Section 9
Biophysical Impacts, Preventative and Management Measures

9. Biophysical Impacts, Preventative and Management Measures

9.1 Introduction

This section of the Draft EIS provides a description and assessment of the relevant biophysical impacts that are expected to, or may potentially occur as a result of the proposed development and discusses the preventative and management measures that will be implemented to reduce these impacts to acceptable levels.

The impact assessment covers those activities described in **Section 5**, which broadly comprises:

- Construction and operation of a 940 km buried pipeline from the proposed Blacktip Gas Plant at Wadeye to the Alcan Gove Alumina Refinery.
- Construction and operation of ancillary support facilities including:
    - compressor, scraper, mainline valve and meter stations;
    - access roads and upgrade of existing road systems;
    - construction camps.

The majority of potential impacts on the terrestrial environment identified through the assessment process can be categorised as having limited adverse or long term impact on the environment and can be managed through the implementation of routine management procedures and safeguards.

Project activities assessed as having a higher level of potential impact, and thus requiring detailed assessment are:

- ***Erosion and runoff and soil compaction*** associated with construction activities including stockpiles, vegetation clearing, pipeline trenching, vehicle movements and road upgrades.
- ***Death, injury and disturbance to fauna*** resulting from various construction activities including earth works, blasting, vegetation clearing and fauna capture in the pipeline trench.
- ***Alteration of natural drainage and hydrology and pollution of ground water and surface water*** from vegetation clearing, road construction, fuel and chemical storage, disposal of sewage and grey water and sourcing and disposal of hydrotest water.
- ***Degradation of visual amenity*** during construction from vegetation clearing, presence of construction camps and dust from construction traffic.
- ***Damage and destruction of vegetation and flora*** associated with vegetation clearing, earthworks, road upgrades and from vehicle and traffic movement during construction.
- ***Damage or destruction of aquatic ecosystems and species*** from various construction activities including vegetation clearing, construction of watercourses, disposal of sewage and grey water from construction camps and from fuel and chemical storage and handling.
- ***Damage to and disturbance of flora and fauna species of conservation significance*** during vegetation clearing, earthworks and from vehicle and traffic movement during construction.

- ***Damage/ disturbance of ecologically sensitive habitats*** resulting from construction activities including vegetation clearing, earthworks and from vehicle and traffic movements.
- ***Introduction and spread of weeds and exotic fauna*** during movements of vehicles, plant and construction materials and from construction of access routes and clearing of native vegetation.
- ***Planned fire*** and alteration of ecological habitats from deliberate ignition of vegetation to reduce fire risk.
- ***Small chemical or hydrocarbon spills*** associated with vehicle and plant refuelling operations during construction.
- ***Dust emissions*** from trucks transporting material and workforce to the construction corridor along access roads and from pipeline trenching, backfill and padding during construction.

In support of the overall assessment approach and to meet the Draft EIS Guideline requirements (**Appendix A**, **Volume 1)**, all of the potential environmental impacts were subject to a semi-quantitative risk assessment. The approach to this risk assessment is detailed in **Section 8**. The results of this risk assessment support the findings of the overall assessment in terms of the potential impacts on the biophysical environment from the proposed pipeline development and the severity of these potential impacts.

9.2 Physical Environment

9.2.1 Topography

Impacts

Topographical environmental impacts are likely to be confined to the construction phase. The pipeline will pass through some relatively high relief (for example the Mitchell Ranges) and over steep slopes. The pipeline route selection process has been undertaken to avoid significant topographical features as far as practicable, thereby inherently reducing potential impacts (**Section 4.4**).

Potential sources of impact during pipeline construction include earthworks associated with topsoil stripping, temporary excavations and the creation of stockpiles within a designated 30 m construction corridor. Furthermore, construction of laydown areas, temporary and permanent access ways, temporary work camps, and associated above ground facilities (i.e. scraper, MLV and compressor stations) will result in ground levelling and earthworks. Pipeline construction activities are not expected to significantly alter the existing topography of the area. However, during trenching activities and subsequent rehabilitation the potential for soil erosion exists as well as disturbance to the topography from rock blasting in areas where engineering difficulties are anticipated to arise (**Section 5.5.9**). These activities will be of short duration and subsequent rehabilitation will be undertaken to return the site to pre-disturbance conditions.

During operation there is an ongoing risk of erosion and preventative and management measures will be required (**Section 9.2.3**).

Preventative and Management Measures

The main preventative measure that will mitigate potential long term impacts to the topography along the 940 km construction corridor will be that the pipeline will be buried below ground and rehabilitated very quickly after installation. Significant topographical features have been avoided as far as practical during the route selection process.

Management measures that will be undertaken during construction activities to reduce potential impacts on the topography include:

- The pipeline will be trenched to a depth of between 1.5–2.0 m and will approximately 700 mm wide.
- The construction corridor will be clearly marked.
- Minimising the area of disturbance.
- In most cases, clearing of vegetation will be minimised to areas within the 30 m construction corridor and the cleared vegetation and stripped topsoil will be stockpiled and respread during reinstatement.
- Cleared areas along the construction corridor and redundant access routes will be rehabilitated, including reseeding with native species, where required. Rehabilitation of disturbed areas will be undertaken as soon as practicable.
- An Erosion and Sediment Control Management Plan (ESCP) will be prepared prior to construction and implemented for the project.
- An ESCP will also be prepared prior to commencement of operations and implemented for the life of the project.
- Existing roads, tracks and disturbed areas will be utilised as far as practicable to minimise disturbance to the surrounding environment.

9.2.2 Geology

Impacts

Potential impacts to geology are likely to be confined to the following construction activities:

- HDD under significant watercourses, roads and railways;
- blasting activities associated with pipeline trenching through hard rock areas between KP80 and KP100 and between KP770 and KP790;
- sourcing of material from borrow pits or quarries.

The construction of the proposed TTP is likely to have an insignificant impact upon the solid geology along the route. Less than 10% of the pipeline route is likely to encounter rock during construction.

Preventative and Management Measures

As part of the pipeline route selection process (**Section 4.4)** the design team took into consideration engineering difficulties associated with blasting and pipeline trenching through hard rock. Consequently, areas of hard rock were avoided as far as possible. Measures to reduce potential geological impacts are limited to reducing blasting activities as far as reasonably practicable and controlling the exploitation of raw materials if required from designated borrow pits and quarries. Suitable sites for quarry and borrow pits will be agreed in consultation with the relevant landowners and regulatory authorities.

9.2.3 Land Systems and Soils

Impacts

Soil erosion potential is affected by a number of complex factors. Some of the more critical ones are discussed below. **Appendix D**, **Volume 2** of this Draft EIS provides a summary of the pipeline route's soil features.

Soil Trafficability and Durability: Trafficability of the natural surfaces is controlled mainly by rock outcrops and depth, size and density of lag gravels, and efficient soil drainage. Some land units in the region can be traversed at any time of year, whereas others may not be traversable until well into the dry season (EcOz 1997).

Durability of the different soils or their ability to take frequent passes of vehicles without sustaining significant damage is related to soil depth, lag gravel size and extent, surface thickness and texture, subsoil structure, and soil moisture condition. Steep rocky slopes can, for instance, take a large number of passes without sustaining much more damage than crushing of the rocks and gravels. Durability will vary with the nature of the rock, with softer materials such as shales suffering more damage than quartzites. Lower gravelly slopes can be reasonably durable because of lag gravel surfaces, but can be incised where vehicles traverse or corner, and may be subject to soil compaction.

Floodplain grasslands may be traversed easily when dry, but represent significant erosion hazards when moist or excessive traffic traverses them. Floodplain grasslands with thin covers of surface soil over clayey sediments, when dry, may be able to take a considerable number of passes of vehicles traversing the plains. Where the soil surface is not broken, impact may be limited to destruction of or damage to the above ground parts of the vegetation (mostly grasses) and floodplain termite mounds. These floodplains should be traversed and worked on with caution as they can be damaged with repeated use and particular types of vehicle usage, and the cumulative effects could result in substantial erosion.

Other areas of floodplain and lowland landscapes can be more fragile and, although they may be able to be trafficked (depending on soil moisture conditions), multiple passes along the same line may cause pulverisation of the soil in dry conditions and thick bulldust layers can be generated. In moist conditions, vehicle bogging, deep rutting and soil heaving are highly probable.

Soil Compaction: Soil compaction under vehicle traffic movement is a common phenomenon which can negatively affect plant root growth, soil moisture potential, vegetation establishment, drainage, runoff and soil erosion. In particular circumstances, compaction can improve trafficability by increasing the load bearing capacity of the surface, and in this sense it can be a desirable change for frequently traversed routes (EcOz 1997).

Likewise, in particular circumstances, soils can recover from compaction through wetting and drying cycles and as plant roots and soils fauna (ants, termites, worms, etc) open new channels and pores, but full recovery may take months or years. Severely compacted soil might need ripping or cultivation to enhance recovery, but these techniques may also present unacceptable risks of increased soil erosion in some circumstances.

The subject of soil compaction is complex. In general, the degree of compaction experienced by a natural soil under traffic depends on a number of factors which can vary from time to time. These factors include the following (EcOz 1997):

The Nature of the Applied Load: Tracked vehicles such as bulldozers generally impose lower point loads than wheeled vehicles, but may pose greater sheer stress when turning. Pneumatic tyres impose greater sheer stress while driving and can spread their loads over an area significantly larger than the tyre footprint. Tyre design (lugged or smooth, soft or rigid), tyre pressures and applied energy (vehicle power) are also important.

The Nature of the Soil: Many soil factors influence soil compressibility and behaviour under stress. These include: extent of ground cover vegetation and nature of included roots; abundance of organic matter in the soil; homogeneity of the profile; particle size distribution; particle shape; type of clay material present; colloidal condition and exchangeable ions present; presence of any cementing agents; compressive strength of coarse particles (crushing); nature and distribution of soils voids; initial bulk density; degree of lateral confinement; and, most importantly, soil moisture content and its distribution at the time of the applied load (EcOz 1997).

In general, coarser soils with less aggregation are less compressible than finer soils. Thus, gravels are less affected than sands (unless crushing is involved) and sands less affected than clay loams or clays, but all these relationships also depend on the other factors listed above.

Grain size distribution is a better indicator of soil behaviour for coarser soils, and plasticity is more indicative of the behaviour of clay soils. Both of these properties are included in the Unified Soil Classification system used by engineers and recorded in the field surveys for the project. They are also inherent in other field based soil texture descriptions but are not so apparent in many standard soil profile descriptions. Plastic state occurs at water contents where soils deform or change shape without change in volume. It occurs between the semi-solid (crumbly) and liquid state and is defined as the difference between the plastic and liquid Atterberg limits (Hicks 1991). Highly plastic soils do not support loads well, and have poor trafficability when wet. Soils with low or no plasticity change from solid to liquid with little change in moisture content and may be prone to mass movement (Hazelton & Murphy 1992; DIPNR 2004).

The Critical Role of Soil Moisture Condition: Dry soils are extremely difficult to compact because of their inherent cohesion and the 'unlubricated' physical contact between particles. The strength of these soils depends on particle interaction. Wet soils on the other hand are also difficult to compact because all pores are filled and pore water is effectively non-compressible.

The strength of wet soils is low, and any increase in pore water pressure can actually weaken the soil and allow soft deformation and eventually may cause flow. In saturated very fine sands and silt clays, repeated disturbance and vibration can cause liquefaction of the sands and the sudden failure of a loaded surface. This behaviour is common in many texture contrast profiles with thick topsoils which are strongly bleached.

Maximum soil compaction per unit effort is attained at an optimum moisture content in the 'moist' range. Relationships between soil density and moisture content can be determined in laboratory tests, but these were not conducted for the field data gathered during this study (EcOz 1997).

Slope and Landscape Position: Slope is a critical factor in determining erodibility of soils and landscapes. Even on exceptionally low slopes, significant soil erosion can occur in some landscapes in northern Australia, especially on floodplains where slopes may be in the order of 0.1%. Soils of some seasonally inundated floodplains consist of duplex soils of fine sandy loams over acid clays, and topsoils have been observed to wash out along tracks for many kilometres (EcOz 1997). On steeper slopes, the combination of angle and length of slope is critical. Spacing of roll-over banks and contour banks should be planned in accordance with the guidelines below (from Sedman 2000) (**Table 9-1**).

- **Table 9-1 Slope and Erosion Control Bank Spacing Guidelines**

Slope (%)	Bank spacing (m)
Low to Moderate Soil Erodibility	
2-4	200
5-9	100
10-15	30
>15	15
High Soil Erodibility	
1	130
2	90
3	75
4	65
5	60
6-10	40
11-15	30
>15	15

These spacings are meant as a guide only, and closer or greater spacings and other erosion control structures may be warranted in some cases. Also in many cases there will be a side slope across the pipeline and alignment that will reduce the spacing requirements.

The position in the landscape to some extent determines the erodibility of the soils. The most severe occurrences of incision are likely to be where tracks pass across or near established erosion gullies or incised streams, allowing pulverised soils to be washed out of the system. The TTP crosses many streams and some erosion surfaces. These areas will require particular attention. For erosion surfaces, head wall banks may be required prior to or during construction. At watercourse crossings, top of bank diversion banks may be required to minimise water flowing along the pipeline directly into the watercourse. Water flow should be spread and directed into adjacent natural vegetation.

Soils vary in their erodibility according to soil type, slope, substrate and vegetation cover. Most of the soils which occur along the TTP route have the potential to erode if not managed adequately. Some particularly erodible soils can produce major erosion and long-term management problems.

Experience with other pipelines and linear developments in the Northern Territory has demonstrated that some of the main problems include:

- presence of a crown of soil over the pipeline trench which causes erosion and gullying along the pipeline;
- uncontrolled vegetation growth along the pipeline corridor and pipeline trench;
- presence of windrows which divert or pond water;
- poorly maintained erosion control installations,
- sediment entering creek and watercourse crossings from the pipeline – a diversion bank at the top of the bank may need to be installed to shed water from the pipeline;
- crossing of multi-channelled creek more than once may cause scouring and may require significant erosion control measures including rock armouring;
- grey clay soils on floodplains which are turned to bulldust by multiple tracking of vehicles;
- roll-over banks too infrequent, allowing water to sheet down slope;
- banks wrong design – too high or low, shedding slope too steep, too short and not diverting water far enough off the construction corridor;
- banks at top of slope too short and allowing water to run onto construction corridor;
- damage to erosion control banks by construction, testing and commissioning traffic after construction, but not re-constructed to make them effective;
- compaction of soils by traffic, creating potential channels;
- loss of soil through creation of dust – watering reduces this but aids in compaction;
- loss of soil through wind and water transport.

Preventative and Management Measures

Removal of vegetation and disturbance of soils during construction will expose the underlying soils. At watercourse crossings the removal and construction of temporary vehicle crossings for use during construction may cause scouring of the stream bed if the crossings are not adequately rehabilitated prior to the wet season. At perennial watercourses where culverts may be required downstream erosion may occur if the culvert outlet or downstream banks are inadequately protected. It is therefore the project's intention to minimise soil disturbance, degradation and erosion, to minimise turbidity impacts on surface and ground waters, to optimise rehabilitation success, and to minimise the potential for soil erosion to occur in the long-term during and post construction.

The following measures will be put in place to minimise erosion and sedimentation:

- The total area to be disturbed will be restricted to the minimum area required to construct the pipeline and above ground facilities.
- A detailed Erosion and Sediment Control Management Plan will be developed in accordance with established guidelines for the control of erosion at construction sites (i.e. Sedman 2000; Witheridge and Walker 1996; Hadden 1993). The plan will identify site specific construction techniques, management requirements and guidelines for erosion and sediment control for all areas disturbed during construction and for post-construction management throughout the life of the project.
- Sensitive watercourse crossings will be crossed using HDD.
- Watercourse crossings on the construction corridor and access tracks will be sited and constructed in accordance with accepted engineering standards and environmental protection guidelines in order to minimise downstream impacts.
- Construction activities involving significant land disturbance will be confined to the 'dry' season.
- Vegetation will be cleared and rehabilitated progressively throughout construction to minimise the period that bare soil is left exposed to erosion.
- Vegetation will be stockpiled along the construction corridor and will be re-used to stabilise and rehabilitate work areas.
- Topsoil will be stripped and stockpiled in stabilised piles less than 1.5 m, along the construction corridor and will be reused in rehabilitation and landscaping.
- Sediment traps, level sills, and silt fences will be installed to minimise soil loss from the working areas, diversion banks and roll-over banks.
- Spoil will be stored and set back from watercourse banks and earthworks will be contained within approved work areas.
- Construction at watercourses will be planned to ensure that the watercourse is open for as short a time period as practicable.
- Sediment control fences will be installed at all rivers, creeks and watercourses where required to prevent silt entering waterways.

- Temporary drains and banks, stabilised to prevent erosion in areas of high water flows, will be installed where required to control surface runoff.
- Cross banks (roll-over banks) of down-hill slopes less than 0.5% and wider than 2 m will be installed across slopes to prevent down-slope runoff.
- Cross banks will be installed across sloping tracks, where required to divert water and sediment to sills or sediment fences adjacent to the tracks.
- Drains will be constructed with broad flat bottoms, not v-shaped.
- Roll-over banks will be longer at the top of slopes and shorter banks down slope to shed as much water from the fall-line as possible.
- Roll-over banks will be re-constructed, as required after construction and commissioning to restore their effectiveness prior to the following wet season.
- Water trucks and other dust suppression and erosion management measures will be implemented to stabilise soils subject to heavy construction traffic.
- Access tracks will be stabilised and temporary watercourse crossings removed prior to the onset of the wet season following construction.
- Rehabilitation of disturbed areas will be undertaken as soon as possible during the work season following construction, and prior to the onset of the wet season.
- A storm water and drainage management system will be developed and implemented for the facility sites including compressor and scraper stations.

Monitoring of erosion will be undertaken regularly for the duration of construction and operation. During construction and commissioning particular attention will be given to soil and vegetation stockpiles and watercourse crossings. During operation particular attention will be given to areas with high erodibility potential, watercourse crossings and access tracks.

Rehabilitation progress will be monitored until areas are adequately stabilised and follow-up monitoring of rehabilitation success will be undertaken after the first wet season following construction.

Reporting procedures will be developed consistent with regulatory, local and project requirements.

9.2.4 Acid Sulfate Soils

Impacts

Trenching, de-watering and drainage of the pipeline and earth works associated with construction of above ground facilities has the potential to disturb and expose Acid Sulfate Soils (ASS). When ASS are drained or disturbed, sulfuric acid is produced which when released into the environment through water or soil mediums, can result in adverse environmental impacts, including water quality, aquatic flora and fauna and terrestrial flora and fauna. This can have knock-on impacts on fishing, recreation, tourism and human health. Potential impacts associated with ASS exposure include:

- soil acidification;
- adverse changes to the water quality of the soil, groundwater, surface water, wetlands, watercourses and estuaries;
- degradation of ecosystems and ecosystem services dependant on water;
- loss of habitat and biodiversity;
- corrosion of metallic and concrete structures such as roads, bridges, pumps, pipes and foundations;
- invasion of and dominance of wetlands and waterways by acid tolerant water plants, plankton and pathogens;
- increased human health risks associated with contamination of soil or, groundwater and acid dust.

A desk-top assessment has identified three principal sites through which the TTP route passes that may contain ASS **(Figure 6-4)**. Disturbance to ASS in these areas will be contained via the implementation of various management measures outlined below which will aim to restrict the migration of sulphuric acid and associated impacts. The presence of ASS along the proposed pipeline route has not been confirmed through site investigations. In the event that potential sites are identified, appropriate management measures will be identified and implemented in advance of construction activities.

