sunrise
energy metals

Sunrise Project

Project Execution Plan Modification

Appendix C

Surface Water Assessment

REPORT

Sunrise Project

Project Execution Plan

Modification

Surface Water Assessment

Prepared for: Sunrise Energy Metals Limited

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1.0 INTRODUCTION

1.1 BACKGROUND

The Sunrise Project (the Project) is a nickel, cobalt and scandium open cut mining project situated near the village of Fifield, approximately 350 kilometres (km) west-northwest of Sydney, in New South Wales (NSW) (Figure 1). Construction of the Project commenced in 2006, which included components of the borefield, however construction of other Project components is yet to commence.

SRL Ops Pty Ltd owns the rights to develop the Project. SRL Ops Pty Ltd is a wholly owned subsidiary of Sunrise Energy Metals Limited (SEM)[1].

Development Consent (DA 374-11-00) for the Project was issued under Part 4 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) in 2001. Six modifications to Development Consent (DA 374-11-00) have since been granted under the EP&A Act.

The Project Execution Plan (Clean TeQ, 2020) identified a number of changes to the approved mine and processing facility, accommodation camp, rail siding and road transport activities. The Project Execution Plan Modification (the Modification) includes these Project Execution Plan changes to allow for the optimisation of the construction and operation of the Project.

Hydro Engineering & Consulting Pty Ltd (HEC) was engaged by SEM to conduct an assessment of the relevant surface water aspects of the modified Project. The results of this assessment are documented in this Surface Water Assessment, which has been prepared to support an application by SEM to modify Development Consent (DA 374-11-00) for the Project.

1.1 MODIFICATION DESCRIPTION

The Modification would include the following changes to the approved Project, as illustrated in Figure 2 and Figure 3:

<u>Mine and Processing Facility</u>

- addition of a temporary construction laydown area inside the approved tailings storage facility surface development area;
- optimised production schedule resulting in an increased mining rate during the initial years of mining and associated changes to mining and waste rock emplacement sequencing;
- revised processing facility area layout, including a revised processing plant layout and two additional vehicle site access points;
- reduced sulphuric acid plant stack height from 80 metres (m) to 40 m;
- revisions to processing plant reagent types, rates and storage volumes;
- revised tailings storage facility (TSF) cell construction sequence and the addition of a decant transfer pond (DTP);
- relocated and resized evaporation pond (EP);
- changes to the water management system to reflect the modified mine and processing facility layout;
- increased number of diesel-powered backup generators (and associated stacks) from one to four;

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[1] SEM was previously Clean TeQ Holdings Limited (Clean TeQ).

- addition of exploration activities within the approved surface development area inside Mining Lease (ML) 1770;
- increased peak construction phase workforce from approximately 1,000 to approximately 1,900 personnel;

Rail Siding

- revised rail siding location and layout;
- addition of an ammonium sulphate storage and distribution facility to the rail siding;
- extension of the Scotson Lane upgrade;
- addition of a 22 kV electricity transmission line (ETL) (subject to separate approval) to the rail siding power supply;
- increased peak operational phase workforce from approximately five to approximately 10 personnel;

Accommodation Camp

- increased construction phase capacity from 1,300 to 1,900 personnel;
- increased size of the treated wastewater irrigation area;
- option for an alternative alignment of the last section of the accommodation camp water pipeline along the accommodation camp services corridor, rather than along the access road corridor; and
- option to transfer treated wastewater to the mine and processing facility for reuse via a water pipeline located inside the approved services corridor.

Road Transport Activities

- changes to construction phase vehicle movements associated with the increased construction phase accommodation camp capacity and changes to heavy vehicle delivery requirements;
- changes to operational phase heavy vehicle movements associated with revisions to processing plant reagent types, rates and storage volumes; and
- changes to operational phase heavy vehicle movements to and from the rail siding associated with the transport of metal sulphate and ammonium sulphate products.

The Modification would not change the following approved components of the Project:

- other mine and processing facility components (e.g. surface development area, mining method, processing method and rate, tailings management and water management concepts);
- other accommodation camp components (e.g. surface development area; operational phase capacity);
- other transport activities and transport infrastructure (e.g. the Fifield Bypass);
- limestone quarry;
- borefield, surface water extraction infrastructure and water pipeline; and/or
- gas pipeline.

1.2 STUDY REQUIREMENTS AND SCOPE

The scope of works for this Surface Water Assessment comprises:

- update of the existing Project site water balance to reflect the modified Project, and subsequent water balance modelling to indicate whether the Modification would result in any changes to the Project water demand or water management system;
- assessment of potential impacts of the Modification on surface water catchments and drainage and downstream water quality impacts;
- consideration of potential surface water license requirements for the modified Project; and
- review of the approved surface water management measures and monitoring program and, if necessary, recommendation of extensions or improvements.

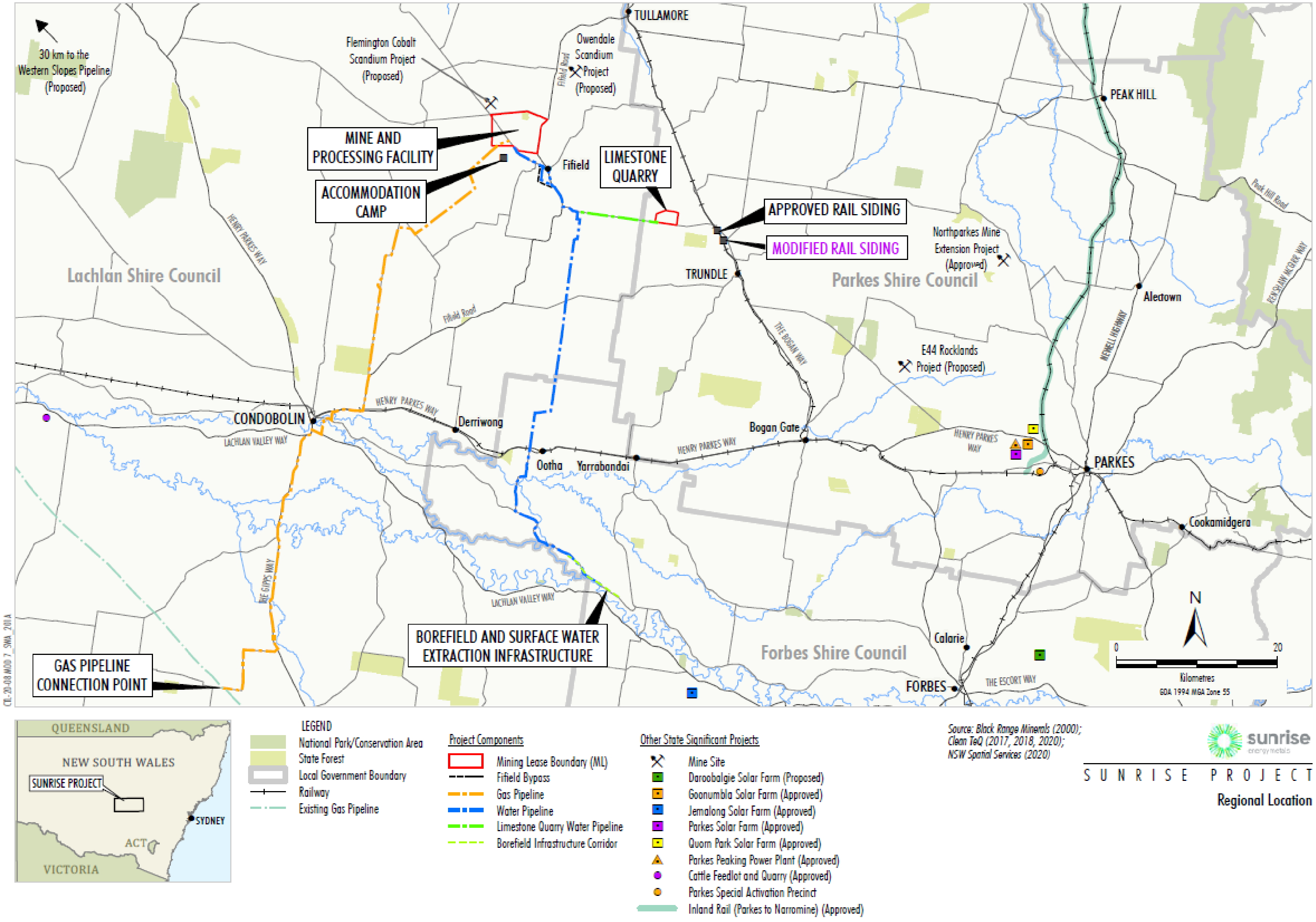


Figure 1 Regional Location

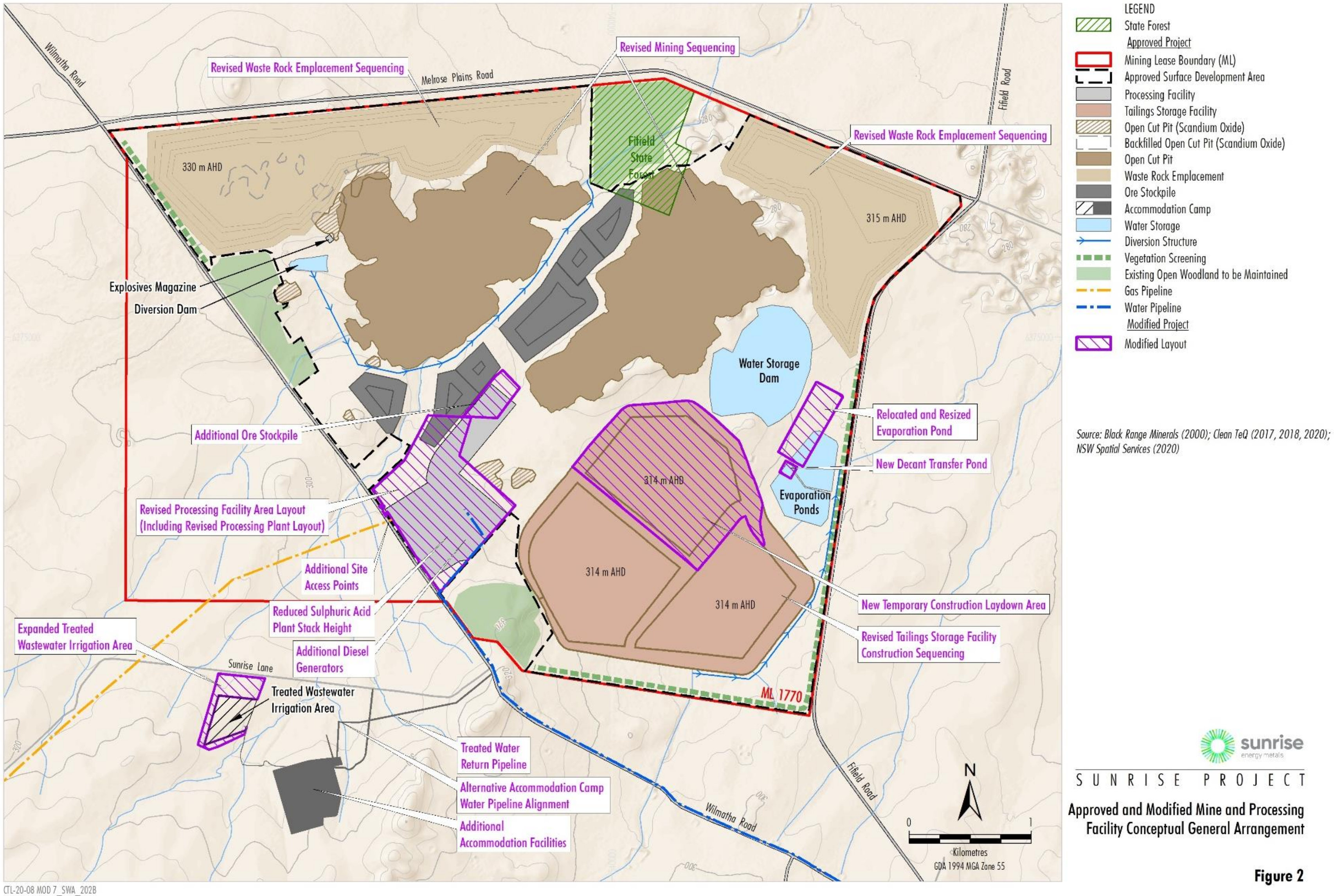


Figure 2 Mine and Processing Facility Conceptual General Arrangement

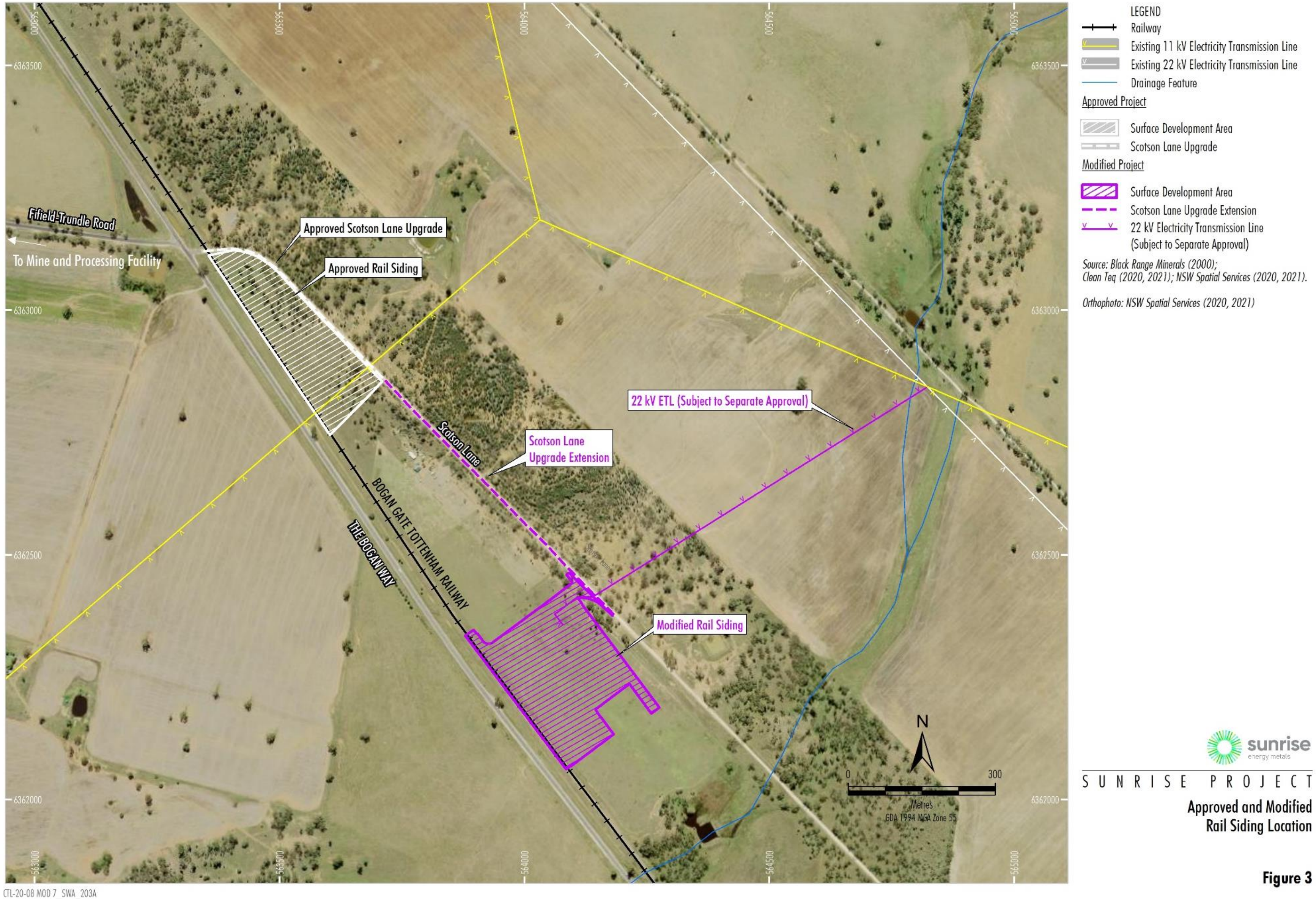


Figure 3 Approved and Modified Rail Siding Location

2.0 OVERVIEW OF RELEVANT STATUTORY REQUIREMENTS

SEM's statutory obligations relevant to water management for the Project are contained in:

- the conditions of Development Consent (DA 374-11-00);
- Environment Protection Licence (EPL) 21146 issued under the *Protection of the Environment Operations Act 1997* (POEO Act);
- water supply works, water use approvals and water access licences (WALs) issued under the *Water Management Act 2000*; and
- other relevant legislation, policies and guidelines.

The obligations relevant to this Surface Water Assessment are described below.

2.1 DEVELOPMENT CONSENT (DA 374-11-00)

Condition 29, Schedule 3 of Development Consent (DA 374-11-00) includes a range of water management performance measures to be implemented for the Project. These performance measures are reproduced in Table 1 below.

Table 1 Project Water Management Performance Measures

Feature	Performance Measure
Water management – General	• *Maintain separation between clean and mine water management systems* • *Minimise the use of clean water on site*
Construction and operation of infrastructure	• *Design, install and maintain erosion and sediment controls generally in accordance with the series Managing Urban Stormwater: Soils and Construction including Volume 1, Volume 2A – Installation of Services and Volume 2C – Unsealed Roads* • *Design, install and maintain infrastructure within 40 m of watercourses generally in accordance with the Guidelines for Controlled Activities on Waterfront Land (DPI, 2012), or its latest version* • *Design, install and maintain any creek crossings generally in accordance with the Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013) and Why Do Fish Need To Cross The Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries, 2003), or their latest versions*
Clean water diversion infrastructure	• *Maximise the diversion of clean water around disturbed areas on site* • *Design, construct and maintain the clean water diversions to capture and convey the 100 year, peak flow rainfall event*
Sediment dams (mine and limestone quarry)	• *Design, install and/or maintain the dams generally in accordance with the series Managing Urban Stormwater: Soils and Construction – Volume 1 and Volume 2E Mines and Quarries*
Mine and limestone quarry water storages	• *Design, install and/or maintain mine and limestone water storage infrastructure to ensure no discharge of mine or limestone quarry water off-site (except in accordance with an EPL)* • *On-site storages (including mine infrastructure dams, groundwater storage and treatment dams) are suitably designed, installed and/or maintained to minimise permeability* • *Ensure that the floor and side walls of the Tailings Storage Facility, Evaporation Basin and Surge Dam are designed with a minimum of a 900 mm clay or modified soil liner with a permeability of no more than* 1×10^{-9} *m/s, or a synthetic (plastic) liner of 1.5 mm minimum thickness with a permeability of no more than* 1×10^{-14} *m/s (or equivalent)* • *Design, install and maintain a seepage interception system in the Tailings Storage Facility embankments in accordance with DSC guidelines*

Table 1 (Cont.) Project Water Management Performance Measures

Feature	Performance Measure
Mine and limestone quarry water storages	• *Design, install and maintain the water storages to capture and convey the 100 year ARI, 72-hour rainfall event* • *Design, install and/or maintain the facilities to meet the requirements of the DSC* • *The design of the Tailings Storage Facility should conform to: DSC3A – Consequence Categories for Dams (DSC); and DSC3F – Tailings Dams (DSC)*
Chemical and hydrocarbon storage	*Chemical and hydrocarbon products to be stored in bunded areas in accordance with the relevant Australian Standards*
Irrigation Area	*Manage the irrigation area in accordance with the EPA's Environmental Guidelines: Use of Effluent by Irrigation*

Condition 30, Schedule 3 of Development Consent (DA 374-11-00) requires that a Water Management Plan be developed for the Project, comprised of the following component plans:

- Water Balance;
- Surface Water Management Plan; and
- Groundwater Management Plan.

Condition 30, Schedule 3 of Development Consent (DA 374-11-00) also prescribes the requirements of the Water Management Plan, Water Balance, Surface Water Management Plan and Groundwater Management Plan. The approved Water Management Plan and its component plans are available on the SEM website.

Conditions 26 and 27, Schedule 3 of Development Consent (DA 374-11-00) are also relevant to this Surface Water Assessment:

Water Supply

26. The Applicant must ensure that it has sufficient water for all stages of the development, and if necessary, adjust the scale of development on site to match its available water supply. Note: Under the Water Act 1912 and/or the Water Management Act 2000, the Applicant is required to obtain the necessary water licences for the development.

Water Pollution

27. Unless an EPL authorises otherwise, the Applicant must comply with Section 120 of the POEO Act.

The modified Project has been considered against the requirements of Development Consent (DA 374-11-00) in Section 7.

2.2 ENVIRONMENT PROTECTION LICENCE 21146

SEM holds EPL 21146 for the Project, issued by the Environment Protection Authority (EPA) under the POEO Act. EPL 21146 includes surface water quality limits for receiving waters at the mine and processing facility (SW4 and SW6 in Figure 7 in Section 3.3.1) and for waters discharged from the sediment dams (refer Figure 9 to Figure 15 in Section 4.3for proposed sediment dam locations).

Table 2 lists the EPL 21146 surface water quality limits for receiving waters at the mine and processing facility and sediment dam discharges.

Table 2 EPL 21146 Surface Water Quality Limits

Parameter	Units	Limit
Receiving Waters		
Electrical Conductivity	µS/cm	2,200
pH	pH units	6.5 – 8.5
Total Suspended Solids	mg/L	50
Iron	mg/L	3.7
Nickel	mg/L	0.008
Sediment Dam Discharges[1]		
Electrical Conductivity	µS/cm	2,200
pH	pH units	6.5 – 8.5
Total Suspended Solids	mg/L	50[2]
Turbidity	Nephelometric Turbidity Units (NTU)	50

µS/cm = micro Siemens per centimetre; mg/L = milligrams per litre.

[1] Limits do not apply when the discharge occurs solely as a result of rainfall measured at the site which exceeds a total of 50.7 mm of rainfall over any consecutive 5 day period (Condition L2.5 of EPL 21146).

[2] Limit is not deemed to be exceeded where the turbidity limit is not exceeded at the time of discharge and the EPA is advised of any total suspended solids exceedances within 3 working days of the completion of the total suspended solids testing (Condition L2.6 of EPL 21146).

The modified Project has been considered against the requirements of EPL 21146 in Section 7.0.

2.3 WATER MANAGEMENT ACT 2000

The *Water Management Act 2000* incorporates the provisions of various prior Acts relating to the management of surface and groundwater in NSW and provides a single statute for regulation of water access, use and works (e.g. pumps or bores) that affect the licensing of surface water and alluvial and non-alluvial (i.e. fractured rock and porous rock) groundwater in the vicinity of the Project.

As water sharing plans have commenced under the *Water Management Act 2000* for all surface and groundwater systems within which the Project lies, the *Water Management Act 2000* is relevant to water licensing considerations for the Project. The following water sharing plans have commenced under the *Water Management Act 2000* for all groundwater and surface water systems within which the Project lies, including:

<u>Mine and Processing Facility and Accommodation Camp</u>

- *Water Sharing Plan for the Macquarie Bogan Unregulated Rivers Water Sources 2012*; and
- *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2020.*

<u>Rail Siding</u>

- *Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012.*

<u>External Water Sources</u>

- *Water Sharing Plan for the Lachlan Regulated River Water Source 2016;* and
- *Water Sharing Plan for the Lachlan Alluvial Groundwater Sources 2020.*

Further to the above, the following water supply works, water use approvals and WALs issued under the *Water Management Act 2000* are relevant to water management for the Project:

- Water Supply Works Approval (WSWA) 70CA614098 for the Project borefield and linking pipeline.
- Water Supply Works Approval (WSWA) 70WA617095 for the surface water extraction infrastructure and water pipeline.
- WAL 32068 in the Upper Lachlan Alluvial Groundwater Source (Upper Lachlan Alluvial Zone 5 Management Zone) for 3,154 share components under the *Water Sharing Plan for the Lachlan Alluvial Groundwater Sources 2020*.
- WAL 39837 in the Upper Lachlan Alluvial Groundwater Source (Upper Lachlan Alluvial Zone 5 Management Zone) for 766 share components under the *Water Sharing Plan for the Lachlan Alluvial Groundwater Sources 2020*.
- WAL 28681 in the Lachlan Fold Belt Murray-Darling Basin (MDB) Groundwater Source (Lachlan Fold Belt MDB [Other] Management Zone), for 243 share components under the *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2020*.
- WAL 6679 in the Lachlan Regulated River Water Source, for 123 share components (General Security) under the *Water Sharing Plan for the Lachlan Regulated River Water Source 2016*.
- WAL 1798 in the Lachlan Regulated River Water Source, for 300 share components (General Security) under the *Water Sharing Plan for the Lachlan Regulated River Water Source 2016*.
- WAL 42370 in the Lachlan Regulated River Water Source, for zero share components (High Security) under the *Water Sharing Plan for the Lachlan Regulated River Water Source 2016*.

Consideration of the modified Project against the water sharing plans, and the relevant water use approvals and WALs above, is provided in Section 5.4 and Section 7.0.

2.4 OTHER LEGISLATION, POLICIES AND GUIDANCE

There are various NSW Acts, water policy and guideline documentation regulated by DPIE – Water and the EPA relevant to this Surface Water Assessment. A summary is provided in the following sub sections.

2.4.1 National Water Quality Management Strategy

The National Water Quality Management Strategy is a joint national approach to improving water quality in Australian and New Zealand waterways. The Australian New Zealand Water Quality Guidelines (ANZG, 2018) have been developed to progressively supersede the ANZECC & ARMCANZ (2000) Guidelines, with revisions provided for aquatic ecosystem default guideline values. Where updated default guideline values are yet to be published under the ANZG 2018 Guidelines, adoption of the ANZECC & ARMCANZ (2000) Guideline default values is recommended.

The modified Project has been considered against the ANZECC & ARMCANZ (2000) and ANZG 2018 Guidelines in Section 7.0.

2.4.2 NSW Water Quality and River Flow Objectives

The NSW Water Quality and River Flow Objectives (Office of Environment and Heritage [OEH], 2006) have been developed to guide plans and actions to achieve healthy waterways in NSW, including the Macquarie-Bogan River catchment. Each objective is based on providing the right water quality for the environment and the different beneficial uses of the water. They are based on measurable environmental values (EVs), which are those values or uses of water that the community believes are important for a healthy ecosystem for public benefit, welfare, safety or health. The water quality trigger values are based on ANZECC & ARMCANZ (2000), which is being progressively superseded by the ANZG 2018 Guidelines and tailored for application to rivers in the Murray-Darling Basin.

The modified Project has been considered against the NSW Water Quality and River Flow Objectives guidelines in Section 7.0.

3.0 BASELINE SURFACE WATER RESOURCES

3.1 CATCHMENTS AND SURFACE WATER RESOURCES

3.1.1 Mine and Processing Facility and Accommodation Camp

The mine and processing facility and accommodation camp are located in the upper headwaters of Bullock Creek, a tributary of the Bogan River, within the Macquarie-Bogan catchment. The mine and processing facility is located approximately 55 km to the south-south-west of the Bogan River (Figure 4). The Bogan River travels in a north-north-westerly direction towards Bourke and ultimately discharges to the Darling River.

