SITE WATER BALANCE

Document	Version	Issue	Effective	Review	Author	Approved
MCO_ENV_PLN_0036	4	Sep 20	Oct 20	Nov 21	MCO	SA

Version	Issue Date	Approval Date	Section Modified	Reason for Modification	Review Team
1	Jul 2015	Jul 2015	All	To address Stage 1 and Stage 2 of the Project	MCO, WRM Water & Environment
2	Feb 2018	Mar 2018	All	General Review and Update	MCO, WRM Water & Environment
3	Feb 2020	Apr 2020	All	To incorporate approved modifications to Stage 1 (MOD 14) and Stage 2 (MOD 3) of the Project	MCO, WRM Water & Environment
4	Sep 2020	Oct 2020	All	To incorporate approval of Modification 14 (Stage 1)	MCO

Approved: S.J. Archinal Date: 28 October 2020

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1.0 INTRODUCTION

The Moolarben Coal Complex is located approximately 40 kilometres (km) north of Mudgee in the Western Coalfields of New South Wales (NSW) (Figure 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], Yancoal Moolarben Pty Ltd and a consortium of Korean power companies). MCO, MCM and YM are wholly owned subsidiaries of Yancoal Australia Limited (Yancoal).

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

Mining operations at the Moolarben Coal Complex are undertaken in accordance with the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) approvals EPBC 2007/3297, EPBC 2008/4444, EPBC 2013/6926 and EPBC 2017/7974.

The current mining operations at the Moolarben Coal Complex are conducted in accordance with the requirements of the conditions of Mining Lease 1605, Mining Lease 1606, Mining Lease 1628, Mining Lease 1691 and Mining Lease 1715 granted under the *Mining Act 1992*.

The general arrangement of the Moolarben Coal Complex, showing modifications, is provided in Figure 2.

1.1 Purpose and Scope

This Site Water Balance (SWB) has been prepared by MCO to satisfy the requirements under NSW Project Approval (05_0117) as modified and the NSW Project Approval (08_0135) as modified.

This SWB describes the movement of water across all areas within the Stage 1 and Stage 2 Project Boundaries (as defined in Appendix 2 of NSW Project Approval 05_0117 [as modified] and NSW Project Approval 08_0135 [as modified]).

1.2 Suitable Qualified and Experienced Persons

The Secretary of the Department of Planning and Environment (now Department of Planning, Industry and Environment (DPIE)) approved David Newton (WRM Water & Environment), Peter Dundon (Dundon Consulting) and Dr Noel Merrick (Hydrosimulations) as suitably qualified and experienced experts for the preparation of the WAMP. The SWB was prepared in consultation with specialist consultants from WRM Water & Environment Pty Ltd.

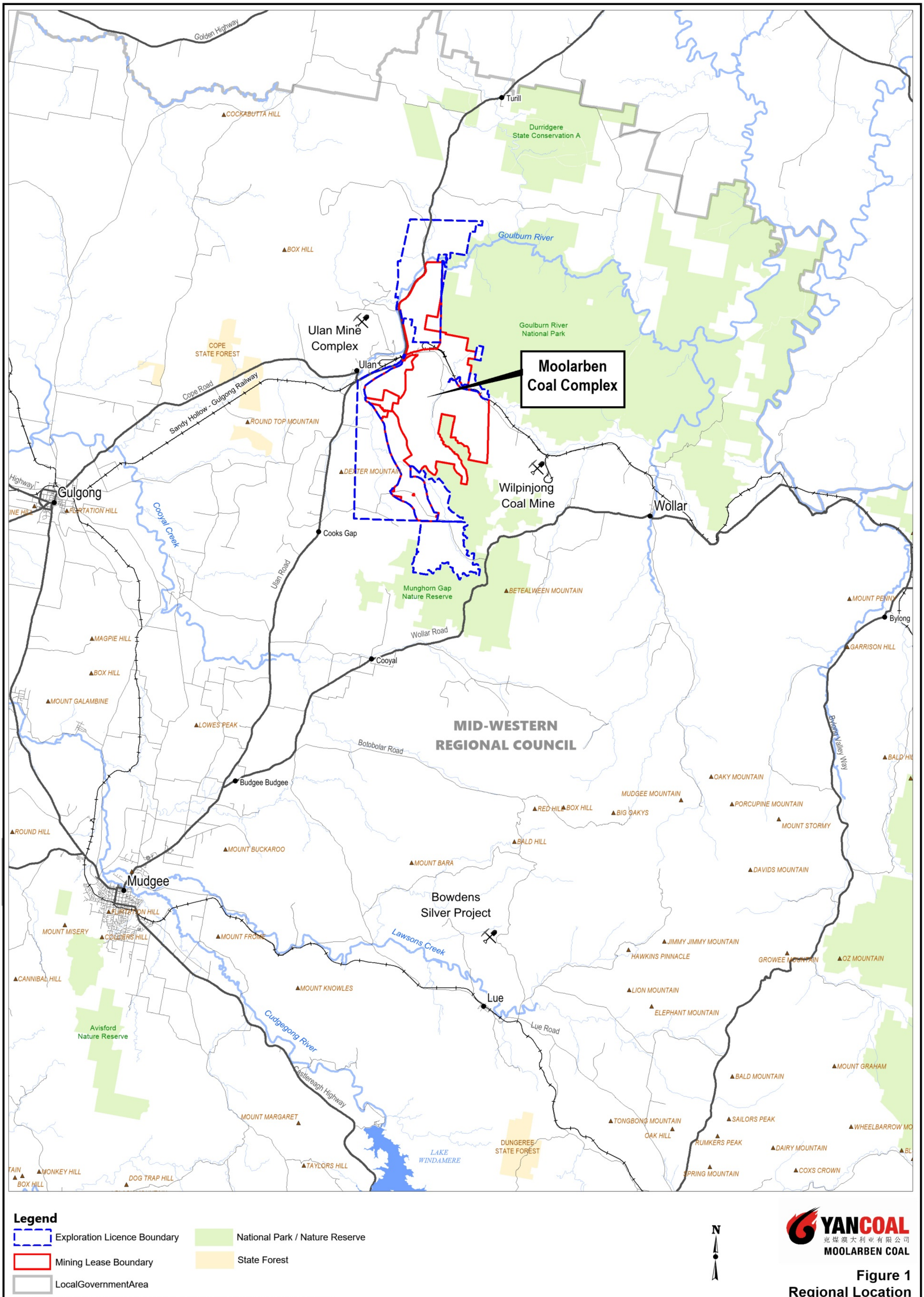

Figure 1
Regional Location

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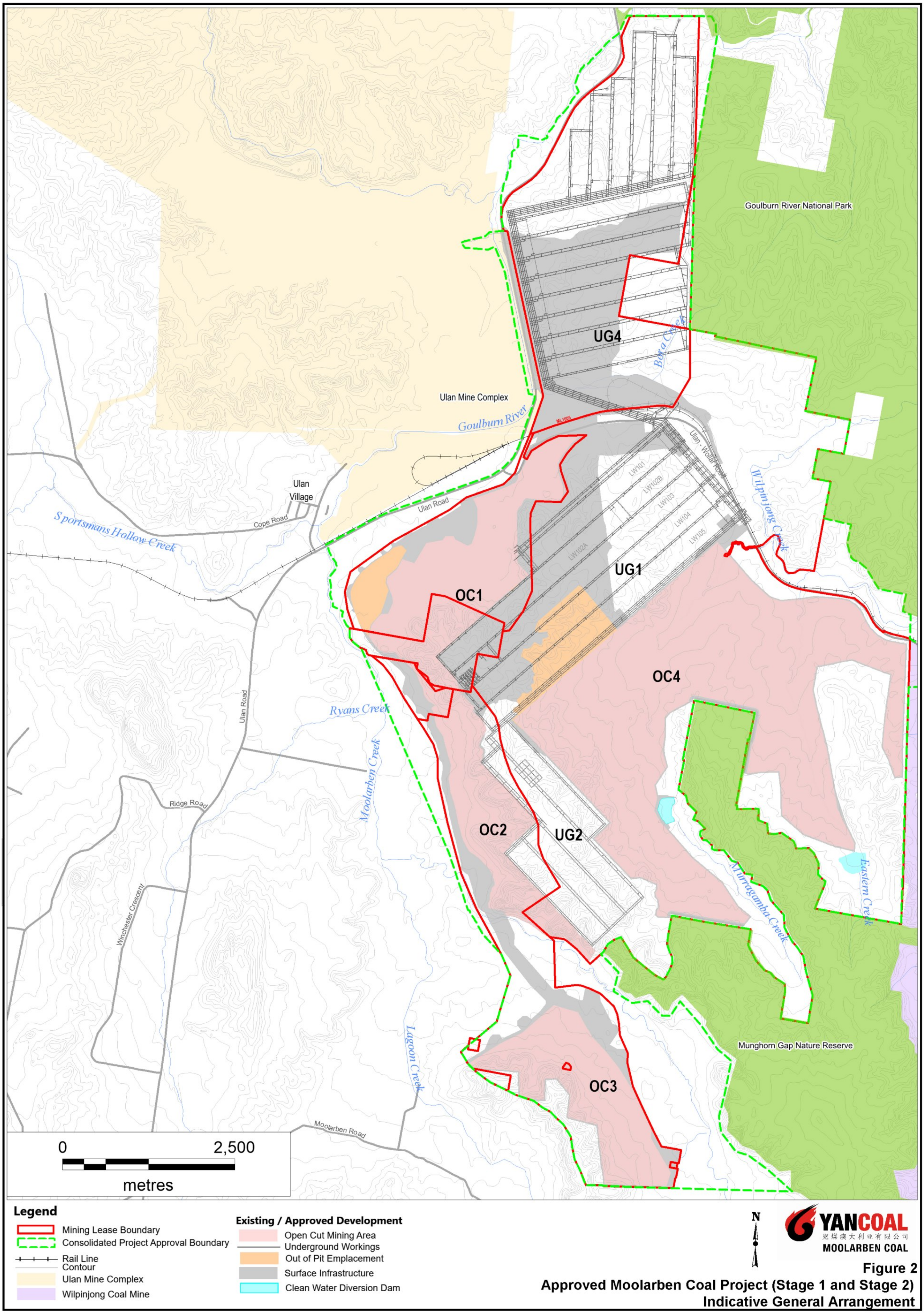


Figure 2
Approved Moolarben Coal Project (Stage 1 and Stage 2)
Indicative General Arrangement

1.3 Structure of the Site Water Balance

The remainder of the SWB is structured as follows:

Section 2:	Outlines the statutory requirements of the SWB
Section 3:	Provides baseline data relevant to the SWB
Section 4:	Describes the elements of the Moolarben Water Management System
Section 5:	Describes the site water demands
Section 6:	Describes the method of water disposal
Section 7:	Outlines the various water sources
Section 8:	Describes the Moolarben Water Balance Model
Section 9:	Describes the review and reporting requirements relevant to the SWB

2.0 STATUTORY AND PROJECT APPROVAL REQUIREMENTS

MCO's statutory obligations are contained in:

- the conditions of the NSW Project Approval (05_0117) as modified and NSW Project Approval (08_0135) as modified;
- the conditions of the Commonwealth Approvals (EPBC 2007/3297, EPBC 2013/6926, EPBC 2017/7974 and EPBC 2008/4444);
- relevant licences and permits, including conditions attached to mining leases and Environment Protection Licence (EPL) 12932; and
- other relevant legislation.

2.1 EP&A Act Approval

This SWB has been prepared in accordance with Condition 33, Schedule 3 and Condition 29, Schedule 3 of the NSW Project Approvals (05_0117 and 08_0135, respectively). Attachment 1 indicates where each component of the relevant conditions has been addressed in the SWB.

In accordance with Condition 33, Schedule 3 and Condition 29, Schedule 3 of the NSW Project Approvals (05_0117 and 08_0135, respectively), this SWB is included as a component of the Water Management Plan (Appendix 1).

Management Plan Requirements

Condition 3, Schedule 5 of Project Approval (05_0117) and Condition 3, Schedule 6 of Project Approval (08_0135) outline the management plan requirements that are applicable to the preparation of the SWB. Attachment 1 presents these requirements and indicates where they are addressed within this SWB.

2.2 Other Legislation

MCO will operate the Moolarben Coal Complex in accordance with the NSW Project Approvals (05_0117 and 08_0135) and Commonwealth Approvals (2007/3297, 2013/6936, 2017/7974 and 2008/4444), as well as any other NSW Acts, Regulations and Guidelines that may be applicable to a Part 3A Project.

The requirements of EPL 12932 regarding water discharge and monitoring are considered in Sections 4.0, 4.6, 6.1 and 6.2. Additional detail regarding MCO's commitments under EPL 12932 can be found in the Surface Water Management Plan (SWMP).

A summary of the NSW Acts, Regulations and Guidelines that may be relevant to the MCO is provided in Section 2 of the WAMP.