Preventative and Management Measures

For sections of coastal wetland identified on the pipeline route, a reconnaissance survey of potential acid sulfate soils will be undertaken by an accredited soil scientist. Where field testing identifies potential acid sulfate soils, further laboratory testing and a management programme based on 'ASS Soil Management Guidelines' (Dear *et al.* 2002) is warranted. Any dewatering of acid sulfate soils will be neutralised with lime and disposed of by land application away from drainage lines.

To reduce the risk of potential impacts resulting from ASS exposure, field studies will be undertaken prior to construction commencing, to determine the extent of ASS along the pipeline route and the risk posed to the receiving environment. All studies and investigations will be

undertaken in consultation with the Northern Territory Government. These studies will adopt the following guidelines where relevant:

- 'Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998', Department of Natural Resources, Indooroopilly, Queensland, Australia.
- 'Environmental Guidelines for Reclamation in Coastal Areas, January 1999', Environmental and Heritage Division, Department of Lands, Planning and Environment, Northern Territory.
- 'Identification and Investigation of Acid Sulfate Soils and Groundwater, Draft 2003', Acid Sulfate Soils Guidelines Series, Department of Environment, Western Australia.

Should the results from this study indicate that ASS are present and will be disturbed during the course of construction, an Acid Sulfate Soil Management Plan will be developed to eliminate the impacts of ASS.

9.2.5 Hydrological Regimes and Water Quality

The main potential impacts of construction and operation of the proposed pipeline and above ground facilities on surface waters and groundwater have been identified as:

- disturbance of vegetation and soils during construction especially at watercourse crossings;
- water contamination from leakage or spillage from fuel and chemical storage, handling and distribution systems during construction and operation;
- water contamination from disposal of sewage and greywater from construction camps;
- water contamination from disposal of hydrotest water during commissioning;
- water contamination from disturbance of acid sulfate soils;
- water contamination from trench dewatering;
- over extraction of water for use during construction.

The principal receptors of impacts are groundwater systems, marine & coastal systems and inland waterways. The potential impacts are presented below from the full report in **Appendix G, Volume 2** of this Draft EIS.

Watercourse Crossings: Each of the watercourse crossings in the pipeline corridor was inspected during field investigations undertaken in October to December 2003 and June to September 2004. Data from environmental, heritage and cultural surveys and desktop studies were used to document the values of each watercourse and subsequently to determine the potential for impacts on those values using each of the pipeline crossing construction techniques described in **Section 5.5.10**. Data from the preliminary engineering and geotechnical surveys were used to determine the technical feasibility of each crossing type. **Table 9-2** summarises the criteria considered in the determination of the most appropriate crossing types for each watercourse.

- **Table 9-2 Issues and Criteria Considered in Determining Crossing Type**

Issue	Criteria
Impact on environmental values	Type and integrity of riparian vegetation Susceptibility to erosion and potential to cause downstream sedimentation impacts Ability to stabilise and rehabilitate in short time frame between construction and the following wet season (dependent on various factors including soil type, vegetation, stream flow) Type and integrity of in-stream habitat Declared Beneficial Uses of water Threatened fauna and flora
Impact on archaeological and heritage sites	Significant archaeological sites or objects Significant historic heritage sites
Impacts on social values	Declared Beneficial Uses of water Landowner wishes Recreational and tourism use of waterways
Impact on cultural values	Aboriginal Sacred Sites Aboriginal cultural values
Engineering feasibility	Soil and rock type Bank profile Cost and logistics of construction Ability to stabilise and rehabilitate Water flow Feasibility of trenching

The process for identifying the most appropriate method to construct each of the waterway crossings involved consideration of each of the above aspects by technical experts, and negotiation between the various stakeholder groups, to ultimately come up with a crossing method with which all groups agreed. The outcome of the crossing assessment was that HDD techniques are proposed for 12 waterway crossings. **Table 9-3** documents the waterways from west to east along the proposed pipeline route where HDD crossings are proposed. The location of each crossing is shown in **Figure 6-5**.

- **Table 9-3 Proposed HDD crossings**

Waterway	KP	Reasons
Moyle River	75	Riparian vegetation and in-stream habitat of conservation significance Declared wetland of national significance
Daly River	266	Riparian vegetation and in-stream aquatic habitat of conservation significance Deep river channel with steep banks could be difficult to stabilise and rehabilitate Significant weed infestations along river banks Known habitat of the Freshwater Sawfish *Pristis microdon* a fish species listed as Vulnerable under the EPBC Act
Katherine River	350	Riparian vegetation and in-stream aquatic habitat of conservation significance Deep river channel with steep banks could be difficult to stabilise and rehabilitate Significant weed infestations along river banks Known habitat of the Freshwater Sawfish *Pristis microdon* a fish species listed as Vulnerable under the EPBC Act
King River	370	Deep and wide river channel with steep banks could be difficult to stabilise and rehabilitate
Waterhouse River	424	Riparian vegetation (very tall trees) and in-stream habitat of conservation significance Deep and wide river channel with steep banks – specific attention is required to stabilise and rehabilitate
Mainoru River	550	Riparian vegetation and in-stream habitat of conservation significance – potential for significant impacts if construction machinery must be transported across multiple braided channels Known habitat of the Freshwater Sawfish *Pristis microdon* a fish species listed as Vulnerable under the EPBC Act
Wilton River	600	Riparian vegetation (very large trees) of conservation significance Deep river channel with steep banks – specific attention is required to stabilise and rehabilitate
Goyder River	701	Riparian vegetation (very large trees) and in-stream habitats of conservation significance Braided channels with sandy banks – specific attention is required to stabilise and rehabilitate
Boggy Creek	852	Riparian vegetation and in-stream habitat of conservation significance Potential for impacts on hydrology of waterhole which has a small outflow
Cato River	880	Riparian vegetation and in-stream aquatic habitat of conservation significance Deep river channel with steep banks – specific attention is required to stabilise and rehabilitate
Giddy River	912	Riparian vegetation and in-stream habitat of conservation significance – potential for significant impacts on the vegetation island in the river channel Known habitat of the Wood Frog *Rana daemeli* a species listed as Vulnerable under NT legislation Banks require attention to stabilise and rehabilitate
Latram River	922	Known habitat of *Pternandra coerulescens* a plant species listed as Vulnerable under NT legislation Riparian vegetation and in-stream habitat of conservation significance

Water Contamination: The following sections of the pipeline route (starting from the gas plant at Wadeye) could potentially impact on aquifers that have significant development potential or high resource value to the community:

- 0 to 10 km (Moyle River Basin);
- 300 to 350 km (Tindal – Katherine Groundwater Management Area, Daly River Basin);
- 780 to 810 km (Goyder River Basin);
- 820 to 910 km (Buckingham River Basin).

As the transported gas is volatile, is less dense than air and will vent from buried infrastructure to the atmosphere (Beer *et al.* 2000), there is no risk of contamination during the operation of the pipeline.

Impacts to freshwater aquatic life may arise in areas where sediment load into creeks is increased as a result of land clearing and earthmoving without the necessary sediment and erosion controls. Road construction and maintenance activity along access routes, and the pipeline corridor, could direct turbid runoff into surface drainage systems. Sediment and erosion control measures will be needed to protect downstream water quality values where temporary and permanent access crosses surface drainage systems. The potential impacts of high sediment loads on aquatic environments are discussed in **Section 9.2.3**.

Logistical plans allow for the transport of approximately 3,500 t of diesel during construction. The diesel and chemical storage and distribution systems have the potential to impact groundwater, if not managed correctly and surface water resources over the life of the project.

Contamination of water resources with sediments, hydrocarbons and other chemicals, and\or over extraction may:

- cause changes to the species composition and abundance of aquatic flora and fauna;
- cause the death of aquatic flora and fauna;
- cause a decline in health of wetland ecosystems and other groundwater dependent systems;
- make water unsuitable for consumption by humans and animals.

Water Extraction and Wastewater: The volumes of water to be extracted and disposed of for hydrostatic testing of the pipeline have the potential to cause impacts on ephemeral surface water bodies in the absence of appropriate controls. The impact will depend on the source water characteristics (marine or freshwater), whether or not the discharge water contains hydrotest chemicals and whether the discharge water is disposed of to an area with surface water flow, a sensitive land use or an ocean outfall.

Local bores, rivers and creeks are identified in the construction plan as possible sources of water for pressure testing. Hydrotest water which may contain low levels of biocides and oxygen scavengers, will be required to be disposed of. The most significant potential impacts of

hydrostatic pressure testing are associated with the pumping of water into a wetland that originates elsewhere (either surface or groundwater).

The potential impacts to surface water may include:

- Aquatic biota being physically removed from water bodies through pumping the water.
- Substantial/complete abstraction of water from small water bodies with an impact to aquatic ecosystems through the removal of dry season refuges and affecting species composition/abundance.
- Translocation of water from one water body to another, posing a risk of introducing non-endemic aquatic biota and, changing species composition and predator-prey relationships.
- Change to physical/chemical properties (for example temperature, pH and salinity) of water may impact on aquatic biota by changing species composition/abundance.

For groundwater, a change in physical/chemical properties (for example temperature, pH, salinity, chemical additives) of water may impact on:

- aquatic biota by changing species composition/abundance;
- drinking water quality.

There will also be potential impacts from water supply and disposal for construction camps. Construction camps comprising up to 100 bunkhouses, mobile generators (900 to 1500 KVA) and wastewater and sewerage systems will be established for each construction spread. Camp water will be extracted from local groundwater bores, potentially lowering local water tables. Camp wastewater discharged into either septic tanks and absorption trenches, or treated by a bio-filter sewerage plant could introduce biological contamination into the groundwater.

Dewatering: Based on a desktop assessment of groundwater depth, the pipeline trench is unlikely to intersect shallow groundwater as long as construction is confined to the dry season. Diverting surface runoff away from the trench will further reduce the need for dewatering in the event of unseasonable storms. HDD techniques will be used where significant watercourses are traversed, removing the need for trench dewatering at these crossings. A further 12 watercourse crossings, and six broad drainage floors are likely to have water or saturated soils present at the time of construction and therefore dewatering will be required. The locations of these perennial watercourses and wetlands are listed in **Appendix F**, **Volume 2, Table 9**. Depending on seasonal rainfall pattern and amount, some dewatering may also be required in seasonal wetland areas.

Based on the limited extent of dewatering likely to be required, it is not expected that the localised lowering of water tables, or the associated impact on aquatic flora and fauna, will be significant. In the event that acid sulfate soils are identified in coastal wetlands being excavated, wastewater will need to be treated and disposed according to guidelines for acid sulfate soil management (Dear *et al.* 2002).

Preventative and Management Measures

During the construction phase of the project, preventative and management actions are needed to address the risks of environmental impact that are associated with land and waterway disturbance, fuel storage and transport, water extraction and disposal of wastewater. During the project operation, preventative and management actions will be focussed on addressing the risks of environmental impact that are associated with the processing, storage and transport of hydrocarbons. During the decommissioning phase of the project, preventative and management actions will be focussed on minimising the risk of turbidity arising from land disturbance on receiving wetland and coastal environments, and meeting stakeholder expectations of the closure process.

Management summary

- An Erosion and Sediment Control Management Plan will be developed and implemented for constructions and operations (**Section 12**).
- Baseline groundwater and surface water monitoring will be undertaken at selected environmentally sensitive sites prior to construction.
- A Hazardous Materials Register detailing the location and quantities of hazardous substances including their storage, use and disposal will be developed and maintained for construction and operation.
- Fuel and chemical storage, handling and distribution systems will be designed and constructed in accordance with Australian Standards.
- Fuel and chemical storage will be above ground and will be located an appropriate distance from surface waters and high quality groundwater resources.
- Construction vehicles, plant and machinery will be adequately maintained to minimise the potential for leaks.
- Frequent visual inspections of fuel and chemical storage, handling and distribution systems, and areas where vehicles, plant and machinery are stored, will be undertaken to identify and fix leaks.
- All construction and operation personnel will be trained in safe work practices for handling of hazardous substances, and in spill clean up procedures.
- A Spill Contingency Plan will be developed and implemented.
- Above ground facilities will be frequently inspected to identify corrosion and leaks, and maintained where necessary.
- A Watercourse Crossing Construction Management Plan will be developed and implemented.
- A Hydrotest Management Plan will be developed and implemented (**Section 12**).
- Permits and regulatory approval will be obtained for the use of groundwater for hydrotesting, dust suppression and potable supplies.
- No water will be extracted from a surface water body for any purpose prior to an assessment of the potential environmental impacts of the amount of water that will be extracted.

- No water used for any purpose during construction, commissioning or operation will be released directly to a water body.
- Targets will be set for and monitoring undertaken of groundwater consumption.
- Construction and maintenance works at watercourses will be confined to the dry season.
- Hydrotest water will be disposed of by ground application in a stable environment.
- An Acid Sulfate Soils Management Plan will be developed and implemented (**Section 12**).
- A Waste Management Plan will be developed and implemented (**Section 12**).
- Sewage and greywater from construction camps will be disposed of in accordance with relevant environment and health guidelines, and statutory requirements.
- Waste water treatment and disposal systems will be located 100 m away from production bores, or 400 m in areas with high groundwater sensitivity.
- Site drainage systems at above ground facilities will be designed to separate potentially contaminated stormwater for treatment and disposal.
- A Rehabilitation Management Plan will be developed in consultation with stakeholder groups.

9.2.6 Visual Amenity

Impacts

Construction*:* Visual impacts on the local population may occur during construction activities, from the presence of construction camps, construction traffic and associated dust, temporary fencing and from construction along the construction corridor. The main visual impact will be from the clearance of vegetation and trees, resulting in a temporary 'scar' on the existing environment. Other sources of potential impacts include inappropriate storage and handling of waste streams.

There are a small number of communities or permanent settlements within the immediate vicinity of the pipeline route and the number of people likely to have a view of the construction corridor is considered to be limited. The nearest residential receptors are at Dorisvale station, approximately 1 km away from the pipeline corridor and at Beswick, located approximately 2 km away from the corridor.

However, the pipeline route will pass close to and cross existing roads and a rail line, which will result in visual impacts. The potential impact on the landscape is closely linked to the successful reinstatement of the construction corridor and in particular the implementation of a Rehabilitation Management Plan.

Operation: During commissioning and operation, potential impacts will be confined to the presence of above ground facilities and permanent pipeline markers. The impact of the development on the landscape will be short term. The majority of the above ground facilities are located in relatively remote areas, away from human receptors. The roads to the proposed compressor stations at KP158, KP361 and KP530 are located approximately 18 km, 1.5 km and 0.5 km away, respectively. The relatively low structures proposed for the site (the highest being

12.5 m over ground level at the compressor station) together with existing screening around the facilities will limit the severity of visual intrusion. In the overall context of the surrounding landscape; the portion of land that will be occupied by the permanent facilities will be comparatively small and will have no significant visual impact on the amenity value of the land.

Preventative and Management Measures

The design of the pipeline is such that it will be buried, which will prevent any potential long term visual intrusion impacts on the existing environment. Management measures that will be implemented include:

- Screening will be undertaken where possible.
- Minimising the width of the construction corridor as far as practicable.
- Implementation of a Rehabilitation Management Plan (**Section 12**) that will ensure that once construction is complete the corridor will be revegetated with native species to reduce visual intrusion.
- Limiting the number of vehicle movements as far as reasonably practicable in the vicinity of towns and local communities and settlements.
- A Traffic Management Plan (**Section 12**) will be developed and implemented prior to construction activities. The plan will include restrictions and speed limits to reduce the generation of suspended dust along unsealed tracks.
- Construction camps will be removed from site following construction and commissioning activities and sites returned to their existing state.
- The equipment and above ground facilities are likely to be painted in neutral tones which blend into the surrounding environment.
- There will be a buffer zone around each of the compressor stations.
- A Waste Management Plan will be implemented to ensure good housekeeping practices and that all construction areas are left in a good state.

9.3 Ecological Environment

9.3.1 Vegetation and Flora

The main potential impacts of construction and operation of the proposed pipeline and above ground facilities on vegetation and flora have been identified as:

- clearing of vegetation;
- degradation of sensitive vegetation communities and habitats;
- disturbance to species of conservation significance;
- introduction and spread of exotic species.

The potential impacts of vegetation clearing are presented in this section from the full report contained in **Appendix H, Volume 2** of this Draft EIS. Potential impacts on threatened species

and ecologically sensitive vegetation communities are discussed in **Section 9.3.4** and **Section 9.3.5**. The introduction of weeds and exotic species is discussed in **Section 9.3.7**.

Vegetation Clearing: The total area that will be permanently cleared of trees and tall shrubs for the pipeline corridor and above ground facilities will be approximately 2,822 ha. A further 4.5 ha of clearing will be required should the two additional compressor stations to be constructed (**Section 5-6**). Temporary clearing of 9 ha of vegetation will be required for eight construction camps, which will be rehabilitated and revegetated when construction is complete. The clearing calculations do not include the clearing of native vegetation that will be required for the construction and upgrade of access tracks and other aspects such as borrow pits. It is not yet known how much vegetation will be cleared for these aspects of the project. However, it is intended that the project will make use of existing access tracks and borrow pits to minimise the amount of vegetation clearing. A summary of the area of vegetation that will be cleared for each project component is presented in **Table 9–4**.

- **Table 9–4 Summary of Vegetation Clearing for Pipeline and Above Ground Facilities**

Project Component	Dimensions	Area Cleared
Pipeline Corridor	940 km x 30 m	2,820 ha
Compressor Stations (x3)	150 m x 150 m	2.25 ha - initially for one compressor station 4.5 ha – additional if a further two compressor stations required
Meter Stations (x2)	N/A	One meter station will be located within the Blacktip gas plant boundary at Wadeye. The second station will be located inside the boundary of the Gove gas station.
Scraper Stations (x6)	20 m x 30 m	Within pipeline corridor
Gove Gas Station (x1)	70 m x 30 m	0.21 ha
Construction Camps	4 camps 250 m x 300 m 4 camps 150 m x 200 m	42 ha temporarily cleared, will be rehabilitated
	Total Permanent	**2,827 ha**
	Total Temporary	**42 ha**

The vegetation type that will be most affected by the clearing required for the project is woodlands to forests dominated by *Eucalyptus miniata* and *E. tetrodonta.* Associations of this vegetation type are the most common in the Top End of the Northern Territory, and they characterise over 60% of the pipeline corridor. Woodlands dominated by associations of *Eucalyptus tectifica* and *Corymbia spp*. are the next most common vegetation type in the project area comprising over 20% of the current pipeline corridor. None of the vegetation communities identified from the vegetation mapping or during the field surveys are considered to be rare or threatened. There are, however, a number of vegetation communities with a restricted geographic distribution, including riparian corridors, wetlands and monsoon rainforest patches that occur in proximity to the project area. These communities typically play an important role in maintaining ecosystem health, are sensitive

to disturbance and have special conservation values that warrant protection. The potential impacts on these ecologically sensitive areas are discussed in **Section 9.3.4** along with management measures to prevent or minimise these impacts. Overall, the permanent vegetation clearing that will be associated with the project is considered unlikely to have a significant impact on vegetation and flora as long as the preventative and management measures recommended below are developed, implemented and monitored.

Preventative and Management Measures

The primary preventative measure that has been adopted to minimise the impacts of vegetation clearing is to avoid sensitive habitats and to plan and manage construction activities so that only the minimum area of vegetation necessary is cleared during construction. The pipeline corridor was selected to avoid direct impacts on ecologically sensitive vegetation communities and where this was not possible, for example at riparian corridors, specific preventative and management measures will be implemented to minimise potential impacts as discussed in **Section 9.3.4**. Construction activities will be confined to the dry season, and reinstatement and erosion control will be completed prior to the onset of the first wet season rains in an effort to maximise rehabilitation success.

