APPENDIX 25 – RECEIVING ENVIRONMENT MONITORING PROGRAM

NEW LENTON COAL PTY LTD

NEW LENTON COAL PROJECT

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Geochemical & Hydrobiological Solutions Pty Ltd
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Underground Coal Gasification / Coal Seam Gas Investigations
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NEW LENTON COAL PROJECT

Receiving Environment Monitoring Program: Design Document

Report Prepared for:

BOWEN COKING COAL

Date:
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Prepared by:

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EXECUTIVE SUMMARY

In April 2009, the Department of Environment and Resource Management (DERM), now administered as the Department of Environment and Science (DES), recommended the installation of receiving environment monitoring programs (REMPs) in all coal mines within the Fitzroy Basin (refer to DERM [2009] report *A study of the cumulative impacts on water quality of mining activities in the Fitzroy Basin*). This recommendation was subsequently included in environmental authorities (EAs) for most coal mines within the Fitzroy Basin.

This REMP design document is designed to monitor all aspects of the receiving environment perceived to be at risk of potential harm from mining activities at New Lenton Coal Project. To achieve the requirements of EA conditions C21 to C24, this document includes:

- Outlines of the receiving environment of relevance to the New Lenton Coal Project.
- Description of the background (upstream) condition of the receiving environment, as well as the environmental values (EVs) relevant to the site, including:
  - Aquatic ecosystems;
  - Stock water;
  - Primary recreation;
  - Secondary recreation;
  - Visual recreation;
  - Drinking water;
  - Industrial use; and
  - Cultural and spiritual values.
- Definitions of targeted objectives to preserve the identified EVs.
- Details of an extensive monitoring program that is inclusive of:
  - Flow monitoring;
  - Water quality monitoring;
  - Sediment quality monitoring;
  - Aquatic habitat condition monitoring;
  - Wetland and riparian corridor monitoring; and
  - Macroinvertebrate community monitoring.
- Summaries of appropriate data analysis techniques for each type of environmental data.
- Details of the responsible parties for each component of the REMP.

In accordance with EA condition C24, a REMP assessment report outlining the findings of the REMP must be prepared annually and presented to the administering authority. The assessment report must also contain notes on general observations of stream condition made throughout the field trips – as well as photographs of each sampling site for comparison to reference photographs.

The REMP assessment report should provide a detailed indication of potential impacts and risk to the aquatic receiving environment from mining activities. Based on the outcomes, recommendations will be determined for future amendments to:

- The methods employed during the REMP to better achieve the aims of the monitoring program; and/or
- Any current trigger levels within the EA, to provide greater protection to the receiving environment – as well as greater flexibility of release conditions for the New Lenton Coal Project.

1. INTRODUCTION

The New Lenton Coal Project (New Lenton, the project) is a proposed open-cut coal mine owned by Bowen Coking Coal (BCC) through its subsidiary New Lenton Coal Pty Ltd (NLC). NLC owns and operates the adjoining Burton Coal Mine (Burton). The mine is located approximately 150 km south-west of Mackay, Queensland (Figure 1), with the proposed operations within three mining leases (ML70337, ML700053 and ML700054; Table 1).

New Lenton will operate under environmental authority (EA) EPML00475513, which authorises the mining of black coal. Material extracted from New Lenton will be processed at the Burton coal handling and preparation plant (CHPP).

Table 1: Mining tenement details.

Tenement	Date granted	Area (ha)
ML 70337	26/06/2004	1,207
ML 700053	21/02/2022	78.2
ML 700054	21/02/2022	27.7
	Total:	1312.9

The project is situated within the upper Isaac River catchment area of the Fitzroy Basin (Figure 1). Under the EA, New Lenton is licenced to release mine-affected water (MAW) into the receiving environment – via two designated release points (RP1 and RP2) – within Ti-Tree Creek prior to the confluence with the Isaac River (Figure 2).

In April 2009, the Department of Environment and Resource Management (DERM; now administered by the Department of Environment and Science [DES]) recommended the installation of receiving environment monitoring programs (REMPs) in all coal mines within the Fitzroy Basin (refer to the report *A study of the cumulative impacts on water quality of mining activities in the Fitzroy Basin*; DERM, 2009). This recommendation was subsequently incorporated in EAs for Fitzroy Basin coal mines and has been included in the New Lenton EA. EA conditions C21 to C24 detail the requirements for the REMP (Table 2).

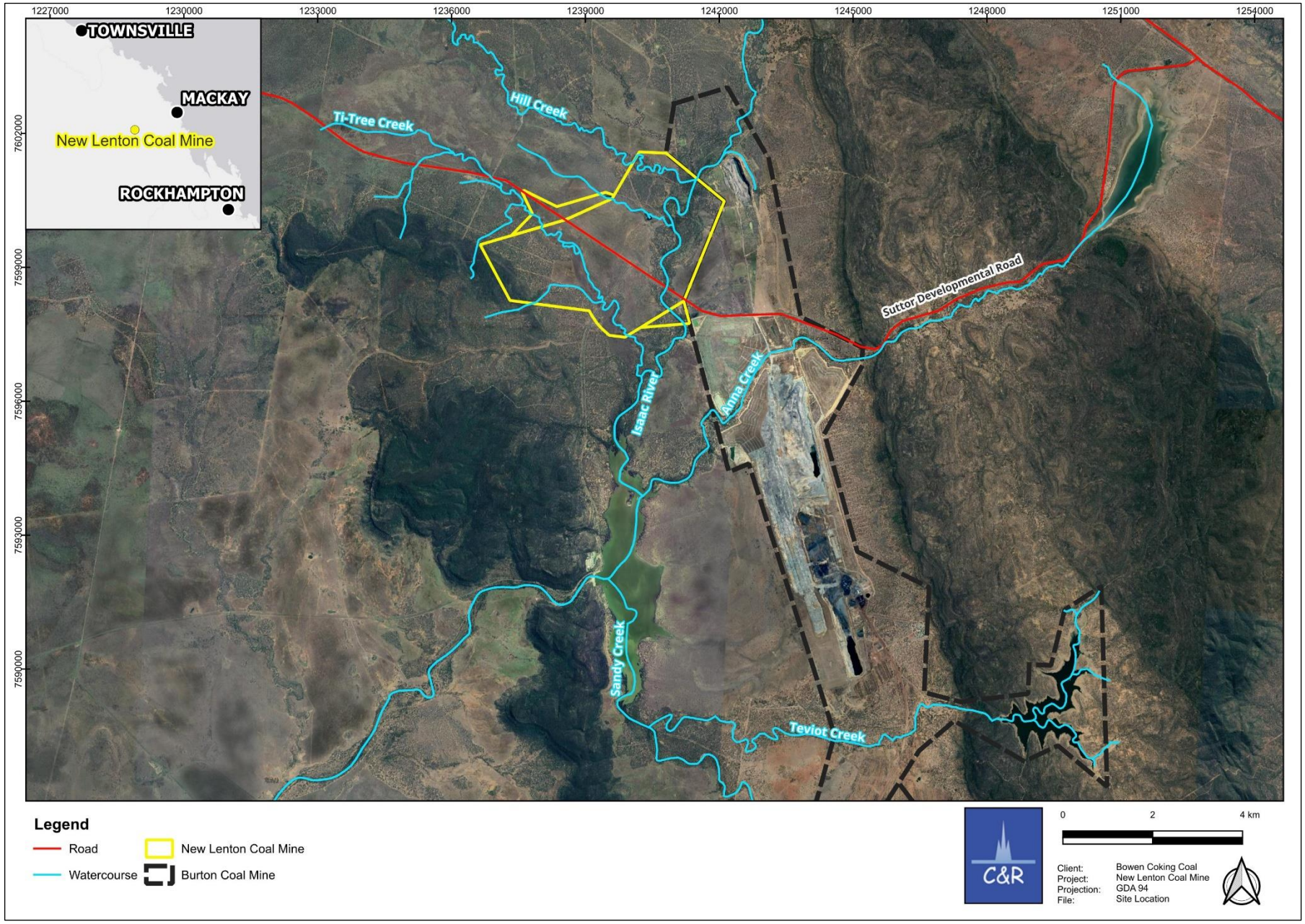


Figure 1: New Lenton Coal Mine location within the upper Isaac River catchment area.

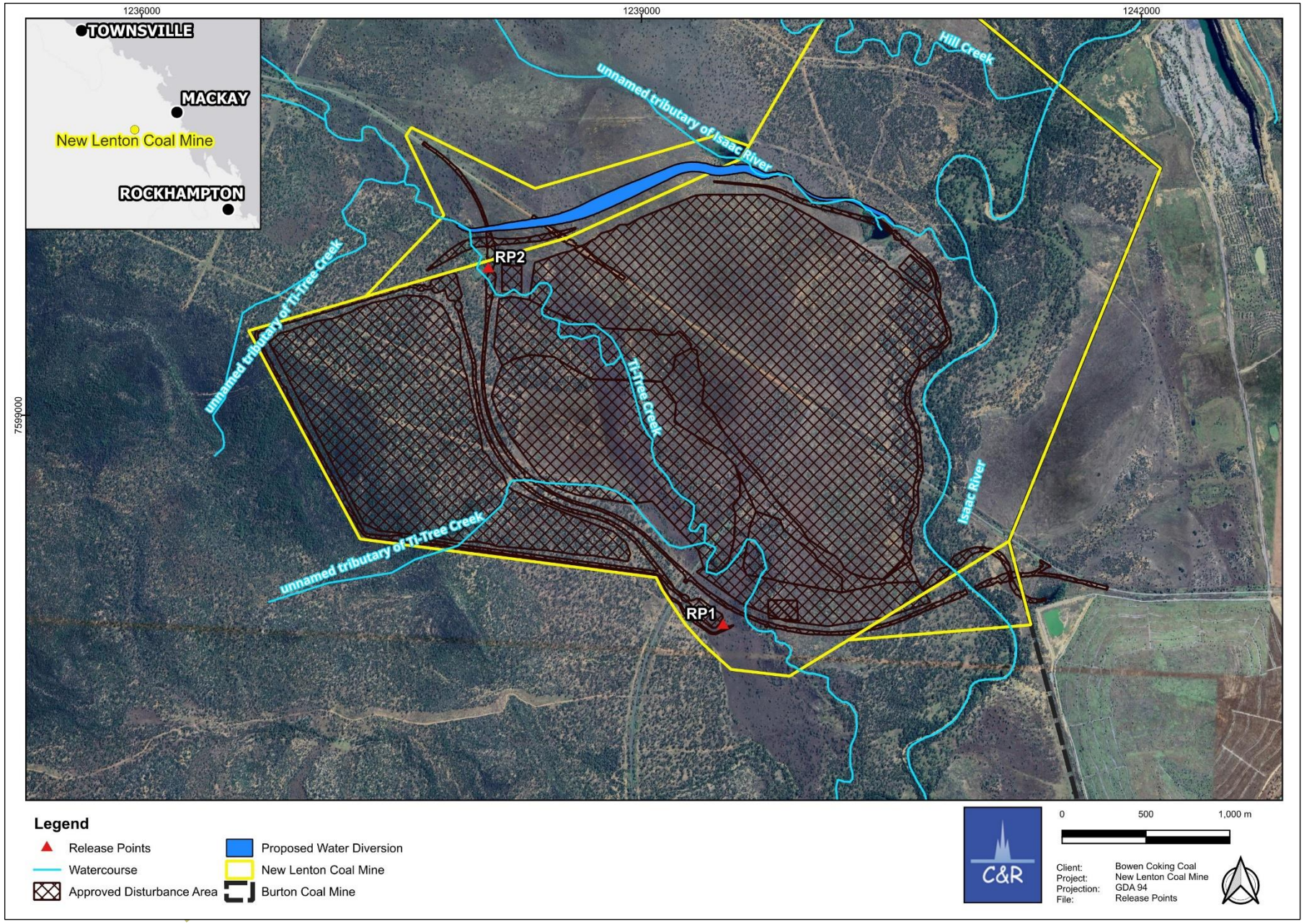


Figure 2: Release points and proposed expansion areas.

Table 2: Conditions within the New Lenton EA referring to the requirements of a REMP.

