# 10.0 Surface water resources

## 10.1 Introduction

This chapter provides a summary of the surface water environment, with respect to water quality and resources within the Project Site of the Ensham Life of Mine Extension Project (the proposed project, hereafter referred to as 'the Project'), and surrounds. The main topics addressed include the characterisation of the existing surface water environment and environmental values, the assessment of water quality impacts, and the presentation of mitigation measures to minimise any potential impacts on the existing surface water environment as a result of the Project.

A detailed water quality assessment is presented in **Appendix E-1** (Surface water quality). A mine water and salt balance assessment, including the development of a comprehensive water and salt balance model (WSBM) has been completed for the Project and is presented in **Appendix E-2** (Mine water balance). The supporting surface water quality report in **Appendix E-1** (Surface water quality) has been prepared based on an earlier Project definition. The Project definition presented in this chapter supersedes that definition and does not require any additional changes to the groundwater study.

The assessment of hydrology, flooding and geomorphology in the Project Site is summarised in **Chapter 11** (Flooding and geomorphology).

**Environmental objectives and outcomes**

The Project seeks to protect environmental values in the Project Site relating to water. Within the Project Site, environmental values specifically relate to those set out under the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 and include aquatic ecosystems, irrigation, farm supply/use, stock water, aquaculture, human consumer, primary recreation, secondary recreation, visual recreation, drinking water, industrial use, and cultural and spiritual values.

Ensham manages mine water releases in accordance with Environmental Authority (EA) EPML00732813 and this has ensured that Ensham has complied with the defined EA water quality triggers and limits. As the Project is an extension of the current underground operation at Ensham Mine, impacts to water are not considered to be significant. On a precautionary basis, impacts to surface water quality have been assessed as a critical matter in the environmental impact statement (EIS).

## 10.2 Legislation and policy

### 10.2.1 Commonwealth legislation

#### 10.2.1.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) provides for the management and protection of flora and fauna of national environmental significance, referred to as matters of national environmental significance (MNES). Large coal mining developments such as the proposed Project can potentially disrupt aquatic ecosystems and therefore have adverse impacts on aquatic species, water resources and Ramsar wetland sites. Any action with the potential for a significant impact on these MNES

must be referred to the Australian Government Environment Minister and may require approval under the EPBC Act.

The Project is a controlled action (EPBC/2020/8669) under the EPBC Act. The controlling provisions are sections 18 and 18A (listed threatened species and communities) and sections 24D and 24E (water resource, in relation to coal seam gas development and large coal mining development) of the EPBC Act. The EIS process will assess the potential impacts of the Project on the controlling provisions consistent with the bilateral agreement (section 45 of the EPBC Act) between the Commonwealth and Queensland governments for the purposes of the Commonwealth Government's assessment under part 8 of the EPBC Act. Discussion of the impacts upon MNES is provided in Chapter 25 (Matters of national environmental significance).

### 10.2.2 State legislation

#### 10.2.2.1 Water Act 2000

The use of water for activities such as irrigation, stock water, drinking water and industrial use is regulated under the *Water Act 2000* (Qld) (Water Act). The Water Act provides the basis for the planning and allocation of Queensland's water resources. The watercourses potentially affected by the Project are subject to protection under the Water Act.

The Water Act defines a watercourse as a:

- river, creek or stream in which water flows permanently or intermittently in a natural channel, whether artificially improved or not, or
- an artificial channel that has changed the course of the watercourse.

Watercourses within the Project Site declared under the Water Act include the Nogoa River and its associated anabranch, and Winton and Mosquito Creeks. Resources within a declared watercourse are managed by the State and may be subject to licensing provisions (DSDMIP, 2019).

The Water Act and its instruments are administered by the Department of Natural Resources, Mines and Energy (DNRME). Water Resource Plans (WRPs) and Resource Operations Plans (ROPs) are governed by the Water Act.

WRPs establish a framework for sharing water between human consumptive needs and environmental values. ROPs are developed in parallel with WRPs and provide a framework by which objectives from the WRPs are implemented, including water allocations and administrative directions. The WRP and ROP applicable to the Project are detailed below.

**Fitzroy Basin Water Resource Plan**

The Project is located within the Fitzroy Basin. The Water Resource (Fitzroy Basin) Plan was finalised in 1999, but was amended in 2005 to address overland flow water management and was again updated in 2011.

**Fitzroy Basin Resource Operations Plan**

The Fitzroy Basin ROP came into force in January 2004 and was amended in October 2011 (Revision 3). It details how the objectives of the Water Resource (Fitzroy Basin) Plan will be met on an operational level, and defines strategies to support the WRP's overall goals for water entitlement security and ecological health.

In general, it provides the basis and rules for trading of water allocations, allows for unallocated water to be identified and allocated, and also details operating rules for the use of water management infrastructure such as weirs and dams. The Nogoa Mackenzie, Lower Fitzroy, and Fitzroy Barrage Supplemented Water Supply Schemes operate within the wider Fitzroy Basin catchment.

#### 10.2.2.2 Environmental Protection (Water and Wetland Biodiversity) Policy 2019

The purpose of the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP WWB) is to achieve the object of the *Environmental Protection Act 1994* (Qld) in relation to waters and wetlands by:

- identifying environmental values for waters and wetlands
- identifying management goals for waters
- stating water quality guidelines and water quality objectives to enhance or protect the environmental values
- providing a framework for making consistent, equitable and informed decisions about waters
- monitoring and reporting on the condition of waters.

Section 8 of the EPP WWB states:

> *For particular water, the indicators and water quality guidelines for an environmental value are—*
>
> *(a) decided using the following documents —*
>
> *(i) site-specific documents for the water;*
>
> *(ii) the document called 'Queensland water quality guidelines 2009', published on the department's website;*
>
> *(iii) the document called 'Australian and New Zealand guidelines for fresh and marine water quality', published in October 2018;*
>
> *(iv) the document called 'Australian drinking water guidelines, paper 6, national water quality management strategy', dated 2011 and published on the National Health and Medical Research Council's website;*
>
> *(v) the document called 'Guidelines for managing risks in recreational waters', dated 2008 and published on the National Health and Medical Research Council's website;*
>
> *(vi) other relevant documents published by a recognised entity; or*
>
> *(b) for water mentioned in schedule 1, column 1—the indicators stated in the document opposite the water in schedule 1, column 2.*

Schedule 1 of the EPP WWB provides reference to the Nogoa River Sub-basin Environmental Values and Water Quality Objectives document (DEHP, 2011a) and the Mackenzie River Sub-basin Environmental Values and Water Quality Objectives document (DEHP, 2011b) both of which are deemed relevant to the Project.

#### 10.2.2.3 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000) provide recommended parameters for:

- water and sediment quality that will sustain the ecological health of aquatic ecosystems
- irrigation and general water use
- livestock drinking water
- aquaculture and human consumers of aquatic food
- waters for recreational activities, such as swimming and boating
- preservation of the aesthetic appeal of these waters.

#### 10.2.2.4 Other guidelines

Information on water quality has also been obtained from the Queensland Water Quality Guidelines (DEHP, 2009). This chapter has also considered the Department of Environment and Science (DES) EIS Information Guideline – Water.

# 10.3 Methodology

## 10.3.1 Surface water quality

The assessment of surface water quality involved the following steps:

- identification of the environmental values of surface waters within the Project Site and immediately downstream that may be affected by the Project
- definition of relevant water quality objectives applicable to the environmental value
- characterisation of the quality of surface waters within the Project Site
- assessment of the likely impact of any releases on all relevant environmental values of the surface water receiving environment
- assessment of how the water quality objectives and performance outcomes will be achieved and monitored.

Available surface water quality data consists of both Ensham Mine and DNRME monitoring covering the period since Ensham commenced operations in 1993. Reliable continuous data is available from June 2016 to July 2019. Monitoring consist of data from upstream sites, downstream site and mine area sites located within the existing Ensham Mine and Project Site.

The locations of surface water quality monitoring sites, divided into the categories above, are shown **Figure 10-1**. These are discussed and illustrated in greater detail in **Appendix E-1** (Surface water quality).

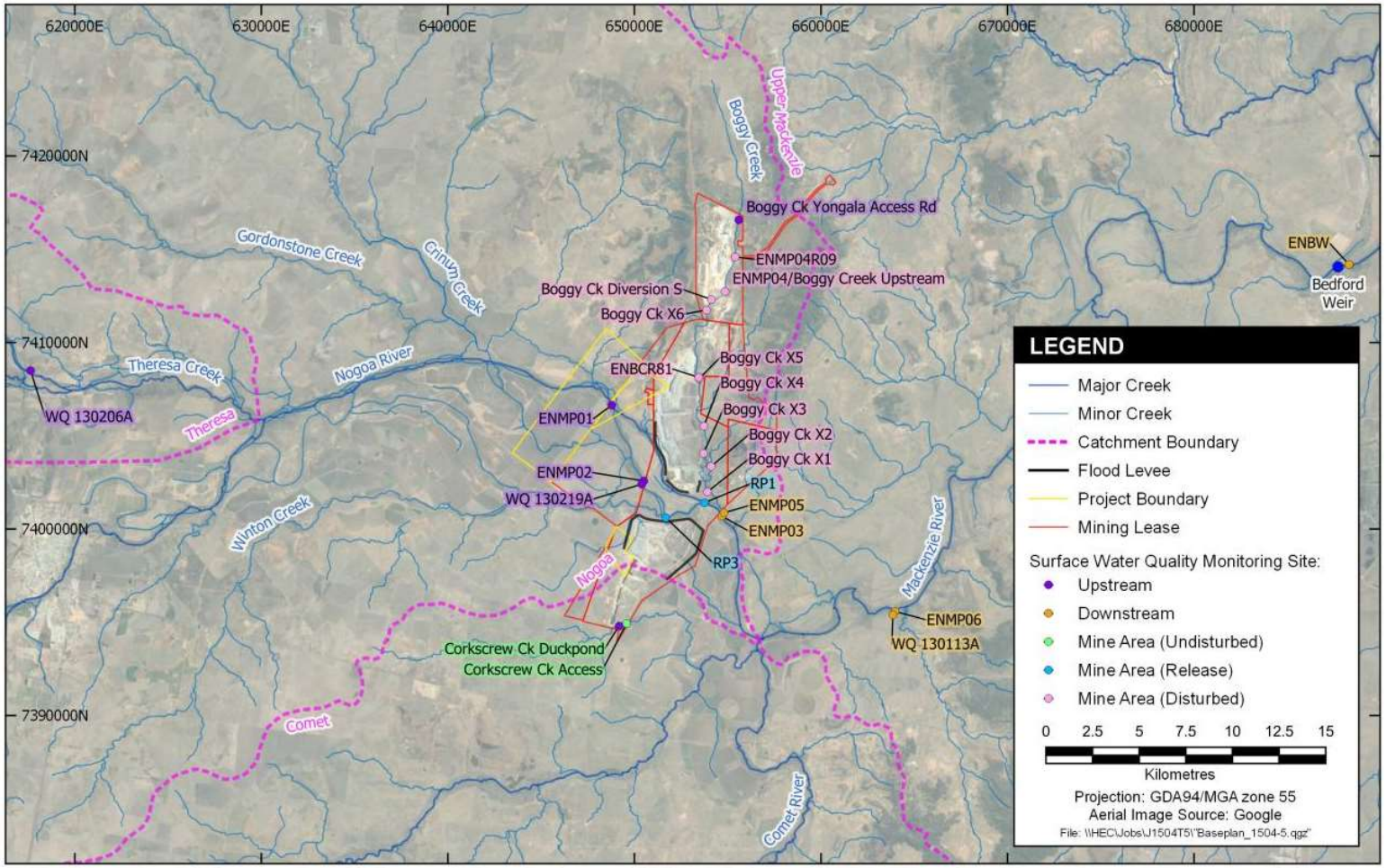



**Figure 10-1 Water quality monitoring sites**

### 10.3.2 Mine water assessment

To inform the mine water assessment for the Project, the following key steps were undertaken:

- identification and description of the existing environment relevant to the conceptual Project mine water management strategy
- identification of key objectives and considerations for the mine water management strategy
- development of the proposed mine water management strategy required to meet the key objectives and considerations
- validation of proposed mine water management strategy through water and salt balance assessment
- development of schematic for mine water management strategy
- confirmation of mine plan and all WSBM input data
- development and confirmation of WSBM
- validation of proposed mine water management strategy to meet outline key objectives and considerations.