3.0 AVAILABLE DATA

The SWB model has been developed using available monitoring data, including the following:

- Climate data; and
- Water Management System monitoring data.

The available monitoring data has been used to calibrate the SWB model and estimate key site parameters (e.g. site demands and losses).

A summary of the relevant site monitoring data is provided in the following sections.

3.1 Climate Data

MCO operates one permanent meteorological monitoring station located on a property on Ulan Road (WS03), which is linked into the real-time monitoring system. Other weather stations may be used to supplement weather data as required. This data was used as part of the model calibration process (see Section 8.4). Site recorded meteorological information is provided in the Annual Review.

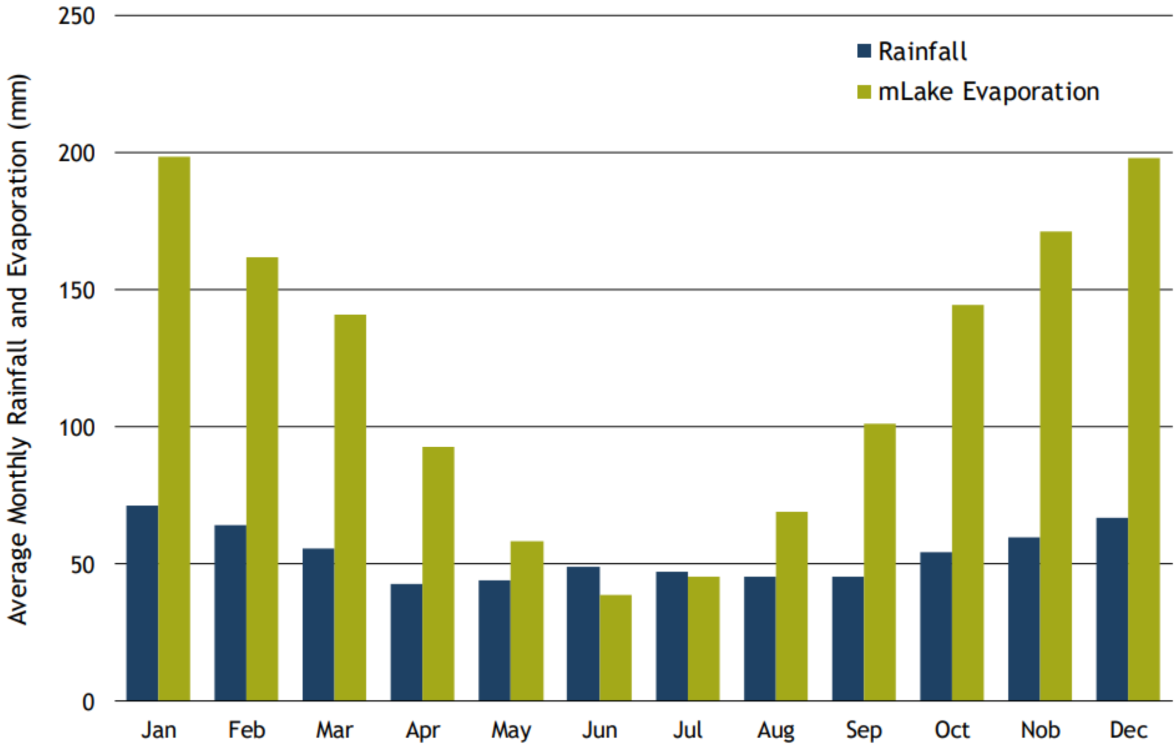
Long term daily rainfall data at the Ulan Water rainfall station from January 1889 to December 2016 (128 years) was obtained from the Patched Point Data service, which is an Australian climate database developed by the Queensland Government (WRM, 2017).

Morton's equation for Lake evaporation has been used to estimate evaporation losses from storages. Table 3 shows the long-term monthly averages for Morton's evaporation and monthly Patched Point rainfall data (WRM, 2017).

Figure 3 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 (WRM, 2017).

Table 1: Mean Monthly Rainfall and Evaporation –Patched Point Dataset (1889 – 2016)

Month	Mean Monthly Rainfall (mm)	Mean Monthly Morton's Lake Evap (mm)
January	71	199
February	64	162
March	56	141
April	43	93
May	44	58
June	49	39
July	47	46
August	45	69
September	46	101
October	54	144
November	60	171
December	67	198
TOTAL	**646**	**1,421**



m Lake Evaporation = Morton's Lake Evaporation.

Figure 3: Distribution of Patched Point Data Service monthly rainfall and Morton's Lake evaporation

3.2 Water Management System Monitoring

MCO monitors the following relevant aspects of the site water management system:

- Storage water levels and volumes;
- Inflows from the following sources:
  - Pit inflows;
  - Mine water provided under agreement from the Ulan Mine Complex (i.e. Ulan Water Sharing Agreement [UWSA]);
  - Dewatering/production bores;
  - Potable water supply;
- Site water demands (including dust suppression);
- Coal Handling and Preparation Plan (CHPP) inflows and outflows including:
  - Feed tonnage and moisture contents;
  - Product tonnage and moisture contents;
  - Rejects/tailings moisture contents;
- Licensed discharges; and
- Flow monitoring at Wilpinjong Creek, Murragamba Creek, Eastern Creek and Goulburn River.

A summary of the relevant water management system monitoring information is provided in the Annual Review.

4.0 WATER MANAGEMENT SYSTEM

Water at the Moolarben Coal Complex will be stored in surface dams, open cut pits, mining voids (when available) and sediment dams. The construction of emergency tailings dams, mine infrastructure dams, groundwater storages and treatment dams will comply with a permeability standard that is the equivalent of <$1x10^{-9}$ m/s. Brine storages will be constructed to a permeability standard that is the equivalent of <1×10^{-9} m/s over 1000mm (as required by Condition 32, Schedule 3 of Project Approval [05_0117]). A monitoring program will be conducted during construction of each of these facilities to confirm the permeability of these dams.

4.1 Dam Storages

The locations of the operational and proposed dams at the CHPP and in OC1 and OC2 are shown in Figure 4, Figure 5 and Figure 6 with detailed information provided in Table 2. This information is the dam capacity following any required upgrades. The dam locations for OC3 and OC4 will be determined and continually adapted as mining progresses, however indicative locations are shown in Figure 7 and Figure 8 with detailed information provided in Table 3.

Table 2: Water Storage Dam and Sediment Dam Requirements

Location of Dam	Name of Dam	Type of Dam	Capacity of Dam (ML)	Status
CHPP	WP01	Mine Water Dam	15.04	Existing
	WP02	Mine Water Dam	11	Existing
	WP07	Sediment Dam	0.45	Existing
	WP08	Sediment Dam	2.0	Existing
	WP09	Sediment Dam	0.7	Existing
	WP17	Mine Water Dam	9.0	Existing
	WP10	Mine Water Dam	2.3	Existing
	WP12	Mine Water Dam	3.37	Existing
	WP13	Sediment Dam	28.0	Existing
	WP14	Sediment Dam	6.68	Existing
	WP15	Mine Water Dam	90.69	Existing
	WP16	Mine Water Dam	130.9	Existing
	WP18	Mine Water Dam	19.5	Existing
	WP19	Mine Water Dam	170	Existing
	WP20	Brine Dam	22	Existing
	WP21	Brine Dam	23	Existing
	WP22	Sediment Dam	1.3	Proposed
	ETD	Mine Water Dam	19.79	Existing
OC1**	101	Sediment Dam	7.6	Existing

Location of Dam	Name of Dam	Type of Dam	Capacity of Dam (ML)	Status
	102	Sediment Dam	5.6	Existing
	103	Sediment Dam	4.0	Existing
	104	Sediment Dam	1.3	Existing
	105	Sediment Dam	2.4	Existing
	106	Sediment Dam and Licensed Discharge Point	85.0	Existing
	107	Mine Water Dam	93.1	Existing
	111	Mine Water Dam	200.0	Existing
	112	Mine Water Dam	57.0	Existing
OC2*†	201	Mine Water Dam	5.6	Existing
	202	Sediment Dam	7.3	Existing
	203	Sediment Dam	13.5	Existing
	204	Brine Dam	500	Existing
	206	Sediment Dam	12.6	Existing
	209	Mine Water Dam	535	Existing
	210	Sediment Dam	4.7	Existing
	211	Sediment Dam	11.0	Existing
	212	Sediment Dam	25	Existing
	213	Sediment Dam	144	Existing
	214	Brine Dam	217	Existing
OC3	301	Mine Water Dam	53	Existing
	303	Mine Water Dam	106	Existing
OC4***	401	Mine Water Dam	550	Existing
	403	Sediment Dam	27	Existing
	409	Sediment Dam	7.5	Existing
	412	Sediment Dam	150	Existing
	426	Sediment Dam	3.0	Existing
	Murragamba Clean Water Dam	Clean Water Dam	500	Existing
UG	UG01	Mine Water Dam	58	Existing
	UG02	Sediment Dam	1.2	Existing
	UG03	Sediment Dam	1.5	Existing
	UG04	Sediment Dam	2.9	Existing

ML = megalitres

* A single mine water dam may be constructed as an alternative to multiple smaller dams.

† Dams "not constructed" will be implemented progressively as required ahead of mining.

** Underground mine and temporary sumps not shown.*** OC4 sediment dams will be progressively decommissioned and/or replaced with mine progression.

Table 3: Indicative Dam Storage Requirements for OC3 and OC4

Location of Dam	Name of Dam	Type of Dam	Capacity of Dam (ML)	Status
OC3†	302	Mine Water Dam	400	Proposed (Will be developed progressively ahead of mining/disturbance of OC3 – refer indicative staging plans in Attachment 2)
	304	Sediment Dam	13.2	
	305	Sediment Dam	15.6	
	306	Sediment Dam	11.8	
	307	Sediment Dam	2	
OC4	413	Sediment Dam	84.7	Proposed (Will be developed progressively ahead of mining/disturbance of OC4 – refer indicative staging plans in Attachment 2)
	414	Sediment Dam		
	415	Sediment Dam		

† A smaller number of sediment water dams may be constructed as an alternative to multiple smaller dams.

Sediment dams are sized and operated generally in accordance with the Landcom (2004) publication '*Managing Urban Stormwater: Soils and Construction – Volume 1 and Volume 2E Mines and Quarries*'. For the purposes of water balance modelling and preliminary sizing, sediment dams have been assumed to be Type F/D basins. Refer to Section 4.3.2 of the Surface Water Management Plan for more detail.

Where practical, surface water infrastructure has been designed to facilitate the diversion of clean water (i.e. run-off from undisturbed or rehabilitated catchments) away from the active pit throughout the duration of mining. Diversion drains are to be designed to cater for a 100-year Average Recurrence Interval flood. Clean water diversion dams on Murragamba and Eastern Creeks will be adequately sized to divert runoff around OC4.