The three drainage lines that traverse the mine and processing facility are shallow broad vegetated ephemeral channels (Golder Associates [Golder], 2017) which flow north-east towards Bullock Creek. These drainage lines lose definition approximately 5 km north-east of ML 1770 (refer Figure 4 for locations). The accommodation camp and irrigation area are located in the headwaters of the central drainage line. The northern and central drainage lines converge approximately 1.5 km downstream of where they enter ML 1770. The drainage lines have a catchment area of approximately 2,800 ha (northern and central) and 1,840 ha (southern) to the downstream boundary of ML 1770.

The drainage lines in the vicinity of the mine and processing facility are not suitable for flow monitoring due to their shallow broad nature. In addition, there are no gauging stations maintained on Bullock Creek.

Numerous farm dams are located along the ephemeral drainage lines and watercourses in the catchment area of Bullock Creek. North of the township of Tullamore, Bullock Creek flows at a relatively low gradient (approximately 0.1%) along a defined floodplain (Black Range Minerals, 2000).

3.1.2 Rail Siding

The rail siding would be relocated approximately 500 m to the south of the approved location as part of the Modification (Figure 3). The modified rail siding is not traversed by any defined natural drainage lines. The closest defined drainage line is located approximately 220 m south-east of the modified rail siding (Figure 3). The modified rail siding would be located in the catchment of the Yarrabandai Creek (Figure 4). Yarrabandai Creek travels south-west through the township of Trundle and connects with the Bumbuggan Creek, a tributary of the Lachlan River, approximately 40 km directly south-west of Trundle.

3.2 RAINFALL AND EVAPORATION

The long term average monthly rainfall recorded at the regional Bureau of Meteorology (BoM) stations located in Trundle and Tullamore are summarised in Table 3 in comparison with Scientific Information for Land Owners (SILO) Point Data[2] average monthly rainfall. The locations of the stations and SILO data point are shown in Figure 5.

[2] The SILO Point Data is a system which provides synthetic daily climate data sets for a specified point by interpolation between surrounding point records held by BoM, https://www.longpaddock.qld.gov.au/silo/point-data/.

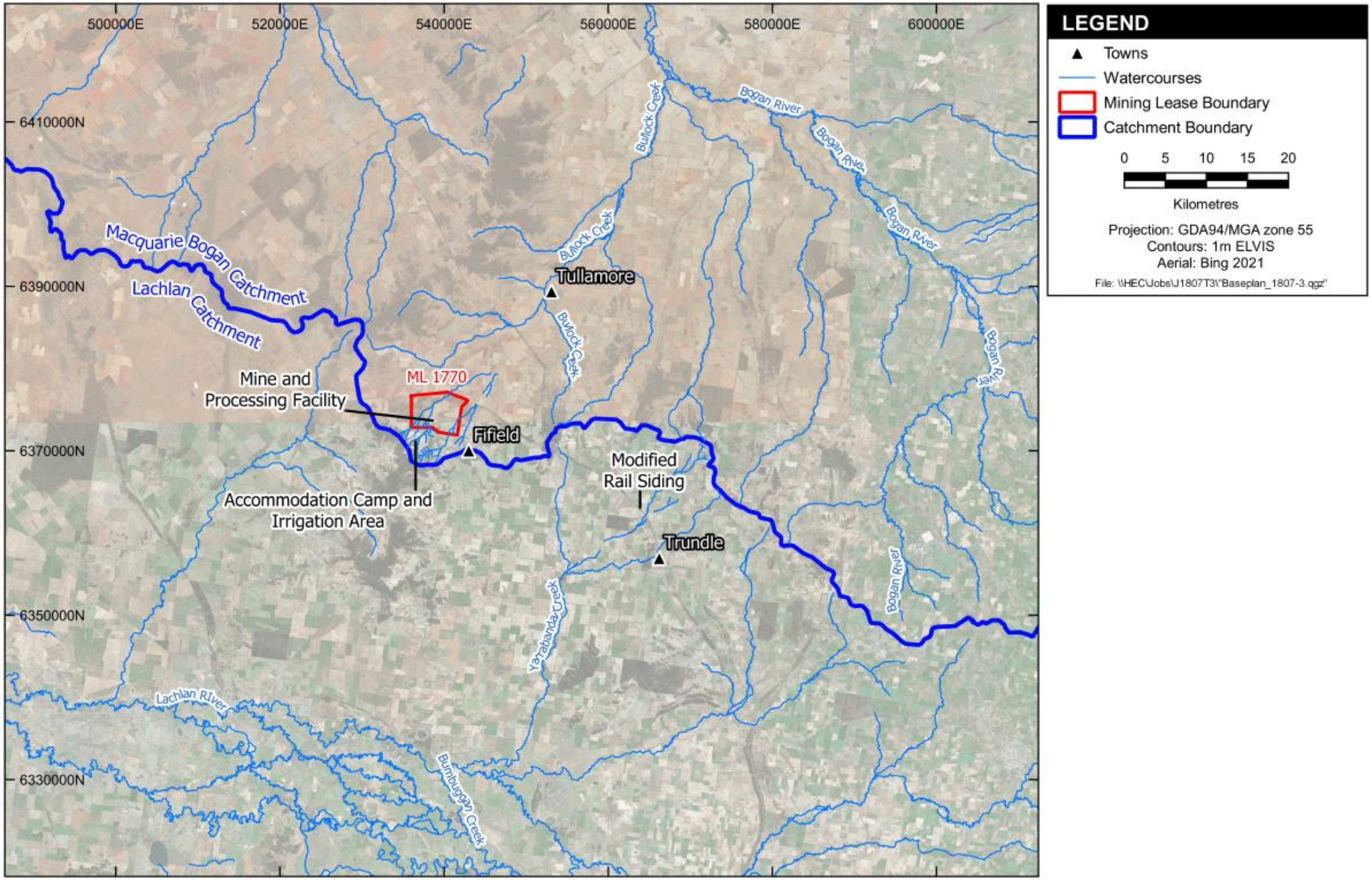


Figure 4 Regional Surface Water Systems

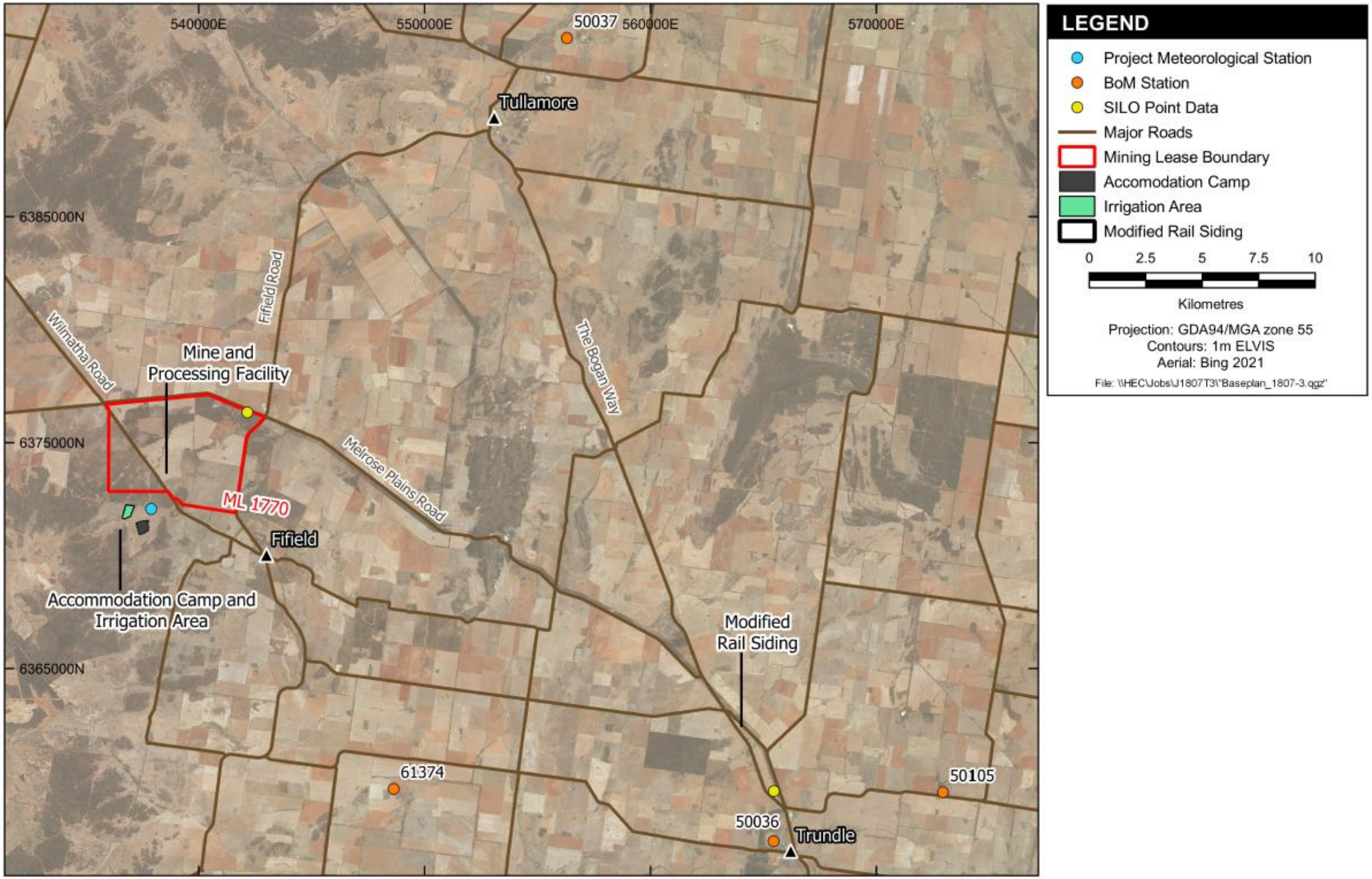


Figure 5 Regional Rainfall and Weather Stations

Table 3 Summary of Average Regional Rainfall and Evaporation

BoM Station Number	50036	50105	61374	50037	SILO Point Data			
BoM Station Name	**Trundle (Long St)**	**Trundle (Huntingdale)**	**Trundle (Murrumbogie)**	**Tullamore (Kitchener St)**	**Mine and Processing Facility**		**Rail Siding**	
Latitude	-32.92	-32.9	-32.9	-32.6	-32.75		-32.9	
Longitude	147.7	147.78	147.52	147.6	147.45		147.7	
Data Period	1883 – May 2021	1968 – Jul 2016	1883 – Jul 2019	1914 – Apr 2021	Jan 1889 – May 2021			
Month	**Rainfall (mm)**				**Rainfall (mm)**	**Evaporation (mm)**	**Rainfall (mm)**	**Evaporation (mm)**
January	47.1	53.0	49.7	51.6	48.9	283.6	45.3	277.2
February	45.0	51.9	44.3	47.7	42.9	227.3	44.2	221.8
March	42.0	40.0	41.9	42.4	42.6	192.9	43.6	188.0
April	39.1	35.9	34.7	36.4	36.3	119.9	37.7	117.2
May	38.6	41.5	37.9	37.6	36.8	70.8	38.3	69.8
June	39.5	37.3	39.1	38.7	39.6	45.5	39.8	45.1
July	37.2	40.2	35.6	34.8	36.2	49.8	38.2	49.3
August	37.2	36.1	35.9	37.0	35.6	75.4	37.5	73.6
September	33.6	35.7	32.8	31.9	32.3	114.5	34.1	110.9
October	42.6	46.3	42.4	43.3	41.6	173.7	44.2	168.7
November	45.4	48.2	41.5	43.8	42.0	223.1	47.8	216.7
December	45.4	48.8	43.9	45.6	42.3	279.9	45.4	273.0
Annual	**493**	**515**	**480**	**491**	**477**	**1856**	**496**	**1812**

As indicated in Table 3, the climatic conditions of the mine and processing facility area are dry (semi-arid), with annual pan evaporation exceeding rainfall by a factor of four. Average rainfall depths are relatively consistent throughout the year with maximum monthly rainfall occurring in January and minimum monthly rainfall occurring in September.

SEM also operate a Project meteorological station adjacent to the accommodation camp (refer Figure 5 for location) with data recorded since mid-November 2018. Figure 6 presents the total monthly rainfall recorded at the Project meteorological station.

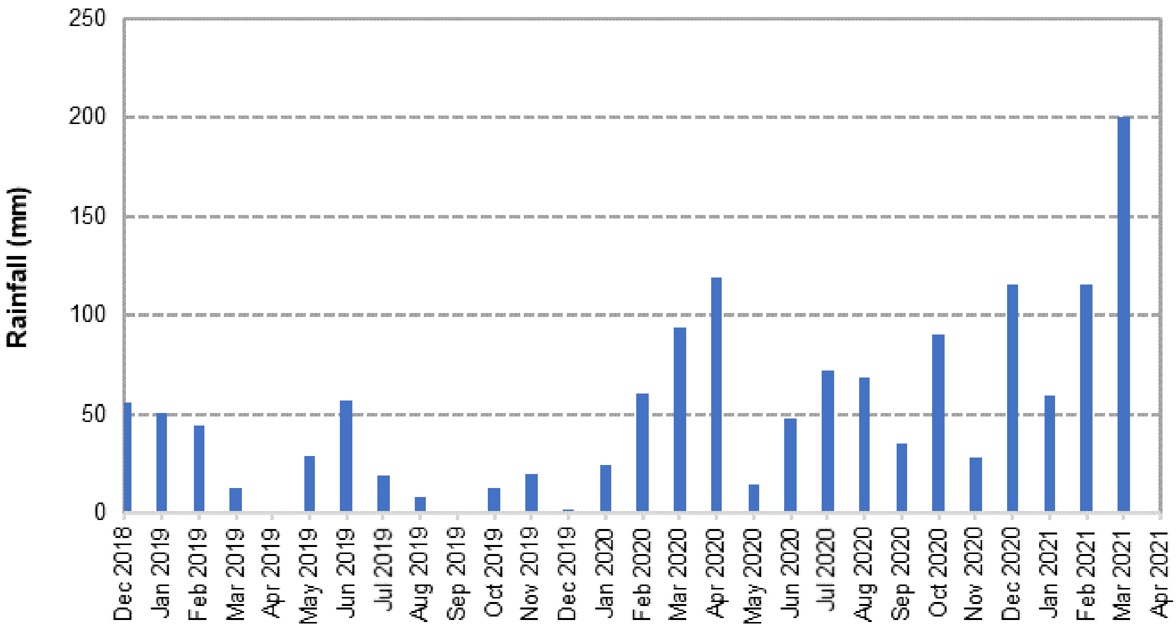


Figure 6 Project Meteorological Station Monthly Rainfall

The data in Figure 6 shows that 200 mm of rainfall was recorded at the Project meteorological station in March 2021 while no rainfall was recorded in April 2021. The total rainfall recorded at the Project meteorological station during 2019 was 258 mm, while the total rainfall recorded during 2020 was 770 mm.

3.3 SURFACE WATER QUALITY

3.3.1 Surface Water Monitoring Program

Surface water quality monitoring has been undertaken intermittently in the vicinity of the mine and processing facility since 1997. The locations of the surface water quality monitoring sites are shown in Figure 7.

Baseline surface water quality monitoring was undertaken at sites FW1 to FW5 between 1997 and 2000 and in August 2017. A summary of the baseline surface water quality monitoring results from sites FW1 to FW5 is presented in the approved Surface Water Management Plan (Clean TeQ, 2019).

SEM commenced baseline surface water quality monitoring at sites SW1 to SW7 in the vicinity of the mine and processing facility in October 2018 in accordance with the approved Surface Water Management Plan (Clean TeQ, 2019). Due to the ephemeral nature of the drainage lines (Section 3.1.1), surface water sampling is only undertaken following rainfall events that result in flow in the drainage lines. Surface water quality monitoring has been undertaken for pH, electrical conductivity, total suspended solids, anions, cations and select total and dissolved metals. A summary of surface water quality monitoring sites SW1 to SW7 is presented in Table 4.

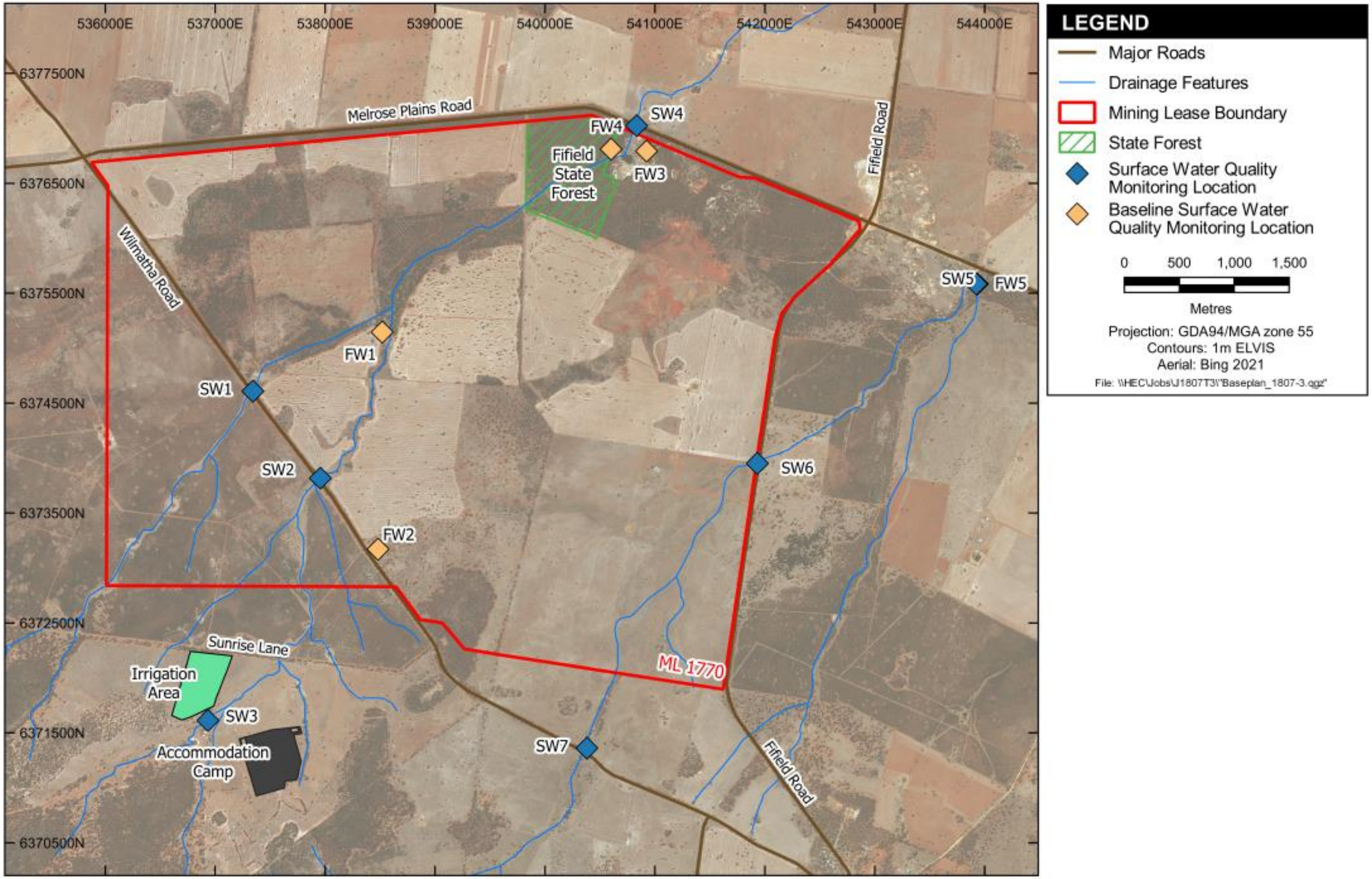


Figure 7 Surface Water Monitoring Locations

Table 4 Surface Water Monitoring Program

Site	Drainage Line & Location	Purpose	Period of Record Presented
SW1	Ephemeral drainage line - western boundary of mine and processing facility	Baseline monitoring / reference site for characterisation of water quality upstream of mine and processing facility	Oct 2018 – Jan 2021 (intermittent)
SW2	Ephemeral drainage line - western boundary of mine and processing facility	Baseline monitoring / assessment of potential downstream water quality influences associated with the accommodation camp and treated wastewater irrigation area	Oct 2018 – Jan 2021 (intermittent)
SW3	Headwaters of ephemeral drainage line - adjacent to accommodation camp and treated wastewater irrigation area	Baseline monitoring / assessment of potential water quality influences associated with the treated wastewater irrigation area and accommodation camp	Oct 2018 – Jan 2021 (intermittent)
SW4	Ephemeral drainage line - downstream of mine and processing facility	Baseline monitoring / assessment of potential downstream water quality influences associated with the mine and processing facility	Oct 2018 – Jan 2021 (intermittent)
SW5	Ephemeral drainage line - downstream of mine and processing facility	Baseline monitoring / assessment of potential downstream water quality influences associated with mine and processing facility	Oct 2018 – Jan 2021 (intermittent)
SW6	Ephemeral drainage line - eastern boundary of mine and processing facility	Baseline monitoring / assessment of potential downstream water quality influences associated with mine and processing facility	Nov 2018 – Jan 2021 (intermittent)
SW7	Ephemeral drainage line - upstream of mine and processing facility	Baseline monitoring / reference site for characterisation of water quality upstream of mine and processing facility	Jan 2020 – Aug 2020 (intermittent)

3.3.2 Water Quality Trigger Values

<u>Site Specific Trigger Values</u>

As described in the approved Surface Water Management Plan (Clean TeQ, 2019), the baseline monitoring results from sites FW1 to FW5 indicate that the water quality conditions of the ephemeral drainage lines in the vicinity of the mine and processing facility exceeded the ANZECC & ARMCANZ (2000) 'default guideline trigger values' for a number of physicochemical constituents. During the construction and operational phases of the Project, the trigger values in EPL 21146 will be used as an indicator of potential impacts to surface water quality with investigations initiated where trigger values are exceeded in accordance with the approved Surface Water Management Plan (Clean TeQ, 2019).

Notwithstanding the above, as additional baseline water quality data is collected at sites SW1 to SW7, the data should be reviewed against the ANZG 2018 Guideline default guideline trigger values, and site-specific trigger values should be developed where constituents naturally exceed the ANZG 2018 Guideline default guideline trigger values. Derivation of the site-specific trigger values should be undertaken in accordance with the ANZG 2018 Guideline.

Default Guideline Trigger Values

In NSW, the level of protection applied to most waterways is that for ‘slightly to moderately disturbed’ ecosystems, for which the ANZG 2018 Guideline recommends adoption of the default guideline values for aquatic ecosystems at the 95% species protection level. The ANZG 2018 Guideline default guideline trigger values listed in Table 5 have been used as a basis for interpretation of the water quality data in Section 3.3.3, in addition to the EPL 21146 trigger values and the ANZECC & ARMCANZ (2000) default guideline trigger value for turbidity.

As the mine and processing facility is located in an agricultural area, default guideline trigger values for primary industries (short term irrigation and livestock drinking) from ANZECC & ARMCANZ (2000) have also been considered in the assessment of baseline water quality data. Where default guideline trigger values were available from multiple sources, excepting EPL 21146, the lower value default guideline trigger value has been adopted.

Table 5 Water Quality Default Guideline Trigger Values

Parameter (mg/L unless otherwise specified)	EPL 21146 (Monitoring Sites SW4 and SW6)	Aquatic Ecosystems (Upland Rivers in NSW)‡	Aquatic Ecosystems (95% Level of Species Protection)†	Primary Industries (Short Term Irrigation and Livestock Drinking)^
pH (pH units)	6.5 – 8.5	-	-	-
Electrical Conductivity (µS/cm)	2,200	-	-	-
Total Dissolved Solids	-	-	-	2,000
Total Suspended Solids	50	-		
Turbidity (NTU)	-	50	-	-
Sulphate as Turbidimetric SO_4	-	-	-	1,000
Calcium	-	-	-	1,000
Sodium	-	-	-	460*
Chloride	-	-	-	700*
Aluminium (pH > 6.5)	-	-	0.055	-
Arsenic - As III	-	-	0.024	-
Cadmium	-	-	0.0002	-
Chromium	-	-	0.001	-
Cobalt	-	-	0.0014	-
Copper	-	-	0.0014	-
Iron	3.7	-	-	-
Lead	-	-	0.0034	-
Manganese	-	-	1.9	-
Nickel	0.008	-	-	-
Zinc	-	-	0.008	-

NTU = Nephelometric Turbidity Units

Note that default guideline trigger values were not tabulated for all sources, only for the source which corresponded with the lowest default guideline trigger value or EPL 21146 trigger value.

† ANZG (2018) – default guideline trigger values were derived for total metals, however, the default guideline trigger value should also be compared with the dissolved metal concentration as this represents the bioavailable fraction.

‡ ANZECC & ARMCANZ (2000) for Upland Rivers – ANZECC & ARMCANZ (2000) define upland streams as those above 150 m elevation, however, for the NSW Murray-Darling Basin, 250 m may be a more scientifically appropriate altitudinal trigger to distinguish between lowland and upland rivers (OEH, 2006). The minimum elevation of the Project area is 273 m AHD.

^ ANZECC & ARMCANZ (2000) for primary industries (short term irrigation and livestock drinking).

* Default guideline trigger value for tolerant crops.

3.3.3 Baseline Water Quality Assessment

Summary statistics of the baseline water quality monitoring data recorded in the vicinity of the mine and processing facility are presented in Table 6 to Table 9 below. The percentage of samples which exceeded the surface water quality trigger value are also presented (% exceedances).

With regard to the interpretation of the water quality monitoring results below, it should be noted that EPL 21146 includes surface water quality limits for sites SW4 and SW6 only, which are located downstream of the mine and processing facility (Figure 7).

The pH records presented in Table 6 to Table 9 indicate that the water quality of the ephemeral drainage lines ranges from slightly acidic to slightly alkaline, with relatively consistent pH values recorded at both upstream and downstream monitoring sites. Minimum values of pH 6.3 have been recorded at monitoring sites SW3 (upstream of the mine and processing facility) and SW6, which is less than the EPL 21146 lower water quality limit for pH. As such, there is potential that the current EPL 21146 lower water quality limit for pH will be exceeded at times during the mine and processing facility construction and operational phases, due to the lower pH levels which naturally occur in the ephemeral drainage lines in the vicinity of ML 1770, rather than operations at the mine and processing facility.

Electrical conductivity values below the EPL 21146 limit of 2,200 µS/cm have been recorded at all sites, with a maximum of 459 µS/cm recorded at monitoring site SW2 which is located at the upstream boundary of ML 1770. Variable total suspended solids have been recorded in the ephemeral watercourses with 12 to 760 mg/L recorded at upstream monitoring site SW2, less than 5 to 21 mg/L recorded at the central monitoring site SW6 and between less than 5 and 290 mg/L recorded at the downstream monitoring site SW4. Total suspended solids concentrations above the current EPL 21146 water quality limit of 50 mg/L were recorded at monitoring sites SW1 to SW5 while turbidity levels above the EPL 21146 water quality limit of 50 NTU were recorded frequently at all monitoring sites. Consequently, there is potential that the current EPL 21146 water quality limits for total suspended solids and turbidity will be frequently exceeded during the mine and processing facility construction and operational phases, due to the higher levels of these constituents which naturally occur in the ephemeral drainage lines in the vicinity of ML 1770.