In order to avoid unauthorised vegetation clearing or disturbance the boundaries of the corridor and all working areas will be clearly delineated on the ground and on all construction drawings. Clearing of vegetation and rehabilitation will be undertaken progressively in accordance with a Vegetation Clearing Management Plan and a Rehabilitation Management Plan which 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, if required. 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 spread within the project area for rehabilitation or will be disposed 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.

Management Summary

- Construction activities will disturb only the minimum area of vegetation necessary.
- The boundaries of the pipeline corridor and all construction sites will be clearly delineated on the ground and in construction drawings.
- Clearing, reinstatement and rehabilitation will be undertaken progressively over the construction period.
- Reinstatement of disturbed areas will occur as soon as possible after construction activities cease in an area.
- Access during construction and operation will be via environmentally approved access tracks and the pipeline corridor only.
- A Vegetation Clearing Management Plan will be developed and implemented.

- A Rehabilitation Management Plan will be developed and implemented.
- The project personnel will be briefed about their obligations to protect native vegetation throughout all stages of the project.
- Siting for additional infrastructure or clearing including: new access routes, borrow pits, lay down areas, construction camps, anode beds, turning circles and compressor stations will be subject to vegetation, flora and fauna assessments.

9.3.2 Fauna

The main impact of the construction and operation of the pipeline and above ground facilities on fauna will be associated with short-term disturbance of animals and habitats during construction. 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 construction period. High levels of vehicle traffic during the construction phase will also result in increased numbers of fauna casualties, mainly birds, macropods and reptiles, as a result of collisions with vehicles. The main potential longer-term impacts of the project on fauna have been identified as:

- habitat loss and disturbance;
- fauna capture in open trench;
- disturbance of species of conservation significance;
- introduction and spread of weeds and exotic fauna species.

The issues of habitat loss and disturbance and fauna capture in the open trench are discussed in this section. Species of conservation significance are discussed in **Section 9.3.4** and the introduction and spread of weeds and exotic fauna is discussed in **Section 9.3.7**.

Habitat Loss and Disturbance: Construction and operation of the pipeline and above ground facilities will result in the direct loss of 2,827 ha of native vegetation which provides habitat for a range of fauna species. Most of the habitats that occur in the pipeline corridor, especially on Aboriginal owned land (approximately two thirds of the corridor) are largely undisturbed by modern technology and as a result are in good ecological condition and have high value as fauna habitat. The majority of the pipeline corridor through pastoral and agricultural lands (the remaining one third of the route) also traverses habitats that are in good condition, although in some areas, weeds, cattle and feral animals have degraded the habitat values to fauna. The potential impacts of habitat loss on biodiversity were minimised during the design phase by locating and refining the pipeline corridor and above ground facilities to avoid direct impacts on significant fauna habitat such as major riparian corridors, wetlands and rainforest patches as discussed in **Section 9.3.3** and **Section 9.3.4**.

Changed environmental conditions will occur at the edges of areas cleared for construction activities (edge effects) (Ford *et al.* 2001; Hobbs 2001). Edge effects can act as a barrier to animal movement between habitat patches (Kozakiewicz 1993), or can affect animal movement by

creating more complex movement paths as individuals approach a barrier, withdraw, and approach again (McDonald and St Clair 2003). The magnitude of edge and barrier effects will depend on species behaviour and mobility (Goosem *et al.* 2001). Species of fauna that are habitat specialists or that move amongst several habitats are particularly at risk (Ford *et al.* 2001; Harrington *et al.* 2001). It is likely that most species will continue to actively use the temporarily disturbed woodland in and around the project area, although in the long-term, the abundance of a few fauna species in the project area may decrease as a result of habitat removal and fragmentation. Some species, such as the Blue-winged Kookaburra, Blue-faced Honeyeater and Brown Honeyeater, which do occur in areas that will be disturbed, are sensitive to habitat modification and may avoid use of the project area altogether during construction. 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. Given that this threshold will not be exceeded at any location in the project area and the widespread regional availability of habitats similar to those found in the pipeline corridor, it is considered unlikely that populations of fauna that occur will decrease in regional abundance.

Fauna Entrapment in Open Trench: Construction of the pipeline has the potential to cause fauna mortality due to capture in the open trench during construction. Animals that are trapped in trenches are exposed to various elements such as stress, predators, effects from the sun and subsequent dehydration (Woinarski *et al*, 2000c). Fauna mortality as a result of entrapment will be minimised through appropriate measures to facilitate their escape or removal from the open trench.

Feral Animals: Feral animal issues and preventative and management measures are discussed in **Section 9.3.7**.

Preventative and Management Measures

The primary preventative measures adopted to minimise the impacts of habitat loss on fauna abundance and diversity are to:

- design, plan and manage corridor alignment and construction activities so that only the minimum area of native vegetation necessary is cleared during construction;
- avoid direct impacts on ecologically sensitive habitat areas as recommended by Woinarski *et al.* (2000c).

The pipeline corridor was selected to avoid direct impacts on significant fauna habitats and where this was not possible, for example at riparian corridors, specific preventative and management measures will be implemented to minimise potential impacts as discussed in **Section 9.3.4**. Large fruiting trees (such as *Ficus virens, Terminalia microcarpa, Syzygium nervosum* and *Canarium australianum*) which provide important fruit resources and act as stepping stones between fragmented habitats, will be identified and retained where possible. Large trees in riparian corridors will also be retained where construction activities can work around them.

To minimise the numbers of animals that become trapped in the open trench, construction activities will be confined to the dry season when activity levels of reptiles, which are most likely to be

captured in the trench, are generally lower due to the cooler weather. Construction activities will be planned so that the excavated trench will be open for the minimum amount of time necessary to lay the pipeline. This could be up to four weeks in some instances.

Despite the above measures to minimise entrapment it is inevitable that a large number of animals will fall into the trench. Fatalities will be minimised by installing escape ramps at regular intervals along the trench, using damp hessian bags to provide temporary shelter and regular inspections of the trench and release of captured animals. Frequent inspections of open excavations will be undertaken by experienced wildlife handlers throughout each day of construction commencing at sunrise, with at least one sunrise collection, one early morning collection and one afternoon collection. Animal handlers will have training in appropriate handling techniques and personal protective equipment for handling a variety of wildlife from snakes and lizards to small and large mammals. All wildlife removed from the excavations will be identified and recorded prior to being released in surrounding vegetated areas and any dead animals will be preserved for lodging with MAGNT. MAGNT will be provided with support to assist with the increased workload. All data will be collated and provided to the Northern Territory Parks and Wildlife Service.

The construction workforce will be briefed about their obligations to protect native fauna. Inductions will also cover reporting of fauna in the open trench as well as ways to avoid potentially dangerous fauna such as snakes.

Management Summary

- Avoidance of sensitive habitats by the pipeline corridor.
- Construction activities will disturb only the minimum area of vegetation necessary.
- The boundaries of the pipeline corridor and all construction sites will be clearly delineated on the ground and in construction drawings.
- Construction activities will be confined to the dry season.
- Direct impacts on significant habitat areas will be avoided.
- Clearing of large fruiting trees and large trees in riparian corridors will be avoided.
- Access during construction and operation will be via environmentally approved access tracks and the construction corridor only.
- A noise and dust minimisation plan will be developed and implemented.
- Blasting activities will be kept to the minimum amount required.
- The trench will be open for the minimum time possible.
- The trench will be interrupted with frequent ‘escape ramps’ while open.
- Damp hesian bags will be placed in the trench to provide fauna with temporary shelter before being removed.
- Trenches will be inspected by an experienced wildlife handler throughout the day.
- Wildlife removed from trenches will be identified, recorded and released into nearby vegetated areas.

- Dead animals will be preserved and submitted as voucher specimens to MAGNT.
- Wildlife data will be provided to the NT Parks and Wildlife Service.
- All animal handlers are to be trained in appropriate handling protocols and will possess the necessary PPE for handling a wide variety of animals.
- The construction workforce will be briefed about their obligations to protect fauna.
- Vehicle travel on access routes will be restricted to daylight hours.

9.3.3 Aquatic Ecosystems

Aquatic ecosystems are possibly the ecosystems most sensitive to disturbance that are encountered in the project area and subsequently these ecosystems are at greatest risk of being negatively affected by the project. The main potential impacts on aquatic ecosystems have been identified as:

- disturbance and loss of aquatic habitats;
- increased sediment loadings and chemical contamination of waterbodies;
- restriction of fish passage;
- translocation of pests and diseases.

Disturbance and Loss of Aquatic Habitats: Where watercourse crossings are constructed using open trench construction techniques the instream and riparian habitat that is present in the pipeline corridor will be disturbed or lost. Riparian vegetation has been recognised as valuable habitat and vital to the functioning of stream ecosystems (Wager and Jackson 1993). The removal or modification of riparian corridor vegetation can adversely affect every aspect of stream habitat. Increased erosion, scouring and changes to channel morphology as a result of riparian vegetation removal can cause increases in nutrient loadings and light penetration and associated unfavourable algal blooms and increases in water temperatures. Disturbance of riparian vegetation is also known to allow the proliferation of weed species. Arthington *et al.* (1983) have documented the adverse effects of Para Grass (*Brachiara mutica*) on native fish habitats in streams around Brisbane after the loss of native riparian vegetation. Decreases in in-stream habitat may also occur with a loss of undercut banks, woody debris and leaves etc.

Sedimentation and Chemical Contamination of Water: Construction of pipeline watercourse crossings where open trench construction techniques are proposed, and watercourse crossings on access routes, will result in mobilisation of sediments into the waterway both during and post construction. The potential impact will be greatest at perennial watercourses where the water is flowing at the time the crossing is constructed, however, erosion and sedimentation will be an issue at all watercourses if they are not adequately stabilised prior to onset of the wet season. Increased sediment loading may have a variety of effects on the downstream aquatic habitats including infilling of holes and channels, smothering of riffle areas and the associated invertebrate fauna, smothering of macrophytes, and smothering of fish eggs deposited in gravel substrates or attached to underwater surfaces (Wager and Jackson 1993). Monsoonal rivers are considered harsh environments and many species other than the generalists will have difficulty coping with further

physiochemical changes during the dry season, or low flow periods which may ultimately lead to their death.

Chemical contamination of waterways could potentially occur from a number of sources including wastewater from construction camps, spills of fuels and oils from vehicles and plant, drilling muds used at HDD crossings and disposal of hydrotest water. It is expected that the risk of chemical contamination of water and associated negative impacts on aquatic environments will be minimal as long as the appropriate measures to prevent impacts identified in the sections below are implemented. In the event that chemical contamination does occur it is likely the aquatic environment affected will have difficulty assimilating the contamination as the system will already be subject to natural dry season stressors, and fish deaths would be likely.

Fish Passage: The installation of causeways and culverts across waterways to facilitate access during construction has the potential to cause significant negative impacts on aquatic environments through restricting fish passage up and down waterways. Causeways can result in many problems for fish passage including debris blockage, excessive flow velocities, inadequate flow and sediment runoff (Fairfull and Witheridge 2003). A poorly designed or installed culvert can affect the fish stocks of an entire drainage basin (Cotterell 1998). If a crossing or culvert is designed such that the channel width is restricted or a drop is created, the velocity of flowing water will be increased. Whilst fish are stimulated to move in response to floods, the water velocity in culverts or at crossings under flow conditions may exceed the swimming ability of many fish, therefore excluding these from upstream habitat that many species require. The risk of negative impacts on fish species will be greatly reduced through the adoption of environmentally sensitive design and construction as described in the management sections below.

Translocation of Pests and Disease: Biological material, including pest species and disease could be transferred from one waterbody to another through inappropriate disposal of hydrotest water and use of unsterilised machinery and equipment to construct watercourse crossings. As long as appropriate preventative measures, as described in the management sections below, are implemented it is considered unlikely that pests and diseases will be translocated by the planned construction activities. If translocation of fish or other aquatic organisms did occur the range of adverse affects could include the introduction of diseased organisms, disturbance of ecosystems, loss of biogeographic information and loss of genetic diversity (Wager and Jackson 1993).

Preventative and Management Measures

A precautionary approach will be taken to protect aquatic environments from disturbance during construction activities. Construction of watercourse crossings where open trench construction techniques will be used, will be prioritised for as early as possible in the dry season and rehabilitation works will be completed as soon as practicable to allow for sufficient revegetation prior to onset of the first wet season rains. The removal of large trees present on the banks of watercourses will be avoided as much as possible. HDD techniques will be used to construct pipeline crossings at the 12 watercourses identified in **Table 5–10** where the potential impacts on the aquatic environments from the use of open trench construction techniques were deemed to be

unacceptable. The aquatic environments at the Cato River, Giddy River, Goromuru River, Daly River and Katherine River, that are attributed a particularly high conservation value, will be protected by using this construction technique.

To minimise erosion and downstream sedimentation of habitats, erosion and sediment control measures will be implemented at all watercourse crossings in accordance with general guidelines developed in an Erosion and Sediment Control Management Plan (**Section 12**) and site specific guidelines developed in a Watercourse Crossing Construction Management Plan. Construction camp sites were selected to minimise the potential for chemical contamination of waterways from wastewater. Original camp sites selected at the Moyle River and Buckingham River were relocated due to the perceived potential for unacceptable impacts on nearby waterbodies. Design and construction of fuel and chemical storage, and wastewater treatment facilities will comply with Australian regulations and will be located appropriate distances from watercourses. A plan for the appropriate treatment and disposal of hydrotest water will be developed and will prohibit disposal directly to watercourses. Water quality will be monitored downstream of construction activities on all perennial watercourses for the duration of construction, and a Water Quality Monitoring Programme will be developed and implemented to establish minimal impacts in the first few years following construction.

Where access routes to the project area cross waterways the crossing will be designed and constructed in accordance with general and site specific environmental guidelines. Each crossing will be subject to a site assessment and the appropriate crossing type and construction techniques will be chosen in accordance with the guidelines for preservation of aquatic environments included in **Appendix F**, **Volume 2 Table 7 & 8** of this Draft EIS. A Watercourse Crossing Construction Management Plan will be developed to encapsulate the full range of preventative measures identified and will include:

- criteria to be used in final selection of the watercourse crossing points;
- appropriate temporary and permanent culverts types for each crossing;
- specific construction techniques and management measures required at HDD crossings, wet crossings and dry crossings;
- erosion and sediment control requirements;
- rehabilitation and revegetation plan.

All temporary in-stream structures such as temporary crossings and bund walls will be removed as soon as practical after the works are completed and the streambed restored to as near as possible original condition. During operation of the pipeline all waterway crossing structures will be inspected and maintained on a regular basis to minimise erosion and sedimentation. All in-stream maintenance will be scheduled for the dry season to avoid critical periods of fish passage and seasonal high flows.

To prevent translocation of aquatic pests and diseases, hydrotest water will be treated and disposed of in accordance with a Hydrotest Management Plan (**Section 12**) and all machinery and equipment

that is submersed in a waterway will be washed down and decontaminated before being used in another waterway.

Management Summary

- Construction of watercourses crossings will be prioritised for early in the dry season.
- Rehabilitation of watercourse crossings will occur as soon as practicable following construction.
- Removal of large trees on river banks will be avoided to the extent possible, and construction activities will disturb as minimum an area of vegetation as possible.
- HDD will be used to construct crossings of 12 major waterways.
- An Erosion and Sediment Control Management Plan will be developed and implemented (**Section 12**).
- A Watercourse Crossing Construction Management Plan will be developed and implemented.
- Construction camps and fuel and chemical storage areas will be located away from watercourses.
- Fuel and chemical storage and wastewater treatment facilities will be designed and constructed to Australian standards.
- A Hydrotest Management Plan (**Section 12**) will be developed and implemented.
- Where access routes to the project area cross waterways, crossings will be designed and constructed in accordance with environmental guidelines.
- Temporary in-stream structures will be removed and the stream bed restored as soon as practicable.
- Watercourse crossings will be regularly inspected and maintained during operation.
- Non-urgent maintenance activities will be confined to the dry season.
- Machinery immersed in waterways will be washed down and disinfected prior to use in another waterway, if required by the final risk assessment or local authorities.

9.3.4 Flora and Fauna Species of Conservation Significance

Sections 6.3.2, **6.3.3, 6.3.4** and **6.3.5** identify flora and terrestrial and aquatic fauna species of conservation significance that have been observed in the project area, or that possibly occur in proximity to the project area based on habitat preferences. The potential impacts on these species are discussed below.

Unnamed Plant Pternandra coerulescens: The project is unlikely to impact on *P. coerulescens* as HDD is proposed for the crossing of the Latram River. Using this crossing technique will avoid destruction of the riparian corridor which is primary habitat for *P. coerulescens*.

Northern Cypress Pine Callitris intratropica: It is likely that individuals of the Northern Cypress Pine *Callitris intratropica*, a species of interest that is not protected under legislation, will be disturbed during construction. The impacts of the project on this species could be reduced by

avoiding *C. intratropica* where it is encountered, especially where small stands of juveniles occur. Specific locations where this is recommended are identified in the preventative management section below, however, there is likely to be other areas where *C. intratropica* also occurs.

Cycads: Cycads will inevitably be disturbed during construction. None of the species with a range extending to the project area are listed as 'threatened' species under Northern Territory or Commonwealth legislation. The Draft Northern Territory Cycad Management Plan (Parks and Wildlife Service of the Northern Territory 2003, p.7) states that where land clearing has been approved under the procedures of the Northern Territory Government, no permit will be required to take unprotected cycads for non-commercial purposes on areas designated to be cleared. However, the conservation value of these plants as commercial species is recognised, and therefore the potential for salvaging plants that will be disturbed should be considered in consultation with land owners.

Gouldian Finch Erythrura gouldiae: The rocky sandstone hills around the Chambers River east of Beswick where the Gouldian Finch was recorded during the field surveys are generally avoided by the pipeline corridor, which traverses lower ground rather than the rocky slopes and hill tops that are the preferred habitat of the finch. The area could be an important breeding site for the finch, and accordingly NT Parks and Wildlife Service have recommended that there should be at least a 500 m buffer between the pipeline corridor and the whole sandstone spur where Gouldian Finches were recorded (*Palmer pers comm. 2004*). The pipeline corridor is 1.6 km north of the area identified as potentially important habitat, and access routes to the pipeline corridor in this area were designed to maintain a 500 m separation distance from finch habitats. Therefore, it is expected that impacts on the species will be minimal.

Red Goshawk Erythrotriorchis radiatus: Nest sites of the Red Goshawk are particularly vulnerable 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 be encountered near to construction activities this could result in failure of the nest. No nest sites were identified during the field surveys of the project area, therefore, it is expected that there will be minimal impacts on this species as long as appropriate measures for identifying and avoiding nest sites are put in place.

Wood Frog Rana daemeli: The pipeline corridor traverses known Wood Frog habitats where it crosses the Cato River (KP880), Giddy River (KP912) and Latram River (KP922). HDD is proposed as the construction method at each of these watercourse crossings, which will mean that the riparian rainforest habitats in the pipeline corridor will not be directly disturbed. Access routes to the pipeline corridor near the Giddy River and Latram River have been sited well away from the riparian habitats, and no access tracks are proposed near the Cato River.

Feral pig activity as well as altered fire regimes have been identified as potential threatening processes that degrade the preferred habitat of the Wood Frog (Woinarski 2002d). The potential for the project to introduce weed species with associated changes to fire regimes is therefore of concern. Appropriate measures to minimise the indirect impacts of feral animal and weed invasions as a result of construction activities will be critical to minimising impacts on Wood Frog

habitats. With safeguards in place to manage weeds and fire it is not expected that the pipeline will have any long-term adverse impacts on this species.

