Section 12

Terrestrial Impacts, Preventative & Management Measures




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12. Terrestrial Impacts, Preventative Measures & Management

12.1 Introduction

This section provides a description and assessment of the relevant terrestrial impacts that are expected to, or may potentially, occur as a result of the proposed development and discusses the appropriate preventative and management measures to reduce these impacts.

This impact assessment covers those activities described in **Section 4**, which broadly comprises:

- Construction and operation of 2.5 km below ground onshore pipeline from landfall to an onshore gas plant.
- Construction and operation of an onshore gas plant that will separate PW and condensate from the gas. The gas will then be exported.
- Construction of the access road between Wadeye Airstrip and the project area.

The majority of potential impacts on the terrestrial environment identified through the assessment process can be categorised as having no adverse long term impact on the environment and can be managed through the implementation of routine management procedures and safeguards.

The only impacts identified through the assessment process as having a higher level of potential impact, and thus requiring detailed assessment are:

- small hydrocarbon spills;
- vegetation clearing;
- the introduction of feral and pest animals;
- fauna death and capture from pipeline trenching;
- biting insects resulting in mosquito borne disease.

With the implementation of appropriate management measures and safeguards none of these project activities are likely to result in unacceptable long term negative impacts on the local terrestrial environment.

In support of the overall assessment approach and to meet the Draft EIS Guidelines, all of the potential impacts identified were subject to a semi quantitative risk assessment, the approach to this risk assessment is detailed in **Section 10**. The results of this risk assessment support the findings of the overall assessment in terms of the potential impact on the terrestrial environment from the proposed development and the severity of these potential impacts.

12.2 Physical Environment

12.2.1 Topography and Soils

Impacts

Construction activities may result in localised changes to topography. General ground disturbance, the development of stockpiles and trenches, and 'cut and fill' activities can result in impacts, which may alter natural erosion and deposition processes.

Construction activities such as clearing of vegetation, earthworks for trenching of the pipeline and construction of the plant, as well as works associated with any road upgrades or borrow pits will result in localised changes to the physical environment. This may potentially result in changes to soil profiles.

Changes to the physical environment may also cause secondary changes to the ecological environment which are discussed in **Section 12.3**.

Erosion and Run-off: Poorly managed construction activities have the potential to cause increased run-off and ponding of water around the site, as well as erosion and soil compaction. Removal of vegetation exposes the underlying soils and can lead to soil loss via wind or water erosion. Erosion could contribute to the sediment load of local waterways and potentially form gullies and unstable soil surfaces, change flow paths and flow rates, all of which can effect aquatic ecosystems (**Section 12.3**). Direct loss of topsoil will reduce soil fertility and complicate rehabilitation due to loss of seed banks and nutrient stores.

Earthworks and vehicle movement can also contribute to soil erosion by moving soils and creating unstable slopes, weakening soil structure through vehicle weight and exposing soils to wind or water. At both the landfall site and along the pipeline route, earthworks are likely to promote soil erosion, depending on weather conditions. Some soil erosion from earthworks may occur at the plant site; however, as earthworks will only be taking place during the construction phase of the project, the impacts are expected to be short term.

Soil Compaction: Soil compaction resulting from earth works and increased traffic, can reduce soil permeability, decrease recharge to groundwater and increase surface drainage, further contributing to surface erosion as water volumes and flows will increase.

Preventative and Management Measures

The principal management measure to reduce the impact of construction activities on topography and soils is to minimise the area of land that will need to be accessed and disturbed. All areas to be cleared will be pegged prior to clearing to eliminate unnecessary or accidental land disturbance.

Although construction activities will alter localised topography, for example disturbance to the dune system, there is low potential for impacts associated with increased run-off, ponding and erosion for the following reasons:

- The topography of the area is relatively flat which reduces the risk of erosion.

- No groundwater is expected to be encountered within any excavation above the high tide level.
- Construction activities and rehabilitation will occur in the dry season prior to the onset of periods of heavy rain.

Removal of vegetation and earthworks can have deleterious impacts on topsoil if not managed correctly, principally due to physical removal of soil, declining soil quality due to erosion, compaction and loss of micro-organisms and trace minerals. However, there is a low potential for soil erosion and associated impacts to occur because:

- There are no watercourses in close proximity to the plant or pipeline area that could be affected by increased run-off or erosion. Only one watercourse will be crossed by the proposed access road between Wadeye airstrip and the project area.
- The topography of the area is relatively flat which reduces the risk of erosion.
- Construction activities and rehabilitation will occur in the dry season prior to the onset of the rains.
- Clearing and earthworks will be carefully managed and construction areas will be rehabilitated as soon as possible.

Several engineering measures will also be implemented to ensure there is no long term impact on the environment. The plant will be designed to allow surface water to drain adequately. Slopes and batters will be designed so they are consistent with the local topography as much as possible.

It has been identified that the near surface clayey sands in the area landward of the beach will be highly erodible, and are likely to be encountered during pipeline construction. This area will therefore be quickly revegetated and any surface water directed away from the ROW.

Consideration will be given to the use of a compacted crushed rock (gravel) surface within the plant site to protect against erosion. A storm water and drainage management system will be developed and implemented for the gas plant site. Temporary drains and banks will be installed where required to slow and divert stormwater, and minimise soil erosion. Sediment control fences will be installed where required to prevent soil and sediment leaving construction sites.

An Erosion and Sediment Control Plan (ESCP) will be prepared prior to construction and implemented for the project.

Where possible, pipelay traffic will utilise the ROW to minimise the need for additional access tracks and confine soil compaction to the ‘running track’.

A Rehabilitation Management Plan will be developed prior to construction in accordance with legislation and in consultation with the relevant landowners. The Framework Rehabilitation Management Plan is contained in **Section 15**.

Management Summary

- The plant will be designed to allow surface water to drain adequately.
- Slopes and batters will be designed so they are consistent with the local topography as much as possible.
- The area containing clayey sands (landward of the beach) will be quickly revegetated to minimise erosion and assist surface water drainage.
- Consideration will be given to the use of a compacted crushed rock (gravel) surface within the plant site to protect against erosion.
- A storm water and drainage management system will be developed and implemented for the onshore gas plant.
- Temporary drains and banks will be installed where required to slow and divert stormwater, and minimise soil erosion.
- Erosion and surface water controls such as sediment control fences, temporary drains and banks will be installed during the construction phase for both the plant and pipeline where practicable.
- Where possible pipelay traffic will utilise the ROW 'running track'.
- A Rehabilitation Management Plan will be developed and implemented prior to construction.
- Construction activities in the vicinity of watercourses will take place as early as possible in the dry season.

Impacts from Acid Sulfate Soils

The disturbance of acid sulfate soils (ASS) by excavation, drainage or dewatering can cause environmental problems unless managed correctly. ASS produce sulfuric acid when drained or disturbed, with associated adverse environmental impacts.

Acid generation from soils can impact on human activities such as fishing, recreation and tourism and can also affect human health. Environmental impacts include changes to the quality and properties of the soil, groundwater, surface water, wetlands, watercourses and estuaries as well as deaths and diseases in fish and other aquatic fauna. Environmental changes may cause degradation of water dependant ecosystems and ecosystem services resulting in loss of habitat, biodiversity, plant yield and the invasion of and dominance of wetlands and waterways by acid tolerant water plants, plankton and pathogens. In addition, acidification of soils and water can lead to corrosion of metallic and concrete structures (concrete cancer) such as roads, bridges, pumps, pipes and foundations. Acidification of soil and water may lead to dissolution of heavy metals from the soils compounding environmental problems.

Preventative and Management Measures for Acid Sulfate Soils

A desktop assessment of the potential for ASS in the plant and onshore pipeline project area indicates that the Moyle Land System has a low risk of ASS. The complete findings of this report are presented in **Technical Appendix D**, **Volume 2**; this report also describes the criteria used to

derive a risk level. However, the Carpentaria Dune Land System around the shore crossing has a moderate to high risk of ASS. On this basis, a further examination of ASS in the project area has taken place. This investigation was conducted in accordance with Northern Territory Government recommendations and the 'Guidelines for Sampling and Analysis of Lowland Acid Sulphate Soils (ASS) in Queensland 1998' (Ahern *et al.*, 1988). Should the results from this study (available before end of 2004) indicate that ASS are present and will be disturbed during the course of the Blacktip Project, an Acid Sulfate Soils Management Plan will be developed to eliminate the impacts of ASS. Preliminary indications from the site investigation are that ASS will not be an issue.

Management Summary

- An ASS desktop study has concluded that the plant and onshore pipeline project area has a low risk of ASS, and the shore crossing a moderate to high risk of ASS.
- ASS site investigation took place in 2004, results will be available before end of 2004.
- A project – specific Acid Sulfate Soils Management Plan will be developed if field investigations indicate ASS are likely to be encountered.

12.2.2 Hydrology and Water Quality

Impacts

The Hydrology and Water Quality Study (**Technical Appendix E, Volume 2**) completed for the Blacktip Project area identified six potential hydrological impacts associated with construction, operation and decommissioning of the project:

- change in chemical composition
- change in biological composition
- increasing acidity
- increasing salinity
- increasing turbidity
- hydrocarbon contamination

Acidity and salinity are considered in **Sections 12.2.1** and **11.18**, respectively. The qualitative hydrological risk assessment identified a high primary risk (ie risk level without any preventative and management measures) of hydrocarbon contamination of groundwater from condensate storage/transport facilities during project operation and decommissioning. This ranking is based on the perceived potential for major off-site impact to external receptors via groundwater pathways and the medium to long-term environmental and community health impacts. The risk will be either eliminated or greatly reduced through the preventative and management measures identified below.

There is a moderate primary risk associated with:

- turbidity at the shore crossing;
- seepage and runoff contamination from laydown areas and construction camp facilities including waste treatment and fuel/chemical storage.

The potential impacts are further discussed below.

Turbidity: Removal of the native vegetation and earthworks for construction of the shore crossing, export pipeline and gas plant has the potential to cause destabilisation of soils and subsequent mobilisation of sediments in storm water runoff. Due to the absence of surface water systems in the project area the potential for elevated turbidity in the surrounding marine and surface waters during construction is low.

Upgrade of the unsealed access road from Wadeye airstrip to the project area, which crosses over the headwaters of Sandfly Creek, has the potential to increase sediment load into the creek during the wet season following construction.

There is some risk of turbid runoff water in the stormwater drainage system entering the near coastal wetland environments, although the perceived level of risk is low as a stormwater and drainage containment and treatment system will be developed for the site. The risk of turbid runoff impacting on marine and coastal areas and inland drainage systems is considered to be low, provided that standard sediment and erosion control planning measures are implemented.

Chemical and Biological Composition: Sewage and putrescible waste generated at accommodation facilities, and chemicals stored at the gas plant site have the potential to contaminate seepage and run-off water, although the risk is negligible given adequate procedures for the safe storage, handling and treatment of biological and chemical waste. If biological and\or chemical contamination of surface water or ground water was to occur it could have associated adverse impacts on groundwater dependent ecosystems identified in **Section 8.2.6** that occur near to the project area.

Hydrocarbons: Hydrocarbons used in construction machinery and equipment may contaminate surface water and groundwater through accidental refuelling spills, leakage of storage tanks, and machinery malfunction. Hydrocarbons released at the shore crossing, along the onshore pipeline route, and at the gas plant site have the potential to adversely impact on the marine environment, and groundwater dependent ecosystems identified in **Section 8.2.6**. Hydrocarbon contaminated run-off from access roads, tracks and laydown areas could adversely impact on inland freshwater ecosystems through discharge into drainage lines; however, the potential for impacts will be minimised through locating these components away from surface drainage. The risk of hydrocarbon spillage across the Blacktip Project is considered to be low, as appropriate procedures for storage and handling of dangerous goods will be adopted.

Hydrocarbon contamination of groundwater resources that underlie the project area may also occur in the event of equipment malfunction, or pipeline leakage or rupture associated with the gas plant and condensate storage and export. Management through project design virtually eliminates the likelihood of hydrocarbon contamination. Furthermore, a spill protection system will be put in place for the condensate storage tanks. Consequently the overall risk is low.

Preventative and Management Measures

The potential impacts of the project on hydrology and water quality have been minimised through the selection of an area in which there are no surface water features and that is remote from wetland ecosystems. The design of all aspects of the project will be in accordance with Australian Standards and all applicable legislation, thereby minimising the risk of impacts on surface and groundwater through design failure. Additionally, a regular inspection and maintenance schedule will be developed to protect against equipment failure.

The potential for leaks from the onshore condensate tanks will be managed through the appropriate design of the tanks. During operation a spill protection system will be put in place for the condensate storage tanks. Significant leaks will be detected by measuring the condensate levels in the tanks. Small leaks, not detectable by this method, will be contained within bunded areas and will then be diverted via the plant collection system to the plant process system where the water and condensate will be separated. The condensate will be transferred back to the tanks for export and the water discharged through the PW system after treatment. Spills are discussed further in **Section 12.5.4**.

Construction of the shore crossing, and access and laydown areas, present a higher risk of sediment-laden run-off entering surface waters, and of spills of chemicals or hydrocarbons. For this reason, these components will be prioritised for construction as early as possible in the dry season construction programme. This approach will minimise the potential for hydrological impacts by:

- confining construction to a period when there is a very low probability of run-off and recharge to the local surface water and ground water systems;
- allowing adequate time for rehabilitation and erosion control to stabilise sediments prior to the onset of the wet season.

Erosion and Sediment Control: An Erosion and Sediment Control Plan (ESCP) will be developed and implemented for each of the construction, operation and decommissioning stages of the project. This plan will demonstrate control of all drainage onto, and leaving, disturbed areas at all times, and will minimise the potential for elevated turbidity in surface waters surrounding the project area. Construction of the access routes presents a high risk of increasing turbidity in surface waters. This risk will be managed through the inclusion of guidelines for the selection, establishment and rehabilitation of vehicle crossings over watercourses in the ESCP. It is not anticipated that trench dewatering will be required as construction will be during the dry season and preliminary geotechnical surveys showed no sign of near surface water table, however,

appropriate procedures for water disposal will be incorporated in to the ESCP. The ESCP will follow accepted guidelines for the control of erosion and sedimentation at construction sites (Witheridge and Walker 1996) and NT Soil Conservation Guidelines (Sedman 2000), and will be developed in consultation with the Department of Infrastructure, Planning and Environment.

Water Quality Monitoring: A Groundwater Protection Management Plan will be designed and implemented to facilitate early identification and management of hydrological impacts, and to assure stakeholders of environmental performance. Groundwater levels and quality will be measured during construction and operation in accordance with ANZECC Guidelines (2000) at locations where the hydrological risk assessment has identified a high risk of potential impacts.

Management Summary

- Construction and operational activities involving land disturbance will be confined to the dry season.
- Construction of the shore crossing, and access and laydown areas will be prioritised for construction as early as possible in the dry season construction programme.
- An Erosion and Sediment Control Plan will be developed and implemented.
- A Waste Management Plan will be developed and implemented.
- A spill protection system will be put in place for the condensate storage tanks.
- Procedures for the storage and handling of dangerous goods will be developed in accordance with relevant legislation and Australian Standards.
- Drainage systems will be designed to minimise local flooding and to capture contaminated stormwater and PW.
- Contaminated stormwater and PW will be treated and disposed via the PW treatment system.
- A Groundwater Protection Management Plan will be developed and implemented.
- A Rehabilitation Management Plan will be developed and implemented.
- A Preliminary Onshore Decommissioning Plan will be developed.

12.3 Ecological Environment

12.3.1 Vegetation Clearing & Habitat Loss

Impacts

At most, approximately 74 ha of native vegetation (ie eucalyptus forest and woodland habitat) will be cleared to construct the onshore export pipeline and gas plant. However, it is likely that 30% of the ground vegetation that currently covers the plant footprint will be retained where hardstand is not required; although trees would still require removal to minimise any fire hazard.

There will also be short-term disturbance of approximately 2 ha of sand dune habitat within the shore crossing 40–100 m wide working corridor and associated laydown areas. When compared with the total area of similar habitat available in the region, the loss of these habitats is considered to be of minor consequence to the regional availability of habitats for flora and fauna. The risk of

negative impacts will be greatly reduced through the implementation of preventative and management measures and monitoring strategies at the landfall as described below. It is acknowledged that the total area of disturbance does not account for any disturbance arising from borrow pits or the upgrade of access tracks to the project area. Vegetation clearing requirements for the access road will be established through further survey work and detailed design.