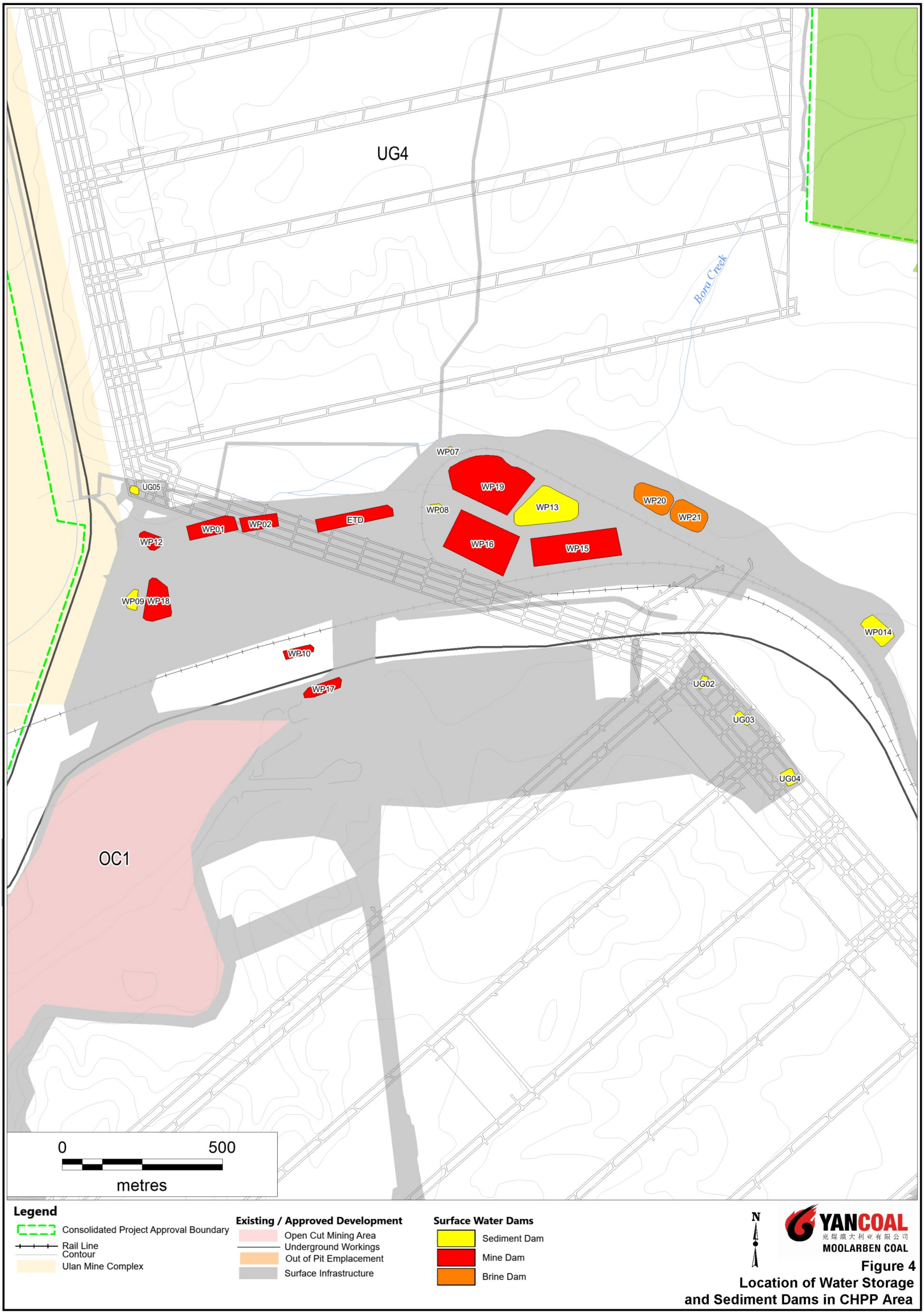


Figure 4
Location of Water Storage and Sediment Dams in CHPP Area

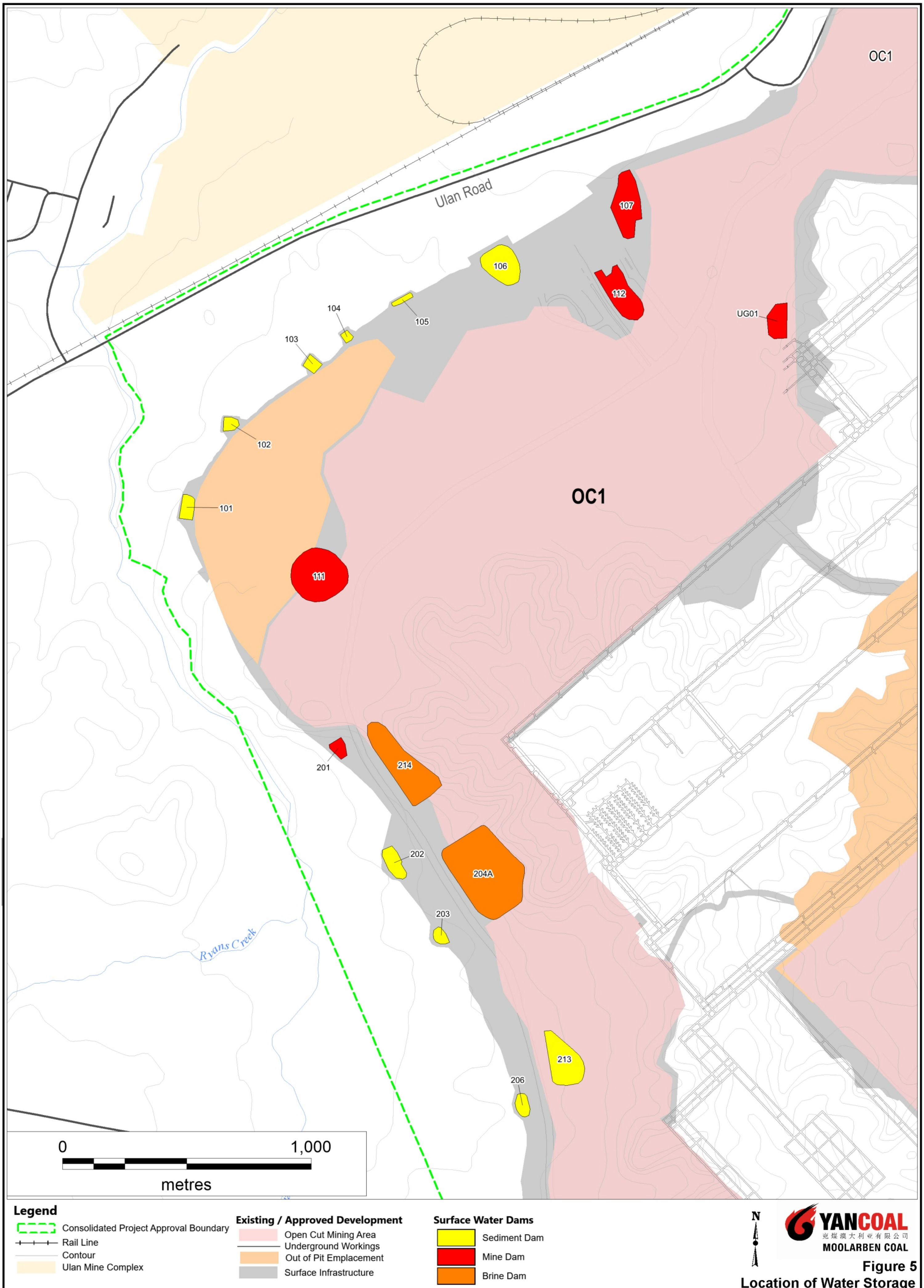


Figure 5
Location of Water Storage and Sediment Dams in OC1

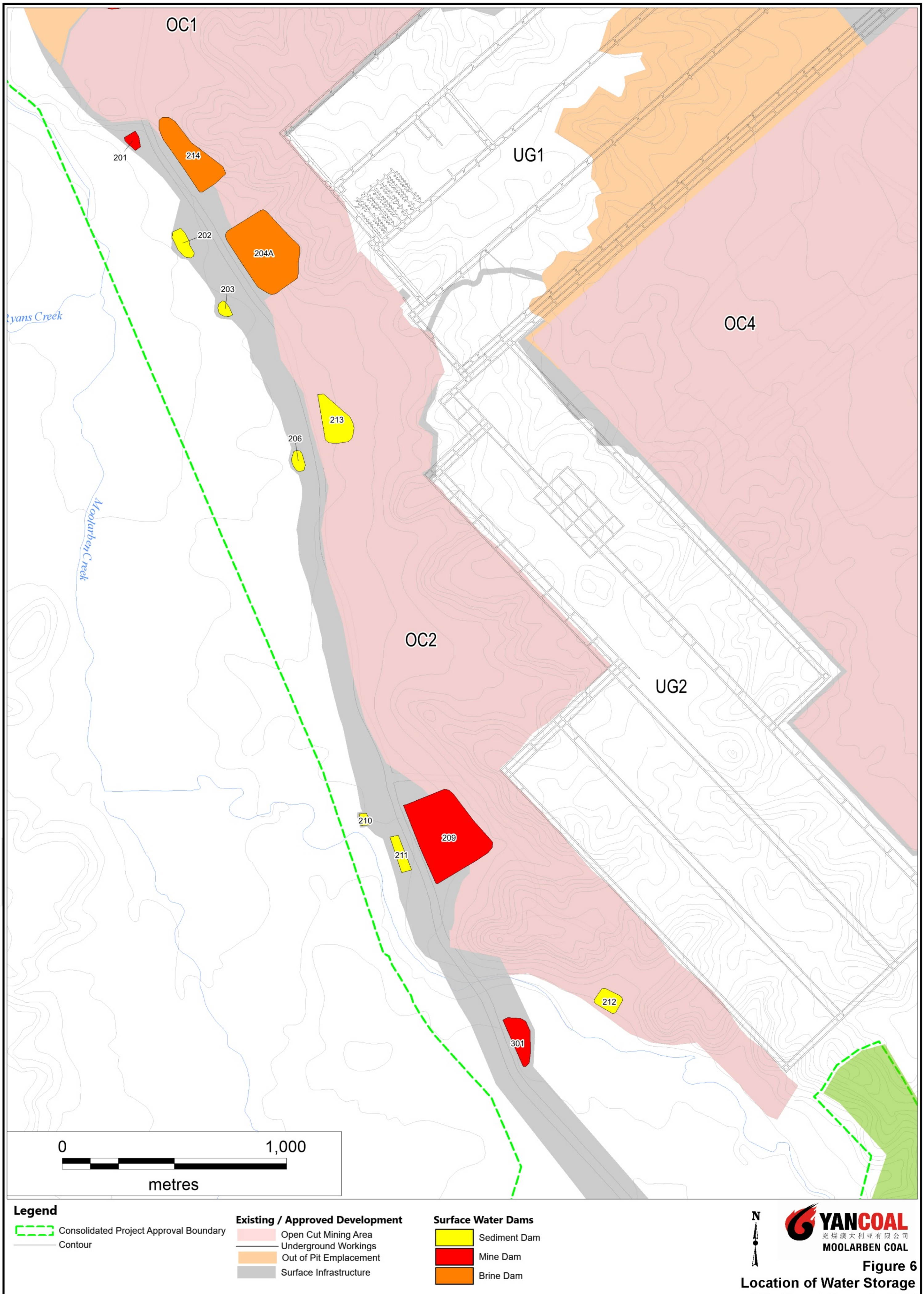


Figure 6
Location of Water Storage and Sediment Dams in OC2

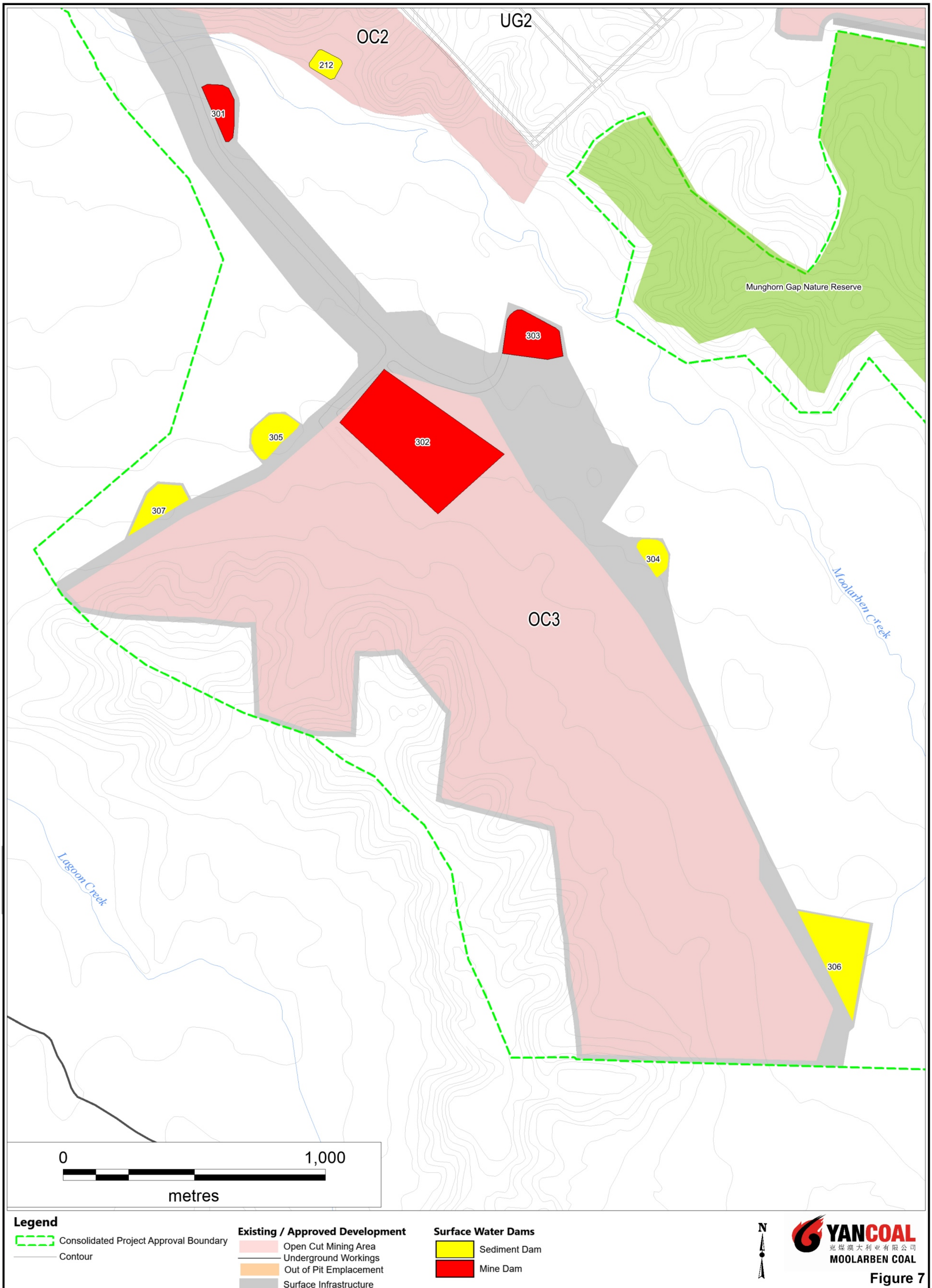


Figure 7
Location of Water Storage and Sediment Dams in OC3

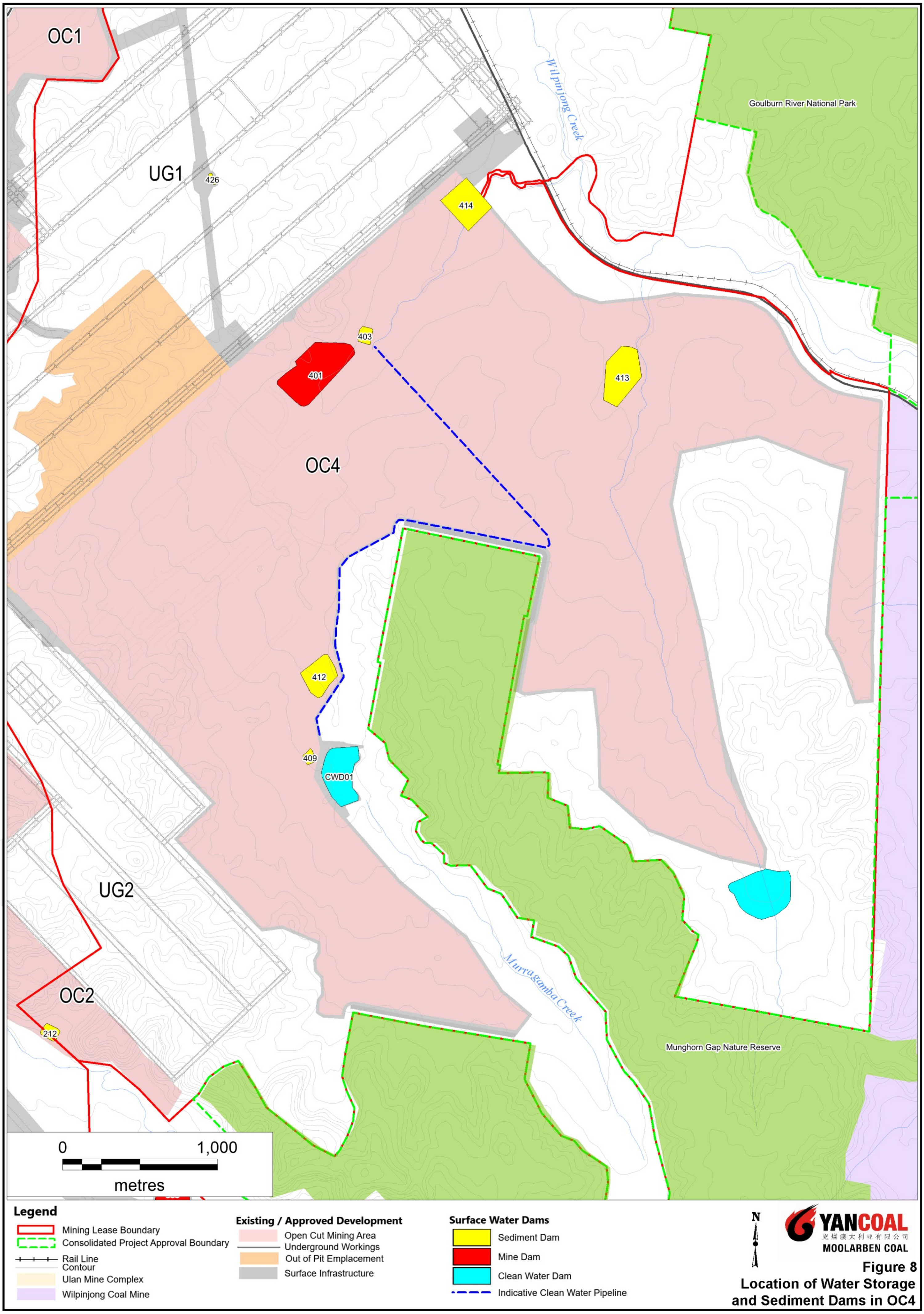


Figure 8
Location of Water Storage and Sediment Dams in OC4

4.2 Runoff from Rehabilitated Areas

Rehabilitated areas will be shaped to the final landform and drainage structures installed in accordance with the Mining Operations Plan (MOP). Run-off from rehabilitated areas will be diverted to sediment dams for treatment until the water quality of surface runoff is suitable for release from the site. Conceptual plans for final voids, drainage lines on rehabilitation and control of potential water pollution from rehabilitated areas are included in the MOP.

4.3 Minimisation of Water Use

MCO's water management strategy includes preferential use of on-site derived mine water, thereby reducing the need to import raw water from external sources for operational purposes. This includes (inter alia):

- Use of a belt filter press to reclaim water from rejects materials for reuse during the coal washing process (Note; use of a belt filter press circumvents the need for disposal of tailings in dedicated tailings storage dams).
- Primarily washing run of mine (ROM) coal from open cut operations (i.e. underground ROM coal will primarily bypass the coal wash plant).
- Irrigation undertaken to minimise surplus water only.
- Use of surplus mine water from the adjacent Ulan Mine Complex as a primary supplementary water source (under the UWSA).
- Use of groundwater from advanced dewatering of underground mining areas as a primary supplementary water source (note the northern borefield is designed to operate as an advanced dewatering/production borefield).
- Diversion of clean water where practicable around the operation, e.g. development and operation of the Murragamba Clean Water Diversion system.

4.4 Pipelines

Water obtained from the Ulan Mine Complex and dewatering/production bores is currently delivered via poly pipe to CHPP dams, located within the rail loop.

The pipeline has a capacity of approximately 63 litres per second (L/s) (5.4 million litres per day [ML/day]) when one pump is in use and approximately 100 L/s (8.6 ML/day) when two pumps are in use. MCO has an agreement with Ulan Coal Mine Limited (UCML) for the supply of up to 1,000ML/year of surplus mine water from its operations.

4.5 Potable Water

Potable water for all facilities is imported from external sources when not available on-site.

4.6 Water Treatment Facility

A water treatment facility has been constructed 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 water treatment process involves pre-treatment followed by a secondary treatment of water via reverse osmosis (RO).

Additional water storages have been constructed part of the water treatment facilities to hold feed water, blend water and treated water, and to store by-products of the treatment process (Figure 4).

Water will be blended and transferred from the water treatment facility to the Goulburn River Diversion via a pipeline. The pipeline will run through culverts under Ulan Road adjacent to the existing water supply pipeline between the Moolarben Coal Complex and Ulan Mine Complex to the discharge point on the Goulburn River Diversion.

4.7 Historical Performance of Water Management System

Since commencing construction in 2008/2009, MCO has supplemented its available on-site water supply with groundwater drawn from production bores on site and from surplus mine water imported from the Ulan Mine Complex.

Imported water volumes (from borefield) since 2010:

- Year 2010/2011: <1 ML
- Year 2011/2012: 0 ML
- Year 2012/2013: 0 ML
- Year 2013/2014: 2.7 ML
- Year 2015: 0 ML
- Year 2016: 4 ML
- Year 2017: 50 ML
- Year 2018: 5.8 ML
- Year 2019 0 ML

Imported water volumes (via the UWSA) since 2010:

- Year 2010/2011: 498 ML

- Year 2011/2012: 83 ML
- Year 2012/2013: 613 ML
- Year 2013/2014: 639 ML
- Year 2015: 116 ML
- Year 2016: 210 ML
- Year 2017: 7 ML
- Year 2018: 423 ML
- Year 2019 178 ML

MCO has the ability to discharge surplus water (of an appropriate quality) from a number of licensed discharge points (not including licensed sediment dam rainfall induced overflow releases) under EPL 12932 (Section 6.2).

EPL licensed discharge volumes since 2010:

- Year 2010/2011: 465 ML
- Year 2011/2012: 0 ML
- Year 2012/2013: 0 ML
- Year 2013/2014: 0 ML
- Year 2015: 0 ML
- Year 2016: 0 ML
- Year 2017: 0 ML
- Year 2018: 0 ML
- Year 2019 0ML

5.0 WATER DEMANDS

5.1 Overview

Water demands on-site include the following:

- Water used in the CHPP, including water retained in coal products and rejects and water for dust suppression (including stockpiles);
- Haul road dust suppression;
- Underground water demands; and
- Miscellaneous water usage such as potable water, irrigation, vehicle wash down, and Main Infrastructure Area (MIA) water usage.

