

Chapter 9

Terrestrial and Aquatic Fauna

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9 Terrestrial and Aquatic Fauna

This chapter provides a detailed assessment of the KGGP project in relation to terrestrial and aquatic fauna, including the results of targeted fauna surveys undertaken in 2004 and 2012 (Appendices D and E). An assessment is provided of the potential impacts on fauna and habitats of conservation significance and key proposed mitigation responses. Species of conservation significance are those not listed under legislation but considered to be of conservation importance in the NT either in relation to endemism or potential indicators of landscape change. Potential impacts on threatened species listed under the EPBC Act are addressed in detail in Chapter 10 (Matters of National Environmental Significance). Those species listed under the TPWC Act are also listed under the EPBC Act and hence are more specifically dealt with in Chapter 10.

9.1 TERRESTRIAL FAUNA

9.1.1 Description

EcOz 2004 survey

Locations for the 2004 field survey were selected on the basis of desktop and conservation significance analysis and consultation with experts (EcOz 2004). Three survey locations within the project area were selected for the field assessment in 2004 (Figure 9-1). The field assessment was undertaken between the 8th of May and the 14th of July, 2004. Six survey sites per location were identified for survey. At each of the 18 sites (within the project area) a 50 m x 50 m quadrat was established, and survey effort at each quadrat consisted of:

- Twenty Elliott-type traps open for three consecutive nights.
- Four cage traps open for three consecutive nights.
- Four pitfall traps open for three consecutive nights (checked twice daily).
- Three diurnal active searches (comprising leaf litter raking and checking under bark and logs).
- Two nocturnal active searches (as for diurnal surveys with the addition of spotlighting).
- Eight diurnal instantaneous bird counts.

Opportunistic observations were recorded during site visits and travel between survey locations. Animals that were unable to be identified in the field were taken as voucher specimens and lodged with the NT Museum for identification.

The EcOz 2004 survey methodology and results are summarised in Appendix D.

ELA 2012 survey

The field survey conducted by ELA in 2012 was designed to complement and supplement the results of the EcOz (2004) fauna survey. To expand on these findings ELA designed a survey using less intensive methods implemented at a greater number of sites spread within the project area, combined with targeted surveys within the known habitat of bird species listed under the EPBC Act (the Gouldian Finch and Northern Crested Shrike-tit).

DSEWPaC's Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011b) and Threatened Birds (DEWHA 2008) were incorporated into the 2012 survey design for targeted MNES. The Guidelines were followed as closely as possible, as permitted by the length of the pipeline and onset of wet season rains. Factors including access limitations required some slight deviations to the recommended survey methods for several species. These are listed and discussed in Table 11 of Appendix D.

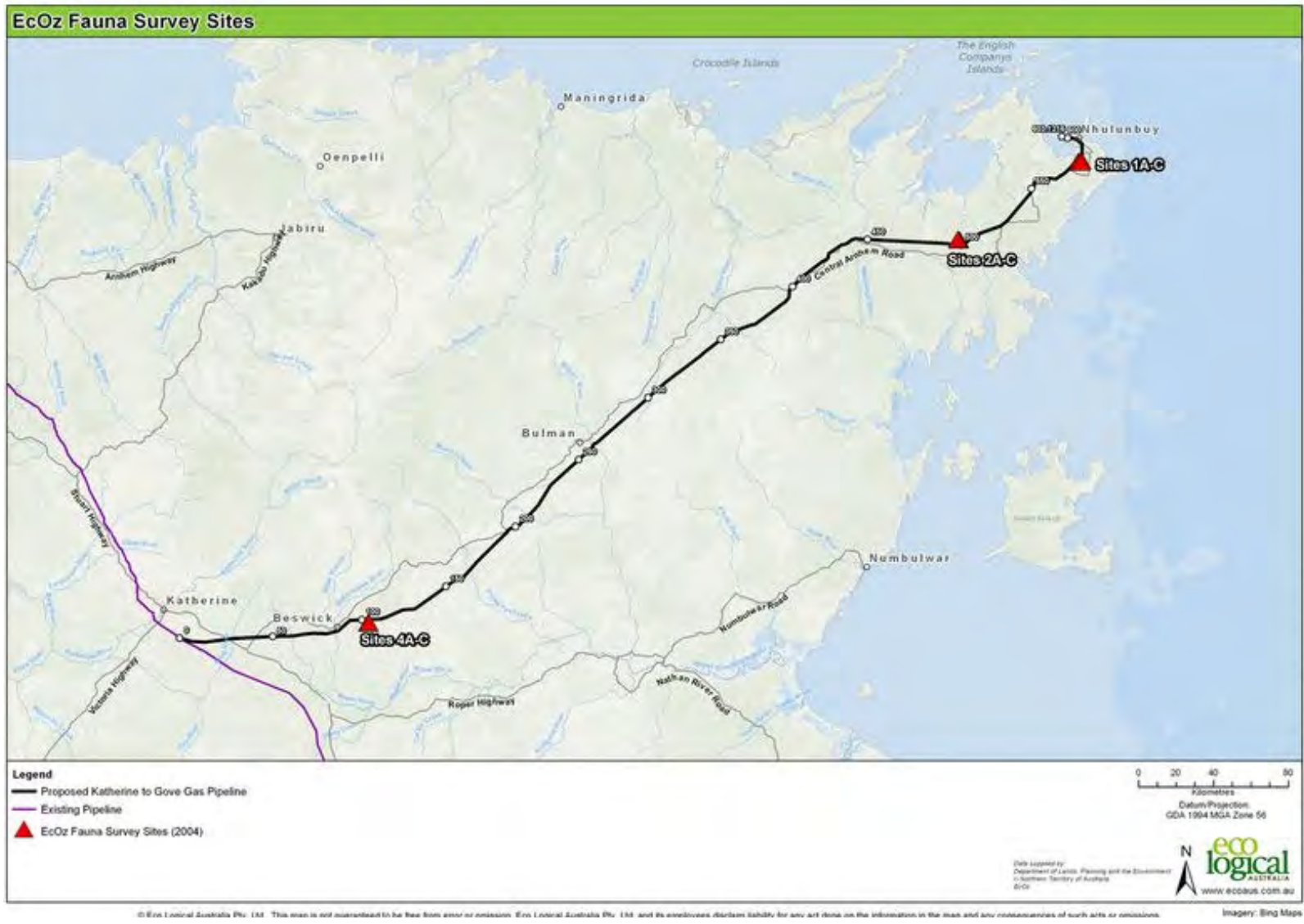


Figure 9-1: 2004 survey sites (EcOz 2004)

Data collected from a review of readily available literature and database records were used to gain an understanding of the existing environment, previous survey methods and results along the pipeline route, species that may potentially occur in the area (particularly threatened species, communities or migratory species listed or removed since 2004) and survey requirements. A list of subject species likely to occur in the pipeline corridor and likely to be impacted by the project was compiled based on the outcomes of the literature review, the 2004 surveys and consultation with experts and traditional owners (Table 9-1).

Table 9-1: Subject species for the 2012 survey

SPECIES	EPBC STATUS	NT STATUS
Birds		
Australasian Bittern (<i>Botaurus poiciloptilus</i>)	Endangered	Not listed
Australian Painted Snipe (<i>Rostratula australis</i>)	Vulnerable	Vulnerable
Eastern Partridge Pigeon (<i>Geophaps smithii smithii</i>)	Vulnerable	Vulnerable
Gouldian Finch (<i>Erythrura gouldiae</i>)	Endangered, Migratory	Vulnerable
Northern Crested Shrike-tit (<i>Falcunculus frontatus whitei</i>)	Vulnerable	Not listed
Northern Masked Owl (<i>Tyto novaehollandiae kimberli</i>)	Vulnerable	Vulnerable
Mammals		
Brush-tailed Tree Rat (<i>Conilurus penicillatus</i>)	Vulnerable	Endangered
Golden Bandicoot (<i>Isodon auratus auratus</i>)	Vulnerable	Endangered
Northern Brush-tailed Phascogale (<i>Phascogale pirata</i>)	Vulnerable	Endangered
Northern Quoll (<i>Dasyurus hallucatus</i>)	Endangered	Critically Endangered

Field surveys were undertaken from 5 to 23 November 2012. The ELA 2012 survey included three sites surveyed by EcOz (2004) and seven additional sites (Figure 9-2). Broad surveys employed a range of passive survey techniques: remote infra-red camera survey, hair tubes, and incidental bird survey. Passive techniques were used because of the remoteness of the survey area, as they are less labour intensive and do not require the survey team to check/release and manage trapped animals. These techniques were deemed an efficient and reliable survey technique for detecting the subject species, along with other fauna.

Results of combined surveys

The dominant habitat type in the project area was recorded as *Eucalyptus tetradonta* and *E. miniata* woodland to open forest with an understorey of tussock grasses (Appendix C). Other observed habitat types included associations of *Eucalyptus* or *Corymbia* occurring in rocky areas of high clay content and *Melaleuca* dominated woodlands and open grasslands occurring in seasonally inundated areas (EcOz 2004b). Outside of agricultural and pastoral areas (approximately KP125–142) the majority of the project area showed little impact of weeds or feral species, although pigs, buffalo, donkeys, horses and cane toads occurred.

