Appendix N

Aquatic Ecology Assessment Addendum

REGIS RESOURCES LTD

McPhillamys Gold Project

Amendment Report - Aquatic Ecology Assessment Addendum

August 2020

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Perth WA 6000
T 02 9339 3184

CANBERRA
PO Box 9148
Deakin ACT 2600

McPhillamys Gold Project

Amendment Report - Aquatic Ecology Assessment Addendum

Report Number

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Client

LFB Resources NL

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Prepared by

Brooke Hay
Senior Aquatic Ecologist
24 August 2020

Approved by

Nathan Garvey
Division Leader – Bushfire, Ecology, Heritage & Spatial Solutions
24 August 2020

Executive Summary

LFB Resources NL is seeking State significant development consent under Division 4.7 of Part 4 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) to develop and operate a greenfield open cut gold mine, associated mine infrastructure and a water supply pipeline in Central West NSW. The McPhillamys Gold Project (the project) is comprised of two key components; the mine site where the ore will be extracted, processed and gold produced for distribution to the market (the mine development), and an associated water pipeline.

In accordance with the requirements of the EP&A Act, the NSW Environmental Planning & Assessment Regulation 2000 (EP&A Regulation) and the Secretary's Environmental Assessment Requirements (SEARs) for the project, an Environmental Impact Statement (EIS) was prepared and was submitted to the NSW Department of Planning, Industry and Environment (DPIE) for public exhibition. During this exhibition period, Regis received submissions from government agencies, the community, businesses and other organisations regarding varying aspects of the project.

In response to issues raised in submissions received, as well as a result of further detailed mine planning and design, Regis has made a number of refinements to the project, detailed in the Amendment Report (EMM, 2020a). This Aquatic Ecology Assessment Addendum report forms an appendix to the Amendment Report and presents an assessment of the revised impacts of the amended project on aquatic ecology relevant to the mine development. It also serves as an update to the *McPhillamys Gold Project Aquatic Ecology Assessment* (Appendix O of the McPhillamys Gold Project EIS), and this report supersedes relevant parts of the impacts section (Section 6) and the aquatic offset strategy (Section 8) within the initial report.

Two submissions relevant to aquatic ecology were received from the Department of Primary Industries – Fisheries Division (DPI Fisheries) and the Environment Protection Authority (EPA). These submissions have been considered in this revised assessment. Detailed responses to all the submissions received are provided in the Submissions Report prepared for the project, which has been prepared in conjunction with the Amendment Report. A summary of the key issues relevant to this assessment are provided in Table ES1 together with how each matter has been addressed within this report.

Table ES1 Key comments received in submissions relating to aquatic ecology, and how they have been addressed

Department	Issue	Where addressed
DPI Fisheries	**Aquatic Ecology Offset Package** DPI therefore requests the inclusion of consent conditions requiring the negotiation of an aquatic ecology offset package with DPI through the use of aquatic biodiversity offsets and/or supplementary measures to ensure a minimum 2:1 offset for approximately 1.8 km of Type 1 highly sensitive Key Fish Habitat and 0.4 km of Type 3 minimally sensitive Key Fish Habitat affected that is directly impacted by the disturbance footprint. Verification of the affected length of waterways of Type 1 and Type 3 key fish habitats within the disturbance footprint should be provided. In addition, it is unclear whether the footprint impedes Tributary A as per Figure 4.3 of Appendix O (Aquatic Ecology Assessment), as this figure differs to Figure 14.1 of the EIS Main Report. The Aquatic Ecology Assessment also needs to identify and quantify the extent of Key Fish Habitat that has been isolated adjacent to the disturbance footprint, particularly Tributaries B in the south east, Tributary G in the north and the Belubula River in the north east for which fish passage is no longer available and assessment of fish passage trade-offs should be considered.	A table summarising the approximate area of revised impact to key fish habitat and a figure showing the extent of the impact within the revised mine development has been included in Section 3 and Figure 3.1. Section 4 provides a discussion of the proposed aquatic offsets strategy. Revision of the impact to key fish habitat within Tributary G and the Belubula River has also been included in Section 3 and Figure 3.1; however, it should be noted that the area of Tributary B within the disturbance footprint ranges from 1st to 2nd order and, therefore, does not align with definitions of key fish habitat in DPI (2013) and therefore does not require offsetting. In addition, sections of the Belubula River and Tributary G, upstream of the disturbance footprint, have not been included in the assessment as they are not considered to constitute key fish habitat as per the definitions in DPI (2013). These waterways are substantially degraded.
DPI Fisheries	**Final Landform - Permanent Clean Water Diversion Channels** There is minimal information regarding design objectives for the reinstatement of previously existing watercourses in the post mining landscape. The post mining landscape should have waterways that have similar characteristics in terms of stream type, alignment (where possible), riparian zone width and longitudinal grade to the existing watercourses. Where existing watercourses are degraded, the reinstated watercourses in the post mining landscape should aim to improve on or at the very least maintain existing aquatic and riparian attributes.	Information on design objectives relating to the reinstatement of waterways, post-mining, is provided in Section 3.4 with more detail presented in the Amended Project Rehabilitation and Landscape Management Addendum (EMM, 2020c).

Table ES1 Key comments received in submissions relating to aquatic ecology, and how they have been addressed

Department	Issue	Where addressed
EPA	The EIS adopts the 80% species protection guideline values to characterise the existing conditions of the receiving waterways. NSW Government policy and the Australian and New Zealand Guidelines for Fresh and Marine Water Quality recommend that a slightly-moderately disturbed level of protection be applied to most waterways, including for highly disturbed ecosystems. For toxicants, the default guideline values for slightly-moderately disturbed ecosystems are the 95% species protection guideline values (99% for bioaccumulating toxicants). The EIS does not adopt a guideline value for iron. The Australian and New Zealand Guidelines for Fresh and Marine Water Quality recommends that interim working levels are adopted for some toxicants where no moderate or high reliability guideline value is available. The interim working level for iron is 300 µg/L. **Requested information/actions** 1 The proponent revises the modelling to use the relevant Australian and New Zealand Guidelines for Fresh and Marine Water Quality guideline values for slightly to moderately disturbed ecosystems. 2 The proponent revises the modelling to adopt interim working levels for toxicants where no moderate or high reliability guideline value is available. **Any site-specific guideline values are developed consistent with Australian and New Zealand Guidelines for Fresh and Marine Water Quality ensuring that the reference sites are representative of a slightly disturbed condition.**	The EIS Aquatic Ecology Assessment (EMM, 2019) compared water quality results to the 80% species protection guideline values. An updated assessment is provided in Section 2.1 comparing values to the ANZECC & ARMCANZ (2000) guideline trigger values ("trigger") for the protection of 95% of species in NSW upland waterways.

The key amendments to the project relevant to aquatic ecological environmental receptors (detailed in *McPhillamys Gold Project Aquatic Ecology Assessment*) are as follows:

- Revised mine layout which has resulted in an amended disturbance footprint.
- The water management system has been redesigned with all operational water management storages now designed with zero spill risk (previously most water management facilities (WMFs) designed to a less than 1% spill risk).
- Revision to the location of the tailings storage facility (TSF), associated bunds, and a number of topsoil stockpiles, primarily within the north-west area of the disturbance footprint.
- Avoidance of Tributary B to the south of the disturbance footprint.
- Development of the post-closure clean water diversion, primarily the waterway design.

The revision of the project has resulted in a small reduction in the extent of waterway, and therefore key fish habitat, that will be directly impacted by mine development infrastructure construction and operation. This includes the movement of the disturbance footprint so that the 3rd order section of Tributary B is now outside of the disturbance footprint (Figure ES1).

In relation to comments from DPI Fisheries, it should also be noted that:

- as per the design presented in the EIS, Tributary A is not impacted by the southwestern extent of the disturbance footprint;
- Tributary B is now wholly avoided by the revised disturbance footprint; and
- impacts will occur to key fish habitat in the Belubula River and Tributary G.

For the purposes of the revised assessment, any unassessed 3rd order or above sections of the Belubula River and Tributary G within the disturbance footprint have been conservatively classed as key fish habitat in accordance with the policy and guidelines (DPI, 2013), based on the classifications assigned to nearby assessment locations and review of the values of these sites. The amended project disturbance footprint will impact directly on approximately 32,549 m^2 of key fish habitat within the Belubula River, and 6,418 m^2 of direct impact will occur within Tributary G, totalling 38,9677 m^2. In addition, a small area of direct disturbance (1,414 m^2) will occur to the north of the operational disturbance footprint to facilitate the construction of the final clean water diversion waterway, post-closure. This key fish habitat will be subject to impact as a result of the placement of the TSF and associated embankments, as well as the construction of the final clean water diversion, post-closure, resulting in an overall impact to 40,381 m^2 of key fish habitat. However, overall, revisions to the disturbance footprint do not significantly change the potential impacts to aquatic ecology outlined in the initial *McPhillamys Gold Project Aquatic Ecology Assessment* (EMM, 2019).

DPI Fisheries also requested that quantification of the extent of isolated key fish habitat be made, adjacent to the disturbance footprint (indirect upstream impact), particularly with regard to Tributary B (south-east), Tributary G (north) and the Belubula River (north-east). However, this has not been addressed as it is not considered that the upstream sections of waterway constitute key fish habitat, with the following justification:

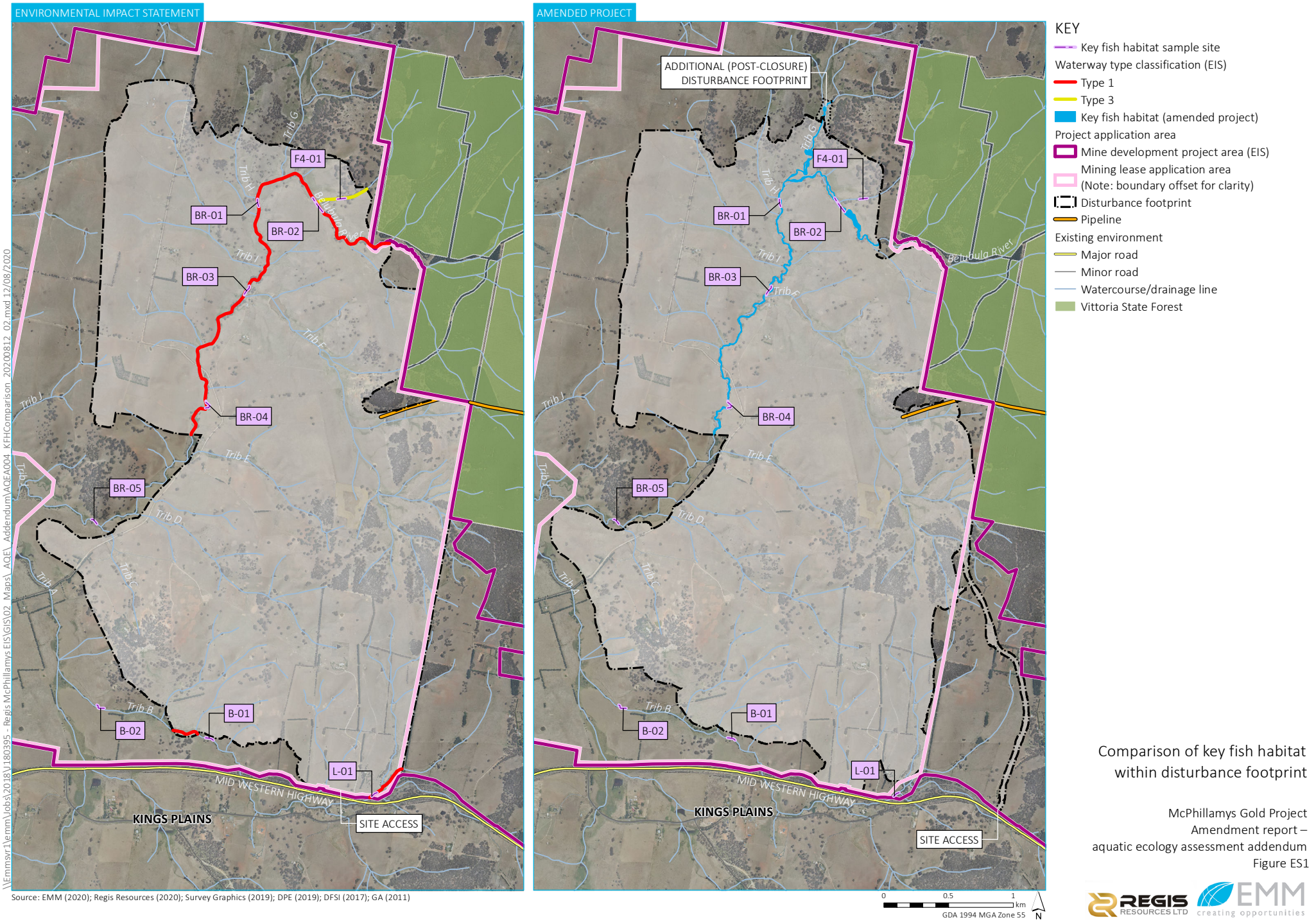
- upstream reaches of the Belubula River are located within a pine plantation, and are highly modified and degraded as a result of existing clearing and other forestry practises (Belubula River);
- these waterways are located within highly modified and degraded agricultural land (Belubula River, Tributary G);
- these waterways contain limited discernible waterway channel, likely only flowing during major rainfall and flood events (Belubula River, Tributary G);
- these waterways are separated from the Belubula River (during low and medium-flow conditions) by several agricultural dams immediately upstream of the confluence with the Belubula River (Tributary G);
- these waterways are separated from downstream sections (during low and medium-flow conditions) by a large agricultural dam immediately inside the disturbance footprint (Belubula River);
- these waterways contain numerous existing dams upstream of the large agricultural dam within the pine plantation (Belubula River); and
- Tributary B is now wholly avoided as a result of the amended project.

In addition, neither of these sections of waterway, nor any within the disturbance footprint, are considered to provide habitat for threatened aquatic species.

As part of the development of the revised project, an update to the TSF and associated drainage design, primarily to improve the clean water diversion was made, with changes also made to the northern and eastern embankments around the TSF, to facilitate clean water diversion during operations and post-closure. A clean water diversion drain will be constructed around on the eastern side of the TSF. Similar to the design presented within the EIS, clean water will be piped through the disturbance footprint during mining operations. The approach taken in terms of rehabilitation of the TSF is such that runoff from rehabilitated surfaces will drain to the clean water diversion system located on the eastern extent of the TSF. The location of the southern end of the clean water diversion has been revised to facilitate channel gradients more consistent with the natural gradients of the Belubula River, in alignment with best practice guidance. The diversion will be fenced to exclude stock (other than at crossing points) and will be revegetated with appropriate riparian community species to form a riparian corridor along the diversion. Where possible, waterways will have similar characteristics in terms of stream type, alignment (where possible), riparian zone width and longitudinal grade to the existing watercourses. Regis commit to ensuring that waterway and riparian zone reinstatement, post-closure, will improve existing aquatic and riparian ecological values.

DPI Fisheries requested that an aquatic ecology offset package be negotiated, with implementation of aquatic biodiversity offsets and/or supplementary measures to occur to ensure a minimum 2:1 offset is met for key fish habitat directly impacted as a result of the disturbance footprint. Further refinement and verification has been undertaken, with the area of direct key fish habitat within the disturbance footprint totalling 40,381 m^2.

Waterway widths were mapped from bank to bank using a combination of a digital elevation model (DEM) derived from light detection and ranging (LiDAR) data and aerial photography and digitised using ArcGIS. It is acknowledged that an offset strategy should be implemented in accordance with *Biodiversity Offsets Policy for Major Projects Fact sheet: Aquatic biodiversity*; however, in the context of the project and due to the high level of habitat disturbance and fragmentation currently existing within the Belubula River catchment, Regis has committed to undertaking a number of rehabilitation and remediation programs as part of an aquatic offset package within the downstream, on-site sections of the Belubula River, Tributary A and Tributary B. However, in the event that the above criteria cannot be met, then funds may be provided towards implementing supplementary measures which provide additional flexibility in fulfilling offset requirements and could be undertaken within the broader region. Any offset strategy will be developed in consultation with DPI Fisheries and relevant technical staff, following approval of the project.



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Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DPE (2019); DFSI (2017); GA (2011)

Comparison of key fish habitat within disturbance footprint

McPhillamys Gold Project
Amendment report – aquatic ecology assessment addendum
Figure ES1

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1 Introduction

1.1 Background

LFB Resources NL is seeking State significant development consent under Division 4.7 of Part 4 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) to develop and operate a greenfield open cut gold mine, associated mine infrastructure and a water supply pipeline in Central West NSW. The project application area is illustrated at a regional scale in Figure 1.1. LFB Resources NL is a 100% owned subsidiary of Regis Resources Limited (herein referred to as Regis).

As shown in Figure 1.1, the McPhillamys Gold Project (the project) is comprised of two key components; the mine site where the ore will be extracted, processed and gold produced for distribution to the market (the mine development), and an associated water pipeline which will enable the supply of water from approximately 90 km away near Lithgow to the mine site (the pipeline development). The mine development is approximately 8 km north-east of Blayney, within the Blayney and Cabonne local government areas (LGAs).

Up to 8.5 Million tonnes per annum (Mtpa) of ore will be extracted from the McPhillamys gold deposit over a total project life of 15 years. The mine development will include a conventional carbon-in-leach processing facility, waste rock emplacement, an engineered tailings storage facility (TSF) and associated mine infrastructure including workshops, administration buildings, roads, water management infrastructure, laydown and hardstand areas, and soil stockpiles.

In accordance with the requirements of the EP&A Act, the NSW Environmental Planning & Assessment Regulation 2000 (EP&A Regulation) and the Secretary's Environmental Assessment Requirements (SEARs) for the project, an Environmental Impact Statement (EIS) was prepared to assess the potential environmental, economic and social impacts of the project. The development application and accompanying EIS was submitted to the NSW Department of Planning, Industry and Environment (DPIE) and subsequently publicly exhibited for six weeks, from 12 September 2019 to 24 October 2019. During this exhibition period, Regis received submissions from government agencies, the community, businesses and other organisations regarding varying aspects of the project.

In response to issues raised in submissions received, as well as a result of further detailed mine planning and design, Regis has made a number of refinements to the project. Accordingly, an Amendment Report has been prepared by EMM Consulting Pty Ltd (EMM, 2020a) to outline the changes to the project that have been made since the public exhibition of the EIS and to assess the potential impacts of the amended project, compared to those that were presented in the EIS. This report forms an appendix to the Amendment Report and presents an assessment of the revised impacts of the amended project on aquatic ecology relevant to the mine development. Accordingly, references to 'the project' throughout this report are therefore referring to the mine development only. Changes to potential aquatic ecology impacts associated with the pipeline development component are addressed in the Amendment Report (EMM, 2020a).

1.2 Project amendment overview

A summary of the key amendments to the project since the exhibition of the EIS are summarised below and described in detail in Chapter 2 of the Amendment Report (EMM, 2020a):

- **Site access** – a new location for the site access intersection off the Mid Western Highway is proposed, approximately 1 km east of the original location assessed in the EIS, in response to feedback from Transport for NSW (TfNSW, former Roads and Maritime Services) and the community. A new alignment is subsequently proposed for the site access road to the mine administration and infrastructure area.

- **Mine and waste rock emplacement schedule** – revision of the mine schedule and the subsequent construction sequence of the waste rock emplacement has been undertaken, in particular consideration of predicted noise levels in Kings Plains. This achieved a reduction in predicted noise levels at nearby residences while extending the construction timeframe for the southern amenity bund.

- **Pit amenity bund** – the size of the pit amenity bund has been reduced as a result of optimisation of the open cut pit design and the improved location of exit ramps for haul trucks.

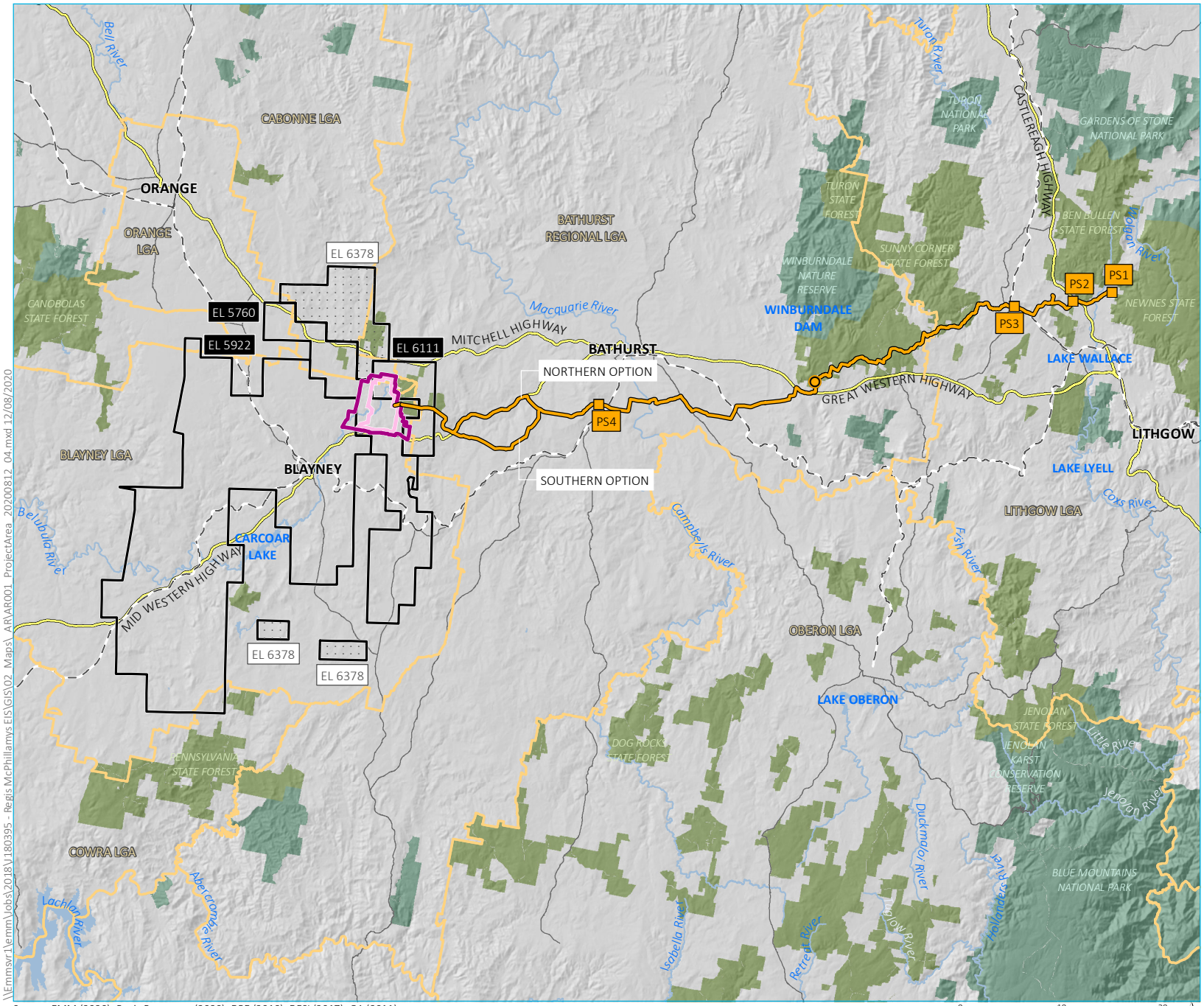
- **Tailings storage facility (TSF)** – amendments to the design include changes to the embankment design and construction timing, the TSF footprint, and the TSF post-closure landform.

