8 Aquatic Ecology

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8 AQUATIC ECOLOGY

8.1 INTRODUCTION

This section provides a summary of the key findings of the *Aquatic Ecology Report* (Appendix D) prepared by Cumberland Ecology. It discusses Matters of National Environmental Significance (MNES) protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), to the extent that they are relevant to aquatic ecology. An assessment of terrestrial ecology is provided in Section 7 – Terrestrial Ecology.

The Environmental Risk Assessment presented in Section 4 identifies all potential project risks in relation to aquatic ecology and determines the consequence and likelihood of each risk, and the overall risk rating. Risk ratings are provided for the risk both with and without the application of mitigation measures. The risk assessment has concluded that, with the application of the proposed mitigation measures, the majority of risks associated with aquatic ecology are low risk, and that there are no high or severe risks. This section provides further detail on the impacts on aquatic ecology that have been identified for the project, as well as the mitigation measures that will be applied.

8.2 OVERVIEW OF THE PROJECT SITE

The project is located in the catchments of the Amagula, Emerald and Angurugu Rivers (Figure 8-1). The upper reaches of the Emerald River and its tributaries drain the majority of the Northern Eastern Lease (Northern EL) and the western area of the Southern Eastern Lease (Southern EL). The Amagula River and its tributaries drain the eastern area of the Southern EL. Although a small section of the Northern EL lies within the catchment of the Angurugu River, the Angurugu River and its tributaries do not traverse the project site. The Amagula, Emerald and Angurugu Rivers drain into the Gulf of Carpentaria, downstream of the project site. The catchment setting for the project is described in detail in Section 10 – Surface Water.

There is no development within the project site, with the exception of the proponent's mineral exploration activities (discussed further in Section 3 – Project Description).

8.3 REGULATORY REQUIREMENTS

8.3.1 EPBC Act

The EPBC Act is described in Section 7 – Terrestrial Ecology. The EPBC Act is administered by the Federal Department of the Environment (DotE). The controlling provisions for the project are listed threatened species and communities (Section 18 and 18A) and listed migratory species (Sections 20 and 20A). This section of the EIS describes aquatic threatened species and communities. Migratory species are described in Section 7 – Terrestrial Ecology.

8.3.2 Territory Parks and Wildlife Conservation Act

The *Territory Parks and Wildlife Conservation Act* (TPWC Act) is discussed in Section 7 – Terrestrial Ecology. The TPWC Act is administered by the Parks and Wildlife Commission NT and provides conservation categories for species in the NT, including aquatic species. Although fish species are listed under the TPWC Act, they are not protected under this Act. Threatened fish species are protected under regulations of the NT *Fisheries Act*.

8.3.3 Fisheries Act

The *Fisheries Act*, which is administered by the Department of Primary Industry and Fisheries, is the primary legislation that provides for the protection, conservation and management of fish, fish habitat and aquatic life in the NT. The purpose of the *Fisheries Act* is to maintain the sustainable utilisation of fisheries and fishery resources, to regulate the sale and processing of fish and aquatic life, and for related purposes. This includes overseeing licensing, permits, and offences related to fisheries. There are no activities proposed to be undertaken on the project site that would require a licence or permit to be obtained under the *Fisheries Act*, and no approvals under this Act are required for the project.

8.3.4 Legislation Related to Environmental Offsets

As detailed in Section 7 – Terrestrial Ecology, the Federal DotE and the NT Environment Protection Authority (NT EPA) have published guidelines related to environmental offsets. No offsets are required or proposed for aquatic ecology and these guidelines are consequently not discussed further in this section.

8.4 METHODOLOGY

The methodology for the aquatic ecology impact assessment included a desktop study, comprising database analysis and literature review, field surveys and data analysis.

8.4.1 Desktop Study

Previous ecological studies that were reviewed as part of the aquatic ecology impact assessment include studies by Webb (1992) and URS (2012). Both studies were commissioned by the proponent, and involved baseline flora and fauna surveys of the western part of Groote Eylandt. Although the studies focused on terrestrial ecology, they included surveys for fish at a number of survey sites in the Angurugu and Emerald Rivers, at locations downstream of the project site.

The desktop assessment also included database searches, including the EPBC Protected Matters Search Tool (PMST) and the NT NRM InfoNet database (InfoNet).

Available information about the project site, including topographic maps and aerial photography, was reviewed.

8.4.2 Field Surveys

Overview

Aquatic field surveys were conducted by specialist ecologists from Cumberland Ecology over two survey periods, namely:

- 20 May and 3 June 2014; and
- 2 October and 5 October 2014

Several members of the Anindilyakwa Land Council (ALC) Land & Sea Rangers participated in the October 2014 field surveys.

The May 2014 survey was undertaken immediately following the wet season, when all of the rivers and their tributaries still contained significant volumes of water, and the natural resources for aquatic fauna were expected to be at their peak. The second survey period occurred toward the end of the dry season in October 2014, when conditions were much drier and water was far more limited.