No exceedances of the default guideline trigger value for arsenic, cadmium or manganese were recorded during the baseline monitoring period at any monitoring site.

Dissolved and total aluminium concentrations exceeded the default guideline trigger value of 0.055 mg/L at all sites and for all samples collected during the baseline monitoring period. A minimum of 0.08 mg/L total aluminium was recorded at monitoring site SW5 and a maximum of 13 mg/L recorded at monitoring site SW2. Total copper concentrations exceeded the default guideline trigger value of 0.0014 mg/L for all samples collected during the baseline monitoring period at all sites except for SW5 for which 86% of samples exceeded the default guideline trigger value. Dissolved copper concentrations frequently exceeded the default guideline trigger value at all sites.

Total zinc concentrations frequently exceeded the default guideline trigger value of 0.008 mg/L at all monitoring sites during the baseline monitoring period. The dissolved zinc concentrations exceeded the default guideline trigger value at monitoring sites SW1 (11% of samples), SW2 (8% of samples) and SW6 (17% of samples).

Total cobalt concentrations exceeded the default guideline trigger value of 0.0014 mg/L at all monitoring sites except SW7 during the baseline monitoring period. The dissolved cobalt concentrations exceeded the default guideline trigger value at monitoring sites SW1 (33% of samples) and SW6 (33% of samples).

Total iron concentrations exceeded the EPL 21146 water quality limit of 3.7 mg/L for 33%, 42%, 17% and 14% of samples recorded at upstream monitoring sites SW1, SW2, SW3 and SW5 respectively. At monitoring sites SW4 and SW6, total iron concentrations exceeded the EPL 21146 water quality limit for 25% and 17% of samples respectively. The water quality limit for iron was not exceeded at any site based on the recorded dissolved iron concentrations.

Total nickel concentrations exceeded the EPL 21146 water quality limit of 0.008 mg/L for 33% and 25% of samples recorded at upstream monitoring sites SW1 and SW2 respectively. At monitoring sites SW4 and SW6, total nickel concentrations exceeded the EPL 21146 water quality limit for 13% and 17% of samples respectively. The water quality limit for nickel was not exceeded at any site based on the recorded dissolved nickel concentrations.

As the default guideline trigger values (Table 5) and EPL 21146 water quality limits (Table 2) have been frequently exceeded for a number of constituents at all or a majority of monitoring sites during the baseline monitoring period, it is recommended that the existing EPL 21146 water quality limits are reviewed for all constituents and revised accordingly. It is recommended that additional baseline monitoring data is collected to inform the development of the site-specific trigger values in accordance with the ANZG 2018 Guideline.

Table 6 Surface Water Quality Data – SW1 and SW7

Parameter (mg/L unless otherwise stated)	Trigger Value	SW1					SW7				
		No. of Samples	Min	Median	Max	% Exceedances	No. of Samples	Min	Median	Max	% Exceedances
Field pH	6.5 - 8.5°	7	6.5	7.2	7.9	0%	2	7.3	-	7.3	0%
Lab pH		9	6.1	6.6	7.8	22%	2	6.9	-	7.3	0%
Field EC (µS/cm)	2200°	3	66	82	210	0%	2	158	-	192	0%
Lab EC (µS/cm)		9	23	39	97	0%	2	79	-	84	0%
Total Dissolved Solids	2000^	9	14	52	96	0%	2	70	-	98	0%
Total Suspended Solids	50°	9	11	64	300	56%	2	<5	-	46	0%
Turbidity (NTU)	50‡	6	23.7	84.8	713	83%	2	25.2	-	119	50%
Sulphate as Turbidimetric SO_4	1000^	9	<1	<1	4.9	0%	2	<1	-	<1	0%
Total Alkalinity as $CaCO_3$	-	9	<1	<1	56	-	2	27	-	53	-
Calcium	1000^	9	0.9	1.6	7.2	0%	2	5.9	-	6.3	0%
Magnesium	-	9	0.9	1.7	2.2	-	2	2.8	-	3.4	-
Potassium	-	9	2.9	5.9	15	-	2	10	-	12	-
Sodium	460^	9	0.9	2.5	5.8	0%	2	4.4	-	5.7	0%
Chloride	700^	9	1.4	6.3	31	0%	2	4.6	-	5.1	0%
Dissolved Aluminium	0.055†	9	0.07	0.36	1	100%	2	0.95	-	0.96	100%
Dissolved Arsenic	0.024†	9	<0.001	<0.001	0.002	0%	2	<0.001	-	<0.001	0%
Dissolved Cadmium	0.0002†	9	<0.0001	<0.0001	<0.0001	0%	2	<0.0001	-	<0.0001	0%
Dissolved Chromium	0.001†	9	<0.001	<0.001	0.008	22%	2	0.002	-	0.002	100%

° EPL 21146; † ANZG (2018) default guideline trigger value for aquatic ecosystems (95% level of species protection for slightly to moderately disturbed ecosystems); ‡ ANZECC (2000) default guideline trigger value for upland rivers in NSW; ^ ANZECC (2000) default guideline trigger value for primary industries.

Table 6 (Cont.) Surface Water Quality Data – SW1 and SW7

Parameter (mg/L unless otherwise stated)	Trigger Value	SW1					SW7				
		No. of Samples	Min	Median	Max	% Exceedances	No. of Samples	Min	Median	Max	% Exceedances
Dissolved Cobalt	0.0014†	9	<0.001	<0.001	0.006	33%	2	<0.001	-	<0.001	0%
Dissolved Copper	0.0014†	8	<0.001	0.0025	0.005	88%	2	0.004	-	0.004	100%
Dissolved Iron	3.7°	9	0.12	0.5	1	0%	2	0.88	-	1.6	0%
Dissolved Lead	0.0034†	8	<0.001	<0.001	0.002	0%	2	<0.001	-	<0.001	0%
Dissolved Manganese	1.9†	8	<0.001	0.03	0.12	0%	2	0.006	-	0.012	0%
Dissolved Nickel	0.008°	9	<0.001	<0.001	0.003	0%	2	0.003	-	0.003	0%
Dissolved Zinc	0.008†	9	<0.005	<0.005	0.012	11%	2	<0.005	-	<0.005	0%
Total Aluminium	0.055†	9	0.54	1.4	11	100%	2	0.94	-	1.6	100%
Total Arsenic	0.024†	9	<0.001	0.001	0.007	0%	2	<0.001	-	0.002	0%
Total Cadmium	0.0002†	9	<0.0001	<0.0001	<0.0001	0%	2	<0.0001	-	<0.0001	0%
Total Chromium	0.001†	9	<0.001	0.008	0.11	89%	2	0.003	-	0.006	100%
Total Cobalt	0.0014†	9	<0.001	0.002	0.018	67%	2	<0.001	-	0.001	0%
Total Copper	0.0014†	8	0.002	0.0075	0.032	100%	2	0.006	-	0.007	100%
Total Iron	3.7°	9	0.83	1.8	26	33%	2	2.5	-	2.9	0%
Total Lead	0.0034†	9	<0.001	<0.001	0.025	33%	2	<0.001	-	0.003	0%
Total Manganese	1.9†	8	0.011	0.1255	0.3	0%	2	0.013	-	0.028	0%
Total Nickel	0.008°	9	<0.001	0.003	0.03	33%	2	0.004	-	0.004	0%
Total Zinc	0.008†	9	0.006	0.015	0.07	67%	2	0.007	-	0.009	50%

° EPL 21146; † ANZG (2018) default guideline trigger value for aquatic ecosystems (95% level of species protection for slightly to moderately disturbed ecosystems); ‡ ANZECC (2000) default guideline trigger value for upland rivers in NSW; ^ ANZECC (2000) default guideline trigger value for primary industries.

Table 7 Surface Water Quality Data – SW2 and SW3

Parameter (mg/L unless otherwise stated)	Trigger Value	SW2					SW3				
		No. of Samples	Min	Median	Max	% Exceedances	No. of Samples	Min	Median	Max	% Exceedances
Field pH	6.5 - 8.5°	10	6.5	7.3	8.1	0%	10	6.3	7.3	7.5	10%
Lab pH		12	6.5	6.7	7.4	0%	12	6.2	6.6	7	25%
Field EC (µS/cm)	2200°	6	45	131	459	0%	6	49	88	395	0%
Lab EC (µS/cm)		12	20	60	120	0%	12	21	42	84	0%
Total Dissolved Solids	2000^	12	14	89	160	0%	12	11	59	110	0%
Total Suspended Solids	50°	12	14	43	760	33%	12	21	35.5	580	33%
Turbidity (NTU)	50‡	9	64.9	97.1	561	100%	11	35.1	81.2	531	82%
Sulphate as Turbidimetric SO_4	1000^	12	<1	<1	21	0%	12	<1	<1	16	0%
Total Alkalinity as $CaCO_3$	-	12	<1	11	49	-	12	<1	<1	31	-
Calcium	1000^	12	0.5	2.2	6.6	0%	12	0.6	1.25	2	0%
Magnesium	-	12	0.7	1.6	2.8	-	12	0.6	1.25	1.9	-
Potassium	-	12	3.5	6.05	19	-	12	3.5	4.15	8.7	-
Sodium	460^	12	1.3	5.75	12	0%	12	<1	5.35	16	0%
Chloride	700^	12	1.2	7.8	53	0%	12	<1	8.85	29	0%
Dissolved Aluminium	0.055†	12	0.06	0.555	2.9	100%	12	0.1	0.33	2.5	100%
Dissolved Arsenic	0.024†	12	<0.001	<0.001	0.002	0%	12	<0.001	<0.001	0.003	0%
Dissolved Cadmium	0.0002†	12	<0.0001	<0.0001	<0.0001	0%	12	<0.0001	<0.0001	<0.0001	0%
Dissolved Chromium	0.001†	12	<0.001	<0.001	0.003	17%	12	<0.001	<0.001	0.002	17%

° EPL 21146; † ANZG (2018) default guideline trigger value for aquatic ecosystems (95% level of species protection for slightly to moderately disturbed ecosystems); ‡ ANZECC (2000) default guideline trigger value for upland rivers in NSW; ^ ANZECC (2000) default guideline trigger value for primary industries.

Table 7 (Cont.) Surface Water Quality Data – SW2 and SW3

Parameter (mg/L unless otherwise stated)	Trigger Value	SW2					SW3				
		No. of Samples	Min	Median	Max	% Exceedances	No. of Samples	Min	Median	Max	% Exceedances
Dissolved Cobalt	0.0014†	12	<0.001	<0.001	<0.001	0%	12	<0.001	<0.001	<0.001	0%
Dissolved Copper	0.0014†	11	<0.001	0.002	0.003	64%	11	<0.001	<0.001	0.004	36%
Dissolved Iron	3.7°	12	0.12	0.45	1.4	0%	12	0.15	0.36	1.3	0%
Dissolved Lead	0.0034†	11	<0.001	<0.001	0.002	0%	11	<0.001	<0.001	<0.001	0%
Dissolved Manganese	1.9†	11	<0.001	0.007	0.19	0%	11	<0.001	<0.001	0.039	0%
Dissolved Nickel	0.008°	12	<0.001	0.0015	0.002	0%	12	<0.001	<0.001	0.002	0%
Dissolved Zinc	0.008†	12	<0.005	<0.005	0.009	8%	12	<0.005	<0.005	0.008	0%
Total Aluminium	0.055†	12	0.63	2.6	13	100%	12	0.38	1.7	5.5	100%
Total Arsenic	0.024†	12	<0.001	0.002	0.007	0%	12	<0.001	0.002	0.004	0%
Total Cadmium	0.0002†	12	<0.0001	<0.0001	<0.0001	0%	12	<0.0001	<0.0001	<0.0001	0%
Total Chromium	0.001†	12	0.002	0.004	0.031	100%	12	<0.001	0.0025	0.033	83%
Total Cobalt	0.0014†	12	<0.001	0.001	0.025	33%	12	<0.001	<0.001	0.003	17%
Total Copper	0.0014†	11	0.002	0.004	0.041	100%	11	0.002	0.002	0.006	100%
Total Iron	3.7°	12	0.77	3.35	28	42%	12	1.1	2.45	6.8	17%
Total Lead	0.0034†	12	<0.001	0.0015	0.025	25%	12	<0.001	<0.001	0.005	17%
Total Manganese	1.9†	11	0.007	0.024	0.34	0%	11	0.013	0.032	0.12	0%
Total Nickel	0.008°	12	<0.001	0.003	0.035	25%	12	<0.001	0.002	0.005	0%
Total Zinc	0.008†	12	0.006	0.009	0.14	50%	12	<0.005	0.008	0.028	33%

° EPL 21146; † ANZG (2018) default guideline trigger value for aquatic ecosystems (95% level of species protection for slightly to moderately disturbed ecosystems); ‡ ANZECC (2000) default guideline trigger value for upland rivers in NSW; ^ ANZECC (2000) default guideline trigger value for primary industries.

Table 8 Surface Water Quality Data – SW4 and SW6

Parameter (mg/L unless otherwise stated)	Trigger Value	SW4					SW6				
		No. of Samples	Min	Median	Max	% Exceedances	No. of Samples	Min	Median	Max	% Exceedances
Field pH	6.5 - 8.5°	6	7.0	7.3	7.8	0%	5	6.3	7.1	7.5	20%
Lab pH		8	6.4	7	7.2	13%	6	6.6	7	7.2	0%
Field EC (µS/cm)	2200°	3	105	129	132	0%	3	100	171	186	0%
Lab EC (µS/cm)		8	26	66.5	110	0%	6	33	66	98	0%
Total Dissolved Solids	2000^	8	13	41.5	110	0%	6	<10	92.5	150	0%
Total Suspended Solids	50°	8	<5	21	290	25%	6	<5	14	21	0%
Turbidity (NTU)	50‡	7	9.8	59.6	743	57%	5	17.8	45.1	79.7	40%
Sulphate as Turbidimetric SO_4	1000^	8	<1	<1	7.8	0%	6	<1	<1	7.1	0%
Total Alkalinity as $CaCO_3$	-	8	<1	25	56	-	6	<1	13.5	51	-
Calcium	1000^	8	2.2	4.25	8.7	0%	6	1.2	3.2	6.3	0%
Magnesium	-	8	1.2	2.85	4	-	6	0.9	2	3.9	-
Potassium	-	8	2.7	7.55	17	-	6	6.1	10	20	-
Sodium	460^	8	<1	4.5	6.8	0%	6	1.3	3.1	5.9	0%
Chloride	700^	8	<1	4.95	29	0%	6	1.5	4.3	16	0%
Dissolved Aluminium	0.055†	8	0.09	0.355	1.9	100%	6	<0.01	0.29	0.85	83%
Dissolved Arsenic	0.024†	8	<0.001	<0.001	0.002	0%	6	<0.001	<0.001	0.002	0%
Dissolved Cadmium	0.0002†	8	<0.0001	<0.0001	<0.0001	0%	6	<0.0001	<0.0001	<0.0001	0%
Dissolved Chromium	0.001†	8	<0.001	<0.001	0.003	38%	6	<0.001	<0.001	0.002	33%

° EPL 21146; † ANZG (2018) default guideline trigger value for aquatic ecosystems (95% level of species protection for slightly to moderately disturbed ecosystems); ‡ ANZECC (2000) default guideline trigger value for upland rivers in NSW; ^ ANZECC (2000) default guideline trigger value for primary industries.

Table 8 (Cont.) Surface Water Quality Data – SW4 and SW6

Parameter (mg/L unless otherwise stated)	Trigger Value	SW4					SW6				
		No. of Samples	Min	Median	Max	% Exceedances	No. of Samples	Min	Median	Max	% Exceedances
Dissolved Cobalt	0.0014†	8	<0.001	<0.001	<0.001	0%	6	<0.001	<0.001	0.002	33%
Dissolved Copper	0.0014†	7	<0.001	0.002	0.004	71%	6	<0.001	0.003	0.007	67%
Dissolved Iron	3.7°	8	0.12	0.29	1.1	0%	6	0.07	0.34	0.58	0%
Dissolved Lead	0.0034†	7	<0.001	<0.001	<0.001	0%	5	<0.001	<0.001	<0.001	0%
Dissolved Manganese	1.9†	7	<0.001	0.008	0.058	0%	5	<0.001	0.006	0.074	0%
Dissolved Nickel	0.008°	8	<0.001	0.002	0.003	0%	6	<0.001	0.002	0.005	0%
Dissolved Zinc	0.008†	8	<0.005	<0.005	0.008	0%	6	<0.005	<0.005	0.01	17%
Total Aluminium	0.055†	8	0.33	1.3	7.1	100%	6	0.35	0.675	2.1	100%
Total Arsenic	0.024†	8	<0.001	<0.001	0.003	0%	6	<0.001	<0.001	<0.001	0%
Total Cadmium	0.0002†	8	<0.0001	<0.0001	<0.0001	0%	6	<0.0001	<0.0001	<0.0001	0%
Total Chromium	0.001†	8	<0.001	0.0035	0.052	88%	6	<0.001	0.002	0.01	67%
Total Cobalt	0.0014†	8	<0.001	<0.001	0.005	25%	6	<0.001	<0.001	0.003	33%
Total Copper	0.0014†	7	0.002	0.004	0.016	100%	6	0.002	0.0045	0.013	100%
Total Iron	3.7°	8	0.53	1.7	12	25%	6	0.51	1.07	4	17%
Total Lead	0.0034†	8	<0.001	<0.001	0.01	25%	6	<0.001	<0.001	<0.001	0%
Total Manganese	1.9†	7	0.021	0.026	0.19	0%	5	0.013	0.034	0.094	0%
Total Nickel	0.008°	8	0.003	0.004	0.009	13%	6	<0.001	0.003	0.009	17%
Total Zinc	0.008†	8	<0.005	0.0075	0.037	25%	6	<0.005	0.007	0.016	33%

° EPL 21146; † ANZG (2018) default guideline trigger value for aquatic ecosystems (95% level of species protection for slightly to moderately disturbed ecosystems); ‡ ANZECC (2000) default guideline trigger value for upland rivers in NSW; ^ ANZECC (2000) default guideline trigger value for primary industries.

Table 9 Surface Water Quality Data – SW5

Parameter (mg/L unless otherwise stated)	Trigger Value	SW5				
		No. of Samples	Min	Median	Max	% Exceedances
Field pH	6.5 - 8.5°	6	7.1	7.7	8.3	0%
Lab pH		7	6.8	7	7.8	0%
Field EC (µS/cm)	2200°	3	73	80	94	0%
Lab EC (µS/cm)		7	56	67	140	0%
Total Dissolved Solids	2000^	7	56	60	91	0%
Total Suspended Solids	50°	7	8.2	22	71	14%
Turbidity (NTU)	50‡	6	10.2	27.6	99.2	17%
Sulphate as Turbidimetric SO_4	1000^	7	<1	<1	11	0%
Total Alkalinity as $CaCO_3$	-	7	23	37	71	-
Calcium	1000^	7	1.9	3.4	3.9	0%
Magnesium	-	7	2.1	3.2	9.2	-
Potassium	-	7	4.7	6.5	11	-
Sodium	460^	7	4.4	5.6	7.6	0%
Chloride	700^	7	1.5	3.4	13	0%
Dissolved Aluminium	0.055†	7	<0.01	0.23	1.2	86%
Dissolved Arsenic	0.024†	7	<0.001	<0.001	0.002	0%
Dissolved Cadmium	0.0002†	7	<0.0001	<0.0001	<0.0001	0%
Dissolved Chromium	0.001†	7	<0.001	<0.001	0.002	14%
Dissolved Cobalt	0.0014†	7	<0.001	<0.001	<0.001	0%
Dissolved Copper	0.0014†	7	<0.001	0.003	0.004	86%
Dissolved Iron	3.7°	7	<0.05	0.49	2.1	0%
Dissolved Lead	0.0034†	6	<0.001	<0.001	<0.001	0%
Dissolved Manganese	1.9†	6	<0.001	0.004	0.04	0%
Dissolved Nickel	0.008°	7	<0.001	0.002	0.002	0%
Dissolved Zinc	0.008†	7	<0.005	<0.005	0.006	0%
Total Aluminium	0.055†	7	0.08	0.82	1.3	100%
Total Arsenic	0.024†	7	<0.001	<0.001	<0.001	0%
Total Cadmium	0.0002†	7	<0.0001	<0.0001	<0.0001	0%
Total Chromium	0.001†	7	<0.001	0.002	0.003	57%
Total Cobalt	0.0014†	7	<0.001	<0.001	0.002	14%
Total Copper	0.0014†	7	<0.001	0.004	0.005	86%
Total Iron	3.7°	7	0.28	2.1	5.2	14%
Total Lead	0.0034†	7	<0.001	<0.001	<0.001	0%
Total Manganese	1.9†	6	0.017	0.0325	0.077	0%
Total Nickel	0.008°	7	0.002	0.002	0.003	0%
Total Zinc	0.008†	7	<0.005	<0.005	0.009	29%

° EPL 21146; † ANZG (2018) default guideline trigger value for aquatic ecosystems (95% level of species protection for slightly to moderately disturbed ecosystems); ‡ ANZECC (2000) default guideline trigger value for upland rivers in NSW; ^ ANZECC (2000) default guideline trigger value for primary industries.

4.0 WATER MANAGEMENT SYSTEM

4.1 OVERVIEW

Consistent with the general water management performance measures for the Project (Section 2.1), the key objectives of the water management system are to manage runoff from the construction and operational areas, while diverting up-catchment undisturbed water around these areas and to reduce to a practical minimum the use of water on-site.

The water management system will include both permanent features that will continue to operate post-closure (e.g. diversion drains) and temporary structures during mining operations (e.g. sediment dams).

An internal drainage system will be constructed to collect and contain runoff generated within the construction and operational areas. Sediment control structures such as sediment dams and sediment fences will be employed where necessary within and downstream of disturbance areas. Mine affected water dams will be constructed to contain water runoff generated from the processing plant and ore stockpile areas.

4.2 APPROVED WATER MANAGEMENT SYSTEM – MINE AND PROCESSING FACILITY AND ACCOMMODATION CAMP

As detailed in the approved Surface Water Management Plan (Clean TeQ, 2019), the following water management structures/facilities are approved for the mine and processing facility:

- TSF;
- EP;
- water storage dam (WSD);
- processing plant runoff dam (PPRD);
- raw water dam (RWD);
- mine water dams (MWD);
- sediment dams (SD);
- diversion dam, northern and southern diversion drains, sediment water collection drains and mine water collection drains;
- Wastewater Treatment Plant (WWTP) and treated wastewater irrigation area.

Water supply for mine and processing facility is approved to be supplied from the following sources:

- internal runoff collection at the mine and processing facility;
- mine dewatering from the open cut pits;
- offsite borefield; and
- surface water extraction from the Lachlan River.

Water will be supplied to the accommodation camp from the RWD via the accommodation camp water pipeline.

Consistent with the relevant water management performance measures (Section 2.1), the approved TSF, EP, WSD, PPRD, RWD and MWD at the mine and processing facility will be:

- designed, installed and/or maintained to ensure no discharge of mine affected water off-site (except in accordance with an EPL);
- designed, installed and/or maintained to minimise permeability; and

- if applicable, designed, installed and/or maintained to meet the requirements of Dams Safety NSW (previously the Dams Safety Committee [DSC]).

In addition:

- the floor and side walls of the TSF, EP and WSD will be designed with a minimum of a 900 mm clay or modified soil liner with a permeability of no more than 1 x 10^{-9} m/s, or a synthetic (plastic) liner of 1.5 mm minimum thickness with a permeability of no more than 1 x 10^{-14} m/s (or equivalent);
- the seepage interception system for the TSF embankments will be designed, installed and maintained in accordance with DSC guidelines; and

The design of the TSF will conform to:

- *DSC3A – Consequence Categories for Dams* (DSC); and
- *DSC3F – Tailings Dams* (DSC).

Consistent with the relevant water management performance measures (Section 2.1), the approved sediment dams at the mine and processing facility and accommodation camp will be designed, installed and/or maintained generally in accordance with the series *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004) and *Managing Urban Stormwater Soils and Construction – Volume 2E – Mines and Quarries* (Department of Environment and Climate Change [DECC], 2008a).

A description of the approved water management system is provided below.

4.2.1 Tailings Storage Facility

The TSF is approved to store tailings from the processing plant with three cells approved to be constructed and filled sequentially over the life of the Project. The approved cell construction sequence is for the northern cell (TSF Cell 2) to be constructed first, followed by the south western cell (TSF Cell 1) and then the south eastern cell (TSF Cell 3). Each cell would be progressively developed using downstream lifts prior to the construction of the next cell. The TSF will be constructed with a fully encompassing raised perimeter embankment to restrict capture of external runoff. Seepage collection/interception drains will be located in the TSF embankment to intercept horizontal seepage through the embankment. Seepage collected in the interception drains, along with runoff from the TSF embankment, will be transferred via an embankment toe seepage collection drain to a seepage collection sump located at the north-eastern corner of the TSF. Any accumulation of seepage in the collection sump will be transferred back to the TSF. The accumulated decant water is approved to be piped/pumped to the WSD for reuse in the processing plant.

4.2.2 Evaporation Pond

The EP is approved to contain and evaporate a processing plant liquid waste stream containing high concentrations of chloride to prevent the build-up of chloride in the process water.

The EP will not be used to harvest runoff from land as it will be used to contain mine water or effluent in accordance with best management practice (Section 7.4). The approved EP has a maximum capacity of approximately 281 million litres (ML).

4.2.3 Water Storage Dam

Decant water from the TSF will be piped/pumped to the WSD for reuse in the processing plant.

The WSD will not be used to harvest runoff from land as it will be used to contain mine water or effluent in accordance with best management practice (Section 7.4). The approved WSD has a maximum capacity of approximately 1,230 ML.

4.2.4 Processing Plant Runoff Dam

The approved PPRD will capture runoff from the processing facility area.

Water collected from disturbance areas within the processing plant footprint will be temporarily contained in the PPRD and then reused in the mine site water system. The approved PPRD has a maximum operating capacity of approximately 34 ML.

4.2.5 Raw Water Dam

The approved RWD will be used as buffer storage for water supplied to the site from the external sources (e.g. borefield and Lachlan River). As illustrated in Figure 8, water will be supplied from the RWD to the processing plant and accommodation camp. Additional water supply requirements for dust suppression will also be supplied from the RWD. The approved RWD has a maximum operating capacity of approximately 15 ML.

4.2.6 Sediment Dams

Construction of sediment dams at the mine and processing facility and the accommodation camp area has been approved to enable capture and treatment of runoff from disturbed areas. The majority of the mine and processing facility sediment dams will be equipped with a pump to transfer water to the WSD for supply to the processing plant (refer Figure 8). Where impracticable to transfer water from a sediment dam to the WSD (i.e. where the distance is excessive), the sediment dam will be emptied via mobile pump and used locally for dust suppression purposes.

Sediment dams SD11a and SD11b, located at the accommodation camp, will be managed independently of the mine and processing facility water management system. Controlled release from SD11a and SD11b will be undertaken in order to reinstate the settling zone capacity following rainfall events.