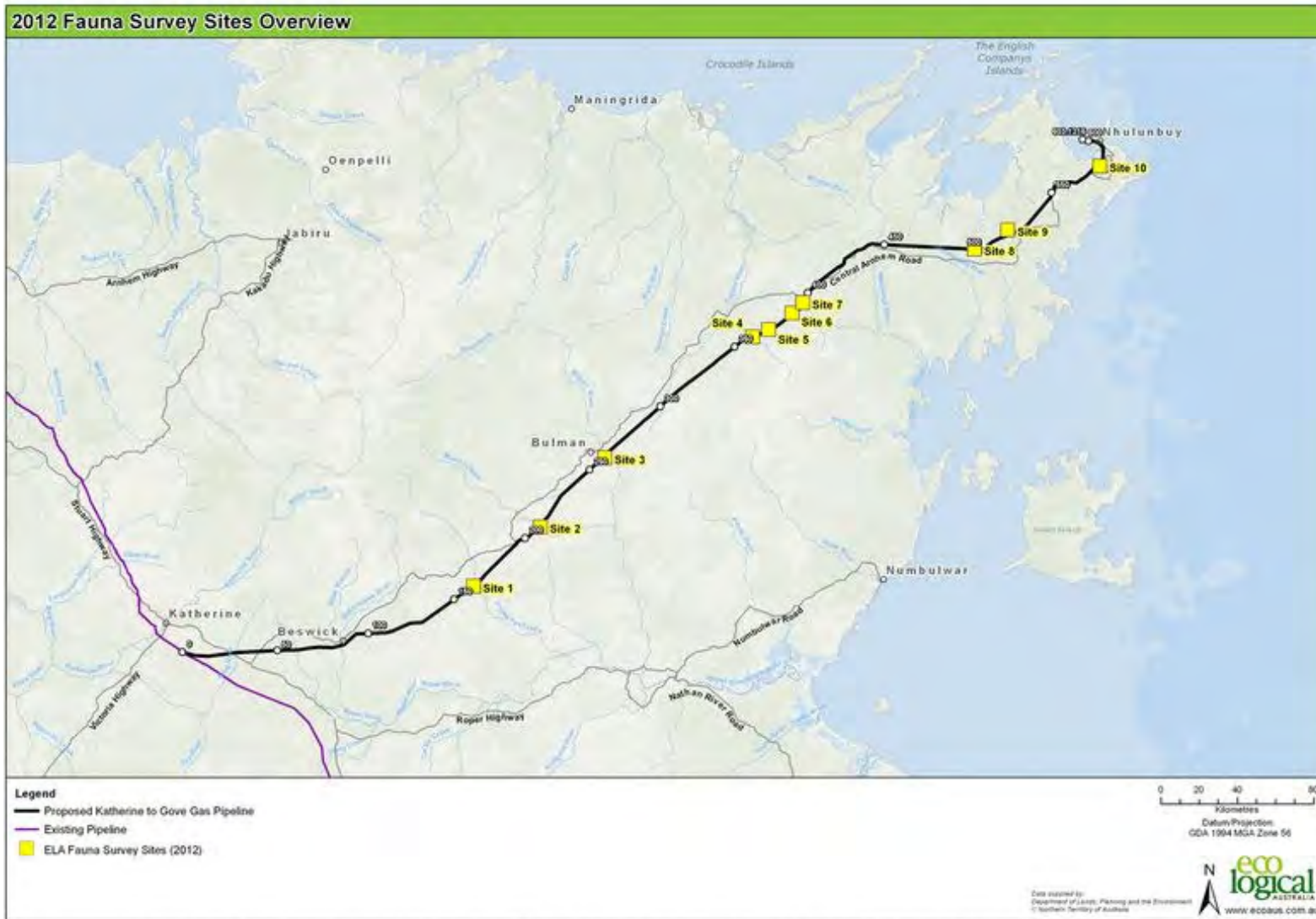


Figure 9-2: 2012 fauna survey sites overview

In most cases the KGGP project has been designed to avoid habitats of conservation significance. Habitats of conservation significance (those that are restricted in distribution and typically support high species diversity) that occur in proximity to the pipeline, access tracks, construction camps and ancillary infrastructure include:

- Riparian corridors (i.e. on banks or in wetlands adjacent to rivers and streams).
- Monsoon rainforest patches.
- Sandstone communities.
- Wetlands.
- Aquatic habitats.
- Habitats of threatened species.

The habitats listed above are discussed in detail below.

A total of 222 native fauna species (18 amphibians, 146 birds, 16 mammals, and 42 reptiles) and nine feral species were recorded during the 2004 and 2012 fauna surveys (Appendix D). Eleven Threatened or Migratory species listed under the EPBC Act were recorded during the surveys. An additional five threatened species identified from desktop analysis were considered likely to occur within the project area, and 12 were considered to possibly occur. Potential impacts on threatened species listed under the EPBC Act are addressed in detail in Chapter 10: MNES. The Gouldian Finch (*Erythrura gouldiae*), listed as Vulnerable under the TPWC Act (and Endangered under the EPBC Act), was recorded.

Numerous other species recorded during the surveys are listed under the TWPC Act as either Near-threatened, Least Concern or Data Deficient. These species are not considered to have confirmed conservation significance status in the NT and are therefore not addressed in this Draft EIS.

Ecologically sensitive habitats

Terrestrial and aquatic habitats considered ecologically sensitive were identified based on the following criteria:

- Areas that provide habitat for threatened flora species as listed under the EPBC Act and/or the TPWC Act.
- Endangered ecological communities as listed under the EPBC Act and areas of essential habitat listed under the TPWC Act.
- Areas that contain regionally restricted species, vegetation types or habitats with outstanding diversity.
- Vegetation types that are outside their normal distribution or have other biogeographical significance.
- Areas that have ecological importance beyond the immediate site, for example wetlands, rainforests, riparian forests, etc.

Habitats that meet these criteria typically have a restricted geographic distribution and provide a niche for species with special habitat requirements. The factors that contribute to the conservation significance of these habitats also make them particularly sensitive to disturbance. The ecologically sensitive habitats identified in the project area from the desktop study and field surveys are:

- Riparian corridors.
- Monsoon rainforest patches.
- Sandstone communities.
- Wetlands.

- Late season waterholes near nesting trees provide habitat for Gouldian Finch (*Erythrura gouldiae*).
- Aquatic habitats (rivers, creeks).
 - (Mertens' Water Monitor (*Varanus mertensi*)).
 - Mitchell's Water Monitor (*Varanus mitchelli*).
 - Pig-nosed Turtle (*Carettochelys insculpta*).

Each of these ecologically sensitive habitats is briefly discussed below. The locations of ecologically sensitive habitats in relation to the project area are shown Figure 9-3.

Riparian corridors

Riparian vegetation provides essential habitat for terrestrial and aquatic fauna species, many of which are confined to riparian habitats for all or parts of their life cycle, or at times of adverse environmental conditions (i.e. late in the dry season). Riparian corridors typically exhibit a higher bird species richness and greater abundance of many species (Woinarski et al. 2000b). Fauna species commonly associated with specialised monsoon rainforest habitats (Bach et al. 1999; Price et al. 1998; Woinarski 1993) were found in some of the riparian corridor habitats along the pipeline corridor during the field surveys. It is likely that fauna move seasonally between riparian and non-riparian vegetation and for this reason there is a need to maintain connections between riparian and non-riparian vegetation (Woinarski et al. 2000b).

The project area traverses a number of surface water management areas (SWMAs) including major permanent rivers and creeks (Figure 7-1):

- Daly River SWMA– King River (KP33).
- Roper River SWMA – Roper Creek, Beswick Creek, Waterhouse River (KP87), Flying Fox Creek, Mainoru River (KP213) and Wilton River (KP263).
- Goyder River SWMA – Goyder River (KP364).
- Buckingham River SWMA – Boggy Creek (KP515), Cato River (KP543), Giddy River (KP575) and Latram River (KP582).
- Koolatong SWMA.

A further two SWMAs (Blyth River and Walker River) are located within the pipeline region (Figure 7-1) as well as a number of other creeks and streams and numerous lesser drainage features.

Detailed descriptions and locations of riparian corridors that are traversed by the KGGP are included in Appendix C of this Draft EIS.

The riparian corridors associated with permanent and semi-permanent watercourses that were assessed during the field surveys were typically characterised by a canopy dominated by *Melaleuca* spp. with other riparian tree species including *Lophostemon lactifluus*, *Barringtonia acutangula*, *Terminalia platyphylla*, *Casuarina cunninghamiana*, *Eucalyptus camaldulensis* and *Nauclea orientalis*. A dense mid storey comprised tree and shrub species including *Pandanus spiralis*, *P. aquaticus*, *Grevillea pteridifolia*, *Banksia dentata*, *Livistona humilis* and *Acacia* spp. often present with or without a grass/sedge understorey. These riparian vegetation communities play an important ecological and hydrological role in maintaining the ecological functions of waterways and associated wetland environments.