- **Water management system –** the secondary water management facility (WMF) has been removed from the water management system, resulting in an avoidance of impacts to a potential item of historic heritage significance (MGP 23 - Hallwood Farm Complex (Hallwood)). The size of the WMFs has also been revised to achieve a reduced likelihood of discharge from the storages within the operational water management system as part of a revised nil discharge design.

- **Mine administration and infrastructure area –** the layout of this area has been revised and optimised.

- **Mine development project area –** a very small change has been made to the mine development project area along the eastern boundary (an additional 1 ha, or 0.04% change), to accommodate the required clean water management system. The change takes the project area from 2,513 hectares (ha) to 2,514 ha.

The amended mine development project layout, compared to that assessed in the EIS, is shown in Figure 1.2. No amendments have been made to other key aspects of the project as presented in the EIS for which approval is sought, such as the proposed mining method, operating hours, annual ore extraction rate of up to 8.5 Mtpa, annual ore processing rate of up to 7 Mtpa, employee numbers, or rehabilitation methods and outcomes.



KEY

Project application area
- Mine development project area (2,514.06 ha)
- Mining lease application area (1,806.17 ha) (Note: boundary offset for clarity)
- Pressure reducing system
- Pumping station facility
- Pipeline

Existing environment
- Rail line
- Primary road
- Arterial road
- River
- Waterbody
- NPWS reserve
- State forest
- Local government area

Exploration lease boundaries (of interest)
- Held by LFB Resources NL (Regis)
- Held by others

Source: EMM (2020); Regis Resources (2020); DPE (2018); DFSI (2017); GA (2011)

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Regional setting – project application area

McPhillamys Gold Project
Amendment report – aquatic ecology assessment addendum
Figure 1.1

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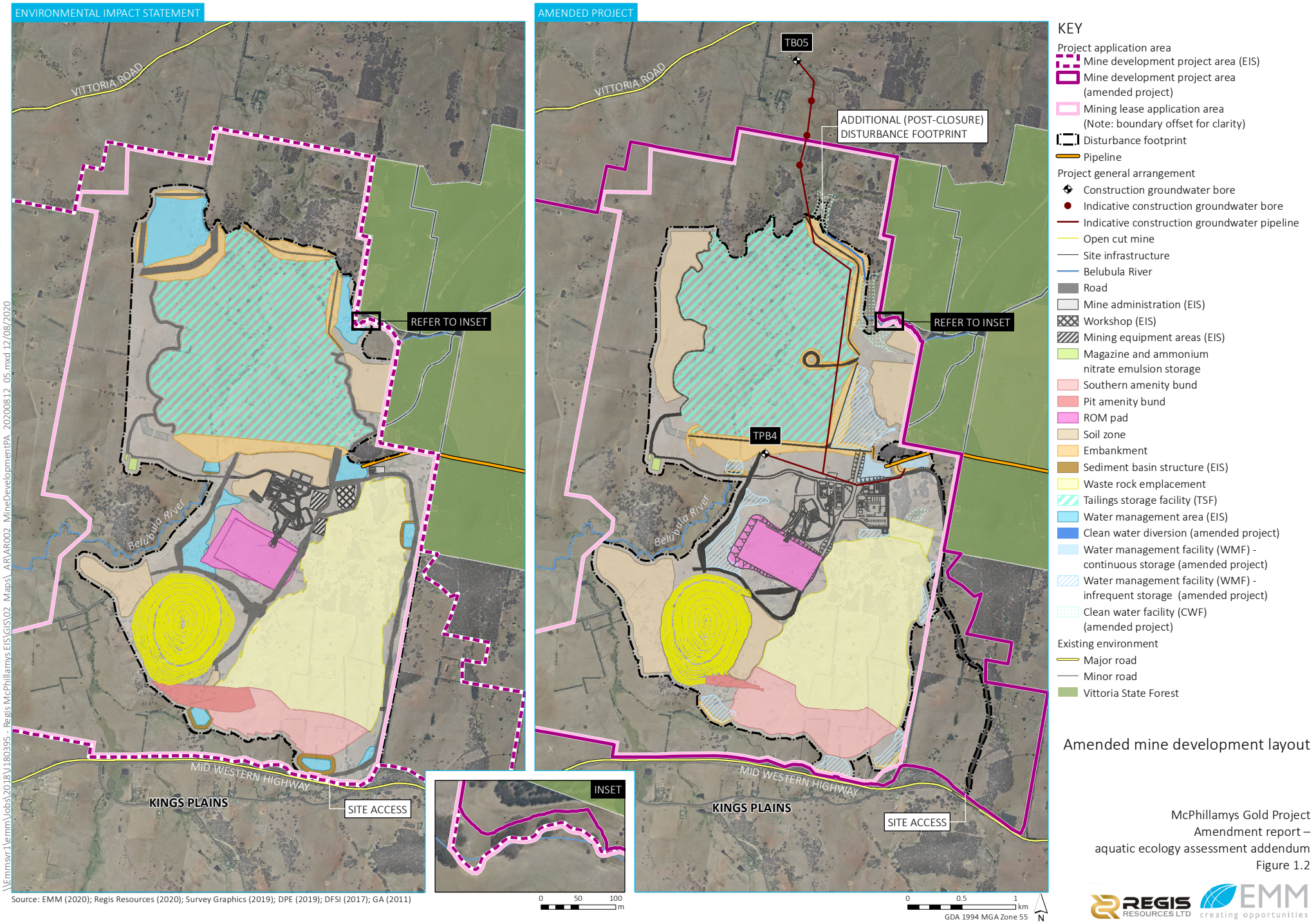

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Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DPE (2019); DFSI (2017); GA (2011)

Amended mine development layout

McPhillamys Gold Project
Amendment report – aquatic ecology assessment addendum
Figure 1.2

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1.3 Purpose of this report

This report has been prepared to assess the potential impacts of the amended project to aquatic ecology. The assessment considers and outlines the differences in impacts compared to the original project as presented in the EIS. It also serves as an update to the *McPhillamys Gold Project Aquatic Ecology Assessment* (EMM, 2019) (Appendix O of the McPhillamys Gold Project EIS).

This report should be read in conjunction with the *McPhillamys Gold Project Aquatic Ecology Assessment* (EMM, 2019) (referred herein as the EIS Aquatic Ecology Assessment); however, this report supersedes relevant parts of the impacts section (Section 6) and the aquatic offset strategy (Section 8) within the initial report.

1.4 Submissions on the EIS

Three submissions relevant to aquatic ecology were received from the Department of Primary Industries – Fisheries Division (DPI Fisheries) and the Environment Protection Authority (EPA). These submissions have been considered in this revised assessment. Detailed responses to all the submissions received are provided in the Submissions Report prepared for the project (EMM, 2020b), which has been prepared in conjunction with the Amendment Report (EMM, 2020a). A summary of the key issues relevant to this assessment are provided in Table 1.1, together with how each matter has been addressed within this report.

Table 1.1 Key comments received in submissions relating to aquatic ecology, and how they have been addressed

Department	Issue	Where addressed
DPI Fisheries	**Aquatic Ecology Offset Package** DPI therefore requests the inclusion of consent conditions requiring the negotiation of an aquatic ecology offset package with DPI through the use of aquatic biodiversity offsets and/or supplementary measures to ensure a minimum 2:1 offset for approximately 1.8 km of Type 1 highly sensitive Key Fish Habitat and 0.4 km of Type 3 minimally sensitive Key Fish Habitat affected that is directly impacted by the disturbance footprint. Verification of the affected length of waterways of Type 1 and Type 3 key fish habitats within the disturbance footprint should be provided. In addition, it is unclear whether the footprint impedes Tributary A as per Figure 4.3 of Appendix O (Aquatic Ecology Assessment), as this figure differs to Figure 14.1 of the EIS Main Report. The Aquatic Ecology Assessment also needs to identify and quantify the extent of Key Fish Habitat that has been isolated adjacent to the disturbance footprint, particularly Tributaries B in the south east, Tributary G in the north and the Belubula River in the north east for which fish passage is no longer available and assessment of fish passage trade-offs should be considered.	A table summarising the approximate area of revised impact to key fish habitat and a figure showing the extent of the impact within the revised mine development has been included in Section 3 and Figure 3.1. Section 4 provides a discussion of the proposed aquatic offsets strategy. Revision of the impact to key fish habitat within Tributary G and the Belubula River has also been included in Section 3 and Figure 3.1; however, it should be noted that the area of Tributary B within the disturbance footprint ranges from 1st to 2nd order and, therefore, does not align with definitions of key fish habitat in DPI (2013) and therefore does not require offsetting. In addition, sections of the Belubula River and Tributary G, upstream of the disturbance footprint, have not been included in the assessment as they are not considered to constitute key fish habitat as per the definitions in DPI (2013). These waterways are substantially degraded.