In accordance with the water management performance measures (Section 2.1), the conceptual design of the approved sediment dams was undertaken in accordance with the Landcom (2004) and DECC (2008a) guidelines as follows (HEC, 2019):

- Type F sediment retention basin;
- Sediment dams to be in place for more than three years unless otherwise stated;
- A sensitive receiving environment and therefore capacity to be adequate to capture runoff from a 95th percentile 5-day duration rainfall event of 50.7 mm or 85th percentile 5-day duration rainfall event of 28.4 mm dependent on duration of disturbance (Dubbo 5-day rainfall depth in Table 6.3a of Landcom, 2004 – Dubbo was selected as the closest location to the Project based on the three Central Tablelands and Central Western Slopes locations presented in Table 6.3a of Landcom, 2004);
- A volumetric runoff coefficient of 0.74 assuming soil hydrologic group D – Table F2 of Landcom (2004);
- Allowance for sediment storage zone capacity equal to 50% of the above calculated settling zone capacity; and
- Pump rate required to reinstate settling zone capacity within 5 days.

A summary of the conceptual design characteristics of the approved sediment dams is provided in Table 10.

Table 10 Conceptual Design Characteristics – Approved Sediment Dams

Sediment Dam	Years Required^	Estimated Maximum Catchment Area (ha)	Settling Zone Volume (ML)	Sediment Zone Volume (ML)	Minimum Required Volume (ML)	Required Pump Rate (L/s)
SD1**	OY1 - OY21	129	48.4	24.2	72.6	120
SD2**	OY1 - OY21	172	64.5	32.2	96.7	150
SD3a**	CY1 - OY6	2	0.6	0.3	0.9	10
SD3b**	OY6 - OY21	88	33.2	16.6	49.7	80
SD4**	CY1 - OY11	210	78.6	39.3	117.9	190
SD5**	OY1 - OY6	23	8.5	4.3	12.8	20
SD6**	OY1 - OY6	11	3.9	2.0	5.9	10
SD8*	CY1 - OY1	71	15.0	7.5	22.5	40
SD11a**	CY1 - OY21	12	4.4	2.2	6.6	20
SD11b**	CY1 - OY21	8	3.1	1.5	4.6	10
SD12*	CY2	15	3.1	1.6	4.7	10

* Assumed to be in place for 6 – 12 months and conceptually designed to capture runoff from an 85th percentile 5-day duration rainfall event of 28.4 mm.

** Assumed to be in place for greater than 3 years and conceptually designed to capture runoff from a 95th percentile 5-day duration rainfall event of 50.7 mm.

^ CY = construction year; OY = operational year

4.2.7 Mine Water Dams

Water collected from the disturbance footprint of the processing facility and ore stockpile areas will be temporarily contained in the approved MWDs. The approved MWDs were conceptually sized based on a 1% AEP, 72-hour rainfall depth for the mine and processing facility of 196 mm (BoM, 2021) and a nominal runoff coefficient of 50%. A summary of the conceptual design characteristics of the approved MWDs is provided in Table 11.

Table 11 Conceptual Sizing – Approved Mine Water Dams

Dam	Years Required^	Estimated Maximum Catchment Area (ha)	Minimum Required Storage Capacity (ML)
MWD1	OY1 – OY21	117	116
MWD2	OY6 – OY21	18	19
MWD3	OY6 – OY21	93	92
MWD4	CY1 – OY21	91	91
MWD5	CY1 – OY21	31	32

^ CY = construction year; OY = operational year

4.2.8 Diversion and Collection Drains

The northern and southern diversion drains and a diversion dam (associated with the northern diversion drain) are approved to divert up-catchment runoff from undisturbed areas offsite, while collection drains are approved to collect and convey disturbed area and mine affected runoff to the PPRD and MWDs.

The diversion dam and northern diversion drain will be operational in the north-western portion of ML 1770 from CY2, as shown in Figure 10, to collect and convey runoff from the external catchment area and undisturbed areas of ML1770. The runoff will be diverted via the northern diversion drain and discharged at the mine and processing facility area boundary to a third order stream which passes through Fifield State Forest.

The southern diversion drain will be constructed along the south-eastern boundary of the mine and processing facility area to collect and convey runoff from the external catchment area and undisturbed areas along the eastern boundary of ML 1770 to discharge offsite to a third order stream. The southern diversion drain was approved to be operational from OY1.

Collection drains will be constructed to collect and convey disturbed area runoff to the sediment dams and mine affected runoff to MWDs and PPRD. Most channels and drains (with the exception of the PPRDs and MWDs) would be grass-lined with minor sections requiring rip-rap protection to protect against erosion. Grass-lined drains should be inspected at regular intervals and rip-rap should be placed where necessary to enhance erosion resistance in areas with poor grass cover (USDA & NRCS, 1984).

Consistent with the relevant water management performance measures (Section 2.1) and best management practices, the diversion and collection drains will be designed, installed and maintained as follows:

- diversion drains and diversion dam: designed to capture and convey the 1% AEP, peak flow in accordance with Development Consent (DA 374-11-00);
- collection drains (less than 3 years duration): sized based on DECC (2008a) to capture and convey the 20% AEP, peak flow; and
- collection drains (greater than 3 years duration): sized based on DECC (2008a) to capture and convey the 5% AEP, peak flow.

4.2.9 Wastewater Treatment Plant and Treated Wastewater Irrigation Area

Wastewater generated at the accommodation camp is approved to be collected and treated at an on-site WWTP. The WWTP will comprise anaerobic and aerobic treatment and final disinfection of treated effluent. The WWTP will be installed and operated in accordance with Lachlan Shire Council requirements.

Treated wastewater is approved to be transferred to the irrigation area via an irrigation water pipeline. The approved treated wastewater irrigation area will be approximately 10.5 ha in size, divided into discrete irrigation zones.

Consistent with relevant water management performance measures (Section 2.1), the treated wastewater irrigation area will be managed in accordance with the *Environmental Guidelines: Use of Effluent by Irrigation* (OEH, 2006) and the irrigation rate would be controlled so as not to:

- cause irrigation water runoff from the treated wastewater irrigation area; or
- exceed the capacity of the soil in the treated wastewater irrigation area to effectively absorb the applied nutrient and hydraulic loads.

4.2.10 Water Supply

The approved external water supply sources for the mine and processing facility and accommodation camp comprise offsite supply from the borefield and the Lachlan River.

<u>Borefield</u>

The approved borefield will extract groundwater from within Zone 5 of the Upper Lachlan Alluvial Groundwater Source which is administered by the *Water Sharing Plan for the Lachlan Alluvial Groundwater Sources 2020* under the *Water Management Act 2000*.

SEM holds WAL 32068 in the Upper Lachlan Alluvial Groundwater Source (Upper Lachlan Alluvial Zone 5 Management Zone) for 3,154 share components. The borefield will be operated in accordance with the conditions of WAL 32068.

SEM holds WSWA 70CA614098 for the approved borefield and linking pipeline.

Lachlan River

SEM holds WAL 6679 and WAL 1798 in the Lachlan Regulated River Water Source, for 123 and 300 General Security share components respectively, under the *Water Sharing Plan for the Lachlan Regulated River Water Source 2016*. In addition, SEM holds WAL 42370 (zero High Security share components) in the Lachlan River Regulated River Source, for subsequent trading of water on the open market under the *Water Sharing Plan for the Lachlan Regulated River Water Source 2016.*

SEM holds WSWA 70WA617095 for the surface water extraction infrastructure and water pipeline.

4.3 MODIFIED WATER MANAGEMENT SYSTEM – MINE AND PROCESSING FACILITY AND ACCOMMODATION CAMP

The approved water management structures/facilities described above are generally proposed to be retained for the modified Project, with changes to the location, number and sizing of some water management structures/facilities proposed. In addition, the construction of a Decant Transfer Pond (DTP) is proposed as part of the Modification.

Consistent with the approved water management system (Section 4.2), the modified water management system will be progressively developed during the construction and operational phases as diversion and collection requirements change. Figure 8 presents a schematic representation of the modified water management system. Figure 9 to Figure 15 show the water management system for each stage of the modified Project. Note that the water management system for the accommodation camp would remain the same over the modified Project life (i.e. Construction Year 1 to Operational Year 21) as currently approved, with the exception of a treated water return pipeline from the WWTP to the process water tank at the mine and processing facility to enable treated water to be used in the processing plant (Section 4.3.10).

As illustrated in Figure 9 to Figure 15, the water management system has been assessed for stages (at different points in time) representative of the Project development:

- Construction Year 1 (CY1) – initial construction activities including construction of the PPRDs, RWD, WSD, TSF (Cell 1), EP, DTP, required sediment dams and the treated wastewater irrigation area;
- Construction Year 2 (CY2) – construction activities including construction of the diversion dam, northern diversion drain and required sediment dams (Stage 1);
- Operational Year 1 (OY1) – initial operations, with preferential mining of high grade ore deposits and one TSF cell (Cell 1) in operation;
- Operational Year 5 (OY5) – mining across both eastern and western open cut pits with one TSF cell (Cell 1) in operation and Cell 2 under construction;
- Operational Year 10 (OY10) – continued mining across both eastern and western open cut pits with one TSF cell (Cell 2) in operation and initial rehabilitation of Cell 1 commenced;
- Operational Year 17 (OY17) - final year of mining across both eastern and western open cut pits, waste rock emplacements at maximum extent, one TSF cell (Cell 3) in operation, initial rehabilitation of Cell 2 commenced and advanced rehabilitation of Cell 1 commenced; and
- Operational Year 21 (OY21) – no mining occurring and on-going processing of stockpiled ore, with maximum extents of the open cut pits and waste rock emplacements and one TSF cell (Cell 3) in operation.

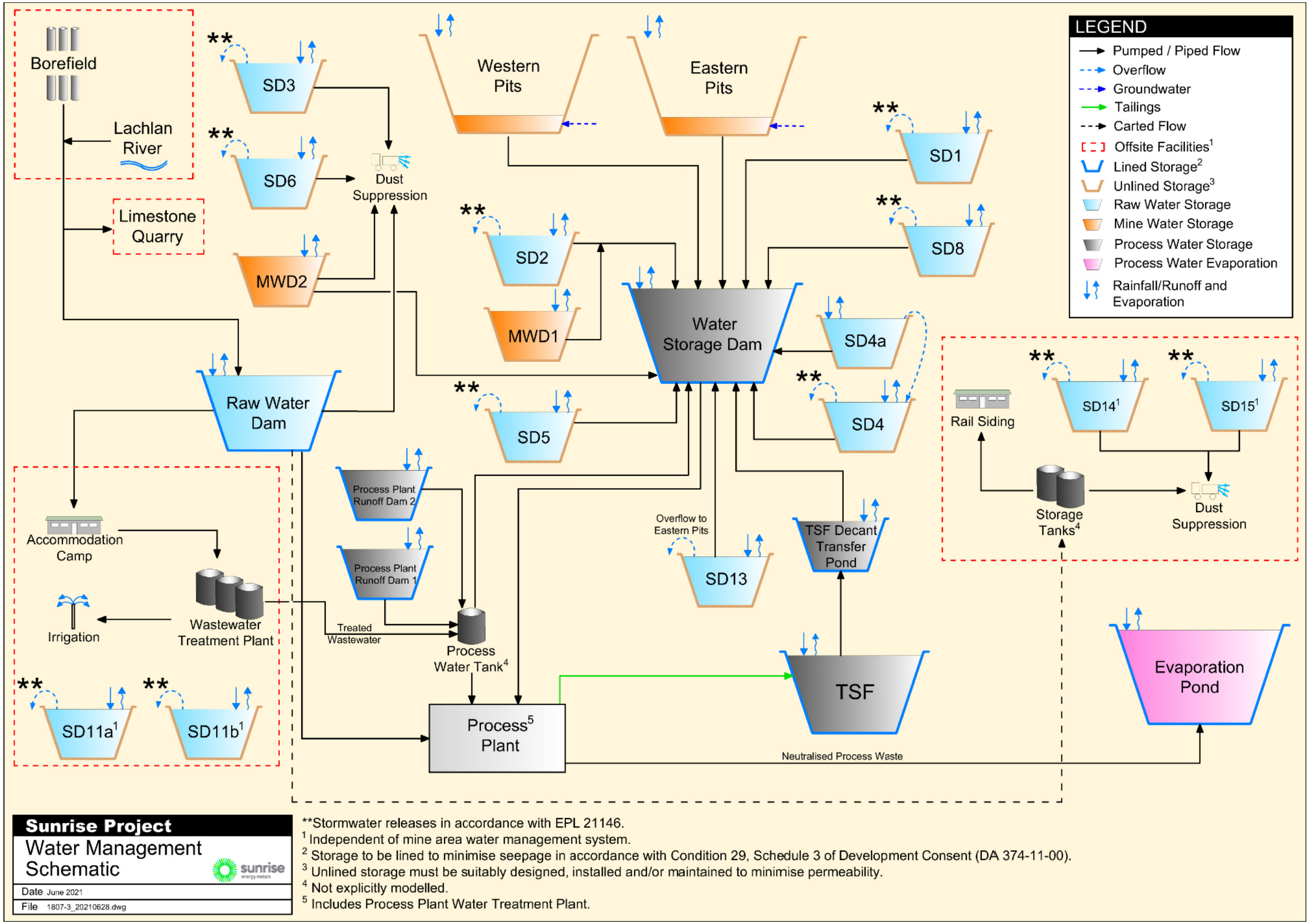


Figure 8 Modified Water Management System Schematic

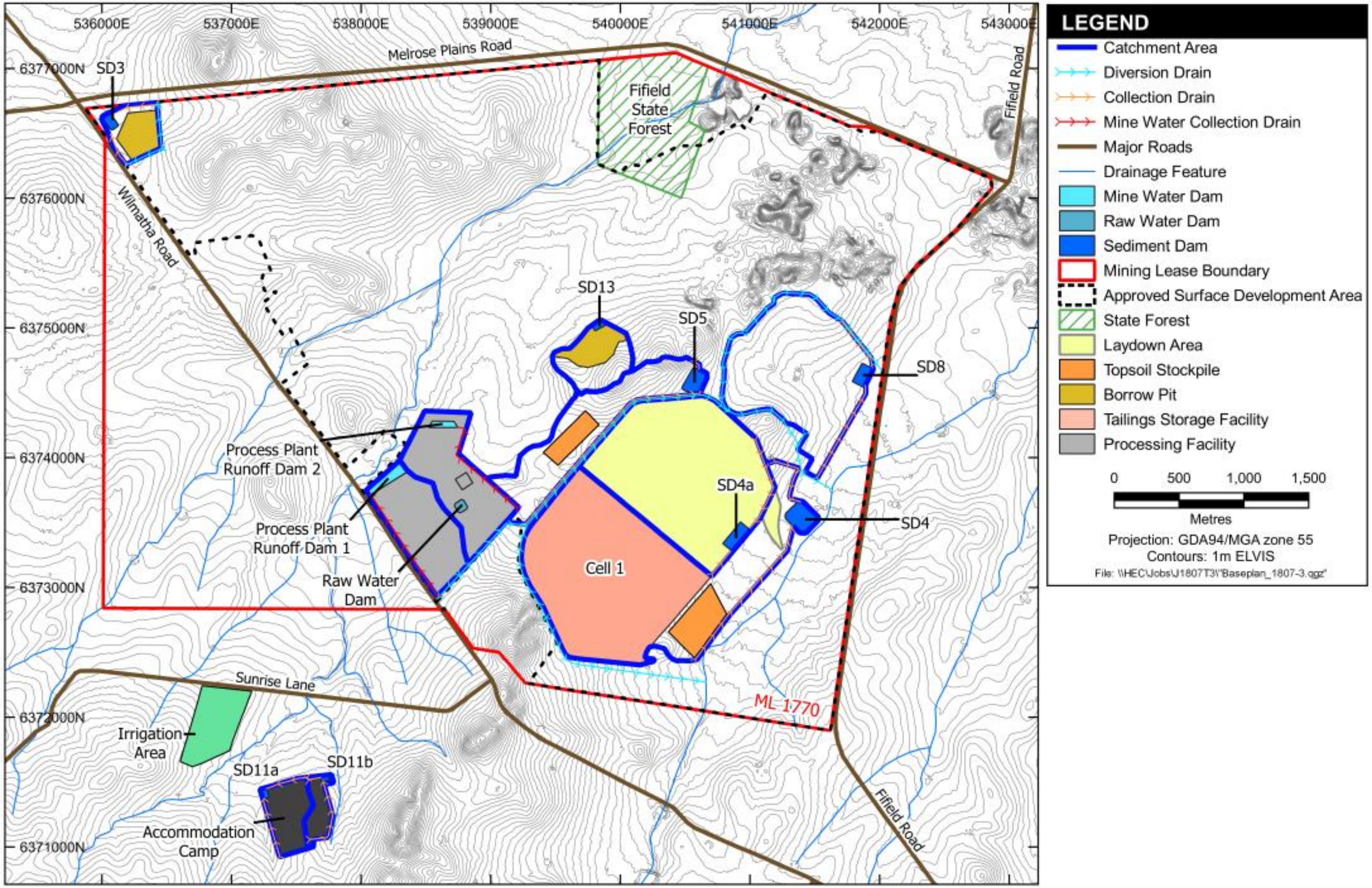
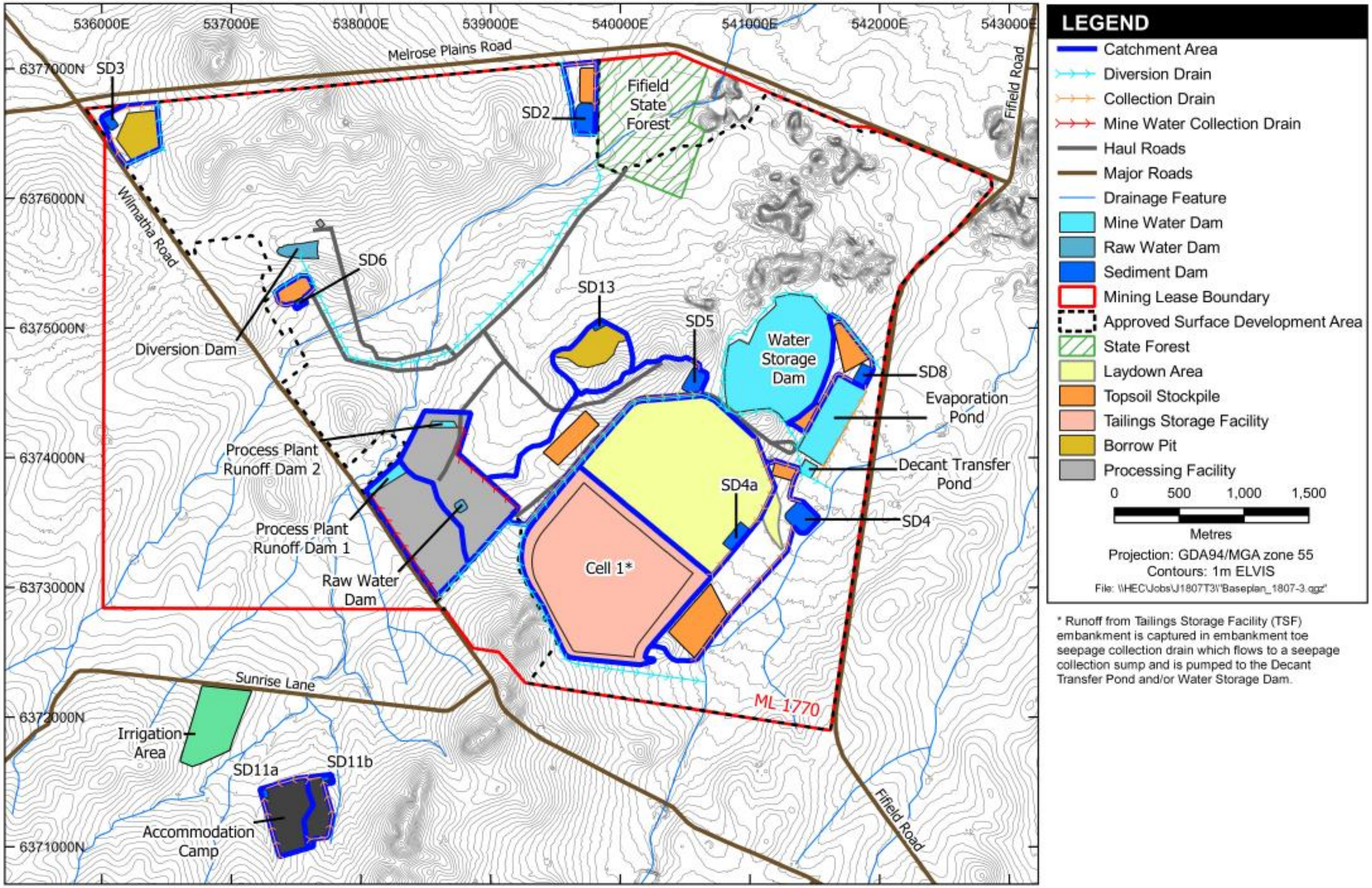


Figure 9 Construction Year 1 Water Management Plan



* Runoff from Tailings Storage Facility (TSF) embankment is captured in embankment toe seepage collection drain which flows to a seepage collection sump and is pumped to the Decant Transfer Pond and/or Water Storage Dam.

Figure 10 Construction Year 2 Water Management Plan

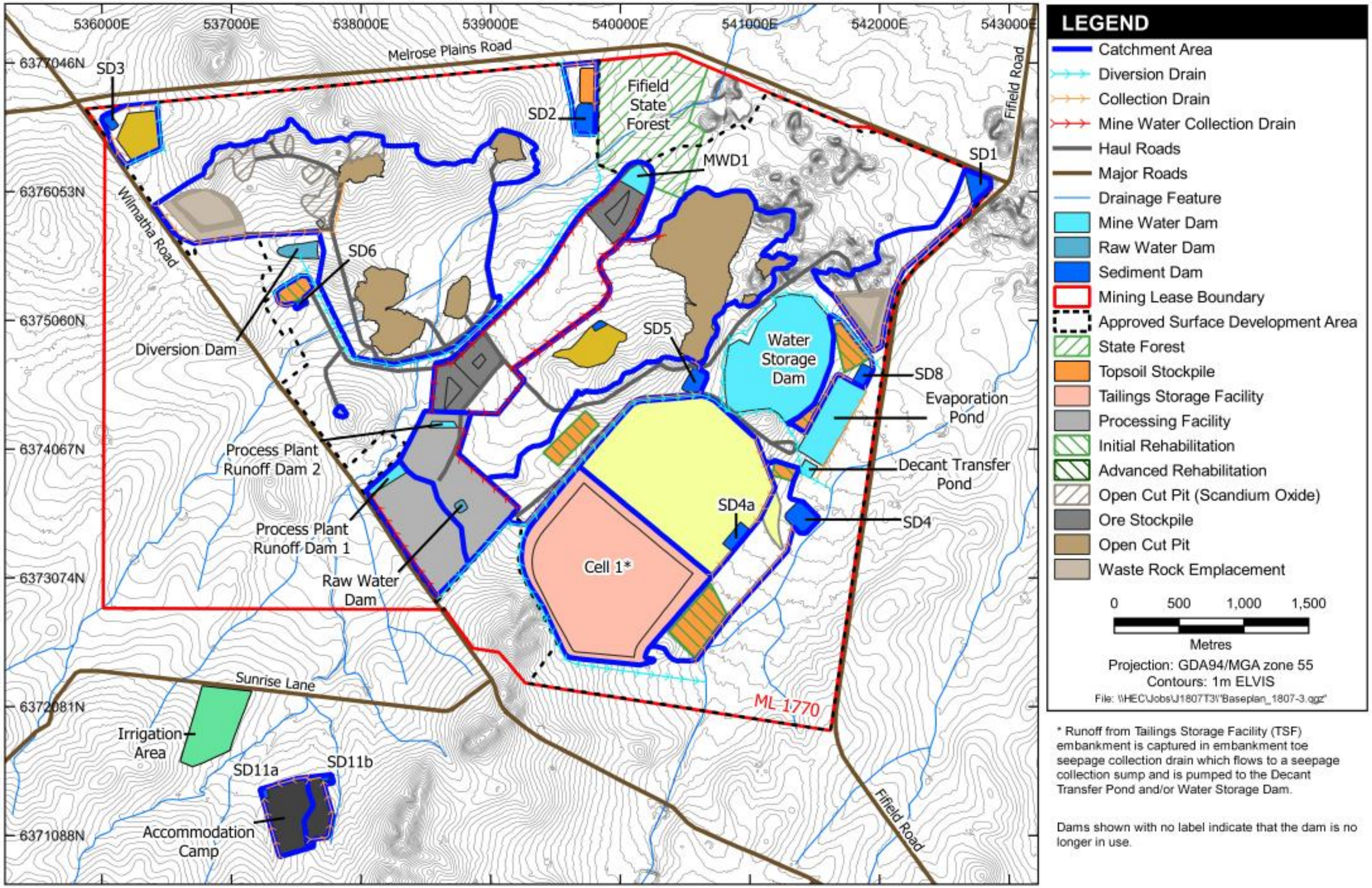
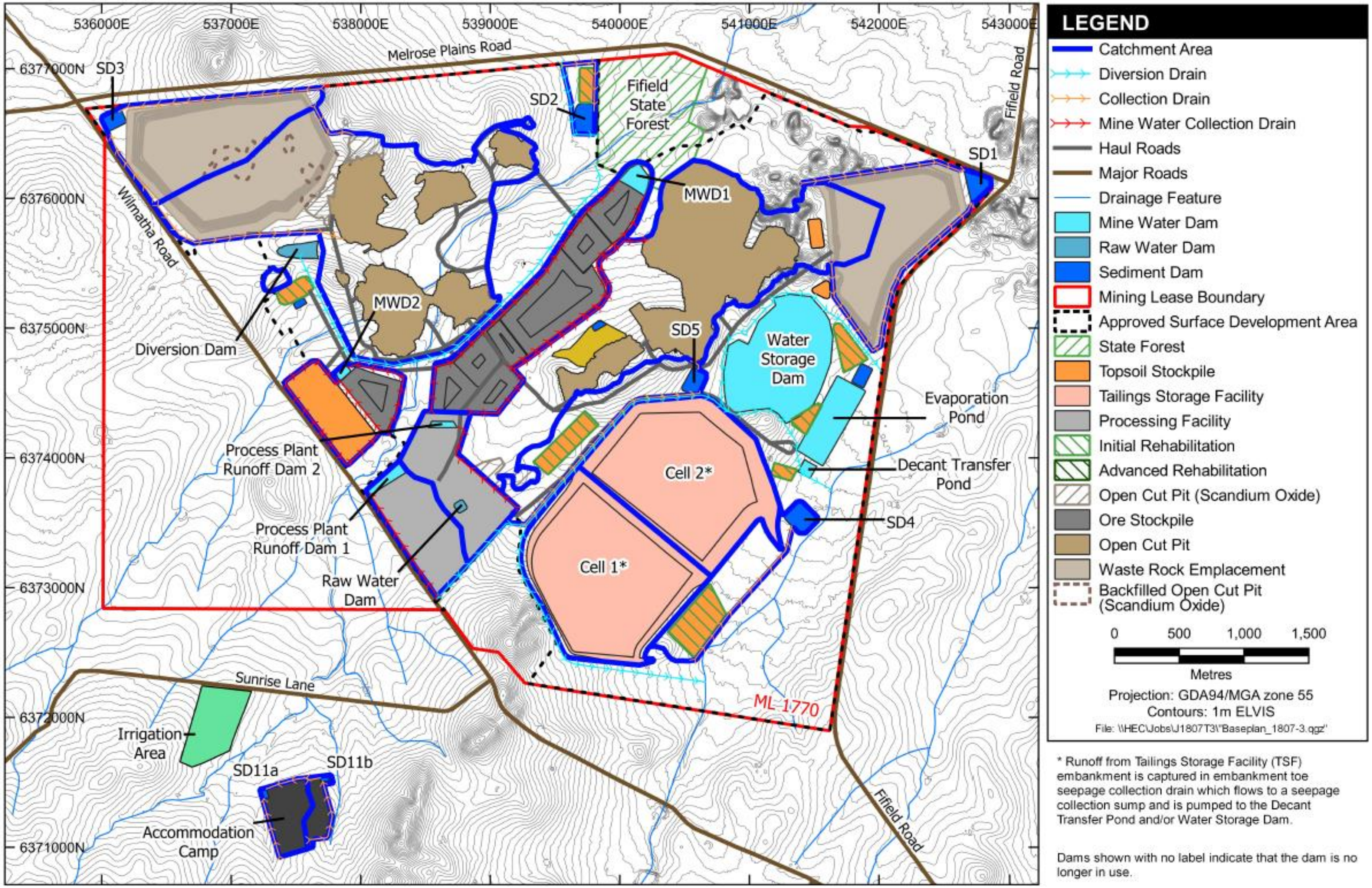