Condition No.	Condition
C21	**Receiving Environment Monitoring Program (REMP)** The environmental authority holder must before the commencement of mining activities (including construction activities, excluding exploration activities) develop, maintain and implement a Receiving Environment Monitoring Program (REMP) to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised mining activity. This must include monitoring the effects of the mine on the receiving environment periodically (under natural flow conditions) and while mine affected water is being released from the site. The REMP must be made available on request
C22	For the purposes of the REMP, the receiving environment is the waters of the Hill Creek, Ti-Tree Creek, and the Isaac River and connected or surrounding waterways within **15 km** downstream of the release. The REMP should encompass any sensitive receiving waters or environmental values downstream of the authorised mining activity that will potentially be directly affected by an authorised release of mine affected water.
C23	The REMP must address (but not necessarily be limited to) the following: a) Description of potentially affected receiving waters including key communities and background water quality characteristics based on accurate and reliable monitoring data that takes into consideration any temporal variation (e.g. seasonality); b) Description of applicable environmental values and water quality objectives to be achieved (i.e. as scheduled pursuant to the Environmental Protection (Water) Policy 2009); c) Any relevant reports prepared by other governmental or professional research organisations that relate to the receiving environment within which the REMP is proposed; d) Water quality targets within the receiving environment to be achieved, and clarification of contaminant concentrations or levels indicating adverse environmental impacts during the REMP; e) Monitoring for any potential adverse environmental impacts caused by the release; f) Monitoring of stream flow and hydrology; g) The locations of monitoring points; h) Specify sampling and analysis methods and quality assurance and control; i) Any historical datasets to be relied upon; j) Description of the statistical basis on which conclusions are drawn; and k) Any spatial and temporal controls to exclude potential confounding factors.
C24	A report outlining the findings of the REMP, including all monitoring results and interpretations must be prepared annually and submitted to the administrating authority. This must include an assessment of background reference water quality, the condition of downstream water quality compared against water quality objectives, the suitability of current discharge limits to protect downstream environmental values

1.1 SCOPE

The New Lenton REMP aims to monitor key aspects of downstream watercourses (i.e. the receiving environment) typically perceived to be at risk of potential harm from New Lenton

mining activities. To achieve the REMP requirements detailed within the EA, this document will:

- Outline the receiving environment(s) of relevance to New Lenton;
- Describe the background (upstream and historical) condition of the receiving environment(s), including the environmental values (EVs) relevant to the site;
- Define targeted water quality objectives (WQOs), sediment quality objectives (SQOs) and biological indices for the site;
- Detail an extensive monitoring program based on the known objectives, including methods for water quality monitoring, sediment quality monitoring, habitat condition assessment and macroinvertebrate community monitoring in accordance with the REMP guideline document (DES, 2022);
- Outline appropriate data analysis techniques for each type of environmental data – including reporting requirements and timeframes; and
- Detail the responsibilities for various site personnel and contractors to comply with the monitoring requirements of the REMP.

2. LOCAL SETTING

2.1 RECEIVING ENVIRONMENT

New Lenton encompasses three mining leases within the upper Isaac River catchment area, a sub-basin of the Fitzroy River drainage basin (Figure 1; refer to Appendix A for the Isaac River sub-basin plan with respect to location within the Fitzroy River drainage basin). The main mining area is traversed by three watercourses (Ti-Tree Creek, Hill Creek and Isaac River) and their associated tributaries. The EA states that the receiving environment of New Lenton is '*the waters of the Hill Creek, Ti-Tree Creek, and the Isaac River and connected or surrounding waterways within 15 km downstream of the release'*.

All of the watercourses associated with the New Lenton receiving environment are considered ephemeral, each flowing only briefly after significant rainfall. The short-lived flows leave remnant pools that can remain into the early- to mid-dry season. The exception to this is the man-made Burton Gorge Dam – located further downstream on the Isaac River – that holds water permanently. A survey of the Isaac River was completed on 7 July 2023, searching for any permanent pools of water upstream, adjacent and downstream of New Lenton. The survey followed a period of rainfall in the region. There were no pools of permanent water observed.

Historical land uses within the Isaac River catchment area have been dominated by agriculture and mining. To facilitate this land use, much of the region has undergone historical, broad-scale clearing, which has affected the characteristics of the catchment's drainage system. Land clearing can result in elevated sediment loads entering – and subsequently being transported along – drainage lines (Kergow *et al*., 2005; McCulloch *et al*., 2003; Walling, 2000; Walling and Fang, 2003). The reduction in riparian cover also increases the rate of erosion along the banks (Simon and Collison, 2002).

Additionally, large dams have been constructed throughout the region (including Burton Gorge Dam, Elphinstone Dam and Teviot Dam) to support both the farming and mining industries.

2.2 CLIMATE

Climate data were extracted from the nearest Bureau of Meteorology (BoM) weather station at Moranbah Airport (station number 34035) from 2013 to present (BoM, 2023). For regional evaluation of longer-term climate, additional data were accessed from the SILO (Scientific Information for Land Owners) database (https://www.longpaddock.qld.gov.au/silo/point-data; Jeffrey *et al*., 2001). Associated median rainfall and temperature characteristics are displayed in Figure 3.

2.2.1 RAINFALL

Rainfall within Queensland's seasonally arid interior is notoriously unreliable in its intensity, duration and location. The climate of the area is dominated by intense rainfall events throughout the wet season (approximately November to March; Figure 3). These rainfall events are often highly variable in their spatial and temporal distribution, with much of the rain falling in distinct, spatially separated cells across the landscape. As a result, flow predictions within the region are made more difficult by the consideration of intense rainfall, combined with drought-like conditions.

November to March tend to be the wettest months (Figure 3). Generally, little rain is experienced throughout the dry season, with an occasional shower/storm in that period. Evaporation tends to exceed rainfall for almost all days of the year, except during intense rainfall events.

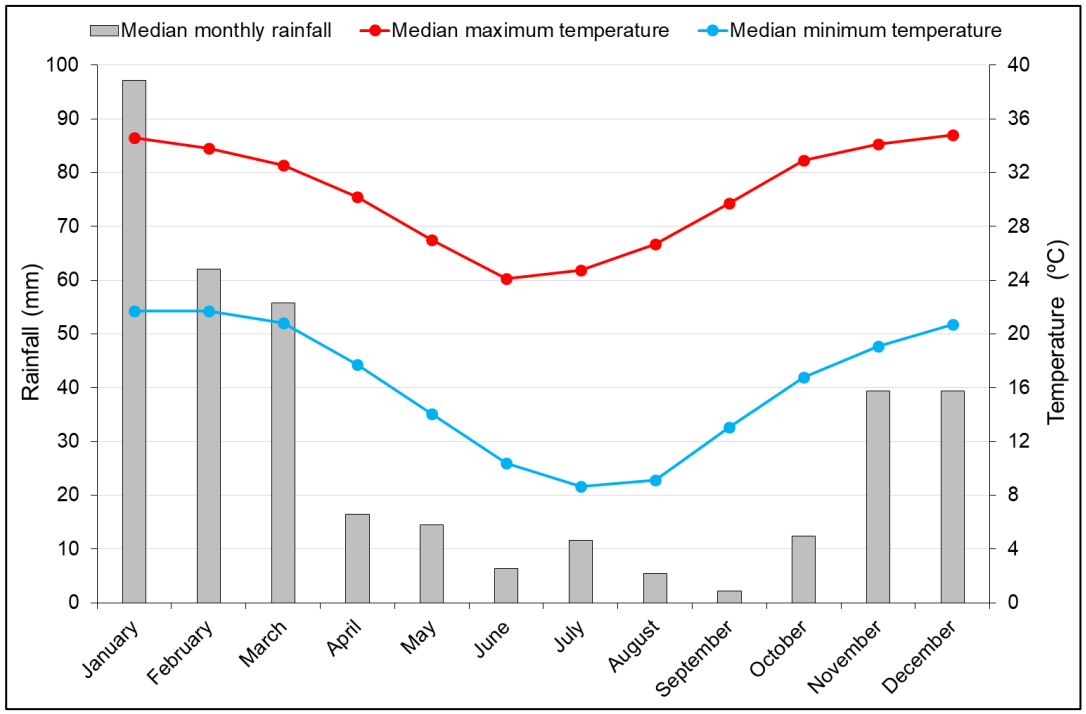


Figure 3: Median monthly temperature and rainfall characteristics at Moranbah Airport (station number 34035) between 2012 and present.

2.2.2 TEMPERATURE

Temperatures within central Queensland can range over 43°C in a yearly cycle, with minima below freezing (-1.1°C; lowest temperature; BoM, 2023) in the winter months and maxima in the high forties in summer (42.3°C, highest temperature; BoM, 2023). Maximum month-median temperatures over the recording period at Moranbah Airport are highest in December (maximum of 34.8°C), when cloud-cover is still relatively restricted. Conversely, minimum month-median temperatures are generally lowest in July (minimum of 8.65°C; Figure 3).

Hotter weather – or large fluctuations in temperatures – can influence aquatic community structure through mortality (Cussac *et al.*, 2009), as well as by altering timing and length of certain phases within an organism's life cycle (Todd *et al.*, 2005). Warmer weather can increase predation pressure from tropical fish. A significant increase in predation pressure may, in turn, have a cascading effect on the lower levels of the food chain (i.e. macroinvertebrate community structure).

2.3 HYDROLOGY

Figure 4 displays the seasonality and size of flows experienced in Burton Gorge (station 130402A; in the Isaac River) between 1964 and 1989 (Queensland Government, 2022), prior to the Burton Gorge Dam's construction in 1992. Flows generally occur within the wet season, at the beginning or end of each year. Large flow events (>300 m^3/sec) recur every 5 to 6 years – and flow events above 100 m^3/sec are evident multiple times per wet season (Figure 4). There are long no-flow periods each year, reinforcing the ephemeral nature of the systems associated with the New Lenton receiving environment.

WRM (2024) found flows within Ti-Tree Creek and Hills Creek are extremely short in duration (only days) following large rainfall events, reinforcing their ephemeral nature, and much smaller (up to an order of magnitude in rate and volume) than those recorded within the main Isaac River channel.

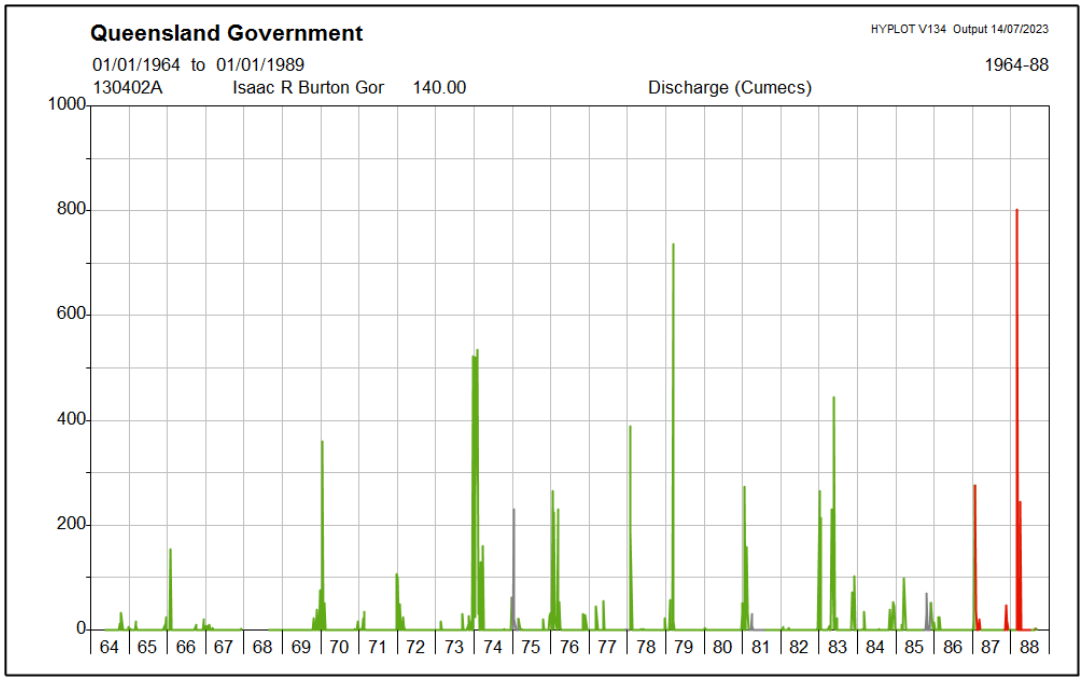


Figure 4: Historical data from the closed stream gauge 130402A (Isaac River at Burton Gorge) showing the seasonality of flow events (image from Queensland Government, 2023).

2.4 WATER QUALITY

As the project is the development of a new mining area, limited historical water quality data is available from the operations. Water quality has been assessed at several sites within and surrounding the project area as part of previous studies including two REMP surveys (completed for Burton, 4T Consultants, 2011; SGM, 2023) and an aquatic ecology assessment (AARC, 2019). Nevertheless, the ephemeral nature of the targeted systems has limited the ability to accumulate large datasets. An assessment of available historical background water quality data made the following findings:

- Watercourses within the region are naturally slightly alkaline, with background 20th and 80th percentiles of the pooled data recording pH values of 7.3 and 8.3 (for laboratory results), respectively.

