breakdown - Phase 1 (Year 2018)

Storage name	Catchment area (ha)					
	Hardstand/ haul roads	Pit	Rehab	Spoil	Natural/ undisturbed	TOTAL
CHPP						
WP01	6.6	0.0	0.0	0.0	0.0	6.6
WP02	7.3	0.0	0.0	0.0	0.0	7.3
WP03	1.5	0.0	0.0	0.0	0.1	1.8
WP06	0.0	0.0	2.9	0.0	0.0	2.9
WP07	0.0	0.0	1.1	0.0	0.0	1.1
WP08	1.6	0.0	0.0	0.0	0.4	2.0
WP09	1.8	0.0	0.0	0.0	0.0	1.8
WP10	4.0	0.0	0.0	0.0	0.8	4.8
WP12	1.7	0.0	0.0	0.0	0.2	1.8
WP13	14.2	0.0	0.0	0.0	7.3	21.5
WP14	5.0	0.0	0.0	0.0	14.7	19.7
WP15	3.1	0.0	0.0	0.0	0.1	3.2
WP16	2.6	0.0	0.0	0.0	0.2	2.8
WP17	4.5	0.0	0.0	0.0	0.0	4.5
WP18	10.1	0.0	0.6	0.0	0.4	11.1
ETD	6.0	0.0	0.0	0.0	0.0	6.0
OC1						
101	0.0	0.0	10.0	0.0	1.4	1.4
102	0.0	0.0	3.9	0.0	0.9	4.8
103	0.0	0.0	7.0	0.0	0.6	7.6
104	0.0	0.0	2.0	0.0	0.7	2.7
105	0.0	0.0	2.6	0.0	0.8	3.4
106	0.1	0.0	95.1	0.0	4.1	99.3
107	20.1	0.0	8.2	0.0	1.0	29.3
111	4.2	2.2	6.9	3.9	5.4	22.5
112	16.2	0.1	33.3	5.7	1.4	56.7
OC1 North	53.2	3.6	1.4	31.4	135.7	225.3
Mod 9 Pit	6.7	56.6	6.6	10.7	122.6	203.2

Storage name	Catchment area (ha)					
	Hardstand/ haul roads	Pit	Rehab	Spoil	Natural/ undisturbed	TOTAL
OC2						
201	7.0	0.0	0.0	0.1	6.7	13.9
202	0.0	0.0	32.1	0.0	0.0	32.1
203	0.0	0.0	6.7	0.0	0.0	6.7
204	6.0	0.0	5.0	0	11.6	22.6
206	0.0	0.0	11.1	0.0	0.0	11.1
209/OC2 Pit	9.5	40.3	3.2	42.9	74.8	170.7
210	1.4	0.0	7.1	0.0	0.0	8.5
211	0.1	0.0	2.6	0.0	0.0	2.6
212/OC2 Pit	0.0	27.0	0.0	0.0	21.3	48.3
213	1.7	0.0	71.9	7.0	74.6	155.2
OC3						
301	7.7	0.0	0.0	0.0	16.7	24.4
302	9.5	2.5	0.0	16.8	0.0	28.7
303	2.6	0.0	0.0	3.0	3.2	8.8
304	1.7	0.0	0.0	0.0	4.2	5.9
305	1.6	0.0	0.0	1.5	4.2	7.3
306	0.0	0.0	0.0	0.0	20.8	20.8
OC3 Pit	0.0	30.5	0.0	1.4	79.1	111.0
OC4						
401	35.8	0.0	0.0	0.0	35.6	71.4
403	0.2	0.0	4.6	0.0	0.0	4.8
405	0.0	19.2	0.0	0.0	58.8	78.0
406,407	0.0	0.0	49.4	0.0	51.8	101.2
408	3.1	0.0	0.0	0.0	0.0	3.1
426	1.4	0.0	0.0	0.0	1.4	2.8
OC4 Pit	0.1	91.9	37.6	59.9	43.2	232.8
UG						
UG01	24.0	0.0	0.0	0.0	26.1	50.1
UG02	0.9	0.0	0.0	0.0	0.0	0.9
UG03	1.6	0.0	0.0	0.0	0.0	1.6
UG04	1.0	0.0	0.0	0.0	0.0	1.0

Table 5.11 - Catchment and land use breakdown - Phase 2 (Year 2021)

Storage name	Catchment area (ha)					
	Hardstand/ haul roads	Pit	Rehab	Spoil	Natural/ undisturbed	TOTAL
CHPP						
WP01	6.6	0.0	0.0	0.0	0.0	6.6
WP02	7.3	0.0	0.0	0.0	0.0	7.3
WP03	1.7	0.0	0.0	0.0	0.1	1.8
WP06 (excl. TP dams)	1.8	0.0	0.0	0.0	0.0	1.8
WP07	0.0	0.0	1.1	0.0	0.0	1.1
WP08	0.0	0.0	0.0	0.0	2.0	2.0
WP09	1.8	0.0	0.0	0.0	0.0	1.8
WP10	4.0	0.0	0.0	0.0	0.8	4.8
WP12	1.7	0.0	0.0	0.0	0.2	1.9
WP13 (excl. TP dams)	11.4	0.0	0.0	0.0	7.3	18.7
WP14	5.0	0.0	0.0	0.0	14.7	19.7
WP15	3.1	0.0	0.0	0.0	0.1	3.2
WP16	268	0.0	0.0	0.0	0.2	2.8
WP17	4.5	0.0	0.0	0.0	0.0	4.5
WP18	10.1	0.0	0.6	0.0	0.4	11.2
ETD	6.0	0.0	0.0	0.0	0.0	6.0
OC1						
101	0.0	0.0	10.0	0.0	1.4	11.4
102	0.0	0.0	3.9	0.0	0.9	4.8
103	0.0	0.0	7.0	0.0	0.6	7.6
104	0.0	0.0	2.0	0.0	0.7	2.7
105	0.0	0.0	2.6	0.0	0.8	3.4
106	0.2	0.0	95.4	0.0	3.7	99.3
107	20.2	0.0	8.1	0.0	1.0	29.3
111	4.2	0.0	13.2	0.0	5.1	22.5
112	16.2	0.0	39.0	0.0	1.5	56.7
114	6.3	0.0	55.7	0.0	115.2	177.2
OC1 North	70.2	3.6	15.6	0.0	135.7	225.1
OC2						
201	6.8	0.0	0.1	0.1	3.0	10.1
202	0.0	0.0	3.9	0.0	0.0	3.9
203	0.0	0.0	6.7	0.0	0.0	6.7