Short-term loss of fauna species is likely to occur in and adjacent to the project area during the construction phase due to increased noise levels, creation of dust, and generally high levels of disturbance for the period during which construction will take place. High levels of vehicle traffic during the construction phase will also result in increased numbers of fauna road casualties. Migratory birds, such as the Oriental Plover, Oriental Pratincole and Little Curlew, that use the inter-tidal zone and shoreline near the landfall will probably move away from the area. However, given the availability of more suitable habitats nearby (Chatto 2000; 2002; 2003) this is unlikely to be of major consequence for these species.

It is likely that most species will continue to actively use the temporarily disturbed woodland in and around the project area, although the abundance of a few sensitive fauna species in the project area may decrease as a result of habitat removal and fragmentation (PWCNT 2001). The magnitude of barrier effects created by the cleared areas will depend on species behaviour and mobility (Goosem *et al.*, 2001). Species that are habitat specialists or that move amongst several habitats are particularly at risk (Ford *et al.*, 2001; Harrington *et al.*, 2001) such as the Blue-winged Kookaburra, Blue-faced Honeyeater and Brown Honeyeater (PWCNT 2001) that were found in the project area. However, given the widespread regional availability of eucalyptus woodland and sand dune habitats similar to those found in the project area, it is considered unlikely that populations of fauna will decrease in regional abundance. According to PWCNT (2001), the critical threshold of native vegetation to maintain the presence of most species of fauna is 30% of bush within a 4 km radius. Less than 3% of native vegetation will be cleared within a 4 km radius of anywhere in the onshore project area. Therefore, it is considered that most species of fauna will continue to maintain populations in the area.

The project area is largely comprised of eucalyptus woodland communities, which typically do not contain a high proportion of rare species. Therefore, risk of potential impacts on 'threatened' species is very low. The project area does not occur in close proximity to any significant shorebird or waterbird colonies (Chatto 2003; 2000). Seabird breeding roosts (ie terns) have been recorded in proximity to the proposed pipeline landfall site; however, these are considered to have a low significance (Chatto 2001). The proposed onshore development is considered unlikely to cause significant impacts on shorebirds or waterbirds in the region (Chatto pers. comm. 2004).

Preventative and Management Measures

The primary preventative measure to minimise the impacts of vegetation and habitat loss is to design the project and plan construction activities so that only the minimum area of vegetation necessary for the project is cleared. Construction activities, especially in the vicinity of

watercourses, will be undertaken as early as possible in the dry season, and rehabilitation and erosion control will be completed prior to the onset of the first wet season rains.

Revegetation will be undertaken quickly by backfilling the trench, pulling back the stockpiled surface soils and the stockpiled vegetation, installing erosion banks and structures, within weeks of pipelaying. This will enable grass roots either side of the trench to start to grow back, will provide viable seed in the surface soil and natural vegetation, as they will not be exposed for long, and will also protect the ground surface. These measures will be defined further in the Rehabilitation Management Plan.

Specific management measures that will be implemented at the shore crossing and gas plant site to stabilise the sand dunes and minimise the risks of erosion, loss and compaction of soils are described in **Section 12.2.1**.

The Rehabilitation Management Plan will be developed prior to construction. The plan will include timings for stages of clearing and rehabilitation, details of the techniques that will be used and species proposed for use. Top soil and vegetation matter suitable for use in rehabilitation will be stockpiled within the project boundary and near to the area from which it was removed. Excavated soil that is not required will be either stored within the project area footprint or will be dumped at an approved location off-site. Reinstatement of disturbed areas will occur with stockpiled topsoil (containing seed stores) as soon as possible after the conclusion of construction activities.

The boundaries of the areas to be cleared will be clearly delineated on the ground, and sensitive vegetation communities that occur in proximity to the area will be fenced off. Large mature native fruiting trees (such as *Ficus virens*, *Terminalia microcarpa*, *Syzygium nervosum* and *Canarium australianum*), which provide important fauna habitat and act as a stepping stone between fragmented habitats, will be identified and retained where possible. The construction workforce will be briefed about the importance of protecting vegetation communities, fauna species and habitats, as part of their HSE induction.

Management Summary

- Construction activities will disturb only the minimum area of vegetation necessary.
- Large mature fruiting trees will be identified and retained where possible.
- Sensitive vegetation communities and fauna habitats that occur in proximity to the area will be fenced off.
- Top soil and vegetation matter suitable for use in rehabilitation will be stockpiled within the project boundary and near to the area from which it was taken.
- A Rehabilitation Management Plan will be developed prior to construction.
- Reinstatement of disturbed areas will occur as soon as possible after the conclusion of construction activities.

- The construction workforce will be briefed about the importance of protecting vegetation communities, fauna species and habitats.

12.3.2 Significant Vegetation, Habitats & Individual Species of Flora & Fauna

Impacts on Sensitive Vegetation Communities and Habitats

The physical removal of vegetation for the construction of the shore crossing, export pipeline and gas plant, will not directly affect any of the sensitive vegetation communities and habitats identified in **Section 8.3.3**. The potential impacts of the project on flora and fauna biodiversity, and threatened species, have been minimised in the design phase by avoidance of monsoon vine forest, riparian, and wetland communities, which are known to typically contain distinct flora and fauna species assemblages. Additional project infrastructure, such as laydown areas, shore anchors, borrow pits, washdown bays etc. will not be located in areas of environmental sensitivity.

Upgrade of the access track from Wadeye airstrip to the project area will cross the headwaters of Sandfly Creek near Wadeye township. In the event that this access track is upgraded, disturbance and removal of riparian vegetation has the potential to cause short-term increases in turbidity of the creek. To prevent or minimise these potential impacts, construction of this section of the route will be planned for early in the dry season, and installation of sediment control devices (such as sediment fences) and rehabilitating riparian habitats prior to the wet season will be included in management plans for the works. The potential impacts of the project on water-dependent ecosystems are discussed in **Section 12.2.2**.

Disturbance caused by the removal of native vegetation and earthworks will create conditions for the establishment of weed species. Movement of vehicles and equipment on and off the project area could result in the introduction of new weed species into the project area. Many of the weed species that are known to occur in the region have the potential to out-compete native flora, alter fire regimes and contribute to an overall decrease of habitat condition and suitability for flora and fauna. Weed incursion and fire are possibly the greatest threats to communities of conservation significance, especially monsoon vine forests, riparian communities and freshwater wetlands.

Impacts on Flora and Fauna Species of Conservation Significance

Section 8.3.3 describes several species of 'threatened' fauna that have a known range which includes the project area, and one 'threatened' species which could possibly occur in the project area, although none of these species have actually been recorded in field surveys or in the Northern Territory Fauna Atlas records for the region. The project area is largely comprised of eucalyptus woodland communities, which typically do not contain a high proportion of rare species. Therefore, risk of potential impacts on 'threatened' species is very low. The potential for impacts on these species is discussed here.

Nesting sites of the Red Goshawk *Erythrotriorchis radiatus* are highly susceptible to disturbance and the tolerance of this species to habitat fragmentation is yet to be determined (Garnett and Crowley 2000). If a nest site was to occur in proximity to locations where construction activities were taking place, this could result in failure of the nest. Surveys of the onshore project area did

not identify any nest sites. Given that nests are large and are typically located in tall trees, it is considered highly likely that any nest sites that did occur in the project area would have been identified during the field surveys. The potential for the project to impact on the Red Goshawk is considered to be low.

It is unlikely that significant populations of the Brush-tailed Tree-rat (NT: Vulnerable; Comm: not listed) or Brush-tailed Phascogale (NT: Vulnerable; Comm: not listed) occur in proximity to the project area, given that these species have never been recorded in the region and were not recorded during field surveys of the project area. The tall forest habitats that are typically the habitat of the Brush-tailed Tree-rat and Brush-tailed Phascogale, are well represented in coastal Northern Territory and in areas adjacent to the project area. If these species were present in the project area it is considered likely that they would move out of the area to utilise other suitable habitat areas that occur nearby. In the context of these observations it is considered unlikely that the project will cause long-term impacts to any populations of these species.

It is unlikely also that significant populations of the False Water-rat *Xeromys myoides* occur in close proximity to the project area, as suitable habitats for this species are not present and field surveys in the nearby mangrove communities, their preferred habitat, did not reveal any signs of the animal. The more extensive mangrove and saline grassland habitats that occur in association with Injin Beach (north of the project area) and Yelcher Beach (south of the project area) are considered more likely to provide suitable habitat. In the event that *Xeromys myoides* does occur in these habitats it is considered unlikely that they will be affected by the project, which is at least 2-3 km away.

The project area does not occur in close proximity to any significant shorebird or waterbird colonies (Chatto 2003; 2000). Seabird breeding roosts (ie. terns) have been recorded in proximity to the proposed pipeline landfall site, however, these are considered to have a low significance (Chatto 2001). The proposed onshore development is considered unlikely to cause significant impacts on shorebirds or waterbirds in the region (Chatto pers. comm. 2004).

Preventative and Management Measures

During the early stages of project design, the location of the gas plant, shore crossing and export pipeline route, were chosen to avoid impacts on sensitive vegetation communities and fauna habitats, including monsoon vine forest, riparian forest and mangroves that occur in proximity to the project area. This design option will minimise the regional impacts of habitat loss on flora and fauna biodiversity.

Specific management measures that will be implemented to minimise the impacts associated with clearing of vegetation and loss of habitat are described in **Section 12.3.1**. Induction and training of the construction workforce will incorporate training in the identification of bird nesting sites and a system for reporting and assessment of identified sites will be established. The Northern Territory Parks and Wildlife Service will be consulted regarding permit requirements for clearing activities that will impact on 'protected' cycad and orchid plants.

Management Summary

- Measures identified in **Section 12.3.1** to minimise the impacts of vegetation clearing and habitat loss will be implemented.
- Additional project infrastructure, such as laydown areas, shore anchors, borrow pits, washdown bays etc. will not be located in areas of environmental sensitivity.
- The construction work force will be trained in the identification and reporting of bird nesting sites.
- A system for reporting of nest sites and evaluation of their significance will be established.
- Parks and Wildlife Service will be consulted on permit requirements for clearing of cycads and orchids.

12.3.3 Fauna Capture In Open Trench

Impacts

Construction activities, especially trenching for the installation of the shore crossing and onshore export pipeline, have the potential to cause fauna mortality due to capture of wildlife in the open excavations. Animals captured in excavations are exposed to various elements such as predators, effects from the sun and subsequent dehydration (Woinarski *et al.*, 2000b). Fauna mortality as a result of capture will be minimised through appropriate measures to facilitate their escape or removal.

Preventative & Management Measures

During the early stages of project design, the location of the gas plant, shore crossing and export pipeline route were chosen to avoid fauna habitats with a restricted distribution, including monsoon vine forest, riparian forest and mangroves.

Construction is planned for the 'dry' season when activity levels of reptiles, which are the wildlife most likely to be captured in the trench, frogs and mammals are generally lower due to the cooler weather. Construction activities will be planned to minimise the amount of time between trenching and pipe laying, so that the excavated trench will be open for minimised periods. Trench escape ramps with slopes no greater than 50% will be installed at appropriate intervals, determined in consultation with the Northern Territory Parks and Wildlife Service, to provide means for fauna to exit the trench.

Frequent inspections of open excavations will be undertaken by experienced wildlife handlers throughout the day. Inspections will commence at sunrise each day to allow the entire excavated trench to be inspected and captured wildlife removed prior to exposure to high daytime temperatures, and at least an afternoon collection will be undertaken. All wildlife removed from the excavations will be identified and recorded prior to being released in vegetated areas near to the location from where the animal was removed, and dead animals will be preserved for lodging with Northern Territory Museum. All data will be provided to the Northern Territory Parks and Wildlife Service.

Management Summary

- Construction will be undertaken in the 'dry' season.
- Excavations will be left open for the shortest periods possible, considering construction requirements and minimising impacts on fauna.
- Escape ramps with slopes no greater than 50% will be installed at appropriate intervals.
- Excavations will be inspected by an experienced wildlife handler at least twice each day.
- Wildlife removed from excavations will be identified, recorded and released, or preserved and lodged with the Northern Territory Museum
- Wildlife data will be provided to the Northern Territory Parks and Wildlife Service.

12.3.4 Weeds & Exotic Fauna

Impacts

The introduction to the project area of earthmoving equipment, vehicles, and construction materials and fill, sourced from elsewhere in the region, Australia and overseas, has the potential to introduce weeds and exotic fauna species that currently do not occur in the area. Road access routes to the project area from Darwin and Katherine traverse areas where infestations of weed species declared under the *Weeds Management Act 2001* are present, and where the Cane Toad *Bufo marinus* is currently found. Species declared under the *Weeds Management Act 2001* that occur in regions around Darwin, Katherine, Daly River and Wadeye are listed in **Table 8-7**. The construction and maintenance of a pipeline right of way cleared of tall vegetation may also facilitate movement of feral grazing animals (ie cattle, donkey, buffalo) and the rapid dispersal of Cane Toads. Cane toads will inevitably arrive in the area in the very near future, regardless of the project's influence or control. Feral pigs are already known to be in the area.

Construction plant and materials will be sourced from and\or will travel through these regions to the project area, and therefore may transport declared weeds. Construction activities will disturb the native vegetation, which will create suitable conditions for new weed species to rapidly establish, and for the existing Rubber Bush *Calotropis procera* and Hyptis *Hyptis suaveolens* infestations to spread. If weed infestations become established they will compete with, and may displace, native vegetation. In the case of the grassy weeds Gamba Grass *Andropogon gayanus* and Mission Grasses *Pennisetum polystachion* and *P. pedicellatum*, they may create conditions for hot, intense fires that have the potential to negatively impact on the environment and to place project personnel and infrastructure at risk.

Preventative and Management Measures

An Exotic Species and Weed Management Plan will be developed in consultation with the Department of Infrastructure, Planning and Environment prior to construction.

Existing weed infestations in the project area, along access routes, at borrow pits and any other locations where vehicles and plant are operating, will be identified and treated prior to construction activities. All vehicles, plant, equipment and materials will be required to be free of weeds and other pests, and a programme of random inspections will be implemented to ensure that hygiene

procedures are being implemented. A particular area of focus will be in the tendering and contracting process where hygiene for exotic species and weeds will be included in the criteria. A washdown pad will be constructed at a location to be determined on the access route to provide a facility for washdown of unclean vehicles and others prior to accessing the works sites. The washdown pad will be designed to separate hydrocarbon contaminants and weed propagules from the washdown water so that they can be disposed of in accordance with Northern Territory Government guidelines and legislative requirements. Vehicles and plant will be inspected for Cane Toads and weed propagules prior to leaving the washdown bay.

Suppliers of construction materials will be required to certify that their products are 'weed free'. Where material is to be sourced from borrow pits, the area will be subject to a weed survey and existing weed infestations will be treated prior to extracting material. Materials and fill will be subject to random inspections to ensure that the preventative measures are working.

The construction and operation workforces will undergo inductions on the importance of weed management and the identification of weed species common to the region and species of most concern, and in the identification of Cane Toads. Systems will be established for the reporting of new weed infestations and Cane Toad sightings to the Northern Territory Government Department of Infrastructure, Planning and Environment.

Only native vegetation species will be used in rehabilitation and landscaping. Species suitability for use will be determined in consultation with traditional Aboriginal owners and experts in rehabilitation in tropical environments.

The project area, access routes, borrow pits, weed washdown and other construction sites will be monitored for weed establishment bi-annually in January–February (subject to accessibility) and November (or other months as required by the Northern Territory Weeds Branch) for the duration of construction and operation. Weed eradication programmes will be implemented as required, in consultation with the Department of Infrastructure, Planning and Environment.

Domestic animals will not be permitted in the project area.

Management Summary

- An Exotic Species and Weed Management Plan will be developed prior to construction.
- Existing weed infestations will be identified and treated prior to construction.
- Plant, vehicles, equipment and construction materials will be certified 'weed free' by the supplier and will be subject to random inspections.
- A washdown pad will be constructed along the access routes to the project area to the specifications of Department of Infrastructure, Planning and Environment.
- Vehicles, plant and construction components and materials will be subject to washdown prior to entering the project area if they cannot be certified weed free.
- Washdown wastewater will be collected and disposed of in accordance with guidelines to be determined with Department of Infrastructure, Planning and Environment.