Water sources and the hierarchy of water use are described in Section 7.

5.2 CHPP

Water consumption at the Moolarben Coal Complex is predominately by the CHPP. Water lost from the coal handling and preparation process is either entrained within product coal or rejects material. Water usage has been estimated to range between 73 and 80 ML per million tonnes (Mt) of ROM coal washed at the CHPP. At maximum production, the Moolarben Coal Complex will mine up to 16 million tonnes per annum (Mtpa) of ROM coal. Applying the CHPP water use rate yields a net water requirement for the CHPP of up to about 1,300 ML/year at maximum production for Phases 1 and 2 of the water balance model (Section 8.2).

5.3 Haul Road Dust Suppression

The total surface area of haul roads has been estimated from the mine plans and an assessment made of the potential water usage for dust suppression. This has been based on an assessment of the amount of water which is lost from these surface areas as a result of evaporation and infiltration. From this assessment, the total water demand for dust suppression across the Moolarben Coal Complex is approximately 3.2 ML/day (1,165 ML/year) at maximum production and haul road footprint.

5.4 Miscellaneous Water Usage

The miscellaneous water demand is an estimate of unmetered site demands such as vehicle wash-down, irrigation and MIA water usage. The total miscellaneous water demand is estimated to be 150 ML/year.

5.5 Underground Water Demands

Based on underground consumption estimates, the underground water demand requires a supply of approximately 17 L/s of suitable quality water to the underground workings. On this basis, the total underground water demand is estimated to be approximately 525 ML/year.

Suspended solids load will be removed from the underground water supply by means of in line filters fitted with a back-flush cleaning. Back-flush water and associated sediment will by contained within the water management system.

5.6 Summary

The resultant water demand distribution for the Moolarben Coal Complex is listed in Table 4. The total volume of water required for mining equates to a ROM factor of 180 ML per Mt.

Table 4: Forecast Water Demand at the Moolarben Coal Complex (Phase 1 and 2)

Area of Use	Usage Rate (unit)	Net Usage Rate (million litres/unit)	Quantity	Maximum Water Usage (ML/year) (SWB Phases 1 and 2)
CHPP (16 Mt open cut [SWB Phases 1 and 2])	Mt	80	16 Mt	1, 279
Haul road dust suppression	day	3.2	1 year	1,165
Underground use	year	263	1 year	263
Miscellaneous usage	year	150	1 year	150
Total	-	-	-	**2, 857**

The water demand in Table 4 is based on an average rainfall year assuming maximum production. Where additional water may be required in “dry” years it may be necessary to increase the amount of water imported from the Ulan Mine Complex under the UWSA. MCO has an agreement with UCML for the supply of 1,000 ML/year of surplus mine water from its operations. The UWSA has provision to increase the supply by agreement. Additional water to meet site demand or water quality requirements will also be available from the water treatment facility of advanced dewatering of the Underground 4 mine (i.e. the northern borefield). All water extraction will be undertaken in accordance with relevant agreements and/or licence conditions.

5.7 Other Water Losses

Evaporation estimates for open water bodies (including dams) were based on evaporation data for the area obtained from the Patched Point Data service. Surface areas for the dams has been determined based on as-constructed drawings and topographical data (for existing storages) and conceptual design plans (for proposed dams).

Water losses associated with potential seepage from water dams is assumed to be negligible in terms of the overall site water balance and has therefore not been modelled. This assumption is supported by the fact that the construction of emergency tailings dams, mine infrastructure dams, groundwater storages and treatment dams will comply with a permeability standard that is the equivalent of $<1x10^{-9}$ m/s (Section 4.0).

6.0 WATER DISPOSAL

6.1 Wastewater Effluent Disposal

Wastewater from offices, workshop and bath houses is collected and treated in on-site effluent treatment systems located near the open cut offices, CHPP Offices, Underground MIA and Administration Offices. Effluent disposal is undertaken in accordance with EPL 12932. Any additional effluent sites installed for expanded operations will be appropriately licensed.

6.2 Licensed Discharges

MCO has the ability to discharge water into the Goulburn River Diversion and Moolarben Creek from three licensed discharge points (Goulburn River Diversion discharge point, Dam 106 and Dam 202) in accordance with EPL 12932.

EPL 12932 and Project Approval (05_0117) permits a maximum discharge of 10 ML/day from the Goulburn River Diversion discharge point for the majority of the Moolarben Coal Complex life, 15 ML/day during mining operations in UG4, and the release of a combined volume greater than 15 ML/day during prolonged wet periods with the approval of the EPA.