A total of 17 survey sites were sampled for aquatic ecology in accordance with the NT AusRivAS Manual (Lloyd and Cook, 2002). This comprised nine sites during the May 2014 field survey period, and eight sites during the October 2014 field survey period. Sites were located within the main channels of the Emerald and Amagula

Rivers, as well as in the major tributaries of these watercourses. The location of the survey sites is shown in Figure 8-2.

Aquatic Habitat Assessment

Aquatic habitat assessments were conducted at each of the 17 aquatic sampling locations in accordance with the NT AusRivAS Manual. The assessment considered the habitats within the survey site in terms of habitat diversity and extent, suitability for aquatic fauna groups, existing disturbances/modifications, riparian condition and flow characteristics. Specific habitat features required for AusRivAS modelling were also recorded at each site, such as substrate characteristics, habitat attributes and variety, vegetation and streamside cover, bank stability and presence of erosion.

In Situ Water Quality

Water quality measurements including alkalinity, electrical conductivity, dissolved oxygen, temperature, pH, total dissolved solids and turbidity, were recorded at each survey site using hand held meters. Water quality data were analysed, tabulated and compared to the relevant guideline values, including the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ, 2000), in particular, Volume 1, Water Quality Guidelines for Aquatic Ecosystems.

Aquatic Flora Assessment

Aquatic flora species at each survey site were noted, and an estimate made of their relative abundance. This assessment targeted aquatic macrophytes and water dependent flora species only. Details of the riparian vegetation community present at each survey site were recorded as part of the standard AusRivAS habitat assessment of each survey site. Further assessment of riparian vegetation was conducted for the terrestrial ecology assessment (refer to Section 7 – Terrestrial Ecology).

Aquatic Macroinvertebrates

Macroinvertebrate samples were collected from bed and/or edge habitat from each survey site where possible, in accordance with methods detailed in the NT AusRivAS Manual. A macroinvertebrate dip net (with 250 micron mesh) was used to collect samples. A maximum of 10 m of habitat was surveyed along a 100 m stretch at each location, where possible. The samples were washed through nested sieves, including a 10 mm coarse sieve to remove the large organic fraction, and a 250 micron fine sieve. Components of the organic fraction were washed and checked for macroinvertebrates prior to being discarded, and the sample from the 250 micron sieve was stored in a solution of 70% ethanol for transport to the laboratory for identification.

Aquatic Vertebrates

Aquatic vertebrates were surveyed using a combination of seine netting and dip nets, depending on habitat type and water depth at the sample location. The length of the seine transects was determined by the habitat characteristics (i.e. depth, length and presence of woody debris) of the water body and generally did not exceed 10 m for each trawl. The macroinvertebrate dip net was used to survey the smaller remnant pools and narrow streams where it was not feasible to use the seine net. All specimens caught were counted, identified, measured (to determine life history stage) photographed, and then returned to the same body of water from which they were sampled. Some locations were unable to be surveyed for aquatic vertebrates for safety reasons, due to the presence or potential presence of Salt-water Crocodiles.

8.4.3 Likelihood of Occurrence Assessment

The likelihood of any threatened species identified in database searches being present on the project site was assessed based on the known habitat preferences of these species, the availability and condition of habitats within the project site, and results of the field surveys. The results of the assessment were used to inform the impact assessment and management measures that will be required for the project.

8.5 RESULTS

8.5.1 Overview

The catchments of the project site are vegetated with forest, woodland and sedgeland (these vegetation types are described in Section 7 – Terrestrial Ecology). The project site has not been subject to any previous land clearing or agricultural grazing practices. The majority of land is burnt annually or biennially, typically by Traditional Owners. Aside from fire, human disturbances are limited to unsealed tracks and trails, most of which are located on well drained areas of the project site away from watercourses. There are no known sources of pollution, nor any developments close to the watercourses, and there are no domestic stock present which may pollute the water or erode the banks of watercourses. The watercourses in the project site are undisturbed and in their natural state. The watercourses that are in the upper catchments of the Angurugu, Emerald and Amagula Rivers are generally small watercourses that are seasonally dry.

The majority of aquatic habitat only receives surface water flows or has standing water during and immediately after the wet season. During the May/June 2014 survey, the watercourses within the project site contained water. However, in the October 2014 survey, most of the watercourses were dry, and freshwater habitat was restricted mainly to remnant pools isolated by dry river or stream beds. Within the project site, the Amagula River is perennial, as are small sections of the Amagula River – Tributary 1 and the Emerald River – Tributary 2. These perennial sections are understood to receive groundwater inflows, which contribute to base flows in the rivers. Figure 8-2 shows the sections of the watercourses that have been mapped as perennial, based on the results of the aquatic ecology impact assessment, and the predictions from groundwater modelling (Section 9 – Groundwater).