Storage name	Catchment area (ha)					
	Hardstand/ haul roads	Pit	Rehab	Spoil	Natural/ undisturbed	TOTAL
204	6.5	23.2	14.4	28.0	18.7	90.9
206	0.0	0.0	11.1	0.0	0.0	11.1
209	9.7	0.0	90.1	0.0	70.9	170.7
210	1.4	0.0	7.1	0.0	0.0	8.5
211	0.1	0.0	2.5	0.0	0.0	2.6
212	0.0	0.0	27.4	4.5	20.4	52.3
213	1.7	0.4	78.1	0.0	64.7	145.0
214/OC2 Pit	0.0	7.4	0.0	0.7	20.6	28.7
OC3						
301	7.7	0.0	0.0	0.0	16.7	24.4
302	9.3	0.0	98.1	21.6	0.0	144.2
303	2.6	0.0	3.0	0.0	3.2	8.8
304	1.7	0.0	0.0	0.0	4.2	5.9
305	1.5	0.0	1.6	0.0	4.2	7.3
306	0.0	0.0	18.1	0.0	5.5	23.6
307	0.0	0.0	16.6	0.0	11.5	28.1
308	0.3	0.9	0.1	0.3	8.0	9.5
309	0.0	0.0	0.0	0.0	4.8	4.8
OC3 Pit	0.0	74.7	0.0	21.8	94.3	190.8
OC4						
401	35.7	0.0	0.0	0.0	30.6	66.3
403	0.2	0.0	4.6	0.0	0.0	4.8
406,407	0.0	0.0	48.5	0.0	52.7	101.2
408	3.1	0.0	0.0	0.0	0.0	3.1
409/410	0.1	0.0	127.8	0.0	0.9	128.8
411	0.0	0.4	0.0	0.0	92.4	92.8
426	1.4	0.0	0.0	0.0	1.4	2.8
OC4 Pit	0.1	69.8	76.0	68.4	176.2	390.5
UG						
UG01	24.0	0.0	0.0	0.0	26.1	50.1
UG02	0.9	0.0	0.0	0.0	0.0	0.9
UG03	1.6	0.0	0.0	0.0	0.0	1.6
UG04	1.0	0.0	0.0	0.0	0.0	1.0

Table 5.12 - Catchment and land use breakdown - Phase 3 (Year 2023)

Storage name	Catchment area (ha)					
	Hardstand/ haul roads	Pit	Rehab	Spoil	Natural/ undisturbed	TOTAL
CHPP						
WP01	6.6	0.0	0.0	0.0	0.0	6.6
WP02	7.3	0.0	0.0	0.0	0.0	7.3
WP03	1.7	0.0	0.0	0.0	0.1	1.8
WP06 (excl. TP dams)	1.8	0.0	0.0	0.0	0.0	1.8
WP07	0.0	0.0	1.1	0.0	0.0	1.1
WP08	0.0	0.0	0.0	0.0	2.0	2.0
WP09	1.8	0.0	0.0	0.0	0.0	1.8
WP10	4.0	0.0	0.0	0.0	0.8	4.8
WP12	1.7	0.0	0.0	0.0	0.2	1.9
WP13 (excl. TP dams)	11.4	0.0	0.0	0.0	7.3	18.7
WP14	5.0	0.0	0.0	0.0	14.7	19.7
WP15	3.1	0.0	0.0	0.0	0.1	3.2
WP16	268	0.0	0.0	0.0	0.2	2.8
WP17	4.5	0.0	0.0	0.0	0.0	4.5
WP18	10.1	0.0	0.6	0.0	0.4	11.2
ETD	6.0	0.0	0.0	0.0	0.0	6.0
OC1						
101	0.0	0.0	10.0	0.0	1.4	11.4
102	0.0	0.0	3.9	0.0	0.9	4.8
103	0.0	0.0	7.0	0.0	0.6	7.6
104	0.0	0.0	2.0	0.0	0.7	2.7
105	0.0	0.0	2.6	0.0	0.8	3.4
106	0.2	0.0	95.4	0.0	3.7	99.3
107	20.2	0.0	8.1	0.0	1.0	29.3
111	4.2	0.0	13.2	0.0	5.1	22.5
112	16.2	0.0	39.0	0.0	1.5	56.7
114	6.3	0.0	55.7	0.0	115.2	177.2
115	70.2	0.0	19.2	0.0	135.8	225.1
OC2						
201	6.8	0.	0.1	0.0	3.1	10.1
202	0.0	0.0	3.9	0.0	0.0	3.9
203	0.0	0.0	6.7	0.0	0.0	6.7

Storage name	Catchment area (ha) Hardstand/ haul roads	Pit	Rehab	Spoil	Natural/ undisturbed	TOTAL
204	6.5	0.0	65.5	0.0	18.9	90.9
206	0.0	0.0	11.1	0.0	0.0	11.1
209	9.7	0.0	90.2	0.0	70.7	170.7
210	1.4	0.0	7.1	0.0	0.0	8.5
211	0.1	0.0	2.5	0.0	0.0	2.6
212	0.0	0.0	31.7	0.0	20.6	52.3
213	1.7	0.0	78.5	0.0	64.9	145.0
214	0.0	0.0	7.8	0.0	20.8	28.7
OC3						
301	7.7	0.0	0.2	0.0	16.5	24.4
302	0.0	0.0	6.8	0.0	0.0	6.8
303	6.4	0.0	15.2	0.0	3.2	24.9
304	7.2	0.0	0.1	0.0	4.2	11.4
305	1.5	0.0	22.8	0.0	6.0	30.4
306	0.0	0.0	84.4	0.0	19.4	103.8
307	0.0	0.0	16.6	0.0	11.5	28.1
308	0.3	0.0	89.3	0.0	38.3	127.9
309	0.0	0.0	27.0	0.0	5.6	32.6
OC3 Void	0.0	24.6	7.8	0.0	21.9	54.3
OC4						
401	0.0	0.0	15.9	0.0	0.0	15.9
403	0.0	0.0	2.9	0.0	0.0	2.9
406,407	0.0	0.0	49.6	0.0	51.6	101.2
408	3.1	0.0	0.0	0.0	0.0	3.1
409/410/412	5.6	0.0	214.9	0.7	1.1	222.3
413	0.0	0.0	0.0	0.0	46.8	46.8
426	1.4	0.0	0.0	0.0	1.4	2.8
OC4 Pit	14.5	148.1	12.1	105.0	202.0	481.8
UG						
UG01	24.0	0.0	0.0	0.0	26.1	50.1
UG02	0.9	0.0	0.0	0.0	0.0	0.9
UG03	1.6	0.0	0.0	0.0	0.0	1.6
UG04	1.0	0.0	0.0	0.0	0.0	1.0