MCO is also permitted to allow stormwater discharge from additional locations in accordance with EPL 12932.

All discharges will be undertaken in accordance with the conditions in EPL 12932 and Condition 31, Schedule 3 of Project Approval (05_0117) and Condition 27, Schedule 3 of Project Approval (08_0135).

Further information on licensed discharges is detailed in Section 7.3 of the SWMP.

6.3 Other Disposal

MCO and Wilpinjong Coal Mine will continue to, liaise regarding opportunities for physical water sharing between the operations. Where reasonable and feasible, water will be shared between the sites.

7.0 WATER SOURCES

Sources of water supply to the Moolarben Coal Complex are summarised in decreasing order of priority:

- Groundwater inflows to open cut and underground mining operations;
- Runoff captured from the footprint of the mining disturbance area by the water management system;
- Groundwater extracted from advanced UG dewatering;
- Mine water imported from the Ulan Mine Complex under agreement with UCML; and
- Groundwater extracted from production bores.

Operational water supply is reviewed monthly, collating all groundwater extractions, in-pit rainfall accumulation and runoff, as well as imported water to inform on-site water management. Water will be sourced based on the supply hierarchy with consideration given to water quality requirements.

MCO will manage the available water sources and, if necessary, adjust the scale of operations to match the available water supply (in accordance with Condition 29, Schedule 3 of Project Approval [05_0117]). Where practical, preference will be given to water captured on-site and sourced from surplus supplies at adjoining mines.

7.1 Groundwater Inflows

Open cut and underground mining within the Moolarben Coal Complex may intercept saline groundwater aquifers. To maintain safe mining operations all of the groundwater that accumulates within mining pits will need to be pumped to surface storages, and will be re-used in mining operations. Table 5 summarises the predicted groundwater inflows. The predictions in Table 5 include an allowance for face evaporation losses.

Table 5: Predicted Groundwater Inflows

Site Water Balance Model Phase	Year	Total Groundwater Inflows (ML/year)
1	2019	2,396
2	2020	3,830
	2021	5,010

7.2 Runoff and Direct Rainfall

As described in Section 4 of the SWMP, as far as practically possible, clean water runoff from up catchment areas is diverted around active mining and other disturbance areas. Diversion design will consider catchment extent, required disturbance and safety. Water that accumulates within mining pits will be pumped to surface storages for re-use in the mining operations and CHPP. Table 6 summarises the predicted runoff and direct rainfall for the Moolarben Coal Complex for dry, median and wet climatic conditions, averaged over Phase 1 (2019) and Phase 2 (2020 to 2021) of the water balance model.

Table 6: Predicted Runoff and Direct Rainfall

Open Cut Mining Area	Average Annual Surface Water Inflows (Dry Climatic Conditions) (ML/year)	Average Annual Surface Water Inflows (Median Climatic Conditions) (ML/year)	Average Annual Surface Water Inflows (Wet Climatic Conditions) (ML/year)
OC1 /Wash Plant	97	193	545
OC2	183	353	784
OC3	174	370	919
OC4	141	295	746

7.3 Water Sharing

Where practical, MCO seeks to share surplus mine water from other mines. MCO has an agreement with UCML for the supply of 1,000 ML/year of surplus mine water from its operations. The volume of water sourced externally under the UWSA (or from dewatering/production bores) will be managed to the available on-site storage capacity. Transferred water can be saline and is therefore treated as mine water.

7.4 Pumping from Licensed Groundwater Sources

Supplementary water supply during dry years may be sourced from licensed dewatering/production bores from advanced dewatering of the UG4 mine (Figure 9). The borefield water supply system may comprise of pumps, pipelines, storage dams and tanks to extract and store groundwater. Groundwater will be drawn from these bores on an as need basis.

Each production bore will be equipped with a meter to measure the volume of water extracted. These meters will be maintained in good working order and calibrated in accordance with the *NSW Non-urban Water Metering Policy* (NSW Department of Industry, 2018). All water extracted from these bores will be monitored with the volumes reported in the Annual Review.

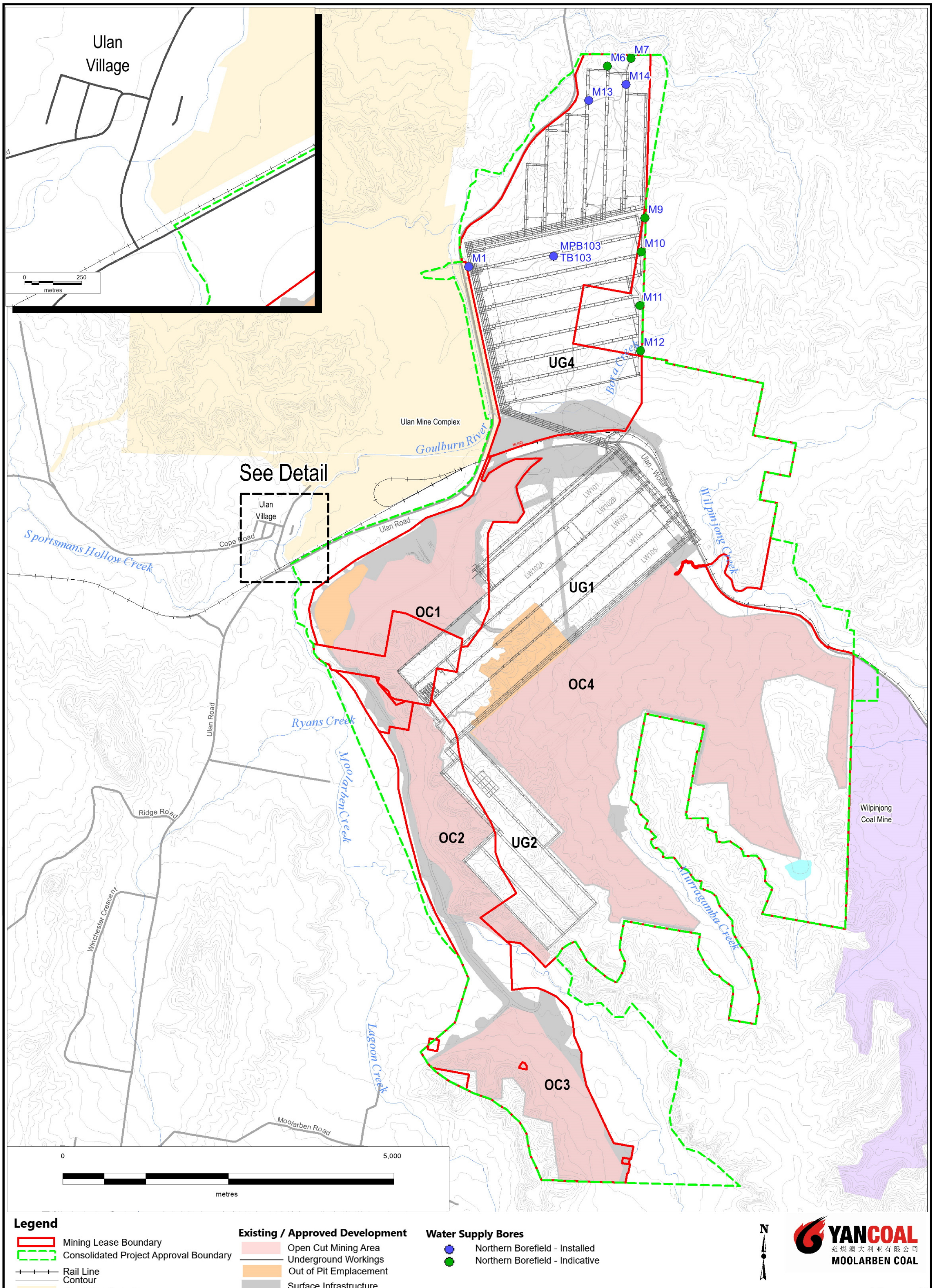


Figure 9
Indicative Locations of Water Supply Bores

8.0 WATER BALANCE MODEL CONFIGURATION AND ASSUMPTIONS

8.1 Overview

A water balance model of Moolarben Coal Complex has been developed, using the OPSIM modelling software package. The model was developed by WRM (2017) as part of the *Moolarben Coal Complex Open Cut Optimisation Modification Site Water Balance and Surface Water Assessment* and refined as part of Version 3 of this SWB. The OPSIM model is used by suitably qualified and experienced consultants to provide advice on the water balance impacts of future site development. A summary of the existing and proposed system operating rules and assumptions are provided in Attachment 3. The OPSIM model is reviewed in accordance with the provisions described in Section 9.2.

Area Managers are responsible for the operation and maintenance of water infrastructures (e.g. pumping requirements) in consultation with the Environment and Community Coordinators.

The water management system schematics for Stage 1 and Stage 2 are shown in Figure 10 and Figure 11.

8.2 Water Management System Staging

The refined water balance model was configured to represent the changing characteristics of the water management system over the modelled period. This included changes in contributing catchment areas draining to the various mine site storages, as well as varying groundwater inflows, coal production rates and site water demand.

Two different representative phases of mine life were modelled to reflect variations over time. These modelling phases are summarised in Table 7. Although the catchment areas will continuously change as mining progresses, the adopted approach of modelling discrete stages will provide a reasonable representation of conditions over the 3 year period.

Staged mine plans for each Representative Mine Phase over the modelled period are included in Attachment 2.

Table 7: Moolarben Coal Complex Model Phases

Representative Mine Phase	Applied Range of Mine Life	Phase Duration
Phase 1	2019/20	1 years
Phase 2	2020-2021	2 years

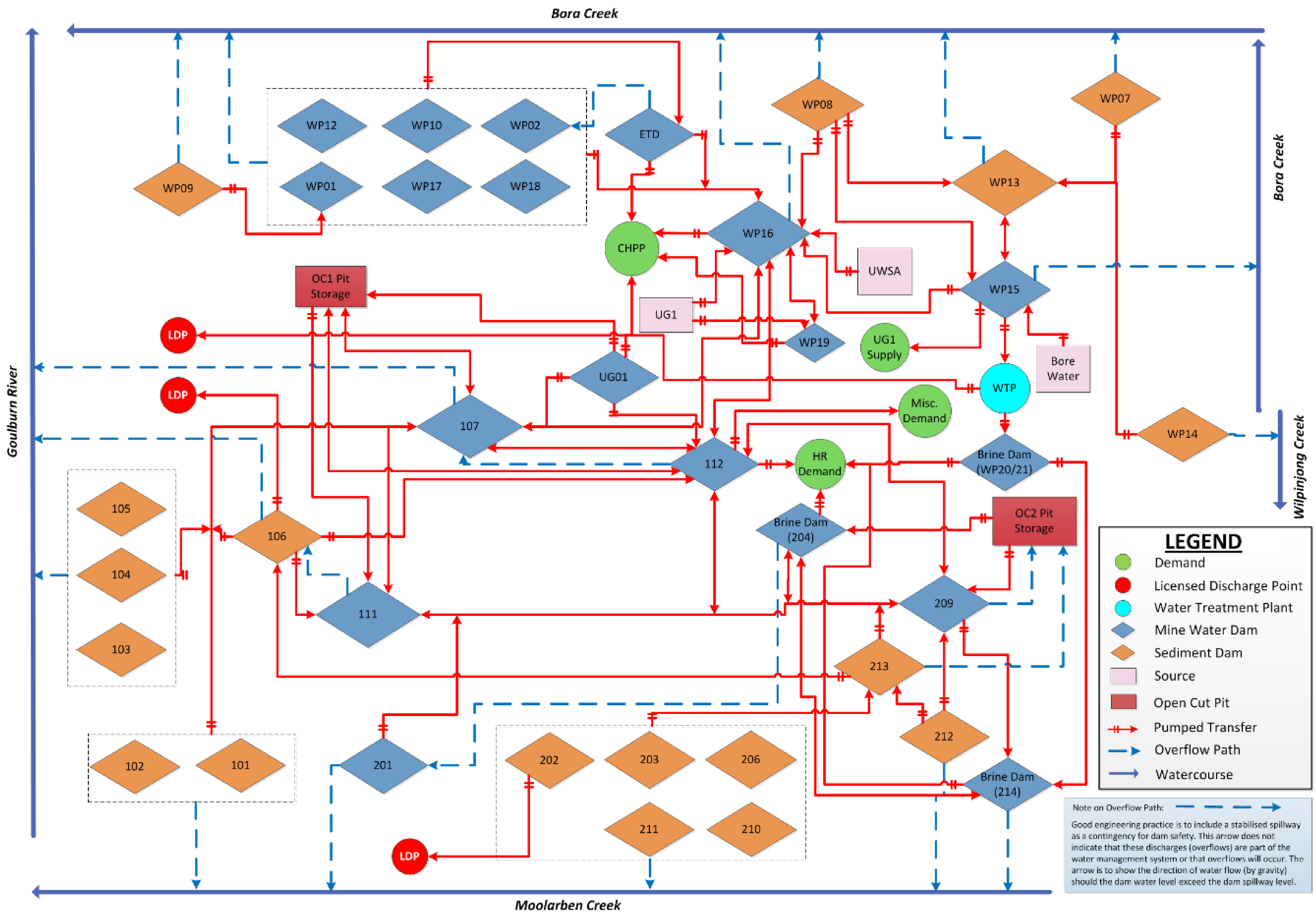


Figure 10: Water management schematic – CHPP/OC1/OC2

Document	Version	Issue	Effective	Review	Author	Approved
MCO_ENV_PLN_0036	4	Sep 20	Oct 20	Nov 21	MCO	SA