The majority of watercourses in the project site have rocky beds, with occasional sand and silt deposits.

Fire scars were noted on the trunks of trees observed growing within the channels of the majority of the watercourses within the project site (including scars close to the tree base). This indicates that these sections of the watercourses dry out thereby exposing the full tree to fire.

Most watercourses are bounded by narrow bands of paperbarks, including *Melaleuca viridiflora* (Swamp Tea Tree), *M. cajuputi* (Cajuput tree) and *M. leucadendra* (Weeping Paperbark). Rainforest elements also occur along the larger watercourses and include trees such as *Canarium australianum* (Brown Cudgerie), *Dillenia alata* (Red Beech) and *Syzigium nervosum*. The riparian communities are described further in Section 8 – Aquatic Ecology.

8.5.2 Aquatic Flora

Macrophytes (aquatic plants) recorded at the survey sites consisted largely of emergent sedges and rushes, with occasional floating macrophytes such as *Nymphaea violacea* and emergent forbs such as *Eriocaulon setacum* and *Eriocaulon longifolium* (Pipewort). A number of sedge species were recorded.

Submerged macrophytes were not well represented and were found mainly in the larger, perennial flowing sections of the Emerald River – Tributary 2 and Amagula River – Tributary 1. Floating macrophytes were largely absent from the smaller watercourses.

The absence of aquatic flora communities within the watercourses of Groote Eylandt is due to the highly ephemeral nature of the watercourses, as well as the relatively fast flow regime of the watercourses during the wet season. Wet season flows shift large volumes of sediment down the bed of the watercourses which reduces substrate stability and affects the ability of macrophyte species to establish and grow.

Database searches did not indicate the potential presence of any threatened aquatic flora species, and none were recorded from field surveys or are expected to occur within the project site.

8.5.3 Macroinvertebrates

Aquatic macroinvertebrates are typically used as biological indicators of freshwater ecosystem health due to their sensitivity to changes in water quality, flow regime and general habitat condition. The presence or absence of particular species, diversity, composition and abundance of communities provide general measures of health which can be used to assess impacts on aquatic systems.

The macroinvertebrate data collected from each site was analysed using standard statistical methods, including Multidimensional Scaling (MDS), Analysis of Similarity (ANOSIM) and Similarity Percentages (SIMPER). The *Aquatic Ecology Report* (Appendix D) provides further detail of these methods. AusRivAS and Stream Invertebrate Grade Number – Average Level (SIGNAL) analyses were also undertaken to provide an indication of the aquatic health at the sample locations. EPT (Ephemeroptera, Plecoptera and Trichoptera) taxa richness was also assessed. The analyses indicated that the watercourses are in good to moderate condition for macroinvertebrates.

8.5.4 Vertebrates

A total of five species of fish were recorded from the project site, namely:

- *Denariusa australis* (Pennyfish);
- *Ambassis agrammus* (Sailfin Glassfish);
- *Mogurnda mogurnda* (Northern Purplespotted Gudgeon);
- *Melanotaenia nigrans* (Blackbanded Rainbow fish); and
- *Oxyeleotris sp.* (likely *O. nullipora* [Poreless Gudgeon] or *O. fimbriatus* [Fimbriate gudgeon]).

These species are all common in tropical waters. With the exception of the *Oxyeleotris* species, the fish species found in the project site were also recorded from the Emerald River by URS in 2012. In that study, a total of 11 freshwater fish species were recorded from the Emerald River although the sampling sites were all located near the mouth of the river where diversity and abundance is expected to be higher due to the permanent nature of the watercourse. None of the fish species recorded in this survey, or during previous surveys on Groote Eylandt, are listed under Commonwealth or NT legislation.

8.5.5 Threatened Species

Database Searches

Several aquatic species listed as threatened or migratory under the EPBC Act were recorded from the PMST as having been recorded from the locality or having the potential to occur. These species are listed in Table 8-1, along with a comment on the potential for these species to occur, and a description of the way in which these species have been addressed in the aquatic ecology impact assessment.

Table 8-1 Aquatic Species Listed from the EPBC Act Protected Matters Search Tool

SPECIES	POTENTIAL TO OCCUR IN THE PROJECT SITE
Species that may be associated with the freshwater environment	
■ Mertens' Water Monitor (*Varanus mertensi*) ■ Salt-water Crocodile (*Crocodylus porosus*)	These species inhabit riparian areas and are discussed in Section 7 – Terrestrial Ecology. They are not considered further in this assessment.