Table 5.13 - Catchment and land use breakdown - Phase 4 (Year 2026)

Storage name	Catchment area (ha)					
	Hardstand/ haul roads	Pit	Rehab	Spoil	Natural/ undisturbed	TOTAL
CHPP						
WP01	6.6	0.0	0.0	0.0	0.0	6.6
WP02	7.3	0.0	0.0	0.0	0.0	7.3
WP03	1.7	0.0	0.0	0.0	0.1	1.8
WP06 (excl. TP dams)	1.8	0.0	0.0	0.0	0.0	1.8
WP07	0.0	0.0	1.1	0.0	0.0	1.1
WP08	0.0	0.0	0.0	0.0	2.0	2.0
WP09	1.8	0.0	0.0	0.0	0.0	1.8
WP10	4.0	0.0	0.0	0.0	0.8	4.8
WP12	1.7	0.0	0.0	0.0	0.2	1.9
WP13 (excl. TP dams)	11.4	0.0	0.0	0.0	7.3	18.7
WP14	5.0	0.0	0.0	0.0	14.7	19.7
WP15	3.1	0.0	0.0	0.0	0.1	3.2
WP16	268	0.0	0.0	0.0	0.2	2.8
WP17	4.5	0.0	0.0	0.0	0.0	4.5
WP18	10.1	0.0	0.6	0.0	0.4	11.2
ETD	6.0	0.0	0.0	0.0	0.0	6.0
OC1						
101	0.0	0.0	10.0	0.0	1.4	11.4
102	0.0	0.0	3.9	0.0	0.9	4.8
103	0.0	0.0	7.0	0.0	0.6	7.6
104	0.0	0.0	2.0	0.0	0.7	2.7
105	0.0	0.0	2.6	0.0	0.8	3.4
106	0.2	0.0	95.4	0.0	3.7	99.3
107	20.2	0.0	8.1	0.0	1.0	29.3
111	4.2	0.0	13.2	0.0	5.1	22.5
112	16.2	0.0	39.0	0.0	1.5	56.7
114	6.3	0.0	55.7	0.0	115.2	177.2
115	70.2	0.0	19.2	0.0	135.8	225.1
OC2						
201	6.8	0.	0.1	0.0	3.1	10.1
202	0.0	0.0	3.9	0.0	0.0	3.9
203	0.0	0.0	6.7	0.0	0.0	6.7

Storage name	Catchment area (ha)					
	Hardstand/ haul roads	Pit	Rehab	Spoil	Natural/ undisturbed	TOTAL
204	6.5	0.0	65.5	0.0	18.9	90.9
206	0.0	0.0	11.1	0.0	0.0	11.1
209	9.7	0.0	90.2	0.0	70.7	170.7
210	1.4	0.0	7.1	0.0	0.0	8.5
211	0.1	0.0	2.5	0.0	0.0	2.6
212	0.0	0.0	31.7	0.0	20.6	52.3
213	1.7	0.0	78.5	0.0	64.9	145.0
214	0.0	0.0	7.8	0.0	20.8	28.7
OC3						
301	7.7	0.0	0.2	0.0	16.5	24.4
302	0.0	0.0	6.8	0.0	0.0	6.8
303	6.4	0.0	15.2	0.0	3.2	24.9
304	7.2	0.0	0.1	0.0	4.2	11.4
305	1.5	0.0	22.8	0.0	6.0	30.4
306	0.0	0.0	84.4	0.0	19.4	103.8
307	0.0	0.0	16.6	0.0	11.5	28.1
308	0.3	0.0	88.1	0.0	39.6	127.9
309	0.0	0.0	27.0	0.0	5.6	32.6
OC3 Void	0.0	24.2	7.8	0.0	22.3	54.3
OC4						
401	0.0	0.0	15.9	0.0	0.0	15.9
406/407	0.0	0.0	72.4	0.0	75.0	147.4
408	3.1	0.0	0.0	0.0	0.0	3.1
409/412/415	3.5	0.0	197.0	2.5	70.1	273.1
416	0.0	4.6	0.0	0.0	88.7	93.2
417	0.0	0.0	64.5	22.0	25.4	111.9
418	31.1	0.0	53.3	1.2	59.8	145.5
426	1.4	0.0	0.0	0.0	1.4	2.8
OC4 Pit	0.0	192.3	0.0	98.3	153.5	444.1
UG						
UG01	24.0	0.0	0.0	0.0	26.1	50.1
UG02	0.9	0.0	0.0	0.0	0.0	0.9
UG03	1.6	0.0	0.0	0.0	0.0	1.6
UG04	1.0	0.0	0.0	0.0	0.0	1.0

Table 5.14 - Catchment and land use breakdown - Phase 5 (Year 2032)