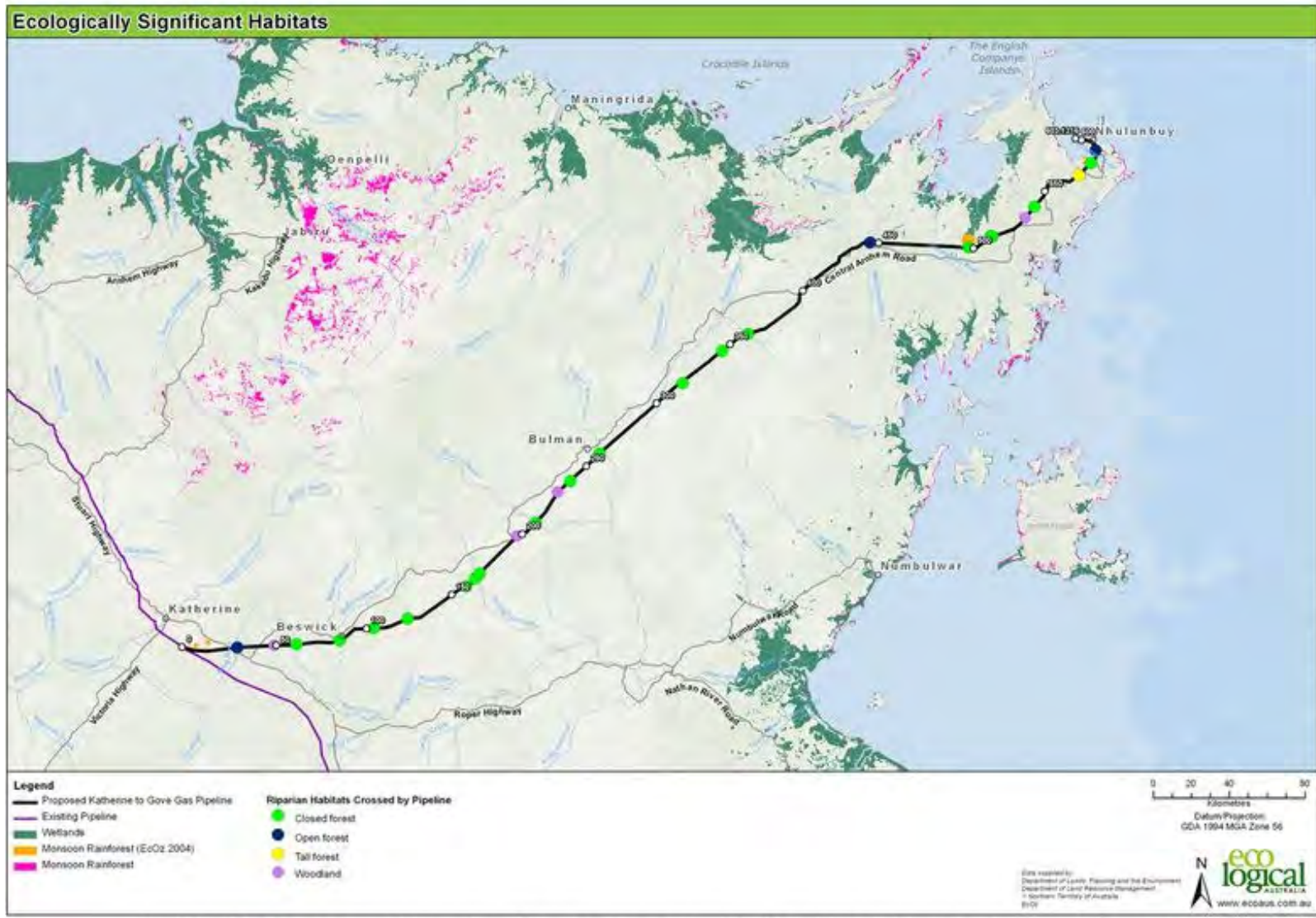


Figure 9-3: Ecologically sensitive habitats within the region traversed by the KGGP

Monsoon rainforest patches

Monsoon rainforests in northern Australia occur as scattered patches in a landscape dominated by Eucalypt savannas (Bach et al. 1999). Rainforests are not uncommon, however, they are generally small in area and contain distinct flora and fauna species assemblages that warrant conservation measures (Woinarski 2004). The project area does not directly impact any monsoon rainforests, as rainforest patches identified during the field surveys were avoided when selecting the pipeline corridor. Three sections of the proposed pipeline corridor (KP8-16, KP494-500 and KP572-585) traverse within two to five kilometres of monsoon rainforest communities (Table 9-2) (EcOz 2004b). Monsoon rainforest traversed by the proposed pipeline corridor is the primary habitat of vulnerable flora species *Pternandra coerulescens* and *Sticherus flabellatus* var. *compactus* (listed under the TPWC Act) and the endangered Gove Crow Butterfly (*Euploea alcathoe enastris*) (listed under the EPBC Act).

Table 9-2: Monsoon rainforest patches occurring within five kilometres of the KGGP route

KP RANGE	COMMUNITY DESCRIPTION
KP8-16	Numerous dry rainforest patches occur 2-4 km north of the proposed pipeline corridor in association with limestone sinkholes near the Cutta Cutta Caves
KP494-500	Numerous spring-fed rainforest patches occur 2-5 km north of the proposed corridor in association with the Goromuru River floodplain
KP572-585	Numerous spring-fed and dry rainforest patches occur 2-4km north of the proposed pipeline route in associated with the Giddy River and Latram River systems and coastline

Sandstone communities

Distribution of heath vegetation within sandstone communities is restricted to the rugged sandstone terrain of north and north-west Australia (Keith et al. 2002). These communities are becoming more restricted because of their high susceptibility to frequent and intense fire regimes that dominate northern Australia (Yates *et al.* 2000). Fire sensitive plant species are also restricted to rugged sandstone landforms (Yates and Russell-Smith 2003).

The Arnhem Plateau Sandstone Shrubland Complex, listed as an endangered ecological community under the EPBC Act, is limited to the Top End of the Northern Territory. It occurs predominantly on the Arnhem Plateau as well as some outlying rocky outcrops (TSSC 2011). The Arnhem Plateau Sandstone Shrubland Complex represents heathlands and other shrublands that are dominated by an understorey of diverse, evergreen sclerophyllous shrubs and herbaceous taxa, including the following genera: *Acacia*, *Asteromyrtus*, *Boronia*, *Calytrix*, *Cajanus*, *Eriachne*, *Goodenia*, *Grevillea*, *Hibbertia*, *Hibiscus*, *Jacksonia*, *Micraira*, *Pityrodia*, *Phyllanthus*, *Stylidium* and *Tephrosia* (TSSC 2011). The Arnhem Plateau Sandstone Shrubland Complex contains a naturally large proportion of obligate seeders (plants with low fire resistance that re-establish through fire-activated or fire-tolerant seeds) along with some resprouters (plant species that can withstand a degree of burning and continue to grow, often from heat-resistant buds) (Russell-Smith et al. 2009). This community may occur within the first 120 km of the KGGP corridor (Blake 2004, as cited in TSSC 2011).

The pipeline corridor traverses rugged sandstone terrain at the locations described in Table 9-3. The landforms traversed are characterised by rocky sandstone slopes, hills and ridges. No heath vegetation communities were identified in the pipeline corridor (Appendix C).

Table 9-3: Sandstone terrain traversed by the KGGP corridor

LOCATION	COMMUNITY DESCRIPTION
Hills east of Beswick between KP90 and KP100	Undulating rocky hills and slopes dominated by <i>Eucalyptus/Corymbia</i> woodland/forests with tussock grasses in the understorey. Common canopy species include <i>Eucalyptus tectifica</i> , <i>Corymbia latifolia</i> , <i>E. ferruginea</i> , <i>E. phoenicea</i> , <i>E. pruinosa</i> and <i>C. bleeseri</i> . Many of the hill tops through this area are vegetated with <i>Acacia shirleyii</i> closed forest.
Mitchell Ranges between KP420 and KP445	To be surveyed in early-mid 2013.

None of these areas have been subject to formal botanical studies prior to the field surveys conducted along the proposed pipeline corridor. No fauna species of notable conservation significance were identified in the sandstone habitats encountered during the field surveys (EcOz 2004b).

Wetlands

Wetlands are of regional conservation significance as they provide a niche for aquatic and semi-aquatic vegetation communities that are uncommon in the drier inland regions of the Northern Territory, and are recognised as significant habitats for fauna (Whitehead and Chatto 1996). The conservation value of wetland communities lies in the strong interactions that exist between fauna and flora, especially where aquatic communities add dimension to the habitat value (Cowie et al. 2000).

The corridor traverses well south of the extensive and highly productive coastal floodplain wetlands that are characteristic of the near coastal environments in the Northern Territory. The proposed route does however, lie in the vicinity of nine regionally significant wetlands, including permanent lagoons and springs, seasonally inundated and permanent swamps and semi-permanent waterholes (Figure 9-4 and Figure 9-5). Of these nine regionally significant wetlands, one semi-permanent swamp (KP394), and two seasonally inundated swamps (KP516 and KP594) will be traversed by the pipeline corridor and will require open trenched crossings (Table 9-4). The KGGP route was realigned to traverse the narrowest section of the swamp at KP394.

The KGGP is also proposed to cross the Goyder River; one of the key rivers feeding into the Arafura Swamp. The upper reaches of the swamp are more than 20 km from the pipeline corridor at the closest point, and greater during the dry season when the majority of pipeline construction works would occur.

The Arafura Swamp is a large freshwater wetland covering an area of approximately 700 km² (Harrison et al. 2009), but which may extend to 1,300km² by the end of the wet season making it one of the largest wooded swamps in the NT (DSEWPaC 2013d). Arafura Swamp is on the Directory of Important Wetlands in Australia and has been nominated as a High Conservation Value Aquatic Ecosystem. It is on the Register of the National Estate for its natural and cultural heritage values and has been designated by the NT Government as an internationally significant Site of Conservation Significance due to the size and importance of very large populations of waterbirds (Harrison et al. 2009). The swamp is a significant breeding area for the Magpie Goose (*Anseranus semipalmata*), Saltwater Crocodile (*Crocodylus porosus*) and Freshwater Crocodile (*Crocodylus johnstonii*). Arafura Swamp is also discussed in Section 11.2.4.

Table 9-4: Regionally significant wetlands traversed by the KGGP corridor and requiring open trenched crossings.

KP	LATITUDE	LONGITUDE	HABITAT DESCRIPTION	WATER BODY
KP394	-12.9617	135.3418	<i>Platyzoma microphyllum</i> and <i>Aristida</i> sp. open grassland with emergent <i>Eucalyptus tetradonta</i> , <i>Pandanus spiralis</i> and <i>Lophostemon lactifluus</i>	Semi-permanent swamp
KP516	-12.6430	136.3236	<i>Corymbia polycarpa</i> , <i>Melaleuca viridiflora</i> and <i>Lophostemon lactifluus</i> open woodland with dense mid-storey of <i>Pandanus spiralis</i> and <i>Banksia dentata</i> and <i>Grevillea pteridifolia</i> with <i>Imperata cylindrica</i> , <i>Eriachne</i> sp. and <i>Cymbopogon refractus</i> understorey	Seasonally inundated swamp
KP 594	-12.2045	136.7697	<i>Melaleuca viridiflora</i> and <i>Acacia leptocarpa</i> closed forest swamp with <i>Eriachne stipacea</i> and <i>Mnesithea rottboellioides</i> understorey	Seasonally inundated swamp

Aquatic habitats

Aquatic habitats, including perennial lagoons, are crucial for the survival of some fish species as they provide refuge during the dry season and breeding grounds prior to floods (Herbert et al. 1995). Lagoons are particularly crucial as refuges in the middle and upper reaches of waterways.