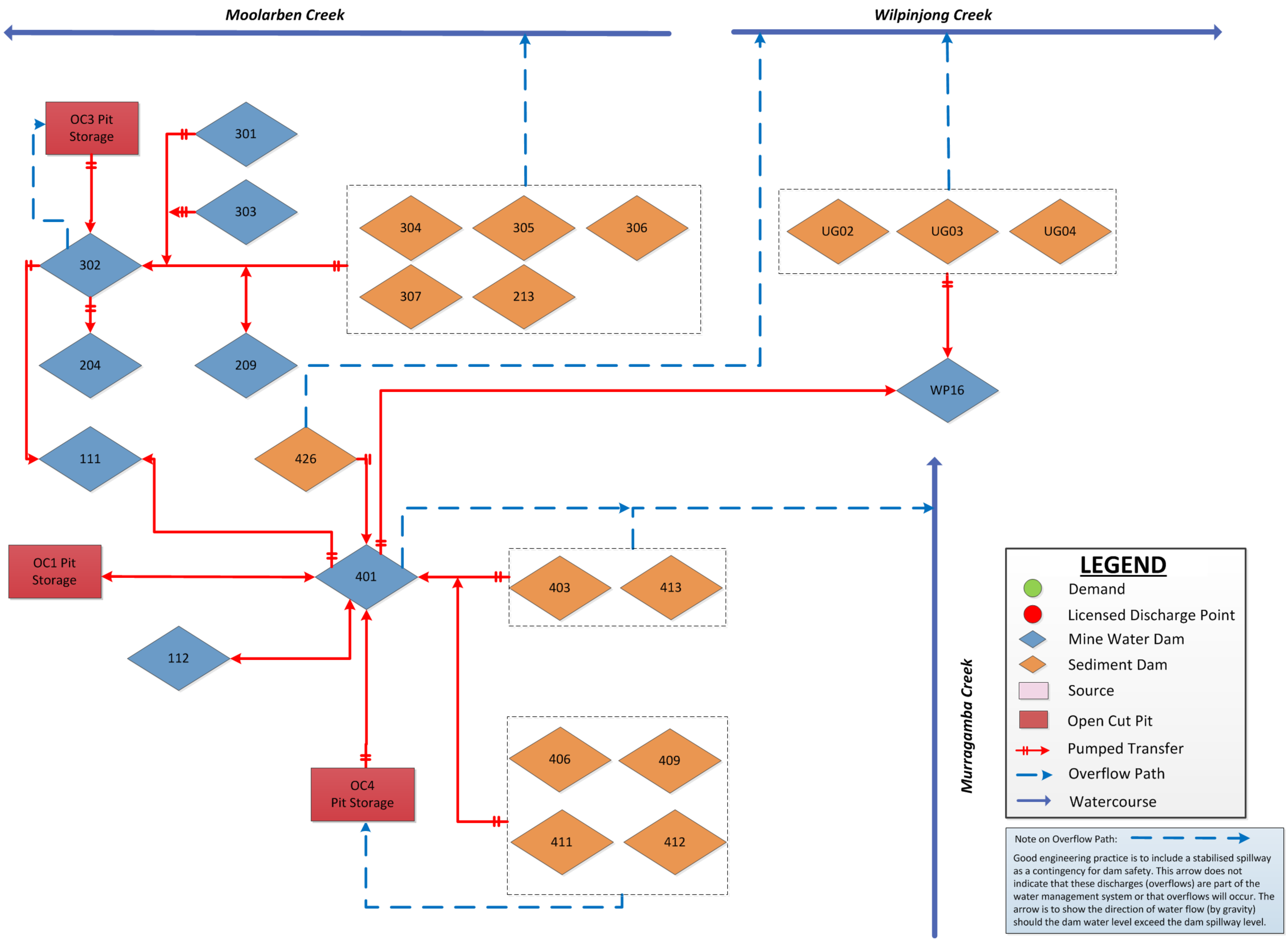


Figure 11: Water management schematic – OC3/OC4

8.3 Water Management System Operating Assumptions

Detailed water management system operating assumptions are documented in Attachment 3.

8.4 Simulation of Catchment Runoff

Catchment runoff inflows to the mine water management system are modelled using the Australian Water Balance Model (AWBM) rainfall-runoff model. Catchments across the site are characterised into the following land use types:

- natural;
- hardstand;
- open cut mining area (active pit);
- overburden emplacement area (spoil); and
- rehabilitated overburden emplacement area.

The AWBM model for natural/undisturbed catchments (i.e. not disturbed by mining) has been calibrated against available stream flow data at the following four locations:

- Moolarben Creek at Moolarben Dam;
- Moolarben Creek at Ulan Road (gauge no. MOOL001);
- Bora Creek at Ulan Road (gauge no. MOOL002); and
- Wilpinjong Creek at Red Hill (gauge no. MOOL003).

The calibrated AWBM parameters for the four locations differed significantly. The most suitable parameter set was determined by undertaking a calibration of the OPSIM model against modelled and observed combined site inventory over a six month period. The results of the OPSIM model calibration showed that the Bora Creek catchment model parameters produced the best match between modelled and observed combined site inventory.

Whilst it is recognised that a small proportion (less than 20%) of the Bora Creek catchment was disturbed during the calibration period, it is considered representative of a natural catchment for modelling purposes. Hence, the Bora Creek catchment model parameters were adopted for natural/undisturbed catchments (shown in Table 8).

Figure 12 and Figure 13 show predicted and recorded daily runoff and flow duration curves for Bora Creek at Ulan Road. Figure 14 compares modelled and observed combined site inventory using the adopted AWBM parameters. The model was calibrated to the 2018 observed site inventory using site rainfall data. The model calibration results show the adopted AWBM parameters are still appropriate.

Model parameters for pit, hardstand and stockpile catchments were adopted based on previous experience with OPSIM modelling on these types of catchments. Model parameters for spoil catchments were adopted from a previous study of runoff from disturbed mine catchments in the Hunter Valley region (ACARP, 2001). Natural/undisturbed catchment AWBM parameters were adopted for rehabilitated spoil catchments. Model parameters for the various catchment types are summarised in Table 8.

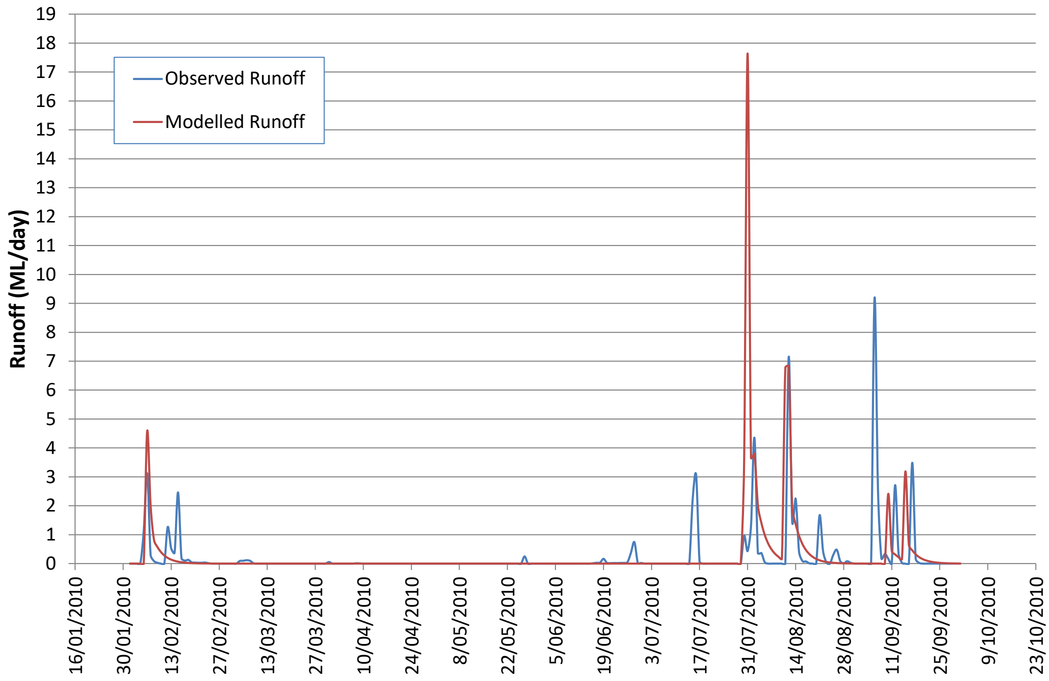


Figure 12 Comparison of Modelled and Observed Daily Runoff, Bora Creek at Ulan Road

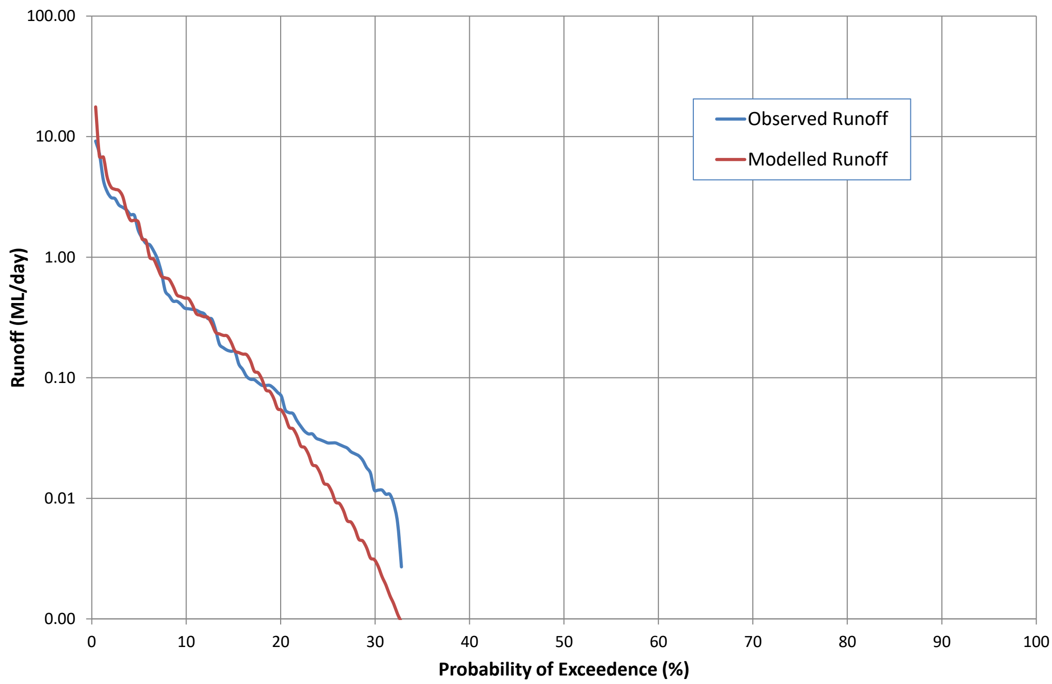


Figure 13 Comparison of Modelled and Observed Flow Duration Curves, Bora Creek at Ulan Road