- Most metals and metalloids (monitored in accordance with Burton EA conditions) are compliant with the trigger levels set out in the EA. However, several metals often exceed the trigger levels, including aluminium and copper which have always been recorded above the trigger level within both Hill Creek and Ti-Tree Creek. Elevated levels of aluminium and accompanying metals (such as iron, chromium and copper) are regularly observed within the dissolved fraction of waters within the region. The majority of the recorded values for each metal generally occurs in colloidal form (particles <0.45 µm) and are not readily bioavailable.
- During flows, waters are generally turbid, with the median and 80th percentile values, non-compliant with the trigger levels set out in the EA (88.8 and 179.4 NTU respectively). This is likely influenced by elevated suspended solids, which are known to be elevated throughout the greater Fitzroy River catchment area as a result of historical broad-scale clearing.
- Petroleum hydrocarbons have been recorded below the LOR on all previous sampling occasions. This suggests that there are few natural processes occurring within the upper Isaac River catchment area to produce these compounds.

2.5 SEDIMENT QUALITY

As with water quality, limited historical sediment quality data exists from waterways within and surrounding the proposed Project. AARC (2019) assessed sediment quality in February 2018 as part of the aquatic ecology assessment for the New Lenton Mine. The samples were assessed for trace metals and particle size distribution. There is also some background sediment quality data available for waterways within the project area from the Burton operations (SGM, 2023). Results from three rounds of sediment sampling are available for two sites in the Isaac River, completed in May 2019, August 2022 and January 2023. These samples were analysed for a range of total metals and metalloids on the whole fraction, and particle size distribution was assessed in the 2023 round.

The results of the previous monitoring indicate that sediments within Isaac River are dominated by sand with some gravel and very little fine sediments (AARC, 2019; SGM, 2023). Meanwhile, the smaller tributaries such as Ti-tree Creek are known to contain sand but also a high proportion of fine sediments. It is suggested that this is because these tributaries flow through an alluvial plain that is known to have a higher concentration of fine particles, with a greater propensity for gully erosion also noted (AARC, 2019).

The metal and metalloid concentrations of sediments within the area are relatively low, with a high level of compliance with corresponding sediment quality guideline (SQG) values. The only parameter to record exceedances of the SQG values was nickel within Ti-tree Creek (AARC, 2019). However, the SQGs are based on the analysis of the <2 mm fraction – not the whole sample – and care must thus be taken when interpreting these results. Despite this, several quality characteristics were recorded below the limit of reporting throughout the receiving environments, suggesting that these elements are naturally low within the systems, including:

- Arsenic;
- Beryllium;
- Boron;
- Cadmium;
- Mercury;
- Molybdenum;
- Selenium;
- Silver; and

2.6 AQUATIC HABITATS

Three different aquatic habitat types are associated with the New Lenton receiving environment (Figure 5), including:

1. Ephemeral watercourses;

2. Palustrine wetlands; and
3. Lacustrine wetlands.

2.6.1 EPHEMERAL WATERCOURSES

Watercourses associated with New Lenton are characterised as ephemeral streams, with coarse, sandy substrates. These systems are generally comprised of a series of shallow pool habitats, interspersed by run (and occasional riffle) habitats (BMT, 2018). The bed habitats are relatively devoid of structure, except for the occasional piece of woody debris. However, some cobble sections are known within the region. The sandy substrates are prone to shifting, with large sediment slugs often observed throughout the systems.

Generally, edge habitats provide increased structural complexity compared to bed habitats. Structural complexity within edge habitats is achieved by exposed roots, trailing vegetation and the increased presence of woody debris and leaf litter. However, the edge habitats observed in local watercourses generally display limited structural complexity, with sparse trailing vegetation and minor exposed roots noted. Therefore, the degree of structural complexity with any watercourse is strongly influenced by the health of the adjacent riparian vegetation, with riparian zones along the watercourses of New Lenton historically impacted by clearing and regional farming practises.

2.6.2 PALUSTRINE WETLANDS

An off-channel palustrine wetland is mapped approximately 7.5 km downstream of the Burton Gorge Dam (Figure 5) (i.e. around 12 km downstream of the Project). The wetland has an associated, mapped regional ecosystem (RE) consisting of melaleuca and eucalypt vegetation (RE 1.3.27f) and is described as a floodplain tree swamp. No data are available on the water permanency, water quality and ecology of this wetland (BMT, 2018), and as it is separated from the Project by the Burton Gorge Dam, is not considered to be at risk of impacts from the Project.

2.6.3 LACUSTRINE WETLANDS

Various lacustrine wetlands have been identified in the region under DES mapping (Figure 5). The largest of these are the Burton Gorge Dam and Lake Elphinstone. Lake Elphinstone is a mapped high ecological significance (HES) wetland (Figure 5). However, this site is located on Anna Creek and upstream of New Lenton, and therefore does not directly interact with New Lenton. That area is therefore not at risk from New Lenton activities. The Burton Gorge Dam is located downstream of the two release points.

Other lacustrine wetlands mapped within the New Lenton receiving environment are a result of anthropogenic activities – not associated with New Lenton – such as mine storage dams and pits (from other mining operations) or farm dams. These will therefore not be a focus of monitoring within this REMP.

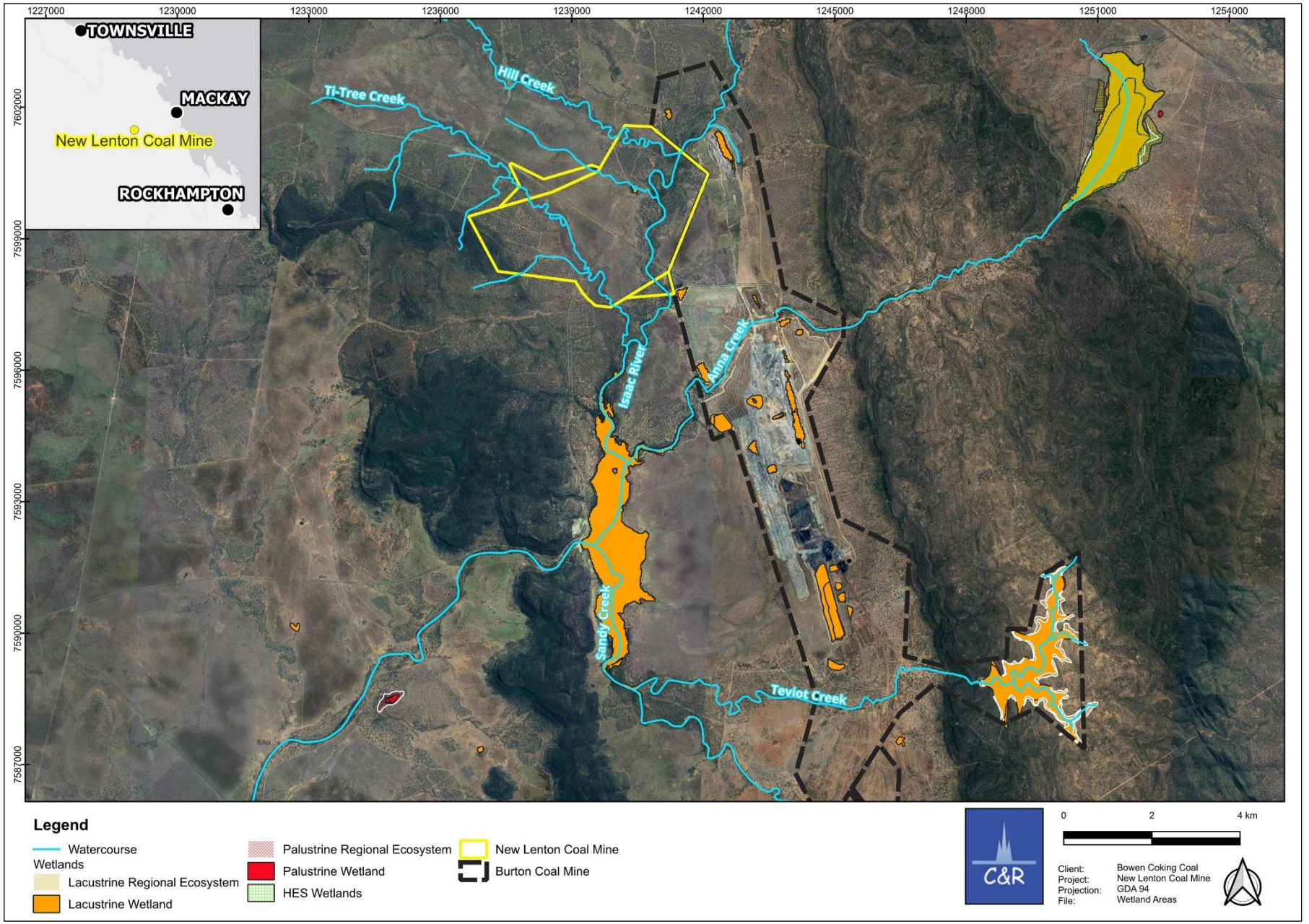


Figure 5: Mapped palustrine and lacustrine wetlands associated with the project site.

2.7 RIPARIAN VEGETATION

The riparian zone associated with New Lenton receiving environment has been highly modified by historical clearing for grazing practices and exotic species invasion. Despite this, the riparian zone on large watercourses within the area – such as the downstream Isaac River reaches – can be quite extensive, extending up to 100 m away from the channel. Often, on these larger channels, a gradual transition into the adjacent floodplain vegetation is evident.

On smaller upstream channels (e.g. Hill Creek or unnamed tributaries), the change from riparian vegetation to the surrounding floodplain is more sudden, with a maximum riparian extent of 35 m from the channel. However, extensive clearing and habitat modification has generally taken place on floodplains adjacent to these smaller drainage channels. Consequently, native riparian vegetation associated with large reaches is now non-existent for the smaller channels. This clearing, combined with historical cattle grazing, has altered the geomorphology of these smaller channels, subsequently increasing their susceptibility to erosion and sediment transportation.

AARC (2019) assessed the riparian condition across the project and found that the tributaries are highly disturbed from grazing practices and historical clearing, particularly damage to riparian banks by stock access and erosion. Erosion was present in the form of gullies and scarps in and around the key waterways.

Habitat modification is also a consequence of species invasion and favourable conditions has resulted in local dominance of exotic grasses and other weeds along the banks of the Isaac River and its tributaries. Several weeds of national significance (WoNS) and 'restricted' invasive plants regulated under the *Biosecurity Act 2014* were identified across the project area, including:

- *Harrisia martinii* ('restricted' invasive plant);
- *Lantana camara* (restricted invasive plant and WoNS);
- *Opuntia stricta* (restricted invasive plant and WoNS);
- *Parthenium hysterophorus* (restricted invasive plant and WoNS); and
- *Vachellia nilotica* (restricted invasive plant and WoNS).

Generally, the native riparian habitat adjacent to the watercourses associated with New Lenton are dominated by Queensland blue gum (*Eucalyptus tereticornis*) and river red gum (*Eucalyptus camaldulensis*), consistent with RE 11.3.25. RE 11.3.25 is described as *Eucalyptus tereticornis* or *Eucalyptus camaldulensis* woodland fringing drainage lines. The canopy layer within the riparian zone is dominated by these two eucalypt species that generally reach a maximum height of 30 m. The tallest stratum canopy cover is highly variable, ranging from 10% to 60%. Other less dominant species in the riparian zone include carbeen (*Corymbia tessellaris*), poplar box (*Eucalyptus populnea*), silver-leaved ironbark (*Eucalyptus melanophloia*) and river oak (*Casuarina cunninghamiana*).

The sub-canopy and low tree layer includes juvenile canopy species as well as Sally wattle (*Acacia salicina*), brigalow (*Acacia harpophylla*), western rosewood (*Alectryon oleifolius* ssp. *elongatus*) and yellowwood (*Terminalia oblongata*).

The shrub layer – where present – is dominated by a very sparse cover of yellowwood (*Terminalia oblongata*), brush cassia (*Cassia brewsteri*), pegunny (*Lysiphyllum hookeri*), Sally wattle and/or common lantana (*Lantana camara* var. *camara*). Immediately adjacent to the bank and generally overhanging the watercourse, *Melaleuca trichostachya* is often observed providing substantial edge habitat for aquatic fauna species via exposed roots and leaf litter.

The composition and density of the ground cover layer is highly variable but generally dominated by exotic species such as buffel grass, green panic (*Megathyrsus maximus* var. *pubiglumis*) and forest bluegrass (*Bothriochloa bladhii* ssp. *bladhii*).