SPECIES	POTENTIAL TO OCCUR IN THE PROJECT SITE
Marine species that may make use of the estuarine environment for parts of their lifecycle	
■ Green Sawfish (*Pristis zijsron*) ■ Dwarf Sawfish (*Pristis clavata*) ■ Dugong (*Dugong dugon*)	The project site is located in the headwaters of the Amagula, Emerald and Angurugu Rivers, more than 9 km upstream of the estuarine reaches of these rivers. These threatened species, if present within these rivers, would be restricted to the estuarine reaches of the rivers. The project site itself does not contain any potential habitat for these species. The project has been specifically designed to minimise potential downstream impacts on these rivers and their catchments, and no impacts on the estuarine reaches of these rivers are predicted. Section 8.6.2 and Section 8.6.4 discuss project design features (e.g. a mine design that avoids the need for river diversions or routine discharge of water) that serve to avoid impacts on surface water. Section 8.7 discusses mitigation measures that will reduce the potential for impacts such as sedimentation. Estuarine species are therefore not discussed further in this section.
Marine species, such as whales, marine turtles and sharks	
■ Various whale, marine turtle and shark species	The whale, turtle and shark species listed in the PMST report are all exclusively marine with no stage of their lifecycle being spent in freshwater or estuarine environments. Exclusively marine species are not relevant to the assessment, given the location of the project site and the lack of any feasible mechanism whereby the project would impact the marine environment.

Several TPWC Act listed fauna species were recorded from the InfoNet database as having been recorded from the locality or having the potential to occur. Of these, the aquatic species were four threatened marine turtles. As discussed in Table 8-1, there is no feasible mechanism whereby the project would impact the marine environment. Exclusively marine species are therefore not considered further in this section.

Largetooth Sawfish

The EIS Terms of Reference (TOR) requires consideration of the Largetooth Sawfish (*Pristis pristis*) (also known as the Freshwater Sawfish – *Pristis microdon*) despite this species not being listed on database searches for the area (i.e. the PMST or InfoNet searches). The Largetooth Sawfish is listed as Vulnerable under the EPBC Act and the TPWC Act. This species was not recorded during field surveys of the project site.

The Largetooth Sawfish is primarily a marine/estuarine species, but it does make use of freshwater habitats during parts of its lifecycle. In particular, this species may occur in the muddy/sandy bottoms of river embayments and estuaries where the water is greater than 1 m depth (DotE, 2014). Sawfishes feed on slow-moving shoaling fish, which are stunned by sideswipes of the rostrum (saw), and molluscs and crustaceans that are swept out of the mud by its rostrum (DotE, 2014).

The majority of watercourses on the project site are unsuitable for this species because they lack prey resources or are unsuitable in terms of river substrate and depth. The Amagula River – Main Channel is the only watercourse on the project site that could potentially provide habitat suitable for the Largetooth Sawfish. However, it is a relatively small river, particularly the small section that traverses the project site, compared to other rivers where this species is known to occur (e.g. the Fitzroy River in the Kimberley region of Western Australia). In addition, a literature review and database search have indicated that the Largetooth Sawfish has never been recorded from any section of the Amagula River, or any other river on Groote Eylandt.

This species has been determined to have a low potential to be present on the project site, and it is not considered further in this assessment.

8.6 IMPACT ASSESSMENT

8.6.1 Overview

This section assesses the potential impacts of the project on the aquatic environment. It includes consideration of potential impacts arising from the construction of the open cut mine and haul roads. It also considers potential impacts on water quality, as well as issues associated with changes in groundwater levels, erosion and sedimentation; and the potential introduction of weeds and pest animals.

8.6.2 Open Cut Mining

The project has been designed to ensure that mining will not encroach on the Emerald River, Amagula River or their tributaries. Buffers have been defined around these watercourses and there will be no mining within the buffers. The buffers were delineated based on the 1% Annual Exceedence Probability (AEP) (1 in 100 year) flood extents. Section 10 – Surface Water provides detail on the flood modelling that was undertaken to delineate the buffers. The buffers have been designed to avoid disturbance of the main channels of the watercourses and to limit any interference with surface water flows. As a result of this approach to mine planning, no river diversions or levees are required for the project. Figure 8-3 shows the location of project mining areas in relation to these watercourses, and shows the buffers that have been delineated around the watercourses. The inclusion of these buffers in the mine plan, and the lack of river diversions and levees, significantly reduces the potential for the project to directly impact the aquatic environment.

8.6.3 Watercourse Crossings

As shown on Figure 8-3, haul roads are proposed to cross watercourses in the following locations:

- The haul road linking the Northern EL and the Southern EL with the existing mine will cross the Emerald River – Main Channel and the Emerald River – Tributary 3.
- There are two haul road crossings of the Emerald River – Main Channel in the Northern EL.
- There will be a haul road crossing of the Amagula River – Tributary 1 in the Southern EL.

Low flow drainage culverts will be installed at waterway crossings. Culverts will be designed to allow drainage of the 2 year average recurrence interval flood flow. Floods larger than the design event will be allowed to flow over the culvert or the haul road itself in order to maintain drainage within these watercourses. These crossings will be constructed progressively as the operations expand over the life of the mine and once constructed will remain operational for the life of the mine. Current planning indicates that the crossings will be removed at the end of the mine life. The culverts will not impede fish passage. The conceptual watercourse crossing design is described in Section 10 – Surface Water.

