Chapter 4

Existing Environmental Overview

PACIFIC ALUMINIUM

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4 Existing Environment Overview

This Chapter summarises the important physical, ecological and social aspects of the pipeline region. More detailed descriptions of the local environment and survey results are provided in the relevant chapters on impacts (Part B, Chapters 6-16).

4.1 PHYSICAL ENVIRONMENT SETTING

4.1.1 Climate

The KGGP project is located in the northern-most part of the Northern Territory. This Top End region typically experiences a mean annual rainfall of 600 mm to 1,500 mm across the region, temperature ranges of 13° C to 30° C during the cooler months, and between 25° C to 40° C during the hotter months.

Rainfall in the Top End is distinctly seasonal. The 'dry season' typically occurs during May to September where the temperatures remain warm to hot during the day, accompanied by relatively low humidity and strong south-easterly winds. The wet season encompasses an early transition and later monsoon period and occurs from October to April. Humidity increases during the transition from the dry season to the wet season, with November and early December generally being the hottest months. Winds are mainly light and humidity remains high in coastal areas throughout the day. Tropical cyclones and extreme rainfall events occur across the region, particularly in coastal areas.

The climate across the region traversed by the KGGP is typical of the Top End. There is a general increase in rainfall from the west to the east along the pipeline route. Mean annual rainfall at Tindal (15 km south-east of Katherine) is 1,081 mm with January the wettest month (267 mm). At the other end of the KGGP route, the climate is reflective of coastal tropical conditions. Nhulunbuy has a mean annual rainfall of 1,471 mm with February the wettest month (283 mm) (BoM 2012). The wet season at the eastern (Gove) end of the pipeline typically commences four to six weeks later than the other regions and the transition period to the Dry season is extended, with regular shower activity persisting until June or later. Potential evaporation is approximately 2,200 to 2,500 mm/year over the region and is significantly greater than annual rainfall.

Temperatures across the region traversed by the KGGP follow the seasonal patterns of the wet and dry seasons. June is the coolest month at Tindal with a mean maximum of 29.7^{o} C and a mean minimum of 14^{o} C. July is the coolest month in Nhulunbuy with a mean maximum of 27.7^{o} C and mean minimum of 20.2^{o} C (BoM 2012).

4.1.2 Topography

Aside from the presence of some disconnected ranges, the pipeline region is relatively flat. The KGGP would traverse the eastern part of the Top End, which features the sandstone escarpment and plateau of Western Arnhem (Figure 4-1). The plateau is a distinct topographical feature, rising to approximately 400–450 m in elevation from the Gulf of Carpentaria. Other topographical features of the eastern Top End region include the High Black Range to the east of Katherine along the south-western portion of the pipeline route, and the Mitchell Ranges located to the south-west of Gove along the north-eastern portion of the pipeline route. The topography of the Top End in relation to the KGGP is described in more detail in Section 6.1.1.

4.1.3 Geology

The Northern Territory is divided into a series of geological regions which are defined based on structural and stratigraphic evolution and deformation together with characteristic mineralisation styles (NTG 2013). The geology of the region traversed by the KGGP is variable and comprises rock dated between the Mesozoic and Proterozoic eras (see Section 6.1.2 for more detail). Extensive surficial deposits overlay sedimentary and metamorphic rocks, locally incised by intrusive igneous rock. The geological regions traversed by the KGGP are:

- Daly Basin – sedimentary and volcanic comprising limestone, dolostone, sandstone, siltstone.
- Carpentaria Basin – sedimentary comprising sandstone, mudstone, limestone.
- McArthur Basin – sedimentary and minor volcanic comprising dolostone, sandstone, shale, felsic and mafic volcanic rocks, minor microgranite.
- Arnhem Province – sedimentary, metamorphic, igneous and volcanic comprising dolostone-greywacke, shale, granulite, amphibolite, felsic volcanic rock and granite.

Karst formations

The term 'karst' is used to describe terrain where the bedrock is usually composed of limestone or dolomite (carbonate rocks) and has been, or has the potential to be, easily dissolved by water. Karst topography is characterised by sinkholes, caves, springs, and streams which disappear underground though well-developed subsurface drainage.

The proposed pipeline route commences and extends east across a karst landscape formed by the weathering/dissolution of soluble carbonate rocks such as limestone and dolomite of the Daly River Group. The Daly River group comprises Oolloo Dolostone over the Jinduckin Formation which in turn gives way to the Tindall Limestone. The latter is a highly soluble rock exposed or close to surface within the Katherine area and is known to possess a thickness of up to 709 m. The occurrence of karst landforms in the vicinity of the pipeline route is discussed in more detail in Section 6.1.2.

4.1.4 Land systems and soils

Landscape classes (associations of land systems) provide the most concise descriptions of land attributes for the purpose of this Draft EIS. A variety of landscape classes are represented in the pipeline region and include alluvial floodplains, coastal sandplains, low hills and rocky outcrops and plateaux and scarps. Steep rocky plateaux and hills intersect the landscape where ranges occur and closer to the coast, seasonally flooded coastal floodplains and tidal mudflats dominate the landscape.

The dominant soils of the eastern portion of the project area, near Katherine, comprise ironstone gravels with sands and neutral red earths and with acidic yellow earths. In the central portion, near Bulman, soils are mainly shallow stony sands and yellow earthy sands. Approaching the Gove region, narrow stream valleys become more common, containing ironstone gravels in a red earth matrix together with red earths and yellow earths. Saline clays dominate on flats near the coast, where shallow gritty sands and sandy loams are also common.

Land systems and soils in the pipeline region are described in more detail in Section 6.1.3.

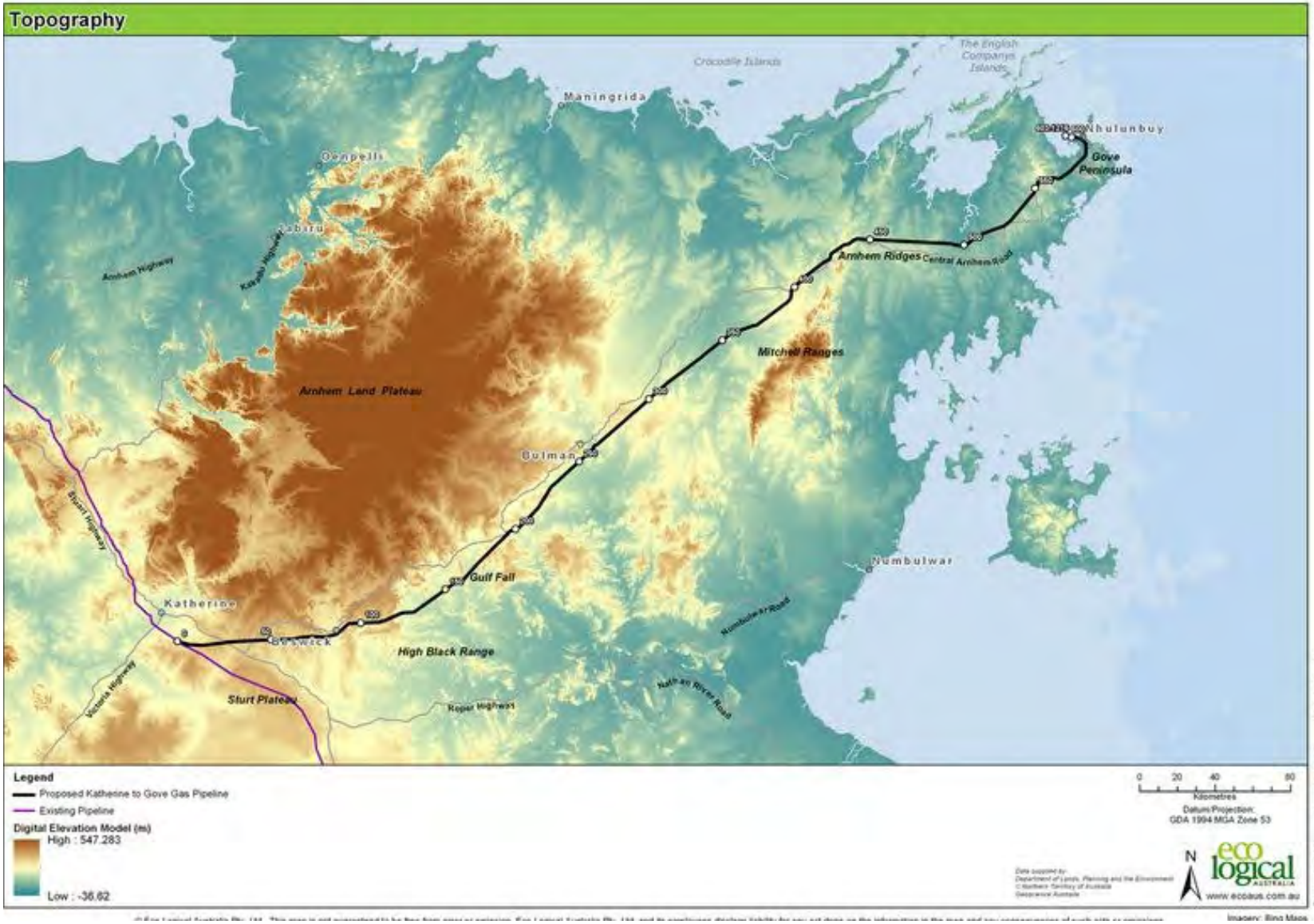

Figure 4-1: Topography

Acid sulphate soils

Acid Sulphate Soils commonly occur in coastal marine environments such as estuarine systems, mangrove swamps and backswamps. They occur less commonly inland, but have been documented to form in waterlogged (anaerobic) and / or drained fresh water conditions where there has been a build-up of sulphidic material, e.g. rivers and stream channels, lakes, wetlands, billabongs, groundwater systems (Fitzpatrick and Shand, 2008). Where these sulphidic materials remain submerged there is little chance of oxidation; however when these materials are disturbed and exposed (for example, during pipeline construction), the sulphides, namely pyrite (FeS_2), react with oxygen to form sulphuric acid (H_2SO_4). If these sulphuric materials are subsequently covered with water, significant amounts of acidity and heavy metals can be released into the water (Fitzpatrick and Shand, 2008).

A detailed desktop review undertaken to ascertain the potential occurrence of ASS in the project area determined that the pipeline ROW intersects the Effington land system which may include potential ASS environments. This assessment was limited by the scale of mapping used to determine potential ASS environments, however, and further field-based assessment is required to confirm areas of potential ASS. (See Section 6.1.3 for further discussion of ASS).

Seismicity

Earthquakes have occurred in the NT in areas including Tennant Creek (approximately 670 km south of Katherine) and the Simpson Desert (approximately 1,500 km south of the project area). In 1991 these two locations, together with Tobin Lake in WA (approximately 1,600 km south-west of the project area), were identified as areas of high earthquake activity. Recorded activity in the Tennant Creek region began in 1987 and seismicity at this location has remained above average. Earthquakes have been recorded in the Simpson Desert since 1937, including a magnitude 6.2 event recorded in 1972 (UWA 2004). The Tobin Lake area has recorded seismic activity since 1970.

4.1.5 Surface water resources

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.

Surface runoff is generally limited to the wet summer monsoon season (December to March), with most watercourses ceasing to flow during late winter and spring. Only the larger rivers are 'permanent' streams, with dry season flow being baseflow supplied from groundwater. Records indicate that 70-85% of the annual runoff of the coastal rivers occurs over the December to April period, while approximately 95% of the annual runoff of the inland rivers occurs over the same period.

There are many wetlands in the region including permanent swamps, most notably the Arafura Swamp in Central Arnhem Land (which lies over 20 km north of the project area) as well as seasonally inundated floodplains, permanent and semi-permanent freshwater lake systems and ephemeral saline lakes. These wetlands are discussed in more detail in Section 4.2.3.

4.1.6 Groundwater resources

Compared to other states, the NT has a much higher reliance on groundwater resources with groundwater accounting for 90% of all of NT water supplies (DLRM 2013a). Currently, groundwater extraction is concentrated in the Daly Basin where water use is principally associated with agriculture and residential development.

The KGGP traverses shallow, high-yielding aquifers that have high resource value and environmental beneficial uses that would be sensitive to development impacts. Relatively minor groundwater extraction occurs in the Roper, Goyder and Buckingham river basins for small community supplies. Groundwater features at Cutta Cutta Caves and Mataranka are down-gradient from the project area and are important for tourism (Appendix B).

Groundwater resources related to the KGGP project area are described in more detail in Chapter 7.

4.2 BIOLOGICAL ENVIRONMENT SETTING

4.2.1 Bioregions

The Interim Biogeographic Regionalisation of Australia (IBRA) (DSEWPaC 2012) identifies the bioregions that cover the Northern Territory (Figure 4-2). The bioregions delineate areas that have a common set of ecological attributes, and provide a framework for characterising the diversity of ecological environments.

There are four bioregions identified within the pipeline region. Approximately 11% of the pipeline route passes through the Daly Basin bioregion, 27% through the Gulf Fall and Uplands, 36% through the Central Arnhem bioregion, and 26% through the Arnhem Coast bioregion (Figure 4-2). Woinarski (2002) assessed and documented the ecological attributes that characterise these bioregions.