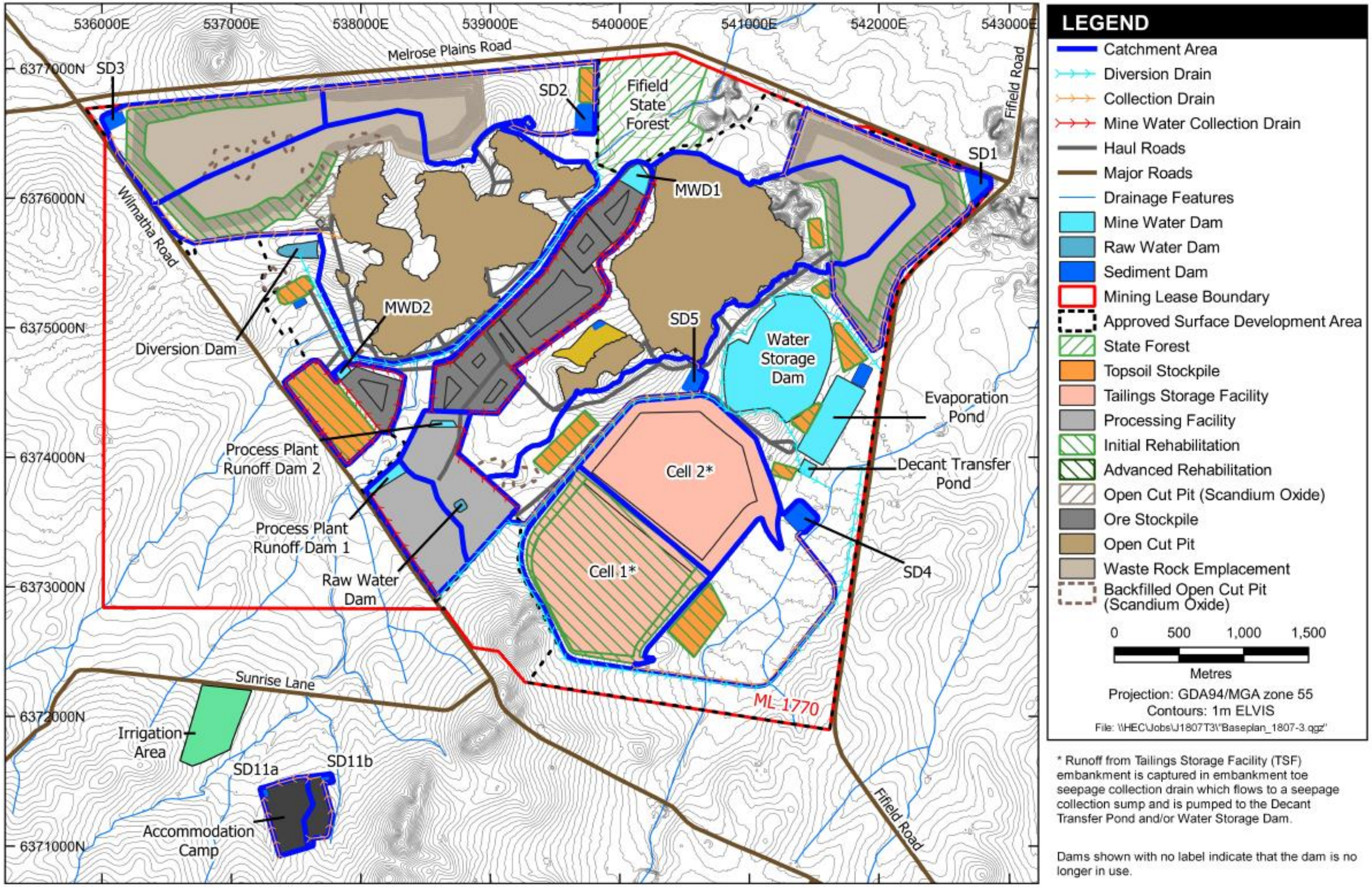
Figure 11 Operational Year 1 Water Management Plan



* Runoff from Tailings Storage Facility (TSF) embankment is captured in embankment toe seepage collection drain which flows to a seepage collection sump and is pumped to the Decant Transfer Pond and/or Water Storage Dam.

Dams shown with no label indicate that the dam is no longer in use.

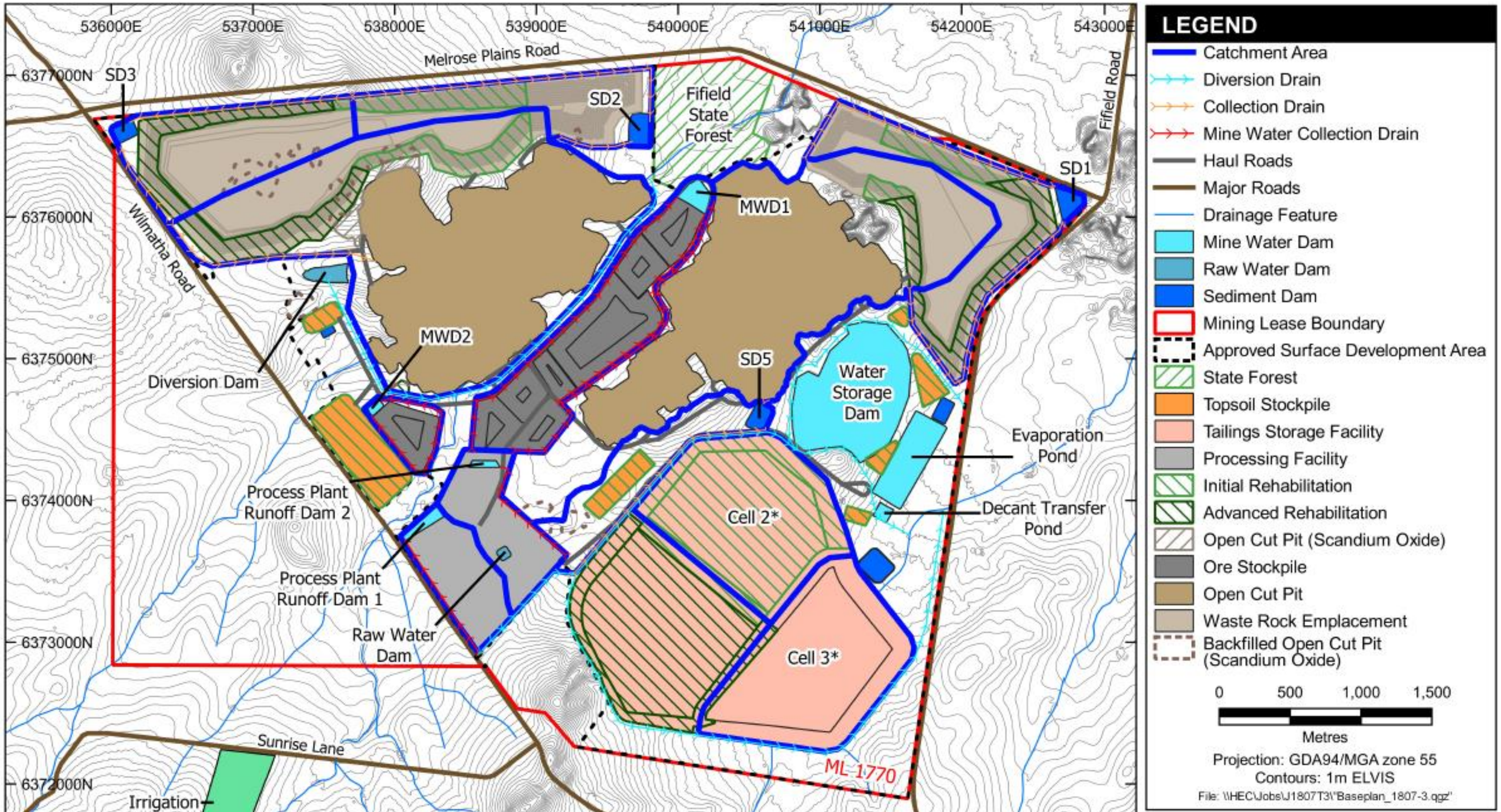
Figure 12 Operational Year 5 Water Management Plan



* Runoff from Tailings Storage Facility (TSF) embankment is captured in embankment toe seepage collection drain which flows to a seepage collection sump and is pumped to the Decant Transfer Pond and/or Water Storage Dam.

Dams shown with no label indicate that the dam is no longer in use.

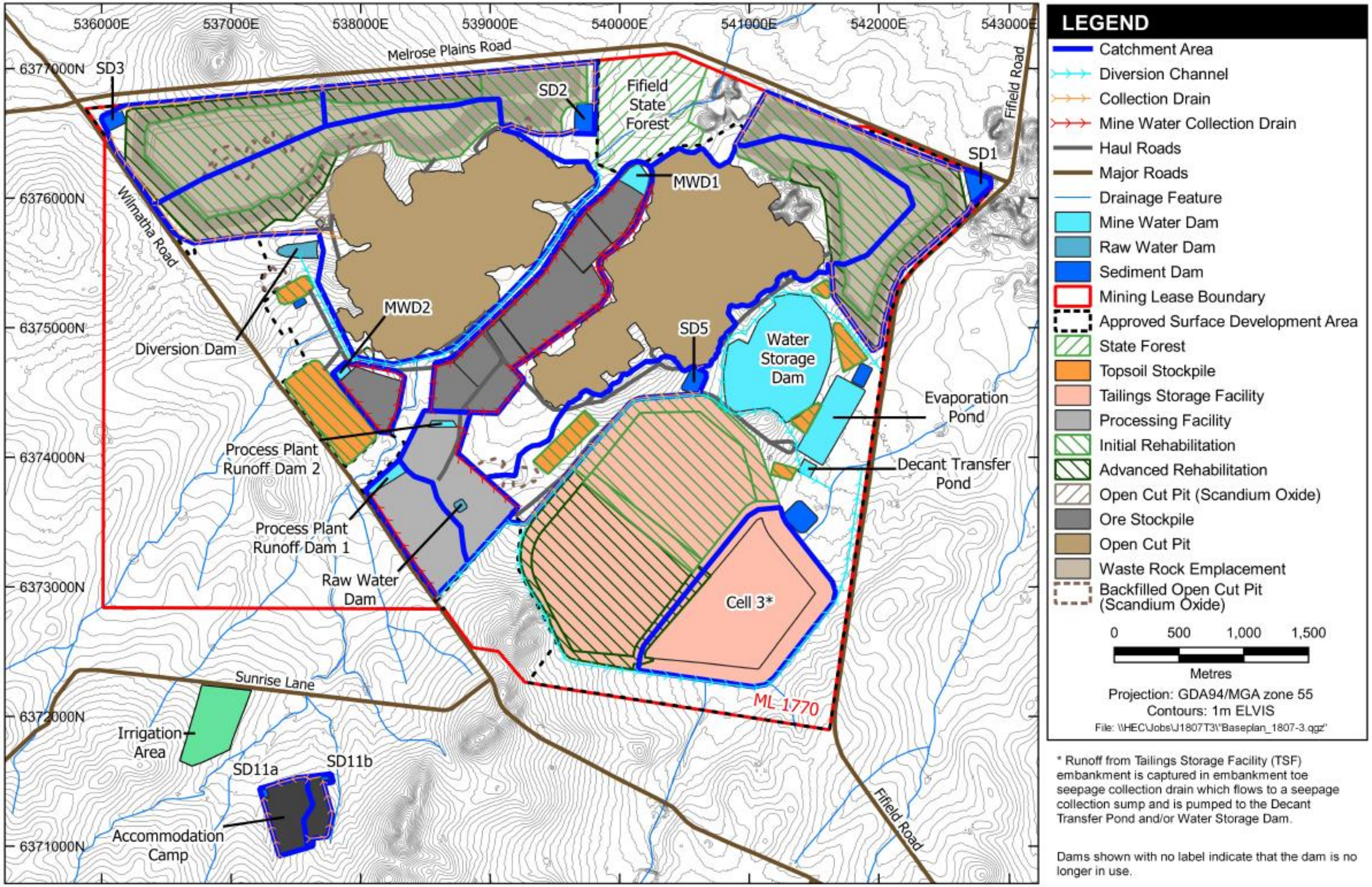
Figure 13 Operational Year 10 Water Management Plan



* Runoff from Tailings Storage Facility (TSF) embankment is captured in embankment toe seepage collection drain which flows to a seepage collection sump and is pumped to the Decant Transfer Pond and/or Water Storage Dam.

Dams shown with no label indicate that the dam is no longer in use.

Figure 14 Operational Year 17 Water Management Plan



* Runoff from Tailings Storage Facility (TSF) embankment is captured in embankment toe seepage collection drain which flows to a seepage collection sump and is pumped to the Decant Transfer Pond and/or Water Storage Dam.

Dams shown with no label indicate that the dam is no longer in use.

Figure 15 Operational Year 21 Water Management Plan

4.3.1 Tailings Storage Facility

The Modification would include a revised TSF construction sequence with TSF Cell 1 constructed first, followed by TSF Cell 2 and then TSF Cell 3 (Figures 11 to 15). As part of the Modification, TSF decant water would first be transferred to the DTP prior to transfer to the WSD, as illustrated in Figure 8.

Any seepage and embankment runoff would also first be pumped to the DTP and then to the WSD for reuse in the processing plant.

The TSF decant pipe and decant pump pond have been sized to transfer a 1% AEP, 72-hour rainfall event to the DTP and WSD within 7 days (Golder, 2020).

4.3.2 Decant Transfer Pond

The Modification would include the addition of a DTP (Figure 10). The DTP would be used to manage stored water volumes in the TSF and WSD.

Supernatant water (including incident rainfall) would initially be decanted from the TSF to the DTP. The TSF seepage collection sumps would also be dewatered to the DTP. The water in the DTP would then be pumped to the WSD for reuse in the processing plant.

The DTP would be constructed to accommodate a 1% AEP, 72-hour rainfall design event in excess of the operational capacity consistent with the water management performance measures (Section 2.1) (Golder, 2020). The operational capacity of the DTP would be approximately 7 ML (1.1 m depth), with a maximum capacity of approximately 22 ML (3 m depth).

In addition, the DTP would be designed and constructed consistent with the requirements of Development Consent (DA 374-11-00):

- designed, installed and maintained to ensure no discharge of mine affected water off-site (except in accordance with an EPL);
- designed, installed and maintained to minimise permeability; and
- designed, installed and maintained to meet the requirements of Dams Safety NSW (if required under the provisions of the *Dams Safety Act 1978*).

4.3.3 Evaporation Pond

The Modification would include the relocation and resizing of the EP approximately 400 m to the north of its approved location (Figure 2) to avoid the predicted flood extent of the southern drainage line (Figures 9 to 15) prior to its diversion in Year 11 (Golder, 2018).

The Modification would increase the capacity of the EP from approximately 281 ML to 340 ML at full development in order to accommodate an increased inflow rate of high chloride process water (Golder, 2020). The inflow rate of high chloride process water has increased from 2.5 m^3/hr adopted for the definitive feasibility study to 9.9 m^3/hr adopted for the detailed design study (Golder, 2020).

Consistent with the approved EP, the modified EP would be designed and constructed in accordance with the requirements of Development Consent (DA 374-11-00) (Section 4.2.2).

4.3.4 Water Storage Dam

No changes to the WSD are proposed as part of the Modification.

4.3.5 Processing Plant Runoff Dams

The Modification would include the construction of two PPRDs to reflect the revised processing facility area layout. The two PPRDs would replace the approved PPRD, MWD4 and MWD5 in that they would capture runoff from the processing facility area.

The PPRDs have been conceptually sized based on the results of the site water balance to avoid overflow from these storages (refer Section 5.3.4).

As illustrated in Figure 8, the PPRDs will be equipped with a pump to transfer water to the Process Water Tank (PWT). The PWT will supply water to the processing plant, based on the processing plant demand requirements, with excess water pumped to the WSD for temporary storage. The PWT will have a maximum capacity of 2,500 m^3.

4.3.6 Raw Water Dam

The Modification would increase the capacity of the RWD from approximately 15 ML to approximately 38 ML. Consistent with the approved RWD, the modified RWD would be designed in accordance with the relevant requirements of Development Consent (DA 374-11-00) (Section 4.2.5).

4.3.7 Sediment Dams

To accommodate the revised mine and processing facility area layout for the Modification, some changes to the location, number and sizing of the approved sediment dams would be required. Consistent with the approved sediment dams (refer Section 4.2.6), the conceptual design of the modified sediment dams has been undertaken in accordance with Landcom (2004) and DECC (2008a) (refer Section 4.2.6).

The modified sediment dam minimum pump rates, as listed in Table 12, have been specified based on the requirement that the sediment dams can be emptied within 5 days of filling, as per Landcom (2004). Water in excess of the sediment dam storage capacity would overflow to the receiving environment in accordance with Landcom (2004) and the requirements of EPL 21146.

Controlled release from SD11a and SD11b will be undertaken in order to reinstate the settling zone capacity following rainfall events. The catchment area of SD11a and SD11b is proposed to increase slightly from that approved (refer Section 4.2.6) due to the proposed additional accommodation facilities (Clean TeQ, 2020).

A summary of the conceptual design characteristics of the modified sediment dams is provided in Table 12.

Table 12   Conceptual Design Characteristics – Modified Sediment Dams

Sediment Dam	Years Required^	Estimated Maximum Catchment Area (ha)	Settling Zone Volume (ML)	Sediment Zone Volume (ML)	Minimum Required Volume (ML)	Minimum Required Pump Rate (L/s)
SD1	CY3 - OY21	93	34.9	17.4	52.3	90
SD2	CY2 - OY21	93	34.7	17.4	52.1	90
SD3	CY1 – OY1	15	2.4	1.2	3.6	10
	OY1 - OY21	88	33.2	16.6	49.7	80
SD4a	CY1 – OY5	125	46.9	23.4	70.3	110
SD4	CY1 – OY15	187	70.0	35.0	105.0	170
SD5	CY1 – OY21	57	21.5	10.7	32.2	50
SD6	CY2 – OY5	5	0.7	0.4	1.1	10
SD8	CY1 – OY5	95	15.1	7.6	22.7	40
SD11a	CY1 – OY21	17	6.2	3.1	9.3	10
SD11b	CY1 – OY21	8	3.1	1.6	4.7	10
SD13	CY1 – OY1	23	3.6	1.8	5.4	10

^ CY = construction year; OY = operational year

4.3.8 Mine Water Dams

To accommodate the revised mine and processing facility area layout for the Modification, some changes to the location, number and sizing of the approved MWDs would be required.

The MWDs have been conceptually sized based on the results of the site water balance to avoid overflow from these storages (refer Section 5.3.4).

As illustrated in Figure 8, water will be pumped from MWD1 and MWD2 to the WSD and from MWD2 for dust suppression purposes.

4.3.9 Diversion and Collection Drains

The mine and processing facility layout changes proposed as part of the Modification, particularly the relocation of the evaporation pond, would delay the requirement for the construction of the southern diversion from OY1 to approximately OY11 (Figure 13). The Modification would also result in minor changes to the layout and construction timing of the collection drains at the mine and processing facility.

The Modification would not change the approved northern diversion drain.

The Modification would not change the key objectives of the water management system, i.e. to manage runoff from the construction and operational areas, while diverting up-catchment undisturbed area water around these areas and to reduce to a practical minimum the use of water on-site.

4.3.10 Wastewater Treatment Plant and Treated Wastewater Irrigation Area

Wastewater generated at the accommodation camp is approved to be collected and treated at an on-site WWTP, as detailed in Section 4.2.9. An increased construction phase capacity of the accommodation camp from approximately 1,300 to approximately 1,900 personnel is proposed as part of the Modification. In order to manage the additional rate of treated wastewater from the WWTP due to the proposed increase in construction phase accommodation camp personnel, the treated wastewater irrigation area is proposed to be increased from approximately 10.5 ha to approximately 21 ha.

The Modification would also include the construction of a return pipeline from the WWTP to the process water tank at the mine and processing facility to enable the option of treated wastewater to be reused in the processing plant.

Consistent with relevant performance measures (Section 2.1), the expanded treated wastewater irrigation area would be designed and managed in accordance with the *Environmental Guidelines: Use of Effluent by Irrigation* (Department of Environment and Conservation [DEC], 2004), as summarised in Section 4.2.9.

4.4 MODIFIED WATER MANAGEMENT SYSTEM - RAIL SIDING

As described in Section 3.1.2, the rail siding would be relocated approximately 500 m to the south of the approved location as part of the Modification (Figure 3). During construction of the modified rail siding, erosion and sediment controls would be designed, installed and maintained in accordance with the relevant requirements of Landcom (2004), *Volume 2A – Installation of services* (DECC, 2008b) and *Volume 2C – Unsealed Roads* (DECC, 2008c). As shown in Figure 16, a diversion drain will be constructed along the northern and eastern boundaries of the modified rail siding to divert undisturbed area water runoff from the upstream catchment area around the modified rail siding. The diversion drain will discharge to an existing overland flow path downstream of the modified rail siding.

The total catchment area of the modified rail siding is approximately 4.7 ha.

Sediment dams SD14 and SD15 would be constructed at the modified rail siding to collect any sediment laden rainfall runoff from the modified rail siding area. Collection drains would be constructed along the southern boundary of the rail siding to capture and convey runoff to the sediment dams. The sediment dams would be designed, constructed and operated in accordance with the relevant requirements of Landcom (2004) and DECC (2008a). Water stored in the sediment dams would be utilised at the rail siding or released from site. Controlled release from SD14 and SD15 will be undertaken in order to reinstate the settling zone capacity following rainfall events, in accordance with Landcom (2004). If required, additional water will be supplied from the RWD at the mine and processing facility to meet dust suppression demands. Water sourced from the mine and processing facility would be transported to the modified rail siding by truck and stored in water storage tanks (refer Figure 8). Water in excess of the sediment dam storage capacity will overflow to the receiving environment in accordance with Landcom (2004).

A summary of the conceptual design characteristics of the proposed rail siding sediment dams is provided in Table 13.

Table 13 Conceptual Design Characteristics – Modified Rail Siding Sediment Dams

Sediment Dam*	Years Required^	Estimated Maximum Catchment Area (ha)	Settling Zone Volume (ML)	Sediment Zone Volume (ML)	Minimum Required Volume (ML)	Required Pump Rate (L/s)
SD14	CY1 - OY21	2	0.9	0.4	1.3	10
SD15	CY1 - OY21	2	0.9	0.4	1.3	10

* Assumed to be in place for greater than 3 years and conceptually designed to capture runoff from a 95th percentile 5-day duration rainfall event of 50.7 mm

^ CY = construction year; OY = operational year

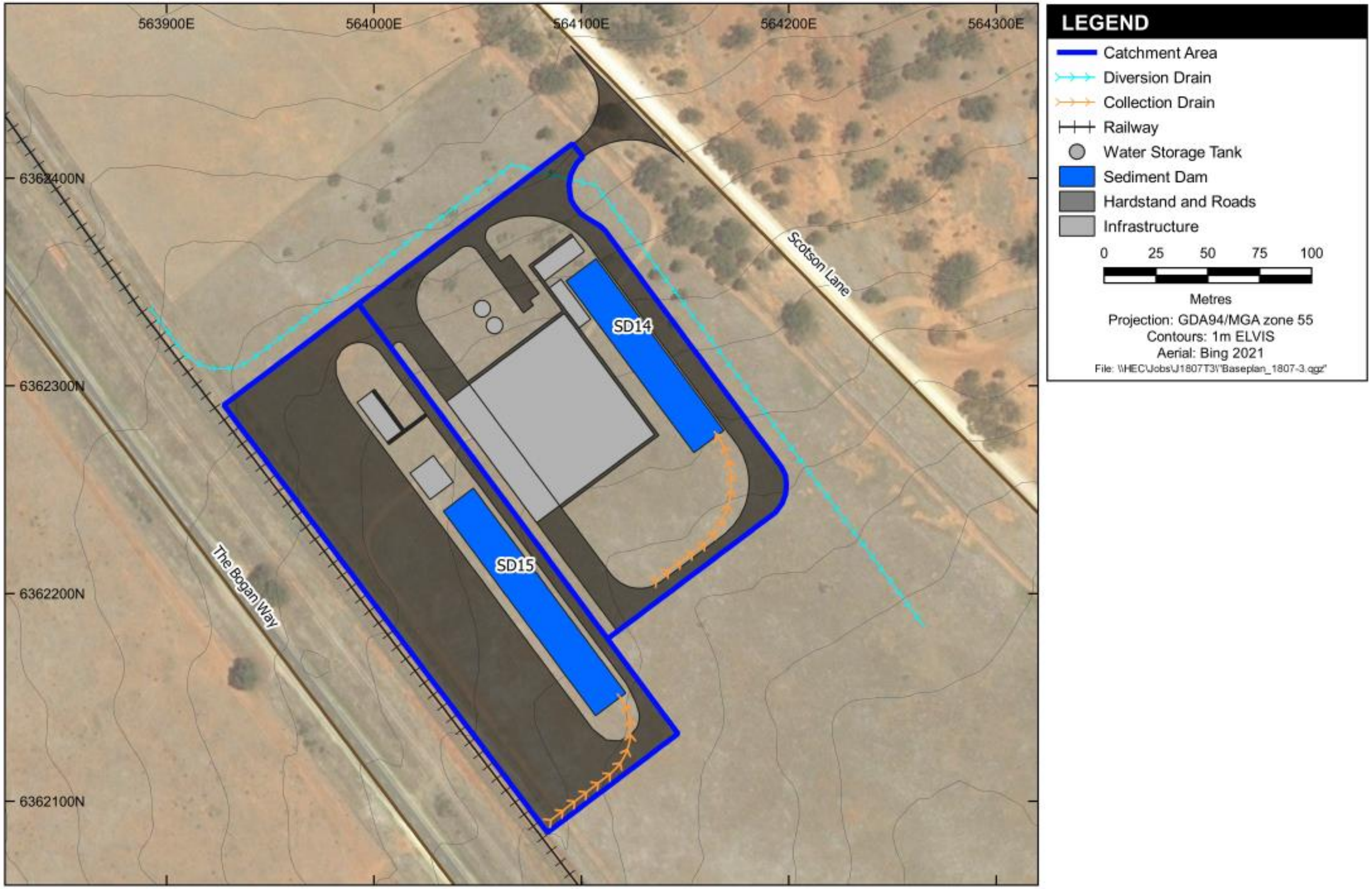


Figure 16 Rail Siding Water Management Plan

4.5 PROPOSED FINAL LANDFORM WATER MANAGEMENT SYSTEM

Key features of the approved mine and processing facility final landform include two final voids, two waste rock emplacements, TSF, EP, WSD and the northern and southern diversion drains.