Table 1.1 Key comments received in submissions relating to aquatic ecology, and how they have been addressed

Department	Issue	Where addressed
DPI Fisheries	**Final Landform - Permanent Clean Water Diversion Channels** There is minimal information regarding design objectives for the reinstatement of previously existing watercourses in the post mining landscape. The post mining landscape should have waterways that have similar characteristics in terms of stream type, alignment (where possible), riparian zone width and longitudinal grade to the existing watercourses. Where existing watercourses are degraded, the reinstated watercourses in the post mining landscape should aim to improve on or at the very least maintain existing aquatic and riparian attributes.	Information on design objectives relating to the reinstatement of waterways, post-mining, is provided in Section 3.4 with more detail presented in the Amended Project Rehabilitation and Landscape Management Addendum (EMM, 2020c).
EPA	The EIS adopts the 80% species protection guideline values to characterise the existing conditions of the receiving waterways. NSW Government policy and the Australian and New Zealand Guidelines for Fresh and Marine Water Quality recommend that a slightly-moderately disturbed level of protection be applied to most waterways, including for highly disturbed ecosystems. For toxicants, the default guideline values for slightly-moderately disturbed ecosystems are the 95% species protection guideline values (99% for bioaccumulating toxicants). The EIS does not adopt a guideline value for iron. The Australian and New Zealand Guidelines for Fresh and Marine Water Quality recommends that interim working levels are adopted for some toxicants where no moderate or high reliability guideline value is available. The interim working level for iron is 300 µg/L. **Requested information/actions** 1 The proponent revises the modelling to use the relevant Australian and New Zealand Guidelines for Fresh and Marine Water Quality guideline values for slightly to moderately disturbed ecosystems. 2 The proponent revises the modelling to adopt interim working levels for toxicants where no moderate or high reliability guideline value is available. Any site-specific guideline values are developed consistent with Australian and New Zealand Guidelines for Fresh and Marine Water Quality ensuring that the reference sites are representative of a slightly disturbed condition.	The EIS Aquatic Ecology Assessment (EMM, 2019) compared water quality results to the 80% species protection guideline values. An updated assessment is provided in Section 2.1 comparing values to the ANZECC & ARMCANZ (2000) guideline trigger values ("trigger") for the protection of 95% of species in NSW upland waterways.

2 Existing environment

2.1 Water quality

Regis conducts regular water monitoring at eight locations along the Belubula River, with six monitoring points located downstream of the mine development, one located within the Blayney township at Goose Park (WED7396A) and one downstream of Blayney at Brewery Bridge (WED5401A). Monitoring has been occurring on an ongoing basis since May 2014.

Updated water quality data collected since the preparation of the EIS Aquatic Ecology Assessment (EMM, 2019) has been combined with the existing dataset, and the summary statistics are presented below (Table 2.1), and in Appendix A. In response to the EPA submission on the EIS, this data is presented in comparison to the ANZECC & ARMCANZ (2000) guideline trigger values ("trigger") for the protection of 95% of species in NSW upland waterways, Foged (1978) and Hammer (1986) (rather than the 80% species protection values guidelines adopted in the EIS Aquatic Assessment). These results are presented as an update to those provided within Section 4.1.3 of the EIS Aquatic Ecology Assessment (EMM, 2019).

The pH of surface water across the mine development ranged from acidic (minimum pH 5.4) to alkaline (maximum pH 9.5) (Table 2.1), with minimum values at four sites recording a pH lower than the lower ANZECC & ARMCANZ (2000) trigger and seven maximum values exceeding the upper ANZECC & ARMCANZ (2000) trigger (Appendix A).

The electrical conductivity, a unit of measurement to describe salinity, of surface water was classified as fresh, ranging from 43 microsiemens per centimetre (µS/cm) to 1,918 µS/cm (Table 2.1). The majority of maximum values, and some minimum values, exceeded the upper ANZECC & ARMCANZ (2000) trigger (Appendix A), likely attributed to the degraded nature of the catchment and subsequent salinization, an issue prevalent throughout the Lachlan River catchment (Murray–Darling Basin Commission, 1999). Contributing to salinity, the major ions recorded in surface water included calcium, magnesium, sodium, potassium, sulphate, bicarbonate and chloride. Concentrations of ions, particularly calcium, are important within aquatic ecosystems as they influence the hardness of water, which has the potential to supress or release a number of inorganic toxicants (metals) (ANZECC & ARMCANZ, 2000). The dominance in ionic balance changes in response to various factors such as evapoconcentration, salinity, and local geology and hydrogeology (Boulton & Brock, 1999; Williams, 1998).

Surface water turbidity also exhibited a large range, with 0.4 NTU the lowest minimum value recorded, and 1,290 NTU the highest maximum value recorded (Table 2.1). All but one site exceeded the upper ANZECC & ARMCANZ (2000) trigger, with the maximum value exceeding the trigger of 25 NTU by more than 50 times (Appendix A). These exceedances were likely attributed to sedimentation and runoff from adjacent cleared land, and intermittent flood events, reflecting the degraded nature of the area resulting from long-term agricultural use. High turbidity may reduce the availability of metals within a waterway; however, it also causes smothering and mortality of aquatic biota and contributes to sedimentation (Dunlop, et al., 2005).

Concentrations of total nitrogen ranged from a minimum of 0.1 milligrams per litre (mg/L) to a maximum of 84 mg/L, with the minimum and maximum values recorded at almost all of the sites exceeding the upper ANZECC & ARMCANZ (2000) trigger. Similarly, total phosphorus also exceeded the upper trigger for the majority of minimum and maximum values, ranging from 0.01 mg/L to 4.83 mg/L (Table 2.1). Considering the location of most sites within agricultural land, these exceedances are anticipated.

All metals (or trace elements) were recorded from at least two sites across the mine development. ANZECC & ARMCANZ (2000) triggers are unavailable for five (barium, beryllium, cobalt, iron, vanadium). Of those with an ANZECC & ARMCANZ (2000) trigger, the maximum value for only three parameters did not exceed the relevant trigger; boron, total cyanide and selenium (Table 2.1). Of the 23 sites sampled, minimum value exceedances were recorded for copper (five sites), while maximum value exceedances were recorded for arsenic (nine sites), cadmium (three sites), chromium (22 sites), copper (22 sites), lead (12 sites), manganese (14 sites), mercury (two sites), nickel (13 sites) and zinc (22 sites) (Appendix A). Inorganic metals have the potential to become toxic in freshwater environments, particularly in anthropogenic settings, and copper is of concern in terms of fish species. However, factors including salinity, turbidity and water hardness have the ability to reduce the availability, and therefore toxicity, of metals to aquatic fauna (Markich & Jeffree, 1994).

Table 2.1 Summary statistics for surface water quality data within the mine development area

	Water quality parameter	Min	Max	Count	ANZECC & ARMCANZ (2000) trigger	
					Lower	Upper
Basic	pH	5.4	9.5	46	6.5	9.0
	EC (µS/cm)	43	1,918	46	-	350
	Turbidity (NTU)	0.40	1,290	46	-	25
Major Ions	Calcium	1.00	230	46	-	-
	Magnesium	0.80	150	46	-	-
	Sodium	0.80	126	46	-	-
	Potassium	0.90	84	46	-	-
	Sulphate	1.00	1,100	34	-	-
	Bicarbonate	1.00	620	46	-	-
	Chloride	1.00	285	46	-	-
	Carbonate	18.00	110	7	-	-
	Hydroxide	5.00	5	31	-	-
	Alkalinity (total)	1.00	620	46	-	-
Nutrients	Nitrogen (total)	0.1	84.0	44	-	0.2
	Kjeldahl nitrogen (total)	0.10	44	28	-	-
	Nitrite+Nitrate	0.02	2.3	14	-	-
	Phosphorus (total)	0.01	4.83	40	-	0.02
Metals & Trace Elements	Arsenic	0.001	0.490	43	-	0.013
	Barium	0.01	0.91	44	-	-
	Beryllium	0.001	0.004	2	-	-
	Boron	0.03	0.03	2	-	0.37
	Cadmium	0.0003	0.0020	3	-	0.0002
	Chromium	0.002	0.202	22	-	0.001
	Cobalt	0.002	0.045	24	-	-
	Copper	0.0020	0.1540	27	-	0.0014
	Cyanide (total)	0.006	0.006	2	-	0.007
	Iron	0.01	84	46	-	-
	Lead	0.0020	0.2340	16	-	0.0034
	Manganese	0.005	7.8	46	-	1.9

Table 2.1 Summary statistics for surface water quality data within the mine development area

Water quality parameter	Min	Max	Count	ANZECC & ARMCANZ (2000) trigger	
				Lower	Upper
Mercury	0.0001	0.0038	14	-	0.0006
Nickel	0.002	0.190	32	-	0.011
Selenium	0.002	0.010	13	-	0.011
Vanadium	0.002	0.14	26	-	-
Zinc	0.001	0.693	43	-	0.008

Note Parameters are dissolved unless otherwise specified; units are mg/L unless otherwise specified; yellow shading indicates exceedance of the lower ANZECC & ARMCANZ (2000) guideline trigger value for the protection of 95% of species in south-eastern Australian upland rivers; red shading indicates exceedance of the upper ANZECC & ARMCANZ (2000) guideline trigger value.

2.2 Key fish habitat

The EIS Aquatic Ecology Assessment (EMM, 2019) identified areas of key fish habitat within the disturbance footprint in accordance with the *Policy and guidelines for fish habitat conservation and management* (DPI, 2013) ("the policy and guidelines"). During the November 2018 field survey, 3rd order and above waterways (based on Strahler (1952)), located within and downstream of, the disturbance footprint were classified as key fish habitat and assigned a waterway type and waterway class in accordance with the definitions provided below (Table 2.2 and Table 2.3, respectively). Waterway types and waterway classes assigned during the November 2018 field survey are presented in Table 2.4, and the survey sites assessed are shown in Figure 2.1.

Table 2.2 Waterway type definitions for habitat sensitivity

Classification	Characteristics of waterway type
Type 1 – Highly sensitive key fish habitat	Freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 metres in length, or native aquatic plants.
Type 2 – Moderately sensitive key fish habitat	Freshwater habitats and brackish wetlands, lakes and lagoons other than those defined in Type 1.
Type 3 – Minimally sensitive key fish habitat	Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation.

Table 2.3 Waterway class definitions for fish passage

Classification	Characteristics of waterway class
Class 1 – Major key fish habitat	Marine or estuarine waterway or permanently flowing or flooded freshwater waterway (eg river or major creek), habitat of a threatened or protected fish species or 'critical habitat'.
Class 2 – Moderate key fish habitat	Generally named intermittently flowing stream, creek or waterway with clearly defined bed and banks, semi-permanent to permanent water in pools or in connected wetland areas. Freshwater aquatic vegetation is present. Type 1 and Type 2 habitats present.
Class 3 – Minimal key fish habitat	Named or unnamed waterway with intermittent flow and sporadic refuge, breeding or feeding areas for aquatic fauna (eg fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or other Class 1-3 fish habitats.