2.8 AQUATIC FLORA AND FAUNA

2.8.1 FLORA

Watercourses within the upper Isaac River catchment area experience high-velocity, pulsed flows throughout the wet season. These flows can be highly sediment-laden and turbid, reducing the ability for sunlight to penetrate the water column. The high velocities and increased sediment movement – as well as the yearly drying process – combine to reduce the ability for macrophytes to establish within watercourses throughout the region. Hence, watercourses within the Isaac River catchment area generally exhibit low macrophyte diversity and percent coverage (C&R, 2013). Instead, wetlands (both palustrine and lacustrine) are the main habitats to promote aquatic flora colonisation. The RE (11.3.27f) associated with the downstream palustrine wetland lists the following aquatic vegetation connected to such systems:

- *Potamogeton crispus*;
- *Myriophyllum verrucosum*;
- *Chara* spp.;
- *Eleocharis* spp.;
- *Nitella* spp.;
- *Cyperus difformis*; and
- *Hydrilla verticillate*.

None of these species are listed under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) or the *Nature Conservation Act 1992* (NC Act).

2.8.2 MACROINVERTEBRATES

Studies completed of the New Lenton receiving environment by Ecowise (2008) reported 50 macroinvertebrate taxa inhabiting the area, with insects comprising the highest proportion of taxa. This is comparable with other results (C&R, 2013) for the region. Further, Ecowise (2008) found no statistically significant difference between the reference and impact sites, irrelevant of waterbody type (i.e. lentic or lotic). Macroinvertebrates were also assessed in the AARC aquatic ecology assessment for the project (AARC, 2019). However, only seven taxa were identified due to poor sampling conditions and no meaningful results were drawn from the assessment.

Macroinvertebrate communities can be powerful indicators of ecosystem health (Chessman, 2003). However, the use of macroinvertebrates as biological indicators within ephemeral systems is often considered limited because many of the sensitive families that inhabit perennial systems do not inhabit ephemeral waterbodies. These are, instead, dominated by families more tolerant of environmental changes (Williams, 2006). Therefore, to appropriately assess the potential impacts for such naturally variable systems from mining activities, continuous, seasonal data collected over a number of years (~5 years) are required.

No listed macroinvertebrate species are known to inhabit the New Lenton receiving environment.

2.8.3 FISH

Forty (40) species of fish from 24 families have been identified inhabiting the Fitzroy Basin (Pusey et al., 2004). Three of these species are suggested to be translocated and a further three are introduced exotics (Pusey et al., 2004). AARC undertook aquatic ecology surveys within the waterways across the project area in February 2018, May 2018 and April 2019 (AARC, 2019). Fish trapping within a dam during a terrestrial ecology survey was conducted in September 2004. A total of five fish species were captured including:

- *Ambassis agassizii* (Agassiz's glassfish);
- *Leiopotherapon unicolor* (spangled perch);
- *Melanotaenia splendida splendida* (eastern rainbowfish);
- *Mogurnda adspersa* (southern purple-spotted gudgeon); and
- *Nematalosa erebi* (bony bream).

All of the fish identified during AARC's surveys were recorded within the Isaac River. C&R (2013) also completed aquatic ecology surveys within the mid-reaches of Isaac River and associated tributaries and recorded an additional nine species, including:

- *Anguilla reinhardtii (longfin eel)*;
- *Gambusia holbrooki* (mosquitofish);
- *Hypseleotris klunzingeri (*western carp gudgeon);
- *Hypseleotris* spp.*;*
- *Macquaria ambigua oriens* (yellowbelly);
- *Neosilurus hyrtlii* (Hyrtl's tandan);
- *Oxyeleotris lineolate* (sleepy cod);
- *Porochilus rendahli* (Rendahl's catfish; and
- *Scortum hillii* (leathery grunter).

This survey recorded mosquitofish, an invasive aquatic species, within the area. Additionally, recent surveys have found the introduced pest fish Mozambique tilapia (*Oreochromis mossambicus*) within the Isaac River mid-reaches (Power, 2015). It is expected that as the tributaries associated with the New Lenton receiving environment are much smaller and do not flow all year round, lacking substantially deep (>2 m) and permanent pools, they would have a slightly different species assemblage to the mid and lower Isaac River.

The environmental tolerances of the species recorded within the region is presented in Table 3. No listed fish species are known to inhabit the New Lenton receiving environment.

Table 3: Environmental tolerances of species known to occur within the mid Isaac River (C&R, 2013; Pusey *et al*., 2004).

Family	Species name	Common name	pH (units)	Electrical conductivity (µS/cm)	Temperature (°C)	Dissolved oxygen (mg/L)	Turbidity (NTU)
Anguillidae	*Anguilla reinhardtii*	Longfin eel	4.5 – 8.5	5.6 – 67.6	13.3 – 32.7	5.1 – 12.4	0.1 – 29.7
Chandidae	*Ambassis agassizii*	Agassiz's glassfish	6.3 – 9.9	19.5 – 15,102.0	11.0 – 33.6	0.3 – 19.5	0.2 – 144.0
Clupeidae	*Nematolosa erebi*	Bony bream	6.0 – 9.1	8.3 – 780.0	15.0 – 33.4	1.1 – 12.0	0.3 – 160.0
Eleotridae	*Hypseleotris klunzingeri*	Western carp gudgeon	4.8 – 9.1	19.5 – 5,380.0	8.4 – 31.7	0.6 – 12.8	0.5 – 65.0
	Hypseleotris sp.	–	NA	NA	NA	NA	NA
	Mogurnda adspersa	Purple spotted gudgeon	5.6 – 8.8	13.3 – 2,495.0	11.9 – 31.7	0.6 – 12.8	0.1 – 200.0
	Oxyeleotris lineolatus	Sleepy cod	6.0 – 9.2	81.0 – 650.0	18.3 – 33.4	1.1 – 11.0	0.1 – 579.0
Melanotaeniidae	*Melanotaenia splendida*	Eastern rainbowfish	5.1 – 8.5	6.0 – 790.0	15.0 – 32.5	1.1 – 11.6	0.1 – 16.0
Percichthyidae	*Macquaria ambugia oriens*	Yellowbelly	7.2 – 8.8	NA	24.0 – 31.0	3.6 – 10.0	NA
Plotosidae	*Neosilurus hyrtlii*	Hyrtl's catfish	6.0 – 9.1	56.0 – 1,855.0	12.8 – 33.4	1.1 – 11.4	0.3 – 120.0
	Porochilus rendahli	Rendahl's catfish	7.22 – 8.3	258 – 435	15 – 28	4.2 – 11.0	1.3 – 4.75
Terapontidae	*Leioptherapon unicolor*	Spangled perch	4.0 – 8.6	≤ seawater	7.3 – 37.5	>0.4	1.5 – 260.0
	Scortum hillii	Leathery grunter	NA	NA	NA	NA	NA

Note: All environmental tolerance data were sourced from Pusey *et al.* (2004), using all data recorded within Queensland (except in the case of barramundi, with all available Australian information used).

NA – Not available.

2.8.4 TURTLES

Two species of freshwater turtles that inhabit the Fitzroy River catchment area are listed under both the EPBC Act and NC Act. The Fitzroy River turtle (*Rheodytes leukops*) is listed as vulnerable under both the EPBC Act and NC Act, whereas the white-throated snapping turtle (*Elseya albagula*) is listed as critically endangered under the EPBC Act and endangered under the NC Act. These species have never been recorded in the mid- or upper reaches of Isaac River and their preferred habitat is largely unavailable throughout the highly ephemeral reaches of the New Lenton receiving environment.

C&R (2013) recorded the common Krefft's river turtle (*Emydura macquarii krefftii*) inhabiting farm dams in the region. This species of freshwater turtle is considered common throughout Queensland, with populations inhabiting many of the east coast catchments.

2.9 ENVIRONMENTAL VALUES (EVS)

Draft environmental values have been developed under the framework of the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP Water and Wetland Biodiversity) for the Fitzroy Basin (Department of Science, Information Technology and Innovation [DSITI], 2017). DSITI (2017) separates the Isaac River sub-basin into several smaller EV zones, with New Lenton associated with the *Isaac Northern Tributaries*, *Isaac River – Main Channel* and *Burton Gorge Dam* (Table 4).

Based on the identified EVs of relevance to the project (Table 4), the EPP Water and Wetland Biodiversity outlines the level of protection (or management intent) required to maintain these values (DSITI, 2017).

Table 4: Surface water environmental values for the Isaac River Basin.

Environmental value	Isaac Northern Tributaries	Isaac River – Main Channel	Burton Gorge Dam
Aquatic ecosystems	✓	✓	✓
Crop irrigation	✓	✓	
Farm supply/use	✓	✓	
Stock water	✓	✓	✓
Aquaculture			
Human consumers	✓	✓	
Primary recreational	✓	✓	✓
Secondary recreational	✓	✓	✓
Visual recreation	✓	✓	✓
Drinking water	✓	✓	✓
Industrial use	✓	✓	✓
Cultural, spiritual and ceremonial	✓	✓	✓

2.9.1 MANAGEMENT INTENT

The EPP Water and Wetland Biodiversity outlines the management framework applicable to different aquatic ecosystems. The framework provides threshold levels of change that are

acceptable for each of the different aquatic ecosystem conditions and involves maintaining the waters in good condition and seeking to sustainably manage water quality in modified waters (DSITI, 2017).

DSITI (2017) characterises the management intent for the majority of the Isaac River sub-basin (including the New Lenton mining leases and receiving environment) as moderately disturbed. For moderately disturbed systems (*waters in which the biological integrity of the water is adversely affected by human activity to a relatively small but measurable degree*; EPP Water and Wetland Biodiversity), the intent is to achieve specified WQOs (DSITI, 2017).

3. OBJECTIVES

The objectives of the REMP aim to protect the EVs of the receiving environment outlined within Section 2.8.4. Site-specific objectives for water quality, sediment quality and biological indices for Ti-Tree Creek, Hill Creek and Isaac River cannot be derived at this time because an insufficient number of background samples have been collected to date. Best-practice guidelines have been used to assign interim objectives until sufficient background samples have been obtained.

Several resources were considered when determining the monitoring objectives for water, sediment and biological indices within the receiving environment of New Lenton, including:

- The draft EVs and water quality guidelines for the Isaac River sub-basin (DSITI, 2017);
- The *Australian and New Zealand guidelines for fresh and marine water quality* (ANZG, 2018);
- The *Queensland water quality guidelines* (Department of Environment and Heritage Protection [DEHP], 2009); and
- The New Lenton EA.

Aquatic ecosystem water quality guidelines for physico-chemical parameters of concern within the Isaac River sub-basin are provided within DSITI (2017). The listed values are based on region-specific data and intend to offer more localised guidelines to support the values provided in the *Queensland water quality guidelines* (DEHP, 2009) for the *Central Coast* region.

3.1 WATER QUALITY

To identify potential impacts from releases of MAW and to protect the identified EVs of the New Lenton receiving environment, water quality parameters – including physico-chemical properties, major ions, nutrients, metals/metalloids and petroleum hydrocarbons – must be analysed for flows within the New Lenton receiving environment.

To date, few samples have been collected from the monitoring sites at Burton or New Lenton. Consequently, the best available guidelines have been employed using the EA trigger levels and water quality guidelines for the Isaac River sub-basin. These WQOs can be used to assess water quality in the receiving environment until site-specific objectives can be derived. Site-specific objectives take into account the natural variation of the receiving environment. It is recommended that – for estimates of 20th and 80th percentiles – a minimum of 18 samples over at least 12 – and preferably 24 – months are applied. However, percentile estimates based on as few as eight samples can be used to derive guidelines if data from multiple background sites are available (DEHP, 2009).

Any exceedances of the WQOs outlined in Table 5 will require further investigation to determine the potential for impact to the EVs. Results above the WQOs should be compared against samples collected from the background sites, against the EA trigger levels and against any historical data to determine whether an impact has taken place.

Table 5: Water quality objectives (WQOs) for the New Lenton receiving environment.