#### 10.3.2.1 Model development

A dynamic water and salt balance model was developed for the Project using GoldSim probabilistic modelling software. GoldSim is a Monte Carlo simulation software package that is commonly used in the mining industry for water balance modelling. The purpose of the water balance assessment was to validate the proposed mine water management strategy under a range of historical climatic conditions, with the aim of:

- estimation of the potential quantity and quality of mine affected water that may be generated during the operation of the Project
- estimation of the storage capacity required to meet the stated mine affected water containment objectives
- confirmation that the proposed operational rules are supportive of the proposed mine affected water containment reuse objectives
- identification of the required transfer capacities to move mine affected water around the mine water management system so that containment, productivity and reuse objectives are met
- estimation of the potential volumes of raw water required to satisfy Project consumptive demands that either:
  - cannot be satisfied through the reuse of mine affected water, or
  - when stored volumes of mine affected water are unavailable following periods of prolonged drought
- development of an understanding of the potential risk of overflow to the receiving environment.

The WSBM was developed to dynamically simulate the proposed production schedule. This allowed for key model inputs such as climate data, water demands and groundwater inflow to vary with each simulated mine year. In this manner, the WSBM provided for a more representative simulation of the Project as it allowed for ready identification of critical water management strategy stress points such as maximum containment requirements and peak raw water demand.

A detailed discussion of the WSBM development is provided in **Appendix E-2** (Mine water balance).

# 10.4 Description of environmental values

## 10.4.1 Regional catchments

Ensham Mine is located within the floodplain of the Nogoa River. The Nogoa River has a catchment area of approximately 27,000 square kilometres ($km^2$) upstream of the mine.

In the vicinity of Ensham Mine, the Nogoa River forms part of the Nogoa Mackenzie Water Supply Scheme which supplies agriculture, industry and towns in Central Queensland. Fairbairn Dam is the major water storage in the scheme, the operation of which involves controlled release of water from the dam, via the Nogoa River, to downstream water users and weirs (e.g. Bedford Weir) on the Mackenzie River. Fairbairn Dam is located on the Nogoa River approximately 60 kilometres (km) upstream of the mine capturing runoff from an area of some 16,320 $km^2$ (Sunwater, 2019).

The majority of the remaining catchment upstream of the mine lies in the Theresa Creek sub-catchment (**Figure 10-2**). This is illustrated in greater detail in **Appendix E-1** (Surface Water Quality).

The Nogoa River meets the Comet River approximately 9 km downstream of the site to form the Mackenzie River which, in turn, flows to the Fitzroy River before discharging to the ocean approximately 45 km south-east of Rockhampton. The Nogoa and Mackenzie Rivers are considered perennial which is largely a result of regulated releases from Fairbairn Dam. Flows are typically low during the late winter and early summer seasons.

## 10.4.2 Local surface water features

As shown on **Figure 10-3**, the Nogoa River flows to the north of B Pit and south of C Pit in a south-easterly direction. The Nogoa River has a floodplain up to 5 km wide downstream of the Ensham Mine. Winton Creek flows into an anabranch of the main channel of the Nogoa River joining it within the Ensham Mine mining lease (ML) (ML 7459) where the floodplain varies from 1 to 2 km wide. Mosquito Creek is a tributary of the Nogoa River and flows through the Project Site.

Boggy Creek is the main tributary within the existing mining leases. It flows generally north to south and joins the Nogoa River downstream of the Winton Creek confluence on the northern side of the river within ML 7459 (**Figure 10-3**). A diversion has been built along Boggy Creek to permanently divert flows around the mine footprint. Recent observations suggest Boggy Creek is ephemeral with waterholes persisting for very brief periods shortly after flow events.

Corkscrew Creek runs generally west to east, south of the Ensham Mine area, before flowing into Sandhurst Creek which in turn flows to the Comet River just upstream of the confluence with the Nogoa River (**Figure 10-3**).This is illustrated in greater detail in **Appendix E-1** (Surface Water Quality).

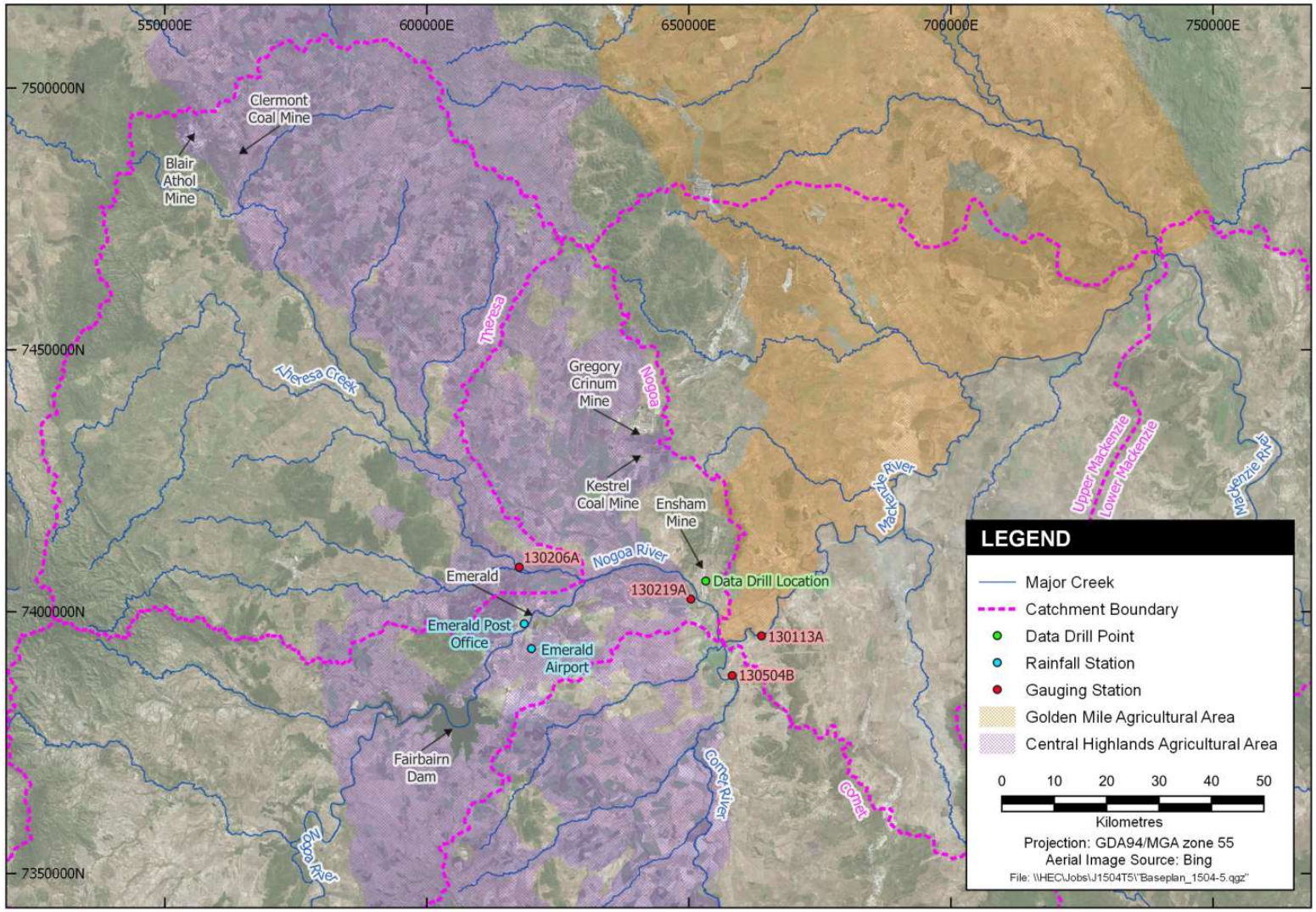



**Figure 10-2 Regional surface water context**

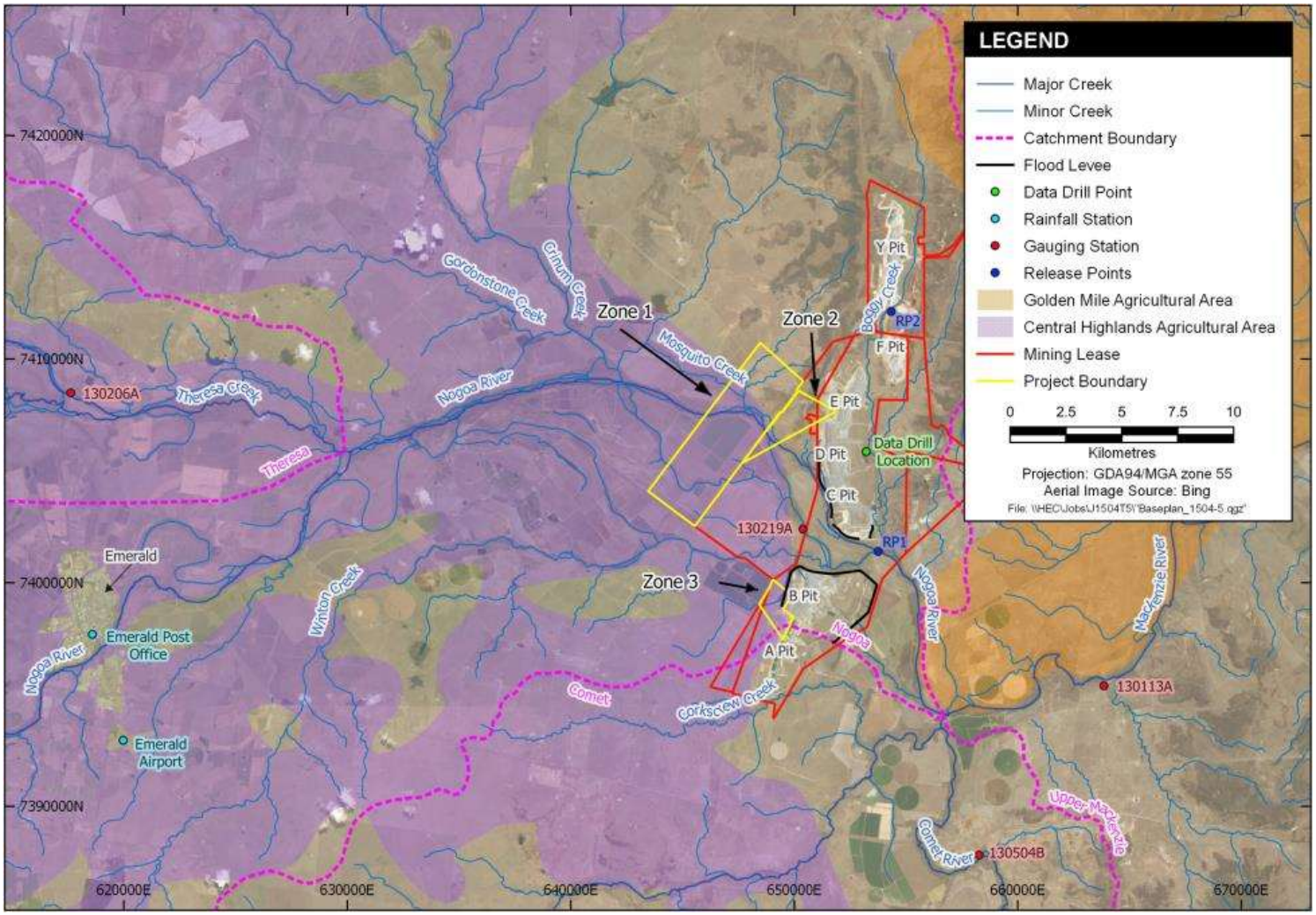



**Figure 10-3 Local surface water context**

### 10.4.3 Published environmental values

Table 1 of the Nogoa River Sub-basin Environmental Values and Water Quality Objectives document (DEHP, 2011a) provides environmental values for waters within the basin. The existing mine is located in both the Lower Nogoa main channel waters and the Lower Nogoa and Theresa Creek tributaries waters. The Project zones are located wholly within the Lower Nogoa main channel waters.