The Daly Basin bioregion comprises gently undulating plains and scattered low plateau remnants on Palaeozoic sandstones, siltstones and limestones; and neutral loamy and sandy red earths. The most extensive vegetation type is open forest dominated by Darwin Stringybark (*Eucalyptus tetrodonta*) and Darwin Woolybutt (*E.miniata*) with perennial and annual grass understory. The Daly Basin includes no subregions. This bioregion comprises much of the catchment of the Daly River.

The Gulf Falls and Uplands bioregions comprises undulating terrain with scattered low, steep hills on Proterozoic and Palaeozoic sedimentary rocks, often overlain by lateritised Tertiary material. Soils are mostly skeletal or shallow sands. The most extensive vegetation is woodland dominated by Darwin Stringybark (*Eucalyptus tetrodonta*) and Variable-barked Bloodwood (*Corymbia dichromophloia*) with spinifex understorey, and woodland dominated by Northern Box (*E. tectifica*) with tussock grass understorey.

The Central Arnhem bioregion comprises gently sloping terrain and low hills on Cretaceous sandstones and siltstones and lateritised Tertiary material; yellow earthy sands and shallow stony sands. The dominant vegetation is Darwin Woolybutt (*Eucalyptus miniata*) and Darwin Stringybark (*E. tetrodonta*) open forests and woodlands with a dense grass understorey. Almost all of the bioregion is Aboriginal land.

The Arnhem Coast bioregion comprises a coastal strip extending from just east of Cobourg Peninsula to just north of the mouth of the Rose River in south-eastern Arnhem Land, and including many offshore islands. Coastal vegetation includes well developed heathlands, mangroves and saline flats, with some floodplain and wetland areas, most notably the extensive paperbark forest and sedgelands of the Arafura Swamp. Coastal dune systems are unusually well developed on sections of Groote Eylandt and Cape Arnhem Peninsula. Tertiary laterites are extensive on the Gove Peninsula. Inland from the coast, the dominant vegetation type is eucalypt tall open forest, typically dominated by Darwin Woolybutt (*Eucalyptus miniata*) and Darwin Stringybark (*E. tetrodonta*), with smaller areas of monsoon rainforest and eucalypt woodlands.

Woinarksi (2002) noted that the overall condition of each of these four bioregions was generally good, but flagged increasing development in the Daly bioregion and broad-scale changes in fire regime and rising numbers of weeds and feral animals in the remaining three bioregions as significant threats.

4.2.2 Vegetation

In the classification of Australian tropical savannas by Fox et al. (2001), vegetation in the pipeline region is characterised in 12 units within eight broad vegetation groups (BVGs) (See Table 8-1). Fox et al.'s original descriptions included a 'monsoon' preface on many of these groups to differentiate these communities from those occurring in the eastern sub-humid zone of the tropical savannas; however, this has been removed for the purposes of this Draft EIS. These BVGs are therefore defined as:

- Woodlands and open woodlands dominated by *Eucalyptus tetrodonta* and *E. Miniata.*
- Open forests and woodlands dominated by *Eucalyptus* spp. and *Corymbia* spp. on drainage lines and alluvial plains.
- Woodlands dominated by *E. tectifica* and *Corymbia* spp.
- Low woodlands to open woodlands dominated by *C. Dichromophloia.*
- Woodlands dominated by *E. pruinosa* and *Bauhinia cunninghamii.*
- *Acacia shirleyi* and *Acacia* spp. associations on dissected residual surfaces and sandstone hills.
- Tussock grasslands.
- Open forests and woodlands of *Melaleuca* spp. associated with rivers, lagoons and swamps.

Geographically restricted vegetation communities including riparian corridors, wetlands (swamps and floodplains), monsoon vine forests and sandstone communities occur within the dominant *Eucalyptus*/*Corymbia* woodland matrix but are not accurately represented in the vegetation classification prepared by Fox et al. (2001). These communities are potentially of high conservation value and are discussed further in Chapter 9.

Threatened flora and species of conservation significance are discussed in Chapter 8.

Weed distribution in the pipeline region is generally related to environmental disturbances caused by the construction of roads and tracks, cattle grazing and feral animals. Weeds tend to be most prevalent on land under pastoral lease, and on the freehold properties in the Katherine region. In these areas infestations are generally concentrated around infrastructure such as water points, fence lines and tracks, and also along the banks of watercourses where cattle and feral animals tend to congregate. Weeds of National Significance (WONS) in the region include Prickly Acacia (*Acacia nilotica*), Parkinsonia (*Parkinsonia aculeata*), Gamba Grass (*Andropogon gayanus*), Olive hymenachne (*Hymenachne amplexicaulis*), Bellyache bush (*Jatropha gossypifolia*) and Mimosa (*Mimosa pigra*). Refer to Chapter 8 for a full list and discussion of declared weeds and WONS within the project area.

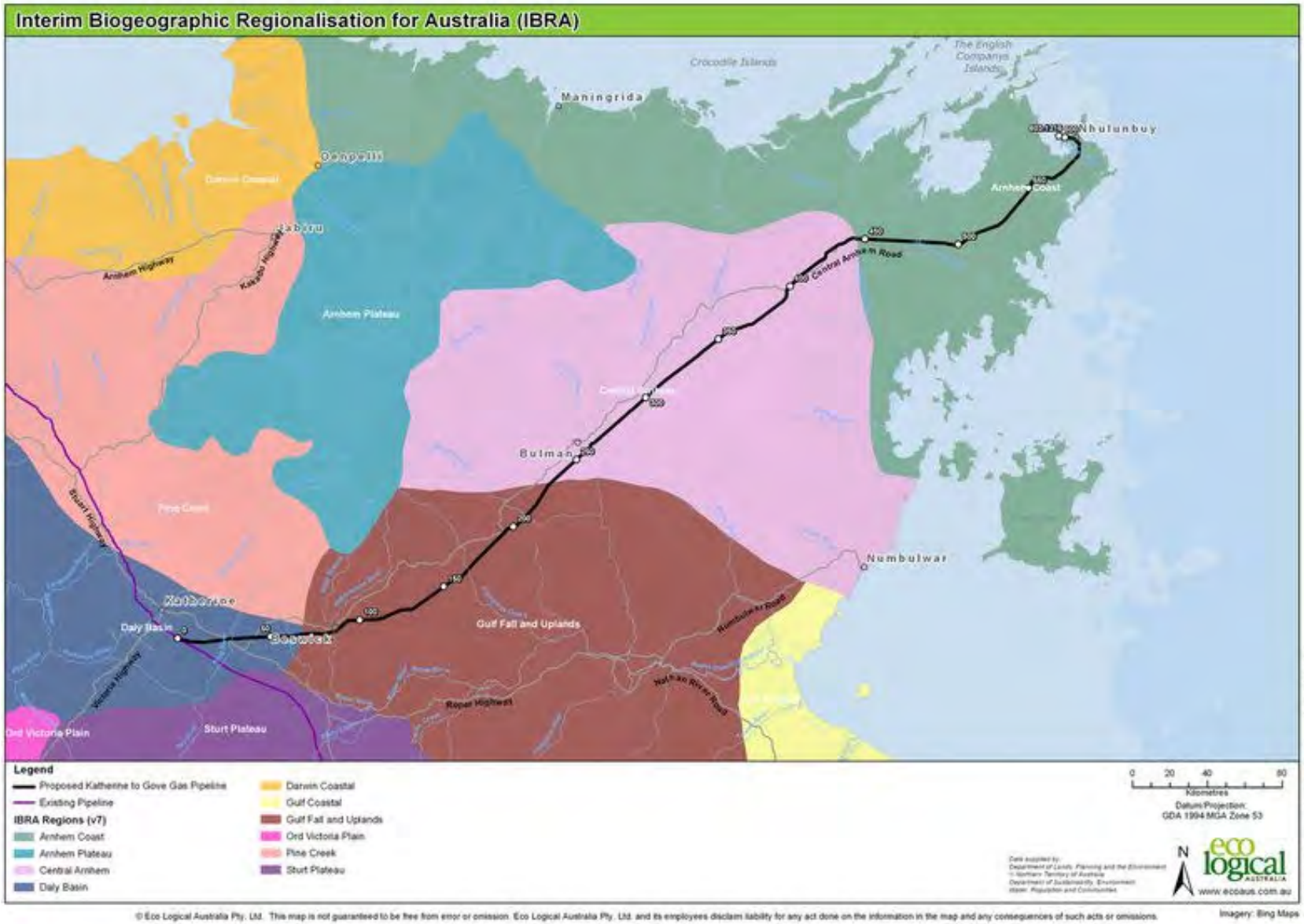

Figure 4-2: Interim Biogeographic Regionalisation for Australia (IBRA)

4.2.3 Ecologically sensitive habitats

Terrestrial and aquatic habitats with high conservation value and which are ecologically sensitive that occur within the pipeline region include:

- Riparian corridors.
- Monsoon rainforest patches.
- Sandstone communities.
- Wetlands.
- Aquatic habitats.
- Habitats of threatened species.

These habitats 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.

Each of these ecologically sensitive habitats is briefly discussed below.

Riparian corridors

The project region comprises a number of major permanent watercourses, smaller perennial watercourses, and seasonal watercourses, many of which support distinct riparian vegetation communities. Riparian communities in the region are typically characterised by *Melaleuca* spp. with other riparian tree species including *Lophostemon lactifluus*, *Barringtonia acutangula*, *Terminalia platyphylla*, *Casuarina cunninghamiana*, *Eucalyptus camaldulensis* and *Nauclea orientalis.* These riparian vegetation communities play an important ecological and hydrological role in maintaining the ecological functions of waterways and associated wetland environments. Riparian vegetation also 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). 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).

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 assemblages that warrant conservation measures (Woinarski 2004). Monsoon rainforest in the project region is the primary habitat of the Vulnerable flora species *Pternandra coerulescens* (listed under the TPWC Act) and the Endangered Gove Crow Butterfly (*Euploea alcathoe enastri*) (listed under the EPBC Act).

Sandstone communities

Rugged sandstone terrain often supports vegetation communities and species that typically do not occur elsewhere. Heath vegetation is a community that is restricted in distribution to the rugged sandstone terrain of north and north-west Australia (Keith et al. 2002) and is becoming more restricted due to high susceptibility to the frequent and intense fire regimes that dominate northern Australia (Yates et al. 2000). The rugged terrain provides topographical protection from fire and therefore can support communities and plant species that typically do not occur in habitats that experience more frequent exposure to fire.

These communities include the EPBC Act listed Arnhem Plateau Sandstone Shrubland Complex threatened ecological community, which was not found in the pipeline corridor during 2003/04 field

surveys (Chapter 8, Appendix C) or a 2012 aerial survey (Chapter 9, Appendix D). Details on the Arnhem Plateau Sandstone Shrubland Complex impact assessment are provided in Chapter 10, along with other Commonwealth Matters of National Environmental Significance.

Wetlands

Extensive and highly productive coastal floodplain wetlands are characteristic of the near coastal environments in the Northern Territory. Scattered isolated billabongs and seasonally inundated swamps that are floristically similar to the coastal floodplains also occur as far inland as Lake Woods (Cowie et al. 2000). 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 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 they are recognised as significant habitats for fauna (Whitehead and Chatto 1996).

The pipeline corridor lies over 20 km to the south of the nationally significant Arafura Swamp and is in the vicinity of nine regionally significant wetlands including permanent lagoons and springs, seasonally inundated and permanent swamps and semi-permanent waterholes. Of these regionally significant wetlands, one semi-permanent swamp, and two seasonally inundated swamps will be traversed by the pipeline corridor.

Arafura Swamp is one of the largest wooded swamps in the NT (DSEWPaC 2013d), 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). It is also a significant breeding area for the Magpie Goose (*Anseranus semipalmata*), Saltwater Crocodile (*Crocodylus porosus*) and Freshwater Crocodile (*Crocodylus johnstonii*).

Aquatic habitats

Perennial lagoons are crucial habitats for some species of fish, as they typically support aquatic vegetation as well as providing important refuges in dry seasons and breeding grounds prior to floods (Herbert et al. 1995). Lagoons are crucial as refuges in the middle and upper reaches of waterways. Perennial waterbodies are present throughout the pipeline region such as the Cato River, Giddy River, Goromuru River and Habgood River.

Threatened species habitats

Habitats of threatened flora and fauna species occur within the project region. Examples may include the following species and their habitats:

- Threatened plant species *Pternandra coerulescens*—occurs within rainforest patches and riparian corridors.
- Threatened bird species Gouldian Finch (*Erythrura gouldiae*)—can be found within *Eucalyptus tintinnans* woodlands on rocky hills.
- Threatened butterfly species Gove Crow Butterfly (*Euploea alcathoe enastri*)—found in the transitional patches between evergreen monsoon vine-forest and eucalypt/paperbark woodland.

4.2.4 Terrestrial fauna and habitats

Terrestrial fauna habitats that are considered significant occur in the project area and have been described in Section 4.2.3. Significant terrestrial fauna habitats are those which provide niche environments for fauna species requiring specific habitat attributes and generally have a restricted geographic distribution in the Top End. Such habitats are therefore assigned a high conservation value and are sensitive to disturbance.