Parameter	Unit	WQOs	Source
Physico-chemical			
pH	–	6.5–8.5	New Lenton EA and DSITI (2017)
Electrical conductivity (EC)	µS/cm	250	New Lenton EA. Note that DSITI (2017) recommends a maximum EC of 720.
Dissolved oxygen	% sat	85–110	DSITI (2017)
Suspended solids	mg/L	55	DSITI (2017)
Turbidity	NTU	50	New Lenton EA and DSITI (2017)
Sulphate as SO_4	mg/L	25	New Lenton EA
Dissolved metals			
Aluminium	mg/L	0.055 (if pH > 6.5)	New Lenton EA and DSITI (2017)
Arsenic	mg/L	0.013	New Lenton EA and DSITI (2017)
Boron	mg/L	0.370	New Lenton EA
Cadmium	mg/L	0.0002	New Lenton EA and DSITI (2017)
Chromium	mg/L	0.001	New Lenton EA and DSITI (2017)
Cobalt	mg/L	0.0014	New Lenton EA
Copper	mg/L	0.0014	New Lenton EA
Iron	mg/L	0.3	New Lenton EA
Lead	mg/L	0.0034	New Lenton EA and DSITI (2017)
Manganese	mg/L	1.9	New Lenton EA and DSITI (2017)
Mercury	mg/L	0.00006	New Lenton EA and DSITI (2017)
Molybdenum	mg/L	0.034	New Lenton EA
Nickel	mg/L	0.011	New Lenton EA and DSITI (2017)
Selenium	mg/L	0.005	New Lenton EA
Silver	mg/L	0.00005	New Lenton EA
Uranium	mg/L	0.0005	New Lenton EA
Vanadium	mg/L	0.006	New Lenton EA
Zinc	mg/L	0.008	New Lenton EA
Nutrients			
Ammonia as N	mg/L	0.9	New Lenton EA
Total nitrogen	mg/L	0.42	DSITI (2017)
Nitrate as N	mg/L	1.1	New Lenton EA
Nitrite + nitrate as N	mg/L	0.06	DSITI (2017)
Filterable reactive phosphorus	mg/L	0.02	DSITI (2017)
Total phosphorus	mg/L	0.05	DSITI (2017)
Chlorophyll *a*	mg/L	0.005	DSITI (2017)
Total petroleum hydrocarbons			
C6 - C9 fraction	µg/L	20	New Lenton EA
C10 - C36 fraction (sum)	µg/L	100	New Lenton EA

NA – Not available.

3.2 SEDIMENT QUALITY

Nineteen (19) metals and metalloids are to be assessed during sediment monitoring for the REMP (refer to Section 4.4). However, SQGs – developed in the ANZG (2018) guidelines – are only available for nine parameters (Table 6). Additionally, insufficient data currently exist to develop site-specific trigger levels (Table 6). Instead, it is recommended that – once sufficient background data have been obtained – site-specific SQOs should be determined.

When assessing receiving environment sediment quality data against the supplied SQGs, if concentrations are recorded between SQO-low and SQO-high trigger values, then they need to be closely compared with background sites and resultant bed macroinvertebrate data. If quality characteristics are recorded above the SQO-high trigger values, then further investigations are required to determine the actual bioavailability of the contaminant and, therefore, the potential toxicity to organisms within the receiving environment.

Table 6: Sediment quality objectives for the New Lenton receiving environment.

Quality characteristic	Units	Trigger level		Source
		Low	High	
Aluminium	mg/kg	TBD	TBD	
Arsenic	mg/kg	20	70	ANZG (2018)
Cadmium	mg/kg	1.5	10	ANZG (2018)
Chromium	mg/kg	80	370	ANZG (2018)
Copper	mg/kg	65	270	ANZG (2018)
Iron	mg/kg	TBD	TBD	
Lead	mg/kg	50	220	ANZG (2018)
Mercury	mg/kg	0.15	1	ANZG (2018)
Nickel	mg/kg	21	52	ANZG (2018)
Zinc	mg/kg	200	410	ANZG (2018)
Boron	mg/kg	TBD	TBD	
Cobalt	mg/kg	TBD	TBD	
Manganese	mg/kg	TBD	TBD	
Molybdenum	mg/kg	TBD	TBD	
Selenium	mg/kg	TBD	TBD	
Silver	mg/kg	1	4.0	ANZG (2018)
Uranium	mg/kg	TBD	TBD	
Vanadium	mg/kg	TBD	TBD	

TBD – To be determined once sufficient background data exist.

3.3 BIOLOGICAL INDICATORS

Macroinvertebrate monitoring must be undertaken within the receiving environment to determine the potential influences that activities associated with New Lenton may be having on the resident aquatic communities. Macroinvertebrates are often used as biological indicators to assess water pollution and other anthropogenic impacts on freshwater systems. The guideline values for assessing macroinvertebrate communities (Table 7) were adopted from DEHP (2009) and were developed to provide an overview of community health within coastal drainages throughout central Queensland. These values are based on AusRivAS methods for sampling macroinvertebrate communities.

It is recommended that site-specific objectives be determined once sufficient background data exist.

Table 7: Biological objectives for the New Lenton receiving environment.

Biological indices	Habitat	Objective	
		20th percentile	80th percentile
Taxonomic richness	Composite bed	12	21
PET richness	Composite bed	2	5
SIGNAL	Composite bed	3.33	3.85
% tolerant taxa	Composite bed	25	50

4. MONITORING

The REMP has been established to assess the potential impacts to the New Lenton receiving environment from controlled releases – and other associated activities – throughout each year. The program is designed using the standard BACI (before-after/control-impact) approach to provide spatial and temporal measures, resulting in sites being assessed as either control (background) or compliance (downstream) sites over seasons/years. This section lists the monitoring methods and data sources (e.g. for external flow information; Table 8) for individual components.

4.1 MONITORING SITES

Table 9 lists the monitoring sites associated with the New Lenton REMP, providing a brief site description. The monitoring sites are strategically positioned to assess upstream (background) as well as downstream (compliance) conditions within the New Lenton receiving environment (Figure 6), ensuring any impacts from point source pollution are identified. The far downstream monitoring site (MP08) is located approximately 7.6 km downstream of RP1. The EA states that the receiving environment incorporates all reaches up to 15 km downstream of the release points. However, access this far afield is limited, and it is highly unlikely that any evidence of influence from New Lenton's operations downstream of the Burton Gorge Dam. Hence, MP08 is the furthest downstream monitoring site targeted.

Table 9 also details the parameters targeted at each site and the frequency of sampling required for each parameter.

4.2 FLOW MONITORING

All waterways associated with New Lenton are classed as ephemeral and will thus only flow for short periods (<2 months) during and immediately after a rainfall events. The gauge measures flow heights, with a ratings curve developed to estimate discharge volumes. After major flows, the data loggers are updated to calibrate for changes in the sand bed profile.

Continuous flow monitoring gauges are operational on the Isaac River, with flow data available from DEHP and BoM. The gauging stations are located downstream of New Lenton and details are presented in Table 8. Release of MAW should only occur during periods of natural flow in accordance with the receiving water flow criteria discharge outlined in Table C4 of the New Lenton EA. The daily quantity of MAW released from each release point must be measured and recorded. Collected data will be reviewed during the annual REMP assessment to determine when and how long flows occurred within the receiving environment.

Table 8: Flow gauging stations on the Isaac River.

Station Name	Station Number	Easting	Northing	Catchment Area	Annual Average (ML)
Burton Gorge[1]	130402A	616113	7607791	551	10,939
Goonyella[1]	130414A	600401	7582713	1214	13,997
Deverill	130410A	642395	7547239	4092	54,485
Yatton	130401A	717408	7492940	197419	568,612

[1]Burton Gorge and Goonyella gauges have closed but can be used for historical assessments.

Table 9: REMP monitoring site locations, descriptions, parameters and frequency.

Site name	Watercourse	Easting (GDA94)	Northing (GDA94)	Description	Monitoring requirements	Timing/frequency
Upstream/Background monitoring points						
MP01	Isaac River	618612.15	7617073.76	Isaac River 1,000 meters upstream of site	Water quality, sediments, habitat condition, macroinvertebrate communities	Routine water quality monitoring should be undertaken within receiving environment sites in accordance with EA requirements. Additionally, all parameters should be monitored – once at the beginning (~4–6 weeks after flows commence) and once at the end of each wet season.
MP03	Ti-Tree Creek	615159.37	7616671.66	Ti-Tree Creek upstream RP2		
Control monitoring point						
MP02	Isaac River	618323.55	7614775.82	Isaac River at downstream site boundary upstream of RP1 but downstream of releases from RP2.	Water quality, sediments, habitat condition, macroinvertebrate communities	Routine water quality monitoring should be undertaken within receiving environment sites in accordance with EA requirements. Additionally, all parameters should be monitored – once at the beginning (~4–6 weeks after flows commence) and once at the end of each wet season.
Downstream monitoring points						
MP04	Isaac River	617711.86	7613087.88	Isaac River downstream of RP1	Water quality, sediments, habitat condition, macroinvertebrate communities	Routine water quality monitoring should be undertaken within receiving environment sites in accordance with EA requirements. Additionally, all parameters should be monitored – once
MP05	Ti-Tree Creek	616544.49	7617010.32	Located in the proposed diversion channel, ~1000 meters downstream of RP2		

Site name	Watercourse	Easting (GDA94)	Northing (GDA94)	Description	Monitoring requirements	Timing/frequency
MP06	Ti-Tree Creek	616680.90	7618374.40	Ti-Tree Creek on the ML boundary downstream of RP1		at the beginning (~4–6 weeks after flows commence) and once at the end of each wet season.
MP07	Unnamed tributary of Isaac River	618353.46	7617642.67	Located downstream of the diversion connecting Ti-Tree Creek with the unnamed tributary of the Isaac River.		
MP08	Isaac River	616750.00	7608620.00	Isaac River downstream of the Burton Gorge Dam. This is a shared monitoring site with Burton.		

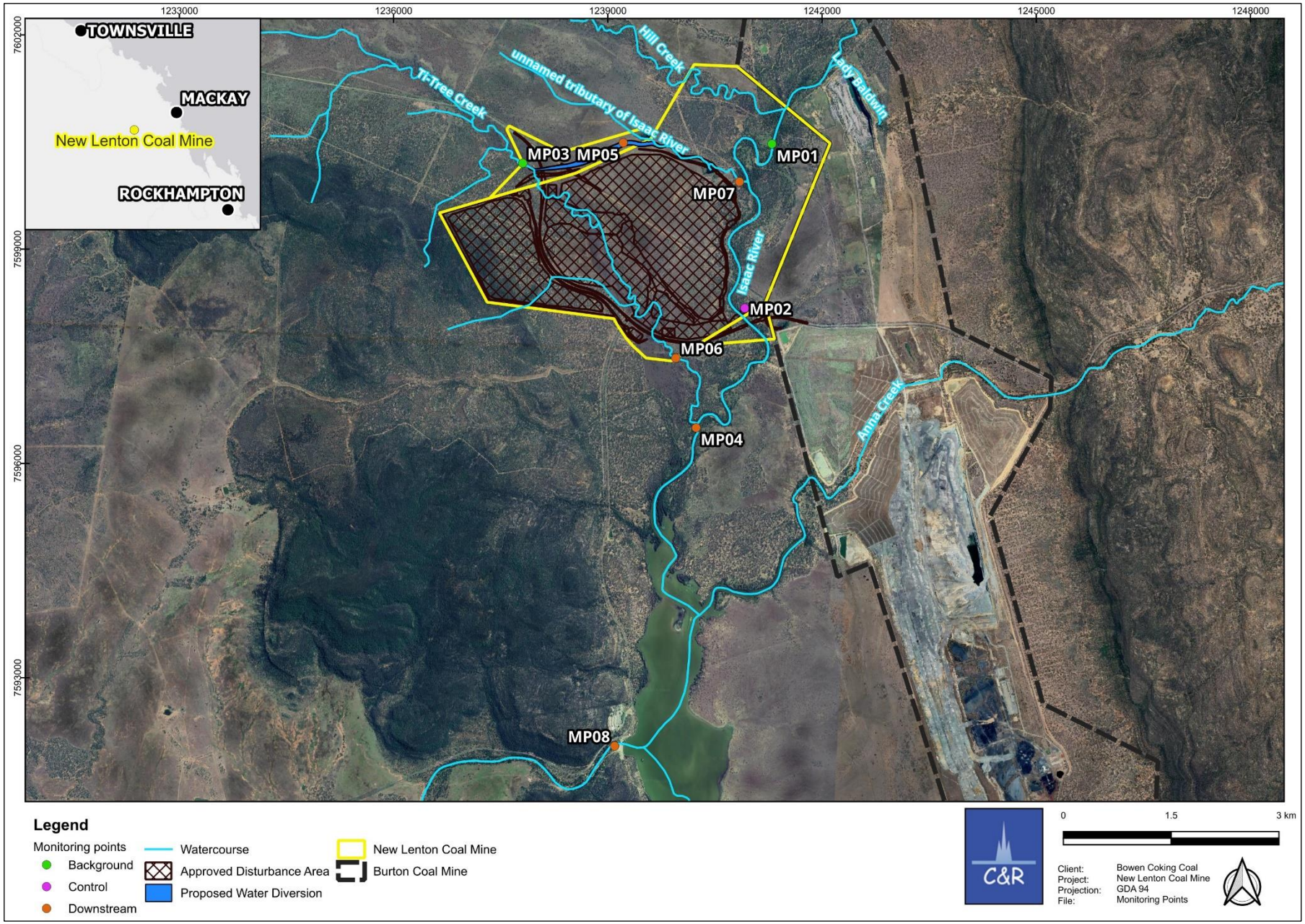


Figure 6: New Lenton REMP monitoring sites associated with the main mining area.