Table 1 of the Mackenzie River Sub-basin Environmental Values and Water Quality Objectives document (DEHP, 2011b) provides environmental values for waters within the basin. The receiving environment for both the existing mine and the Project is within the Mackenzie main channel waters.

The Lower Nogoa main channel waters and the Mackenzie main channel waters are identified as having all the environmental values listed below while the Lower Nogoa and Theresa Creek tributaries waters are identified as having all except aquaculture:

- aquatic ecosystems
- irrigation
- farm supply/use
- stock water
- aquaculture
- human consumer
- primary recreation
- secondary recreation
- visual recreation
- drinking water
- industrial use
- cultural and spiritual values.

### 10.4.4 Water quality objectives and default guideline values

Water quality objectives (WQOs) are defined in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (www.waterquality.gov.au/anz-guidelines), herein referred to as the Guidelines, as the:

*"...guideline value or narrative statement for each selected indicator that should ensure the protection of all identified community values. Where there are multiple environmental (community) values it is recommended that the most stringent guideline value be chosen to ensure that all community values are protected"*

The Guidelines recommend that site specific trigger values (SSTVs) be adopted in preference to the default guideline values where warranted. The Guidelines recommend that SSTVs should be based on at least two years of monthly monitoring data from an appropriate site; for example, upstream of impacted areas, or from appropriate local reference systems that are representative of unimpacted water bodies. Derivation of SSTVs was not possible for any of the surface water quality monitoring sites in this analysis due to the lack of an appropriate reference site or sites.

WQOs of relevance to the Project are summarised in **Table 10-1**.

**Table 10-1 Adopted water quality objectives**

| Constituent | Environmental value | WQO |
|---|---|---|
| Electrical conductivity (EC) | Aquatic ecosystems | Lower Nogoa: <340 microsiemens per centimetre (µS/cm) (baseflow)[∞]<br>Theresa Creek: <720 µS/cm (baseflow)[∞]<br>Mackenzie River: <310 µS/cm (baseflow)[∞] |
| Total dissolved solids (TDS) | Recreation | <1,000 milligrams per litre (mg/L) |
| pH | Aquatic ecosystems (tropical aquaculture) | 6.8-8.5 |
| Suspended solids | Aquatic ecosystems | <10 mg/L |
| Turbidity | Aquatic ecosystems | <50 Nephelometric Turbidity Units (NTU) |
| Total nitrogen | Aquatic ecosystems | Lower Nogoa and Theresa Creek: <500 micrograms per litre (µg/L)<br>Mackenzie River: <775 µg/L |
| Total phosphorus | Aquatic ecosystems | Lower Nogoa and Theresa Creek: <50 µg/L<br>Mackenzie River: <160 µg/L |
| Sulphate as $SO_4$ | Aquatic ecosystems | Lower Nogoa and Theresa Creek: <25 mg/L<br>Mackenzie River: <10 mg/L |
| Hardness | Aquatic ecosystems (tropical aquaculture) | 20-450 mg/L |
| Alkalinity | Aquatic ecosystems (tropical aquaculture) | 20-400 mg/L |
| Iron | Aquatic ecosystems (tropical aquaculture) | <0.01 mg/L |
| Manganese | Aquatic ecosystems (tropical aquaculture) | <0.01 mg/L |
| Aluminium | Aquatic ecosystems | <0.03 mg/L |
| Chromium | Aquatic ecosystems | <0.001 mg/L |
| Copper | Aquatic ecosystems | <0.0014 mg/L |
| Nickel | Aquatic ecosystems | <0.01 mg/L |
| Zinc | Aquatic ecosystems | <0.008 mg/L |

[∞] Comparison has been made against the baseflow EC (higher number – refer Table 10-1) because the flow regime at the time of sampling was unknown and the definition of high flow is unknown.

WQOs have been sourced for the Lower Nogoa, Theresa Creek and Mackenzie River catchments for each of the relevant water quality monitoring sites as summarised in **Table 10-2**.

**Table 10-2 Water quality monitoring sites and source of water quality objective**

| Catchment | Source of water quality objectives | Relevant water quality monitoring sites |
|---|---|---|
| Lower Nogoa main channel<br>Lower Nogoa and Theresa Creek tributaries | Nogoa River Sub-basin Environmental Values and Water Quality Objectives document (DEHP, 2011a) | ENMP01, ENMP02, ENMP03, ENMP04, ENMP04R09, ENMP05, WQ 130219A, Corkscrew Creek Access, Corkscrew Creek Duckpond, RP1, RP2, Boggy Ck X1, Boggy Ck X2, Boggy Ck X3, Boggy Ck X4, Boggy Ck X5, Boggy Ck X6, Boggy Ck Yongala Access Rd, Boggy Ck Diversion S, Boggy Ck Upstream, ENBCR81 |
| Theresa Creek main channel | Nogoa River Sub-basin Environmental Values and Water Quality Objectives document (DEHP, 2011a) | WQ 130206A |
| Mackenzie main channel | Mackenzie River Sub-basin Environmental Values and Water Quality Objectives document (DEHP, 2011b) | ENMP06, WQ 130113A, ENBW |

The most stringent WQOs for all parameters have been identified and used for comparative benchmarking of baseline data. As noted in the Nogoa River Sub-basin Environmental Values and Water Quality Objectives document (DEHP, 2011a), the median water quality value of a number of independent samples (preferably five or more) at a particular monitoring site should be compared to the WQO. For toxicant test data (i.e. aluminium, arsenic, boron, cadmium, chromium, cobalt, copper, manganese, mercury, molybdenum, nickel, selenium, silver, uranium, vanadium and zinc) Australian and New Zealand Governments (ANZG, 2018) guidelines recommend that action is triggered if the 95$^{th}$ percentile exceeds the WQO. ANZG (2018) guidelines also suggest a minimum of 40 samples are required to calculate the 95$^{th}$ percentile from a data set hence this statistic is only calculated where sufficient samples are available.

The WQOs do not distinguish between “total” and “dissolved” samples both of which are common methods to express the results of analysis of metal constituents. From an aquatic ecology perspective, the total result can be considered an upper limit on the concentration of metals which can be compared with benchmark values while the dissolved result can be considered as being more representative of the bio-available fraction in the water. For this reason, both the total and dissolved samples have been included in this analysis.

### 10.4.5 Streamflow characteristics

The DNRME operates a number of flow monitoring (gauging) stations on Theresa Creek as well as the Nogoa, Comet and Mackenzie rivers. Details of the stations near the Project Site are summarised in **Table 10-3**.

**Table 10-3 Summary of flow monitoring stations near the Project Site**

| Gauging station no. | Gauging station name | River system | Location | Establishment date* |
|---|---|---|---|---|
| 130206A | Theresa Creek at Gregory Highway | Theresa Creek | Gregory Highway crossing 14.5 km upstream of Nogoa River confluence | 10/1/1956 |
| 130219A | Nogoa River at Duck Ponds | Nogoa River | At the mine site access road | 2/4/1993 |

| Gauging station no. | Gauging station name | River system | Location | Establishment date* |
|---|---|---|---|---|
| 130504A | Comet River at Comet Weir | Comet River | Some 11 km upstream of Nogoa River confluence | 10/8/1971 (ceased: 14/4/2004) |
| 130504B | | | | 12/6/2002 |
| 130113A | Mackenzie River at Rileys Crossing | Mackenzie River | Some 11 km downstream of Nogoa River and Comet River confluence | 13/10/2004 |

Source: Queensland Water Monitoring Information Portal (Queensland Government, 2019a)

* Unless specified, all stations are open as at November 2019.

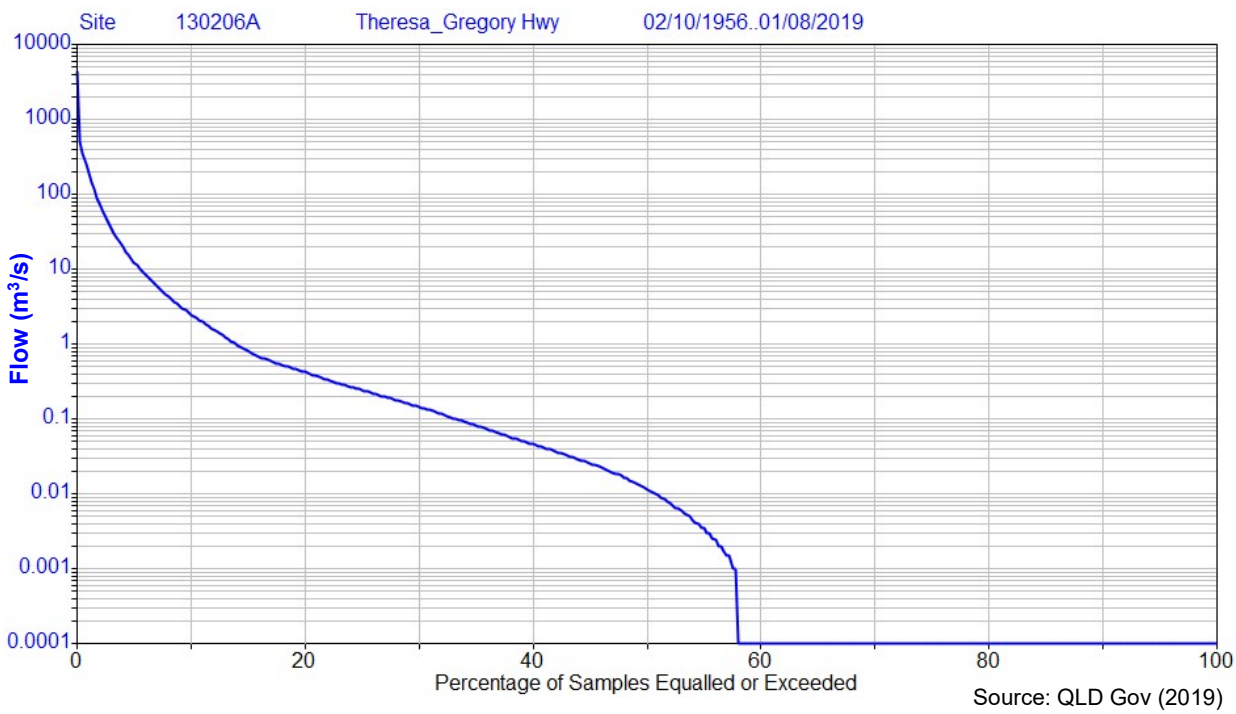
The existing flow monitoring station on the Comet River (130504B) was installed in 2002 and was preceded by an earlier station (130504A) which commenced in 1971.

Note that level monitoring is also conducted in Boggy Creek at RP2 however flow data was only available for episodic events between 2016 and 2019 hence was insufficient to characterise flow behaviour further.

No river flow objectives were available for the watercourses at the locations provided in **Table 10-3** hence a comparison to available flow data in the sections to follow was not possible.

#### 10.4.5.1 Theresa Creek

The mean annual flow in the Theresa Creek at Gregory Highway gauging station (130206A) over the available record is some 257,000 megalitres per year (ML/y) or the equivalent to a catchment runoff of 30.2 millimetres per year (mm/y). The daily flow duration curve for the site is reproduced as **Figure 10-4**. It is apparent that Theresa Creek is ephemeral with flow recorded for slightly less than 60 per cent of days.