Woinarski (2002) assessed and documented the ecological attributes that characterise these bioregions through which the pipeline route passes. Approximately 11% of the pipeline route passes through the Daly Basin bioregion which comprises much of the catchment of the Daly River, one of the largest river systems in northern Australia and which hosts a rich diversity of freshwater turtle species. Approximately 27% of the pipeline route passes through the Gulf Fall and Uplands bioregion, comprising ranges which Woinarski (2002) identified as important refugial areas and including some endemic or near-endemic species. The Central Arnhem bioregion contains large areas of relatively intact ecosystems and includes part of the nationally significant Arafura Swamp and small coastal areas which provide breeding sites for threatened marine turtles. Approximately 36% of the pipeline route passes through this bioregion. The Arnhem Coast bioregion also hosts important breeding sites for marine turtles and colonial seabirds, habitat for migratory shorebirds and important off-shore refugia. Approximately 26% of the pipeline route passes through this bioregion.

A search of the DSEWPaC Protected Matters database identified that 35 terrestrial species listed under the EPBC Act are known to occur in the broader region of the project area. Twenty of these species are listed as threatened and 18 are listed as migratory species under the EPBC Act. Seventeen species are listed as threatened under the NT TPWC Act. These species are discussed further in Chapters 9 and 10 and Appendix D**.**

Terrestrial fauna and habitats in the region surrounding the project area are subject to a number of threatening processes including the impact of a variety of invasive fauna species.

Threatening processes

The KGGP traverses a region which is subject to a number of threatening processes that operate at a landscape scale to impact on local environmental values. Some of these threatening processes have been formally recognised nationally under the EPBC Act including:

- Invasion of northern Australia by Gamba Grass (*Andropogon Gayanus*) and other introduced grasses.
- The biological effects, including lethal toxic ingestion, caused by Cane Toads (*Rhinella marina*).
- Predation, habitat degradation, competition and disease transmission by feral pigs.
- Land clearance.
- Predation by feral cats.

Cane toads have spread across the Top End of the Northern Territory and across the entire KGGP route.

Fire is major influence across the region and a high proportion of the tropical savannas are burnt each year. Studies at Kapalga (in Kakadu National Park to the north of the KGGP route) indicate that key components of the savannah biota favour habitat that has remained unburnt for at least several years (Andersen et al. 2005). Invasive grasses such as Gamba Grass increase fuel loads compared to

native grass species, producing more intense, late dry season fires that burn into the forest crown (Setterfield et al. 2010).

A marked decline in small native mammals in the Top End and across broader northern Australia has become increasingly apparent in recent years, most likely in response to a combination of threatening processes. Marked declines have been recorded for the Northern Quoll (*Dasyurus hallucatus*), Fawn Antechinus (*Antechinus bellus*), Northern Brown Bandicoot (*Isoodon macrourus*), Common Brushtail Possum (*Trichosurus vulpecular*) and Pale Field Rat (*Rattus tunneyi*). The most plausible causes are too frequent fire, predation by feral cats, and invasion by cane toads (particularly affecting the Northern Quoll) (Woinarski et al. 2010). To a lesser extent, impacts to vegetation associated with the pastoral industry and potentially disease are factors (Fitzsimons et al. 2010).

The small mammal declines experienced across the region have been reflected in the recent reclassification of the conservation status of the wildlife, by the Northern Territory Government. Previously widespread and abundant species such as the Common Brushtail Possum (*Trichosurus vulpecular)* and Northern Brown Bandicoot (*Isoodon macrourus*) have been reclassified to near threatened.

The pattern of declines appears widespread across northern Australia (Ziembicki et al. 2013) and the role of predation by cats is the subject of an active research program at Wongalara Sanctuary, immediately to the south of the KGGP route (UTAS 2013).

It is probable that the presence and abundance of small mammals in the region traversed by the proposed KGGP will have been affected by the declines observed across Northern Australia.

Invasive animal species

Invasive animal species play a role in many of the threatening processes outlined above. Those present in the pipeline region include:

- Black rat (*Rattus rattus*).
- Cat (*Felis catus*).
- Cane Toad (*Rhinella marina*).
- Cattle (*Bos taurus*).
- Donkey (*Uquus asinus*).
- Horse (*Equus caballus*).
- House mouse (*Mus musculus*).
- Pig (*Sus scrofa*).
- Swamp Buffalo (*Bubalus bubalis*).
- Yellow Crazy Ant (*Anoplolepis gracilipes*).

The majority of these species are widely dispersed throughout the pipeline region, while species such as the Yellow Crazy Ant occupy very specific habitats around the north-eastern extent of the pipeline corridor. Most of the species are subject to little specific control activity due to remoteness and limited resourcing although indigenous ranger groups in the regions participate in management activities where resources permit.

4.2.5 Aquatic fauna and habitats

The biological and physical nature of north Australia's tropical river systems is underpinned by flow regimes resulting from the extreme seasonal contrast between the wet and dry. Jardine et al. (2011) describe the seasonal patterns of flow and the role that each of these plays in shaping the aquatic systems of the wet-dry tropics. Strong wet season flow physically shapes river channels and floodplains, transports nutrients and sediments, and provides opportunities for new plant growth and the movement and spawning of fish, crustaceans and waterbirds. As floodwaters recede and floodplains drain, flow becomes disconnected in ephemeral rivers, plant growth is at its peak and aquatic fauna seeks refuge in increasingly disconnected waterholes which become critically important for sustaining life over the dry. Those few systems which retain flow throughout the year (such as the Daly and Roper Rivers) support a different suite of species which are reliant on that continuing flow. The transition from the dry to the wet season is then characterised by periodic 'first flush' flows which push organic matter, sediments and generally poor quality water from the landscape into river systems and estuaries. Increasing flows eventually enables the movement of fauna across the landscape.

Research has shown the importance of connectivity between tropical rivers, floodplains and estuaries and the significant differences in nutrient levels and food webs in northern Australian river systems, as compared to those in temperate environments. Nutrient levels are low across much of terrestrial and aquatic landscapes of northern Australia, while tropical food webs depend more on in-stream carbon food sources than those of southern Australian systems, which are more heavily reliant on inputs from riparian vegetation (Jardine et al 2011).

Aquatic invertebrates play an important role in tropical aquatic food webs and despite significant research progress in the Alligator Rivers region in recent decades, the ecology of relatively common and abundant species remains poorly known (Garcia et al 2011).

Pusey et al (2011) note that the fish of northern Australia are a 'highly distinctive subset of the Australian fish fauna' and that a total of 176 species of bony fish and six species of elasmobranch (sharks and rays) have been recorded in the freshwaters of northern Australia (p. 73). Critically, many of these species occupy more than one habitat over their life cycle and more than half of these species require access to estuarine or marine waters. In occupying 17% of the continental area, northern Australia hosts over half of Australia's freshwater fish species (Pusey et al. 2011). Modelling has also determined that the river basins of north Australia host an average of approximately 36 fish species/basin, with larger basins hosting larger numbers of species. Basins with high species richness were also found to be characterised by perennial steam flows (Kennard 2010a,b in Pusey et al 2011).

The values of aquatic environments, including aquatic fauna, relating to the KGGP project are described in more detail in Chapter 9.

Threatening processes

In an assessment of high conservation value aquatic ecosystems across northern Australia Kennard et al. (2011) identified a range of key threats including:

- Overgrazing by cattle leading to increased runoff, erosion and stream bank degradation.
- Increasing occurrence of feral animals and weeds.
- Nutrients from agricultural fertilisers or sewerage effluent.
- Agricultural pesticides and herbicides.
- Increasing sediments and pollutants from mining and extraction industries.
- Groundwater extraction for irrigation and domestic/urban use.

- Increasing development of physical infrastructure such as dams, weirs, barrages and road crossings.
- Changing natural flows causing barriers to animal movements and increasing weed incursions.
- Over-fishing and tourism activities.
- Climate change.

4.2.6 Biting insects

The pipeline region includes a variety of habitats including seasonally flooded waterways and swamps, which are potential sources of mosquitoes and biting midges. Biting midges can be considerable pests within a few kilometres of the coast or large tidal rivers in the NT (Whelan 1991). These pests can cause direct effects to a workforce due to their painful bites, and indirect effects due to secondary infection and loss of a sense of well-being. Minor biting midge pest problems can also occur in inland areas, particularly near freshwater lakes and streams.

Mosquitoes are a serious potential public health issue in the NT, both as pest insects and as vectors of a number of human diseases including the potentially fatal Murray Valley encephalitis virus (MVEV), and a number of other non-fatal diseases caused by Kunjin virus (KUNV), Ross River virus (RRV) and Barmah Forest virus (BFV).

The most common biting midge species likely to be encountered in the project region is the Mangrove Biting Midge (*Culicoides ornatus*), with other possible species including *C. marksi*, *C. flumineus*, *Culicoides* undescribed sp. (near *C. immaculatus*), *Lasiohelia* spp. and *Styloconops* sp. (Warchot and Whelan 2004). These species have been recorded from previous studies across the region (Warchot and Whelan 2004).

There are over 100 species of mosquitoes recorded in the Northern Territory of which 16 are regarded as either potential pest species and\or disease vector species. There are likely to be at least eight mosquito species capable of causing minor to major pest and\or potential mosquito borne disease problems within the project region (Warchot and Whelan 2004). The main mosquito species likely to be present within the region include Salt Marsh Mosquito (*Ochlerotatus vigilax*), Common Banded Mosquito (*Culex annulirostris*), Floodwater Mosquito (*O. normanensis*), North Australian Malaria Mosquito (*Anopheles farauti s.l.*), Black Malaria Mosquito (*A. bancroftii*), Golden Mosquito (*Coquillettidia xanthogaster*), Waterlily Mosquito (*Mansonia uniformis*) and Australian Anopheles Mosquito (*A. annulipes s.l.*) (Warchot and Whelan 2004).

4.2.7 Bushfires

Frequent and widespread bushfires occur throughout the grassy savannas of Northern Australia. Throughout the pipeline region and broader areas of Arnhem Land and surrounds, bushfires typically occur from the early dry season (March or April) to the early wet season (November or December).

The pipeline region experiences fires on an annual basis (see Section 8.3.3 for more detail). Fire history studies indicate that the frequency and scale of fires can vary considerably from a few hectares to hundreds of square kilometres in extent. Early dry season fires are usually of less intensity than later fires when conditions are hotter and drier, and winds are stronger. Almost one-third of Australia's savanna region, including the portion within the Top End of the NT, is burned each year by pastoralists, Aboriginal landholders, and conservationists (Russell-Smith et al. 2000). The scale and intensity of fires can be reduced if many small patches are lit throughout the dry season. Although lightning itself is not a significant source of fire ignition, during the transition period from dry to wet fuel moisture is still relatively low and lightning strikes may ignite fires (Rorig and Ferguson 2002).

Fires in the savannas are generally lower in severity and intensity than those in temperate zones, but can create large amounts of smoke, burn very hot in some grass types (especially the exotic weeds Gamba Grass, Mission Grass, and Grader Grass), and move rapidly.

The Bushfires Act 2009 regulates the lighting of fires throughout the Northern Territory. For much of the dry season, permits to light fires must be obtained from the Bushfires NT, through the regional offices. The project region covers three Bushfires Regions – Arnhem Land, Katherine, and the north-west corner of the Gulf Bushfire Region. There are annual prescribed burning programs for these regions, which include aerial control burning and ground-based burning.

4.2.8 National parks and protected areas

National parks and reserves

National Parks and other conservation areas comprise an important land use in the region and are discussed in more detail in Chapter 11. The most significant National Park in the region is Kakadu National Park located approximately 60 km to the north of the project area (Figure 11-1). This park is classified as a World Heritage Site by the United Nations Educational Scientific and Cultural Organisation (UNESCO). Kakadu is also an internationally designated RAMSAR site.

Parks and reserves located in close proximity to the KGGP route include Nitmiluk National Park, Cutta Cutta Caves Nature Reserve and Kintore Caves Nature Reserve.

Indigenous protected areas

Indigenous Protected Areas (IPAs) are areas of Aboriginal-owned land or sea where traditional owners have entered into an agreement with the Australian Government to protect the biodiversity and associated cultural values of a region. IPAs comprise nearly one-third of Australia's National Reserve System. In addition to conservation objectives, IPAs aim to deliver benefits to Indigenous people in the form of education, training, employment and business opportunities based on natural resource management.

In the far northeast of the East Arnhem Region, within 150 km of Nhulunbuy and the Gove Peninsula, two IPAs lie within the pipeline region: the Dhimurru IPA and Laynhapuy IPA (Chapter 11). The pipeline corridor passes through the northern section of the Dhimurru IPA (Figure 11-1).

The Dhimurru IPA, declared in November 2000 is categorised as IUCN *Category V – Protected Area managed mainly for landscape/seascape conservation and recreation*. The IPA covers 920 km^2 of coastline and hinterland country on the western edge of the Gulf of Carpentaria, within the traditional lands of the Yolngu people. The Laynhapuy IPA was declared in September 2006 and is categorised as IUCN *Category VI – Protected Area managed mainly for the sustainable use of natural ecosystems*. This category recognises that the natural environment and rare flora and fauna are virtually intact, in addition to having internationally-significant wetlands and coastal landforms. This IPA is larger than the Dhimurru IPA, covering 6,900 km^2 of land and 630 km of coastline, including the northern half of the Blue Mud Bay coastline.