Table 2.3 Waterway class definitions for fish passage

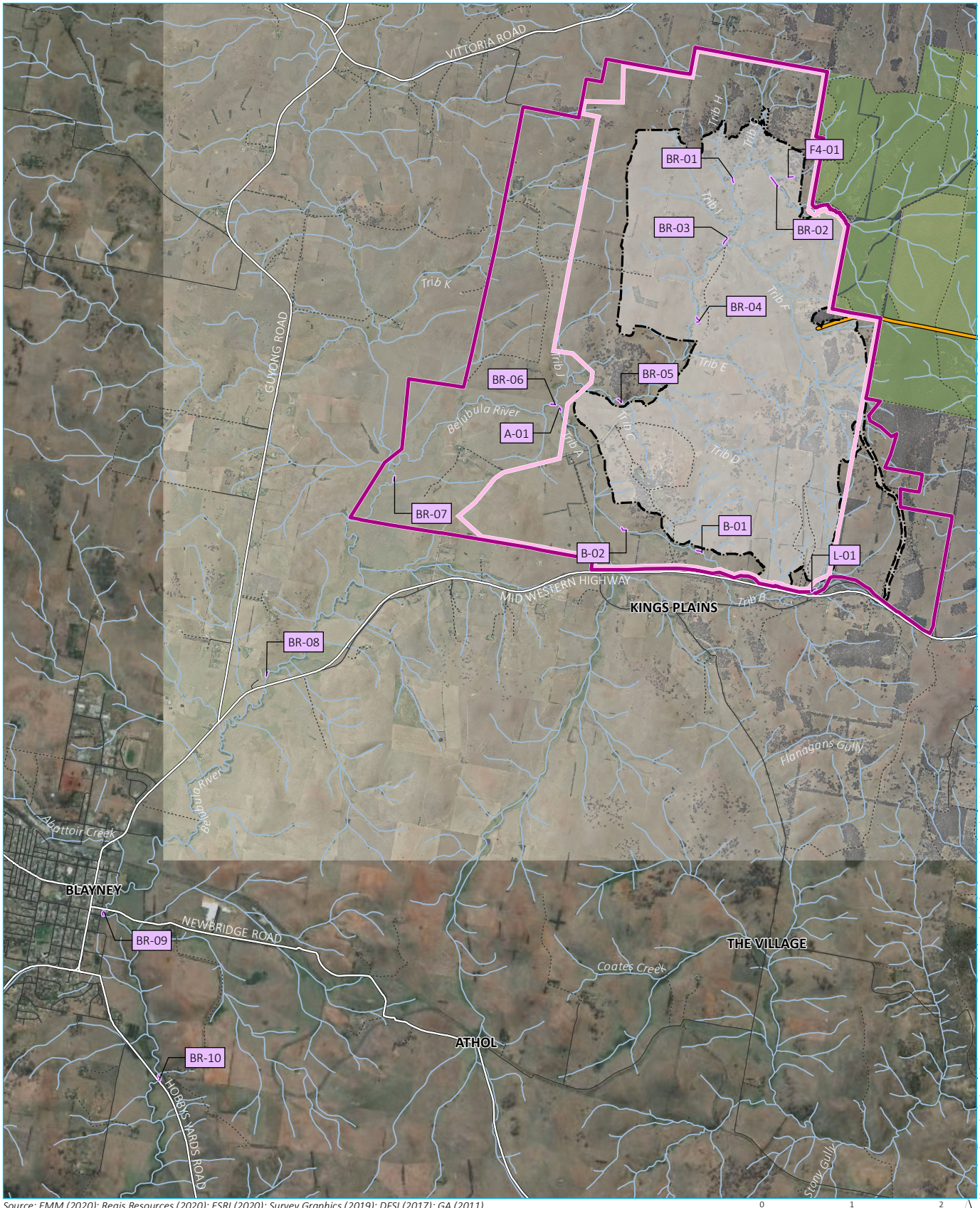
Classification	Characteristics of waterway class
Class 4 – Unlikely key fish habitat	Generally unnamed waterway with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free-standing water or pools post-rain events (eg dry gullies, shallow floodplain depressions with no aquatic flora).

Table 2.4 Summary of stream order, waterway type and waterway class along the Belubula River and associated tributaries, November 2018

Waterway	Site	Stream order	Key Fish Habitat Waterway Type	Key Fish Habitat Waterway Class
Tributary A	A-01	5th	Type 1 - Highly sensitive key fish habitat	Class 2 - Moderate key fish habitat
Tributary B	B-01	3rd	Type 1 - Highly sensitive key fish habitat	Class 3 - Minimal key fish habitat
Tributary B	B-02	4th	Type 1 - Highly sensitive key fish habitat	Class 3 - Minimal key fish habitat
Belubula River	BR-01	4th	Type 1 - Highly sensitive key fish habitat	Class 3 - Minimal key fish habitat
Belubula River	BR-02	3rd	Type 1 - Highly sensitive key fish habitat	Class 3 - Minimal key fish habitat
Belubula River	BR-03	4th	Type 1 - Highly sensitive key fish habitat	Class 2 - Moderate key fish habitat
Belubula River	BR-04	5th	Type 1 - Highly sensitive key fish habitat	Class 2 - Moderate key fish habitat
Belubula River	BR-05	5th	Type 1 - Highly sensitive key fish habitat	Class 2 - Moderate key fish habitat
Belubula River	BR-06	6th	Type 2 - Moderately sensitive key fish habitat	Class 2 - Moderate key fish habitat
Belubula River	BR-07	6th	Type 2 - Moderately sensitive key fish habitat	Class 2 - Moderate key fish habitat
Belubula River	BR-08	6th	Type 1 - Highly sensitive key fish habitat	Class 2 - Moderate key fish habitat
Belubula River	BR-09	6th	Type 2 - Moderately sensitive key fish habitat	Class 2 - Moderate key fish habitat
Belubula River	BR-10	6th	Type 2 - Moderately sensitive key fish habitat	Class 2 - Moderate key fish habitat
Tributary F4	F4-01	2nd	Not considered to be key fish habitat	Not considered to be key fish habitat
Tributary L	L-01	3rd	Type 1 - Highly sensitive key fish habitat	Class 4 - Unlikely key fish habitat

Notes: Sites B-01 and B-02 are located on Tributary B. These sites were incorrectly labelled in the EIS Aquatic Ecology Assessment (EMM, 2019). This has been corrected above. In response to the DPI Fisheries submission on the EIS Aquatic Ecology Assessment (EMM, 2019), further description of the Belubula River upstream of the disturbance footprint, as well as Tributary B and Tributary G is provided below.

As outlined in the EIS Aquatic Ecology Assessment (EMM, 2019) the upstream sections of the Belubula River within the disturbance footprint, upstream of the dam above site BR-02 (Figure 2.1), consist of a minimally defined channel with little aquatic vegetation. There is some erosion of bank edges occurring due to access by stock and past land use practices. Towards the edge of the project area boundary, the channel becomes less define and grades to a grassy swale. Despite this, these areas were conservatively classed as key fish habitat in accordance with (DPI, 2013).



Source: EMM (2020); Regis Resources (2020); ESRI (2020); Survey Graphics (2019); DFSI (2017); GA (2011)

0 1 2 km

GDA 1994 MGA Zone 55

N

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KEY

Key fish habitat sample site

Project application area

- Mine development project area
- Mining lease application area (Note: boundary offset for clarity)
- Disturbance footprint
- Additional (post-closure) disturbance footprint
- Pipeline

Existing environment

- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line
- Vittoria State Forest

EIS aquatic ecology assessment survey sites

McPhillamys Gold Project
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Figure 2.1

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Upstream of the project area boundary, within the Vittoria State Forest, the Belubula River becomes a poorly defined grassy channel. There are a number of dams that have been constructed within the State Forest, and forestry operations are conducted over this waterway. Surface water flow in the Belubula River, upstream of the disturbance footprint, is highly intermittent, although high-flow events may occur after large rainfall events. However, these flows are infrequent and pooled surface water does not persist over a sufficient time period to support aquatic species, thus unlikely to provide any fish habitat. It is considered negligible habitat for threatened species.

The values of Tributary B are described in the EIS Aquatic Ecology Assessment (EMM, 2019), with this tributary classified as Type 1 - Highly sensitive key fish habitat and Class 3 - Minimal key fish habitat. As a result of project revision, Tributary B is now located wholly outside of the disturbance footprint.

Tributary G was visited but not formally assessed during the November 2018 field survey undertaken for the EIS Aquatic Ecology Assessment (EMM, 2019) as *"there was no detectable waterway and surface water features were limited to constructed pastoral dams"* (p.14). Upstream of the Belubula River, Tributary G consisted of a series of three dams with a poorly defined grassy channel largely dominated by exotic species (Plate 2.1). Limited native vegetation was present on the channel bed, consisting of a sparse and disjunct cover of Slender Knotweed (*Persicaria decipiens*) and *Carex* spp. close to the dams, with large swales of native species such as *Poa* spp. and *Carex* spp. in damp, low lying areas. Exotic vegetation tended to dominate the groundcover. This waterway was assessed as Type 3 – Minimally sensitive key fish habitat due to the intermittency of this waterway and lack of any significant cover of aquatic native vegetation. Tributary G is assigned a class of Class 4 - Unlikely key fish habitat based on the little or no defined drainage channel and little to no standing water post-rainfall. It is considered that Tributary G would be unlikely to provide suitable habitat for threatened species.

Plate 2.1 Tributary G, ~200 m upstream of the Belubula River, immediately above the first dam

It is noted that while Tributary F4 was assessed during the November 2018 field survey as Type 3 Minimally sensitive key fish habitat and Class 4 unlikely key fish habitat, it has been excluded from areas requiring offsetting as it is a 2nd order waterway and is therefore not classified to be key fish habitat, in accordance with DPI (2013). Tributary F was poorly defined and did not exhibit an incised channel or any aquatic habitat features (Plate 2.2). This waterway is not considered further in this report.

Plate 2.2 Vegetation monitoring site (103_DG_9) located on Tributary F

3 Revised impact assessment

3.1 Key project revisions

The key amendments to the project relevant to aquatic ecology are as follows:

- Revised mine layout (Figure 1.2) which has resulted in an amended disturbance footprint.
- Water management system has been redesigned with all operational water management storages now designed with zero spill risk (previously designed to a less than 1% spill risk).
- Revision to the location of the TSF and associated embankments (Figure 1.2), primarily within the north-west area of the disturbance footprint.
- Avoidance of Tributary B to the south of the disturbance footprint.
- Development of the post-closure clean water diversion, primarily the waterway design.

3.2 Environmental receptors

No additional environmental receptors were identified as a result of the amended project; however, there is likely to be a reduction in the extent of these impacts, detailed above. The primary environmental receptors identified in the EIS Aquatic Ecology Assessment (EMM, 2019) comprise:

- water and sediment quality, downstream of construction areas;
- key fish habitat;
- aquatic biodiversity (eg algae, macrophytes, aquatic invertebrates and aquatic vertebrates); and
- native plants inhabiting the riparian zone.

3.3 Impacts

The revision of the project has resulted in a small reduction in the extent of waterway, and therefore key fish habitat, that will be directly impacted by mine development infrastructure construction and operation. This includes the movement of the disturbance footprint so that the 3rd order section of Tributary B is now outside of the disturbance footprint. A comparison of the disturbance footprint presented in the EIS with the amended disturbance footprint is provided in Figure 3.1.