Storage name	Catchment area (ha)					
	Hardstand/ haul roads	Pit	Rehab	Spoil	Natural/ undisturbed	TOTAL
CHPP						
WP01	6.6	0.0	0.0	0.0	0.0	6.6
WP02	7.3	0.0	0.0	0.0	0.0	7.3
WP03	1.7	0.0	0.0	0.0	0.1	1.8
WP06 (excl. TP dams)	1.8	0.0	0.0	0.0	0.0	1.8
WP07	0.0	0.0	1.1	0.0	0.0	1.1
WP08	0.0	0.0	0.0	0.0	2.0	2.0
WP09	1.8	0.0	0.0	0.0	0.0	1.8
WP10	4.0	0.0	0.0	0.0	0.8	4.8
WP12	1.7	0.0	0.0	0.0	0.2	1.9
WP13 (excl. TP dams)	11.4	0.0	0.0	0.0	7.3	18.7
WP14	5.0	0.0	0.0	0.0	14.7	19.7
WP15	3.1	0.0	0.0	0.0	0.1	3.2
WP16	268	0.0	0.0	0.0	0.2	2.8
WP17	4.5	0.0	0.0	0.0	0.0	4.5
WP18	10.1	0.0	0.6	0.0	0.4	11.2
ETD	6.0	0.0	0.0	0.0	0.0	6.0
OC1						
101	0.0	0.0	10.0	0.0	1.4	11.4
102	0.0	0.0	3.9	0.0	0.9	4.8
103	0.0	0.0	7.0	0.0	0.6	7.6
104	0.0	0.0	2.0	0.0	0.7	2.7
105	0.0	0.0	2.6	0.0	0.8	3.4
106	0.2	0.0	95.4	0.0	3.7	99.3
107	20.2	0.0	8.1	0.0	1.0	29.3
111	4.2	0.0	13.2	0.0	5.1	22.5
112	16.2	0.0	39.0	0.0	1.5	56.7
114	6.3	0.0	55.7	0.0	115.2	177.2
115	70.2	0.0	19.2	0.0	135.8	225.1
OC2						
201	6.8	0.	0.1	0.0	3.1	10.1
202	0.0	0.0	3.9	0.0	0.0	3.9
203	0.0	0.0	6.7	0.0	0.0	6.7

Storage name	Catchment area (ha)					
	Hardstand/ haul roads	Pit	Rehab	Spoil	Natural/ undisturbed	TOTAL
204	6.5	0.0	65.5	0.0	18.9	90.9
206	0.0	0.0	11.1	0.0	0.0	11.1
209	9.7	0.0	90.2	0.0	70.7	170.7
210	1.4	0.0	7.1	0.0	0.0	8.5
211	0.1	0.0	2.5	0.0	0.0	2.6
212	0.0	0.0	31.7	0.0	20.6	52.3
213	1.7	0.0	78.5	0.0	64.9	145.0
214	0.0	0.0	7.8	0.0	20.8	28.7
OC3						
301	7.7	0.0	0.2	0.0	16.5	24.4
302	0.0	0.0	6.8	0.0	0.0	6.8
303	6.4	0.0	15.2	0.0	3.2	24.9
304	7.2	0.0	0.1	0.0	4.2	11.4
305	1.5	0.0	22.8	0.0	6.0	30.4
306	0.0	0.0	84.4	0.0	19.4	103.8
307	0.0	0.0	16.6	0.0	11.5	28.1
308	0.3	0.0	89.4	0.0	38.3	127.9
309	0.0	0.0	27.0	0.0	5.6	32.6
OC3 Void	0.0	24.2	7.8	0.0	22.3	54.3
OC4						
401	0.0	0.0	15.9	0.0	0.0	15.9
406/407	0.0	0.0	72.4	0.0	75.0	147.4
408	3.1	0.0	0.0	0.0	0.0	3.1
409/412/415	3.5	0.0	199.7	0.0	69.9	273.1
417	0.0	0.0	86.2	0.0	25.7	111.9
418	31.1	0.0	55.0	0.0	59.3	145.5
419/420/421	0.0	0.0	177.3	0.0	288.1	465.4
422	0.0	0.0	172.9	0.0	9.1	182.0
423/424	0.0	0.0	130.3	2.6	20.8	153.8
425	0.0	0.6	0.0	0.0	92.0	92.5
426	1.4	0.0	0.0	0.0	1.4	2.8
427	0.0	3.9	0.0	0.1	46.3	50.4
OC4 Pit	0.0	91.8	23.7	62.3	159.4	337.1
UG						
UG01	24.0	0.0	0.0	0.0	26.1	50.1

Storage name	Catchment area (ha)					
	Hardstand/ haul roads	Pit	Rehab	Spoil	Natural/ undisturbed	TOTAL
UG02	0.9	0.0	0.0	0.0	0.0	0.9
UG03	1.6	0.0	0.0	0.0	0.0	1.6
UG04	1.0	0.0	0.0	0.0	0.0	1.0

6 Water management system assessment

6.1 OVERVIEW

The OPSIM model was used to assess the performance of the Moolarben Coal Complex water management system (incorporating the Modification), using the following key performance indicators:

- mine water inventory – the risk of accumulation (or reduction) of the overall mine water inventory (Section 6.3.1);
- in-pit storage – the risk of accumulation of water in the mining pits, and the associated water volumes (Section 6.3.2);
- external water demand – the risk and associated volumes of requiring imported external water (via the UWSA) to supplement site mine water supplies (Section 6.3.3); and
- Controlled water releases – the risk and associated volumes of controlled water releases to the receiving environment (Section 6.3.4); and
- uncontrolled spillway discharges – the risk of uncontrolled discharge from the site storages to the receiving environment (Section 6.3.5).

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. It is important to note that the results of the water balance modelling are dependent on the accuracy of input assumptions. There is inherent uncertainty with respect to some key site characteristics (e.g. catchment yield/runoff, groundwater inflows, borefield inflows).

6.2 INTERPRETATION OF RESULTS

In interpreting the results of the water balance assessment, it should be noted that the results provide a statistical analysis of the water management system's performance over the 21 years of mine life, based on 108 realisations with different climatic sequences.

The model results are presented as a probability of exceedance. For example, the 10th percentile represents 10% probability of exceedance and the 90th percentile results represent 90% probability of exceedance. There is an 80% chance that the result will lie between the 10th and 90th percentile traces.