Northern Quoll Dasyurus hallucatus: Direct disturbance of habitats in the pipeline corridor is unlikely to cause long-term impacts on the Northern Quoll because the species occupies a wide range of eucalyptus forest, monsoon rainforest and rocky habitats and these are readily available away from the project area. Of greater concern is the potential for the project to increase the rate of spread of the Cane Toad *Bufo marinus* west of the Daly River as poisoning from the Cane Toad has been identified as a key threatening process for the Northern Quoll (Maxwell *et. al.* 1996). With safeguards in place to ensure that the spread of Cane Toads into the west of the Northern Territory is not assisted, it is expected there will be minimal impacts on the Northern Quoll.

Gove Crow Butterfly Euploea alcathoe enastri: The tall spring-fed forest patches associated with groundwater seepages inhabited by the 'threatened' Gove Crow Butterfly *Euploea alcathoe enastri* do not occur in the pipeline corridor, however, these habitats may be sensitive to improved road access to Gove and associated increases in fire activity (Wilson 2002) which could occur as a result of the proposed project. The spread of the Yellow Crazy Ant *Anoplolepis gracilipes* is also thought to potentially impact the Gove Crow Butterfly as it also favours permanently wet forest patches. Appropriate measures to minimise feral animal and weed invasions as a result of construction activities will be critical to minimising impacts on the habitats of the Gove Crow Butterfly.

Brush-tailed Tree-rat Conilurus penicillatus, Brush-tailed Phascogale Phascogale tapoatafa pirata and Northern Shrike-tit Falcunculus (frontatus) whitei: Each of these species is wide ranging and utilises Eucalyptus woodland and forest habitats that are widespread and common outside of the project area. For this reason it is not expected that the proposed project would cause significant impacts on these species.

Pig-nose Turtle Carettochelys insculpta: The pipeline corridor traverses the Daly River (KP266) where the Pig-nose Turtle is known to occur. HDD is proposed as the construction method for the Daly River crossing, which will mean that the riparian rainforest and aquatic habitats will not be directly disturbed. No access routes to the pipeline corridor are situated near the Daly River.

Aquatic Species: The 'threatened' Freshwater Sawfish *Pristis microdon* is a species that typically occurs in the tidal areas of the large tropical rivers where high sediment loads are present as a result of the large tidal movement (Allen *et al*. 2002). Therefore, it is considered that increased sediment loadings or minor changes in water chemistry as a result of the construction and operation of the pipeline will have little impact on this species. Barriers to movement such as poorly constructed stream crossings and culverts in the pipeline corridor and on access tracks, as well as gross water quality issues such as low dissolved oxygen levels that could result from high sediment loads or chemical contamination, present some risk to this species. There a number of fish species of unknown conservation status (Data Deficient) in most of the watercourses traversed by the pipeline corridor that could similarly be at risk from barriers to fish movement, high sediment loads and chemical contamination which may impact on fish development and embryo survival.

Migratory Species: Considering that the pipeline corridor and access routes do not traverse near to any known significant shorebird or waterbird colonies (Chatto 2003, 2001, 2000) it is expected that the migratory bird species that utilise the project area will be minimally impacted by the project (Woinarski *pers comm.* 2001). The likelihood of disturbing colonies has been minimised by selecting the pipeline corridor to avoid permanently inundated wetland areas, and no colonies were observed during surveys of the pipeline corridor.

It is unlikely that the project will cause significant long-term impacts on populations of the Freshwater Crocodile *Crocodylus johnstoni* or Saltwater Crocodile *Crocodylus porosus*. During the construction of watercourse crossings the movement of these species may be restricted, however, it is expected that as long as access along the watercourse is restricted only for the time that it takes to construct the crossing, there will not be any significant impacts. Crocodiles are likely to move away from an area during construction activities, however, the potential threat that they pose to construction workers will need to be managed with appropriate education strategies.

Preventative and Management Measures

During the early stage of project design the pipeline corridor, above ground facilities sites and access routes were chosen to avoid direct impacts on habitats and flora and fauna species of recognised conservation significance. Changes to the proposed access routes through the Chambers River area were made as the original route traversed through potential Gouldian Finch habitat. The route was changed to maintain the recommended 500 m buffer distance between the development and Gouldian Finch habitats. A number of changes to the route were made to avoid permanent and seasonal wetlands, which are potential habitat for Commonwealth listed Migratory bird species. Changes to the pipeline corridor were also made near the Goromuru River to avoid a large patch of evergreen monsoon rainforest habitat.

Where total avoidance of habitats was not possible at major watercourse crossings HDD will be used as a construction technique to avoid direct disturbance of riparian and aquatic habitats. HDD will be used at the Latram River (KP922) to protect the 'threatened' plant *Pternandra coerulescens* and the Wood Frog *Rana daemeli*. Wood Frog habitats on the Giddy River and Cato River will also be protected through the use of HDD to construct the pipeline crossing. The Pig-nose Turtle *Carettochelys insculpta* will be protected by the use of HDD techniques to cross the Daly River (KP266).

A system for the identification and avoidance of large bird nests where possible will be implemented during construction with the aim of avoiding impacts on the Red Goshawk *Erythrotriorchis radiatus.* Impacts on other 'threatened' fauna species including the Gove Crow Butterfly *Euploea alcathoe enastri,* Northern Quoll *Dasyurus hallucatus,* Brush-tailed Tree-rat *Conilurus penicillatus,* Brush-tailed Phascogale *Phascogale tapoatafa pirata and* Northern Shrike-tit *Falcunculus (frontatus) whitei* will be minimised through the development and implementation of plans to manage the introduction and spread of weeds and exotic species, and changes to fire regimes.

The risk of the project causing negative impacts on the Freshwater Sawfish *Pristis microdon* and other fish species of uncertain conservation status will be minimised through the adoption of specific environmental guidelines for the design and construction of watercourse crossings along the pipeline corridor and on access tracks. A Watercourse Crossing Management Plan will be developed to document general guidelines and site specific environmental management requirements for each watercourse. At perennial pipeline watercourse crossings that will be constructed using an open trench, and at crossings of perennial watercourses along access routes, strict erosion and sediment control measures will be implemented and downstream water quality will be monitored.

Northern Cypress *Callitris intratropica* trees will be retained where construction activities can practically proceed around them. Specific areas where it will be attempted to avoid known stands of Northern Cypress Pine trees are at KP285, KP357, KP370, KP394, KP775 and the construction camp near Buckingham River. The potential for salvaging Cycad plants that will inevitably be disturbed, will be investigated in consultation with landowners.

The full range of preventative measures that will be implemented to minimise impacts on ecologically sensitive species and habitats are summarised in **Appendix F**, **Volume 2**, **Table 9** of this Draft EIS.

Management Summary

- Construction activities between KP320 and KP460 will maintain a distance of at least a 500 m from Gouldian Finch habitats.
- HDD will be used at the Latram River, Giddy River, Cato River and Daly River to protect 'threatened' species habitats.
- Watercourse crossings in the pipeline corridor and along access tracks will be designed and constructed in accordance with guidelines to protect aquatic ecosystems.
- A Watercourse Crossing Management Plan will be developed.
- Erosion and sediment control during construction will be strictly implemented at all watercourse crossings where water is present.
- Downstream water quality will be monitored during construction at all perennial watercourses.
- Construction activities will maintain a distance of at least 100 m from isolated wetlands.
- Northern Cypress Pine trees will be retained where possible.
- Landowners will be consulted about the potential for salvaging Cycad plants.
- A Weed and Exotic Species Management Plan will be developed (**Section 12**).
- A Fire Management Plan will be developed (**Section 12**).

9.3.5 Ecologically Sensitive Habitats

Habitats with high ecological conservation values and high sensitivity to disturbance that occur in or near the project area are identified in **Section 6.3.5** and in **Figure 6–9**. Potentially unacceptable impacts on ecologically sensitive habitats were minimised during the design phase by avoiding

direct disturbance of a number of highly sensitive rainforest and wetland habitats, and proposals for HDD crossings at 12 permanently flowing waterways. Consequently, construction and operation will avoid disturbing ecologically sensitive habitats where long-term impacts on those communities cannot be prevented or managed. Activities associated with construction and operation of the pipeline will still occur in proximity to some ecologically sensitive habitat areas, and in the absence of adequate controls there is potential for indirect impacts to occur through changes to hydrology and increased sedimentation in watercourses. Potential impacts on ecologically sensitive riparian corridors, wetland and rainforest habitats are discussed below. Potential impacts on sensitive aquatic habitats and habitats of flora and fauna species of conservation significance were discussed in **Sections 9.3.2**and **Section 9.3.3**.

Riparian Corridors: Construction of open trench watercourse crossings will result in direct removal and disturbance of riparian corridor vegetation in the pipeline corridor. At the 12 watercourses crossings that will be constructed using HDD construction techniques there will still be potential for construction plant and machinery to disturb riparian corridors unless appropriate distances are maintained from riparian vegetation which can extend some distance away from the river bank. The removal or disturbance of riparian vegetation will destabilise the banks, and at locations where waterways will be crossed by construction access routes, the bank profile will be altered by the construction of trafficable crossings. At the 25 crossings identified in **Appendix F**, **Volume 2**, **Table 9** of this Draft EIS where perennial waterbodies are present there will be high potential for mobilisation of sediments during construction, which in the absence of appropriate erosion and sediment control measures could cause negative impacts on downstream aquatic and riparian environments. At these crossings there will be increased potential for vehicles and plant to sink in the soils on the banks, creating high levels of disturbance beyond the pipeline trench and therefore making rehabilitation more difficult. At the crossings that are dry during construction the potential for downstream impacts will be greatly reduced as long as rehabilitation is sufficiently advanced at the onset of the wet season to minimise damage to bank vegetation and mobilisation of sediments.

Wetlands: Six semi-permanent to permanent broad drainage depressions, located at KP107, KP111, KP167, KP734, KP852 and KP929, will be directly impacted by construction activities in the pipeline corridor. Where the pipeline corridor crosses these areas, digging of the pipeline trench and high levels of traffic during construction are likely to cause significant disturbance of the soil profile, potentially making the areas difficult to rehabilitate. The wetlands are on broad drainage floors that feed into nearby watercourses, therefore, if rehabilitation is not sufficiently advanced prior to onset of the wet season there will be potential for downstream impacts as a result of mobilisation of sediments into nearby watercourses. Other wetland areas encountered during the field surveys were avoided during the design.

The potential for the project to impact on the conservation of the Moyle River and Hyland Bay System and Arafura Swamp 'Wetlands of National Importance' is considered to be low for the following reasons:

- the pipeline corridor has been chosen to avoid permanent floodplain swamps;
- the pipeline corridor was redesigned to avoid a lagoon near KP71 and to traverse the narrowest section of the seasonally inundated broad drainage floor at KP734 in the Goyder River catchment;
- HDD construction techniques will be used to construct the Moyle River and Goyder River crossing.

Monsoon Rainforest: No monsoon rainforest communities will be directly affected by the development. The rainforest communities encountered on Boggy Creek during the field surveys (near KP852) have been avoided by an 800 m vegetated buffer, which is more than the 500 m minimum distance recommended by Price *et al.* (1998) in their guidelines for rainforest conservation. Therefore, it is considered unlikely that the project will impact on these rainforest communities. This said, rainforest communities on the Goromuru River and Boggy Creek do occur within 1 km downstream of the pipeline corridor, and therefore appropriate management of construction of the crossings at these locations will be important to avoid creating any potential for negative impacts on the downstream communities.

Weed incursion and fire possibly present the greatest threats to ecologically sensitive habitats, especially monsoon vine forests, riparian communities and freshwater wetlands. Woinarski (2002e) observes that the monsoon rainforest patch network along the Northern Territory coast is being degraded by incursion of weeds and the impacts of more frequent hot late dry season fires. The project, if not properly managed, has the potential to create conditions for weed invasion and increased fire frequency. These issues are further discussed in **Section 9.3.7**.

Preventative and Management Measures

The primary preventative measure that has been adopted to minimise potential impacts on ecologically sensitive habitat is to design the project and to plan and manage construction activities so that these habitats are avoided. The full range of preventative and management measures that will be implemented during construction to minimise impacts on ecologically sensitive habitats and species are listed at **Appendix H**, **Volume 2** of this Draft EIS.

Construction activities will be confined to the dry season when the risks of potential off-site impacts on sensitive vegetation communities will be greatly reduced as potential pollutants in the form of sediment and chemicals can be more readily contained. To ensure that ecologically sensitive communities near to work areas are protected as intended in the design, the boundaries of the working areas will be verified against the known locations of sensitive habitats prior to construction. The boundaries of the working areas will be clearly delineated on the ground and in construction drawings, and access to ecologically sensitive habitats near to the project area will be prohibited.

Construction of watercourse crossings where open trench construction techniques will be used will be prioritised for as early as possible in the dry season and rehabilitation works will be completed as soon as practicable to allow for sufficient revegetation of riparian habitats prior to onset of the first wet season rains. The removal of large trees that stabilise the banks of watercourses and provide fauna habitat will be avoided as much as possible. HDD techniques will be used to construct pipeline crossings at the 12 watercourses identified in **Table 5–10** where the potential impacts on the sensitive riparian and aquatic environments from the use of open trench construction techniques were deemed to be unacceptable. Construction of the route sections in areas of saturated soils, including the six broad wetland drainage depressions at KP107, KP111, KP167, KP734, KP852 and KP929, will be accompanied by measures to minimise significant disturbance of the saturated soils. Where access routes traverse watercourses the approaches will be stabilised and surfaced with gravel, and temporary culverts will be installed where necessary to minimise long-term impacts to the bank structure. A Watercourse Crossing Construction Management Plan will be developed to encapsulate the full range of preventative measures and to provide site specific construction guidelines.

Crossings of waterways and wetlands will be inspected following construction to monitor the success of rehabilitation. During operation waterway crossings will be inspected annually following the wet season and appropriate maintenance will be undertaken to repair erosion damage.

Management Summary

- Construction activities will be planned for the dry season.
- Avoidance of ecologically sensitive communities in the final delineated work area will be verified, prior to construction.
- The boundaries of the construction corridor and all construction sites will be clearly delineated on the ground and in construction drawings and other documentation.
- Access to ecologically sensitive areas will be prohibited.
- Construction of watercourse crossings will be prioritised and planned for early in the dry season.
- Rehabilitation of disturbed areas will be undertaken as soon as possible during the work season following construction, and prior to the onset of the wet season.
- HDD will be used to construct crossings at the 12 watercourse crossings identified in **Section 5.5.10**.
- Large trees in riparian corridors will be retained where possible.
- Watercourse approaches on access tracks will be stabilised and surfaced with gravel.
- Temporary culverts will be constructed at watercourse crossings that will receive a high level of traffic during construction.
- Construction management strategies and rehabilitation plans will be implemented for areas of saturated soils.

- Rehabilitation success will be frequently monitored at watercourses and areas of saturated soils.
- A monitoring and maintenance programme will be implemented to regularly check the condition of each watercourse crossing for the duration of operation, and repair damage caused by erosion as necessary.
- The construction workforce will be briefed on their obligations at inductions to protect ecologically sensitive habitats.

9.3.6 Biting Insects

The main potential impacts of biting insect problems during construction and operation are:

- exposure to pest species;
- infection with mosquito-borne disease;
- creation of new breeding habitats;
- introduction of mosquito species.

The potential receptors are the construction workforce and communities that occur in proximity to the pipeline corridor. The potential impacts on these receptors are discussed below.

Exposure to Pest Species: The construction workforce may be exposed to bites from a number of biting midge species (**Section 6.3.5**), which although not carriers of disease can be a major pest problem. The main biting midge pest species of concern is *Culicoides ornatus* which is a widespread species that is responsible for major pest problems throughout coastal areas of northern Australia and along the east coast of Queensland (Shivas and Whelan 2001). This midge species breeds in mangrove areas, with the bulk of dispersing females moving up to 1 to 2 km inland of the mangrove margin. The construction workforce will be at greatest risk of exposure to pest numbers of this species when working either side of sunrise and sunset within 3.5 km of areas subject to inundation by tides in the months of August to November.

The construction workforce will also be exposed to a number of mosquito species which as well as causing minor to major pest problems can also act as vectors of disease. The potential mosquito pest and disease problems associated with the project are discussed below.

Mosquito-borne Disease: Several mosquito species of public health importance that are likely to occur in the project area are listed in **Table 6–15**. The most important potential endemic mosquito borne diseases that could affect the construction workforce and communities near to the project area are those caused by Murray Valley encephalitis virus (MVEV), Ross River virus (RRV) and Barmah Forest virus (BFV). The greatest risk of exposure to mosquito pest problems and disease will occur within a few kilometres of extensive seasonally flooded swamps and floodways, poorly draining grasslands, creeks and rivers, and tidal areas. Specifically, the risk of exposure will be high near western and eastern ends of the pipeline corridor.

The period of risk for MVEV disease for workers along the pipeline corridor is when *Culex annulirostris* numbers are elevated in the mid-wet season to early dry season months of January to August. The peak risk period for MVEV transmission is from March to May. *Culex annulirostris* is also a vector of RRV and BFV, with the greatest risk period of RRV and BFV transmission from this species being the January to March period, with the overall risk period being January to August.

Ochlerotatus vigilax is a vector of RRV and BFV. The vector status of this species is enhanced due to its persistent and day biting habits. High to severe numbers of this species will occur in the project area within 5 km of the coast from September to January, with minor to moderate numbers likely in February. Moderate to very high numbers of this species are likely to be present in the project area near Gove from December to February. This species may be present in pest numbers from September to January in other parts of the project area within 5 km of tidal areas. The greatest risk period of RRV and BFV transmission from this species will be from December to February, with the overall risk period being September to February.

Exposure to bites of potential vector species will introduce a risk of infection and associated illness. Also, there is a risk of re-introduction of Malaria, if a proportion of the workforce is mobile and sourced from countries where malaria is present. Cases of imported malaria may not be rapidly detected in isolated areas with reduced medical services and may subsequently infect the local population of *Anopheles* mosquitoes.

Creation of New Breeding Sites: Construction activities will involve disturbance to the land, which in turn could lead to the creation of mosquito breeding sites, especially in and near seasonally inundated areas such as floodways, creeks and rivers. The creation of new mosquito breeding sites could expose local human populations to a number of pest and disease problems. The greatest potential for impacts will be where the pipeline corridor traverses near to populations centres (**Table 9-6**).

- **Table 9-5 Population Centres Near Pipeline Corridor**

KP	Distance (km)	Population Centre
9-13	5	Wadeye
51	2.4	Palumpa
230	1	Dorisvale
268	5.5	Florina
324	1	Manbulloo
346	9	Tindal
399	7.7	Baymili
425	2	Beswick
550	2.4	Mainoru
599	6	Bulman
932–END	<1	Nhulunbuy and Alcan Gove Refinery

Introduced Mosquito Species: Plant, machinery and construction materials sourced from outside the region could potentially introduce mosquito species currently not present and cause associated pest and disease problems. Of specific concern to the Medical Entomology Branch, Northern Territory Department of Health, is the risk of importation of the Dengue Mosquito *Aedes aegypti* and Asian Tiger Mosquito *Aedes albopictus* into developed human habitation areas along the pipeline corridor from artificial receptacles sourced from North Queensland and Tennant Creek, or in the case of the Asian Tiger Mosquito, from overseas. *Aedes aegypti* is a vector of dengue fever and was likely introduced to the Northern Territory by road transport (Whelan *et al* 2004). Even a small risk of potentially introducing this species is considered serious because control can be very difficult to achieve and the potential health implications in terms of exposure to Dengue Fever are great.