- Construction and operation workforces will be trained in weed and Cane Toad identification and awareness.
- Systems will be established for reporting of new weed infestations and Cane Toad sightings to Department of Infrastructure, Planning and Environment.
- A weed monitoring and control programme will be implemented for the duration of construction and operation.
- Declared weed species will be monitored for establishment and spread, within two years of construction.
- Only native vegetation species sourced from local areas will be used in rehabilitation and landscaping.
- Domestic animals will not be permitted in the project area.

12.3.5 Fire

Bushfires are frequent and widespread throughout the savannas of northern Australia. In the Wadeye area, where the onshore project area is located, they occur throughout the dry season from March or April each year to the end of the dry season in about November or December. The area experiences fires on an annual basis, and half the natural vegetation may burn each year. Fire history maps indicate that the frequency and scale of fires in the Wadeye area may be less than in other areas (Allan *et al.*, 2001; Russell-Smith 2001). Most fires are lit by people, although lightning has been suggested as a source of ignition in the late dry season ('build-up') when lighting storms are common. There are no data on the frequency and occurrence of lightning fires (Preece 2002). Observations of Aboriginal fire practices in the area (Preece, *pers obs*, 2002; 2003) suggest that fires are lit at any time of the year, and that the fire patches are generally smaller than those occurring in other landscapes of the northern savannas. Early dry season fires are usually of less intensity than the later fires when the conditions are hotter and drier, and winds are stronger. The scale and intensity of fires can be reduced if many small patches are lit throughout the dry season.

Impacts

There are two types of fire possible in the area – planned and unplanned fire. Planned fire for the purposes of the project is fire lit deliberately to reduce habitat for mosquitoes to breed and harbour, which is discussed below. Unplanned fire is fire which is accidentally caused by construction activities. There will be an increased risk of unplanned fire during the construction phase, and to a lesser extent, operational phase of the project. During the construction phase, potential fire ignition sources will include:

- vehicle and plant exhausts
- sparks from contact with rock
- cooking or camp fires and cigarettes
- deliberate ignition

During the operational phase of the project, the risk of ignition from the above sources will be greatly reduced with decreased numbers of vehicles and workers at the site, and through management of vegetation in the project area to reduce fuel loads. Fire could occur as a result of plant malfunction or pipeline rupture although the likelihood of these occurring is highly remote.

The integrity of the vegetation in and surrounding the project area would be diminished by more frequent fires. This is particularly an issue for monsoon vine forest communities and riparian areas, the edges of which may become more susceptible to fires as a result of clearing of adjacent vegetation communities. Long-term, repeated high intensity fires cause the erosion of rainforest boundaries and habitat decline (Russell-Smith and Bowman 1992). One of the most significant threats to the integrity of these communities is the combined threat of fire and weeds. This threat will be mitigated through coordination of weed and fire management activities.

Vegetation cleared from the plant site will probably have to be burned to avoid large stockpiles remaining on or adjacent to the plant site. This should ideally be cleared and burnt very late in the dry season shortly before rains, or very early in the dry season when fuels have not yet cured. The Bushfires Council will be further consulted on the best methods and timing of burning, and the Fire Management Plan will incorporate their recommendations.

Planned fire was recommended for reduction of mosquito habitat. Burning of the swamps north and south of the pipeline and plant (Swamp 1 at 1.5 km north and Swamp 2 at 3 km south) will be required in the dry season when the grasses and other vegetation have dried sufficiently, in order to reduce any mosquito breeding habitat (**Section 12.4**).

Preventative and Management Measures

Fire Management Plans will be developed and implemented in consultation with the Northern Territory Bushfires Council and traditional Aboriginal owners, for both the construction and operation phases of the project.

The construction workforce will be inducted in fire awareness and prevention. During construction a fire-fighting unit, and persons trained in fire fighting, will be available at all times to extinguish spot fires. Spark arresters will be fitted to all earthmoving equipment. Cooking or camp fires will not be permitted.

The risk of fires that start in the project area spreading will be managed through the establishment and maintenance of fire breaks around the boundary of the project area for the duration of construction and operation. During operation, the risk of fires starting will be minimised by managing vegetation to reduce fuel in the project area and along the road verges. An Emergency Response Plan will be developed and implemented and all operational personnel will be trained in emergency response to fire.

An Exotic Species and Weeds Management Plan will be developed and implemented, which will incorporate monitoring and eradication of grassy weed species that create a high fire risk.

Management Summary

- Fire Management Plans will be developed for construction and operation.
- Construction workforce will be trained in fire awareness, prevention and safety.
- A fire fighting unit and persons trained in fire response will be readily available at all times during construction.
- Spark arrestors will be required for all earthmoving equipment.
- Cooking and camp fires will be prohibited.
- Fire breaks will be established and maintained for the duration of construction and operation as required by Bushfires Council.
- Vegetation in the project area and along road verges will be managed to minimise fire risk.
- An Emergency Response Plan will be developed and implemented.
- All operational personnel will be trained in emergency fire response.

12.4 Biting Insects and Mosquito Borne Diseases

12.4.1 Biting Insects

Impacts

Biting insects pose two types of problems. They cause a nuisance because of their bites, and they can cause a health risk to workers involved with the Blacktip Project and the Wadeye community, particularly as the local environment is vulnerable and receptive to mosquito-borne disease. Mosquito-borne diseases are addressed in **Section 12.4.2**. Most of the treatments addressed in the following section, however, are pertinent to minimising health risks from mosquitoes.

Works associated with the project, and equipment brought in for the Blacktip Project, which contains standing water, can support exotic mosquito larvae, and increase the breeding habitat for mosquitoes.

Two types of biting insects which cause a nuisance are of concern:

- biting midges
- mosquitoes

Biting Midges: *Culicoides ornatus* is the principal biting midge pest species in the Blacktip Project development area. This species may cause minor pest problems during August to November for three or four days around the full moon and new moon. Pest problems are likely to be greatest one hour either side of sunset and sunrise and numbers will be greatest in those areas of the development nearest to Swamp 2 located 3–4 km south of the shore crossing (**Figure 8–9**). However, it is unlikely that *C. ornatus* will reach numbers sufficient to warrant fogging with insecticides in the development area, due to the buffer distance of the development area from breeding sites.

Mosquitoes: Several species of mosquitoes can cause nuisance and health problems. *Ochlerotatus vigilax* will pose the greatest pest problem as it poses a high disease risk between October and January and occurs in numbers which pose severe pest problems for up to 10 days per month from September to January inclusive, nine days after significant rainfall or monthly high tides. Low to moderate pest problems may also occur in February. *Culex annulirostris* also poses a high risk of causing a nuisance from January to June.

Anopheles farauti s.l. will pose a high risk from April to June. Other mosquito species including *Coquillettidia xanthogaster* and *Anopheles bancroftii* can cause pest problems, mainly in the post wet season months of April, May and June.

Preventative and Management Measures

A range of preventative and management measures will be utilised to manage the potential nuisance problems posed by biting insects.

Biting Midges: Elimination of biting midge breeding sites is not feasible as it would require the filling of the upper tidal creek mangrove areas in Swamp 1 and 2 (**Figure 8–9**) and the entire Sonneratia mangrove foreshores adjacent to the onshore pipeline crossing.

High use personnel areas such as accommodation, mess and recreation areas will be landscaped to allow effective insecticide barrier control of midges. Bifenthrin barrier treatments around personnel areas will be implemented to reduce adult biting midge numbers as needed. Yellow or red lights will be used in personnel areas, where possible, to prevent attracting biting midges and white or UV lights will be used in non-personnel areas to divert biting midges away from personnel areas.

The workforce and visitors will be notified of a potential minor biting midge pest problem in the months of August to November so they can take appropriate personal protection precautions such as appropriate clothing and insect repellent.

Mosquitoes: Elimination of natural mosquito breeding sites in the area surrounding the onshore gas plant is not feasible, however mosquito larval reduction measures will be implemented to assist with the control of mosquito populations. These include:

- The annual burning of Swamps 1 and 2 (**Figure 8-9**) as soon as possible after the swamps dry out. Burning reduces shelter for mosquito larvae, which allows predator access to larvae.
- A mosquito larval control programme will also be established during the construction phase using the larvicide methoprene 30 day residual pellet formulation. This larvicide will be applied before the October monthly high tide and reapplied after every 30 days of water inundation in the breeding site until the end of January. This control programme will be continued during the production phase of the Blacktip Project if warranted.

High use personnel areas such as accommodation, mess and recreation areas will be landscaped to allow effective insecticide barrier control of mosquito and these facilities will preferentially be

located on the southern section of the onshore gas processing plant, as far away from Swamp 1 as possible. Bifenthrin barrier treatments around personnel areas will be implemented to reduce mosquito numbers as needed. Yellow or red lights will be used in personnel areas, where possible, to prevent attracting mosquitoes and white or UV lights will be used in non-personnel areas to divert mosquitoes away from personnel areas.

Man-made mosquito breeding sites will be minimised by the elimination, as far as possible, of structures capable of stranding or ponding water and the active management of equipment and facilities to minimise their potential to gather standing water. A particular area of focus will be in the tendering and contracting process where management and rehabilitation works to prevent mosquito breeding potential will be included in the criteria. Minimisation efforts will include:

- The bunded drains, washdown area, condensate and fuel bunded areas, as well as any other bunded area will be sloped, where possible, so all water is contained in the smallest area possible. Standing water in bunded areas will be actively managed to ensure that it is removed or treated before mosquito breeding can occur. Additionally, impervious lining will be utilised to ensure vegetation does not grow and create ideal mosquito breeding conditions.
- Stormwater drains throughout the development will have erosion control structures, where appropriate, to minimise ponding water. Drains with the likelihood of dry season low flows will be have impervious linings and low flow facilities to reduce the likelihood of mosquito breeding.
- Temporary earth works undertaken as part of the Blacktip Project will be rehabilitated quickly to ensure the surface topography does not impede the natural flow of surface water that could lead to the creation of mosquito breeding sites. Access roads will be fitted with culverts where necessary, to prevent the upstream ponding of water that can lead to mosquito breeding. Construction activities will be monitored to ensure activities such as machinery disturbance do not lead to the creation of new mosquito breeding sites and remedial action will be taken as necessary.
- Artificial receptacles such as tyres, drums etc will be disposed of, holed or stored away from rainfall to minimise the likelihood of standing water gathering. If this is not possible, ongoing sanitation measures such as treatment with a chlorine solution or residual insecticide may be required to prevent mosquito breeding.

Regular inspections will be undertaken to monitor mosquito breeding activity and to remove man-made mosquito breeding sites where possible, occurring monthly during production and weekly during construction. These inspections will include:

- all bunded areas
- all drains on the onshore gas plant site
- laydown areas and waste disposal areas

Any larvae found will be sent to the Medical Entomology Branch (MEB) laboratory in Darwin for analysis, with appropriate remedial action advised by MEB.

The workforce will be notified of mosquito pest problem during inductions so they can take appropriate personal protection precautions such as appropriate clothing and insect repellent.

Management Summary

- Construction and operational personnel will be inducted on the appropriate clothing and personal protection measures to minimise the potential to be bitten by mosquitoes and biting midges.
- Landscaping and other engineering solutions to reduce the abundance of biting insects will be implemented.
- Insecticides may be used selectively to prevent salt marsh mosquitoes breeding.
- Inspections of materials from Qld or overseas will be conducted to identify and treat mosquito larvae sources, and materials treated where necessary.
- Materials will be stored to prevent water accumulating, and monthly inspections undertaken to eliminate standing water.
- Swamps 1 & 2 will be burnt annually to reduce mosquito habitat.
- Medical Entomology Branch will be notified of mosquito problems.
- Supervisors will be trained to recognise breeding activity and to treat breeding sites.
- Infrastructure will be designed and constructed to prevent creation of artificial habitat.
- Breeding habitat will be eliminated from earthworks by suitable rehabilitation and contouring.
- A Biting Insect Management Plan will be prepared.

12.4.2 Mosquito-borne diseases

Impacts

Mosquitoes pose a health risk to workers involved with the Blacktip Project and the Wadeye community, particularly as the local environment is vulnerable and receptive to mosquito-borne disease. Existing mosquito populations, works associated with the project, and equipment brought in for the Blacktip Project, which contains standing water, can support exotic mosquito larvae, and personnel already infected with mosquito-borne diseases can spread these diseases to the local mosquito population.

Treatments to minimise impacts from and potential increases in habitats for mosquitoes and other biting insects are addressed in **Section 12.4.1**, and are not repeated here.

Of particular concern regarding mosquitoes is the potential for the establishment of Malaria and the introduction of Dengue Fever (DF). The spread of Ross River Virus (RRV), which has the potential to cause epidemic polyarthritis, and Murray Valley Encephalitis Virus (MVEV), which may lead to Australian Encephalitis, and Barmah Forest Virus (BFV), are also of concern.

Several species of mosquitoes can cause health problems. *Ochlerotatus vigilax* will pose the greatest pest problem as it poses a high risk for RRV and BFV transmission between October and January. *O. vigilax* occurs in numbers which pose severe pest problems for up to 10 days per

month from September to January inclusive, nine days after significant rainfall or monthly high tides. Low to moderate pest problems may also occur in February. *Culex annulirostris* also poses a high risk for RRV and BFV transmission in January to March, and a high risk for MVEV transmission from January to June.

Anopheles farauti s.l. will pose a high risk of local malaria transmission at the Blacktip Project development site, should a person with the infectious stages of malaria be present in the development area from April to June.

Preventative and Management Measures

A range of preventative and management measures will be utilised to manage the potential health problems posed by mosquitoes. The physical and management measures are treated in **Section 12.4.1** on biting insects.

To prevent the introduction of exotic dengue transmitting mosquitoes (*Aedes aegypti and Ae. albopictus*), any equipment and cargo originating from overseas or North Queensland, or transported through Tennant Creek, will be inspected and treated as per Department of Health and Community Services Northern Territory (DHCS) guidelines. Any larvae found will also be sent to the MEB laboratory in Darwin for analysis, with appropriate remedial action advised or coordinated by MEB.

The workforce will be notified of mosquito pest problem during inductions so they can take appropriate personal protection precautions such as appropriate clothing and insect repellent.

Personnel who are suspected to have contracted or become infected with Ross River Virus, Murray Valley Encephalitis Virus and Barmah Forest Virus, or possibly carry Dengue Fever, will be given a medical examination and treatment as required.

Malaria has the potential to be introduced to the local population of mosquitoes and then humans by transmission from an infected person. To minimise the risks posed by a person infected with Malaria, all personnel who have arrived from overseas where Malaria is likely to have occurred will be required to be examined for Malarial infection, and may be subject to a quarantine period as per Department of Health and Community Services Northern Territory (DHCS) guidelines before entering the project area. Possible Malaria cases will be reported as soon as possible to health authorities, and management measures will be put in place to ensure potential and actual cases are kept away from mosquitoes. All personnel will receive Malaria and other mosquito-borne disease awareness material.

Management Summary

- Construction and operational personnel will be inducted on the appropriate clothing and personal protection measures to minimise the potential to be bitten by mosquitoes.
- Landscaping and other engineering solutions to reduce the abundance of biting insects will be implemented.

- Insecticides may be used selectively to prevent salt marsh mosquitoes breeding.
- Inspections of materials from Qld or overseas will be conducted to identify and treat mosquito larvae sources, and materials treated where necessary.
- Materials will be stored to prevent water accumulating, and monthly inspections undertaken to eliminate standing water.
- Swamps 1 & 2 will be burnt annually to reduce mosquito habitat.
- Suspected malaria cases will be quarantined and checked by medical personnel.
- Medical Entomology Branch will be notified of disease and mosquito problems.
- Supervisors will be trained to recognise breeding activity and to treat breeding sites.
- Infrastructure will be designed and constructed to prevent creation of artificial habitat.
- Breeding habitat will be eliminated from earthworks by suitable rehabilitation and contouring.
- A Biting Insect Management Plan will be prepared.
- Systems will be in place to manage and ensure contractor responsibility for attaining a high performance with regards to environmental management.

12.5 Waste

12.5.1 Non-Hazardous Waste Stream

Impacts

As discussed in **Section 6.2**, it is anticipated that the majority of non-hazardous waste will be generated during drilling, construction and installation of the various project components. The non-hazardous waste stream will typically include construction camp waste (both domestic and food waste) and construction site waste items such as plastic, packaging materials, scrap metal, waste pipe, and non-hazardous drums and containers.

Waste can lead to adverse environmental impacts when managed or disposed of incorrectly. Impacts on visual amenity will result if poor housekeeping is maintained, while litter may also pose a hazard to local wildlife. Litter ingested by animals can also be fatal. If litter and general waste is not contained it can cause pollution and impact on visual amenity.