Sediment collection and control measures will be implemented to manage runoff during the construction of watercourse crossings, and to mitigate potential downstream sedimentation effects. These measures will be undertaken and managed in accordance with an Erosion and Sediment Control Plan. These measures will be maintained for the operating life of the project. Monitoring will be undertaken to confirm the measures are effective and to identify any necessary remedial actions. Further detail on erosion and sedimentation is provided in Section 8.6.6.

8.6.4 Potential Impacts on Water Quality

Release of Mine-Affected Water

Given the cultural and environmental sensitivities associated with the watercourses on the project site, the project has been designed to avoid the need for any routine discharges of mine-affected water. In particular, water storages (i.e. dams) will be constructed to store the mine-affected water generated during mining activities (i.e.

water captured in quarries). Mine-affected water will then be used on-site for purposes such as dust suppression. Water balance modelling has been undertaken to confirm that the storages have sufficient capacity, even during the wet season. Long-term water balance modelling was undertaken, using all available climate data, and involved modelling a total of 124 years of data. The modelling demonstrates that there will be sufficient storage capacity to contain mine-affected water, with a low potential for release. Section 10 – Surface Water discusses mine water management and discharges.

Bunding and Storage of Hazardous Materials

The project is an additional mining area that will be operated as part of the existing mine, rather than an independent mine. There will consequently be very limited infrastructure on the project site and storage of diesel and chemicals will be limited to small scale, portable containers.

Section 18 – Health and Safety describes the measures that will be adopted to prevent contamination from the transport, handling and storage of diesel or chemicals. Given the limited activities proposed on the project site, and the controls that will be adopted, the project has a very limited potential to impact water quality in any of the watercourses that traverse the project site.

8.6.5 Changes in Groundwater Levels

The majority of the watercourses within the project site are dependent on surface water, and are consequently ephemeral. However, there are a number of areas where watercourses receive groundwater inflows, leading to sections of the watercourses being perennial. The perennial reaches of the watercourses are shown in Figure 8-2.

Section 9 – Groundwater documents the groundwater investigations undertaken for the project (including 3D numerical groundwater modelling). This report includes an assessment of the potential for drawdown of aquifers to impact on groundwater inflows to watercourses. It concludes that changes to groundwater inflows will have a negligible impact on total surface water flows, and any change in flow rate or stream level would be imperceptible downstream of the project site. No impacts on aquatic biology are therefore predicted as a result of changes in groundwater levels. Further detail on this issue is provided in Section 9 – Groundwater.

8.6.6 Erosion and Sedimentation

As noted in Section 8.6.2, the project has been designed to ensure that there will be no mining activities within the main channel of watercourses or within the 1% AEP (1 in 100 year) flood extents of the watercourses. This design principle will significantly reduce the potential for the project to give rise to erosion and sedimentation impacts on watercourses.

Active mining areas may be subject to erosion, potentially leading to runoff with elevated levels of suspended sediment. An Erosion and Sediment Control Plan will be developed prior to the commencement of construction to address erosion and the control of suspended sediment in drainage waters from these areas. Runoff from disturbed areas will be captured in collection drains and directed through sediment traps and sediment retention dams for control of suspended sediment prior to discharge from site. Sediment collected in sediment dams will be excavated at regular intervals and disposed of in the overburden emplacement areas. Diversion drains will be installed to divert overland flow from the upstream catchment around disturbed areas. All works will be designed and constructed in accordance with an Erosion and Sediment Control Plan. Monitoring will be undertaken to confirm the success of these measures and to identify any necessary remedial actions. Mined areas will be progressively rehabilitated, which will further limit the potential for erosion and sedimentation.

It is considered that, with the implementation of appropriate measures, as described above, it is unlikely that erosion or sedimentation will significantly affect the aquatic ecology of the project site or downstream areas.

8.6.7 Spread of Weeds and Pest Animals

During the construction and operation phases of the project, environmental management measures will be required to prevent the introduction and spread of weeds and feral animals. Further detail is provided in Section 7 – Terrestrial Ecology.

8.6.8 Potential Impact to Threatened Species

No threatened aquatic species, habitats, populations or communities listed under the EPBC Act or TPWC Act have been recorded in the project site, or were assessed as having a high or moderate potential to occur. Consequently it is concluded that the project would not adversely impact any populations of Federal or Territory listed aquatic species.

8.7 IMPACT MITIGATION

8.7.1 Measures to Avoid Impacts

As noted in previous sections, key features of the project design that avoid potential impacts on aquatic ecology include:

- The project has been designed to ensure that there will be no mining activities within the main channel of the Emerald and Amagula Rivers and their tributaries or within the 1% AEP (1 in 100 year) flood extents of the watercourses.
- The project has been designed with sufficient storage capacity for mine-affected water to ensure that no routine discharges of mine-affected water will be required.