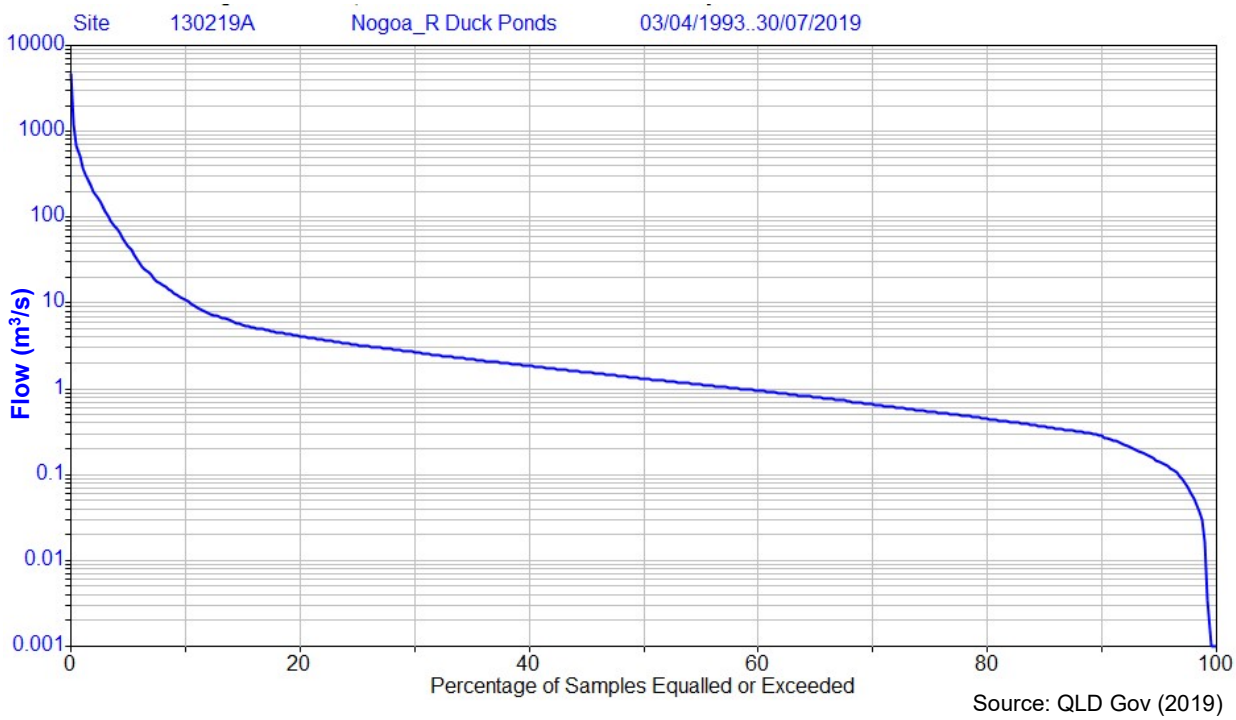



Source: QLD Gov (2019)

**Figure 10-4 Daily flow duration curve for Theresa Creek at Gregory Highway**

#### 10.4.5.2 Nogoa River

The mean annual flow in the Nogoa River at Duck Ponds gauging station (130219A) over the available record is some 640,000 ML/y or the equivalent to a catchment runoff of 23.6 mm/year. The daily flow duration curve for the site is reproduced as **Figure 10-5**. The Nogoa River is considered to be perennial which may be attributable to controlled releases from Fairbairn Dam.

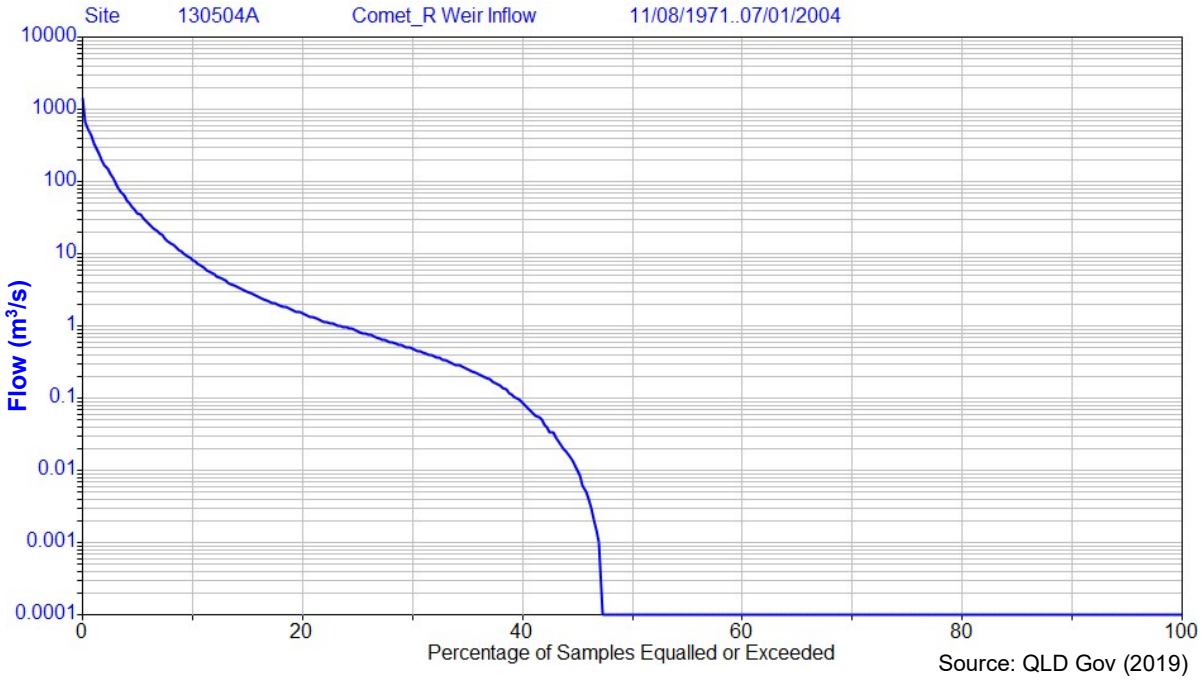



Source: QLD Gov (2019)

**Figure 10-5 Daily flow duration curve for Nogoa River at Duck Ponds**

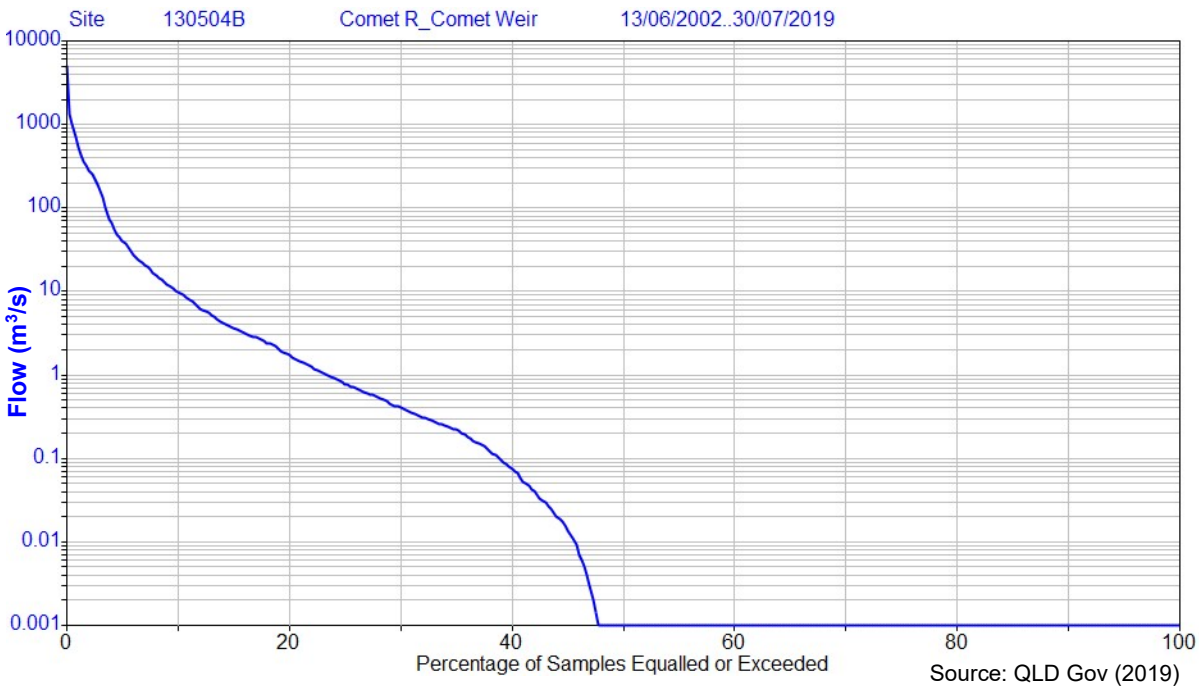
#### 10.4.5.3 Comet River

The mean annual flow in the Comet River at the two Comet Weir gauging stations vary with the historical station (130504A) recording some 393,000 ML/y while the existing station (130504B) recording some 668,000 ML/y or the equivalent to a catchment runoff of 40.6 mm/year. The daily flow duration curves for the two monitoring sites are reproduced as **Figure 10-6** and **Figure 10-7**. The flow duration curves show that the Comet River is ephemeral with flow recorded on approximately 47 per cent of days.




Source: QLD Gov (2019)

**Figure 10-6 Daily flow duration curve for Comet River at Comet Weir (130504A)**

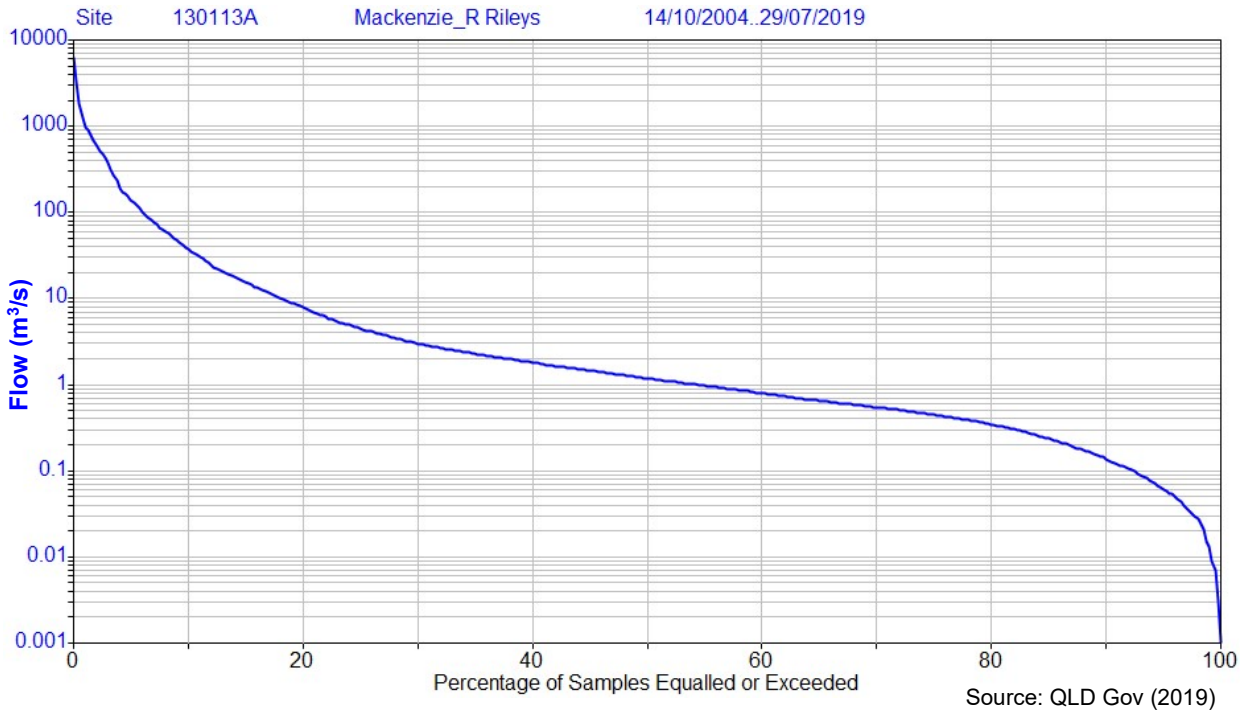



Source: QLD Gov (2019)

**Figure 10-7 Daily flow duration curve for Comet River at Comet Weir (130504B)**

#### 10.4.5.4 Mackenzie River

The mean annual flow in the Mackenzie River at Rileys Crossing gauging station (130113A) downstream of the mine over the available record is some 1,578,000 ML/y or the equivalent to a catchment runoff of 35.0 mm/year. The daily flow duration curve for the site is reproduced as **Figure 10-8**. The Mackenzie River downstream of the mine is perennial which, as noted for the Nogoa River (refer **Section 10.4.5.2**), may be attributable to controlled releases from Fairbairn Dam.