Preventative and Management Measures

Effective waste management practices will be implemented during all phases of the proposed development and by Woodside support services. These procedures will be in accordance with Woodside's Waste Minimisation Policy and Guidelines, and the Environmental Standards and Aspirations document (Woodside 2003c). Waste Management Plans will be developed for each phase of the development to ensure that waste is disposed of promptly and correctly. The plans will be based on the waste hierarchy of 'Reduce, Reuse, Recycle, Dispose'. Only waste management procedures consistent with the relevant local authority requirements will be implemented.

The primary preventative measure will be to avoid waste being generated in the first place. A particular area of focus will be in the tendering and contracting process where waste minimisation will be included in the criteria. Opportunities for recycling materials will be investigated by the construction contractor and implemented where practicable (depending upon the availability and capacity of nearby facilities). The management strategies will be developed by the construction contractor and approved by the project management prior to construction commencing. In particular, recycling will be sought for tyres and steel. If possible, the tyres shall be recycled by being retreaded, and will be transported to such a location, most likely to be in Darwin.

Waste disposal during the construction phase of the project will be carried out in consultation with the relevant authorities. Where practical and taking into account health and hygiene issues, waste will be segregated and collected on-site and stored in suitable containers for removal to approved facilities as agreed with the relevant authorities prior to construction.

Where waste is generated, it will be disposed of immediately. Contractors will be required to place a high emphasis on housekeeping and all work areas will be required to be maintained in a neat and orderly manner.

All solid waste will be stored in clearly marked skips and segregated into recyclable and non-recyclable waste depending on the prevailing market/receiving facilities for recyclable waste. Waste will be accumulated in a waste transfer area. Suitable waste will be compacted on site and transferred to landfill possibly at Wadeye provided it has the appropriate capacity and handling procedures. Wadeye Landfill currently accepts domestic non-industrial waste.

Food waste will be segregated from the other waste streams and disposed of at an approved landfill facility. The precise disposal site for food waste is to be confirmed; however, the landfill facility at Wadeye could potentially be used to dispose of food waste.

Sewage sludge generated from the construction camp will be disposed of, subject to approval, at Wadeye Landfill.

Excavated soil that is not required will be either stored within the project boundary or will be dumped at an approved location off-site.

All other waste will be minimised and recycled wherever practicable, or disposed of at approved waste disposal facilities.

Management Summary

- Waste management practices will be in accordance with Woodside's Waste Minimisation Policy and Guidelines, and the Environmental Standards and Aspirations document (Woodside 2003c).
- Waste Management Plans will be developed for each phase of the development to ensure that waste is disposed of promptly and correctly. The plans will include recycling, reuse and recovery options.

- Waste minimisation will be included in the criteria for tendering and contracting processes.
- Opportunities for recycling will be investigated by the construction contractor and implemented where practicable.
- Contractors will be required to place a high emphasis on housekeeping.
- All solid waste will be stored in clearly marked skips and segregated into recyclable and non-recyclable waste if receiving facilities/end markets for recyclables are available.
- Food waste will be segregated from other waste streams and disposed of at an approved landfill facility.
- Sewage sludge from the construction camp will be treated and/or disposed of in accordance with regulatory requirements.
- Putrescible waste will be transported to landfill.
- Excavated soil will be stored within the project boundary or will be dumped at an approved location off-site.

12.5.2 Liquid Waste Stream

Impacts

The main liquid waste streams that will be generated will include the following:

- domestic wastewater (sewage and grey water), for construction and operation;
- stormwater including clean and contaminated stormwater;
- PW.

Sewage and Domestic Wastewater: Sewage and domestic wastewater must be managed to prevent a range of environmental impacts including odours; health considerations due to the presence of bacteria such as coliforms in untreated sewage; as well as the fouling, eutrophication and contamination of waterways or groundwater. During the construction phase these issues will be managed by reducing the bacterial, nutrient and Biochemical Oxygen Demand (BOD) load of the wastewater stream through appropriate treatment on-site.

Stormwater: Stormwater from the site may generate a range of environmental impacts, including sedimentation, erosion, and contamination of local ground water resources. Rapid drainage, particularly over disturbed ground, may lead to erosion of soil and result in a large sediment load being carried downstream, potentially silting up watercourses and altering flow regimes. Stormwater can also mobilise contaminants left on site due to spillage or inappropriate storage of chemicals and hydrocarbons, leading to contamination of local water resources with potential for eutrophication or toxic effects to occur. The issues associated with stormwater are managed by minimising and containing stormwater run-off, and separating and treating contaminated wastewater streams.

The stormwater drainage system is likely to be a three-tier system. Clean water will drain off site; potentially contaminated stormwater and PW will be treated and discharged via the PW export

pipeline; and contaminated water will be stored and tankered off site for disposal at an approved location.

Produced Water (PW): Impacts associated with discharge via the PW pipeline are discussed in **Section 11.18**.

Preventative and Management Measures

A portable sewage system will be used during the first 3–5 months of construction (while the construction camp is being built); the treated effluent will be used for irrigation. No negative impacts are anticipated from the discharge of this water.

The permanent sewage treatment facility, for use during the main construction phase and operation, will be in the form of an above ground proprietary package membrane reactor, will be provided for a workforce of approximately 130. These units will work by aerobic treatment methods and will consist of a series of chambers combined with an irrigation or drain disposal system. The aerobic reactions reduce the bacterial, BOD and nutrient loadings. Bacteria break the solids down to sludge. The sludge will require disposal at the existing Wadeye Landfill facility, subject to approval. To ensure that no health impacts occur upon discharge, disinfectant, usually chlorine, is added to the treatment system.

As a back up and also subject to approval, should either of the proposed systems fail, sewage will be diverted to the existing sewage treatment facilities at Wadeye, which may require upgrading.

Waste volumes during operation will not be large, and facilities will be sufficient to provide adequate treatment.

Stormwater minimisation will be most applicable during construction activities, to separate stormwater flows from contaminated or erosion-prone areas. Stormwater minimisation will be undertaken using diversion drains and bunding. The construction of temporary surface drainage, and the use of bunds to divert flows will be the responsibility of construction contractors as guided by relevant Environmental Management Plans. However, since the majority of construction will take place during the dry season, stormwater management is not anticipated to be a major environmental issue.

During operations, stormwater generation will only be of concern at the gas plant. As the plant is located in a flat area, away from any major water bodies, rivers or wetlands there are few local sensitive receptors that may be adversely impacted by stormwater discharges.

Stormwater generation and discharge from the gas plant will be managed by:

- Implementation of a Groundwater Protection Management Plan (specifying the required measures to stormwater management).
- Appropriate site drainage ensuring that contaminated stormwater and clean stormwater are separated.

- Ensuring that the storage and handling of all chemicals and potential contaminants conform to Australian Standards and relevant guidelines.

Sites will be designed so that all stormwater generated from potentially contaminated areas drain separately to an oily-water system. Bunding and containment facilities will be provided around areas of chemical storage or hydrocarbon use. Any oily stormwater will be treated prior to discharge, or will be removed for appropriate treatment and disposal at an approved facility.

Clean stormwater will be directed off site and allowed to infiltrate through the soil.

Management Summary

- During construction and operation sewage treatment facilities will be provided using aerobic treatment methods.
- Stormwater minimisation will be undertaken using diversion drains and bunding.
- The gas plant will be located in a flat area, away from major water bodies, rivers or wetlands.
- A Groundwater Protection Management Plan (specifying the required measures to stormwater management) will be implemented.
- Appropriate site drainage ensuring that contaminated stormwater and clean stormwater are separated will be implemented.
- Storage and handling of all chemicals and potential contaminants will conform to Australian Standards and relevant guidelines.
- Sites will be designed so that all stormwater generated from potentially contaminated areas drain separately to an oily-water system.
- Bunding and containment facilities will be provided around areas of chemical storage or hydrocarbon use.

12.5.3 Hazardous Waste Stream

Impacts

Hazardous waste is that which presents a risk with regards to health, safety or environmental consideration if not handled, stored, or disposed of correctly. Potential hazardous waste that will be generated by the Blacktip Project include recovered solvents, excess or spent chemicals, paints, oil contaminated materials (for example; sorbents, filters and rags), spent X-ray films and used lubricating oils.

The environmental impact of the disposal/recycling of small volumes of hazardous waste at approved onshore facilities will be a negligible to slight incremental increase in the environmental impacts associated with these facilities.

Preventative and Management Measures

Hazardous waste will be stockpiled or stored appropriately near the construction camp in segregated, signed areas. The areas will be bunded to ensure that any spillage is contained.

Rainfall will be taken into consideration when sizing the bunds. The waste will be collected on a weekly basis and disposed of accordingly at waste transfer stations, or private waste companies.

All hazardous waste materials generated will be documented and tracked, segregated from other waste streams and stored in suitable containers. Recyclable hazardous waste, such as oils and batteries, will be stored separately from non-recyclable materials. All hazardous waste materials will be disposed of or recycled at an approved facility in accordance with Woodside's Waste Minimisation and Disposal guidelines, the project Waste Management Plan and all applicable regulations.

During operation silica gel will need to be replaced every three years (**Section 6.2.3.3**); two options are being explored for silica replacement:

1) All the used material will be removed from the site for appropriate disposal/recycling by the vendor, and the system will be replenished with new silica.
2) The used silica will be sieved to remove waste material, and the system will be topped up with new silica. The waste material will be taken offsite for disposal/recycling by the vendor.

No silica gel will be disposed of on site.

All chemicals will be stored according to Australian legislation and guidelines where applicable. The types and quantities of chemicals required for production, maintenance and operation are not yet known, however, all chemicals will be screened according to their technical requirements and environmental performance. The most environmentally acceptable options will be preferentially accepted, and Woodside's HSE Safety Case will further review health, safety and environmental aspects of selected chemicals. Furthermore every effort will be made to minimise the amount of chemicals used on site and therefore reducing the volume of hazardous waste.

All storage facilities and handling equipment will be designed and constructed in such a way as to prevent and contain any spills, and will be maintained in good order. All waste and products will be stored, handled and transported with consideration for dangerous goods segregation, as per the *Dangerous Goods Act 1998*, and the *Dangerous Goods Regulations 1985*. Spill clean-up kits and Material Safety Data Sheets will be stored in easily accessible areas. Transport of dangerous goods will be in accordance with the *Dangerous Goods (Road and Rail Transport) Act 2003* and associated Regulations.

Management Summary

- All hazardous waste materials will be disposed of/recycled at an approved facility in accordance with Woodside's Waste Minimisation and Disposal guidelines, the project Waste Management Plan and all applicable regulations.
- Hazardous waste will be stockpiled or stored appropriately near the construction camp in segregated, signed areas.
- Hazardous waste areas will be bunded to ensure that any spillage is contained.

- Hazardous waste will be collected on a weekly basis.
- All hazardous waste materials will be documented and tracked, segregated from other waste streams and stored in suitable containers.
- All chemicals will be stored according to Australian legislation and guidelines where applicable.
- All storage facilities and handling equipment will be designed and constructed in such a way as to prevent and contain any spills.
- All waste products will be stored according to Australian legislation and guidelines where applicable.
- Spill clean-up kits and Material Safety Data Sheets will be stored in easily accessible areas.
- Transport of dangerous goods will be in accordance with the *Dangerous Goods (Road and Rail Transport) Act 2003* and associated Regulations.

12.5.4 Chemical and Hydrocarbon Spills

Due to the remote location of the development, fuel and other hazardous materials required during construction will have to be stored at the site. If lost to the environment these materials may have the potential to contaminate the soil and groundwater. Contamination of watercourses is discussed in **Section 12.2.2**.

During the production phase of the Blacktip Project, some hazard chemicals will be stored at the gas plant site (**Section 4.8.2**), including Blacktip condensate awaiting export.

Preventative and Management Measures

A permanent laydown area will be required for the onshore facilities during the life of the project. The laydown area will be located within the 64 ha gas plant site boundary. During construction, this area will be used for storage of materials, vehicles and equipment. It will also house the construction camp. Fuel will also be stored within the designated laydown area near the shore crossing.

All hazardous materials will be handled and stored in accordance with the corresponding Materials Safety Data Sheets (MSDS) and Australian Standards as a minimum. Where possible all hazardous materials will be handled and stored in bunded areas within the plant site.

Fuel will be stored within the plant area and shore crossing laydown area in accordance with AS1940-1993, *The Storage and Handling of Combustible and Flammable Liquids.* This standard includes the requirement of a bunding capacity of 110% of the stored volume. Appropriate spill kits will be available where fuel and hazardous materials are used and stored. All personnel handling fuel and other hazardous materials will be trained and competent in the correct handling procedures and management of spills of applicable materials.

The potential for leaks from the onshore condensate tanks will be managed through the appropriate design of the tanks. During operation a spill protection system will be put in place for the

condensate storage tanks. Significant leaks will be detected by measuring the condensate levels in the tanks. Small leaks, not detectable by this method, will be contained within bunded areas and will then be diverted via the plant collection system to the plant process system where the water and condensate will be separated. The condensate will be transferred back to the tanks for export and the water discharged through the PW system after treatment.

Management Summary

- The volume of chemicals and hydrocarbons that will be stored on site will be minimised.
- Laydown areas will be used for the storage of hazardous materials and equipment.
- A Waste Management Plan will be developed and implemented.
- During operation a spill protection system will be put in place for the condensate storage tanks.
- All hazardous materials will be handled and stored in accordance with the corresponding Materials Safety Data Sheets (MSDS).
- Fuel and other hazardous materials will be handled and stored in bunded areas within the plant site and shore crossing laydown area in accordance with the corresponding MSDSs and Australian Standards.
- Appropriate spill kits will be available where fuel and hazardous materials are used and stored.
- All personnel handling fuel and other hazardous materials will be trained and competent in correct the handling procedures and management of spills of applicable materials.

12.6 Atmospheric Emissions

12.6.1 Greenhouse Gases

Impacts

The Greenhouse Effect: 'The Greenhouse Effect' is a natural phenomenon by which thermal radiation is partially retained in the Earth's atmosphere due to its interaction with naturally occurring greenhouse gases which impede the emission of heat from the atmosphere. This leads to the Earth's temperature being warmer than it would be in the absence of these gases.

In recent times, a great deal of effort has been directed towards defining the changes in atmospheric greenhouse gas concentrations and global temperatures. Gases of particular concern are: carbon dioxide (CO_2); methane (CH_4); and nitrous oxide (N_2O). Concentrations of these gases have increased since pre-industrial times. It is believed that the increased concentrations of these gases has enhanced the greenhouse effect, leading to an excess of energy being retained within the Earth and atmosphere, and consequently resulting in 'global warming'.

***Greenhouse Gases and Global Warming Potential*:** The impact of individual gases on global warming varies depending on their particular properties and the time span over which the effect is being considered. To describe differences, gases are described in terms of their 'global warming potential'. This is expressed relative to carbon dioxide (CO_2) over a time horizon (100 years usually) and is referred to as CO_2 equivalents (CO_2e). The global warming potential of the six

main greenhouse gases is given in **Table 12-1**. There will be no emissions of perfluorocarbons, hydrofluorocarbons or sulphurhexafluorides from the Blacktip Project.

- **Table 12-1 Global Warming Potential of Difference Gases Relative to CO_2**

Gas	Global Warming Potential tonnes CO2e/tonne gas released
Carbon dioxide	1
Methane	21
Nitrous oxides (N_2O)	310
Perfluorocarbons	6,500–8,700
Hydrofluorocarbons	560–11,700
Sulphurhexafluoride	23,900

Source: IPCC (1995)

Gross Emissions: It is predicted that the Blacktip Project will emit greenhouse gases at the rate of approximately 90,000 tpa of CO_2-e and to produce 1.5 Mtpa of hydrocarbon products for approximately 30 years.

Benchmarking & Emissions Intensity: As a means of determining the relative contribution of the Blacktip Project to the global impact of greenhouse gas generation, benchmarking of the Project's greenhouse efficiency was undertaken. This benchmarking was undertaken using the mean intensity of the Australian Petroleum Production and Exploration Association (APPEA) members as the standard. APPEA records show that during 2002, the Australian petroleum industry emitted 16,331,483 tonnes of CO_2-e, producing 52.1 million tonnes of hydrocarbons, at a greenhouse gas emission intensity of 0.31286 tonnes CO_2-e per tonne hydrocarbons produced. These emissions include production from and emissions generated by Australian onshore and offshore facilities. Using the APPEA intensity as a benchmark provides a generic industry 'average' greenhouse intensity against which to benchmark the Blacktip Project.