In relation to comments from DPI Fisheries, it should also be noted that:

- as per the design presented in the EIS, Tributary A is not impacted by the southwestern extent of the disturbance footprint (Figure 3.1);
- Tributary B is now wholly avoided by the revised disturbance footprint (Figure 3.1); and
- impacts will occur to key fish habitat in the Belubula River and Tributary G (Figure 3.1).

In response to DPI Fisheries submission on the EIS and the EIS Aquatic Ecology Assessment (EMM, 2019), this report identifies revised direct impacts to key fish habitat within the disturbance footprint, as a result of construction of the project. While 10 locations along the Belubula River were assessed during the November 2018 field survey, no sites were assessed upstream of the confluence of the Belubula River and Tributary G due to a lack of key fish habitat features and a proliferation of agricultural dams which blocked fish passage as well as access (Plate 3.1). However, for the purposes of the revised assessment, any unassessed 3rd order or above sections of the Belubula River and Tributary G within the disturbance footprint have been conservatively classed as key fish habitat in accordance with the policy and guidelines, based on the classifications assigned to nearby assessment locations (Table 2.4) and review of the values of these sites.

As a result of the revision of the disturbance footprint, 32,549 m^2 of direct impact will occur within the Belubula River, and 6,418 m^2 of direct impact will occur within Tributary G (Table 3.1, Figure 3.1), totalling 38,967 m^2. This key fish habitat will be subject to impact as a result of the placement of the TSF and associated embankments, (Figure 1.2). In addition, a small area of direct disturbance (1,414 m^2) will occur to the north of the operational disturbance footprint to facilitate the construction of the final clean water diversion waterway, post-closure (Figure 3.1), resulting in an overall impact to 40,381 m^2 of key fish habitat. However, overall, revisions to the disturbance footprint are unlikely to substantially change the potential impacts to aquatic ecology outlined in EMM (2019).

DPI Fisheries also requested that quantification of the extent of isolated key fish habitat be made, adjacent to the disturbance footprint (indirect upstream impact), particularly with regard to Tributary B (southeast), Tributary G (north) and the Belubula River (north-east). However, this has not been addressed as it is not considered that the upstream sections of waterway constitute key fish habitat, with the following justification:

- Located within a pine plantation, highly modified and degraded as a result of existing clearing and other forestry practises (Belubula River).
- Located within highly modified and degraded agricultural land (Belubula River, Tributary G).
- Contains limited discernible waterway channel, likely only flowing during major rainfall and flood events (Belubula River, Tributary G).
- Separated from the Belubula River (during low and medium-flow conditions) by several agricultural dams immediately upstream of the confluence with the Belubula River (Tributary G).
- Separated from downstream sections (during low and medium-flow conditions) by a large agricultural dam immediately inside the disturbance footprint (Belubula River).
- Contains numerous existing dams upstream of the large agricultural dam within the pine plantation (Belubula River).
- Tributary B is now wholly avoided as a result of the revised project.

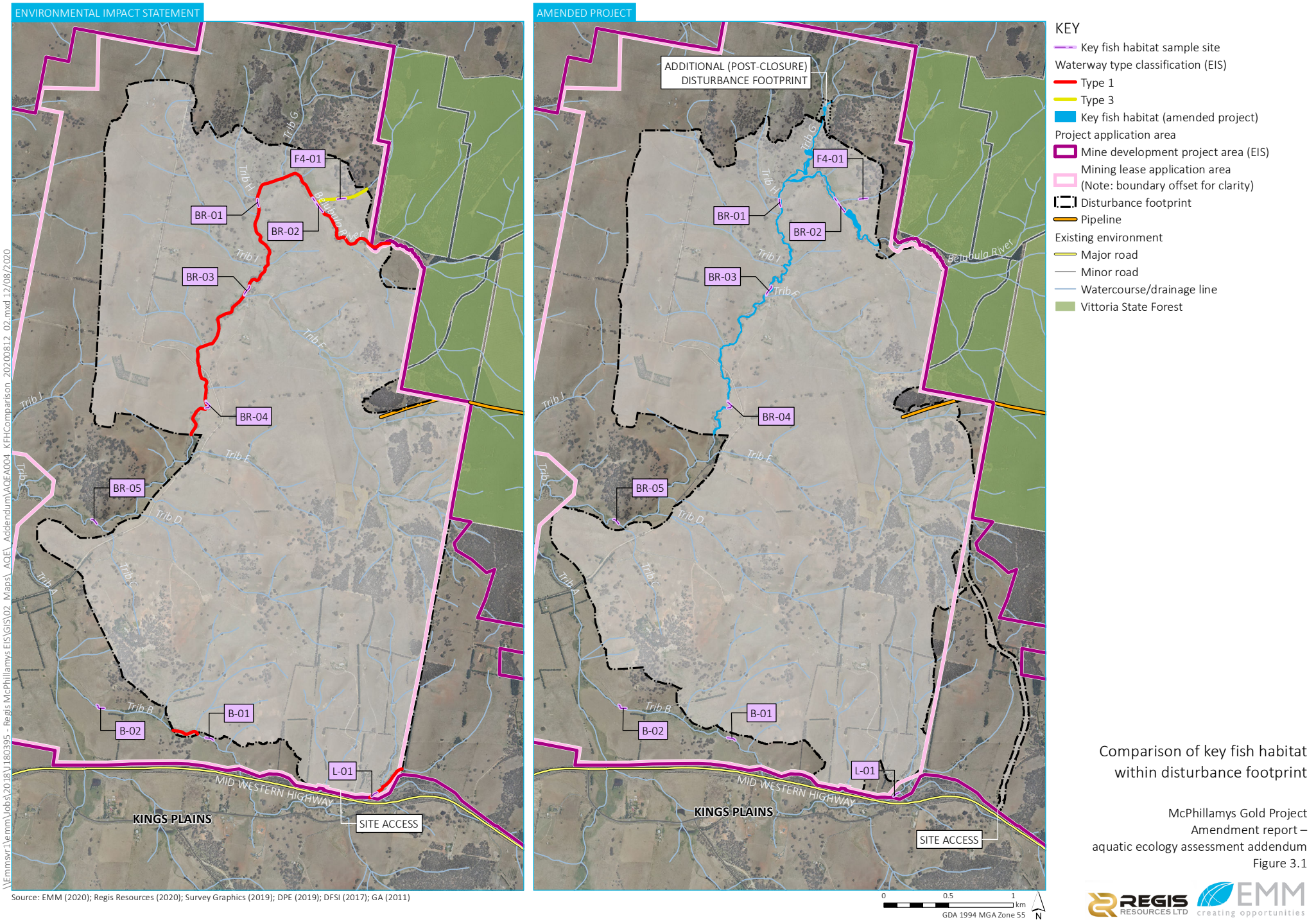
In addition, neither of these sections of waterway, nor any within the disturbance footprint, are considered to provide habitat for threatened aquatic species (DPI, 2020).

Table 3.1 Area of direct impact calculated for key fish habitat within the disturbance footprint

Waterway	Direct impact area (m^2)
Belubula River	32,549.4
Tributary G	7,831.9
Total area of direct impact	**40,381.27**

Note Tributary G was not assessed during the November 2018 field survey, therefore a key fish habitat classification of Type 3 was assumed.

Plate 3.1 Site BR-02 assessed during the November 2018 field survey showing presence of dam wall blocking interface between upstream and downstream key fish habitat, Belubula River



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Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DPE (2019); DFSI (2017); GA (2011)

Comparison of key fish habitat within disturbance footprint

McPhillamys Gold Project
Amendment report – aquatic ecology assessment addendum
Figure 3.1

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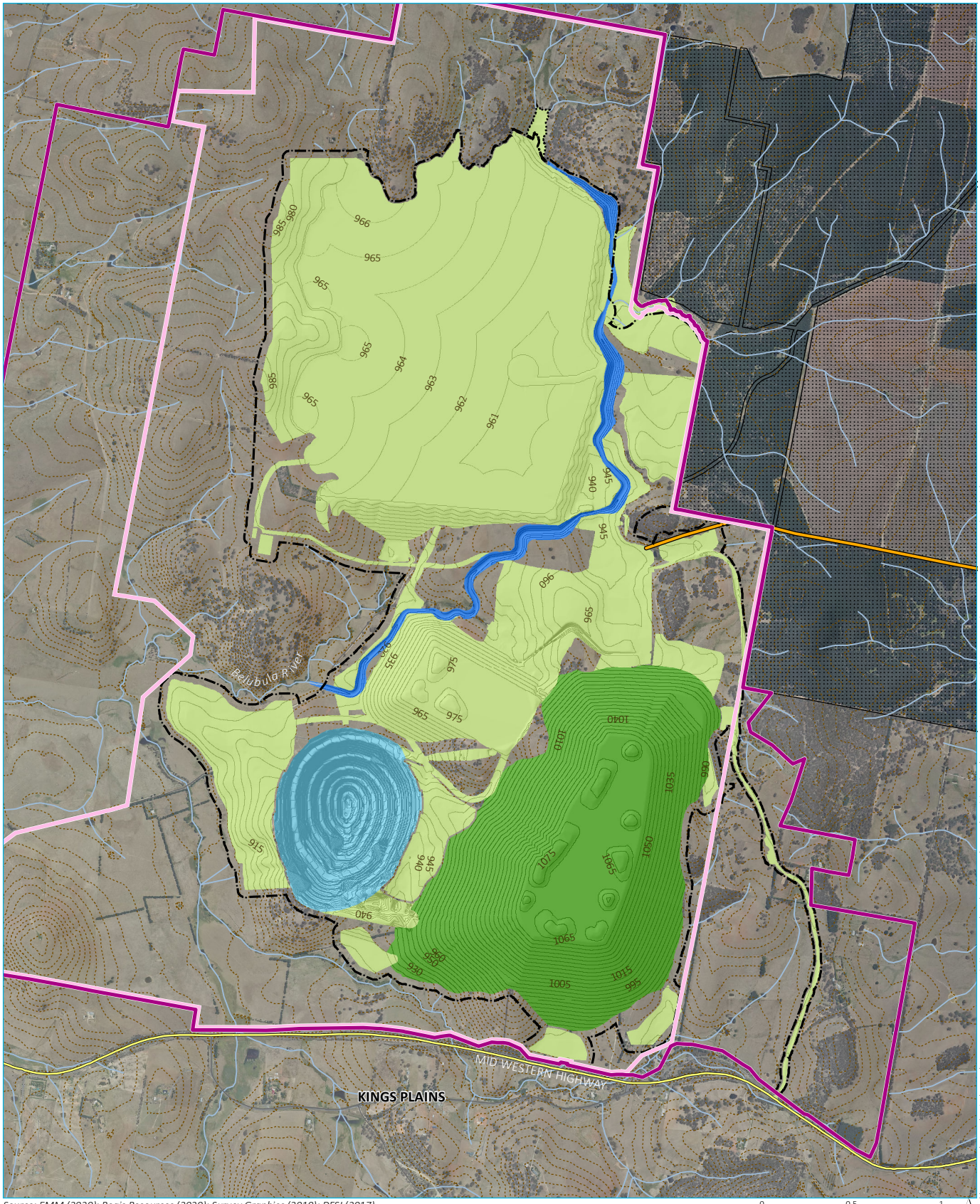
3.4 Post-closure rehabilitation of waterways

As part of the development of the revised project, ATC Williams (2020) conducted a review and update of the TSF and associated drainage design, primarily to improve the clean water diversion around the TSF. Changes were also made to the northern and eastern embankments around the TSF, to facilitate clean water diversion during operations and post-closure. The post-closure drainage system is detailed in *Amended Project - Rehabilitation and Landscape Management Strategy Addendum* (EMM 2020c). A key component of the post-closure drainage system is a clean water diversion that will be constructed around the eastern side of the TSF.