The Cato River is of high conservation significance with the highest recorded fauna species diversity of the surveyed rivers (Appendix E). Two fish species not previously recorded from the Northern Territory were found in the Cato River during field surveys. These species were all recorded from swamps within associated monsoon rainforest patches that occur downstream of the pipeline corridor. It is likely that other rivers within north-eastern Arnhem Land such as the Giddy River, Goromuru River and Habgood River, would also support a similar diversity of fish species. The aquatic habitat of both the Daly and Katherine River systems may also be of high conservation significance because of their high number of aquatic fauna species recorded as well as the extensive water flows through these systems.

9.1.2 Potential impacts of construction and operation

The project has the potential to directly impact terrestrial fauna and their associated habitat through vegetation clearing, fire ignition, vehicular movements, dust emissions, water use/groundwater extraction, waste disposal and physical presence of infrastructure. These aspects may potentially result in:

- Disturbance/ loss/ degradation of terrestrial fauna habitat.
- Fragmentation of fauna habitat.
- Mortality of individuals from capture in trench.
- Introduction and spread of exotic species.
- Mortality of individuals from vehicle strike.
- Degradation of fauna habitat from groundwater drawdown.
- Habitat degradation from increased fire ignition.
- Impacts resulting from other environmental aspects.



Figure 9-4: Regionally significant wetlands in vicinity of pipeline – Katherine end

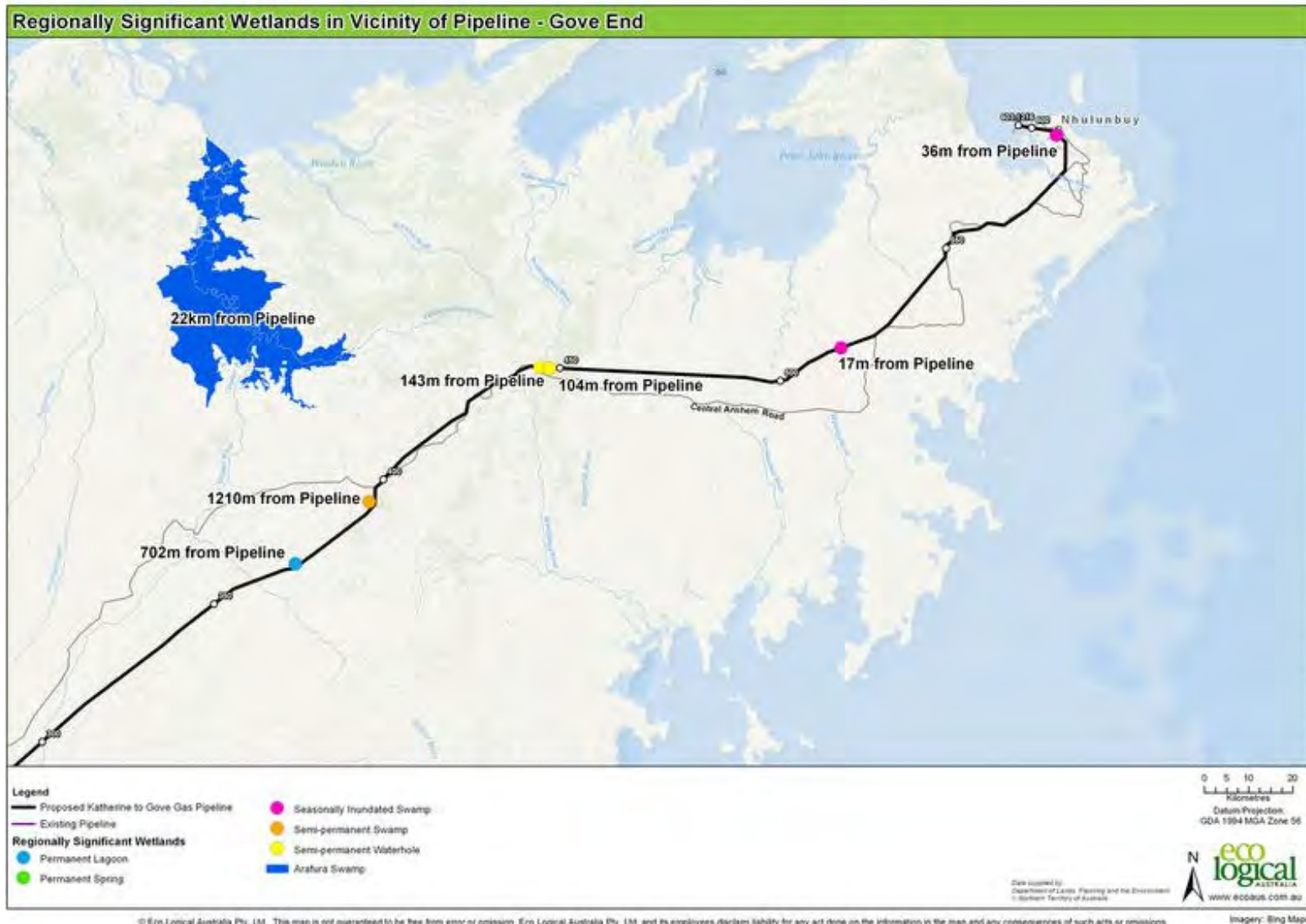


Figure 9-5: Regionally significant wetlands in vicinity of pipeline – Gove end

9.1.3 Mitigation responses and assessment of potential impacts

An assessment of the potential impacts on terrestrial fauna and habitats as a result of the project, and key proposed mitigation responses to minimise these impacts are presented in the following sections and summarised in Table 9-5. Potential impacts on threatened species listed under the EPBC Act are addressed in detail in Chapter 10 on Matters of National Environmental Significance. All species listed under the TPWC Act are also listed under the EPBC Act and hence are more specifically dealt with in Chapter 10.

A full outline of the management and mitigation measures to be implemented as part of the project is available in the EMP (Appendix O).

Disturbance/ loss/ degradation of terrestrial fauna habitat

Clearing of terrestrial fauna habitat is required to allow construction of the KGGP project. Clearing would result in up to 2,200 ha of terrestrial fauna habitat loss in the project area.

Construction of the project may cause direct or indirect disturbance or loss of fauna habitats. Clearing of vegetation for construction of the project would have a direct impact, although with proper management of rehabilitation and revegetation the effect would be short term. Approximately 60% of the habitat impacted by the project would be rehabilitated or re-established through natural re-colonisation and regrowth. Indirect effects, including introduction or spread of weeds and pest animals or changes to fire regimes, have the potential to cause longer term changes to fauna habitats and are discussed in detail below.

Habitat clearing would be restricted to the project area and would be the minimum necessary for safe construction and operation of the KGGP Project. Impacts on habitats from vegetation clearing would be managed through implementation of measures described in the Vegetation Clearing Management Plan and the Terrestrial and Aquatic Fauna Management Plan contained in Appendix O and summarised in Table 9-5.

Conservation significant fauna habitats occurring in the project area include riparian corridors, monsoon rainforest patches, tall coastal Eucalypt woodland, and permanent and semi-permanent wetlands. All monsoon rainforest patches have been avoided through design of the project. Riparian corridors, river crossings, eucalypt woodland and some wetlands cannot be completely avoided and construction through these areas would be carefully managed.

Fragmentation of terrestrial fauna habitat

Habitat clearing is not anticipated to cause any lasting fragmentation of habitat or disruptions to ecological linkages. Clearing of habitat associated with the construction of the pipeline trench may fragment fauna habitat temporarily (during construction), with some species affected more than others based on their movement patterns (flying versus ground moving fauna, and long versus short range movers). Vegetation would be cleared and rehabilitated (or naturally re-established) progressively throughout construction to minimise the period that habitats might be fragmented.

Provision is proposed for vehicle access along the corridor following rehabilitation; however, this would be restricted to a single 4WD track adjacent to the pipeline (interrupted by watercourses along the way, which would discourage public use).

Maintenance of a single 4WD track adjacent to the pipeline is proposed for vehicle access along the corridor during the operational phase of the project. Watercourses will cross the track, discouraging public use.

This area would be kept free of trees and re-spread brush, but grass coverage would be encouraged, continuing to allow fauna movement across. The cleared ROW that would remain once the pipeline has been constructed is unlikely to act as a barrier to movement of species as appropriate revegetation of the ground layer would occur and the corridor would not be fenced.

All habitats within the project area are represented by large areas of similar habitat in good condition outside of the corridor, and sites for construction camps and above-ground facilities have been chosen to avoid significant habitat areas. Subsequent to the temporary construction phase of the project, and following rehabilitation of cleared areas, connectivity between habitats within and outside of the project area would remain.

Impacts on fauna from vegetation clearing would be managed through implementation of the Vegetation Management Plan contained in Appendix O and summarised in Table 9-5. Mitigation and management measures prescribed in this plan would be implemented during construction and operation to reduce the potential for degradation/fragmentation of terrestrial fauna habitat. As a result of planned mitigation measures, it is considered unlikely that native fauna species or habitat would be significantly impacted by vegetation clearing.

Mortality of individuals from capture in trench

Construction of the project has the potential to result in some fauna mortality from individuals becoming trapped in the open trench during construction. Individuals that are captured in trenches can be exposed to various elements such as stress, predators, heat and subsequent dehydration (Woinarski et al., 2000).

The pipeline route has been designed to avoid where possible areas of high faunal conservation value such as monsoon vine forests, wetlands and riparian areas. However, it is inevitable that animals would still be captured and therefore appropriate measures need to be in place to facilitate their escape or assisted removal.

The duration of construction (and period during which there would be open trench) would be minimised through construction occurring in two 'construction spreads' (i.e. commencing construction of two sections simultaneously, that will eventually meet and be joined) along the ROW. It is expected that these measures would minimise the number of animals that become trapped in the open trench, and minimise potential fatalities. During construction, 40-60 km of trench (in each spread) would be open. At any one time, the trench would be open for two to three weeks.

Implementation of the Terrestrial and Aquatic Fauna Management Plan (Appendix O) would minimise the potential for mortality of individual fauna species through entrapment in the open trench. The terrestrial fauna plan would include the placement numerous escape ramps along the trench and frequent checking of the trench for captured animals, to release. The Management Plan would include details on number of ramps per length of trench and frequency of monitoring and release of trapped fauna.