4.3 LAND TENURE, LAND USE, LOCAL GOVERNMENT AND SOCIAL ENVIRONMENT SETTING

4.3.1 Land tenure, land use and governance

The proposed pipeline route is predominantly located on Aboriginal Land Trust Land, across the Local Government Areas of East Arnhem Shire Council, the Roper Gulf Shire Council, the Katherine Town Council, and Nhulunbuy Corporation. Land use across the Project area is a mix of pastoral farming, mining and tourism uses (Table 4-1, Figure 4-3).

Land owned by an Aboriginal Land Trust is freehold land, and persons wishing to enter the area must seek permission from the landowners.

The proposed pipeline route passes through the Roper Gulf and East Arnhem Shire Councils and the Municipality of Katherine.

The East Arnhem Shire Council covers an area of approximately 33,359 km^2 and provides local government services to nine communities: Milingimbi, Ramingining, Galiwin'ku, Gapuwiyak, Yirrkala, Gunyangara, Umbakumba, Angurugu and Milyakburra. Five of these communities are located on islands, and two are within close proximity to Nhulunbuy (Yirrkala and Galiwinku).

The mining operations and township of Nhulunbuy are located on Aboriginal land, its tenure granted via a Special Mineral Lease and Special Purposes Leases. Nhulunbuy is a privately-operated company-managed town, and is largely a service centre to the Gove bauxite mine, and alumina refinery and support industries. A number of local government services are also located in Nhulunbuy and the town serves as a regional hub for communities in north-east Arnhem Land.

The Roper Gulf Shire Council covers an area of approximately 185,176 km^2 and comprises five wards (i.e. Never Never, Numbulwar, Numburindi, Nyirranggulung, South West Gulf) and 11 communities (Barunga, Borroloola, Bulman, Jilkminggan, Manyallalak, Mataranka, Minyerri, Ngukurr, Numulwarr, Robinson River, Wugularr). The Shire Council has a number of pastoral stations, and some former pastoral stations which have since been reclaimed by traditional Aboriginal owners through the lands claims processes. Tourism is a growing industry in the Shire, particularly smaller-scale cultural tourism. Significant portions of the Shire are owned by Aboriginal Land Trusts.

The Municipality of Katherine covers an area of 7,421 km^2 and is the fourth largest town in the Northern Territory. The township of Katherine serves both as a service centre and a tourist centre and there are a number of pastoral stations surrounding the town. The Tindal Royal Australian Air Force (RAAF) base is located 15 km south of Katherine, and its staff and accompanying families make up almost 25% of Katherine's population.

The area between Katherine and Nhulunbuy is sparsely populated apart from a number of small, predominantly Aboriginal communities located along, or near, the Central Arnhem Road.

Northern Land Council

The NLC is an independent statutory authority responsible for matters under the Aboriginal Land Rights (Northern Territory) Act 1976 in the Top End of the Northern Territory. The NLC acts on behalf of traditional owners to conduct consultations and negotiations with those interested in carrying out commercial activities on Aboriginal land. The NLC is also the Native Title Representative Body for the Northern Region and is authorised to perform functions under Northern Territory law.

The project area falls completely within the NLC's regional boundaries.

Regional Council, Shire, Municipal and Local Implementation Plans

Regional Management Plans are a requirement under the NT Local Government Act 1978 and are developed jointly between the relevant Regional Council and the Department of Local Government. The intention is that key local government issues are addressed through a regional approach. The Regional Management Plans also address resource sharing and regional development issues.

There are two Regional Management Plans relevant to the Project area. The Northern Region Regional Management Plan July 2012 – June 2016 incorporates the East Arnhem Shire, while the Big Rivers Region Regional Management Plan includes the Roper Gulf Shire and the Katherine Town Council.

Table 4-1: NT land tenure

TENURE TYPE	% OF TOTAL NT AREA[1]	% IN PIPELINE REGION
Major tenure types		
Aboriginal freehold land (granted as Commonwealth or NT title)	46.47	Total Freehold (Aboriginal + Other) 72.94
Perpetual Pastoral Lease	41.80	17.81
Pastoral Lease	2.94	3.64
Crown Lease Perpetual	2.01	4.61
Subtotal	93.22	99.00
Minor tenure types		
Crown Lease Term	0.70 Land & <0.01 Sea	0.44
Special purpose lease	0.05	0.04
Freehold (Private/Government)	1.58	
Government Usage Land	0.08 Land & 0.24 Sea	0.00
Vacant Crown Land (Urban/Rural)	0.10	Total Vacant Crown Land 0.16
Vacant Crown Land (Pastoral)	3.83	
Reserves	0.06	0.01
Other Leases (Building, Grazing, Mineral, Misc and Occupation)	0.02	0.34
Roads, River Esplanades, etc.	0.36	
TOTAL	**100.00**	**99.99**

[1]Source: DLPE 2012a.

Each Northern Territory Shire Council is required to develop an annual Shire Plan that feeds into the relevant Regional Management Plan.

The Katherine Town Council Municipal Plan 1 July 2012 – 30 June 2017 outlines the Council's strategic direction and the Katherine Town Council has voluntarily contributed to the development and implementation of the Roper Gulf Shire Regional Management Plan.

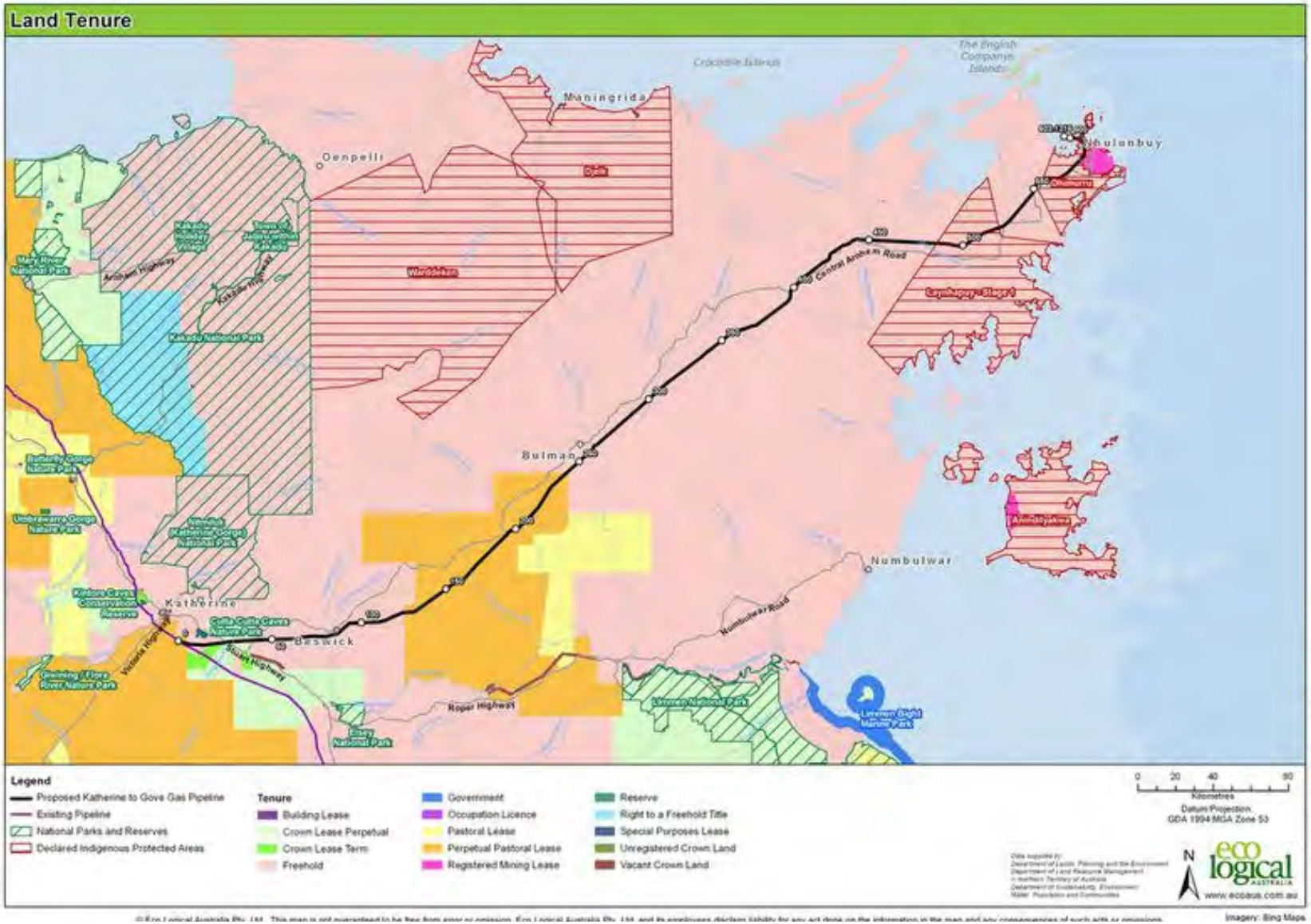

Figure 4-3: Land tenure

Two communities in the study area, (i.e. Yirrkala and Gapuwiyak) have developed Local Implementation Plans under the National Partnership on Remote Service Delivery. The objective of this partnership is to improve service delivery in remote Indigenous communities to a standard that could be reasonably expected of communities of comparable size, location and need, elsewhere in Australia.

The details of all of these plans are provided in the Social Impact Assessment technical report at Appendix M. In general, however, they cover a broad range of economic, health, safety, employment, educational and other goals, usually with an acknowledged priority to redress Indigenous disadvantage. Technical Appendix M and Chapter 15 (Social and Economic Considerations) provide detailed assessments demonstrating opportunities for the project to contribute to and support achievement of the goals and objectives of these plans.

4.3.2 Social setting

The following sections provide a brief description of the current population, demography, health, education, employment, housing and other indicators of the social environment existing in and near the project area. These are more fully described in Appendix M.

Major towns and communities: Katherine, Nhulunbuy, Yirrkala and Marrngarr

Katherine and Nhulunbuy, situated at opposite ends of the proposed pipeline route, are the larger population centres within the study area, with higher median incomes and education levels than other smaller communities along the pipeline route (Table 4-2). Both towns function as regional service centres, with a range of government services, such as health and education, located in these towns.

Katherine

Katherine is the fourth largest settlement in the NT, after the capital Darwin, Palmerston and Alice Springs. In 2011, the population was 6,998 (Table 4-2).

The infrastructure, services and facilities of Katherine are unusually well-developed, reflecting that Katherine is the service hub for a surrounding regional population roughly as large as the population of the Town. Further, it is a major transport hub on the Asia Pacific Railway and at the nexus of the Victoria Highway and Central Arnhem Road with the Stuart Highway.

The town of Katherine has diverse industry sectors, with 75% of businesses representing the following industry sectors:

- Construction.
- Agriculture, forestry and fisheries.
- Retail trade.
- Property and business services.

The six industry sectors employing the largest number of people in 2006 were:

- Public administration and safety (government).
- Health care and social assistance.
- Retail trade.
- Education and training.
- Construction.
- Accommodation, cafés and restaurants.

Nhulunbuy

Nhulunbuy Township is governed by the Nhulunbuy Corporation Limited and was established in 1972 to house mining employees. While it is essentially a 'mining town', it has grown to also function as a regional service centre, supporting numerous outlying communities, including 7 major community townships; 2 minor townships; and approximately 100 homelands and outstations.

The population of Nhulunbuy is predominantly non-Indigenous and median household incomes are significantly higher than reported elsewhere in the region. In 2011, its population was 4,287 (ABS. 2011; Table 4-2).

The outlying communities and homelands have a limited economic base and limited capacity for growth, contributing to high unemployment levels.

The three industry sectors contributing the most to gross regional product in 2009 (NTG 2011a) were:

- Mining ($745 m (million)).
- Manufacturing ($185 m).
- Construction ($239 m).

A more detailed breakdown of gross regional product for 2008 can be found at Appendix M Table 4-21.

The six industry sectors with greatest numbers of employees in Nhulunbuy were:

- Manufacturing.
- Construction.
- Health care and social assistance.
- Mining.
- Retail trade.
- Public administration and safety.
- Education and training.

A more detailed breakdown can be found at Appendix M Table 4-23.

Yirrkala

The township of Yirrkala is 18 km southeast of Nhulunbuy and is the largest Yolngu community on Gove Peninsula, with a population of approximately 800-850 people (RAHC. 2009). A proportion of the population moves between Yirrkala and surrounding outstations and homelands.

A 2011 survey of employment in Yirrkala indicated that seventy-five per cent of filled jobs were either in Public Administration and Safety or Education and training. A more detailed breakdown can be found at Appendix M Table 4-26.

Marngarr (also known as Gunyangara or Ski Beach)

The community of Marngarr is on Gunyangara Island in Melville Bay and is joined to the mainland by a causeway at Drimmie Peninsula, west of Nhulunbuy. It is 13 km west of Nhulunbuy CBD. In 2007, its population was 299. In the September quarter of 2012, there were 4 unemployed persons, comprising an unemployment rate of 4.1 per cent, and 97 persons in the labour force.