The Modification would not change the key features of the approved final landform with the exception of the location of the rehabilitated EP and DTP.

Figure 17 illustrates the conceptual rehabilitated final landform and post-mining land uses of the modified mine, processing facility and accommodation camp. Permanent diversion drains would be constructed around the final voids to convey runoff from upstream areas away from the final void and divert runoff to existing surface water drainages to reduce the final void catchment areas. The permanent diversion drains will be designed to convey runoff from the 1% AEP peak rainfall event (refer Section 4.2.8). The final landform catchment area directed to the final voids is estimated at 600 ha. The final void catchment areas have been reduced where practicable in accordance with Condition 55, Schedule 3 of Development Consent (DA 374-11-00).

The long term drainage strategy for the EP (i.e. embankment breached and profiled to be a free-draining landform with runoff reporting to the natural environment) would be unchanged.

The conceptual rehabilitation strategy for the DTP would be as follows:

- The embankments would be removed and profiled to provide a free-draining landform with runoff reporting to the natural environment.
- If there are any contaminated soils associated within the DTP area, these would be identified and remediated in accordance with the requirements of the NSW *Contaminated Land Management Act 1997*.
- A layer of soil (depending on the outcomes of trials) would be placed on the reprofiled landform prior to revegetation.
- Following rehabilitation, the rehabilitated DTP would comprise endemic woodland.

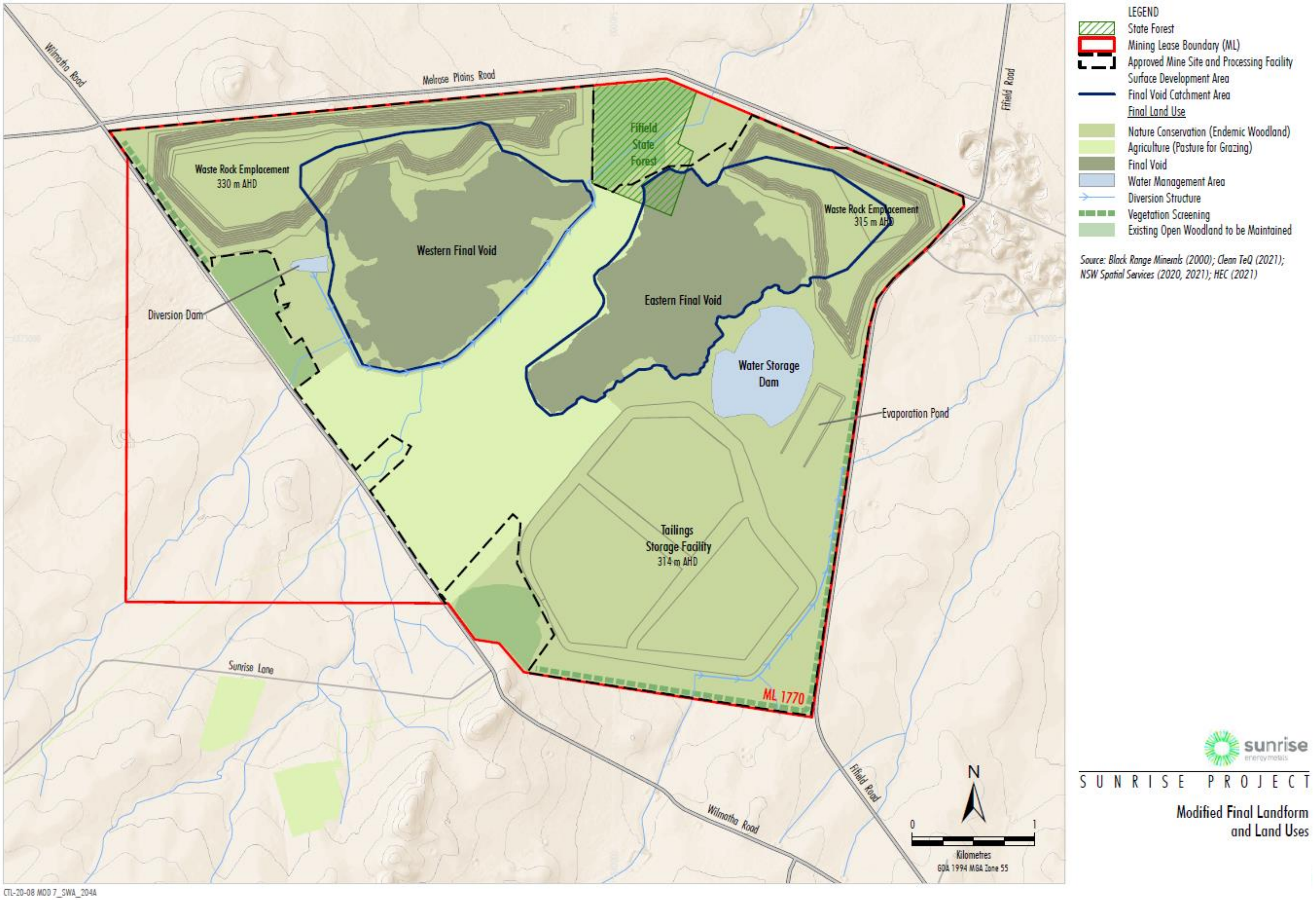


Figure 17 Final Landform Water Management Plan

5.0 SITE WATER BALANCE MODEL

5.1 MODEL DESCRIPTION

The approved water balance for the Project is described in the approved Water Management Plan (Clean TeQ, 2019).

The water balance model has been revised to reflect the modified Project and to assess whether the Modification would result in any changes to the Project water demand or site water management system. The water balance model is described below and the results of the water balance modelling undertaken for the Modification are summarised in Section 5.3.

The Project water balance model has been updated to simulate the storages and linkages shown in the modified water management schematic in Figure 8. The approved and modified water balance models were developed using the GoldSim® simulation package. The model simulates the behaviour of water held in and pumped between all simulated water storages. For each storage, the model simulates:

Change in Storage = Inflow – Outflow

Where:

Inflow includes rainfall runoff, groundwater inflow (for the open cut pits), tailings supernatant water[3] (for the tailings storage), water sourced from offsite and all pumped inflows from other storages.

Outflow includes evaporation, overflow and all pumped outflows to other storages or to a demand sink (e.g. the processing plant).

The model operates on an 8-hourly time step and is simulated for a 24 year period equivalent to the 3 year construction phase and 21 year operational phase for the modified Project. The model simulates 132, 24 year “realizations”, derived using a climatic data set from 1889 to 2020[4]. The first realization uses climatic data from 1889-1912, the second 1890-1913, the third 1891-1914, and so on. This method effectively includes all historical climatic events in the water balance model, including high, low and median rainfall periods.

5.2 MODEL ASSUMPTIONS AND DATA

A summary of key model assumptions and underpinning data are provided in the sub-sections that follow.

5.2.1 Rainfall and Evaporation

A data set comprising 132 years of rainfall and pan evaporation data (1889 - 2020 inclusive) was obtained for the mine and processing facility area and for the rail siding area from SILO Point Data. A summary of the rainfall and pan evaporation data for each location is provided in Table 3 and Section 3.2.

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[3] Tailings supernatant water is water liberated from tailings slurry as it settles within the TSF. This water reports to the tailings surface and is available for reclaim pumping to the DTP.

[4] Additional climate data after 2020 was generated by “wrapping” data from the beginning of the climate data set to after 2020. In this way, data from the beginning and end of the data set was used in the same number of realizations as all other data.

5.2.2 Rainfall Runoff Simulation and Catchment Areas

For water surface areas, rainfall was modelled to add directly to the storage volume with no losses. Rainfall runoff in the water balance model is simulated using the Australian Water Balance Model (AWBM) (Boughton, 2004). The AWBM is a nationally-recognised catchment-scale water balance model that estimates catchment yield (flow) from rainfall and evaporation.

The AWBM simulation of flow from six different sub-catchment types was undertaken, namely: undisturbed (natural) areas, hardstand (for example, roads and infrastructure areas), open cut pit/pre-strip areas, active waste rock emplacement, rehabilitated waste rock emplacement and tailings. The AWBM parameters were specified on the basis of experience with similar projects. Catchment evaporation pan factors were set to 1 for tailings and hardstand areas and 0.85 for all other sub-catchment types. The tailings sub-catchment was split into two classifications; wet beach (20% of the area) and dry beach (80% of the area) to allow for the different runoff characteristics expected.

Each modelled storage catchment area was divided into sub-catchment areas corresponding with the above specified sub-catchment types. Catchment areas for the modified Project (e.g. open cut pits, processing facility, ore stockpiles areas, water storages) were calculated for CY1, CY2, OY1, OY5, OY10, OY17 and OY21 on the basis of the stage plans (refer Figure 9 to Figure 15). The catchment area is calculated in the model by linearly interpolating between the values derived from the stage plans. The total catchment area, including the accommodation camp and rail siding, will increase from approximately 640 hectares (ha) in CY1 to 1,680 ha in OY10 as mining progresses. From OY10 to OY21, the total catchment area is proposed to reduce to approximately 1,420 ha as areas are rehabilitated and runoff from these areas is directed offsite.

5.2.3 Groundwater Inflow

Groundwater inflow rates to the open cut pits were estimated by Golder (2017) using a two-dimensional (2D) fine element groundwater model. Two cases were simulated: 1. base case – simulated using calibrated hydraulic conductivities; and 2. sensitivity case – simulated with increased hydraulic conductivity (half an order of magnitude). Forecast open cut pit groundwater inflow rates are presented in Table 14 for the base case and sensitivity case (Golder, 2017).

Table 14 Open Cut Pit Groundwater Inflow Rates

Operational Year	Base Case Inflow Rate (ML/year)	Sensitivity Case Inflow Rate (ML/year)
1	0.071	0.153
2	0.058	0.113
3	0.052	0.098
4 - 21	0.046	0.084

As the forecast open cut pit groundwater inflow rates are negligible and do not vary greatly between the base case and sensitivity case, only the base case groundwater inflow rates have been adopted in the site water balance modelling.

The model simulates an equal distribution of groundwater inflow, based on the rates specified in Table 14, to the eastern and western pits. Groundwater and rainfall runoff are then simulated pumped from the open cut pits to the WSD for use in the processing plant.

5.2.4 Evaporation from Storage Surfaces

Level-volume-area relationships for each modelled storage were obtained or estimated from the following sources:

- WSD, EP and DTP – Golder (2020).
- RWD – Drawing No. 2020-SPT-1100-41DK-0001 (SEM, 2020).
- Sediment dams and MWDs - estimated to achieve the required storage capacity with consideration to surface area constraints as assessed from contour plans provided by SEM.
- Open cut pits – estimated based on the maximum surface area extent and depth, as indicated by SEM.

The water surface area of each storage (calculated on each day from the modelled volume and volume-area relationships) was multiplied by daily pan evaporation obtained from SILO Point Data and by a pan factor[5] to calculate an evaporation volume. Monthly pan factors for Cobar (approximately 200 km north-west of the site) obtained from McMahon et al. (2013) were used, as listed in Table 15. The monthly pan factors were selected for Cobar as this is the closest location to the mine and processing facility with similar geographic characteristics (i.e. elevation and proximity to the coast) presented in McMahon et al. (2013).

Table 15 Adopted Monthly Pan Evaporation Factors

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pan Factor	0.736	0.727	0.725	0.765	0.802	0.863	0.882	0.873	0.843	0.815	0.768	0.732

5.2.5 Construction Demand

Water supply during the construction phase (CY1 to CY3) will be required for infrastructure construction, dust suppression and the accommodation camp.

The water demand for construction purposes was modelled as 900 ML/year as specified by SEM.

Dust suppression for the modified mine and processing facility and rail siding roads during the construction phase was modelled as summarised in Section 5.2.7.

Daily raw water demand requirements modelled for the accommodation camp for the construction phase (CY1 to CY3), as provided by SEM, are illustrated in Figure 18.

All wastewater from the accommodation camp (including from the reverse osmosis plant) will be treated in the WWTP. The treated wastewater generated from the WWTP was modelled as 80% of the raw water supply rate. Treated wastewater was simulated as supplied in entirety to the treated wastewater irrigation area in CY1 and CY2. In CY3, 95% of the treated wastewater was simulated as transferred to the mine and processing facility, and 5% to the treated wastewater irrigation area, as advised by SEM.

[5] A pan factor is a multiplier (usually less than one) used to convert monitored pan evaporation data to estimates of open water evaporation.

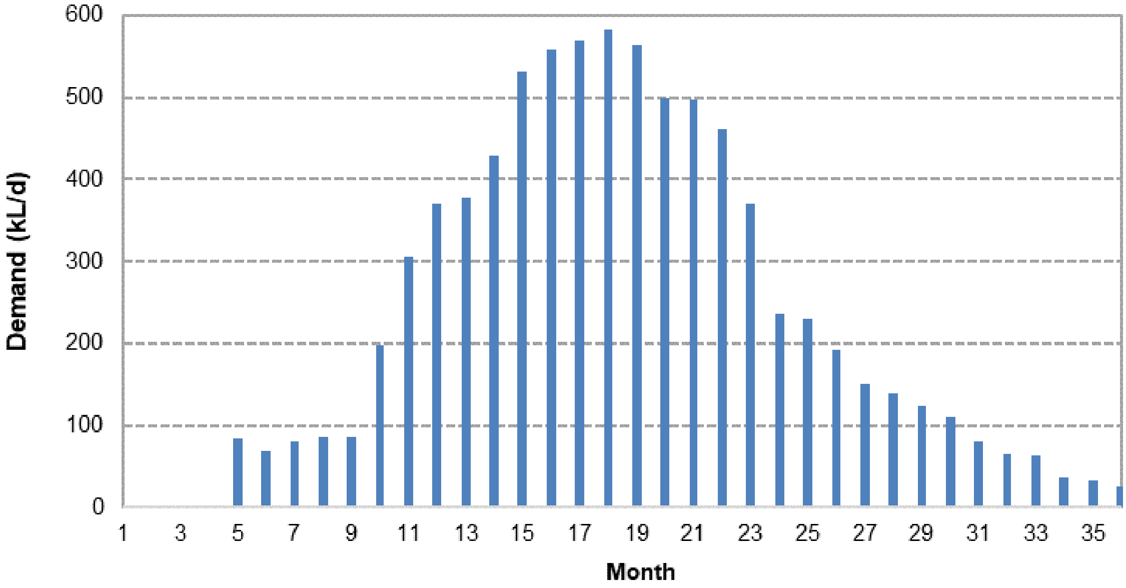

Figure 18 Accommodation Camp Raw Water Demand During Construction

5.2.6 Processing Plant Demand and Tailings Disposal

The ore and tailings properties provided by SEM for estimation of processing plant water make-up demand and tailings supernatant rate[6] were as follows:

- Ore moisture content: 10% free moisture
- Tailings slurry solids concentration: 48%
- Initial tailings settled dry density: 0.75 t/m^3
- Tailings particle density: 3.3 g/cm^3

Table 16 presents the process ore feed rate, autoclave feed rate and tailings output rate, as provided by SEM. Limestone will be added to the tailings to neutralise sulphuric acid, approved at up to 990,000 tonnes/year, prior to transfer to the TSF. The addition of limestone to the tailings will result in a greater tailings output rate than that of the process ore feed rate. The water makeup demand and tailings supernatant rate estimated based on these rates and the above specified parameters are also presented for each year of the modified Project life.

Table 16 Mined Ore Tonnes, Processing Plant Water Make-Up Rate and Tailings Supernatant Rate

Year	Process Ore Feed Rate (tonnes/year)	Autoclave Feed Rate (tonnes/year)	Tailings Output (tonnes/year)	Water Makeup Demand (ML/d)	Tailings Supernatant Rate (ML/d)
CY3	681,231	630,769	820,000	2.3	0.12
OY1	830,769	769,231	1,000,000	2.7	0.15
OY2 – OY20	2,700,000	2,500,000	3,250,000	8.9	0.47
OY21	1,700,000	1,574,074	2,046,296	5.6	0.30

Additional processing plant input and loss rates at full production (OY2 – OY20) are listed in Table 17. The input and loss rates for other operational years were scaled based on the annual mined ore rate.

[6] Tailings supernatant is water liberated from tailings slurry as it settles within the TSF. This water reports to the tailings surface and is available for reclaim pumping to the DTP.

Table 17 Processing Plant Water Supply and Loss Rates at Full Production

Water Stream		Rate (ML/d)
Input	Reagents	0.07
Loss	Ore reject entrainment	0.03
	Evaporation from process	0.67
	Process plant water treatment plant effluent	0.21
	Product entrainment	0.14

5.2.7 Dust Suppression Demand

Dust suppression demand for the mine and processing facility and rail siding roads was calculated as the difference between daily pan evaporation and rainfall multiplied by the respective area, up to a maximum rate of 4 L/m^2/d. The road areas were estimated based on the stage plans for CY1 to OY21 (Figures 9 to 15).

5.2.8 Tailings Storage

The TSF will comprise three cells which will be constructed and filled sequentially over the life of the Project. The modified cell construction sequence would be TSF Cell 1 constructed first, followed by TSF Cell 2 and then TSF Cell 3 (Figures 9 to 15). The simulated timing of the construction and operation of each cell is presented in Table 18.

Table 18 Modified TSF Cell Staging

Year	Cell Construction Occurring	Cell Receiving Tailings
CY1	Cell 1	
CY2		
CY3		Cell 1
OY1		Cell 1
OY2		Cell 1
OY3		Cell 1
OY4	Cell 2	Cell 1
OY5		Cell 1
OY6		Cell 1 / Cell 2
OY7		Cell 1 / Cell 2
OY8		Cell 1 / Cell 2
OY9		Cell 1 / Cell 2
OY10		Cell 2
OY11		Cell 2
OY12		Cell 2
OY13	Cell 3	Cell 2
OY14		Cell 2
OY15		Cell 2 / Cell 3
OY16 - 21		Cell 3

The decant pond was assumed to be located near the eastern internal corner of each cell with a beach slope of 1%. The volume-area relationship for the maximum decant pond simulated for each active TSF cell is presented in Table 19.

Table 19 TSF Cell Decant Pond Storage Characteristics

Cell	Maximum Depth (m)	Maximum Storage Volume (ML)	Maximum Surface Area (ha)
1	4.4	889	59.7
2	4.4	889	59.7
3	3.5	624	38.5

Table 19 shows the maximum storage volume and surface area of each TSF cell decant pond simulated in the model. However, water would be transferred from the internal decant ponds within each cell to the DTP and then to the WSD for reuse in processing. Therefore, the actual stored water volume of the TSF cell decant ponds would be significantly less than the maximum allowable storage volume for the majority of the time (refer Section 5.3.5).

For the purposes of modelling, it was assumed that each filled TSF cell would be rehabilitated over a subsequent four-year period. For the first year of rehabilitation, the TSF cell under rehabilitation was modelled with AWBM parameters representative of a TSF cell, with rainfall runoff reporting to the decant pond. For the second and third year of rehabilitation, the TSF cell being rehabilitated was modelled with AWBM parameters representative of a waste rock emplacement, with rainfall runoff reporting to the decant pond. For the fourth year, the TSF cell being rehabilitated was modelled with AWBM parameters representative of a rehabilitated surface, with rainfall runoff reporting to the decant pond. Following completion of the four-year rehabilitation period, the rainfall runoff from the rehabilitated TSF cell was not included in the water balance as it was assumed to discharge offsite.

5.2.9 Evaporation Pond

The high chloride waste stream approved to be transferred to the EP was simulated at the following rates, as advised by SEM:

- OY1 – 0.1 ML/d
- OY2 – 0.18 ML/d
- OY3 to OY21 - 0.2 ML/d

5.2.10 Water Supply Priority

Consistent with the approved Project water management system, the modified water management system has been designed to utilise onsite water supply as a priority over external supply. The simulated priority of water supply to the processing plant was as follows:

Priority 1 – PPRDs supply to the processing plant via the PWT.

Priority 2 – WSD supply to the processing plant.

Priority 3 – RWD (i.e. offsite supply from the Project borefield/Lachlan River) supply to the processing plant.

5.2.11 Pumping Rates and Triggers

Simulated pumped transfer rates between storages and the triggers which dictate whether pumping occurs are summarised in Table 20. The simulated pump rates for the sediment dams were specified in accordance with the design criteria (refer Section 4.3.7) or as advised by SEM. Pump rates for the mine water storages and the triggers which dictate pumping were set based on iterative simulations to ensure no modelled occurrences of overflow from these storages.

Table 20 Modelled Pump Rates and Triggers

Source	Destination	Max Pump Rate (L/s)	Trigger
SD1	WSD	120	If >2 ML and WSD<369 ML, pump out; if <=1 ML or WSD>=369 ML, turn off
SD2		150	
SD3	Mine area dust suppression	80	If >1 ML, pump out at lesser of demand and pump rate; if <=0.5 ML, turn off
SD4	WSD	170	If >2 ML and WSD<369 ML, pump out; if <1= ML or WSD>=369 ML, turn off
SD4a		150	
SD5		50	
SD6	Mine area dust suppression	10	If >0.2 ML, pump out at lesser of demand and pump rate; if <=0.1 ML, turn off
SD8	WSD	40	If >2 ML and WSD<369 ML, pump out; if <=1 ML or WSD>=369 ML, turn off
SD13		10	If >1 ML and WSD<369 ML, pump out; if <=0.5 ML or WSD>=369 ML, turn off
SD14	Rail siding dust suppression	20[†]	If >0.2 ML, pump out at lesser of demand and pump rate; if <=0.1 ML, turn off
SD15			
MWD1	WSD	120	If >3 ML and WSD<1,107 ML, pump out; if <=2 ML or WSD>=1,107 ML, turn off
MWD2	Mine area dust suppression	No pump rate set - water transferred for dust suppression usage based on demand	
	WSD	100	If >2 ML and WSD<1,230 ML, pump out; if <=1 ML or WSD>=1,230 ML, turn off
PPRD1	Process plant (via PWT^)	50	If >2 ML, pump out at lesser of demand and pump rate; if <=1 ML, turn off
	WSD (via PWT^)	100	If >2 ML and WSD<1,230 ML, pump out; if <=1 ML or WSD>=1,230 ML, turn off
PPRD2	Process plant (via PWs)	50	If >2 ML, pump out at lesser of demand and pump rate; if <=1 ML, turn off
	WSD (via PWT^)	130	If >2 ML and WSD<1,230 ML, pump out; if <=1 ML or WSD>=1,230 ML, turn off
WSD	Process plant	150	If >7.5 ML, pump out at lesser of demand and pump rate; if <=5 ML, turn off
TSF Cell 1	DTP	150	If >2 ML and DTP<6.9 ML and WSD<861ML, pump out; if <=1 ML or DTP>=6.9 ML or WSD>=861 ML, turn off
TSF Cell 2			
TSF Cell 3			
DTP	WSD	150	If >2 ML and WSD<1,230 ML, pump out; if <=1 ML or WSD>=1,230 ML, turn off
RWD	Project demands	No pump rate set - water transferred for processing plant and dust suppression usage based on demand	
Western Pits	WSD	150	If >10 ML and WSD<861 ML, pump out; if <=5 ML or WSD>=861 ML, turn off
Eastern Pits		150	

[†] A combined pump rate of 20 L/s from SD14 and SD15 was found to be adequate to meet dust suppression demands at the rail siding where sufficient water supply was available from SD14 and SD15. At times when insufficient water supply is available, water would be trucked from the mine and processing facility RWD (refer Section 4.4).

^ The PWT was not explicitly modelled.

5.3 SITE WATER BALANCE MODEL RESULTS

5.3.1 Probabilistic Results

Probabilistic outputs for key model results are presented in the following sections. The probability outputs are presented for the 5th to 95th percentile predicted volumes, with a 90% chance that the predicted volumes will fall in between the 5th/95th percentile results. It is important to note that none of these outputs represents a single climatic realization – these probabilities are compiled from all 132 realizations simulated – e.g. the median volume does not represent model forecast volume for median climatic conditions.

5.3.2 Overall Site Water Balance

Table 21 summarises the average annual water balance for the modified Project life based on the average water balance results (averaged over the 24 year simulation period).

Table 21 Modified Project Summary Water Balance

Average Inflows (ML/year)	
Rainfall runoff	2,033
Groundwater	0.04
Offsite supply	1,985
Reagents	22
Water in ore	227
Accommodation camp WWTP treated water to mine and processing facility	7.9
TOTAL	**4,275**
Average Outflows (ML/year)	
Evaporation	539
Dust suppression	314
Sediment dam overflow	130
Process loss	326
Water entrained in tailings	2,817
Construction use	113
Accommodation camp WWTP treated wastewater to irrigation area	0.42
Accommodation camp treatment process waste	2.1
TOTAL	**4,241**
Stored Water Inventory (ML/year)	
Increase in stored water inventory	34

Table 21 illustrates that rainfall runoff contributes the majority of system inflows over the modified Project life while water entrained in tailings dominates system outflows.

The average water balance results presented in Table 21 indicate an average annual increase in stored water inventory of 34 ML. The increase in stored water inventory relates predominately to the high chloride waste stream stored in the EP which is not able to be reused (up to 75 ML per year). The increase in simulated stored water inventory is also due to 'rules' that are simulated in the model for each site water storage regarding operating volumes i.e. to ensure site water demands are met and to reduce the potential for overflow from mine water storages.

An average volumetric runoff coefficient of 0.27 was calculated for the site based on the AWBM rainfall runoff predictions for the 24 year simulation period and 132 realizations – that is, 27% of site rainfall becomes runoff on average.

5.3.3 Predicted Total Stored Water Inventory

The predicted total stored water inventory over the modified Project life is shown in Figure 19 as probability plots. Note that the total stored water inventory and total storage capacity includes the water management storages only and does not include water stored temporarily in the eastern and western pits or the TSF cell internal decant ponds. The model simulation commences in July and hence each year is from 1 July to 30 June.