During operation, surface water from Tributary G upstream of the disturbance will be pumped from the north along a channel to the east of the TSF where together with upstream flows from the Belubula River, will be piped through the mine infrastructure area and into the Belubula River downstream from the disturbance footprint. During mine closure, and with the removal of infrastructure, the water will follow the same course; however, it will flow through an artificial reinstated waterway rather than via pumping though a channel and pipeline. Infilling of a small area of Tributary G, to the north of the disturbance footprint (Figure 1.2, Figure 3.1), will be required to allow water in Tributary G to freely drain to the reinstated waterway. This detailed design of the reinstated waterway will facilitate construction of a more 'meandering' waterway which will focus on the design objectives to be implemented during the closure phase. The approach taken in terms of rehabilitation of the TSF is such that runoff from rehabilitated surfaces will drain to the clean water diversion located to the east of the TSF.

The alignment of the southern end of the clean water diversion has been revised for the amended project to facilitate channel gradients more consistent with the natural gradients of the Belubula River. The final landform, as indicated in the amended project, is a diversion of over 4,700 m with an average grade of approximately 1%, ranging between 0.5% and 2%, which more accurately represents existing gradients in the mine project area. The diversion channel will be constructed to generally mimic natural geomorphological features consistent with appropriate reference tributaries within the catchment and guided by *A Rehabilitation Manual for Australian Streams* (Rutherford, et al., 2000) or current best practice natural channel design guidance. The diversion will be fenced to exclude stock (other than at crossing points) and will be revegetated with appropriate riparian community species to form a riparian corridor along the diversion. Species proposed for use in rehabilitation will be indigenous, and consistent with riparian communities within the local catchment. This method will ensure that, where possible, waterways have similar characteristics in terms of stream type, alignment, riparian zone width and longitudinal grade to the existing watercourses.

Regis commits to ensuring that waterway and riparian zone reinstatement, post-closure, will improve existing aquatic and riparian ecological values.



Source: EMM (2020); Regis Resources (2020); Survey Graphics (2019); DFSI (2017)

0 0.5 1 km

GDA 1994 MGA Zone 55

N

KEY

Project application area
- Mine development project area
- Mining lease application area (Note: boundary offset for clarity)
- Disturbance footprint
- Additional (post-closure) disturbance footprint
- Pipeline
- Mine plan contour (5 m); TSF contour (1 m)

Conceptual final landform elements
- Rehabilitated area (grazing)
- Rehabilitated area (open woodland)
- Clean water diversion
- Void

Existing environment
- Major road
- Minor road
- Watercourse/drainage line
- Existing contour (5 m)
- Vittoria State Forest

Amended project post closure water diversion

McPhillamys Gold Project
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aquatic ecology assessment addendum
Figure 3.2

4 Aquatic offset approach

DPI Fisheries has requested that an aquatic ecology offset package be negotiated, with implementation of aquatic biodiversity offsets and/or supplementary measures to occur to ensure a minimum 2:1 offset is met for key fish habitat that is directly impacted as a result of the disturbance footprint. Further refinement and verification has been undertaken with regard to the area of impacted waterways, summarised in Table 3.1, totalling 38,967 m^2 during operations with a further 1,414 m^2 directly impacted during the closure phase of the project to construct the final clean water diversion. A total of 40,381 m^2 of key fish habitat will be impacted by the project.

Waterway widths were mapped from bank to bank using a combination of a digital elevation model (DEM) derived from light detection and ranging (LiDAR) data and aerial photography. Banks were digitised using ArcGIS.

It should be noted that:

- Tributary B is no longer impacted by the revised mine disturbance footprint; and
- as per the design presented in the EIS, Tributary A is not impacted by the south-western extent of the disturbance footprint (Figure 1.2).

In accordance with *Biodiversity Offsets Policy for Major Projects Fact sheet: Aquatic biodiversity* (DPI, 2014), it is acknowledged that an offset strategy should be implemented:

- within the Belubula River catchment;
- within “like for like” habitat;
- within the same or a similar habitat in the same catchment that is more threatened than the habitat being impacted on; and/or
- as part of an offset site, as versus implementing supplementary measures.

In the context of the project and, due to the high level of habitat disturbance and fragmentation currently existing within the Belubula River catchment, Regis has committed to undertaking a number of rehabilitation and remediation programs as part of an aquatic offset package within the downstream on-site sections of the Belubula River, Tributary A and Tributary B. These rehabilitation and remediation programs may include any of the following items:

- undertaking aquatic habitat rehabilitation within degraded areas outside of the disturbance footprint, including remediation of eroded waterways and planting of indigenous aquatic macrophyte species;
- undertaking riparian habitat rehabilitation within degraded areas outside of the disturbance footprint, including remediation of eroded banks and planting of indigenous riparian plant species;
- removal of terrestrial and aquatic introduced and weed species from the riparian zone and within waterways;
- fencing of rehabilitated areas and waterways to ensure grazing by stock and native herbivores is mitigated (excluding areas where final land use will comprise pastoralism);
- re-snagging of areas of waterway with large woody debris where semi-permanent or permanent surface water pools exist, and/or in areas where high-flow would occur during flood events;
- removal of existing artificial and anthropogenic barriers to fish passage in the project area (not critical to transport, mine development or closure stock watering requirements), including constructed soil dams, livestock dams, sediment alluviation, access tracks and blocked culverts (Plate 4.1);

- undertaking habitat mapping programs and/or aquatic fauna surveys; and/or
- undertaking biodiversity research and survey programs identified by the DPI Fisheries.

Funds may potentially be provided towards implementing supplementary measures which provide additional flexibility in fulfilling offset requirements and could be undertaken within the broader region. These may include:

- supporting state-based threatened species hatchery or monitoring/management programs;
- implementing actions outlined in relevant threatened species recovery plans or Priorities Action Statement in the absence of threatened species recovery plans; and/or
    - eg Priorities Action Statement – Actions for the Southern Purple Spotted Gudgeon;
- implementing actions that contribute to threat abatement plans;
    - eg Threat Abatement Plan – large woody debris.

Any offset strategy will be developed in consultation with DPI Fisheries and relevant technical staff, following approval of the project.

Plate 4.1 Evidence of existing impediment to fish passage, Belubula River

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Appendix A

Surface water quality data summary

Table A.1 Summary of surface water quality data within the mine development area

Water quality parameter		WES1164A		WED1276A		WED1825A		WED2344A		WED2847A		WED2935A		WED3052A		WED3275A		WED3466A		WED3662A		WED4061A		WED4775A		ANZECC & ARMCANZ (2000) trigger	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Lower	Upper
Basic	pH	7.2	8.3	5.7	8.4	6.9	9.1	7.3	9.1	7.5	9.5	7.1	8.6	7.0	8.5	6.4	9.3	7.0	7.9	7.7	8.3	6.6	7.9	6.6	8.9	6.5	9.0
	EC (µS/cm)	384	1,059	79	247	503	1,650	123	839	301	1,256	498	1,557	474	1,550	43	127	858	1,048	713	1,180	377	1,040	69	1,194	-	350
	Turbidity (NTU)	1	30	11	110	4	190	14	286	2	103	2	61	3	38	4	320	1	760	2	28	4	91	13	1,290	-	25
Major Ions	Calcium	32	134	2	10	29	76	3.8	48	24	80	27	121	37	121	1	9	8.1	110	59	104	27	91	2.5	38	-	-
	Magnesium	14	65	2	8	23	88	1.7	32	13	84	26	94	21	78	0.8	5	3.1	47	38	80	15	46	1.4	27	-	-
	Sodium	13	49	2.1	19	18	126	1.5	35	11	107	20	78	25	56	0.8	15	1.9	36	34	76	15	53	1.1	41	-	-
	Potassium	2.2	10	5.8	24	4	62	14	84	4	14	4	32	2	13	3	12	1	11	3	13	2	10	6.5	73	-	-
	Sulphate	<1	385	<1	10	5	176	<1	38	8	120	<1	251	13	239	<1	11	<1	39	<10	100	<1	190	<1	200	-	-
	Bicarbonate	156	395	24	71	158	460	38	277	120	393	190	598	155	580	5	48	44	400	275	513	94	420	5	193	-	-
	Chloride	26	136	2	33	23	285	4	82	16	208	8	231	27	102	1	10	5	86	49	113	23	68	2	127	-	-
	Carbonate	<5	<5	<5	<5	<5	18	<5	<5	<5	59	<5	27	<5	<5	<5	<5	<5	<5	-	-	<5	<5	<5	<5	-	-
	Hydroxide	<1	5	<1	5	<1	5	<1	5	<1	5	<1	5	<1	5	<1	5	<1	5	<1	<1	<1	5	<1	5	-	-
	Alkalinity (total)	156	395	24	71	170	460	38	277	130	433	190	598	155	580	5	48	44	400	275	513	94	420	5	193	-	-
Nutrients	Nitrogen (total)	<0.1	1.0	1.9	9.7	0.5	28.0	1.6	16.7	0.8	7.3	0.5	6.0	0.2	4.0	0.8	15.1	0.3	2.2	0.5	2.7	0.3	2.4	2.0	84.0	-	0.2
	Kjeldahl nitrogen (total)	0.1	1	2.1	9.7	0.7	28	2.4	14.5	0.8	7.3	0.6	6	0.2	3.6	1.7	15.1	0.1	1.3	0.5	2.6	0.3	2.4	0.6	44	-	-
	Nitrite+Nitrate	<0.01	<0.01	<0.01	0.76	<0.01	0.4	0.02	2.3	<0.01	0.08	<0.01	0.13	<0.01	0.06	<0.01	0.15	0.4	1.75	<0.01	0.04	<0.01	0.1	<0.01	0.04	-	-
	Phosphorus (total)	<0.01	0.13	0.09	0.53	<0.01	2.34	0.16	1.55	0.02	0.52	<0.01	0.75	<0.01	1.04	0.10	2.52	<0.01	0.78	0.02	0.27	0.01	0.50	0.10	3.40	-	0.02
Metals & Trace Elements	Arsenic	<0.001	0.007	0.002	0.013	0.001	0.026	0.001	0.009	0.002	0.015	0.002	0.027	0.001	0.019	0.001	0.028	<0.001	0.008	0.001	0.007	0.001	0.015	0.001	0.018	-	0.013
	Barium	0.072	0.15	0.028	0.13	0.088	0.2	0.049	0.3	0.052	0.14	0.052	0.21	0.054	0.084	0.019	0.12	0.053	0.32	-	-	0.039	0.093	0.053	0.58	-	-
	Beryllium	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	<0.0005	0.001	-	-
	Boron	<0.02	<0.02	<0.02	<0.05	<0.02	<0.05	<0.02	<0.05	<0.02	<0.05	<0.02	<0.05	<0.02	<0.05	<0.02	<0.05	<0.02	<0.02	<0.05	<0.05	<0.02	<0.05	<0.02	<0.05	-	0.37
	Cadmium	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0003	-	0.0002
	Chromium	<0.001	0.006	<0.001	0.009	<0.001	0.039	<0.001	0.087	<0.001	0.012	<0.001	0.011	<0.001	0.006	<0.001	0.022	<0.001	0.012	<0.001	0.003	<0.001	0.005	<0.001	0.046	-	0.001
	Cobalt	<0.001	0.002	0.002	0.006	<0.001	0.009	0.003	0.026	<0.001	0.003	<0.001	0.002	<0.001	0.002	<0.001	0.011	<0.001	0.007	-	-	<0.001	0.004	0.004	0.033	-	-
	Copper	<0.001	0.0090	<0.001	0.0060	<0.001	0.0160	0.0030	0.0370	<0.001	0.0080	<0.001	0.0060	<0.001	0.0120	<0.001	0.0110	<0.001	0.0110	<0.001	0.0030	<0.001	0.0050	0.0020	0.0210	-	0.0014
	Cyanide (total)	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.006	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.006	-	0.007
	Iron	0.16	0.91	0.98	7.2	0.05	15	0.05	22.3	0.05	2.94	0.05	2.8	0.05	5.5	0.12	20	0.12	13	0.05	2.09	0.21	12.9	0.15	48	-	-
	Lead	<0.001	0.0060	<0.001	0.0060	<0.001	0.0060	<0.001	0.0250	<0.001	0.0030	<0.001	0.0020	<0.001	<0.001	<0.001	0.0190	<0.001	0.0040	<0.001	<0.001	<0.001	0.0020	<0.001	0.0860	-	0.0034
	Manganese	0.1	2.2	0.1	1.0	0.1	2.9	0.2	6.8	0.0	0.5	0.0	4.6	0.2	7.5	0.0	0.5	0.1	2.6	0.0	1.8	0.3	4.1	0.5	7.8	-	1.9
	Mercury	<0.00005	0.0003	<0.00005	0.0002	<0.00005	0.0004	<0.00005	0.0003	<0.00005	0.0003	<0.00005	0.0003	<0.00005	<0.0001	<0.00005	<0.0001	<0.00005	0.0002	<0.0001	0.0008	<0.00005	0.0004	<0.00005	<0.0001	-	0.0006
	Nickel	<0.001	0.005	0.002	0.020	0.003	0.028	0.003	0.039	0.002	0.013	0.002	0.014	<0.001	0.003	<0.001	0.021	<0.001	0.006	<0.001	0.004	<0.001	0.190	0.002	0.025	-	0.011
	Selenium	<0.001	<0.001	<0.001	0.010	<0.001	0.010	<0.001	0.010	<0.001	0.010	<0.001	0.010	<0.001	0.010	<0.001	0.010	<0.001	<0.001	0.010	0.010	<0.001	0.010	<0.001	0.010	-	0.011
	Vanadium	<0.001	0.003	<0.001	0.009	0.002	0.047	<0.001	0.02	0.003	0.021	0.002	0.008	<0.001	0.003	<0.001	0.035	<0.001	0.015	-	-	<0.001	0.005	<0.001	0.096	-	-
	Zinc	<0.005	0.023	<0.005	0.015	0.004	0.025	0.004	0.068	0.003	0.014	0.002	0.014	0.004	0.015	0.004	0.044	0.003	0.048	<0.005	0.014	0.003	0.023	0.004	0.500	-	0.008