Table 4-2: Key characteristics of the major towns and statistical regions of the project area, 2011

CHARACTERISTIC	KATHERINE UCL	NHULUNBUY UCL	ELSEY SA2	KATHERINE SA2	EAST ARNHEM SA2	NORTHERN TERRITORY
Population	6,998	4,287	3,042	10,719	7,488	234,422
Average age	34	33	35	36	25	33
Indigenous population	26.3%	6.5%	52.9%	22.5%	89.5%	24.8%
People per household	2.7	2.9	4.1	2.7	5.4	2.9
Grade 12 completion	36.5%	48%	24.9%	35.2%	19%	34.9%
No schooling	0.9%	0.4%	2.0%	1.1%	5.8%	1.4%
Need for assistance	3.3%	1.1%	3.6%	3%	3.6%	2.7%
Unemployment Rate	4%	1.7%	5.5%	4.1%	8.1%	5.1%
Median weekly household income	$1,403	$2,565	$938	$1,427	$1,458	$1,608
Average weekly rent	$185	$3*	$60	$200	$40	$224

Source: ABS Census of Population and Housing, 2011. UCL = Urban Centre/Locality; SA2= Statistical Area2.

*Figure low due to high proportion of employer-provided accommodation.

Communities along the pipeline

Outside of the town centres of Katherine and Nhulunbuy, at each end of the pipeline, communities along the proposed pipeline route are small, remotely located, and predominantly Indigenous. The populations of these communities are young, with the median age of communities ranging between 21 and 27 years. Education levels are low and unemployment levels are high. These demographic characteristics (Table 4-4) indicate low levels of social amenity, and a high likelihood that aspirations or expectations of the Project in terms of improving social amenity may be high.

Employment opportunities are limited in many of these communities, and employment aspirations in relation to the project are potentially high.

Natural and cultural resources hold significant value to these communities, particularly in relation to sacred sites and traditional lands. Traditional practices are valued highly and the likely impact of any development on the ability of communities to participate in traditional practices, such as traditional burning practices, may cause concern amongst these communities.

Population

Population size and growth

At the time of the 2011 Census, the population of the Urban Centre Locality (UCL) of Katherine was 6,998 people, representing 69% of the population of the larger Katherine Statistical Area. The population of the Nhulunbuy UCL was 4,287 people, representing 57% of the population of East Arnhem Statistical Area (Statistical Area 2).

Between 2006 and 2011 the population of Katherine increased by 6.0%, while Nhulunbuy's population decreased by 4% compared to a growth rate of 9.8% for the Northern Territory over the same time period. The Elsey Statistical Area (SA2), located between Katherine and East Arnhem Statistical Area, appeared to have a population growth of 13.0% for the period (Table 4-3). Note, however, that the census boundary for Elsey changed substantially between the censuses, with an increase of approximately 20,000 km^2 (when the ABS used Elsey Statistical Area 2 in 2011, rather than the Statistical Local Area used for the 2006 census).

Between 2010 and 2025, the population of the Northern Territory is expected to grow at an average of 1.5% - 1.6% per annum, which is similar to the growth trend noted between the last two Census periods. Population projections for the East Arnhem and Katherine region for 2010-2025 are slightly lower than this, with average annual growth rates of between 1.1% and 1.3% predicted over this period (Department of Treasury and Finance, 2011).

Table 4-3: Population size and growth 2006-2011

LOCALITY	TOTAL POPULATION 2006	TOTAL POPULATION 2011	CHANGE 06-11 (%)	AVG ANNUAL GROWTH RATE 06-11 (%)
Katherine UCL	6,925	6,998	1.1	0.2
Nhulunbuy UCL	5,221	4,287	-17.9	-3.6
Elsey SA2	1,090	3,042	179.1	35.8
Katherine SA2	10,088	10,719	6.3	1.3
East Arnhem SA2	6,518	7,488	14.9	3.0
Northern Territory	217,093	234,422	8.0	1.6

Source: ABS Census of Population and Housing, 2006 and 2011. UCL= Urban Centre Locality; SA2 = Statistical Area 2

Table 4-4: Key characteristics of communities located on pipeline route

CHARACTERISTIC	ROCKHOLE ILOC	BARUNGA (BAMYILI) UCL	BULMAN-WEEMOL UCL	WULGULAR - BESWICK UCL	MANYALLU LUK ILOC	BINJARI UCL	YIRRIKALA UCL	GAPUWIYAK UCL	NT
Population	143	309	262	549	105	216	856	889	234,422
Average age	15/27*	24	24	22	21	24	27	25	33
Indigenous population	89.5%	86.4%	90.1%	96.1%	100%	100%	75.2%	91.6%	24.8%
People per household	5.7	4.3	4.4	5.8	7.0	5.3	4.7	6.2	2.9
Grade 12 completion	10%	20.3%	18.6%	12.6%	10.6%	6.2%	20.9%	12.1%	34.9%
No schooling	0%	0%	7%	7.5%	5.3%	18.6%	0%	17.5%	1.4%
Need for assistance	0%	2.9%	6.9%	2.2%	2.7%	5.5%	4.1%	4.3%	2.7%
Unemployment rate	9.1%	18.3%	8.9%	6.0%	28.9%	46.2%	2.1%	4.7%	5.1%
Median weekly household income	$553	$985	$774	$977	$1,666	$766	$1,799	$1,325	$1,608
Median weekly rent	$75	$60	$70	$60	$150	$68	$40	$25	$224

Source: ABS Census of Population and Housing, 2011

Demographic composition

In 2011, the median age in Katherine and Nhulunbuy was recorded at 34 and 33 years respectively, which is consistent with the median age of the Northern Territory as a whole (33 years). The median age for East Arnhem and the smaller, regional communities close to the pipeline route, between Katherine and Nhulunbuy, was considerably younger than this and ranged from 15 years to 27 years. This finding is in line with the median age of Australia's Indigenous population (21 years) and is reflective of the large Indigenous population within the East Arnhem and Elsey Statistical Areas.

Table 4-2 shows that the project area has a large Indigenous population. The East Arnhem and Elsey Statistical Areas have the largest Indigenous populations, representing 90% and 53% of the population respectively.

A detailed demographic analysis is provided in the Social Impact Assessment in Appendix M.

Workforce characteristics

Labour force and unemployment

At the 2011 Census, labour force participation varied significantly across the study area. Nhulunbuy in particular recorded a significantly more economically active population than other communities in the study area, with over 81% of eligible residents participating in the workforce. Nhulunbuy also had low unemployment, of only 1.7%, compared to much higher levels across the rest of the study area (Table 4-5).

In the East Arnhem and Elsey Statistical Areas, only 44% - 47% of the eligible population were participating in the workforce, considerably lower than the Northern Territory rate of 66%. The percentage of people involved in full-time and part-time work opportunities was also significantly lower than the Territory average, and unemployment rates were accordingly high. This may be the result of a low education participation rate or a lack of employment opportunities across the region, and may be indicative of lower skills and experience levels.

Table 4-5: Labour force participation 2011 (%)

LOCALITY	TOTAL LABOUR FORCE	TOTAL EMPLOYED	TOTAL UNEMPLOYED	FULL TIME WORK	PART TIME WORK
Katherine UCL	66.2	62.2	4.0	43.9	11.9
Nhulunbuy UCL	81.3	79.6	1.7	60.6	12.8
Elsey SA	47.1	41.5	5.5	22.0	10.1
Katherine SA	68.4	57.0	4.1	44.7	12.3
East Arnhem SA	44.4	36.3	8.1	18.5	13.9
Northern Territory	66.4	63.0	5.1	66.1	19.9

Source: ABS Census of Population and Housing, 2011

Significant employer categories in the pipeline region include:

- Mining.
- Construction.
- Manufacturing.
- Retail trade.
- Accommodation, cafes and restaurants.
- Public administration and safety (Government).

- Health care and social assistance.
- Education and training.

Skills profile

At the time of the 2011 Census, the principal industries of employment in Katherine were public administration and safety (21%), healthcare and social assistance (17%), education and training (9%) and accommodation and food services (9%). This is reflective of Katherine's position as a regional centre for government and private organisations.

In contrast, the principal industry of employment in Nhulunbuy was manufacturing, representing 30% of all employment in the locality. In Nhulunbuy the mining industry also featured more highly (7% of employment) than the other locations and the Northern Territory as a whole which is indicative of the town's origin. The majority of these industries and opportunities would be directly associated with the Pacific Aluminium mine and refinery.

Across the broader region, public administration and safety, education and training and health care and social assistance were prominent. Elsey Statistical Area was the only location to record significant employment in the agriculture, forestry and fishing industries (at 17%).

A more detailed description of the workforce characteristics of the region is presented in the Social Impact Assessment at Appendix M.

Housing profile

Both Katherine Town Council and the East Arnhem Shire Council noted during consultations that housing markets were tight, with low availability and affordability in Katherine and Nhulunbuy respectively. Despite this, housing is not seen as an existing or future issue for communities along the pipeline.

Across the study area the most common dwelling type was a separate house. Nhulunbuy reported the largest proportion of residents living in a flat, unit or apartment (22%) when compared to the rest of the study area and the Northern Territory, which ranged between 2% and 17% in this category. Nhulunbuy's more diverse mix of dwelling type can be accounted for by the high level of company-provided accommodation in this locality. The Elsey Statistical Area reported the highest percentage of people living in an 'other' dwelling type (46%).

In 2011, the majority of the population of the project area were renting accommodation, particularly those residents in Nhulunbuy and the broader East Arnhem Statistical Area. Overall, fewer residents in the study area either owned or were purchasing their home when compared to the Northern Territory as a whole, with the exception of the Elsey Statistical Area, where almost 40% of residents owned their homes. The study area also had a high percentage of residents renting from 'other landlord types', particularly in Nhulunbuy (63%). 'Other landlord type' includes dwellings rented through government and other employers and residential parks. Given that Nhulunbuy is predominantly a mining town, many local residents would be renting accommodation directly from their employers.

A more detailed description of housing in the region is provided in the Social Impact Assessment at Appendix M.

Community wellbeing and social infrastructure

Throughout this section, the socio-economic health and wellbeing of the project area have been compared to the health and wellbeing of the other areas and the Northern Territory as a whole. The sections that follow provide a quantitative analysis of some key socio-economic wellbeing indicators, including health, education, and safety.

Socio-economic wellbeing

The ABS produces four Socio-Economic Indices for Areas (SEIFA) based on Census data for local areas, and these identify areas of relative advantage and disadvantage.

The Index of Relative Socio-Economic Advantage/Disadvantage is a continuum of advantage to disadvantage. It considers indicators relating to income, education, occupation, wealth and living conditions. The Index of Economic Resources reflects indicators such as income and expenditure including wages and rental cost for families, and variables that reflect wealth (e.g. dwelling size). Income variables are also specified by family structure, as this affects disposable income. The baseline for the SEIFA is a score of 1,000, with a score of over 1,000 indicating an area of socio-economic advantage, while a score below 1,000 indicates an area of relative disadvantage.

Table 4-6 shows that in 2006 the Elsey and Katherine Statistical Local Areas (SLAs - similar to Statistical Areas) are both slightly disadvantaged, while the East Arnhem SLA is significantly disadvantaged. This signifies that income levels and the proportion of professional people are lower in these regions when compared to the Northern Territory overall.

Table 4-6: Socio-economic advantage / disadvantage and economic resources 2006

LOCALITY	ADVANTAGE / DISADVANTAGE			ECONOMIC RESOURCES		
	SCORE	RANKING NT	PERCENTILE TANKING IN NT	SCORE	RANKING NT	PERCENTILE TANKING IN NT
Elsey SLA	911	41	46	903	43	48
Katherine SLA	977	53	59	926	41	51
East Arnhem-Balance SLA	644	4	5	505	2	3

Note: 2006 SEIFA data is based on 2006 Statistical Local Area boundaries, which are similar to 2011 boundaries.
Source: ABS SEIFA, 2006

Table 4-7 presents median household and individual incomes in the study area as well as median number of persons per household as reported in the 2011 Census.

These data show that income levels in Nhulunbuy, both household ($2,565) and individual weekly incomes ($1,295), are substantially higher than the Northern Territory average despite the persons per household being the same. Nhulunbuy also had a high proportion of individual residents (54%) earning over $1,000 per week and households earning over $1,500 (72%). In contrast, individual incomes in the broader East Arnhem Statistical Area (which includes Nhulunbuy), are the lowest across the study area and lower than the Northern Territory overall. Although household incomes in East Arnhem are similar to the Katherine, the number of persons per households in East Arnhem is double that of Katherine, indicating higher levels of disadvantage. Consultations with the East Arnhem Shire Council indicated the level of dependence on government centrelink payments across the Shire.