As stated previously, the Blacktip Project is predicted to produce 90,000 tpa of CO_2-e and to produce 1.5 Mtpa of hydrocarbon products. This is an emission intensity of approximately 0.06 tonnes CO_2-e per tonne of hydrocarbon product, significantly less than the APPEA average.

Based on 2002 figures, the Blacktip Project would contribute less than 1% of total greenhouse gas emissions from the facilities reporting through APPEA. As numerous other gas developments will eventuate in the intervening period, it is anticipated that by the time the Blacktip Project is operational, it will represent an even smaller proportion of the greenhouse gas emissions from the Australian petroleum industry.

Product Life Cycle: Gas and condensate products produced by the Blacktip Project will ultimately provide a fuel source for consumers, resulting in approximately 4.5 Mtpa of CO_2-e being released to the atmosphere. However, gas generates the smallest quantity of CO_2 per unit of energy produced of any fossil fuel, roughly half the amount of CO_2 produced by coal and 30 % less than crude oil or condensate (Office of Energy 2003)

Over the product life cycle, the emissions from the Blacktip Project represent approximately 3% of total greenhouse gas emissions, with 97% of emissions resulting from the use of the product by others. A reduction in emissions from the Blacktip Project itself, therefore, represents a minimal decrease in the total life cycle greenhouse gas emissions.

Preventative and Management Measures

In accordance with the Northern Territory Government's objectives for managing greenhouse gas emissions, Blacktip Project emissions will be reduced to as low as reasonably practicable. Measures specifically identified by the Government, which will be adopted by Woodside to meet these requirements include:

- Applying best practice to maximise energy efficiency and minimise emissions.
- Undertaking an ongoing programme to monitor and report emissions and periodically assess opportunities to further reduce greenhouse gas emissions over time.
- Undertaking comprehensive analysis to identify emissions offsets.
- Giving consideration to preparing for possible climate change impacts.

Applying Best Practice to Maximise Energy Efficiency & Minimise Emissions: The largest continuous source of greenhouse gas emissions will be associated with the combustion of fuel gas used in the compression system driver, and other gas fired equipment at the onshore gas plant. Management of greenhouse gas emissions will be achieved by the use of efficient machinery and the maximum practicable use of waste heat.

The following additional measures will be applied to minimise greenhouse gas emissions at the gas plant:

- Continued identification of sources of emissions during detailed design, and elimination where possible.
- Maximising facility reliability, thereby reducing the likelihood that gas will require flaring due to process upset.
- Minimising releases by ensuring equipment is correctly specified and maintained.
- Designing feed gas and product pipelines to be isolatable from the plant, allowing gas plant maintenance to occur without requiring that the pipelines are depressurised.
- Connecting feed gas and export gas pipelines to the flare system, so that if pipeline depressurisation is required, gas will be produced to the maximum possible extent and the remainder flared, rather than vented.
- Ensuring gas compression systems and power generation systems are commissioned to the maximum extent possible in the vendors' works to minimise site commissioning thereby avoiding lengthy flaring during on-site commissioning.
- Compressors using dry gas seals.
- Directing liquids from knockout vessels back to the process rather than to the flare.

- Specifying high integrity valves (to minimise leakage through them to the flare and from them to atmosphere).
- Establishing isolation philosophy to minimise emissions.
- Providing flow meters in the flare and fuel gas systems, and sampling points in exhaust and vent stacks (or similar systems provided) to enable emissions sampling. Information obtained from these measures will be used to enable reporting of emissions, performance reviews and setting reduction targets in line with Woodside's corporate initiatives.
- Small solar panels, solar hot water systems and other alternative energy devices may be installed at the onshore gas plant where appropriate; however, it is not envisaged that these will have a significant impact on the total emissions from the Blacktip Project.
- Minimising flaring and venting of hydrocarbons and fuel gas consumption by using best available technical and procedural solutions at a reasonable cost.

Fugitive emissions from the Blacktip Project will be small, as every effort will be made to avoid gas leaks for safety purposes. The latter will be achieved by specification of equipment and implementation of appropriate safety systems. Fire and gas protection and shutdown systems will be installed in line with industry practice to ensure that any unexpected leaks are detected and rectified. Safety systems are discussed in **Section 4.8.5**.

Management Plans: Although the main focus for greenhouse gas emissions reduction will be operational measures at the onshore gas plant, a Greenhouse Gas Management Plan will be drawn up to consolidate and address greenhouse gas emissions reduction across the life of the project encompassing both offshore and onshore emissions. The Greenhouse Gas Management Plan will be prepared for each significant phase of the development, namely: drilling; construction; commissioning; operation and decommissioning. The plan will be consistent with the principles of continuous improvement and will include a programme for ongoing monitoring, investigation, review and reporting of internal and external greenhouse gas abatement measures.

Flaring Management Plans will also be developed for drilling, commissioning and production activities. In each case the objectives of the Flaring Management Plan will be to:

- Meet the intent of Woodside's Environmental Standards and Aspirations objectives.
- Avoid excessive flaring of natural gas.
- Minimise release of gas to the safety flare system during normal operations, except as required for safety and operability.
- Describe the hardware in place, and procedural steps that will be taken, to reduce the period of time required to commission the compression facilities and reduce the quantities of gas flared.
- Ensure the quantity of hydrocarbons flared is measured.
- Identify responsibilities for monitoring and reporting emissions from daily operations all the way through the chain of command through to the Woodside Board.
- Define a process to review flared gas quantities and seek to reduce these through continuous improvement, consistent with Woodside's Environmental Policy.

Monitoring & Reporting: Under the Greenhouse Challenge Cooperative Agreement participants undertake an ongoing programme to monitor and report emissions and periodically assess opportunities to further reduce greenhouse gas emissions over time. Woodside also contributes to Australia's greenhouse response by appropriately investing in efficient technology and identifying opportunities for continuous improvement in the greenhouse emissions intensity of its projects. The Blacktip Project will be included in Woodside's Greenhouse Challenge Report.

Woodside entered into a Greenhouse Challenge Cooperative Agreement with the Commonwealth Government in 1997. The Cooperative Agreement currently covers all Australian operations and activities operated by Woodside. Woodside is committed to maintaining participation in the Greenhouse Challenge Programme. Reporting of emissions and abatement measures at the Blacktip Project under the Greenhouse Challenge will occur through existing Woodside arrangements.

Since joining the Programme in 1997, Woodside has achieved significant reductions in greenhouse emissions through its commitment to its environmental policy, such as by producing energy in an efficient manner and applying best economically available technology in design to reduce greenhouse gas emissions.

The aim of the Woodside Greenhouse Strategy is to identify cost effective technological and external opportunities to abate greenhouse emissions.

Emissions Offsets: Emissions offsets include activities that sequester carbon or reduce the greenhouse gas output or intensity per unit product from current or future activities. In this regard, Woodside's sustainable energy company, Metasource Pty Ltd, a wholly owned subsidiary, continues to pursue sustainable and renewable energy solutions through investment in new technologies. Metasource Pty Ltd is responsible for maintaining and expanding the existing portfolio of sustainable energy investments which includes:

- Geodynamics Limited, a publicly listed company, is focused on renewable geothermal energy generation from hot dry rocks (HDR) in the Cooper Basin. During 2003, Geodynamics drilled their first geothermal well to a depth of 4,421 m and successful fractured the granite hot rock. In 2004, Geodynamics are planning to drill a second geothermal well to circulate water through the hot granite structure, thereby proving up the concept of HDR technology. Further details can be obtained from www.geodynamics.com.au.
- Ceramic Fuel Cells Ltd. (CFCL) is an unlisted Melbourne based company developing high efficiency power generation products fuelled by natural gas. During 2003, CFCL continued to develop its 2 kW solid oxide fuel cell prototype. CFCL is planning to list on the Australian Stock Exchange during 2004, which will provide additional equity to fund its development work and effort to secure application development and manufacturing partners in order to commercialise the technology. Further information can be obtained from www.cfcl.com.au.
- Ocean Power Technologies Inc. (OPT) is a United States (US) based company listed on London's secondary market, AIM. OPT is developing an environmentally sound offshore

wave power technology. OPT has entered several agreements (including with the US navy) to commercialise its technology. Further information can be obtained from www.oceanpowertechnologies.com.

Consideration to Possible Climate Change: Due to the seasonal extremes in climatic conditions experienced in the Northern Territory between dry and wet seasons, project design criteria already take into account construction and operation in such conditions. Furthermore, engineering design of all facilities both offshore and onshore takes into consideration extreme climatic conditions, for example cyclones, tidal surges, flooding etc. If required, these potential climatic change impacts will be investigated in the Greenhouse Gas Management Plan that will be drawn up specifically for this project.

Management Summary

- Best Practice Methods will be applied to maximise energy efficiency and minimise emissions.
- Sources of emissions will be continually identified during detailed design, and eliminated where possible.
- Facility reliability will be maximised, thereby reducing the likelihood that gas will require flaring due to process upset.
- Emission releases will be minimised by ensuring equipment is correctly specified and maintained.
- Flaring and venting of hydrocarbons and fuel gas consumption will be minimised by using best available technical and procedural solutions at a reasonable cost.
- Excessive flaring of natural gas will be avoided.
- Flaring will be kept to a minimum for maintenance and emergencies only.
- A Flaring Management Plan and a Greenhouse Gas Management Plan will be prepared and implemented to meet the intent of Woodside's Environmental Standards and Aspirations Objectives.
- A monitoring and reporting programme will be undertaken to periodically assess opportunities to further reduce greenhouse gas emissions over time.
- Comprehensive analysis of emissions will be undertaken to identify and analyse emission offsets.
- If required, potential climate change impacts will be investigated in the Greenhouse Gas Management Plan.

12.6.2 Other Combustion Products

Impacts

As specified in **Section 6.3.3**, NO_x and SO_x will be produced to varying extents during Blacktip Project operations. These gases are acidic and are associated with photochemical smogs, acid rain and acid deposition, which may potentially harm cultural sites or vegetation.

Preventative and Management Measures

Technological solutions are available to minimise the production of NO_x using low NO_x burners. The currently available technologies; however, tend to decrease efficiency, power output and reliability of compressor drivers and power generation equipment, creating a trade-off between NO_x and direct or indirect CO_2 emissions.

Given the low quantities of NO_x anticipated to be emitted from the Blacktip Project low NO_x technology is not currently proposed for offshore or onshore infrastructure.

The major source of SO_x emissions will be associated with fuel gas consumption at the onshore gas plant; however, Blacktip gas has a very low sulphur content which will limit the volumes of SO_x produced. Additionally, the management measures applied to maximise the plant efficiency and minimise fuel use will effectively reduce SO_x emissions.

Any impacts on human health due to an increase in NO_x and SO_x, which might also result in the generation of smog or potentially harm cultural sites or vegetation, are not expected as the area is located in a remote non-industrial coastal area where there are no pre-existing high levels of any such emissions. Furthermore, any such emissions from the Blacktip Project are expected to be minor.

Management Summary

- Blacktip gas has a low sulphur content.
- The project is located in a remote location with no nearby inhabitants.
- Low emissions of NO_x and SO_x expected.
- Low sulphur diesel will be used.
- Management measures applied to maximise the plant efficiency and minimise fuel use will effectively reduce SO_x emissions.

12.6.3 Other Atmospheric Emissions & Pollutants

Impacts

NMHC Emissions: Non Methane Hydrocarbons (NMHC) Emissions are estimated to be minor, due to the high levels of fugitive emission control applied around the Blacktip Project, and the very low production rate of condensate. The selection of efficient combustion equipment will minimise the emission of NMHC from incomplete combustion.

Volatile Organic Compounds (VOCs): VOC's will be present to a very small extent in the uncombusted component of flares and combustion engines, from fugitive emissions and off-take tankers.

Ozone Depleting Substances: ODSs will not be installed in or used in the manufacture or installation of any new systems associated with the Blacktip Project.

Any impacts on human health due to an increase in these emissions, which might also aid in the generation of smog are not expected as the area is located in a remote non-industrial coastal area where there are no pre-existing high levels of any such emissions. Furthermore, any such emissions from the Blacktip Project are expected to be minor.

Preventative and Management Measures

The major measure adopted to minimise NMHC emissions will be contained within the process design where the condensate is treated to meet market demand specifications. The condensate will be stored in tanks with a conventional floating roof. During condensate loading, emissions from the tankers will occur but these loading operations will be very infrequent.

Other NMHC sources may be identified during the detailed design; these are not expected to be significant and if identified will be minimised to the lowest practicable level.

ODSs will not be included in any new facilities associated with the Blacktip Project. The use of ODSs by contractors during the construction and commissioning phases will be strictly controlled by the following measures specified in the Woodside Energy Services Agreement:

- Contractors to use ODS-free systems wherever alternative options are available;
- Contractors to obtain written approval from Woodside before using any substance with Ozone Depleting Potential (ODP) >0.1;
- Contractors to provide Woodside with a list of ODS inventories and identify any expected emissions;
- Contractors to:
  - avoid halon fire protection systems
  - avoid pressure pack canisters containing CFCs
  - avoid laboratory chemicals containing CFCs
  - avoid foam insulation products manufactured using CFCs
  - use no ODP and Global Warming Potential (GWP) substances in refrigeration and air conditioning systems
  - avoid cleaning agents containing CFCs.

Management Summary

- Measures to minimise NMHC emissions will be contained within the process design where the condensate is treated to meet market demand specification.
- Condensate will be stabilised and tanks will have floating roof tanks.
- Infrequent condensate loading.
- The use of ODSs by contractors during the construction and commissioning phases will be strictly controlled by measures specified in the Woodside Energy Services Agreement.
- Contractors will be required to use ODS free systems wherever alternatives are available.

- Written approvals from Woodside will have to be obtained to approve the use of substances with Ozone Depleting Potential.
- Contractors will be requested to provide a list of ODS inventories to identify any expected emissions.
- Any release of OSDs will be treated as a reportable incident.

12.6.4 Odour

Impacts

Odours can present a nuisance to nearby residences, members of the public and workers if they are not managed effectively. A trace amount of mercaptan and hydrogen sulphide (H_2S) may naturally occur in the gas entering the gas plant (**Section 6.3.4**). Under normal operating conditions there should be no odour emanating from the plant. However, under upset conditions there is the potential for gas to escape from the plant. Even with a substantial leak and in calm conditions (worst case) preliminary dispersion calculations indicate that beyond 350 m there should not be any odour impact due to H_2S. Similarly, if the gas contains mercaptans then at 350 m from the source, concentrations would be half the detectable limit and 1/3 the recognition limit.

Based on these very conservative calculations nuisance odours should not extend beyond the plant boundary during normal operating conditions or upset conditions.

Preventative and Management Measures & Summary

- The plant is located in a remote area with the closest (temporary) community 2.5 km from the plant site and the closest permanent residence some 10 km away.
- No mercaptans will be added to the gas stream.
- Onshore condensate tanks will have floating roofs significantly reducing the potential for emissions.
- Only trace amounts of H_2S and mercaptans will be present (if at all) in the gas.
- Preliminary dispersion calculations indicate that beyond 350 m there should not be any odour impact due to H_2S.
- The plant will be designed to high industrial standards ensuring that upset conditions and associated leaks are minimised.

12.6.5 Dust Emissions

Impacts

Dust may be generated by construction activities such as the clearing of vegetation, movement of vehicles, earthworks, the formation of soil stockpiles and exposed surfaces. Dust emissions have the potential to affect the health of workers, members of the public, impact on vegetation and amenity, and to lead to the loss of topsoil.

Dust can potentially present a hazard at the proposed plant and along the pipeline ROW principally due to reduced visibility for vehicle drivers, dust inhalation to the workforce, detrimental effects on

the welding and damage to equipment. Dust is a hazard on access tracks, mainly due to reduced visibility and the risk of floating and skidding on thicker layers of bulldust. This also presents a hazard to the public if the track is not exclusive to the project.

Dust can also reduce the photosynthetic activity of plants, physically smothering leaves and blocking stomata. Photosynthesis can be reduced due to dust thereby reducing plant growth. Effects of dust on natural communities may alter the competitive balance between species in a community.

Preventative and Management Measures

The proposed access road between Wadeye Airstrip and the project area will be aligned to avoid access through Wadeye, thereby avoiding dust emissions at this sensitive receptor.

Minimising dust and the subsequent impact to vegetation will require active management throughout the construction period. Activities that will require management will include clearing, and earthworks, particularly during dry, windy conditions.