8.7.2 Minimising Impacts

Construction Activities and Vegetation Clearing

A number of controls will be placed on project activities to limit potential impacts on aquatic habitat. Clearing will be undertaken in accordance with a clearing procedure that restricts the area of vegetation to be cleared to that required for the safe construction and operation of facilities. The clearing procedure is described in Section 7 – Terrestrial Ecology. Particular care will be taken in relation to any work in or adjacent to drainage lines.

Mitigation measures also include the installation of any necessary sediment control works, and undertaking the works in accordance with the requirements of an Erosion and Sediment Control Plan (Section 8.7.3). Culverts will be designed to ensure that they do not lead to sedimentation or provide a barrier to fish passage.

Mine Water Management System

The mine water management system has been designed to avoid the need for the routine release of mine-affected water. Routine monitoring of the mine water management system will be undertaken, including monitoring of the water level and water quality in all storages. Further detail on the mine water management system is provided in Section 10 – Surface Water.

Spills and Water Contamination

Management measures in relation to the transport and use of hazardous materials, including diesel, will be adopted to minimise and avoid the potential for spills and associated impacts on water quality. Section 18 – Health and Safety provides details on these measures.

8.7.3 Monitoring and Management Plans

Monitoring of Watercourse Crossings

Haul road crossings of watercourses (culverts) will be inspected throughout the construction phase. The inspections will confirm that appropriate erosion and sediment controls are in place and that external batter slopes have been designed in accordance with engineering design criteria and are stable and revegetated. Periodic inspections (i.e. monthly during the wet season) will be undertaken following construction to confirm that all culverts are operating effectively and not causing sedimentation.

Water Quality Monitoring

An ongoing water quality monitoring program will be implemented, comprising regular monitoring of surface water quality based on a select suite of analytical parameters. Further detail is provided in Section 10 – Surface Water.

Groundwater Monitoring

Groundwater monitoring will be undertaken during the life of the project to confirm that impacts on groundwater levels are in accordance with the predictions in the *Groundwater Report* (Appendix F). Further detail is provided in Section 9 – Groundwater.