4.3 WATER QUALITY MONITORING

4.3.1 TARGETED PARAMETERS

Releases and environmental flows should be assessed for the analytes detailed within EA tables C2, C3 and C6. The analytes listed for the WQOs (see Section 3.1, Table 5) are an extension of the release event monitoring requirements of the EA and are based on the best available guidelines.

At a minimum, the electrical conductivity, pH, turbidity and sulphate concentrations within release water and the receiving environment should be monitored daily during the release, while the concentration of the other water quality analytes detailed in Table 5 should be monitored within two hours of commencement of release and weekly thereafter during the release. Monitoring of water quality within the receiving environment should occur as per Table 9 during flow events, irrelevant of a release of MAW.

Additionally, during macroinvertebrate sampling (twice annually), REMP monitoring sites must be tested for parameters that have the potential to influence macroinvertebrate assemblages but are not regularly tested as a requirement of the EA. Water samples must be tested for the parameters listed in Table 10.

Table 10: Water quality parameters measured during macroinvertebrate sampling.

Quality characteristic	Unit
In situ	
pH	–
Electrical conductivity	µS/cm
Temperature	°C
Dissolved oxygen	% sat.
Turbidity	NTU
Laboratory	
pH	–
Electrical conductivity	µS/cm
Temperature	°C
Dissolved oxygen	% sat.
Turbidity	NTU
Alkalinity	mg/L
Filterable reactive phosphorus	mg/L
Total phosphorus	mg/L
Ammonia	mg/L
Nitrite	mg/L
Nitrate	mg/L
Total nitrogen	mg/L

4.3.2 SAMPLING METHODS

In addition to release monitoring, collection of water samples from the REMP sites is a requirement, regardless of whether a release has occurred, in accordance with condition

C21 and C22 of the EA. Sampling of the receiving environment over the wet season should be undertaken to target the different stages of the hydrograph for flow events, including the rising limb, peak and falling limb. Sampling should not be undertaken if deemed unsafe to do so.

In-situ measurements are to be collected with an appropriately calibrated instrument and in accordance with the methods detailed within the Queensland *Monitoring and sampling manual* (DES, 2018).

Each grab sample will be collected from the mid-channel (or as close as safely possible) at each site by automated sampler or sampling pole at a depth of at least 20 cm below the surface of the water. All grab samples will be collected within appropriate sampling containers, using methods outlined by the National Association of Testing Authorities (NATA) accredited laboratory (e.g. field-filtered for dissolved metals through a 0.45 µm filter).

The date and time of each sample must be recorded so that the analysis results can be linked back to water depth and flow values from relevant gauging stations. Field sheets will also be completed, detailing anecdotal observations of flow velocity/height, water colour, water odour, any debris, etc. Additionally, time- and date-stamped photos must be taken while facing upstream and downstream at each sampling point on each sampling occasion. Where possible, permanent photo points should be established.

4.3.3 QA/QC

All water quality sampling will be conducted by a suitably qualified person, in accordance with the Australian Standard (AS) AS5667 (*Water quality sampling*) and the *Monitoring and sampling manual* (DES, 2018). In summary:

- In-situ water quality meters must be regularly calibrated, with a calibration record retained;
- Water quality meters must be washed with ambient site water prior to sampling and thoroughly cleaned at the end of a sampling event and prior to storage;
- Water samples for laboratory analysis will be collected via the methods recommended by the NATA-accredited laboratory of choice;
- Samples will be delivered to the laboratory within the appropriate holding times and holding conditions (specified by the NATA-accredited laboratory);
- Powder-free latex gloves must be worn during sampling;
- Open sample containers and their lids must not be placed on the ground or other potentially contaminated surfaces;
- If a separate container is used for collection of samples (such as a bucket or a sample jar on a pole), this must be thoroughly rinsed with ambient site water prior to taking the sample;
- A duplicate and a field blank will be collected from one site during each sampling event to assess laboratory precision and sampling procedures, respectively;
- Field filtering (using a 0.45 µm filter) must be undertaken for dissolved metals;
- An appropriate chain-of-custody form must be completed for each sample event for submission to the laboratory; and
- All samples must be assessed in a NATA-accredited laboratory.

4.4 Sediment Quality Monitoring

Water quality monitoring, within ephemeral systems, provides an indication of contamination over one flow cycle (depending on frequency of sampling). However, sediment quality monitoring can provide an assessment of the accumulation of potential contaminants within

the drying system over an extended period of time (e.g. years), specifically the accumulation of metals and metalloids. Further, sediment quality provides an indication of contaminants available to the organisms living within the substrate and/or ingesting fine sediments.

4.4.1 SAMPLING METHODS

Sediment sampling will be undertaken in accordance with the best-practice methods outlined in the Australian Standard AS5667.1 (*Guidance on sampling of bottom sediments*), the CSIRO-published *Handbook for sediment quality assessment* (Simpson *et al.*, 2005), as well as the Queensland *Monitoring and sampling manual* (DES, 2018).

One sediment sample will be collected from each monitoring site twice yearly (coinciding with macroinvertebrate sampling). Fine surface sediments (<0.2 m deep) will be targeted, with samples collected (using a stainless-steel or hardened plastic trowel) from the upstream end of standing pools or recently formed bars where increased deposition has occurred. If the water is deeper (>0.5 m but <1 m) and still running, a stainless-steel corer may be required to collect the sample. Again, this sample will be collected from an area where deposition is noted. Samplers must wear powder-free latex gloves when sampling sediment.

Approximately 1 kg of sediment will be collected for each sample and placed in a plastic, sealable sample bag (for particle size distribution analysis) and a sterile glass jar (for all other analytes) for transport to the NATA-accredited laboratory.

At the laboratory, samples will be sieved to assess their particle size distribution. The <63 µm and <2 mm fraction of each sample will be tested for a total of 19 metals and metalloids. The <63 µm fraction is comprised of fine clays and provides an indication of the worst-case scenario (i.e. highest potential concentrations of contaminants experienced by aquatic organisms) for toxicant concentrations, whereas the <2 mm fraction is the basis of the ANZG (2018) guidelines. Each sediment sample will then be tested in a NATA-accredited laboratory for the following metals and metalloids:

- Aluminium;
- Antimony;
- Arsenic;
- Boron
- Cadmium;
- Chromium;
- Cobalt;
- Copper;
- Iron;
- Lead;
- Manganese;
- Mercury;
- Molybdenum;
- Nickel;
- Selenium;
- Silver;
- Uranium;
- Vanadium; and
- Zinc.

4.4.2 QA/QC

Sediment sampling must be conducted by a suitably qualified person in accordance with Australian Standard AS5667.1 (*Guidance on sampling of bottom sediments*), the CSIRO-published *Handbook for sediment quality assessment* (Simpson *et al.* 2005), as well as the DES (2018) *Monitoring and sampling manual*, including:

- Sediment sample bottles or bags must not be rinsed prior to collection;
- Sediment samples must be placed directly into the sample bottle or bag, wherever possible;
- Personnel must wear powder-free latex gloves when collecting sediment samples;
- Care must be taken not to touch the inside of the sampling container or place an open container and/or lid on potentially contaminated surfaces;

- If a separate container is used for collection of samples (such as a bucket), this must be thoroughly rinsed with ambient site water prior to taking the sample;
- A duplicate sample will be collected from one site during each sampling event to assess laboratory precision.
- Samples will be delivered to the laboratory within the appropriate holding times and holding conditions (specified by the NATA-accredited laboratory);
- An appropriate chain-of-custody form must be completed for each sample event for submission to the laboratory; and
- All samples must be assessed in a NATA-accredited laboratory.

4.5 HABITAT CONDITION

During macroinvertebrate assessments, habitat condition will be evaluated in accordance with the methods outlined within the *Queensland AusRivAS sampling and processing manual* (Department of Natural Resources and Mines [DNRM], 2001). Under these methods, nine key physical habitat characteristics are given a rating based on their condition, with the overall habitat bioassessment score for a site (the sum of all the possible ratings) allocated to one of four possible categories, signifying the condition of the habitat at a site (Table 11). These categories are:

- Excellent (>110);
- Good (75 – 110);
- Moderate (39 – 74); and
- Poor (≤38).

Further, general observations of stream condition will be undertaken at each site during the field visits, with specific reference to any erosion, bank instability or excessive fine sediment deposition observed within – or immediately downstream of – New Lenton operations. Photographs will be taken at each sampling site and compared to reference photographs. To ensure that comparisons can be achieved, permanent photo points should be established at each monitoring site where habitat condition is assessed.

Table 11: Rating system used to determine habitat bioassessment scores (DNRM, 2001).

Number	Habitat Variable	Habitat condition rating ranges			
		Poor	Moderate	Good	Excellent
1.	Bottom substrate / available cover	0 – 5	6 – 10	11 – 15	16 – 20
2.	Embeddedness	0 – 5	6 – 10	11 – 15	16 – 20
3.	Velocity/depth category	0 – 5	6 – 10	11 – 15	16 – 20
4.	Channel alteration	0 – 3	4 – 7	8 – 11	12 – 15
5.	Bottom scouring and deposition	0 – 3	4 – 7	8 – 11	12 – 15
6.	Pool/riffle, run/bend ratio	0 – 3	4 – 7	8 – 11	12 – 15
7.	Bank stability	0 – 2	3 – 5	6 – 8	9 – 10
8.	Bank vegetative stability	0 – 2	3 – 5	6 – 8	9 – 10
9.	Streamside cover	0 – 2	3 – 5	6 – 8	9 – 10

Number	Habitat Variable	Habitat condition rating ranges			
		Poor	Moderate	Good	Excellent
–	Total habitat bioassessment score	0 – 38	39 – 74	75 – 110	111 – 135

4.5.1 QA/QC

Habitat condition assessments must be performed by a suitably trained and competent person in accordance with the methods outlined in the *Queensland AusRivAS sampling and processing manual* (DNRM, 2001).

4.6 MACROINVERTEBRATE MONITORING

Macroinvertebrate community assessments are regularly conducted to determine the health of a watercourse / aquatic ecosystem. AusRivAS methods use macroinvertebrates as a biological indicator to provide a broad description of ecosystem health at a targeted site. AusRivAS sampling generally targets both bed and edge habitats at a site. However, as discussed in Section 2.6, the edge habitat at most receiving environment sites is predicted to be limited. Therefore, it is recommended that only macroinvertebrate communities inhabiting bed habitats are assessed during the REMP. The mixture of all bed habitats present at a site (e.g. sandy pool, rocky pool, riffle, run, cascade) is also referred to as a 'composite' sample in DEHP (2009).

The REMP guideline (DES, 2022) outlines the best-practice methods to be adopted for macroinvertebrate sampling, with particular reference to Smith *et al.* (2004). Smith *et al.* (2004) suggest that the standard-practice AusRivAS methods for assessing macroinvertebrate communities do not provide statistically rigorous data on macroinvertebrate community structure to sufficiently identify potential impacts from point source contamination. However, this can be partially overcome by collecting replicate AusRivAS samples from each site. Therefore, it is recommended that three replicate bed habitat samples are collected from each site on each sampling occasion (if water is present).

4.6.1 SAMPLE COLLECTION

Macroinvertebrates will be collected from all monitoring sites, using a standard, triangular-framed, 250 µm mesh dip-net to sample a 'known' area of 5 m^2. Three replicate composite samples (i.e. a mixture of run, sandy pool, silty pool, etc., if available) will be collected from the bed habitat at each site. The replicate composite bed samples will be collected by disturbing the 5 m^2 area (i.e. a 10 m long transect x 0.5 m wide, or 5 m long x 1 m wide), generally via kicking and sweeping the macroinvertebrate net through the disturbed area.

Each sample must be field-picked live for specimens, in accordance with Queensland AusRivAS methods (i.e. relative abundances) for a period of 30 minutes (to standardise the effort across samples; DNRM, 2001). The resultant field-picked samples must be placed in specimen jars with >70% ethanol for preservation and transported back to the laboratory for identification.

Macroinvertebrate sampling will be conducted twice yearly (subject to suitable climatic conditions): once in the beginning of the wet season, at least 4 weeks after the first flush (generally between December and February, if safety permits) and once again at the end of the wet season, at least 4 weeks after the last significant flow event (generally between April and June), dependent on the timing of rainfall and subsequent flows.

4.6.2 SAMPLE PROCESSING

In the laboratory, all samples must be sorted, counted and identified to the lowest taxonomic level possible (preferably family) – in accordance with AusRivAS standards (DNRM, 2001) and the methods of Chessman (2003) – by a suitably qualified/experienced aquatic ecologist / taxonomist. A detailed list of keys useful in the identification process is available on the AusRivAS, Lucid Keys and the Murray-Darling Freshwater Research Centre websites. For QA/QC purposes, 10% of all samples must be enumerated and identified by a second suitably qualified/experienced aquatic ecologist / taxonomist.