Table 4-7: Median incomes and persons per household 2011

LOCALITY	MEDIAN HOUSEHOLD INCOME	MEDIAN INDIVIDUAL INCOME	PERSONS PER HOUSEHOLD
Katherine UCL	$1,403	$695	2.7
Nhulunbuy UCL	$2,565	$1,295	2.9
Elsey SA	$938	$312	4.1
Katherine SA	$1,427	$704	2.7
East Arnhem SA	$1,458	$261	5.4
Northern Territory	$1,608	$733	2.9

Source: ABS Census of Population and Housing, 2011

Health

As at 2013, there were two main district hospitals within the study area, located in Katherine and Nhulunbuy. The Gove District Hospital in Nhulunbuy is a 32 bed acute care facility servicing the East Arnhem region and providing medical, surgical, paediatric, respite and maternity services. The hospital also provides a district medical officer who services the region, including outlying community clinics. Patients can be referred to the hospital for inpatient, outpatient and specialist care from one of the surrounding community clinics (Northern Territory Health, 2013).

The Katherine District Hospital is a 60-bed non-specialist medical, diagnostic and treatment facility which services Katherine town, Katherine region and remote areas, extending approximately 340,000 km^2 between the Western Australian and Queensland borders (Northern Territory Health, 2013). The hospital does not have any surgery capability.

There are two hospitals in Darwin, one private and one public. Consultations revealed that Darwin has one of the busiest emergency departments in the country.

There are also health centres or community clinics located in Nhulunbuy, Katherine, Beswick, Bulman- Weemol, Manyalluluk, Barunga (Wugularr), Yirrkala, Gapuwiyak and Binjari.

The Public Health Information Development Unit's *Social Health Atlas of Australia, Northern Territory, 2011* provides data on key population characteristics, including health status and risk factors. The available data demonstrate that the health of the study area is generally lower than for Australia a whole. The median age of death was found to be low, with a median age of death between 53 and 64 years, compared to 70 years for Australia more generally.

More detailed information on the health of communities in the region and medical/health care facilities in the region is provided in the Social Impact Assessment in Appendix M.

Education

Within Nhulunbuy, Katherine and the communities located along the proposed pipeline route, there are five primary schools, two secondary schools, and twelve combined schools. Consistent with the region's demographic profile, many of the schools have high percentage of Indigenous students. In these schools, a high proportion of students spoke a language other than English at home, which is likely to be an Australian Indigenous language. School attendance rates across the study area vary. In general, school attendance in Katherine and Nhulunbuy is higher than in many of the smaller combined schools located within regional communities between Katherine and Nhulunbuy.

A more detailed description of the educational profile of the region, including educational institutions and childcare facilities, is provided in the Social Impact Assessment at Appendix M.

Safety

Within the study area there are three police stations, including one in Katherine, one in Bulman and one in Nhulunbuy. Crime statistics are provided in Appendix M with additional information on the safety profile of the region.

Recreation - Katherine

The Katherine Town Council manages a number of sport and recreation facilities.

The Sports Ground Complex houses the YMCA, the Swimming Pool, Tennis Club, four Ovals, Cricket, BMX Track, Basketball, Football and Soccer. The Katherine Showgrounds Complex houses all the Horse Sports and Australian Rules Football as well as the Katherine and District Show Society.

For the annual Katherine Festival, the community comes together to enjoy a wide variety of arts and entertainment over a period of ten days. The events have included Mayoral Debutante Ball, Katherine Prize Art and Craft Acquisition Awards, exhibitions, artistic workshop activities, Aboriginal culture, Chinese Dragon Boat Races on the Katherine Gorge in Nitmiluk National Park, Flying Fox Walk and Talk,' and many other recreational events.

Katherine hosts a number of historic and cultural museums and galleries, and locals take advantage of the same recreational attractions that bring tourists to the region: nature tours and experiences (e.g. Katherine Gorge, Edith Falls, Springvale Homestead, Cutta Cutta Caves National Park and several other national parks, hot springs, popular bushwalks, kayaking, Aboriginal rock paintings, etc).

Katherine, on the main north-south Stuart Highway, has year-round road access via the Stuart Highway.

Recreation - Nhulunbuy and Yirrkala (East Arnhem Land)

Nhulunbuy has a broad range of sporting and recreational clubs for squash, all types of football and soccer, BMX biking, tennis, surfing, yachting, speedway racing and swimming, with associated sports ovals and other infrastructure (Nhulunbuy Corporation Ltd, 2013).

The region is popular for camping, fishing, boating, bush-walking and other outdoor activities; however, recreational permits are required from the Dhimurru Aboriginal Corporation (DAC) if activities occur outside lease boundaries for the towns of Nhulunbuy and Yirrkala. Recreation areas are detailed in Chapter 11 – Parks, Reserves and Conservation Values.

Permits from the NLC are needed to visit Ganarrimirri (Shady Beach), Garrai (Rocky Bay Beach), Witimurru (Yirrkala Boat Ramp) and Gowupu (Catalina boat ramp).

Permits are aimed at accommodating recreational users and tourists whilst ensuring the privacy of Indigenous people, protecting the environment and promoting the safety of visitors. They also protect the numerous sacred sites or other sites of Indigenous cultural significance, by limiting access, including during culturally-sensitive ceremonies.

Road transit permits are required for travel between Katherine and Gove, on the Central Arnhem Road and can be obtained from the Northern Land Council in Nhulunbuy or Katherine.

4.3.3 Aboriginal culture and heritage

Settlement history

A large part of the pipeline region lies within Aboriginal land in which access has been historically restricted to non-traditional owners. Access to Arnhem Land was restricted in 1931 when the Arnhem Land Aboriginal Reserve was declared. The remoteness of some areas in Arnhem Land meant that there were groups of Arnhem Land Aborigines leading traditional lives until much later than other areas of the Northern Territory, in closer proximity to European settlements.

In the Katherine area, significant European activity commenced in 1871, when construction teams for the Overland Telegraph Line reached the King River. A repeater site was constructed near the present Katherine township and was used as a depot for the line crews and in time became a nucleus for the development of the pastoral and mining industries.

The establishment of Springvale Station on the Katherine River in 1878 prompted a flurry of pastoral development over the next two decades. By 1880 the majority of the large cattle stations had started, however most of them in the Top End were unsuccessful. For example Florida Station in eastern Arnhem Land on the Goyder River was abandoned in 1893 because of Aboriginal resistance and because the country was unsuitable for cattle (Powell 1996). Other pastoral stations established in the late nineteenth century and located close to the project area include Beswick, and Mataranka, while Mainoru was not established until 1918 (Gleeson and Richards 1985).

During the period of pastoral expansion Aboriginal inhabitants started to leave their traditional life style and work on the stations. Permanent European occupation of the Gove Peninsula did not begin until 1935 with the establishment of a Methodist Mission at Yirrkala (Cole 1980:90-91). This contact with Europeans led to a gradual decline in the reliance on hunting and gathering activities as the Aboriginal population concentrated in these centres (Altman 1995).

Geological surveys in 1952 and 1954 proved the existence of high-grade bauxite deposits at Gove Peninsula resulting in the construction of the Nabalco mines and Nhulunbuy township in 1968. Mining was also an important activity in the Katherine region following the discovery of tin at Maranboy in 1913. The mine became the Northern Territory's major tin producer and operated with fluctuating success until the early 1960s (Harlow 1997). The Bulman lead and zinc deposits were discovered and briefly worked in 1910, again in 1925 and the early 1950s (Roberts and Plumb 1963).

The project area also crosses the North Australian Railway extension from Katherine to Birdum that was completed in 1929 (Powell 1996). A single wire line was also erected from Katherine to the Maranboy tin mines in 1924 (Leonard 1981).

During World War II numerous military airstrips and camps were constructed along the Stuart Highway and around Gove. The Manbullo airstrip is located 15 km south west of Katherine and the project area is located just north of the airstrip. In the Gove area a large base was established by RAAF 13 Squadron to fly bombing missions to the Aru Islands and patrol the shipping lanes between Thursday Island and Darwin (Powell 1988).

Aboriginal sacred sites

The pipeline region includes sites that are sacred to the Aboriginal people of the area and significant according to Aboriginal tradition. Sacred sites comprise natural features in the landscape such as waterholes, escarpments and trees that have special significance under Aboriginal social and cultural tradition. They are an essential part of a continuing body of practices and beliefs, deriving from Aboriginal laws and beliefs. Sacred sites are the responsibility of recognised custodians who must

ensure they are kept safe. Consequences flow from any damage to a sacred site both in terms of disturbance to the spiritual relationships in the land and to the custodians. Aboriginal law dictates that other Aboriginal people will hold custodians responsible for damage to a sacred site (AAPA 2013)

The Northern Territory Aboriginal Sacred Sites Act (NTASS Act) protects all sacred sites and makes it an offence to desecrate a site or enter, remain on or carry out work on a sacred site except with the appropriate authorisation (an Authority Certificate). Under the NTASS Act a sacred site is defined as:

> '…a site that is sacred to Aboriginals or otherwise of significance according to Aboriginal tradition and includes any land that, under law of the Northern Territory, is declared to be sacred to Aboriginals or of significance according to Aboriginal tradition."

The NTASS Act sets up a system which established the Register of Sacred Sites, facilitates discussions between custodians of sacred sites and people performing, or proposing to perform work in the vicinity of a sacred site, aimed at the avoidance and protection of sacred sites.

This is achieved by the establishment of a system for the registration of sacred sites and a procedure whereby a person wishing to perform work on land in the Northern Territory may obtain an Authority Certificate from the Aboriginal Areas Protection Authority. This, when complied with, protects that person from prosecution under the NTASS Act. The Northern Territory Government will require provision of an Authority Certificate for the KGGP.

Identification of sacred sites in the project area is culturally sensitive and the broader transmission of information is therefore of necessity, generalised in nature and discussed further in Chapter 13.

Aboriginal archaeological sites

Aboriginal archaeological sites relate to places that have been occupied in the past by Aboriginal people and were modified by the activity of those people. Aboriginal archaeological objects are relics that relate to the past human occupation of the Northern Territory by Aboriginal people and are in an Aboriginal archaeological site. All aboriginal archaeological places (sites) and objects are protected under the Heritage Act 2011.

There has been very little archaeological research carried out in the pipeline region. Early archaeological research in the vicinity of the pipeline alignment concentrated around Katherine. In the Katherine district, Macintosh (1951) excavated a rock shelter at Tandandjal Cave near Beswick south east of Katherine. Reay (1962) examined the rock art around the town of Katherine, Katherine Gorge and Kintore Caves and Chaloupka has recorded many rock art sites (the reports now held at MAGNT) on the Arnhem Land plateau.

More recently, archaeological studies conducted for the Tindal RAAF Base (approximately 6 km north of the KGGP found sites that included stone artefact scatters, rock shelters, quarries and rock art sites (Hughes and Baker 1983). Sites were often associated with major creeks, rock outcrops and sinkholes that provided either shelter, water and food resources or raw material for the manufacture of stone artefacts.

In the central region of the KGGP route, the nearest location of any major archaeological research has been in Kakadu National Park 70 km north of the alignment where the research examined settlement patterns and rock art studies in western Arnhem Land. The KGGP generally avoids escarpment country where there is a higher potential for locating rock art sites. In the Beswick area there are two rock shelters containing art: Tandandjal and Beswick Cave. Tandandjal is located two km north of the pipeline corridor and 20 km east of Bamiyili. Beswick Cave is located seven km from the old Beswick Homestead at the head of a gorge.

In the north eastern section of the KGGP route, the majority of archaeological sites documented in Arnhem Land are coastal sites of either Aboriginal shell middens or the remains of Macassan trepanging sites consisting of stone lines, tamarind trees and pottery (Baker 1984).

More recent cultural heritage surveys in the Arnhem Land region have been associated with the optic fibre cable that was constructed along the Central Arnhem Road (Bourke 2006) and surveys on Pacific Aluminium mine site and refinery (Earthsea Heritage 2010, Raupp *et al* 2009, Guse and Raupp 2008,Guse 2006, 2007a and b, 2008, Crassweller 2006a and b).

There are several common factors that may predict the presence or absence of archaeological material along the pipeline corridor. Archaeological material is more likely to be located near rivers, creeks and billabongs as they were a focal point in Aboriginal settlement patterns providing both food and water. Much of the pipeline corridor is located on sandy plains and it is unlikely that artefacts will remain long on the surface. Ethnographic data also suggests sandy plains were not frequently crossed by Aboriginal people in the past. In the area south of Katherine archaeological sites are more likely to be located along major creeks, rock outcrops and sinkholes. Rock art sites may be identified on isolated rock outcrops in this area. There is an increased potential for locating Aboriginal archaeological material in the higher rocky ground of the southern edge of the Arnhem Land escarpment and the presence of dolerite outcrops may increase the potential for locating quarries. Recorded archaeological surveys in inland Arnhem Land identified several quarries next to creeks in the Mitchell Ranges area (Appendix J).

Indigenous customary use of natural resources

Aboriginal people of the region hold considerable ecological knowledge associated with their customary use of plants and animals for food, cultural practices and art. Use of plants and animals for customary use contributes to family incomes and diets as well as maintenance of social networks. Harvesting of aquatic resources from rivers and wetlands can provide a substantial component of the indigenous economy and contribution to household income in indigenous communities (Jackson *et al.* 2011).