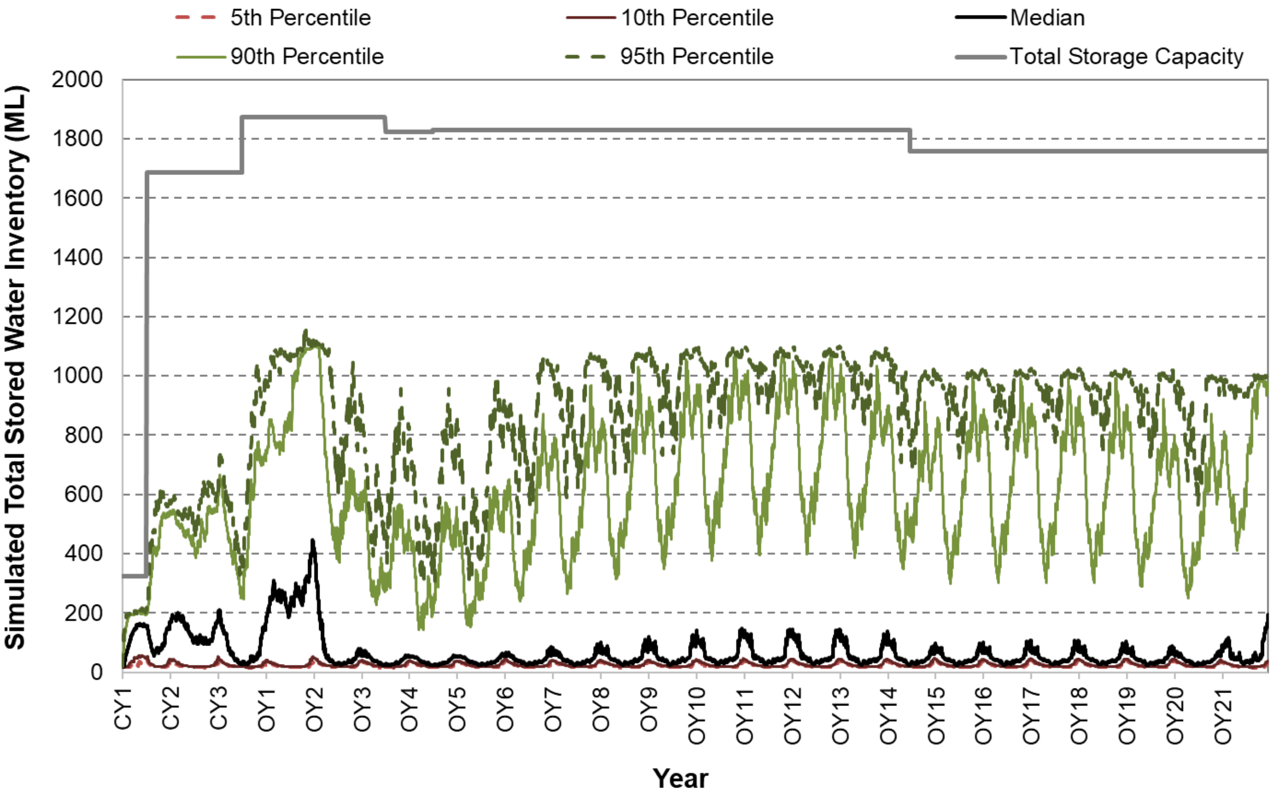

Figure 19 Simulated Total Water Inventory

Figure 19 illustrates that the forecast 95th percentile inventory peaks at approximately 1,160 ML at the end of OY1 in comparison with a maximum available storage capacity of 1,871 ML. The increase in stored water volume between CY3 and end of OY1 occurs due to an increase in catchment area, and therefore increase in rainfall runoff volumes, during the ramp up period prior to full production.

The median modelled stored water volume peaks at approximately 450 ML at the end of OY1. Following commencement of full production in OY2, the median total stored water volume is predicted to decrease and would not exceed approximately 145 ML during the remainder of the modified Project life.

Although on-site storage capacity exceeds the 95th percentile modelled inventory, the stored water volumes are not equally distributed between storages and hence overflows are predicted from sediments dams (but not mine water storages) during the modified Project life (refer Section 5.3.6).

5.3.4 Predicted MWD and PPRD Storage Requirements

The required capacity of the MWDs and PPRDs to achieve no overflows over the modified Project life was assessed based on the site water balance results for the full 24 year, 132 realization simulation and adoption of the operational characteristics summarised in Table 20. Table 22 presents the predicted minimum capacity requirements of the MWDs and PPRDs to achieve no overflows.

Table 22 Predicted Capacity Requirements – Modified MWDs and PPRDs

Dam	Years Required^	Estimated Maximum Catchment Area (ha)	Minimum Required Storage Capacity (ML)
MWD1	OY1 - OY21	103	113
MWD2	OY5 - OY21	45	19
PPRD1	CY1 - OY21	40	48
PPRD2	CY1 - OY21	45	61

^ CY = construction year; OY = operational year

5.3.5 Predicted TSF Cell Stored Water Volume

Decant water from the TSF cell internal decant ponds to the DTP and then to the WSD, may be restricted at times dependent on the available storage capacity of the WSD. Table 23 presents the model predictions of the maximum stored water volume in each TSF cell based on the 5th percentile, median and 95th percentile model results. The 95th percentile stored water volumes are compiled from all 132 realizations and are those which would be expected to be exceeded 5% of the time and the 5th percentile values are those which would be expected to be exceeded 95% of the time.

Table 23 Predicted Maximum Stored Water Volume in TSF Cells

TSF Cell	Predicted Maximum Stored Water Volume (ML)		
	5th Percentile	Median	95th Percentile
Cell 1	9	35	182
Cell 2	8	34	177
Cell 3	8	32	169

It should be noted that the stored water volumes in the TSF cells will be intermittent and temporary following significant rainfall only, with water transferred to the DTP and then to the WSD when sufficient storage capacity is available in the WSD.

5.3.6 Predicted Dam Overflow

No overflow was predicted from the WSD, MWDs, PPRDs, RWD, EP, TSF or DTP based on all results for the 24 year, 132 realization simulation.

Predicted average annual overflow volumes, for the 5th percentile, median and 95th percentile, are presented in Figure 20 for the mine and processing facility sediment dams and Figure 21 for the rail siding and accommodation camp sediment dams.

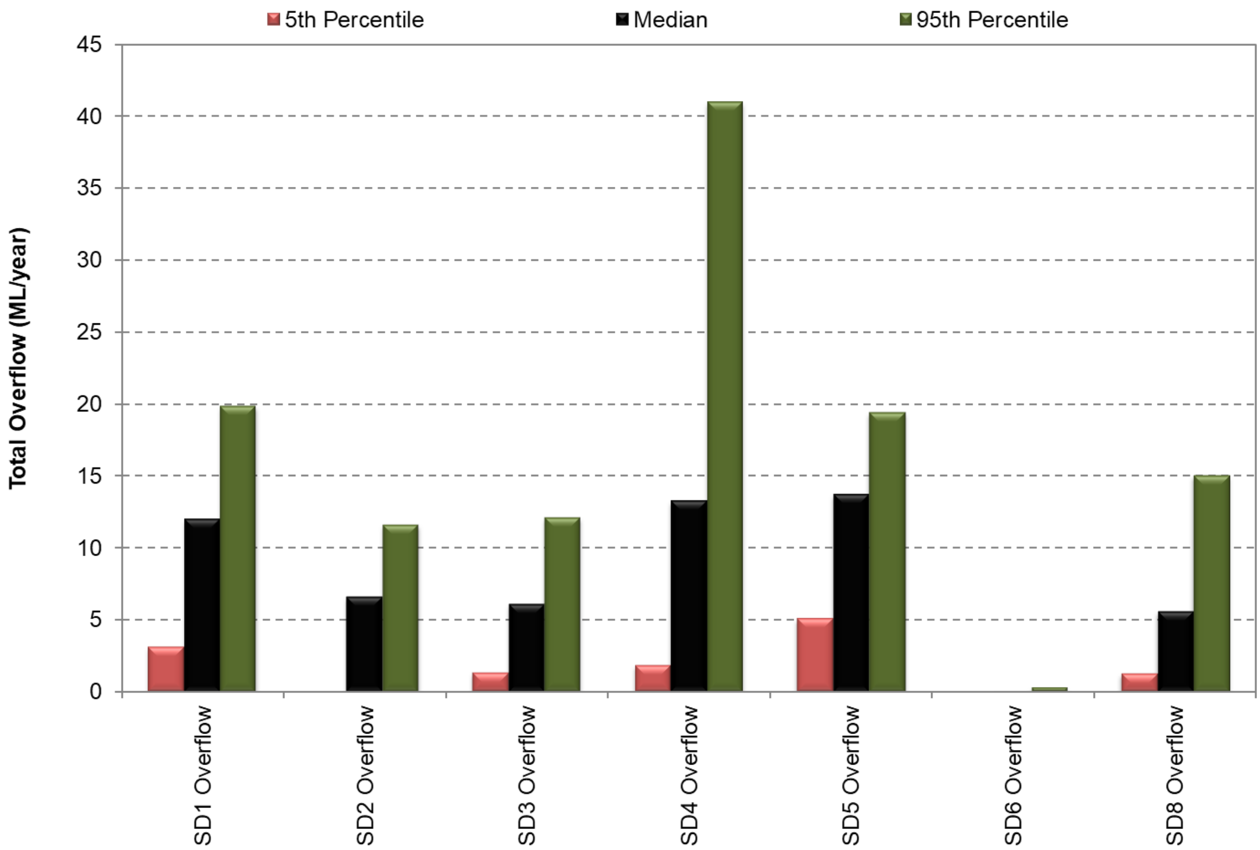

Figure 20 Predicted Average Annual Overflow from Mine and Processing Facility Sediment Dams

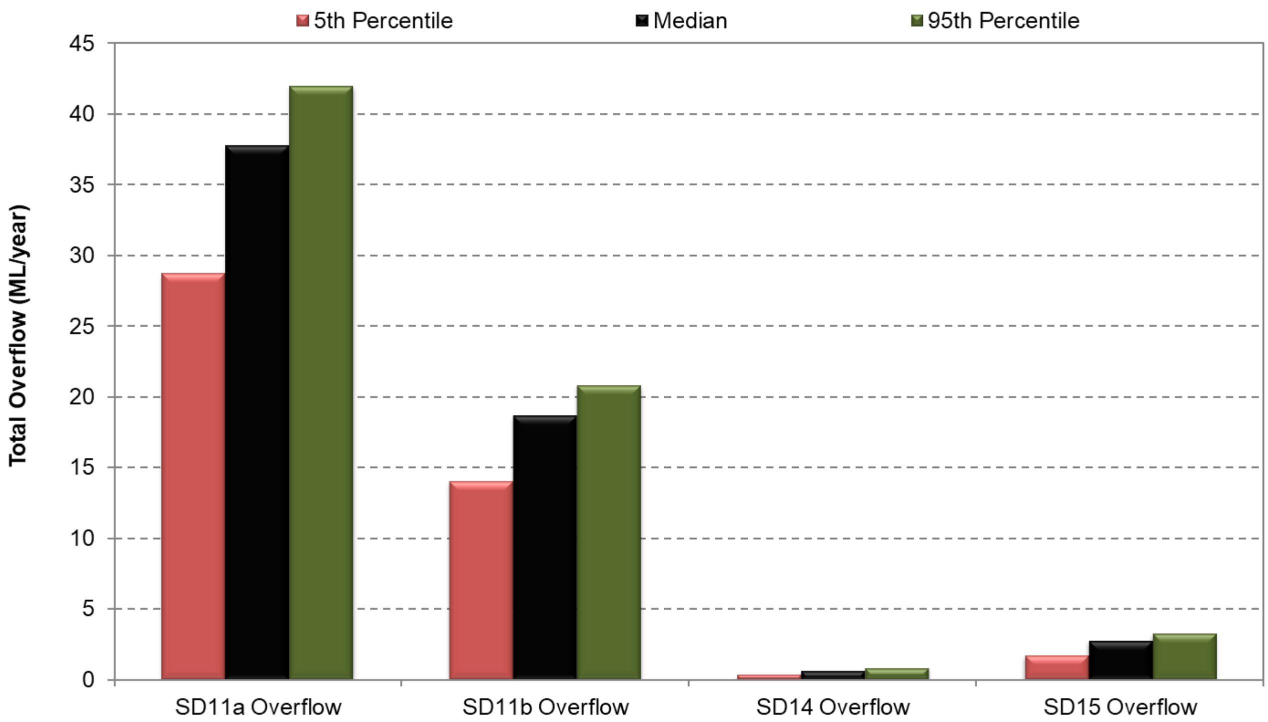

Figure 21 Predicted Average Annual Overflow from Accommodation Camp and Rail Siding Sediment Dams

Figure 20 illustrates variable overflow volumes from the mine and processing facility sediment dams. For the larger catchment area sediment dams (SD3 and SD4), an average annual overflow volume of 1 ML to 12 ML and 2 ML to 41 ML respectively was predicted based on the 5th percentile and 95th percentile model results.

Figure 21 illustrates that the average annual overflow from the accommodation camp sediment dams (SD11a and SD11b) is predicted at 28 ML to 42 ML and 14 ML to 21 ML respectively, based on the 5th percentile and 95th percentile model results. The accommodation camp sediment dams will be managed independently of the mine and processing facility, with controlled release from SD11a and SD11b undertaken in order to reinstate the settling zone capacity following rainfall events (Section 4.3.7). Controlled release from the accommodation camp sediment dams has not been simulated in the water balance model and, as such, the volumes presented in Figure 21 are a conservative estimate of average annual overflow.

For the rail siding sediment dams (SD14 and SD15), an average annual overflow volume of 0.4 ML to 0.8 ML and 1.7 ML to 3.3 ML respectively was predicted based on the 5th percentile and 95th percentile model results. Supply from the rail siding sediment dams for dust suppression purposes has been simulated in the water balance model, however, controlled release from the sediment dams has not been simulated and, as such, predicted overflow from SD14 and SD15 is a conservative estimate.

5.3.7 Potential Mining Disruption

The risk of mining disruption has been assessed by comparing the number of days per year that more than 200 ML is held in a given open cut pit (an arbitrary volume chosen to represent conditions which *could* lead to mining disruption). Table 24 presents the model predictions where the 95th percentile values are the number of days per year which would be expected to be exceeded in 5% of years and the median values are those which would be expected to be exceeded in 50% of years.

Table 24 Predicted Annual Number of Days in Excess of 200 ML Stored in Pit

Open Cut Pits	Number of Days Annually		
	5th Percentile	Median	95th Percentile
Western Pits	0	10	23
Eastern Pits	0	6	17

The results in Table 24 indicate a low risk of impact to mining operations associated with excess stored water in the open cut pits.

5.4 EXTERNAL SUPPLY REQUIREMENTS

Figure 22 presents the total annual maximum and average offsite supply predicted over the life of the Project based on the 24 year, 132 realization simulation.

Figure 22 illustrates that the maximum annual off-site water demand during the construction phase is predicted at 1,960 ML in CY3. SEM currently holds groundwater and surface water entitlements necessary to supply the predicted maximum annual offsite water demand during the construction phase (refer Section 4.2.10).

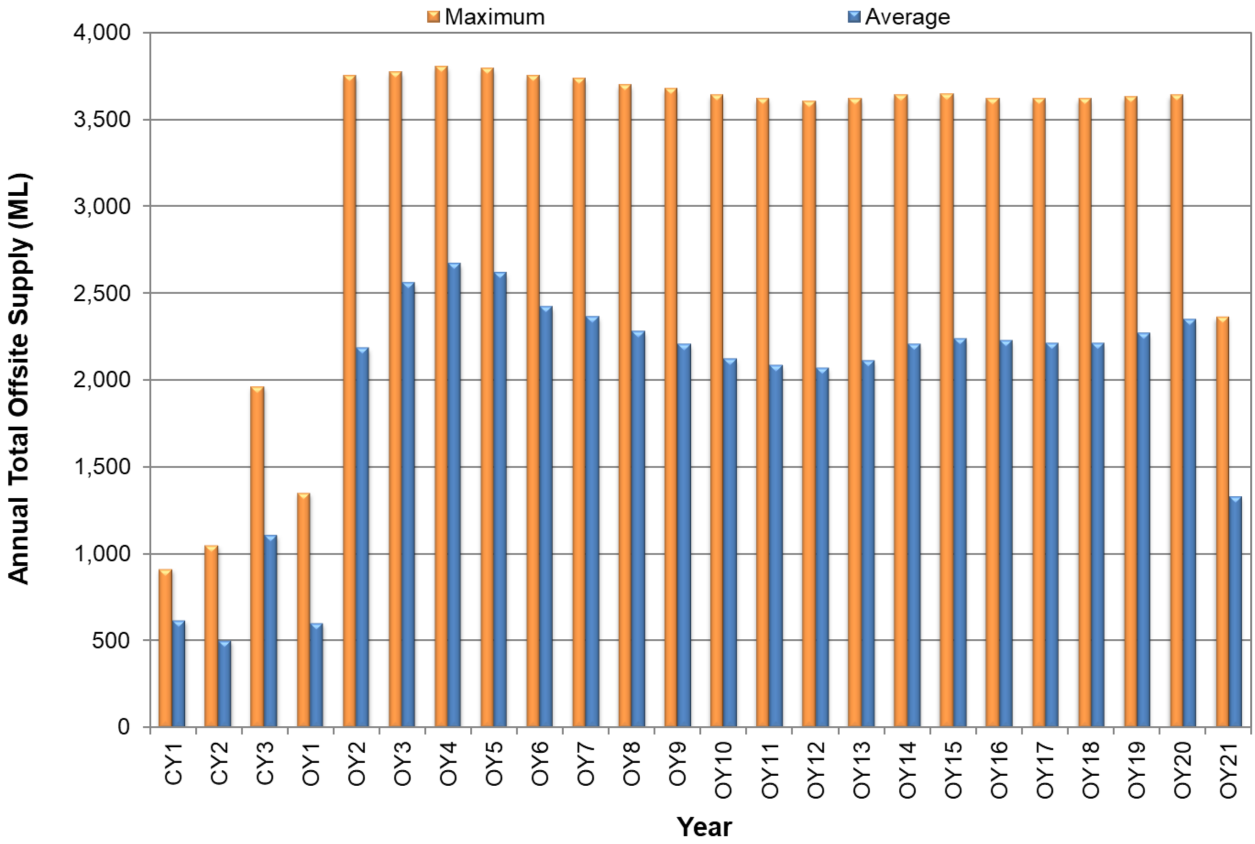

Figure 22 Simulated Annual Offsite Supply Volume

The annual offsite supply requirement is greatest in OY4, with a maximum supply requirement of 3,804 ML and an average supply requirement of 2,670 ML predicted in this year. Over the full operational phase (OY1 to OY21), the average annual offsite supply requirement is in the order of 2,160 ML. As noted in Section 4.2.10, SEM currently holds 3,154 share components from groundwater sources and 423 share components from surface water entitlements, which is greater than the predicted average annual offsite water demand during the operational phase although less than the predicted maximum annual offsite water demand during the operational phase.

SEM currently holds WAL 42370 in the Lachlan Regulated River Water Source, for zero share components (High Security) under the *Water Sharing Plan for the Lachlan Regulated River Water Source 2016*. The Lachlan Regulated River Water Source has a history of available water determinations (AWDs) orders and water trading. While the water market is variable (availability subject to rainfall), it is mature (administered since 2004) and has significant available shares for trading. If required to meet the predicted maximum annual external water demand during the operational phase, SEM could purchase volumetric allocations under WAL 42370 on the open market in accordance with Condition 26, Schedule 3 of Development Consent (DA 374-11-00), and if necessary, adjust the scale of the Project to match its available water supply.

6.0 FINAL VOID WATER BALANCE MODELLING

6.1 MODEL DESCRIPTION

A daily timestep, final void water balance model has been developed using the GoldSim® simulation package. The model simulates the volume of the final void water bodies by simulating the inflows, outflows and resultant volume of water and salt mass:

Change in Storage = Inflow – Outflow

Where:

Inflow includes direct rainfall, runoff and groundwater inflow.

Outflow includes evaporation.

6.2 KEY DATA AND ASSUMPTIONS

The model simulates inflow from rainfall runoff within the final void catchment areas (Figure 17), direct rainfall on the surface area of the final voids, groundwater inflow from bedrock as well as outflow due to evaporation on a daily basis for each final void. Key model input data include the following:

- Eastern final void: a catchment area of 291 ha comprising 93 ha of rehabilitated waste rock emplacement and disturbed area sub-catchment and 198 ha of remnant open cut pit sub-catchment.
- Western final void: a catchment area of 313 ha comprising 104 ha of rehabilitated waste rock emplacement and disturbed area sub-catchment and 209 ha of remnant open cut pit sub-catchment.
- A 132-year rainfall data set (1889 to 2020) obtained from SILO Point Data and a 132-year evaporation data set for the same period (refer Section 5.2.1). The data set was repeated several times over to generate an extended period of climate data for final void simulation – to ensure equilibrium water levels were reached during the simulation period.
- A constant pan factor of 0.8 was assumed for calculation of evaporation from the final void until the water level reached 10 m below the spill point (if this occurs) at which point monthly pan factors taken from McMahon et al. (2013) were used – refer Section 5.2.1. The lower pan factor used for lower final void levels reflects lower evaporation likely at depth as a result of shading effects.
- Surface rainfall runoff was estimated using the AWBM applied to the final void sub-catchments, in a manner similar to the operational water balance model (refer Section 5.2.2). Direct rainfall was simulated on the contained water surface.
- Long term groundwater inflow rates of 0.002 L/s to each final void (Golder, 2017).

As described in Section 4.5, the catchment area directed to the final voids has been reduced where practicable in accordance with Condition 55, Schedule 3 of Development Consent (DA 374-11-00).

6.3 SIMULATED FUTURE PERFORMANCE

The model-predicted water level for the eastern and western final voids is shown in Figure 23 in comparison with the final void spill levels of 274 m AHD and 278 m AHD respectively.

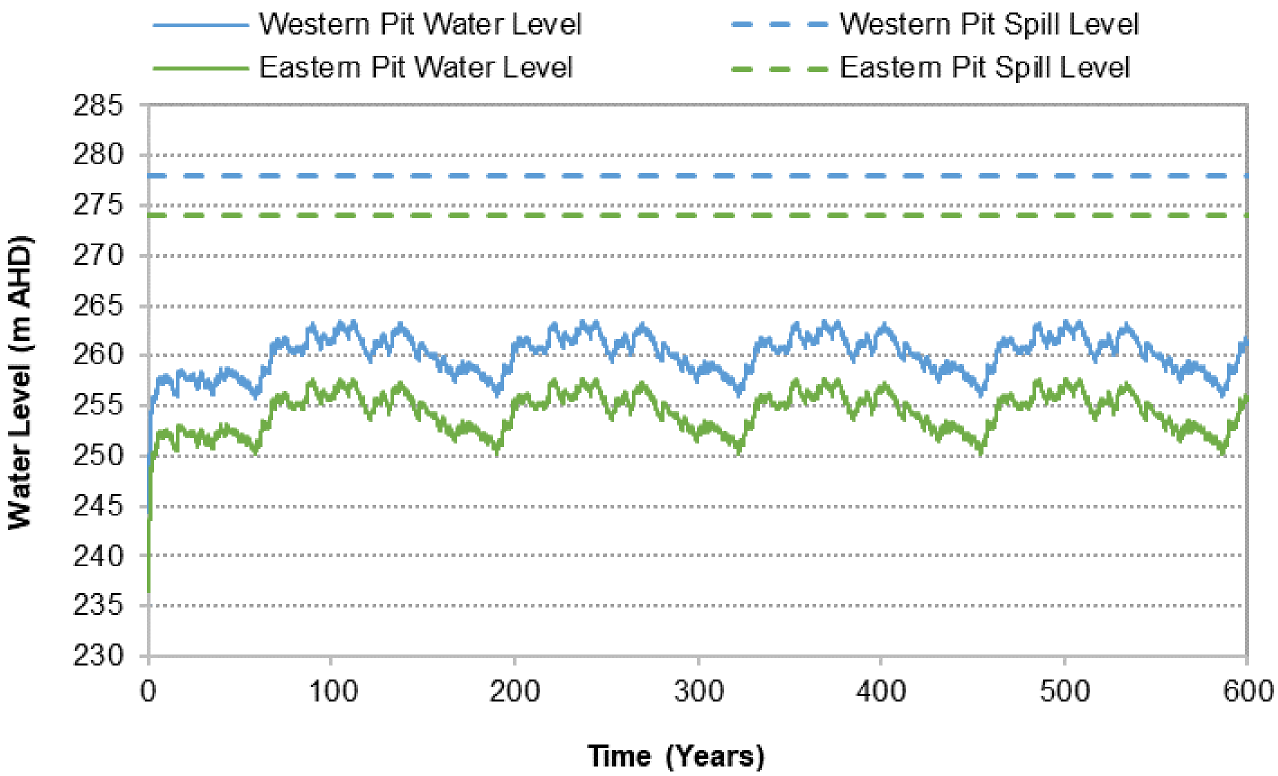

Figure 23 Predicted Final Void Water Level

The model predictions indicate that the eastern and western final void would reach a peak equilibrium level of 258 m AHD and 263.5 m AHD respectively – approximately 16 m and 14.5 m below the spill level respectively (i.e. the final voids are not predicted to overflow). The water level is predicted to rise rapidly in the first 13 years when the water surface area is smaller and therefore evaporation rates are lower. After approximately 13 years, the water level is predicted to rise at a lower rate and reach equilibrium over a period of approximately 250 years.

Given that the only outflow from the final void would be to evaporation, salinity is predicted to increase trending to hyper-salinity in the very long term. Water quality in the final void at any given point in time would vary with depth as a result of mixing and stratification processes that would occur as a result of temperature and salinity differentials.

6.4 IMPLICATIONS OF CLIMATE CHANGE ON FINAL VOID WATER BALANCE

Assessments of likely future concurrent rainfall and evapotranspiration changes for the mine and processing facility area have been undertaken using the online Climate Futures Tool (CSIRO and BoM, 2015a). The assessment was undertaken for the year 2090 (approximately 45 years post-mine closure). Climate variable inputs for the 'best case', 'maximum consensus' case and 'worst case' as defined by CSIRO and BoM (2015b) for the RCP4.5 climate change scenarios are provided in Table 25.

The majority of climate models predict a decrease in rainfall and an increase in evapotranspiration. This would result in a lower void water level than predicted in Section 6.3. The 'worst case' climate model predicts an increase in annual rainfall of 3.8%, however, this is offset by an increase in evapotranspiration of 5.5%.

Table 25 RCP4.5 Scenario Climate Variable Inputs

Scenario	Climate Model	Annual Change	
		Rainfall	Evapotranspiration
Best Case (largest reduction in rainfall)	GFDL-CM3	-24.2%	9%
Maximum Consensus (highest agreement between different climate models)	CanESM2	-4%	11.5%
Worst Case (largest increase in rainfall)	CESM1-BGC	3.8%	5.5%

The potential effects of climate change as reported by CSIRO and BoM (2015a) are not expected to alter the prediction that water in the final voids would be contained. Accordingly, application of the RCP8.5 emissions scenario, which typically predicts even lower rainfall and higher evapotranspiration conditions than the RCP4.5 scenario, is not predicted to alter the prediction that water in the final voids would be contained. The net impacts of all scenarios would result in negligible change to final void equilibrium levels.

7.0 POTENTIAL SURFACE WATER IMPACTS

The potential impacts of the modified Project on local and regional surface water resources and water licensing requirements comprise:

- impacts on surface water catchments and drainage associated with the mine and processing facility, modified rail siding and expanded treated wastewater irrigation area;
- downstream surface water impacts associated with the modified mine and processing facility water management system, expanded treated wastewater irrigation area and modified rail siding, including potential impacts to downstream water quality; and
- surface water licencing requirements for the modified mine and processing facility and rail siding.