Whether a percentile trace corresponds to wet or dry conditions depends upon the parameter being considered. For site water storage, where the risk is that available storage capacity will be exceeded, the lower percentiles correspond to wet conditions. For example, there is only a small chance that the 1 percentile storage volume will be exceeded, which would correspond to wet conditions. For off-site site water supply volumes (for example), where the risk is that insufficient water will be available, there is only a small chance that more than the 1 percentile water supply volume would be required. This would correspond to dry climatic conditions.

It is important to note that a percentile trace shows the likelihood of a particular value on each day, and does not represent continuous results from a single model realisation. For example, the 50th percentile trace does not represent the model time series for median climatic conditions.

6.3 WATER BALANCE MODEL RESULTS

6.3.1 Mine water inventory

Figure 6.1 shows the combined forecast inventory for the key mine water storages over the 21 year forecast. The key mine storages are as follows:

- WP15
- WP16
- OC1 107
- OC1 111
- OC1 112
- OC1 115
- UG01 (Boxcut sump)
- OC2 204
- OC2 209
- OC3 302
- OC4 401
- OC4 418

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.

Note also that the WTP begins to operate when the combined volume of the key mine water dams exceeds 1,200 ML.

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 changes over time, as additional catchments are disturbed and rehabilitated around the water management system.

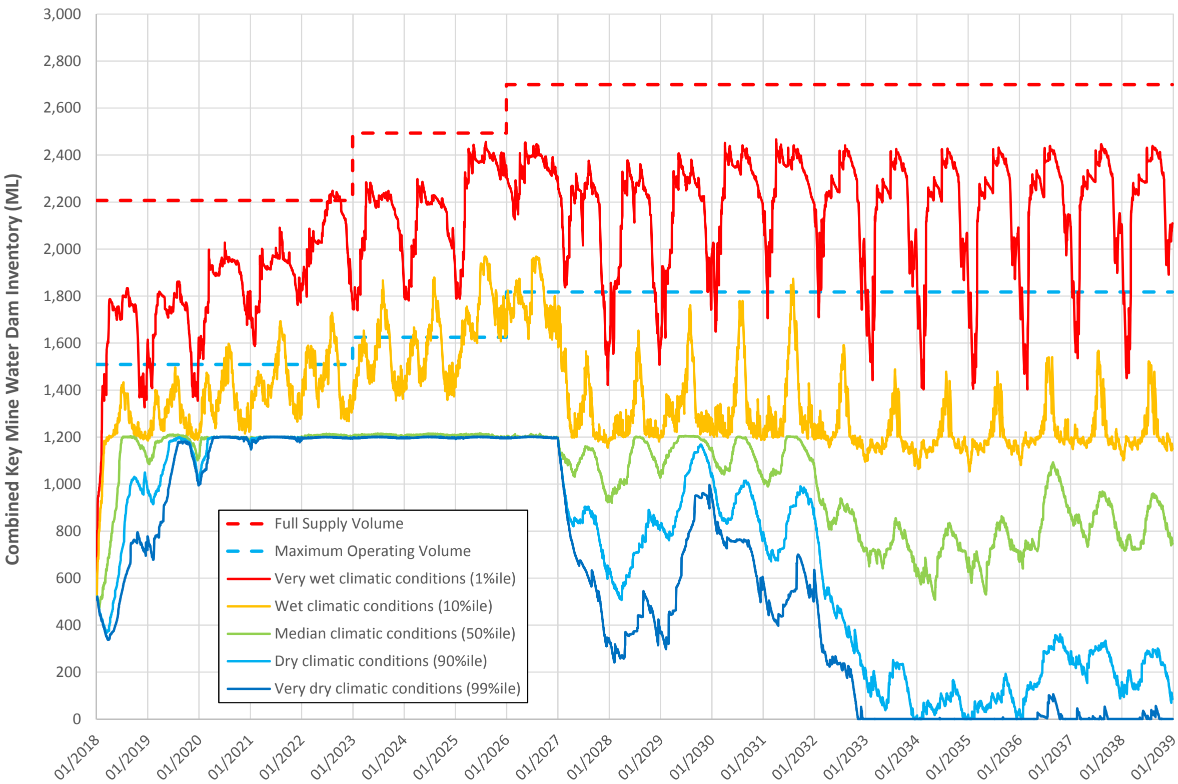


Figure 6.1 – Forecast mine water inventory

6.3.2 In-pit storage

Figure 6.2 shows the forecast inventory for the combined mining pits over the 21 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 or the pumping infrastructure is unable to dewater the pits quickly enough.

The combined capacity of the proposed in-pit sumps has also been included. If this capacity is exceeded, then it is possible that mining operations may be affected. The forecast modelling results for the combined mining pit inventory are summarised as follows:

- Under all but the wettest climatic conditions, it is unlikely that enough water would accumulate within the pits to affect mining operations.
- Under very wet climatic conditions (1%ile), there is a risk that up to 2,750 ML of mine water would need to be stored in-pit at various times during the project.
- Prior to Year 2028, there is a small risk that the capacity of the in-pit sumps would be exceeded in Year 2026 and Year 2027 by 500 to 700 ML. After Year 2028, additional storage capacity will be available in the UG1 and UG4 underground voids.