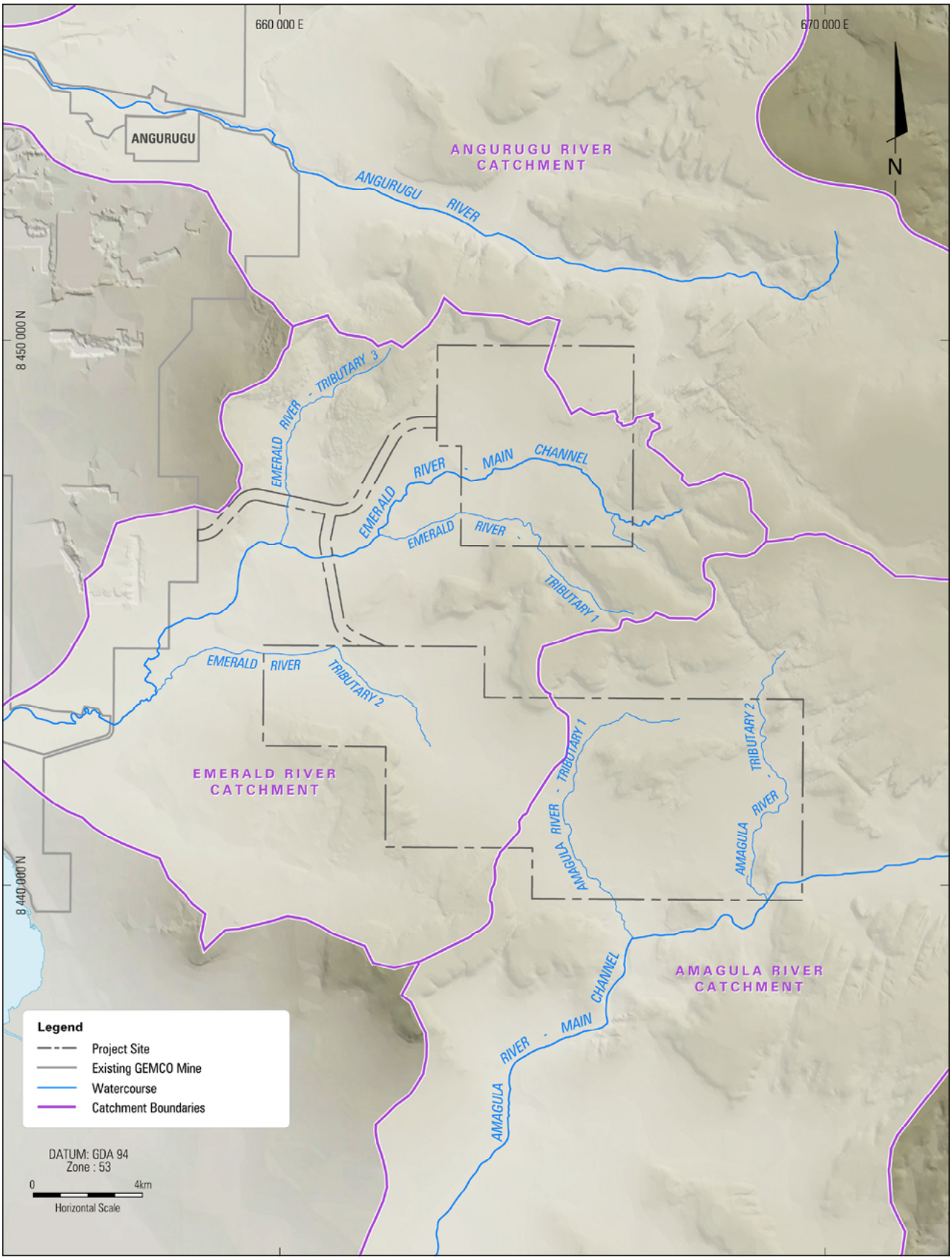
Erosion and Sediment Control Plan

An Erosion and Sediment Control Plan will be prepared for the project. It will include mitigation measures that aim to minimise erosion and the release of sediment to receiving waters and minimise the potential for contamination of stormwater. These measures may include revegetating topsoil stockpiles, scheduling appropriate timing for soil disturbance activities, and the installation of erosion, drainage and sediment control measures.

Weed and Pest Animals

The proponent has various procedures designed to control the spread of weeds and pest animals. These procedures will be adopted for the project site, and are described in Section 7 – Terrestrial Ecology.