With mitigation measures in place, it is considered unlikely that native fauna species or habitat would be significantly impacted by excavation.

Introduction and spread of exotic species

Ground disturbance and vehicle movements can result in the introduction or spread of weeds or feral animals, increasing predation of, or competition with, native fauna. Specifically, the movement of vehicles, equipment and workers along the ROW and the clearing of native vegetation would present

opportunities for the spread of invasive species. The spread of invasive species has the potential to cause long-term changes to fauna habitat.

The majority of the project area is considered good quality, relatively undisturbed habitat with little existing influences of feral animals or weeds (excluding pastoral areas in the east of the project area).

Key feral fauna species known from the project area with the potential to effect native fauna and their habitats are; Cane Toad (*Rhinella marina*) and Yellow Crazy Ant (*Anoplolepis gracilipes*). The Cane Toad is known to impact native fauna through predation, competition and lethal toxic ingestion. Cane Toads are widespread across the Top End. Construction of the project is unlikely to exacerbate the already prevalent nature of their distribution in the region.

The Yellow Crazy Ant is known to affect ecosystem processes such as litter decomposition, and can impact vegetation community structure and composition. Yellow Crazy Ants are established on the Gove mine site in the east of the project area. New colonies are, however, difficult to establish, and there is considered to be little risk of spreading the species outside of carting substantial amounts of soil containing an entire colony (Dr Ben Hoffmann, CSIRO pers. comm.).

The introduction/spread of weeds including Gamba Grass (*Andropogon gayanus*) and Mission Grass (*Pennisetum polystachion*) in the project area has the potential to cause secondary impacts through promoting intense, hot fires causing widespread damage to fauna habitats, and potential individual fauna mortality. The introduction/spread of these weed species would be minimised through appropriate management measures (refer Table 9-5).

Impacts on fauna from the introduction and spread of exotic flora and fauna species would be managed through implementation of the Exotic Species and Weed Management Plan and the Terrestrial and Aquatic Fauna Management Plan contained in Chapter 17: Management Framework. With implementation of the measures in these management plans, it is considered unlikely that native fauna species or habitat would be significantly impacted by exotic species.

Mortality of individuals due to vehicle strike

Vehicle movements associated with implementation of the project have the potential to cause the loss of some individuals of terrestrial fauna species through vehicle strikes (particularly those species that are less-mobile such as reptiles) and could potentially damage fauna habitat through the spread of weed species (potential impacts associated with the spread of weed species are addressed above), or direct crushing or damage from vehicles driving over vegetation.

The increase in vehicular traffic during the construction phase of the project would be associated with the delivery of construction materials and transport of personnel and other equipment. However, this activity would be restricted to discrete sections of the project area at any one time and vehicles would be restricted to using designated access tracks. Also, the majority of work would be done during daylight hours, 6 am – 6 pm.

On completion of the construction phase, the majority of access tracks would be rehabilitated or re-colonised by surrounding vegetation, and only those tracks required to facilitate maintenance during the operation phase would remain. Vehicle movements during operation of the pipeline would consist solely of maintenance vehicles using the remaining designated access tracks.

Speed limits would be enforced on roads within the project area during construction and operation, to reduce the risk of fauna strikes. Native fauna encountered along access tracks during construction and operation would be avoided and given an opportunity to move on.

Management of potential impacts on fauna from vehicle movements would be through implementation of the Traffic Management Plan contained in Appendix O. Application of measures in this plan, during construction and operation, is expected to reduce the potential for mortality of individual fauna through vehicle strike to a negligible and therefore acceptable level.

Degradation of fauna habitat from extraction of groundwater or surface water

During construction, water would be required for activities such as dust suppression, HDD, hydrotest and camp supplies. The water may be sourced from existing local bores, rivers and creeks, trucked from existing bores or council supplies, or new bores may be required to be drilled. Potable water may be piped in from watercourses, wells or bores (and treated) or trucked in from the nearest existing source.

If water supply bores are to be installed in or near the project area, the drawdown of groundwater has the potential to result in disturbance/ loss of fauna habitat associated with groundwater-dependent vegetation. Reduced groundwater discharge to surface waterbodies could also occur as a result of groundwater drawdown, which could reduce the availability of drinking water for fauna species in the project area, particularly for those species for which remnant waterholes late in the dry season comprise critical habitat, e.g. for Gouldian finches. Extraction of water from rivers and creeks could similarly affect the amount of remaining surface water from smaller non-perennial watercourses.

Impacts on fauna and fauna habitat from extraction of groundwater or surface water would be managed through implementation of the Groundwater and Surface Water Protection Management Plan contained in the EMP. With implementation of these measures, it is considered unlikely that native fauna species or habitat would be significantly impacted by use of these existing water resources during the construction or operational phases.

Habitat degradation from increased fire ignition

Native fauna species and habitats could be impacted by changes in the fire regime within the project area during construction of the project and following construction if fires were inadvertently lit and not quickly extinguished or if weeds were allowed to establish in rehabilitated areas. Individual fauna species may be impacted by silt and ash resulting from a fire, or could be subject to direct mortality from being burnt. The quality of the vegetation within and surrounding the project area could be reduced by fire, therefore decreasing the availability of higher quality fauna habitat.

During construction, the fire regime of the local area may be altered through a potential increase in the number, intensity and spatial extent of fires. Aspects of the construction process that may influence these changes are the accidental ignition of fires from vehicles (or their occupants), sparks from equipment or use of flammable products, or the introduction and spread of weeds such as Gamba Grass and Mission Grass (described above). Alternatively, there may be a reduction in the severity or duration of wildfire as any detected wildfire near the pipeline corridor during construction would likely be prevented from spreading by rapidly extinguishing any fire

Impacts on fauna from fire ignition would be managed through implementation of the Fire Management Plan and the Weed Management Plan contained in the EMP. The implementation of measures in these plans is expected to be effective in minimising inadvertent ignition of fires and the spread of weeds that are known to increase the frequency and intensity of fires; therefore, it is considered unlikely that native fauna species or habitat would be significantly impacted by fire ignition.

Impacts resulting from other environmental aspects

Other environmental aspects of the project that have the potential to impact fauna and fauna habitats include:

- Light emissions.
- Dust emissions.
- Noise and vibration emissions.
- Liquid and solid waste disposal.
- Spills and leaks.

Light, dust and noise and vibration emissions from construction activities may affect native fauna by deterring individuals from their habitats and/or altering species' foraging, roosting or breeding behaviour. This could potentially occur as a result of construction of the project, in the area immediately around the sources of light, dust, noise and vibration.

Vehicles and plant would need to be refuelled during construction. Spills of fuel and other chemicals could occur during refuelling operations and other construction activities, potentially contaminating fauna habitat. Impacts may include contamination of water sources and degradation of nesting/foraging habitat. Storage facilities for hazardous wastes and equipment for handling waste would be segregated and banded, with such areas kept in good order and designed in such a way as to prevent and contain spills as far as practicable.

Poor waste management can result in the spread or introduction of weeds or feral animals, increasing predation of, or competition with, native fauna. Liquid waste storage areas could also potentially leak, causing degradation to fauna habitat in the vicinity.

Environmental Management Plan (EMP)

All potential impacts on terrestrial fauna and fauna habitats would be mitigated through the implementation of measures described in issue-specific management plans comprising the overarching Environmental Management Plan (Appendix O) and summarised in Table 9-5:

- Terrestrial and Aquatic Fauna Management Plan.
- Terrestrial and Aquatic Fauna and Habitat Management Plan.
- Vegetation Clearing Management Plan.
- Groundwater and Surface Water Protection Management Plan.
- Spill Contingency Plan.
- Dust Management Plan.
- Noise Management Plan.

9.1.4 Summary – predicted environmental outcome

After mitigation is applied, construction and operation of the Project would be expected to result in the following outcomes in relation to terrestrial fauna and their associated habitats:

- Clearing of approximately 2,200 ha of potential fauna habitat, with approximately 60% of this to be rehabilitated or re-established through natural re-colonisation and regrowth.
- Minimise the introduction or spread of weeds or feral animals into the pipeline ROW.
- Minimal fauna mortality from vehicle strike or capture in trench.
- Minimal degradation to fauna habitat from fire ignition, dust, waste disposal or extraction of groundwater or surface water.
- No impact to significant fauna habitat areas/nests through avoidance and re-location of ancillary infrastructure.

Anticipated impacts on terrestrial fauna and their associated habitats would therefore be negligible to low.

Table 9-5: Potential impacts and mitigation outcomes for terrestrial fauna and habitats

POTENTIAL IMPACT	PROPOSED MITIGATION (ACTION)		ANTICIPATED EFFECT OF MITIGATION
	AVOIDANCE	MINIMISATION	
Disturbance/ loss/ degradation of terrestrial fauna habitat	<ul style="list-style-type: none"> • Monsoon rainforest habitats will be avoided • Majority of wetlands will be avoided 	<ul style="list-style-type: none"> • The total area of habitat to be cleared will be restricted to the minimum area required for construction of the project • Vegetation will be rehabilitated progressively and sensitive fauna habitats/nests avoided where possible 	<ul style="list-style-type: none"> • Disturbance/ degradation of fauna habitat will be minimised
Fragmentation of fauna habitat	<ul style="list-style-type: none"> • Monsoon rainforest habitats will be avoided • Majority of wetlands will be avoided 	<ul style="list-style-type: none"> • Grass coverage would be encouraged along the single 4WD track adjacent to the pipeline to remain post-construction, continuing to allow fauna movement across • Vegetation will be rehabilitated progressively 	<ul style="list-style-type: none"> • Temporary fragmentation during construction only
Mortality of individuals due to capture in trench	<ul style="list-style-type: none"> • Construction activities involving excavations will be restricted to the 'dry season' as much as possible • The time between opening and closing the pipeline trench will be the shortest time possible for construction 	<ul style="list-style-type: none"> • The open trench will be interrupted with numerous escape ramps for captured fauna • Open trenches will be inspected on a daily basis, and fauna identified and released 	<ul style="list-style-type: none"> • Minimal cases of fauna mortality due to trenching
Introduction and spread of exotic species	<ul style="list-style-type: none"> • Existing weed infestations will be identified and treated prior to construction 	<ul style="list-style-type: none"> • Plant, vehicles, equipment and materials will be required to be washed/blown down (at specially-prepared sites for these actions) to remove weeds and pests prior to being brought into the project area • Systems will be established for reporting of new weed infestations, and Cane Toad and Crazy Ant sightings 	<ul style="list-style-type: none"> • No new introductions or spread of exotic species
Mortality of individuals due to vehicle strike	<ul style="list-style-type: none"> • Truck movements on the construction corridor and access tracks will take place during daylight hours where possible 	<ul style="list-style-type: none"> • Speed limits will be posted on site and along access roads and all project work areas 	<ul style="list-style-type: none"> • Minimal incidents of fauna mortality