Note Parameters are dissolved unless otherwise specified; units are mg/L unless otherwise specified; yellow shading indicates exceedance of the lower ANZECC & ARMCANZ (2000) trigger for the protection of 95% of species in south-eastern Australian upland rivers; red shading indicates exceedance of the upper ANZECC & ARMCANZ (2000) trigger.

Table A.2 Summary of surface water quality data within the mine development area (cont'd)

Water quality parameter		WES5669A		WES7729A		WED5401A		WED7396A		WED9913A		WED2726A		WES4660A		WES4866A		WES5361A		WED6647A		WES4865A		ANZECC & ARMCANZ (2000) trigger	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Lower	Upper
Basic	pH	6.6	8.5	5.4	7.6	6.3	7.7	6.8	9.2	6.9	8.1	7.3	9.5	6.6	7.9	6.8	8.0	7.0	7.6	7.2	9.2	6.8	7.2	6.5	9.0
	EC (µS/cm)	731	1,058	58	553	180	688	155	755	397	1,124	361	720	233	1,514	156	1,275	205	1,918	178	426	594	985	-	350
	Turbidity (NTU)	2	510	3	980	2	31	0	200	5	61	1	47	0	64	2	71	2	590	6	55	4	10	-	25
Major Ions	Calcium	45	82	3	18	6.6	49	14	82	30	86	15	40	19	180	19	110	170	230	7.9	22	58	84	-	-
	Magnesium	40	69	1	11	2.3	27	4.6	83	18	61	15	38	9.3	76	11	56	97	150	5.8	16	27	39	-	-
	Sodium	25	62	1.1	14	1.3	39	4.4	31	14	61	12	69	9.6	46	20	100	37	72	8.8	36	26	54	-	-
	Potassium	1	10	3	11	2.5	12	3.3	8.5	4.8	9.4	4.7	13	1.6	3.7	0.9	9.3	3.2	10	7.2	10	2.5	4.1	-	-
	Sulphate	8	48	<1	28	<1	46	5	38	4	52	5	120	50	450	<1	47	460	1100	1	5	10	22	-	-
	Bicarbonate	320	522	1	122	36	270	48	410	140	430	76	280	35	290	87	500	200	620	80	110	290	390	-	-
	Chloride	16	54	1	7	3	55	1	110	19	110	10	74	9	88	18	170	34	51	7	29	27	85	-	-
	Carbonate	<5	33	<5	<5	<5	<5	<5	23	<5	<5	<5	110	<5	<5	<5	<5	<5	<5	<5	59	<5	<5	-	-
	Hydroxide	<1	5	<1	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	-	-
	Alkalinity (total)	320	522	1	122	36	270	48	410	140	430	91	280	35	290	87	500	200	620	80	170	290	390	-	-
Nutrients	Nitrogen (total)	<0.1	5.2	0.7	28.4	0.4	2.8	0.5	8.3	0.6	3.1	0.1	3.8	1.0	2.8	0.4	3.4	0.7	9.7	2.6	6.3	0.6	1.7	-	0.2
	Kjeldahl nitrogen (total)	0.1	5.2	1.5	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Nitrite+Nitrate	<0.01	0.03	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Phosphorus (total)	<0.01	0.22	0.06	4.83	0.08	1.00	0.05	1.40	0.06	0.70	0.05	0.20	0.05	0.20	0.05	0.30	0.05	0.70	0.10	0.60	0.05	0.07	-	0.02
Metals & Trace Elements	Arsenic	<0.001	0.007	0.002	0.040	0.001	0.010	0.001	0.012	0.002	0.011	0.001	0.490	0.001	0.002	0.001	0.008	0.001	0.009	0.005	0.010	0.001	0.001	-	0.013
	Barium	0.11	0.42	0.009	0.91	0.009	0.091	0.019	0.43	0.06	0.18	0.042	0.26	0.025	0.034	0.04	0.25	0.008	0.079	0.023	0.081	0.084	0.11	-	-
	Beryllium	<0.0005	<0.0005	<0.0005	0.004	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	-
	Boron	<0.02	<0.02	<0.02	0.03	<0.02	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	0.37
	Cadmium	<0.0001	<0.0001	<0.0001	0.0006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0020	<0.0001	<0.0001	<0.0001	<0.0001	-	0.0002
	Chromium	<0.001	0.083	<0.001	0.202	<0.001	0.002	<0.001	0.011	<0.001	0.002	<0.001	0.004	<0.001	0.002	<0.001	0.004	<0.001	0.018	<0.001	0.004	<0.001	<0.001	-	0.001
	Cobalt	<0.001	0.02	<0.001	0.045	<0.001	0.008	<0.001	0.008	<0.001	0.01	<0.001	0.006	<0.001	<0.001	<0.001	0.005	<0.001	0.003	0.002	0.005	<0.001	<0.001	-	-
	Copper	<0.001	0.0150	<0.001	0.1540	<0.001	0.0060	0.0020	0.0100	<0.001	0.0050	0.0020	0.0060	<0.001	0.0060	<0.001	0.0070	<0.001	0.0140	0.0020	0.0030	<0.001	<0.001	-	0.0014
	Cyanide (total)	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	0.007
	Iron	0.56	16	1.1	84	0.72	3.8	0.01	6.4	0.68	6	0.088	1.8	0.018	2.1	0.32	3.1	0.067	11	0.84	8	0.58	0.81	-	-
	Lead	<0.001	0.0110	<0.001	0.2340	<0.001	<0.001	<0.001	0.0080	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0020	<0.001	0.0110	<0.001	0.0060	<0.001	<0.001	-	0.0034
	Manganese	0.1	3.3	0.0	4.2	0.1	2.6	0.0	3.3	0.2	2.8	0.0	1.3	0.0	0.2	0.2	3.3	0.0	0.3	0.6	1.7	0.3	0.6	-	1.9
	Mercury	<0.00005	<0.0001	<0.00005	<0.0001	<0.00005	0.0038	<0.00005	0.0004	<0.00005	0.0001	<0.00005	0.0002	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.0001	<0.00005	<0.00005	-	0.0006
	Nickel	<0.001	0.037	0.002	0.150	<0.001	0.013	<0.001	0.007	0.003	0.013	0.003	0.016	<0.001	0.002	<0.001	0.006	<0.001	0.003	0.002	0.004	<0.001	<0.001	-	0.011
	Selenium	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	-	0.011
	Vanadium	<0.001	0.034	<0.001	0.14	<0.001	0.005	<0.001	0.018	0.002	0.009	<0.001	0.018	<0.001	0.004	<0.001	0.005	<0.001	0.043	0.006	0.01	<0.001	<0.001	-	-
	Zinc	0.001	0.019	0.002	0.693	0.004	0.031	0.006	0.043	0.003	0.016	0.002	0.018	0.002	0.016	0.002	0.032	0.001	0.023	0.003	0.010	0.003	0.005	-	0.008

Note Parameters are dissolved unless otherwise specified; units are mg/L unless otherwise specified; yellow shading indicates exceedance of the lower ANZECC & ARMCANZ (2000) trigger for the protection of 95% of species in south-eastern Australian upland rivers; red shading indicates exceedance of the upper ANZECC & ARMCANZ (2000) trigger.

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