Source: QLD Gov (2019)

**Figure 10-8 Daily flow duration curve for Mackenzie River at Rileys Crossing**

## 10.4.6 Existing water quality

Surface water quality monitoring at and in the vicinity of the Ensham Mine has been categorised into upstream sites, downstream sites and mine area sites. Comparisons have been made to WQOs for the Lower Nogoa, Theresa Creek and Mackenzie River catchments.

At the four upstream sites, median values exceed WQOs at all sites for suspended solids, at two sites for nutrients, at two sites for EC (salinity) and at one site for turbidity. Continuously recorded (gauging station) EC values are low at high flows but cover a wide range at low to moderate flows. EC data at low to moderate flows is likely affected by regulated releases from Fairbairn Dam. Recorded values of iron, total manganese, aluminium, total chromium, copper and zinc were elevated compared with the WQOs at most sites.

At the five downstream sites, median values exceed WQOs at all sites for which data were available for suspended solids, at two sites for EC, at one site for turbidity, one site for total nitrogen and two sites for sulphate. Recorded values of iron, manganese, aluminium, total chromium, copper and zinc were elevated compared with the WQOs at most sites.

Limited data were available for the two mine area undisturbed sites. For those sites with sufficient data, EC, suspended solids, total iron, total manganese and total aluminium were elevated compared with the WQOs.

Data for RP1 (EA release point) indicates elevated median EC, TDS, suspended solids, sulphate and hardness compared with the WQOs. However, 80th percentile EC, turbidity and sulphate values are less than EA limits for controlled release. It is noteworthy that median values for recorded trace metals concentrations at RP1 do not exceed the respective WQOs.

# 10.5 Mine water management

The aim of the water management strategy is to provide adequate water for the Project whilst minimising environmental impacts through the collection and management of mine affected water. This is broadly achieved through:

- managing the generation, storage, distribution and reuse of all potentially mine affected water captured and generated by the Project
- handling the conveyance of natural runoff originating from undisturbed clean catchments through the Project Site
- managing the storage and distribution of raw water.

Ensham Mine currently operates a mine water management system encompassing the existing open-cut and underground operations. As the Project is an extension of the existing underground operations, the Project will utilise the existing mine water management system as underground mining transitions from the existing approved areas to the Project Site.

Ensham Mine has a Water Management Plan (WMP) which details the mine water management system across the existing operations. It is not expected that there will be any change to the current WMP given the Project is simply a continuation of the existing underground mining operations.

This section describes the mine water infrastructure already in place in the existing mine water management system at Ensham Mine and the assessment of the mine water balance with the inclusion of the Project. The potential changes required to the system as a result of the Project are described in **Section 10.6**.

## 10.5.1 Mine water infrastructure

The existing mine water management system at Ensham Mine comprises a number of interlinked components, including open-cut pit storages, water storage dams, a water treatment plant (WTP) and pumping systems. The existing water management system includes three main open-cut pit storages located north and south of the Nogoa River, and west of Boggy Creek. The open-cut pit storages are connected by a pipeline (Northern Backbone) to allow water to be transferred between the open-cut pits. All of the pits are subject to groundwater inflow.

In addition to the open-cut pit storages, a system of water storage dams is located to the east of Boggy Creek and the Nogoa River. These dams store and transfer water to the coal handling plant (CHP), the WTP and the underground mine workings. The mine water system is illustrated in **Figure 10-9**.

A detailed description of the existing mine water management system operating and transfer rules is provided in **Appendix E-2** (Mine water balance). The existing water management system is considered adequate for the Project, including consideration of groundwater inflows discussed in **Chapter 12** (Groundwater), **Section 12.5.1**.

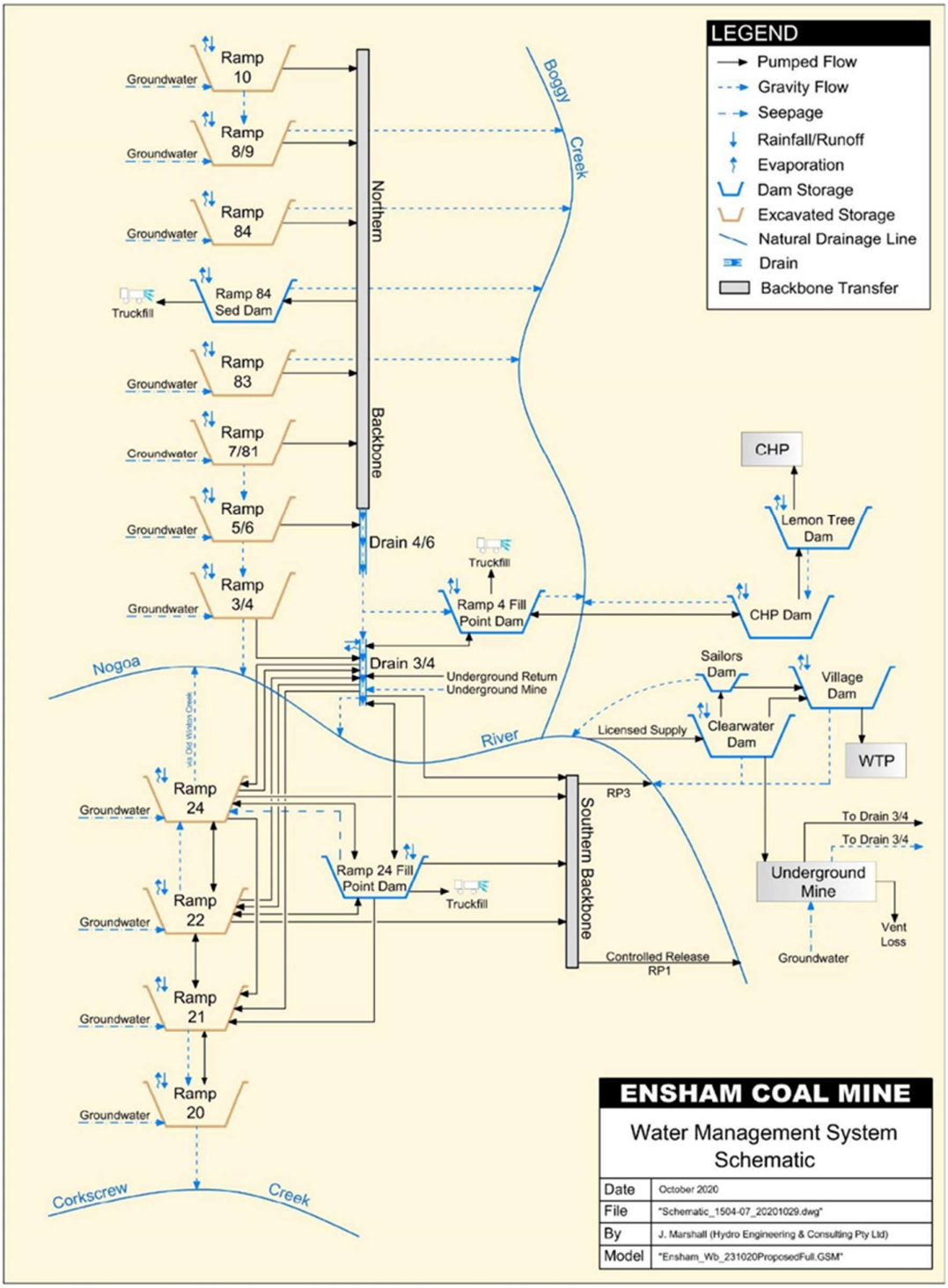



**Figure 10-9 Water management schematic**

### 10.5.2 Mine and salt water balance

The GoldSim water balance model developed for Ensham Mine's existing operation has been used as a basis for the development of a comprehensive water and salt balance model for the Project. The model simulates the site water management system for the existing operation and the Project to enable an assessment of the overall water management system's performance. The storages and linkages illustrated in **Figure 10-9** are simulated in the model to represent the systems operation once the Project becomes operational.

The model simulates the volume of water and the mass of salt stored in, and pumped between, all simulated water storages and ultimately released to the Nogoa River. The model operations on an eight hourly time step from June 2020 until April 2037 when the Projects mining operations are expected to cease. The model has been run for 131 climate sequences (known as 'realisations') derived using historic daily climate data from 1889 to 2020. The results of all realisations are used to generate water storage volume estimates, supply reliability and other relevant water balance statistics.

The Project does not require and additional surface infrastructure or surface disturbance within Zone 1 of the Project Site. Therefore, the changes to the model are confined to the Ensham Mine's underground operations, taking account of the predicted groundwater inflow rates for the Project. Groundwater inflow rates for the Project are based on the groundwater impact assessment for the Project presented in **Chapter 12** (Groundwater).

The model predicts changes to storage requirement for the Project based on the inflows and outflows in the mine water management system. Inflows in the system include rainfall, runoff, groundwater inflow (for the open-cut pits and dam), water sourced from Nogoa River and pumped inflows from other storages. Outflows in the system include evaporation, spill, pumped outflows to other storages or to supplement process water demands (e.g. the CHP) and controlled release to the Nogoa River. These inflows and outflows are discussed in the following sections.

#### 10.5.2.1 Rainfall and runoff

The water balance model incorporates long-term daily rainfall and evaporation data for Ensham Mine obtained from the Queensland Government's Data Drill service. The Data Drill is a system that provides synthetic data sets for a specified point by interpolation between surrounding point records held by the Bureau of Meteorology. The dataset provides 131 years of daily rainfall and evaporation data, enabling 131 model realisations to be simulated to encompass all historic climatic events.

The data indicate an annual average rainfall of 578 mm and an annual average evaporation rate of 2,108 mm at Ensham Mine. The average monthly rainfall and evaporation depths derived from the dataset are presented in **Figure 10-10**.

Rainfall runoff is simulated in the model using the Australian Water Balance Model (AWBM) (Boughton, 1993). The AWBM is a nationally-recognised overland flow model which estimates daily values of runoff using a daily water balance of soil moisture.

AWBM simulation of flow from six different sub-catchment types was undertaken, namely: rehabilitated and natural areas, haul road areas, pit floor areas, non-rehabilitated spoil areas, cleared areas and stockpile and industrial areas. The sub-catchment areas for each storage were estimated from aerial photography and recent mine contour plans. The AWBM parameters for the sub-catchment types are described in **Appendix E-2** (Mine water balance).