4.6.3 QA/QC

Field sampling must be undertaken by a suitably trained ecologist, experienced in assessing ephemeral watercourses of central Queensland. Macroinvertebrate identification must be undertaken by a suitably qualified/experienced aquatic ecologist. A reference collection of specimens for all macroinvertebrate taxa must be established, with the identification of individual specimens cross-checked by a second AusRivAS-certified ecologist. This reference collection can then be used for future assessments.

Enumeration and identification will also be checked by a second suitably qualified ecologist for 10% of samples. An error rate of ≥10% (in both correct identification and abundance of each taxa) will be considered unacceptable (in accordance with DES, 2018) and will result in a further 10% of samples being checked, and so on.

4.7 ASSUMPTIONS

The outlined REMP monitoring program is highly dependent on the timing of the wet season. For instance, the AusRivAS methods suggest that sampling must be undertaken at the end of spring and/or the beginning of autumn each year to assess compositions dependent on life history of each major group. However, the wet season may arrive late, rendering it impossible to assess macroinvertebrate assemblages at the end of spring due to the lack of water. Therefore, the timing and the amount of rainfall experienced each year may limit the number of field trips undertaken during a REMP reporting period. This must be taken into consideration by the assessors and the administering authority when reviewing the subsequent data.

5. DATA ANALYSIS

5.1 SITE OBSERVATIONS

General observations will be recorded at each site during the biannual macroinvertebrate surveys. These will include looking for evidence of erosion and deposition, chemical precipitation, as well as algae blooms (e.g. green colour to water). All observed evidence will be photographed and presented, along with site photos, in the annual REMP assessment report.

The occurrence of fish kills that do not appear to be related to the natural drying of pools will be noted and reported to the Department of Agriculture and Fisheries as well as DES.

5.2 FLOWS

Each reporting period, hydrographs will be produced for each receiving environment to portray high-flow events and length of flows within the receiving environment. Graphs of flow versus electrical conductivity may also be created (where available data exist) to provide a more detailed assessment of background water quality experienced under differing flow conditions. Available streamflow and hydrological information will be included in interpretations during the annual REMP assessment.

5.3 WATER QUALITY

Data collected during routine (EA) monitoring of the receiving environment and during release events will be compared against the WQOs presented in Table 5 – as well as with previous background ranges. Any exceedances of the WQOs will be outlined and evaluated within the yearly REMP assessment report.

Analyses of released waters will be compared against results from within the background and receiving environment to provide an indication of the influence New Lenton activities can have on the chemistry of the downstream receiving environment.

When analysing the laboratory results, all values that are below the LOR should be reduced to 50% of the LOR for statistical analyses, in accordance with DES (2021). For example, a result of <0.01 would be entered into the database as 0.005 prior to statistical analysis. When reporting on results, the number of samples collected in that particular year with results less than the LOR should be stated.

5.4 SEDIMENT QUALITY

Sediment quality data collected during the twice-yearly field surveys will be compared against the SQOs outlined in Table 6 and historical results. More detailed analysis may be undertaken to determine any correlation between sediment quality and patterns observed within the macroinvertebrate communities present at each site (e.g. the BIO-ENV analysis using PRIMER). All outcomes are to be documented within the annual REMP assessment report.

Any pre-treatment or validation of data undertaken on water quality results prior to detailed analysis should also be adopted on sediment quality results (refer to Section 5.3).

5.5 HABITAT CONDITION

Habitat bioassessment data collected from receiving sites will be compared against background sites and historical results. These data will also aid in the interpretation of the macroinvertebrate results by providing a detailed description of physical factors potentially influencing the macroinvertebrate assemblages at each site. All outcomes must be documented within the annual REMP assessment report.

5.6 MACROINVERTEBRATE COMMUNITIES

The median of replicates throughout the bed habitat at each site will be compared against objectives for biological indicators – as well as historical data (refer to Table 7). All data will be assessed further using high-level multivariate analyses. The relative abundance and, therefore, composition of families within each replicate will be analysed to provide information on the similarities in the macroinvertebrate community structure within and between background and downstream sites during the same sampling event – as well as temporally (i.e. compared to historical data – or prior to and after a release event). Based on this assessment, the patterns within and between the macroinvertebrate communities can then be compared against the water and sediment quality results to identify any correlation and, therefore, determine quality characteristics that are potentially influencing macroinvertebrate community structure.

More rigorous statistical analysis should be undertaken by pooling the replicate macroinvertebrate data collected at background sites and separately pooling the replicate data collected from downstream sites (during the same sampling event). Note: Data should not be pooled across sampling events (i.e. do not pool data collected in different seasons). The data must be transformed and analysed (via resemblance matrices) using an array of techniques, including:

- Non-metric multi-dimensional scaling (MDS) plots – This technique constructs a ‘map’ of the samples that have been analysed via a similarity (or dissimilarity) matrix, in a specified number of dimensions (generally two or three). Samples that display greater similarity will appear closer together (Clarke and Warwick, 2001).
- Cluster analysis (dendrogram) – This type of analysis ‘groups’ samples together that are more similar to each other. For example, in PRIMER, this is achieved based on the results of a similarity matrix (Clarke and Warwick, 2001). The output of such an analysis provides a dendrogram which displays at what percentage replicates are considered similar. These results can also be displayed on the MDS plot via rings that distinguish percent similarity between groups.
- Species contributions analysis (e.g. SIMPER in PRIMER) – SIMPER calculates percentage contribution of macroinvertebrate families (in this case) to the similarity between replicates within a site – as well as the percent contribution of macroinvertebrate families to the dissimilarities between sites (Clarke and Warwick, 2001). This analysis allows for the determination of potential indicator species. The presence and/or abundance of these species may then be used to identify impacted sites from non-impacted sites.
- One- or two-way analysis of variance (ANOVA; e.g. ANOSIM in PRIMER) – When performing this analysis in PRIMER, the null hypothesis that there are no differences between macroinvertebrate assemblages at each site is tested. The output provides an R-value and p-value for each paired site. The closer the R-value is to one, the greater the dissimilarities are between sites (Clarke and Warwick, 2001). The p-value provides the significance value of the relationship (i.e. $p < 0.01$ is highly significant). If two sites are found to display strongly and significantly different macroinvertebrate assemblages, the results will display an R-value of close to one and $p < 0.01$, thereby rejecting the null hypothesis.

- Linking community analyses to environmental variables (e.g. BEST/BIO-ENV in PRIMER) – This multivariate analysis determines if any environmental variables (in this case, physico-chemical water quality and sediment metal concentrations) are significantly influencing macroinvertebrate community structure (Clarke and Warwick, 2001). The technique can determine if one or a combination of environmental variables best 'explain' the biotic pattern (Clarke and Warwick, 2001). The result is a correlation statistic – or Rho. The closer Rho is to 1, the greater the correlation between the variable(s) and the biotic pattern (Clarke and Warwick, 2001).

It is not a requirement to use the computer program PRIMER for the analysis of macroinvertebrate data in the REMP assessment. It has been included in the discussion of the required data analysis techniques above as an example only. It is acknowledged that there are several different computer programs (e.g. SPSS, JUMP, etc.) that can perform similar – if not the same – analyses.

5.7 QA/QC Data Analysis

One duplicate surface water sample is required for each surface water sampling round – as well as one duplicate sediment sample during each of the biannual sediment sampling rounds. A field blank will also be collected during each surface water sampling round. All duplicate and blank samples must be collected in accordance with the Queensland *Monitoring and sampling manual* (DES, 2018).

Duplicate samples assess the precision of the laboratory via the relative percent difference (RPD) equation, defined in the Queensland *Monitoring and sampling manual* (DES, 2018) as:

$$RPD = |C_1 – C_2| / (C_1 – C_2) / 2 \times 100$$

where: C_1 is the concentration of analyte from sample 1; and
C_2 is the concentration of analyte from sample 2.

DES (2018) notes that an RPD value below 20% for water and 50% for sediments may be acceptable, provided the result is five to ten times the laboratory LOR. This is an expression of the reduced certainty associated with results near the LOR.

Blank samples must be assessed for any results above the laboratory LOR to provide an estimate of potential contamination associated with environmental conditions or sampling procedures.

6. REPORTING AND CORRECTIVE ACTIONS

6.1 REPORTING

Condition C24 of the New Lenton EA outlines the reporting requirements of the REMP as follows:

'A report outlining the findings of the REMP, including all monitoring results and interpretations must be prepared annually and submitted to the administrating authority. This must include an assessment of background reference water quality, the condition of downstream water quality compared against water quality objectives, the suitability of current discharge limits to protect downstream environmental values'.

The annual REMP assessment report will outline the findings of the field assessments and compare results against guideline values – as well as historical values previously noted for each site within past reports. General observations throughout the field visits will also be included, with specific reference to any detected erosion, bank instability or excessive fine sediment deposition. Photographs taken at each sampling site will be compared to reference photographs.

The REMP assessment report must also outline any recommendations for future potential amendments to the methods employed during the REMP and/or to any current trigger levels within the New Lenton EA (i.e. potential derivation of site-specific objectives). Further, the REMP assessment report must be completed by a suitably qualified person.

An example of the report structure is as follows:

- Executive Summary
- Introduction
  - Scope
- Background Condition
  - Receiving Environment Description
  - Past REMP Findings
  - Climate – Especially rainfall experienced over the targeted wet season.
- Methods – Ensure any deviations from the methods outlined within the REMP document are appropriately discussed.
  - Sites
  - Timing
  - Flow Monitoring
  - Habitat Condition
  - Water Quality
  - Sediment Quality
  - Macroinvertebrate Community
  - Riparian Corridor
  - Wetland Condition
- Results
  - Flows and Releases – Describe the flows experienced within the receiving environment and any subsequent, controlled releases undertaken by the mine.

- Site Description – Display site photographs for comparison between field surveys and between treatments, also outlining site observations.
- Habitat Condition – Present habitat bioassessment results for all sites, including comparisons with previous assessments.
- Water Quality – Present in-situ water quality data, potential release water quality data, release event water quality data and all receiving environment data (i.e. control and receiving sites), with comparisons made between current datasets, historical results and guideline values. Also determine updated, site-specific objectives if sufficient data are available.
- Sediment Quality – Present sediment quality data for all receiving environment sites (i.e. control and receiving sites) and compare current data to historical results – as well as guideline values, where applicable. Also determine updated, site-specific objectives if sufficient data are available.
- Macroinvertebrate Community – Present results of all macroinvertebrate indices and compare to past results and guideline values, where applicable. Outline community structure and any trends observed between taxonomic composition and sediment and water quality results. Also determine updated, site-specific objectives if sufficient data are available.

- Discussion
  - All Results – Discuss all the results in relation to the influence the different parameters can have on each other, and the resultant ecological processes noted at each site – as well as the impacts any observed changes may have on these processes.
  - Environmental Management Practices – Discuss the current management techniques/strategies in place to control releases of MAW and their influence on the receiving environment.
  - EA Compliance – Discuss the requirements of the EA in relation to controlled releases and subsequent monitoring, stating the ability of the mine to successfully comply with these requirements over the reporting period.
- Recommendations – List all recommendations that have resulted as part of the REMP assessment over the reporting period, including site-specific objectives, amendments to environmental management practices, amendments to the REMP, etc.

6.2 CORRECTIVE ACTIONS

The results of the REMP assessment report must detail if any potential or actual impacts to the receiving environment were identified each year. Where a potential impact has been identified, further research/sampling should be recommended within the REMP assessment report that will assist in identifying if the impact is occurring. Where an impact is identified, corrective actions must be detailed within the REMP assessment report to reduce the potential risks to the receiving environment from further impact. Such corrective measures may include (but not be limited to) the review and amendment of:

- Water management infrastructure and the associated water management plan to determine if control measures are effectively reducing the potential for impacts to the receiving environment from MAW;
- EA release conditions;
- EA monitoring requirements; and
- Erosion and sediment control measures and associated plan to ensure all sediment laden runoff is appropriately controlled.

7. ROLES AND RESPONSIBILITIES

There are a number of tasks designated each year under the REMP. This section has been provided to allow New Lenton environmental personnel to keep track of the tasks and responsibilities recommended within this REMP design document.

Table 12 outlines the responsibilities for monitoring and reporting under the REMP. Definitions of responsible personnel are outlined below.

Table 12: Roles and responsibilities for tasks required under the REMP.