The potential cumulative impacts from surrounding operations have also been considered for the modified mine and processing facility.

7.1 CATCHMENT YIELD AND FLOW IMPACTS

7.1.1 Mine and Processing Facility and Accommodation Camp

As the Modification would not increase the extent of the approved surface development area at the mine and processing facility and accommodation camp, no significant change to the approved flow impacts in the drainage lines in the vicinity of the mine and processing facility and accommodation camp would be expected.

Given the above, the Modification is expected to result in negligible change to the approved flow impacts in Bullock Creek and the Bogan River.

Notwithstanding the above, a description of the catchment yield and flow impacts for the mine and processing facility has been provided below for completeness.

Table 26 presents the total area captured over the life of the mine and processing facility from the Bullock Creek at Tullamore and Bogan River at Dandaloo catchments.

Table 26 Total Area Excised from Surface Water Catchments

Year	Excised Area (km^2)	Bullock Ck at Tullamore*	Bogan River at Dandaloo (GS 421083)^
		Percentage of Catchment Area	Percentage of Catchment Area
CY1	6.4	1.3%	0.1%
CY2	8.6	1.7%	0.2%
OY1	12.7	2.5%	0.2%
OY5	14.3	2.8%	0.3%
OY10	16.8	3.3%	0.3%
OY17	15.5	3.0%	0.3%
OY21	14.3	2.8%	0.3%
Final Landform	6.0	1.2%	0.1%

* Approximate total catchment area of 518 km^2

^ Total catchment area of 5,440 km^2 as stated at: https://realtimedata.waternsw.com.au/

The maximum area excised by the mine and processing facility and accommodation camp from the Bullock Creek and Bogan River catchment is estimated at 16.8 km^2 in OY10, equating to 3.3% of the total catchment area of Bullock Creek at Tullamore and 0.3% of the total catchment area of the Bogan River at Dandaloo. A reduction in 3.3% of the total catchment area of Bullock Creek at Tullamore is not considered significant given the discontinued nature of watercourses within the catchment. Post-closure, the mine and processing facility is estimated to result in a 1.2% and 0.1% reduction in catchment area of Bullock Creek at Tullamore and the Bogan River at Dandaloo respectively.

With a mean annual flow volume of 63,504 ML in the Bogan River at Dandaloo (WaterNSW gauging station [GS] 421083), the maximum reduction in mean annual flow due to the Project is estimated at 167 ML (0.3%). This represents a very small and indiscernible impact to flow in the Bogan River at Dandaloo.

7.1.2 Rail Siding

The drainage line to the south-east of the modified rail siding (Figure 3) has a catchment area of approximately 51.6 km^2 upstream of the modified rail siding. The maximum area excised by the modified rail siding would be approximately 0.05 km^2, equating to 0.1% of the drainage lines catchment area. This would represent a very small and indiscernible impact to flow in this drainage line.

7.2 DRAINAGE AND FLOODING IMPACTS

7.2.1 Mine and Processing Facility and Accommodation Camp

Regional Scale

As noted in Section 3.1.1, the mine and processing facility and accommodation camp are located in the upper headwaters of the Bullock Creek catchment. The Bullock Creek floodplain is prominent to the north of Tullamore while, to the south of Tullamore, Bullock Creek flows through steeper terrain. At its closest point, Bullock Creek is 7.5 km from the mine and processing facility. As such, it is unlikely that the mine and processing facility and accommodation camp will be affected by regional flooding impacts.

Given the above, the Modification is not expected to significantly change approved flooding impacts due to the mine and processing facility.

Local Scale

As described in Section 4.3.9, the diversion and collection drains, sediment dams and water storages at the mine and processing facility and accommodation camp will be designed, installed and maintained in accordance with the water management performance measures described in Condition 29, Schedule 3 of Development Consent (DA 374-11-00).

As the Modification would not change the Development Consent (DA 374-11-00) requirements for the diversion and collection drains and diversion dam, and that no overflow was predicted from the WSD, MWDs, PPRDs, RWD, EP, TSF or DTP based on all results for the 24 year, 132 realization simulations (Section 5.3.6), no significant changes to the approved potential localised drainage and flooding impacts is expected for the modified Project.

Notwithstanding the above, it is recognised that potential localised drainage and flooding impacts may occur in the vicinity of the mine and processing facility area. It is therefore recommended that further assessment (i.e. hydrologic and hydraulic modelling) be undertaken for the mine and processing facility during the detailed design stage to assess the potential localised flooding impacts and develop mitigation and management measures.

7.2.2 Rail Siding

The Modification is not expected to result in significant flooding impacts at the modified rail siding.

7.3 WATER QUALITY IMPACTS

7.3.1 Mine and Processing Facility and Accommodation Camp

The Modification would not change the approved water management performance measures or objectives of the water management system (i.e. control runoff from construction and operational areas, while diverting up-catchment water around these areas, and to minimise the use of undisturbed area water on-site).

Further, the water management system would be designed such that overflow from the sediment dams occurs in accordance with the Development Consent (DA 374-11-00) and EPL 21146. Detailed design of the sediment dams would be undertaken and appropriate sediment and erosion control would be implemented during construction and operations. Sediment and erosion control is likely to incorporate level spreaders or similar (refer Landcom [2004]) with appropriate armouring (e.g. rockfill) to mitigate the risk of erosion caused by overflow. Details would be included in the Surface Water Management Plan (Clean TeQ, 2019) and the sediment dams would be operated in accordance with EPL 21146.

A geochemical investigation conducted for the Environmental Impact Statement (Black Range Minerals, 2000) identified that materials excavated by the mining operations would be highly weathered and would be non-acid forming. As such, the risk of developing acid drainage at the Project was deemed to be very low to nil. The waste rock samples were found to be naturally alkaline and slightly to moderately saline. Chromium, iron and nickel were expected to be significantly enriched in the waste rock relative to average crustal abundances. However, as runoff from the waste rock emplacement areas is expected to maintain a near neutral pH in the long term, the risk of increased solubility of these elements is expected to be low. As described in Section 8.0, water quality monitoring of discharge from the sediment dams would be undertaken and assessed against the requirements of EPL 21146, as well as background and baseline water quality.

As stated in Section 5.3.6, no overflow was predicted from the WSD, MWDs, PPRDs, RWD, EP, TSF or DTP based on all water balance results for the 24 year, 132 realization simulation.

Based on the above, it is expected that there will be a low risk of adverse water quality impacts on the adjacent surface water systems due to the Modification during construction and operations.

The final void water balance modelling (Section 6.0) has indicated that the water level of the final voids should stabilise well below spill level under both natural conditions and with consideration to potential climate change effects. As such, there is a negligible risk of overflow from the final voids and therefore negligible risk to the water quality of adjacent watercourses in the long term.

7.3.2 Rail Siding

The rail siding water management system would be designed such that overflow occurs from active sediment control structures following settlement. Detailed design of the sediment dams would be undertaken and appropriate sediment and erosion control would be implemented during construction and operations. Sediment and erosion control is likely to incorporate level spreaders or similar (refer Landcom [2004]) with appropriate armouring (e.g. rockfill) to mitigate the risk of erosion caused by overflow. Details would be included in the Surface Water Management Plan (Clean TeQ, 2019).

As presented in Section 5.3.6, low overflow volumes are likely to occur from the rail siding sediment dams with a predicted average annual overflow volume of 0.4 ML to 0.8 ML and 1.7 ML to 3.3 ML from SD14 and SD15 respectively based on the 5th percentile and 95th percentile water balance model results.

It is recommended that overflow from the sediment dams is directed to a gross pollutant trap (GPT) prior to discharge offsite. A specifically designed GPT (e.g. triple interceptor) would aid in providing treatment for overflow (e.g. hydrocarbons, oils and gross pollutants from the rail siding roads and hardstand areas) prior to offsite release (Johnstaff, 2020).

Based on the above, it is expected that there will be a low risk of adverse water quality impacts on the adjacent surface water systems due to the Modification rail siding.

7.3.3 Treated Wastewater Irrigation Area

Consistent with the relevant performance measure (Section 2.1), the accommodation camp treated wastewater irrigation area will be managed in accordance with the *Environmental Guidelines: Use of Effluent by Irrigation* (DEC, 2004) with the irrigation controlled so as not to:

- cause irrigation water runoff from the treated wastewater irrigation area; or
- exceed the capacity of the soil in the treated wastewater irrigation area to effectively adsorb the nutrient and hydraulic loads.

The accommodation camp WWTP is proposed to treat wastewater to Class B/Class C standards. The recommended water quality specifications for Class B and Class C recycled water are presented in Table 27.

Table 27 Water Quality Specifications for Class B and Class C Recycled Water

Constituent	Class B (Median Value)	Class C (Median Value)
E. coli (cfu/100 mL)	< 100	< 1,000
Biological Oxygen Demand (mg/L)	20	20
Suspended Solids (mg/L)	30	30
Total Dissolved Solids (mg/L)	1,000 / 1,600	1,000 / 1,600
pH	6.8 - 5	6.8 - 5

* Source: Truewater Australia (2018)

Based on the expected total dissolved solids concentration of the recycled water, the recycled water will be of medium strength as defined in DEC (2004). For medium strength effluents, runoff diversion and collection management are required to divert external runoff away from the treated wastewater irrigation area (DEC, 2004). As such, it is recommended that a diversion drain is constructed along the western boundary of the treated wastewater irrigation area and a diversion bund is constructed along the southern boundary to divert external runoff further downstream where the topography is naturally sloped away from the treated wastewater irrigation area.

In accordance with DEC (2004), a tailwater collection system may be required to manage runoff from the treated wastewater irrigation area. Catch drains that direct runoff to a collection pond and a system to return the collected runoff to the effluent storage facility and/or the irrigation supply system is recommended in accordance with DEC (2004). Additionally, a water balance assessment of the proposed irrigation system should be undertaken prior to operation to assess the volume of recycled water that could be sustainably used on average each year, in accordance with DEC (2004).

DEC (2004) recommend a separation distance of 50 m from the treated wastewater irrigation area to natural waterbodies. Based on the modified treated wastewater irrigation area, the minimum distance of the irrigation area to the closest defined drainage line is estimated to be 68 m.

With the treated wastewater irrigation area designed, operated and maintained in accordance with the DEC (2004) guidelines, it is expected that there will be a low risk of adverse water quality impacts on the adjacent surface water systems due to the modified treated wastewater irrigation area.

7.4 WATER LICENCING REQUIREMENTS

7.4.1 Mine and Processing Facility and Accommodation Camp Water Licencing Requirements

Water Sharing Plan for the Macquarie Bogan Unregulated Rivers Water Sources 2012

The mine and processing facility and accommodation camp are located within the mapped extent of the Upper Bogan River Water Source under the *Water Sharing Plan for the Macquarie Bogan Unregulated Rivers Water Sources 2012*. The key objectives of the modified water management system are to manage runoff from construction and operational areas, while diverting up catchment water around these areas and to minimise the use of undisturbed area water on-site.

Licensing considerations for the water storages at the modified mine and processing facility and accommodation camp are summarised in Table 28.

The modified water storages are solely for the capture, containment and recirculation of mine affected water consistent with best management practice to prevent the contamination of a water source. These types of dams are "excluded works" under the Water Management (General) Regulation 2018 and, given that they are located on minor streams, are exempt from the requirement for water supply works approvals and WALs. Specifically, Item 12 of Schedule 4 of the Water Management (General) Regulation 2018 provides WAL exemptions in relation to water take from or by means of an 'excluded work' as defined in Schedule 1:

> *Dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice or required by a public authority (other than Landcom or the Superannuation Administration Corporation or any of their subsidiaries) to prevent the contamination of a water source, that are located on a minor stream.*

Therefore, the water captured in these water storages would not be subject to licencing under the *Water Sharing Plan for the Macquarie Bogan Unregulated Rivers Water Sources 2012*.

Notwithstanding the above, where appropriate, SEM may rely on its harvestable right entitlement for the water storages at the modified mine and processing facility and accommodation camp. Under the *Water Management Act 2000*, landholders in rural areas are permitted to collect a proportion of the rainfall runoff on their property and store it in one or more dams up to a certain size on minor streams. A dam can capture up to 10% of the average regional rainfall runoff for their landholding without requiring a licence. The landholding owned by SEM (located in the *Water Sharing Plan for the Macquarie Bogan Unregulated Rivers Water Sources 2012*) which is attributable to the mine and processing facility provides a maximum harvestable right capacity (i.e. maximum dam capacity) of 205 ML (Clean TeQ, 2019).

Table 28 Summary of Water Licensing Requirements for the Project Water Storages

Water Storage	Water Type Stored	Purpose	Water Licensing Requirement
SD1	Disturbed area runoff	Capture, containment and recirculation of drainage and/or effluent consistent with best management practice	Nil - Excluded Work
SD2			
SD3			
SD4			
SD4a			
SD5			
SD6			
SD8			
SD11a			
SD11b			
SD13			
MWD1	Mine water		
MWD2			
PPRD1			
PPRD2			
TSF			
DTP			
WSD			
EP			
RWD	Raw water	Turkeys nest dam to hold raw water from external water supply	Nil – Turkeys nest dam

<u>Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2020</u>

The mine and processing facility and accommodation camp are located within the mapped extent of the Lachlan Fold Belt MDB Groundwater Source under the *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2020*. SEM holds WAL 28681 under this water sharing plan for 243 share components. The existing volumetric licence allocations held by SEM are greater than the predicted groundwater inflows during the Project life and post-mining (i.e. less than 1 ML/year) (Golder, 2017) and therefore no additional licences are expected to be required.

7.4.2 Rail Siding Water Licencing Requirements

<u>Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012</u>

The modified rail siding is located within the mapped extent of the Gunningbland and Yarrabandai Water Source under the *Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012*.

Sediment dams SD14 and SD15 at the modified rail siding would be solely for the capture, containment and recirculation of drainage consistent with best management practice to prevent the contamination of a water source and are therefore exempt from the requirement for water supply works approvals or WAL under the *Water Sharing Plan for the Lachlan Unregulated River Water Sources 2012*.

Notwithstanding the above, where appropriate, SEM may rely on its harvestable right entitlement for the water storages at the modified rail siding (subject to incorporation in the Water Management Plan). The landholding owned by SEM which is attributable to the modified rail siding provides a maximum harvestable right capacity (i.e. maximum dam capacity) of 0.26 ML.

7.4.3 External Water Licencing Requirements

A description of SEMs water supply works, water use approvals and WALs issued under the *Water Management Act 2000* is provided in Section 2.3.

SEM currently holds a combined total of 3,577 share components for the Project borefield and surface water extraction infrastructure, which is greater than the predicted average annual offsite water demand during the operational phase (2,160 ML), although less than the predicted maximum annual offsite water demand during the operational phase (3,804 ML) (Section 5.4).

SEM currently holds WAL 42370 in the Lachlan Regulated River Water Source, for zero share components (High Security) under the *Water Sharing Plan for the Lachlan Regulated River Water Source 2016*. The Lachlan Regulated River Water Source has a history of available water determinations (AWDs) orders and water trading. While the water market is variable (availability subject to rainfall), it is mature (administered since 2004) and has significant available shares for trading. If required to meet the predicted maximum annual external water demand during the operational phase, SEM could purchase volumetric allocations under WAL 42370 on the open market.

7.5 CUMULATIVE IMPACTS

Other key proposed or approved projects that may potentially interact with, or have potential cumulative impacts with, the modified Project include:

- Parkes Special Activation Precinct
- Cattle Feedlot and Quarry
- Flemington Cobalt Scandium Mine
- Owendale Scandium Mine
- Western Slopes Pipeline
- Northparkes Mine Extension Project
- Inland Rail Parkes to Narromine
- Parkes Solar Farm
- Goonumbla Solar Farm
- Quorn Park Solar Farm
- Parkes Peaking Power Plant
- Parkes Bypass
- E44 Rocklands Project
- Jemalong Solar Farm
- Daroobalgie Solar Farm

Of these key proposed or approved projects, only the proposed Flemington Cobalt Scandium Mine and Owendale Scandium Mine may potentially interact with, or have potential cumulative surface water impacts with, the modified Project as they are located immediately north-west and north east of the mine and processing facility, respectively. The Environmental Assessment Requirements for these projects were issued in 2018. In accordance with the draft *Assessing Cumulative Impacts Guide - Guidance for State Significant Projects* (Department of Planning, Industry and Environment, 2020) guideline, these projects are 'potentially relevant projects', and are therefore not required to be considered. It is expected that any potential cumulative interactions between these projects and the modified Project would be considered and assessed in the surface water assessments for these projects.

8.0 RECOMMENDATIONS FOR MONITORING, MITIGATION AND MANAGEMENT

Surface water monitoring for the Project will be undertaken in accordance with EPL 21146 and the approved Surface Water Management Plan (Clean TeQ, 2019). Existing and recommended surface water monitoring for the modified Project are summarised in Table 29.

Table 29 Existing and Recommended Surface Water Monitoring

Type of Monitoring	Monitoring Sites/ Locations	Parameters	Frequency	Recommendation
Baseline surface water quality	SW1 to SW7	pH, electrical conductivity, total suspended solids, anions, cations and select total and dissolved metals (including chromium, iron and nickel)	Event based and weekly thereafter (if flowing)	Collection of additional baseline monitoring data to inform the development of site-specific trigger values
Wet weather and controlled release water quality	SD1, SD2, SD3, SD4, SD5, SD6, SD8, SD11a, SD11b	pH, electrical conductivity, total suspended solids, turbidity, select total and dissolved metals (including chromium, iron and nickel)	Event based	Commence once dams commissioned
	SD14, SD15	Oil and grease, pH and total suspended solids	Event based	Commence once dams commissioned
Reference and impact site surface water quality	SW1 to SW7	pH, electrical conductivity, total suspended solids, anions, cations, select total and dissolved metals (including chromium, iron and nickel)	Event based and weekly thereafter (if flowing)	Implement during construction and operational phase Additional monitoring in the vicinity of the treated wastewater irrigation area is recommended (refer Section 8.2)
			Event based and monthly thereafter (if flowing)	Continue during post-mining phase
Surface water quality	TSF, EP, WSD, open cut pits	pH, electrical conductivity, total suspended solids, anions, cations and select total and dissolved metals (including chromium, iron and nickel)	Quarterly	Implement at commencement of operational phase
Climate	Sunrise Weather Station	Rainfall	Continuous	Continue

Table 29 (Cont.) Existing and Recommended Surface Water Monitoring

Type of Monitoring	Monitoring Sites/ Locations	Parameters	Frequency	Recommendation
Water level	All water management system storages	Stored water level	At least once per month	Implement at commencement of operational phase
Water volume monitoring	Treated wastewater Irrigation area	Application rates, times, duration and areas	Continuous	Implement at commencement of operation of the accommodation camp
Visual monitoring	Treated wastewater Irrigation area	Runoff, waterlogging and erosion	Weekly	Implement at commencement of operation of the accommodation camp
Erosion and sediment control	Erosion and sediment control structures	Integrity/function, silt build up	Monthly and within five days of 50.7 mm of rainfall occurring over any consecutive five day period	Commence once installed
Structural integrity, erosion and sediment control	Diversion and collection drains			
Pipeline leakage, integrity and erosion and sediment control	Treated water pipeline and water supply pipeline	Pipeline leakage monitoring (e.g. differential flow monitoring) (water supply pipeline only)	Regular	Commence once pipeline installed
Site water demands	Truckfill (dust suppression)	Water usage rates	Daily truck count	Implement at commencement of operational phase
	Process plant		Logged continuously via flow meter, recorded monthly	
Site water supply	Borefield and Lachlan River water extraction	Water supply rates	Logged continuously via flow meter, recorded monthly	
Mine pit inflows	Open cut pits	Dewatering rates	Logged continuously via flow meter, recorded monthly	

8.1 BASELINE MONITORING

As stated in Section 3.3.2, the default guideline trigger values and EPL 21146 water quality limits have been frequently exceeded for a number of constituents at all or a majority of monitoring sites during the baseline monitoring period. As such, it is recommended that site-specific trigger values are developed for all constituents in accordance with the ANZG 2018 Guideline and the EPL 21146 water quality limits revised accordingly. The EPL 21146 water quality limits for the sediment dams should also be reassessed as the water quality of the sediment dams will reflect the baseline water quality of the region.

It is recommended that additional baseline monitoring data is collected to inform the development of the site-specific trigger values in accordance with ANZG (2018). ANZG (2018) recommend that data should be collected over 2 years of monthly sampling in order to derive site-specific trigger values. Where flow does not occur monthly in the monitored watercourses, it is recommended that the duration of baseline monitoring is extended to collect a minimum of 24 samples.

8.2 OPERATIONAL MONITORING AND MANAGEMENT

Surface water monitoring for the construction and operational phase of the Modification should be undertaken in accordance with EPL 21146 and the approved Water Management Plan (Clean TeQ, 2019), as summarised in Table 29.

It is recommended that the existing water quality monitoring site, SW3, is moved further upstream to provide a reference site for the drainage line that flows adjacent to the treated wastewater irrigation area and accommodation camp.

To enable calibration and update of the site water balance model, it is recommended that monitoring of the water level of site water storages and water usage/extraction rates is undertaken during the operational phase (refer Table 29).

Local erosion and sediment control is recommended to be implemented during the construction and operational phases. Monitoring of the integrity/function and silt accumulation of the sediment controls is recommended to be undertaken monthly and within five days of 50.7 mm of rainfall occurring over any consecutive five day period.

Pipeline leakage monitoring (e.g. differential flow monitoring installed at either end of the pipeline) should be installed as part of the construction of the water supply pipeline.

8.3 POST-MINING MONITORING AND MANAGEMENT

Water quality monitoring should continue for two years following cessation of operations with monitoring data reviewed at annual intervals (as part of the Annual Review process) over this period. Reviews should involve assessment against long term performance objectives that are derived from baseline conditions or a justifiable departure from these, with due allowance for climatic variations. If objectives are not substantially met within the two-year period, management measures should be revised and the monitoring period extended.

8.4 POTENTIAL CONTINGENCY MEASURES

In accordance with the approved Surface Water Management Plan (Clean TeQ, 2019), potential contingency measures in the event of unforeseen impacts or impacts in excess of those predicted would include:

- The conduct of additional monitoring (e.g. increase in monitoring frequency or additional sampling locations) to confirm impacts and inform the proposed contingency measures.
- Implementation of adaptive management strategies and refinements to the water management system design such as additional sedimentation dams, increases to pumping capacity, installation of new structures as required to address the identified issue.

Annual forecast water balance modelling is recommended to be undertaken to inform near term water supply reliability for the Modification as it progresses. Such forecasts will allow SEM to plan for contingency measures such as implementation of water reduction measures (including reduced production) should water shortfalls be predicted.

8.5 REVIEW AND REPORTING

In accordance with Development Consent (DA 374-11-00), SEM will review the environmental performance of the Project by the end of March each year for the previous calendar year). The Annual Review will be made publicly available on the SEM website.

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REFERENCES

ANZECC & ARMCANZ (2000). "Australian Water Quality Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy", Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resources Management Council of Australia and New Zealand (ARMCANZ), October.

ANZG (2018). "Australian and New Zealand Guidelines for Fresh and Marine Water Quality". Australian and New Zealand Governments and Australian State and Territory Governments, Canberra ACT, Australia. Available at: https://www.waterquality.gov.au/anz-guidelines.

Black Range Minerals Ltd (2000). "Syerston Nickel Cobalt Project Environmental Geochemical Assessment of Waste Rock and Tailings".

Boughton, W.C. (2004). "The Australian Water Balance Model", *Environmental Modelling and Software*, vol.19, pp. 943-956.

BoM (2021). "Intensity-Frequency-Duration". Bureau of Meteorology (BoM), http://www.bom.gov.au/water/designRainfalls/ifd/, accessed January 2021.

Clean TeQ (2019). "Clean TeQ Sunrise Project Surface Water Management Plan". 2020-CTEQ-0000-66AA-0015, September.

Clean TeQ (2020). " Clean TeQ Sunrise Project Execution Plan Phase Report". Unpublished.

CSIRO and BoM (2015a). "Climate Change in Australia". Accessed June 2021, http://www.climatechangeinaustralia.gov.au/en/. CSIRO and the Australian BoM, Australia.

CSIRO and BoM (2015b). "Climate Change in Australia Information for Australia's Natural Resource Management Regions: Technical Report". CSIRO and the Australian BoM, Australia.

DEC (2004). "Environmental Guidelines: Use of Effluent by Irrigation". NSW Department of Environment and Conservation (DEC), September.

DECC (2008a). "Managing Urban Stormwater Soils and Construction – Volume 2E – Mines and Quarries". NSW Department of Environment and Climate Change (DECC), June.

DECC (2008b). "Managing Urban Stormwater Soils and Construction – Volume 2A – Installation of Services". NSW Department of Environment and Climate Change (DECC), June.

DECC (2008c). "Managing Urban Stormwater Soils and Construction – Volume 2C – Unsealed roads". NSW Department of Environment and Climate Change (DECC), June.

Department of Planning, Industry and Environment (2020). "Assessing Cumulative Impacts Guide – Guidance for State Significant Projects". Exhibition Draft, December.

Dams Safety Committee (2012). "Tailings Dams", DSC3F, NSW Government.

Dams Safety Committee (2015). "Consequence Categories for Dams", DSC3A, NSW Government.

Golder (2017). "Syerston Project – Modification 4 Water Management Assessment". Submitted to Clean TeQ Holdings Limited, November 2017.

Golder (2018). "Clean TeQ Sunrise Project Clean Water Diversion and Stormwater Management Design Report". Prepared for Clean TeQ Holdings Limited, June.

Golder (2020). "Clean TeQ Sunrise Project Tailings Storage Facility, Water Storage Dam, Evaporation Pond, and Northern Diversion Drain". 2020-GOLD-1105-C12-00002, February.

HEC (2019). "Clean TeQ Sunrise Project Water Balance Review". Prepared for Clean TeQ Sunrise Pty Ltd by Hydro Engineering and Consulting (HEC), June.

Johnstaff (2020). "CleanTeQ Sunrise Project AmSul Storage Facility Concept Design Report". CleanTeQ Doc No: 2020-JHST-9210-A06-00005, January.

Landcom (2004). "Managing Urban Stormwater: Soils and Construction Volume 1", 4th edition, March.

McMahon, T.A., Peel, M.C., Lowe, L., Srikanthan, R. & McVicar, T.R., (2013). "Estimating actual, potential, reference crop and pan evaporation using standard meteorological data: a pragmatic synthesis", *Hydrology and Earth System Sciences*, vol. 17, pp. 1331-1363.

Minister for Urban Affairs and Planning (2001). "Development Consent DA 374-11-00". Sydney, File No.S98/01078.

OEH (2006). "NSW Water Quality and River Flow Objectives Macquarie-Bogan River". Office of Environment and Heritage (OEH), Department of Environment, Energy and Science, NSW Government. Available at: https://www.environment.nsw.gov.au/ieo/.

Truewater Australia (2018). "Irrigation Management Plan", April.

USDA & NRCS (1984). "Grassed waterways", *National Engineering Handbook, Part 650, Engineering Field Handbook*, Chapter 7, US Department of Agriculture (USDA), Washington D.C.

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