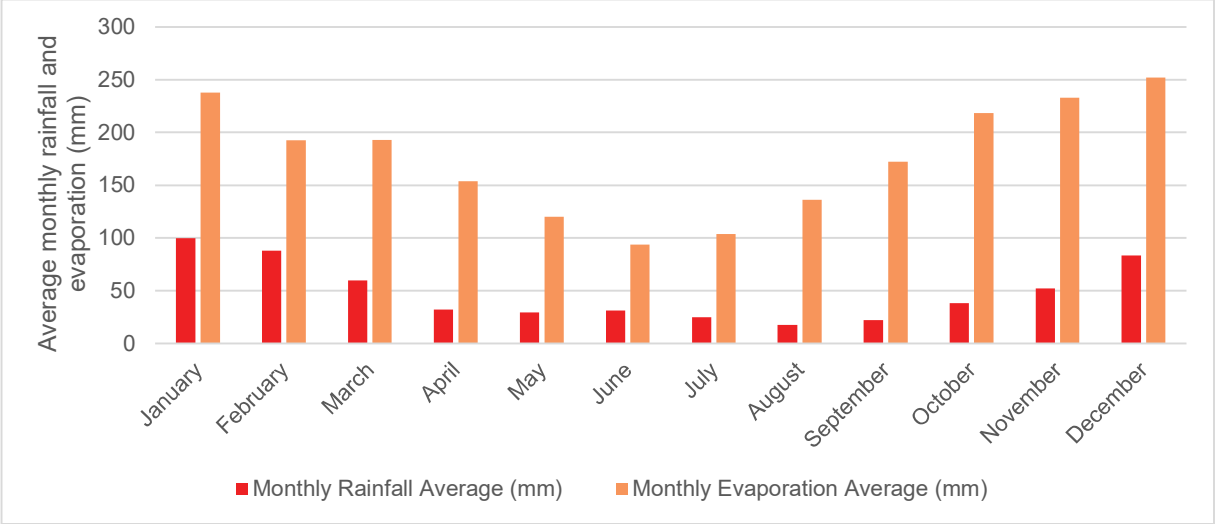



**Figure 10-10 Monthly average rainfall and evaporation**

#### 10.5.2.2 Catchment areas and storage characteristics

Catchment areas for the open-cut pit storages and dams are estimated based on site plans, aerial imagery and topographic data recorded in December 2019. Storage characteristics, including capacity and stored water volume, were derived from aerial survey data. The catchment areas for each of the modelled storages and their storage characteristics are provided in **Appendix E-2** (Mine water balance).

#### 10.5.2.3 Groundwater inflow

Groundwater inflows for the existing operation and the Project have been estimated as part of the groundwater impact assessment presented in **Chapter 12** (Groundwater). The groundwater inflow predictions for the existing approved operation fluctuate across the life of the mine at up to 19.3 ML per day (ML/d) at the end of June 2020. The predicted groundwater inflow rates for the Project range from 19.3 ML/d at the end of June 2020, before falling to a low of approximately 5 ML/d and rising again to approximately 16 ML/d in late 2025. The predicted inflow rates then fluctuate for the remainder of the Project life, at an average rate of approximately 7 ML/d.

#### 10.5.2.4 Nogoa River

The Nogoa River streamflow rates are considered in the model to simulate the licensed discharge from Ensham Mine which is dependent on the flow and salinity of the Nogoa River. Streamflow characteristics incorporated in the model are presented in **Section 10.4.5.2**.

#### 10.5.2.5 Demands

A number of water demands across Ensham Mine's operations were considered as an outflow in the water balance model. These water demands are associate with the WTP, truckfill for dust suppression, underground mine demand and the CHP demand.

The WTP is supplied directly by the Village Dam at a rate of 170,000 litres per day. Additional water supply is provided to the Village Dam from the Clearwater Dam, as required. The Clearwater Dam is supplied via a licenced water allocation from the Nogoa River. Ensham Mine currently has a licenced allocation limit of 1,500 ML/y from the Nogoa River.

Water for dust suppression is collected from three fill points across Ensham Mine. Dust suppression truckfill demand is based on seasonal and anecdotal rainfall conditions. The maximum dust suppression demand rates fluctuate throughout the year, with a maximum demand of up to 3.5 ML/d in December and January.

The underground water demands are supplied from the Clearwater Dam. Demands for Ensham Mine's existing underground operations from May 2015 to June 2020 were used to estimate underground water demands for the Project. The reflect current site conditions, a median daily supply rate of 1.36 ML/d recorded between July 2019 and June 202 was adopted for the water balance model.

The current CHP demands of 1.16 litres per second are not expected to change for the Project and, therefore, has been assumed in the water balance model.

Further discussion on the water demands assumed in the water balance model is provided in **Appendix E-2** (Mine water balance).

#### 10.5.2.6 Controlled releases

Proposed releases would be controlled based on the release conditions specified in EA EPML00732813.

Currently at Ensham Mine, controlled releases can be made to the Nogoa River from the Southern Backbone via release points RP1 and RP3. In accordance with the existing Ensham Mine EA, the discharge EC from this pipeline must not exceed 12,500 µS/cm, there must be at least 30 cubic metres per second ($m^3/s$) flow in the Nogoa River and the EC in the river must not exceed 850 µS/cm in order for discharge to occur. These requirements have been built into the water balance to ensure that simulated discharges do not occur outside of the set criteria.

#### 10.5.2.7 Pumping controls

The water balance model is based on several controls for the transfer of water between storages, demands and release points. These controls, including pump rules and rates, are described in **Appendix E-2** (Mine water balance).

## 10.6 Potential impacts

The Project does not require materially additional surface infrastructure above what is already provided at the existing Ensham Mine. Therefore, impacts to surface water resources are expected to be minimal. There are no works associated with the Project that would alter waterways providing fish passage. This section provides an assessment of potential impacts to water resources as a result of the Project.

The assessment of potential impacts as a result of flooding in provided in **Chapter 11** (Flooding and geomorphology). No assessment of regulated structures is made in this EIS as there are no regulated structures associated with the Project.

### 10.6.1 Regional water availability

There are no additional water requirements, above the demands of the existing Ensham Mine, for the Project. Water requirements will be sourced primarily from water collected and stored on site, including rainfall runoff and groundwater inflows which are stored on site for reuse. Groundwater inflow is predicted to contribute to the majority of the mine water management system inflows with supply from the Nogoa River expected to continue at the same rate as the existing operation. Supply reliability is expected to improve upon commencement of the Project due to the increased groundwater inflow rates.

Therefore, the Project is considered unlikely to have an impact on regional water availability under normal and future climate change scenarios.

### 10.6.2 Stream flow impacts

Modelling undertaken as part of the Mine Water Balance Assessment (**Appendix E-2** (Mine water balance)) enables an assessment of potential changes in stream flows as a result of the Project to be made.

Section 4.1 of **Appendix E-3** (Hydrology and Flooding Assessment indicates that extractions from the Nogoa River are expected to be 546.7 ML/year on average, compared to 546 ML/year for the existing mine operations. In both cases, these flows are notably lower than the existing 1,500 ML/year high priority allocation held by Ensham Resources Pty Ltd on the Nogoa McKenzie Water Supply Scheme (reference: Water Account 103347). Typically when water from this allocation is required, Ensham Mine contact Sunwater and / or neighbouring allocation holders so a co-ordinated release is made from Fairbairn Dam and captured downstream by Ensham. The Project will operate under the same high priority allocation conditions, and as such it will not impact water from natural flows in the Nogoa River.

During flood conditions, the total volumes released by Ensham Mine during current operations are limited by the conditions in EA EPML00732813, as well as maximum pumping capacities. As such, the maximum possible amount of flow (based on physical infrastructure limitations) is released in each flow event, providing the trigger limits in the EA are met. The Project will maintain this managed release methodology and hence no impacts on release volumes are expected, both for individual events and cumulatively over time. The small numerical differences in predicted annual release rates described in Section 4.1 of **Appendix E-2** are caused by the different timeframes modelled in each case (i.e. eight years for the existing operation versus 17 years for the Project). These are a function of the water balance modelling methodology rather than the current and planned operation of the managed releases.

Overall, the Project is not expected to have any additional significant impact on the flows or flow regime of the Nogoa River compared to existing approved operations (**Appendix E-3** (Hydrology and flooding assessment) Section 4.2)).

Impacts to stream flow as a result of the Project are further discussed in **Appendix E-3** (Hydrology and flooding).

### 10.6.3 Water quality impacts

As very limited surface disturbance is expected for the Project, changes to water quality as a result of the extended mining operations are expected to be minimal.

The site water management system ensures that no overflows from the northern and southern pit ramp storages occur, by transferring water to other site storages with available capacity. This is discussed further in **Appendix E-2** (Water balance model development) Section 4.5.

Available storage capacity will increase with the project because completed underground mine areas will be progressively filled with water. Storage characteristics of the site water management are discussed further in Section 3.6 of **Appendix E-2** (Water balance model development).

Potential changes to release quantity and quality would be limited to changes in groundwater inflow resulting from the Project. Groundwater inflow in the Project Site is predicted to have similar quality as groundwater inflows in the existing underground operations at Ensham Mine. Impacts on groundwater quality are discussed in **Chapter 12** (Groundwater).

Groundwater modelling shows that the Project will result in additional groundwater inflow compared to the existing operations due to the proposed extension to the life of mine. On the basis of these predictions, it is considered likely that groundwater inflows should increase in the near-term (within the term of the existing operations) before trending downwards with time, while fluctuating over a similar range as the near-term.

The higher rates of groundwater inflow will continue to be managed within the existing Ensham Mine water management system, including the controlled release system, and be subject to the provisions of EA

EPML00732813, which ensure protection of EVs through management of release volumes and monitoring of water quality.

The REMP annual reports (Hydrobiology Pty Ltd, 2018, 2019, 2020) for the last three years indicate that a comparison of assessed parameters downstream of the mine to upstream results indicate the suitability of current release contaminant limits to protect downstream EVs. The monitored variables (habitat, stream flow, water quality, sediment and macroinvertebrates) have typically remained similar or improved since 2017, highlighting the correct operation of managed releases. The EA conditions for which releases were made between 2017 and 2020 allowed the downstream trigger level to be up to 1,440 µS/cm (1,200 µS/cm 80$^{th}$ percentile) and a minimum flow of 10m$^3$/sec. Considering that the Project will result in no changes to managed releases (refer to Section 10.6.2), and more stringent conditions were applied in the EA issued 19$^{th}$ March 2020, it is concluded that no negative impacts to EVs are to be expected.

Climate projections, reported in **Chapter 6** (Climate), indicate no significant change to the frequency and intensity of storms and cyclones within the Project area for the Project duration.

Ensham Mine's existing measures with respect to extreme weather events, such as severe storms and flooding, are considered to adequately address any further risk of climate change. Additionally, climate change in the region would be monitored, and adaptation measures implemented as required. Potential impacts and mitigation measures for climate change are discussed in **Chapter 6** (Climate).

Project changes and potential water quality impacts are addressed in **Section 4.2** of **Appendix E-1** (Surface Water Quality Assessment). Use of the existing Ensham Mine water management system is identified as appropriate for the Project to continue to meet the provisions of EA EPML00732813. It is concluded that no environmentally significant impacts to surface water quality should occur as a result of Project activities.

Longer periods of settling can mean decreasing quality of stored water. Monitoring and management of controlled releases to the Nogoa River (Section 4.1 & 4.2 of **Appendix E-1** (Surface water quality assessment)) will ensure the Project meets the provisions of EA EPML00732813.

**Figure 10-11** below (**Figure 22** of **Appendix E-2** (Water balance model development)) shows that the 95$^{th}$ percentile salinity (EC) results for the controlled releases range approximately between 7,000 and 9,000 µS/cm over the life of the Project. The 95$^{th}$ percentile salinity results correspond to concentrations that have a 5 per cent chance to be exceeded over the life of the Project. These values remain below the 12,500 µS/cm EA discharge condition, and as such any water discharged to the Nogoa River would meet the maximum salinity levels required by the EA.