Task	When and where	Responsibility
Flow monitoring (Section 4.2)	All flows at nominated locations	New Lenton environmental personnel; Routine monitoring contractor
Routine water quality monitoring (Section 4.3)	Water quality sampling from all monitoring sites when flows persist (regardless of releases)	New Lenton environmental personnel or delegates; Routine monitoring contractor
Sediment quality monitoring (Section 4.4)	Once in the dry season and once in the post-wet season	REMP monitoring contractor or New Lenton environmental personnel
Macroinvertebrate and habitat monitoring (sections 4.5 and 4.6)	Once in the early wet season, once following the wet season	Suitably qualified REMP monitoring contractor
REMP assessment report	Annually after the reporting period	Suitably qualified REMP monitoring contractor

Definitions

New Lenton environmental staff	Environmental personnel employed at New Lenton, generally the environmental superintendent or other environmental personnel.
Routine monitoring contractor	Suitably qualified specialists employed to undertake routine flow and surface water quality monitoring across the site.
REMP monitoring contractor	Suitably qualified specialists employed to undertake habitat condition, macroinvertebrate and sediment quality monitoring, and prepare the REMP assessment report, with suitable experience in undertaking such assessments.

8. REFERENCES

4T Consultants (2011). *New Lenton Coal Project – Mining Lease 70337: Receiving Environment Monitoring Program*. Report prepared by 4T Consultants Pty Ltd for New Hope Group.

AARC (2019). *New Lenton Mine – Aquatic Ecology Assessment.* Report prepared by AARC Environmental Solutions Pty Ltd for New Lenton Coal Pty Ltd.

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 www.waterquality.gov.au/anz-guidelines.

BMT (2018). *Burton Coal Mine – Receiving environment monitoring program*. Report prepared for New Hope Group.

BoM (2023) *Climate Data Online*. Bureau of Meteorology, http://www.bom.gov.au/climate/data/ (accessed 14 July 2023).

C&R (2013). *Moranbah South Project – Aquatic ecology report.* Prepared for Hansen Bailey Pty Ltd on behalf of Anglo American Metallurgical Coal Pty Ltd.

Chessman, B.C. (2003). New sensitivity grades for Australian river macroinvertebrates. *Marine and Freshwater Research*, 54: 95-103.

Clarke, K.R., Warwick, R.M. (2001). *Changes in marine communities: an approach to statistical analysis and interpretation*, 2nd edition. PRIMER-E, Plymouth, UK.

Cussac, V.E., Fernandez, D.A, Gomez, S.E., Lopez, H.L. (2009). Fishes of southern South America: a story driven by temperature. *Fish physiology and biochemistry*, 35(1): 29-42.

DEHP (2009). *Queensland water quality guidelines,* Version 3. Department of Environment and Heritage Protection, Queensland. ISBN 978-0-9806986-0-2, pp. 184.

DERM (2009). *A study of the cumulative impacts on water quality of mining activities in the Fitzroy Basin.* Queensland Department of Environment and Resource Management, pp. 49.

DES (2022). R*eceiving environment monitoring program guideline – For use with environmentally relevant activities under the Environmental Protection Act (1994).* Department of Environment and Science Queensland Government, Brisbane, pp. 11.

DES (2018). *Monitoring and sampling manual: Environmental Protection (Water) Policy.* Department of Environment and Science, Queensland Government, Brisbane, pp. 263.

DES (2021). *Using monitoring data to assess groundwater quality and potential environmental impacts. Version 2*. Department of Environment and Science (DES), Queensland Government, Brisbane.

DNRM (2001). *Queensland Australian River Assessment System (AusRivAS) sampling and processing manual.* Queensland Department of Natural Resources and Mines, Rocklea, QLD.

DSITI (2017). *Draft environmental values and water quality guidelines: Fitzroy Basin fresh, estuarine and marine waters, including Keppel Bay*. Newham, M., Moss, A., Moulton, D., Honchin, C., Thames, D., Shrestha, K., Elledge, A. Department of Science, Information Technology and Innovation, Queensland Government, pp. 132.

Ecowise (2008). *Burton biological monitoring program*. March 2008, Final Report.

Jeffrey, S.J., Carter, J.O., Moodie, K.B., Beswick, A.R. (2001). Using spatial interpolation to construct a comprehensive archive of Australian climate data. *Environmental Modelling & Software*, 16(4): 309-330.

Kergow, L.A., Prosser, I.P., Hughes, A.O., Brodie, J. (2005). Sources of sediment to the Great Barrier Reef World Heritage Area. *Marine Pollution Bulletin*, 51: 200-211.

McCulloch, M., Fallon. S., Wyndham, T., Hendy, R., Lough, J., Barnes, D. (2003). Coral record of increased sediment flux to the inner Great Barrier Reef since European settlement. *Nature*, 421: 727-730.

Peabody (2016). *Burton Coal Mine receiving environment monitoring program*.

Platten (2011). *Fish water quality guidelines for Fitzroy Basin freshwaters.* Department of Environment and Resource Management, Queensland Government, Brisbane, pp. 15.

Power, T. (2015). *Preliminary investigation into the distribution of Tilapia in the Upper Fitzroy Catchment*. Report prepared by Catchment Solutions Pty Ltd.

Pusey, B., Kennard, M., Arthington, A. (2004). *Freshwater fishes of north-eastern Australia.* CSIRO Publishing, Victoria.

Queensland Government (2023). *Water Monitoring Information Portal*. https://water-monitoring.information.qld.gov.au/ (accessed 14 July 2023).

Simon, A., Collison, A.J.C. (2002). *Quantifying the mechanical and hydrologic effects of riparian vegetation on streambank stability*. Earth Surface Processes and Landforms, 27: 527-546.

Simpson, S.L., Batley, G.E., Chariton, A.A., Stauber, J.L., King, C.K., Chapman, J.C., Hyne, R.V., Gale, S.A., Roach, A.C., Maher, W.A. (2005). *Handbook for sediment quality assessment*. CSIRO, Lucas Heights, NSW.

SGM (2023). *2023 Receiving Environment Monitoring Program – Burton Coal Mine*. Report prepared by SGM Environmental (Mackay) Pty Ltd for New Lenton Coal Pty Ltd.

Smith, R., Jeffree, R., John, J., Clayton, P. (2004). *Review of methods for water quality assessment of temporary stream and lake systems*. Australian Centre for Mining Environmental Research, Kenmore, QLD, pp. 46.

Todd, C.R., Ryan, T., Nichol, S.J., Bearlin, A.R. (2005). The impact of cold water releases on the critical period of post-spawning survival and it implications for Murray cod (Maccullochella peelii peelii): a case study of the Mitta Mitta River, southeastern Australia. *River Research and Applications*, 21(9): 1035-1052.

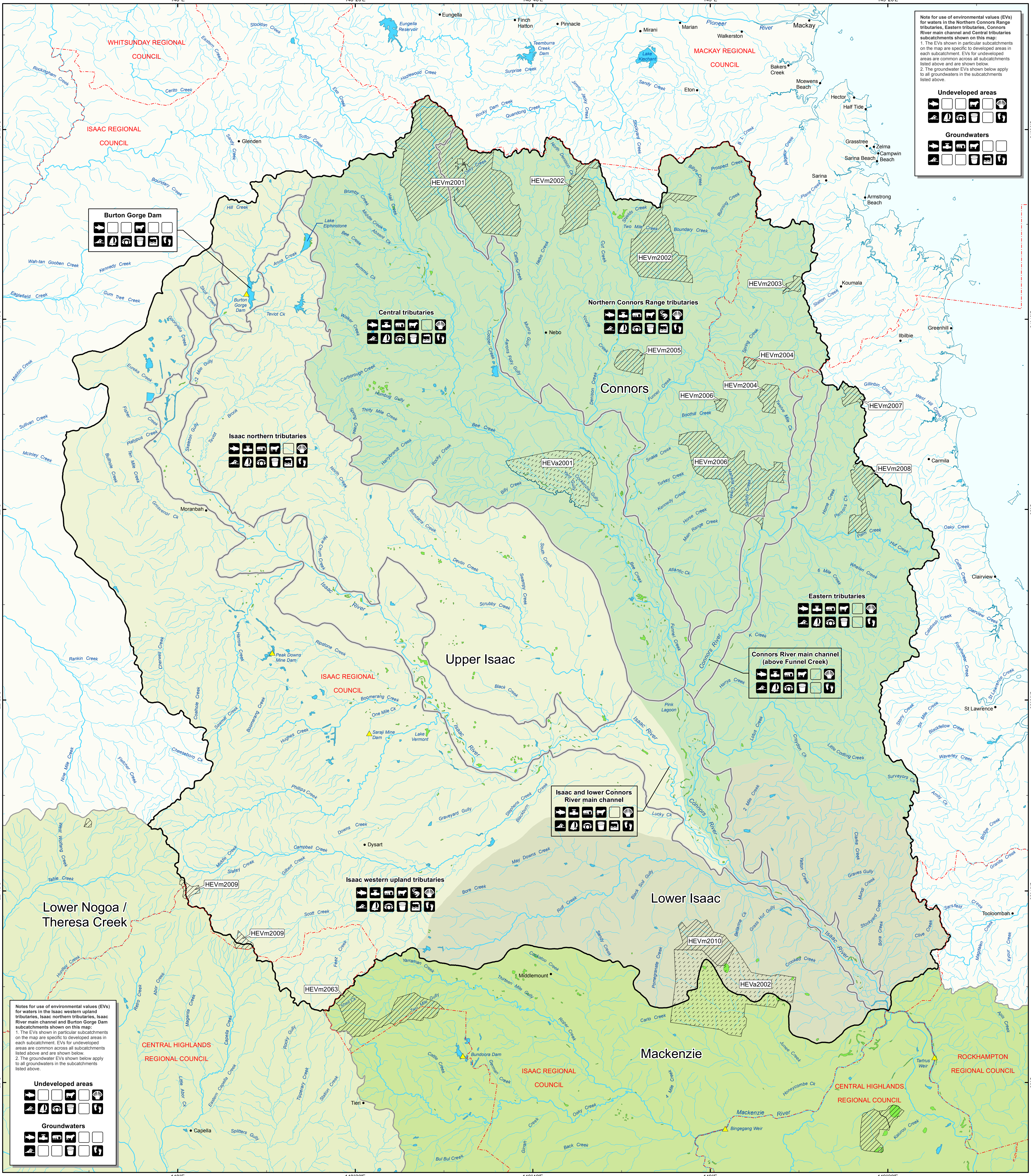
Walling, D.E. (2000). Linking land use, erosion and sediment yields in river basins. *Hydrobiologia*, 410**:** 223-240.

Walling, D.E, Fang, D. (2003). Recent trends in the suspended sediment loads of the world's rivers. *Global and Planetary Change*, 39: 111-126.

Williams, D. (2006). *The biology of temporary waters*. Oxford University Press.

WRM (2024). *New Lenton Coal Project: Surface Water and Flood Impact Assessment*. Report prepared for Bowen Coking Coal Pty Ltd.

Appendix A – Isaac River sub-basin plan



Legend

- Town
- Dam / weir / barrage
- Coastline
- River / creek
- Subcatchment boundary
- Boundary of waters covered by the scheduling document
- Local government boundary

Management Intent for Waters

- High ecological value fresh waters (maintain)
- High ecological value fresh waters (achieve)

Water Types

Fresh waters

- Upper Isaac River catchment fresh waters
- Lower Isaac River catchment fresh waters
- Connors River catchment fresh waters
- Lower Nogoa / Theresa Creek catchment fresh waters
- Mackenzie River catchment fresh waters
- Wetlands (palustrine)
- Lakes / reservoirs

Key to Environmental Values

Aquatic Ecosystems, Irrigation, Farm Supply, Stock Water, Aquaculture, Human Consumer

Primary Recreation, Secondary Recreation, Visual Recreation, Drinking Water, Industrial Use, Cultural & Spiritual Values

Notes:

1. For areas outside of the waters covered by the scheduling document please refer to the relevant plan.
2. Waterways in the catchment that are not shown on this map as having a management intent of high ecological values (maintain or achieve) have a **management intent of moderately disturbed.**
3. Refer to plan WQ1310 for mapping of groundwater chemistry zones.
4. Wetlands shown on this map are sourced from the Queensland Wetland Data Version 2.0 developed by the Queensland Wetlands Program. Refer to the Wetland*Info* website (www.ehp.qld.gov.au) for the most current information on Queensland wetlands.

Disclaimer

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WQ1301 - Isaac River Sub-basin

Part of basin 130

Environmental Protection (Water) Policy 2009

Central Queensland Map Series

This plan forms part of the Isaac River Sub-basin Environmental Values and Water Quality Objectives scheduling document, prepared pursuant to the *Environmental Protection (Water) Policy 2009*.

QUEENSLAND GOVERNMENT

Publication date: September 2011 (Re-published in July 2013)

N

0 10 20 30 40
Kilometres

Scale: 1:350,000 @ A1

Projection: Mercator

Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)

Location Map