Dust suppression is a commonly used practise on plant and pipeline construction projects. There are several proven methods that can be adopted.

Limiting vehicle speed has a significant effect on the amount of dust that is generated. Speed limits will be implemented along the pipeline ROW and on access tracks in accordance with Traffic Management Plans. The speed limits must be enforced and all personnel must be made well aware of the hazards and speed restrictions during the initial induction, and subsequent toolbox meetings.

Water can be sprayed on the ground to settle and compact the dust. The water forms a temporary crust and generally works for periods of time, but will need to be reapplied, as the traffic breaks the crust and loosens the dust again. At the construction sites this may be required several times per day. Along the access tracks, this may be required on a daily basis or every few days, depending on the traffic density and the dry conditions.

Another method of suppressing dust is the use of a chemical binder. This is generally a hygroscopic solution based on magnesium chloride. It is a bulk liquid delivered to site ready to be used without mixing, and can be spread from a water-cart. It binds the soil particles together and this, together with the compaction from the traffic, suppresses the dust.

A Dust Management Plan will be developed; a framework is contained in **Section 15**. The plan will specify management measures to ensure that vehicle speeds will be kept as low as possible, traffic movements will be confined to approved roads, stockpiles will be limited in height and stabilised against erosion, and that cleared areas will be rehabilitated as soon as possible. Measures for the watering of roads and stockpiles if necessary to contain dust emissions will also be specified.

Management Summary

- Speed limits will be implemented along the pipeline ROW and on access tracks in accordance with Traffic Management Plans.
- Water or an approved alternative will be employed to ensure that access roads and the ROW is adequately managed to minimise dust.
- A Dust Management Plan will be prepared and implemented.
- Exposed surfaces such as stockpiles and cleared areas will be kept to a minimum.
- During the site induction the workforce will be made aware of dust generation and control measures.

12.7 Noise

Impacts during Construction

The nearest sensitive receptor for the Blacktip Project is the Tchindi Aboriginal Camping Ground, 2.5 km south-west of the gas plant and Wadeye township which is approximately 10 km east of the proposed gas plant site.

A noise assessment was conducted allowing the compilation of the noise emission inventory summarised in **Section 6** and detailed in **Appendix A**, **Volume 2**. The assessment concluded that there is limited potential for noise impacts from construction activities on surrounding land uses and potentially sensitive receptors at Wadeye Township and the Tchindi Camping Ground.

Compliance to recommended construction criteria is expected for all day time construction activities but if any of these activities occur during the evening or night time compliance is not predicted for activities such as clearing and grading, and trenching. As detailed below, management measures will be implemented to deal with any such occurrences; it is expected that the shore pull for the export pipelines will be a 24 hour operation.

A minimal volume of construction road traffic through Wadeye Township is expected to marginally breach the recommended construction criteria. However, as the source of noise is expected to be infrequent it is not considered a significant long term impact. Furthermore, an access road will be constructed between Wadeye airstrip and the project area, which will mean the vast majority of traffic will bypass the town and any impacts will therefore be greatly reduced. Management measures will be implemented to reduce any short term impacts as detailed below.

Preventative and Management Measures during Construction

The draft Environmental Noise Regulations will be adopted for all onshore construction activities. In accordance with these regulations during the hours of 7 am and 7 pm Monday to Saturday (excluding public holidays) the following measures will be adopted:

- Work will be undertaken in accordance with AS 2436–1981 ‘Guide to Noise Control on Construction, Maintenance and Demolition Sites’;
- The equipment used will be the quietest reasonably available;

- A construction Noise Management Plan will be approved and complied with.

If night time construction works are proposed it is recommended that validation monitoring is undertaken to assess actual noise levels during works in accordance with the recommended criteria described in **Section 6.4.3**. Generally, the recommended criteria for noise levels during construction at sensitive receptors are 5dB(A) greater than the existing background noise level.

Management noise impacts associated with the operation of machinery will be addressed in a Noise Management Plan. The plan will address hours of operation, the use of mufflers and other devices to reduce noise emissions, and heightening awareness amongst construction workers about the importance of minimising noise emissions. A framework Noise Management Plan is included in **Section 15**.

The project-specific Noise Management Plan and Traffic Management Plan will also ensure appropriate management measures are specified for any construction road traffic through Wadeye township by identifying suitable transport routes through the town to reduce noise impacts from traffic. Where possible heavy vehicle movements will be restricted to normal day time periods (7 am to 6 pm Monday to Saturday). However, an access road will be constructed between Wadeye airstrip and the project area, which will mean the vast majority of traffic will bypass the town and any impacts will therefore be greatly reduced.

Impacts from noise emissions, resulting from increased construction traffic is unlikely, given the proposal to direct construction traffic away from the town.

Management Summary

- An access road will be constructed between Wadeye airstrip and the project area, which will mean the vast majority of traffic will bypass the township.
- The *draft Environmental Noise Regulations* will be adopted for all onshore project construction activities.
- A Noise Management Plan will be implemented which will address hours of operation, the use of mufflers and other devices to reduce noise emissions, and heightening awareness amongst construction workers about the importance of minimising noise emissions.
- A Traffic Management Plan will be developed and implemented which will address impacts from traffic.

Impacts during Operation and Maintenance

Based on the noise assessment undertaken it was concluded that noise impacts during the operation phase will be minimal due to the significant buffer distances to potentially sensitive receptors (**Figure 12-1**).

Normal Operations: During normal operations noise levels at the plant boundary will not exceed 82 dB(A). Based on the modelling assessment undertaken, the noise level is predicted to be 25 dB

approximately 2.5 km from the plant boundary at the Tchindi Camping Ground. The noise level will be significantly less than this 10 km away at Wadeye.

This indicates that expected emission levels during operations are unlikely to be significant due to the buffer distances to potentially sensitive receptors, and will comply with day time criteria and the more stringent evening and night time criteria for receptor locations. Furthermore, internal noise levels, specifically with regard to the on-site accommodation will comply with AS 2107:2000 'Recommended Design Sound Levels and Reverberation Times for Building Interiors'.

Given the small number of vehicle movements expected during operation, traffic impacts are considered negligible.

Maintenance and Emergency Flaring: The greatest noise impacts are expected to occur during planned maintenance and emergency flaring (**Figure 12-2**). The noise modelling undertaken (based on a conservative absolute noise level of 115Db(A) concluded that the noise levels for maintenance operations are expected to be less than 47 dB(A) at the Tchindi Camping Ground and less than 20 dB(A) at Wadeye which are within the recommended 'Area 4' day time, evening and night time criteria. It is recognised that the noise levels may be audible at the Tchindi Camping Ground which is closer to the proposed gas plant site. Appropriate management measures are included below.

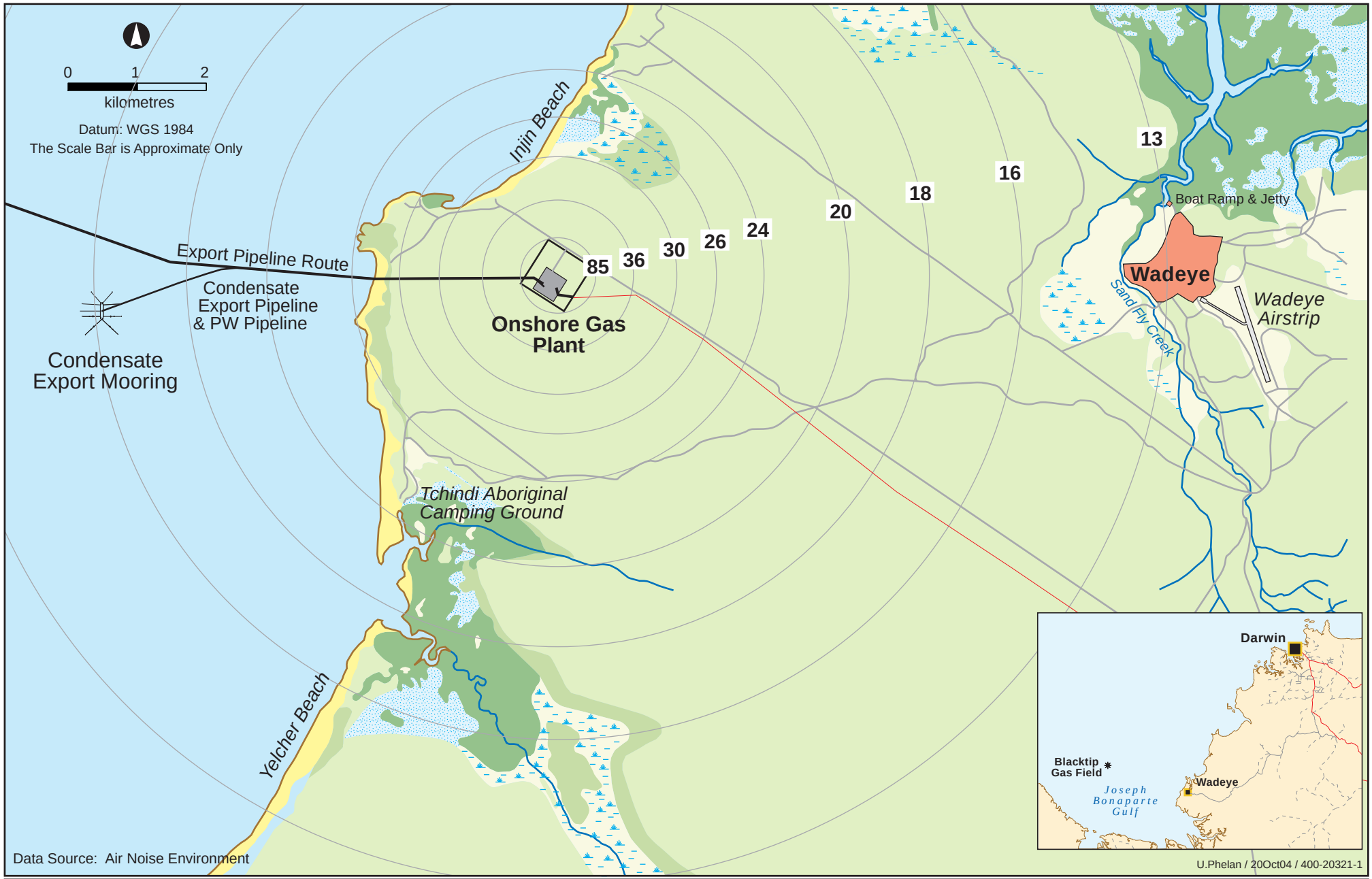
Preventative and Management Measures during Operation and Maintenance

Noise impacts during the operational phase are only likely to be significant if flaring is required for planned maintenance and emergency flaring. During planned maintenance events flaring will occur quarterly or annually, over a 1–24 hour period. In these circumstances, representatives of the Tchindi Aboriginal Camping Ground and the Wadeye local community will be notified at least 24 hours prior to any flaring commencing.

Non-emergency flaring will be kept to a minimum and will be infrequent.

The detailed design of the flare has not been undertaken but it will take into consideration the need to limit noise levels to appropriate standards. The noise levels emitted from this type of flaring will be determined during the detailed design for the flare but will be less than the Woodside absolute standard for noise emissions of 115dB(A) at ground level.

During emergency cases, issues such as noise emissions tend to be exempt from normal amenity criteria. This is because in an emergency other factors (health and safety) generally take priority over noise. Nose generally has no residual effect on the environment once the event has ceased and hence has little risk in terms of long term environmental impact. Automatic control measures will be in place for the detection and control of such releases. These events will be very infrequent (maybe only every five years) and of short duration and will not exceed Woodside's absolute standard for noise emissions of 115dB(A) at ground level.



Blacktip Project

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NORMAL OPERATIONS NOISE CONTOURS

Figure 12.1

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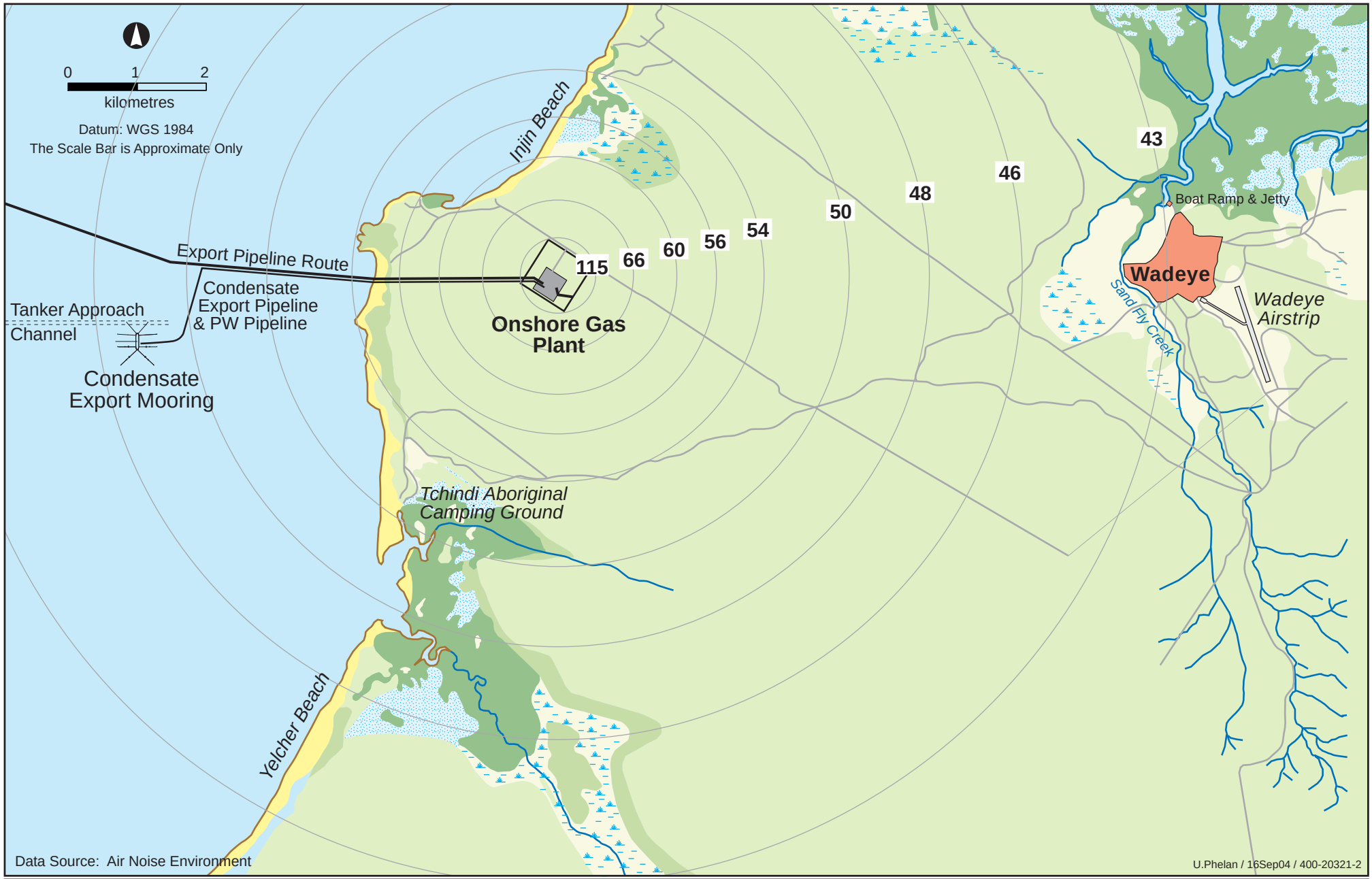

Blacktip Project

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EMERGENCY FLARING NOISE CONTOURS

Figure 12.2

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Management Summary

- Site boundary noise levels will be validated during commissioning and early stages of the operation to confirm the assumptions used in the Noise Assessment.
- A Flaring Management Plan will be developed to reduce non-emergency flaring to as low as reasonably practical.
- A Noise Management Plan will be developed and implemented which will address impacts from traffic.

12.8 Vibration

Impacts

Vibrational impacts may be arise due to blasting and from the operation of machinery and vehicles. The impacts associated with the latter are not expected to be significant but increased vibrational energy may impact on local fauna and in particular the growth and development of sea turtles along the beach. Impacts on sea turtles are discussed in **Section 11.4**.

If blasting occurs it would be associated with trenching of the export pipeline in the nearshore area. However, based on geotechnical data gathered to date blasting is highly unlikely to form part of the construction phase of the project. A final decision on the requirement for blasting will be made once the full results of the geotechnical survey are available which is anticipated to be in December 2004.