POTENTIAL IMPACT	PROPOSED MITIGATION (ACTION)		ANTICIPATED EFFECT OF MITIGATION
	AVOIDANCE	MINIMISATION	
Degradation of fauna habitat from groundwater drawdown	<ul style="list-style-type: none"> Groundwater for construction to be consistent with the Water Supply and Adaptive Management Strategy 	<ul style="list-style-type: none"> No water used for any purpose during construction, commissioning or operation will be released directly to a water body 	<ul style="list-style-type: none"> No degradation of fauna habitat
Habitat degradation due to increased fire ignition	<ul style="list-style-type: none"> Construction workforce will be trained in fire awareness, prevention and safety Cooking and camp fires outside the approved camp boundaries will be prohibited 	<ul style="list-style-type: none"> A fire fighting unit and persons trained in fire response will be readily available at all locations and at all times during construction An Emergency Response Plan will be developed and implemented 	<ul style="list-style-type: none"> Minimal cases of fire ignition
Impacts resulting from other environmental aspects	<ul style="list-style-type: none"> Fuel and chemical storage, handling and distribution systems will be designed and constructed in accordance with Australian Standards, and will be fitted with leak detection systems 	<ul style="list-style-type: none"> All waste will be contained appropriately, taking into consideration fire safety, pest and odour control, and protection of water and soil resources Unsealed roads and exposed ground surfaces will be watered regularly 	<ul style="list-style-type: none"> Minimal impacts on fauna and habitats

9.2 AQUATIC FAUNA

The freshwater environments that occur in the project area are identified and classified in Chapter 7 and watercourse crossings are shown in Figure 9-6. A detailed report on the aquatic fauna study of the pipeline corridor was undertaken during 2003-04 is included in Appendix E of this Draft EIS. The methodology and results from that study are summarised below.

9.2.1 Description

Methodology

The aquatic fauna that occur or are likely to occur in the project area were identified through:

- A desktop review of literature, datasets and database searches.
- Field survey: 17 sites were surveyed.
- Sampling was done using standard field methods, including multi-panel gill-nets, fine-mesh seine, scoop-nets or push-nets, hooks and lines, dip-nets and torches at night, and sight observations from the bank or by snorkelling. Methods and detailed site information are provided in Appendix E.

The survey guidelines for Australia's Threatened Fish (DSEWPaC 2011c) were not released at the time the aquatic fauna survey was undertaken in 2003. However, the aquatic fauna survey methodologies were developed by the Curator of Fishes at the NT Museum and were provided to the NT Office of Environment and Heritage (now the NT Environment Protection Authority (EPA)) for review and comment prior to field survey work being conducted' (Appendix E). A review of the current Guidelines for Australia's Threatened Fish (DSEWPaC 2011c) and the Aquatic Fauna Survey Report for the 2003-2004 survey (Appendix E) indicates that the survey methodologies, literature review and database searches, and field survey methods are in-line with the guidelines.

It should be noted that in any one survey it is unlikely that all species of fish in a river system would be sampled, as species composition varies diurnally and seasonally. Given that the 2003/04 survey was based on a single sampling event at a single site, it is unlikely that all species likely to be present were recorded. For this reason, mitigation of potential impacts on watercourses will emphasise avoidance, including use of HDD to cross flowing watercourses.

In addition to sampling methods above, informal interviews with Traditional Owners and pastoralists were conducted to supplement the information collected during the short survey periods and to identify species likely to occur in each watercourse.

Desktop review results

A search with the EPBC Act Protected Matters Search Tool (Appendix K) and review of the fauna species listed under the TPWC Act recognised eight threatened aquatic fauna species that could potentially occur along the KGGP corridor (50 m either side of the pipeline). Species afforded protection under the EPBC Act are discussed in further detail within Chapter 10 of this Draft EIS, and are not discussed further within this chapter.

The two aquatic fauna species that occur or are likely to occur in watercourses traversed by the pipeline and are listed as threatened under the TPWC Act (but not listed under the EPBC Act) are described in Table 9-6.

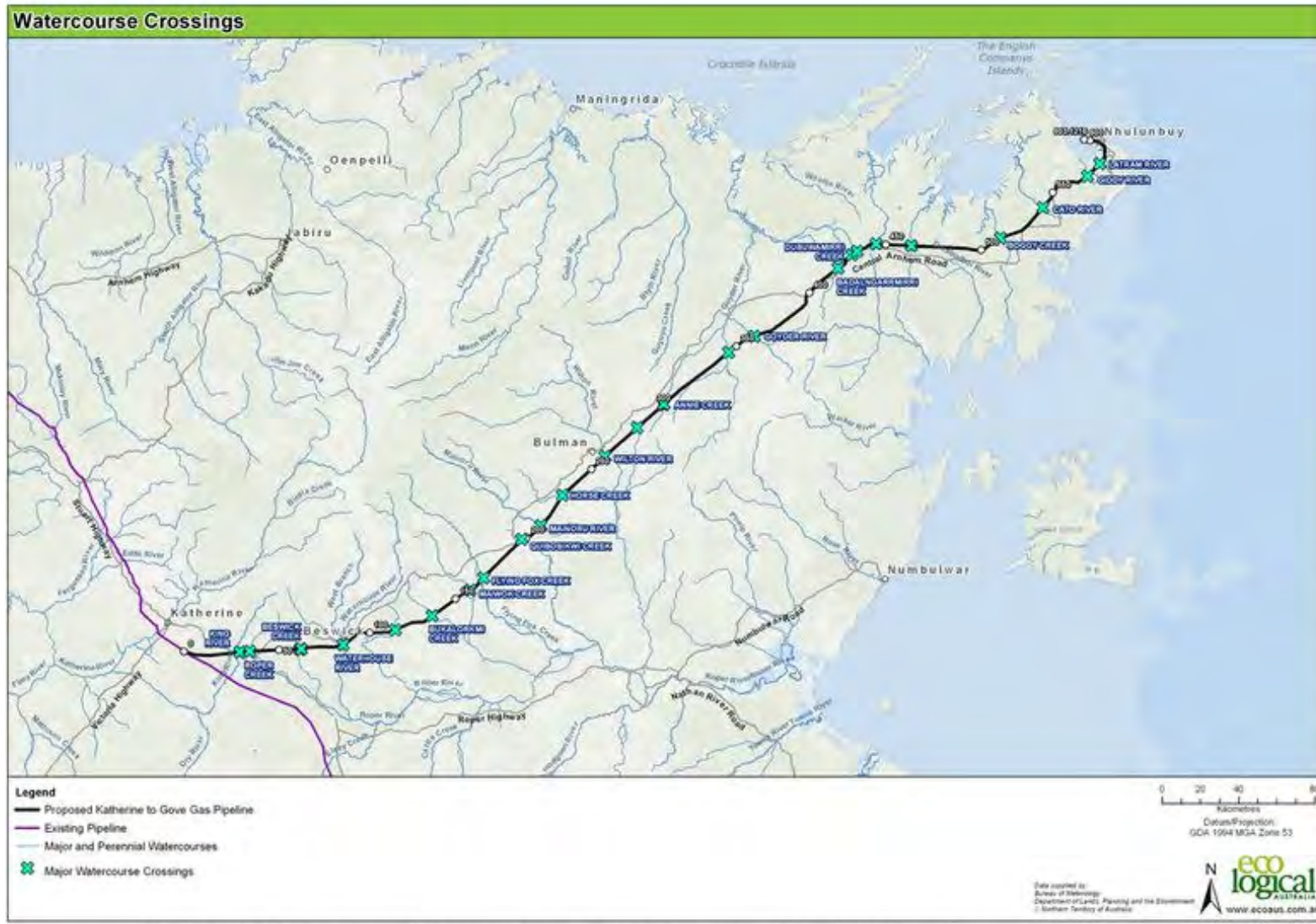


Figure 9-6: Proposed watercourse crossings

Table 9-6: Aquatic fauna listed as Threatened under the TWPC Act, and likelihood of occurrence

COMMON NAME	SPECIES NAME	CONSERVATION STATUS	HABITAT AND DISTRIBUTION	LIKELIHOOD OF OCCURRENCE
Mertens' Water Monitor	<i>Varanus mertensi</i>	Vulnerable	Small streams and creeks. Often found basking on rocks and branches near water.	Present Recorded in Mainoru River, Barmguerikba Creek and Wonga Creek (Appendix E).
Mitchell's Water Monitor	<i>Varanus mitchelli</i>	Vulnerable	Swamps, lagoons, inland rivers and other bodies of water. Often found on trees close to the water where it prefers to shelter in tree hollows and under bark.	Likely Suitable habitat present although not recorded during aquatic fauna surveys. Species is reportedly very shy, so is difficult to find.

Mertens' Water Monitor (*Varanus mertensi*) is classified as Vulnerable under the TPWC Act, and was recorded from the Mainoru River, Barmguerikba Creek and Wonga Creek during the 2003-2004 aquatic fauna survey (Appendix E). This species is a semi-aquatic monitor that occurs across most of the Top End and Gulf region where it is seldom seen far from water (Ward et al. 2006). The species has recently experienced a decline in population, largely due to the arrival and dispersal of Cane Toads (*Rhinella marina*) (Ward et al. 2006).