Preventative and Management Measures

Exposure of the construction workforce to biting insect pest and disease problems will be minimised by locating construction camps away from extensive seasonally flooded areas such as floodways, swamps, billabongs, creeks and rivers, as well as tidal areas where possible. Vegetated areas surrounding construction camps, and problem areas where workers will be spending extended periods, will be treated with bifenthrin to provide an insecticide barrier to reduce mosquito numbers. Other areas where mosquitoes are likely to rest, such as toilets, showers and other structures that contain dark, shaded areas, will be sprayed with bifenthrin to control mosquitoes that rest in these areas during the daytime.

It is inevitable that workers will be exposed at some stage during construction and therefore the construction workforce will be encouraged to use personal protection measures where problems are encountered. Personal protection measures will include:

- loose, light coloured long sleeved clothing and full length trousers.
- use of a personal repellent containing the active ingredient DEET or Picaridin;
- impregnation of clothing with permethrin where serious problems are encountered (Whelan 2003).

All workers will be notified of the potential pest and disease problem associated with biting midges and mosquitoes, and workers will be made aware of periods and areas of expected high numbers. All prospective workers will be provided with personal protection guidelines, which will be included in a Biting Insects Management Plan (**Section 12**). Inductions of the construction workforce will include education about the symptoms and treatment of mosquito-borne diseases. Workers will be asked to report high biting insect numbers so that management measures can be implemented to minimise exposure.

Various measures will be implemented during construction, reinstatement and rehabilitation of the pipeline corridor, access tracks and construction camps to prevent the creation of new mosquito breeding sites. These measures are identified in the Management Summary below.

Management Summary

- Construction and operational workforces will be advised at induction of the biting midge and mosquito pest disease problems that they may be exposed to.
- Construction and operational personnel will be required to use personal protection measures.
- All personnel will be advised of the potential mosquito borne diseases that may be carried by mosquitoes that are likely to inhabit work areas and the symptoms of these diseases.
- Areas around construction camps and high biting insect risk areas where personnel will be working for extended periods will be sprayed with bifenthrin to control adult biting midges.
- Tents will be well screened and impregnated with permethrin or sprayed with bifenthrin to control biting insects.
- Personnel clothing will be impregnated with bifenthrin if serious biting insect problems are encountered.
- Construction, reinstatement and rehabilitation will be undertaken to ensure that there is no impoundment of natural drainage or water pooling that can create new biting insect breeding sites.
- Excess spoil from trench digging will be stored appropriately to prevent the impoundment of water.
- Existing borrow pits that are used during construction will be made free draining.
- Culverts along the pipeline corridor and access tracks will be of sufficient size to prevent the upstream pooling of water.
- Water tanks, sewage systems and wastewater treatment facilities will be screened to prevent mosquito entry.
- Wastewater will be disposed of in a manner that prevents water pooling.
- Artificial receptacles such as used tyres, buckets, machinery and any type of receptacle capable of holding water will be stored in a manner that ensures breeding sites for exotic dengue carrying mosquito species are not created.
- Any artificial receptacle sourced from North Queensland or Tennant Creek will be treated with a chlorine solution to kill any mosquito eggs that may be present.
- Breeding sites created will be treated and rectified in consultation with MEB.
- The construction workforce will be educated about symptoms and treatment of mosquito-borne diseases.
- Prior to the onset of the wet season following construction all work areas will be inspected to ensure that they have been adequately reinstated.
- The MEB will be requested to inspect work areas close to human populated areas within one year following construction.

9.3.7 Weeds and Exotic Fauna

The potential for the introduction of weed species, and the spread of existing exotic flora and fauna species, will be critical environmental management issues for the project. Species of concern are identified in **Section 6.3.2** and **Section 6.3.3**.

Potential exists for the project to introduce and spread weed species into areas that are currently mostly weed free, especially in the Wingate Mountains and in areas through north-east Arnhem Land. The greatest risk of weeds being introduced and spread will occur during the construction phase of the project when there will be high levels of disturbance associated with vegetation clearing and large numbers of vehicles, plant and construction materials being transported in and out of the project area. Activities that involve disturbance of native vegetation create suitable conditions for weeds to rapidly establish and develop into infestations that are then difficult to manage. Once weeds become established they compete with native vegetation, and in the case of the grassy weeds, can create conditions for hot, intense fires that have adverse impacts on habitat integrity, especially in ecologically sensitive riparian, rainforest and wetland communities. On land used for pastoral or agricultural production weed infestations can adversely affect land use by causing injury to animals and invading pastures.

Cane Toads *Bufo marinus* and Crazy Ants *Anoplolepis gracilipes* may be transported from one area to another by construction vehicles in the absence of controls to prevent this. Cane Toads are present across most of the project area east of the Daly River and will inevitably disperse west in the near future, regardless of the project's influence or control. Crazy Ant colonies present in north-east Arnhem Land are planned for eradication under a programme sponsored by Alcan and the Northern Territory Government, prior to the planned construction start date (*Hoffman. pers. comm. 2004*). As long as eradication of these colonies is successful and no new colonies are identified the risk of the project assisting the dispersal of Crazy Ants will be minimal. However, due to the substantial negative impacts that Crazy Ants can have on ecological systems the presence of colonies in areas where construction activities will take place will need to be reassessed prior to construction. The risk of the project assisting the dispersal of both Crazy Ants and Cane Toads will be greatly reduced through the implementation of the preventative and management measures discussed below.

Feral animals and pastoral cattle will be attracted to regrowth vegetation and may use the cleared area as a movement corridor. This is not expected to cause significant adverse impacts on rehabilitation success or a substantial increase in feral animal numbers.

Preventative and Management Measures

A Weed and Exotic Species Management Plan (**Section 12**) will be developed in consultation with the Northern Territory Government DIP, prior to construction.

Existing major weed infestations in the pipeline corridor, along access routes, and any other locations where construction activities will occur, will be identified and treated prior to construction. 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 weeds and exotic fauna species will be included in the criteria. Washdown facilities will be constructed at locations to be determined in consultation with the Northern Territory Government DIPE. The locations will be chosen with the aim to prevent the spread of weeds from the priority weed management areas as identified below in **Table 9-6**.

- **Table 9-6 Priority Areas for Weed Management**

Area	KP Range	Species Encountered*
South of Wadeye and Palumpa, Wadeye Road, Moyle River and floodplain	KP0–KP75	Rubber Bush *Calotropis procera*, Hyptis *Hyptis suaveolens*
Dorisvale Station, Bradshaw Creek, Daly River, Florina Station, Katherine River, Manbullo Station, small properties to east of Manbulloo	KP215–375	Noogoora Burr *Xanthium strumarium,* Hyptis *Hyptis suaveolens,* Rubber Bush *Calotropis procera,* Noogoora Burr *Xanthium strumarium,* Yellow Oleander *Cascabela thevetica*
Goondooloo Station, Mainoru Station and Mountain Valley Station	KP460–580	Hyptis *Hyptis suaveolens,* Parkinsonia *Parkinsonia aculeata,* Prickly Acacia *Acacia nilotica*, Flannel Weed *Sida cordifolia*, Mission Grass *Pennisetum polystachion*, Sicklepod *Senna obtusifolia,* Rubber Bush *Calotropis procera*
Bulman and Wilton River area	KP580–615	Hyptis *Hyptis suaveolens,* Sicklepod *Senna obtusifolia,* Spinyhead Sida *Sida acuta,* Grader Grass *Themeda quadrivalvis*
Gove Peninsula	KP910–end	Hyptis *Hyptis suaveolens,* Snakeweed *Stachytarpheta sp.*

*Note – other species of concern in addition to those encountered during the field surveys are likely to be present.

The washdown pads will be designed to separate hydrocarbon contaminants and weed propagules from the washdown water so that they can be disposed of in accordance with the Northern Territory Government guidelines and legislative requirements. Vehicles and plant will be inspected for Cane Toads and weed propagules prior to leaving the washdown bays.

The success of the planned eradication of the existing Crazy Ant infestations that occur in proximity to the project area will be verified prior to construction. Where Crazy Ant colonies remain in areas where construction activities will take place, specific quarantine, washdown and inspection procedures will be implemented.

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 in the identification of Cane Toads and Crazy Ants. Systems will be established for the reporting of new weed infestations, Cane Toad sightings and Crazy Ant infestations to the Northern Territory Government DIPE.

Only native vegetation species will be used in rehabilitation and landscaping. Species suitability for use will be determined in consultation with 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 Northern Territory Government DIPE.

Domestic animals will not be permitted to be taken into the project area.

Management Summary

- A Weed and Exotic Species Management Plan will be developed (**Section 12**).
- Existing major weed infestations will be identified and treated prior to construction.
- The locations of all work areas, including borrow pits and lay down areas, will be accurately recorded so that they can be monitored for weed infestations post construction.
- Plant, vehicles and equipment will be certified 'weed free' by the supplier and will be subject to random inspections.
- Washdown pads will be constructed to the specifications of DIPE at locations to be determined.
- Vehicles, plant and equipment will be washed down and inspected when moving from infected to clean areas.
- Washdown wastewater will be collected and disposed of in accordance with guidelines to be determined with DIPE.
- Weed washdown locations used during the design phase of the project will be monitored for weed establishment.
- Crazy Ant colonies will be identified and specific quarantine, washdown and inspection procedures will be implemented.
- Construction and operation workforces will be trained in weed, Cane Toad and Crazy Ant identification and awareness.
- Systems will be established for reporting of new weed infestations, and Cane Toad and Crazy Ant sightings.
- Rehabilitation and landscaping will be undertaken in accordance with a Rehabilitation Management Plan, which will specify that only native vegetation species will be used (**Section 12**).
- Domestic animals will not be permitted in the project area.

9.3.8 Bushfire

Impacts

The TTP will be affected by wildfires across the region, and could be the cause of some unplanned fires from sources during the construction period. In order to manage these two aspects of fire, a Fire Management Plan (**Section 12**) will be developed in conjunction with the Bushfires Council of the Northern Territory.

Planned Fires: The Fire Management Plan (**Section 12**) will address the need to reduce the potential for fires to affect the pipeline route markers, plant, equipment, vehicles and personnel active on the pipeline construction. Reduction of grassy fuels will be required to some extent to ensure that wildfires do not burn these assets and threaten life and property, especially as most of the construction crews will be inexperienced with fires in the northern savannas and may react inappropriately or unsafely to fires. In conjunction with traditional owners of Aboriginal lands, pastoralists on pastoral stations, and the Bushfires Council, the plan will identify locations, timing and methods for planned fires along the pipeline route. A permit under the *Bushfires Act* will be required for these fires. Negotiations with the regional councils will be conducted to plan the most appropriate methods to minimise the fire risk to and from the TTP.

Planned fires will most likely be lit as small strategic patch burns at many points along the TTP route. The intention is to break up the grassy fuels to prevent the spread of fires.

The integrity of the vegetation in and surrounding the project area could be diminished by more frequent planned and unplanned 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 and an increase in grassy weeds, which can be stimulated by fires. This threat will be mitigated through coordination of weed and fire management activities. Planning for fires will take these matters into account.

Vegetation which has been cleared from the route and from compressor stations and other infrastructure sites will be stockpiled in windrows to be used for rehabilitation wherever possible. There may be excess timber after rehabilitation, especially on compressor station sites and construction camp sites as these are larger areas, and this may have to be burnt on site as no windrows of vegetation should be left along the pipeline route. Burning of excess vegetation will be addressed in the Fire Management Plan (**Section 12**).

Unplanned Fires: During the construction phase, potential unplanned fire ignition sources could include:

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

During the operational phase of the project, fire could occur as a result of plant malfunction, although the risk of this occurring is negligible. Fire may also affect certain facilities associated with the pipeline, including the compressor stations.

Preventative and Management Measures

A Fire Management Plan (**Section 12**) will be developed and implemented in consultation with the Northern Territory Bushfires Council, pastoralists, 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 for each construction spread, 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 and camp fires will not be permitted.

Fires will be lit to remove the grassy fuels along sections of the pipeline route prior to works commencing. These will be staged to be lit in advance of construction crews, and in some cases may be lit in advance of the survey crews. Particular attention will be paid to areas where exotic weed grasses occur, and where monsoon vine forests and riparian forests occur. Land use, such as grazing and Indigenous food resource gathering, will influence how, when and whether fires are lit on pastoral lands and Aboriginal lands. Some burning of excess cleared vegetation may also be required. Planned fires will be lit and managed by personnel skilled in lighting and managing fires in this environment, in accordance with the Fire Management Plan (**Section 12**).

An Emergency Response Plan (ERP) (**Section 13**) will be developed and implemented and all operational personnel will be trained in emergency response to fire.

A Weed and Exotic Species Management Plan (**Section 12**) will be developed and implemented to prevent introductions of grassy weed species and will consider the fire risks associated with these grasses.

During the operation of the pipeline and associated infrastructure, such as the compressor and scraper stations, operational personnel will be required to be trained in emergency response to fires. There may also be a need to maintain firebreaks around certain facilities, such as compressor and scraper stations. The Fire Management Plan will also address these issues (**Section 12**).

Burning during construction will be undertaken in accordance with the relevant permits.

Management Summary

- A Fire Management Plan will be developed for construction and operation (**Section 12**).
- 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 for each construction spread.
- Spark arresters will be required for all earthmoving equipment.

- Cooking and camp fires will be prohibited.
- Fires will be lit along the pipeline route to minimise impacts of fires on the construction work force and equipment.
- Planned fires will be lit by personnel skilled in lighting and managing fires.
- An Emergency Response Plan will be developed and implemented (**Section 13**).
- Operational personnel will be trained in emergency fire response and maintenance of firebreaks where necessary.
- Monitoring for weed establishment will occur for the duration of construction and operation.
- Weed eradication programmes will be implemented as required.
- A Weed and Exotic Species Management Plan will be developed and implemented (**Section 12**).
- Burning during construction will be undertaken in accordance with the relevant permits.

9.4 Waste

9.4.1 Non-Hazardous Solid Waste

Impacts

During construction activities, large volumes of non-hazardous solid waste will be generated along each of the spreads and at the proposed above ground facilities, construction camps and laydown areas. Typical waste types are detailed in **Section 5.8**.

The main potential impacts from uncontrolled waste handling and disposal include:

- potential contamination of soils and groundwater;
- impact on the capacity of existing waste management facilities;
- potential entanglement or ingestion of litter and waste by native, and migratory fauna, and livestock leading to mortality;
- spread of disease through the introduction of vermin;
- potential fire hazard (for example, waste packaging);
- impact on visual amenity (for example litter)(**Section 9.2.6**);
- generation of odours.

Waste management will be an ongoing issue throughout the construction phase and to a lesser extent, during operation. The implementation of a Waste Management Plan (**Section 12**) and measures outlined below will reduce the potential impacts.

Preventative and Management Measures

Waste is a key environmental issue that will require appropriate management, particularly when considering the remoteness of the project area and distance from existing waste management facilities. The project is committed to managing waste in a responsible manner. Alcan, as part of

their EHS commitments, have developed an environmental directive which will be adopted by the BOO consortium. The primary objectives of which are to:

- prevent the generation of waste;
- maximise reuse and recycling;
- ensure safe management of non reusable and non recyclable wastes.

One of Alcan's over-arching environmental performance criteria with regards to non-hazardous waste is that 'waste is to be minimised by minimising packaging to site and maximising recycling and return of waste to suppliers through 'cradle to grave' contracts'.

Preventative measures that will be implemented prior to construction commencing will include:

- Ensuring that the BOO consortium selected to construct the TTP has appropriate management measures and plans in place.
- Landfill sites will be identified and consultation sought with regulatory authorities and landfill operators on existing capacity and their use by the project. Potential waste reception facilities are located at Wadeye, Katherine, Barunga, Beswick, Manyallaluk, Weemol and Nhulunbuy. Approvals and permits will be obtained prior to using any waste reception facilities.
- A Waste Management Plan (**Section 12**) will be developed by the BOO consortium, based on the principles of 'Reduce, Reuse, Recycle' and appropriate disposal, and approved by the appropriate regulatory body prior to construction activities commencing. An inventory of all waste disposal volumes, types and disposal locations will be maintained as part of the plan, which will place a high emphasis on housekeeping. The BOO consortium will need to ensure that waste is cleared from the construction corridor and above ground facility construction sites on a regular basis and appropriately stored.
- Waste management will be conducted in accordance with Northern Territory Government legislation, including: *Waste Management and Pollution Control Act, 1988* and the *Waste Management and Pollution Control (Administration) Regulations* and the *Water Act 1992.*

Management measures during construction will include the following:

- All construction crews will receive a site induction, which will include reference to appropriate waste management procedures.
- All non-hazardous waste will be stored in clearly marked skip bins.
- Options to reuse any waste material (for example surplus soil, rock) will be evaluated before any waste is designated for disposal.
- Opportunities for recycling materials will be investigated and implemented where practicable (depending upon the availability and capacity of nearby facilities). The management strategies will be developed by the BOO consortium and approved by the project management prior to construction commencing.

- Recycling opportunities will be sought for tyres and steel. If possible, the tyres will be recycled by being retreaded, and will be transported to such a location, most likely in Darwin.
- 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. In very remote locations where it may not be appropriate to stockpile putrescible waste for later disposal, alternative arrangements (for example on-site burial) will be negotiated with the relevant authorities and local stakeholders. It may also be necessary to construct a small temporary waste disposal site near the construction camps.
- Non-hazardous waste from the camps and corridor will generally be removed from the camp by garbage truck twice per week for reasons of hygiene, and transported to the nearest licensed landfill site.
- Any excess non reusable excavated soil will be stored within the construction corridor and only disposed of at licensed landfill facilities subject to approval.
- Cuttings and spoil displaced during HDD activities will be contained and disposed of in an approved manner, in accordance with the provisions contained within the Waste Management Plan (**Section 12**).
- Accurately map the location of any newly approved waste disposal sites along the pipeline route and report these to relevant regulatory authorities and landowners.

9.4.2 Non-Hazardous Liquid Waste

Impacts

The greatest volume of non-hazardous liquid waste will be generated during construction and commissioning and will include hydrotest water, sanitary wastewater and grey water from construction camps along the construction corridor. Other liquid waste will include wastewater from vehicle washdown facilities during construction, and stormwater runoff at the MLVs, scraper stations and compressor stations during operation. Potential impacts relating to uncontrolled discharges and liquid waste management include:

- Localised increases in erosion resulting from both continuous and intermittent discharges of surface water including hydrotest water.
- Impacts on surface water quality and hydrological regimes from disposal of hydrotest water.
- Changes in hydrological regimes resulting from uncontrolled discharge of grey water or hydrotest water during construction period which coincides with the dry season.
- Contamination of surface and groundwater from untreated liquid waste disposal impacting on aquatic flora and fauna (for example eutrification of surface waters and degradation of vegetation communities or fauna habitat) leading to fouling and eutrophication of watercourses.
- Health considerations due to the presence of bacteria, such as coliforms, in untreated sewage.

Disposal of hydrotest water represents a significant issue if managed incorrectly. Normally, chemicals that are added to the hydrotest water degrade quickly with time, resulting in minimal environmental impact upon discharge. Disposal options for hydrotest include discharge to the land, evaporation ponds and irrigation (**Section 5.8.**).

Preventative and Management Measures

A suite of management measures will be developed and implemented which are listed below. Management measures specifically relating to sewage and hydrotest water are specified separately below.

- A Waste Management Plan (**Section 12**) will be developed which will include an inventory of all liquid waste volumes, types and disposal locations.
- An Erosion and Sediment Control Management Plan will be developed and implemented (**Section 12**).
- A Groundwater and Surface Water Management Plan specifying the required measures for stormwater management will be implemented (**Section 12**).
- Grey water will be managed in accordance with regulatory requirements.
- In the event that treated grey water is deemed to be of sufficient quality, then it may be recycled for laundry and toilet use.
- In the event that treated wastewater is not considered to be of a sufficient quality for disposal to ground, then it will be stored in tanks, removed by a licensed contractor and disposed off-site at an approved facility.
- Appropriate site drainage will be employed at construction camps and at above ground facilities to ensure that contaminated stormwater and clean stormwater are separated.