Indigenous ranger groups are also active in the region. These groups undertake a range of land management activities including weed control, fire management and feral animal eradication. The following indigenous ranger groups are active in the pipeline region:

- Bagala Rangers (operating out of Beswick and Barunga).
- Mimal Rangers (operating out of Bulman).
- South East Arafura / Gurrwiling Rangers who are active in the Arafura Wetlands area.
- Yirralka Rangers who manage the Laynhapuy Indigenous Protected Area.
- Dhimurru Rangers who manage the Dhimirru Indigenous Protected Area.

4.3.4 Natural and built heritage

Areas of natural and built heritage in the Northern Territory can be recognised and protected in three ways:

- World Heritage Sites are declared by the World Heritage Committee of the United Nations Educational, Scientific and Cultural Organisation and in Australia, these places are protected through the provisions of the Federal EPBC Act.
- National Heritage Places are assessed and declared by the Federal Government through the provisions of the EPBC Act.
- Northern Territory Heritage Places are assessed and declared by the Northern Territory Government through the provisions of the Heritage Act.

Other places may have historic values are broadly acknowledged but have not been formally declared through any of the above processes and are therefore not afforded any legal protection. The former Register of the National Estate no longer has any legal effect but is maintained by the Federal Government on a non-statutory basis as a publicly available archive and educational resource.

The built heritage of the pipeline region is a reflection of the historical settlement and development patterns described in Chapter 13. In broad historical terms, European activity along the pipeline corridor has been concentrated along the Stuart Highway in the Katherine area and on the Gove Peninsula. The main historical settlement and development influences in the region have been:

- Overland telegraph.
- Pastoral industry.
- Mission settlements.
- Mining.
- North Australian Railway.
- World War II activity.

There is however little formal recognition or protection of heritage places in the pipeline region. Kakadu National Park is the nearest World Heritage Site (approximately 60 km from the pipeline corridor). There are no National Heritage Places within the pipeline region. Two Northern Territory Heritage Places are located within the pipeline region: the Maranboy Mining Precinct near Beswick and the Wurrwurrwuy ("Stone Pictures") near Nhulunbuy. Neither site will be directly affected by construction of the pipeline.

A number of significant (but not formally protected) historic and natural sites occur in the pipeline region. The pipeline corridor would cross any remains of the North Australian Railway, and the Overland Telegraph line south of Katherine. The only known World War II historic site located in the vicinity is Manbulloo Airstrip. Any historic sites on areas that are, or were pastoral leases in the past are most likely in the form of individual graves of Europeans, cattle yards or outstations. A tree blazed by the explorer and surveyor David Lindsay is located approximately 20 km south east of Bulman and therefore will not be affected by construction of the KGGP Site. The carved tree is listed on the archived Register of the National Estate along with the Arafura Wetlands which lie over 20 km to the north of the pipeline corridor. The Register records that "the Arafura Wetlands represent the largest fresh water ecosystem in East Arnhem Land and the largest contiguous paperbark swamp in the Northern Territory and Australia."

Details of specific heritage and archaeological sites identified through survey of the pipeline corridor are discussed in Chapter 13.

4.3.5 Existing infrastructure and transport network

Essential services and related infrastructure

Diverse arrangements characterise the provision of essential services to towns and communities in proximity to the pipeline. A number of communities have town supply of water, electricity and sewage treatment while others rely on on-site bore water extraction (and disinfection), diesel-powered generators (occasionally supplemented with solar), and septic systems (serviced by independent commercial providers). A detailed summary of service provision in towns, communities and outstations within 20 km of the pipeline corridor is presented in Table 4-8.

Telecommunications (particularly for remote communities)

The larger towns and settlements near the pipeline corridor (Tindal RAAF Base, Nhulunbuy, Yirrkala) have access to the full range of wired and wireless telecommunications technologies (including phone and internet).

Typical infrastructure components in remote communities include wireless technologies (for example, Wi-Fi; microwave access) or solid-state components such as copper cabling. Optical fibre cable, high-capacity microwave radio systems or satellite links are usually needed to connect these remote communities to external networks (*National Indigenous Infrastructure Guide* prepared by the Centre for Appropriate Technology, for the Australian Government in 2010).

Smaller communities and outstations in the pipeline region will generally have access to one or more public phones, usually at a service centre (health, police, social services, etc. Private phone services can be organised for houses in communities, but if a number of services are to be provided (for example, for the community organisations and services in a community), then phone systems that share lines connected to the carrier's network can be established.

Mobile phone service is limited for most remote communities; however, where land based infrastructure exists to support mobile phone services, or where satellite technology can be used, remote communities can have wireless telecommunication. Where mobile services are available (such as at Beswick, Yirrkala, Barunga, and Gapuwiyak), up-take often exceeds fixed-line home phone services.

In 2008, Nhulunbuy was connected to Jabiru in West Arnhem Land via an optical fibre cable. Roll-out of the National Broadband Network (NBN) is underway, with an aim of improving access to and performance of the Internet, throughout Australia. For remote communities in the pipeline region this will depend on the NBN's improved fixed satellite connections.

Transportation network

The pipeline route traverses two of the five broad regions of the NT: Katherine and East Arnhem (Table 4-8).

Wet season rainfall and the topography in the Katherine and East Arnhem regions have major impacts on the road and rail infrastructure through flooding. Large sections of the road network connecting most towns, communities and outstations are impassable and cannot be repaired until the dry season. These communities therefore strongly depend on barge and air transport services.

The pipeline corridor crosses the following highways and major roads:

- Stuart Highway.
- Charlie Toms Yards Road (which intersects the Stuart Highway 8 km before the Central Arnhem Highway meets the Stuart Highway, south of Katherine and Tindal RAAF Base).
- Central Arnhem Road.
- Goondooloo Road (meets the Central Arnhem Road 110 km east of the Stuart Highway).

The pipeline corridor runs close to the Central Arnhem Road, generally within 10-15 km. The greatest distance between the pipeline and the Central Arnhem Road is between Beswick and Mainoru, where there is a gap of 25 km. The Central Arnhem Road provides access to Yirrkala, Nhulunbuy and the Gove Peninsula via the 650 km of unsealed road, which is normally open only during the dry season.

Pastoral properties and remote communities generally have unsealed roads that connect to the Central Arnhem Road, with access impacted seasonally by flooding (wet season November through March).

A single transcontinental railway running north and south between Darwin and Adelaide provides the only railway in the NT and in the pipeline region. The passenger service terminates at Palmerston, a satellite city approximately 20 km south of Darwin, and the freight service terminates at Darwin's East Arm Port (in Darwin Harbour). The largest train station in the region of the Central Arnhem Road is in Katherine. The pipeline corridor may cross the railway near KP30.

The railway is a significant component of the AustralAsia trade route, for export and import of goods between Australia and south-east Asia via port facilities at East Arm (in Darwin Harbour). The East Arm Port is equipped to handle container and general cargo, bulk minerals and bulk liquids (including petroleum), live cattle and offshore oil and gas rig services. The port is operated by the Darwin Port Corporation.

At the eastern end of the pipeline region, the Gove Port straddles Dundas Point in Melville Bay. Alumina and bauxite are loaded at a bulk cargo terminal on the north side of Dundas Point. On the south side of the Point, a general cargo wharf is used by coastal vessels to dock and unload bulk materials required for the refinery and load hydrate for export. The port is linked to the alumina refinery by a three kilometre conveyor.

A weekly barge services Nhulunbuy from Darwin. Freight for the Gove operations as well as residents and businesses is carried by these barge services. Large items (cars, boats) are also transported to the region by barge, particularly during the wet season (NCL 2013).

A range of air transport services exist in the pipeline region. The Katherine Tindal Civilian Airport is located approximately 15 km south of town, along the Stuart Highway. Although there are no regular passenger transport services through Tindal airport, it is regularly used for tourism charters. The Gove/Nhulunbuy airport is approximately 8 km west of Yirrkala and is owned and operated by Pacific Aluminium. The runway is sealed and serviceable in all weather, and can accommodate aircraft as large as a Boeing 737.

The NT Government also maintains a network of smaller airstrips to service all major communities in the NT, including Barunga, Beswick and Weemol. Many outstations also have self-maintained airstrips, such as Barrapunta, Donydji, Gurrumuru and Dhalinybuy.

Table 4-8: Essential services infrastructure for towns and communities within 20 km of the pipeline

SETTLEMENT/TOWN	POWER SUPPLY (ELECTRICITY)	WATER SUPPLY	WASTEWATER MANAGEMENT (AND UTILITIES)	WASTE REPOSITORY	COMMENTS
Tindal RAAF Base	Darwin-Katherine Grid (gas-fired power station at Channel Island, Darwin Harbour)	Town water (from Katherine)	On-base sewerage and treatment	Katherine Town Council Waste Transfer Station (7 km west of the Town) Bin collection service	
Maranboy (N/A)	Darwin-Katherine Grid (gas-fired power station at Channel Island, Darwin Harbour)	Town water (from Katherine)	N/A	Rubbish dump	Maranboy used to be a thriving tin mining town, but currently it is home to just two policemen and their families
Barunga (Major)	Darwin-Katherine Grid (gas-fired power station at Channel Island, Darwin Harbour)	Surface water source (monitored and licenced; sodium hypochlorite and UV disinfection). Water demand 999 L/Equivalent Population per day (L/EP/d)	Community sewage treatment plant infrastructure (secondary sewage treatment)	Rubbish dump	Essential services provided by Indigenous Essential Services P/L, subcontracting to NT Power and Water Corporation
Beswick (Major)	Darwin-Katherine Grid (gas-fired power station at Channel Island, Darwin Harbour)	Groundwater; two bores; storage tank (monitored and licenced; sodium hypochlorite and UV disinfection). Water demand 865 L/EP/d	Community sewage treatment plant infrastructure (secondary sewage treatment)	Rubbish dump	Essential services provided by Indigenous Essential Services P/L, subcontracting to NT Power and Water Corporation

SETTLEMENT/TOWN	POWER SUPPLY (ELECTRICITY)	WATER SUPPLY	WASTEWATER MANAGEMENT (AND UTILITIES)	WASTE REPOSITORY	COMMENTS
Bulman (Major)	Diesel-powered generators and solar-power station generation (shared with Weemol); to local grid	Groundwater; storage tank (monitored and licenced; sodium hypochlorite disinfection). Water demand 608 L/EP/d	Community sewage treatment plant infrastructure (secondary sewage treatment)	Rubbish dump	Essential services provided by Indigenous Essential Services P/L, subcontracting to NT Power and Water Corporation
Weemol (Minor)	Diesel-powered generators and solar-power station generation (shared with Bulman) through Bulman grid	Groundwater; two bores; storage tank (monitored and licenced; sodium hypochlorite disinfection). Water demand 675 L/EP/d	Septic system; commercial collection	Rubbish Dump	Essential services provided by Indigenous Essential Services P/L, subcontracting to NT Power and Water Corporation
Mobarn (Outstation)	Diesel-powered generators	Groundwater (bore); 10 kL Poly Tank on 6 m stand	Septic system; commercial collection	Rubbish dump	Water data from 2001 SLAP Map (DPI)
Baghetti (Outstation)	Diesel-powered generators	Surface water (Wilton River); Waterhole; and groundwater; 10 kL Poly Tank 4 m stand	Septic system; commercial collection	Rubbish dump	Water data from 2001 SLAP Map (DPI)
Barrapunta (Outstation)	Hybrid (diesel/solar) power system	Surface water (waterhole); 10 kL Galvanised Tank on 4 m stand	Septic system; commercial collection	Rubbish dump	Water data from 2003 SLAP Map (DPI)
Donydji (Outstation)	Diesel-powered generators; and solar	Surface water (River), with solar pump; 20 kL	Septic system; commercial collection	Rubbish dump	From 2006 SLAP map from DPI

SETTLEMENT/TOWN	POWER SUPPLY (ELECTRICITY)	WATER SUPPLY	WASTEWATER MANAGEMENT (AND UTILITIES)	WASTE REPOSITORY	COMMENTS
	power	galvanised tank on 4 m stand			
Galingar (Outstation)	Diesel-powered generators	Groundwater (bores); storage tanks	Septic system; commercial collection	Rubbish dump	No SLAP map available; Google Earth displays no infrastructure.
Dhamiyaka (Outstation)	Diesel-powered generators	Surface water (waterhole); 20 kL Poly Tank on 3 m stand	Pit toilets	Rubbish dump	From 2006 SLAP map from DPI
Gurrumuru (Major)	Hybrid (Solar/Diesel Generator) power system	Groundwater (bores); elevated water tank (no details on SLAP map)	Septic system; commercial collection	Multiple rubbish dumps	From 2006 SLAP map from DPI
Dhalinybuy (Minor)	Diesel-powered generators	Groundwater (bore)	Septic system and pit toilets; commercial septic collection		From 2001 SLAP map
Yirrkala (Major)	Fuel oil powered station at Pacific Aluminium Mine. Power is purchased by Power Water Corporation from Pacific Aluminium.	Groundwater (bores); pumped to a high level tank and gravity fed to the community. These facilities are owned and operated by Power water Corporation w sodium hypochlorite disinfection. Water demand 740 L/EP/d	Connected to Pacific Aluminium's sewage treatment plant	Rubbish dump	Essential services provided by Indigenous Essential Services P/L, subcontracting to NT Power and Water Corporation