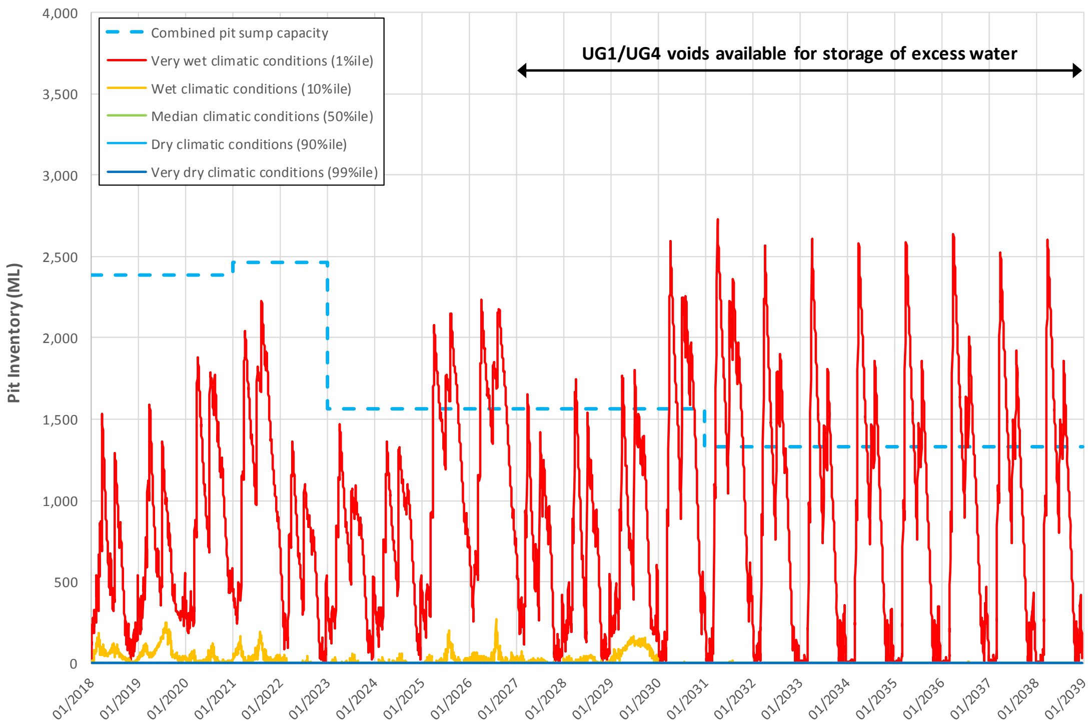


Figure 6.2 - Forecast pit inventory

6.3.3 External makeup requirements

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

A key objective of the mine site water management system is to maximise the reuse of captured 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 and groundwater inflows. Hence, the required makeup water volume from the external sources is likely to vary significantly from year to year.

Figure 6.3 shows the total annual modelled demand for water from external sources over the 21 year simulation.

The modelling results show the following:

- Between 2018 and 2031, little or no external water is required to satisfy site demands. The inflows from groundwater, the borefield and catchment runoff are greater than the overall site water demands.
- Between 2032 and 2038, between 0 megalitres per year (ML/year) and 830 ML/year of external water is required to satisfy site demands, depending on climatic conditions.

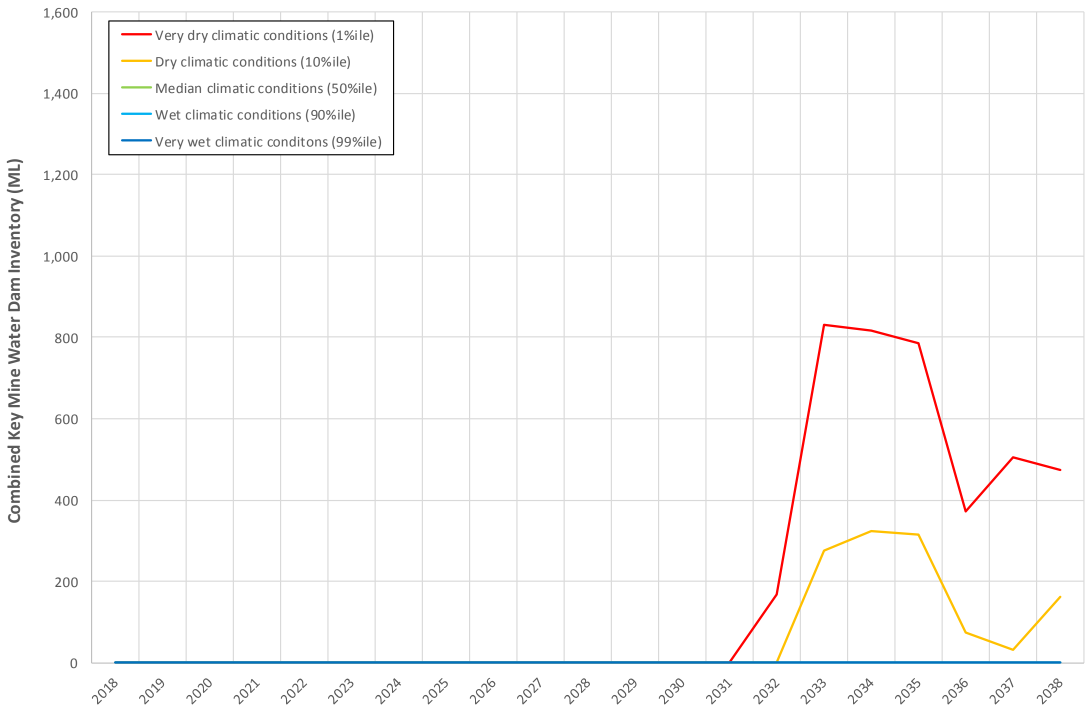


Figure 6.3 – Forecast annual external water requirements

6.3.4 Controlled water releases

The water balance model is configured to controlled release water, in accordance with the rules outlined in Section 5.8. The risk and associated volumes of modelled releases from the Moolarben Coal Complex (incorporating the Modification) have been assessed using a forecast assessment simulation. The predicted annual controlled release volumes are provided in Table 6.1, and the average days of controlled release per year are provided in Table 6.2. The results show that:

- For very wet climatic conditions (1%ile), the WTP will be operating almost continually between 2020 and 2026 when the groundwater inflows are highest.
- For wet climatic conditions (10%ile), the WTP will still need to be operated about 65-80% of the time (on average) between 2020 and 2026, however the usage reduces to around 35-50% of the time (on average) after 2026.
- For median climatic conditions (50%ile), the WTP usage outside of the peak groundwater period reduces significantly.
- For the dry (90%ile) and very dry (99%ile) climatic conditions, the WTP is only used occasionally outside of the peak groundwater period.