Sites will be designed so that all stormwater generated from potentially contaminated areas, drains 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 with disposal at an approved facility. Clean stormwater will generally be allowed to infiltrate on site. Sites will be covered with a gravel fill, facilitating rapid drainage.

Sewage Management: Sewage systems will be approved by the regulatory authorities and will comply with all relevant standards and legislation. Applicable legislation and standards include:

- Environmental Health Standards for Remote Communities in the Northern Territory (Territory Health Services 1998).
- *Public Health Act (1997) and Regulations*.

Hydrotest Management: The options for disposal of hydrotest water are currently under evaluation (**Section 5.5.14**). The following measures will be implemented to ensure appropriate management of the various hydrotest discharge options.

- A Hydrotest Management Plan will be submitted to regulatory authorities for review and approval prior to implementation (**Section 12**). The plan will provide details on the source of the water, chemicals and concentrations to be used, water minimisation options, discharge locations, options and discharge rates.
- The required concentrations of hydrotest chemical additives in hydrotest water will be determined using approved testing techniques. Hydrotest chemicals will be chosen based on the best technical and environmental solutions, such that the hydrotest water can be safely discharged to the environment.
- Hydrotest water will be disposed of in accordance with AS 2885.5.
- Hydrotest water will be reused as much as possible along various pipeline sections to reduce the volume of water to be sourced and disposed.
- An assessment of hydrotest water quality will be undertaken prior to discharge.

In the event that hydrotest water is released to surface, it must meet the following criteria:

- The receiving ground is not prone to erosion, ie does not consist of softer soils, expansive clays or on steeper slopes.
- The water is not discharged onto a site considered to represent significant flora or fauna habitat.
- All containment and erosion control measures are in place.
- The water flow does not lead into or adjacent to, an existing watercourse.
- The water does not soak into drainage areas for watercourses or bores used for domestic water supply.

These measures may be refined during detailed design to suit site conditions and environmental sensitivities at disposal locations.

9.4.3 Hazardous Solid and Liquid Waste

Impacts

Hazardous waste, if handled incorrectly can lead to adverse impacts on the environment. These wastes will be generated during construction and commissioning of the TTP, and to a much smaller extent during operation. The volume of waste will be variable and can not be quantified. Key waste types are described in **Section 5.8** and include spent solvents, paint and radiography or cleaning chemicals.

Key potential impacts associated with poor hazardous waste management include:

- Impact on the capacity of existing hazardous waste facilities from increased waste volumes.
- Potential fire hazard (flammable or explosive hazards).
- Potential contamination of surface and groundwater.
- Flora and fauna may also be affected by inappropriate waste handling practices.

Preventative and Management Measures

All potential environmental impacts associated with hazardous waste will be effectively managed. A Waste Management Plan will be developed to address hazardous waste as well as a Spill Contingency Plan (**Section 12**).

Prior to construction activities commencing, materials will be sourced according to their technical and environmental performance to reduce potential environmental impacts. All hazardous waste materials generated during pipeline construction 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, and all hazardous waste materials will be collected by a licensed contractor and removed from site as required. Two sites at Nhulunbuy and at Katherine may potentially be used for the disposal of waste.

Additional measures will include:

- Minimising the use of hazardous chemicals to the absolute minimum required.
- Approvals and permits will be obtained for disposal of hazardous waste at licensed facilities.
- Non-hazardous chemicals that serve the same purpose and are as cost-effective will be given preference.
- Selection of storage compounds will take into account volumes and flammability of the waste.
- Hazardous waste storage facilities and handling equipment will be segregated and bunded, kept in good order and designed in such a way as to prevent and contain spills as far as practicable.
- Fuel storage areas will be bunded and stored in accordance with AS 1940:2004 'The Storage and Handling of Flammable and Combustible Liquids'.
- Hazardous waste will be stockpiled and stored appropriately near to the construction camp in segregated, signed areas in accordance with the Waste Management Plan (**Section 12**).
- Empty fuel drums will be stored in a dedicated area and transported off-site for reuse or disposal as appropriate.
- Hazardous wastes will be collected from site on a weekly basis and disposed of accordingly at waste transfer stations.
- Options for the disposal of hazardous waste, that are not accepted at a licensed waste management facility, include using the services of a private waste disposal company.

9.4.4 Chemical and Hydrocarbon Spills

Impact

Due to the relatively remote location of the TTP, there will be a logistical requirement to store fuel and other hazardous materials at the construction camps. Refuelling trucks will service the construction corridor, fuelling machinery and plant operations. Accidental spillages may potentially occur during transport and refuelling or due to poor packaging, rupturing of tanks, vehicle maintenance and improper handling. Small spills usually comprise low volumes of fuel. In

the event of large fuel spills, for example if a fuel truck was involved in a traffic accident up to 20,000 litres of fuel could be lost. However, the likelihood of a large spill event such as this occurring is remote although the consequences could be significant.

Potential impacts associated with a chemical or hydrocarbon spill include:

- aquatic and terrestrial habitat destruction/ modification;
- contamination of soils, surface and groundwater and vegetation from accidental spills;
- acute and chronic toxicity and bio-accumulation of hazardous materials resulting from spills and contaminated water discharge into sensitive flora and fauna habitats.

The severity of a potential spill will depend on a number of variables including, the sensitivity of environmental receptors, the size of the spill, spill type and spill response measures.

Preventative and Management Measures

A Waste Management Plan and Spill Contingency Plan will be prepared and implemented prior to construction to address the management of spills (**Section 12**). All hazards and risks will be identified and the need for spill response equipment will be assessed.

During construction, laydown areas will be designated for the safe storage of fuel and other hazardous materials. All hazardous materials will be handled and stored in accordance with the corresponding Materials Safety Data Sheets (MSDS) and Australian Standards as a minimum. Fuel will be stored in accordance with AS1940-1993, 'The Storage and Handling of Flammable and Combustible 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. Other measures that will be implemented include:

- Minimising chemical use to the absolute minimum required.
- For activities taking place on non-absorbent surfaces, such as sealed roads and concrete pads at the compressor station site, spill equipment will include absorbent materials such as blankets, that will be removed from site and disposed of appropriately.
- For activities taking place on absorbent surfaces, such as activities along the construction corridor or trucks travelling along dirt tracks, spill kits will include bags for the collection of contaminated material, which will be removed and disposed of appropriately.
- Spill equipment will be available at watercourse crossings and will include floating booms for containment and retrieval using suction trucks.
- Fuel storage and refuelling will be located sufficiently far away from watercourses to reduce potential contamination and will be operated by trained personnel only.
- Delivery vehicles will have road access to storage areas, and will be fitted with mechanisms such as drip trays to ensure containment in the event of a spill.

- Vehicles and all main crews will be equipped with spill response kits.
- Refuelling trucks will only travel on approved roads within weight restrictions.
- Each construction site will have emergency spill response equipment and an Emergency Response Plan (**Section 13**) to deal with accidental spills.

9.4.5 Atmospheric Emissions

9.4.5.1 Atmospheric Emissions and Pollutants

Impacts

The expected sources and types of gaseous emissions are detailed in **Section 5.9.1**. Greenhouse gases are discussed in **Section 9.4.5.2**. Atmospheric emissions from the TTP are anticipated to be relatively minor, given that there will be no significant or permanent sources of emission. In addition, atmospheric emissions and pollutant levels from the TTP should be considered in the context of the significant secondary impacts and improvements in air quality at Gove, due to change in fuel supply from fuel oil to natural gas at the Gove Refinery.

Construction: Combustion products other than greenhouse gases associated with construction and commissioning have the potential to cause adverse environmental and health impacts. Such products include particulate matter, particularly PM_{10} or smaller, and emissions of acid gases including SO_x and NO_x. The emissions of these gases will be small, representing a small percentage of the total emissions from vehicle usage. Considering the absence of other significant sources of such emissions they are unlikely to pose any significant adverse environmental or health risks. During start–up activities, additional emissions will be associated with the compressor station, during which time the engine is purged with natural gas. This is a critical part of the start–up sequence as it ensures that an explosive gas mixture cannot form in the combustion chamber.

Operation: Minor emissions will be generated from operation of above ground facilities. Small gas fired heaters at Gove will emit some CO_2, CO and NO_x, while the compressor stations will be driven by gas fired turbines. The turbines have a fuel management system that ensures efficient burning of the natural gas feed. The emissions that would be generated by these turbines, operating continuously at 100% for a year are shown in **Table 9-7**. This represents maximum emissions, as the compressors will not run continuously at full speed. Impacts associated with normal operations are therefore anticipated to be minor. Additional emissions will be associated with compressor station start-up during which time the engine is purged with natural gas.

- **Table 9-7 Turbine Exhaust Gas Emissions**

Pollutant	Volume (tpa)
NO_x	4,500
CO	11
Un-burnt Hydrocarbons	3

Preventative and Management Measures

Atmospheric impacts during normal operations are expected to be minor. The release of gas from the pipeline will be minimised for economic and environmental reasons. Periodic leak surveys will be conducted to detect fugitive gas releases from the pipeline as required by AS2885.3. A Gas Venting Management Plan will be developed and implemented.

Any impacts on human health due to an increase in these emissions are not expected due to the small quantity and lack of other industry in the area.

9.4.5.2 Greenhouse Gases

Construction: Greenhouse gases (GHG) will be generated during construction and commissioning of the project. Relevant greenhouse gases will include combustion products such as CO_2, CH_4 and N_2O. GHG from the TTP should be considered in the context of the improved efficiency of GHG per tonne of product produced that will result from the conversion of fuel at the Gove Refinery from fuel oil to natural gas.

Operation: During operation, there will be minor losses of gas from leaks (pumps, seals, joints), failures and maintenance operations (pigging). The major greenhouse gas from such releases will be methane. Small volumes of gas may need venting for maintenance of scraper stations or compressor station components.

GHGs in the earth's atmosphere contribute to global warming by selectively absorbing and re-radiating electromagnetic radiation of various wavelengths, reducing the radiation of heat from the earth's surface to space. CO_2 and water vapour (H_2O) play significant roles in this process, although the impact of water emitted from combustion sources is not generally reported because it is rapidly incorporated into the hydrological cycle as rain, dew, clouds. Other contributors to greenhouse gas include N_2O and CH_4. N_2O is formed in small quantities from atmospheric gases during and after combustion of fuels, and methane is a major component of natural gas.

N_2O and CH_4 are more efficient contributors to global warming than CO_2 because of their greater absorption capacity at infra-red wavelengths. Their efficiency is normalised against that of CO_2 by assignment of a Global Warming Potential (GWP) significantly higher than that of CO_2, which is assigned a value of one.

A summary of recommended GWPs for gases relevant to the TTP on a-100 year global warming horizon potential is provided in **Table 9-8** (AGO 2004a).

- **Table 9-8 Global Warming Potential of Greenhouse Gases for the TTP**

Gas	100-Year Global Warming Potential
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	310

Source: AGO 2004b

CO_2 molecules take part in biological processes of photosynthesis and respiration and chemical processes of solution and combustion, while gases such as methane typically have a lifetime measured in years. Therefore, the gases will have different GWPs on the timescale of 20 or 100 years that are frequently reported.

The total volume of GHG during construction will be approximately 12,411 tpa of CO_2-e. During operation the total volume of GHG generated will be approximately 13,300–14,500 tpa of CO_2, which is less than 0.0003% of the Australian total greenhouse emissions of 550.1 Mtpa. (AGO 2004b). Emissions of greenhouse gases will therefore be limited during operation and potential impacts are considered minor.

Preventative and Management Measures

A Greenhouse Gas Emissions Management Plan will be developed and implemented to minimise emissions of GHG (**Section 12**).

Measures will be taken to reduce potential GHG contribution from construction machinery through development of provisions contained within a Traffic Management Plan (**Section 12**). These will be practical and achievable, for example using people carriers where possible. In addition, double trailers will be used to minimise the number of truck movements, where regulations and access track or construction corridor conditions permit.

Measures to ensure that greenhouse gas emissions are minimised during construction will include:

- A Traffic Management Plan will be developed and implemented (**Section 12**). The plan will specify measures to ensure that transportation options are used in the most efficient manner possible, for example ensuring that vehicles are fully occupied where possible. Four wheel drive (4WD) vehicles will be used and utilities, and multiple passenger vehicles (for example mini buses and troop carriers) will be encouraged.
- Diesel engines in the trucks and plant-laying equipment will be maintained to prevent excessive exhaust emissions.
- Double trailers will be used to minimise the number of truck movements, where regulations and access track or construction corridor conditions permit.

Measures that will be implemented to reduce potential impacts from venting include:

- A Greenhouse Gas Emissions Management Plan will be developed and implemented (**Section 12**).
- Pipeline monitoring will be ongoing using a SCADA system to monitor operating parameters, equipment status and malfunction alarms at the remote facilities.
- Minimising the volumes of gas vented.
- During gas venting the nearest scraper station or main line valve will be closed and venting will be controlled manually. Trained crews will be dispatched from the nearest maintenance facility and in conjunction with operations personnel, will perform this work.

- By allowing pressures in the line to decline prior to venting, the volume of gas released to the atmosphere can be reduced.
- Early detection of gas release, minimising the volumes of gas vented where possible.

9.4.5.3 Dust

Impacts

Due to the nature of pipeline construction, there is the potential for dust to be generated. Dust emissions have the potential to adversely impact the condition of the environment including topsoil, vegetation, fauna and public amenity.

The major sources of dust will be trucks transporting material and workforce to the construction corridor along unpaved access tracks and main roads, as well as trenching, padding, backfill operations, earth moving activities, and open stockpiles. In the event that construction traffic use roads which pass through towns and small communities, dust generation will be an issue, which will be dependent upon the frequency and timing of traffic operations and road type and conditions. The highest dust levels are likely to occur down wind under light wind conditions where the dust plumes are relatively undispersed. Traffic impacts are discussed further in **Section 10.7**.

Construction activities will be confined to the dry season, which will result in the re-suspension of dust from areas of construction activities. Dust can affect vegetation and flora near to the construction corridor and to access tracks. Furthermore, dust generation will result in the loss of some topsoil and is likely to increase the potential for wind erosion.

Minimal dust is likely to be generated during operation. On occasion, dust may be generated during inspection and maintenance activities, associated with vehicle movements and ground disturbance. Operation impacts are therefore likely to be negligible and infrequent.

The impact on air quality in the vicinity of the construction corridor as a result of dust emissions is expected to be minimal. Trenching and pipe lay is a continuous operation and it is expected that the construction rate will average between three and five kilometres per day. Furthermore, the route passes through almost entirely remote areas where there are very few sensitive receptors.

However, considering the expected volume of traffic, including large trucks, which will pass through towns and communities in the region to support and supply construction activities (**Section 5.5.8**), and that construction will be undertaken in the dry season, potential environmental impacts are considered significant. During construction, these impacts will be carefully managed through the development of specific management measures and controls.

Preventative and Management Measures

A range of measures will be employed to manage potential impacts resulting from dust re-suspension. Measures will include:

- A Dust Management Plan will be developed and implemented (**Section 12**).

- A Rehabilitation Management Plan (**Section 12**) will be developed and implemented to ensure early rehabilitation of the construction corridor to assist in soil stabilisation.
- A Traffic Management Plan (**Section 12**) will be developed and implemented which will ensure stringent controls on vehicle speeds and restricting travel to approved roads during construction.
- During the site induction the workforce will be made aware of dust generation and control measures.
- Exposed surfaces such as stockpiles and cleared areas, and the duration that these areas are exposed, will be minimised.
- Dust suppression techniques and / or watering of unsealed roads and access routes.
- General housekeeping practices will be undertaken to ensure there is no accumulation of waste materials, within the construction area, that may generate dust.

9.5 Noise

Impacts

As detailed in **Section 5.9** the nearest sensitive receptor to the pipeline is Dorisvale station located approximately 1 km away from the proposed pipeline route. In addition, the small community of Beswick is located approximately 1.5 km away from the route. The distances of residential receptors to the pipeline route are presented in **Section 7.2.3** of the Draft EIS.

The location of the nearest above ground facility to any residential receptors is the MLV and metering station located approximately 3 km away from Nhulunbuy on the Gove Peninsula.

A noise study has been undertaken by 'Air Noise Environment' (**Appendix A**, **Volume 2**) as part of the EIA process to assess potential impacts during construction and operation activities. The key findings from this assessment are presented below. This section excludes the impacts of noise on workers as their noise exposure will be determined by occupational health regulations.

Construction: Typically, construction and commissioning activities result in the most significant sources of noise emissions. A summary of maximum noise emissions associated with typical construction equipment and machinery is presented in **Section 5** of the Draft EIS.

The results of the Noise Assessment indicate that there is limited potential for noise impacts from day-time construction of the proposed pipeline, due to the distances to potentially sensitive receptors located at Wadeye, Tchindi Aboriginal Camping Ground, Beswick, Nhulunbuy, Palumpa and Dhamiyaka. At Dorisvale, located 1 km away from the pipeline route, trenching and stringing activities will not comply with daytime noise criteria. Construction of the pipeline will be transitory (3–5 km per day) and the progression of the construction crew along the corridor will result in noise impacts being limited in duration to small sections of each spread. Potential noise impacts from construction camps located along the pipeline route have been assessed and are likely to be minimal given that no residential receptors have been identified within 5 km of these camps.

However, the exact location of the Katherine construction camp has not been identified, although this is likely to be located within an industrial zone.

The main potential impact during construction will be associated with vehicles travelling to the construction corridor, accessing the pipeline construction corridor. During construction activities transportation will be an intensive activity and there are likely to be 3,760 single trailer truck movements associated with transportation of pipe sections alone. The existing and planned access routes are not fully known at present, but will be confirmed during detailed design. Noise disturbance at residential receptors in close proximity to access routes and roads is likely to be experienced.

Commissioning and Operation: Potential noise sources will include:

- Commissioning of the compressor station during start-up activities.
- Hydrotesting pipe sections during the day and night-time.

Pipeline hydrotesting is the only planned night-time construction activity and this construction stage is not predicted to comply with evening and night-time construction criteria at Dorisvale, should a test end section be necessary near this location.

During operation of the pipeline there is limited potential for noise impacts due to the buffer distance to potentially sensitive receptors. The main sources will include noise from compressor stations, scraper stations, main line valve stations, planned and emergency venting. Noise modelling results indicates that the nearest receptor to the pipeline, and hence the potential to be near a future compressor station is approximately 2.5 km away. The day-to-day operational noise for a compressor station at this distance is expected to be well within noise criteria levels. Furthermore, the planned six monthly pigging of the pipeline will result in noise levels of 120 dB(A) for a 30 second period. However, the noise assessment has concluded that potential impacts will be minimal.

During emergency non-routine cases when significant venting may occur, 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. Noise 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.