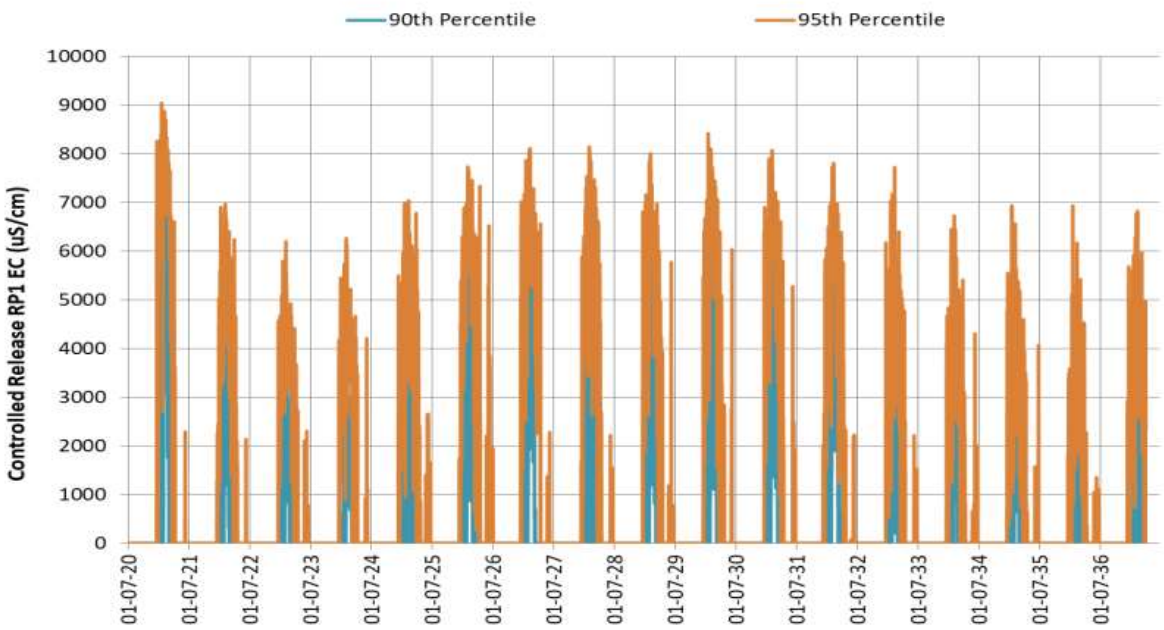



**Figure 10-11 Predicted Controlled Release EC - Project**

**Figure 10-12** below (**Figure 19 of Appendix E-2** (Water balance model development)) shows the total surface water inventory for the Project for the 5th, 50th and 95th percentile results respectively, together with the total mine affected water storage capacity. For the 5th percentile results (long-term lower rainfall conditions), total inventory values range approximately between 8,000 ML and 10,000 ML during the Project life. This compares with the maximum MAW storage capacity of 17,000 ML between 2020 and early 2023. This indicates that in dry conditions there is between 7,000 ML and 9,000 ML of available storage between 2020 and early 2023 on surface to manage Project water volumes without requiring any releases to the Nogoa River. Large rainfall events that may increase these inventory levels will contribute to a reduction of salinity in the Project's surface water storages, due to dilution. Additionally, such storm events will also result in increased flows in the Nogoa River, promoting background dilution should a release be required.

From mid-2023 onwards, the mine affected water storage capacity remains above 48,000 ML which is notably higher than the predicted total site surface inventory which remains capped at a maximum of approximately 10,000 ML during dry (5th percentile) conditions. With simulated inventory volumes well below capacity, water can be sourced from the Nogoa River in line with licensed allocation limits and water can be discharged to the Nogoa River in line with the current EA discharge limits.

**Figure 12 of Appendix E-2** shows that the average groundwater inflows for the Project are expected to be 3,762 ML/yr. Although some of this flow will be stored in the site's inventory, the vast majority of it will either get recycled or evaporated. As such, should prolonged drought conditions occur during the Project, the available storage (with a minimum of 7,000 ML to 9,000 ML between 2020 and early 2023) provides sufficient capacity to manage increased groundwater inflows without the need to rely on releases onto the Nogoa River.

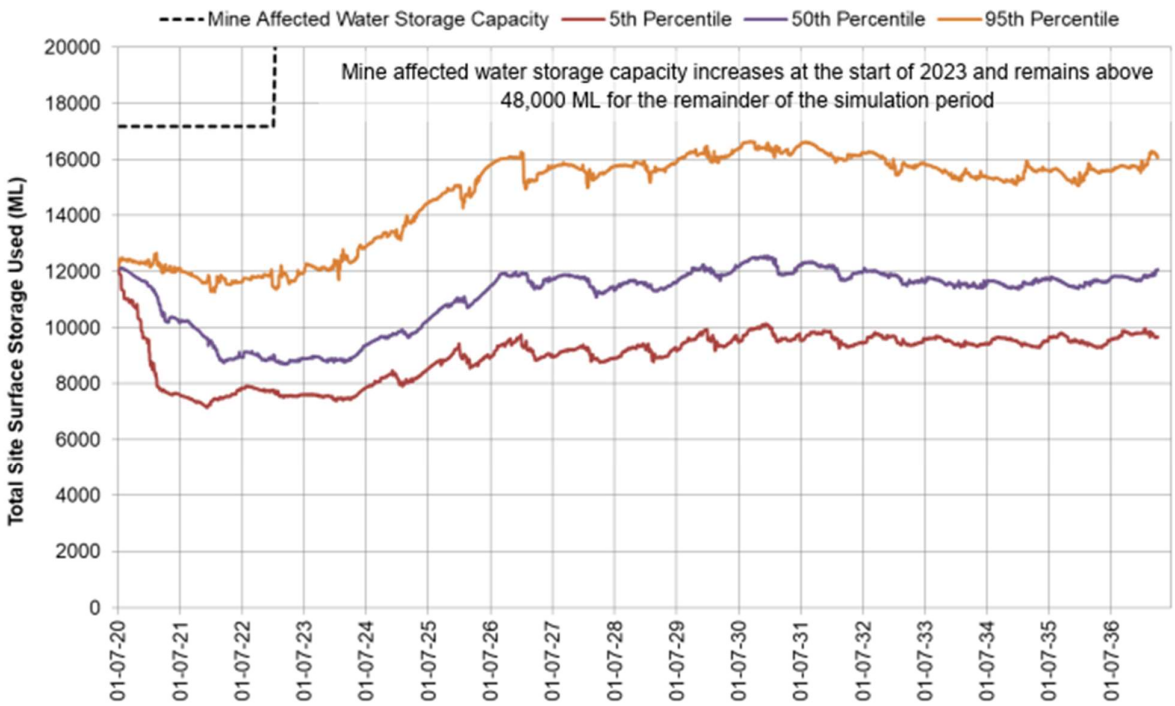



**Figure 10-12 Predicted total site surface inventory – proposed Project**

The REMP annual reports (Hydrobiology Pty Ltd, 2018, 2019, 2020) for the last three years indicate that a comparison of assessed parameters downstream of the mine to upstream results indicate the suitability of current release contaminant limits to protect downstream EVs. The monitored variables (habitat, stream flow, water quality, sediment and macroinvertebrates) have typically remained similar or improved since 2017, highlighting the correct operation of managed releases. The EA conditions for which releases were made between 2017 and 2020 allowed the downstream trigger level to be up to 1,440 µS/cm (1,200 µS/cm 80th percentile) and a minimum flow of 10m$^3$/sec. Considering that the Project will result in no changes to managed releases (refer to Section 10.6.2), and more stringent conditions were applied in the EA issued 19th March 2020, it is concluded that no negative impacts to EVs are to be expected.

Climate projections, reported in **Chapter 6** (Climate), indicate no significant change to the frequency and intensity of storms and cyclones within the Project area for the Project duration.

Ensham Mine's existing measures with respect to extreme weather events, such as severe storms and flooding, are considered to adequately address any further risk of climate change. Additionally, climate change in the region would be monitored, and adaptation measures implemented as required. Potential impacts and mitigation measures for climate change are discussed in **Chapter 6** (Climate).

Project changes and potential water quality impacts are addressed in **Section 4.2** of **Appendix E-1** (Surface water quality assessment). Use of the existing Ensham Mine water management system is identified as appropriate for the Project to continue to meet the provisions of EA EPML00732813. It is concluded that no environmentally significant impacts to surface water quality should occur as a result of Project activities.

Longer periods of settling can mean decreasing quality of stored water. Monitoring and management of controlled releases to the Nogoa River (**Section 4.1** & **4.2** of **Appendix E-1** (Surface water quality assessment)) will ensure the Project meets the provisions of EA EPML00732813.

**Figure 10-11** below (**Figure 22** of **Appendix E-2** (Water balance model development)) shows that the 95th percentile salinity (EC) results for the controlled releases range approximately between 7,000 and 9,000 µS/cm over the life of the Project. The 95th percentile salinity results correspond to concentrations that have a 5 per cent chance to be exceeded over the life of the Project. These values remain below the 12,500 µS/cm EA discharge condition, and as such any water discharged to the Nogoa River would meet the maximum salinity levels required by the EA.

The Ensham Mine EA EPML00732813, which came into effect in 3 September 2020, states that the discharge EC from this pipeline must not exceed 12,500 µS/cm, that there must be at least 30 $m^3/s$ flow in the Nogoa River and that the EC in the river downstream of the discharge point must not exceed 850 µS/cm in order for a controlled release to occur (i.e. combined controlled release and river EC). These requirements have been built into the WSBM to ensure that simulated controlled releases do not occur outside of the EA criteria.

Hence, overall, it is concluded that no environmentally significant impacts to surface water quality should occur as a result of the Project activities.

### 10.6.4 Mine water management

The water management strategy for the Project will utilise the existing water management infrastructure for the current Ensham Mine. The current water management system has sufficient capacity to deal with project, inclusive of the existing operation.

The developed water balance model for Ensham Mine's existing operations has been updated for the Project to assess the performance of the site water management system. The water and salt balance assessment enables a comparison of key changes associated with the Project relating to:

- occurrence and volume of any uncontrolled discharge from mine affected water storages
- volumes and predicted salinity of controlled discharge from release points defined in EA EPML00732813
- volumes of water required to be imported to support operations.

Mine affected water from the Project is limited to dewatered groundwater from the underground mine. Consistent with current operations at Ensham Mine, mine water from the Project will be stored and managed through the existing Ensham Mine water management system.

The sections below outline the outcomes of each component of the water management system. The operation of the water management system is discussed in **Section 10.5**.

#### 10.6.4.1 Water balance

Groundwater inflows for the Project are predicted to contribute to the majority of the system inflows, with supply from the Nogoa River expected to be equivalent to Ensham Mine's existing operation. The Project is predicted to result in increased volumes of outflow from the site through controlled release to the Nogoa River, evaporative loss and dust suppression. Upon commencement of the Project, the average annual release to the Nogoa River for the Project is estimated at 2,766 ML/y which is a decrease of 130 ML/y from the existing operation.