Table 6.1 - Summary of simulated controlled releases - annual volume

Year	Annual controlled releases (ML/year)				
	1%ile	10%ile	50%ile	90%ile	99%ile
2018	4,080	2,425	614	-	-
2019	4,717	3,048	1,259	469	130
2020	6,177	3,935	2,253	1,539	1,198
2021	6,697	4,748	3,048	2,369	2,059
2022	6,749	4,726	3,010	2,347	2,033
2023	6,893	5,338	3,476	2,815	2,515
2024	6,981	5,363	3,620	2,973	2,631
2025	7,079	5,707	4,019	3,328	2,959
2026	7,300	5,784	4,134	3,385	2,952
2027	5,260	3,070	705	21	11
2028	4,808	3,011	551	-	-
2029	5,361	3,500	1,020	207	-
2030	5,531	3,447	565	-	-
2031	5,649	3,449	582	-	-
2032	5,002	2,946	130	-	-
2033	5,015	2,660	-	-	-
2034	5,133	2,654	-	-	-
2035	5,078	2,716	-	-	-
2036	5,379	3,005	100	-	-
2037	5,300	3,078	127	-	-
2038	5,346	2,956	60	-	-

Table 6.2 – Summary of simulated controlled releases – minimum days per year

Year	Annual controlled releases (min. days/year)				
	1%ile	10%ile	50%ile	90%ile	99%ile
2018	204	122	31	-	-
2019	236	153	63	24	7
2020	309	197	113	77	60
2021	335	238	153	119	103
2022	338	237	151	118	102
2023	345	267	174	141	126
2024	350	269	181	149	132
2025	354	286	201	167	148
2026	365	290	207	170	148
2027	263	154	36	2	1
2028	241	151	28	-	-
2029	269	175	51	11	-
2030	277	173	29	-	-
2031	283	173	30	-	-
2032	251	148	7	-	-
2033	251	133	-	-	-
2034	257	133	-	-	-
2035	254	136	-	-	-
2036	269	151	5	-	-
2037	265	154	7	-	-
2038	268	148	3	-	-

6.3.5 Uncontrolled spillway discharges

Mine water dams

The long term (128 years) historical patch point daily rainfall data at Ulan Water was used to assess the risk of uncontrolled offsite spills from the mine water management system. The mine water dams that would overflow directly to the receiving environment if rainfall exceeded design criteria include:

- WP12
- WP15
- WP16
- 107
- 201
- 301

No overflows were modelled from WP12, WP15, WP16, 201 and 301.

A small risk of discharge (between 1 and 2% Annual Exceedance Probability [AEP]) was modelled from Dam 107.The modelled discharges at 107 only occur in very wet climatic conditions, and are due to the relatively large upstream catchment which drain to this dam. The spill volume is mitigated as initial spill volumes from Dam 107 report to the OC1 Void. The modelled spill risk of 107 is consistent with the approved design standard for this dam (50 year Annual Recurrence Interval [ARI], 72 hour event as per Condition 32, Schedule 3 of Project Approval 05_0117).

Sediment dams

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 annual combined sediment dam overflows are provided in Figure 6.4. The results show that:

- During very wet climatic conditions (1%ile) where rainfall events often exceed the required design standard, modelled sediment dam overflows are between 350 ML/year and 1,200 ML/year.
- During wet climatic conditions (10%ile) where rainfall events sometimes exceed the required design standard, modelled sediment dam overflows are between 130 ML/year and 520 ML/year.
- 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 60 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.

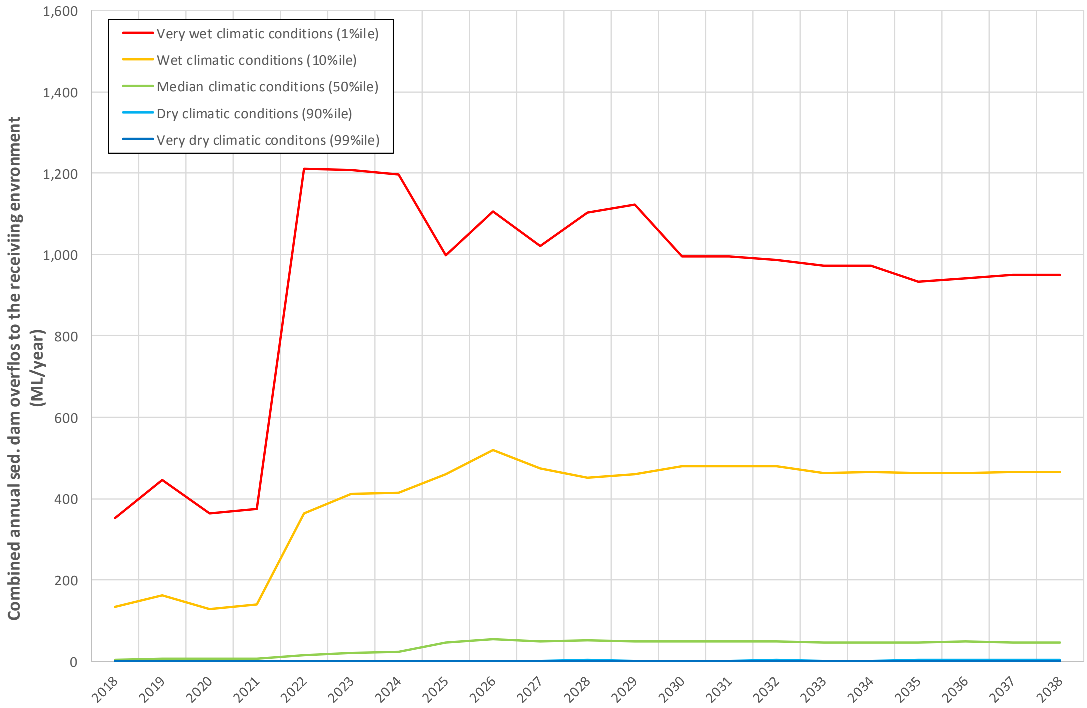


Figure 6.4 – Forecast annual sediment dam overflows

7 Impact assessment

7.1 OVERVIEW

The Modification would involve the following:

- increases in annual production limits;
- increases to the open cut pit limits;
- changes to the sequence of mining; and
- minor changes to mine infrastructure footprints.

The Modification would also involve the installation of water treatment facilities adjacent to the existing rail loop area to support the controlled release of water under EPL release conditions, with an increase in the rate of controlled releases.