SETTLEMENT/TOWN	POWER SUPPLY (ELECTRICITY)	WATER SUPPLY	WASTEWATER MANAGEMENT (AND UTILITIES)	WASTE REPOSITORY	COMMENTS
Gunyangara (Ski Beach)(Minor)	Power Water Corp purchases power from the Pacific Aluminium grid, through a PWC transmission line	Groundwater (bores) purchased from Pacific Aluminium by Power Water Corp; storage tanks (sodium hypochlorite disinfection). Water demand 1638 L/EP/d	Secondary sewage treatment by external service provider (Indigenous Essential Services/Power Water Corp)	Rubbish dump	
Nhulunbuy (Town)	Fuel oil powered station at Pacific Aluminium Mine.	The potable water supply is drawn from bores, pumped to high level tanks and gravity fed to the Town. These facilities are owned and operated by Pacific Aluminium.	Connected to Pacific Aluminium sewage treatment plant	A twice weekly residential rubbish collection service is provided to all households in the Nhulunbuy Township serviced by NCL's collection contractor	Nhulunbuy Corporation Ltd provides a range of municipal services to town residents, including sewage treatment and reticulation and the rubbish dump

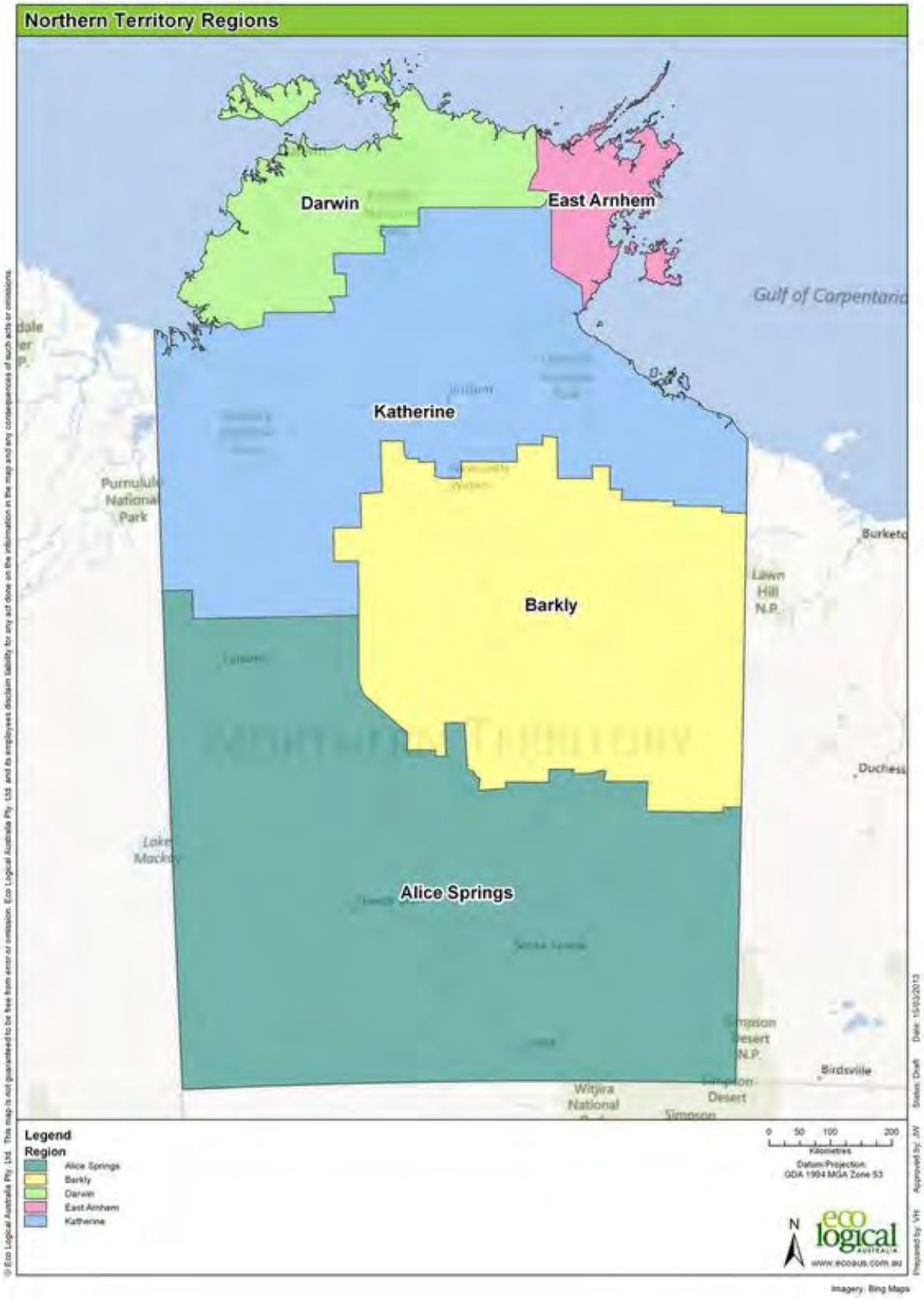

Figure 4-4: Regional areas of the Northern Territory

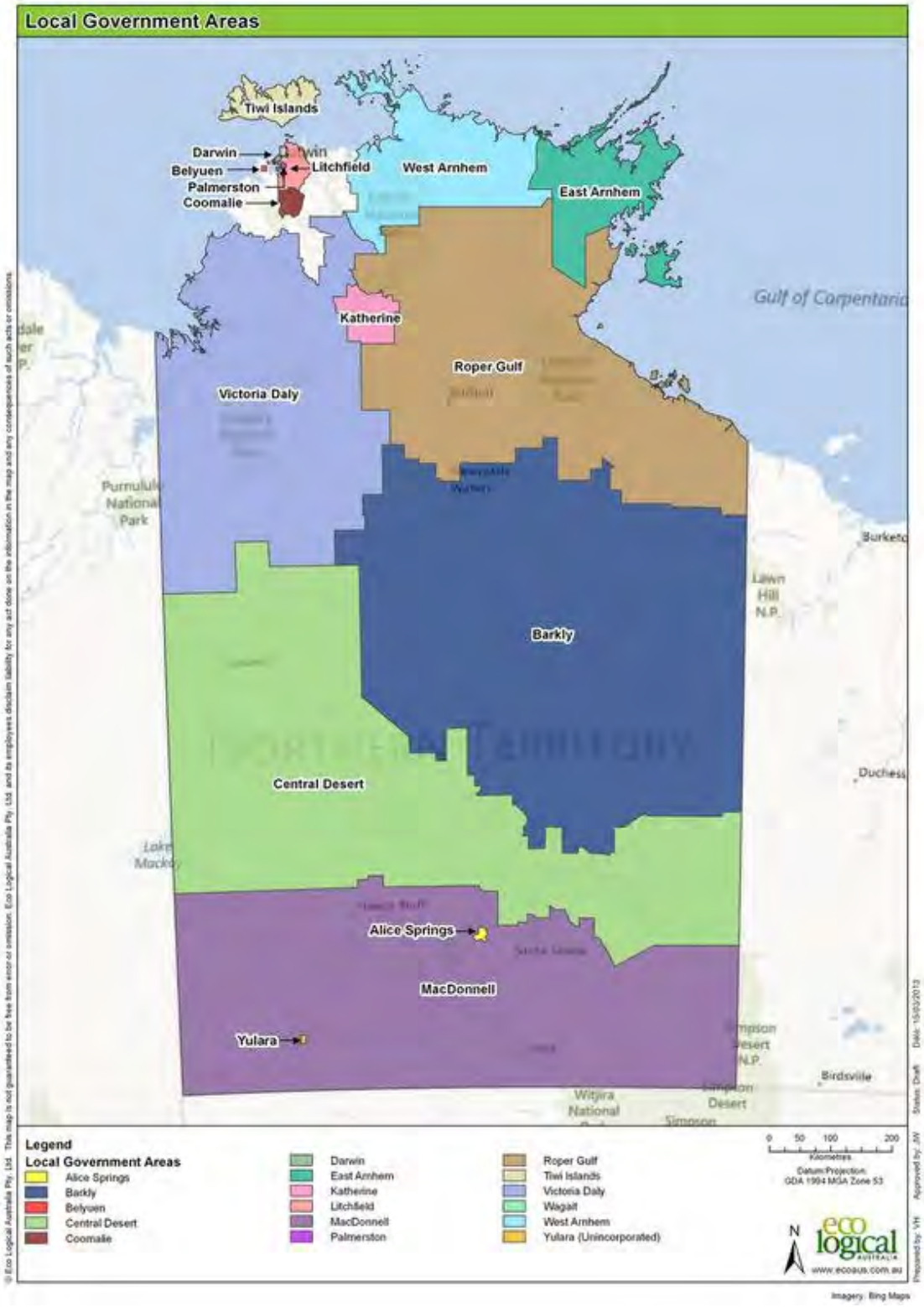

Figure 4-5: Local government areas of the Northern Territory

4.4 ECONOMIC ENVIRONMENT SETTING

4.4.1 Regional economic environment

Katherine Region

Economic data are available only for the broader Katherine Region, which includes substantial lands west of the Stuart Highway and are therefore extend far beyond the pipeline region. These data will therefore include industries, population, employment and other data that are not directly relevant to the KGGP project area (Figure 4-4).

The Roper Gulf Region, covering the eastern portion of the Katherine Region, is more relevant to an assessment of environmental impacts; however, pertinent data are not always available for this portion of the Katherine Region. Wherever possible, data from the Roper Gulf region have been used (Figure 4-5).

The Katherine region supports diverse industries, including defence (e.g. Tindal RAAF Base just south of Katherine), pastoralism, horticulture, mining, tourism, transport, construction, retail and community and government services.

Pastoral production was worth an estimated $110.1 million in 2008-9, and horticultural production estimated at $47 million over the same period. Hay, silage and crop production was worth $10.1 million, with 30,563 tonnes produced (DoB 2010bb).

In 2010, Tindal RAAF Base had 625 personnel from 75 Squadron and 322 Combat Support Wing, with $35 million spent annually on defence salaries. Approximately 2,000 people comprise the Defence community at Tindal, with significant additional personnel visiting during defence exercises (DoB 2010bb).

Tourism plays a significant role in the Katherine region economy. The majority of visitors to the region are from within Australia (Tourism NT. 2012). An average of 270,000 tourists visits the region each year. Nineteen per cent are from overseas; 50% are from interstate; and the remainder are from the NT (DoB 2010bb). Detailed tourism statistics can be found at Appendix M.

The business profile in the region can be found at Appendix M. Micro and small businesses with an annual turnover of less than $2 million per annum dominate in the region.

East Arnhem Region

The region supports a range of industries including fishing, mining, tourism, Aboriginal services, construction, retail, community and government services. Nhulunbuy comprises a service hub to the 100 or more remote communities and outstations in the region.

Many of these remote communities and outstations have some form of micro-economic activity, from carving or weaving by individual artists, to outstation stores providing food and essential items to community airline services. The business profile in the region can be found at Appendix M. Micro and small businesses with an annual turnover of less than $2 million per annum dominate in the region. A significantly greater proportion of businesses are indigenous owned or controlled compared to the Katherine region.

4.4.2 Key industries

Tourism

The direct and indirect contributions of tourism to the NT economy are significant. In 2011-12, the NT had 1.3 million visitors, with a total expenditure of $1.5 billion (Gross State Product, GSP, which is approximately 8.7% of the total NT GSP. Domestic visitors comprised 80% of total visitors to the NT. Holiday-makers to the NT accounted for 56% of total visitors to the NT (TNT 2011).

The tourism share of GSP in the NT is the highest of any Australian jurisdiction. Tourism is estimated to employ directly and indirectly 14,000 people; or 12% of the total NT workforce in 2010-11 – almost double the national share of 8.0% (TNT 2011).

In the broader Katherine region, tourism centres on the major National Park attractions some distance from the pipeline region. In the East Arnhem region, the Dhimurru Aboriginal Corporation and East Arnhem Tourism Association manage and promote tourism around Nhulunbuy. Dhimurru issues permits for access to recreation areas (identified below), monitors visitors' compliance with access conditions and develops resource management plans for the region. Fishing and indigenous culture are major draw cards. From 2010-11 to 2011-12, visitor numbers to Nhulunbuy and surrounding recreational areas increased 100% (Source: Parks Forum: Agency Statistics Report. VI Summary 2010/11 and 2011/12 financial years).

In the central portion of the pipeline region, tourism is limited, apart from Aboriginal sports and cultural festivals at regional centres. The majority of the central portion is Aboriginal Freehold and permits must be obtained from the Northern Land Council (NLC) to enter at times other than during festivals. The Central Arnhem Road provides the only significant access. The road is unsealed and suitable for 4WD vehicles only during the dry season.

Accommodation, access and tourism opportunities in regional centres and communities in the pipeline region can be found at Appendix M.

Mining

Mining in the pipeline region is confined to Pacific Aluminium Gove operations at Nhulunbuy. The operation includes the mine, refinery, residue disposal storage facility, port and steam power station (powered by fuel oil).

In the broader East Arnhem and Katherine Regions there are a number of operating mines and their value is presented at Appendix M.