FIGURES

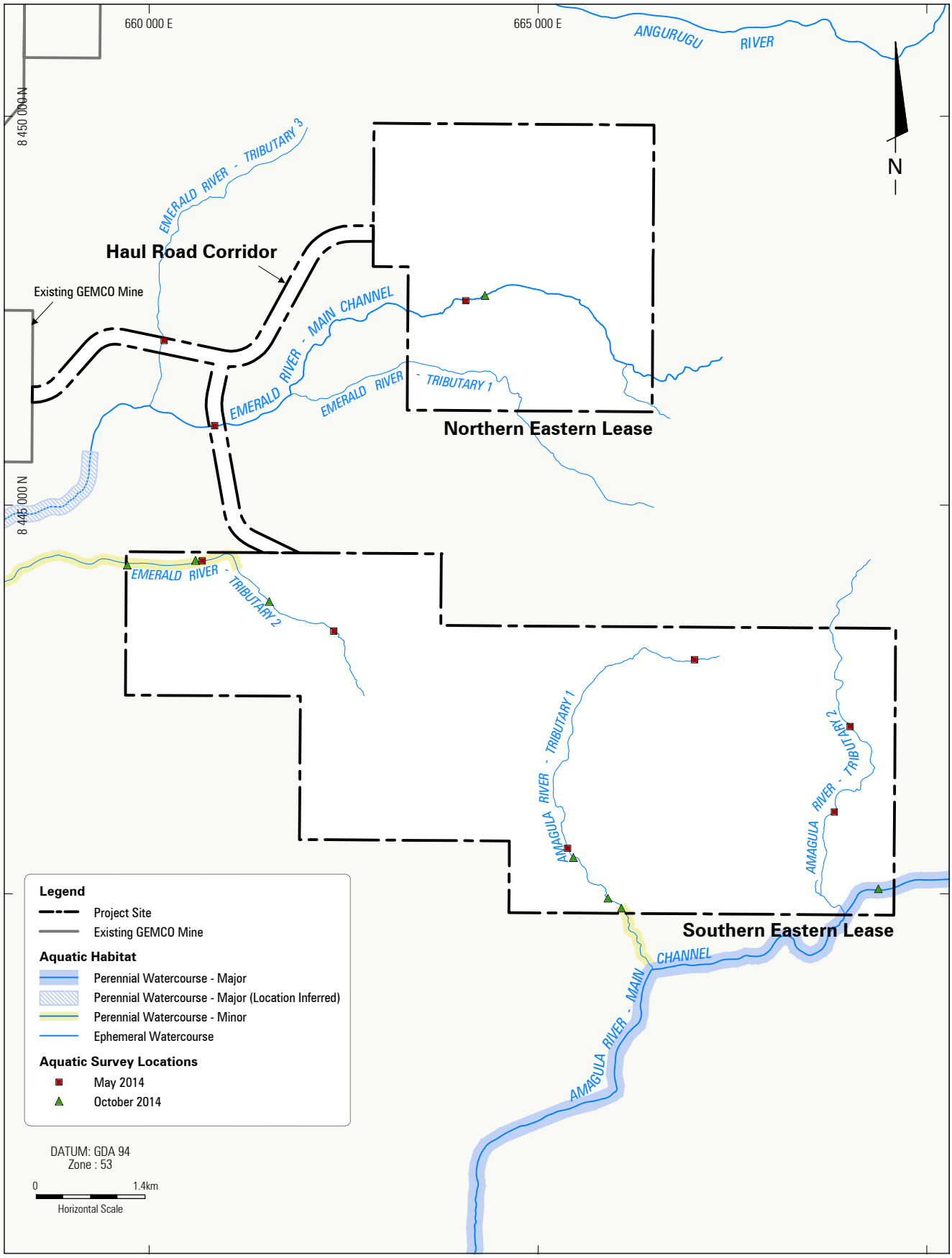


EASTERN LEASES PROJECT

Hansen Bailey
ENVIRONMENTAL CONSULTANTS

Local Catchment Setting

FIGURE 8-1



EASTERN LEASES PROJECT

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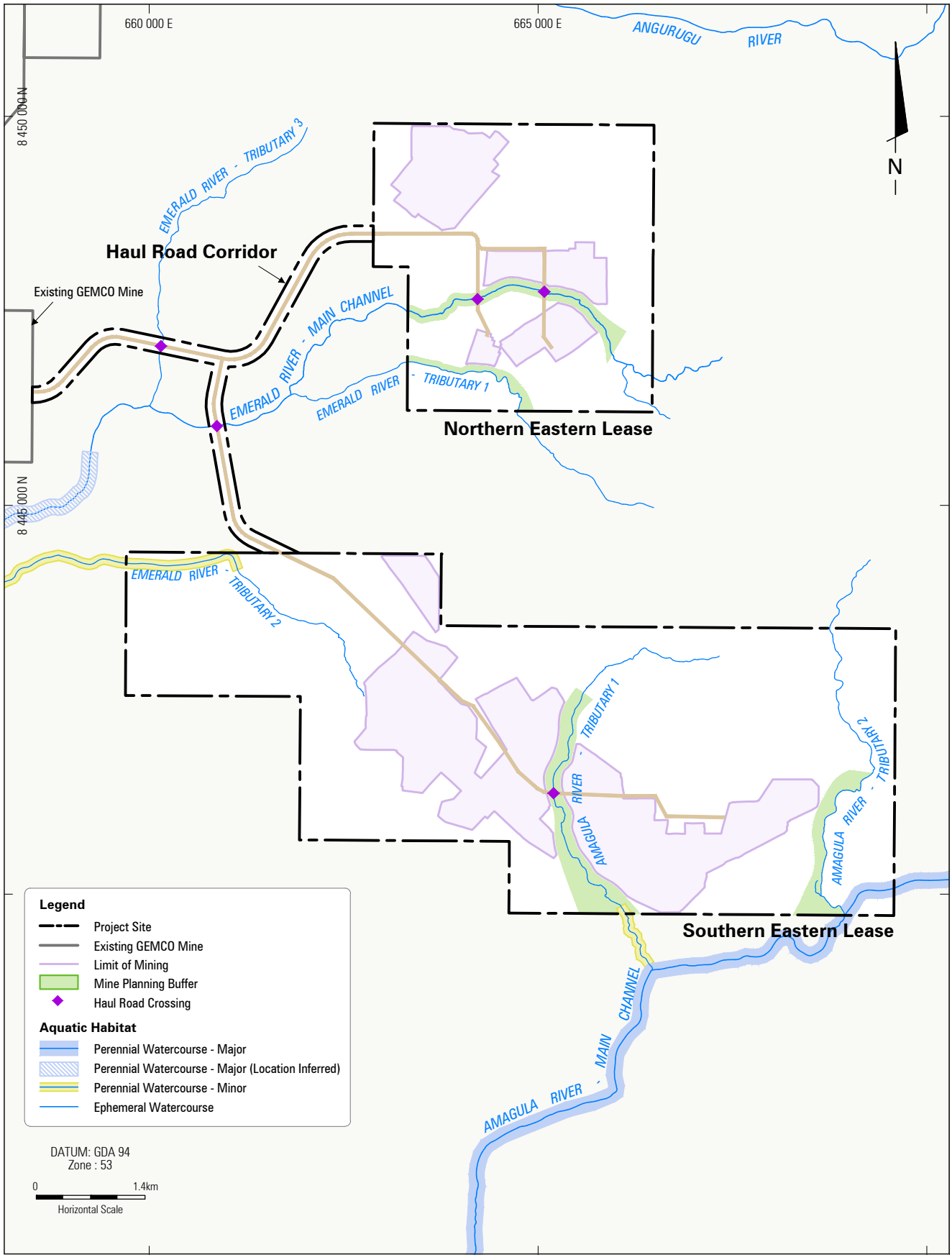
Aquatic Survey Sites within the Project Site

FIGURE 8-2



EASTERN LEASES PROJECT

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Aquatic Ecology Impacts

FIGURE 8-3