A site water balance has been developed for the Moolarben Coal Complex incorporating the Modification. In addition to the Modification components above, the new model has also been used to evaluate the implications of the increased groundwater inflows (HydroSimulations, 2017) on controlled release requirements. Following preliminary analysis, an increase in the total controlled release volume from 10 ML/day to 20 ML/day has been evaluated.

Potential impacts of the proposed modification include:

- Impacts on the volume of controlled water releases to the Goulburn River;
- Impacts on runoff volumes to receiving watercourses due to changes in disturbance areas;
- Impacts on flooding in Moolarben Creek;
- Changes in surface water management arrangements and monitoring requirements.

7.2 CONTROLLED WATER RELEASES

The site water balance demonstrates that an increase in controlled release rate from 10 to 20ML/day will minimise the potential for uncontrolled releases to an acceptable level. Potential treated water release volumes are presented in Section 6.3.4. An assessment of the potential impacts of treated water releases is presented in the Controlled Water Release Impact Assessment for the Goulburn River (Advisian, 2017) and Aquatic Ecology Assessment (MPR, 2017).

Advisian (2017) has assessed the potential impacts of the proposed increased volume of licensed discharges on the Goulburn River in terms of:

- flow regime;
- channel stability; and
- water quality (including analysis of salt loads and potential impacts on the Hunter River Salinity Trading Scheme).

MPR (2017) considered the potential impacts of the controlled releases on Aquatic Ecology based on the outcomes of the Advisian (2017) assessment. A summary of the conclusions from these assessments is provided in the following subsections.

7.2.1 Flow Regime

Advisian (2017) has developed a Hydraulic Engineering Center's River Analysis System (HEC-RAS) hydraulic model to determine the potential impacts of the increased discharge volume on water levels and velocities downstream of the relocated discharge point. Three flow regimes were considered in the modelling, with flows determined based on high (90th percentile), medium (mean) and low (10th percentile) historic flows in the Goulburn River. For each of the three flow regimes the following scenarios were modelled:

- existing flows;
- approved flows – incorporating discharges from the Moolarben Coal Complex in accordance with the existing EPL limits (10 ML/day); and
- proposed flows – incorporating the proposed discharge from relocated EPL ID 1 (20 ML/day).

Based on the results of the HEC-RAS analysis, Advisian (2017) concludes:

- The key potential change to flow regime associated with the proposed discharges is a decrease in the frequency of low to very low flow periods.
- Predicted changes in average velocity would be minor, and are not expected to lead to scour at or downstream of the proposed discharge point.
- Predicted increases in water levels in the Diversion and the Goulburn River would be minimal, and easily contained within the channel's capacity.

7.2.2 Channel Stability

The relocated discharge point would be situated at the confluence of Bora Creek and the Goulburn River Diversion. This location was chosen following site inspection by Advisian (2017) based on the stability provided by the rock platform at the edge of the Goulburn River Diversion.

Discharge water would be piped from the water treatment facilities to the rock platform at the relocated discharge point via a flow spreader/diffuser, and then would drain into the Goulburn River Diversion.

The relocation of the existing discharge point is considered to be beneficial (in comparison to the discharge regime currently authorised by EPL 12932), as potential increases in erosion along the sandy channel bed of Bora Creek would be avoided (Advisian, 2017). The HEC-RAS modelling results indicate the minor increases in velocity are not expected to lead to scour at or downstream of the proposed discharge point (Advisian, 2017).

7.2.3 Water Quality

Advisian (2017) modelled and assessed the proposed licensed discharges of 20 ML/day from the relocated discharge point and concluded:

- There would be no adverse change in downstream pH levels, EC or TSS concentrations (i.e. when compared to baseline water quality, ANZECC default trigger levels or site specific [80th percentile] trigger levels]).
- As metal concentrations would be controlled by the water treatment process, the proposed licensed discharges would not result in downstream exceedances of ANZECC default or site specific trigger values.

7.2.4 Aquatic Ecology

Based on the findings of Advisian (2017) and analysis of existing aquatic ecology monitoring data, MPR (2017) concluded potential impacts to aquatic ecology associated with the licensed discharges would be negligible, given:

- No adverse impacts to downstream water quality concentrations are predicted, given water to be discharged would meet EPL water quality concentration limits and/or ANZECC default or site specific trigger values at the point of discharge.
- No significant adverse impacts to aquatic ecology have been observed over the period 2011 to 2017 due to licensed discharges from the Ulan Mine complex.
- Negligible impacts on aquatic ecology habitat are predicted, as the minor changes in velocity and river levels associated with the proposed licenses discharges are predicted to result in negligible impacts to downstream channel stability.

7.3 CHANGES IN DISTURBANCE AREAS

The changes in disturbance areas under the proposed modification (see Figure 1.2) are minor and would have no measurable impact on runoff volumes to receiving watercourses.

It is also noted that much of the proposed disturbance areas are located within areas that would be captured in the mine water management system for the approved Moolarben Coal Complex (i.e. located in areas where diversion of up-catchment runoff is impractical).

7.4 MOOLARBEN CREEK FLOODING

The proposed modification will slightly alter disturbance areas in the vicinity of Moolarben Creek between OC2 and OC3. These disturbance areas are generally outside the Moolarben Creek flood extent as defined in a previous flood study (PB, 2006). Minor changes to the haul road crossing of Moolarben Creek are proposed, however there would be no change in the design criteria of the haul road crossing of Moolarben Creek. On this basis, the Modification would not affect flooding in Moolarben Creek.

7.5 MANAGEMENT AND MONITORING

The Modification would not affect the overall site water management strategy at the Moolarben Coal Complex. Ongoing management and monitoring of the site water management system will continue to be undertaken in accordance with the Water Management Plan (including the Surface Water Management Plan and Site Water Balance).

The Water Management Plan should be updated to describe the water treatment facility and updated discharge process (including discharge monitoring). The Site Water Balance should also be updated to reflect the outcomes of the new site water balance model prepared for this assessment.

The surface water monitoring outlined in the existing Water Management Plan is considered appropriate for the Moolarben Coal Complex (incorporating the Modification).

8 References

Advisian, 2017	*Controlled Water Release Impact Assessment for the Goulburn River.*
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