Preventative and Management Measures

A number of preventative and management measures will be incorporated into the design of the TTP to minimise potential impacts. The proposed TTP route has also been selected to avoid noise sensitive human receptors as far as possible. The pipeline route passes through remote areas for the majority of its route and avoids towns and communities. During construction and commissioning the following measures will be implemented:

- A Noise Management Plan (**Section 12**) will be developed and implemented in accordance with the requirements of the *Draft Waste Management and Pollution Control (Environmental Noise) Regulations* and will be submitted to the relevant regulatory authority.
- Where the proposed access routes pass close to occupied residences, the project will carry out further noise assessments and identify management measures. These measures will be incorporated into the Noise Management Plan (**Section 12**).
- A Blasting Management Plan will be developed and implemented. Measures to mitigate impacts from blasting activities will include increasing the depth of material cover, increased spacings between charge and reducing the size of charge detonated per event.
- A Traffic Management Plan will be developed and implemented to control vehicle operations and potential impacts on human receptors.
- Construction equipment will be equipped with appropriate noise abatement devices.
- Evening and night-time construction activities will be avoided as far as reasonably practicable at sensitive receptors (for example Dorisvale).
- Truck movements along the construction corridor, access tracks and main roads, will take place during daylight hours, where possible. Night traffic will be avoided, but in the event that no other option is viable, access arrangements will be made with landowners in accordance with regulatory requirements.
- Local residents will be notified of construction activities in advance.
- It is recommended that hydrotesting activities at Dorisvale are avoided as far as practicable. However, if evening and night-time hyrdotesting is required, residents at Dorisvale will be informed 48 hours prior to commencement.
- In the event that night-time construction or commissioning is required, viable site access requirements will be made in consultation with landowners and in accordance with local regulatory requirements.
- If sensitive receptors are identified in the vicinity of the Katherine construction camp, silencing of generator plant will be undertaken.

During operation the following measures will be implemented:

- Automatic controls will be in place for the detection and control of accidental release during operation.
- Residents at Dorisvale will be notified in advance of the planned maintenance activities during operation of the pipeline.

- Near any sensitive receptors, exhaust silencers will be used on the gas turbine at compressor stations to ensure that maximum night-time noise emissions are within acceptable regulatory levels.
- The compressor will also be located within an enclosure.
- Noise levels at the boundary of the compressor station will be within the limits specified under the relevant legislation.

9.6 Vibration and Blasting

Impacts

Use of heavy plant equipment, rock blasting and rock sawing activities during pipeline construction have the potential to cause discernible vibration effects at residential receptors located in the pipeline corridor vicinity. Blasting activities during construction of the TTP are likely to be required at two locations, KP80 to KP100 near Wadeye and in the Mitchell Ranges KP770 to KP790. In addition, other areas along the pipeline route may require blasting, but these sites have yet to be identified. Noise and vibration will be generated from the blasting itself and from the 'airtracks' used to drill the holes. The nearest residential receptors to the proposed blasting sites are at Gallingar, approximately 9 km away from the construction corridor (**Table 9-9)**.

- **Table 9-9 Location of Residential Receptors in Relation to Proposed Blasting Sites**

Residential Receptor	Distance from Blasting Site (km)
Vicinity of KP80–-KP100	
Peppimenari	12.6
Nemarluk	10.6
Emu Point	15
Vicinity of KP760–KP780	
Galingar	8.6
Donydji	10.5
Dhupuwamirri	18.6
Dhunganda	20.5
Dhamiyaka	23.7

In the event that blasting activities are undertaken in the vicinity of Dorisvale or south of Katherine, it is likely that blasting will not comply with noise criteria. Given that rock blasting activities will be confined to isolated areas and for limited duration along the pipeline corridor, predicted impacts are considered minor.

Preventative and Management Measures

Potential impacts from vibrations will be managed by ensuring that blasting is not carried out within close proximity to any buildings or structures. Management measures will be similar to those discussed in **Section 9.5** including:

- Development and implementation of a Blasting Management Plan. Measures to mitigate impacts from blasting activities will include increasing the depth of material cover, increased spacings between charge and reducing the size of charge detonated per event.
- Blasting will be carried out in accordance with AS2187.2.
- Equipment will have silencers, where feasible and practical to do so.
- Timing of specific operations as far as practicable.

9.7 Summary of Impacts

A summary of the potential biophysical impacts of the proposed TTP is presented in **Table 9-10**. Column 1 specifies the environmental factor likely to be impacted by the project and Column 2 identifies the source or hazard. Column 3 describes the potential impact if the environmental hazard or event were to occur without the implementation of any preventative or management measures. Column 4 outlines the management and preventative measures that will be implemented during all project phases. Column 5 summarises the residual risk after the specified preventative and management measures have been implemented to reduce the likelihood or the consequence of the impact.