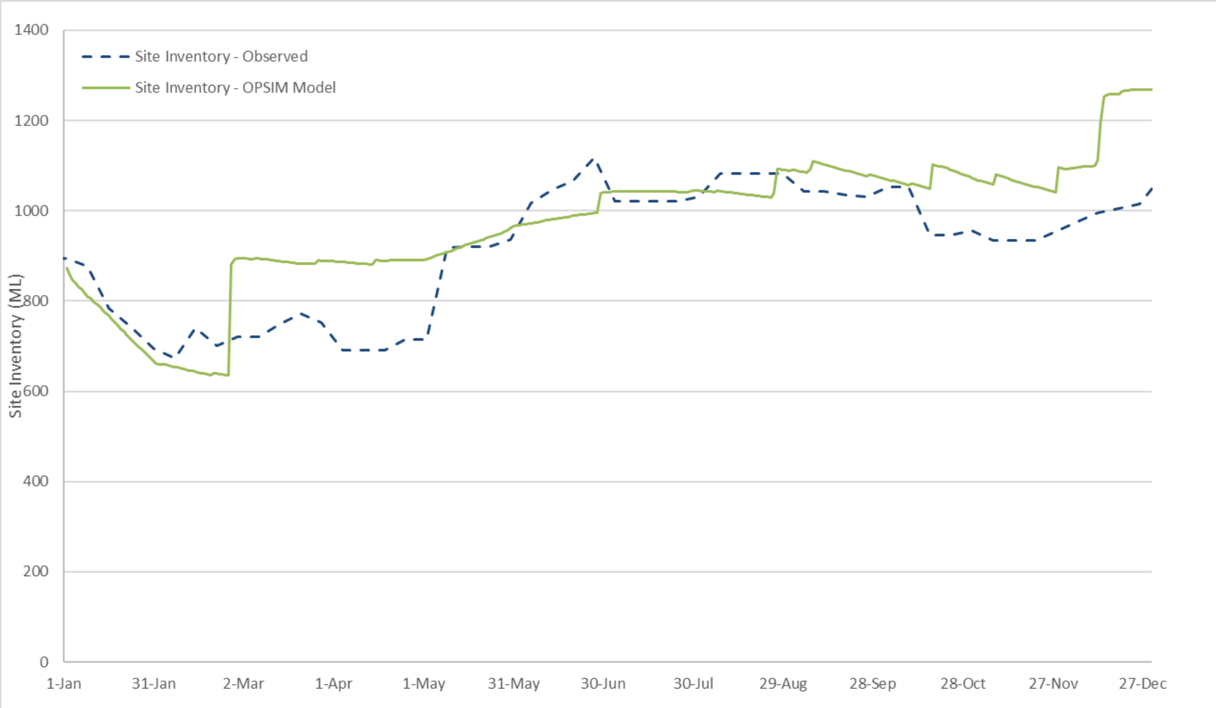


Figure 14 Comparison of Modelled and Observed Combined Site Inventory

Table 8: Adopted AWBM Parameters

Parameter	Natural/ Undisturbed	Roads/Industrial/ Hardstand	Mining Pit	Unrehabiltated Spoil	Rehabiltated Spoil	Coal Stockpile	Cleared
A1	0.2	0.3	0.3	0.3	0.2	0.1	0.3
A2	0.2	0.2	0.2	0.2	0.2	0.9	0.2
C1	90	3	3	10	90	4	4
C2	170	30	12	100	160	16	25
C3	200	200	70	350	250	-	220
BFI	0.6	0	0	0.8	0.6	0	0.6
Kb	0.70	0	0	0.7	0.70	0	0.5
Ks	0	0	0	0	0	0	0

8.5 Overall Water Balance

Water balance results for all modelled realisations are presented in Table 9, averaged over both of the first 2 phases of modelled mine life. The results for this single realisation show inflows, outflows and overall water balance for each of the mine phases for a representative climate sequence. It should be recognised that the following items are subject to climatic variability:

- rainfall runoff;
- evaporation;
- mine water imported from UCML;
- bore water requirements; and

- licensed site releases (including licensed sediment dam spills).

The results presented in Table 9 are an average of all realisations, and will include wet and dry periods distributed throughout the mine life. Rainfall yield for each phase is affected by the variation in climatic conditions within the adopted climate sequence.

Water management contingencies include the storage of additional water on-site, reducing the water sourced externally during extended wet periods and sourcing additional water from neighbouring mines or ground water during dry periods. Additional contingencies and response measures are discussed in Section 6 of the SWMP.

Table 9: Average Annual Water Balance

	Phase 1 **2019**	**Phase 2** **2020 – 2021**
Water Inputs (ML/a)		
Rainfall Runoff Yield	1,553	1,891
Groundwater Inflows	2,396	4,420
UWSA+Borefield	0	0
Gross Water Input	**3,949**	**6,311**
Water Outputs (ML/a)		
Evaporation from storages	541	738
Dam overflows (offsite)		
Mine water system	0	0
Sediment dam system	12	49
Total	12	49
CHPP demand (loss)	1,279	1,175
Controlled releases† (including RO plant releases)	0	2,331
Haul road dust suppression	1,109	1,168
Net underground loss	262	262
Misc. water demand	150	150
Total	**3,353**	**5,873**
Water Balance (ML/a)		
Change in Site Water Inventory	596	438

* The volume of water sourced externally under the UWSA (or from dewatering/production bores) will be managed to the available on-site storage capacity.

† EPL 12932 permits up to 10ML/day of controlled water release from licensed discharge points. While water sourced externally will be managed to the available on-site storage capacity, the ability for MCO to discharge under licence provides a contingency for managing surplus water (of a suitable quality) in the event storage capacity becomes constrained as a result of intensive or prolonged rainfall conditions.

9.0 REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

9.1 Annual Review

Annual Review reporting and revision protocols are described in Section 4 of the WAMP.

10.0 REFERENCES

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Hansen Bailey (2012) *Moolarben Coal Project Stage 2 – Preferred Project Report*.

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11.0 DEFINITIONS

CHPP	Coal Handling and Preparation Plant
EA	Environmental Assessment
EP&A Act	*Environmental Planning and Assessment Act 1979*, the primary legislation for the regulation of land use, planning and development within NSW
EPL	Environment Protection Licence
Incident	A set of circumstances that causes or threatens to cause material harm to the environment and/or breaches or exceeds the limits or performance measures/criteria in the Part 3A Approval
MCO	Moolarben Coal Operations Pty Limited
MIA	Main Infrastructure Area
ML	Megalitre
MOP	Mining Operations Plan
Mt	Million tonnes
OC	Open Cut
POEO Act	NSW *Protection of the Environment Operations Act 1997*, principal piece of legislation governing environmental protection in NSW
ROM	Run of Mine coal
UCML	Ulan Coal Mines Limited
UWSA	Ulan Water Sharing Agreement
UG	Underground
WAMP	Water Management Plan (in relation to the Moolarben Coal Project - this Plan)

Attachment 1: Project Approval (05_0117) and (08_0135) Reconciliation

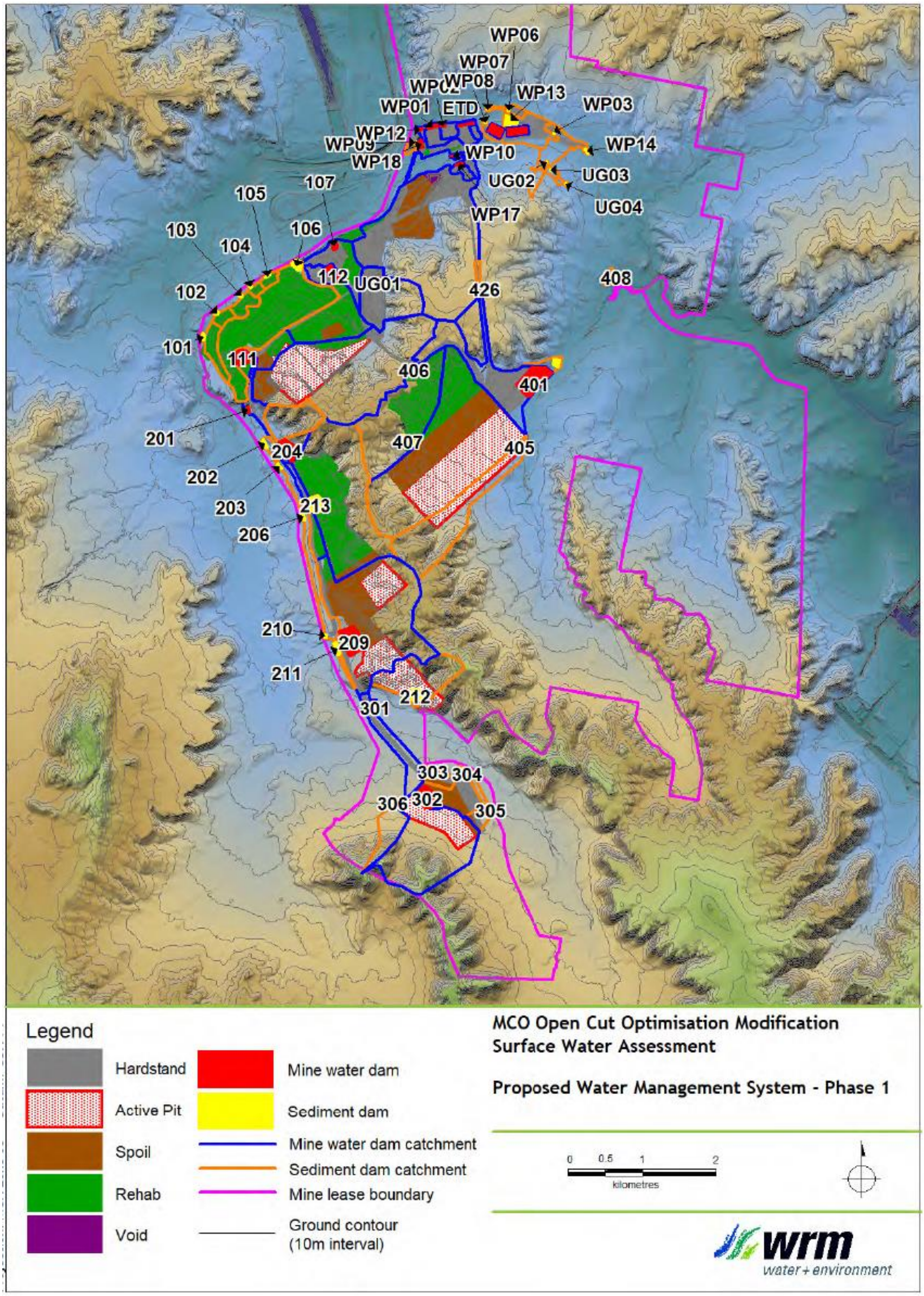
Table A-110: Site Water Balance Requirements in Project Approvals (05_0117 and 08_0135)

NSW Project Approval Condition	SWB Section
Water Management Plan	
33 (b) in addition to the standard requirements for management plans (see condition 3 of Schedule 6), this plan must include a:	
(i) <u>Site Water Balance</u> that:	
• includes details of:	
- sources and security of water supply, including contingency planning for future reporting periods;	Section 7
- water use and management on site, including details of water sharing between neighbouring mining operations;	Sections 4 to 7
- reporting procedures, including the preparation of a site water balance for each calendar year;	Section 9
• describes the measures that would be implemented to:	
- minimise clean water use on site;	Section 4
- maximise water sharing with the other mines in the region;	Section 7.3
...	

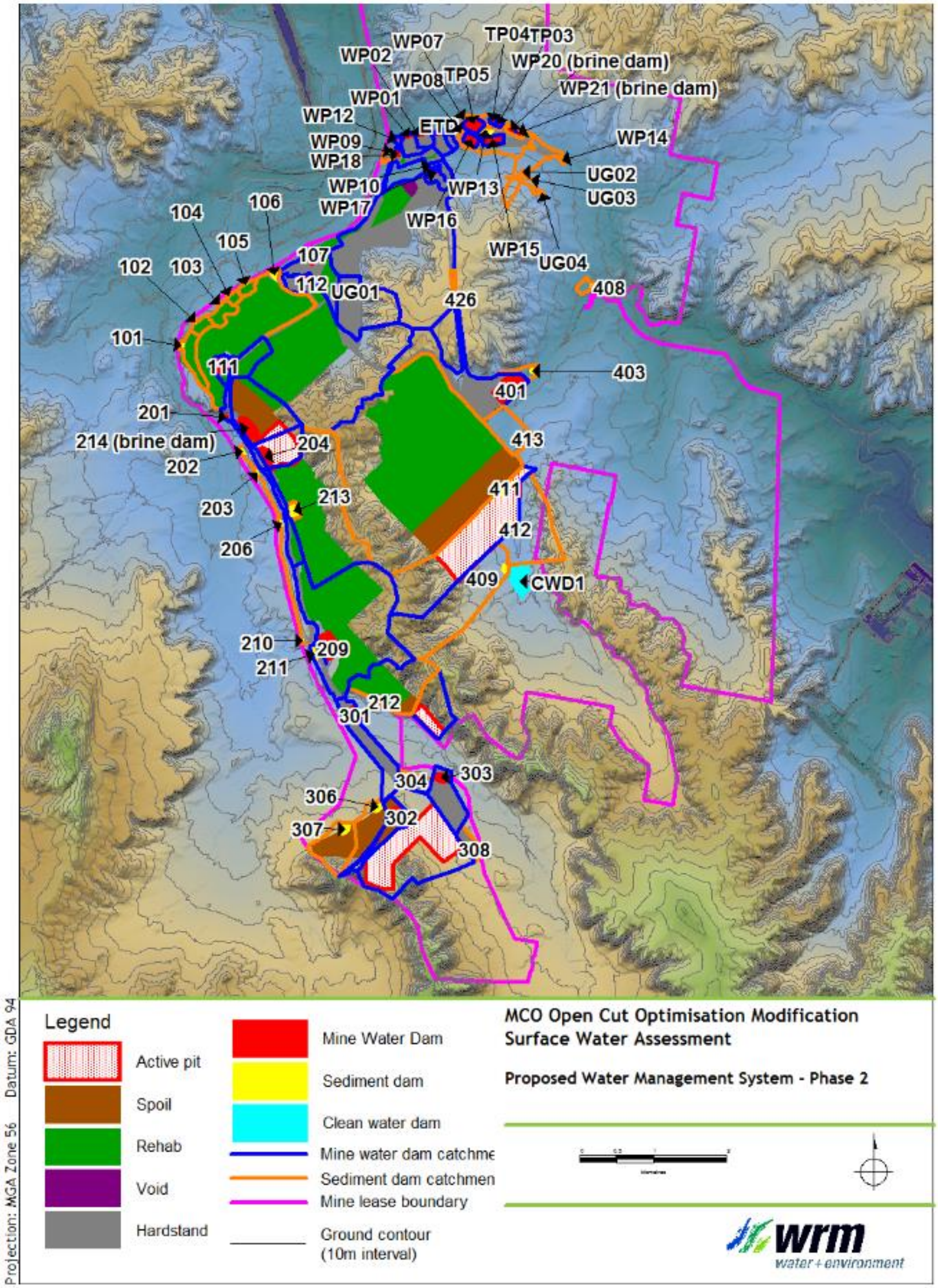
Table A-2: Management Plan Requirements Project Approval (08_0135)