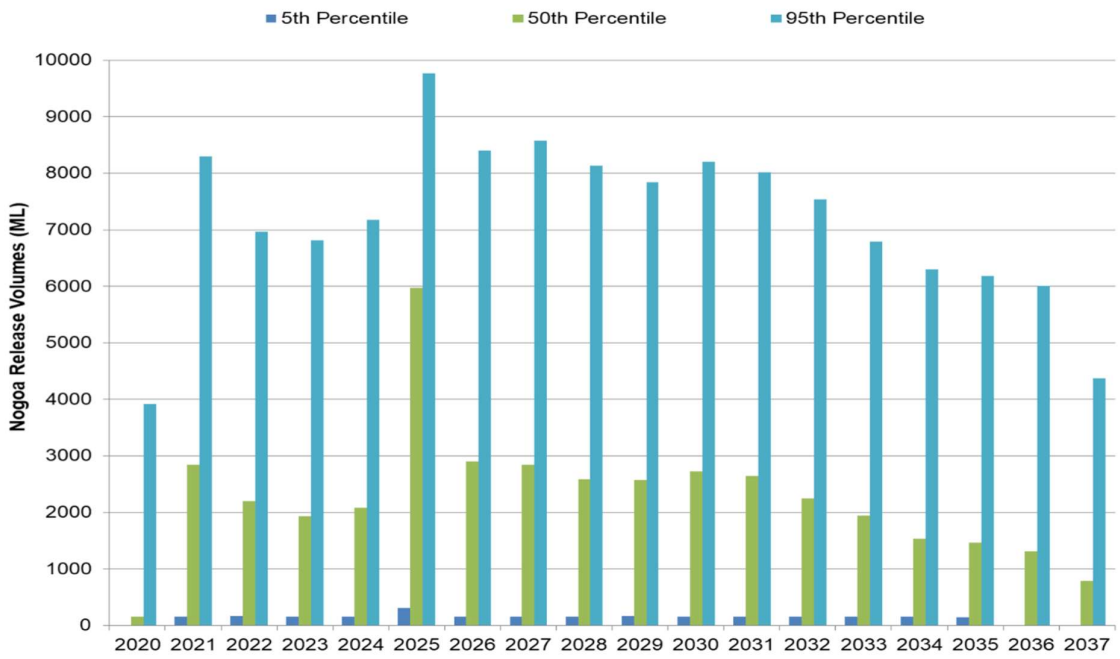
The total storage inventory across Ensham Mine was simulated for the existing operations and the Project. The stored water volumes are predicted to be similar for both scenarios until mid-2028 (the end of the existing operational scenario). From mid-2028 to 2037, overall predicted surface storage volumes remain fairly consistent and within the capacity of the existing WMS.

#### 10.6.4.2 Controlled releases

Proposed releases would be controlled based on the release conditions specified in EA EPML00732813.

The annual controlled release volumes to the Nogoa River have been predicted across a range of scenarios (presented in percentile ranges). The predicted controlled release volumes are illustrated in **Figure 10-13**. The median annual controlled release volume is estimated at 2,189 ML. This is an increase of 47 ML/yr from the existing operation attributable to a peak in groundwater inflows being pumped from the underground in 2025.

As shown in Figure 10-12, large surface storage volumes are available during the life of the Project to efficiently manage groundwater and other inflows in accordance with EA EPML00732813, in particular during prolonged dry conditions. On the other hand, ongoing environmental monitoring in the receiving environment (refer to **Section 10.7.2.1**) will help in identifying potential impacts from a hypothetical increase in median annual controlled releases. Thus, the modelled managed releases can be reduced at any time if it is identified that the release conditions specified in EA EPML00732813 are not met (or if ongoing environmental monitoring detect potential impacts), such as there are no cumulative or long-term impacts in the receiving environment.




*Years 2020 and 2037 show only partial years extraction due to simulation start and end dates (5th percentile results are zero)

**Figure 10-13 Predicted controlled release to the Nogoa River**

The predicted EC of the controlled releases is illustrated in **Figure 10-11**.

The EC in the Nogoa River downstream of the controlled release point will not be affected by controlled releases in the Project scenario (in comparison to existing operations). Releases are set only to occur when they allow downstream EC's in the Nogoa River to remain below the EA stipulated 850 µS/cm threshold.

#### 10.6.4.3 Uncontrolled releases

The water balance model was used to assess the risk of uncontrolled releases from the mine water management system. The modelled annual uncontrolled releases from the site is predicted to be approximately 265 ML based on the 95th percentile of all climate scenario realisations. All modelled overflows are from Sailors Dam (raw water storage only) due to surface runoff from upstream undisturbed catchment during heavy rainfall events.

The predicted annual volumes of uncontrolled releases are illustrated in **Figure 10-14**.

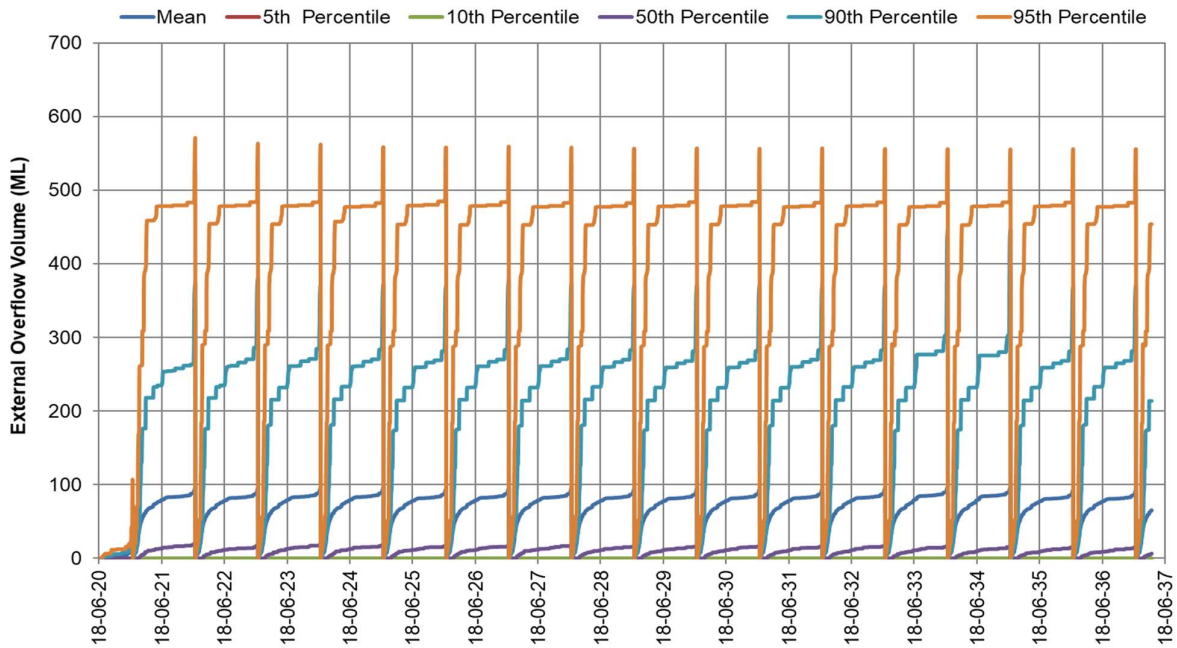



**Figure 10-14 Modelled annual uncontrolled release**

# 10.7 Mitigation measures

## 10.7.1 Mine water management

The management of impacts to surface water is primarily achieved through the design of the site water management system. As discussed in **Section 10.5**, the objective of mine water management is to minimise the quantity of mine affected water released from site through its efficient storage, use and distribution.

The Project will extend the current underground operation using existing infrastructure with minor surface disturbance (i.e. drilling, 3D seismic) and flaring infrastructure required to facilitate its operation. The Project will continue to use the existing water management system and mine affected water release system, with controlled releases occurring subject to the requirements of EA EPML00732813. The key objectives of the EA which govern release include:

- mine affected water release quality limits (RP1 and RP3) of 12,500 µS/cm EC, pH 6.5-9.0, sulphate 1,000 mg/L and turbidity 360 NTU
- release permitted from RP1 only when Nogoa River flow exceeds 30 $m^3/s$

- monitoring of water quality at downstream monitoring points ENMP05 and ENMP06 during release events, with:
  - a 'cease release' EC trigger at ENMP05 of 850 µS/cm
  - an 'approval' trigger of 650 µS/cm at ENMP06 (approval required to continue release if EC rises above this level)
  - 'investigation' triggers for pH (6.5 - 9.0), suspended solids (1,000 mg/L) and sulphate (250 mg/L). If triggers are exceeded, a comparison to upstream values is required. Where upstream values are exceeded, an investigation into the potential for environmental harm is required.
  - 'investigation' triggers for a range of water quality parameters, including trace metals (to be monitored at the release points and ENMP05 only). If triggers are exceeded at the release point, a comparison to ENMP05 is required. Where ENMP05 values are exceeded, an investigation into the potential for environmental harm is required.

The existing mine water management system described in **Section 10.5.1** is designed to achieve these objectives and mitigate potential impacts on the receiving environment. The water balance modelling results indicate that the existing water management system (i.e. the combined storage capacities) will be more than sufficient to manage the Project's climatic extremes (including drought conditions).

Ensham Mine currently manages controlled releases using an EC calculator which models expected EC at downstream monitoring sites during releases. The calculator uses upstream monitored EC and flow rate and release water EC to determine release rates to ensure EA limits are not exceeded. Paired with the monitoring required by the EA during release, this has ensured that Ensham Mine has complied with the defined EA triggers and limits.

#### 10.7.1.1 Monitoring and maintenance

In accordance with existing practice at Ensham Mine, the mine water management system will be subject to routine monitoring and maintenance to ensure it operates as intended. Ongoing monitoring and maintenance activities currently undertaken include:

- continual monitoring of water quality and storage volumes in the mine water storages to ensure that uncontrolled releases do not occur and cause a downstream impact
- the pit and dam pumps are inspected and operated regularly to ensure they operate when required
- sediment dams are cleaned out on a regular basis to maintain the available sediment storage volume
- diversion drains are monitored regularly to ensure they are operating as designed and do not allow mixing of clean and dirty water
- contaminated water sumps and interceptors at the mine infrastructure area are inspected and cleaned out regularly.

These activities are proposed to continue for the life of the Project.

### 10.7.2 Surface water monitoring

Ensham Mine has an established surface water monitoring programme covering the existing open-cut and underground operations. This monitoring programme will be extended for the life of the Project.

Surface water quality monitoring sites have been established upstream and downstream of Ensham Mine, and within the existing operational mining area. Upstream sites monitor water quality entering the operation mining areas at Ensham Mine, and downstream sites monitor waters which may have been affected by site activities and disturbance. The mine area sites monitor catchment runoff and release waters within Ensham Mine's

existing mining leases. Surface water quality monitoring comprises chemical and physical analysis of water samples collected at defined surface water quality monitoring sites.

In addition to Ensham Mine's monitoring sites, the DNRME also have three gauging stations in the vicinity of the site. Data from the DNRME gauging stations is available from a Queensland Government water monitoring information portal, which is used to supplement Ensham Mine's surface water monitoring dataset.

#### 10.7.2.1 Receiving environment monitoring program

Ensham Mine has established a receiving environment monitoring program (REMP) across their current operations which monitors water quality and stream flow at upstream and downstream locations as well as sediment sampling and monitoring of bio-indicators. Monitoring is undertaken in accordance with the *Monitoring and Sampling Manual – Environmental Protection (Water) Policy 2009* (DES, 2018).

The Ensham Mine REMP was developed based on the specific requirements of the EA which requires monitoring of:

- habitat
- stream flow
- surface water quality
- sediment quality
- bio-indicators (macroinvertebrates).

Monitoring sites were selected to best represent all of the monitoring parameters both before and after mining operations. Sites were identified both upstream and downstream of Ensham Mine in order to measure the influence of mining operations on the surface water environment.

As a requirement under the EA, Ensham Mine also prepare an annual report outlining the findings of the REMP. The existing REMP will be extended to consider the Project activities over the life of the mine.

## 10.8 Summary and conclusions

The assessment of surface water resources is based on water quality monitoring undertaken at Ensham Mine and mine water balance modelling undertaken for the Project. The mine water balance shows that, consistent with existing operations, the Ensham Mine water management system has sufficient capacity to manage all mine affected water generated by the Project. There will continue to be a requirement for controlled releases from Ensham Mine.

As very limited surface disturbance is expected as a result of the Project, changes to runoff water quality as a result of the extended mining operations are expected to be negligible. Potential changes to release quantity and quality would be limited to changes in groundwater inflow resulting from the Project. Groundwater inflow in the Project Site is predicted to have similar quality as groundwater inflows in the existing underground operations at Ensham Mine.

The Project will continue to use the existing water management system and mine affected water release system in accordance with the requirements of EA. As the Project is an extension of the current underground operation at Ensham Mine, with no material changes to the existing infrastructure, impacts to water are not considered to be significant.