The noise emissions associated with blasting are predicted to comprise a 'quiet thud' and are not deemed significant. Based on the modelling undertaken for blasting the recommended criteria for day time and evening construction work would be complied with; at night time the criteria is only very marginally breached (0.3 dB (A); this is not deemed a significant exceedance, and it will be of a temporary duration.

Shock waves and noise emissions from blasting operations are therefore not expected to have a significant impact on terrestrial fauna. At most, animals would temporarily vacate the immediate area and then return to the area and resume normal behaviour soon after.

Preventative and Management Measures

During construction, the most significant vibrational impact is likely to result from blasting, should blasting be necessary. If blasting is required a Blasting Management Plan will be developed. There are no sensitive receptors within 2 km of project area.

This plan will also include the following management measure:

- The results of the blasting predictions will be provided to the regulatory authority prior to commencement of blasting for approval along with any proposed mitigation measures including the possibility to increase cover material depth, increase spacings between charges and reduce the size of charges detonated per event.

The plan will also outline blasting procedures to minimise the impact on fauna including:

- measures to control vibration and noise associated with blasting;
- approvals and permits for the storage and use of explosives;
- implementation of management strategies including drill and blast techniques with a smaller zone of effect.

Management Summary

- There are no sensitive receptors within 2 km of project area.
- Blasting is highly unlikely to be required based on geotechnical investigations.
- If blasting is required, a Blasting Management Plan will be prepared.

12.9 Light

Impacts

Terrestrial light spill may occur around the plant due to the need for road lighting and plant lighting to ensure a safe working environment. It is possible that light spill from these activities will result in some disturbance to terrestrial fauna; however, this is likely to be highly localised and minimal.

The beach area will be illuminated on a 24 hour basis for safety reasons during the shore pull of the export pipeline resulting in light spill potentially covering the entire beach. Impacts on marine fauna, such as turtles, are discussed in **Section 11.23**. Light spill will also emanate from the gas plant flare.

Preventative and Management Measures

Lighting at the plant site during the operational phase will be minimised to that required to ensure safe working conditions. Design of lighting will take into account the operational, safety and health issues, as well as the need to manage light spill and address the biting insects issues (**Section 12.4**).

The main preventative measure in dealing with light spill from the flare will be in the design of the gas plant itself. During normal every day operations the flare will consist only of a small pilot flare only. During planned maintenance (quarterly/annually) and emergency situations (rare) the flare will have a much greater flame height, 20–60 m high. The level of light will be dependent on the volume of gas flared. Flaring will be undertaken during daylight hours where possible.

During planned maintenance events flaring will occur over a 1–24 hour period. In these circumstances, representatives of the Tchindi Aboriginal Camping Ground and any dwellings within a 5 km radius of the gas plant will be notified at least 24 hours prior to any flaring commencing.

During emergency situations, flaring will mostly only occur over a 10 minute period and therefore will be very infrequent and short term. During emergency cases, issues such as illumination tends

to be exempt from normal amenity criteria. This is because in an emergency other factors (health and safety) will generally take priority over light. Light generally has no residual effect on the environment once the event has ceased and hence has little risk in terms of long term environmental impact. Automatic control measures will be in place for the detection and control of such releases. These events will be very infrequent and of short duration.

Management Summary

- All lighting will comply with AS4282, with lights being directed downward and chosen to minimise light spill.
- Lighting will be designed to minimise the potential to attract biting insects, and to optimise deterrence of biting insects.
- Vehicle traffic at night will be limited to minimise fauna disturbance.
- All non-essential lighting (minimum requirements to meet HSE standards) will be minimised.
- During normal everyday operations only a very small pilot flare will operate at the gas plant.
- Planned flaring will be infrequent and of short duration and undertaken during daylight hours where possible.
- Automatic control measures will be in place for the detection and control of emergency flaring.
- The local community will be informed at least 24 hours prior to any planned maintenance flaring commencing.
- A Lighting Management Plan will be prepared and implemented for construction of the plant site and laydown areas.

12.10 Summary of Impacts

A summary of the potential terrestrial impacts of the proposed Blacktip Project is presented in **Table 12-2**. Column 1 specifies the environmental factor likely to be impacted by the project and Column 2 identifies the source of that hazard. Column 3 specifies the aspect of the development posing an environmental hazard. Column 4 describes the potential impact if the environmental hazard or event were to occur. Column 5 summarises the predicted impact after the specified preventative and management measures have been implemented to reduce the likelihood or the consequence of the impact.

To describe the type of change and duration of impacts, the terms already defined in **Table 10-3** have been used.

■ **Table 12-2 Summary of Terrestrial Impacts**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Physical Environment				
Erosion and Runoff and Soil Compaction **Section 12.2.1**	Development of stockpiles and trenches, and 'cut and fill' activities Vegetation clearing Earthworks for trenching of the pipeline and construction of the plant Road upgrades and borrow pits Vehicle movements Increase traffic	Localised changes to topography and the physical environment Increased run-off leading to erosion of soil and subsequent deposition Soil loss via wind or water erosion Increased sediment load of waterways Creation of unstable soil surfaces/slopes Formation of gullies Reduction in soil fertility Loss of seed banks and nutrient stores Weakening soil structure Increased scouring or accretion particularly in beach/dune areas Reduction in soil permeability and recharge to groundwater, and increased surface drainage Compaction of soil	The topography of the area is relatively flat which reduces the risk of erosion. There are no watercourses in close proximity to the plant or the pipeline ROW that could be affected by increased run-off or erosion. Only one watercourse (Sandfly Creek) will be crossed by the proposed new access road between Wadeye airstrip and the plant. The plant will be designed to allow surface water to drain adequately. Slopes and batters will be designed so they are consistent with the local topography as much as possible. All areas to be cleared will be pegged prior to clearing to eliminate unnecessary or accidental land disturbance. No groundwater is expected to be encountered within any excavation above high tide level. Construction activities and rehabilitation will occur in the dry season prior to the onset of the rains. Clearing and earthworks will be carefully managed and construction areas will be rehabilitated as soon as possible. The area containing clayey sands (landward of the beach) will be quickly revegetated to minimise erosion and assist surface water drainage. Consideration will be given to the use of a compacted crushed rock (gravel) surface within the plant site to protect against erosion. A storm water and drainage management system will be developed and implemented for the onshore gas plant. Temporary drains and banks will be installed where required to slow and divert stormwater, and minimise soil erosion. Erosion and surface water controls such as sediment control fences, temporary drains and banks will be installed during the construction phase for both the plant and pipeline where practicable. Where possible pipelay traffic will utilise the ROW 'running track'. A **Rehabilitation Management Plan** will be developed and implemented prior to construction. Construction activities in the vicinity of watercourses will take place as early as possible in the dry season. Predicted Impacts: **Negative, Short term** Consequence: **Minor** Likelihood: **Highly Unlikely**	**Low**
Generation of Acid Sulfate Soils **Section 12.2.1**	Excavation, drainage or dewatering especially in nearshore/coastal areas	Impacts on human activities such as fishing, recreation, tourism Impacts on human health Changes in the quality and properties of the soil, groundwater, surface water, wetlands, watercourses and estuaries Degradation of water dependant ecosystems Habitat loss, decreased biodiversity and plant yield Invasion and dominance of wetlands by acid tolerant plants, plankton and pathogens Corrosion of metallic and concrete structures (concrete cancer) Dissolution of heavy metals from the soil and compounding environmental problems	An ASS desktop study has concluded that the plant and onshore pipeline project area has a low risk of ASS, and the shore crossing a moderate to high risk of ASS. ASS site investigation took place in 2004, results will be available before the end of 2004. Based on preliminary findings ASS is not likely to be an issue. A project – specific **Acid Sulphate Soils Management Plan** will be developed if field investigations indicate ASS are likely to be encountered. Predicted Impacts: **Negative, Short term** Consequence: **Minor** Likelihood: **Highly Unlikely**	**Low**
Alteration of Natural Drainage and Hydrology **Section 12.2.2**	Vegetation clearing Installation of drainage Land disturbance	Changed aquifer characteristics and recharge dynamics Changed surface water flows	The project works will be designed in accordance with Australian Standards and legislative requirements. Natural contours and surface flows will be retained where possible and rehabilitation will be planned and implemented to emulate natural flows. Predicted Impacts: **Negative, Temporary** Consequence: **Moderate** Likelihood: **Remote**	**Low**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Pollution of Ground Water Change to Water Quality or Characteristics **Section 12.2.2**	Vegetation clearing Installation of drainage Land disturbance Processing, storage and transport of hydrocarbons Spills from condensate tanks and associated pipelines Hydrotest water for tanks and pipework at plant likely to be sourced from bore water Disposal of hydrotest water (approx 6,000 m^3) from tanks and plant pipework	Change in chemical & biological composition of water Increased turbidity Hydrocarbon contamination of potable water supplies Lowering of water table level	The project works will be designed in accordance with Australian Standards and legislative requirements. Construction and operational activities involving land disturbance will be confined to the dry season wherever possible. If borewater is used for plant hydrotesting it is likely that no chemicals will be added to the hydrotest water. Disposal of hydrotest water from tanks and plant pipework will be to sea via condensate or PW pipeline. Disturbed areas will be rehabilitated as early as possible prior to wet season. Effective safety and spillage response systems will be implemented prior to construction. A Spill Protection system will be put in place for the condensate storage tanks. An **Erosion and Sediment Control Plan** will be prepared prior to construction and implemented. A **Groundwater Protection Management Plan** will be implemented prior to construction. A **Waste Management Plan** will be prepared prior to construction. Predicted Impacts: **Negative Temporary** Consequence: **Minor** Likelihood: **Highly Unlikely**	**Low**
Ecological Environment				
Planned Vegetation Clearing, Fauna Disturbance & Habitat Loss **Section 12.3.1 & 12.3.2**	Vegetation clearing Excavation activities Vehicle and traffic movement Construction of access routes and borrow pits	Habitat and species loss of 74 ha. within development footprint Destabilisation of the dune system Reduction in the suitability of surrounding habitat Habitat fragmentation Short-term loss of species from area Damage to or destruction of significant vegetation, habitats and species	Design and location of the pipeline and gas plant avoided all significant vegetation and habitats, and most species. Construction activities will disturb only the minimum area of vegetation necessary. Sensitive vegetation communities and fauna habitats that occur in proximity to the area will be fenced off. Topsoil will be stockpiled and rehabilitation undertaken as soon as possible following completion of construction. A **Rehabilitation Management Plan** will be prepared and implemented, and rehabilitation undertaken as soon as possible. Access works and ancillary requirements such as lay-down areas will also avoid these. Works for access across riparian habitats, which are considered sensitive, will be planned for the dry season to minimise impacts. Nests of significant species (for example the Red Goshawk) will be identified if in the project area and avoided or advice sought from NT Parks & Wildlife Service on appropriate actions (no nests have been identified during surveys). Training of personnel will be provided to identify nests. A system for reporting of nest sites and evaluation of their significance will be established. Parks & Wildlife Service will be consulted on permit requirements for clearing of cycads and orchids. Predicted Impacts: **Negative, Short to Long term** Consequence: **Minor** Likelihood: **Likely**	**Medium**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Unplanned Vegetation Clearing, Fauna Disturbance & Habitat Loss **Section 12.3.1**	Unnecessary/accidental clearing Excessive excavation Vehicle and traffic movement off designated tracks	Habitat and species loss outside development footprint Destabilisation of the dune system Decline in the physical condition of vegetation and habitats beyond the actual zone of disturbance Reduction in the suitability of surrounding habitat Disturbance of riparian areas creates potential for a decline in ecosystem condition and impacts often extend beyond the immediate site of disturbance Injury or death of individual fauna due to increased road traffic Habitat fragmentation Short-term loss of species from area Social and cultural consequences, for example ethnographic sites, species with special cultural values.	Construction activities will disturb only the minimum area of vegetation necessary. Project will make use of existing access tracks where possible to minimise the amount of vegetation clearing, and avoid disturbing sensitive vegetation communities when locating laydown areas, quarries, etc. Construction activities in the vicinity of watercourses (for example for access tracks) will take place as early as possible in the dry season Large mature fruiting trees will be identified and retained where possible. Sensitive vegetation communities and fauna habitats that occur in proximity to the area will be fenced off. Additional project infrastructure, such as laydown areas, shore anchors, borrow pits, washdown bays etc. will not be located in areas of environmental sensitivity. The construction work force will be trained in the identification and reporting of bird nesting sites. A system for reporting of nest sites and evaluation of their significance will be established. Topsoil will be stockpiled and rehabilitation undertaken as soon as possible following completion of construction. Restrict contractor movements outside development zone. A **Traffic Management Plan** will be prepared and implemented. A **Rehabilitation Management Plan** will be prepared and implemented, and rehabilitation undertaken as soon as possible. Predicted Impacts: **Negative, Short to Long term** Consequence: **Minor** Likelihood: **Highly Unlikely**	**Low**
Pipeline Trenches **Section 12.3.3**	Fauna capture in open trench for pipelines A 2.5 km trench open for several weeks	Fauna mortality due to increased exposure to predators, effects from the sun and subsequent dehydration and starvation	Infrastructure was located away from key fauna habitats in the design phase. Soft plugs or lateral escape ramps will be used at regular intervals to allow fauna to escape the trench. The open trench will be monitored by expert wildlife personnel and animals identified, recorded and released, or preserved and lodged with NT Museum. A **Fauna Management Plan** will be developed. Predicted Impacts: **Negative Temporary** Consequence: **Minor** Likelihood: **Likely**	**Medium**
Introduction and Spread of Weeds **Section 12.3.4**	Vehicles, plant and construction materials transport on and off the project site	Displacement of native species Creation of increased fuel loads from grassy weeds to change fire behaviour and frequency Direct competition for resources (for example water, habitat) with existing flora Degradation of vegetation communities Herbicide/pesticide impacts on native flora and/or fauna Proliferation of existing introduced species	All plant, equipment and vehicles will be required to be clean prior to entering the project area, and random and systematic inspections will be conducted Key staff will be trained in recognition and management of weed outbreaks Existing weed infestations in locations where there could be sources for spread will be identified and treated where necessary Construction personnel will be provided with training and inductions in exotic fauna awareness Wash down facilities will be provided and operators required to use them if vehicles, plant and equipment are found to be unclean Only native plant species will be used in rehabilitation Declared weed species will be monitored for establishment and spread caused by the construction within two years of construction An **Exotic Species and Weed Management Plan** will be prepared and implemented prior to construction Predicted Impacts: **Negative, Long term** Consequence: **Minor** Likelihood: **Highly Unlikely**	**Low**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Introduction and Spread of Feral & Pest Animals **Section 12.3.4**	Vehicles, plant and construction materials transport on and off the project site	Displacement of native species Direct competition for resources (for example water, habitat) with existing fauna and/or flora Degradation of vegetation communities Herbicide/pesticide impacts on native flora and/or fauna Direct competition for resources (for example water, habitat) with existing fauna and/or flora Death of individual fauna/flora Proliferation of existing introduced species	All plant, equipment and vehicles will be required to be clean prior to entering the project area, and random and systematic inspections will be conducted. Construction personnel will be provided with training and inductions in exotic fauna awareness, including Cane Toad recognition. Domestic animals will be prohibited from being taken into the project area. Wash down facilities will be provided and operators required to use them if vehicles, plant and equipment are found to be unclean. An **Exotic Species and Weed Management Plan** will be prepared and implemented prior to construction. A Cane Toad reporting strategy will be included in the **Exotic Species** and **Weed Management Plan**. Predicted Impacts: **Negative, Long term** Consequence: **Minor** Likelihood: **Highly Unlikely**	**Low**
Unplanned Fire **Section 12.3.5**	Vehicle and plant exhausts Sparks from contact with rock Cooking or camp fires and cigarettes	Alteration of habitat	The construction workforce will be trained in fire awareness, prevention and safety. A fire fighting unit and persons trained in fire response will be readily available at all times during construction. Spark arrestors will be required for all earthmoving equipment. Cooking and camp fires will be prohibited. Fire breaks will be established and maintained for the duration of construction and operation as required by Bushfires Council. Vegetation in the project area and along road verges will be managed to minimise fire risk. All operational personnel will be trained in emergency fire response. Monitoring for weed establishment will occur for the duration of construction and operation. Weed eradication programmes will be implemented as required to minimise the risk of increasing fire fuels. An **Emergency Response Plan** will be developed and implemented. A **Fire Management Plan** will be prepared and implemented. Predicted Impacts: **Negative, Short term** Consequence: **Minor** Likelihood: **Highly Unlikely**	**Low**
Planned Fire **Section 12.3.5**	Deliberate ignition of swamps for biting insect/mosquito management.	Alteration of habitat	A fire fighting unit and persons trained in fire response will be readily available at all times during planned fires. A **Fire Management Plan** will be prepared and implemented. Predicted Impacts: **Neutral, Short term** Consequence: **Minor** Likelihood: **Highly Unlikely**	**Low**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Biting Insects **Section 12.4.1**	Existing sources Import of materials, provisions, equipment containing mosquito larvae Creation of breeding habitat through works Poor management of waste	Creation of additional biting insect/mosquito habitat Increased sources of irritation to workforce and locals	Construction and operational personnel will be inducted on the appropriate clothing and personal protection measures to minimise the potential to be bitten by mosquitoes and biting midges. Landscaping and other engineering solutions to reduce the abundance of biting insects will be implemented. Insecticides may be used selectively to prevent salt marsh mosquitoes breeding. Inspections of materials from Queensland or overseas will be conducted to identify and treat mosquito larvae sources, and materials treated where necessary. Materials will be stored to prevent water accumulating, and monthly inspections undertaken to eliminate standing water. Swamps 1 & 2 will be burnt annually to reduce mosquito habitat. Medical Entomology Branch will be notified of mosquito problems. Supervisors will be trained to recognise breeding activity and to treat breeding sites. Infrastructure will be designed and constructed to prevent creation of artificial habitat. Breeding habitat will be eliminated from earthworks by suitable rehabilitation and contouring. A **Biting Insect Management Plan** will be prepared. Predicted Impacts: **Negative, Short term** Consequence: **Minor** Likelihood: **Unlikely**	**Low**
Mosquito-borne disease **Section 12.4.2**	Existing sources Import of materials, provisions, equipment containing mosquito larvae Creation of additional breeding habitat through works Poor management of waste	Illness of workers for example Ross River Virus Introduction and spread of disease, for example malaria in workers Increased sources of irritation to workforce and locals	Construction and operational personnel will be inducted on the appropriate clothing and personal protection measures to minimise the potential to be bitten by mosquitoes. Landscaping and other engineering solutions to reduce the abundance of biting insects will be implemented. Insecticides may be used selectively to prevent salt marsh mosquitoes breeding. Inspections of materials from Queensland or overseas will be conducted to identify and treat mosquito larvae sources, and materials treated where necessary. Materials will be stored to prevent water accumulating, and monthly inspections undertaken to eliminate standing water. Swamps 1 & 2 will be burnt annually to reduce mosquito habitat. Suspected malaria cases will be quarantined and checked by medical personnel. Medical Entomology Branch will be notified of disease and mosquito problems. Supervisors will be trained to recognise breeding activity and to treat breeding sites. Infrastructure will be designed and constructed to prevent creation of artificial habitat. Breeding habitat will be eliminated from earthworks by suitable rehabilitation and contouring. A **Biting Insect Management Plan** will be prepared. **Risk:** Not assessed as an environmental risk. Refer to **Section 16**.	**N/A**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Waste				
Non-Hazardous Solid Waste Stream **Section 12.5.1**	Generation and storage of general non-hazardous waste.	Impact on visual amenity Injury or death of individual fauna Negligible to slight incremental increase in the environmental impact associated with existing facilities.	Woodside's Waste Minimisation Policy and Guidelines will be implemented. **Waste Management Plans** will be developed for each phase of the development to ensure that waste is disposed of promptly and correctly. The plans will include recycling, reuse and recovery options. Waste minimisation will be included in the criteria for tendering and contracting processes. Opportunities for recycling will be investigated by the construction contractor and implemented where practicable. Contractors will be required to place a high emphasis on housekeeping. All solid waste will be stored in clearly marked skip bins and segregated into recyclable and non-recyclable. Food waste will be segregated from other waste streams and disposed of at an approved landfill facility. Subject to approval sewage sludge will be transported to the existing Wadeye Landfill Facility. Putrescible waste will be transported to landfill. Excavated soil will be stored within the project boundary or will be disposed at an approved location off-site. Waste streams will be segregated and recycling and reuse undertaken where possible. Suitable waste will be compacted on site and transferred to landfill with the appropriate capacity and handling procedures for example Wadeye subject to approval. Predicted Impact: **Negative, Long term** Consequence: **Slight** Likelihood: **Likely**	**Low**
Liquid Waste Stream **Section 12.5.2**	Generation and storage of domestic wastewater (sewage and grey water), and stormwater	Generation of odours Health considerations due to the presence of bacteria such as coliforms in untreated sewage Nutrification of surface waters Contamination of soil, surface water and/or groundwater Degradation of vegetation communities or fauna habitats Erosion and sedimentation of waterways	During the first 3–5 months of construction temporary portable sewage treatment facilities will be used on site. After the effluent has been treated through this process it may be used for irrigation. Permanent sewage treatment facilities will be installed for the reminder of the construction period and operation phase in the form of an above ground proprietary package membrane reactor. Subject to approval sewage sludge will be transported to the existing Wadeye Landfill Facility. Wadeye Sewage Treatment Facilities will be used as a back up should either system fail, subject to approval. Upgrade requirements for the Wadeye Sewage Treatment Facilities will be assessed prior to construction. Sewage systems will be approved by the Northern Territory Health Department prior to construction, and will comply will all relevant standards and legislation. Stormwater minimisation will be undertaken using diversion drains and bunding. The gas plant will be located in a flat area, away from major water bodies, rivers or wetlands. Appropriate site drainage ensuring that contaminated stormwater and clean stormwater are separated will be implemented. Storage and handling of all chemicals and potential contaminants will conform to Australian Standards and relevant guidelines. Sites will be designed so that all stormwater generated from potentially contaminated areas will drain separately to an oily-water system. Drainage system design will take into consideration high rainfall events. Bunding and containment facilities will be provided around areas of chemical storage or hydrocarbon use. A **Groundwater Protection Management Plan** will be implemented. Predicted Impact: **Negative, Long term** Consequence: **Slight** Likelihood: **Highly Unlikely**	**Low**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Hazardous Waste Stream **Section 12.5.3**	Generation and storage of hazardous waste for example spent silica gel	A negligible to slight incremental increase in the environmental impact associated with existing facilities.	Silica gel will only need to be replaced approximately every three years. The spent gel that has some oil on it will be removed from site for appropriate disposal/recycling by the vendor. All hazardous waste materials will be disposed of/recycled at an approved facility in accordance with Woodside's Waste Minimisation and Disposal guidelines, the project **Waste Management Plan** and all applicable regulations. Hazardous waste will be stockpiled or stored appropriately near the construction camp in segregated, signed areas. Hazardous waste areas will be bunded to ensure that any spillage is contained. Hazardous waste will be collected on a weekly basis. All hazardous waste materials will be documented and tracked, segregated from other waste streams and stored in suitable containers. All chemicals will be stored according to Australian legislation and guidelines where applicable. All storage facilities and handling equipment will be designed and constructed in such a way as to prevent and contain any spills. All waste products will be stored according to Australian legislation and guidelines where applicable. Spill clean-up kits and Material Safety Data Sheets will be stored in easily accessible areas. Transport of dangerous goods will be in accordance with the *Dangerous Goods (Road and Rail Transport) Act 2003* and associated Regulations. Predicted Impact: **Negative, Long term** Consequence: **Slight** Likelihood: **Likely**	**Low**
Chemical or Hydrocarbon Spills **Section 12.5.4**	Generation and storage of hazardous liquids including hazardous chemicals and fuels Spills from diesel generators and vehicles Spills from condensate storage tanks or associated spills	Contamination of soil profile and/or groundwater Contamination of watercourse, for example Sand Fly Creek	Minimise the chemicals/fuels to be used or stored on site. Laydown areas will be used for the storage of hazardous materials and equipment. A **Waste Management Plan** will be developed and implemented. A Spill Protection System will be put in place for the condensate storage tanks. All hazardous materials will be handled and stored in accordance with the corresponding Materials Safety Data Sheets (MSDS). Fuel and other hazardous materials will be handled and stored in bunded areas within the plant site in accordance with the corresponding MSDSs and Australian Standards. Appropriate spill kits will be available where fuel and hazardous materials are used and stored. All personnel handling fuel and other hazardous materials will be trained and competent in correct the handling procedures and management of spills of applicable materials. **Small Spill** Predicted Impact: **Negative, Short term** Consequence: **Minor** Likelihood: **Possible** **Large Spill** Predicted Impact: **Negative, Short term** Consequence: **Moderate** Likelihood: **Remote**	Low (large spill) Medium (small spill)