NSW Project Approval Condition	SWB Section
3. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
(a) detailed baseline data;	Section 3
(b) a description of:	
• *the relevant statutory requirements (including any relevant approval, licence or lease conditions);*	Section 2 and Attachment 1
• *any relevant limits or performance measures/criteria;*	WAMP
• *the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;*	WAMP
(c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	WAMP
(d) a program to monitor and report on the:	WAMP
• *impacts and environmental performance of the project;*	
• *effectiveness of any management measures (see c above);*	
(e) a contingency plan to manage any unpredicted impacts and their consequences;	WAMP
(f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Section 9
(g) a protocol for managing and reporting any:	WAMP
• *incidents;*	
• *complaints;*	
• *non-compliances with statutory requirements; and*	
• *exceedances of the impact assessment criteria and/or performance criteria; and*	
(h) a protocol for periodic review of the plan.	Section 9

Attachment 2: Water Management System – Indicative Stage Plans



Moolarben Coal Complex Stage Plans – Phase 1 (indicatively 2019/20)



Moolarben Coal Complex Stage Plans – Phase 2 (indicatively 2020 to 2021)

Attachment 3: Water Management System Operating Rules

The modelled water management system assumptions are summarised in the table below. Actual water management practices on-site may change as mining progresses. The overflows described in the table below represent stabilised spillways designed as a contingency for dam safety and do not indicate that these discharges or overflows are part of normal water management system operating practice.

Table A-3: Water Management System Operating Assumptions

Item	Node Name	Operating Rules
1.0	**Water Supply**	
1.1	Ulan Water Sharing Agreement	• Supplies water to WP16 from the "East Pit" of Ulan Mine Complex as part of the UWSA as required
1.2	Borefield water supply	• Supplies to WP15 as required
2.0	**Water Demands**	
2.1	CHPP	• Supplied from WP16
2.2	Dust suppression	• Supplied from 111, 112, 204, 209, 401
2.2	MIA usage	• Supplied from 112.
3.0	**Open–Cut Operations**	
3.1	Open Cut 1 (OC1 Pit)	• Receives groundwater inflows at varying rates dependent on mine stage • Receives stormwater runoff from disturbed and undisturbed areas • Continuous dewatering to 107, 111
3.2	Open Cut 2 (OC2 Pit)	• Receives groundwater inflows at varying rates dependent on mine stage • Receives stormwater runoff from disturbed and undisturbed areas • Continuous dewatering to 204 and 209
3.2	Open Cut 3 (OC3 Pit)	• Receives groundwater inflows at varying rates dependent on mine stage • Receives stormwater runoff from disturbed and undisturbed areas • Continuous dewatering to 302
	Open Cut 4 (OC4 Pit)	• Receives groundwater inflows at varying rates dependent on mine stage • Receives stormwater runoff from disturbed and undisturbed areas • Continuous dewatering to 401
4.0	**Underground Operations**	
4.1	Underground 1 (UG1)	• Receives groundwater inflows at varying rates dependent on mine stage • Receives water from WP15, WTP & open cut pits • Continuous dewatering to WP16, WP19, OC1 Pit
5.0	**Water Storages - CHPP**	
5.1	WP01	• Receives catchment inflows from product stockpile, WP18 • Supplies to ETD, WP16 • Overflows to WP12 • Dam level is maintained at or below 10%

Item	Node Name	Operating Rules
5.2	WP02	• Receives catchment inflows from product stockpile pad, overflows from clarified water sump • Supplies to WP16 • Overflows to WP01 • Dam level is maintained at or below 10%
5.3	WP07	• Receives catchment inflows from disturbed areas • Pump transfers to WP13 • Overflows to Bora Creek
5.4	WP08	• Receives catchment inflows from disturbed areas • Pump transfers to WP13, WP15, WP16 • Overflows to Bora Creek
5.5	WP09	• Receives catchment inflows from Admin area and car park • Pump transfers to WP01 • Overflows to Bora Creek
5.6	WP10	• Receives catchment inflows from ROM area and Rejects bin • Overflows to WP01
5.7	WP12	• Receives catchment inflows from disturbed areas and overflows from WP01 • Pump transfers to WP01 • Overflows to Bora Creek
5.8	WP13	• Receives catchment inflows from disturbed and undisturbed areas • Receives pumped transfers from WP07, WP08, WP14 • Pump transfers to WP15 • Overflows to Bora Creek
5.9	WP14	• Receives catchment inflows from disturbed areas • Pump transfers to WP13 • Overflows to Wilpinjong Creek
5.10	WP15	• Pump transfers to WP16 & UG Supply • Receives pump transfers from northern borefields, WP08, WP13, WTP • Overflows to Bora Creek
5.11	WP16	• Supplies to the CHPP • Pump transfers to 107, 112, & WP19 • Dam level is maintained between 60% and 80% • Receives pump transfers from Ulan Mine, ETD, WP01, WP02, WP08, WP15, WP18, 107, 112 and UG1 • Overflows to Bora Creek
5.12	WP17	• Receives catchment inflows from ROM area and Reject bin area • Pump transfers to WP01, WP10 • Overflows to WP10
5.13	WP18	• Receives catchment inflows from disturbed areas and overflows from WP10 • Pump transfers to WP01, WP16 • Overflows to WP01

Item	Node Name	Operating Rules
5.14	ETD	• Receives overflows from clarified water tank and clarified water sump and WP01, WP02. • Dam level is maintained between 20% and 60% • Pump transfers to WP16 • Overflows to WP02
5.15	WP19	• Pump transfers to WTP • Receives pump transfers from WP16, 112, UG1, 401 • Overflows to Bora Creek
6.0	**Water Storages – OC1**	
6.1	101	• Receives catchment inflows from rehabilitated areas • Pumped transfers to 107, 111 • Overflows to Moolarben Creek
6.2	102	• Receives catchment inflows from rehabilitated areas • Pump transfer to 106 • Overflows to Moolarben Creek
6.3	103	• Receives catchment inflows from rehabilitated areas • Pump transfer to 106 • Overflows to Goulburn River
6.4	104	• Receives catchment inflows from rehabilitated areas • Pump transfer to 106 • Overflows to Goulburn River
6.5	105	• Receives catchment inflows from rehabilitated areas • Pump transfers to 106 • Overflows to Goulburn River
6.6	106	• Receives catchment inflows from rehabilitated areas • Receives pump transfers from 102, 103, 104, 105 • Pumped transfer to 107, 111, 112 • Licensed discharge point, discharges to Goulburn River • Overflows to Goulburn River
6.7	107	• Receives catchment inflows from disturbed areas and rehab area and 112 • Pump transfers to 111, 112, WP16, 401 • Receives pumped transfers from OC1 Pit, WP16, 101, 108, 111, 112, 401, UG01, UG04 • Overflows to Goulburn River
6.8	108	• Receives catchment inflows from the environmental bund • Pump transfer to 107 • Overflows to 107
6.9	111	• Primary mine water storage dam for OC1 • Pumped transfer to 107, 112, 204, 209 • Receives pump transfers from OC1 Pit, 101 106, 107, 112, 201, 20, 209, 213 • Overflows to 106
6.10	112	• Receives catchment inflows from disturbed areas, wash down bay • Receives pumped transfer from 106, 107, 111, UG01, WP16, OC1 Pit

Item	Node Name	Operating Rules
		• Pumped transfer for OC1 water cart fill point, fire water miscellaneous demand, 111, 204, 209, 401, WP16 • Overflows to 107
6.11	OC1 North Pit	• Receives catchment inflows from ROM & rejects area & other disturbed areas • Pumped transfers to 107, 112, 401, WP16
7.0	**Water Storages – OC2**	
7.1	201	• Receives catchment inflows from disturbed areas • Pump transfers to 111, 204, 209 • Overflows to Moolarben Creek
7.2	202	• Receives catchment inflows from the out-of-pit-dump & rehabilitated areas • Pump transfers to 213, 111 • Receives pumped transfer from 203 • Overflows to Moolarben Creek • Licenced discharge point
7.3	203	• Receives catchment inflows from the out-of-pit dump & rehabilitated areas • Pumped transfers to 213 • Overflows to 202 •
7.4	204	• Receives catchment inflows from undisturbed and disturbed areas • Pump transfers to 111, 209, 214 & OC2 water cart fill point • Receives pump transfers from OC2 Pit, 111, 201, 209, 213 • Overflows to 214
7.5	206	• Receives catchment inflows from the out-of-pit dump & rehabilitated areas • Pump transfers to 203, 213 • Receives pumped transfers from 210 • Overflows to 203
7.7	209	• Receives catchment inflows from disturbed areas • Receives pumped transfers from OC2 Pit, 111, 112 201, 204, 213, 301 • Pump transfers to 111, 112, 204, 301 • Overflows to OC2 Pit
7.8	210	• Receives catchment inflows from the out-of-pit dump & rehabilitated areas • Pumped transfers to 206 • Overflows to 211
7.9	211	• Receives catchment inflows from the out-of-pit dump • Pumped transfers to 213 • Overflows to Moolarben Creek
7.10	212	• Receives catchment inflows from disturbed areas • Pumped transfers to 209, 213. • Overflows to Moolarben Creek
7.11	213	• Receives catchment inflows from the out-of-pit dump & rehabilitated areas • Receives pumped transfers from 202, 206, 211 212, • Pump transfers to 106, 111, 204, 209 • Overflows to OC2 Pit

Item	Node Name	Operating Rules
7.12	214	• Receives water from WTP, 209, 204 • Pumped transfer to Water cart fill point
8.0	**Water Storages – OC3**	
8.1	301	• Receives catchment inflows from disturbed areas, & haul road • Pumped transfer to 302, 209 • Overflows to Moolarben Creek
	302	• Receives catchment inflows from disturbed areas, & haul road • Pumped transfer to 111, 209, OC3 water cart fill point • Receives pump transfers from OC3 Pit, 301, 303 & 304 to 307 • Overflows to Open Cut 3
	303	• Receives catchment inflows from disturbed areas, OC3 MIA, & haul road • Pumped transfer to 209, 302 • Receives pump transfers from 304 to 306 • Overflows to Moolarben Creek
8.2 -8.6	304 to 307	• Receives catchment inflows from disturbed areas • Pump transfers to 213, 302 • Overflows to Moolarben Creek
9.0	**Water Storages – OC4**	
9.1	401	• Primary mine water storage dam for OC4 • Receives catchment inflows from disturbed areas, OC4 MIA & conveyor trace • Pumped transfer to 107, WP16, OC4 water cart fill point, Fire water – OC4 ROM • Receives pump transfers from OC1 North Pit, OC4 Pit, and OC4 Sediment Dams • Overflows to Murragamba Creek
9.2 - 9.10	403	• Receives catchment inflows from disturbed areas • Pump transfers to 401 • Overflows to Murragamba Creek
	408	• Receives catchment inflows from disturbed areas • Pump transfers to 401 • Overflows to Murragamba Creek
	409 to 412	• Receives catchment inflows from disturbed areas • Pump transfers to 401 • Overflows to Murragamba Creek or OC4 Pit
9.14	426	• Receives catchment inflows from disturbed areas • Pump transfers to 401 • Overflows to Wilpinjong Creek
10.0	**Treatment Plant (2019 onwards)**	
10.1	Water Treatment Plant	• Receives water from WP19 • Pumped transfers to WP20, WP21, WP15, UG, CHPP, LDP
10.2	WP20 & 21	• Receives pump transfers from WTP • Pump transfers to 214, 204 and water fill points. • Overflows to WP13

Item	Node Name	Operating Rules
10.3	Release point	• Released to Goulburn River at max rate of 10 ML/day (685 µs/cm) and increased to 15ML/day when operating in UG4