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■ **Table 9-10 Summary of Biophysical Impacts, Preventative and Management Measures**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Physical Environment				
Erosion and Runoff and Soil Compaction (**Section 9.2.3**)	Development of stockpiles and trenches, and 'cut and fill' activities. Vegetation clearing. Earthworks for trenching of the pipeline and construction of infrastructure. Road upgrades and borrow pits. Vehicle movements. Increased 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. Creation of bulldust. Formation of gullies. Reduction in soil fertility. Loss of seed banks and nutrient stores. Weakening soil structure. Increased scouring or accretion. Reduce soil permeability and recharge to groundwater, and increase surface drainage. Compaction of soil.	Total area to be disturbed restricted to the minimum area required to construct the pipeline and above ground facilities. Sensitive watercourse crossings will be crossed using HDD. Watercourse crossings on the corridor and access tracks will be sited and constructed in accordance with accepted engineering standards and environmental protection guidelines in order to minimise downstream impacts. Construction activities involving significant land disturbance will be confined to the 'dry' season. Vegetation will be cleared and rehabilitated progressively throughout construction to minimise the period that bare soil is left exposed to erosion. Vegetation will be stockpiled along the construction corridor and will be re-used to stabilise and rehabilitate work areas. Topsoil will be stripped and stockpiled in stabilised piles less than 1.5m high along the construction corridor and will be reused in rehabilitation and landscaping. Sediment controls will be installed to minimise soil loss from the working areas, diversion banks and roll-over banks. Sediment control fences will be installed at rivers, creeks and watercourses, where required to prevent silt entering waterways. Spoil will be stored and set back from watercourse banks and earthworks will be contained within approved work areas. Construction at watercourses will be planned to ensure that the watercourse is open for as short a time period as practicable. Temporary drains and banks, stabilised to prevent erosion in areas of high water flows, will be installed where required to control surface runoff. Cross banks (roll-over banks) of down-hill slopes less than 0.5% and wider than 2 m will be installed across slopes, where required to prevent down-slope runoff. Cross banks will be installed across sloping tracks, where required to divert water and sediment to sills or sediment fences adjacent to the tracks. Drains will be constructed with broad flat bottoms, not v-shaped. Roll-over banks will be longer at the top of slopes and shorter banks down slope to shed as much water from the fall-line as possible. Roll-over banks will be re-constructed after construction as required and commissioning to restore their effectiveness prior to the following wet season. Water trucks and other dust suppression and erosion mitigation measures will be implemented to stabilise soils subject to heavy construction traffic. Access tracks will be stabilised and temporary watercourse crossings removed prior to the onset of the wet season following construction. Rehabilitation of disturbed areas will be undertaken as soon as possible during the work season following construction, and prior to the onset of the wet season. A storm water and drainage management system will be developed and implemented for the facility sites including compressor and scraper stations. An **Erosion and Sediment Control Management Plan** will be developed (**Table 12-15**). Predicted Impacts: **Negative, Long term**. Consequence: **Moderate**. Likelihood: **Possible**.	**High**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Generation of and leaching from Acid Sulfate Soils (**Section 9.2.4**)	Trenching of the pipeline. Earth works associated with construction of above ground facilities.	Soil acidification. Adverse changes to the water quality of the soil, groundwater, surface water, wetlands, watercourses and estuaries. Degradation of ecosystems and ecosystem services dependant on water. Loss of habitat and biodiversity. Corrosion of metallic and concrete structures. Invasion of and dominance of wetlands and waterways by acid tolerant water plants, plankton and pathogens. Increased human health risks associated with arsenic, aluminium and other heavy metal contamination of soil, groundwater and acid dust.	A field reconnaissance survey will be undertaken by an accredited soil scientist prior to construction commencing, to determine the geographical extent of ASS along the pipeline route and the risk posed to the receiving environment. An **Acid Sulfate Soil (ASS) Management Plan**, if deemed necessary will be developed and implemented to reduce potential impacts during construction activities. Dewatering of acid sulfate soils will be neutralised with lime and disposed of by land application away from drainage lines. Predicted Impacts: **Negative, Short term**. Consequence: **Minor**. Likelihood: **Highly Unlikely**.	**Low**
Alteration of Natural Drainage and Hydrology Pollution of Ground Water and Surface Waters **Section 9.2.5**	Disturbance of vegetation and soils during construction especially at watercourse crossings. Road construction\upgrade and borrow pits. Fuel and chemical storage, handling and distribution systems. Disposal of sewage and greywater from construction camps. Disturbance of acid sulfate soils. Sourcing and disposal of hydrotest water. Trench dewatering. Installation of drainage. Over extraction of water for use during construction.	Erosion and sedimentation. Adverse changes to water quality of surface water and groundwater. Chemical contamination of waterways. Decline in health of wetland ecosystems and other groundwater dependent systems. Changes to the species composition and abundance of aquatic flora and fauna. Disturbance/ injury/ death of aquatic flora and fauna. Water unsuitable for consumption by humans and animals.	Baseline groundwater and surface water monitoring will be undertaken at selected environmentally sensitive sites over a prior to construction. A Hazardous Materials Register detailing the location and quantities of hazardous substances including their storage, use and disposal will be developed and maintained for construction and operation. Fuel and chemical storage, handling and distribution systems will be designed and constructed in accordance with Australian Standards. Fuel and chemical storage will be above ground and will be located an appropriate distance from surface waters and high quality groundwater resources. Construction vehicles, plant and machinery will be adequately maintained to minimise the potential for leaks. Frequent visual inspections of fuel and chemical storage, handling and distribution systems, and areas where vehicles, plant and machinery are stored, will be undertaken to identify and fix leaks. All construction and operation personnel will be trained in safe work practices for handling of hazardous substances, and in spill clean up procedures. Above ground facilities will be frequently inspected to identify corrosion and leaks, and maintained where necessary. No water will be extracted from a surface water body for any purpose prior to an assessment of the potential environmental impacts of the amount of water that will be extracted, and the relevant approvals. No water used for any purpose during construction, commissioning or operation will be released directly to a water body. Construction and maintenance works at watercourses will be confined to the dry season. Sewage and greywater from construction camps will be disposed of in accordance with relevant environment and health guidelines, and statutory requirements. Waste water treatment and disposal systems will be located 100 m away from production bores, or 400 m in areas with high groundwater sensitivity. Site drainage systems at above ground facilities will be designed to separate potentially contaminated stormwater for treatment and disposal. A rehabilitation plan will be developed in consultation with all stakeholder groups. An **Erosion and Sediment Control Management Plan** will be developed and implemented – (**Table 12-16**). An **Acid Sulfate Soils Management Plan** will be developed and implemented. A **Waste Management Plan** will be developed and implemented – (**Table 12-3**). A **Watercourse Crossing Construction Management Plan** will be developed and implemented. A **Hydrotest Management Plan** will be developed and implemented – (**Table 12-9**). A **Spill Contingency Plan** will be developed and implemented – (**Table 12-20**). Predicted Impacts: **Negative, Medium term**. Consequence: **Minor**. Likelihood: **Unlikely to Likely**.	**Medium**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Degradation of visual amenity during construction (**Section 9.2.6**)	Construction camps. Vehicles operating along the pipeline construction corridor. Dust from construction traffic. Construction of the construction corridor (for example clearance of vegetation and trees) inappropriate storage and handling of waste. Presence of above ground facilities.	Negative impact on visual aesthetics.	The pipeline will be buried and this will mitigate any potential long term visual intrusion impacts on the existing environment. Potential impacts associated with compressor stations and above ground facilities will be limited given the remoteness and siting of these facilities away from residential receptors. Management measures that will be implemented to reduce visual impacts will include: Minimising the width of the construction corridor as far as practicable. Large trees will be left in situ along the construction corridor, where practicable. Implementation of a **Rehabilitation Management Plan** (**Table 12-14**) to reduce potential visual intrusion. Limiting the number of vehicle movements as far as reasonably practicable in the vicinity of towns, local communities and settlements. A **Waste Management Plan** (**Table 12-2**) will be developed and implemented to ensure good housekeeping practices and that all construction areas are left in a good state. A **Traffic Management Plan** (**Table 12-8**) will be developed and implemented prior to construction activities. The plan will include restrictions and speed limitations to reduce the generation of suspended dust along unsealed tracks. **During Operation** Predicted Impacts: **Negative, Long term**. Consequence: **Slight**. Likelihood: **Highly Unlikely**. **During Construction** Predicted Impacts: **Negative, Short-term**. Consequence: **Minor**. Likelihood: **Likely**.	**Medium** (during construction) **Low** (during operation)
Ecological Environment				
Disturbance/ damage/ destruction of vegetation and flora (**Section 9.3.1**)	Vegetation clearing. Earthworks. Vehicle and traffic movement. Road construction\upgrade and borrow pits.	Loss of vegetation. Degradation of sensitive vegetation communities and habitats. Disturbance to species of conservation significance. Introduction and spread of weed species.	Construction activities will disturb only the minimum area of vegetation necessary. The boundaries of the pipeline corridor and all construction sites will be clearly delineated on the ground and in construction drawings. Clearing, reinstatement and rehabilitation will be undertaken progressively over the construction period. Reinstatement of disturbed areas will occur as soon as possible after construction activities cease in an area. Access during construction and operation will be via environmentally approved access tracks and the pipeline corridor only. The construction workforce will be informed about their obligations to protect native vegetation during inductions. A **Vegetation Clearing Management Plan** will be prepared and implemented – (**Table 12-10**). A **Rehabilitation Management Plan** will be developed and implemented – (**Table 12-14**). Predicted Impacts: **Negative, Short to Long term**. Consequence: **Minor**. Likelihood: **Likely**.	**Medium**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Disturbance/ injury/ death to fauna (**Section 9.3.2**)	Vegetation clearing. Earthworks and blasting. Vehicle and traffic movement. Fauna capture in pipeline trench.	Habitat loss and disturbance. Disturbance/ injury/ death of individual fauna. Disturbance of species of conservation significance. Introduction and spread of weeds and exotic fauna species.	Construction activities will be designed, planned and managed so that only the minimum area of native vegetation necessary is cleared during construction. Direct impacts on ecologically sensitive habitat areas will be avoided wherever possible. Pipeline corridor alignment and construction activities will disturb only the minimum area of vegetation necessary. The boundaries of the pipeline corridor and all construction sites will be clearly delineated on the ground and in construction drawings. Construction activities will be confined to the dry season. Direct impacts on significant habitat areas will be avoided. Clearing of large fruiting trees and large trees in riparian corridors will be avoided. Access during construction and operation will be via environmentally approved access tracks and the pipeline corridor only. A **Dust Management Plan** (**Table 12-5**) and a **Noise Management Plan** (**Table 12-6**) will be developed and implemented. Blasting activities will be kept to the absolute minimum amount required. The trench will be open for the minimum amount of time possible. "Escape ramps" will be provided at suitable spacings in the open trench. Trenches will be inspected by an experienced wildlife handler throughout each day. Wildlife removed from trenches will be identified, recorded and released into nearby vegetated areas. Dead animals will be preserved and submitted as voucher specimens to MAGNT. MAGNT will be provided with support to assist with the increased workload. Wildlife data will be provided to the Northern Territory Parks and Wildlife Service. All animal handlers are to be trained in appropriate handling protocols and will possess the necessary PPE for handling a wide variety of animals. The construction workforce will be informed about their obligations to protect fauna at induction. Predicted Impacts: **Negative Temporary**. Consequence: **Moderate**. Likelihood: **Likely**.	**High**
Disturbance/ damage/ destruction of aquatic ecosystems and species (**Section 9.3.3**)	Clearing of riparian vegetation. Construction of watercourse crossings. Road construction\upgrade and borrow pits. Vehicle and traffic movements. Translocation of water between catchments. Fuel and chemical storage, handling and distribution systems. Disposal of sewage and greywater from construction camps. Disturbance of acid sulfate soils. Sourcing and disposal of hydrotest water and other water required during construction. Trench dewatering.	Disturbance and loss of aquatic habitats. Changes to species composition of aquatic flora and fauna. Reduced fecundity or injury/ death of aquatic fauna or flora. Restriction of fish passage. Translocation of pests and diseases.	Construction of watercourse crossings will be prioritised for early in the dry season. Rehabilitation of watercourse crossings will occur as soon as practicable following construction. Removal of large trees on river banks will be avoided to the extent possible, and construction activities will disturb as minimum an area of vegetation as possible. HDD will be used to construct crossings of 12 major waterways. An **Erosion and Sediment Control Management Plan** will be developed and implemented (**Table 12-15**). A **Watercourse Crossing Construction Management Plan** will be developed and implemented. Construction camps and fuel and chemical storages will be located away from watercourses. Fuel and chemical storage and wastewater treatment facilities will be designed and constructed to Australian standards. A **Hydrotest Management Plan** (**Table 12-8**) will be developed and implemented that will outline the source and subsequent disposal of water – required for hydrotest. Access track watercourse crossings will be designed and constructed in accordance with environmental guidelines. Temporary in-stream structures will be removed and the streambed restored as soon as practicable. Watercourse crossings will be regularly inspected and maintained during operation. Non-urgent maintenance activities will be confined to the dry season. Machinery immersed in waterways will be washed down and disinfected prior to use in another waterway, if required by the final risk assessment or local authorities. Predicted Impacts: **Negative Temporary**. Consequence: **Moderate**. Likelihood: **Highly Unlikely**.	**Medium**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Disturbance/ damage/ destruction of flora and fauna species of conservation significance (**Section 9.3.4**)	Vegetation clearing. Earthworks Vehicle and traffic movement. Construction of access routes and borrow pits.	Destruction or damage to habitat and plants of *Pternandra coerulescens.* Destruction of stands of Northern Cypress Pine. Excessive loss of Cycads. Disturbance of Gouldian Finch habitat. Destruction of Red Goshawk nests. Disturbance of Wood Frog habitat. Disturbance of Northern Quoll habitat. Indirect degradation of Gove Crow Butterfly habitat through incursion of weeds and fire. Disturbance of Brush-tailed Tree-rat, Brush-tailed Phascogale and Northern Shrike-tit habitat. Disturbance of Pig-nose Turtle habitat. Disturbance of Freshwater Sawfish habitat. Disturbance of Migratory Species.	Construction activities between KP320 and KP460 will maintain a distance of at least a 500 m from Gouldian Finch habitats. HDD will be used at the Latram River, Giddy River, Cato River and Daly River to protect 'threatened' species habitats. Watercourse crossings in the pipeline corridor and along access tracks will be designed and constructed in accordance with guidelines to protect aquatic ecosystems. A **Watercourse Crossing Management Plan** will be developed. Erosion and sediment control during construction will be strictly implemented at all watercourse crossings where water is present. Downstream water quality will be monitored during construction at all perennial watercourses. Construction activities will maintain a distance of at least 100 m from isolated wetlands. Northern Cypress Pine trees will be retained where possible. Landowners will be consulted about the potential for salvaging Cycad plants. An **Exotic Species and Weed Management Plan** will be developed and implemented (**Table 12-12**). A **Fire Management Plan** will be developed and implemented (**Table 12-14**). Predicted Impacts: **Negative Temporary**. Consequence: **Moderate**. Likelihood: **Highly Unlikely**.	**Medium**
Disturbance/ damage/ destruction to Ecologically Sensitive Habitats (**Section 9.3.5**)	Vegetation clearing. Earthworks Vehicle and traffic movement. Construction of access routes and borrow pits.	Damage to and loss of riparian corridor habitats. Disturbance and loss of aquatic habitats. Damage to wetland habitats. Damage to Monsoon Rainforest habitats. Downstream impacts.	Construction activities will be planned for the dry season. Avoidance of ecologically sensitive communities in the final delineated work area will be verified prior to construction. The boundaries of the pipeline corridor and all construction sites will be clearly delineated on the ground and in construction drawings and other documentation. Access to ecologically sensitive areas will be prohibited. Construction of watercourse crossings will be prioritised and planned for early in the dry season. Rehabilitation of disturbed areas will be undertaken as soon as possible during the work season following construction, and prior to the onset of the wet season. HDD will be used to construct crossings at the 12 watercourse crossings identified in **Table 5-11**. Large trees in riparian corridors will be retained where possible. Watercourse approaches on access tracks will be stabilised and surfaced with gravel. Temporary culverts will be constructed at watercourse crossings that will receive a high level of traffic during construction. Construction management strategies and rehabilitation plans will be implemented for areas of saturated soils. Rehabilitation success will be frequently monitored at watercourses and areas of saturated soils. A monitoring and maintenance programme will be implemented to regularly check the condition of each watercourse crossing for the duration of operation, and repair damage caused by erosion as necessary. The construction workforce will be informed on their obligations at inductions to protect ecologically sensitive habitats. Predicted Impacts: **Negative Temporary**. Consequence: **Moderate**. Likelihood: **Highly Unlikely**.	**Medium**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Biting Insects (**Section 9.3.6**)	Existing biting insect breeding habitats near project area. Sewage and greywater storage and disposal. Hydrotest water disposal. Drinking water storage. Changes to natural drainage patterns causing water to pool. Import of materials, provisions, equipment containing mosquito larvae.	Exposure to pest species. Infection with mosquito-borne disease. Creation of new breeding habitats. Introduction of non-endemic mosquito species.	Construction and operational workforces will be informed at induction of the biting midge and mosquito pest disease problems that they may be exposed to. Construction and operational personnel will be required to wear long sleeve shirts and long trousers. All personnel will be advised of the potential mosquito borne diseases that may be carried by mosquitoes that are likely to inhabit work areas and the symptoms of these diseases. Areas around construction camps and high biting insect risk areas where personnel will be working for extended periods will be sprayed with bifenthrin to control adult biting midges. Tents will be well screened and impregnated with permethrin or sprayed with bifenthrin to control biting insects. Personnel clothing will be impregnated with bifenthrin if serious biting insect problems are encountered. Construction, reinstatement and rehabilitation will be undertaken to ensure that there is no impoundment of natural drainage or water pooling that can create new biting insect breeding sites. Excess spoil from trench digging will be stored appropriately to prevent the impoundment of water. Existing borrow pits that are used during construction will be made free draining. Culverts along the pipeline corridor and access tracks will be of sufficient size to prevent the upstream pooling of water. Water tanks, sewage systems and wastewater treatment facilities will be screened to prevent mosquito entry. Wastewater will be disposed of in a manner that prevents water pooling. Artificial receptacles such as used tyres, buckets, machinery and any type of receptacle capable of holding water will be stored in a manner that ensures breeding sites for exotic dengue carrying mosquito species are not created. Any artificial receptacle sourced from North Queensland or Tennant Creek will be treated with a chlorine solution to kill any mosquito eggs that may be present. Breeding sites created will be treated and rectified in consultation with MEB. The construction workforce will be educated about symptoms and treatment of mosquito-borne diseases. Prior to the onset of the wet season following construction all work areas will be inspected to ensure that they have been adequately reinstated. The MEB will be requested to inspect work areas close to human populated areas within one year following construction. Predicted Impacts: **Negative, Short term**. Consequence: **Minor**. Likelihood: **Highly Unlikely**. Note: Assessment of risks of mosquito-borne diseases has been addressed in **Section 13**.	**Low**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Introduction or Spread of Weeds and Exotic Fauna (**Section 9.3.7**)	Clearing of native vegetation. Earthworks Movement of vehicles, plant and construction materials. Construction of access routes and borrow pits. Rehabilitation with inappropriate species.	Introduction and spread of weeds. Spread of Cane Toads. Introduction and spread of Yellow Crazy Ants. Displacement of native flora and fauna 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. Direct competition for resources (for example water, habitat) with existing fauna and/or flora. Degradation of vegetation communities and habitats. Herbicide/pesticide impacts on native flora and/or fauna.	An **Exotic Species and Weed Management Plan** will be developed and implemented (**Section 12-12**). Existing major weed infestations will be identified and treated prior to construction. The locations of all work areas, including borrow pits and lay down areas, will be accurately recorded so that they can be monitored for weed infestations post construction. Plant, vehicles and equipment will be certified 'weed free' by the supplier and will be subject to random inspections. Washdown facilities will be constructed to the specifications of DIPE at locations to be determined. Vehicles, plant and equipment will be washed down and inspected when moving from infected to clean areas. Washdown wastewater will be collected and disposed of in accordance with guidelines to be determined with DIPE. Weed washdown locations used during the design phase of the project will be monitored for weed establishment. Crazy Ant colonies will be identified and specific quarantine, washdown and inspection procedures will be implemented. Construction and operation workforces will be trained in weed, Cane Toad and Crazy Ant identification and awareness. Systems will be established for reporting of new weed infestations, and Cane Toad and Crazy Ant sightings. Rehabilitation and landscaping will be undertaken in accordance with a **Rehabilitation Management Plan**, which will specify that only native vegetation species will be used (**Table 12-13**). Domestic animals will not be permitted in the project area. Predicted Impacts: **Negative, Long term**. Consequence: **Moderate**. Likelihood: **Unlikely**.	**Medium**
Unplanned Fire (**Section 9.3.8**)	Vehicle and plant exhausts. Sparks from contact of equipment with rock, grinding or welding. Cooking or camp fires and cigarettes. Deliberate ignition.	Threat to life. Damage to equipment and infrastructure. Alteration of flora and fauna habitats.	A **Fire Management Plan** will be developed for construction and operation (**Table 12-14**). 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 for each construction spread. All vehicles will be fitted with a fire extinguisher. Spark arrestors will be required for all earthmoving equipment. Cooking and camp fires will be prohibited. An **Emergency Response Plan** will be developed and implemented (**Section 13-4**). Operational personnel will be trained in emergency fire response and maintenance of firebreaks where necessary. Monitoring for weed establishment will occur for the duration of construction and operation. Weed eradication programmess will be implemented as required. Predicted Impacts: **Negative, Short term.** Consequence: **Minor**. Likelihood: **Highly Unlikely**.	**Low**
Planned Fire (**Section 9.3.8**)	Deliberate ignition of vegetation to reduce fire risk.	Alteration of habitat. Maintenance of ecosystem dynamics.	Fires will be lit along the pipeline route to minimise impacts of fires on the construction work force and equipment. Excess cleared vegetation which cannot be used in rehabilitation may need to be burnt on site. Planned fires will be lit by personnel skilled in lighting and managing fires. 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 (**Table 12-14**). Predicted Impacts: **Neutral, Short term**. Consequence: **Minor**. Likelihood: **Likely**.	**Medium**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Waste				
Non-Hazardous Solid Waste Stream (**Section 9.4.1**)	Generation and storage of general non-hazardous waste, including: ■ pipe off-cuts; ■ packaging materials; ■ metal; ■ waste tyres; ■ electrical offcuts; ■ domestic waste; ■ excess spoil from trenching and land clearing for above ground facilities.	Impact on visual amenity. Disturbance/ injury/ death of individual fauna. Generation of odours. Potential contamination of soils and groundwater. Impact on existing waste management facilities and associated capacity.	Landfill sites will be identified and consultation sought with regulatory authorities and landfill operators on existing capacity and their use by TTP. Pipeline construction will reuse material during pipeline backfilling activities. Waste management will be conducted in accordance with Northern Territory Government legislation, including: *Waste Management and Pollution Control Act, 1988* and the *NT Water Act 1992.* A **Waste Management Plan** will be developed by the BOO Consortium and approved by the appropriate regulatory body prior to construction activities commencing (**Table 12-2**). All construction crew will receive a site induction, which will include requirements for waste management procedures. The BOO Consortium will ensure that wastes are cleared from the construction corridor and above ground facility construction sites on a regular basis and separated and appropriately stored. Non-recyclable non hazardous wastes will be collected from the campsites and construction corridor and transported to the nearest licensed landfill site. Options to reuse any waste material (for example surplus soil, rock) will be evaluated before any waste is designated for disposal. Waste tyres will be stockpiled and disposed of at approved waste recycling facilities. Food waste at the construction camps will be segregated from other waste streams and disposed of at a licensed landfill facility. Any excess non reusable excavated soil will be stored within the construction corridor and only disposed of at licensed landfill facilities subject to approval. Accurately map the location of any newly approved waste disposal sites along the pipeline route and report these to relevant regulatory authorities and land owners. Cuttings and drilling mud displaced during HDD activities will be contained and disposed of in an approved manner as per the **Waste Management Plan** specifications (**Table 12-2**). Any excess non reusable excavated soil will be stored within the construction corridor and only disposed of at licensed landfill facilities, subject to approval. Predicted Impact: **Negative, Long term**. Consequence: **Minor**. Likelihood: **Highly Unlikely**.	**Low**
Non-Hazardous Liquid Waste Stream (**Section 9.4.2**)	Generation, storage and disposal of hydrotest water. Generation and storage of domestic wastewater (sewage and grey water), and stormwater.	Alteration of surface hydrological regimes resulting from uncontrolled discharge of grey water during the dry season construction period. Localised increases in erosion rates resulting from both continuous and intermittent discharges of surface water including hydrotest water. Contamination of surface and groundwater from untreated liquid waste disposal and potential impact on aquatic flora and fauna. Impacts on surface water quality and hydrological regimes from disposal of untreated hydrotest water, particularly in the vicinity of planned water crossing locations. Health considerations due to the presence of bacteria such as coliforms present in untreated sewage.	An inventory of all waste disposal volumes and types and disposal locations will be maintained as part of the **Waste Management Plan** (**Table 12-2**). Site drainage will ensure that contaminated stormwater and clean stormwater are separated. **Groundwater and Surface Water Protection Management Plan** will be developed and implemented (**Table 12-16**). An **Erosion and Sediment Control Management Plan** will be developed and implemented (**Table 12-15**). Sewage systems will be approved by the relevant regulatory authority prior to construction, and will comply will all relevant standards and legislation. Prior to commissioning activities, a **Hydrotest Management Plan** (**Table 12-8**) will be developed to provide details on the source of the water, chemicals and concentrations to be used water minimisation options and discharge locations, options and discharge rates. The **Hydrotest Management Plan** will be submitted to regulatory authorities for review and approval prior to implementation (**Table 12-8**). Emphasis will be placed on selecting chemicals with low potential for environmental harm and carefully determine the levels or concentrations required. Hydrotest water will be disposed in accordance with AS 2885.5. Reusing hydrotest water along various pipeline sections to reduce the volume of water to be sourced and disposed. Testing hydrotest water quality prior to discharge. Predicted Impact: **Negative, Long term**. Consequence: **Slight**. Likelihood: **Likely**.	**Low**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Hazardous Solid and Liquid Waste (**Section 9.4.3**)	Generation and storage of hazardous waste including: ■ waste oils from vehicles, construction machinery and construction camps; ■ accidental fuel spills from vehicle and equipment fuelling operations; ■ explosives; ■ acids (for example spent car batteries); ■ medical waste; ■ radiography or cleaning chemicals.	Contamination of soils, surface and groundwater and vegetation from accidental spills. Impact on existing licensed hazardous waste handling facilities from increased waste volumes generated from the TTP. Acute and chronic toxicity and bio-accumulation of hazardous materials resulting from contaminated water discharge into sensitive flora and fauna habitats. Potential fire hazard (flammable or explosive hazards).	A **Waste Management Plan** will be developed and implemented (**Table 12-3**). A **Spill Contingency Plan** will be developed and implemented (**Table 12-19**). Hazardous waste storage areas and handling equipment will be segregated, bunded and kept in good order and designed in such a way as to prevent and contain spills as far as practicable. Approvals and permits will be obtained for disposal of hazardous waste at licensed facilities. Non-hazardous chemicals that serve the same purpose and are as cost-effective will be given preference. Fuel storage areas will be bunded and stored in accordance with AS 1940-1993 – 'The Storage and Handling of Combustible and Flammable Liquids'. Minimising the use of hazardous chemicals to the absolute minimum required. Predicted Impact: **Negative, Long term** Consequence: **Minor**. Likelihood: **Highly Unlikely**.	**Low**
Chemical or Hydrocarbon Spills (**Section 9.4.4**)	Generation and storage of hazardous liquids including hazardous chemicals and fuels. Transport or refuelling accidents, poor packaging, rupturing of tanks, improper handling or use of construction materials and accidents.	Soil, surface and groundwater contamination. Aquatic and terrestrial habitat destruction/ modification. Air emissions.	Minimising chemical use to absolute minimum required. Laydown areas will be used for the storage of hazardous materials and equipment. A **Waste Management Plan** will be developed and implemented (**Table 12-2**). A **Spill Contingency Plan** will be developed and implemented (**Table 12-19**). Vehicles will be equipped with spill response kits. All hazardous materials will be handled and stored in accordance with the corresponding Materials Safety Data Sheets (MSDS). Each construction site will have emergency spill response equipment and an Emergency Response Plan to deal with accidental spills. Appropriate spill kits and PPE 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. Vehicles and all main crew will be equipped with spill response kits. Spill equipment will be available at watercourse crossings and will include floating booms for containment and retrieval using suction trucks. **Small Spill** (for example during refuelling: litres (tens)) Predicted Impact: **Negative, Short term**. Consequence: **Minor**. Likelihood: **Likely**. **Large Spill** (for example road tanker over-turn: spillage of 20,000 litres of fuel) Predicted Impact: **Negative, Short term**. Consequence: **Moderate**. Likelihood: **Remote**.	**Low** (large spill) **Medium** (small spill)
Atmospheric Emissions				
Atmospheric Emissions and Pollutants (**Section 9.4.5.1**)	Combustion of fuels (including power generation equipment). Fugitive emissions of Non-methane volatile organic compounds (NMVOCs). Burning of vegetation and waste.	Local air quality deterioration.	The pipeline route has been selected to avoid residential areas and will be constructed in a remote area and there are no other industries around. Construction will be for a short duration. Volumes of gaseous emissions during operation are anticipated to be minimal. The release of gas from the pipeline will be minimised for economic and environmental reasons. Periodic leak surveys will be conducted to detect fugitive gas releases from the pipeline as required by AS 2885.3. A **Gas Venting Management Plan** will be developed and implemented. Predicted Impact: **Negative, Long term**. Consequence: **Slight**. Likelihood: **Highly Unlikely**.	**Low**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Greenhouse Gases (**Section 9.4.5.2**)	Combustion of fuel (primarily diesel) in engines of vehicles and generators associated with the project. Gas leaks, failures and cleaning operations (pigging). Burning of gas as fuel in compressor and heaters during operation. Gas venting during operation and maintenance.	Contribution to global warming from release of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).	A **Greenhouse Gas Emissions Management Plan** will be developed and implemented (**Table 12-4**). Diesel engines in the trucks and plant-laying equipment will be maintained to prevent excessive exhaust emissions. Measures will be implemented in the **Traffic Management Plan** to ensure that transportation options are used in the most efficient manner possible (**Table 12-7**). To minimise vehicle movements, four wheel drive (4WD) vehicles will be used such as troop carriers and utes, and multiple passenger vehicles (for example mini buses and troop carriers) will be encouraged. Double trailers will be used to minimise the number of truck movements, where regulations and access track or construction corridor conditions permit. During gas venting the nearest Scraper Station or main line valve will be closed and venting will be controlled manually. Trained blowdown crews will be dispatched from the nearest maintenance facility and in conjunction with operations personnel will perform this work. Volume of gas vented will be minimised to reduce risks associated with venting. Early detection of gas release, minimising the volumes of gas vented where possible. Pressures in the line will be allowed to decline prior to venting, to reduce the volume of gas released to the atmosphere. Predicted Impact: **N/A**. Consequence: **N/A**. Likelihood: **N/A**.	**N/A**
Dust Emissions (**Section 9.4.5.3**)	Trucks transporting material and workforce to the construction corridor along access roads, trenching, backfill and padding operations earth moving activities, and open stockpiles. Dust may be generated during some inspection and maintenance activities.	Potential impacts include: ▪ Impact on vegetation and amenity. ▪ Loss of topsoil. ▪ Local air quality deterioration.	Minimise the extent of exposed surfaces and the periods that these areas are exposed. Dust suppression techniques and watering all unsealed roads and access tracks, as required. Stringent controls on vehicle speeds will be applied through development of a **Traffic Management Plan** and by restricting travel to designated roads during construction (**Table 12-7**). A **Rehabilitation Management Plan** will be developed and implemented (**Table 12-13**) Early rehabilitation of the construction corridor will be encouraged to assist in soil stabilisation. A **Dust Management Plan** will be developed and implemented prior to construction activities (**Table 12-5**). Exposed surfaces such as stockpiles and cleared areas will be kept to a minimum. During the site induction the workforce will be informed of dust generation and control measure requirements. Predicted Impact: **Negative, Short term**. Consequence: **Minor**. Likelihood: **Likely**.	**Medium**

Hazard	Source	Potential Impact	Preventative and Management Measures	Risk Level
Noise Emissions (**Section 9.5**)	Construction vehicles operating along the construction corridor including bulldozers, loaders, grazers, tractors, excavators and trenching and padding machines. Fuel tankers and trucks transporting pipe sections from the laydown area along the construction corridor and associated access roads. Rock blasting and rock sawing along the pipeline construction corridor during construction. Commissioning of the compressor station during start-up activities. Hydrotesting pipe sections at night-time.	Disturbance to fauna. Disturbance to residences.	The proposed TTP route avoids noise sensitive receptors as far as practicable. Construction equipment will be equipped with appropriate noise abatement devices and noisy equipment will be located at appropriate distances from residences. In the event that proposed access routes pass close to residential receptors, the TTP project is committed to carrying out further noise assessment and the identification of additional management measures. These measures will be incorporated into the Noise Management Plan. A **Noise Management Plan** will be developed and implemented (**Table 12-6**). Construction activities will be limited to daytime hours as far as practicable, which will reduce potential impacts to sensitive receptors in the vicinity of construction activities. Exhaust silencers will be used on the gas turbine located at compressor stations along the pipeline. Compressors will be located within enclosures to lower the noise levels. Noise levels at the boundary of the compressor station will be within the limits specified under the relevant legislation. In the event that hydrotesting is required, nearby residents will be informed 48 hours prior to commencement. Nearby residents will be notified of construction activities in advance. Nearby residents will be notified of in advance of the planned maintenance activities during operation. If sensitive receptors are identified in the vicinity of Katherine construction camp, silencing of generator plant will be undertaken. Noise levels at the boundary of the compressor station will be within the limits specified under the relevant legislation. A **Blasting Management Plan** will be developed and implemented. A **Traffic Management Plan** will be developed to control vehicle operations and potential impacts on human receptors (**Table 12-7**). Truck movements along the Construction corridor, access tracks and main roads will take place during daylight hours, where possible. Predicted Impact: **Negative, Short term** Consequence: **Slight** Likelihood: **Likely**	**Low**
Vibration and Blasting (**Section 9.6**)	HDD under significant watercourses, roads and railways. Blasting activities associated with pipeline trenching through hard rock between KP80 and KP100 as well as KP760 and KP780. Sourcing of material from borrow pits or quarries if required. Operation of heavy vehicles and machinery during construction phase.	Direct disturbance to local residences and fauna.	The nearest residential receptor to proposed blasting activities is located approximately 9 km away. A **Blasting Management Plan** will be developed and implemented. Blasting will be carried out in accordance with AS2187.2. Measures to mitigate impacts from blasting activities will include increasing the depth of material cover, increased spacings between charge and reducing the size of charge detonated per event. Equipment will have silencers where feasible and practical to do so. Timing of specific operations as far as practicable. Predicted Impact: **Negative, Temporary** Consequence: **Slight**. Likelihood: **Highly Unlikely**.	**Low**

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