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Atmospheric Emissions				
Greenhouse Gases **Section 12.6.1**	Power generation Flaring Vehicle movements Fugitive emissions	Incremental increase in global atmospheric concentration of greenhouse gases, approx 90,000 CO_{2}-e per annum. Beneficial impact of natural gas use at Alcan Gove Refinery with regards to local air quality improvements and greater efficiency in greenhouse gas emissions per ton of product produced.	Best Practice Methods will be applied to maximise energy efficiency and minimise emissions. Sources of emissions will be continually identified during detailed design, and eliminated where possible. Facility reliability will be maximised, thereby reducing the likelihood that gas will require flaring due to process upset. Emission releases will be minimised by ensuring equipment is correctly specified and maintained. Flaring and venting of hydrocarbons and fuel gas consumption will be minimised by using best available technical and procedural solutions at a reasonable cost. Flaring will be kept to a minimum for maintenance and emergencies only. A **Flaring Management Plan** and a **Greenhouse Gas Management Plan** will be prepared and implemented to meet the intent of Woodside's Environmental Standards and Aspirations Objectives. A monitoring and reporting programme will be undertaken to periodically assess opportunities to further reduce greenhouse gas emissions over time. Comprehensive analysis of emissions will be undertaken to identify and analyse emission offsets. Woodside is a member of the Commonwealth Greenhouse Challenge Program; the Blacktip Project will be included in Woodside's Greenhouse Challenge Report. If required, potential climate change impacts will be investigated in the **Greenhouse Gas Management Plan**. Predicted Impact: **N/A** Consequence: **N/A** Likelihood: **N/A**	**N/A**
Other Combustion Products **Section 12.6.2**	Construction, commissioning, production and decommissioning of pipelines, onshore gas plant Emission of NOx and Sox	Potential impact on cultural sites or vegetation due to photochemical smogs, acid rain and acid deposition	Blacktip gas has a low sulphur content. Plant is not located in close proximity to residences. Low sulphur diesel will be used. Management measures applied to maximise the plant efficiency and minimise fuel use will effectively reduce SO_x emissions. Low emissions of NO_x and SO_x expected. Predicted Impact: **Negative, Long term** Consequence: **Slight** Likelihood: **Highly unlikely**	**Low**
Other Atmospheric Emissions & Pollutants **Section 12.6.3**	Non Methane Hydrocarbons (NMHC) venting to atmosphere Pumping condensate into the storage tanks Transfer of condensate from the gas plant onto a tanker	Impacts on human health and increase in smog Non Methane Hydrocarbons (NMHC) emissions are estimated to be minor Volatile Organic Compounds (VOC's) will be present to a very small extent in the uncombusted component of flares and combustion engines, from fugitive emissions and off-take tankers.	Measures to minimise NMHC emissions will be contained within the process design where the condensate is treated to meet market demand specification. High levels of fugitive emission control applied around the project to further reduce. Low production rate of condensate. Condensate will be stabilised and tanks will have floating roof tanks. Infrequent condensate loading. Predicted Impact: **Negative, Long term** Consequence: **Slight** Likelihood: **Likely**	**Low**
Ozone Depleting Substances (ODS) **Section 12.6.3**	Ozone Depleting Substances contained in fire extinguishers and deluge systems Refrigerants Emergency situations	Damage to ozone layer	The use of ODSs by contractors during the construction and commissioning phases will be strictly controlled. Contractors will be required to use ODS free systems wherever alternatives are available. Written approvals from Woodside will have to be obtained to approve the use of substances with Ozone Depleting Potential. Contractors will be requested to provide a list of ODS inventories to identify any expected emissions. Any release of OSDs will be treated as a reportable incident. Predicted Impact: **N/A** Consequence: **N/A** Likelihood: **N/A**	**N/A**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Odour Emissions **Section 12.6.4**	Plant upset conditions resulting in gas leaks	Odours can present a nuisance to nearby residences, members of the public and workers if they are not managed effectively	The plant is located in a remote area with the closest (temporary) community 2.5 km from the plant site and the closest permanent residence some 10 km away. No mercaptans will be added to the gas stream. Onshore condensate tanks will have floating roofs significantly reducing the potential for emissions. Only trace amounts of H_2S and mercaptans will be present (if at all) in the gas. Preliminary dispersion calculations indicate that beyond 350 m there should not be any odour impact due to H_2S. The plant will be designed to high industrial standards ensuring that upset conditions and associated leaks are minimised. Predicted Impact: **Negative, Temporary to short term** Consequence: **Slight** Likelihood: **Possible**	**Low**
Dust Emissions **Section 12.6.5**	Clearing of vegetation Stockpiling of earth Vehicle and machinery movements	Health impacts Impact on vegetation and amenity Loss of topsoil	Vehicle speeds will be limited along the ROW and access tracks as specified in the Traffic Management Plan. Water or an approved alternative will be employed to ensure that access roads and the ROW is adequately managed to minimise dust. Exposed surfaces such as stockpiles and cleared areas will be kept to a minimum. During the site induction the workforce will be made aware of dust generation and control measures. A **Dust Management Plan** will be prepared and implemented. Predicted Impact: **Negative, Short term** Consequence: **Slight** Likelihood: **Likely**	**Low**
Noise Emissions **Section 12.7**	Vehicle movement Construction machinery and equipment Processing plant operation Commissioning/Maintenance for example flaring	Direct disturbance to fauna Disturbance to residences	Noise modelling indicates that all day time work will conform with recommended construction criteria for sensitive receptors. Work will be undertaken in accordance with AS 2436–1981 ‘Guide to Noise Control on Construction, Maintenance and Demolition Sites’. The equipment used will be the quietest reasonably available. Site boundary noise levels will be validated during commissioning and early stages of the operation to confirm the assumptions used in the Noise Assessment. A construction **Noise Management Plan** will be approved and complied with. A **Flaring Management Plan** will be developed to reduce non-emergency flaring to as low as reasonably practical. **Traffic** and **Noise Management Plans** will be developed and implemented which will address impacts from traffic. Predicted Impact: **Negative, Short term** Consequence: **Slight** Likelihood: **Unlikely**	**Low**
Vibration **Section 12.8**	Blasting Operation of vehicles and machinery	Direct disturbance to fauna Disturbance to residences Interference with sea turtle embryo development, hatching, and hatchling migration to the ocean (**Section 11**)	Blasting is highly unlikely to be required, based on geotechnical investigations. If blasting is required, a **Blasting Management Plan** will be prepared. Potentially sensitive receptors within a 2 km radius of the proposed blasting activities will be advised 24 hours in advance. Should receptors be located within 1 km of the proposed blast site, prediction of potential air overblast pressure and vibration will be undertaken, and if necessary the blasting regime will be modified to reduce the size of charges detonated and increase the time between detonation in order to reduce impacts. The results of the predictions will be provided to the regulatory authority prior to commencement of blasting for approval along with any proposed mitigation measures including the possibility to increase cover material depth, increase spacings between charges and reduce the size of charges detonated per event. Predicted Impact: **Negative, Temporary** Consequence: **Slight** Likelihood: **Unlikely**	**Low**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Light Emissions **Section 12.9**	Road lights within the plant fence Safe day/night operation and security lighting Flaring at onshore facility	Disturbance to fauna Attraction of some fauna species	All lighting will comply with AS4282, with lights being directed downward and chosen to minimise light spill. Lighting will be designed to minimise the potential to attract biting insects, and to optimise deterrence of biting insects. Vehicle traffic at night will be limited to minimise fauna disturbance. All non-essential lighting (minimum requirements to meet HSE standards) will be minimised. During normal everyday operations only a very small pilot flare will operate at the gas plant. Planned flaring will be infrequent and of short duration, and undertaken during daylight hours where possible. Automatic control measures will be in place for the detection and control of emergency flaring. The local community will be informed at least 24 hours prior to any planned maintenance flaring commencing. A **Lighting Management Plan** will be prepared and implemented for construction of the plant site and laydown areas. Predicted Impact: **Negative, Long term** Consequence: **Slight** Likelihood: **Unlikely**	**Low**

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