Mitchell's Water Monitor (*Varanus mitchelli*) is classified as Vulnerable under the TPWC Act. It is usually associated with swamps, lagoons and inland rivers, and is often found on trees close to the water where it prefers to shelter in tree hollows and under bark (Ward 2012). Although Mitchell's Water Monitor was not recorded during the 2003-2004 aquatic fauna survey, suitable habitat occurs along the pipeline. The main threatening process to this species is the presence of the Cane Toad (*Rhinella marina*) across the species' range in the NT.

Survey results

A total of 47 fish species, representing 23 families, were recorded during the 2003-2004 field survey. A further 31 species, from seven families, were identified from the desktop review. Overall a total of 78 species, comprising 30 families, are known from the aquatic systems that will be crossed by the proposed KGGP pipeline (Appendix E).

A number of fish species recorded during the aquatic fauna survey were far outside of their known habitat range, including:

- Four species recorded in the Cato River.
 - Aru Gudgeon (*Oxyeleotris aruensis*).
 - Concave Goby (*Glossogobius concavifrons*).
 - Munro's Goby (*Glossogobius munroi*).
 - Freshwater Whipray (*Himantura dalyensis*).
- One species in Dook Creek.
 - Exquisite Rainbowfish (*Melanotaenia exquisite*).
- One species in both the Goyder River and Rocky Bottom Creek
 - Butler's Grunter (*Syncomistes butleri*).

Many NT fish species are classified as Data Deficient (DD) because of the paucity of aquatic fauna surveys. Thirty-two DD fish species were identified during the surveys, and at least one DD species was present at all watercourses traversed by the pipeline corridor that were surveyed (except the seasonal Krabakuk Creek). These findings highlight the importance of taking a precautionary approach to the protection of aquatic environments from disturbance.

Five species of crustacean were recorded during the field surveys and are listed in Appendix E. None of the species recorded are listed under Territory or Commonwealth conservation legislation, and are therefore not considered further.

Eight species of amphibian were recorded during the survey and are listed in Appendix E. None of the amphibians recorded are specially protected under Territory or Commonwealth law, and are therefore not considered further.

Seven species of aquatic reptiles were identified during the field surveys including the Saltwater Crocodile (*Crocodylus porosus*) and the Threatened Mertens' Water Monitor (*Varanus mertensi*). The Saltwater Crocodile is listed as a migratory species under the Commonwealth EPBC Act and is discussed in detail Chapter 10 of this Draft EIS. Mertens' Water Monitor (*Varanus mertensi*) is listed as Vulnerable under TPWC Act and is discussed in the desktop review section above.

9.2.2 Potential impacts of construction and operation

The KGGP has the potential to directly impact aquatic fauna and their associated habitat through the disturbance of watercourses and in-stream habitat from clearing riparian vegetation, watercourse crossing construction, and degradation of existing water quality. These aspects may potentially result in a number of direct and indirect impacts including:

- Loss/degradation of threatened species habitat.
- Increased sedimentation and erosion.
- Restrictions to fish passage.
- Degradation of water quality including chemical contamination.
- Translocation of fish, pests and/or disease.
- Indirect impacts resulting from dust emissions, changes in fire regimes and introduced species.

9.2.3 Mitigation responses and assessment of potential impacts

An assessment of potential impacts and the mitigation response is summarised in Table 9-7.

Loss/degradation of aquatic fauna habitat

In-stream and riparian habitat present along the pipeline corridor could potentially be lost or impacted where watercourse crossings are constructed using open trench construction techniques. Riparian vegetation is vital to the functioning of aquatic ecosystems (Wager and Jackson 1993) and the removal or modification of such vegetation can result in increased erosion, sedimentation, scouring and changes to channel morphology.

The method used to lay the pipeline at each watercourse crossing would be dependent on environmental factors, geotechnical constraints and stakeholder views in regards to the significance of the watercourse. Horizontal Directional Drilling (HDD) and open-trenching are the preferred construction methods. HDD minimises surface disturbance and substantially reduces any potential impacts to aquatic habitats and riparian vegetation (see Section 2.6.5 for more detail). HDD would be used at any watercourse that is determined to be 'in flow' by the construction contractor at the time of

constructing the crossing, however nine watercourses have already been identified as potentially requiring HDD for ecological and engineering reasons (Chapter 2, Table 2-6 and Figure 9-7).

As identified in Appendix C there are however, 26 major watercourses in or near the proposed pipeline corridor. The total amount of riparian vegetation associated with these waterways and within the proposed corridor is 14 ha. Of this, at least six hectares will not be cleared as HDD crossing techniques would be employed (the nine crossings already identified). Hence the maximum amount of riparian vegetation associated with the 26 major watercourses identified in Appendix C that would possibly be cleared is eight hectares. It is, however, likely that much less than eight hectares will be cleared as all waterways identified as additional crossings where watercourses are 'in flow' when the pipeline is to be laid, will also be crossed using HDD.

Although Appendix C indicates that Beswick Creek would be crossed using HDD, subsequent review has suggested that this creek might not be in flow across the pipeline route when the crossing is to be done. Therefore, consistent with the project's overall approach regarding watercourse crossings, if Beswick Creek is not in flow, this watercourse will be crossed using open trenching.

Where open trenching is used, river bed and bank morphology would be reformed following completion of construction activities, and riverbanks and areas of riparian vegetation would be rehabilitated progressively and prior to the onset of the first wet season.

Increased sediment loading and erosion

The mobilisation of sediments into the waterway would occur during the construction of pipeline watercourse crossings where open trench construction techniques and where construction of watercourse crossings on access routes are proposed.

While perennial watercourses would be most at risk, erosion and sedimentation would be of concern at all watercourses if not adequately stabilised prior to the next wet season. Increased sediment loading could result in a variety of negative impacts on downstream aquatic habitats including infilling of holes and channels, and smothering of riffle areas (and associated invertebrate fauna), macrophytes and fish eggs deposited in gravel substrates or attached to underwater surfaces (Appendix E). Monsoonal rivers are harsh environments and many less resilient species may not adapt to, or survive, additional physiochemical changes during dry or low flow periods.

These impacts, however, would be avoided, because the use of HDD will avoid the removal of significant riparian vegetation at nine major watercourse crossings and will therefore greatly reduce the risk of erosion and increased sedimentation. At watercourse crossings where HDD is not proposed, construction activities will be restricted to the dry season when river beds are dry or subject to greatly reduced flows.

Rehabilitation of riverbanks and areas of significant riparian vegetation would be completed prior to onset of the first wet season following construction. This would further reduce potential impacts from erosion and increased sedimentation.

Barriers to fish passage

The potential for barriers to fish passage occurring within watercourses would be greatly minimised through construction activities associated with watercourses being undertaken in the dry season when many watercourses are dry, or flow regimes are greatly reduced.

For flowing watercourses, HDD would completely avoid disruption to the in-stream habitat, and would greatly avoid the formation of barriers. In addition, all in-stream structures would be temporary and removed as soon as practical after the works were completed.

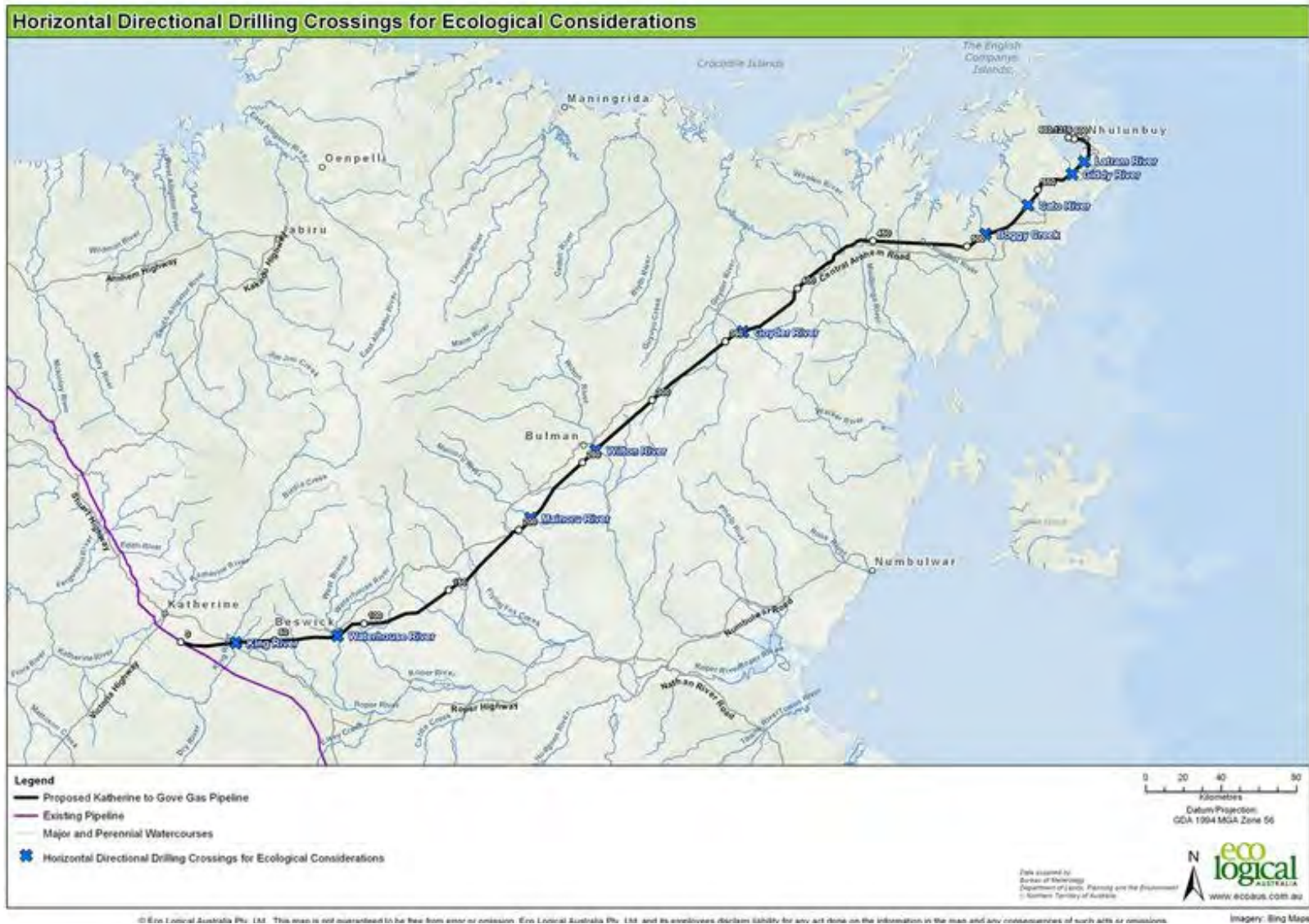


Figure 9-7: Horizontal directional drilling crossings for ecological considerations

Degradation of water quality (including chemical contamination) and over-extraction of water.

Degradation of water quality may occur through:

- Increased sedimentation.
- Chemical contamination.
- Spills and leaks.
- Inappropriate disposal of hydrotest water and wastewater, or
- Over-extraction of water.
- A decrease in water quality may cause changes to the composition and abundance of aquatic fauna species; death of aquatic fauna; a decline in the health of wetland ecosystems and other groundwater dependent ecosystems; and/or a reduction in the suitability of water for consumption by humans and animals.

Construction and maintenance works at watercourses would be confined to the dry season to reduce the potential for degradation of water quality. Baseline groundwater and surface water monitoring would be undertaken at selected environmentally sensitive sites prior to construction, and a Hydrology and Water Quality Management Plan in the EMP would be developed to ensure construction activities do not impact water quality to the extent that species that utilised aquatic habitats might be significantly impacted. This includes a commitment by the proponent that HDD would be used at any watercourse that is determined to be in flow by the construction contractor at the time of constructing the crossing.

Translocation of fish, pests and/or pathogens

Biological material, including pest species and pathogens, could potentially be transferred from one water body to another through inappropriate disposal of hydrotest water and use of machinery and equipment that might inadvertently be carrying fish, pest species or pathogens. If translocation of fish or other aquatic organisms were to occur, the range of adverse effects could include the introduction of diseased organisms; disturbance of ecosystems; loss of biogeographic information; and loss of genetic diversity (Wager and Jackson 1993).

As long as appropriate preventative measures (as described in the management sections below) are implemented, it is considered unlikely that pests and diseases will be translocated into watercourses by the planned construction activities.

Management measures to minimise the risk of translocation of species, pests and disease into watercourses include

- Not releasing water used for any purpose during construction, commissioning or operation into a water body.
- Disposing of hydrotest water by ground application in a stable environment following treatment to remove contaminants.
- Collecting and disposing of washdown wastewater in a manner approved by the regulatory authority.

Introduced species

The spread or introduction of weeds or feral animals may cause an increase in predation of, or competition with, native aquatic fauna and has the potential to cause long-term changes to aquatic habitats. The proliferation of weed species is associated with disturbance of riparian vegetation (Arthington *et al.* 1983), along with decreases in in-stream habitats associated with undercut banks, woody debris and leaves etc.

The Cane Toad (*Rhinella marina*) is the key feral fauna species known from the project area, with the potential to affect native fauna and their habitats. Cane Toads are widespread across the Top End, and their distribution is unlikely to be exacerbated by the KGGP.

Indirect impacts

Indirect impacts on aquatic fauna may arise from changes in fire regimes and dust emissions.

Higher fire frequencies or more intense fires may result in the loss or disturbance of aquatic fauna habitat through reductions in water quality by the input of ash and sediments into waterways; and/or the fragmentation of riparian habitats.

Dust emissions from construction activities could also potential result in degradation of surface water quality, e.g. excessive dust settling on remnant but critical drinking water holes for a range of fauna, including Gouldian Finches, whose distributions are limited by the availability of such waterholes toward the end of the dry season.

Measures to prevent or reduce the incidence of inadvertent ignition of fires, and to reduce generation of dust, have already been discussed above, including in Chapter 8: Vegetation. These measures are aimed at minimising the risk of impacting the health of aquatic environments and their associated flora and fauna communities.

Environmental Management Plans

All potential impacts on aquatic fauna and fauna habitats would be mitigated through the implementation of measures described in the following Provisional EMPs for the project (Appendix O):

- Terrestrial and Aquatic Fauna Management Plan.
- Terrestrial and Aquatic Fauna and Habitat Management Plan.
- Hydrology and Water Quality Management Plan.
- Erosion and Sedimentation Control Management Plan.
- Rehabilitation Management Plan.
- Vegetation Clearing Management Plan.
- Introduced and Exotic Species Management Plan.
- Fire Management Plan.
- Dust Management Plan.

Table 9-7: Potential impacts and mitigation outcomes for aquatic fauna

POTENTIAL IMPACT	PROPOSED MITIGATION (ACTION)		ANTICIPATED EFFECT OF MITIGATION
	AVOIDANCE	MINIMISATION	
Loss/degradation of aquatic fauna habitat	<ul style="list-style-type: none"> Crossing of watercourses deemed to be 'in flow' by the constructor at the time of construction will be by HDD 	<ul style="list-style-type: none"> The majority of construction will take place during the dry season Rehabilitation will be progressive Rehabilitation will occur prior to onset of wet season In-stream bed and banks will be restored to original condition after construction completion Removal of large trees on river banks will be avoided as much as possible 	<ul style="list-style-type: none"> Minor, short-term, temporary removal of potential aquatic species habitat No long-term or permanent detectable change to surface water hydrology or flow regimes (including no loss or reduction of number and/or volume of dry season remnant pools)
Increased sedimentation and erosion	<ul style="list-style-type: none"> Crossing of watercourses deemed to be 'in flow' by the constructor at the time of construction will be by HDD 	<ul style="list-style-type: none"> Rehabilitation will be accordance with the Soils and Landforms Management Plan and Rehabilitation Plan. The majority of construction will take place during the dry season Water crossings to use HDD, sediment controls and/or be constructed to minimise erosion Progressive vegetation clearing and rehabilitation to minimise period of bare soil exposed to erosion 	<ul style="list-style-type: none"> The risk of soil erosion and sedimentation is minimised and effective management measures are applied to control erosion and sedimentation if detected
Barriers to fish passage	<ul style="list-style-type: none"> Crossing of watercourses deemed to be 'in flow' by the constructor at the time of construction will be by HDD Construction associated with watercourses will occur during the dry season 	<ul style="list-style-type: none"> All temporary in-stream structures would be removed as soon as practicable after works are complete and the bed reinstated to pre-construction form Rehabilitation of vegetation will occur progressively and prior to onset of wet season Crossing design will be in accordance with appropriate NT Government standards 	<ul style="list-style-type: none"> No barriers to fish movement will be present in watercourses as a result of watercourse-crossing construction
Degradation of water quality	<ul style="list-style-type: none"> Fuel and chemical storage will be above ground and will be located an appropriate distance from surface water resources 	<ul style="list-style-type: none"> Fuel and chemical storage, handling and distribution systems will be designed and constructed in accordance with Australian Standards, and will be fitted with leak detection systems Appropriate training will be provided, as well as strategic placement of spill kits and environmentally sound treatment and disposal of resulting waste 	<ul style="list-style-type: none"> No substantial or long-term degradation of existing surface water quality Minimised risk of accidental spills and effective management measures are deployed in the event of a spill

POTENTIAL IMPACT	PROPOSED MITIGATION (ACTION)		ANTICIPATED EFFECT OF MITIGATION
	AVOIDANCE	MINIMISATION	
Translocation of fish, pests and disease	<ul style="list-style-type: none"> Crossing of watercourses deemed to be 'in flow' by the constructor at the time of construction will be by HDD 	<ul style="list-style-type: none"> No surface water will be extracted and released into a different catchment unless a thorough risk assessment has been undertaken Plant, vehicles, equipment and materials will be required to be washed/blown down (at specially-prepared sites for these actions) to remove weeds and pests prior to being brought into the project area 	<ul style="list-style-type: none"> No translocation of fish, pests, disease and other aquatic organisms
Introduced species - feral animals		<ul style="list-style-type: none"> Systems will be established for reporting feral animal sightings Domestic animals will not be permitted in the project area 	<ul style="list-style-type: none"> No Cane Toads transported in construction vehicles and equipment. Spread of feral animals into pipeline ROW kept to a minimum
Introduced species - aquatic weeds	<ul style="list-style-type: none"> Access to areas of sensitive vegetation communities and habitats will be prohibited 	<ul style="list-style-type: none"> Plant, vehicles, equipment and materials will be required to be washed/blown down (at specially-prepared sites for these actions) to remove weeds and pests prior to being brought into the project area. Systems will be established for reporting of new weed infestations Wastewater collected and treated prior to disposal or transport offsite 	<ul style="list-style-type: none"> Aquatic weeds will not be introduced or spread into the project area or between catchments in the project area
Indirect impacts - Fire regimes and dust emissions		<ul style="list-style-type: none"> Fire breaks will be maintained around above ground ancillary infrastructure A fire response unit with trained fire fighters will be readily available at all locations during construction 	<ul style="list-style-type: none"> Fire is minimised to the greatest extent possible The potential impact of fire on the surrounding environment is minimised

9.2.4 Summary – predicted environmental outcome

After mitigation is applied, construction and operation of the KGGP is expected to result in the following outcomes in relation to aquatic fauna and associated habitats:

- Temporary, short-term loss or disturbance to a maximum of 7.96 ha of significant riparian vegetation which represents a very small proportion of the riparian vegetation found across the region.
- Progressive rehabilitation completed prior to the onset of the first wet season following construction completion.
- Minor local habitat modification and/or lifecycle disruption for aquatic fauna.
- No barriers to fish passage within watercourses traversed by the pipeline.
- No substantial or long-term degradation of existing surface water quality
- No translocation of pests and/or diseases.
- No spread of weeds, or introduction of feral animals into the pipeline ROW.
- In-stream habitat restored to original condition prior to onset of following wet season.

Potential impacts on aquatic fauna and their associated habitats are expected to be negligible to low.